



HADI – iBoard Pro

Operation Manual

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1. Introduction

1.1. Introduction

HADI v.3 is a Template-based inspection software.
You can use HADI v.3 as Automated BGA Detection and Automated Void Inspection software.

It supports the following inspection features:

	Inspection Functions	Support
1	Template Management	YES
2	Automated BGA Detection	YES
3	Automated Void Inspection	YES
4	Inline Void Inspection	YES
5	Inline PCB Inspection	NO
6	Batch Processing Simulation	YES

Check for more information: [products comparison](#).

1.2. Basic Features

- Support various image formats to load and save. (GIF, BMP, JPG, TIF, TIFF, PNG, etc.)
- Support to load and save the image/scene.
- Support 16-bit images and Window/Level adjustment.
- Support image calibration.
- Support image histogram and profile.
- Support multiple languages. (Korean, English, Japanese and Chinese)
- Support up to 25 measurement tools.
- Support up to 14 images filters.
- Support command line invoke with various parameters.
- Advanced template management.
- Powerful reporting and printing functions.
- Support windows explorer integration.

1.3.HADI Products Comparison

Functions	HADI Inspection	HADI BGA	HADI Inspection Pro	HADI iBoard	HADI iBoard Pro
Image Import / Ex- port	√	√	√	√	√
Scene Import / Export	√	√	√	√	√
Print Images	√	√	√	√	√
Image / Screen Cap- ture	√	√	√	√	√
Multiple Language Support	√	√	√	√	√
Measurement Tools	√	√	√	√	√
Image Filters	√	√	√	√	√
Image Calibration	√	√	√	√	√
Histogram and Pro- file	√	√	√	√	√
Multiple Image Display	√	√	√	√	√
16-bit image support	√	√	√	√	√
Image Conversion	√	√	√	√	√
Image Alignment	√	√	√	√	√
Command Line Support	√	√	√	√	√
Void Inspection	√	√	√		√
BGA Detection		√	√	√	√
Batch Processing Simulation			√	√	√
UDP Communication Support			√	√	√
PCB Inspection				√	√

1.4. System Requirements

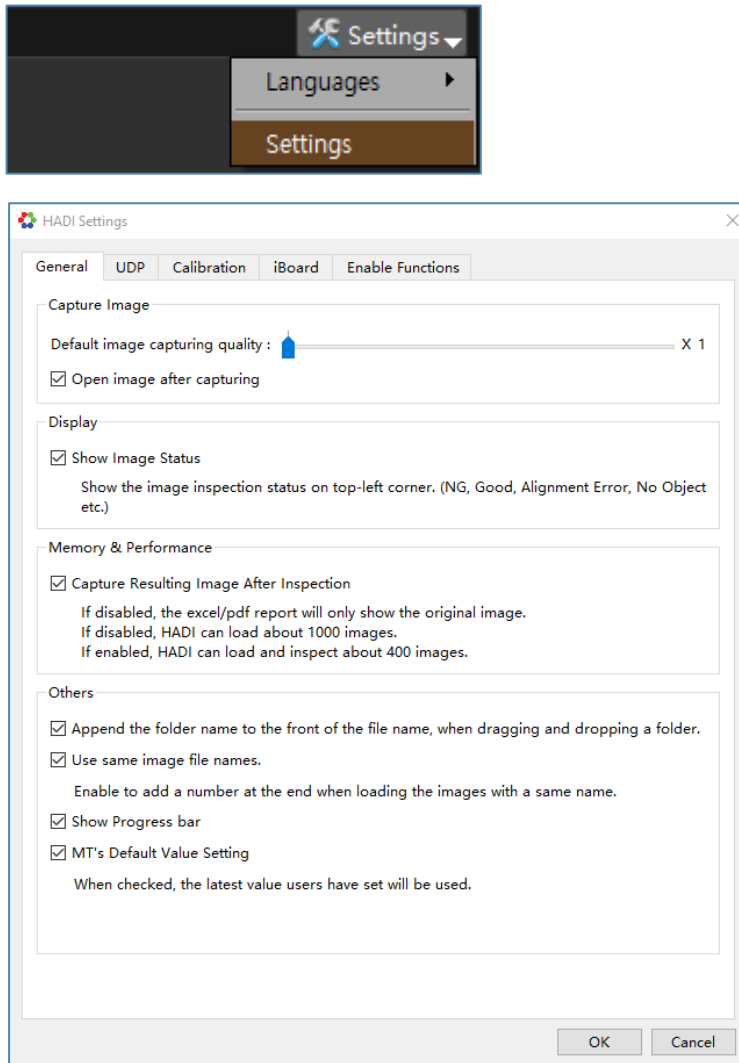
	Minimum	Recommended	Inline Inspection ^{*1}
OS	Windows 7 Windows 10 Pro	Windows 7 Windows 10 Pro	Windows 7 (64-bit) Windows 10 Pro (64-bit)
HDD	20GB	200GB	500GB or higher
SSD	None	128GB	128GB or higher
CPU	Intel i5	Intel i7	Intel i7 3.40 GHz or Higher
RAM	2 GB	4 GB	8 GB
GPU	none	extra GPU required	extra GPU required
Display Resolution	1920 x 1080	1920 x 1080	1920 x 1080
3 rd party applications	None	Microsoft Excel PDF Reader	Microsoft Excel PDF Reader
Network	None	required	required

^{*1}) Only for HADI-InspectionPro, HADI-iBoard, HADI-iBoardPro

2. HADI v.3 Settings

2.1. Global Settings - General

Click on top-right menu "Settings" -> "Settings" -> "General".



Capture Image

Default image capturing quality

Set the image capturing quality.

For example, "X3" means the captured image resolution is $3 \times 3 = 9$ times of original resolution.

Higher quality image capturing takes more time.

Open Image After Capturing

Open the captured image after capturing.

Display

Show Image Status

Show or hide the image status that appears on the top-left corner of main view.



Memory & Performance

Capture Resulting Image After Inspection

Set whether to capture the resulting image or not.
See the link "Improve Performance" for more information.

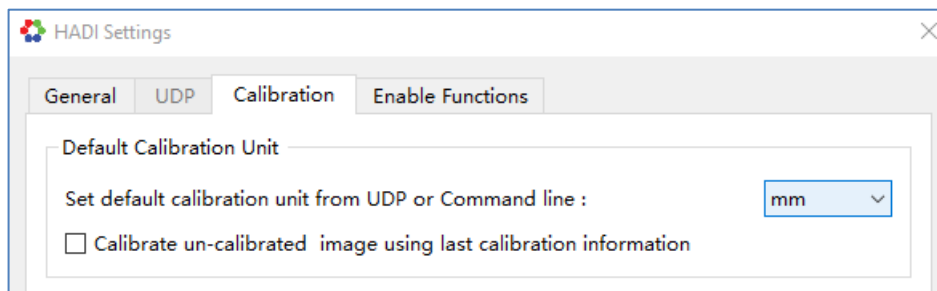
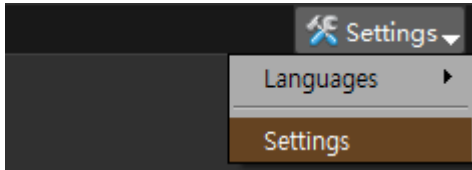
[Clear All] function

[Clear All] Function

If you set this option, the [Clear All] button will also clear the inspection result of the image.

2.2.Global Settings - Calibration

Click on top-right menu "Settings" -> "Settings" -> "Calibration".



Calibrate un-calibrated image using last calibration information

If you set this option, the last used calibration information will be used for calibration.

Default Calibration Unit

In UDP mode, you can send the UDP command for calibration from other application to HADI. It will be applied to the calibration setting of HADI. The default unit is millimeter. You can change the default unit using the unit combo box. Please see the following example for more information:

For example:

Suppose that you send the UDP (calibration) command "**image_name; 1.5**" to HADI.

- "1.5" means "1 pixel = 1.5 millimeter". (Default unit = millimeter)
- If you change the default unit from "millimeter" to "**centimeter**", then "1.5" means "1 pixel = 1.5 **centimeter**"

2.3.Template-based Inspection

All HADI products support Template-based inspection.

Template Saves

The purpose to use template is to

- save all parameters of the image or the Measurement Tools.
- save the image alignment information.
- apply all saved parameters and Measurement Tools to a new image (to be inspected).

Template Auto Saving

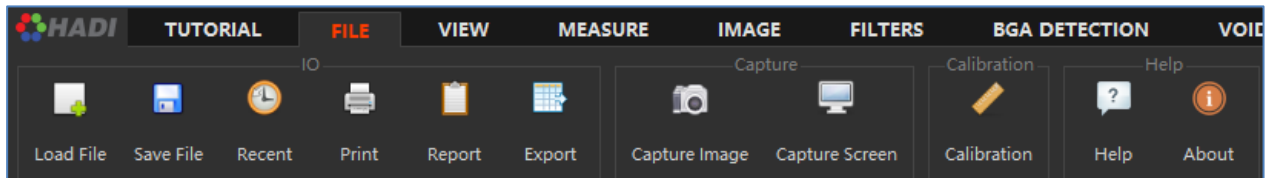
In a Template, all changes will be saved automatically, including

- Measurement Tool changes.
- Window/Level changes (for 16-bit image).
- Void Inspection parameter changes.
- BGA Detection parameter changes.
- PCB Inspection parameter changes.

3. Toolbars

3.1. Toolbar - FILE

Click on the "FILE" tab to display the following toolbar:

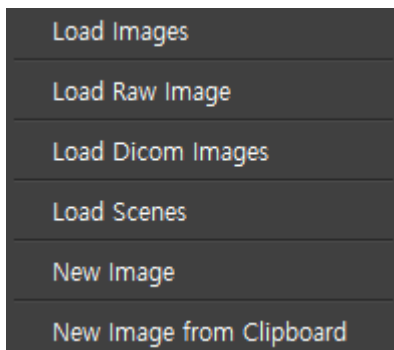


IO

Load File

You can load image files into HADI v.3 using several ways.

HADI v.3 maintains the path to the last used folder for images and scenes.



- **Load Images**

Load images such as PNG, XPM, JPG, BMP, GIF, TIF and TIFF.

- **Load Raw Image:**

Load a RAW format Images.

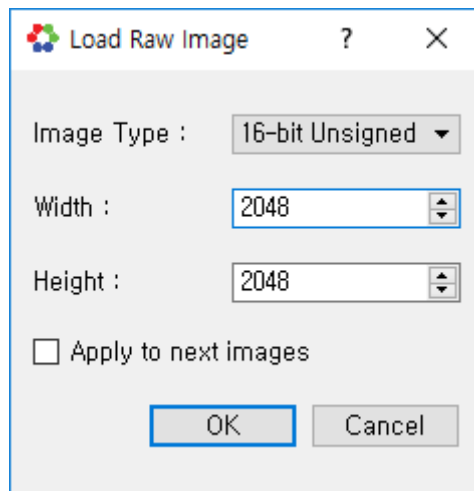
The following parameters will be shown in the next dialog window:

Image Type: specify image types.

Width: specify image width.

Height: specify image height.

Apply to next images: If you check this option, all the above parameters apply to the next image when loading multiple raw images.



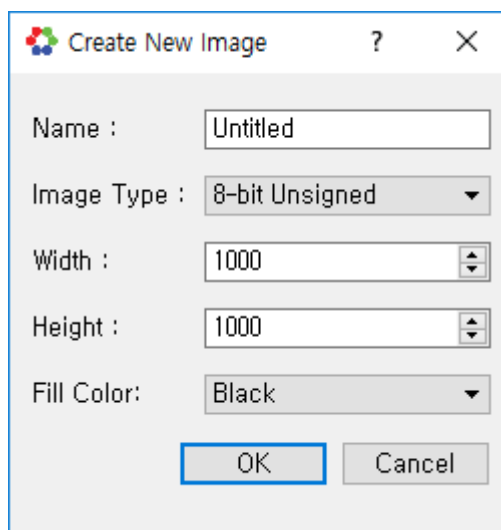
- **Load Scenes:**

Load a scene file.

You can save current scene as a XML file, and load it using this menu.

- **New Image**

Create a new image with the specified parameters.

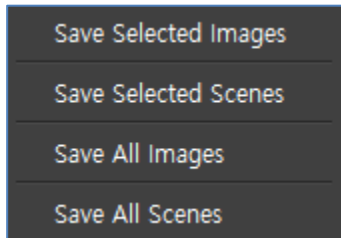


- **New Image from Clipboard**

Create a new image from Clipboard.

Save File

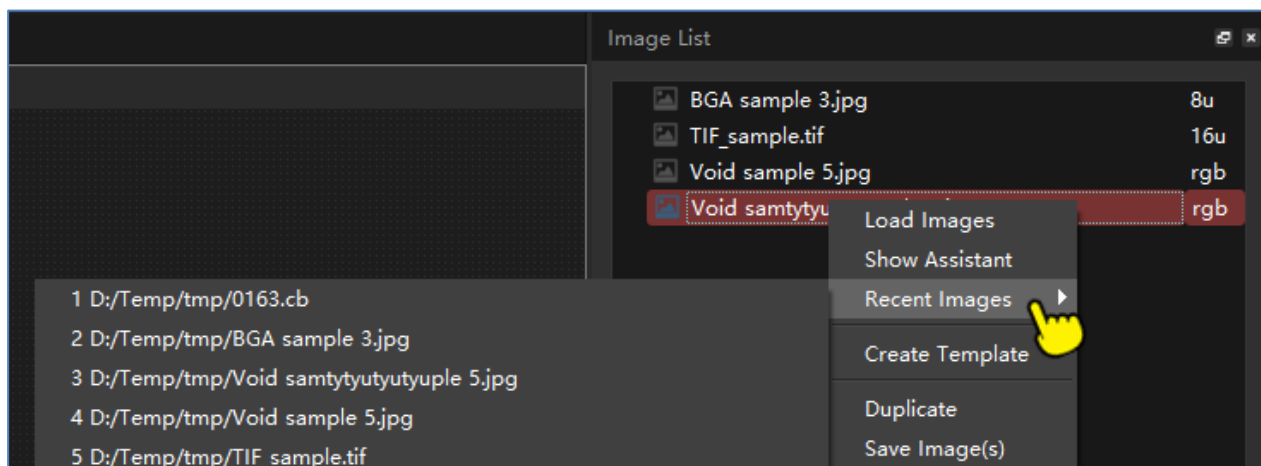
You can save images and scenes as files.



- **Save Selected Images**
Save selected Images in the image list panel.
- **Save Selected Scenes**
Save the selected images in the image list panel as scenes.
- **Save All Images**
Save all Images in the image list panel.
- **Save All Scenes**
Save all images in the image list panel as scenes.

Recent

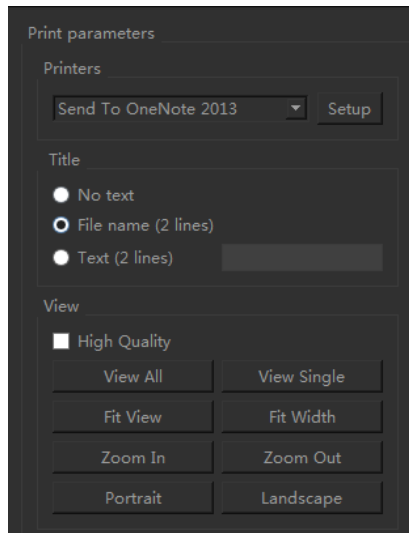
Displays recently used images and folders.



Print

Print the selected images.

You can insert the title of the image and print it in high quality.



Print parameters

Printers

Send To OneNote 2013 Setup

Title

☐ No text

☐ File name (2 lines)

☐ Text (2 lines)

View

☐ High Quality

View All View Single

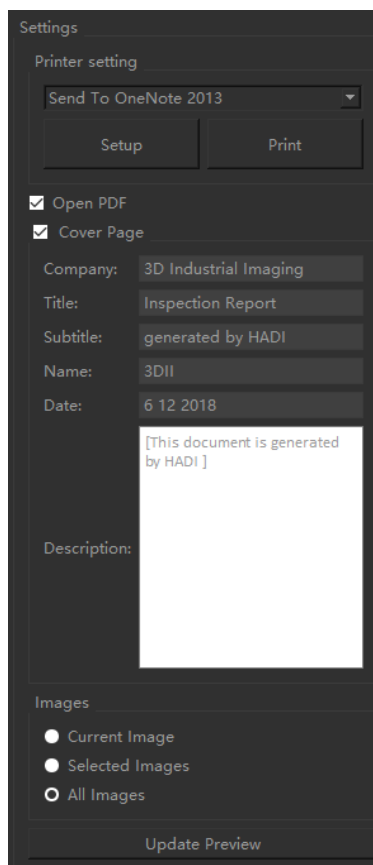
Fit View Fit Width

Zoom In Zoom Out

Portrait Landscape

Report

Generate a report for selected images.



Settings

Printer setting

Send To OneNote 2013

Setup Print

☒ Open PDF

☒ Cover Page

Company: 3D Industrial Imaging

Title: Inspection Report

Subtitle: generated by HADI

Name: 3DII

Date: 6 12 2018

[This document is generated by HADI]

Description:

Images

☐ Current Image

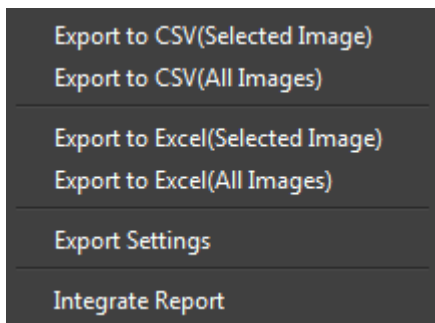
☐ Selected Images

☐ All Images

Update Preview

Export

Export information from images to a CSV or Excel file.



- **Export to CSV(Selected Image)**
Export the information of selected images to CSV file.
- **Export to CSV(All Images)**
Export the information of all images to CSV file.
- **Export to Excel(Selected Image)**
Export the information of selected images to MS-Excel file.
- **Export to Excel(All Images)**
Export the information of all images to MS-Excel file.
- **Export Settings**
See "Export Settings" in "MT Info" dock panel.
- **Integrate Report**
Display the report integrator dialog window.
- **Load**
Load the Excel files to integrate.
- **Save**
Integrate the loaded Excel files into one file.
- **Up**
Move up the selected rows in the file list.
- **Down**
Move down the selected rows in the file list.
- **Remove**
Remove selected files.
- **Clear**
Remove all files.

Capture

Capture Image

It saves the current image displayed in the view window.

- Click "Capture Image" in the Capture panel.
- Click the camera icon  on the top-left corner of any view.

You can also capture high-quality images.

Go to "Settings" -> "General" -> "Capture Image" to adjust the default image quality.

Capture Screen

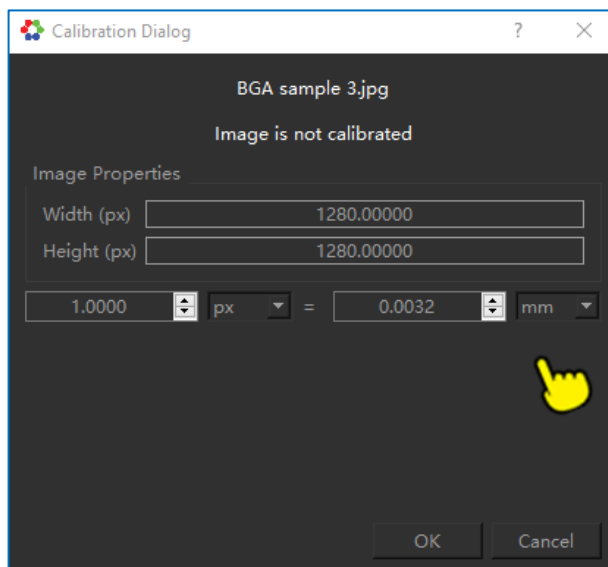
It captures the whole or part of the screen.

You can save the captured image or copy the captured image to the clipboard or HADI v.3.

Calibration

You can calibrate the pixel unit to the actual unit.

See "Image Calibration" for more information.



Help

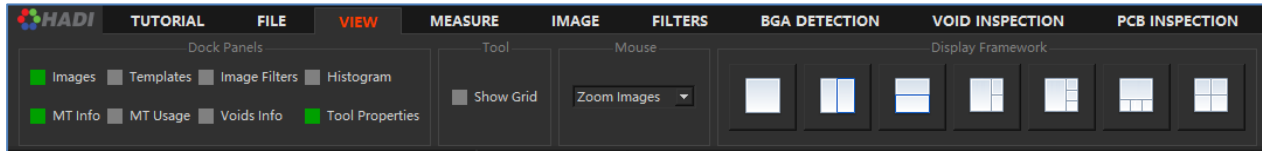
Open the operation manual.

About

Show the information such as product version, download link, etc.

3.2.Toolbar - VIEW

Click on the "VIEW" tab to display the following toolbar:



Dock Panels

Images

Shows or hides Images dock panel.

Templates

Shows or hides Templates dock panel.

Image Filters

Shows or hides Image Filters dock panel.

Histogram

Shows or hides Histogram dock panel.

MT Info

Shows or hides MT Info dock panel.

MT Usage

Shows or hides MT Usage dock panel.

Voids Info

Shows or hides Void Info dock panel.

Tool Properties

Shows or hides Tool Properties dock panel.

Tool

Show Grid

Shows or hides a grid on the image.

Mouse

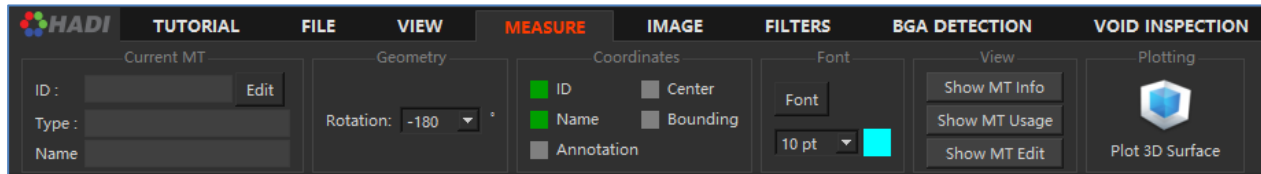
Set the function of the mouse wheel: "Zoom Images" or "Switch Images".

Display Framework

Set the display framework in the main workspace.

3.3.Toolbar - MEASURE

Click on the "MEASURE" tab to display the following toolbar:



[Note]: All the parameters apply to the selected Measurement Tools

Current MT

ID

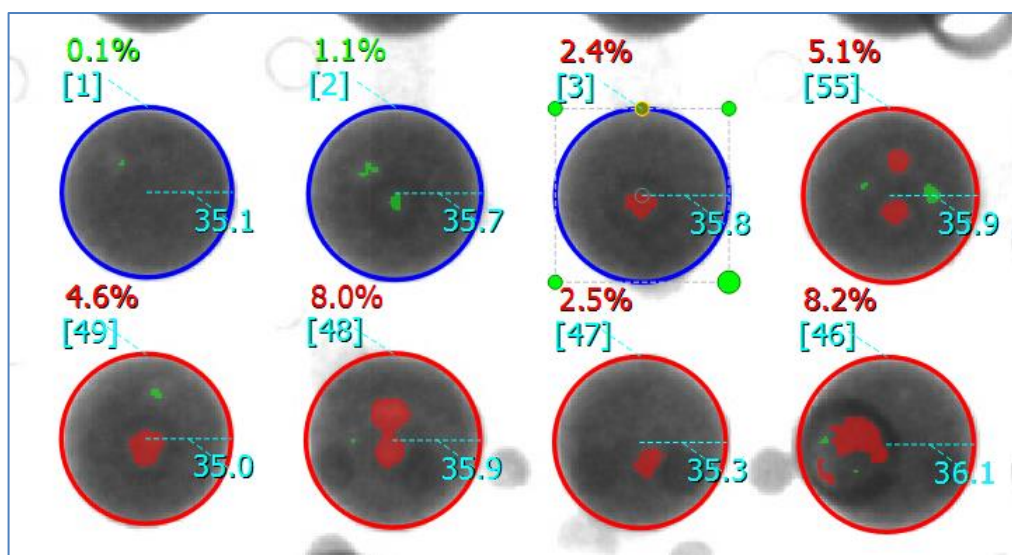
Identification (ID) of the selected Measurement Tool (Hereinafter referred to as "MT").

Edit

You can change the ID of Measurement Tools.

1. Select a MT in the active view.
2. Click "Edit" button, then the MT color changes to red.
3. Click MT in the order in which you want to reassign the ID number. The IDs are reassigned sequentially from 1. The MTs that have been assigned are displayed in blue.
4. Once you have clicked on all MTs, the editing will automatically end.

To finish editing on the way, click the "Finish" button to finish editing.



Type

The type of MT you have selected, such as lines, rectangles, circles, polygons, and so on.

Name

The name of MT you have selected.

The default value is empty. Type a name and press "Enter" key.

Geometry

Rotation

The rotation angle to rotate the MTs you have selected.

You can select multiple MTs and rotate them simultaneously.

The range of angle: -180° (counterclockwise) $\sim 180^{\circ}$ (clockwise).

Coordinates

Set to show or hide the coordinate information and label of the selected MT.

ID

Set to show or hide the ID of the selected MT.

Name

Set to show or hide the name of the selected MT.

Annotation

Set to show or hide the default annotation of the selected MT.

Center

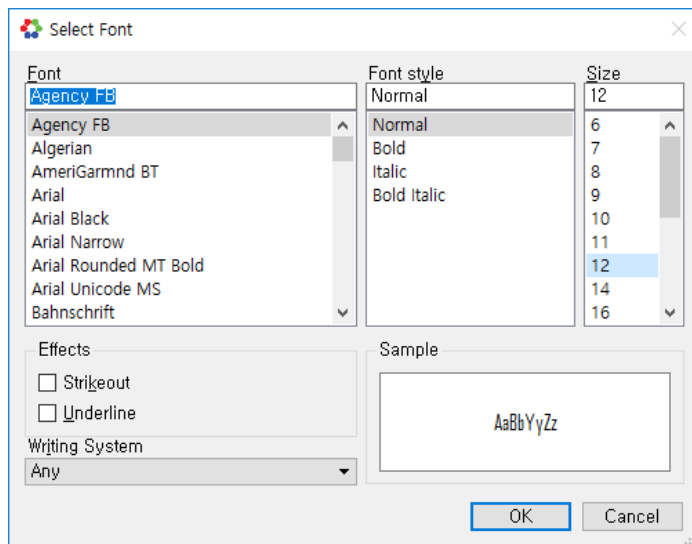
Set to show or hide the center coordinates of the selected MT.

Bounding

Set to show or hide the vertex coordinates of the selected MT.

Font

You can set the font type, size, and color for the selected MT.



View

Show MT Info

Show Measurement Tool Info dock panel.

Show MT Usage

Show Measurement Tool Usage dock panel.

Show MT Edit

Show Measurement Tool Edit dock panel.

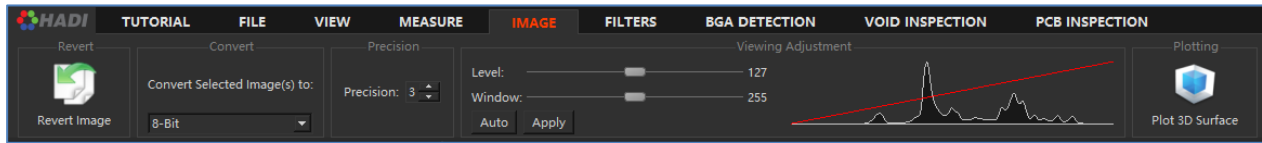
Plotting

Plot 3D Surface

Display the 3D plotting window of the selected closed-shape Measurement Tools.

3.4.Toolbar - IMAGE

Click on the "IMAGE" tab to display the following toolbar:



Revert

Revert Image

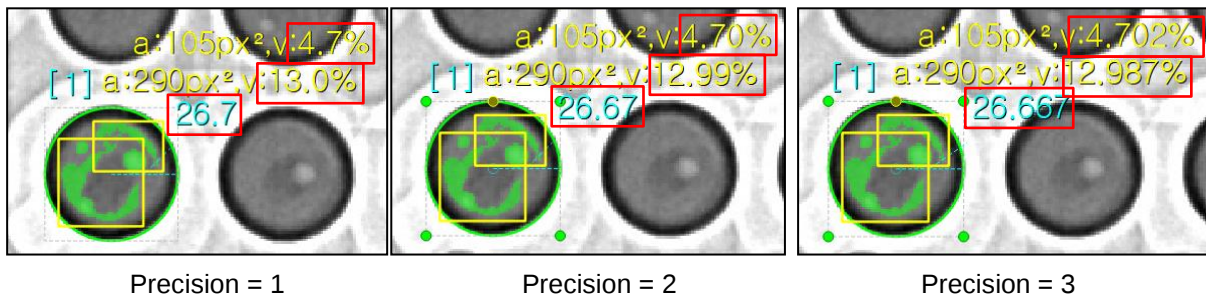
Reload the image from the original file and all changes are discarded.

Convert

Same as Conversion filter. You can use this to convert images to 8-bit, 16-bit, or RGB.

Precision

You can set the number of decimal places for the selected MT.



Viewing Adjustment

Level

Adjust the view level of the current image.

Window

Adjust the viewing window of the current image.

Auto

Automatically adjust the level and window of the current image.

Apply

Apply the current value of level and window to the current image.

Histogram

Display the histogram of the current image.

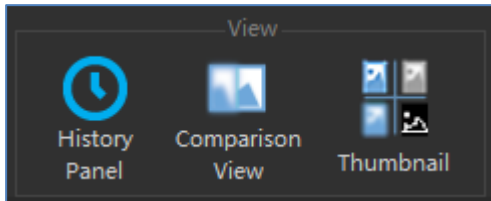
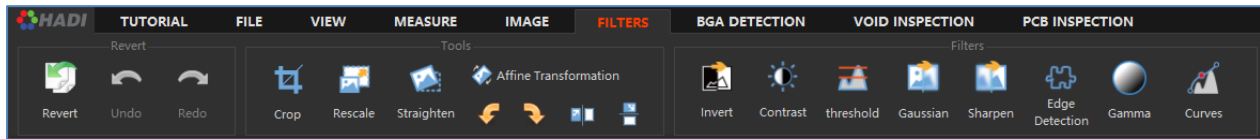
Plotting

Plot 3D Surface

Display the 3D plotting image of the current image.

3.5.Toolbar - FILTERS

Click on the "FILTERS" tab to display the following toolbar:



Revert

Revert

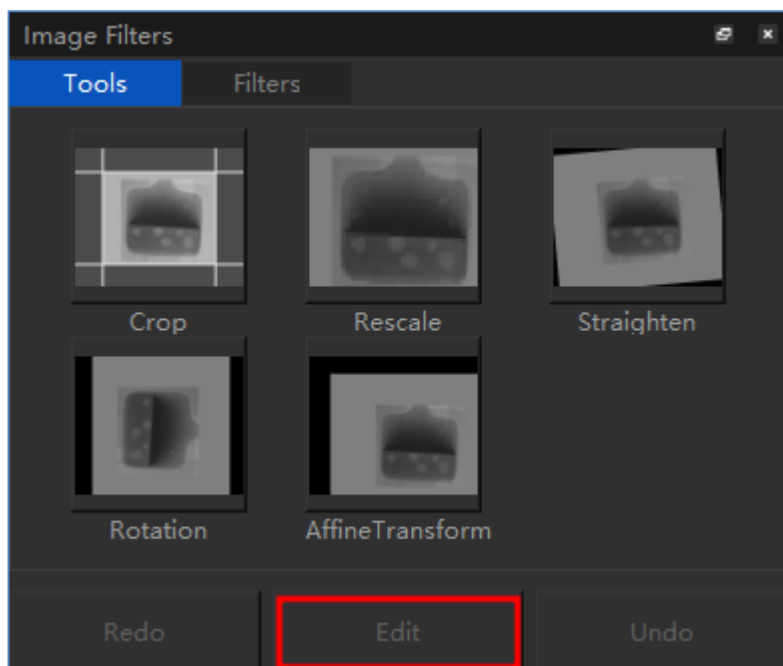
Reload the image from the original file and all changes (Undo/Redo history) are discarded.

Undo

Undo and revert the previous user action.

Redo

Run the previous undo operation again.



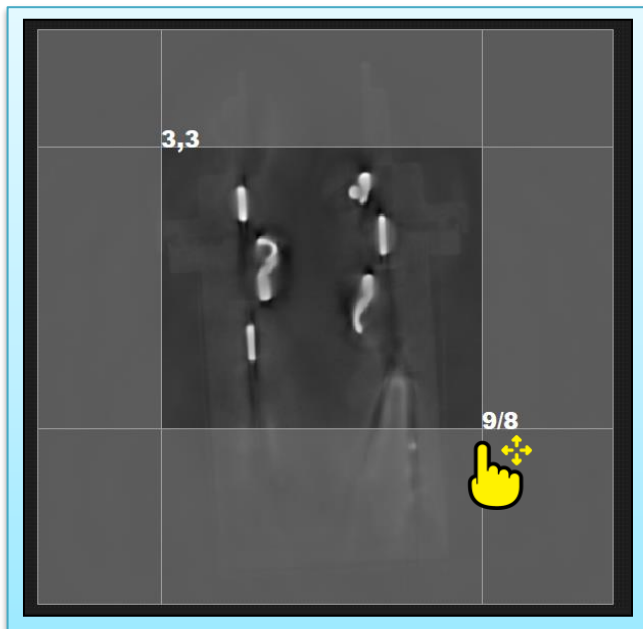
Edit

Edit previous user action.

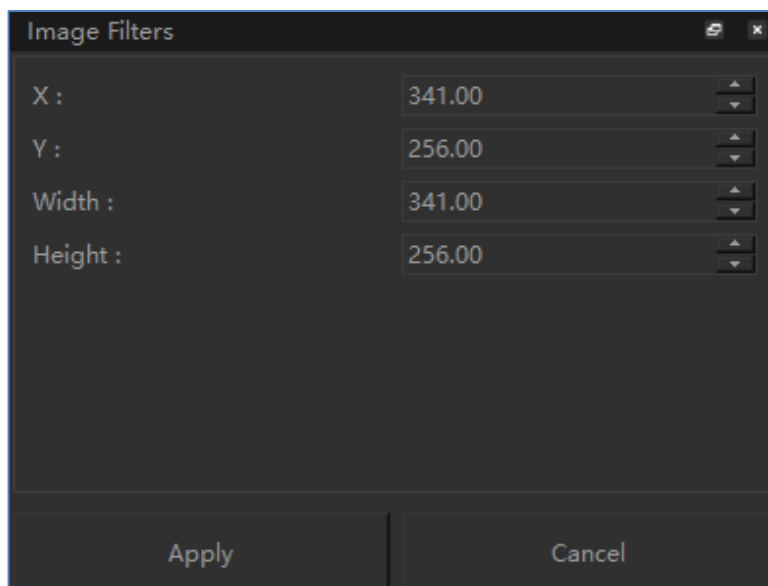
Tool

Crop

This tool crops the image.



You can crop the image using the mouse drag or by entering coordinate values, width, and height.



- You can set a new top-left position by clicking around the current top-left position.
- You can set a new bottom-right position by clicking around the current bottom-right position.

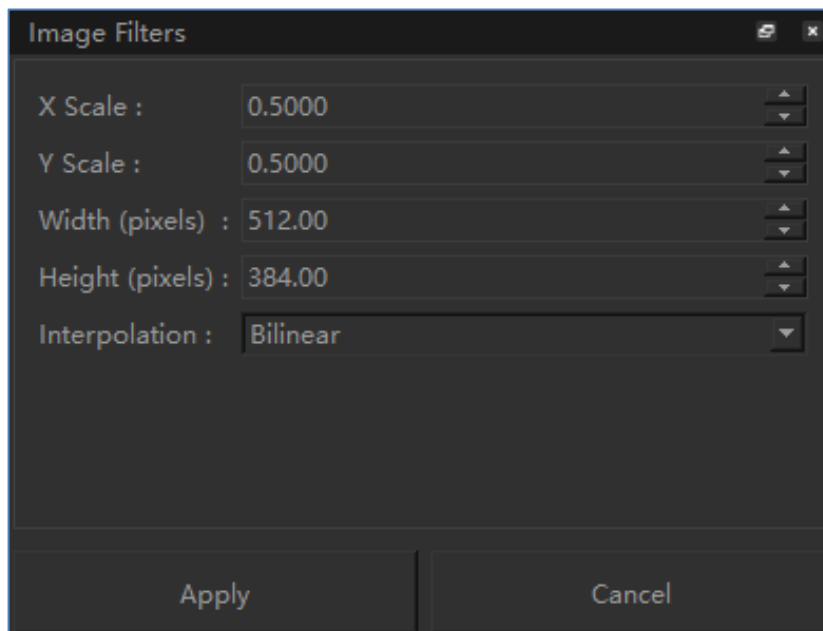
Rescale

This tool rescales the image.



The rectangle area shows the preview image when rescaled.

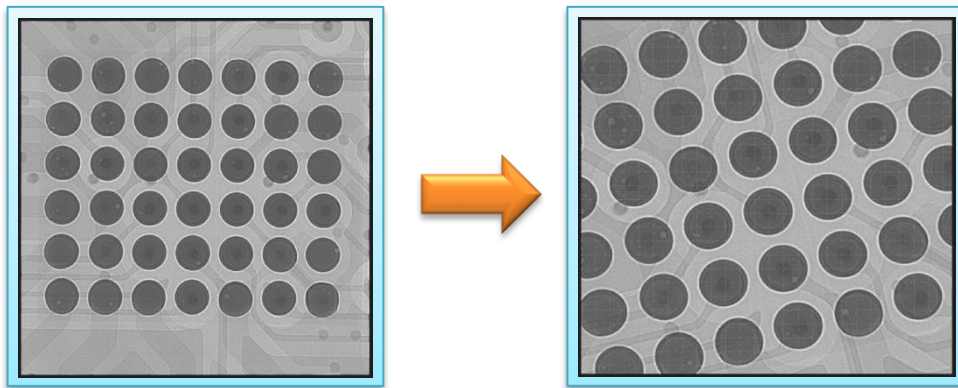
- You can rescale the image using the mouse at the hover points.
- You can rescale the image by entering scale ratio, width, height, and interpolation.



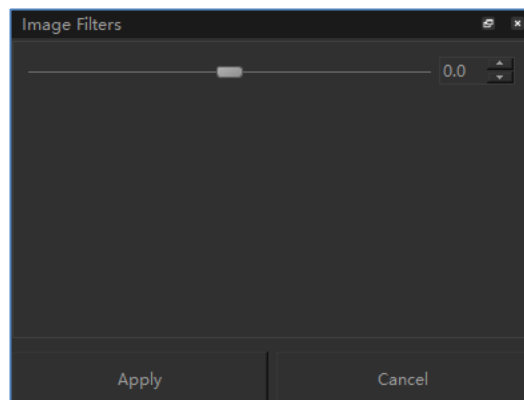
Adjustment

Straighten: the rotation and scale change slightly.

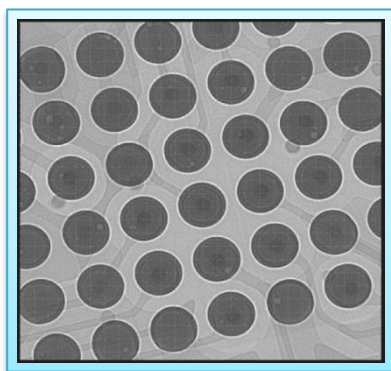
This function slightly changes the rotation and scale of the image.



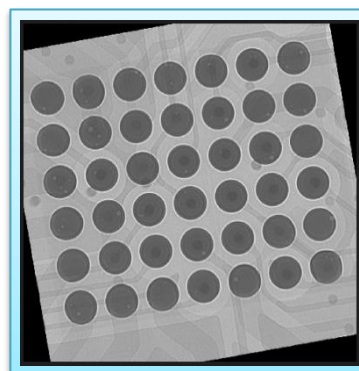
- You can use the weight parameter to straighten the image.



The difference between "Rotation" and "Straighten" is that "Straighten" rotates the image and slightly rescale it to avoid the black border area.



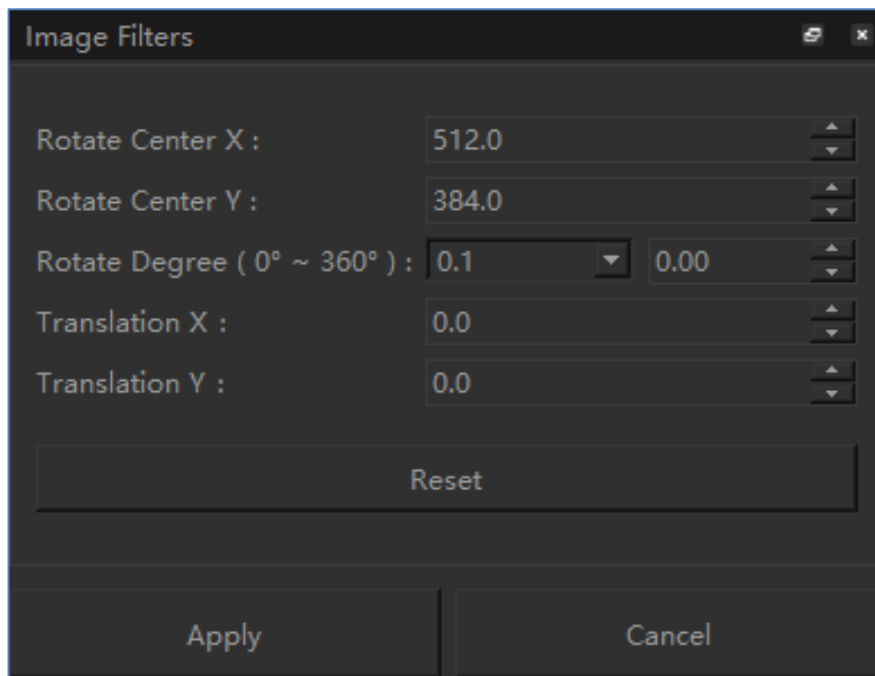
Straighten



Rotation

Affine Transformation

You can use several parameters for “Affine Transformation” as shown below:

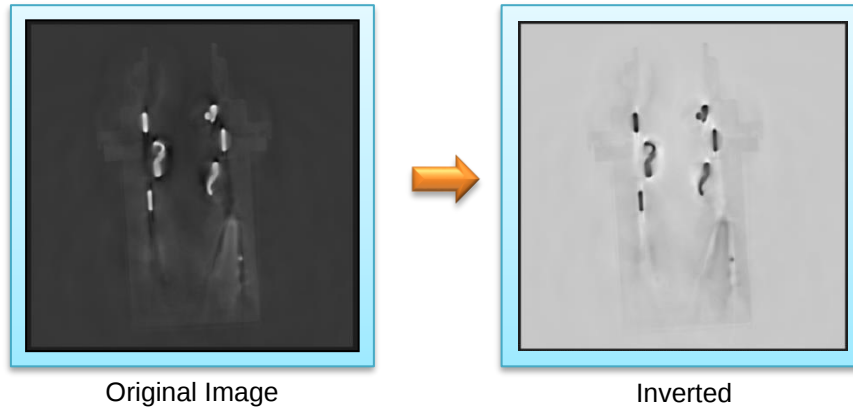


- You can rotate the image 90 ° clockwise or counterclockwise.
- You can define the axis of rotation by adjusting the “Rotate Center X” and “Rotate Center Y”.
- You can rotate the image by setting the “Rotate Degree”.
- You can zoom in and out the image by adjusting the “Image Scale”.
- You can use "Translation X" and "Translation Y" to move the image in the x or y direction for a specified number of pixels.

Filters

Invert

This filter inverts the current image.

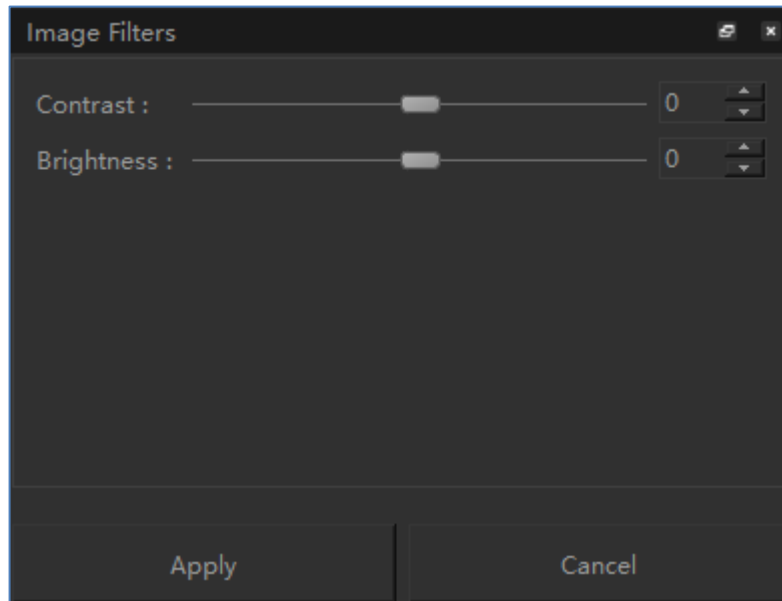


Contrast

Auto Contrast: automatically adjust the contrast and brightness of the current image.

Contrast: adjust the contrast of the current image.

Brightness: adjust the brightness of the current image.



Threshold

This filter applies the threshold to the current image.

The "Threshold value" adjusts the pixel value of the current image by converting the value to a black or white value. Pixel values smaller than "Threshold value" are changed to 0 (=black).

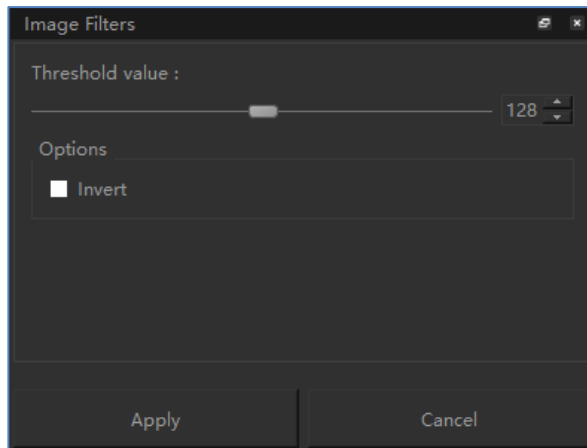
The "Thresholded value" is used together with the "Binary" option (checked):

- If the pixel value is smaller than "Threshold value", the pixel value will be changed to 0 (black).
- If the pixel value is larger than "Threshold value", the pixel value will be changed to "Thresholded value".

"Binary": This changes the current image to binary image (black and white).

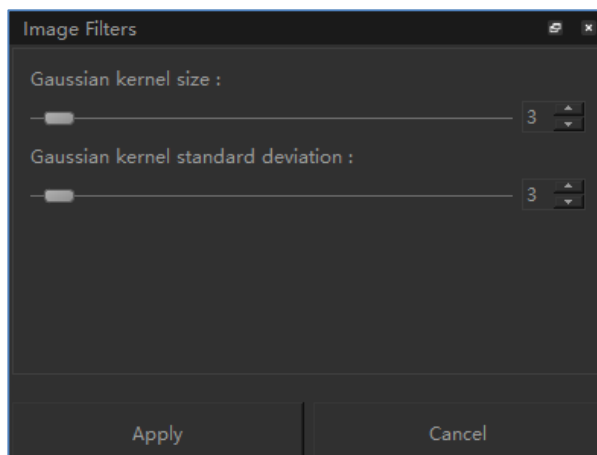
This is used together with the "Thresholded value".

"Invert": Inverts the current image.



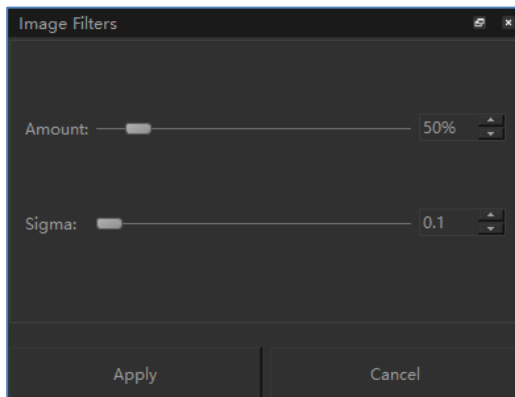
Gaussian

Use the Gaussian filter to blur the current image.



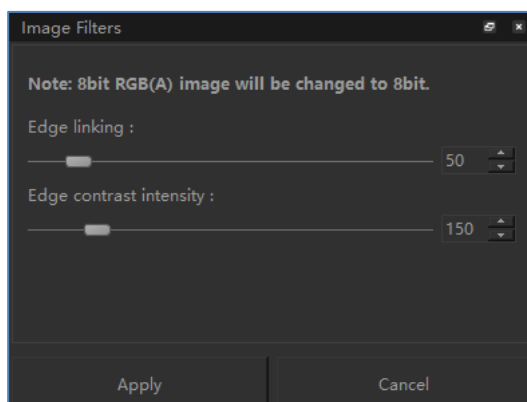
Sharpen

Sharpen the current image.



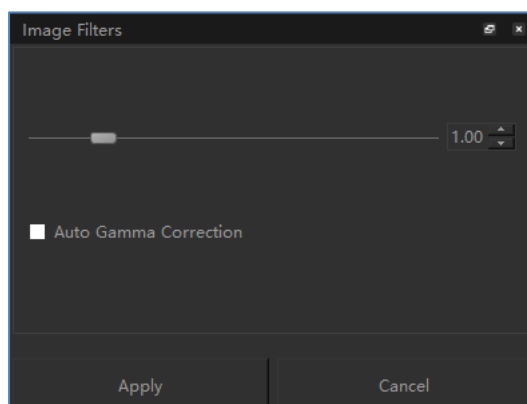
Edge Detection

Find edges in the current image.



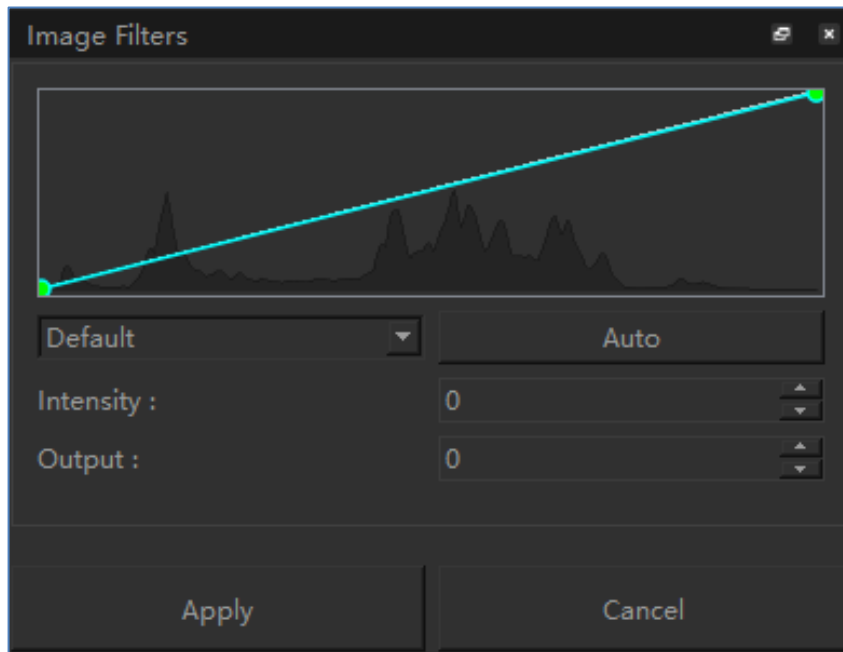
Gamma

You can adjust how an image is displayed on the monitor.
This filter adjusts only the dark tones.



Curves

You can use the curved brightness control as shown below:

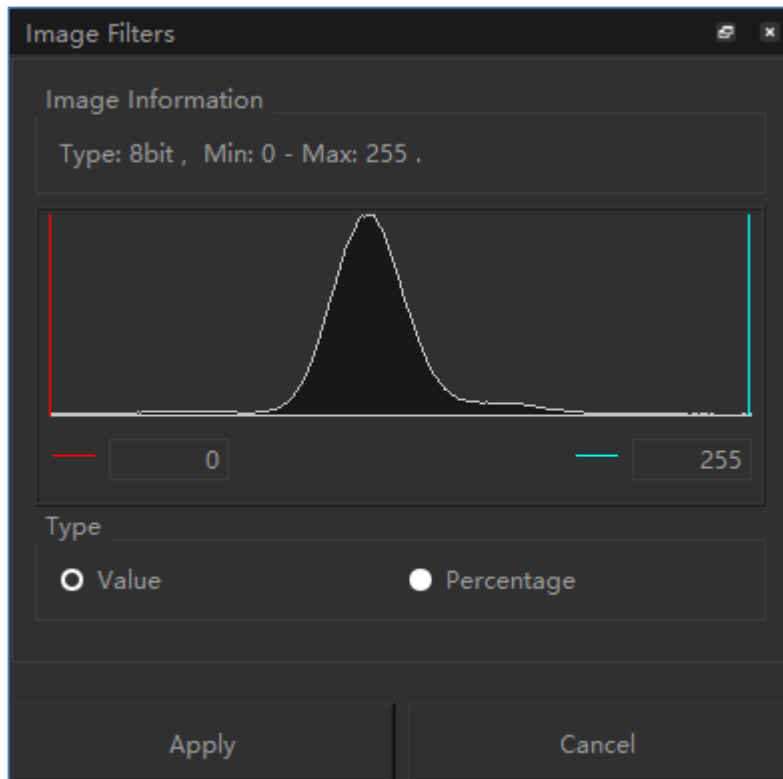


Initially, the intensity of the image is displayed on a graph with a straight diagonal line.

- You can select various image processing algorithms.
- When you click a line, the adjustment point is added to the line. If you move the adjustment point to change the shape of the curve, the image changes.
 - ✓ Moving the adjustment point at the top of the curve adjusts the bright area of the image.
 - ✓ Moving the adjustment point in the middle of the curve adjusts the middle area of the image.
 - ✓ Moving the adjustment point at the bottom of the curve adjusts the dark area of the image.
 - ✓ To darken the bright area, move the adjustment point at the top of the curve down.

Window

You can adjust the window as shown below:

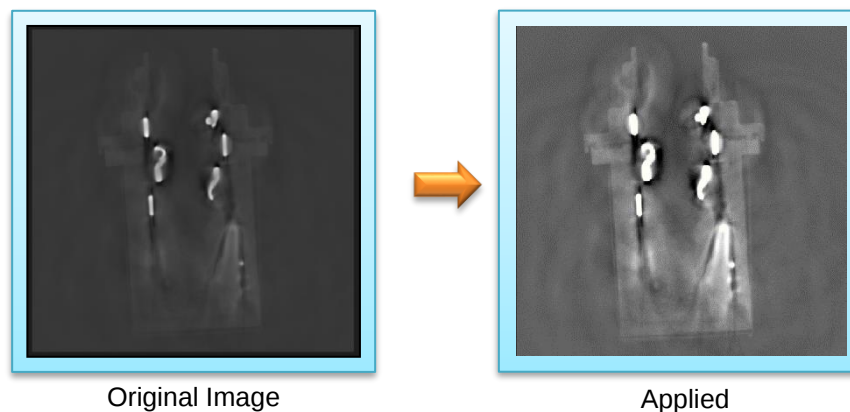


Initially, the histogram of the image is displayed.

- Value: Manually adjust the window of the image by setting it to pixel values.
- Percentage: Automatically adjusts the window of the image by setting percentage.

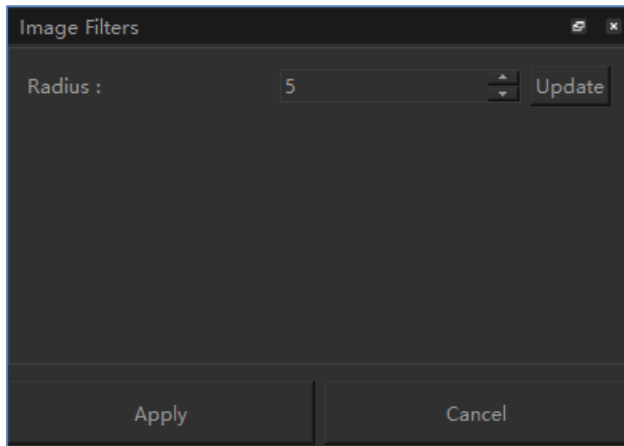
Auto Contrast

This filter automatically adjusts the contrast and brightness of the current image.



Local Thresholding

You can set the radius of the local domain over which the threshold will be applied.
This filter does not support the 16bit an RGB(A) format.

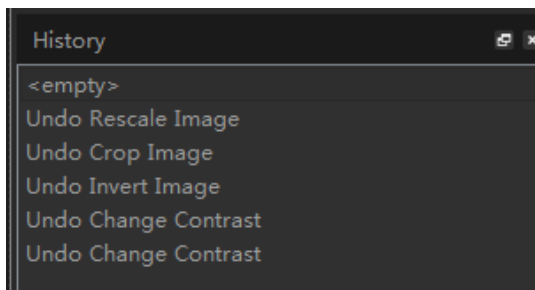


View

History Panel

HADI- iBoard Pro records the operation history of the image filters.
You can roll back to previous state using "History" panel.

Click one of the history states in the "History" panel to roll back.



Comparison View

When you click this button, half of the current image is applied to the image filter.
Therefore, you can compare the previous and future images.

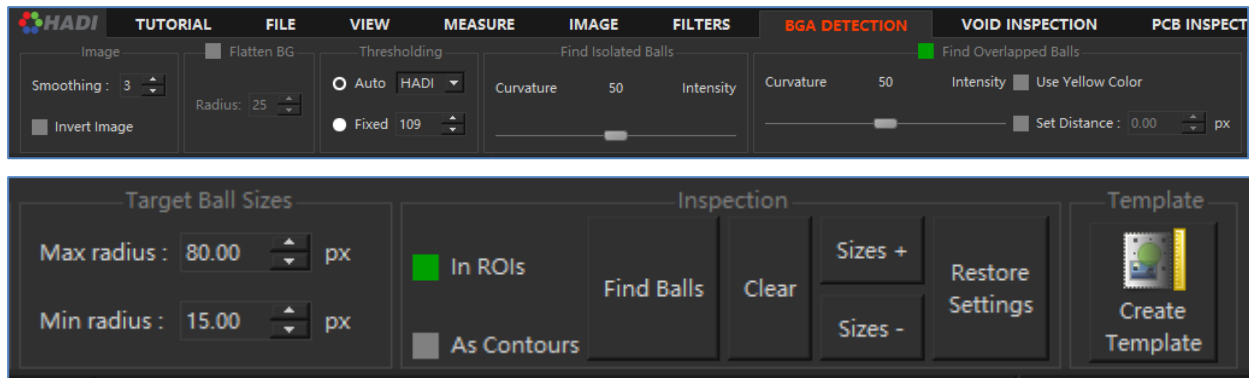
Thumbnail

Click this button to preview the image with the filter applied.
When unclicked, you can preview the logo with the filter applied.

4. Inspection

4.1. BGA DETECTION

Click on the "BGA DETECTION" tab to display the following toolbar:



Image

Smoothing

Set the number of Gaussian smoothing iterations. The default value is 3.

Invert Image

In general, HADI- iBoard Pro detects black balls on white background.

Check this option if you want to detect white balls on black background.

Flatten BG

If the background is not flat, use this option.

Radius

The radius is usually set to twice the diameter of the ball.

Thresholding

Auto

HADI: Default value. You can use this option in most cases.

OSTU: You can use this option in some cases.

Fixed

The value of "Auto" may not be operated correctly in a noisy image.

You can set a value of thresholding using this option.

If you change this parameter, the image gets an overlay to show the segmentation area.

Find Isolated Balls & Find Overlapped Balls

Two slider bars in the "Find Isolated Ball" and "Find Overlapped Ball" are designed for finding balls as contour.

The contour shape will be changed slightly depending on the curvature and intensity values.

Normally, you don't need to change these parameters (default value=50).

For more information, see the tutorial "BGA Detection".

Target Ball Sizes

You can use this option to define the radius size of the ball you are finding.

It is very important to define the radius range of a BGA ball to get more accurate result.

Set the minimum and maximum radius size of the ball.

Default values:

Minimum radius = 15 pixels

Maximum radius = 80 pixels

If the radius of ball to find is greater than 80 pixels (default), you must change the value of "Max radius".

To measure a size of ball, you can use Line Tools.

Inspection

In ROIs

Insert a rectangle tool in the image and set it as "Tool3 (BGA Detection)".

Check "In ROIs" option.

HADI will find balls only in the ROI.

As Contours

If you check this option, HADI- iBoard Pro will show you the balls as Polygon (Contour).
If you uncheck this option, HADI- iBoard Pro will show you the balls as Circle.

Find Balls

Click this button to find the balls.
It will first remove all the detected balls, and then find out balls with current parameters.

Clear

Click this button to remove all the detected balls.

Size+

Increase the radius size of all balls selected in the ROI by one.

Size-

Decrease the radius size of all balls selected in the ROI by one.

Restore Settings

Restore all parameter settings to their default values.

Template

You can create a template with current image and its parameters.

For more information, see the tutorial "Template".

Selected MTs

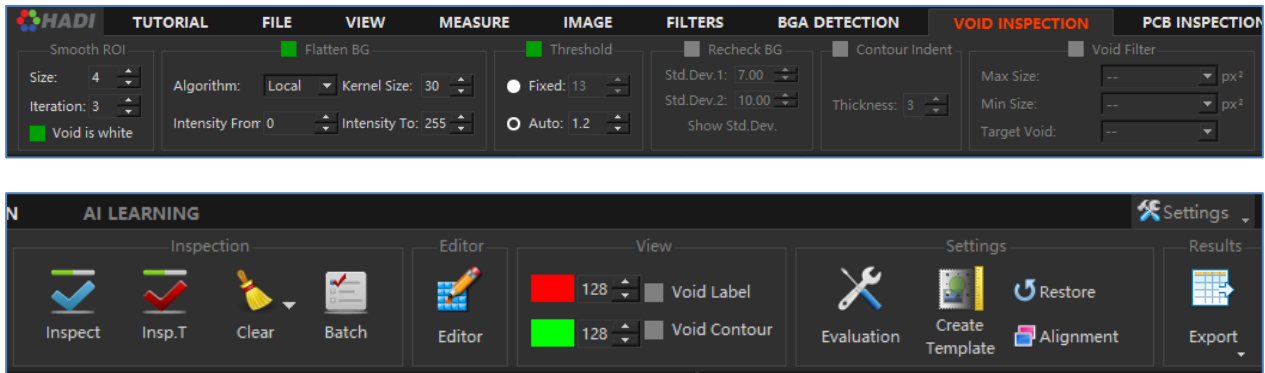
Insert measurement tools (rectangles, polygons, and circles) as ROIs in the image.

Check "Set as Mask Area" option, and then HADI- iBoard Pro will set all selected ROIs as mask areas.

HADI- iBoard Pro will not find the ball in these masks ROI.

4.2.VOID INSPECTION

Click on the "VOID INSPECTION" tab to display the following toolbar:



Note: Only the closed-shape Measurement Tools can be used for "Void Inspection".

Smooth ROI

Smooth the ROI with Gaussian smoothing algorithm.

Size and Iteration:

Set the Gaussian kernel size and smoothing iteration.

Void is white

By default, HADI- iBoard Pro looks for void objects that are brighter than the background. Disable this option to find void objects that are darker than the background.

Flatten BG

Flatten BG (background) makes the background flat.

Kernel Size

Set the maximum width or height of a void.
At the maximum void of the ROI, the larger of the width and height is the **Kernel Size**.

Intensity From

The start value of intensity to which the void inspection is applied.
HADI v.3 ignores surrounding pixels whose intensity value is less than "Intensity From".

Intensity To

The end value of intensity to which the void inspection is applied.
HADI- iBoard Pro ignores surrounding pixels whose intensity value is greater than "Intensity To".

Threshold

The threshold process is used to separate the foreground and background of an image.

Fixed

You can define a fixed value.
When "Flatten BG" is applied to an image, the range of pixel values starts at zero and the threshold is applied to the flattened image.
Normally, values between 4 and 20 are used.

Auto

Dynamic threshold values are applied to each ROI. A floating-point value is used.
If you increase "Auto" value, it fine-tunes the segmentation more.
If you decrease "Auto" value, the segmentation areas are expanded.

Recheck BG

Recheck BG is used to detect the void of the outer part connected to the outside.

Show Standard Deviation

The standard deviation value of the selected ROI is displayed.

Standard Deviation 1

Usually set to a value less than the standard deviation.

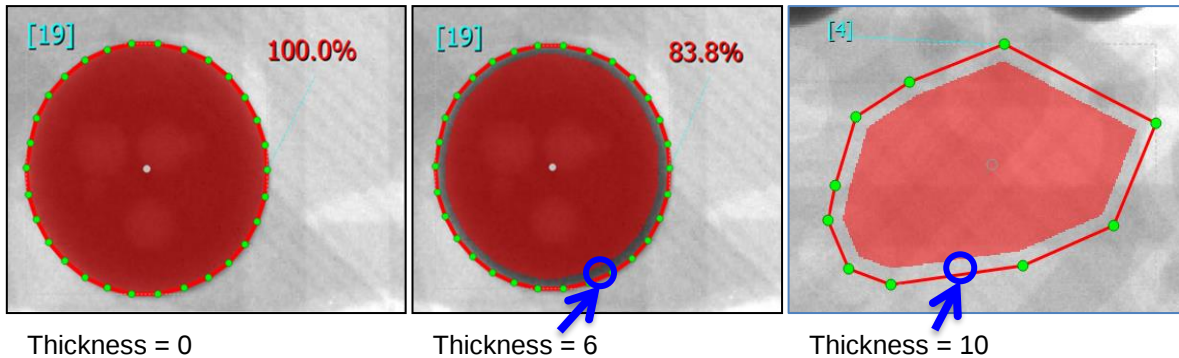
Standard Deviation 2

Usually set to a value greater than the standard deviation.

Exception: If the area of the outer pore is large, the standard deviation 2 is gradually decreased.

Contour Indent

You can define areas to exclude from the inspection.
The "Thickness" option is the pixel indented at the boundary of the MT (measurement tool).
The indented area is excluded from the inspection.



Void Filter

You can specify the size of the void you want to find in the ROI.

Max Size

Set the maximum void area in the selected MT (measurement tool).
If a void area is greater than this value, the void is excluded.

Min Size

Set the minimum void area in the selected MT (measurement tool).
If a void area is less than this value, the void is excluded.

Target Void

Set whether the selected MT (Measurement Tool) finds void by size-based or center-based.

Inspection

Inspect

Run a void Inspection on the current image.

Apply Template & Inspect

Run a void Inspection by applying the selected template to the current image.

Clear

Clear

Clear inspection results and ROIs in the current displayed image. [Keeping the alignment result]

Clear All

Clear inspection results and ROIs in the current displayed image. [Going back to the original image]

Clear Result

Clear inspection results in the current displayed image. [Keeping the alignment result]

Editor

Editor

You can edit voids in the ROI.

When you click this, the popup window is appeared.

View

The void inspection will result in "Defect (NG)" or "Non-Defective (GOOD)" depending on the evaluation settings.

Defects Color

You can set the colors and transparency value for "Defect (NG)" state.

Non-Defects Color

You can set the colors and transparency value for "Non-Defect (GOOD)" state.

Void label

Click this button to display the information of void.

Void Contour

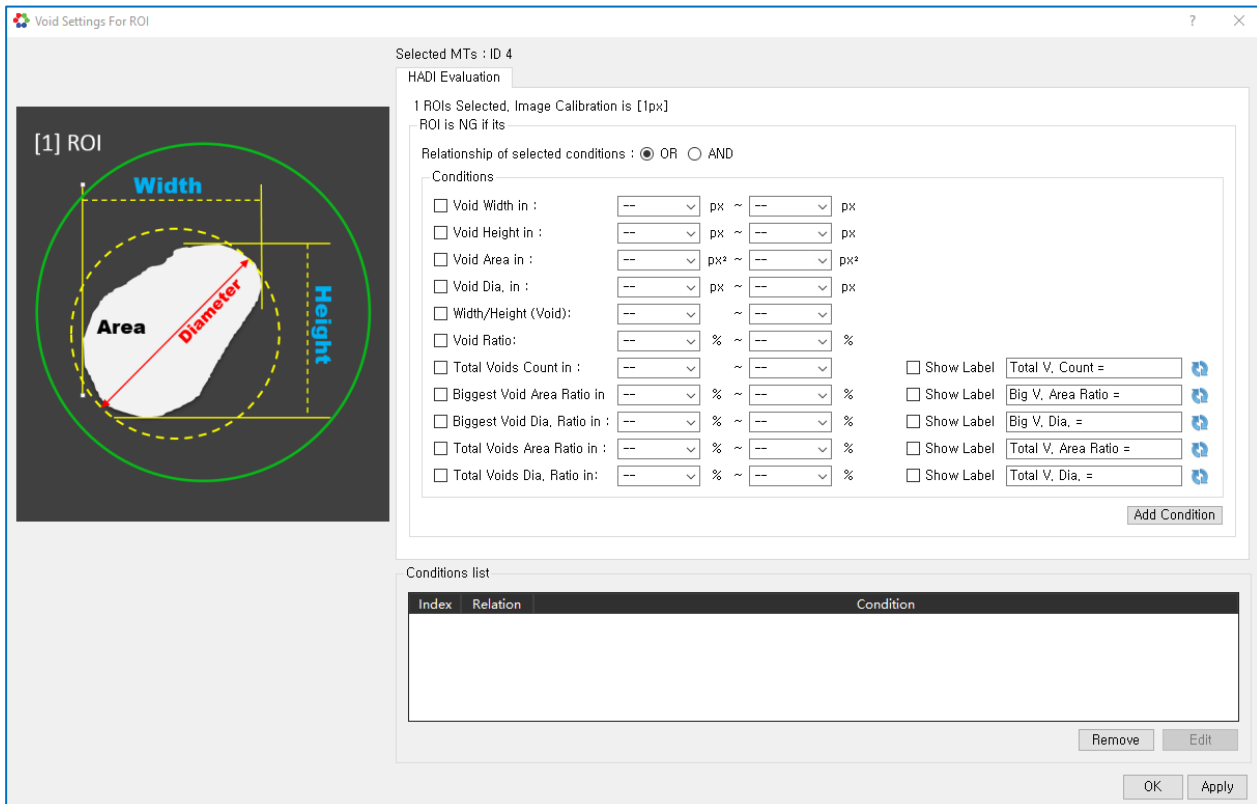
Click this button to display the void as outline.

Note: This option applies to all voids of the entire ROI in the current image.

Settings

Evaluation

You can define the NG conditions of a ROI for void inspection.
The setting applies to all selected MTs (measurement tool).
There are several conditions for NG.



Void Width in

If the void width is within this range, the selected tool and current image are NG.

The void is indicated by Defect Color.

The border line of the tool is indicated by Defect Color.

Void Height in

If the void height is within this range, the selected tool and current image are NG.

The void is indicated by Defect Color.

The border line of the tool is indicated by Defect Color.

Void Area in

If the void area is within this range, the selected tool and current image are NG.

The void is indicated by Defect Color.

The border line of the tool is indicated by Defect Color.

Void Dia. in

If the void diameter is within this range, the selected tool and current image are NG.

The void is indicated by Defect Color.

The border line of the tool is indicated by Defect Color.

Width/Height (Void)

If the value of void width/height is within this range, the selected tool and current image are NG.

The void is indicated by Defect Color.

The border line of the tool is indicated by Defect Color.

Void Ratio

If the void ratio is within this range, the selected tool and current image are NG.

The void is indicated by Defect Color.

The border line of the tool is indicated by Defect Color.

Total Voids Count in

If the total void count of the selected ROI is within this range, the selected tool and current image are NG.

The border line of the tool is indicated by Defect Color.

Biggest Void Area Ratio in

If the area ratio of the biggest void in the selected ROI is within this range, the selected tool and current image are NG.

The biggest void is indicated by Defect Color.

The border line of the tool is indicated by Defect Color.

Biggest Void Dia. in

If the diameter of the biggest void in the selected ROI is within this range, the selected tool and current image are NG.

The biggest void is indicated by Defect Color.

The border line of the tool is indicated by Defect Color.

Total Voids Area Ratio in

If the area ratio of the total void in the selected ROI is within this range, the selected tool and current image are NG.

The border line of the tool is indicated by Defect Color.

Total Voids Dia. in

If the diameter of the total voids in the selected ROI is within this range, the selected tool and current image are NG.

The border line of the tool is indicated by Defect Color.

Conditions

After setting the evaluation condition, click the **[Add Condition]** button and it will be added to the condition list.

You can add more than one condition.

The relationship between the added conditions is OR.

To remove a condition from the condition list, click the **[Remove]** button.

Show Label

Display the annotation prefix of the condition in the MT (measurement tool).



Reset "Show Label"



If you want to re-enter the default values for the "Show label", click this button to bring up the original values.

Create Template

Create a Template using the currently displayed image.

Alignment

The "Image Alignment" dialog is displayed.

Show the Alignment settings for the selected template.

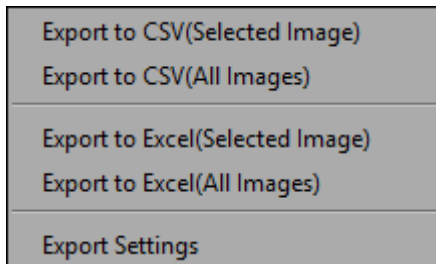
Restore Parameters

Restore the void inspection parameters of the selected MT to their default values.

Results

Export

Exports information about all or selected images.

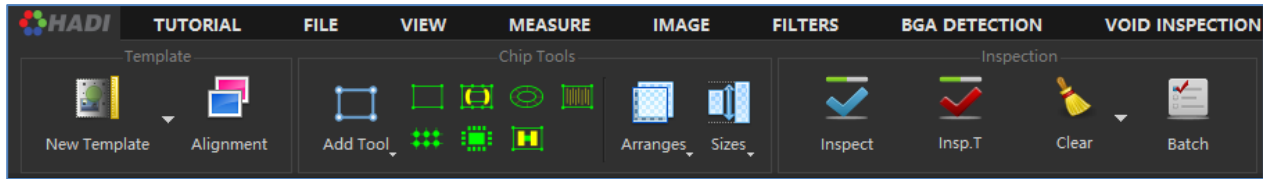


- Export to CSV format (Selected Image)
- Export to CSV format (All Images)
- Export to Excel (Selected Image)
- Export to Excel (All Images)
- Export Settings

See "Export Settings" in the "MT Info" dock panel.

4.3.PCB INSPECTION

Click on Toolbar "PCB INSPECTION", the following toolbar will be shown



Template

New Template

- Create a new iBoard Template through loading an image.
- Create a new Template from current displaying image.

Alignment

Select a Template, then user can set alignment parameters for it.

See "Template-based Inspection" to get detail parameter description on Image Alignment.

Chip Tools

Add Tools

Add Chip Tools to the current displaying image(can be Template).

Arrange and Sizes

Adjust Chip tool layouts, arrangements, and sizes of selected Chip tools.

Inspection

Load Image

- Select a Template first, and then load an image with this button to inspect it.

It will first do the image alignment between the image and Template. The alignment process will do transformations on image to match the template.

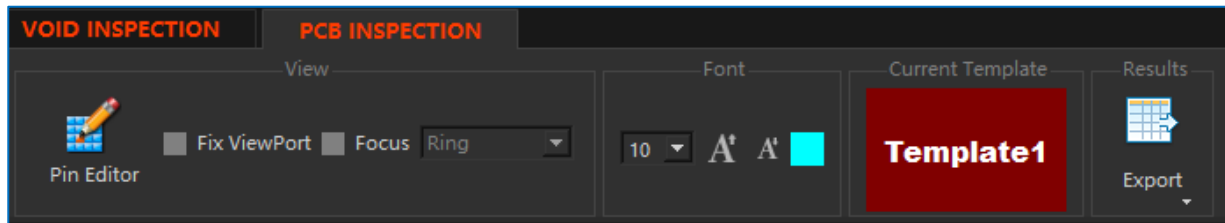
- The second process is mapping all ROIs in Template to the image.
- Now the image is ready to do inspection.

Inspect

Inspect current image with selected Template.

Every time clicked on "Inspection", all the ROIs in the current image will be removed. All the ROIs in Template will be mapped to current image again.

The alignment process doesn't repeat. So, if user change Alignment settings, the image needs to be loaded again to perform alignment with new alignment parameters.



View

Pin Editor

Click this button, the Pin Editor will appear. Double click each cell, use can edit its value. User can set different Base value, Size restraint and Name etc.

Fix Viewport

Fix the viewport of current image, the incoming new images will have same Translation and Scaling with the current Viewport.

It is a convenient function that focusing on a certain area of an image.

Focus

During the inspection, the viewport will be focused on a Chip tool. User can select the target Chip type by the dropdown menu.

Current Template

Show the current selected Template name.

Results

Export

User can generate report or export images and Templates. See more details in "Exporting".

5. Getting Started

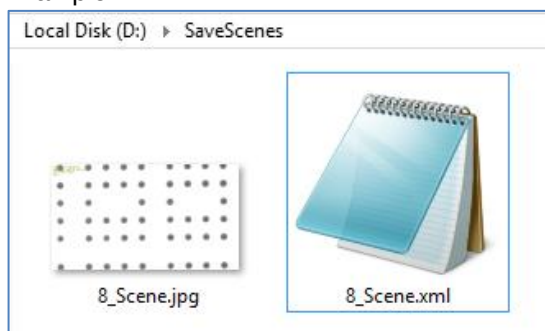
5.1. General

5.1.1. Working with Scenes

You can save current scene as a XML file, and load it in the HADI-Inspection Pro later.

The image is saved with the same name as the XML file.

Example:



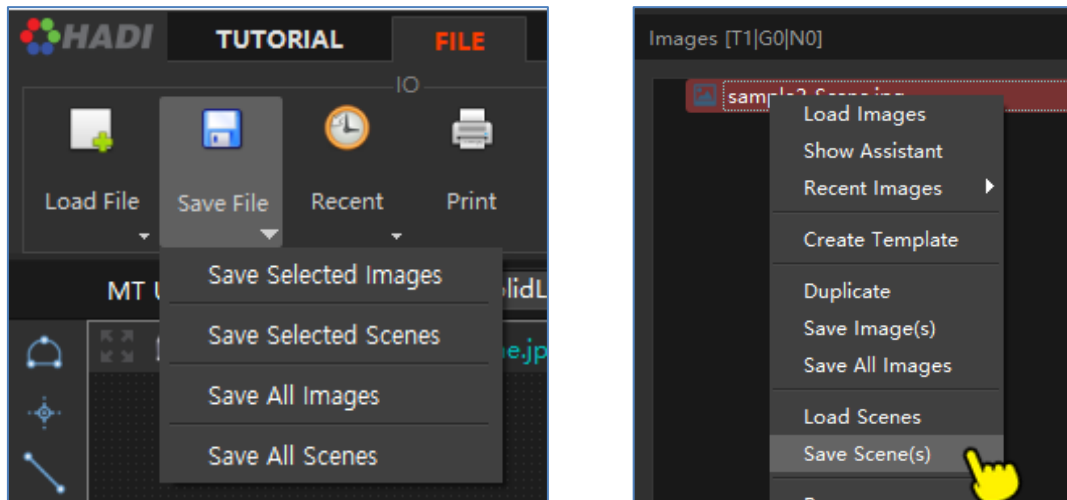
The XML file contains:

- All measurement tool (MT) and their properties (e.g. position, color, pen, etc.).
- All parameter of MT.
- All parameter of the image.

Save Scenes

You can save the scene using one of the following menus:

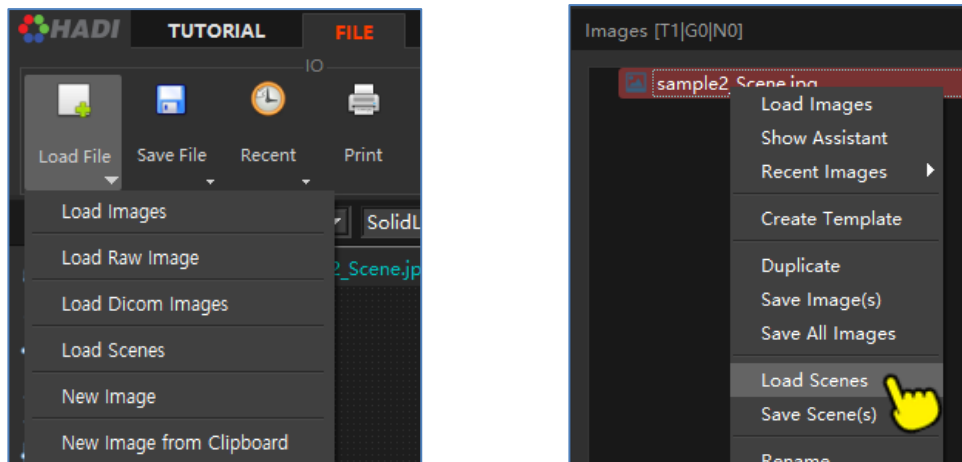
- **[FILE]** tab → "Save File" → "Save Selected Scenes" menu
- **[FILE]** tab → "Save File" → "Save All Scenes" menu
- Right-click the image in the image dock panel → "Save Scene(s)" in the popup menu



Load Scenes

You can load the scene using one of the following menus:

- **[FILE]** tab → "Load File" → "Load Scenes" menu
- Right-click the image in the image dock panel → "Load Scenes" in the popup menu

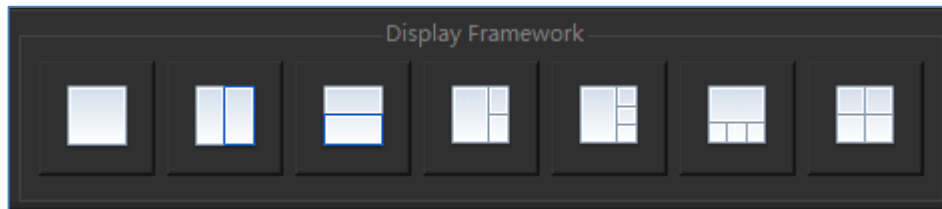


5.1.2. Multi-View Display

HADI- iBoard Pro supports multiple view windows. You can view up to 4 images at the same time.

By default, HADI- iBoard Pro displays a single image view.

You can change the display framework in the **[VIEW]** tab → "Display Framework".



Single view



Two vertical views



Two horizontal views



One main view and two small vertical views



One main view and three small vertical views



One main view and three small horizontal views

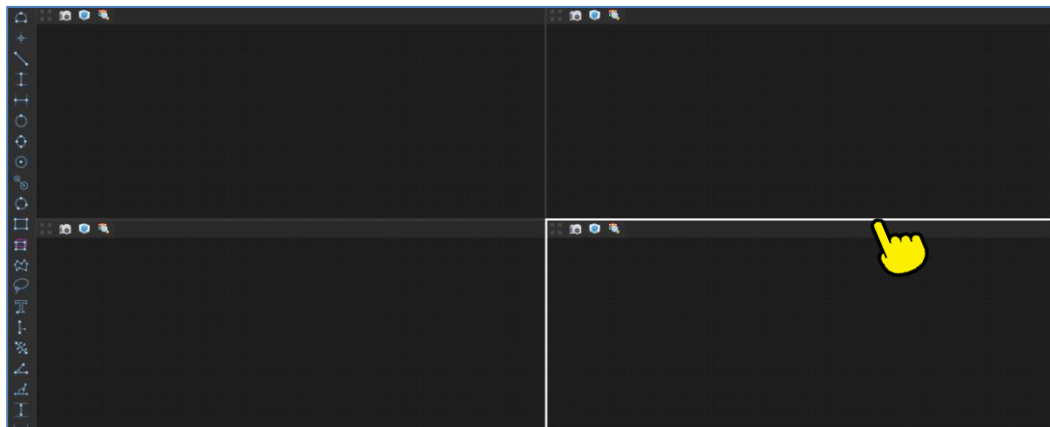


Four views

Activated View

The active view has a white border that is different from other views.

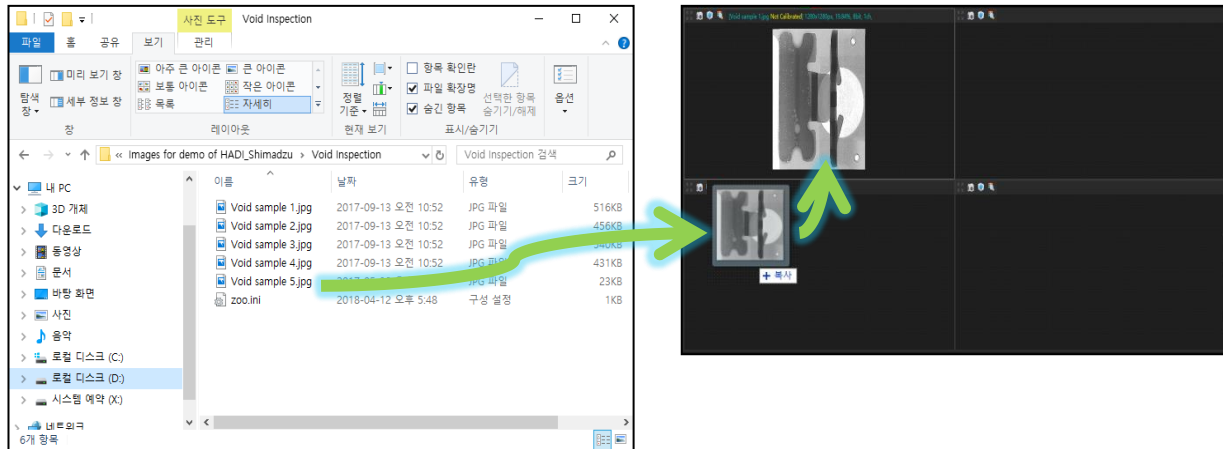
You can click a view to activate it.



How to display images in the multiple views

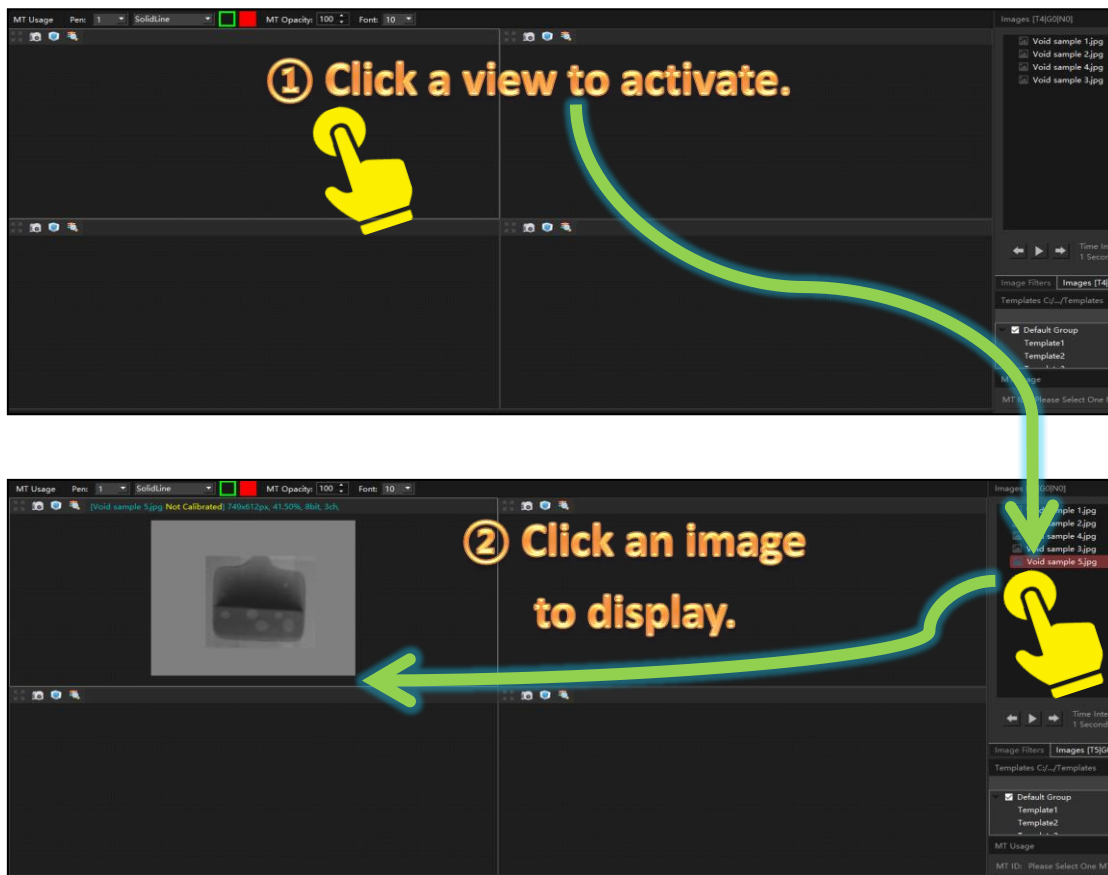
Method 1

Loading images using a mouse drag from Windows explorer into a view.



Method 2

First, click the view you want to activate, and then click the image name in the Image List panel. The image will be displayed to the activated view.



5.1.3. Image Loading Assistant

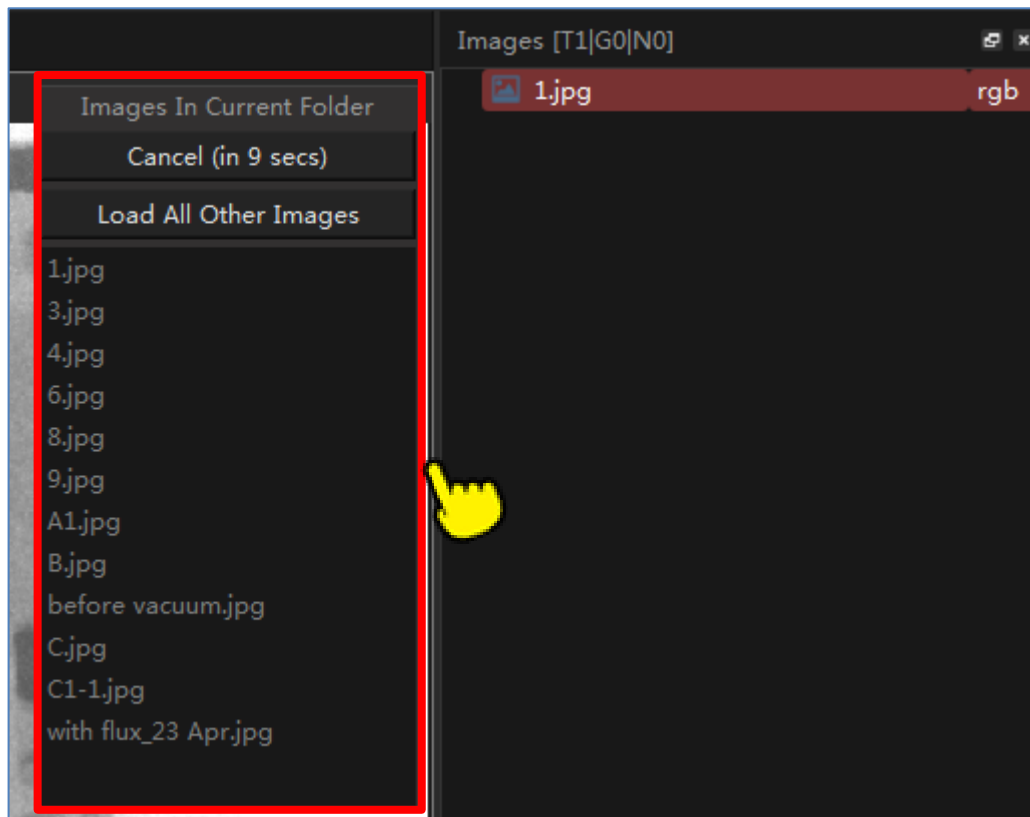
When you load images, "Assistant" window will be appeared.

It shows a list of all images in the same image folder.

You can click on an image file name in the list to load it.

If you don't click anything, this window will be disappeared after 10 seconds.

- **[Cancel]** button: Close the Assistant window.
- **[Load All Other Images]** button: You can also load all other images that are not loaded.



5.1.4. Exporting

HADI v.3 provides the following functions for exporting information:

- Save Images
- Save Working Scenes
- Capture Image
- Capture Screen
- Print Images
- Export Inspection Results to PDF file
- Export Inspection Results to CSV/Excel file

5.1.5. Supported file formats

HADI v.3 supports various image formats such as PNG, XPM, JPG, BMP GIF and TIFF. The TIFF file can be 16-bit.

HADI- iBoard Pro also support to load RAW image files.

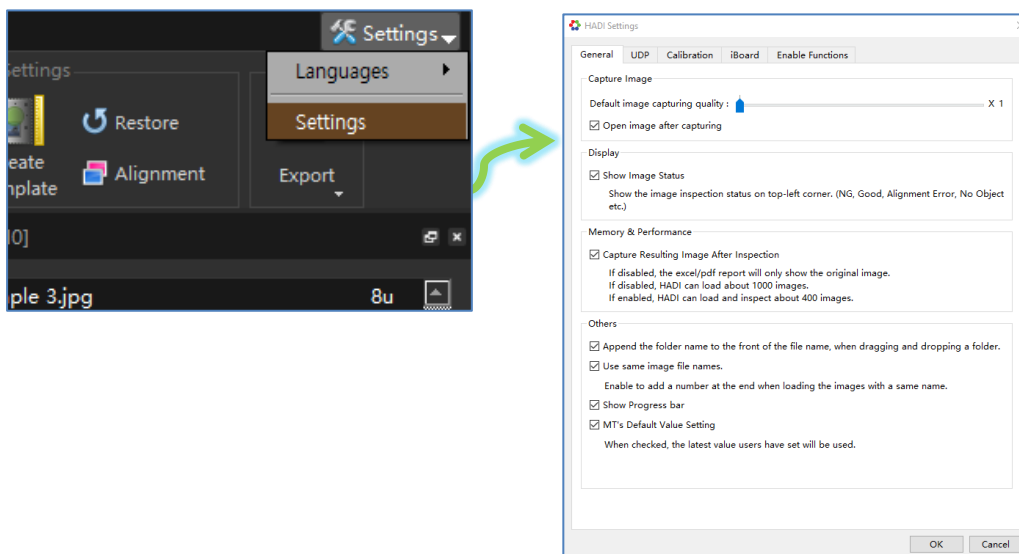
HADI- iBoard Pro saves the working scene as a XML file. You can also load XML scene files.

5.1.6. HADI v.3 Terminology

Name	Description
NG	Not Good. Used for inspection and evaluation
GOOD	Good. Used for inspection and evaluation
Void Inspection Tool	Measurement Tool whose MT usage type is Void Inspection.
Measurement Tool	HADI-Inspection Pro supports 25 measurement tools. It can be assigned to different MT usage type.
Closed-Shape MT	Measurement Tools such as Circle, Rectangle, and Polygon are MTs with closed shapes.
Non-Closed-Shape MT	Measurement Tools such as Angle, Line, and Distance are MTs with non-closed shapes.
Image Alignment	Image Alignment is used for Template.

5.1.7. Improve Performance

You can improve performance with HADI v.3 settings.



Memory & Performance

HADI v.3 maintains the inspected image after inspection and this image is used for the Report. To disable it, use "Global Settings" → "General" → "Memory & Performance" menu.

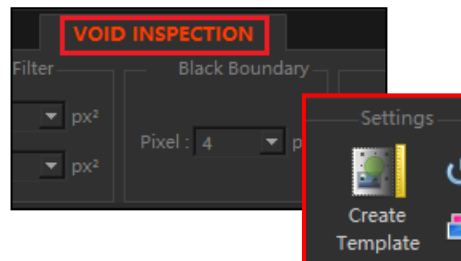
5.2. Automated and Template based Inspection

5.2.1. Create Template

Create a Template from the current image

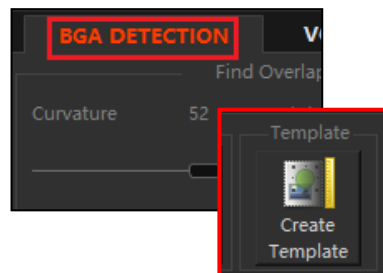
[Method 1]

Go to [VOID INSPECTION] tab → "Create Template" button.



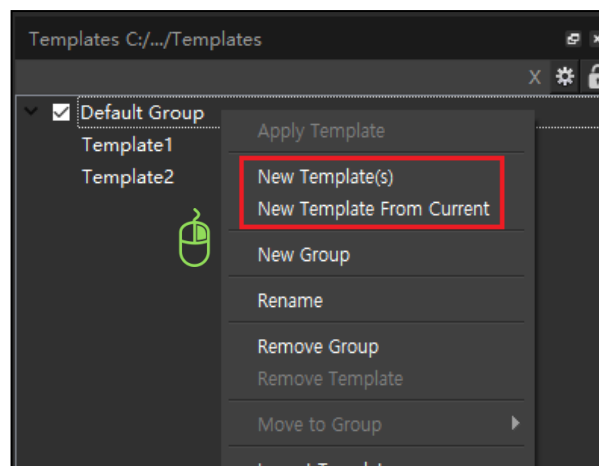
[Method 2]

Go to [BGA DETECTION] tab → "Create Template" button.



[Method 3]

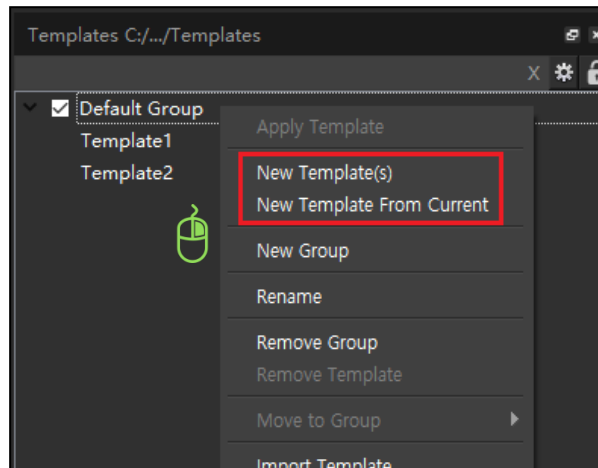
Go to "Templates" dock panel → Right-click on the panel → "New Template from Current" popup menu.



Create a Template from the image selection dialog window

[Method 1]

Go to "Templates" dock panel → Right-click on the panel → "New Template(s)" popup menu.



Show a Template

Double click on a Template item in dock panel "Templates" will show that Template.

Edit a Template

User can put Measurement Tools and tuning parameters directly on the Template.

Each action on the Template will be automatically saved.

5.2.2. Image Alignment

To do the Template-based Image Inspection or Inline Inspection, image alignment is necessary.

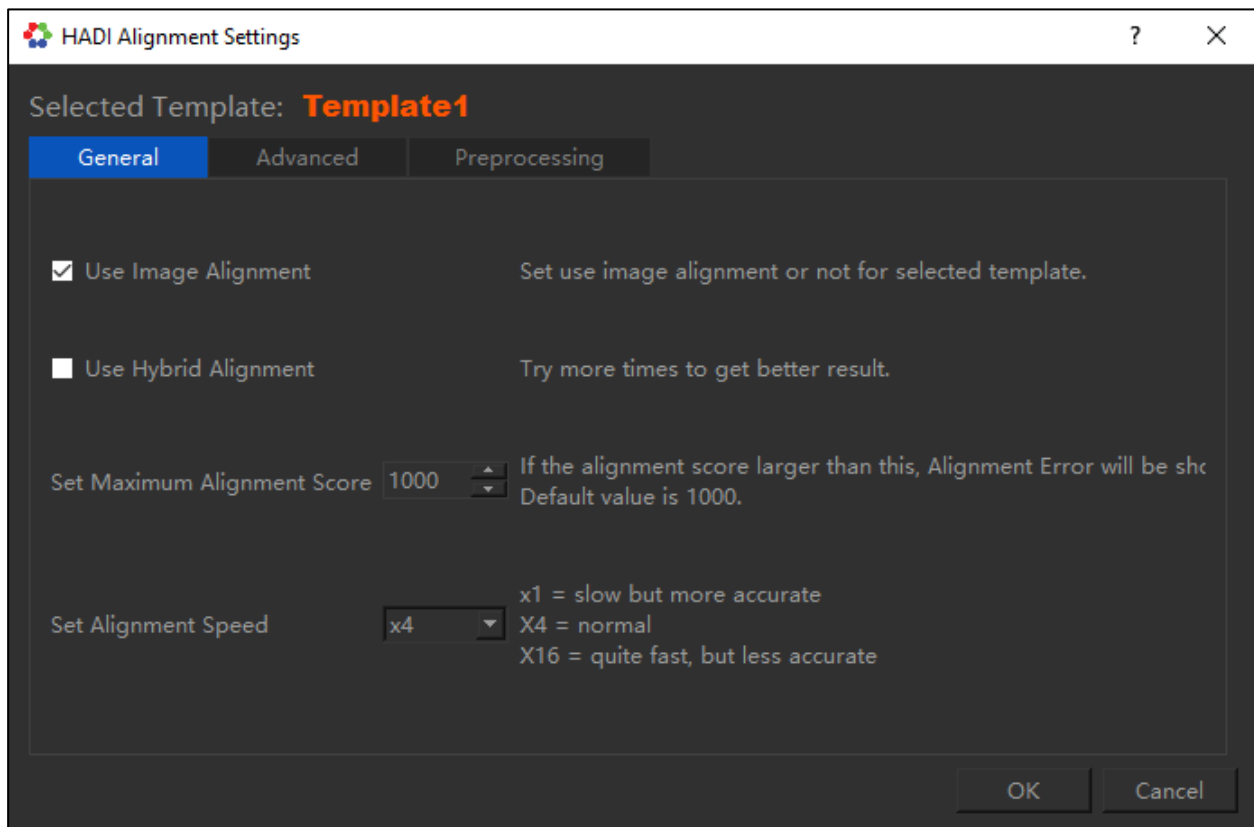
HADI uses full image to do alignment.

Open Image Alignment

Select Template(s) in the dock panel "Templates".

- In HADI - iBoard Pro, click button "Alignment" in toolbar "VOID INSPECTION".
- In HADI - iBoard, or iBoard Pro, click button "Alignment" in toolbar "PCB INSPECTION"

General Settings



Use Image Alignment

User can choose to use the image alignment or not.

Use Hybrid Alignment

If this option enabled, HADI would try few more times to make sure the alignment works.

Set Maximum Alignment Score

For each alignment iteration, a score will be calculated.

After alignment process done, a score which calculates the sum of intensity differences between image and Template is grained.

If the score lower than defined score, the alignment process is succeeded, or else, "Image Alignment Error" will be displayed in the main window.

The default score value is 1000. In 1000 x 1000 resolution images, if

- the brightness doesn't change much and
- the translation less than 200 pixels and
- the rotation less than 30 degrees.

The alignment score value is about 500~1000.

For larger image like 1500 x 1000, the score can over 1000, about 1500.

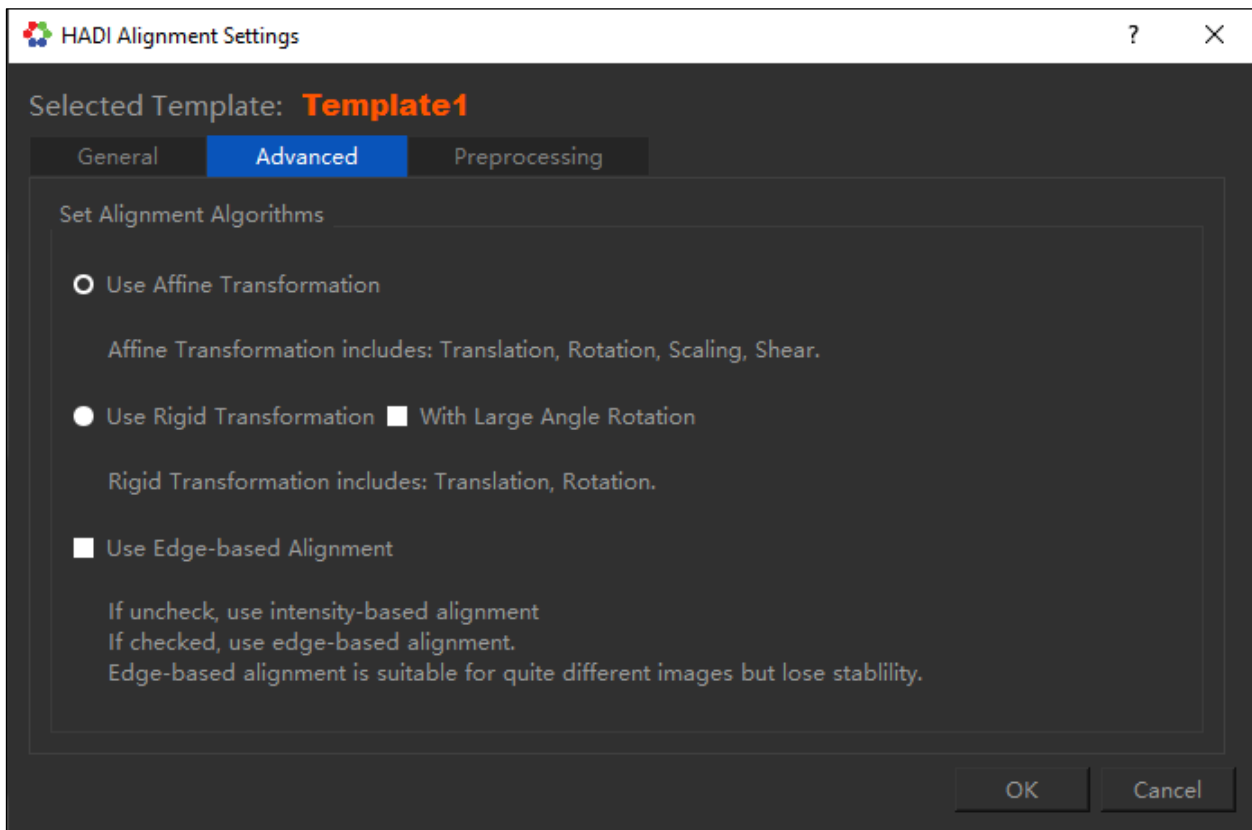
Set Alignment Speed

Set the alignment speed, default is 4 times faster than normal.

Obviously, set higher speed will cause less accuracy.

See "Improve Performance" to speed up alignment or inspection

Advanced Settings



Use Affine Transformation

Use affine transformation to align incoming image and Template(image).

The affine transformation supports image translation, image Rotation, image scaling and image shearing.

The image alignment process will consider all the above transformations.

Use Rigid Transformation

The image alignment process will only consider Translation and Rotation between incoming image and Template.

Use Edge-based Alignment

The default image alignment is using image intensities as the major factor.

In some case, the brightness and contrast between incoming image and Template changes a lot.

Since the alignment score is sum of intensity difference between incoming image and Template,

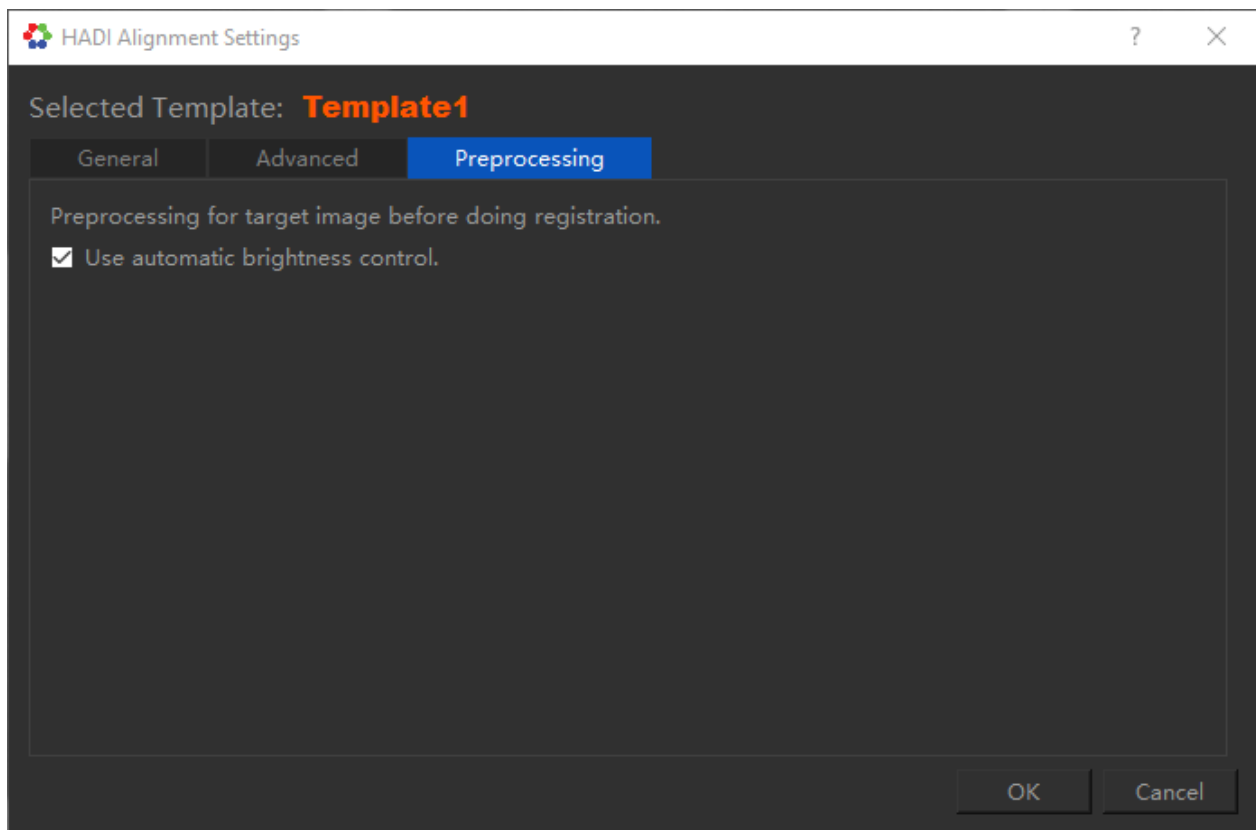
it will become abnormal even the image structure (object layout) is exactly same.

So, for the image that have the similar structures with Template, but brightness is quite different, use edge-based alignment would be better.

The edge information shows the structure while ignoring the intensity values.

The brightness differences can be ignored.

Processing Settings



In some case, it is difficult to find the threshold value if the shape is similar.

Using automatic brightness control to process image alignment.

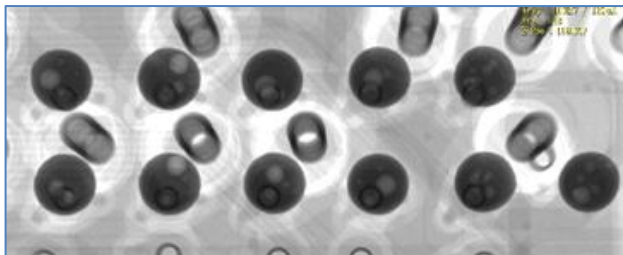
5.2.3. Automated BGA Inspection

Click on the "BGA DETECTION" tab to detect balls in the BGA image.

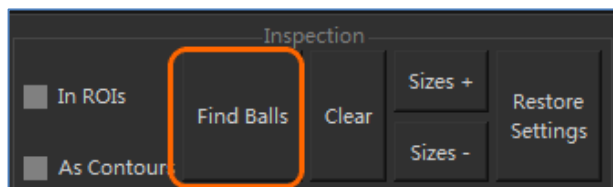
- General BGA Detection Procedure
- If failed...
- Ball Representations
- Advanced BGA Detection
- Find Overlapped Balls
- Set Mask Area

General BGA Detection Procedure

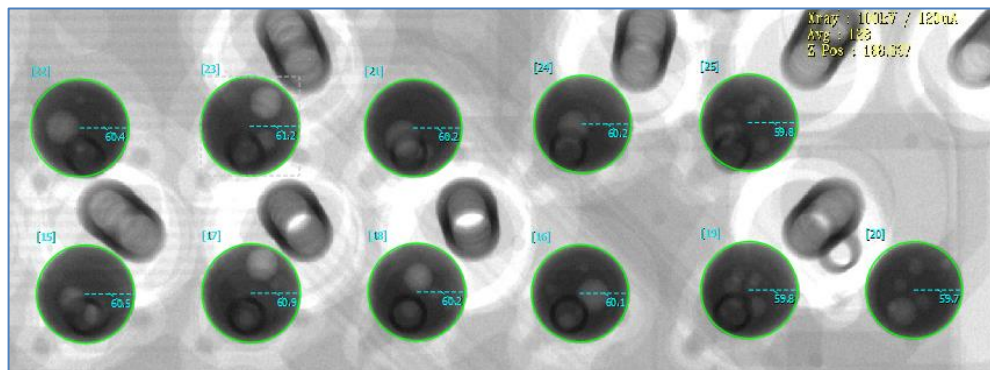
1. Load a BGA Image.



2. Click on "Find Balls" button.



In general, BGA of images is detected and displayed as the following image.
Balls are indicated by a Circle MT and the ball radius by a label.



If failed...

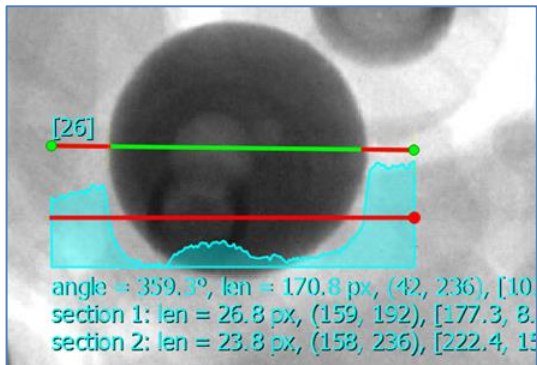
Please follow the steps below:

- **Reset Parameters**

Click "Restore Settings" button to reset all BGA detection parameters to the default values. Then run the "Find Balls" button again.

- **Change "Target Ball Sizes"**

HADI- iBoard Pro only detects balls that match the defined range (default: 15px ~ 80px). Therefore, it is very important to set the appropriate ball size. You can define the target ball size by measuring the radius of the ball using the Line Tools.



- **If the Ball is White**

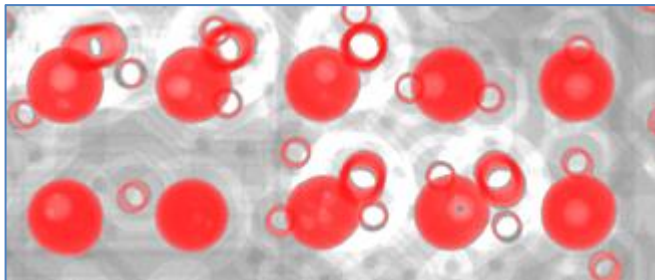
In general, HADI- iBoard Pro detects black balls on white background. Check "Invert Image" option if you want to detect white balls on black background.

- **Use Fixed Threshold**

HADI- iBoard Pro uses automatic thresholds ("Auto" option) to distinguish balls by default. If the background is very complex, automatic thresholds may not work.

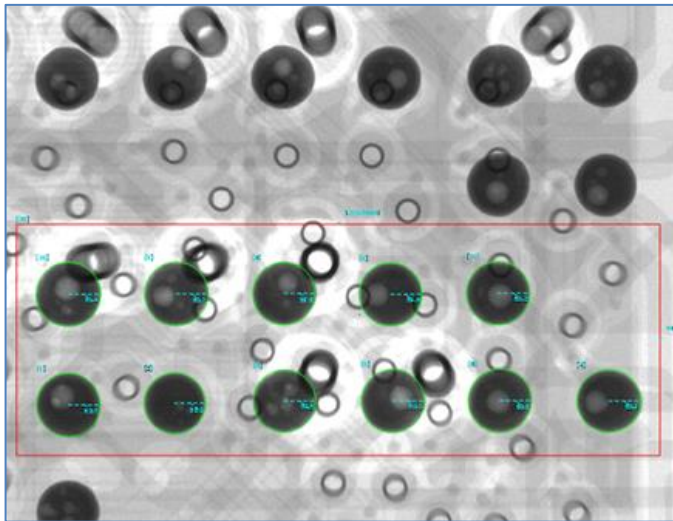
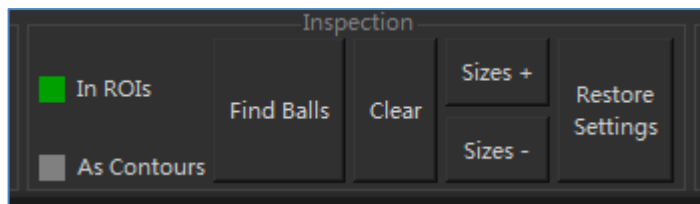
In that case, you can use a fixed threshold value to correctly distinguish balls.

If you set a fixed threshold value, HADI- iBoard Pro represents the overlaid ball segments.



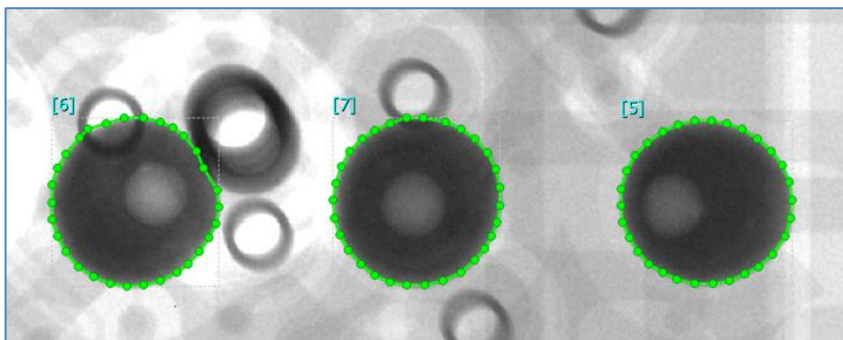
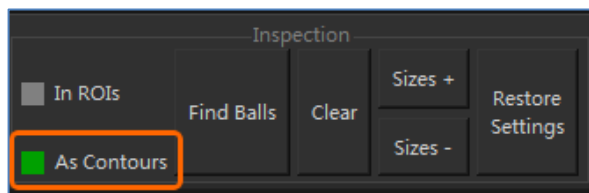
- **Try to find balls in ROIs**

Insert a rectangle tool in the image and set it as the MT usage "Tool3 (BGA Detection)". HADI- iBoard Pro will find balls only in the ROI.



Ball Representations

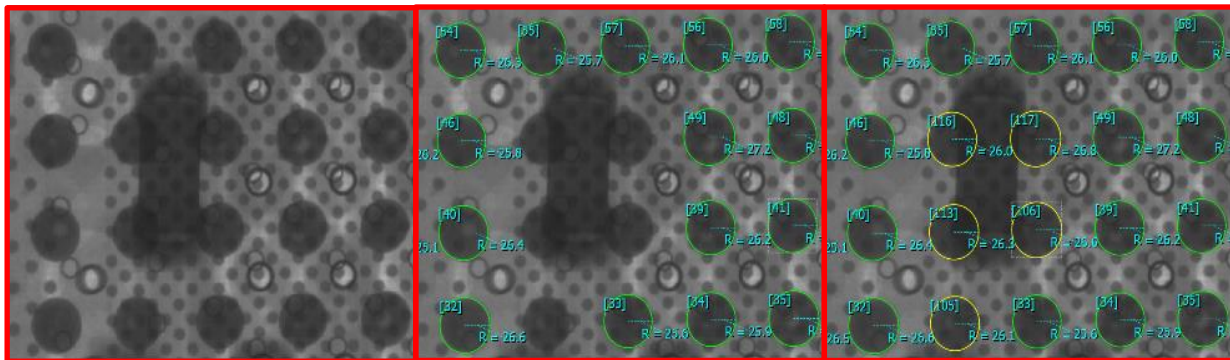
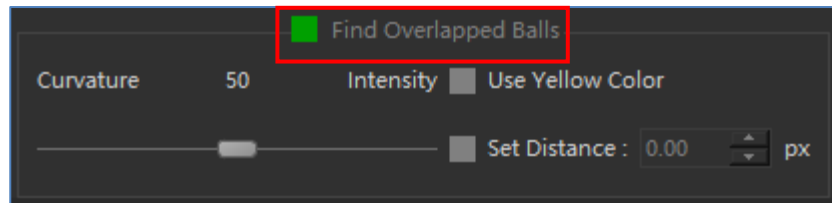
If you check “**As Contours**” option, HADI- iBoard Pro will show you the balls as polygon not as circle.



Advanced BGA Detection

Find Overlapped Balls

If you check **"Find Overlapped Balls"** option, HADI- iBoard Pro will detect balls that are overlapped with other objects.



Original image

Finding isolated balls

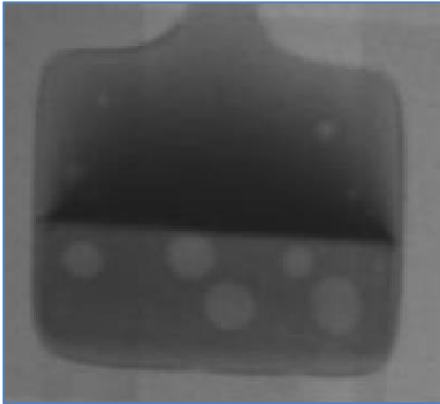
Finding isolated balls
and overlapped balls

5.2.4. Automated Void Inspection

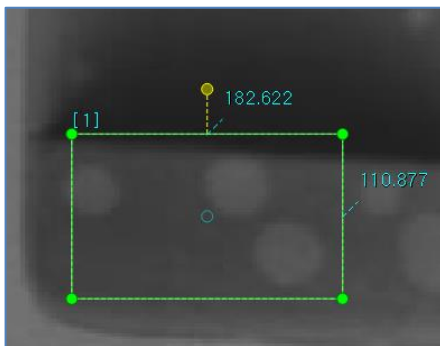
Click on the "VOID INSPECTION" tab to inspect voids in the image.

General Void Inspection Procedure

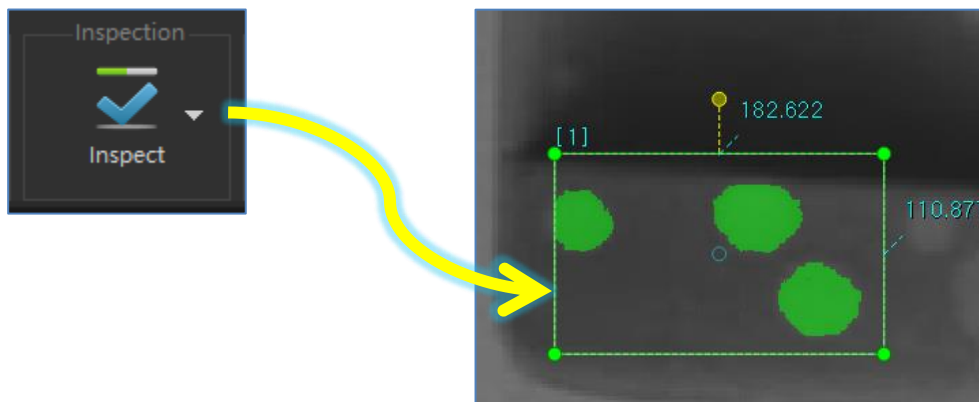
1. Load an Image.



2. Insert a closed-shape MT in the Image.



3. Click [Inspect] button



If failed...

Please follow the checkpoints below:

1. Check whether the tool is closed-shape or non-closed shape.
Void Inspection works only on a closed-shape MT.
2. Check the usage type of the tool in the "MT Usage" dock panel.
Void Inspection works only in the "Tool2 (Void Inspection)" type.
3. Check the Void Color:
 - By default, HADI- iBoard Pro looks for void objects that are brighter than the background.
 - Disable **"Void is white"** option to find void objects that are darker than the background.
4. Check the "Flatten BG" parameters.
5. Check the "Threshold" parameters.
6. Check the "Void Filter" parameters.

Show Voids as Contour

Check "Void Contour" option to display the void as outline.

Void Evaluation

You can define the NG conditions of a ROI for void inspection.
Click on "Evaluation" button to open the evaluation settings for selected MTs.

Create a Template with Current Image

You can use "Template" to inspect multiple images with the same ROI setting.
The image to be inspected should be like the image in the template.
You can create a template by clicking the "Create Template" button.

Export Results

[Method 1]

To export the results as a PDF file, click the "Report" button on the "FILE" tab.

[Method 2]

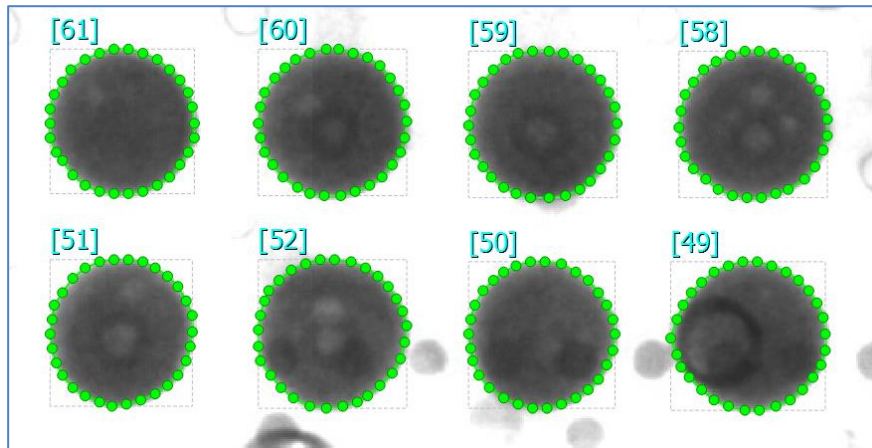
To export the results as an Excel file, click the "Export" button on the "VOID INSPECTION" tab.

5.2.5. Automated PCB Inspection

Teaching Experience

BGA Teaching

Circles or Polygons should be exactly matching the Ball.



Void Inspection Tool Teaching

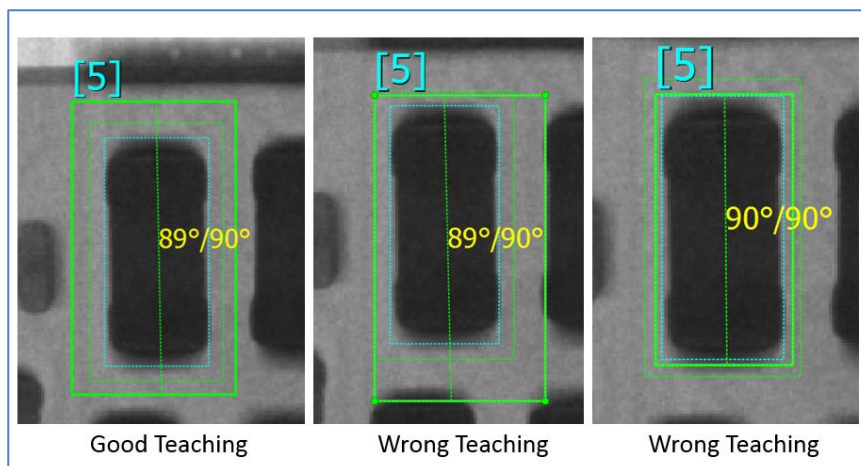
Free teaching

iBoard C-Chip Teaching

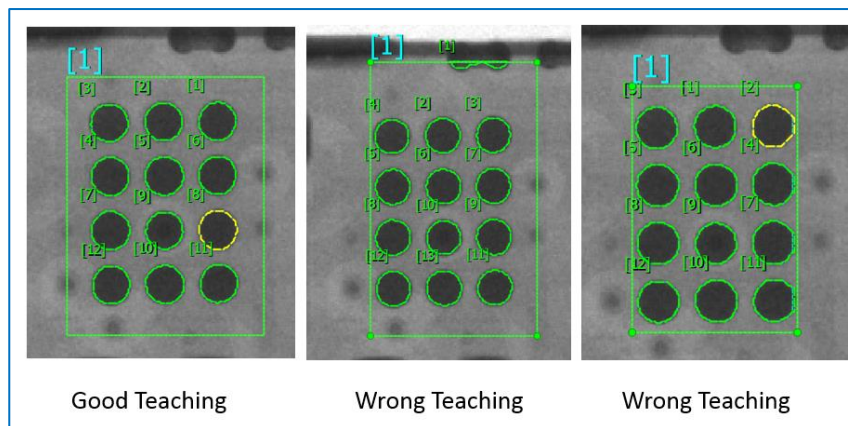
The MT boundary should larger than the C-Chip itself. And do not touch with other chip-sets.

If the MT boundary too small,

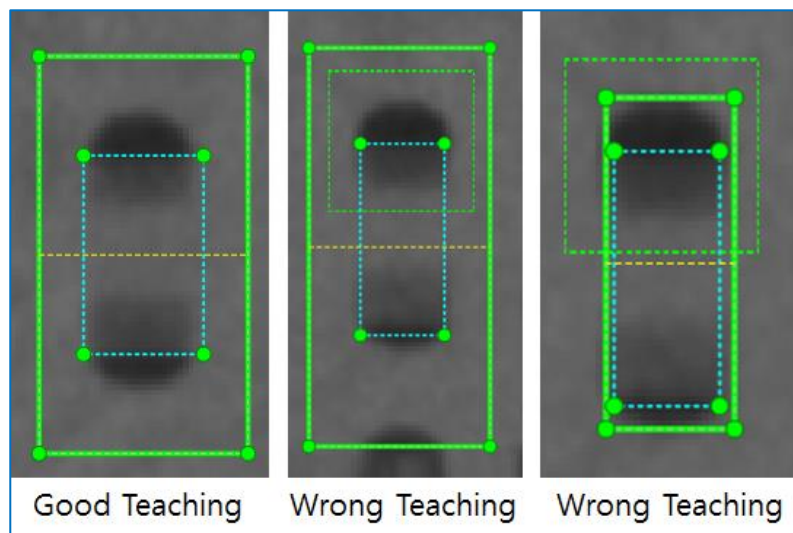
- the "Check Boundary" may have problem.
- the Segmentation may have problem.



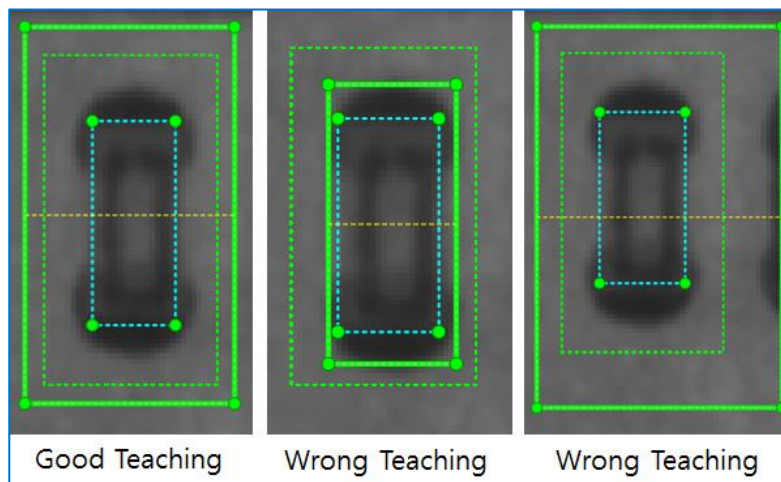
iBoard BGA Teaching



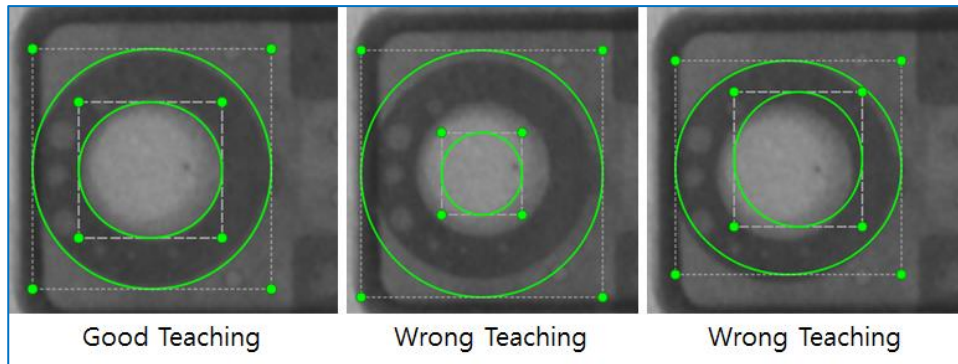
iBoard R-Chip Teaching



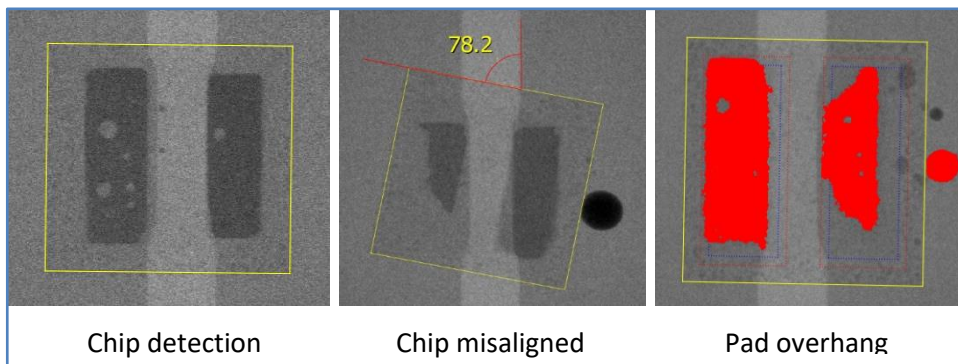
iBoard L-Chip Teaching



iBoard MIC Teaching



iBoard LED Teaching



5.2.6. Image Calibration

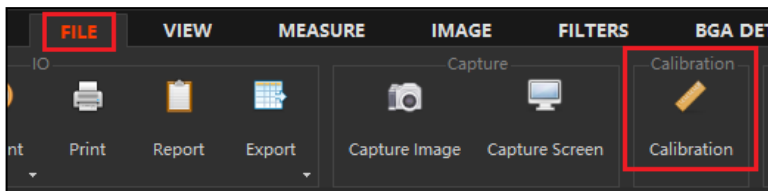
Use the Calibration menu to calibrate the pixels to their actual size.

- Open Calibration Window
- Remove Calibration Information
-

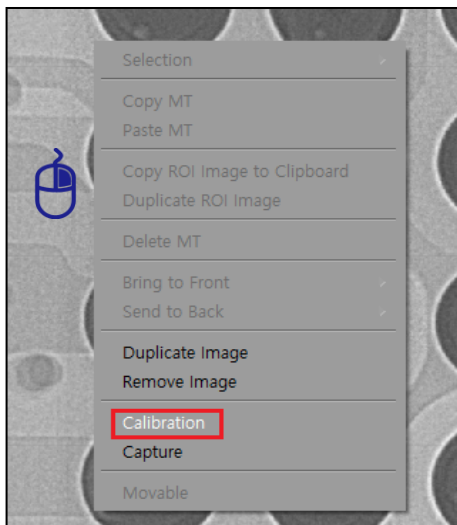
Open Calibration Window

To calibrate the current image, do one of the following:

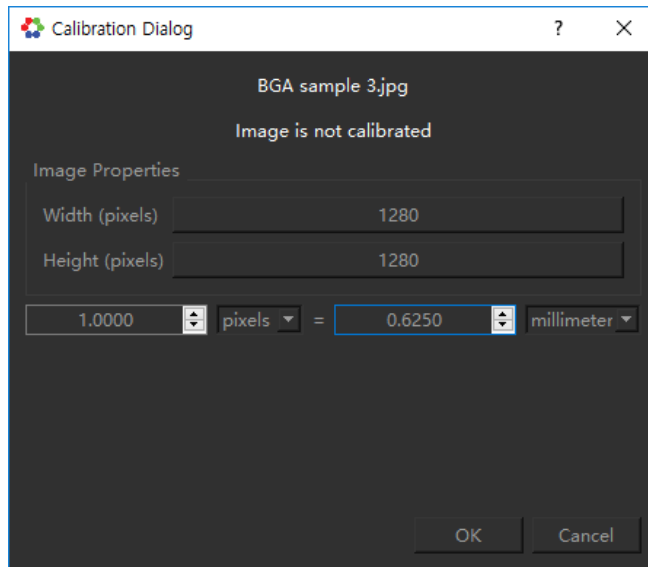
- Click the "Calibration" button in the **[FILE]** tab.



- Click the "Calibration" menu from the popup menu on the image.
(Right-click on the image)



Then the calibration dialog window appears.



- If you right-click on the image, the image properties section displays the properties of the whole image.
- If you right-click on the measurement tool (MT), the image properties section displays the properties of the ROI (MT) area.

HADI v.3 supports the following units:

- centimeter
- millimeter
- micrometer
- nanometer

Remove Calibration Information

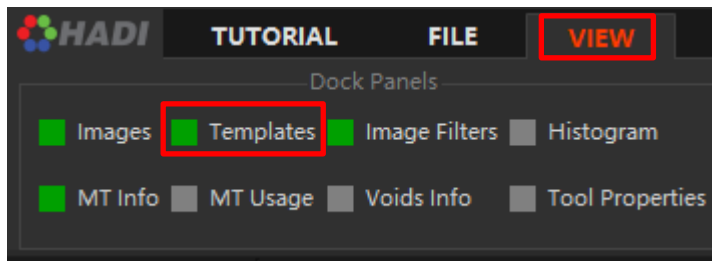
To remove the calibration setting of an image, set "Pixel = Pixel" without changing the value or "1 pixel = 1 pixel".

5.3. Dock Panels

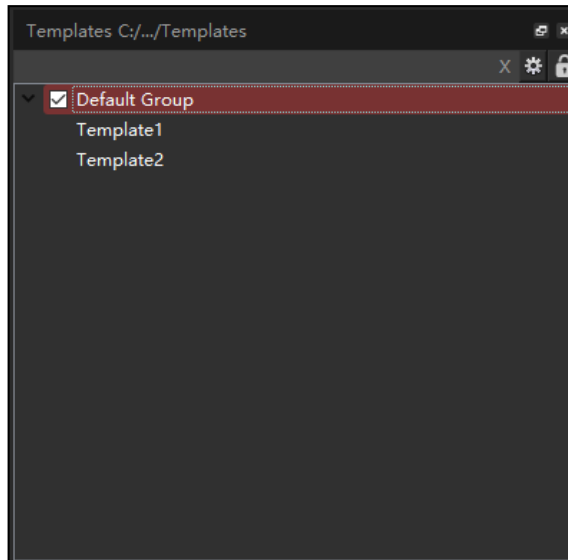
5.3.1. Templates

Show Templates Dock Panel

To display the Templates dock panel, select the **[VIEW]** tab and enable the “Templates” option in the “Dock Panels” menu.

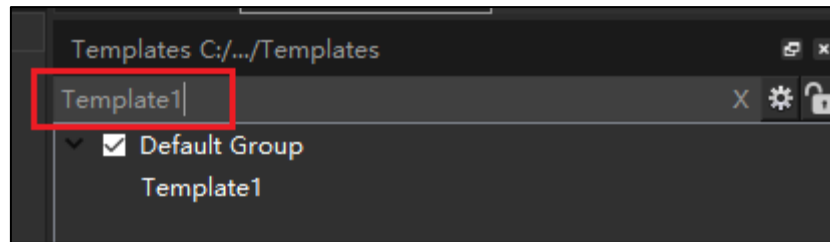


The Templates panel is displayed on the lower right corner of the screen.



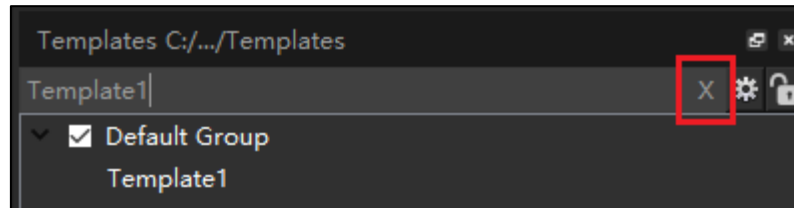
UI elements and Mouse behaviors

- **Search Window**
Search for a template by keyword.



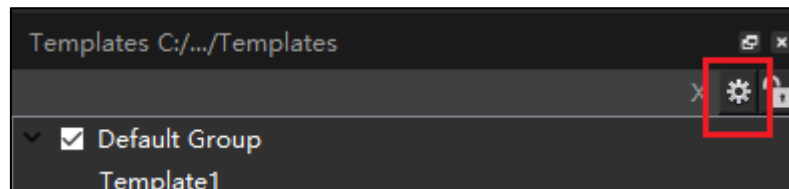
- **Clear Search Text**

Clear a keyword text from the search window.



- **Settings**

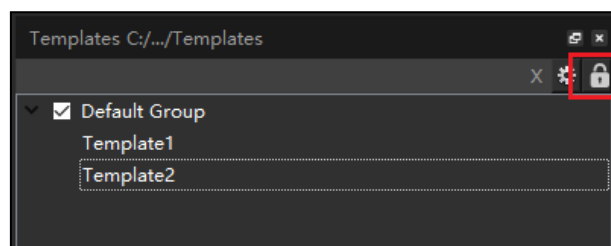
You can change the path of template folder.



- **Lock**

To edit the template, click the "Lock" button and enter the password to unlock it.

The default password is "3dii".

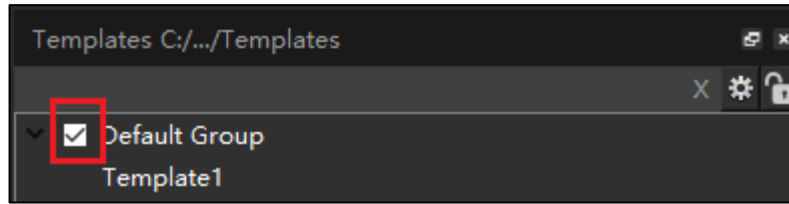


- **Check a Group**

When you restart HADI v.3, all templates in that group are loaded.

- **Uncheck a Group**

When you restart HADI- iBoard Pro, all templates in that group are not loaded.



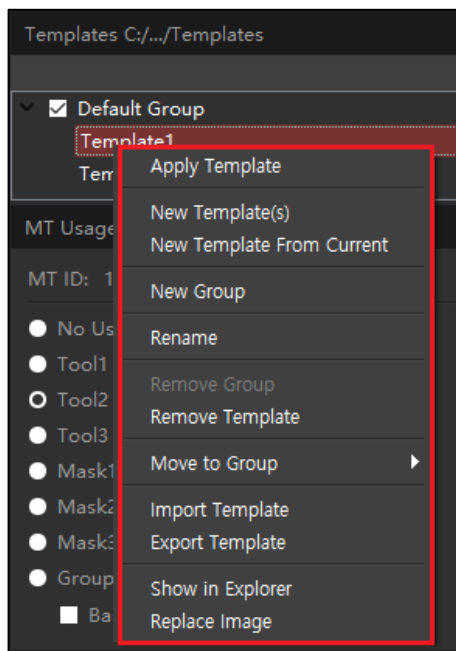
- **Mouse click on the template**

Single click → select a template

Double click → display a template image

Context Menu

Right click on the template dock panel to display the context menu.



- **Apply Template**

Apply the template to the current image to be inspected.

- **New Template(s)**

The Select Image File dialog window opens.

You must select an image to use for the template.

- **New Template from Current**

Create a new template with the currently loaded.

All Measurement Tools and their parameters are copied to the template.

- **New Group**

Create a new group.

You can manage templates with groups.

- **Rename**

Rename a group or a template.

- **Remove Template / Remove Group**

Remove selected template(s) or remove selected group(s).

- **Move to Group**

Move selected template(s) to another group.

- **Import Template**

Import the template (XML file) into HADI-Inspection Pro.

The template is copied to the current template folder.

- **Export Template**

Export the template to your hard disk.

- **Show in Explorer**

Run Windows Explorer to display the Templates folder.

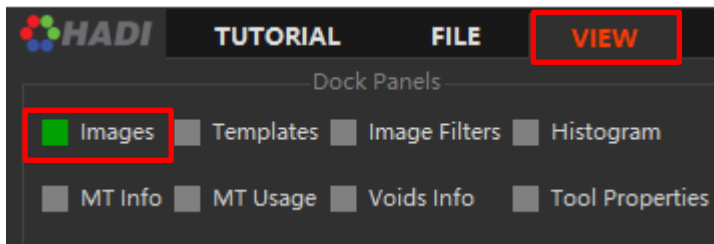
- **Replace Image**

Replace the current template image with another image.

5.3.2. Images

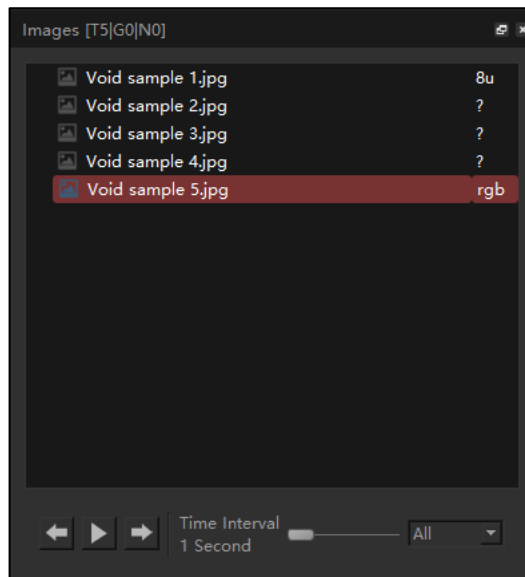
Show Images Dock Panel

To display the Templates dock panel, select the **[VIEW]** tab and enable the “Images” option in the “Dock Panels” menu.



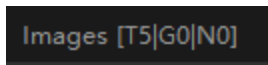
When multiple images are loaded into the image dock panel, not all images are loaded simultaneously into memory. Only the image you click on will be loaded into memory. This is to improve performance.

- The images you didn't click are indicated by "?" in the type column of the image dock panel. When you click on these images, they are loaded into memory and "?" changes to the actual format.
- The images you clicked are indicated by their image format such as "8u", "rgb", "rgba" and "16u".



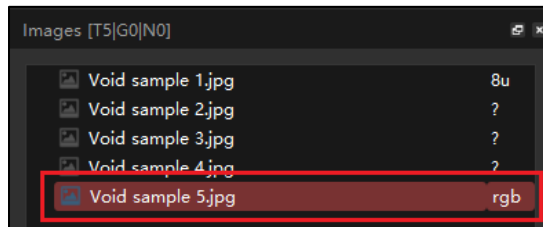
UI elements and Mouse behaviors

- Title



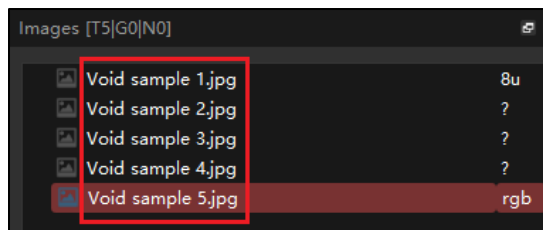
T = Total Images, G = Good Images, N = NG Images

- Red color item



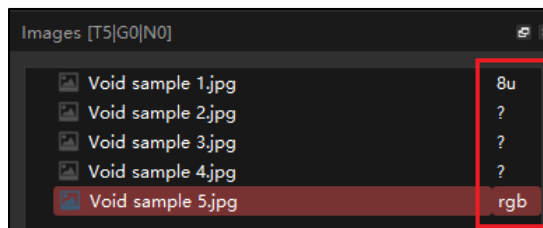
Current selected image. The selected image is displayed in the main view.

- First Column



The name of the image file.

- Second Column



The image formats.

- Click and Drag

Select multiple images at once.

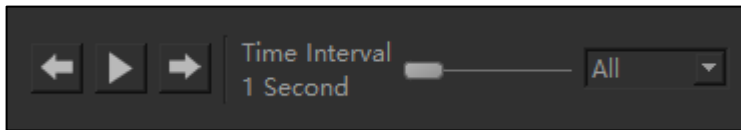
- [Ctrl] + Click

Select multiple images individually.

- [Shift] + Click

Select multiple images at once.

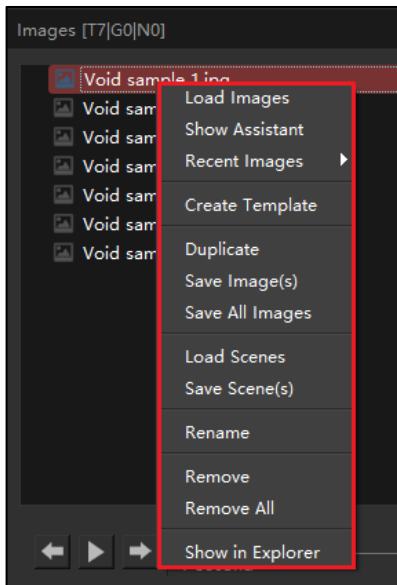
Bottom Toolbar



1.  Click to view previous image.
2.  Click to play a slideshow of images.
3.  Click to view next image.
4.  Set the time interval for the slideshow.
5.  Set the target of the slideshow. "All images", "Good image" or "NG image".

Context Menu

Right click on the images dock panel to display the context menu.



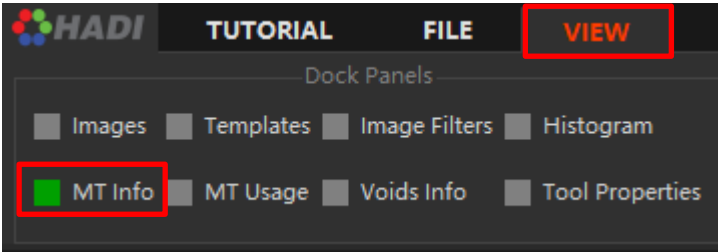
- **Load Images**
Load images into the images dock panel.
- **Show Assistant**
Display the image assistant window.
- **Recent Images**
Load recently used images or folders.

- **Create Template**
Create a template from the selected image.
- **Duplicate**
Make a copy of the selected image.
- **Save Image(s)**
Save selected image(s).
- **Save All Images**
Save all images in the images dock panel.
- **Load Scenes**
Load a scene file.
- **Save Scene(s)**
Save selected images as scenes individually.
- **Rename**
Rename the selected image.
- **Remove**
Remove the selected image(s) from HADI-Inspection Pro.
- **Remove All**
Remove all images in the images dock panel from HADI-Inspection Pro.
- **Show in Explorer**
Run Windows Explorer to display the folder that contains the selected image file.

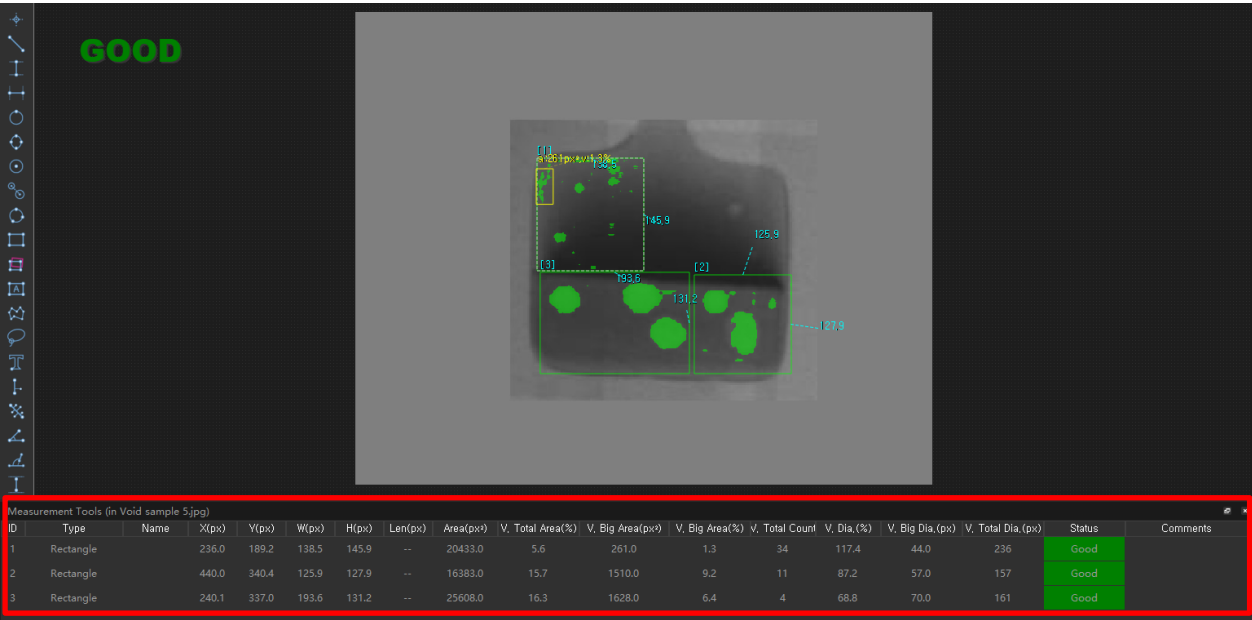
5.3.3. MT Info

Show MT Info Dock Panel

To display the MT Info dock panel, select the **[VIEW]** tab and enable the “MT Info” option in the “Dock Panels” menu.



The MT Info panel displays the information and properties of the measurement tools for the current image in the main view.

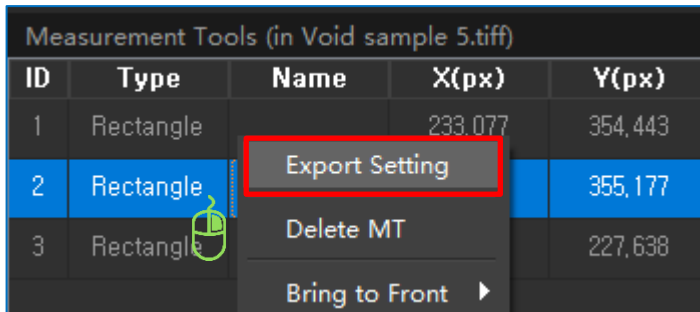


- **ID**
ID of a measurement tool.
- **Type**
Type of a measurement tool.
- **Name**
Name of a measurement tool.

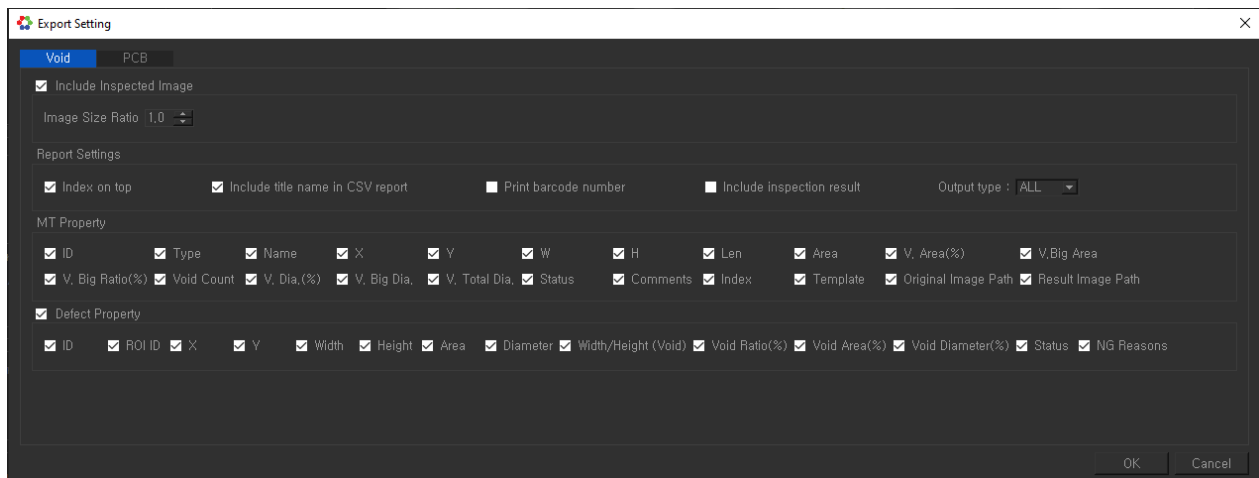
- **X**
X coordinate of the upper left position of the measurement tool.
- **Y**
Y coordinate of the upper left position of the measurement tool.
- **W**
Width of a measurement tool.
- **H**
Height of a measurement tool.
- **Len**
Length of a non-closed shape measurement tool.
- **Area**
Area of a closed-shape measurement tool.
- **V. Total Area (%)**
The percentage of the total void area ratio of the measurement tool.
- **V. Big Area**
Area of the biggest void of the measurement tool.
- **V. Big Area (%)**
The percentage of the biggest void area ratio of the measurement tool.
- **V. Total Count**
The number of voids in the measurement tool.
- **V. Dia. (%)**
The ratio of “sum of each void’s diameter” to “measurement tool’s diameter”.
- **V. Big Dia.**
The diameter of the biggest void of the measurement tool.
- **V. Total Dia.**
The total diameter of voids of the measurement tool.
- **Status**
The evaluation status of a measurement tool.
 (“Good” = Good, “NG” = NG, “Pending” = Not Inspected, “--” = Not Inspectable).
- **Comments**
Additional comments (or properties) of a measurement tool.
(e.g. start and end points of a Line Tool)

Export Settings

Right click on the MT Info dock panel and click “Export Setting” menu.



The “Export Setting” include the following options:



Void

- **Include Inspected Image**

Select this option to include a screenshot of inspected image in the exporting file.

- **Report Settings**

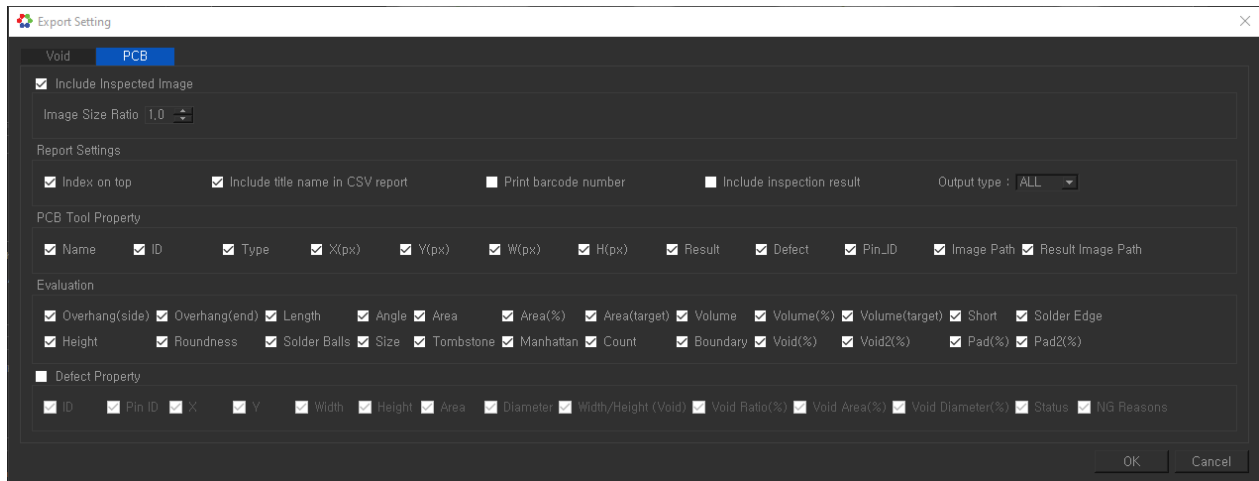
Select this option to include inspection results in the exporting file.

- **MT Property**

Select the column of properties you want to show or hide in the MT information panel.

- **Defect Property**

Select the column of “Void Info” you want to show or hide in the MT information panel.



PCB

- **Include Inspected Image**

Select this option to include a screenshot of inspected image in the exporting file.

- **Report Settings**

Select this option to include inspection results in the exporting file.

- **PCB Tool Property**

Select the column of properties you want to show or hide in the Tool Properties panel.

- **Evaluation**

Select the column of inspection items you want to show or hide in the Tool Properties panel.

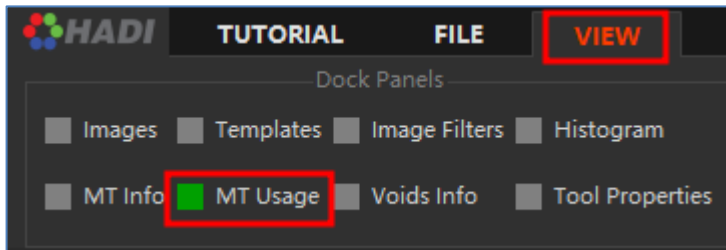
- **Defect Property**

Select the column of “Void Info” you want to show or hide in the MT information panel.

5.3.4. MT Usage

Show MT Usage Dock Panel

To display the MT Usage dock panel, select the **[VIEW]** tab and enable the "MT Usage" option in the "Dock Panels" menu.

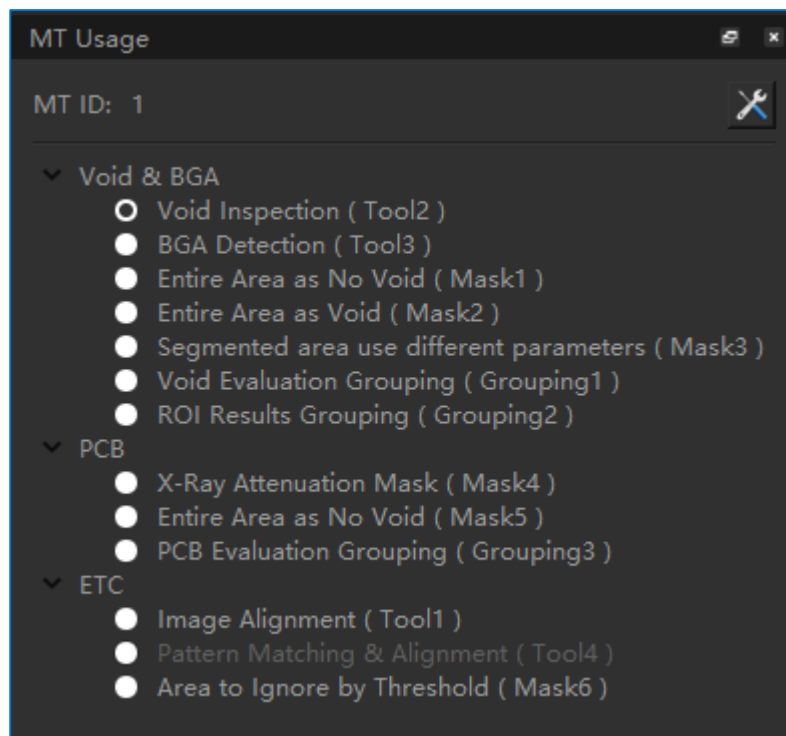


By default, when you create a MT in the Measurements panel, it is set to one of the following:

- "Tool2 (Void Inspection)" for closed-shape MT.
- "No Usage" for non-closed shape MT.

MT Usages

HADI v.3 supports several "MT usage" and varies depending on the product type of the HADI series.



- **Tool1 (Image Alignment)**

Set the selected MT to the image alignment tool in the template.

If you don't use this option, HADI v.3 will use the entire image area as the basis for image alignment.

In some cases, it takes time to perform image alignment depending on the image resolution.

To improve performance, you can define a specific area as the basis for image alignment.

In this case, you can apply this option to the selected MT in the template.

[Notice]

- The size of the MT should not be too small.
- A template image can have only one image alignment tool.
Using more than one will result in unexpected image alignment.

- **Tool2 (Void Inspection)**

Set the selected MT to the Void Inspection tool. The MT must be a closed-shape MT.

- **Tool3 (BGA Detection)**

Set the selected MT to the BGA Detection tool. The MT must be a closed-shape MT.

- **Mask1 (Entire Area as No Void)**

Set the entire area of the selected MT to the "No Void" area.

- **Mask2 (Entire Area as Void)**

Set the entire area of the selected MT to the "Void" area.

- **Mask3 (Segmented Area as Void)**

Set the segmented area of the selected MT to the "Void" area.

- **Mask4 (X-Ray Attenuation Mask)**

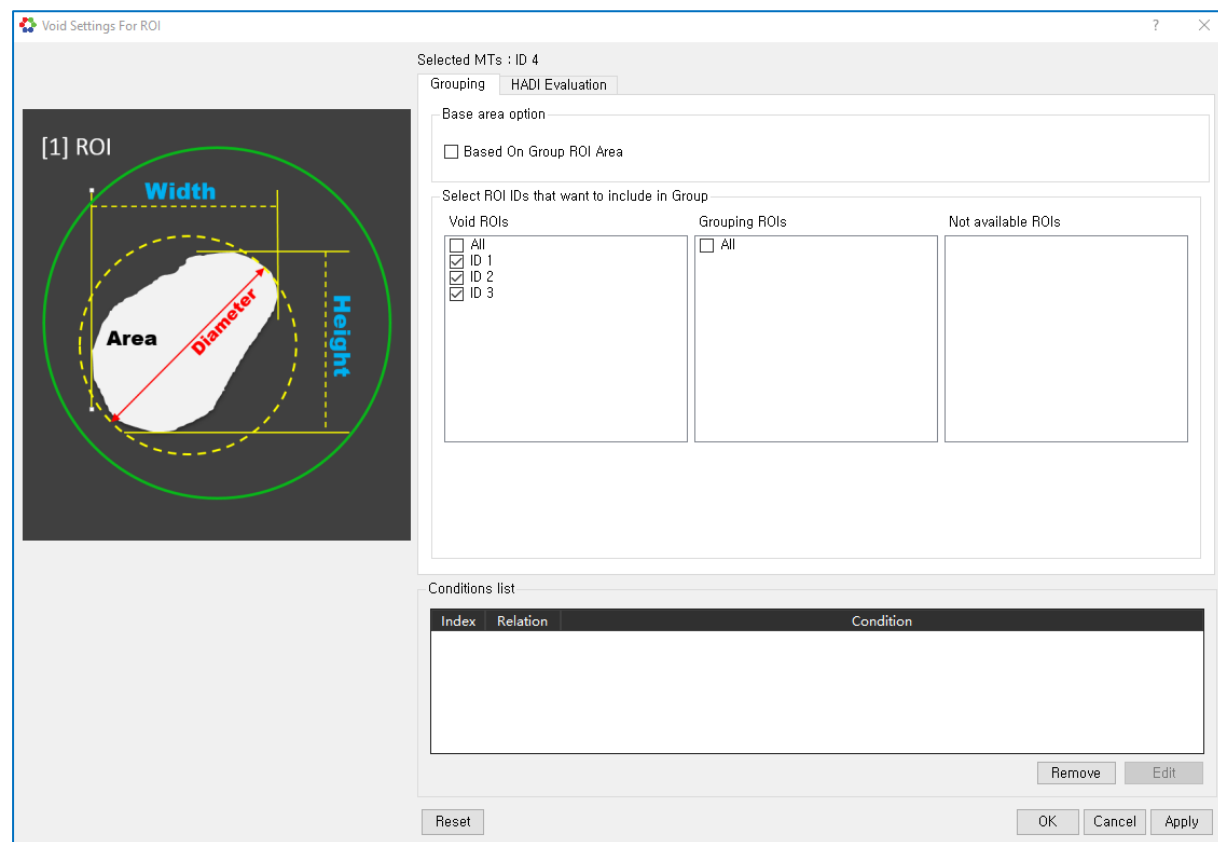
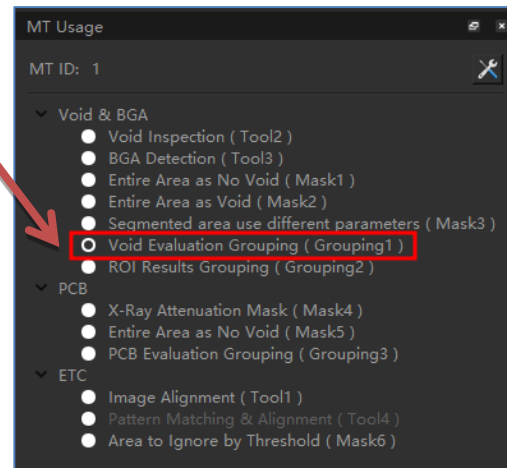
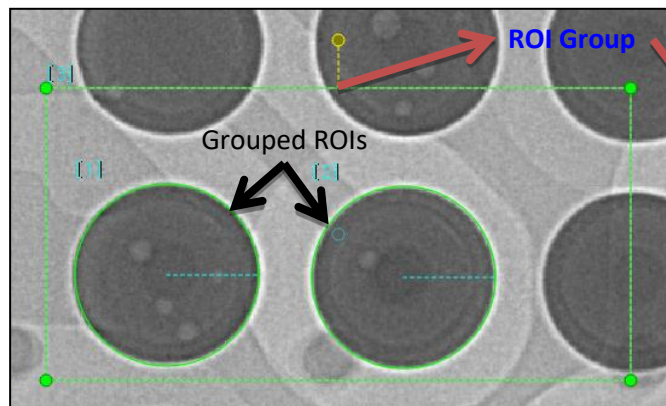
Set selected MT as X-Ray Attenuation Mask. see Mask Tools.

- **Grouping1 (Void Results Grouping)**

Set the selected MT to the Void Results grouping tool.

This MT must contain other regular MTs for grouping.

- "Based On Group ROI Area": if you select this checkbox, ROI Group evaluates only the area of grouped MT, not all area of ROI Group.

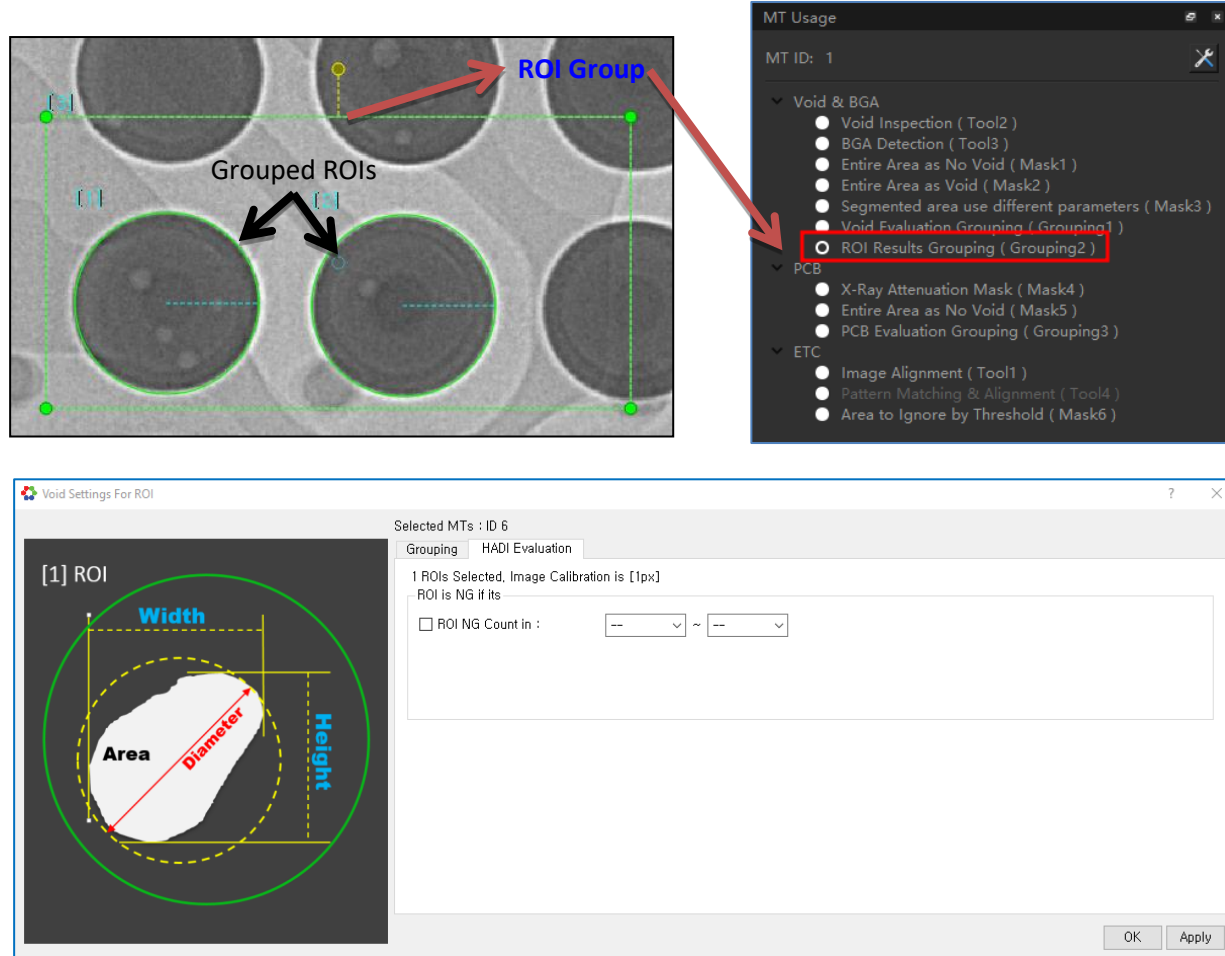


- **Grouping2 (MT Evaluation Grouping)**

Set the selected MT to the Select ROI grouping tool.

This MT must contain other regular MTs for grouping.

- . You can select only the ROIs to set conditions for evaluation.



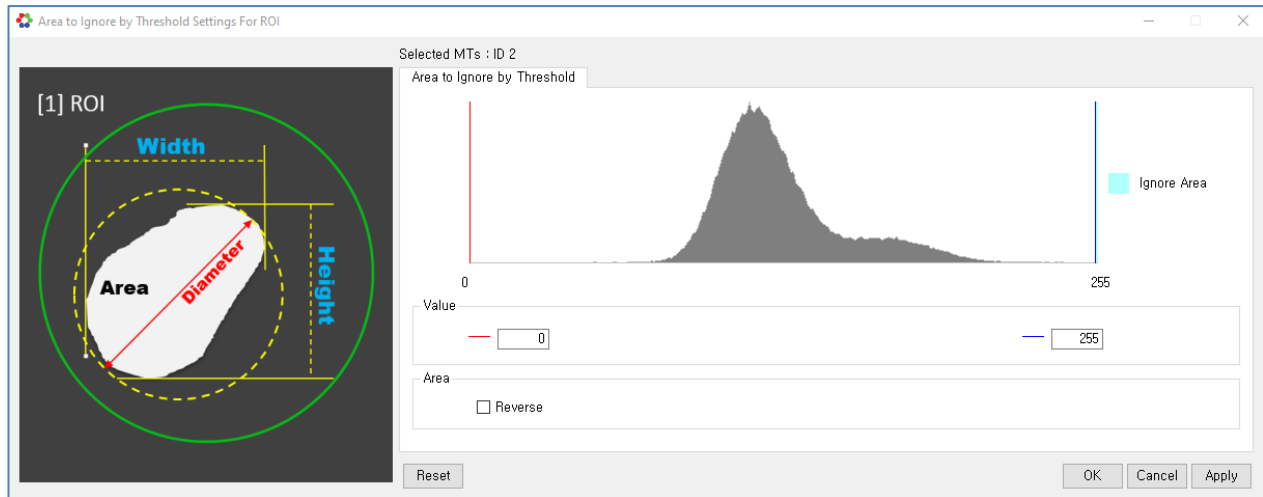
- **Grouping3 (PCB Evaluation Grouping)**

Set selected MT as PCB Evaluation grouping tool. see MT Grouping.

The screenshot displays the HADI v.3 software interface. The top section, titled 'Grouping Evaluation', contains the text 'ROI is NG if its' and 'ROI NG Count in :'. Below this, there are two numeric input fields with up/down arrows, containing the values '1' and '2', separated by a tilde '~'. The bottom section, titled 'ROI List(All)', contains a list of checkboxes: 'All' (unchecked), 'ID 1' (checked), 'ID 2' (checked), and 'ID 3' (checked).

- **Mask6 (Area to Ignore by Threshold)**

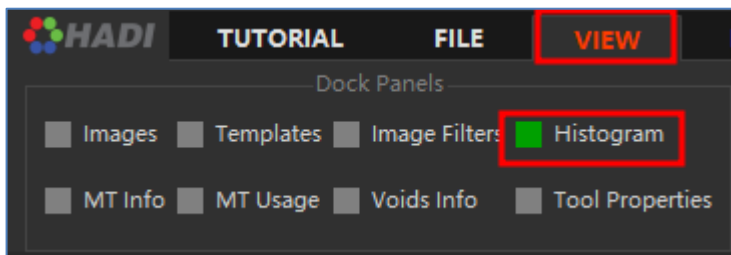
Set the selected MT as the tool that sets the exclusion area by the reference value for the ROI.



5.3.5. Histogram

Show Histogram Dock Panel

To display the Histogram dock panel, select the **[VIEW]** tab and enable the "Histogram" option in the "Dock Panels" menu.



Histogram and Profile

The histogram panel is then displayed on the right side of the screen.

If no ROI is selected, a **histogram** of the entire image is displayed.

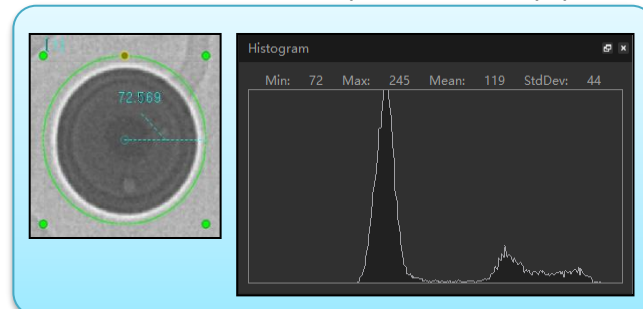
If a ROI is selected,

- ROI is a closed shape (e.g. Circle, Polygon or Rectangle):
A **histogram** of the ROI is displayed on it.
- ROI is a non-closed shape (e.g. Line):
A **profile** of the ROI is displayed on it.

The top label of the histogram or profile shows the minimum, maximum, average, and standard deviation values of the images within the ROI



Profile for a Line ROI (non-closed shape)

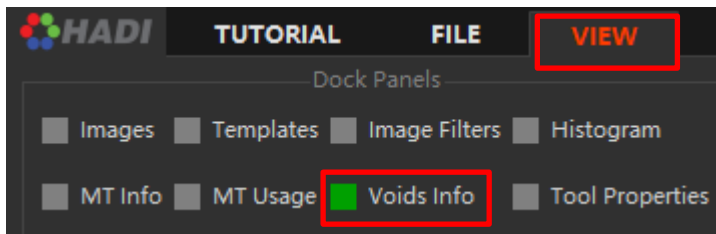


Histogram for a Circle ROI (closed shape)

5.3.6. Voids

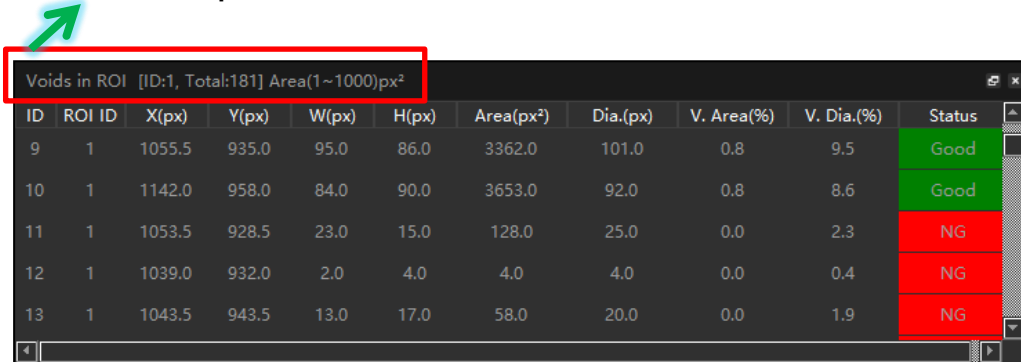
Show Voids Info Dock Panel

To display the Voids Info dock panel, select the **[VIEW]** tab and enable the "Voids Info" option in the "Dock Panels" menu.



The "Voids Info" dock panel displays the void information for the selected measurement tool (ROI).

The title of dock panel: it shows the ID and the evaluation conditions of the selected ROI.



ID	ROI ID	X(px)	Y(px)	W(px)	H(px)	Area(px²)	Dia.(px)	V. Area(%)	V. Dia.(%)	Status
9	1	1055.5	935.0	95.0	86.0	3362.0	101.0	0.8	9.5	Good
10	1	1142.0	958.0	84.0	90.0	3653.0	92.0	0.8	8.6	Good
11	1	1053.5	928.5	23.0	15.0	128.0	25.0	0.0	2.3	NG
12	1	1039.0	932.0	2.0	4.0	4.0	4.0	0.0	0.4	NG
13	1	1043.5	943.5	13.0	17.0	58.0	20.0	0.0	1.9	NG

- **ID**
ID of the void.
- **ROI ID**
ID of the ROI to which the void belongs.
- **X**
X coordinate of the upper left position of a void.
- **Y**
Y coordinate of the upper left position of a void.
- **W**
Width of a void.

- **H**
Height of a void.
- **Area**
Area of a void.
- **Dia.**
Diameter of a void.
- **Width/Height**
Value of dividing width by height of Void.
- **Void Ratio**
The percentage of the total voids area ratio in ROI.
- **V.Area**
The percentage of the void area ratio.
- **V.Dia**
The percentage of the void diameter ratio.
- **Status**
The evaluation status of void inspection.
- **NG Reasons**
Shows the NG reasons if its evaluation is NG.

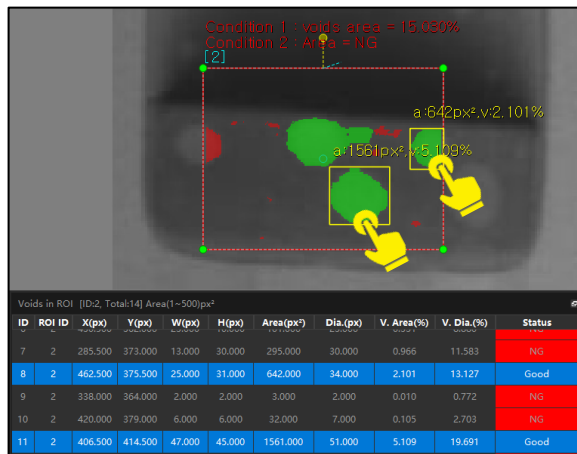
Mouse Actions

When you click any cell in the “Voids Info” panel, the selected row is highlighted and the corresponding void in the image is also selected.



If you click any void in the image, the corresponding row in the “Voids Info” dock panel is also selected.

Multiple selections are also supported.



Export Settings

See "Export Settings" in the "MT Info" dock panel.

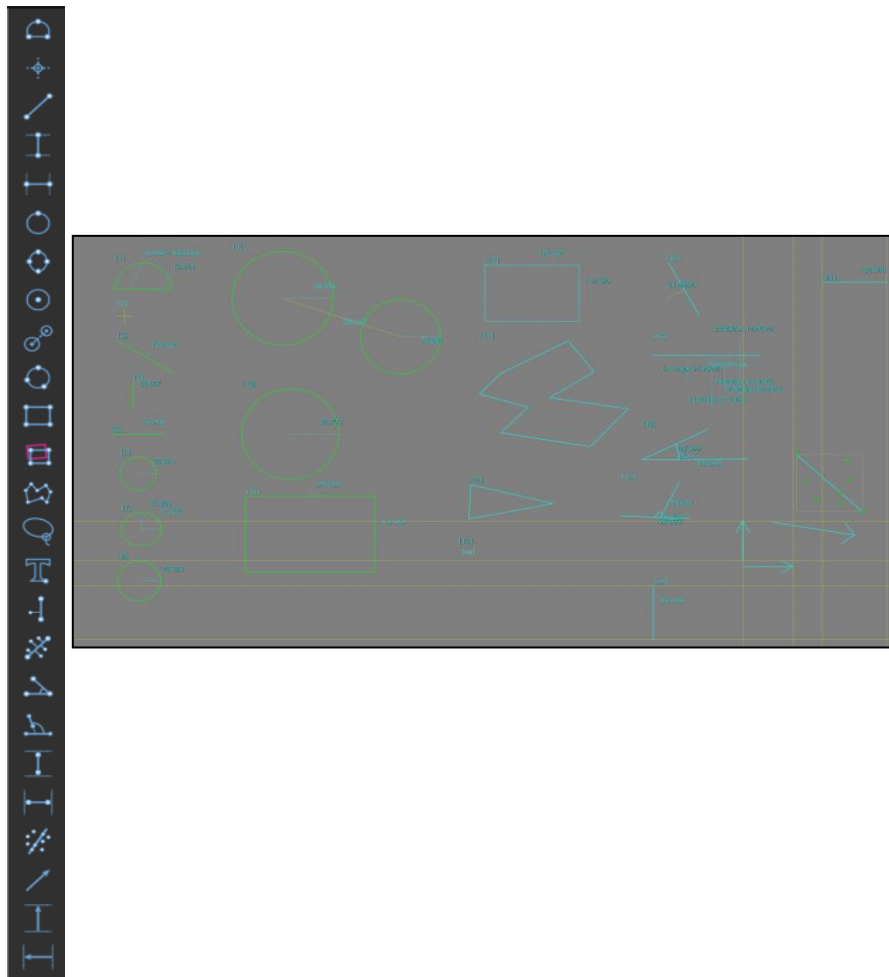
5.4. Measurements

5.4.1. Measurement Tools

HADI v.3 supports 26 measurement tools (MT).

Click on a MT in the MT panel and insert it into the current image.

- | | |
|------------------------|----------------------------|
| - Chord | - Point |
| - Free Line | - Vertical Line |
| - Horizontal Line | - Circle |
| - Ellipse | - Circle from center |
| - Circle to Circle | - Circle from three Points |
| - Rectangle | - Alignment Tool |
| - Polygon | - Lasso |
| - Text | - Solder fill tool |
| - Perpendicular tool | - Angle from three Points |
| - Angle from two lines | - Vertical Ruler |
| - Horizontal Ruler | - Fit Points |
| - Arrow | - Vertical Arrow |
| - Horizontal Arrow | - Rectangle Auto |



5.4.2. Closed Shapes

Chord



Usage

Usually used for void inspection.

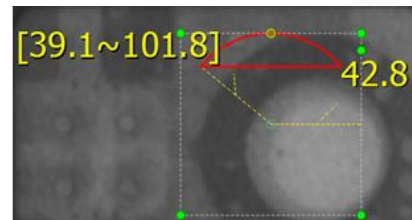
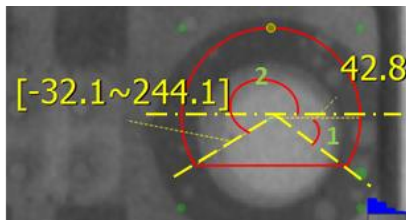
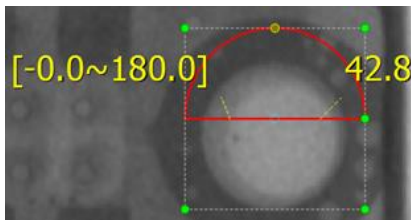
Annotation Example

Radius: 42.8

In this sample, 42.8 means the radius of the potential circle.

Angle: $[-32.1^\circ \sim 244.1^\circ]$

In this sample, angle 1 = -32.1° , angle 2 = 244.1°



Circle



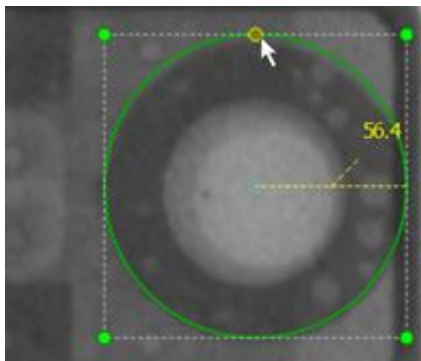
Usage

Usually used for void inspection.

Annotation Example

Radius: 56.4

In this sample, 56.4 means the radius of the circle.



Circle to Circle



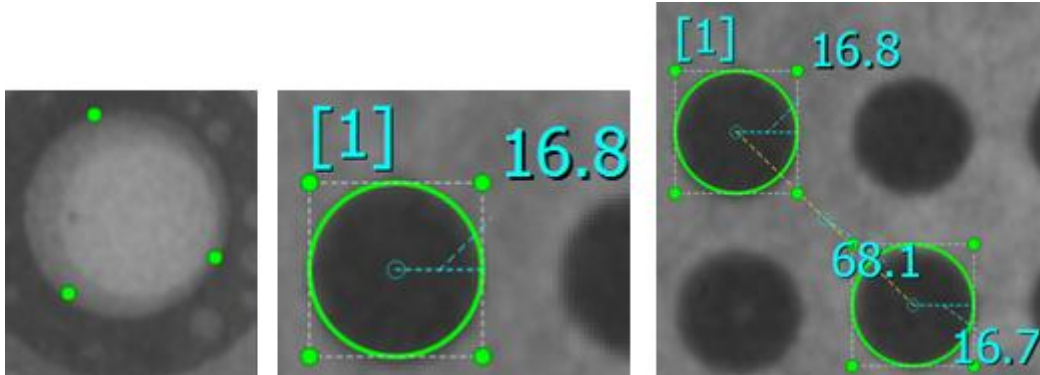
Usage

Usually used for void inspection.

Annotation Example

Radius: 16.8 and 16.7 mean the radius of the two circles.

Distance: 68.1 means the distance between the two circles (from center to center).



Ellipse



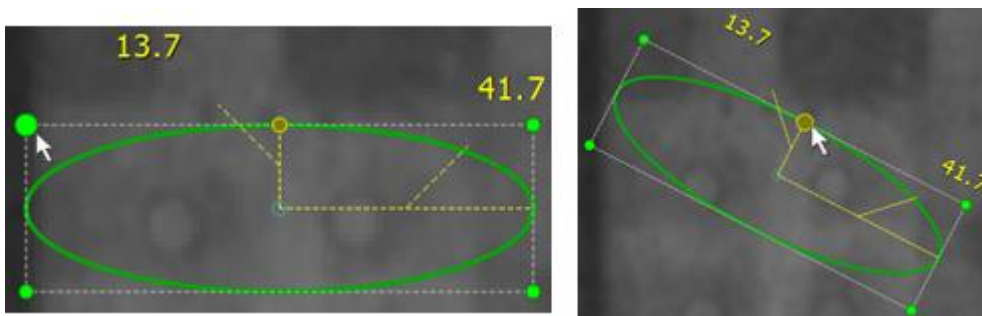
Usage

Usually used for void inspection.

Annotation Example

Major radius & Minor radius:

In this sample, 41.7 means the major radius and 13.7 means the minor radius of the ellipse.



Rectangle



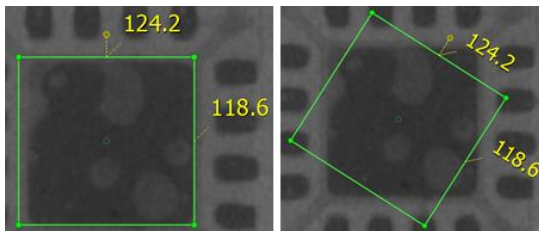
Usage

Usually used for void inspection.

Annotation Example

Length: 124.2 means the length of the rectangle.

Width: 118.6 means the width of the rectangle.

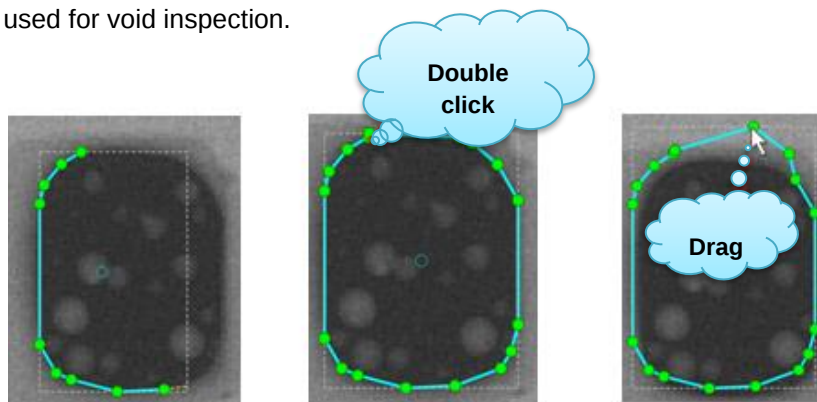


Polygon



Usage

Usually used for void inspection.

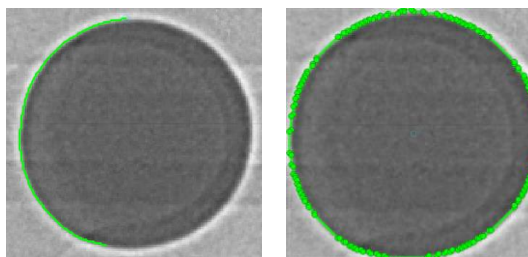


Lasso



Usage

Usually used for void inspection.

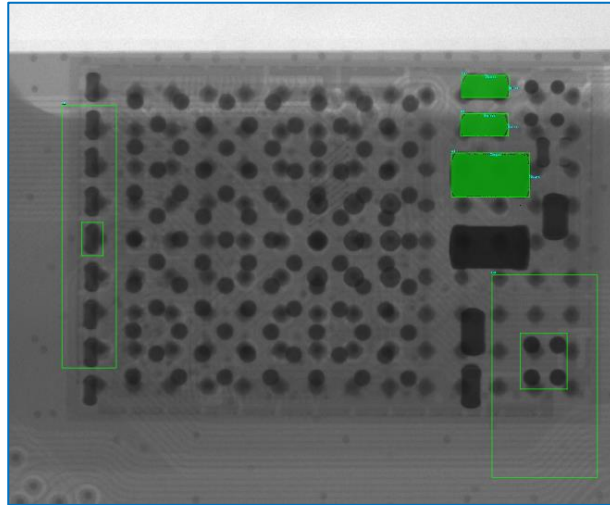


Pattern Matching



Usage

Usually used to find features registered in the search area or part of an image.

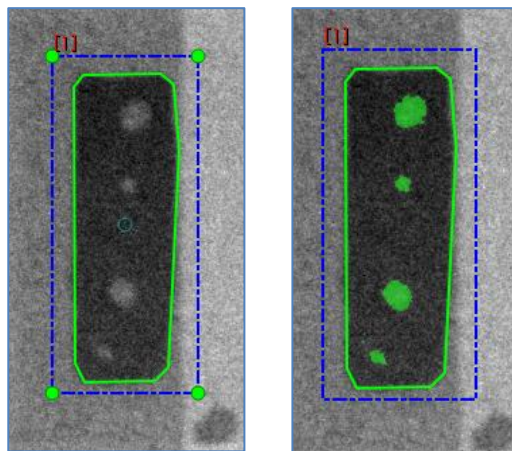


Rectangle Auto



Usage

Usually used for void inspection.



5.4.3. Non-Closed Shapes

Line Tools



Usage

Usually used to measure length or height.

[NOTE]

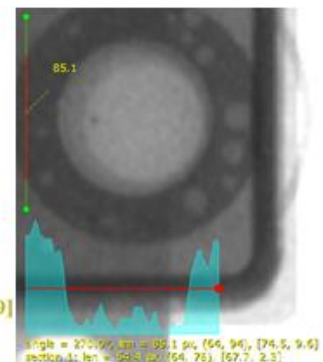
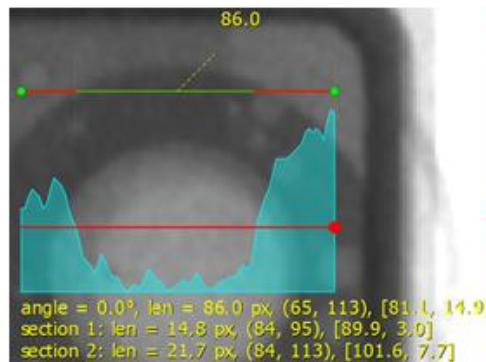
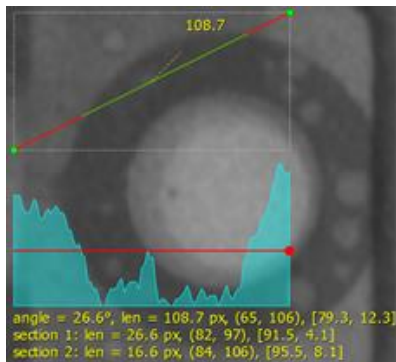
HADI v.3 uses **red** and **green** colors to separate lines into sections based on profile thresholds. If you cannot distinguish between sections, change the measurement tool border color to a different color (not red).

Annotation Example

1. Angle: the angle between the horizontal and free line (counterclockwise)
2. Length: displayed in pixels or calibrated unit.
3. Intensity Value:
(65,106) and [79.3, 12.3] = (min, max) and [mean, variance] intensity value of the line.
4. Section: length and intensity values for each red section.

[NOTE]

1. Double-clicking the line changes the measurement part (indicated by **red**).
2. Only the measurement (**red part**) information is displayed in the annotation.



Text Tool



Usage

It is typically used to insert information about measurement tools.



Ratio Tool

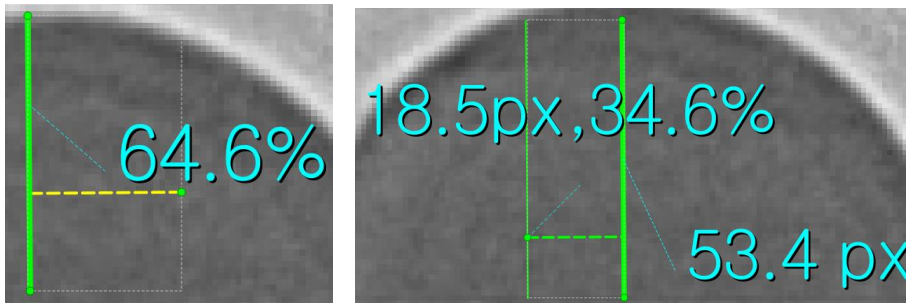


Usage

It is typically used to measure the ratio of the length of a vertical point to a set criterion (length).

Annotation Example

Ratio: the ratio of the length of a vertical point to a set criterion (length).



Distance Tool

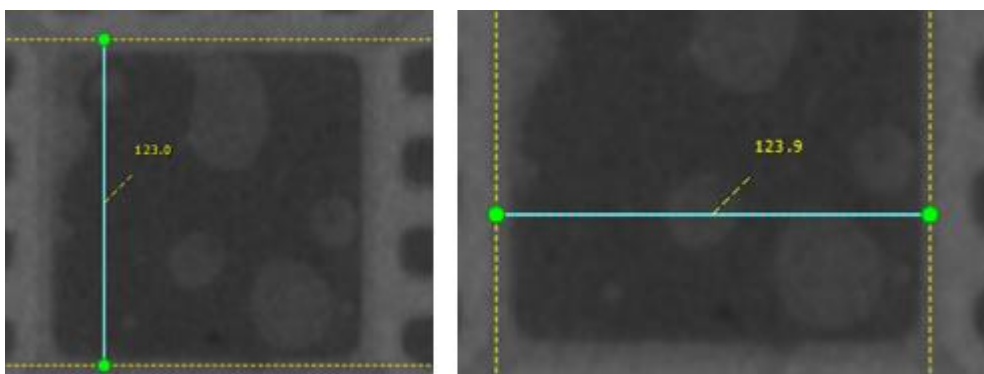


Usage

It is usually used to measure the length or width of the chip.

Annotation Example

Length: The length from the start point to the end point of the ruler.
It is displayed in pixels or calibrated unit.



Angle Tools

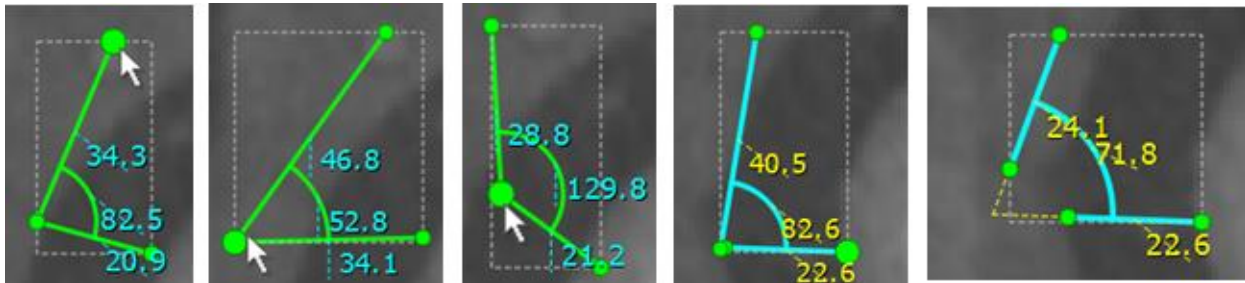


Usage

It is usually used to measure the angle between two lines.

Annotation Example

Angle: The angle between two lines.



Others

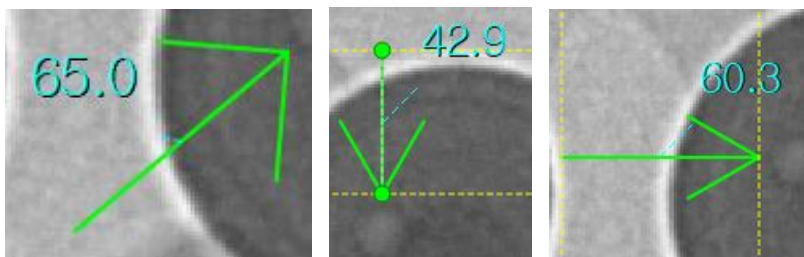


Usage

Usually used to mark a specific part.

Annotation Example

Length: The length from the start point to the end point of the ruler.
It is displayed in pixels or calibrated unit.



5.4.4. MT – PCB

HADI - iBoard has provided a series of Chip tools to help inspecting PCB chips. Now it supports various standard chips and their variations, such as C-Chip, R-Chip, L-Chip, QFP/QFN, BGA, Mic etc.

General Tool



Usage

Usually used to inspect C-Chip. Click icon  to add a General Tool from "PCB INSPECTION" tab.

Also, can be used to check some important features of other unknown chips. For example, to check the boundary, angle, object count, length, and roundness of some unknown chips.

Parameters

☐ Auto Threshold :

sigma = 6.00

☒ Fixed Threshold :

from : 0 to: 50

Morph: None

size = 1

Inspection

☒ Check Solder Area (2D) :

check area by Ratio

☐ base area = 920 px²

minimum = 50%

maximum = 200%

☐ Check Solder Volume (3D) :

check volume by Ratio

☐ base volume = 1px³

minimum = 50%

maximum = 200%

☐ Check Count :

valid count = 1

object size >= 10px²

☒ Check Boundary

offset <= 6 px

☒ Check Side Overhang :

offset <= 6 px

☒ Check End Overhang :

offset <= 6 px

☒ Check Length:

maximum offset = 6 px

minimum offset = -6 px

☐ base length = 49 px

☒ Check Direction (angle)

offset <= 4°

☐ Check Roundness :

☐ base angle = 89°

☐ Check Wrong Part:

roundness >= 0.80

set max solder height = 16 px

Parameter Settings

Auto Threshold

Segment the target object automatically by sigma value. The sigma value controls the segmentation area of target object. The sigma also represents the coherence of the target object. Default value is 6. It is similar with the “Standard Deviation of Object Intensity Values”, so if the object has homogeneous intensity values, the Sigma can use smaller value. While the object has inhomogeneous intensity values, its standard deviation can be larger, the Sigma should be larger.

Fixed Threshold

Using fixed threshold to segment the target object. The target object's intensity value is set from “from value” to “to value”. For example, if we use 30 ~ 50, it means the segmentation intensity values of the object are between 30 ~ 50.

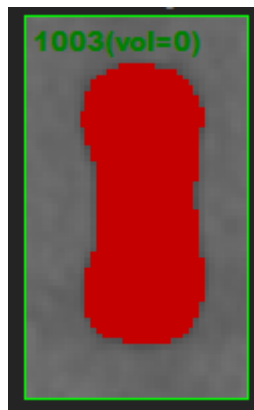
Morph

Apply morphology after segmentation. There are 4 morphology operations with kernel size.

Inspection Items

Check Solder Area

Check the solder area size. The area size is just the segmented RED area shows in the preview window “Current Image ROI”



- The red area is the solder area size. The number 1003 shows the area size, and if checked “Check Solder Volume” option, the volume size will be shown as (vol=#).
- User can also define the Base size.
- Base Value: Base value tries to replace the unstable Template value when calculating the Ratio.

- Check solder area by Ratio
 - If base size checked, $\text{Ratio} = \text{area size in target image} / \text{base size}$.
 - If base size unchecked, $\text{Ratio} = \text{area size in target image} / \text{area size in Template image}$.

NG DEFINITION: $\text{Ratio} < \text{minimum}$ or $\text{Ratio} > \text{maximum}$.

- Check solder area by Pixel count

NG DEFINITION: $\text{Pixel Count} < \text{minimum}$ or $\text{Pixel Count} > \text{maximum}$

Check Solder Volume

Same as solder area calculation. The difference is that the value is defined from the internal Volume calculation algorithm.

Check Count

Check that how many objects inside the General Tool. Objects size (pixel area size) that less than defined size will be ignored.

NG DEFINITION: Count in image is not equal to defined count.

Check Boundary

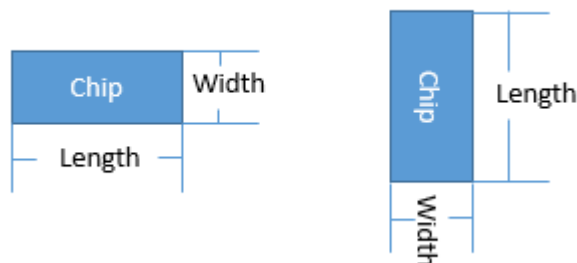
Check that there is no object attached to the boundary border. The boundary offset defines the area that larger than the object size from TOP, LEFT, RIGHT, BOTTOM direction.

NG DEFINITION: Any object that attached to the boundary border.

Check Side Overhang

Check the side overhang. Side overhang evaluates the chip's movement along the width direction. An offset defines the maximum allowed movement pixel value.

NG DEFINITION: $\text{Overhang} > \text{Defined Offset}$



Check End Overhang

Check the end overhang. End overhang evaluates the chip's movement along the length direction. An offset defines the maximum allowed movement pixel value.

NG DEFINITION: Overhang > Defined Offset

Check Length

Check the length offset of a chip in target image comparing to the chip length in Template or defined base length.

NG DEFINITION:

- Use base: Chip length in Image - Base length < minimum offset or
- Use base: Chip length in Image - Base length > maximum offset or
- Not Use base: Chip length in Image - Chip length in Template < minimum offset or
- Not Use base: Chip length in Image - Chip length in Template > maximum offset

Check Direction(angle)

Check the center line direction of a chip.

NG DEFINITION: Angle Offset > Defined Offset

Check Roundness

Check the roundness of the boundary of a chip.

NG DEFINITION: Roundness < Defined Roundness

Check Wrong Part

Check whether there is another kind of chip mounted in this position. Now supports wrong mount among R-Chip, L-Chip and C-Chip.

NG DEFINITION: R-Chip or L-Chip mounted in this position.

R/L Chip



Usage

Usually is designed to inspect both R-Chip and L-Chip.

Click icon  to add R/L Chip Tool from "PCB INSPECTION" tab.

☒ Vertical
 ☒ R-Chip
 Threshold Offset: 0

☒ Check Solder Area (2D) :
 check area by Ratio
 base size = 1 px²
 minimum = 30%
 maximum = 200%

☐ Check Solder Volume (3D) :
 check volume by Ratio
 base size = 1 px²
 minimum = 30%
 maximum = 200%

☒ Check Boundary
 offset <= 6 px

☒ Check Side OverHang :
 offset <= 6 px

☒ Check End OverHang :
 offset <= 6 px

☒ Check Length :
 maximum offset <= 6 px
 minimum offset >= -6 px
 base length = 52 px

☐ Check Solder Edge :
 max edge weight = 1

☒ Check Moro :
 sensitivity = 5

☒ Check Manhattan :
 single solder width <= 10 px

☒ Check Wrong Chip
 segmentation radius = 5

Parameter Settings

Vertical

Use this check box to define the layout of R-Chip or L-Chip. The direction can be automatically determined by algorithm. In case the direction is wrong, user need to use the checkbox to modify it.

R-Chip

Use this checkbox to define the target chip is R-Chip or L-Chip. The chip type can be automatically determined.

- Unchecked status: Chip is L-Chip.
- Checked status: Chip is R-Chip.

Threshold Offset

The segmentation for the target chip is automated. The “Threshold Offset” will be added to the automatically determined Threshold value.

Inspection Items

Check Solder Area

Check the solder area size. User can define the base size. (See the Discussion on solder area and base in “General Tool”)

- Check solder area by Ratio
 - If base size checked $\text{Ratio} = \text{area size in target image} / \text{base size}$.
 - If base size unchecked, $\text{Ratio} = \text{area size in target image} / \text{area size in Template image}$.

NG DEFINITION: $\text{Ratio} < \text{minimum}$ or $\text{Ratio} > \text{maximum}$.

- Check solder area by Pixel count

NG DEFINITION: $\text{Pixel Count} < \text{minimum}$ or $\text{Pixel Count} > \text{maximum}$

Check Solder Volume

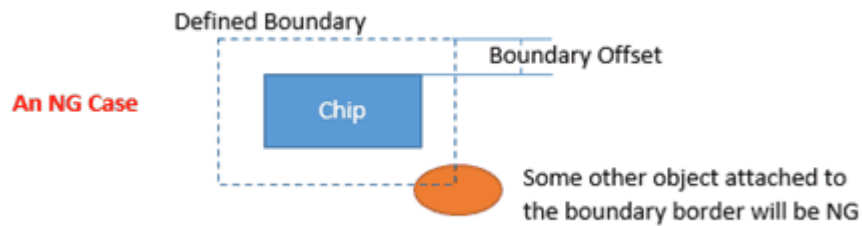
Same as solder area calculation. The difference is that the value is defined from the internal Volume calculation algorithm.

Check Boundary

Check that there is no object attached to the boundary border.

The boundary offset defines the area that larger than the object size from TOP, LEFT, RIGHT, BOTTOM direction.

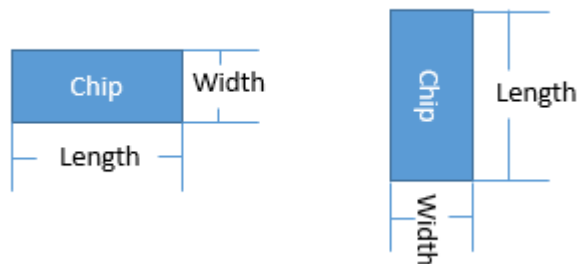
NG DEFINITION: Any object that attached to the boundary border.



Check Side Overhang

Check the side overhang. Side overhang evaluates the chip's movement along the width direction. An offset defines the maximum allowed movement pixel value.

NG DEFINITION: Overhang > Defined Offset



Check End Overhang

Check the end overhang. End overhang evaluates the chip's movement along the length direction. An offset defines the maximum allowed movement pixel value.

NG DEFINITION: Overhang > Defined Offset

Check Length

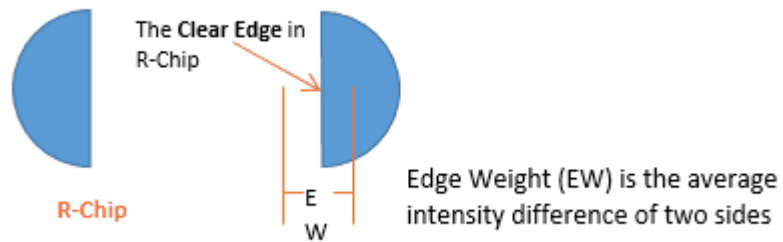
Check the length offset of a chip in target image comparing to the chip length in Template or defined base length.

NG DEFINITION:

- Use base: Chip length in Image - Base length < minimum offset or
- Use base: Chip length in Image - Base length > maximum offset or
- Not Use base: Chip length in Image - Chip length in Template < minimum offset or
- Not Use base: Chip length in Image - Chip length in Template > maximum offset

Check Solder Edge

This option is for R-Chip. It tries to check the intensity value between the Clear Edge.



Check Moro

Check the Moro of a chip. Fully automatic.

Check Manhattan

Check the Manhattan error of a chip. A sensitivity value controls the inspection accuracy. Default value is 5.

Check Wrong Chip

Check whether there is another kind of chip mounted in this position. Now supports wrong mount among R-Chip, L-Chip and C-Chip.

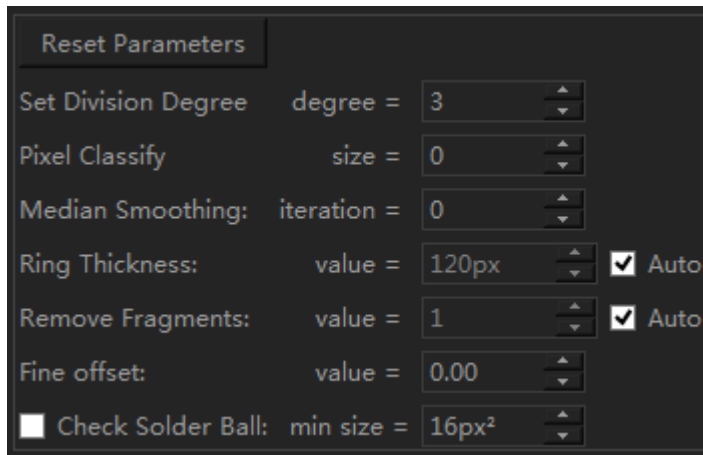
NG DEFINITION: Wrong chips mounted in this position.

Ring Tool



Usage

Usually is designed to inspect Mic. Click on  to add Ring Tool from "PCB INSPECTION" tab.



Parameter Settings

Reset Parameters

Reset all parameters to default.

Set Division Degree

The inspection algorithm divides the Ring into a certain block. Here the division degree defined how many blocks will be divided. Divided Blocks = 360 / Division Degree.

Default value is 3, the Ring is divided into 120 blocks.

NG DEFINITION: If any block contains no segmented pixel, recognized as Disconnected NG.

Pixel Classify

Deprecated.

Median Smoothing

Deprecated.

Ring Thickness

For the Mic segmentation, please use "Auto".

Remove Fragments

For the Mic segmentation, please use "Auto".

Find Offset

Slightly tuning the mic segmentation result.

- The higher value, the segmentation will be more strictly.
- The lower value, the segmentation will be more loosely.

Check Solder Ball

Check the Solder Ball. Users need to define the minimum solder ball size.

QFP/QFN Tool



Usage

Usually, can be used to inspect QFP-like Chip. Click icon  to add a QFP/QFN Tool from "PCB INSPECTION" tab.

The screenshot shows the 'Parameters' and 'Inspection' sections of the QFP/QFN Tool interface.

Parameters Section:

- ☐ Use Central Mask
- ☐ Use 2-Section Pin
- ☒ Show Information
- Auto Thresholding Offset:
- Reset Pins button

Inspection Section:

- ☒ Check Solder Area: Ratio
 - inner: min = 30%, max = 300%
 - outer: min = 30%, max = 300%
- ☐ Check Solder Volume: Ratio
 - inner: min = 30%, max = 300%
 - outer: min = 30%, max = 300%
- ☒ Check Short
- ☐ Check Void
 - bounding =

Parameter Settings

Use Central Mask

Use central mask to remove objects inside the central mask ROI. The ROI is using Yellow Dashed rectangle.

Generally, the algorithm will automatically remove the center object of a QFP.

Reset Pins

Reset the Pin shape.

Use 2-Section Pins

In Checked status, each Pin will be divided into two parts. And the evaluation of Area size and Volume size will be separated into inner pin and outer pin.

Show Information

Show the Area and Volume information of each Pin.

Auto Thresholding Offset

QFP tool use full adaptive Thresholding technique. If user set the Thresholding offset, the final thresholding value = Adaptive Thresholding value + Thresholding offset.

Inspection Items

Check Solder Area

Check the solder area size. User can define the base size.

- Check solder area by Ratio

Ratio = area size in target image / area size in Template image.

NG DEFINITION: Ratio < minimum or Ratio > maximum.

- Check solder area by Pixel count

NG DEFINITION: Pixel Count < minimum or Pixel Count > maximum

Check Solder Volume

Same as solder area calculation. The difference is that the value is defined from the internal Volume calculation algorithm.

Check Short

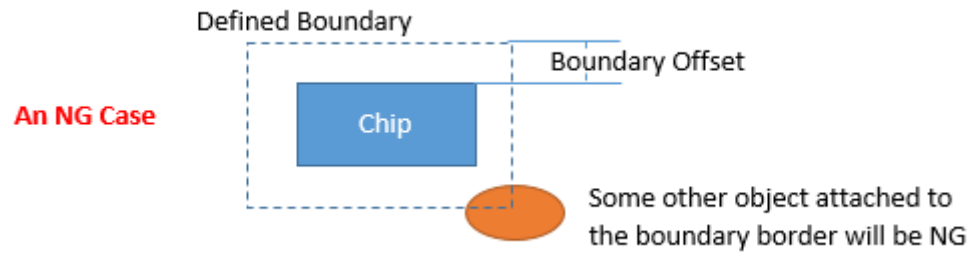
Check short among Pins.

NG DEFINITION: Any two pins are connected

Check Boundary

Check that there is no object attached to the boundary border. The boundary offset defines the area that larger than the object size from TOP, LEFT, RIGHT, BOTTOM direction.

NG DEFINITION: Any object that attached to the boundary border.



BGA/Pins Tool



Usage

Usually designed to inspect BGA, QFP and any other chip that contains pins. It is a kind of General tool to inspect chips with pins.

The screenshot displays the BGA/Pins Tool interface, which is divided into several sections for configuring inspection parameters.

- View:**
 - Pin Shape: Contour
 - ☒ Show Pin ID
 - ☐ Show Area/Volume Info
 - ☒ Show Pins of Target Image
 - ☒ Show Pins of Template Image
- Smoothing:**
 - ☒ Use Smoothing:
 - smoothing kernel size = 3
 - smoothing iteration = 3
- Pin Segmentation:**
 - ☒ Auto Global Thresholding:
 - intensity range from 0 ~ 200
 - thresholding offset = 0
 - ☐ remove background = 8
 - ☐ on partial board
 - ☒ Auto Local Thresholding:
 - radius = 50
 - fine offset = 0.0
- Pin Filter:**
 - ☐ Remove Pins on edge
- Pin Inspection:**
 - Reset Paras, Reset Pins, Edit ID, Edit Pins
 - ☒ Check Solder Area (2D):
 - base size = 1 px²
 - min = 50%
 - method = Ratio
 - max = 200%
 - Height & Volume Inspection:**
 - height offset = 0
 - height base = 0
 - height Ref. = Average
 - ☐ Check Height (3D):
 - method = Median
 - min = 0
 - max = 0
 - ☐ Check Solder Volume (3D):
 - method = Ratio
 - min = 50%
 - max = 200%
 - sigma = 0.30
 - ☐ Check Void: void ratio based on = Image Pin Area
 - ☐ Check Short
 - ☐ Check Boundary:
 - Width = 7 px
 - height = 7 px
 - ☐ Check Side Overhang:
 - min offset = 8 px
 - ☐ Check End Overhang:
 - min offset = 8 px
 - ☐ Check Solder Ball:
 - min size = 16px²
 - ☐ Use Maxima:
 - tolerance = 15

View

Show Pin ID

Show Pin ID inside ROI.

Show Area/Volume Info

Show Area/Volume information of a Pin inside ROI.

Show Pins of Target Image

Show Pin Contour of Target image, its color is same with ROI border color.

Show Pins of Template Image

Show Pin Contour of Template image, its color is Cyan.

Smoothing

Use Smoothing

Check to use Gaussian smoothing.

Gaussian Kernel and iteration can be defined.

Pin Segmentation

Auto Global Thresholding

Check to use adaptive global thresholding.

The adaptive thresholding algorithm will choose a suitable Threshold value between the defined intensity ranges. Now only the maximum value of the range can be defined. For example, default value is 200. It means the adaptive thresholding algorithm will choose a value between 0~200 to separate the background and foreground (object).

The “remove background” option will slightly remove the background.

If the BGA is located on the partial board. Use can check the “on partial board” to make the segmentation more accurate.

Auto Local Thresholding

User can also choose the auto local thresholding to do the segmentation. The radius defines that for each pixel, how many surrounded pixels need to be evaluated. And find offset can tuning the segmentation result slightly.

Pin Filter

Remove Pins on Edge

Check this option to remove any pins that attached on the Tool border.

Pin Inspection

Reset Paras

Reset all parameters as default.

Reset Pins

Reset all pin shapes according to current parameters.

Edit ID

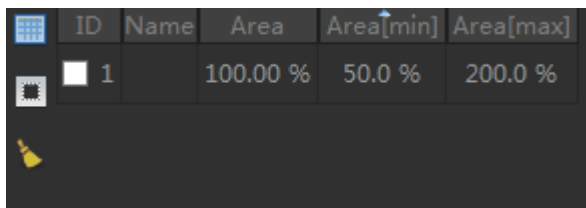
Each Pin ID can be edited by this button.

- Click this button, the ROI goes into Pin-Editing state. User can click each Pin one by one to assign ID from 1.
- Click it again will end Pin-Editing state.

Edit Pins

Click this button, the Pin Editor will appear. Double click each cell, use can edit its value.

User can set different Base value, Size restraint and Name etc.



ID	Name	Area	Area[min]	Area[max]
1		100.00 %	50.0 %	200.0 %

Check Solder Area

Check the solder area size. User can define the base size.

- Check solder area by Ratio
 - If base size checked Ratio = area size in target image / base size.

➤ If base size unchecked, Ratio = area size in target image / area size in Template image.

NG DEFINITION: Ratio < minimum or Ratio > maximum.

- Check solder area by Pixel count

NG DEFINITION: Pixel Count < minimum or Pixel Count > maximum

Height & Volume Inspection

Check Short

Check short among Pins.

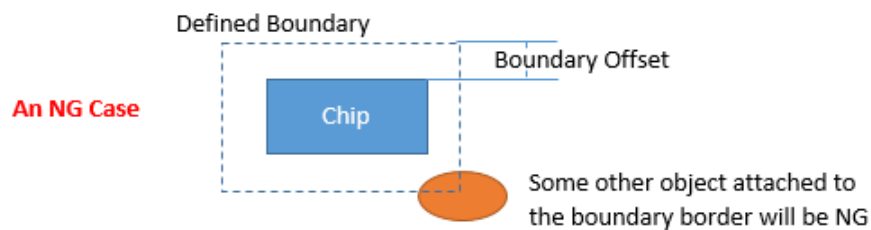
NG DEFINITION: Any two pins are connected

Check Boundary

Check that there is no object attached to the boundary border.

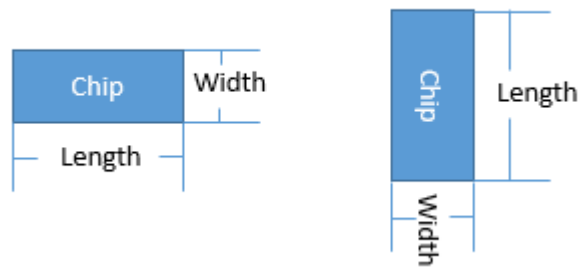
The boundary offset defines the area that larger than the object size from TOP, LEFT, RIGHT, BOTTOM direction.

NG DEFINITION: Any object that attached to the boundary border.



Check Side Overhang

Check the side overhang. Side overhang evaluates the chip's movement along the width direction. An offset defines the maximum allowed movement pixel value.



Check End Overhang

Check the end overhang. End overhang evaluates the chip's movement along the length direction. An offset defines the maximum allowed movement pixel value.

Check Solder Ball

Check the Solder Ball. Users need to define the minimum solder ball size.

LED Tool



Usage

Usually, can be used to inspect LED Chip. Click icon to add a LED Tool from "PCB INSPECTION" tab.

Chip

Smooth

Kernel Size3

Iteration3

Flatten BG

Kernel Size255

Threshold

☒ Fixed

10

☐ Auto

0.0

Check Angle

Angle Range(+/-)11°

MethodAdvanced

Solder

Flatten BG

Kernel Size155

Threshold

☒ Fixed

10

☐ Auto

1.7

Pad1

Left Margin24.00px

Top Margin22.00px

Width70.00px

Height200.00px

☐ Enable Overhang

Offset15.00px

Min Area70.00%

Unit%

Void Max Ratio35.00%

Pad2

Right Margin24.00px

Top Margin22.00px

Width70.00px

Height200.00px

☐ Enable Overhang

Offset15.00px

Min Area70.00%

Unit%

Void Max Ratio35.00%

Solder Ball

Outer margin65.00px

Max Length125.00px

Radius

Chip

Smooth

Enable/disable the noise reduction function in the image.

- Kernel Size : Enter the average range over which noise affects the image.

For example, enter 3 if the average area over which the object's borders are blurred is 3px.

- Iteration : The larger the noise effect, the larger the value.

Flatten BG

Activate when the value of the background brightness around the chip area is not constant.

- Kernel Size : If the chip size is large, input a large value.

Threshold

Set how tight the chip boundary will be explored.

- Fixed : It is used when the difference in brightness of the chip area within all images to be inspected is small (average brightness difference is less than 3).

The higher the value, the tighter the chip area to the borderline.

- Auto : It is used when there is a large difference (average brightness value difference is more than 4) in the brightness of the chip area within all the images to be inspected.

The higher the value, the tighter the chip area to the borderline.

Check Angle

Enables/disables the chip misalignment check function.

- Angle Range(+/-) : Set the tolerance value for distortion.

If the deviation is larger than the set value, it is treated as a 'WrongChip' as a defect.

Solder

Flatten BG

Activate when the brightness value around the solder area is not constant.

- Kernel Size : If the solder size is large, enter a large value.

Threshold

Set how tight the chip boundary will be explored.

- Fixed : It is used when the difference in brightness of the chip area within all images to be inspected is small (average brightness difference is less than 3).
The higher the value, the tighter the chip area to the borderline.
- Auto : It is used when there is a large difference (average brightness value difference is more than 4) in the brightness of the chip area within all the images to be inspected.
The higher the value, the tighter the chip area to the borderline.

Pad 1/ Pad 2

The reference pad area is the standard area of the pad area located inside the searched chip.

It is indicated by the blue dotted line inside the chip and is set separately for each of pad 1 and 2.

- Margin : The area that is as far as the input value inside the chip area is set as the reference pad area. Enter top, left and right margins.
- Width : Enter the width of the reference pad.
- Height : Enter the height of the reference pad.

Enable offset

- Overhang Offset : The area outside the reference pad area by the value you entered is set as the overhang reference area. If the pad area touches the overhang reference boundary line, it is treated as 'Overhang'.
- Min Area : Enter the threshold for less lead. If the pad width is smaller than the input value, it is treated as 'LessLead' as defective.

- Unit : Set the unit for 'Min Area'.

Calibration application unit and '%' unit (compared to reference pad area) can be set.

- Void Max Ratio : Set the maximum ratio of void area within the pad.

Inspection is performed with the void area versus the reference pad area.

Solder ball]

- Outer margin : Area that is outside the chip area by the value you entered is set as the lead search area.

- Max Length : Enter the maximum allowable diameter(radius) of the lead ball circumscribed circle.

If the diameter (radius) of the circumscribed circle of the solder ball is larger than the entered value, 'SolderBall' is treated as defective.

6. 64-bit function

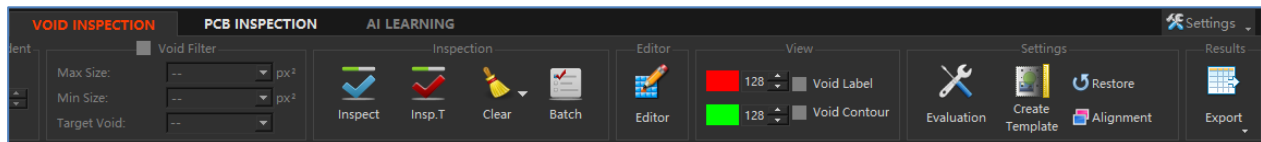
6.1. Image Load Capacity

Unlike 32-bit (less than 1.4 GB) in HADI 64-bit, more than 2.0 GB of images can be loaded.

Image loadable capacity may vary for each image.

6.2. Pattern Matching

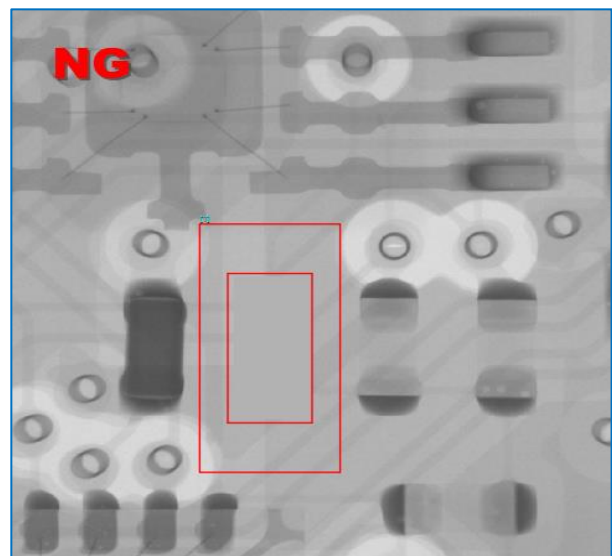
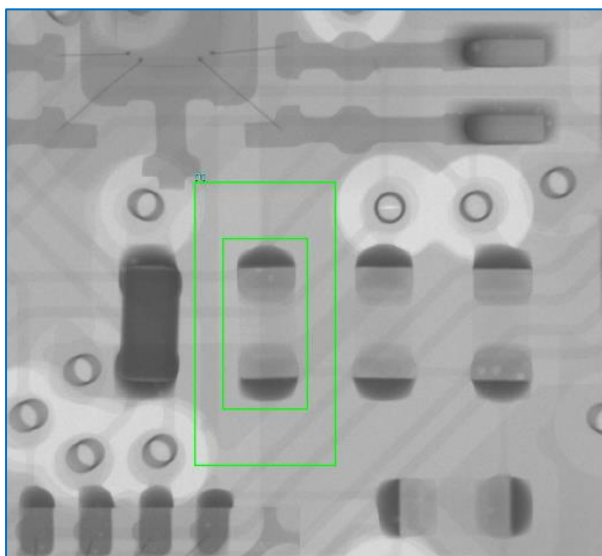
“Pattern Matching” tool  is available on the left MT panel in the “Void Inspection” tab:



The pattern matching tool allows users to find features or parts of images registered in the search area.

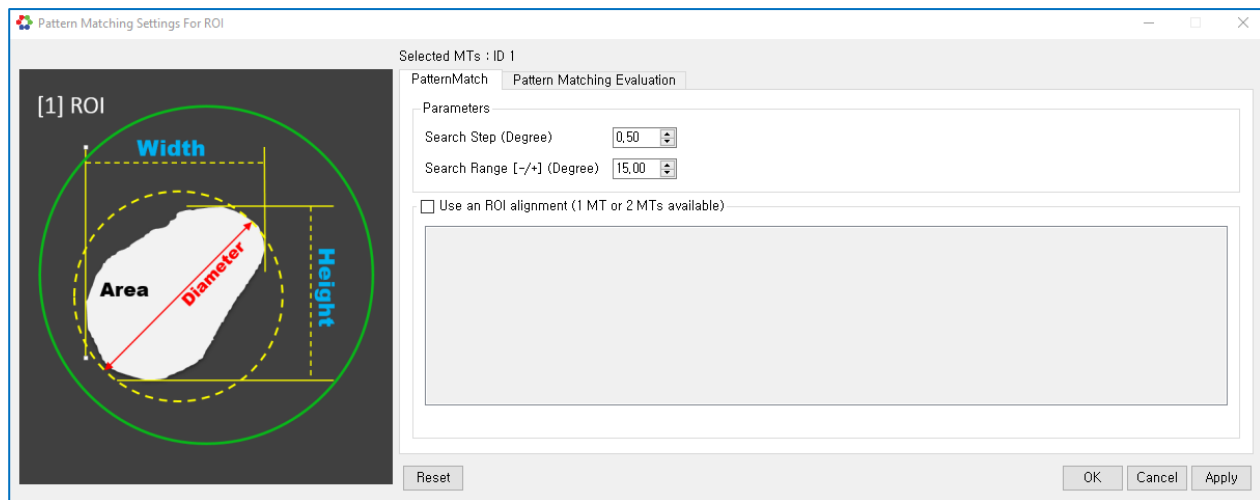
Presence inspection

You can check for missing parts using the pattern matching tool.



Pattern Match

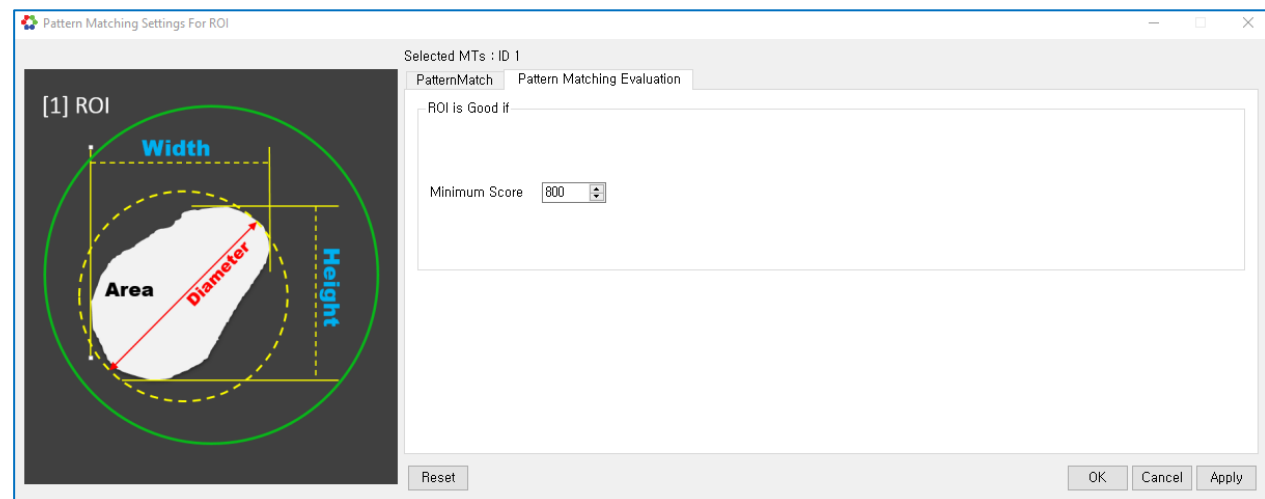
You can match by adjusting the search step (degree) and search range (degree) settings.



Pattern Matching Evaluation

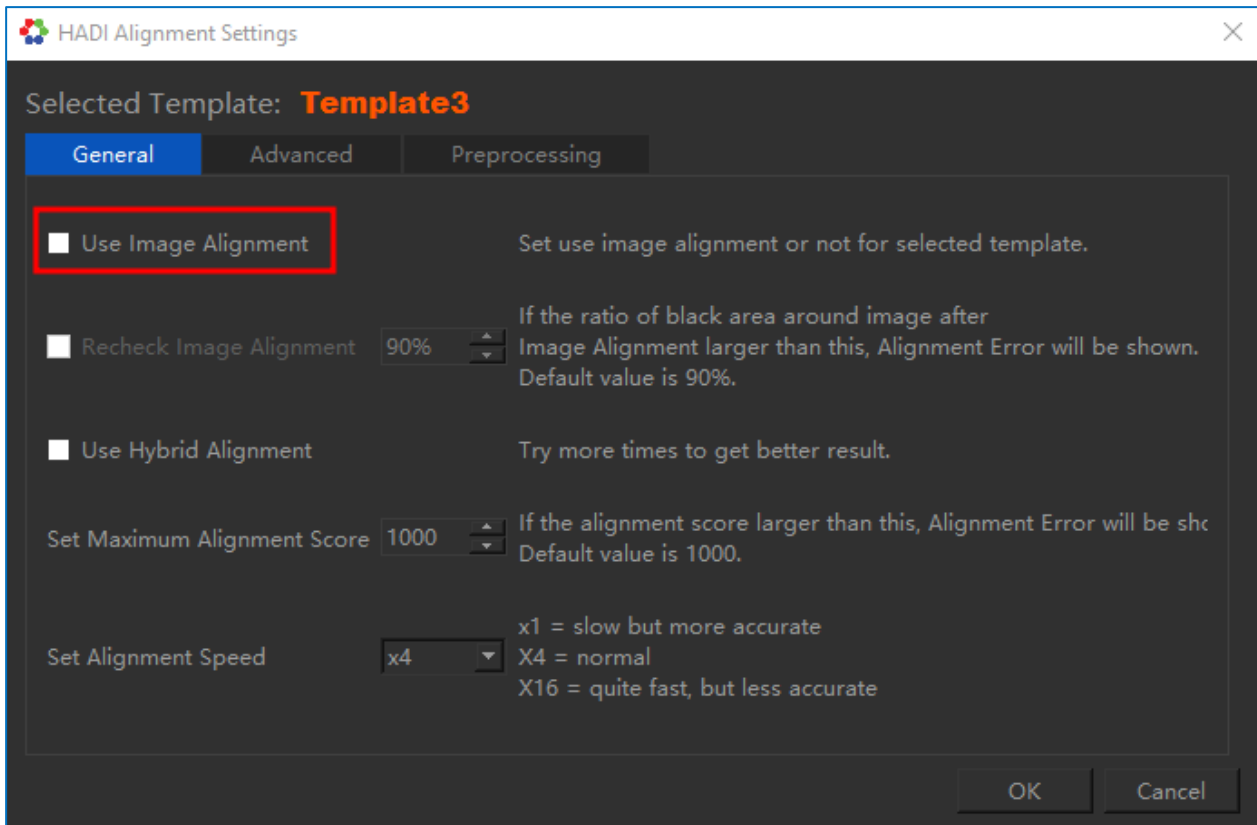
If pattern matching fails, matching can be performed by adjusting the minimum score.

The closer the score is to the minimum reference score setting, the more successful the pattern matching is.

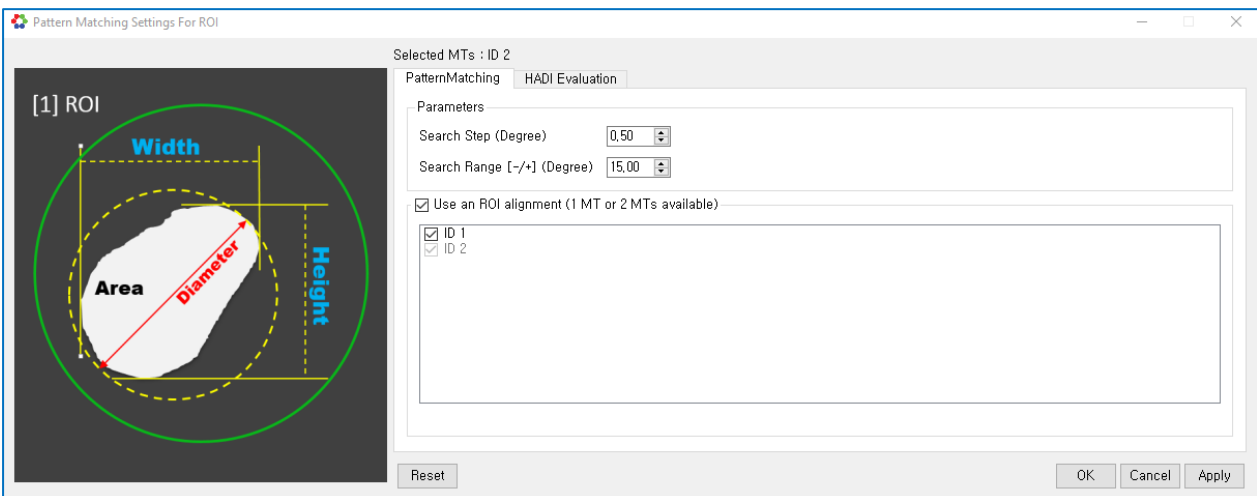


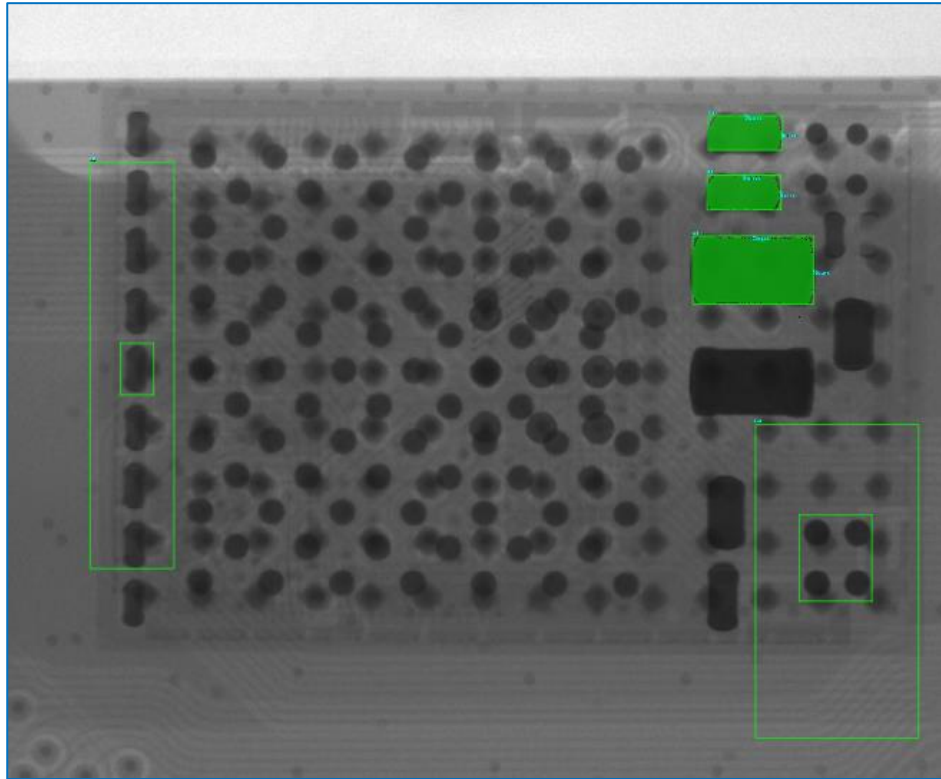
Alignment by using pattern matching

Uncheck “Use image alignment” algorithm to do alignment using only the pattern matching tool without using the entire image as the alignment criterion.

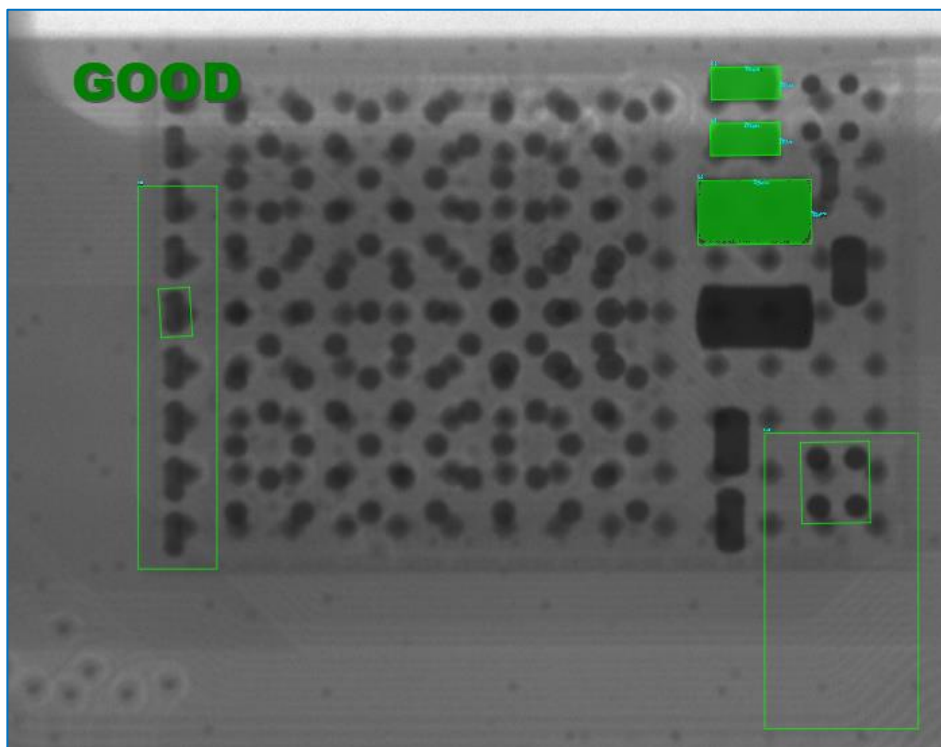


ROI alignment can be used to achieve more accurate alignment with two alignment criteria.





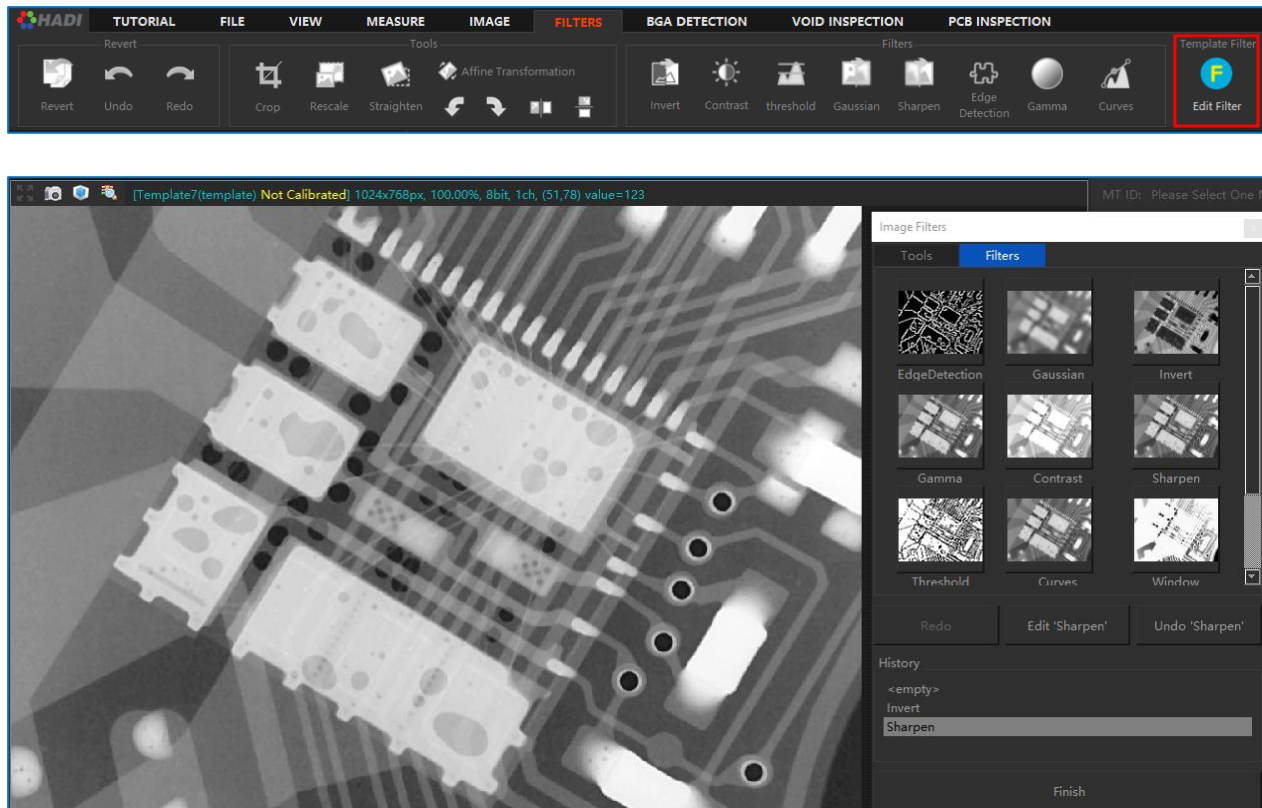
Align and inspect through the pattern matching tool without moving the image.



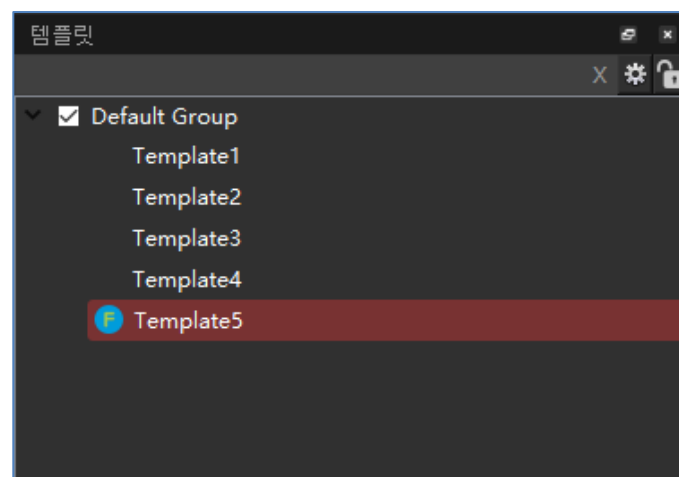
6.3. Template Filter

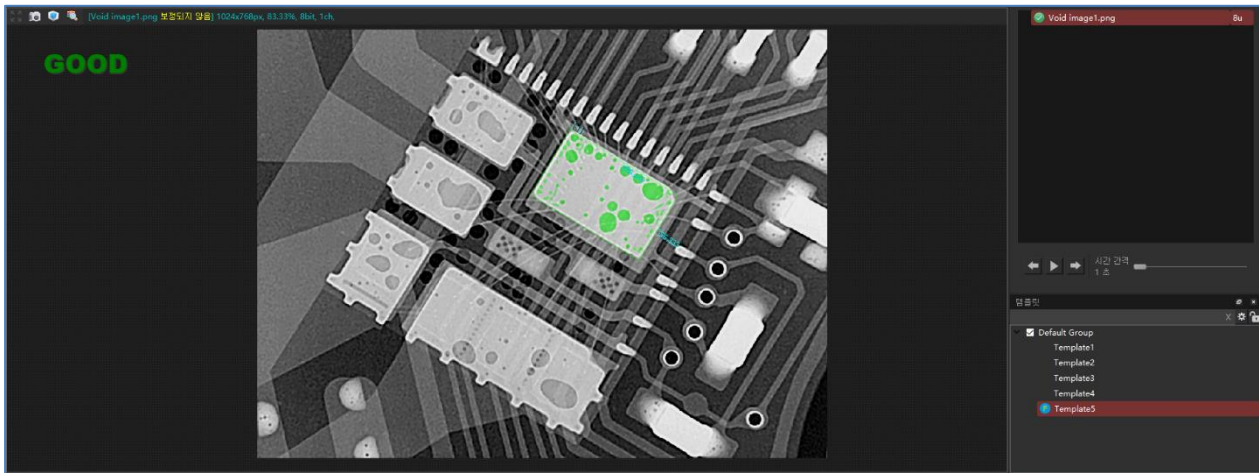
Template Filter

“Click “Template Filter” → “Edit Filter” in the “Filters” tab to bring up the following tools and filters:



When you finish editing the template filter,  appears in front of the edited template in the Template dock panel.





By applying the filter to the template, the same filter can be applied to the image to be inspected later, resulting in improved image inspection ability through image processing.

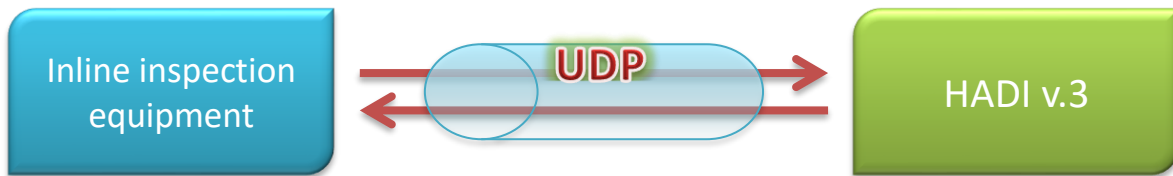
[Note]: The template filter function is only used for templates.

7. Inline Inspection Support

7.1. Overview

7.1.1. Inline Inspection Support

HADI v.3 provides UDP communication commands that support inline inspection equipment. The inline inspection equipment sends images to HADI v.3 using UDP commands. HADI v.3 inspects the images with predefined templates and sends the results to the equipment via UDP.



7.1.2. How to inspect?

- (1) Define the templates of target images to be inspected in HADI v.3.
* You need an image to use as a template.
- (2) Configure the communication program in the inline inspection equipment to communicate with HADI v.3 via UDP.
* See Chapter 6.2 for information on available commands.
- (3) Using UDP commands, the inline inspection equipment communicates with HADI v.3 to send and inspect images.

7.1.3. Recommendations for image acquisition

When inspecting images using HADI v.3, you can get more accurate results by acquiring images (including template images) from the inline inspection equipment in accordance with the criteria below:

- . Acquire images under the same voltage and current conditions
- . Image conversion under the same histogram conditions

7.2.UDP communication

7.2.1. Overview

HADI v.3 supports UDP (User Datagram Protocol) communication protocol. Also, it supports several commands using UDP communication.

This allows third-party software (clients) to run and inspect the image in HADI v.3 using these UDP commands (see Section 6.1).

The command can receive a return message for the execution results. Some commands return simple results such as “success” or “failure” of the command, and others return more detailed information.

(Example) If you are using the command "**VUDP_GET_ROILIST**":

- **VUDP_GET_ROILIST**: this command requests a list of ROIs in the image that is assigned by the parameter of the command.
- When you send this command to HADI v.3, HADI v.3 returns all ROIs of the image taken from the parameters.

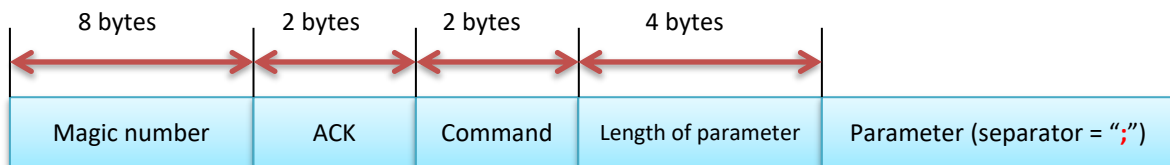
Since UDP protocol doesn't support an acknowledgment (ACK) signal, HADI- iBoard Pro supports its own ACK signal. The ACK signal is an integer value and is used by the client to determine which return message is the return value for which command.

(Example) Assume that the client sends three commands with an ACK value (5, 6, 7 for each command) to HADI- iBoard Pro:

- HADI- iBoard Pro will send the return message with the same ACK value.
- If the client receive return messages with only ACK = 5 and ACK = 7, then the client will wait for the return message with ACK = 6. Then, if the client cannot receive a return message with ACK = 6, it resends the command with ACK = 6.

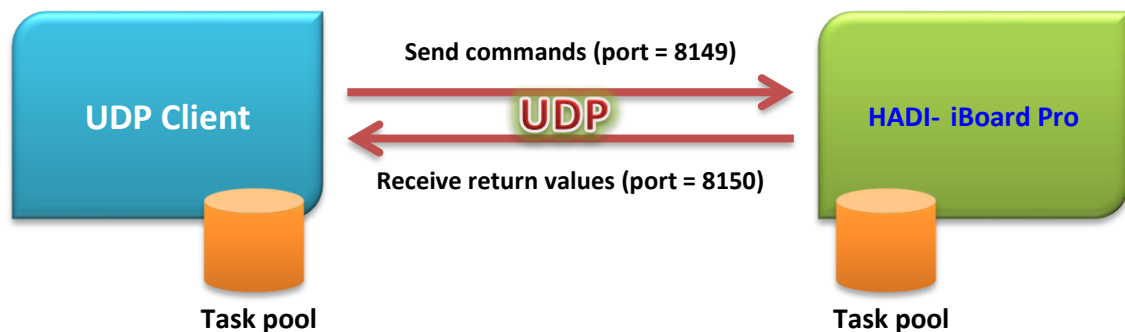
7.2.2. UDP communication protocol

- (1) UDP port numbers:
 - Send Port: **8149**
 - Receive Port: **8150**
- (2) UDP data packet format



Byte number	Data type	Item	Value
0 ~ 7	string	Magic number	"HADI"
8 ~ 9	unsigned short	ACK number	1, 2, 3, ...
10 ~ 11	unsigned short	Command	*See section 6.2.3
12 ~ 15	int	Length of parameter	*See section 6.2.3

- (3) Example of a communication program for a UDP client.



- Create a task pool where each task and ACK value is stored.
- Create a thread for the return values received from HADI- iBoard Pro.
- Create a thread to check each task.

7.2.3. UDP Commands

(1) UDP Commands (Client → HADI- iBoard Pro)

No.	Command		Parameter	Return value
	Code	Definition	[(data type) <i>parameter name</i>]	[(data type) <i>return value</i>]
1	100	ADDIMAGE	[(string) <i>image path</i>]	[(string) <i>image UUID</i>]
			[(string) <i>image path</i>];[(string) <i>image path</i>]; ...	[(string) <i>image UUID</i>];[(string) <i>image UUID</i>]; ...
2	101	ADDIMAGE_WITHTEMPLATE	[(string) <i>image path</i>];[(string) <i>template name</i>]	[(string) <i>image UUID</i>];[(string) <i>result</i>] <i>result</i> is one of the following values: "NG", "GOOD", "AlignmentError" and "NoObject"
3	102	REMOVEIMAGE	[(string) <i>image UUID</i>]	
4	103	REMOVEALLIMAGE		
5	104	INSPECTIMAGE	[(string) <i>image UUID</i>];[(string) <i>template name</i>]	
6	105	CALIBRATION	[(string) <i>image UUID</i>];[(string) <i>x pitch</i>];[(string) <i>y pitch</i>]	
7	106	SHOWWINDOW		
8	107	HIDEWINDOW		
9	108	SHOWIMAGE	[(string) <i>image UUID</i>]	
10	109	GENERATEREPORT	[(string) <i>image UUID</i>];[(string) <i>report filename</i>]	
11	110	CAPTUREIMAGE	[(string) <i>image UUID</i>];[(string) <i>image name</i>]	
12	112	ADDIMAGE_WITHCALIBRATION	[(string) <i>image path</i>];[(string) <i>x pitch</i>];[(string) <i>y pitch</i>]	[(string) <i>image UUID</i>]
13	200	GET_VERSION		[(string) <i>version</i>]
14	202	GET_ALLTEMPLATENAMES		[(string) <i>template name</i>]
				[(string) <i>template name</i>];[(string) <i>template name</i>]; ...
15	203	GET_DEFECTINFO	[(string) <i>image UUID</i>]	[(string) <i>result</i>] <i>result</i> is one of the following values: "NG", "GOOD"
16	204	GET_ROILIST	[(string) <i>image UUID</i>]	[(string) " <i>ID:name:defect ratio:max defect ratio</i> "]
				[(string) " <i>ID:name:defect ratio:max defect ratio</i> "; [(string) " <i>ID:name:defect ratio:max defect ratio</i> "; ...

No.	Command		Parameter	Return value
	Code	Definition	[(data type) <i>parameter name</i>]	[(data type) <i>return value</i>]
17	205	GET_ALLIMAGEIDS		[(string) <i>image UUID</i>]
				[(string) <i>image UUID</i>];[(string) <i>image UUID</i>]; ...
18	900	FEEDBACK_CHANGEINSPECTIONRESULT	[(string) <i>image UUID</i>];[(string) <i>result</i>] <i>result</i> is one of the following values: "NG", "GOOD"	
19	500	AUTOINSPECTION_START		
20	599	AUTOINSPECTION_STOP		

(2) Example of using parameters

- For example, the parameters of the "**GENERATEREPORT**" command can be used as follows:

```
{image uuid};C:\TestReport\report1.csv
{image uuid};C:\TestReport\report2.xls
{image uuid};C:\TestReport\report3.pdf
all;C:\TestReport\report4.csv
all;C:\TestReport\report5.xls
all;C:\TestReport\report6.pdf
```

(3) Error codes

Error Codes	
Code	Definition
0	RET_SUCCESS
1	RET_FAILURE
2	ERR_PARAMETER
3	ERR_MEMORY
4	ERR_NO_IMAGE
5	ERR_CMD_NOT_SUPPORT
6	ERR_NOT_INSPECTED
7	ERR_NO_TEMPLATE

7.3. Batch function

7.3.1. Introduction

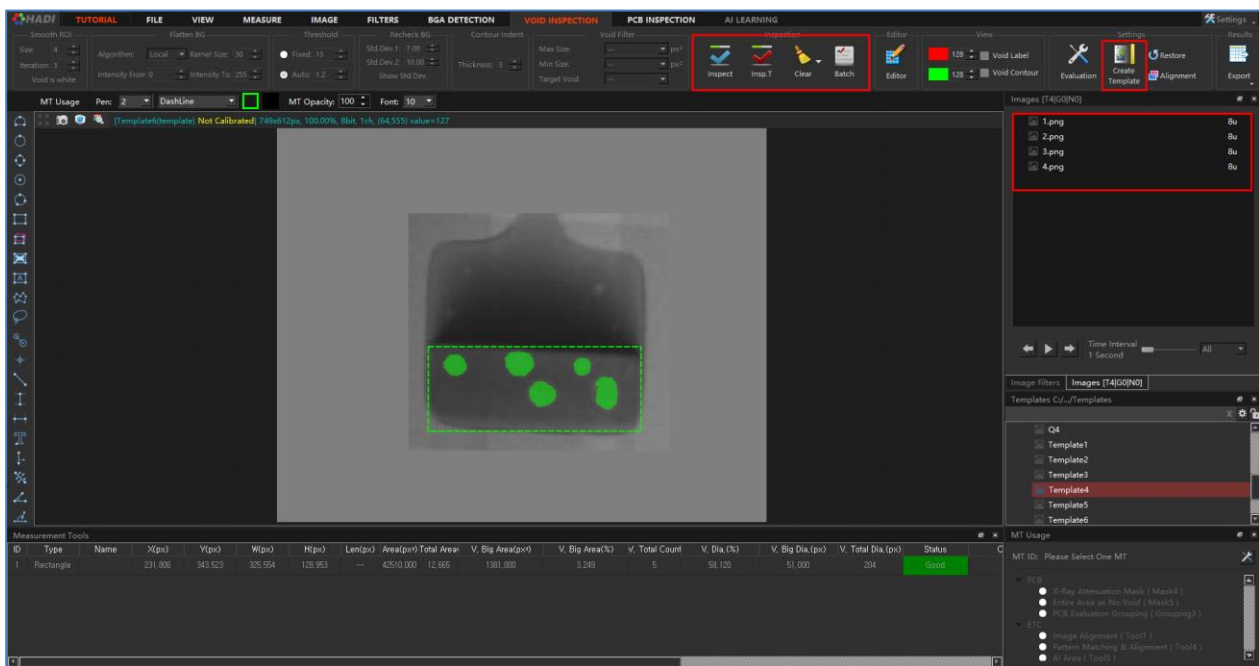
In addition to manually inspecting images one by one, you can inspect multiple selected images with the Batch function with one click of a button.

7.3.2. How to inspect

Batch

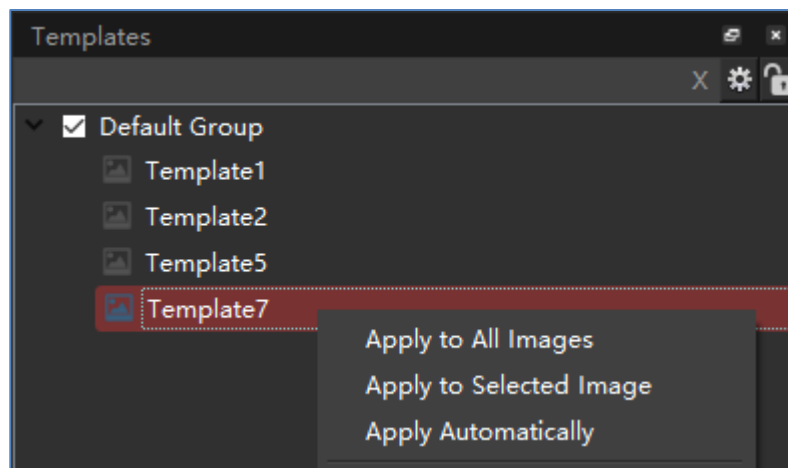
Run a void Inspection on multiple selected images at once.

- Compare images and templates and match them to the most similar template automatically.
- Display GOOD/NG results for each image after batch inspection.
- Users can save Inspection Result in a file such CSV, Excel, etc.



1. Create templates as much as user needs
2. Load X-ray images
3. Click “Batch” button
4. Click “Inspect all” button

You can select one of 3 options; "apply to all images", "Apply to selected images", and "Apply automatically".



You can see GOOD/NG results for each image.

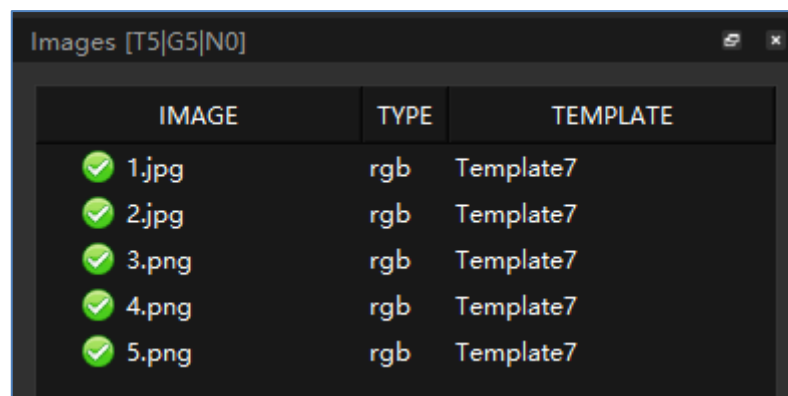
The screenshot shows a window titled "Images [T5|G5|N0]" with a table of image processing results. The table has three columns: "IMAGE", "TYPE", and "TEMPLATE". Each row represents an image, with a green checkmark icon in the "IMAGE" column indicating a successful result. All images are of type "rgb" and used "Template7".

IMAGE	TYPE	TEMPLATE
✓ 1.jpg	rgb	Template7
✓ 2.jpg	rgb	Template7
✓ 3.png	rgb	Template7
✓ 4.png	rgb	Template7
✓ 5.png	rgb	Template7