Using the Caliper Tool

The Caliper tool finds, locates, and measures the gap between one or more edge pairs on an object.

The Caliper uses pixel greylevel values within region of interest to build projections needed for edge detection.

After the Caliper detects potential edges, the Caliper determines which edge pairs are valid by applying the constraints that are configured for each edge pair. Finally, the Caliper scores and measures each valid edge pair.

Basic Steps for Configuring a Caliper

1. Select the tool that will provide input images. See Input.
2. Position the Caliper tool. See Location.
3. Configure Pair Settings for each edge pair. Configuring Caliper Settings
4. Test and verify results. See Caliper Results.
5. Configure Advanced properties if required. Configuring Advanced Caliper Parameters.

Input

The Input required by the Caliper is an image provided by another tool in the sequence.

- Typically, the Input is provided by an Acquire Image tool.
- Input can also be provided by other AdeptSight tools that output images, such as the Image Processing Tool.

To set the Input:

1. Execute the sequence once to make sure that an input image is available.
2. From the Input dropdown list, select the tool that will provide the input image.
3. If the required tool does not appear in the dropdown list, make sure that the required tool (Acquire Image or other) has been added to the Sequence Manager, above the Caliper.

Location

Location parameters define the position of the tool’s region of interest in which the tool carries out its process.

The region of interest can be positioned relative to another tool (frame-based) or relative to a fixed area in the input image (image-based). The positioning mode is defined by the Frame Input parameter.
Using the Caliper Tool

Frame Input

The **Frame Input** defines whether the tool will be frame-based or image-based.

- **Frame-Based** positioning is the recommended mode for applications in which the tool needs to be repeatedly applied to a feature on an object, or to a specific area relative to an object. With frame-based positioning, the Caliper is positioned relative to a frame of reference provided by another tool, called the frame-provider.

- **Image-Based** positioning is applied when the tool is not frame-based. In this mode, the tool region of interest is always positioned on the same area of the image, relative to the frame of reference of the image.

  To set image-based positioning, set the **Frame Input** value to *(none)*.

**To set the Frame Input:**

1. From the **Frame Input** dropdown list, select the frame-provider tool. Selecting a tool in the list enables frame-based positioning.

   The ideal frame-provider tool is a Locator. See [Frame-Provider Tools](#) for more details on using other tools as frame-providers.

2. If the tool must be positioned to a static area on all images (image-based) select *(none)* in the **Frame Input** dropdown list.

3. If the Caliper must be placed on all frames output by the frame-provider tool, enable the **All Frames** check box.

4. If the Caliper must be only be applied to a *single frame*, (output by frame-provider tool) disable the **All Frames** check box and select the required frame.

   The default value is 0; the numbering of frames is 0-based.

5. Click **Location** to position the tool region of interest relative to the frame provider tool. See [Positioning the Caliper](#).

Positioning the Caliper

Positioning the tool defines the region of interest in which the tool will find and measure edge pairs.

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**Figure 69** Positioning the Caliper Tool relative to a Frame
To position the Caliper:

1. Click **Location**. The Location dialog opens as shown in Figure 69. This dialog defines the size and position of the tool region of interest. The display represents the region of interest as a green bounding box.

2. If the tool is frame-based, a blue marker indicates the frame provided by the frame-provider tool (**Frame Input**). If there is more than one object in the image, make sure that you are positioning the bounding box relative to the object identified by a blue axes marker.

3. Enter values in the **Location** dialog, or use the mouse to configure the bounding box in the display.

   If the tool is frame-based, Location values are relative to the origin of the frame-provider tool (blue marker). If the tool is image-based, values are relative to the origin of the image frame of reference.

4. **Important**: Position the bounding box so that **Y-Axis is parallel to the edges that must be detected**. To rotate the bounding box, drag the X-Axis marker. To skew the bounding box, drag the Y-Axis marker.

Before configuring the Caliper, execute the tool (or sequence) at least once and verify in the display that the tool is being positioned correctly in the image.

The display represents the Caliper as a green rectangle, with found edges and caliper measure represented in red.

**Related Topics**

Configuring Caliper Settings
Configuring Caliper Settings

The Caliper can measure any number of pairs. When the Caliper is executed, the Caliper first applies edge detection parameters to the entire region of interest. Then, the tool applies pair settings constraints to determine which caliper pairs. Results are then calculated for each edge pair as well as for individual edges in each edge pair.

As shown in figure, the **Pairs** section contains a list of all the pairs that are configured for the current Caliper tool. This list always contains at least one pair, which by default is called Pair(0).

From the **Pairs** list, you can:

- Access the configuration parameters for each pair.
- Add and remove edge pairs.
- Rename edge pairs.

![Pairs List in the Caliper Interface](image)

**Figure 70** Pairs List in the Caliper Interface

**To access configuration parameters for an edge pair:**

1. In the **Pairs** list, click on a pair to select it.
2. Click **Edit**. This opens the **Pair Settings** window for the selected pair.
3. See [Configuring Pair Settings](#) for details.

**To add an edge pair:**

1. Under the **Pairs** list, click the 'Add Pair' icon.
2. A pair is added with the default name: Pair(n).
3. The **Pairs Settings** window opens, ready for editing the new edge pair.

**To remove an edge pair:**

1. In the **Pairs** list, select the pair that must be removed.
2. Click the 'Remove Pair' icon.

**To rename an edge pair:**

1. In the Pairs list, double-click on the name of the pair to be renamed.
2. Type a new name for the edge pair. This will not affect the configuration parameters of the pair.
Configuring Caliper Settings

When the Caliper is executed, the Caliper first applies edge detection constraints to the entire region of interest. Then, the tool applies edge scoring constraints to determine which edges are valid for the caliper measure. If only one valid edge is found, no caliper measure is output.

**Pair Settings** parameters set how the tool detects edges and determines which edge pair are valid.

Before configuring the Caliper, execute the tool (or sequence) at least once and verify in the display that the tool is being positioned correctly in the image.

The display represents the Caliper as a green rectangle, with found edges and caliper measure represented in red.

**To configure edge pair settings:**

1. Under the **Pairs** section of the interface, select a pair name in the list. The default name for a first pair is **Pair(0)**.
2. Click **Edit**.
3. The **Pair Settings** window opens, as shown in [Figure 71](#). This window provides parameters for each edge of the Caliper edge pair, named: **First Edge** and **Second Edge**.
4. Configure settings for each edge. Refer to sections below for help on configuring **Pair Settings**, and using the display and function editor.
Figure 71 Configuring Pair Settings

If the display in the Pair Settings window is blank, or the edges are not properly placed, close the window and verify the following:

Are Location parameters correct? The Y-axis of the tool must be parallel to the edges you want to detect.

Was the tool executed after positioning the tool? Execute the tool or sequence at least once before opening the Pair Settings window.

**Pair Settings**

There are two basic types of constraints that affect the choice of valid edges: **Polarity** and edge-score **Constraints**, which are based on position and magnitude of the edges.

**Polarity**

**Polarity** corresponds to the change in light values, moving from left to right in the display, along the X-Axis in the region of interest. The Caliper applies the Polarity constraint before applying edge-score **Constraints**.


**Polarity** is does not affect the edge score, however only edges that meet the selected Polarity constraint are retained as valid edges, regardless of their scores.

- **Dark to Light** will only accept edges occurring at transitions from a dark area to a light area.
- **Light to Dark** will only accept edges occurring at transitions from a light area to a dark area.
- **Either** will accept any edge, regardless of its polarity.

![Figure 72 Edge Polarity](image)

**Constraints**

There are two types of constraints: **Position** and **Magnitude**. You can set the Caliper to use only one constraint type or both. The graphical function editor is provided for viewing and setting each type of constraint.

- If only one constraint is selected, edges are scored only based on the selected constraint
- If both constraints are selected, then each constraint accounts for 50% of the edge score.

**Magnitude Constraint**

The **Magnitude** constraint is based on edge values relative to the **Magnitude Threshold**, which is represented in the display by 2 red lines. Edges having a magnitude equal to, or exceeding the Magnitude Threshold, are attributed a score of 1. Edges with values below the Magnitude Threshold receive a score ranging from 0 to 0.999, according to a manually set magnitude constraint function.

The Magnitude Threshold value can be modified in the **Advanced Parameters** section of the tool interface. See **Magnitude Constraint**.

- A **Magnitude** constraint must be defined individually for each edge.
- **Figure 73** shows examples of two different setups for a magnitude constraint function.

**To set a Magnitude Constraint:**

1. In the drop-down list above the function editor, select **First Edge Magnitude Constraints** or **Second Edge Magnitude Constraints**.
2. In the Function Editor, use the mouse to drag handles and set the magnitude limits. See examples in **Figure 73**.
Position Constraint

Position constraints restricts the Caliper’s search for edges to a specific zone of the region of interest.

- It is possible to graphically set a position constraint function when the approximate position of an edge is known beforehand. This is useful for scoring an edge based on its offset from the expected position.

- Values in the Constraint function Editor indicate relative distance in the region of interest where 0.0 is the leftmost position and 1.0 is the rightmost position.

To set a Position Constraint:

1. In the drop-down list above the function editor, select First Edge Position Constraints or Second Edge Position Constraints.

2. In the Function Editor, use the mouse to drag handles and set the position limits. See examples in Figure 74.

   The physical position in the function editor corresponds to the same physical position in the display.

![Figure 73 Setting the Magnitude Constraint in the Function Editor](image)

Edge Score = 1.0 if Magnitude > 95
Edge Score = 0.0 if Magnitude < 95

Edge Score = 1.0 if Magnitude > 130
Edge Score = [0.01 to 0.99] for 130 > Magnitude > 50
Edge Score = 0.0 if Magnitude < 50
Configuring Caliper Settings

**Score Threshold**

The score threshold sets the minimum acceptable score for a valid edge. The Caliper will disregard edges that obtain a score lower than the **Score Threshold**.

- Scores attributed by the Caliper for constraints range from 0 to 1.
- If both **Position** and **Magnitude** constraints are enabled, each constraint accounts for 50% of the total edge score.

**Related Topics**

[Configuring Advanced Caliper Parameters](#)
Caliper Results

The Caliper outputs two types of results: *Frames and Results* that provide information on each of the found edges.

- *Frames* output by the Caliper can be used by other AdeptSight tools for frame-based positioning. The output frames are represented in the display, and numbered, starting at 0.
- Results for edges found by the Caliper tool are show in the grid of results, below the display, as illustrated in Figure 75.

Saving Results

The results of a tool process can be saved to a text file. This can be useful for analyzing performance of each tool. At each execution of the tool, time, date and results for each execution are appended to the results log.

**To create and store results to a log file:**

1. Enable the check box under *Results Log*.
2. Click the 'Browse' icon.
3. Set the name of the file (*.log) and the location where the file will be saved.
4. The next time the sequence is executed, a new results log will be started, with the name and file path that are currently shown in the text box.

Viewing Results

The results for each execution of the tool are represented in the display window, and the grid of results.

Results Display

The Results display represents each frame output by the Caliper, as well as the Caliper measure, edge pair results and results for each edge in an edge pair.
Caliper Results

Grid of Results
The grid of result presents the results for all caliper measures found by the Caliper tool. Results include the score and position for each edge in an edge pair. These results can be saved to file by enabling the Results Log.

Description of Caliper Results
The Caliper outputs the following results:

**Elapsed Time**
The *Elapsed Time* is the total execution time of the Caliper. *Elapsed Time* is not visible in the results grid but is output to the results log for each iteration of the Caliper.

**Frame**
*Frame* identifies the number of the frame output by the Caliper tool. If the tool is frame-based, this number corresponds to the input frame that provided the positioning.

**Pair**
The name of the edge pair, as it appears in the Pairs list. Each pair instance outputs a frame that can be used by a frame-based tool for which the Caliper is a frame-provider.

**Score**
*Score* is the calculated score, between 1 and 0, for the edge pair. The score is calculated according to the constraint functions defined for the pair. If both *Position* and *Magnitude* constraints are enabled, each constraint accounts for 50% of the score.
Each edge of the pair is also scored individually, in a similar manner. See **Edge1/Edge2** results below.

**Size**

Size is the Caliper measure, which is the calculated distance between the pair of edges.

**Position X**

Position X is the X coordinate of the center point of the caliper measure, at the midpoint of the edge pair.

**Position Y**

Position Y is the Y coordinate of the center point of the caliper measure, at the midpoint of the edge pair.

**Rotation**

The angle of rotation for the edge pair.

**Edge 1/Edge 2 Score**

The score of the individual edge, calculated according to the defined constraints.

**Edge 1/Edge 2 Position X**

The X coordinate of the edge, at the midpoint of the edge segment.

**Edge 1/Edge 2 Position Y**

The Y coordinate of the edge, at the midpoint of the edge segment.

**Edge 1/Edge 2 Rotation**

The angle of rotation for the edge.

**Edge 1/Edge 2 Position Score**

Position score for the edge, calculated according to the **Position** constraint function.

**Edge 1/Edge 2 Magnitude**

The calculated Magnitude value for the edge.

**Edge 1/Edge 2 Magnitude Score**

Magnitude score for the edge, calculated according to the **Magnitude** constraint function.
Configuring Advanced Caliper Parameters

The Advanced Parameters section of the Caliper tool interface provides access to advanced Caliper parameters and properties.

Configuration Parameters

Processing Format

ProcessingFormat defines the format applied to process images provided by the camera.

- **hsNative**: When hsNative is selected, the Caliper processes images in the format in which they are output by the camera - either grey-scale or color.

- **hsGreyScale**: When hsGreyScale is enabled, the Caliper processes only the grey-scale information in the input image, regardless of the format in which the images are provided. This can reduce the execution time when color processing is not required.

Edge Detection Parameters

Edge Detection settings configure the parameters that the Caliper will use to find potential edges in the area of interest. The display represents the Caliper region of interest and provides information to assist in configuring Edge Detection parameters.

Edge Magnitude Threshold

EdgeMagnitudeThreshold sets the acceptable magnitude value for potential edges. This value is expressed as an absolute value; there are two magnitude lines: an upper (positive) threshold and lower (negative) threshold.

Edge Magnitude expresses the strength of a potential edge. The (green) magnitude curve, represents magnitude values across the area of interest. Potential edges must have a magnitude above the upper threshold, or below the lower threshold. See Figure 76.

![Figure 76 Interpreting the Magnitude Threshold in the display area](image)

Filter Half-Width

The filtering process attenuates peaks in the magnitude curve that are caused by noise. EdgeFilterHalfWidth should be set to a value approximately equivalent to the width of the edge, in pixels. An incorrect value can cause edges to be incorrectly detected.

Frame Transform Parameters

The Scale To Instance parameter is applicable only to a Caliper that is frame-based, and for which the Input Frame is provided by a Locator. Otherwise this parameter is ignored. If the Locator is configured to
locate parts of varying scale, the **Scale To Instance** parameter determines the effect of the scaled instances on the Caliper.

### Scale To Instance
When **ScaleToInstance** is *True*, the Caliper region of interest is resized and positioned relative to the change in scale of the Input frame. This is the recommended setting for most cases. When **ScaleToInstance** is *False*, the Caliper ignores the scale and builds frame relative to the input frame without adapting to the change in scale.

### Location Parameters

#### Tool Position Parameters
Most tool position parameters can be set through the **Location** section of the tool interface. These are the parameters that define the tool’s region of interest. Additionally, the **Advanced Parameters** section gives access to the **CalibratedUnitsEnabled** parameter.

#### Calibrated Units Enabled
When **CalibratedUnitsEnabled** is set to *True* (default value), the tool results are returned in millimeters. When set to *False*, tool results are returned in pixels.

- **Height**
  Height of the Caliper region of interest.

- **Width**
  Width of the Caliper region of interest.

- **Rotation**
  Angle of rotation of the Caliper region of interest.

- **Width**
  Width of the Caliper region of interest.

- **X**
  X coordinate of the center of the tool region of interest.

- **Y**
  Y coordinate of the center of the region of interest.

![Figure 77 Location Properties of the Caliper Region of Interest](image_url)
Tool Sampling Parameters
Sampling refers to the procedure used by the tool for gathering values within the portion of the input image that is bounded by the tool's region of interest. Two sampling parameters, the Sampling Step and Bilinear Interpolation, can be used as necessary to create a required tradeoff between speed and precision.

For specific applications where a more appropriate tradeoff between speed and precision must be established, the sampling step can be modified by setting the CustomSamplingStepEnabled to True and modifying the CustomSamplingStep value.

Bilinear Interpolation
Bilinear Interpolation specifies if bilinear interpolation is used to sample the image before it is analyzed for image sharpness.

To ensure subpixel precision in inspection applications, Bilinear Interpolation should always be set to true (enabled). Non-interpolated sampling (Bilinear Interpolation disabled) should only be used in applications where the speed requirements are more critical than precision.

Sampling Step Default
SamplingStepDefault is the best sampling step computed by the tool, based on the average size, in calibrated units, of a pixel in the Image. This default sampling step is usually recommended. SamplingStepDefault is automatically used by the tool if SamplingStepCustomEnabled is True.

Sampling Step
SamplingStep is the step by the tool to sample the input image that is bounded by the tool region of interest. The sampling step represents the height and the width of a sampled pixel.

Sampling Step Custom
SamplingStepCustom enables you to set a sampling step value other than the default sampling step. To set a custom sampling step, SamplingStepCustomEnabled must be set to False.

- Increasing the sampling step value reduces the tool's precision and decreases the execution time.
- Reducing the sampling step can increase the tool's precision but can also increase the execution time.

SamplingStepCustomEnabled
Setting SamplingStepCustomEnabled to True, enables the tool to apply a custom sampling step defined by SamplingStepCustom. When set to False (default) the tool applies the default, optimal sampling step defined by SamplingStepDefault.

Results
Coordinate System
The CoordinateSystem parameter sets the coordinate system used by the tool to express results. The available coordinate systems are: Image (hsImage), World (hsTool), Object (hsObject), Tool (hstool).

Edge Count
EdgeCount indicates the number of valid edges that were found.
Using the Edge Locator Tool

The Edge Locator tool finds, locates, and measures the position of one or more edges on an object.

The Edge Locator uses pixel greylevel values to detect edges found within the region of interest. Once potential edges have been located, the Edge Locator applies the constraints to determine which edges are valid.

The Edge Locator determines the position of one or more edges, it *does not measure the length* of lines detected in the region of interest. To extrapolate and measure a line on an object, use the Edge Finder tool.

**Basic Steps for Configuring an Edge Locator**

1. Select the tool that will provide input images. See Input.
2. Position the Edge Locator tool. See Location.
4. Test and verify results. See Edge Locator Results.
5. Configure Advanced properties if required. Configuring Advanced Edge Locator Parameters.

**Input**

The **Input** required by the Edge Locator is an image provided by another tool in the sequence.

- Typically, the Input is provided by an Acquire Image tool.
- Input can also be provided by other AdeptSight tools that output images, such as the Image Processing Tool.

**To set the Input:**

1. Execute the sequence once to make sure that an input image is available.
2. From the **Input** dropdown list, select the tool that will provide the input image.
3. If the required tool does not appear in the dropdown list, make sure that the required tool (Acquire Image or other) has been added to the Sequence Manager, above the Edge Locator.

**Location**

Location parameters define the position of the tool’s region of interest in which the tool carries out its process.

The region of interest can be positioned relative to another tool (frame-based) or relative to a fixed area in the input image (image-based). The positioning mode is defined by the **Frame Input** parameter.
Figure 78  Positioning the Edge Locator Tool relative to a Frame

**Frame Input**

The **Frame Input** defines whether the tool will be frame-based or image-based.

- **Frame-Based** positioning is the recommended mode for applications in which the tool needs to be repeatedly applied to a feature on an object, or to a specific area relative to an object. With frame-based positioning, the Edge Locator is positioned relative to a frame of reference provided by another tool, called the frame-provider.

- **Image-Based** positioning is applied when the tool is not frame-based. In this mode, the tool region of interest is always positioned on the same area of the image, relative to the frame of reference of the image.

To set image-based positioning, set the **Frame Input** value to **(none)**.

**To set the Frame Input:**

1. From the **Frame Input** dropdown list, select the frame-provider tool. Selecting a tool in the list enables frame-based positioning.
   
   The ideal frame-provider tool is a Locator. See **Frame-Provider Tools** for more details on using other tools as frame-providers.

2. If the tool must be positioned to a static area on all images (image-based) select **(none)** in the **Frame Input** dropdown list.

3. If the Edge Locator must be placed on all frames output by the frame-provider tool, enable the **All Frames** check box.

4. If the Edge Locator must be only be applied to a single frame, (output by frame-provider tool) disable the **All Frames** check box and select the required frame.

   The default value is 0; the numbering of frames is 0-based.

5. Click **Location** to position the tool region of interest relative to the frame provider tool. See **Positioning the Edge Locator.**
Positioning the Edge Locator

Positioning the tool defines the area of the image that will be processed by the Edge Locator. Location parameters define the position of the tool region of interest.

Location

The Location button opens the Location dialog and displays the tool region of interest as a bounding box in the image display. The bounding box can be configured in both the display area and in the Location dialog.

To position the Edge Locator:

1. Click Location. The Location dialog opens as shown in Figure 78. This dialog defines the size and position of the tool region of interest. The display represents the region of interest as a green bounding box.

2. A blue marker indicates the frame provided by the Frame Input tool. If there is more than one object in the image, make sure that you are positioning the bounding box relative to the object identified by a blue axes marker.

3. Enter values in the Location dialog, or use the mouse to configure the bounding box in the display.

   If the tool is frame-based, Location values are relative to the origin of the frame-provider tool (blue marker). If the tool is image-based, values are relative to the origin of the image frame of reference.

4. Important: Position the bounding box so that Y-Axis is parallel to the edges that must be detected. To rotate the bounding box, drag the X-Axis marker. To skew the bounding box, drag the Y-Axis marker.

Before configuring the Edge Locator, execute the tool (or sequence) at least once and verify in the display that the tool is being positioned correctly in the image.

The display represents the Edge Locator as a green rectangle, with found edges represented in red.

Related Topics

Configuring Edge Locator Settings
Configuring Edge Locator Settings

When the Edge Locator is executed, the Edge Locator first applies edge detection parameters to the entire region of interest. Then, the tool applies edge scoring constraints to determine which edges are output as valid edges.

**Edge Settings** parameters set how the tool detects edges and determines which edges are valid.

> Before configuring the Edge Locator, execute the tool (or sequence) at least once and verify in the display that the tool is being positioned correctly in the image.

> The display represents the Edge Locator as a green rectangle, with found edges represented in red.

**To configure edge detection parameters:**

1. Under the **Edges** section of the interface, click **Configure**.
2. The **Edge Settings** window opens, as shown in Figure 79. This window provides edge detection settings and constraints, as well as visual aids for configuring edge location settings.
3. Refer to sections below for help on configuring edge settings, and using the display and function editor.

![Figure 79 The Edge Settings Window](image)

Right-click in display to show edge detection values

Graphical function Editor for setting Position constraints and Threshold constraints
Configuring Edge Locator Settings

**Edge Detection**

**Edge Detection** settings configure the parameters that the Edge Locator will use to find potential edges in the area of interest. The display represents the Edge Locator region of interest and provides information to assist in configuring Edge Detection parameters.

**Magnitude Threshold**

The **Magnitude Threshold** sets the acceptable magnitude value for potential edges. This value is expressed as an absolute value; there are two magnitude lines: an upper (positive) threshold and lower (negative) threshold.

Edge **Magnitude** expresses the strength of a potential edge. The (green) magnitude curve, represents magnitude values across the area of interest. Potential edges must have a magnitude greater than the upper threshold, or lower than the lower threshold. See Figure 80.

**Filter Half-Width**

The filtering process attenuates peaks in the magnitude curve that are caused by noise. Filter Half-Width should be set to a value approximately equivalent to the width of the edge, in pixels. An incorrect value can cause edges to be incorrectly detected.

**Edge Score**

The Edge Locator scores potential edges according to the constraints set for edges. The scoring method restricts the Edge Locator’s search so that only results for valid edge pairs are returned.

There are two basic types of constraints that affect the choice of valid edges: Polarity and edge-score Constraints, which are based on position and magnitude of the edges.

**Polarity**

**Polarity** corresponds to the change in light values, moving from left to right in the display, along the X-Axis in the region of interest. The Edge Locator applies the Polarity constraint before applying edge-score Constraints.
Polarity is does not affect the Edge Score, however only edges that meet the selected Polarity constraint are output as valid edges, regardless of their scores.

- **Dark to Light** will only accept edges occurring at transitions from a dark area to a light area.
- **Light to Dark** will only accept edges occurring at transitions from a light area to a dark area.
- **Either** will accept any edge, regardless of its polarity.

![Figure 81 Edge Polarity](image)

**Constraints**

There are two types of constraints: Position and Magnitude. You can set the Edge Locator to use only one constraint type or both. The graphical function editor is provided for viewing and setting each type of constraint.

- If only one constraint is selected, edges are scored only based on the selected constraint
- If both constraints are selected, then each constraint accounts for 50% of the edge score.

**Magnitude Constraint**

The **Magnitude** constraint is based on edge values relative to the **Magnitude Threshold**. Edges having a magnitude equal to, or exceeding the Magnitude Threshold, are attributed a score of 1. Edges with values below the **Magnitude Threshold** receive a score ranging from 0 to 0.999, according to a manually set magnitude constraint function.

- The Magnitude Constraint is applied globally to all edges detected by the Edge Locator.
- **Figure 82** shows two different setups for a magnitude constraint function.

**To set the Magnitude Constraint:**

1. In the drop-down list above the function editor, select **Magnitude Constraints**.
2. In the Function Editor, use the mouse to drag handles and set the Magnitude limits. See examples in **Figure 82**.
Configuring Edge Locator Settings

Position Constraint

Position constraints restricts the Edge Locator’s search for edges to a specific zone of the region of the region of interest.

- It is possible to graphically set a position constraint function when the approximate position of an edge is known beforehand. This is useful for scoring an edge based on its offset from the expected position.

- Values in the Constraint function Editor indicate relative distance in the region of interest where 0.0 is the leftmost position and 1.0 is the rightmost position.

To set the Position Constraint:

1. In the drop-down list above the function editor, select Position Constraints.

2. In the Function Editor, use the mouse to drag handles and set the Position limits. See examples in Figure 82.

- The position in the function editor corresponds to the same position in the display.

![Figure 82 Setting the Magnitude Constraint in the Function Editor](image)

![Figure 83 Setting the Position Constraint Function Editor](image)
**Score Threshold**

The score threshold sets the minimum acceptable score for a valid edge. The Edge Locator will disregard edges that obtain a score lower than the **Score Threshold**.

- Scores attributed by the Edge Locator for constraints range from 0 to 1.
- If both Position and Magnitude constraints are enabled, each constraint accounts for 50% of the total edge score.

**Sort Results**

You can enable the Sort Results check box to sort the located edges in descending order of score values. By default, Sort Results is not enabled and edges are output in the same left to right order as they appear on the projection curve.
Edge Locator Results

The Edge Locator outputs two types of results: Frames and Results that provide information on each of the found edges.

- Frames output by the Edge Locator can be used by other AdeptSight tools for frame-based positioning. The output frames are represented in the display, and numbered, starting at 0.
- Results for edges found by the Edge Locator tool are show in the grid of results, below the display, as illustrated in Figure 84.

Saving Results

The results of a tool process can be saved to a text file. This can be useful for analyzing performance of each tool. At each execution of the tool, time, date and results for each execution are appended to the results log.

To create and store results to a log file:

1. Enable the check box under Results Log.
2. Click the 'Browse' icon.
3. Set the name of the file (*.log) and the location where the file will be saved.
4. The next time the sequence is executed, a new results log will be started, with the name and file path that are currently shown in the text box.

Viewing Results

The results for each execution of the tool are represented in the display window, and the grid of results.

Results Display

The Results display represents each frame output by the Edge Locator, as well as the edges found in each frame.
Grid of Results

The grid of results presents the results for all found by the Edge Locator tool. Results include the score and position for each edge. These results can be saved to file by enabling the Results Log.

Description of Edge Locator Results

The Edge Locator outputs the following results.

Elapsed Time

The **Elapsed Time** is the total execution time of the Edge Locator. **Elapsed Time** is not visible in the results grid but is output to the results log for each iteration of the Edge Locator.

Frame

**Frame** identifies the number of the frame output by the Edge Locator tool. If the tool is frame-based, this number corresponds to the input frame that provided the positioning.

Edge

Identification number of the edge. Enabling **Edge Sort** affects the order of edge numbering. Each edge outputs a frame that can be used by a frame-based tool for which the Edge Locator is a frame-provider.
Score

Score is the calculated score, between 1 and 0, for each edge. The score is calculated according to the defined constraint functions. If both Position and Magnitude constraints are enabled, each constraint accounts for 50% of the score.

Position X
The X coordinate of the center point for each edge segment.

Position Y
The Y coordinate of the center point for each edge segment.

Rotation
Rotation shows the angle for the edge.

Position Score
Position Score for the edge, calculated according to the Position Constraint function.

Magnitude
The Magnitude of the edge indicates its peak value in the magnitude curve.

Magnitude Score
Magnitude Score for the edge, calculated according to the Magnitude Constraint function.
Configuring Advanced Edge Locator Parameters

The **Advanced Parameters** section of the Edge Locator tool interface provides access to advanced Edge Locator parameters and properties.

**Configuration**

**Processing Format**

**ProcessingFormat** defines the format applied to process images provided by the camera.

- **hsNative**: When **hsNative** is selected, the Edge Locator processes images in the format in which they are output by the camera - either grey-scale or color.

- **hsGreyScale**: When **hsGreyScale** is enabled, the Edge Locator processes only the grey-scale information in the input image, regardless of the format in which the images are provided. This can reduce the execution time when color processing is not required.

**Frame Transform**

The **Scale To Instance** parameter is applicable only to an Edge Locator that is frame-based, and for which the Input Frame is provided by a Locator. Otherwise this parameter is ignored. If the Locator is configured to locate parts of varying scale, the Scale to Instance parameter determines the effect of the scaled instances on the Edge Locator.

**Scale to Instance**

When **ScaleToInstance** is **True**, the Edge Locator region of interest is resized and positioned relative to the change in scale of the Input frame. This is the recommended setting for most cases. When **ScaleToInstance** is **False**, the Edge Locator ignores the scale and builds frame relative to the input frame without adapting to the change in scale.

**Location**

**Tool Position**

Most tool position parameters can be set through the **Location** section of the tool interface. These are the parameters that define the tool’s region of interest. Additionally, the **Advanced Parameters** section gives access to the **CalibratedUnitsEnabled** parameter.

**Calibrated Units Enabled**

When **CalibratedUnitsEnabled** is set to **True** (default value), the tool results are returned in millimeters. When set to **False**, tool results are returned in pixels.

**Height**

Height of the Edge Locator region of interest.

**Width**

Width of the Edge Locator region of interest.

**Rotation**

Angle of rotation of the Edge Locator region of interest.
**Width**
Width of the Edge Locator region of interest.

**X**
X coordinate of the center of the tool region of interest.

**Y**
Y coordinate of the center of the region of interest.

![Diagram of Location Properties of the Edge Locator Region of Interest](image)

**Tool Sampling**
Sampling refers to the procedure used by the tool for gathering values within the portion of the input image that is bounded by the tool’s region of interest. Two sampling parameters, the **Sampling Step** and **Bilinear Interpolation**, can be used as necessary to create a required tradeoff between speed and precision.

For specific applications where a more appropriate tradeoff between speed and precision must be established, the sampling step can be modified by setting the **CustomSamplingStepEnabled** to True and modifying the **CustomSamplingStep** value.

**Bilinear Interpolation**
**Bilinear Interpolation** specifies if bilinear interpolation is used to sample the image before it is analyzed for image sharpness.

To ensure subpixel precision in inspection applications, Bilinear Interpolation should always be set to true (enabled). Non-interpolated sampling (Bilinear Interpolation disabled) should only be used in applications where the speed requirements are more critical than precision.

**Sampling Step Default**
**SamplingStepDefault** is the best sampling step computed by the tool, based on the average size, in calibrated units, of a pixel in the Image. This default sampling step is usually recommended. **SamplingStepDefault** is automatically used by the tool if **SamplingStepCustomEnabled** is True.

**Sampling Step**
**SamplingStep** is the step by the tool to sample the input image that is bounded by the tool region of interest. The sampling step represents the height and the width of a sampled pixel.
**Sampling Step Custom**

**SamplingStepCustom** enables you to set a sampling step value other than the default sampling step. To set a custom sampling step, **SamplingStepCustomEnabled** must be set to *False*.

- Increasing the sampling step value reduces the tool's precision and decreases the execution time.
- Reducing the sampling step can increase the tool's precision but can also increase the execution time.

**SamplingStepCustomEnabled**

Setting **SamplingStepCustomEnabled** to *True*, enables the tool to apply a custom sampling step defined by **SamplingStepCustom**. When set to *False* (default) the tool applies the default, optimal sampling step defined by **SamplingStepDefault**.

**Results**

**Coordinate System**

The **CoordinateSystem** parameter sets the coordinate system used by the tool to express results. The available coordinate systems are: Image (**hsImage**), World (**hsTool**), Object (**hsObject**), Tool (**hstool**).

**Edge Count**

**EdgeCount** indicates the number of valid edges that were found.

**Sort Results Enabled**

**SortResultsEnabled** specifies if edges are sorted in descending order of score values. When set to False (default) edges are sorted in order of their location within the region of interest. When True, edges are sorted in the order of their score, from highest to lowest.
Using the Arc Caliper Tool

The Arc Caliper tool finds, locates, and measures the gap between one or more edge pairs on a circular object. Edges can be disposed in a radial or an annular position.

The Arc Caliper uses pixel greylevel values within region of interest to build projections needed for edge detection.

After the Arc Caliper detects potential edges, the Arc Caliper determines which edge pairs are valid by applying the constraints that are configured for each edge pair. Finally, the Arc Caliper scores and measures each valid edge pair.

Basic Steps for Configuring an Arc Caliper

1. Select the tool that will provide input images. See Input.
2. Position the Arc Caliper tool. See Location.
3. Configure Pair Settings for each edge pair. Configuring Arc Caliper Settings
4. Test and verify results. See Arc Caliper Results.
5. Configure Advanced properties if required. Configuring Advanced Arc Caliper Parameters

Input

The Input required by the Arc Caliper is an image provided by another tool in the sequence.

- Typically, the Input is provided by an Acquire Image tool.
- Input can also be provided by other AdeptSight tools that output images, such as the Image Processing Tool.

To set the Input:

1. Execute the sequence once to make sure that an input image is available.
2. From the Input dropdown list, select the tool that will provide the input image.
3. If the required tool does not appear in the dropdown list, make sure that the required tool (Acquire Image or other) has been added to the Sequence Manager, above the Arc Caliper.

Location

Location parameters define the position of the tool’s region of interest in which the tool carries out its process.

The region of interest can be positioned relative to another tool (frame-based) or relative to a fixed area in the input image (image-based). The positioning mode is defined by the Frame Input parameter.
Using the Arc Caliper Tool

Positioning the Arc Caliper Tool relative to a Frame

**Frame Input**

The **Frame Input** defines whether the tool will be frame-based or image-based.

- **Frame-Based** positioning is the recommended mode for applications in which the tool needs to be repeatedly applied to a feature on an object, or to a specific area relative to an object. With frame-based positioning, the Arc Caliper is positioned relative to a frame of reference provided by another tool, called the frame-provider.

- **Image-Based** positioning is applied when the tool is not frame-based. In this mode, the tool region of interest is always positioned on the same area of the image, relative to the frame of reference of the image.

To set image-based positioning, set the **Frame Input** value to **(none)**.

**To set the Frame Input:**

1. From the **Frame Input** dropdown list, select the frame-provider tool. Selecting a tool in the list enables frame-based positioning.

   The ideal frame-provider tool is a Locator. See [Frame-Provider Tools](#) for more details on using other tools as frame-providers.

2. If the tool must be positioned to a static area on all images (image-based) select **(none)** in the **Frame Input** dropdown list.

3. If the Arc Caliper must be placed on all frames output by the frame-provider tool, enable the **All Frames** check box.

4. If the Arc Caliper must be only be applied to a single frame, (output by frame-provider tool) disable the **All Frames** check box and select the required frame.

   The default value is 0; the numbering of frames is 0-based.

5. Click **Location** to position the tool region of interest relative to the frame provider tool. See [Positioning and Modifying the Arc Caliper Region of Interest](#).
Positioning and Modifying the Arc Caliper Region of Interest

Positioning the tool defines the area of the image that will be processed by the Arc Caliper. Location parameters define the position of the tool region of interest.

Location

The Location button opens the Location dialog and displays the tool region of interest in the image display.

The tool’s region of interest is bounded by a Sector defined by the parameters Position X, Position Y, Opening, Thickness, Rotation, and Radius.

To position and resize the sector region of interest in the display:

1. Click Location. The Location dialog opens as shown in Figure 86. This dialog defines the size and position of the tool region of interest. The display represents the region of interest as a green bounding sector.

2. If the tool is frame-based, a blue marker indicates the frame provided by the frame-provider tool (Frame Input). If there is more than one object in the image, make sure that you are positioning the bounding box relative to the object identified by a blue axes marker.

3. Enter values in the Location dialog, or use the mouse to configure the bounding sector in the display. Values are relative to the origin of the frame-provider tool (blue marker) if the tool is frame-based. If the tool is image-based, values are relative to the image origin.

   • To move the sector, drag its border or its origin, which located at the intersection of its two bounding radii shown with dotted lines. Handle A in Figure 87.

   • To adjust the radius, drag the center that is located at the intersection between the bisector and the median annulus. Handle F in Figure 87.

   • To set the thickness, drag any of the four resizing handles located at intersections between its two bounding radii and annuli or by dragging the two resizing handles located at the intersections of the bisector and the two bounding annuli. Handles B, D, E, G, H, and J in Figure 87.

   • To set the opening, drag any of the four resizing handles located at intersections between its two bounding radii and annuli. Handles B, D, H, and J in Figure 87.

   • To set the rotation, drag either of the intersection points between the median annulus and the two bounding radii. Handles C, and I in Figure 87.
Before configuring the Arc Caliper, execute the tool (or sequence) at least once and verify in the display that the tool is being positioned correctly in the image. The display represents the Arc Caliper region of interest in green and any found edges in red.

**Figure 87** Illustration of Location Parameters for a Sector Region of Interest

**Related Topics**

Configuring Arc Caliper Settings
Configuring Arc Caliper Settings

The Arc Caliper can measure any number of pairs. When the Caliper is executed, the Arc Caliper first applies edge detection parameters to the entire region of interest. Then, the tool applies pair settings constraints to determine which caliper pairs. Results are then calculated for each edge pair as well as for individual edges in each edge pair.

As shown in figure, the **Pairs** section contains a list of all the pairs that are configured for the current Caliper tool. This list always contains at least one pair, which by default is called Pair(0).

From the **Pairs** list, you can:

- Access the configuration parameters for each pair.
- Add and remove edge pairs.
- Rename edge pairs.

![Figure 88 Pairs List in the Arc Caliper Interface](image)

**Figure 88** Pairs List in the Arc Caliper Interface

**To access configuration parameters for an edge pair:**

1. In the **Pairs** list, click on a pair to select it.
2. Click **Edit**. This opens the **Pair Settings** window for the selected pair.
3. See Configuring Pair Settings for details.

**To add an edge pair:**

1. Under the **Pairs** list, click the 'Add Pair' icon.
2. A pair is added with the default name: Pair(n).
3. The **Pairs Settings** window opens, ready for editing the new edge pair.

**To remove an edge pair:**

1. In the **Pairs** list, select the pair that must be removed.
2. Click the 'Remove Pair' icon.

**To rename an edge pair:**

1. In the Pairs list, double-click on the name of the pair to be renamed.
2. Type a new name for the edge pair. This will not affect the configuration parameters of the pair.
Configuring Pair Settings

When the Arc Caliper is executed, the Arc Caliper first applies edge detection constraints to the entire region of interest. Then, the tool applies edge scoring constraints to determine which edges are valid for the caliper measure. If only one valid edge is found, no caliper measure is output.

**Pair Settings** parameters set how the tool detects edges and determines which edge pair are valid.

Before configuring the Arc Caliper, execute the tool (or sequence) at least once and verify in the display that the tool is being positioned correctly in the image. The display represents the Arc Caliper as a green rectangle, with found edges and caliper measure represented in red.

To configure edge pair settings:

1. Under the **Pairs** section of the interface, select a pair name in the list. The default name for a first pair is Pair(0).
2. Click **Edit**.
3. The **Pair Settings** window opens, as shown in Figure 89. This window provides parameters for each edge of the Caliper edge pair, named: **First Edge** and **Second Edge**.
4. Configure settings for each edge. Refer to sections below for help on configuring **Pair Settings**, and using the display and function editor.
Pair Settings

There are two basic types of constraints that affect the choice of valid edges: Polarity and edge-score Constraints, which are based on position and magnitude of the edges.

Polarity

Polarity corresponds to the change in light values, moving from left to right in the display, along the X-Axis in the region of interest. The Arc Caliper applies the Polarity constraint before applying edge-score Constraints.
**Polarity** is does not affect the edge score, however only edges that meet the selected Polarity constraint are retained as valid edges, regardless of their scores.

- **Dark to Light** will only accept edges occurring at transitions from a dark area to a light area.
- **Light to Dark** will only accept edges occurring at transitions from a light area to a dark area.
- **Either** will accept any edge, regardless of its polarity.

![Figure 90 Edge Polarity](image)

**Constraints**

There are two types of constraints: **Position** and **Magnitude**. You can set the Arc Caliper to use only one constraint type or both. The graphical function editor is provided for viewing and setting each type of constraint.

- If only one constraint is selected, edges are scored only based on the selected constraint
- If both constraints are selected, then each constraint accounts for 50% of the edge score.

**Magnitude Constraint**

The **Magnitude** constraint is based on edge values relative to the **Magnitude Threshold**, which is represented in the display by 2 red lines.

Edges having a magnitude equal to, or exceeding the Magnitude Threshold, are attributed a score of 1. Edges with values below the Magnitude Threshold receive a score ranging from 0 to 0.999, according to a manually set magnitude constraint function.

The **Magnitude Threshold** value can be modified in the **Advanced Parameters** section of the tool interface. See **Magnitude Constraint**.

- A **Magnitude** constraint must be defined individually for each edge.
- **Figure 91** shows examples of two different setups for a magnitude constraint function.

**To set a Magnitude Constraint:**

1. In the drop-down list above the function editor, select **First Edge Magnitude Constraints** or **Second Edge Magnitude Constraints**.
2. In the Function Editor, use the mouse to drag handles and set the magnitude limits. See examples in **Figure 91**.
Position Constraint

Position constraints restrict the Arc Caliper’s search for edges to a specific zone of the region of interest.

- It is possible to graphically set a position constraint function when the approximate position of an edge is known beforehand. This is useful for scoring an edge based on its offset from the expected position.
- Values in the Constraint function Editor indicate relative distance in the region of interest where 0.0 is the leftmost position and 1.0 is the rightmost position.

To set a Position Constraint:

1. In the drop-down list above the function editor, select First Edge Position Constraints or Second Edge Position Constraints.

2. In the Function Editor, use the mouse to drag handles and set the position limits. See examples in Figure 92.

   The physical position in the function editor corresponds to the same physical position in the display.
Score Threshold

The score threshold sets the minimum acceptable score for a valid edge. The Arc Caliper will disregard edges that obtain a score lower than the **Score Threshold**.

- Scores attributed by the Arc Caliper for constraints range from 0 to 1.
- If both **Position** and **Magnitude** constraints are enabled, each constraint accounts for 50% of the total edge score.

**Related Topics**

- [Positioning and Modifying the Arc Caliper Region of Interest](#)
- [Configuring Advanced Arc Caliper Parameters](#)
Arc Caliper Results

The Arc Caliper outputs two types of results: Frames and Results that provide information on each of the found edges.

- Frames output by the Arc Caliper can be used by other AdeptSight tools for frame-based positioning. The output frames are represented in the display, and numbered, starting at 0. Results for edges found by the Arc Caliper tool are shown in the grid of results, below the display, as illustrated in Figure 93.

Saving Results

The results of a tool process can be saved to a text file. This can be useful for analyzing performance of each tool. At each execution of the tool, time, date and results for each execution are appended to the results log.

**To create and store results to a log file:**

1. Enable the check box under Results Log.
2. Click the 'Browse' icon.
3. Set the name of the file (*.log) and the location where the file will be saved.
4. The next time the sequence is executed, a new results log will be started, with the name and file path that are currently shown in the text box.

Viewing Results

The results for each execution of the tool are represented in the display window, and the grid of results.

Results Display

The Results display represents each frame output by the Arc Caliper, as well as the Arc Caliper measure, edge pair results and results for each edge in an edge pair.
Grid of Results

The grid of result presents the results for all caliper measures found by the Arc Caliper tool. Results include the score and position for each edge in an edge pair. These results can be saved to file by enabling the Results Log.

Description of Arc Caliper Results

The Arc Caliper outputs the following results:

**Elapsed Time**

The *Elapsed Time* is the total execution time of the Arc Caliper. *Elapsed Time* is not visible in the results grid but is output to the results log for each iteration of the Arc Caliper.

**Frame**

*Frame* identifies the number of the frame output by the Arc Caliper tool. If the tool is frame-based, this number corresponds to the input frame that provided the positioning.

**Pair**

The name of the edge pair, as it appears in the *Pairs* list. Each pair instance outputs a frame that can be used by a frame-based tool for which the Arc Caliper is a frame-provider.

**Score**

*Score* is the calculated score, between 1 and 0, for the edge pair. The score is calculated according to the defined constraint functions. If both *Position* and *Magnitude* constraints are enabled, each constraint accounts for 50% of the score.

Each edge of the pair is also scored individually, in a similar manner. See *Edge1/Edge2* results below.

**Size**

*Size* is the Caliper measure, which is the calculated distance between the pair of edges.
Position X
Position X is the X coordinate of the center point of the caliper measure, at the midpoint of the edge pair.

Position Y
Position Y is the Y coordinate of the center point of the caliper measure, at the midpoint of the edge pair.

Rotation
The angle of rotation for the edge pair.

Edge 1/Edge 2 Score
The score of the individual edge, calculated according to the defined constraints.

Edge 1/Edge 2 Position X
The X coordinate of the edge, at the midpoint of the edge segment.

Edge 1/Edge 2 Position Y
The Y coordinate of the edge, at the midpoint of the edge segment.

Edge 1/Edge 2 Rotation
The angle of rotation for the edge.

Edge 1/Edge 2 Position Score
Position score for the edge, calculated according to the Position constraint function.

Edge 1/Edge 2 Magnitude
The calculated Magnitude value for the edge.

Edge 1/Edge 2 Magnitude Score
Magnitude score for the edge, calculated according to the Magnitude constraint function.
Configuring Advanced Arc Caliper Parameters

The Advanced Parameters section of the Arc Caliper tool interface provides access to advanced Arc Caliper parameters and properties.

Configuration

Processing Format

ProcessingFormat defines the format applied to process images provided by the camera.

- **hsNative**: When hsNative is selected, the Arc Caliper processes images in the format in which they are output by the camera - either grey-scale or color.

- **hsGreyScale**: When hsGreyScale is enabled, the Arc Caliper processes only the grey-scale information in the input image, regardless of the format in which the images are provided. This can reduce the execution time when color processing is not required.

Frame Transform

The Scale to Instance parameter is applicable only to an Arc Caliper that is frame-based, and for which the Input Frame is provided by a Locator. Otherwise this parameter is ignored. If the Locator is configured to locate parts of varying scale, the Scale to Instance parameter determines the effect of the scaled instances on the Arc Caliper.

**Scale To Instance**

When ScaleToInstance is True, the Arc Caliper region of interest is resized and positioned relative to the change in scale of the Input frame. This is the recommended setting for most cases. When ScaleToInstance is False, the Arc Caliper ignores the scale and builds frame relative to the input frame without adapting to the change in scale.

Edge Detection

Edge Detection settings configure the parameters that the Arc Caliper will use to find potential edges in the area of interest. The display represents the Arc Caliper region of interest and provides information to assist in configuring Edge Detection parameters.

**Magnitude Threshold**

The Magnitude Threshold sets the acceptable magnitude value for potential edges. This value is expressed as an absolute value; there are two magnitude lines: an upper (positive) threshold and lower (negative) threshold.

Edge Magnitude expresses the strength of a potential edge. The (green) magnitude curve, represents magnitude values across the area of interest. Potential edges must have a magnitude above the upper threshold, or below the lower threshold. See Figure 94.
Filter Half-Width

The filtering process attenuates peaks in the magnitude curve that are caused by noise. Filter Half-Width should be set to a value approximately equivalent to the width of the edge, in pixels. An incorrect value can cause edges to be incorrectly detected.

Location

Tool Position

Most tool position parameters can be set through the Location section of the tool interface. These are the parameters that define the tool’s region of interest. Additionally, the Advanced Parameters section gives access to the CalibratedUnitsEnabled parameter.

Calibrated Units Enabled

When CalibratedUnitsEnabled is set to True (default value), the tool results are returned in millimeters. When set to False, tool results are returned in pixels.

Opening

Angle between the two bounding radii of the tool’s sector.

Radius

The radius of the tool corresponds to the radius of the median annulus of the tool’s sector.

Thickness

Distance between its two bounding annuli of the tool sector.

Rotation

Angle of rotation of the Arc Caliper region of interest.

Width

Width of the Arc Caliper region of interest.

X

X coordinate of the origin of the Tool.

Y

Y coordinate of the origin of the Tool.
Configuring Advanced Arc Caliper Parameters

Tool Sampling

Sampling refers to the procedure used by the tool for gathering values within the portion of the input image that is bounded by the tool’s region of interest. Two sampling parameters, the Sampling Step and Bilinear Interpolation, can be used as necessary to create a required tradeoff between speed and precision.

For specific applications where a more appropriate tradeoff between speed and precision must be established, the sampling step can be modified by setting the CustomSamplingStepEnabled to True and modifying the CustomSamplingStep value.

Bilinear Interpolation

Bilinear Interpolation specifies if bilinear interpolation is used to sample the image before it is analyzed for image sharpness.

To ensure subpixel precision in inspection applications, Bilinear Interpolation should always be set to true (enabled). Non-interpolated sampling (Bilinear Interpolation disabled) should only be used in applications where the speed requirements are more critical than precision.

Sampling Step Default

SamplingStepDefault is the best sampling step computed by the tool, based on the average size, in calibrated units, of a pixel in the Image. This default sampling step is usually recommended. SamplingStepDefault is automatically used by the tool if SamplingStepCustomEnabled is True.

Sampling Step

SamplingStep is the step used by the tool to sample the area of the input image that is bounded by the tool region of interest. The sampling step represents the height and the width of a sampled pixel.
**Sampling Step Custom**

**SamplingStepCustom** enables you to set a sampling step value other than the default sampling step. To set a custom sampling step, **SamplingStepCustomEnabled** must be set to *False*.

- Increasing the sampling step value reduces the tool's precision and decreases the execution time.
- Reducing the sampling step can increase the tool's precision but can also increase the execution time.

**SamplingStepCustomEnabled**

Setting **SamplingStepCustomEnabled** to *True*, enables the tool to apply a custom sampling step defined by **SamplingStepCustom**. When set to *False* (default) the tool applies the default, optimal sampling step defined by **SamplingStepDefault**.

**Results**

**Coordinate System**

The **CoordinateSystem** parameter sets the coordinate system used by the tool to express results. The available coordinate systems are: Image (**hsImage**), World (**hsTool**), Object (**hsObject**), Tool (**hstool**).

**Edge Count**

**EdgeCount** indicates the number of valid edges that were found.
Using the Arc Edge Locator Tool

The Arc Edge Locator tool finds, locates, and measures the position of one or more edges on a circular object. Edges can be disposed in a radial or an annular position.

The Arc Edge Locator uses pixel greylevel values within region of interest to build projections needed for edge detection.

After the Arc Edge Locator detects potential edges, the Arc Edge Locator determines which edge pairs are valid by applying the constraints that are configured for each edge pair. Finally, the Arc Edge Locator scores and measures each valid edge pair.

The Arc Edge Locator uses pixel greylevel values to detect edges found within the region of interest. Once potential edges have been located, the Arc Edge Locator applies the constraints to determine which edges are valid.

The Arc Edge Locator determines the position of one or more edges, it does not measure the length of lines detected in the region of interest. To extrapolate and measure a line on an object, use the Edge Finder tool.

Basic Steps for Configuring an Arc Edge Locator

1. Select the tool that will provide input images. See Input.
2. Position the Arc Edge Locator tool. See Location.
4. Test and verify results. See Arc Edge Locator Results.
5. Configure Advanced properties if required. Configuring Advanced Arc Edge Locator Parameters.

Input

The Input required by the Arc Edge Locator is an image provided by another tool in the sequence.

- Typically, the Input is provided by an Acquire Image tool.
- Input can also be provided by other AdeptSight tools that output images, such as the Image Processing Tool.

To set the Input:

1. Execute the sequence once to make sure that an input image is available.
2. From the Input dropdown list, select the tool that will provide the input image.
3. If the required tool does not appear in the dropdown list, make sure that the required tool (Acquire Image or other) has been added to the Sequence Manager, above the Arc Edge Locator.

Location

Location parameters define the position of the tool’s region of interest in which the tool carries out its process.
The region of interest can be positioned relative to another tool (frame-based) or relative to a fixed area in the input image (image-based). The positioning mode is defined by the Frame Input parameter.

**Frame Input**

The Frame Input defines whether the tool will be frame-based or image-based.

- **Frame-Based** positioning is the recommended mode for applications in which the tool needs to be repeatedly applied to a feature on an object, or to a specific area relative to an object. With frame-based positioning, the Arc Edge Locator is positioned relative to a frame of reference provided by another tool, called the frame-provider.

- **Image-Based** positioning is applied when the tool is not frame-based. In this mode, the tool region of interest is always positioned on the same area of the image, relative to the frame of reference of the image.

To set image-based positioning, set the Frame Input value to **(none)**.

To set the Frame Input:

1. From the Frame Input dropdown list, select the frame-provider tool. Selecting a tool in the list enables frame-based positioning.

   The ideal frame-provider tool is a Locator. See Frame-Provider Tools for more details on using other tools as frame-providers.

2. If the tool must be positioned to a static area on all images (image-based) select **(none)** in the Frame Input dropdown list.

3. If the Arc Edge Locator must be placed on all frames output by the frame-provider tool, enable the All Frames check box.

4. If the Arc Edge Locator must be only be applied to a single frame, (output by frame-provider tool) disable the All Frames check box and select the required frame.

   The default value is 0; the numbering of frames is 0-based.

5. Click Location to position the tool region of interest relative to the frame provider tool. See Positioning and Modifying the Arc Edge Locator Region of Interest.
Positioning and Modifying the Arc Edge Locator Region of Interest

Positioning the tool defines the area of the image that will be processed by the Arc Edge Locator. Location parameters define the position of the tool region of interest.

Location

The Location button opens the Location dialog and displays the tool region of interest in the image display.

The tool’s region of interest is bounded by a Sector defined by the parameters Position X, Position Y, Opening, Thickness, Rotation, and Radius.

To position and resize the sector region of interest in the display:

1. Click Location. The Location dialog opens as shown in Figure 96. This dialog defines the size and position of the tool region of interest. The display represents the region of interest as a green bounding sector.

2. If the tool is frame-based, a blue marker indicates the frame provided by the frame-provider tool (Frame Input). If there is more than one object in the image, make sure that you are positioning the bounding box relative to the object identified by a blue axes marker.

3. Enter values in the Location dialog, or use the mouse to configure the bounding sector in the display. Values are relative to the origin of the frame-provider tool (blue marker) if the tool is frame-based. If the tool is image-based, values are relative to the image origin.

   • To move the sector, drag its border or its origin, which located at the intersection of its two bounding radii shown with dotted lines. Handle A in Figure 97.

   • To adjust the radius, drag the center that is located at the intersection between the bisector and the median annulus. Handle F in Figure 97.

   • To set the thickness, drag any of the four resizing handles located at intersections between its two bounding radii and annuli or by dragging the two resizing handles located at the intersections of the bisector and the two bounding annuli. Handles B, D, E, G, H, and J in Figure 97.

   • To set the opening, drag any of the four resizing handles located at intersections between its two bounding radii and annuli. Handles B, D, H, and J in Figure 97.

   • To rotate the sector, drag either of the intersection points between the median annulus and the two bounding radii. Handles C, and I in Figure 97.
Before configuring the Arc Edge Locator, execute the tool (or sequence) at least once and verify in the display that the tool is being positioned correctly in the image.

The display represents the Arc Edge Locator in green and found edges in red.

**Related Topics**

[Configuring Arc Edge Locator Settings](#)
Configuring Arc Edge Locator Settings

When the Arc Edge Locator is executed, the Arc Edge Locator first applies edge detection parameters to the entire region of interest. Then, the tool applies edge scoring constraints to determine which edges are output as valid edges.

**Edge Settings** parameters set how the tool detects edges and determines which edges are valid.

Before configuring the Arc Edge Locator, execute the tool (or sequence) at least once and verify in the display that the tool is being positioned correctly in the image.

**To configure edge detection parameters:**

1. Under the **Edges** section of the interface, click **Configure**.
2. The **Edge Settings** window opens, as shown in **Figure 98**. This window provides edge detection settings and constraints, as well as visual aids for configuring edge location settings.
3. Refer to sections below for help on configuring edge settings, and using the display and function editor.

![](Image)

**Figure 98** The Edge Settings Window

Right-click in display to show edge detection values

Graphical function Editor for setting Position constraints and Threshold constraints
Configuring Arc Edge Locator Settings

Edge Detection

**Edge Detection** settings configure the parameters that the Arc Edge Locator will use to find potential edges in the area of interest. The display represents the Arc Edge Locator region of interest and provides information to assist in configuring **Edge Detection** parameters.

**Magnitude Threshold**

The **Magnitude Threshold** sets the acceptable magnitude value for potential edges. This value is expressed as an absolute value; there are two magnitude lines: an upper (positive) threshold and lower (negative) threshold.

Edge **Magnitude** expresses the strength of a potential edge. The (green) magnitude curve, represents magnitude values across the area of interest. Potential edges must have a magnitude greater than the upper threshold, or lower than the lower threshold. See **Figure 99**.

![Magnitude curve](image)

**Figure 99** Interpreting the Magnitude Threshold in the display area

**Filter Half-Width**

The filtering process attenuates peaks in the magnitude curve that are caused by noise. **Filter Half-Width** should be set to a value approximately equivalent to the width of the edge, in pixels. An incorrect value can cause edges to be incorrectly detected.

Edge Score

The Arc Edge Locator scores potential edges according to the constraints set for edges. The scoring method restricts the Arc Edge Locator’s search so that only results for valid edge pairs are returned.

There are two basic types of constraints that affect the choice of valid edges: Polarity and edge-score Constraints, which are based on position and magnitude of the edges.

**Polarity**

**Polarity** corresponds to the change in light values, moving from left to right in the display, along the X-Axis in the region of interest. The Arc Edge Locator applies the Polarity constraint before applying edge-score Constraints.
**Polarity** is does not affect the Edge Score, however only edges that meet the selected Polarity constraint are output as valid edges, regardless of their scores.

- **Dark to Light** will only accept edges occurring at transitions from a dark area to a light area.
- **Light to Dark** will only accept edges occurring at transitions from a light area to a dark area.
- **Either** will accept any edge, regardless of its polarity.

**Figure 100  Edge Polarity**

**Constraints**

There are two types of constraints: Position and Magnitude. You can set the Arc Edge Locator to use only one constraint type or both. The graphical function editor is provided for viewing and setting each type of constraint.

- If only one constraint is selected, edges are scored only based on the selected constraint.
- If both constraints are selected, then each constraint accounts for 50% of the edge score.

**Magnitude Constraint**

The **Magnitude** constraint is based on edge values relative to the **Magnitude Threshold**. Edges having a magnitude equal to, or exceeding the Magnitude Threshold, are attributed a score of 1. Edges with values below the **Magnitude Threshold** receive a score ranging from 0 to 0.999, according to a manually set magnitude constraint function.

- The Magnitude Constraint is applied globally to all edges detected by the Arc Edge Locator.
- **Figure 101** shows two different setups for a magnitude constraint function.

**To set the Magnitude Constraint:**

1. In the drop-down list above the function editor, select **Magnitude Constraints**.
2. In the Function Editor, use the mouse to drag handles and set the Magnitude limits. See examples in **Figure 101**.
Configuring Arc Edge Locator Settings

Position Constraint

Position constraints restricts the Arc Edge Locator’s search for edges to a specific zone of the region of interest.

- It is possible to graphically set a position constraint function when the approximate position of an edge is known beforehand. This is useful for scoring an edge based on its offset from the expected position.
- Values in the Constraint Function Editor indicate relative distance in the region of interest where 0.0 is the leftmost position and 1.0 is the rightmost position.

To set the Position Constraint:

1. In the drop-down list above the function editor, select Position Constraints.
2. In the Function Editor, use the mouse to drag handles and set the Position limits. See examples in Figure 101.

- The position in the function editor corresponds to the same position in the display.
**Score Threshold**

The score threshold sets the minimum acceptable score for a valid edge. The Edge Locator will disregard edges that obtain a score lower than the **Score Threshold**.

- Scores attributed by the Arc Edge Locator for constraints range from 0 to 1.
- If both **Position** and **Magnitude** constraints are enabled, each constraint accounts for 50% of the total edge score.

**Sort Results**

You can enable the Sort Results check box to sort the located edges in descending order of score values. By default, Sort Results is not enabled and edges are output in the same left to right order as they appear on the projection curve.
Arc Edge Locator Results

The Arc Edge Locator outputs two types of results: Frames and Results that provide information on each of the found edges.

- Frames output by the Arc Edge Locator can be used by other AdeptSight tools for frame-based positioning. The output frames are represented in the display, and numbered, starting at 0.
- Results for edges found by the Arc Edge Locator tool are show in the grid of results, below the display, as illustrated in Figure 103.

Saving Results

The results of a tool process can be saved to a text file. This can be useful for analyzing performance of each tool. At each execution of the tool, time, date and results for each execution are appended to the results log.

To create and store results to a log file:

1. Enable the check box under Results Log.
2. Click the 'Browse' icon.
3. Set the name of the file (*.log) and the location where the file will be saved.
4. The next time the sequence is executed, a new results log will be started, with the name and file path that are currently shown in the text box.

Viewing Results

The results for each execution of the tool are represented in the display window, and the grid of results.

Results Display

The Results display represents each frame output by the Arc Edge Locator, as well as the edges found in each frame.
Grid of Results

The grid of results presents the results for all edges found by the Arc Edge Locator tool. These results can be saved to file by enabling the Results Log.

Description of Arc Edge Locator Results

The Arc Edge Locator outputs the following results:

Elapsed Time

The *Elapsed Time* is the total execution time of the Arc Edge Locator. *Elapsed Time* is not visible in the results grid but is output to the results log for each iteration of the Arc Edge Locator.

Frame

*Frame* identifies the number of the frame output by the Arc Edge Locator tool. If the tool is frame-based, this number corresponds to the input frame that provided the positioning.

Edge

Identification number of the edge. Enabling *Edge Sort* affects the order of edge numbering.

Score

*Score* is the calculated score, between 1 and 0, for each edge. The score is calculated according to the defined constraint functions. If both *Position* and *Magnitude* constraints are enabled, each constraint accounts for 50% of the score.
Position X
The X coordinate of the center point for each edge segment.

Position Y
The Y coordinate of the center point for each edge segment.

Rotation
Rotation shows the angle for the edge.

Position Score
Position Score for the edge, calculated according to the Position Constraint function.

Magnitude
The Magnitude of the edge indicates its peak value in the magnitude curve.

Magnitude Score
Magnitude Score for the edge, calculated according to the Magnitude Constraint function.
Configuring Advanced Arc Edge Locator Parameters

The **Advanced Parameters** section of the Arc Edge Locator tool interface provides access to advanced Arc Edge Locator parameters and properties.

**Configuration Parameters**

**Processing Format**

**ProcessingFormat** defines the format applied to process images provided by the camera.

- **hsNative**: When **hsNative** is selected, the Arc Edge Locator processes images in the format in which they are output by the camera - either grey-scale or color.

- **hsGreyScale**: When **hsGreyScale** is enabled, the Arc Edge Locator processes only the grey-scale information in the input image, regardless of the format in which the images are provided. This can reduce the execution time when color processing is not required.

**Frame Transform Parameters**

The **Scale to Instance** parameter is applicable only to an Arc Edge Locator that is frame-based, and for which the Input Frame is provided by a Locator. Otherwise this parameter is ignored. If the Locator is configured to locate parts of varying scale, the Scale to Instance parameter determines the effect of the scaled instances on the Arc Edge Locator.

**Scale to Instance**

When **ScaleToInstance** is **True**, the Arc Edge Locator region of interest is resized and positioned relative to the change in scale of the Input frame. This is the recommended setting for most cases. When **ScaleToInstance** is **False**, the Arc Edge Locator ignores the scale and builds frame relative to the input frame without adapting to the change in scale.

**Location Parameters**

**Tool Position parameters**

Most tool position parameters can be set through the **Location** section of the tool interface. These are the parameters that define the tool’s region of interest. Additionally, the **Advanced Parameters** section gives access to the **CalibratedUnitsEnabled** parameter.

**Calibrated Units Enabled**

When **CalibratedUnitsEnabled** is set to **True** (default value), the tool results are returned in millimeters. When set to **False**, tool results are returned in pixels.

**Opening**

Angle between the two bounding radii of the tool’s sector.

**Radius**

The radius of the tool corresponds to the radius of the median annulus of the tool’s sector.

**Thickness**

Distance between its two bounding annuli of the tool sector.
**Rotation**
Angle of rotation of the Arc Edge Locator region of interest.

**Width**
Width of the Arc Edge Locator region of interest.

**X**
X coordinate of the origin of the Tool

**Y**
Y coordinate of the origin of the Tool

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**Figure 104** Illustration of Tool Position for a Sector-type Region of Interest

**Tool Sampling Parameters**
Sampling refers to the procedure used by the tool for gathering values within the portion of the input image that is bounded by the tool's region of interest. Two sampling parameters, the **Sampling Step** and **Bilinear Interpolation**, can be used as necessary to create a required tradeoff between speed and precision.

For specific applications where a more appropriate tradeoff between speed and precision must be established, the sampling step can be modified by setting the **CustomSamplingStepEnabled** to True and modifying the **CustomSamplingStep** value.

**Bilinear Interpolation**
**Bilinear Interpolation** specifies if bilinear interpolation is used to sample the image before it is analyzed.

To ensure subpixel precision in inspection applications, Bilinear Interpolation should always be set to true (enabled). Non-interpolated sampling (Bilinear Interpolation disabled) should only be used in applications where the speed requirements are more critical than precision.)
Configuring Advanced Arc Edge Locator Parameters

**Sampling Step Default**

SamplingStepDefault is the best sampling step computed by the tool, based on the average size, in calibrated units, of a pixel in the Image. This default sampling step is usually recommended. SamplingStepDefault is automatically used by the tool if SamplingStepCustomEnabled is True.

**Sampling Step**

SamplingStep is the step used by the tool to sample the area of the input image that is bounded by the tool region of interest. The sampling step represents the height and the width of a sampled pixel.

**Sampling Step Custom**

SamplingStepCustom enables you to set a sampling step value other than the default sampling step. To set a custom sampling step, SamplingStepCustomEnabled must be set to False.

- Increasing the sampling step value reduces the tool's precision and decreases the execution time.
- Reducing the sampling step can increase the tool's precision but can also increase the execution time.

**SamplingStepCustomEnabled**

Setting SamplingStepCustomEnabled to True, enables the tool to apply a custom sampling step defined by SamplingStepCustom. When set to False (default) the tool applies the default, optimal sampling step defined by SamplingStepDefault.

**Results Parameters**

**Coordinate System**

The CoordinateSystem parameter sets the coordinate system used by the tool to express results. The available coordinate systems are: Image (hsImage), World (hsTool), Object (hsObject), Tool (hstool).

**Edge Count**

EdgeCount indicates the number of valid edges that were found.

**Sort Results Enabled**

SortResultsEnabled specifies if edges are sorted in descending order of score values. When set to False (default) edges are sorted in order of their location within the region of interest. When True, edges are sorted in the order of their score, from highest to lowest.