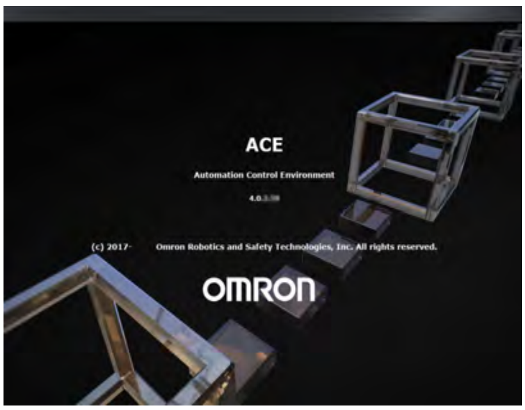
OMRON

Automation Control Environment (ACE) Version 4

User’s Manual



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Revision History

Revision code	Date	Revised Content
01	April, 2019	Original release
02	September, 2019	Style and content update
03	July, 2020	Revisions for an upgrade to version 4
04	August, 2020	Minor revisions and restructuring
05	September, 2020	Minor updates and additions, v4.2
06	February, 2021	Added 3D Pick Manager, minor updates
07	January, 2022	Added FH Camera and minor updates for v4.4

Chapter 1: Introduction

This manual contains information that is necessary to use Automation Control Environment (ACE) software. Please read this manual and make sure you understand the ACE software features, functions and concepts before attempting to use it.

Use the information in this section to understand ACE software features, functions and concepts.

1.1 Intended Audience

This manual is intended for the following personnel.

- Personnel in charge of introducing Factory Automation systems.
- Personnel in charge of designing Factory Automation systems.
- Personnel in charge of installing and maintaining Factory Automation systems.
- Personnel in charge of managing Factory Automation systems and facilities.

1.2 Related Manuals

Use the following related manuals for reference.

Manual	Description
Robot Safety Guide (Cat. No. I590)	Provides safety information for OMRON industrial robots.
T20 Pendant User's Manual (Cat. No. I601)	Provides information for the setup and use of the T20 Pendant.
eV+ Language User's Guide (Cat. No. I604)	Provides information about the eV+ language.
eV+ Language Reference Guide (Cat. No. I605)	Provides references to eV+ language and functionality.
Robot Vision Manager User's Manual (Cat. No. I667)	Provides information necessary for understanding the correct use of vision cameras.
V+ Module Reference Manual (Cat. No. I668)	Provides references to V+ language and functionality.
V+ User's Manual (Cat. No. I671)	Provides references to V+ language and functionality.
V+ Keyword Reference Manual (Cat. No. I672)	Provides references to V+ Keyword use and functionality.
S8BA-series Uninterruptible Power Supply (UPS) User’s Manual (Cat. No. U726)	Provides installation and operating instructions for the S8BA UPS.
Sysmac Studio for Project Version Control Function Operation Manual (Cat. No.	Provides version control information to properly save, import, export and manage projects

Manual	Description
W589)	in multi-user environments.
Sysmac Studio for Robot Integrated System Building Function with Robot Integrated CPU Unit Operation Manual (Cat. No. W595)	Provides information that is necessary to use the robot control function of the NJ-series CPU Unit.
FH/FHV Series Vision System Operation Manual for Sysmac Studio (Cat. No. Z343)	Provides information for the integration and operation of the FH camera with Sysmac Studio.
FH/FHV Series Vision System User's Manual (Cat. No. Z365)	Provides information for proper operation of the FH camera within a network.
FH Series Vision System Hardware Setup Manual (Cat. No. Z366)	Contains information to install and properly wire the FH cameras.
Anyfeeder User's Guide (18876-000)	Provides information about the operation of the AnyFeeder unit.

1.3 Software Overview

The Automation Control Environment (ACE) software allows you to build applications, such as Pack Manager packaging applications, which can be basic pick-and-place cells or complex cells with multiple cameras, conveyors, and robots. You can create and configure these cells without having to write any programming code. For applications that require greater control, you can override the default V+ program code and make changes as needed.

Because the ACE software runs on the PC, the PC must remain connected when the application is running. The only exception to this rule is when the application does not rely on any ACE functionality at run-time. In this case, ACE software can be used for setup and configuration and then removed for the operation of the system.

The ACE software optimizes the cell programming to maximize throughput, handle part flow and robot utilization (line balancing), and other cell parameters based on settings that you specify. This is accomplished by dividing functions between the PC and the SmartController as described below.

PC Functions (Application Manager Devices)

- Vision location / camera management
- Vision result filtering
- Hardware / line configuration and balancing scenarios
- Tracking part status as parts are processed by the robots
- 3D motion visualization of robot cell objects

Controller Functions (SmartController Devices)

- Queue managing instances that have been passed to the controller for processing. This includes notifying the PC concerning the status of parts being processed and not processed.
- Robot control

Use the descriptions provided below to have a general understanding of the ACE software terminology, concepts, and other functionality needed to create applications. More details for these items are provided in separate sections of this document.

Configuration Wizards

Many of the ACE software components are configured using wizards. These wizards provide a series of screens that guide you through a detailed configuration process.

Selections and steps in the wizards will vary depending on the application and because of this, each wizard is not fully detailed in this document. Use the information provided in the wizard steps to understand the selections that are required.

An example robot-to-belt calibration wizard is shown below.

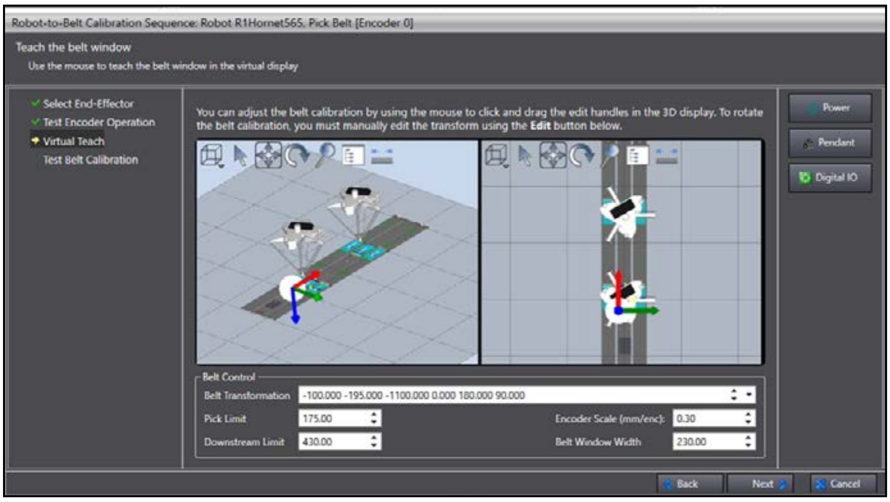


Figure 1-1 Example Wizard - Robot-to-Belt Calibration

Wizard Elements

Many of the wizards share common elements such as buttons, fields, etc.) The following information describe common wizard interface items.

Navigation

Use the following table to understand wizard navigation.

Table 1-1 Wizard Navigation Items Description

Item	Description
Back Button	Opens the previous screen in the wizard. For certain procedures, you cannot go back to repeat the previous screen. In those cases, the **Back** button is not available.

Item	Description
Next Button	Opens the next screen in the wizard. The **Next** button will not be available until the current screen is completed.
Cancel Button	Cancels the operation and closes the wizard.

Dialog-access Controls

Use the following table to understand wizard dialog-access controls.

Table 1-2 Wizard Dialog Access Control Items Description

Item	Description
Pendant Button	Opens the V+ Jog control.
Power Button	Toggles high power for the robot.

Robot Position Controls

Use the following table to understand wizard robot positioning controls.

Table 1-3 Robot Position Control Items Description

Item	Description
Approach	Moves the robot to the approach position (the taught position plus the approach height).
Current Position	Displays the current position of the robot.
Depart	Moves the robot to the depart position (the taught position plus the depart height).
End Effector	Displays the selected end effector (gripper) for the robot.
Gripper	Activates / deactivates the gripper (end effector). Click the **Signal** button (/) to toggle the state.
Here	Records the current position of the robot. The recorded position is displayed in the Taught Position field.
Monitor Speed	Adjusts the monitor speed (percent of full speed) for the robot movements.
Move	Moves the robot to the recorded (taught) position using the speed specified in Monitor Speed.
Taught Position	Displays the taught (recorded) position.

Conveyor Belt Controls

Use the following table to understand wizard conveyor belt controls.

Additional Information: These controls require the following conditions.
- The belt is under active control by the controller
- The conveyor supports the selected control (for example, to use Reverse / Forward, the conveyor must have a motor that supports operation in reverse direction)
- The appropriate control signals have been defined in the Belt object editor.

Table 1-4 Conveyor Belt Control Items Description

Item	Description
Fast / Slow	Selects fast or slow speed. Click the **Signal** button (/) to toggle the signal state.
On / Off	Starts and stops the conveyor belt. Click the **Signal** button (/) to toggle the signal state.
Reverse / Forward	Selects forward or reverse direction. Click the **Signal** button (/) to toggle the signal state.

Vision Controls

Use the following table to understand vision controls.

Table 1-5 Vision Control Items Description

Item	Description
Edit	Opens the Vision Tools Properties window that is used to edit various parameters of the vision tool.
Live	Displays a live image from the camera input.
Picture	Acquires a still image from the camera input.
Stop	Stops the currently-running vision tool or process (this is only active in Live mode).

Wizard Functionality in Emulation Mode

When Emulation Mode is enabled, some of the ACE software wizards contain differences from their operation in standard mode. This section describes those differences.

Calibration Wizards in Emulation Mode

When performing a belt calibration or sensor calibration in Emulation Mode, those wizards include special interactive 3D Visualizer windows that allow you to interactively position the elements being calibrated. This feature allows you to see what is being changed and how the change affects the calibration. An example is shown in the following figure.

When multiple robots are present that access the same belt in the workspace, if a belt has not been taught it is not displayed in the 3D teach processes.

> **NOTE:** For Emulation Mode calibrations, the belt controls in the Calibration wizards will allow you to operate the belt even when the Active Control option of the Belt object is not enabled.

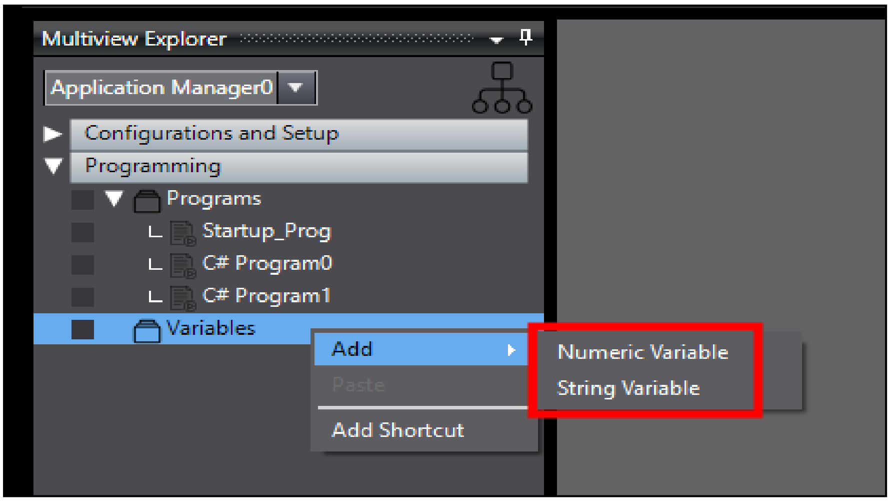


Figure 1-2 Calibration Wizard in Emulation Mode

For these wizard pages, there are two ways to change the settings.

1. Use the interactive 3D windows to drag the elements to the desired positions. After positioning the elements, you can see the changes to the values in the fields below the 3D windows.
2. Use the fields below the interactive 3D windows to enter the values. After entering the values, you can see the changes in the 3D windows.

Licenses

To enable full functionality, the ACE software requires the V+ controller licenses and PC licenses supplied on the USB hardware key (dongle) as described below. For details on obtaining these items, please contact your local Omron representative.

To view the licenses installed on the dongle, access the Help menu item and then select **About...** This will open the About ACE Dialog Box as shown below where license information is provided.

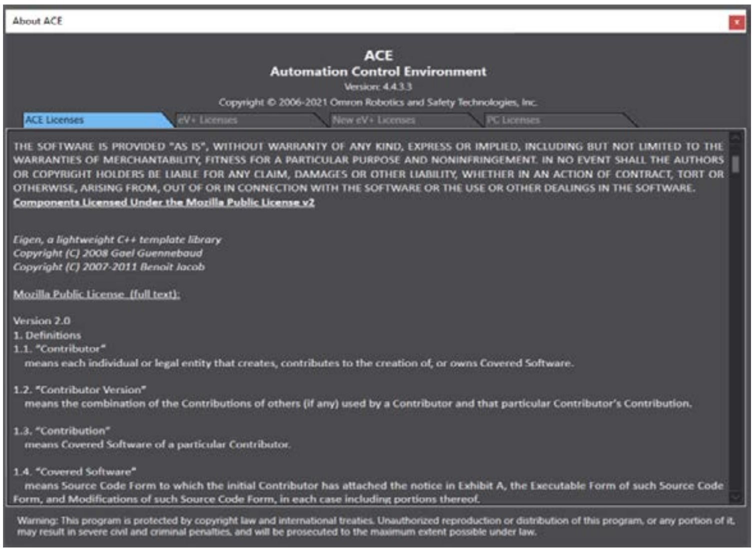


Figure 1-3 ACE Licenses

Figure 1-4 eV+ Licenses

PC Licenses

The following licenses are available for the PC running ACE software. The PC licenses are supplied on the USB hardware key (dongle, sold separately). Contact your local Omron representative for more information.

- Robot Vision Manager
- Pack Manager

The ACE software will still work without licensing in place, but the following restrictions will apply.

Emulation Mode (Not Connected to Physical Devices)

When licensing is not activated, you will have full functionality for two hours while running in Emulation Mode. After two hours expires, you must restart the ACE software to continue.

While Connected to Physical Devices (Not in Emulation Mode)

Execution of Pack Manager or Robot Vision functionality is restricted.

1.4 Software Features

This section provides details about the following ACE software features.

- Emulation Mode
- Application Samples

Emulation Mode

The ACE software contains an operating mode called Emulation Mode. This mode provides a virtual environment that emulates the physical hardware you have in your application. This allows you to program and operate your application with no connection to physical hardware.

Although the Emulation Mode is an optional operating mode, it behaves as though you are working in the standard operating mode of the ACE software. Once you have enabled Emulation Mode, you can create and program an ACE application in the same manner that you would when connected to physical hardware. This provides a seamless user experience that is nearly identical to running with real, physical hardware.

Emulation Mode can run multiple, simultaneous instances of controllers and robots on the same PC at the same time. This includes the handling of network ports and multiple file systems. This feature allows you to design, program, and operate a real multi-controller / robot application.

This section details the start up, features, and limitations of Emulation Mode.

Emulation Mode Features

Emulation Mode provides the following features and benefits.

> **NOTE:** The term offline implies that no connection to physical hardware is present.

- Create applications offline

  If no hardware is available, you can still create your application offline. Emulation Mode allows you to configure a project with robots, belts, feeders, and other hardware. When the physical hardware becomes available, you can transition from the virtual hardware to the physical hardware easily.

- Program offline

  You can open and edit existing ACE projects. You can also edit V+ programs and C# programs.

- Operate applications offline

If you have an existing project, you can open it and run an application without the physical hardware. The application runs in the Emulation Mode and uses the 3D Visualizer feature to simulate the behavior of the system.

- Experimentation with products and hardware

  Because the Emulation Mode application is created with virtual hardware, you can experiment with different robot cell designs and layouts before purchasing the physical hardware.

- Training without products or hardware

  The emulated environment provides a convenient and low-risk method for training technicians, operators, and other system users.

Emulation Mode Differences

Emulation Mode has the following differences when compared to operating while connected to physical hardware.

> **Additional Information**: Other minor Emulation Mode differences not listed below exist. These are noted in the related sections of this document.

- Saving data to the emulated controller is not supported.

  When Emulation Mode is enabled, ACE software creates a new emulated-controller file system in a temporary folder. When ACE software is shut down, that file system is deleted which means the contents of any user-created folders, files, or data will also be deleted. You should save your data in a PC folder and/or with the ACE project to avoid loss of data.

- No automatic import of robots when creating a new controller.

  When Emulation Mode is enabled, the Create a New Controller wizard does not automatically import robots. It prompts you to select the robot(s) connected to the controller instead.

- Some controller and robot configuration items are disabled.

  When Emulation Mode is enabled, certain Controller Settings and Robot Object configuration items are not available. Those items are dimmed or hidden to indicate that they are not available. Refer to Controller Settings on page 192 and Robot Objects on page 224 for more information.

- I/O signals are managed differently.

  In Emulation Mode, you can use the Digital I/O window to set input signals. Refer to Task Status Control on page 121 for more information.

- Robot-to-hardware calibrations use the 3D Visualizer.

  In Emulation Mode, the robot-to-hardware calibrations and project referencing procedures are different. When Emulation Mode is enabled, these procedures use the 3D Visualizer display to allow for offline calibration and configuration. Refer to Process Objects on page 362 for more information.

- The Belt object control, speed, and latch settings are different.

When Emulation Mode is enabled wizards allow use of belt control signals even if Active Control is disabled, fast and slow speed settings are used, and the Latch Period generates a new latch at each distance interval of belt travel. Refer to Belt Object on page 377 for more information.

- The Virtual Camera configuration is different.

  When Emulation Mode is enabled, the Virtual Camera object uses an Emulation Configuration parameter that is used to specify the operating mode. Refer to Camera Objects on page 436 for more information.

- Cycle times are not identical.

  When Emulation Mode is enabled, the cycle times will not exactly match those obtained when connected to physical hardware.

- Enable power and calibration are managed differently.

  When Emulation Mode is enabled, the robot power is enabled and the robot is automatically calibrated when loading a project, creating a controller, rebooting a controller, and when changing a Quattro platform.

Enabling and Disabling Emulation Mode

Emulation Mode can be enabled or disabled by clicking the Enable Emulation Mode icon ( ) or the Disable Emulation Mode icon ( ), respectively. Any unsaved data must be saved before doing this. Note that the icons are disabled if they do not apply. For example, if Emulation Mode is enabled, the Enable Emulation Mode icon cannot be clicked.

Alternatively, Emulation Mode can be enabled when opening a project with the following procedure:.

1. Start the ACE software. The ACE Start page will be displayed.
2. Select the **Open in Emulation Mode** option.

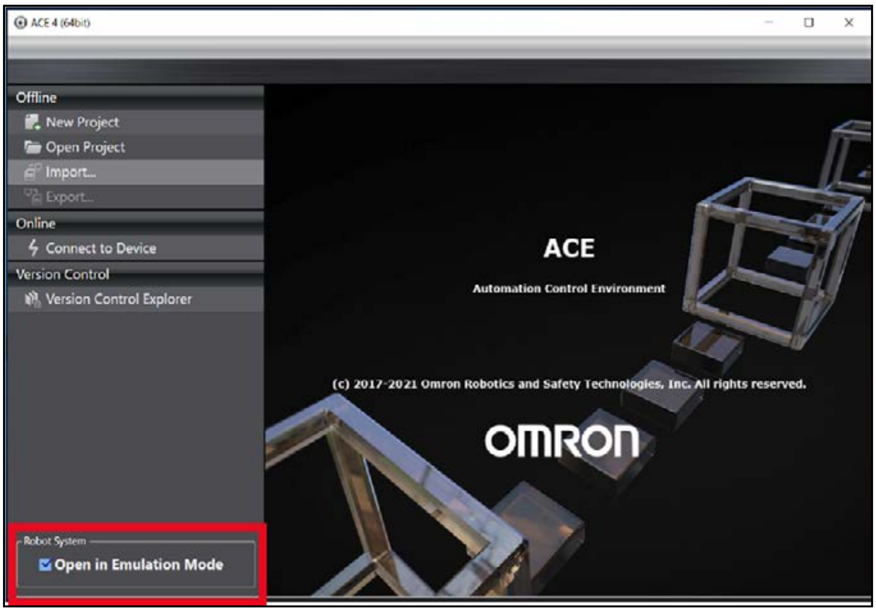


Figure 1-5 Open ACE 4.4 in Emulation Mode

3. Make other selections for opening a new or existing project, or connecting to an emulated device, refer to Project Management on page 50 for more information. After these selections are made and you proceed, the ACE project will open and guide you through any additional steps if necessary. Emulation Mode will be indicated in the Status bar at the bottom of the ACE software, as shown in the following figure. The Enable and Disable Emulation icons are indicated on the ACE 4.4 Toolbar.

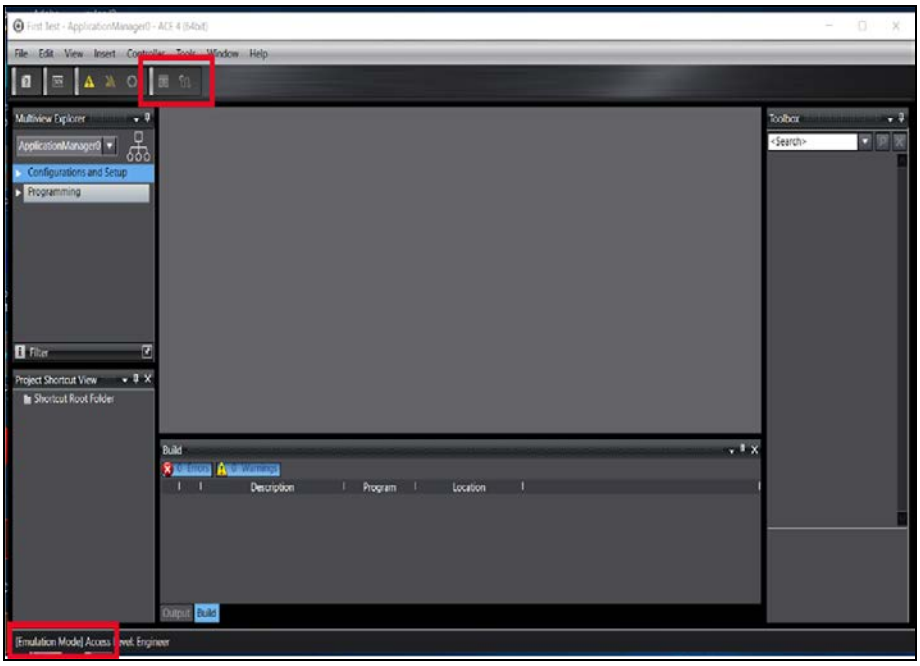


Figure 1-6 Emulation Mode Indication

4. After the ACE project is open and Emulation Mode is active, the procedure is complete. The same procedure can be done while deselecting the **Open in Emulation Mode** option to disable Emulation Mode.

Application Samples

The ACE software provides Application Samples to assist in the development of robotic applications. When an Application Sample is created, a wizard is launched to collect preliminary information about the application. When the wizard is completed, an ACE project is created with the basic objects and configurations for the application. This new project can be used as a starting point for many types of robotic applications.

There are two types of Application Samples that are currently offered with the ACE software: Robot Vision and Pack Manager. Refer to Application Samples on page 22 and Application Samples on page 22 for more information.

NOTE: Application Samples are not intended to develop an entire application.

Canceling a wizard before completion can lead to an ACE project with partial or no functionality. Completing the wizard is recommended.

You must have Engineer access and either be connected to a physical controller or in Emulation Mode to use the ACE Application Sample functions.

All information collected during the wizard can be modified within the project later.

The Application Sample wizard follows the basic steps listed below. These may vary based on the Application Sample type and selections made during the wizard, but generally follow this sequence.

1. Select robots to install on the controller (Emulation Mode only).
2. Identify the pick and place configuration.
3. Teach the pick operation.
4. Teach the place operation.
5. Specify the robot used in the application sample.
6. Specify the end effector configuration.
7. Teach the safe robot position.
8. Teach the part pick position.
9. Teach the part placement position.

Robot Vision Application Sample

Robot Vision Application Samples can be used to create example V+ programs and Robot Vision objects for integrating Robot Vision with robots, belts, feeders, and more. When using Robot Vision with V+ programs you are responsible for writing the V+ programs that drive robot motion and other activity in the robot cell.

NOTE: Robot Vision sample wizards can be used for example application structure, but are not intended to provide all V+ program code required for the application.

Pack Manager Application Sample

Pack Manager Application Samples can be used to create single-robot packaging application projects with Pack Manager. These single-robot samples can later be expanded for multi-robot applications. The ACE software provides a point-and-click interface to develop many packaging applications without writing V+ programs. If the default behavior does not meet the needs of the application, V+ programs can be customized. Pack Manager uses a Process Manager to manage run-time control of the application including allocation of part and target instances in multi-robot packaging lines, visualization of resources, and statistics tracking.

Additional Information: Refer to *Part Object on page 372* and the *Process Manager Object on page 395* for more information.

Creating an Application Sample

There are two methods used to create an Application Sample as described below.

Create an Application Sample from the Start Page

Use the following procedure to create an Application Sample from the Start Page.

1. Start the ACE software.
2. Select **Connect to Device** from the Start Page.

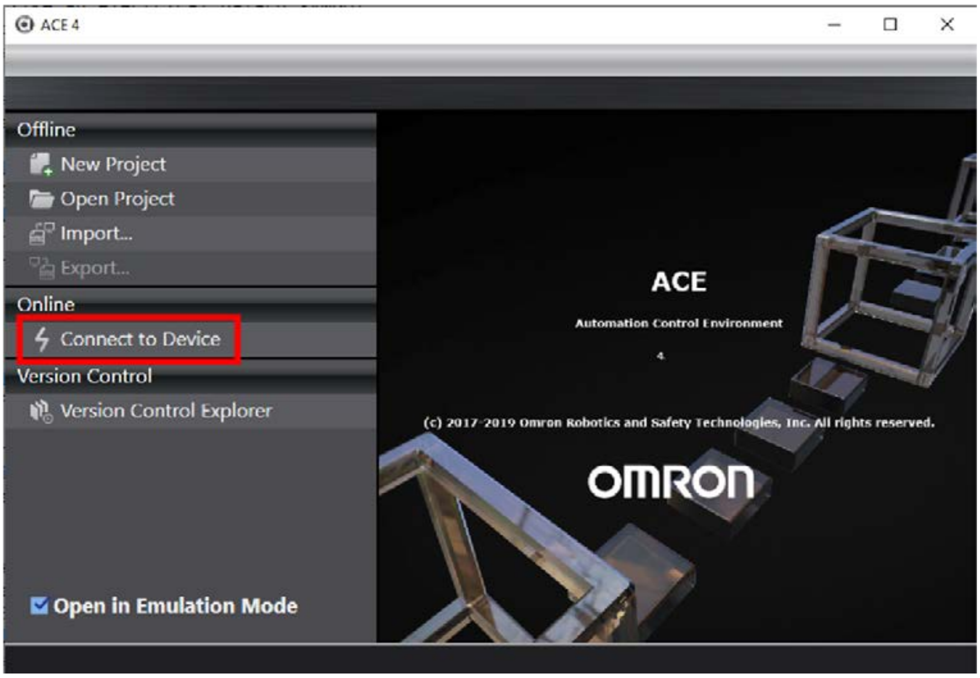


Figure 1-7 Connect to Device on the Start Page

3. If you are creating the application while connected to a physical controller, make the appropriate Connect to Device settings. Refer to Online Connections to SmartControllers on page 76 for more information. If you are not connected to a physical controller, select the check box for ***Open in Emulation Mode***.
4. Select the **Create Application Sample**.
5. Then choose **Robot Vision Manager Sample** or **Pack Manager Sample**.
6. Then, click the **Connect** Button. This will create a new ACE project with the selected Application Sample and launch the Application Sample wizard.
7. Select robots to install on the controller (if running in Emulation Mode) and finish all wizard steps to complete the procedure. A new ACE project will be created according to the collected wizard information.

Create an Application Sample from an ACE Project

To create an Application Sample from an ACE project, select **Insert** from the menu bar, select **Application Sample,** and then click **Robot Vision Manager Sample** or **Pack Manager Sample**. An Application Sample wizard will appear. Finish all wizard steps and then the Application Sample will be added to the ACE project.

NOTE: You must select the SmartController device to access the Application Sample item from the menu bar. If the Application Manager device is selected, these menu items will not be available.

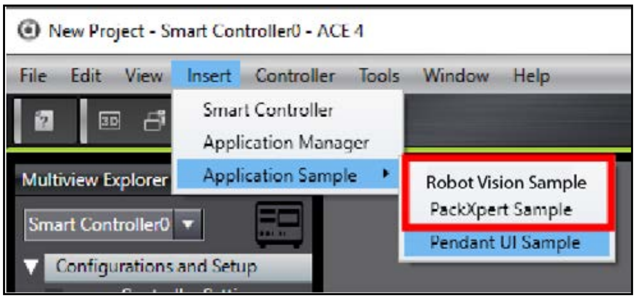


Figure 1-8 Create an Application Sample from an ACE Project

1.5 Robot Concepts

The topics in this section describe basic robot concepts that you should be familiar with when using the ACE software.

Coordinate Systems

The ACE software uses multiple coordinate frames to define the locations of elements. These are often positioned in reference to other objects or origins. Each coordinate system is briefly described in the following table.

The coordinates in each system are measured in terms of (X, Y, Z, Yaw, Pitch, Roll) unless otherwise specified, where Yaw, Pitch, and Roll are defined as:

- Yaw: Rotation about the local reference frame Z-axis.
- Pitch: Rotation about the local reference frame Y-axis.
- Roll: Rotation about the local reference frame Z-axis after Yaw and Pitch have been calculated.

Table 1-6 Coordinate System Overview

Coordinate System	Overview
Workspace	This is the global coordinate system of the 3D Visualizer in ACE software. Workspace Coordinates are used to define the position of objects. Refer to Workspace Coordinates on page 26 for more information.
Robot - World	Each robot has a world coordinate system. The X-Y plane of this coordinate system is the robot mounting surface. The Z-axis and origin are defined for each robot model and can be viewed by enabling the **Edit Workspace Position** Button in the 3D Visualizer. V+ Location variables that record the current robot position

Coordinate System	Overview
	will be defined relative to this coordinate system. Refer to Robot Coordinates - World on page 27 for more information.
Robot - Joint	Each robot has a joint coordinate system based on the orientation of each individual joint. Each element of a coordinate is the angular position of the joint. V+ Precision Point variables will be defined relative to this coordinate system for each robot. Refer to Robot Coordinates - Joint on page 28 for more information.
Robot - Tool	This is the coordinate system based on the robot tool. The origin is positioned at the tool flange with the Z-axis oriented away from the tool flange when a null tool offset is applied. Refer to Robot Coordinates - Tool on page 29 for more information.
Belt	This is the coordinate system describing the direction and orientation of a conveyer belt. Each robot may have a different reference to belt coordinates for the same physical conveyor belt. Refer to Belt Coordinates on page 30 for more information.
Camera	This is the coordinate system defining the coordinates within the camera field of view. 2D vision primarily uses only the X, Y, and Roll components of a coordinate. The origin is located at the center of the field of view. Refer to Camera Coordinates on page 32 for more information.

Workspace Coordinates

The workspace coordinate system is a global reference frame for all object positions in the 3D Visualizer. The workspace origin is not visible, but it is positioned at the center of the tile grid, as shown in Figure 1-9 below.

Workspace coordinates are primarily used for positioning robots and other features in the workspace. Allocation of belt-relative Part and Part Target instances during run time depends on the relative position of robots along a process belt object, therefore robot positions cannot be changed while a Process Manager is active.

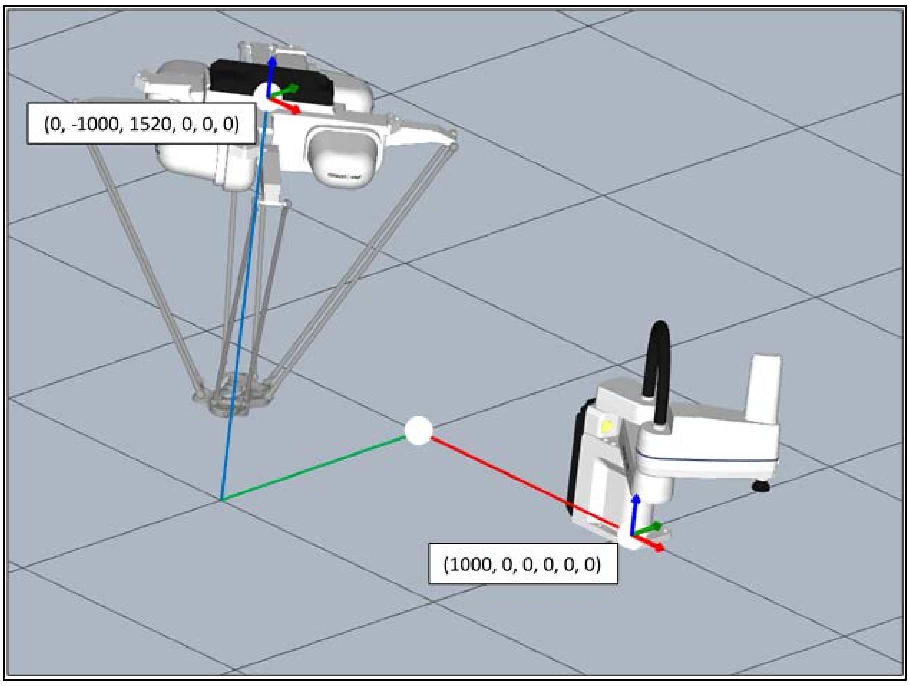


Figure 1-9 Workspace Coordinates

Robot Coordinates - World

The robot world coordinate system is a frame of reference for all transformations recorded by a specific robot. It is primarily used to define points with respect to the robot itself. Each robot model has a unique base frame, but the X-Y plane is typically located at the robot mounting surface. For example, the position markers of the robots shown in Figure 1-10 and Figure 1-11 are also the robot origin in each robot world coordinate system.

This coordinate system is used when a program defines a transformation-type location. Whenever a position is taught or motion executed, it is usually done with respect to this coordinate system.

> **NOTE:** A position defined as a location variable is not unique and depends on applicable arm configuration parameters, including ***lefty-righty***, ***above-below***, and ***flip-noflip***. Refer to the *eV+ Language Reference Guide (Cat. No. I605)* or the *V+ Keyword Reference Manual (Cat. No. I672)* for details on these keywords.

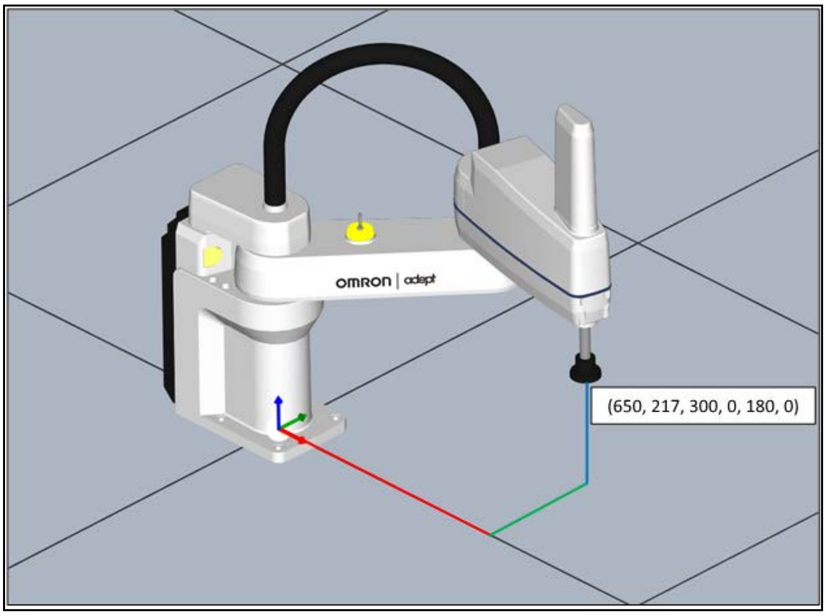


Figure 1-10 Robot Coordinates - World (Cobra)

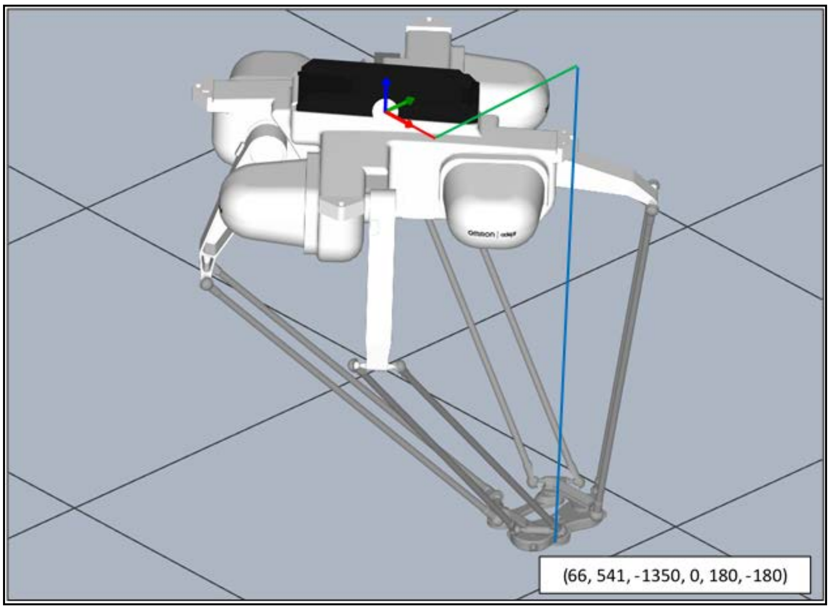


Figure 1-11 Robot Coordinates - World (Quattro)

Robot Coordinates - Joint

The joint coordinate system is used to define the position of each individual joint. Each coordinate has as many elements as there are joints in the robot. For example, a Cobra would have four elements in a coordinate while a Viper would have six elements.

Joint coordinates become useful when defining a point that can be reached in multiple orientations. For example, the two configurations shown in Figure 1-12 have the gripper in the same position (550, 0, 317, 0, 180, 180) as defined by robot world coordinates. However, the robot arm can be oriented in two different ways to reach this position. The top configuration in the figure shows joint coordinates (-43, 93.5, 77, 50.5) and the bottom configuration shows joint coordinates (43, -93.5, 77, -50.5).

NOTE: The size of the tool is exaggerated in the figures to clearly demonstrate the orientation of J4.

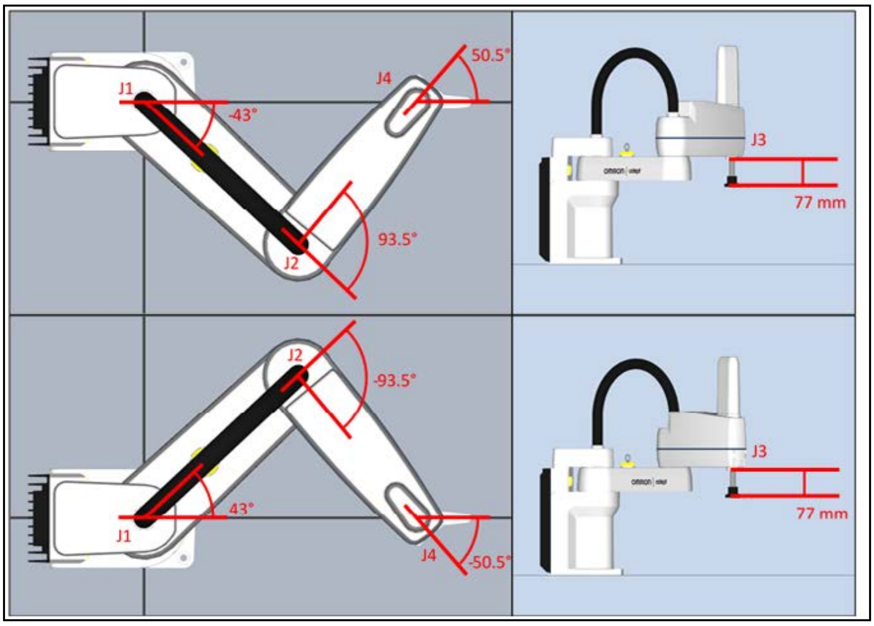


Figure 1-12 Robot Coordinates - Joint

A location based on joint coordinates instead of world coordinates is called a precision point. These are useful in cases where one orientation would cause the robot to strike an obstacle.

A precision point guarantees that a robot will always move to the correct orientation. This is most commonly seen in Cobra and Viper robots, since locations can be reached from multiple positions. Precision points can be defined for parallel robots such as the Hornet and Quattro, but because each location can only be reached while the joints are in one position, joint coordinates and precision points usually are not used with these robots. Joint coordinate jogging is also not allowed for parallel arm robots.

NOTE: The orientation of the servo is important when considering joint coordinates. For example, in Figure 1-12 above, the J4 orientation convention is in the opposite direction of the other two rotational joints. This is because the joint 4 servo internal mounting position is inverted.

Robot Coordinates - Tool

The tool coordinate system is used to define the position of tool tips. Its frame of reference is positioned at the tool flange itself. The tool Z-axis points opposite the other frames. This is because the main purpose of this system is to define the offset of tool tips. For example, a tool tip with coordinates (0, 0, 100, 0, 0, 0) is an offset of 100 mm in the negative Z-axis of the workspace and robot world coordinate systems.

NOTE: The reversal of the Z-axis does not affect the controls in the V+ Jog Control. The down arrow still moves the tool along the negative Z-axis with respect to the robot world coordinates.

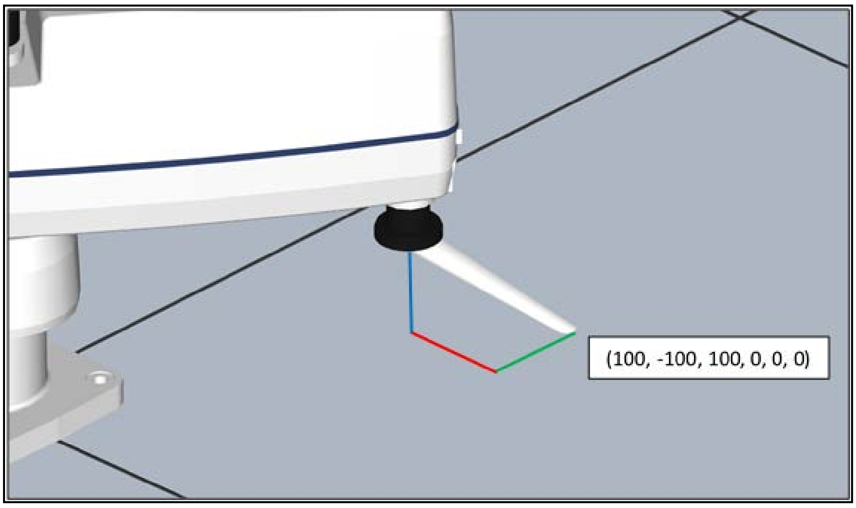


Figure 1-13 Robot Coordinates - Tool

Belt Coordinates

The belt coordinate system is used to define positions on a belt window. Its frame of reference is at one of the upstream corners of the belt. The axes are oriented so the positive X-axis is in the direction of the belt vector and the Y-axis is along the belt width. The belt is typically positioned so that the Z-axis of the belt frame aligns with the tool Z-axis, but it can be reversed if necessary.

This coordinate system is primarily used to provide part locations on a belt to a robot and to verify that a belt-relative location is within the belt window before commanding a motion to the location. When an instance is located, the identified belt coordinate is converted to a robot world coordinate. This means that a belt-to-robot calibration must be done before any belt coordinates are recorded.

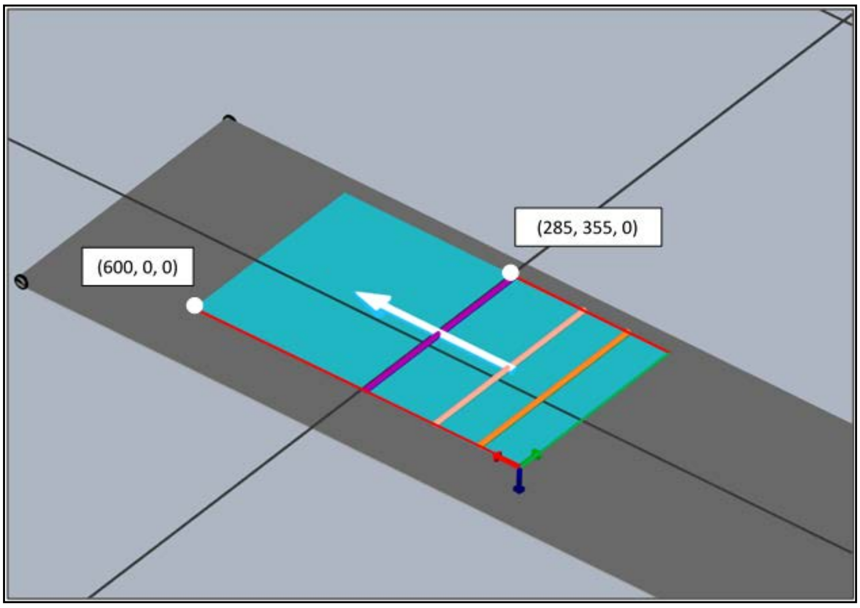


Figure 1-14 Belt Coordinates

The belt coordinate system is also used to set the various allocation limits in the belt window for a Process Manager. The various limits are set using X-coordinates and, for the Downstream Process Limit Line, an angle. In this case, the angle translates to both X and Y-coordinates to determine when an instance crosses that line. The various coordinates can be seen in Figure 1-14 based on the numbers shown in the Belt Calibration Editor in Figure 1-15 below. Refer to Belt Calibration on page 292 for more information.

> **NOTE:** Belt coordinates do not apply to a Belt object created in the Process area of the Multiview Explorer (that is separate from a belt window). Belt objects are used to record information about the belt itself, such as encoders and signals, and provides a representation of a belt in the 3D Visualizer. Their location in the workspace is set by their Workspace Location parameter that uses workspace coordinates. Conversely, belt windows regard the positioning of the robot gripper with respect to the belt and use belt coordinates to determine instance locations.

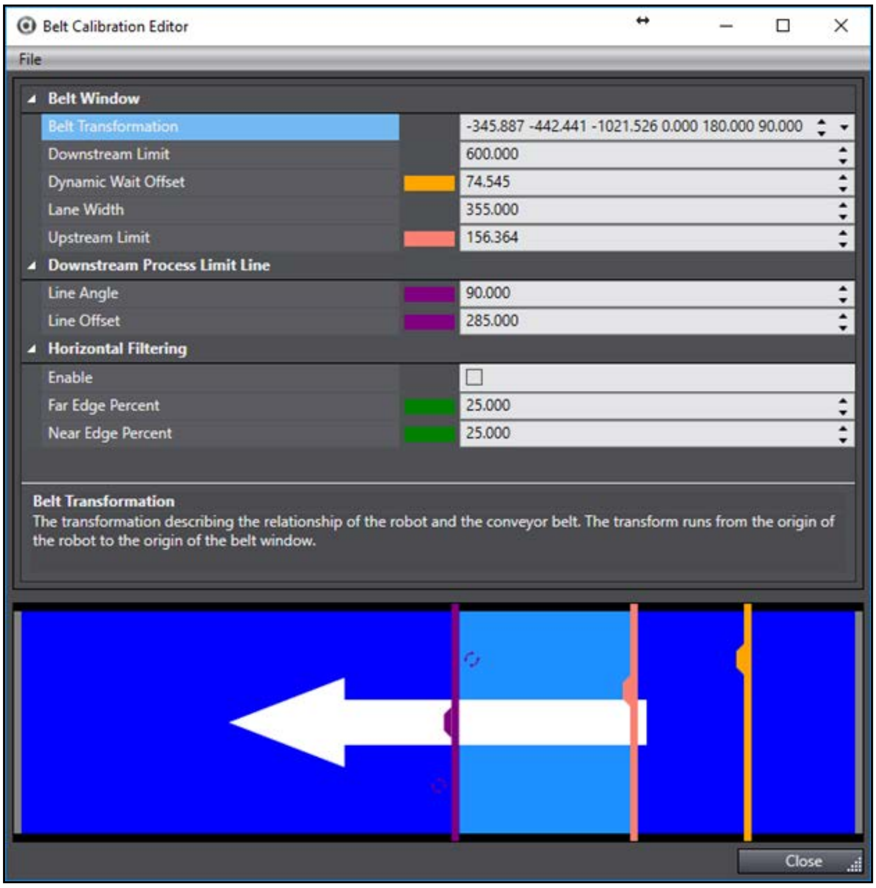


Figure 1-15 Belt Calibration Editor Example

Camera Coordinates

The camera coordinate system is used to define positions relative to a camera. Vision tools return positional data on detected instances or points in camera coordinates. 2D vision only requires the X, Y, and Roll components. Since the positions are still returned and used as 6-element transformations, the resulting locations are in the form of (X, Y, 0, 0, 0, Roll).

Camera coordinates must be interpreted into a different coordinate system before they can be practically used in an application. A robot-to-camera calibration is required to translate vision results to locations a robot can move to.

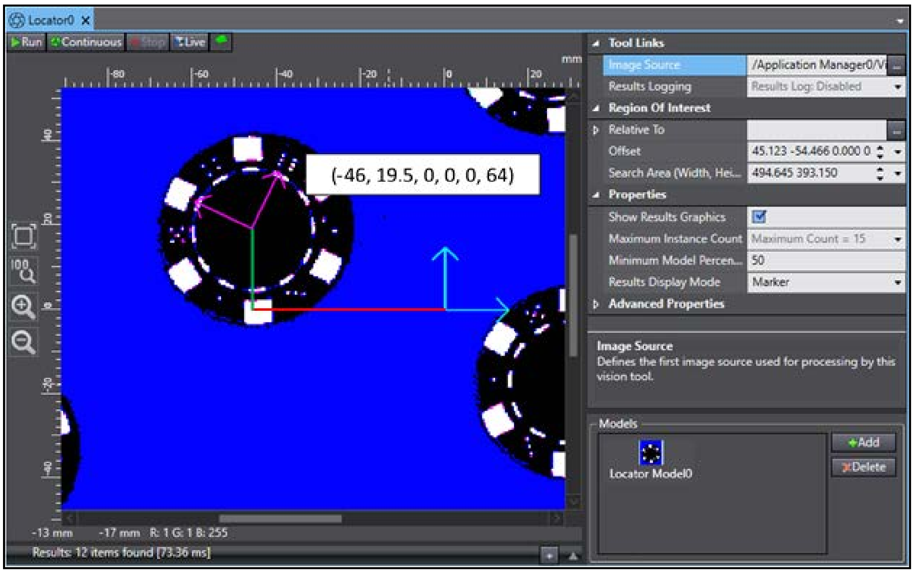


Figure 1-16 Camera Coordinates

Calibrations

Calibrations are used to define relationships between coordinate frames. The calibration method may differ depending on whether the application uses Robot Vision Manager or a Process Manager, but the function of calibration is the same. In applications using Process Manager, the calibrations can be found in their respective sections in the Process Manager edit pane. The Process Manager will show calibrations required for defined processes.

When Robot Vision Manager is used, the calibrations are found by right-clicking **Robot Vision** in the Multiview Explorer, clicking **Add**, and selecting the appropriate calibration object.

> **NOTE:** Verify that any necessary tool tip offsets have been defined before beginning calibration.

Calibration Order

There are two types of hardware calibrations used in the ACE software. Most applications will use at least one, but if more than one are necessary, the calibrations should always be performed in the following order:

- Robot-to-Belt Calibration
- Robot-to-Sensor Calibration (these include a wide range of different calibrations including Robot-to Camera and Robot-to-Latch calibrations)

This is important because calibrations are dependent on previously defined locations. For example, a robot-to-camera calibrations in an application with a belt utilizes a belt vector to define the locations of instances detected by the camera. If the camera is calibrated first, then the camera location will not be recorded properly and will need to be recalibrated once the belt has been defined.

NOTE: This assumes robot hardware calibrations were performed before doing the calibrations shown above. If robot hardware calibration changes, the other calibrations may need to be performed again.

Robot-to-Belt Calibration

This calibration translates positional information from the belt coordinate system to the robot world coordinate system. This is required whenever a belt is used in an application. One calibration needs to be performed for each encoder input associated with a robot.

Robot-to-belt calibration will require three points to be defined on the surface of the belt, shown in order in Figure 1-17 below. Use the following procedure to execute a robot-to-belt calibration.

1. Place a calibration target on the belt at the farthest point upstream that the robot can reach. Verify that the robot can reach that belt position across the entire width of the belt.
2. Position the robot at the calibration target and record the position. This saves the robot location and the belt encoder position.
3. Lift the robot and advance the belt to move the calibration target to the farthest downstream position that the robot can reach. Again, verify the robot can reach across the entire width of the belt to ensure that the entire belt window remains within the work envelope.

   NOTE: It is important to ensure the calibration target does not move relative to the belt while advancing the belt.

4. Reposition the robot at the calibration target and record the position. The combination of recorded robot world coordinates and the belt encoder positions of these two points define the belt vector, which is the X-axis of the belt transformation, and the millimeter-per-count scale factor (mm/count).
5. Remove the calibration target from the belt and reposition on the opposite side of the belt at the farthest downstream position the robot should pick a part. Record its position in the same way as the other two points. This defines the belt pitch or Y-axis of the belt transformation. The Z-axis of the belt transformation is defined based on the right-hand rule. After completing this step, the robot-to-belt calibration procedure is finished.

NOTE: The three points in this calibration also define other values, such as the upstream and downstream allocation limits, also shown in Figure 1-17 below. However, these do not directly affect the calibration of the belt and can later be changed to fit the needs of the application. For Robot Vision Manager and V+ programs, the pick limits will be defined in a V+ program. For applications with a Process Manager, refer to Belt Calibrations on page 417 for more information.

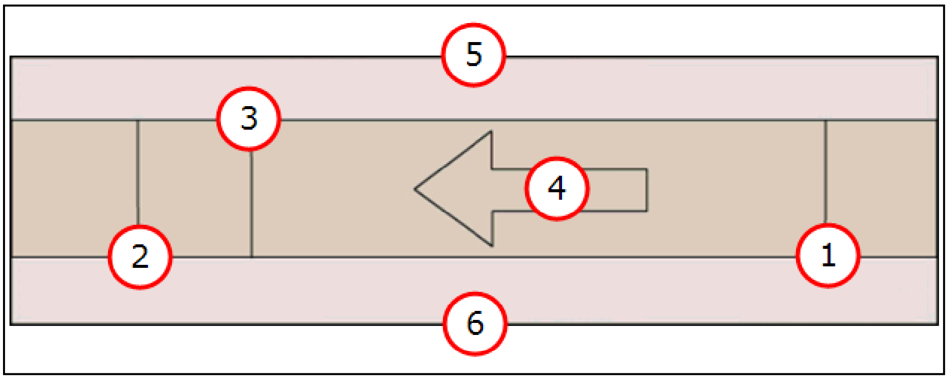


Figure 1-17 Robot-to-Belt Calibration Points

Table 1-7 Robot-to-Belt Calibration Points Description

Item	Description
1	Upstream Limit
2	Downstream Limit
3	Downstream Pick Limit
4	Belt Direction
5	Robot Side
6	Far Side

Robot-to-Camera Calibration

This calibration orients a camera frame of reference relative to a robot world coordinate system. It is used to translate positional information of vision results from the camera coordinate system to the robot world coordinate system. One of these is required for each association between a robot and a camera.

To perform this calibration, a grid calibration must be active in the Virtual Camera. If it is not, perform a grid calibration before proceeding. Refer to Grid Calibration Method on page 317 for more information.

The process of calibrating the camera is dependent on the type of pick application in which it is involved. Generally, there are three categories with which the application could be associated:

- Fixed-mounted
- Arm-mounted
- Belt-relative

In all cases, the robot tool tip will be used to record various positions on the pick surface to associate it with the robot world coordinates. At least four points are required to generate the calibration, but a grid of 3x3 is recommended. The accuracy of the calibration increases with the distribution of the targets across the field of view (refer to Figure 1-18 below). The configuration on the left would result in an accurate calibration while the configuration on the right could yield inaccurate results.

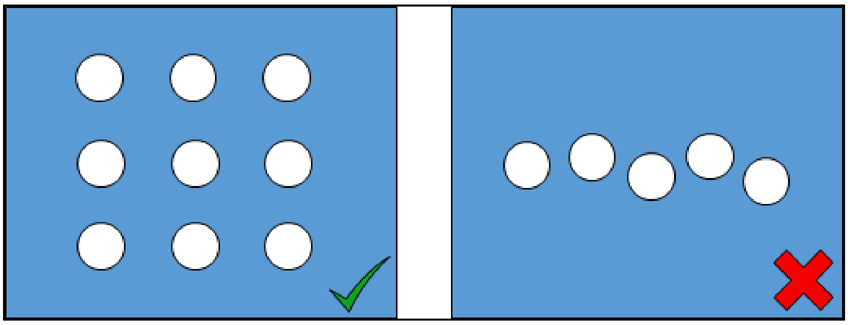


Figure 1-18 Correct (Left) and Incorrect (Right) Robot-to-Camera Calibration Target Configurations

When the camera is fixed-mounted, a calibration target is recorded as a Locator Model and the target is placed in a defined region of interest of a Locator included in the calibration wizard. The target then must be repositioned in several different points on the pick surface. For each one, the camera detects the instance and records the position in camera coordinates, and then the position is taught to the robot by moving the gripper to the instance. The combination of the recorded data teaches the robot where the pick surface and the camera are relative to the robot, thus translating camera data to robot world coordinates.

If the application has a belt, the calibration is effectively the same, but it must be executed in two phases since the robot cannot reach the camera field of view. In the first phase, the targets are placed on the belt underneath the camera and their positions are recorded with respect to the camera. Then, the belt is advanced to where the robot can touch the targets and record their position in the robot world coordinate system. These locations and the associated belt encoder positions are used to define the location of the camera with respect to the robot world coordinate system.

Robot-to-Latch Calibration

This calibration positions a latch sensor relative to a belt coordinate system. It is used to translate latch detection results to belt coordinate positions. One of these is required for each association between a robot and a belt with a latch sensor.

The robot-to-latch calibration is similar to the robot-to-camera calibration when a belt is present. However, instead of using a camera to detect the location of the target, the calibration is used to determine a part detection point, relative to a sensor signal.

The target and the associated object are placed upstream of the latch sensor. When the belt is advanced past the sensor, the belt encoder position is recorded. Then, the belt is advanced to where the robot can touch the part. The recorded location combined with the belt encoder position indicates where the part will be detected by the sensor relative to the latched belt encoder position. The Figure 1-19 below shows an example using a pallet with slots for six parts.

In the following figure, the blue field represents the belt with the arrows indicating the direction of belt travel. The numbered sections represent the different steps of the calibration, explained as follows.

1. The pallet is positioned upstream of the latch sensor and the belt is not in motion.
2. The belt is advanced and the pallet is detected by the latch sensor. The belt encoder position at this position is recorded.
3. The belt is advanced to a position where the pallet is within the robot range of motion.

4. The robot tool tip (marked by a black circle) is positioned where the first part will be placed. The current belt encoder position is recorded and compared to the latched belt encoder position. This difference and the position of the robot along the belt vector are used to position the upstream part detection point for the latch sensor.

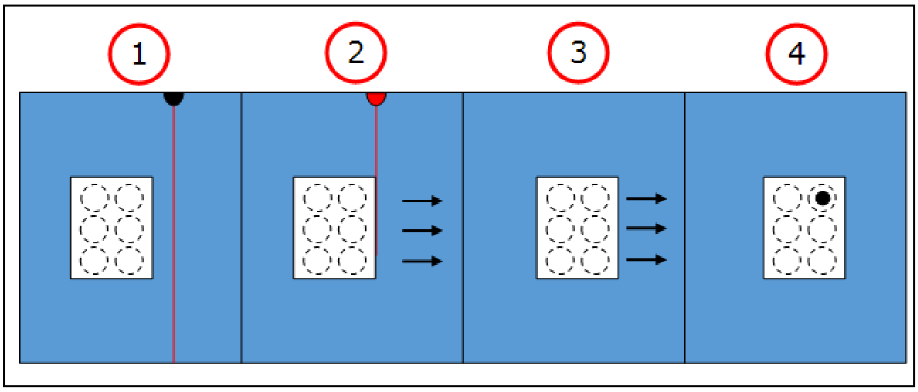


Figure 1-19 Robot-to-Latch Calibration Example

NOTE: When calibrating multiple robots to a single sensor, ensure the initial position of the calibration object is identical for each robot calibration to avoid large a deviation in part placement relative to a latched position. There should not be a large deviation in sensor position for a single detection source, as shown in Figure 1-20 below. Instead, the sensors should be close together, as shown in Figure 1-21 below. It is normal for there to be a small deviation due to differences between physical assemblies and ideal positions in 3D visualization.

Additional Information: If large deviations are caused by incorrect robot object Offset from Parent Properties, adjust this property to match the hardware system as closely as possible.

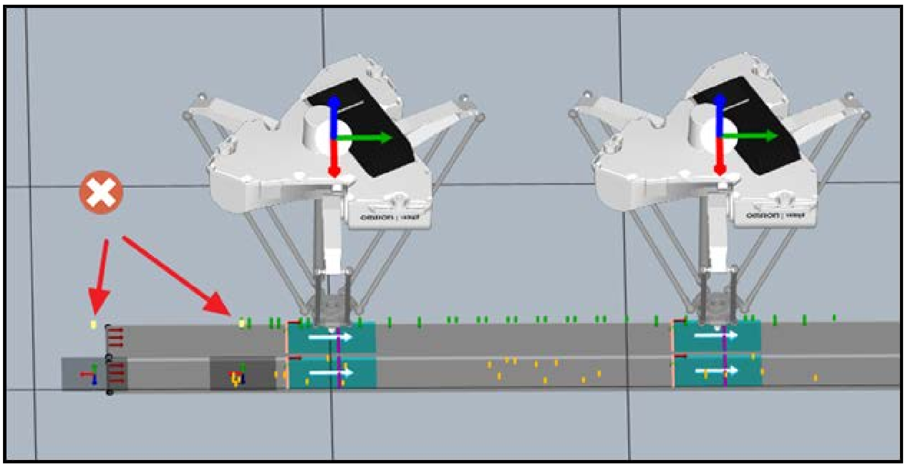


Figure 1-20 Latch Sensor Calibration - Incorrect Multi-Robot Teaching

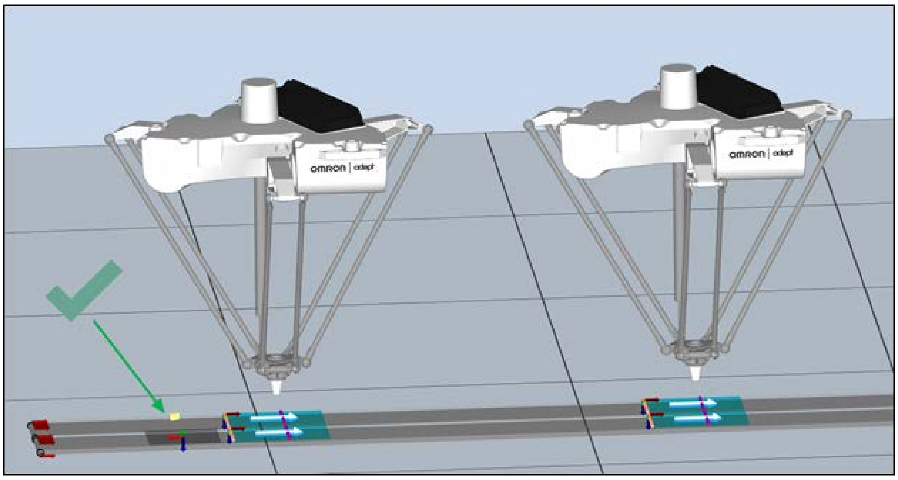


Figure 1-21 Latch Sensor Calibration - Correct Multi-Robot Teaching

Basic Robot Motion

Use the information in this section to understand basic robot motion parameters to optimize overall system performance.

Speed, Acceleration, and Deceleration

Robot speed is usually specified as a percentage of normal speed, not as an absolute velocity. The speed for a single robot motion is set in the Speed parameter of the Pick Motion Parameters or Place Motion Parameters dialogs for each Part or Part Target location. The result obtained by the speed value depends on the operating mode of the robot (joint-interpolated versus straight-line). Refer to Speed, Acceleration, and Deceleration on page 38 for more information.

Whether in joint-interpolated mode or straight-line mode, the maximum speed is restricted by the slowest moving joint during the motion, since all the joints are required to start and stop at the same time. For example, if a given motion requires that the tool tip is rotated on a SCARA robot (Joint 4), that joint could limit the maximum speed achieved by the other joints since Joint 4 is the slowest moving joint in the mechanism. Using the same example, if Joint 4 was not rotated, the motion could be faster without any change to the speed value.

> **NOTE:** The motion speed specified in the Pick Motion Parameters or Place Motion Parameters dialogs must always be greater than zero for a regular robot motion. Otherwise, an error will be returned.

You can use the acceleration parameter to control the rate at which the robot reaches its designated speed and stops. Like speed, the acceleration / deceleration rate is specified as a percentage of the normal acceleration/ deceleration rate. To make the robot start or stop smoothly using lower acceleration and deceleration for a less-abrupt motion, set the acceleration parameter to a lower value. To make the robot start or stop quickly using higher acceleration and deceleration for a more abrupt motion, set the acceleration parameter to higher values.

The speed and acceleration parameters are commonly modified for cycle time optimization and process constraints. For instance, abrupt stops with a vacuum gripper may cause the part being held to shift on the gripper. This problem could be solved by lowering the robot speed. However, the overall cycle time would then be increased. An alternative is to lower the acceleration / deceleration rate so the part does not shift on the gripper during motion start or stop. The robot can still move at the maximum designated speed for other movements. Another case would be a relatively high payload and inertia coupled with tight positioning tolerances. A high deceleration rate may cause overshoot and increase settling time.

> **NOTE:** Higher acceleration / deceleration rates and higher speeds do not always result in faster cycle times due to positioning overshoot that may occur.

Approach and Depart

Approach and depart heights are used to make sure that the robot approaches and departs from a location without running into any other objects or obstructions in the robot envelope. Approaches and departs are always parallel to the Z-axis of the tool coordinate system. Approach and depart heights are typically specified for pick and place locations. The approach segment parameters are shown in the following figure.

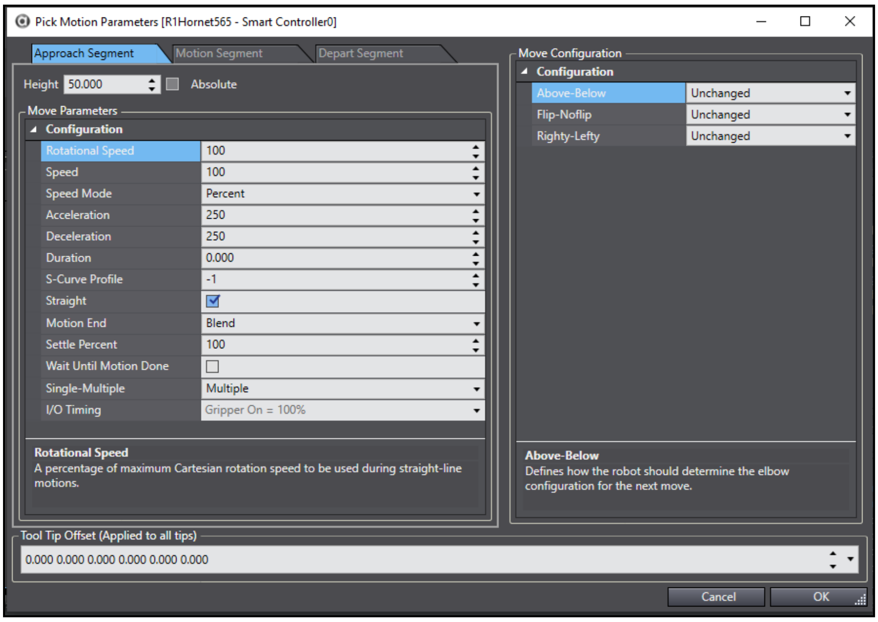


Figure 1-22 Approach Segment

When approach and depart heights are specified, the robot moves in three distinct motions. In the first motion (Approach segment), the robot moves to a location directly above the specified location. For the second motion, the robot moves to the actual location and the gripper is activated. In the third motion (Depart segment), the robot moves to a point directly above the location.

Notice that all the motion parameters that apply to a motion to a location also can be applied to approach and depart motions. This allows you to move at optimum speed to the approach height above a location, then move more slowly when actually acquiring or placing the part, and finally depart quickly if the application requires this.

Arm Configuration

Another motion characteristic that you can control is the configuration of the robot arm when moving to a location. However, configuration options apply only to specific types of robots.

For example, the lefty / righty option applies to SCARA-type robots, but the above / below option does not apply to those robots.

The arm configuration can be specified in the Configuration Items of the Process Manager object. Refer to Configuration Items on page 426 for more information.

Configuration Items on page 426 *eV+ Language Reference Guide (Cat. No. I605)* and *V+ Keyword Reference Manual (Cat. No. I672)* for more information.

The following figure illustrates how a SCARA robot can reach a point with a lefty or righty arm configuration.

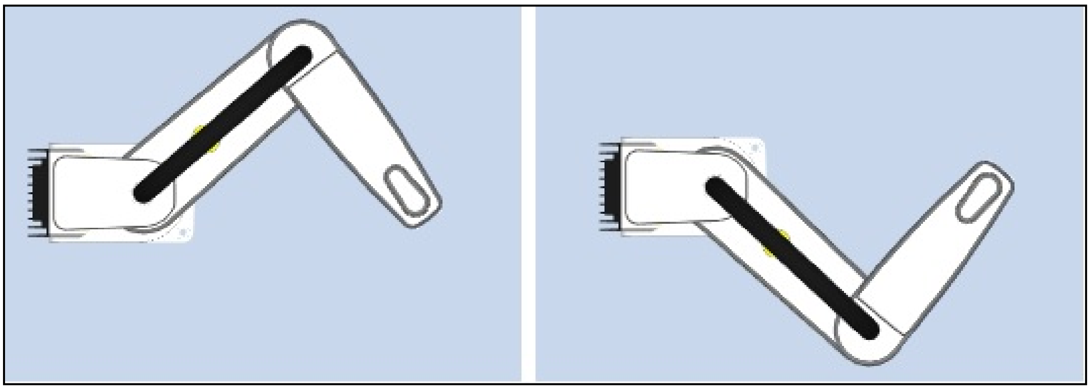


Figure 1-23 Lefty / Righty Arm Configuration

Location Precision

When a robot moves to a location, it actually makes several moves, each of which is a closer approximation of the exact location. You can control the precision with which the robot moves to a location using the Motion End parameter (Settle Fine / Settle Coarse). If Settle Coarse is selected, the robot will spend less time attempting to reach the exact location. In many cases, this setting will be adequate and will improve robot cycle times.

Continuous Path Motion

Making smooth transitions between motion segments without stopping the robot motion is called continuous path operation. When a single motion instruction is processed, the robot begins moving toward the location by accelerating smoothly to the commanded speed. Sometime later, when the robot is close to the destination location, the robot decelerates smoothly to a stop at the location. This motion is referred to as a single motion segment, because it is produced by a single motion instruction.

When a continuous-path series of two motion instructions is executed, the robot begins moving toward the first location by accelerating smoothly to the commanded speed just as before. However, the robot does not decelerate to a stop when it gets close to the first location. Instead, it smoothly changes its direction and begins moving toward the second location. Finally, when the robot is close to the second location, it decelerates smoothly to a stop at that location. This motion consists of two motion segments since it is generated by two motion instructions.

If desired, the robot can be operated in a non-continuous-path mode, which is also known as breaking-continuous-path operation. When continuous-path operation is not used, the robot decelerates and stops at the end of each motion segment before beginning to move to the next location. The stops at intermediate locations are referred to as breaks in continuous-path operation. This method is useful when the robot must be stopped while some operation is performed (for example, closing the gripper or applying a dot of adhesive). The continuous or non-continuous path motion is set using the Wait Until Motion Done parameter and Motion End parameter in the Pick Motion Parameters or Place Motion Parameters dialogs. To enable continuous-path operation, you must set both parameters as follows.

- l Wait Until Motion Done = False
- l Motion End = Blend

> **NOTE:** Breaking continuous-path operation affects forward processing (the parallel operation of robot motion and program execution). Program operation is suspended until the robot reaches its destination.

Continuous-path transitions can occur between any combination of straight-line and joint-interpolated motions. Refer to Continuous Path Motion on page 40 for more information.

Joint-Interpolated Motion vs. Straight-Line Motion

The path a robot takes when moving from one location to another can be either a joint-interpolated motion or a straight-line motion. A joint-interpolated motion moves each joint at a constant speed except during the acceleration / deceleration phases (refer to Joint-Interpolated Motion vs. Straight-Line Motion on page 41 for more information).

With a rotationally-jointed robot, the robot tool tip typically moves along a curved path during a joint-interpolated motion. Although such motions can be performed at maximum speed, the nature of the path can be undesirable. Straight-line motions ensure that the robot tool tip traces a straight line. That is useful for cutting a straight line, or laying a bead of sealant, or any other situation where a totally predictable path is desired.

> **NOTE:** The joint-interpolated or straight-line motion is set using the Straight parameter in the Pick Motion Parameters or Place Motion Parameters dialogs in the Process Manager or in V+ programs.

Performance Considerations

Things that may impact performance in most applications include robot mounting, cell layout, part handling, and programming approaches.

Robot Mounting Considerations

The mounting surface should be smooth, flat and rigid. Vibration and flexing of the mounting surface will degrade performance. Therefore, it is recommended that you carefully follow the robot-mounting procedures described in your robot user's guide.

When positioning a robot in the workcell, take advantage of moving multiple joints for faster motions. On a SCARA robot, the “Z” and “theta” axes are the slowest, and motion of these joints should be minimized whenever possible. This can be accomplished by positioning the robot and setting conveyor heights and pick-and-place locations to minimize Z-axis motion.

Cell Layout Considerations

Regarding cell layout and jointed arms, the same point-to-point distance can result in different cycle times. Moving multiple joints combines the joint speeds for faster motion. If the same distance is traversed using motion of a single joint, the motion of that joint will be longer, and therefore will take more time.

Part Handling Considerations

For part handling, settling time while trying to achieve a position can be minimized by centering the payload mass in the gripper. A mass that is offset from the tool rotation point will result in excess inertia that will take longer to settle. In addition, minimizing gripper mass and tooling weight will improve settling time. This could include using lighter materials and removing material that is not needed on tooling.

Programming Considerations

For part handling, settling time while trying to achieve a position can be minimized by centering the payload mass in the gripper. A mass that is offset from the tool rotation point will result in excess inertia that will take longer to settle. In addition, minimizing gripper mass and tooling weight will improve settling time. This could include using lighter materials and removing material that is not needed on tooling.

Understanding Belts (Conveyors)

This section describes basic belt (conveyor) concepts.

> **Additional Information**: Conveyors are referred to as belts in the ACE software. Refer to Belt Calibrations on page 417 for more information.

Indexing versus Tracking Conveyors

There are two basic types of conveyor systems: indexing and tracking. In an indexing conveyor system, also referred to as a noncontinuous conveyor system, you specify either control signals or a time interval for the belt to move between stops. When the conveyor stops, the robot removes parts from the belt and then it is signaled to move again. The conveyor must be equipped with a device that can use digital output to turn the conveyor ON and OFF.

Indexing Conveyors

Indexing conveyor systems are configured as either non-vision or vision. With a non-vision indexing system, the part must be in the same location each time the belt stops. In a vision-equipped indexing system, a fixed-mount camera takes a picture when the belt stops and the robot accesses any objects found.

Tracking Conveyors

In a tracking conveyor system, the belt moves continuously and the robot tracks parts until the speed and location of the robot gripper match those of a part on the belt. The robot then accesses the part.

Tracking conveyors must be equipped with an encoder that reports the movement of the belt and distance moved to the ACE software. Tracking conveyor systems are configured as either non-vision or vision.

With a non-vision tracking conveyor, a sensor signals that a part has passed a known location. The ACE software tracks the progress of the belt and accesses the part when it comes into the robot working area (belt window). Parts must always be in the same location with respect to the center line of the belt.

With a vision-equipped tracking conveyor, the vision system detects parts that are randomly positioned and oriented on the belt. A fixed-mount camera takes pictures of the moving parts and based on the distance the conveyor travels, returns the location of parts. These part locations are queued and accessed by the robot.

Chapter 2: Installation and Uninstallation

This section describes installation and uninstallation details for the ACE software.

2.1 Installing the Software

This section describes the ACE software installation procedure and other software installation details.

System Requirements

ACE software has the following system requirements.

- Windows operating system running Windows 10.
- Installation and use of the Photoneo 3D camera requires a Windows 10, 64 bit OS.
- An external graphics card, supporting OpenGL v 2.0 for operating the Photoneo camera.
- It is recommended to have more than 8 GB of RAM, a minimum 2 GB for the application and a minimum of 4 GB free disk space.
- Microsoft .NET Framework 4.6.1. The .NET Framework 4.6.1 will be installed automatically, if required. This will require a valid network connection to the internet.
- DirectX 11 compatible graphics card.
- The SmartController EX or compatible device running eV+ 2.1 B8 or above. The controller should also have a CompactFlash card containing up-to-date utility software.
- Ethernet communication between the PC and the controller.

ACE Installation Instructions

NOTE: If there is an existing version of ACE on the computer, it should be uninstalled prior to installing the latest version.

Once installation media is loaded, you can access the installation media contents from a Windows Explorer window, and double click on the file setup.exe.

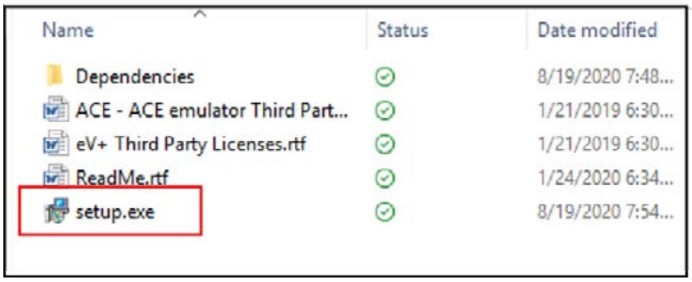


Figure 2-1 Installer Setup

The installation will be performed in two distinct phases. The first phase checks for pre-requisites on your PC. The second phase installs the ACE software on the computer.

In the first phase, the installer checks for the following prerequisites:

- Microsoft .NET Framework 4.6.1
- Basler Pylon
- PhoXi Control
- Git
- Sentinel Protection Installer
- TortoiseGit
- OPC Redistributables

If these required packages are not on the computer, they will be installed. If the Microsoft .NET Framework 4.6.1 is missing, the installer will attempt to download the files from the internet. If the computer does not have internet connectivity, you will need to manually download and install the Microsoft .NET Frameworks 4.6.1 from the Microsoft download site.

If any packages are already on the computer, they will be grayed out and not selectable from the installation GUI and they will not be installed.

The ACE 4.4 Setup wizard provides options depending on the required use of ACE. Selecting the “ACE Files” option will install the standard version of ACE. Selecting the “ACE Application Manager Files” option will install a version of ACE that is designed to act as a server instance. Refer to Remote Application Manager for more information. Additionally, “Git Files” and “Tortoise Files” can be selected to install the latest versions of Git and TortoiseGit, respectively.

> **NOTE:** If the installer detects that a version of Git or TortoiseGit is installed, the respective option in the window will be unchecked and disabled.

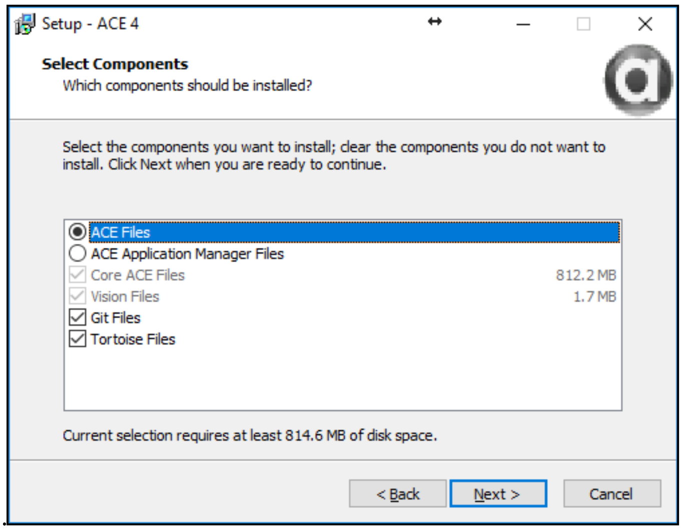


Figure 2-2 ACE 4.4 Installation Options

When the installation completes the directory will be similar to that shown in the following figure. There will be two executables within the installation folder.

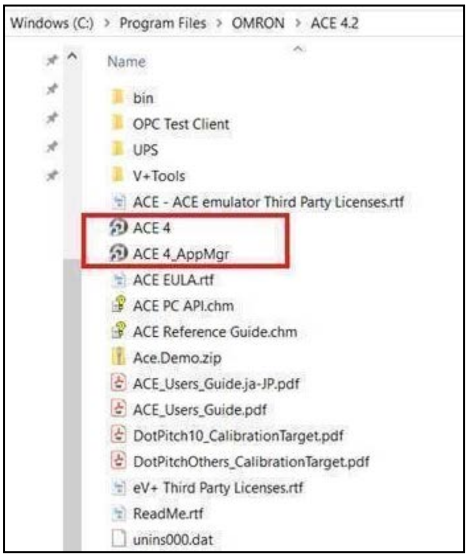


Figure 2-3 ACE 4.4 Installation Directory

Usage Considerations

The following network ports are used by the ACE software.

PC network ports:

- UDP port 69: TFTP file transfer
- UDP ports 1993: Controller scan
- UDP 1994 and 1996: Startup communications
- TCP port 43434: Remote connections to ACE
- UDP port 1990: Robot Vision Manager V+ communications

Controller network ports:

- UDP port 1992: Controller scan
- UDP ports 1994-1997: ActiveV
- TCP port 1999: AdeptWindows
- TCP port 43234: ACE communication

Controllers must be set to auto-boot when rebooting from ACE; otherwise the connect attempt will fail.

If other programs are running in the V+ controller while ACE is running, certain operations (such as configuring FireWire or rebooting the controller) will fail.

Do not run the DC_SETUP or SPEC utility programs while ACE is running. They may delete variables required by ACE for proper operation.

Not all functions work properly if the hardware front-panel keyswitch for the controller is set to Manual mode.

When the ACE software connects to a controller, it will use a certain number of V+ tasks. It will use two tasks for general system functions and an additional task for each robot configured on the controller. In applications using the Pack Manager module, the process manager will allocate additional tasks based on the specific process configuration.

Other Installed Items and Software

Other items are installed with ACE software to supplement the application as described below. Access these items in the ACE software installation directory.

Third Party and End User License Agreements

Copies of software license agreements are provided in the installation directory.

Basler Pylon Suite

A Basler Pylon software suite is installed for support and configuration of Basler cameras.

Sentech ST Utilities

The ST Utilities are used from the configuration of the Sentech cameras.

Git/Tortoise Repository Access (Reserved for Future Use)

Git and Tortoise repository resources are installed for use with project version control.

OPC Test Client

An OPC test client is included with the ACE software installation. Refer to OPC Container on page 332 for more information.

Offline Visualizer

Software used for playback of 3D Visualizer recording files (.awp3d). Refer to 3D Visualizer on page 107 for more information.

Uninterruptible Power Supply Script File Example

Find an uninterruptible power supply script file example in the ACE software installation directory in the UPS folder. Refer to Uninterruptible Power Supply (UPS) on page 144 for more information.

ACE User's Guide (This Document)

A PDF file of this document is included in the ACE software installation directory.

Dot Pitch Calibration Targets

Two PDF files are included to assist in vision system grid calibrations. Refer to Custom Devices on page 326 for more information.

PhoXi Control

Software resource for defining the operation and target accuracy for 3D imaging sensor.

ACE Software Language Variations

When installing ACE software, the following language variations are included. Access the different language variants with the Windows Start Menu group or in the following default installation directory.

C:\ProgramData\Microsoft\Windows\Start Menu\Programs\Omron\ACE 4.4\Localized Shortcuts

Language Variants

- French
- German
- Italian
- Spanish
- Japanese
- Korean
- Simplified Chinese
- Traditional Chinese

2.2 Uninstalling the Software

Use the following procedure to uninstall the ACE software and all associated items and other software.

1. Open the Control Panel from the Windows Start Menu and then select ***Programs and Features*** (***Apps & features***). The Uninstall or change a program Dialog Box is displayed.
2. Select ***ACE 4.4*** and then click the **Uninstall** Button.
3. Proceed with any confirmation messages to uninstall the software.
4. Click the **Finish** Button to complete the uninstallation of the ACE software.

Chapter 3: Project Management

This section describes how to start and exit the ACE software. Once connected, this chapter also shows how to create, configure and save individual and version controlled projects, on either a PC, or in a shared repository for multiple users.

3.1 Starting and Exiting the ACE Software

Use the following precautions when you start the ACE software.

- Exit all applications that are not necessary to use the ACE software. If the ACE software startup or operations are affected by virus checking or other software, take measures to remove ACE software from the scope.
- If any hard disks or printers that are connected to the computer are shared with other computers on a network, isolate them so that they are no longer shared.
- With some notebook computers, the default settings do not supply power to the USB port or Ethernet port to save energy. There are energy-saving settings in Windows, and also sometimes in utilities or the BIOS of the computer. Refer to the user documentation for your computer and disable all energy-saving features.

Starting the ACE Software

The installation includes ACE Application Manager and ACE, where ACE is the server instance that can integrate with clients. Use one of the following methods to start the ACE software.

- Double-click the ACE software shortcut icon on your desktop that was created during the installation process.

Figure 3-1 ACE 4.4 Software Shortcut Icon

- From the Windows Start Menu, select **Omron -** ***ACE 4.4*** **in the desired language**.

The ACE software starts and the following window is displayed. This window is called the Start page. The language displayed on this page will be the one selected at start up.

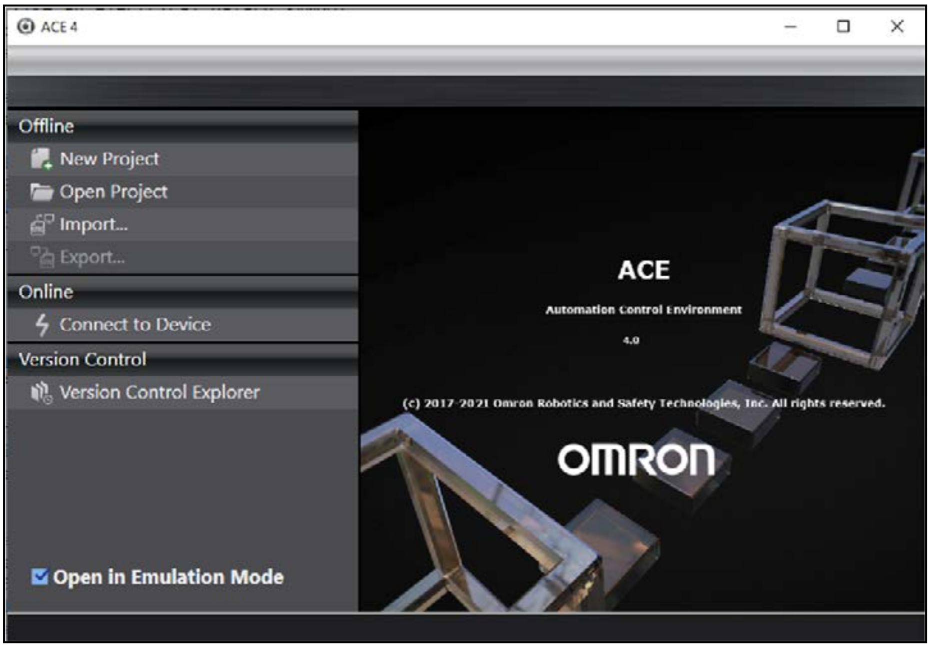


Figure 3-2 ACE 4.4 Software Start Page

Right clicking the desktop icon and selecting Properties shows the path to the installed application, as shown in the following figure.

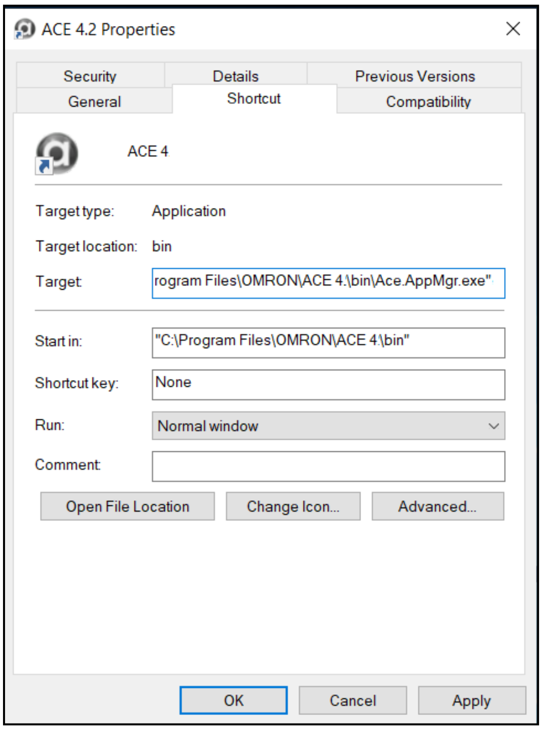


Figure 3-3 Shortcut Properties Panel

The path for this instance is: "C:\Program Files\OMRON\ACE 4.4\bin\Ace.AppMgr.exe".

Starting Application Manager

To change the short cut to start the ACE Application Manager, the properties file needs to be edited. With the Properties panel opened and the Properties line highlighted, add startserver to the end, so that it now reads: "C:\Program Files\OMRON\ACE 4.4\bin\Ace.AppMgr.exe" startserver. When done, click **Apply** and then click **OK**.

An alternative to this is to go to the installation folder, refer to ACE 4.4ACE 4.4 Installation Directory on page 46 and create a desktop shortcut from the ACE 4.4_AppMgr file. Using this method allows you to have both an Application Manager and ACE desktop short cut.

Automatic Project Launch on System Boot Up Procedure

The ACE software can be configured to automatically launch and open a specific project when the system boots up. The procedure for launching a project on boot up is described below.

> **NOTE:** You may need to disable Windows Login to allow automatic launch of the ACE project. Contact your system administrator for more information.

Use the following procedure to configure automatic project launch on system boot up.

> **NOTE:** Depending on the application, it may be necessary to configure items such as an Auto Start program, a Program System Startup object, and a Controller Connection Startup object. Refer to the following sections for more information.
>
> - Configure on page 205
> - Program System Startup on page 338
> - Configuration on page 326
>
> The following procedure assumes a default ACE software installation directory. Modify the file paths below accordingly if an alternate path was chosen during the ACE software installation.

1. Identify the preferred language variant to use with the ACE project. Take note of the language code. This will be used later in this procedure.

Table 3-1 ACE Software Language Codes

Language	Code
German	de-DE
English	en-US
Spanish	es-ES
French	fr-FR
Italian	it-IT
Japanese	ja-JP
Korean	ko-KR

Language	Code
Simplified Chinese	zh-CN
Traditional Chinese / Taiwanese	zh-TW

2. Locate the ACE software executable file. The default software installation directory where the ACE software executable file is normally located can be found here:

   C:\Program Files\Omron\ACE 4.4\bin\Ace.AppMgr.exe

3. Create a shortcut to the Ace.AppMgr.exe file in new location that can be accessed in the next step (on the desktop, for example).
4. Access the new shortcut to the Ace.AppMgr.exe file. Open the shortcut properties by right-clicking the shortcut and selecting **Properties**. Then, view the shortcut tab of the Properties Dialog Box.

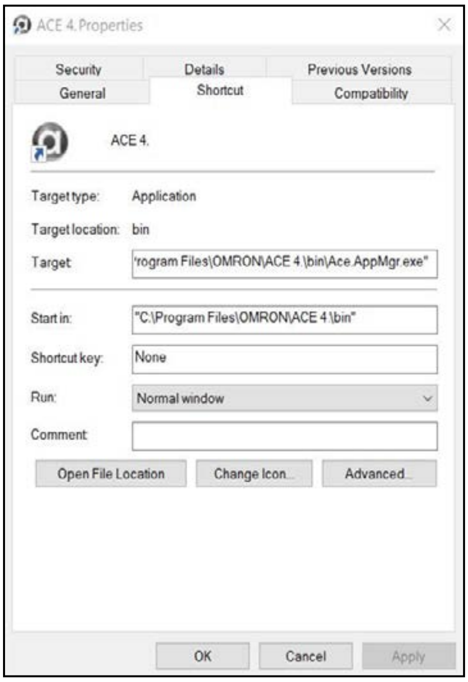


Figure 3-4 ACE 4.4 File Shortcut Properties

5. Modify the file name at the end of the Target path by replacing \Ace.AppMgr.exe" with the following.

```
\Ace.AppMgr.exe" start --culture=xx-XX --project="Project Name"
```

   - Substitute "xx-XX" with the preferred language code from Table 3-1 above.
   - Substitute "Project Name" with the name of the project to automatically open.

   An example Target path would appear as shown below for the Ace.AppMgr.exe short-cut that was created. The example below uses the preferred language of English and the project name of Part Place 1.

```
"C:\Program Files\Omron\ACE 4.4\bin\Ace.AppMgr.exe" start --
```

NOTE: Before assigning the project to the Autostart, review the project name list in the repository to confirm there is only one project with that name. Multiple names in a repository can create problems when attempting Autostart.

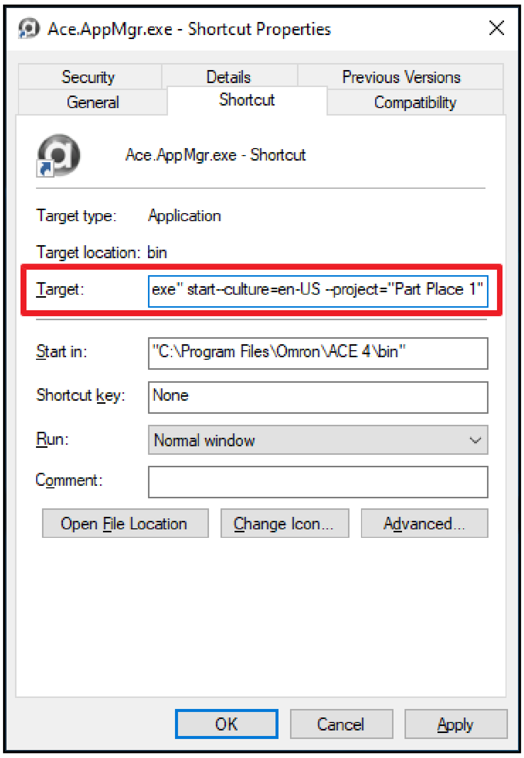


Figure 3-5 Modified ACE 4.4 Target Path Example

6. Confirm the function of the modified shortcut Target path by double-clicking the shortcut. The project should open in the ACE software to confirm the correct target command was used.
7. Access the Windows Startup Folder, found in C:\ProgramData\Microsoft\Windows\Start Menu\Programs\Startup. The Windows Startup folder will open.
8. Move the modified shortcut into the Windows Startup folder. This will cause the ACE project to automatically open upon boot up as shown in ACE 4.4 Startup Folder on page 55.
9. To complete this procedure, reboot the PC and confirm that the ACE project automatically launches.

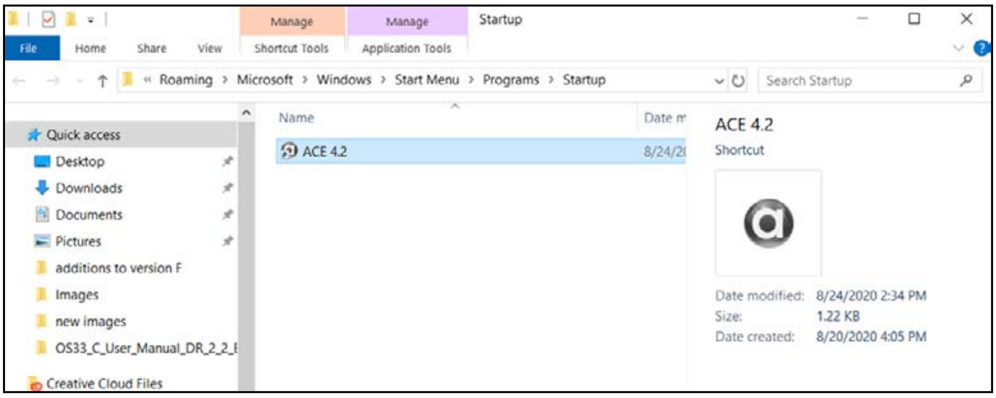


Figure 3-6 ACE 4.4 Startup Folder

Clear Application Manager Memory

When creating an Autostart process there may be interference from server objects. This interference shows when attempting the synchronize process. To correct any issues and transfer objects the Autostart needs to be deleted. Use the following steps to delete the Autostart.

With Application Manager opened, click **Controller** on the menu, as shown below. Select **Clear All Memory**.

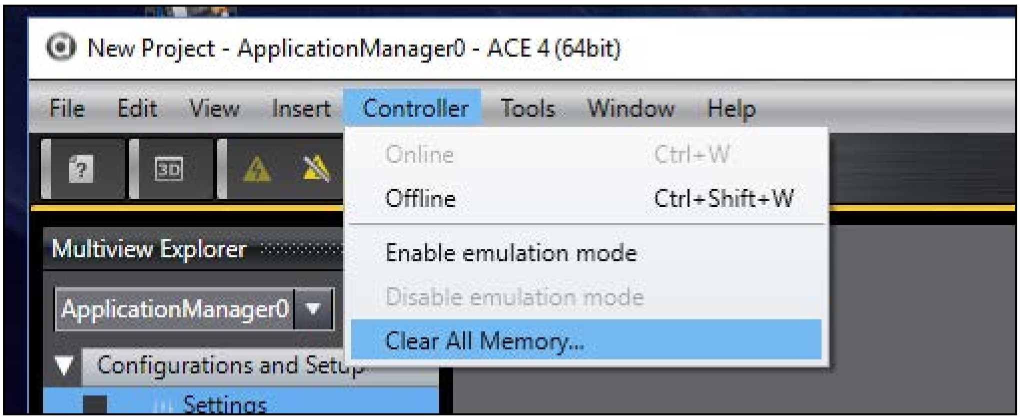


Figure 3-7 Clear All Memory

The following warning opens. Click **Yes**.

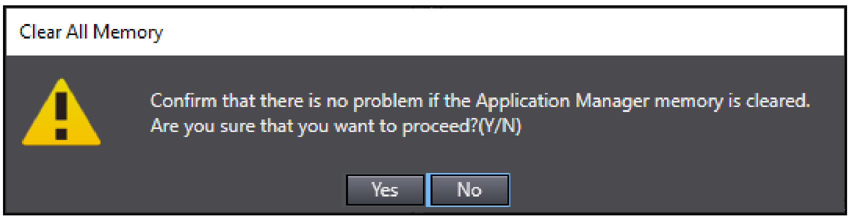


Figure 3-8 Clear Memory Warning

When ***Yes*** is clicked the @autostart project is deleted from the server instance.

Perform the needed changes and synchronize the server. Once done a project can be added to the server instance. This is used when there is interference from server objects when attempting synchronization.

Exiting the ACE Software

Use one of the following methods to exit the ACE software.

- Click the **Close** Button in the title bar of the Start page.

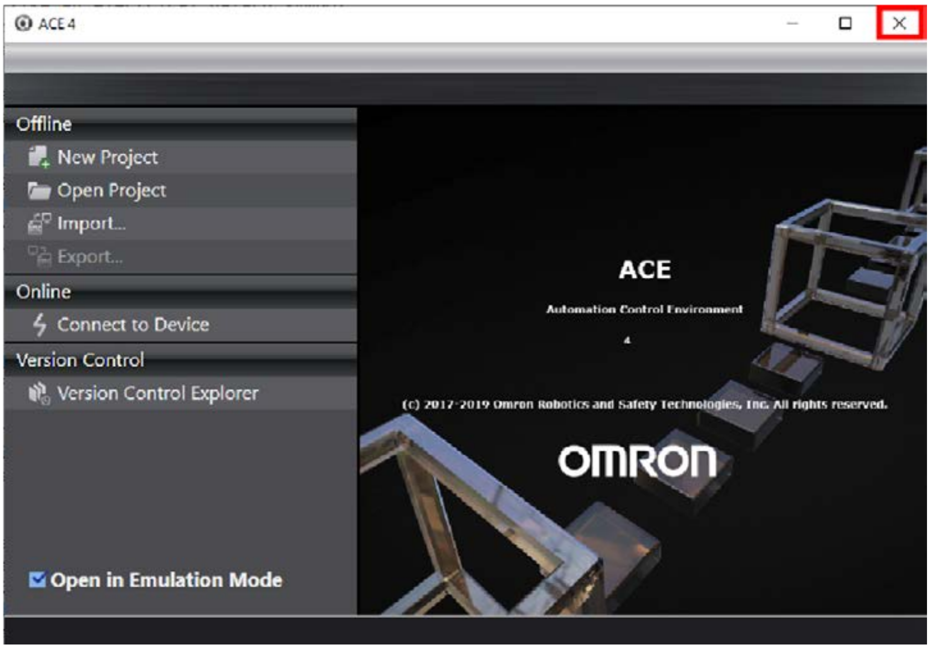


Figure 3-9 Exit ACE Software from the Start Page

- Select **Exit** from the File Menu when working in an open project.

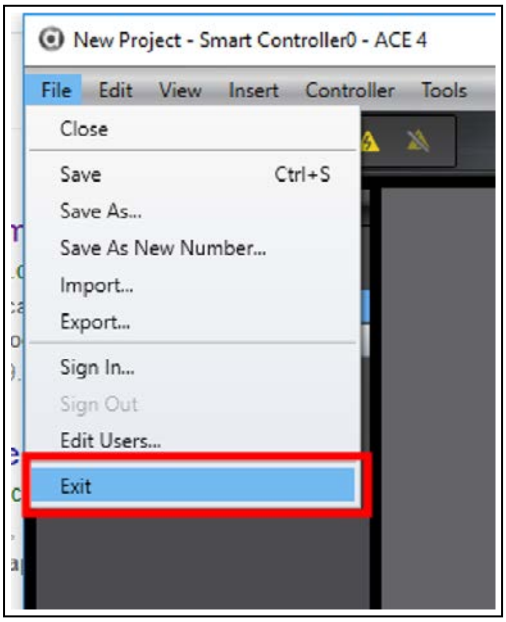


Figure 3-10 Exit ACE Software from an Open Project

The ACE software will close.

Additional Information: If there is unsaved data when you exit the ACE software, a dialog box will appear that asks if you want to save the data.

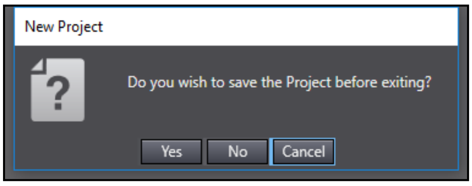


Figure 3-11 Save Project Dialog Box

Save the data if required. The ACE software will close after this operation.

3.2 Creating a Project File

The following procedure describes how to create a project file from the start page.

Additional Information: A project file can also be created with the **Connect to Device** method when a SmartController is present. Refer to Creating a Project from an Online Connection on page 62 for more information.

1. Click **New Project** on the Start page.

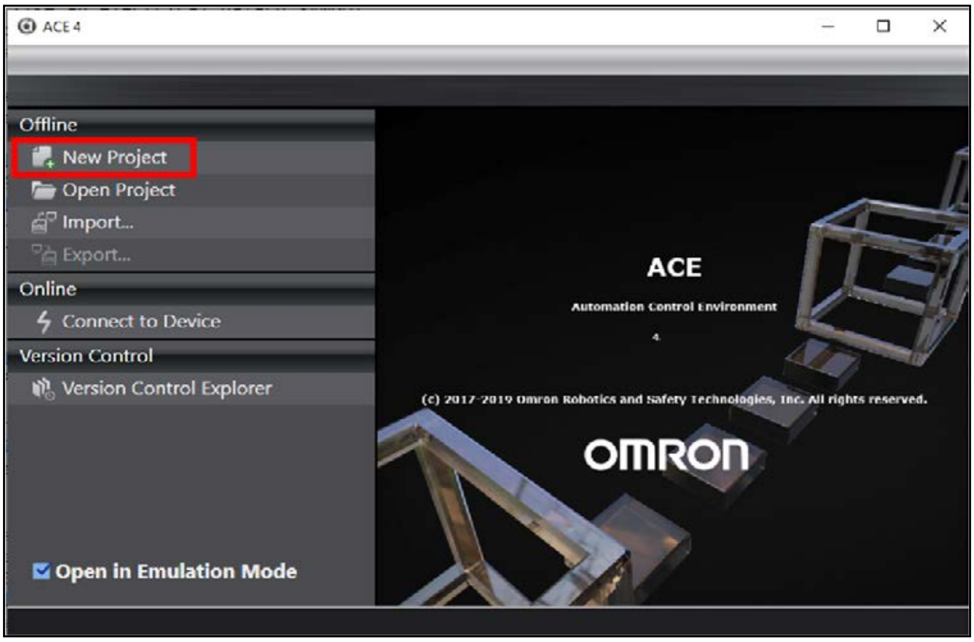


Figure 3-12 Create a New Project

The Project Properties Screen is displayed.

2. Enter the project name, author, and comment in the Project Properties Screen, select the device category and the device to use, and then click the **Create** Button. (Only the project name is required.)

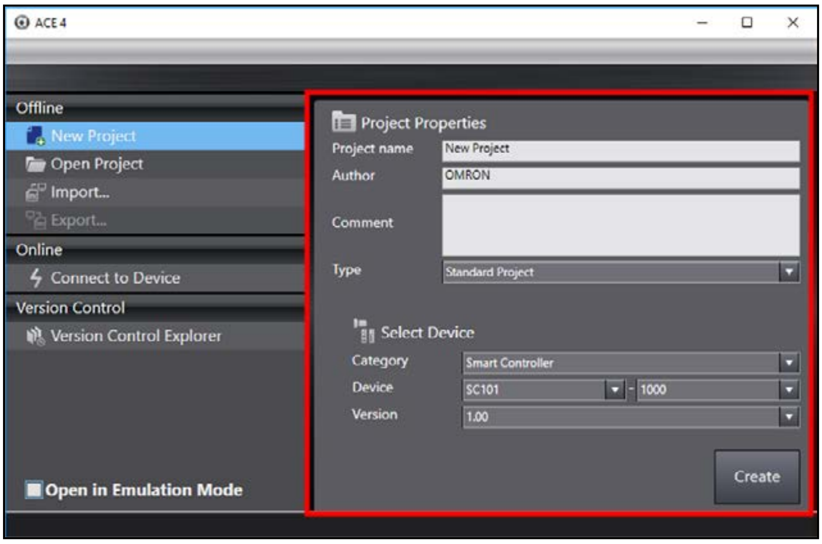


Figure 3-13 Project Properties Screen

The property settings are listed below.

Table 3-2 Project Property Descriptions

Property	Description
Project name	Enter the project name (required)
Author	Enter the author name (optional). If this is the first time you are creating a project after installing the ACE software, the user name that you entered when you logged onto Windows is displayed (see note below).
Comment	Enter a comment about the project (optional).
Type	Select the project type (required). • Standard Project This type is used for a normal project. • Library Project This type is used to create a library project (reserved for future use).
Category	Select the device category for the project (required). Refer to Multiview Explorer on page 93 for more information.
Device	Specify the device type based on the category selection (required).

Property	Description
Version	Specify the device version based on the category selection (required). The ACE software is compatible with controllers running eV+ version 2.1 B8 or above. Application Manager device AM101-1000 version 2.0 is compatible with any Application Manager device in ACE software version 4.2 or higher. Version 1.0 is compatible with ACE 4.0 or higher.

NOTE: You can change the author name that is displayed when you create a project in the option settings. Refer to Project Settings on page 141 for more information.

Additional Information: You can change the properties later. Refer to Opening a Project File on page 65 for more information.

3. After entering the project properties, make a selection for ***Open in Emulation Mode***. Refer to Emulation Mode on page 19 for more information.

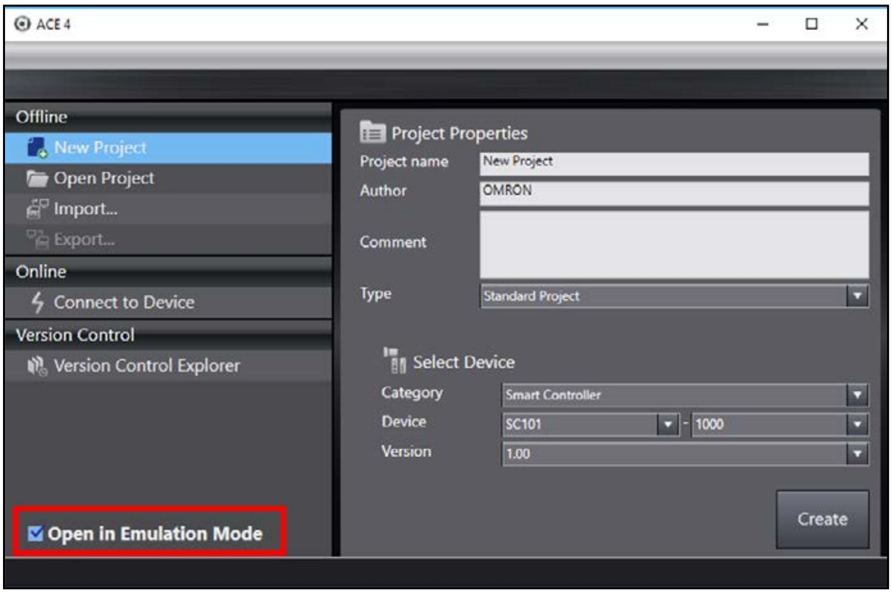


Figure 3-14 Open in Emulation Mode Selection

4. After the new project properties are complete, click the **Create** Button. A project file is created and the following window is displayed with the specified device inserted.

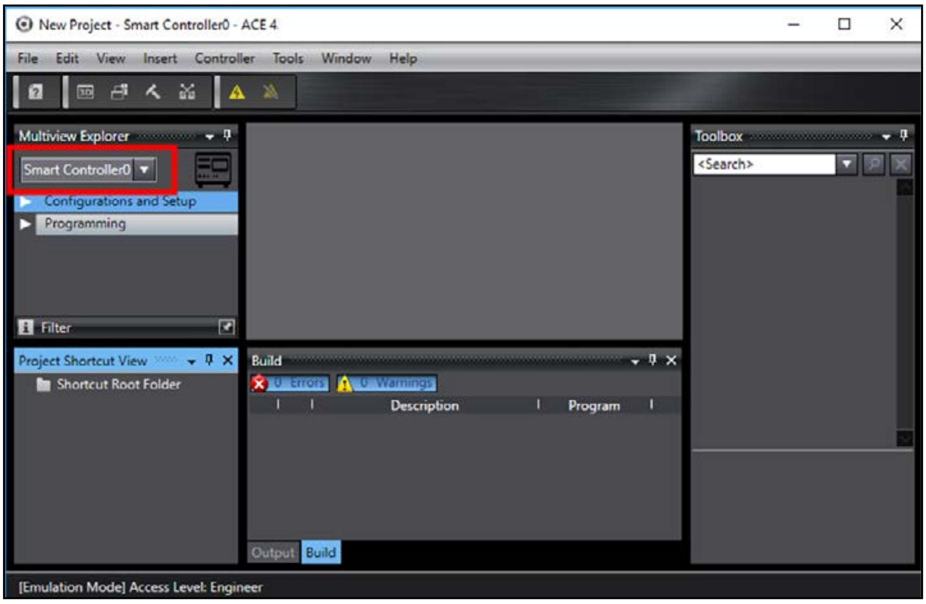


Figure 3-15 The ACE New Project Window

3.3 Saving the Project File

This section describes how to save the project file.

ACE software project files are serialized and saved on the PC at C:\OMRON\Ace\Data\Solution. This directory can be backed up if necessary.

> **NOTE:** This directory applies when the default software installation path is used.

All project files that have been saved will be displayed in a list when the **Open Project** selection is made. Refer to Opening a Project File on page 65 for more information.

> **IMPORTANT:** Do not modify data internal to the default save location. Data can be corrupted and project files can be lost as a result.

To save an existing project file, select **Save** from the File Menu (or press the **Ctrl + S** keys).

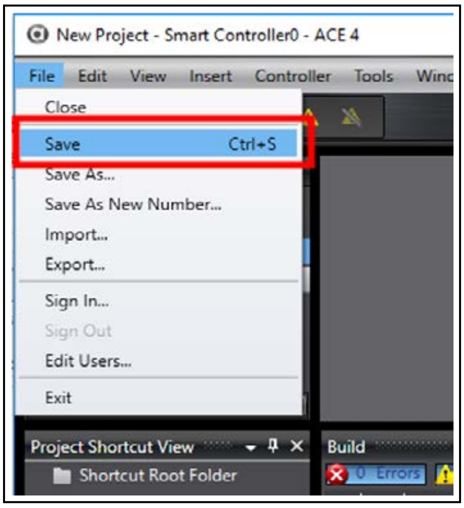


Figure 3-16 Save a Project File

To save a new project, select *Save As*. Enter a specific project name, do not accept the default, this may create multiple projects with the same name but different serial numbers.

> **NOTE:** Projects with the same name may cause runtime issues when opened with AutoStart. Confirm each project has a unique name.

The new project file is saved. To use a project file on a different computer, export the project file as described in Exporting a Project File on page 69.

> **IMPORTANT:** Refer to Pull V+ Memory on page 163 for information about saving controller memory contents to the project file.

For further information about version control, refer to *Sysmac Studio for Project Version Control Function Operation Manual (Cat. No. W589)*.

3.4 Saving a Project File Under a Different Name

This section describes how to save a project file under a different name.

Select ***Save As*** from the File Menu. This will display the Project Properties Dialog Box.

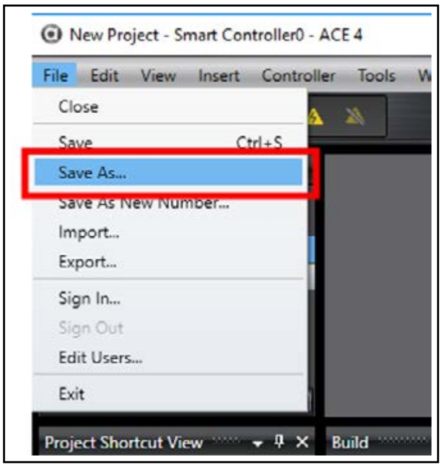


Figure 3-17 Save a Project as a Different Name

Change the project file name and any other project property details, and then click the **Save** Button.

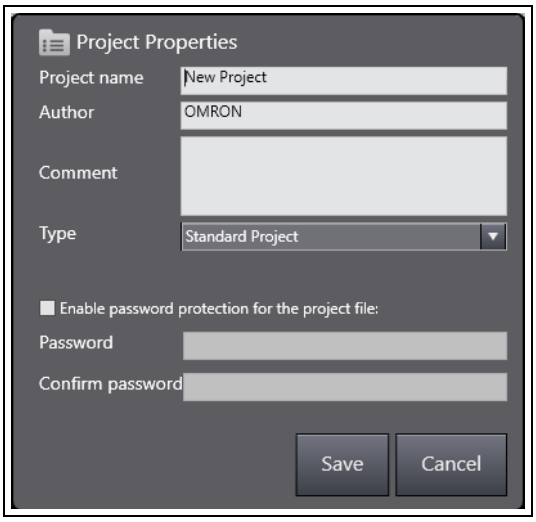


Figure 3-18 Change the Project File Name

Additional Information: For information about project file password protection, refer to Password Protection for Project Files on page 72.

3.5 Creating a Project from an Online Connection

If you connect to a device without specifying a project, a new project is created automatically. Use the procedure below to connect to a device and create a new project after uploading from the SmartController memory.

1. Click **Connect to Device** from the Start page. This will open the Connect to Device Dialog Box.

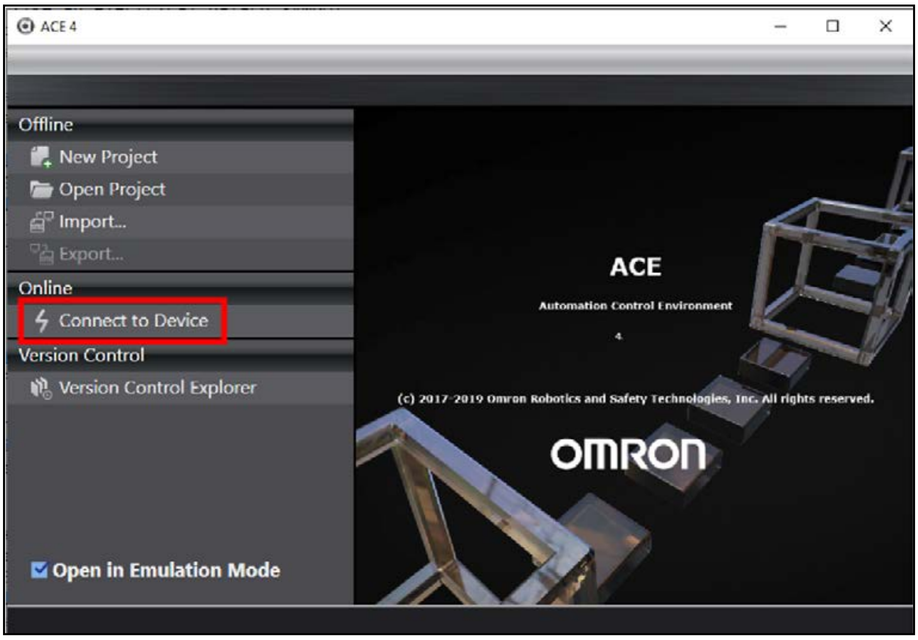


Figure 3-19 Connect to a Device

2. Make the appropriate connection settings in the Connect to Device Dialog Box and click the **Connect** Button (refer to Online Connections to SmartControllers on page 76 for more information).
3. After the connection is established, the Application window will be shown. A new project has been created from an online connection.

> **NOTE:** This new project gets a default project name. Select **Save as...** from the File Menu to save this project with a different name and adjust project properties if necessary.

> **Additional Information**: To capture the V+ memory into the new project, pull V+ memory from the SmartController. Refer to Pull V+ Memory on page 163 for more information.

3.6 Closing a Project and Returning to the Start Page

Use the following procedure to close a project file and return to the Start page.

1. Select ***Close*** from the File Menu.

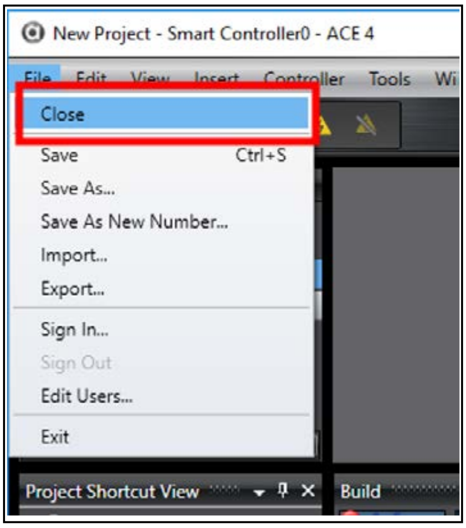


Figure 3-20 Close a Project

2. A dialog box is displayed to ask if you need to save the project. Click the **Yes** Button or **No** Button for the project saving choice.

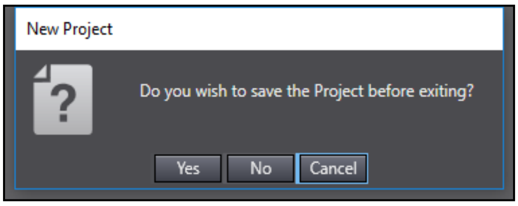


Figure 3-21 Save Project Selection

3. The Start page is displayed.

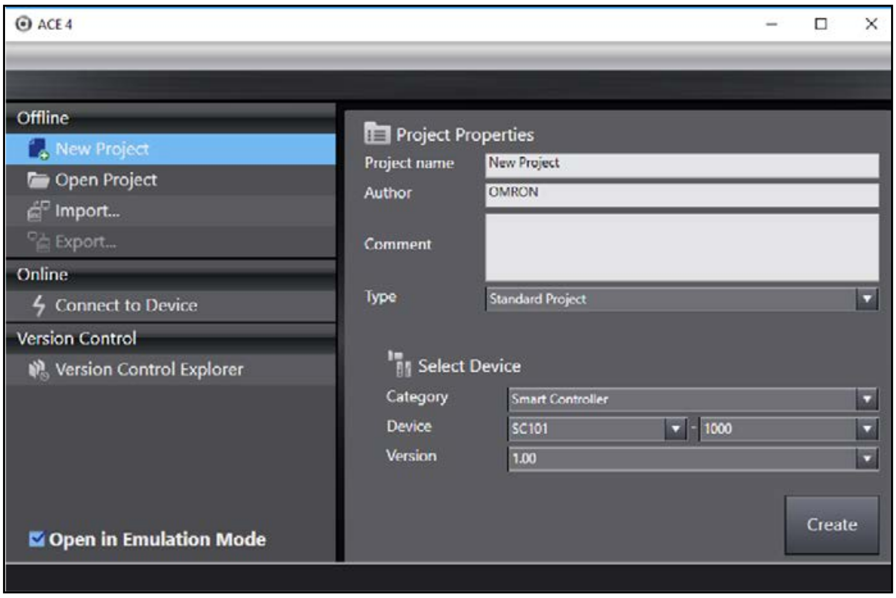


Figure 3-22 Start Page After Closing a Project

3.7 Opening a Project File

Use the following procedure to open an existing project file.

1. Click **Open Project** on the Start page. This will display the Project Screen.

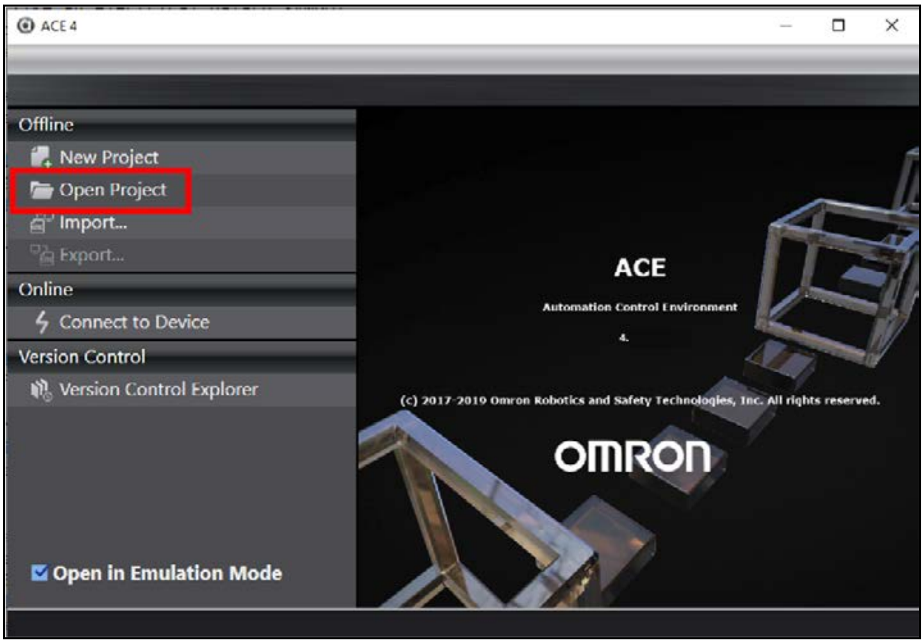


Figure 3-23 Open a Project on the Start Page

2. Find a project by searching for its name or selecting it from the project list and click the **Open** Button. This will open the project.

   The following information is displayed to help with the selection of the correct project file to open.

Table 3-3 Open Project Item Descriptions

Item	Description
Project name	The project names that were entered when the projects were created are displayed. The default name is ***New Project*** when creating a new project. The default name is ***Auto Connect Project*** when **Connect to Device** is used.
Comment	The comment that was entered when the project was created.
Last Modified	The last date that the project was modified.
Created	The date and time that the project was created.

Item	Description
Author	The name that was entered when the project was created.

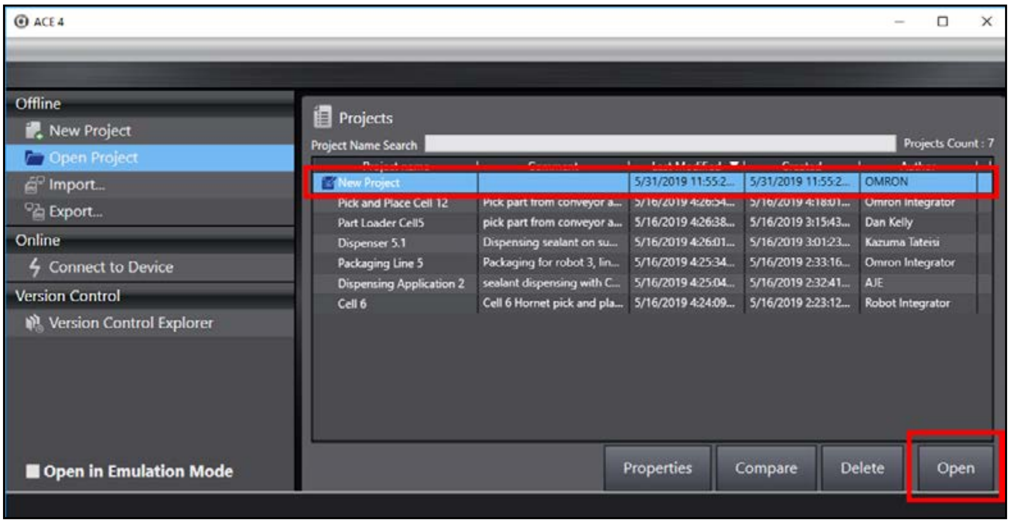


Figure 3-24 Select a Project to Open

Additional Information: A project's properties can be accessed and edited by selecting the project first, and then clicking the edit icon ( ) or the **Properties** Button. A project can be deleted by selecting the project and then clicking the **Delete** Button.

NOTE: The **Compare** Button is reserved for future use.

The Project Properties panel allows the project to be set with password security, See "Properties Password Protection".

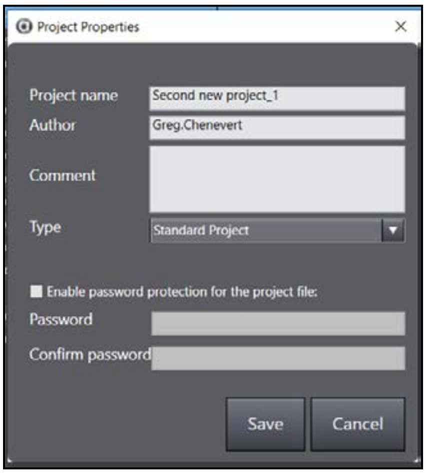


Figure 3-25 Properties Password Protection

To enable password protection, click the check box, then enter and confirm the password and then click *Save*.

3.8 Importing a Project File

Project files can be imported with three methods described below.

- Import from the Start page
- Import from the Menu Bar in the Application Window
- Import an .awp2 ACE project file

Importing from the Start Page

Select **Import** on the Start page and then browse to find the .awp2 ACE project file to import.

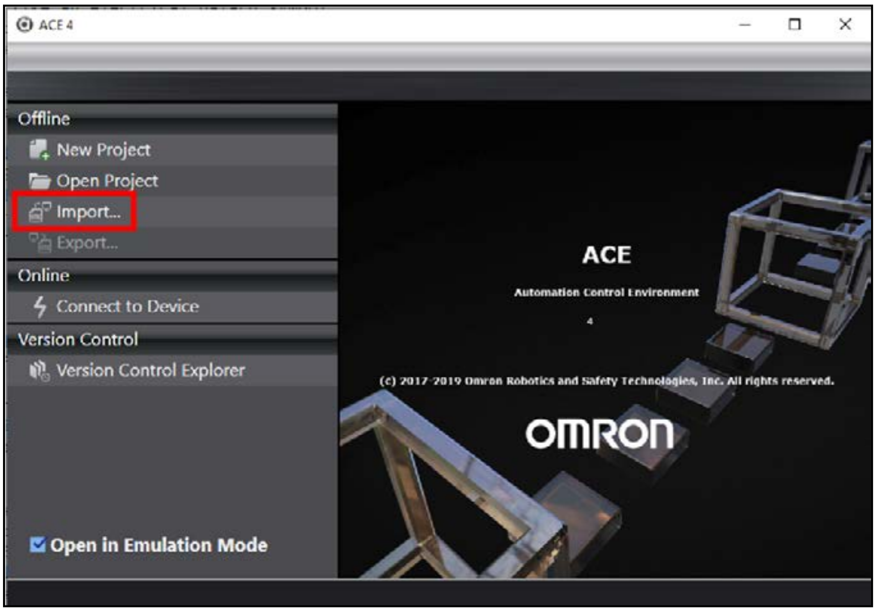


Figure 3-26 Importing a Project from the Start Page

Importing from the Menu Bar in the Application Window

Select ***Import*** from the File Menu in the Application Window and then browse to find the .awp2 ACE project file to import.

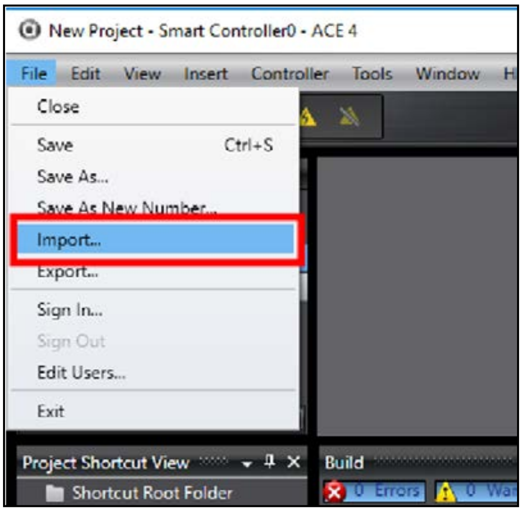


Figure 3-27 Import a Project from the Application Window

Importing an .awp2 ACE Project File

Browse to an .awp2 ACE project file with a file explorer:

Figure 3-28 ACE Project File / Icon

Opening the ACE project file will automatically launch the ACE software, import a new project file, and open the project.

> **IMPORTANT:** Repeated opening of a particular .awp2 ACE project file will result in duplicate copies of the project. This method should be used for projects not previously imported.

Importing from Version Control

With ACE opened, click the Version Control Explorer to open the Version Control Projects, See "Version Control Projects".

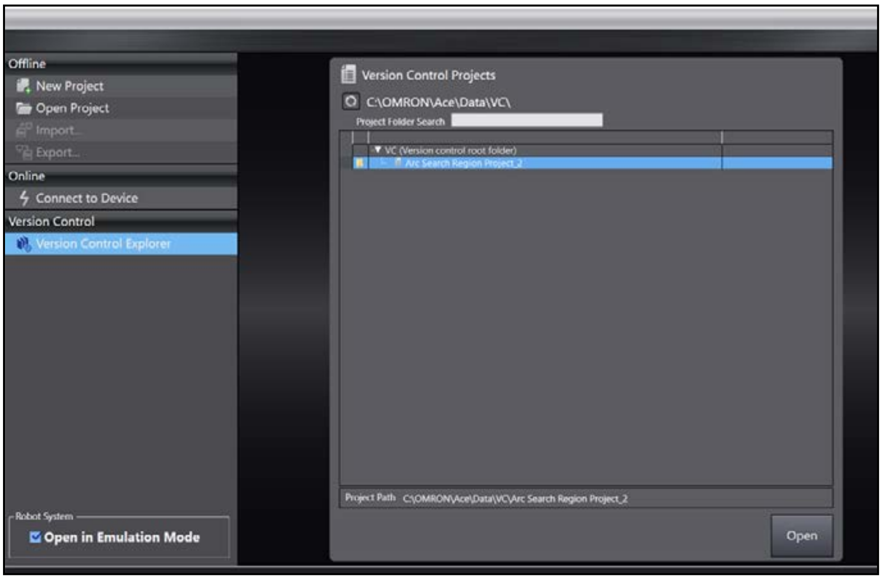


Figure 3-29 Version Control Projects

Select the project you want and click ***Open***. The project opens in the Multiview Explorer.

3.9 Exporting a Project File

Project files can be exported from the Start page and also from the Application Window. Both procedures are described below.

The exported project file has the same contents as a project that was saved in the ACE software.

Exporting from the Start Page

1. Select **Open Project** on the Start Page.

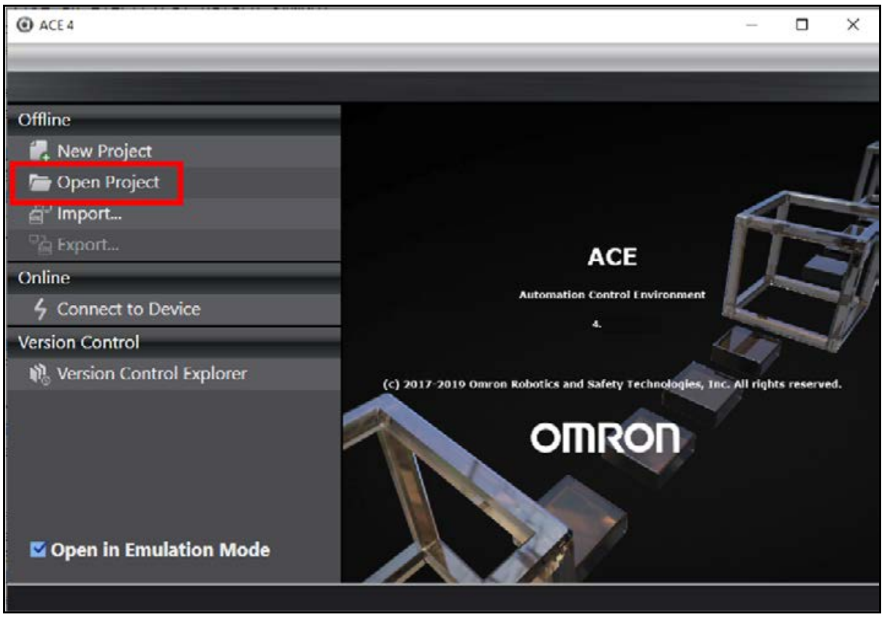


Figure 3-30 Accessing Project List for Exporting

2. Select a project to export from the list of project names and click ***Export***. The Export Project Dialog Box will be displayed.

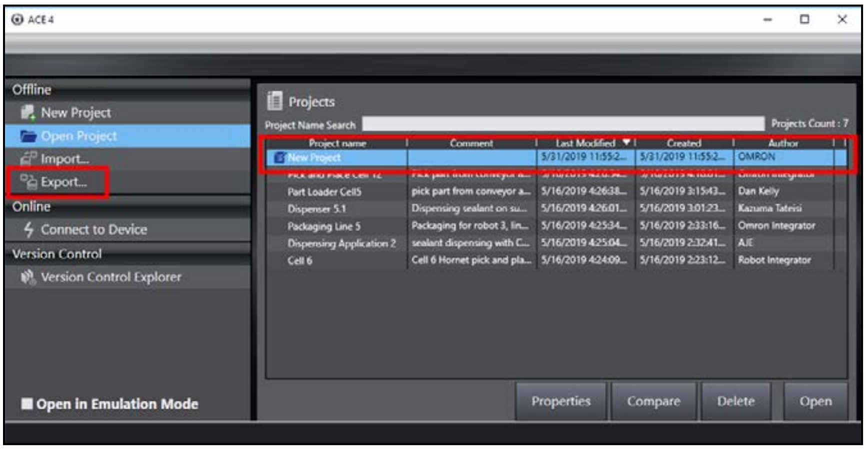


Figure 3-31 Select a Project and Click Export

Exporting from the Application Window

Select **Export** from the File Menu in the Application Window. The Export Project Dialog Box will be displayed.

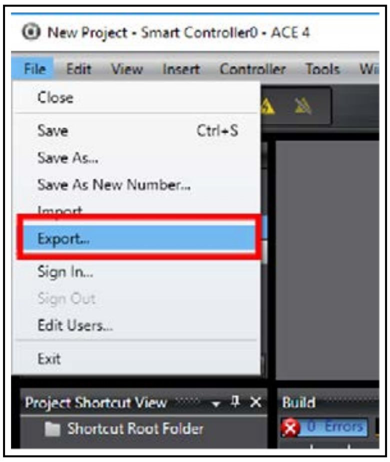


Figure 3-32 Export a Project from the Application Window

When Git is installed onto the computer, or the ACE application is connected to a remote repository, clicking Export opens the repository view, See "Repository View".

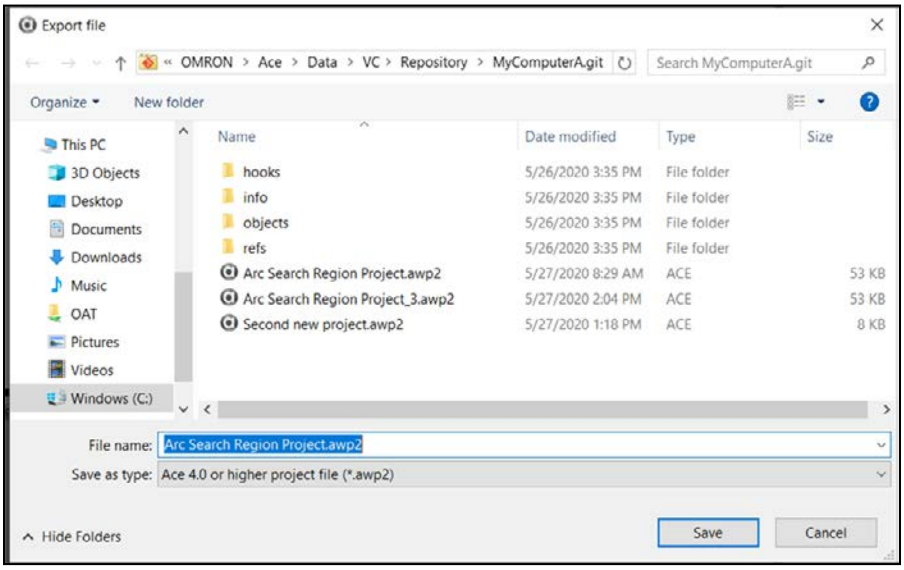


Figure 3-33 Repository View

For further details to use Git repositories.

Saving an Exported Project File

Specify a directory, enter a file name, select the file type, and then click the **Save** Button. This will export the project to a file.

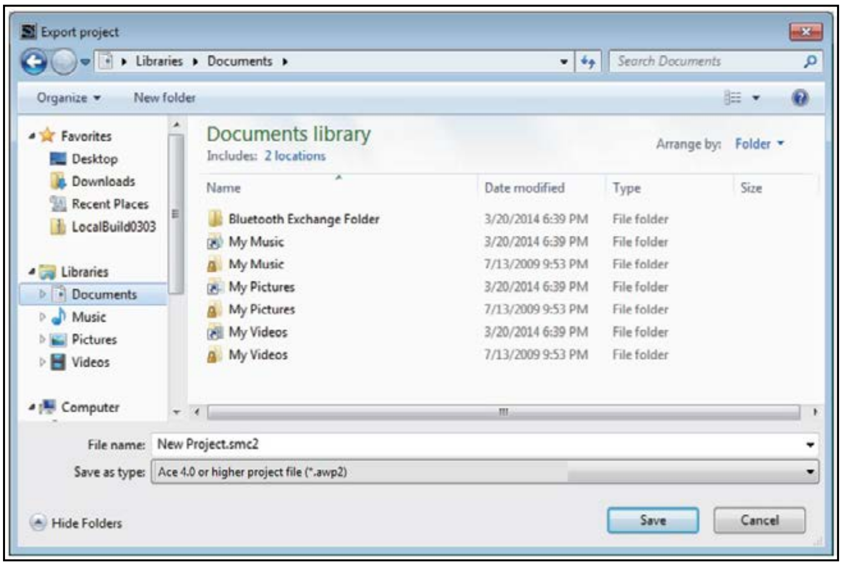


Figure 3-34 Export the Project to a File

NOTE: Save as type: Sysmac Studio V1.08 or higher project file (*.smc2) is reserved for future use.

Additional Information: You can export the contents of a project file for which password protection is set. Refer to Password Protection for Project Files on page 72 for the procedure to set password protection.

3.10 Password Protection for Project Files

You can set password protection for project files to protect your assets.

Passwords are case sensitive and must be a string of 8 to 32 alphanumeric characters.

Password protection for project files does not apply to data that is transferred to the SmartController.

If password protection is set, a password is required for the following operations.

- Opening the project file
- Changing the properties of the project file
- Importing the contents of the project file

IMPORTANT: If you forget the password, you will no longer be able to open the project file, change the properties of the project file, or import the contents of the project file. Be sure to record the password in case you forget it.

Setting Password Protection for Project Files

Use the following procedure to set password protection for project files.

1. Click **Open Project** on the Start page. Then, click the **Properties** Button or click the **Edit Properties** icon ( ). This will display the Properties Dialog Box.
2. Select the **Enable password protection for the project file** Check Box.

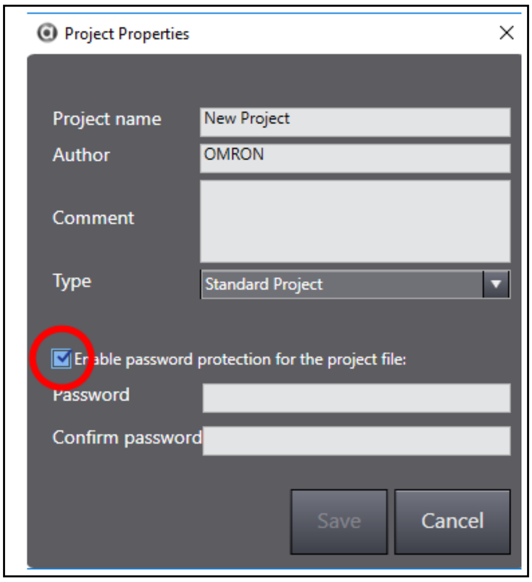


Figure 3-35 Enable Password Protection

3. Enter the password, confirm the password (these must match) and then click the **Save** Button. The file is saved and password protection is set for this project.

The Edit Properties icon displayed in the project file list will indicate password protection.

No password protection set: 

Password Protection set: 

Removing Password Protection for Project Files

Use the procedure below to remove password protection for a project file.

1. Click **Open Project** on the Start page. Then, click the **Properties** Button or click the **Edit Properties** icon (). This will display the password entry prompt.
2. Enter the correct password for the project and click the **OK** Button. This will display the Project Properties Dialog Box.
3. Uncheck the ***Enable password protection for the project file*** and then click the **Save** Button. This will remove password protection for the project.

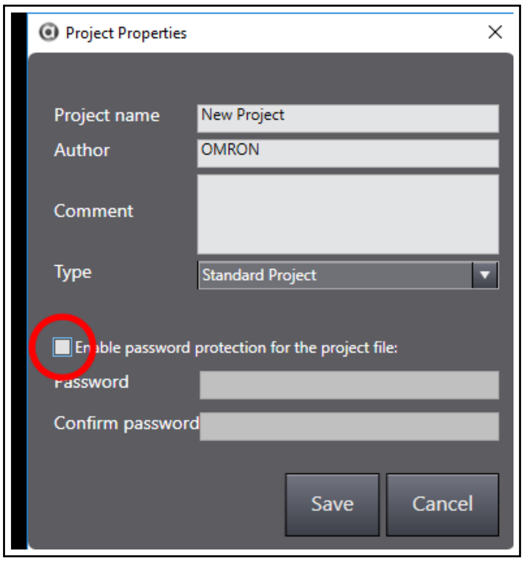


Figure 3-36 Uncheck Password Protection

3.11 Project Version Numbers

You can assign numbers to projects to manage the project history. The project numbers are displayed in a hierarchy in the Open Project Screen.

NOTE: Once a new project number is created, the number cannot be changed.

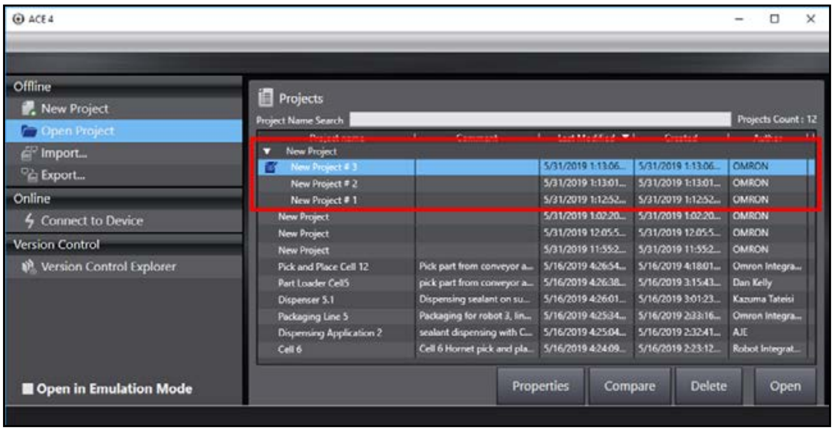


Figure 3-37 Project Hierarchy

Use the ***Save As New Number...*** from the File Menu to assign an incrementing number to an open project.

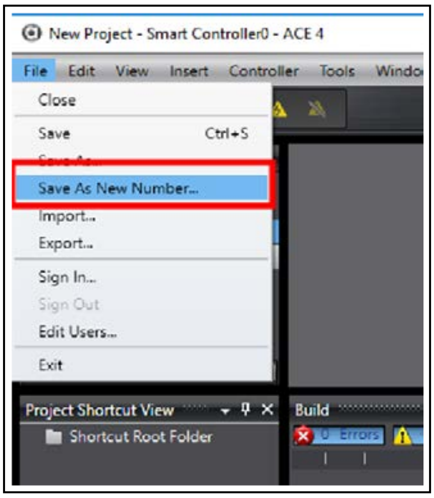


Figure 3-38 Save as New Number

A new number is automatically added for the project number.

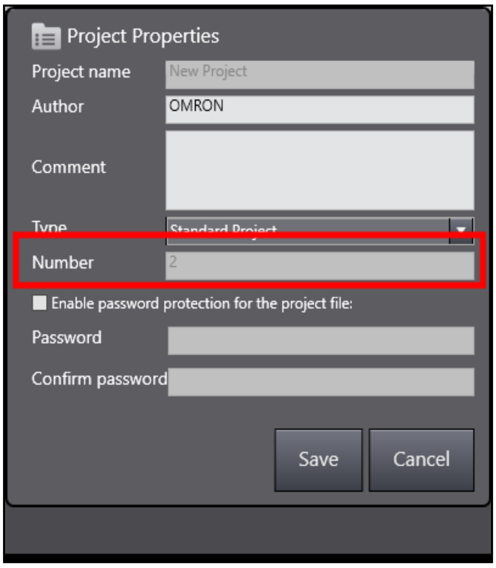


Figure 3-39 Project Numbers

Chapter 4: Online Connections to SmartControllers

An online connection must be established to allow communications between the ACE software and a SmartController. Online connections are also possible in Emulation Mode (refer to Emulation Mode on page 19 for more information).

NOTE: ACE software version 3.8 (and older) cannot connect to a controller that ACE software version 4.2 (or higher) has connected to previously until a zero memory or reboot have been executed.

If an online connection has been established, you can perform operations such as:

- Program debugging, transfer, and comparison
- Task management
- I/O monitoring
- File transfer
- Robot jogging
- Monitoring system performance

Use the information in this chapter to understand how to use the online connection functionality with the ACE software and SmartControllers.

4.1 Going Online with a SmartController

An online connection to a SmartController or an emulated controller can be established from the ACE software Start page or from within an existing open project.

NOTE: You can simultaneously go online with more than one SmartController in a project from the ACE software. The operations that are described in this section apply to the currently selected SmartController in the Multiview Explorer. If there is more than one registered SmartController in the project, select the SmartController in the Multiview Explorer before attempting to go online.

Going Online from the Start Page

Clicking **Connect to Device** on the Start page will open the Connect to Device Dialog Box. The *Connect to Device* screen is used to prepare the online connection to a controller.

NOTE: A successful connection to a controller with this method will automatically create a new project with the name "Auto Connect Project". After the project is open, it is recommended to save the project with a more specific name using *Save As...* from the File menu. Closing without saving may result in an empty project.

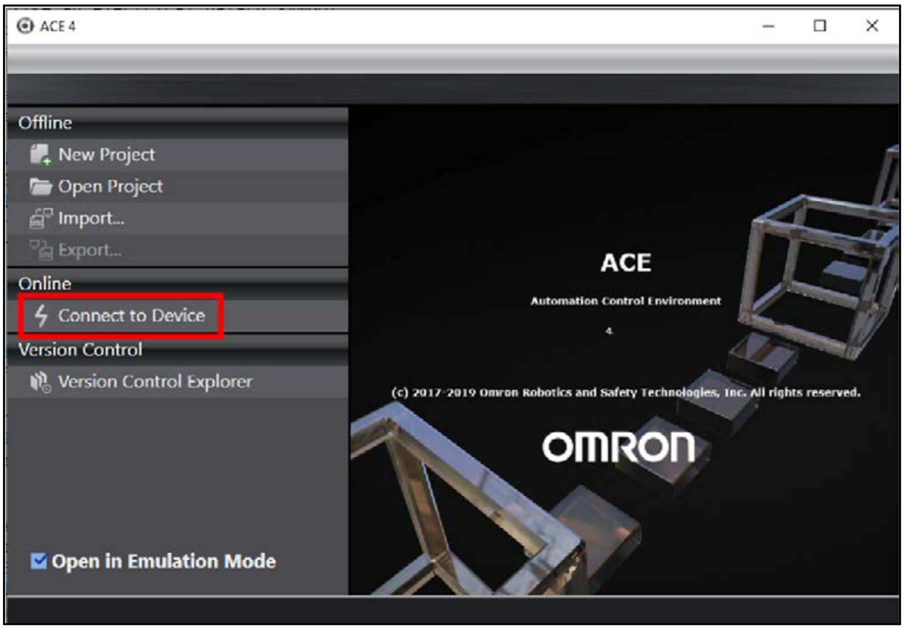


Figure 4-1 Connect to Device on the Start Page

The main areas of the *Connect to Device* Dialog Box are described below.

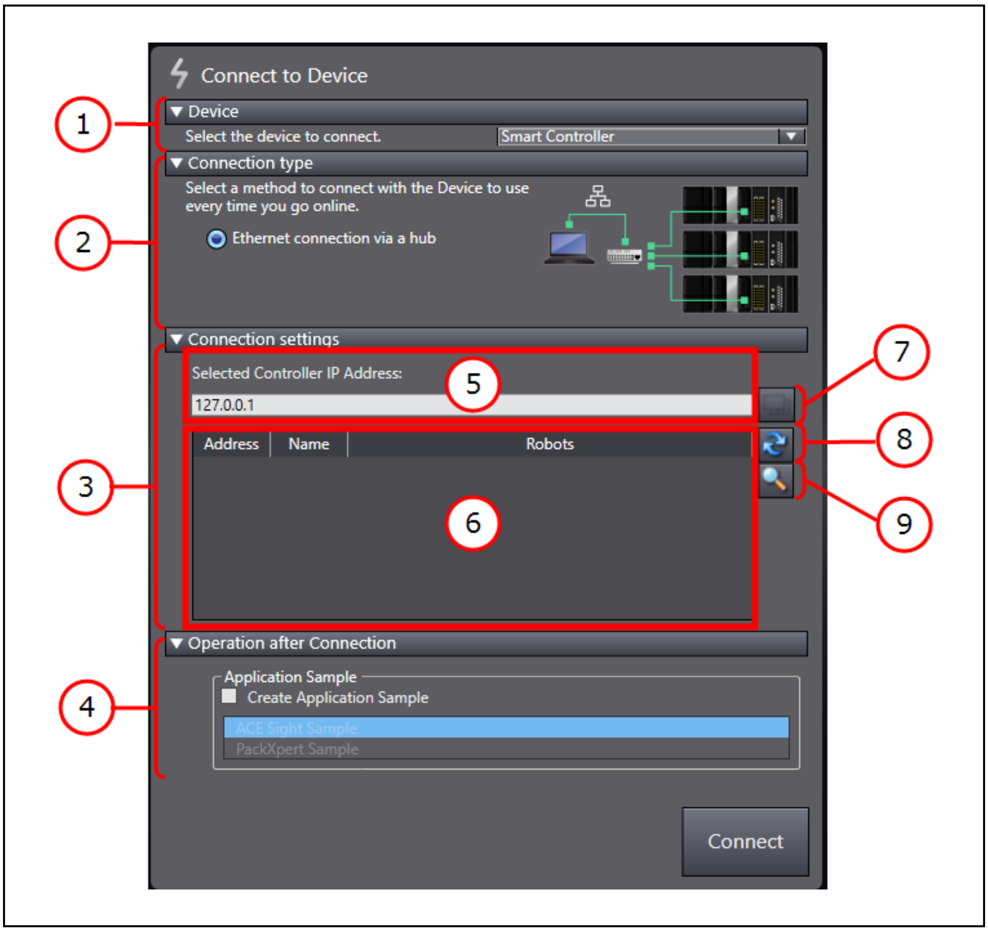


Figure 4-2 Connect to a Device Dialog Box

Table 4-1 Connect to a Device Description

Item	Name	Description
1	Device	Use this area to select the device to connect.
2	Connection Type	Use this area to select a connection method when going online.
3	Connection Settings	Use this area to detect and select controller IP addresses used for online connection.
4	Operation after Connection	Use this area to create an Robot Vision Manager or Pack Manager application sample after a connection is established.
5	Selected Controller IP Address	Used to manually enter a controller IP address (such as when connecting through a gateway) or displays the currently selected controller IP address. **NOTE:** To create a project in Emulation Mode that

Item	Name	Description
		uses a specific controller IP address, use this area to set the IP address before connecting. The controller created in Emulation Mode will have the IP address entered into this field.
6	Detected Controller IP Addresses	After a controller has been detected, it will appear in this area for selection. **NOTE:** A controller configured to use a gateway will not appear in this area. If the network configuration is correct, the controller should be able to connect by manually entering the IP address of the desired controller. Refer to Detect and Configure Controller on page 79 for more information.
7	Monitor Window	Used for opening the Monitor Window for the selected controller. Refer to Monitor Window on page 222 for more information.
8	Refresh	Used to refresh the detected controller IP address area.
9	Detect and Configure Controller	Opens the Controller IP Address Detection and Configuration Dialog Box. Refer to Detect and Configure Controller on page 79 for more information.

If the Controller appears in the Detected Controller IP Address area, select it and click the **Connect** Button. This will initiate the online connection process. If the Controller does not appear, refer to Detect and Configure Controller on page 79 below.

The project workspace appears and a yellow bar is present under the toolbar when an online connection is present.

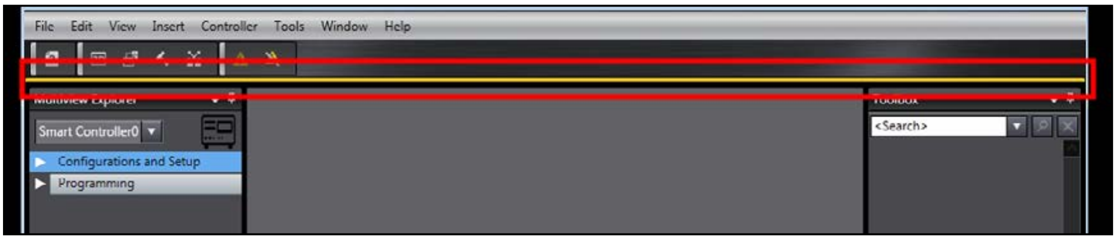


Figure 4-3 Online Indication

Detect and Configure Controller

This area is used to detect and configure controllers on a network. In this area, a detected controller's properties can be modified to establish an online connection. You can also change the Desired AutoStart behavior for a connected device in this area. Refer to Configure on page 205 for more information.

If a controller is detected, but resides on a different LAN and does not have a gateway configured, an online connection is not possible until one of the following actions are taken.

- The detected controller's IP address and/or subnet is changed for compatibility with the PC's LAN connection. Change the Desired Properties Address, Subnet, and Name accordingly in the area shown below.

Additional Information: Refer to Configure on page 205 to change the address, subnet, or name of a connected controller.

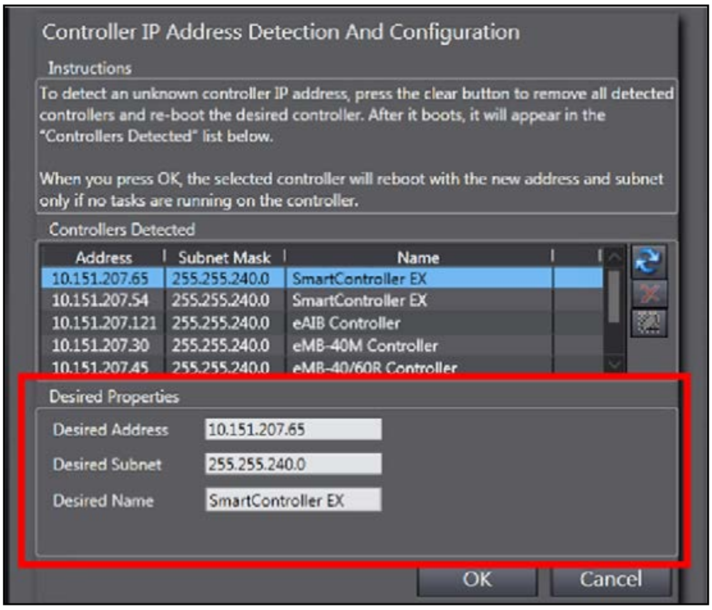


Figure 4-4 Change the Controller Network Configuration, Name and Autostart Properties

- The PC's IP address and LAN connection are changed to be compatible with the controller. Adjust the PCs network adapter properties accordingly.

Going Online from an Open Project

There are three methods available for going online from an open project:

1. Use the **Online** icon ( ) in the toolbar to go online with the controller selected in the Multiview Explorer.
2. Select ***Online*** from the Controller Menu to go online with the controller selected in the Multiview Explorer.
3. Click the **Online** icon ( ) in the Task Status Control area to go online with the associated controller. Refer to Task Status Control on page 121 for more information about Task Status Control.

   Use the **Online** and **Offline** Buttons to control the online connections to each controller.

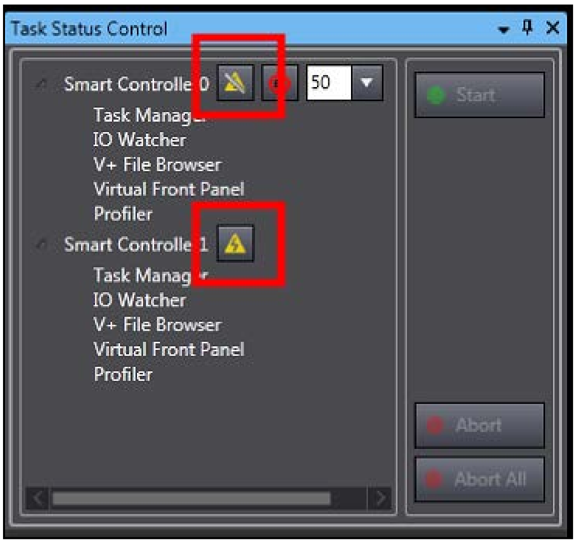


Figure 4-5 Task Status Control for Online Monitoring

These methods rely on a correct IP assignment for the controller. Refer to Controller Settings on page 192 for more information.

> **Additional Information**: The Controller Connection Startup object allows the ACE software to automatically establish an online connection when the project opens. Refer to Controller Connection Startup on page 326 for more information.

4.2 Going Offline with a SmartController

Use the offline function to close an active connection to a controller. Use one of the following methods to go offline with a controller.

- Click the **Offline** Button in the toolbar.

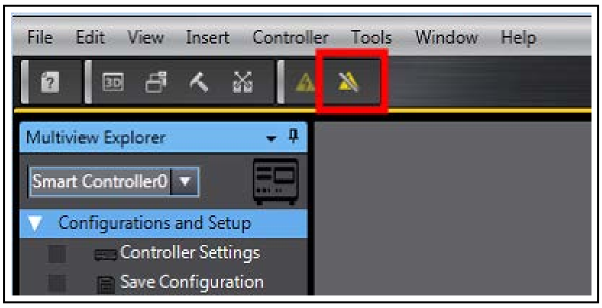


Figure 4-6 Offline Button

- Click the **Offline** icon in the Task Status Control area (refer to Task Status Control on page 121 for more information).

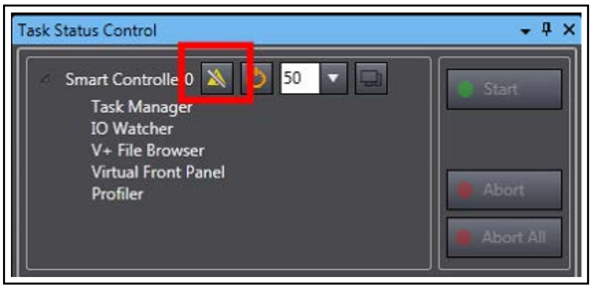


Figure 4-7 Offline Icon in Task Status Control Area

4.3 Memory Comparison

When an online connection is initiated, after opening a project, ACE makes a comparison between the controller memory and the ACE project memory operating on the PC. Upon a successful connection with a controller, ACE will try and synchronize its memory by comparing V+ modules, V+ programs and V+ Variables with the controller memory. If any of the above are different between ACE and the controller memory ACE will indicate this to the user in the Multiview Explorer with red icons.

With the ACE V+ editor opened and synchronized between the PC and controller, any changes to a program are written to both the PC and controller. If any unsynchronized changes exists between the ACE project and the controller memory it is reflected in the V+ Editor window with yellow color indicating the unsynchronized changes. The ACE editor shows the differences between the ACE project and the controller memory with three indicators: red icons next to the program, a yellow bar within the editor next to the unsynchronized code and the yellow icon on the bottom tab, as shown in the following figure.

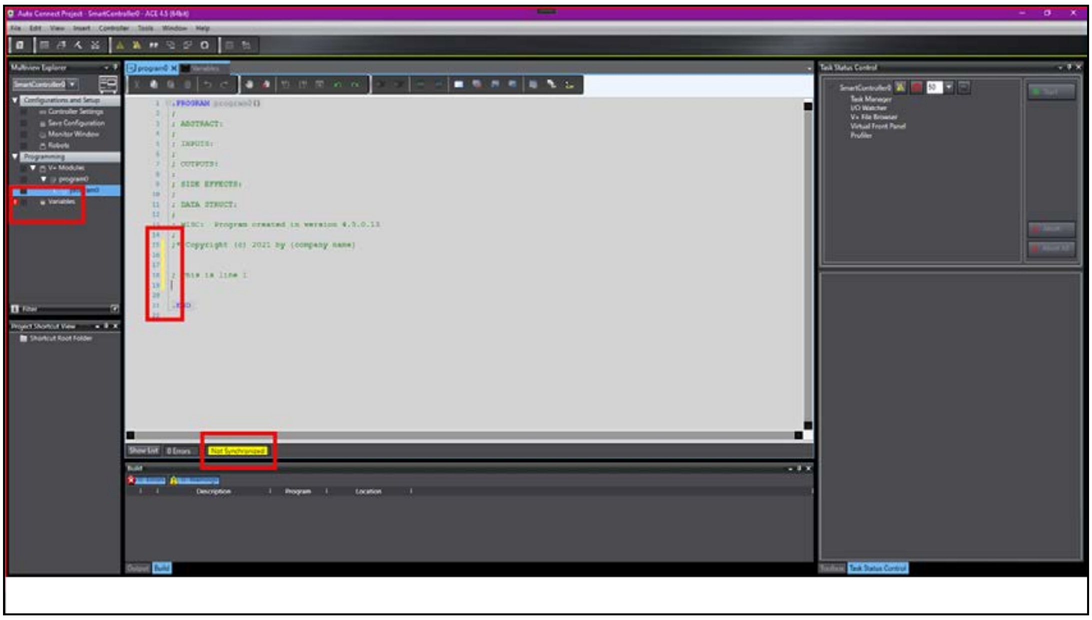


Figure 4-8 Multiview Explorer with Editor Indicators

The changes are made, in the Offline mode, you can then either push the changes to the controller, or pull the file from the controller and overwrite the PC editor, eliminating your changes.

When you have finished making your changes to a program, click the synchronize button, shown in the following figure.

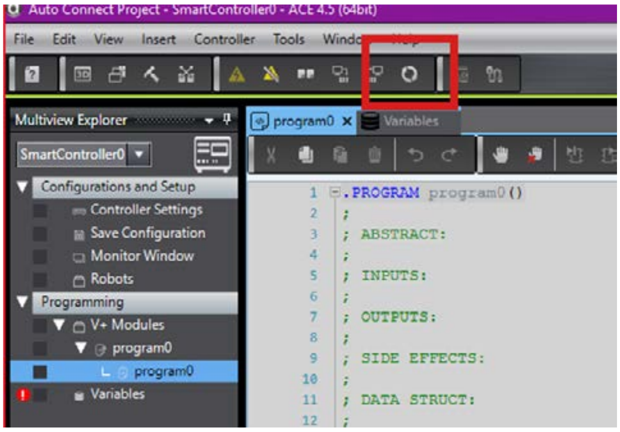


Figure 4-9 Synchronize Button.

ACE will open the following panel, showing the status of the controller memory and ACE project memory, as shown in the following figure.

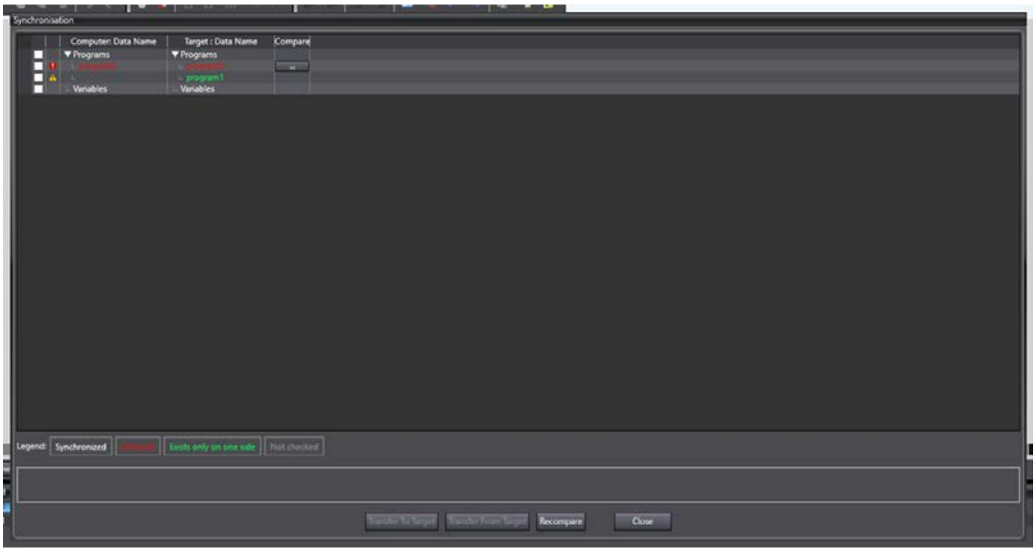


Figure 4-10 Program Status, Offline.

You can compare the status of the controller and ACE project memory, as shown in the following figure. The Legend for colors on the bottom left shows you what the colored bar on the left side of the comparison panel. When you select the compare option the following panel shows a comparison between a selected V+ program, as it exists in the ACE project memory on the left hand side, and the V+ program as it exists in the controller memory on the right hand side, as shown in the following figure.

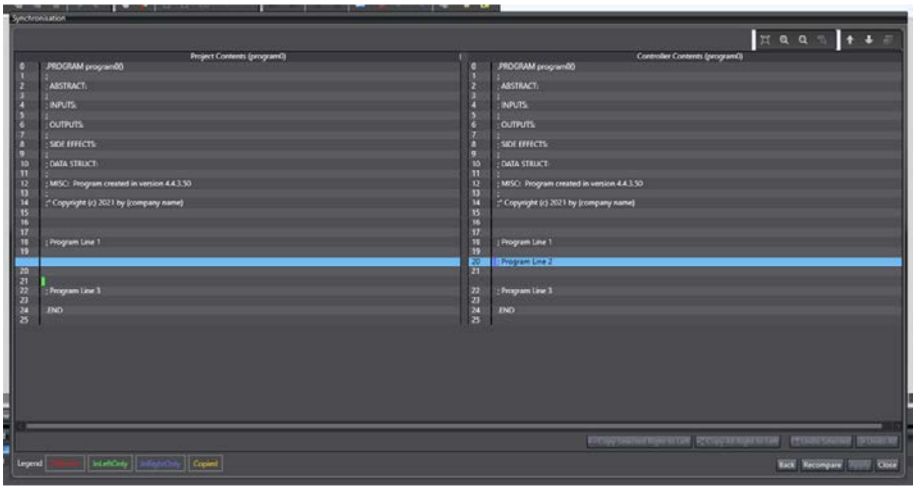


Figure 4-11 PC and Controller Status.

After review and selecting the programs, you synchronize the ACE project memory and controller by either pulling the unchanged controller program into the ACE project memory or pushing the ACE project memory to the controller. You can pull from the controller memory by clicking the **Transfer From Target** Button. You can push the changed program from your ACE project memory to the controller by clicking the **Transfer To Target** Button as shown in the following figure.

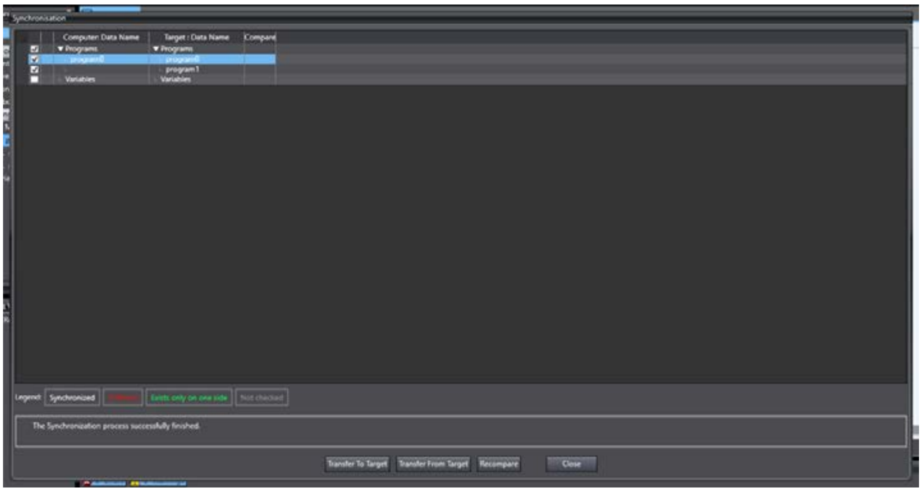


Figure 4-12 Update Changes Panel.

You can also set the connection to automatically push, pull or notify you through thee Options, as shown below. To open this option, click **Tools**, then **Options** and then **Connection Settings**.

Figure 4-13 Connection Settings Option

NOTE: If you overwrite the ACE project V+ memory with the contents of the controller, there is no way to recover previous project data unless a backup copy has been created. Consider selecting ***Save As...*** from the File Menu to save a new backup copy of the project before pushing the program to the Controller memory.

You can set the memory comparison function to a default that allows three options: notify user, pull from controller or push to controller. You set these defaults with the following steps.

With the Multiview Explorer opened to SmartController, select *Configurations and Setup*. On the Menu bar, select Tools > Options > Connection Settings. The following figure shows the Option panel.

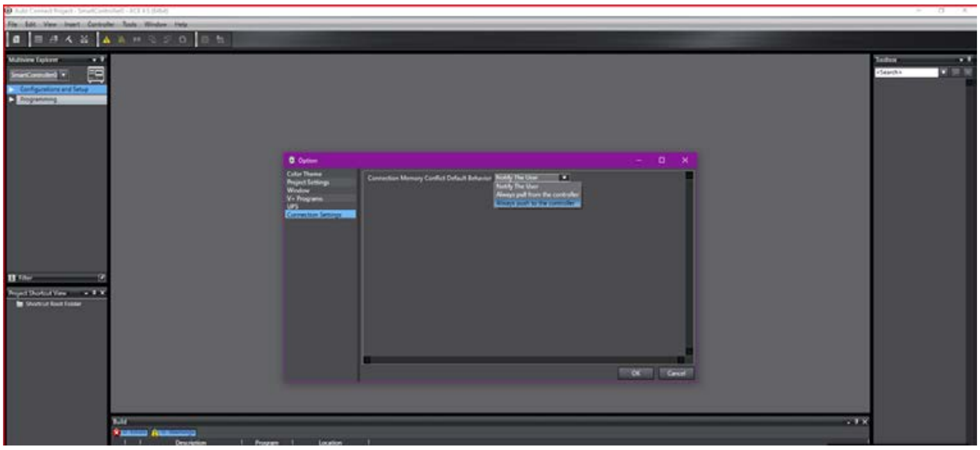


Figure 4-14 Settings Default Options.

Use the drop-down options to select the default behavior and then click the **OK** Button.

Chapter 5: Understanding the ACE User Interface

This section provides the names, functions, and basic arrangement of the ACE software user interface.

5.1 The Main Application Window

The default application window layout is described below.

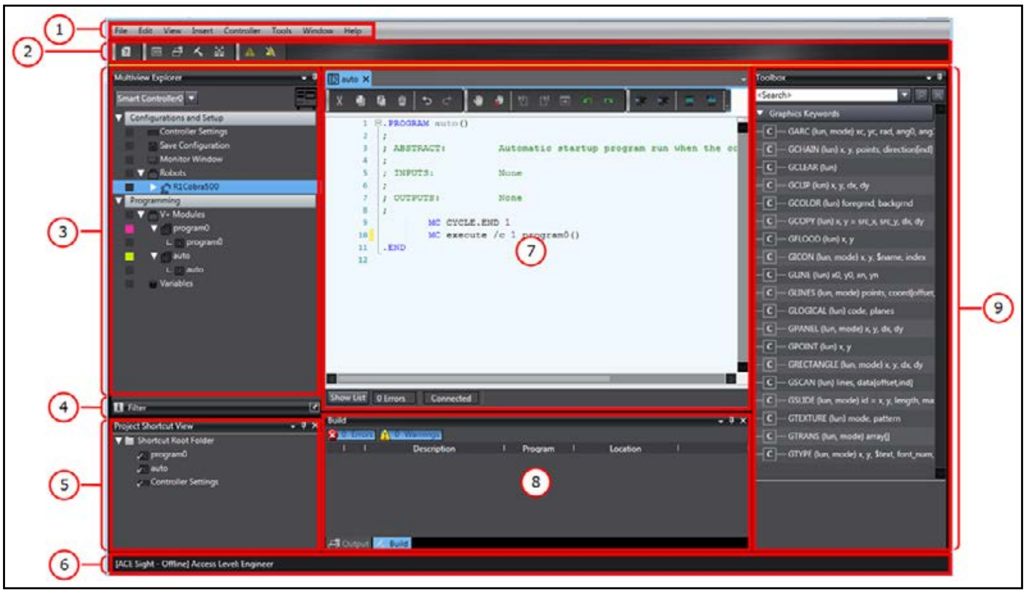


Figure 5-1 ACE Main Application Window

Table 5-1 Ace Main Application Window Description

Item	Description
1	Menu bar
2	Toolbar
3	Multiview Explorer
4	Filter Pane
5	Project Shortcut View
6	Status Bar
7	Edit Pane
8	Multifunction Tabs

Item	Description
9	Multipurpose Tools

Menu Command Structure

The menu bar contains the following command structure.

Table 5-2 File Menu Bar Item Description

Contents	Description
Close	Clears all objects and project data and returns to the ACE start screen.
Save	Saves the current project to the project library.
Save As...	Save the currently opened project with options to adjust project properties.
Save As New Number	Save the currently opened project with an incremented number.
Import...	Import an ACE project file. Refer to Importing a Project File on page 67 for more information.
Export...	Export an ACE project to a file. Refer to Exporting a Project File on page 69 for more information.
Sign In...	Sign in with a specific user access level. Refer to User Management on page 138 for more information.
Sign Out	Sign out of a specific user access level. Refer to User Management on page 138 for more information.
Edit Users...	Edit user access levels. Refer to User Management on page 138 for more information.
Exit	Exit the ACE software.

Table 5-3 Edit Menu Bar Item Description

Contents	Description
Undo	Undo the last action.
Redo	Redo the last action.
Cut	Cut the selected item to the clipboard.
Copy	Copy the selected item to the clipboard.
Paste	Paste an item from the clipboard to the selected area.
Delete	Delete the selected item.

Contents	Description
Select All	Select all items in an area or list.
Search and Replace	Open the Search and Replace tool. Refer to Search and Replace on page 136 for more information.
Find Previous	Find a previous instance of a search term.
Find Next	Find the next instance of a search term.
Jump...	Reserved for future use.
Jump to Multiview Explorer	Display the active item in the expanded Multiview Explorer.

Table 5-4 View Menu Bar Item Description

Contents	Description
Multiview Explorer	Display the Multiview Explorer. Refer to Multiview Explorer on page 93 for more information.
Project Shortcut View	Display the Project Shortcut view. Refer to Project Shortcut View on page 97 for more information.
Toolbox	Display the Toolbox in the multipurpose tools area. Refer to Toolbox on page 107 for more information.
3D Visualizer	Display the 3D Visualizer in the multipurpose tools area. Refer to 3D Visualizer on page 107 for more information.
Output Tab Page	Reserved for future use.
Cross Reference Tab Page	Reserved for future use.
Build Tab Page	Display the Build Tab in the multifunction tabs area. Refer to Build Tab Page on page 114 for more information. This is not available when the Application Manager device is selected.
Event Log	Display the Event Log in the multifunction tabs area. Refer to Event Log on page 115 for more information.
Smart Project Search	Display the Smart Project Search tool as a pop up window. Refer to Other Application Window Functions on page 101 for more information.
Recently Closed Windows	Display the Recently Closed Windows as a pop up window. Refer to Other Application Window Functions on page 101 for more information.

Contents	Description
Clear Recently Closed Windows History	Clear the Recently Closed Windows history. Refer toOther Application Window Functions on page 101 for more information.
V+ Jog Control	Display the V+ Jog Control in the multipurpose tools area. Refer to V+ Jog Control on page 116 for more information.
Task Status Control	Display the Task Status Control in the multipurpose tools area. Refer to Task Status Control on page 121 for more information.
Vision Window	Display the Vision Window in the multipurpose tools area. Refer to Vision Window on page 132 for more information.
V+ Watch	Display the V+ Watch in the multifunction tabs area. Refer to V+ Watch on page 135 for more information.
System Monitor	Display the System Monitor in the multifunction tabs area. Refer to Other Application Window Functions on page 101 for more information.
Reset Window Layout	Reset the window layout to the default view.

Table 5-5 Insert Menu Bar Item Description

Contents	Description
SmartController	Insert a new SmartController in the project.
Application Manager	Insert a new Application Manager in the project. Refer to Software Overview on page 13 for more information.
Application Sample	Insert a Robot Vision Manager Sample, Pack Manager Sample, or Pendant UI Sample in the project. This is not available when the Application Manager device is selected.

Table 5-6 Controller Menu Bar Item Description

Contents	Description
Online	Go online with a SmartController. The Controller menu item is not available when the Application Manager device is selected.
Offline	Go offline with a SmartController. The Controller menu item is not available when the Application Manager device is selected.

Table 5-7 Tools Menu Bar Item Description

Contents	Description
Customize Shortcut Keys...	Display the Shortcut Key Customization pop up window.
Option...	Display the project Option pop up window. Refer to Project Options on page 140 for more information.

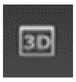
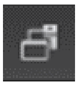
Table 5-8 Window Menu Bar Item Description

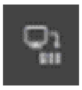
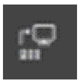
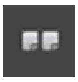
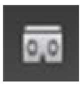
Contents	Description
Close	Close the active window.
Float	Float the active window.
Dock	Dock the active window.
New Horizontal Tab Group	Divide the Edit Pane into upper and lower sections. Only available when the Edit Pane has more than one tab open.
New Vertical Tab Group	Divide the Edit Pane into left and right sections. Only available when the Edit Pane has more than one tab open.
Move to Next Tab Group	Move the selected tab page to the tab group below or to the right of the current tab group. Only available when there is a tab group below or to the right of the current tab group.
Move to Previous Tab Group	Move the selected tab page to the tab group above or to the left of the current tab group. Only available when there is a tab group above or to the left of the current tab group.
Close All But This	Close all tab pages and floating Edit Panes, except for the selected tab page.
Close All Except Active Device	Close all tab pages and floating Edit Panes for other devices, leaving those for the selected device.
Close All	Close all tab pages and floating Edit Panes, including the selected tab page.
Close Tab	Close the active Edit Pane tab.
Open Next Tab	Open the next Edit Pane tab. Only available when the Edit Pane has more than one tab open.
Open Previous Tab	Open the previous Edit Pane tab. Only available when the Edit Pane has more than one tab open.

Table 5-9 Help Menu Bar Item Description

Contents	Description
ACE Manuals	Access to the following resources: • *Automation Control Environment (ACE) Version 4 User's Manual (Cat. No. I633)* • *Robot Vision Manager User's Manual (Cat. No. I667)* • *V+ Module Reference Manual (Cat. No. I668)* • ACE API Reference Manual
V+ Manuals	Access to the following resources when *Standard Control* is selected: • *V+ User's Manual (Cat. No. I671)* • *V+ Keyword Reference Manual (Cat. No. I672)* Access to the following resourcs when *eV+2* is selected: • eV+ Language Reference Guide • eV+ OS Reference Guide
About...	Display information about the ACE software.

Table 5-10 Toolbar Icons Description

Icon	Name	Description
	Help	Opens ACE User's Guide.
	3D Visualizer	Opens the 3D Visualizer. For more information, refer to 3D Visualizer Basic Features on page 108.
	Output Tab Page	Only available when a SmartController device is selected. Shows the Output Tab. If the Output Tab is already displayed and selected, it will be hidden instead. For more information, refer to Output Tab Page on page 114.
	Build Tab Page	Only available when a SmartController device is selected. Shows the Build Tab. If the Build Tab is already displayed and selected, it will be hidden instead. For more information, refer to Build Tab Page on page 114.
	Cross Reference Tab Page	Only available when a SmartController device is selected. Shows the Cross Reference Tab. If the Cross Reference Tab is already displayed and selected, it will be hidden instead. For more information, refer to Cross Reference Tab Page on page 114

Icon	Name	Description
	Online	Opens communication between the IPC and the specified controller or between the Application Manager and the specified server, depending on which type of object is selected. This is disabled if the device is already online. For more information, refer to Going Online with a SmartController on page 76.
	Offline	Closes communication between the IPC and the specified SmartController or between the Application Manager and the specified server, depending on which type of object is selected. This is disabled if the device is already offline. For more information, see See "Going Offline with a SmartController".
	Synchronize	Opens the Synchronize window. If a SmartController is selected, the window will compare ACE and the controller. If an Application Manager is selected, the window will compare the client with the server. For more information, refer to Memory Comparison on page 82.
	Push V+ Memory	Only available when a SmartController device is selected. Pulls all V+ modules from the controller to ACE. This is disabled if there are no detected differences between the V+ code in ACE and the controller. For more information, refer to Memory Comparison on page 82.
	Pull V+ Memory	Only available when a SmartController device is selected. Pulls all V+ modules from the controller to ACE. This is disabled if there are no detected differences between the V+ code in ACE and the controller. For more information, refer to Memory Comparison on page 82.
	Check V+ Memory	Only available when a SmartController device is selected. Compares the V+ Modules in the project to those in the controller. Differences are marked as errors in the Multiview Explorer. This is disabled if the device is not online. For more information, refer to Memory Comparison on page 82.
	Enable Emulation Mode	Closes and reopens the project with Emulation Mode enabled. If there is unsaved data, a dialog box will appear asking if the user wants to save before continuing. For more information, refer to Emulation Mode on page 19.
	Disable Emulation Mode	Closes and reopens the project with Emulation Mode disabled. If there is unsaved data, a dialog box will appear asking if you want to save it before continuing. This button enables you to quickly change from Emulation Mode to using physical hardware, including cameras and controller devices.

NOTE: Float, Dock and Close functions are also accessible with the Options menu.

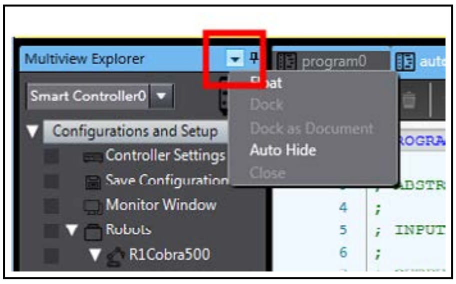


Figure 5-2 Options Menu

Additional Information: You can hide or show the menu bar, toolbar, and status bar. Right-click the title bar in the main window and select or deselect the item to show or hide.

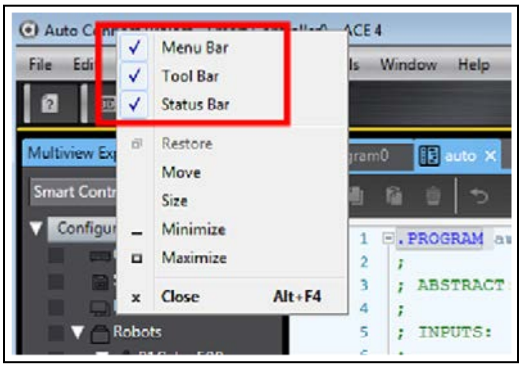


Figure 5-3 Hide or Show Menu, Tool, Status Bars

Multiview Explorer

The Multiview Explorer pane is your access for all ACE project data. It is separated into *Configurations and Setup* and *Programming*.

Click the icons (▶ or ▼) in front of each item in the tree to expand or collapse the tree.

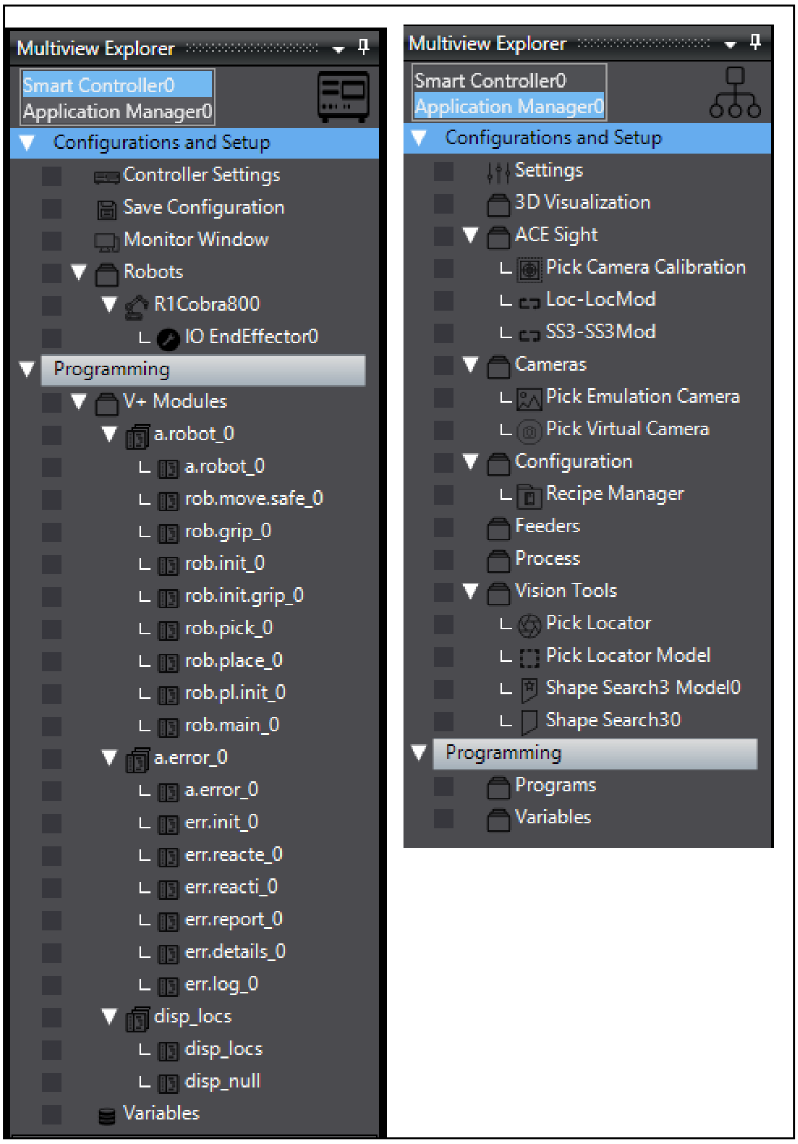


Figure 5-4 Multiview Explorer Views

Device List and Device Icon

An ACE project can include SmartController devices or Application Manager devices (or both).

The Device List contains all devices registered in the project. Use the Device List to select the active device and access the objects associated with that device. The active device and associated toolbar and menu items can automatically change based on the Edit Pane object that is currently selected.

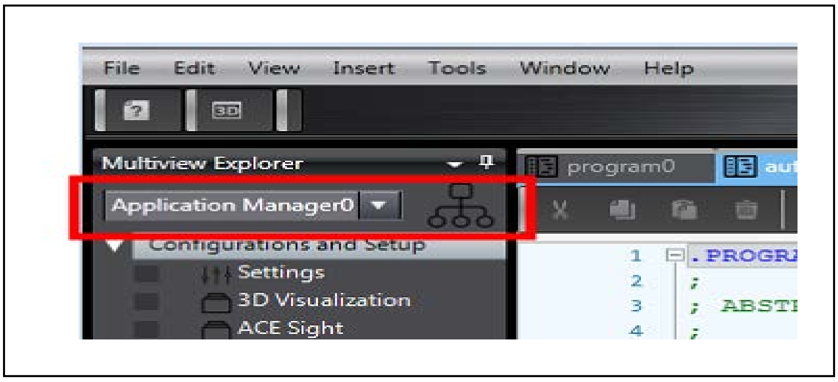


Figure 5-5 Device List

Right-click the icon (or) to add, rename, and delete a device. You can also select ***Switch Device Control Display*** to switch from a dropdown view (default) to a list view.

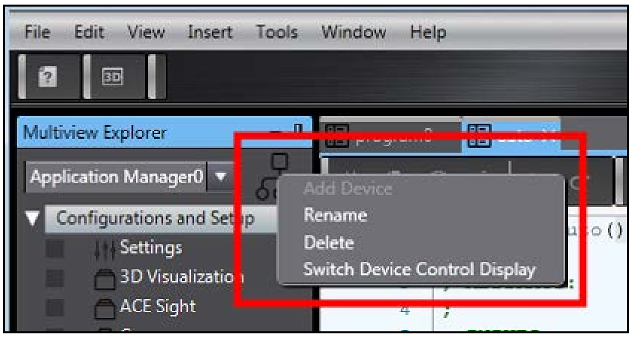


Figure 5-6 Device Icon Menu

Color Codes

You can display marks in five colors on the categories and members of the Multiview Explorer. These colors can be used as filter conditions in the Filter Pane that is described later in this section.

You can define how you want to use these marks. For example, you may want to indicate associated objects within a device. The following example uses color codes to indicate which vision tools are used in each Vision Sequence.

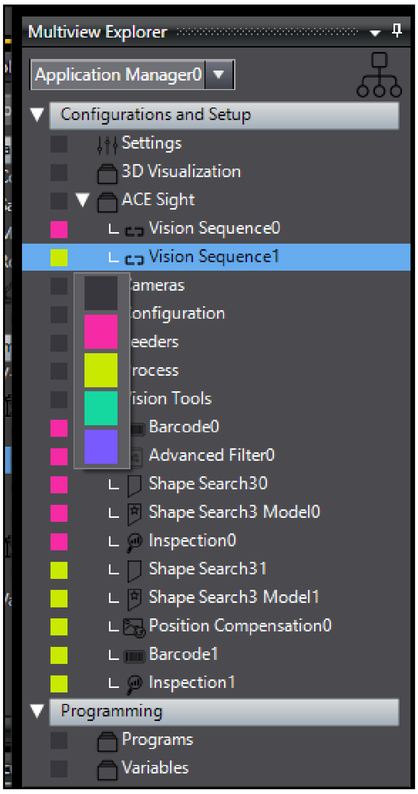


Figure 5-7 Multiview Explorer Color Codes

Error Icons

Error icons in the Multiview Explorer indicate an object that is improperly configured or a program that is not executable.

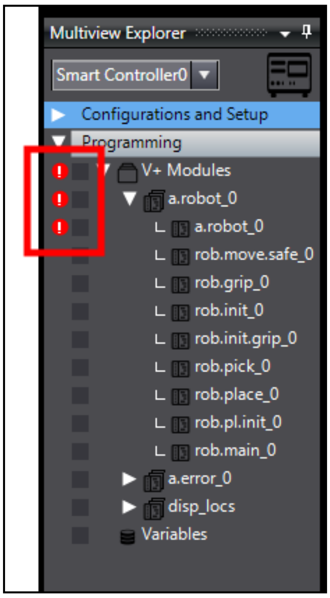


Figure 5-8 Multiview Explorer Error Icons

Additional Information: You cannot execute a program with an error present. You cannot execute a Process Manager when an error is present on an associated object.

Filter Pane

The Filter Pane allows you to search for color codes and for items with an error icon. The results are displayed in a list. Click the Filter Pane Bar to display the Filter Pane. The Filter Pane is hidden automatically if the mouse is not placed in it for more than five seconds at a time.

Automatically hiding the Filter Pane can be canceled by clicking the pin icon ( ).

Figure 5-9 Filter Pane

You can search for only items with a specific color code or items with error icons to display a list with only items that meet the search condition. Click any item in the search result to display the item in the Edit Pane.

Project Shortcut View

The Project Shortcut View provides a convenient location for storing shortcuts to Multiview Explorer items. Any item placed in this view can be quickly opened with a double-click. This area provides more flexibility than the Multiview Explorer view, allowing you to group shortcuts to objects belonging to multiple devices for quick reference without changing the selected device in the Multiview Explorer.

To add an item to the Project Shortcut View, right-click it in the Multiview Explorer and select **Add Shortcut**. An item can also be added by right-clicking a folder in the Project Shortcut View and then clicking **Add Shortcut of Selected Item** (any item that is currently selected in the Multiview Explorer will be added). A new shortcut to the item will be placed in the Project Shortcut View.

To access functions in the Project Shortcut View, right click the item to open a menu. The functions of the Project Shortcut View are described below.

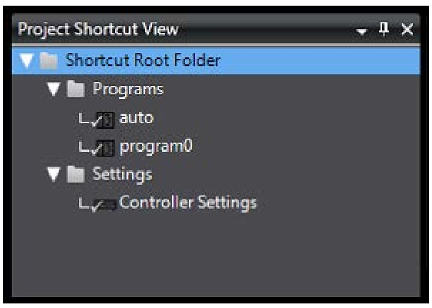


Figure 5-10 Project Shortcut View

Table 5-11 Project Shortcut View Function Description

Item Type	Item Name	Description
Folder	Add Folder	Add a new folder.
	Add Shortcut of Selected Item	Add a shortcut of the item currently selected in the Multiview Explorer.
	Cut Folder	Cut a selected folder.
	Copy Folder	Copy a selected folder.
	Paste Folder	Paste a folder to the selected location.
	Delete Folder	Delete a selected folder.
	Rename Folder	Rename a selected folder.
Shortcut	Multiview Explorer Menu	Access the item's Multiview Explorer menu.
	Cut Shortcut	Cut a shortcut.
	Copy Shortcut	Copy a shortcut.
	Paste Shortcut	Paste a shortcut.
	Delete Shortcut	Delete a shortcut.
	Jump to Multiview Explorer	Highlight and locate the selected item in the Multiview Explorer.

Additional Information: Selecting ***Edit Comment*** will allow the addition of a comment for an item in the Project Shortcut View. This comment can be viewed in the tooltip for that item.

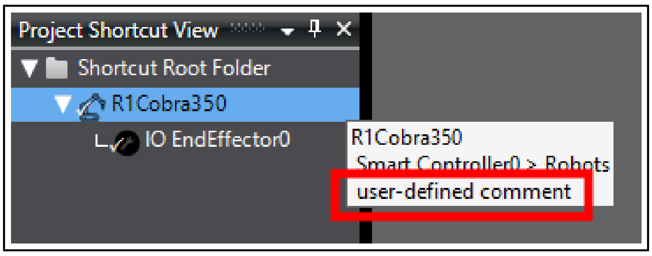


Figure 5-11 See a Comment in the Project Shortcut View

Status Bar

The status bar provides additional information about the project state and the user access level.

Edit Pane

The Edit Pane is used to display and edit the data for any of the items. Double-click an item in the Multiview Explorer to display details of the selected item in the Edit Pane.

The Edit Pane is displayed as tab pages, and you can switch the tab page to display in the Edit Pane by clicking the corresponding tab. You can undock the Edit Pane from the main window.

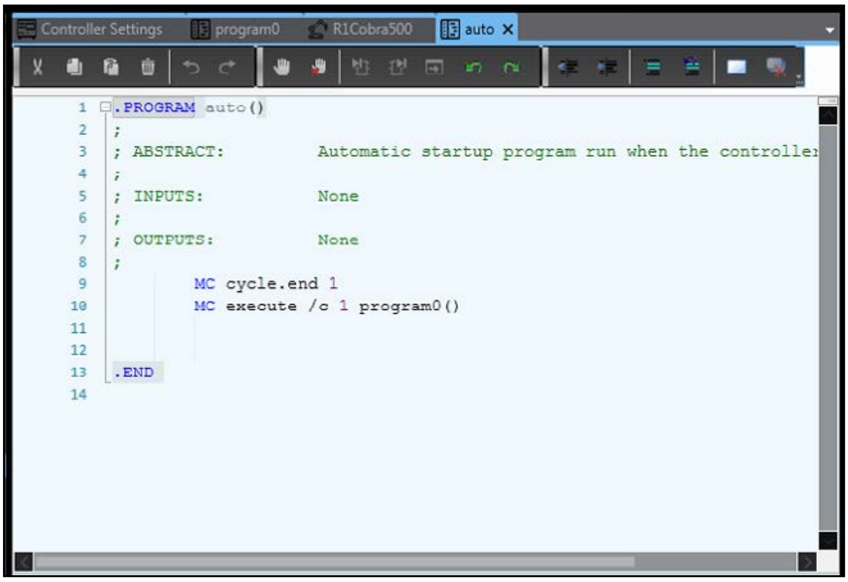


Figure 5-12 Edit Pane

Edit Pane Details

You can use an Option setting to change the number of tab pages in the Edit Pane that can be displayed at a time. The default setting is 10 and the maximum display number is 20. Refer to Window on page 142 for details on the settings.

You can close the Edit Pane from the pop-up menu that appears when you right-click one of the tabs. The following options are available.

Table 5-12 Edit Pane Close Option Details

Menu Command	Description
Close	Select this command to close the currently selected edit window.
Close All But This	Select this command to close all tab pages and floating edit windows, except for the selected tab page.
Close All Except Active Device	Select this command to close all tab pages and floating edit windows for other devices, leaving those for the active device open.
Close All	Select this command to close all tab pages and floating edit windows, including the selected tab page.

Tab Groups

Tab groups can be created to organize similar items in the Edit Pane. By creating tab groups, you can manage more than one tab page within the Edit Pane.

To create a tab group, right-click any of the tabs to display the pop-up menu.

NOTE: More than one tab must be open in the Edit Pane to use the following functions.

Table 5-13 Tab Group Function Descriptions

Menu Command	Description	Remarks
New Horizontal Tab Group	Select this command to divide the Edit Pane into upper and lower sections and move the selected tab page to the tab group that is newly created.	You can display the pop-up menu when the current tab group has more than one tab page.
New Vertical Tab Group	Select this command to divide the Edit Pane into left and right sections and move the selected tab page to the newly created tab group.	You can display the pop-up menu when the current tab group has more than one tab page.
Move to Next Tab Group	Select this command to move the selected tab page to the tab group below or to the right of the current tab group.	You can display the pop-up menu when there is a tab group below or to the right of the current tab group.
Move to Previous Tab Group	Select this command to move the selected tab page to the tab group above or to the left of the current tab group.	You can display the pop-up menu when there is a tab group above or to the left of the current tab group.

Additional Information: You can also move tab pages between tab groups by dragging the mouse.

Multifunction Tabs

The Multifunction Tabs area contains several objects that are described in this chapter.

- Output Tab Page (reserved for future use)
- Cross Reference Tab Page (reserved for future use)
- Build Tab Page (refer to Build Tab Page on page 114 for more information)
- Event Log (refer to Event Log on page 115 for more information)
- V+ Watch (refer to V+ Watch on page 135 for more information)

Multiple objects can be open in the Multifunction Tabs area. Use the tab selections to switch between active objects.

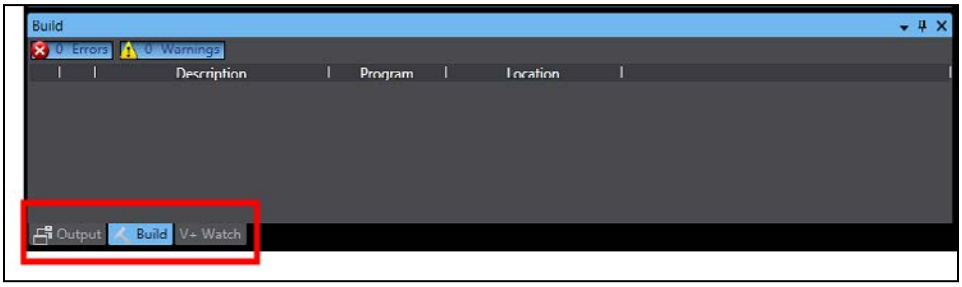


Figure 5-13 Multifunction Tab Selection

Special Tools

- Toolbox (refer to Toolbox on page 107 for more information)
- 3D Visualizer (refer to 3D Visualizer on page 107 for more information)
- V+ Jog Control (refer to V+ Jog Control on page 116 for more information)
- Task Status Control (refer to Task Status Control on page 121 for more information)
- Vision Window (refer to Vision Window on page 132 for more information)

Multiple objects can be open in the Special Tools area. Use the tab selections to switch between active objects. You can also dock these objects in other areas of the software by dragging and dropping them to different locations.

Figure 5-14 Special Tool Tab Selection

Other Application Window Functions

Other application window functions are described below. These can be accessed in the View menu item.

Recently Closed Windows

For the device selected in the Multiview Explorer, you can display a thumbnail index of the windows that were previously displayed in the Edit Pane, and you can select a window from the thumbnail index to display it again.

Select **Recently Closed Windows** from the View Menu. The windows previously displayed in the Edit Pane are displayed in the thumbnail index of recently closed windows. Double-click the window to display.

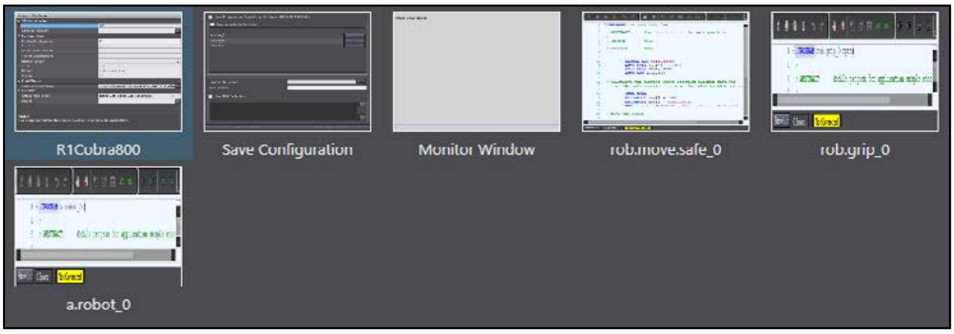


Figure 5-15 Recently Closed Windows

The thumbnails of up to the 20 most recently closed windows are displayed in the order they were closed (the upper left is the most recent). Select the window to display with the mouse or the **Arrow** Keys. You can select more than one window if you click the windows while you hold down the **Shift** or **Ctrl** Key or if you press the **Arrow** Keys while you hold down the **Shift** or **Ctrl** Key.

> **Additional Information**: The history of recently closed windows is retained for each device.

Clear Recently Closed Windows History

You can delete the history of recently closed windows from a project. Select **Clear Recently Closed Windows History** from the View Menu, and then click the **Yes** button in the confirmation dialog box that is displayed. All of the histories are deleted.

Reset Window Layout

You can restore the window layout to the ACE software default layout. Select **Reset Window Layout** from the View Menu

System Monitor

The System Monitor can be used to perform real-time monitoring of robot hardware performance and Process Manager objects (when present in the Application Manager device). The data can be used to identify inefficient part allocation, for example.

It is important to recognize that Process Manager statistics reflect the defined processes and represent exactly what is happening in the Process Manager. Although it may appear that the statistics are not accurate, the data needs to be interpreted appropriately for each system.

Consider a system containing one belt camera and three robots. If a part identified by the camera is allocated to robot one, not picked, then allocated to robot two, not picked, then allocated to robot three and picked, there would be two parts not processed because the instance was allocated and not picked by the first two robots. To understand the parts not processed count for this system, you should examine the Parts Not Processed for Robot 3 (the most downstream robot).

If a system requires customized statistics processing, this can be achieved using a C# program and the API provided in the *StatisticsBin Methods* section of the *ACE Reference Guide*.

> **NOTE:** You must be connected to a physical controller when using the System Monitor (Emulation Mode is not supported).

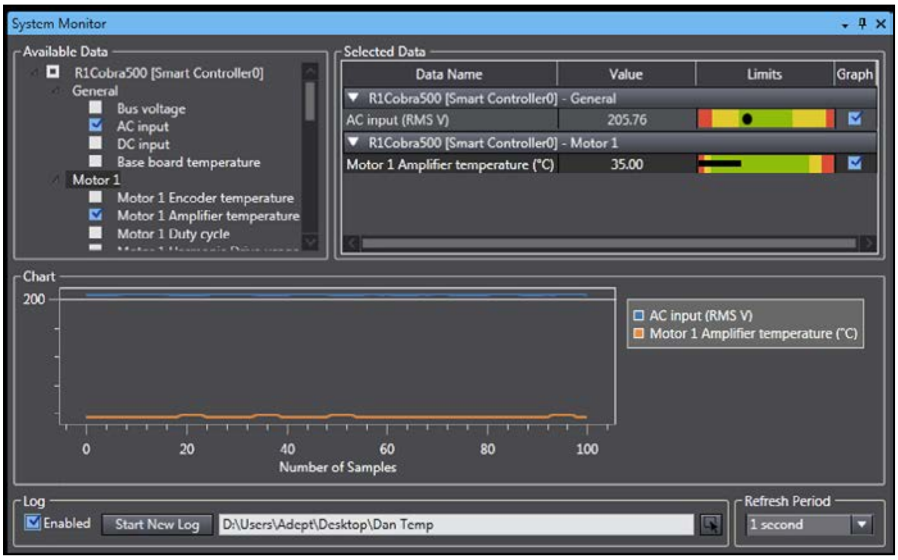


Figure 5-16 System Monitor View

Use the following tables to understand System Monitor data.

Table 5-14 Robot Parameter Descriptions

Parameter Name	Description
Amplifier bus voltage (V)	The current amplifier bus voltage for the robot. This should operate within the specified min/max warning limits (yellow bars), and never reach the min/max error limits (red bars). If the value drops below the range minimum, this means that the motion is too hard or the AC input voltage is too low; if the value exceeds the range maximum, this means that the motion is too hard or the AC input voltage is too high. Lowering the motion speed (more than the acceleration) can help correct these issues.
AC input (V)	The current AC input voltage (220 VAC) for the robot. This should operate within the specified min/max warning limits (yellow bars), and never reach the min/max error limits (red bars). Running outside or close the limits may create envelope errors.

Parameter Name	Description
DC input (V)	The current DC input voltage (24 VDC) for the robot. This should operate within the specified min/max warning limits (yellow bars), and never reach the min/max error limits (red bars).
Base board temperature (°C)	The current temperature (°C) for the amp-in-base processor board. This should operate within the specified min/max warning limits (yellow bars), and never reach the min/max error limits (red bars).
Encoder temperature (°C)	The current encoder temperature (°C) for the selected motor. This should operate within the specified min/max warning limits (yellow bars), and never reach the min/max error limits (red bars).
Amplifier temperature (°C)	The current temperature (°C) for the motor amplifier. This should operate within the specified min/max warning limits (yellow bars), and never reach the min/max error limits (red bars).
Duty cycle (% limit)	The current duty cycle value, as a percentage, for the selected motor. This should operate below the specified max warning limit (yellow bar), and never reach the max error limit (red bar).
Harmonic Drive usage (%)	The current usage of the Harmonic Drive, as a percentage of design life, for the selected motor. This should operate below the specified max warning limit (yellow bar), and never reach the max error limit (red bar). If the value is less than 100%, the maximum life for the Harmonic Drive will be extended; if the value exceeds 100%, the maximum life of the Harmonic Drive will be diminished.
Peak torque (% max torque)	The peak torque, as a percentage based on maximum torque, for the selected motor. If this is frequently exceeded, consider reducing acceleration, deceleration, or speed parameters or changing s-curve profile to reduce peak torque required for the motion. This should operate below the specified max warning limit (yellow bar), and never reach the max error limit (red bar).
Peak velocity (RPM)	The peak velocity, in rotations per minute, for the selected motor. This should operate below the specified max warning limit (yellow bar), and never reach the max error limit (red bar).
Peak position error (% soft envelope error)	The peak position error, as a percentage of soft envelope error, for the selected motor. This should operate below the specified max warning limit (yellow bar), and never reach the max error limit (red bar).

Table 5-15 Process Manager Belt Parameter Descriptions

Parameter	Description
Instance Count	The number of instances that have been available since the last restart or reset.
Belt Velocity	The average velocity of the conveyor belt.
Instantaneous Instances	The instantaneous instances since the last restart or reset. This is calculated over the update period selected in the System Diagnostics settings. If the graph is updated 500 ms, it will tell you the instantaneous instances/minute over each 500 ms time segment.
Instances Per Minute	The average number of instances per minute.
Active Instances	The number of active instances on the belt.
Latch Faults	The number of latch faults since the last restart or reset.

Table 5-16 Process Manager Robot and Process Parameter Descriptions

Parameter	Description
Idle Time (%)	The average idle time percentage of the total run time since the last restart or reset. ("Idle" is when the Process Manager is waiting on part or part target instances to process.)
Processing Time (%)	The average processing time percentage of the total run time since the last restart or reset. ("Processing" is when the Process Manager is actively processing part or part target instances.)
Average Total Time (ms)	For the Process Manager group only. The *average* total time for all robots. Other fields, such as Parts Processed/Not Processed and Targets Processed/Not Processed, show a summation for all robots.
Parts Per Minute	The average number of parts per minute. When viewing the Process Manager group, this is a summation for all robots.
Targets Per Minute	The number of targets per minute. When viewing the Process Manager group, this is a summation for all robots.
Parts Not Processed	The number of parts not processed since the last restart or reset. When viewing the Process Manager group, this is a summation for all robots.
Targets Not Processed	The number of targets not processed since the last restart or reset. When viewing the Process Manager group, this is a summation for all robots.
Parts Processed	The number of parts processed since the last restart or reset. When viewing the Process Manager group, this is a summation for all robots.
Targets Processed	The number of targets processed since the last restart or reset. When viewing the Process Manager group, this is a summation for all robots.

Table 5-17 Process Manager Process Strategy Parameter Descriptions

Parameter	Description
Average Allocation Time (ms)	The average time it takes to run the allocation algorithm for allocating all parts and part targets.

Smart Project Search

The Smart Project Search allows you to quickly find items in the Multiview Explorer. For example, if there are a large number of programs or sections present in the project, you can quickly find the desired program or section with the Smart Project Search. The search is performed only within the project active device.

The following procedure describes the use of the Smart Project Search function.

1. Select **Smart Project Search** from the View Menu. The Smart Project Search Dialog Box is displayed.

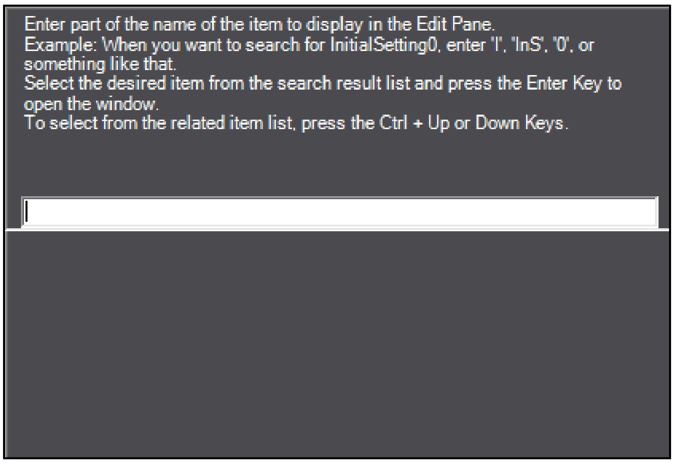


Figure 5-17 Smart Project Search Dialog Box

1. Enter part of the name of the item in the Search Box The items in the Multiview Explorer or menus that contain the entered text string are displayed on the left side of the search result list.

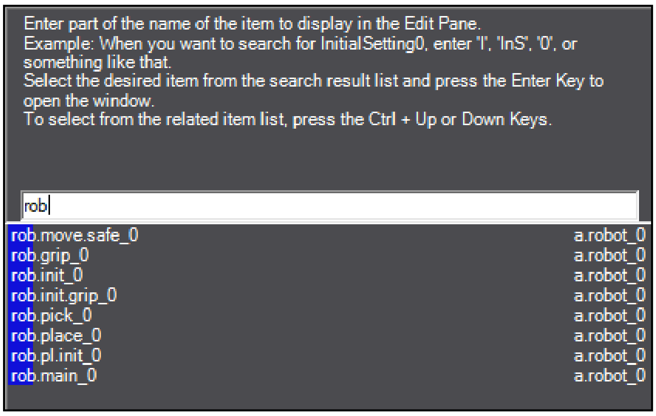


Figure 5-18 Search Box Text String Example

The search results are displayed from the top in the order they are displayed in the Multiview Explorer. On the right side of the search result list, the level that is one higher than the item that resulted from the search is displayed.

2. Double-click the desired item in the search result list or press the **Enter** key after making a selection. The Search Dialog Box is closed and the selected item is displayed in the Edit Pane. To close the Search Dialog Box without selecting an item, click in a pane other than the Search Dialog Box or press the **Esc** key.

Additional Information: You can enter English characters into the Search Box to search for item names that contain words that start with the entered characters in capitals. Example: If you enter *is0* in the Search Box, an item named InitialSetting0 is displayed in the search result list.

5.2 Toolbox

The Toolbox shows the program instructions (Keywords) that you can use to edit and create V+ programs. When a V+ program is open in the Edit Pane, the Toolbox will display a list of available V+ keywords. If you drag a keyword into the V+ program Edit Pane and drop it into the program, syntax will auto-generate for the chosen V+ keyword, as shown in the figure below.

A search tool within the Toolbox can be used to find items with a text string.

You can expand or collapse all categories by right-clicking an item and selecting ***Expand All*** or ***Collapse All*** from the pop-up menu.

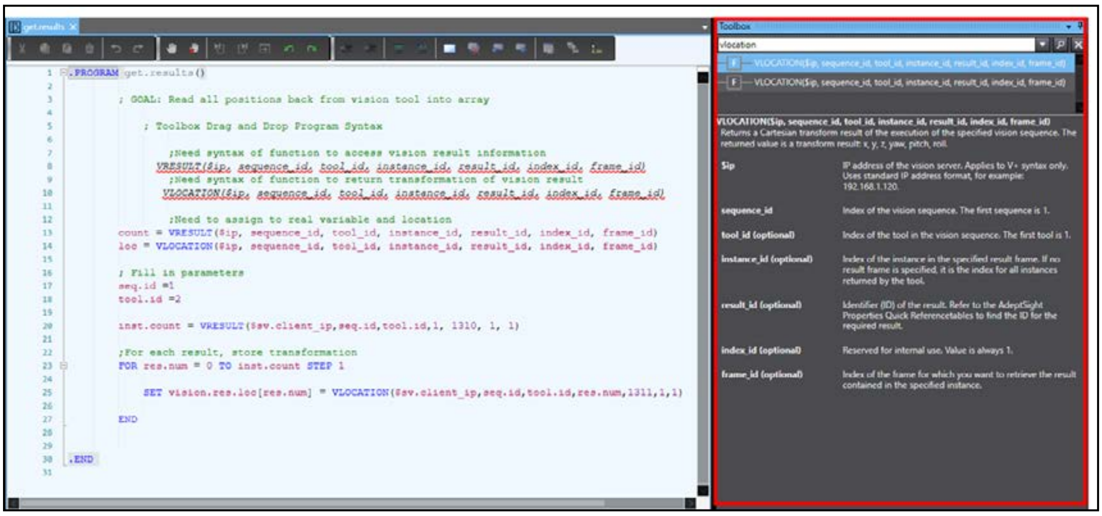


Figure 5-19 Toolbox View

5.3 3D Visualizer

The 3D Visualizer allows you to see simulated and real 3D motion for robots and other Process Manager items such as belts and parts. The 3D Visualizer window displays the following information.

- Graphical representation of all belts, cameras, robots, fixed objects, and obstacles in the workspace
- Robot belt windows and allocation limits
- Robot work envelopes
- Teach points and other part locations
- Belt lane widths
- Location of latch sensors
- Field of view for cameras
- Process Manager objects and Part / Part Target instances

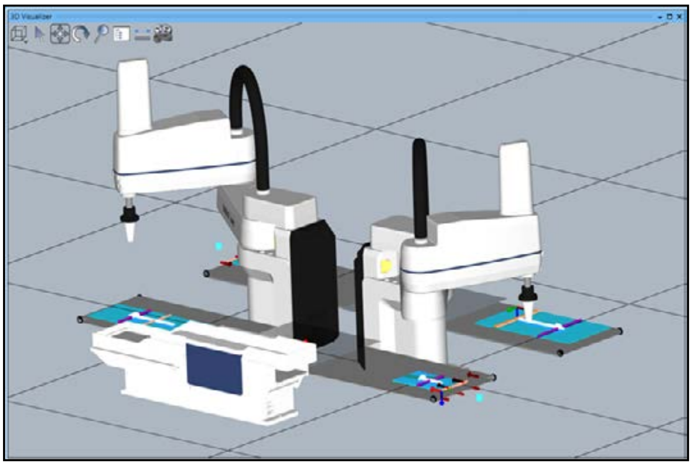


Figure 5-20 3D Visualizer Example View

Additional Information: Refer to 3D Visualization on page 278 for more information about Application Manager objects.

3D Visualizer Basic Features

The 3D Visualizer has several functions to enable easy development and testing. The 3D Visualizer tool is available in both Emulation Mode and also while connected to physical controllers. The 3D Visualizer has the following features to help develop and test robot applications.

- 2D and 3D recording for playback in the ACE Offline Visualizer
- Collision detection in Emulation Mode
- Measurements
- Robot jogging
- Location visualization and editing
- Integration of workcell objects such as belts, parts, end effectors, and cameras

Use the following sections to understand the 3D Visualizer operation and functions.

Creating a 3D Workspace

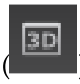
To use the 3D Visualizer, an accurate 3D workspace must be create to represent all objects of concern in the application. Use the following procedure to create a 3D workspace.

1. Configure robots by selecting robot types and offset positions. Refer to Robot Objects on page 224 for more information.
2. Add static objects such as boxes, cylinders, and imported CAD shapes if necessary.
3. Add cameras if necessary.
4. Add feeders if necessary.
5. Add Process Manager items if necessary (part buffer, part target, part, belt, pallet, .etc).

Additional Information: Static objects such as boxes, cylinders, and imported CAD shapes are stored in the ACE project, not the controller.

Refer to 3D Visualization on page 278 for more information about steps 2 through 5 above.

3D Visualizer Window

Access the 3D Visualizer Window with the main toolbar icon () or by selecting ***3D Visualizer*** from the View Menu.

The 3D Visualizer Window has the following control icons.

NOTE: The use of the term "camera" in this section refers to the perspective at which the 3D Visualizer is viewed and not a camera configured in the Application Manager (unless specified).

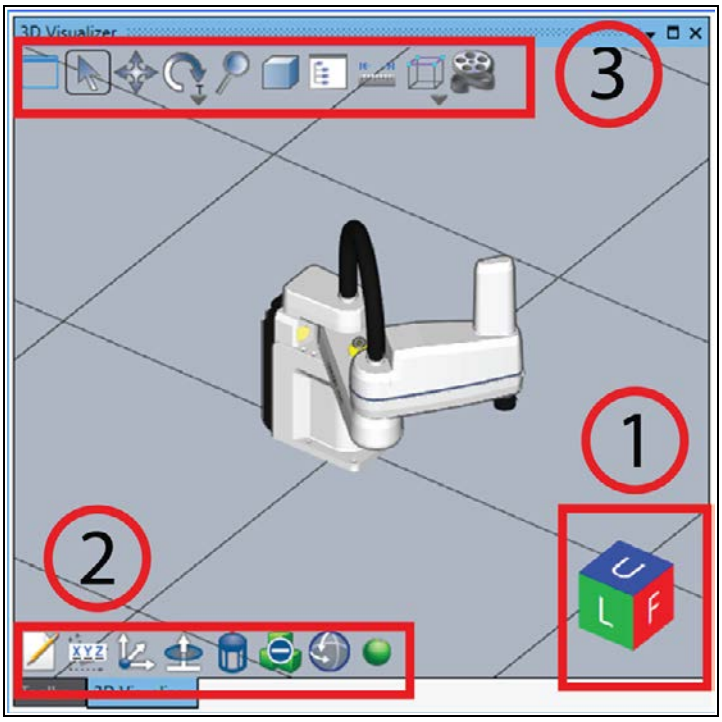


Figure 5-21 3D Visualizer Window Items

The rectangles marked above (2, refer to Table 5-19) and (3 refer to Table 5-20) show where the control icons appear. The square marked (1) shows the Projection Mode for the displayed, 3D cube. When you select this icon and move it, the projection of the 3D cube follows your changes, which can be used to quickly change user perspective of the visualization area to a different orientation. The following table provides information for the specific orientations.

Table 5-18 (1) Projection Mode

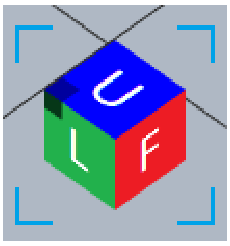
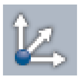
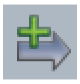
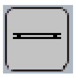
Item	Icon	Description
1		F (front): the side facing the user. B (back): the back face. R (right): the right face. L (left): the left face. U (up): the upper face. D (down): the side opposite to the upper face.

Table 5-19 (2) 3D Visualizer Window Item Description

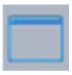
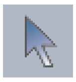
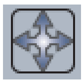
Item	Icon	Description
2		Edit Opens the selected object's settings in the Edit Pane.
		Edition Control Manager: Opens the Edition Control Manager. Refer to 3D Visualizer Window for more information refer to .
		Edit Workspace Position: Displays a coordinate icon for relocating the X, Y, and Z location of the selected object. Hover over an axis of the coordinate icon to see the cursor change and then left-click and drag the object to a new position. Hovering the cursor in the white circle portion of the coordinate icon will allow free movement of the object when clicked and dragged. The new position will be reflected in the Offset from the Parent value of that object
		Edit Workspace Orientation Displays a coordinate icon for manipulating the orientation of an object. Hover over any of the axis rings to see the cursor change and then click and drag to rotate the object to a new orientation. Hovering the cursor in the white circle portion of the coordinate icon will allow free movement of the object when clicked and dragged. The new position will be reflected in

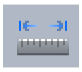
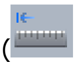
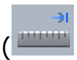
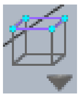
Item	Icon	Description
		the Offset from Parent value of that object. Note that a different number of axis rings will be available depending on the selected object.
		Jog mode: Click to toggle the jog mode between world, tool, and joint. Jog icons will appear. Use the jog icons to manually control the selected robot's position. This is available for robot objects only.
		Show Obstacles: Toggles visibility of obstacles that are present. Refer to Robot Objects for more information. This is only available for robot objects.
		Show Robot Work Envelope: Toggles visibility of the selected robot work envelope. This is only available for robot objects. **NOTE:** The displayed work envelope applies to the robot tool flange and does not account for any applied tool offsets.
		Teach Point: Adds a new location variable at the robot's current position. This is only available for robot objects.
		Show/Hide Mount Points: Toggles visibility of mount points on the selected object. This is only available for Box, Cylinder, and CAD Data objects.
		Delete: Delete a selected position from the variables list. This is only available when a point is selected.
		Jog To: Jog to the selected position. This is only available when a point is selected.
		Approach Height: Toggle the approach height for the Jog To command between 0, 10, and 25 mm for the selected position. This is only available when a point is selected.
		Jog Speed: Toggle the jog speed between 100%, 50%, 25%, and 5% for the selected position. This is only available when a point is selected.

Item	Icon	Description
		Clear All Instances: Clear all instances being tracked by the selected Process Manager. This is only available when a point is selected.
		Show Camera Image: Display camera images for a selected camera configured in the Application Manager. This is only available when a point is selected. **NOTE:** This is typically used during setup and troubleshooting and keeping this enabled during run time is not recommended.

Additional Information: Many of the functions in the previous table can be accessed by right-clicking an object in the 3D Visualizer view.

Table 5-20 (3) 3D Visualizer Window Item Description

Item	Icon	Description
3		Split Window: Click this icon to open a new dialog window that allows splitting the visualizer window into multiple views. This allows the user to view the workspace from multiple positions at the same time.
		Selection: Select an object in the view for editing.
		Translate (pan): Move the camera position without rotation. Click with the third mouse button and drag as an alternative. Use the **Alt** key + the left mouse button as an alternative.
		Rotate: the camera position without translation. Click the right mouse button and drag as an alternative. Click the arrow beneath this icon to choose between Tumbler and Turntable rotation.
		Zoom Move: the camera position closer or farther from the workspace. Use the mouse scroll wheel as an alternative.
		Scene Graph: Opens the Scene Graph window. The Visibility tab allows the user to set the usability of each object shown in the Visualizer. The Collision Filter tab configures collision sources. Refer to Graphical Collision Detection for more information.

Item	Icon	Description
		Measurement Ruler: Add a ruler to the 3D Visualizer to make a measurement. Once enabled, the ruler will appear and can be selected to change the position on the visualizer for individual measurements. Selecting the ruler will display the Select Point 1 () and Select Point 2 () icons, which can be used to adjust the ruler position. Total X, Y, and Z distances will be displayed. It is often easiest to position the ruler using camera angles that are aligned with global coordinate planes.
		Clicking the down arrow in the icon opens an option pane with 3 choices. Using this you can snap your view to the top, center or perimeter of the view.
		Record: Begin a recording for playback in ACE Offline Visualizer. The icon will change while recording (flashing ). Click the flashing icon to stop recording. A Save As window will appear for saving the recording to the PC as a .awp3d file. Opening this file will launch an Offline Visualizer window for playback. This is only available on PCs with ACE software installed.

Additional Information: Many of the functions in the previous table can be accessed by right-clicking an object in the 3D Visualizer view.

Edition Control Manager

The Edition Control Manager is opened by clicking the Edition Control Manager. This allows you to set certain editing parameters for the 3D Visualizer Window. The parameters can be set in millimeters or degrees, refer to .

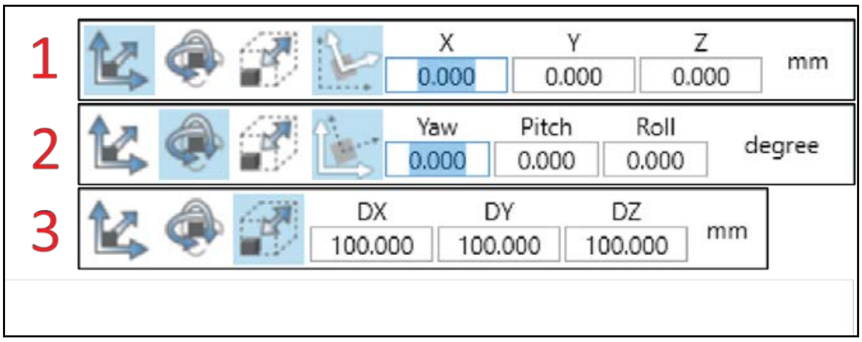
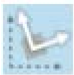
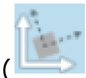


Figure 5-22 Edition Control Manager

The icons in the manager are explained in the following table.

Table 5-21 Edition Control Manager Icons

Icon	Description
	Edit Workspace Position: Changes the fields to X, Y, and Z, as shown by item (1) of the above figure. Changing the values of these fields will translate the object in the Visualizer.
	Edit Workspace Orientation: Changes the fields to Yaw, Pitch, and Roll, as shown by item (2) of the above figure. Changing the values of the fields will rotate the object in the Visualizer.
	Edit Size: Changes the fields to DX, DY, and DZ for a selected Box object or changes them to Radius and Height for a selected Cylinder object, as shown by item (3) of the above figure. Changing these fields will change the object size. This is only available for Box and Cylinder objects.
	Object Coordinates/World Coordinates: Toggles between the Object Coordinates and World Coordinates modes. When Object Coordinates is selected, the icon will appear as it does to the left, and any adjustments will be with respect to the objects parent. When World Coordinates is selected, the icon will change () and any adjustments will ignore parent constraints. This icon is hidden when Edit Size is selected .

Graphical Collision Detection

The 3D Visualizer can be configured to detect collisions between objects. When a collision is detected in the 3D Visualizer, any C# Collision program(s) that are associated with the objects in the collision are called.

This is typically used while testing an application with the 3D Visualizer in Emulation Mode and will not prevent physical hardware collisions.

NOTE: This should not be confused with obstacles that are configured in robot objects. Refer to Configure on page 255

5.4 Output Tab Page

The Output Tab Page is reserved for future use.

5.5 Cross Reference Tab Page

The Cross Reference Tab Page is reserved for future use.

5.6 Build Tab Page

The Build Tab Page shows the output from the ACE V+ program parser to identify potential issues with program syntax or control structures.

Double-click items in the Build Tab Page to directly access the program location where the issue occurs.

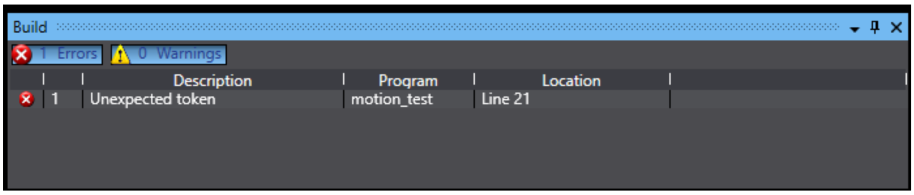


Figure 5-23 Build Tab Page

5.7 Event Log

The Event Log displays a log of controller events that have occurred since the ACE software was started. Events are categorized as Error, Warning, and Information and can be used for troubleshooting and diagnostics. Refer to Troubleshooting on page 644 for more information.

Event Log messages can be displayed by event type, time stamp, and message. Use the following functions to adjust the Event Log display.

> **NOTE:** Past information that is displayed in the logs may not reflect the current status of the controller or programs.

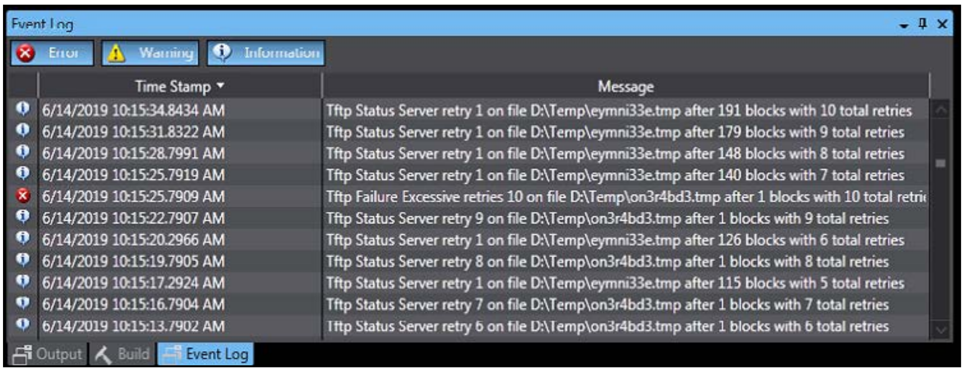
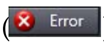


Figure 5-24 Event Log

Display Messages by Event Type

Click the message type buttons to display messages by type. Click the **Error** Button (
) to display all error message types. Click the **Warning** Button (
) to display all warning message types. Click the **Information** Button (
) to display all information message types.

Sorting Messages

Click the Time Stamp column heading to sort messages by the event occurrence time. Click the Message column heading to sort messages by the message.

Selecting and Copying Messages

Right-click any message to display a pop-up. Choose ***Copy*** or press Ctrl+C to copy a selected message to the clipboard. To select all messages, choose ***Select All*** or press Ctrl+A. All messages will be selected.

Clearing the Event Log

Right-click a message and choose Clear All. All messages will be cleared from the Event Log.

> **Additional Information**: Many items logged to the Event Log are also logged to the Windows Application Event Log. Use the Windows Application Event Log to retrieve past ACE events as an alternative.

5.8 V+ Jog Control

V+ Jog Control provides an interface for positioning and monitoring the position of the selected robot. It is typically used for teaching robot locations.

Use the 3D Visualizer to see robot motion when the V+ Jog Control is used in Emulation Mode. The V+ Jog Control functions and operation is described below.

> **NOTE:** The V+ Jog Control works for both emulated and physical robots.
>
> Many jog commands and setting are disabled while a robot is under program control. Refer to Current Position Section on page 117 for more information.

Figure 5-25 V+ Jog Control Interface

Robot Section

The robot section provides the following functionality.

Robot Power

The **Power** button toggles the robot high power ON and OFF and calibrates the selected robot. Robot power must be ON to allow jog control.

> **Additional Information**: Turning the robot high power ON for the first time after system power up executes the CALIBRATE() keyword to load joint calibration offsets into memory. This does not perform a full robot hardware calibration.

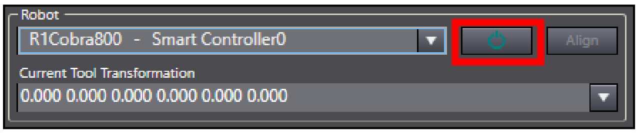


Figure 5-26 V+ Jog Control - Robot Power

Align

The **Align** button aligns the robot tool Z-axis with the nearest World axis (six-axis robots only).

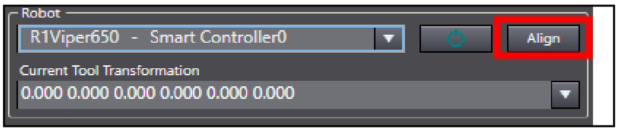


Figure 5-27 V+ Jog Control - Align

Current Tool Transformation

This displays the current tool transformation applied to the robot. The dropdown can be used to clear the tool transformation or choose a tool transformation provided by an I/O EndEffector tip.

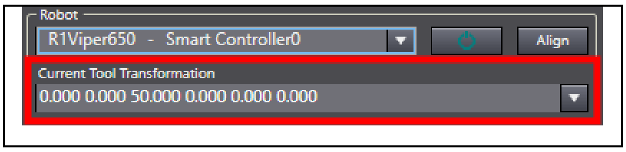


Figure 5-28 V+ Jog Control - Current Tool Transformation

Current Position Section

This section displays the status and current position of the robot in world or joint coordinates. Click the **World** Button to display coordinates in world mode. Click the **Joint** Button to display coordinates in joint mode.

NOTE: Jogging is only possible when ***Ready*** is displayed in the status area.

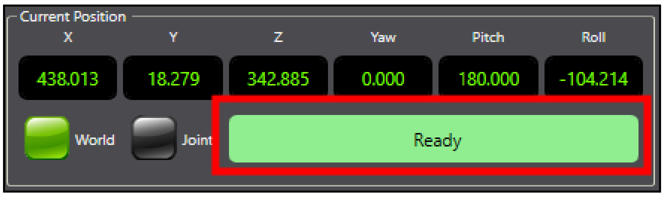


Figure 5-29 Jogging Ready

If a robot is under program control, "Robot under program control" will be displayed in this area and jogging is not possible. The task controlling the robot must be stopped before jogging functions are enabled.

Jog Control Section

The jog control section is used to manually position the robot.

Move Axis Buttons

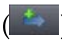
After all jog control settings are made, use the move axis buttons to move the selected axis in the positive () or negative () direction.

Figure 5-30 V+ Jog Control - Move Axis Buttons

Speed, Increment Selection Buttons

Jogging is possible at a preset speed or in incremental distances, to allow greater positioning precision.

When the **Speed** button is active, use the slider or input a value between 0 and 100% to set the jog speed when a move axis button is pressed.

When the **Increment** button is active, use the slider or input a value between 0 and 10 mm to set the movement distance when a move axis button is pressed.

Figure 5-31 V+ Jog Control - Speed, Increment Selection Buttons

World, Joint, Tool Selection

Choose world, joint or tool for the jog control mode.

Figure 5-32 V+ Jog Control - World, Joint, Tool Selection

- World - Enables the jog control to move the robot in the selected direction: X, Y, or Z axes of the world frame of reference or rotated around the RX, RY, or theta axes in the world coordinate system.
- Joint - Enables the jog control to move the selected robot joint.
- Tool - Enables the jog control to move the robot in the selected direction: X, Y, or Z axes of the tool frame of reference or rotated around the RX, RY, or theta axes in the tool coordinate system.

Location Section

The Location Section is used to view, teach, remove, and jog to robot locations. Refer to V+ Variables on page 170 for more information.

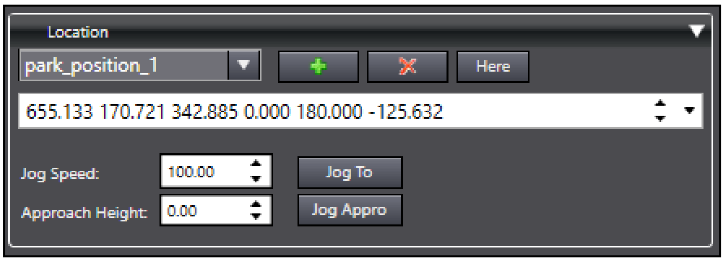


Figure 5-33 V+ Jog Control - Location Section

Jog to a Robot Location

Use the following procedure to jog to a robot location.

NOTE: A robot location must exist and be selected to use this function.

1. Select a location with the dropdown menu.
2. Make selections for the *Jog Speed* and *Approach Height* fields.
3. Click and hold the **Jog To** Button ( ) to make the robot jog to the specified location

   Click and hold the **Jog Appro** Button ( ) to make the robot jog to the specified location at the approach height specified.

IMPORTANT: Using the **Jog Appro** Button will cause straight-line motion to occur. Monitor the robot during this movement to avoid collisions with obstacles between the starting location and the destination location.

Teach Robot Locations

Before teaching a location, move the robot to the desired location (either by jogging or powering OFF and physically moving the robot) and then click the **Here** button ( ). Clicking the **Here** button will put the robot's current axis positions into the display field for use in the following teach procedure.

NOTE: In Emulation Mode, you can change the robot tool tip position in the 3D Visualizer with the mouse cursor. Hover over the tool tip until the mouse pointer changes ( ) and then left-click and drag to the new position.

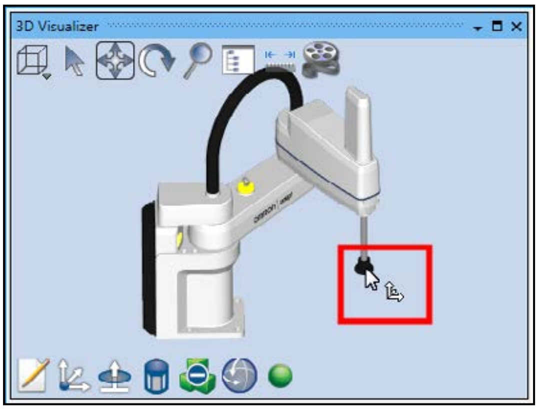


Figure 5-34 Move Tool Tip Position

Additional Information: Refer to V+ Variable Editor on page 172 for other robot position teach functions.

1. Click the **Plus** button ( ). This opens the Add a new variable Dialog Box.

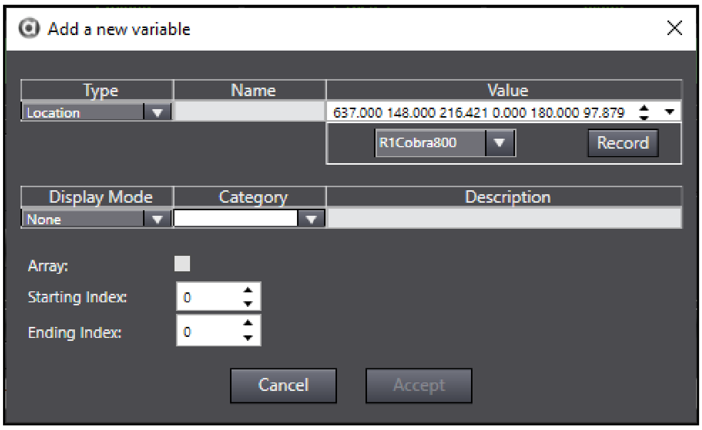


Figure 5-35 V+ Jog Control - Teach Position - Add a new Variable

2. Select a variable type (location or precision point), provide a new name, and verify the value. If the robot dropdown selection is changed, click the **Record** button (Record) to update the value for that robot accordingly.
3. Choose the display mode, category, and provide an optional description.
4. Make a selection for array, starting and ending index when applicable.
5. Click the **Accept** button to create the new robot location variable.

Remove Robot Locations

To remove an existing robot location, select the location from the dropdown menu and then click the **Delete** button ( ). A confirmation dialog box will appear. Click ***Yes*** to remove the robot location variable.

5.9 Task Status Control

The Task Status Control provides a multi-device monitoring interface for all robot related activity in the project. This allows you to quickly view and access all controller connection and power statuses, monitor speeds, and execution status of Vision Sequences, C# programs, Process Managers, and more.

All controllers in a project will be displayed in the Task Status Control interface. If an Application Manager Device is present in the project, items such as Robot Vision Manager Sequences, C# programs, Process Managers, and Recipe Managers may also be displayed in the Task Status Control interface.

Task Status Control functions are described below.

- Online / Offline
- Robot High Power Control
- Monitor Speed Setting
- Open the Monitor Window
- Task Manager
- IO Watcher
- V+ File Browser
- Virtual Front Panel
- Profiler
- Application Manager Control (when applicable)

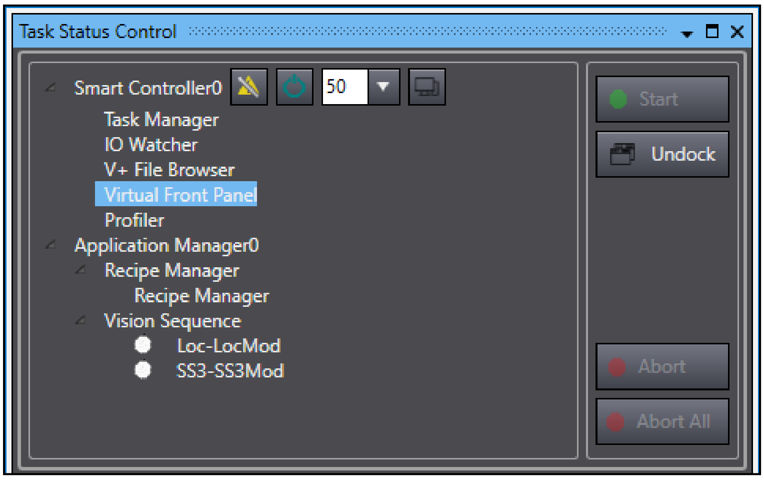


Figure 5-36 Task Status Control

Online/Offline

Use the **Online/Offline** Buttons (/) to control the connection status to a controller.

Robot Power Control

Use the **ON/OFF** Button (/) to control the robot power state. This button is only available while online with the controller. The **Robot Power** Button in the Virtual Front Panel have the same functionality.

NOTE: Enabling robot power is not possible in an E-Stop state.

Monitor Speed Setting

The monitor speed setting is used to adjust the monitor speed for the associated controller. This is a multi-robot speed scaling parameter for each controller that allows you to decrease the overall speed of the system without modifying programs. This is typically used while debugging programs.

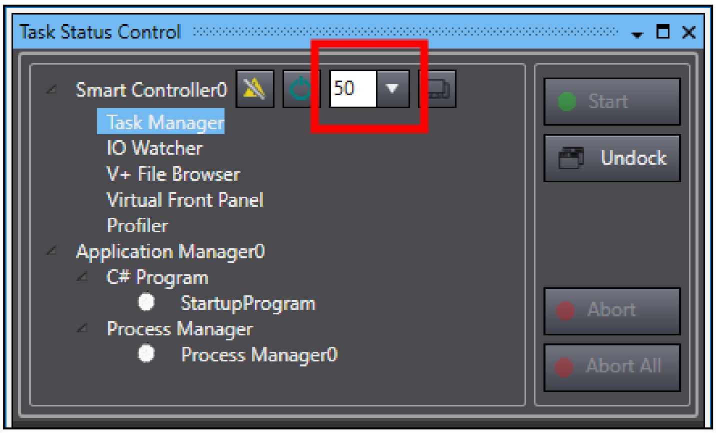


Figure 5-37 Monitor Speed Adjustment

Open the Monitor Window

Use the **Monitor Window** Button ( ) to open the Monitor Window in the Edit Pane. Refer to Monitor Window on page 222

Task Manager

The Task Manager displays and controls activity on user tasks 0 to 27. The ACE software uses two tasks plus one task per robot, counting down from 27. The remaining tasks (0 to 21, or more if fewer than four robots) are available for the execution of user-created V+ programs. This includes programs started by a Process Manager as shown below.

> **NOTE:** If a program is paused the task can be expanded to view the current program stack.

Use the following descriptions to understand Task Manager controls.

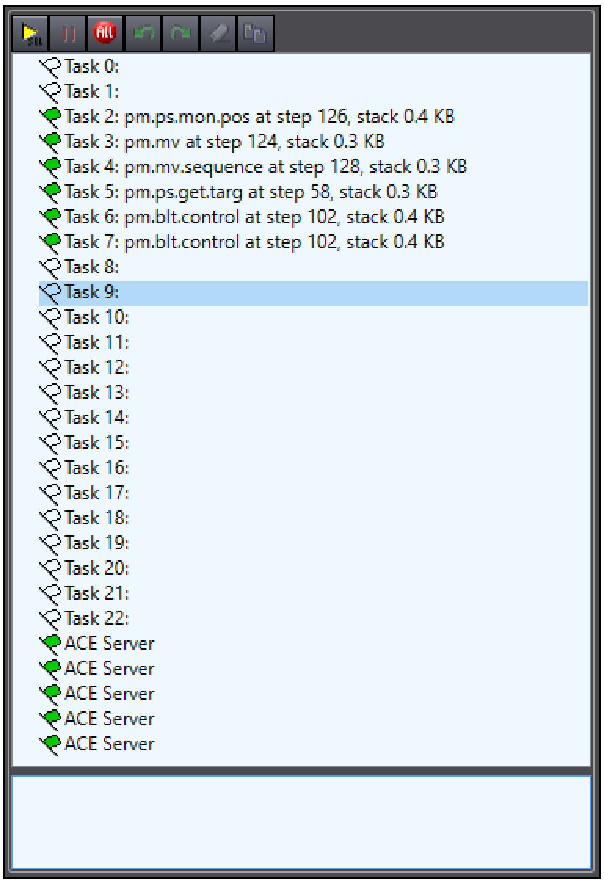


Figure 5-38 Task Status Control - Task Manager

Task Manager Toolbar Items

Table 5-22 Task Manager Toolbar Item Description

Item	Icon	Description
Execute Task		If a stopped program is selected, this button will execute that program on the task.
		If a task is selected with no program, this button will open a dialog box for program selection. Selecting a program name and clicking ***OK*** will execute the program on the selected task.
Pause Task		The selected task execution is paused at the next command.
Stop All Tasks		Stops the execution of all running tasks.
Retry Step		If the selected task was paused or stopped due to an error, this button attempts to re-execute the current step and continue execution.
Proceed Task		If the selected task was paused or stopped due to an error, this button attempts to proceed execution of the task. This button is dimmed if there is no program for the given task or no task selected.
Kill Task		Clears the selected task of any programs. AUTO variables or calling arguments cannot be changed while a program is in a task stack.
Copy Stack to Windows Clipboard		Copies the contents of the selected task stack to the Windows clipboard. If a program terminates with an error, this allows you to copy and paste the stack contents for troubleshooting. The robot ID is also recorded in this operation.

Task Manager List Area

The flag icon next to each task in the list area represents the task state. Use the following table to understand different task states.

Table 5-23 Task State Description

Task Flag Icon	Description
	Task is idle or primed.
	Task is executing.
	Task is paused or at a breakpoint. A program's task flag icon will be yellow if you drag it onto a task to

Task Flag Icon	Description
	prime it.
	Task has an execution error or program execution was manually aborted.
	Task execution has completed.

Other Functions

Right-clicking a task in the task list will open a menu with other functions not described above. Use the following descriptions to understand the other functions.

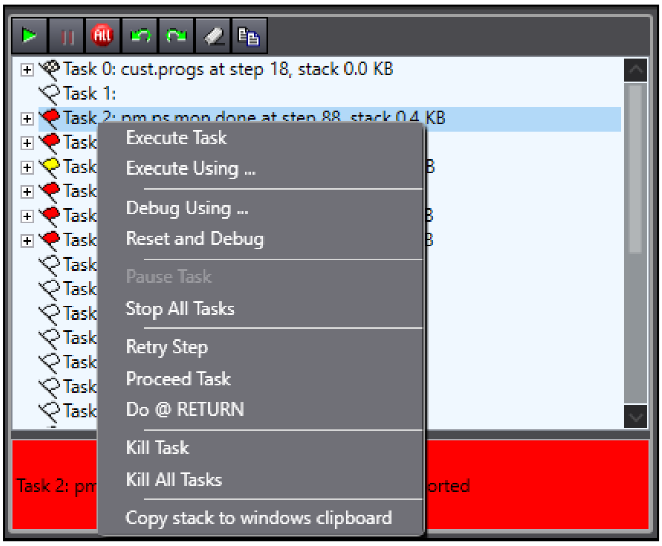


Figure 5-39 Task Manager - Other Functions

Table 5-24 Task Manager Other Functions Description

Other Function	Description
Execute Using...	Prompts for the name of the program to execute on the selected task.
Debug Using...	Prompts for the name of a program to debug, primes the specified program, and opens the V+ program in the Edit Pane.
Reset and Debug	Resets the program and open the V+ program in the Edit Pane for the selected task.
Do @ RETURN	Execute the task when the ***Return*** Key is pressed.
Kill All Tasks	Clears all tasks that do not have running programs.

I/O Watcher

Select I/O Watcher to display an interface for monitoring the state of digital I/O signals (inputs, outputs, soft signals, and robot signals) on the connected controller. Digital output signals and soft signals can be turned ON and OFF manually by clicking on the Signal Button (/).

NOTE: When Emulation Mode is enabled, digital input signals can be manipulated.

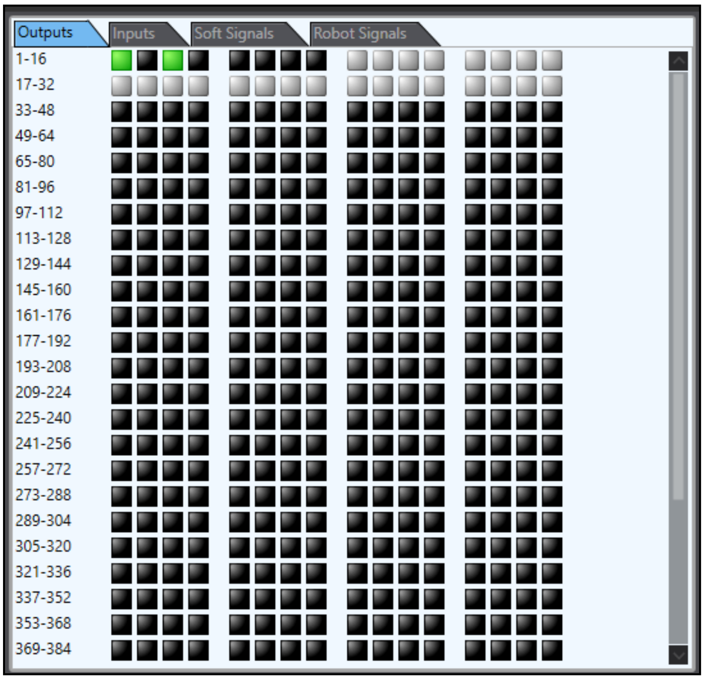


Figure 5-40 I/O Watcher

V+ File Browser

The V+ File Browser allows you to browse files and folders on the controller. This is only possible while online with the controller.

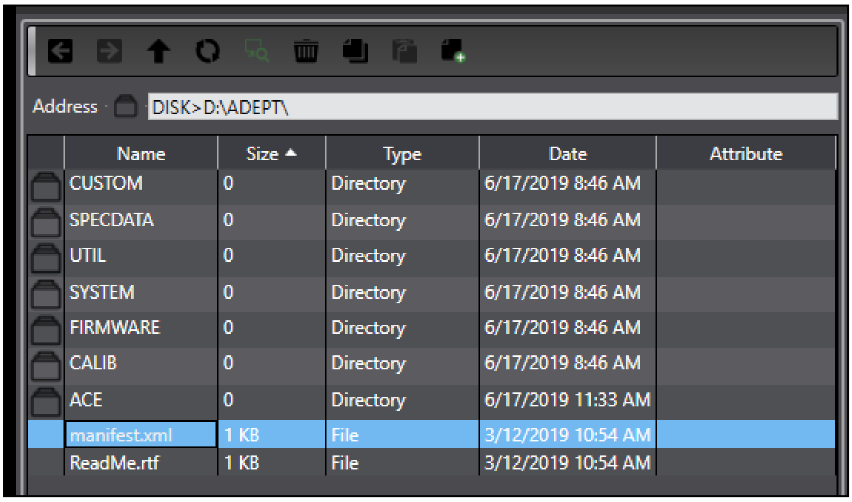


Figure 5-41 V+ File Browser

The V+ File Browser works with the Windows clipboard to enable easy transferring of files to and from controllers.

Use the icons in the V+ File Browser toolbar to perform common file browser functions such as navigation, creating new folders, rename, delete, cut, copy, and paste. Right-clicking a file or folder will also display a menu with common file browser functions and other items described below.

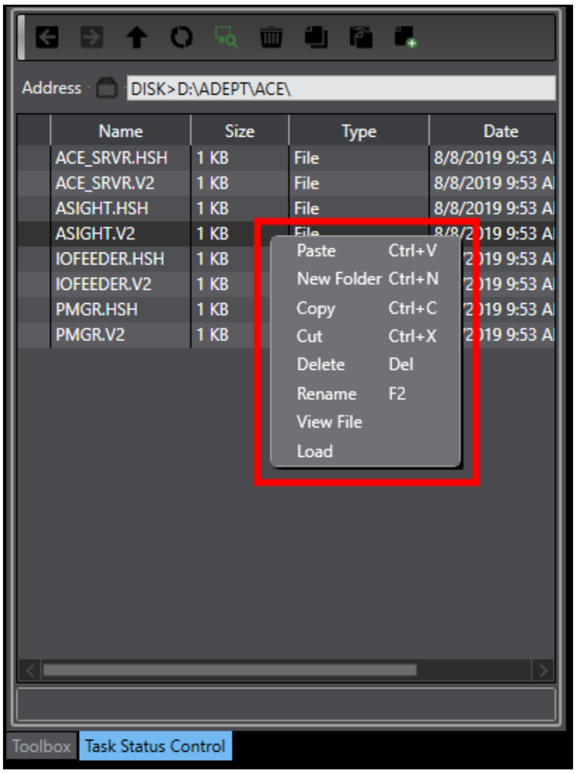


Figure 5-42 V+ File Browser Right-click Options

View File

Selecting ***View File*** will open the file in a quick-view window without the need for transferring the file to a PC. This is available for program, variable, and text files.

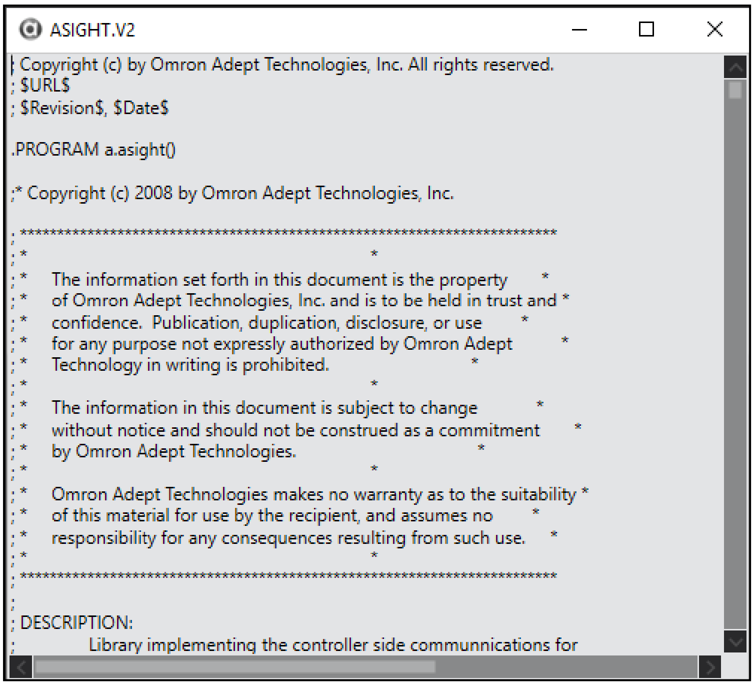


Figure 5-43 V+ File Browser Quick View

Load

Selecting ***Load*** will transfer the contents of the selected file from disk to system memory.

Virtual Front Panel

The Virtual Front Panel provides a simulated front panel for testing robot behavior when mode selection, robot power, and E-stop conditions are changed.

In Emulation Mode, full use of the Virtual Front Panel is possible.

When connected to a physical controller, Virtual Front Panel functions are read-only.

Virtual Front Panel functions are described below.

Figure 5-44 Virtual Front Panel

Mode Selection

Switches between Manual ( ) and Automatic ( ) mode. In Automatic mode, executing programs control the robot, and the robot can run at full speed. In Manual mode, the system limits robot speed and torque so that an operator can safely work in the cell. Manual mode initiates software restrictions on robot speed, commanding no more than 250 mm/sec. There is no high speed mode in manual mode. Refer to the robot's user's guide for more information.

Robot Power

The **Power** button toggles the robot high power ON and OFF and calibrates the selected robot. Robot power must be ON to allow jog control.

> **Additional Information**: Turning the robot high power ON for the first time after system power up executes the CALIBRATE() keyword to load joint calibration offsets into memory. This does not perform a full robot hardware calibration.

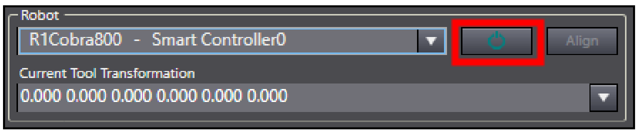


Figure 5-45 V+ Jog Control - Robot Power

E-Stop

E-Stop behavior can be tested and monitored with the **E-Stop** button on the Virtual Front Panel. Use the ESTOP Channel area to simulate various E-Stop system functions.

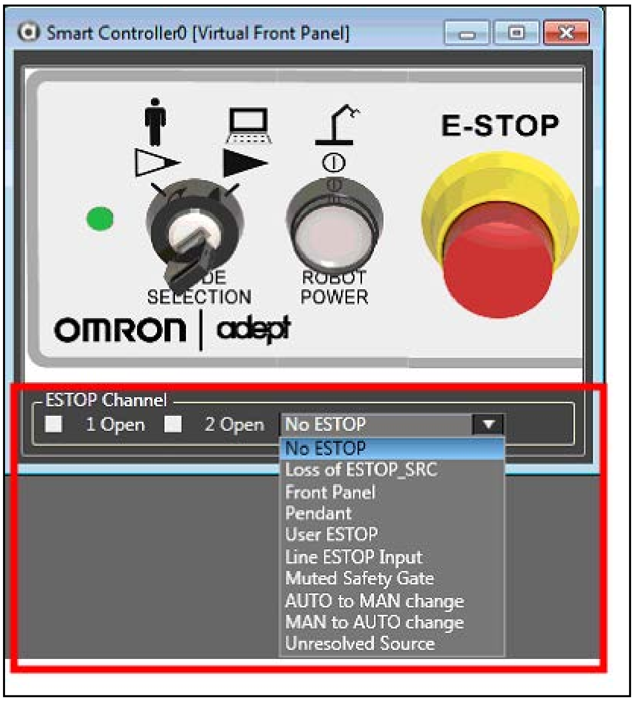


Figure 5-46 ESTOP Channel Simulation Functions

NOTE: Refer to the robot user's manual for more information about E-Stop functions.

Profiler

The Profiler is available for each controller in the project. It is used to provide a graphical display of controller processor usage for diagnostic purposes. There are two tabs in the Profiler view as described below.

NOTE: The Profiler function is not available in Emulation Mode.

Current Values Tab

The Current Values tab shows a list of tasks and their respective processor usage. Use the Display and Timing menu items to adjust the listed items and the update rate.

NOTE: Selecting ***All User Tasks*** displays all the user tasks available to your system. If ***All User Tasks*** is not selected, only tasks with a program on the execution stack are displayed.

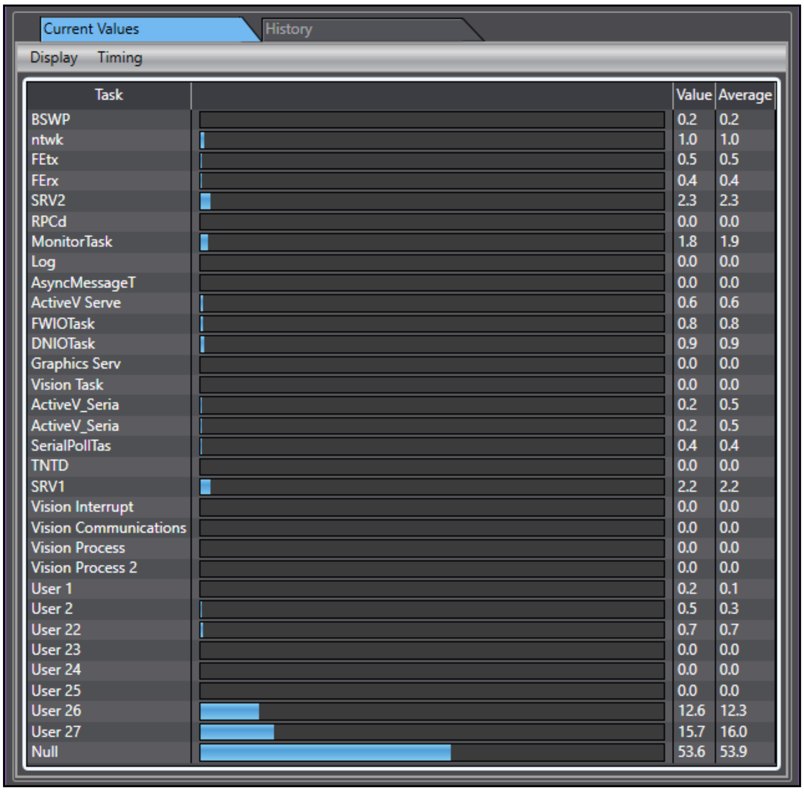


Figure 5-47 Profiler - Current Values

History Tab

Viewing the History tab displays a line plot history of CPU load over time for each task.

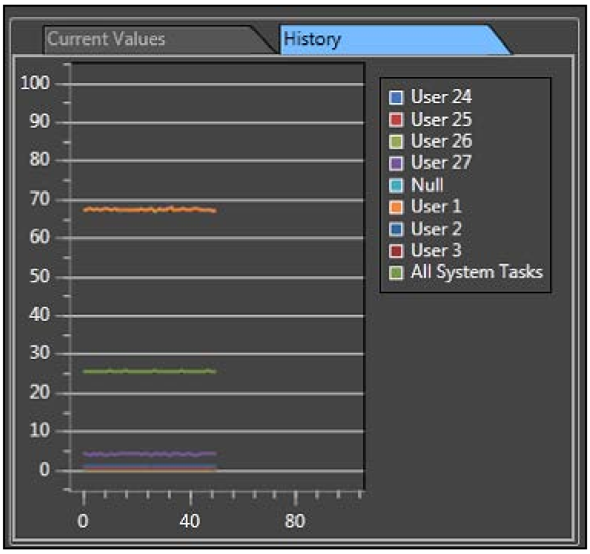


Figure 5-48 Profiler - History

Application Manager Control

Use the Application Manager Control area to examine information about, and control activity associated with the Application Manager. Application Manager objects such as Robot Vision Manager sequences, C# programs, Process Managers, and Recipe Managers that require user interaction for execution or run time monitoring are displayed in this area.

Selecting a task will provide additional information in the areas below. More information about the Task Status Control functions for Application Manager items can be found in the associated sections of this document.

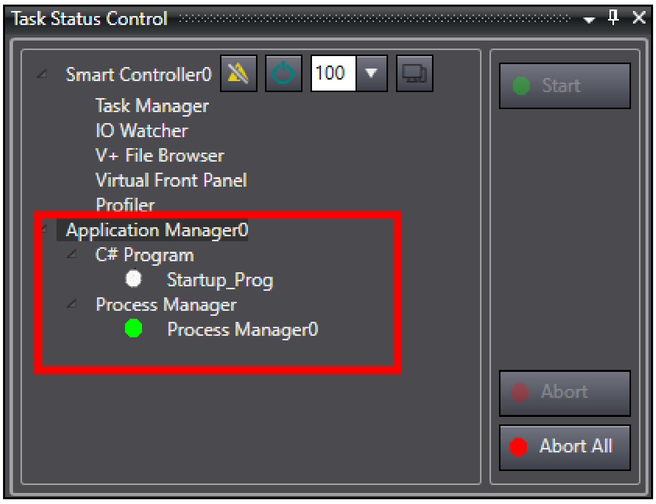


Figure 5-49 Application Manager Control

Control Buttons

Selecting a particular Application Manager object in the list enables or disables buttons on the display according to the allowed recovery for the current state.

The buttons on the Task Status Control have the following functions.

- **Start** Button (Start): Executes the selected object.
- **Undock** Button (Undock): Undocks the selected Task Status Control item.
- **Abort** Button (Abort): Aborts the selected, running object.
- **Abort All** Button (Abort All): Aborts all objects.

5.10 Vision Window

The Vision Window displays the input for each image source defined in the system. Using a tab for each source, you can view various cameras and tools configured in the project. Most vision tools can display their results in this window, allowing you to troubleshoot, test, or monitor the system performance during run time. In addition, like the Edit Pane in the ACE main application window, the tabs in the Vision Window can be rearranged for better observation. Each window also includes rulers on the side and top of the image to show the scale of the items in the image. Refer to Vision Tools on page 467 for more information.

Use the following details to understand the Vision Window functions.

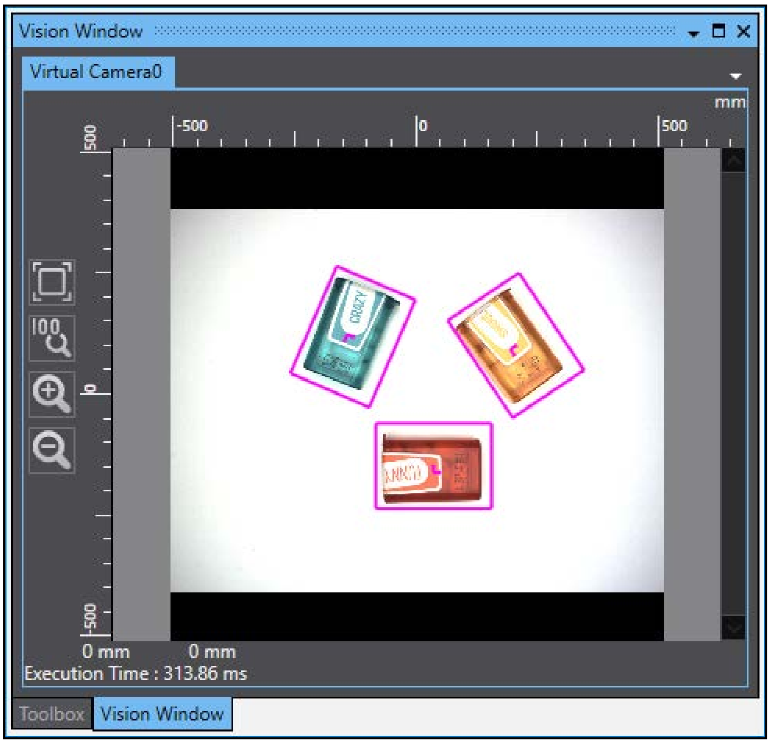


Figure 5-50 Vision Window

Zoom Level

Use the icons on the left of the window to adjust the zoom level. These icons are described below.

Fit to Screen

Click the fit to screen icon ( ) to change the zoom level so the entire image fits in the Vision Window.

Zoom to 100%

Click the zoom to 100% icon ( ) to change the zoom level to the default size of the acquired image.

Zoom in or out

Click the zoom in ( ) and zoom out ( ) icons to manually adjust the zoom level.

Calibration Scale

The left and top axis values represent the calibration scale setting in mm/pixel that is present in the Virtual Camera settings. Refer to Virtual Camera Calibration on page 316 for more information.

Execution Time

The Vision Sequence execution time is displayed in the lower left area of the Vision Window.

Camera Selection

Use the dropdown arrow to select from all available Image Sources defined in the system.

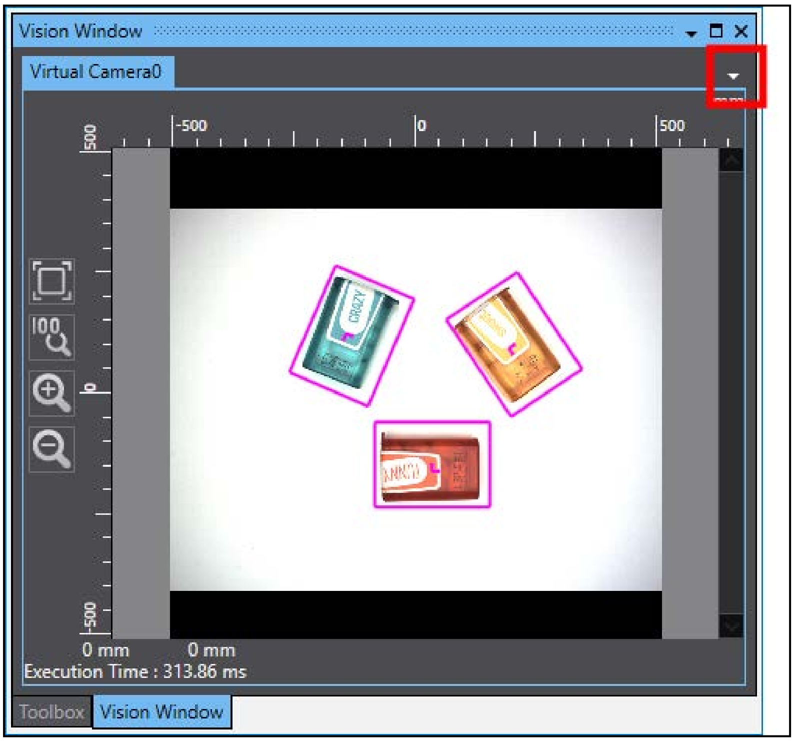


Figure 5-51 Virtual Camera Selection

Cursor Information

Moving the cursor in the field of view portion of the Vision Window will reveal additional information about the inspection results.

The X-Y coordinates are displayed at the bottom of the Vision Window for the current cursor position. Color / gray scale values are also displayed when applicable.

Hover over the coordinate icon in the field of view to display inspection results as shown below.

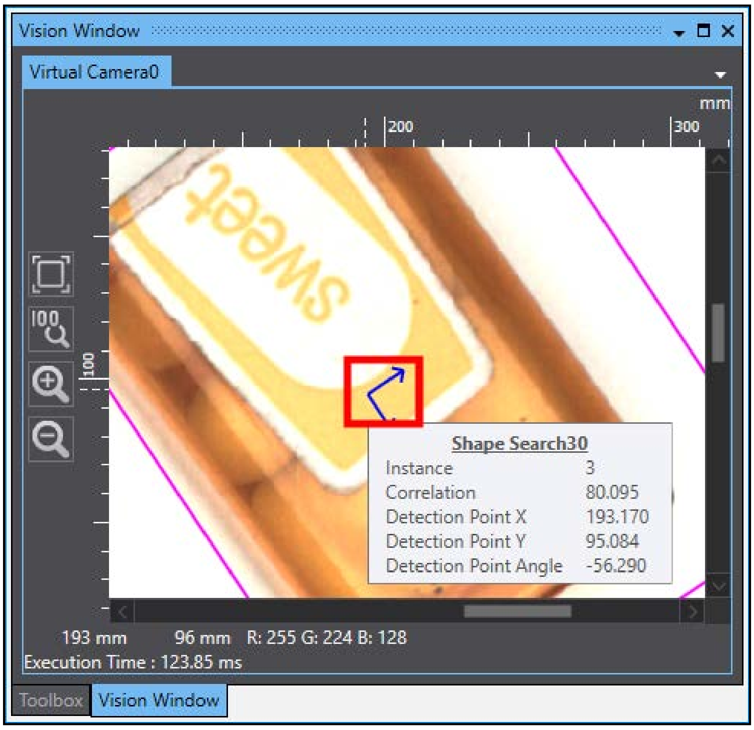


Figure 5-52 Cursor Information Display

5.11 V+ Watch

V+ Watch is used to monitor specified variables while developing or debugging V+ programs.

Variables can be added to the V+ Watch window in several different ways as described below. The V+ Watch window contents will be saved with the project. Refer to V+ Variables on page 170 for more information.

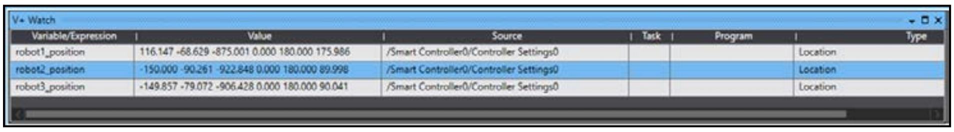


Figure 5-53 V+ Watch Window

Adding Variables to the V+ Watch Window

Use one of the following methods to add variables to the V+ Watch window.

- Select one or more variables in the Variable Editor and right-click. Selecting ***Add to Watch*** will place these variables in the V+ Watch window.
- Right-click in the V+ Watch window area and select ***New***. Type the name of the variable to add it to the V+ Watch window.
- Right-click the variable name in the V+ Editor. Selecting ***Add to Watch*** will place this variable in the V+ Watch window.

5.12 Search and Replace

Use the Search and Replace tool to find any text strings within the project. Access the Search and Replace tool in the Edit Menu Bar list or with CTRL+F keys.

NOTE: You can search and replace text strings in modules and programs.

If more than one device is registered in the project, the target of a search and replace is the currently active device only. Be sure to check the active device in the device list for the project before you perform a search and replace.

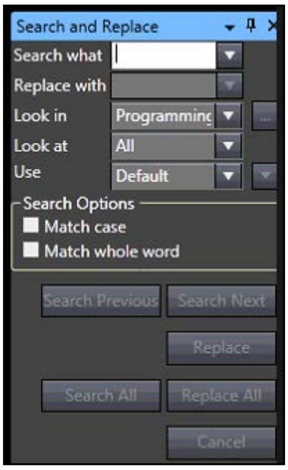


Figure 5-54 Search and Replace Tool

Table 5-25 Search and Replace Tool Description

Item	Description	Details
Search what	Use this field to enter a string for a search.	You can also select from previous search strings with the drop down arrow.
Replace with	Enter a string to replace the search string with.	You can also select from previous replace with strings with the drop down arrow.
Look in	Specify a range to search. You can select from the following. • Programming: all of the programs of the project's currently active device. • Checked elements: the items selected in the Select search and replace scope Dialog Box are searched. • Current view: the active V+ Editor tab is searched.	When selecting ***Checked elements***, use the **More Options** Button (...) to display the Select search and replace scope Dialog Box.
Look at	Specify the items to search. You can	---

Item	Description	Details
	search for text strings in the following items. • All: Searches all text strings. • Variable name: Reserved for future use. • Instruction: Reserved for future use.	
Use	Specify if you want to use wildcard characters. • Default: Do not use wildcard characters. • Wildcard: Use wildcard characters.	If you choose to use wildcard characters, you can click the ( ) button to the right to view a list of characters used for wildcard characters. Select any of these characters to enter them in the search string. Refer to the Wildcards section below for more details.

Search Options

Table 5-26 Search Options Description

Item	Description
Match case	When this option is selected, searches are case sensitive.
Match whole word	When selected, only exact string matches are returned.

Button Functions

Use the following table to understand the functions of the buttons in the Search and Replace tool.

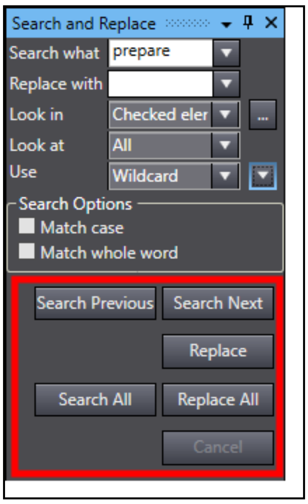


Figure 5-55 Search and Replace Tool Buttons

Table 5-27 Button Functions Description

Item	Description
Search Next	Performs a search according to the selected options.
Search Previous	Performs a search in the reverse order of **Search Next**.
Search All	Searches all items and displays the results in the Search and Replace Results Tab Page displayed in the Multifunction Tabs area.
Replace	Performs a replace according to the selected options.
Replace All	Replaces all items and displays the results in the Search and Replace Results Tab Page.
Cancel	Cancels the current search and replace operation.

5.13 User Management

The User Manager provides an interface to add, remove, and edit existing users. All settings in the User Manager are stored with the ACE project. This can be accessed with the ***Edit Users...*** selection in the ***File*** menu item.

Use the following details to understand the User Manager interface shown below.

> **NOTE:** Passwords are not mandatory for new and existing users. Refer to Passwords on page 140 for more information.

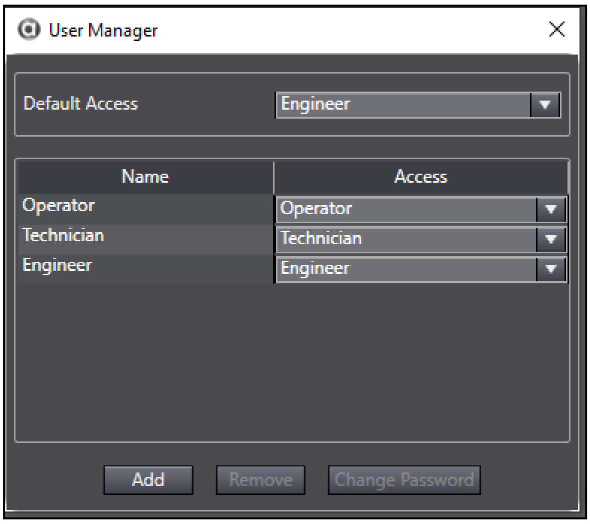


Figure 5-56 User Manager

Default Access

Designate the default access level when opening a project or signing out.

Name

This is the User Name when signing in. The Name field can be edited for each user. Default names of Operator, Technician, and Engineer are provided for all new ACE projects.

Access

Designate the access level for each Name in the User Manager list (Operator, Technician, or Engineer).

Click the **Add** Button to add a new name with a specific access level to the user list. A new user will be added and sign in will be possible with the User Name and Password (if specified).

Click the **Remove** Button to remove a selected name from the User Manager list. The user will be deleted and sign in will not be possible with the previously stored credentials.

Click the **Change Password** Button to create a unique password for each user listed. Clicking this button will open the Change Password Dialog Box. Refer to Passwords on page 140 for more information.

User access levels allow software feature and function access control for designated users for an ACE project. Signing in to each user level can be password protected (optional). This allows you to create a list of users and assign a specific access level to each one.

> **IMPORTANT:** The User Manager implements a basic level of user-access security. For applications that require a higher level of security, you will need to implement a security scheme within a custom user-interface. This could be based on the network login credentials from Windows or other similar access-control methods.

One of the following three access levels can be assigned to a user.

1. Engineer (highest level): full access to all items
2. Technician: limited access to some items
3. Operator (lowest level): read-only access

Engineer Accessible Items

All features and functions in the ACE software are accessible to a user with the Engineer access level.

> **NOTE:** A user signed in with Technician or Operator access or cannot edit users or access the User Manager. Only a user with Engineer access can edit users with the User Manager.

Technician Accessible Items

The following features and functions are accessible to a user with the Technician access level. The Technician access level cannot add any new items to the ACE project and can only view and edit the following items if they already exist in the workspace.

- Save Controller Configuration
- AnyFeeder Objects
- Application Manager Settings
- Pack Manager Belt Objects
- Robot Vision Manager Objects
- 3D / CAD Data Objects

- Data Mapper Objects
- Emulation Camera Images
- I/O EndEffector
- I/O Feeder Objects
- OPC Container
- Process Manager
- Recipe Manager
- System Startup
- V+ and C# Variables
- Vision Tools

Operator Accessible Items

The notes function is editable for a user with the Operator access level only when a note was already created by another user with Technician or Engineer access. All other features and functions are either read-only or inaccessible.

Passwords

Passwords for each User Name can be specified, but are not mandatory. Passwords can include symbols, letters, and numbers and are case sensitive.

If a password has not been specified for a user, the following password omissions are present.

- The Old Password field can be left blank when changing a password.
- The Password field can be left blank when signing in as this user.

5.14 Project Options

Project options can be access in the Tools menu item. The following project option settings are detailed below.

- Color Theme
- Project Settings
- Window
- V+ programs
- UPS

To access the project options, click the Tools menu bar item and then select ***Option***... The Option window will open.

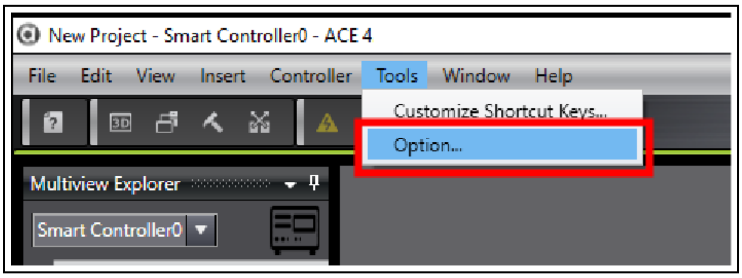


Figure 5-57 Access the Option Window

Color Theme

To access the color theme setting, select ***Color Theme*** from Option Dialog Box. The color theme settings will be displayed.

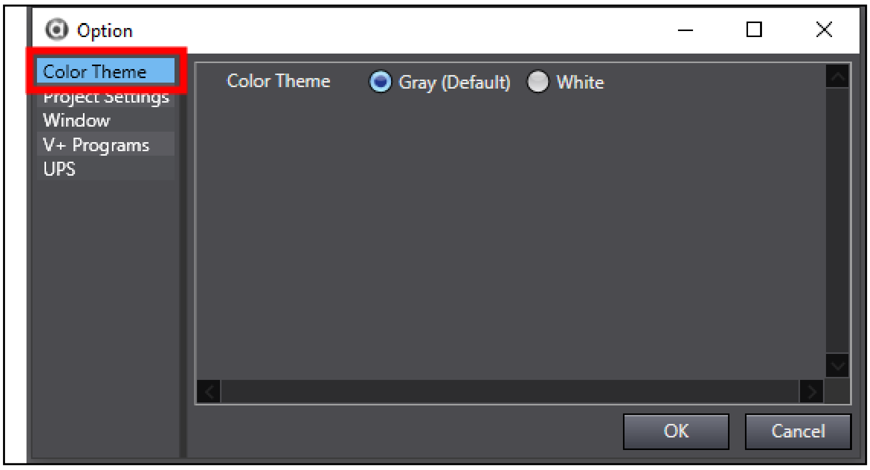


Figure 5-58 Color Theme Settings

Choose Gray (default) or White as the color theme for the ACE software. Changing this setting will require a software restart to see the result. Both color themes are shown below.

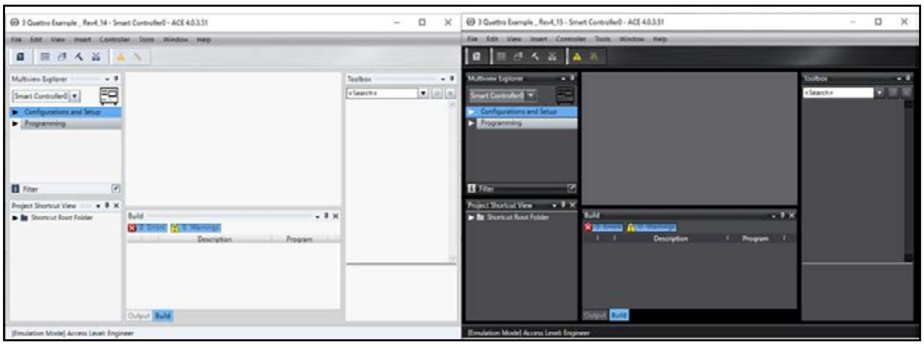


Figure 5-59 White (left) and Gray (right) Color Themes

Project Settings

To access the project settings, select ***Project Settings*** from Option Dialog Box. The project settings will be displayed.

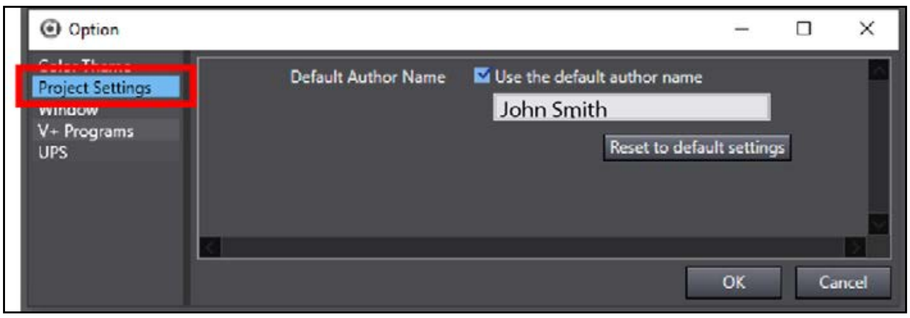


Figure 5-60 Project Settings

The default project author name can be specified in the Project Settings area. The following settings are available.

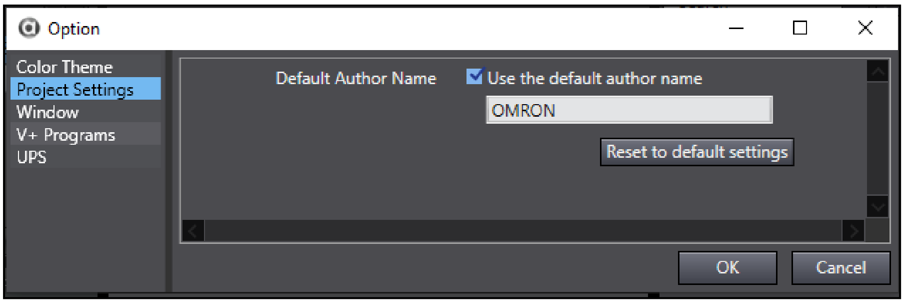


Figure 5-61 Project Settings

Use the Default Author Name

Selecting this will use the name specified when saving or creating a new ACE project. A restart of the ACE software is required to see this change.

If this is not selected, the author field for saving or creating a new ACE project will be blank.

Reset to Default Settings

Clicking the **Reset to default settings** Button will set the project's author name to the Windows user name. A restart of the ACE software is required to see this change.

Window

To access the Window settings, select ***Window*** from Option Dialog Box. The Window settings will be displayed.

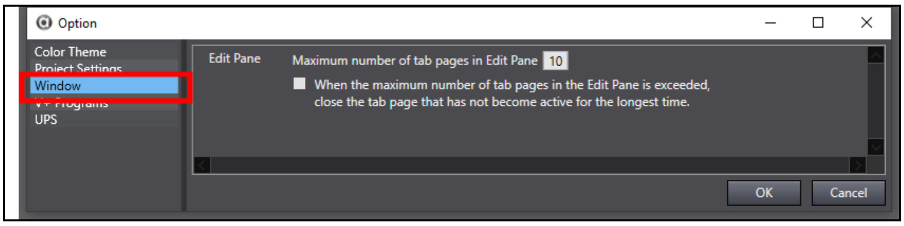


Figure 5-62 Window Settings

Enter the maximum number of tab pages to view in the Edit Pane. With this setting, you can set the number of tab pages in the Edit Pane and floating edit windows that can be displayed at a time.

If the check box is selected for ***When the maximum number of tab pages in the Edit Pane is exceeded, close the tab page that has not become active for the longest time*** is active, the Edit Pane that was opened first will automatically close when attempting to open new tab that exceeds the set amount. If this is not selected, a warning is displayed and new Edit Pane tabs cannot be opened until old tabs are closed.

Header for New V+ Programs

Text can be specified as the header for all new V+ programs in an ACE project when this is enabled. If no text is specified, a new V+ program will consist of only .PROGRAM and .END statements.

Other Parameters

If the ***Allow automatic inteliprompt pop-ups in the V+ editor*** option is selected, typing commands in the V+ editor will trigger suggestions with matching text, as shown below.

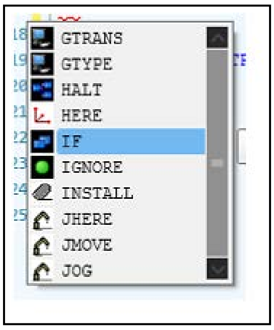


Figure 5-63 Intelliprompt Pop-up Enabled

If the ***Use Custom Font*** option is selected, you can specify a system font for the V+ program editor. Click the **Select** button and choose from the Font Setting Dialog Box and then click ***OK***. The new font setting will be used in the V+ program editor.

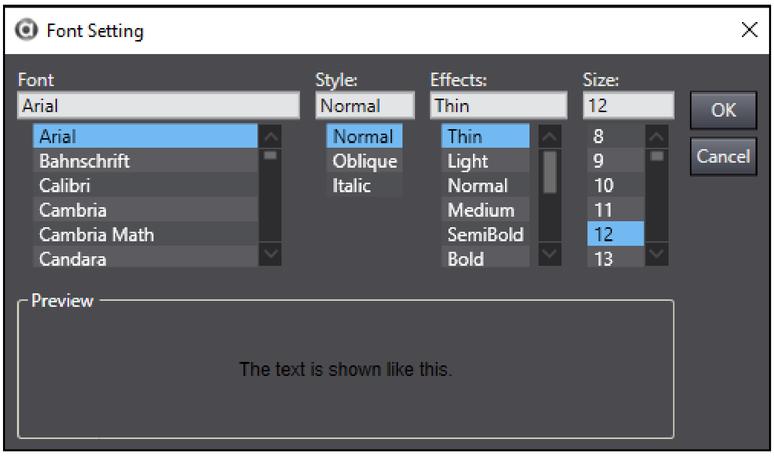


Figure 5-64 V+ Editor Font Setting

V+ Programs

To access the V+ programs settings, select ***V+* Programs** from Option Dialog Box. The V+ program settings will be displayed.

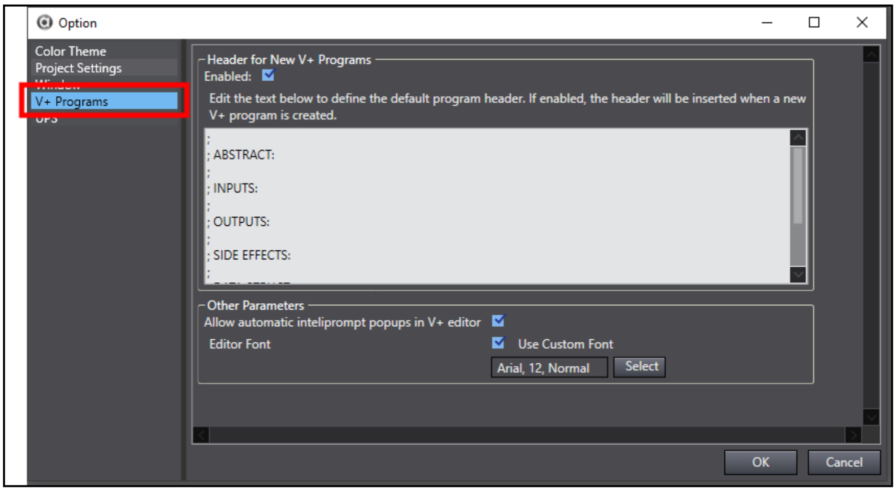


Figure 5-65 V+ Program Settings

Uninterruptible Power Supply (UPS)

The ACE software can communicate with an Omron S8BA-Series UPS to provide a controlled shutdown during run-time if a power abnormality or other such event occurs (referred to as a UPS event). You have the choice of using either an AC-AC or DC-DC UPS, depending upon you facility requirements. Using the script command function described below, it is possible to perform the following functions in a systematic fashion when a UPS event occurs.

- Save the ACE project.
- Disable high power on all connected controllers.
- Close the ACE software.
- Shut down the operating system.

UPS Software Required

- PowerAct Pro (Master Unit)
- PowerAct Pro (Slave Unit)

The PowerAct Pro software is included with the AC UPS. The Slave Unit needs to be installed on the computer running the ACE software.

AC-AC Hardware Configuration

The basic hardware needed to use the UPS within a robot installation is: Omron AC UPS BU5002RWL, Omron Web Card SC20G2, Omron S8VKS DC Power Supply, Omron NY Industrial PC and an Industrial Robot.

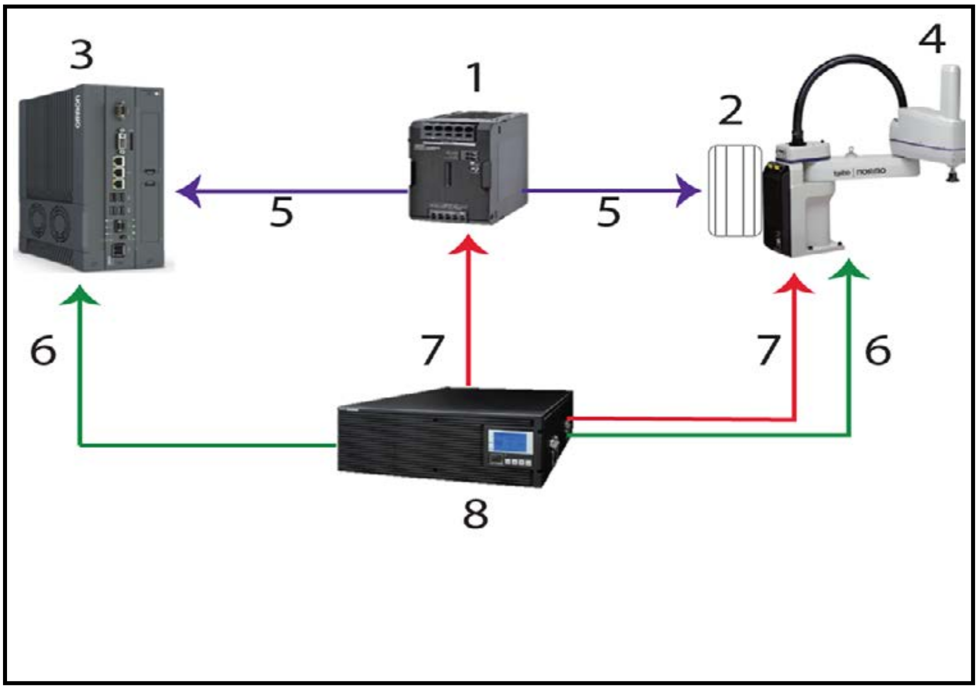


Figure 5-66 UPS Hardware Wiring Diagram

Table 5-28 Hardware Wiring Components

Item Number	Description
1	Switching Power Supply 20A/480W S8VKS48024
2	Amplified Power Control Logic
3	Omron Industrial PC
4	Industrial Robot
5	24VDC
6	Ethernet Cable
7	240VAC
8	AC UPS BU5002RWL with SC20G2 Network Card Installed

The BU5002RWL back panel is the location for the power and network interface connections. The following figures identifies the ports. The table that follows identifies the back panel features and purpose for each port.

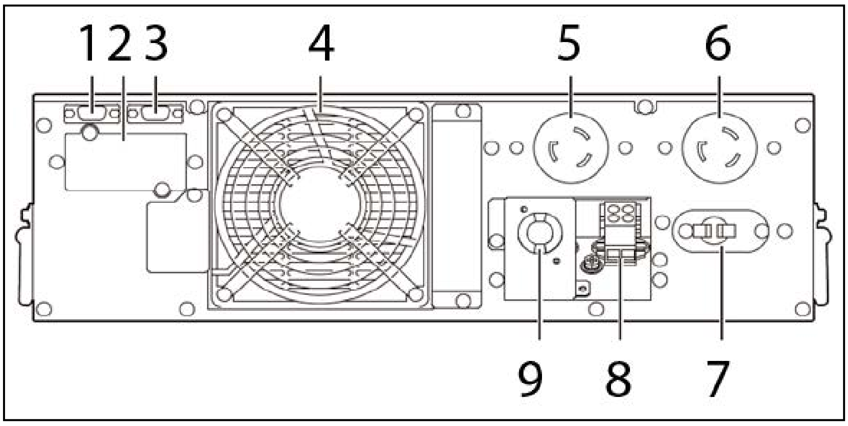


Figure 5-67 UPS Power and Network Connections

Table 5-29 UPS Connections

Number	Description
1	Contact signal port
2	Optional slot
3	RS-232C Port
4	Cooling fan
5	200-240VAC output, L6-20P socket
6	200-240VAC output, L6-20P socket
7	AC input overcurrent protection switch
8	200-240VAC output terminal
9	AC input cable

Use the following steps to make the equipment connections for the full system.

1. Install the SC20G2 into the UPS
2. Connect the Industrial PC to the S8VK power supply outlet
3. Connect the robot Industrial PC to the SC20G2 with Ethernet cable
4. Connect the robot to the UPS 240VAC output, port 5
5. Connect the S8VK power supply to the UPS 240VAC output, port 6
6. Connect the UPS to a 240VAC power supply/source

AC-AC UPS Software Configuration

When the SC20G2 is installed in the UPS it operates as the "Master Unit" in the PowerAct Pro connection. The connected devices operate as "Slave Units'" to the UPS. The Slave Units are then configured to initialize .exe or .bat files on the Industrial PC. When these files are executes the UPS is able to initiate a safe stop to the program upon low battery.

Use the following steps to set up PowerAct Pro:

1. Install PowerAct Pro onto the Industrial PC
2. Connect to the AC UPS with the IP, 10.151.24.79, in the browser, opening the UPS Monitor.

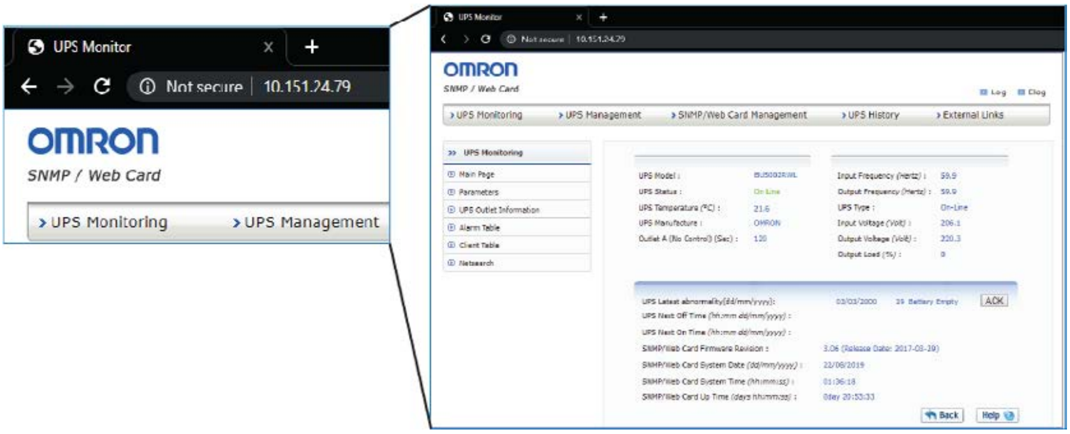


Figure 5-68 UPS Monitor Opened in Browser

- Select **UPS Management**, along the top bar.
- Select **Shutdown Setting** from the options in the left side of the window.
- Select the **Become Administrator** Button.
- When prompted, the login is OMRON and the password is admin. Then click **OK** to open the Shutdown Settings window.

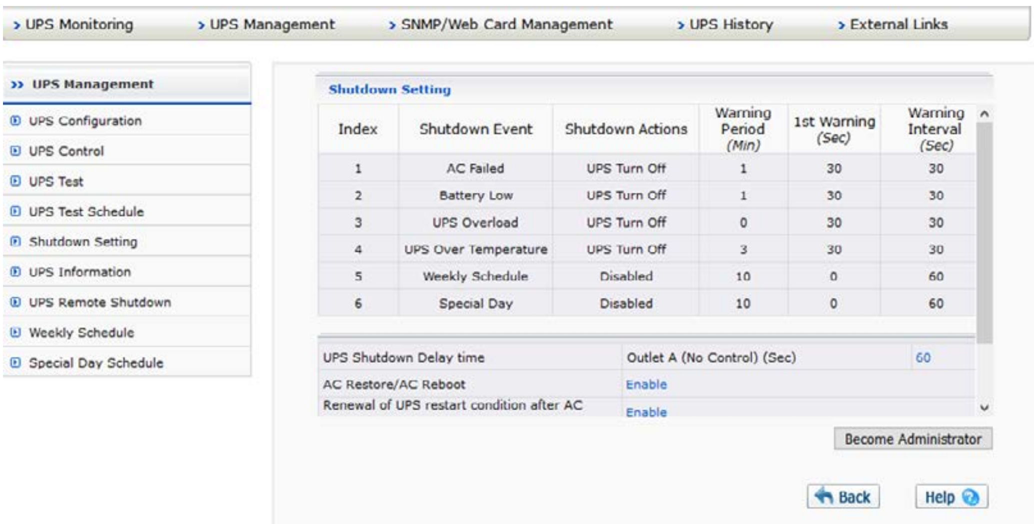


Figure 5-69 Shutdown Setting Window

The Shutdown Event menu, See "Shutdown Event Menu", allows you to customize the shutdown parameters for the UPS. You can customize the UPS reaction to different events, including Warning delays and UPS Shutdown delays.

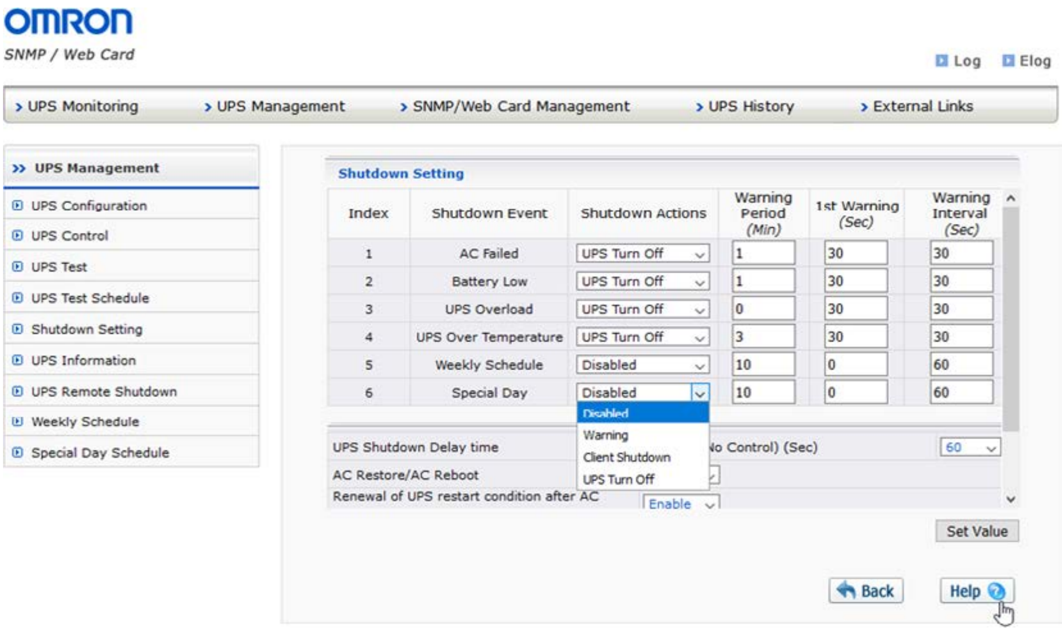


Figure 5-70 Shutdown Event Menu

Add ACE Batch File

ACE reacts to the UPS shutdown through a .bat file within the Slave Unit Client. You need to create the .bat and save it with a unique name in the directory, C:\Program Files\Omron\ACE 4.\UPS. Copy and paste the following into the .bat file: "C:\Program Files\Omron\ACE 4.\UPS\SignalUpsEvent\SignalUpsEvent.exe". Include the quote marks, " ",in the string.

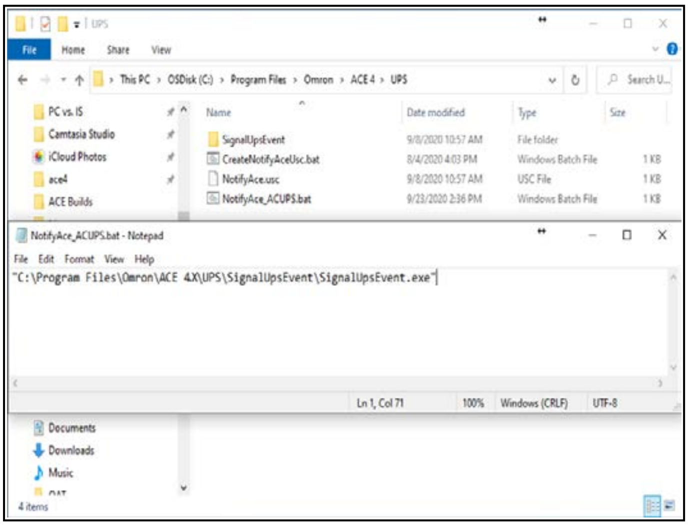


Figure 5-71 Client .bat File

After the .bat file is created and saved, open the PowerAct Pro on the Industrial PC and go to the Configuration Setting, shown below.

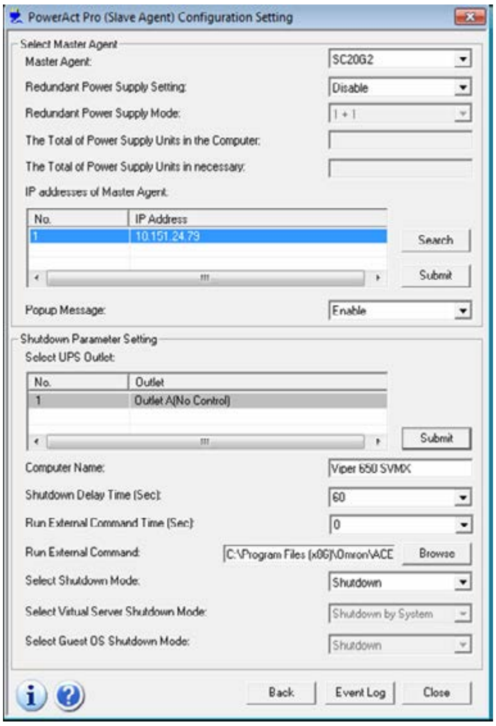


Figure 5-72 PowerAct Pro Configuration Setting

1. Within the Configuration Setting, select SC20G2 as the Master Unit.
2. Click the ***Search*** button and select the IP of the UPS
3. Click the upper ***Submit*** button
4. Select the outlet the robot is connected to
5. Set the Shutdown Delay Time to 120(sec)
6. For Run External Command, click ***Browse*** and select the previously identified .bat file
7. For Shutdown Mode, select Shutdown

Enable ACE Software UPS Response

To access the UPS settings in the ACE software, open ACE and select Tools > Options from the toolbar.

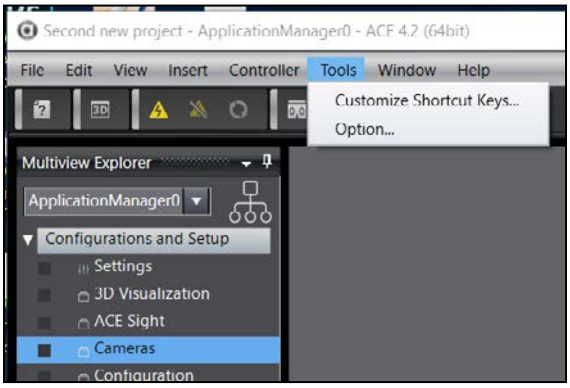


Figure 5-73 Tools > Options Selection

When the window opens, select ***UPS*** from Option Dialog Box. The UPS settings will be displayed. Select ***Enable UPS monitor and respond to UPS events, Save Project File and Disable High Power on all connected controllers***. Click **OK**. The definition of the individual UPS options follows the figure.

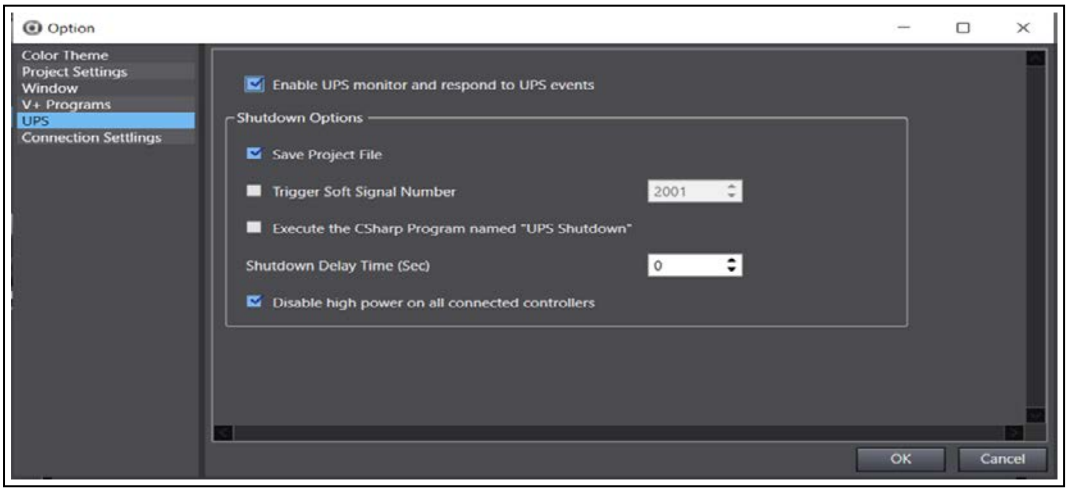


Figure 5-74 UPS Settings

Enable UPS Monitor and Respond to UPS Events

This option enables or disables the UPS functionality in the ACE software. The functions are described below.

Shutdown Options

The shutdown options area provides selections for the UPS event functions described below.

Save Project File

Once the changes are made, select **Save Project File** from the menu.

Trigger Soft Signal Number

ACE will trigger a soft signal on all connected controllers. This allows you to setup a REACTI to create a specific error response for a power loss.

Execute the C# Program names "UPS Shutdown"

Triggers the C# program named "UPS Shutdown". This allows you to have a C# script that will execute on a power event. The C# program must be named exactly as "UPS Shutdown".

Shutdown Delay Time (s)

If selected, this specifies the amount of time in seconds that ACE will wait before saving and closing. You should verify that this time is long enough for a REACTI or C# program to complete before ACE closes.

Disable High Power on All Controllers

If this option is enabled, it disables High Power on all controllers connected to the instance of ACE. Omron recommends using a C# or REACTI program to bring robot to safe stop instead. This will stop the robots as quickly as possible immediately after the shutdown signal is received.

UPS Shutdown Sequence (Typical)

When a UPS is connected and configured, a UPS event can trigger the following sequence to execute a controlled shutdown of the system.

1. The UPS communicates to the PC running ACE software that a UPS event occurred.
2. An event listener on the PC running ACE detects the UPS event.
3. A script on the PC running ACE is triggered that makes the SignalUPSEvent.exe program run.
4. The SignalUPSEvent.exe activates the items set in the ACE Software UPS settings such as saving the project file disabling high power on connected controllers.
5. The PC running the ACE software shuts down in a controlled manner after a designated amount of time.

S8BA-Series UPS Configuration

The S8BA-Series UPS must be configured and connected to the PC running the ACE software. Refer to the *Automatic Shutdown Software for Omron Uninterruptible Power Supply (UPS) PowerAttendant Lite for Windows Users Manual* for more information.

The PowerAttendant Lite (PAL) software provides configuration and management of the S8BA-Series UPS and must be installed on the PC running ACE software. Use the PowerAttendant Lite software to configure the operation of the S8BA-series UPS and configure settings such as power failure delay time, shutdown start delay time, script execution time, UPS shutdown delay time, and operating system termination mode.

Script Command Function

The script command function is used to specify an executable when a UPS event occurs. The SignalUPSEvent.exe executable runs when a UPS event occurs and this will trigger the actions set in the ACE Software UPS Settings area described below.

The NotifyAce.usc script file must be placed in a specific directory of the PC running the ACE software. This file is included with an ACE software installation and can be found in the ACE software installation directory in the UPS folder. The default path to find this script file is provided below.

C:\Program Files\Omron\ACE 4.\UPS

The NotifyAce.usc script must be copied to the following location on the PC running the ACE software.

C:\Users\Public\Documents\OMRON\PAL

> **IMPORTANT:** The PowerAttendant Lite software must be installed on the PC running the ACE software.

ACE Software UPS Configuration Procedure

Use the following procedure to configure a UPS with the ACE software.

1. Adjust the ACE software UPS settings. Refer to ACE Software UPS Configuration Procedure on page 152 for more information.
2. Make all wiring and communication connections between the S8BA-Series UPS and the PC running the ACE software. Refer to the *Automatic Shutdown Software for Omron Uninterruptible Power Supply (UPS) PowerAttendant Lite for Windows Users Manual* for more information.
3. Install PowerAttendant Lite on the PC running the ACE software.
4. Place the provided NotifyAce.usc script in the C:\Users\Public\Documents\OMRON\PAL directory. Refer to ACE Software UPS Configuration Procedure on page 152 for more information.
5. Set the shutdown parameters using the PowerAttendant Lite software installed on the PC running the ACE software. Example parameter values are provided below (these parameters should be adjusted for specific application requirements). After these steps are finished, the procedure is complete.
   - Power Failure Delay Time: 30 seconds
   - Shutdown Start Delay Time: 0 seconds
   - Script Execution Time: 60 seconds
   - UPS Shutdown Delay Time: 180 seconds
   - OS Termination Mode: Shutdown

DC-DC Hardware Configuration

The basic hardware needed to use the DC-DC UPS within a robot installation is shown in the following figure. The Omron components are the S8VKS48024 20A, S8BA-24D24D480SBF and S8BA-S480L The robot application manager can be a non-Omron device.

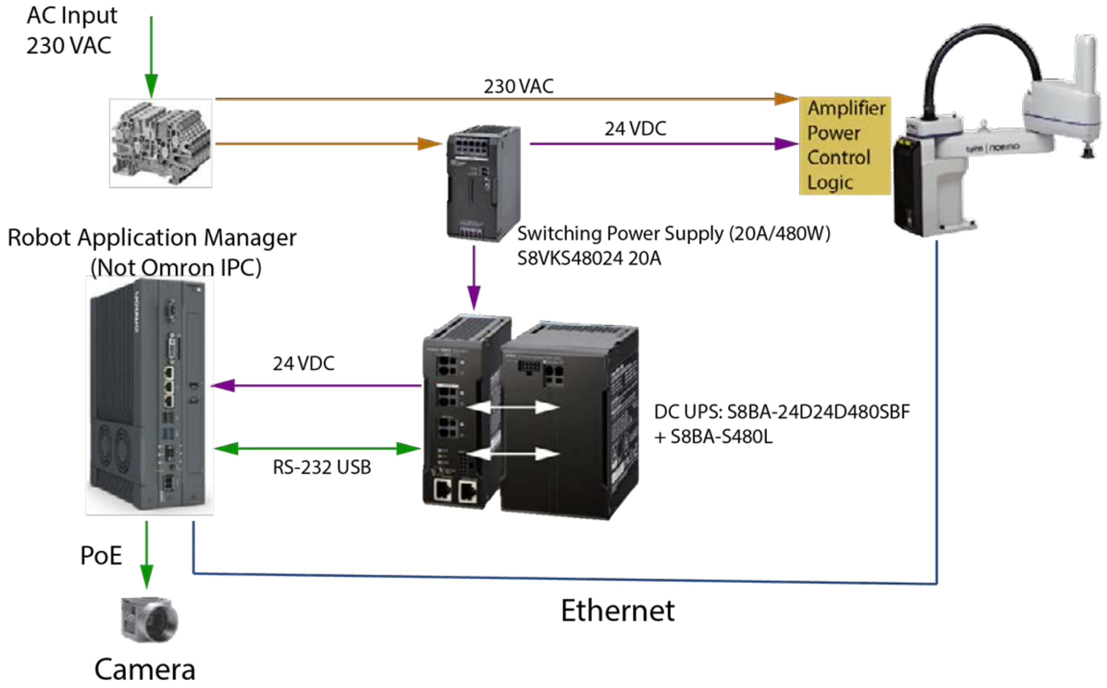


Figure 5-75 DC-DC UPS Hardware Wiring Diagram

CAUTION: The UPS will not maintain high power (230VAC) to the robot or conveyor belts. Also the system will not automatically resume on Power Restoration. Some user intervention may be required to restore flow of production.

CAUTION: Please test and verify the setup before actual power event occurs.

DC-DC UPS Software Configuration

Once the units are connected, following the figure in the See "DC-DC Hardware Configuration"you need to install and configure the Power Attendant Lite (PAL application). Once installed, you will need to write a script to trigger the operation and configure it.

Use the following steps to set up the Power Attendant Lite.

1. Install Power Attendant Lite to the Robot Application Manager
2. Launch Power Attendant Lite and Login: Username = Admin, password = omron
3. Set the parameters as follows:

- Power Failure Delay Time： 30 seconds
- Shutdown Start Delay Time： 0 seconds

- Script Execution Time：60 seconds
- UPS shut down delay time：180 seconds
- Using script：Choose the script that is registered in "Script setting"
- OS Termination Mode：Shutdown

DC-DC UPS Script File

Open Notepad and create the script file similar to the following example, NotifyAce.usc, and save with a .usc extension in the UPS folder of the ACE 4. installation directory.

In this example, D:\Program Files\ACE4.\UPS

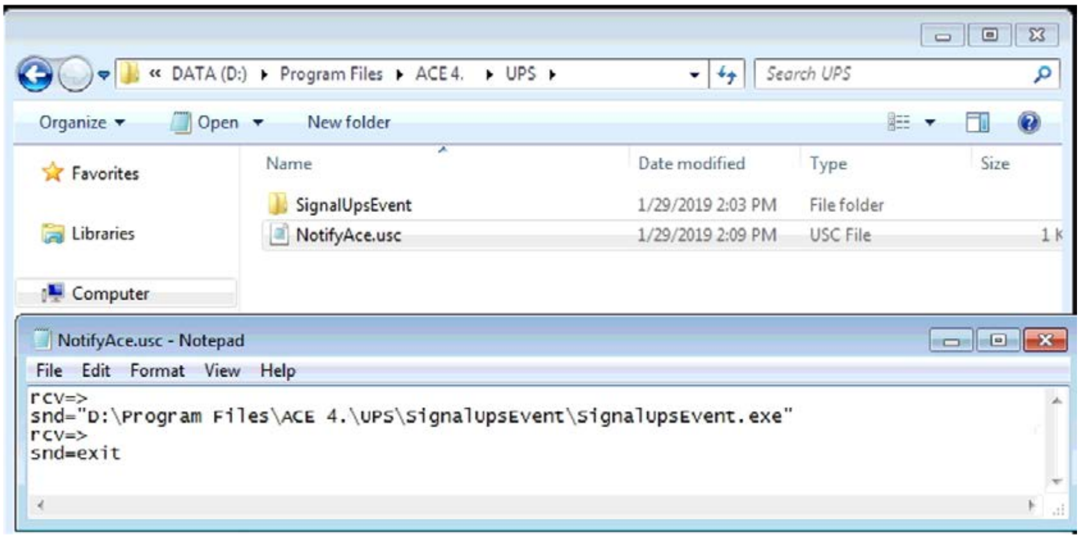


Figure 5-76 UPS Script File

The files in the directory, SignalUpsEvent are shown in the following figure.

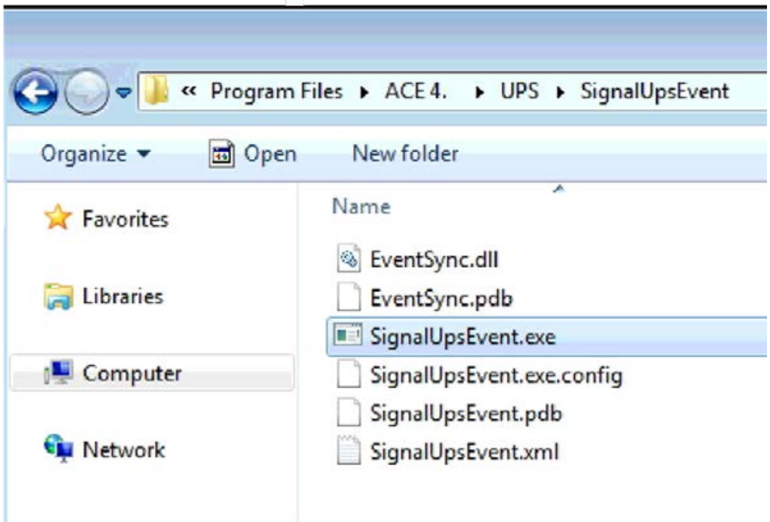


Figure 5-77 SignalUpsEvent Directory

DC-DC UPS Script File

Open Notepad and create the script file similar to the following example, NotifyAce.usc, and save with a .usc extension in the UPS folder of the ACE 4. installation directory.

In this example, D:\Program Files\ACE4.\UPS

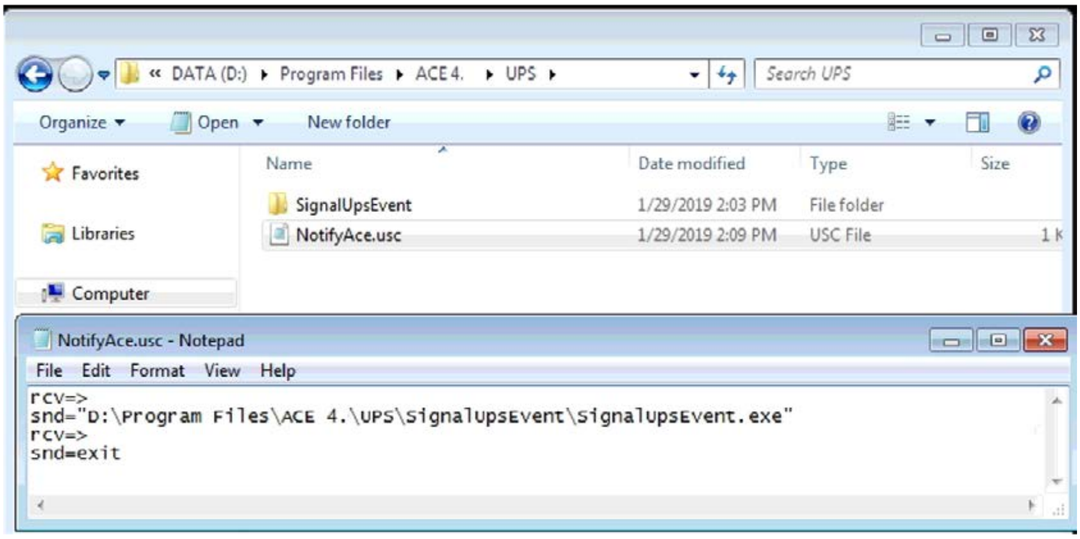


Figure 5-78 UPS Script File

The files in the directory, SignalUpsEvent are shown in the following figure.

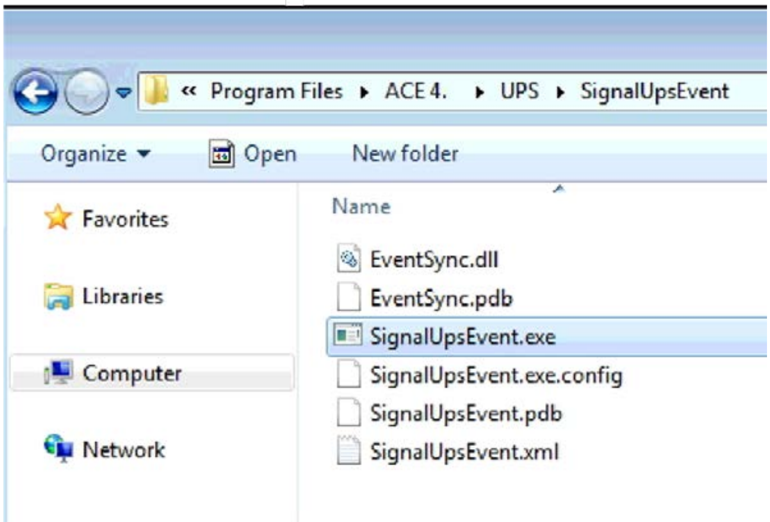


Figure 5-79 SignalUpsEvent Directory

DC-DC Set Up Power Attendant Lite

The following steps are used to enable the UPS and set the Power Attendant Lite parameters to trigger if there is a power loss.

Log onto the U the Power Attendant Lite. and then double click the UPS. You will log onto the UPS with User Name Admin and password Omron, as shown in the following figure.

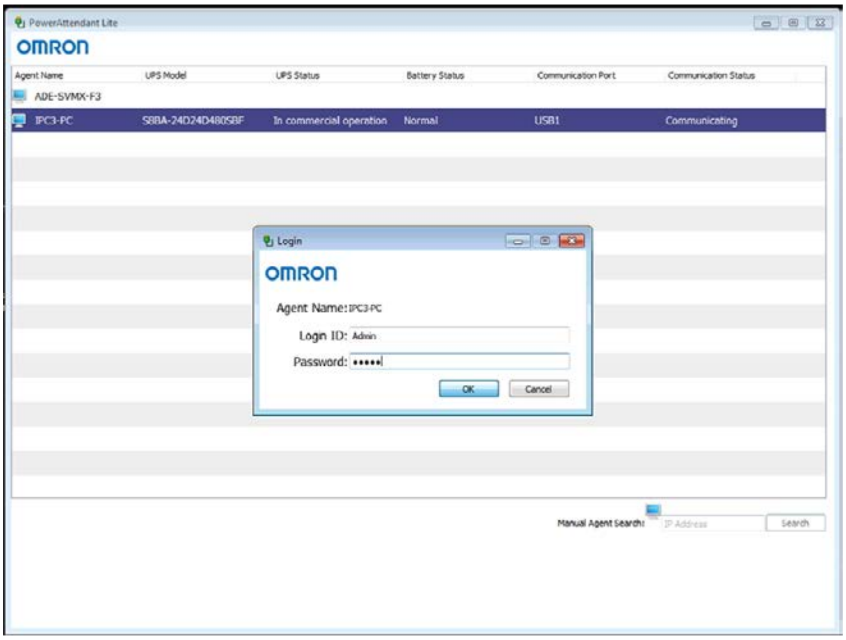


Figure 5-80 UPS Logon

Once logged on, the following screen opens.

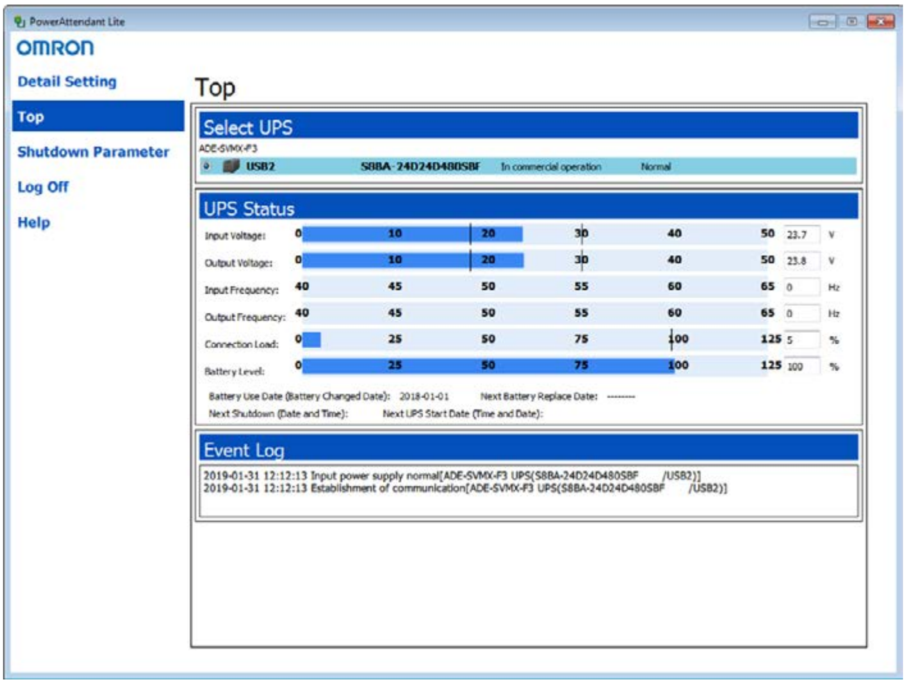


Figure 5-81 PAL Settings

Click **Detail Setting**, on the left menu panel. Then click the **Register** Button in the top right of the panel.

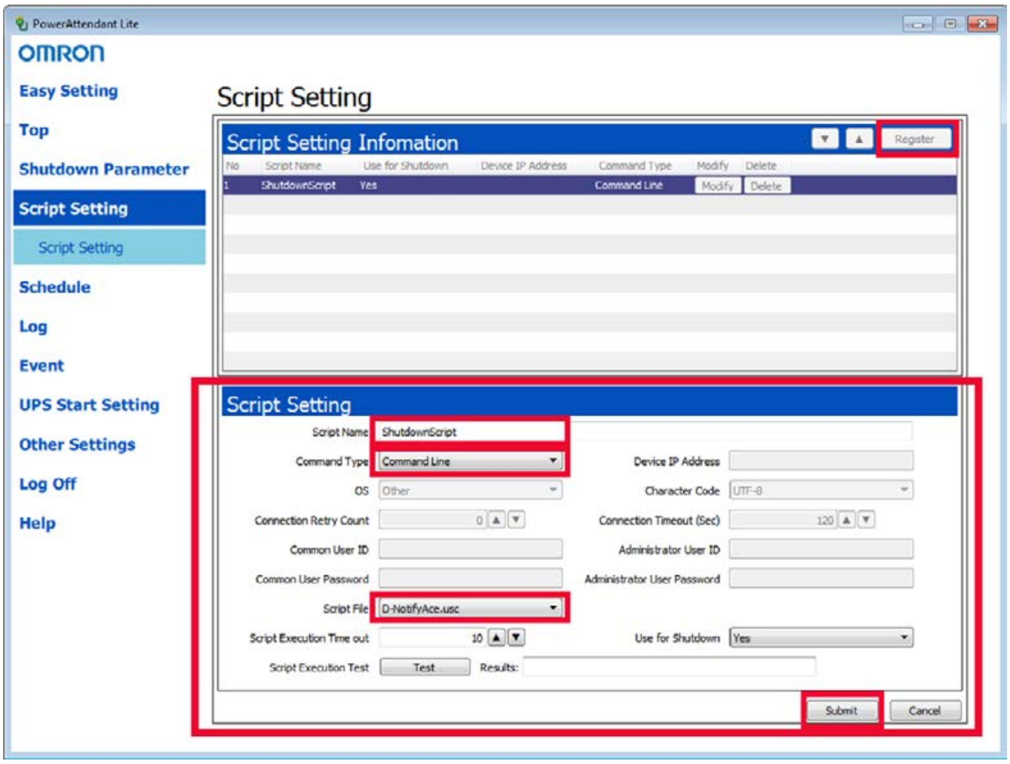


Figure 5-82 Power Attendant Lite Scrip Setting

Next, enter the Script Name that was previously saved. Select Command Type: **Command. Line.** Select the script file and then click **Submit.**

DC-DC ACE Enable UPS Shutdown

With

ACE Multiview Explorer opened, confirm that Smart Controller is selected, then from the Toolbar, click **Tools** and then **Option**.

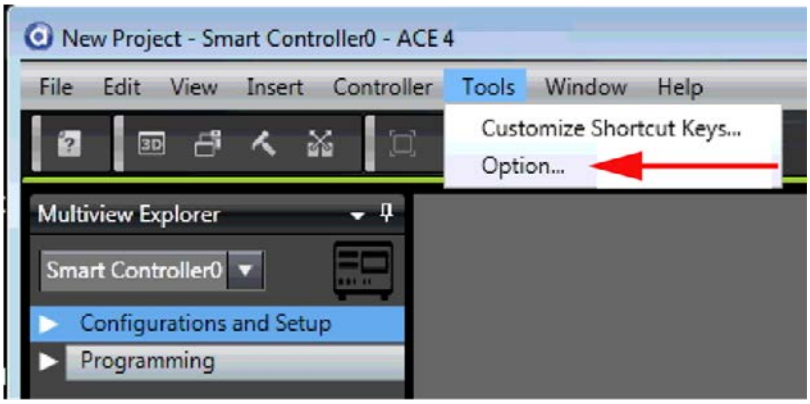


Figure 5-83 ACE Option

When the Option panel opens, select the **UPS** option.

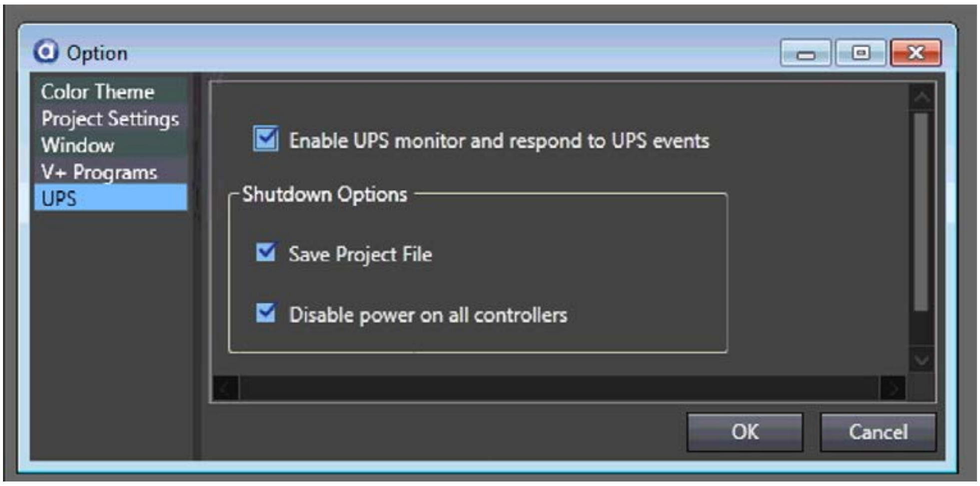


Figure 5-84 Selected UPS Option

Select the **UPS** option in the left-side panel.

Check the **Enable UPS monitor and respond to UPS events** check box.

Select the appropriate Shutdown options:

- Save Project File
- Disable power on all controllers

Click **OK** to close the panel and enable the changes.

Chapter 6: Programming with ACE Software

There are two methods of programming ACE applications. The method you choose depends on type of application you want to develop. The available methods are summarized below and described in more detail in this chapter.

SmartController Programming Overview

The V+ Editor described in this chapter is the main tool used to develop programs for the SmartController.

Application Manager Programming Overview

The C# Editor described in this chapter is the main tool used to develop C# programs for the Application Manager.

6.1 SmartController Programming

Creating SmartController programs can be accomplished by working with V+ Modules, V+ programs, and variables. These items can be accessed in the Programming section of the Multiview Explorer for a SmartController device as shown below.

> **NOTE:** When an ACE project is saved, all V+ Modules, V+ programs, and Variables are saved with the project.

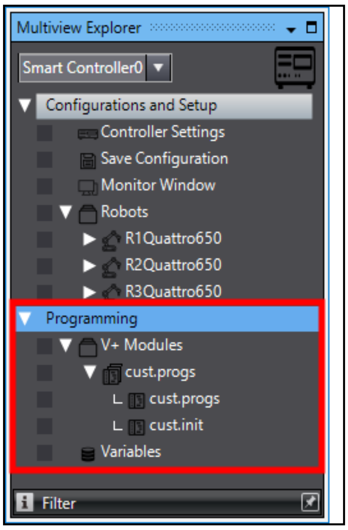


Figure 6-1 V+ Modules and Variables

V+ Module and Program Structure

V+ Modules are used to organize and group related programs. Group all similar or related V+ programs inside a specific V+ Module for easy and clear program referencing.

Each V+ Module needs to have a designated Module Program. A Module Program is the primary V+ program that ACE software uses for Module naming and other internal functions.

When adding a new V+ Module, a new V+ Module Program will be inserted with the default name of *program0*. To change the name of the V+ Module, edit the name of the V+ Module Program. To designate a different V+ program as the Module Program, right click a selected program and click **Set as Module Program**.

All V+ programs are created inside V+ Modules. V+ programs will be displayed under a V+ Module as shown below.

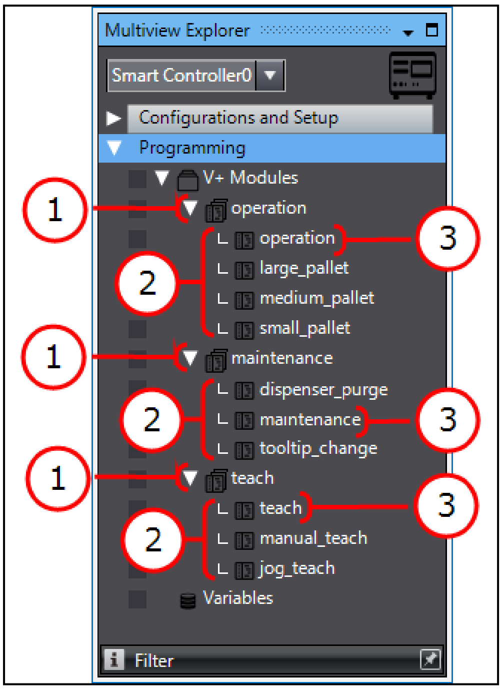


Figure 6-2 V+ Module and V+ Program Structure

Table 6-1 V+ Module and V+ Program Structure Description

Item	Description
1	V+ Modules
2	V+ programs
3	V+ Module Programs

V+ Module and Program Names

Rename V+ programs by right-clicking the program and selecting ***Rename***. Renaming the V+ Module Program will also rename the parent V+ Module. The V+ Module name will always become the name of the V+ program that is designated as the Module Program.

Use the following rules when naming a V+ Module or Program.

- Names must begin with a letter and can be followed by any sequence of letters, numbers, periods, and underscores.

- There is a 15 character limit for names.
- Names are not case sensitive and always default to lower-case letters.

Creating a New V+ Module

To create a new V+ Module, right-click **V+ Modules** in the Multiview Explorer and select **Add New Module**. A new V+ Module and default V+ program will be created.

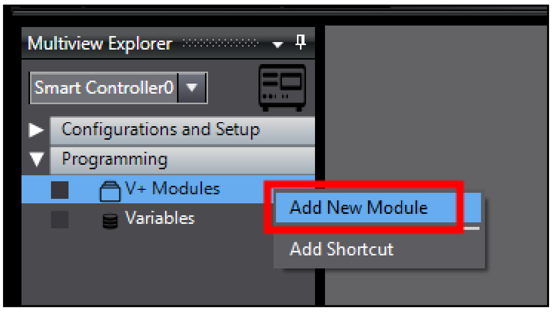


Figure 6-3 Add a New Module

Save a V+ Module to the PC

V+ Modules and their programs can be saved to the PC. Right-click a module and select ***Save to PC File***. A Save As Dialog Box will be displayed for saving a V+ File (*.pg) to the selected PC file.

Show Global Variable References

All global V+ variable references can be displayed for a particular V+ Module. Right-click a module and select **Show Global Variables**. A Show References Dialog Box will be displayed. This displays all V+ programs and all V+ Variables that are used. Clicking on a V+ Variable in the list will display its use in the program.

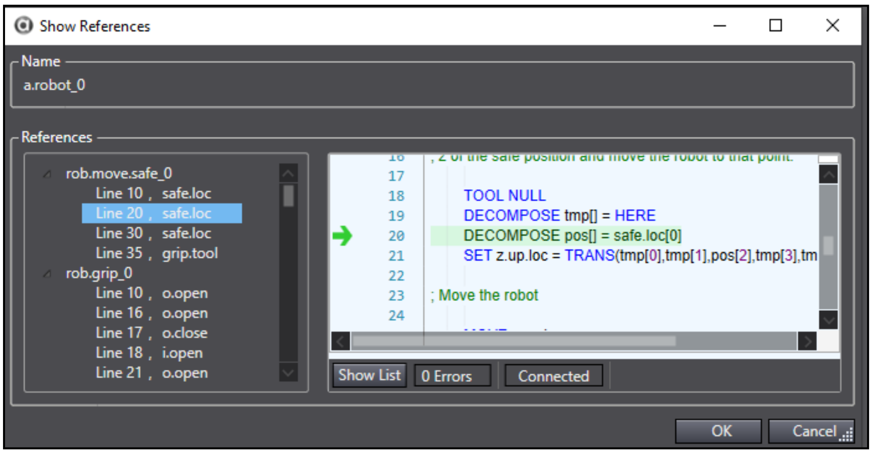


Figure 6-4 Show V+ Variable References

Show Program Call Commands

All program CALL commands can be listed for a particular V+ Module. Right-click a module and select **Show CALLers**. A Show CALLers Dialog Box will be displayed to provide a list of all CALL commands used throughout the V+ Module's programs. Clicking on an item in the list will display its use in the program.

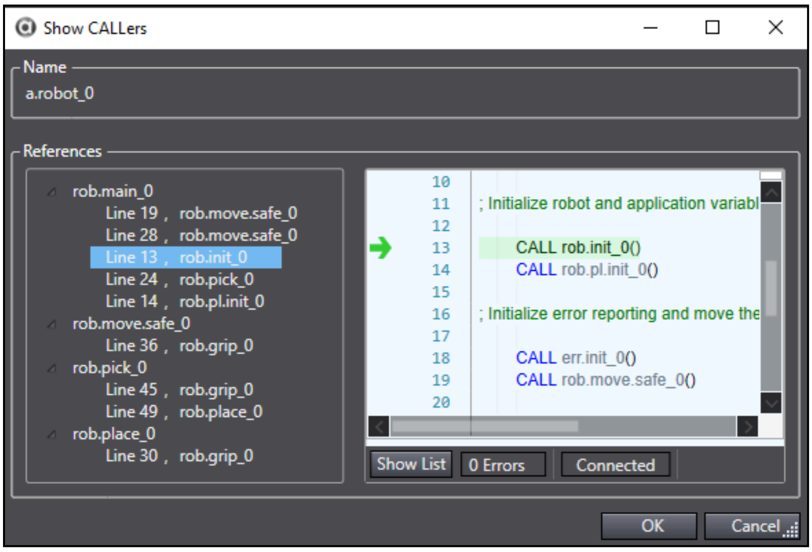


Figure 6-5 Show CALL Command References

Pull V+ Memory

Use the Pull V+ memory function to ensure the ACE software has the full contents of a controller available to the user interface. This function will upload V+ Modules, V+ programs, and Variables from the controller to the ACE project.

To upload V+ programs and Modules, right click any V+ Module and select **Pull V+ Memory**. This will upload all controller settings, V+ Modules and Programs to the ACE project.

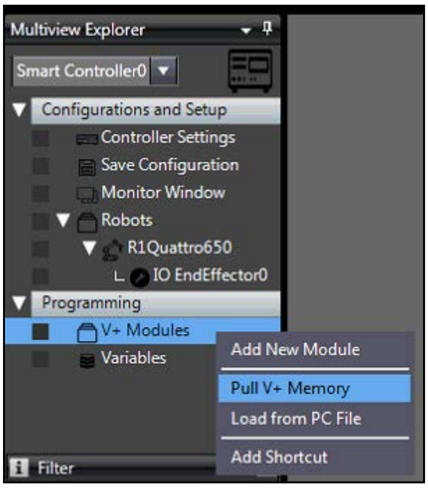


Figure 6-6 Pull V+ Memory

V+ Editor

The ACE V+ Editor is an online, interactive editor. The editor performs syntax checking and formatting while you are programming.

When the ACE software is online with a controller and you open a program, the program will be read from the controller memory. If a program is opened while offline, the program is read from the ACE project memory.

During the ACE online connection process, the controller and project memory are compared. Refer to Memory Comparison on page 82 for more info.

To access the V+ Editor, double-click a program in the Multiview Explorer. The V+ Editor will open in the Edit Pane.

> **NOTE:** The V+ Editor appearance can be adjusted. Refer to Project Options on page 140 for more information.

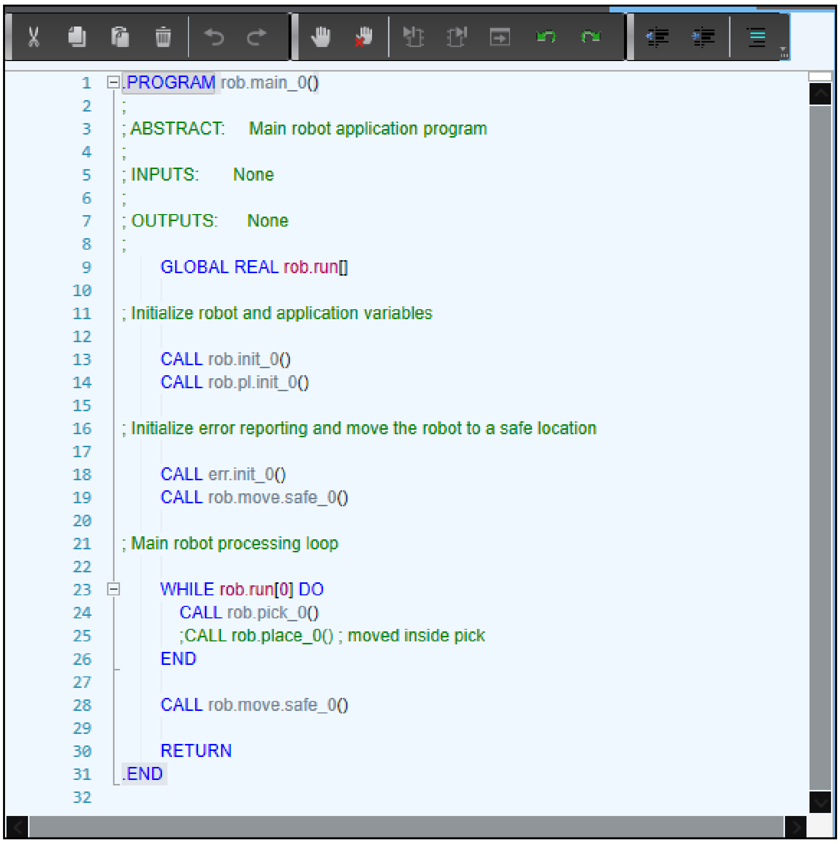


Figure 6-7 V+ Editor

V+ Editor Functions

The Editor Tool has the following functions.

Copy/Paste

Allows you to copy and paste ASCII text from other programs or other sources.

Inteliprompt Popups

When you type the significant letters of a V+ keyword and then press the **Enter** key, the editor attempts to complete the keyword.

- If the keyword is successfully completed, it is displayed in blue text.
- If there is an error, it is displayed in red text.

Intelliprompt Popups can be disabled in the project options area. Refer to Project Options on page 140 for more information.

Tool Tip Syntax

If the you hover the mouse cursor over a statement, the syntax and short description for that statement is displayed in a tool tip.

Formatting and Syntax Checking

As each line of program is entered it is processed by ACE. This processing performs the formatting and checking, reports back the resulting format, and then the editor is updated to reflect this. If there is a problem with the entry, an error appears in the Error List tab below the Edit Pane. Refer to Formatting and Syntax Checking on page 165 for more information.

Drag and Drop

The editor supports drag and drop of ASCII text from another Windows program onto an open area of the editor. You can also use this feature to move lines of code within the editor. To move text, highlight the text and then drag it to the new position.

Colorization

The code lines and text are colored to help visually distinguish between actual code, comments, and errors.

Code lines can have the following colors.

- No Color: code line has no change.
- Green: code line has a saved edit.
- Yellow: code line has an unsaved edit.

Text can have the following colors.

- Green: text used as comments.
- Blue: valid V+ keywords.
- Red underline: misplaced declaration statement or unknown command.
- Gray: object member.

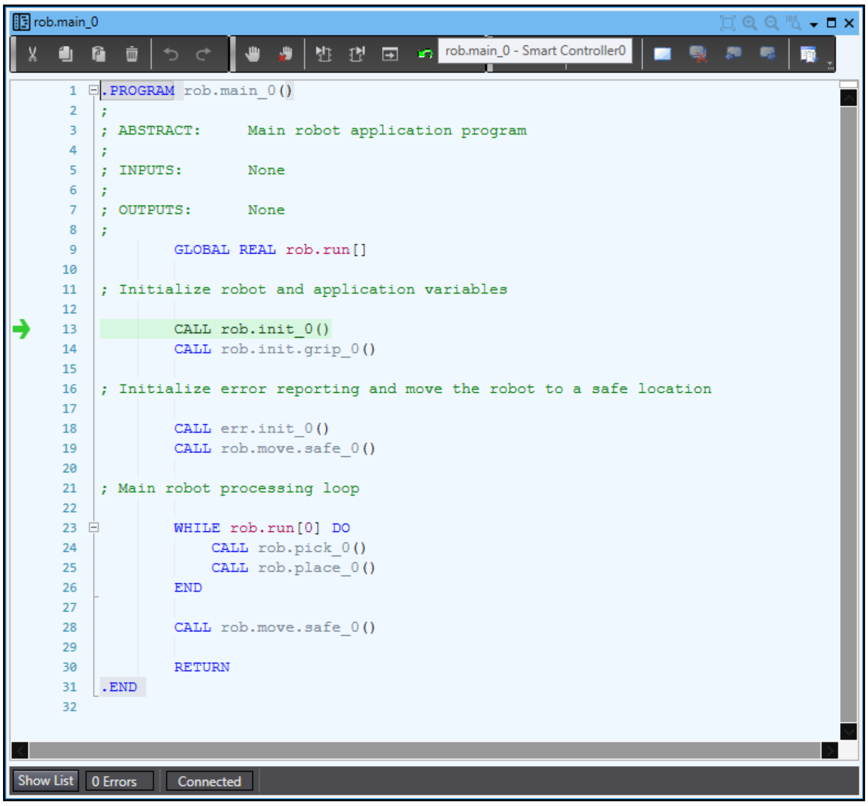


Figure 6-8 V+ Editor Colorization

Right-click Menu Functions

Right-clicking in the V+ Editor opens a menu with several functions. In a addition to basic editing commands (cut, copy, paste, delete, and select all), the following functions are also available.

- Comment/Uncomment Selection: change a code line to/from commented text.
- Execute on task/Debug on task: execute or debug a V+ program on a selected task number. Right-click the program name in the editor and select **Execute on task** or **Debug on task** as shown below.

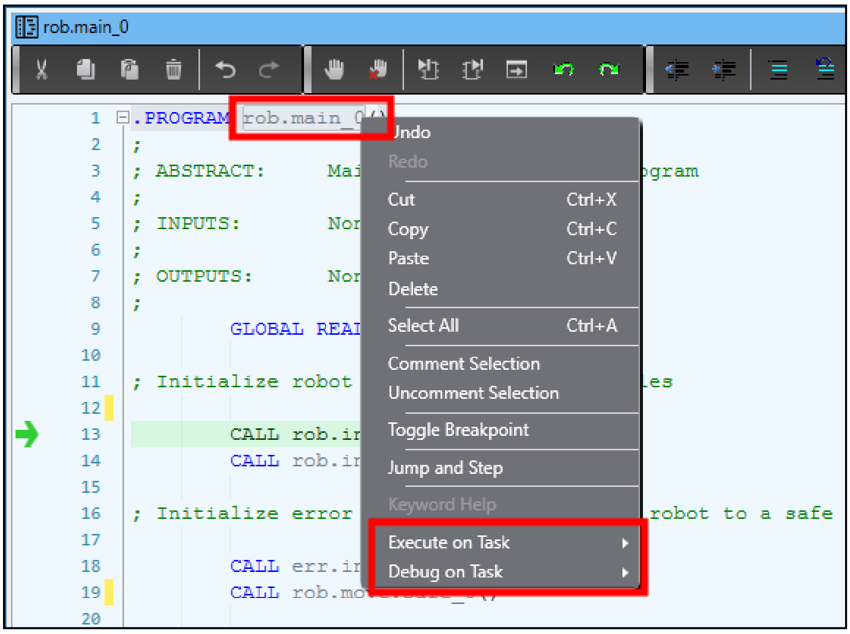


Figure 6-9 Execute/Debug on Task

- Toggle Breakpoint: insert a breakpoint to pause a program at a specific line (used for troubleshooting and diagnostics). A breakpoint is indicated with a red dot to the left of the code line as shown below.

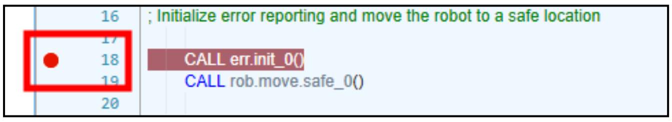


Figure 6-10 Breakpoint Added to a V+ Program

Step Into/Over

Use the following Step Into and Step Over functions during troubleshooting and diagnostics.

- Step Into: Single step operation that will enter a program call and single-step through the program. After the last line of the program has been executed, it returns to the step following the program call.
- Step Over: Single step operation that skips a program call. When the execution pointer is positioned at a CALL or CALLS keywords, typing F10 will cause the entire sub-routine to be executed and execution pauses at the step following the program call.

Comments

Add comments to a program for explanation and annotation. Commented program lines are not executed.

Bookmarks

Add bookmarks to a program for quick access to specific program lines. Bookmarks do not affect program execution. A bookmarked program line will be indicated with the following symbol.

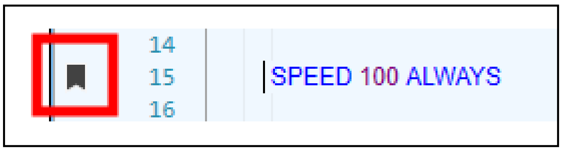


Figure 6-11 Bookmarked Program Line

Status Bar

The area below the V+ Editor window has the following functions.

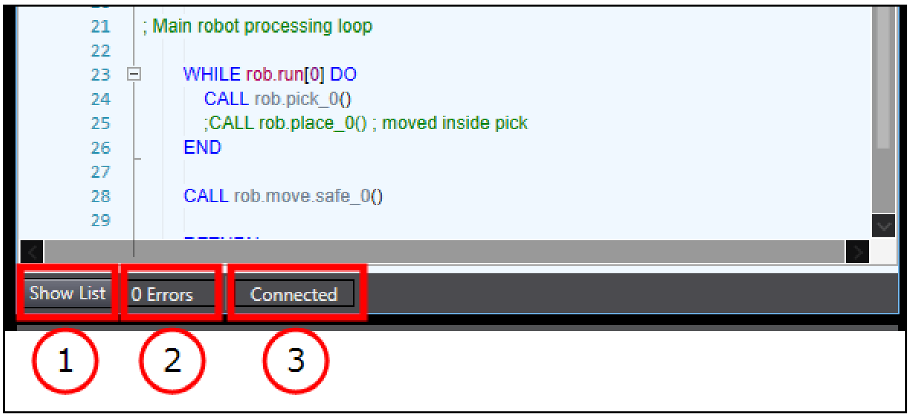


Figure 6-12 V+ Editor Status Bar

Table 6-2 V+ Editor Status Bar Description

Item	Name	Description
1	**Show List** Button	Open the Build Tab Page and display any errors that are present for any programs in the project.
2	Error List	Displays the total count of errors present in the program.
3	Connection State	Displays the connection state of the ACE project.

Toolbar Items

The V+ Editor has the following buttons on the toolbar.

Table 6-3 V+ Editor Toolbar Item Description

Icon	Name	Description
	Cut	Cut the selection and store on the clipboard.
	Copy	Copy the selection to the clipboard.
	Paste	Paste an item from the clipboard.
	Delete	Delete the selection.
	Undo	Undo the last action.
	Redo	Redo the last action.
	Toggle breakpoint at current line	Add a breakpoint to the currently selected program line.
	Clear all breakpoints	Remove all breakpoints from the active program.
	Step into (V+ program debugging)	Single step operation that will enter a program call and single-step through the program. After the last line of the program has been executed, it returns to the step following the program call.
	Step over (V+ program debugging)	Single step operation that skips a program call. When the execution pointer is positioned at a CALL or CALLS keyword, typing F10 will cause the entire program to be executed and execution pauses at the step following the program call.
	Jump to current line and step (V+ program debugging)	Jump to the currently selected line and then single-step through the program.
	Retry line (V+ program debugging)	Retries the current line
	Proceed execution (V+ program debugging)	Continues execution of the task until the next breakpoint or the program terminates.
	Outdent	Outdents the current line.
	Indent	Indents the current line.

Icon	Name	Description
	Comment section	Adds a semicolon to the beginning of a selected line to make it a program comment.
	Uncomment section	Removes a semicolon from the beginning of a selected line to make it an executable statement.
	Toggle bookmark	Add a bookmark to the selected line.
	Clear bookmark	Remove all bookmarks from the program.
	Previous bookmark	Move the cursor to the previous bookmark in the program.
	Next bookmark	Move the cursor to the next bookmark in the program.
	Display an object member list	Based on the cursor location, this displays a list of the available object members.
	Display parameter info	While the cursor is on a command, this will display that command's parameter info.
	Display quick info	Displays the tooltip info for the cursor location (the same as the tooltip when the cursor hovers).

V+ Program Debugging

The V+ Editor provides debugging tools when an online connection to the controller is present. This allows interactive program stepping while simultaneously displaying code variables and states. If a program in one module steps into a program in another module, the V+ Editor will automatically step you into that program. Breakpoints in the code can be added or removed while debugging. You can have as many active debugging sessions as there are tasks.

> **NOTE:** The ACE project must be online to use the V+ Editor program debugging functions.

Use one of the following methods to access the V+ Editor debugging functions for a program.

- Right-click the program in the Multiview Explorer and select ***Debug on Task***. Select a task and the program will run with the V+ debugging functions activated.
- Right-click a stopped task in the Task Manager and select ***Reset and Debug***. The program will reset and run with the V+ debugging functions activated.

A green arrow ( ) indicates the current program line where the stepping function occurs.

6.2 V+ Variables

V+ Variables are values used for storing various types of data. They can be created and edited with the V+ Variable Editor for use in V+ programming. Use the information below to understand how to create and use V+ Variables with the ACE software.

> **NOTE:** C# Variable objects can also be created and edited, but these are used with C# programs only. Refer to Application Manager Programming on page 178 for more information.

V+ Variable Types

The different V+ Variable types are described below.

> **NOTE:** All V+ Variables that are created with the V+ Variable Editor become global variable types accessible in all V+ programs. Refer to the *eV+ Language User's Guide (Cat. No. I604)* or the *V+ User's Manual (Cat. No. I671)* for more information about Auto and Local variables.

Real

A real V+ Variable type is a floating-point data type used to represent a real number.

String

A string V+ Variable type is a text-based data type used to represent characters.

Valid string characters include 128 8-bit ASCII characters.

Precision Point

A precision point variable type allows you to define a location by specifying a value for each robot joint. These joint values are absolute and cannot be made relative to other locations or coordinate frames. Precision point locations are useful for jointed-arm applications and with applications that require full rotation of robot arms with joint 4. They are also helpful where joint orientation is critical to the application or when you want to move an individual joint.

Location

A location variable type specifies the position and orientation of the robot tool tip in three-dimensional space. You can define robot locations using Cartesian coordinates (transformations).

A transformation is a set of six components that identifies a location in Cartesian space and the orientation of the robot tool flange (X, Y, Z, Yaw, Pitch, Roll). A transformation can also represent the location of an arbitrary local reference frame (also know as a frame of reference). Refer to Location on page 171 for more information.

The coordinate offsets are from the origin of the World coordinate system which is located at the base of the robot by default.

> **Additional Information**: Refer to the following sections for more information.
> - Coordinate Systems on page 25
> - 3D Visualizer on page 107
> - Location on page 254

Defining a Location

V+ Variable location values can be manually entered or acquired from the current robot position. Refer to V+ Jog Control on page 116 for more information.

6.3 V+ Variable Editor

The V+ Variable Editor is used to create and edit different types of V+ Variables. Refer to the *eV+ Language User's Guide (Cat. No. I604)* or the *V+ User's Manual (Cat. No. I671)* for more information. All variable types share the following properties but some variables have additional properties (see below).

Access the V+ Variable Editor by double-clicking **Variables** in the Multiview Explorer (or right-click and select **Edit**).

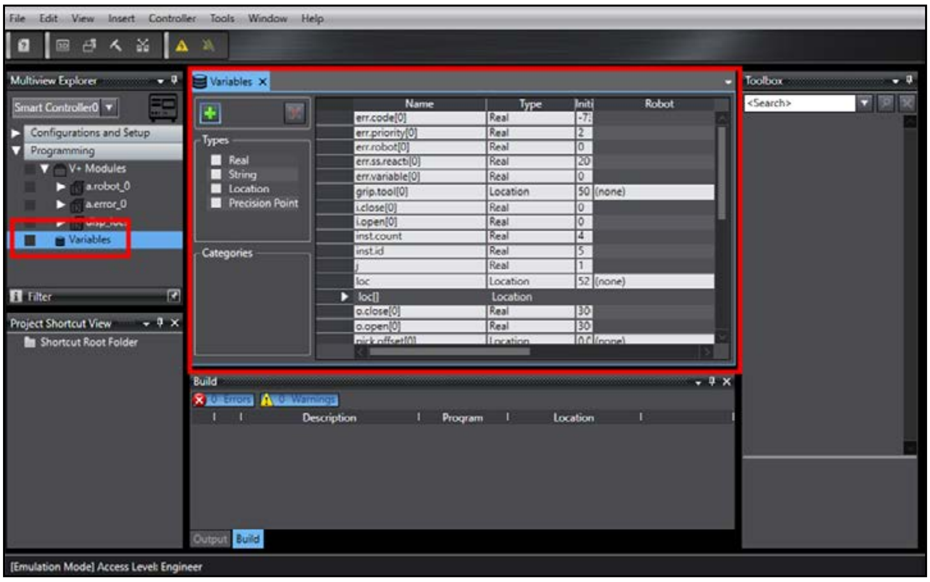


Figure 6-13 V+ Variable Editor

V+ Variable Names

V+ Variables must have a unique name. Use the name to reference V+ Variables in V+ programs.

Use the following rules when naming the different V+ Variable types.

- Real and Location variables must begin with a letter and can be followed by any sequence of letters, numbers, periods, and underscores.
- String variables must begin with the $ symbol and can be followed by any sequence of letters, numbers, periods, and underscores.
- Precision Point variables must begin with the # symbol and can be followed by any sequence of letters, numbers, periods, and underscores.
- There is a 15 character limit for variable names.
- Variables are not case sensitive and always default to lower-case letters.
- Because ACE automatically creates default system variable names, avoid creating variable names that begin with two or three letters followed by a period to prevent coincidental variable name duplications. For example, sv.error, tsk.idx, and tp.pos1 are variable names that should be avoided. This restriction applies when creating variables in the V+ Editor and within V+ programs.

V+ Variable Properties

Variables contain properties that define the behavior and use within the ACE software. Use the V+ Variable property types described below as new variables are created and edited. Refer to the *eV+ Language User's Guide (Cat. No. I604)* or the *V+ User's Manual (Cat. No. I671)* for additional information about V+ variable properties.

Name

The name property is used as a reference to a V+ Variable in a V+ program.

Type

The type property defines what type of data is stored in the variable.

Initial Value

The initial value property is used to set the variables default value before any program or other function alters it.

Category

A category can be defined for each variable to help classify and organize variables. V+ Variables can be saved by category as well. Refer to Save Configuration on page 220 for more information.

Description

A description can be added to each variable for annotation and clarification purposes.

Robot

A robot in the ACE project can be assigned to a location or precision point variable. This property does not apply to other variable types. When assigning a robot current position to the location or precision point variable, a robot must be selected. The robot must be assigned for display purposes and for inclusion in location lists provided by the V+ Jog Control.

Display Mode

The following Display Mode options affect how a location or precision point variable appears in the 3D Visualizer. This property does not apply to other variable types.

- Do not display: the point will not appear in the 3D Visualizer.
- Display as point: the point will appear as a circle ().
- Display as frame: the point will appear as a coordinate symbol ().

Arrays

A variable can be created as a 1D, 2D, or 3D array. Use the array selection options in the Add a new variable Dialog Box to establish the dimensions of the array. Refer to Creating a New V+ Variable on page 174 for more information.

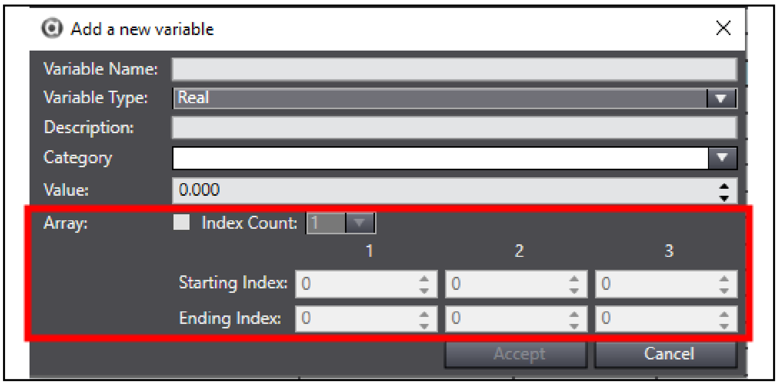


Figure 6-14 Array Dimension Settings

Creating a New V+ Variable

Use the following procedure to create a new V+ Variable with the V+ Variable Editor.

NOTE: V+ Variables can also be created from a V+ program. Refer to the *eV+ Language User's Guide (Cat. No. I604)* or the *V+ User's Manual (Cat. No. I671)* for more information.

New Precision Point and Location variable types can also be created from the V+ Jog Control. Refer to V+ Jog Control on page 116 for more information.

Additional Information: Once a variable is created, the type and array size cannot be changed.

1. Click the **Add** Button ( ). This will open the Add a new variable Dialog Box.

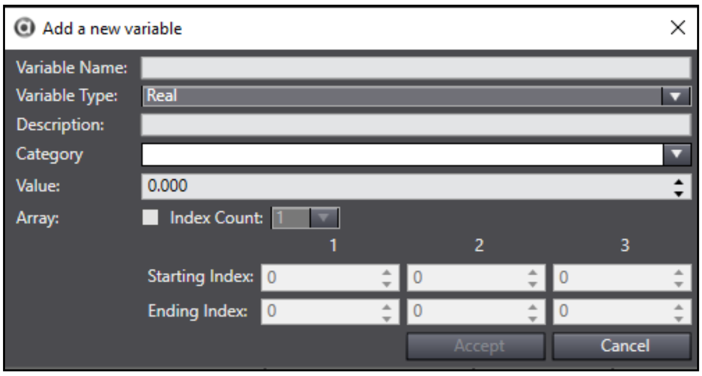


Figure 6-15 Add a New V+ Variable

2. Input a unique variable name.
3. Select a variable type from the dropdown menu.

NOTE: Selecting the variables types of location and precision point will expose the additional field for robot assignment, the **Here** Button (for acquiring position values from a robot), and the Display mode selection.

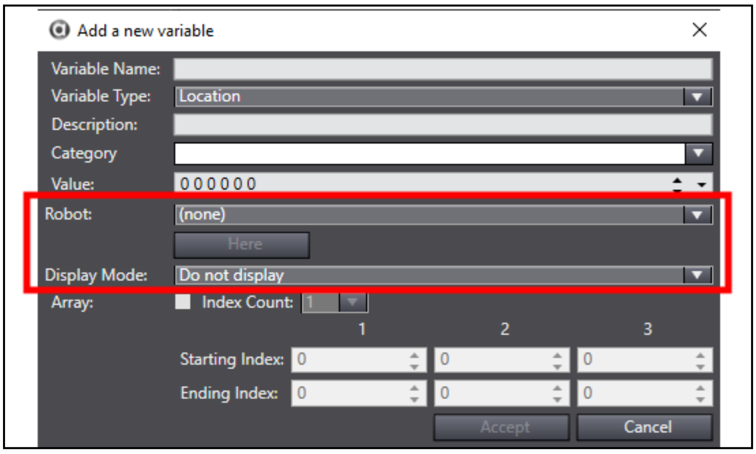


Figure 6-16 Additional Variable Properties

4. Provide an optional description.
5. Enter a new category name or select an existing category for the new variable (optional).
6. Enter a value for the new variable.
7. If this variable is an array, select the array option, choose the ***Index Count***, and enter the array dimensions.
8. After all fields are set, click the **Accept** Button and the new V+ Variable is created and visible in the V+ Variable Editor.

Editing an Existing V+ Variable

To edit an existing V+ Variable, click the field to edit in the V+ Variable Editor window and change the value accordingly.

To delete an existing V+ Variable, either select the variable row and click the **Delete** Button () or right-click the variable row and select ***Delete***. A Confirmation Dialog Box will be shown.

> **NOTE:** Multiple variables can be selected by using the Shift or Control buttons and selecting multiple rows.

Filtering by Types and Categories

Existing variables can be filtered by type or category. Category selections will only appear if they have been pre-assigned to existing variables.

Make selections to filter variables by type and category.

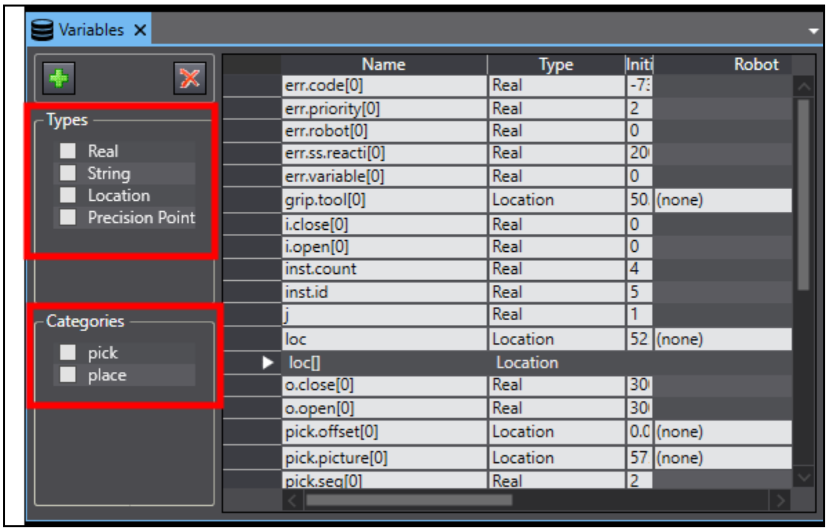


Figure 6-17 Filter by Type and Category

Other V+ Variable Editor Function Keywords

Several other functions are available in the V+ Variable Editor. These functions can be accessed by right-clicking an existing variable in the editor window as described below.

Cut, Copy, Paste, Delete

C# Variable objects can be cut, copied, pasted, and deleted with these options. Pasting will prepend "Copy_1_of_" to the name of the new C# Variable object.

Show References

Selecting **Show References** will display a list of program references where the variable is used. If a variable is used in programs, the program name and line numbers are provided to locate exactly where the variable is used. Clicking a line number will display the program reference as shown below.

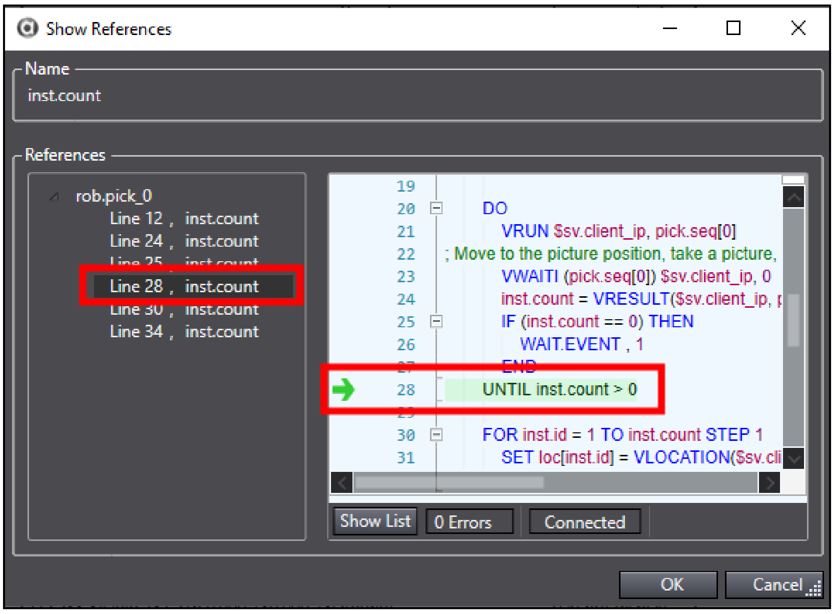


Figure 6-18 Show References

Add to Watch

Selecting **Add to Watch** will place the C# Variable object in the V+ Watch window. Refer to V+ Watch on page 135 for more information.

Record Here

Selecting **Record Here** will acquire the robot's current position values and place them in the initial value field. This option is only available if a robot has been assigned in the variable. This option is only available for precision point and location variable types.

Select in Virtual Pendant

Choosing **Select in Virtual Pendant** will open the V+ Jog Control with the variable pre-selected in the Location area. This is a convenient method for jogging and teaching a robot position for a variable. This is only available if robot has been assigned in the variable. Refer to V+ Jog Control on page 116 for more information. This option is only available for precision point and location variable types.

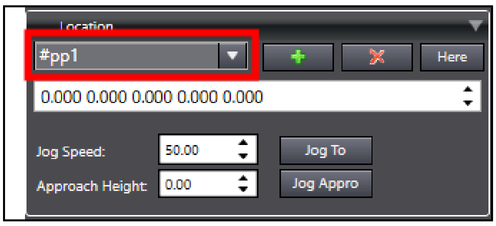


Figure 6-19 Pre-selected Variable in V+ Jog Control

Focus in 3D Visualization

Selecting **Focus in 3D Visualization** will open the 3D Visualizer and center the view at the coordinates. This option is only available for precision point and location variable types with an assigned robot.

6.4 Application Manager Programming

This chapter will describe the basics of C# programs in the ACE software. These concepts apply to the other C# interfaces as well. For additional ACE API documentation and simple C# program examples, refer to the *ACE Reference Guide*.

> **IMPORTANT:** If you are inexperienced with the object-oriented C# programming language, it is recommended that you explore Microsoft's documentation and tutorials to become familiar before attempting to create or edit these types of programs.

The Application Manager device provides C# interfaces for the following functions.

- C# custom program functions (see below)
- Custom Vision Tool (refer to Custom Vision Tool on page 634 for more information)
- Allocation Scripts (refer to Allocation Script Object on page 458 for more information)
- Recipe Manager Scripts (refer to Recipe Manager Script on page 350 for more information)

C# programs can be used for the following functions, for example.

- Managing product changes for a workcell or production line.
- Enabling or disabling processes of a Process Manager in a packaging application.
- Changing properties of vision tools or associating different vision models with a Locator Tool.
- Custom statistics tracking
- Manipulating the position and visibility of objects in the 3D Visualizer.

The use of numeric and string variable objects is required if you need to share variable values between multiple C# programs. C# programs and variables can be accessed in the Programming section of the Multiview Explorer for a Application Manager device as shown below.

> **NOTE:** When an ACE project is saved, all C# programs and Variables objects are saved with the project.

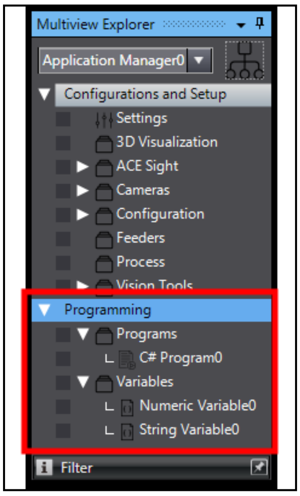


Figure 6-20 C# Programs and Variables

Creating a New C# Program

To create a new C# program, right-click ***Programs*** and select ***Add*** and then ***C# Program***. A new C# program will be created.

> **Additional Information**: New C# programs are created with minimum program structure in place as well as a basic trace message to indicate when a script has started.

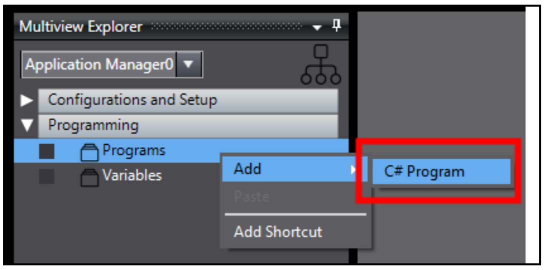


Figure 6-21 Add a new C# Program

C# Program Names

Rename C# programs by right-clicking the program and selecting ***Rename***. Program names can include letters, numbers, and special characters.

C# Program Editor

The C# program editor can be used to create and edit programs for performing various tasks and automation within the ACE project.

To access the C# Editor, double-click a program in the Multiview Explorer. The C# Editor will open in the Edit Pane.

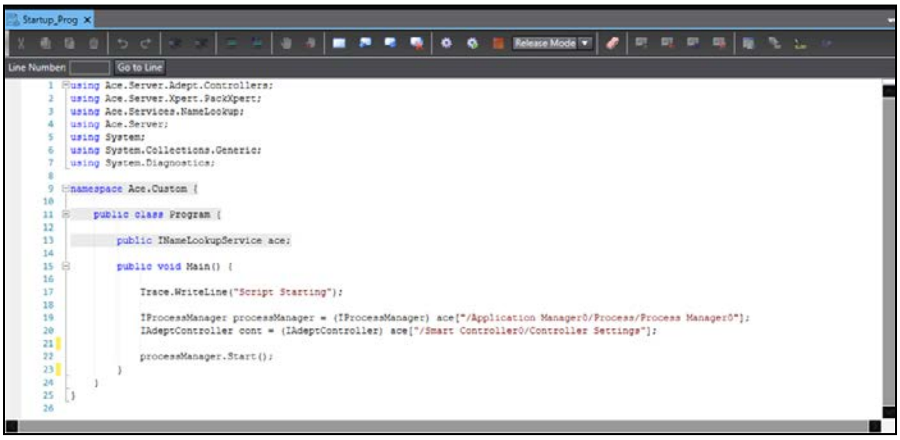


Figure 6-22 C# Editor

C# Editor Details

The Editor Tool has the following functions.

Drag and Drop Reference to Objects

Application Manager objects can be referenced in the C# program with a drag and drop action. For example, drag and drop a virtual camera object to place a reference to that object in the C# program.

Access to Controller Memory Contents

Drag and Drop Controller Settings into a C# program to create a reference to a specific SmartController device. You can access V+ variables, digital I/O, and more from this reference. Refer to the *ACE Reference Guide* for more information.

Copy/Paste

Allows you to copy and paste ASCII text from other programs or other sources.

Auto-complete

When you type the significant letters of a statement and then press the Enter key, the editor attempts to complete the keyword.

Tool Tip Syntax

If the you hover the mouse cursor over a statement, the syntax and short description for that statement is displayed in a tool tip.

Formatting and Syntax Checking

As each line of program is entered it is processed by ACE. This processing performs the formatting and checking, reports back the resulting format, and then the editor is updated to reflect this. If there is a problem with the entry, an error appears in the Error List tab below the Edit Pane. Refer to Formatting and Syntax Checking on page 180 for more information.

Drag and Drop

The editor supports drag and drop of ASCII text from another Windows program onto an open area of the editor. You can also use this feature to move lines of code within the editor. To move text, highlight the text and then drag it to the new position.

Colorization

The code lines and text are colored to help visually distinguish between actual code, comments, and errors. Code lines can have the following colors.

- No Color: code line has no change.
- Yellow: code line has an unsaved edit.

Text can have the following colors.

- Green: text used as comments.
- Blue: definitions
- Red: Strings
- Black: non-keywords and operators as valid syntax

Right-click Menu Functions

Right-clicking in the C# Editor opens a menu with several functions. In a addition to basic editing commands (cut, copy, paste, delete, and select all), the following functions are also available.

- Toggle All Outlining: collapse/expand all outlining regions of code.
- Toggle Outlining Expansion: collapse/expand selected outlined region of code.
- Collapse to Definitions: collapse areas for all members.
- Comment/Uncomment Lines: change a code line to/from commented text.

C# Program Editor Comments

Add comments to a program for explanation and annotation. Commented text is not executed.

C# Program Editor Bookmarks

Add bookmarks to a program for quick access to specific program lines. Bookmarks do not affect program execution. A bookmarked program line will be indicated with the following symbol.

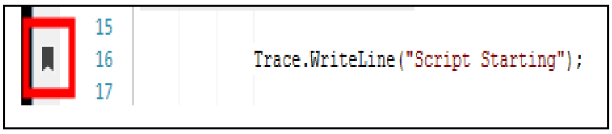


Figure 6-23 Bookmarked Program Line

Error List

Program compile errors are shown in the Error List Tab below the C# program Edit Pane. When errors are present in the list, execution is not possible. Use the Error List Line, Char (character), and Description information to resolve program compile errors.

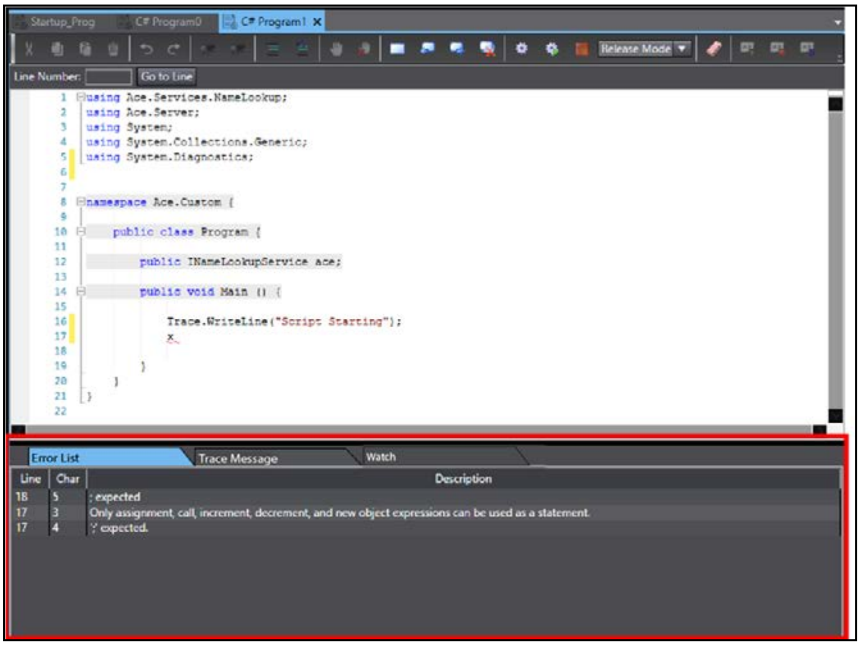


Figure 6-24 C# Error List

Trace Messages

Trace Messages are shown in the Trace Message Tab below the C# program Edit Pane. This displays messages created from any Trace.WriteLine() call in the program and can be useful when troubleshooting or debugging a program.

> **Additional Information**: Erase all Trace Messages with the ( ) icon in the C# program editor toolbar. This will also clear Trace Messages from the Task Status Control Trace Messages area.

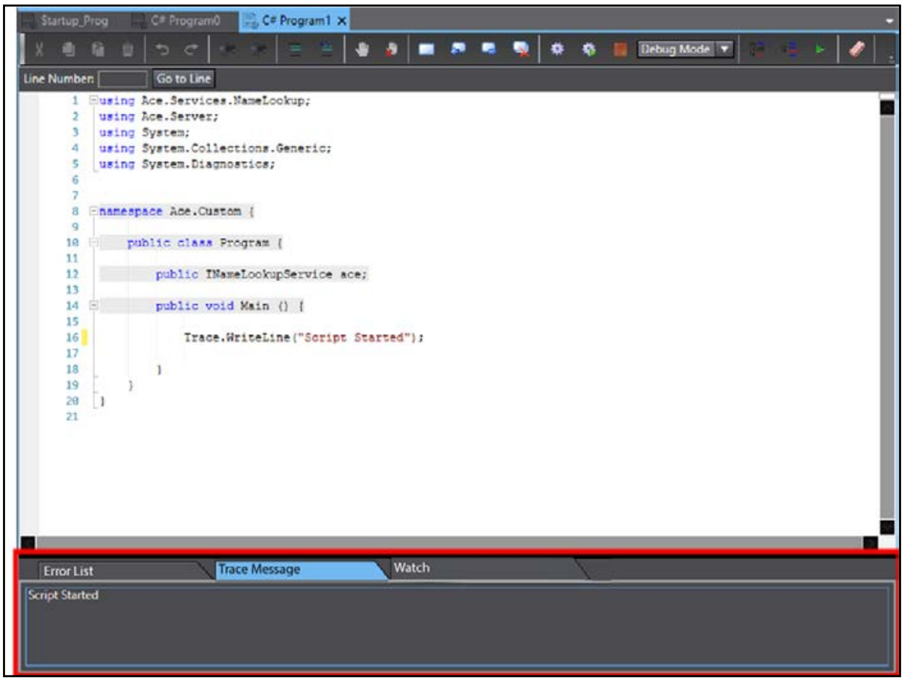


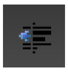
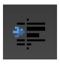
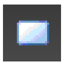
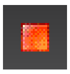
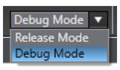
Figure 6-25 C# Trace Messages

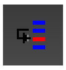
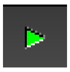
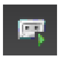
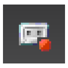
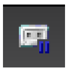
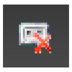
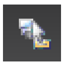
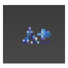
Toolbar Items

The C# Editor has the following buttons on the toolbar.

Table 6-4 C# Editor Toolbar Description

Icon	Name	Description
	Cut	Cut the selection and store on the clipboard.
	Copy	Copy the selection to the clipboard.
	Paste	Paste an item from the clipboard.
	Delete	Delete the selection.
	Undo	Undo the last action.
	Redo	Redo the last action.

Icon	Name	Description
	Outdent	Outdents the current line.
	Indent	Indents the current line.
	Comment section	Adds a semicolon to the beginning of a selected line to make it a program comment.
	Uncomment section	Removes a semicolon from the beginning of a selected line to make it an executable statement.
	Toggle breakpoint at current line	Add a breakpoint to the currently selected program line.
	Clear all breakpoints	Remove all breakpoints from the active program.
	Toggle bookmark	Add a bookmark to the selected line.
	Clear bookmark	Remove all bookmarks from the program.
	Previous bookmark	Move the cursor to the previous bookmark in the program.
	Next bookmark	Move the cursor to the next bookmark in the program.
	Compile	Compile the program.
	Compile and Run	Compiles and runs the program.
	Stop	Stops the program. Only available when the program is running.
	Debug/Release Mode	Selects the editor mode. Release Mode is the normal execution mode. Debug Mode is used to debug the program.
	Step Over	Single step operation that skips a program call. Only available when breakpoints are present in Debug Mode.

Icon	Name	Description
		A green arrow () indicates the current program line where the stepping function occurs.
	Step Into	Single step operation that will enter a program call and single-step through the program. Only available when breakpoints are present in Debug Mode. A green arrow () indicates the current program line where the stepping function occurs.
	Go	Runs the program. Only available when breakpoints are present in Debug Mode.
	Erase Trace	Clears messages from the Trace Message Tab and the Task Status Control Trace Messages Area.
	Run Recorded Macro	Runs a recorded Macro. This button is only available if a Macro has been recorded. **NOTE:** Closing the C# Editor will erase any recorded Macros.
	Record Macro	Begin recording a Macro. Recording a Macro captures a series of keystrokes for replay with the **Run Recorded Macro** button. Click the **Record Macro** button while recording to end and save the Macro.
	Pause Recording	Pauses a Macro recording. This button is only available while a Macro is recording.
	Cancel Recording	Cancels a Macro Recording. This button is only available while a Macro is recording.
	Display an object member list	Based on the cursor location, this displays a list of the available object members.
	Display parameter info	While the cursor is on a command, this will display that command's parameter info.
	Display quick info	Displays the tooltip info for the cursor location (the same as the tooltip when the cursor hovers).
	Display Word Completion	Based on the cursor location, this displays a list of the available object members.

6.5 C# Variable Objects

C# Variables objects are values used for storing numeric and string data types. After adding C# Variables objects, they can be edited with the C# Variable Editor. Use the information below to understand how to create and use C# Variables objects with the ACE software.

> **NOTE:** V+ Variables objects can also be created and edited, but these are used with V+ programs only. Refer to SmartController Programming on page 160 for more information.

C# Variable Object Types

Numeric and string C# Variable objects can be used to share data between C# programs that run separately. Numeric types hold numerical values and string types hold text-based values used to represent characters. Valid string characters include 128 8-bit ASCII characters.

Creating a New C# Variable Object

Right-click ***Variables*** in the Multiview Explorer and select ***Add*** and then ***Numeric Variable*** or ***String Variable***. The new variable will be added to the Variables list.

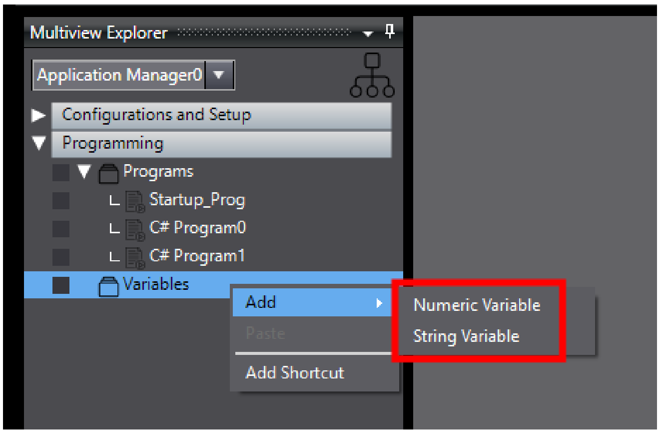


Figure 6-26 Creating a New C# Variable Object

Other C# Variable Object Function Keywords

Several functions are available for existing C# Variables objects. Right-click an existing C# Variable object to display a menu with function selections described below.

Cut, Copy, Paste, Delete

C# Variable objects can be cut, copied, pasted, and deleted with these options. Pasting will prepend "Copy_1_of_" to the name of the new C# Variable object.

Editing C# Variable Objects

After a C# Variable object has been created, double-click the variable in the Multiview Explorer to open the C# Variable Editor in the Edit Pane. This editor allows you to assign a current value and provide a description.

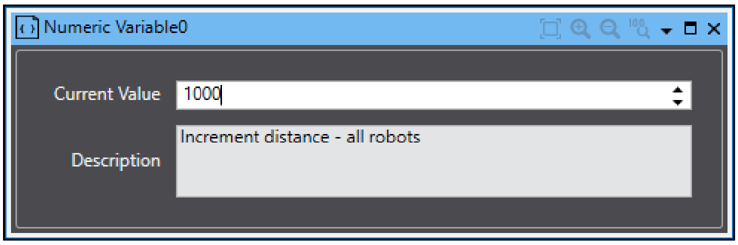


Figure 6-27 C# Variable Object Editor

You can also add a watch to the C# Edit Pane, using the steps in the following section.

Set Value in C# Watch Window

Besides editing C# objects in the editor you can also add a Watch to the C# process.

> **NOTE:** To use the Watch function you must be in debug mode and the insertion point is at a break.

1. With the editor in debug mode, select the string that you want to watch.
2. Left click the line you want to watch, so that a red circle shows to the left of the string.
3. Right click the editor at that point, and from the drop-down, select **Add Watch**.
4. A watch line opens in the panel under the C# editor.

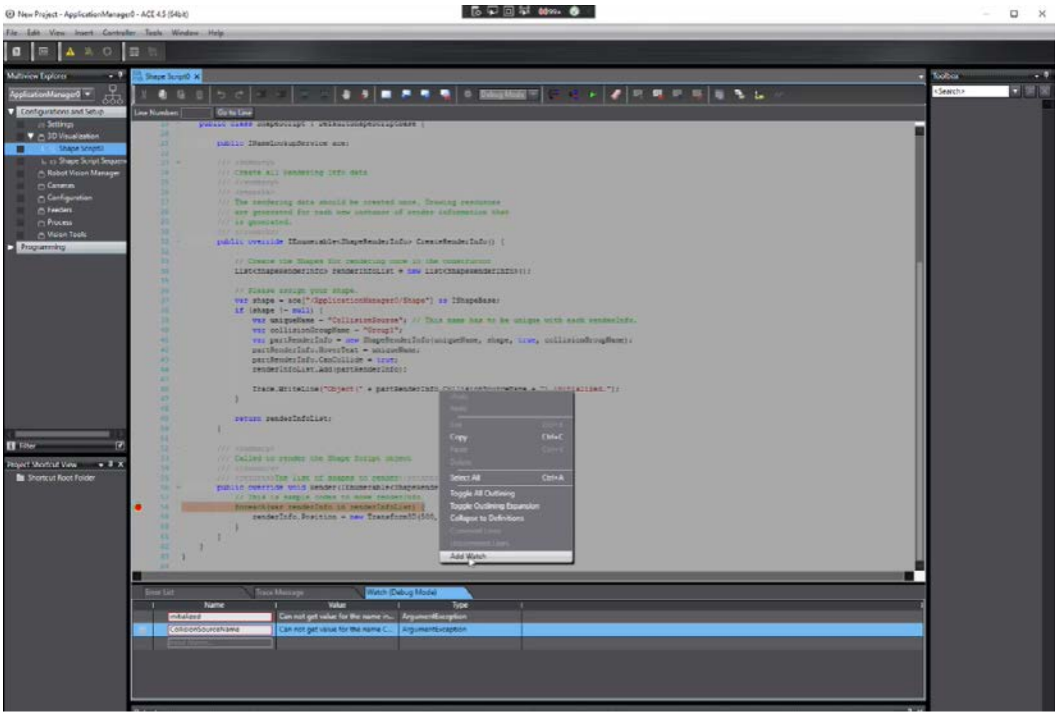


Figure 6-28 Add Single Watch Option

You can also left click and drag in the editor window to select multiple strings, then right click in the editor and from the drop-down, select **Add Watch**. This adds watch lines in the lower pane for each of the selected lines in the editor.

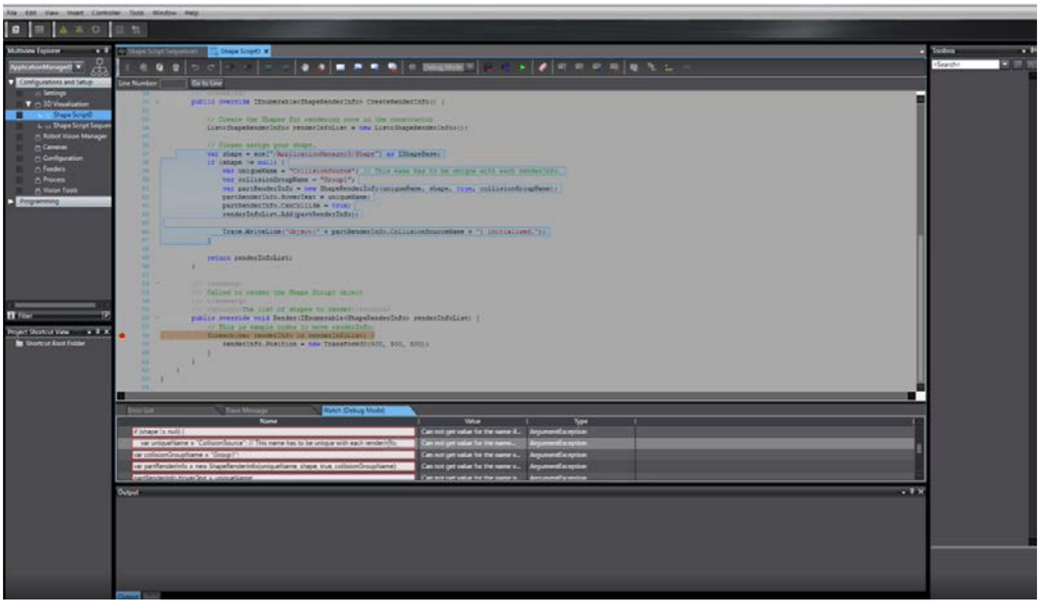


Figure 6-29 Multiple Watch Selection

Chapter 7: SmartController Configuration and Setup

The following items are available for the configuration and setup of a SmartController.

Use the Multiview Explorer to access these items as shown below.

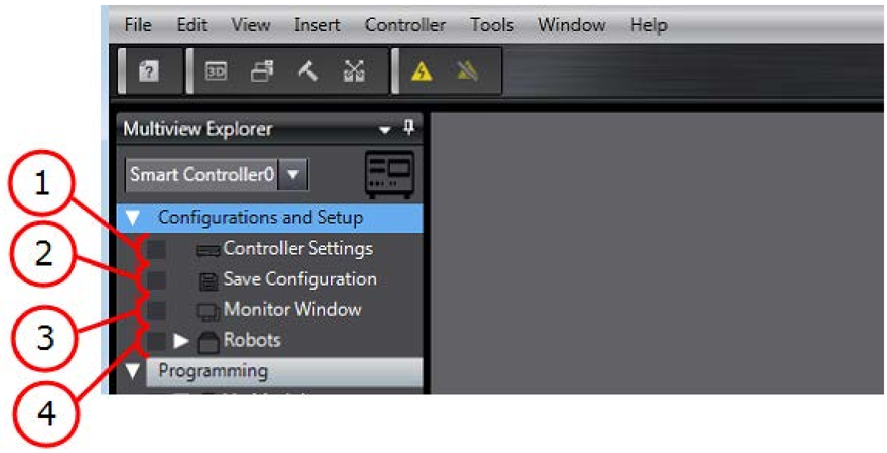


Figure 7-1 SmartController Configuration and Setup Items

NOTE: These items do not apply when viewing an application manager device in the ACE project.

Table 7-1 SmartController Configuration and Setup Items

Item	Name	Contents	Reference
1	Controller Settings	Configuration	Refer to Configuration on page 197 for more information.
		Parameters	Refer to Parameters on page 198 for more information.
		Control • Set Time • Reboot V+ • Servo Reset • Zero Memory • Save Startup Specifications • Save Memory to a File • View eV+ Log	Refer to Control on page 199 for more information.
		Upgrade	Refer to Upgrade on page 201

Item	Name	Contents	Reference
		• Upgrading V+ • Upgrading FireWire Firmware	for more information.
		Configure • Configuring Licenses • Configuring Robot • Configuring FireWire Nodes • Configure I/O • Configure Belt Encoder Latches • Configure Robot Position Latches • Configure System Settings	Refer to Configure on page 205 for more information.
		Backup/Restore • Backup V+ • Restore V+ • Compare V+ to Backup	Refer to Backup/Restore on page 217 for more information.
		Encoders	Refer to Encoders on page 219 for more information.
2	Save Configuration		Refer to Save Configuration on page 220 for more information.
3	Monitor Window		Refer to Monitor Window on page 222 for more information.
4	Robot Objects	3D Visualization	Refer to 3D Visualization on page 278 for more information.
		Configuration	Refer to Configuration on page 250 for more information.
		I/O EndEffector	Refer to I/O EndEffectors on page 242 for more information.
		Location	Refer to Location on page 254 for more information.
		Object (Menu Item) • Expert Access	Refer to Object on page 255 for more information.
		Configure (Menu Item) • Save Startup Specifications • Load Spec File • Save Spec File • Axes, Options and Kinematics • Obstacles • S-Curve Profiles • Safety Settings	Refer to Configure on page 255 for more information.
		Control (Menu Item) • Hardware Diagnostics • Data Collection • Motor Tuning	Refer to Control on page 261 for more information.

7.1 Controller Settings

The Controller Settings item in the Multiview Explorer provides tools for installing and configuring the system. Use the information below to understand the functions of the Controller Settings area.

> **IMPORTANT:** When Emulation Mode is enabled, some controller settings are not available. Refer to Emulation Mode on page 19 for more information.

> **NOTE:** Many Controller Settings items are not available while offline. See the following sections for more information.

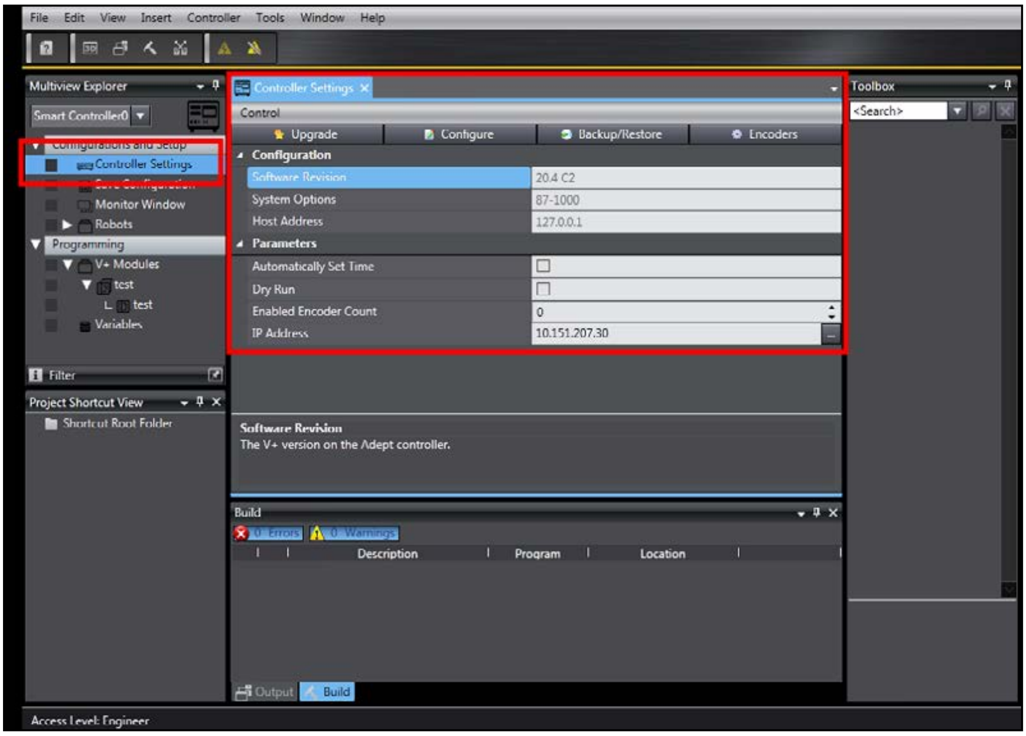


Figure 7-2 Controller Settings Area

Controller Customization

The general controller parameters are displayed when the controller node is selected in the process strategy editor. The Controller can then be customized for the identified objects by selecting a specific check-box, as shown below.

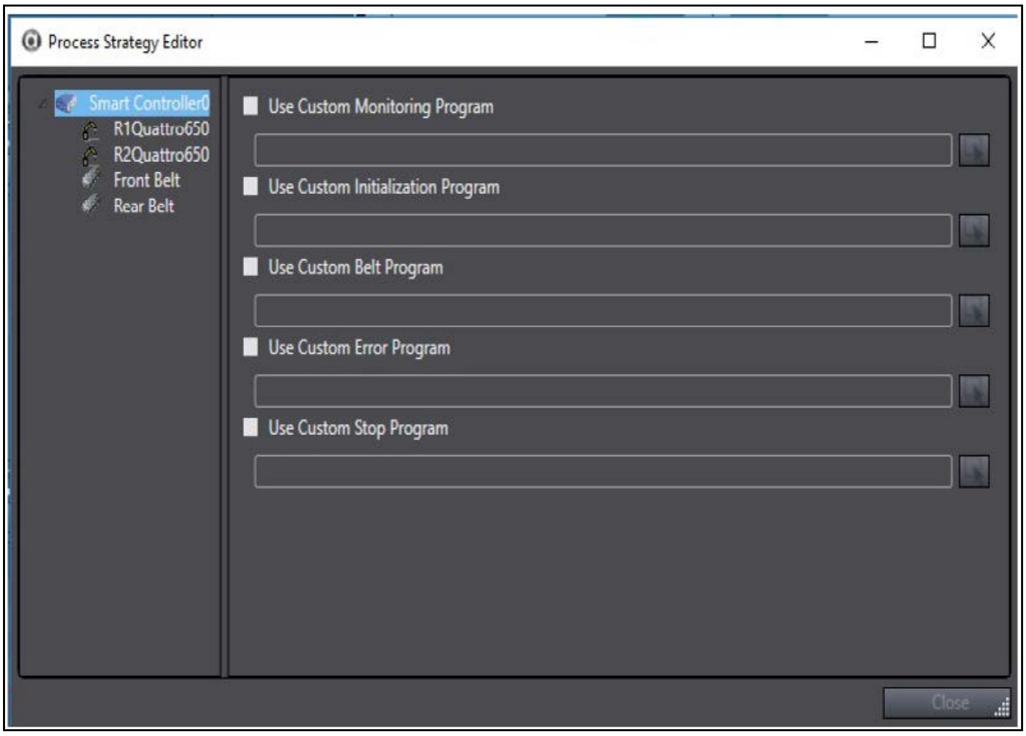


Figure 7-3 Controller Customization

The following section provide information about Custom Error Programs, which is when a V+ program is called when any robot error occurs.

If the V+ program that runs when process manager stops running, the Customizing Stop Behavior section identifies how to handle the results.

Custom Error Programs

The process manager runtime control will display errors that are reported during the execution of a process manager application. Many of these errors are generated from the V+ programs that control the robot and monitor other aspects of the hardware on the robot controller.

For all errors generated on the controller, you can customize how errors are handled and which errors are reported to the user interface.

Error Display

The process manager runtime display will show errors for all hardware sources, controllers, and robot stations, as shown in the following figure.

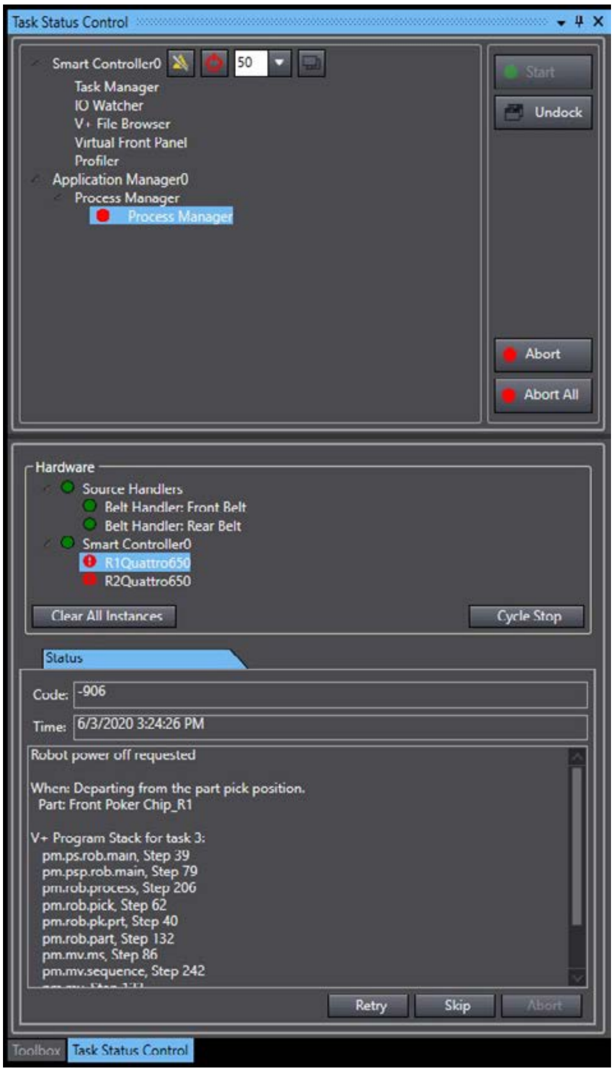


Figure 7-4 Object V+ Errors

V+ Error Customization

When an error is generated on a controller, a single program on the robot is called to handle the error. This program makes a determination if an error is to be send to the PC to display or if the error should be automatically handled without user notification.

This program can be customized on a controller by controller basis using the GUI shown in the following figure.

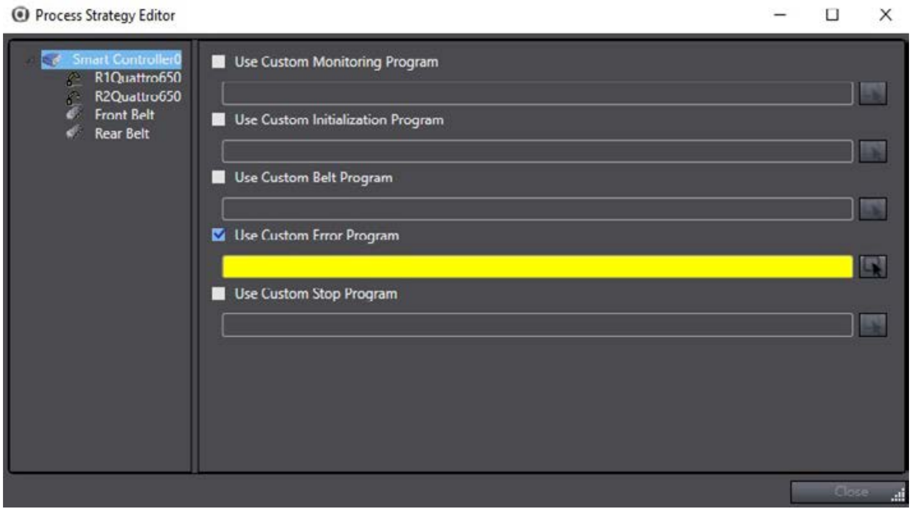


Figure 7-5 Customized V+ Error Status

When the program is customized, the user will start with a copy of the default error handling program. The following figure is a copy of the default program.

```
.PROGRAM pm.psp.error(tsk.idx, code, code2, resp.mask, $stack[], resp)

; ABSTRACT:  Report errors to the PC. This program can filter
;       errors and change the reported code or handle errors
;       without reporting to the user interface.
;
; INPUTS:       tsk.idx         Task index for error reporting
;               code            Error code/status of the operation
;               code2           Variable portion of error code.
;               resp.mask       Available responses
;               $stack[]        V+ program stack information. Indices
;                                 of 0 and 1 are valid.
;
; OUTPUTS:      resp            Possible error responses:
;                                 pm.tsk.success = The operation has
;                                     completed successfully.
;                                 pm.tsk.skip = Stop processing current
;                                     instance and move to next operation.
;                                 pm.tsk.retry = Retry processing of the
;                                     current instance.
;                                 pm.tsk.abort = Stop processing the
;                                     current process and clear the gripper.
;                                 pm.tsk.next = Move to the next instance
;                                     in the queue.
;                                 pm.tsk.fail = The operation has
;                                     not completed due to an error.
;
; SIDE EFFECTS: None
;
;* Copyright (c) 2007-2011 by Adept Technology, Inc.

        AUTO REAL is.grip.error

; If a belt window violation occurs, return with the response
; indicating the operation will be aborted.

        IF code == pm.err.blt.viol THEN
            resp = pm.tsk.abort

            ; To supress the movement to the idle position
            ; and clearing of the gripper, set the gripper
            ; clear state to FALSE by uncommenting the following
            ; line. When uncommented, the robot will stay at the
            ; current location and the gripper I/O will not be changed.
            ; CALL pm.rob.clear.st(tsk.idx, FALSE)

            GOTO 100
        END

; If an end effector error occurs, return with the response
; indicating the operation failed.

        is.grip.error = (code == pm.err.no.gr.cl) OR (code == pm.err.no.gr.op) OR (code == pm.err.inv.grip)
        is.grip.error = is.grip.error OR (code == pm.err.no.gr.ex) OR (code == pm.err.no.gr.rt)

        IF (is.grip.error == TRUE) THEN

        ; In the case of a gripper error, we report the pm.tsk.fail response.
        ; Part or target on which the error occured will be marked as failed.

            resp = pm.tsk.fail
            GOTO 100
        END


; Report the error

        CALL pm.error(tsk.idx, code, code2, pm.tsk.default, $stack[], resp)

   100  RETURN
.END
```

Figure 7-6 Code Error Sample

The error program will be called and passed the task number that has the error, the error code, and other details of the error. The program must pass back a status code the describes the response on how the error is to be handled in the resp parameter. The possible values are either Response or Description.

Table 7-2 Code Definitions

Code	Definition
pm.tsk.success	The operation has completed successfully.
pm.tsk.skip	Stop processing current instance as if it was properly processed and move to the next operation.
pm.tsk.retry	Retry processing of the current instance.
pm.tsk.abort	Stop processing the current process and clear the gripper.

Code	Definition
pm.tsk.next	Stop processing the current instance and move to the next instance in the queue
pm.tsk.fail	The operation failed.

The default program will also check to see if an error code indicates an error from the gripper operation. If this is true, the error program will automatically return a pm.tsk.fail response. Doing so, the part or target that was being processed will be marked as failed causing the system to remove it from queues and not pushing it to the next robot on the conveyor : indeed we assume it may have moved when we tried to process it.

If the error is not a belt window violation, the default program will call pm.error, which will send the error to display on the process manager runtime control. When called, the error is presented to the user and any response will be returned.

Some applications may want to display errors in a different way. For example, if a user wants to display an error using an IO panel with lights and monitor for button presses, the application should not call the pm.error program. Rather, it should turn on IO signals to indicate an error has been detected and then monitor for the press of a button through digital input points.

Configuration

The Configuration area is found in the main view of the Controller Settings editor area. It contains the following read-only items for informational purposes.

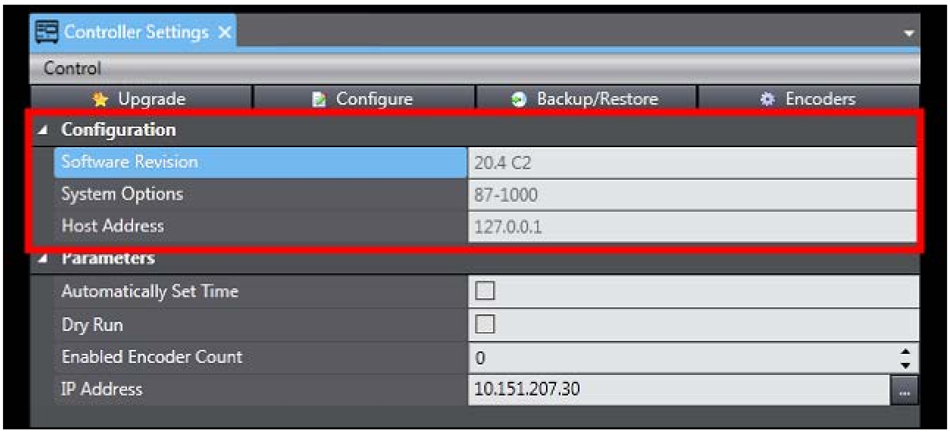


Figure 7-7 Controller Settings - Configuration Area

Software Revision

The Software Revision field displays the V+ software revision number installed on the SmartController. This is displayed only while online with the controller.

System Options

The System Options field displays the configuration of the V+ system in a two-word, hexadecimal format. This is displayed only while online with the controller.

Host Address

The Host Address field displays the IP address of the connected PC (host). This is displayed only while online with the controller.

Parameters

The Parameters area is found in the main view of the Controller Settings editor area. It contains the following items that are described below.

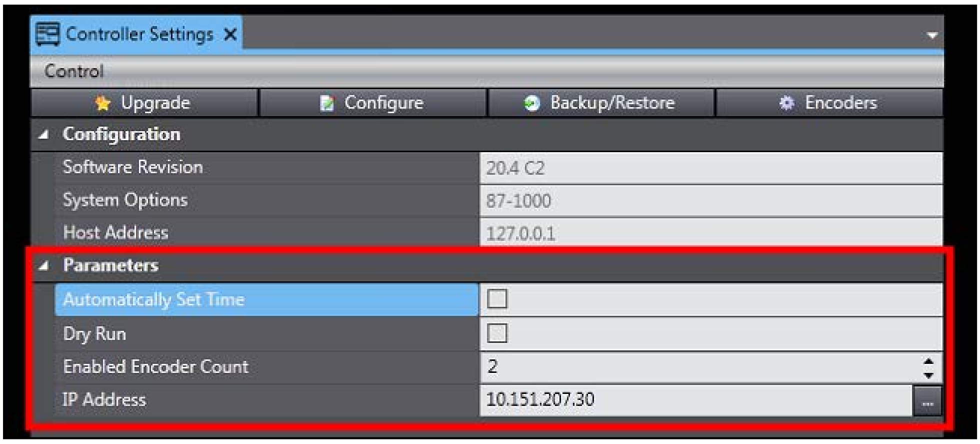


Figure 7-8 Controller Settings - Parameters Area

Automatically Set Time

Select **Automatically Set Time** to automatically synchronize the controller to the PC time.

Dry Run

Select Dry Run to test a project without robot motion. This will cause robots to ignore motion commands. This is selectable only while online with the controller.

Enabled Encoder Count

Enabled Encoder Count displays the number of external encoders used by the system. The number displayed is related to the number of Belt Encoder Channels configured (refer to Configure Belt Encoder Latches on page 213 for more information).

IP Address

The IP Address field displays the current IP address of the controller. When offline, it is possible to change or select a controller's IP address by clicking the **More** Button as shown below. Clicking this button will display the Select a Controller Address Dialog Box.

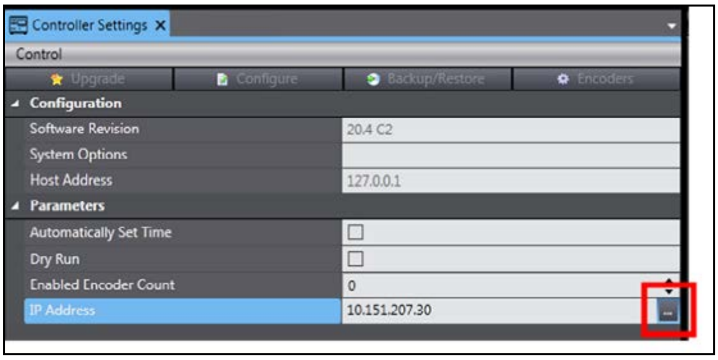


Figure 7-9 Change or Select a Controller IP Address

NOTE: If the desired controller is not available or the changed IP address will not allow an online connection, refer to Detect and Configure Controller on page 79 for more information.

Additional Information: The controller IP address is also accessible in the configuration area. Refer to Configure System Settings on page 215 for more information.

Control

The Control Menu displays controller-specific setting items described below. These are selectable only while online with the controller.

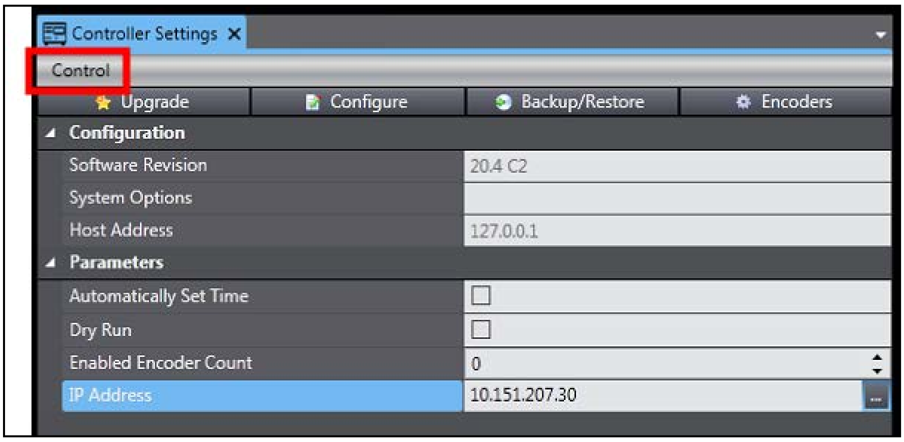


Figure 7-10 Control Menu Item

NOTE: When using ACE *Controller Settings* with a stand alone robot, the Systems Options line in the Configuration view will not be shown.

Set Time

In order to use error log time stamps for troubleshooting, the correct time needs to be set in the controller(s).

Selecting ***Set Time*** will manually synchronize the controller time to match the time detected on the connected PC. The following confirmation dialog box will be displayed.

NOTE: The Set Time function will not set the time for a robot node. Use the FireWire configuration to set robot node times. Refer to Configure FireWire Nodes on page 206 for more information.

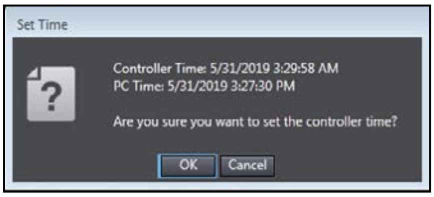


Figure 7-11 Set the Controller Time Confirmation

Reboot V+

Selecting ***Reboot V+*** will reboot the controller. The following confirmation dialog box will be displayed.

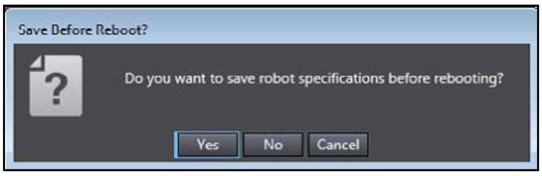


Figure 7-12 Reboot V+ Confirmation

Servo Reset

Selecting ***Servo Reset*** will reset communication with the robot servo nodes.

Zero Memory

Selecting ***Zero Memory*** will clear all user programs and variables from the workspace and the controller. The following confirmation dialog box will be displayed.

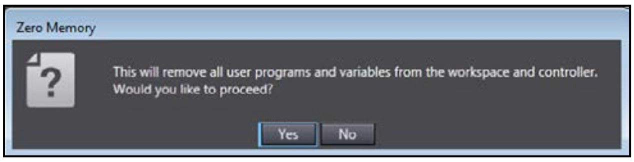


Figure 7-13 Zero Memory Confirmation

Save Startup Specifications

Selecting ***Save Startup Specifications*** will save all robot and motor specifications to the V+ boot disk.

NOTE: This is the same function that is present in the Robot Object - Configure menu. Refer to Control on page 199 for more information.

Save Memory to a File

Selecting ***Save Memory to a File*** will save all V+ programs to a file in the PC. A Save As window will be displayed.

View eV+ Log

Selecting ***View eV+ Log*** will display a list of eV+ event messages for the controller. The following View eV+ Log will be displayed. Refer to eV+ Log on page 645 for more information.

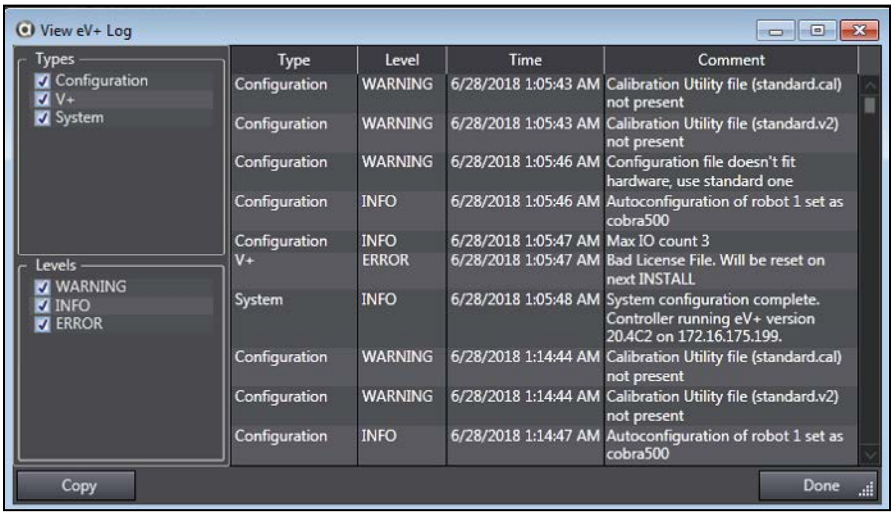


Figure 7-14 View eV+ Log Display

Additional Information: View eV+ Log is also accessible by right-clicking ***Controller Settings*** in the Multiview Explorer

Upgrade

Use the Upgrade function to upgrade V+ or the FireWire firmware. Clicking the **Upgrade** button displays the Upgrade Options Dialog Box. This is selectable only while online with the controller.

IMPORTANT: Upgrading the FireWire node firmware is not possible in Emulation Mode.

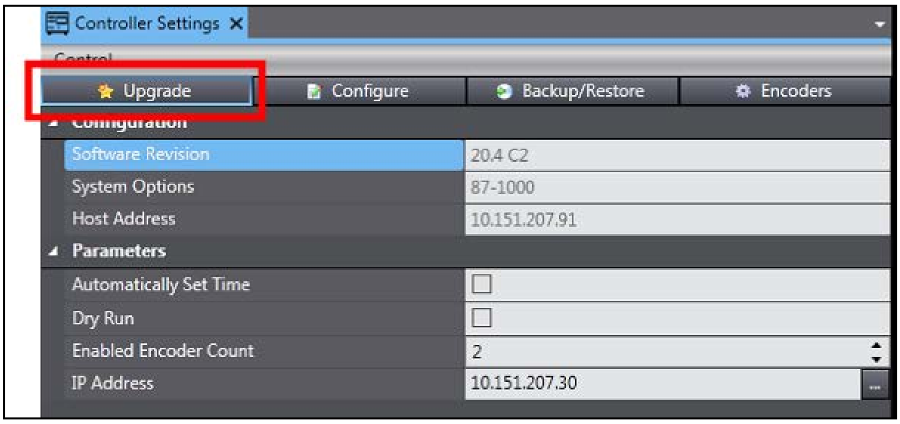


Figure 7-15 Controller Settings - Upgrade Function

Basic Upgrade Procedure

When updates are required, it is recommended to upgrade both V+ and the FireWire Node Firmware to ensure the entire system has the latest firmware version(s). Use the following procedure to upgrade V+ and the FireWire firmware.

> **NOTE:** The V+ firmware distribution file is supplied as a compressed zip file. Extract this file before beginning the procedure below.

1. Select ***Upgrade V+*** in the Upgrade Options Dialog Box and then click the **Finish** button.
2. Provide the V+ directory where the new V+ distribution is located. Provide a file path to the \SYSTEM folder located in the distribution file root directory.
3. Select a backup directory to use during the upgrade process.
4. Select the **Upgrade Controller FPGA** option.
5. After the V+ directory, backup directory, and FPGA controller upgrade items fields and selections are made, click the **Go** button to proceed with the upgrade process. The process can take several minutes to complete. A progress bar is displayed during the upgrade procedure. After the V+ upgrade process is complete, proceed to the next step.
6. Select the **Upgrade FireWire Firmware** option from the Upgrade Options Dialog Box.
7. Select all detected robot amplifier nodes. This process is used to check and update servo code firmware on robot nodes. If a newer version is not provided, an upgrade will not occur. Alternatively, select only the node you wish to upgrade / downgrade with a specific file from the PC.
8. Select **Update FPGA** and **Update Servo** options.
9. Select the source of the firmware update files from either the PC or the controller.

   If the update files are located on the PC, provide the firmware directory where the new firmware distribution is located. Provide a file path to the \SYSTEM folder of the distribution file directory. Do not select the option for Copy FIRMWARE files from controller in this case.

   If the update files are located on the controller, select the option for **Copy FIRMWARE files from controller**. The FIRMWARE directory field is not accessible or necessary in this case.
10. After all fields and selections are made, click the **Go** button to proceed with the update process. The process can take several minutes to complete. A progress bar is displayed during the upgrade procedure.
11. After updating servo / FPGA you will be prompted to cycle 24 VDC power to the updated nodes. The update process is complete when the power is cycled.

Upgrade V+

The Upgrade V+ function is used to upgrade the V+ operating system and optionally, to upgrade an external controller FPGA (firmware). Selecting ***Upgrade V+*** from the Upgrade Options Dialog Box and then clicking the **Finish** button will display the following window. Refer to Upgrade V+ on page 202 for detailed steps.

Additional Information: If V+ backup operation fails, an error is displayed and the upgrade process is automatically stopped. This prevents overwriting the new V+ system with corrupt data.

Upgrade functions are also available by right-clicking ***Controller Settings*** in the Multiview Explorer.

A V+ distribution includes all compatible firmware files for robot nodes and the T20 Teach Pendant.

IMPORTANT: No other tasks should be running in your V+ system while the upgrade is underway. Your system can become corrupted if power is lost while the upgrade is underway.

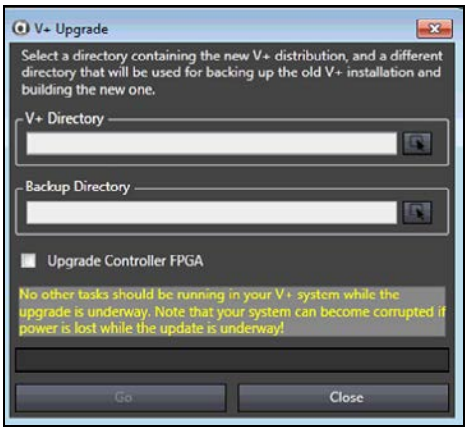


Figure 7-16 V+ Upgrade Selection

Upgrade FireWire Firmware

The Upgrade FireWire Firmware function is used to upgrade a FireWire node's firmware. Selecting ***Upgrade FireWire Firmware*** from the Upgrade Options Dialog Box and then clicking the **Finish** button will display the following window. Refer to Basic Upgrade Procedure on page 202 for detailed steps.

NOTE: The firmware upgrade process will require several minutes for each node in the distributed network.

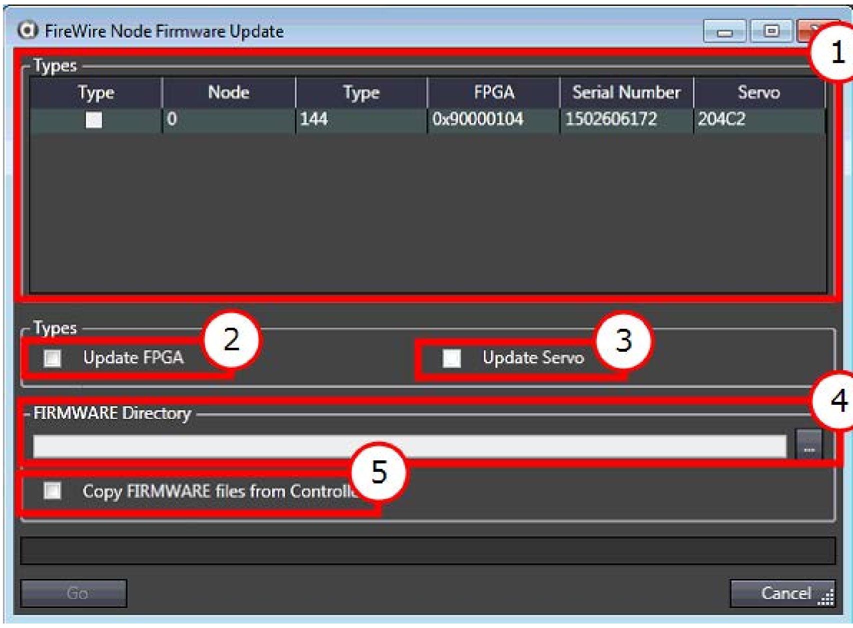


Figure 7-17 FireWire Node Firmware Update

Table 7-3 FireWire Node Firmware Update Description

Item	Description	Details
1	FireWire Node Identification and Selection Area	Select nodes to be updated.
2	Update FPGA	Updates the firmware for the FireWire node.
3	Update Servo	Enable to update the servo binary image stored in the selected node's flash memory. Not performing this relies on successful dynamic download from controller to robot during boot up (see note below). Performing the servo update eliminates any potential risk of dynamic download failure during boot up.
4	Firmware Directory	Select the PC directory where the new firmware files are located. Provide a file path to the \SYSTEM folder of the distribution file directory.
5	Copy FIRMWARE files from Controller	Use firmware files in controller for FireWire node updates.

NOTE: During boot, a SmartController will attempt a dynamic download to robot nodes to give them a compatible servo version (stored in RAM), if the compatible version is not already present in RAM. Updating servo firmware with this method removes the risk of issues arising if dynamic download fails during boot up.

Configure

Clicking the **Configure** Button displays the Configure Options Dialog Box. Several configuration items are selectable as described below. The **Configure** Button is available only while online with the controller.

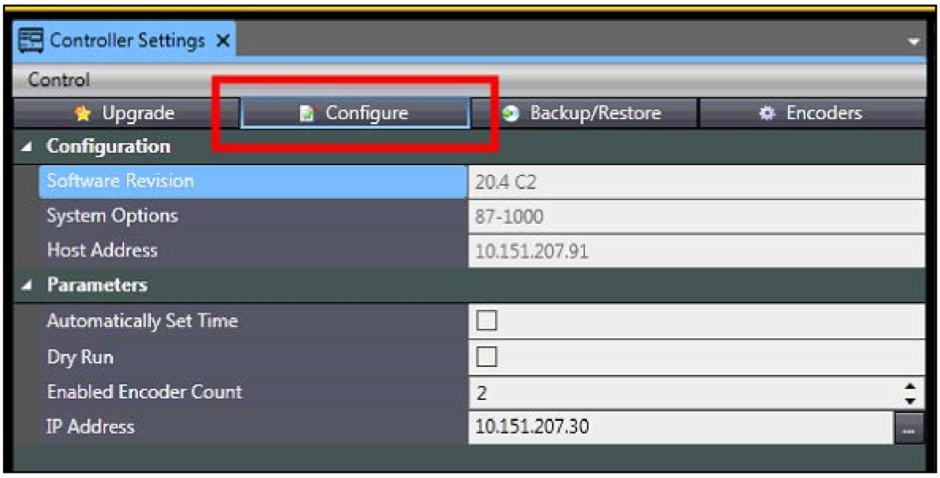


Figure 7-18 Controller Settings - Configure Function

Configure Licenses

Selecting ***Configure Licenses*** allows you to view, install, or remove V+ licenses. Each license is uniquely paired to a corresponding Security ID and every device has a unique Security ID number associated with the memory card.

To install or remove a license, first select the device from the left side list, enter the license key in the Password field, and then click either the **Install** or **Remove** buttons.

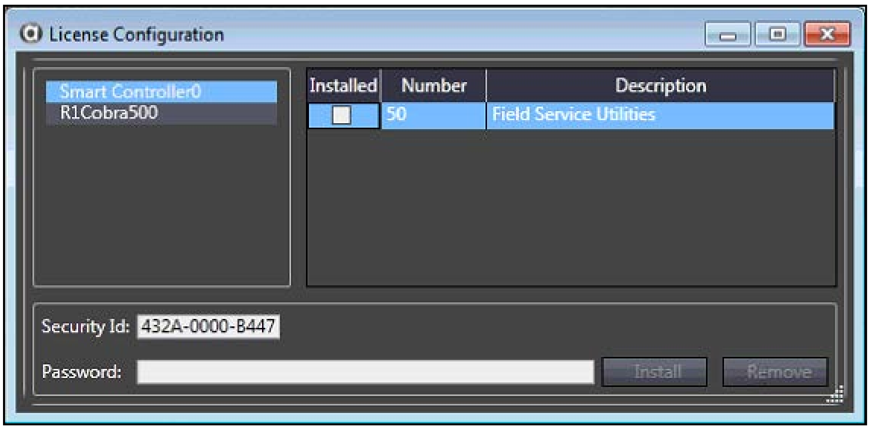


Figure 7-19 Controller Settings - License Configuration

Configure Robots

Use the Configure Robots Dialog Box to select robots to install on the controller. In the Configure Robots Dialog Box, you can select specific robots to manually install on the controller or you can select Auto Configuration. After selecting robots to install on the controller, platform selection (if applicable) and robot positioning are required to complete the Configure Robots process.

Additional Information: Refer to 3D Visualizer on page 107 for more information about robot positioning in a 3D workspace.

Configure FireWire Nodes

Selecting ***Configure FireWire Nodes*** allow you to create a valid FireWire network configuration to enable communication with devices such as robots, belt encoders, digital I/O, and force sensors. Selecting ***Configure FireWire Nodes*** and clicking the **Finish** button will open the dialog box shown below.

NOTE: Always review the initial FireWire configuration to ensure it is compatible and appropriate for the application. When connecting to a controller, ACE software will check for FireWire configuration conflicts. If a conflict is present, error messages will be displayed. Refer to FireWire Event Log on page 646 for more information.

IMPORTANT: Once a network configuration is modified and saved, the physical connections will be identified and restored accordingly on next boot.

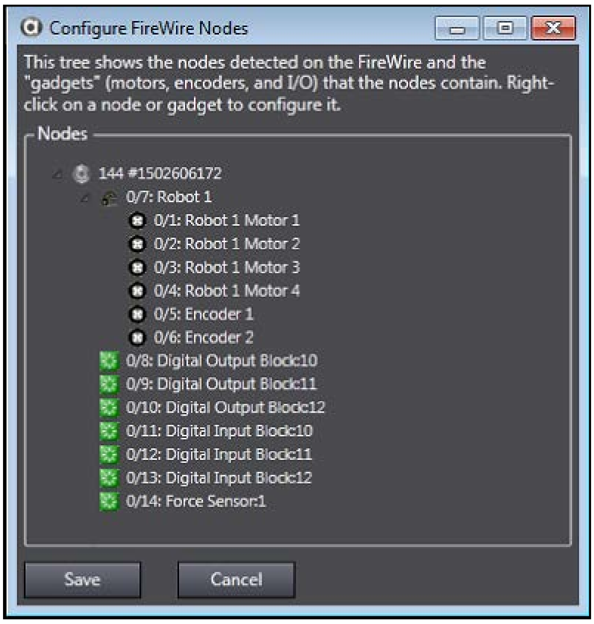


Figure 7-20 Configure - Configure FireWire Nodes

Right-click an item in the list to display information and settings for each FireWire node. The following information and settings are available.

- View and clear FireWire node logs for controllers
- Set a robot node clock
- View a robot node's information
- Unconfigure or designate a robot's FireWire node number
- Designate encoder FireWire node numbers

- Designate force sensor FireWire node numbers
- Configure I/O Block address ranges

Configure I/O for DeviceNet

Selecting ***Configure I/O*** allows you to map I/O to numerical signal numbers for use in programming. The Configure I/O function provides DeviceNet scanning, configuration, and mapping.

> **NOTE:** FireWire nodes must be configured before attempting to map I/O to numerical signal numbers.

Configure DeviceNet

The following steps are used for configuring DeviceNet IO with ACE 4.

Required equipment for DeviceNet IO configuration

- SmartController EX
- Slave DeviceNet Device

Confirm that the SmartController EX and slave DeviceNet devices are connected according to the DeviceNet topology. See at https://www.odva.org/Publication-Download and download DeviceNet Planning and Installation Manual file.

Once all the components are installed and connected, use ACE 4 and connect to the SmartController EX.

> **NOTE:** The configuration cannot be done in Emulation Mode.

Once Multiview Explorer is opened, click **Connect to Device** in the left-side panel. On the right-side panel then click the controller address that you want to connect to, as shown in the following figure.

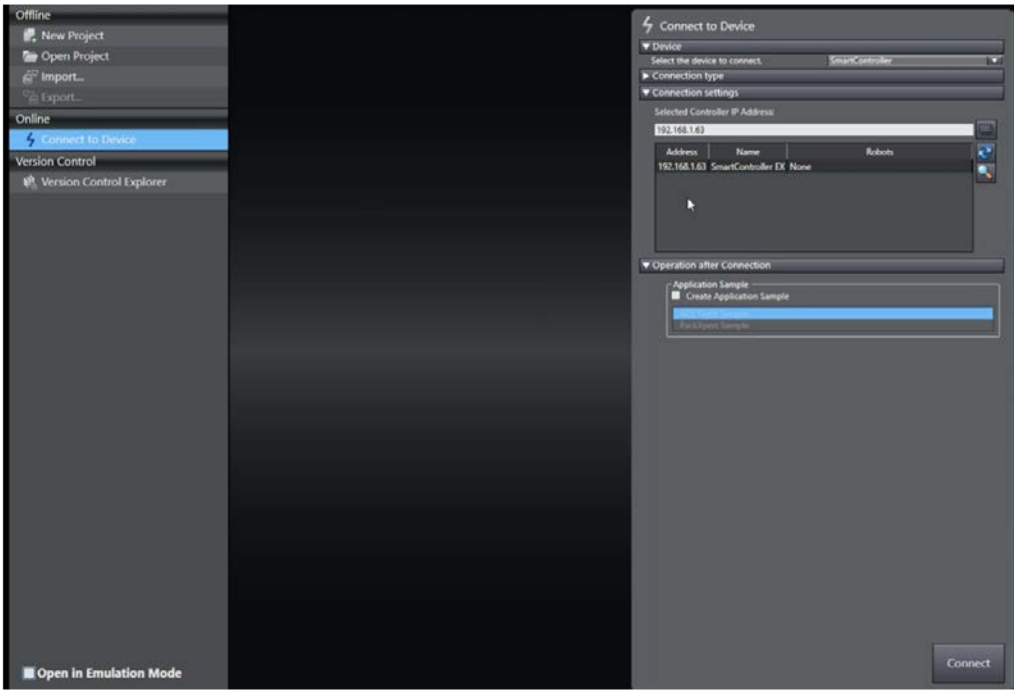


Figure 7-21 Connect to Device

Then click the **Connect** Button.

After the Multiview Explorer shows the connection to the device has been established. expand the *Configurations and Setup* drop down menu. From the drop-down menu, select **Controller Settings** in order to display that window, as shown in the following figure.

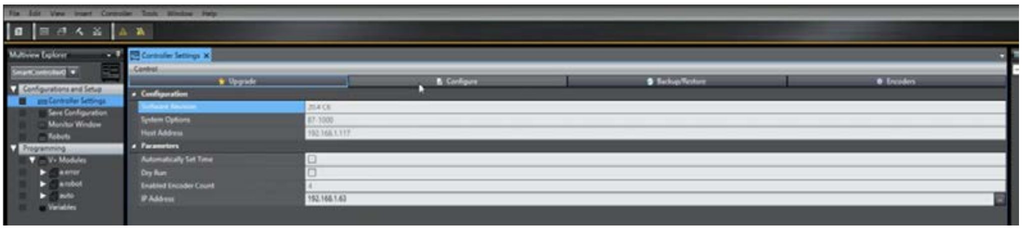


Figure 7-22 Controller Settings

Click the **Configure** Button. When the panel opens, select the **Configure I/O** option and click **Finish** Button. This starts the Configure I/O sequence.

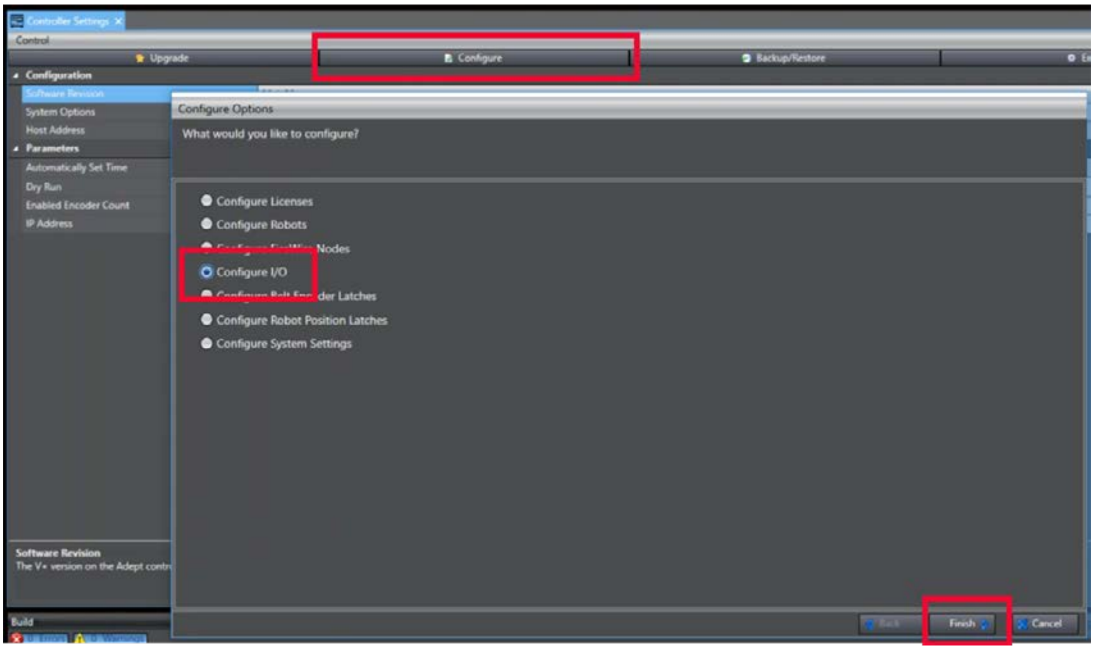


Figure 7-23 Configure I/O option

When the Introduction pop-up appears, click **Next** Button to continue.

At the DeviceNet Scan step, shown in the following figure, select **Yes, I want to configure DeviceNet for this controller** then click the **Next** Button.

The second option in the following figure, **No, I want to configure Robot IO nodes for this controller**, would be used for configuring SDIO and IOBlox signals ranges if the default configuration is not sufficient.

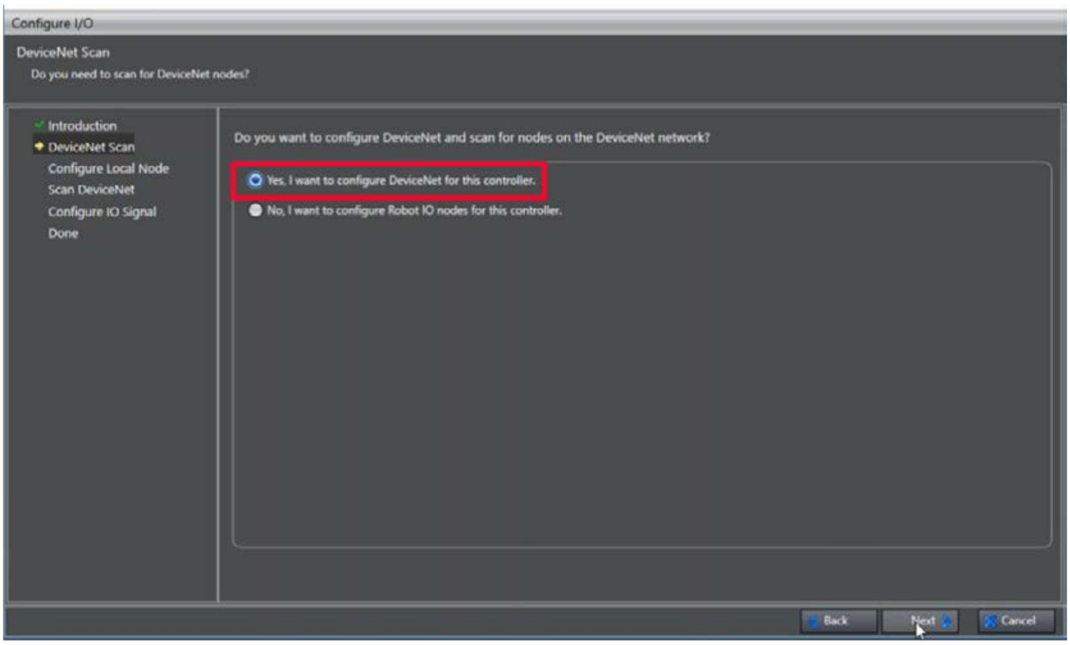


Figure 7-24 Configure DeviceNet

The panel opens the Configure Local Node step for selecting the network Baud Rate and the SmartController EX node ID. In the example shown below, the Baud Rate is 500K and the SmartController EX ID is 10. Once selected, click the **Next** Button.

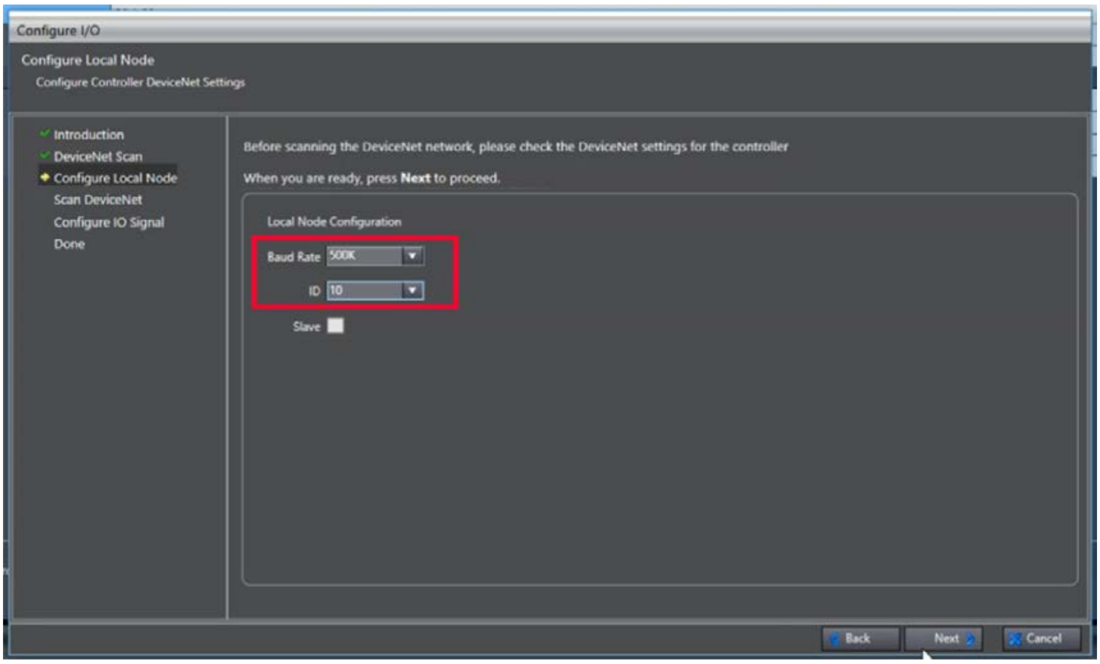


Figure 7-25 Configure Local Node

If the SmartController EX already had a network configuration, the selections will be displayed. If it is the first time the configuration has been entered, a pop-up message requesting a reboot will appear. Click the **Yes** Button to continue.

Once the reboot is completed, a default list with node IDs will appear. Click the **Scan Nodes** Button to start scanning the network. Scanning the nodes may require a few minutes. Please wait until it completes.

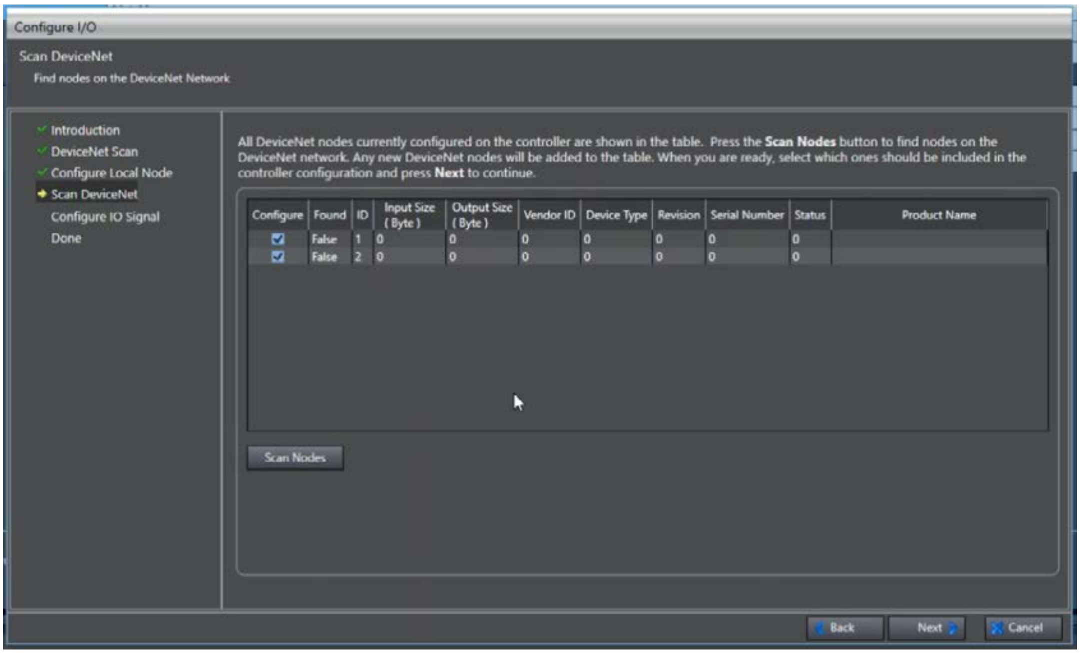


Figure 7-26 Scan Nodes Window

When the scan completes a panel opens showing the discovered nodes. To add a particular device in the robot IO configuration, check the Configure box of the device and click the **Next** Button, as shown below. The SmartController EX will reboot. Wait fr the reboot to complete.

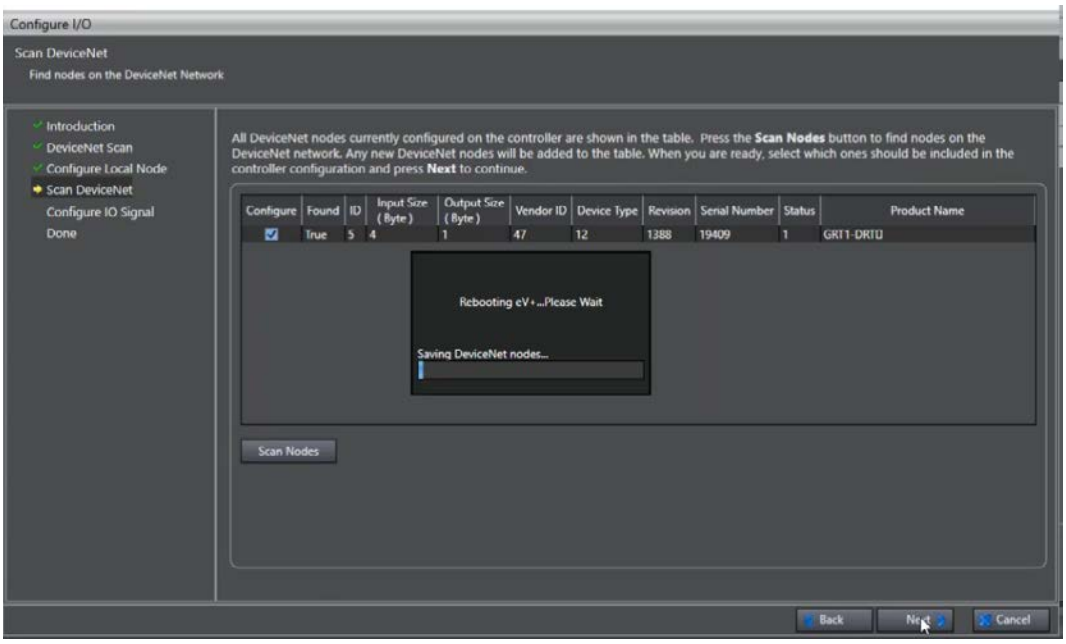


Figure 7-27 SmartController Reboot

After the reboot, the Configure IO Signal windows will appear and show all the selected Devices and IDs, as shown below. At this step, it is possible to configure the inputs and outputs to the robot IO.

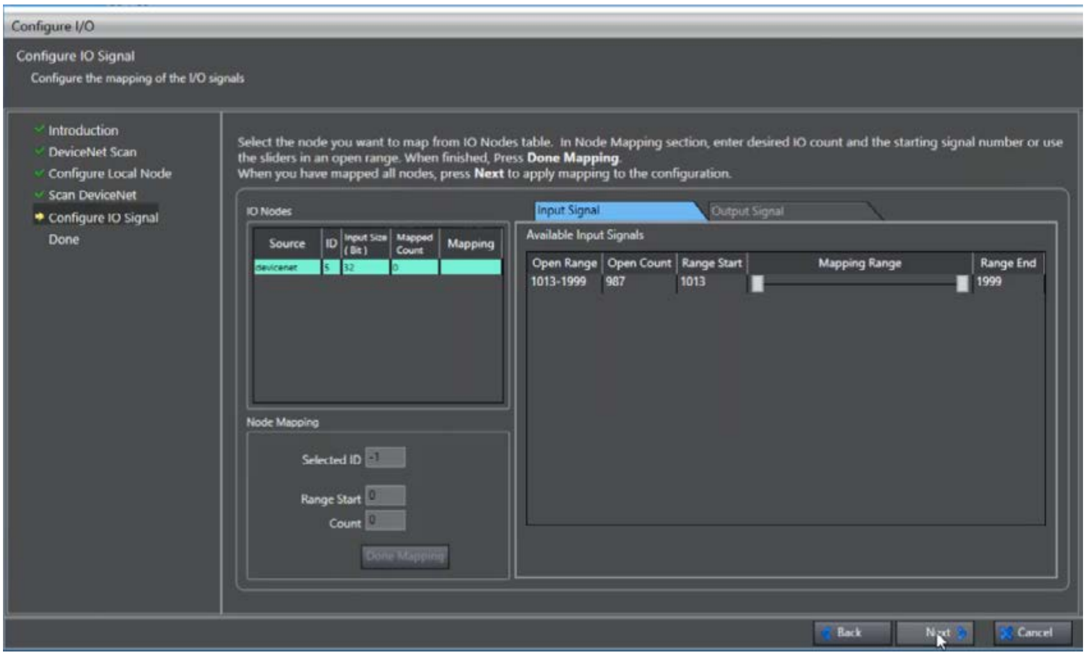


Figure 7-28 Configure I/O Window

To configure the inputs and outputs, select the device to configure in the IO Nodes windows by clicking on the line. The Selected ID will appear in the Node Mapping window shown below.

Click the **Open Range** line to select the *Range Start*. If the Range Start is not what is desired, enter a different signal number. Finally, enter the *Count* of bits that will be used. Usually, it is equal to the Input Size (Bit). When all values are entered, click on the **Done Mapping** Button.

A new line with the same color then the device will appear on the *Available Input Signals* list.

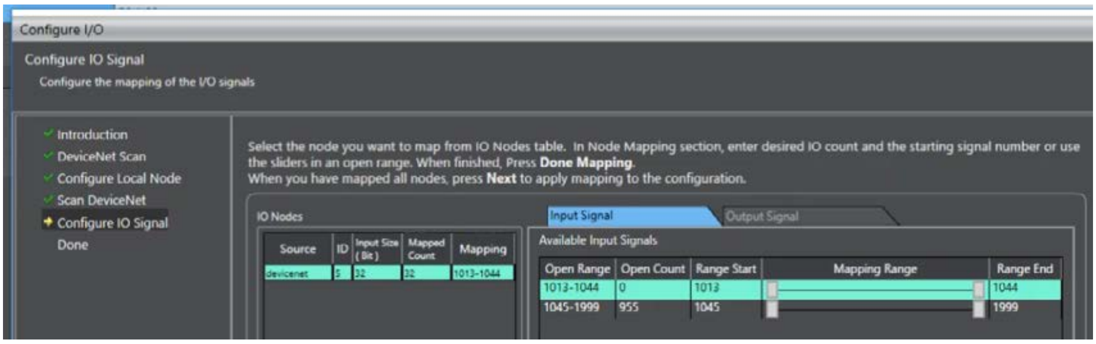


Figure 7-29 Available Input Signals

Clicking the **Output Signal** tab allows you to do the same steps for Outputs.

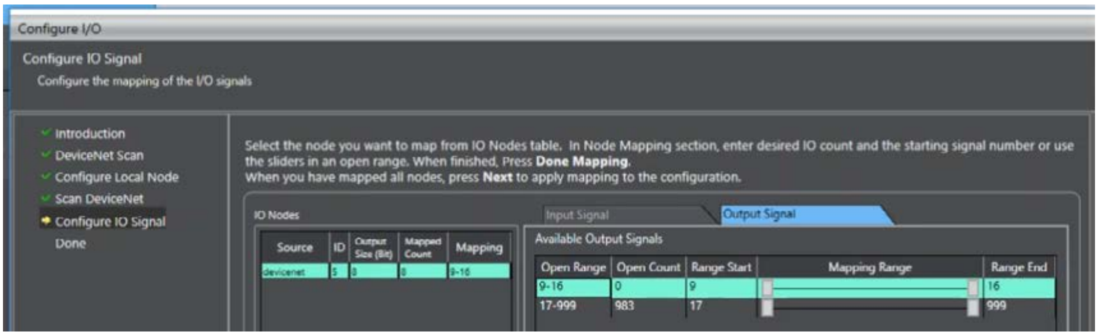


Figure 7-30 Available Output Signals

Once all Input and Output are configured, click the **Next** Button to reboot the Controller and apply the updates to the IO configuration. When the reboot is complete, click the **Finish** Button to close the Configure IO window.

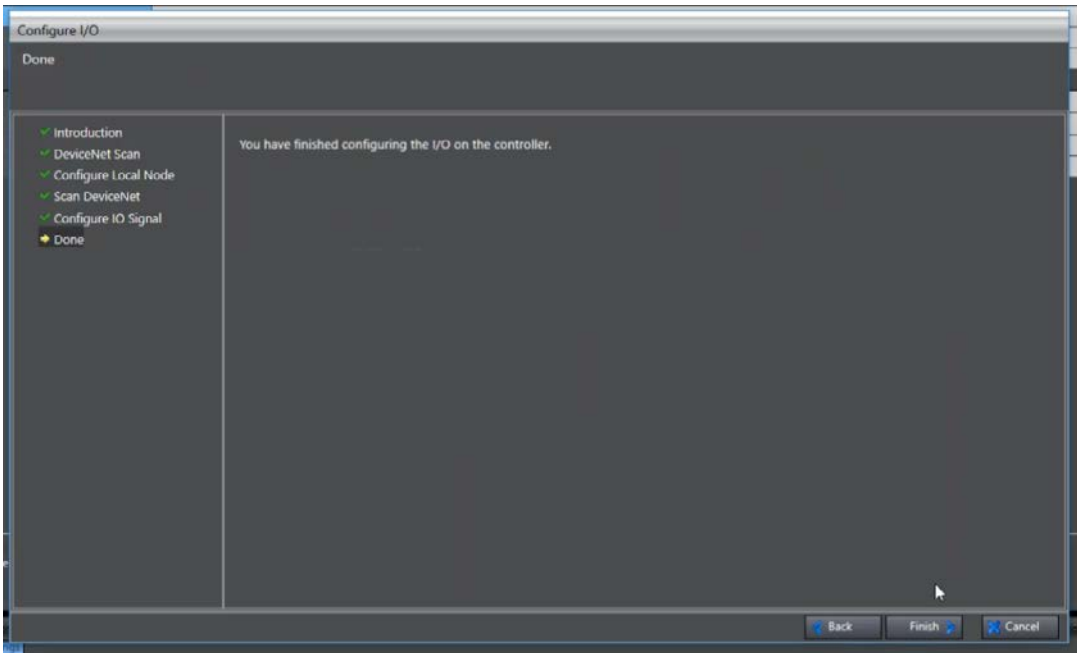


Figure 7-31 Finish Configuration

Configure Belt Encoder Latches

Selecting **Configure Belt Encoder Latches** allows you to view and change latch signals for each encoder channel of the controller. A Belt Encoder Latch refers to the capture of a conveyor belt encoder position value when an input signal (latch) changes state. Once configured, the system will monitor and record the latch signal number and corresponding encoder position (one encoder value) in a first-in-first-out buffer for later access and use in a program. This area can also be used to check current position and velocity for each encoder channel.

> **NOTE:** Belt encoder latches are not required for conveyor belt tracking but are recommended for positional accuracy. Pack Manager requires use of latch signals for all belt tracking applications for positional accuracy, as well as cross-controller latch handling.
>
> Encoders should be uniquely numbered in the FireWire configuration before configuring encoder channels/latches.

Selecting ***Configure Belt Encoder Latches*** and clicking the **Finish** button will display the dialog box shown below.

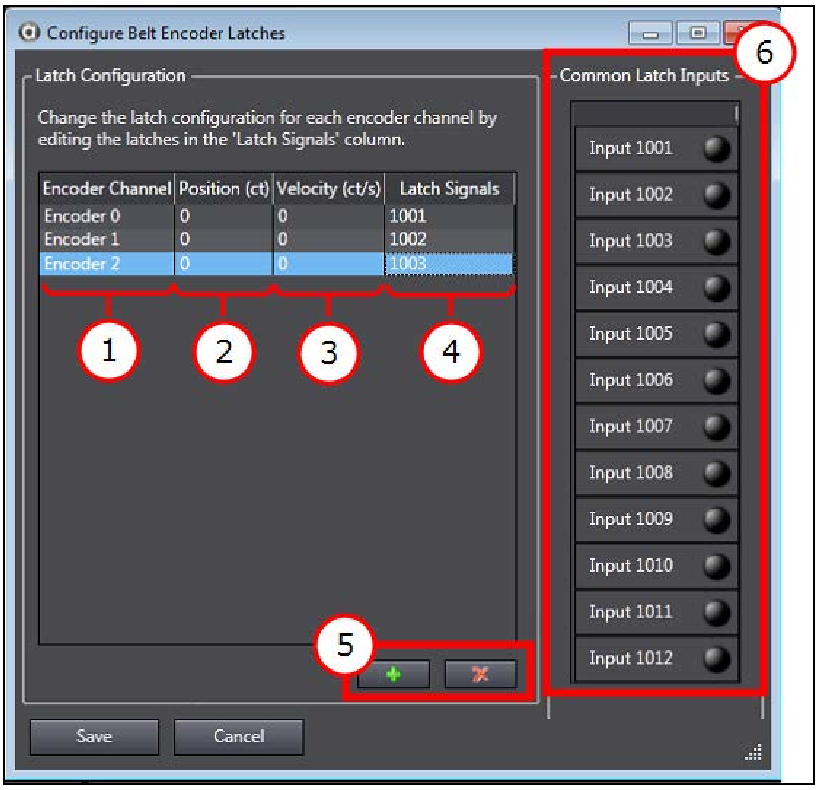


Figure 7-32 Configuration - Configure Belt Encoder Latches

Table 7-4 Configure Belt Encoder Latches Description

Item	Name	Description
1	Encoder Channel	Shows the belt encoder channels for the system.

Item	Name	Description
2	Position (ct)	Shows the current position in counts of the corresponding belt encoder.
3	Velocity (ct/s)	Shows the current velocity in counts per second for the corresponding belt encoder.
4	Latch Signals	Shows the latch signal assignments for the corresponding belt encoder. One or more signals can be configured as described below. Use the minus sign to designate a falling edge condition: • 1001: When signal 1001 changes from OFF to ON, the encoder channel position data will be latched. • -1001: When signal 1001 changes from ON to OFF, the encoder channel position data will be latched. Use a space between signals to configure multiple signals: • 1001 1004: When either signal 1001 or 1004 changes from OFF to ON, the encoder channel position data will be latched. • -1001 1003: When signal 1001 changes from ON to OFF or signal 1003 changes from OFF to ON, the encoder channel position data will be latched.
5	Add/Remove Encoder Channels	Add or remove an encoder channel from the configuration. **NOTE:** If an encoder channel is not configured here, that encoder input will not be accessible in V+ programs or be visible in other Encoder windows in the project. Similarly, if extra encoder channels are present here, they will not provide input. A correct configuration will allocate one encoder channel for each belt encoder on the FireWire network.
6	Common Latch Inputs	Displays the state of available latch input signals. ON:  OFF:  **NOTE:** Input signals 1001-1008 are the position latch signals for e-Series controllers on the XIO terminal block. Input signals 1001-1012 are the position latch signals for the SmartControllerEX on the XDIO terminal block. These signals are also used for Robot Position Latches (refer to Configure on page 255 for more information).

Configure System Settings

Selecting ***Configure System Settings*** and clicking the **Finish** Button will display the dialog box shown below.

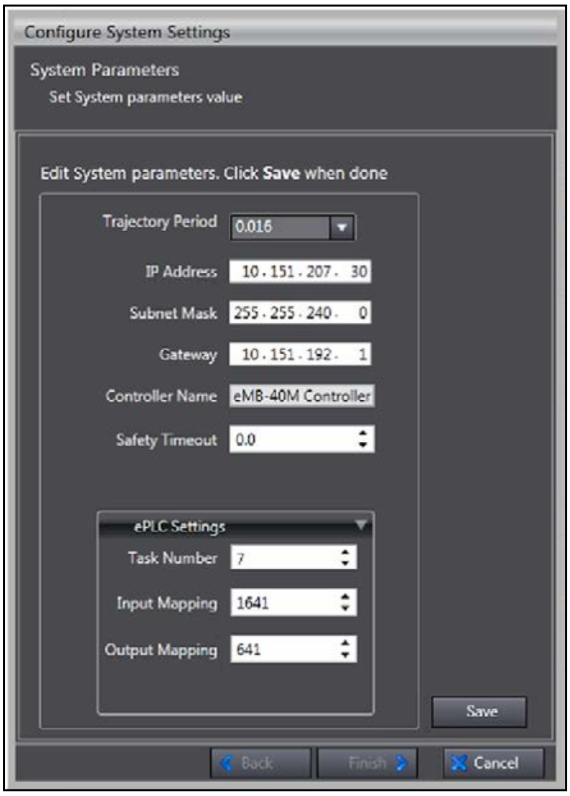


Figure 7-33 Configure - Configure System Settings

The following items are accessible in this area.

Trajectory Period

The trajectory period defines the interval between set points calculated during robot motion trajectory generation. The default setting of 16 ms is adequate for most applications because the servo loop receives set points and controls motor position based on micro-interpolation at 8 khz (125 µs). In some situations it is helpful to decrease trajectory period, which results in more frequent set point generation to decrease path following error. However, reducing this value can have a noticeable impact on quantity of calculations and processor usage, especially for embedded controllers.

> **IMPORTANT:** Unnecessary decrease of trajectory period may consume processing time needed for user programs running in the controller. Refer to Profiler on page 130 for more information

IP Address

View and change the IP address of the connected controller.

Subnet Mask

View and change the subnet mask of the connected controller.

Gateway

View and change the Gateway of the connected controller

Controller Name

View and change the connected controller's name.

Safety Timeout

View and change the Safety Timeout setting for the connected controller. This controls the behavior of the robot high power request sent by a connected PC, executing program, Front Panel High Power Enable button, or optional pendant. If a safety timeout is enabled, the robot power button on the front panel will blink for a specified amount of seconds after a high power request is made. If the robot power button is not pressed within the specified time, a safety timeout occurs and robot power is not applied.

> **IMPORTANT:** Ensure adequate safety measures are taken if the safety timeout is disabled.

The default setting for the Safety Timeout is 10 seconds. Use the following settings to adjust the Safety Timeout.

- 0 seconds: disables the high power request secondary action and robot power is applied immediately.
- 1 to 60 seconds: enables the high power request secondary action and robot power is applied if the **Robot Power** button is pressed on the front panel within the specified amount of time.

> **IMPORTANT:** Robot maintenance and troubleshooting procedures require the safety timeout to be enabled. The robot's flashing high power indicator is used to verify that the lamp is not burned out and this should be considered before disabling the safety timeout feature.

Auto Start

Enable or disable an Auto Start program. If Auto Start is enabled, as the controller completes boot process it will load and execute D:\AUTO.V2. An AUTO.V2 program has no user-defined error handling and should be kept simple to load modules or variable files and execute a program that handles system startup. Refer to Save Configuration on page 220 for more information.

> **NOTE:** Although the Program System Startup function and the Auto Start function share some similarities, the startup file for the Program System Startup function is stored on the PC whereas the Auto Start function files are stored on the controller. Refer to Program System Startup on page 338 for more information.

Task Number (ePLC Settings)

View and change the Task Number used for an ePLC configuration. This defines the first task that ePLC programs will start executing on when Auto Start is enabled (eplc_autostart). ePLC task numbers must be between 7 and 15 and will occupy at least 5 tasks when Auto Start is enabled.

> **NOTE:** ePLC settings typically do not need to be changed after Auto Start is enabled.

Input Mapping (ePLC Settings)

View and change the Input Mapping used for an ePLC configuration. This defines the first input signal in the range of signals mapped by ePLC programs.

Output Mapping (ePLC Settings)

View and change the Output Mapping for an ePLC configuration. This defines the first output signal in the range of signals mapped by ePLC programs.

Auto Start (ePLC Settings)

Select the Auto Start behavior when using the ePLC function. When Auto Start is enabled, D:\ADEPT\UTIL\ePLC3.v2 will be loaded and executed on the designated task number and initialized with the Input and Output Mapping signal numbers.

Backup/Restore

Use the Backup/Restore function to backup, restore, or compare the V+ operating system files and directories. Clicking the **Backup/Restore** Button displays the Backup/Restore Options Dialog Box. This is selectable only while online with the controller.

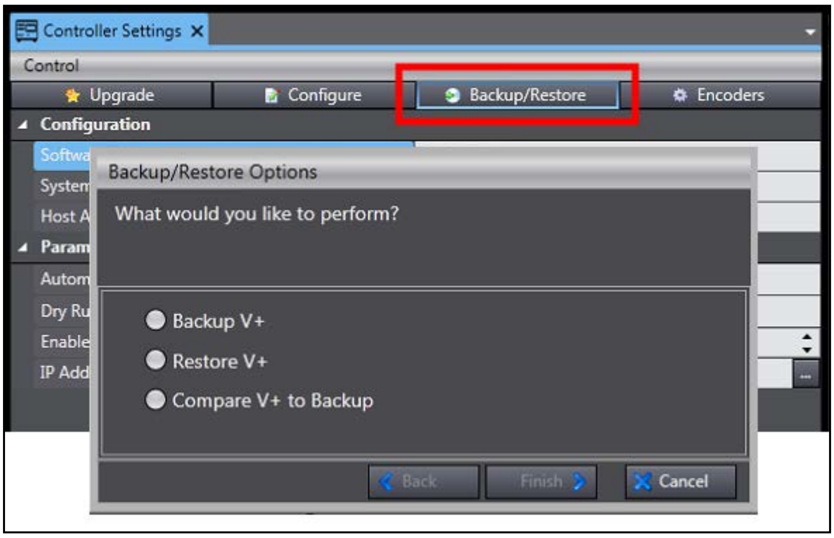


Figure 7-34 Controller Settings - Backup/Restore Function

Backup V+

The Backup V+ function allows you to back up the V+ operating system files and directories to the connected PC. Selecting ***Backup V+*** and then clicking the **Finish** button will display the following window.

Choose a PC directory for the V+ operating system files and directories to be stored and then click the **Backup** button to proceed.

> **NOTE:** The backup process takes several minutes. If there are files present in the selected PC directory, you will be prompted to remove them before the backup process can begin.

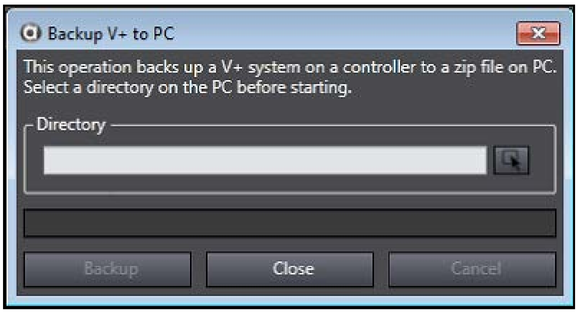


Figure 7-35 Controller Settings - Backup V+ to PC

Restore V+

The Restore V+ function allows you to restore the V+ operating system files and directories from a directory on the connected PC. Selecting ***Restore V+*** and then clicking the **Finish** button will display the following window.

Choose a PC directory where the desired V+ system zip file is located and then click the **Restore** button to proceed.

> **NOTE:** The restore process takes several minutes.

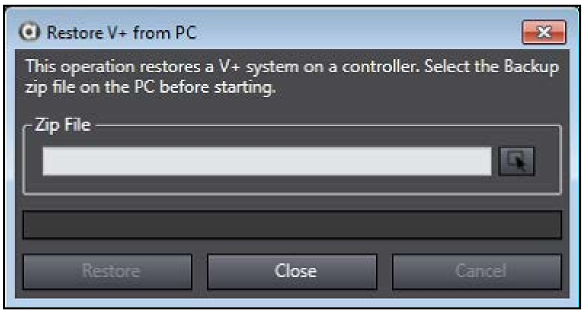


Figure 7-36 Controller Settings - Restore V+ From PC

Compare V+ to Backup

The Compare V+ to Backup function allows you to compare V+ operating system files and directories stored on the connected PC with those in the connected controller. Selecting ***Compare V+*** to Backup and then clicking the **Finish** button will display the following window.

Select a PC directory where the V+ system zip file for comparison is located and then click the **Compare** button to proceed.

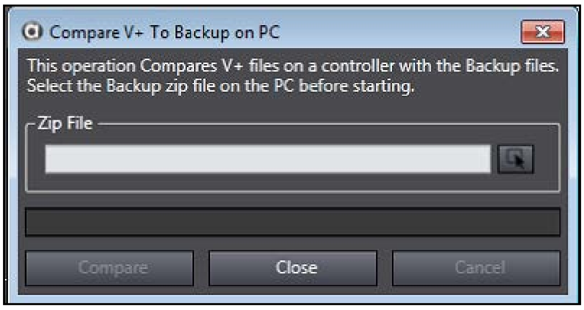


Figure 7-37 Compare V+ to Backup on PC

NOTE: The compare process takes several minutes.

Encoders

Use the Encoders function to configure and check operating status of devices connected to the controller's encoder channels. Clicking the **Encoders** Button displays the Encoders Dialog Box.

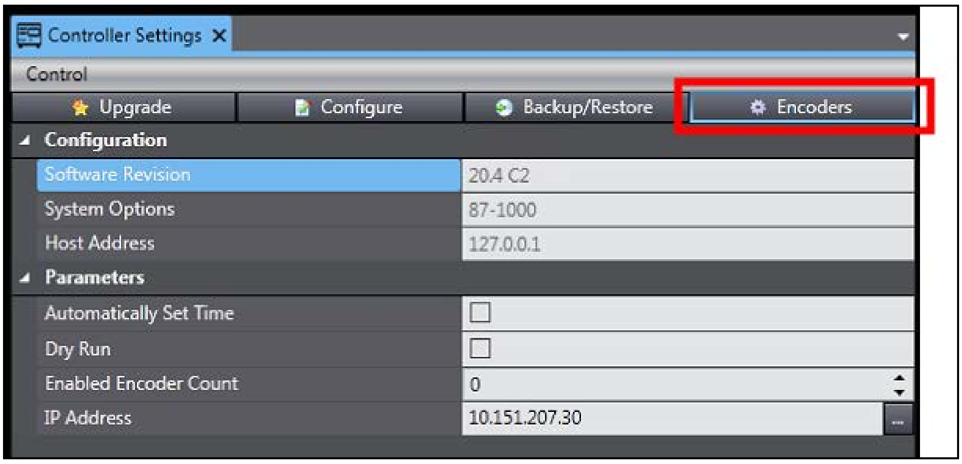


Figure 7-38 Controller Settings - Encoders

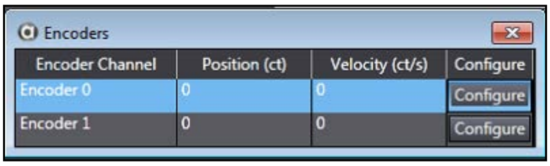


Figure 7-39 Encoders Dialog Box

The Encoders Dialog Box displays all encoder channels that have been configured. The **Configure** Button is reserved for future use.

If an encoder channel that is present does not appear, check the FireWire Configuration and Belt Encoder Latch configuration.

NOTE: To view and configure all encoder channels, ensure that all encoder channels are added in the Configure Belt Encoder Latches Dialog Box even if latches are unnecessary. Refer to Configure on page 205 for more information.

Additional Information: It is possible to enter position and velocity values for an encoder while in Emulation Mode. However, typical interaction with emulated belt encoder travel is handled in a V+ program or a Process Belt object when working with a Process Manager.

Robot Vision Manager Sample wizards that include belt tracking demonstrate an example of turning on a simulated belt encoder in a V+ program. Refer to the rob.pick.init V+ program created with a Robot Vision Manager Sample using belt tracking, as shown below.

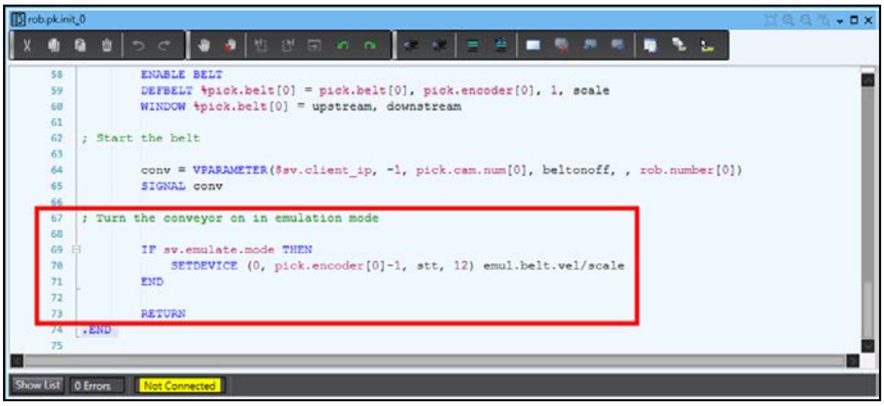


Figure 7-40 Robot Vision Manager Sample Belt Tracking

7.2 Save Configuration

The Save Configuration selection in the Multiview Explorer provides options for saving programs, variables, and belt calibrations to the controller in the DISK>D:\ARCHIVE\ location.

NOTE: When Emulation Mode is enabled, saving data to the virtual controller may result in a loss of data.

This area also provides the capability to generate an AUTO.V2 program that can load modules, variable file contents, and execute a specific program on a specific task. The **Program to Execute** and **Task Number** fields are used when generating the contents of the AUTO.V2 file stored at D:\ on the controller.

If the **Save Programs and Variables on Controller** is enabled, the generated AUTO.V2 will also include program instructions for loading the saved modules. In order to execute this program at bootup, you must enable Auto Start (refer to Configure on page 205 for more information).

The **Save to Controller** and **Generate Auto Module** buttons function only when an online connection is present.

Use the information below to understand the functions of the Save Configuration area.

NOTE: Many Save Configuration items are not available while offline.

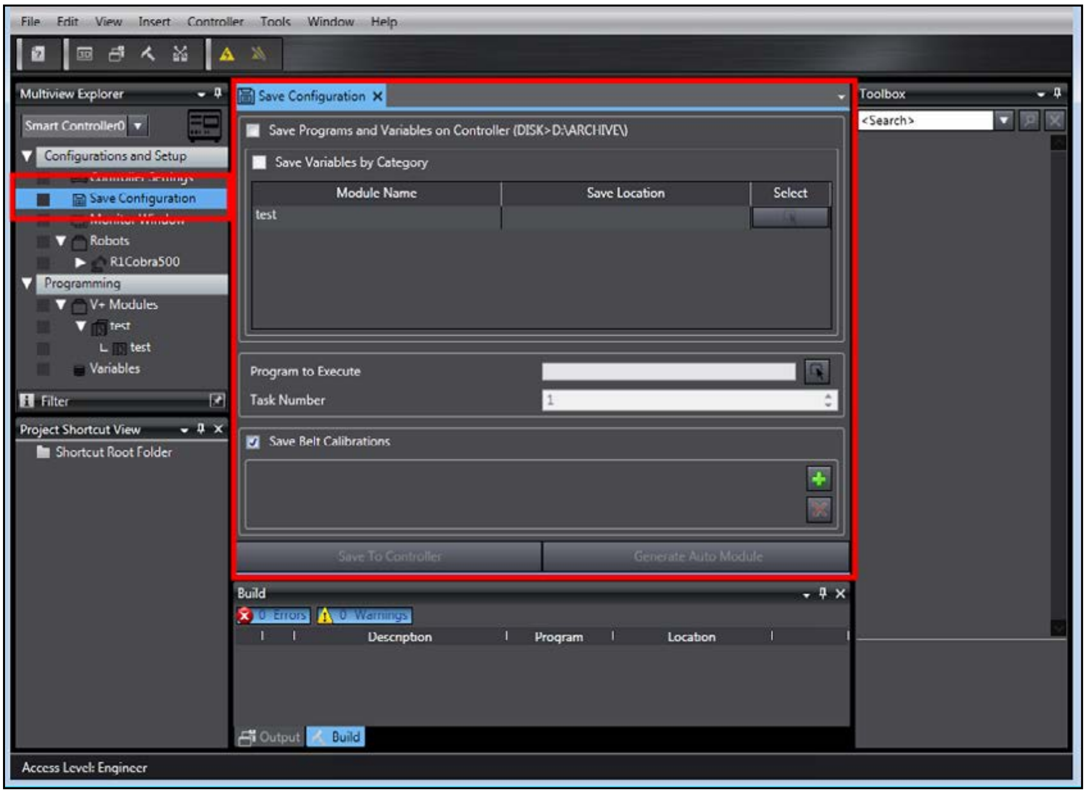


Figure 7-41 Save Configuration

Save Programs and Variables on Controller

When Save Programs and Variables on Controller is selected, all V+ Modules and Variables will be saved to the controller in DISK>D:\ARCHIVE\ when the **Save To Controller** button is clicked.

- All variables will be saved in a single file named GLOBALS.VAR if **Save Variables by Category** is not selected. If **Save Variables by Category** is selected, refer to the following section.
- Modules will be saved in a file called {*module name*}.pg.

Use the **Select** button ( ) to choose an alternate storage location for the Variable and Module files on the controller.

Save Variables by Category

If the ***Save Variables by Category*** option is selected, individual files will be saved based on the category name. Variables without a category designation will be saved to a file named OTHERS.VAR. Refer to V+ Variable Properties on page 173 for more information about variable categories.

Save Belt Calibrations

If Robot Vision Manager Belt Calibrations are present, select **Save Belt Calibrations** and then use the **Add** ( ) or **Remove** ( ) buttons to choose calibrations that you wish to save to the controller. Refer to Belt Calibration on page 292 for more information.

Belt Calibrations will be saved to DISK>D:\ARCHIVE\BELT.DAT when the **Save To Controller** Button is clicked.

> **NOTE:** The selection for *Save Programs* and *Variables on Controller* must be enabled to save belt calibrations to the controller.

7.3 Monitor Window

The Monitor Window is used to input V+ Monitor Commands and receive responses from a controller. When the Monitor Window is open it can also output error information when an error occurs. User program output from the TYPE keyword can also be displayed within this window.

> **NOTE:** The Monitor Window operates in read-only mode while offline.

> **Additional Information**: For a complete list of V+ Monitor Command Keywords, refer to the *eV+ Language Reference Guide (Cat. No. I605)* or the *V+ Keyword Reference Manual (Cat. No. I672)*.

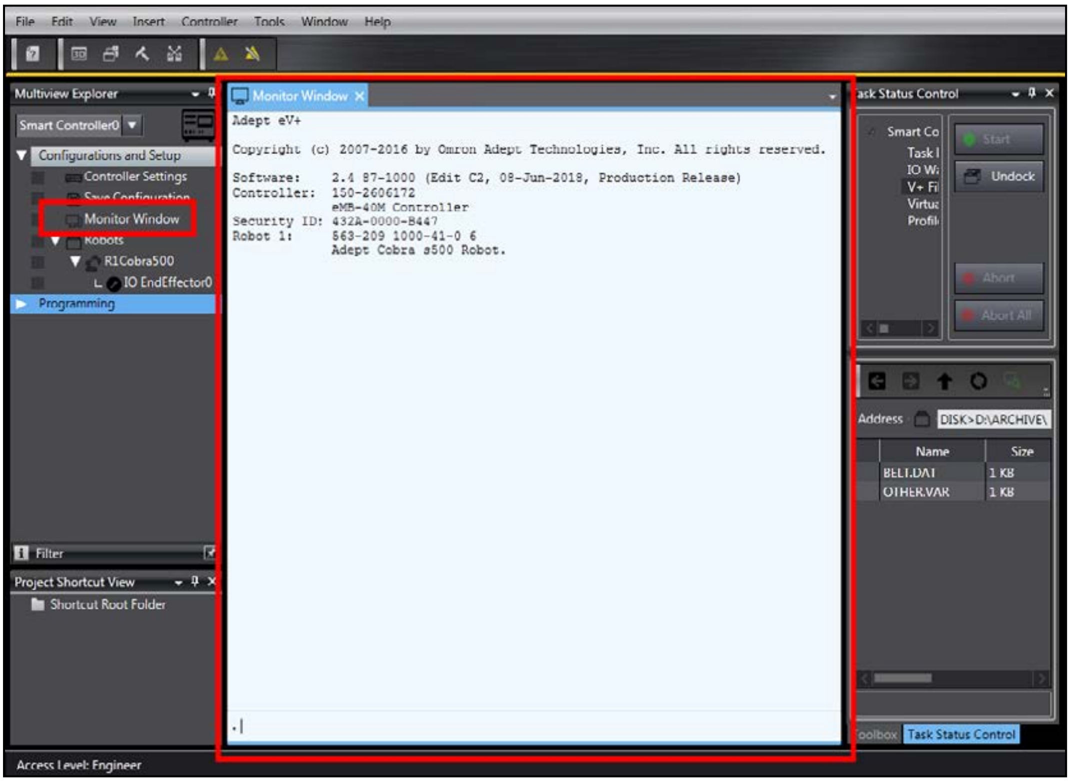


Figure 7-42 Monitor Window

Using the Monitor Window

When the input prompt cursor is blinking, the system is ready to accept Monitor Commands. Find the input prompt cursor at the bottom of the Monitor Window.

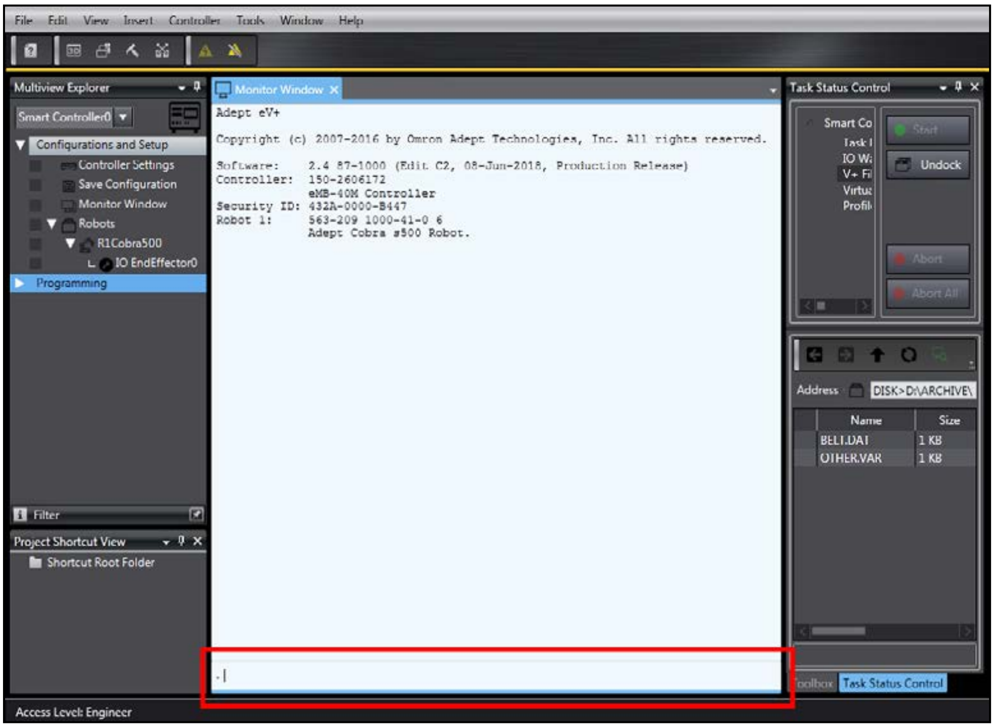


Figure 7-43 Monitor Window Input Cursor

NOTE: Moving the scroll bar away from the bottom will pause auto-scroll. Return the scroll bar to the bottom to resume auto-scroll.

Up and down arrow keys can recall recent Monitor Commands for convenient re-execution. Closing the Monitor Window will clear the recent Monitor Command history.

Monitor Command Entry

Monitor Command do not have to be typed completely. You need to type only enough characters to uniquely identify the Monitor Command Keyword. For example, the only Monitor Command Keyword that begins with "STAT" is STATUS. Therefore, typing "STAT" is sufficient to execute the STATUS Monitor Command. Typing "STA" will result in the Ambiguous Name error because it could refer to either the STATUS or STACK command.

Monitor Command Keyword Parameters

Most Monitor Command Keywords require additional information that tells the system exactly how you want the command executed. This additional information is specified as parameters on the command line. You specify unique information for each Monitor Command Keyword parameter.

Monitor Command Keyword parameters must be entered in the order they are listed and they must be separated (delimited) in exactly the fashion shown. A comma is normally used to separate parameters. Occasionally, an equal sign is used. You must always type a space between a command and its list of parameters.

Spaces before and after parameter separators are optional. Monitor Command Keyword parameters can be optional or required. If a parameter is required, a value must be entered on the command line or the Monitor Command will not execute correctly. If a parameter is optional, its value can be omitted and the system will substitute a default value. For example, the command STATUS has one optional parameter. If the command STATUS is entered, status information for all the used system tasks will be displayed. If the command STATUS 1 is entered, status information will be displayed only for system task number 1.

If one or more parameters follow an omitted parameter, the parameter separator(s) must be typed. If all the parameters following an omitted parameter are optional, and those parameters are omitted, the separators do not need to be typed.

Canceling a Monitor Command

To cancel an executing Monitor Command, press CTRL+C. This will NOT halt a program that was started with the EXECUTE command (the ABORT command halts an executing program).

Executing a Monitor Command

To execute a Monitor Command, type the command at the input prompt cursor. The results of the command are displayed in the same window.

> **Additional Information**: You cannot abort any ACE tasks from the Monitor Window in an ACE project. You can abort an ACE task from the Monitor Window that is provided at the Connect to Device Dialog Box. Refer to Going Online with a SmartController on page 76

7.4 Robot Objects

Robot Objects represent robots that are installed on a controller. After a robot is installed, it appears in the Multiview Explorer to provide access to robot configuration and other related settings.

> **NOTE:** Many Robot Object configuration and control settings are not available while offline. To access all available items, open the Robot Object while online. Refer to the following section for more details.
>
> When Emulation Mode is enabled, certain Robot object settings are not available.

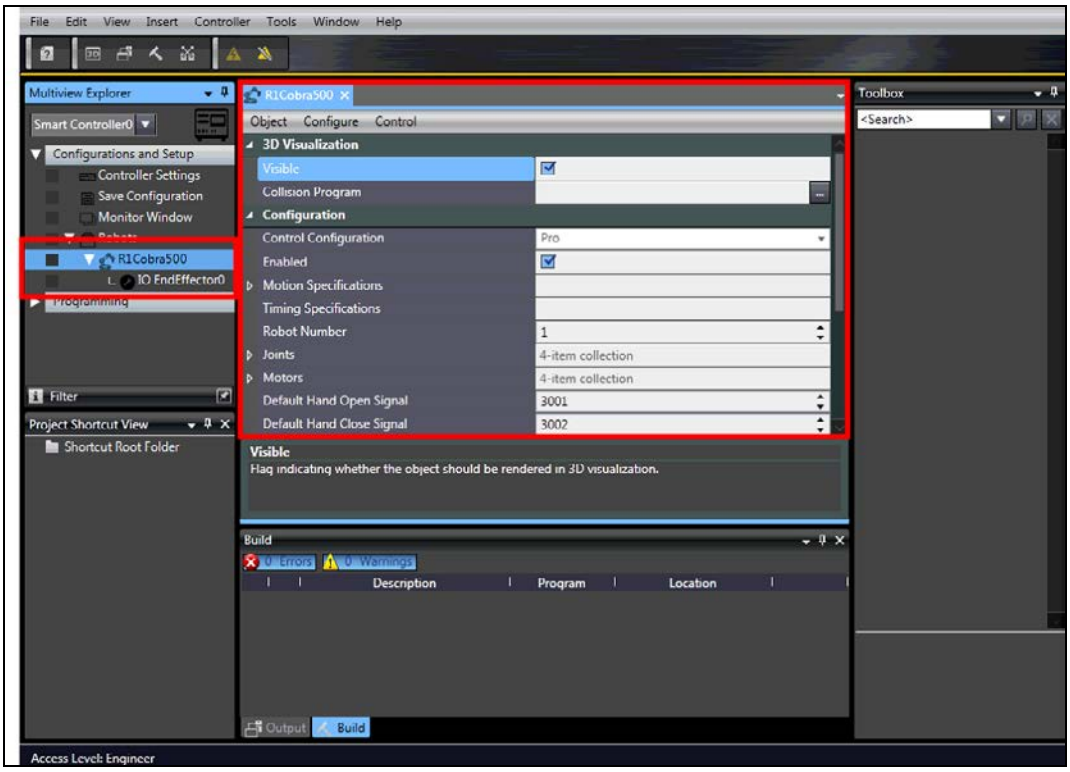


Figure 7-44 Robot Object in the Multiview Explorer

Robot Objects must be added to a new ACE project while online with a controller. Right-clicking the ***Robots*** item in the Multiview Explorer will display the option to Configure Robots. Selecting this option will display the Configure Robots Dialog Box shown below. Use this method to add a new robot to an ACE project.

Additional Information: The Configure Robots Dialog Box can also be accessed through the Controller Settings area. Refer to Configure on page 205 for more information.

NOTE: When using Emulation Mode, you must manually add robots to the project. When connecting to a physical controller, robots will be present in the project after the connection is established.

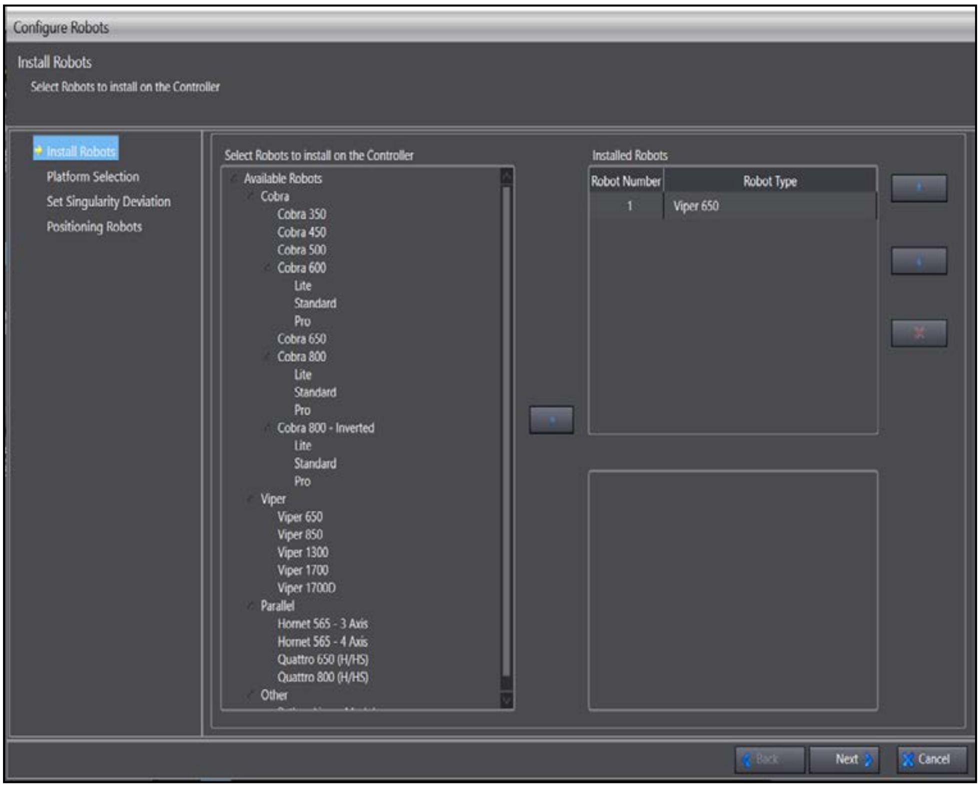


Figure 7-45 Install Robots

Depending upon the configuration and robot workspace, a configuration singularity may develop. A configuration singularity can be defined as a location in the robot workspace where two or more joints no longer independently control the position and orientation of the tool. As a robot executes a straight-line motion that moves close to a configuration singularity, the robot joint speeds necessary to achieve that motion become excessive. This speed control and motion can be controlled through the use of the Singularity Deviation.

When the robot is selected, such as a Viper, the Singularity Deviation can be set to prevent the condition from occurring thereby preventing excessive joint motor speeds. The addition and testing of the Singularity Deviation offset should be done in JOG mode.

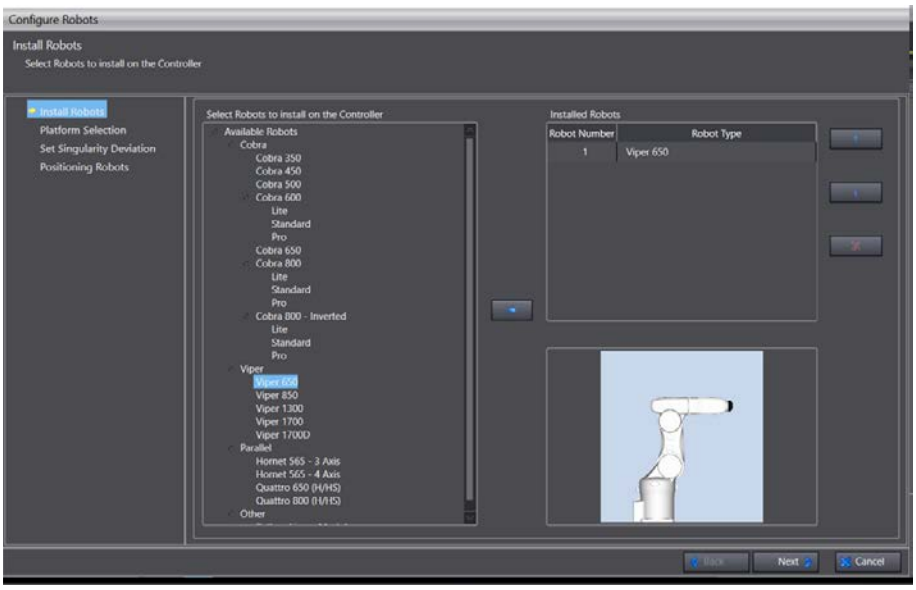


Figure 7-46 Robot Selection

After the robot is selected, click Set Singularity Deviation to enable that option.

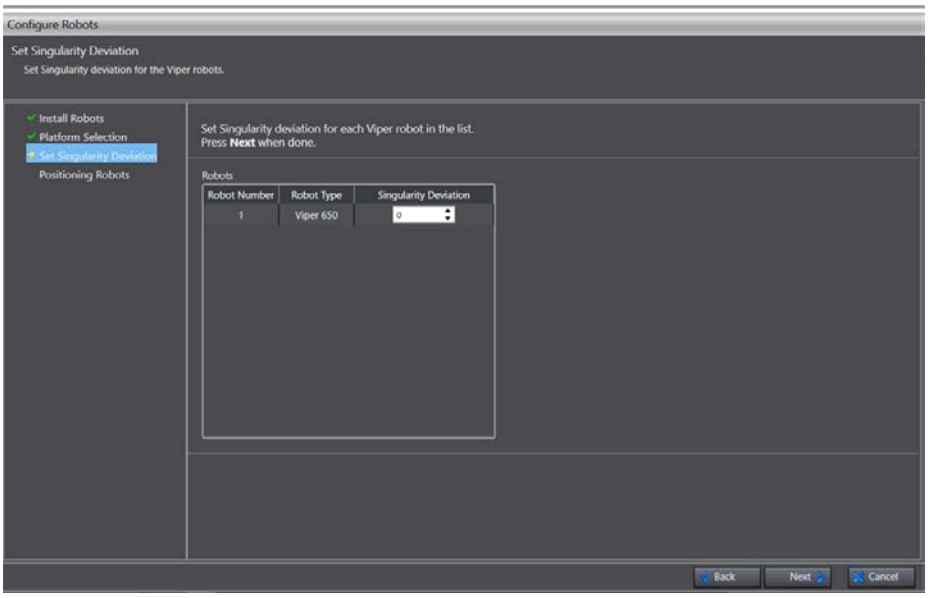


Figure 7-47 Set Singularity Deviation

You can then set the value for the deviation between 0, for no deviation to 100. The deviation is not linear and applies to the relative joint positions and motor speeds as the robot moves through the workspace.

Configure Robots

Use the Configure Robots Dialog Box to select robots to install on the controller. In the Configure Robots Dialog Box, you can select specific robots to manually install on the controller or you can select Auto Configuration. After selecting robots to install on the controller, platform selection (if applicable) and robot positioning are required to complete the Configure Robots process.

> **Additional Information**: Refer to 3D Visualizer on page 107 for more information about robot positioning in a 3D workspace.

Auto Configuration Considerations

The default robot configuration uses Auto Configuration for identifying the physically connected robot type(s). The identification process occurs when V+ accesses a connected robot's RSC (Robot Signature Card) data during boot up.

Auto Configuration is convenient when a controller is used with a varying number of connected robots (such as demonstrations or other applications needing interchangeable robots).

The V+ log may contain extra errors or warnings if there are fewer robots connected than present in the controller configuration.

If more robots are physically connected than listed in the controller configuration, they will exist on the FireWire network but need configuration before ACE and V+ programs can fully support them.

> **NOTE:** Auto Configuration is not available when ACE software is running in Emulation Mode.

Robot Customizations

The robot parameters are displayed when a robot node is selected in the process strategy editor. There are many parameters associated with a robot. These settings are further broken down into a variety of categories represented by the four tabs in the display: General, Allocation, Wait Mode and Error Responses.

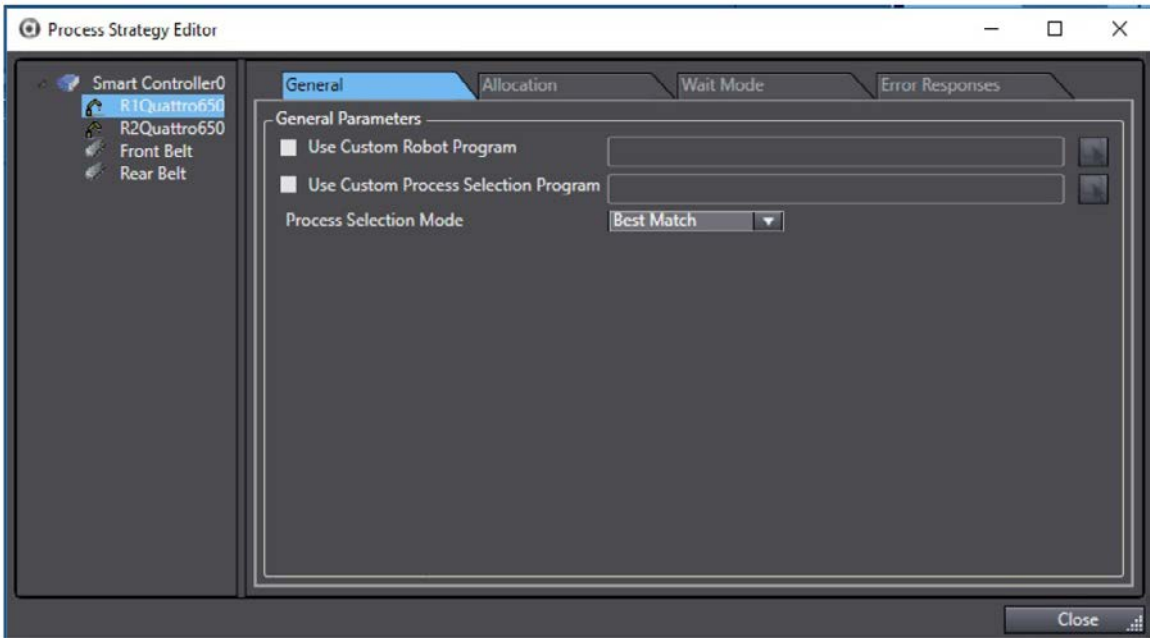


Figure 7-48 Robot Categories

There are two available parameters for the General tab; Use Custom Robot Program and Use Custom Process Selection Program.

Custom Robot Process Selection Program

The process manager application software allows you to take complete control over the behaviors of a robot by customizing the main program that governs the robot top level behaviors. When a custom robot program is created, a copy of the default program is used as the basis for the custom program.

The default main robot program will call a process selection program and then execute that process. However, some applications may benefit from customizing the main robot program to force the selection of a process directly based on some custom condition or bypass the concept of processes entirely and command the robot to pick directly from the part and target queues. These two possibilities are detailed below.

The robot program can be customized in the process strategy editor.

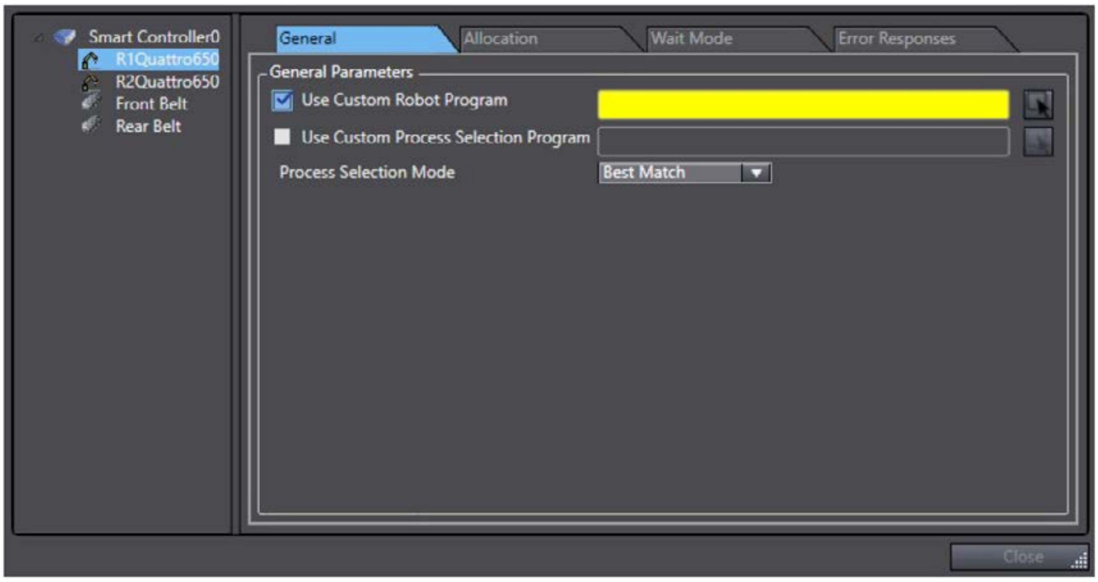


Figure 7-49 Process Strategy Editor

Use the following customization steps to change the selection of processes. Below is an example of a program that does the following:

- Initializes the robot program moving it to an idle position
- Looks up the process index for 2 processes defined in the process manager
- Command the robot to execute the first process 3 times followed by 1 execution of process two.
- Check to see if the stop button was pressed

```
.PROGRAM cu.robot2()

; ABSTRACT: Custom robot program for the Process Manager
; Process Strategy.

        AUTO REAL task.idx, i, sts
        AUTO REAL proc.idx.1, proc.idx.2

        tsk.idx = TASK()

        ; Initialize the robot
        CALL pm.rob.init(tsk.idx)
        CALL pm.rob.idlemd(tsk.idx, FALSE, 0, "")

        ; Get the index associated with the first two processes in the process manager
        CALL pm.ps.map.idx(0, proc.idx.1)
        CALL pm.ps.map.idx(1, proc.idx.2)

        ; Control loop
        DO

            ; Execute the first process 3 time
            FOR i = 1 TO 3
                CALL pm.rob.process(tsk.idx, proc.idx.1, sts)
            END

            ; Execute the second process
            CALL pm.rob.process(tsk.idx, proc.idx.2, sts)

            ; Check process status
            CALL pm.chk.stat(is.running)

        UNTIL is.running == FALSE

        RETURN
.END
```

The process index used in the custom robot program in the call to pm.ps.map.idx is the process index associated with the process on the PC. This process index can be located in the part process editor in the process manager editor.

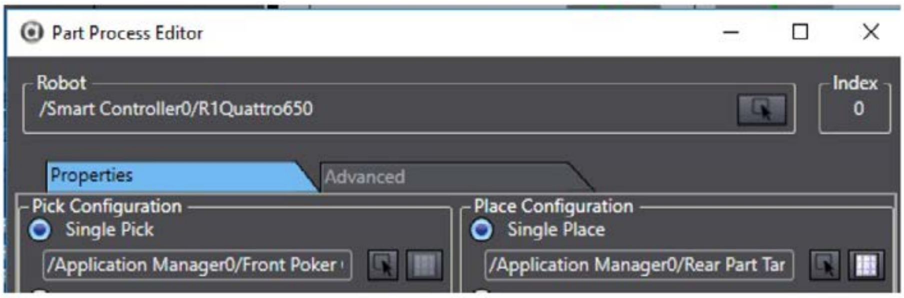


Figure 7-50 Process Index

The program pm.ps.map.idx converts the process index on the PC to an index relative to the current robot task. It is this converted index that must be used when calling pm.rob.process.

Access Queues Customization

You can also access queues as an alternative to using process selection to customize the robot behaviors. A custom application can directly access the part and target queues without using processes. There are times where the options allowed in the confines of a process are to restrictive. Using this technique, you can create more custom logic without having to specify low level motions of the robot.

- Below is an example of a program that does the following:
- Initializes the robot program moving it to an idle position
- Looks up the queue numbers for a part and a part target.
- Command the robot to pick a part and then perform a placement of that part at a part target.
- Check to see if the stop button was pressed

```
.PROGRAM cu.robot3()

; ABSTRACT: Custom robot program for the Process Manager
; Process Strategy.

        AUTO REAL tsk.idx, is.reset, sts
        AUTO REAL part.idx, target.idx

        tsk.idx = TASK()

; Initialize the robot

        CALL pm.rob.init(tsk.idx)
        CALL pm.rob.idlemd(tsk.idx, FALSE, 0, "")

; Get the part and target indexes

        CALL pm.prt.get.idx(tsk.idx, "/Process/Part - Spacing 2", part.idx)
        CALL pm.trg.get.idx(tsk.idx, "/Process/Target 2 - Static", target.idx)

; Control loop

        DO

            ; Perform a pick
            CALL pm.rob.pick(tsk.idx, part.idx, -1, pm.ms.mv.norm, , is.reset, sts)

            ; Perform a place
            CALL pm.rob.place(tsk.idx, target.idx, part.idx, -1, pm.ms.mv.norm, , is.reset, sts)

            ; Check to see if the process manager is still running
            CALL pm.chk.stat(is.running)

        UNTIL is.running == FALSE

        CALL pm.rob.clear(tsk.idx, sts)

        RETURN
.END
```

Figure 7-51 Accessing Queues

Custom Robot Wait Programs

When the robot does not have product available, it enters idle mode. The process strategy allows you to select the behavior of the robot when it enters an idle waiting mode:

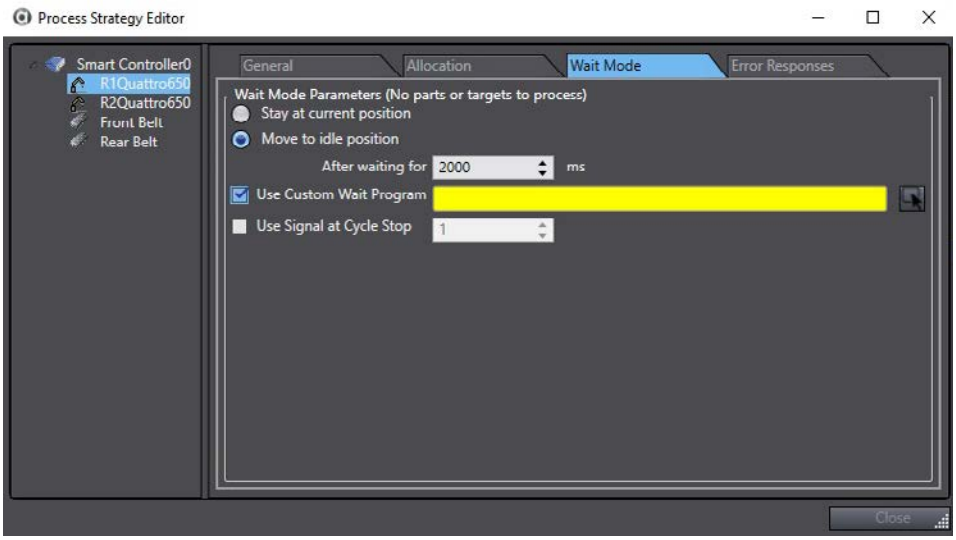


Figure 7-52 Custom Robot Wait

By default you have the option to leave the robot at the current position or move it to the idle position after waiting a certain amount of time. If you want, you can customize the robot wait program. When it is customized, you start with a copy of the default program:

```
.PROGRAM cu.rwait(rob.idx, $type, time, done)

; ABSTRACT:  Method called when the robot does not have a part or target
;       available. This program checks to see if the robot needs to be
;       moved to the idle location or should stay at the current location.
;
;       This can be called if no process is available -or- a process is
;       selected but the expected part or target is not in the robot queue.
;
;       This program will be called iteratively. This program should do a
;       check to see if the robot should be moved then return. If it issues
;       the move, it should set the done parameter to TRUE.
;
; INPUTS:       rob.idx         Index of the robot
;               $type           Type of object the robot is waiting for
;                                 or empty ("") if no process has been selected
;               time            Time that has elapsed. Units are in ms.
;
; OUTPUTS:      done            Has the robot been moved? Setting this to TRUE
;                                 will indicate the robot has been moved to the
;                                 waiting position.
;
; SIDE EFFECTS: None
;
;* Copyright (c) 2007-2009 by Adept Technology, Inc.
```

Figure 7-53 Default Wait Program

The default program gets called while the robot is waiting. By default this program implements the logic described above. If Move to Idle is enabled, it will monitor the elapsed time and move the robot to the idle position as needed. This can be seen in the body of the program, in the following figure.

```
        AUTO REAL move.to.idle, values[4]

; Extract the parameters for the waiting

        CALL pm.psp.rob.pars(rob.idx, values[])

; See if we need to move to idle

        IF (values[psp.rob.mvidle]) THEN
            IF (time > values[psp.rob.delay]) THEN
                move.to.idle = TRUE
            ELSE
                move.to.idle = FALSE
            END
        ELSE
            move.to.idle = FALSE
        END

; Perform the move to idle position, if needed

        IF (move.to.idle) THEN
            CALL pm.mv.idle(rob.idx)
            done = TRUE
        END

        RETURN
```

Figure 7-54 Idle Wait Return

Customizing Stop Behavior

When the process manager application is stopped, the system will perform a stop procedure to stop the V+ tasks used by the runtime.

The user can define a V+ program that is called when the process manager is in the process of stopping through the following menu:

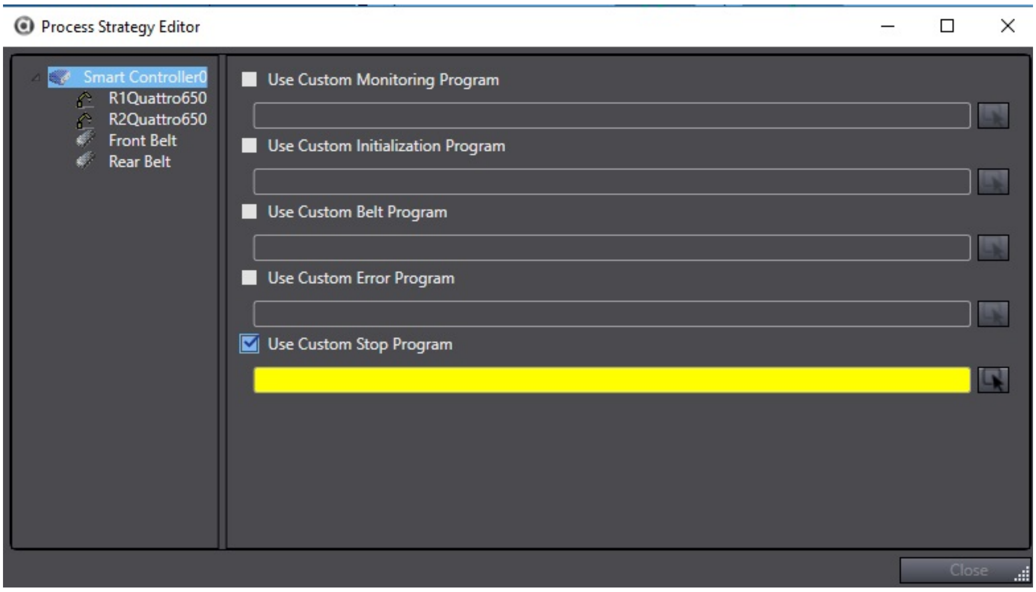


Figure 7-55 Custom Stop

The default stop program looks similar to the following figure.

```
.PROGRAM cu.stop(tasks.stopped)

; ABSTRACT:  Perform operations required when the application is stopped.
;       This method will be called before tasks have been stopped and
;       after the tasks have been stopped.
;
;       This program will be allowed to run for at most 500 ms. It should only
;       perform operations that will be completed within that 500 ms time limit.
;
; INPUTS:       tasks.stopped   Have the tasks been stopped?
;
; OUTPUTS:      None
;
; SIDE EFFECTS: None
;
;* Copyright (c) 2007-2008 by Adept Technology, Inc.

; Check the belts to see if they need to stop running

        IF (tasks.stopped) THEN
            CALL pm.psp.belt(pm.ps.tsk, FALSE)
        END

        RETURN
.END
```

Figure 7-56 Custom Stop Program

Robot Allocation

The parameters in the allocation section control how part and target instances are allocated to the associated robot:

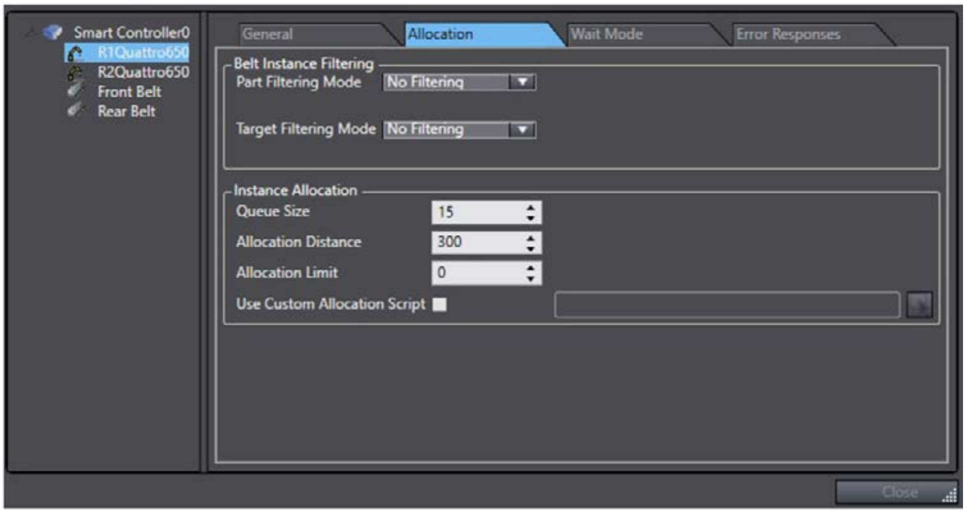


Figure 7-57 Robot Allocation Options

Custom Allocation Script

The process manager allows for customization of the allocation logic if the default allocation strategy does not fit your needs.

The default allocation strategy is designed so that each robot will pick as many instance as possible and instances are ordered from farthest downstream to farthest upstream. Any instances not processed by a given robot are placed in the next robot queue that is capable of processing the instance.

The following are two examples of situations that would require a custom allocation script.

- Instances need to be picked up in rows perpendicular to the flow of parts. In this case, instances may need to be grouped into rows then sorted left-to-right.
- Instances need to be "load balanced" between a certain number of robots.

An allocation script can be added to the workspace by clicking, **Process**, then **Add** and selecting **Allocation Script**, as shown in the following figure.

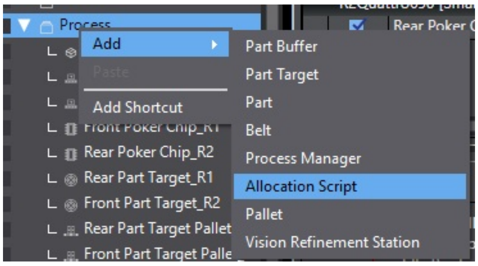


Figure 7-58 Create Allocation Script

Once created, the script must be associated with each robot that will use the script.

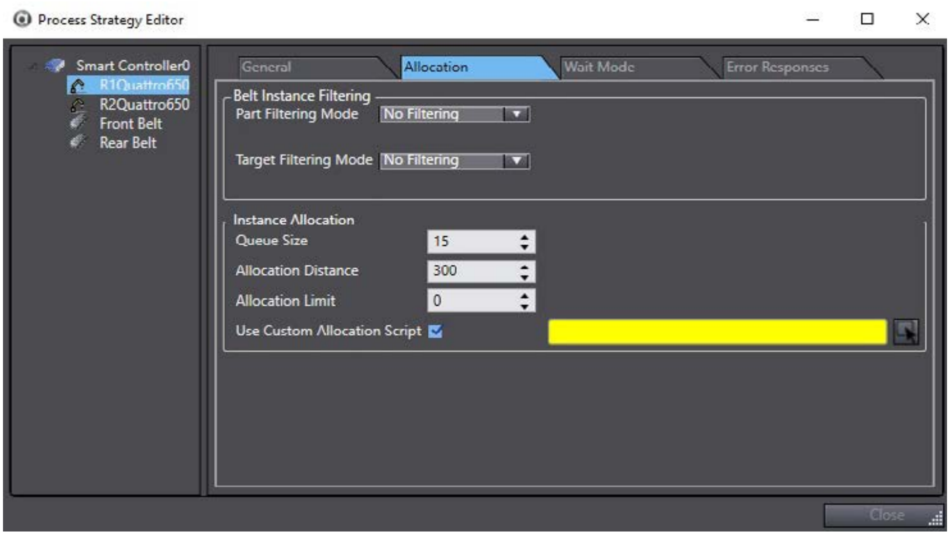


Figure 7-59 Script Associated with Robot

Each robot maintains a queue size which defines how many instances of a given kind can be send to a robot controller. This queue size parameter is not the total number of instances, it is the total number of instances of each part or target that can be sent. The robot controller maintains a different queue for each possible part or target that a robot can process. This parameter defines the queue size for each of these queues.

After you create a default allocation script, you need to be initialize it to use the logic of the default allocation algorithm. There are 4 different methods that can be customized:

- Initialize
- Allocate Non-Belt Instances
- Allocate Belt Instances
- Notification as Instances are Processed

Default Allocation Script Initialize Method

The Initialization method is called when the process manager is started. Each robot that is associated with the script will used to call the initialize method:

```
/// <summary>
/// Initializes the allocation algorithm at the start of runtime processing.
/// </summary>
/// <param name="station">The station.</param>
public void Initialize(RobotStation station) {
    Trace.WriteLine("Initializing for: "+station.Robot.FullPath);
}
```

Figure 7-60 Initialize Method Example

Allocate Non-Belt InstancesObject

The data requirements and allocation logic for belt based instances are very different than for non-belt based instances. As such, each class of instances is handled by a separate method. The non-belt instance method is called to allocate static and non-belt camera instances. The default behavior is to allocate the instances to the robot as long as there is space in the queues.

The non-belt instances method is passed two different arrays of note:

- **availableInstance**s: Input parameter containing the list of all instances that could be allocated.
- **instancesToAllocate**: Output parameter containing the instances that should be sent to the robot controller.

It is the job of the **AllocateNonBeltInstances** to move instances from the **availableInstance**s list to the **instancesToAllocate** list.

```
/// <summary>
/// Allocates the non-belt relative instances to a robot station.
/// </summary>
/// <param name="station">The station.</param>
/// <param name="processType">The type of object being allocated.</param>
/// <param name="queueSize">The queue size of the robot station.</param>
/// <param name="availableInstances">The available instances.</param>
/// <param name="instancesToAllocate">The instances to allocate to the station.</param>
public void AllocateNonBeltInstances(RobotStation station, IProcessType processType, int queueSize, Locat

    // If no instances, do not process
    if (availableInstances.Count == 0)
        return;

    // Get the number of items in the robot queue for that type
    int numberInQueue = station.GetInstancesInProcess(processType);

    // Add as many items as we can to the queue
    foreach (LocatedInstance instance in availableInstances) {

        // Make sure there is room to add
        if (numberInQueue >= queueSize)
            break;

        // Allocate the part to the station
        instancesToAllocate.Add(instance);

        // Note that one more has been added
        numberInQueue++;

    }
}
```

Figure 7-61 Allocate Non-Belt Instance Example

Allocate Belt Instances

The default behavior for allocation of belt-based instances is similar to non-belt instance handling from the standpoint that instances are allocated to a robot as long as the queue can take more instances.

The belt instances allocation method is passed three different arrays of note:

- **availableInstances**: Input parameter containing the list of all instances that could be allocated.
- **instancesToAllocate**: Output parameter containing the instances that should be sent to the robot controller.
- **instancesToSkip**: Output parameter containing the instances that should be sent to the next down-stream robot capable of processing the instance.

It is the job of the **AllocateBeltInstances** to move instances from the **availableInstances** list to either the **instancesToAllocate** list or the **instancesToSkip** list. The **availableInstances** list is an ordered list where the first instance in the list is the farthest downstream instance that is still capable of being processed by the robot station.

If an instance is never allocated by the **AllocateBeltInstances** method, the instance will automatically be moved to the queue of the next downstream robot once the instance passes out of the robot belt window.

```
/// <summary>
/// Allocates the belt-relative instances to a robot station.
/// </summary>
/// <param name="station">The station.</param>
/// <param name="queueSize">Size of the queue.</param>
/// <param name="availableInstances">The available instances.</param>
/// <param name="instancesToAllocate">The instances to allocate.</param>
/// <param name="instancesToSkip">The instances to skip and send to the next downstream robot.</param>
public void AllocateBeltInstances(RobotStation station, int queueSize, LocatedInstanceCollection availabl

    // If no instances to process, skip
    if (availableInstances.Count == 0)
        return;

    // Assign parts to the robot
    int count;
    Dictionary<string, int> allocatedCount = new Dictionary<string, int>();

    foreach (LocatedInstance locatedInstance in availableInstances) {

        if (allocatedCount.ContainsKey(locatedInstance.ObjectType) == false) {
            count = station.GetInstancesInProcess(ace[locatedInstance.ObjectType] as IProcessType);
            allocatedCount.Add(locatedInstance.ObjectType, count);
        }

        // Get the number of parts in or allocated to the station
        count = allocatedCount[locatedInstance.ObjectType];

        // If there are too many parts in the queue
        if (count >= queueSize)
            continue;

        instancesToAllocate.Add(locatedInstance);
        allocatedCount[locatedInstance.ObjectType]++;

    }
}
```

Figure 7-62 AllocateBeltInstances Example

Notify Instance Processed

After an instance is sent to a RobotStation, the robot will either respond indicating that the instance was processed successfully or the instance was not processed. For example, if a belt-based instance was picked by the robot, it would respond to the PC that the instance was successfully processed. However, there are times where the robot was not able to pick all the instances on the conveyor because there are too many given the belt speed. In this case, the instances are robot responds to the PC that those instances were not processed.

As robots report which instances are processed and not processed, the **NotifyInstanceProcessed** method is called. An example is shown in the following figure.

```
/// <summary>
/// Method called notifying that instances sent to a RobotStation have been processed.
/// </summary>
/// <param name="station">The station.</param>
/// <param name="instancesProcessed">The instances sucessfully processed.</param>
/// <param name="instancesNotProcessed">The instances that were not processed by the station.</param>
public void NotifyInstancesProcessed(RobotStation station, LocatedInstanceCollection instancesProcessed,

}
```

Figure 7-63 NotifyInstanceProcessed Method

Located Instance

The **LocatedInstance** class represents an instance that can be processed by a robot. There are many properties which can be useful when defining if an instance should be processed. These properties include:

- BeltRelativePosition
- DistanceToPickLine
- DistanceToUpstreamWindow
- Handler
- Location
- ObjectType
- PalletIndex
- PalletInstance
- GetControllerLatchPosition

The **BeltRelativePositon** property gives the position of the Instance relative to the belt frame and varies with time. A visual example is shown in the following figure.

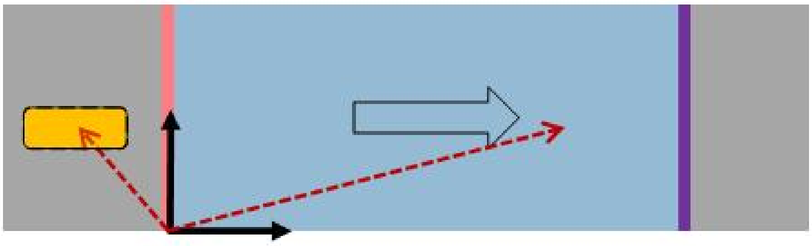


Figure 7-64 Belt Relative Position

The **DistanceToPickLine** property gives the distance between the instance and the pick line limit and varies with time. A visual example is shown in the following figure.

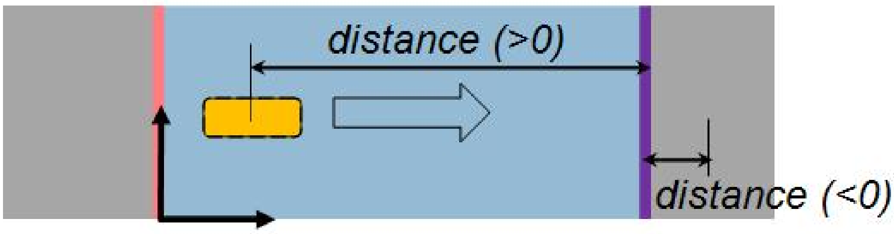


Figure 7-65 Distance to Pick Line

The **DistanceToUpstreamWindow** property gives the distance the upstream line and the instance and varies with time. A visual example is shown in the following figure.

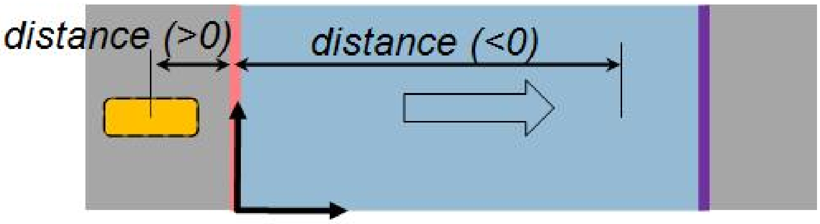


Figure 7-66 Distance to Upstream Window

The **Handler** gives the source handler the generated instance. A visual example is shown in the following figure.

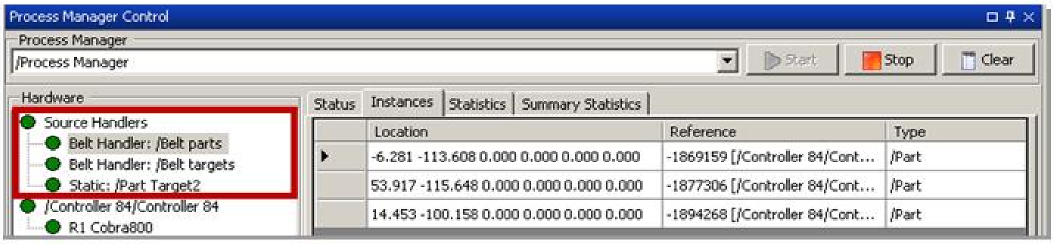


Figure 7-67 Handler

The **Location** property gives the location of the instance in its locator frame.

The **ObjectType** gives the name of that object type as a string, as shown in the following figure.

```
Part myPart = (Part) ace["/process1/Part"];
PartTarget myTarget = (PartTarget) ace["/process1/Part Target"];

if (locatedInstance.ObjectType == myPart.FullPath)
    ace.AppendToLog("this is my part");

if (locatedInstance.ObjectType == myTarget.FullPath)
    ace.AppendToLog("this is my target");
```

Figure 7-68 Object Type

The **PalletIndex** property is used only if the instance relates to a pallet and it defines the index of the pallet slot. This is shown in the following figure.

Figure 7-69 Pallet Index

The **PalletInstance** is used only if the instance is related to a pallet and has a unique identifier (Guid) of the pallet associated with this instance

There are also several methods that can be used in the process of allocating instances, such as

GetControllerLatchPosition: which gets the latched value of the instance (reference).

LocatedInstance Tag Property

There is one additional property that can be very useful when synchronizing a custom allocation script with a C# custom vision tool and/or robot behavior in V+. When a custom vision tool executes, a **VisionTransform** collection is returned as an output of the **Main** method. The **VisionTransform** class has a **Tag** property which is of type object. You can use this property to tag a vision instance in the custom vision tool and retrieve this tag from an allocations script.

For example, your custom vision tool might look like the following figure.

```
foreach (BlobResult res in myBlob.Results){

    // declare a List used to tag the instance
   List<float> myTag = new List<float>();

   // fill that List
   myTag.Add(res.Area);
   myTag.Add(res.GreyLevelMean);

   // tag the vision result
   res.Position.Tag = myTag;

   // add the vision result in Results of the custom vision tool
   results.Add(res.Position);
}
```

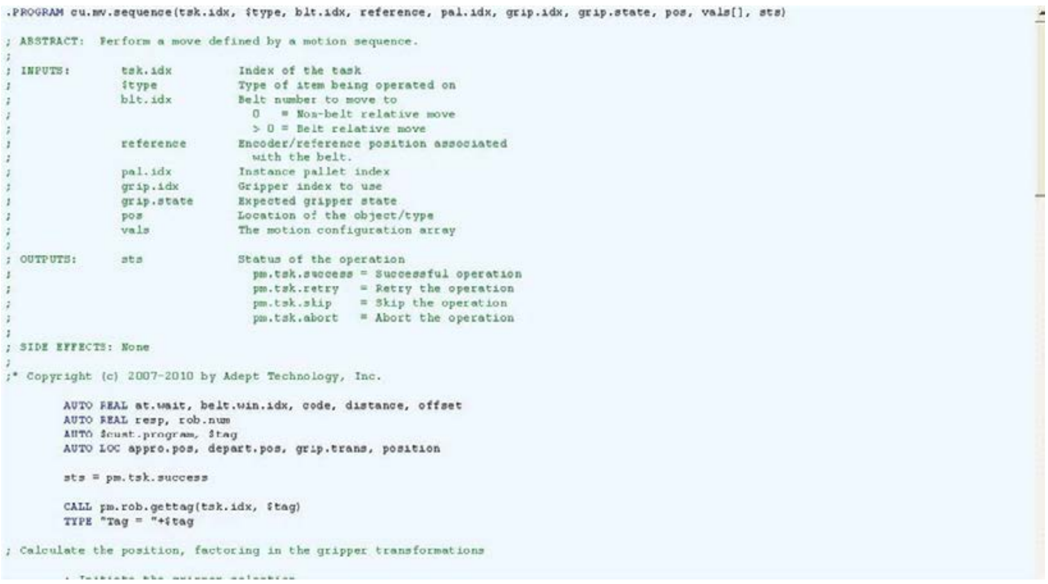
Figure 7-70 Tag Property Example

From within the allocation script, you can access the information as such shown in the following figure.

```
List<float> tagInstance = (List<float>) locatedInstance.Tag;
float instanceArea = tagInstance[0];
float instanceMeanGrey = tagInstance[1];
```

Figure 7-71 Tag Instance

Additionally, if the Tag is defined for a LocatedInstance, the Tag will be converted to a string representation and send to V+ as part of the instance information. From within a custom motion sequence program, the tag can be extracted as shown below.



```
.PROGRAM cu.mv.sequence(tsk.idx, $type, blt.idx, reference, pal.idx, grip.idx, grip.state, pos, vals[], sts)

; ABSTRACT:  Perform a move defined by a motion sequence.
;
; INPUTS:       tsk.idx         Index of the task
;               $type           Type of item being operated on
;               blt.idx         Belt number to move to
;                                 0   = Non-belt relative move
;                                 > 0 = Belt relative move
;               reference       Encoder/reference position associated
;                                 with the belt.
;               pal.idx         Instance pallet index
;               grip.idx        Gripper index to use
;               grip.state      Expected gripper state
;               pos             Location of the object/type
;               vals            The motion configuration array
;
; OUTPUTS:      sts             Status of the operation
;                                 pm.tsk.success = Successful operation
;                                 pm.tsk.retry   = Retry the operation
;                                 pm.tsk.skip    = Skip the operation
;                                 pm.tsk.abort   = Abort the operation
;
; SIDE EFFECTS: None
;
;* Copyright (c) 2007-2010 by Adept Technology, Inc.

        AUTO REAL at.wait, belt.win.idx, code, distance, offset
        AUTO REAL resp, rob.num
        AUTO $cust.program, $tag
        AUTO LOC appro.pos, depart.pos, grip.trans, position

        sts = pm.tsk.success

        CALL pm.rob.gettag(tsk.idx, $tag)
        TYPE "Tag = "+$tag

; Calculate the position, factoring in the gripper transformations
```

Figure 7-72 Tag as a String

I/O EndEffectors

I/O EndEffectors, also called tools, end effectors, and grippers can be used in picking, placing, dispensing, or other functions common to robotic applications. End effectors are often driven by digital outputs to grip, extend, retract, or dispense. Inputs are commonly used on end effectors to detect parts presence and extend / retract status.

Most robots have a single end effector, but some may have multiple end effectors to pick and place multiple objects at the same time. ACE supports these variations with the I/O EndEffector settings described below.

By default, one end effector object is automatically added with a Robot Object (I/O EndEffector0). This is an I/O driven gripper with single or multiple end effector tips. It uses digital input and output signals to control each tip. Additional I/O EndEffector objects may be added as needed for your application, such as calibration pointers used to perform calibration for systems with multi-tip process grippers.

> **NOTE:** I/O EndEffector objects represent grippers that are wired to and controlled by the SmartController device. I/O EndEffectors are defined in the SmartController device because they are associated with specific robots, but full functionality of the I/O EndEffector is utilized by a Process Manager configured in an Application Manager device.

To add additional I/O EndEffector objects, right-click a Robot Object in the Multiview Explorer, select **Add** and then click **I/O EndEffector.**

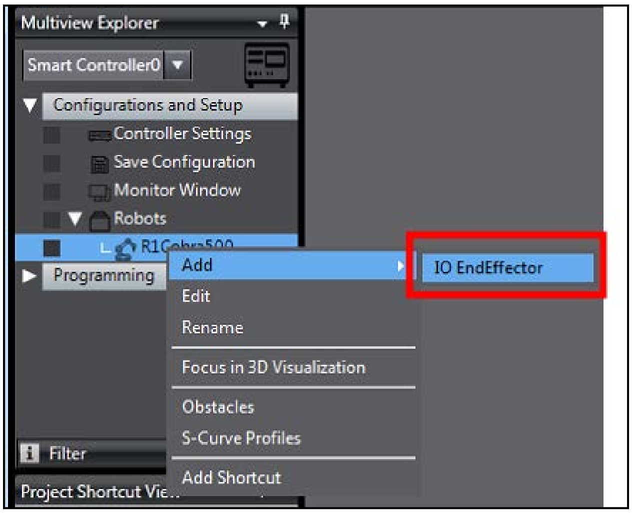


Figure 7-73 Add Additional I/O EndEffectors

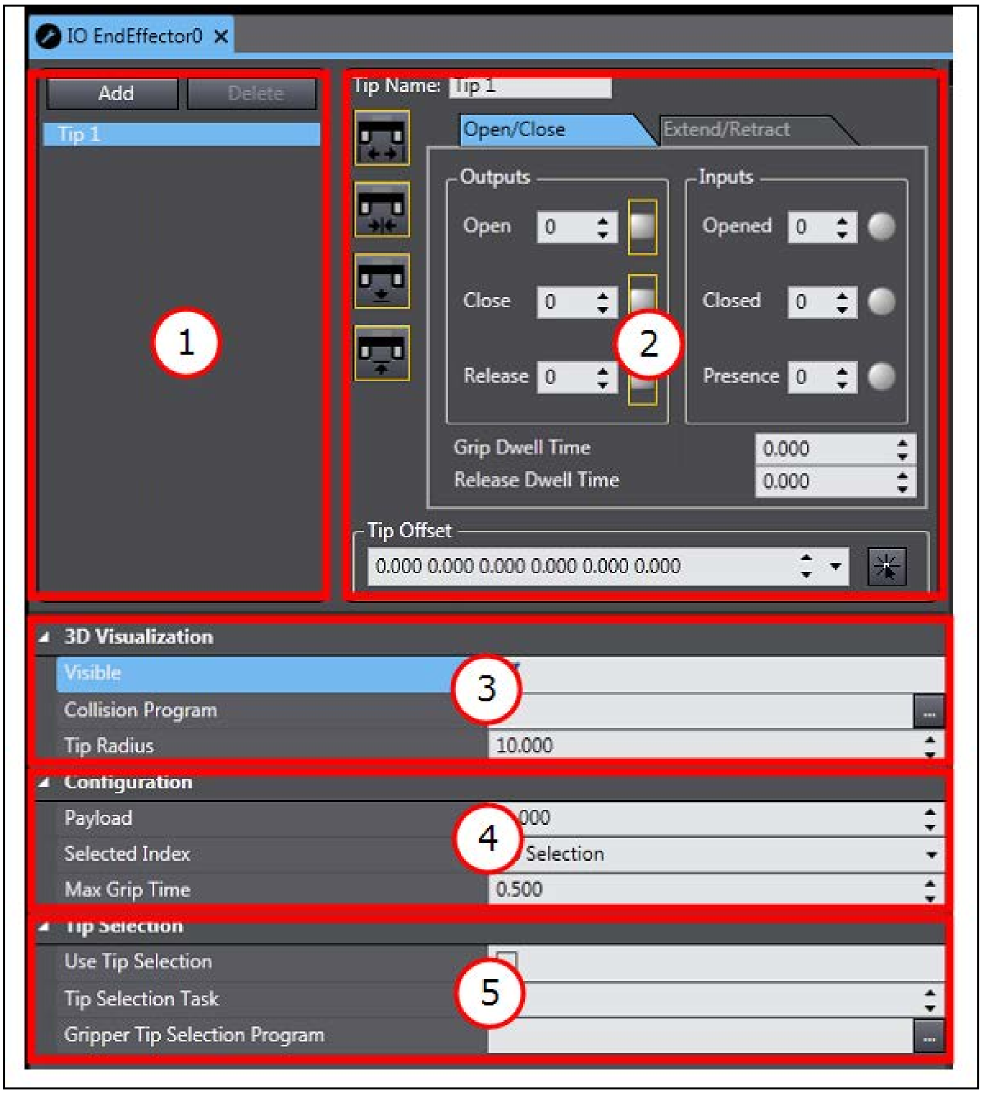


Figure 7-74 I/O EndEffector Settings

Table 7-5 I/O EndEffector Setting Description

Item	Name	Description
1	Add/Delete Buttons	Used to add a new gripper tip or to delete an existing gripper tip.
	Tip List	Displays the list of defined gripper tips. For robot-to-belt or robot-to-camera calibrations, if a gripper has multiple tips defined, the entire tool (all tips) will be used to pick up and release the part during the calibration procedure. The center line of the gripper will be used as the reference tool in the calibration procedure. **NOTE:** If multiple tips are defined, it can be useful to create a second I/O EndEffector object that stores a single tip offset for use when performing calibrations because the calibration process allows you to choose which I/O EndEffector object to use, regardless if the physical end effector needs to be changed. Refer to Process Manager Object on page 395 for more information.
2	Outputs / Inputs	Defines the Open / Close or Extend / Retract activation signals and Opened / Closed or Extended / Retracted status signals for the selected tip. You can define multiple signals by entering the signal numbers separated by a space (for example: 97 98). If the output signals are not valid signals, they are ignored. When multiple signals are defined, the following icon colors apply: ON OFF multiple signals (not all signals are ON or OFF) When Emulation Mode is enabled, the input signals are ignored, but soft signals can be substituted for testing purposes.
	Presence	Defines an input signal from a part-presence sensor that indicates the presence (ON) or absence (OFF) of a part in the gripper. If specified, the status of the presence sensor is checked when picking or placing a part. Before the robot places a part at a target, the signal must be ON. Before the robot picks a part, the signal must be OFF. Input signals are ignored in Emulation Mode, but soft signals will be monitored.

Item	Name	Description
	Grip Dwell Time Release Dwell Time	The time (in seconds) to wait when gripping or releasing before continuing operation. This should be the actuation time for the gripper.
	Open/Close Tab	Click this tab to access the Open/Close signal settings for the selected tip.
	Extend/Retract Tab	Click this tab to access the Extend/Retract signal settings for the selected tip.
	Open tip / Close Tip Buttons	Use the **Open Tip** and **Close Tip** Buttons to send a open tip ( ) or close tip ( ) signal to the selected tip.
	Extend Tip / Retract Tip Buttons	Use the **Extend Tip** and **Retract Tip** Buttons to send an extend tip ( ) or retract trip ( ) signal to the selected tip.
	Extend/Retract Dwell Time	The time (in seconds) to wait when extending or retracting, before continuing operation. The value represents the minimum time to dwell. After the specified dwell time, the input signals are checked.
	Tip Offset	Shows the current offset for the selected tip in the 3D Visualizer. To change the offset, click the **Teach Tool Tip Wizard** Button ( ), which starts the Tool Offset Wizard.
3	Visible	Enables the display of the IO EndEffector tip positions in the 3D Visualizer. Refer to 3D Visualization on page 278 for more information.
	Collision Program	Select a program that is invoked when the 3D Visualizer detects a collision. Refer to Graphical Collision Detection on page 114 for more information.
	Tip Radius	The radius of the tip when drawing the I/O EndEffector in the 3D Visualizer. Refer to 3D Visualization on page 278 for more information.
4	Payload	The weight of the gripper plus the weight of the heaviest part the robot will carry (in kg). Setting the correct payload will lower tracking error and settling time, making the robot motion more precise and faster at the end of the motion. A negative value restores the default payload for this robot.
	Selected Index	The currently selected IO EndEffector tip. Choose Centerline when multiple tips are present.
	Max Grip Time	Maximum time allowed for the grip to be verified and part presence to be satisfied, in seconds.
5	Use Tip Selection	When enabled, the tip selection program will be called when a tip is selected.
	Tip Selection Task	The task used when executing the tip selection program.
	Gripper Tip	The V+ program that is called when a tip is selected.

Item	Name	Description
	Selection Program	This is used in the case where the gripper has some additional operation required to switch the tips. For example, there might be some additional I/O that needs to be set (or a motor moved) to physically move the tips.

I/O EndEffector Settings

ACE software provides an interface for setting various gripper-related parameters, such as end effector tips, minimum grip time, and maximum grip time. To open the I/O EndEffector settings area, double-click the I/O EndEffector object in the Multiview Explorer.

I/O EndEffector Settings are described below.

Additional Information: I/O EndEffector properties can be accessed from V+ programs using VPARAMETER and VLOCATION keywords. Refer to the *ACE Reference Guide* for more details or create a Robot Vision Manager application sample that includes vision for V+ program code examples. Using Robot Vision Manager keywords requires an online connection between the ACE software and a controller.

IMPORTANT: I/O EndEffector settings are not saved on the controller with the Save Configuration function.

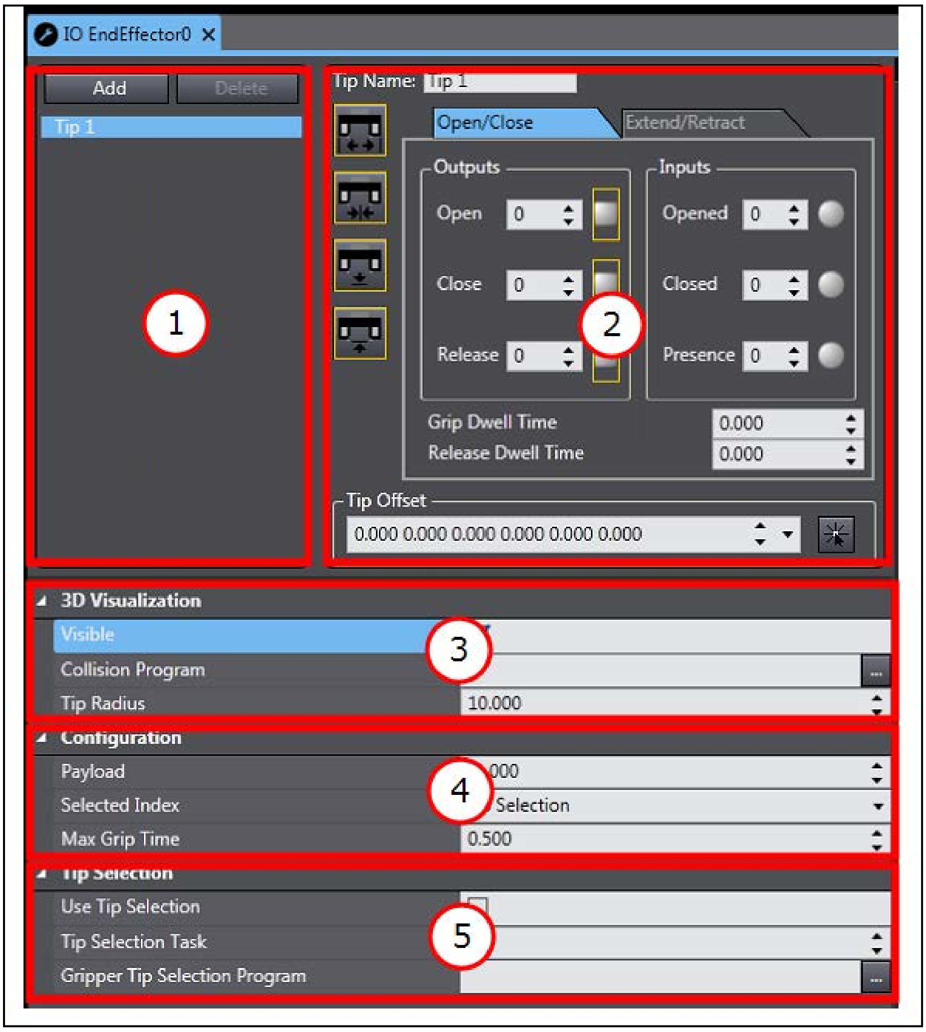


Figure 7-75 I/O EndEffector Settings

Table 7-6 I/O EndEffector Setting Description

Item	Name	Description
1	**Add/Delete** Buttons	Used to add a new gripper tip or to delete an existing gripper tip.
	Tip List	Displays the list of defined gripper tips. For robot-to-belt or robot-to-camera calibrations, if a gripper has multiple tips defined, the entire tool (all tips) will be used to pick up and release the part during the calibration procedure. The center line of the gripper will be used as the reference tool in the calibration procedure. **NOTE:** If multiple tips are defined, it can be useful to create a second I/O EndEffector object

Item	Name	Description
		that stores a single tip offset for use when performing calibrations because the calibration process allows you to choose which I/O EndEffector object to use, regardless if the physical end effector needs to be changed. Refer to Process Manager Object on page 395 for more information.
2	Outputs / Inputs	Defines the Open / Close or Extend / Retract activation signals and Opened / Closed or Extended / Retracted status signals for the selected tip. You can define multiple signals by entering the signal numbers separated by a space (for example: 97 98). If the output signals are not valid signals, they are ignored. When multiple signals are defined, the following icon colors apply: ON OFF multiple signals (not all signals are ON or OFF) When Emulation Mode is enabled, the input signals are ignored, but soft signals can be substituted for testing purposes.
	Presence	Defines an input signal from a part-presence sensor that indicates the presence (ON) or absence (OFF) of a part in the gripper. If specified, the status of the presence sensor is checked when picking or placing a part. Before the robot places a part at a target, the signal must be ON. Before the robot picks a part, the signal must be OFF. Input signals are ignored in Emulation Mode, but soft signals will be monitored.
	Grip Dwell Time Release Dwell Time	The time (in seconds) to wait when gripping or releasing before continuing operation. This should be the actuation time for the gripper.
	Open/Close Tab	Click this tab to access the Open/Close signal settings for the selected tip.
	Extend/Retract Tab	Click this tab to access the Extend/Retract signal settings for the selected tip.
	Open Tip/**Close Tip** buttons	Use the Open Tip and Close Tip buttons to send a open tip ( ) or close tip ( ) signal to the selected tip.
	Extend Tip/**Retract Tip** buttons	Use the Extend Tip and Retract Tip buttons to send an extend tip ( ) or retract trip ( ) signal to the selected tip.

Item	Name	Description
	Extend/Retract Dwell Time	The time (in seconds) to wait when extending or retracting, before continuing operation. The value represents the minimum time to dwell. After the specified dwell time, the input signals are checked.
	Tip Offset	Shows the current offset for the selected tip in the 3D Visualizer. To change the offset, click the **Teach Tool Tip Wizard** button ( ), which starts the Tool Offset Wizard.
3	Visible	Enables the display of the I/O EndEffector tip positions in the 3D Visualizer. Refer to 3D Visualization on page 278 for more information.
	Collision Program	Select a program that is invoked when the 3D Visualizer detects a collision. Refer to Graphical Collision Detection on page 114 for more information.
	Tip Radius	The radius of the tip when drawing the IO EndEffector in the 3D Visualizer. Refer to 3D Visualization on page 278 for more information.
4	Payload	The weight of the gripper plus the weight of the heaviest part the robot will carry (in kg). Setting the correct payload will lower tracking error and settling time, making the robot motion more precise and faster at the end of the motion. A negative value restores the default payload for this robot.
	Selected Index	The currently selected IO EndEffector tip. Choose Centerline when multiple tips are present.
	Max Grip Time	Maximum time allowed for the grip to be verified and part presence to be satisfied, in seconds.
5	Use Tip Selection	When enabled, the tip selection program will be called when a tip is selected.
	Tip Selection Task	The task used when executing the tip selection program.
	Gripper Tip Selection Program	The V+ program that is called when a tip is selected. This is used in the case where the gripper has some additional operation required to switch the tips. For example, there might be some additional I/O that needs to be set (or a motor moved) to physically move the tips.

3D Visualization

The 3D Visualization setting area is found in the main view of the Robot Object editor area. It is used to adjust 3D visualization settings for the Robot Object. It contains the following items.

Additional Information: Refer to 3D Visualization on page 278 for more information about 3D Visualizer.

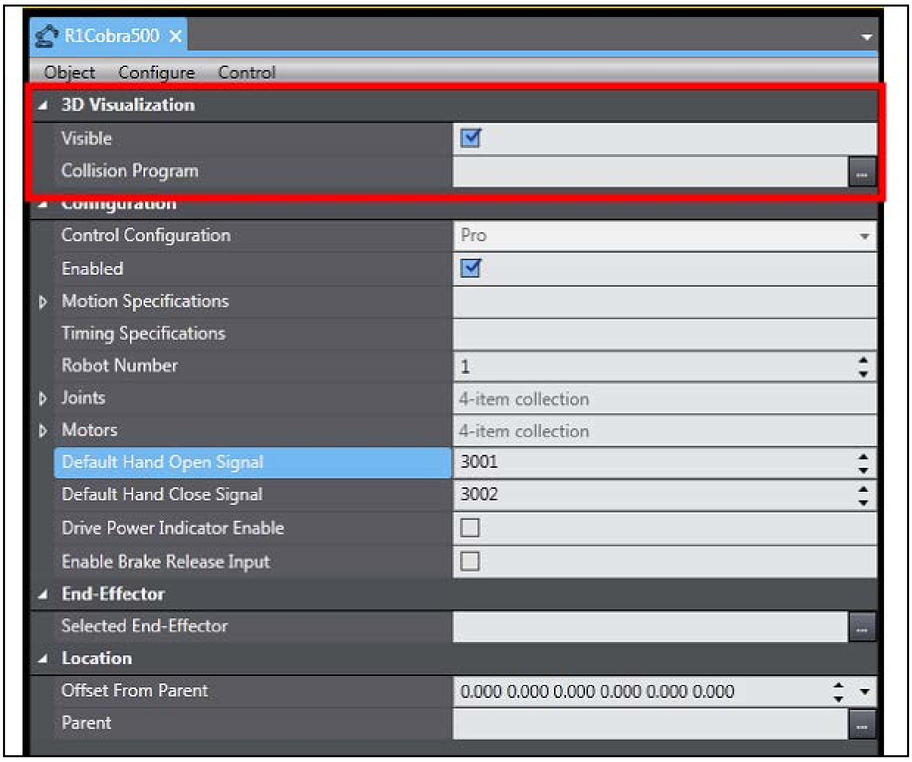


Figure 7-76 Robot Object - 3D Visualization

Visible

The Visible check box indicates whether the Robot Object should be rendered in 3D visualization.

Collision Program

The Collision Program field allows selection of a C# program that is invoked when the 3D Visualizer detects a collision between two objects. Use the **Selection** button ( ) to select a program.

> **Additional Information**: Refer to Application Manager Programming on page 178 for more information about C# programs. Refer to Graphical Collision Detection on page 114 for more information about collision detection with the 3D Visualizer.

Configuration

The Configuration setting area is found in the main view of the Robot Object editor area. It is used to adjust robot configuration settings for the Robot Object. It contains the following items.

> **NOTE:** Configuration setting changes take affect immediately, but will not be retained after a power cycle or reboot unless ***Save Startup Specifications*** is selected from the Configure Menu. Refer to Configure on page 255 for more information.

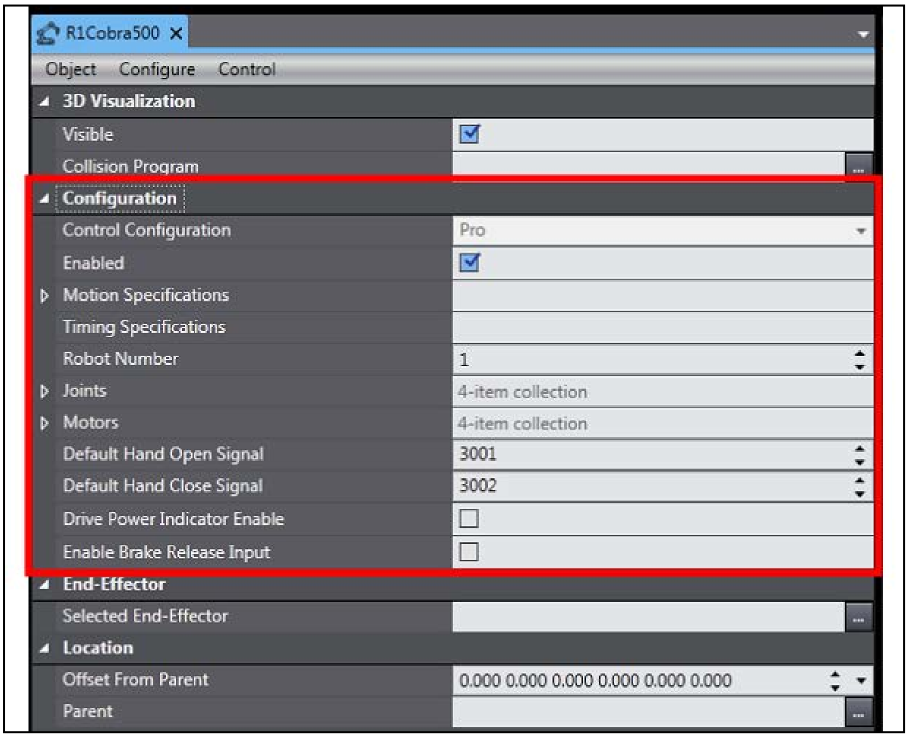


Figure 7-77 Robot Object - Configuration

Control Configuration

The Control Configuration item displays the license status of the Robot Object.

Enabled

The Enabled selection enables or disables control of this robot. This is typically used during debugging and troubleshooting.

Motion Specifications

The Motion Specifications item can be expanded to display several settings for robot speed and acceleration as described below.

Table 7-7 Motion Specifications Description

Item	Description
Cartesian Rotation Acceleration	Specifies the Cartesian rotation acceleration at ACCEL 100 (deg/sec^2).
Cartesian Rotation Speed	Specifies the Cartesian rotation speed at SPEED 100 (deg/sec).
Cartesian Translation Acceleration	Specifies the Cartesian translation acceleration at ACCEL 100 (mm/sec^2).
Cartesian	Specifies the Cartesian translation speed at SPEED 100

Item	Description
Translation Speed	(mm/sec).
Max Percent Acceleration	Specifies the Maximum allowable percent acceleration from an ACCEL command.
Max Percent Deceleration	Specifies the Maximum allowable percent deceleration from an ACCEL command.
Max Percent Speed	Specifies the Maximum allowable speed from a SPEED command.
SCALE.ACCEL Upper Limit	Specifies the Program speed above which accelerations are saturated when SCALE.ACCEL is enabled.

Timing Specifications

Reserved for future use. Timing Specifications are only available with Expert Access.

Robot Number

The Robot Number field specifies the robot's designated number for the FireWire configuration. Use the Configure Options - Configure FireWire Nodes to change this value. Refer to Configure on page 255 for more information.

Robot Number Considerations

- If only one robot is present in the system, it must be configured as Robot Number 1.
- If multiple robots are present in the system, they must have unique Robot Numbers.

Joints

The Joints item can be expanded to display settings for range of motion limit, full speed limit, and full acceleration limit of each robot joint.

Motors

The Motors item can be expanded to display settings for motor gain and nulling tolerances for each servo motor in the robot.

Table 7-8 Motors Adjustment Item Description

Item	Description
Motor Gains	Only available with Expert Access enabled. Contact your local Omron representative for more information.
Fine Nulling Tolerance	Specifies the tolerance for the number of servo motor encoder feedback counts to consider a move complete when a move is made after specifying FINE tolerance. Refer to the *eV+ Language Reference Guide (Cat. No. I605)* or the *V+ Keyword Reference Manual (Cat. No. I672)* for more information.
Coarse Nulling Tolerance	Specifies the tolerance for the number of servo motor encoder feedback counts to consider a move complete when a move is made after specifying COARSE tolerance. Refer to the *eV+ Language Reference Guide (Cat. No. I605)* or the *V+ Keyword Refer-*

Item	Description
	ence Manual (Cat. No. I672) for more information.

Default Hand Open Signal

The Default Hand Open Signal field specifies the output for the V+ keywords OPEN, OPENI, CLOSE, and CLOSEI. Refer to the *eV+ Language Reference Guide (Cat. No. I605)* or the *V+ Keyword Reference Manual (Cat. No. I672)* for more information.

Default Hand Close Signal

The Default Hand Close Signal field specifies the output for the V+ keywords OPEN, OPENI, CLOSE, and CLOSEI. Refer to the *eV+ Language Reference Guide (Cat. No. I605)* or the *V+ Keyword Reference Manual (Cat. No. I672)* for more information.

Drive Power Indicator Enable

The Drive Power Indicator Enable selection is used to enable or disable the signal to indicate robot power. When enabled, an external indicator can be used to signal when robot power is ON. Refer to the appropriate robot user's guide for more information.

> **IMPORTANT:** The user is responsible to connect and install the appropriate visual indicator(s) as per the requirements of UL 1740. This function is required to be enabled to meet UL 1740 requirements.

Enable Brake Release Input

The Enable Brake Release Input selection is used to turn ON or OFF the brake release input signal. Selecting this item will allow an external signal to be used for robot brake control.

End-Effector

The End-Effector setting is used to select an I/O EndEffector for the Robot Object. This allows a Process Manager to reference the number of tips available for that robot when defining multi-pick process, and to control the gripper signals for a specific robot when the Process Manager is active.

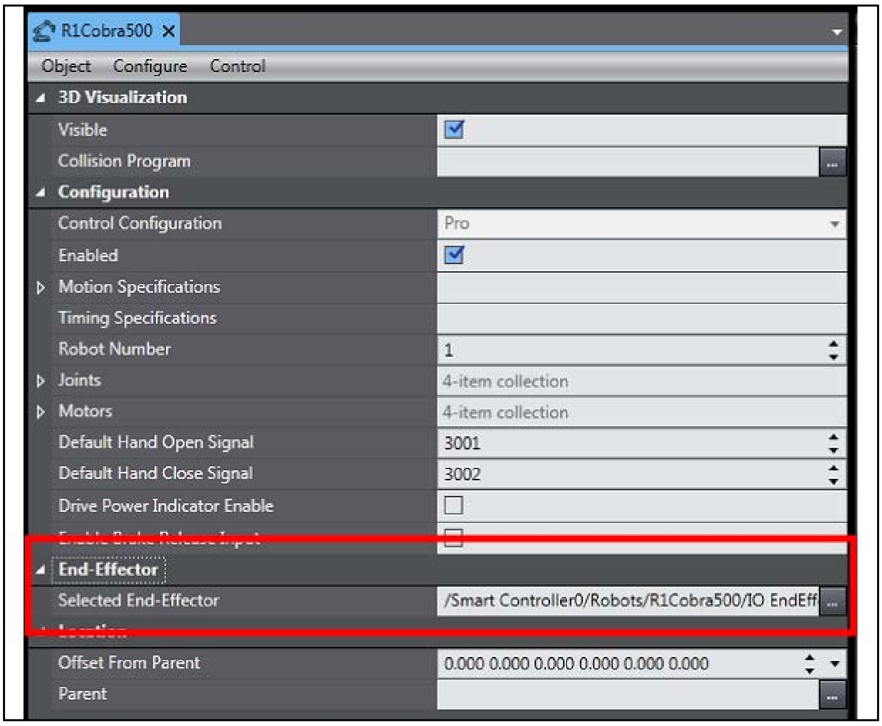


Figure 7-78 Robot Object - End-Effector

Offset From Parent

The Offset From Parent field specifies a coordinate offset for the Robot Object relative to a parent item for 3D Visualization. This allows relative positioning of objects in workspace coordinates. A robot is typically a parent to other objects. The values are specified as X, Y, Z, yaw, pitch, and roll.

Parent

The Parent selection specifies the object this robot will be relative to (using the Offset From Parent parameter). Refer to Adding Shapes on page 278 for more information.

Location

The Location setting area is used to set the workspace coordinates of the Robot Object in 3D Visualization. It contains the following items.

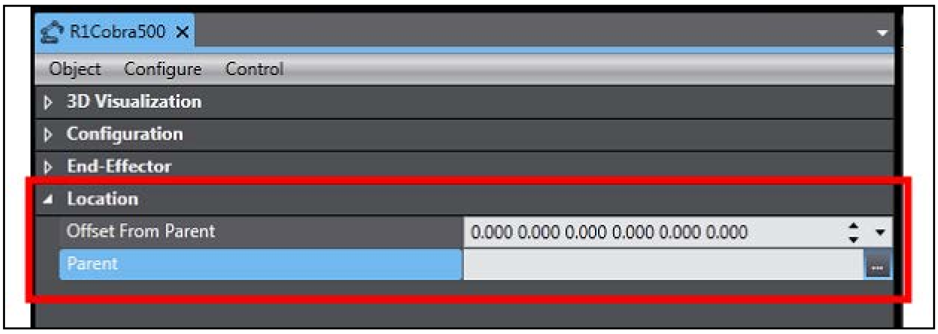


Figure 7-79 Robot Object - Location

Object

The Object Menu displays the Expert Access options described below.

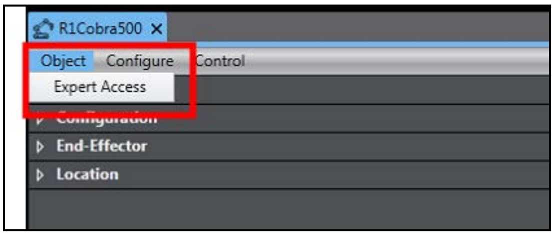


Figure 7-80 Robot Object - Object

Expert Access

Expert Access grants access to all available parameters and settings. Contact your local Omron representative for more information.

Configure

The Configure Menu displays the configuration items described below.

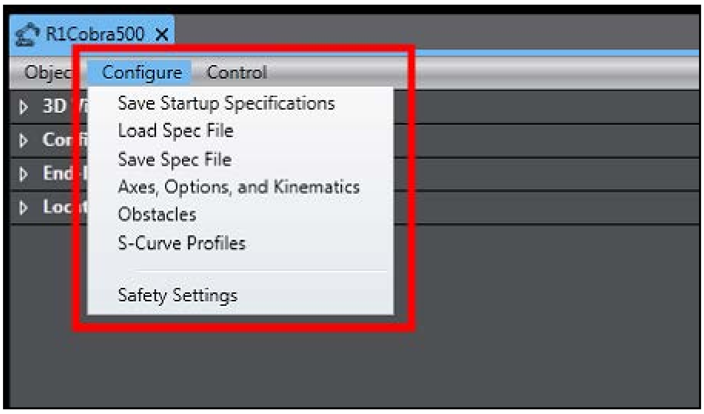


Figure 7-81 Robot Object - Configure Menu Item

Save Startup Specifications

Selecting *Save Startup Specifications* will save all robot and motor specifications to the V+ boot disk.

> **NOTE:** This is the same function that is present in the Controller Settings - Control menu. Refer to Control on page 199 for more information

Load Spec File

A Spec file can be used to restore robot and motor specifications from a saved file. Selecting ***Load Spec File*** will open the Load Spec File Dialog Box. Choose a location where the saved Spec File is stored and then click the **Next** button to proceed.

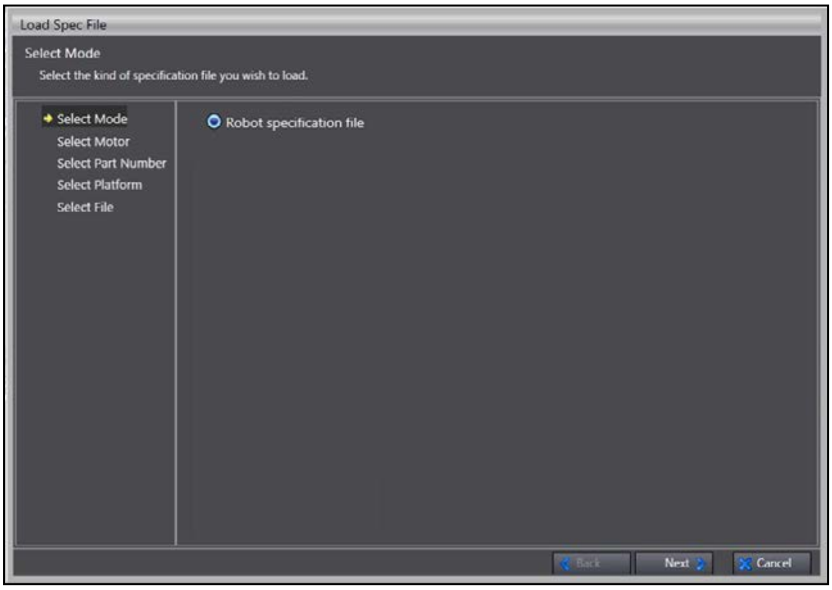


Figure 7-82 Robot Object - Load Spec File

Save Spec File

A Spec file can be saved to store robot and motor specifications. Selecting ***Save Spec File*** will open the Save Spec File Dialog Box. Choose a location on the PC to save the Spec File and then click the **Next** button to proceed.

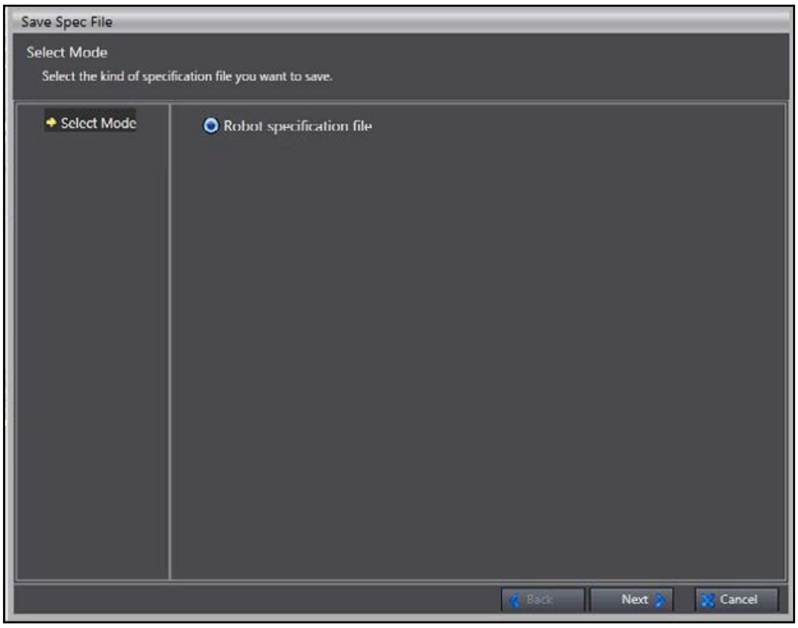


Figure 7-83 Robot Object - Save Spec File

Axes, Options and Kinematics

Some robots have a variable number of joints and option bits that control the presence of special features and kinematic parameters used in position calculations. The Axes, Options, and

Kinematic Parameters Dialog Box allows you to edit these parameters.

> **IMPORTANT:** Improper editing of robot joints, option bits, and kinematic parameters can cause the robot to malfunction or become inoperable. Therefore, editing must be performed by qualified personnel.

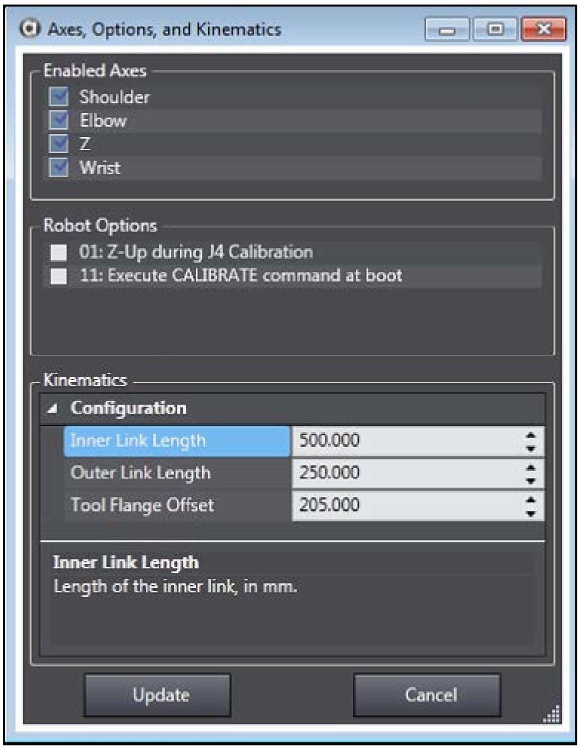


Figure 7-84 Robot Object - Axes, Options, and Kinematics

Enabled Axes

The Enabled Axes area is used to enable / disable the joints (axes) of the robot. If the robot does not have joints that can be enabled / disabled, the Enabled Axes check boxes will be disabled.

Robot Options

The Robot Options area is used to select the robot option bits for your robot. See your robot kinematic module documentation for the robot option bits that apply to your robot. See the table below for some common option bits.

Table 7-9 Robot Option Bit Description

Item	Description
Free mode power OFF	Robot power is turned OFF rather than disabling the individual amplifier.
Execute CALIBRATE command at boot	Calibrate the robot after the V+ operating system boots. This is set by default on all Viper and Cobra s350 robots. This only works

Item	Description
	if the robot can calibrate with power OFF. It does not work on Cobra robots because they must move joint 4 during calibration.
Check joint inter-polated collisions	While moving, check for obstacle collisions even for joint-inter-polated moves. This causes slightly more CPU usage if set, because it requires the robot to perform a kinematic solution that is not part of the normal operation.
Z-up during J4 cal-ibration	On Cobra robots, J4 must rotate slightly during calibration. This causes J3 to retract before moving J4.
J6 multi-turn	This bit allows infinite rotation of J6. Note that individual moves must be no more than 360 degrees.
Software motor limits	In robot models with multiple motors coupled to move a single joint, the standard joint motion limits may not be adequate to pre-vent the motors from hitting physical limits. In such cases, you may use software motor limits to restrict motor motion.

Kinematics

The Kinematics area is used to display the kinematic parameters for your robot.

Obstacles

Select Obstacles to add / edit the location, type, and size of workcell obstacles. This will open the Edit Obstacles Dialog Box. It contains the following items.

> **IMPORTANT:** Obstacles are predefined and evaluated in the controller when commanding robot motion and should not be confused with Collision Detection in the 3D Visualizer. Refer to Graphical Collision Detection on page 114 for more information.

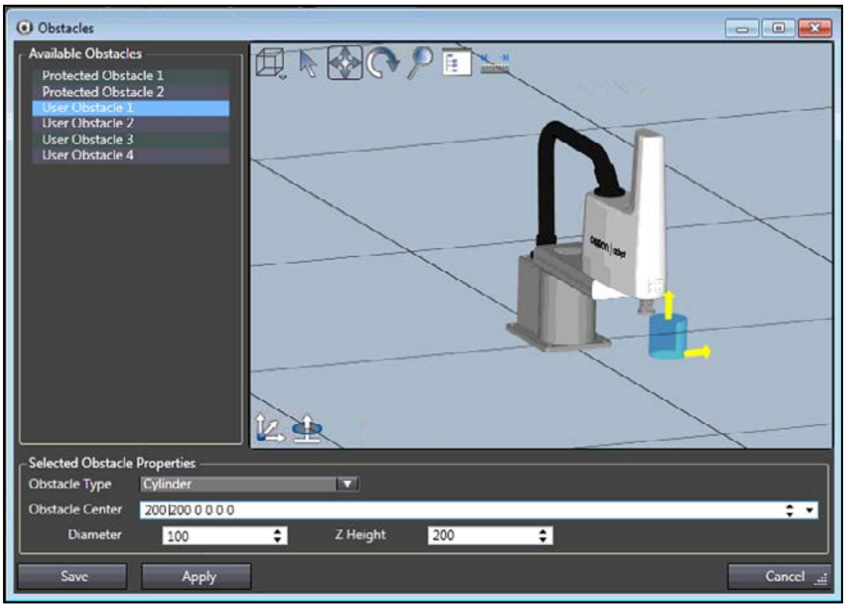


Figure 7-85 Robot Objects - Obstacles

Table 7-10 Obstacles Description

Item	Description
Protected Obstacles	Predefined system obstacles that cannot be edited by the user.
User Obstacles	Each row provides an entry for a workcell obstacle.
Obstacle Type	This drop-down list is used to select the type of obstacle: box, cylinder, sphere or frustum. These types are also offered as containment obstacles for applications where you want to keep the robot working within a defined area.
Obstacle Center	This text box is used to enter the coordinates of the center of the obstacle.
Obstacle Dimensions	Dimensions such as diameter and height are required depending on the obstacle type chosen.

S-Curve Profiles

The S-Curve Profile Configuration Dialog Box is used to configure the four time values required to create a new s-curve profile for use in robot motion (also called a trapezoidal acceleration curve). Selecting ***S-Curve Profiles*** will display the S-Curve Profiles Dialog Box.

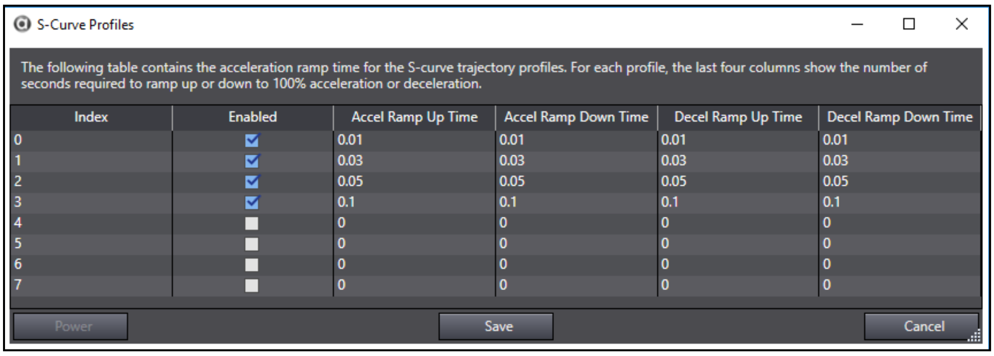


Figure 7-86 Robot Objects - S-Curve Profiles

S-Curve Profile Considerations

An S-Curve Profile is a trajectory that has a trapezoidal acceleration profile, giving an S-shaped velocity profile. The benefit of a trapezoidal acceleration profile is that the rate of change of acceleration can be controlled for a smoother motion.

For many mechanisms, controlling the acceleration is significant because high values can cause the mechanical structure of the robot to vibrate. Minimizing structural vibrations is especially important at the end of a motion, since such oscillations can adversely affect the settling time of the robot, which can affect the cycle time. However, for stiff, strong mechanisms a square-wave profile may result in shorter cycle times.

For a general trapezoidal profile, there are four time values that can be specified.

1. Ramp up to maximum acceleration
2. Ramp down from maximum acceleration
3. Ramp up to maximum deceleration
4. Ramp down to zero acceleration.

Each of these four acceleration values can be individually specified and a set of the four values defines a specific acceleration "profile" for use in programming robot motion routines.

Safety Settings

Safety Settings are used to restore the E-Stop hardware delay and the teach-mode restricted speed to the factory settings. Selecting ***Safety Settings*** will display the dialog box shown below. It contains the following items.

> **NOTE:** Safety Settings are not available in Emulation mode. This menu item is only available for robots using eAIB or eMB-40R/60R amplifiers.

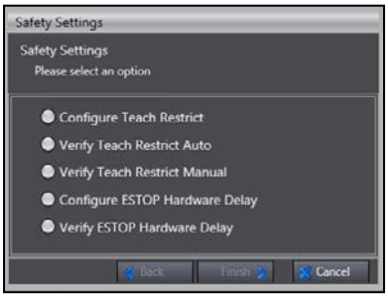


Figure 7-87 Robot Object - Safety Settings

Configure Teach Restrict

Selecting ***Configure Teach Restrict*** and clicking the **Next** Button will step through the procedure for setting predetermined speed limits for each robot motor.

The objective of the Teach Restrict feature is to comply with safety regulations which require the speed to be limited while the robot is in manual mode. This is hardware-based safety functionality to prevent rapid robot motion in manual mode even in the unexpected event of software error attempting to drive a robot faster than allowed. While jogging the robot in manual mode, if any joint exceeds its configured speed limit the system will disable high power.

> **IMPORTANT:** This configuration process is tuning circuitry in the amplifier units based on characteristics of specific motors. This process should be performed any time an amplifier is replaced in an existing system

Verify Teach Restrict Auto

Selecting ***Verify Teach Restrict Auto*** and clicking the **Next** button will step through a procedure to verify that Teach Restrict is operating properly with a series of automatic commanded motions.

Verify Tech Restrict Manual

Selecting ***Verify Teach Restrict Manual*** and clicking the **Next** button will step through a procedure to verify Teach Restrict is operating properly with a series of jogging operations performed by the user with a T20 pendant. This may also be useful for troubleshooting or testing individual joints when Teach Restrict commissioning process or automatic verification fails.

Configure ESTOP Hardware Delay

Selecting ***Configure ESTOP Hardware Delay*** and clicking the **Next** button will step through the procedure for configuring the delay on the ESTOP timer circuit. The objective of the ESTOP hardware delay feature is to comply with safety regulations which require the robot to have the capability of disabling high power without software intervention in an emergency stop scenario.

Verify ESTOP Hardware Delay

Selecting ***Verify ESTOP Hardware Delay*** and clicking the **Next** button will step through the procedure to verify that robot high power is disabled without software intervention when an ESTOP is triggered.

Control

The Control Menu displays Hardware Diagnostics, Data Collection and Motor Tuning items described below. These items are not available in Emulation Mode or while offline.

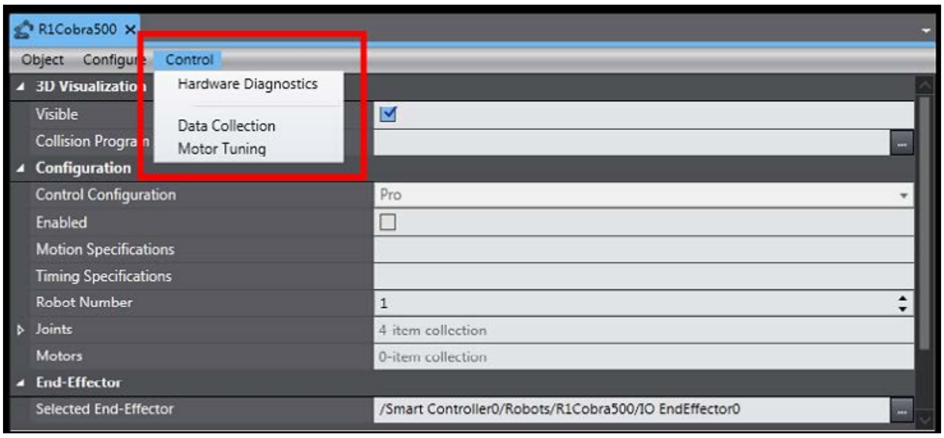


Figure 7-88 Robot Objects - Control Menu

Hardware Diagnostics

Hardware Diagnostics are used to check robot motor status. For example, when a robot's segmented display shows encoder error "E2", this means encoder error on Motor 2. Hardware Diagnostics can be used to determine what Encoder Alarm Bit on Motor 2 is triggering the encoder error.

Selecting ***Hardware Diagnostics*** will display the Hardware Diagnostics Dialog Box.

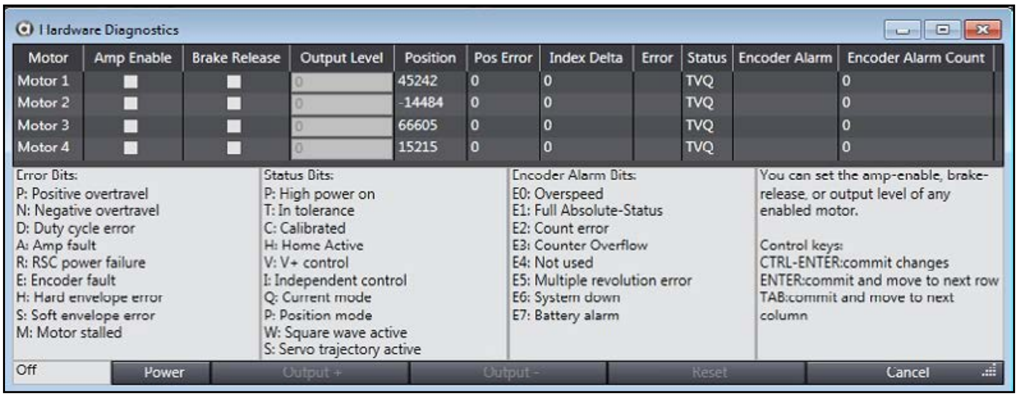


Figure 7-89 Robot Object - Hardware Diagnostics

Table 7-11 Hardware Diagnostics Description

Item	Description
Amp Enable	Enables / disables the amplifier for the selected motor.
Brake Release	Enables / disables the brake release for the selected motor.
Output Level	Specifies a commanded torque, which is used to test the operation of the selected motor. The range is from -32767 to 32767, or the range specified by the Max Output Level parameter for that motor in the Robot Editor (restricted Expert Access parameter).
Position	Displays the current position in encoder counts of the selected motor.
Pos Error	Displays the position error in encoder counts of the selected motor.
Index Delta	Displays the change in encoder counts from the previous latched zero index and the most recent latched zero index of the selected motor. Note that this is only useful with incremental encoders to verify zero index spacing and proper encoder readings.
Error	Displays the following error codes for the selected motor. • P - Positive overtravel • N - Negative overtravel • D - Duty cycle error • A - Amp fault • R - RSC (Robot Signature Card) power failure • E - Encoder fault • H - Hard envelope error • S - Soft envelope error • M - Motor stalled
Status	Displays the following status codes for the selected motor. • P - High power on • T - In tolerance • C - Calibrated • H - Home sensor active

Item	Description
	• V+ control • I Independant control • Q - Current mode • P - Position mode • W - Square wave active • S - Servo trajectory active
Reset	Resets any encoder errors for the selected motor.
Power	Toggles the high power (the status field displays the current power state).
Output + Output -	DAC output controls. Click the **Output +** button to increase the DAC output to the selected motor Click the **Output -** button to decrease the DAC output to the selected motor.

Data Collection

Data Collection can be used to view, store, and plot various robot system data while online with a controller. A maximum of 8 data items can be examined at up to an 8 khz sampling rate, up to the memory limit of the controller's data buffer.

Selecting ***Data Collection*** will display the following window. Data Collection is not available in Emulation Mode.

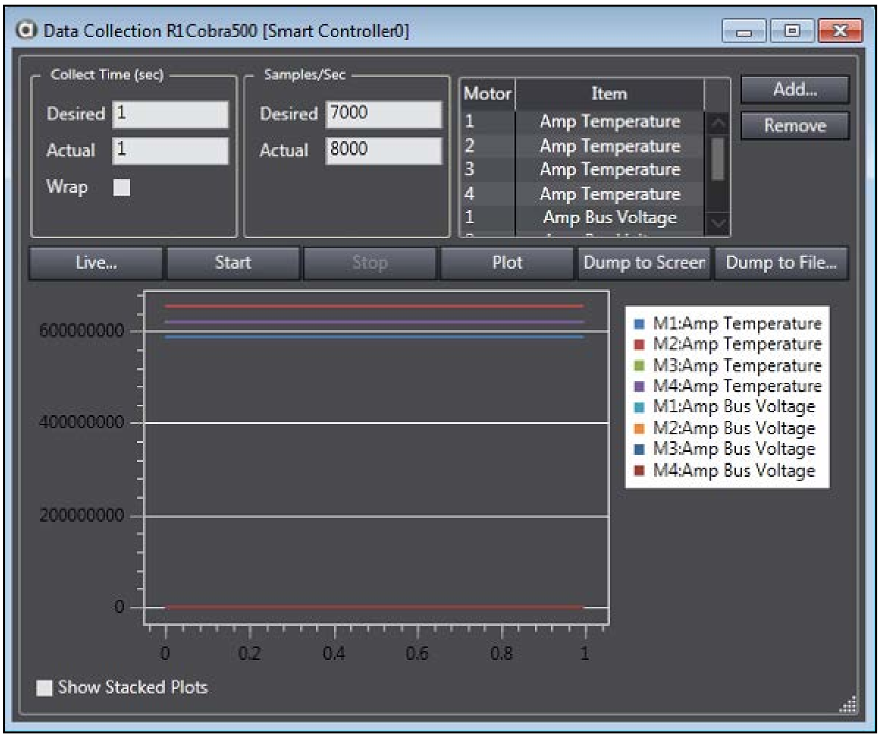
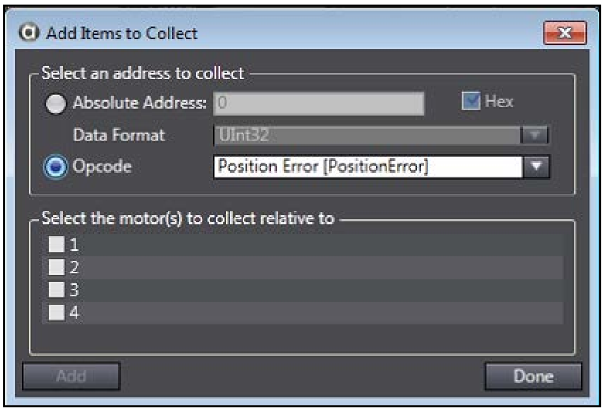


Figure 7-90 Robot Objects - Data Collection

Table 7-12 Data Collection Description

Item	Description
Collect Time (sec)	Specifies the data collection time in seconds. The default value is 1.
Samples/Sec	Specifies the data collection rate in samples per second. The default value is 1000.
Add... Remove	Add or remove motor items to examine with these buttons. Clicking the **Add** button will display the Add Items to Collect Dialog Box.  *Figure 7-91 Add Items to Collect* Enter an Absolute Address or select **Opcode** and choose an available data item from the dropdown list. Then select the motor(s) to collect data from.
Live	Displays a window that shows the real-time data being collected.
Start	Click to start the data collection. The data collection will continue until either the **Stop** button is clicked or the specified collect time is reached.
Stop	Click to stop the data collection. If the specified collect time has already expired, this button is disabled.
Plot	Click to plot the collected data. A progress bar displays while the data is processed. After the processing has completed, the data is plotted on the graph located at the lower portion of the Data Collection Dialog Box.
Dump to Screen	Displays the collected data in a Data Dump window in text-file format.
Dump to File...	Displays a Save As Dialog Box used for saving the collected data to a text file, which can be viewed or processed at a later time.

Data Collection Sample

Data collection can be customized and collected from within a C# program. The script is comprised of several major elements:

- C# class definition
- INameLookupService field
- Main method entry point

The script contains lines that cannot be modified and are considered protected. These are designated by the light grey background. The namespace, class name, IAceServer field name, and Main method lines are protected and cannot be changed.

When the C# Program is executed, the text in the script is dynamically compiled in memory and the Main method is called. It is up to the user to define the logic of the script.

The following sample shows how to use data collected in this way.

```
using Ace.Services.NameLookup;
using Ace.Server;
using System;
using System.Collections.Generic;
using System.Diagnostics;

namespace Ace.Custom {

    public class Program {

        public INameLookupService ace;

        public void Main () {

            Trace.WriteLine("Script Starting");

        }
    }
}
```

Figure 7-92 Data Collection Sample

Referencing other objects and tools

It is useful to reference other objects in the workspace when running a script. You can reference other objects by dragging and dropping vision tools from the Workspace Explorer into the body of the script as shown below.

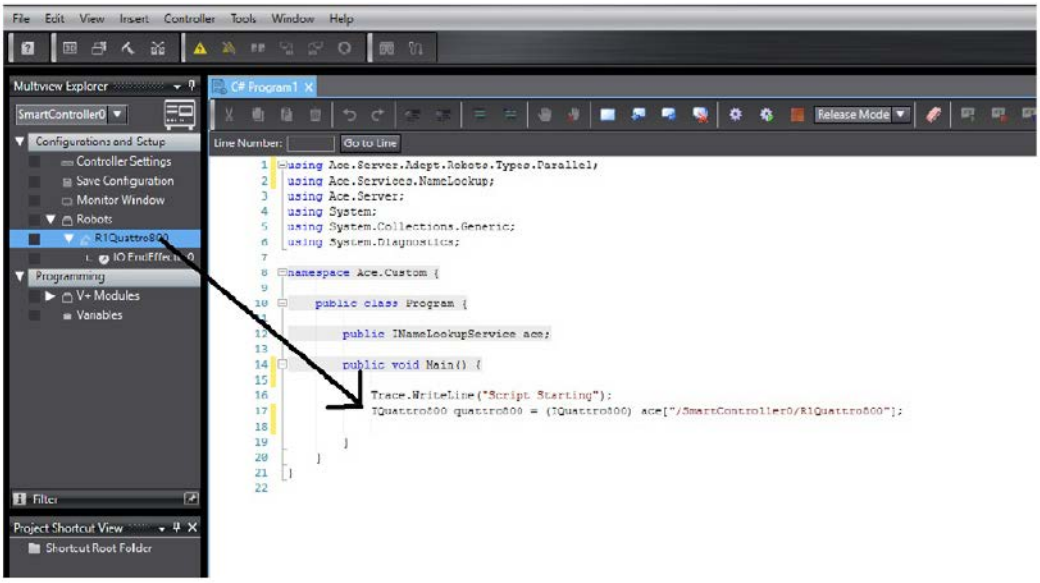


Figure 7-93 Drag and Drop Vision Tools

Data Collection Overview

In the following sample, the script will collect the encoder position for all 4 motors of a Cobra robot while the robot is moving, to do this, the following steps will be required:

- Acquire a handle to a robot
- Identify the data to be collected
- Collect the data
- Extract the data
- Save the data

Step 1: Acquire a handle to a robot

First, drag and drop a robot from the workspace into the script. Since the script will be moving the robot, the script will ensure that robot power is enabled and the robot is calibrated.

```
//Drag n Drop Reference to a robot
IQuattro800 robot = (IQuattro800) ace["/SmartController0/R1Quattro800"];

if (!robot.Power){
    robot.Power = true;
    robot.Calibrate();
}
```

Figure 7-94 Acquire Robot Handle

Step 2: Identify the data to be collected

The script must create *DataCollectionConfiguration* collection and add *DataCollectionItem* objects associated with each data item that should be collected. In this case, you must create a *DataCollectionItem* for each motor of the robot and associate each one with the ServoData you wish to collect.

The *DataCollectionConfiguratio*n also must be told how many samples are to be collected each second and how many seconds to run the test. The last step is to associate the *DataCollectionConfiguration* with the robot.

```
//Reference to robot data configuration
DataCollectionConfiguration config = robot.DataCollectionConfiguration;

//Clear all items that may be present in config from previous collection
config.Clear();

//Set data collection parametersa
config.TimeToCollect = 1; // Units in Seconds
config.SamplesPerSecond = 3;
int numberOfSamples = Convert.ToInt32(config.TimeToCollect * config.SamplesPerSecond);
int maxItemCount = robot.MaximumDataCollectionItemCount;

ServoData[] dataTypesToCollect = new ServoData[] {ServoData.CommandedPosition,
                                                  ServoData.PositionError};

//Add data items to data collection configuration
foreach (ServoData datatype in dataTypesToCollect)
    foreach (IMotor motor in robot.Motors)
        config.Add(new DataCollectionItem(motor, datatype));

//Assign configuration to the robot
robot.DataCollectionConfiguration = config;
```

Figure 7-95 Collected Data

Step 3: Collect the data

Once the data collection is enabled, the script should wait for the data collection to complete.

```
//Start Collection in robot controller
robot.DataCollectionEnabled = true;

//Option 1: wait for collection to complete
while(robot.DataCollectionEnabled)
    System.Threading.Thread.Sleep(200);

//Option 2: End collection prematurely (after 500ms)
// System.Threading.Thread.Sleep(1500);
// robot.DataCollectionEnabled = false;
```

Figure 7-96 Completed Data Collection

Step 4: Extract the data

After data collection completes, the data resides on the Controller and must be extracted. This extraction is done using the *AdeptRobot::ReadDataCollection* method as noted below.

```
//Read Data from buffer in robot controller
List<double[]> rawData = new List<double[]>();

for (int i=0; i<config.Count; i++)
    rawData.Add(robot.ReadDataCollection(config[i],false,0,0));

//Output Data to Trace Message window, or write to file
string header =  "Sample";
foreach (DataCollectionItem item in config)
    header += "\t| " + item.ToString();
Trace.WriteLine(header);

for (int i=0; i<rawData[0].Length; i++){
    string entry = i.ToString().PadLeft(3,' ');
    foreach (double[] item in rawData)
        entry += " | " + String.Format("{0:F3}",item[i]).PadLeft(30, ' ');
    Trace.WriteLine(entry);
}
```

Figure 7-97 Data Extraction

Motor Tuning

Motor Tuning is used to send a square wave positioning command to the specified motor and observe the response for servo motor tuning purposes. Observing the response has the same functionality as Data Collection (refer to Data Collection on page 263 for more information).

Selecting ***Motor Tuning*** will display the following window. Motor Tuning is not available in Emulation Mode.

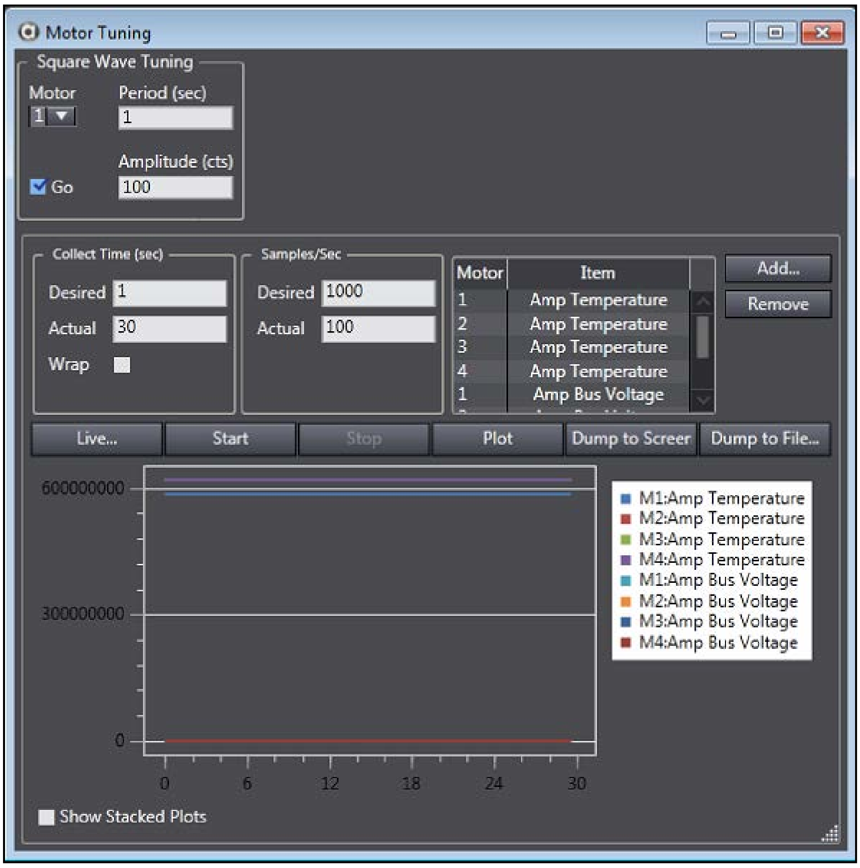


Figure 7-98 Robot Objects - Motor Tuning

Table 7-13 Motor Tuning Description

Item	Description
Motor	Specifies the motor that will receive the square wave positioning command.
Period (sec)	Specifies the length of the square wave in seconds.
Amplitude (cts)	Specifies the amplitude of the square wave in servo counts.
Go	Turns ON/OFF the square wave positioning command to the specified motor.

Chapter 8: Application Manager Configuration and Setup

This section describes the functions, configuration, and setup of Application Manager items and objects.

8.1 Remote Application Manager

ACE introduces the ability to install and run ACE as an Application Manager. This allows transfer of Application Manager device contents from one IPC to another. This in turn allows flexibility for users to:

- Maintain one project file for multiple devices on a network
- Manage multiple Application Manager ACE instances from one interface
- Allows for projects to be modified offline and transferred to network connected PCs
- Monitor and modify project data over network connection to an IPC

Using a remote Application Manager requires two types of ACE instances. The first is called a server instance and is primarily used for application control during runtime functionality. The second is called a client instance and is used to create projects and transfer them to the server instances. A client instance is virtually identical to a standard ACE instance and is created just by opening ACE. It is called a client instance solely due to its connection to one or more server instances.

The client instance is connected to the server instances by using Ethernet connections between different computers. Typically, the server instances will be opened on IPCs connected to necessary cameras and controllers while the client instance will be on a separate computer, called the Remote PC in this section. If configured correctly, you can transfer the client instance to the server instances and interact with the system. When the Application Manager is then configured and operating as desired, the Remote PC can go Offline and disconnect from the system without stopping production.

An example layout is shown, See "Remote Application Manager Connections", where the project on the client instance, in this example, has three Application Managers that are synchronized with a different server instance.

> **NOTE:** All remote Application Manager functionality requires the Application Manager device AM101-1000 version 2.0.

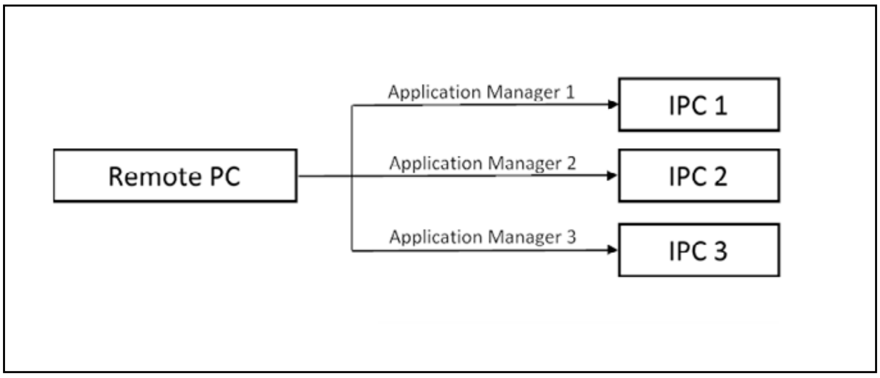


Figure 8-1 Remote Application Manager Connections

Remote Application Manager Set Up

Establishing a connection between an instance of ACE and an Application Manager server instance requires the following:

- One computer (called the Remote PC in this section)
- At least one IPC application controller with necessary cameras
- One network switch and Ethernet cables
- At least one robot controller
- A recent version of ACE 4 installed on all computers

Any cameras need to be connected directly to their respective IPC, but the robot controllers should be arranged so both the Remote PC and the IPC can go Online with them. See "Example Remote PC to IPC Diagram" for an example of the recommended layout. The sample IP addresses are shown to illustrate sample networks.

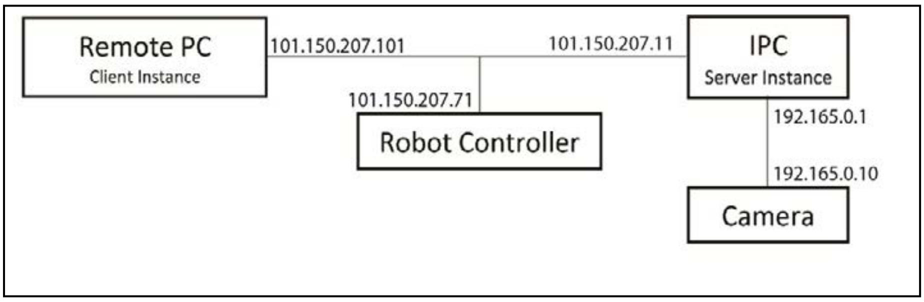


Figure 8-2 Example Remote PC to IPC Diagram

To transfer a project from the remote PC to the IPC, an exception must first be made for the port in the Windows firewall. Continuing without the exception will cause an error message, shown below:

Figure 8-3 Windows Connection Exception Message

A firewall exception for all TCP and UDP ports should be automatically created during installation, but if additional security is needed, an exception for the default port can be created with the following steps:

1. Open Windows Firewall with Advanced Security. The name of this program may vary depending on the software version and computer model.
2. Right-click on ***Inbound Rules*** in the navigator on the left and then click on ***New Rule….***
3. Select the bubble next to ***Port*** in the Rule Type step. Click the **Next** button.
4. Confirm the bubbles next to "TCP" and "Specific Local Ports" are selected in the Protocol and Ports step. Type the number 48987 in the "Specific local ports" field. Then click the ***Next*** button.
5. Verify the ***Allow the connection*** is selected in the Action step and click the ***Next*** button.
6. Confirm that all checkboxes are selected in the Profile step and click the ***Next*** button.
7. Assign a name and description as necessary and click ***Finish***.

Click on ***Inbound Rules*** to see the new rule listed among the others.

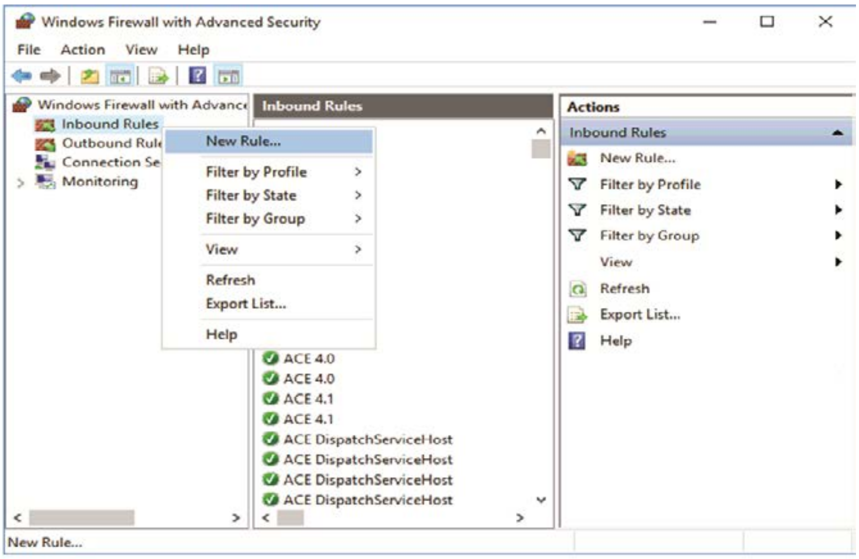


Figure 8-4 Firewall Inbound Rule

Double-clicking on the rule will show its properties. Firewall Inbound Rule - General, Protocols and Ports Tabs for an example of what this should look like. Double-check the areas outlined in red and ensure they match the image.

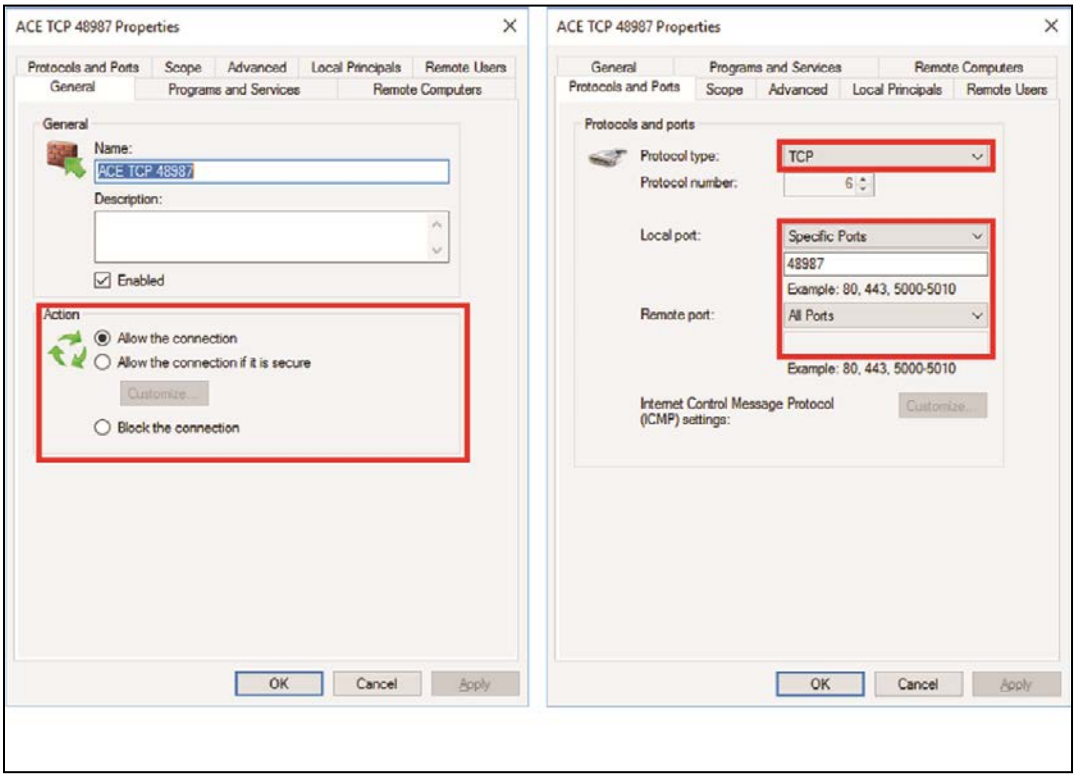


Figure 8-5 Firewall Inbound Rule - General, Protocols and Ports Tabs

ACE Server Instance

An ACE server instance is used as a recipient for projects from a remote computer. While it has similar functionality to a standard instance of ACE, when synchronized from a client instance, the active project will become the one from that client instance. A server instance is identified with a tag in the bottom-left corner, located in the same place as the Emulation Mode label. This tag also shows the name of the computer it is operating on as well as the port number. An example of this is outlined in red in the following figure.

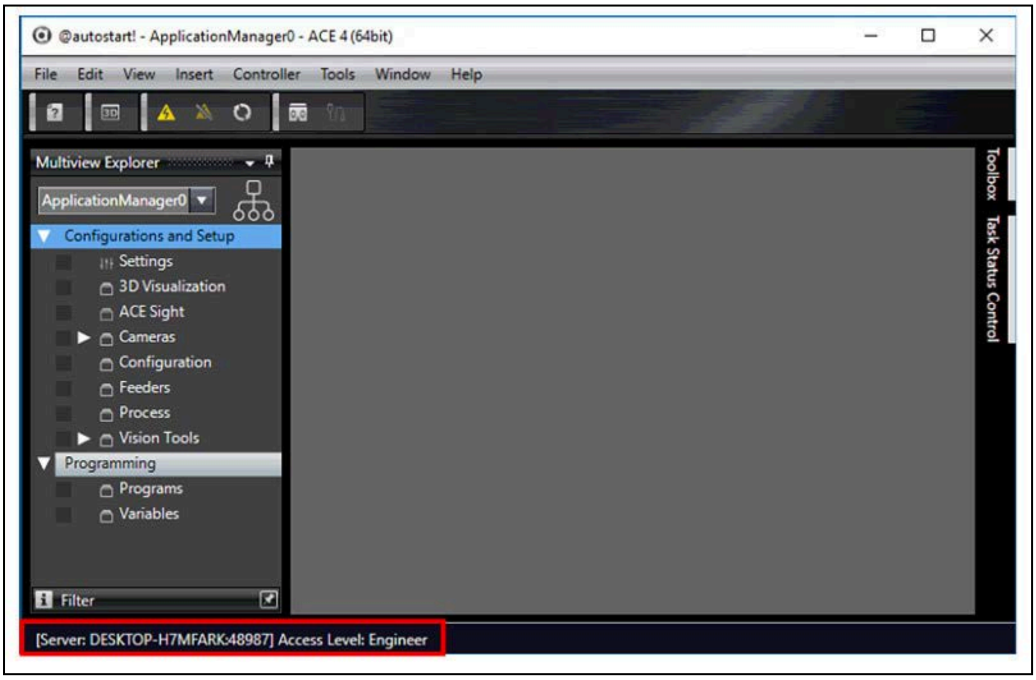


Figure 8-6 ACE Server in Application Manager

Creating a Server

During the installation of ACE, selecting the Application Manager option allows ACE to open as a server, and installs a desktop short cut for this purpose. Opening an existing installation of ACE as a server requires the use of a keyword. ACE uses utilizes the following keywords in Command Prompt open ACE for different purposes:

- "startclient" is used to start a client session, which is the same as opening a standard instance of ACE.
- "startserver" is used to open a server instance.
- "start" is used to open a server instance with specified defaults
- "help" displays information about the command and offers options.
- "version" displays information about the currently installed version of ACE.

In general, the only one needed for the architecture illustrated above is "startserver." A client session can be created by opening ACE normally or using the "startclient" keyword. However, "startserver" is required to create a server instance using Windows Command Prompt, as shown in the steps below:

1. Open the Windows Command Prompt.
2. Change to the directory containing the ACE 4 "bin" folder. The command should be similar to "cd C:\Program Files\Omron\ACE 4\bin". Depending on the computer storage, the folder may be in a different location.
3. Type the command "Ace.AppMgr.exe startserver".

Note that Steps 2 and 3 can be done in the same command by including the directory navigation in the command.

A server instance can also be opened by creating a shortcut specifically for it. This is done by opening the properties of an ACE shortcut and adding the “startserver” keyword after the quotation marks in the “Target” field, See "Ace Server Properties Short Cut".

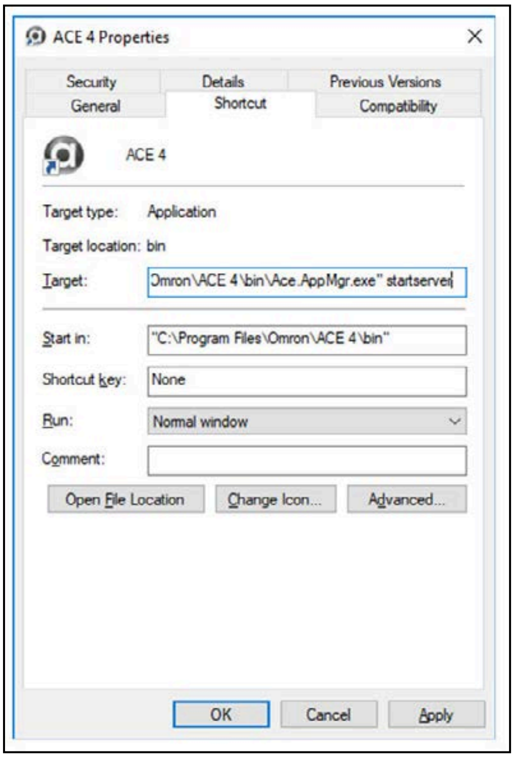


Figure 8-7 Ace Server Properties Short Cut

Additional Information: Opening a server instance of ACE will automatically open the project named “@autostart!” if it exists. Otherwise, it will open the ACE Start Page and will look like a regular instance, but it will still function as a server. See "Creating a Server" for more information.

NOTE: If the server instance must use a different port number than the default, add "--tcpport=[port number]" after the keyword "startserver". The target port number should be indicated by the tag, See "Creating a Server"."

ACE Client Instance

An ACE client instance is the standard instance of ACE that is used to connect to a server. This is done by opening the Settings of an Application Manager from the Multiview Explorer and entering the IP address of the server computer into the IP Address field. The Port No. should remain as the default 48987 to match the firewall exception. The connection is shown in the following figure.

If a different port number is required due to the needs of the application, a new Inbound Rule must be created for that number. See "ACE Client Instance" for this process.

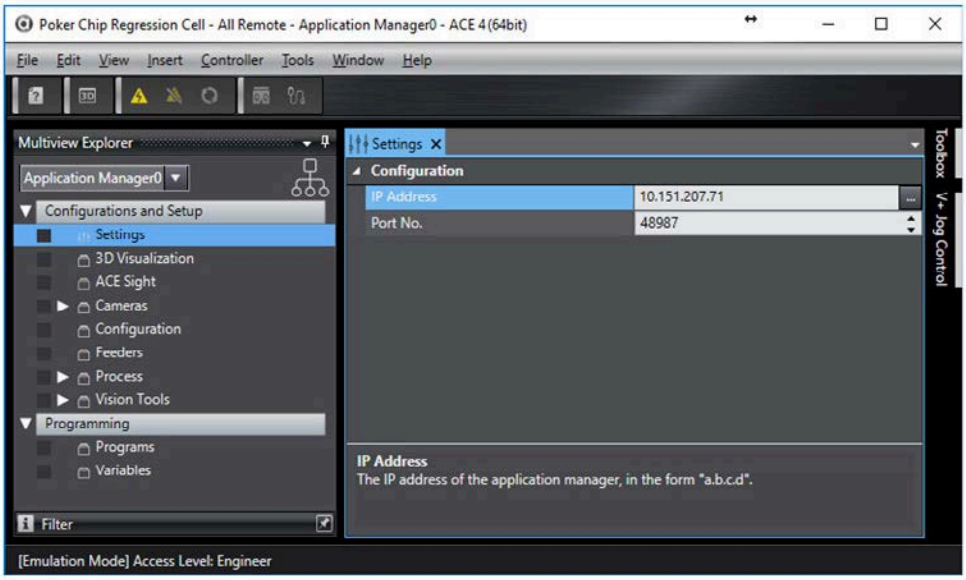


Figure 8-8 Application Manager Client Instance Settings

If a server instance exists on a computer with the defined IP address, the client instance can connect to it. This is done using the Online () icon in the toolbar. If the connection cannot be established, an error similar to the one shown, See "ACE Client Instance" will appear. Otherwise, the client will go online with the server instance. To disconnect, click the Offline () icon.

Synchronization

The Synchronize button is used to transfer Application Managers between clients and servers. Clicking this opens the Synchronization window, shown in the following figure.

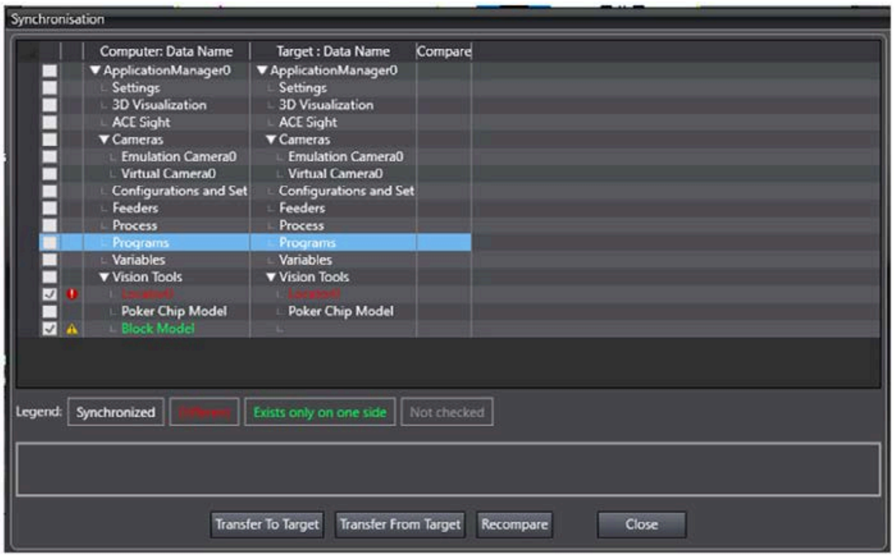


Figure 8-9 Application Manager Synchronization

The main portion of the window shows the objects in the client and the server Application Managers in comparison to one another. The "Computer: Data Name" column shows the items in the client and the "Target: Data Name" column shows those in the server. The text in each row is color-coded depending on the results of the comparison:

- White: The items are synchronized between the two computers. No differences are detected.
- Red: There are detected differences between the two items. They must be synchronized for the project to properly function. This is also marked by a red Error marking on the left side.
- Green: The item only exists on one computer. It must be transferred to the other. This is also marked by a yellow Caution symbol on the left side.
- Gray: The item has not been checked. This will usually only occur if there is an error outside of the Synchronization window.

The space at the bottom displays any necessary messages from the synchronization process.

The four buttons along the bottom of this window are used to synchronize the two ACE instances.

Transfer To Target synchronizes all checked object data from the client to the server. Clicking Transfer To Target adds Block Model to the server

Transfer From Target synchronizes all checked items object data from the server to the client. In addition, the instances of Locator0 in each computer would match whichever was being transferred.

In the example shown by Application Manager Synchronization, clicking Transfer To Target would do the following:

- Locator0 from the client instance would overwrite differences on the IPC.
- Block Model from the client instance would be created on the IPC.

Conversely, clicking Transfer From Target would do the following:

- Locator0 from the server instance would overwrite differences in the client instance project data.
- Block Model would be removed from the client instance project data."

The **Recompare** button will search for differences between the two Application Managers. This happens when the Synchronization window is opened, but the button serves as a way to verify that the items were properly synchronized.

Finally, the **Close** button closes the window.

Successfully transferring an Application Manager from a client instance to a server instance will create an ACE project on the IPC with the name “@autostart!”. Transferring a different Application Manager to the server instance will replace an existing “@autostart!” project with the new data.

> **Additional Information**: Synchronization can only occur when the client instance is online with the server instance.

Remote User Management

By default, client instances of ACE have Engineer access and, by default, server instances have Operator access. The Engineer level has the access to make process changes, and because all changes should be made in the client instance and then transferred to the server instance. In some cases, however, it may be necessary for changes to be made directly to the server. This activity can be managed and limited by creating users and passwords for the higher access levels, such as Engineer.

> **NOTE:** If changes are made directly on the server instance, it is recommended to immediately transfer the changes to a client instance. The changes will be erased if a new project is transferred to the server instance, so it is best to save it on another system as soon as possible.

The server instance can further be protected by adding additional users with various access levels and setting passwords for them. These can be created on the server instance directly or they can be created on a client instance and then transferred to the server instance using Synchronization.

Refer to User Management on page 138 for more information.

8.2 3D Visualization

In addition to robots, several other objects that are configured in the Application Manager are represented in the 3D Visualizer. The location, orientation and dimensions of these items are defined during the initial configuration of each item and can be adjusted to precisely simulate the application. The following items will appear in the 3D Visualizer after they are configured.

- Process Belts (Belt Calibrations, Windows, and Allocation Limits)
- Latch sensor calibrations
- Camera calibrations and field of views
- Part and Part Target instances
- Boxes, Cylinders, and imported CAD files

> **Additional Information**: After a shape has been added, functions such as rename, cut, copy, paste, delete, and focus in 3D Visualizer can be accessed for each shape by right clicking the object in the Multiview Explorer and making a selection.

Adding Shapes

Boxes and cylinders can be added to the 3D Visualizer to represent objects in the robot workspace. Use the following procedure to add cylinders and boxes to the 3D Visualizer.

1. Right-click **3D Visualization** in the Multiview Explorer and select **Add** and then choose **Box** or **Cylinder**. A new object will be added to the Multiview Explorer under 3D Visualization and it will appear in the 3D Visualizer Window.
2. Access the properties for this object by double-clicking it or right-click and select **Edit**. This opens the properties editor in the Edit Pane.

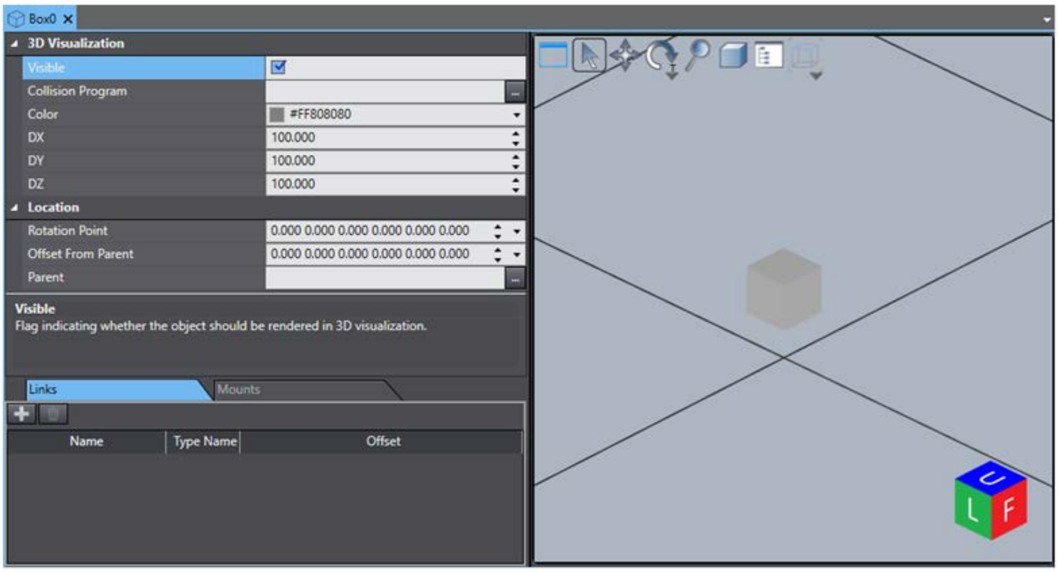


Figure 8-10 Shape Properties Editor (Box Shown)

Table 8-1 Shape Properties Editor Item Description

Object	Description
3D Visualization	
Visible	Display or hide the object from the 3D Visualizer.
Collision Program	Select a program that is invoked when the 3D Visualizer detects a collision. Refer to Graphical Collision Detection for more information.
Color	Choose a color for the shape in the 3D Visualizer.
DX/DY/DZ	Only available for Box. Defines the dimensions of the shape in the respective direction. DX and DY are both centered about the origin while DZ is measured from the box base.
Radius/Height	Only available for Cylinder. Defines the respective dimension of the shape. Radius is from the center axis and Height is measured from the cylinder base.
Location	
Offset From Parent	Set an offset distance from a parent object (X Y Z Yaw, Pitch, Roll).
Parent	Select an optional reference to a parent object where the base of the shape will be positioned. If a parent object is selected, when the parent object location moves, this object will be moved accordingly. Using robot objects as Parent will result in the object moving

Object	Description
	relative to the robot tool flange. This is particularly useful for moving end effectors with the robot tool flange, and visualizing objects held by the gripper. **NOTE:** A C# program can be used to manipulate visibility of Visualizer objects (for example, to visualize parts on an end effector while the gripper output signals are ON). An example of this can be found in Pack Manager Packaging Application Sample Exercise on page 689.

1. Adjust the shape's properties according to the application.

   Additional Information: After a shape has been added, functions such as rename, cut, copy, paste, delete, and focus in 3D Visualizer can be accessed for each shape by right clicking the object in the Multiview Explorer and making a selection.

Adding and Configuring CAD Data

You can open a project created in an earlier ACE version and open it in 4.4, modify it, save it, then re-open in that earlier version if you do not change the device type from the earlier version to 4.4. Once you explicitly upgrade the device, then it is no longer compatible with the earlier ACE version.

A CAD Data object is a three-dimensional shape created with computer-aided design (CAD) software. ACE supports the following CAD file types: .stp, .step, .igs, .iges, and .stl. CAD Data objects can be added to the 3D Visualizer. When a CAD Data object is created, an import wizard is opened that guides you through the process of importing the file.

To create a CAD Data object, right-click the 3D Visualization object in the Multiview Explorer and select **Add** and then click **CAD Data Object**. An import CAD file wizard will appear with two methods for adding CAD Data as described in the following sections. Once created, the CAD Data Object can be opened and edited like any other object in the Multiview Explorer.

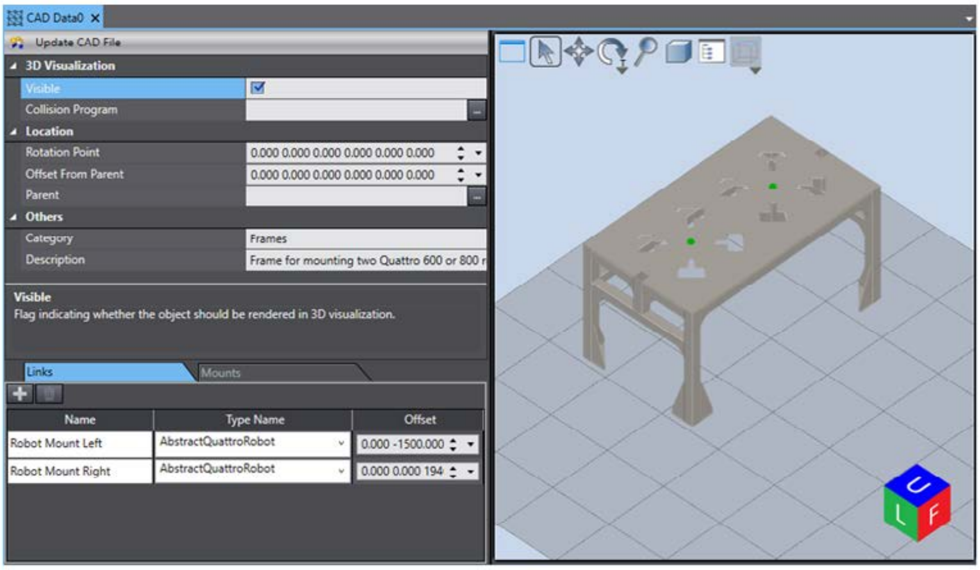


Figure 8-11 CAD Data Editor

Standard CAD Library Object

Select *CAD Library*, as shown in the following figure, and then click the **Next** Button to access the CAD Library section of the wizard. The displayed objects appear in one of the following categories:

- Grippers - vacuum, pointers, and other gripper types.
- Tables - typically used for mounting SCARA and articulated robots.
- Components - controllers, mobile robots, and accessories.
- Frames - typically used for mounting parallel robots.

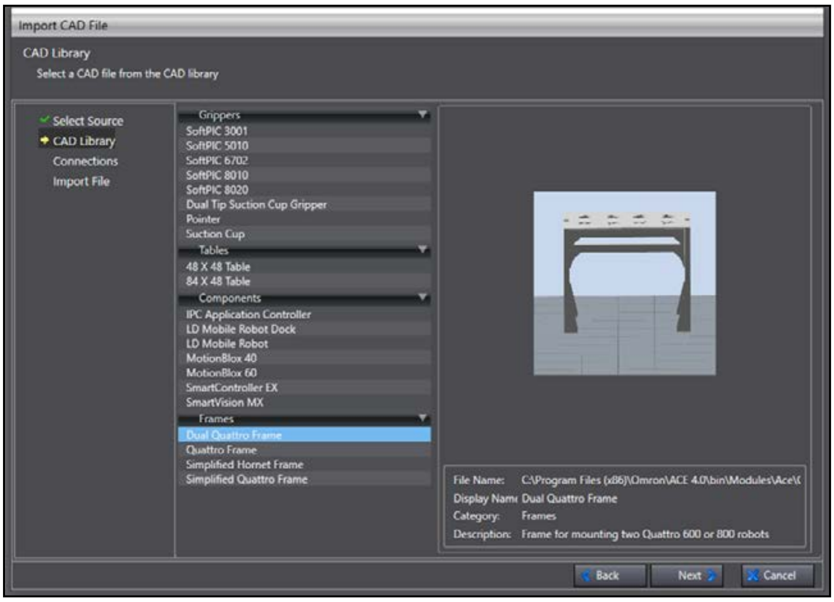


Figure 8-12 Import CAD Files

Selecting one of the CAD objects will show a preview of it in the window on the right as well as the details down below, including its Name, Category, and Description. An example of this is shown with the Dual Quattro Frame, as shown in the above figure.

Once the correct part has been adjusted, click **Next** to continue to the Connections step. This step is optional, but it can be used to define how objects are connected in the 3D Visualizer and will automatically set Parent and Offset From Parent values based on the links and mounts associated with that library object. Refer to Update 3D Shapes on page 284 for more information.

Clicking **Finish** in this step of the wizard will create the CAD Data object. The initial placement of the object depends on the connections and category:

- If no connections are added, it will always be created at the origin.
- If the CAD Data is in the Gripper category and a robot is selected for the Robot Flange connection, it will be created with the specified robot as its parent and positioned at the end effector. When the end effector moves, the CAD Data will move with it.
- If a connection is created to mount a robot to the CAD Data, such as mounting a SCARA robot onto a table, the CAD Data will be created at the origin and the specified robot will be moved to the correct mounting position with the CAD Data as its parent. Note that this cannot be undone and if the previous robot position is required, the parent CAD Data will need to be moved to accommodate this.

Once created, the CAD Data object can be repositioned by accessing its coordinates in the editor or using the Edit Workspace Position icon to drag it around the window. Refer to 3D Visualization on page 278 for more information.

Imported CAD File

Select "Open my own CAD file" in the first step of the Import CAD File wizard to access the Import File step. Then click the selection icon next to the File Name field. A browser window will open to select the CAD file. The supported CAD file format is STEP. Selecting a file and clicking open imports the file into the wizard.

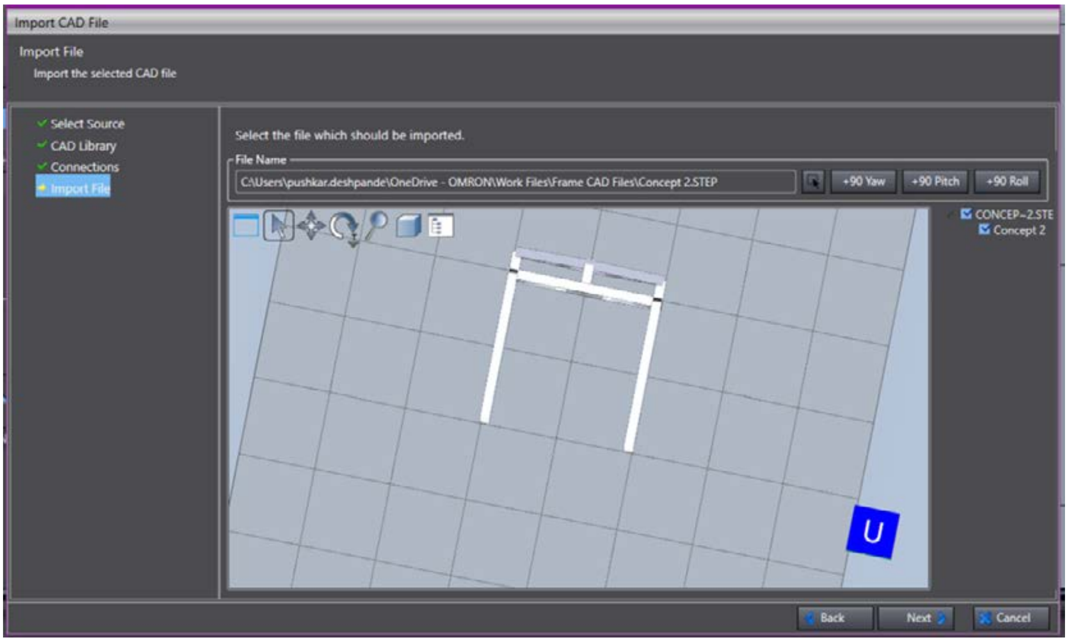


Figure 8-13 Import Step File

Once imported, the main window of this step shows the CAD Data file as it will be saved in the project. Some modifications can be made to it here before it is fully integrated. First, the +90 Yaw and +90 Pitch rotate the object to control its standard orientation in the 3D Visualizer. This is particularly useful if the file orientation is interpreted differently than ideal. For example, custom frames, as in the above figure, should be positioned so their feet are flat against the base plane. If they are shown in a different orientation in this window, the buttons can rotate them into the correct position.

The navigator on the right side shows all of the components in the CAD file. The checkboxes define which of the parts are imported. By default, all parts will be selected. Deselecting these will omit them from the resulting CAD Data object in the project.

When the necessary adjustments are made, click **Next** to close the wizard and import the file.

Configuration of CAD Objects

Table 8-2 CAD Properties Editor

Object	Description
3D Visualization	
Visible	Display or hide the object from the 3D Visualizer.
Collision Program	Select a program that is invoked when the 3D Visualizer detects a collision. Refer to Graphical Collision Detection on page 114 for more information.
Color	Choose a color for the shape in the 3D Visualizer.
Location	
Rotation Point	Set the offset of the object's center of rotation from the origin.
Offset From Parent	Set an offset distance from a parent object (X Y Z Yaw, Pitch, Roll).
Parent	Select an optional reference to a parent object where the base of the shape will be positioned. If a parent object is selected, when the parent object location moves, this object will be moved accordingly. Using robot objects as Parent will result in the object moving relative to the robot tool flange. This is particularly useful for moving end effectors with the robot tool flange, and visualizing objects held by the gripper. **NOTE:** A C# program can be used to manipulate visibility of Visualizer objects (for example, to visualize parts on an end effector while the gripper output signals

Object	Description
	are ON). An example of this can be found in Pack Manager Packaging Application Sample Exercise on page 689.
Others	
Category	Defines the category of the CAD Data file in the CAD Lirary. By default, this field is blank for imported files.
Description	Shows a brief description of the item and its purpose By default, this field is blank in imported files.

Update 3D Shapes

Boxes and Cylinders used to represent objects in the robot workspace may eventually need to be replaced by custom CAD Data. In addition, CAD Data objects may be revised outside of ACE, requiring the object in the workspace to be updated. Both of these tasks can be accomplished using Update All 3D Shapes.

To update 3D Shapes, right-click in 3D Visualization in the Multiview Explorer and select **Update All 3D Shapes**. This opens a wizard similar to importing a custom CAD Data object, refer to Adding and Configuring CAD Data. The first step to the updating process requires you to select a CAD file saved on the local drive. Once selected, the wizard will allow replacement of the existing 3D Visualization objects as shown in 3D Shapes Wizard. The left side shows the hierarchy of the selected CAD file, including all parts and sub-assemblies. The right side of this is a list shows all the existing 3D Visualization objects. The far right shows the imported file in the 3D Visualizer.

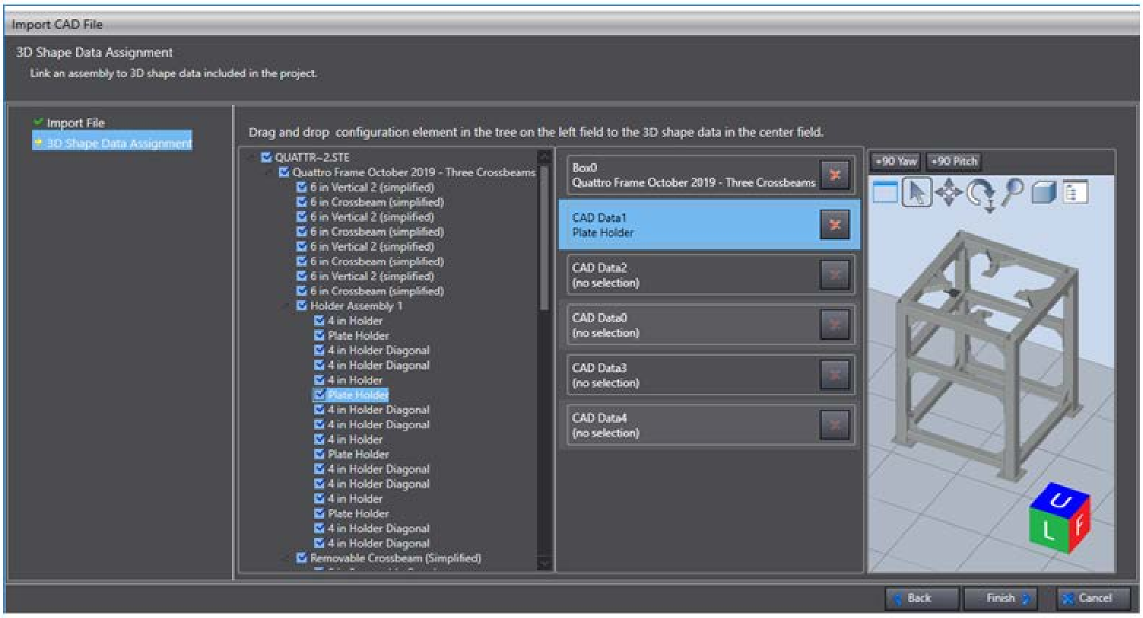


Figure 8-14 3D Shapes Wizard

The 3D Visualization objects can be replaced by the imported file or any part or sub-assembly contained within it. To do this, first set the specifications of the imported file by unchecking any parts and sub-assemblies that should not be imported. Also, set the orientation using the **+90 Yaw** and **+90 Pitch** buttons above the visualizer window. Then click the appropriate entry in the hierarchy and drag it to the respective visualization object. The text beneath the object name will change from "(no selection)" to the name of the CAD Data. Once the necessary selections are made, click **Finish** to close the wizard and replace the objects.

3D Shapes Wizard shows an example of this process. When you click **Finish**, Box0 will be replaced by the Quattro Frame October 2019 – Three Crossbeams assembly and CAD Data1 will be replaced by the Plate Holder part. None of the other objects will be updated.

Connection Points

Each object in the 3D Visualizer can have associated connection points. These allow the user to easily create connections between objects.

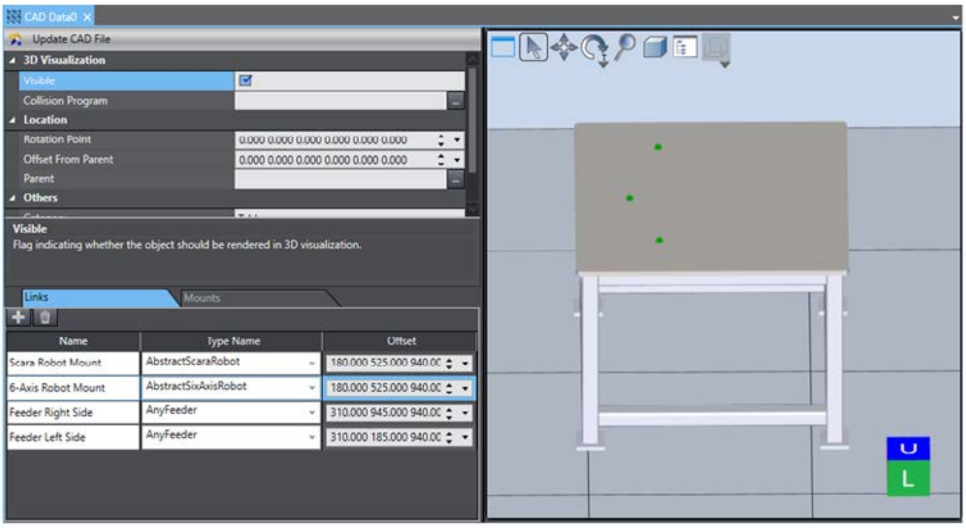


Figure 8-15 Connection Points Editor

There are two types of connection points: Links, where the associated object is the parent item, and Mounts, where the connected item is the parent. For example, if a connection is made where a robot is attached to a table, the connection point for the table will be a link and the connection point for the robot will be a mount. In this way, the table becomes the parent of the robot. Moving the robot will not affect the table, but moving the table will also move the robot.

The links and mounts for an object are accessed in the lower part of 3D Visualization object editors, as shown above, See "Connection Points Editor". Clicking the tabs above the displayed items will toggle between the two connection types. Connection points have the following properties:

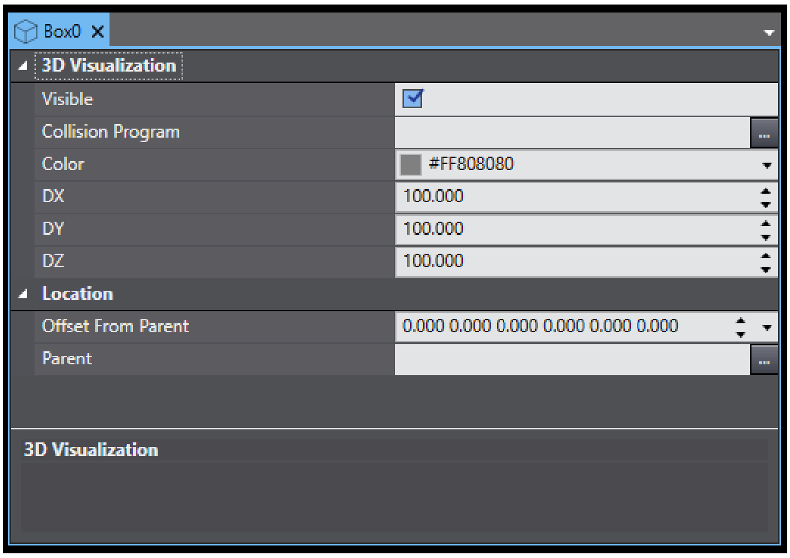


Figure 8-16 Shape Properties Editor (Box Shown)

Table 8-3 Connection Point Properties

Object	Definition
Name	User-defined name of the connection. This has no functional effect and is primarily used so the user can easily show the purpose of the connection.
Type Name	Defines the type of connection for which the point is designed. Links and mounts will only be able to connect if they have the same Type Name.
Offset	Set the offset of the connection point from the object origin.

The connections will be displayed in the editor 3D Visualizer window as green dots.

To create a new connection point, open the correct tab in the editor and click the plus button. A new entry will appear in the editor. It is recommended that the name is set to something distinct to differentiate it from others. Click the **Type Name** drop-down menu and set the type from the following options:

- AbstractHornetRobot: Defines a connection to any Hornet robot. This is primarily used for robot-to-frame connections.
- AbstractQuattroRobot: Defines a connection to any Quattro robot. This is primarily used for robot-to-frame connections.
- AbstractScaraRobot: Defines a connection to any Scara robot. This is primarily used for robot-to-frame or robot-to-table connections.
- AbstractSixAxisRobot: Defines a connection to any six-axis robot. This is primarily used for robot-to-frame or robot-to-table connections.
- AdeptRobot: Defines a connection to a robot end effector.
- AnyFeeder: Defines a connection to an AnyFeeder object. This is primarily used for AnyFeeder-to-table connections.
- Box: Defines a connection to any Box object.
- CadData: Defines a connection to any CAD Data object.

- Cylinder: Defines a connection to any Cylinder robot.
- IODrivenEndEffector: Defines a connection to any robot end effector. This is primarily used for grippers.

Connecting Links and Mounts

Mounts can be connected to links in two ways. The first is when a CAD Data object is created from the library. In this case, the last step of the wizard is the Connections step, where you can select any connections to make upon creation of the object.

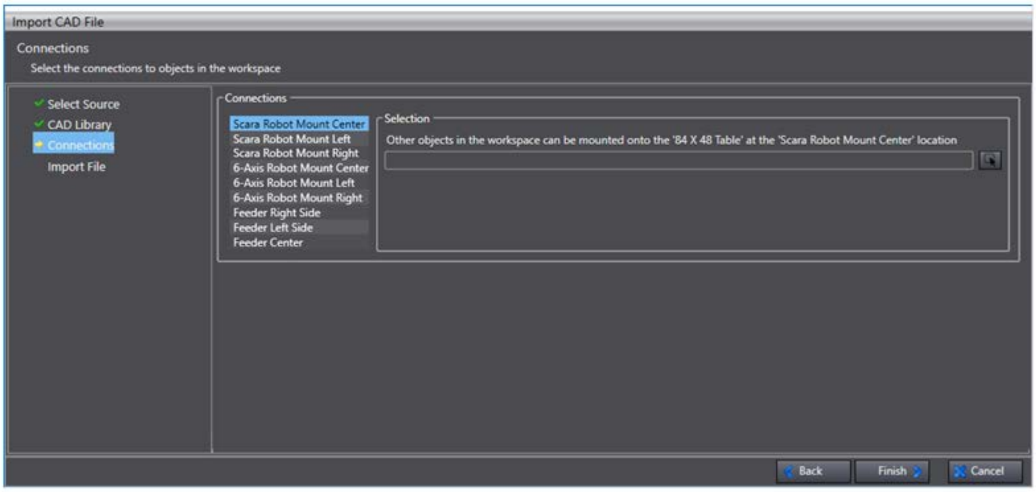


Figure 8-17 Import CAD File Connections

The rows on the left side of the Connections pane show the links and mounts associated with the CAD Library part. Clicking the selection icon on the right allows you to choose an existing 3D Visualizer object to link to the new object. Only objects with connection points that match the highlighted one will appear in the menu. For example, the option selected in See "Import CAD File Connections" connects to SCARA Robot Mount Center, so only robots of that type will be available to select.

The second method to make a connection is to open the 3D Visualizer and use the Snap feature in the 3D window.

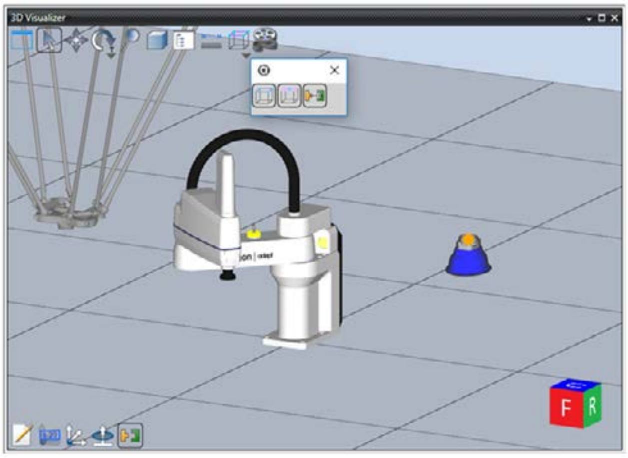
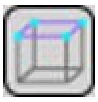
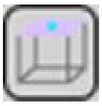
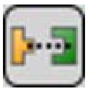


Figure 8-18 3D Visualizer Snap Function

Icon	Name	Definition
	Snap to Edge	Snaps the origin of the selected object or a selected mount point to either an endpoint or the midpoint of the edge of another object.
	Snap to Face	Snaps the origin of the selected object or a selected mount point to the centroid of a face of another object.
	Snap to Link	Snaps a mount to a link of the same Type Name. Only links of the selected mount will be visible in the Visualizer.

Selecting a Box, Cylinder, or CAD Data object in the Visualizer will allow selection of either Snap To Edge and Snap To Face. However, Snap To Link can only be activated by first selecting an existing mount. To do this, select an object with a mount and click the Show/Hide Mount Points icon at the bottom of the window (). Then select a mount point. The link points are shown by hovering the cursor over a linked object, at which point one can be selected. This will snap the object with the mount to the link.

> **NOTE:** Snapping cannot change the relationship of one of the objects to be the parent of the other. If the two objects need to be moved as a group, the parents need to be set manually using the editors.

8.3 Robot Vision Manager

Robot Vision Manager enables the integration of vision and V+ programs. Refer to *Robot Vision Manager User's Manual (Cat. No. I667)* and the *V+ Module Reference Manual (Cat. No. I668)* for more information.

The ACE software provides a collection of Robot Vision Manager objects for the purposes of creating and storing calibrations as well as communicating vision results to V+ programs. These objects provide the following functions.

> **NOTE:** Robot Vision Manager operation requires that a controller connection exists between the Application Manager and the NJ device.

- Belt Latch Calibration: calibrating a robot to a latch signal. Refer to Belt Latch Calibration on page 426 for more information.
- Belt Calibration: calibrating a robot to a conveyor belt. Refer to Belt Calibration on page 292 for more information.
- Camera Calibration: calibrating a robot to a camera. Refer to Camera Calibration on page 295 for more information.
- Gripper Offset Table: defining the offset on a part to be picked from the actual pick point to the part origin. Refer to Gripper Offset Table on page 297 for more information.
- Vision Sequence: displays the order and dependency of vision tools while providing program access to the results. Refer to Vision Sequence on page 298 for more information.

- Overlap Tool: define a method to prevent double processing of belt-relative vision results located in more than one image acquired by a camera. Refer to Overlap Tool on page 305 for more information.
- Communication Tool: this tool is added to a Vision Sequence and communicates belt-relative vision results to a controller queue for processing by a robot. Refer to Communication Tool on page 307 for more information.
- Saving calibration data to a file and loading calibration data from a file. Refer to Saving and Loading Calibration Data on page 311 for more information.

IMPORTANT: Only one instance of ACE software can run with Robot Vision Manager functions. If an additional instance of the ACE software is started on the PC, ***[Robot Vision Manager Offline]*** will be displayed in status bar. In this state, any Robot Vision Manager Keywords may return an error.

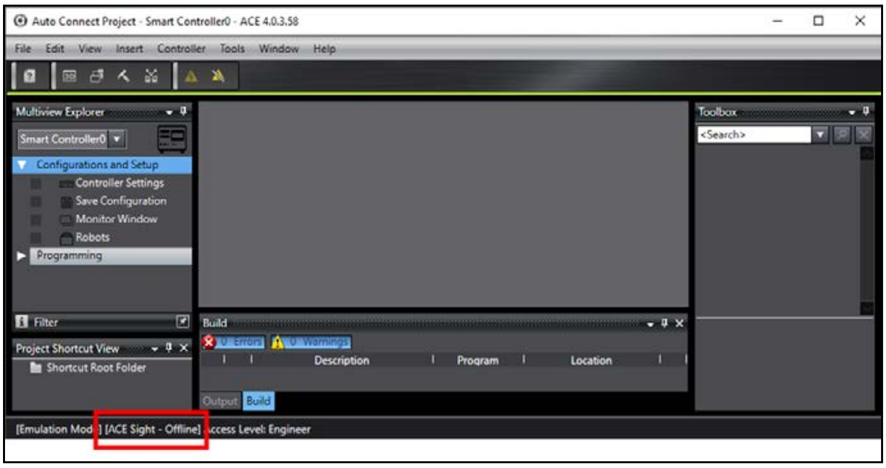


Figure 8-19 Robot Vision Manager - Offline Message

You can enable and disable the Robot Vision Manager for an application. This enables you to select which V+ application receives the Robot Vision Manager communication. You perform this task by clicking **Controller** and then selecting **Robot Vision Manager** and then the **Enable** or **Disable** as shown below.

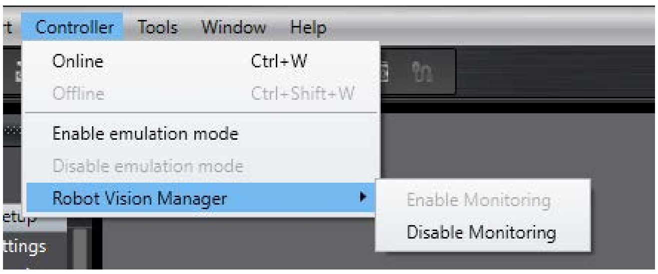


Figure 8-20 Robot Vision Enable/Disable

Robot Vision Manager Object Configuration

Many Robot Vision Manager objects are dependent on other ACE software objects. When configuring a new Robot Vision Manager object, the editor will provide information about other objects that may need to be configured or defined. When configuring a new Robot Vision Manager object, the Edit Pane will indicate missing dependencies as shown below (as an example).

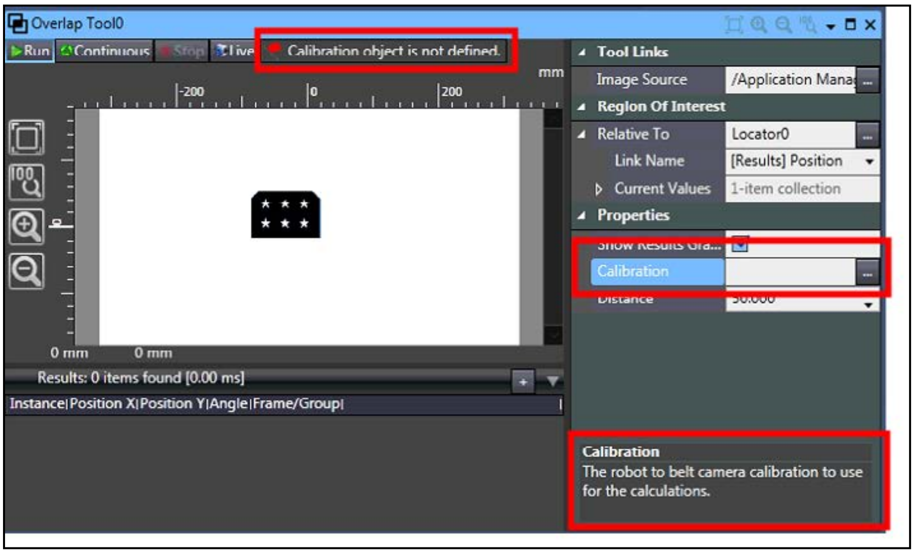


Figure 8-21 Robot Vision Manager Object Configuration - Missing Dependency

Belt Latch Calibration

Belt Latch Calibration calibrates a robot to a latch. This calibration uses a user-supplied sensor to generate a latch signal when an object, such as a pallet, reaches a specific point on a conveyor belt. This synchronizes the rest of the system with the position of the object.

Requirements

- The PC running the ACE software must be connected to the controller for the robot.
- A belt calibration must be completed.
- The robot, controller, and belt encoder must be properly connected and functioning.
- The belt encoder position latch signal must be configured in SmartController. Refer to Configure Belt Encoder Latches on page 213 for more information.

NOTE: A latch signal number is not required while in Emulation Mode.

Add Belt Latch Calibration Object Procedure

Follow the procedure below to add a Belt Latch Calibration object.

1. Right-click **Robot Vision Manager** in the Multiview Explorer, select **Add**, and then click **Belt Latch Calibration.** The Robot Vision Manager Robot-to-Belt Latch Calibration Wizard will open.

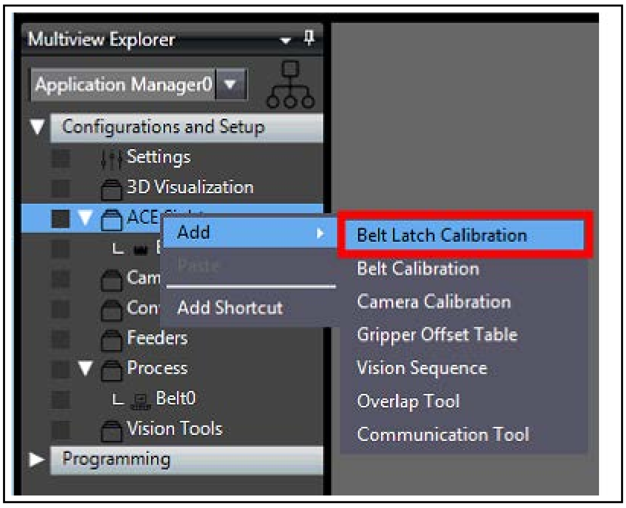


Figure 8-22 Add Belt Latch Calibration

2. Follow the Calibration Wizard steps to select the robot, end effector, and belt calibration. Clicking the **Finish** button will create the Belt Latch Calibration object in the Multiview Explorer.

   NOTE: After the Belt Latch Calibration object is created, you can rename the new Belt Latch Calibration object by right-clicking the item and selecting **Rename**.

3. Open the new Belt Latch Calibration editor by right-clicking the object and selecting **Edit** or double-clicking the object. The Belt Latch Calibration editor will open in the Edit Pane.
4. Open the Calibration Wizard by clicking the **Calibration Wizard** Button. The Robot-to-Belt Latch Calibration Sequence will open.

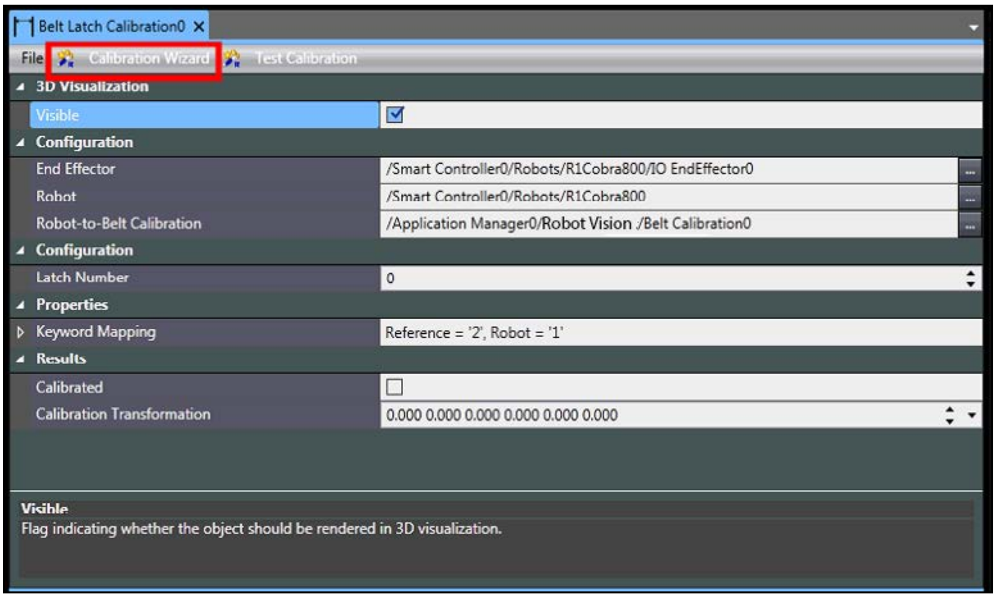


Figure 8-23 Calibration Wizard - Belt Latch Calibration

5. Make a selection for the end effector and set the latch sensor offset position. After completing these steps, click the **Finish** Button. This will close the Robot-to-Belt Latch Calibration Sequence.

   NOTE: The latch sensor is depicted in the wizard's virtual display as shown below.

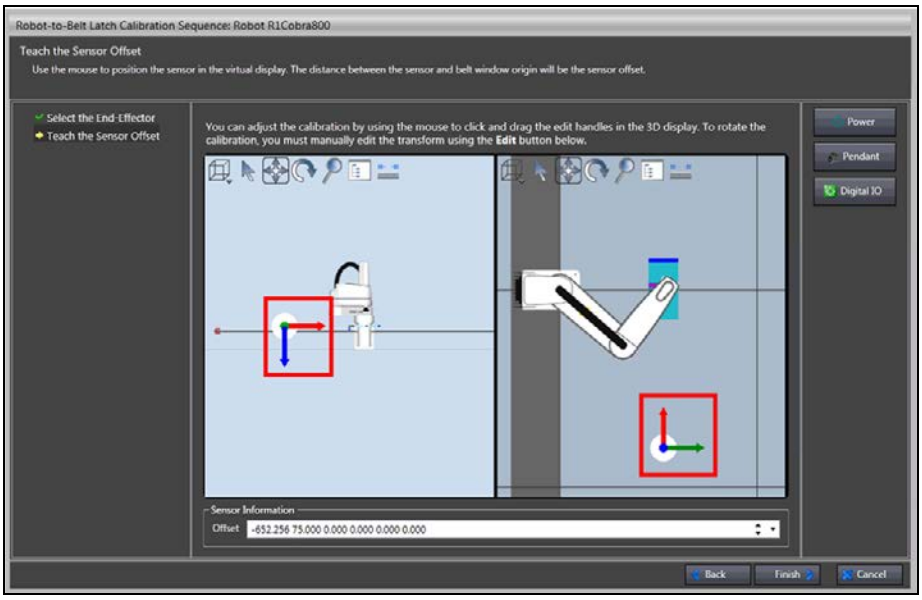


Figure 8-24 Teach the Sensor Offset

6. Review the Belt Latch Calibration object properties in the Belt Latch Calibration editor to confirm the configuration. You can also use the Robot-to-Belt Latch Calibration Test Sequence by clicking the **Test Calibration** Button (

) to confirm the configuration is correct. If the configuration is correct, the calibration procedure is complete.

Belt Calibration

Belt Calibration calibrates a robot to a conveyor belt. Configuring this object will establish a relationship between the belt, its encoder, and the robot. This calibration is necessary when the robot will handle parts that are moving on a conveyor belt. Refer to Robot-to-Belt Calibration on page 34 for more information.

Requirements

- The robot, controller, and belt must be correctly connected and functioning.
- The PC running the ACE software must be connected to the controller for the robot and belt.
- The robot and gripper must be defined in the ACE software

Add Belt Latch Calibration Object Procedure

Follow the procedure below to add a Belt Latch Calibration object.

1. Right-click **Robot Vision Manager** in the Multiview Explorer, select **Add**, and then click **Belt Latch Calibration.** The Robot Vision Manager Robot-to-Belt Latch Calibration Wizard will open.

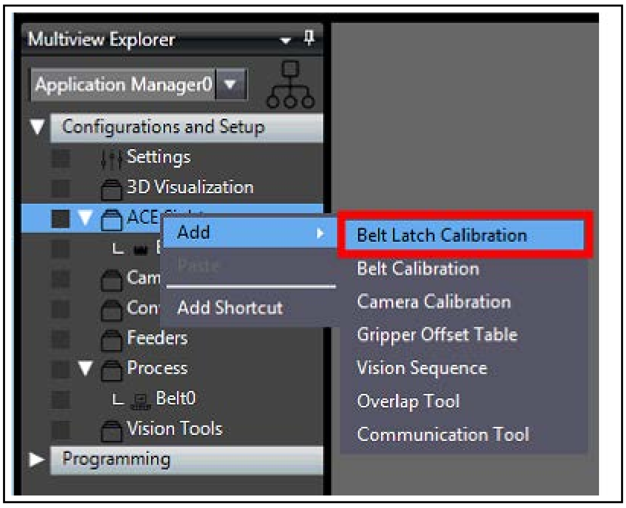


Figure 8-25 Add Belt Latch Calibration

2. Follow the Calibration Wizard steps to select the robot, end effector, and belt calibration. Clicking the **Finish** button will create the Belt Latch Calibration object in the Multiview Explorer.

   NOTE: After the Belt Latch Calibration object is created, you can rename the new Belt Latch Calibration object by right-clicking the item and selecting **Rename**.

3. Open the new Belt Latch Calibration editor by right-clicking the object and selecting **Edit** or double-clicking the object. The Belt Latch Calibration editor will open in the Edit Pane.
4. Open the Calibration Wizard by clicking the **Calibration Wizard** Button. The Robot-to-Belt Latch Calibration Sequence will open.

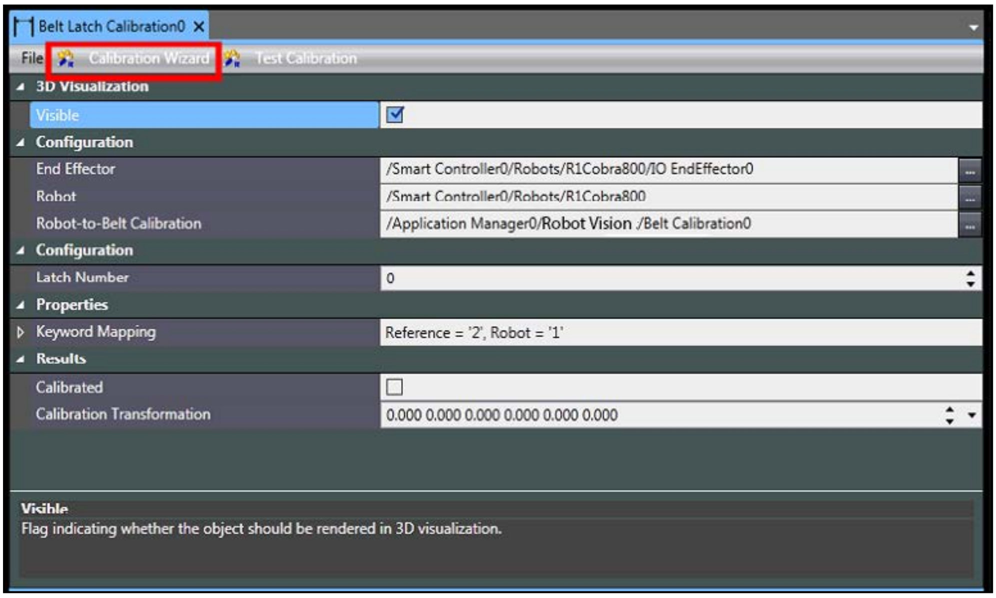


Figure 8-26 Calibration Wizard - Belt Latch Calibration

5. Make a selection for the end effector and set the latch sensor offset position. After completing these steps, click the **Finish** Button. This will close the Robot-to-Belt Latch Calibration Sequence.

   NOTE: The latch sensor is depicted in the wizard's virtual display as shown below.

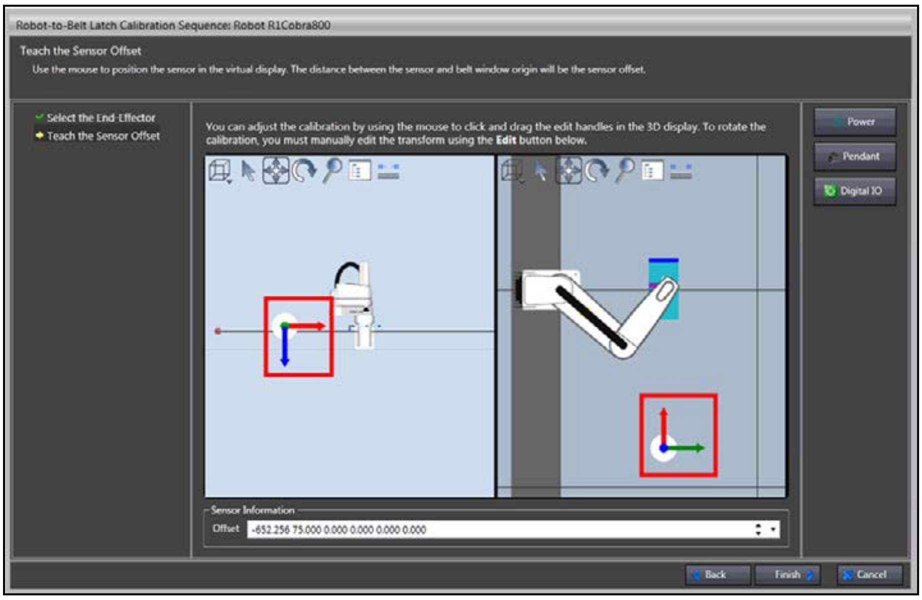


Figure 8-27 Teach the Sensor Offset

6. Review the Belt Latch Calibration object properties in the Belt Latch Calibration editor to confirm the configuration. You can also use the Robot-to-Belt Latch Calibration Test Sequence by clicking the **Test Calibration** Button (

) to confirm the

configuration is correct. If the configuration is correct, the calibration procedure is complete.

Belt Calibration Results

The belt calibration results are used to define the belt area for the robot to access. When using these values in V+ programs, they may need to be adjusted based on your application and will vary based on factors like robot travel times, part flow rates, belt speed, and other timing conditions.

The values of the items below are set during the belt calibration process.

> **Additional Information**: A Robot Vision Manager Application Sample demonstrates how these results can be used in V+ programs.

Belt Transform

The Belt Transform is the frame that is generated from the downstream and upstream transform values to define the orientation of the belt window.

Downstream Transform

The Downstream Transform is used to define the downstream belt window limit in a V+ program. This sets the downstream threshold where the robot is allowed to access an object. If the robot is tracking a part when it reaches this point, a Belt Window Violation will occur.

Nearside Transform

The Nearside Transform is the third point taught in the calibration and is used to define the width of the belt window.

Upstream Transform

The Upstream Transform is used to define the upstream belt window limit in a V+ program.

(Encoder) Scale Factor

The belt encoder Scale Factor sets the amount of millimeters per encoder count for the belt's encoder.

Camera Calibration

Camera Calibration calibrates a robot to a camera. This calibration is necessary if you will be using a vision system with a robot.

Configuring this object will establish a relationship between the following objects (where applicable).

- Camera
- Belt
- Robot
- Robot end effector (robot tool)

Requirements

- The robot, controller, belt (if used), and camera must be correctly connected and functioning.
- The Virtual Camera calibration (mm/pixel) must be complete.
- The PC running the ACE software must be connected to the controller for the robot (and belt).
- The Belt Calibration Wizard must have completed successfully if a conveyor belt is used.

Add Camera Calibration Object Procedure

Follow the procedure below to add a Camera Calibration object.

1. Right-click **Robot Vision Manager** in the Multiview Explorer, select **Add**, and then click **Camera Calibration**. The Robot Vision Manager Camera Calibration Wizard will open.

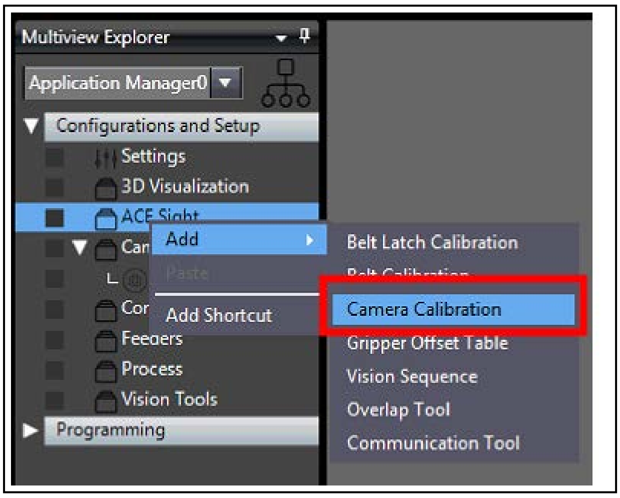


Figure 8-28 Add Camera Calibration

2. Follow the Calibration Wizard steps to select the robot, end effector, camera, scenario, camera link, and belt calibration. Clicking the **Finish** Button will create the Camera Calibration object in the Multiview Explorer.

   NOTE: After the Camera Calibration object is created, you can rename the new Camera Calibration object by right-clicking the item and selecting **Rename**.

3. Open the new Camera Calibration editor by right-clicking the object and selecting **Edit** or double-clicking the object. The Camera Calibration editor will open in the Edit Pane.
4. Open the Calibration Wizard by clicking the **Calibration Wizard** button. The Calibration Sequence will open.

   Additional Information: The Calibration Sequence will vary depending on the scenario choice selections made during the Calibration Wizard.

5. Make selections for all steps of the Calibration Sequence. After completing these steps, click the **Finish** Button. This will close the Calibration Sequence.
6. Review the Camera Calibration object properties in the Camera Calibration editor to confirm the configuration. You can also use the **Test Calibration** Button to confirm the configuration is correct. If the configuration is correct, the calibration procedure is complete.

Gripper Offset Table

The Gripper Offset Table defines where on the part a robot can pick up a part, giving the relationship between the pick point, the part model, and the robot flange center.

> **Additional Information**: The Gripper Offset Table can be useful when a robot must pick a part in different poses / orientations located by different models. It may be necessary to create a pick point in a different orientation than the part has been detected.

A gripper can have two types of offsets:

1. A tip offset from the center of the tool flange to the gripper tip(s).

   This offset is established when the robot end effector is defined. This offset will be applied to that gripper whenever it is used, including calculating values for the Gripper Offset Table. Refer to Robot Objects on page 224 for more information.

2. The offset(s) from the actual pick point to the part origin which indicates where the robot must pick the part in relation to the origin of the part. This is defined in the Gripper Offset Table and is assigned to a specific robot.

Requirements

- The robot and controller must be correctly connected and functioning.
- The PC running ACE software must be connected to the controller.
- All associated objects such as belts, cameras, and vision tools must be defined and configured if used.

Add Gripper Offset Table Object Procedure

Follow the procedure below to add a Gripper Offset Table object.

1. Right-click **Robot Vision Manager** in the Multiview Explorer, select **Add**, and then click **Gripper Offset Table**. The Gripper Offset Table Creation window will open.

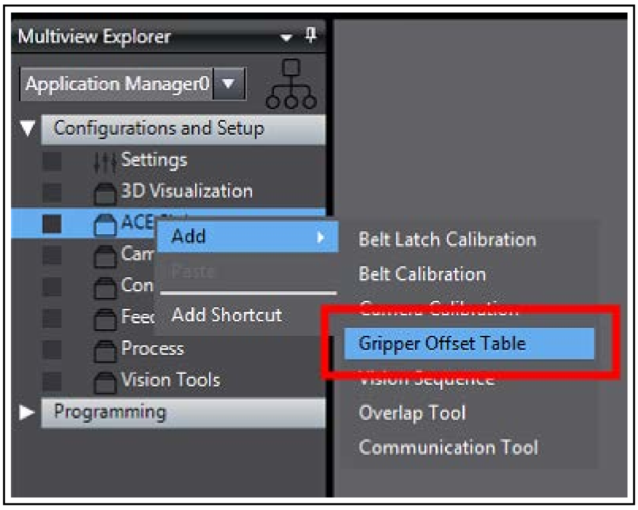


Figure 8-29 Add Gripper Offset Table

2. Follow the Gripper Offset Table Wizard steps to select the robot. Clicking the **Finish** button will create the Gripper Offset Table object in the Multiview Explorer.

   NOTE: After the Belt Latch Calibration object is created, you can rename the new Belt Latch Calibration object by right-clicking the item and selecting **Rename**.

3. Open the new Gripper Offset Table editor by right-clicking the object and selecting **Edit** or double-clicking the object. The Gripper Offset Table editor will open in the Edit Pane.
4. Use the Add button to create a new Gripper Offset index item. There are two methods for editing the Offset values:

Vision Sequence

A Vision Sequence lets you see the order and dependency of vision tools that will be executed while giving V+ programs a means for retrieving results from vision tools. The Vision Sequence object shows the list of tools that will be executed as part of the sequence, the order in which they will be executed, and the Index associated with each one. The Index is the execution order of each tool.

The sequence cannot be modified from the Sequence Display Window. It shows the order in which the tools will be executed, based on the parent tool specified in each tool. The actual order of a sequence is determined when you specify the Relative To parameter for each of the tools to be included in the sequence.

When you add a Vision Sequence object to the project, the Vision Tool parameter determines the Top-Level tool, and all the tools you specified as the Relative To parameter in the chain under that will automatically show up as members of the sequence, in the order you set.

In a sequence, you specify a robot-to-camera calibration. The calibration is applied to any result accessed by a VLOCATION transformation function.

A Vision Sequence maps a V+ sequence number to the top-level vision tool. Top-level means the vision tool with the highest number in the sequence (this will be the last tool executed).

This enables you to access an Vision Sequence with the sequence_id parameter from a V+ program command.

> **NOTE:** V+ programs can access the results of intermediate (not only top-level) tools when a sequence is executed because each tool has an index that can be accessed.
>
> The Default Calibration is applied to all results, even if they are not the top-level tool.

Requirements

- The robot and controller must be correctly connected and functioning.
- At least one Vision Tool must be configured to define in the sequence.
- A camera must be defined in the ACE software.
- A Camera Calibration must be completed if a VLOCATION command is used in a V+ program.

Add Vision Sequence Object Procedure

Follow the procedure below to add a Vision Sequence object.

1. Right-click **Robot Vision Manager** in the Multiview Explorer, select **Add**, and then click **Vision Sequence**. A Vision Sequence object will be added to the Multiview Explorer.

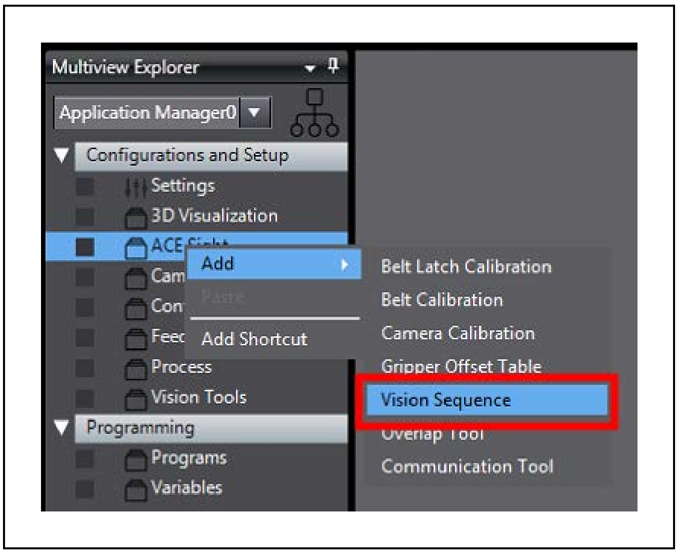


Figure 8-30 Add Vision Sequence

> **NOTE:** After the Vision Sequence object is created, you can rename the new Vision Sequence object by right-clicking the item and selecting ***Rename***.

2. Open the new Vision Sequence editor by right-clicking the object and selecting ***Edit*** or double-clicking the object. The Vision Sequence editor will open in the Edit Pane.

   Items in the Vision Sequence editor are described below.

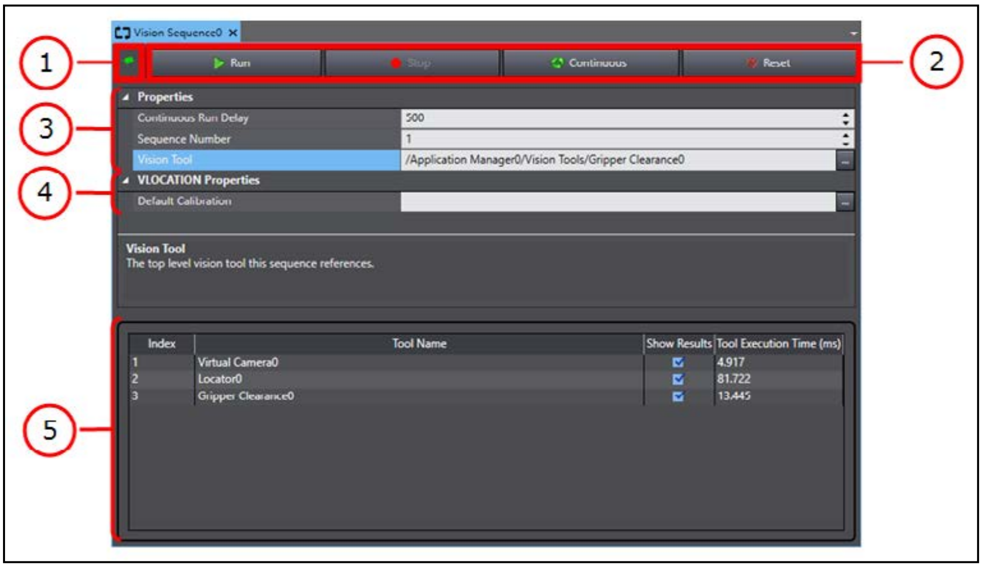


Figure 8-31 Vision Sequence Editor

Table 8-4 Vision Sequence Editor Item Description

Item	Description
1	Configuration Status • A red flag ( ) indicates incomplete configuration. • A green flag ( ) indicates the configuration is completed. The configuration status will update after the **Run** button is clicked. Hover over the red flag for information about the incomplete configuration.
2	Sequence Control Buttons • **Run**: Runs the sequence once. • **Stop**: Stops the running sequence. This can only be selected if the sequence is in the middle of a run or the **Continuous** button has been clicked. • **Continuous**: Runs the sequence repeatedly. • **Reset**: Reset the communication queue, which flushes all instances on the PC that have been identified but not yet sent to a V+ program and resets the Overlap tool tracking of previously-located instances.
3	Properties • Continuous Run Delay: Amount of time in milliseconds to delay between execution of the Vision Sequence in continuous mode. This is the interval at which the Vision Sequence will be executed for V+ conveyor tracking programs using Robot Vision Manager. • Sequence Number: The number associated with the sequence. This sequence number is used in V+ programs to reference this vision operation. • Vision Tool: Top-level vision tool this sequence references. All tools

Item	Description
	required to operate the tool selected here will be included in the sequence.
4	VLOCATION Properties Default Calibration: Default camera calibration used to apply to a VLOCATION transformation function from V+ programs. This must reference a Camera Calibration object shown in the Multiview Explorer.
5	Sequence Layout The Vision Sequence for the specified Vision Tool.

3. Make the necessary configuration settings in the Edit Pane to complete the procedure for adding a Vision Sequence object.

Vision Sequence Configuration

The Vision Sequence editor shows the list of tools that will be executed as part of the sequence, the order in which they will be executed, and the associated index number of each. The tools are executed in ascending Index value.

The main property of a Vision Sequence is the Vision Tool parameter that defines what tool marks the end of the sequence. Once it is selected, the Sequence Layout will be populated by the top-level tool's dependencies down to the initial image source. For example, the Vision Sequence shown in Figure 8-31 is based on a Gripper Clearance tool that has Relative To set to a Locator tool. These are included by starting with the top-level tool and its Image Source and Relative To properties and working through the same properties of subsequent tools. This is laid out in the following figure that shows how the tools are associated and what data is passed between them.

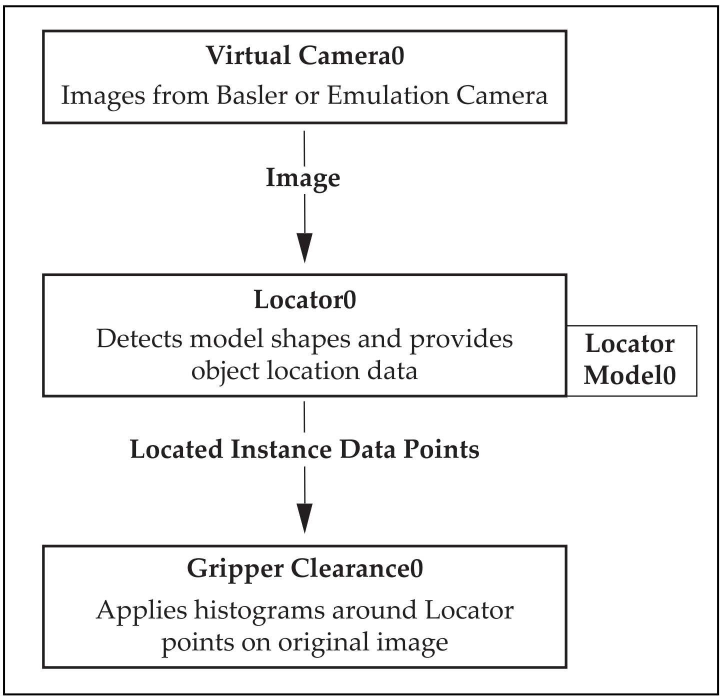


Figure 8-32 Vision Sequence Flow Chart - Gripper Clearance

Another example is shown in the following figure, where the image is modified for instance locating before the bar codes are actually read. Refer to Figure 8-34 to see this sequence.

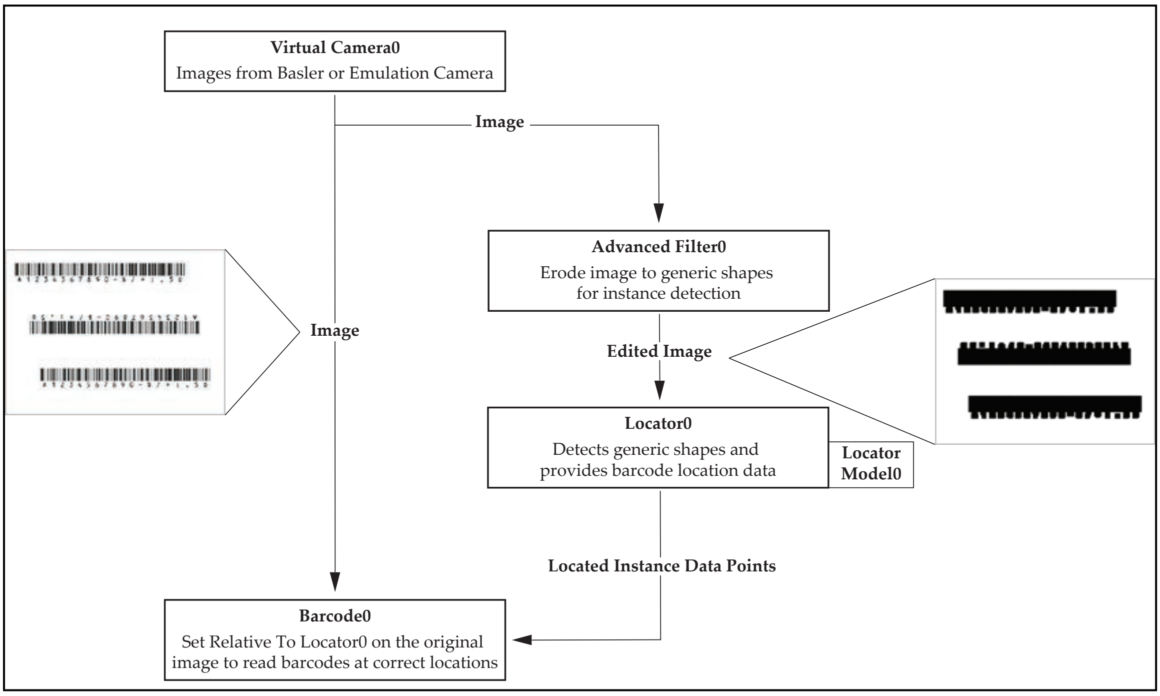


Figure 8-33 Vision Sequence Flow Chart - Barcode

Index	Tool Name	Show Results	Tool Execution Time (ms)
1	Virtual Camera0	☑	3.267
2	Advanced Filter0	☑	16.292
3	Locator0	☑	46.189
4	Barcode0	☑	19.962

Figure 8-34 Vision Sequence - Barcode

NOTE: The sequence itself cannot be changed in the Vision Sequence editor. The Relative To properties in the tools themselves must be used to do this.

For some applications, it may be beneficial to have multiple sequences where one sequence is a subset of another.

Vision Sequences also provide a means for V+ programs to obtain information from vision tools using a sequence_id parameter. In addition, the robot-to-camera calibration in the Default Calibration property can be accessed using a VLOCATION transformation function. The returned values are provided in the following table.

Additional Information: Refer to the *ACE Reference Guide* for more information about VLOCATION.

Table 8-5 Vision Sequence Returned Values

Value	Description
Index	Tool number within the sequence. The tools are run in ascending order.
Tool Name	Name of the tool to run.
Show Results	Defines if the tool results will be shown in the Vision Window. This is based on the Show Results Graphics property of the respective tool. **NOTE:** This option is not selectable for tools that do not have the Show Results Graphics property.
Tool Execution Time (ms)	Time (in milliseconds) taken for the tool to run in the most recent execution of the sequence.

Frame and Group Behavior

The Frame / Group result defines the number of the frames referenced in the calculation of the tool. If the tool is not set relative to any other tool, the results for this column will all be returned as 1. However, when the tool is set relative to a tool with more than one returned instance, the Frame / Group value reflects the result instance of the previous tool.

For example, Figure 8-35 and Figure 8-36 show a sequence that is designed to find the stars within the defined shapes. The Locator tool in Figure 8-35 disambiguates between the shapes with five stars and those with six. Then, the Shape Search 3 tool shown in Figure 8-36 locates the stars within the shape.

The Results section shows that the Frame / Group results directly correlate with the Instance result from the Locator in Figure 8-35 above. Instances 1 through 6 in Figure 8-36 are in Frame / Group 1 since they are located with respect to Instance 1 in Figure 8-35 below. Instances 7 through 11 are in Frame / Group 2 for the same reason. The other regions correlate in the same way.

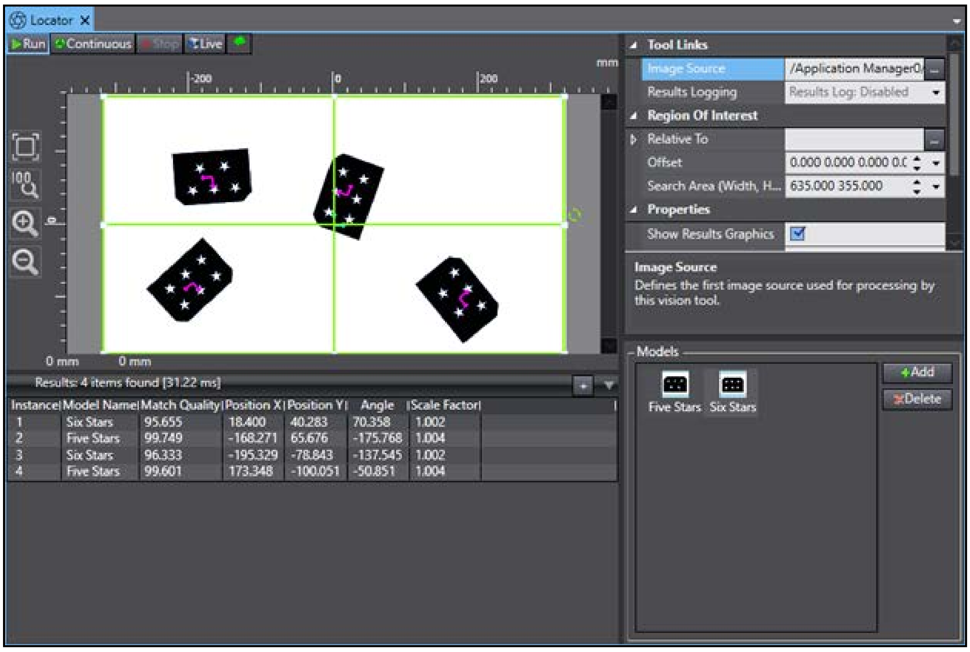


Figure 8-35 Frame / Group - Locator

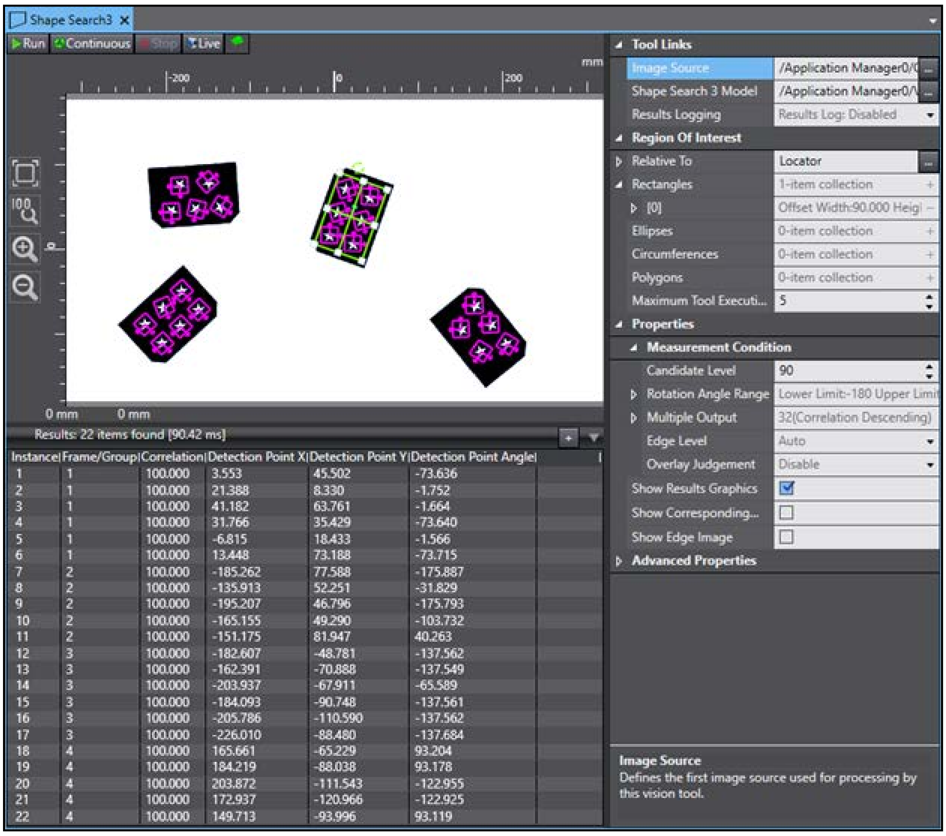


Figure 8-36 Frame / Group - Shape Search 3

The Frame / Group can also be used as an argument for the VLOCATION transformation function in V+ program code to limit the returned location to a particular instance in another tool. The syntax of the VLOCATION transformation is provided below.

```
VLOCATION ($ip, sequence_id, tool_id, instance_id, result_id, index_id, frame_id)
```

If there is an argument for frame_id, then instance_id will be evaluated based on that frame. Otherwise, it will be evaluated with reference to all instances. For example, the following code returns the location (21.388, 8.330, 0, 0, 0, -1.752) based on Instance 2 in the results of Figure 8-36 above.

```
VLOCATION ($ip, 1, 3, 2, 1311, 1)
```

However, when the frame_id is added as shown below, the line returns (-135.913, 52.251, 0, 0, 0, -31.829) since that is Instance 2 of Frame / Group 2.

```
VLOCATION ($ip, 1, 3, 2, 1311, 1, 2)
```

> **Additional Information**: Refer to the ACE Reference Guide for more information on VLOCATION.

Overlap Tool

The Overlap Tool ensures that parts moving on a conveyor belt are processed only once if located in multiple images. A part found by the Locator Vision Tool (or other input tools) may be present in multiple images acquired by the camera and this tool ensures that the robot is not instructed to pick up or process the same part more than once. The input required by the Overlap Tool can be provided by any tool that returns a transform instance. This tool is typically used in conveyor tracking applications.

> **Additional Information**: It is often desirable to have images taken at an interval that is one-half of the field of view of belt travel. This makes it possible to get two images of the same part. In this case, the Overlap Tool can be used to filter out duplicates.

If an instance in the image is a new instance (Pass result) it is passed on to the next tool in the sequence. If an instance is already known, it is rejected (Fail result), and is not sent to the next tool in the sequence. This avoids double-picking or double-processing of the object.

The Overlap Tool should be placed near the beginning of a sequence, just after the input tool and before any inspection tools in the sequence. This ensures that the same instance is not processed multiple times by the inspection tools. Refer to Vision Sequence on page 298 for more information.

Requirements

- The camera, robot, and conveyor belt are calibrated, connected, and correctly functioning.
- The PC running the ACE software must be connected to the controller for the robot and belt.
- The tool is receiving latched values from the input tool. The belt latch must be wired to the controller and properly configured.

- A vision input tool is defined and configured.
- The conveyor belt and the controller have been correctly assigned to a camera.

Add Overlap Tool Object Procedure

Follow the procedure below to add an Overlap Tool object.

1. Right-click **Robot Vision Manager** in the Multiview Explorer, select **Add**, and then click **Overlap Tool**. An Overlap Tool object will be added to the Multiview Explorer.

   NOTE: After the Overlap Tool object is created, you can rename the new Overlap Tool object by right-clicking the item and selecting **Rename**.

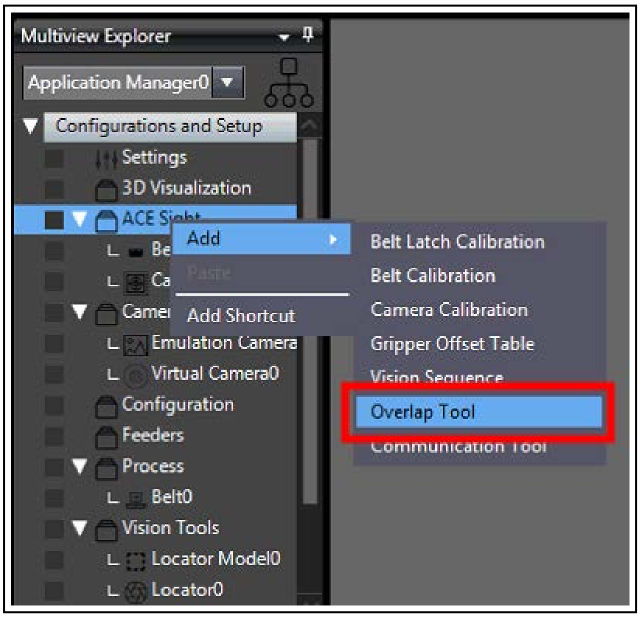


Figure 8-37 Add Overlap Tool

2. Open the new Overlap Tool editor by right-clicking the object and selecting ***Edit*** or double-clicking the object. The Overlap Tool editor will open in the Edit Pane.
3. Make all necessary settings in the Overlap Tool editor. When all settings are completed, the Overlap Tool object configuration procedure is complete.

The Distance Parameter

This specifies how far an instance must be from the expected location of a known instance in a different image for it to be considered a new instance. Distance is specified in mm. It should be as small as possible without causing double-picks.

- If Distance is too large, nearby instances will be interpreted as duplicates of a different instance, and some will not be picked.
- If Distance is too small, two transforms will be interpreted as different instances, and the system will try to double-pick the object.

  Additional Information: 5 mm is a recommended starting value for the Distance parameter.

NOTE: Rotation is ignored by the Overlap Tool. Only the difference in X and Y is considered.

Communication Tool

The Communication Tool is a tool for conveyor tracking applications. The purpose of the Communication Tool is to transfer belt-relative vision results into a controller queue for processing by a robot.

The Communication Tool typically receives instances from an Overlap Tool, which prevents different images of the same instance from being interpreted as different instances. The input to the Communication Tool can also be provided by other tools that output instances, such as an Inspection or a Locator Tool. The Communication Tool processes the input instances by applying region-of-interest parameters.

The Communication Tool acts as a filter in the following way.

- Instances that are passed by the tool are sent to the controller queue.
- Instances that are not output to the controller because they are outside the region of interest or because the queue is full, are rejected. These instances are passed to the next tool in the sequence, such as another communication tool.

Order of the Communication Tool in a Vision Sequence

In a simple vision-guided, belt-tracking application, one or more Communication Tools are inserted at the end of a sequence, frequently just after the Overlap Tool.

In a sequence that requires inspection of parts before they are picked by a robot, the Communication Tool must be placed after one or more Inspection tools. In such a case, the Inspection tools provide valid instances (parts that have passed inspection) to the Communication Tool.

Using Multiple Communication Tools

In many applications, it may be useful to use two or more Communication Tools. Examples when multiple Communication Tools are necessary are provided below.

NOTE: Each tool must have its "Relative To" property set to the preceding tool, so any parts not queued by one tool are passed to the next tool.

- Use two Communication Tools for managing either side of a conveyor belt. Each Communication Tool sends instances to a robot that picks parts on one side of the belt only.
- Use two (or more) Communication Tools so that the subsequent tools can process instances that were rejected by the preceding tools because the queue was full. Each tool will send its passed parts to a different queue, so any parts missed by a robot because its queue is full will be picked by a subsequent robot.
- Use multiple Communication Tools to send instances to multiple robots positioned near a single conveyor belt with a single camera.

Requirements

- The camera, robot, and conveyor belt are calibrated, connected, and correctly functioning.
- The conveyor belt and the controller have been correctly assigned to a camera.

Add Communication Tool Object Procedure

Follow the procedure below to add a Communication Tool object.

1. Right-click **Robot Vision Manager** in the Multiview Explorer, select **Add**, and then click **Communication Tool**. A Communication Tool will be added to the Multiview Explorer.

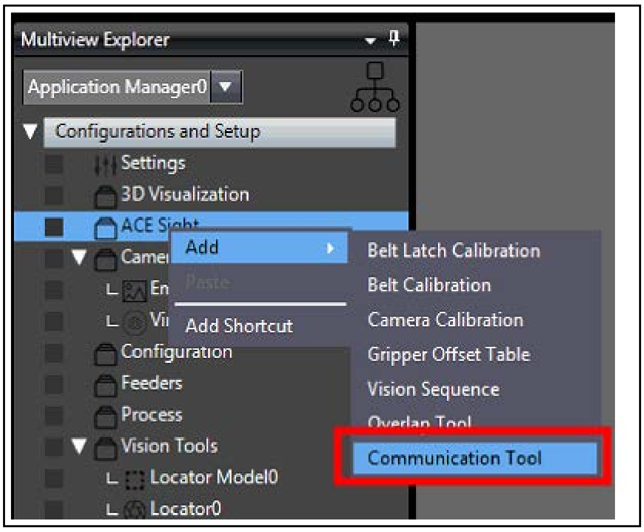


Figure 8-38 Add Communication Tool

NOTE: After the Communication Tool object is created, you can rename the new Communication Tool object by right-clicking the item and selecting **Rename**.

2. Open the new Communication Tool editor by right-clicking the object and selecting **Edit** or double-clicking the object. The Communication Tool editor will open in the Edit Pane.
3. Make all necessary settings in the Communication Tool editor. When all settings are completed, the Communication Tool object configuration procedure is complete.

Communication Tool Parameter Details

The Communication Tool has unique parameters that are described below.

Search Area

Search Area is the size of the region of interest is defined the width and height of the region of interest. Modifying the region of interest is useful for applications in which two or more robots pick or handle objects on different sides of the belt.

For example, an application could use one Communication Tool configured to output objects on the right side of the belt to Robot A and a second Communication Tool configured to output instances on the left side of the belt to Robot B. The region of interest can be the entire image or a portion of the input image. It can be set in one of the following ways.

- Enter or select values for the Offset and Search Area parameters: Position X, Position Y, Angle, Width, and Height.

- Resize the bounding box directly in the display. The rectangle represents the tool region of interest. Drag the mouse to select the portion of the image that should be included in the region of interest.

Robot

The Robot parameter selects the robot that will handle or pick the instances output by the Communication tool.

> **NOTE:** Ensure the selected robot and the robot of the selected camera calibration are the same. If not, the transformation may be invalid.

Queue Parameters

The Communication Tool sends instances that pass its criteria to its queue, which is configured with the following parameters.

Queue Index

The Queue Index identifies the queue to which instances will be sent. Two different Communication Tools cannot write to the same queue on a controller. If there are multiple Communication Tools, either on the same or different PCs, each tool must be assigned a unique queue index. Choose a value from 1 to 100.

In a V+ program, this queue index must be used to access the instances sent to the controller by the communication tool. For example, in the Robot Vision Manager application sample for belt camera pick to a static place, the "rob.pick" program will use "pick.queue" variable to store the queue index used when obtaining instances. This occurs with the following V+ program call.

```
CALL getinstance(pick.queue, peek, inst.loc, model.idx, encoder.idx, vision.x, vision.y, vision.rot)
```

Queue Size

Queue Size specifies the number of instances that can be written to the queue. The ideal queue size varies greatly and may require some testing to optimize this value for a specific application and environment. Choose a value from 1 to 100.

Queue Update

Queue Update specifies how often the Communication Tool will write new instance data to the queue on the controller. The recommended setting is After Every Instance. The Queue Update options are described below.

- After Every Instance: The After Every Instance setting sends each instance to the queue separately as it becomes available. This minimizes the time until the first instance is available for use by the V+ program. If a large number of instances are located, then it can take longer to push all of the data to the controller.
- After Last Instance: The After Last Instance setting sends multiple instances to the queue at once. This mode minimizes the total data transfer time, but can increase the time until the first instance is available for use since the robot is inactive during the time that the PC is writing to the queue.

NOTE: Both Queue Update settings have the same function when only one instance is found.

Use Soft Signal

Select this option to enable the Soft Signal.

Soft Signal

This sets the value of the Soft Signal to use when Use Soft Signal is enabled. The signal can be used by a V+ program to synchronize the controller and the PC. This signal instructs the controller that all instances detected by the input tool have been sent to the controller.

Gripper Offset Configuration

This specifies the method and details needed for determining the offset index of the gripper. Refer to Gripper Offset Table on page 297 for more information.

Use the item descriptions below to make the appropriate configuration settings.

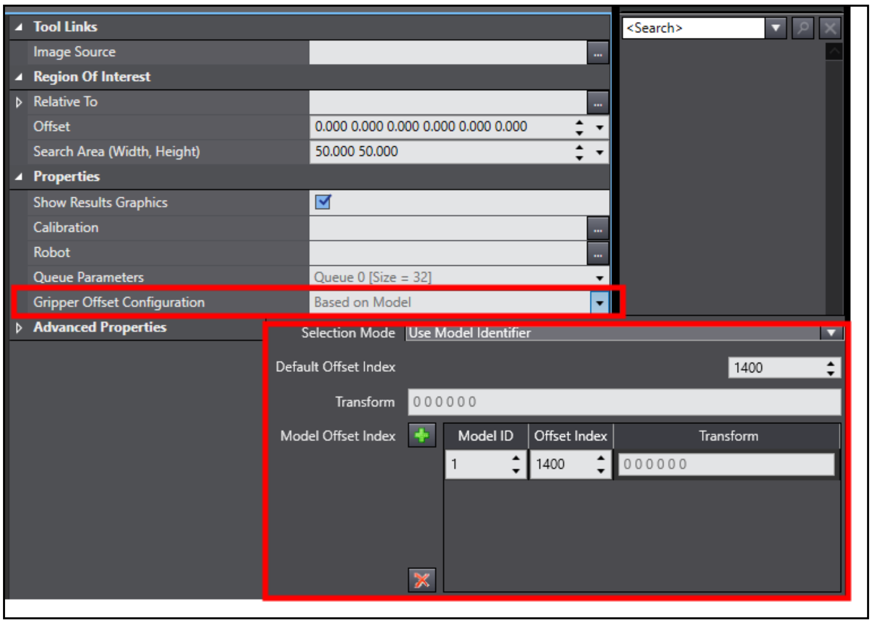


Figure 8-39 Gripper Offset Configuration

Selection Mode

Make one of the following selections as described below.

Disabled: No Gripper Offset is applied.

Use Default: Use the value set in the Default Offset Index field.

Use Model Identifier (Model ID): Use the values set in the Model Offset Index area.

Default Offset Index

This specifies the index in the Gripper Offset Table to apply as the gripper offset. This setting can be from 1400 to 1499.

Model Offset Index

Use this area to create associations between Model IDs from a Locator Model and Gripper Offset Table index numbers. This refers to the Custom Model Identifier property of the Locator Model.

Use the **Add** button ( ) and **Remove** button ( ) to create necessary associations.

Tool Relative Coordinates

Selecting this option indicates that locations should be returned relative to the robot tip position when the picture was taken. This is only used if the selected camera calibration was performed with the calibration object attached to the robot tool (an upward looking camera for example).

Saving and Loading Calibration Data

All Robot Vision Manager calibrations (Belt Latch, Belt, and Camera) can be saved to a file or loaded from a file. Use the File Menu item in the object's editor to save or load a configuration file.

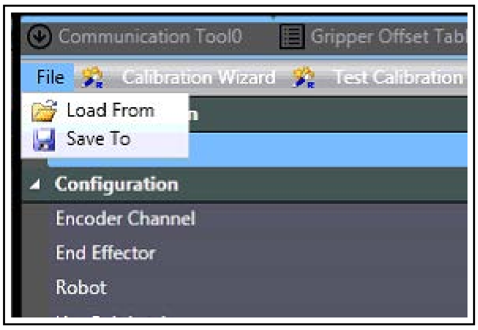


Figure 8-40 Save and Load Calibration Files

Camera Objects

Camera objects can be added to the ACE project to provide a method for obtaining an image to be used for processing. A camera object can be either a physical camera, virtual camera, or an emulated camera. You can have multiple camera objects in the ACE project.

Use the information in this section to understand the different camera object types and their configurations in an ACE project.

To add a camera object to the Application Manager in the Multiview Explorer, right-click **Cameras**, select **Add** and then choose a camera type. A new camera object will be added to the Multiview Explorer.

NOTE: When adding an Emulation camera for a Basler Camera, Sentech Camera, Phoxi 3D camera or Custom Device, you also have the option to also add a Virtual Camera. A Virtual Camera is typically required for most applications.

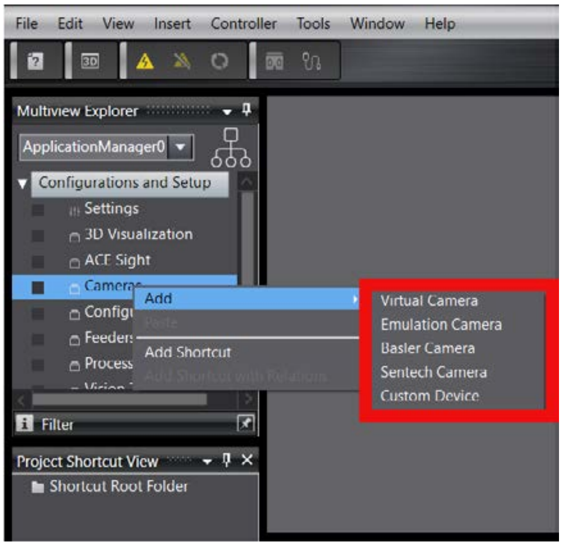


Figure 8-41 Adding a Camera Object

Virtual Cameras

The Virtual Camera object provides an interface between a Vision Sequence and the object used to acquire an image. The Virtual Camera object is typically used as the Image Source reference for vision tools (except when Image Processing tools are used).

The Virtual Camera object editor provides access to pixel-to-millimeter calibration data, acquisition settings, image logging, and references for the camera object to use for acquiring an image. The Default Device setting for the Virtual Camera designates the object used to acquire an image. When configured properly, this can provide a seamless transition between a physical camera and an Emulation Camera without changing vision tool settings.

Adding a Virtual Camera

To add a Virtual Camera, right-click **Cameras**, select **Add**, and then click **Virtual Camera**. A new Virtual Camera will be added to the Multiview Explorer.

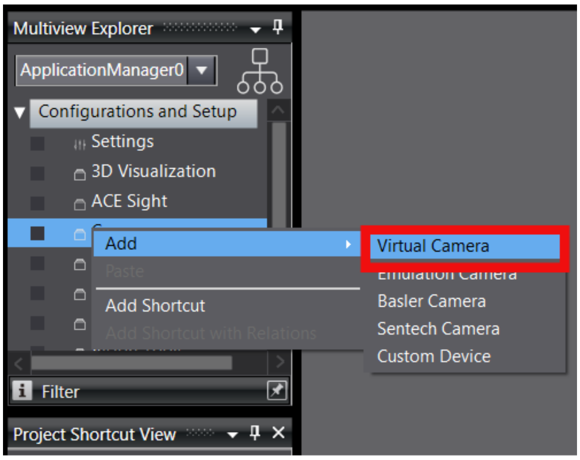


Figure 8-42 Add a Virtual Camera

NOTE: The option to add a Virtual Camera is present when adding an Emulation Camera, Basler Camera, Sentech Camera or a Custom Device. This is typically how a Virtual Camera is added to the ACE project.

You can rename a Virtual Camera after it has been added to the Multiview Explorer by right-clicking the object and then selecting **Rename**.

Virtual Camera Configuration

To access the Virtual Camera configuration, right-click the object in the Multiview Explorer and then select **Edit**, or double-click the object. This will open the Virtual Camera editor in the Edit Pane.

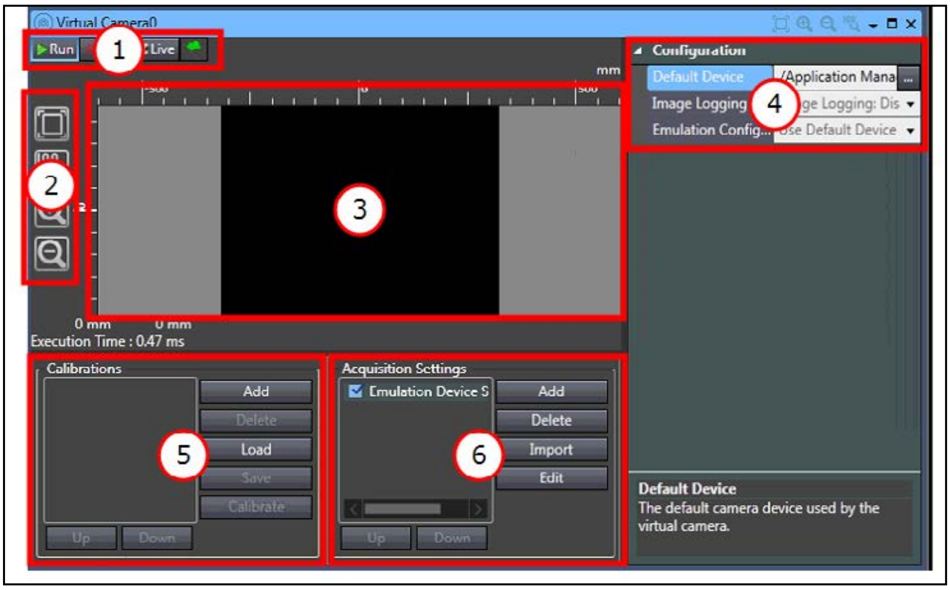


Figure 8-43 Virtual Camera Configuration

Table 8-6 Virtual Camera Configuration Item Description

Item	Description
1	Camera Control Buttons • The **Run** button will acquire the image once from the camera device specified. • The **Stop** button will stop continuous Live image acquisition. • The **Live** button will start continuous image acquisition from the camera device specified.
2	Camera Image View Adjustments Use these buttons to adjust the image view area. You can also use the mouse scroll to zoom in and out.
3	Camera Image View This area shows the most recent image acquired by the Virtual Camera.
4	Virtual Camera Configuration Items This area is used to configure the Virtual Camera. Refer to Virtual Camera Configuration Items on page 314 for more information.
5	Virtual Camera Calibrations Area This area is used to calibrate the Virtual Camera. Refer to Virtual Camera Calibration on page 316 for more information.
6	Virtual Camera Acquisition Settings This area is used to adjust image acquisition settings for the camera. Refer to Acquisition Settings on page 319 for more information.

Virtual Camera Configuration Items

Default Device

Select a default camera device used by the Virtual Camera (when not in Emulation Mode).

Image Logging

Make the following settings for saving images when the Virtual Camera acquires an image.

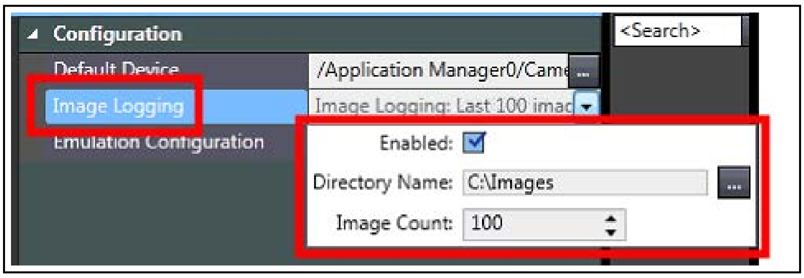


Figure 8-44 Virtual Camera Image Logging

Table 8-7 Virtual Camera Image Logging Item Description

Item	Description
Enabled	Enable or disable the image logging function with this selection
Directory Name	Select a directory on the PC where images will be stored.
Image Count	Enter the number of images to store. Up to 1000 images can be stored.

Image Logging Considerations

If you are logging images from a physical, belt-relative camera for use in Emulation Mode, record the average belt velocity and picture interval in effect while logging images. These two pieces of information are necessary for the picture spacing on an emulated belt to be similar. If using a Process Manager, the belt velocity can be recorded from the System Monitor and the picture interval can be recorded from Process Manager in the Control Sources area. If using a V+ program and Robot Vision Manager, the belt velocity can be recorded from the Controller Settings - Encoders area and the picture interval can be recorded from the Robot Vision Manager Sequence, Continuous Run Delay area.

Without recording using this information, the replayed images may be overlapping and part flow may be different than you expect. When using the logged images in emulation, be sure to apply these values in the appropriate fields for the flow of images to match the physical system.

Emulation Configuration

When Emulation Mode is enabled, the Virtual Camera object editor uses an Emulation Configuration parameter that specifies one of the following modes for the image source.

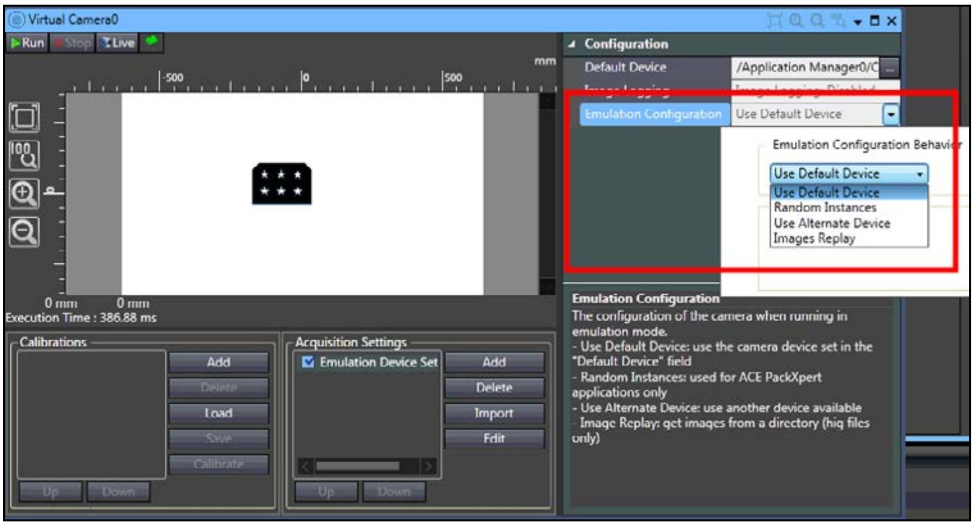


Figure 8-45 Virtual Camera Emulation Configuration Behavior

Use Default Device

This setting will use the camera device specified in the Default Device field.

Random Instances

This setting allows generation of a random quantity of randomly oriented vision results. You specify the range of possible instance count with minimum and maximum values, but you do not have control over the random X, Y, and Roll values of the results generated. If this level of control is required, consider using a Custom Vision tool with user-defined logic.

> **Additional Information**: When using this mode, vision tools will display an error "There is no image in the buffer.
>
> **NOTE:** When the Basler Pylon Device is used and Random Instances is selected, the Fixed Pixel calibration will automatically load as the calibration type in the Basler Pylon Device Virtual Camera object.

Use Alternate Device

This setting allows pictures to be obtained from another vision device that is configured in the project (typically an Emulation camera object). Select the alternate vision device with this setting if required.

Images Replay

This setting allows a set of images to be displayed from a specified directory (.hig files only).

Virtual Camera Calibration

Virtual camera calibration is required before vision tools are created to ensure that accurate measurements and locations are acquired. This is a spatial adjustment that corrects for perspective distortion, lens distortion, and defines the relationship between the camera pixels and real-world dimensions in millimeters. There are two methods available for virtual camera calibration as described below.

> **Additional Information**: You should calibrate the camera before you create any vision tools.
>
> **NOTE:** The offset of the camera from the robot or other equipment is not part of this calibration. That information is obtained during the robot-to-camera calibration. Refer to Camera Calibration on page 295 for more information.

Access the camera calibration in the Virtual Camera's editor that is associated with the camera device. An example is provided below.

- Click the **Add** Button to begin the calibration procedure. Use the **Delete** Button to remove a previous calibration.
- Click the **Load** Button to load a previously saved calibration. Click the **Save** Button to save an existing calibration to the PC.
- Click the **Calibrate** Button to adjust an selected calibration.

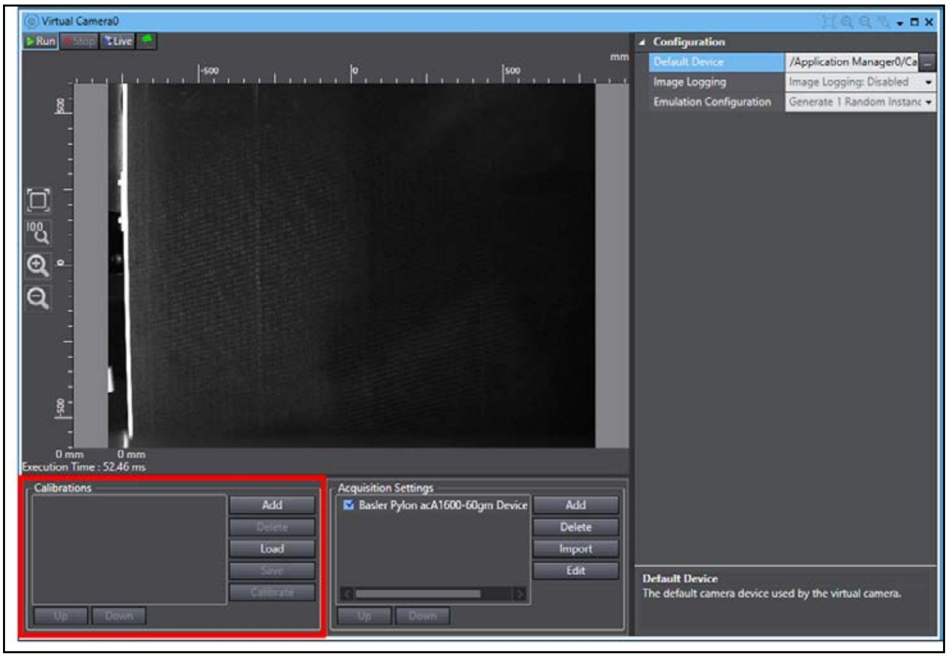


Figure 8-46 Standalone Calibration Area

Grid Calibration Method

You can use a grid with known spacing to calibrate the camera. Sample dot target files are provided with the ACE software installation. Find these in the default installation directory with the following file names:

- DotPitchOthers_CalibrationTarget.pdf
- DotPitch10_CalibrationTarget.pdf

NOTE: The sample target is intended for teaching purposes only. It is not a genuine, accurate vision target.

IMPORTANT: Because any error introduced into the vision system at this calibration will be carried into all following calibrations, the target should be as accurate as possible. Commercially available targets can be acquired through third parties such as Edmund Optics or Applied Image Inc.

Creating a Dot Target

Dot targets are commercially available, but you can also create your own targets by following the guidelines provided below. The quality and precision of a grid of dots target have a direct impact on the overall precision of your application.

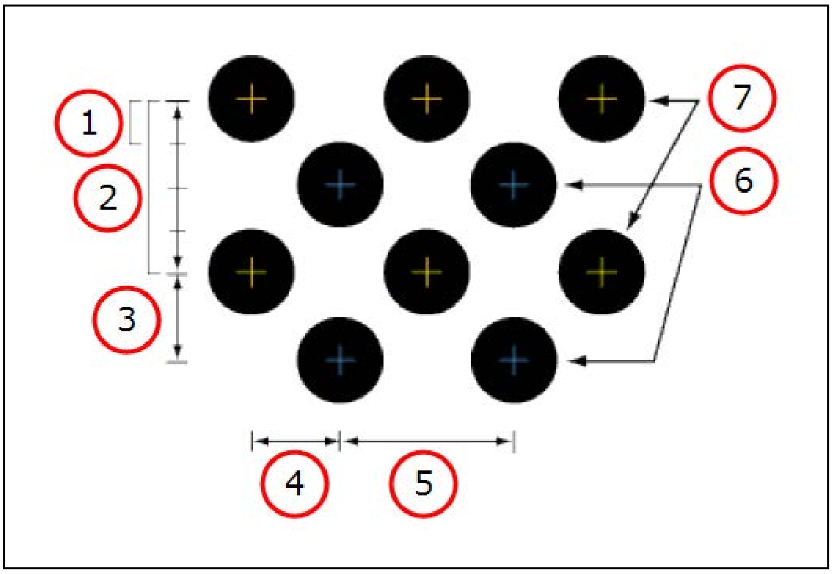


Figure 8-47 Specifications for a Grid of Dots Target

Table 8-8 Grid of Dots Target Description

Item	Description
1	Dot Radius
2	Dot Pitch
3	1/2 Dot Pitch
4	1/2 Dot Pitch
5	Dot Pitch
6	Validation Dots (blue markers)
7	Calibration Dots (yellow markers)

Dot Target Guidelines

- A dot target is made up of a matrix of evenly-spaced, identical calibration dots.
- A secondary matrix of validation dots can be added, offset to the matrix of calibration dots, to validate the calibration process. Although they are not absolutely required, these dots are useful for error calculations.
- Dots in both matrices should be identical in size and have the same dot pitch (the distance between the centers of two dots in the same matrix). Dot pitch must be the same in both X and Y directions.
- The offset between the calibration dot matrix and the validation dot matrix must be 1/2 dot pitch in the X and Y axes.
- Dots should be round and well-contrasted.
- The recommended pitch range is 4 to 12 mm. Dot pitch should be four times the dot radius.

- Dot pitch must be the same in both X and Y axes.
- The target should cover the entire field of view.
- For best results, targets should be of high photo quality on a stable medium, not prin-ted.

NOTE: You should measure the pitch of your dots after printing a grid to confirm that your printer did not change the scale of the grid. If the dots are not exactly the pitch you expect, the camera calibration will be inaccurate.

Additional Information: The dot grid rows and columns must be aligned with the field of view. Ideally after executing the Calibrate func-tion, there should be a uniform distribution of yellow and blue altern-ating dots. A region without blue dots indicates the calibration is not sufficient in that region to predict the location of the validation dots.

With the above concepts in mind, you can use the following steps to create specific dot targets.
Measure the width or height of your FOV by using a ruler inside the camera image in live mode to obtain the length of the FOV. Using the camera manual, take the matching pixel resolution, Then calculate the resulting mm-to-pixel ratio. With this information you can identify the optimal dot pitch and dot radius for your target. As an example, with a 400mm FOV in the horizontal direction and 1600 pixels in the horizontal dir-ection, camera, the calculation for that direction would be:

Dot pitch = (Field of View (mm)/Pixel (count))*36
Dot radius = (Field of View (mm)/Pixel (count))*9

Dot pitch = (400mm / 1600)*36 = 9 mm
Dot radius = (400mm / 1600)*9 = 2.25mm

A standard dot grid with a pitch of 10mm would still be within the scope for accuracy.

Fixed Pixel Calibration Method

Fixed-pixel calibration allows you to specify what physical distance is represented by each camera pixel. All camera pixels will be given the same dimension, which is not necessarily the case with a grid of dots. This method of camera calibration will not correct for lens distortion or perspective.

Acquisition Settings

Acquisition settings are used to view information about the camera and make other image adjustments for vision devices used by the Virtual Camera.

When configuring a Virtual Camera that uses an Emulation Camera, the settings in this area are limited to only gray scale conversion and image selection.

When using a Virtual Camera that uses a vision device such as a Basler camera, you can make several adjustments to the image such as shutter, gain, and exposure along with other camera related settings as described below.

NOTE: The settings in this area will vary depending on the vision device associated with the Virtual Camera.

Information

The Information tab displays the Model, Vendor, and Serial Number of the attached camera. These fields are read-only.

Stream Format

The Stream Format tab lets you set the Pixel Format and Timeout value for the data being sent from the camera.

The available pixel formats will be displayed in the drop-down box when you click the down-arrow (the default selection is recommended).

The Timeout value sets a time limit in milliseconds, after which the vision tool terminates the processing of an image. If the vision tool has not finished processing an image within the allotted time, the tool returns all the instances it has located up to the timeout. Although Timeout can be disabled, it is recommended that you use a Timeout value. This is useful for time-critical applications in which fast operation is more important than the occasional occurrence of undetected object instances. This value is only approximate and the actual processing time may be slightly greater.

Video Format

The Video Format tab lets you set Exposure, Gain, Black Level, and color balance.

Each line displays the minimum allowable value for that property, a bar indicating the current value, the maximum allowable value , and the numeric value of the current level.

Some of the minimum and maximum values, particularly for Gain, will differ depending on the camera being used.

Exposure Adjustment Considerations

The Exposure time setting determines the time interval during which the sensor is exposed to light. Choose an exposure time setting that takes into account whether you want to acquire images of still or moving objects. Adjust Exposure, Gain, and Black Level (in that order) to improve the quality of acquired images with the following considerations.

- If the object is not moving, you can choose a high exposure time setting (i.e., a long exposure interval).
- High exposure time settings may reduce the camera’s maximum allowed acquisition frame rate and may cause artifacts to appear in the image.
- If the object is moving, choose a low exposure time setting to prevent motion blur. As a general rule, choose a short enough exposure time to make sure that the image of the object does not move by more than one pixel during exposure. A shorter exposure time setting may require a higher illumination level.

NOTE: Acquisition parameters are validated before being sent to the camera. If you enter an exposure time that your camera does not support, the time will be adjusted to be valid. If you haven't typed in an invalid exposure time, the left and right arrows will provide valid times.

Gain Adjustment Considerations

Gain is the amplification of the signal being sent from the camera. The readout from each pixel is amplified by the Gain, so both signal and noise are amplified. This means that it is not possible to improve the signal-to-noise ratio by increasing gain. You can increase the contrast in the image by increasing the camera’s gain setting.

Unless your application requires extreme contrast, make sure that detail remains visible in the brightest portions of the image when increasing gain. Noise is increased by increasing gain. Increasing gain will increase the image brightness. Set the gain only as high as is necessary.

Black Level Adjustment Considerations

Black Level is an offset, which is used to establish which parts of an image should appear black. High black level settings will prevent high contrast. Make fine adjustments to the Black Level to ensure that detail is still visible in the darkest parts of the acquired images.

White Balance Considerations

Balance Red, Balance Green, and Balance Blue are only available if you have a color camera connected. On some Basler color cameras, such as the A601fc-2, the green balance is a fixed value that cannot be adjusted. In such cases, only the balance for blue and red will be enabled in this window (***Balance Green*** will be grayed out).

> **NOTE:** It is recommended to consider white balance of the camera when using color camera models. For Basler cameras, this is supported in Pylon Viewer. Refer to Configuring Basler Cameras on page 650 for more information.

Trigger

The Trigger tab lets you enable an external trigger for taking a picture and set parameters that pertain to that trigger.

Most applications will not use trigger mode and the image is taken when requested by the PC, but some applications need to reduce latency in communication. In this type of situation, a trigger signal would be wired directly to a camera input and trigger mode is enabled and configured in the Virtual Camera. A V+ program would execute a VRUN command to execute a Vision Sequence but instead of acquiring an image, it will create the image buffer and wait to receive the image from the camera when it is triggered. A camera exposure active signal could still be used for position latching if necessary.

Other Acquisition Settings Functions

Use the **Add** and **Delete** buttons to add or remove acquisition settings.

The **Import** button opens a selection window to copy acquisition settings from another Virtual Camera in the ACE project.

The **Edit** button opens a window for changing acquisition settings for the selected device.

Use the **Up** and **Down** buttons to arrange multiple acquisition settings in a specific order.

Emulation Cameras

An Emulation Camera is a stored collection of images, which the ACE software can treat as if they were coming from a physical camera. Emulation Cameras are mostly used in Emulation Mode when a camera is not available or when viewing images from another application.

Emulation Cameras require imported images to be the same size (pixel X by Pixel Y) and format (color vs mono). Emulation Cameras should be used with limited quantities of images because they directly impact the size of projects. If a large quantity of images must be used, it is advisable to use Image Replay and provide a directory of logged images.

Since there are no .hig image file viewers, Emulation Cameras can be used to import logged .hig images and export those images as other common formats for viewing with other software (.jpg, .png, etc).

> **NOTE:** Emulation Camera acquisition settings in the Virtual Camera allow color-to-gray scale conversion for convenience.

Add an Emulation Camera

To add an Emulation Camera, right-click **Cameras**, select **Add**, and then click **Emulation Camera**. The Create Emulator Device window will open.

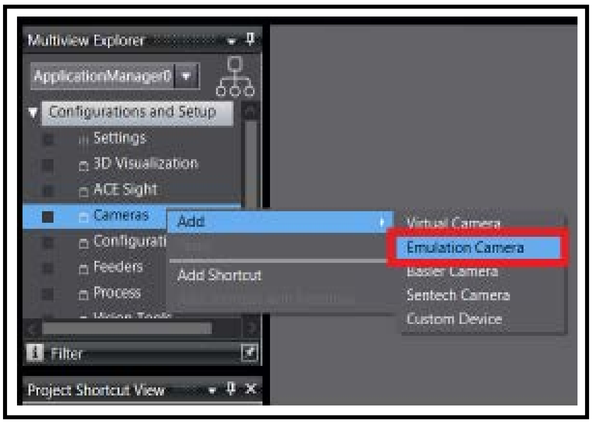


Figure 8-48 Add an Emulation Camera

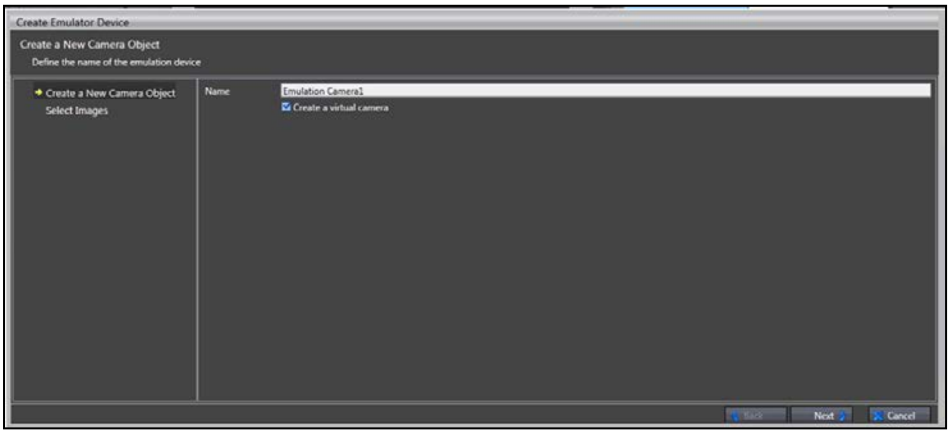


Figure 8-49 Create Emulator Device (Camera)

Provide a name for the Emulation Camera and make a selection for creating a Virtual Camera associated with this device. Then, click the **Next** Button and use the **Add** Button to load images to be used with this device. Click the **Finish** Button when all images are added and then the Emulation Camera (and Virtual Camera) object will be added to the ACE project.

> **NOTE:** After the Emulation Camera object is created, you can rename the new Emulation Camera object by right-clicking the item and selecting **Rename**.

Emulation Camera Configuration

To access the Emulation Camera configuration, right-click the object in the Multiview Explorer and then select **Edit**, or double-click the object. This will open the Emulation Camera editor in the Edit Pane.

The Emulation Camera Configuration allows you to manage all images used for this device. The order of the added images will be used in the associated Virtual Camera during subsequent image acquisition.

Use the table below to understand the Emulation Camera configuration items.

> **NOTE:** When adding images, image files must be of the same type (color vs. monochrome) and the same size.

Table 8-9 Emulation Camera Configuration Item Description

Item	Description
Add / **Delete** Buttons	Use these buttons to add or remove images.
Export Button	Use this button to export images from the Emulation Camera to files on the PC.
Source Button	Use this button to add images from another camera source within the ACE project.
Move Buttons	Use the move buttons to arrange the images in a specific order.
File Menu - Load from Database	Load a collection of images from an emulation database file (.hdb).
File Menu - Save All To Database	Save a collection of images to an emulation database file (.hdb).
File Menu - Sort Images	Sort images in alphabetical order by file name.

When working with a 3D emulation camera, you can import an image from a 3D vision source. Conversely, in the 3D emulation camera, you also have the ability to export a 3D image.

Basler and Sentech Cameras

Basler and Sentech Cameras are physical devices that are used for image acquisition. These devices use Basler Pylon and Sentech devices drivers, respectively.

Additional Information: Basler Cameras are typically configured using the Basler Pylon utilities installed with ACE software. Refer to Configuring Basler Cameras on page 650 for more information. The configuration is done for Sentech Cameras with the ST utilities. Refer to Configure Network and Camera Settings on page 662for more information.

A camera object stores information necessary for communicating with a physical camera, such as the Device Friendly Name, Model, Vendor, and Device Full Name for identifying devices when communicating through the drivers.

Adding a Camera

To add a camera object, right-click **Cameras**, in Multiview Explorer and select **Add**, and then click either **Basler Camera** or **Sentech Camera**. The Create Device wizard will appear to step through the addition procedure.

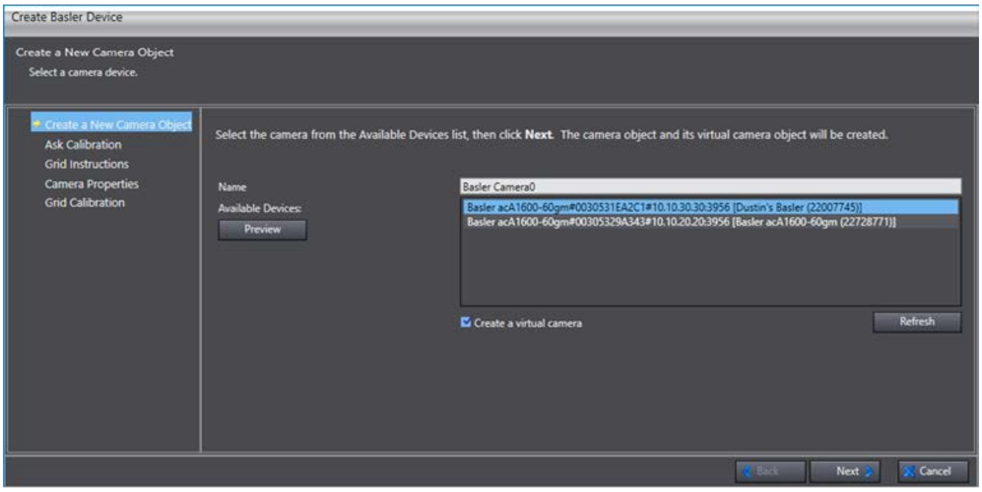


Figure 8-50 Create Camera Device Wizard (Basler shown)

NOTE: After the Camera object is created, you can rename the new Camera object by right-clicking the item and selecting **Rename**.

Camera Object Configuration

The camera configuration will vary depending on the camera type, Basler or Sentech, added to the ACE project, but configuration follows the steps below.

1. Create a New Camera Object: This is where the user selects the camera that will be linked to the camera object. As shown in Camera Object Configuration Editor (Basler shown) on page 325, the wizard shows all accessible cameras to which the created object can connect. Clicking the **Preview** Button will display the current camera image. The object name can also be adjusted. It is recommended to check the box next to “Create a virtual camera” or this will have to be done later. The box is checked by default.

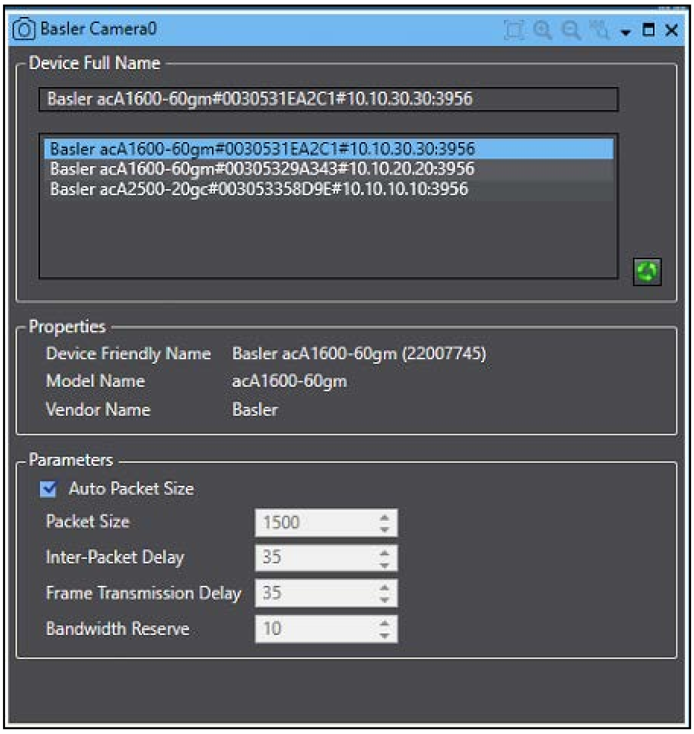


Figure 8-51 Camera Object Configuration Editor (Basler shown)

2. Ask Calibration: The wizard will ask the user to choose to calibrate now or later. Choosing to calibrate later and clicking the **Next** button will skip the last three steps and close the wizard.
3. Grid Instructions: This step displays the instructions for grid calibration. Refer to Virtual Cameras on page 312for more information.
4. Camera Properties: The image is from the camera is displayed in this. The user can click the **Edit** Button to modify the camera settings.
5. Grid Calibration: The image is calibrated with the grid. Set the appropriate values in the settings and click the **Finish** Button to close the wizard.

Once the camera object has been created, it can be opened edited like any other object in the Multiview Explorer.

FH Camera

FH series cameras are primarily used for visual inspection. The cameras use pre-built, packaged processes that contain all the tasks (for image input, measurement processing, displays, outputs, etc.) that are required for vision inspections. The order of these tasks are called flows. Users arrange these packaged processes to make measurement flows within the order needed for the vision inspection.

The FH camera executes the vision inspections according to user-created flows developed with the TDM Editor and ACE.

Adding an FH Camera

To add an FH camera you need to first set up the viewed scene with the Location Array, Location Tool and Output. Once done this step, you use the ACE FH Tool to configure ACE to communicate with the FH camera. Finally, you calibrate the camera through ACE. See "Configuring FH Cameras" for more information.

Custom Devices

The Custom Device object is a C# program that executes at the level of a camera object and can be used to acquire an image from any camera device or external vision system. It can also be used to manipulate image data from one Virtual Camera's image buffer before input to a second Virtual Camera that is linked to a Vision Sequence.

A C# program template will be created when the Custom Device is added to the ACE Project.

Adding a Custom Device

To add a Custom device, right-click **Cameras**, select **Add**, and then click **Custom Device**. A new Custom Device will be added to the Multiview Explorer. Use this object to access the C# program associated with the device.

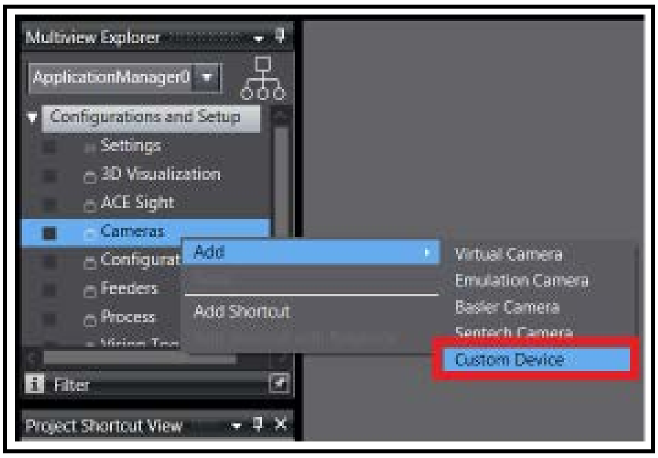


Figure 8-52 Add a Custom Device

NOTE: After the Custom device object is created, you can rename the new Custom device object by right-clicking the item and selecting **Rename**.

8.4 Configuration

Various configuration objects can be added to the ACE project for different control, setup, and other functions. Use the information in this section to understand the functions of the Configuration objects.

Controller Connection Startup

The Controller Connection Startup item is used to establish a connection, monitor, and maintain the connection to one or more controllers upon the startup of the ACE project. It can also be configured to start a V+ program on a specified task number upon startup.

When the Controller Connection Startup object is configured, opening the ACE project will automatically initiate a connection to a controller and program execution, once the connection is fully established.

> **NOTE:** Although the Controller Connection Startup function and the Auto Start function share some similarities, the startup file for the Controller Connection Startup function is stored on the PC whereas the Auto Start function files are stored on the controller. This allows the Auto Start function to provide a head-less (no PC required) operation of the application. Refer to Configure on page 205 for more information.

Adding a Controller Connection Startup Object

To add a Controller Connection Startup object, right-click **Configuration**, select **Add**, and then click **Controller Connection Startup**. A new Controller Connection Startup object will be added to the Multiview Explorer.

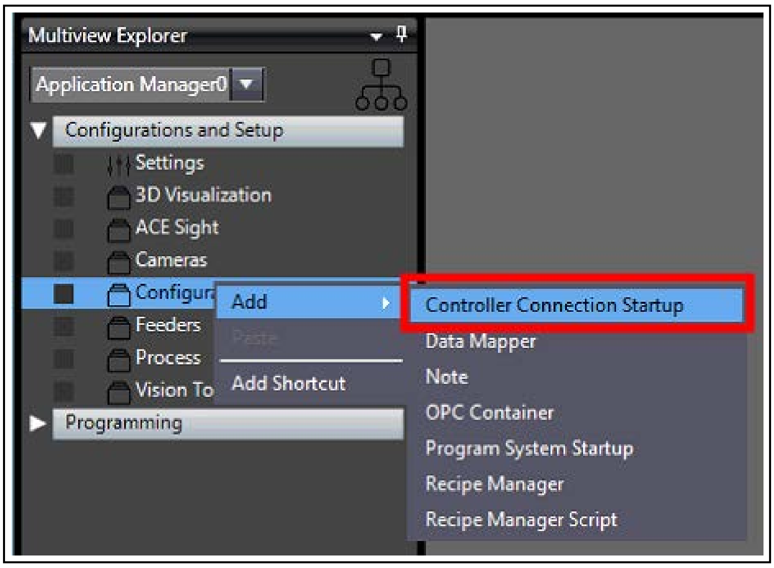


Figure 8-53 Adding a Controller Connection Startup Object

> **NOTE:** After the Controller Connection Startup object is created, you can rename the new Controller Connection Startup object by right-clicking the item and selecting **Rename**.

Controller Connection Startup Configuration

To access the Controller Connection Startup configuration, right-click the object in the Multiview Explorer and then select **Edit**, or double-click the object. This will open the Controller Connection Startup editor in the Edit Pane.

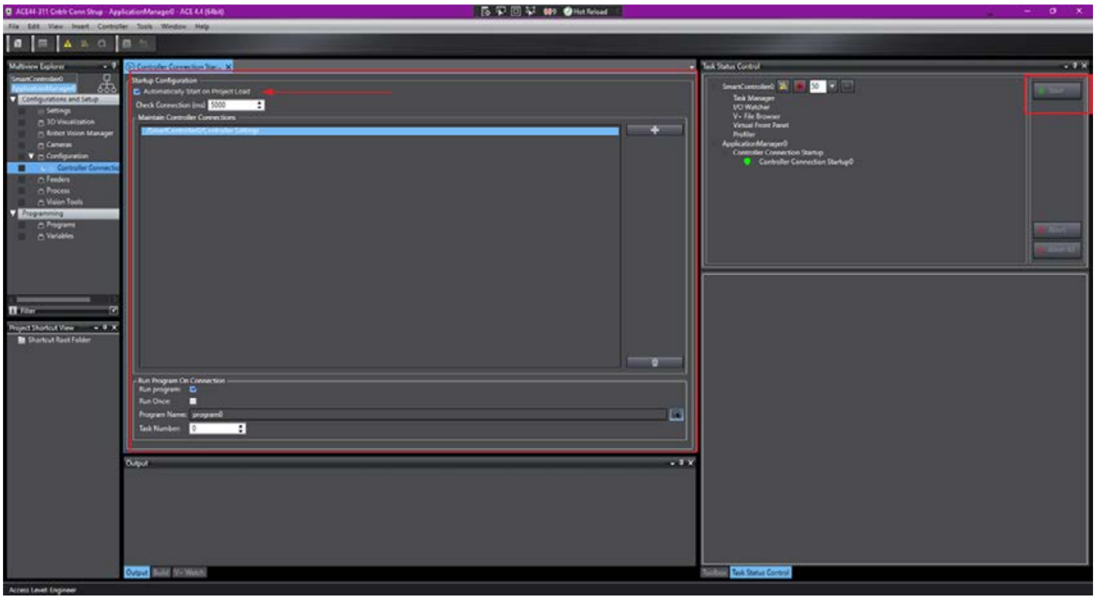


Figure 8-54 Controller Connection Startup - Configuration

When the *Automatically Start on Project Load* check box is selected, the *Start* button is disabled, as shown above in the top right of the figure. You cannot modify the Controller Connection when it is loaded and running. Use the table below to understand the Controller Connection Startup configuration items.

Table 8-10 Controller Connection Startup Configuration Item Description

Group	Item	Description
Startup Configuration	Enable Startup Object	Enable or disable the function of the Controller Connection Startup object when the ACE project is opened.
	Add / **Delete** Buttons	Add or remove controllers to/from the Maintain Controller Connections list. You can only add a controller that already exists in the ACE project. You cannot create a new controller connection here.
	Check Connection (ms)	Specifies the interval in milliseconds for checking the connections to the controllers specified on the Maintain Controller Connections list.
	Maintain Controller Connections	Displays a list of controller connections being monitored.
Run Program on	Run program	Select to enable a specified V+

Group	Item	Description
Connection		program to run when the selected controller is connected.
	Run Once	When selected, the specified program will be run one time when ACE is first connected to the controller. It will not re-run when disconnected and reconnected. If the program needs to run again, you will need to shutdown ACE and restart it.
	Program Name	Specifies the program to run when the selected controller is connected.
	Task Number	Specifies the V+ task number for the V+ program. The specified V+ task number must be idle. Otherwise, the program will not run on connection.

Data Mapper

The Data Mapper provides a method to associate different data items within the ACE project. For example, you can trigger a Process Manager object to run when a digital input signal turns on. Any data items that are associated in the Data Mapper will be continuously checked while the ACE project is open.

Adding a Data Mapper Object

To add a Data Mapper object, right-click **Configuration**, select **Add**, and then click **Data Mapper**. A new Data Mapper object will be added to the Multiview Explorer.

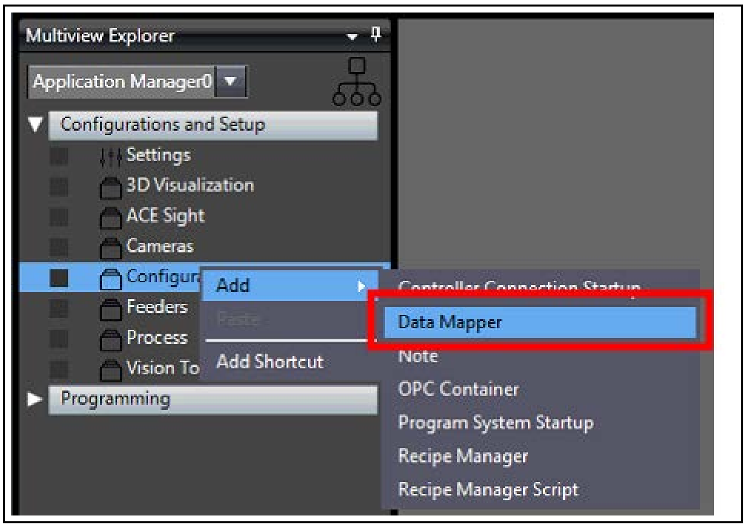


Figure 8-55 Adding a Data Mapper Object

NOTE: After the Data Mapper object is created, you can rename the new Data Mapper object by right-clicking the item and selecting **Rename**.

Data Mapper Configuration

To access the Data Mapper configuration, right-click the object in the Multiview Explorer and then select ***Edit***, or double-click the object. This will open the Data Mapper editor in the Edit Pane.

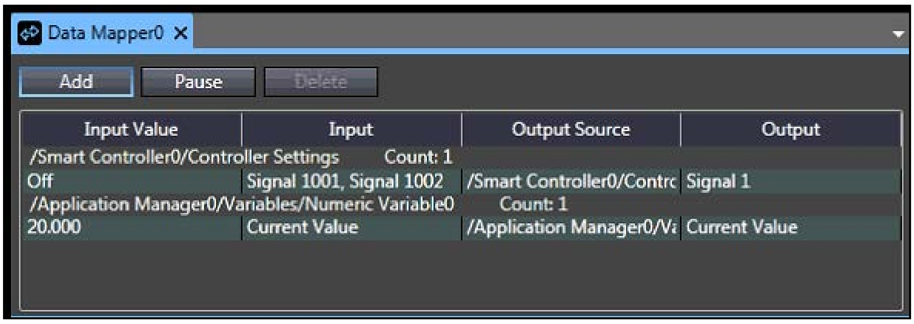


Figure 8-56 Data Mapper Editor

Data Mapper Editor Buttons

Use the Data Mapper Editor buttons to add, delete, and pause/run Data Mapper items.

Pausing a selected Data Mapper item will prevent it from executing. Click the **Run** Button to resume a paused Data Mapper item.

Data Mapping

When the **Add** Button is clicked in the Data Mapper editor, an Edit Data Map Dialog Box will open. This is used to create and edit Data Mapping items. The Data Mapping configuration is described below.

To edit an existing Data Mapper item, double-click the item in the Data Mapper list to access the Edit Data Map Dialog Box.

> **Additional Information**: The Data Mapping input and output items that are available depend on the objects present in the ACE project.

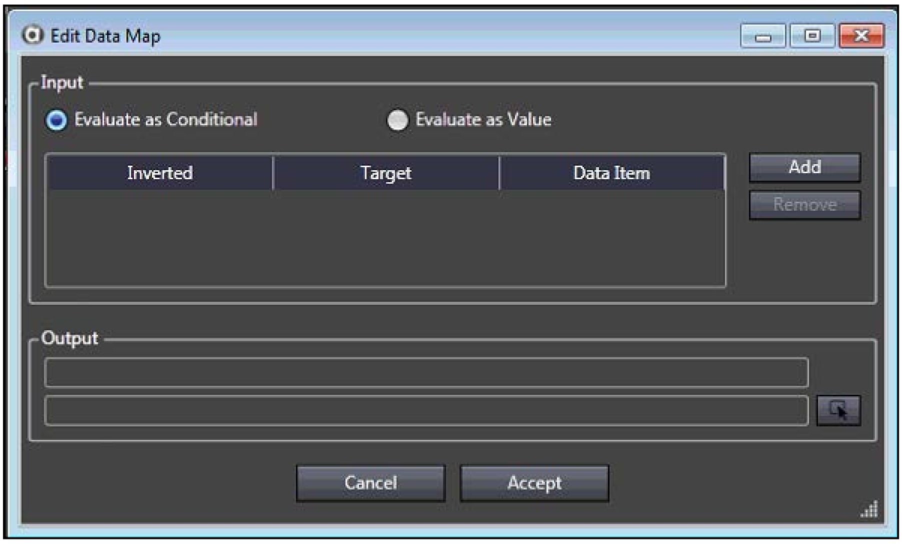


Figure 8-57 Edit Data Map

Evaluate as Conditional

When **Evaluate as Conditional** is selected, the Data Mapper will interpret all input conditions as a Boolean item. If the value of the input item is 0, the condition is considered OFF. If the value is non-zero, the condition is considered ON. If all items in the input list are ON, then the output condition is asserted. If any item in the input list is OFF, the output condition is not-asserted.

Additionally, when Evaluate as Conditional is selected, you can invert the expected value of an input item. In that case, if the value is 0, the condition is considered to be ON.

Evaluate as Value

When Evaluate as Value is selected, the value of all input conditions are added together and written to the output value.

Note Object

The Note object provides a means for creating documentation within an ACE project. Use this object to create detailed notes for future reference.

Adding a Note Object

To add a Note object, right-click ***Configuration***, select **Add**, and then click **Note**. A new Note object will be added to the Multiview Explorer.

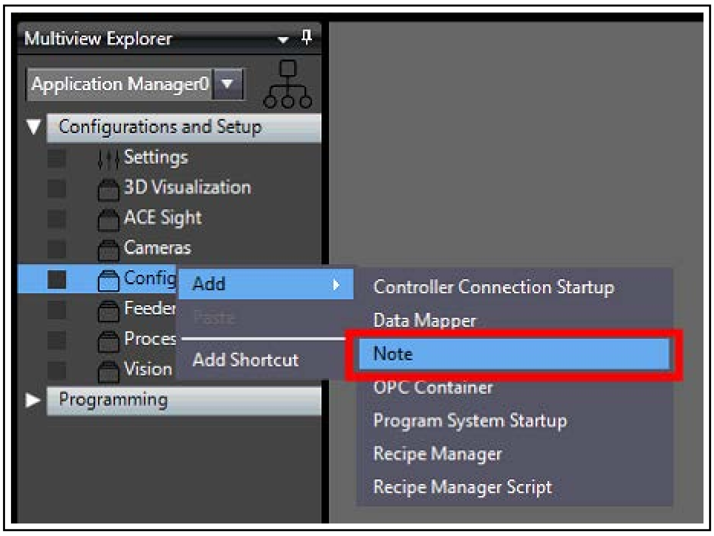


Figure 8-58 Adding a Note Object

NOTE: After the Note object is created, you can rename the new Note object by right-clicking the item and selecting **Rename**.

Note Editing

To access the Note object for editing, right-click the object in the Multiview Explorer and then select **Edit**, or double-click the object. This will open the Note editor in the Edit Pane.

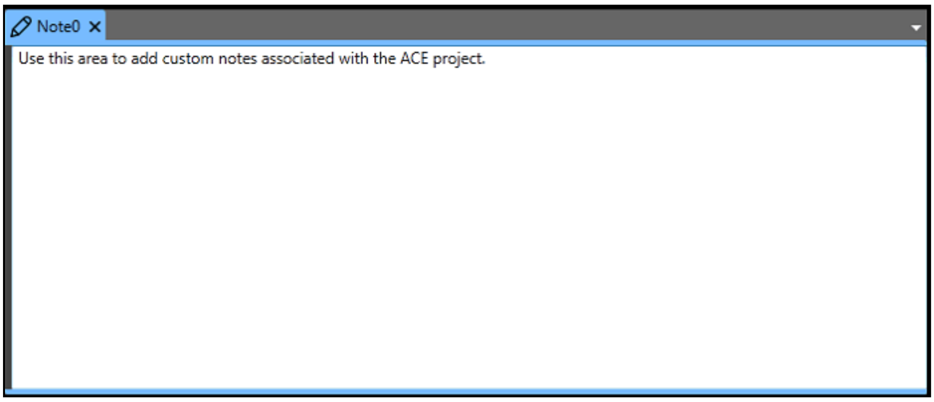


Figure 8-59 Note Editor

OPC Container

The purpose of an OPC container is to provide a standardized infrastructure for the exchange of process control data that accommodates different data sources, connections, and operating systems.

OPC stands for Object Linking and Embedding (OLE) for Process Control. It uses Microsoft's Component Object Model (COM) and Distributed Component Object Model (DCOM) technology to enable applications to exchange data on one or more computers using a client/server architecture.

OPC defines a common set of interfaces which allows various applications to retrieve data in exactly the same format regardless of whether the data source is a PLC, DCS, gauge, analyzer, software application, or anything else with OPC support. The data can be available through different connections such as serial, Ethernet, or radio transmissions for example. Different operating systems such as Windows, UNIX, DOS, and VMS are also used by many process control applications.

The OPC protocol consists of many separate specifications. OPC Data Access (DA) provides access to real-time process data. Using OPC DA you can ask an OPC server for the most recent values of anything that is being measured, such as flows, pressures, levels, temperatures, densities, and more. OPC support in ACE software is limited to the DA specification.

For more information on OPC, please see the OPC Foundation website at the following URL:

https://www.opcfoundation.org

An OPC container can be configured for the following functions.

- Communicate values of V+ Global Variables and Process Manager statistics.
- Start or stop a process within an ACE application.

OPC Test Client

An OPC test client is included with the ACE software installation. Refer to OPC Container on page 332 for more information.

Adding an OPC Container

To add an OPC Container object, right-click **Configuration**, select **Add**, and then click **OPC Container**. A new OPC Container object will be added to the Multiview Explorer.

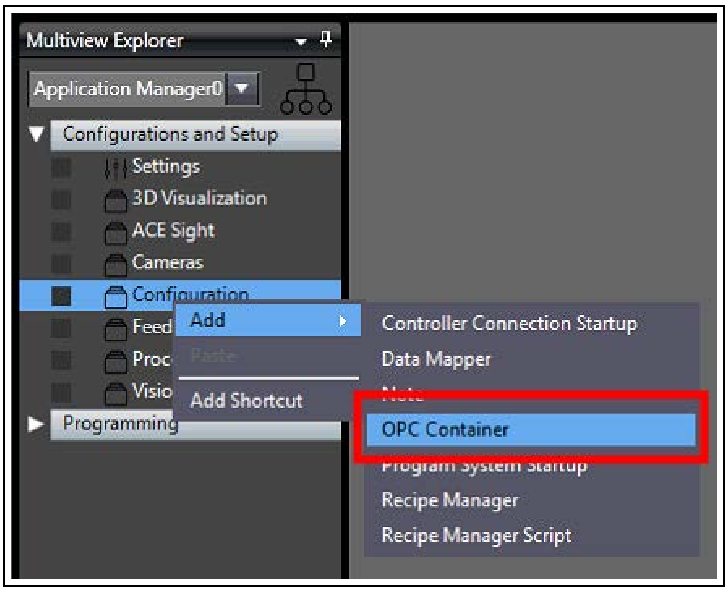


Figure 8-60 Adding an OPC Container Object

NOTE: After the OPC Container object is created, you can rename the new OPC Container object by right-clicking the item and selecting **Rename**.

OPC Container Configuration Procedure

Use the following procedure to configure an OPC Container object.

> **NOTE:** Depending on the ACE project configuration, the items available in the Data Item Selection list will vary. The procedure below has one robot configuration that was generated using a Robot Vision Manager Application Sample with a fixed pick and a fixed place arrangement.

1. To access the OPC Container configuration, right-click the object in the Multiview Explorer and then select **Edit**, or double-click the object. This will open the OPC Container editor in the Edit Pane.

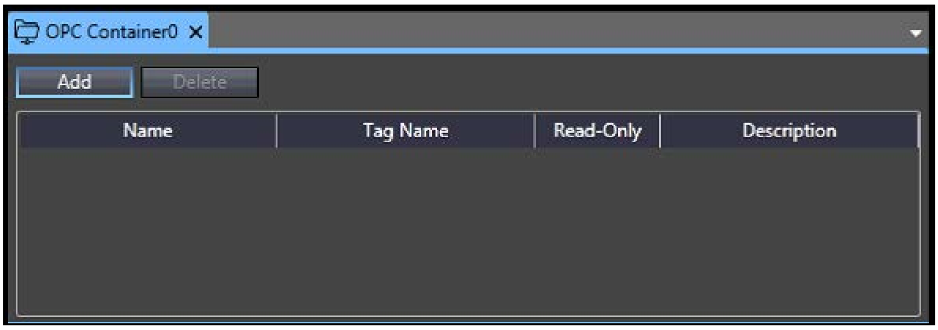


Figure 8-61 OPC Container Editor

2. Click the **Add** Button to select a Data Item. The Data Item Selection Dialog Box will appear.

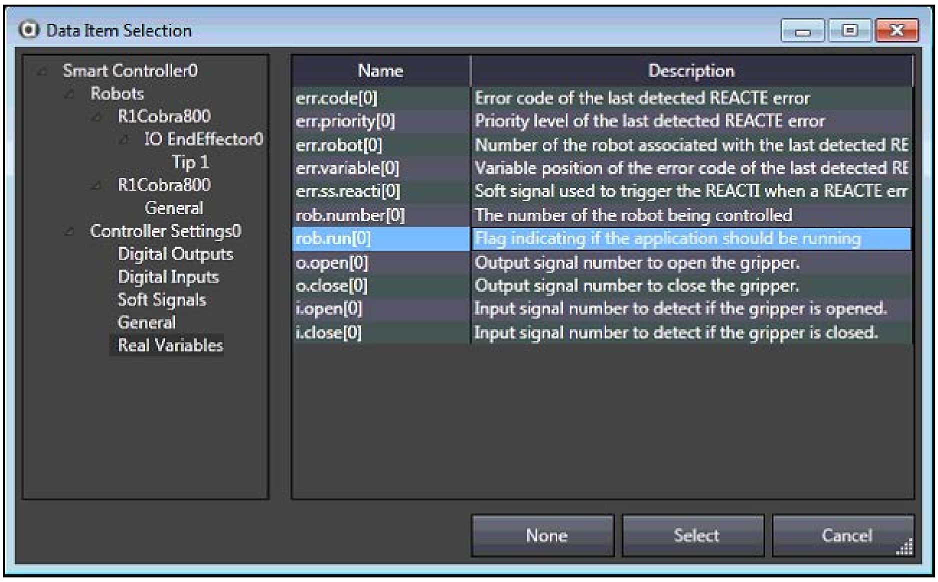


Figure 8-62 Data Item Selection

3. Select an item from the list and then click the **Select** Button. The item will be added to the OPC Container publish list in the Edit Pane.

Figure 8-63 OPC Container Publish List

4. Make a selection for the **Read-Only** option. If checked, an external OPC client cannot write to the item. If the Read-Only option is not checked, the OPC client has access to read and write the item's value.
5. Once all items have been added to the OPC Container publish list, the OPC client can be configured as shown in the next steps. Run the SOClient.exe file found in the default ACE installation directory (C:\Program Files\OMRON\ACE 4.X\OPC Test Client).
6. Select the OPC Server Tab and then expand the Local item to expose all Data Access items.

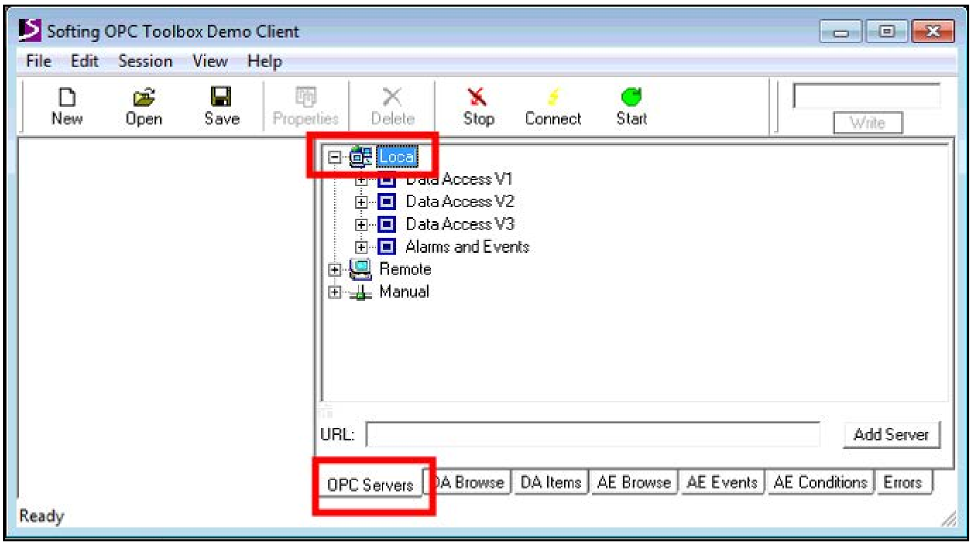


Figure 8-64 OPC Servers - Local Items

7. Expand a Data Access item to show the Adept OPC Server item and then double-click it to add it in the left window pane. You can also right-click the Adept OPC Server item and then select **Add Server**.

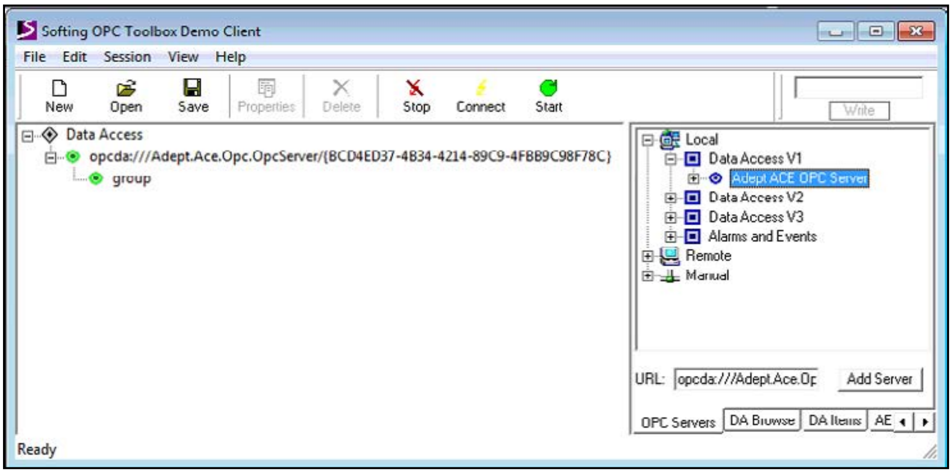


Figure 8-65 Add Adept OPC Server

8. Select the **DA Browse** tab and then right-click the server on the right window and select **Add Items for all Tags**. This will add all associated tags to the server in the left window.

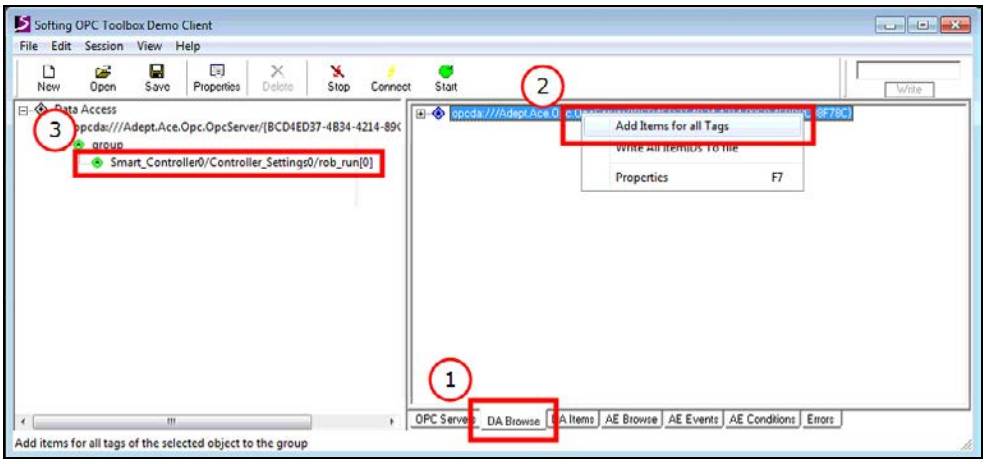


Figure 8-66 Add Items for all Tags

9. Select the **DA Items** tab to see the item's value and other related information.

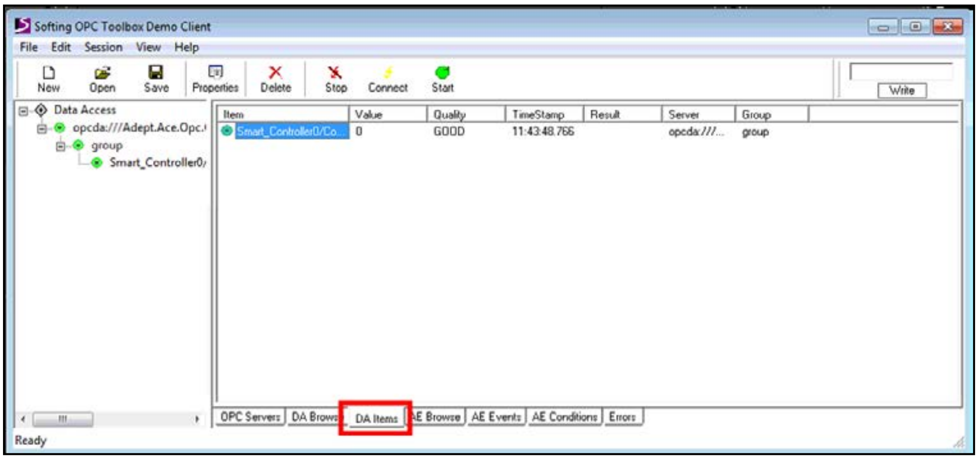


Figure 8-67 DA Items Tab

The Quality column indicates that the communication with the OPC DA server worked normally ("GOOD" indicates successful communications).

The TimeStamp column indicates the last update time of the tag.

10. Tags that were configured with the Read-Only selection unchecked can be modified with the OPC client. To change the value from the OPC client, right click the tag and select **Write**. The dialog box below will appear. Enter a new value and then click the **Write** button to change the value in the ACE application.

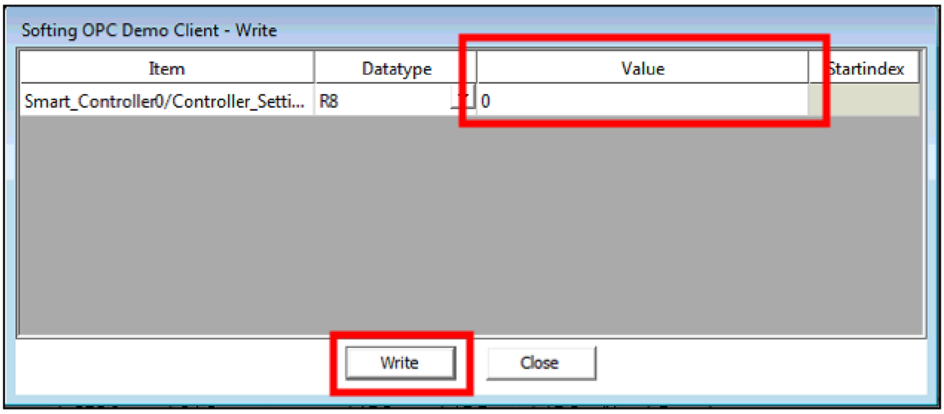


Figure 8-68 Write a New Value

11. Values that have been updated from the ACE application can be verified using the read function in the OPC client. Right-click the tag and select **Read** to update values in the OPC client.

    If the values are updating correctly, the configuration procedure is complete.

Add or Delete Items to Publish on OPC DA

Use the **Add** button to add a new item to publish on OPC DA. Use the **Delete** button to remove a selected item from the list.

Program System Startup

The Program System Startup object is used to specify a C# program to run when the ACE project opens.

> **NOTE:** Although the Program System Startup function and the Auto Start function share some similarities, the startup file for the Program System Startup function is stored on the PC whereas the Auto Start function files are stored on the controller. This allows the Auto Start function to provide a headless (no PC required) operation of the application. Refer to Configure on page 205 for more information.

Adding a Program System Startup Object

To add a Program System Startup object, right-click **Configuration**, select **Add**, and then click **Program System Startup**. A new Program System Startup object will be added to the Multiview Explorer.

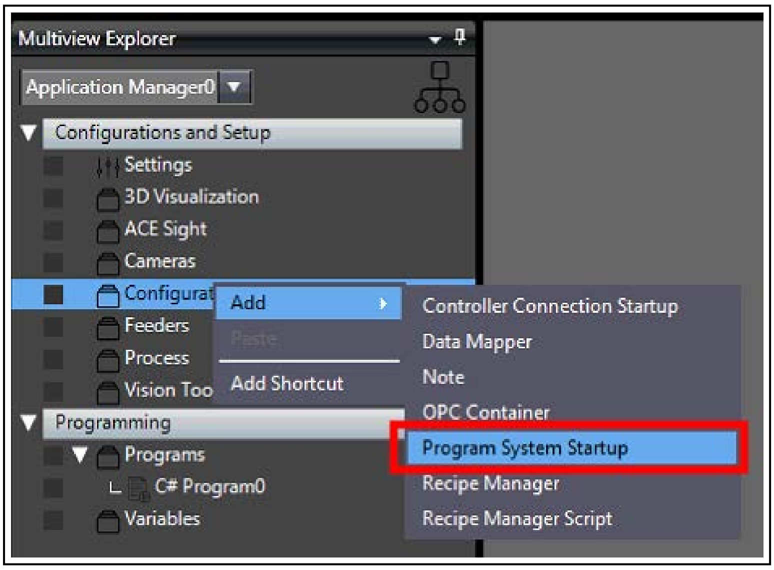


Figure 8-69 Adding a Program System Startup Object

> **NOTE:** After the Program System Startup object is created, you can rename the new Program System Startup object by right-clicking the item and selecting **Rename**.

Program System Startup Configuration

To access the Program System Startup configuration, right-click the object in the Multiview Explorer and then select **Edit**, or double-click the object. This will open the Program System Startup editor in the Edit Pane.

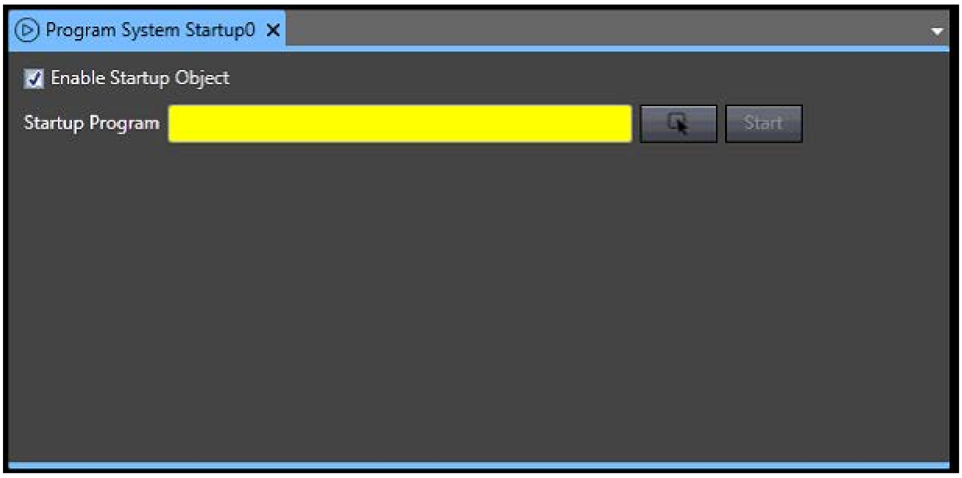


Figure 8-70 Program System Startup Editor

Use the **Selector** button () to make a startup C# program selection.

Uncheck the **Enable Startup Object** option to disable the object.

Use the **Start** button (
) to manually test the Program System Startup object.

Recipe Overview

Manufacturing processes often require frequent product changeover resulting in the need for changes to variable values, vision models, vision tool parameters, pallet layouts, motion parameters, process definitions, motion offsets, and more. The ACE software provides a Recipe Manager that simplifies the complex process of saving and restoring large amounts of data to minimize downtime during frequent product changeover.

There are three steps for recipe management in the ACE software, as described below.

Recipe Definition

Recipe definition involves selecting which objects will be the Sources of recipe data. Sources are similar to ingredients of a traditional cooking recipe. A recipe will contain a copy of the data for each Source. Recipes can only store data of objects that are defined as Sources in the Recipe Manager edit pane. All other objects will have common parameters for all recipes. When a recipe is created, it will contain a copy of the data that is currently present in the Source objects. This can significantly reduce the number of objects that must be created and maintained.

For example, consider a situation where a camera is used to locate a product to be packaged. In this example, the system can process five different types of products, but only one product type at a time. Rather than creating five Locator Models and five Locators, you would create one Locator and one Locator Model, add each as a source, and create five recipes containing the Model data and Locator parameters optimized for each product type. Alternatively, if two types of product must be recognized by the same Locator, you could have two Locator Model objects and include both as sources.

Recipe Creation and Modification

After the recipe Sources have been defined in the Recipe Manager Edit Pane, recipes can be created in the Recipe Manager section of Task Status Control.

NOTE: Typically, a system should be sufficiently optimized for one product before creating recipes. This minimizes the amount of parameters in Source objects that need to be individually edited in each recipe. Although this is recommended, it is not mandatory.

Task Status Control provides a Recipe Editor that can be used to edit the parameters of all Source types that are commonly modified by operators. When a recipe is selected, the entire ACE software interface becomes the editor for the active recipe. The Recipe Editor does not provide an editor window for all Sources. For example, if a Process Manager is a source for a recipe, it will not be visible in the Recipe Editor, however the Process Manager edit pane can be used to make modifications to all Process Manager parameters for the selected recipe.

IMPORTANT: It is important to recognize that if changes are made to objects that are Sources in a recipe while no recipe is selected, when a recipe is selected, those changes may be lost. Be sure to always use the Recipe Editor or select a recipe before making changes to recipe Source objects.

Refer to Recipe Editor on page 344 for more information regarding creating, modifying, and deleting recipes.

Recipe Selection

Recipe Selection is a single item selection process for applying the parameters stored in the recipe to the Source objects.

Once all recipes have been defined and optimized you may want to automate the recipe selection process so that it does not need to be performed from Task Status Control. This can be achieved using a V+ program and Robot Vision Manager, or C# program.

When a Recipe is selected, the parameters saved in the Recipe are applied to the ACE project. All V+ variables will be set to the corresponding values. All vision tool and feeder properties will be copied into the appropriate sources in the ACE project.

Use the information in the following sections to understand the configuration of recipe managerment.

Recipe Manager

The Recipe Manager is used to define all sources that will be used when creating individual recipes. You must add sources to the Recipe Manager before creating a Recipe. A recipe is a dedicated object that is added to Application Manager.

The following objects in an ACE project can be used as sources for the Recipe Manager.

Table 8-11 Recipe Configuration Objects and Descriptions

Item	Description
V+ Variables	Specify V+ Variables to be included in a recipe. You can identify how the variable is displayed to the user and what access level a user will have.
Vision Tools	All vision tools can be accessed with the Recipe Manager, except the following tool types. • Calculation Tools • Image Process Tools

Item	Description
	• Custom Tools
Virtual Camera	Specify Virtual Camera object data to be included in a recipe.
AnyFeeder	Specify AnyFeeder object data to be included in a recipe.

Adding a Recipe Manager Object

To add a Recipe Manager object, right-click **Configuration**, select **Add**, and then click **Recipe Manager**. A new Recipe Manager object will be added to the Multiview Explorer.

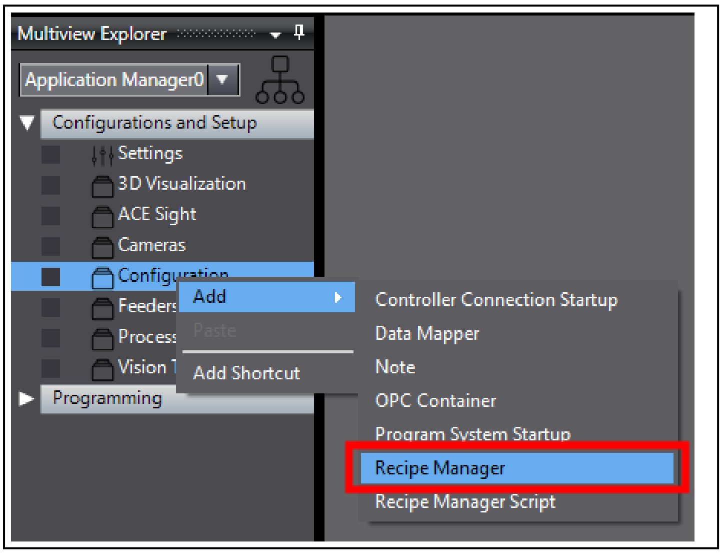


Figure 8-71 Adding a Recipe Manager Object

NOTE: After the Recipe Manager object is created, you can rename the new Recipe Manager object by right-clicking the item and selecting **Rename**.

Additional Information: You can drag and drop a Recipe Manager object into a C# program. Refer to RecipeManager Topics in the *ACE Reference Guide* for more information.

Recipe Manager Configuration

To access the Recipe Manager configuration, right-click the object in the Multiview Explorer and then select **Edit**, or double-click the object. This will open the Recipe Manager editor in the Edit Pane, shown in the center of the following figure.

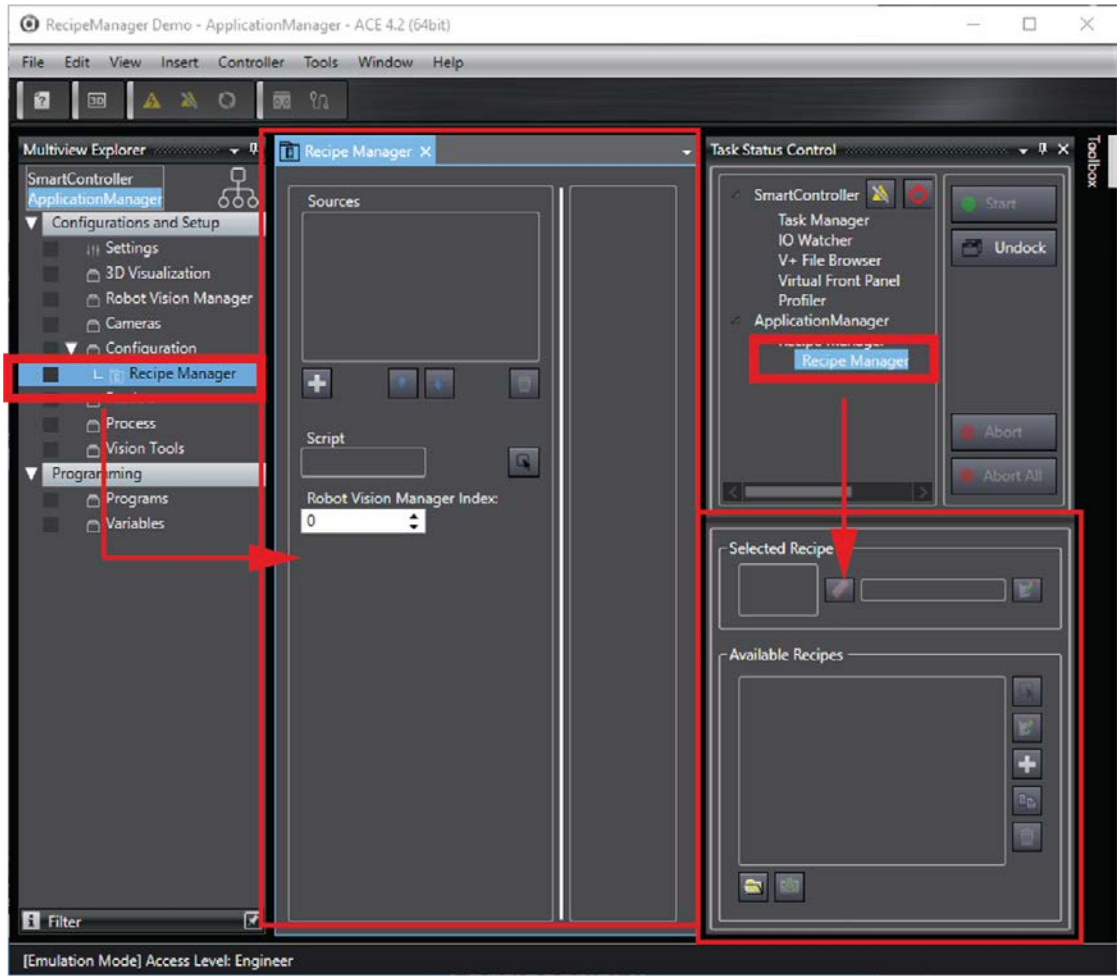


Figure 8-72 Recipe Manager Configuration

You can also open the Recipe Object by selecting it in the Task Status Control, which is shown on the right side of the above figure.

Sources

The Sources area displays a list of all active sources available for Recipe creation and editing. Use the **Add** button () and **Remove** button () to build a list of sources for use in Recipe creation. The **Up** and **Down** buttons () change the order of the items in the list and order of these items in the tabs of the Recipe Editor. Place frequently used items near the top of the list.

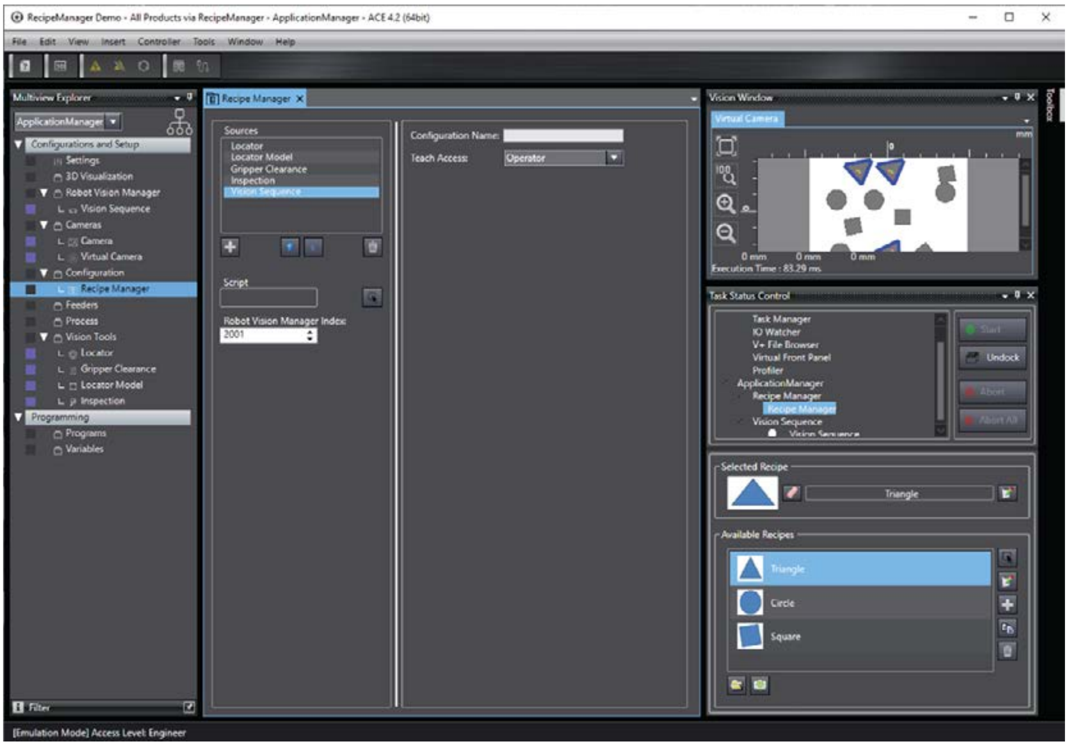


Figure 8-73 Recipe Manager Sources List

When a data source is added to the Sources list, you can select it to display the settings in the configuration window. Configuration window options will vary based on the Source type selected. All Source types include settings for the following items.

- Configuration Name - Provide a unique name for the Source. This is the name that is displayed in the Recipe Editor.
- Teach Access - You can restrict write access to Recipe Manager sources by setting user access levels. Refer to User Management on page 138 for more information.

V+ Variable Sources

When configuring a V+ Variable Source in the Recipe Manager, you must add individual variables in the configuration area. Use the **Add** button ( ) and **Remove** button ( ) to make a list of V+ Variables that will be used in individual Recipes.

Each type of variable contains different properties that affect how the variable is presented to the you in the Recipe Editor. For example, you can define unique display names and access levels. To access the V+ Variable Recipe attributes, make a Variable selection and then adjust its properties as shown below.

V+ Variable values must be edited in the recipe component directly with the Recipe Editor or a C# program. These values are used to initialize V+ Variables when the recipe is selected, but the V+ variable values may change while the recipe is active (without it being stored in the recipe).

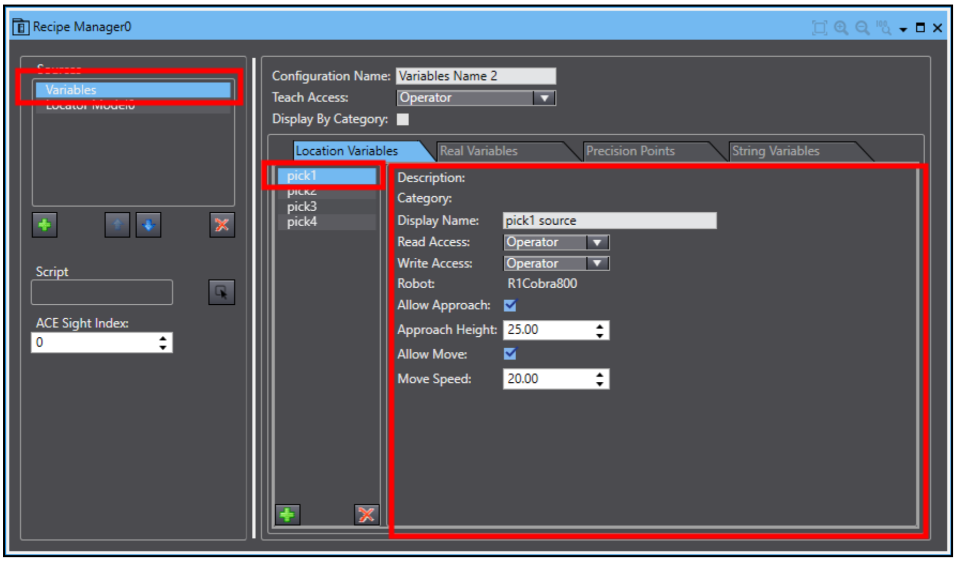


Figure 8-74 Modifying V+ Variable Attributes for Recipes

Vision Tool Sources

Finder, Inspection, and Reader vision tools can be added to a Recipe configuration. For each Recipe you create, a copy of the vision tool will be saved with each Recipe.

When a Recipe is selected with a vision tool, it is linked with the vision tool object in the ACE project that they correspond to. When a vision tool included in the Recipe configuration is modified in the ACE project object, the selected recipe copy of the vision tool is automatically updated. Likewise, when the vision tool is modified in the Recipe Editor, the ACE project vision tool object is automatically updated. Because of this linking between the Recipe and ACE project object, you can configure a vision tool object and it will be saved with the active Recipe.

The Recipe Editor will vary depending on the vision tool object in use. Typically, the Recipe Editor is only a small subset of vision tool object's properties. Refer to Recipe Editor on page 344 for more information.

Recipe Script Selection

Select a Recipe Script object created with the Recipe Manager Script editor. Refer to Recipe Manager Script on page 350 for more information.

Robot Vision ManagerIndex Setting

The Robot Vision Manager index setting defines the index used as the sequence_id when accessing the recipe manager object from a V+ program. Refer to *RecipeManager Properties* in the *ACE Reference Guide* for more information.

Recipe Editor

After the Recipe Manager object has been configured and all sources are defined, individual Recipes can be created with the Recipe Editor.

The Recipe Editor can be access from the Task Status Control area. Refer to Task Status Control on page 121 for more information. The Recipe Editor is described below.

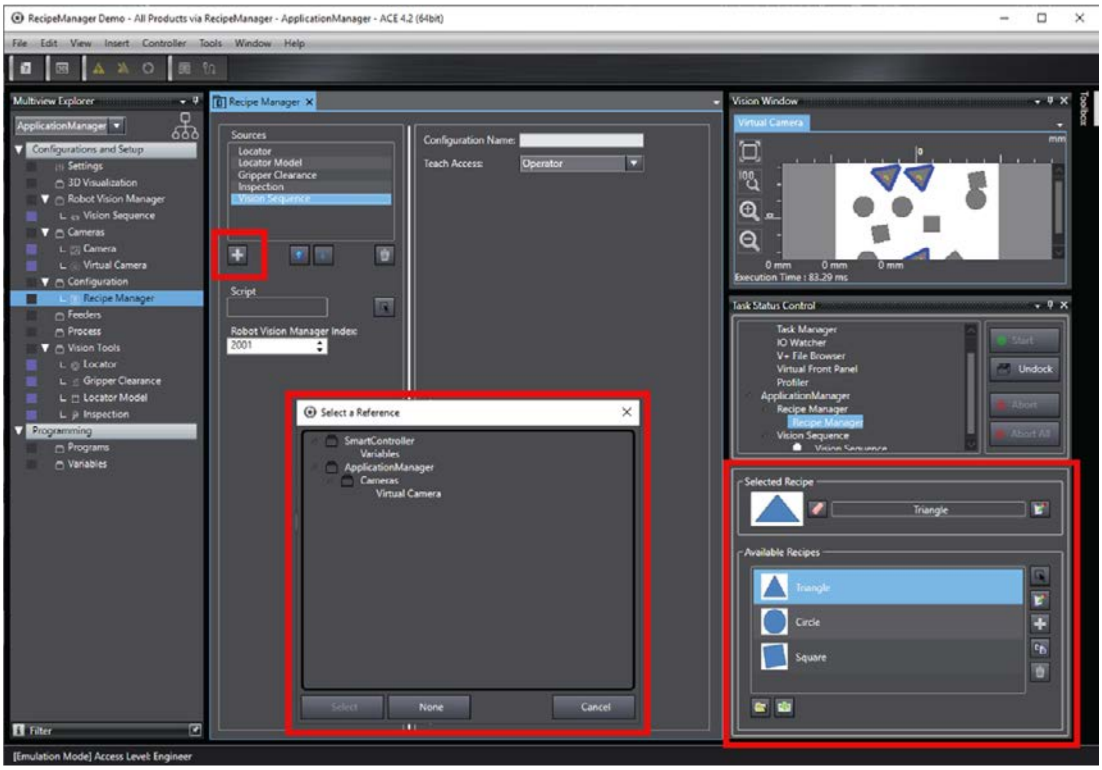


Figure 8-75 Recipe Access Area

With the Multiview Explorer opened and Recipe Manager selected, click the **Add** Button, bordered in red above. This allows you to add those items shown in the colored boxes, under Recipe Manager, in the left side panel. The select an available option in the Available Recipe, which opens the center highlighted box. Clicking the **Edit** Button in the Selected Recipe box then allows you to edit that specific recipe. The Recipe Editor is shown in the following figure.

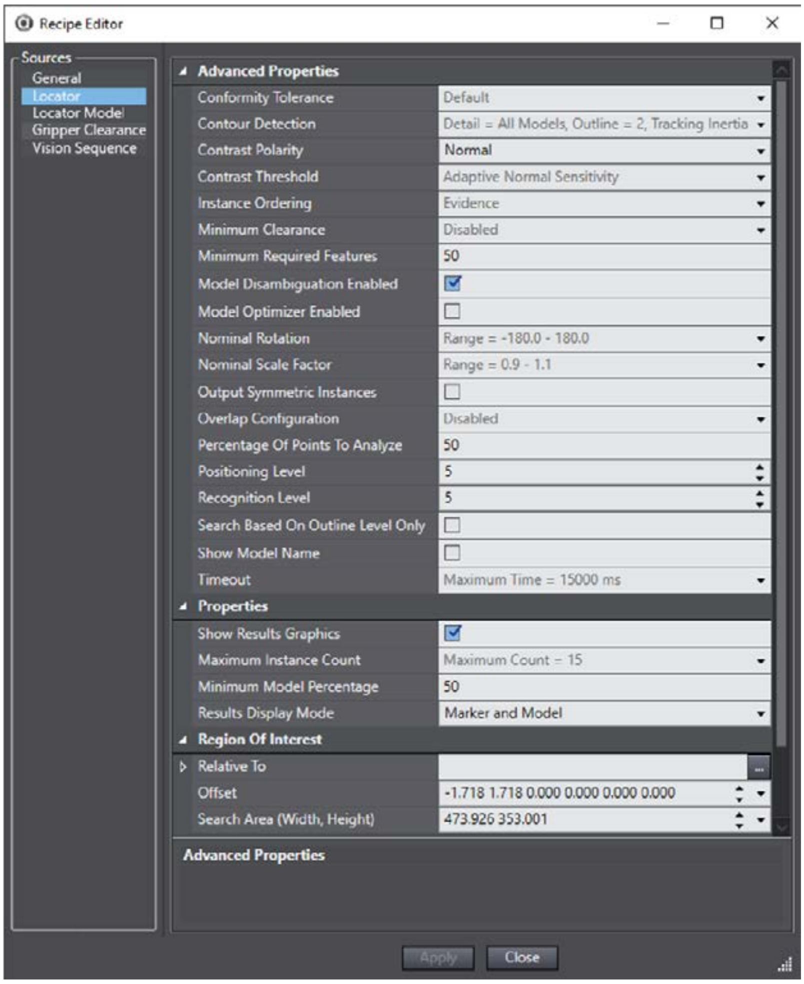


Figure 8-76 Recipe Editor

The following table identifies the control buttons in the Vision Window used for Recipe editing. The available recipe scan be exported and reloaded from a directory on the PC.

Table 8-12 Recipe Access Area Item Description

Group	Item	Description
Selected Recipe		Edit the selected Recipe.
		Clear the selected Recipe.
Available Recipes		Makes the highlighted Recipe in the Available Recipe list the active Recipe.
		Edit the selected Recipe.
		Add a new Recipe.

Group	Item	Description
		Create a copy of the selected Recipe.
		Delete a selected Recipe.
		Load a Recipe from a saved file on the PC.
		Save a Recipe to a file on the PC.

All of the buttons can also be activated through a C# script, refer to Recipe Script Selection on page 344 for more information.

V+ Variable Source

Each selected variable is displayed in a list. The display is changed as each variable is selected based on the settings in the Recipe configuration.

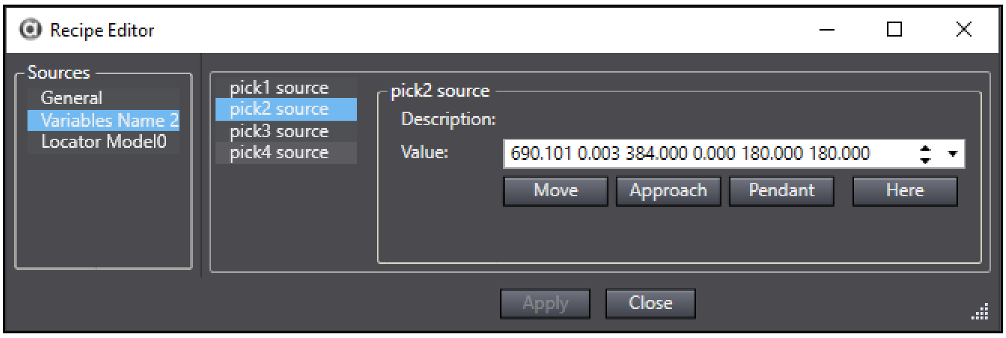


Figure 8-77 Recipe Editor - V+ Variable

Locator Model Source

You can see the currently trained locator model and can edit or retrain the locator model.

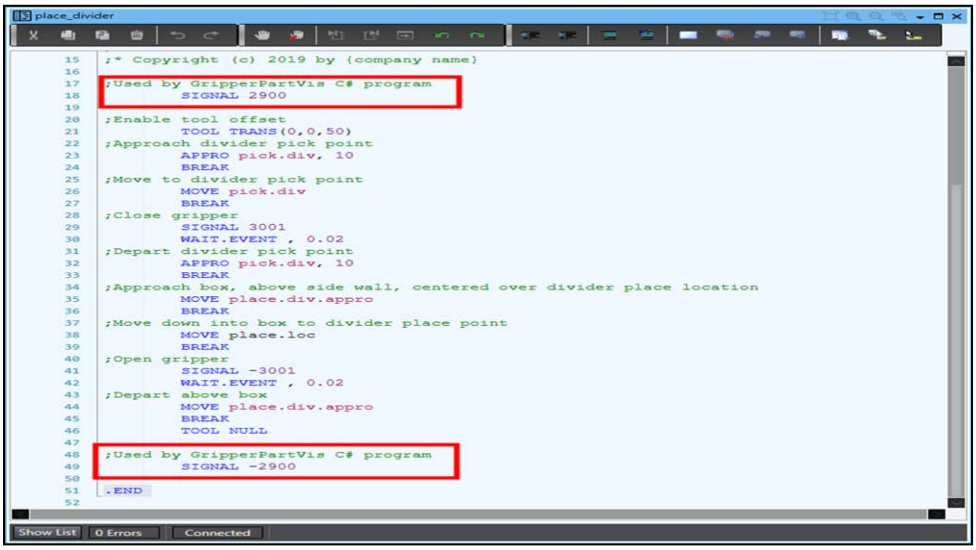


Figure 8-78 Recipe Editor - Locator Model

Virtual Camera Source

The acquisition properties are displayed in a list. You can modify, add, or remove acquisition settings as needed.

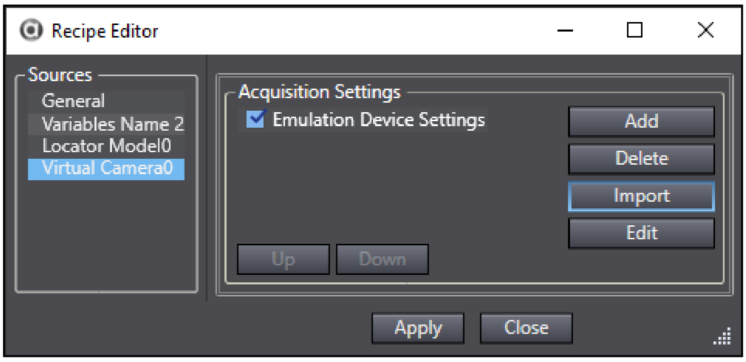


Figure 8-79 Recipe Editor - Virtual Camera (Emulation Mode Shown)

Other Vision Tool Sources

Adjust the parameters of the vision tool.

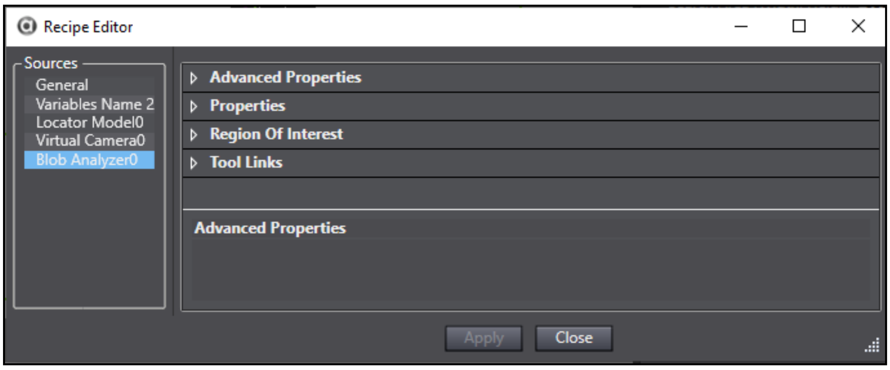


Figure 8-80 Recipe Editor - Blob Analyzer Tool (Example)

AnyFeeder Sources

Adjust the Feed Controls of the AnyFeeder.

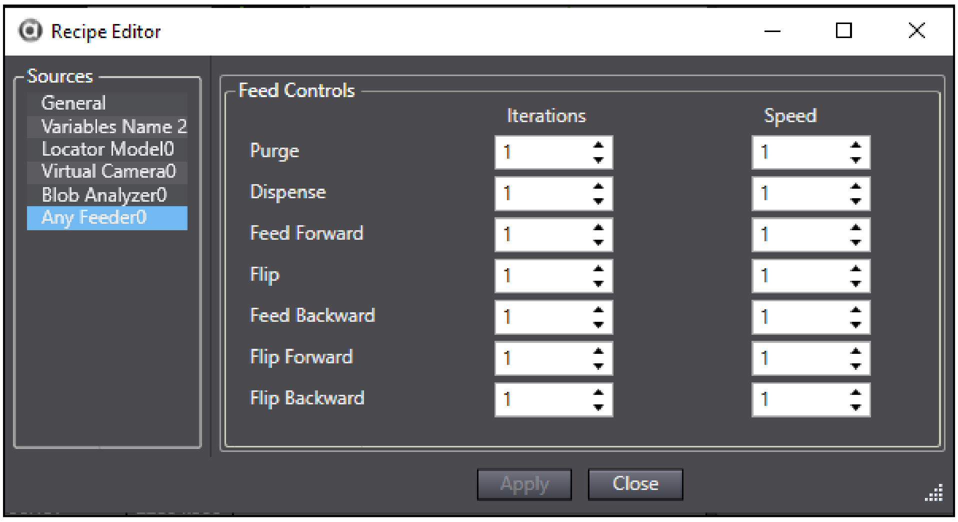


Figure 8-81 Recipe Editor - AnyFeeder

Creating a New Recipe

Use the following procedure to create a new Recipe.

1. Add a new recipe with the **Add** button (). A new Recipe will appear in the Available Recipes list.
2. Select the recipe and then click the **Edit** button (). This will open the Recipe Editor window.

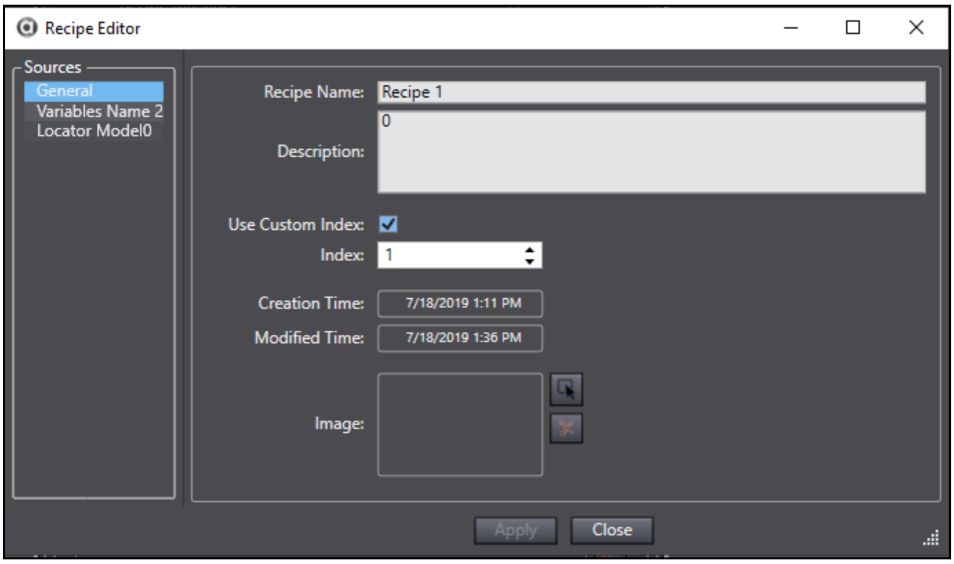


Figure 8-82 Recipe Editor

3. Select the General item in the Sources list and then input the general information and settings about the Recipe.

Item	Description
Recipe Name	Provide a unique name for the Recipe.
Description	Provide a description associated with the Recipe.
Index	If the **Use Custom Index** option is selected, you can set a unique index number. This is the index of the Recipe used when accessing the Recipe through Robot Vision Manager or with a C# program. Refer to the *ACE Reference Guide* for more information.
Creation Time	The time the Recipe was created.
Modified Time	The last time the Recipe was modified.
Image	User-defined picture associated with the Recipe.

4. Make any adjustments to other data source items for the currently selected Recipe and then click the **Apply** button. When all data source items have been adjusted for that Recipe, click the **Close** button. The Recipe creation procedure is complete.

Recipe Manager Script

A Recipe Manager Script allows customization of C# methods invoked when certain events occur in the lifetime of a Recipe. These methods are summarized below.

> **NOTE:** Most applications that use a Recipe Manager do not require a Recipe Manager Script.

Table 8-13 Recipe Manager Script Method Descriptions

Script Method	Description
string CanEdit(Recipe recipe)	Called to check if a Recipe can be edited. If this method returns an empty string, the Recipe can be edited. If it returns a non-empty string, editing will be prevented and the string will be displayed.
void BeforeEdit(Recipe recipe)	If a Recipe can be edited, this method is called before the editor is displayed.
void AfterEdit(Recipe recipe)	This method is called after the Recipe Editor is closed.
string CanSelect(Recipe recipe)	Called to check if a Recipe can be selected. If this method returns an empty string, the Recipe can be selected. If it returns a non-empty string, selection will be prevented and the string will be displayed.
void BeforeSelection(Recipe recipe)	If a Recipe can be selected, this method is called before the Recipe Editor is selected.
void AfterSelection(Recipe recipe)	This method is called after the Recipe is selected.

Adding a Recipe Manager Script Object

To add a Recipe Manager Script object, right-click ***Configuration***, select ***Add***, and then click ***Recipe Manager Script***. A new Recipe Manager Script object will be added to the Multiview Explorer.

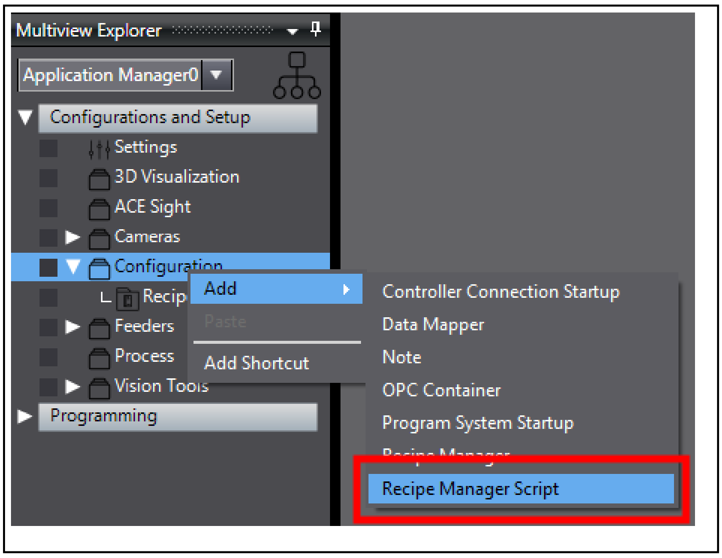


Figure 8-83 Adding a New Recipe Manager Script Object

NOTE: After the Recipe Manager Script object is created, you can rename the new Recipe Manager Script object by right-clicking the item and selecting ***Rename***

8.5 Feeders

Feeders are objects in an ACE project that represent devices used to dispense and present parts to a robot. There are two different feeder objects that can be added to the ACE project.

- AnyFeeder - a feeder object that uses serial communications with the PC running ACE software for sequence control and feedback purposes. This is typically controlled using Robot Vision Manager from a V+ program or from a Custom Vision tool.
- IO Feeder - a feeder object that uses discrete signals for control and feedback purposes. This is typically used with a Process Manager object to indicate Part and Part Target availability and can be associated in Control Sources for static Part and Part Target sources.

Both types of feeder objects can be configured in the Application Manager device of an ACE project as described in the following sections.

AnyFeeder Object

AnyFeeder objects represent an integrated parts feeding system optimized to work together with vision, motion, and robots. AnyFeeder objects can be added to provide control and configuration of the parts feeder in the ACE project.

NOTE: When Emulation Mode is enabled, all Feeder Function durations are emulated. Durations for error reset, initialization, operation abort, or firmware restart are not emulated because these operations are not intended to be requested during a feed cycle.

Additional Information: More information about AnyFeeder devices is available in the *AnyFeeders User's Guide* (P/N 18876-000).

Adding an AnyFeeder Object

To add an AnyFeeder object, right-click **Feeders**, select **Add**, and then click **AnyFeeder**. The Create New AnyFeeder wizard will open.

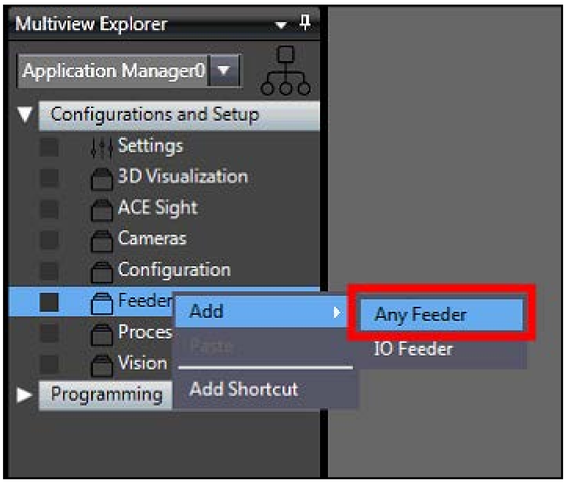


Figure 8-84 Adding an AnyFeeder Object

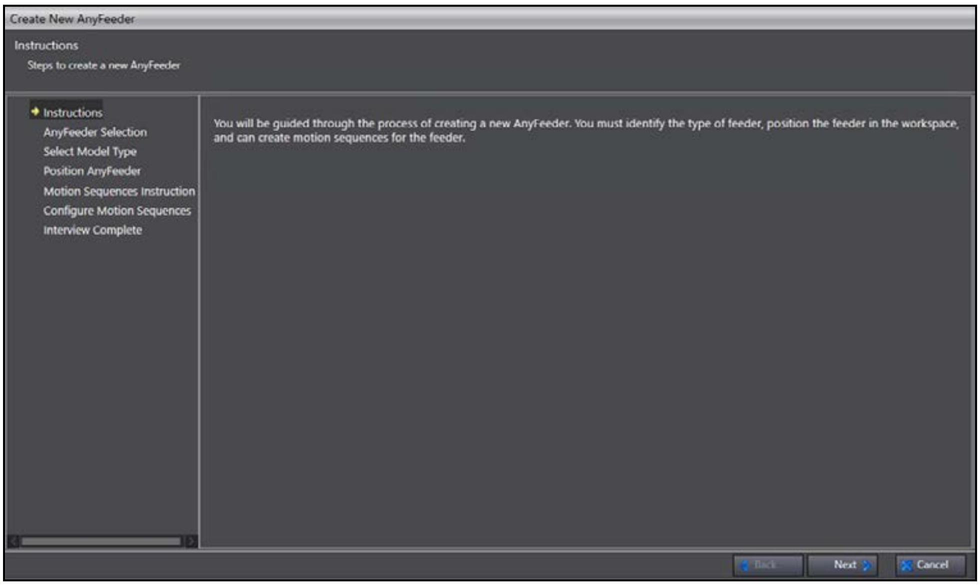


Figure 8-85 Create New AnyFeeder Wizard

Make selections for the model type, position in the workspace, and motion sequences in the Create New AnyFeeder wizard. Click the **Finish** Button after completing all steps and then the AnyFeeder object will be added to the Multiview Explorer. Refer to the sections below for more information about wizard configuration items.

> **Additional Information**: The communication port selection and connection test functions are not available while operating in Emulation Mode.

> **NOTE:** After the AnyFeeder object is created, you can rename the new AnyFeeder object by right-clicking the item and selecting **Rename**.

AnyFeeder Configuration

To access the AnyFeeder configuration, right-click the object in the Multiview Explorer and then select **Edit**, or double-click the object. This will open the AnyFeeder editor in the Edit Pane.

Use the information below to understand the AnyFeeder configuration items.

Configuration Items

The Configuration tab contains the following items used for general configuration settings.

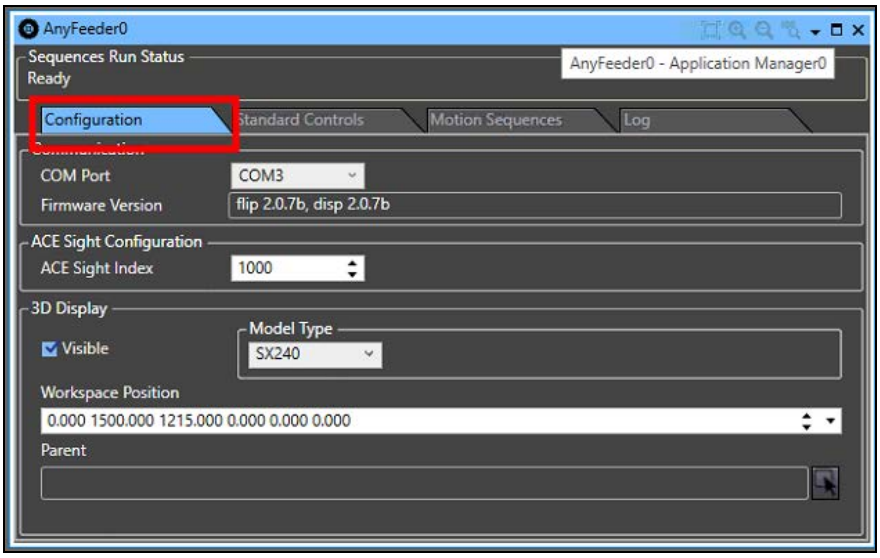


Figure 8-86 AnyFeeder Configuration Tab

Table 8-14 AnyFeeder Configuration Tab Item Description

Group	Item	Description
Communication	COM Port	Specifies the PC serial communications port that is used to send commands to the AnyFeeder device. This is not available in Emulation Mode.
	Firmware Version	Displays the firmware version of the con-

Group	Item	Description
		nected AnyFeeder device. This is not available in Emulation Mode
Robot Vision Manager Configuration	Robot Vision Manager Index	The Robot Vision Manager Index can be used to reference this configuration from a V+ program. Specify a unique number between 0 to 9999 as the Robot Vision Manager reference. **NOTE:** When an AnyFeeder device configuration and a Robot Vision Manager sequence have the same index value, the PC will only try to run the Robot Vision Manager sequence.
3D Display	Model Type	Select the AnyFeeder Model type from the dropdown selection menu.
	Visible	Use the Visible selection box display or hide the device from the 3D Visualizer.
	Workspace Position	Enter the location of the AnyFeeder device in the workspace.
	Parent	Select a reference to a parent object.

Standard Controls Items

The Standard Controls tab contains the following items used for manually controlling the AnyFeeder device. The buttons are used to control the AnyFeeder device as described below.

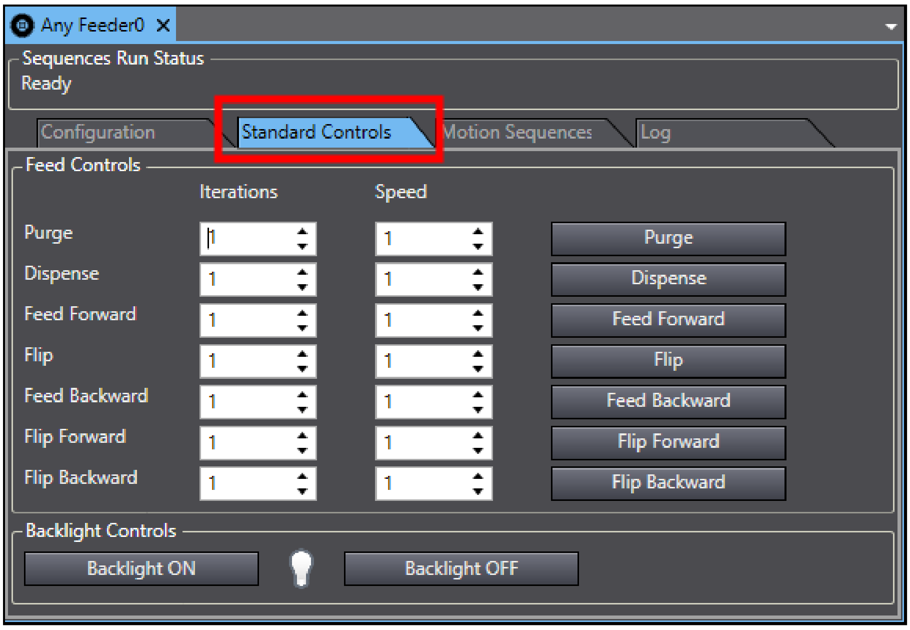


Figure 8-87 AnyFeeder Standard Controls Tab

Table 8-15 AnyFeeder Standard Controls Tab Item Description

Group	Item	Description
Feed Controls	Feeder Functions	• Purge: Feed parts out of the feeder backwards. • Dispense: Move parts from the bulk container onto the feed surface. • Feed Forward: Feed parts forward. • Flip: Flip parts without moving forwards or backwards. • Feed Backward: Feed parts backward. • Flip Forward: Flip parts and move them forward. • Flip Backward: Flip parts and move the backward.
	Iterations	Specify the number of times this action is performed. **NOTE:** There are some actions that are designed to occur at the end of all motion and will only occur once, regardless of iteration number. For example, the Dispense command causes the lip in

Group	Item	Description
		the top bin of the AnyFeeder to retract at the beginning and then come back up at the end. This will only occur once when iteration is set to a number greater than 1.
	Speed	Set the speed of the Feeder Function. Settings can range from 0-10 where 0 is the minimum speed and 10 is the maximum speed.
Backlight Controls	Backlight ON/OFF	Turn the backlight ON or OFF. The indicator ( ) turns ON or OFF to show the state of the backlight.

Motion Sequence Configuration

The Motion Sequences tab shows a listing of high level motion sequences associated with the AnyFeeder device. You can define a sequence as a collection of individual feeder functions. When a sequence is executed, all the operations are performed in the order defined in this area.

Motion sequences can be triggered through the AnyFeeder user interface, a C# program, or with a V+ program. Motion sequences are stored as Command Index numbers between 1000 to 10000. The motion sequence is referenced with this number in C# and V+ programs.

Sequences and sequence steps can be removed using the **Delete** buttons ( ).

Sequence actions can be rearranged with the **Up** ( ) and **Down** ( ) buttons.

A sequence can be tested with the **Play** button ( ).

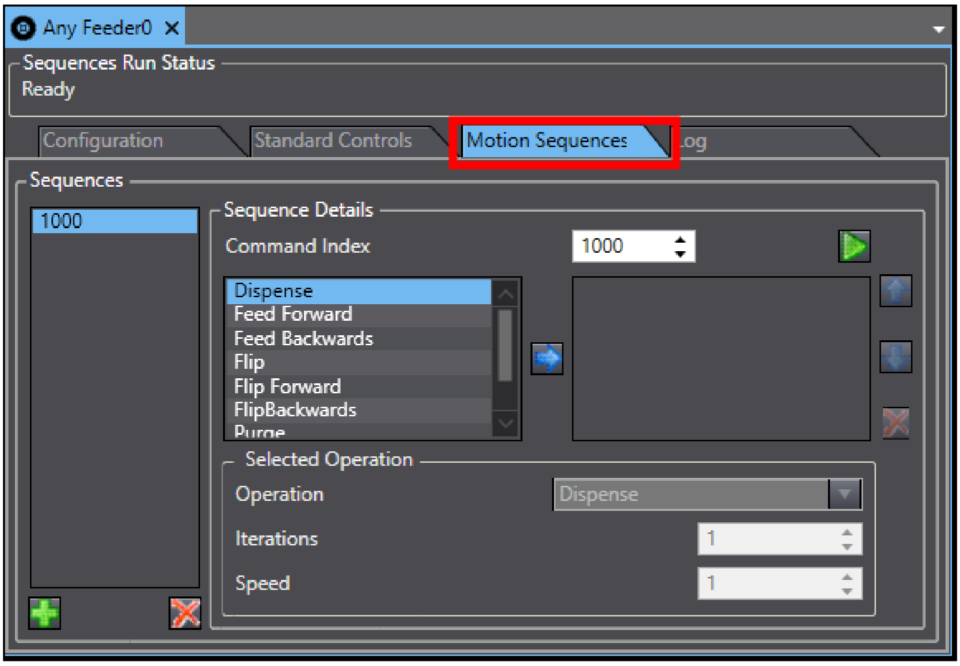


Figure 8-88 AnyFeeder Motion Sequences Tab

Use the following procedure to create new Motion Sequences.

1. Add a new sequence with the **Add** button ( ). A new sequence will be placed in the sequence list.

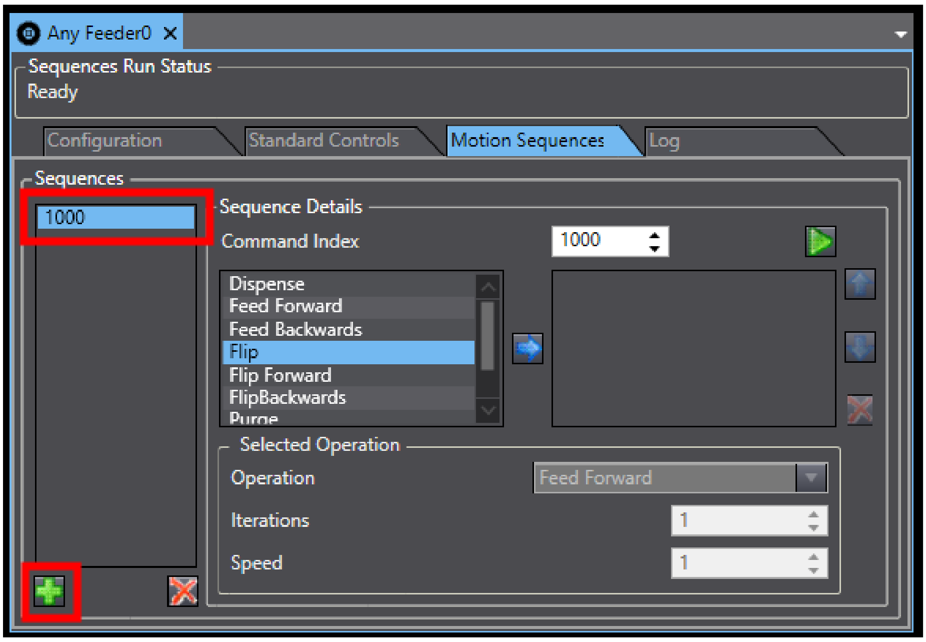


Figure 8-89 Add a New AnyFeeder Sequence

2. Adjust the Command Index value if necessary.

3. Select the first Feeder Function from the list and then click the **Select** Button () to add it to the action list. The Flip function has been added in the example below.

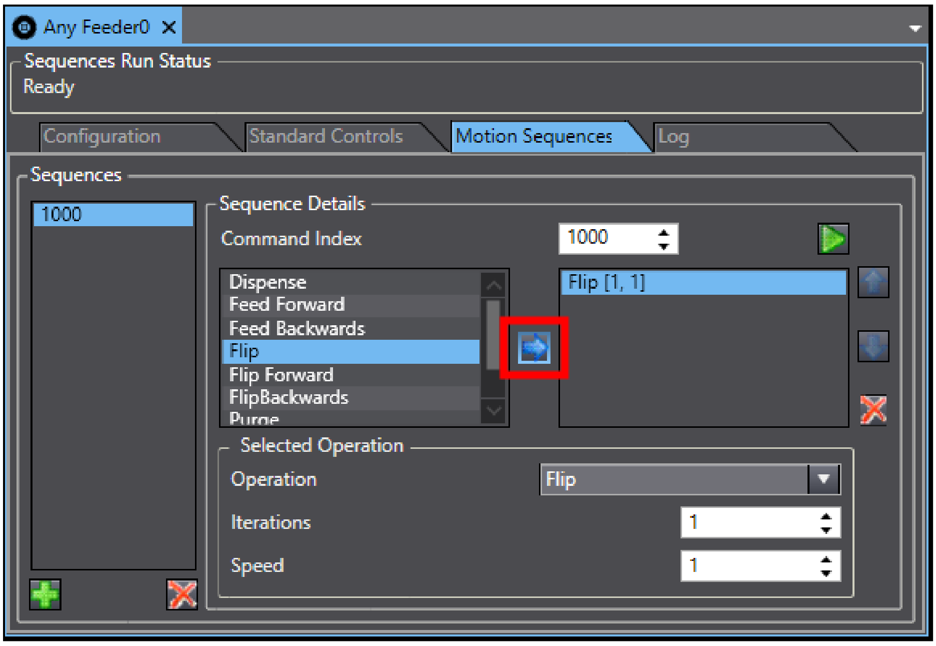


Figure 8-90 Add a New Function to the Sequence

4. Select the action from the Selected Operation list and then make any necessary adjustments to Iterations and Speed.
5. Repeat steps 4 through 8 to add more actions to the sequence as needed.
6. Click the **Play** Button () to execute the sequence as a test. This will cause the connected AnyFeeder to move and execute the sequence. If the sequence executes correctly, the procedure is complete.

Log Items

The log page shows a history of the communications between the AnyFeeder device and the PC.

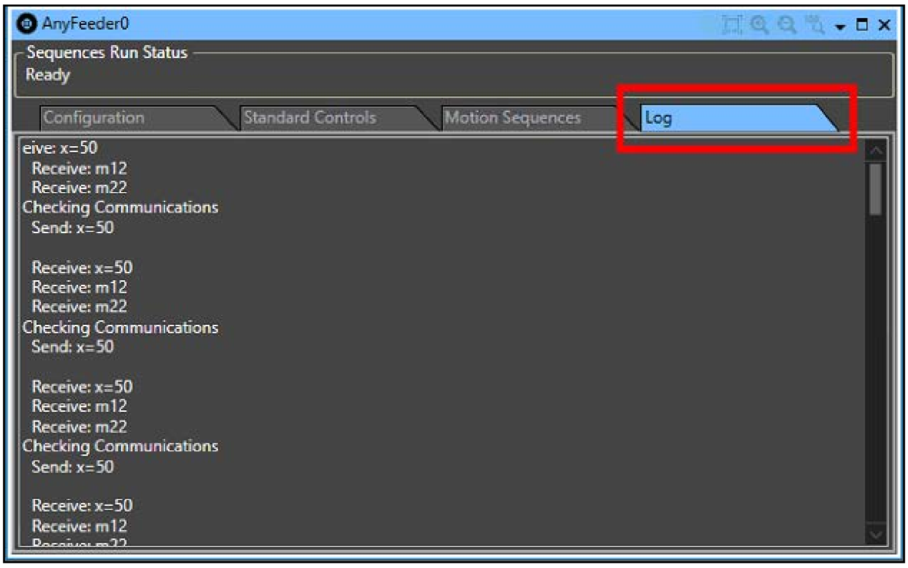


Figure 8-91 AnyFeeder Configuration

When ACE is unable to properly communicate with the AnyFeeder the Sequence Run Status will display an ACE error. These are ACE errors 30-38 as shown below. These errors are typically associated with incorrect COM port selection, a busy RS232 COM port due to access by a different application, or the AnyFeeder may not be powered on. To resolve this error, click the **Configuration** tab, shown below, and change the Com port to the one used by the AnyFeeder. For further information, please refer to *Anyfeeder User's Guide (18876-000)*.

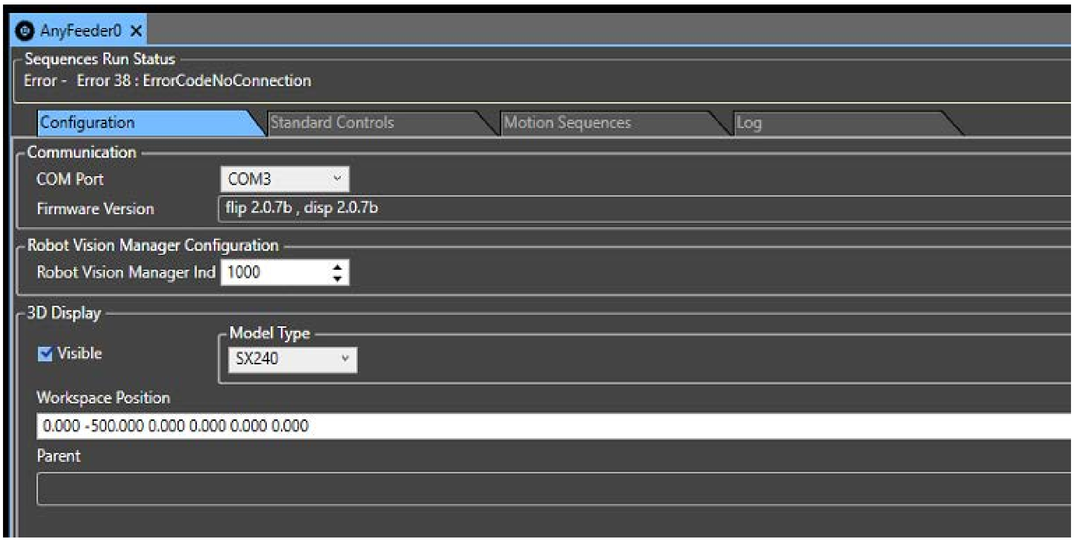


Figure 8-92 AnyFeeder Configuration Tab.

I/O Feeder Object

I/O Feeder objects represent generic feeder devices that are controlled with input and output signals from a connected SmartController.

Adding an I/O Feeder Object

To add an I/O Feeder object, right-click **Configuration**, select **Add**, and then click **IO Feeder**. A new I/O Feeder object will be added to the Multiview Explorer.

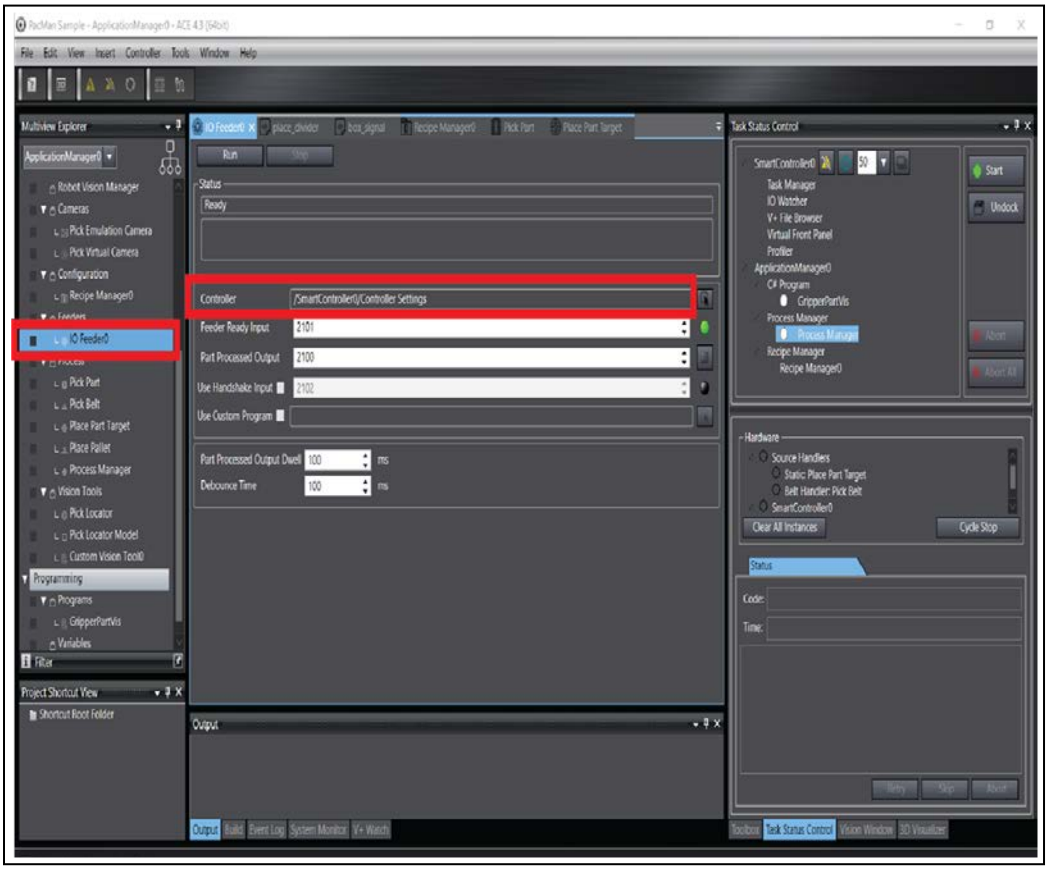


Figure 8-93 Adding an I/O Feeder Object

> **NOTE:** After the I/O Feeder object is created, you can rename the new IO Feeder object by right-clicking the item and selecting **Rename**.

On Multiview Explorer, with Process Manager opened, select the **Control Sources** Tab.

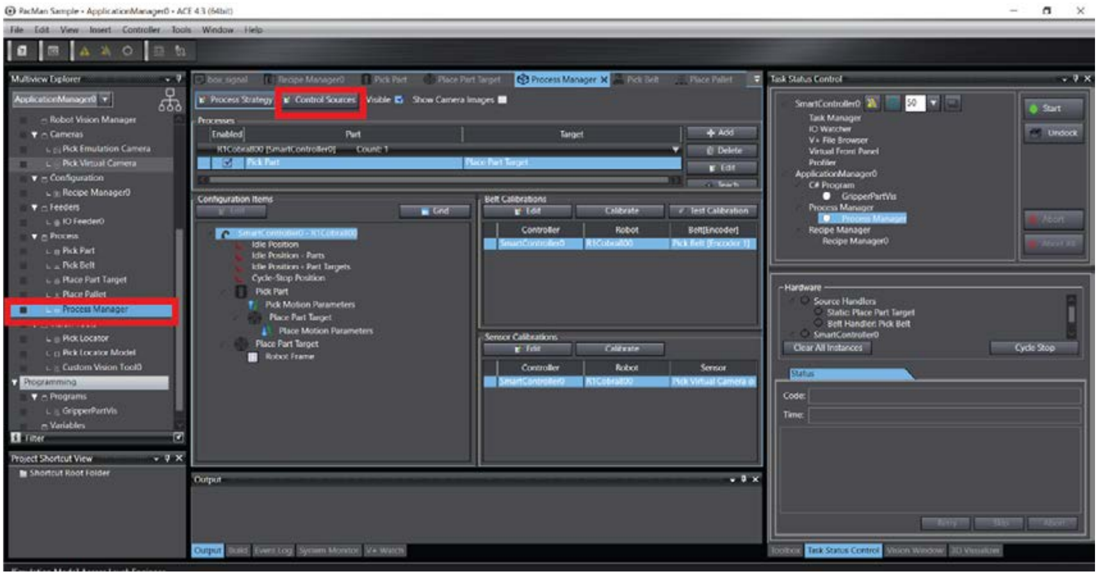


Figure 8-94 Control Sources Tab

I/O Feeder Configuration

To access the I/O Feeder configuration, right-click the object in the Multiview Explorer and then select **Edit**, or double-click the object. This will open the I/O Feeder editor in the Edit Pane.

Use the table below to understand the IO Feeder configuration items.

Table 8-16 I/O Feeder Configuration Item Description

Item	Description
Run Button	Used to perform one test cycle of the feeder. The operation stops when the cycle has completed or if the **Stop** button is clicked before the end of the cycle. To repeat or restart the cycle, click the **Start** button again. When clicked, this button dims until the **Stop** button is clicked (feeder test cycle has been interrupted) or the cycle has completed .
Stop Button	Stops (interrupts) the test cycle. The test cycle can be restarted by clicking the **Start** button. This icon is dimmed until the **Start** button is clicked (feeder test cycle has started).
Status	The Status item provides operation and error information about the I/O Feeder object. The current status is shown in the top field. A description of the status is shown in the lower field.
Controller	Specifies the controller that will process the feeder signals. Click the **Select** icon ( ) to display the list of available controllers and

Item	Description
	then select a reference controller from the list.
Feeder Ready Input	Specifies the input signal that indicates the feeder is ready and available to present a part instance. When Emulation Mode is enabled, this signal is ignored, but soft signals can be substituted for testing purposes.
Part Processed Output	Specifies the output signal that indicates the instance has been processed (acquired) by the robot. The feeder should cycle and present a new part instance. When Emulation Mode is enabled, this signal is ignored, but soft signals can be substituted for testing purposes.
Use Handshake Input	If enabled, the feeder will assert a signal indicating it has acknowledged the part processed signal. When Emulation Mode is enabled, this signal is ignored, but soft signals can be substituted for testing purposes.
Use Custom Program	The feeder interface code runs as a V+ program on the specified controller. This program can be overwritten if some custom logic needs to be applied. If you enable this option, you must use the **Select** icon ( ) to select the custom program. A custom V+ program selection wizard will appear to step through the procedure.
Part Processed Output Dwell	Specifies the dwell time (time to wait) in milliseconds after the Part Processed output signal is turned ON before turning it OFF.
Debounce Time	Specifies the amount of time (in milliseconds) that a signal must be detected in the ON state before it is considered logically ON.

Figure 8-95 I/O Feeder Configuration

8.6 Process Objects

Process objects are used to define, configure, and manage the process elements of an Pack Manager packaging application.

As Process objects are added to the Application Manager device, they can be shown in the 3D Visualizer, if the ***Visible*** option or ***Show in Visualization*** option is enabled in the object editor. For example, in addition to the robot, the 3D Visualizer shows:

- The robot Belt object windows.
- The location of latch sensors.
- The location of each camera field of view.
- Part and Part Target instances.

Additional Information: Part and Part Target instances are represented in the 3D Visualizer with different colors to indicate their current state.
- Yellow: part is allocated.
- Orange: part is not allocated.
- Light green: part target is allocated.
- Green: part target is not allocated.

Process objects listed below are described in detail in the following sections.

Part Buffer

The Part Buffer object defines an object that is an overflow area where parts can be temporarily stored when part targets are unavailable to accept more parts.

Refer to Part Buffer Object on page 364 for more information.

Part Target

The Part Target object defines an object that is a possible destination for a part.

Refer to Part Target Object on page 367 for more information.

Part

The Part object defines an object to be picked and processed to an available Part Target.

Refer to Part Object on page 372 for more information.

Belt

The Belt object defines a physical conveyor belt used by the system. The Belt object maintains a list of encoders that are associated with the physical conveyor.

Refer to Belt Object on page 377 for more information.

Process Manager

Process Managers are the central control point for developing packaging applications. A Process Manager allows you to create complex applications without having to write any programming code. It provides access to automatically generated V+ and C# programs that allow you to customize the default behavior to meet the requirements of your application, if necessary.

The Process Manager run-time handler is the supervisory control for the entire packaging system, managing allocation and queuing for multiple controllers, robots, conveyors, parts, and targets.

Refer to Process Manager Object on page 395 for more information.

Allocation Script

The Allocation Script object is used to create and edit custom part-allocation programs for use with the Process Manager.

Refer to Allocation Script Object on page 458 for more information.

Pallet

The Pallet object defines the layout of a pallet, which can be used to pick parts from or place parts to.

Refer to Pallet Object on page 460 for more information.

Vision Refinement Station

The Vision Refinement Station object defines an object that is used to refine the part to gripper orientation for improved placement accuracy.

Refer to Vision Refinement Station Object on page 465 for more information.

Part Buffer Object

The Part Buffer object defines a physical object that is an overflow area where parts can be temporarily stored when an output conveyor belt or feeder is unavailable to accept the parts. This buffer can hold a single part, it can be a static pallet, or just a flat surface that acts as a pallet that holds multiple parts.

For pallets, you can also control the access method in the following ways.

- Last In, First Out (LIFO).
- First In, First Out (FIFO).

The Pallet object editor is used to specify the pallet parameters and access method. Refer to Pallet Object on page 460 for more information.

Adding a Part Buffer Object

To add a Part Buffer object, right-click **Process**, select **Add**, and then click **Part Buffer**. A new Part Buffer object will be added to the Multiview Explorer.

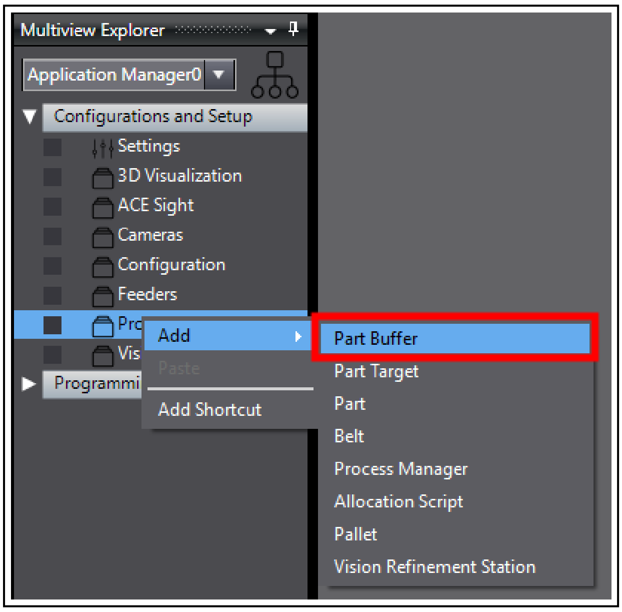


Figure 8-96 Adding a Part Buffer Object

NOTE: After the Part Buffer object is created, you can rename the new Part Buffer object by right-clicking the item and selecting **Rename**.

Part Buffer Configuration

To access the Part Buffer configuration, right-click the object in the Multiview Explorer and then select **Edit**, or double-click the object. This will open the Part Buffer editor in the Edit Pane.

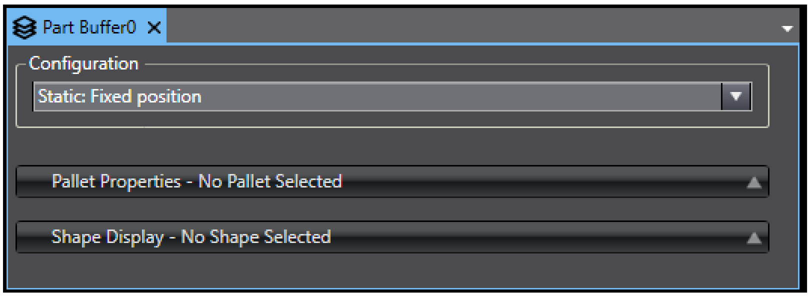


Figure 8-97 Part Buffer Configuration

Configuration Drop-down List

The Configuration drop-down list box is used to specify how the Part Buffer is used by the system. **Static: Fixed Position** is the only option for this item. This means parts are placed at a static location.

> **NOTE:** This object does not support dynamic Part Buffers by default and operates under the assumption that parts placed in the buffer will be available in the same position when accessed later. Be sure to consider the physical state of parts in the buffer when a Process Manager is stopped and restarted.

Pallet Properties

Use the Pallet Properties area if you need to specify a pallet that is used to hold the part(s). Make reference to a Pallet object by checking **Pallet** and then use the *Select* button to specify that object as shown below.

> **NOTE:** A Pallet object must already exist in the project. Refer to Pallet Object on page 460 for more information.

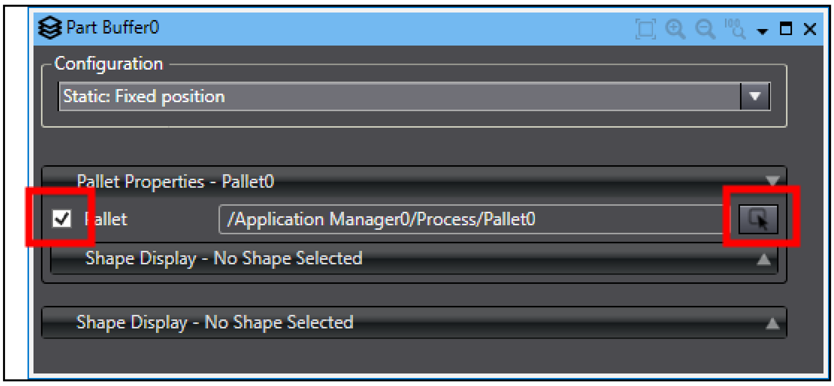


Figure 8-98 Add a Reference to a Pallet Object - Part Buffer

Shape Display (Pallet)

Use the Shape Display to specify a shape to represent the Pallet in the 3D Visualizer when the Process Manager runs. Select the **Shape** check box and then use the **Select** Button to specify a shape.

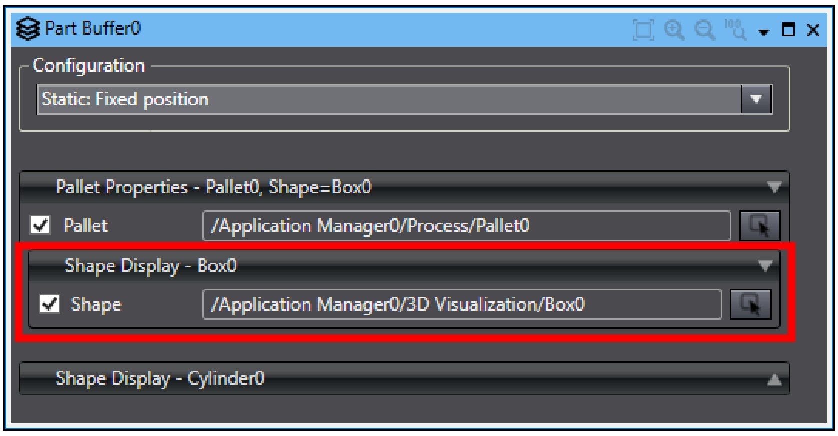


Figure 8-99 Pallet Shape Selection - Part Buffer

Adding a Part Buffer to a Process

Use the following procedure to add a Part Buffer to a Process after creating and configuring the Part Buffer object.

> **NOTE:** The default Process Strategy can choose the appropriate process based on part / target availability.

1. Create a Process that includes a Robot, a Part as the Pick Configuration, and a Part Target as the Place Configuration.
2. Create a second Process that includes the original Robot and Part, and select the Part Buffer as the Place Configuration.
3. Create a third Process that includes the original Robot and Part Target, and select the Part Buffer as the Pick Configuration.
4. Use the **Up** and **Down** buttons in the Process Manager Processes area to arrange the process by priority. The process at the top of the list has the highest priority.

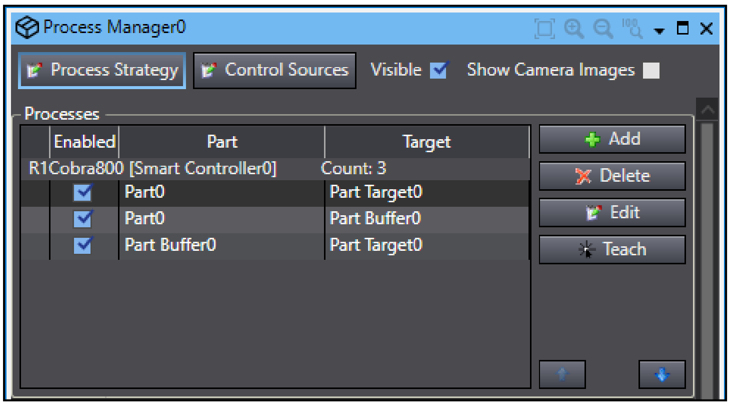


Figure 8-100 Arrange Processes by Priority

5. Set the Part Buffer access order. After the Part Buffer access order is set, the procedure is complete.

Setting the Part Buffer Access Order

When a pallet is used for the part buffer, you need to specify how the parts will be accessed as the buffer is being emptied. You can choose between the following options.

- First In, First Out (FIFO): The first part placed into the part buffer will be the first part removed.
- Last In, First Out (LIFO): The last part placed into the part buffer will be the first part removed.

  NOTE: When parts are stacked (more than one layer is specified for the pallet), the access order must be set as LIFO.

Use the following procedure to set the Part Buffer access order. Refer to Control Sources on page 435 for more information.

1. In the Control Sources setting area, select the **Static Sources For Part Buffer** item from the Sources list (if the Part Buffer object has been renamed, select the corresponding item).

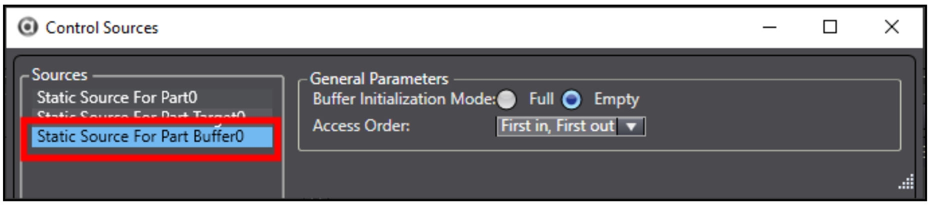


Figure 8-101 Select Static Source For Part Buffer

2. If necessary, select the desired Buffer Initialization Mode to indicate the state of the part buffer when it is initialized. The default state is Empty, which means the buffer is empty when initialized.
3. Select the required Access Order from the list and then the Part Buffer access order setting procedure is complete.

Part Target Object

The Part Target object defines a location that is a possible destination for a part. The Part Target has a configuration property that specifies how the target / instance is handled by the application.

Adding a Part Target Object

To add a Part Target object, right-click **Process**, select **Add**, and then click **Part Target**. A new Part Target object will be added to the Multiview Explorer.

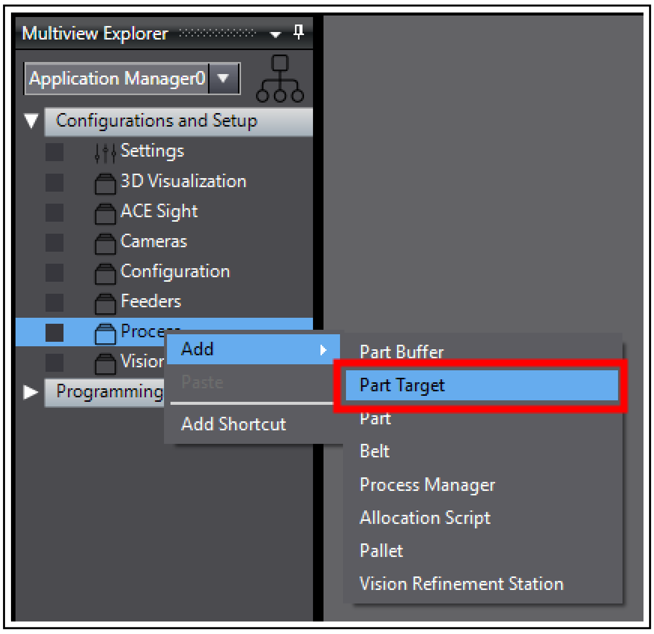


Figure 8-102 Adding a Part Target Object

NOTE: After the Part Target object is created, you can rename the new Part Target object by right-clicking the item and selecting ***Rename***.

Part Buffer Configuration

To access the Part Buffer configuration, right-click the object in the Multiview Explorer and then select **Edit**, or double-click the object. This will open the Part Buffer editor in the Edit Pane.

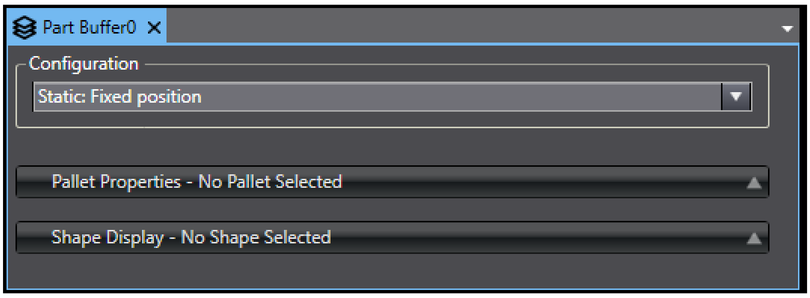


Figure 8-103 Part Buffer Configuration

Configuration Drop-down List

The Configuration drop-down list box is used to specify how the target is input to the system. The options are described below.

- **Belt: Latching, belt camera, or spacing interval** - targets / instances are located on a conveyor belt using latching or fixed-spacing. Vision and / or a pallet may be included in the part delivery system. Refer to Configuration Drop-down List on page 368 for more information.

- **Static: Fixed position** - targets / instances are acquired from a static location such as a part feeder or a pallet. Refer to Configuration Drop-down List on page 368 for more information.
- **Vision: Fixed camera not relative to a belt** - locations are acquired through camera that is not located over a belt. Refer to Configuration Drop-down List on page 368 for more information.

NOTE: If the part is supplied on a belt with a camera, the **Belt: Latching, belt camera, or spacing interval** option must be selected.

Pallet Properties

Use the Pallet Properties area if you need to specify a pallet that is used to hold the part(s). Make reference to a Pallet object by checking **Pallet** and then use the *Select* button to specify that object as shown below.

NOTE: A Pallet object must already exist in the project. Refer to Pallet Object on page 460 for more information.

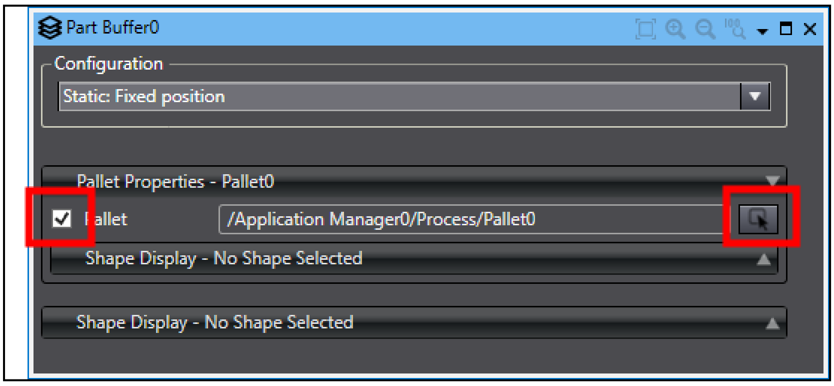


Figure 8-104 Add a Reference to a Pallet Object - Part Buffer

Shape Display (Pallet Properties)

Use the Shape Display to specify a shape to represent the Pallet in the 3D Visualizer when the Process Manager runs. Select the **Shape** check box and then use the **Select** button to specify a shape.

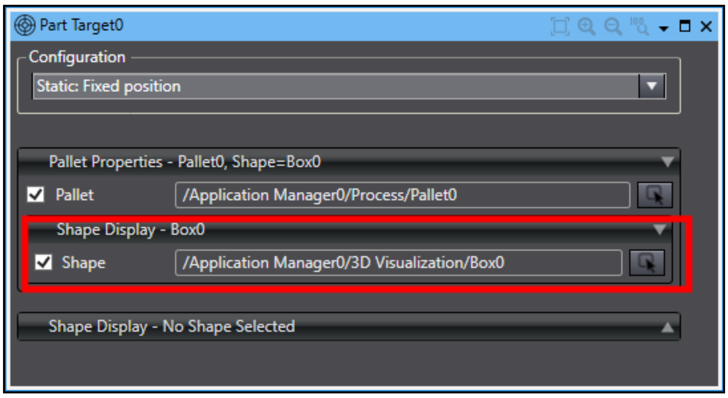


Figure 8-105 Shape Display - Pallet Properties - Part Target Object

Shape Display

Use the Shape Display to specify a shape to represent the Part in the 3D Visualizer when the Process Manager runs. Select the **Shape** check box and then use the **Select** button to specify a shape.

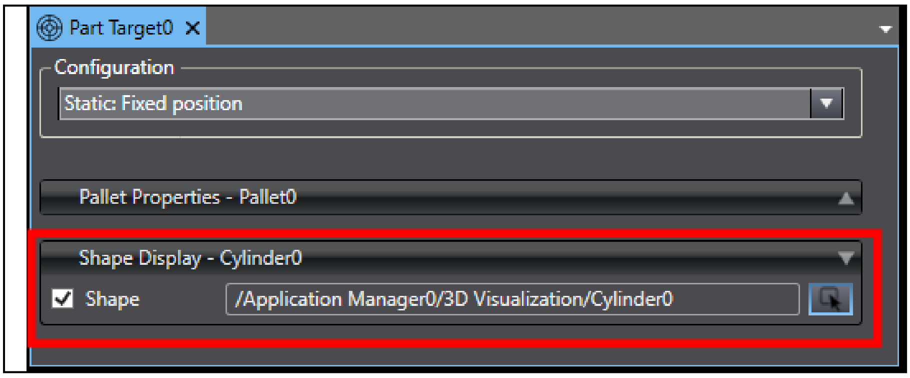


Figure 8-106 Part Shape Selection - Part Target

Belt: Latching, Belt Camera, or Spacing Interval Configuration

When Belt is selected for the Part Target configuration, the operation mode can be either Vision, Latch, or Spacing.

- Vision: a vision tool is used to detect the part on the belt.
- Latch: a latch sensor is used to detect the part on the belt.
- Spacing: parts are spaced evenly on the belt.

Belt Properties

This area is used to select the mode of the belt that is used to handle the part. You also specify other details related to the belt mode selection in this area. Use the information below to make appropriate selections.

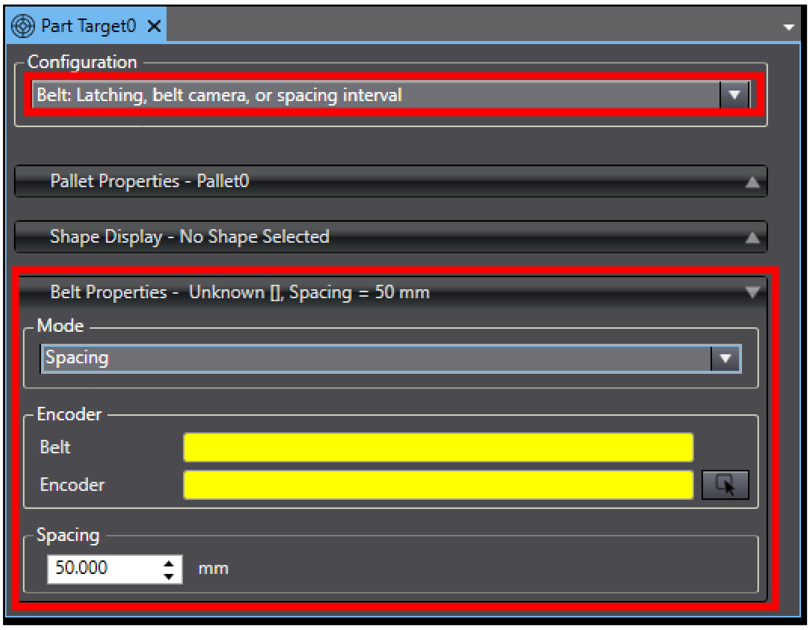


Figure 8-107 Belt Configuration - Part Target

Table 8-17 Belt Configuration - Belt Properties Item Description

Item	Description
Belt / Encoder	Select the encoder from a list of available Process Belt Encoders. This will populate the associated Belt object automatically.
Vision Tool (Vision Mode)	Select the vision tool used to detect the part on the belt. For applications where a custom vision tool is used, this item would be used to specify custom names that had been associated with the different results returned from that tool. As an option, select ***Use Named Instance (select Model or enter custom result name)*** and then use the **Select** button ( ) to reference an existing Locator Model or use the **Add** button ( ) to add a custom result name.
Spacing (Spacing Mode)	Specify the spacing in millimeters between targets / instances on the conveyor belt. It is important to recognize that there is no physical reference for where the spacing instances begin when a Process Manager is started. Spacing is convenient for emulation purposes, but in physical systems an upstream or downstream process or conveyor belt geometry may require that the spacing be synchronized with the rest of the machine. A latch sensor is recommended in this situation.

Static: Fixed Position Configuration

When Static is selected for the Part Target configuration, the Part Target is in a fixed position. There are no additional settings to configure with this selection.

Vision: Fixed camera not relative to belt

When Vision is selected for the Part Target configuration, a vision tool must be specified in the Vision Properties area.

Vision Properties

This area is used to select the vision tool and optionally, the named instance that is used to acquire the part position.

You can optionally specify a named instance and then select a Model or enter a custom result name.

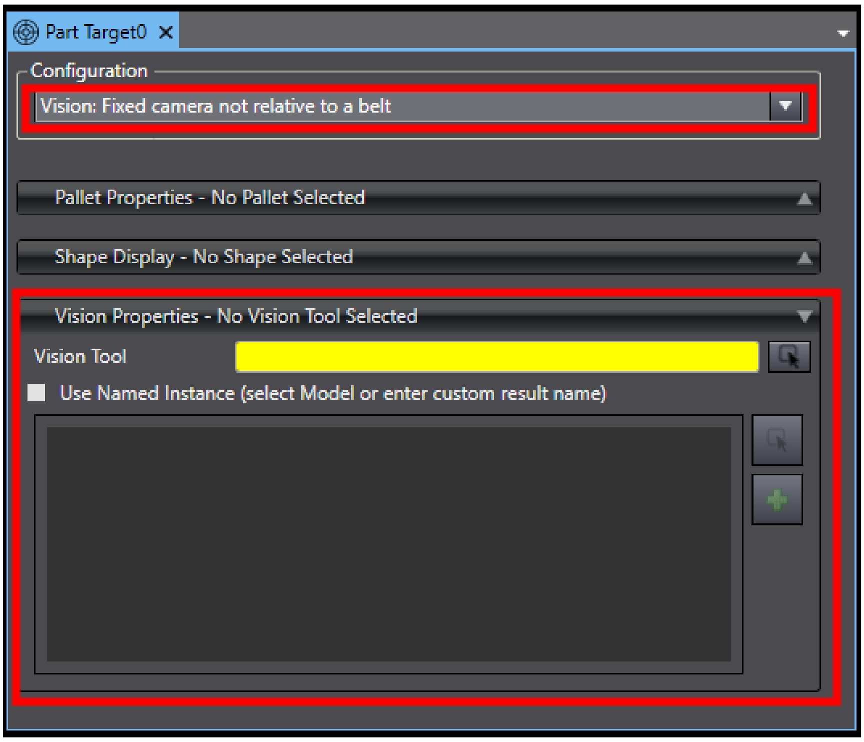


Figure 8-108 Vision Configuration - Vision Properties

Part Object

The Part object defines a physical object that is input to the application for processing. The Part has a configuration property that specifies how the target / instance is input to the application.

Adding a Part Object

To add a Part object, right-click ***Process***, select ***Add***, and then click ***Part*** . A new Part object will be added to the Multiview Explorer.

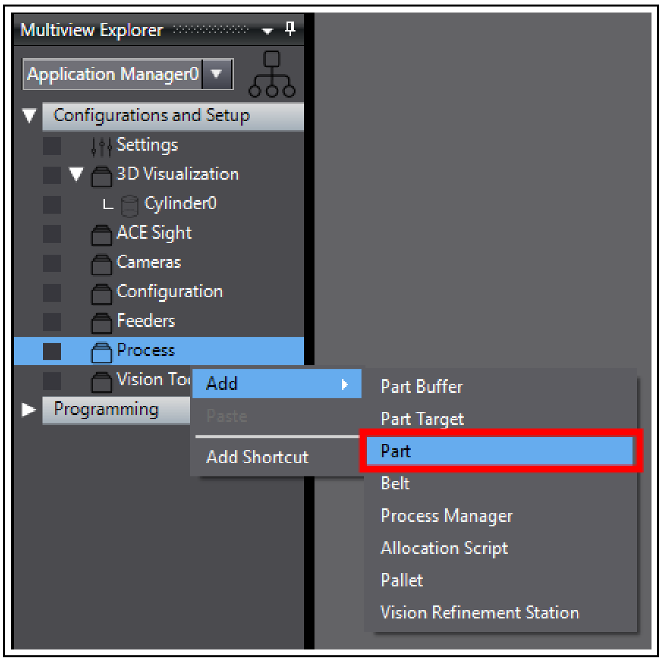


Figure 8-109 Adding a Part Object

NOTE: After the Part object is created, you can rename the new Part object by right-clicking the item and selecting ***Rename***.

Part Configuration

To access the Part configuration, right-click the object in the Multiview Explorer and then select *Edit*, or double-click the object. This will open the Part editor in the Edit Pane.

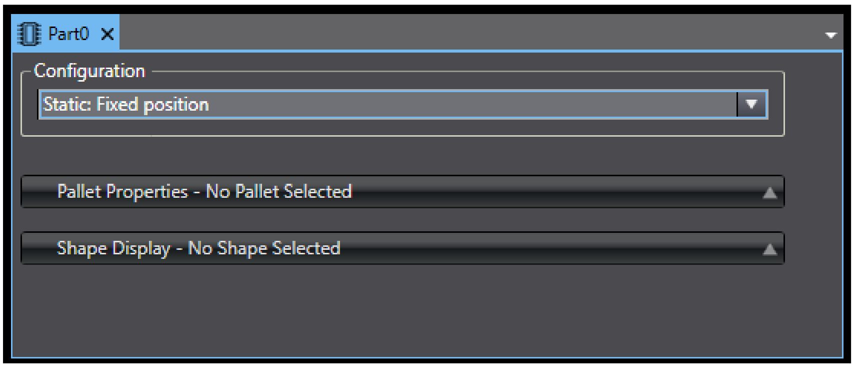


Figure 8-110 Part Configuration (Static Configuration Selected)

Configuration Drop-down List

The Configuration drop-down list box is used to specify how the target is input to the system. The options are described below.

- **Belt: Latching, belt camera, or spacing interval** - targets / instances are located on a conveyor belt using latching or fixed-spacing. Vision and / or a pallet may be included in the part delivery system. Refer to Configuration Drop-down List on page 373 for more information.

- **Static: Fixed position** - targets / instances are acquired from a static location such as a part feeder or a pallet. Refer to Configuration Drop-down List on page 373 for more information.
- **Vision: Fixed camera not relative to a belt** - locations are acquired through camera that is not located over a belt. Refer to Configuration Drop-down List on page 373 for more information.

NOTE: If the part is supplied on a belt with a camera, the **Belt: Latching, belt camera, or spacing interval** option must be selected.

Pallet Properties

Use the Pallet Properties area if you need to specify a pallet that is used to hold the part(s). Make reference to a Pallet object by checking **Pallet** and then use the *Select* button to specify that object as shown below.

NOTE: A Pallet object must already exist in the project. Refer to Pallet Object on page 460 for more information.

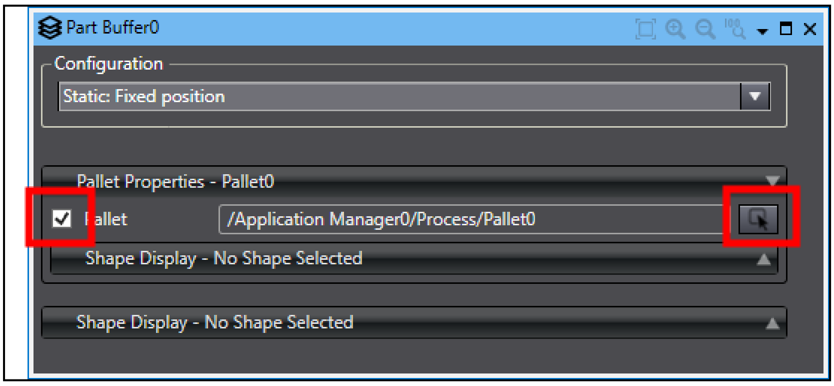


Figure 8-111 Add a Reference to a Pallet Object - Part Buffer

Shape Display (Pallet Properties)

Use the Shape Display to specify a shape to represent the Pallet in the 3D Visualizer when the Process Manager runs. Select the **Shape** check box and then use the **Select** button to specify a shape.

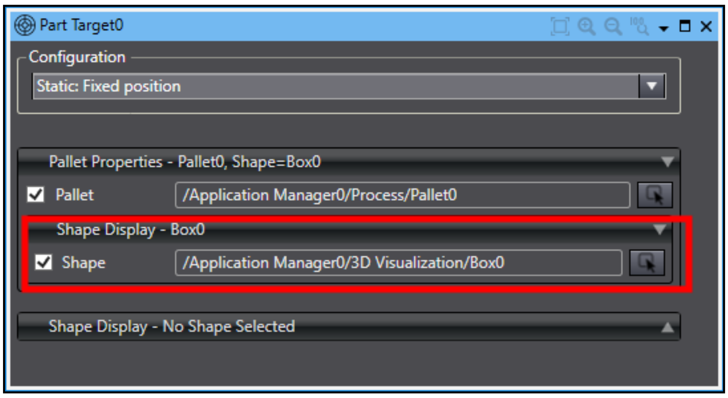


Figure 8-112 Shape Display - Pallet Properties - Part Target Object

Shape Display

Use the Shape Display to specify a shape to represent the Part in the 3D Visualizer when the Process Manager runs. Select the **Shape** check box and then use the **Select** button to specify a shape.

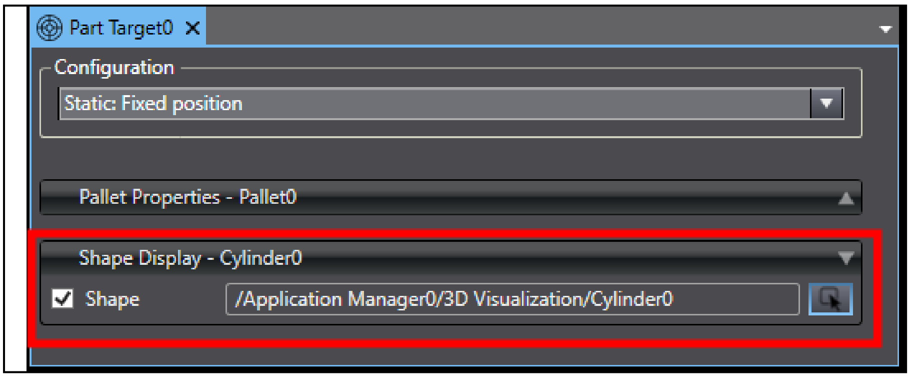


Figure 8-113 Part Shape Selection - Part Target

Belt: Latching, Belt Camera, or Spacing Interval Configuration

When Belt is selected for the Part Target configuration, the operation mode can be either Vision, Latch, or Spacing.

- Vision: a vision tool is used to detect the part on the belt.
- Latch: a latch sensor is used to detect the part on the belt.
- Spacing: parts are spaced evenly on the belt.

Belt Properties

This area is used to select the mode of the belt that is used to handle the part. You also specify other details related to the belt mode selection in this area. Use the information below to make appropriate selections.

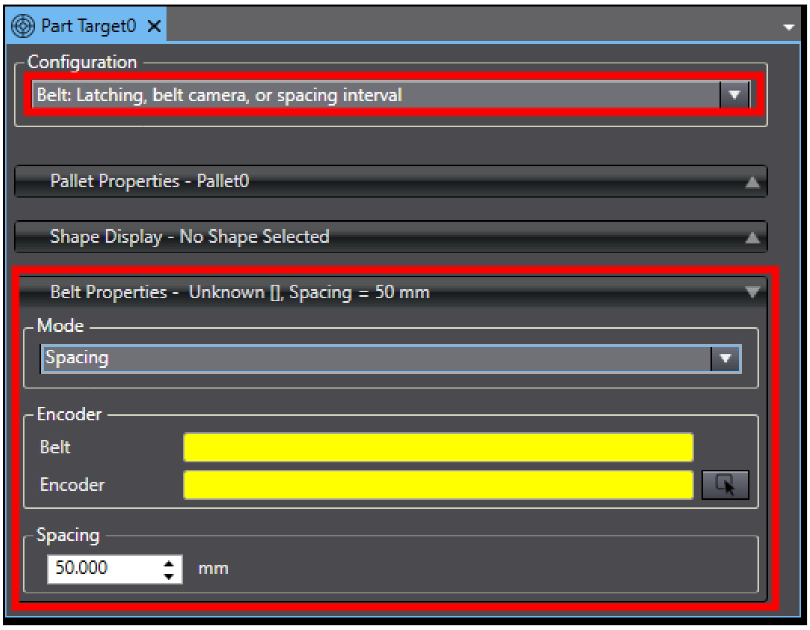


Figure 8-114 Belt Configuration - Part Target

Table 8-18 Belt Configuration - Belt Properties Item Description

Item	Description
Belt / Encoder	Select the encoder from a list of available Process Belt Encoders. This will populate the associated Belt object automatically.
Vision Tool (Vision Mode)	Select the vision tool used to detect the part on the belt. For applications where a custom vision tool is used, this item would be used to specify custom names that had been associated with the different results returned from that tool. As an option, select ***Use Named Instance (select Model or enter custom result name)*** and then use the **Select** button ( ) to reference an existing Locator Model or use the **Add** button ( ) to add a custom result name.
Spacing (Spacing Mode)	Specify the spacing in millimeters between targets / instances on the conveyor belt. It is important to recognize that there is no physical reference for where the spacing instances begin when a Process Manager is started. Spacing is convenient for emulation purposes, but in physical systems an upstream or downstream process or conveyor belt geometry may require that the spacing be synchronized with the rest of the machine. A latch sensor is recommended in this situation.

Static: Fixed Position Configuration

When Static is selected for the Part Target configuration, the Part Target is in a fixed position. There are no additional settings to configure with this selection.

Vision: Fixed camera not relative to belt

When Vision is selected for the Part Target configuration, a vision tool must be specified in the Vision Properties area.

Vision Properties

This area is used to select the vision tool and optionally, the named instance that is used to acquire the part position.

You can optionally specify a named instance and then select a Model or enter a custom result name.

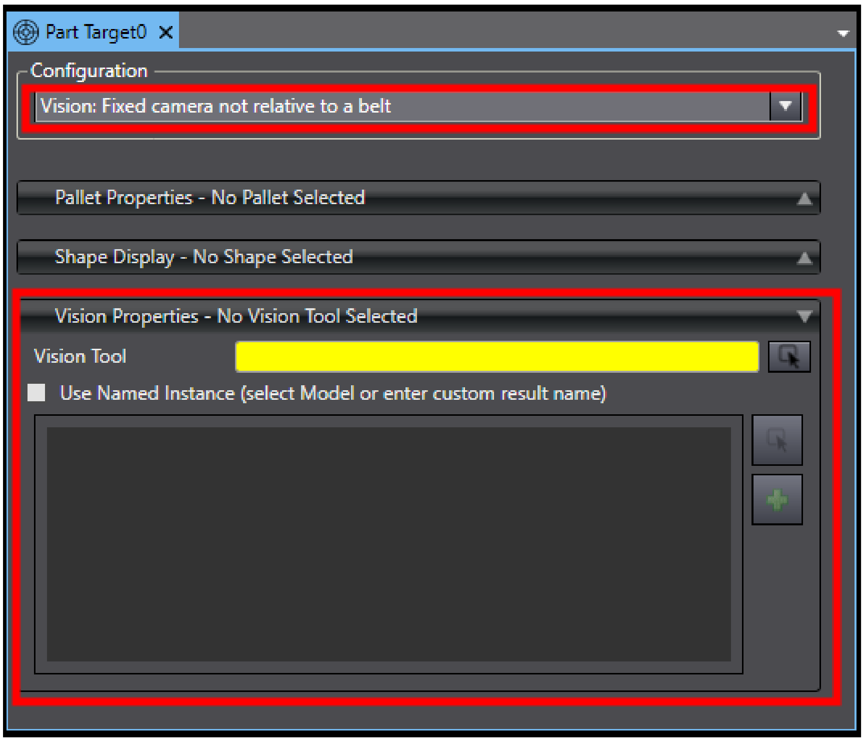


Figure 8-115 Vision Configuration - Vision Properties

Belt Object

A Belt object represents a physical conveyor belt in the workcell or packaging line. A belt may be tracked by multiple robots that may be controlled by a single or multiple controllers. Belts may also be related to multiple part or part target objects.

The Belt object provides settings for Active Control, Emulation Mode behavior, workspace positioning for 3D visualization and multi-robot allocation order, and a list of associated belt encoder inputs for related controllers. This section will describe how these settings are used.

NOTE: Belt objects operate differently in Emulation Mode. Refer to Emulation Mode on page 19 for more information.

Adding a Belt Object

To add a Belt object, right-click **Process**, select **Add**, and then click **Belt**. The new Belt object wizard will open.

NOTE: Controllers to be associated with the new Belt object must be online before adding the Belt object.

Follow the wizard steps below to define the Belt object.

- Set the belt size.
- Position the belt in the workspace.
- Select any controllers to be associated with the belt.
- Set belt control I/O signals (if the belt can be controlled).
- Select and test the encoder channel(s).

When you have completed the wizard steps, a Belt object will be added to the Multiview Explorer.

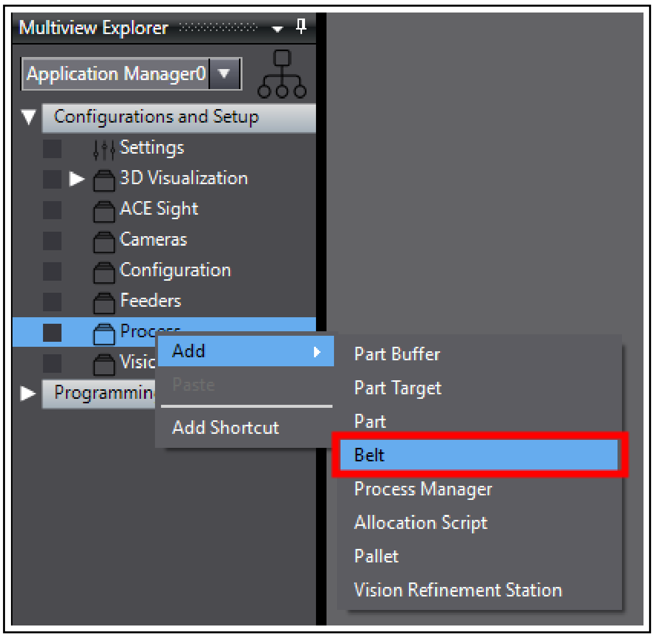


Figure 8-116 Adding a Belt Object

NOTE: After the Belt object is created, you can rename the new Belt object by right-clicking the item and selecting **Rename**.

Belt Configuration

To access the Belt configuration, double-click the object in the Multiview Explorer or right-click it and select **Edit**. This will open the Belt editor in the Edit Pane.

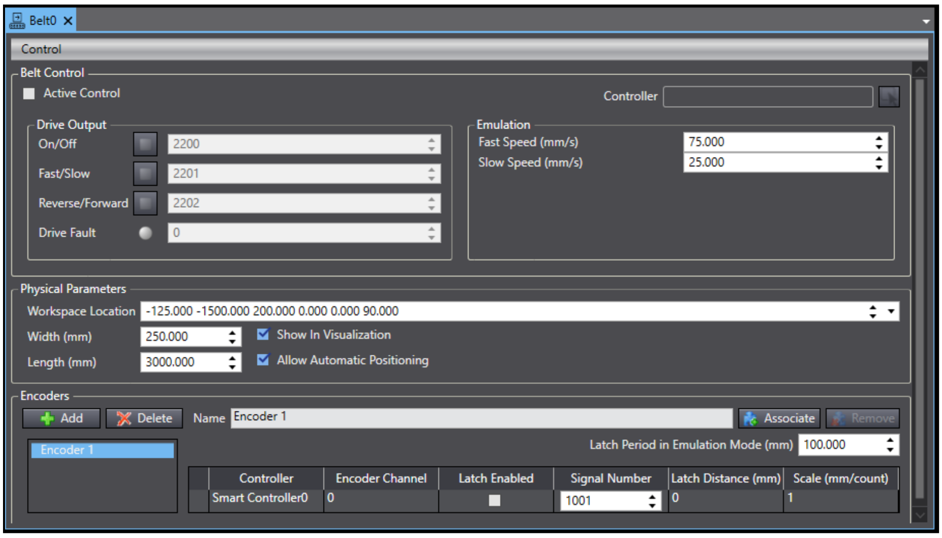


Figure 8-117 Belt Configuration Editor

Custom Belt Monitoring

When a belt is used to present part or target instances to a robot, the software creates a default V+ pro-gram to manage the belt operation. The settings associated with the belt monitoring can be viewed under the Control Sources section in the process manager editor.

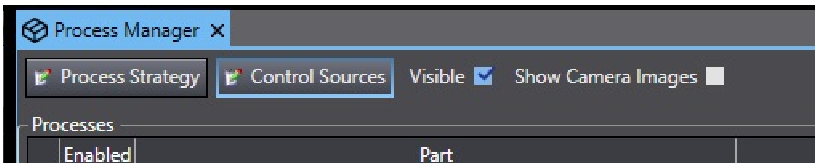


Figure 8-118 Belt, Control Sources

When selected, the available control sources are presented in a list on the left. When you select the belt source for a given belt object in your process configuration, you will see a page sim-ilar to the following figure. Selecting the Use Custom Program option will enable the custom configuration.

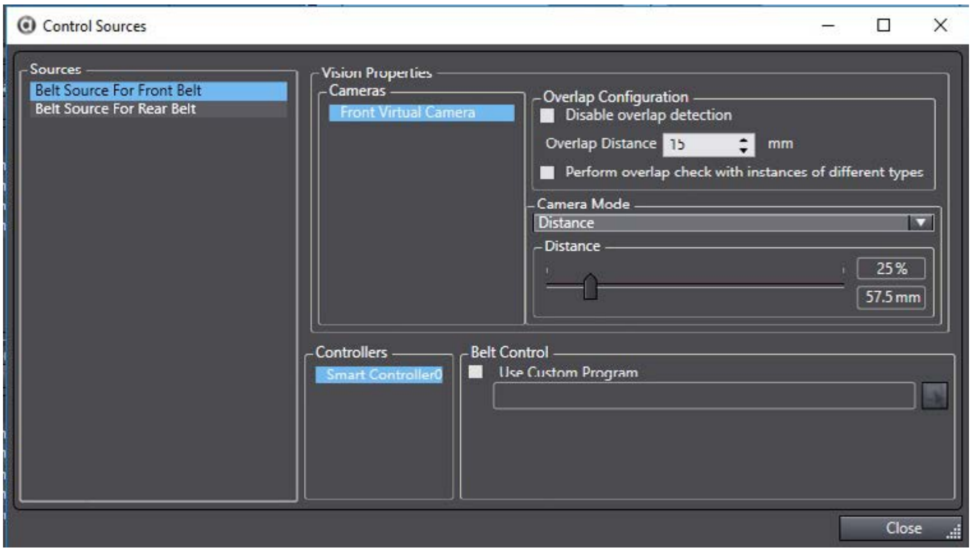


Figure 8-119 Belt Control

Depending on your specific configurations, different settings will be available. The V+ program can monitor the status of a belt, and any associated latches, cameras, and spacing configurations. The program also reports the status of these items to the PC.

Custom Belt Control

A part or target can be configured for presentation on a belt in one of three modes:

- Belt Camera
- Latch Input signal
- Instances created at a spacing interval

To handle these 3 cases, the process manager must download and run a V+ program. This program must monitor and control when parts and targets are created based on feedback from the belt encoders. As the various belt encoders change position, the program will send messages to the PC triggering the creation of parts and targets.

If the default behavior of the belt program is not sufficient, then the user can customize the default belt control program. The customization can be done in the control source editor. To open the editor, select **Use Custom Program**, as shown in the following figure.

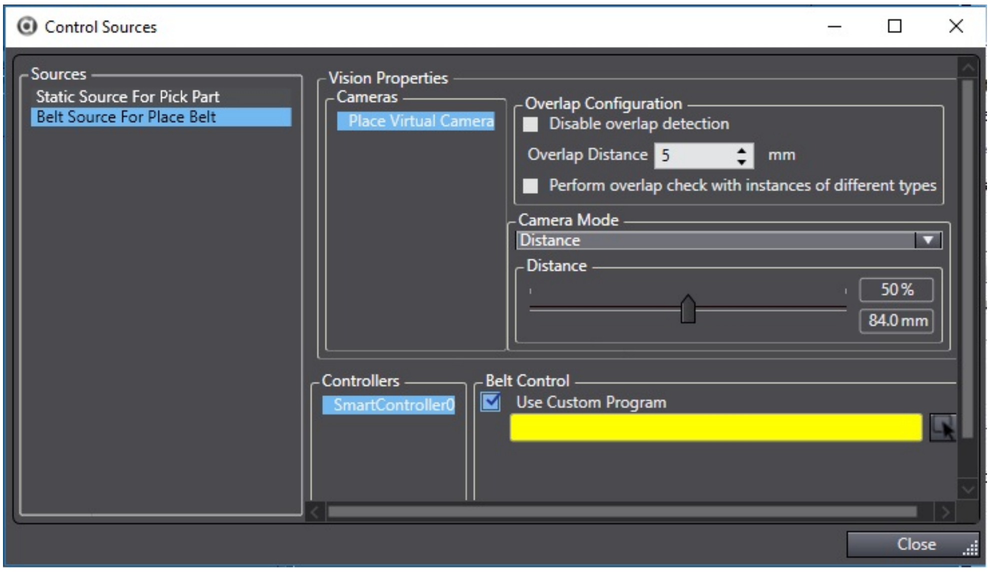


Figure 8-120 Custom Belt Program

The belt control program is a rather long program. To understand the behavior, it can best to break it into separate sections:

- Initialization
- Monitor encoder motion
- Monitor spacing points
- Monitor hardware latches
- Monitor camera points

Monitor Encoder Motion

Once the belt control finishes initializing control variables, it will monitor the encoder position and velocity. After it checks all of the encoders, it will periodically send the current encoder position and velocity to the PC using the call pm.ace.blt.pos, as shown in the following figure.

```
DO

    IF (TIMER(-3) < scan.time) AND (TIMER(-3) < send.time) THEN
        WAIT
        NEXT
    END

    CALL pm.blt.init(blt.idx)            ; Monitor belt tracking structures from the PC
    CALL pm.blt.chk.dflt(blt.idx)        ; Check drive fault status

    ; Read the current status of the encoders
    ; Periodically update the PC with the encoder velocity. If a 5%
    ; change in encoder velocity is detected, then send immediately

    send.encoder = (TIMER(-3) > send.time)
    FOR i = 0 TO pm.belt[blt.idx,pm.bcf.encoder]-1
        belt.num = pm.belt[blt.idx,pm.bcf.encoder,i]
        CALL pm.read.encoder(belt.num, encoder.value[blt.idx,i], encoder.vel[blt.idx,i])
        IF (last.enc.vel[blt.idx,i] <> encoder.vel[blt.idx,i]) THEN
            IF (last.enc.vel[blt.idx,i] == 0) OR (encoder.vel[blt.idx,i] == 0) THEN
                send.encoder = TRUE
            ELSE
                IF ABS((last.enc.vel[blt.idx,i]-encoder.vel[blt.idx,i])/encoder.vel[blt.idx,i]) > 0
                    send.encoder = TRUE
                END
            END
        END
        last.enc.vel[blt.idx,i] = encoder.vel[blt.idx,i]
    END

    IF (send.encoder) THEN
        FOR i = 0 TO pm.belt[blt.idx,pm.bcf.encoder]-1
            belt.num = pm.belt[blt.idx,pm.bcf.encoder,i]
            CALL pm.ace.blt.pos(blt.idx, belt.num, encoder.value[blt.idx,i], encoder.vel[blt.idx,i]
        END
        send.time = TIMER(-3)+send.interval
    END

    IF (TIMER(-3) < scan.time) THEN
        WAIT
        NEXT
    END
    scan.time = TIMER(-3)+scan.interval
```

Figure 8-121 Encoder Motion

Monitor Spacing Points

In the initialization section, tracking variables are initialized for the spacing reference points. When a spacing part or target is defined, the user specifies the distance between the generated instances. This spacing parameter is used, along with the scale, to determine how much the conveyor must move before a part is generated. After the conveyor moves the specified distance from the reference point, it will send a message to the PC to create an instance using pm.ace.blt.sp, as shown in the following figure.

```
; Look through the spacing reference points. If the encoder
; has reached a reference point, send the reference to ACE.
; Loop and make sure to send all reference points.

FOR i = 0 TO pm.belt[blt.idx,pm.bcf.sp.obj]-1

    idx = pm.belt[blt.idx,pm.bcf.sp.enc,i]
    encoder = encoder.value[blt.idx,idx]
    scale = pm.belt[blt.idx,pm.bcf.scale,idx]

    DO

        CALL pm.blt.travel(encoder, space.ref[blt.idx,i], distance)
        distance = distance*scale

        IF distance >= pm.belt[blt.idx,pm.bcf.spacing,i] THEN

            ; Update the reference position and handle
            ; encoder rollover.

            space.ref[blt.idx,i] = space.ref[blt.idx,i]+(pm.belt[blt.idx,pm.bcf.spacing,i]/scal
            CALL pm.blt.convert(space.ref[blt.idx,i])

            $spacing.item = $pm.belt[blt.idx,pm.bcf.sp.obj,i]
            CALL pm.ace.blt.sp(blt.idx, $spacing.item, space.ref[blt.idx,i], "")

        END
    UNTIL distance < pm.belt[blt.idx,pm.bcf.spacing,i]
END
```

Figure 8-122 Spacing Points

If you would like a custom tag to be associated with instances created by the spacing event, the call to pm.ace.blt.sp can be modified to pass in a tag for the last argument.

Monitor Hardware Latches

The program will go through the list of encoders that need to be monitored for latches. When a latch is detected, it will check the latched encoder position against the minimum latch distance that was defined in the belt editor. If the latch distance is sufficient, the latch information is sent to the PC using pm.ace.blt.ltch., as shown in the following figure.

```
; Look through the latch items. If a latch had been seen
; previously, then ensure the new latch is spaced far enough
; apart from the previous latch.

FOR i = 0 TO pm.belt[blt.idx,pm.bcf.latch]-1

    idx = pm.belt[blt.idx,pm.bcf.latchenc,i]
    encoder = pm.belt[blt.idx,pm.bcf.encoder,idx]+1
    scale = pm.belt[blt.idx,pm.bcf.scale,idx]

    latch.num = LATCHED(-encoder)
    WHILE (latch.num) DO

        ; Get the index associated with the latch that was
        ; found and read the latch. The latch may not be one we are
        ; monitoring for. In that case, ignore the latch

        CALL pm.blt.gltchix(blt.idx, latch.num, idx)
        latch.value = DEVICE(0,encoder-1,sts,4)

        IF (idx >= 0) THEN

            ; If latch distance checking is in effect, we must check
            ; if the distance between latches is large enough.

            IF latch.ref.chk[blt.idx,idx] THEN
                CALL pm.blt.travel(latch.value, latch.ref[blt.idx,idx], distance)
                scale = pm.belt[blt.idx,pm.bcf.scale,i]
                distance = distance*scale
                IF (distance < pm.belt[blt.idx,pm.bcf.latchdst,idx]) THEN
                    latch.num = 0
                END
            END

            ; If there is a latch to report, send to the PC.
            ; Update the latch reference for latch distance
            ; checking when the next latch is detected.

            IF latch.num THEN
                IF (sts >= 0) THEN
                    CALL pm.ace.blt.ltch(blt.idx, encoder-1, latch.num, latch.value, "")
                    latch.ref[blt.idx,idx] = latch.value
                    latch.dist[blt.idx,idx] = 0
                    latch.ref.chk[blt.idx,idx] = TRUE
                END
            END
        END

        latch.num = LATCHED(-encoder)
    END
```

Figure 8-123 Monitor Hardware Latches

Some applications may want to change the logic for when latches are reported. For example, an application may require only sending every-other latch so a robot only processes 50% of the instances generated from the latch.

Additionally, if you would like a custom tag to be associated with instances created by the latch event, the call to pm.ace.blt.ltch can be modified to pass in a tag for the last argument.

Monitor Camera Points

In the initialization section, tracking variables are initialized for the camera reference points. When a belt-camera based part or target is referenced in the process manager, the user can specify if the picture is triggered by conveyor motion or a digital signal. When conveyor motion is specified, you will specify a camera picture percent. This is used, along with the scale and the average field of view size, to determine how much the conveyor must move before a camera picture request is generated. After the conveyor moves the specified distance from the reference point, it will send a message to the PC to per-form a picture using pm.ace.blt.cam.

If you specified a signal trigger, pictures will be taken when the signal is triggered.

```
; Look through the belt camera items

FOR i = 0 TO pm.belt[blt.idx,pm.bcf.cameras]-1

    take.picture = FALSE

    ; If operating in picture distance mode, then calculate how far the encoder
    ; has moved and see if a picture needs to be taken.

    IF pm.belt[blt.idx,pm.bcf.pic.md,i] == pm.bc.pmd.dist THEN

        idx = pm.belt[blt.idx,pm.bcf.cam.enc,i]
        encoder = encoder.value[blt.idx,idx]
        scale = pm.belt[blt.idx,pm.bcf.scale,idx]

        CALL pm.blt.travel(encoder, cam.ref[blt.idx,i], distance)
        distance = distance*scale

        inc = pm.belt[blt.idx,pm.bcf.cam.fov,i]*pm.belt[blt.idx,pm.bcf.fov.intv,i]

        IF distance > inc THEN

            take.picture = TRUE

            ; Update the reference position and look for
            ; rollover. If the camera gets behind by 2x the
            ; distance, set the reference based on the encoder
            ; position. The belt is moving faster than the
            ; camera can process.

            IF distance > 2*inc THEN
                cam.ref[blt.idx,i] = encoder-(inc/scale)
            ELSE
                cam.ref[blt.idx,i] = cam.ref[blt.idx,i]+(inc/scale)
            END
            CALL pm.blt.convert(cam.ref[blt.idx,i])

        END
    ELSE
        ; Operating in trigger mode. If the trigger signal goes on, then we need to take a pict

        IF SIG(pm.belt[blt.idx,pm.bcf.pic.trig,i]) THEN
            take.picture = TRUE
        END
    END

    IF take.picture THEN

        $spacing.item = $pm.belt[blt.idx,pm.bcf.cameras,i]
        remote = pm.belt[blt.idx,pm.bcf.cam.isrm,i]
        CALL pm.ace.blt.cam(blt.idx, $spacing.item, remote, cam.ref[blt.idx,i])

        ; If we are in trigger mode, then we need to wait until the signal goes low
        ; But we check if the process manager has not been stopped
        ; If we are in emulation mode, we will simply reset the trigger with no wait

        IF (pm.belt[blt.idx,pm.bcf.pic.md,i] == pm.bc.pmd.trig) THEN
            IF sv.emulate.mode THEN
                SIGNAL -pm.belt[blt.idx,pm.bcf.pic.trig,i]
            ELSE
                DO
                    CALL pm.chk.stat(run)
                    WAIT
                UNTIL NOT ((SIG(pm.belt[blt.idx,pm.bcf.pic.trig,i]) AND run == TRUE))
            END
        END
    END
END
```

Figure 8-124 Monitor Camera Points

Custom Belt Control

A part or target can be configured for presentation on a belt in one of three modes:

- Belt Camera
- Latch Input signal
- Instances created at a spacing interval

To handle these 3 cases, the process manager must download and run a V+ program. This program must monitor and control when parts and targets are created based on feedback from the belt encoders. As the various belt encoders change position, the program will send messages to the PC triggering the creation of parts and targets.

If the default behavior of the belt program is not sufficient, then the user can customize the default belt control program. The customization can be done in the control source editor. To open the editor, select **Use Custom Program**, as shown in the following figure.

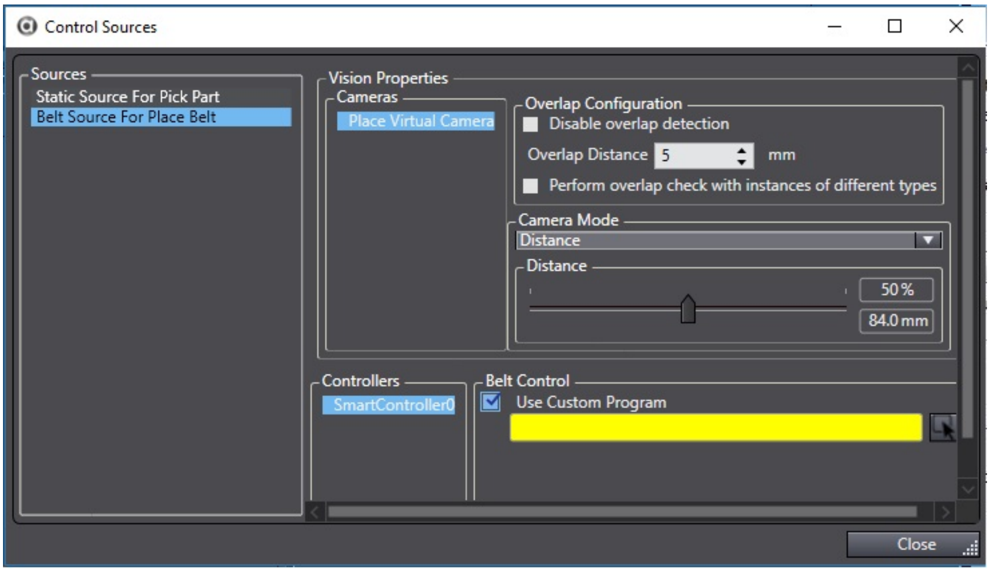


Figure 8-125 Custom Belt Program

The belt control program is a rather long program. To understand the behavior, it can best to break it into separate sections:

- Initialization
- Monitor encoder motion
- Monitor spacing points
- Monitor hardware latches
- Monitor camera points

Control Menu Items

The Belt Control Menu items provide the following functions that can be used as necessary while configuring a Belt object.

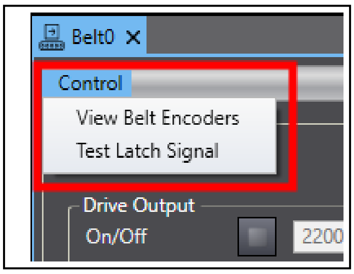


Figure 8-126 Belt Control Menu Items

View Belt Encoders

Selecting this menu item will display a wizard used to view the operation of the belt encoder.

Select a belt encoder from the list and then activate the belt and observe the values. These values should change when the belt moves. You can use the belt controls in the wizard if Active Control is enabled or you are in Emulation mode.

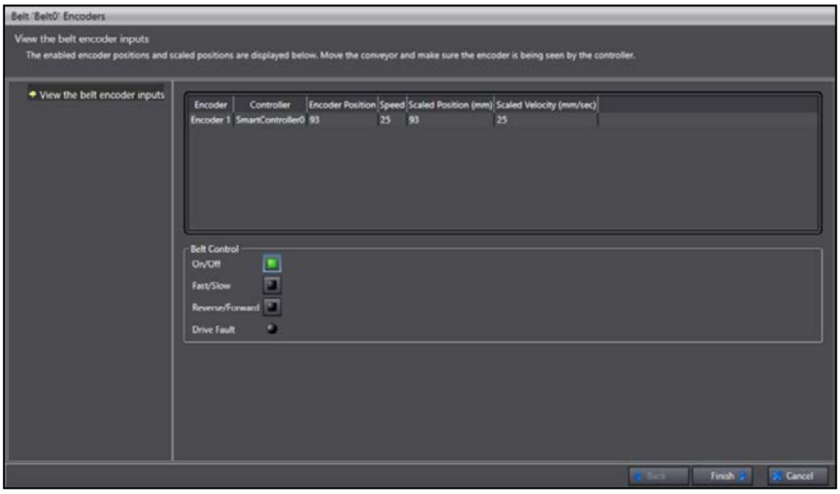


Figure 8-127 View the Belt Encoder Inputs

Test Latch Signal

Selecting this menu item will display a wizard used to view the operation of the encoder latch signal. Select an encoder latch you want to test, click the **Next** Button, and then use the **Pulse** Button to ensure the Latch Count increments correctly.

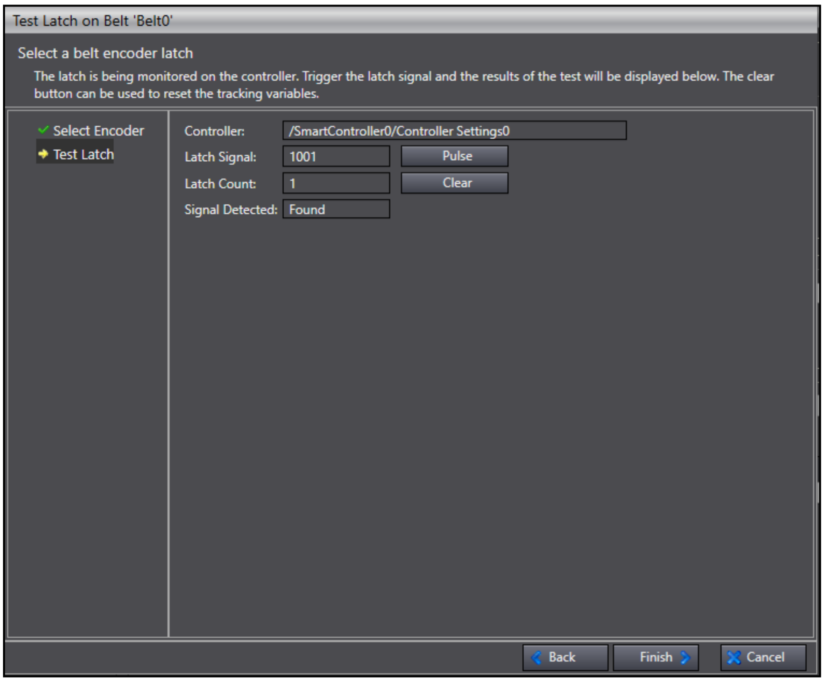


Figure 8-128 Test Encoder Latch Signal

NOTE: A Belt Encoder Latch must be configured and the latch must be enabled in the Encoders section to make the latch signal appear in the Test Latch Signal wizard. Refer to Configure Belt Encoder Latches on page 213 for more information.

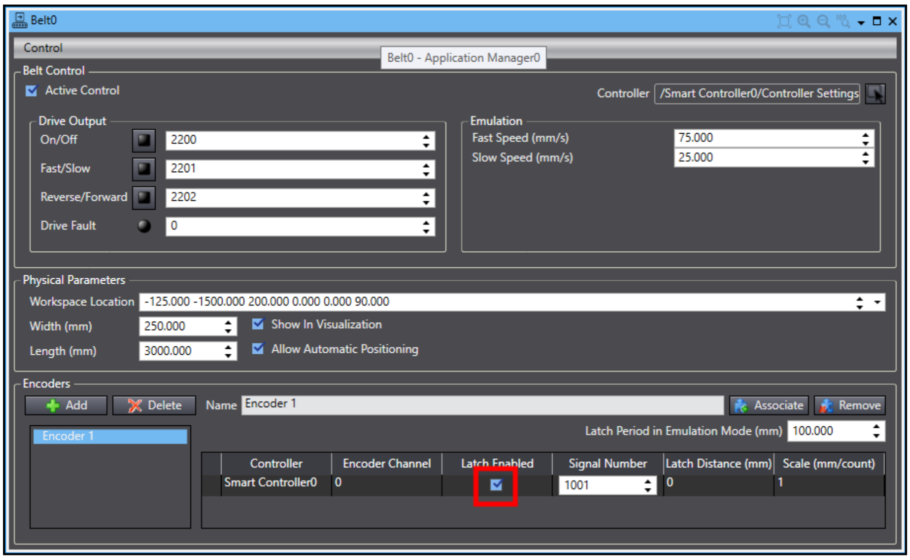


Figure 8-129 Test Encoder Latch Signal - Latch Enabled

Active Control

Active Control can be configured to control the belt during the calibration and teaching process. It can also optionally be set to control the belt during run time based on part or part target instance location.

If the conveyor belt can be controlled by SmartController digital I/O signals, enable Active Control, select the controller, and enter the appropriate signal numbers in the Drive Output fields. Typically, if the Process Manager can stop the belt without affecting upstream or downstream processes, then the controller of the robot positioned farthest downstream is selected to control the belt. This robot is usually selected to provide all robots the opportunity to process the part or part target instance, and if an instance is not processed by any robot, the belt can be stopped to ensure all of them are processed. Refer to Process Strategy Belt Control Parameters on page 447 for more information.

Physical Parameters

The Physical Parameters are generally set when creating the Belt object, but they can be modified as needed when the Process Manager is not executing. The Workspace Location, Width, and Length of the Belt object should be configured to closely approximate the position of the physical belt relative to robots and other workcell hardware. The accuracy of robot belt tracking behavior is dependent on the belt calibration and scale factor, not on the location of the Belt object. However, the Belt object shown in the 3D Visualizer provides a graphical representation of the conveyor and is used to understand the relative position of multiple robots along the belt for the purposes of instance allocation.

NOTE: In Emulation Mode it is common to set the Belt object position before performing calibrations so that it can be used as a visual reference. On physical systems it is common to refine the position of the Belt object after performing belt calibrations.

Belt Direction of Travel

In the 3D Visualizer, the Belt object displays three red arrows in the 3D Visualizer at one end of the belt that represent direction of belt travel. These red arrows must align with the white arrows that indicate direction of belt travel for each belt calibration.

Figure 8-130 shows examples of correct and incorrect belt direction of travel. Notice the lower belt has three red arrows on the right oriented in the opposite direction of the white arrows in the calibrations, which is incorrect. This results in the parts within the red box not being allocated to the upstream robot because the Belt object indicates parts should be allocated to the downstream robot first. This results in the downstream robot processing parts while all upstream robots do not pick available instances.

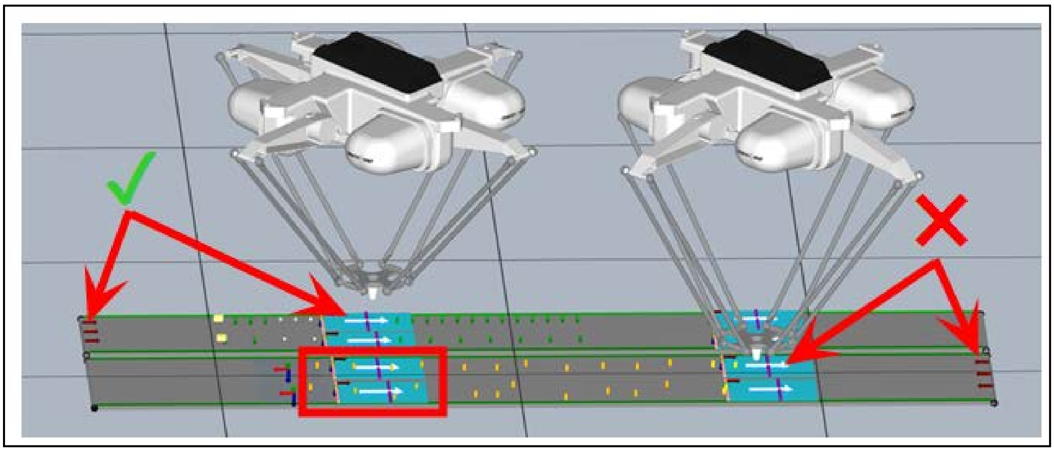


Figure 8-130 Correct (Left) and Incorrect (Right) Belt Direction of Travel

Incorrect belt direction of travel can be corrected by rotating the roll angle of the Belt object 180 degrees to align the direction of belt travel between the Belt object and the associated belt calibrations, and adjusting X and Y position to accurately represent the physical belt in the system. Once corrected, both robots can process instances as expected, where any instances not processed by the upstream robot can be processed by the downstream robot as shown in Figure 8-131 .

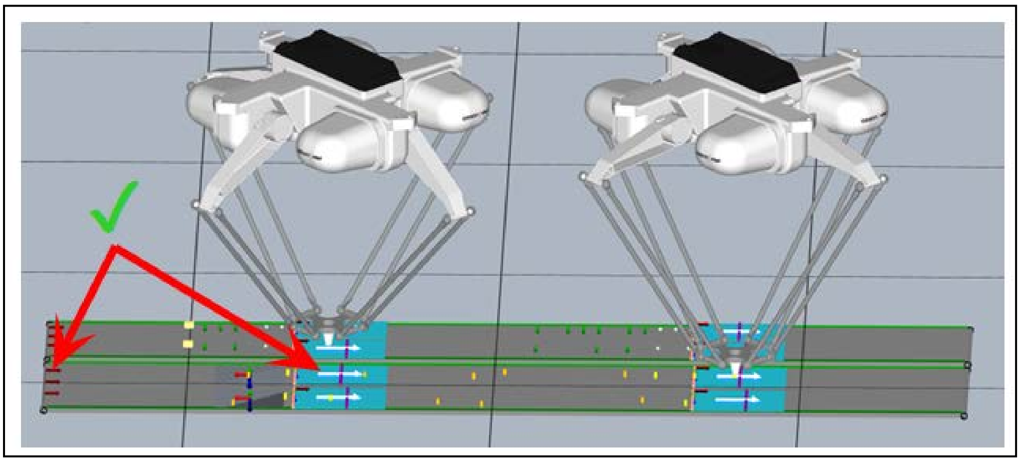


Figure 8-131 Corrected Belt Direction of Travel

Encoders and Encoder Associations

The Belt object provides an interface for defining Encoders and Encoder Associations. A single Belt object may be used as a belt source for multiple part and part target types, and also may be associated with belt encoder inputs for multiple controllers.

Belt object Encoders are effectively virtual encoders for the purpose of constructing tracking structures and allocation limits independently for each part or part target object type.

Encoder Associations are used to understand the physical belt encoder and latch signal inputs that are wired to each robot controller that tracks the belt. Depending on the system configuration, you may need to configure Encoders, Encoder Associations, or both. This section will describe the different situations that are supported.

Multi-Robot, Multi-Belt Configuration Example

Consider the system configuration shown in the following figure with two robots and two controllers (one controller per robot). The lower belt is the part picking belt with two belt-relative cameras locating two different part types (camera one locates Part1 one and camera two locates Part2). The upper belt is the part placing belt with two latch sensors used for generating two different part target type instances. A belt encoder input for each belt is required for each controller.

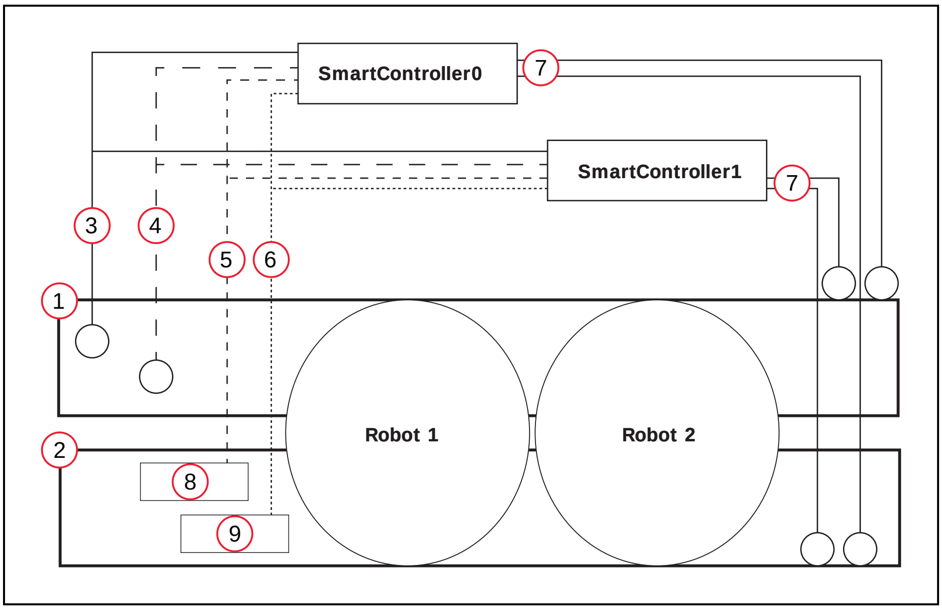


Figure 8-132 Encoder Associations Example Configuration

Table 8-19 Encoder Associations Example Configuration Description

Item	Description
1	Place Belt
2	Pick Belt

Item	Description
3	Sensor Signal 1003
4	Sensor Signal 1004
5	Latch Signal 1002
6	Latch Signal 1001
7	Belt Encoder Inputs
8	Camera 2
9	Camera 1

With the configuration shown in the figure above, Belt Encoder Latches are configured as shown below, assuming a rising edge for each part and part target detection.

With a different configuration the falling edge could be assumed, both latches are available.

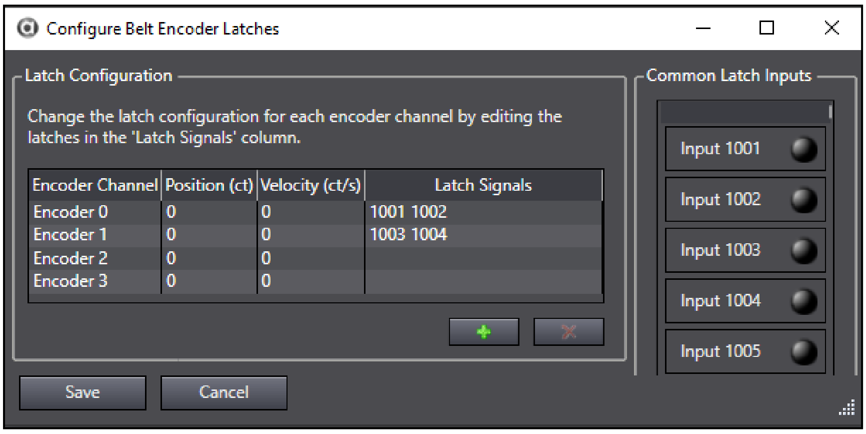


Figure 8-133 Belt Encoder Latch Configuration

In the Belt object, a virtual encoder is needed for each part object (Part1 and Part2). Each virtual encoder will have an encoder association with the corresponding Belt object Encoder Channel of each controller, and the latch signal of the corresponding camera detecting that part object type as shown below in Figure 8-134 and Figure 8-135 below.

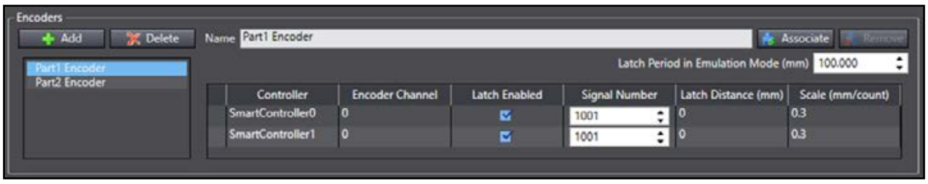


Figure 8-134 Part1 Encoder Associations and Latch Signals

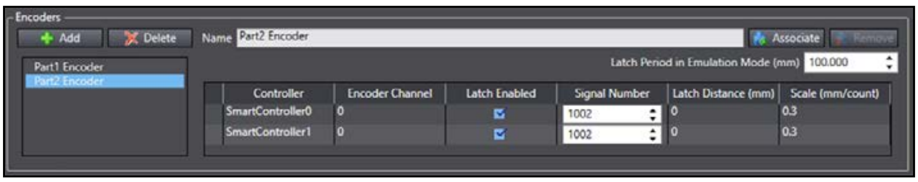


Figure 8-135 Part2 Encoder Associations and Latch Signals

Part1 and Part2 configurations include references to their respective virtual encoders and vision tool for location as shown in the figure below.

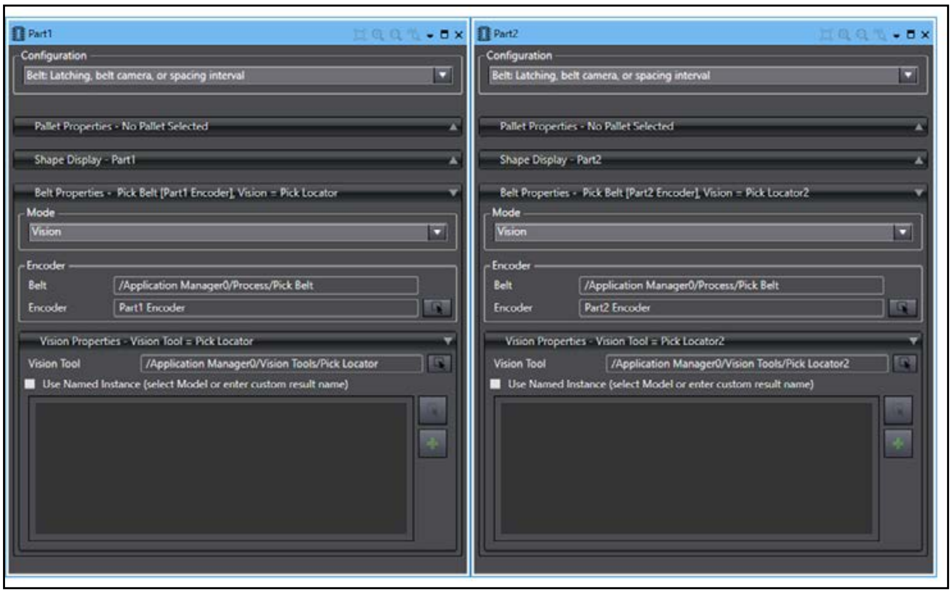


Figure 8-136 Part1 and Part2 Configurations

The separate virtual encoders are necessary to support independent tracking structures for the different part and part target types, including individual belt calibrations and allocation limits.

The separate encoder associations and latch signals allow Pack Manager applications to manage capturing and storing latch signals and encoder positions of every instance for each controller. When an instance is not processed by the upstream robot and is reallocated to the downstream robot, the latch position reference is automatically changed from the SmartController0 encoder latch position to the SmartController1 encoder latch position.

> **Additional Information**: When an instance is allocated to the next controller and the latch reference changes, an instance can jump in the 3D Visualizer. This is often due to poor sensor calibrations or incorrect robot locations, as shown in the figure below. This can cause confusion when instances jump farther upstream when deallocated from the upstream robot. It is highly recommended to keep the 3D Visualizer orderly and represent the hardware system as closely as possible. This prevents many issues during commissioning and makes troubleshooting easier if issues arise.

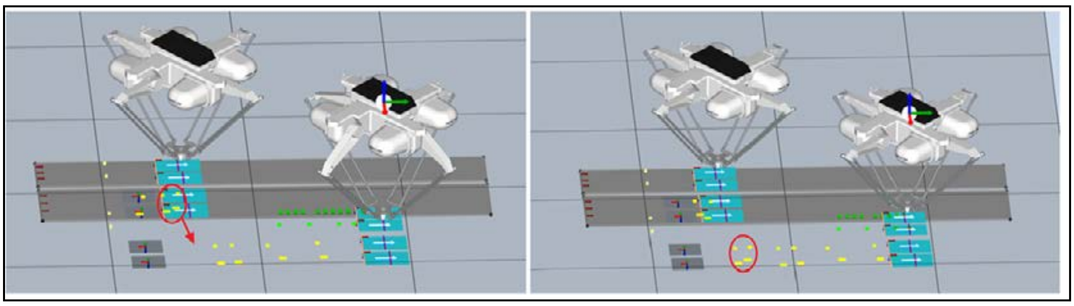


Figure 8-137 Instances Jumping from Reallocation/Latch Reference Change

In this configuration, each camera is relative to independent belt calibrations and allocation limits as shown in Figure 8-138 and Figure 8-139 below. Notice that there is a Pick Belt calibration for each virtual encoder.

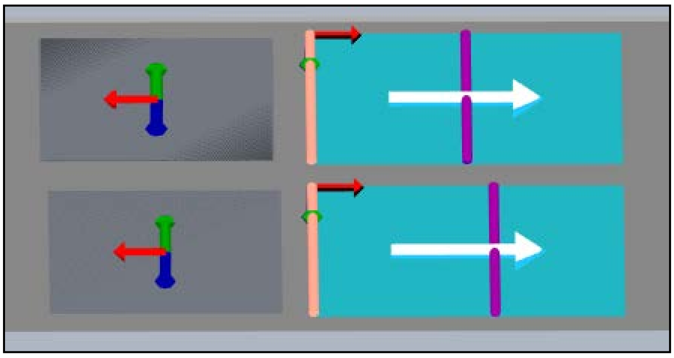
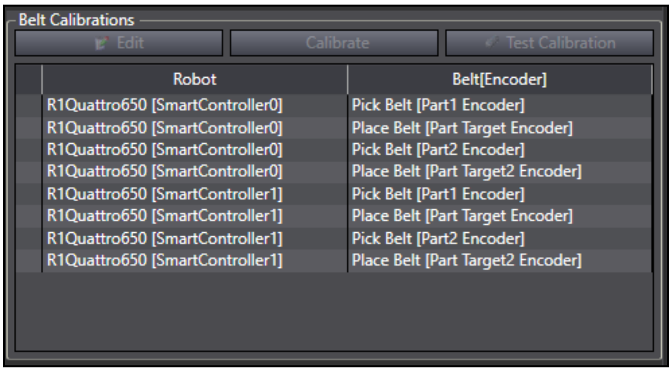


Figure 8-138 Independent Belt Calibrations



Belt Calibrations

Edit | Calibrate | Test Calibration

Robot	Belt[Encoder]
R1Quattro650 [SmartController0]	Pick Belt [Part1 Encoder]
R1Quattro650 [SmartController0]	Place Belt [Part Target Encoder]
R1Quattro650 [SmartController0]	Pick Belt [Part2 Encoder]
R1Quattro650 [SmartController0]	Place Belt [Part Target2 Encoder]
R1Quattro650 [SmartController1]	Pick Belt [Part1 Encoder]
R1Quattro650 [SmartController1]	Place Belt [Part Target Encoder]
R1Quattro650 [SmartController1]	Pick Belt [Part2 Encoder]
R1Quattro650 [SmartController1]	Place Belt [Part Target2 Encoder]

Figure 8-139 Pick Belt Calibrations for Each Virtual Encoder

Alternatively, the ACE software supports configurations that require multiple cameras to be relative to a single robot-to-belt calibration and set of allocation limits as shown in Figure 8-140 and Figure 8-141 below, where Part1 and Part2 are configured to use a single virtual encoder. This is achieved by defining multiple latch signals for specific encoder associations and configuring the corresponding robot-to-sensor belt camera calibrations to use specific latch signal numbers. This is only valid for belt cameras. For example, multiple latch signals are not allowed if the configuration is for belt-latch configuration, such as locating multiple pallets with different latch signals. For latch and spacing calibrations, use multiple virtual encoders.

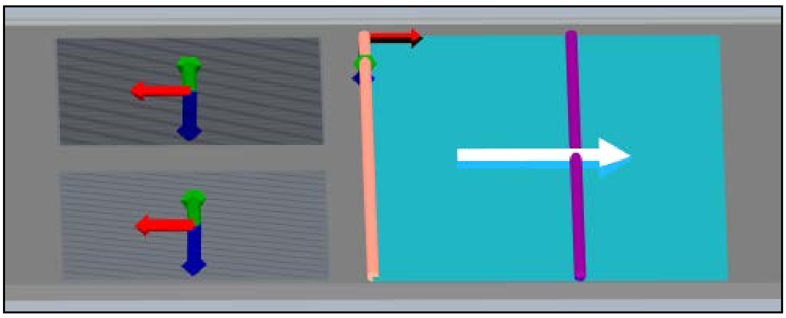


Figure 8-140 Part1 and Part2 Configured to Use Single Virtual Encoder

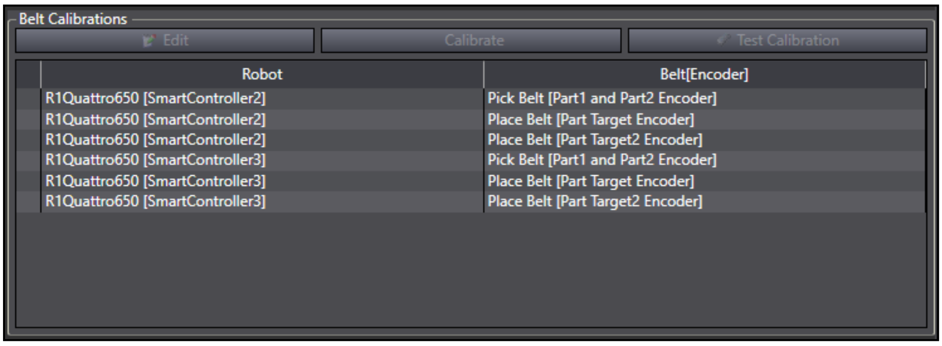


Figure 8-141 Allocation Limit Associations in Belt Calibrations

Multiple Cameras Relative to a Single Robot-to-belt Calibration

Use the following procedure to configure multiple cameras relative to a single robot-to-belt calibration.

1. Open the Belt object and verify that you have associated a controller with the belt encoder.

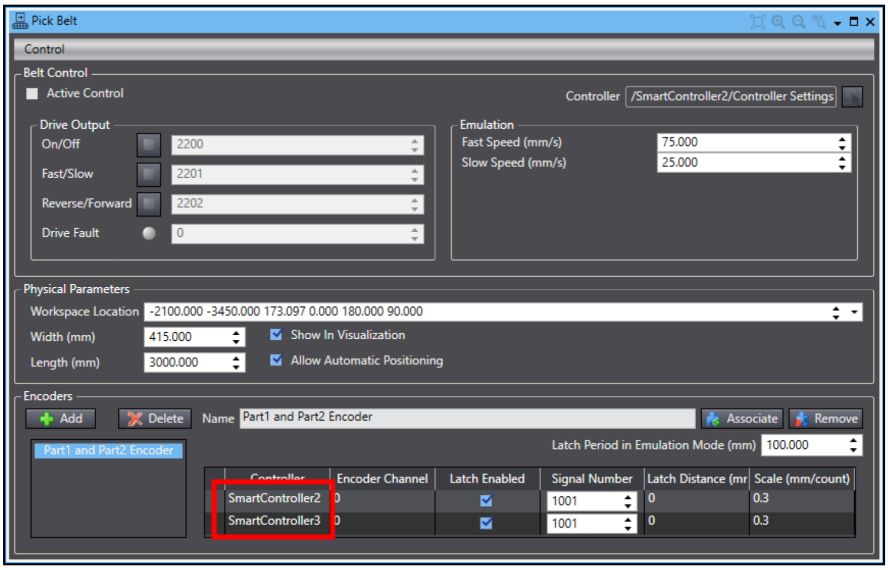


Figure 8-142 Belt Encoder Association

2. Specify the latch signals used by each camera in the Signal Number field. Multiple signals must be separated by a space, as shown in the following figure.

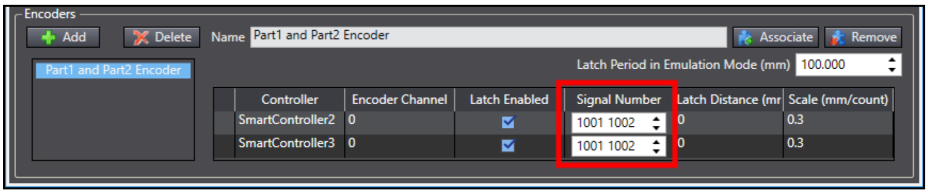


Figure 8-143 Specify Multiple Latch Signals

3. Locate the Robot-to-Sensor belt camera calibrations in the Process Manager. Select a Sensor Calibration and click the **Edit** Button.

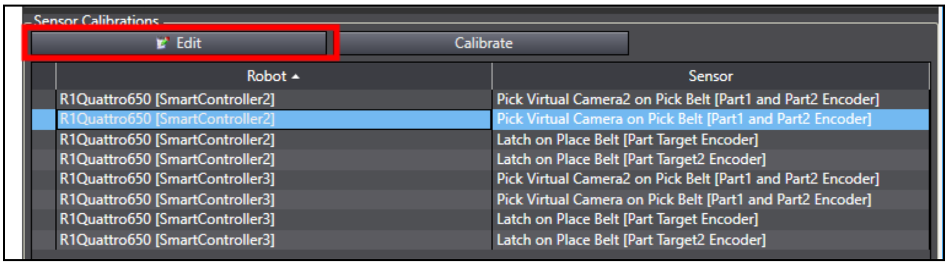


Figure 8-144 Edit the Sensor Calibration

4. Expand the Belt Latch Configuration parameter group, uncheck ***Use Default***, and then enter the desired latch signal number associated with that camera.

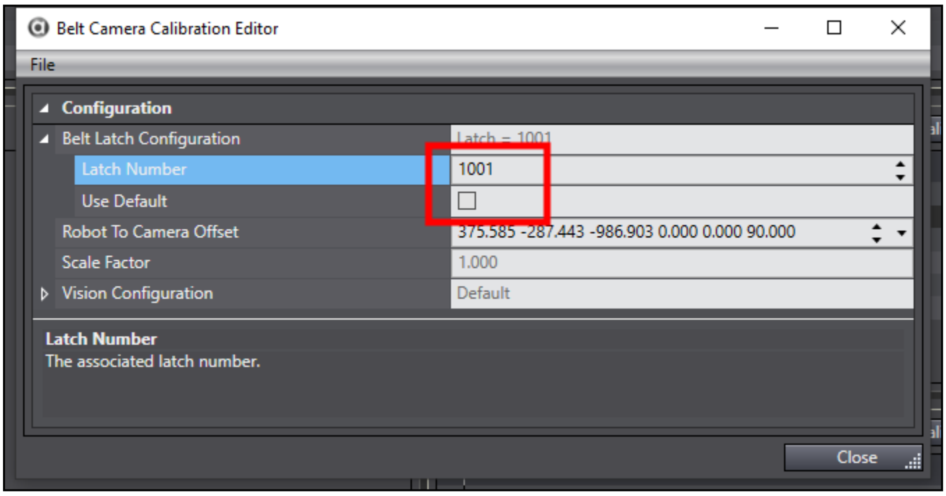


Figure 8-145 Edit the Belt Camera Calibration

5. Repeat steps 3 and 4 for the other belt camera calibrations and corresponding latch signals. Once all belt camera calibrations and latch signals are accounted for, the procedure is complete.

Process Manager Object

The Process Manager is the central control point for developing a process-managed application, such as an Pack Manager packaging application. It allows you to create and configure complex applications without writing any programming code. For advanced development, it provides access to V+ programming controls that allow you to modify or customize your application.

> **NOTE:** When Emulation Mode is enabled, robot-to-hardware calibrations and referencing procedures use 3D Visualization. Refer to Emulation Mode on page 19 for more information.

Process Components

This section describes the Process components, which are accessed from the Process Manager object. The other application components, such as robots, grippers (end effectors), controllers, and vision tools are described in other sections of this documentation.

Process Pallets

The Process Pallet object is used to define the layout and location of a pallet. The pallet can be in a static position or it can be located on a conveyor belt. The pallet can use a traditional row and column part layout or use a radial part layout.

Belts and Belt Encoders

The Belt object defines a conveyor belt used by the system. The Belt object maintains a list of encoders that are associated with the conveyor. The Belt Encoder defines the mm/count ratio of the encoder. The Belt Encoder Controller Connection maintains a list of controllers that the encoder is electrically connected to. The controller connection can also specify controller latching to a particular encoder. The Belt object also contains belt speed and start / stop controls

Parts and Part Targets

A Part object defines a part that is input for processing. The Part object has a Configuration drop-down list box that is used to specify how the part is input to the system.

A Part Target object defines a possible destination for a part. The possible configurations for a Part Target object are the same as for a Part object. Depending on the selected configuration, additional information can be defined when configuring the Part / Part Target as described below.

Part / Part Target Configuration	Vision Properties	Belt Properties	Pallet
Belt	Optional	Required	Optional
Static	Not Used	Not Used	Optional
Vision	Required	Not Used	Optional

Part and Part Target Configuration Options

The Part and Part Target configuration defines the part pick or place requirements. The following options are available.

Table 8-20 Part and Part Target Configuration Option Details

Part and Part Target Configuration	Description	Details
Belt	The part is picked from or placed onto a conveyor belt. It may use latching, a camera, or a spacing interval to determine the position.	A belt and encoder must be specified for use with the Part / Part Target. Then, a Belt Mode is defined that describes how the part is related to the belt.

<table>
<tr><th>Part and Part Target Configuration</th><th>Description</th><th>Details</th></tr>
<tr><td></td><td>A pallet is optional.</td><td>For this item, additional information is required based on the options below.
Belt Mode: Vision
• Vision properties are required.
• Spacing is not used.
Belt Mode: Latch
The latch information is taken from the Belt object linked to the Belt Properties.
• Vision properties are not used.
• Spacing is not used.
Belt Mode: Spacing
• Vision properties are not used.
• Spacing is required.</td></tr>
<tr><td>Static</td><td>The part is picked from or placed to a fixed location. Because it is a fixed location, no camera or belt is used.
A pallet is optional.</td><td>---</td></tr>
<tr><td>Vision</td><td>The part pick or place process requires a fixed-location camera. There is no belt used.
A pallet is optional.</td><td>A vision tool is specified that is used to locate the part. For example, this could be an inspection tool that filters instances based on some criteria.
Additionally, the vision properties can be configured to filter the vision results based on a part name. This will most likely be associated with a named part returned from a locator model.</td></tr>
</table>

Part Process

A Part Process identifies a robot that can pick a Part or collection of Parts and place it at a Part Target or collection of Part Targets. The Process Manager is responsible for processing Parts input to the system and routing them to a Part Target. To do so, it maintains a Part Process list. The Process Manager examines the list of Part and Part Targets associated with the Part Processes defined by the user. It will generate a list of Calibration objects, which are displayed to the user, as follows.

- Robot-to-Belt Calibration
- Robot-to-Belt-Camera Calibration
- Robot-to-Belt-Latch-Sensor Calibration
- Robot-to-Fixed-Camera Calibration
- Robot-to-Belt-Spacing-Reference Calibration

Each calibration object relates the robot to another hardware element in the application.

The Part Process defines a possible processing scenario for handling a Part. The Process Strategy is responsible for deciding which robots will process which parts. This is done using the list of Part Process objects as a guide to the valid combinations.

If a Part or Part Target is a pallet, then the Part Process object allows for a Pallet Exclusion Configuration to be defined. The user can limit the pallet positions that can be accessed by the robot in this configuration.

A relative priority can be associated with a given part process. This priority is used by the Process Manager when allocating parts to robots.

The Part Process defines a gripper pick configuration and where the robot will place the parts.

The Process Manager examines the list of Part and Part Targets associated with the Part Processes defined by the user. It will generate a list of Calibration objects, which are displayed to the user, as follows: l Robot-to-Belt Calibration l Robot-to-Belt-Camera Calibration l Robot-to-Belt-Latch-Sensor Calibration l Robot-to-Fixed-Camera Calibration l Robot-to-Belt-Spacing-Reference Calibration Each calibration object relates the robot to another hardware element in the application.

Pallets

Pallet is an optional parameter that specifies the parts are acquired from a pallet or placed into a pallet. This optional parameter can be used in conjunction with a Belt, Static, or Vision configuration. It is important to note that when used with a Vision or Belt, the vision or belt is configured to locate the origin of the pallet, not the parts in the pallet.

Process Manager Customization

The process manager architecture was designed with extensibility and customization in mind. Many aspects of the product can be changed to meet custom application needs. When you customize some aspect of a process manager application, the system will create a copy of the default behavior as a starting point for your changes.

Customizations can be defined at various places in the process manager user interface. This section details provides an overview of the possible customizations and identifies where these are located in the user interface.

The primary process manager customizations are:

- Process Strategy Customization
- Controller Customizations, refer to See "Controller Customization"
- Robot Customizations
- Belt Monitoring
- Motions Settings: Pick and Place and Refinement

Process Strategy Controller Parameters

The Controller Parameters are displayed when the controller is selected in the Process Strategy Editor. The Controller Parameters group is used to specify custom V+ programs for the selected controller.

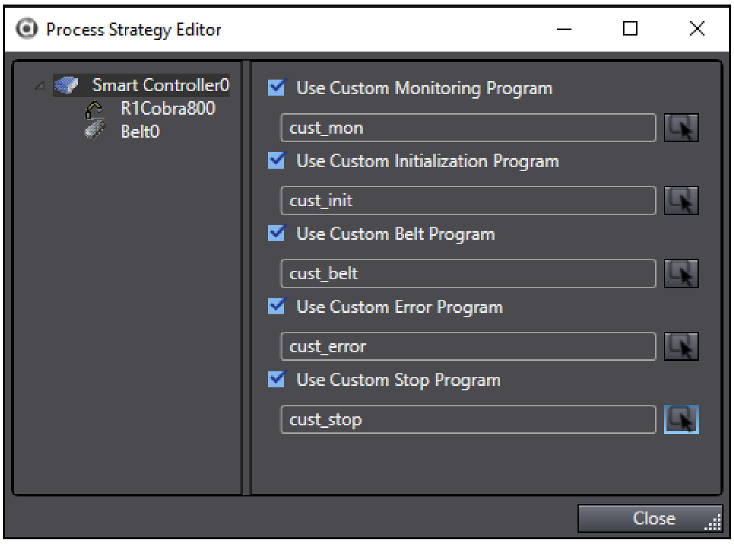


Figure 8-146 Process Strategy Editor - Controller Parameters

Table 8-21 Process Strategy Editor Item Description - Controller Parameters

Item	Description
Use Custom Monitoring Program	The default process monitoring has the following functions. • Checks for updates to process strategies. • Handles belt monitoring. • Monitors parts and part targets. You can copy the default V+ monitoring program for editing, or select an existing program. **NOTE:** Most applications do not require a Custom Monitoring Program
Use Custom Initialization Program	The default initialization program that executes before the control programs (robot, belt, process strategy, etc.) are started. This can be used to initialize system switches, parameters, and variables or execute V+ programs that need to be started in parallel to the Process Manager. You can copy the default V+ initialization program for editing, or select an existing program.
Use Custom Belt Program	The default belt program monitors the speed / ON / OFF status of all belts. You can copy the default V+ belt program for editing, or select an existing program. **NOTE:** Most applications do not require a Custom Belt monitoring program and can be sufficiently controlled using Process Strategy Belt Control Parameters as described in this section.

Item	Description
Use Custom Error Program	The default error program handles the processing and reporting of errors during the execution of a process. You can copy the default V+ error program for editing, or select an existing program. This program can be used to automate error handling that are reported to the PC by default. All Process Manager V+ program error handling will lead to this program. Use this program to automate error handling of errors that are reported to the PC by default. This program will check if any user-defined error responses exist in the Process Strategy - Robot parameters.
Use Custom Stop Program	The custom stop program can be used to perform certain operations after the application has stopped. You can copy the default V+ stop program for editing, or select an existing program.

Motion Information

After a collection of Part Processes is defined, the Process Manager scans the collection to determine what additional configuration data is needed to properly drive the process. Some examples are listed below.

- Each robot will need an idle position.
- For each part that is picked, motion parameters describing the approach height, depart height, motion configuration, and offset at the pick location must be defined.
- For each part that is to be delivered to a target, the approach height, depart height, motion configuration, and offset at the place location must be defined.

The Process Manager maintains a list of the required information that must be taught as part of the configuration of the system. The motion information is located in the Configuration Items group of the Process Manager editor.

Motion Settings: Pick and Place

When the user defines a process that is composed of a part and a part target, the software will create motion settings that are used when processing the parts and targets. You can access the settings in the configuration item section. When one is selected, it will look similar to the following figure.

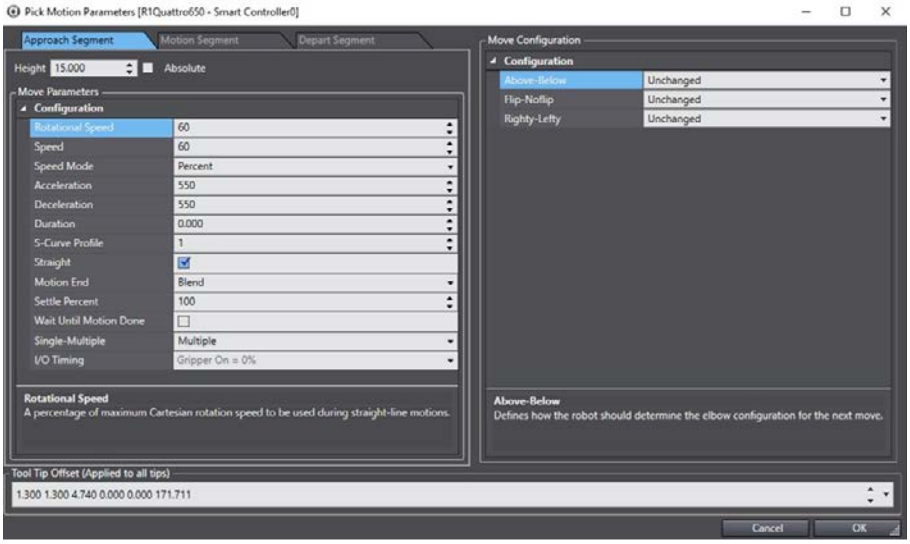


Figure 8-147 Pick and Place Motion

In this example, the V+ Program called when an instance is to be picked or placed. When a process is created, the process specifies that a robot must pick a set of parts and should place those parts at a set of targets. The process manager will supply a default set of motions used to acquire the parts and place at the targets. If the default motions do not meet the requirements, the program that governs the behavior of the motions can be customized.

In addition to defining parts and targets, a process may also reference a refinement station that locates parts in the gripper before placement at targets. The program that defines the motions of a refinement operation can also be overridden if the default motions are not sufficient.

In the Process Manager > Configuration Items there is a Place Motion Parameter with a Depart/ Release I/O timing the percentage slider, shown below. This shows a percentage of the motion from place to depart location, typically this depart is lifting off of the target location.

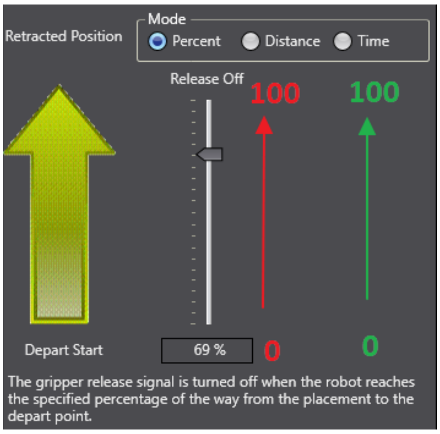


Figure 8-148 Approach/Depart Slider

Sources

A Source is an object that interacts with the hardware and discovers Part Instances and Part Target Instances. The Process Manager analyzes the configuration of Part Processes in order to determine what Sources are needed to control the hardware. A Source is allocated for each of the following conditions

- For each Static-defined Part or Part Target, a Source is created.
- For each Vision-defined Part or Part Target, one Source is created for each Virtual Camera referenced. This Source will process the collection of all Part or Part Targets referenced by the Virtual Camera.
- For each Belt-defined Part or Part Target, one Source is created for each Belt referenced. This Source will process the collection of all Part or Part Targets referenced by the Belt.

For each Source, the Process Manager allows you to modify certain parameters associated with the Source. As an example, the Vision and Static Source objects can be configured to interface with a feeder.

Part and Part Target Instances

When an individual Part is located, it is represented by a Part Instance. When an individual Part Target point is identified, it is represented by a Part Target Instance. These objects identify the transformation and Part / Part Target information so the complete location can be resolved. If an individual Part Instance must be placed at a specific Part Target Instance, the Part Instance will have a link to the appropriate Part Target Instance.

Part Instance and Part Target Instance objects get allocated to a controller for processing by a robot. The Process Manager uses the Process Strategy to identify that allocation.

> **NOTE:** The Process Manager knows if a Part/Part Target instance was processed, not processed, or if an error happened during processing because of a grip error. If a grip error occurs, that instance will not be transferred to next robot and will be counted as not processed in the statistics.

Process Handler

When the Process Manager executes a process, it relies on a series of internal objects to manage the interaction with the hardware. The Process Manager is responsible for organizing and containing the information that is going to be processed. The Process Handler is responsible for using that information and managing the execution of the process.

In general, the run-time operation of the Process Manager will use the Part Process information to locate Part Instances and Part Target Instances. Internally, the Process Handler maintains a collection of internal objects that are responsible for interacting with individual elements of the hardware. These objects fall into two categories: objects that generate Part / Part Target Instances and objects that can process the instances.

Controller Queue

The Controller Queue represents a controller with associated robots that can pick from Part Instances and place to Part Target Instances.

The Controller Queue communicates with the Queue Manager task that manages the collection of parts to be processed by the robots on a given controller. The Controller Queue receives notification as the controller processes the instance information. The Controller Queue also monitors for functionality or capacity issues with the robots connected to the controller. It notifies the Process Manager through an event in the case that the controller is unable to process the items in its queue within a given time-frame.

The time-frame is based on the belt speed and location of the parts on the belt given the upstream / downstream limits of the individual robots. The Controller Queue maintains state information regarding its ability to accept parts. This information is used by the Process Strategy when determining how to allocate parts.

The Controller Queue also maintains statistics that are captured for a certain number of cycles, such as idle time, processing time, and parts / targets processed per minute. This information is available to you and may be used in the allocation of Part Instances.

Line Balancing

A Process Strategy is invoked to determine how to allocate the Part / Part Target Instances identified by the Process Manager. It uses the list of Part Processes to allocate the instances to specific robots. The output of this process is passed to the Controller Queue object by the Process Manager.

Each Process Strategy operates under certain assumptions based on the process being monitored. Those assumptions determine which algorithms are used to perform the allocation.

Line Balancing and Process Strategy

This process strategy is predicated around certain assumptions on how robots will handle Parts and Part Targets. For part processing, the overflow from an upstream robot will be passed to the next downstream robot on the same controller. In other words, the first robot along the conveyor will pick all parts it is capable of picking. Any part it cannot pick will be picked by the next robot in the line. This pattern is repeated for all robots in the line.

For the processing of Part Targets, any targets configured as a latched Pallet will be passed from robot to robot, allowing each one to fill the slots with parts as defined by the Process Strategy.

There is no logic function that tries to optimize the allocations of parts or targets. The Process Strategy simply requests that each robot process as many Parts and Part Targets as possible, and remaining parts are passed to the next robot.

There are user-defined parameters that control this Process Strategy, as described below.

- **Robot Parameters**: used to specify the queue size for the robot.
- **Belt Window Parameters**: used to set part-processing filters, which help to optimize cycle time.
- **Belt Control Parameters**: used to set conveyor belt on / off and speed controls, which can dynamically adjust the part flow to the robot.

These parameters are available in the Process Strategy editor.

Custom Process Strategy

If required, the system allows you to define your own Process Strategies using C# within the application.

Controller Software

The application is split into the following two sections.

1. A series of V+ programs that are responsible for picking and placing an instance.
2. A series of V+ programs responsible for managing the queue of parts and communicating with the PC.

Robot Control Code

The V+ program code is designed to run without any PC interaction. It is triggered by items arriving in the queue. Motion parameters are defined on the PC and then downloaded to variables on the controller. Multiple instances of this program are run (one for each robot in the configuration).

Process Manager Editor

Use the following information to understand the Process Manager Editor area.

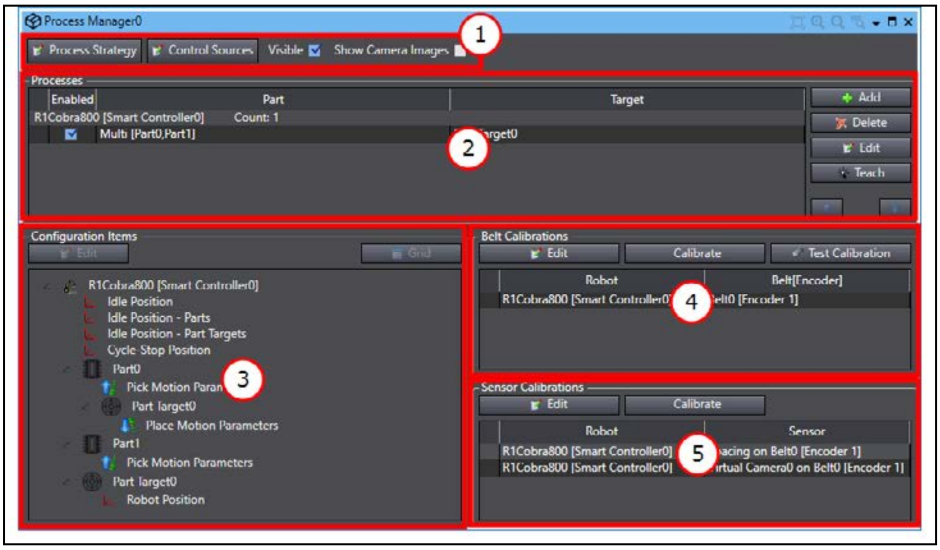


Figure 8-149 Process Manager Editor Area

Table 8-22 Process Manager Editor Area Item Description

Item	Name	Description
1	Editor Functions	**Process Strategy** button (Process Strategy) Displays the Process Strategy editor, which defines the pick / place strategy for the Process Manager. Refer to Process Strategy on page 439 for more information.
		Control Sources button (Control Sources) Displays the Control Sources editor, which defines the properties for part and target hardware sources, as required by

Item	Name	Description
		the selected workcell configuration. Refer to Control Sources on page 435 for more information.
		Visible check box Display or hide all Process Manager calibrations and instances in the 3D Visualizer.
		Show Camera Images check box Display or hide the camera image in the camera calibration / field of view shown in the 3D Visualizer.
2	Processes List	Displays a list of defined processes. Refer to Processes in the Process Manager Object on page 406 for more information.
3	Configuration Items Editors	Provides access to editors for all motion parameters, offsets, and static frames that must be provided for the processes defined in the Process List. Refer to Configuration Items on page 426 for more information.
4	Belt Calibrations Editor	Lists all Robot-to-Belt calibrations required for the defined processes. Also provides access to edit belt allocation limits. Refer to Belt Calibrations on page 417 for more information.
5	Sensor Calibrations Editor	Lists all Robot-to-Camera, Robot-to-Sensor, and Spacing calibrations required for the defined processes. Refer to Sensor Calibrations on page 422 for more information.

Process Manager Configuration Errors

If there is a configuration error, an alert icon ( ) displays in the corresponding item. If you hover the mouse cursor over the icon, a message displays that describes the error as shown below.

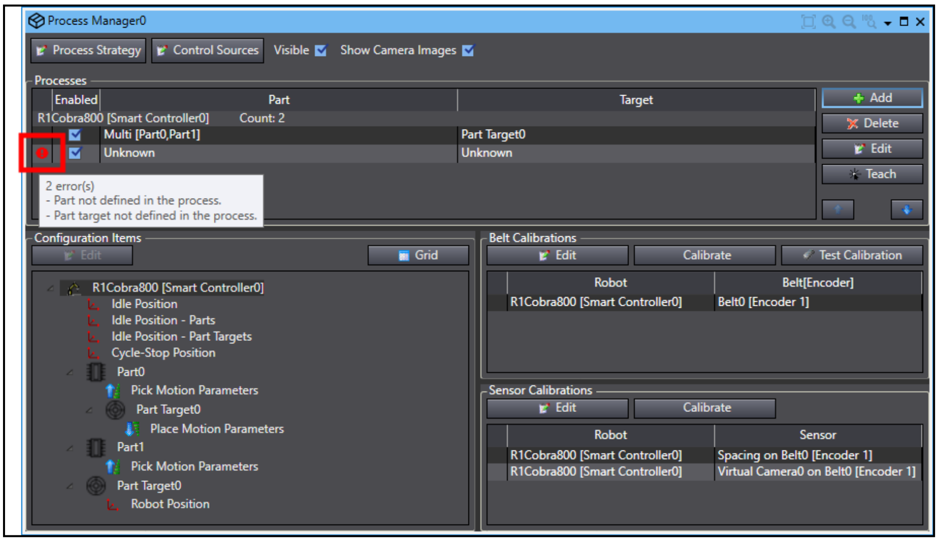


Figure 8-150 Process Manager Configuration Errors

Adding a Process Manager Object

To add a Process Manager object, right-click ***Process***, select ***Add***, and then click ***Process Manager***. A new Process Manager object will be added to the Multiview Explorer.

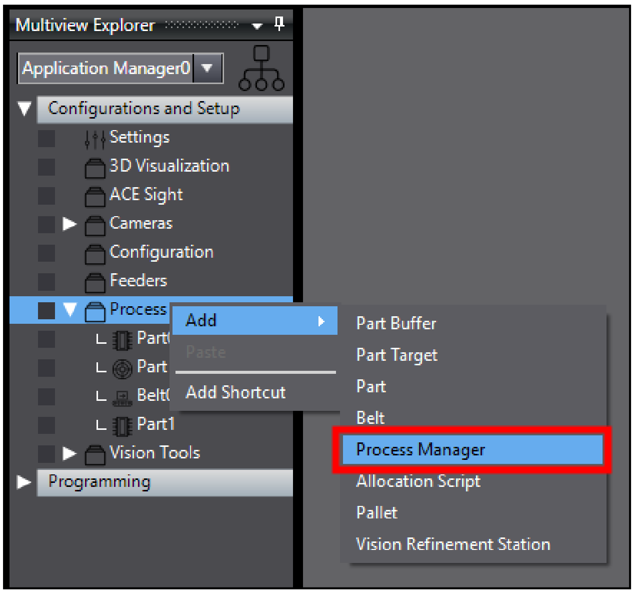


Figure 8-151 Adding a Process Manager Object

Processes in the Process Manager Object

This section describes the Processes Editor section of the Process Manager Object. This area defines the elements (robot, pick location, place location) for a particular process that will be controlled by the Process Manager.

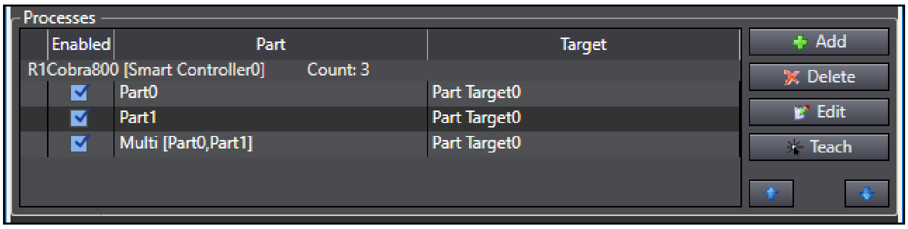


Figure 8-152 Process Manager - Processes

Table 8-23 Processes Item Description

Item	Description
Up/Down Buttons ( )	Sets the priority for the selected process. The process at the top of the list receives the highest priority. Refer to Changing Process Priority on page 413 for more information.
Enabled Check Box	If checked, the process is enabled for use.
Part	The Part(s) specified for the process. You can double-click this item or select the process and then click the **Edit** button to change it.
Target	The Part Target(s) specified for the process. You can double-click this item or select the process and then click the **Edit** button to change it.
Add Button (Add)	Add a new process to the Processes list.
Delete Button (Delete)	Remove the selected process from the Processes list.
Edit Button (Edit)	Edit the selected process. Refer to Part Process Editor on page 407 for more information.
Teach Button (Teach)	Teach the selected process. Refer to Teaching a Process on page 414 for more information.
Alert Icon ( )	Indicates the process needs to be taught or there is some other problem. Hover the mouse pointer over the icon to view the alert message for a description of the reason(s) for the alert.

Part Process Editor

The Part Process Editor is used to specify the items used in the process. Access the Part Process Editor by double-clicking an existing process, or by clicking the **Add** button for a new process.

Use the **Pallet Slot Selection** button ( ) to select the pallet slots the robot can access for pick or place configurations. This button is only available when a Pallet object is configured for the selected part / target.

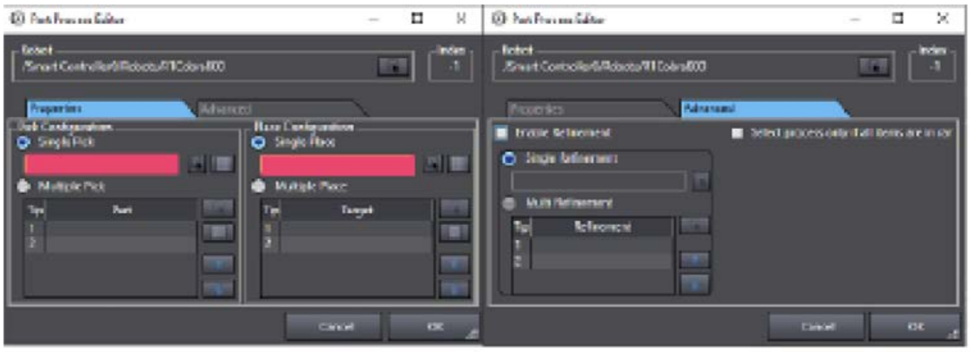


Figure 8-153 Part Process Editor

Robot Reference

The Robot reference is used to specify the robot that will be used for the pick-and-place process. Use the **Select** button ( ) to open the Select a Reference Dialog Box, which allows you to create or specify the robot that will be used in the pick-and-place process.

Index

This item displays the index number of the process, which can be referenced in V+ programs and C# programs.

Properties Tab: Pick Configuration Group

The Pick Configuration group is used to specify the single or multi-pick Part items for the pick-and-place process, as follows.

Single Pick/Place and Multiple Pick/Place can be used together. For example, if you want to pick multiple parts individually and then place them all at the same time, you would use Multiple Pick and Single Place.

Single Pick

Select this item for a single-pick application where only one pick motion is performed. Use the **Select** icon to browse for the part that will be picked.

> **NOTE:** When Single Pick / Place configuration is used with an I/O EndEffector that has multiple tips defined, the center line Tip Offset is applied. This is the average of all Tip Offsets defined in the I/O EndEffector object. Refer to I/O EndEffectors on page 242 for more information.

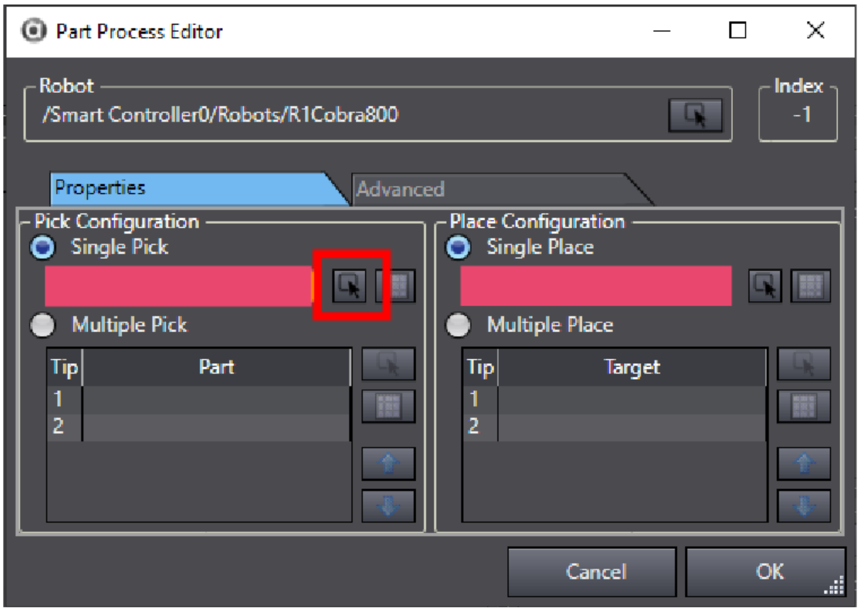


Figure 8-154 Select a Single Pick Object

Multiple Pick

Select this item for a multiple-pick application where multiple parts will be picked before placement at a target. When multi-pick is enabled, the available tip indexes will be provided for the selected robot I/O EndEffector. Use the **Select** icon to browse for the part that will be picked by each tip.

Use the **Up/Down** buttons to change the order of the tip processing.

> **NOTE:** Multiple Tips must be defined in the robot's I/O EndEffector configuration. The Process Manager will access the I/O EndEffector object specified in the ***Selected End-Effector*** property of the robot object.

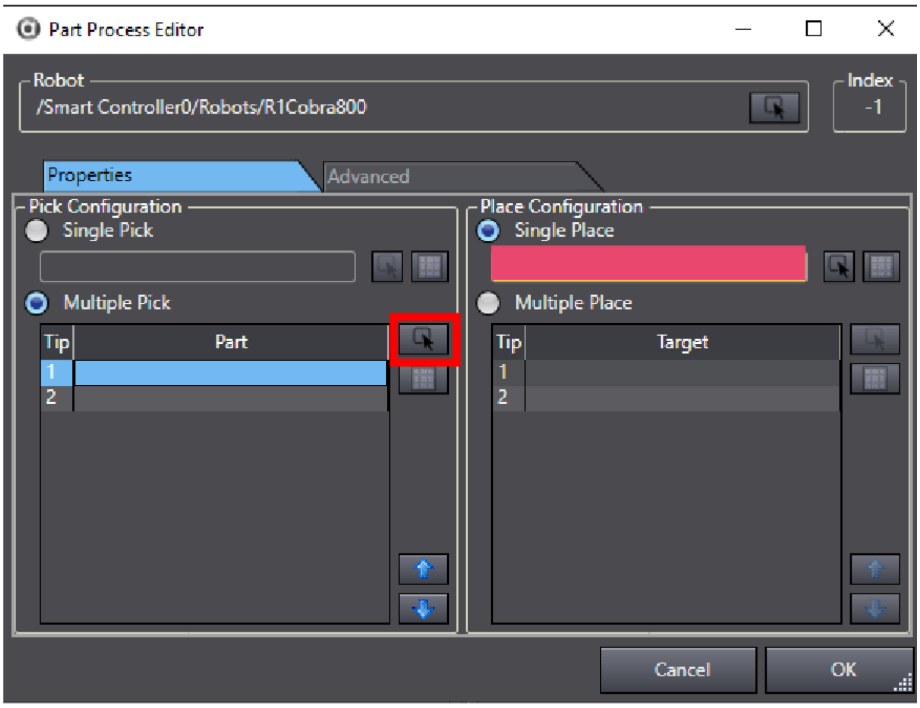


Figure 8-155 Select Multiple Pick Objects

Properties Tab Place Configuration Group

The Place Configuration group is used to specify the single or multi-place Part Target items for the pick-and-place process as follows.

Single Place

Select this item for a single-place application where only one place-motion is performed. Use the **Select** icon to browse for the part target where the part will be placed.

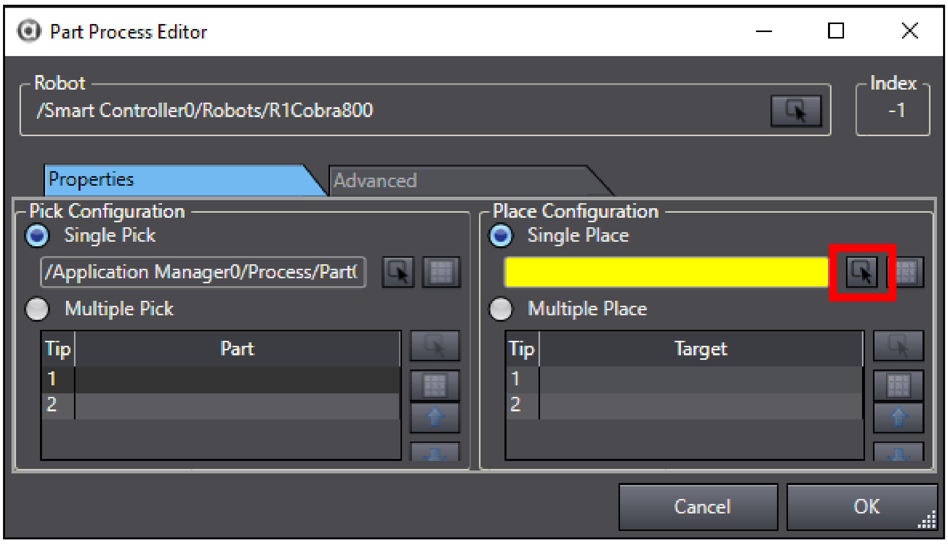


Figure 8-156 Select a Single Place Object

Multiple Place

Select this item for a multiple-place application where multiple place-motions are performed. Use the **Select** icon to browse for the part that will be picked.

Use the **Up/Down** buttons to change the order of the tip processing.

> **NOTE:** Multiple Tips must be defined in the robot's /IO EndEffector configuration. The Process Manager will access the I/O EndEffector object specified in the ***Selected End-Effector*** property of the robot object.

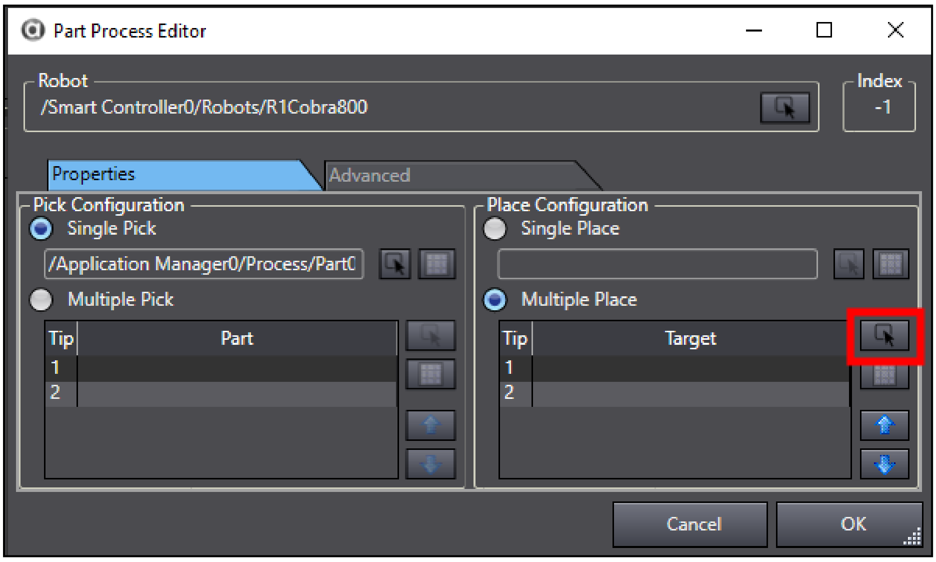


Figure 8-157 Select Multiple Place Objects

Advanced Tab: Enable Refinement

The Enable Refinement option is used to perform a position refinement operation over an upward-facing camera to improve part placement accuracy. This is used when placement error needs to be smaller than error introduced during the pick operation.

When this option is selected, the part is moved to a predefined vision refinement station for additional processing before being moved to the place (Part Target) location. Refer to Vision Refinement Station Object on page 465 for more information.

Single Refinement

Select this item for a single-vision-refinement application under the following conditions.

- Only one part at a time is being moved by the robot.
- A multi-tip-gripper is moved to the vision refinement station, but only one picture is taken that includes all parts on the gripper. If you want to process an individual refinement for each part, use the Multi Refinement option.

Use the **Select** icon to browse for the vision refinement station.

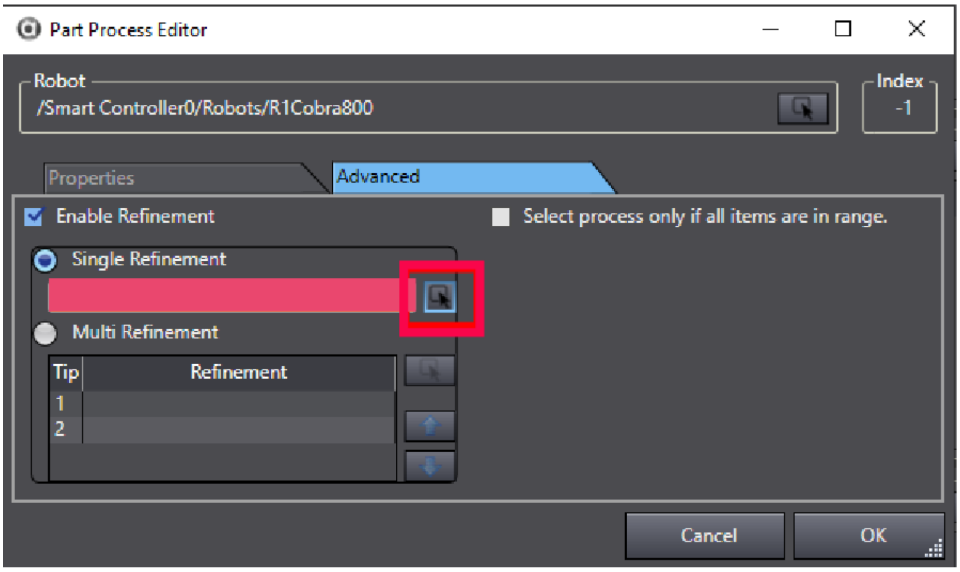


Figure 8-158 Enable Single Refinement

Multi Refinement

Select this item for a multiple-tip-gripper applications. Each tip will be moved individually to the specified vision refinement station.

Use the **Select** icon to specify the tool tip and corresponding vision refinement.

Use the **Up/Down** buttons to change the order of the tip processing.

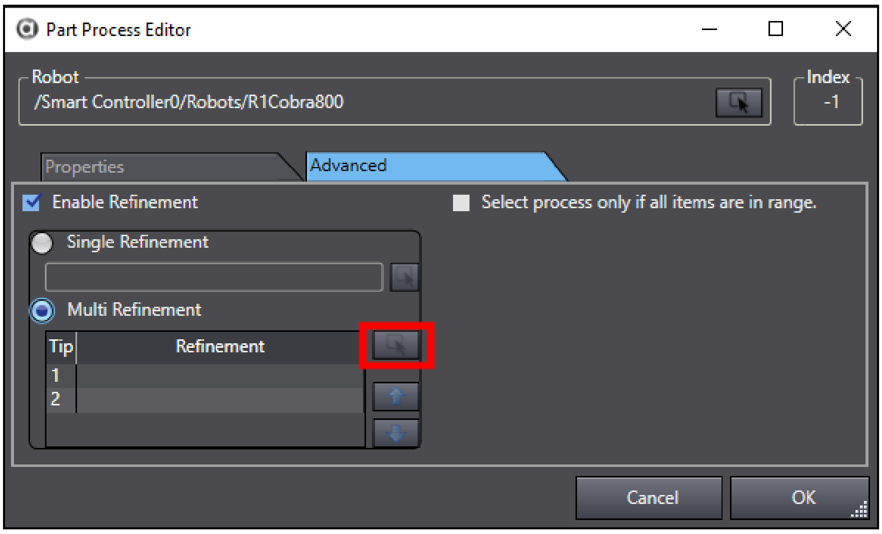


Figure 8-159 Enable Multi Refinement

Select Process Only if All Items are in Range

The **Select process only if items are in range** check box tells the system to only select this process if all parts and targets are in range of the robot. This option is typically disabled, but may be useful in multi-process applications where you want to select this Process only if the required Part(s) and Part Target(s) are within range.

This may not be sufficient in parallel-flow configurations with many Parts and Part Targets. In this case you may need to consider part and target filtering to reduce the number of instances the robot has to process through when checking position of all instances.

This is typically not necessary, but can be helpful in multi-process configurations. For example, in a situation where Process A has higher priority than Process B, Process A Part is further upstream relative to Process B Part, but Process B Target is further downstream than Process A Target, you may want the system to select Process B when both part and target are already within range rather than selecting process A by priority and waiting for Part A to come into range. During this waiting time, Process B Target may move downstream and out of range.

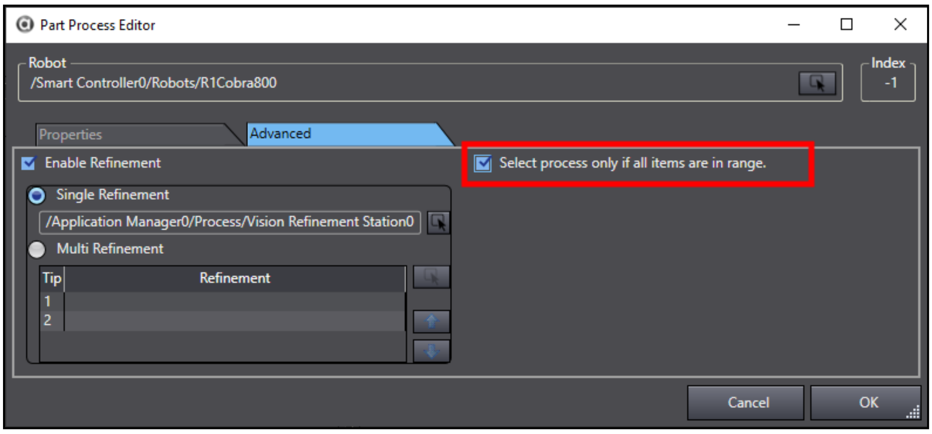


Figure 8-160 Select Process Only If All Items Are In Range

Changing Process Priority

The process priority is used in situations where multiple processes are defined and a given robot is capable of doing several of the potential processes. The process at the top of the Process list receives highest priority.

You can change the priority for a process by using the **Up / Down** buttons on the Process list editor, shown in the following figure.

> **NOTE:** In addition to the arrows, you can also affect process priority through the Process Selection Mode setting of the Robot Parameters in the Process Strategy Editor area. Refer to Process Strategy on page 439 for more information.

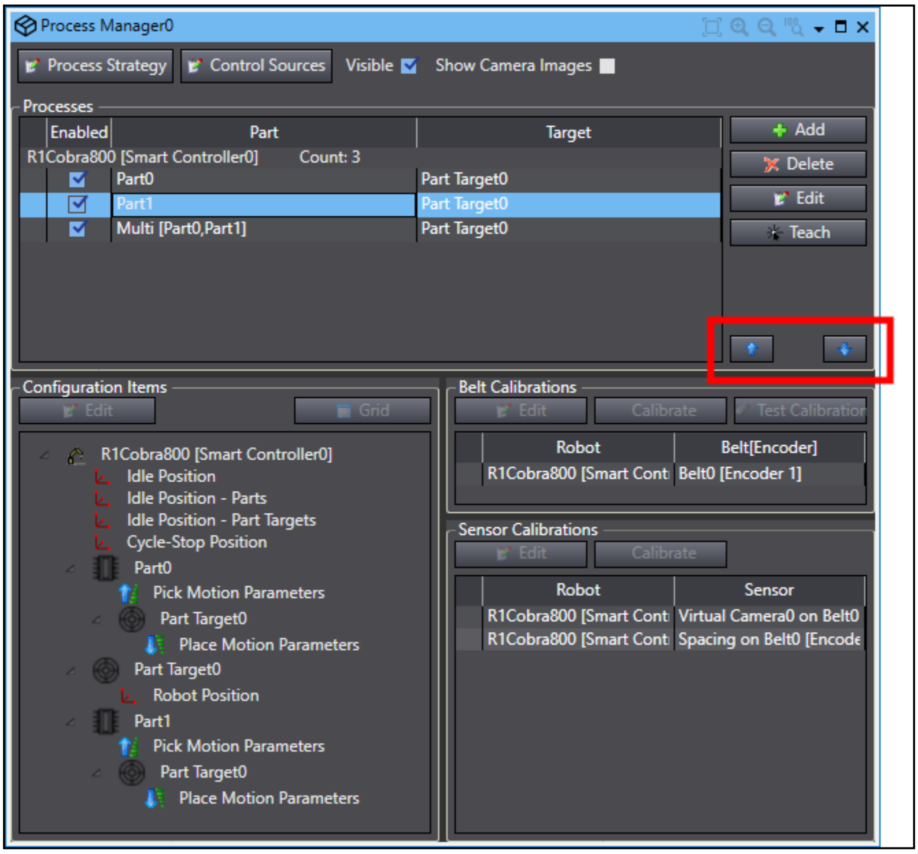


Figure 8-161 Change Process Priority

For example, you have three processes defined in the Process Manager, as follows.

1. Pick from input Part, place to output Part Target.
2. Pick from Part Buffer, place to output Part Target.
3. Pick from input Part, place to output Part Buffer.

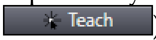
In this case, the Process Manager would always execute the first process if there are parts at the input, and move them to the output. If no parts are present at the input, it will then check for process 2 and 3.

However, if you change the order (the priority), you will get a different behavior as follows.

1. Pick from Part Buffer, place to output (Part Target).
2. Pick from input (Part), place to output (Part Target).
3. Pick from input (Part), place to Part Buffer.

In this case, the Process Manager will always remove parts from the Part Buffer until no parts remain in the Part Buffer, before processing the input (Part).

Teaching a Process

The last step in creating the Process is the teach function. This must be performed after all calibrations are complete. Ideally, all calibrations would be performed as accurately as possible with a calibration pointer and disk. After calibrations are complete, the process end effector can be installed to teach the process. Every step of the process is performed one at a time to capture any necessary motion offsets. Select a Process and then click the **Teach** button () to open the Teaching Process wizard.

NOTE: The following process illustrates the steps for a basic pick-and-place application. The steps in your wizard will vary depending on the application and types of Parts and Part Targets you have defined for your application.

Additional Information: If a Pallet object is used for a Part or Part Target, you will see additional screens in the wizard for teaching the pallet frame (the orientation of the pallet in the workspace) and the first position in the pallet. Each of these steps contain an image of the pallet item being taught, which provides a visual reference. Refer to Pallet Object on page 460 for more information.

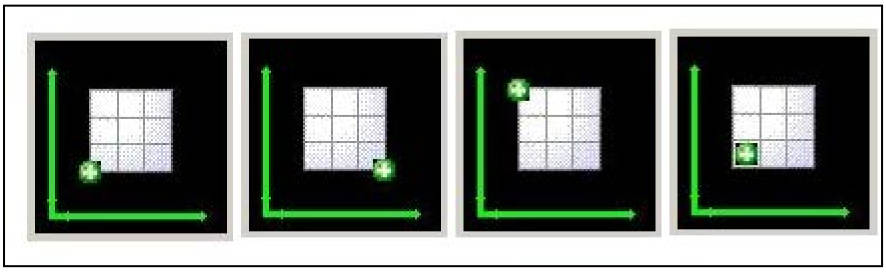


Figure 8-162 Frame Origin, X-Axis, Y-Axis, and First Pallet Position (left-to-right)

Use the Teaching a Process wizard to make selections for pick, place, and idle robot positions.

IMPORTANT: When the ***Absolute*** option is selected, the approach or depart heights will be an absolute Z coordinate in robot world coordinates. You must ensure that value is in-range and safe. Otherwise, the robot could move to an unintended location or out of range, which may damage the robot or other equipment in the workcell.

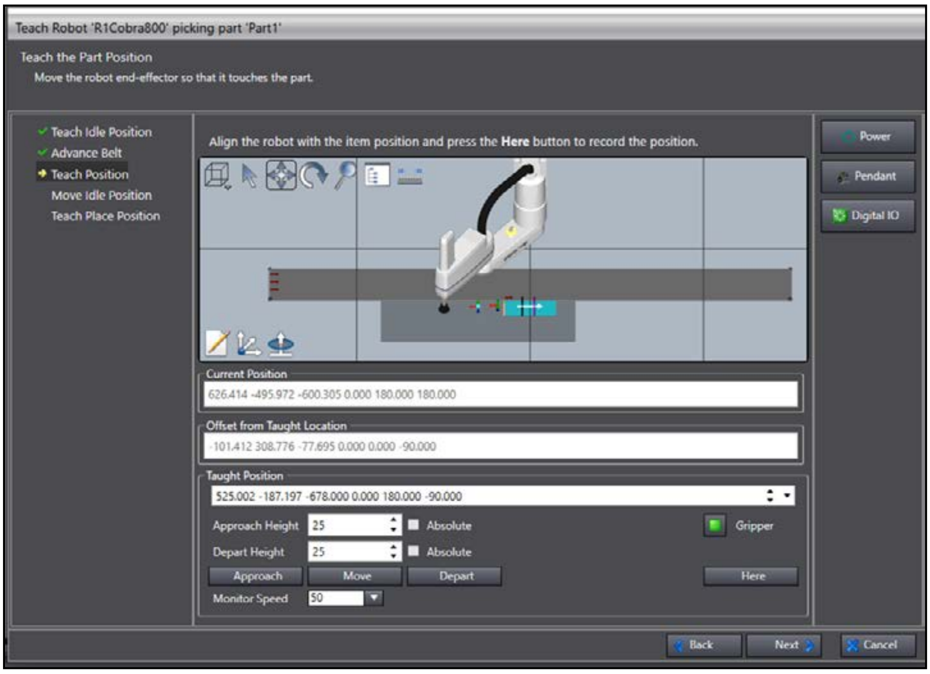


Figure 8-163 Teaching a Process Wizard

Using Multiple Process Manager Objects

The ACE project can share robot-to-hardware calibration information between multiple Process Manager objects. If you use the same robot and hardware for each process, you can create multiple Process Manager objects in the ACE project without having to repeat the calibrations.

For example, assume you are setting up an ACE project to handle the packaging of various fruits. You have three fruits that you want to pack: apples, oranges, and peaches. All fruits will use the same robot, sensor, and infeed belt. To create the packaging processes for each fruit, use the following procedure.

1. Create a Process Manager object for apples named "Apple Packing".
2. Add the Belt, Sensor, Part, and Part Target objects.
3. Perform the Robot-to-Belt calibration.
4. Perform the Robot-to-Sensor calibration.
5. Optionally, edit the Process Strategy as needed.
6. Optionally, edit the Control Sources as needed.
7. Teach the Process.
8. Optionally, edit the Configuration Items, as needed.
9. Add a second Process Manager object for oranges named "Orange Packing".
10. Add a new Part and/or Part Target if the pick or place requirements are different than those for apples. If the Part and/or Part Target use the same robot, sensor, and belt objects that were used with the Apple Packing process, you do not need to repeat the calibrations.
11. Optionally, edit the Process Strategy and Control Sources as needed.
12. If a new Part and/or Part Target was added for Orange Packing, teach the Process.
13. Optionally, edit the Configuration Items as needed.

14. Repeat steps 9 to 13 for "Peaches Packing". After all Process Manager objects are added, the procedure is complete.

Belt Calibrations

This section describes the Belt Calibrations list in the Process Manager. The Belt Calibrations area defines the robot-to-belt calibrations required by the defined Processes in the Process list. Refer to Processes in the Process Manager Object on page 406 for more information.

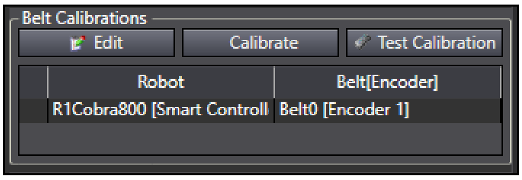
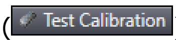


Figure 8-164 Belt Calibrations

Table 8-24 Belt Calibration Item Description

Item	Description
Edit Button ()	Click to edit the selected belt calibration. Refer to Belt Calibrations on page 417 for more information.
Calibrate Button ()	Click to begin the belt calibration procedure. Refer to Belt Calibrations on page 417 for more information.
Test Calibration Button ()	Click to test the current belt calibration. This button is not available until the belt has been calibrated. Refer to Belt Calibrations on page 417 for more information.
Robot	Specifies the robot for the belt calibration. Double-click this item or click the **Edit** button to display the Belt Calibration Editor. Refer to Belt Calibrations on page 417 for more information.
Belt [Encoder]	Specifies the belt and encoder for the belt calibration. Double-click this item or click the **Edit** button to display the Belt Calibration Editor. Refer to Belt Calibrations on page 417 for more information.

Creating a Belt Calibration

When a belt calibration is required, the Process Manager displays the Belt object name with an **Alert** icon ( ) in the Belt Calibrations list. The belt is calibrated using the Belt Calibration wizard, which is accessed from the **Calibrate** button in the Belt Calibrations area. After the belt is calibrated using the wizard, values such as allocation limits, upstream limits, dynamic wait line, process limit, and horizontal filtering limits can be manually edited.

Belt Calibration Wizard

The Robot-to-Belt Calibration wizard provides an interactive series of steps that guide you through the calibration process. Each step of the wizard contains graphical aids and text that describe the particular step being performed. As each step of the wizard is completed, the information from that step is collected and used to populate the fields in the Belt Calibration Editor.

Click the **Calibrate** button to begin the Belt Calibration wizard.

> **NOTE:** This feature operates differently in Emulation Mode. Refer to Emulation Mode on page 19 for more information.

Editing the Belt Calibration Parameters

After the belt has been calibrated using the Belt Calibration wizard, you can manually edit the stored belt calibration parameters and allocation limits, such as upstream limit, downstream limit, and downstream process limit. These parameters are edited using the Belt Calibration Editor. The following figure illustrates several of the Belt Calibration Editor items in a typical workcell.

> **NOTE:** The belt must be calibrated using the wizard before the values can be manually edited.

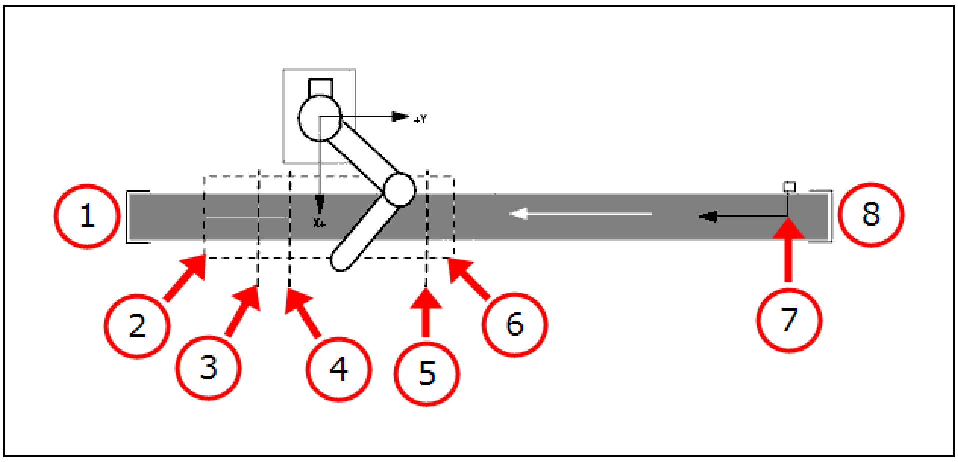


Figure 8-165 Typical Belt Calibration Items

Table 8-25 Typical Belt Calibration Item Description

Item	Description
1	Downstream
2	Downstream Limit
3	Process Limit
4	Belt Stop Line

Item	Description
5	Dynamic Wait Line
6	Upstream Limit
7	Object Sensor Origin
8	Upstream

To access the Belt Calibration editor, click the **Edit** button in the Belt Calibrations group. The Belt Calibration editor will open.

Adjust the parameter values or use the graphical representation to reposition the lines accordingly.

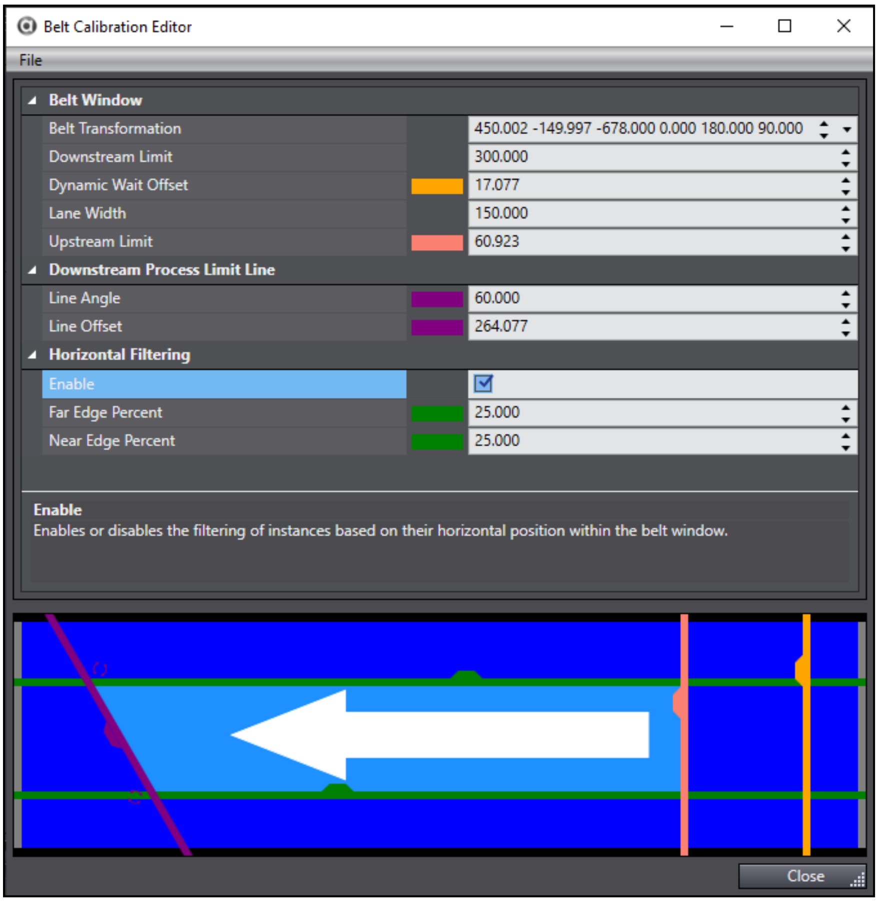


Figure 8-166 Belt Calibration Editor

Table 8-26 Belt Calibration Editor Item Description

Group	Item	Description
Belt Window	Belt Transformation	The transformation describing the location of the belt window relative to the origin of the robot. This location also defines the upstream tracking limit of the belt window.

Group	Item	Description
		The X-axis of the belt transformation is often referred to as the belt vector.
	Downstream Limit	Downstream window limit (mm from the belt frame origin along the belt vector). The robot will not track beyond this limit.
	Dynamic Wait Offset	Distance along belt vector (mm from belt transformation origin) where robot will wait for a part or target that is currently upstream of the upstream limit. Once the part or target reaches the Upstream Limit, the robot will approach the part. **NOTE:** This may be upstream or downstream of the Upstream Limit depending on the motion parameters and path of travel to a target.
	Lane Width	The width of the belt window starting from the belt transform, pointing in the positive Y-direction.
	Upstream Limit	Upstream pick limit (mm from belt transformation along the belt vector).
Downstream Process Limit Line	Line Angle	The angle of the downstream process limit line.
	Line Offset	Downstream process limit. If a robot has initiated a move to an instance that is upstream or at this limit, it will proceed with that motion unless a belt window violation occurs at the downstream limit of the belt window. However, if an allocated instance crosses the downstream process limit line before a robot initiates a motion to it, then it will be unallocated from this robot queue. The value must be between the upstream limit and the downstream limit. **Additional Information**: A good initial value can be calculated by subtracting the distance the belt will travel during a pick or place operation from the Downstream limit (length of belt window), and then subtract an additional 15-25mm. If the process limit is any closer to the downstream limit, you will likely experience belt window violations.
Horizontal Filtering	Enable	Enables or disables the filtering of instances based on their horizontal position within the belt window.

Group	Item	Description
		When this is enabled, the pick area is limited to a subset of the width of the belt window. You can force different robots to pick in different horizontal regions (lanes) of the belt. For example, if you think of the conveyor belt as a three-lane highway (as shown in the previous figure), you may have robot one filtered to pick from the near one-third of the belt window, robot two filtered to pick from the middle one-third of the belt window, and robot three filtered to pick from the far one-third of the belt window.
	Far Edge Percent	The distance from the far edge of the conveyor where the robot cannot process.
	Near Edge Percent	The distance from the near edge of the conveyor where the robot cannot process.

Testing the Belt Calibration

The Test Belt Calibration page allows you to test the current robot-to-belt calibration. Click the **Test Calibration** button to begin the Belt Calibration test.

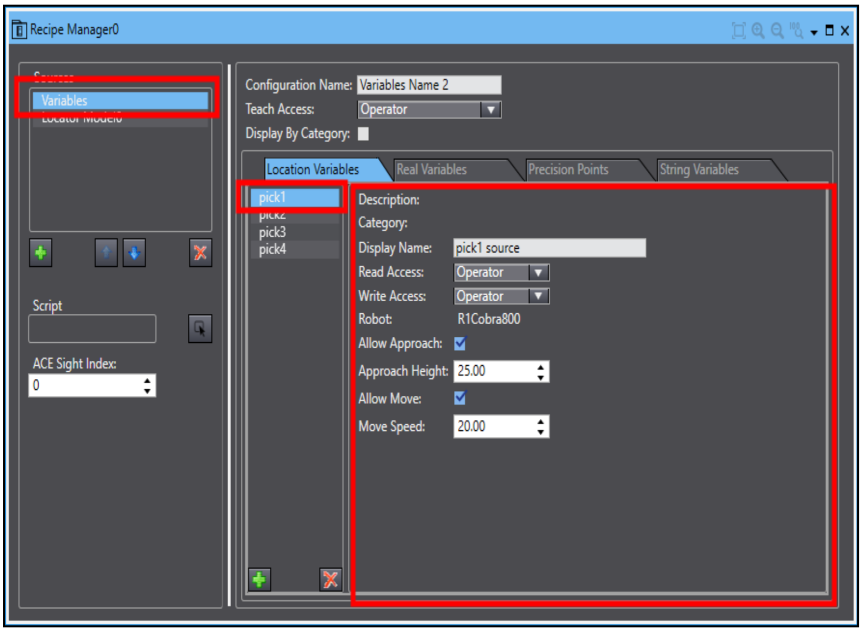


Figure 8-167 Belt Calibration Test

Use the following procedure to test the robot-to-belt calibration.

1. Make sure the belt is turned OFF so the belt is not moving.
2. Place a part on the belt.
3. Position the robot tool tip so that it is just above the center of the part.
4. On the Test Calibration page, click the **Start Tracking** Button.

5. Start the conveyor so the belt is moving. The robot should track the target location until it leaves the tracking region.
6. When you have confirmed correct tracking, click the **Stop Tracking** Button to stop the tracking.
7. Click the **Next** Button to proceed. The Robot-to-Belt Calibration wizard closes and the procedure is completed.

Additional Information: The distance between the robot tool tip and the part on the belt should remain constant while tracking. If not, the calibration procedure should be executed again.

Saving and Loading a Belt Calibration

After a calibration has been completed, the data can be saved by selecting ***File*** > ***Save To*** on the calibration editor menu. You can load a previously-saved calibration file by selecting ***File*** > ***Load From*** on the calibration editor menu.

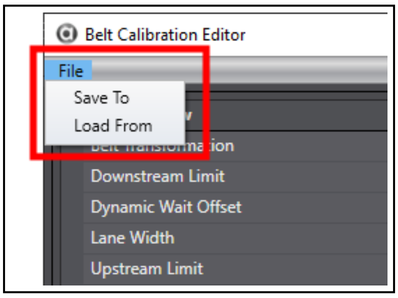


Figure 8-168 Saving and Loading a Belt Calibration

Sensor Calibrations

The Sensor Calibrations area defines the robot-to-sensor calibrations for the selected workcell process. Refer to Processes in the Process Manager Object on page 406 for more information. These should be performed after Robot-to-Belt calibrations.

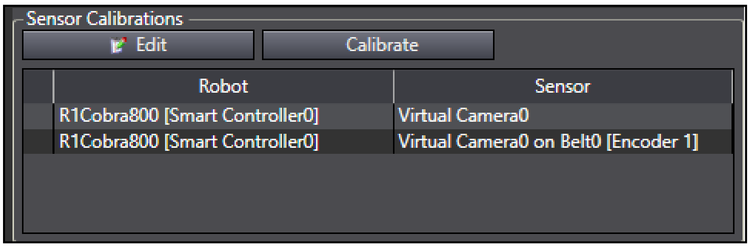


Figure 8-169 Sensor Calibrations

Table 8-27 Sensor Calibrations Item Description

Item	Description
Robot	The robot specified for the belt calibration. Double-click this item or click the **Edit** button to display the Sensor Calibration Editor.

Item	Description
	Refer to Sensor Calibrations on page 422 for more information.
Sensor	The sensor specified for the process. Double-click this item or click the **Edit** button to display the Sensor Calibration Editor. A sensor can be any of the following, depending on the type of configuration selected for the Part or Part Target. • Belt camera. • Fixed camera (downward-looking camera). • Latch sensor. • Spacing reference. • Refinement camera (upward-looking camera). Refer to Sensor Calibrations on page 422 for more information.
Edit Button ()	Click to edit the selected belt calibration. Refer to Sensor Calibrations on page 422 for more information.
Calibrate Button ()	Click to teach the selected process. Refer to Sensor Calibrations on page 422 for more information.

Creating a Sensor Calibration

When a sensor calibration is required, the Process Manager displays the Sensor object name with an alert icon in the Sensor Calibrations Group.

The sensor is calibrated using the Sensor Calibration wizard, which is accessed from the **Calibrate** button (in the Sensor Calibrations group. After the sensor is calibrated using the wizard, the stored calibration values can be manually edited.

For details on the Vision Windows and image-editing controls in the wizards, refer to the *ACE Reference Guide*.

Editing the Calibration Parameters

After the sensor is calibrated through the Sensor Calibration wizard, you can manually edit the stored sensor-calibration parameters, such as the robot-to-sensor offset. These parameters are edited using the sensor Calibration Editor. To access the sensor Calibration Editor, select a sensor and then click the **Edit** Button in the Sensor Calibrations group. The Sensor Calibration Editor opens.

> **NOTE:** The sensor must be calibrated, or loaded from a previously-saved calibration data file, before the values can be manually edited.

The Sensor Calibration Editor contains the sensor properties configuration parameters. These are used to configure various settings of the selected sensor.

The following figure shows the Latch Calibration Editor, which has one property for controlling the calibration offset.

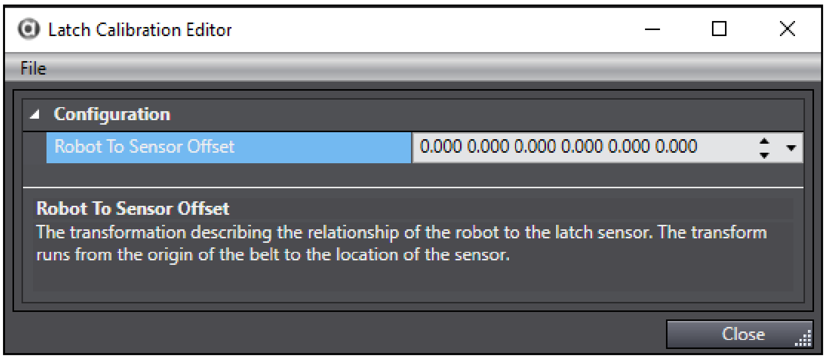


Figure 8-170 Sensor Calibration Editor - Latch

The following figure shows the Vision Calibration Editor, which contains a calibration offset along with additional parameters for controlling the robot motion during the picture-taking and part-pick operations of the automated hardware calibration. These are not used during run time when the robot is performing the process (run time motion parameters will be found in configuration items).

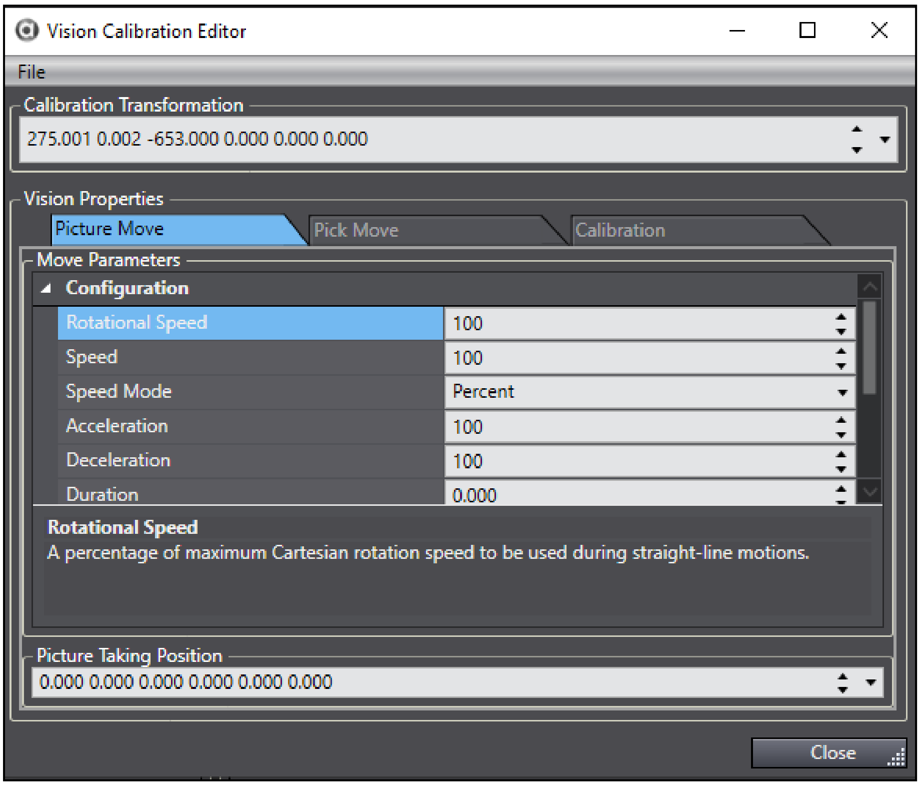


Figure 8-171 Sensor Calibration Editor - Vision

Saving and Loading a Sensor Calibration

After a calibration has been completed, the data can be saved by selecting ***File*** and then ***Save To*** on the calibration editor menu.

You can load a previously-saved calibration file by selecting ***File*** and then ***Load From*** on the calibration editor menu.

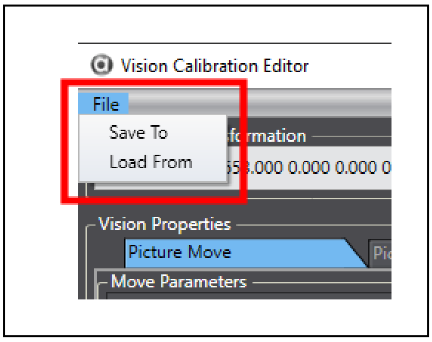


Figure 8-172 Saving and Loading a Calibration

Calibration Wizard - Automatic Versus Manual Calibrations

The calibrations can be performed using either the automatic calibration (preferred method) or the manual calibration procedure. In the automatic calibration procedure, you teach the initial locations and then the wizard automatically performs the robot movements to acquire enough data points to calibrate the system. In the manual procedure, you have to move the robot through each step of the process until enough data points have been acquired. The manual method is provided for cases where obstructions in the workcell do not allow for automated movement of the robot during the calibration process.

> **NOTE:** It is recommended that you use the calibration wizard, in order to obtain the optimum performance from your system.
>
> The manual calibration procedure is available for the Fixed Camera and Refinement Camera calibrations.
>
> Some calibrations operate differently in Emulation Mode. Refer to Emulation Mode on page 19

Using the Sensor Calibration Wizard

The Sensor Calibration wizard provides an interactive series of steps that guide you through the calibration process. Each step of the wizard contains graphical aids and text that describe the particular step being performed. As each step of the wizard is completed, the information from that step is collected and used to populate the fields in the Sensor Calibration Editor, which is described in the previous section.

Calibration Types

The Sensor Calibrations area defines all of the calibration types that are used in the project. These calibration types are described below.

Fixed Camera Calibration

The Fixed Camera Calibration wizard configures the positioning of a camera with respect to a robot when both the camera and the surface in the field of view are stationary. The wizard will show the 3D visualization of the camera vision window at various steps in the process.

Depending on the application, the wizard will end with manual or automatic configuration. Automatic calibration assumes that the pick surface is parallel to the tool plane. If the pick surface is not parallel to the tool plane, the parameters should be adjusted so manual calibration is performed instead.

Refer to Robot-to-Camera Calibration on page 35 for a more detailed explanation of the calibration process.

Belt Camera Calibration

The Belt Camera Calibration wizard configures the positioning of a camera with respect to a robot when a belt object is present. It includes controls for moving the belt, indicators to show if the belt is ON, and fields for speed, position, and direction. Depending on the step in the calibration wizard, it also shows the 3D visualization of the vision window for the associated camera.

Refer to Robot-to-Camera Calibration on page 35 for a more detailed explanation of the calibration process.

Belt Latch Calibration

Belt Latch Calibration calibrates a robot to a latch. This calibration uses a user-supplied sensor to generate a latch signal when an object, such as a pallet, reaches a specific point on a conveyor belt. This synchronizes the rest of the system with the position of the object.

Refinement Camera Calibration

The Refinement Camera Calibration wizard is functionally similar to the Fixed Camera Calibration. Refinement Camera Calibrations require the robot to be able to pick up a part. Calibration pointers will not be helpful in this scenario.

Spacing Reference Calibration

The Spacing Reference Calibration wizard configures the positioning of parts along a belt at defined intervals. This process is performed by setting a stationary point along the belt from which the instances will be generated. This point should be calibrated outside of the belt window to avoid difficulties in allocation. If creating spacing instances for multiple robots, the spacing calibrations must reference the same upstream position.

Configuration Items

The Configuration Items area defines the workcell items and the relationships between those items that are associated with a particular workcell configuration. The Configuration Items area also allows quick access to the robot position (location) editors for a particular item, such as the idle, part pick, or part place location.

Creating the Configuration Items

The Configuration Items are created automatically as the workcell process is defined through the Part Process editor. As items are added/deleted in the Part Process editor, they are added/deleted in the Configuration Items area. For example, a basic pick and place application would look like this in the Part Process editor:

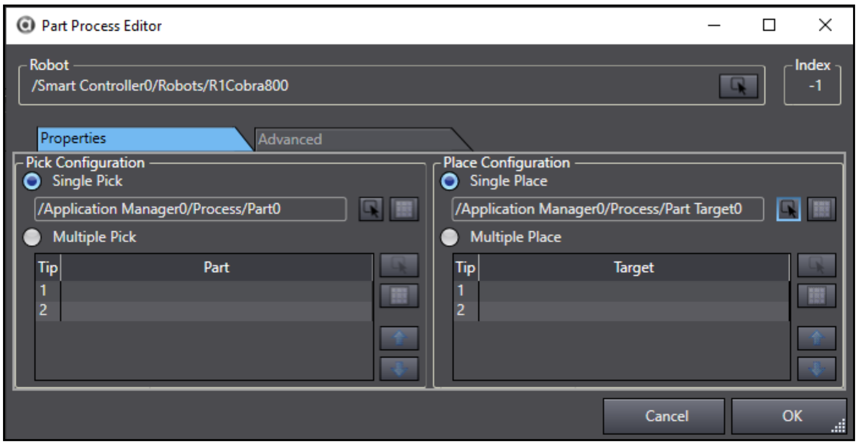


Figure 8-173 Part Process Editor - Basic Pick and Place Application

The corresponding Configuration Items area has the following appearance.

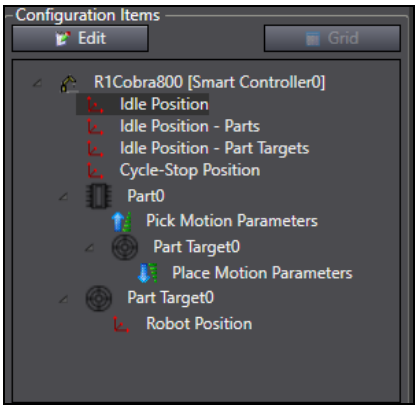


Figure 8-174 Configuration Items - Basic Pick and Place Application

Configuration Item Area Structure and Features

The Configuration Items are arranged in a tree structure to show the relationships between the workcell items. The Configuration Items group contains the following features.

- Expand or collapse a tree branch by clicking the arrow icons next to an item name.
- Double-click any of the Position objects (idle or robot) or select the Position object and click the **Edit** button to open the location editor that can be used to manually enter the object location. Refer to the following section for more information.
- Click the **Grid** button (

) and use the Motion Sequence Grid Editor to edit the motion parameters and offset locations (a robot must be selected in the list to enable the **Grid** button). Refer to Configuration Item Area Structure and Features on page 427 for more information.

Location Editors

There are two types of location editors: a simple editor, which allows you to enter location information and an enhanced position editor, which contains additional sections such as Move

Parameters, Move Configuration, Approach/Depart Parameters, etc.

For example, the Idle Position editor shown in the following figure is an enhanced position editor, which contains additional properties for Move Parameters and Move Configuration. Refer to Location Editors on page 427 for more information.

> **NOTE:** The Location Editor title bar indicates the type of parameters being edited.

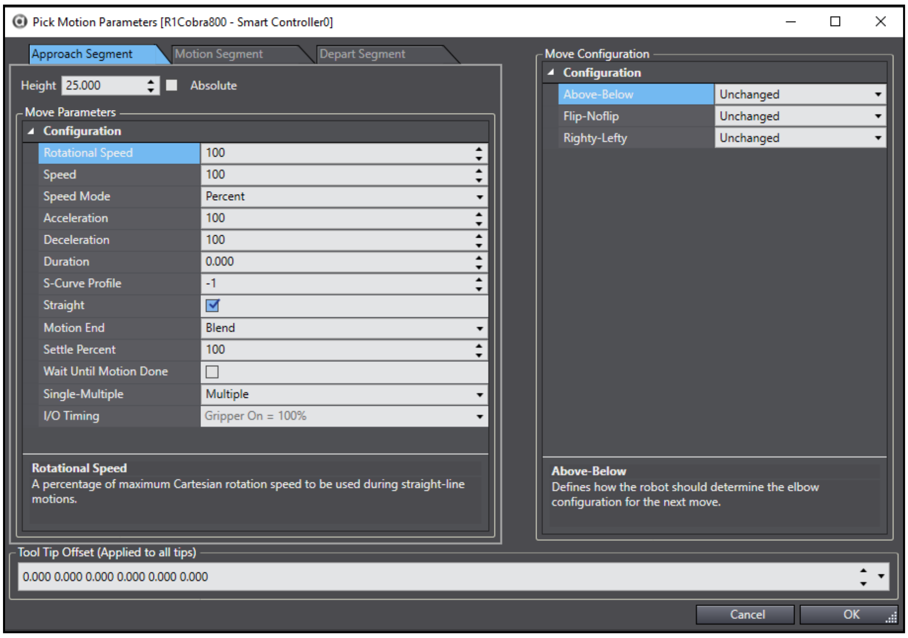


Figure 8-175 Location Editor - Enhanced Type

The Robot Position editor shown below is a simple position editor. This allows you to enter or teach the location information for a static fixed position frame that does not require a robot-to-belt or robot-to-sensor calibration.

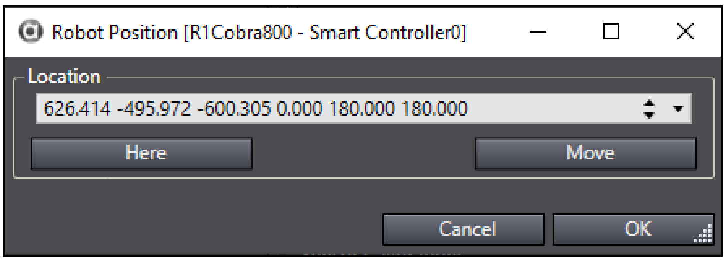


Figure 8-176 Location Editor - Simple Type

Enhanced Location Editor Parameters

Use the editor's parameter input fields to adjust the Move Parameters and Move Configuration for the approach, motion, and depart segments. Use the following examples of various enhanced location editor parameter grids to understand the editor functions.

- **Move Configuration Area**

  These parameters control the configuration of the robot at the selected location. For example, if your workcell contains a SCARA robot and you want it to be in a lefty configuration, you would set the Righty-Lefty parameter to Lefty.

- **Move Parameters for Approach/Motion/Depart Segments**

  These parameters control how the robot moves to and from the selected Part, Vision Refinement Station, or Part Target location. They allow you to fine-tune the robot's motion. To optimize the speed of the robot, apply coarser and faster settings for less-precise motions to and from the location. To optimize the precision of the robot, apply finer and slower settings for smoother, more precise motions to and from the location.

- **Absolute Check Box and Height**

  The Height input field allows you to enter a value for the approach and depart segments. The **Absolute** check box allows you to enter absolute height values for the Approach and/or Depart motion segments. You can enter positive or negative values, as needed.

  > **IMPORTANT:** When the Absolute option is selected, you must ensure the approach/depart heights are set correctly. Otherwise, the robot could move to an unintended location or out of range, which may damage the robot or other equipment in the workcell.

- **I/O Timing Parameter**

  An I/O Timing parameter is included which controls the open/close timing of the gripper during each part of the motion segment. The I/O Timing (Gripper On) can use either a percent value, a distance value, or a time value as shown in the following figures.

  For example, if you set the value to 25 mm, the gripper will activate at 25 mm from the pick position. If you set it at 25%, the gripper will activate at 25% of the distance from the approach start to the pick position. The time value allows you to set the gripper timing (in milliseconds).

  > **Additional Information**: The distance value is useful when accessing pallets with multiple layers and an absolute approach height has been specified.

- **Use Custom Program Option (Motion Segment Tab)**

  The **Use Custom Program** check box allows you to specify a custom V+ program that controls the motion segment. To use this option, select the check box and then click the **Select** ( ) icon to display the Robot Motion Sequence Program wizard.

Vision Refinement Motion Parameters

The Vision Refinement Motion Parameters specify how the robot moves to and from the Vision Refinement Station.

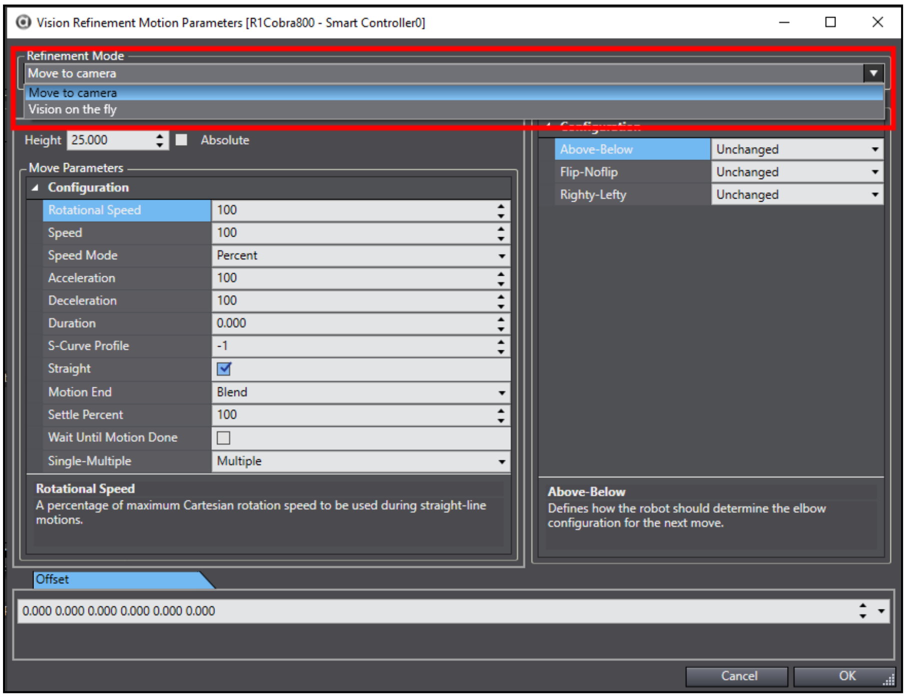


Figure 8-177 Vision Refinement Motion Parameters

- **Move to camera**

  This is a static refinement where the robot pauses at the Vision Refinement Station.

  The **Offset** tab allows you to edit the gripper (tool) offset.

- **Vision on the fly**

  This is an in-motion refinement, where the robot passes through the Vision Refinement Station without any pause in the robot motion.

  The **Start Location** and **End Location** tabs allow you to edit the start and end points for the robot path through the camera's field of view. The **Trigger Percent** tab allows you to edit where the picture request is triggered as a percentage of the robot motion, from Start Location to End Location.

> **NOTE:** The **Vision on the fly** mode can provide faster throughput, but may require more lighting and shorter Exposure Time compared to the **Move to camera** mode. A robot position latch should be used for Vision on the fly mode.

Idle Positions

Idle Positions are staging positions between picking and placing operations. They are initially defined by the teach process to be the same location, or can be manually taught to be different locations. If the Wait Mode is set to **Move to idle position**, then the following descriptions apply. If not, the Idle Position - Parts and Idle Position - Part Targets locations are not used.

> **Additional Information**: The Wait Mode setting can be found in the Process Strategy area. Refer to Process Strategy on page 439 for more information.

Idle Position

This is the location the robot uses when no Process is selected or when the Process Manager is aborted or stopped.

Idle Position - Parts

This is the location the robot uses when it is waiting to pick a part, typically when no parts are available.

The Idle Position - Parts location is not associated with a specific process. If you have multiple Part sources in different areas of the work envelope, consider setting the Idle Position - Parts location in an area between the Part source locations and not near one specific Part source.

Idle Position - Part Targets

This is the location the robot uses when it has picked a part and is waiting for a target to become available.

The Idle Position - Part Targets location is not associated with a specific process. If you have multiple Part Target sources in different areas of the work envelope, consider setting the Idle Position - Part Targets location in an area between the Part Target source locations and not near one specific Part Target source.

To access the Idle Position editor, double-click the ***Idle Position*** Configuration Item or select the item and click the **Edit** button. The Idle Position editor will open.

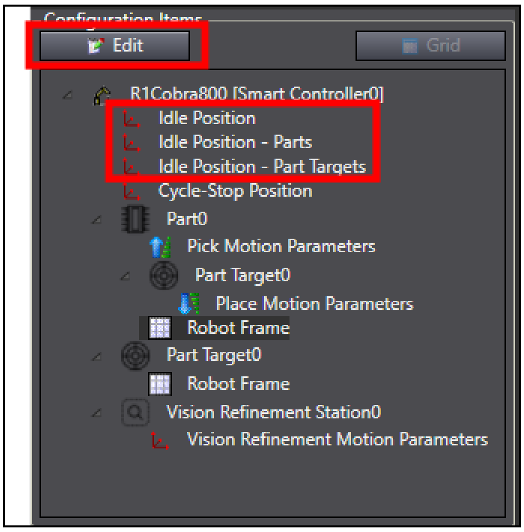


Figure 8-178 Idle Position Configuration Items

Cycle-Stop Position

The Cycle-Stop Position is a location that is used when the process Cycle-Stop is requested. The Cycle-Stop can be requested with one of the following methods.

- OPC
- Data Mapper
- C# program

- Clicking the **Cycle Stop** button in the Task Status Control area

  NOTE: Using this method will result in the robot finishing the current process and then waiting for the Cycle-Stop request to be released.

To access the Cycle-Stop Position editor, double-click the **Cycle-Stop** Configuration Item or select the item and click the **Edit** Button. The Cycle-Stop Position editor will open.

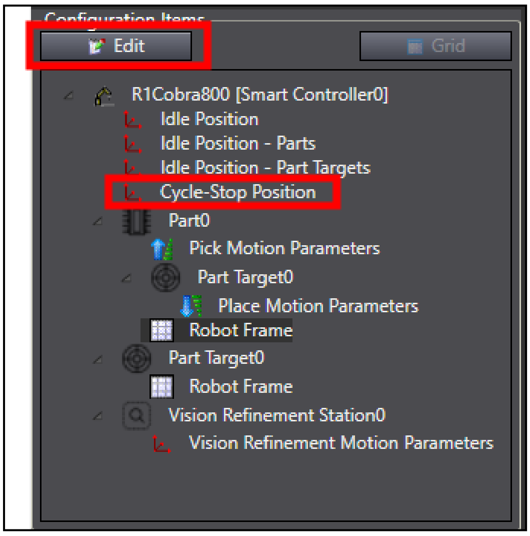


Figure 8-179 Cycle-Stop Configuration Items

Robot Frames

Robot frames (also known as reference frames) are useful because they allow you to teach locations relative to the frame. If the location of the frame changes in the workcell, you simply have to update the frame information to reflect its new location. Then you can use any locations created relative to that frame without further modifications.

A process pallet is typically taught relative to a reference frame. This avoids the problem of teaching many individual pallet positions and then having to reteach all of those positions if the pallet moves for some reason. Instead, the pallet is taught relative to a frame. If the pallet moves in the workcell, the frame position is re-taught and the part positions relative to that frame remain intact.

The Robot Frame editor is used to teach a reference frame, such as a pallet frame. To access the Robot Frame editor, double-click the ***Robot Frame*** Configuration Item or select the item and click the **Edit** button.

> **Additional Information**: Robot Frames are only available when a part or target object is configured as **Static: Fixed Position** and a Pallet object is defined in that object.

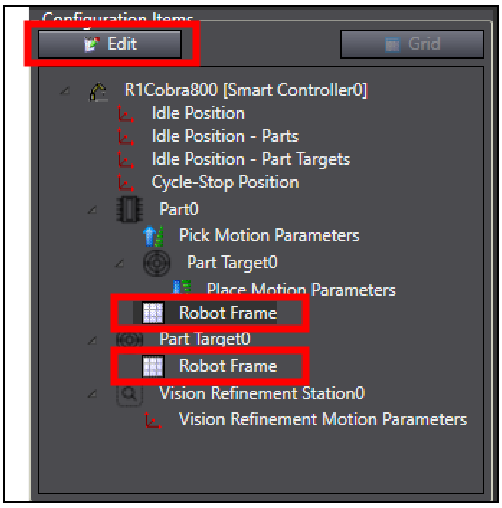


Figure 8-180 Robot Frame Configuration Items

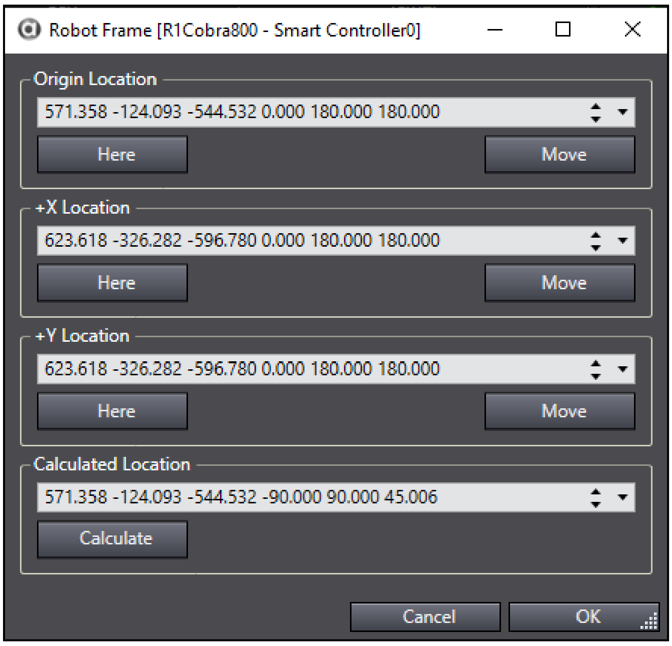


Figure 8-181 Robot Frame Configuration

Robot Frames will typically be defined during the teach process wizard, but can be manually defined as well. Use the following procedure to manually define a Robot Frame.

1. Teach the Origin Location.

   Use the V+ Jog Control to position the robot tool tip at the origin (in the case of a rectangular pallet, this can be the first pocket position) and then click the **Here** button to record the position.

2. Teach the +X Location.

Use the V+ Jog Control to position the robot tool tip at a point on the +X axis. In the case of a rectangular pallet, this can be any pocket position along the +X axis. Optimum results will be obtained by using a point as far away from the origin as possible. Then, click the **Here** button to record the position.

3. Teach the +Y Location.

   Use the V+ Jog Control to position the robot tool tip at a point on the +Y axis. In the case of a rectangular pallet, this can be any pocket position along the +Y axis. Optimum results will be obtained by using a point as far away from the origin as possible. Then, click the **Here** Button to record the position.

4. Click the **Calculate** Button to calculate the position of the robot frame relative to the robot.
5. Click the **OK** Button to close the Robot Frame editor and complete this procedure.

Motion Sequence Grid Editor

The Moti Sequence Grid Editor provides a grid / table interface that allows you to access and individually edit the comm motion parameters used to optimize cycle time. Also, you can change multiple speed / acceleration / deceleration parameters at the same time. Click on on one of the necessary fields and drag the cursor across the others, as shown, refer to Multiple Parameter Selection. Enter a new value to change all of the selected fields.

- Pick motion parameters.
- Place motion parameters.
- Vision refinement parameters.
- Offset location parameters.

> **NOTE:** If parameters change significantly, I/O timing in the Pick and Place Motion Parameter editors may need to be adjusted. Otherwise, faster motions and blending may lead to missed picks or poor placement.

To access the grid editor, select the robot object in the Configuration Items group and then click the **Grid** Button (Grid). The Motion Sequence Grid Editor opens.

Figure 8-182 Motion Sequence Grid Editor

The left pane is used to select the items you wish to display for editing. The right pane contains the editing parameters by group.

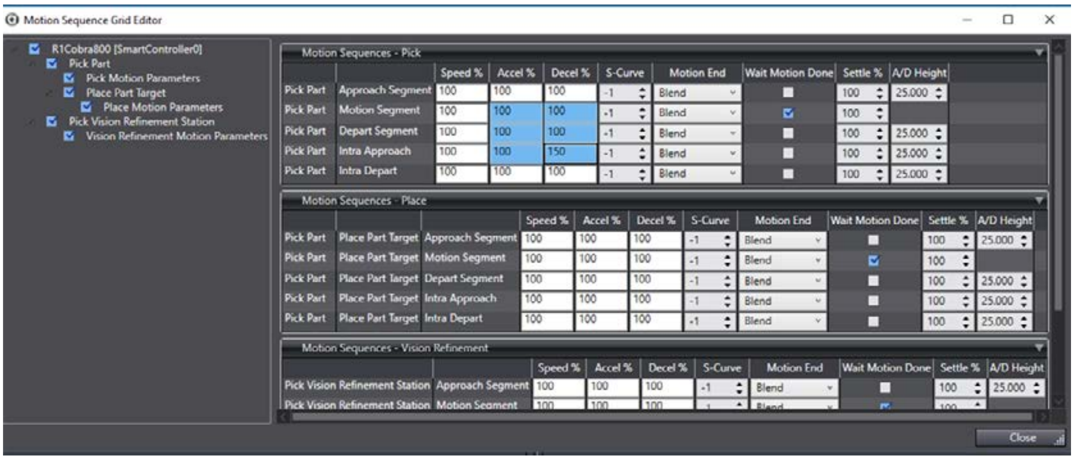


Figure 8-183 Multiple Parameter Selection

Control Sources

The Control Sources editor provides access to parameters that affect Part and Part Target sources for the defined processes. Sources are responsible for providing instances to a process. These are automatically created based on the Part and Part Target object configuration property. There are three types of Sources that are described in the following sections.

- Belt Control Sources (includes belt-relative cameras)
- Static Control Sources
- Vision Control Sources (not belt-relative)

To access the Control Sources Editor, click the **Control Sources** button (Control Sources).

Belt Control Sources

This section describes the Control Sources Editor when a Belt source is selected.

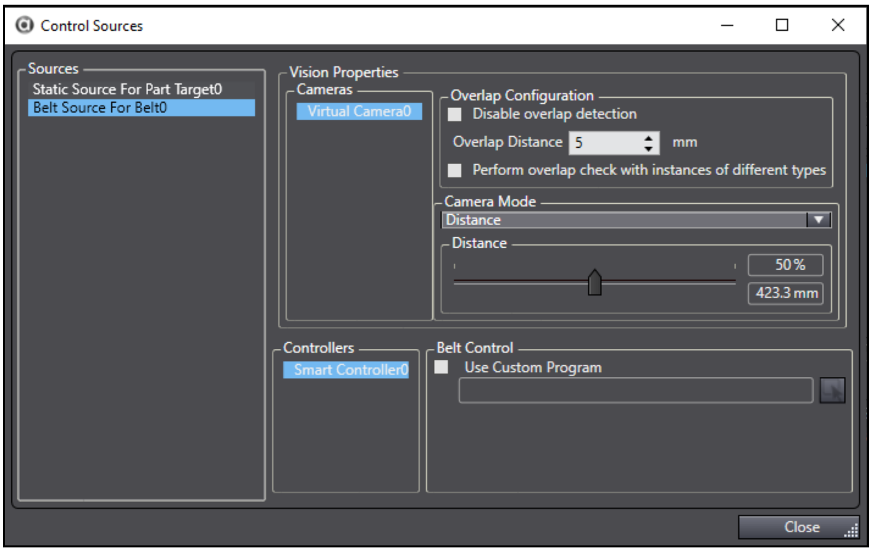


Figure 8-184 Control Sources Editor - Belt Control Source

Camera Objects

Camera objects can be added to the ACE project to provide a method for obtaining an image to be used for processing. A camera object can be either a physical camera, virtual camera, or an emulated camera. You can have multiple camera objects in the ACE project.

Use the information in this section to understand the different camera object types and their configurations in an ACE project.

To add a camera object to the Application Manager in the Multiview Explorer, right-click **Cameras**, select **Add** and then choose a camera type. A new camera object will be added to the Multiview Explorer.

> **NOTE:** When adding an Emulation camera for a Basler Camera, Sentech Camera, Phoxi 3D camera or Custom Device, you also have the option to also add a Virtual Camera. A Virtual Camera is typically required for most applications.

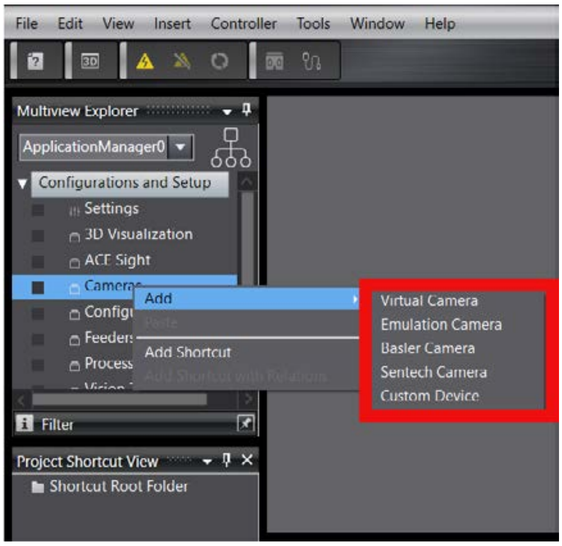


Figure 8-185 Adding a Camera Object

Camera Mode

There are three camera modes available: Distance, Trigger, and Time that are described below.

When **Distance** is selected, the Field of View Picture interval control is enabled. This control is used to adjust the picture interval relative to belt travel. The setting is displayed as a percentage of the field of view, and in millimeters (mm) as calculated from the calibration in the selected virtual camera.

When **Trigger** is selected, the Trigger Signal control is enabled. This specifies the signal number to use for the vision trigger. When the specified trigger signal number is activated, a new vision image will be acquired. For example, this can be used in an application where an image only needs to be acquired when an object activates a sensor if it is below the camera. In this case, the trigger signal is wired to the robot controller and should not be confused with applications that require triggering the camera directly. Triggering a camera directly is configured in the Virtual Camera object Acquisition Settings.

NOTE: In Emulation Mode, Trigger mode will use the **Trigger Period in Emulation Mode** distance value specified. This is used to simulate the trigger occurring based on the specified distance of belt travel.

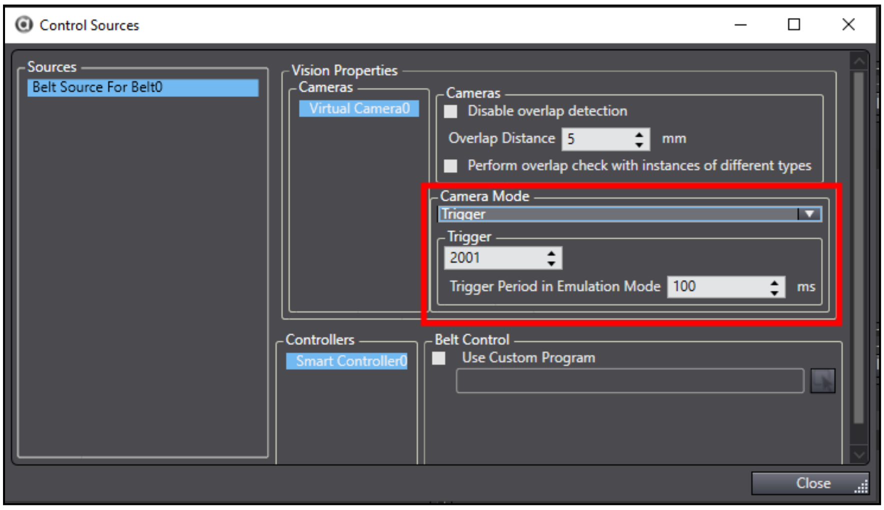


Figure 8-186 Control Sources Editor - Camera Mode - Trigger

When **Time** is selected, an image will be requested on the specified time interval.

Overlap Configuration

When a part is located in an image associated with a conveyor, the position of the object is compared with the position of objects located in previous images that have already been added to the queue of instances to process.

If ***Disable Overlap Check*** is selected, all overlap checking is disabled. When this option is selected, the remaining Overlap Configuration items are not available. If a part is located in multiple images, the robot will attempt to pick at the same belt-relative position multiple times. If this occurs when Overlap Configuration is not disabled, consider increasing the Overlap distance.

If the newly-located part is within the specified Overlap Distance of a previously located part (accounting for belt travel), it is assumed to be the same part and will not be added as a duplicate new instance.

If ***Perform overlap check with instances of different types*** is selected, the overlap calculation will check for overlap of any parts, rather than just parts of the same type.

Use Custom Program

The default belt program (pm.belt.control) is optimized for performance of all default Process Manager configurations and flexible functionality. The Controllers list will display all controllers associated with the selected Belt object. Each controller executes a V+ program for monitoring and updating encoder position, belt velocity, image requests, latches, and instance information for all instances allocated to that controller.

Occasionally, applications require customization of this program. For example, you may need to sacrifice available controller processing time to achieve more frequent latch reporting or image requests. In these cases, select ***Use Custom Program*** and then edit the default program accordingly. You may need to make the same modifications to the belt program on each controller depending on application requirements.

Static Control Sources

This section describes the Control Sources Editor when a Static Control Source is selected.

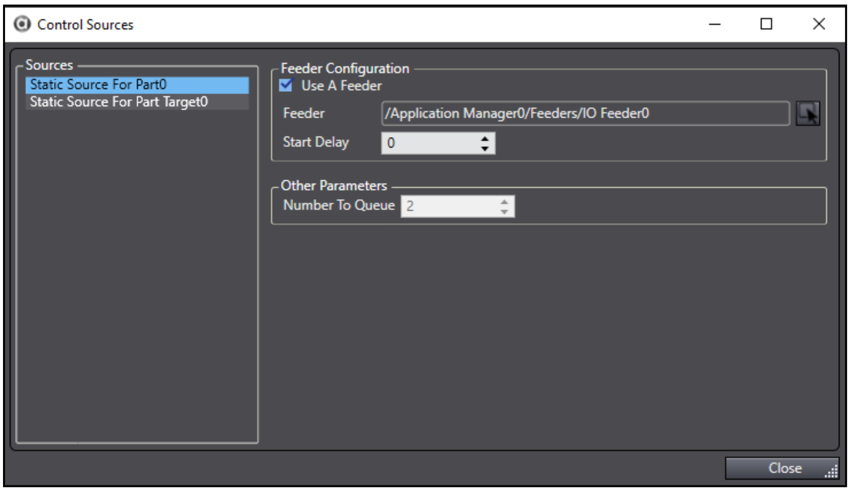


Figure 8-187 Control Sources Editor - Static Control Source

Static Sources are used for Part and Part Targets that are not related to belts or cameras.

If an IOFeeder is not enabled, then the PC generates instances for these sources at the Robot Frames defined in configuration items. Each time the controller has emptied the queue of instances, the PC will generate another set of instances and pass them to the controller. The quantity of instances generated is set by the Number to Queue property. The default value is two instances to overcome any disturbances in the communication flow between the PC and controller.

Alternatively, select **Use A Feeder** and choose an IOFeeder object that controls when parts are generated. When this is selected, another V+ program is executed for monitoring feeder activity. This can be used for individual parts or pallet configurations. For example, associate an IOFeeder with a target pallet source to use an input signal from a sensor to indicate when a box is present to be filled.

> **NOTE:** When the Feeder Configuration option is enabled, the **Number To Queue** parameter is disabled.

Use the **Feeder** selection to specify a feeder object. Click the Select button ( ) to select the feeder object.

Use the **Start Delay** selection to specify the delay in milliseconds before the feeder is activated. This delay can be used to ensure the robot has moved out of the pick / image area before the feeder is activated.

Vision Control Sources

This section describes the Control Sources Editor when a Vision Source is selected.

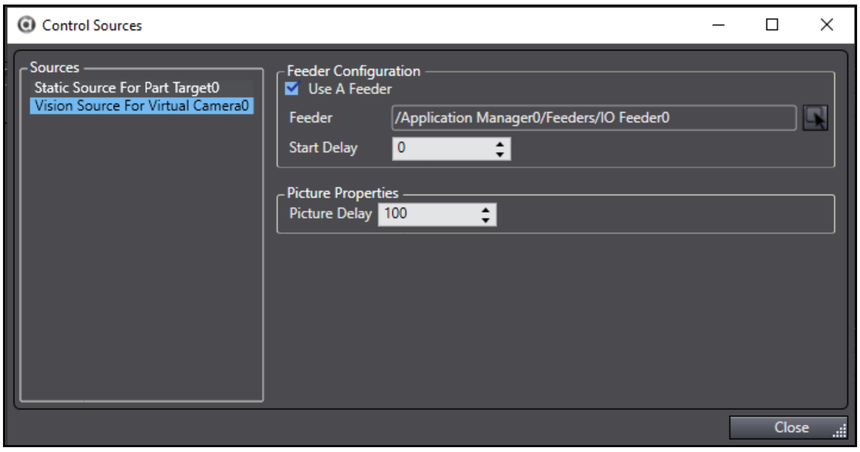


Figure 8-188 Control Sources Editor - Vision Control Source

Vision Sources are used for fixed-mounted cameras. They can be associated with IOFeeder objects, similar to Static Sources.

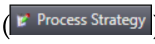
If a Feeder is not enabled, Vision Sources will trigger a new image to be taken when the last instance of the previous image has been processed, delayed by the Picture Delay (in milliseconds). This delay can be used to ensure the robot has moved out of the pick / image area before a new image is requested because the last part instance is considered processed once the pick operation has completed without error.

Process Strategy

The Process Manager invokes a Process Strategy to determine how to allocate the Parts and Part Targets identified by the Process Manager. It uses the list of Part Processes to allocate the Parts and Part Targets to specific robots. The output of this process is passed to the controller queue by the Process Manager. Each Process Strategy operates under certain assumptions based on the process being monitored. Those assumptions determine which algorithms are used to perform the allocation.

The Process Strategy Editor provides access to the following parameters editors.

- Controller Parameters. Refer to Process Strategy on page 439 for more information.
- Robot Parameters. Refer to Process Strategy on page 439 for more information.
- Belt Control Parameters. Refer to Process Strategy on page 439 for more information.

To access the Process Strategy editor, click the **Process Strategy** Button (
). The appropriate editor is shown based on the object selected in the left pane of the Process Strategy Editor.

Process Strategy Controller Parameters

The Controller Parameters are displayed when the controller is selected in the Process Strategy Editor. The Controller Parameters group is used to specify custom V+ programs for the selected controller.

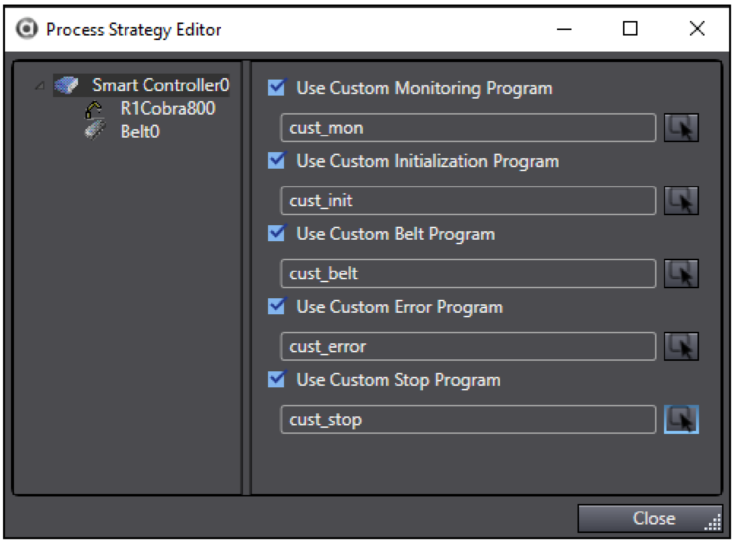


Figure 8-189 Process Strategy Editor - Controller Parameters

Table 8-28 Process Strategy Editor Item Description - Controller Parameters

Item	Description
Use Custom Monitoring Program	The default process monitoring has the following functions. • Checks for updates to process strategies. • Handles belt monitoring. • Monitors parts and part targets. You can copy the default V+ monitoring program for editing, or select an existing program. **NOTE:** Most applications do not require a Custom Monitoring Program
Use Custom Initialization Program	The default initialization program that executes before the control programs (robot, belt, process strategy, etc.) are started. This can be used to initialize system switches, parameters, and variables or execute V+ programs that need to be started in parallel to the Process Manager. You can copy the default V+ initialization program for editing, or select an existing program.
Use Custom Belt Program	The default belt program monitors the speed / ON / OFF status of all belts. You can copy the default V+ belt program for editing, or select an existing program. **NOTE:** Most applications do not require a Custom Belt monitoring program and can be sufficiently controlled using Process Strategy Belt Control Parameters as described in this section.
Use Custom	The default error program handles the processing and reporting of errors

Item	Description
Error Program	during the execution of a process. You can copy the default V+ error program for editing, or select an existing program. This program can be used to automate error handling that are reported to the PC by default. All Process Manager V+ program error handling will lead to this program. Use this program to automate error handling of errors that are reported to the PC by default. This program will check if any user-defined error responses exist in the Process Strategy - Robot parameters.
Use Custom Stop Program	The custom stop program can be used to perform certain operations after the application has stopped. You can copy the default V+ stop program for editing, or select an existing program.

Process Strategy Robot Parameters

The Robot Parameters are displayed when the robot is selected in the Process Strategy Editor.

There are four tabs of robot parameters: the **General Parameters** tab, the **Allocation** tab, the **Wait Mode Parameters** tab, and the **Error Response** tab that are described below.

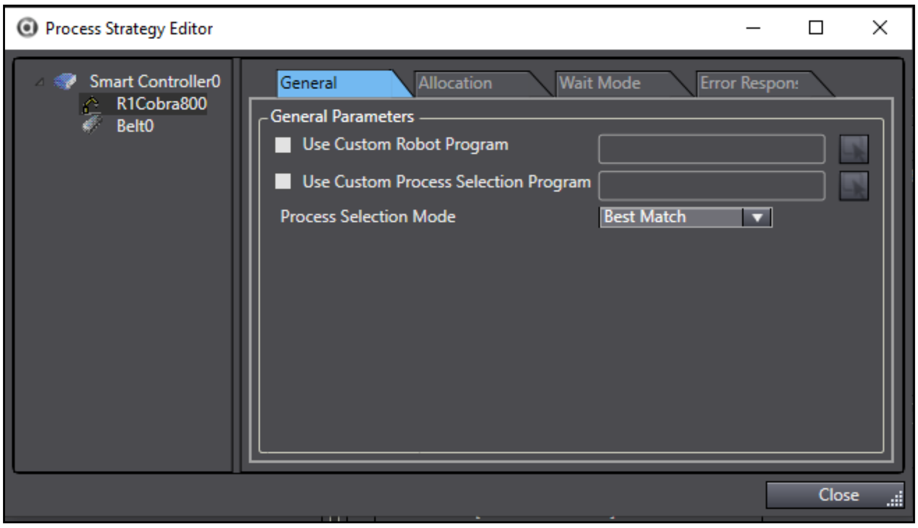


Figure 8-190 Process Strategy Editor - Robot Parameters

Table 8-29 Process Strategy Editor Item Description - Robot Parameters

Group	Item	Description
General	Use Custom Robot Program	Allows you to specify a custom V+ main robot-control program. For example, this would allow you to customize exactly when a given robot executes each process. You can copy the default V+

Group	Item	Description
		program for editing, or select an existing program.
	Use Custom Process Selection Program	Allows you to specify a custom V+ process-selection program. For example, this would allow you to customize the selection and ordering of the processes. You can copy the default V+ program for editing, or select an existing program.
	Process Selection Mode	Specifies the process selection mode used by the robot. • Best Match: Evaluates all process on the list. It gives priority to the process with belt-relative parts or targets whose product is furthest downstream in the belt window of the associated robot. If no process is belt-relative, it will select the first available process in the list. • As Ordered (no Timeout): Selects the processes in the order they are listed. For example, if three processes are listed, it will select process 1, then process 2, and then process 3. The currently-selected process must be completed before the next one can begin. When the last process has completed, the list repeats. • As Ordered with Timeout: Selects the processes based on their order and user-supplied timeout (the timeout is specified in milliseconds). Normally, it selects the next process in the list, but if the pro-

Group	Item	Description
		cess cannot be selected within the given timeout, it will move to the next process for possible selection.
Allocation	Part or Target Filtering Mode	Specifies how instances are identified for processing by this robot. **NOTE:** The filtering process occurs before the allocation process. • No Filtering: All instances are sent to the robot. • Pick / Skip Instances: Processes a certain number of instances then skips a certain number of instances. • Even Distribution: Distributes instances by allocating an equal percentage to all robots. • Percentage of Instances: Allocate a percentage of instances evenly across the range of available instances. • Skip Rate: The robot should process and skip instances to maintain a balanced flow and robot work load in a multi-robot system. • Relative Belt Position: Process instances that are separated by a certain distance. • Pick / Skip Pallets: Process a certain number of pallets then skip a certain number of pallets.
	Queue Size	Specifies the queue size for the robot. Each robot has a queue size, which represents the maximum number of Part or

Group	Item	Description
		Part Target instances that can be sent to the robot. Each part and target is associated with a different queue for a given robot. This parameter defines the size of each queue. This parameter has a default value of 10. To change the parameter, enter the new value into the Queue Size field, or adjust the value using the up/down arrows.
	Allocation Distance	Specifies the distance upstream from the belt window that a part instance must be within before the system is allowed to allocate that part instance to the robot. This can be considered the maximum distance upstream that an instance can be allocated to the robot.
	Allocation Limit	Specifies the distance upstream from the Process Limit Line that a part instance must be to allocate that part instance to the robot. This can be considered the minimum distance upstream that an instance must be for allocation. • If set to zero, instances will be allocated if they are at or upstream of the process limit line. • If greater than 0, it represents the upstream distance (in mm) from the process limit line an instance must be for it to be allocated. This parameter is useful in the case of fast-moving belts where the robot needs additional look ahead to process instances.

Group	Item	Description
		For example, if a part pallet has four instances and the robot queue size is two, when the robot picks instance one, there is now space in the queue for one more instance. If instance three is upstream of the allocation limit, it will be allocated but if it is downstream of the allocation limit, (>0) it will not be allocated. This prevents allocation of instances that are in the downstream portion of the allocation area.
	Use Custom Allocation Script	Specifies a Custom Allocation Script. The Custom Allocation Script provides two different entry points that are called. One is for allocating non-belt instances (parts and targets). The other is for belt instances. The program can manipulate the lists to indicate to the system what should be allocated to a given robot. This is called by the Process Manager when it needs to allocate parts. If this option is enabled, click the **Select** button ( ) to select the desired Custom Allocation Script. Refer to the *ACE Reference Guide - Custom Allocation Scripts* for more information.
Wait Mode	Stay at current position	Causes the robot to remain at the current position while waiting for a part or target to process.
	Move to Idle Position	Causes the robot to move to the idle position after the specified **After waiting for** time (in milliseconds) while waiting for a part or target to process. For example, if the **After waiting for** time is 500 ms, when there is a break in the part or

Group	Item	Description
		part target processing queue, the robot will move to the idle position after 500 ms. **NOTE:** This must be enabled for the Idle Position Parts and Idle Position Part Targets to be used. Refer to Idle Positions on page 430 for more information.
	Use Custom Wait Program	Allows you to specify a custom V+ wait program. The program would be called when the robot does not have a part or target available. The program could check to see if the robot needs to be moved to the idle location or if it should stay at the current location. This program starts with the logic specified by one of the selections above. You can copy the default V+ program for editing, or select an existing program.
	Use Signal at Cycle Stop	When a cycle stop is issued and this option is enabled, the specified I/O signal will be turned ON when the robot has reached the cycle stop state. When the cycle is resumed (cycle stop state is canceled), it will turn the specified signal OFF and will attempt to enable power, if high power was disabled.
Error Responses	Output Signal - On Error	Defines a digital signal to assert when an error is detected for the selected robot.
	Error Listing (use the **Add**, **Delete**, and **Up / Down** buttons to arrange the	Specifies how specific error conditions are to be handled. By default, all errors will be reported to you and the soft-

Group	Item	Description
	list).	ware will wait until you respond to the error. If an error condition is defined, it will override this default error handling. It can be used to define automatic handling of the following errors. • Single Error Code: User-defined error code. • Range of Error Codes: User-defined error code range. • Belt Window Access Error: Belt window violations. • Robot Power Errors: Problems with power being enabled or enabling power. • Gripper Errors: All gripper actuations. • All Errors: All other errors. When an error is detected for the robot, it will process the error listing handlers defined and find the first one that can handle the condition. If the error cannot be handled by an item in the list, the error is reported to Task Status Control. Alternatively, create a Custom Error Program (refer to Process Strategy Robot Parameters on page 441 for more information).

Process Strategy Belt Control Parameters

The Belt Control Parameters are displayed when the belt is selected in the Process Strategy Editor.

NOTE: Belt Control Parameters are only available when the following items are configured.

- Active Belt Control is enabled in the Belt object configuration.
- A controller is selected in the Belt object configuration.
- A defined process includes a Part or Part Target that references the Belt Object.

The Belt Control Parameters group as shown in the following figure is used to set the belt control parameters for the selected conveyor belt. These parameters can be set to determine when a conveyor belt is turned ON or OFF. An optional speed control parameter is also provided. The decision point for the belt I/O control is based on the selected robot. If objects on the belt in the selected robot queue reach the specified thresholds, the belt will be turned OFF or the belt speed will be adjusted.

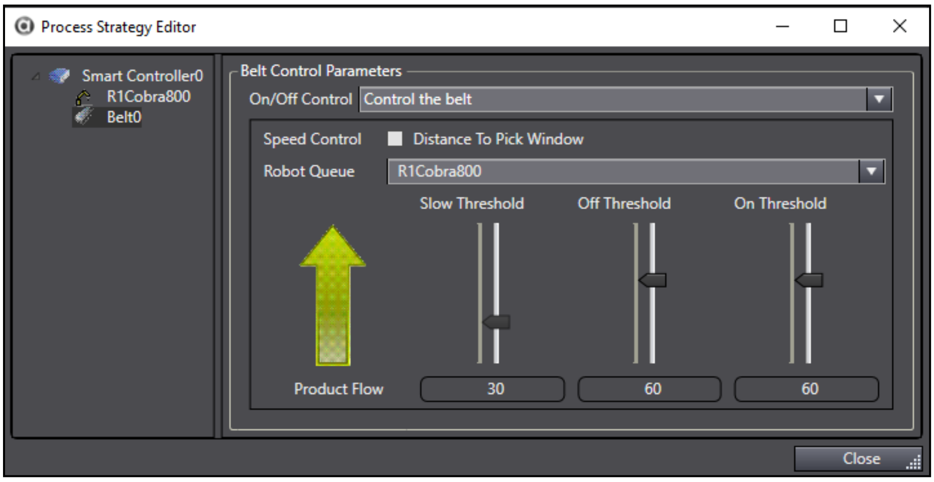


Figure 8-191 Process Strategy Editor - Belt Parameters

Table 8-30 Process Strategy Editor Item Description - Belt Parameters

Item	Description
On/Off Control	Specifies the ON / OFF control of the belt. There are three selections available: • **Do not control the belt**: Use this option if there are output signals that can control the belt, but you do not want the Process Manager to control the belt during run time. If the belt control is provided by a PLC and output signals are not able to control the belt, disable Active Control in the Belt object. • **Leave the belt always ON**: The belt is turned ON when the process starts and OFF when the Process Manager is stopped. • **Control the belt**: (Default) The belt is controlled based on thresholds described below. The belt is automatically turned OFF when the Process Manager stops the application.
Speed Control	If this is selected, you can use the Slow Threshold control to adjust the conveyor speed threshold based on how full the robot queue is. Otherwise, the conveyor belt operates at a constant speed.
Robot Queue	Specifies a robot for queue monitoring (the queue size for the robot is set in the Robot Parameters group). The selected robot will typically be the most downstream robot if multiple robots service the same belt. If parts get to the last robot, it needs to slow / stop the conveyor to ensure all Parts or Part Targets are processed.
Slow, Off, and On	These thresholds are used to control the belt based on instance position. This is useful for preventing the belt from feeding the robot faster than the robot

Item	Description
Thresholds	can pick the parts, or preventing not-processed Part or Part Targets from passing the most downstream robot. **Slow Threshold**: Specifies the point in the belt window for slowing the conveyor if parts reach that point. For example, 50% means that if a part reaches the midpoint of the belt window, the conveyor will be slowed. **Off Threshold**: If an instance reaches this threshold, the belt will be turned OFF. This is set as a percentage from upstream belt window limit to downstream process limit and is visualized as a black line in the 3D Visualizer (in the belt window for the selected robot). **On Threshold**: When a belt is turned OFF by the Off Threshold, the belt will remain OFF until all instances are removed between the Off Threshold point and the On Threshold point. This can be used to minimize the number of times the belt is started and stopped. This is set as a percentage from upstream belt window limit to downstream process limit and is visualized as a green line in the 3D Visualizer (in the belt window for the selected robot).
Product Flow	Shows the product flow (belt window) direction of travel in relation to the Slow and Off Threshold slide controls. It is a reference for the thresholds. The bottom of the arrow represents the start of the belt window. The top of the arrow represents the Downstream Process Limit.

Process Manager Control

The Process Manager Control is used to start and stop a process-managed application, such as a Pack Manager packaging application.

Using the Process Manager Control

The Task Status Control interface is used to monitor and control Process Manager objects in the ACE project. A Process Manager item in the Task Status Control area is used to select the Process Manager object, start and stop the selected application, and view status and instances on the application while it is operating.

Process Manager control items are added to the Task Status Control area as shown in the following figure. Select a Process Manager control item to view the Hardware and Application information areas. Refer to Application Manager Control on page 132 for more information.

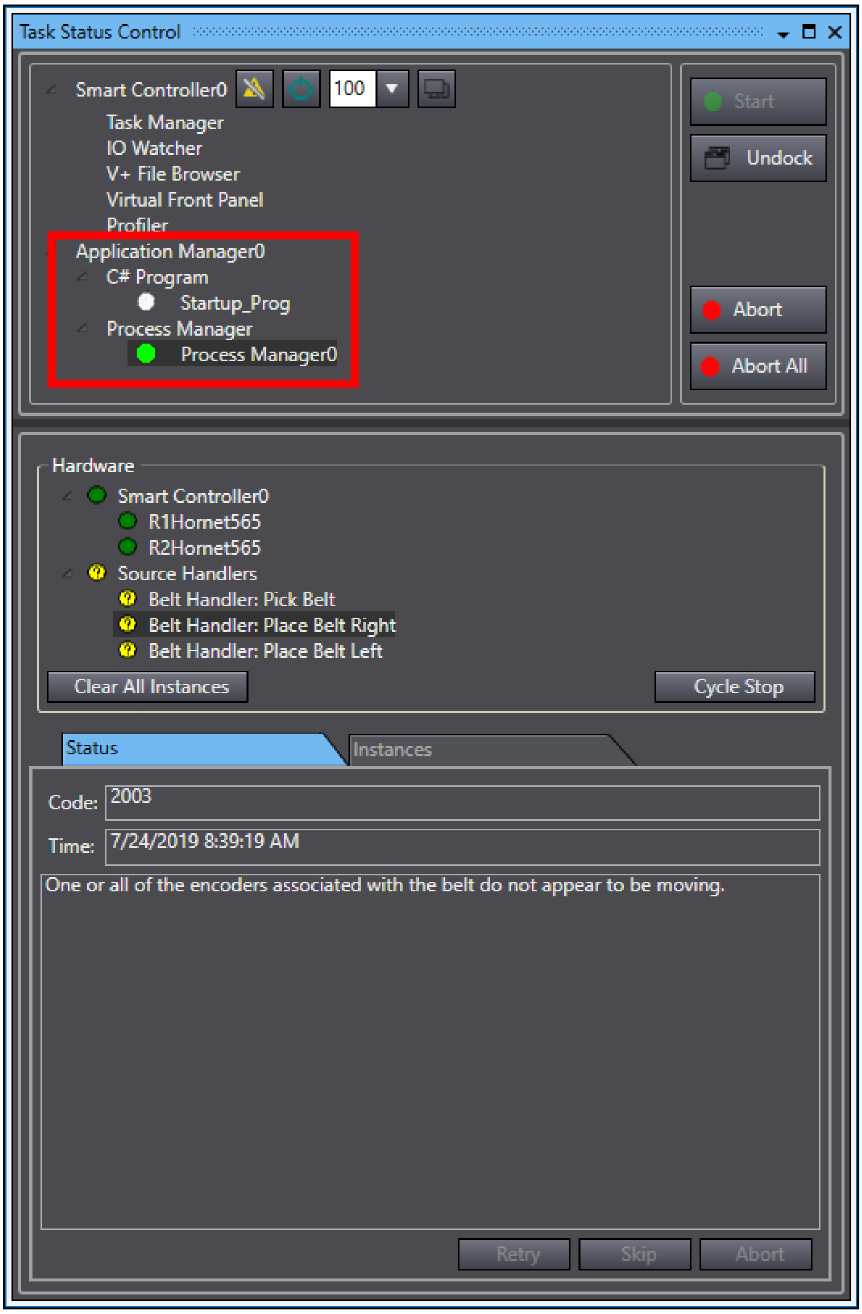


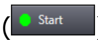
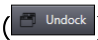
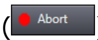
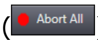
Figure 8-192 Process Manager in Task Status Control

Process Manager Tasks

Process Manager tasks are displayed under the Application Manager group in a tree view. Tasks are grouped by type (C# program, Process Manager, etc.). When you select a task, the following functions become available.

> **Additional Information**: Double-clicking a Process Manager task in the Task Status Control interface will open the item in the Edit Pane.

Table 8-31 Process Manager Tasks Function Description

Function	Description
Start ()	Executes the selected task.
Undock ()	Undocks the selected task's hardware and application information area. **NOTE:** Close the undocked window to restore the view.
Abort ()	Stops execution of the selected task.
Abort All ()	Stops execution for all tasks.

Tasks are marked with icons to indicate operational status.

Table 8-32 Task Status Icons

Icon	Description
	The task is running.
	The task is stopped/aborted.
	The task is idle.

Hardware Information Area

The Hardware information area displays the hardware items and their status for the selected Process Manager task. Use the information below to understand the functions of the hardware information area.

When a robot is waiting (for example, waiting for Parts or Part Targets to arrive or because of a cycle stop request), a yellow warning condition is displayed on the Process Manager control. Selecting the item in the Hardware Information area will display additional information in the status and instance tabs below.

> **NOTE:** Some items on the Hardware list are in Error and Warning states until the Process Manager establishes communications with and initializes those items.

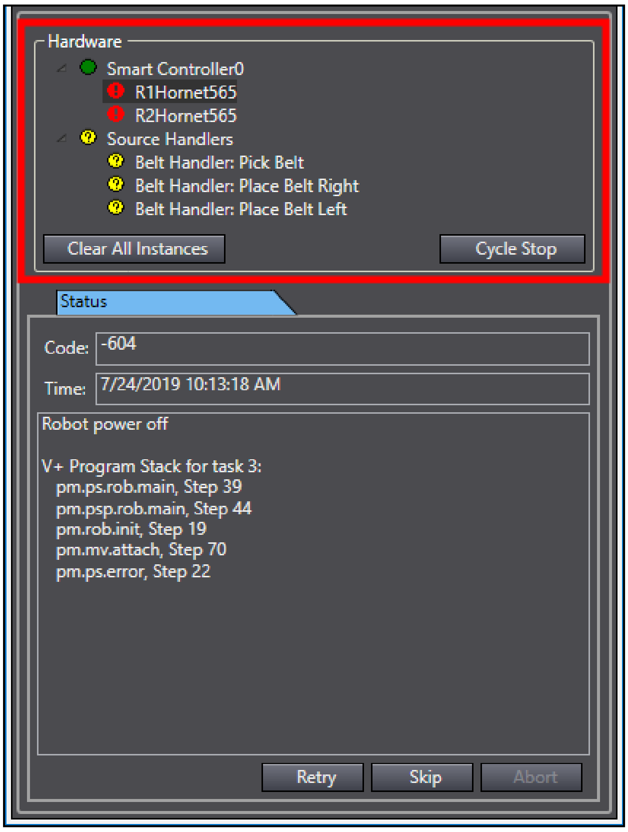
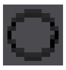
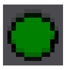


Figure 8-193 Hardware Information Area

Table 8-33 Hardware Information Area Item Description

Item	Icon/Button	Description
Idle State Icon		The item is idle.
Operating State Icon		The item is operating.
Warning State Icon		A warning condition is present for the item. The specific warning message is displayed on the Status tab. Refer to Hardware Information Area on page 451 for more information.
Error State Icon		An error condition is present for the item. The specific warning message is displayed on the Status tab. Refer to Hardware Information Area on page 451 for more information.
ClearAll	Clear All Instances	Clears all Part and Part Target instances from the sys-

Item	Icon/Button	Description
Instances Button		tem.
Cycle Stop Button		Sends a signal to each robot to stop after the current process cycle has completed. Each robot stops after it reaches the end of its current process, and then "Robot is waiting because of a cycle stop request." is displayed in the Status tab. You can resume the robot(s) and process operations by clicking the **Cycle Stop** button. The **Cycle Stop** button provides the capability to implement a variety of situations. For example, you could click the **Cycle Stop** button and leave the system running. When the system is in this state, all tracking is enabled. Therefore, you could either click the **Abort** button which stops everything or you could simply resume the current cycle by clicking the **Cycle Stop** button again.

Application Information Area

The Application information area displays feedback on the operation of the item selected in the Hardware area. The Application information area has a Status tab and an Instances tab which are described below.

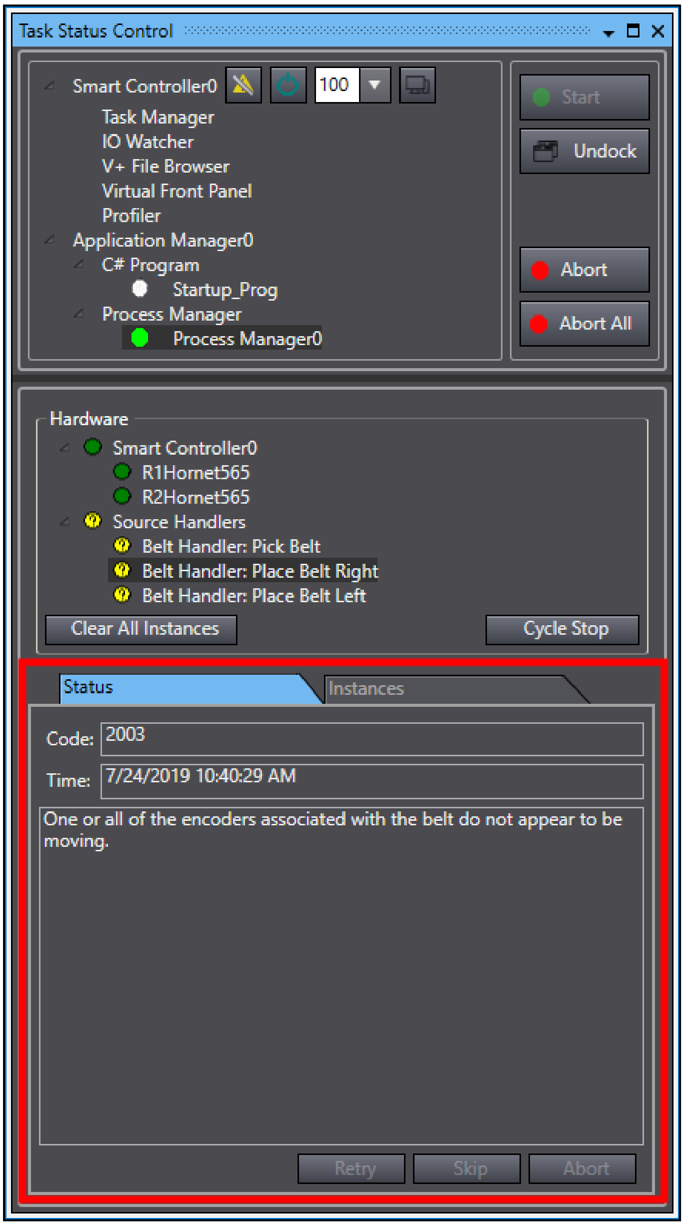


Figure 8-194 Application Information Area

Status Tab

This tab displays information on the status of the control components driving the process. It shows the hardware in the system and the status of the selected item.

Refer toSection Chapter 9: , Troubleshooting on page 644 for more information about status codes and messages.

The Status tab includes the following information.

- **Code**: displays the error number for the message.
- **Time**: displays the controller time when the error occurred.

- **Message Information**: displays the details of an ACE exception by showing the contents of the V+ program stack, when available (the exception source must be a V+ error) or displays general status and error message text.
- **Retry, Skip, Abort** buttons: These buttons and their functions are enabled are enabled when in error state and return the corresponding response. See *Custom Error Programs* in the *ACE Reference Guide* for more information.

Instances Tab

The Instances tab displays information on the parts and part targets that are associated with each control source. The **Clear** button removes all instances from the selected source. To remove all instances from all sources, use the **Clear All Instances** button in the Hardware section of the Process Manager Control area.

Motion Settings: Pick and Place

When the user defines a process that is composed of a part and a part target, the software will create motion settings that are used when processing the parts and targets. You can access the settings in the configuration item section. When one is selected, it will look similar to the following figure.

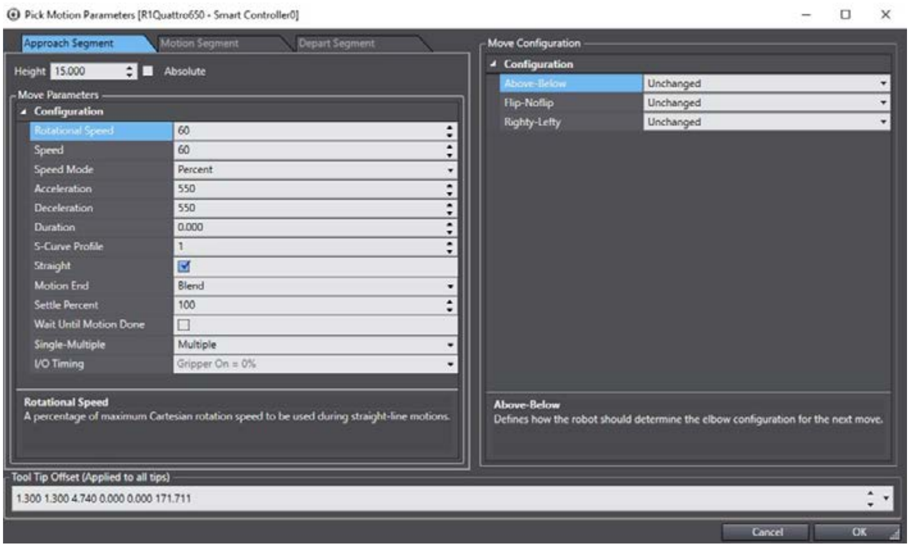


Figure 8-195 Pick and Place Motion

In this example, the V+ Program called when an instance is to be picked or placed. When a process is created, the process specifies that a robot must pick a set of parts and should place those parts at a set of targets. The process manager will supply a default set of motions used to acquire the parts and place at the targets. If the default motions do not meet the requirements, the program that governs the behavior of the motions can be customized.

In addition to defining parts and targets, a process may also reference a refinement station that locates parts in the gripper before placement at targets. The program that defines the motions of a refinement operation can also be overridden if the default motions are not sufficient.

In the Process Manager > Configuration Items there is a Place Motion Parameter with a Depart/ Release I/O timing the percentage slider, shown below. This shows a percentage of the motion from place to depart location, typically this depart is lifting off of the target location.

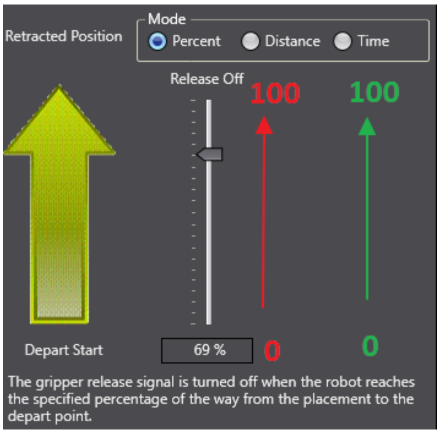


Figure 8-196 Approach/Depart Slider

Motion Settings Refinement

A process can be configured to refine the location of a part in the gripper before placement. Once this is defined, the software will create motion settings for the refinement operation in the configuration item section. When selected, it will look similar to the following figure.

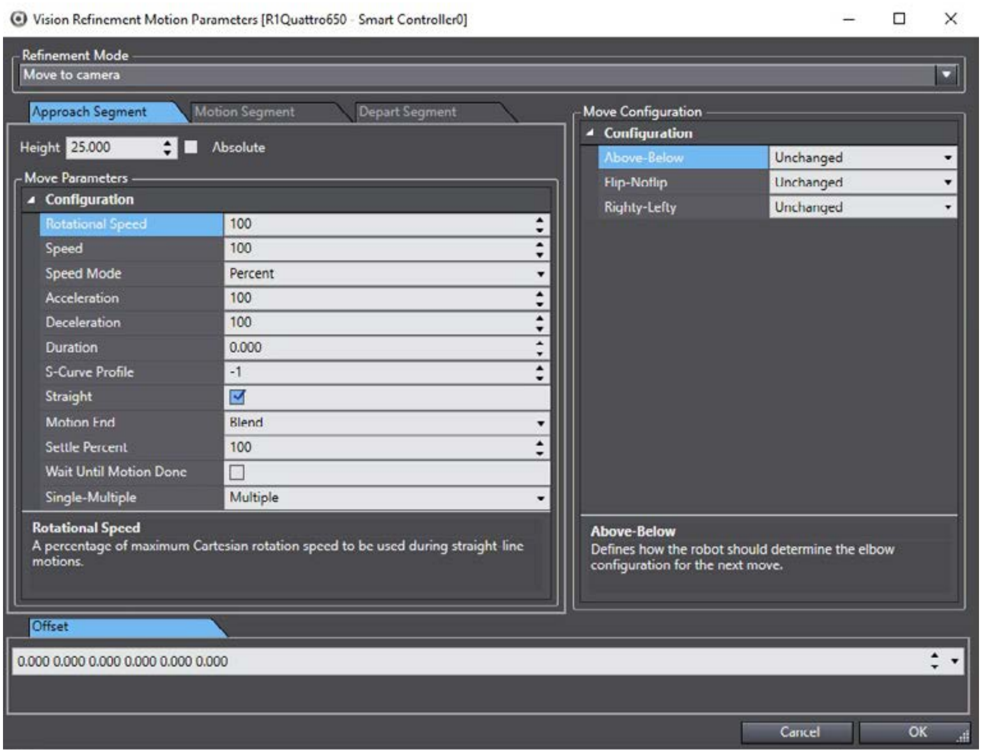


Figure 8-197 Refinement Operation Settings

When a process is created, the user can define a refinement operation. When the refinement is specified, the instance will be located with a camera after the pick operation and before the placement operation.

The program that defines the motions of a refinement operation can also be overridden if the default motions are not sufficient. The refinement configuration item defines all the parameters used when refining parts in the gripper before placing at a target. The motion sequence logic can be overridden.

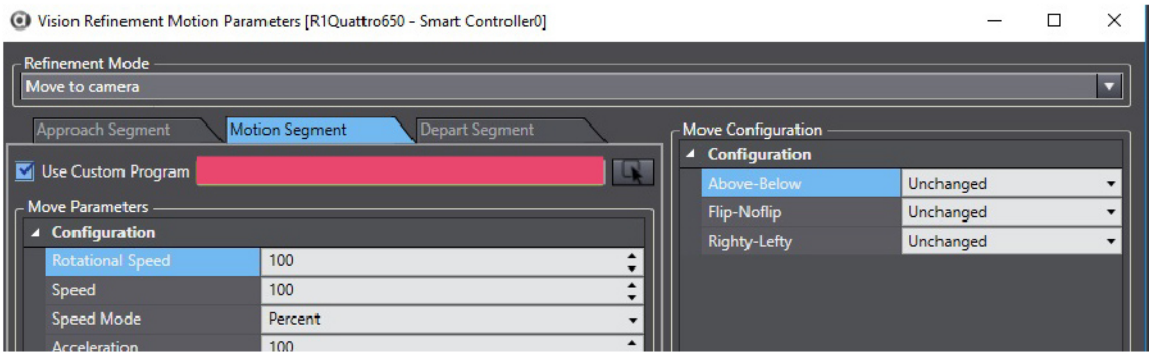


Figure 8-198 Configure Motion Sequence

When the refinement program is customized, the system starts by creating a copy of the default refinement sequence. The default refinement sequence can be broken down into several steps:

If normal camera refinement is enabled

- Calculate the Approach, Move, and Depart Positions
- Perform the Approach Sequence
- Perform Move to Destination
- Issue Camera Refinement Operation
- Perform the Depart Sequence

If Vision-on-the-Fly refinement is enabled

- Calculate the Start and End Positions
- Move to the Start Position
- Start Moving to the End Position
- Trigger the Refinement Operation

The definition of the default refinement program header example is shown below.

```
.PROGRAM cu.refinement(tsk.idx, grip.idx, cal.idx, cfg.idx, $refine, vals[], calc.offset, sts)

; ABSTRACT:  Perform a vision refinement operation.
;
; INPUTS:       tsk.idx         Index of the task
;               grip.idx        Gripper index to use
;               cal.idx         Index of the camera calibration
;               cfg.idx         Index of the vision refinement configuration
;                                 item parameters
;               $refine         The name of the refinement operation
;               vals            The motion configuration array
;
; OUTPUTS:      calc.offset     The calculated position of the part
;                                 relative to the gripper.
;               sts             Status of the operation:
;                                 pm.tsk.success = Successful operation
;                                 pm.tsk.retry   = Retry the operation
;                                 pm.tsk.skip    = Skip the operation
;                                 pm.tsk.abort   = Abort the operation
;
; SIDE EFFECTS: None
;
;* Copyright (c) 2009-2010 by Adept Technology, Inc.
```

Figure 8-199 Refinement Program Header

Allocation Script Object

The Allocation Script object is used to create and edit custom part allocation programs for use with the Process Manager.

The Allocation Script object provides two different entry points. One entry point is used for allocating non-belt-relative instances to a robot system. The other entry point is used for allocating belt-relative instances to a robot system. These programs can manipulate the instances to indicate to the system what should be allocated to a given robot. This is called by the Process Manager when it needs to allocate parts.

Allocation Script objects are edited with the C# program editor. Refer to Application Manager Programming on page 178 for more information.

Adding an Allocation Script Object

To add an Allocation Script object, right-click **Process**, select **Add**, and then click **Allocation Script**. A new Allocation Script object will be added to the Multiview Explorer.

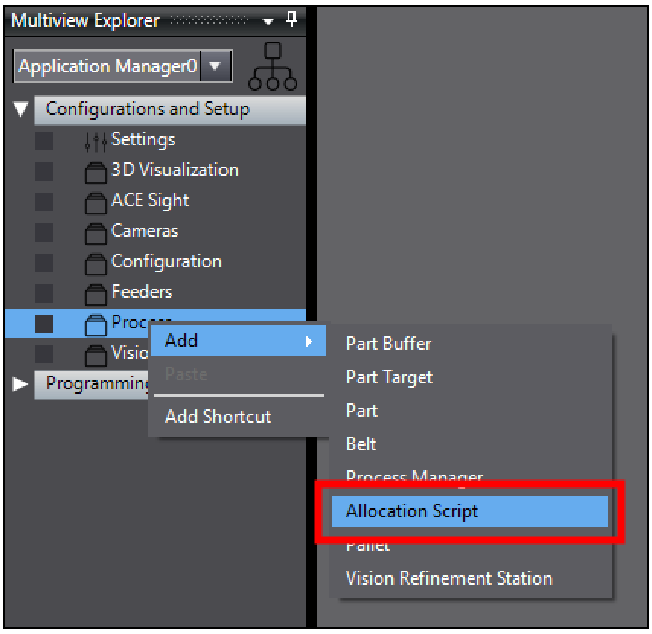


Figure 8-200 Adding an Allocation Script Object

NOTE: After the Allocation Script object is created, you can rename the new Allocation Script object by right-clicking the item and selecting **Rename**.

Allocation Script Configuration

To access the Allocation Script configuration, right-click the object in the Multiview Explorer and then select **Edit**, or double-click the object. This will open the Allocation Script editor in the Edit Pane.

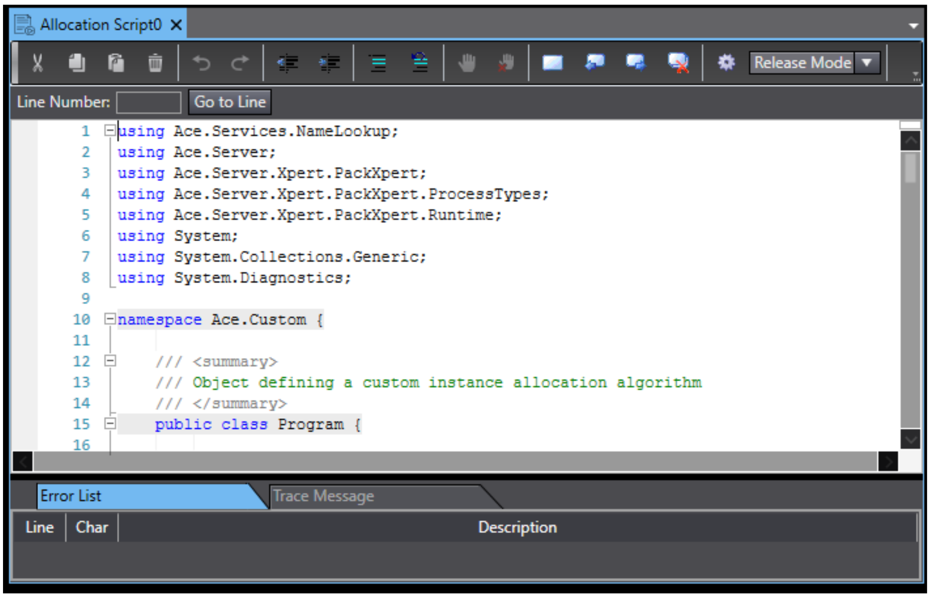


Figure 8-201 Allocation Script Configuration

Refer to the *ACE Reference Guide* for an example of an Allocation Script.

Pallet Object

The Pallet object defines the layout of a pallet which can be used to pick parts from or place parts to. The Pallet object defines the dimensional information only (three-dimensional pallets are supported). When linked to a frame, it will position the pallet in Cartesian space.

> **NOTE:** When used with a camera or belt, the camera or belt will be configured to locate the origin of the pallet, not the parts in the pallet.

Defining a Pallet Layout

When defining a pallet layout, you are teaching points for the pallet, such as the pallet origin, a point along the pallet X-axis, and a point along the pallet Y-axis. See the following figure for an example.

> **NOTE:** The points labeled in the figures are only for example. You could define the pallet using any corner part as the origin, and using any row or column orientation. That is, the pallet rows do not need to be parallel to the robot World axes as shown in the example.

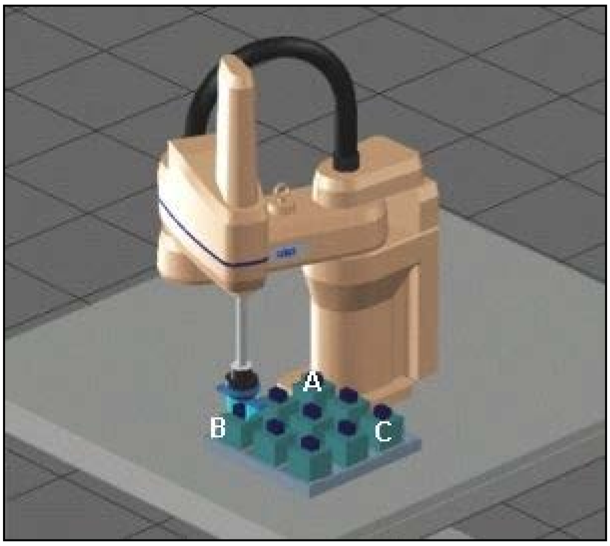


Figure 8-202 Defining a Pallet Layout

Table 8-34 Defining a Pallet Layout Description

Item	Description
A	Pallet Origin
B	A point along the pallet X-axis
C	A point along the pallet Y-axis

For example, assuming a 40 mm part spacing, the 3 x 3 pallet in the previous figure would be defined as follows.

Table 8-35 Pallet Example Definition

Pallet Properties	Location Components					
	X	Y	Z	Yaw	Pitch	Roll
Pallet Origin (A)	220.0	220.0	54.0	0.0	180.0	0.0
Position Along X-axis	300.0	220.0	54.0	0.0	180.0	0.0
Position Along Y-axis	220.0	300.0	54.0	0.0	180.0	0.0

You can also define the following for each Pallet object as described in this section.

- Access order
- Number of parts and part spacing on the X-axis
- Number of parts and part spacing on the Y-axis
- Number of parts and part spacing on the Z-axis

Teaching a Pallet

When teaching the pallet using the ACE software wizard, the system automatically computes the orientation and origin offset of the pallet. Then, the system has all of the information it needs to pick or place parts from or to positions in the pallet.

The initial pallet teaching process occurs in the Process Manager object configuration during calibration or process teaching (depending on the application needs). You can change the values obtained during the teaching process. Refer to Process Manager Object on page 395 for more information.

> **IMPORTANT:** When teaching locations, remember that the gripper orientation relative to the part is important. As you teach your pallet, you should check the gripper orientation to make sure you have not changed it. This will ensure that the parts are picked and placed in the correct orientation.

Adding a Pallet Object

To add a Pallet object, right-click **Process**, select **Add**, and then click **Pallet**. A new Pallet object will be added to the Multiview Explorer.

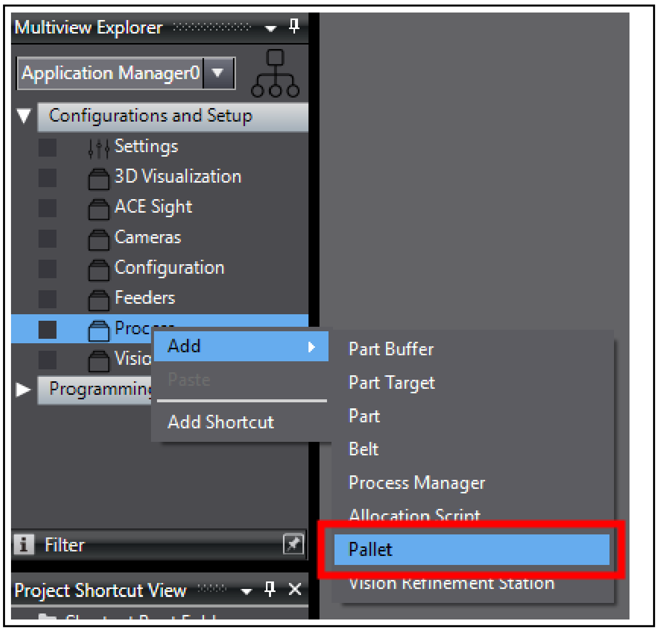


Figure 8-203 Adding a Pallet Object

NOTE: After the Pallet object is created, you can rename the new Pallet object by right-clicking the item and selecting **Rename**.

Pallet Configuration

To access the Pallet configuration, right-click the object in the Multiview Explorer and then select ***Edit***, or double-click the object. This will open the Pallet editor in the Edit Pane.

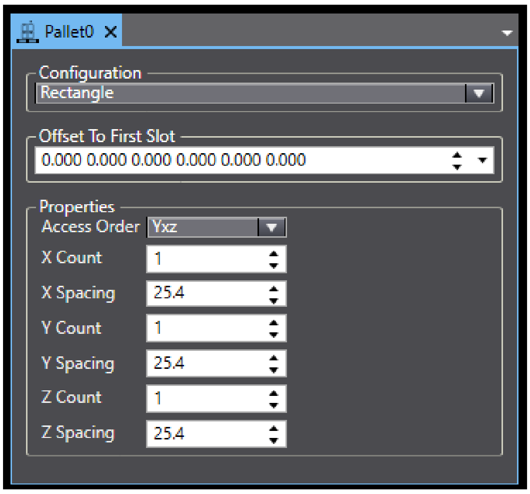


Figure 8-204 Pallet Configuration (Rectangular)

The Pallet editor provides an interface for setting various pallet-related parameters, such as the pallet configuration, location, and properties. This allows you to define individual X, Y, and degree positions of each slot. You can define circular pallets or pallets with offset rows.

The ACE software calculates the individual positions based on the input data and defines the positions in the Pallet object.

> **Additional Information**: The pallet is created as a separate object that can be linked with a frame. Refer to Robot Frames on page 432 for more information.

Configuration Drop-down List

The Configuration drop-down list box is used to specify the type of pallet being used.

- **Rectangle**: parts are arranged on the pallet in rows and columns.
- **Custom**: parts are arranged in rectangular or radial pattern. For a rectangular pallet, you specify the offsets, spacing, and part counts for X, Y, and Z. For radial pallets, you specify the start angle, angle spacing, part count, and radius.

Offset to First Slot

The Offset to First Slot setting defines the origin of the pallet to reference all slot positions.

Properties Area

When a rectangular pallet configuration is selected, use the Properties area to specify the access order, part count and part spacing for X, Y, and Z.

When a custom pallet configuration is selected, this area changes to a table that contains information collected from the Add Pattern Dialog Box. Refer to Properties Area on page 463 for more information.

Rectangular Pallet Configuration Settings

Use the information below to make the settings for a rectangular pallet configuration.

Access Order

The Access Order property defines how the robot will access the pallet. For example, if an access order of **Yxz** is selected, the robot will begin accessing the pallet positions with the first Y-row. After the Y row is finished, it will move to the next row in the X-direction. After all X-direction rows are accessed, it will move in the z-direction to access the next row.

X, Y, Z Count

This defines the number of slots on the X, Y, and Z axes.

X, Y, Z Spacing

This defines the slot spacing for the X, Y, and Z axes.

Custom Pallet Configuration Settings

A custom Pallet is typically used for irregular slot arrangements. The custom Pallet configuration allows you to define each slot position. For example, if your pallet is 3 x 3 x 2, you will have 18 slot position items defined in the Properties area of the custom Pallet object as shown below.

You can define individual slot positions manually using the **Add** Button or automatically using the **Pattern** Button as described below.

> **Additional Information**: When the Pallet has no pattern, use the **Add** button to define individual slot positions.

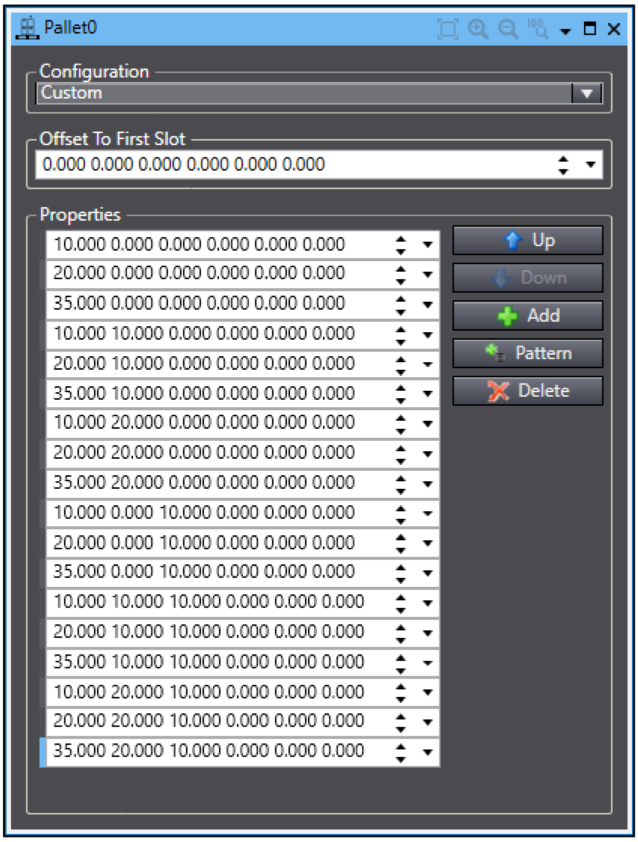


Figure 8-205 Custom Pallet Configuration Example

Use the **Add**, **Delete, Up** and **Down** buttons to create and arrange each Pallet slot location.

Adding a Custom Pattern

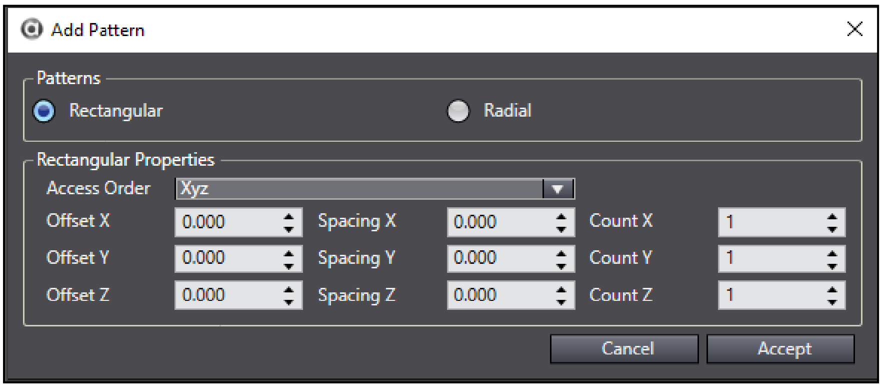


Figure 8-206 Add a Custom Pattern - Rectangular

Click the **Pattern** Button (

) to define the custom Pallet using the Add Pattern Dialog Box and then choose **Rectangular** or **Radial**.

- **Rectangular Properties**: Set the X,Y and Z offset, spacing, and count for the entire Pattern. When the Rectangular Properties are set, click the **Accept** Button and the Custom Properties list will be populated accordingly.
- **Radial Properties**: Set the Start Angle, Angle Spacing, Count, and Radius for the entire Pattern. When the Radial Properties are set, click the **Accept** Button and the Custom Properties list will be populated accordingly.

Pallet Visualization

You can select a shape to represent the pallet in the 3D Visualizer. The shape is specified on the Part or Part Target object editor. The shape can be selected from a box, cylinder, or Refer to Part Target Object on page 367, and Part Object on page 372 for more information.

Vision Refinement Station Object

The Vision Refinement Station object defines a location with an upward-mounted camera that is used to improve the part-to-gripper orientation for more accurate placement of the part.

> **NOTE:** The following information assumes you have already installed a physical camera, created a virtual camera, calibrated the camera, and created a vision tool and model.

Adding a Vision Refinement Station Object

To add a Vision Refinement Station object, right-click ***Process***, select ***Add***, and then click ***Vision Refinement Station***. A new Vision Refinement Station object will be added to the Multiview Explorer.

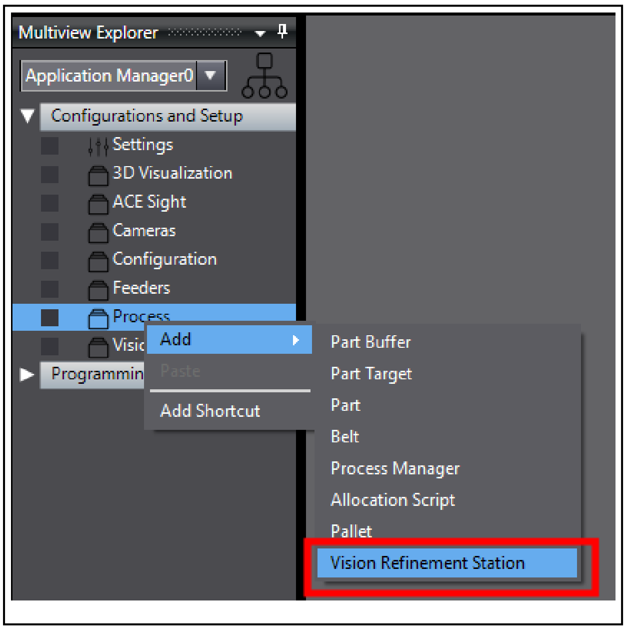


Figure 8-207 Adding a Vision Refinement Station Object

NOTE: After the Vision Refinement Station object is created, you can rename the new Vision Refinement Station object by right-clicking the item and selecting ***Rename***.

Vision Refinement Station Configuration

To access the Vision Refinement Station configuration, right-click the object in the Multiview Explorer and then select **Edit**, or double-click the object. This will open the Vision Refinement Station editor in the Edit Pane.

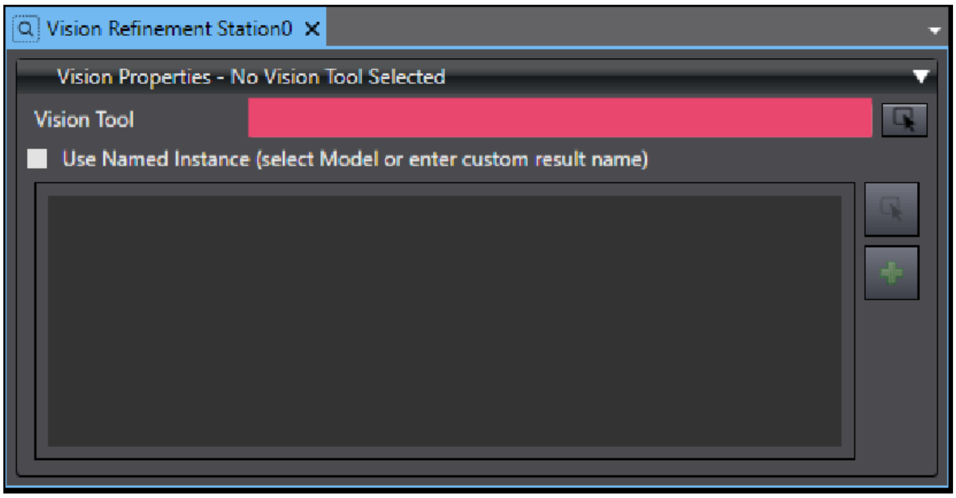


Figure 8-208 Vision Refinement Station Configuration

Vision Properties

The Vision Refinement Station only has a single configuration item. Use the Vision Properties drop-down to specify the vision tool that will be used to locate the part in the gripper.

As an option, select ***Use Named Instance (select Model or enter custom result name)***and then click the **Select** Button ( ) to reference an exiting Locator Model or click the **Add** Button ( ) to add a custom result name. For applications where a custom vision tool is used, this item would be used to specify custom names that had been associated with the different results returned from that tool.

Adding the Vision Refinement Station to a Process

After you create the Vision Refinement Station, it must be added to a pick-place process. This is done using the Advanced tab of the Part Process Editor, shown in the following figure. Refer to Part Process Editor on page 407 for more information.

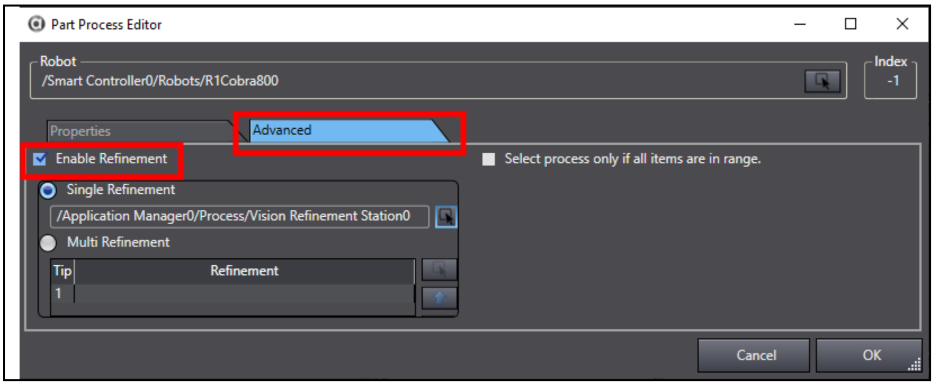


Figure 8-209 Adding Vision Refinement Station to a Process

Editing Motion Parameters

After you add the Vision Refinement Station to the pick-place process, you can optionally edit the motion parameters for the station. This is done using Vision Refinement Motion Parameters that are accessed from the Configuration Items group. Refer to Vision Refinement Motion Parameters on page 429 for more information.

8.7 Vision Tools

ACE software provides an extensive set of vision tools for basic and complex applications.

These tools can perform the following functions.

- Image processing and filtering
- Coarse and fine location
- Position refinement
- Inspection
- Text and code reading

Each tool requires configuration to determine what data to collect, how to interpret the data, and the location of that data within the field of view. ACE software provides the ability to specify this information, either by making menu selections or by using the mouse to manipulate the tools directly in the Vision Window.

Tools are categorized as follows.

- **Finder Tools**

  Finder Tools create a vectorized description of objects or object features and typically return coordinate results. These are used to identify features in image sources and provide locations of objects to be picked.

- **Inspection Tools**

  Inspection Tools are often used in conjunction with Finder Tools to inspect objects that have been located. They rely on the analysis of pixel information and are designed to check various aspects of a detected object or feature, such as color deviation, defects, or product density.

- **Reader Tools**

Reader Tools are used to return character text string data from codes and text in an image.

- **Calculation Tools**

  Calculation Tools allow the creation of new entities in an image that can be user-defined or based on existing entities.

- **Image Process Tools**

  Image Process Tools provide various operations and functions for the analysis and processing of images.

- **Custom Tools**

  Custom Tools allow the user to more directly control the way an image or tool is processed.

The following table shows all vision tools provided in the ACE software, their respective categories, and a brief summary of their functions. The tools are described in detail in the following sections.

Category	Tool	Description
Finder Tools	Arc Finder	Identifies circular features on objects and returns the coordinates of the arc center, the angle of separation between the two ends, and the radius.
	Blob Analyzer	Processes information within a region of interest to identify groups of similarly-colored pixels, called blobs, and returns the position and size of each.
	Gripper Clearance	Uses histograms to identify regions of clearance around detected objects.
	Gripper Clearance 3D	Uses histograms to identify clearances within a three dimensional space.
	Labeling	Searches the image for areas of a user-defined color or color range and returns the results. Multiple colors or ranges can be searched.
	Line Finder	Identifies linear features on and returns the end-point coordinates and line angle.
	Locator	Identifies instances of objects defined by a Locator Model within a region of interest. This tool is customizable and accurate, but slower than Shape Search3.
	Locator 3D	Identifies objects based on specified geometry after a specific part 3D model has been uploaded into the Locator Model.
	Locator Model	Defines the geometry of a model used by a Locator tool to identify instances.

Category	Tool	Description
	Shape Search3	Identifies instances of objects defined by a Shape Search3 Model within regions of interest. This tool is fast, but cannot be customized as much as the Locator tool.
	Shape Search3 Model	Defines the geometry of the model used by a Shape Search3 tool to identify instances.
Inspection Tools	Arc Caliper	Identifies one or more edge pairs in an arc-shaped or circular area and measures distance between the edges of each pair.
	Arc Edge Locator	Identifies an edge or set of edges that meet user-defined criteria within an arc-shaped or circular area.
	Caliper	Identifies one or more parallel edge pairs and measures distance between the edges of each pair.
	Color Data	Finds the average color within a region and analyzes its color variation and deviation from a specified reference color.
	Edge Locator	Identifies an edge or set of edges that meet user-defined criteria within a rectangular region.
	Feeder Histogram	Calculates product density in specified regions of interest. This tool is often used with the AnyFeeder object in regions associated with the dispense, pick, and front zones.
	Image Histogram	Computes gray-level statistics within a specified region of interest.
	Inspection	Judges the results of a tool and determines if they fall within a series of user-defined categories and filters.
	Precise Defect Path	Performs differential processing on an image to detect defects and contamination on a line or along an edge.
	Precise Defect Region	Performs differential processing on an image to detect defects and contamination within an area.
Reader Tools	Barcode	Reads bar codes in an image and acquires text string data.
	Data Matrix	Reads data matrices in an image and acquires text string data.
	OCR	Identifies text characters in image and returns them as text data. Custom characters can also be registered to an OCR

Category	Tool	Description
		Dictionary for future identification.
	OCR Dictionary	Stores dictionary data that OCR can use to identify text characters.
	QR Code	Reads QR or Micro QR code in an image and acquires text string data.
Calculation Tools	Calculated Arc	Calculates an arc based on a specified calculation mode and returns the encompassing circle.
	Calculated Frame	Calculates a frame based on a specified calculation mode and returns coordinates and orientation.
	Calculated Line	Calculates a line based on a specified calculation mode and returns coordinates and dimensions.
	Calculated Point	Calculates a point based on a specified calculation mode and returns coordinates.
Image Process Tools	Advanced Filter	Filters or alters an image using one of a variety of filter libraries, such as Background Suppression, Erosion / Dilation, and Color Gray Filter. This tool can be combined with other tools (including other Advanced Filters) to modify an image to the necessary specifications.
	Color Matching	Filters and analyzes areas of a specified color or color range in images.
	Image Processing	Filters or alters a gray scale image using one of a variety of filters, including logical and arithmetic calculations. This tool can be combined with other tools (including other Image Processing tools) to modify an image to the necessary specifications.
	Image Sampling	Extracts an area of an image and outputs it as a new image source.
	Position Compensation	Converts all pixels outside a rectangular region to black and outputs the result as a new image.
Custom Tools	Custom Vision Tool	Allows you to specify a program to be called when executed. This tool can execute other tools and return a custom set of results.
	Remote Vision Tool	Enables operation of configured vision tools by creating a vision server instance.

Adding Vision Tools

To add a new vision tool, right-click on the Vision Tools object in the Multiview Explorer, expand one of the categories and then select one of the tools, as shown in the figure below.

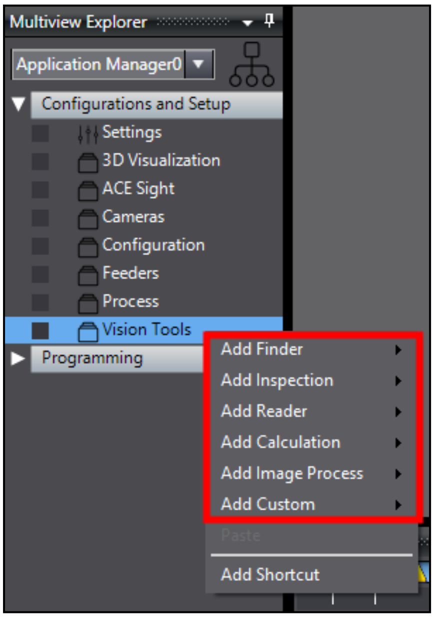


Figure 8-210 Adding a New Vision Tool

Vision Tool Editor

Each vision tool is configured using its corresponding object editor in the Edit Pane. In general, most of the tool editors have a similar configuration that can be split into five sections as described below.

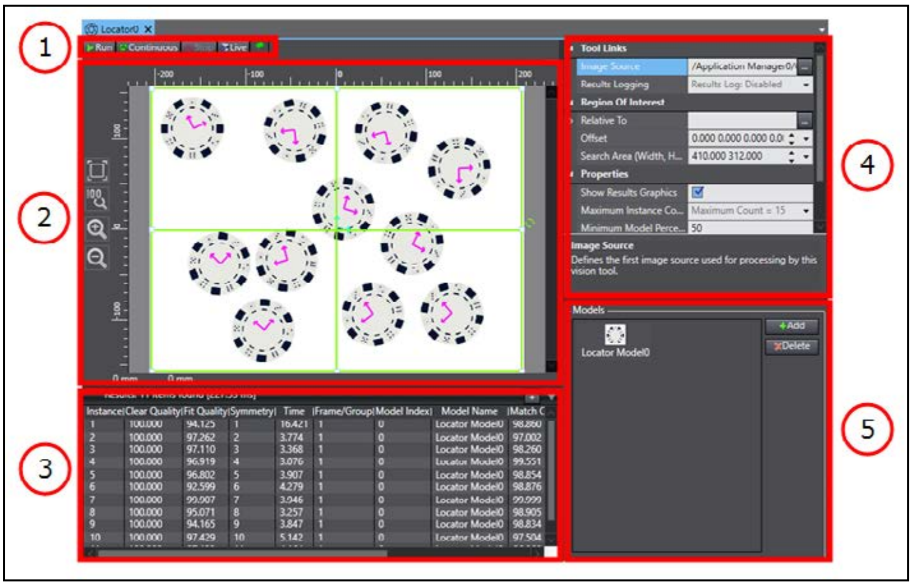


Figure 8-211 Vision Tool Editor

Table 8-36 Vision Tool Editor Item Description

Item	Name	Description
1	Execution Buttons	This area provides direct control of the tool with the following buttons. • **Run**: Run the tool once. This is available with most vision tools. • **Continuous**: Run the tool continuously. This is available with most vision tools. • **Stop**: Stop the tool or live operation. Can only be selected if Live or Continuous has been activated. This is available with most vision tools. • **Live**: Send images without running the tool. This is available with most vision tools. • **Auto Tuning**: Automatically sets parameters based on pixel data. This functions differently depending on the tool. See those tools for more information. This is available with the Barcode, Color Data, Data Matrix, OCR, and QR Code tools. • **New Image** button: Loads a new image into the tool. The model will need to be retrained. This replaces the **Run** button in the respective tools. This is available with the Locator Model and Shape Search 3 Model tools. • **Register to OCR Dictionary** button: Registers a character to the OCR Dictionary. This is available with the OCR Dictionary tool.
2	Image Display	This area displays the current image from the camera. This will also include any required graphics or controls. For example, the Locator tool shown in Figure 8-211 displays markers for each identified instance within the green region of interest, which can be modified as needed.
3	Results	This area displays the output of the tool . In most cases, this contains returned data organized in columns. The columns can be chosen by clicking the **Plus** button () which will display the Results Column Selection Dialog Box. Use this dialog box to select and arrange the data displayed in this area.

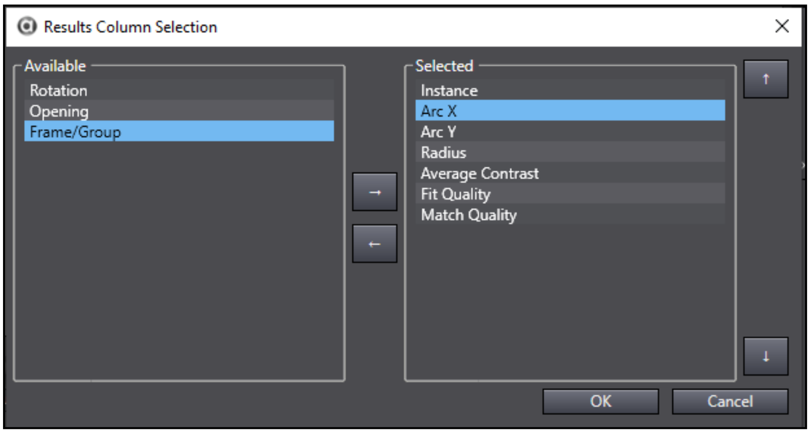
<table>
<tr><th>Item</th><th>Name</th><th>Description</th></tr>
<tr><td></td><td></td><td>

Figure 8-212 Results Column Selection

NOTE: If the tool is in the Image Process category, it returns an image instead of data. The Results section of the tool editor will either show the result image, such as in Advanced Filter, or be nonexistent, such as in Color Matching. In the latter case, the Vision Window must be opened to view the resultant image.</td></tr>
<tr><td>4</td><td>Properties</td><td>This area displays the tool parameters.

You can modify these parameters to change tool operation.

Details of these parameters are found in the following sections.</td></tr>
<tr><td>5</td><td>Additional Information Pane</td><td>This area provides any additional information about the tool.

This is only found in some of the tools and generally utilizes something specific to only that tool.</td></tr>
</table>

Region of Interest

Most tools use regions of interest to define the location where the tool will be executed. Some tools allow multiple regions based around a single reference point, but most use a single rectangular region in which to execute the operation. In both cases, the region or regions are outlined in green in the tool Vision Window.

Regions of interest can be modified in two ways:

1. Clicking and dragging the green outline or its nodes. Dragging the nodes will re-size the region while dragging the outline itself will translate it. In some tools, the regions have a node for rotation.
2. Adjusting the parameters in the properties. All tools with regions of interest have a Region Of Interest section in the properties that governs the size, location and, in some cases, behavior of the region. The location and size of the region are typically governed by the Offset and Search Region properties, but the property names may vary.

NOTE: The region orientation of some tools can only be controlled with the Offset property.

Tools with Multiple Regions of Interest

Tools with multiple regions of interest can be manipulated to allow different behavior in individual regions. This is achieved by modifying two properties as described below.

- **Overlap**

  This defines the region as either inclusive or exclusive by setting it to OR or NOT, respectively. An inclusive region returns all detected contours or instances within its boundaries. An exclusive region hides all detected contours or instances within its boundaries. Figure 8-213 shows how individual regions are registered in the figure. The original regions are displayed on the left and the resulting processed region is displayed on the right, where the green area shows what parts are read. For example, in the second set of regions, the NOT region eliminates a section of the full region, resulting in a rectangular section that is not read.

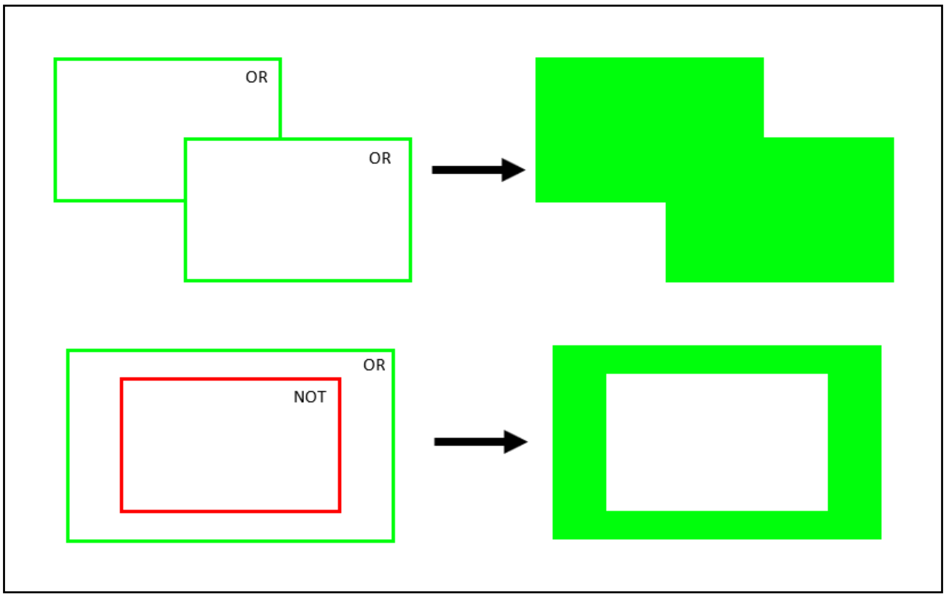


Figure 8-213 Overlap - OR Versus NOT

- **Z-Order**

  This defines the order in which regions are processed. Each region has its own property that defines its order in the Z-direction of an image. Since the image is two-dimensional, this value is used to determine which regions are processed first. Regions are processed in ascending order. This can be seen in the regions in Figure 8-214 where the regions are processed according to their written Z-Order. In the first example, the results of all three regions can be seen, since no region is entirely blocked. However, in the second example, the smallest region is hidden because the red region has a higher value than it does, according to Z-order.

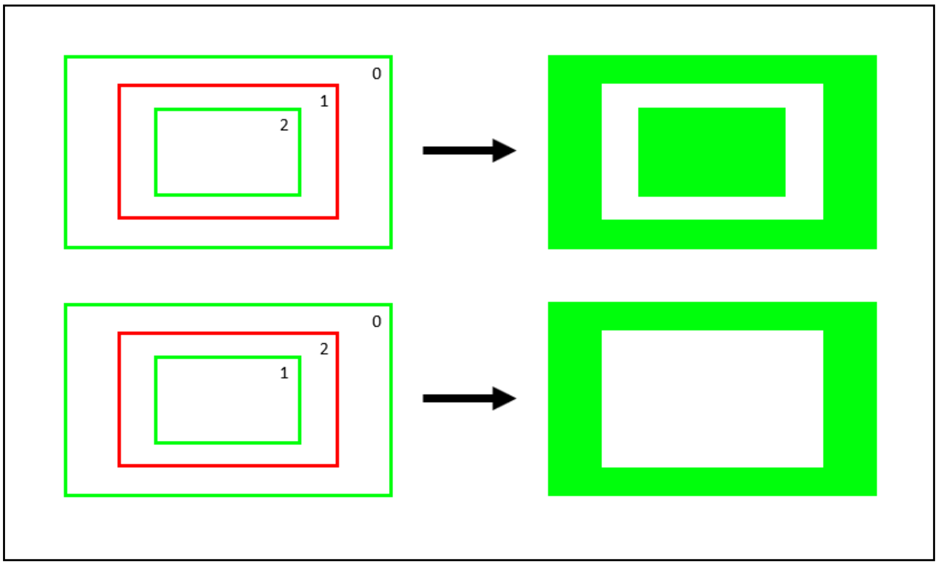


Figure 8-214 Z-order Layout

Relative To Parameter Details

Most of the tools with regions of interest can be set relative to another tool. A vision tool is ordinarily executed with respect to the origin of the image, but when it is set relative to another tool, it will instead execute with respect to the result values of that tool. This will cause the secondary tool to execute once for every input value, unless it is otherwise constrained.

To create this relationship, set the primary tool as the Relative To property of the secondary tool in the editor of the secondary tool. In this way, the output values of the primary tool become the input values of the secondary tool. In the following figure, the Gripper Clearance tool is set relative to a Locator tool and is able to position histograms around all of the objects by creating new reference points with respect to the Locator results. The input locations are shown under the Current Values section in the properties.

> **NOTE:** Some tools display all instances in the image display. Some only display the region created with respect to the first instance and return the remainder in the Results section. The additional instances can be viewed in the ACE Vision Window as long as the property Show Results Graphics is enabled. Refer to the Vision Window in Figure 8-215 (which is based on the tool in Figure 8-216 below).

A tool set relative to another tool can be used to create a Robot Vision Manager Sequence. Refer to Vision Sequence on page 298 for more information.

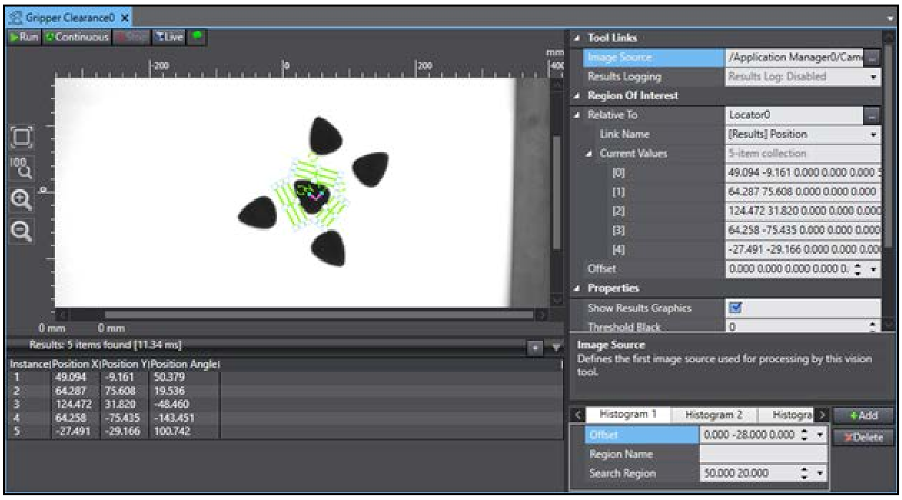


Figure 8-215 Gripper Clearance - Relative To Locator Tool (Editor)

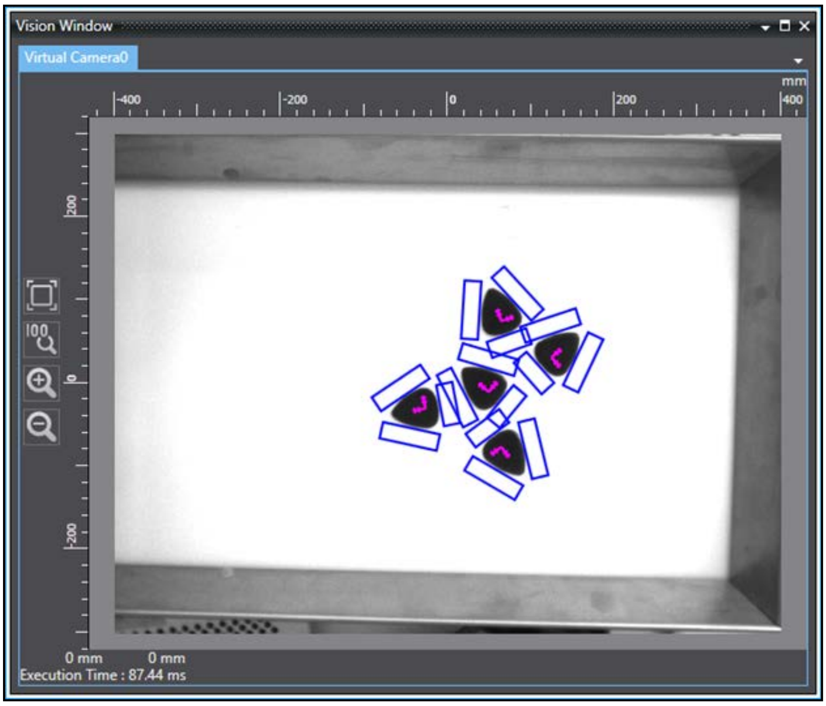


Figure 8-216 Gripper Clearance - Relative To Locator Tool (Vision Window)

Color Spaces

The term color space refers to numeric values (or percentages) of the visible color spectrum, specifically organized to allow both digital and analog representations of color. A color space is a spectrum or range of colors with specific values.

This section describes color spaces, color values, and how to define colors by those values.

HSB and RGB Color Spaces

The two different types of color spaces are described below.

Hue, Saturation, and Brightness (HSB) Color Space

The HSB color space arranges colors of each hue radially around a central axis of basic colors, from white at the top to black at the bottom. Hue values are set in degrees from 0 to 360. Saturation and brightness are set in percentages from 0 to 100%.

Hue is the quality of color perceived as the color itself. The hue is determined by the perceived dominant wavelength, or the central tendency combined wavelengths within the visible spectrum.

Saturation is the purity of the color, or the gray in a color. For example a high saturation value produces a very pure, intense color. Reducing the saturation value adds gray to the color.

Brightness is the amount of white contained in the color. As the value increases, the color becomes lighter and becomes more white. As the luminance value decreases the color is darker and becomes more black.

> **NOTE:** HSB is also referenced as HSL (Hue, Saturation, Luminance) and HSV (Hue, Saturation, Value) in the ACE software.

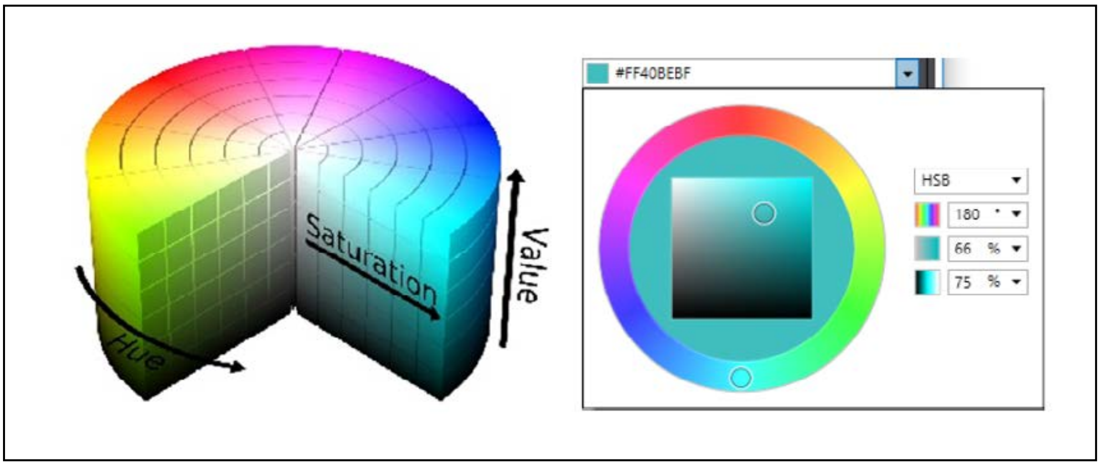


Figure 8-217 HSB Color Space

Red, Green, and Blue (RGB) Color Space

The RGB color space uses combinations of red, green, and blue to create all colors. Red, green, and blue values are expressed with a range of 0 to 255.

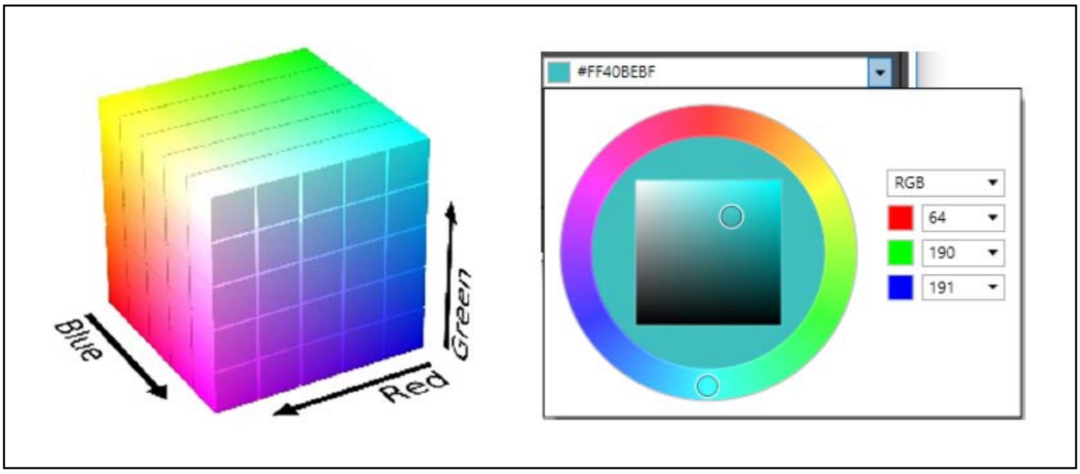


Figure 8-218 RGB Color Space

NOTE: ACE software also accepts the hexadecimal color value in the color input field.

HSB and RGB Color Values

Settings for items such as color filters and reference colors can be adjusted with HSB, RGB, or hexadecimal values. The following table provides example values for common colors.

Table 8-37 Common HSB and RGB Color Values

Color	HSB Values	RGB Values	Hexadecimal Values
White	0, 0, 100	255, 255, 255	#FFFFFF
Black	0, 0, 0	0, 0, 0	#000000
Gray	0, 0, 50	127, 127, 127	#7F7F7F
Red	0, 100, 100	255, 0, 0	#FF0000
Green	120, 100, 100	0, 255, 0	#00FF00
Blue	240, 100, 100	0, 0, 255	#0000FF

Color Tolerances

Color tolerances can be applied to allow for slight color variations. Color tolerances can only be set with HSB values.

A color tolerance value is distributed equally above and below the color value to which it applies. For example, if the color hue value is 50 and the hue tolerance value is 20, the filter will accept colors within a range of hue values from 30 to 70.

Finder Tools

Finder tools are used to identify objects and create detection points for location guidance.

The following Finder tools are described in this section.

- Refer to Arc Finder on page 479 for more information.
- Refer to Blob Analyzer on page 483 for more information.
- Refer to Gripper Clearance on page 490 for more information.
- Refer to Labeling on page 615 for more information.
- Refer to Line Finder on page 501 for more information.
- Refer to Locator on page 503 for more information.
- Refer to Locator Model on page 519 for more information.
- Refer to Shape Search 3 on page 528 for more information.
- Refer to Shape Search 3 Model on page 534 for more information.

Arc Finder

This tool identifies circular features on objects and returns the coordinates of the center of the arc, the angle between the two ends, and the radius.

Arc Finder is most commonly used to return information about round edges or refine the orientation of a located object. For example, the tool in Figure 8-219 identifies the arc created by trapezoidal features on the chip. In this way, it can be used to locate circular patterns or shapes within an object. If the arc to be located should only be in a certain position, the guideline position and properties such as Search Mode can be adjusted to specify the desired range of the location.

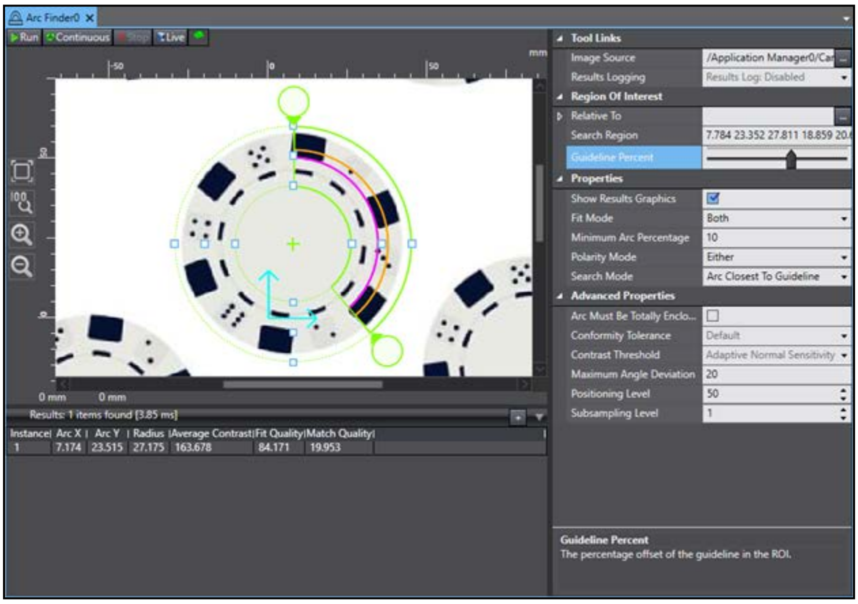


Figure 8-219 Arc Finder Tool Editor

To create an Arc Finder tool, right-click **Vision Tools** in the Multiview Explorer and select **Add Finder** and then **Arc Finder**. An Arc Finder tool will be added to the Vision Tools list.

The following figure identifies the specific segments of the Arc Finder tool, shown in the Editor, refer to Arc Finder Segments on page 480.

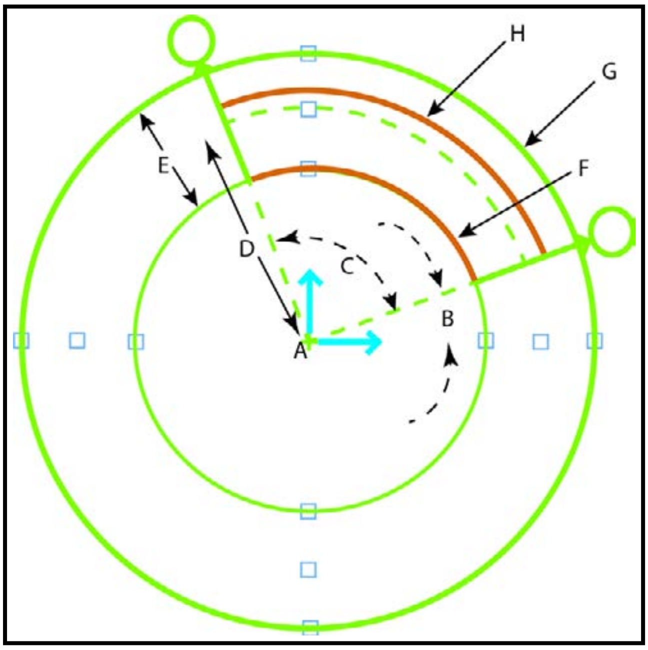


Figure 8-220 Arc Finder Segments

Indicator	Description
A	Center
B	Rotation
C	Opening
D	Radius
E	Region of Interest Thickness
F	Inner Annular Bound
G	Outer Annular Bound
H	Guideline

Arc Finder Configuration Items

Use the table below to understand the Arc Finder tool configuration items.

Table 8-38 Arc Finder Configuration Item Description

Group	Item	Description
Tool Links	Image Source	Defines the image source used for processing by this vision tool.
	Results Logging	Enables logging of tool results to a file.
Region of Interest	Relative To	The tool relative to which this tool executes. The output values of the selected tool are the input values

Group	Item	Description
		of this one.
	Link Name	Select the property in the defined Relative To tool that will provide the input values.
	Current Values	Collection of current input values.
	Search Region	Defines the location and size of the region (X, Y, radius, thickness, mid-angle position, arc angle degrees).
	Guideline Percent	Adjusts the location of the orange guideline in the region of interest. Move the slider left to position the guideline closer to the center and to the right to position it farther away.
Properties	Show Results Graphics	Specifies if the graphics are drawn in the Vision Window.
	Fit Mode	Select how the tool will calculate and return a valid arc from hypotheses. • Both: calculates the arc center and arc radius and uses both values to return the most accurate results. • Center: calculates the arc center. • Radius: calculates the arc radius.
	Minimum Arc Percentage	Specifies the minimum percentage of arc contours that need to be matched for a hypothesis to be considered valid.
	Polarity Mode	Select the polarity deviation required for a hypothesis to be considered valid. • Dark to Light: only detect arcs that are darker towards the center. • Light to Dark: only detect arcs that are lighter towards the center. • Either: accept any polarity as long as it is consistent. • Do Not Care: does not take polarity into account.
	Search Mode	Select the method used to generate and select a hypothesis. • Best Arc: chooses the best quality arc but will increase processing time. • Arc Closest To Guideline: chooses the arc closest to the guideline. • Arc Closest To Inside: chooses the arc closest to the inner circle. • Arc Closest To Outside: chooses the arc closest to the outer arc of the region of interest.

Group	Item	Description
Advanced Properties	Arc Must Be Totally Enclosed	Specifies if the detected arc can exist outside of the region of interest. When enabled, the start and end points of the arc must be located on the angle boundary lines. Otherwise, the arc can enter or exit the region at any point.
	Conformity Tolerance	Set the maximum local deviation between the expected arc contours and the arc contours actually detected in the input image.
	Contrast Threshold	Defines the minimum contrast needed for an edge to be detected in the input image. This threshold is expressed in terms of a step in gray level values. Higher values reduce noise but also reduce the number of contours detected.
	Maximum Angle Deviation	Defines the maximum angle deviation between the calculated arc's tangents and the edge contours.
	Positioning Level	Set the configurable effort level of the instance positioning process. A value of 10 will provide coarser positioning and lower execution time. Conversely, a value of 100 will provide high accuracy positioning of arc entities. The setting range is 10 to 100.
	Subsampling Level	Set the subsampling level used to detect edges that are used by the tool to generate hypotheses. High values provide a coarser search and lower execution time than lower values. The setting range is 1 to 8.

Arc Finder Results

Use the table below to understand the results of the Arc Finder tool.

Table 8-39 Arc Finder Results Description

Item	Description
Instance	Index of the result instance.
Frame/Group	Index of the related result. It is associated with the tool that this tool is set Relative To.
Arc X	X-coordinate of the arc center point.
Arc Y	Y-coordinate of the arc center point.
Radius	Radius of the arc, measured from the center determined by Arc X and Arc Y.
Opening	Angle (in degrees) measured between the two arc endpoints.
Rotation	Rotation of the region of interest, measured from the positive X-axis.
Average Contrast	Average contrast between light and dark pixels on either side of the arc, expressed in gray level values.

Item	Description
Fit Quality	Normalized average error between the calculated arc contours and the actual contours detected in the input image. Fit quality ranges from 0 to 100 where the best quality is 100. A value of 100 means that the average error is 0. A value of 0 means that the average matched error is equal to the Conformity Tolerance property.
Match Quality	Amount of matched arc contours for the selected instance expressed as a percentage. Match quality ranges from 0 to 100 where the best quality is 100. A value of 100 means that 100% of the arc contours were successfully matched to the actual contours detected in the input area.

Blob Analyzer

This tool uses pixel information within the region of interest to apply image segmentation algorithms for blob detection. A blob is any region within a gray scale image with a range of gray level values that differs from the adjoining areas of the region. The Blob Analyzer tool is primarily used to find irregularly-shaped objects.

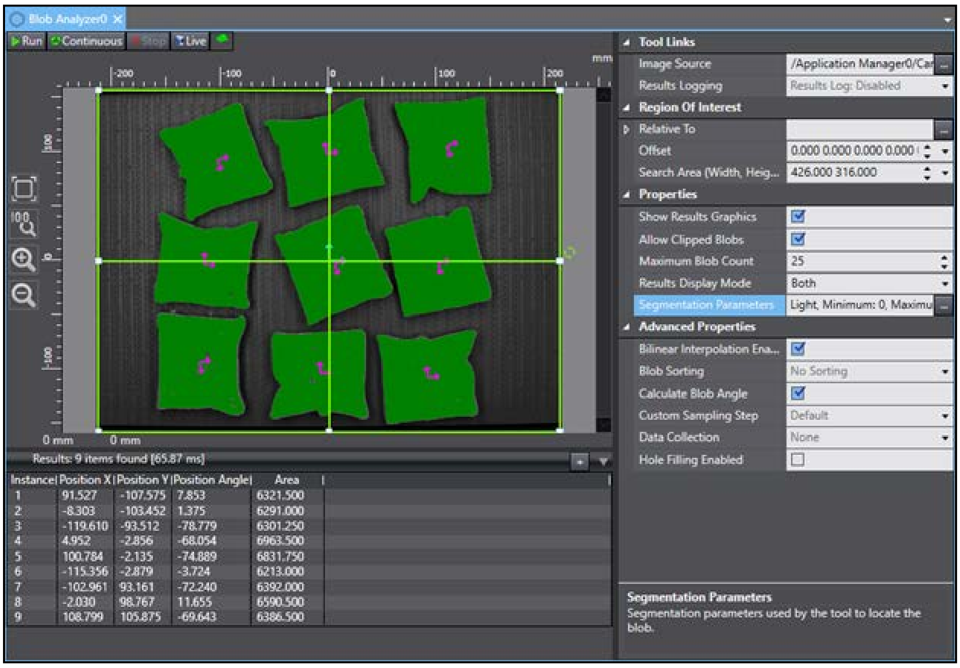


Figure 8-221 Blob Analyzer Tool Editor

To create a Blob Analyzer tool, right-click **Vision Tools** in the Multiview Explorer, select **Add Finder** and then **Blob Analyzer**. A Blob Analyzer tool will be added to the Vision Tools list.

Blob Analyzer Configuration Items

Use the table below to understand the Blob Analyzer tool configuration items.

Table 8-40 Blob Analyzer Configuration Item Description

Group	Item	Description
Tool Links	Image Source	Defines the image source used for processing by this vision tool.
	Results Logging	Enables logging of tool results to a file.
Region Of Interest	Relative To	The tool relative to which this tool executes. The output values of the selected tool are the input values of this one.
	Link Name	Select the property in the defined Relative To tool that will provide the input values.
	Current Values	Collection of current input values.
	Offset	Defines the center coordinates of the region.
	Search Area (Width, Height)	Defines the size of the region.
Properties	Show Results Graphics	Specifies if the graphics are drawn in the Vision Window.
	Allow Clipped Blobs	Enables the inclusion of blobs that have been cut off by the edge of the region of interest.
	Maximum Blob Count	Set the maximum number of blobs that the tool is able to return.
	Results Display Mode	Defines how results are rendered in the image display. • Marker: shows only the centroid marker of the blob. • Blob Image: shows the blobs highlighted with green. • Both: displays the centroid marker and the blobs.
	Segmentation Parameters	Properties used by the tool to locate the blob. Refer to Blob Analyzer Configuration Items on page 483 for more information.
Advanced Properties	Bilinear Interpolation Enabled	Enables using bilinear interpolation to sample the input image. By default, this is enabled because it ensures subpixel accuracy.
	Blob Sorting	Select the order in which the blobs are processed and output. Most sorting options use the values in a specific result column. This is disabled by default.
	Calculate Blob Angle	Enables the calculation of each blob angle. This is enabled by default. The angle is calculated by collecting four additionally properties if they are not already calculated: Inertia Minimum, Inertia Max-

Group	Item	Description
		imum, Elongation, and Position Angle.
	Custom Sampling Angle	Defines the sampling step used in calculation. This is set to 1 by default. Enable this to adjust the setting.
	Data Collection	Enables the calculation and collection of additional results. Refer to Blob Analyzer Data Collection on page 487 for more information.
	Hole Filling Enabled	Enables all background pixels within the perimeter of a given blob become included in the blob. Note that this effects the tool window but not the main Vision Window.

Blob Analyzer Segmentation Mode Editor

The Segmentation Mode editor is accessed by clicking the ellipsis next to the Segmentation Parameters property. It controls the parameters that dictate which pixels are selected as blobs.

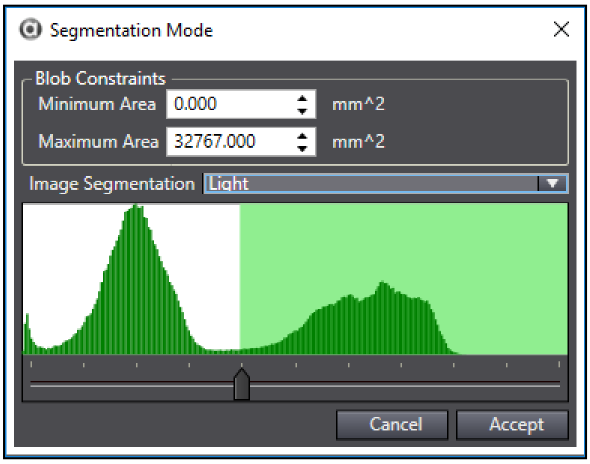


Figure 8-222 Blob Analyzer Segmentation Mode

Blob Constraints determine the minimum and maximum area of a blob in calibrated units. This is useful for filtering out individual or small groups of pixels that are returned as their own blobs, but are not desired result instances.

Image Segmentation defines the method used to locate blobs. The following options can be selected.

- Light: Creates blobs from all pixels brighter than the set gray level boundaries.
- Dark: Creates blobs from all pixels darker than the set gray level boundaries.
- Inside: Creates blobs from all pixels inside the set gray level boundaries.
- Outside: Creates blobs from all pixels outside the set gray level boundaries.
- Dynamic Light: Creates blobs from the pixels on the brighter side of a percentage marker set by the user.
- Dynamic Dark: Creates blobs from the pixels on the darker side of a percentage marker set by the user.

- Dynamic Inside: Creates blobs from the pixels between two percentage bounds set by the user.
- Dynamic Outside: Creates blobs from the pixels outside of two percentage bounds set by the user.
- HSL Inside: Creates blobs from all the pixels that fall within an HSL tolerance.
- HSL Outside: Creates blobs from all the pixels that fall outside an HSL tolerance.

Image Segmentation settings are made using the slider(s) shown at the bottom of the editor (except for HSL Inside/Outside). The green area indicates which pixels in the histogram will be included in the blobs and the white area indicates which ones will not be included as shown in the following figure.

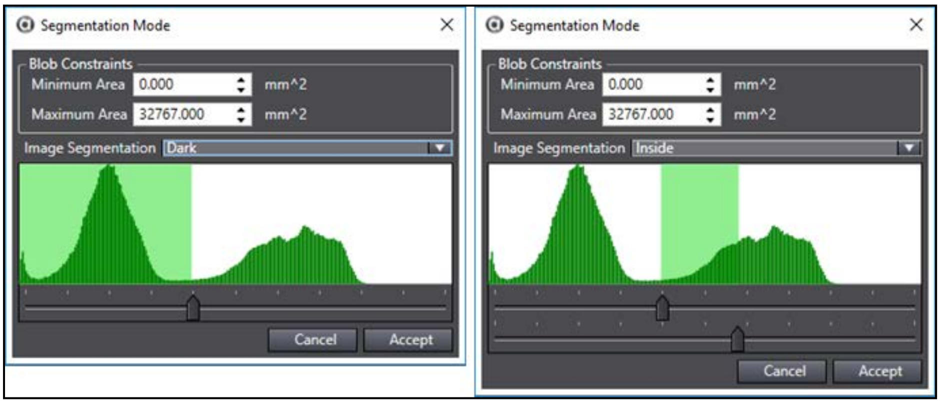


Figure 8-223 Blob Analyzer Image Segmentation Adjustments (Not HSL Inside/Outside)

> **NOTE:** When a Dynamic option is selected in Image Segmentation, the display will continue to show the green and white overlay, but the calculation will not take the histogram into account.

HSL Inside and HSL Outside use a different viewer in the editor since they are based on HSL color instead of brightness. Therefore, the histogram has no impact. Instead, the editor appears as shown below and the histogram is replaced by the following properties. Refer to Color Spaces on page 476 for more information about color definition.

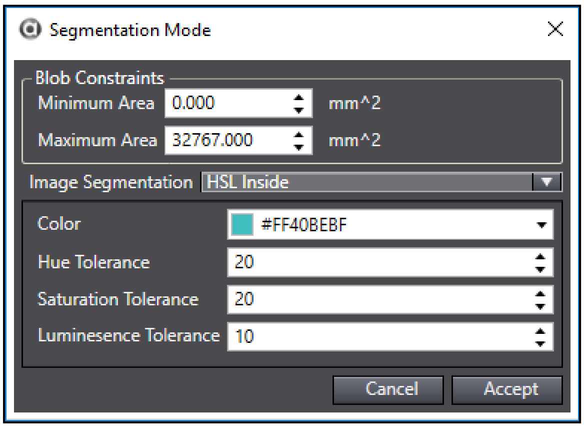


Figure 8-224 Blob Analyzer Image Segmentation Adjustments for HSL Inside/Outside

- Color: Defines the nominal color for which Blob Analyzer will search. Clicking the arrow will open an additional menu where the specific color can be defined.
- Hue Tolerance: Maximum difference between the nominal and pixel hue values for the pixel to be included in a blob.
- Saturation Tolerance: Maximum difference between the nominal and pixel saturation values for the pixel to be included in a blob.
- Luminescence Tolerance: Maximum difference between the nominal and pixel luminescence values for the pixel to be included in a blob.

Blob Analyzer Data Collection

To increase processing speed, Blob Analyzer provides adjustments to identify which specific results to calculate and collect. Only by selecting the necessary options in Data Collection can those results be properly calculated and displayed. For details on the results themselves, refer to the Blob Analyzer Data Collection on page 487. The list below details the options. Any number of options can be selected.

- Chain Code Results: Refers to the sequence of direction codes that describes the boundary of a blob. Unlike the other options in this list, selecting ***Chain Code Results*** does not affect any results columns. It can be disabled for most applications.
- Extrinsic Inertial Results: Returns moments of inertia results. A moment of inertia measures the inertial resistance of the blob to rotation about a given axis. Extrinsic moments of inertia measure the moment of inertia about the X-Y axes of the camera coordinate system.
- Gray Level Results: Returns information about the gray level distribution within the blob.
- Intrinsic Box Results: Returns information about the intrinsic bounding box, which is a bounding box that has been rotated to fit the edges of the blob as tightly as possible.
- Perimeter Results: Returns data regarding the perimeter.
- Topological Results: Returns the Hole Count result.

Blob Analyzer Results

Use the tables below to understand the results of the Blob Analyzer tool.

Table 8-41 Blob Analyzer Standard Results Description

Item	Description
Instance	Index of the result instance.
Frame/Group	Index of the related result. It is associated with the tool that this tool is set Relative To.
Position X	X-coordinate of the blob center of mass.
Position Y	Y-coordinate of the blob center of mass.
Position Angle	Calculated angle of the blob origin with respect to the X-axis. Only available when Calculate Blob Angle is enabled.
Area	Area of the blob in units defined by the workspace.

Item	Description
Elongation	The degree of dispersion of all pixels belonging to the blob around its center of mass. This is calculated as the square root of the ratio of the moment of inertia about the minor axis (Inertia Maximum) to the moment of inertia about the major axis (Inertia Minimum). Only available when Calculate Blob Angle is enabled.
Bounding Box Center X	X-coordinate of the center of the bounding box with respect to the camera coordinate system. Only available when Calculate Blob Angle is enabled.
Bounding Box Center Y	Y-coordinate of the center of the bounding box with respect to the camera coordinate system. Only available when Calculate Blob Angle is enabled.
Bounding Box Height	Height of the bounding box with respect to the Y-axis of the coordinate system. Only available when the angle is calculated.
Bounding Box Width	Width of the bounding box with respect to the X-axis of the coordinate system. Only available when the angle is calculated.
Bounding Box Left	X-coordinate of the left side of the bounding box with respect to the camera coordinate system. Only available when the angle is calculated.
Bounding Box Right	X-coordinate of the right side of the bounding box with respect to the camera coordinate system. Only available when the angle is calculated.
Bounding Box Top	Y-coordinate of the top side of the bounding box with respect to the camera coordinate system. Only available when the angle is calculated.
Bounding Box Bottom	Y-coordinate of the bottom side of the bounding box with respect to the camera coordinate system. Only available when the angle is calculated.
Bounding Box Rotation	Rotation of the bounding box with respect to the X-axis of the camera coordinate system.
Extent Left	Distance along the X-axis between the blob center of mass and the left side of the bounding box. Only available when Calculate Blob Angle is enabled.
Extent Right	Distance along the X-axis between the blob center of mass and the right side of the bounding box. Only available when Calculate Blob Angle is enabled.
Extent Top	Distance along the Y-axis between the blob center of mass and the top side of the bounding box. Only available when Calculate Blob Angle is enabled.
Extent Bottom	Distance along the Y-axis between the blob center of mass and the bottom side of the bounding box. Only available when Calculate Blob Angle is enabled.
Inertia Minimum	Moment of inertia about the major axis, which corresponds to the lowest moment of inertia. Only available when Calculate Blob Angle is enabled
Inertia Maximum	Moment of inertia about the minor axis, which corresponds to the highest moment of inertia. Only available when Calculate Blob Angle is enabled.

Table 8-42 Blob Analyzer Extrinsic Inertial Results Description

Item	Description
Inertia X Axis	Moment of inertia about the X-axis of the camera coordinate system.
Inertia Y Axis	Moment of inertia about the Y-axis of the camera coordinate system.

Table 8-43 Blob Analyzer Gray Level Results Description

Item	Description
Gray Level Mean	Average gray level of the pixels belonging to the blob.
Gray Level Range	Calculated difference between the highest and lowest gray levels found in the blob.
Gray Std Dev	Standard deviation of gray levels for the pixels in the blob.
Gray Level Minimum	Lowest gray level found in the blob.
Gray Level Maximum	Highest gray level found in the blob.

Table 8-44 Blob Analyzer Intrinsic Box Results Description

Item	Description
Intrinsic Bounding Box Center X	X-coordinate of the center of the bounding box with respect to the X-axis (major axis) of the principal axes.
Intrinsic Bounding Box Center Y	Y-coordinate of the center of the bounding box with respect to the Y-axis (minor axis) of the principal axes.
Intrinsic Bounding Box Height	Height of the bounding box with respect to the Y-axis (minor axis) of the principal axes.
Intrinsic Bounding Box Width	Width of the bounding box with respect to the X-axis (major axis) of the principal axes.
Intrinsic Bounding Box Left	Leftmost coordinate of the bounding box with respect to the X-axis (major axis) or the principal axes.
Intrinsic Bounding Box Right	Rightmost coordinate of the bounding box with respect to the X-axis (major axis) or the principal axes.
Intrinsic Bounding Box Top	Topmost coordinate of the bounding box with respect to the Y-axis (minor axis) of the principal axes.
Intrinsic Bounding Box Bottom	Bottommost coordinate of the bounding box with respect to the Y-axis (minor axis) of the principal axes.
Intrinsic Bounding Box Rotation	Rotation of the intrinsic bounding box corresponding to the counterclockwise angle between the X-axis of the bounding box (major axis) and the X-axis of the camera coordinate system. Only available when Calculate Blob Angle is enabled.
Intrinsic Extent Left	Distance along the major axis between the blob center of mass and the left side of the intrinsic bounding box.

Item	Description
Intrinsic Extent Right	Distance along the major axis between the blob center of mass and the right side of the intrinsic bounding box.
Intrinsic Extent Top	Distance along the minor axis between the blob center of mass and the top side of the intrinsic bounding box.
Intrinsic Extent Bottom	Distance along the minor axis between the blob center of mass and the bottom side of the intrinsic bounding box.

Table 8-45 Blob Analyzer Perimeter Results Description

Item	Description
Convex Perimeter	Perimeter calculated based on projections made at four different orientations: 0°, 45°, 90°, and 180°. The average diameter calculated from this projections is multiplied by pi to obtain these results.
Raw Parameter	Sum of the pixel edge lengths on the contour of the blob. This result is sensitive of to the blob's orientation with respect to the pixel grid, so results may vary greatly. Unless blobs are non-convex, Convex Perimeter results provide greater accuracy.
Roundness	Degree of similarity between the blob and a circle on a scale of 0 to 1, where 1 is a perfectly circular blob.

Table 8-46 Blob Analyzer Topological Results Description

Item	Description
Hole Count	Number of holes found in the blob.

Gripper Clearance

This tool uses histogram analysis to determine which parts can be picked without interference. It is configured as a series of rectangular histograms positioned around a part. The histograms are often set relative to a finder tool, such as Locator or Shape Search 3, so that they are positioned according to part locations.

In the Gripper Clearance properties, you can define parameters that determine if the area around a part has clearance necessary for the gripper. These parameters are applied to the histograms to filter the parts. Instances passed through the filter can be picked by the gripper.

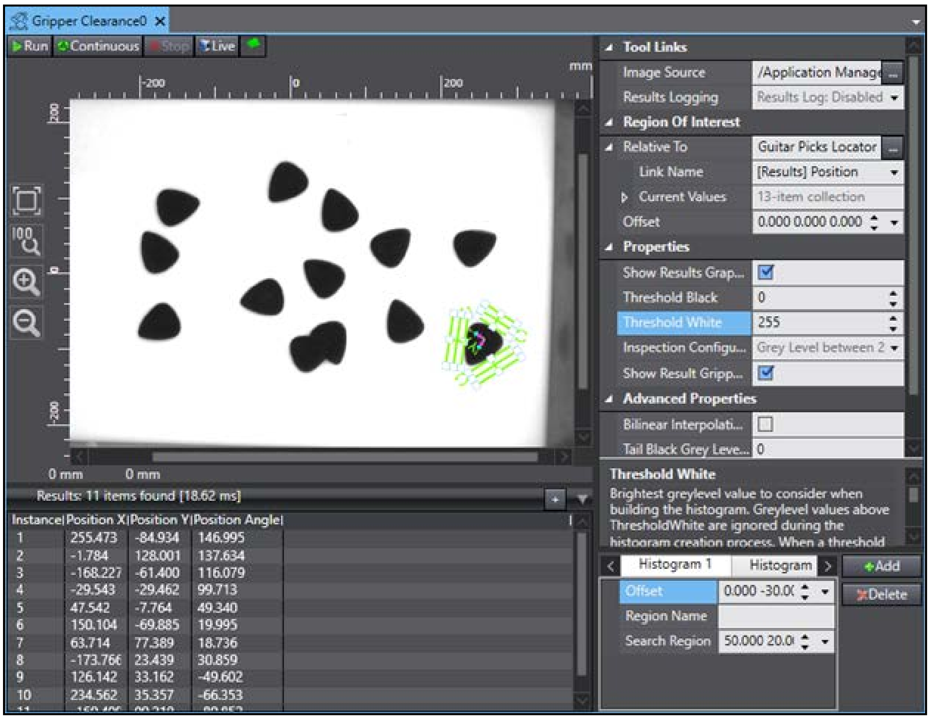


Figure 8-225 Gripper Clearance Tool Editor

Clearance itself is determined by the Inspection Configuration property. This is configured by selecting one of the parameter options and experimentally determining an appropriate range. Note that a trial-and-error approach may be required to determine the correct values of the thresholds. If the results of the histogram fall within the defined range, then the area of that histogram region is assumed to be clear. All histograms of an instance must pass for the instance to be considered valid.

Passing instances are indicated with purple frames and blue histograms while failing instances are indicated with red histograms, as shown in the following figure.

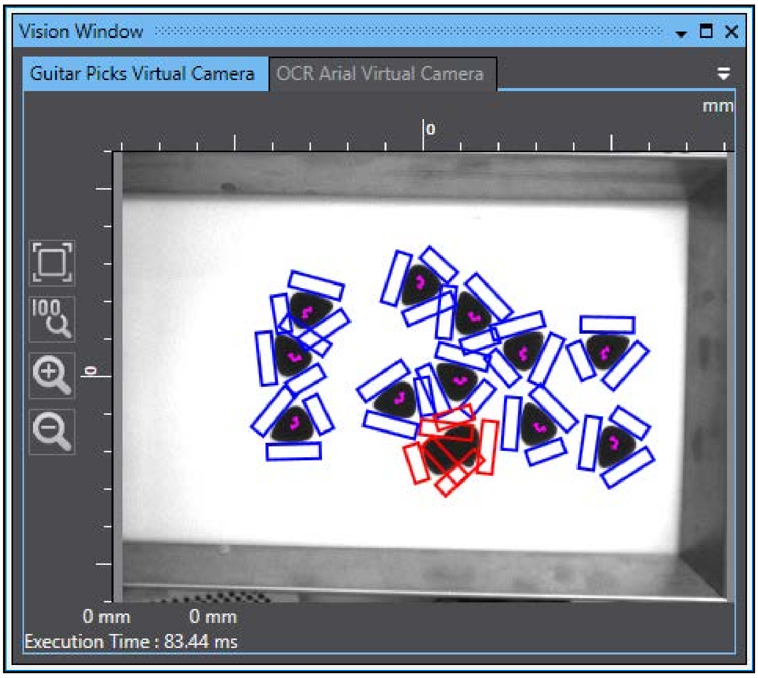


Figure 8-226 Gripper Clearance Pass/Fail Histograms

To create a Gripper Clearance tool, right-click **Vision Tools** in the Multiview Explorer, select **Add Finder** and then **Gripper Clearance**. A Gripper Clearance tool will be added to the Vision Tools list.

Gripper Clearance Configuration Items

Use the table below to understand the Gripper Clearance tool configuration items.

Table 8-47 Gripper Clearance Configuration Item Description

Group	Item	Description
Tool Links	Image Source	Defines the image source used for processing by this vision tool.
	Results Logging	Enables logging of tool results to a file.
Region Of Interest	Relative To	The tool relative to which this tool executes. The output values of the selected tool are the input values of this one.
	Link Name	Select the property in the defined Relative To tool that will provide the input values.
	Current Values	Collection of current input values.
	Offset	Defines the coordinates of the origin point referenced by the histograms.
Properties	Show Results Graphics	Specifies if the graphics are drawn in the Vision Window.

Group	Item	Description
	Threshold Black	Defines the darkest pixels the histogram considers when running. Any pixels with gray level lower than this value will be ignored while the histogram is building.
	Threshold White	Defines the brightest pixels the histogram considers when running. Any pixels with gray level above higher than this value will be ignored while the histogram is building.
	Inspection Configuration	Set the parameter and range that determines if a histogram is clear. • Gray Level: Maximum and minimum allowable gray level values for pixels within the region. These are set with a range of 0 to 255. • Variance: Maximum and minimum allowable variance of the gray level values within the region. These values must be greater than 0. • Histogram Pixel Count: Maximum and minimum allowable number of pixels within the region after applying tails and thresholds. These values must be greater than 0. • Histogram Pixel Percent: Maximum and minimum allowable percentage of pixels that are detected by the histogram after applying tails and thresholds. These values must be between 0 to 100.
	Show Result Image Histogram Regions	Specifies if the histogram regions are drawn in the ACE Vision Window. Show Results Graphics must be enabled for this to work.
Advanced Properties	Bilinear Interpolation Enabled	Enables using bilinear interpolation to sample the input image. By default, this is enabled because it ensures subpixel accuracy.
	Tail Black Gray Level Value	Percentage of pixels to ignore at the dark end of the gray level distribution. This is calculated after the pixels affected by the Threshold Black property have been removed.
	Tail White Gray Level Value	Percentage of pixels to ignore at the light end of the gray level distribution. This is calculated after the pixels affected by the Threshold White property have been removed.

Gripper Clearance Histogram Pane

The histograms are measured using the Histogram Pane located beneath the properties area.

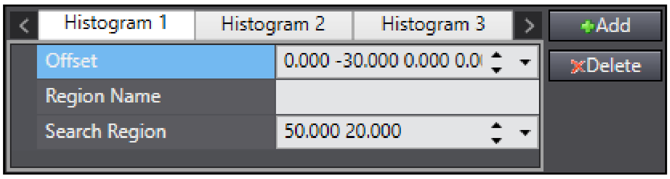


Figure 8-227 Gripper Clearance Histogram Pane

The **Add** button (Add) and **Delete** button (Delete) are used to create and remove histograms from the tool. The Histogram Pane displays the properties for the currently selected histogram tab. The properties are described in the following table.

Table 8-48 Histogram Pane Property Description

Item	Description
Offset	Defines the center coordinates of the histogram region with respect to the reference point defined by Offset in the main tool properties.
Region Name	User-defined name of the histogram. This is displayed in the lower left corner of the histogram region in the Vision Window.
Search Region	Defines the size (width, height) of the histogram region.

Gripper Clearance Results

Gripper Clearance returns each instance that has passed the all histogram ranges. For these instances, the histogram analysis is available in additional columns. These are not shown by default and must be added using the Results Column Editor. The numbers of the histograms are variable and are denoted in the table below as <number> instead of actual values.

> **NOTE:** All results are calculated after applying tails and thresholds.

Use the table below to understand the results of the Gripper Clearance tool.

Table 8-49 Gripper Clearance Results Description

Item	Description
Instance	Index of the result instance.
Frame/Group	Index of the related result. It is associated with the tool that this tool is set Relative To.
Position X	X-coordinate of the instance origin.
Position Y	Y-coordinate of the instance origin.
Position Angle	Angle of the instance origin.
Gray Level Mean <number>	Average gray level within the region of this histogram.
Histogram Pixel Count <number>	Number of pixels within the region of this histogram.

Item	Description
Histogram Pixel Percent <number>	Percentage of pixels within the region of this histogram.
Variance <number>	Variance of the gray level values of the pixels within the region of this histogram.

Labeling

Similar to the Labeling tool, this filter isolates masses of pixels that fall within a certain color range and meet different extraction conditions. You can set a single color by right-clicking in the image or a color range by right-clicking and dragging to establish a region. Alternatively, you can manually enter the colors using the Color Region section in the Properties.

Once one or more color thresholds have been established, the tool will filter everything out of the image except for the pixels that fall within the ranges. Additional extraction conditions can be set to further limit the identified regions. Unlike the Labeling tool, the regions are not returned as data. Instead, Labeling Filter results in a new image.

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Labeling Configuration Items

Use the table below to understand the Labeling tool configuration items.

Table 8-50 Labeling Configuration Item Description

Group	Item	Description
Tool Links	Image Source	Defines the image source used for processing by this vision tool.
	Results Logging	Enables logging of tool results to a file.
Region Of Interest	Relative To	The tool relative to which this tool executes. The output values of the selected tool are the input values of this one.
	Link Name	Select the property in the defined Relative To tool that will provide the input values.
	Current Values	Collection of current input values.
	Rectangles Ellipses Circumferences Polygons WideArcs	Sets of regions of interest of a particular shape. The field will show how many regions exist ("1-item collection","2-item collect', etc.). Click the plus sign in the field to create additional regions and click the arrow to see all regions.
	<region number>	Identifies the region of the specified shape. It will appear as [0], [1], [...] within the shape category. Click the minus sign in the field to remove the region and click the arrow to see its properties.

Group	Item	Description
	Name	Available in all region types. Sets the user-defined name of the region.
	Overlap	Available in all region types. Select the behavior of the region. OR causes the region to be included in the search area and NOT excludes it from the search area. The behavior of specific regions is further defined in Z-Order. Refer to Region of Interest on page 473 for more information.
	Z-Order	Available in all region types. Sets the order for overlapping regions of interest. Higher numbers will be in front and resolved first. Refer to Tools with Multiple Regions of Interest on page 474 for more information.
	Offset	Available in all region types except for Polygons. Defines the coordinates of the region's center.
	Search Region (Width, Height)	Sets the height and width of the rectangular region. Only available in Rectangles.
	Radius X/Y	Defines the distance from the center to the exterior along the X- and Y-axes, respectively. Only available in Ellipses.
	Radius	Only available in Ellipses. Defines the distance from the center to the exterior along the region X- and Y-axes, respectively.
	Thickness	Defines the distance between the two visible rings. Only available in Circumferences and WideArcs.
	Start/End Angle	Defines the start and end angle of the Wide Arc bounds. Angles are measured in degrees counterclockwise from the positive X-axis. The arc is created clockwise starting from the Start Angle and ending at the End Angle. Only available in WideArcs.
	Vertexes	Sets of vertexes in a polygon region of interest. The field will show how many vertexes exist ("3-item collection", "4-item collection", etc). Click the plus line in the field to create additional regions and click the arrow to see all regions. Only available in Polygons.
	<vertex number>	Identifies a particular vertex in the region. It will appear as [0], [1], [2], and etc. The field defines the X/Y coordinates of the vertex. Click the minus sign to remove the vertex, as long as there are not fewer than three. Only available in Polygons.

Group	Item	Description
	Maximum Tool Execution Count	Maximum number of tool executions for Relative To performance. If this tool is not set relative to another tool, the tool will only run once upon execution.
Properties	(Label Condition) Outside Condition	Defines the behavior of the area outside the search area. When enabled, the entirety of the area outside the regions of interest will be returned as the extracted color, connecting all detected masses that touch the edges of the regions.
	(Label Condition) Sort Condition	Select the order in which the returned masses are processed and output. The order will be descending (largest to smallest) by default; checking the Ascending box will sort them smallest to largest.
	(Label Condition) Neighborhood Mode	Specifies the connection conditions for labeling. Select 4 Neighborhood to process contiguous parts up, down, left, and right of the target pixel as the same label. Select 8 Neighborhood to add oblique directions.
	Extract Condition 1/2/3	Defines the type and limitation of conditions that constrain the returned masses
	(Extract Condition 1/2/3) Kind	Available under Extract Condition 1/2/3. Select the property that will define the constraints on the returned masses.
	(Extract Condition 1/2/3) Min/Max	Available under Extract Condition 1/2/3. Defines the minimum and maximum values that are acceptable for returned masses.
	Show Results Graphics	Specifies if the graphics are drawn in the Vision Window.
	Hole Plug Color	Defines which color will fill in detected holes in the masses. This is disabled by default.
Advanced Properties	Additional Data Set	Allows additional data values to be added to the output. Select the types of results based on what is needed. • Rectangle Coordinate Results: Upper left, lower right coordinates when enclosing a label with a circumscribed rectangle. • Cont Length Results: Length of the entire circumference of the label. • Circularity Results: Roundness of the label. • Elliptic Results: Long axis length, minor axis length, and angle when label is elliptically approximated.

Group	Item	Description
		• Rotated Rectangle Results: Long side length, short side length, and angle of rotating short form circumscribing the label. • Inner Circle Results: Center coordinates and radius of the circle inscribed on the label. • Outer Circle Results: Center coordinates and radius of circumscribing circle. • Holes Number Results: Number of holes detected in the label.
	Image Type	Set the color scheme of the image to display. All Colors shows all extracted colors, Binary outputs all extracted colors as white and everything else as black, and the rest of the options only extract the masses that match one defined color.
	Max Result Display Count	Set the number of results to display. The tool will not output more instances than this value.

Color Region Pane

This pane shows the color ranges to be extracted from the image. This is imperative when using a color image. The color range(s) can be chosen by specifying the minimum and maximum for hue, saturation, and value. Conversely, the color range(s) can be selected in the image. Right-click on a pixel to select a specific color or right-click and drag to select a range. The detected colors will be displayed in the Color Setting region and the user can define the limits based on these data points.

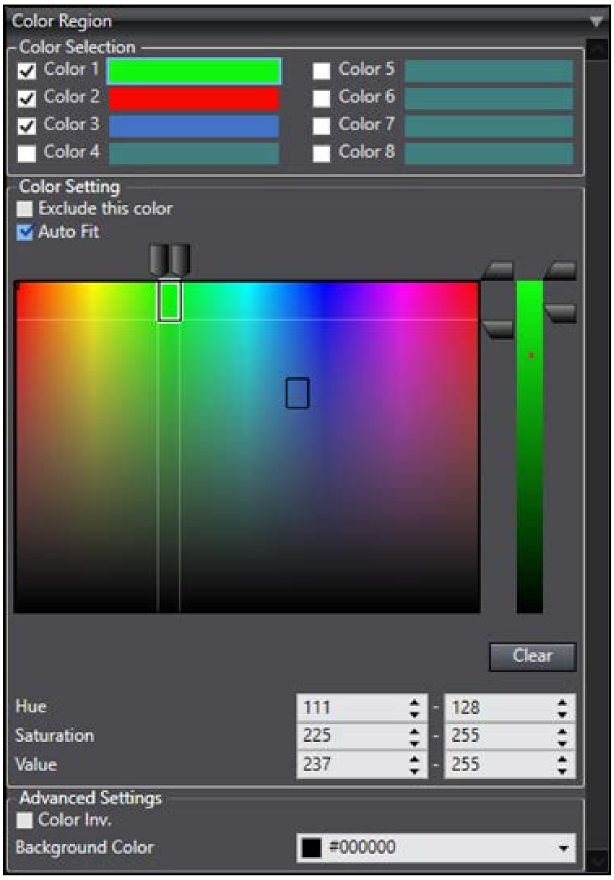

Figure 8-228 Color Region Pane

The Color Region Pane is split into the following three sections.

1. **Color Selection**

   This shows the colors that have been selected. Up to eight different colors can be extracted each time the tool is run. The user can determine which colors are extracted from among the selected ones by checking or unchecking the boxes next to them. For example, deselecting Colors 2 and 3 in Figure 8-228 will cause only the green regions to be extracted.

2. **Color Setting**

   This highlights the regions on the color spectrum that are used by the selected colors. They are also defined by the Hue, Saturation, and Value fields down below. The highlighted regions can be modified by dragging them in the color spectrums or adjusting the values in the fields down below. The selected color range is shown as a rectangle with a black and white border. Other ranges defined will have a black border. The colors of the pixels in the most recently selected range will appear as gray markers on the rectangular field and as red marks in the Value slider on the right.

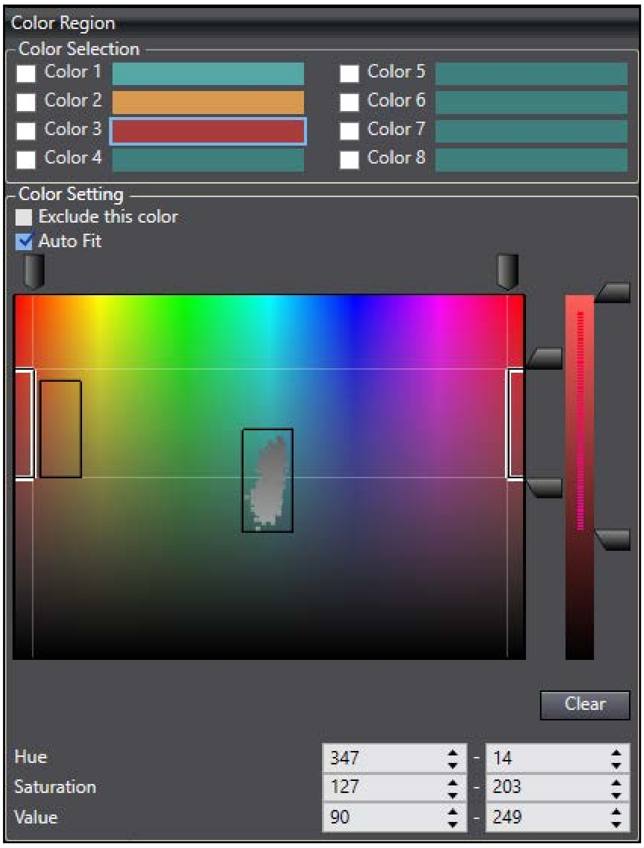

Figure 8-229 Color Region Pane - Color Setting

NOTE: The X-axis of the rectangular color region is ranged from 0 to 360, represented in the number fields below it. Because the Hue range is supposed to be circular, it is possible for a red color range to begin close to the right side of the region and end on the left side.

Checking the box next to ***Exclude this color*** prevents the color from being extracted. Checking the box next to ***Auto fit*** allows the right-click shortcut to be used to define this color range. This is enabled by default.

Advanced Settings

This provides two additional properties that affect the resulting image. ***Background Color*** defines the color that will be set everywhere that is not an extracted mass. ***Color Inv.*** returns all masses as the background color and everywhere else as a white field.

Locator Results

Use the table below to understand the results of the Locator tool.

Table 8-51 Locator Results Item Description

Item	Description
Instance	Index of the result instance.
Frame/Group	Index of the related result. It is associated with the tool that this tool is set Relative To. This will only be different if the Locator is set relative to another tool.
Model Index	Index of the model located for each instance. If only one model is used, this will be the same for every instance.
Model Name	Name of the model located for each instance. Each Model Name is identical to the associated Locator Model tool name.
Fit Quality	Normalized average error between the matched model contours and the actual contours detected in the input image. Fit quality ranges from 0 to 100 where the best quality is 100. A value of 100 means that the average error is 0. A value of 0 means that the average matched error is equal to the Conformity Tolerance.
Match Quality	Amount of matched model contours for the selected object instance expressed as a percentage. Match quality ranges from 0 to 100 where the best quality is 100. A value of 100 means that 100% of the model contours were successfully matched to the actual contours detected in the input image.
Clear Quality	Measurement of the clear area surrounding the specified object instance. Clear quality ranges from 0 to 100 where the best quality is 100. A value of 100 means that the instance is completely free of obstacles. If Minimum Clearances is Disabled, this value is 100.
Position X	X-coordinate of the instance origin.
Position Y	Y-coordinate of the instance origin.
Angle	Angle of the instance.
Scale Factor	Relative size of the instance with respect to its associated model.
Symmetry	Index of the instance of which this instance is a symmetry. Output Symmetric Instances must be enabled.
Time	Time in milliseconds needed to recognize and locate the object instance.

NOTE: The result columns Fit Quality, Match Quality, and Clear Quality do not directly correlate with the Minimum Model Percentage property. This is because Minimum Model Percentage is compared to the initial coarse outline while these results are originated from the refined detail search.

Line Finder

This tool identifies linear features on objects and returns angle of inclination and the endpoint coordinates of the detected line.

Line Finder is most commonly used to return information about straight edges. For example, the tool in Figure 8-230 is used to locate line created by the left edge of the wire square. In this way, it can be used to locate and measure straight features within an object . Multiple detected lines can be used to calculate intersection points and refine a pick position based on part object geometries. If the line to be located should only be in a certain position, the guideline position and properties such as Search Mode can be used to decrease the detection range.

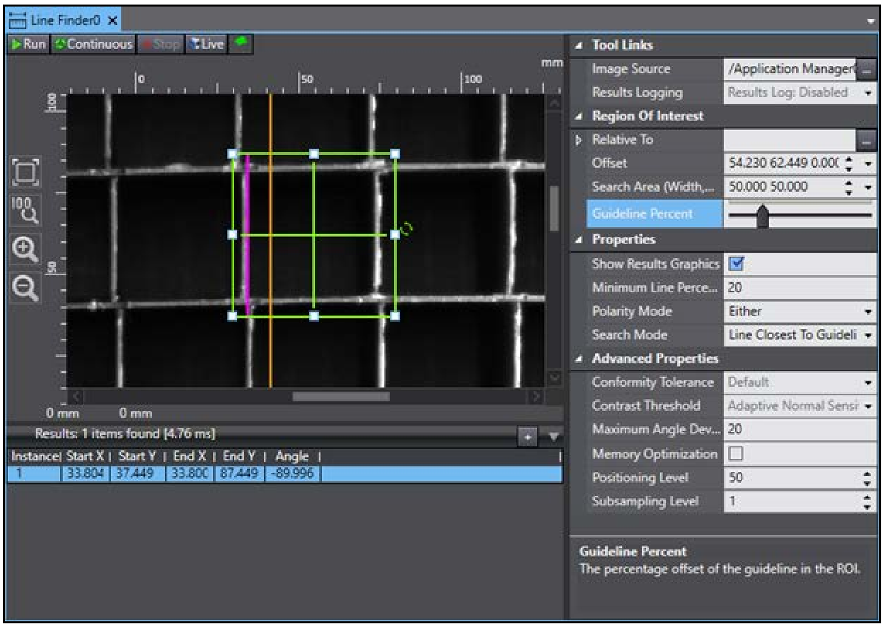

Figure 8-230 Line Finder Tool Editor

To create a Line Finder tool, right-click **Vision Tools** in the Multiview Explorer, select **Add Finder** and then **Line Finder**. A Line Finder tool will be added to the Vision Tools list.

Line Finder Results

Use the table below to understand the results of the Line Finder tool.

Table 8-52 Line Finder Results Description

Item	Description
Instance	Index of the result instance.
Frame/Group	Index of the related result. It is associated with the tool that this tool is set Relative To.
Start X	X-coordinate of the first endpoint.
Start Y	Y-coordinate of the first endpoint.
Center X	X-coordinate of the midpoint.
Center Y	Y-coordinate of the midpoint.
End X	X-coordinate of the second endpoint.
End Y	Y-coordinate of the second endpoint.
Angle	Angle (in degrees) of the detected line, measured from the positive X-axis

Item	Description
	of the camera frame.
Average Contrast	Average contrast between light and dark pixels on either side of the found arc, expressed in gray level values.
Fit Quality	Normalized average error between the calculated arc contours and the actual contours detected in the input image. Fit quality ranges from 0 to 100 where the best quality is 100. A value of 100 means that the average error is 0. A value of 0 means that the average matched error is equal to the Conformity Tolerance property.
Match Quality	Amount of matched arc contours for the selected instance expressed as a percentage. Match quality ranges from 0 to 100 where the best quality is 100. A value of 100 means that 100% of the arc contours were successfully matched to the actual contours detected in the input area.

Locator

This tool identifies objects in an image based on geometries defined in one or more Locator Models. Because of its speed, accuracy, and robustness, the Locator is the ideal frame provider for Robot Vision Manager inspection tools.

The Locator tool functions by detecting edges in the input images and then using them to generate a vectorized description of the image. The contours are generated on two coarseness levels: Outline and Detail. Outline is used to generate hypotheses of potential instances while Detail is used to confirm the hypotheses and refine the location. The detected contours are then compared to the model(s) to identify instances of the model(s) within the image.

A Locator can be set relative to other tools, such as another Locator or a Shape Search 3. This allows the Locator tool to be used to locate features, sub-features, or sub-parts on a parent object.

> **NOTE:** The Locator tool will not work until a Locator Model has been created. Refer to Locator Model on page 519 for more information.
>
> Locator provides disambiguation between multiple similar models, but it typically has longer execution times than Shape Search 3. Shape Search 3 is often used for simple models while Locator is better when handling multiple models or situations where the model training process requires user control.

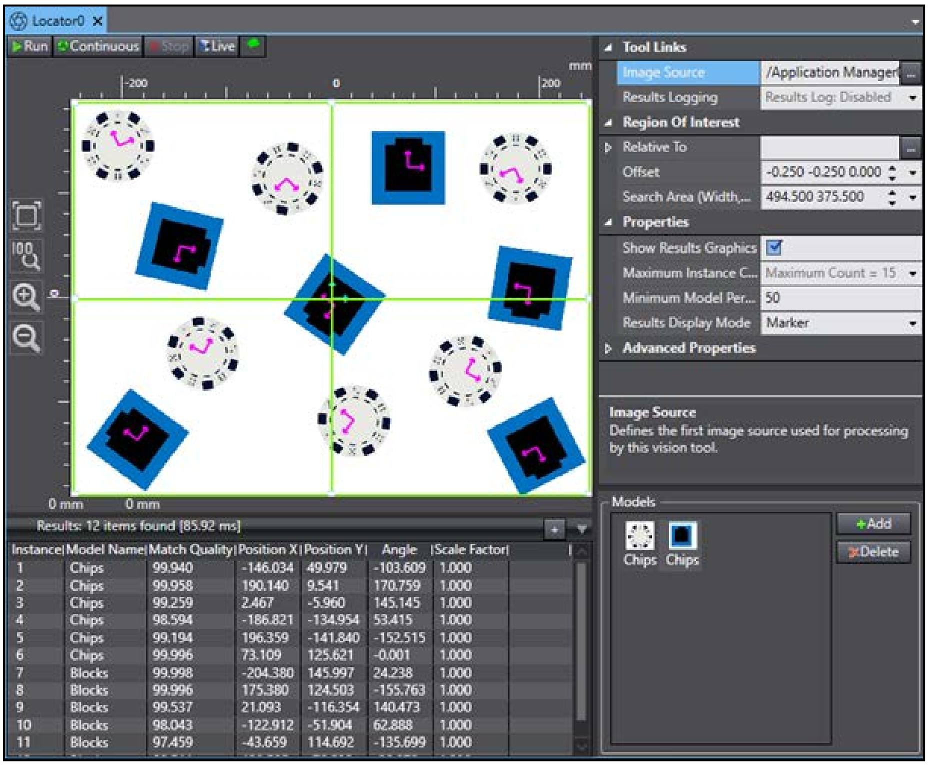

Figure 8-231 Locator Tool Editor

To create a Line Finder tool, right-click **Vision Tools** in the Multiview Explorer, select **Add Finder** and then **Locator**. A Locator tool will be added to the Vision Tools list.

Locator Configuration Items

Use the table below to understand the Locator tool configuration items.

Table 8-53 Locator Configuration Item Description

Group	Item	Description
Tool Links	Image Source	Defines the image source used for processing by this vision tool.
	Results Logging	Enables logging of tool results to a file.
Region Of Interest	Relative To	The tool relative to which this tool executes. The output values of the selected tool are the input values of this one.
	Link Name	Select the property in the defined Relative To tool that will provide the input values.
	Current Values	Collection of current input values.
	Offset	Defines the center coordinates of the region.

Group	Item	Description
	Search Area (Width, Height)	Defines the size of the region.
Properties	Show Results Graphics	Specifies if the graphics are drawn in the Vision Window.
	Maximum Instance Count	Set the maximum number of instances to be detected in the image. All of the object instances matching the search constraints are output, up to a maximum of this value.
	Minimum Model Percentage	Minimum percentage of model contours that need to be matched in the input image in order to consider the object instance as valid.
	Results Display Mode	Defines how the results are rendered in the image display. Marker shows only the origin marker of the model, Model shows the outline of the detected model, and Marker and Model shows both.
Advanced Properties	Conformity Tolerance	Set the maximum local deviation between the expected model contours of an instance and the contours actually detected in the input image. Refer to Locator Configuration Items on page 504 for more information.
	Contour Detection	Set how the contour detection parameters are configured. Refer to Locator Configuration Items on page 504 for more information.
	Contrast Polarity	Select the direction of polarity required for instance detection. Refer to Locator Configuration Items on page 504 for more information.
	Contrast Threshold	Defines the minimum contrast needed for an edge to be detected in the input image. This threshold is expressed in terms of a step in gray level values. Refer to Locator Configuration Items on page 504 for more information.
	Instance Ordering	Select the order in which the instances are processed and output. Refer to Locator Configuration Items on page 504 for more information.
	Minimum Clearance	Set the minimum percentage of the model bounding box area that must be free of obstacles to consider an object instance as valid. Refer to Locator Configuration Items on page 504 for more information.

Group	Item	Description
	Minimum Required Features	Set the minimum percentage of required features that must be recognized in order to consider the object instance as valid. Locator Configuration Items on page 504 for more information.
	Model Disambiguation Enabled	Set to apply disambiguation to discriminate between similar models and between similar hypo-theses of a single object. Refer to Locator Configuration Items on page 504 for more information.
	Model Optimizer Enabled	Set to interactively optimize the model. Refer to Locator Configuration Items on page 504 for more information.
	Nominal Rotation	Set the required rotation range for valid instances. Refer to Locator Configuration Items on page 504 for more information.
	Nominal Scale Factor	Set the required scale factor for an object instance to be recognized. Refer to Locator Configuration Items on page 504 for more information.
	Output Symmetric Instances	Enable to output all symmetric poses of the object instances. If disabled, the tool will only output the best quality instance of a symmetric object. Refer to Locator Configuration Items on page 504 for more information.
	Overlap Configuration	Enable to check if any instances overlap. These will be excluded from the results. Refer to Locator Configuration Items on page 504
	Percentage Of Points To Analyze	Set the percentage of points on a model contour that are actually used to locate instances. Refer to Locator Configuration Items on page 504 for more information.
	Positioning Level	Set the level of positioning accuracy on a scale from 0 to 10. Refer to Locator Configuration Items on page 504 for more information.
	Recognition Level	Set the level of recognition effort on a scale of 0 to 10. Refer to Locator Configuration Items on page 504 for more information.

Group	Item	Description
	Search Based On Outline Level Only	Set to cause the tool to only use the Outline Level contours of the model to detect instances. Refer to Locator Configuration Items on page 504 for more information.
	Show Model Name	Set whether the model name will be displayed in the Vision Window. Refer to Locator Configuration Items on page 504 for more information.
	Timeout	Enable to set the maximum time period (in milliseconds) that the tool is able to run. Refer to Locator Configuration Items on page 504 for more information.

Locator Models Pane

The Models pane is used to edit the models used in this tool.

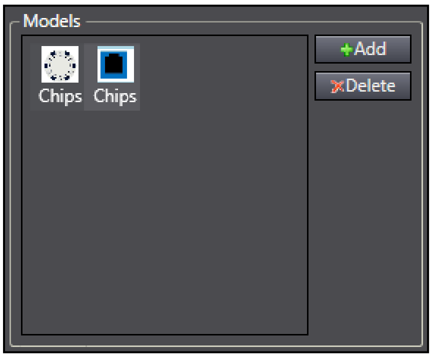

Figure 8-232 Locator Models Pane

There are two ways to add models to the tool.

1. Click the **Add** Button and select the model from the defined Locator Model tools.
2. Click and drag the Locator Model object from the Multiview Explorer to the Models Pane.

Models can be deleted from this pane by selecting them and clicking the **Delete** Button.

> **NOTE:** The order in which models are added defines the Model Index result value. Models cannot be reordered once they have been added to the Models Pane.

Locator Advanced Properties - Edge Detection Parameters

The properties in this section modify the quality and quantity of contours that are generated from the input image.

Contour Detection

This property sets how the contour detection parameters are configured. For most applications, Contour Detection should be set to All Models, where the contour detection parameters are optimized by analyzing the parameters that were used to build all the currently active models.

Custom contour detection should only be used when the default values do not work correctly. Setting this to Custom allows the user to specify Outline Level, Detail Level, and Tracking Inertia as described below.

- The Outline Level contours are used to rapidly identify potential instances of the object. Coarseness values range from 1 to 16 where 1 is full resolution and all other values are factors of 1. For example, at level 8, the resolution is 8 times lower than an image at full resolution. Lower values of Outline Level lead to higher execution times.
- The Detail Level contours are used to confirm recognition and refine the position of valid instances. For images that are not in perfect focus, better results will be obtained with a higher value of Detail Level. To obtain high-accuracy object location, use images with sharp edges and set Detail Level to the lowest coarseness value. Detail Level and Outline Level have the same range, but Detail Level must have a lower value. Lower values of Detail Level lead to higher execution times.
- Tracking Inertia defines the longest gap that can be closed to connect two edge elements when building the source contours. It is set on a scale of 0 to 1. Higher values can help close small gaps and connect contours that would otherwise be broken into smaller sections.

Contrast Polarity

This property defines the polarity change in gray level values between an object and its background, which can be dark to light, light to dark, or a combination of both. The reference polarity for an object is defined by its Model with respect to the polarity in the image on which the Model was created. It can be set to the following options.

- Normal searches only for instances that match the polarity of the Model. For example, if the Model is a dark object on a light background, the Locator searches only for dark objects on a light background (refer to the middle image in the following figure).
- Reverse searches only for instances that have opposite polarity from the Model. For example, if the Model is a dark object on a light background, the Locator searches only for light objects on a dark background (refer to the right image in the following figure).

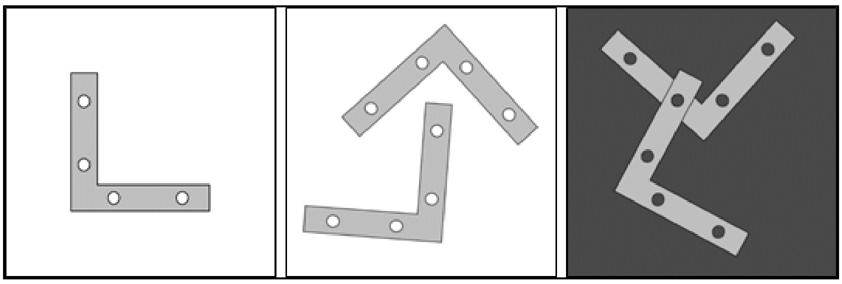

Figure 8-233 Locator Contrast Polarity (Model, Normal, and Reverse)

- Normal And Reverse searches for both of the above. This will not include cases where polarity is reversed at various locations along the edges of an object.
- Do Not Care indicates that polarity should not be taken into account when searching for instances. This is useful when a model has multiple local polarity changes, such as in the checkerboard background of the figure below, where Do Not Care must be selected in order for the object to be detected.

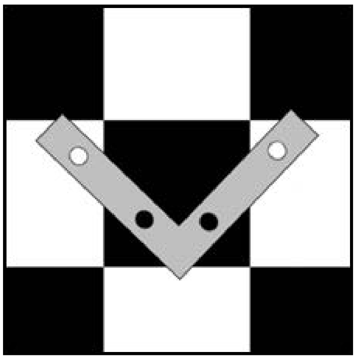

Figure 8-234 Locator Contrast Polarity (Local Changes in Polarity)

Contrast Threshold

This property sets the minimum contrast needed for an edge to be detected in the input image. The threshold value is interpreted as the change in gray level value required to detect contours.

Contrast Threshold can be set to Adaptive Low Sensitivity, Adaptive Normal Sensitivity, Adaptive High Sensitivity, or Fixed Value. Higher values reduce sensitivity to contrast, reducing noise and lowering the amount of low-contrast edges. Conversely, lower values increase sensitivity and add a greater amount of edges to the contours at the expense of adding more noise, which can generate false detections and/or increase execution time .

Adaptive thresholds set a sensitivity level based on image content. This provides flexibility to variations in image lighting conditions and variations in contrast during the Search process, and can generally be used for most applications. The Fixed Value option allows the user to set the desired value on a scale from 1 to 255, corresponding to the minimum step in gray level values required to detect contours. This is primarily used when there is little variance in lighting conditions.

Search Based on Outline Level Only

This property restricts the search to using only the Outline Level source contours to search, recognize, and position object instances. Detail Level contours are ignored completely. Enabling this can increase speed with possible loss of accuracy and detection of false instances.

An Outline-based search is mainly used for time critical applications that do not require a high-positioning accuracy or that only need to check for presence/absence of objects. To be effective, this type of search requires clean run time images that provide high-contrast contours with little or no noise or clutter.

Labeling Configuration Items

Use the table below to understand the Labeling tool configuration items.

Table 8-54 Labeling Configuration Item Description

Group	Item	Description
Tool Links	Image Source	Defines the image source used for processing by this vision tool.
	Results Logging	Enables logging of tool results to a file.
Region Of Interest	Relative To	The tool relative to which this tool executes. The output values of the selected tool are the input values of this one.
	Link Name	Select the property in the defined Relative To tool that will provide the input values.
	Current Values	Collection of current input values.
	Rectangles Ellipses Circumferences Polygons WideArcs	Sets of regions of interest of a particular shape. The field will show how many regions exist ("1-item collection","2-item collect', etc.). Click the plus sign in the field to create additional regions and click the arrow to see all regions.
	<region number>	Identifies the region of the specified shape. It will appear as [0], [1], [...] within the shape category. Click the minus sign in the field to remove the region and click the arrow to see its properties.
	Name	Available in all region types. Sets the user-defined name of the region.
	Overlap	Available in all region types. Select the behavior of the region. OR causes the region to be included in the search area and NOT excludes it from the search area. The behavior of specific regions is further defined in Z-Order. Refer to Region of Interest on page 473 for more information.
	Z-Order	Available in all region types. Sets the order for overlapping regions of interest. Higher numbers will be in front and resolved first. Refer to Tools with Multiple Regions of Interest on page 474 for more information.
	Offset	Available in all region types except for Polygons. Defines the coordinates of the region’s center.
	Search Region (Width, Height)	Sets the height and width of the rectangular region. Only available in Rectangles.
	Radius X/Y	Defines the distance from the center to the exterior along the X- and Y-axes, respectively. Only avail-

Group	Item	Description
		able in Ellipses.
	Radius	Only available in Ellipses. Defines the distance from the center to the exterior along the region X- and Y-axes, respectively.
	Thickness	Defines the distance between the two visible rings. Only available in Circumferences and WideArcs.
	Start/End Angle	Defines the start and end angle of the Wide Arc bounds. Angles are measured in degrees counterclockwise from the positive X-axis. The arc is created clockwise starting from the Start Angle and ending at the End Angle. Only available in WideArcs.
	Vertexes	Sets of vertexes in a polygon region of interest. The field will show how many vertexes exist ("3-item collection", "4-item collection", etc). Click the plus line in the field to create additional regions and click the arrow to see all regions. Only available in Polygons.
	<vertex number>	Identifies a particular vertex in the region. It will appear as [0], [1], [2], and etc. The field defines the X/Y coordinates of the vertex. Click the minus sign to remove the vertex, as long as there are not fewer than three. Only available in Polygons.
	Maximum Tool Execution Count	Maximum number of tool executions for Relative To performance. If this tool is not set relative to another tool, the tool will only run once upon execution.
Properties	(Label Condition) Outside Condition	Defines the behavior of the area outside the search area. When enabled, the entirety of the area outside the regions of interest will be returned as the extracted color, connecting all detected masses that touch the edges of the regions.
	(Label Condition) Sort Condition	Select the order in which the returned masses are processed and output. The order will be descending (largest to smallest) by default; checking the Ascending box will sort them smallest to largest.
	(Label Condition) Neighborhood Mode	Specifies the connection conditions for labeling. Select 4 Neighborhood to process contiguous parts up, down, left, and right of the target pixel as the same label. Select 8 Neighborhood to add oblique directions.
	Extract Condition 1/2/3	Defines the type and limitation of conditions that constrain the returned masses
	(Extract Condition	Available under Extract Condition 1/2/3. Select the

Group	Item	Description
	1/2/3) Kind	property that will define the constraints on the returned masses.
	(Extract Condition 1/2/3) Min/Max	Available under Extract Condition 1/2/3. Defines the minimum and maximum values that are acceptable for returned masses.
	Show Results Graphics	Specifies if the graphics are drawn in the Vision Window.
	Hole Plug Color	Defines which color will fill in detected holes in the masses. This is disabled by default.
Advanced Properties	Additional Data Set	Allows additional data values to be added to the output. Select the types of results based on what is needed. • Rectangle Coordinate Results: Upper left, lower right coordinates when enclosing a label with a circumscribed rectangle. • Cont Length Results: Length of the entire circumference of the label. • Circularity Results: Roundness of the label. • Elliptic Results: Long axis length, minor axis length, and angle when label is elliptically approximated. • Rotated Rectangle Results: Long side length, short side length, and angle of rotating short form circumscribing the label. • Inner Circle Results: Center coordinates and radius of the circle inscribed on the label. • Outer Circle Results: Center coordinates and radius of circumscribing circle. • Holes Number Results: Number of holes detected in the label.
	Image Type	Set the color scheme of the image to display. All Colors shows all extracted colors, Binary outputs all extracted colors as white and everything else as black, and the rest of the options only extract the masses that match one defined color.
	Max Result Display Count	Set the number of results to display. The tool will not output more instances than this value.

Locator Advanced Properties - Search Parameters

The properties in this section are constraints that restrict the Locator's search process.

Conformity Tolerance

This property defines the maximum allowable local deviation of instance contours from the expected model contours. Its value corresponds to the maximum distance by which a matched contour can deviate from either side of its expected position in the model. Portions of the instance hypothesis that are not within the Conformity Tolerance range are not considered to be valid. Only the contours within Conformity Tolerance are recognized and calculated for the Minimum Model Recognition search constraint. See the following figure for an example.

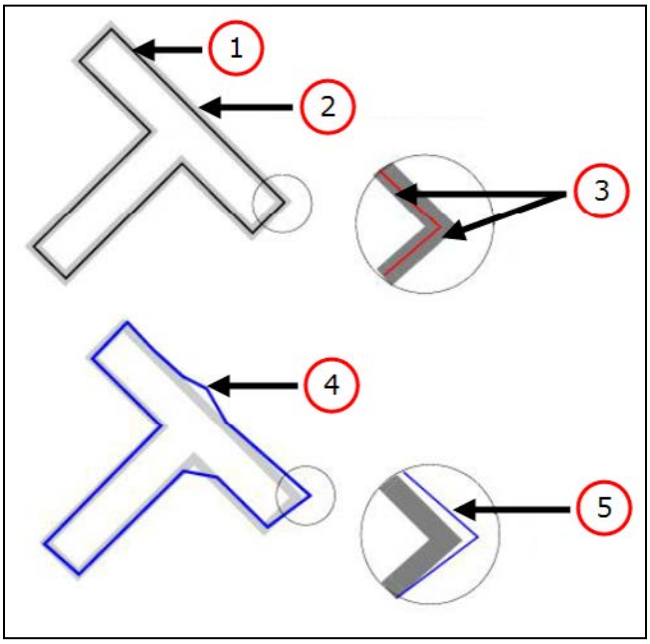

Figure 8-235 Locator Conformity Tolerance

Table 8-55 Locator Conformity Tolerance Description

Item	Description
1	Model contour (red).
2	Conformity tolerance (gray).
3	Conformity tolerance (gray) value applies to both sides of model contour (red).
4	Contours of the found object (blue). Contours outside conformity tolerance are not valid.
5	Portion of object contour outside the conformity tolerance zone.

The Conformity Tolerance options are described below.

- Use Default: Enabling this causes the Locator tool to calculate a default value by analyzing the calibration, contour detection parameters, and search parameters. This box must be unchecked if either of the other options are going to be used.

- Range Enabled: Enables the use of the manually-set tolerance value. This is set by Tolerance, which defines the maximum difference in calibrated units by which a matched contour can deviate from either side of its expected position. It can be set on a range of 1 to 100.

Nominal Rotation

This property constrains the rotation range within which Locator can detect instances. Any possible instance must satisfy this property in order to be recognized as instances. By default, the range is set from -180 to 180 degrees. This can be changed depending on the needs of the application. The rotation range spans counterclockwise from the minimum to the maximum angle, as shown in Figure 8-236 .

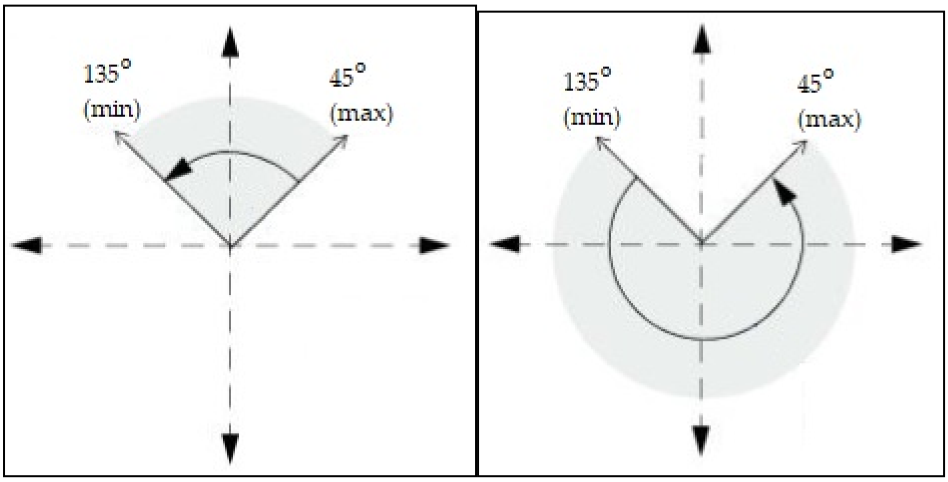

Figure 8-236 Locator Nominal Rotation Valid Range of Motion

Conversely, Use Nominal can be enabled. This applies the value in the Nominal field to the Locator, which searches for instances within a tolerance of that angle. Any instances found within the tolerance will automatically be set to the angle in the Nominal field. If the actual angle of rotation is required, it is recommended to leave the Use Nominal box disabled and instead enter a small range, such as 89 to 91 degrees.

> **NOTE:** If the trained Locator Model has rotational symmetry, it is possible that Nominal Rotation will cause an instance to be detected that is not actually within the target angle range. In this case, raising the Minimum Model Percentage can be used to prevent the symmetric instance from being detected.

Nominal Scale Factor

This property sets the required scale factor for an object to be recognized. Similar to Nominal Rotation, it can constrain the range of scale factors for which the Locator will search by either setting a minimum and maximum value or a fixed nominal value. By default, the range is set from 0.9 to 1.1. Any possible instance must lie within this range in order to be output as an identified instance. Note that the scale factor parameter has one of the most significant impacts on search speed and using a large scale factor range can significantly slow down the process. The range should be configured to include only the scale factors that are expected from the application.

Conversely, Use Nominal can be enabled to make the Locator search only for the value in the Nominal range. However, if objects have a slight variation in scale, the objects may be recognized and positioned with reduced quality because their true scale factor will not be measured. In such a case, it is recommended to configure a narrow scale range instead of a nominal value.

The Minimum, Maximum, and Nominal values can all be set within a range of 0.1 to 10.

Positioning Level

This property modifies the positioning accuracy. This can be set on a range from 0 to 10, although the default setting of 5 is the optimized and recommended setting for typical applications. Lower values provide coarser positioning with faster execution times while higher values provide high-accuracy positioning at the cost of speed.

Positioning Level does not have a large impact on execution speed. However, in applications where accuracy is not critical, the value can be decreased to lower the processing the time.

Recognition Level

This property slightly modifies the level of recognition effort. This can be set on a range from 0 to 10, but the default setting of 5 is the optimized and recommended setting for typical applications. Lower values provides faster searches that may miss partially blocked instances while higher values more accurately recognize all objects in cluttered or noisy images at the cost of speed.

When adjusting the Recognition Level, it is important to repeatedly test the application to find the optimum speed at which the process will still find all necessary objects. If the recognition level is too low, some instances may be ignored, but if it is too high, the application may run too slowly.

Recognition Level does not affect positioning accuracy.

Locator Advanced Properties - Model Parameters

The properties in this section constrain how the tool interacts with the model.

Minimum Required Features

This property defines the percentage of required features that need to be recognized for the Locator to accept a valid instance of an object. In most applications, a feature in the Locator Model will be set as Required if it needs to be present in every single instance, but this property allows some flexibility. Minimum Required Features is set as a percentage of all required features on a range from 0.1 to 100. Note that this parameter is expressed in terms of a percentage of the number of required features in a model and does not consider the amount of contour each required feature represents.

Refer to Locator Model Feature Selection Pane on page 522 for information on how to set a feature as required.

Model Disambiguation Enabled

This property determines if disambiguation is applied to the detected instances to resolve ambiguity between similar models by analyzing distinguishing features. This is enabled by default and should remain enabled in most applications. Disabling this will significantly reduce the time needed to learn or relearn models, but it prevents the Locator from differentiating between similar models. This should only be done in applications that require many different models.

Model Optimizer Enabled

This property determines if the models can be optimized interactively by building a model from multiple instances of an object. When enabled, the user can build an optimized model by creating an initial Locator Model and then running the Locator. Each new instance of the object found by the Locator is analyzed and compiled into the current optimized model. Strong features that recur frequently in the analyzed instances are retained in the optimized model. Once the model is considered satisfactory, the optimized model can be saved.

By default, this property is disabled and can remain disabled for most applications. It may be useful for applications where the objects have a variable shape.

Percentage of Points to Analyze

This property defines points used to create an optimization model. It is set as a percentage of the points on a model contour actually used to locate instances. For example, when it is set to the default value of 50%, one out of every two points is used. This can be set on a range from 0.1 to 100. Higher values can increase the accuracy of the optimized model but incur longer optimization time while lower values lower the accuracy while improving speed.

Show Model Name

This property determines if the model name is displayed in the Vision Window. Enabling this will display the name of the respective Locator Model tool name(s) in the tool window and the Vision Window. This is only evaluated if Show Results Graphics is enabled.

Locator Advanced Properties - Instance Output Constraints

The properties in this section constrain how the tool outputs instances.

Instance Ordering

This property sets the order in which object instances are output. In general, it is adjusted by opening the dropdown menu and changing the method. Reference values may also be required.

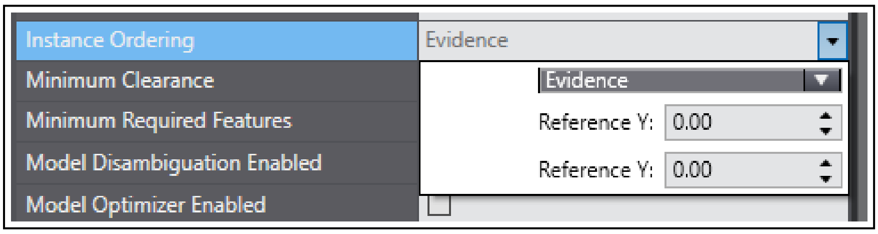

Figure 8-237 Locator Instance Ordering Menu

- Evidence: The instances are ordered according to their hypothesis strength.
- Directional: Four of the options are Left to Right, Right to Left, Top to Bottom, and Bottom to Top. This refers to the position of the instance within the image and is useful for pick-and-place applications in which parts that are farther down a conveyer must be

picked first.

- Quality: The instances are ordered according to their Match Quality. If two instances have the same Match Quality, then they are sorted by their Fit Quality. Note that this setting can significantly increase the search time because the tool cannot output instance results until it has found and compared all instances to determine their order. The time required to output the first instance corresponds to the total time needed to search the image and analyze all potential instances. The time for additional instances is then zero because the search process is already complete.
- Distance: Two of the options are Distance Image and Distance World. In both, the instances are ordered according to their proximity to a user-defined point in the camera coordinate system, as defined by the fields Reference X and Reference Y. In Distance Image, these fields are in terms of pixels while in Distance World they are expressed in calibrated length units.
- Shading Consistency: The instances are ordered according to the custom shading area created in the model. If no Custom Shading Area is defined in the model, the locator uses the entire model area for shading analysis. This mode is useful when the shading information can assist in discriminating between similar hypotheses. This is a requirement for color processing of models and also often used for ball grid array applications, as illustrated in the figures below.

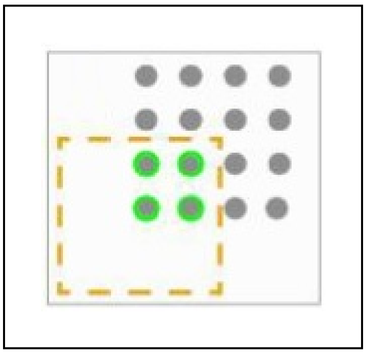

Figure 8-238 Locator Instance Ordering - Custom Shading Area Created in the Model

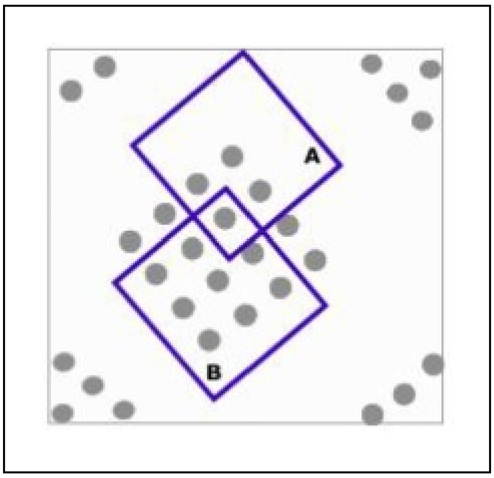

Figure 8-239 Locator Instance Ordering - Sorting by Shading Consistency (Hypothesis A Rates Higher Than Hypothesis B With Reference to the Model)

Minimum Clearance

This property sets the minimum percentage of the model bounding box area that must be free of other instances to consider an object instance as valid. It is disabled by default. When enabled, the Locator tool scans the bounding boxes of all instances for obstacles, such as other instances. If the amount of obstacle-free space is less than the bounding box percentage listed in the Minimum Clearance field, then the instance is not returned.

Enabling this property may significantly increase the search time. It is primarily intended for pick-and-place applications to confirm that objects have the necessary clearance to be picked. Minimum Clearance also activates the computation of the Clear Quality result for each instance.

Output Symmetric Instances

This property defines how the Locator will handle symmetric (or nearly symmetric) objects. It is disabled by default, causing the search process to output only the best quality instance of a symmetric object. If enabled, all possible symmetries of a symmetric object will be output. This can significantly increase execution time when there are many possible symmetries of an object, such as when the object is circular.

Overlap Configuration

When a part is located in an image associated with a conveyor, the position of the object is compared with the position of objects located in previous images that have already been added to the queue of instances to process.

If ***Disable Overlap Check*** is selected, all overlap checking is disabled. When this option is selected, the remaining Overlap Configuration items are not available. If a part is located in multiple images, the robot will attempt to pick at the same belt-relative position multiple times. If this occurs when Overlap Configuration is not disabled, consider increasing the Overlap distance.

If the newly-located part is within the specified Overlap Distance of a previously located part (accounting for belt travel), it is assumed to be the same part and will not be added as a duplicate new instance.

If ***Perform overlap check with instances of different types*** is selected, the overlap calculation will check for overlap of any parts, rather than just parts of the same type.

Locator Results

Use the table below to understand the results of the Locator tool.

Table 8-56 Locator Results Item Description

Item	Description
Instance	Index of the result instance.
Frame/Group	Index of the related result. It is associated with the tool that this tool is set Relative To. This will only be different if the Locator is set relative to another tool.
Model Index	Index of the model located for each instance. If only one model is used, this will be the same for every instance.

Item	Description
Model Name	Name of the model located for each instance. Each Model Name is identical to the associated Locator Model tool name.
Fit Quality	Normalized average error between the matched model contours and the actual contours detected in the input image. Fit quality ranges from 0 to 100 where the best quality is 100. A value of 100 means that the average error is 0. A value of 0 means that the average matched error is equal to the Conformity Tolerance.
Match Quality	Amount of matched model contours for the selected object instance expressed as a percentage. Match quality ranges from 0 to 100 where the best quality is 100. A value of 100 means that 100% of the model contours were successfully matched to the actual contours detected in the input image.
Clear Quality	Measurement of the clear area surrounding the specified object instance. Clear quality ranges from 0 to 100 where the best quality is 100. A value of 100 means that the instance is completely free of obstacles. If Minimum Clearances is Disabled, this value is 100.
Position X	X-coordinate of the instance origin.
Position Y	Y-coordinate of the instance origin.
Angle	Angle of the instance.
Scale Factor	Relative size of the instance with respect to its associated model.
Symmetry	Index of the instance of which this instance is a symmetry. Output Symmetric Instances must be enabled.
Time	Time in milliseconds needed to recognize and locate the object instance.

NOTE: The result columns Fit Quality, Match Quality, and Clear Quality do not directly correlate with the Minimum Model Percentage property. This is because Minimum Model Percentage is compared to the initial coarse outline while these results are originated from the refined detail search.

Locator Model

This model tool describes the geometry of an object to be found by the Locator tool.

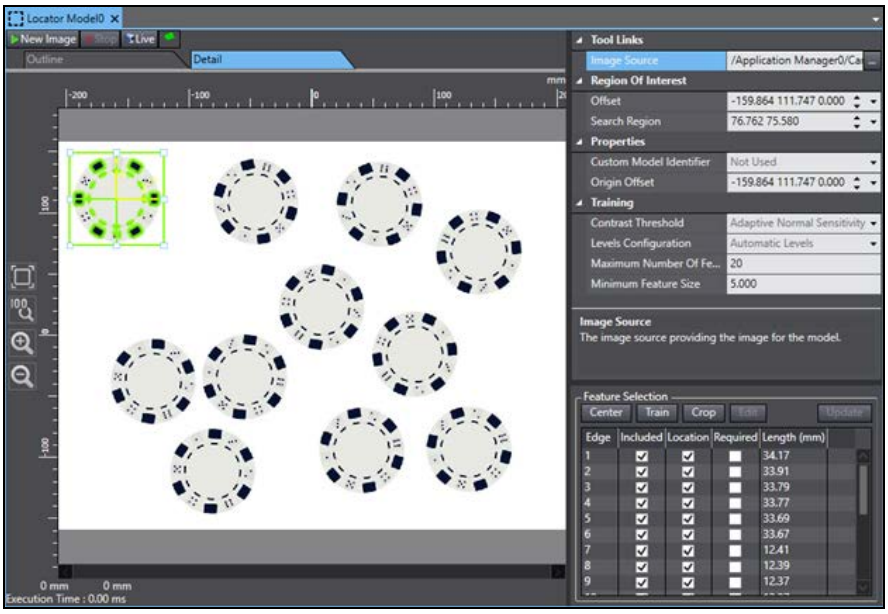

Figure 8-240 Locator Model Editor

To create a Locator Model, right-click ***Vision Tools*** in the Multiview Explorer, select ***Add Finder*** and then ***Locator Model***. A Locator Model will be added to the Vision Tools list.

> **NOTE:** The Virtual Camera should be calibrated before any Locator Models are created. If it is not calibrated, any applied calibration will cause the model geometries to scale incorrectly.

Locator Model Configuration Items

Use the table below to understand the Locator Model configuration items.

Table 8-57 Locator Model Configuration Item Description

Group	Item	Description
Tool Links	Image Source	Defines the image source used for processing by this vision tool.
Region Of Interest	Offset	Defines the center coordinates of the region.
	Search Region	Defines the size of the region.
Properties	Custom Model Identifier	Enable to identify this model with a user-defined identifier for a Robot Vision Manager Application.
	Origin Offset	Defines the model origin. This will be referenced as the Position point of this model any time it is referenced by another tool.
Training	Contrast Threshold	Set the minimum contrast needed for an edge to be detected in the input image and used for arc computation. This threshold is expressed in terms

Group	Item	Description
		of a step in gray level value.
	Levels Configuration	Specifies the levels used for contour detection. In most cases, Automatic Levels can be enabled. The Outline value cannot be lower than the Detail value. For each level, coarseness values range from 1 to 16, where 1 has the best resolution. Every other value is a factor of the best resolution. For example, if one of these is set to 8, then the resolution is 8 times lower than an image at full resolution (level 1).
	Maximum Number Of Features	Set the maximum number of features the model will detect.
	Minimum Feature Size	Set the minimum length of a feature (in millimeters) required for it to be selected. This has no impact on feature detection, only feature selection.

Locator Model Region of Interest

The region of interest defines where Locator Model will look for the contours defined by contrast changes. Any contours located outside the region will not be detected or considered to be part of the model. Therefore, it is best to set the region as close to the part as possible so it can be identified without cropping any part edges.

The Locator Model region of interest can be set by dragging the corners of the green box in the display window or by modifying the numbers in the Offset and Search Region properties. In the property fields, the numbers can either be entered manually or changed using the up / down arrows for each value. Note that only the property fields can be used to rotate the region.

Locator Model Origin

The model origin, depicted as a yellow frame, defines the position and orientation of the pick location. It can be set in the following ways.

- Manually drag the yellow origin indicator to the desired location. Adjust the orientation by clicking and dragging the rotation symbol. This is the best method for irregularly-shaped parts with off-center masses. The coordinates in the property fields will automatically adjust to the new position.
- Manually enter a desired location in the Origin Offset field. This is typically used to make small adjustments on the origin position.
- Click the **Center** button in the Feature Selection pane without a feature selected. The origin will be centered in the model’s region of interest. This may not be optimal in irregularly-shaped parts and depends entirely on the size of the region of interest. This does not affect the origin orientation. If a feature is selected when Center is clicked, the origin will be centered on the feature.

- Select a feature in the Feature Selection pane and click the **Center** button. The origin will be centered on that feature. This is useful when a particular feature is going to be used as the pick point. This does not affect the origin orientation.
- Cropping the model will automatically center the origin in the region of interest if the origin is outside of the region. This does not affect the origin orientation.

Locator Model Custom Model Identifier

The Custom Model Identifier can be any integer from 0 to 10000. It is defined in the property's dropdown menu, as shown in the following figure.

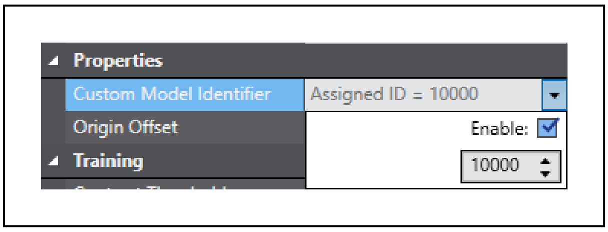

Figure 8-241 Locator Model - Custom Model Identifier

NOTE: The **Enable** box must be checked before a value can be entered for the identifier. If this box is not checked, the Locator tool will assign numbers automatically.

Locator Model Feature Selection Pane

The Edge Editor allows the user to split a feature into multiple segments and choose which segments to include or exclude from a model. This can be useful when improper lighting results in a feature including both part object and shadow outline geometries.

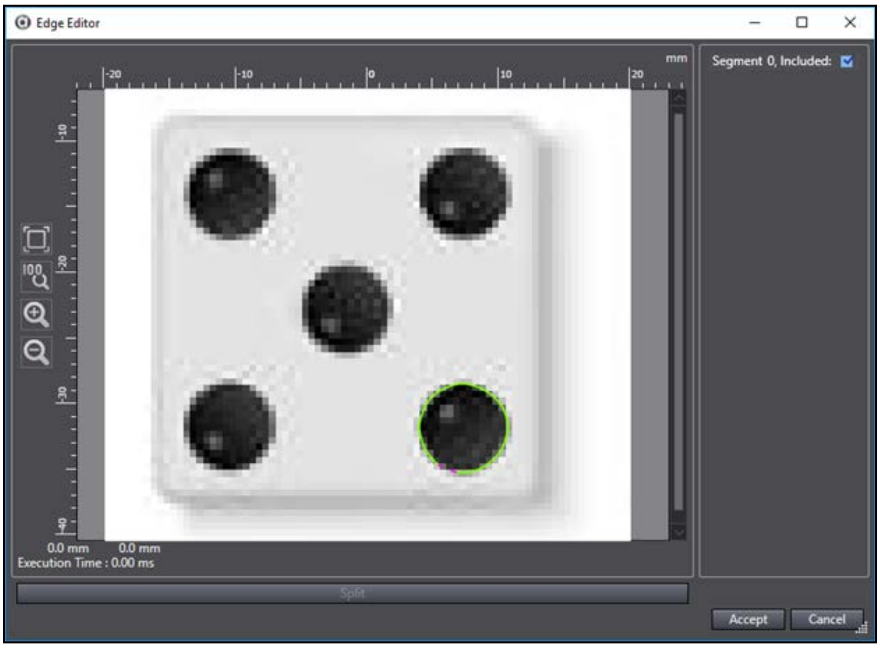

Figure 8-242 Locator Model - Edge Editor

The main part of this editor is the Vision Window, which is controlled in the same way as the tool Vision Window. The only feature that appears in this window is the one currently being edited. The right side of the editor shows the segments of the feature and the check boxes that control if they are included.

Features can be split into multiple segments by clicking somewhere on the feature and then clicking the **Split** button below the image. This adds a new segment on the right side and allows you to determine which segments are included in the overall feature. Only segments with checked boxes are included in the feature.

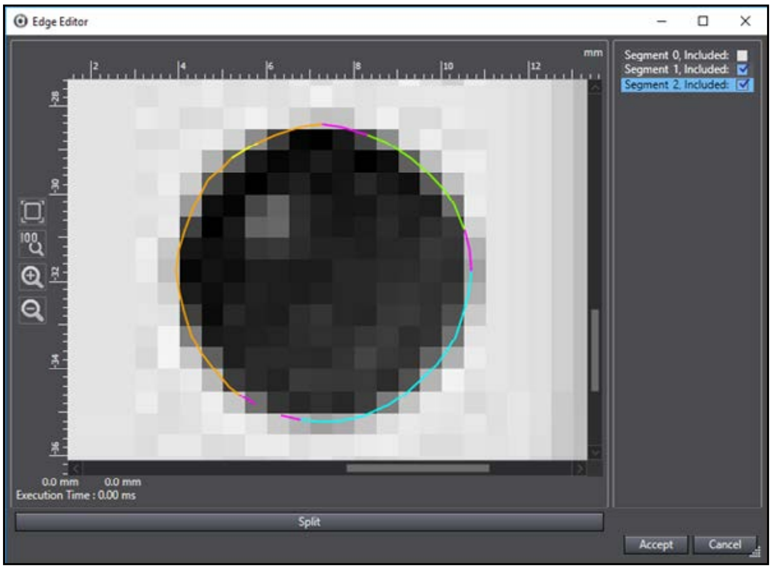

Figure 8-243 Locator Model Edge Editor with Split Feature

The feature is color-coded in this Vision Window with the following designations.

- Orange: Currently selected segment.
- Purple: Ends of segments. A purple line that connects to lines at both ends represents a split between two segments. If it only connects at one end, it is an endpoint of the feature.
- Green: Segment is included in the overall feature.
- Light blue: Segment is excluded from the overall feature.

NOTE: Accepting the changes here will be reflected in the tool Vision Window. See the bottom-right die circle in the figure below. Making any changes to the Included property of the feature in the Feature Selection pane will revert all changes made in the Edge Editor.

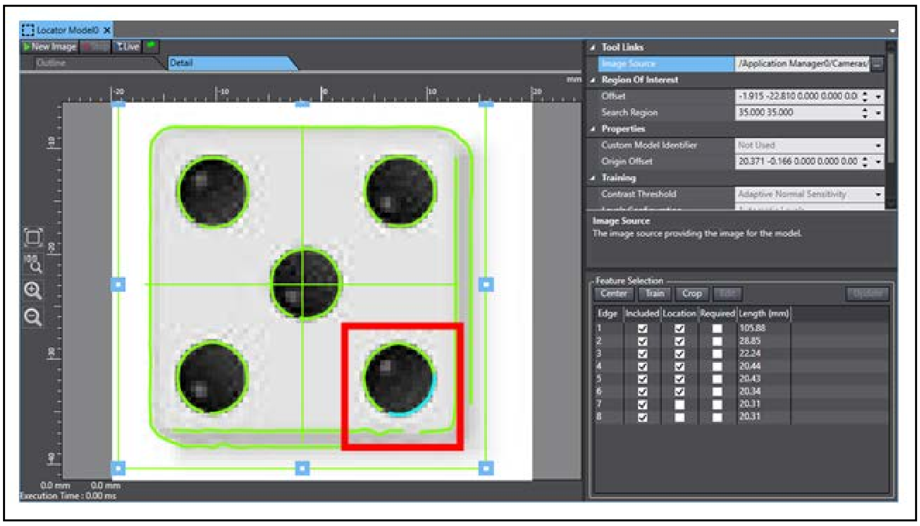

Figure 8-244 Locator Model with Split Feature

Locator Model Results

Locator Model has no data or image results. Its only function is to create a model to be used in the Locator tool. Refer to Locator on page 503 for more information.

Configuration Process

The general steps required to configure a Locator Model are listed below.

1. Create a new Locator Model.
2. Select the correct Image Source and click the **New Image** Button to load an image.
3. Define the Maximum Number Of Features and Minimum Feature Size properties based on the geometries of the part to be located.
4. Set the region of interest around the part.
5. Click the **Train** Button to train the model.
6. Edit feature selection as needed in the Feature Selection pane. Use the Edge Editor when necessary.
7. Define model origin and crop the image around the model.

The following sections include additional details related to the Train operation, Feature Selection, and Edge Editor.

Training a Model

The region of interest defines where the Locator Model will look for contours identified by contrast changes. Any contours outside the region will not be detected or considered to be part of the model. Therefore, it is best to set the region as close as possible to the part to be identified without omitting any edges of the part.

Once the region has been defined, the model needs to be trained by clicking the **Train** button. This is also required whenever the region of interest is adjusted or a new image is loaded. You can then decide which features to include using the Feature Selection pane. A Locator tool will search for features included in the model when detecting instances. Locator searches by comparing a potential match with the Minimum Model Percentage property of that tool, which defines a percentage that an instance needs to match to be considered a valid instance. This can be further controlled by marking some features as Required in this pane. If a Locator detects a potential instance that meets the Minimum Model Percentage but lacks the required features, the detected candidate will not be returned as a result.

> **NOTE:** Whenever any change is made in the Feature Selection pane, the **Update** button must be clicked for the changes to take effect.

> **Additional Information**: Refer to Training a Model on page 525 for a detailed description of the feature selection process. Refer to Locator on page 503 for more information on instance detection.

The training process is also controlled by the parameters in the Training section. Contrast Threshold and Levels Configuration can usually be set to automatic parameters, but the other two need to be defined.

Maximum Number Of Features defines the maximum number of edge contours that will be detected to potentially be included in the model. Locator Model will always return all detected edges if it is less than or equal to this value. However, if there are more edges within the region of interest, the largest ones will be returned until the number of edges is equal to this value. For example, if Maximum Number Of Features is set to 20 and the tool detects 30 edges, only the 20 largest will be shown in the Feature Selection pane. Conversely, Minimum Feature Size has no effect on which edges are returned. Instead, it defines which features are initially included in the model itself. When the **Train** button is clicked or a new image is loaded, Locator Model will automatically include all features in the model that have length greater than or equal to this value.

All other features within the Maximum Number Of Features constraint will be returned and shown in the Feature Selection pane, but they will not automatically be included. Figure 8-245 and Figure 8-246 show how this property is utilized during training. It can be seen in Figure 8-246 that all the features included in Figure 8-245 are still returned, but only some of them are actually included in the model.

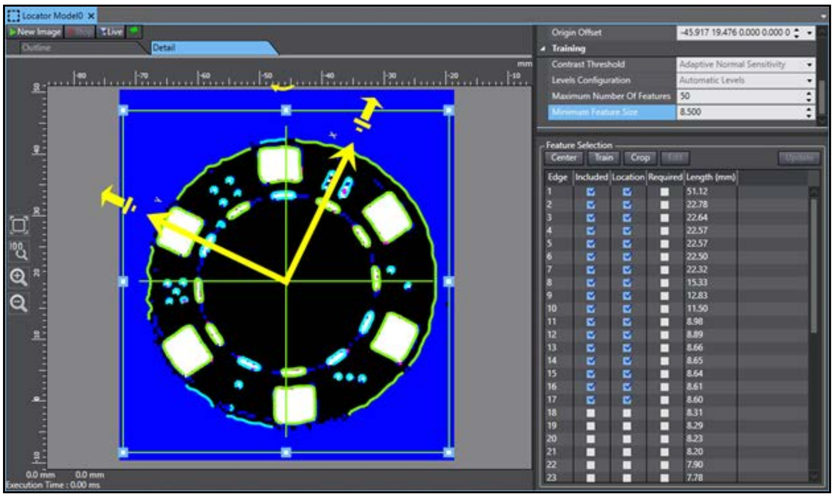

Figure 8-245 Locator Model - Small Minimum Feature Size

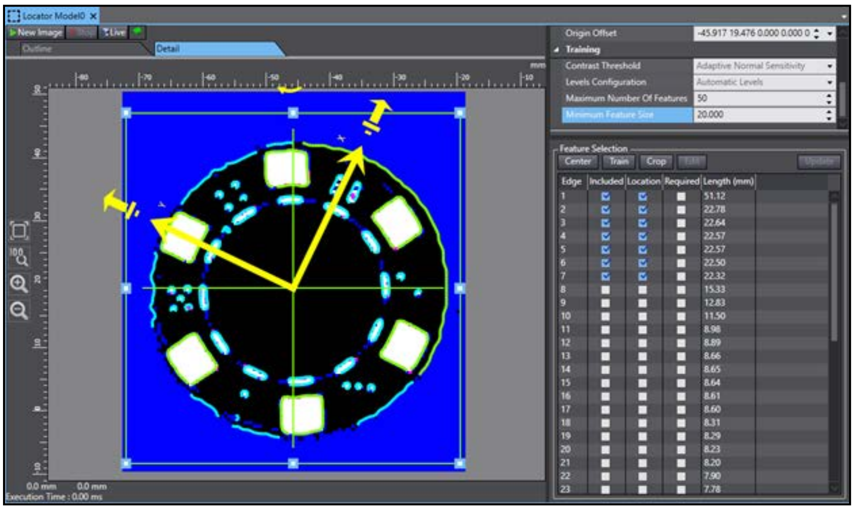

Figure 8-246 Locator Model - Large Minimum Feature Size

NOTE: If a single contour of the part is broken into multiple features, you may need to adjust lighting or the Contrast Threshold and Levels Configuration.

Once the model has been fully trained, the model origin must be set. This point is depicted as a yellow frame and defines the position and orientation of the pick location. When the model is used in a Locator tool, this location will be used as the point of reference to define instance positions. The origin can be set in five ways as described below.

- Manually drag the yellow origin indicator to the desired location. Adjust the orientation by clicking and dragging the rotation symbol or the extendable arrows. This is the best method for irregularly-shaped parts with off-center masses. The coordinates in the property fields will automatically adjust to the new position.
- Manually enter a desired location in the Origin Offset field. This is typically used to make small adjustments of the origin.
- Click the **Center** Button in the Feature Selection pane without a feature selected. The origin will be centered in the region of interest. This may not be optimal for irregularly-shaped parts and depends entirely on the size of the region of interest. This does not affect the origin orientation. If a feature is selected when the **Center** button is clicked, the origin will be centered on the feature.
- Select a feature in the Feature Selection pane and click the **Center** Button. The origin will be centered on that feature. This is useful when a particular feature is going to be used as the pick point. This does not affect the origin orientation.

In many situations the origin can be centered on one feature and the roll angle can be set by aligning an extendable arrow with another part geometry that may or may not be included in the model.

Cropping the model will automatically center the origin in the region of interest if the origin is located outside of the region after cropping. This does not affect the origin orientation.

After testing that the Locator Model and Locator sufficiently locate the object, it is recommended to crop the image using the **Crop** button. Figure 8-247 shows a model in the original image on the left and the cropped version on the right.

Additional Information: Cropping Locator Model Images can reduce project file size.

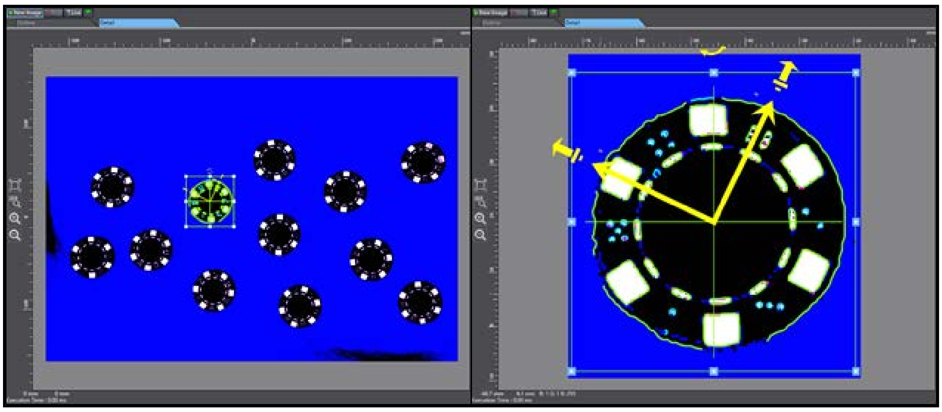

Figure 8-247 Locator Model Image (Left) vs. Cropped Image (Right)

Shape Search 3

This tool identifies objects in an image based on geometries defined in a Shape Search 3 Model. Because the model requires a small degree of training, Shape Search 3 can output instances and correlation values based on similarity, measurement target position, and orientation.

Unlike other search methods where color and texture information are used to detect objects, Shape Search 3 uses edge information as features. This enables highly robust and fast detection despite environmental variations including shading, reflections, lighting, shape deformations, pose, and noise.

> **NOTE:** Shape Search 3 will not work until a Shape Search 3 Model has been created. Refer to Shape Search 3 Model on page 534 for more information.
>
> Shape Search 3 typically provides shorter execution times than Locator, but it cannot provide disambiguation between multiple similar models. Shape Search 3 is useful for simple models while Locator is better for handling multiple models or situations where the model training process requires user control.

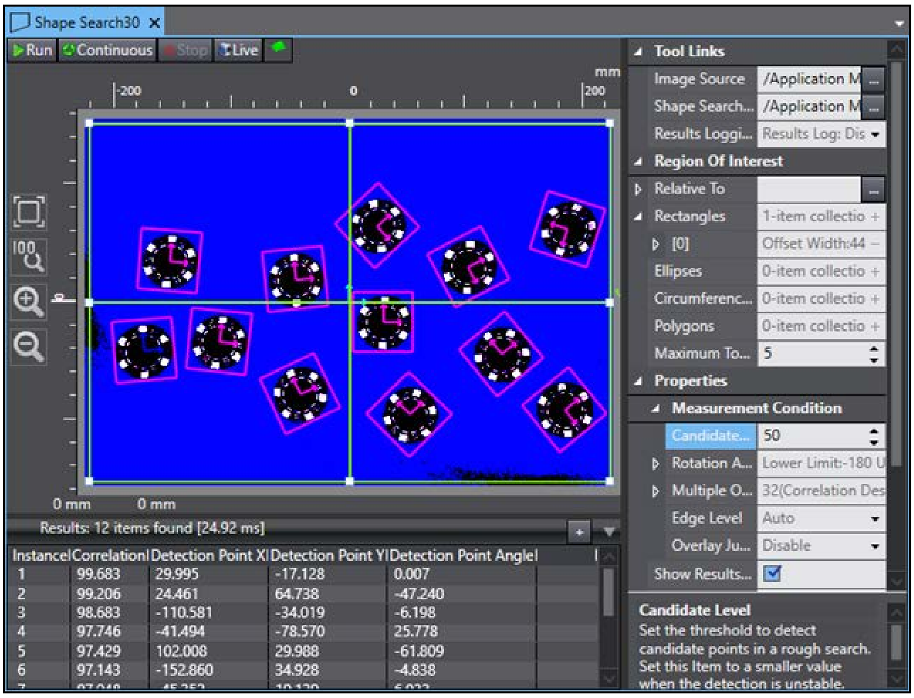

Figure 8-248 Shape Search 3 Tool Editor

To create a Shape Search 3 tool, right-click ***Vision Tools*** in the Multiview Explorer, select ***Add Finder*** and then ***Shape Search 3***. A Shape Search 3 tool will be added to the Vision Tools list.

Shape Search 3 Configuration Items

Use the table below to understand the Shape Search 3 configuration items.

Table 8-58 Shape Search 3 Configuration Item Description - Tool Links

Group	Item	Description
Tool Links	Image Source	Defines the image source used for processing by this vision tool.
	Shape Search 3 Model	Select the Shape Search 3 Model that will be searched for in the image.
	Results Logging	Enables logging of tool results to a file.

Table 8-59 Shape Search 3 Configuration Item Description - Region of Interest

Group	Item	Description
Region Of Interest	Relative To	The tool relative to which this tool executes. The output values of the selected tool are the input values of this one.
	Link Name	Select the property in the defined Relative To tool that will provide the input values.
	Current Values	Collection of current input values.
	Rectangles Ellipses Circumferences Polygons	Sets of regions of interest of a particular shape. The field will show how many regions exist ("1-item collection", "2-item collect, etc.). Click the plus sign in the field to create additional regions and click the arrow to see all regions.
	<region number>	Identifies the region of the specified shape. It will appear as [0], [1], [...] within the shape category. Click the minus sign in the field to remove the region and click the arrow to see its properties.
	Name	Available in all region types. Sets the user-defined name of the region.
	Overlap	Available in all region types. Select the behavior of the region. OR causes the region to be included in the search area and NOT excludes it from the search area. The behavior of specific regions is further defined in Z-Order. Refer to Region of Interest on page 473 for more information.
	Z-Order	Available in all region types. Sets the order for overlapping regions of interest. Higher numbers will be in front and resolved first. Refer to Region of Interest on page 473 for more information.
	Offset	Available in all region types except for Polygons. Defines the coordinates of the region’s center.
	Search Region (Width, Height)	Only available in Rectangles. Sets the height and width of the rectangular region.
	Radius X/Y	Only available in Ellipses. Defines the distance from the center to the exterior along the X- and Y-axes in the camera coordinate system respectively.

Group	Item	Description
	Radius	Only available in Circumferences. Defines the distance from the center to the unseen center ring.
	Thickness	Only available in Circumferences. Defines the distance between the two visible rings.
	Vertexes	Only available in Polygons. Sets of vertexes in a polygon region of interest. The field will show how many vertexes exist ("3-item collection", "4-item collection, etc.). Click the plus line in the field to create additional regions and click the arrow to see all regions.
	<vertex number>	Only available in Polygons. Identifies a particular vertex in the region. It will appear as [0], [1], [2], [...] and etc. The field defines the X/Y coordinates of the vertex. Click the minus sign to remove the vertex, as long as there are not fewer than three.
	Maximum Tool Execution Count	Maximum number of tool executions for Relative To performance. If this tool is not set relative to another tool, the tool will only run once.

Table 8-60 Shape Search 3 Configuration Item Description - Properties

Group	Item	Description
Properties	Measurement Condition - Candidate Level	Set the percentage of match required for the tool to detect instances. Any instance that has a Correlation Results value lower than this value will not be recognized.
	Rotation Angle Range	Set the angle range within which the tool will detect candidates.
	Correlation Range	Set the range of correlation values within which the tool will return results. This operates as min-max properties.
	Multiple Output	Set the maximum number of output instances and the order in which they are sorted.
	Count	Sub-property of Multiple Output. Enter the maximum number of instances.
	Sort Condition	Sub-property of Multiple Output. Select the necessary order of instance sorting.
	Edge Level	Enable automatic edge level adjustment or enter a value to set it manually.

Group	Item	Description
	Overlay Judgment	Prevent the tool from detecting overlapped instances. Increased value will result in overlapped instances to be removed.
	Show Results Graphics	Specifies if the graphics are drawn in the Vision Window.
	Show Corresponding Model	Highlights the edges of detected models in the tool window.
	Show Edge Image	Shows only the detected edges of each model. All edge pixels become white and all others are set to black.

Table 8-61 Shape Search 3 Configuration Item Description - Advanced Properties

Group	Item	Description
Advanced Properties	Acceptable Distortion Level	Select the degree of influence of correlation values when model edge has small uneven patterns. To avoid reduction of correlation value, set this item to High.
	Complex Background	Stabilizes measurement result when there are many edges in the model background.

Shape Search 3 - Detecting Models

Shape Search 3 must reference a Shape Search 3 Model in the Shape Search 3 Model property. This is done by clicking the ellipsis next to the field and selecting an appropriate tool. Shape Search 3 will then compare the model to the image and search within the region(s) of interest for contours that match the model.

Shape Search 3 - Image View

Shape Search 3 always displays the model region(s) of interest and origin in purple around the detected instances. It also allows you to view the detected instances in different ways. These are controlled by the Show Corresponding Model and Show Edge Image properties. If both of these are disabled, only the border of the model region(s) of interest will be displayed, as shown in above. Enabling these provides a different view.

Show Corresponding Model shows all of the edges drawn in the Shape Search 3 Model in green. It also applies a darkened mask to everything except the pixels within the model edges (refer to the following figure).

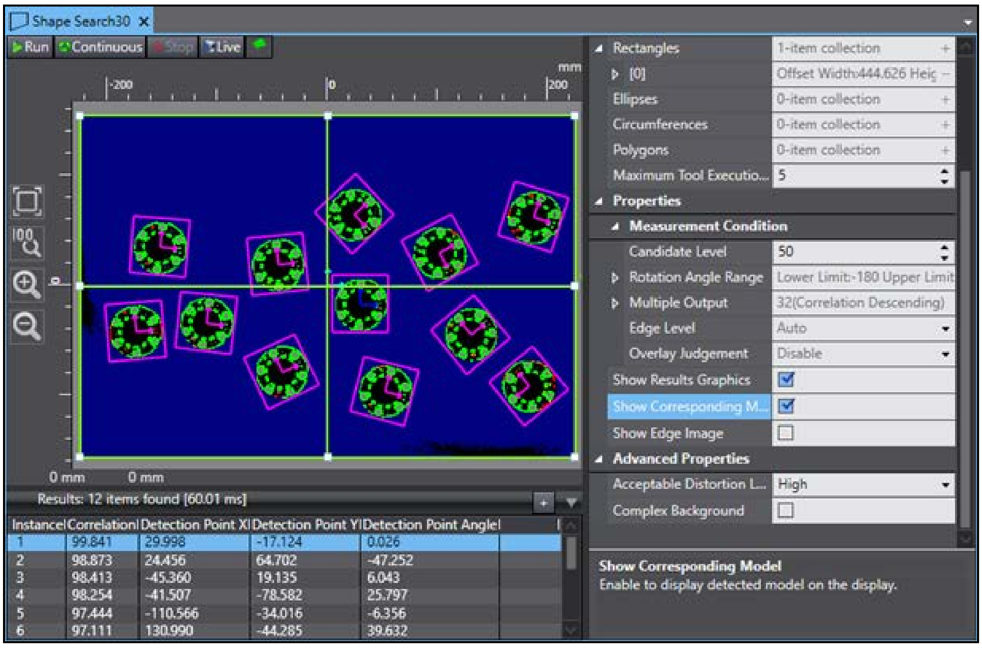

Figure 8-249 Shape Search 3 - Show Corresponding Model

Show Edge Image changes everything to black except for the edges detected in the image, which become white (refer to the following figure).

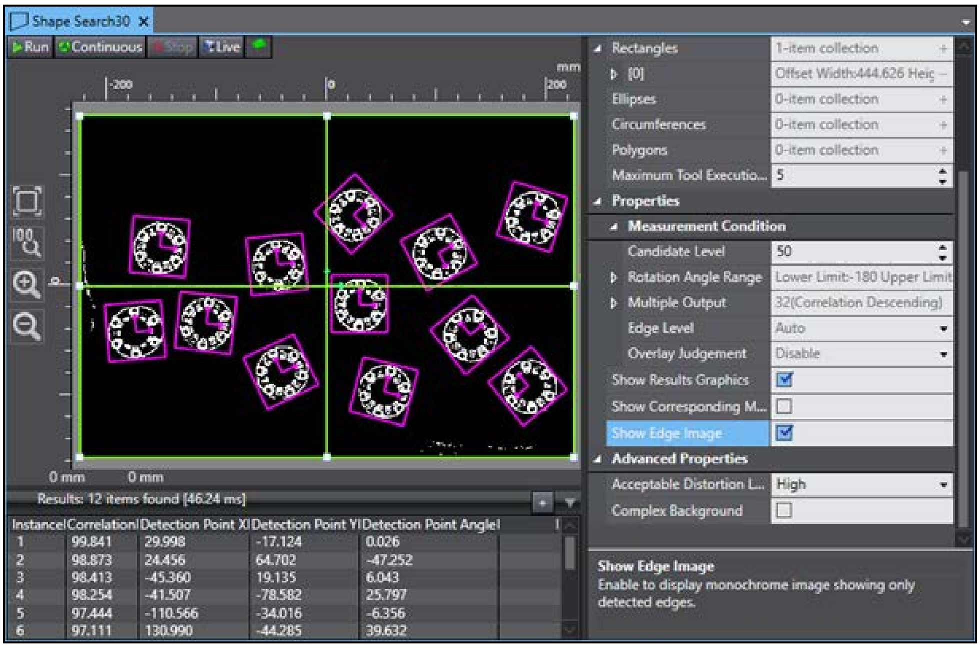

Figure 8-250 Shape Search 3 - Show Edge Image

NOTE: These views are overlaid if both are selected.

Shape Search 3 Results

Use the table below to understand the results of the Shape Search 3.

Table 8-62 Shape Search 3 Results Description

Item	Description
Instance	Index of the result instance.
Frame/Group	Index of the related result. It is associated with the tool that this tool is set Relative To. This will only be different if Shape Search 3 is set relative to another tool.
Correlation	Percentage the instance correlates with the model. Any instance will be omitted if this value is lower than the defined Candidate Level property.
Detection Point X	X-coordinate of the instance origin.
Detection Point Y	Y-coordinate of the instance origin.
Detection Point Angle	Angle of the instance origin.

Shape Search 3 Model

This model describes the geometry of an object to be found by the Shape Search 3 tool. Shape Search 3 Model is designed to detect specific edges in an image and register them.

Before running the tool, the region of interest must be verified in the correct location so the model can be properly trained.

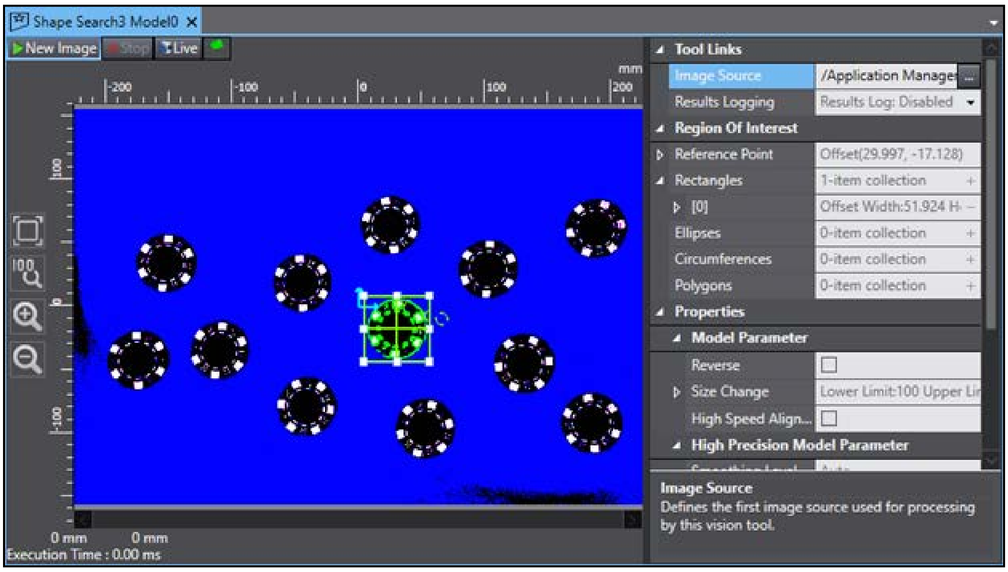

Figure 8-251 Shape Search 3 Model Editor

To create a Shape Search 3 Model, right-click **Vision Tools** in the Multiview Explorer, select **Add Finder** and then **Shape Search 3 Model**. A Shape Search 3 Model will be added to the Vision Tools list.

Shape Search 3 Model Configuration Items

Use the table below to understand the Shape Search 3 Model configuration items.

Table 8-63 Shape Search 3 Model Configuration Item Description - Tool Links

Group	Item	Description
Tool Links	Image Source	Defines the image source used for processing by this vision tool.
	Results Logging	Enables logging of tool results to a file.

Table 8-64 Shape Search 3 Model Configuration Item Description - Region of Interest

Group	Item	Description
Region Of Interest	Reference Point	Define the model origin. This will be referenced as the instance center in the Shape Search 3 tool.
	Relative To	The tool relative to which this tool executes. The output values of the selected tool are the input values of this one.
	Link Name	Select the property in the defined Relative To tool that will provide the input values.
	Current Values	Collection of current input values.
	Rectangles Ellipses Circumferences Polygons WideArcs	Sets of regions of interest of a particular shape. The field will show how many regions exist ("1-item collection", "2-item collect", etc). Click the plus sign in the field to create additional regions and click the arrow to see all regions.
	<region number>	Identifies the region of a particular shape. It will appear as [0], [1], [...] within each region. Click the minus sign in the field to remove the region and click the arrow to see its properties.
	Name	Available in all region types. Sets the user-defined name of the region.
	Overlap	Available in all region types. Select the behavior of

Group	Item	Description
		the region. OR causes the region to be included in the search area and NOT excludes it from the search area. The behavior of specific regions is further defined in Z-Order. Refer to Region of Interest on page 473 for more information.
	Z-Order	Available in all region types. Sets the order for overlapping regions of interest. Higher numbers will be in front and resolved first. Refer to Tools with Multiple Regions of Interest on page 474 for more information.
	Offset	Available in all region types except for Polygons. Defines the coordinates of the region's center.
	Search Region (Width, Height)	Sets the height and width of the rectangular region. Only available in Rectangles.
	Radius X/Y	Defines the distance from the center to the exterior along the X- and Y-axes, respectively. Only available in Ellipses.
	Radius	Defines the distance from the center to the unseen center ring. Only available in Circumferences and WideArcs.
	Thickness	Defines the distance between the two visible rings. Only available in Circumferences and WideArcs.
	Start/End Angle	Defines the start and end angle of the Wide Arc bounds. Angles are measured in degrees counterclockwise from the positive X-axis. The arc is created clockwise starting from the Start Angle and ending at the End Angle. Only available in WideArcs.
	Vertexes	Sets of vertexes in a polygon region of interest. The field will show how many vertexes exist ("3-item collection", "4-item collection', etc). Click the plus line in the field to create additional regions and click the arrow to see all regions. Only available in Polygons.
	<vertex number>	Identifies a particular vertex in the region. It will appear as [0], [1], [2], [...]. The field defines the X/Y coordinates of the vertex. Click the minus sign to remove the vertex, as long as there are not fewer than three. Only available in Polygons.
	Maximum Tool Execution Count	Maximum number of tool executions for Relative To performance. If this tool is not set relative to another tool, the tool will only run once.

Table 8-65 Shape Search 3 Model Configuration Item Description - Properties

Group	Item	Description
Properties	Model Parameter - Reverse	Enables detection of objects whose dark areas and bright areas are fluctuating due to glossiness or shine.
	Model Parameter - Size Change	Set the upper and lower limit of model size fluctuation.
	Model Parameter - High Speed Alignment Mode	Enables detection of simple shapes such as alignment marks. Disable this when detecting complex patterns or shapes with thin elements or lines.
	High Precision Model Parameter - Smoothing Level	Set the level of smoothing for the High Precision Edge Model. Enabling the Auto box causes the tool to automatically set it as necessary. Disabling it allows the user to adjust it manually. Higher values remove more details from the high precision model.
	Edge Settings - Mask Size	Select the neighborhood of pixels to use to detect model edges. Higher selections will help detection when brightness varies among pixels.
	Edge Settings - Edge Level	Set the lower limit of edge level for an edge to be recognized. Edges with a higher edge level than this value will be included in the model. Higher settings will result in fewer edges.
	Edge Settings - Noise Removal Level	Set the upper limit of noise level to eliminate. Noise with a level below this value will be eliminated. Higher numbers will lead to more features being removed from the model.
	Edge Settings - Show Edge Model	Specifies if the Edge Model is drawn in the Vision Window.
	Edge Settings - Show High Precision Edge Model	Specifies if the High Precision Edge Model is drawn in the Vision Window.

Shape Search 3 Model - Training a Model

Shape Search 3 Model automatically runs whenever any change is made to the parameters or region(s) of interest. Because of this, the training process only requires you to position the reference point and the region(s) of interest in the necessary location(s). As many regions can be added as necessary to create a custom model shape. The Overlap can further define a custom model.

When the trained model is used in Shape Search 3, the position result for each detected instance will be returned as the position of the model Reference Point property. Therefore, before continuing, the location of the reference point needs to be verified.

Shape Search 3 Model has fewer controlling parameters than Locator Model since the focus of Shape Search 3 is speed. However, several properties provide control over this tool. In particular, the parameters in the Edge Settings section are useful to adjust the model. Mask Size helps balance brightness issues, Edge Level sets the necessary deviation of edges in order to be included, and Noise Removal Level removes unnecessary features.

Shape Search 3 Results

Use the table below to understand the results of the Shape Search 3.

Table 8-66 Shape Search 3 Results Description

Item	Description
Instance	Index of the result instance.
Frame/Group	Index of the related result. It is associated with the tool that this tool is set Relative To. This will only be different if Shape Search 3 is set relative to another tool.
Correlation	Percentage the instance correlates with the model. Any instance will be omitted if this value is lower than the defined Candidate Level property.
Detection Point X	X-coordinate of the instance origin.
Detection Point Y	Y-coordinate of the instance origin.
Detection Point Angle	Angle of the instance origin.

Inspection Tools

Inspection tools are typically used for part inspection purposes.

The following Inspection tools are described in this section.

- Refer to Arc Caliper on page 538 for more information.
- Refer to Arc Edge Locator on page 544 for more information.
- Refer to Caliper on page 549 for more information.
- Refer to Color Data on page 554 for more information.
- Refer to Edge Locator on page 557 for more information.
- Refer to Feeder Histogram on page 562 for more information.
- Refer to Image Histogram on page 565 for more information.
- Refer to Inspection on page 568 for more information.
- Refer to Precise Defect Path on page 574 for more information.
- Refer to Precise Defect Region on page 578 for more information.

Arc Caliper

This tool identifies and measures the gap between one or more edge pairs of arc-shaped objects. Using pixel gray-level values within regions of interest, Arc Caliper is able to build projections needed for edge detection. Edges can be displayed in a radial or annular position. After detecting potential edges, the tool determines which edge pairs are valid by applying the user-defined constraints configured for each one. The valid pairs are then scored and measured.

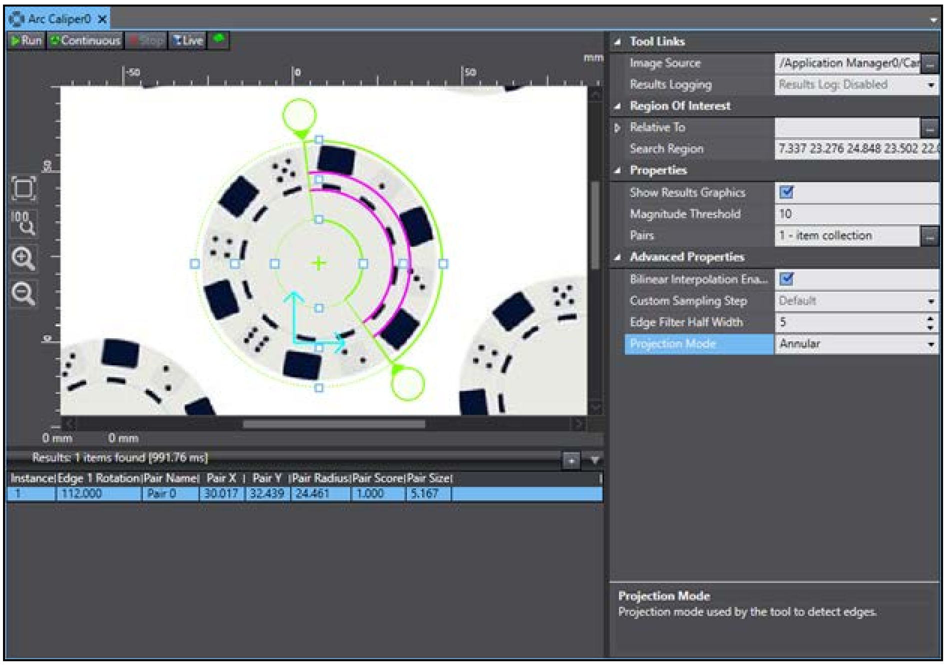

Figure 8-252 Arc Caliper Tool Editor

To create an Arc Caliper tool, right-click ***Vision Tools*** in the Multiview Explorer, select ***Add Inspection*** and then ***Arc Caliper***. An Arc Caliper tool will be added to the Vision Tools list.

Arc Caliper Configuration Items

Use the table below to understand the Arc Caliper configuration items.

Table 8-67 Arc Caliper Configuration Item Description

Group	Item	Description
Tool Links	Image Source	Defines the image source used for processing by this vision tool.
	Results Logging	Enables logging of tool results to a file.
Region Of Interest	Relative To	The tool relative to which this tool executes. The output values of the selected tool are the input values of this one.
	Link Name	Select the property in the defined Relative To tool that will provide the input values.
	Current Values	Collection of current input values.
	Search Region	Defines the location and size of the region (X, Y, radius, thickness, mid-angle position, arc angle

Group	Item	Description
		degrees).
Properties	Show Results Graphics	Specifies if the graphics are drawn in the Vision Window.
	Magnitude Threshold	Specifies the minimum gray level deviation required to detect an edge. A subpixel peak detection algorithm is applied on the region of every minimum or maximum of the curve that exceeds this threshold in order to locate edges.
	Pairs	Collection of transition pairs to search for with the caliper tool. Click the ellipsis to make detailed changes. Refer to Arc Caliper - Edge Constraint Editor on page 540 for more information.
Advanced Properties	Bilinear Interpolation Enabled	Enables using bilinear interpolation to sample the input image. By default, this is enabled because it ensures subpixel accuracy.
	Custom Sampling Step	Defines the sampling step used in calculation. This is set to 1 by default. Enable this to adjust the setting. Higher values decrease execution time and sensitivity and can improve processing in high-resolution images.
	Edge Filter Half Width	Half width of the convolution filter used to compute the edge magnitude curve, from which actual edges are detected. The filter approximates the first derivative of the projection curve. The half width of the filter should be set in order to match the width of the edge in the projection curve (the extent of the gray scale transition, expressed in number of pixels).
	Projection Mode	Defines the direction in which edges are detected and displayed. Annular detects edges as concentric arcs and Radial displays edges along radii.

Arc Caliper - Edge Constraint Editor

Clicking the ellipsis next to Pairs opens the Edge Constraint Editor. This allows the user to set specific constraints on the detected pair(s) of edges.

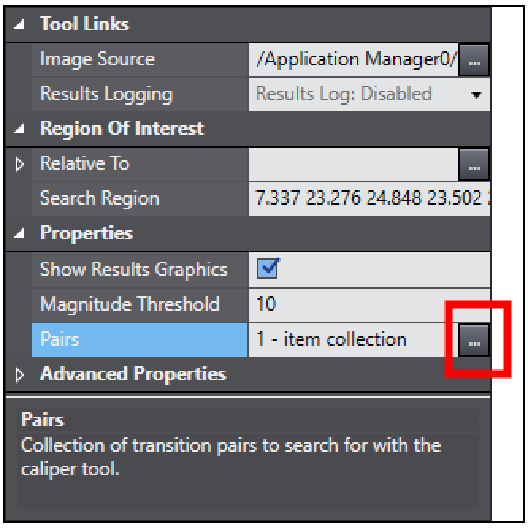

Figure 8-253 Arc Caliper - Edge Constraint Editor

The Edge Constraint Editor has the following sections.

Pairs Pane

The area highlighted in the figure below lists the pairs of edges to be detected. By default, Arc Caliper will try to detect only one pair. The **Add** and **Delete** buttons at the bottom change the number of pairs to be searched for when the tool is run. The name of each pair is adjusted by selecting the associated label in this pane and then changing the Pair Name field to the right.

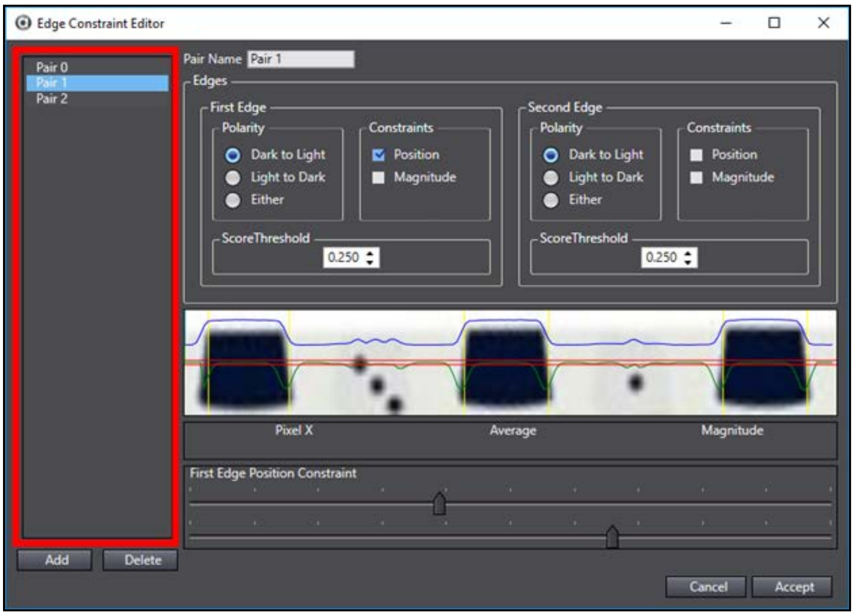

Figure 8-254 Arc Caliper - Edge Constraint Editor - Pairs Pane

Edges

This section defines the constraints on the detected edges within a pair.

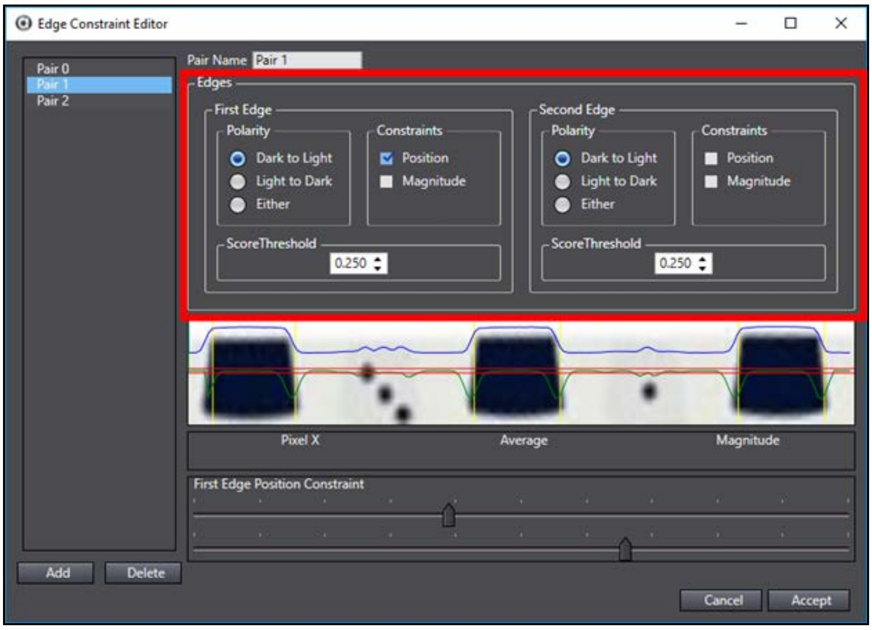

Figure 8-255 Arc Caliper - Edge Constraint Editor - Edges

Each edge is adjusted individually with the following properties.

- Polarity: defines the gray level deviation for which the tool searches. This is performed with respect to the clockwise direction of the region of interest. For example, in Figure 8-255 Dark to Light is selected for both edges, and in both cases, the left side of the edge is black.
- Constraints: enables constraining the edge by both Position and Magnitude. When each is enabled, an associated slider bar appears below the image. The edge position must be between the two position sliders and its magnitude must be larger than defined in the magnitude slider.
- Score Threshold: defines the minimum score (quality) an edge must have to pass. This value is set between 0 and 1.

Region Image

The image beneath the edge constraints shows only the pixels within the region of interest in the main image window. The image is altered from the region of interest to be rectangular instead of circular. The positive X-axis in this image is oriented to be aligned with the counterclockwise direction in the region of interest.

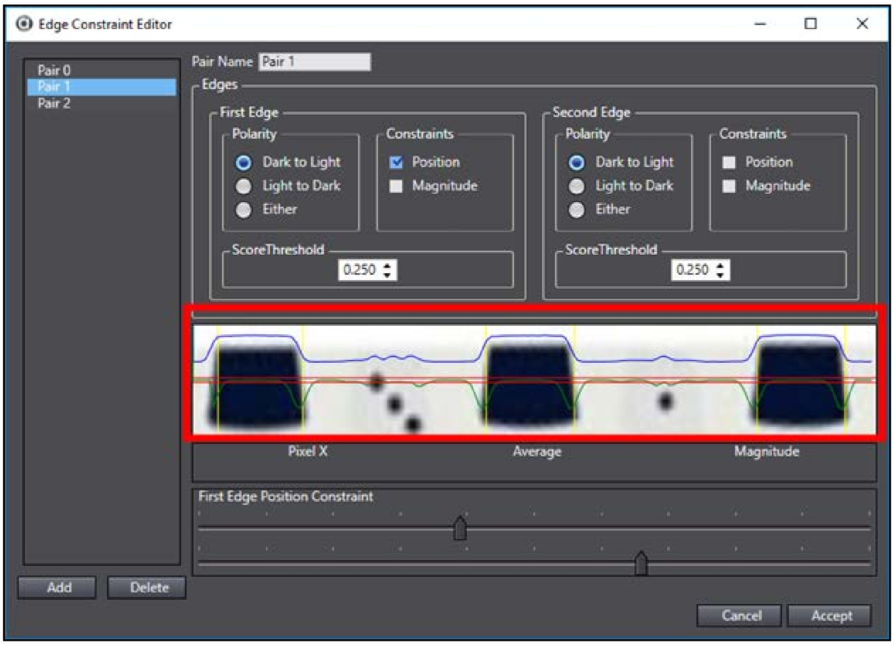

Figure 8-256 Arc Caliper - Edge Constraint Editor - Region Image

Arc Caliper Results

Use the table below to understand the results of the Arc Caliper tool.

Table 8-68 Arc Caliper Results Description

Item	Description
Instance	Index of the result instance.
Frame/Group	Index of the related result. It is associated with the tool that this tool is set Relative To.
Pair Name	Name of the edge pair.
Pair X	X-coordinate of the center point of the caliper measure at the midpoint of the edge pair.
Pair Y	Y-coordinate of the center point of the caliper measure at the midpoint of the edge pair.
Pair Radius	Radius of the detected edge. This is only properly measured when Projection Mode is set to Annular.
Pair Score	Score of the resultant pair, which is equal to the mean score of the two edges in the pair.
Pair Size	Distance between the midpoints of the pair edges.
Edge 1 X	X-coordinate of the midpoint of the first edge.
Edge 1 Y	Y-coordinate of the midpoint of the first edge.

Item	Description
Edge 1 Magnitude	Magnitude of the first edge.
Edge 1 Magnitude Score	Score between 0 and 1 of the first edge, calculated according to the Magnitude Constraint property.
Edge 1 Position Score	Score between 0 and 1 of the first edge, calculated according to the Position Constraint property.
Edge 1 Radius Score	Radius score of the first edge.
Edge 1 Rotation	Angle of rotation of the first edge, measured from the positive X-axis. This returns valid results only when Projection Mode is set to Radial.
Edge 1 Score	Score of the first edge, computed according to the constraints set by the Edge Constraints properties.
Edge 2 X	X-coordinate of the midpoint of the second edge.
Edge 2 Y	Y-coordinate of the midpoint of the second edge.
Edge 2 Magnitude	Magnitude of the second edge.
Edge 2 Magnitude Score	Magnitude score of the second edge.
Edge 2 Position Score	Position score of the second edge.
Edge 2 Radius Score	Radius score of the second edge.
Edge 2 Rotation	Angle of rotation of the second edge, measured from the positive X-axis. This returns valid results only when Projection Mode is set to Radial.
Edge 2 Score	Score of the second edge, computed according to the constraints set by the Edge Constraints properties.

Arc Edge Locator

This tool identifies and measures the position of one or more edges on a circular object. Using pixel gray-level values within regions of interest, Arc Edge Locator is able to build projections needed for edge detection. Edges can be displayed in a radial or annular position. After detecting potential edges, the tool determines which edges are valid by applying the user-defined constraints on the edge candidates. The valid edges are then scored and measured.

> **Additional Information**: While Arc Edge Locator can determine the position of one or more edges, it cannot measure the length of lines detected in the region of interest. To measure arcs and lines on an object, use the Arc Finder or Line Finder tools. Refer to Arc Finder on page 479 and Line Finder on page 501 for more information.

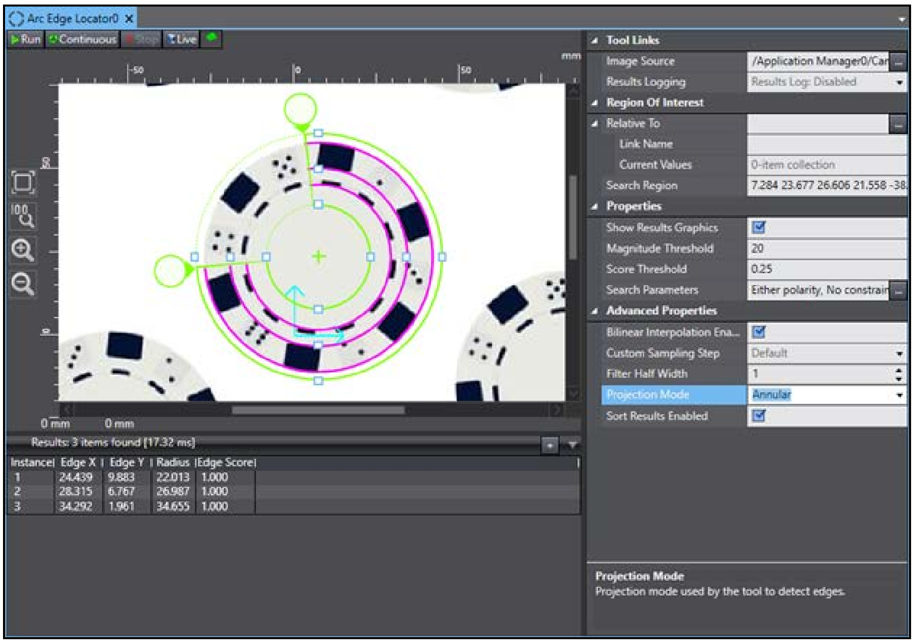

Figure 8-257 Arc Edge Locator Tool Editor

To create an Arc Edge Locator tool, right-click **Vision Tools** in the Multiview Explorer, select **Add Inspection** and then **Arc Edge Locator**. An Arc Edge Locator tool will be added to the Vision Tools list.

Arc Finder Configuration Items

Use the table below to understand the Arc Finder tool configuration items.

Table 8-69 Arc Finder Configuration Item Description

Group	Item	Description
Tool Links	Image Source	Defines the image source used for processing by this vision tool.
	Results Logging	Enables logging of tool results to a file.
Region of Interest	Relative To	The tool relative to which this tool executes. The output values of the selected tool are the input values of this one.
	Link Name	Select the property in the defined Relative To tool that will provide the input values.
	Current Values	Collection of current input values.
	Search Region	Defines the location and size of the region (X, Y, radius, thickness, mid-angle position, arc angle degrees).
	Guideline Percent	Adjusts the location of the orange guideline in the region of interest. Move the slider left to position the

Group	Item	Description
		guideline closer to the center and to the right to position it farther away.
Properties	Show Results Graphics	Specifies if the graphics are drawn in the Vision Window.
	Fit Mode	Select how the tool will calculate and return a valid arc from hypotheses. • Both: calculates the arc center and arc radius and uses both values to return the most accurate results. • Center: calculates the arc center. • Radius: calculates the arc radius.
	Minimum Arc Percentage	Specifies the minimum percentage of arc contours that need to be matched for a hypothesis to be considered valid.
	Polarity Mode	Select the polarity deviation required for a hypothesis to be considered valid. • Dark to Light: only detect arcs that are darker towards the center. • Light to Dark: only detect arcs that are lighter towards the center. • Either: accept any polarity as long as it is consistent. • Do Not Care: does not take polarity into account.
	Search Mode	Select the method used to generate and select a hypothesis. • Best Arc: chooses the best quality arc but will increase processing time. • Arc Closest To Guideline: chooses the arc closest to the guideline. • Arc Closest To Inside: chooses the arc closest to the inner circle. • Arc Closest To Outside: chooses the arc closest to the outer arc of the region of interest.
Advanced Properties	Arc Must Be Totally Enclosed	Specifies if the detected arc can exist outside of the region of interest. When enabled, the start and end points of the arc must be located on the angle boundary lines. Otherwise, the arc can enter or exit the region at any point.
	Conformity Tolerance	Set the maximum local deviation between the expected arc contours and the arc contours actually detected in the input image.
	Contrast Threshold	Defines the minimum contrast needed for an edge to be detected in the input image. This threshold is

Group	Item	Description
		expressed in terms of a step in gray level values. Higher values reduce noise but also reduce the number of contours detected.
	Maximum Angle Deviation	Defines the maximum angle deviation between the calculated arc's tangents and the edge contours.
	Positioning Level	Set the configurable effort level of the instance positioning process. A value of 10 will provide coarser positioning and lower execution time. Conversely, a value of 100 will provide high accuracy positioning of arc entities. The setting range is 10 to 100.
	Subsampling Level	Set the subsampling level used to detect edges that are used by the tool to generate hypotheses. High values provide a coarser search and lower execution time than lower values. The setting range is 1 to 8.

Arc Edge Locator - Edge Constraint Editor

Clicking the ellipsis next to Search Parameters as shown in the following figure opens the Edge Constraint Editor. This allows you to set specific constraints on the detected edges.

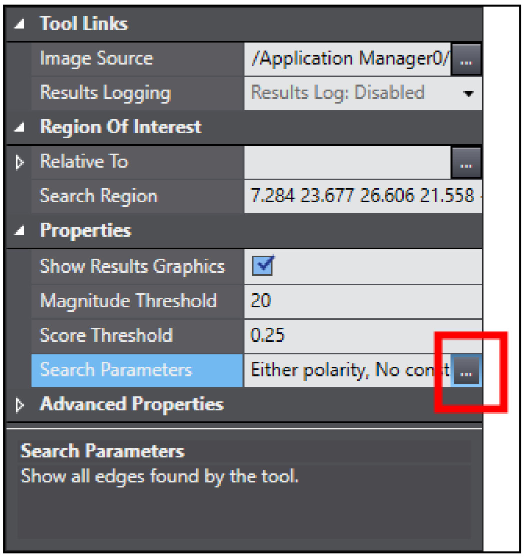

Figure 8-258 Edge Constraint Editor Access (Arc Edge Locator)

The Editor has two different sections named Edges and Region Image as described below.

Edges

This section defines the constraints on the detected edges. Constraints affect all detected edges with the following properties.

- Polarity: defines the gray level deviation for which the tool searches. This is performed with respect to the clockwise direction of the region of interest. For example, in the following figure, Either is selected, and dark and light areas can be seen on different sides of multiple edges.

- Constraints: enables constraining the edge by both Position and Magnitude. A slider bar appears below the image in both cases. The edge must be between the two position sliders and its magnitude must be higher than defined in the magnitude slider (refer to the following figure for an example).
- Score Threshold: defines the minimum score (quality) an edge must have to be considered valid. The value is set between 0 and 1.

Region Image

The image beneath the edge constraints shows only the pixels within the region of interest in the main image window. The image is altered from the region of interest so that it appears rectangular instead of circular. Regardless of the region's orientation in the main image, this will always be shown with the region's positive X-axis oriented to the right.

Arc Edge Locator Results

Use the table below to understand the results of the Arc Edge Locator tool.

Table 8-70 Arc Edge Locator Results Description

Item	Description
Instance	Index of the result instance.
Frame/Group	Index of the related result. It is associated with the tool that this tool is set Relative To.
Edge X	X-coordinate of the edge midpoint.
Edge Y	Y-coordinate of the edge midpoint.
Radius	Radius of the edge. This is only properly measured when Projection Mode is set to Annular.
Edge Score	Calculated score (quality) of the edge, computed according to the constraints set by the Edge Constraints properties.
Magnitude	Measurement of how well the region of interest arc or radii matches the found arc or radii. This will be returned as negative if the found arc is a reflection of the region of interest arc.
Magnitude Score	Score between 0 and 1 calculated according to the Magnitude Constraint property.
Position Score	Score between 0 and 1 calculated according to the Position Constraint property.
Projection Magnitude	Measurement of the deviation between the gray level of the projection pixels and the pixels surrounding it. This is returned on a range between -255 and 255. Positive and negative peaks in the value indicate potential edges. Sharp peaks indicate strong, well-defined edges while dull peaks may indicate noise or poorly-defined edges.
Projection	Average gray level value for all projection paths within the physical area

Item	Description
Average	bounded by the region of interest. This minimizes variations in pixel values caused by non-edge features or noise.

Caliper

This tool identifies and measures the distance between one or more parallel edge pairs in an image. It uses pixel gray-level values within the region of interest to build projections needed for edge detection. After the potential edges are detected, Caliper determines which edge pairs are valid by applying constraints that are manually configured for each edge pair.

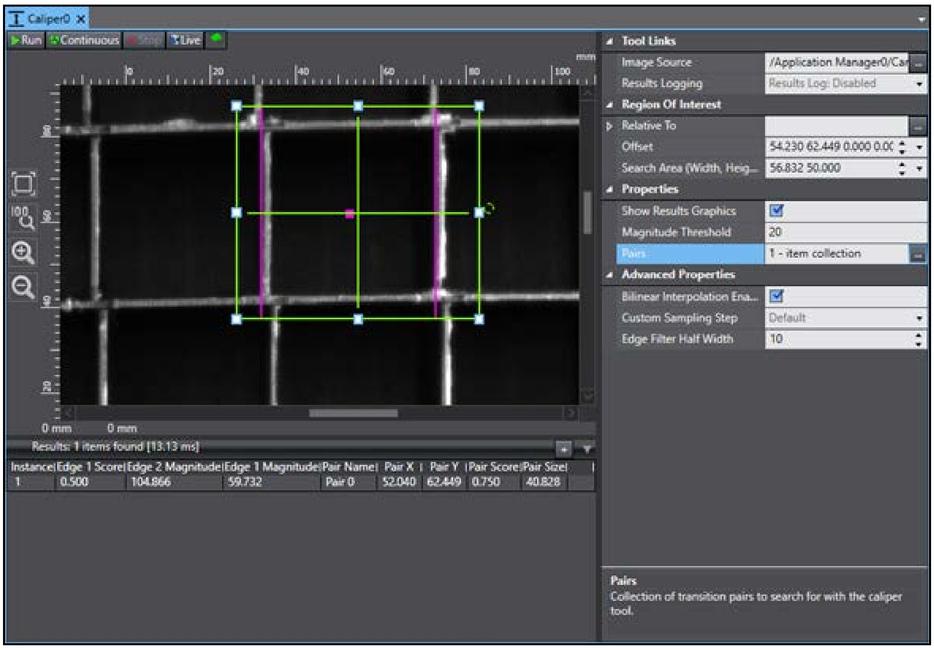

Figure 8-259 Caliper Tool Editor

To create a Caliper tool, right-click **Vision Tools** in the Multiview Explorer, select **Add Inspection** and then **Caliper**. A Caliper tool will be added to the Vision Tools list.

Caliper Configuration Items

Use the table below to understand the Caliper configuration items.

Table 8-71 Caliper Configuration Item Description

Group	Item	Description
Tool Links	Image Source	Defines the image source used for processing by this vision tool.
	Results Logging	Enables logging of tool results to a file.
Region Of Interest	Relative To	The tool relative to which this tool executes. The output values of the selected tool are the input values of this one.

Group	Item	Description
	Link Name	Select the property in the defined Relative To tool that will provide the input values.
	Current Values	Collection of current input values.
	Offset	Defines the center coordinates of the region.
	Search Area (Width, Height)	Defines the size of the region.
Properties	Show Results Graphics	Specifies if the graphics are drawn in the Vision Window.
	Magnitude Threshold	Specifies the minimum gray level deviation required to detect an edge. A subpixel peak detection algorithm is applied on the region of every minimum or maximum of the curve that exceeds this threshold in order to locate edges.
	Pairs	Collection of transition pairs to search for with the caliper tool. Click the ellipsis to make detailed changes. Refer to Caliper Configuration Items on page 549 for more information.
Advanced Properties	Bilinear Interpolation Enabled	Enables using bilinear interpolation to sample the input image. By default, this is enabled because it ensures subpixel accuracy.
	Custom Sampling Step	Defines the sampling step used in calculation. This is set to 1 by default. Enable this to adjust the setting. Higher values decrease execution time and sensitivity and can improve processing in high-resolution images.
	Edge Filter Half Width	Half width of the convolution filter used to compute the edge magnitude curve, from which actual edges are detected. The filter approximates the first derivative of the projection curve. The half width of the filter should be set in order to match the width of the edge in the projection curve (the extent of the gray scale transition, expressed in number of pixels).

Caliper - Edge Constraint Editor

Clicking the ellipsis next to Pairs opens the Edge Constraint Editor. This allows you to set specific constraints on the detected pair(s).

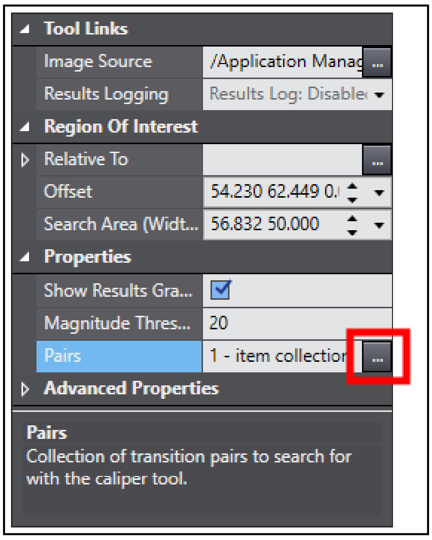

Figure 8-260 Edge Constraint Editor Access (Caliper)

The editor has several different sections that are described below.

Pairs Pane

The area highlighted in the figure below lists the pairs of edges to be detected. By default, Caliper will try to detect only one. The **Add** and **Delete** buttons at the bottom can change the amount of pairs detected when the tool is run. The name of each pair is adjusted by selecting the pair in this pane and then changing the Pair Name field.

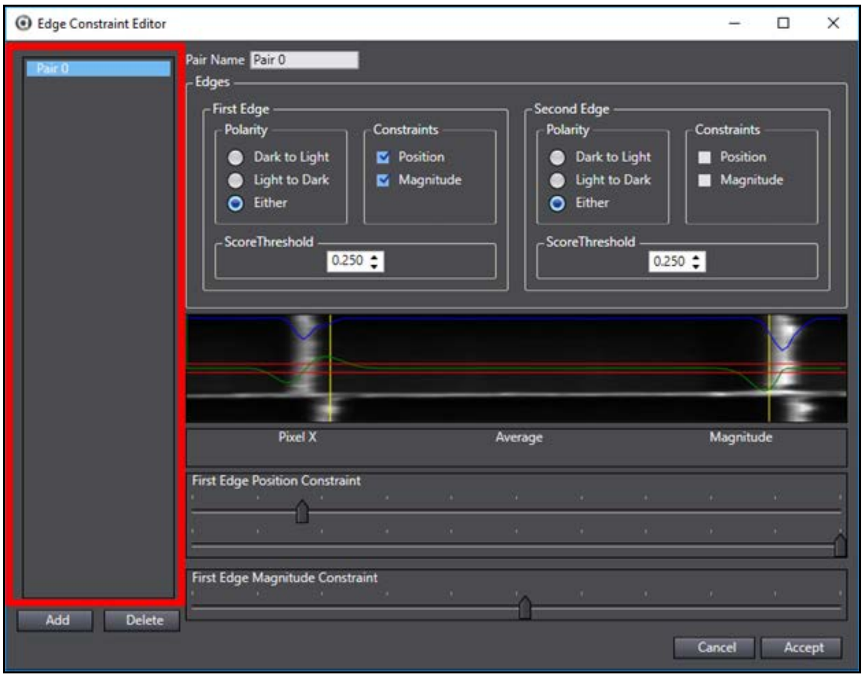

Figure 8-261 Edge Constraint Editor Pairs Pane (Caliper)

Edges

This section defines the constraints on the detected edges within a pair. Each edge is adjusted individually with the following properties.

- Polarity: defines the gray level deviation for which the tool searches. This is performed with respect to moving from left to right across the region (shown in an image in this editor). For example, in the following figure, Either is selected, and dark and light areas can be seen on different sides of the two edges.
- Constraints: enables constraining the edge by both Position and Magnitude. A slider bar appears below the image in both cases. The edge must be between the two position sliders and its magnitude must be higher than defined in the magnitude slider (refer to the following figure for an example).
- Score Threshold: defines the minimum score (quality) an edge must have to pass. This value is set between 0 and 1.

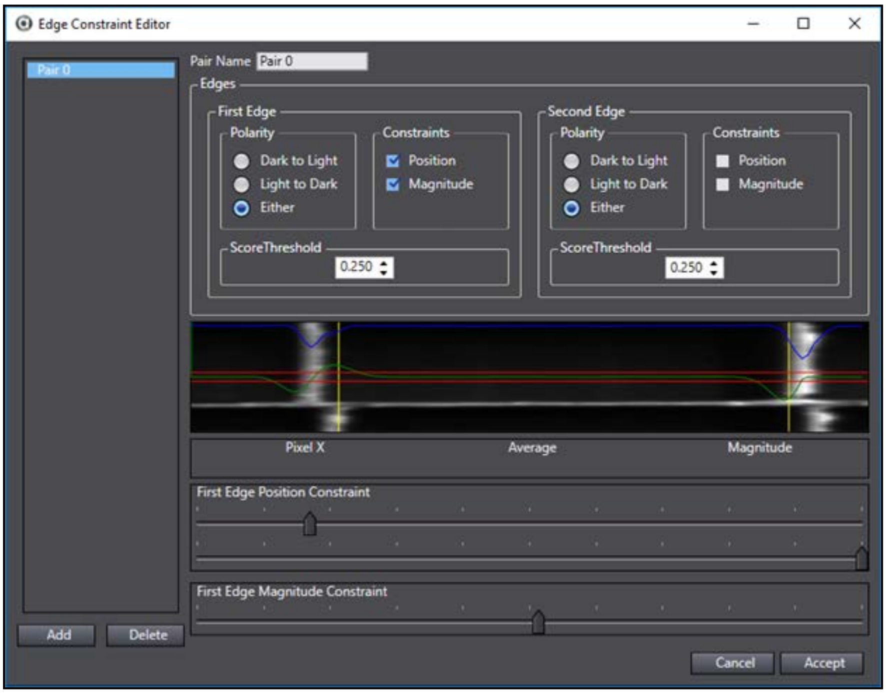

Figure 8-262 Edge Constraint Editor (Caliper)

Region Image

The image beneath the edge constraints shows only the pixels within the region of interest in the main image window. Regardless of the region's orientation in the main image, this will always be shown with the region's positive X-axis oriented to the right.

Caliper Results

Use the table below to understand the results of the Caliper tool.

Table 8-72 Caliper Results Description

Item	Description
Instance	Index of the result instance.
Frame/Group	Index of the related result. It is associated with the results of the Relative To tool.
Pair Name	Name of the edge pair.
Pair X	X-coordinate of the center point of the caliper measure at the midpoint of the edge pair.
Pair Y	Y-coordinate of the center point of the caliper measure at the midpoint of the edge pair.
Pair Score	Score of the resultant pair, which is equal to the mean score of the two edges in the pair.
Pair Size	Distance between the midpoints of the pair edges.
Edge 1 X	X-coordinate of the midpoint of the first edge.
Edge 1 Y	Y-coordinate of the midpoint of the first edge.
Edge 1 Magnitude	Magnitude of the first edge.
Edge 1 Magnitude Score	Magnitude score of the first edge.
Edge 1 Position Score	Position score of the first edge.
Edge 1 Score	Score of the first edge, computed according to the constraints set by the Edge Constraints Properties.
Edge 2 X	X-coordinate of the midpoint of the second edge.
Edge 2 Y	Y-coordinate of the midpoint of the second edge.
Edge 2 Magnitude	Magnitude of the second edge.
Edge 2 Magnitude Score	Magnitude score of the second edge.
Edge 2 Position Score	Position score of the second edge.
Edge 2 Score	Score of the second edge, computed according to the constraints set by the Edge Constraints Properties.

Color Data

This tool finds the average color within a region and performs statistical analysis using the deviation from a user-defined reference color and color variation of the measurement range. It is primarily used to obtain data that will be analyzed by an Inspection tool.

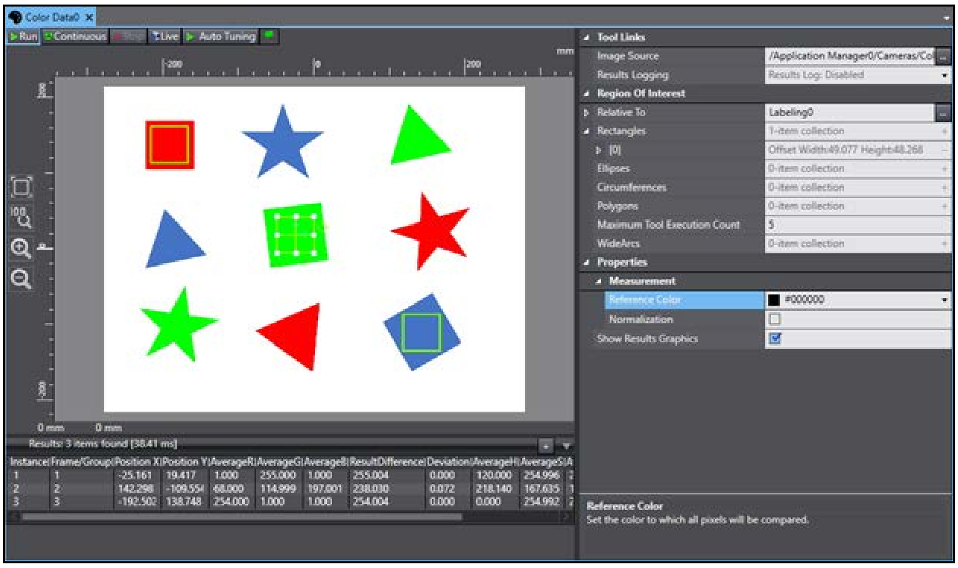

Figure 8-263 Color Data Tool Editor

To create a Color Data tool, right-click **Vision Tools** in the Multiview Explorer, select **Add Inspection** and then **Color Data**. A Color Data tool will be added to the Vision Tools list.

Color Data Configuration Items

Use the table below to understand the Color Data configuration items.

Table 8-73 Color Data Configuration Item Description

Group	Item	Description
Tool Links	Image Source	Defines the image source used for processing by this vision tool.
	Results Logging	Enables logging of tool results to a file.
Region Of Interest	Relative To	The tool relative to which this tool executes. The output values of the selected tool are the input values of this one.
	Link Name	Select the property in the defined Relative To tool that will provide the input values.
	Current Values	Collection of current input values.
	Rectangles Ellipses Circumferences	Sets of regions of interest of a particular shape. The field will show how many regions exist ("1-item collection", "2-item collect", etc). Click the plus sign in the field to create additional regions

Group	Item	Description
	Polygons WideArcs	and click the arrow to see all regions.
	<region number>	Identifies the region of a particular shape. It will appear as [0], [1], [...] within each region type. Click the minus sign in the field to remove the region and click the arrow to see its properties.
	Name	Available in all region types. Sets the user-defined name of the region.
	Overlap	Available in all region types. Select the behavior of the region. OR causes the region to be included in the search area and NOT excludes it from the search area. The behavior of specific regions is further defined in Z-Order. Refer to Tools with Multiple Regions of Interest on page 474 for more information.
	Z-Order	Available in all region types. Sets the order for overlapping regions of interest. Higher numbers will be in front and resolved first. Refer to Tools with Multiple Regions of Interest on page 474 for more information.
	Offset	Available in all region types except for Polygons. Defines the coordinates of the region center.
	Search Region (Width, Height)	Sets the height and width of the rectangular region. Only available in Rectangles.
	Radius X/Y	Defines the distance from the center to the exterior along the X- and Y-axes, respectively. Only available in Ellipses.
	Radius	Defines the distance from the center to the unseen center ring. Only available in Circumferences and WideArcs.
	Thickness	Defines the distance between the two visible rings. Only available in Circumferences and WideArcs.
	Start/End Angle	Defines the start and end angle of the Wide Arc bounds. Angles are measured in degrees counterclockwise from the positive X-axis. The arc is created clockwise starting from the Start Angle and ending at the End Angle. Only available in WideArcs.
	Vertexes	Sets of vertexes in a polygon region of interest. The field will show how many vertexes exist ("3-item collection", "4-item collection", etc). Click

Group	Item	Description
		the plus line in the field to create additional regions and click the arrow to see all regions. Only available in Polygons.
	<vertex number>	Identifies a particular vertex in the region. It will appear as [0], [1], [2], [...]. The field defines the X/Y coordinates of the vertex. Click the minus sign to remove the vertex, as long as there will not be fewer than three. Only available in Polygons.
	Maximum Tool Execution Count	Maximum number of tool executions for Relative To performance. If this tool is not set relative to another tool, the tool will only run once.
Properties (Measurement)	Reference Color	Defines the color that will be compared to all pixels in the search area. The Auto Tuning button sets this property based on what is currently in the region of interest.
	Normalization	Specify whether to normalize the brightness in calculating the color difference. When enabled, the result is not affected by the total brightness and only the color tone can be detected.
	Show Results Graphics	Specifies if the graphics are drawn in the Vision Window.

Color Data - Measuring Color Data

The colors in a region are measured against a reference color, which can be set in two ways. If there is a specific color against which the pixels need to be measured, it can be chosen manually using the Reference Color property. Alternatively, in color images, a particular color can be highlighted within the search area. Clicking the **Auto Tuning** button will automatically set this as the Reference Color. All results will then be measured against it.

The ResultDifference result illustrates the difference between the measured color range and the Reference Color by using the following formula.

$=\sqrt{((\text{AverageR-Reference R})^2+(\text{AverageG-Reference G})^2+(\text{AverageB-Reference B})^2)}$

This tool is particularly useful when used in conjunction with Inspection tool. When the Mode Of Operation for an Inspection Filter is set to Color Data, the Inspection tool can determine whether Color Data tool results fall within a specified range, allowing instances to be categorized by hue. Refer to Inspection on page 568 for more information.

NOTE: Color Data accuracy is dependent on the camera white balance settings, which may need to be modified outside of the ACE software.

Color Data Results

Use the table below to understand the results of the Color Data tool.

Table 8-74 Color Data Results Description

Item	Description
Instance	Index of the result instance.
Frame/Group	Index of the related result. It is associated with the tool that this tool is set Relative To.
Position X	X-coordinate of the reference point. If Color Data is set relative to another tool, this will be the X-coordinate of the associated instance. Otherwise, it will be the origin of the image field of view.
Position Y	Y-coordinate of the reference point. If Color Data is set relative to another tool, this will be the Y-coordinate of the associated instance. Otherwise, it will be the origin of the image field of view.
AverageR	Average R (Red) value of color within the search area.
AverageG	Average G (Green) value of color within the search area.
AverageB	Average B (Blue) value of color within the search area.
ResultDifference	Color difference between the average color in the measurement area and the Reference Color.
Deviation	Color deviation in the measurement region.
AverageH	Average H (Hue) value within the search area.
AverageS	Average S (Saturation) value within the search area.
AverageV	Average V (Value) value within the search area.
MonAve	Only calculated in gray scale images. Average gray level value within the search area.
MonDev	Only calculated in gray scale images. Gray level deviation in the measurement region.

Edge Locator

This tool identifies and measures the position of one or more straight edges on an object. Using pixel gray-level values within regions of interest, Edge Locator is able to build projections needed for edge detection. After detecting potential edges, the tool determines which edges are valid by applying the user-defined constraints on the edge candidates. The valid edges are then measured to determine score (quality), length, and position.

> **Additional Information**: While Edge Locator can determine the position of one or more edges, it cannot measure the length of lines detected in the region of interest. To extrapolate and measure a line on an object, use the Line Finder tool. Refer to Line Finder on page 501 for more information.

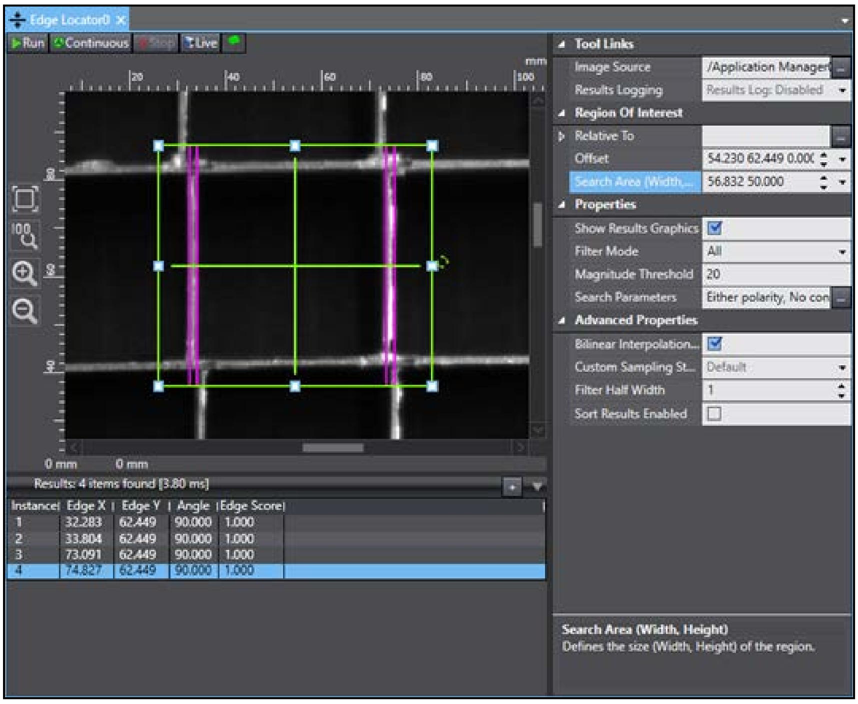

Figure 8-264 Edge Locator Tool Editor

To create an Edge Locator tool, right-click ***Vision Tools*** in the Multiview Explorer, select ***Add Inspection*** and then ***Edge Locator***. An Edge Locator tool will be added to the Vision Tools list.

Edge Locator Configuration Items

Use the table below to understand the Edge Locator configuration items.

Table 8-75 Edge Locator Configuration Item Description

Group	Item	Description
Tool Links	Image Source	Defines the image source used for processing by this vision tool.
	Results Logging	Enables logging of tool results to a file.
Region Of Interest	Relative To	The tool relative to which this tool executes. The output values of the selected tool are the input values of this one.
	Link Name	Select the property in the defined Relative To tool that will provide the input values.
	Current Values	Collection of current input values.
	Offset	Defines the center coordinates of the region.
	Search Area (Width, Height)	Defines the size of the region.
Properties	Show Results Graphics	Specifies if the graphics are drawn in the Vision

Group	Item	Description
		Window.
	Filter Mode	Select the edge results to be returned. Measured in the positive direction of the X-axis of the region of interest • **All** returns all detected results. • **First Edge** returns the first edge detected. • **Last Edge** returns the last edge detected. • **Middle** returns the line that is halfway between the first and last edges.
	Magnitude Threshold	Specifies the minimum gray level deviation required to detect an edge. A sub-pixel peak detection algorithm is applied on the region of every minimum or maximum of the curve that exceeds this threshold in order to locate edges.
	Search Parameters	Sets the constraints and thresholds calculated when determining the validity of the edge. Click the ellipsis to make detailed changes. Refer to Edge Locator Configuration Items on page 558 for more information.
Advanced Properties	Bilinear Interpolation Enabled	Enables using bilinear interpolation to sample the input image. By default, this is enabled because it ensures subpixel accuracy.
	Custom Sampling Set	Defines the sampling step used in calculation. This is set to 1 by default. Enable this to adjust the setting.
	Filter Half Width	Half width of the convolution filter used to compute the edge magnitude curve, from which actual edges are detected. The filter approximates the first derivative of the projection curve. The half width of the filter should be set in order to match the width of the edge in the projection curve (the extent of the gray scale transition, expressed in number of pixels).
	Sort Results Enabled	Enables the results to be sorted.

Edge Locator - Edge Constraint Editor

Clicking the ellipsis next to Search Parameters opens the Edge Constraint Editor. This allows you to set specific constraints on the detected edges.

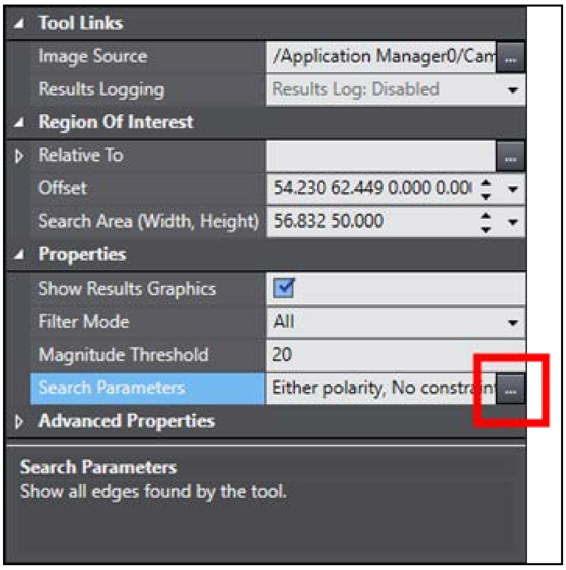

Figure 8-265 Edge Constraint Editor Access (Edge Locator)

The Editor has two different sections named Edges and Region Image as described below.

Edges

This section defines the constraints on the detected edges. Constraints affect all detected edges with the following properties.

- Polarity: defines the gray level deviation for which the tool searches. This is performed with respect to the clockwise direction of the region of interest. For example, in the following figure, Either is selected, and dark and light areas can be seen on different sides of multiple edges.
- Constraints: enables constraining the edge by both Position and Magnitude. A slider bar appears below the image in both cases. The edge must be between the two position sliders and its magnitude must be higher than defined in the magnitude slider (refer to the following figure for an example).
- Score Threshold: defines the minimum score (quality) an edge must have to be considered valid. The value is set between 0 and 1.

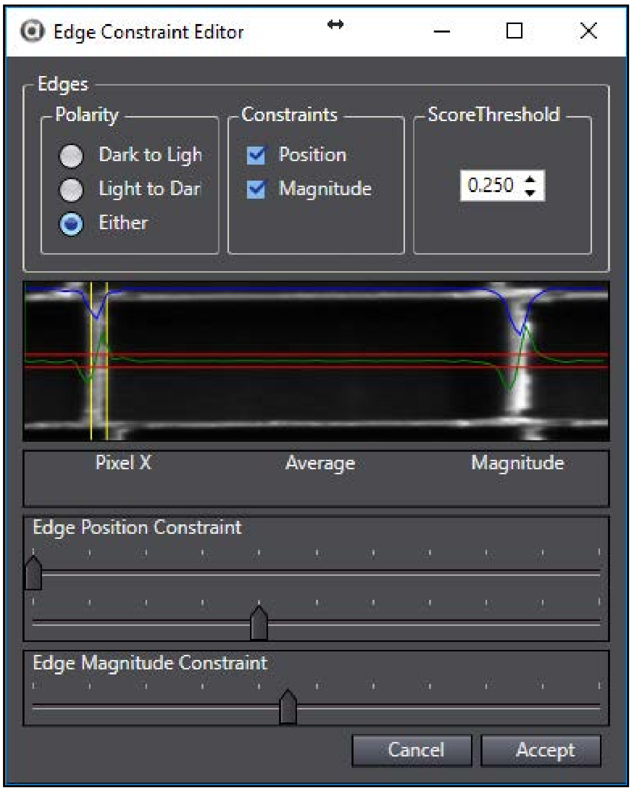

Figure 8-266 Edge Constraint Editor (Edge Locator)

Region Image

The image beneath the edge constraints shows only the pixels within the region of interest in the main image window. The image is altered from the region of interest so that it appears rectangular instead of circular. Regardless of the region's orientation in the main image, this will always be shown with the region's positive X-axis oriented to the right.

Edge Locator Results

Use the table below to understand the results of the Edge Locator tool.

Table 8-76 Edge Locator Results Description

Item	Description
Instance	Index of the result instance.
Frame/Group	Index of the related result. It is associated with the tool that this tool is set Relative To.
Edge X	X-coordinate of the edge midpoint.
Edge Y	Y-coordinate of the edge midpoint.
Angle	Angle of the edge segment with respect to the image X-axis.
Edge Score	Calculated score (quality) of the edge, computed according to the con-

Item	Description
	straints set by the Edge Constraints properties.
Magnitude	Peak value of the edge in the magnitude curve. Negative values indicate a light-to-dark transition while positive values indicate the opposite.
Magnitude Score	Score between 0 and 1 calculated according to the Magnitude Constraint property.
Position Score	Score between 0 and 1 calculated according to the Position Constraint property.
Projection Magnitude	Measurement of the deviation between the gray level of the projection pixels and the pixels surrounding it. This is returned on a range between -255 and 255. Positive and negative peaks in the value indicate potential edges. Sharp peaks indicate strong, well-defined edges while dull peaks may indicate noise or poorly-defined edges.
Projection Average	Average gray level value for all projection paths within the physical area bounded by the region of interest. This minimizes variations in pixel values caused by non-edge features or noise.

Feeder Histogram

This tool is used to calculated product density in user-defined regions of interest. It is designed to function in conjunction with an AnyFeeder to identify the density of products within regions associated with the dispense, pick, and front zones. Refer to AnyFeeder Object on page 351 for more information.

Additional Information: Feeder Histogram does not support color images.

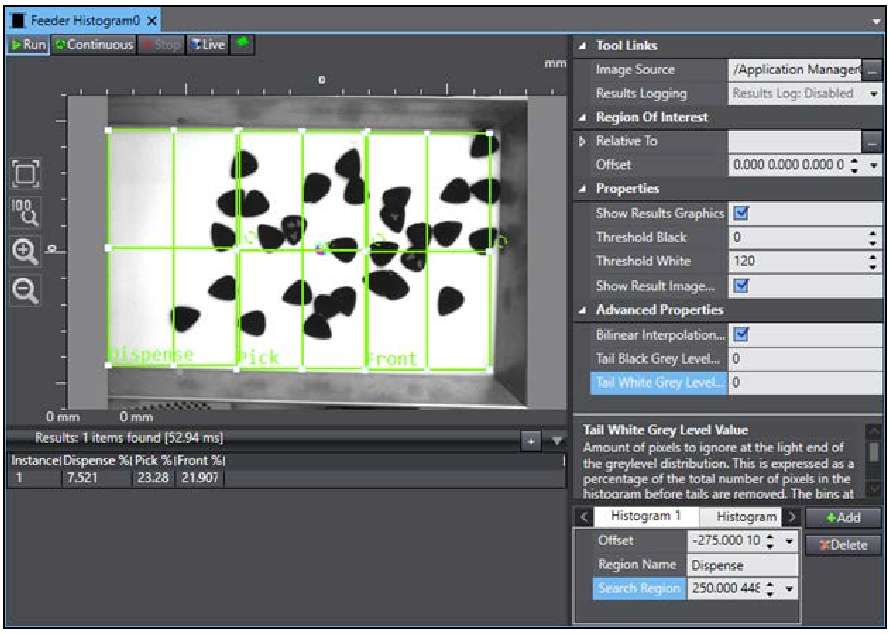

Figure 8-267 Feeder Histogram

To create a Feeder Histogram tool, right-click ***Vision Tools*** in the Multiview Explorer, select ***Add Finder*** and then ***Feeder Histogram***. The Feeder Histogram tool will be added to the Vision Tools list.

Feeder Histogram Configuration Items

Use the table below to understand the Feeder Histogram configuration items.

Table 8-77 Feeder Histogram Configuration Item Description

	Item	Description
Tool Links	Image Source	Defines the image source used for processing by this vision tool.
	Results Logging	Enables logging of tool results to a file.
Region Of Interest	Relative To	The tool relative to which this tool executes. The output values of the selected tool are the input values of this one.
	Link Name	Select the property in the relative tool that will provide the input values.
	Current Values	Collection of current input values.
	Offset	Defines the coordinates of the reference point that the histograms reference.
Properties	Show Results Graphics	Specifies if the graphics are drawn in the Vision Window.
	Threshold Black	Defines the darkest pixels the histogram considers when running. Any pixels with gray level lower than this value will be ignored while the histogram is building.
	Threshold White	Defines the brightest pixels the histogram considers when running. Any pixels with gray level above higher than this value will be ignored while the histogram is building.
	Show Result Image Histogram Regions	Specifies if the histogram regions are drawn in the ACE Vision Window. Show Results Graphics must be enabled for this to work.
Advanced Properties	Bilinear Interpolation Enabled	Enables using bilinear interpolation to sample the input image. By default, this is enabled because it ensures subpixel accuracy.
	Tail Black Gray Level Value	Percentage of pixels to ignore at the dark end of the gray level distribution. This is calculated after the pixels affected by the Threshold Black property have been removed.
	Tail White Gray Level Value	Percentage of pixels to ignore at the light end of the gray level distribution. This is calculated after the pixels affected by the Threshold White property have been removed.

Feeder Histogram Pane

Feeder Histogram is designed so you can create a series of histograms to measure product density in multiple ranges in the image. These histograms are organized using the Histogram Pane positioned beneath the properties, as shown in the figure below.

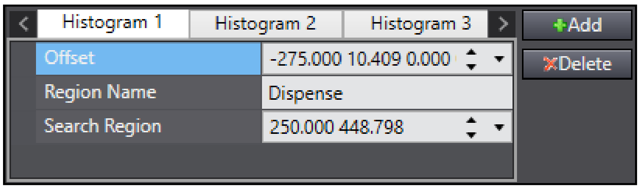

Figure 8-268 Feeder Histogram Pane

The **Add** and **Delete** buttons are used to create or remove histograms from the tool. Typically, 2 to 4 zones will be configured depending on the complexity of feeding logic required for the application.

The pane also shows properties that apply only to the selected histogram. They are shown in the table below.

Table 8-78 Feeder Histogram Item Description

Item	Description
Offset	Defines the center coordinates of the histogram region with respect to the reference point defined by Offset in the main tool properties.
Region Name	User-defined name of the histogram. This is displayed in the lower left corner of the histogram region in the region.
Search Region	Defines the size (width, height) of the histogram region.

The product density is calculated for each histogram region using the following formula:

Product Density = Histogram Pixel Count / Image Pixel Count

where Histogram Pixel Count is the number of pixels that fall within the defined thresholds and Image Pixel Count is the number of total pixels in the histogram region.

Feeder Histogram Results

A Feeder Histogram tool will return one result containing the product densities for each histogram. These are not shown by default and must be added using the Results Column Editor. The numbers of the histograms are variable and are denoted here as <number> instead of actual values.

NOTE: Results are calculated after applying tails and thresholds.

Table 8-79 Feeder Histogram Results Description

Item	Description
Instance	Index of the result instance.

Item	Description
Histogram <number> %	Product density percentage of the denoted histogram.

Image Histogram

This tool computes image statistics for all the pixels contained in the region of interest. This is used primarily for identifying product or clutter density, verifying the camera or lighting adjustment during setup of an application, and providing input for the Inspection tool.

NOTE: Image Histogram only functions for gray scale images.

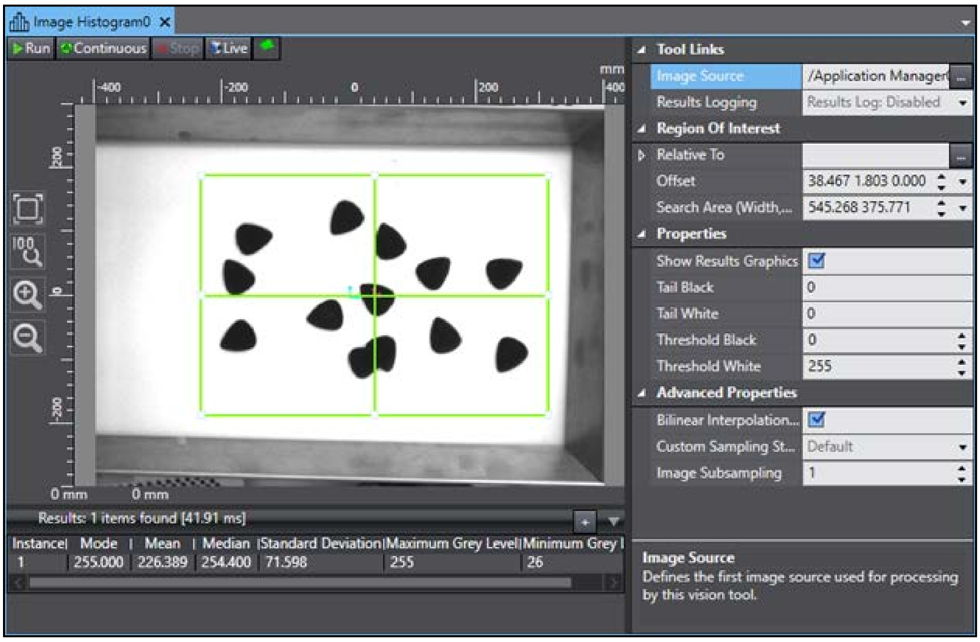

Figure 8-269 Image Histogram Tool Editor

To create an Image Histogram tool, right-click ***Vision Tools*** in the Multiview Explorer, select ***Add Inspection*** and then ***Image Histogram***. An Image Histogram tool will be added to the Vision Tools list.

Image Histogram Configuration Items

Use the table below to understand the Image Histogram configuration items.

Table 8-80 Image Histogram Configuration Item Description

Group	Item	Description
Tool Links	Image Source	Defines the image source used for processing by this vision tool.
	Results Logging	Enables logging of tool results to a file.
Region Of Interest	Relative To	The tool relative to which this tool executes. The output values of the selected tool are the input val-

Group	Item	Description
		ues of this one.
	Link Name	Select the property in the defined Relative To tool that will provide the input values.
	Current Values	Collection of current input values.
	Offset	Defines the coordinates of the reference point that the histograms reference.
	Search Area (Width, Height)	Defines the size of the region.
Properties	Show Results Graphics	Specifies if the graphics are drawn in the Vision Window.
	Tail Black	Percentage of pixels to ignore at the dark end of the gray level distribution. This is calculated after the pixels affected by the Threshold Black property have been removed.
	Tail White	Percentage of pixels to ignore at the light end of the gray level distribution. This is calculated after the pixels affected by the Threshold White property have been removed.
	Threshold Black	Defines the darkest pixels the histogram considers when running. Any pixels with gray level lower than this value will be ignored while the histogram is building.
	Threshold White	Defines the brightest pixels the histogram considers when running. Any pixels with gray level above higher than this value will be ignored while the histogram is building.
	Show Result Image Histogram Regions	Specifies if the histogram regions are drawn in the ACE Vision Window. Show Results Graphics must be enabled for this to work.
Advanced Properties	Bilinear Interpolation Enabled	Enables using bilinear interpolation to sample the input image. By default, this is enabled because it ensures subpixel accuracy.
	Custom Sampling Step	Defines the sampling step used in calculation. This is set to 1 by default. Enable this to adjust the setting. Higher values result in higher processing time.
	Image Subsampling	Factor used to subsample the image in the region of interest. The value defines the length (in pixels) of square neighborhoods that will be subsampled. For example, if it is set to 1, there is no subsampling. If it is set to 2, the image is subsampled in 2x2 tiles.

Image Histogram - Configuration

Image Histogram is designed to return a range of statistics about the pixels within a region of interest. The final calculation ignores pixels that have been excluded by thresholds or tails.

These properties provide a way for the user to ignore pixels in the histogram. Threshold Black and Threshold White set a maximum and minimum gray level to consider when building the histogram. Tail Black and Tail White remove a percentage of pixels from the ends of the spectrum within the thresholds. In this way, the user is able to eliminate results from areas that are not required by the application.

For example, the tool shown in can be manipulated to only return results about the pixels within the guitar picks by setting the Threshold White property to 200, as shown in the figure below. This removes all pixels with a gray level value higher than 200 from analysis.

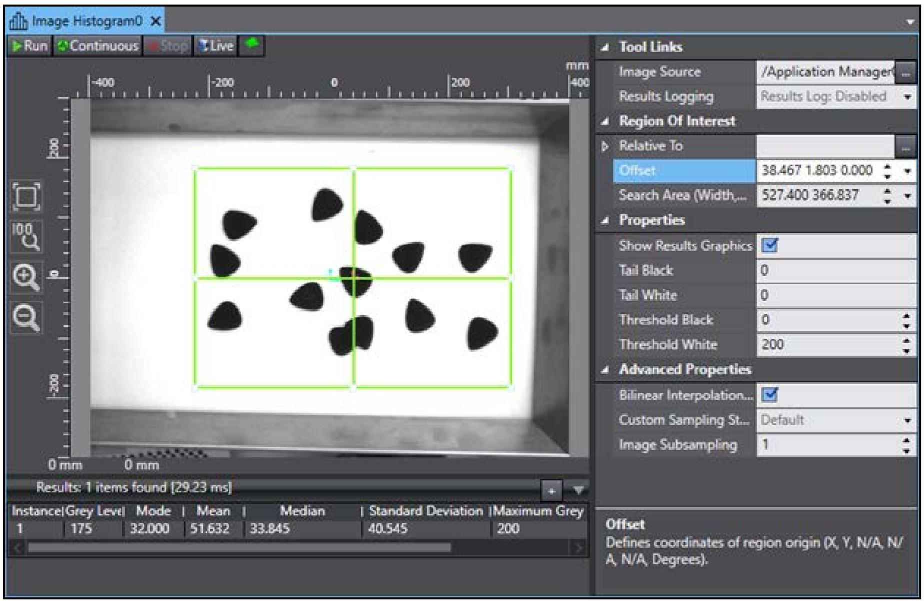

Figure 8-270 Image Histogram with Threshold White

Image Histogram Results

Use the table below to understand the results of the Image Histogram tool.

NOTE: All results are calculated after applying white and black tails and thresholds.

Table 8-81 Image Histogram Results Description

Item	Description
Instance	Index of the result instance.
Frame/Group	Index of the related result. It is associated with the tool that this tool is set Relative To.
Mode	Gray level value that appears in the largest number of pixels compared to other gray level values.

Item	Description
Mode Pixel Count	Number of pixels that correspond to the Mode gray level value.
Mean	Average gray level distribution of the pixels in the region of interest.
Median	Median of the gray level distribution of the pixels in the region of interest.
Standard Deviation	Standard deviation of the gray level distribution of the pixels in the region of interest.
Variance	Variance of the gray level distribution of the pixels in the region of interest.
Minimum Gray Level	Minimum gray level value in the region of interest.
Maximum Gray Level	Maximum gray level value in the region of interest.
Gray Level Range	Difference between the Minimum Gray Level and Maximum Gray Level values.
Histogram Pixel Count	Number of pixels in the region of interest.
Image Width	Width (in pixels) of the region of interest.
Image Height	Height (in pixels) of the region of interest.
Tail Black Gray Level	Darkest gray level value that remains in the histogram after the tail is removed.
Tail White Gray Level	Brightest gray level value that remains in the histogram after the tail is removed.

Inspection

This tool organizes instances based on the results of other tools and inspection filters. Custom categories and filters can be created to identify information about data or images from another tool. In this way, returned instances from another vision tool can be sorted into groups.

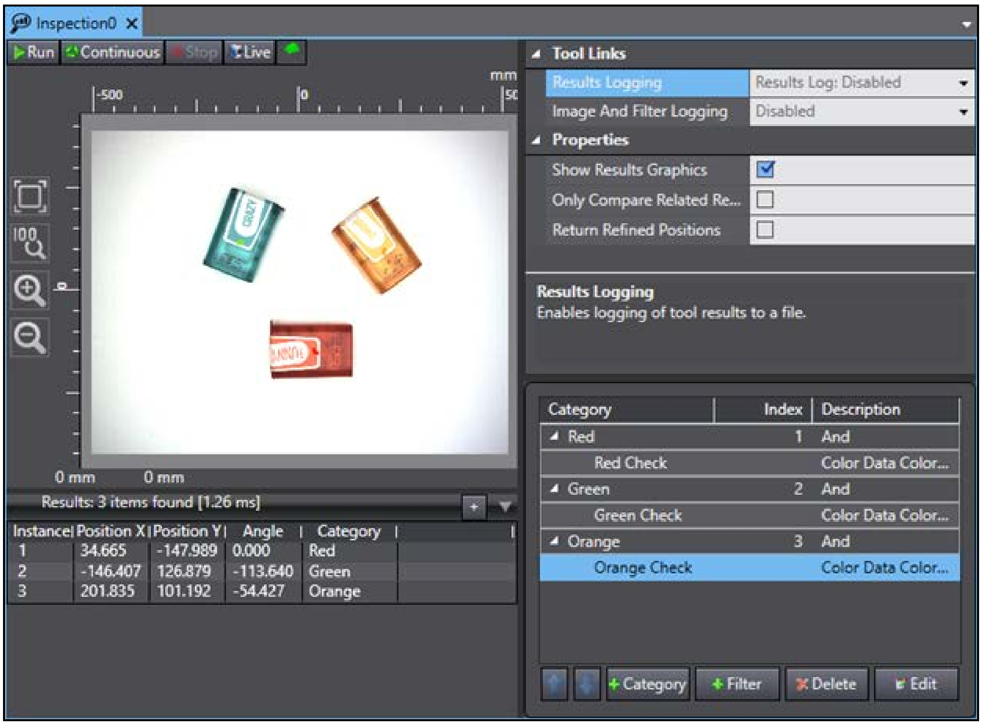

Figure 8-271 Inspection Tool Editor

To create an Inspection tool, right-click ***Vision Tools*** in the Multiview Explorer, select ***Add Inspection*** and then ***Inspection***. An Inspection tool will be added to the Vision Tools list.

Inspection Configuration Items

Use the table below to understand the Inspection configuration items.

Table 8-82 Inspection Configuration Item Description

Group	Item	Description
Tool Links	Results Logging	Enables logging of tool results to a file.
	Image And Filter Logging	Enables logging of inspection data to a file. • Log all data: records all numerical data. • Log pictures for inspections that fail: saves images for any failed inspections. • All inspections must fail: records data only if all inspections in the tool have failed. The File Mode dropdown defines how often files are recorded.
Properties	Show Results Graphics	Specifies if the graphics are drawn in the Vision Window.
	Only Compare Related Results	Specifies which results are compared. Enable to compare only those result values that are connected by instances. When disabled, all results are compared.

Group	Item	Description
	Return Refined Positions	Specifies if instance positions will be adjusted by subsequent tools. When enabled, the input position is determined by the tool directly before this one in the sequence. When disabled, the original position is input.

Inspection Filter Pane

The filter pane is found below the Properties viewer on the right side of the tool editor. This shows the current categories and filters used by the tool.

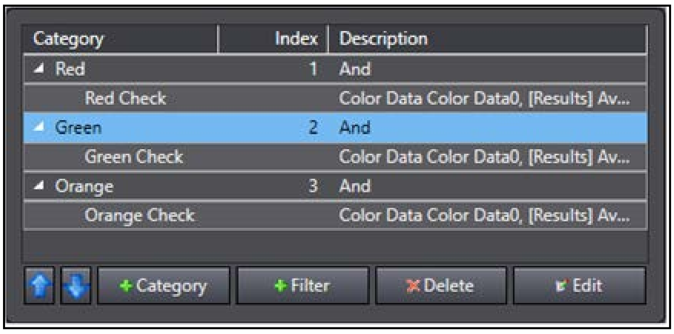

Figure 8-272 Inspection Filter Pane

The buttons at the bottom of the pane are detailed as follows.

Item	Description
Up/Down Arrows	Move selected categories up or down to determine the order in which they will be used to sort instances. Moving categories retains the order of filters within that category. Filters cannot be moved outside of their category.
Category	Add a new category at the bottom of the list.
Filter	Add a new filter at the bottom of the selected category list.
Delete	Delete the selected filter or category. Deleting a category deletes all filters within it.
Edit	Edit the selected filter or category. This can also be done by double-clicking a filter or category.

Inspection Categories

The purpose of categories is to group instances using defined filters. For each instance, categories are evaluated starting with the category listed at the top of the Filter pane. An instance is put into the first category for which it passes the required number of filters as defined by the operator.

Each category is assigned a name and an operator. The operator (AND or OR) is applied to all filters within that category to evaluate the instances. The operator associated with a category is displayed in the Description field of the Configuration section. If the category has an AND operator, an instance must pass all filters in that category to qualify. Conversely, if the category has an OR operator, an instance needs to pass only one of the filters to qualify.

The name and operator of a category can be changed by editing the category in the filter pane.

Inspection Category Order

Because instances are put into the first category for which they qualify, the order of the category in the Filter pane is important. The Up/Down arrow buttons are used to adjust the category order.

If the selected category is at the top or bottom of the list, the Up or Down Arrow button will be disabled, respectively. These cannot be used to move filters between categories.

> **NOTE:** The location results associated with each category are exposed to Robot Vision Manager in a separate frame index for each category. The frame number is equal to the category's position; the first is associated with Frame 1, the second with Frame 2, and the pattern continues.

Filters

Filters define the actual inspection or comparison to be performed. Each filter has a name and belongs to a category. A filter cannot be added if an existing category is not selected (the **Add Filter** button will be disabled until then). The inspection performed by a filter is displayed in the Description field of the Filter pane.

Editing a filter opens the Filter Editor. The filter setting items are described below.

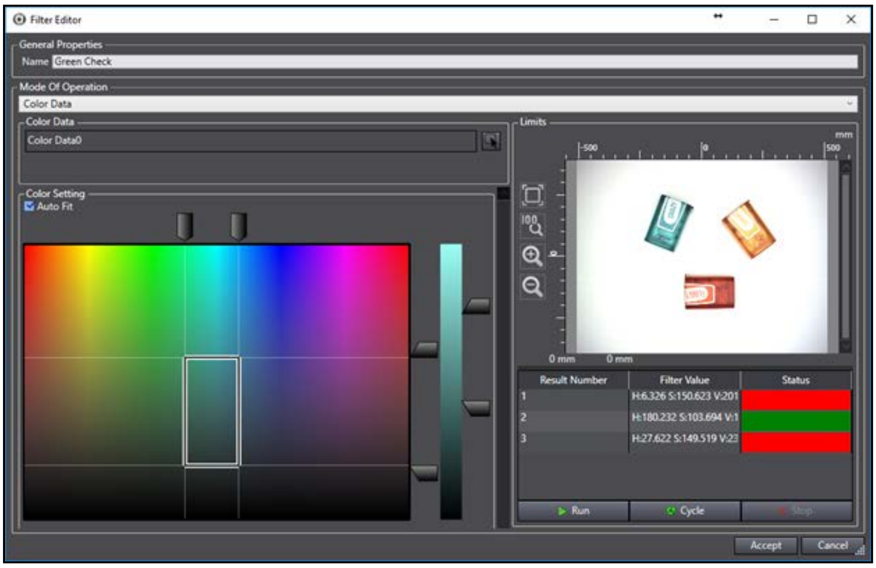

Figure 8-273 Inspection Filter Editor

Table 8-83 Inspection Filter Editor Item Description

Item	Description
Name	An identifying name for this filter.
Mode Of Operation	Defines the type of evaluation this filter performs. The options are: • Measure Distance Between Two Points • Measure The Shortest Distance Between A Point and a Line • Measure The Angle Between Two Lines • Test The Value Of A Vision Result Variable • Vision Tool Transform Results • Number of Results • Number of Characters • OCR Quality • String • Color Data
Vision Tools	The appropriate vision tools and the necessary properties. This varies depending on the Mode Of Operation.
Limits	The bounds of this filter. If the results of an inspection fall between these values, the instance passes this filter. Like the Vision Tools, this also varies with the Mode Of Operation, but it is a Minimum and Maximum Value in most cases.
Results	Sample results from evaluating this filter on the current image. This can be used to show whether certain instances pass or fail, allowing the user to tune the limits. In most cases, there are three result columns in this editor: • Result Number: The instance number. • Filter Value: The evaluated property from the vision tool. • Status: Shows if the instance has satisfied this filter. This field will be green if the instance passes and red if it fails.
Control Buttons	• **Run**: Run the tool once. • **Cycle**: Run the tool continuously. • **Stop**: Stop the tool or live operation.

Inspection Vision Results Selection

If the Mode Of Operations is set to Test The Value Of A Vision Result Variable, an additional Result from another Vision Tool will need to be selected. This requires its own window, as described below.

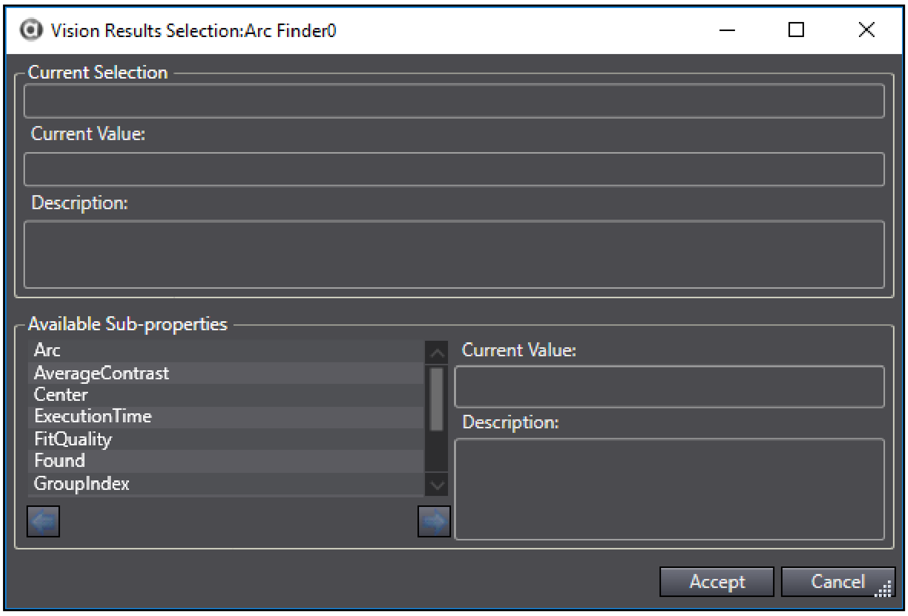

Figure 8-274 Inspection Vision Results Selection

Highlighting any of the sub-properties will display its description. When the appropriate sub-property has been highlighted, click the **Right Arrow** Button to select and test it.

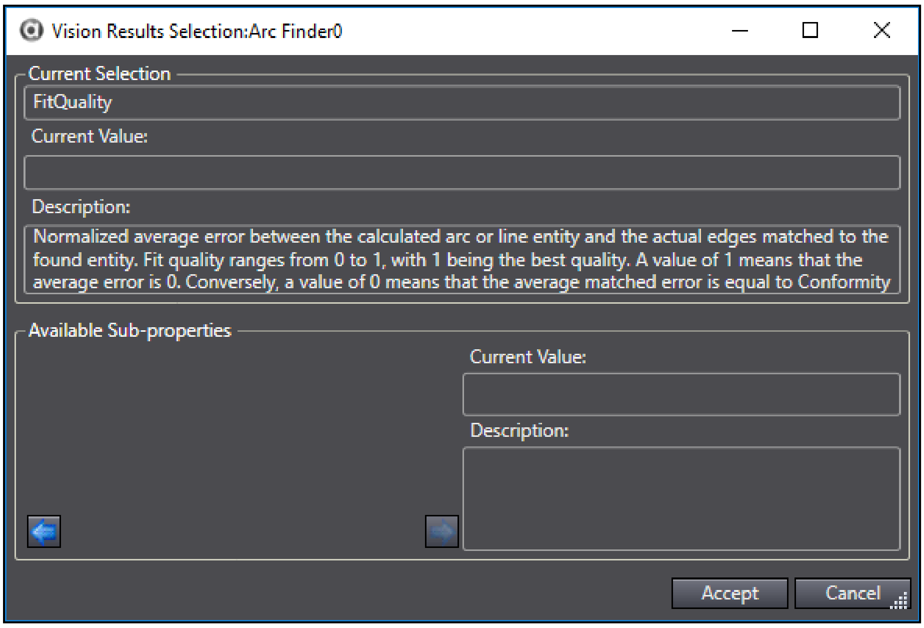

Figure 8-275 Inspection Vision Results Selection - Selected Sub-property

The fields above the available sub-properties pane will be filled. Click the **Accept** Button to confirm the selection and close the window.

> **Additional Information**: Some properties have sub-properties that can also be selected. In these cases, the left arrow is used to step back to the previous level.

Inspection Results

Use the table below to understand the results of the Inspection tool.

> **NOTE:** The Results columns refer to existing filters and thus change depending on the name of the filter. For these columns in the following table, these instances will include <filter> instead of specific names.

Table 8-84 Inspection Results Description

Item	Description
Instance	Index of the result instance, starting with 1.
<filter> Pass Status	Shows whether or not the instance passes a filter by displaying "True" if it passes and "False" if it does not.
<filter> Measurement	The measured value of the evaluated result from filter.
Category	The category for which this instance qualifies. If this instance does not qualify for any category, this will display "Unassigned".
Position X	X-coordinate of the reference point. If Inspection is set relative to another tool, this will be the X-coordinate of the associated instance. Otherwise, it will be the origin of the image field of view.
Position Y	Y-coordinate of the reference point. If Inspection is set relative to another tool, this will be the Y-coordinate of the associated instance. Otherwise, it will be the origin of the image field of view.
Angle	Angle of the located instance.

Precise Defect Path

This tool performs differential processing on the image to detect defects and contamination on the edges of plain measurement objects with high precision. This is done by using elements of varying size and comparison intervals. By changing these parameters, fine customization of speed and precision is possible. Precise Defect Path is primarily used for identifying 1-dimensional defects or variations and can be utilized for part edge inspection, as shown in the following figure.

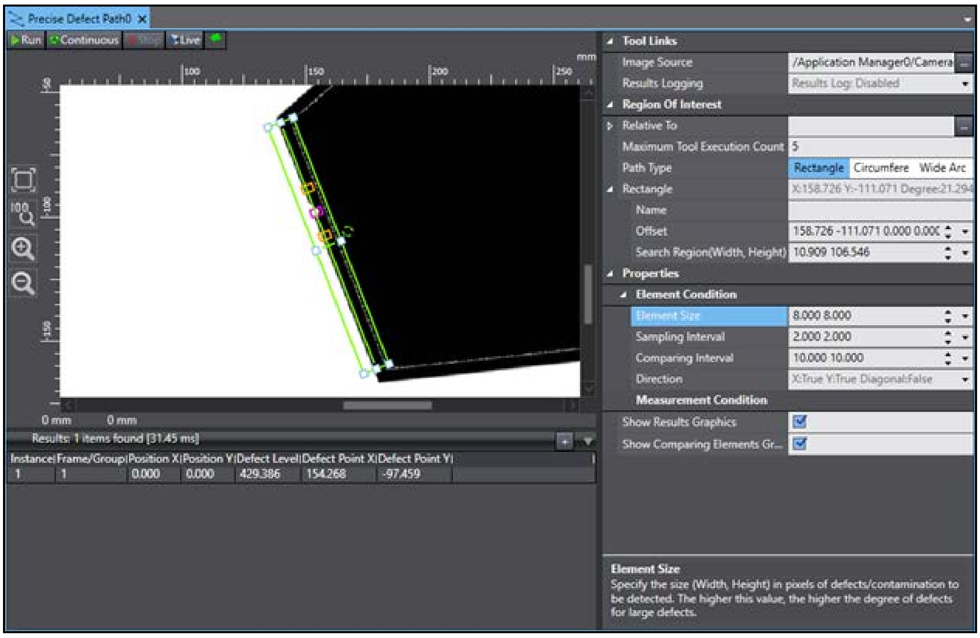

Figure 8-276 Precise Defect Path Tool Editor

To create a Precise Defect Path tool, right-click **Vision Tools** in the Multiview Explorer, select **Add Inspection** and then **Precise Defect Path**. A Precise Defect Path tool will be added to the Vision Tools list.

Precise Defect Path Configuration Items

Use the table below to understand the Precise Defect Path configuration items.

Table 8-85 Precise Defect Path Configuration Item Description

Group	Item	Description
Tool Links	Image Source	Defines the image source used for processing by this vision tool.
	Enables logging of tool results to a file.	Enables logging of tool results to a file.
Region Of Interest	Relative To	The tool relative to which this tool executes. The output values of the selected tool are the input values of this one.
	Link Name	Select the property in the defined Relative To tool that will provide the input values.
	Current Values	Collection of current input values.
	Maximum Tool Execution Count	Maximum number of tool executions for Relative To performance. If this tool is not set relative to another tool, the tool will only run once.
	Path Type	Defines the shape and detection method of the

Group	Item	Description
		region of interest. The region changes shape depending on this property.
	Rectangle Circumference Wide Arc	Changes to match the selection in Path Type. Shows the properties of the region of interest. Click the arrow next to it to see all properties in detail.
	Name	Available for all Path Type selections. Sets the user-defined name of the region.
	Offset	Available for all Path Type selections. Defines the coordinates of the region's center.
	Search Region (Width, Height)	Sets the height and width of the rectangular region. Only available when Path Type is set to Rectangle.
	Radius	Defines the distance from the center to the unseen center ring. Only available when Path Type is set to Circumference or Wide Arc.
	Thickness	Defines the distance between the two visible rings. Only available when Path Type is set to Circumference or Wide Arc.
	Start/End Angle	Defines the start and end angle of the Wide Arc bounds. Angles are measured in degrees counterclockwise from the positive X-axis. The arc is created clockwise starting from the Start Angle and ending at the End Angle. Only available when Path Type is set to Wide Arc.
Properties	(Element Condition) Element Size	Set the width and height in pixels of defects / contamination to be detected. Higher values increase the degree of defects for larger defects.
	(Element Condition) Sampling Interval	Set the interval in pixels for creating elements. Smaller values lead to more precise defect detection, but slow the processing speed.
	(Element Condition) Comparing Interval	Set the number of neighboring elements used to compare the calculated degree of defect. The number is determined by multiplying the Comparing Interval and Sampling Interval values.
	(Element Condition) Direction	Select the direction(s) used to detect defects. The processing time will be shorter if fewer directions are checked. • **X (circumferential)**: Detects defects along the X-axis if Path Type is set to ***Rectangle*** and along the circumference if Path Type is set to ***Circumference*** or ***Wide Arc***.

Group	Item	Description
		• **Y (radial)**:Detects defects along the Y-axis if Path Type is set to ***Rectangle*** and along the radii if Path Type is set to ***Circumference*** or ***Wide Arc***. • **Diagonal**: Detects defects in diagonal directions.
	(Measurement Condition) Show Result Graphics	Specifies if the graphics are drawn in the Vision Window.
	(Measurement Condition) Show Comparing Elements Graphics	Specifies if the comparison elements are drawn in the Vision Window. Elements are automatically created during measurement, but they are only shown if this is enabled.

Precise Defect Path - Defect Detection

This tool functions by creating elements in the search area and comparing them to determine which elements deviate the most from their neighboring elements. The elements to be compared are determined by all parameters in the Element Condition section. The size and spacing of the created elements is also determined by the properties. This tool focuses primarily on detecting defects along a path, making it useful for locating scratches or dents in a uniform surface or edge, as shown in above.

When run, Precise Defect Path will return the position of the largest detected defect, shown in the Vision Window. Only one result will be returned per input instance. For edge inspections, multiple Precise Defect Path tools may be linked to an Inspection tool or used within a Custom Vision Tool with logic to filter results as needed.

Precise Defect Region Results

Use the table below to understand the results of the Precise Defect Region tool.

Table 8-86 Precise Defect Region Results Description

Item	Description
Instance	Index of the result instance.
Frame/Group	Index of the related result. It is associated with the tool that this tool is set Relative To.
Position X	X-coordinate of the search area origin.
Position Y	Y-coordinate of the search area origin.
Defect Level	Maximum degree of defect in the search area.
Defect Point X	X-coordinate of the element of the largest detected defect.
Defect Point Y	Y-coordinate of the element of the largest detected defect.
Defect Num	Number of defects found in the search area.

Item	Description
Min Area	Pixel area of the smallest defect in the search area.
Max Area	Pixel area of the largest defect in the search area.

Precise Defect Region

This tool performs differential processing on the image to detect defects and contamination within plain measurement objects with high precision. This is done by using elements of varying size and comparison intervals. By changing these parameters, fine customization of speed and precision is possible. Precise Defect Region is primarily used for identifying 2-dimensional defects or variations and can be utilized for inspection of a part area.

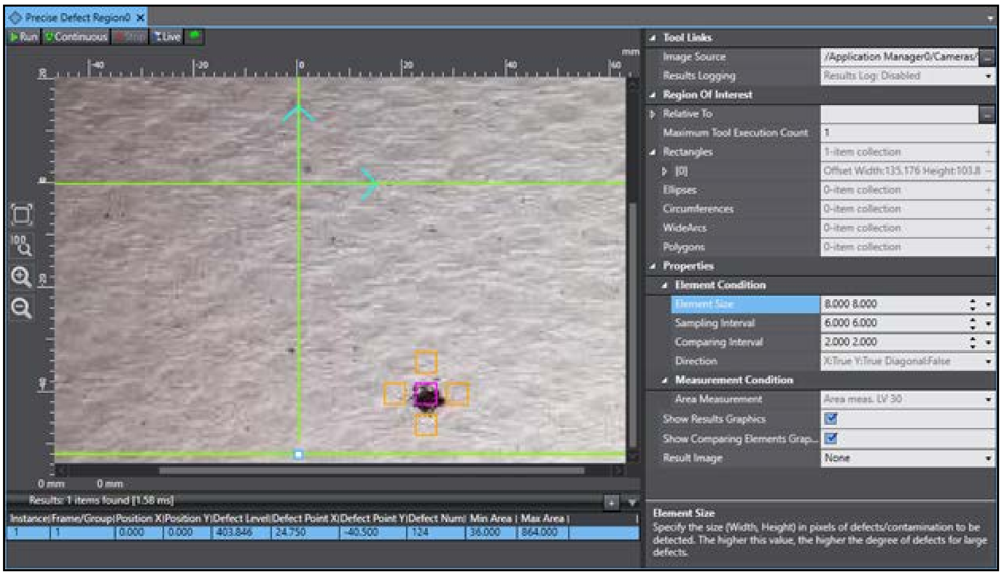

Figure 8-277 Precise Defect Region Tool Editor

To create a Precise Defect Region tool, right-click **Vision Tools** in the Multiview Explorer, select **Add Inspection** and then **Precise Defect Region**. A Precise Defect Region tool will be added to the Vision Tools list.

Precise Defect Region Configuration Items

Use the table below to understand the Precise Defect Region configuration items.

Table 8-87 Precise Defect Region Configuration Item Description

Group	Item	Description
Tool Links	Image Source	Defines the image source used for processing by this vision tool.
	Results Logging	Enables logging of tool results to a file.
Region Of Interest	Relative To	The tool relative to which this tool executes. The output values of the selected tool are the input values of this one.

Group	Item	Description
	Link Name	Select the property in the defined Relative To tool that will provide the input values.
	Current Values	Collection of current input values.
	Rectangle Ellipse Circumferences Polygons WideArcs	Sets of regions of interest of a particular shape. The field will show how many regions exist ("1-item collection", "2-item collection", etc.). Click the plus sign in the field to create additional regions and click the arrow to see all regions.
	<region number>	Identifies the region of the specified shape. It will appear as [0], [1], [...] within the shape category. Click the minus sign in the field to remove the region and click the arrow to see its properties.
	Name	Available in all region types. Sets the user-defined name of the region.
	Overlap	Available in all region types. Select the behavior of the region. OR causes the region to be included in the search area and NOT excludes it from the search area. The behavior of specific regions is further defined in Z-Order. Refer to Tools with Multiple Regions of Interest on page 474 for more information.
	Z-Order	Available in all region types. Sets the order for overlapping regions of interest. Higher numbers will be in front and resolved first. Refer to Tools with Multiple Regions of Interest on page 474 for more information.
	Offset	Available in all region types except for Polygons. Defines the coordinates of the region center.
	Search Region (Width, Height)	Sets the height and width of the rectangular region. Only available in Rectangles.
	Radius X/Y	Defines the distance from the center to the exterior along the X- and Y-axes, respectively. Only available in Ellipses.
	Radius	Defines the distance from the center to the unseen center ring. Only available in Circumferences and WideArcs.
	Thickness	Defines the distance between the two visible rings. Only available in Circumferences and WideArcs.
	Start/End Angle	Defines the start and end angle of the Wide Arc bounds. Angles are measured in degrees coun-

Group	Item	Description
		terclockwise from the positive X-axis. The arc is created clockwise starting from the Start Angle and ending at the End Angle. Only available in WideArcs.
	Vertexes	Sets of vertexes in a polygon region of interest. The field will show how many vertexes exist ("3-item collection", "4-item collection, etc.). Click the plus line in the field to create additional regions and click the arrow to see all regions. Only available in Polygons.
	<vertex number>	Identifies a particular vertex in the region. It will appear as [0], [1], [2], [...]. The field defines the X/Y coordinates of the vertex. Click the minus sign to remove the vertex, as long as there are not fewer than three. Only available in Polygons.
	Maximum Tool Execution Count	Maximum number of tool executions for Relative To performance. If this tool is not set relative to another tool, the tool will only run once.
Properties	(Element Condition) Element Size	Set the width and height in pixels of defects / contamination to be detected. Higher values increase the degree of defects for larger defects.
	(Element Condition) Sampling Interval	Set the interval in pixels for creating elements. Smaller values lead to more precise defect detection, but slow the processing speed.
	(Element Condition) Comparing Interval	Set the number of neighboring elements used to compare the calculated degree of defect. The number is determined by multiplying the Comparing Interval and Sampling Interval values.
	(Element Condition) Direction	Set the direction for detecting defects. The processing time will be shorter if fewer directions are checked.
	(Measurement Condition) Area Measurement	Enables measurement of the size of defects, dividing the high defect detection regions into groups and outputting the surface and center of gravity coordinates of the group with the largest area.
	(Measurement Condition) Show Result Graphics	Specifies if the graphics are drawn in the Vision Window.
	(Measurement Condition) Show Comparing Elements Graphics	Specifies if the comparison elements are drawn in the Vision Window. Elements are automatically created during measurement, but they are only shown if this is enabled.
	(Measurement Condition) Result	Sets the display condition of the resulting image. Select None to display the original image, Area

Group	Item	Description
	Image	Image to display the image in area measurement mode, and Profile Image to show areas with high defect levels in bright colors. Note that Area Measurement must be enabled for Area image to work properly.

Precise Defect Region - Defect Detection

This tool functions by creating elements in the search area and comparing them to determine which elements deviate the most from their neighboring elements. The elements to be compared are determined by all parameters in the Element Condition section. The size and spacing of the created elements is also determined by the properties. To see an example of how the various parameters affect detection, refer to above.

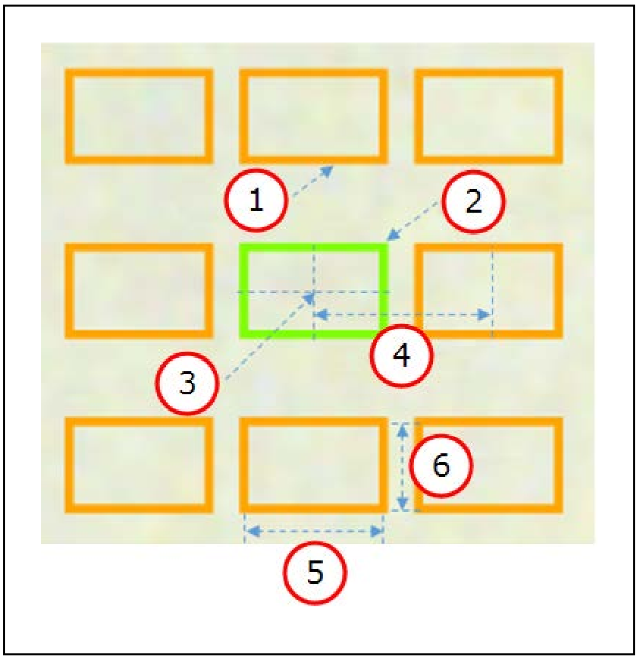

Figure 8-278 Precise Defect Region Size and Spacing

Table 8-88 Precise Defect Region Size and Spacing Description

Item	Description
1	Comparing Element
2	Result Element
3	Defect Point
4	Comparing Interval x Sampling Interval
5	Element Size X
6	Element Size Y

When run, Precise Defect Region will return the position of the largest detected defect, shown in the Vision Window. Only one result will be returned per input instance. For example, if Precise Defect Region is set relative to another tool, one result will be returned for each instance created by that tool.

If Area Measurement is enabled, the result will include the number of defects on that part in the Defect Num result. Otherwise, Defect Num will be 0.

The tool will display a grid of elements at the location of the largest detected variation. This allows the user to gain information on the size and proximity of features being detected as defects.

Precise Defect Region Results

Use the table below to understand the results of the Precise Defect Region tool.

Table 8-89 Precise Defect Region Results Description

Item	Description
Instance	Index of the result instance.
Frame/Group	Index of the related result. It is associated with the tool that this tool is set Relative To.
Position X	X-coordinate of the search area origin.
Position Y	Y-coordinate of the search area origin.
Defect Level	Maximum degree of defect in the search area.
Defect Point X	X-coordinate of the element of the largest detected defect.
Defect Point Y	Y-coordinate of the element of the largest detected defect.
Defect Num	Number of defects found in the search area.
Min Area	Pixel area of the smallest defect in the search area.
Max Area	Pixel area of the largest defect in the search area.

Reader Tools

Reader tools are typically used for reading data from located objects and features.

The following Reader tools are described in this section.

- Refer to Barcode on page 582 for more information.
- Refer to Data Matrix on page 586 for more information.
- Refer to OCR on page 590 for more information.
- Refer to OCR Dictionary on page 596 for more information.
- Refer to QR Code on page 598 for more information.

Barcode

This tool reads a barcode in a region of interest and returns text string data.

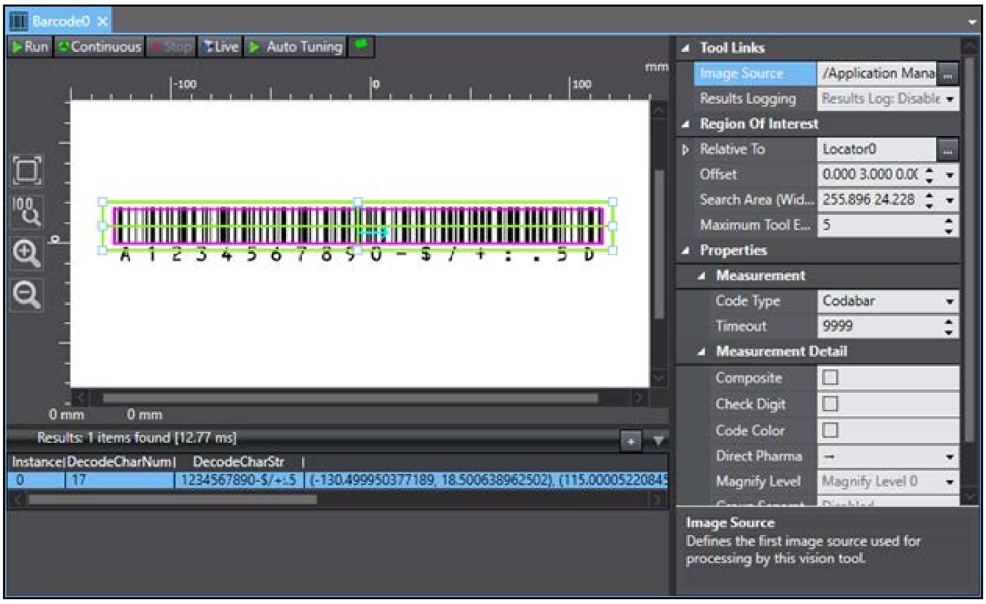

Figure 8-279 Barcode Tool Editor

To create a Barcode tool, right-click **Vision Tools** in the Multiview Explorer, select **Add Reader** and then **Barcode**. A Barcode tool will be added to the Vision Tools list.

Barcode Configuration Items

Use the table below to understand the Barcode configuration items.

Table 8-90 Barcode Configuration Item Description

Group	Item	Description
Tool Links	Image Source	Defines the image source used for processing by this vision tool.
	Results Logging	Enables logging of tool results to a file.
Region Of Interest	Relative To	The tool relative to which this tool executes. The output values of the selected tool are the input values of this one.
	Link Name	Select the property in the defined Relative To tool that will provide the input values.
	Current Values	Collection of current input values.
	Offset	Defines the center coordinates of the region.
	Search Area (Width, Height)	Defines the size of the region.
	Maximum Tool Execution Count	Maximum number of tool executions for Relative To performance. If this tool is not set relative to another tool, the tool will only run once.

Group	Item	Description
Properties	(Measurement) Code Type	Select the appropriate code type from among the following options: • JAN/EAN/UPC • Code39 • Codabar • ITF • Code93 • Code128/GS1-128 • GS1 DataBar • Pharmacode
	(Measurement) Timeout	Set the time in milliseconds that can elapse before the tool execution is aborted. Any instances recorded before this time period is reached will be returned.
	(Measurement Detail) Composite	Enables the detection and reading composite code, defined as a combination of 1D and 2D barcode.
	(Measurement Detail) Check Digit	Select whether to perform a check using the check digit. When this is enabled, the check digit is not included in the returned character string.
	(Measurement Detail) Code Color	Enables the tool to read white code on a black background. This is disabled by default since standard barcode color is black on a white background.
	(Measurement Detail) Direct Pharma	Select the direction in which to read the code. By default, this set from left to right.
	(Measurement Detail) Magnify Level	Set the image magnify level to be applied when reading code. Increasing this value allows the tool to better read high-resolution images.
	(Measurement Detail) Group Separator Replacement String	Defines the character to be set between different strings in various code types. Enabling this allows the user to better control the string output.
	Show Result Graphics	Specifies if the graphics are drawn in the Vision Window.

Barcode Reading

The Barcode tool is typically configured relative to a Finder tool such as Locator or Shape Search 3 to locate and orient the region of interest on one barcode at a time. To configure, use an image with only one barcode present and configure the region of interest around the code with sufficient white space. Once the region has been set, the **Auto Tuning** button can be used to attempt to automatically configure many of the properties in the property grid, particularly Code Type, as shown in the previous figure. If Auto Tuning does not work properly, a small adjustment of the region of interest may resolve this. Note that the orientation of the region relative to the barcode must be close to 0°.

After the parameters have been set, the Barcode tool can be run like any other vision tool. Clicking the **Run** button executes the tool and returns a text string for each region of interest created using the Relative To property, as shown in the figure below.

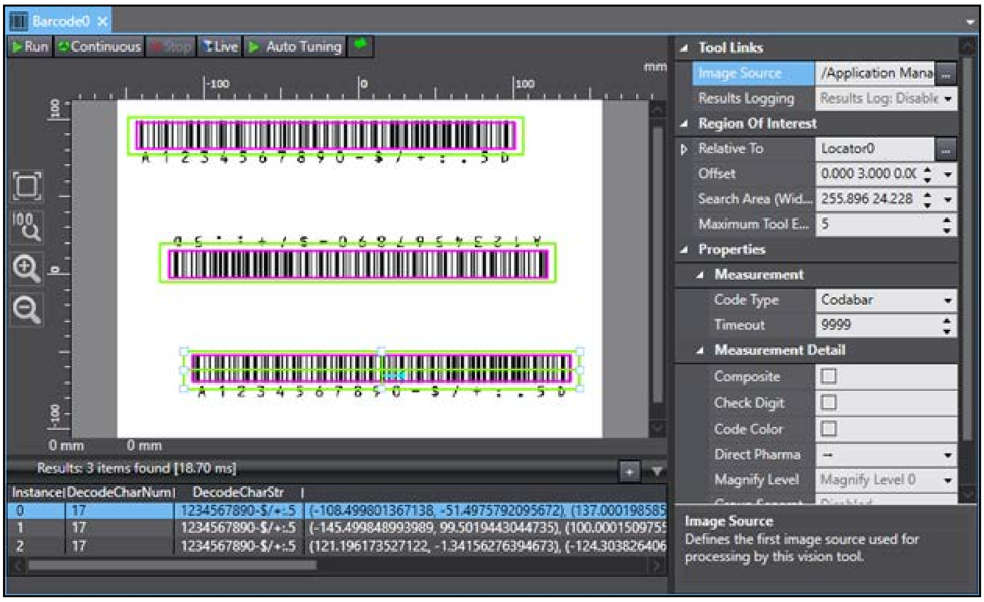

Figure 8-280 Barcode Relative To Workspace

Barcode Results

Use the table below to understand the results of the Barcode tool.

Table 8-91 Barcode Description

Item	Description
Instance	Index of the result instance.
DecodeCharNum	Number of decoded characters.
DecodeCharStr	String of decoded characters.
Detected Polygon	Vertices of the rectangle around the barcode.
ProcErrorCode	ProcErrorCode
1D Decode	1D decode, data range of 0 to 4.
1D Symbol Contrast	1D symbol contrast, data range of 0 to 4.
1D Minimum Reflection Ratio	1D minimum reflection ratio, data range of 0 to 4.
1D Minimum Edge Contrast	1D minimum edge contrast, data range of 0 to 4.
1D Modulation	1D modulation, data range of 0 to 4.

Item	Description
1D Defect	1D defect, data range of 0 to 4.
1D Decodability	1D decodability, data range of 0 to 4.
1D Additional	1D additional, data range of 0 to 4.
1D One Line Overall	1D one line overall.
PDF Decode	2D decode, data range of 0 to 4.
PDF Symbol Contrast	PDF symbol contrast, data range of 0 to 4.
PDF Minimum Reflection Ratio	PDF minimum reflection ratio, data range of 0 to 4.
PDF Minimum Edge Contrast	PDF minimum edge contrast, data range of 0 to 4.
PDF Modulation	PDF modulation, data range of 0 to 4.
PDF Defect	PDF defect, data range of 0 to 4.
PDF Decodability	PDF decodability, data range of 0 to 4.
PDF Additional	PDF additional, data range of 0 to 4.
PDF One Line Overall	PDF overall quality, data range of 0 to 4.
PDF Code Word Yield	Code word yield, data range of 0 to 4.
PDF Unused Error Correction	Unused error correction, data range of 0 to 4.
PDF Code Word Decodability	2D decodability, data range of 0 to 4
PDF Code Word Defect	2D defect, data range of 0 to 4.
PDF Code Word Modulation	Modulation 2D, data range of 0 to 4.
PDF Symbol Overall	PDF symbol overall.

Data Matrix

This tool reads a data matrix in a region of interest and returns text string data.

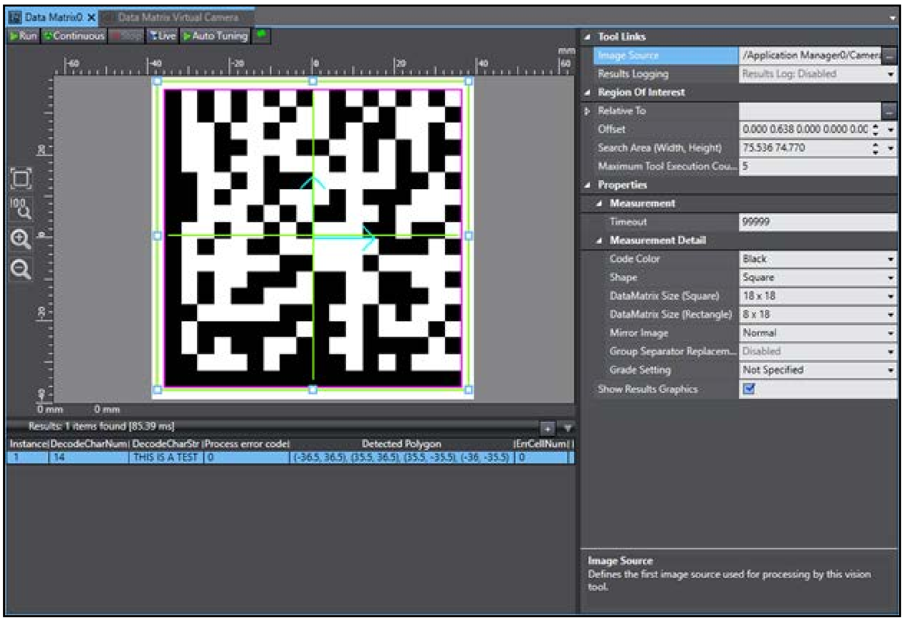

Figure 8-281 Data Matrix Tool Editor

To create a Data Matrix tool, right-click **Vision Tools** in the Multiview Explorer, select **Add Reader** and then **Data Matrix**. A Data Matrix tool will be added to the Vision Tools list.

Data Matrix Configuration Items

Use the table below to understand the Data Matrix configuration items.

Table 8-92 Data Matrix Configuration Item Description

Group	Item	Description
Tool Links	Image Source	Defines the image source used for processing by this vision tool.
	Results Logging	Enables logging of tool results to a file.
Region Of Interest	Relative To	The tool relative to which this tool executes. The output values of the selected tool are the input values of this one.
	Link Name	Select the property in the defined Relative To tool that will provide the input values.
	Current Values	Collection of current input values.
	Offset	Defines the center coordinates of the region.
	Search Area (Width, Height)	Defines the size of the region.
	Maximum Tool Execution Count	Maximum number of tool executions for Relative To performance. If this tool is not set relative to another tool, the tool will only run once.

Group	Item	Description
Properties	(Measurement) Timeout	Set the time in milliseconds that can elapse before the tool execution is aborted. Any instances recorded before this time period is reached will be returned.
	(Measurement Detail) Code Color	Select the color of the code. Select Auto to automatically detect the color, Black to look for black code on a white background, and White to look for white code on a black background.
	(Measurement Detail) Shape	Select the shape of the code. Select Auto tool to automatically detect the shape, Square to look for a square matrix, and Rectangle to look for a rectangular matrix.
	(Measurement Detail) Data Matrix Size (Square)	Only measured if Shape is set to Square or Auto and a square data matrix is detected. Select the size of the code in cells.
	(Measurement Detail) Data Matrix Size (Rectangle)	Only measured if Shape is set to Rectangle or Auto and a rectangular data matrix is detected. Select the size of the code in cells.
	(Measurement Detail) Mirror Image	Specify the direction in which the matrix will be read. Select Auto for the tool to automatically detect the direction, Normal for the matrix to be read normally, or Mirror for the matrix to be read in reverse.
	(Measurement Detail) Group Separator Replacement String	Defines the character to be set between different strings in various code types. Enabling this allows the user to better control the string output.
	(Measurement Detail) Grade Setting	Select the method of print quality evaluation. • Not Specified: no specific print quality. • ISO/IEC 15415: evaluate with ISO/IEC 15415 standard. • ISO/IEC TR 29158: evaluate with ISO/IEC TR 29158 standard.
	Show Result Graphics	Specifies if the graphics are drawn in the Vision Window.

Data Matrix Reading

The Data Matrix tool is typically configured relative to a Finder tool such as Locator or Shape Search 3 to decode all matrices in an image. To configure, use an image with only one matrix present and configure the region of interest around the code with sufficient white space. Once the region has been set, the Auto Tuning button can be used to attempt to automatically configure many of the properties in the property grid. If Auto Tuning does not work properly, increasing white space around the matrix or improving its alignment with the center of the matrix may resolve this.

After the parameters have been set, the Data Matrix tool can be run like any other vision tool. Clicking the **Run** button executes the tool and returns a text string for each region of interest created using the Relative To property.

Data Matrix Results

Use the table below to understand the results of the Data Matrix tool.

Table 8-93 Data Matrix Results Description

Item	Description
Instance	Index of the result instance.
DecodeCharNum	Number of decoded characters.
DecodeCharStr	String of decoded characters.
Detected Polygon	Coordinates of the vertices that form a rectangle around the matrix.
Process error code	Process error code.
ErrCellNum	ErrCellNum
Grade ISO15415 Integrated Quality	Integrated Quality.
Grade ISO15415 Decodability	Decode, range of 0 to 4.
Grade ISO15415 Symbol Contrast	Contrast, range of 0 to 4.
Grade ISO15415 Modulation	Modulation, range of 0 to 4.
Grade ISO15415 Fixed Pattern Damage	Fixed pattern damage, range of 0 to 4.
Grade ISO15415 Axial Nonuniformity	Axis nonuniformity, range of 0 to 4.
Grade ISO15415 Grid Nonuniformity	Grid nonuniformity, range of 0 to 4.
Grade ISO15415 Unused Error Correction	Correction of error not used, range of 0 to 4.
Grade ISO15415 Reflectance Margin	Reflectance, range of 0 to 4.
Grade ISO15415 Print Scale	Print expansion/contraction, range of 0 to 4.
Grade ISO15415 Print Scale X	Print expansion/contraction X, range of 0 to 4.
Grade ISO15415 Print Scale Y	Print expansion/contraction Y, range of 0 to 4.
Value ISO15415 Symbol Contrast	Symbol contrast, range of 0 to 4.
Value ISO15415 Axial Nonuniformity	Axis nonuniformity, range of 0 to 4.
Value ISO15415 Grid	Grid nonuniformity, range of 0 to 4.

Item	Description
Nonuniformity	
Value ISO15415 Unused error Correction	Correction of error not used, range of 0 to 4.
Value ISO15415 Print Scale	Print expansion/contraction, range of 0 to 4.
Value ISO15415 Print Scale X	Print expansion/contraction X, range of 0 to 4.
Value ISO15415 Print Scale Y	Print expansion/contraction Y, range of 0 to 4.
Grade ISOTR29158 Integrated Quality	Integrated Quality, range of 0 to 4.
Grade ISOTR29158 Cell Contrast	Contrast, range of 0 to 4.
Grade ISOTR29158 Self Modulation	Modulation, range of 0 to 4.
Grade ISOTR29158 Fixed Pattern Damage	Fixed pattern damage, range of 0 to 4.
Grade ISOTR29158 Axial Nonuniformity	Axis nonuniformity, range of 0 to 4.
Grade ISOTR29158 Grid Nonuniformity	Grid nonuniformity, range of 0 to 4.
Grade ISOTR29158 Unused Error Correction	Correction of error not used, range of 0 to 4.
Grade ISOTR29158 Print Scale	Print expansion/contraction, range of 0 to 4.
Grade ISOTR29158 Print Scale X	Print expansion/contraction X, range of 0 to 4.
Grade ISOTR29158 Print Scale Y	Print expansion/contraction Y, range of 0 to 4.
Value ISOTR29158 Cell Contrast	Contrast, range of 0 to 4.
Value ISOTR29158 Axial Uniformity	Axis nonuniformity, range of 0 to 4.
Value ISOTR29158 Grid Uniformity	Grid nonuniformity, range of 0 to 4.
Value ISOTR29158 Unused Error Correction	Correction of error not used, range of 0 to 4.
Value ISOTR29158 Print Scale	Print expansion/contraction, range of 0 to 4.
Value ISOTR29158 Print Scale X	Print expansion/contraction X, range of 0 to 4.
Value ISOTR29158 Print Scale Y	Print expansion/contraction Y, range of 0 to 4.

OCR

This tool detects text characters in images and compares them to an internal font property to output character strings. A custom user dictionary can also be prepared to recognize characters in special fonts using the OCR Dictionary tool. Refer to OCR Dictionary on page 596 for more information.

OCR provides a higher level of recognition stability than character inspection when reading closely spaced characters, curved text strings, and other deviational characters. It can also reference internal dictionary data, but a specialty dictionary only needs to be created if abnormal fonts are used.

> **NOTE:** Typical OCR applications use strings of number and capital letters. If the application involves detection of lower case letters, a user-defined OCR Dictionary is required.

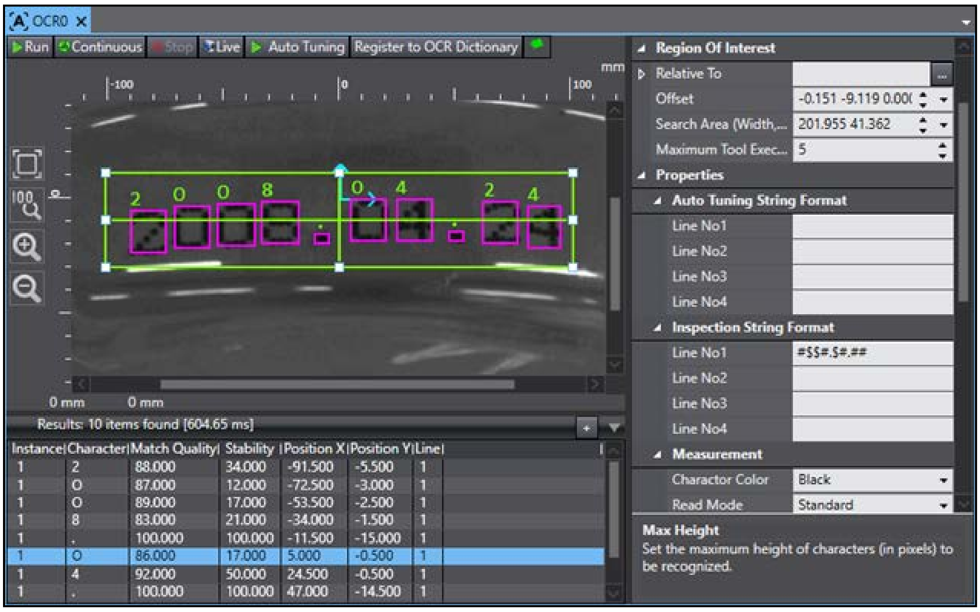

Figure 8-282 OCR Tool Editor

To create an OCR tool, right-click **Vision Tools** in the Multiview Explorer, select **Add Reader** and then **OCR**. An OCR tool will be added to the Vision Tools list.

OCR Configuration Items

Use the table below to understand the OCR configuration items.

Table 8-94 OCR Configuration Item Description

Group	Item	Description
Tool Links	Image Source	Defines the image source used for processing by this vision tool.
	OCR Dictionary	Defines which OCR Dictionary tool is used for reference and registering characters.
	Results Logging	Enables logging of tool results to a file.
Region Of Interest	Relative To	The tool relative to which this tool executes. The output values of the selected tool are the input values of this one.
	Link Name	Select the property in the defined Relative To tool that will provide the input values.

Group	Item	Description
	Current Values	Collection of current input values.
	Offset	Defines the center coordinates of the region.
	Search Area (Width, Height)	Defines the size of the region.
	Maximum Tool Execution Count	Maximum number of tool executions for Relative To performance. If this tool is not set relative to another tool, the tool will only run once.
Properties	(Auto Tuning String Format) Line No1/2/3/4	Enter the specific characters that are expected to be read in the region of interest. This defines what the tool will look for during the Auto Tuning process. If this field is left blank, it will not be populated. The generic characters can also be entered here. Refer to the Inspection String Format property for details.
	(Inspection String Format) Line No1/2/3/4	Enter the character types that are expected to be read in the region of interest. Enter "$" for a character, "#" for a number, and a symbol for that specific symbol. For example, if a slash is expected, "/" would be entered. If Auto Tuning String Format is populated, this will change to match it. Otherwise, it will be based on detected. If one of the characters in this property is changed and then the tool is run, the results will be based on this property.
	(Measurement) Character Color	Set the color of characters to be recognized.
	(Measurement) Read Mode	Set the reading method used. Standard can be selected for most applications. If there is a large gap between characters, select Fast.
	(Measurement) Delete Frame	Enables the removal of black pixels at the border of the measurement region as noise.
	(Measurement) Italic Robust	Enables the detection of italic characters.
	(Measurement) Rotation Robust	Enables detection of characters that are rotated relative to each other. The rotation range is ±15°.
	(Measurement Detail) Font	Set the font of the characters to be recognized. Select Common for most font types and Dot when the font is comprised of a series of dots.
	(Measurement Detail) Thick Threshold	Set the thickness of the characters to be recognized on a scale of 0-128. Higher values will improve reading of broken or fine characters.

Group	Item	Description
	(Measurement Detail) Dot Pitch X/Y	Set the dot pitch of characters to be recognized. When Font is set to Common, these define the horizontal (X) and vertical (Y) widths of character breaks. When Font is set to Dot, these define the horizontal (X) and vertical (Y) dot intervals.
	(Measurement Detail) Max Width	Defines the maximum width (in pixels) of characters to be recognized. This is disabled by default.
	(Measurement Detail) Max Height	Set the maximum height (in pixels) of characters to be detected.
	(Measurement Detail) Min Height (%)	Set the minimum height of characters to be recognized as a percentage of the Max Height property. Characters below this threshold are recognized as symbols.
	(Measurement Detail) Max Aspect Ratio	Set the maximum aspect ratio (calculated as height divided by width) of characters to be recognized. Characters with an aspect ratio greater than this value are recognized as special characters or symbols.
	(Measurement Detail) Hyphen Threshold	Set an upper and lower limit as a percentage of the closest neighboring character
	Show Results Graphics	Specifies if the graphics are drawn in the Vision Window.
	Results Display	Select the type of result marker to be displayed. Recognition Markers displays only markers related to recognized characters and All Markers displays markers for all characters.
	Cut out image display	Enables display to show all characters as cutouts. Recognized characters will be isolated on a white background. The gray region displayed in the cutout image display is the region bounded by the Dot Pitch X and Dot Pitch Y parameters.

OCR - Acquiring Text Strings

Clicking the Auto Tuning button will attempt to automatically detect the types of characters in the region. These will be displayed in the Inspection String Format section, as shown the previous figure. If the tool is not correctly tuning to the text, it can be manipulated using this section and Auto Tuning String Format.

For example the tool will try to find the best numerical matches for all the letters in Line 1 and the best letter matches for all the numbers in Line 2 if the corresponding lines in the Auto Tuning String Format section are set to the number symbol "#" and the character symbol "$", respectively. In this way, characters that are read inaccurately can be corrected to their proper form. The specific expected characters can also be entered to further improve the results.

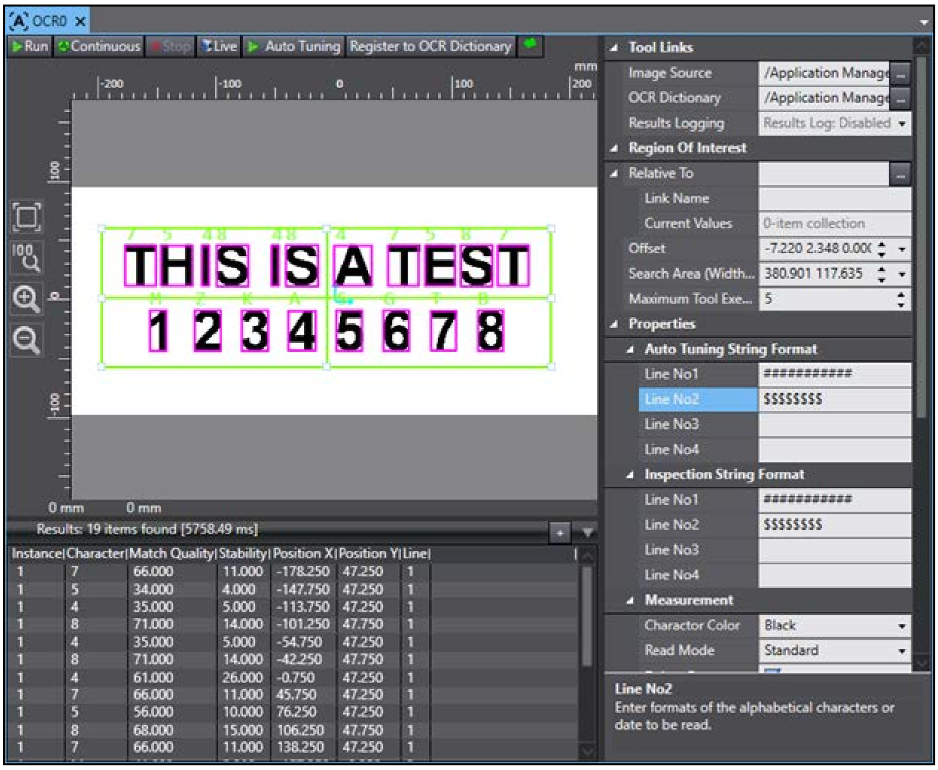

Figure 8-283 OCR Auto Tuning String Format

OCR - Registering to a Dictionary

With some fonts and applications, OCR incorrectly identifies a character or fails to distinguish one character from another. When this is the case, it is recommended to register these characters to an OCR Dictionary tool. OCR tools that reference an OCR Dictionary will compare detected characters to those saved in the dictionary before returning a text string.

To register detected characters to a dictionary, the OCR Dictionary property must be linked to an OCR Dictionary Tool. Clicking the **Register to OCR Dictionary** button will then allow the user to select what characters to save. Refer to the following figures for more information.

The registered characters do not need to match the appropriate character upon registration. For example, in Figure 8-285 the character in C is actually a 6. That can be moved now (as shown) or later in the OCR Dictionary tool. Refer to OCR Dictionary on page 596 for more information.

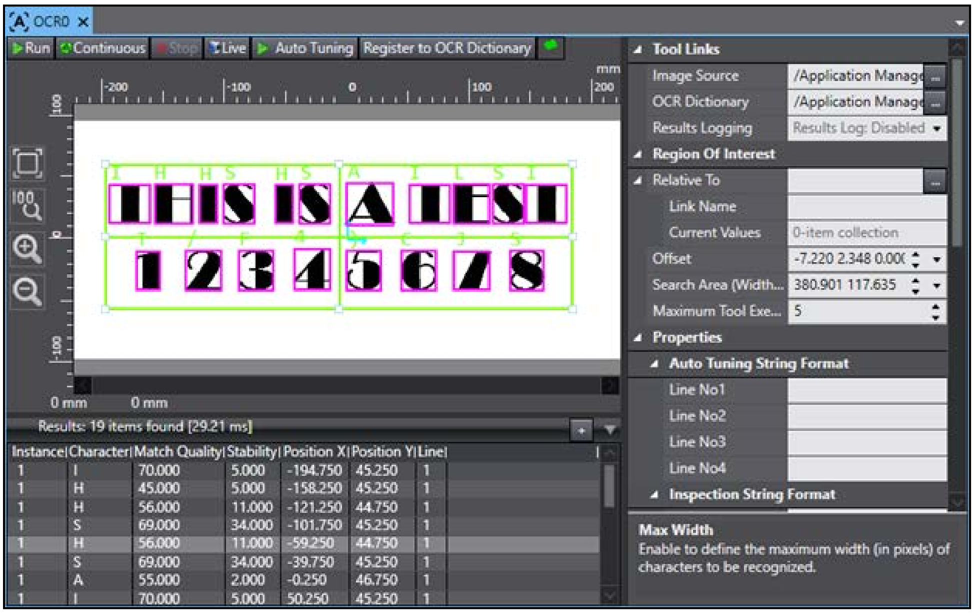

Figure 8-284 OCR Editor (Obscure Font)

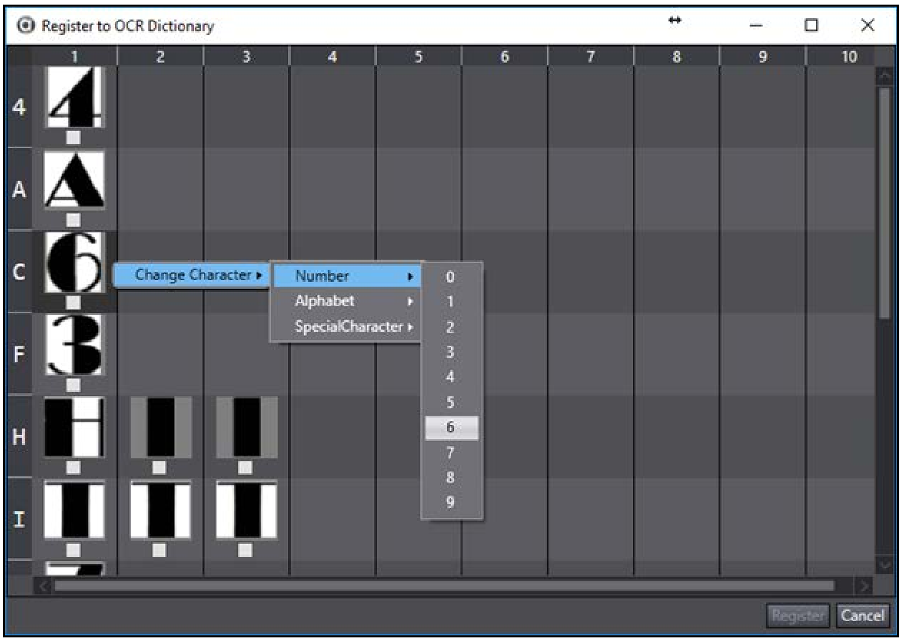

Figure 8-285 Register to OCR Dictionary

OCR Results

Use the table below to understand the results of the OCR tool.

Table 8-95 OCR Results Description

Item	Description
Instance	Index of the result instance, starting with 1.
Frame/Group	Index of the related result. It is associated with the tool that this tool is set Relative To. This will only be different if the Locator is set relative to another tool.
Character	Detected character identification.
Match Quality	Percentage that the detected character matches the recorded character in the internal dictionary or OCR Dictionary tool.
Stability	Measurement of how likely the character is to be the result that was identified.
Position X	X-coordinate of the detected character with respect to the image origin.
Position Y	Y-coordinate of the detected character with respect to the image origin.
Line	Character's line of text within the region of interest.

OCR Dictionary

This tool is used only as a reference for OCR tools and can only be configured for and populated by an OCR tool. It is used to save characters that the OCR identifies incorrectly or fails to identify. An OCR tool will first compare detected characters to an internal dictionary data and then to a referenced OCR Dictionary. Internal dictionary data cannot be modified. Refer to OCR on page 590 for more information.

Because OCR Dictionary is only a reference, it has no properties or results. It only contains data about registered characters.

> **NOTE:** The following figure shows the OCR Dictionary with some registered characters. The OCR Dictionary will appear blank if no characters have been registered.

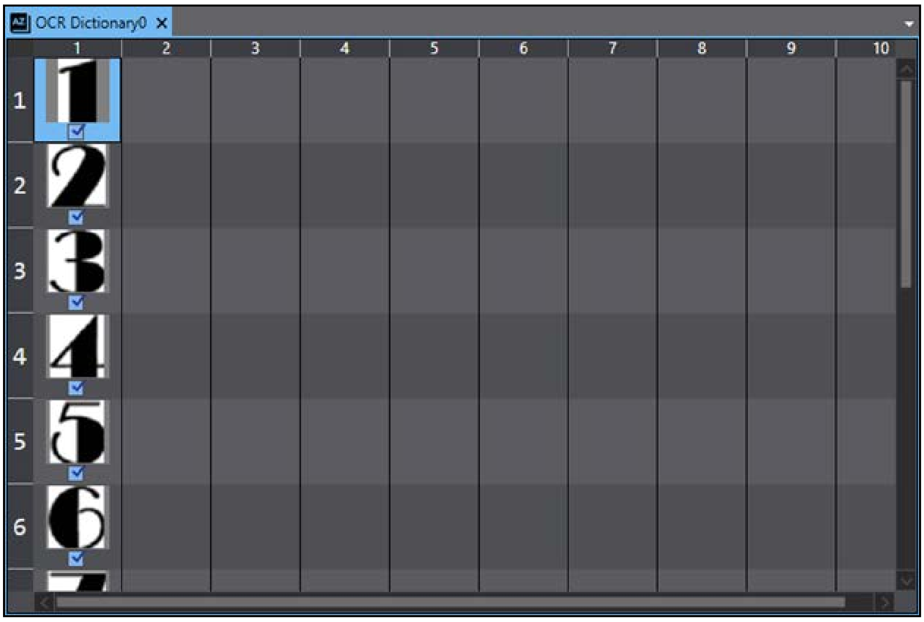

Figure 8-286 OCR Dictionary Tool Editor

To create an OCR Dictionary tool, right-click **Vision Tools** in the Multiview Explorer, select **Add Reader** and then **OCR Dictionary**. An OCR Dictionary tool will be added to the Vision Tools list.

OCR Dictionary Configuration

Up to ten dictionary entries can be registered for each character. If more than ten characters are registered, the tool will only save the first ten and remove the others.

The characters can be changed or deleted at any time by right-clicking on the figure. Selecting ***Delete*** will remove the entry from the dictionary. Selecting ***Change Character*** will allow the entry to be saved to any other character.

If the character to which the entry would be changed already contains ten entries, the entry will not move. shows the OCR Dictionary after all necessary changes have been made. The following figure shows one such change in progress.

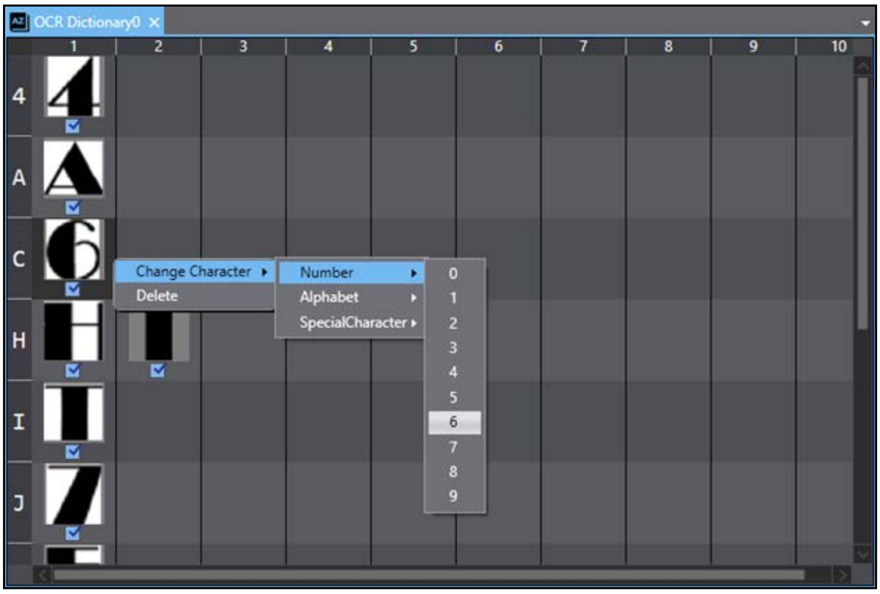

Figure 8-287 OCR Dictionary Entry Change

QR Code

This tool reads QR Codes and Micro QR Codes in the image and returns text string data.

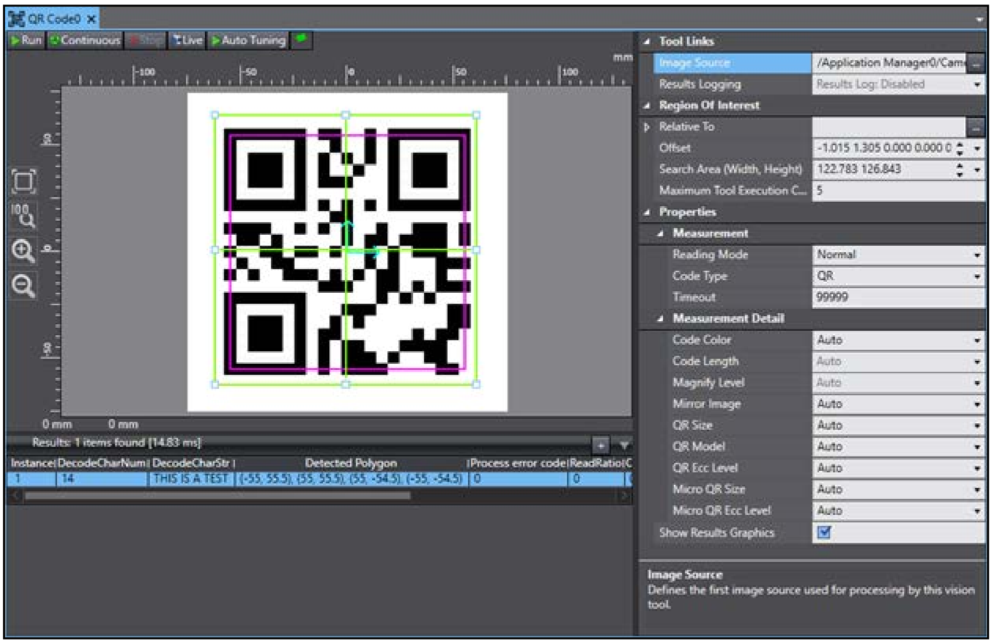

Figure 8-288 QR Code Tool Editor

To create a QR Code tool, right-click **Vision Tools** in the Multiview Explorer, click **Add Reader** and then click **QR Code**. The tool will be added to the Vision Tools list.

QR Code Configuration Items

Use the table below to understand the QR Code configuration items.

Table 8-96 QR Code Configuration Item Description

Group	Item	Description
Tool Links	Image Source	Defines the image source used for processing by this vision tool.
	Results Logging	Enables logging of tool results to a file.
Region Of Interest	Relative To	The tool relative to which this tool executes. The output values of the selected tool are the input values of this one.
	Link Name	Select the property in the defined Relative To tool that will provide the input values.
	Current Values	Collection of current input values.
	Offset	Defines the center coordinates of the region.
	Search Area (Width, Height)	Defines the size of the region.
	Maximum Tool Execution Count	Maximum number of tool executions for Relative To performance. If this tool is not set relative to another tool, the tool will only run once.
Properties	(Measurement) Reading Mode	Set the method of code reading. Select ***Normal*** for standard applications and DPM to read 2D code where direct parts marking (DPM) is applied.
	(Measurement) Code Type	Select the type of code from either QR or MicroQR.
	(Measurement) Timeout	Set the time in milliseconds that can elapse before the tool execution is aborted. Any instances recorded before this time period is reached will be returned.
	(Measurement Detail) Code Color	Select the color of the code. Select ***Auto*** to automatically detect the color, ***Black*** to look for black code on a white background, and ***White*** to look for white code on a black background.
	(Measurement Detail) Code Length	Specify the code length (in characters). Auto is enabled by default, causing the tool to automatically detect the number of characters. Disable this to set an exact number.
	(Measurement Detail) Magnify Level	Set the reduction ratio for images when reading code. This is automatically determined by the teaching process. Disable **Auto** to set it manually.
	(Measurement Detail) Mirror Image	Select the direction in which the tool will read the code. Select ***Auto*** for the tool to automatically detect the direction during the teaching process, ***Normal*** for the code to be read normally, or ***Mirror*** for the code to be read in reverse.

Group	Item	Description
	(Measurement Detail) QR Size	Only applicable if Code Type is set to QR. Select the size of the QR code (in cells). Select ***Auto*** for the size to be detected automatically.
	(Measurement Detail) QR Model	Only applicable if Code Type is set to QR. Set the QR code model. Select ***Auto*** for the model to be detected automatically.
	(Measurement Detail) QR Ecc Level	Select the code error correction (ECC) level. Select ***Auto*** to automatically adjust it as necessary.
	(Measurement Detail) Micro QR Size	Only applicable if Code Type is set to MicroQR. Select the size of the Micro QR code (in cells).
	(Measurement Detail) Micro QR Ecc Level	Only applicable if Code Type is set to MicroQR. Select the code error correction (ECC) level. Select ***Auto*** to automatically adjust it as necessary.
	Show Result Graphics	Specifies if the graphics are drawn in the Vision Window.

QR Code Reading

The QR Code tool is typically configured relative to a Finder tool such as Locator or Shape Search 3 to decode all codes in an image. To configure, use an image with only one QR Code present and configure the region of interest around it with sufficient white space.

Once the region has been set, the Auto Tuning button can be used to attempt to automatically configure many of the properties in the property grid. To expedite this, most of the properties are set to Auto by default so they automatically detect the necessary information. If Auto Tuning does not work properly, increasing white space around the code or improving its alignment with the center of the code may resolve this.

Auto Tuning will not function if the code around which the region of interest is aligned does not match the Code Type property. For example, if Code Type is set to MicroQR and the code in the image is a standard QR code, the data will not be output. Unlike most of the other properties, Code Type cannot be set automatically, so you must verify that it is accurate before running the tool.

After the parameters have been set, the QR Code can be run like any other vision tool. Clicking the **Run** Button executes the tool and returns a text string for each region of interest created using the Relative To property.

QR Code Results

Use the table below to understand the results of the QR Code tool.

Table 8-97 QR Code Results Description

Item	Description
Instance	Index of the result instance.
DecodeCharNum	Number of decoded characters.

Item	Description
DecodeCharStr	String of decoded characters.
Detected Polygon	Coordinates of the vertices that form a rectangle around the code.
Process error code	Process error code.
ReadRatio	Effective codeword ratio.
Contrast	Sharpness of an image on a scale of 0 to 100.
Focus	Number of false cell detections in the finder pattern, timing pattern, and data region.
ErrCellNum	ErrCellNum
Position	X/Y coordinates of the center of the detected QR code.
Angle	Angle of the detected QR code.

Calculation Tools

Calculation tools are used for calculating or refining detection points. The following Calculation tools are described in this section.

- Refer to Calculated Arc on page 601 for more information.
- Refer to Calculated Frame on page 604 for more information.
- Refer to Calculation Line on page 606 for more information.
- Refer to Calculated Point on page 609 for more information.

Calculated Arc

This tool is used to create a graphical circle enclosing an arc based on referenced elements. The circle can be used for tasks such as better defining a circular part or creating a clearance histogram. It can also be used to identify the center of a part with corners, as shown in the following figure.

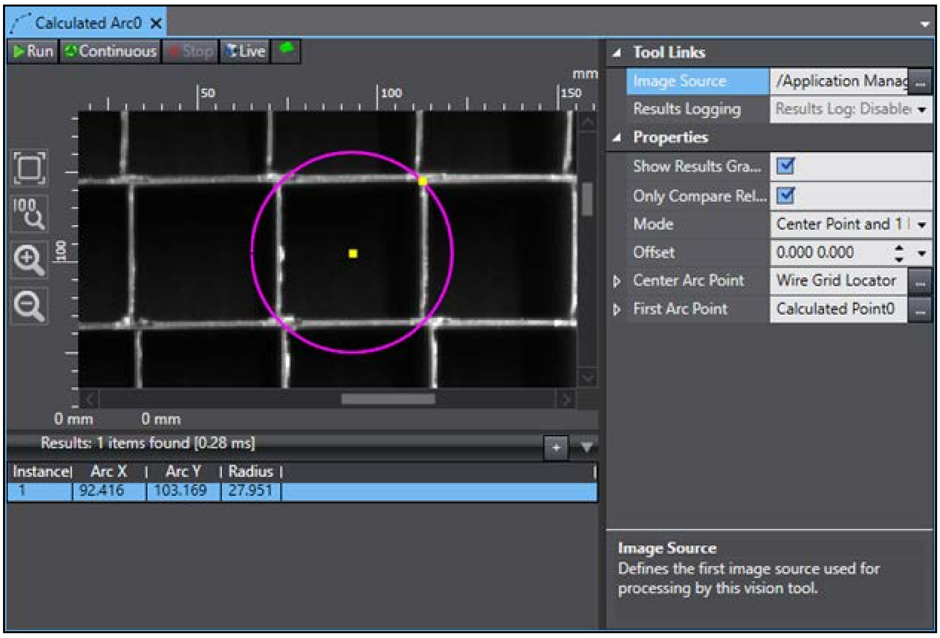

Figure 8-289 Calculated Arc Tool Editor

To create a Calculated Arc tool, right-click **Vision Tools** in the Multiview Explorer, select **Add Calculation** and then **Calculated Arc**. A Calculated Arc tool will be added to the Vision Tools list.

Calculated Arc Configuration Items

Use the table below to understand the Calculated Arc configuration items.

Table 8-98 Calculated Arc Configuration Item Description

Group	Item	Description
Tool Links	Image Source	Defines the image source used for processing by this vision tool.
	Results Logging	Enables logging of tool results to a file.
Properties	Show Results Graphics	Specifies if the graphics are drawn in the Vision Window.
	Only Compare Related Results	Specifies which results are compared. Enable to compare only those result values that are connected by instances. When disabled, all results are compared.
	Mode	Select the method used to calculate the frame. Refer to Calculated Arc Configuration Items on page 602 for more information.
	Offset	Defines the arc offset from the calculated location.
	First Arc Point	Select the tool that contains the first, second, or third point on the desired arc.

Group	Item	Description
	Second Arc Point	Select the tool that contains the appropriate point on the desired arc. Only available when Mode is set to Three Points On The Arc.
	Third Arc Point	Select the tool that contains the appropriate point on the desired arc. Only available when Mode is set to Three Points On The Arc.
	Center Arc Point	Select the tool that contains the center point for the arc. Only available when Mode is set to Center Point and 1 Point on Arc.
	Link Name	Select the property in the defined Relative To tool that will provide the input values. Available in all Point properties.
	Current Values	Additional property to all point properties. Collection of current input values. Available in all Point properties.

Calculated Arc - Mode Property

This property defines the way the arc is calculated. Depending on the selection, different tools and properties will need to be referenced. For example, the Center Point and 1 Point on Arc mode as shown in uses the properties Center Arc Point and First Arc Point to find the circumscribed circle of a grid square. The links to use for those properties are defined by clicking the ellipsis next to each property and then selecting the correct source. Only tools that yield the possible result will be shown in the box.

The possible mode types are listed below.

- Three Points On The Arc: Requires First Arc Point, Second Arc Point, and Third Arc Point. The arc is created across the three points and the center is calculated based on these.
- Center Point and 1 Point on Arc: Requires Center Arc Point and First Arc Point. The arc is created based on the center and calculated radius.

NOTE: All calculations are adjusted based on Offset.

Calculated Arc Results

Use the table below to understand the results of the Calculated Arc tool.

Table 8-99 Calculated Arc Results Description

Item	Description
Instance	Index of the result instance.
Frame/Group	Index of the related result. It is associated with the tool that this tool is set Relative To. This will only be different if the tool is set relative to another tool.

Item	Description
Arc X	X-coordinate of the arc center.
Arc Y	Y-coordinate of the arc center.
Radius	Calculated arc radius.
Opening	Opening of the arc in degrees. Since this tool always generates circles, this is invariably returned as 360.
Rotation	Rotation of the arc. This is always returned as 0.
Thickness	Thickness of the arc. This is always returned as 0.

Calculated Frame

This tool is used to create a vision frame from referenced elements. Frames allow placement of vision tools on objects that are not always in the same location or orientation. When a new vision tool is created, it can be specified to be relative to a vision frame. If the object that defines the vision frame moves, so will the frame and the tools that are relative to that frame.

> **Additional Information**: A fixed frame can also be created using this tool.

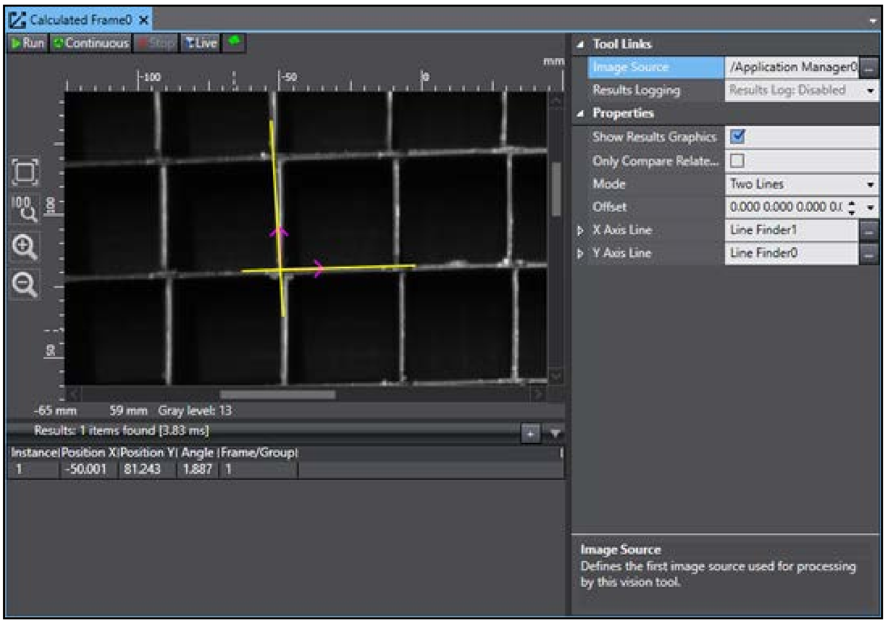

Figure 8-290 Calculated Frame Tool Editor

To create a Calculated Frame tool, right-click ***Vision Tools*** in the Multiview Explorer, click **Add Calculation** and then click **Calculated Frame**. A Calculated Frame tool will be added to the Vision Tools list.

Calculated Frame Configuration Items

Use the table below to understand the Calculated Frame configuration items.

Table 8-100 Calculated Frame Configuration Item Description

Group	Item	Description
Tool Links	Image Source	Defines the image source used for processing by this vision tool.
	Results Logging	Enables logging of tool results to a file.
Properties	Show Results Graphics	Specifies if the graphics are drawn in the Vision Window.
	Only Compare Related Results	Specifies which results are compared. Enable to compare only those result values that are connected by instances. When disabled, all results are compared.
	Mode	Select the method used to calculate the frame. Refer to Calculated Frame Configuration Items on page 604 for more information.
	Offset	Defines the frame offset from the calculated location. If Mode is set to Fixed, this refers to the offset from the image origin.
	X Axis Line	Select the tool that contains the appropriate line. Only available when Mode is set to Two Lines or Origin Point Following Line Angle.
	Y Axis Line	Select the tool that contains the appropriate line. Only available when Mode is set to Two Lines.
	Origin Point	Select the tool that contains the appropriate point. Only available when Mode is set to Two Points, One Point, or Origin Point Following Line Angle.
	Positive X Point	Select the tool that contains the appropriate point. Only available when Mode is set to Two Points.
	Origin Transform	Select the tool that contains the appropriate point. Only available when Mode is set to Frame Relative.
	Link Name	Select the property in the defined Relative To tool that will provide the input values. Available in all Line, Point, and Transform properties.
	Current Values	Collection of current input values. Available in all Line, Point, and Transform properties.

Calculated Frame - Mode Property

This property defines the way the frame is calculated. Depending on the selection, different tools and properties will need to be referenced. For example, the Two Lines mode as shown in uses the properties X Axis Line and Y Axis Line. The links to use for those properties are selected by clicking the ellipsis next to each property and then selecting the correct source. Only tools that yield the possible result will be shown in the box. Points are generated from most tools, but lines are only generated by Calculated Line and Line Finder tools.

The possible mode types are listed below.

- Two Lines: Requires X Axis Line and Y Axis Line. The frame is positioned at the intersection and oriented so that the X-axis is collinear with X Axis Line.
- Two Points: Requires Origin Point and Positive X Point. The frame is positioned at Origin Point and oriented so that the X-axis points towards Positive X Point.
- Fixed: No required references. The frame is positioned according to the Offset property.
- One Point: Requires Origin Point. The frame is positioned and oriented to match Origin Point.
- Frame Relative: Requires Origin Transform. The frame is positioned and oriented to match Origin Transform.
- Origin Point Following Line Angle: Requires Origin Point and X Axis Line. The frame is positioned at Origin Point and oriented so that the X-axis is parallel to X Axis Line.

NOTE: All calculations are adjusted based on Offset unless otherwise specified.

Calculated Frame Results

Use the table below to understand the results of the Calculated Frame tool.

Table 8-101 Calculated Frame Results Description

Item	Description
Instance	Index of the result instance.
Frame/Group	Index of the related result. It is associated with the tool that this tool is set Relative To. This will only be different if the tool is set relative to another tool.
Position X	X-coordinate of the instance origin.
Position Y	Y-coordinate of the instance origin.
Angle	Angle of the instance with respect to the X-axis of the camera coordinate system.

Calculation Line

This tool is used to create lines based on referenced elements These lines are primarily used to create other graphical features, such as a Calculated Point or Calculated Frame.

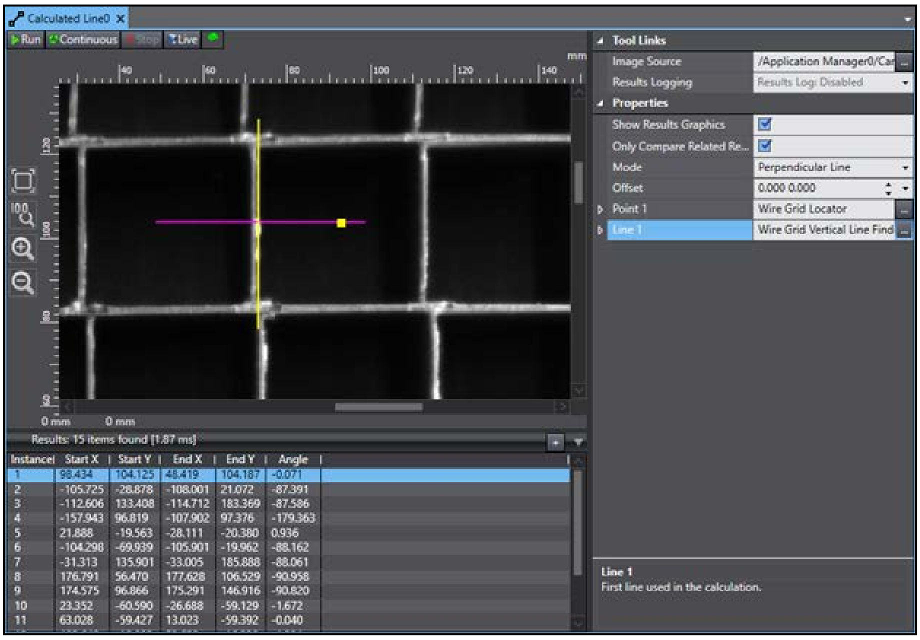

Figure 8-291 Calculated Line Tool Editor

To create a Calculated Line tool, right-click **Vision Tools** in the Multiview Explorer, select **Add Calculation** and then **Calculated Line**. A Calculated Line tool will be added to the Vision Tools list.

Calculated Line Configuration Items

Use the table below to understand the Calculated Line configuration items.

Table 8-102 Calculated Line Configuration Item Description

Group	Item	Description
Tool Links	Image Source	Defines the image source used for processing by this vision tool.
	Results Logging	Enables logging of tool results to a file.
Properties	Show Results Graphics	Specifies if the graphics are drawn in the Vision Window.
	Only Compare Related Results	Specifies which results are compared. Enable to compare only those result values that are connected by instances. When disabled, all results are compared.
	Mode	Select the method used to calculate the line. Refer to Calculated Line Configuration Items on page 607 for more information.
	Offset	Defines the line offset from the calculated location.
	Point 1	Select the tool that contains the first endpoint of

Group	Item	Description
		the line.
	Point 2	Select the tool that contains the second endpoint of the line. Only available when Mode is set to Two Points.
	Line 1	Select the tool that contains the line perpendicular to the calculated line. Only available when Mode is set to Perpendicular Line.
	Link Name	Select the property in the defined Relative To tool that will provide the input values. Available in all Line, Point, and Transform properties.
	Current Values	Collection of current input values. Available in all Line, Point, and Transform properties.

Calculated Line - Mode Property

This property defines the way the line is calculated. Depending on the selection, different tools and properties will need to be referenced. For example, the Perpendicular Line mode as shown in uses the properties Point 1 and Line 1. The links to use for those properties are selected by clicking the ellipsis next to each property and then selecting the correct source. Only tools that yield the possible result will be shown in the box. Points are generated from most tools, but lines are only generated by Calculated Line and Line Finder tools.

The possible mode types are listed below.

- Two Points: Requires Point 1 and Point 2. The line is positioned between the two points.
- Perpendicular Line: Requires Point 1 and Line 1. The line is positioned with an endpoint at Point 1 and passes through Line 1 so that the two lines are perpendicular.

NOTE: All calculations are adjusted based on Offset.

Calculation Line Results

Use the table below to understand the results of the Calculation Line tool.

Table 8-103 Calculation Line Results Description

Item	Description
Instance	Index of the result instance.
Frame/Group	Index of the related result. It is associated with the tool that this tool is set Relative To. This will only be different if the tool is set relative to another tool.
Start X	X-coordinate of the first endpoint.
Start Y	Y-coordinate of the first endpoint.

Item	Description
Center X	X-coordinate of the midpoint.
Center Y	Y-coordinate of the midpoint.
End X	X-coordinate of the second endpoint.
End Y	Y-coordinate of the second endpoint.
Angle	Calculated angle of the line with respect to the X-axis of the camera coordinate system.

Calculated Point

This tool is used to create points based on referenced elements. These points can be used to create other graphical features, such as Calculated Arc or Calculated Line, or to act as a reference point from which other measurements can be made.

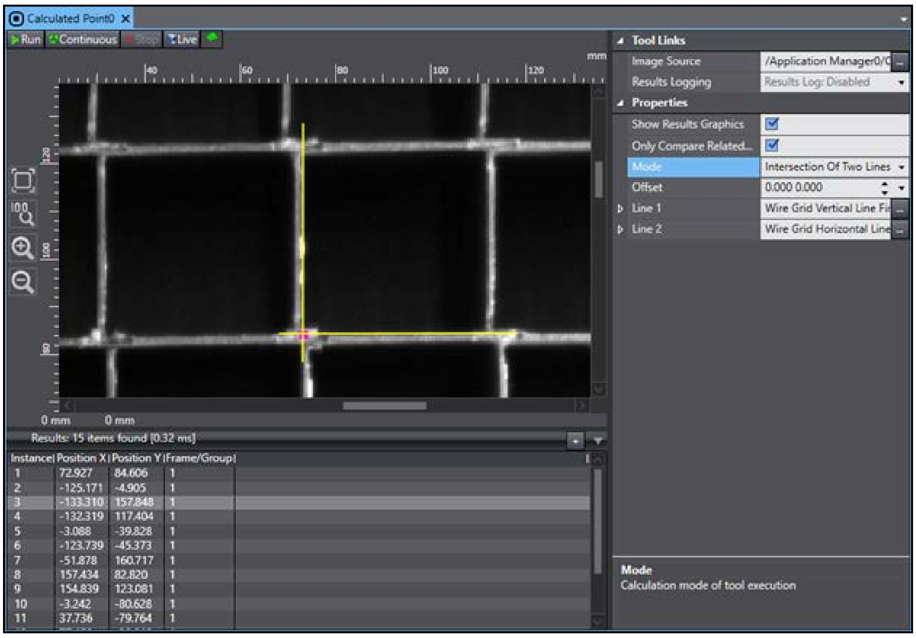

Figure 8-292 Calculated Point Tool Editor

To create a Calculated Point tool, right-click **Vision Tools** in the Multiview Explorer, select **Add Calculation** and then **Calculated Point**. A Calculated Point tool will be added to the Vision Tools list.

Calculated Point Configuration Items

Use the table below to understand the Calculated Point configuration items.

Table 8-104 Calculated Point Configuration Item Description

Group	Item	Description
Tool Links	Image Source	Defines the image source used for processing by this vision tool.

Group	Item	Description
	Results Logging	Enables logging of tool results to a file.
Properties	Show Results Graphics	Specifies if the graphics are drawn in the Vision Window.
	Only Compare Related Results	Specifies which results are compared. Enable to compare only those result values that are connected by instances. When disabled, all results are compared.
	Mode	Select the method used to calculate the point. Refer to Calculated Point Configuration Items on page 609.
	Offset	Defines the point's offset from the calculated location.
	Point 1	Select the tool that contains the first reference point. Only available when Mode is set to Midpoint, Point On A Line Closest To A Point, or Point On An Arc Closest To A Point.
	Point 2	Select the tool that contains the second reference point. Only available when Mode is set to Midpoint.
	Line 1	Select the tool that contains the first reference line. Only available when Mode is set to Point On A Line Closest To A Point, Line – Arc Intersection, or Intersection Of Two Lines.
	Line 2	Select the tool that contains the second reference line. Only available when Mode is set to Intersection Of Two Lines.
	First Arc	Select the tool that contains the first reference arc. Only available when Mode is set to Point On An Arc Closest To A Point, Line – Arc Intersection, or Intersection of Two Arcs.
	Second Arc	Select the tool that contains the second reference arc. Only available when Mode is set to Intersection of Two Arcs.
	Link Name	Select the property in the defined Relative To tool that will provide the input values. Available in all Line, Point, and Transform properties.
	Current Values	Collection of current input values. Available in all Line, Point, and Transform properties.

Calculated Point - Mode Property

This property defines the way the point is calculated. Depending on the selection, different tools and properties will need to be referenced. For example, the Intersection Of Two Lines mode as shown in uses the properties Line 1 and Line 2. The links to use for those properties are selected by clicking the ellipsis next to each property and then selecting the correct source. Only tools that yield the correct type of result will be shown in the box. Points are generated by most tools, but lines and arcs are only generated by Calculated Arc/Line and Arc/Line Finder tools.

The possible mode types are listed below.

- Midpoint: Requires Point 1 and Point 2. The point is positioned halfway between the two points.
- Point On A Line Closest To A Point: Requires Point 1 and Line 1. The point is positioned on the line as close to the reference point as possible.
- Point On An Arc Closest To A Point: Requires Point 1 and First Arc. The point is positioned on the arc as close to the reference point as possible.
- Fixed: No required references. The frame is positioned according to the Offset property.
- Line – Arc Intersection: Requires First Arc and Line 1. The point is the positioned at the intersection of the line and the arc.
- Intersection Of Two Lines: Requires Line 1 and Line 2. The point is positioned at the intersection of the two lines.
- Intersection of Two Arcs: Requires First Arc and Second Arc. The point is positioned at the intersection of the two points.

NOTE: All calculations are adjusted based on Offset unless otherwise specified.

Calculated Point Results

Use the table below to understand the results of the Calculated Point tool.

Table 8-105 Calculated Point Results Description

Item	Description
Instance	Index of the result instance.
Frame/Group	Index of the related result. It is associated with the tool that this tool is set Relative To. This will only be different if the tool is set relative to another tool.
Position X	X-coordinate of the point location.
Position Y	Y-coordinate of the point location.

Image Process Tools

Image Process tools are used to manipulate image data. The output image of an Image Process tool can be used as an Image Source by another tool.

The following Image Process tools are described in this section.

- Refer to Advanced Filter on page 612 for more information.
- Refer to Color Matching on page 621 for more information.
- Refer to Image Processing on page 624 for more information.

- Refer to Image Sampling on page 629 for more information.
- Refer to Position Compensation on page 632 for more information.

Advanced Filter

This tool applies a filter or operation to the input image to better facilitate processing by other tools, including additional Advanced Filters. It can be used to perform tasks such as Background Suppression, Color Gray Filter, Erosion/Dilation, and edge extraction. In this way, it can prepare the image to be used by less versatile tools. For example, the Background Suppression filter shown in the following figure can be used by a Locator or Shape Search 3 tool to more easily detect the poker chips.

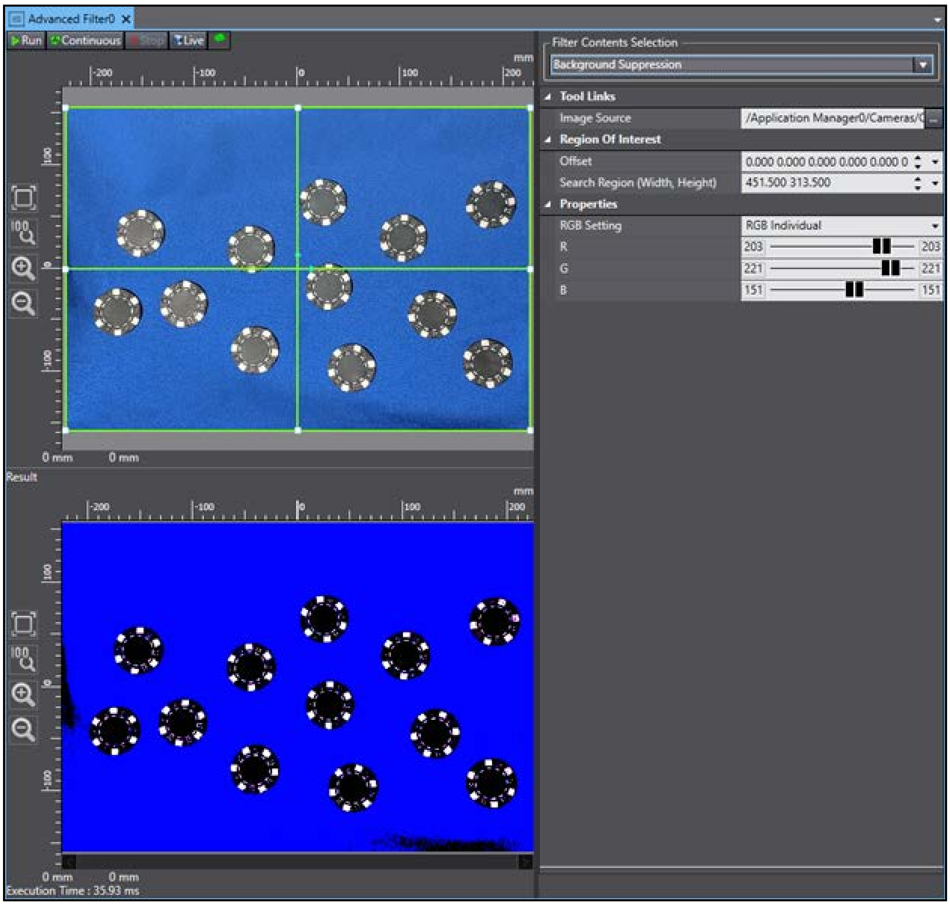

Figure 8-293 Advanced Filter Tool Editor

To create an Advanced Filter tool, right-click **Vision Tools** in the Multiview Explorer, select **Add Image Process** and then click **Advanced Filter**. An Advanced Filter tool will be added to the Vision Tools list.

NOTE: The Advanced Filter is also available through the Recipe Manager.

Advanced Filter - Filter Contents Selection

The following filters can be applied by selecting the appropriate option in Filter Contents Selection.

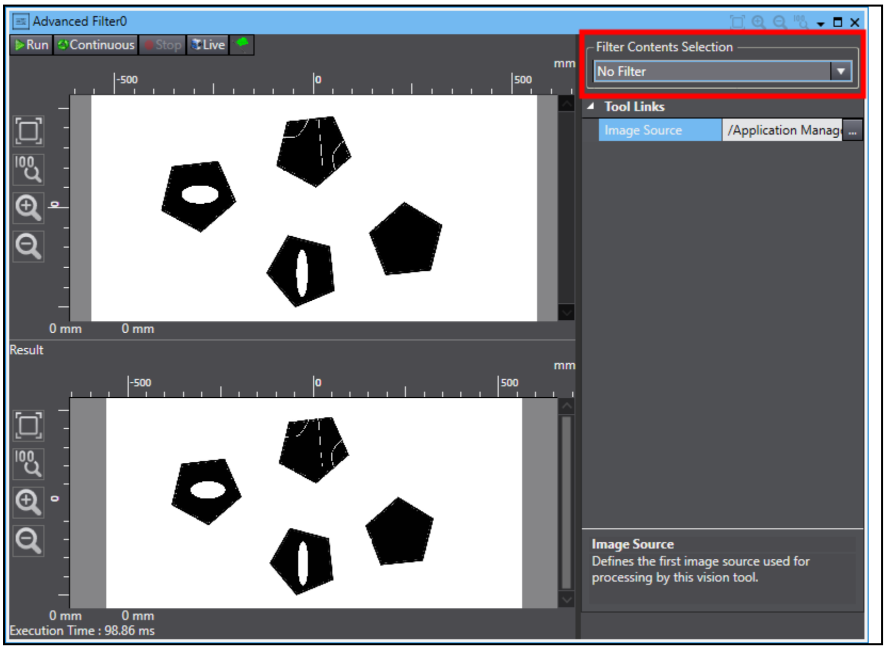

Figure 8-294 Advanced Filter - Filter Contents Selection

No Filter

This is the default setting and makes no change to the input image. This setting is typically used to temporarily disable Advanced Filter during testing and creation of the application. It has no practical use during run time.

Smoothing Weak/ Strong

This filter blends each pixel value with the others in its neighborhood to blur the image, a process used to reduce detail and emphasize deviations. This is used to blur an image to emphasize contrast. In particular, it can be used to reduce deviations between individual pixels to make consistent deviations more distinct, thus improving edge detection. Smoothing Weak and Smoothing Strong filters function by using a Gaussian blur to distribute color / gray level within neighborhoods of pixels. Smoothing Strong does this to a higher degree than Smoothing Weak.

Dilation

This filter changes the value of each pixel to the brightest (highest gray level value) within its neighborhood. This is used to artificially raise the brightness of an image. Dilation determines the highest gray level value within a kernel and then changes all pixels within that kernel to match it.

> **NOTE:** Since large sections of pixels are changing each time the tool is run, the quality of the image decreases with each iteration.

Erosion

This filter changes the value of each pixel to the darkest (lowest gray level value) within its neighborhood. This is used to artificially lower the brightness of an image. Erosion determines the lowest gray level value within a kernel and then changes all pixels within that kernel to match it.

Similar to Dilation, the quality of the image decreases with each iteration.

Median

This filter changes the value of each pixel to the median gray level value of the pixels within its neighborhood. This is used to reduce details and defects while maintaining the overall shapes and edges within an image. Median determines the median values within a neighborhood and enhances those over the other pixels.

Similar to Dilation and Erosion, the quality of the image decreases with each iteration.

Edge Extraction

This filter changes all pixels to black except for those on detected edges. If there is a strong deviation between pixels, then those pixels are highlighted. Otherwise, they are changed to black to emphasize the edges.

Horizontal Edge Extraction

This filter performs Edge Extraction only with edges detected from deviations that would result in horizontal edges.

Vertical Edge Extraction

This filter performs Edge Extraction only with edges detected from deviations that would result in vertical edges.

Edge Enhance

This filter blends pixel values along detected deviations to increase edge visibility. This emphasizes the deviation between touching dark and light regions. It is mainly used in the case of blurry images to clearly show the offset between light and dark regions.

Color Gray Filter

This filter returns a gray scale image by setting a standard white color. The image can be process based on RGB or HSV colors.

When RGB is selected, the option selected in the RGB Filter property will define the governing color scheme of the filter. For example, if Red is selected in the RGB Filter property, the gray level value in the resulting pixels will be equal to the red value of the original pixels. This works similarly for HSV except that everything outside of the defined tolerances will become black in the resultant image. Refer to Color Spaces on page 476 for more information.

Background Suppression

This filter sets a threshold for gray level or individual / collective color level to filter backgrounds. It is designed to filter out the background of images in order to emphasize the targets in the image. This supports both gray scale and color images. In both cases, a defined range of color or gray level values will be passed through the filter.

All pixels with color levels or gray level below the range will be converted to black and all pixels above the range will be converted to white (or Red, Green, or Blue, if RGB Setting is set to RGB Individual).

Labeling

Similar to the Labeling tool, this filter isolates masses of pixels that fall within a certain color range and meet different extraction conditions. You can set a single color by right-clicking in the image or a color range by right-clicking and dragging to establish a region. Alternatively, you can manually enter the colors using the Color Region section in the Properties.

Once one or more color thresholds have been established, the tool will filter everything out of the image except for the pixels that fall within the ranges. Additional extraction conditions can be set to further limit the identified regions. Unlike the Labeling tool, the regions are not returned as data. Instead, Labeling Filter results in a new image.

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Image Operation/ 2 Image Operation

The Image Operation filter uses mathematical or bit operations to alter the value of pixels using a constant operand value.

The 2 Image Operation filter uses mathematical or bit operations to alter the value of pixels by using a second image as an operand.

In a 2 Image Operation filter, the images must be the same size and type (monochrome or color) and the operand value is the gray level or color value of corresponding pixels. The operation options are listed below.

- Arithmetic Operation: Perform a mathematical calculation between the two values.
  - Add: Add the operand value to the pixel gray level to a maximum of 255.
  - Subtraction: Subtract the operand value from the pixel gray level to a minimum of 0.
  - Subtraction (Absolute): Subtract the operand value from the pixel gray level with no minimum. The resulting gray level will be the absolute value of the operation result.
  - Multiplication: Multiply the operand value by the pixel gray level to a minimum of 0 and a maximum of 255.
  - Multiplication (Normalization): Performs a multiplication operation and then normalizes for brightness.
  - Average: Only available for 2 Image Operations. Returns the average of the corresponding pixel values.
  - Maximum: Only available for 2 Image Operations. Returns the maximum of the corresponding pixel values.
  - Minimum: Only available for 2 Image Operations. Returns the minimum of the corresponding pixel values.
- Bit Operation: Perform a logical test on the image.

- NOT: Reverses the RGB or gray level polarity of the image, regardless of the operand value.
- AND: Performs an AND operation on the pixels by comparing the binary digits of the two values. It is generally used to compare two images. It can also be used in masking.
- OR: Performs an OR operation on the pixels by comparing the binary digits of the two values. It is generally used to merge two images together.
- XOR: Performs an XOR operation on the pixels by comparing the binary digits of the two values. It is generally used to create a binary image (black and white).

- NAND: Performs a NAND operation on the two pixels by comparing the binary digits of the two values. Like AND, this is used to compare images, but it also essentially returns negatives of what the AND result would be.
- NOR: Performs a NOR operation on the pixels by comparing the binary digits of the two values. It is generally used to merge two images together and return the negatives.
- XNOR: Performs an XNOR operation on the pixels by comparing the binary digits of the two values. It is generally used to create a negative binary (black and white) image.

- Bit Shift: Shift the values of the binary digits to the left or right. The bits on the digit that is shifted away from (first digit in a right shift and last digit in a left shift) becomes 0. This is only available in a single image operation. This is used when Arithmetic Multiplication is too computationally taxing.
- Change Pixel Value: Assign a fixed value to all pixels that fall within a certain gray level range. Change Pixel Value defines the resulting gray level and the Bounds define the range to be changed or retained, depending on the Change Pixel Mode.

Advanced Filter Configuration Items

The properties of Advanced Filter change depending on what type of filter is selected in Filter Contents Selection. The table below shows all properties.

The Filter Contents Selection column defines those filter(s) for which the property is available. If it is blank, the property is available for all or most of them.

Table 8-106 Advanced Filter Configuration Item Description

Group	Filter Contents Selection	Item	Description
Tool Links	---	Image Source	Defines the image source used for processing by this vision tool.
	2 Image Operation	Image Source2	Defines the second image source used as the operand for 2 Image Operations.
Region Of Interest	---	Offset	Defines the center coordinates of the region.
	---	Search Region (Width, Height)	Defines the size of the region.
Properties	---	Iteration	Defines the amount of iterations the filter will run each time this tool is initiated.
	---	Kernel Size	Sets the size of pixel neighborhoods used in the processing of this tool.
	Color Gray Filter	Filter Kind	Select whether the image will be filtered in RGB or HSV.
	Color Gray Filter	RGB Filter	Determines what RGB value (s) will be considered to be the gray level value in the resulting image. Only available when Filter Kind is set to RGB.
	Color Gray Filter	Gain (Red/Green/Blue)	These set the scale from 0-1 of how the gray level value is calculated. Only available when Filter Kind is set to RGB and RGB Filter is set to custom.
	Color Gray Filter	Standard Hue	Defines the nominal hue color that the filter will return on a 360-degree circle. Red is 0, green is 120, and blue is 240. Only available when Filter Kind is set to HSV.
	Color Gray Filter	Hue Range	Sets the tolerance for the Hue value within which the gray level value will be returned. Only available when Filter Kind is set to HSV.

Group	Filter Contents Selection	Item	Description
	Color Gray Filter	Color Chroma	Set the bounds for the filter's saturation range.
	Background Suppression	Gray	Sets the gray level threshold to be retained in the results. Only available with gray scale images.
	Background Suppression	RGB Setting	RGB Common adjusts R, G, and B all together and RGB Individual adjusts them separately. Only available with color images. Select the method of color threshold creation.
	Background Suppression	RGB Common	Sets the threshold of color to be retained in the results. Only available with color images and when RGB Setting is set to RGB Common.
	Background Suppression	R/G/B	Sets the threshold of each individual color setting to be retained in the results. Only available with color images and when RGB Setting is set to RGB Individual.
	Labeling Filter	Hole Plug Color	When enabled, sets the color that will fill all holes in the detected masses.
	Labeling Filter	Outside Trimming	When enabled, everything outside of the region of interest will be returned as the extracted color.
	Labeling Filter	Labeling Select	Allows the selection of a single extracted mass. The sort condition and number define which one will be selected.
	Labeling Filter	Neighborhood Mode	Defines the ways pixels will be connected in order to qualify as a single mass. 4 Neighborhood will only allow pixels to connect to others that are up, down, left, or right, while 8 Neighborhood will also connect diagonal directions.

Group	Filter Contents Selection	Item	Description
	Labeling Filter	Extract Condition 1/2/3	Define the conditions this tool will consider when extracting masses from the image. Conditions can be set by the type (kind) and minimum and maximum values.
	Labeling Filter	Extract Condition Setting	Define how the combined extraction settings will behave. Select ***And*** to return only those masses that satisfy all conditions and ***Or*** to return masses that satisfy any condition.
	Labeling Filter	Binary Image	Returns a monochrome image.
	Image Operation/2 Image Operation	Operation Type	Defines the type of operation that will be performed on the image(s).
	Image Operation/2 Image Operation	Arithmetic Mode	Set the type of operation to be performed on the image(s). Only available when Operation Type is set to ***Arithmetic Operation***. Refer to Advanced Filter Configuration Items on page 616 for more information.
	Image Operation	Arithmetic Value	Set the operand value for the arithmetic operation. Only available when Operation Type is set to ***Arithmetic Operation***.
	Image Operation/2 Image Operation	Operation Mode	Set the type of operation to be performed on the image(s). Only available when Operation Type is set to ***Bit Operation***. Refer to Advanced Filter Configuration Items on page 616 for more information.
	Image Operation	Operation Value	Set the operand value for the bit operation. Only available when Operation Type is set to ***Bit Operation***.
	Image Operation	Bit Shift Mode	Set the type of operation to be

Group	Filter Contents Selection	Item	Description
			performed on the image. Only available when Operation Type is set to ***Bit Shift***. Refer to Advanced Filter Configuration Items on page 616 for more information.
	Image Operation	Bit Shift Value	Set the operand value for the bit shift. Only available when Operation Type is set to ***Bit Shift***.
	Image Operation	Change Pixel Mode	Select whether the pixels outside or inside the bounds will be changed. Only available when Operation Type is set to ***Change Pixel Value***.
	Image Operation	Change Pixel Value	Set the gray level value to which pixels will be changed. Only available when Operation Type is set to Change Pixel Value.
	Image Operation	Bounds	Set the bounds that define what gray level values will be changed or retained. Only available when Operation Type is set to ***Change Pixel Value***.

Configuring the Advanced Filter

The Advanced Filter tool can execute several types of functions on an image, so it is important that the appropriate choice is selected from the Filter Contents Selection menu before any other changes are made. The Properties will adjust to match the type of filter.

There is no generic way to configure this type of tool because it is designed to perform a multitude of different operations. However, in general, the tool is operated by first adjusting the region of interest to the appropriate location and size. The exception to this is Color Gray Filter, which does not have a region of interest. Any filters or operations performed will take place only within the established region.

Most filter types require the Iteration and Kernel Size item. The Iteration value can be increased for the tool to run multiple times whenever executed. This leads to higher processing time, but it can be useful to remove detail from an image. Conversely, Kernel Size affects the size of the pixel neighborhoods. Larger selections lead to fewer calculations and faster processing time. Modifying these will impact performance and can be used to yield optimum images.

Several filters use both RGB and HSV color schemes. Refer to Color Spaces on page 476 for more information.

Advanced Filter Results

Advanced Filter returns a modified image that can be used by other vision tools. To do this, set Advanced Filter as the Image Source property of the subsequent tool. The resultant image can be viewed in the Result section of the object editor. Refer to for an example.

Color Matching

This tool searches and analyzes images to find areas of color that match user-defined filters. It is typically used to analyze an area on an object for the purpose of verifying if the object meets defined color criteria. It can also be used to filter unnecessary colors from the image before use in later tools.

The Color Matching tool applies defined filters to the region of interest for this analysis. Any number of filters can be added.

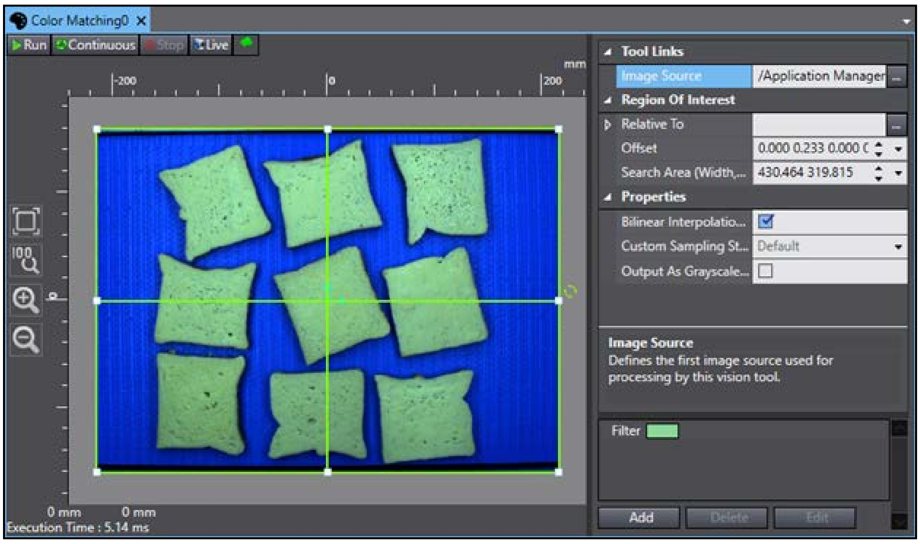


Figure 8-295 Color Matching Tool Editor

To create a Color Matching tool, right-click **Vision Tools** in the Multiview Explorer, select **Add Image Process** and then **Color Matching**. A Color Matching tool will be added to the Vision Tools list.

Color Matching Configuration Items

Use the table below to understand the Color Matching configuration items.

Table 8-107 Color Matching Configuration Item Description

Group	Item	Description
Tool Links	Image Source	Defines the image source used for processing by this vision tool.
Region Of	Relative To	The tool relative to which this tool executes. The

Group	Item	Description
Interest		output values of the selected tool are the input values of this one.
	Link Name	Select the property in the defined Relative To tool that will provide the input values.
	Current Values	Collection of current input values.
	Search Area (Width, Height)	Defines the size of the region.
Properties	Bilinear Interpolation Enabled	Enables bilinear interpolation to sample the input image. By default, this is enabled because it ensures subpixel accuracy.
	Custom Sampling Set	Defines the sampling step used in calculation. This is set to 1 by default. Enable this to adjust the setting.
	Output As Gray scale Image	Specifies the color scheme of the output image. When enabled, the resultant image is converted to gray scale after color filters are applied.

Color Matching Filters Pane

The filters required for Color Matching are organized using the pane located below the properties. Color Matching will output the colors that are included in any filter listed in this pane. All other pixels in the image will be output as black.

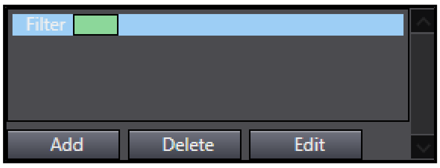


Figure 8-296 Color Matching Filters Pane

Any number of filters can be added to the pane. They are managed using the three buttons described below.

- **Add**: Creates a new filter and adds it at the end of the current list of filters.
- **Delete**: Removes the currently selected filter. This is only available if a filter is highlighted.
- **Edit**: Opens the Color Finder editing window. This is only available if a filter is highlighted. Refer to the following section for more information.

Color Matching - Color Finder Editor

The Color Finder editor allows modification of specific filters.

The right side of the editor shows the input image. The left side is where the Filter Parameters are adjusted as described below.

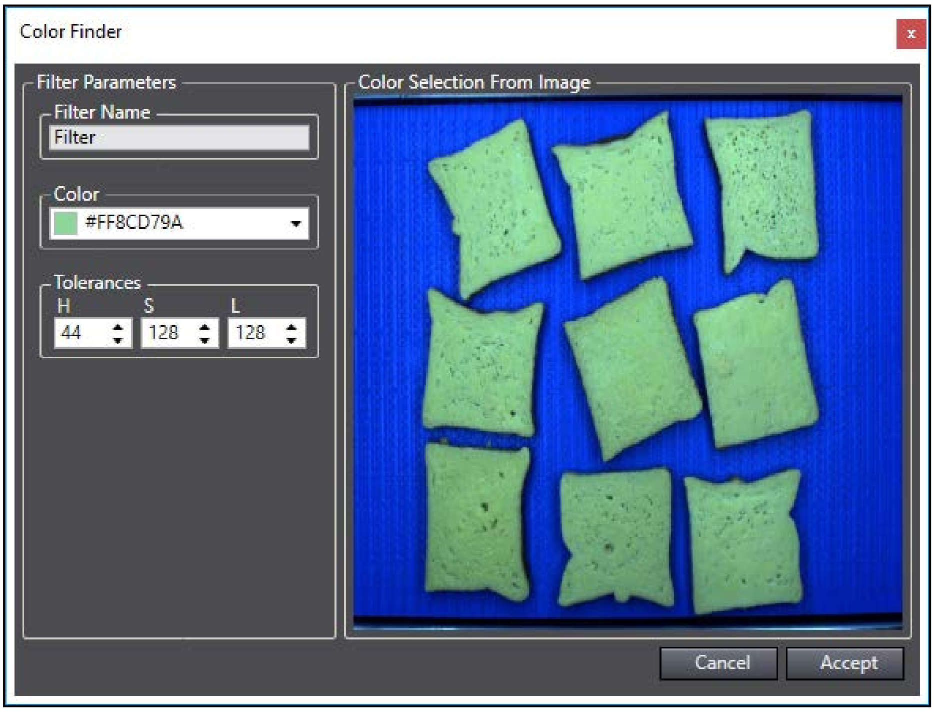


Figure 8-297 Color Matching - Color Finder Editor

Filter Name

The name of the filter as it appears in the Filters Pane. This is modified by typing in the text box and causes no change to the operation of the tool. It is used to label filters and is useful when there are multiple filters.

Color

Defines the color to be searched for by the filter and included in the resulting image. This is defined in two different ways:

1. Right-click and drag in the image on the right to return the average color from the resulting rectangular region. For example, the Color in was created by clicking and dragging within one of the green-tinted bread slices of the corresponding image.
2. Click the arrow next to the Color field and choose a specific color from the color wheel window.

Tolerances

Specifies the ranges of allowable color from the nominal one defined by the Color parameter. Any color that has a Hue (H), Saturation (S), or Luminescence (L) value that has a smaller difference from the nominal than the values defined in the H, S, and L fields is included in the resultant image. These are initially set to 25 by default, but using the right-click method to select a color will automatically change these so that the entire region defined in the image is output.

Color Matching Results

Color Matching returns a modified image that can be used by other vision tools. This image will only include the colors defined in the filters. All other pixels will be returned as black. To use this image with another tool, set Color Matching as the Image Source property of the subsequent tool.

The resultant image can be viewed in the Vision Window as shown in the following figure.

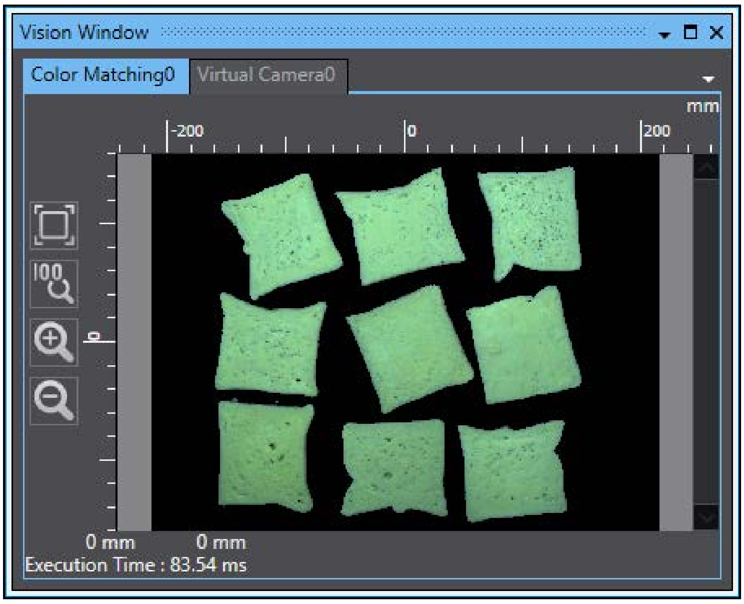


Figure 8-298 Color Matching Resultant Image

Image Processing

This tool applies a filter to gray scale images to better facilitate processing by other tools, including additional Image Processing tools.

> **NOTE:** Advanced Filter tool provides more capabilities and may offer faster execution times than the Image Processing tool. Refer to Advanced Filter on page 612 for more information.

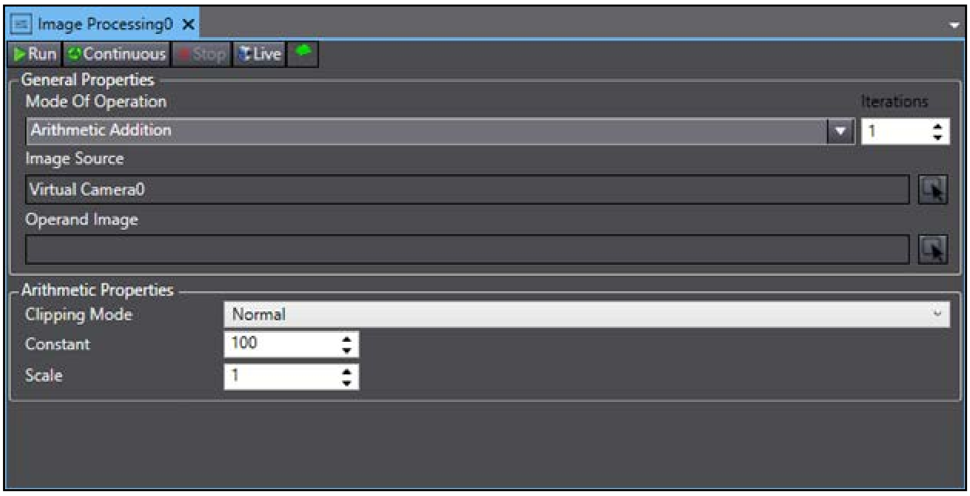


Figure 8-299 Image Processing Tool Editor

To create an Image Processing tool, right-click **Vision Tools** in the Multiview Explorer, select **Add Image Process** and then **Image Processing**. An Image Processing tool will be added to the Vision Tools list.

Image Processing - Mode of Operation

The following filters can be applied by selecting the appropriate option in Mode Of Operation.

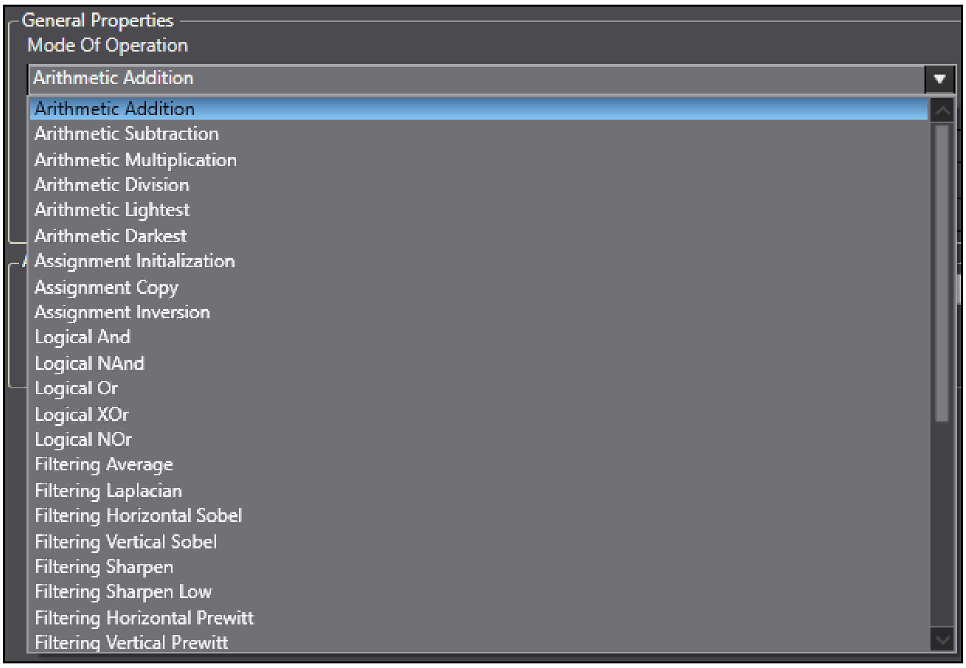


Figure 8-300 Image Processing - Mode of Operation

Table 8-108 Mode of Operation Item Description

Mode of Operation	Description
Arithmetic Addition	Add the operand value to the pixel gray level to a maximum of 255.
Arithmetic Subtraction	Subtract the operand value from the pixel gray level to a minimum of 0.
Arithmetic Multiplication	Multiply the operand value by the pixel gray level to a minimum of 0 and a maximum of 255.
Arithmetic Division	Divide the operand value by the pixel gray level to a minimum of 0 and a maximum of 255.
Arithmetic Lightest	Returns the maximum of the pixel value and operand value.
Arithmetic Darkest	Returns the minimum of the pixel value and operand value.
Assignment Initialization	Assigns a defined gray-level value to all pixels in the image.
Assignment Copy	Copies the input value of each pixel to the corresponding output pixels. Virtually no change is made to the image.
Assignment Inversion	Inverts the gray level value of each pixel and outputs it.
Logical And	Performs an AND operation on the pixels by comparing the binary digits of the two values.
Logical NAnd	Performs a NAND operation on the two pixels by comparing the binary digits of the two values.
Logical Or	Performs an OR operation on the pixels by comparing the binary digits of the two values.
Logical XOr	Performs an XOR operation on the pixels by comparing the binary digits of the two values.
Logical Nor	Performs an OR operation on the pixels by comparing the binary digits of the two values.
Filtering Average	Changes the color of each pixel to the average gray level value of the pixels within its neighborhood.
Filtering Laplacian	Increases or decreases the gray level values of light and dark pixels at high contrast areas, respectively, to enhance edges. This filter is extremely sensitive to noise and should only be performed after the image has been blurred or smoothed.
Filtering Horizontal Sobel	Uses the Sobel operator to brighten pixels at horizontal edges and darken the others. This has slightly better noise filtering than Filtering Horizontal Prewitt.
Filtering Vertical Sobel	Uses the Sobel operator to brighten pixels at vertical edges

Mode of Operation	Description
	and darken the others. This has slightly better noise filtering than Filtering Vertical Prewitt.
Filtering Sharpen	Increases or decreases the gray level values of light and dark pixels, respectively, to increase contrast.
Filtering Sharpen Low	Increases or decreases the gray level values of light and dark pixels, respectively, to increase contrast. This filter performs this to a lesser degree than Filtering Sharpen.
Filtering Horizontal Prewitt	Uses the Prewitt operator to brighten pixels at horizontal edges and darken the others. This has slightly worse noise filtering than Filtering Horizontal Sobel.
Filtering Vertical Prewitt	Uses the Prewitt operator to brighten pixels at vertical edges and darken the others. This has slightly worse noise filtering than Filtering Vertical Sobel.
Filtering Gaussian	Blurs the image to remove contrast between individual pixels, removing noise and enhancing overall contours.
Filtering High Pass	Increases or decreases the gray level values of light and dark pixels at high contrast areas, respectively, to enhance edges. This filter is extremely sensitive to noise and should only be performed after the image has been blurred or smoothed. It is functionally identical to Filtering Laplacian.
Filtering Median	Changes the color of each pixel to the median gray level value of the pixels within its neighborhood.
Morphological Dilate	Changes the color of each pixel to the brightest (highest gray level value) within its neighborhood.
Morphological Erode	Changes the color of each pixel to the darkest (lowest gray level value) within its neighborhood.
Morphological Close	Removes small dark particles and holes within an image.
Morphological Open	Removes peaks from an image, leaving only the image background.
Histogram Equalization	Enhances the input image by flattening the histogram of the input image.
Histogram Stretching	Increases the contrast in an image by applying a piecewise linear intensity transformation based on the image histogram.
Histogram Light Threshold	Changes each pixel value depending on whether they are less or greater than the specified threshold. If an input pixel value is less than the threshold, the corresponding output pixel is set to the minimum acceptable value. Otherwise, it is set to the maximum presentable value.
Histogram Dark Threshold	Changes each pixel value depending on whether they are less or greater than the specified threshold. If an input pixel value is less than the threshold, the corresponding

Mode of Operation	Description
	output pixel is set to the maximum presentable value. Otherwise, it is set to the minimum acceptable value.
Transform FFT	Converts and outputs a frequency description of the input image by applying a Fast Fourier Transform (FFT).
Transform DCT	Converts and outputs a frequency description of the input image by applying a Discrete Cosine Transform (DCT).

Image Processing Configuration

The Image Processing tool is generally configured by selecting a Mode Of Operation and one or two input images. All of the available Modes can be performed with one image and some can be performed with two.

The properties in the bottom half of the tool editor will change depending on the selected Mode Of Operation, as shown in the following table. Any mode with a Constant property can be operated with two images. If an Operand Image is selected, the filter will use the values of the corresponding pixels in that image. Otherwise, it will default to the Constant property.

Image Processing Configuration Items

The properties of Image Processing change depending on what type of filter is selected in Mode Of Operation. General properties are described below.

- Mode of Operation: Defines the type of operation applied to the image(s).
- Iterations: Defines the amount of iterations the filter will run each time this tool is initiated.
- Image Source: Select the source of the input image. This must be gray scale.
- Operand Image: Select the source of the operand image. This must be gray scale.

The table below describes all other properties specific to the Mode of Operation selection.

The Mode Of Operation column defines the mode(s) for which the property is available.

Table 8-109 Image Processing Configuration Item Description

Mode of Operation	Properties	Description
Arithmetic Operations	Clipping Mode	Select the method by which the calculation handles resultant values below 0. Normal converts all of them to 0 while Absolute returns the absolute value of any result below 0.
	Constant	Value used in operation if there is no operand image.
	Scale	Defines the initial gray level scale of the image before processing. For example, if this value is equal to 0.5, all gray level values are halved before the operation is performed.
Assignment	Constant	Value used in operation if there is no operand

Mode of Operation	Properties	Description
Initialization		image.
Logical Operations	Constant	Value used in operation if there is no operand image.
Filtering Operations	Clipping Mode	Select the method by which the calculation handles resultant values below 0. Normal converts all of them to 0 while Absolute returns the absolute value of any result below 0.
	Kernel Size	Defines the size of the square neighborhoods of pixels that the image is split into during filter operation.
	Scale	Defines the initial gray level scale of the image before processing. For example, if this value is equal to 0.5, all gray level values are halved before the operation is performed.
Morphological Operations	Neighborhood Size	Defines the size of the square neighborhoods of pixels that the image is split into during morphological operation. This property cannot be changed.
Histogram Operations	Threshold	Defines the gray level value threshold for the histogram. The gray level values of all pixels in the image change to either 0 or 255 depending on this value and the type of histogram (available for Histogram Light / Dart Threshold Mode of Operation only).
Transform Operations	Flags	Defines the method of calculation performed by each transform.

Image Processing Results

There are no results in the tool editor. Image Processing outputs a modified version of the input image and it does not return any data. The modified image can be viewed in the Vision Window or by selecting ***Image Processing*** as another tool's Image Source.

Image Sampling

This tool is used to extract a rectangular section of an image and output it as a separate image.

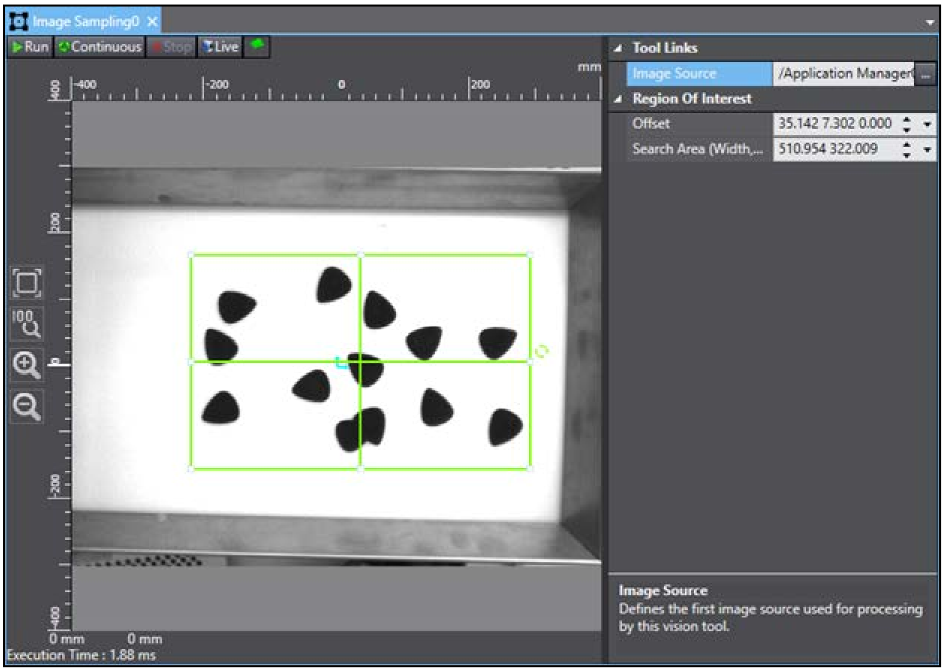


Figure 8-301 Image Sampling Tool Editor

To create an Image Sampling tool, right-click **Vision Tools** in the Multiview Explorer, select **Add Image Process** and then **Image Sampling**. An Image Sampling tool will be added to the Vision Tools list.

Image Processing Configuration Items

The properties of Image Processing change depending on what type of filter is selected in Mode Of Operation. General properties are described below.

- Mode of Operation: Defines the type of operation applied to the image(s).
- Iterations: Defines the amount of iterations the filter will run each time this tool is initiated.
- Image Source: Select the source of the input image. This must be gray scale.
- Operand Image: Select the source of the operand image. This must be gray scale.

The table below describes all other properties specific to the Mode of Operation selection.

The Mode Of Operation column defines the mode(s) for which the property is available.

Table 8-110 Image Processing Configuration Item Description

Mode of Operation	Properties	Description
Arithmetic Operations	Clipping Mode	Select the method by which the calculation handles resultant values below 0. Normal converts all of them to 0 while Absolute returns the absolute value of any result below 0.
	Constant	Value used in operation if there is no operand

Mode of Operation	Properties	Description
		image.
	Scale	Defines the initial gray level scale of the image before processing. For example, if this value is equal to 0.5, all gray level values are halved before the operation is performed.
Assignment Initialization	Constant	Value used in operation if there is no operand image.
Logical Operations	Constant	Value used in operation if there is no operand image.
Filtering Operations	Clipping Mode	Select the method by which the calculation handles resultant values below 0. Normal converts all of them to 0 while Absolute returns the absolute value of any result below 0.
	Kernel Size	Defines the size of the square neighborhoods of pixels that the image is split into during filter operation.
	Scale	Defines the initial gray level scale of the image before processing. For example, if this value is equal to 0.5, all gray level values are halved before the operation is performed.
Morphological Operations	Neighborhood Size	Defines the size of the square neighborhoods of pixels that the image is split into during morphological operation. This property cannot be changed.
Histogram Operations	Threshold	Defines the gray level value threshold for the histogram. The gray level values of all pixels in the image change to either 0 or 255 depending on this value and the type of histogram (available for Histogram Light / Dart Threshold Mode of Operation only).
Transform Operations	Flags	Defines the method of calculation performed by each transform.

Image Sampling Configuration

The Image Sampling tool is primarily used to limit image processing to a specific area of the vision field of view. This means that subsequent tools will only need to view the resultant region of this tool. For example, in the image is cropped so that only the region with guitar chips is returned.

To do this, the region of interest can be defined in the target location. Everything outside of it will be removed from the resultant image, which can be used as an image source in other tools.

NOTE: The resultant image does not automatically center the new image. The new image will be returned with respect to the original image frame. This can be seen in the figure below where the right extent and left extent are not centered about zero.

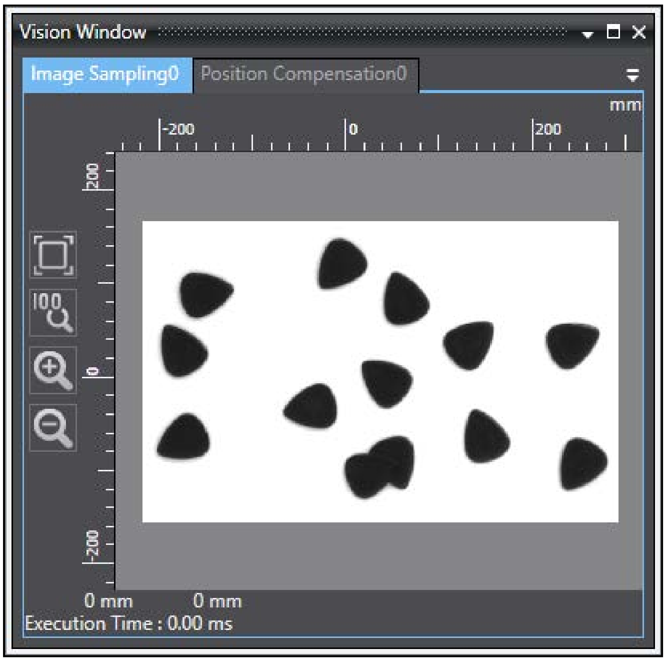


Figure 8-302 Image Sampling Resultant Image

Image Sampling Results

There are no results in the tool editor. Image Sampling returns a cropped image that can be used by other vision tools. To do this, set Image Sampling as the Image Source property of the subsequent tool. The resultant image can be viewed in the Vision Window. Refer to above.

Position Compensation

This tool is used to execute a transformation on a region of an image and orient it into a specific orientation. This contrasts with the Relative To function of most tools, which transforms the tool itself to an instance of an object without changing image orientation. Position Compensation instead orients an image so that processing only needs to occur in one location.

While Relative To is more convenient for processing during run time, Position Compensation can be used to make an operation more user-friendly while configuring the application. For example, Relative To can move any reader tool into an orientation and read the character string, but Position Compensation can be used during configuration so the character strings are always in a readable orientation.

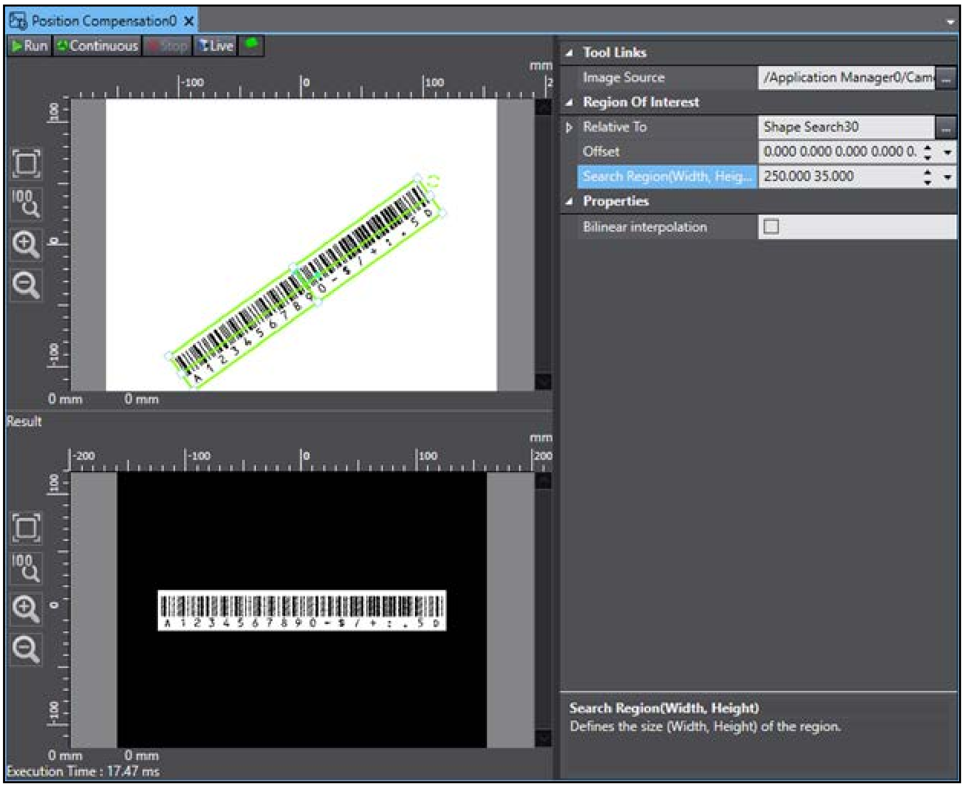


Figure 8-303 Position Compensation Tool Editor

To create a Position Compensation tool, right-click **Vision Tools** in the Multiview Explorer, select **Add Image Process** and then **Position Compensation**. The Position Compensation tool will be added to the Vision Tools list.

Position Compensation Results

There are no results in the tool editor. Position Compensation returns a modified image that can be used by other vision tools. To do this, set Position Compensation as the Image Source property of the subsequent tool. The resultant image can be viewed in the Result section of the object editor. Refer to Figure 8-303 for an example.

Position Compensation Configuration Items

Use the table below to understand the Position Compensation configuration items.

Table 8-111 Position Compensation Configuration Item Description

Group	Item	Description
Tool Links	Image Source	Defines the image source used for processing by this vision tool.
	Results Logging	Enables logging of tool results to a file.
Region of Interest	Relative To	The tool relative to which this tool executes. The output values of the selected tool are the input values of this one.

Group	Item	Description
	Link Name	Select the property in the relative tool that will provide the input values.
	Current Values	Collection of current input values.
	Offset	Defines the center coordinates of the region.
	Search Area (Width, Height)	Defines the size of the region.
Properties	Bilinear Interpolation	Enables using bilinear interpolation to sample the input image. By default, this is enabled because it ensures subpixel accuracy.

Position Compensation Configuration

The Position Compensation tool is primarily used to focus an image on only a specific area of the vision field of view. This is useful during configuration to allow the user to develop an application while images are in an ideal orientation. For example, the barcode is rotated and centered so that a Barcode tool will only need to focus on the center region of the image.

To do this, Position Compensation can be set in a known orientation to guarantee that the instance is centered and returned in a target orientation. All pixels outside of the region of interest will be returned as black. This may cause interference with reader tools if there is not sufficient white space around the object to be read.

Custom Tools

Custom tools allow you to specify a program that will be called when the tool is executed. The following Custom Tools are described in this section.

- Refer to Custom Vision Tool on page 634 below for more information.
- Refer to Remote Vision Tool on page 640 for more information.

Custom Vision Tool

This tool is a C# program that can be referenced and executed as a vision tool. Other vision tools and objects can be referenced and used within the program. At the end of the program, a collection of defined vision transform results will be returned.

> **NOTE:** A basic understanding of C# is required to use the Custom Vision Tool.

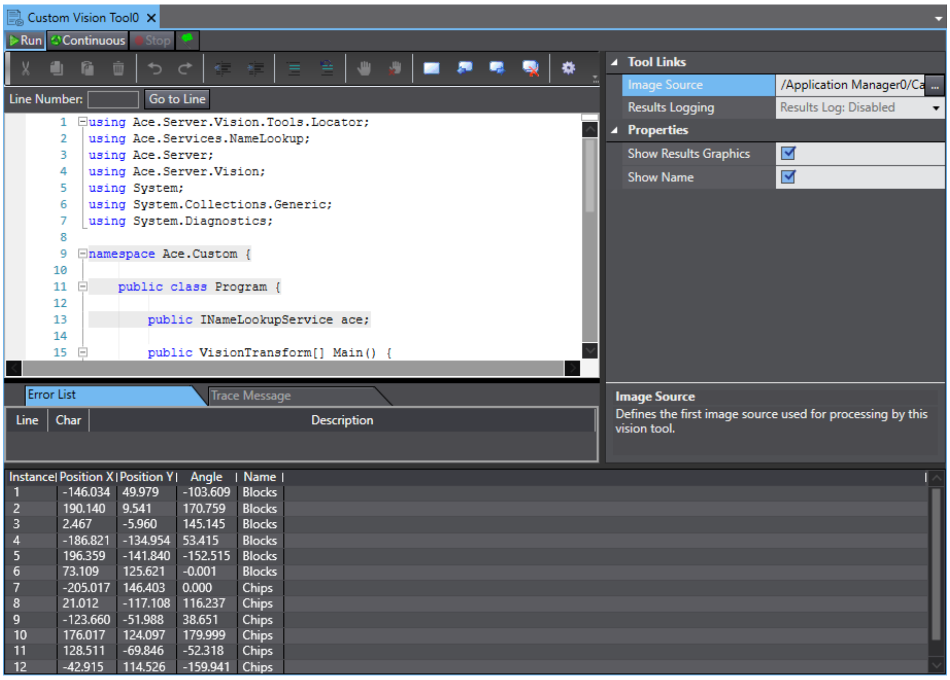


Figure 8-304 Custom Vision Tool Editor

To create a Custom Vision tool, right-click **Vision Tools** in the Multiview Explorer, click **Add Custom** and then click **Custom Vision Tool**. A Custom Vision tool will be added to the Vision Tools list.

Custom Vision Tool Results

Use the table below to understand the results of the Custom Vision tool.

Table 8-112 Custom Vision Tool Results Description

Item	Description
Instance	Index of the result instance, starting with 1.
Position X	X-coordinate of the instance. This is returned using the "x" entry of the VisionTransform list.
Position Y	Y-coordinate of the instance. This is returned using the "y" entry of the VisionTransform list.
Angle	Angle of the instance. This is returned using the "roll" entry of the VisionTransform list.
Name	Name of the instance. This is returned using a VisionTransformResult.Name method.

Custom Vision Tool Configuration Items

Use the table below to understand the Custom Vision tool configuration items.

Table 8-113 Custom Vision Tool Configuration Item Description

Group	Item	Description
Tool Links	Image Source	Defines the image source used for processing by this vision tool.
	Results Logging	Enables logging of tool results to a file.
Properties	Show Results Graphics	Specifies if the graphics are drawn in the Vision Window.
	Show Name	Specifies if the name associated with each instance is written in the Vision Window.

Storing part information for later use.

Any information can be stored in the tag property or directly into a controller variable structure to be used later in a process.

Simulating application to improve emulation accuracy

In many situations, the Random Instances feature does not provide adequate control over vision result generation for effectively emulating the application. A Custom Vision Tool can be used to program the logic of vision result generation to be as simple or complex as necessary.

Creating Custom Vision Processing Logic

This can include the use of tools configured ahead of time or modifying tool parameters before executing them during run time. A Custom Vision Tool has access to vision tool parameters, frames, and results to allow for complete flexibility in selecting which results are accessed and returned.

Custom Vision Tool Customization

Custom Vision Tools can be used to do almost anything with other vision tools in the workspace. For example, the tool shown in is a simple example used to return instances from a Locator. The instances are drawn in the Vision Window as shown in the figure below.

Like other tools, Custom Vision Tool must have a camera or tool selected in the Image Source to operate.

> **Additional Information**: Every Custom Vision Tool should end with the line "return results.ToArray();". This outputs the results to the Results section of the tool editor.

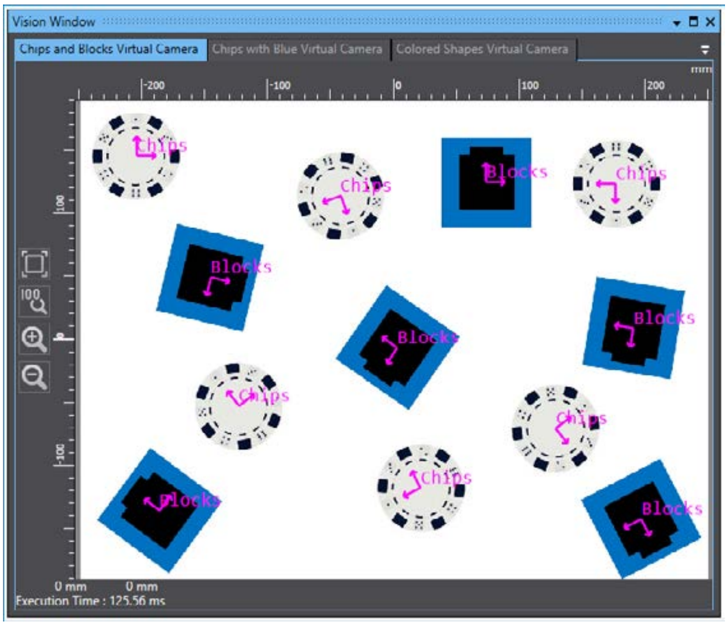


Figure 8-305 Custom Vision Tool Vision Window

Vision Tool Customization

This sample shows how to create a custom vision tool.

Default Custom Vision Tool

When a custom vision tool is created, the following is created:

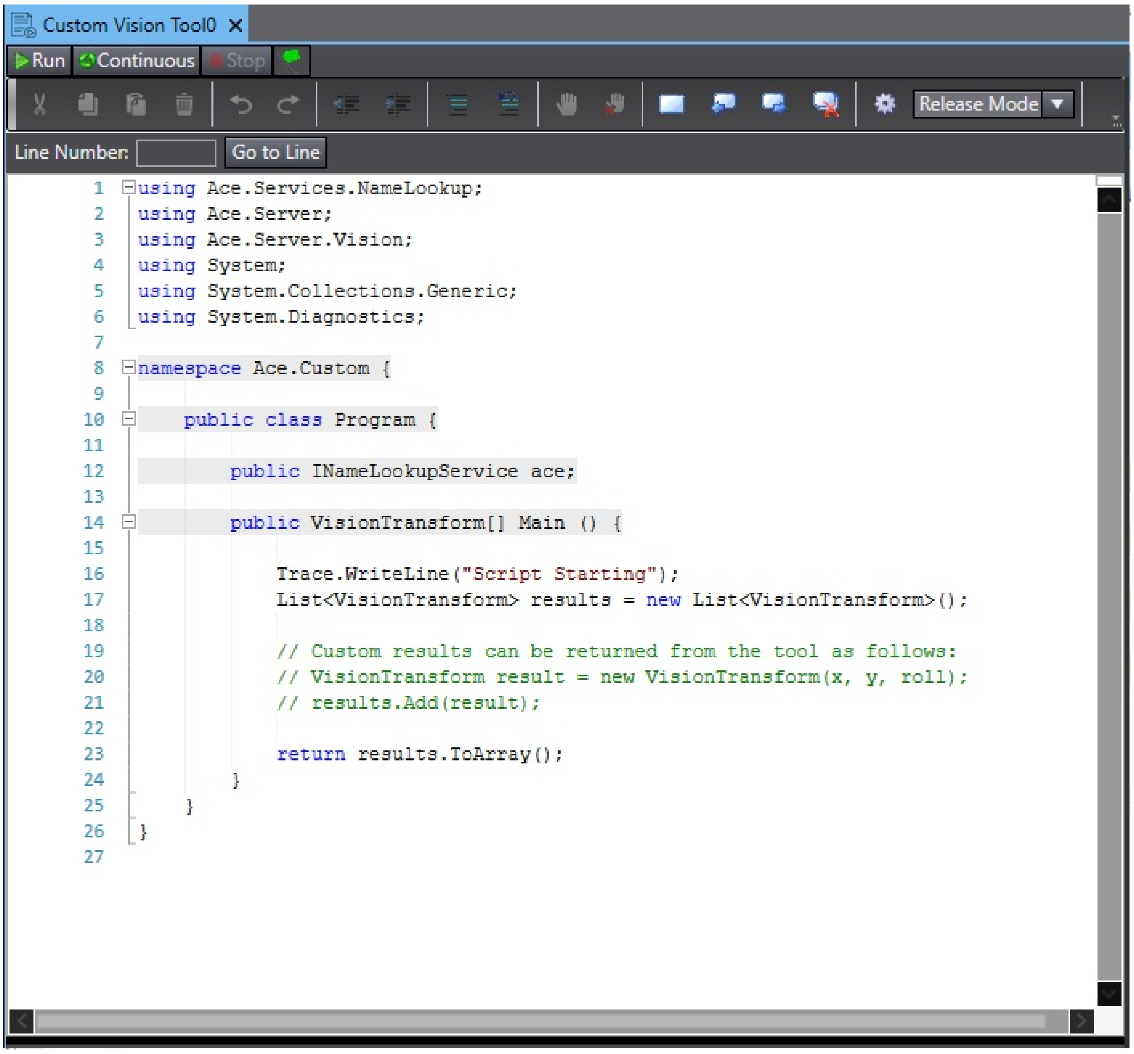


Figure 8-306 Vision Tool Editor

The script is comprised of several major elements:

- C# class definition
- INameLookupService field
- Main method entry point
- return values from the script

The script contains many lines that cannot be modified and are considered protected. These are designated by the light grey background. Notice that the namespace, class name, INameLookupService field name, and ***Main*** method lines are protected and cannot be changed.

When the custom vision tool is invoked, the text in the script is dynamically compiled in memory and the ***Main*** method is called. By default, the script must return an array of ***VisionTransform*** objects. These define the coordinates of any objects located by the tool. The default custom vision tool simply returns an empty array of transformations. It is up to the user to define the logic of the script and to return an array of transformations.

Referencing other objects and tools

It is often useful to reference other vision tools or objects when running a script. You can reference other objects by dragging and dropping vision tools from the MVE to the body of the script as such:

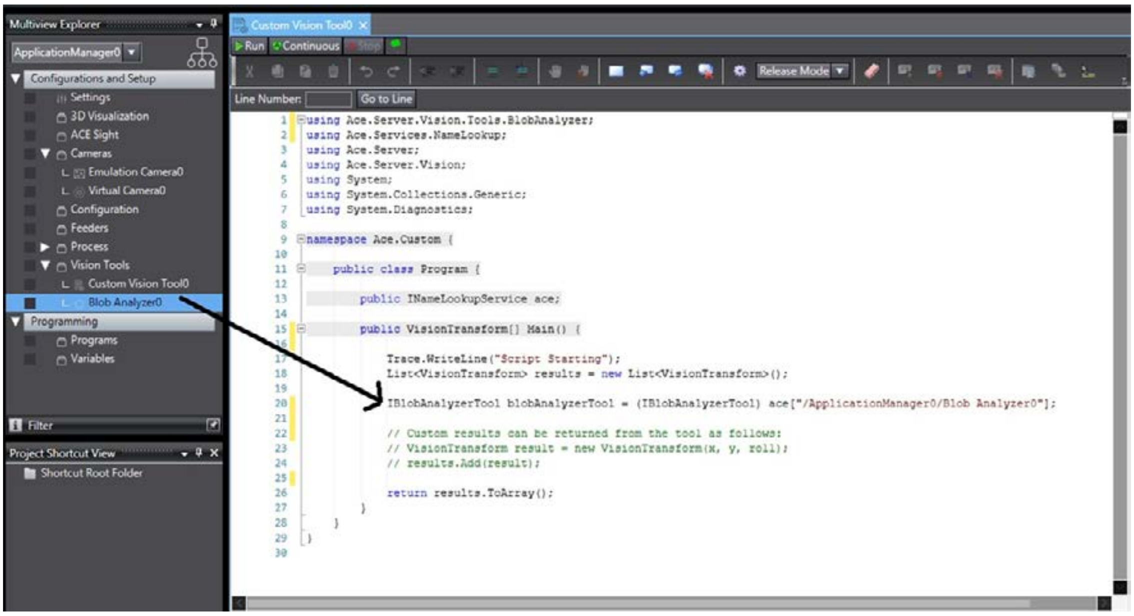


Figure 8-307 Referenced Tool in Editor.

Any object can be dragged and dropped from the workspace explorer to the body of a script. When an object is dropped, the script automatically creates a reference to the object through the INameLookupService field defined in the scrip. Once an object has been inserted into a script, you can access the properties and methods of that object as such:

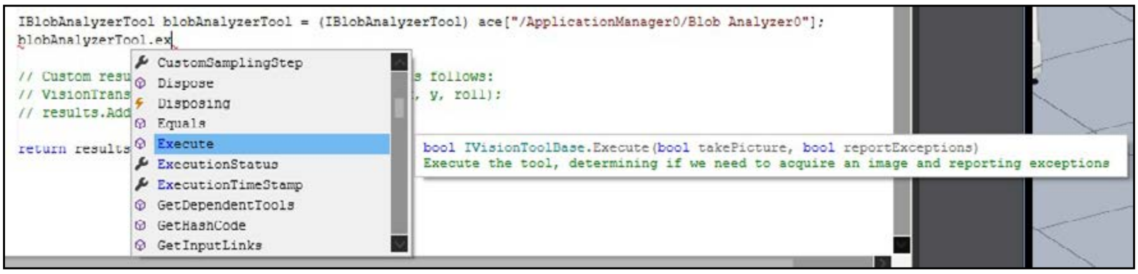


Figure 8-308 Added Object

Here is a sample of a custom vision tool that executes a blob tool and returns the results of the blob tool:

```
    public VisionTransform[] Main() {

        Trace.WriteLine("Script Starting");
        List<VisionTransform> results = new List<VisionTransform>();

        IBlobAnalyzerTool blobAnalyzerTool = (IBlobAnalyzerTool) ace["/ApplicationManager0/Blob Analyzer0"];
        blobAnalyzerTool.Execute(false);

        // Add all blob results but rotate by 45 degrees
        foreach(var blobResult in blobAnalyzerTool.Results){
            VisionTransform newPosition = blobResult .Position * new VisionTransform(0, 0, 45);
            results.Add(newPosition);
        }

        return results.ToArray();
    }
}
```

Figure 8-309 Blob Tool Added to Custom Vision.

Remote Vision Tool

Some applications require Process Managers to operate several different processes for multiple robots and cameras. However, these applications sometimes need to operate on a single PC, where the PC hardware can limit available processing power. For example, if a PC is operating with multiple robot process and several different vision tools, the operation may produce a lag in response and motion. In this case, it may be useful to offload vision operations to another computer to improve application speed and performance.

This transfer can be accomplished by creating a Remote Vision Tool (RVT), which references another vision tool in a separate Application Manager and returns the results. To distribute vision operations, you can create and configure another Application Manager and then move an existing Vision Tool to it using the "Move To" option. Then, an RVT on the original Application Manager can be configured to reference it and return its VisionTransform results. In this way, the Vision Tool processing requirements are offloaded to a second PC.

To create a Remote Vision Tool, right-click on **Vision Tools** in the Multiview Explorer and select: **Add Custom** and then **Remote Vision Tool**, as shown in the following figure.

> **NOTE:** This is not necessary for eV+ applications using Robot Vision Manager objects because eV+ can directly request results from multiple Application Managers.

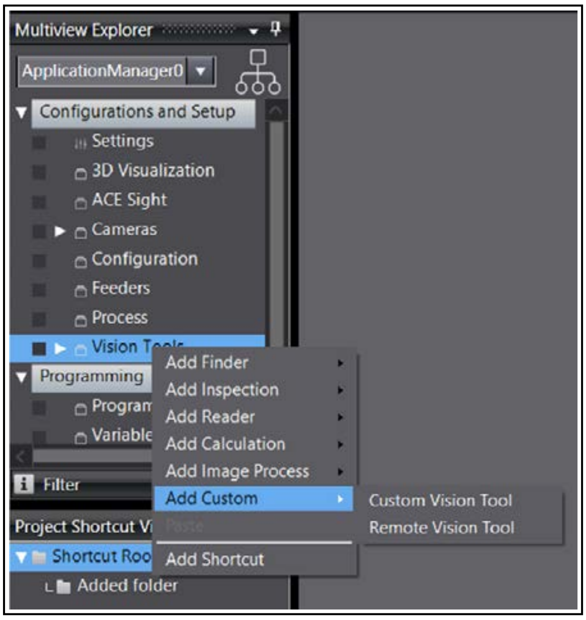


Figure 8-310 Add Remote Vision Tool

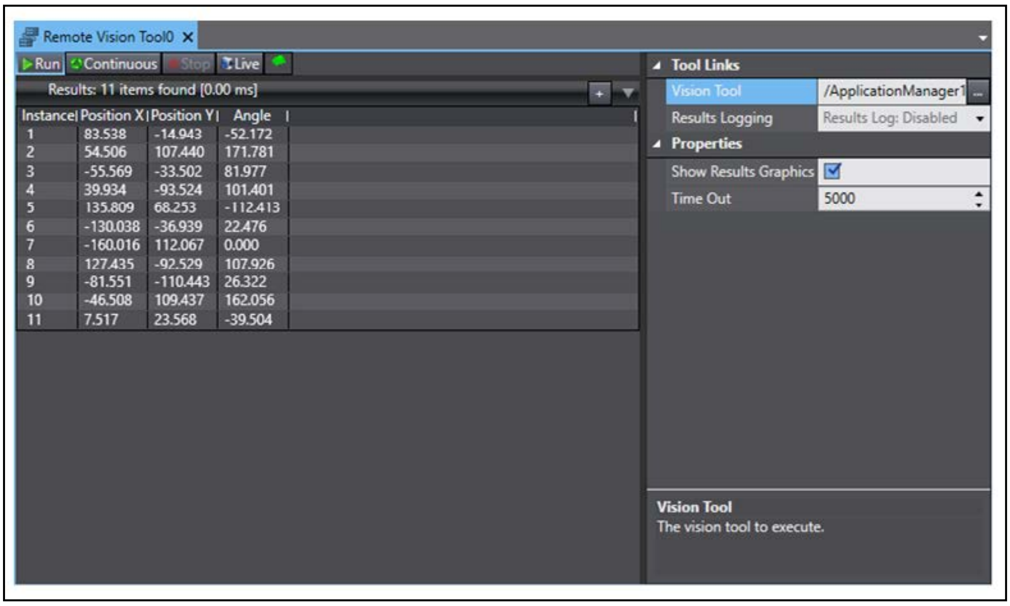


Figure 8-311 Remote Vision Tools Editor

Remote Vision Tool Configuration

Table 8-114 Remote Vision Tool Configuration Item Description

Object	Definition
Tool Links	
Vision Tool	Selects the vision tool that the Remote Vision Tool will execute and from which it will acquire results.
Results Logging	Enables logging of tool results to a file.
Properties	
Show Results Graphics	Specifies if the graphics are drawn in the Vision Window.
Time Out	Set the maximum time period (in milliseconds) that the tool is able to run. This includes both execution of tool and acquisition of results.

RVTs will likely utilize a camera that is connected to a separate computer. Therefore, all hardware connections should be verified before configuration. The camera calibrations should also be performed. This can be done either remotely or on the server computer. For more information, refer to Remote Application Manager on page 270.

While the function of RVT depends entirely on the Vision Tool to which it is linked, the configuration is largely the same. The user should first create and configure a separate Application Manager to act as a vision server and create the necessary vision tool on there. Only then should the correct Vision Tool be selected in the properties. Linking an RVT to a Vision Tool that already has errors will cause the RVT to fail.

> **NOTE:** Each RVT can link to only one Vision Tool, but RVTs in the same Application Manager can link to Vision Tools in multiple other Application Managers.

Runtime

During runtime, RVT will continuously update to show the latest values of its results, as would any other Vision Tool. However, RVT does not return the images or graphics from these values. Therefore, it is recommended to perform any image processing or editing in the Application Manager containing the linked Vision Tool.

Results

Object	Definition
Instance	Index of the result instance, starting with 1.
Position X	X-coordinate of the origin of the returned instance.
Position Y	Y-coordinate of the origin of the returned instance.

Object	Definition
Angle	Angle of the returned instance.
Name	Identifies Name of returned vision instance.

Tool Compatibility

RVT is not able to connect to every type of Vision Tool. It is primarily designed to work with Finder Tools so it can return the locations of instances. RVT supports the following Vision Tools:

- Blob Analyzer
- Labeling
- Locator
- Shape Search 3
- Custom Vision Tool

In the first four Vision Tools listed, the RVT obtains its results by returning the values for each instance that match the Results columns shown, refer to Remote Vision Tools Editor. Any other Vision Tool can be supported through a Custom Vision Tool in the Application Manager, acting as a vision server. RVT supports VisionTransform object type to give proper values to Position X, Position Y, and Angle.

Chapter 9: Troubleshooting

This section describes the different messages that are available for troubleshooting purposes.

9.1 Event Log

The Event Log is a tool used to display event messages that have been logged since system startup. The Event Log collects the time stamp and details about the particular event message that can be used by service personnel to troubleshoot problems.

> **NOTE:** If you have a problem to report to field service, it is helpful to include the Event Log information in any communication.

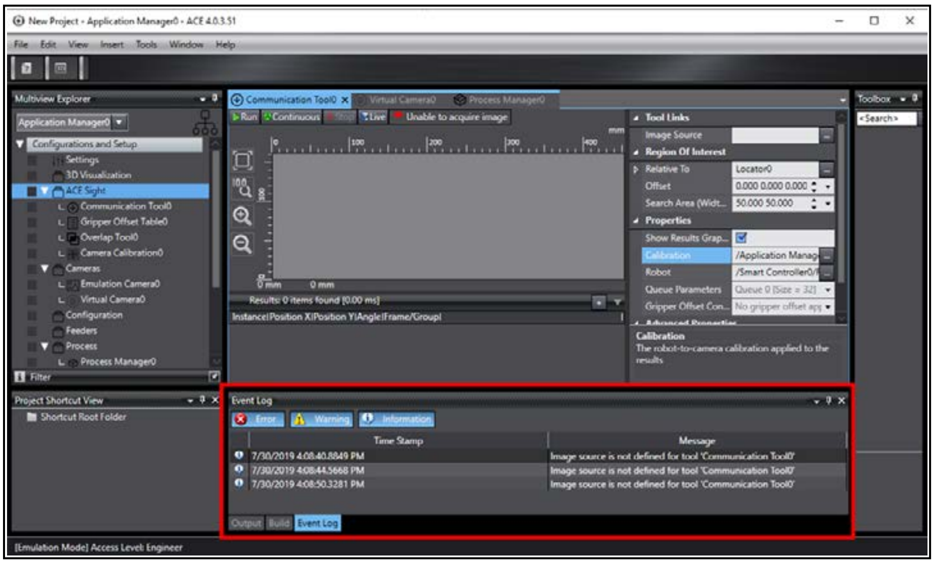


Figure 9-1 Event Log

You can sort the events by clicking the ***Type***, ***Time Stamp***, or ***Message*** column headings. Each click will toggle the sort between ascending and descending order.

You can filter events by clicking the event type buttons in the Event Log area.

- Click the **Error** button (

) to view all error events.
- Click the **Warning** button (

) to view all warning events.
- Click the **Information** button (

) to view all information events.

> **NOTE:** In addition to the Event Log, most events are also written to the Windows Application Log. Therefore, if the Event Log is no longer available (for example, it was cleared it or ACE software has been shut down) you can still view the ACE events in the Windows Application Log file.

You can copy, clear, and select all Event Log entries by right-clicking the list and making a selection.

Accessing the Event Log

To access the Event Log, select ***View*** from the menu bar and then click ***Event Log***. The Event Log will appear in the Multifunction Tab area.

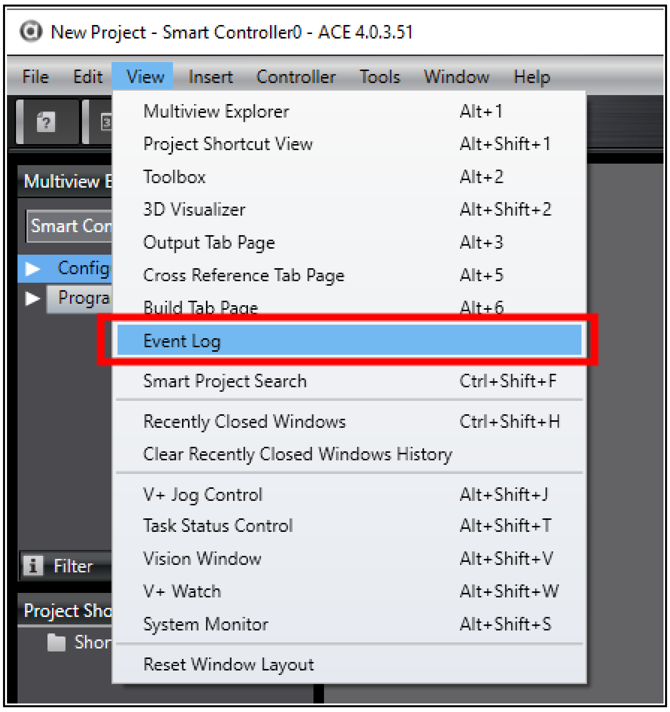


Figure 9-2 Access the Event Log

9.2 eV+ Log

The eV+ Log displays a history of SmartController events since the controller was powered on for the first time. The eV+ Log stores the eV+ event type, level, time stamp, and comment for each entry. Use the eV+ to see a history of SmartController events related to configuration, FieldBus, V+, and System changes. You can also use the eV+ Log for troubleshooting purposes.

The information contained in the eV+ Log is stored in the SmartController at the following location. Refer to Task Status Control on page 121 for more information.

D:\ADEPT\CUSTOM\LOG.XML

> **Additional Information**: Some errors (such as servo errors) may require accessing the FireWire event log for additional information. Refer to FireWire Event Log on page 646 for more information.

> **NOTE:** The eV+ Log is available when connected to a SmartController. Accessing the eV+ Log is not possible in Emulation Mode.

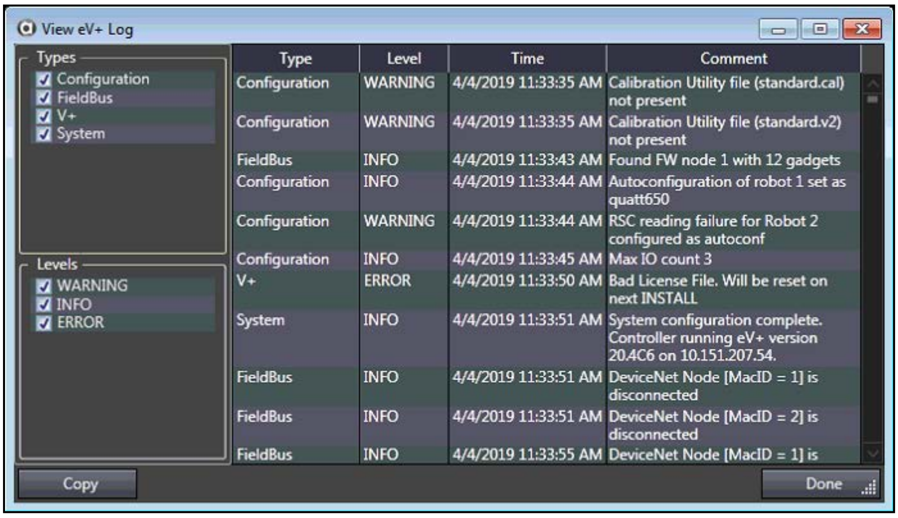


Figure 9-3 View eV+ LogS

Use the Types and Levels selections to filter events. The *Copy* button will copy all events in the list to the clipboard.

Accessing the eV+ Log

To access the eV+ Log, open the Controller Settings. Then, click the ***Control*** menu item and select **View eV+ Log**. The eV+ Log will be displayed.

Refer to Controller Settings on page 192 for more information.

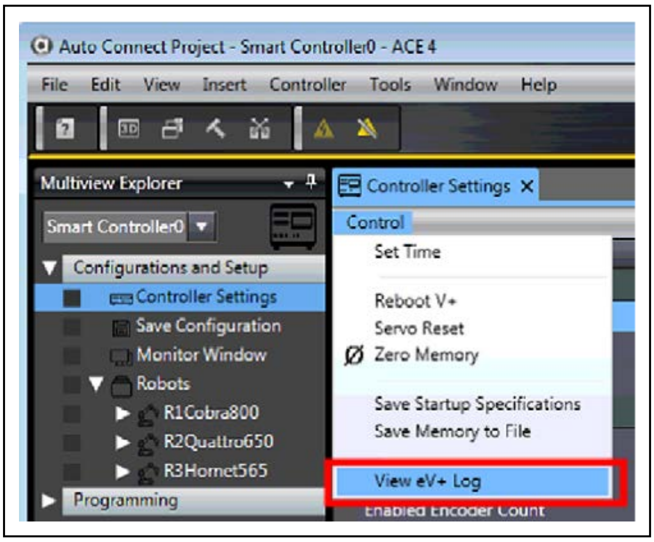


Figure 9-4 Access the eV+ Log

9.3 FireWire Event Log

Each FireWire node in the system contains an event log. The FireWire Event Log collects an ID number, description, time stamp, occurrence count, and additional information about the last event that can be used by service personnel to troubleshoot problems.

NOTE: You must be connected to a physical controller to access the FireWire Event Log. The FireWire Event Log is not available in Emulation Mode.

Accessing and Clearing the FireWire Event Log

To access or clear the FireWire Event Log, use the following procedure.

1. While online with a physical controller, access the Controller Settings area. Refer to Controller Settings on page 192 for more information.
2. Click the **Configure** Button to display the Configure Options Dialog Box.
3. Select **Configure FireWire Nodes** and then click the **Finish** Button. The Configure FireWire Nodes Dialog Box will be displayed.

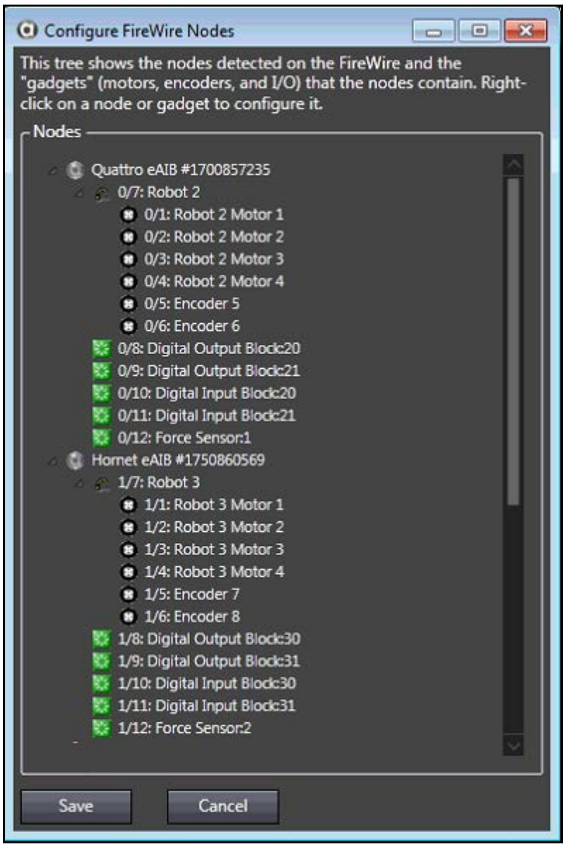


Figure 9-5 Configure FireWire Nodes Dialog Box

4. Right-click a FireWire node and then select **View Event Log** to access the FireWire Event Log. Select **Clear Event Log** to clear the FireWire Event Log. After the selection is made, the procedure is complete.

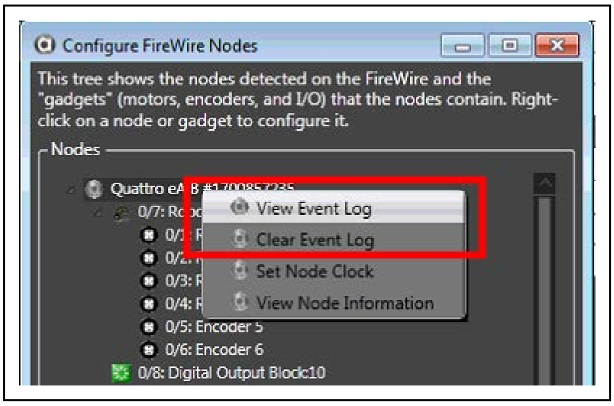


Figure 9-6 Clear or View the FireWire Event Log

FireWire Configuration Conflicts

When connecting to a controller, ACE software will check for FireWire configuration conflicts.

If a conflict is present, error messages will be displayed after the connection is established.

Figure 9-7 FireWire Configuration Conflict Example (Duplicate Robot Numbers)

To correct FireWire configuration conflicts, access the Configure FireWire Nodes Dialog Box and adjust the configuration to resolve the issue described in the error message.

Appendix A

A.1 Configuring Basler Cameras

Robot Vision Manager vision tools support Basler cameras supplied by Omron. These cameras need to be configured before use with the ACE software.

Use the following steps to understand the general Basler camera configuration procedure. The steps are detailed in the following sections.

1. Communication and power connections
2. Configure network and camera settings
3. Add the camera to an ACE project
4. Position Latch Wiring (application dependent)
5. Latch Signal Test (application dependent)

> **NOTE:** The ACE software installation includes the Basler Pylon Suite that is required for the camera configuration.

Camera Connections

The Basler cameras ship with power and data cables. The following identifies the Omron part numbers.

Basler:
Power I/O cable p/n 09454-610
Cat6 Camera Cable p/n 18472-000

Use the following information to understand the Basler camera connections. Cameras with GPIO are models: acA60-300, acA800-200, acA1300-75, acA1920-40, acA1920-48, acA1920-50, acA2500-20. All other Basler camera models do not have GPIO capability, use the following two tables as guides for power connections.

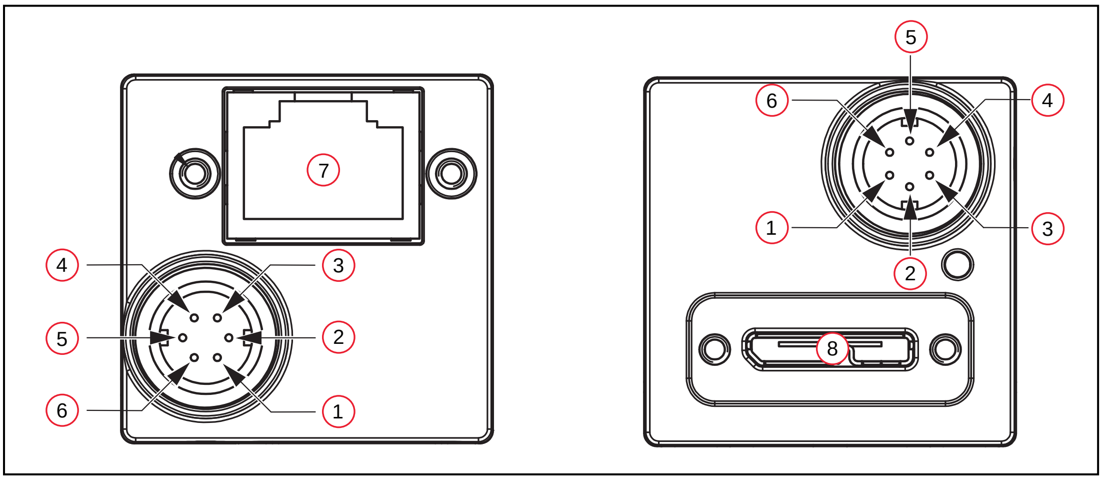


Figure A-1 Basler Camera Connections

Table A-1 Basler Camera without GPIO, Connection Description

Item	Wire Color	Description
1	Brown	Camera Power (+12 VDC)
2	Pink	Opto IN 1
3	Green	No Connection
4	Yellow	Opto OUT 1
5	Gray	Opto I/O Ground
6	White	Camera Power (0 VDC)
7	--	Camera Communications Port (RJ45)
8	--	Camera Communications Port (USB)

NOTE: Wire colors indicated in the table above correspond to the power I/O cable supplied with the camera.

Table A-2 Basler Camera with GPIO, Connection Description

Item	Wire Color	Description
1	Brown	Camera Power (+24 VDC)
2	Pink	Opto IN 1
3	Green	No Connection
4	Yellow	Opto OUT 1
5	Gray	Opto I/O Ground
6	White	Camera Power (0 VDC)
7	--	Camera Communications Port (RJ45)
8	--	Camera Communications Port (USB)

NOTE: Wire colors indicated in the table above correspond to the power I/O cable supplied with the camera.

Power and Communication Connections

There are two types of cameras supported by the ACE software as described below. The camera connections will vary depending on the camera type.

Camera Power Connections

Use the following information to supply power to the camera. Refer to Camera Connections on page 650 for more information.

NOTE: If using a GigE type camera, external power connections should not be used if the camera is connected to a PoE port. Only the optocoupler needs to be connected after the Ethernet PoE cable.

Use the following connections to supply external power to the camera if the model uses GPIO.

- Pin 1: + 24 VDC
- Pin 6: 0 VDC

Use the following connections to supply external power to the camera if the model does NOT use GPIO.

- Pin 1: + 12 VDC
- Pin 6: 0 VDC

Camera Communication Connections

If using a GigE type camera, connect the RJ45 camera port to the PC or the local area network using the supplied cable.

If using a USB camera, connect the provided USB cable to the PC using the supplied cable.

Configure Network and Camera Settings

After connecting the camera to the PC or local area network, configure the network and camera settings described below.

NOTE: The Pylon tools referenced in this section can be found in the Windows Start Menu under the Pylon program group. These tools are included with the default ACE software installation.

Jumbo Packet Setting

Access the PC network adapter configuration and enable the ***Jumbo Packet*** property. Set the value to 9014 Bytes.

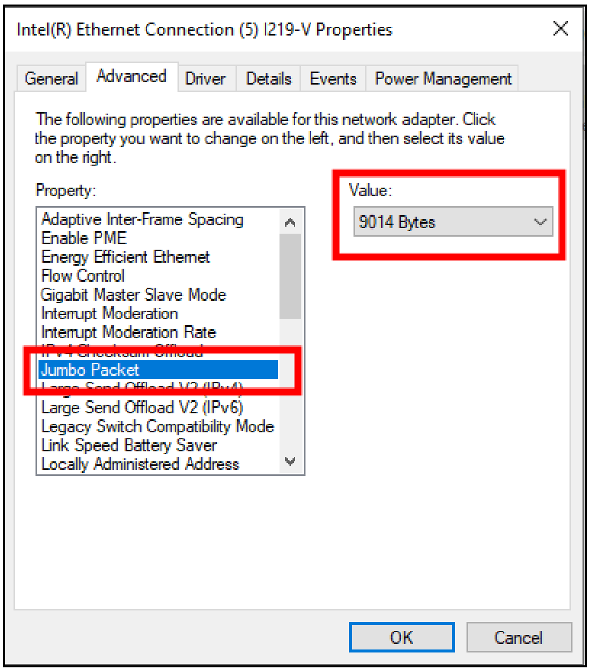


Figure A-2 Network Adapter Jumbo Packet Setting

Adjust the Camera Network Settings

Open the Pylon IP Configurator tool to view the camera communication status with the PC. If the camera IP configuration is incorrect, this tool can be used to correct the settings. Click the **Save** Button after making any setting adjustments.

> **NOTE:** If an active connection is present between the camera and the ACE software, the Pylon IP Configurator IP settings will be inaccessible.

The figure below provides an example that shows one camera that is communicating properly and one camera that is not reachable due to an incompatible subnet configuration.

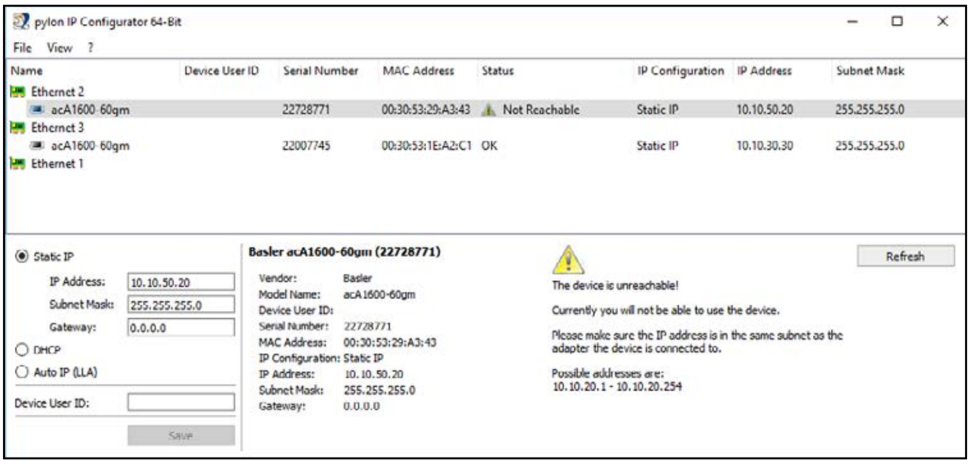


Figure A-3 Pylon IP Configurator Example

The above figure shows two cameras connected to individual Ethernet connections. When the cameras are connected on the same IP address, as shown in the following figure. The figure shows two acA1600-60gm running in continuous mode. Each of them on an own network interface of the Omron IPC – having the Basler GigE Vision Adapter properly installed.

Each camera is using more than 100 MByte/s for 1600 x1200 pixels at 50+ fps. In the Pryncy-Teka setup, you need to share the max. of 125 Mbyte/s, which is what a perfect hardware can deliver per channel, between two even higher resolution cameras with 1920 x1200 pixels.

The only way to check, if the cameras properly communicate with the Windows PC is the Pylon Viewer.

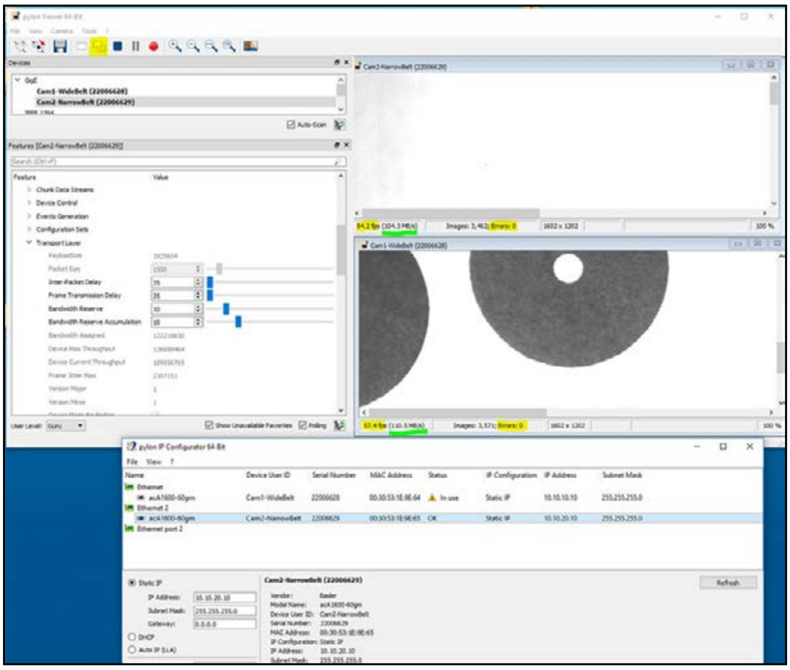


Figure A-4 Pylon Viewer Two Cameras

An operating issue is that different NICs and switches support different packet sizes. Defining the correct packet size is system dependent. When the packets are too small the NIC buffers can become overloaded and packets can be dropped. When packets are too large the NIC may not support that size and it drops the packet. In either case, when packets are dropped, the ACE driver detects the drop and requests the camera to resend.

The typical packet size of ~500 are too small when dealing with large images that naturally consist of lots of data. And, not many devices support the full 16000 Byte packets. Starting at 1500 Bytes is usually the fail-safe. If you notice your CPU load is higher than you'd like.

You can also enable the "Auto Packet Size" feature in the camera, and the camera will try to negotiate a working packet size on its own.

Adjust Camera Image Acquisition Settings

The Pylon Viewer is used to adjust the camera image acquisition settings. Use this tool to enable the Exposure Active signal and change any other necessary camera settings before adding a camera to the ACE project.

NOTE: If any camera settings are changed with the Pylon Viewer tool after it has been added to the ACE project, camera functions may be disrupted.

Open the Pylon Viewer tool and select a camera from the Devices list. Then, click the **Open Camera** Button to access all settings associated with the selected camera.

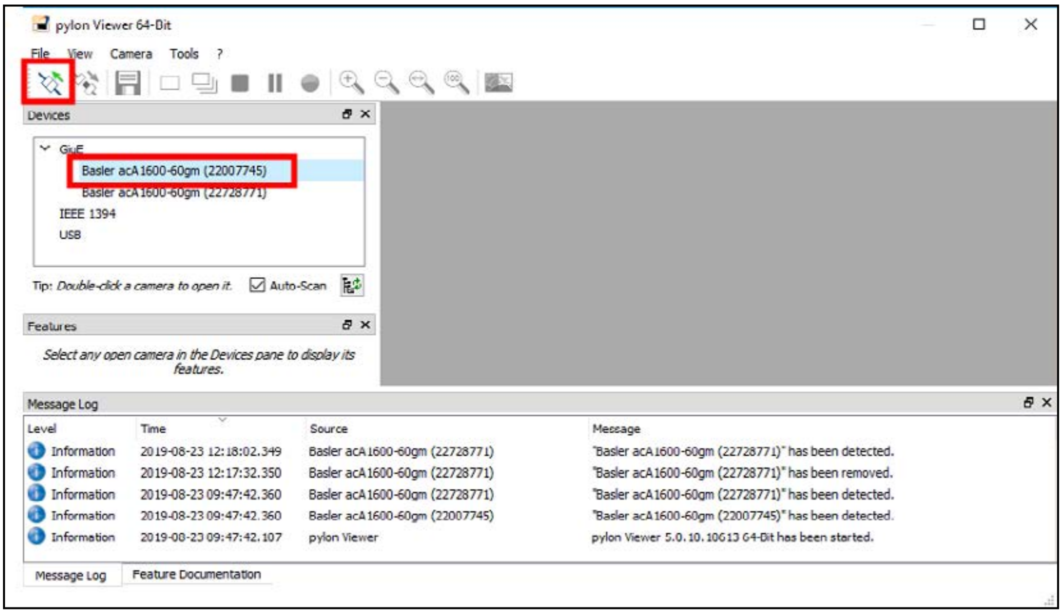


Figure A-5 Pylon Viewer - Open Camera

Enable the Exposure Active Signal

The Exposure Active signal is an output from the camera to the robot controller that indicates the moment when the camera acquired an image. This signal is used by the controller for position latching in applications that use vision-guided motion. The Exposure Active signal must be enabled for all applications that require robot or belt encoder position latching.

Expand the Digital I/O Controls item and make the following settings.

- Set the Line Selector item to ***Output Line 1***.
- Set the Line Source item to ***Exposure Active***.

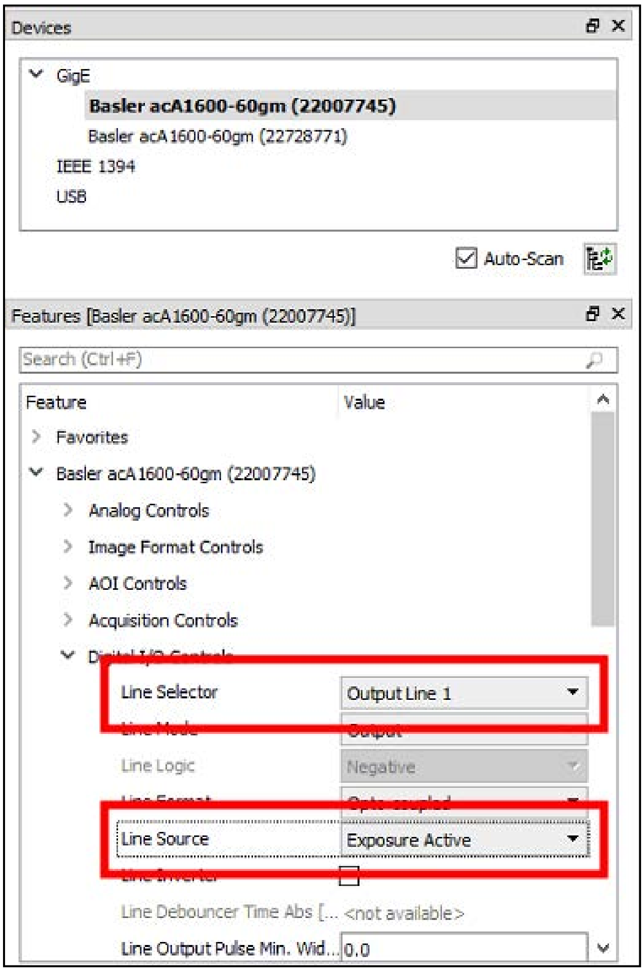


Figure A-6 Exposure Active Setting

Image Acquisition Check

It may be helpful to use the Pylon Viewer tool to confirm image acquisition before adding the camera object to the ACE project. Use the **Single Shot** Button to acquire an image and then make any necessary adjustments such as exposure or white balance if required.

After you have completed configuring the Basler camera using Pylon, close the Pylon application to avoid connection errors. If you test the camera and have the exception shown below, it indicates that Pylon is operating on the PC and camera.

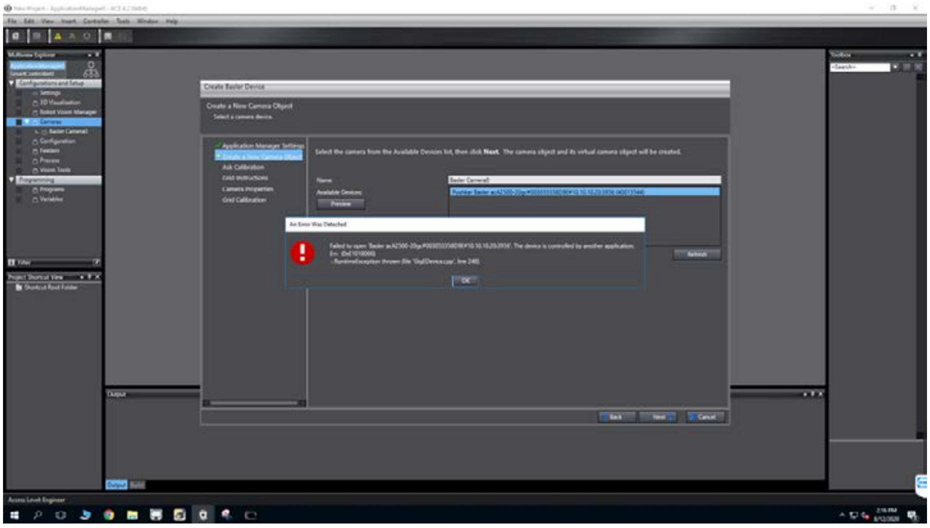


Figure A-7 Basler Pylon Exception

Add a Basler Camera to the ACE Project

After the camera connections, network settings, and camera settings have been completed, the camera object can be added to the ACE project. Refer to Basler and Sentech Cameras on page 323 for more information.

> **NOTE:** The ACE software and Pylon Viewer tool cannot access a camera simultaneously. Always disconnect the Pylon Viewer tool before opening an ACE project with a Basler camera object present.

Position Latch Wiring

If a camera is used in a vision-guided application with functions such as belt tracking or position refinement, a position latch signal must be connected from the camera to a robot controller input signal. This will allow the robot controller to capture the belt or robot position when the latch condition is met.

Use the information in this section to wire and configure a typical latch position signal from a connected Basler camera.

Latch Signal Pin Connections

The latch signal pin connections are indicated as follows. Refer to Camera Connections on page 650 for more information.

- Pin 4: Opto OUT 1 (yellow)
- Pin 5: Opto I/O Ground (gray)

SmartController XDIO Terminal Block Connection Example

The following example applies when using the SmartController XDIO terminal block to receive a rising edge latch on input 1001 (+1001 in the latch configuration). Refer to Configure on page 205 for more information.

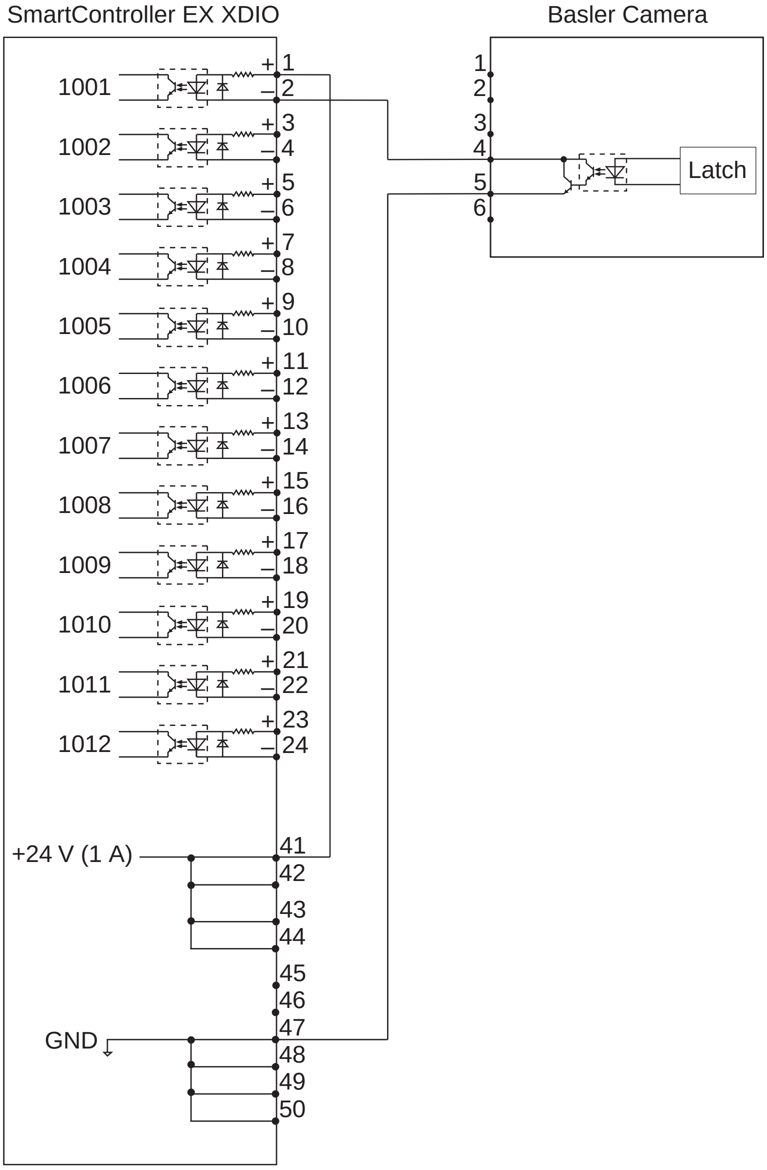


Figure A-8 SmartController XDIO Latch Wiring Example

e-Series Controller XIO Terminal Block Connection Example

The following example applies when using the e-Series controller XIO terminal block to receive a rising edge latch on input 1001. Refer to Configure on page 205 for more information.

NOTE: Signal numbers may differ than what is shown in the following figure. Refer to the robot User Guide for more information.

Ensure the appropriate XIO Termination Block bank switch is in the LO position.

Additional Information: Refer to the XIO Termination Block Installation Guide for more information.

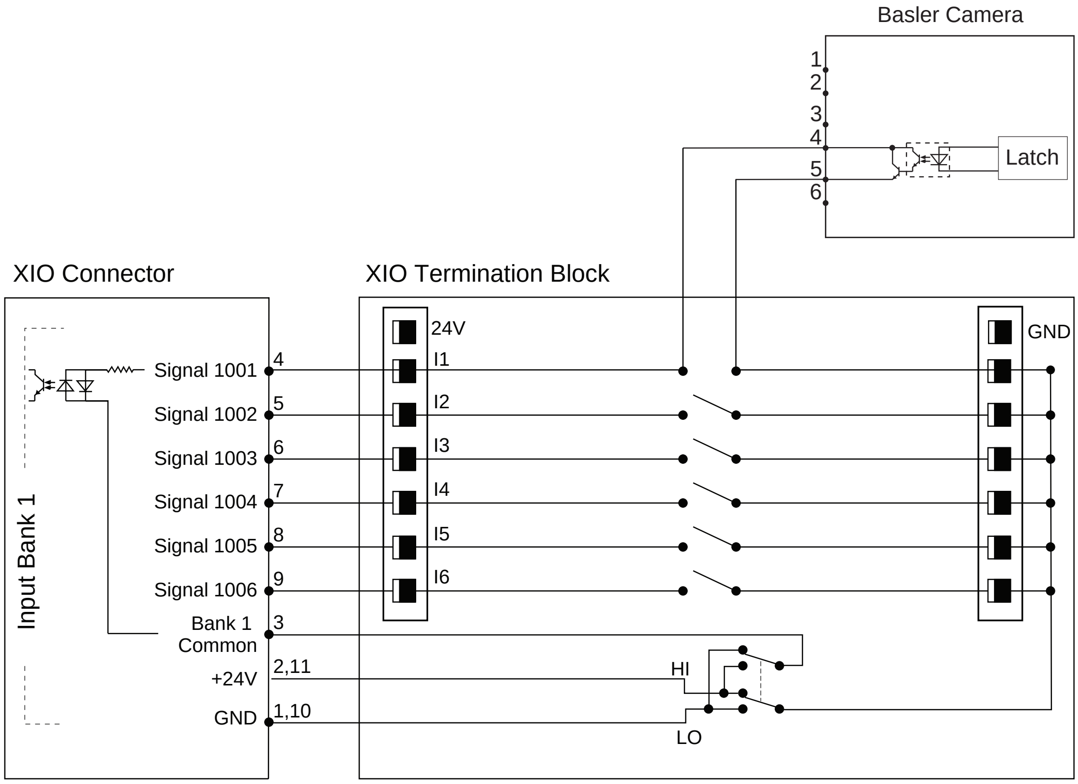


Figure A-9 XIO Latch Wiring Example

Latch Signal Test

Use the following procedure to test a latch signal. The following settings and configurations must be complete before the procedure is followed.

- Camera communication and power supply is present.
- Network and camera settings are complete.
- The camera object must be present and configured in ACE project.
- The position latch signal connections must be present.

Latch Signal Test Procedure

This is a simple test that can be performed for each camera in an application before proceeding with calibrations.

1. Access the Monitor Window. Refer to Monitor Window on page 222 for more information.
2. Clear the latch FIFO buffer using the program keyword CLEAR.LATCHES.

   For belts, use "do@1 clear.latches(-n)" where "n" is the belt object number.

   For robots, use "do@1 clear.latches(+n)" where "n" is the robot number.
3. Ensure the latch FIFO buffer is empty by entering "listr latched(-n)" or "listr latched (+n)", where "n" is the same as in step 2. This should return "0" if the FIFO buffer is clear. If not repeat step 2 and 3, or confirm the latch signal was wired and configured properly.
4. Trigger the camera by clicking the **Run** Button in the Virtual Camera object. Enter "listr latched(-n)" or "listr latched(+n)" respectively to return the most recent latch signal from the FIFO buffer. For the example circuit and configuration described above on Encoder Channel 0, "listr latched(-1)" would return "1001". If this occurs, the test procedure is successful and complete.

A.2 Configuring Sentech Cameras

ACE Robot Vision Manager tools support Sentech cameras supplied by Omron. These cameras need to be configured before use with the ACE software.

Sentech Camera Connections

Use the following steps for the connection and configuration procedure.

1. Communication and power connections
2. Configure network and camera settings
3. Save User Settings for the Camera
4. Add the camera to an ACE project
5. Position Latch Wiring (application dependent)
6. Latch Signal Test (application dependent)

> **NOTE:** The ACE software installation includes the Sentech 'StViewer' and 'GigECameraIPConfig' utilities that are required for the camera configuration.

The Sentech cameras ship with power and data cables. The following identifies the Omron part numbers.

Sentech:
Power I/O Cable p/n 21942-000
Cat5e Camera Cable p/n 21943-000

Use the following information to understand the Sentech camera connections.

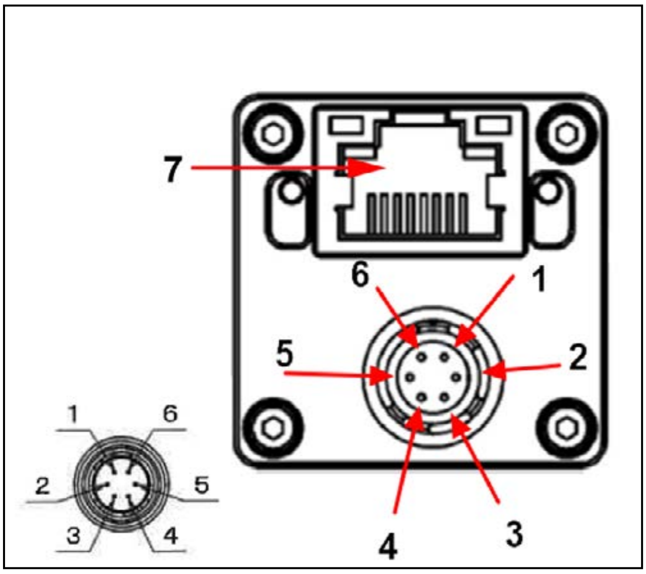


Figure A-10 Sentech Camera Connections

Table A-3 Sentech Camera , Connection Description

Item	Wire Color	Description
1	Blue	Power IN
2	White	Opto isolated IN (Line 0)
3	Yellow	Open Collector GPIO (Line 2)
4	Brown	Opto isolated OUT (Line 1) Open Collector
5	Green	Opto isolated Common
6	Black	GND
7	--	Camera Communications Port (RJ45)

NOTE: Wire colors indicated in the table above correspond to the power I/O cable (ORT P/N 21942-000) supplied with the camera kit. For more information regarding pin voltages and camera specifications please refer to Sentech Camera Documentation

Sentech Power and Communication Connections

ACE supports Sentech GigE PoE cameras. Section below describes how to ensure communication between the Camera and the PC.

Camera Power Connections

Power can be supplied to Sentech PoE cameras in two manners: default PoE, if capable, and with PoE Ethernet cable or the Power I/O cable. Use the following information to supply power to the camera. Refer to Sentech Camera Connections on page 660 for more information.

> **NOTE:** When using a GigE type camera, external power connections should not be used if the camera is connected to a PoE port.

Use the following connections to supply external power to the camera if the model uses GPIO.

- Pin 1: + 24 VDC
- Pin 6: 0 VDC

Camera Communication Connections- Sentech

If using a GigE type camera, connect the RJ45 camera port to the PC or the local area network using the supplied cable, ORT P/N 21943-000.

If using a USB camera, connect the provided USB cable to the PC using the supplied cable.

Configure Network and Camera Settings

After connecting the camera to the PC or local area network, configure the network and camera settings described below.

> **NOTE:** The StViewer tools referenced in this section can be found in the Windows Start Menu under the Sentech SDK program group. These tools are included with the default ACE software installation.

PC Port Settings

Open the PC Control Panel and then open the Network Connections. Right click the port used for the Sentech camera and select **Properties**. Select Internet Protocol Viewer 4 (TCP/IPv4) and click **Properties**, to open that panel, as shown in the following figure.

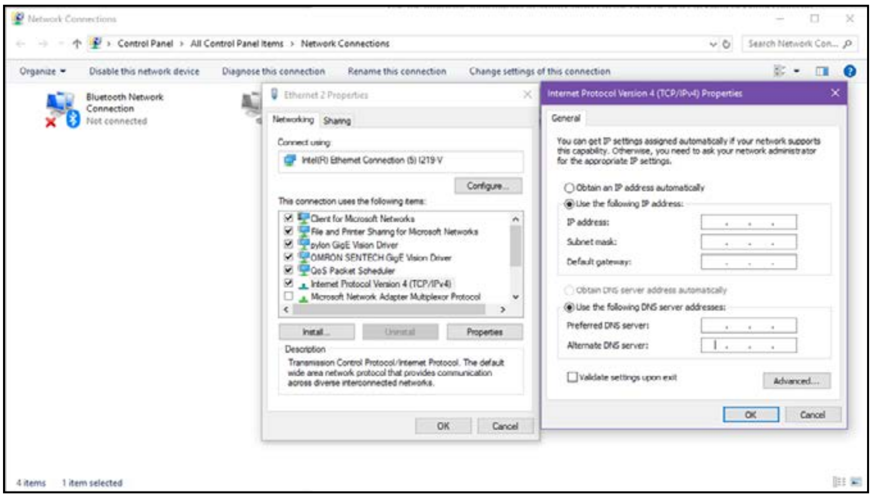


Figure A-11 TCP/IPv4 Network Properties

Use the Network Properties setup the correct compatible IP address for the PC port communicating with the Sentech Camera. It is recommended to connect one GigE camera per port. It is recommended that you configure one GigE camera per port or NIC address. When done, click **OK** on the Properties panel. The Ethernet Properties panel should remain open.

Jumbo Packet Setting - Sentech

On the Ethernet Properties panel, click the **Configure** Button. The enables the PC network adapter configuration and enable the ***Jumbo Packet*** property. Set the value to 9014 Bytes. Click the Advanced tab and scroll down the Property options and select ***Jumbo Packet***. In the *Value* side, use the drop down and select 9014 Bytes, matching the settings in the GigE camera, as shown in the following figure. Then click, **OK** to close the panel.

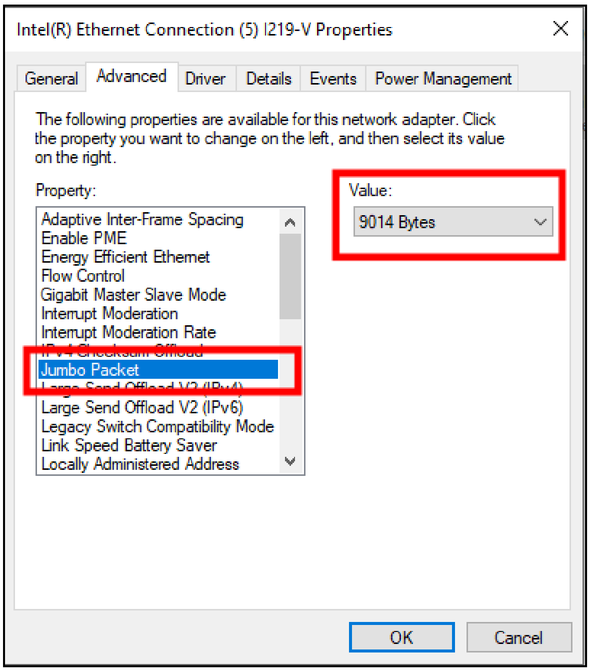


Figure A-12 Network Adapter Jumbo Packet Setting

Adjust the Camera Network Settings - Sentech

In the Windows Start Menu, navigate to the Sentech SDK and open the ***GigECameraIPConfig*** to view the camera communication status with the PC. If the camera IP configuration is incorrect, this tool can be used to correct the settings. Click the Apply button after making any setting adjustments.

> **NOTE:** If an active connection is present between the camera and the ACE software, the Sentech StViewer settings may be inaccessible since only one software may access the camera at any time.

> **NOTE:** Click the DHCP and persistent IP check-boxes, as shown in the following figure, to ensure the IP settings persists even after the camera is rebooted.

The figure below provides an example that shows the IP settings for one camera that is communicating properly.

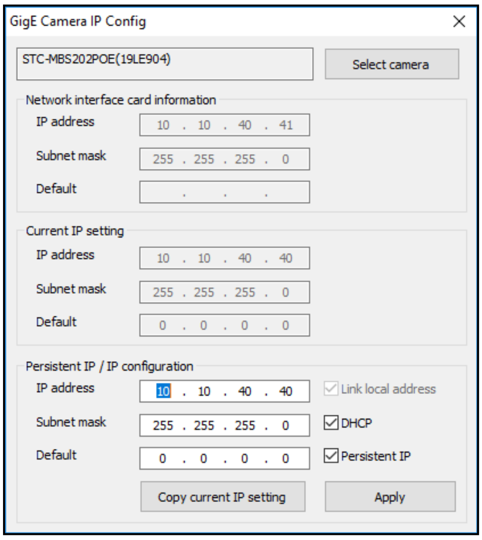


Figure A-13 StViewer IP Configurator Example

Adjust Camera Image Acquisition Settings - Sentech

The StViewer is used to adjust the camera image acquisition settings. Use this tool to enable the Exposure Active signal and change any other necessary camera settings before adding a camera to the ACE project.

> **NOTE:** If any camera settings are changed with the GigECameraIPConfig or the StViewer tool after it has been added to the ACE project, camera functions may be disrupted.

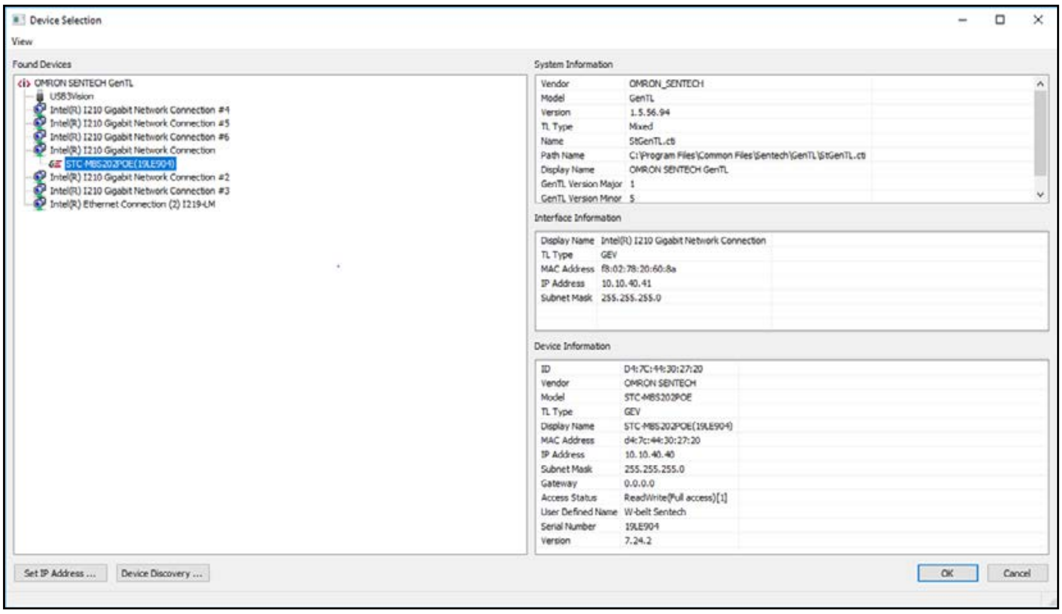


Figure A-14 StViewer - Open Camera

Close ACE and open StViewer and then select a camera from the *Found Devices* list. Then, click the **OK** Button to access all settings associated with the selected camera.

Enable the Exposure Active Signal Sentech

The Exposure Active signal is an output from the camera to the robot controller that indicates the moment when the camera acquired an image. This signal is used by the controller for position latching in applications that use vision-guided motion. The *Exposure Active* signal must be enabled for all applications that require robot or belt encoder position latching.

Expand the **Digital I/O Controls** item, as shown in the following figure, and make the following settings.

- Set the Line Selector item to ***Line 1***.
- Set Line Mode to *Output*.
- Set the Line Source item to ***Exposure Active***.
- Set Line Inverter to *True*.

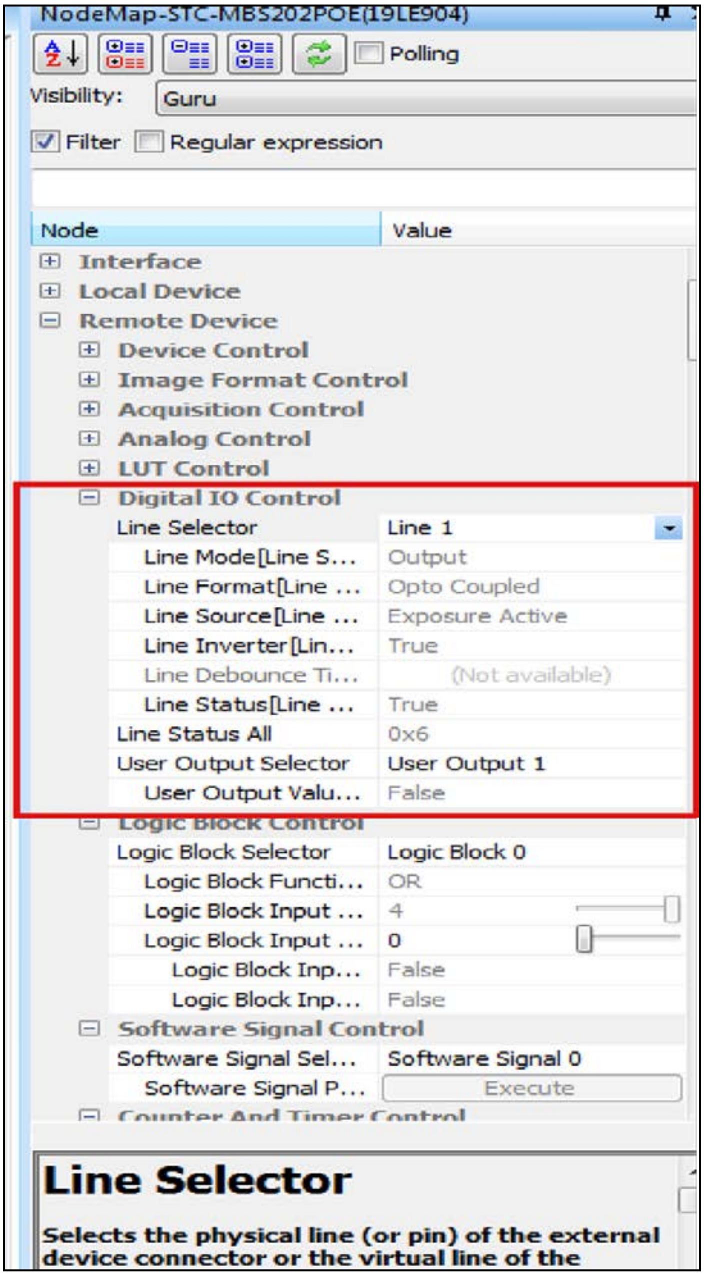


Figure A-15 Digital IO Content

Save Camera Settings

Sentech Camera Settings need to be saved to a User Set to ensure the settings are applied when the camera loses power or the connected PC is restarted. Before loading or saving User Profiles, the acquisition needs to be turned off by pressing the ***STOP*** Acquisition button in the top left corner in the tool bar.

To save these settings, for example to User Set 0, "***User Set Selector*** should be changed to "User Set 0", then execute **User Set Save**. When "User Set Default" is set to "User Set 0" the camera will load User Set 0 settings when power is applied. All changes made to the camera's setting need to be saved to the profile using the ***User Set Save***. The profile selected under User Set Default will be loaded on reboot. When User Set Default is set to User Set 0 the camera will load User Set 0 settings when the camera boots up.

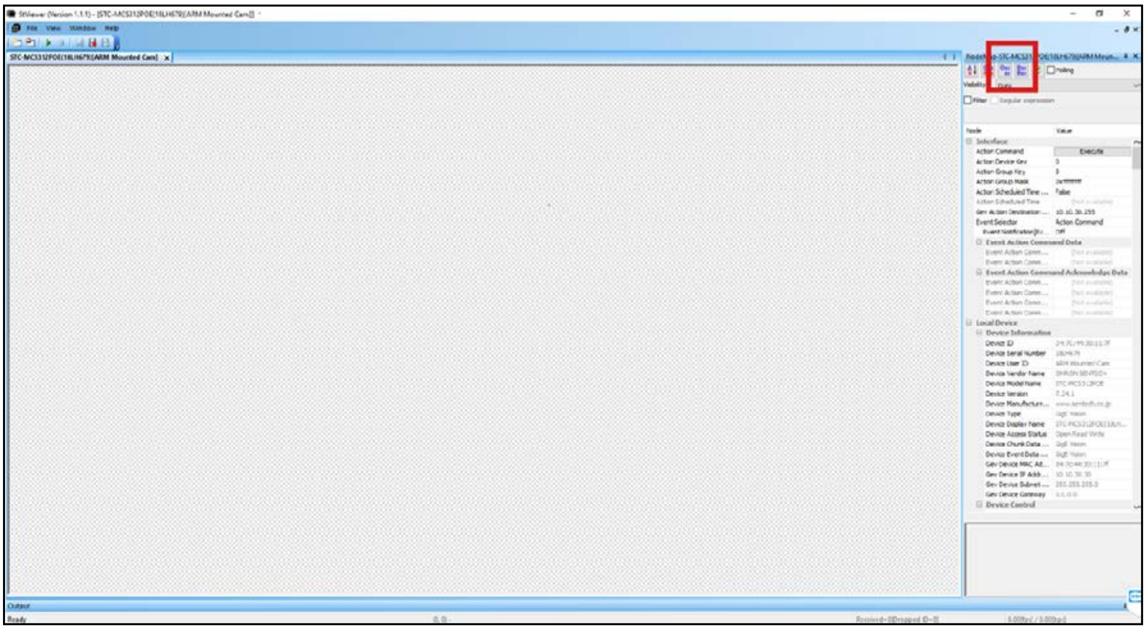


Figure A-16 StViewer - Sentech Camera Settings

In the above figure, the icons within the red box are used to expand or collapse the details and options in the right-side column.

Image Acquisition Check

It may be helpful to use the StViewer tool to confirm image acquisition before adding the camera object to the ACE project. After selecting the appropriate camera, enable image acquisition using the **PLAY** Button in the top left corner and use the **Trigger Software Execute** Button under *Remote Device_Acquisition Control* to acquire an image. Customize the camera exposure or white balance if required.

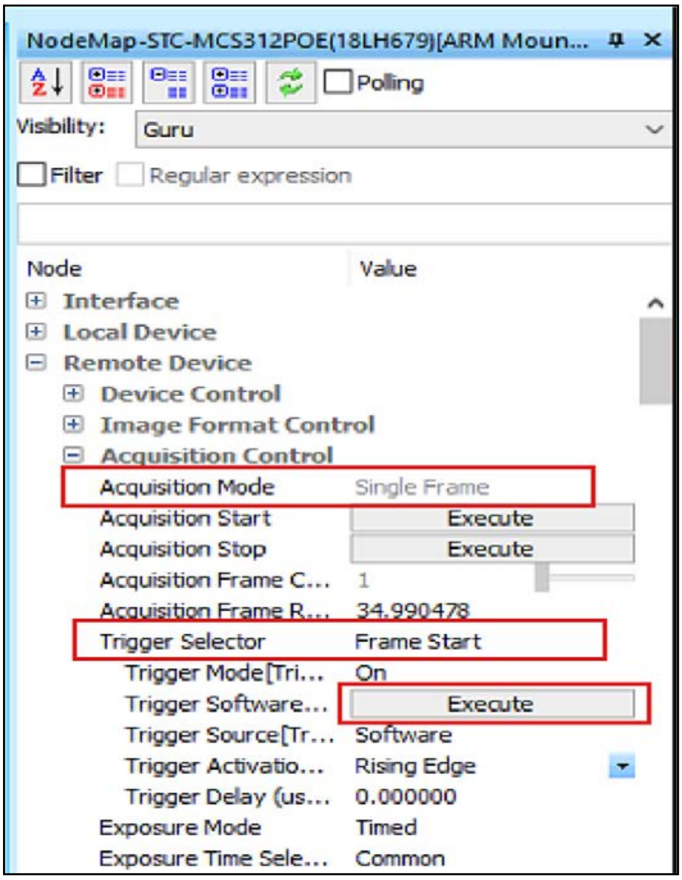


Figure A-17 Trigger Software Selector

After you have completed the check process, close STViewer. If STViewer is not closed, ACE may not be able to communicate with the camera, and the following exception may open.

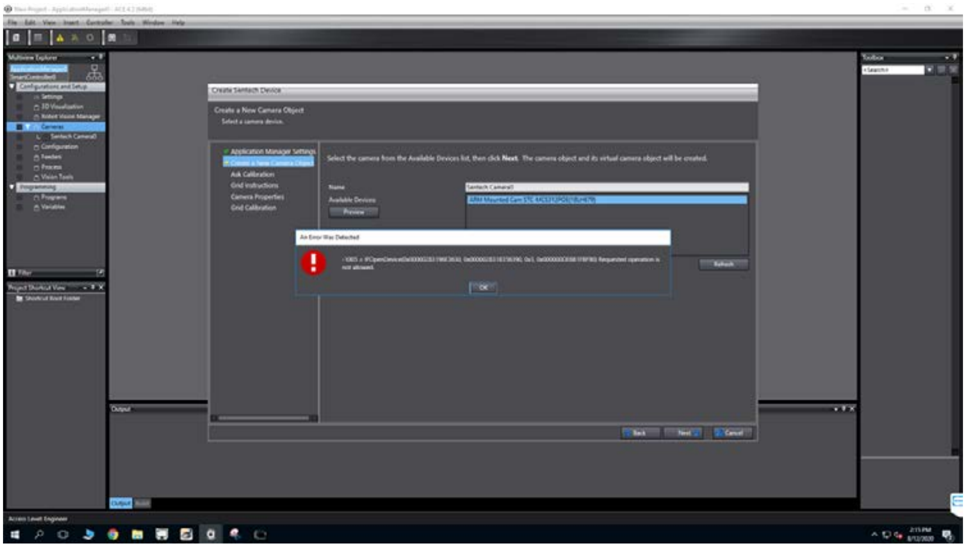


Figure A-18 STViewer-Sentech Exception.

Add a Sentech Camera to the ACE Project

After the camera connections, network settings, and camera settings have been completed, the camera object can be added to the ACE project. Refer to Basler and Sentech Cameras on page 323 for more information.

> **NOTE:** The ACE software and StViewer tool cannot access a camera simultaneously. Always disconnect the StViewer tool before opening an ACE project with a Sentech camera object present.

Position Latch Wiring

If a camera is used in a vision-guided application with functions such as belt tracking or position refinement, a position latch signal must be connected from the camera to a robot controller input signal. This will allow the robot controller to capture the belt or robot position when the latch condition is met.

Use the information in this section to wire and configure a typical latch position signal from a connected Sentech camera.

Latch Signal Pin Connections

The latch signal pin connections are indicated as follows. Refer to Camera Connections on page 650 for more information.

- Pin 4: Opto OUT 1 (yellow)
- Pin 5: Opto I/O Ground (gray)

SmartController XDIO Terminal Block Connection Example

The following example applies when using the SmartController XDIO terminal block to receive a rising edge latch on input 1001 (+1001 in the latch configuration). Refer to Configure on page 205 for more information.

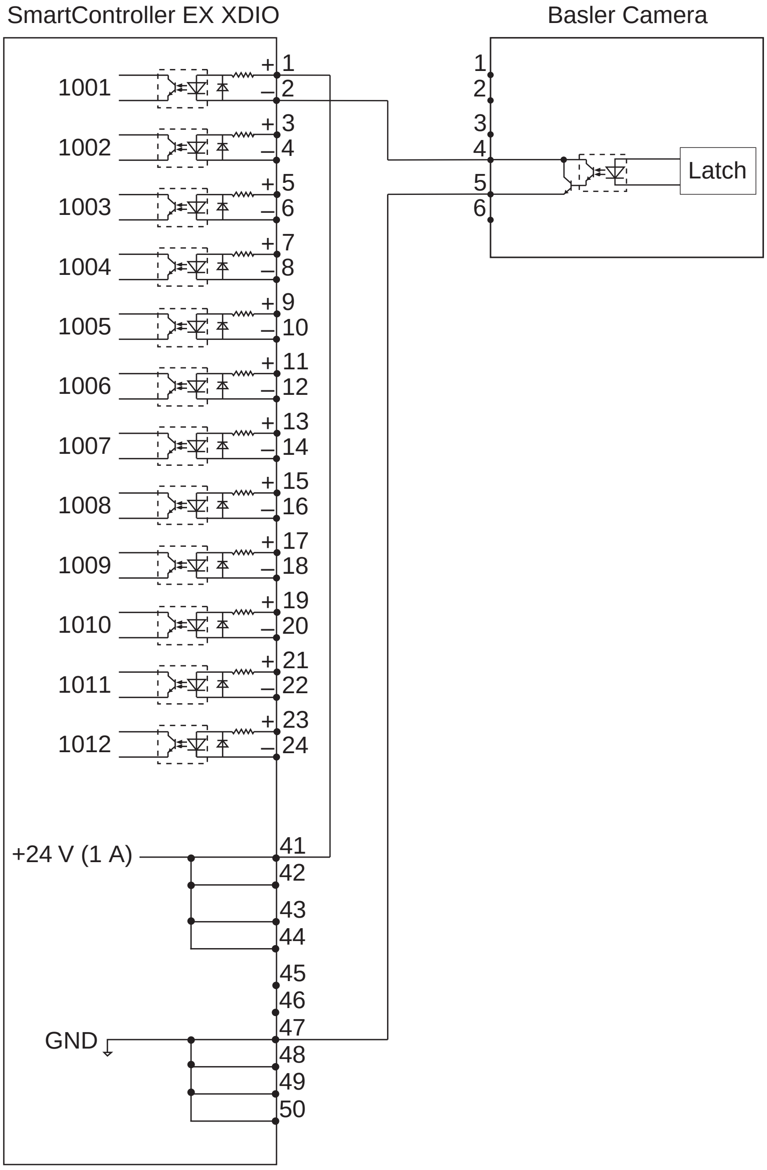


Figure A-19 SmartController XDIO Latch Wiring Example

e-Series Controller XIO Terminal Block Connection Example - Sentech

The following example applies when using the e-Series controller XIO terminal block to receive a rising edge latch on input 1001. Refer to Configure on page 205 for more information.

> **NOTE:** The figure shows a rising edge latch, falling edge latches are also possible, and set during configuration.

> **NOTE:** Signal numbers may differ than what is shown in the following figure. Refer to the robot User Guide for more information.

Ensure the appropriate XIO Termination Block bank switch is in the LOW position.

Additional Information: Refer to the XIO Termination Block Installation Guide for more information.

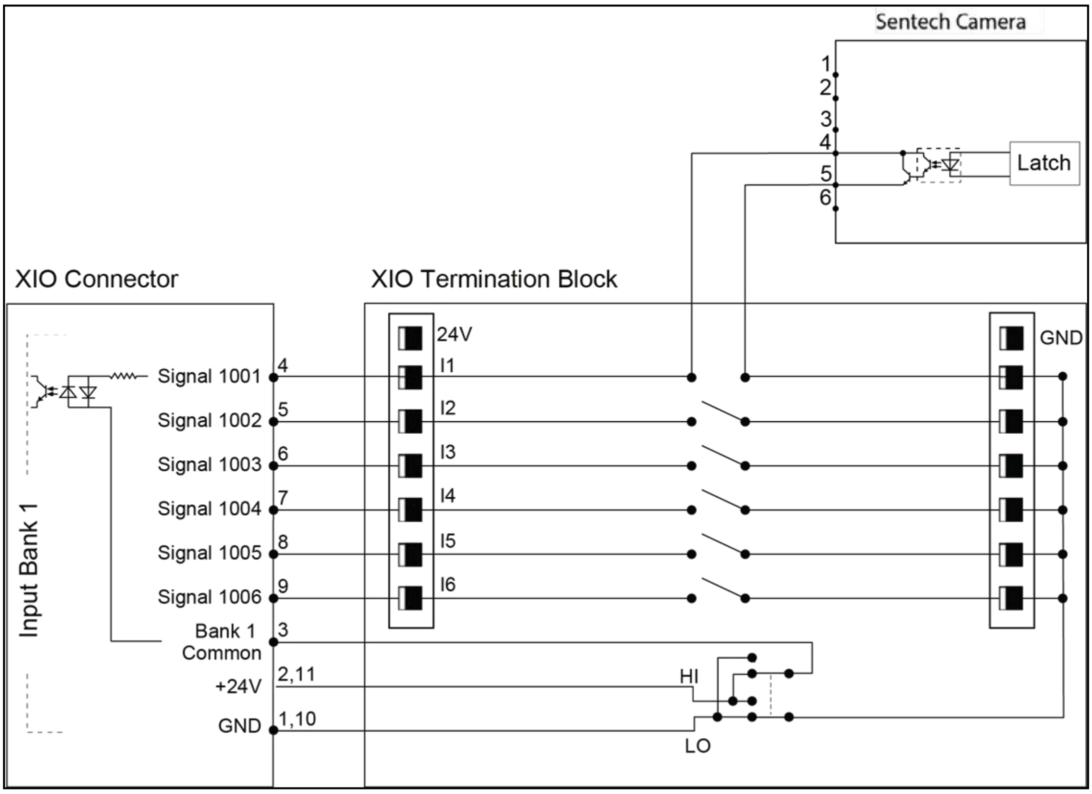


Figure A-20 XIO Latch Wiring Example

Latch Signal Test

Use the following procedure to test a latch signal. The following settings and configurations must be complete before the procedure is followed.

- Camera communication and power supply is present.
- Network and camera settings are complete.
- The camera object must be present and configured in ACE project.
- The position latch signal connections must be present.

A.3 Configuring Photoneo 3D Cameras

Robot Vision Manager vision tools supports 3D Pick Manager and Phoxi cameras supplied by Photoneo. These cameras need to be configured before use with the ACE software.

Use the following steps to understand the general 3D camera configuration procedure. The steps are detailed in the following sections.

1. Communication and power connections
2. Configure network and camera settings
3. Add the camera to an ACE project

NOTE: The ACE software installation includes the PhoXi configuration tool that is required for the camera configuration.

WARNING: The PhoXi 3D small scanners are laser class 3R devices. These are considered safe when handled properly

WARNING: The PhoXi 3D medium and large scanners are laser class 3R or laser class 2 devices. Class 3R lasers are considered safe when handled carefully. Class 2 lasers are considered safe for normal use.

WARNING: Do not look directly into the laser beam. This may cause injury to your retina. Laser protective eyewear is normally not necessary.

3D Camera Connections

The PhoXi 3D cameras are used with Omron Viper 650/850 robots for emptying bins or pallets. This means they are used to identify a part, by shape, within a random assortment of parts. The part is identified, located and then picked and placed onto a stationary fixture or location. The cameras ship with power and data cables. The following identifies the Omron part numbers.

3D Camera, p/n 21857-100, -200, -300 include the following:
Scanner + PoE injector + cable: 21844-100, -200, -300
Programmed License Key: 22869-000
Ethernet cable (3 m): 81030-001

WARNING: The surface of the processing unit becomes hot to touch when the device is in use. Mount the device on a metal mounting plate that will act as a thermal bridge to dissipate the heat and use the camera's carbon body to adjust the device.

Before connecting cables to the camera, it must be mounted onto the work space. Use the following figure to properly mount the 3D camera for your application.

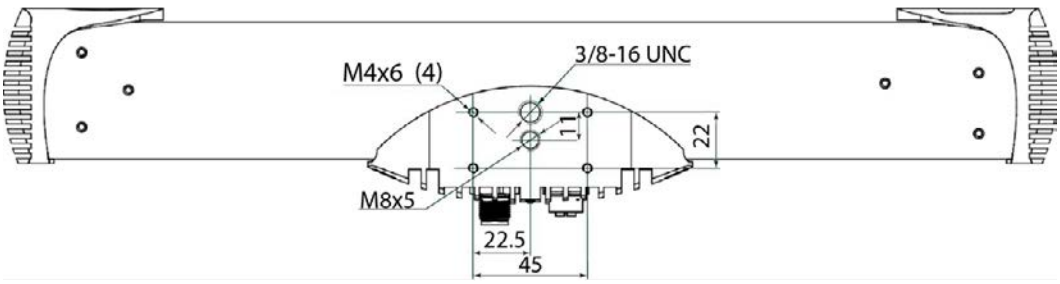


Figure A-21 PhoXi 3D Mounting Dimensions

The suggested mounting method, for heat dissipation, is to use the 4xM4 screws with a metal mounting plate of suitable size. You want to ensure the mounting is rigid, to avoid vibrations during scanning. The optimal operating temperature for scanning is 22 °C to 25 °C; while the operating temperature range is 0 °C to 45 °C.

The following information shows the PhoXi camera connections. The tables that follow provide the details about each pin and any cable requirements. Always use cables of a Cat5e category or higher that support Gigabit Ethernet or 10 Gigabit Ethernet standards. Do not use Cat5 category cables as their speed is usually 10 - 100 Mbps, which is too low to obtain a good scanning performance. If you are connecting your Scanner to a switch, make sure it is able to run at 1 Gbps or more.

NOTE: Connect the network cable to the scanner first, followed by the power cable.

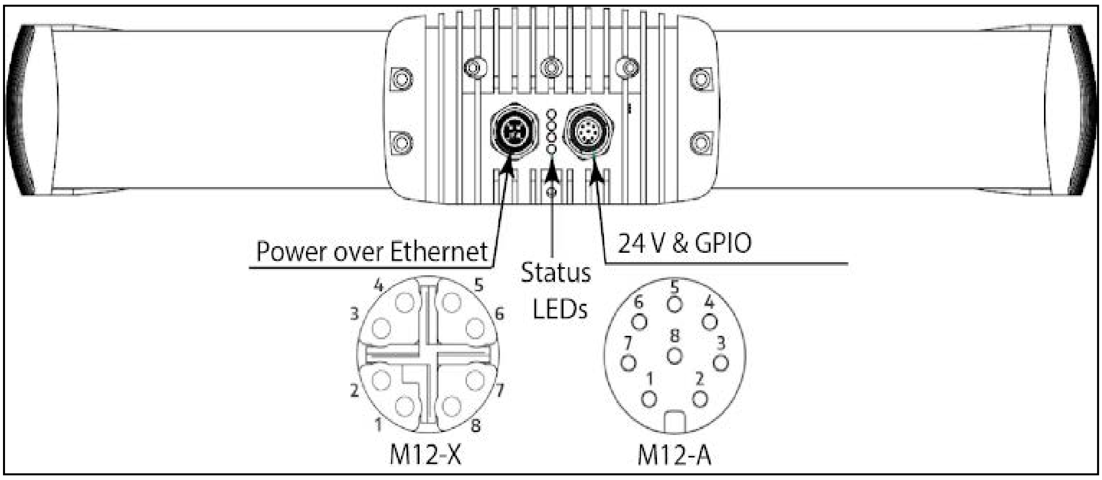


Figure A-22 3D Camera Connections

Table A-4 3D Camera M12 A 24V and M12-X Pinout

Item	Wire Color	Pin Out	Function
1	White	DC IN	+24VDC
2	Brown	Opto IN2 GND	Laser interlock ground

Item	Wire Color	Pin Out	Function
3	Green	GND	Ground
4	Yellow	Opto IN 1	
5	Grey	Opto IN 1 Ground	
6	Pink	Opto Out	
7	Blue	Opto Out GND	
8	Red	Opto IN 2	Laser interlock signal

NOTE: Wire colors indicated in the table above correspond to the cable supplied with the camera.

NOTE: The laser interlock ground and signal functions require special firmware.

The M12-X PoE port is the recommended powering option. It has a 1 Gbps connection to the PoE injector IN port. The 24V and GPIO M12-A connector supports desktop and DIN rail adapters.

Table A-5 3D Camera Power Requirements

Connector	MX12 X	M12 A
PoE Standard	DC IN	+24VDC
PoE Standard	IEEE802.3at	
Operating Voltage DC	min. 55 Vt	24 V (20 - 30 V)
Residual ripple max.	0.5%	2%
Rated operating current	0.36 A (0.6 A)	1 A (2 A)
Minimum Power	33 W	60 W
Shielding	Fully Shielded RJ45	
Data transfer rate		
Max. cable length	20 m	20 m (see Note)

NOTE: For cables over 10 meters in length, ensure the operating voltage is at a minimum of 28 VDC.

3D Camera Indicators

The Photoneo 3D camera has status LEDs on the connector side of the device, refer to . Each of the 4 LEDs has the ability to show multiple status values. The following figure shows the value possibilities for each of the four indicator LEDs as shown in .

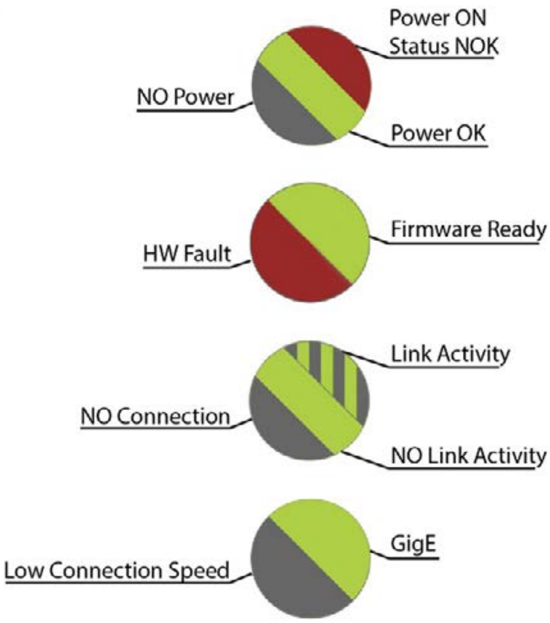


Figure A-23 Indicator LED Status

3D Power and Communication Connections

There 3D camera connections are the same for the three sizes of PhoXi cameras.

Camera Power Connections - 3D Power

Use the following information to supply power to the camera. Refer to 3D Camera Connections on page 672 for more information.

Add a 3D Camera to the ACE Project

After the camera connections, network settings, and camera settings have been completed, the camera object can be added to the ACE project. Refer to Basler and Sentech Cameras on page 323 for more information about the connections and settings.

> **NOTE:** It is possible to simultaneously access the 3D camera through ACE and Phoxi. However, changing camera settings in Phoxi while running ACE may result in unexpected camera and system behavior. For this reason it is recommended that you close Phoxi before opening ACE.

Open ACE and select Application Manager in the Multiview Explorer pane, as shown below.

Figure A-24 ACE Multiview Explorer

Click and expand the Configuration and Setup option. Then, right click Cameras, select **Add** and sequentially add the **Photoneo Camera**, **3D Virtual camera** and **Emulation 3D Camera**, as shown in the following figure.

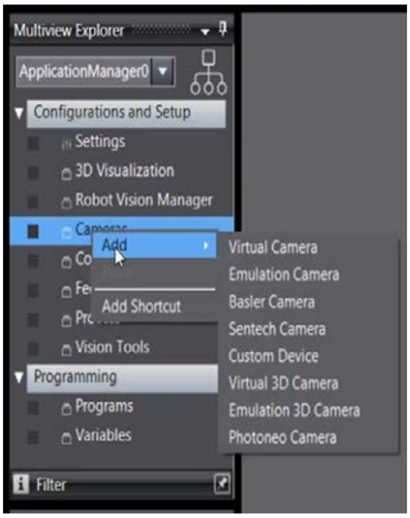


Figure A-25 Add 3D Cameras

After they are added, the camera objects need to be qualified. The Photoneo 3D camera is first. Click the camera object, opening the device identification, and select the camera, as shown below.

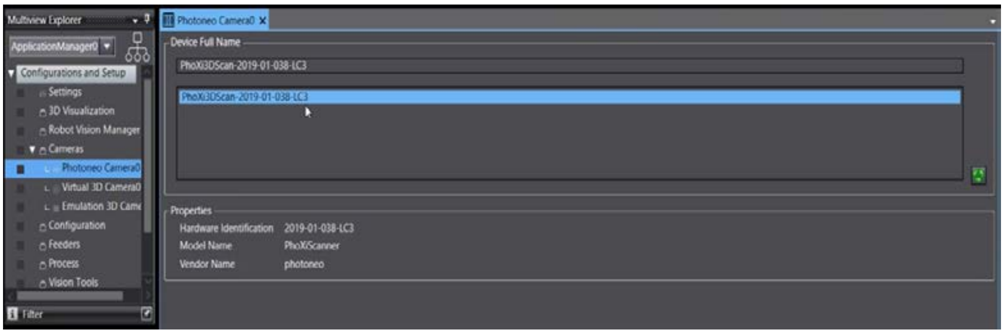


Figure A-26 Photoneo Selection

Next, select the Virtual 3D Camera from the Cameras section. Confirm the 3D tab is selected, then click the **ellipsis** Button, highlighted in red. This opens the reference option, shown in the center of the following figure.

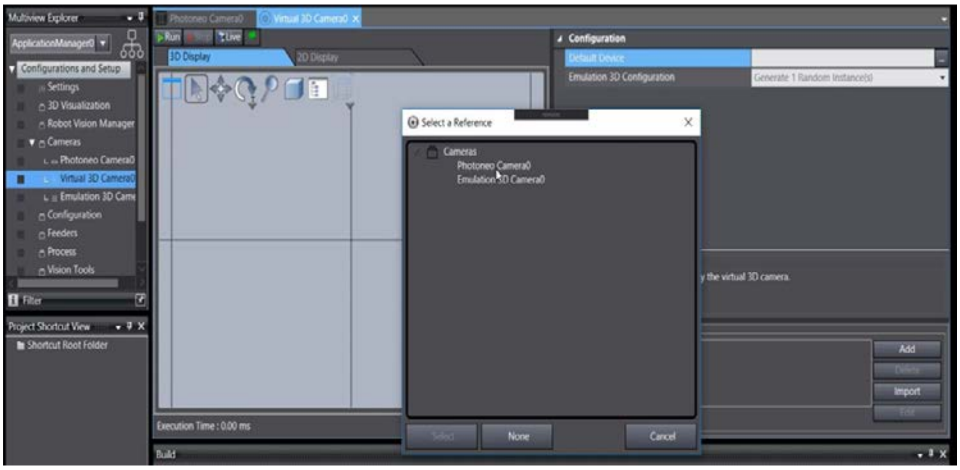


Figure A-27 Photoneo Virtual Camera

Select the **Photoneo Camera** option and then click the **Select** Button. When the center panel closes, click the **Run** Button shown in the following figure.

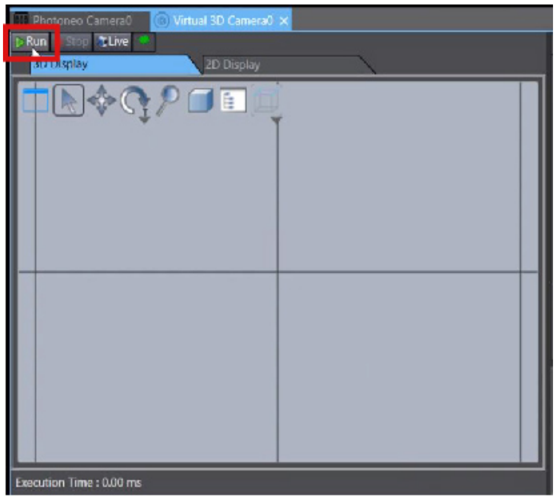


Figure A-28 Run Button Selected

The center of the pane populates with an image. The Camera Properties settings then need to be edited.

Check the camera in the **Acquisition Settings** box and then click the **Edit** Button. The Camera Properties panel opens, as in the following figure.

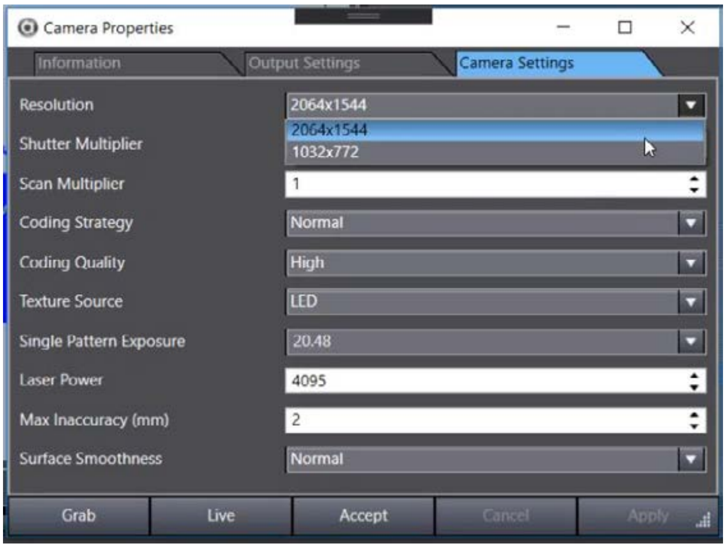


Figure A-29 Camera Properties

The resolution can remain at 2064 x 1544, or for fasted processing, you can change the resolution from the default to 1032 x 772, as shown above. Then click **Accept**.

After this, navigate to the Multiview Explorer and select **Vision Tools**, as shown in the following figure, and click **Locator 3D**.

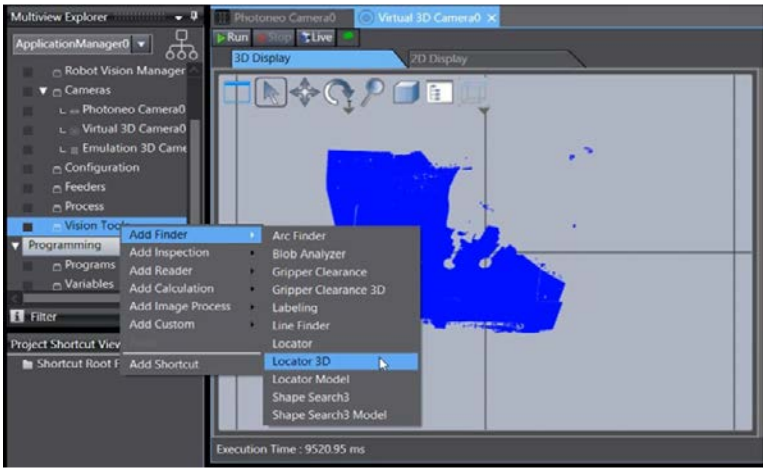


Figure A-30 Add 3D Locator

At this point you need to add a model that the 3D camera can use as a model to identify the pieces to be picked. This is done by now selecting the plus sign (**+**) in the Model part of the ACE application, as shown in the following figure.

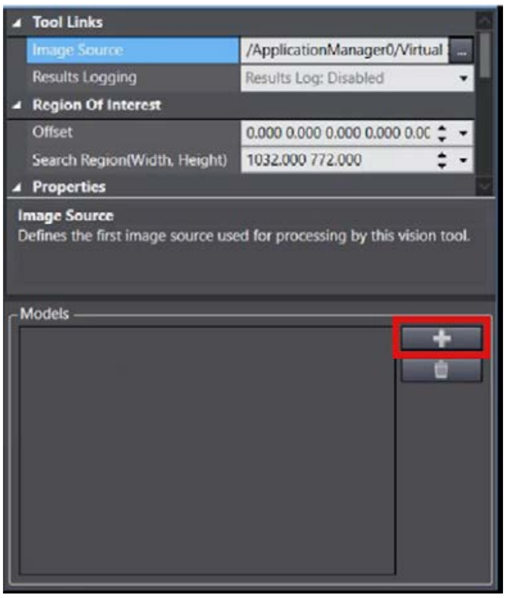


Figure A-31 Add Model to 3D Locator

The Create Locator Model 3D panel opens. Click the **Import File** Button on the top left of the panel. Windows Explorer opens where you select the specific CAD model to include into the camera. Select the model, click **OK** and the file loads into the Locator tool. If the part is asymmetric then you will need to select and register both sides of the object. Once the loading stops, click the **Next** Button. Enter a new Object ID value to identify the 3D Model, this is only used for display purposes. Then click **Finish**, as shown in the following figure.

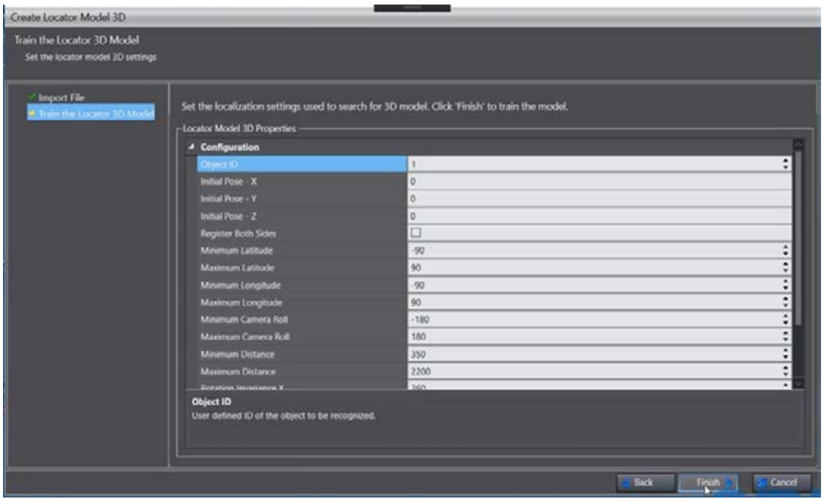


Figure A-32 Create Model Locator Model 3D

The above panel closes, returning to the ACE Multiview Explorer with the added model showing in the Models panel of the Explorer, as shown in the following figure.

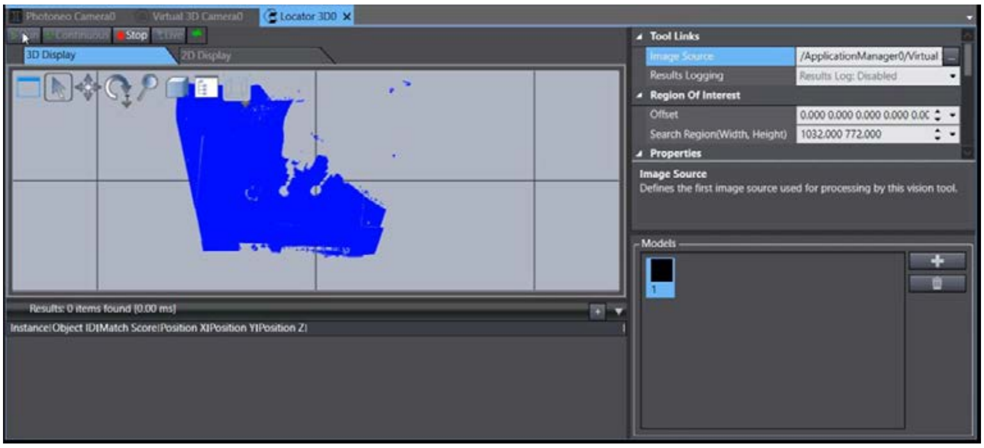


Figure A-33 Run Models

After the model has been loaded, the locator needs to be operated before it can be identified in the point cloud. To do this, click the **Run** Button on the top left of the panel, shown in the above figure. When the model is added, the instance line is added. You can now left clicking the image and moving it to confirm the addition.

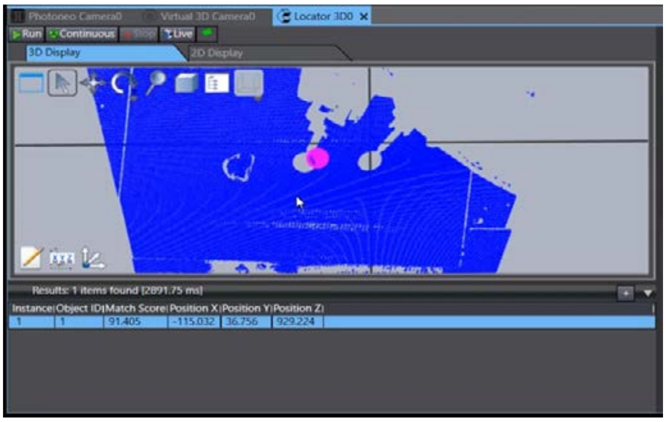


Figure A-34 Instance Line Populated

After the camera is connected, the 3D camera requires calibration. In the Multiview Explorer, select **Robot Vision**, then **Add** and click **Camera Calibration 3D**. The calibration option is added under Robot Vision. Left click the **Camera Calibration 3D** to open the Calibration panel, shown in the following figure.

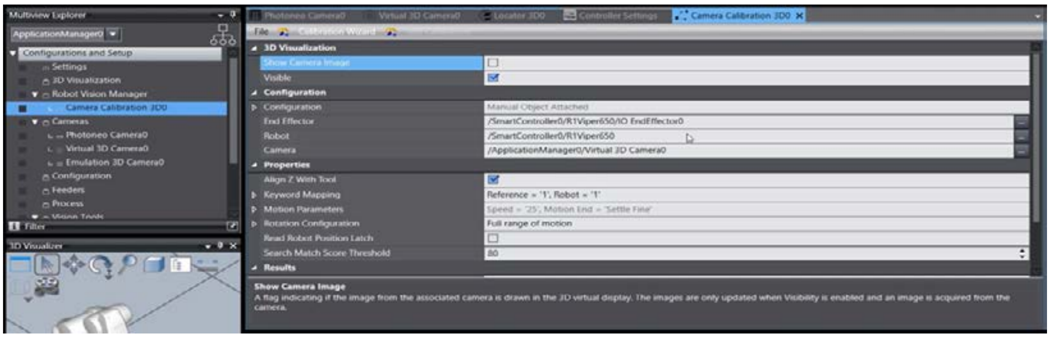


Figure A-35 Camera Calibration 3D

Click the **Calibration** Button at the top of the panel next to the *File* button. When the wizard opens, it connects to the camera and retrieves parameters to prepare the calibration process. Click the **Next** Button to continue with the wizard.

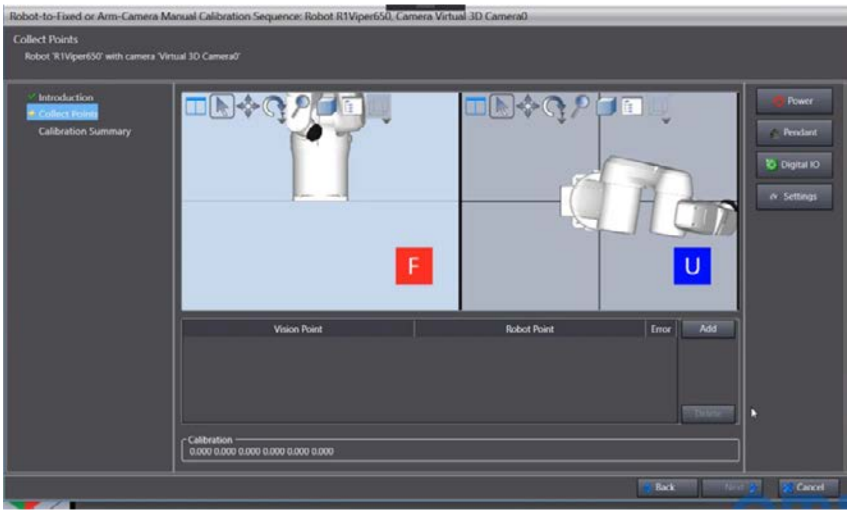


Figure A-36 Collect Calibration Points

Click the **Power** Button and wait for the Enable icon to close, indicating the robot is powered and connected. Open the Robot Jog Control Window by clicking on the **Pendant** Button. The robot needs to be jogged to at least 4 locations within the camera's field of view, moving in the X, Y, and Z axes.

Figure A-37 Jog Control

Use the Jog Control arrow buttons to move the robot arm, viewed through the calibration panel. After moving the robot to each new location, click the **Add** Button to take an image and record the location. When completed, the panel will populate with each position, as shown in the following figure. After 4 points, the calibration error will be calculated and displayed next to each point. This number should be between 0 to 3, with lower the number being more accurate.

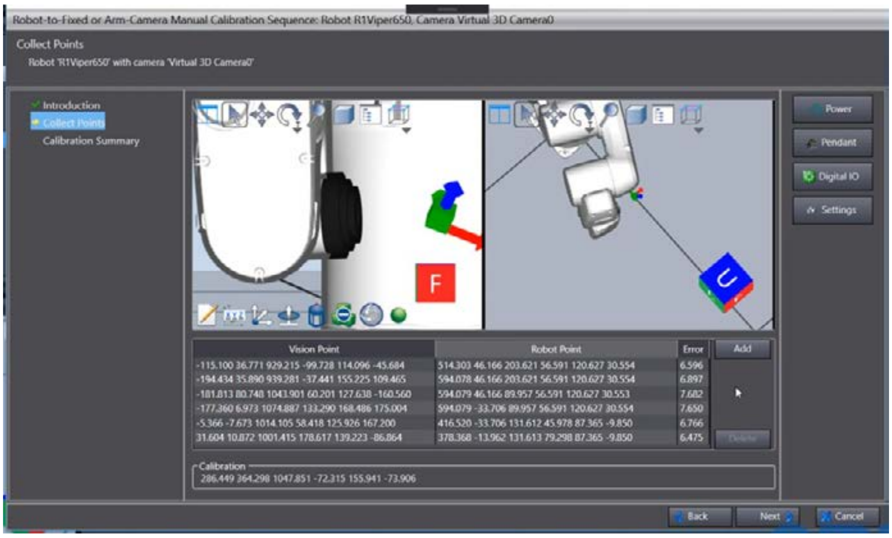


Figure A-38 Calibration Window with Points.

Once the points are identified, click the **Next** Button, to see the errors, shown in the following figure.

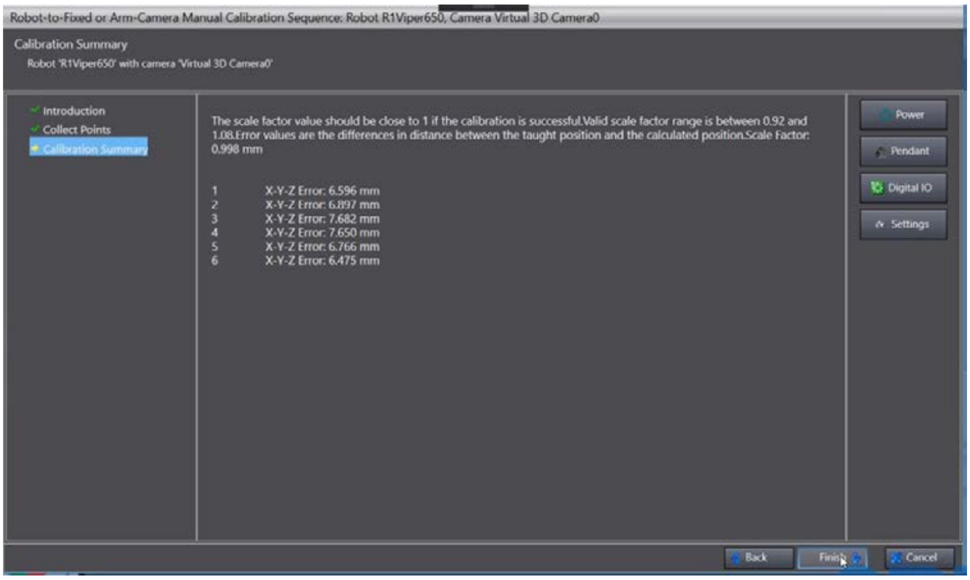


Figure A-39 Calibration Errors

Click the **Next** Button again. After locating and identifying the object and the end effector of the robot, the calibration process is complete.

A.4 Configuring FH Cameras

Robot Vision Manager vision tools support FH cameras, but the cameras need to be configured with FZ Panda before use with the ACE software.

The following FH camera connection and configuration procedures are provided in the detailed steps provided in the following sections.

1. Communication and power connections
2. Configure network and camera settings
3. Add the camera to an ACE project

FH Camera Connections

Connecting FH Cameras

Use the following steps for the FH camera configuration. after the communications and power connections are made.

> **NOTE:** Refer to the *FH Series Vision System Hardware Setup Manual (Z366-E1)* for the correct steps to install the communication and power connections to your specific camera and installation requirements.

1. Add Location Array
2. Associate Array to Locator Tool

3. Setup Output Messages
4. Add FH Tool AceObject
5. Set configuration
6. Pixel calibration

FH Camera Location Array and Variables

After you have connected the FH camera to the power source and computer a location array needs to be added, using the following steps after the camera is powered ON.

1. Open the *FZ Panda* application and connect to the camera.

2. Once connected, open the *TDM Editor* and then click the **Scene Variable** tab.

3. Add a Double Array for the X, Y, RZ and 32 elements.

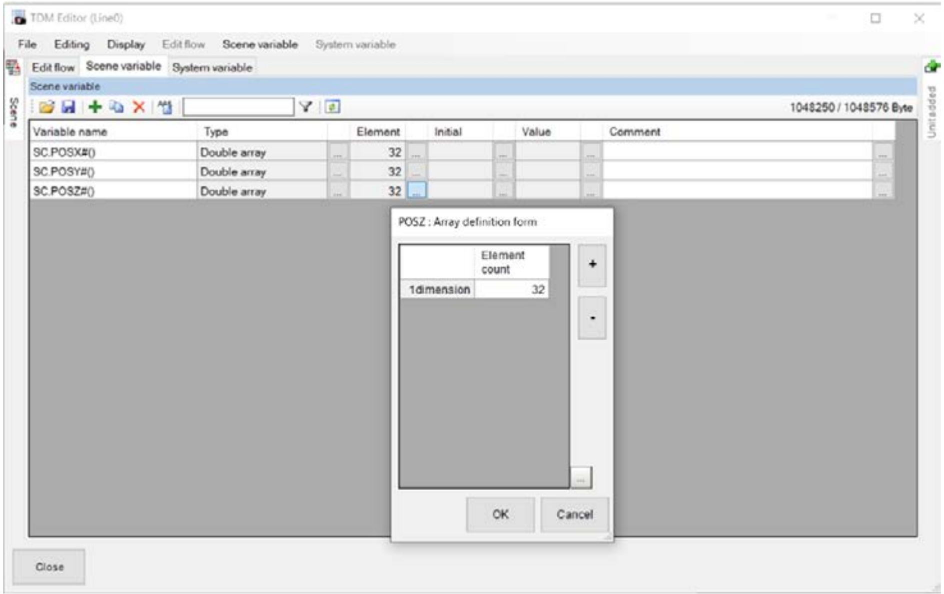


Figure A-40 TDM Editor

Associate Variables

After the array is created you need to associate each array element with the corresponding Search Job output variable.

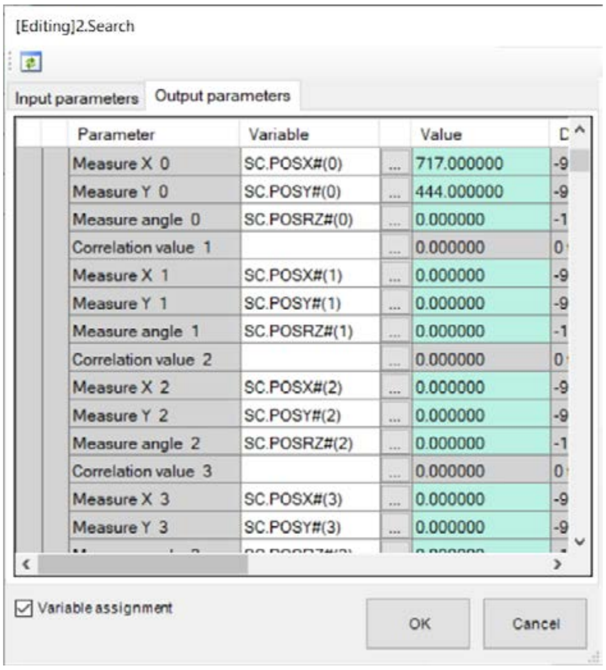


Figure A-41 Output Variables

1. Open the *TDM* editor and click **Edit Flow.**
2. Select **Search Job** and then edit with the New Editor.
3. Open the *Output Parameters* and then check the **Variable Assignment** box, as shown in the bottom left of the above figure.
4. Click next to the Measure ... in the *Parameter* column and select the corresponding **Variable Array** element.
5. Assign the corresponding *Variable Array* element for each *Parameter*.

Setup Output Message

The TDM editor is used to setup the output messages, as defined in the following steps.

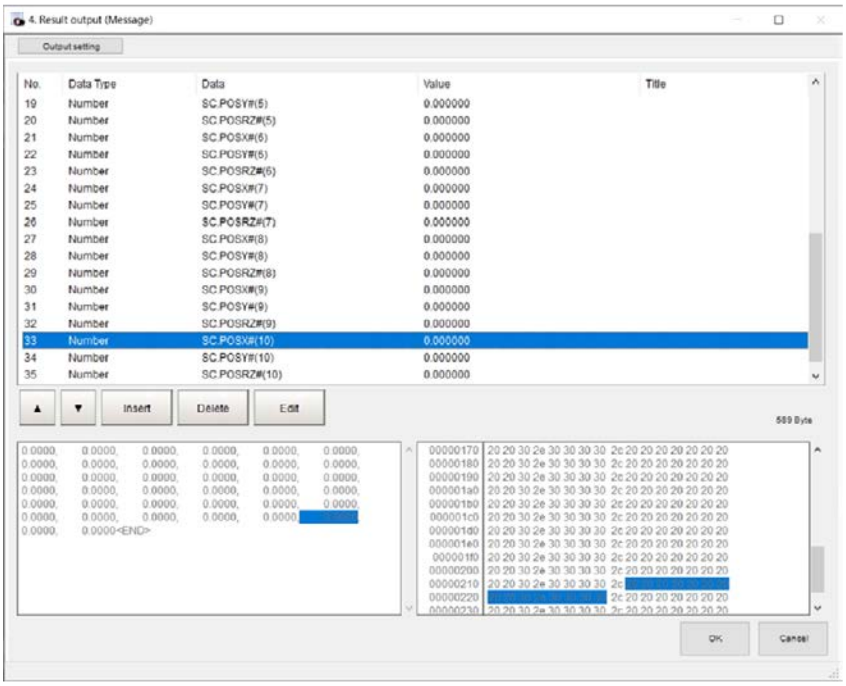


Figure A-42 TDM Editor, Edit Flow

1. Open the *TDM Editor* and select **Edit Flow**.
2. When opened, add **Result Output (Parallel)**
3. Open the editor and then set **Data Separator**, **Data Terminator**, and **Port.**
4. Click **Insert** and add each variable element in order, using the number option. As an example, x1, y1, rz1, m1, x2, y2, rz2, m2.
5. Once done, Click **OK** and then click **Save** and close the FZ Panda.

Add an FH Camera to the ACE Project

After the camera connections, network settings, and camera settings have been completed, the camera object can be added to the ACE project.

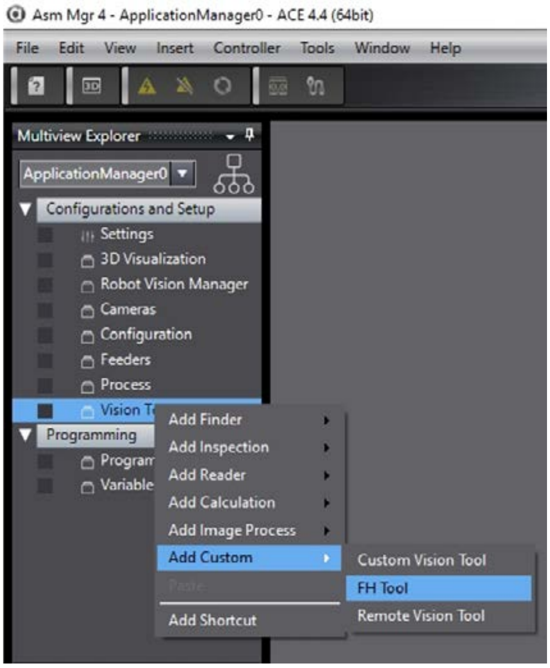


Figure A-43 ACE Add FH Camera

1. With the camera powered ON, open ACE. The add an Application Manager.
2. From the Multiview Explorer, *Configuration and Setup*, navigate to *Vision Tool* > *Add Custom* and select **FH Tool**, as shown above.
3. When the *FH Tool* opens, as shown in the following figure, set the following camera connection parameters:
    1. Camera IP Address
    2. Camera Port Number
    3. Job Number
    4. Element Separator
    5. Data Terminator
    6. Select and set the Result Configuration

NOTE: The element separator, data terminator, and result configuration must match what was set in the *Results Output Message* that was configured in the previous step.

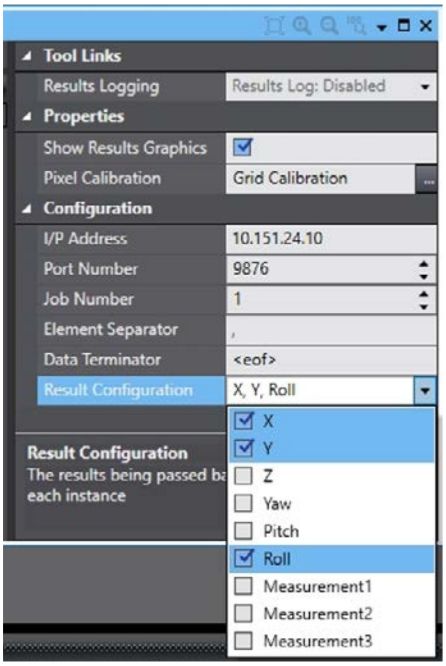


Figure A-44 FH Tool Panel

Camera Calibration

1. Once the FH camera is connected to ACE, the next step is to calibrate the camera for the inspection application, using the following steps.
2. Open the Grid Calibration and select **Camera Properties**. Next, place the ACE calibration under the camera, and within the camera view, as shown below.

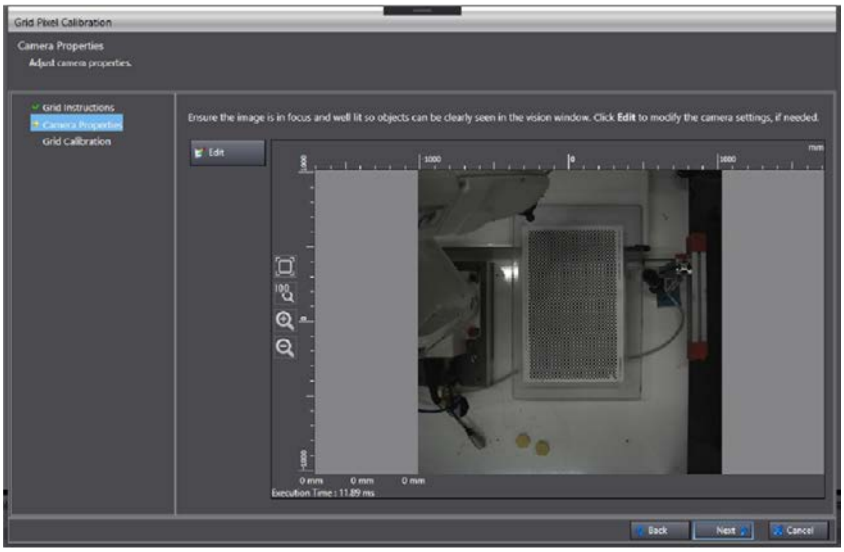


Figure A-45 ACE Calibration

3. Open the *FH Log* in FZ Panda and select a single image to USB, SD or FTP and export a logged image
4. Open the *FH Tool* in ACE and select **Pixel Calibration** and load the logged image.

Calibrate the image using the right-side panel of the Grid Pixel Calibration tool, as shown below.

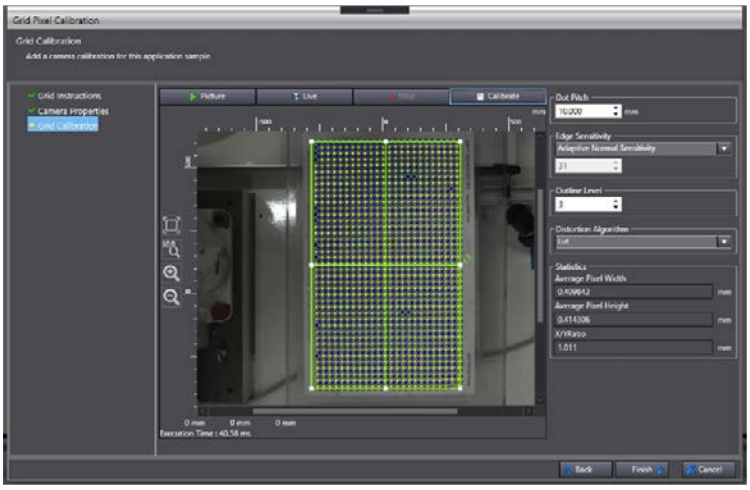


Figure A-46 Camera Grid Calibration

To use the ACE *Automated Camera Calibration* for this process you need to first setup a Virtual Camera in ACE. Once set, you can use the *Vision Parameters* and select the **Use Vision Tool** option that points to the FH Tool, as shown below. This automated calibration operates identically to a GigE camera.

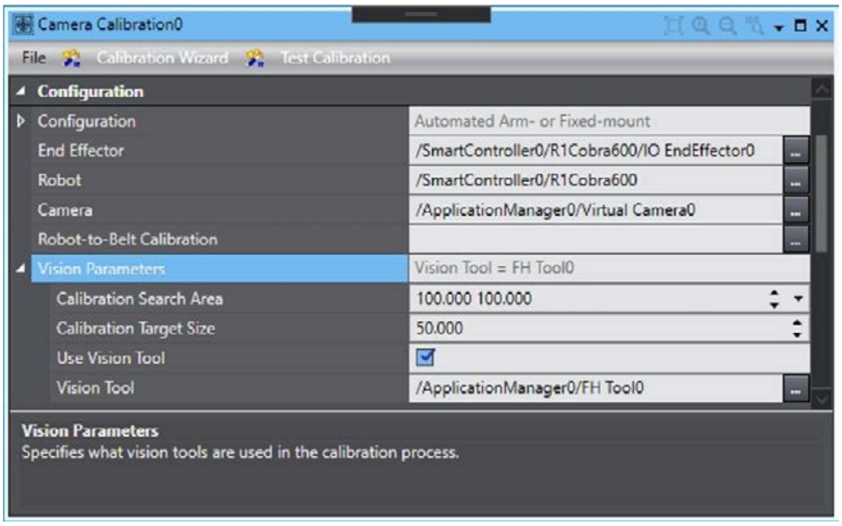


Figure A-47 Virtual Camera Calibration

A.5 Pack Manager Packaging Application Sample Exercise

This section will explain the process of building a packaging application with the Pack Manager Application Sample. This exercise can help you understand the project development process and the relationship between various software components and concepts. It will begin with a Pack Manager Application Sample and include an introduction to V+ programs, 3D Visualization, IO Feeder, Recipes, and more. This will not include multiple robot applications or discussion of belt-relative allocation strategies.

> **NOTE:** A connection must be made between Application Manager and NJ to enable the use of Pack Manager and its functionality.

The steps for creating a fully functional Pack Manager Packaging Application Sample in Emulation Mode are provided in the following sections.

> **NOTE:** Canceling the application sample wizard before completion can lead to an ACE project with partial or no functionality. Completing the wizard is recommended.

Create a Basic Pack Manager Application Sample

An Application Sample can be used to generate the basic structure of the application for single robot applications. Create the Pack Manager Application Sample in Emulation Mode with the following procedure based on the details provided in the Jar Packing Application Summary on page 700.

This procedure creates a basic Pack Manager application sample that serves as a foundation for the application described in the Jar Packing Application Summary on page 700. Use the information found in Modify the Pack Manager Application Sample Project on page 701 to configure the basic Pack Manager application sample to match the application summary requirements.

1. Launch the ACE software to access the Start Page.
2. Select **Connect to Device**, **Open in Emulation Mode**, and then select the **Create Application Sample** option, choose **Pack Manager Sample**, and then click the **Connect** Button. The project will be created and the robot will be selected in the next step.

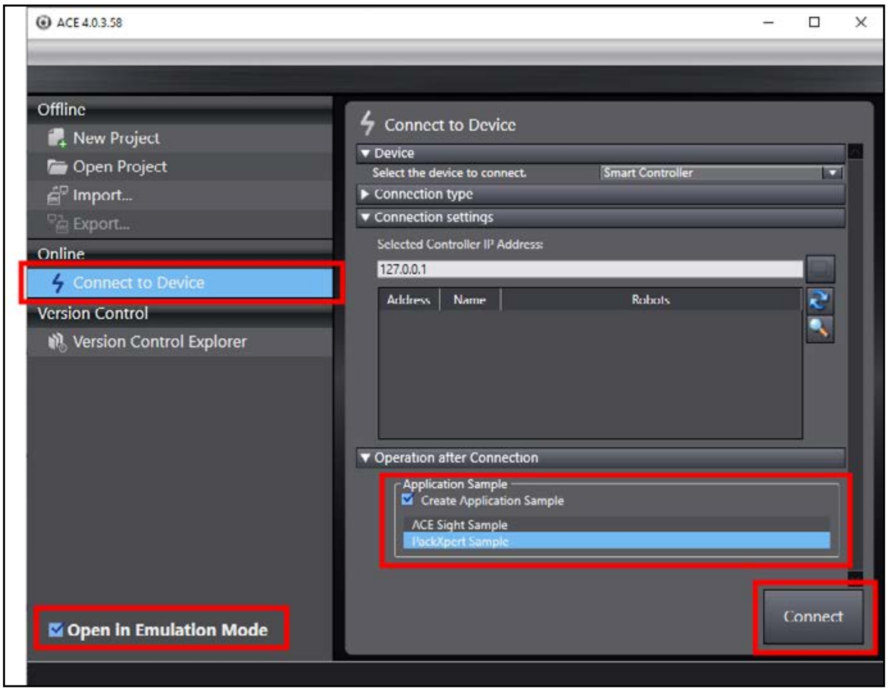


Figure A-48 Create the Pack Manager Application Sample

3. Add a Cobra 800 Pro robot to the Installed Robots area and then click the **Next** Button.

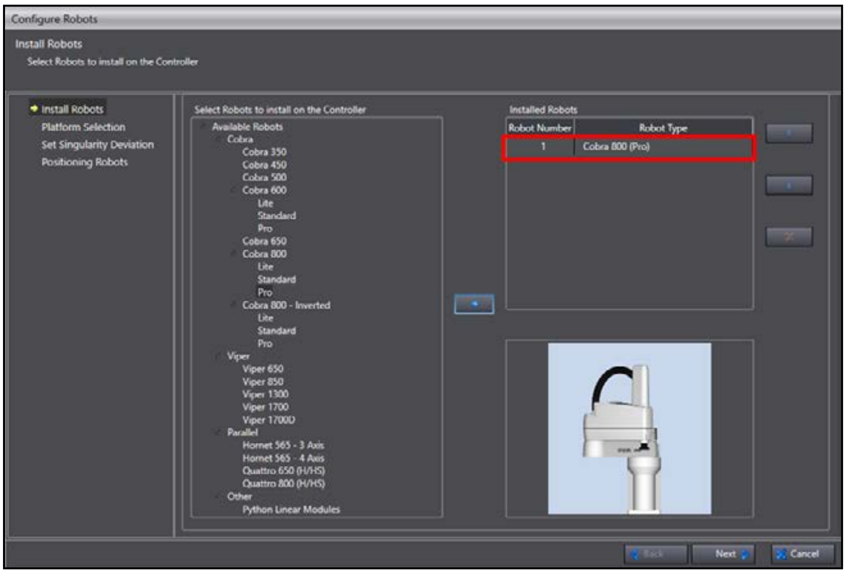


Figure A-49 Add Cobra 800 Pro Robot

4. After adding a robot, the Pack Manager application sample wizard will begin and the next phase will establish the pick and place configuration. Proceed with the wizard and select the Pick Configuration of **On a belt located with a camera** because the robot will be picking the jars from a belt and using a camera for location information.

5. There is no position refinement for this application, so select **No, do not refine the position of the part for the Refinement Configuration** step.
6. The Place Configuration should be set to ***At a fixed pallet*** because the robot will place the jars in a box that is in a fixed and known location. The part and part target object details have been established and a process is defined for the robot, part, and part target objects in the Process Manager after completing this step.
7. Proceed with the next phase that will establish robot and end effector configurations. Select the R1Cobra800 for the Robot Selection step and then proceed.
8. Make the following settings for the Digital I/O Signals and the Tool Offset for the end effector configuration step. These settings will be stored in an I/O EndEffector object for the Cobra 800 Pro robot. The tip radius and gripper dwell time will be added to the I/O EndEffector object later.

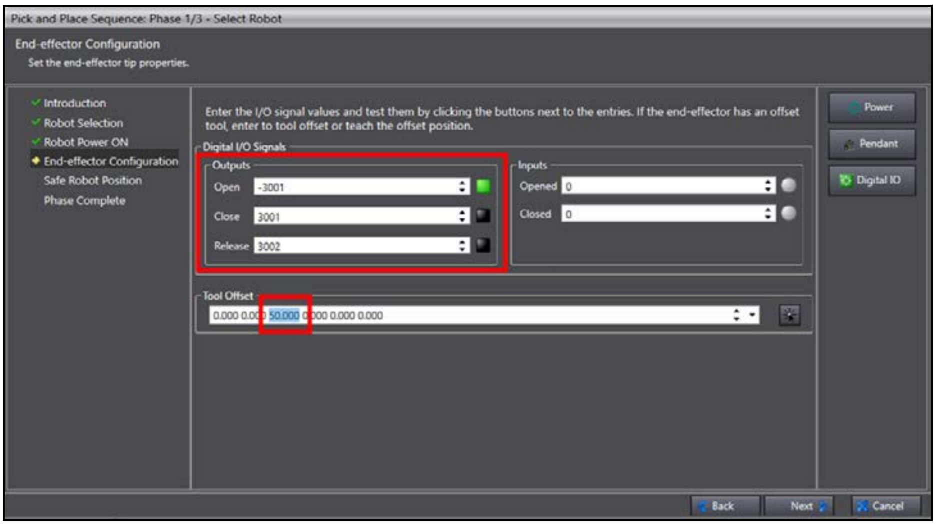


Figure A-50 End Effector Configuration

9. Use the default robot position as the Safe Robot Position or move the robot to an alternate position and then click the **Here** Button. This step completes the robot and end effector configuration phase. Proceed to the Pick Configuration phase described below.
10. Select **Create an Emulation Camera** in the Create a New Basler Camera step. This will bypass all steps in this phase that are needed when a physical camera is used. This phase of the sample wizard process creates the camera, virtual camera, and vision tool objects in the project and associates them with the Part object.
11. Select Encoder Channel 0 on SmartController0 for the Select the Encoder step. This configures the Belt object, virtual encoder, and encoder association and links it to the Part object.
12. The Test Encoder Operation step does not require output signals in Emulation Mode. Leave these settings set to 0. These settings can be modified later if necessary.
13. The Virtual Teach step simulates performing a belt calibration. This step will require positioning the belt window while ensuring the entire belt window is within the robot work envelope. Use the belt transformation values shown in the figure below to ensure

consistency with the rest of this procedure. These settings will be stored in the Process Manager Robot-to-Belt calibration and Pick Belt object.

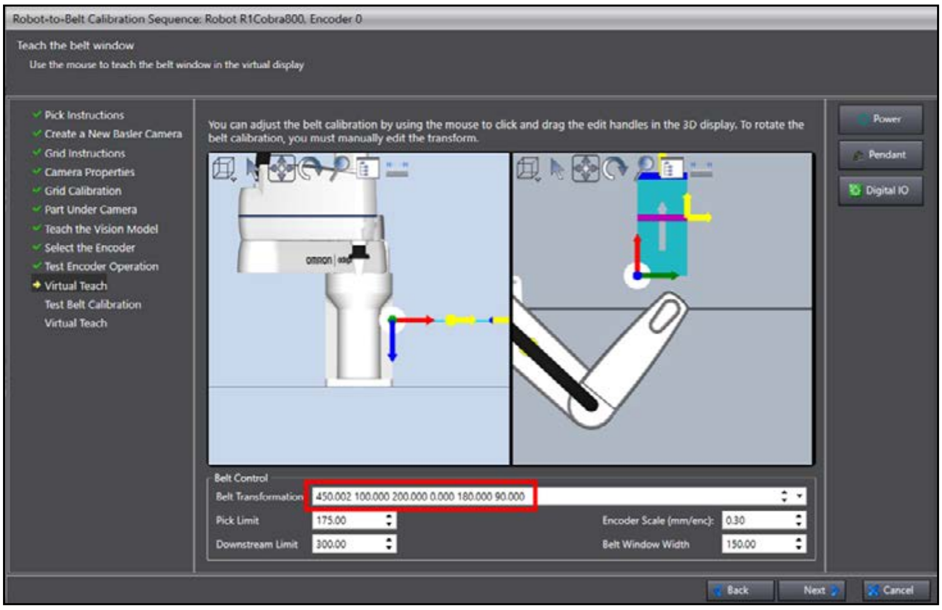


Figure A-51 Teach the Belt Window

14. The Test Belt Calibration step allows you to test belt tracking by moving the robot into the belt window and then tracking along the belt. Position the robot over the belt, click the **Start Tracking** Button, and move the conveyor with the belt control I/O signals to verify the robot tracks the belt movement.

    Additional Information: In Emulation Mode, testing the belt calibration is simplified because tracking along the belt vector is based on an incrementing encoder count multiplied by the specified scale factor. If using hardware, this allows you to check that the distance between the tool tip and a jar on the belt remains relatively constant. Any deviation while tracking typically indicates the belt calibration needs to be performed again.

15. The Virtual Teach step will teach the camera location to simulate performing a robot-to-sensor, belt-relative camera calibration which defines the position of the camera field of view relative to the robot world coordinate system. Use the Sensor Information Offset values shown in the figure below to ensure consistency with the rest of this procedure. These settings will be stored in the Process Manager Sensor Calibration area. After this is completed, proceed to the next phase that will define the pallet properties for the jar placement.

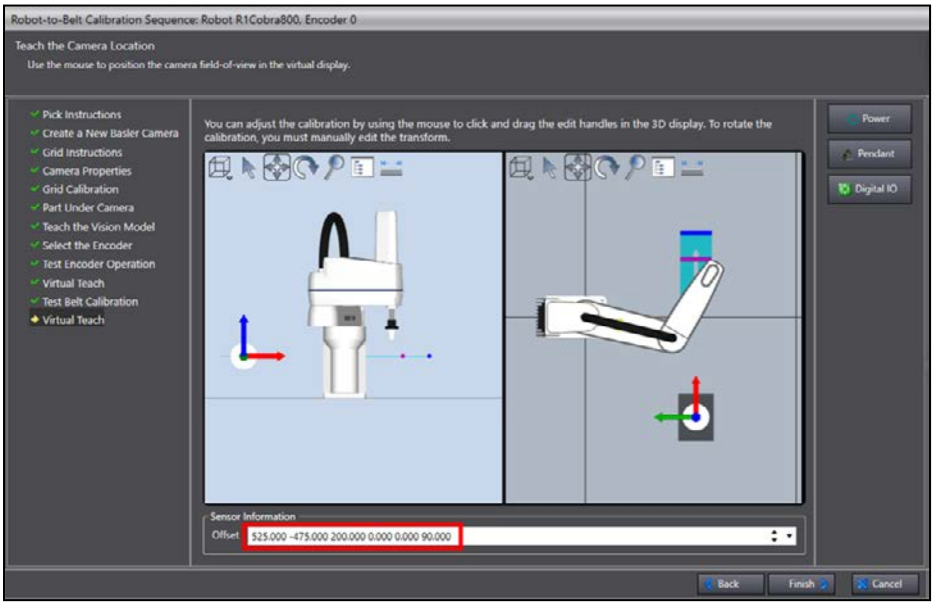


Figure A-52 Teach the Camera Location

16. The application sample only supports X-Y (2D) arrays, so the Z dimension of the Pallet Properties will need to be modified later. Set the X-Y pallet properties as follows to complete the Place Configuration phase.
    - X Count: 4
    - X Spacing: 54 mm
    - Y Count: 4
    - Y Spacing: 54 mm

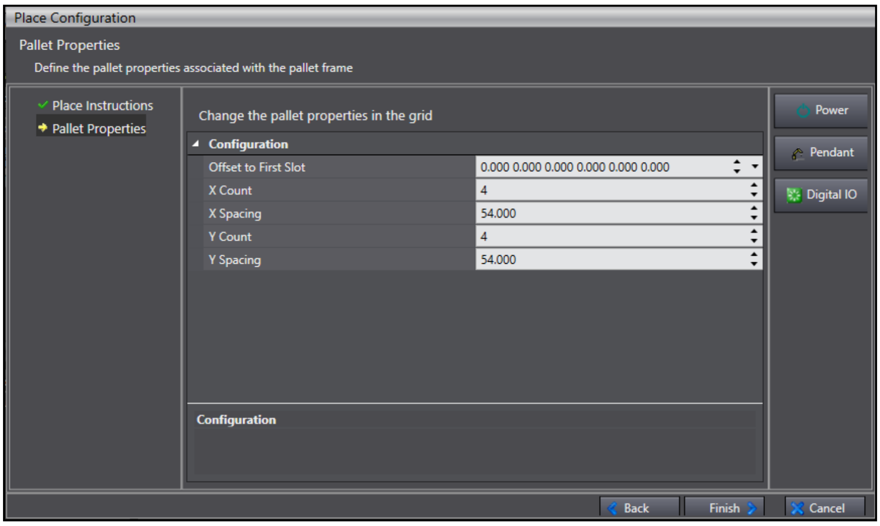


Figure A-53 Define the Pallet Properties

17. The Teach Robot phase consists of completing the Teach Process wizard to step through the sequence of operations the robot will perform for this process. Begin with the Teach Idle Position step that is used when the robot is not picking or placing jars.

Move the robot to the idle position shown in the figure below and then click the **Here** button. Use the values shown in the figure below to ensure consistency with the rest of this procedure.

> **IMPORTANT:** The robot will move to this location without a tool offset applied. This location should be positioned above all obstacles in the work envelope. When the robot moves to this Idle Position, it will first align in the Z direction before moving parallel to the X-Y plane. If this location is taught incorrectly and below an obstacle in the work envelope, the robot may crash into an obstacle.

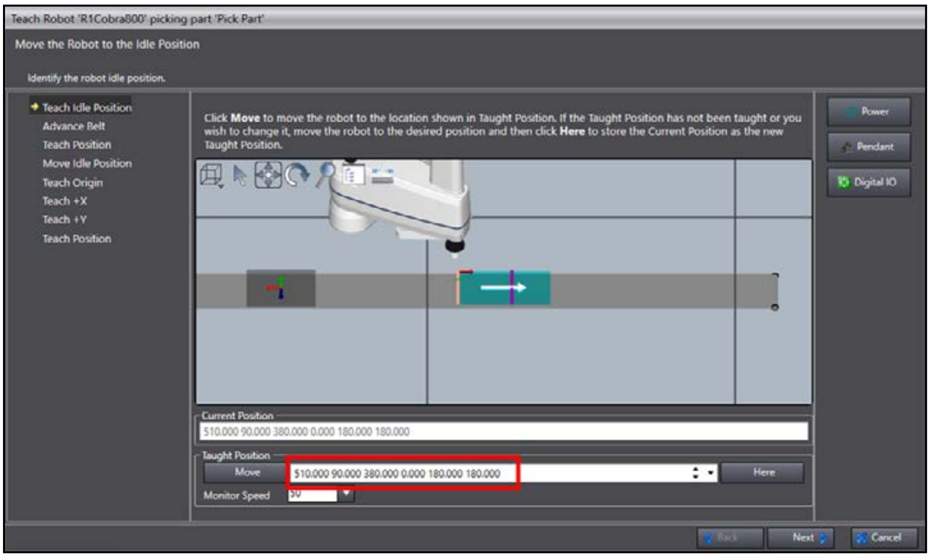


Figure A-54 Teach the Idle Position

18. In the Advance Belt step, you will advance the belt to move the part instance from the center of the camera field of view to the belt window. Use the buttons in the Belt Control area to move the belt until the part instance is between the Upstream limit (orange line) and Process Limit (purple line) as shown below.

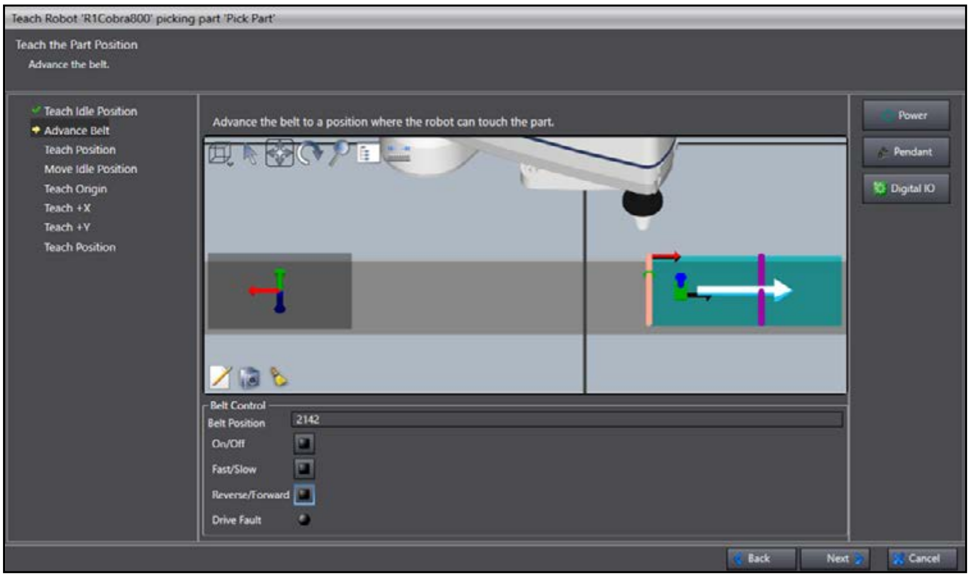


Figure A-55 Advance Belt

19. In the Teach Position step, you will teach the robot where and how to pick the jar. This will compare the predicted position based on all calibrations to the actual taught position. Any difference will be stored in the Pick Motion Parameters Tool Tip Offset, and is often referred to as the pick offset. Be sure to consider the following.
    - The height of the jar
    - The height of any obstacles in the work envelope
    - How the robot will approach and depart this location

    The part instance location is on the belt surface with negligible height, however the jars are 35 mm tall. To account for this, click the **Move** Button to move the robot to the instance location. Then add 35 mm to the Z coordinate (235 mm) and then click the **Here** button. You are adding a Tool Tip Offset of 35 mm, applied to offset the placement location to account for the jar height. Enter this value into thee Process Manager Configuration Items Place Motion Parameters *Tool Tip Offset*, as shown below.

    Additional Information: When approaching and departing the pick location, the robot must avoid collision with the box. This collision can typically be avoided by enabling Absolute Approach and Depart Height, and specifying an appropriate Z-coordinate in robot world coordinates (330 mm for this example).

    NOTE: The Y coordinate of the Taught Position may be slightly different depending on where you stopped the belt in the previous step. This is acceptable for the correct function of this application.

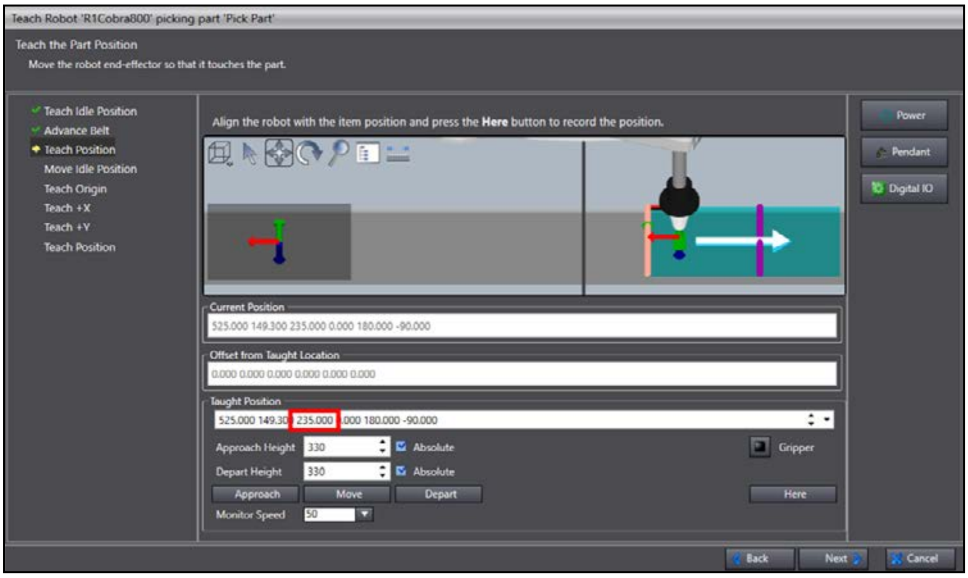


Figure A-56 Teach the Part Position

20. After departing from the pick operation, the robot may move to the idle position if no targets are available and the Process Strategy Robot Wait Mode is set to **Move to idle position**. If you wish to see the motion from the pick depart position to the idle position, click the **Move** Button on the Move to Idle Position step. Otherwise, proceed without moving to the Idle Position.
21. The Teach Origin, Teach +X, Teach +Y, and Teach Position steps are used to create the pallet frame, and will be stored in the Place Part Target Robot Frame in the Process Manager Configuration Items area. Because there are three different box sizes used in this example, the pallet frame is defined in such a way that all three boxes can be aligned at a common reference location. Then, recipe management of the Pallet object can be used to manage the pallet layouts. The following figure depicts three box sizes aligned to a common pallet frame that is in close proximity to the picking location. Proceed to teach pallet frame points in the steps below while considering the largest pallet X-Y layout.

    Click the **Here** Button to teach the origin position of the frame using the values shown in the Figure A-57 to ensure consistency with the rest of this procedure.

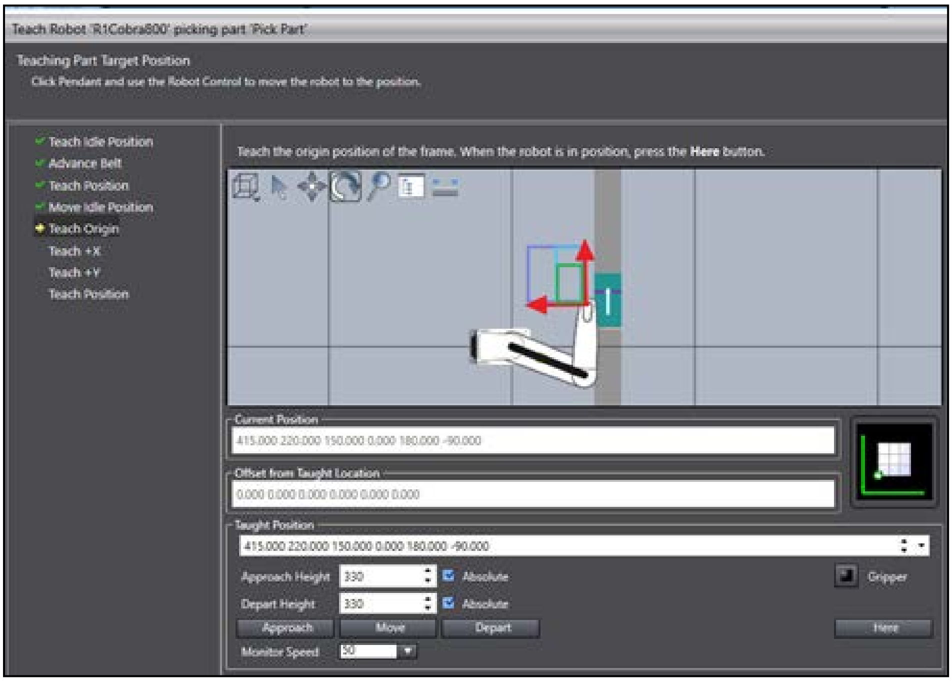


Figure A-57 Origin Position of the Frame

22. Click the **Here** Button to teach the +X position of the frame using the values shown below to ensure consistency with the rest of this procedure.

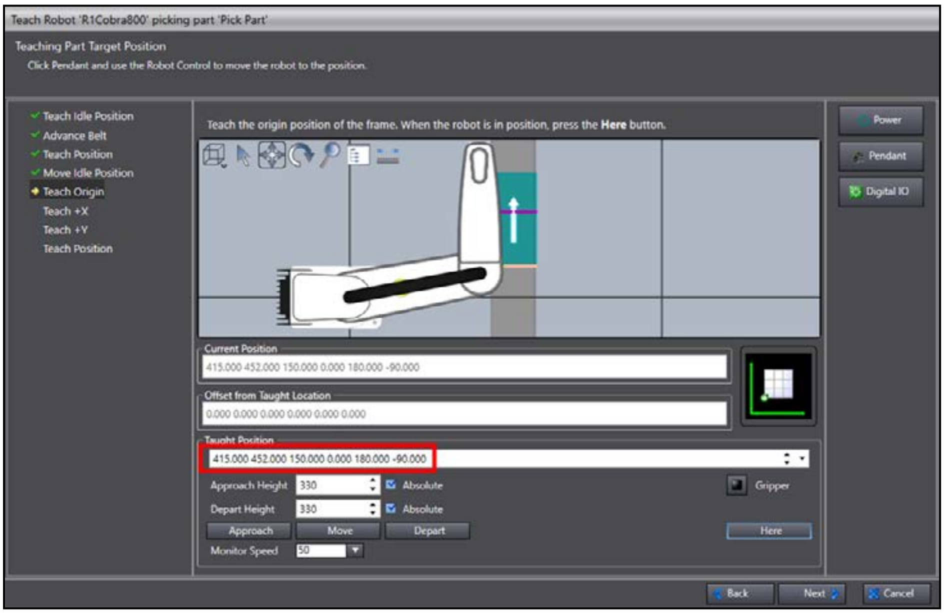


Figure A-58 +X Position of the Frame

23. Click the **Here** Button to teach the +Y position of the frame using the values shown below to ensure consistency with the rest of this procedure.

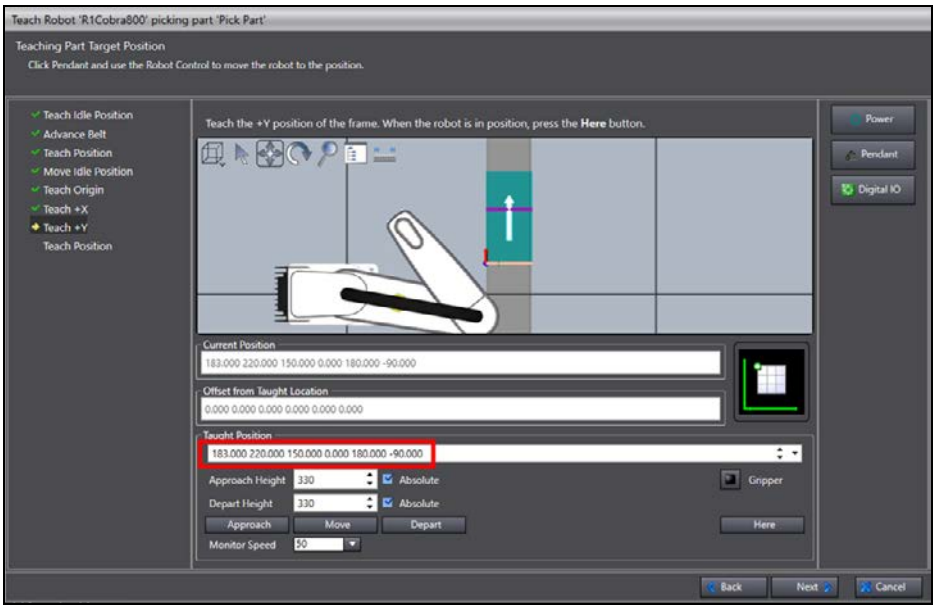


Figure A-59 +Y Position of the Frame

24. Click the **Here** Button to teach the robot the first pallet / slot position as a 35 mm X and Y offset from the origin of the frame using the values shown below to ensure consistency with the rest of this procedure.

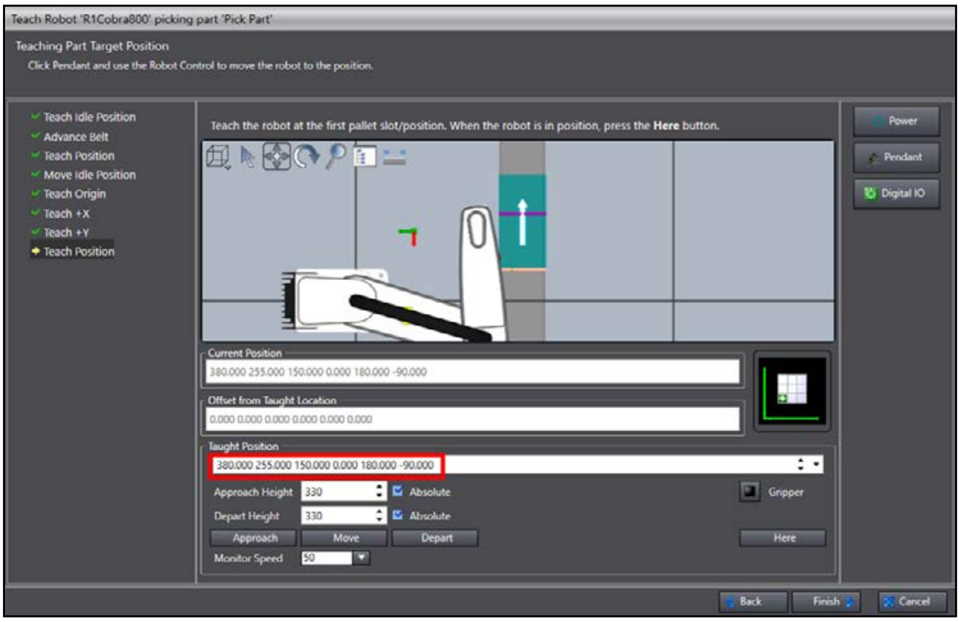


Figure A-60 First Pallet / Slot Position

25. Complete the wizard and then save the project with a new name. The basic Pack Manager Application Sample is completed after this step.

Additional Information: Test the application by opening the 3D Visualizer, access the Task Status Control, and start the Process

Manager. This will need to be stopped (aborted) before any modifications can be made.

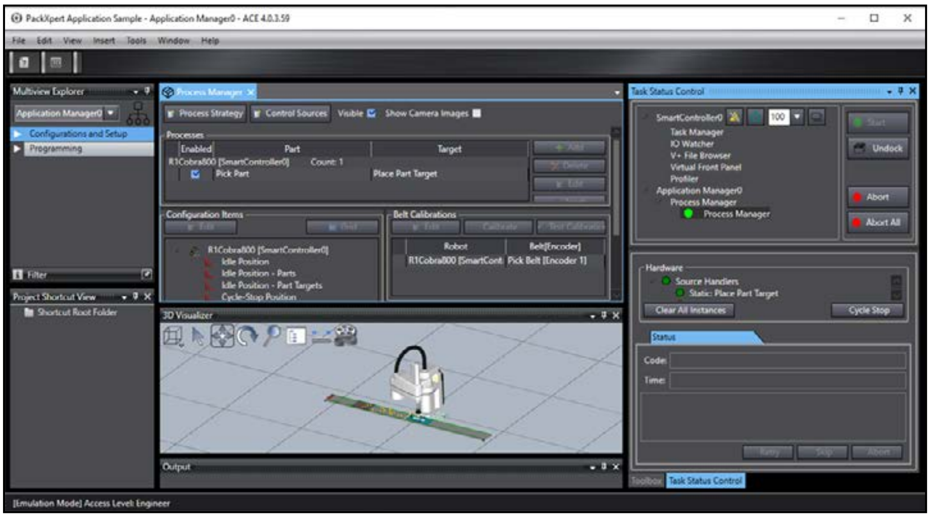


Figure A-61 Test the Pack Manager Application Sample

Jar Packing Application Summary

Consider an application where a production line fills glass jars with product and then places lids on the jars before releasing the jars to a conveyor belt. The jars travel down the conveyor belt to an operator who then packs the jars into boxes by hand. Occasionally, these jars are dropped and this creates a safety hazard and stops production. This application attempts to solve these problems with the integration of a camera used to locate the jars and a Cobra 800 Pro SCARA robot used to pack the jars into boxes.

Application Specifics

The following details are used for this Pack Manager application sample exercise.

- The robot turns a signal ON when the box is full, stops the belt, and waits for an input signal indicating an empty box is in position before resuming the belt and pick / place motion.
- There is only one jar size that is approximately 35 mm tall with a 25 mm radius. A spacing of 4 mm between jars in the box is required.
- A pair of jars spaced 60 mm apart (center-to-center) will be positioned every 98 mm on the belt as they travel towards the robot to the picking location.
- Jars can be packed into boxes containing 12 (3 x 2 x 2), 24 (4 x 2 x 3), or 48 (4 x 4 x 3) jars each. The robot must place a cardboard divider between each layer of jars in the box. These dividers are available at a static location for the robot to use as needed.
- The conveyor is 150 mm wide and moves at a rate of 42.5 mm/s.
- The jars are picked using a vacuum tip gripper that is 50 mm long with a suction cup that is 15 mm in radius, requiring approximately 20 ms dwell time to grip and release the jars.

- The end effector uses internal robot solenoids triggered with -3001 to open, 3001 to close, and 3002 to release.
- An emulation camera is used for simulation purposes.

This exercise will explain how to create one possible cell layout for this application. This cell layout is pictured below, where the box has been represented with only two sides and a bottom to expose the target instances within.

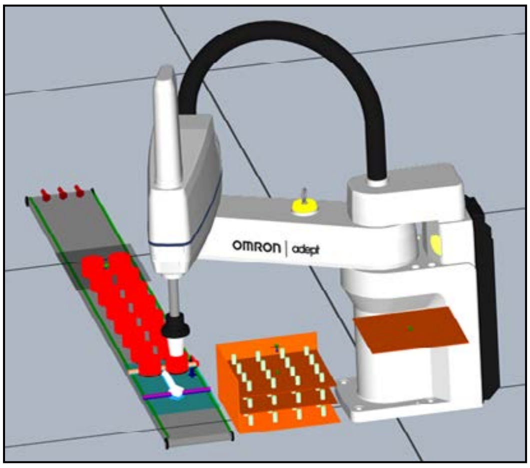


Figure A-62 Sample Exercise Cell Layout

Modify the Pack Manager Application Sample Project

Use the sections below to modify the project from the Create a Basic Pack Manager Application Sample on page 690 so it functions as specified in the Jar Packing Application Summary on page 700.

> **IMPORTANT:** These modifications require that the Pack Manager Application Sample functions properly according to the procedure detailed in Create a Basic Pack Manager Application Sample on page 690

Adjust the Belt Velocity

To adjust the belt velocity specified as 42.5 mm/s, set the Pick Belt object Emulation Fast / Slow Speed settings as shown below.

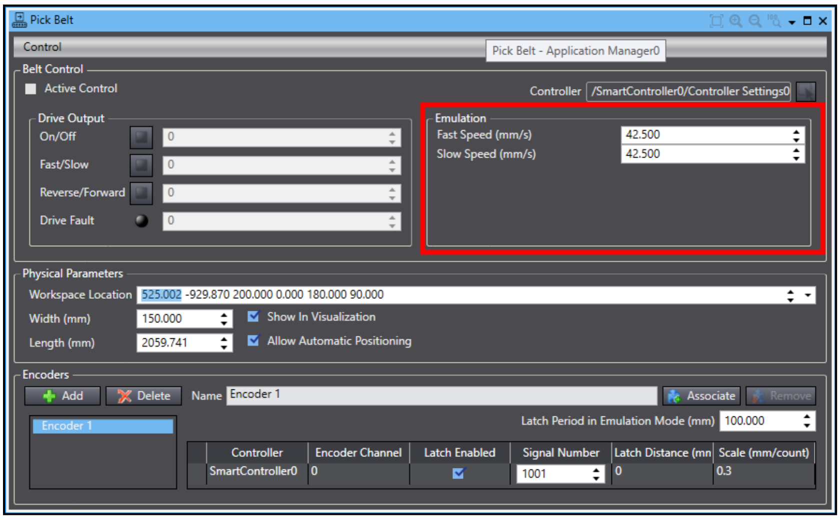


Figure A-63 Pick Belt Object Emulation Speed Settings

Adjust the I/O EndEffector Radius and Dwell Time

To adjust the I/O EndEffector radius to 15 mm and dwell time to 20 ms, open the I/O EndEffector object and adjust the following settings.

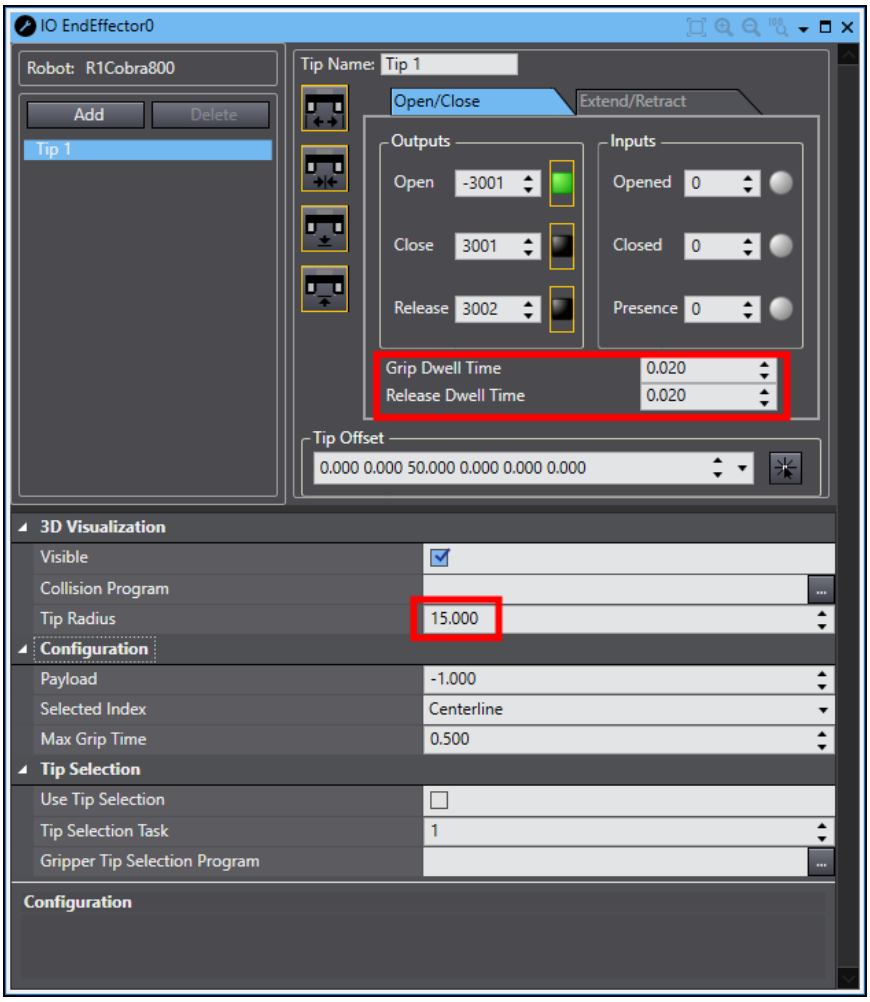


Figure A-64 Adjust the I/O EndEffector Radius and Dwell Time

Change from Random Jar Belt Locations to Fixed Spacing Locations

The default setting for the Virtual Camera Emulation Configuration Behavior is ***Random Instances***. To change this so the jars are spaced 60 mm apart (center-to-center) every 98 mm on the belt to accurately represent the application, you can load images into the Emulation Camera and train the Locator Model and Locator tools, or you can use a Custom Vision Tool to generate vision results in specific locations.

The procedure below uses a Custom Vision tool to generate vision results in the desired locations to represent the application accurately when images are not available.

1. Create a Custom Vision tool and insert the following code.

```
using Ace.Services.NameLookup;
using Ace.Server;
using Ace.Server.Vision;
using System;
using System.Collections.Generic;
using System.Diagnostics;

namespace Ace.Custom {

    public class Program {

        public INameLookupService ace;

        public VisionTransform[] Main () {

            Trace.WriteLine("Script Starting");
            List<VisionTransform> results = new List<VisionTransform>();

            // Custom results can be returned from the tool as follows:
            VisionTransform result = new VisionTransform(0, 30, 0);
             results.Add(result);

            VisionTransform result2 = new VisionTransform(0, -30, 0);
             results.Add(result2);

            return results.ToArray();
        }
    }
}
```

Figure A-65 Custom Vision Tool Example

2. Set the Pick Virtual Camera Emulation Configuration Behavior to ***Use Default Device***.

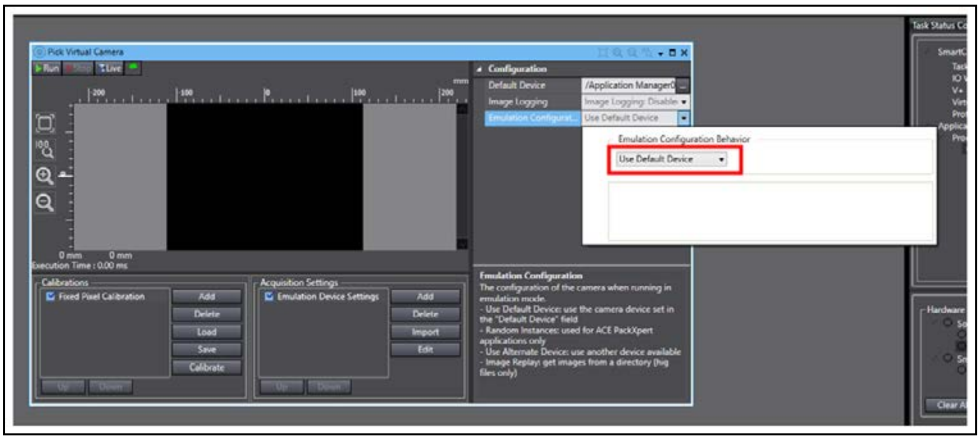


Figure A-66 Use Default Device Setting

3. Set the Pick Part object vision tool to reference the Custom Vision tool created in step one above. After this step is finished, the procedure is complete and vision results will be located according to the application summary.

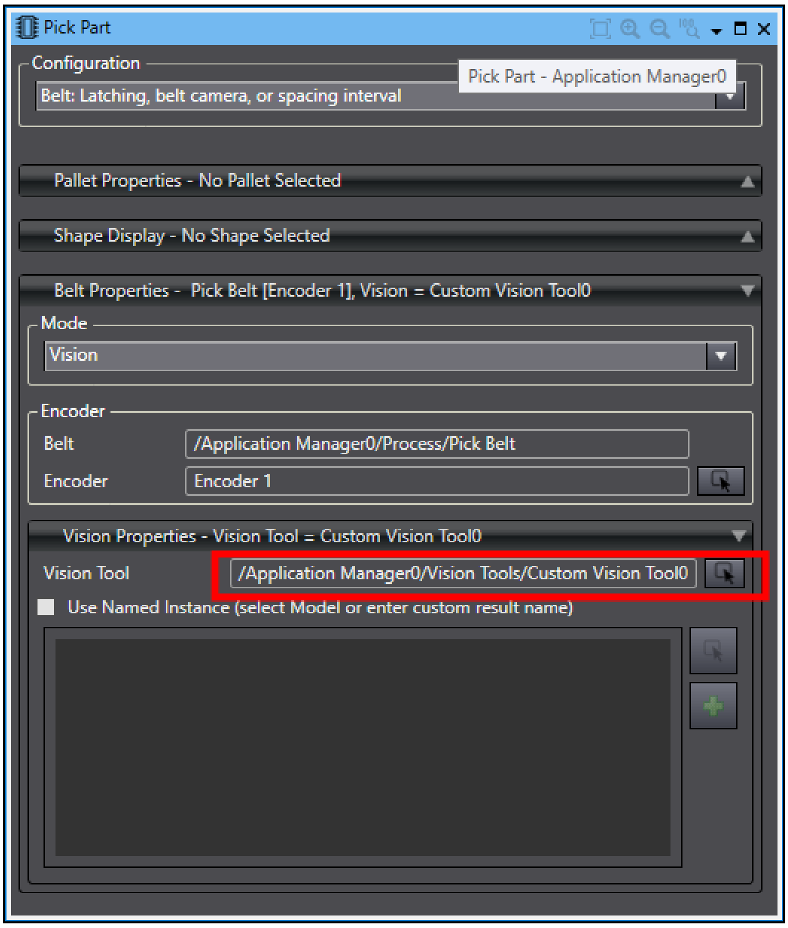


Figure A-67 Reference the Custom Vision Tool

Adding Cylinder Shapes to Represent the Jars

Use the following procedure to add cylinder objects to accurately represent the jar dimensions of 35 mm tall with a 25 mm radius.

> **Additional Information**: The color of the objects are changed from the default color of gray to red to make them easier to see in the 3D Visualizer.

1. Add a new Cylinder object to the 3D Visualization with the following settings. Rename this object "PartCAD" for reference later.

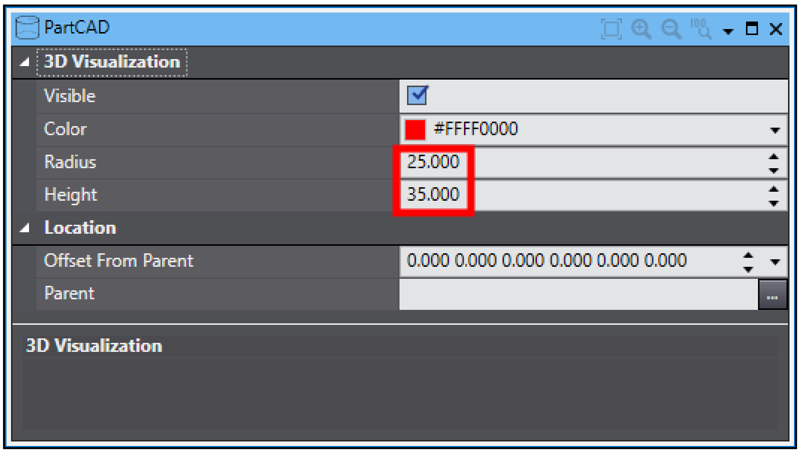


Figure A-68 Create a new 3D Visualization Cylinder Object

2. Set the Pick Part object Shape Display to use the PartCAD object.

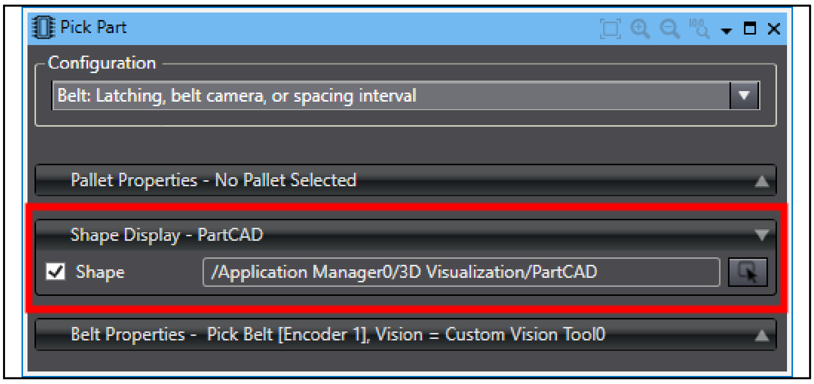


Figure A-69 Set the Pick Part Shape Display

3. Copy the PartCAD object created in step 1 and rename the copy to "TargetCAD". Change the color to differentiate this from the PartCAD object (blue is used in this example).
4. Set the Place Part Target object Shape Display to use the TargetCAD object. After this step is finished, the 3D Visualizer will display cylinders that accurately represent the jar dimensions for the pick and place instances.

   NOTE: Default Pack Manager part and part target instance display coloration based on allocation status (light / dark yellow for parts, light / dark green for part targets) is not available when part and part target object Shape Display is enabled. When Shape Display is enabled, parts and part targets are displayed according to properties of the 3D Visualization object.

Create Shapes to Represent the Placement Box

Use the following procedure to create bottom, front, and side box surfaces to show a cutaway view of the box that represents an obstacle that the robot must place the jars inside. These are positioned using the pallet frame transformation from Process Manager Configuration Items and half the length of the box sides applied in X, Y, and Z accordingly.

1. Add a new Box object to the 3D Visualization with the following settings. Rename this object "BoxBottom" for reference later.

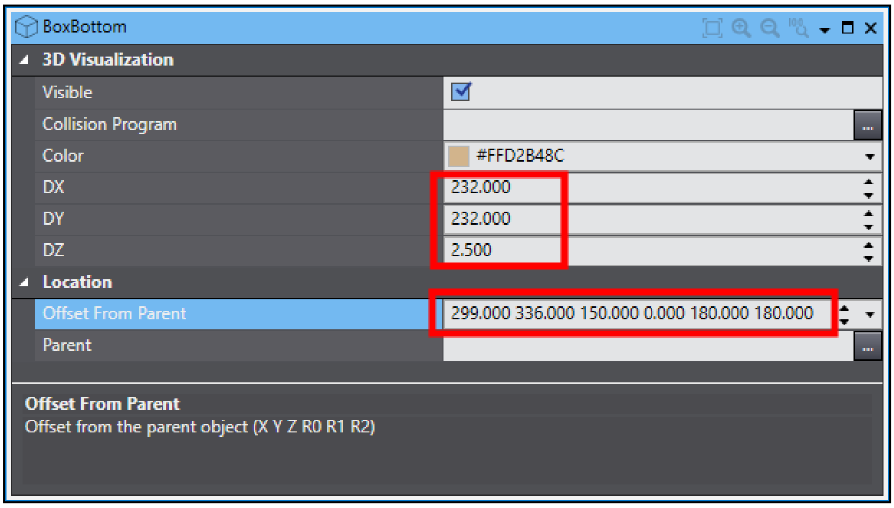


Figure A-70 Create the BoxBottom Object

2. Add a new Box object to the 3D Visualization with the following settings. Rename this object "BoxFront" for reference later.

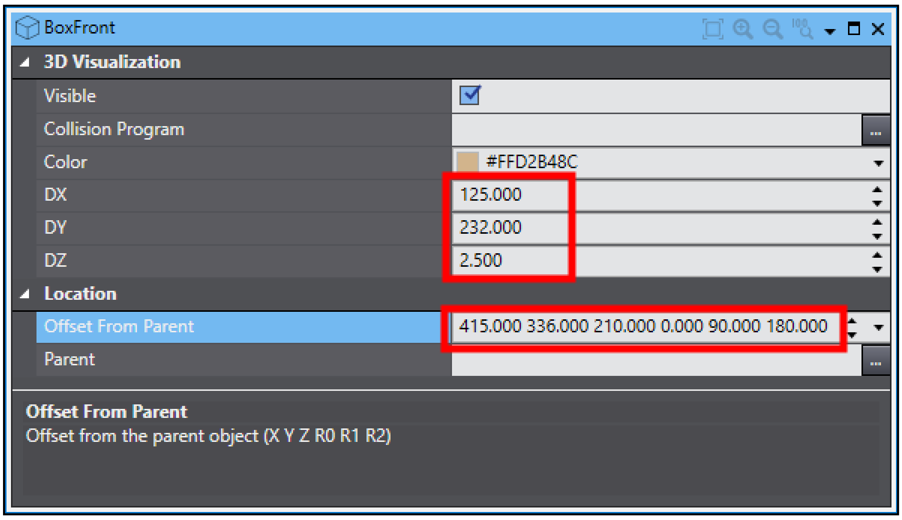


Figure A-71 Create the BoxFront Object

3. Add a new Box object to the 3D Visualization with the following settings. Rename this object "BoxSide" for reference later. After the three sides are created, shapes to represent the placement box will be visible in the 3D Visualizer.

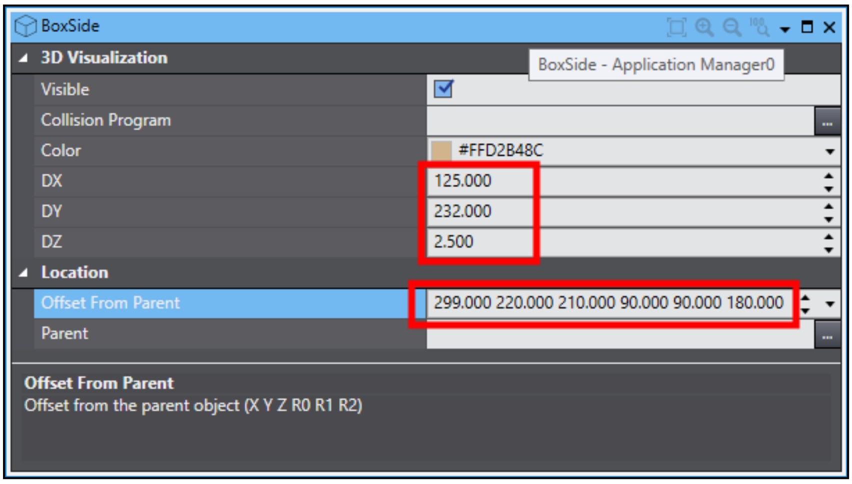


Figure A-72 Create the BoxSide Object

Adjust the Tool Tip Offset for the Target Instances

By default, the robot tool tip interferes with the target instance, when it should be moving to the top of the target instance instead.

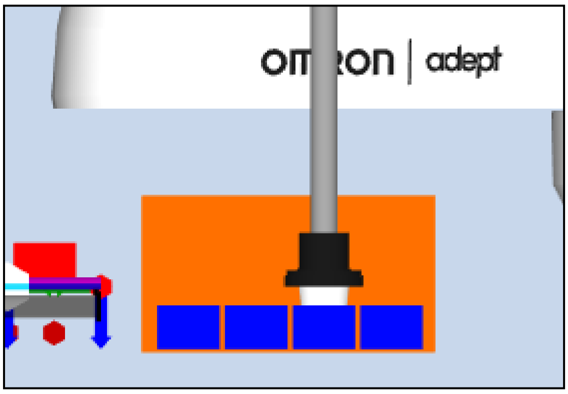


Figure A-73 Tool Tip Interference

A Tool Tip Offset of 35 mm should be applied to offset the placement location accounting for the jar height. Enter this value into the Process Manager Configuration Items Place Motion Parameters *Tool Tip Offset* field as shown below.

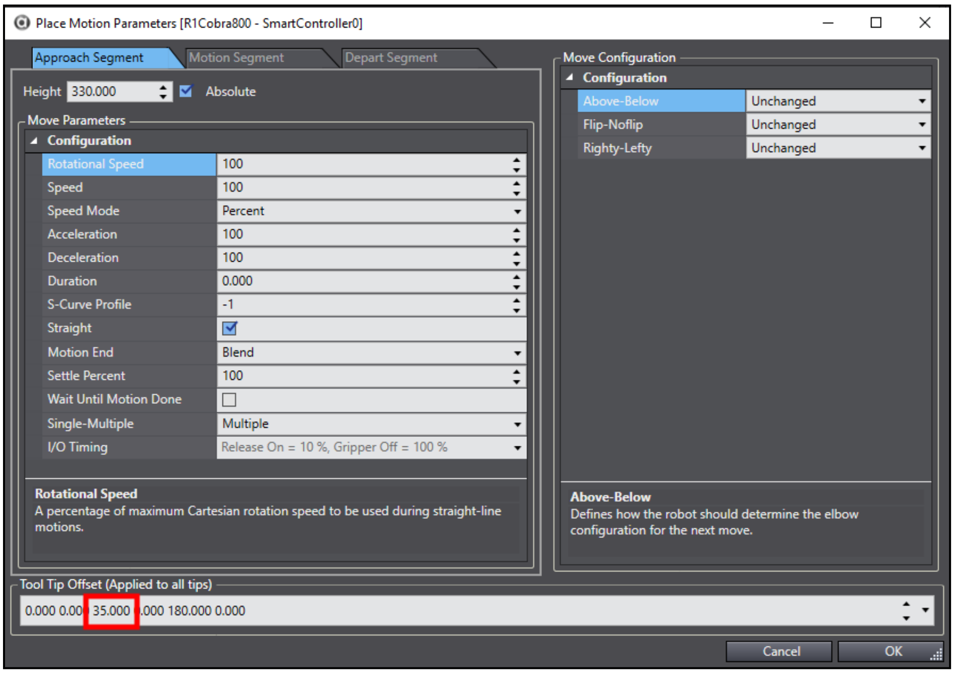


Figure A-74 Tool Tip Offset Setting

The result is an accurate tool tip position for each target instance.

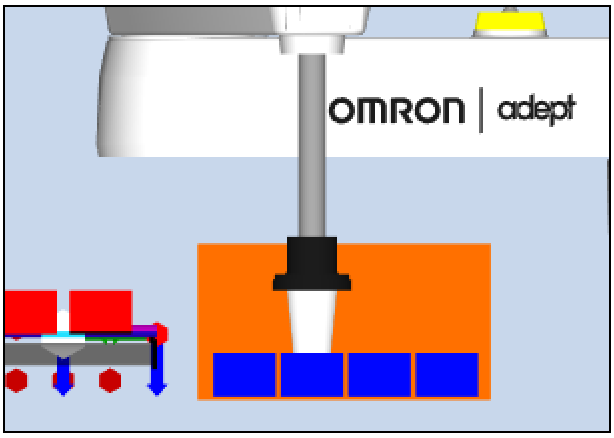


Figure A-75 Tool Tip Correction

Add the Z Dimension to the Pallet

Because the Pack Manager application sample only supports X-Y (2D) arrays, the Z dimension needs to be added to the Place Pallet object. To add the Z dimension, access the Place Pallet object and make the following settings according to the box packaging details defined in the application summary.

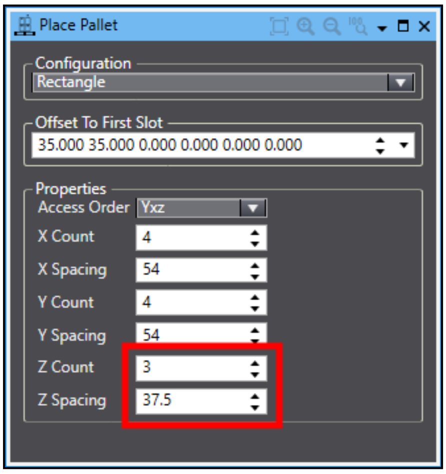


Figure A-76 Place Pallet Z Dimensions

You are at this point with the ACE Multiview Explorer.

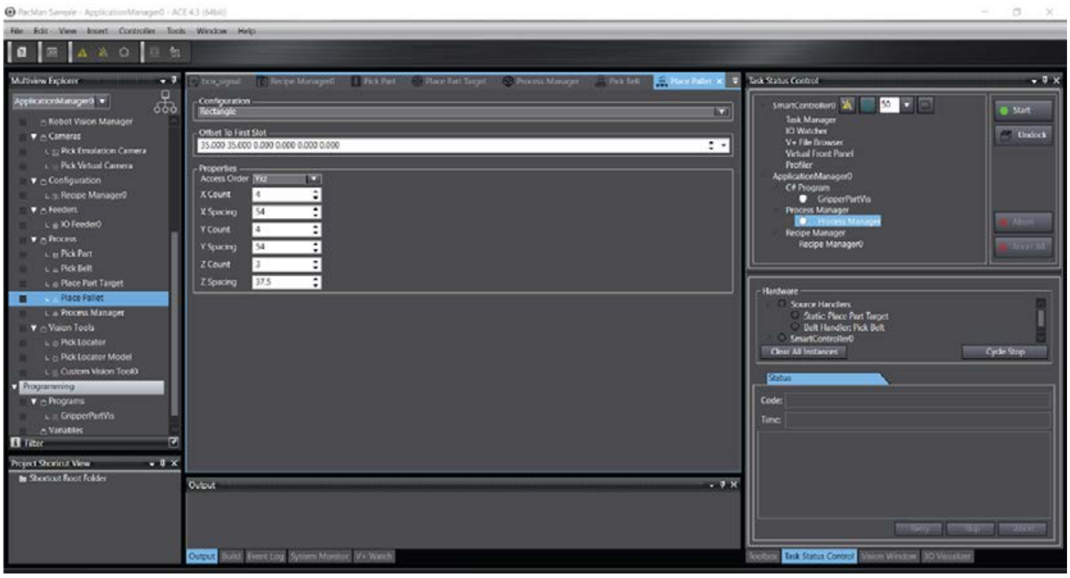


Figure A-77 Z Dimension for Pallet

Click the **Process Manager** Tab to open the following view.

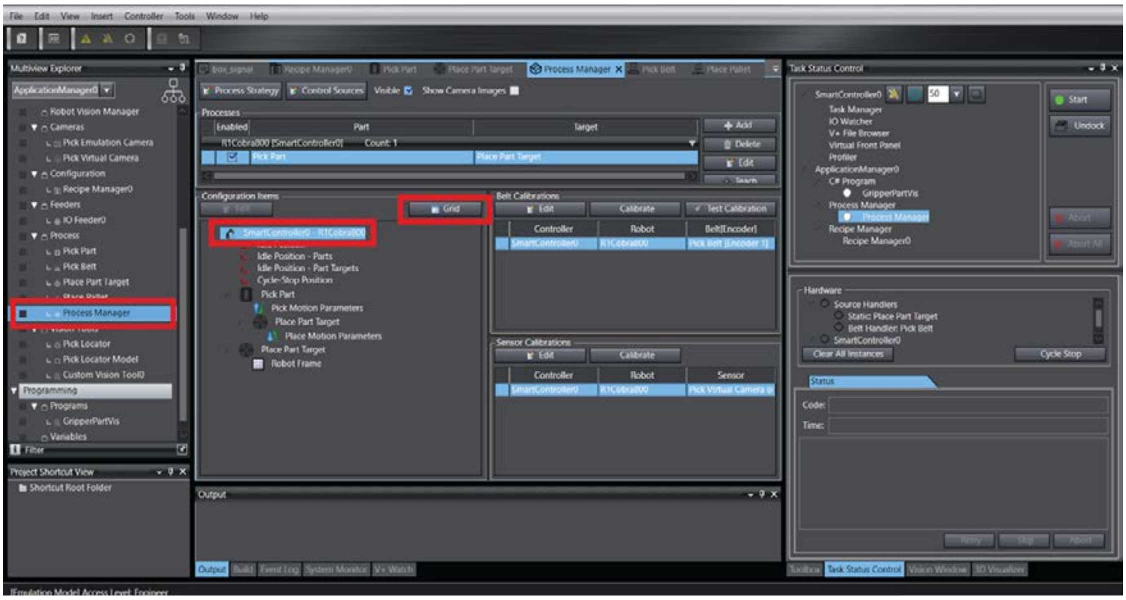


Figure A-78 Motion Sequence Grid Editor

With the Process Manager and Smart Controller, you can use the Grid button to set your dimensions.

Make Motion Sequence Adjustments

To improve the speed of the Pack Manager application, make the following adjustments.

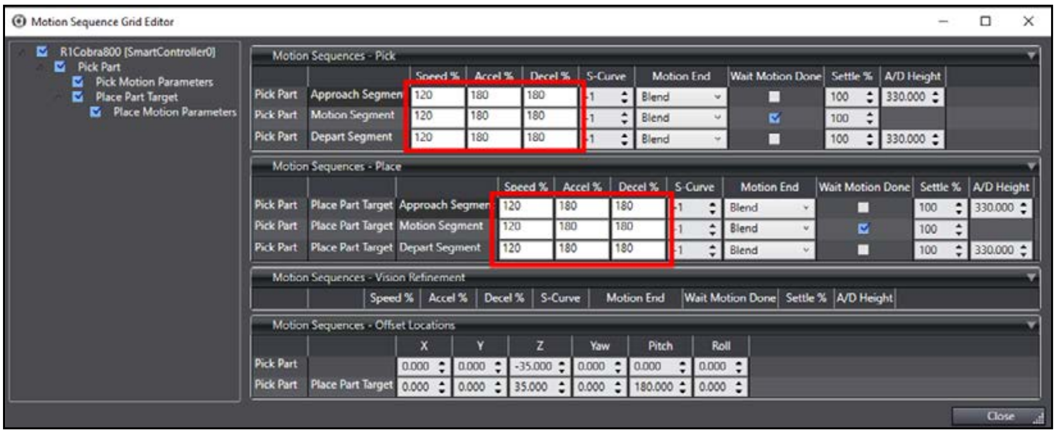


Figure A-79 Motion Sequence Adjustments

Picking and Placing Dividers Between Layers of Parts

There are many methods to incorporate picking and placing of dividers between layers of parts, but all of these methods require customization of the existing process. One of the simplest methods is to customize a place operation to check if a divider is needed based on how many target instances remain to be filled and if a divider is needed, call a program to handle picking and placing a divider. This should be structured in a way that can be flexible for the different box sizes and configurations.

The following procedure will provide an example method for picking and placing dividers between layers of parts.

1. In the Process Manager Configuration Items Place Motion Parameters Motion Segment tab, select **Use Custom Program** and then click the **Selection** Button ().

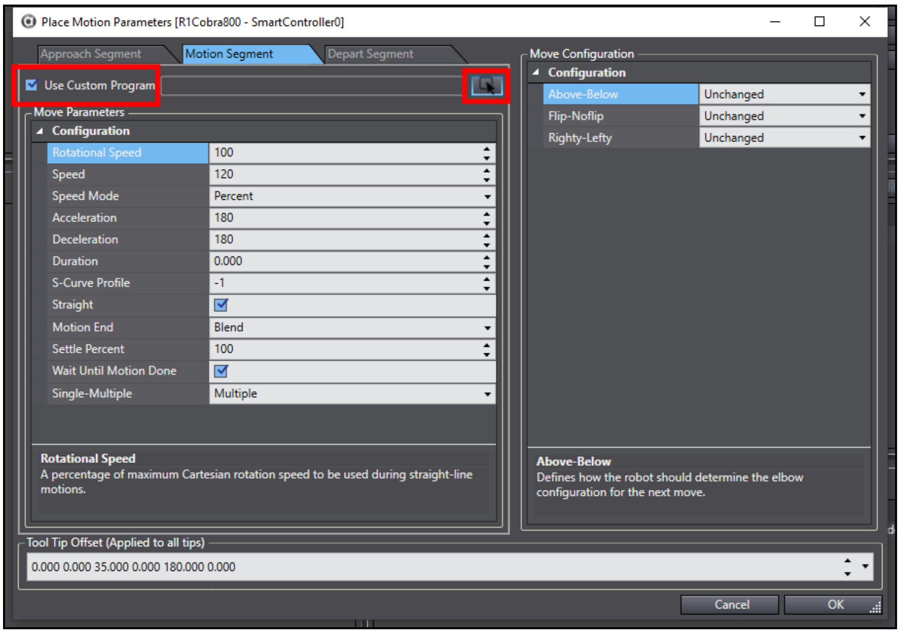


Figure A-80 Use Custom Program

2. Select the **Create a new program from the default** option and click the **Next** Button.

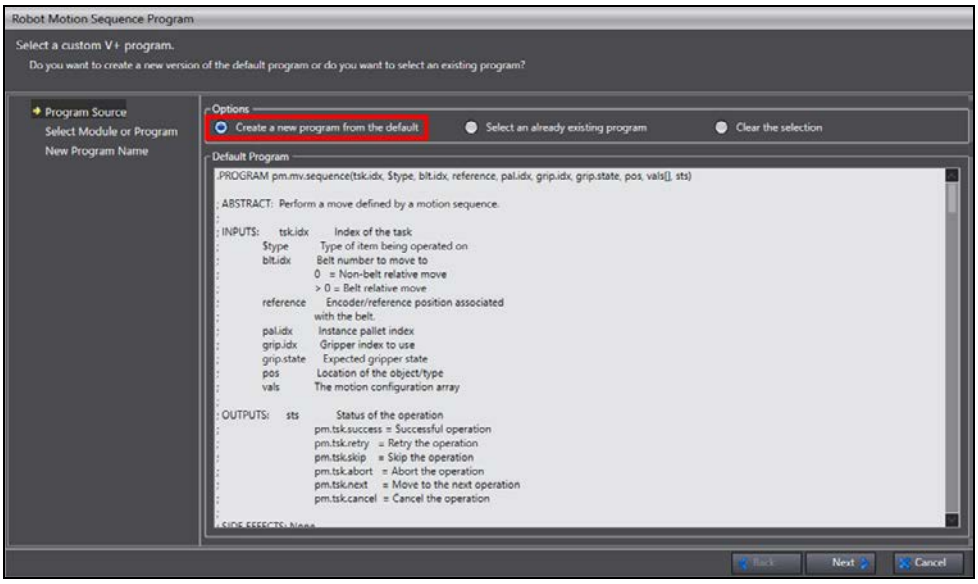


Figure A-81 Create a New Program From the Default

3. Create and select a new module where the new program will be created and then click the **Next** Button.
4. Name the new V+ program "cust_place" and then click the **Finish** Button.
5. Create new V+ location variables that will be used for the divider pick point, divider approach point, and each divider placement point. Use the figure below to create the variables. Use the exact names and initial values to ensure consistency with the rest of this procedure.

   NOTE: The purpose of the divider approach point is to ensure that the robot is centered above the box before moving into the box with the divider.

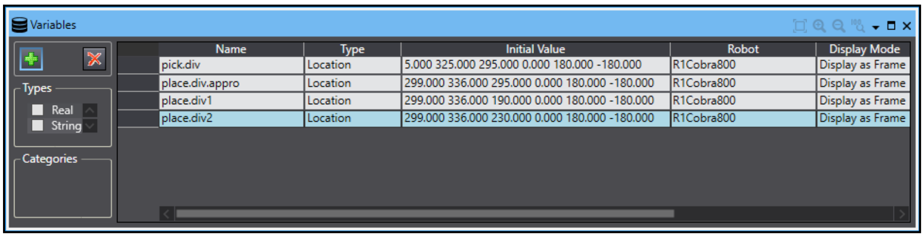


Figure A-82 Divider V+ Location Variables

6. Create a new V+ program named "place_divider". This will be used to pick and place the divider at a location passed in as an argument. Add the following code to the new place_divider V+ program.

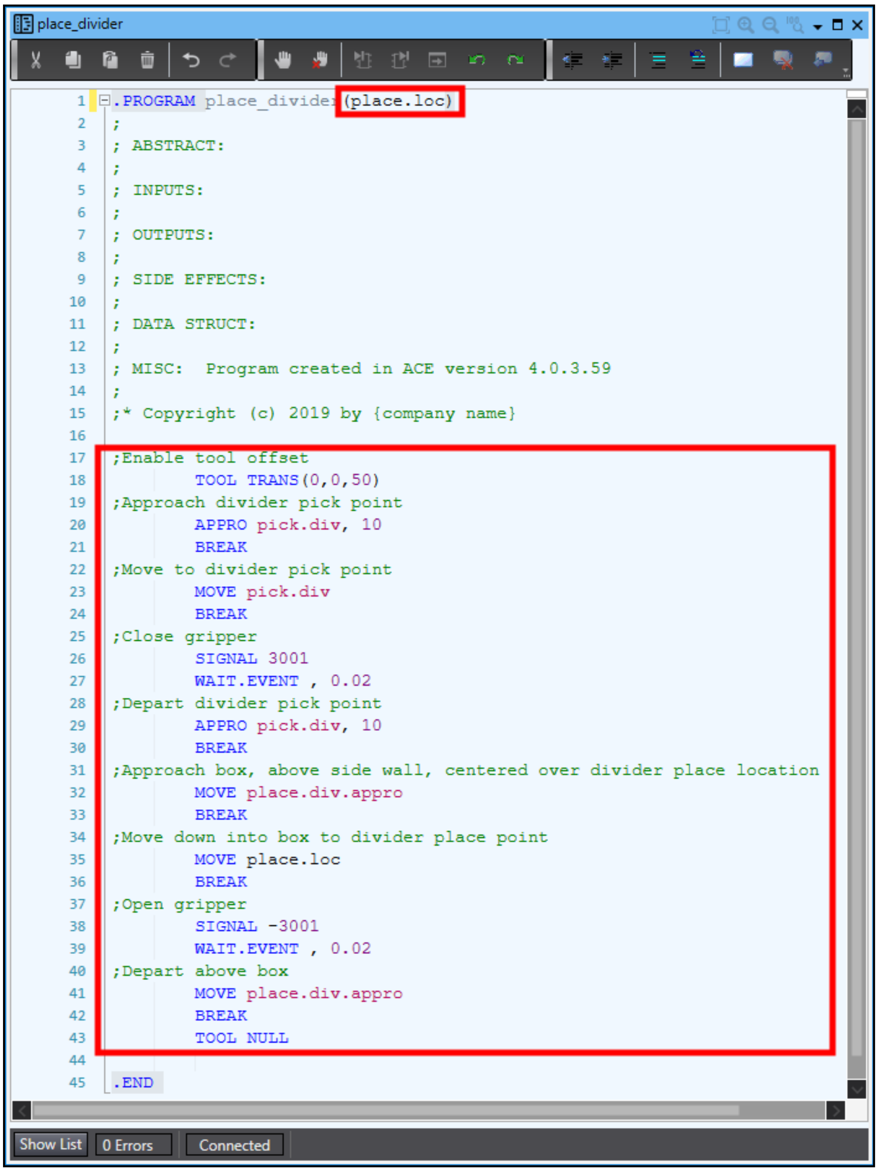


Figure A-83 place_divider V+ Program Edits

7. Edit the cust_place() program to check if a divider is needed. The following approach monitors the target queue and checks how many instances are remaining.

   There are two steps with this approach:

   - Retrieve the index of the specific target type queue using program pm.trg.get.idx().
   - Retrieve how many targets are available in the queue using program pm.trg.avail().

   After each place operation, the program will check how many target instances are remaining to determine when a layer is full. Edit the cust_place() program to check how many targets remain. Remember to add any new variables to the AUTO variable declarations at the top of the program unless they need to be global as shown in the figure below.

> **Additional Information**: Refer to the *ACE Reference Guide* and search for "Part and Target Queues" to learn more about methods of finding how many target instances are available.

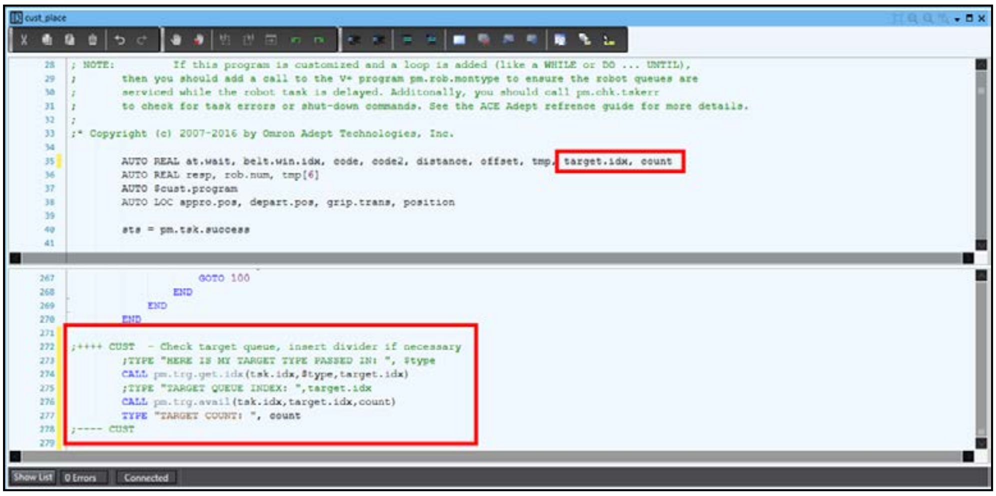


Figure A-84 cust_place V+ Program Edits

8. The default part target instance queue size of 10 needs to be changed so the available target count will decrement properly. The available target count incorrectly remains at 10 and this can be viewed in two places:

   - Open the Monitor Window, clear all instances, and start the Process Manager. You will see the available target count will return 10 after each place operation, and does not decrement as desired.

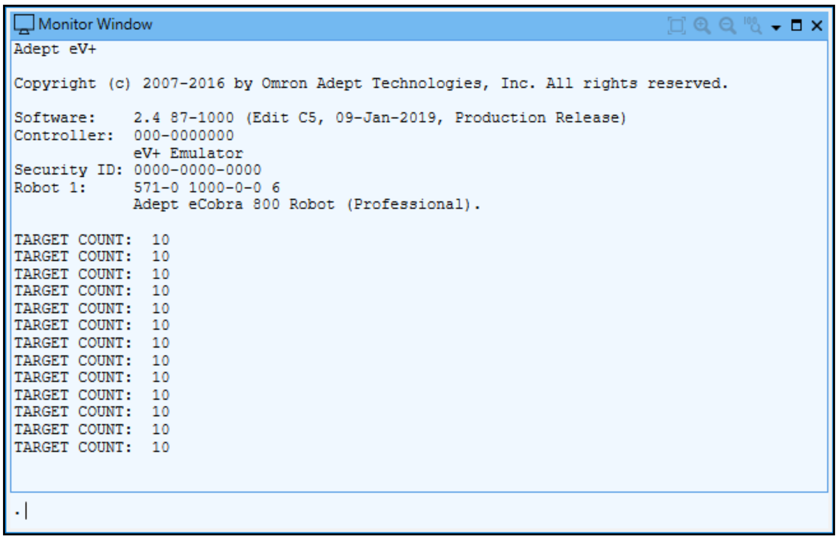


Figure A-85 Available Target Count Remains at 10

- Temporarily disable the Shape Display for the Place Part Target and then start the Process Manger while viewing the 3D Visualizer. Notice there are only ten part targets allocated (light green objects).

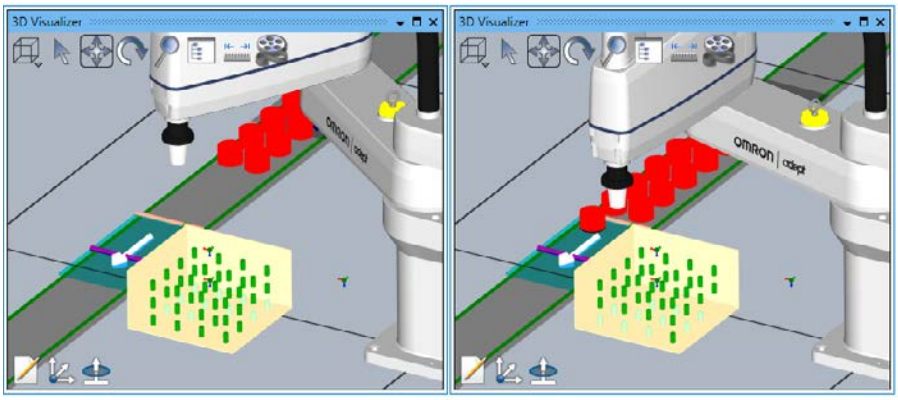


Figure A-86 Ten Part Targets Allocated

For the customization to work for this application, the entire box of part target instances must be allocated to the robot. In Process Strategy Robot Allocation, increase Queue Size to the total target count in the largest pallet, which is 48.

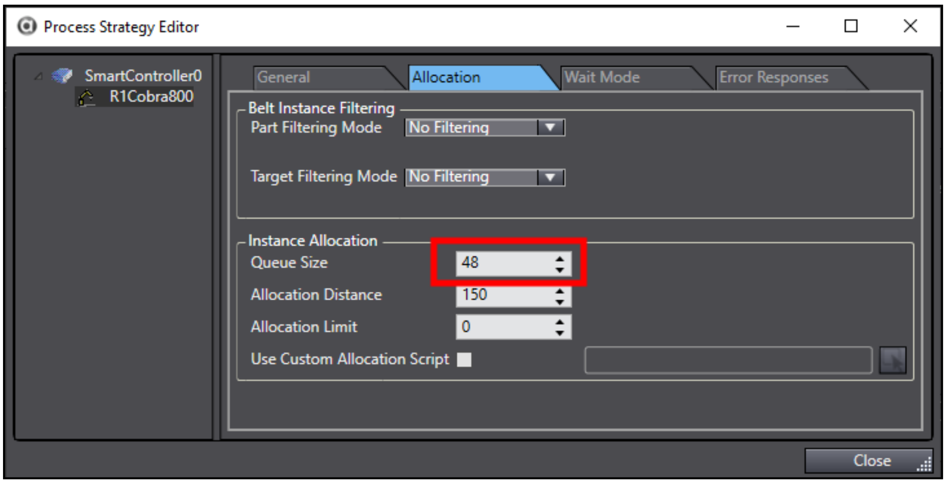


Figure A-87 Increase Queue Size

Clear all instances and start the Process Manager while viewing the 3D Visualizer (temporarily disable the Shape Display for the Place Part Target) . See that all 48 target instances are allocated to the robot as shown in the figure below.

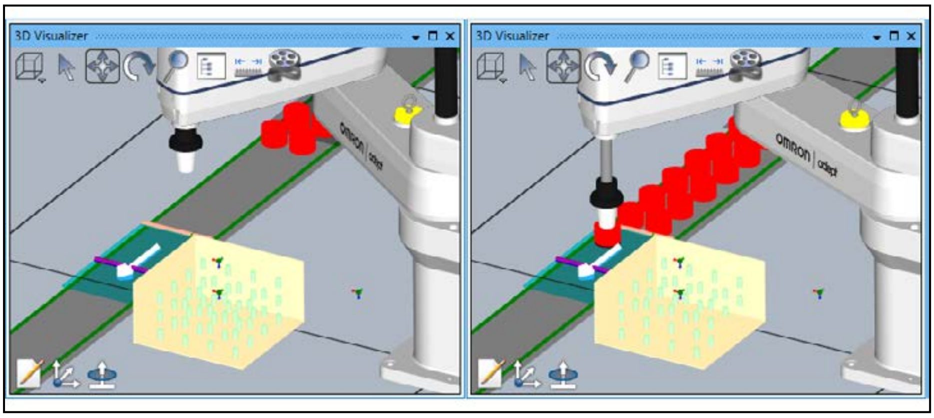


Figure A-88 Forty Eight Part Targets Allocated

The Monitor Window will now correctly decrement after jars are placed in the box as shown in the figure below.

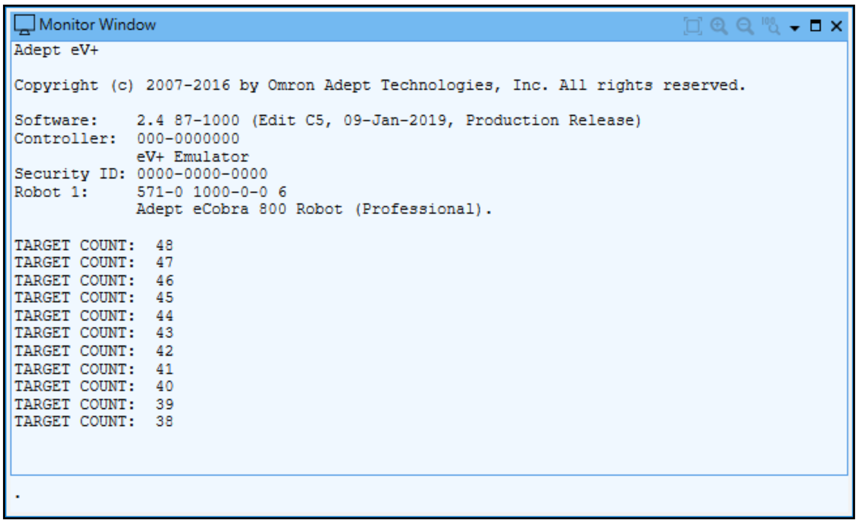


Figure A-89 Available Target Count Decrements Correctly

9. The available target count is updated after a jar is placed but this custom program should account for target instances currently being processed. The remaining target count needs to decrement from 47 when starting with an empty box and a full pallet of target instances. To accomplish this, edit the cust_place V+ program and add the lines shown in the figure below.

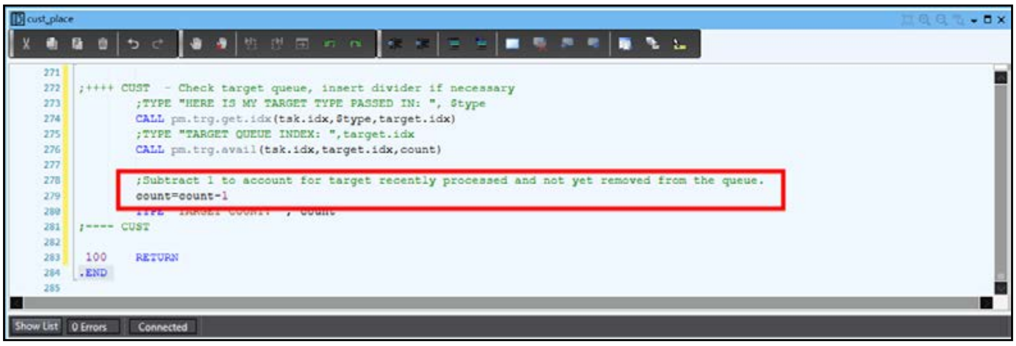


Figure A-90 cust_place V+ Program Edits

10. Now that a counter decrements with each jar place operation, this can be used to check if a divider is necessary by storing a global V+ Variable for the number of available target instances remaining in the pallet, at the end of each layer.

    Edit the cust_place V+ program as shown in the figure below to compare the remaining part target count to global V+ Variables "layer1" and "layer2". These are the number of target instances remaining when each layer is complete.

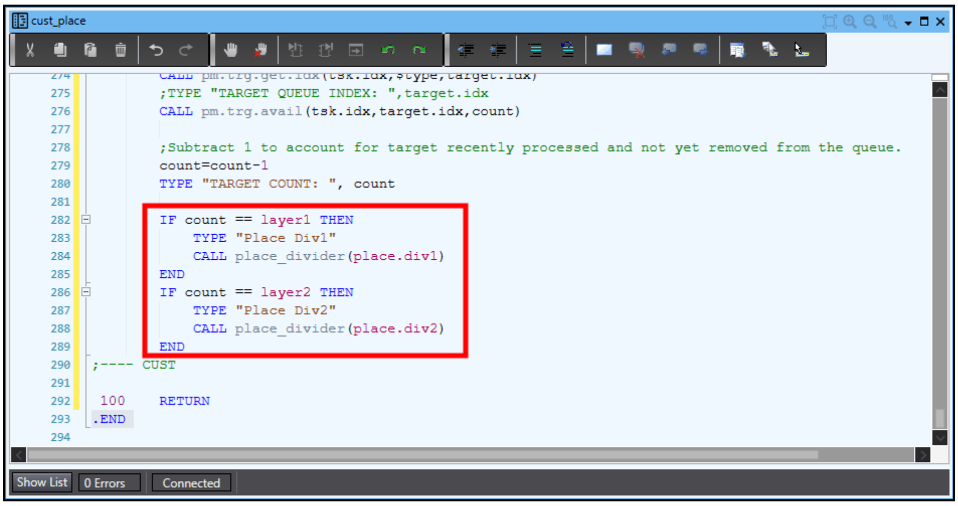


Figure A-91 cust_place V+ Program Edits

11. Create two new V+ Variables as shown in the figure below.

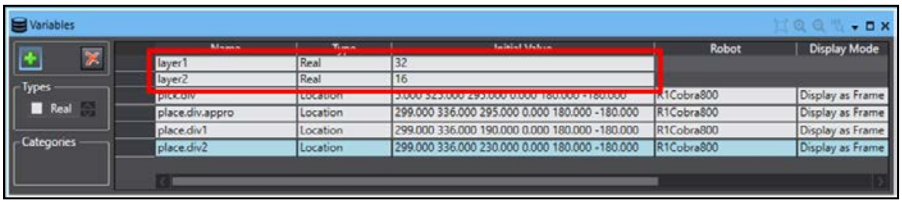


Figure A-92 Layer V+ Variables

12. To confirm correct functionality and complete this procedure, clear all instances and start the Process Manager with the Monitor Window and 3D Visualizer open. You will

see the robot now places targets and performs the motion to insert a divider at the end of each layer as shown in the figure below. By performing the customization in this way, the 3D Visualizer is not yet updated to remove the final instance of each layer until the divider has been placed, but functionally the robot motion is performing the desired motions at the correct point in the process.

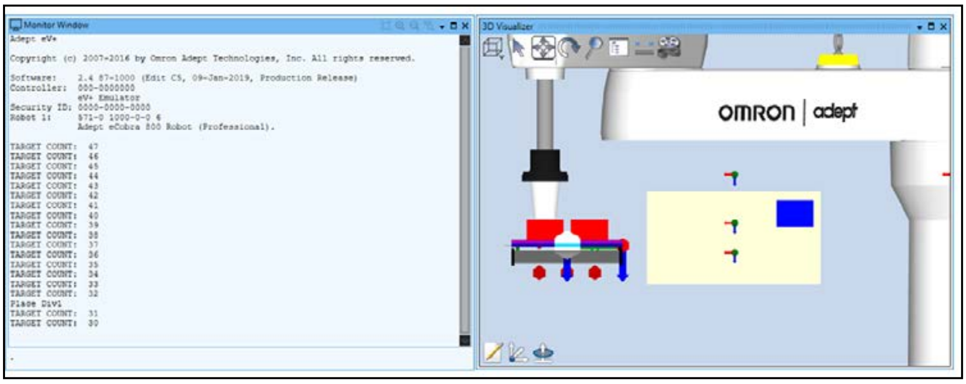


Figure A-93 Confirm Correct Functionality

Visualize Divider Pick and Place Locations

To visualize the divider pick and place locations, use the following procedure to create box objects and position them at the corresponding V+ location variables.

> **NOTE:** This procedure requires that all previous steps for creating the Pack Manager Packaging Application Sample are completed.

1. Create a new Box object in the 3D Visualization with the following settings. Rename this object "Divider" for reference later. This will represent the divider on the gripper.

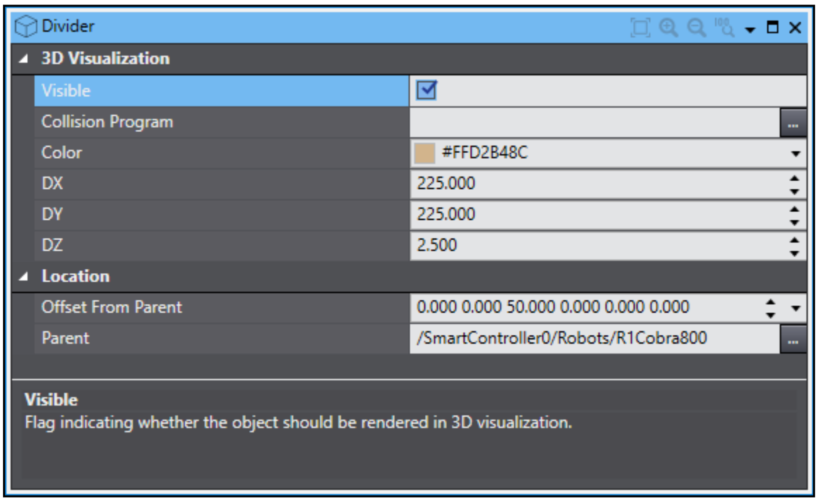


Figure A-94 Create the Divider Gripper 3D Visualization Object

2. Create a new Box object in the 3D Visualization with the following settings. Rename this object "Divider pick.div" for reference later. This will represent the divider pick location.

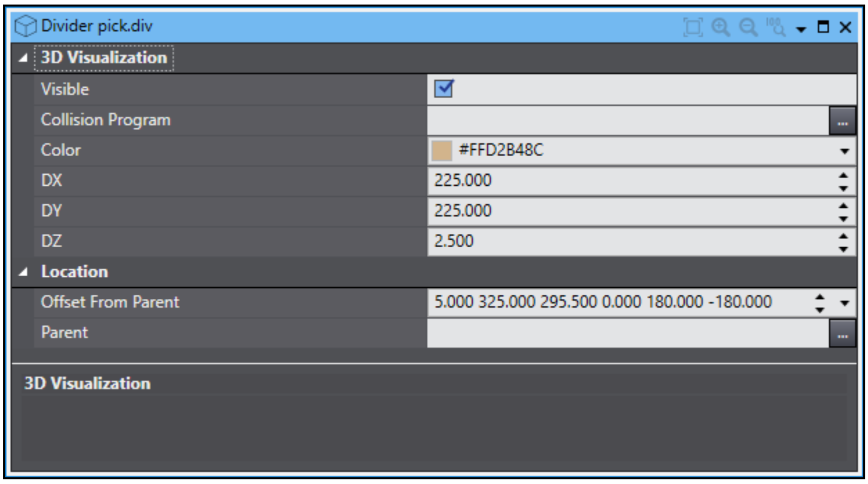


Figure A-95 Create the Divider Pick 3D Visualization Object

3. Create a new Box object in the 3D Visualization with the following settings. Rename this object "Divider pick.div1" for reference later. This will represent the lower divider in the place location.

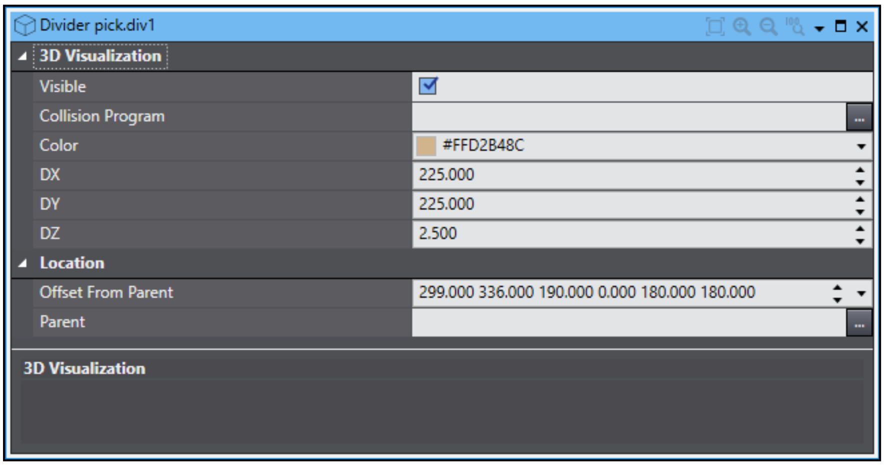


Figure A-96 Create the Divider Place (Lower) 3D Visualization Object

4. Create a new Box object in the 3D Visualization with the following settings. Rename this object "Divider pick.div2" for reference later. This will represent the upper divider in the place location.

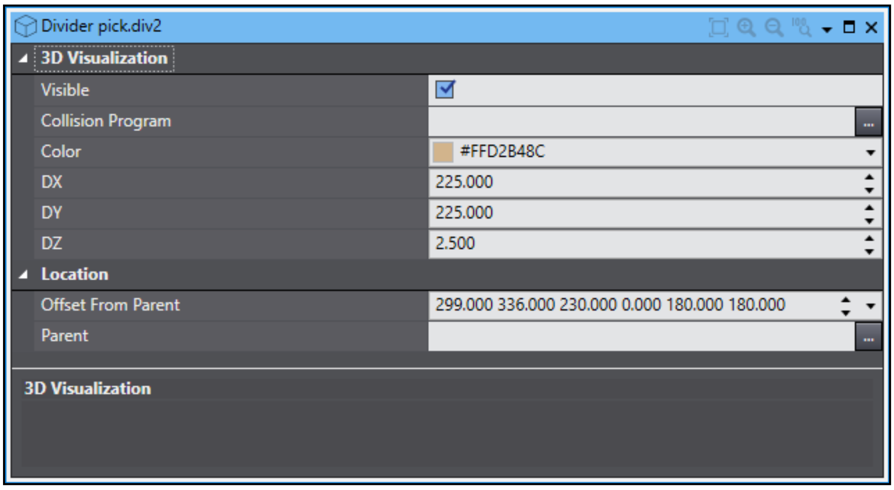


Figure A-97 Create the Divider Place (Upper) 3D Visualization Object

5. To confirm correct functionality and complete this procedure, view the objects in the 3D Visualizer to ensure they are accurately represented.

I/O Feeder Integration

This section demonstrates how to integrate an I/O Feeder into the application to create target pallet instances only if a box is present. The I/O Feeder can use an input signal from a sensor to the robot controller, a signal from a PLC, or a handshake with another V+ program with soft signals to ensure the next pallet of target instances is not created until a full box is removed and a new empty box is present.

For the purposes of demonstrating how the I/O Feeder object is used in this application, we will assume the following.

- A signal is turned ON when a box is available to be filled.
- The signal is turned OFF when the Part Processed Output is triggered by the Process Manager, when the last pallet instance has been processed.
- The signal is turned ON again after an operator has removed the full box and replaced it with an empty box.

The following procedure will provide steps to integrate an I/O Feeder.

> **NOTE:** This procedure requires that all previous steps for creating the Pack Manager Packaging Application Sample are completed.

1. Add an I/O Feeder object and select a reference to the controller.

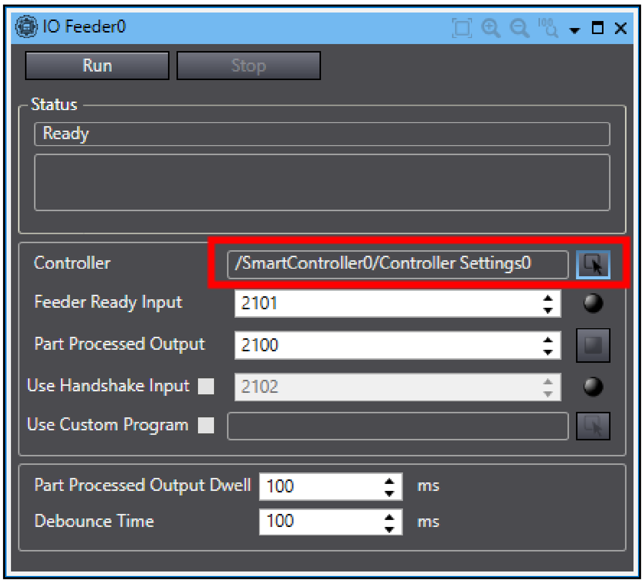


Figure A-98 Add an I/O Feeder Object

2. In Control Sources for the Static Source for Place Part Target, enable Use A Feeder and select the I/O Feeder object that was just created.

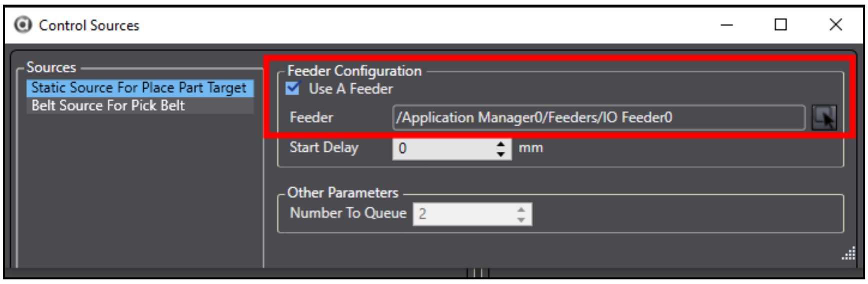


Figure A-99 Set the Control Sources Feeder Configuration

3. Create a V+ program to simulate I/O Feeder signal operation. This is typically done during development in Emulation Mode to simulate signals that would normally be present during run time. This will be executed on another task when the Process Manager starts by using a Process Strategy Custom Initialization program as described in the following steps.

   Create a new V+ program named "box_signal" with the code shown in the figure below.

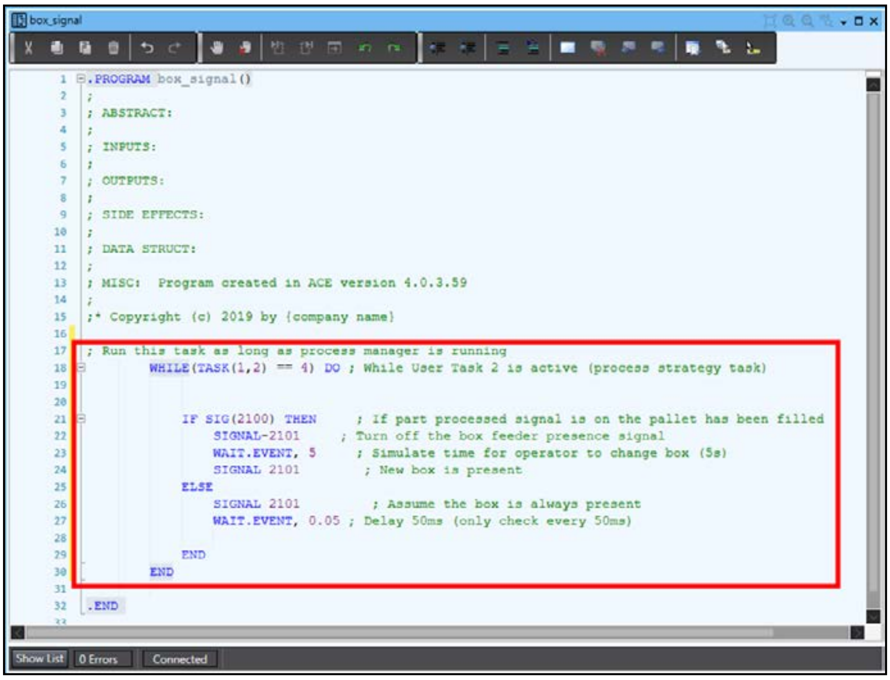


Figure A-100 Create the box_signal V+ Program

4. In the Process Manager Process Strategy Editor, select **Use Custom Initialization Program** and then click the **Selection** Button ( ).

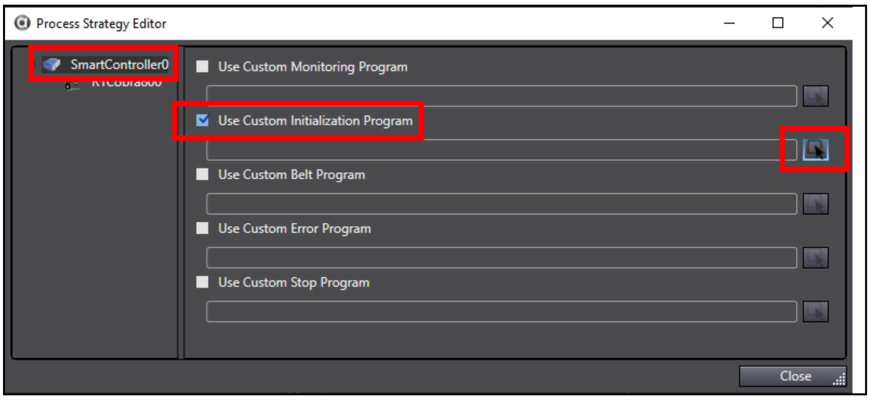


Figure A-101 Use Custom Initialization Program

5. Select **Create a new program from the default** and then click the **Next** Button.

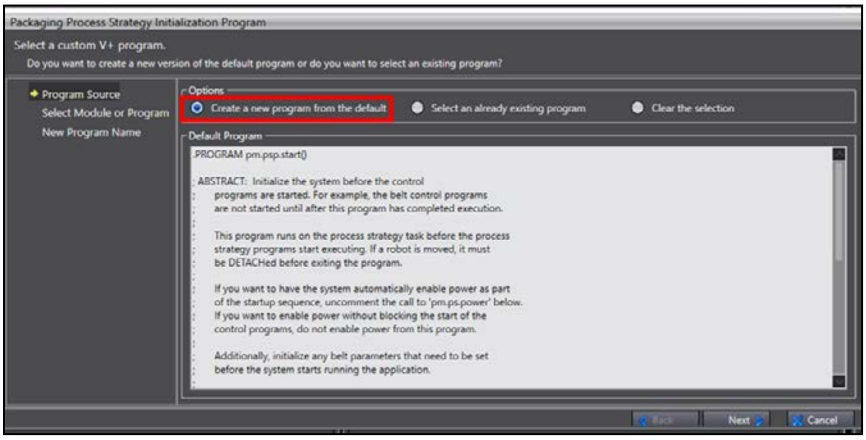


Figure A-102 Create a New Program from the Default

6. Select the module where the new program will be created and then click the **Next** Button.
7. Name the new V+ program "cust_init" and click the **Finish** Button.
8. Edit the cust_init V+ Program to execute the previously created box_signal V+ program, as shown in the figure below.

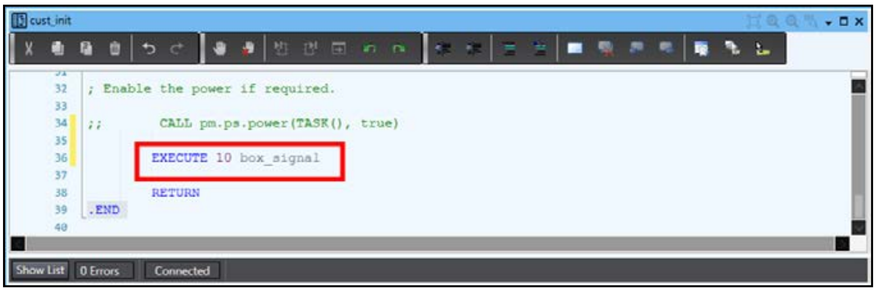


Figure A-103 cust_init Program Edits

9. To confirm correct functionality and complete this procedure, confirm the I/O Feeder integration and simulation by clearing all instances, starting the Process Manager, and observing a 5 second robot pause after the box is filled.

Adding Recipes

This section demonstrates how to integrate recipes into the application to accommodate the different package sizes described in the application summary.

The following procedure will provide steps to integrate recipes in this application.

> **NOTE:** This procedure requires that all previous steps for creating the Pack Manager Packaging Application Sample are completed.

1. Add a Recipe Manager object to the project.
2. Add the following Sources to the Recipe Manager object as shown in the following figure.

- Process Manager
- Place Pallet
- Variables (SmartController0)
- Pick Locator
- Pick Locator Model

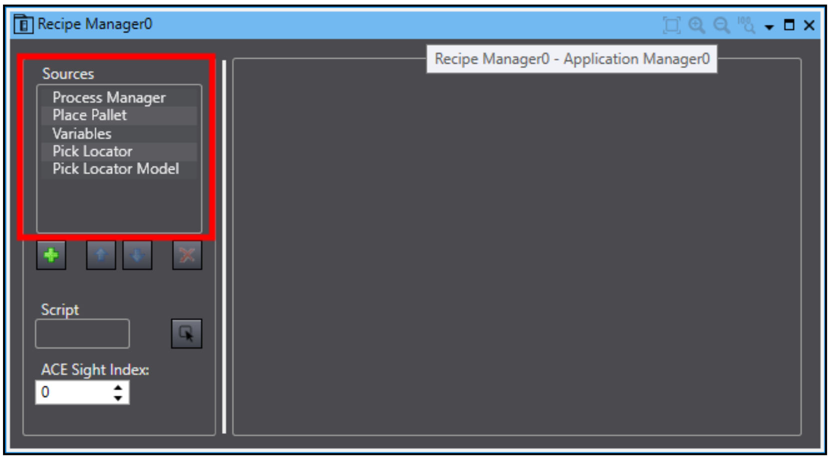


Figure A-104 Add Sources to the Recipe Manager

3. Select the Variables source and add the global variables to the recipe (in the Location Variables area). The size of dividers for the boxes will change, therefore the locations associated with the dividers should be included.

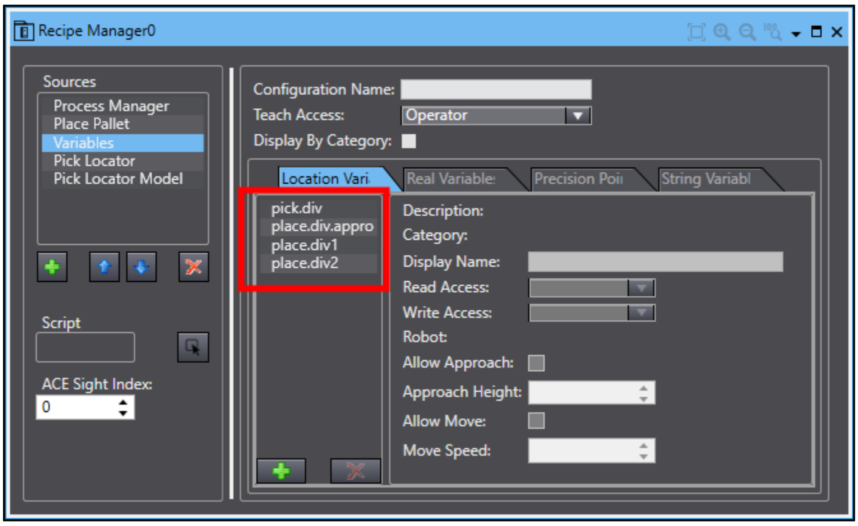


Figure A-105 Add Location Variables to the Recipe Manager

4. Since the number of target instances per layer may change, add layer1 and layer2 variables (in the Real Variables area).

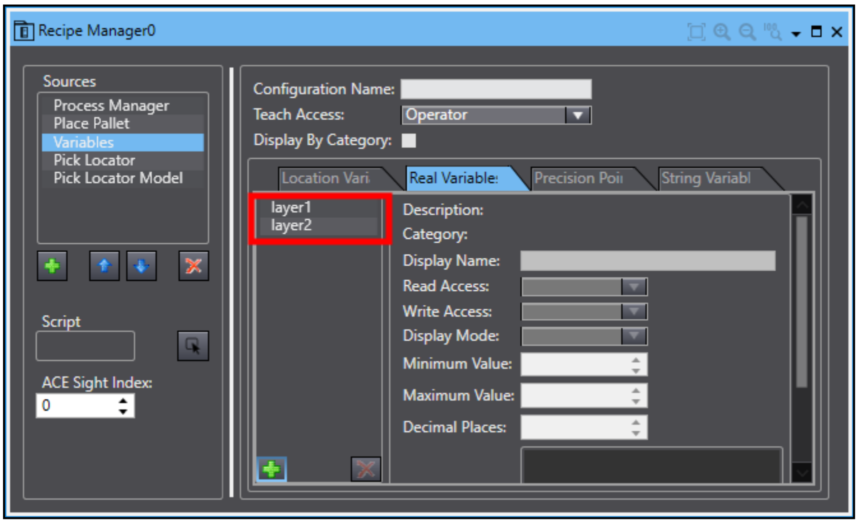


Figure A-106 Add Real Variables to the Recipe Manager

5. Open the Recipe Manager in Task Status Control and add new recipes named "48-pack", "24-pack", and "12-pack".

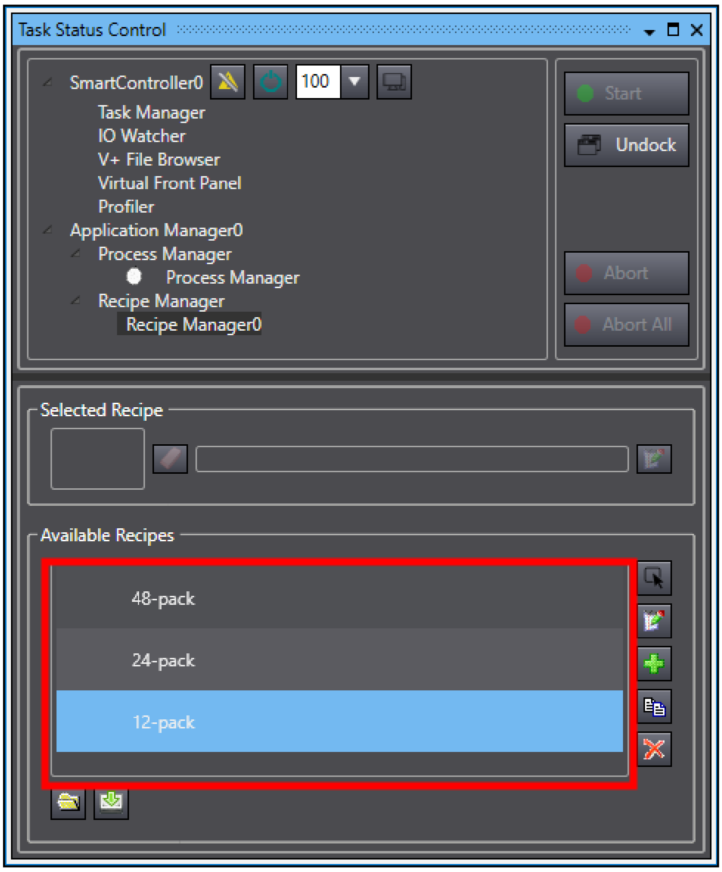


Figure A-107 Add Recipes

6. The 48-pack recipe is already configured properly but the 24-pack and 12-pack recipes need to be edited. Make the following changes to the 24-pack recipe.

   Adjust the pallet arrangement:

   - Pallet Y-Count = 2
   - Layer1 = 16 (4 x 2 x 2)
   - Layer2 = 8 (4 x 2 x 1)

   Adjust locations to center the divider in the smaller box size:

   - Place.div.appro = 353.000 336.000 295.000 0.000 180.000 180.000
   - Place.div1 = 353.000 336.000 190.000 0.000 180.000 180.000
   - Place.div2 = 353.000 336.000 230.000 0.000 180.000 180.000
7. Make the following changes to the 12-pack recipe.

   Adjust the pallet arrangement:

   - Pallet X-Count = 3
   - Pallet Y-Count = 2
   - Pallet Z-Count = 2
   - Layer1 = 6 (2 x 3 x 1)
   - Layer2 = 16 (Only 2 layers, divider 2 unnecessary, leave value larger than total count)

   Adjust locations to center the divider in the smaller box size:

   - Place.div.appro = 353.000 309.000 295.000 0.000 180.000 180.000
   - Place.div1 = 353.000 309.000 190.000 0.000 180.000 180.000
   - Place.div2 = 353.000 309.000 230.000 0.000 180.000 180.000
8. To confirm correct functionality and complete this procedure, select each recipe, clear all instances, and start the Process Manager to observe the different pallet layouts and divider locations when changing between recipes as shown in the figure below.

   NOTE: The box size would be changing, but each box size would be oriented and positioned at the pallet frame location and share common bottom, front, and side locations.

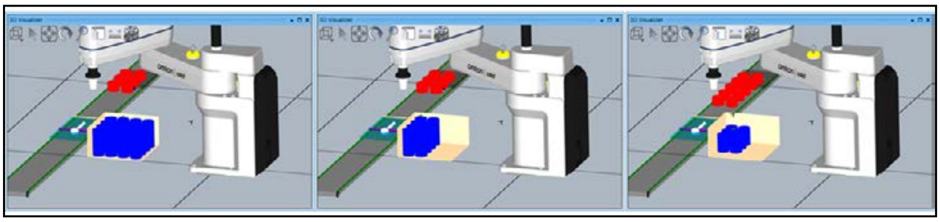


Figure A-108 48, 24, and 12-Pack Pallet Recipe Configurations (Left-to-Right)

Visualize the Jar on the Gripper

This section demonstrates how to visualize the part (jar) on the gripper in the 3D Visualizer using a C# program.

The following procedure will provide steps to view the PartCAD object as a 3D Visualizer object on the gripper tip when the gripper signal is turned ON.

NOTE: This procedure requires that all previous steps for creating the Pack Manager Packaging Application Sample are completed.

1. Access the PartCAD object, set the Parent Offset the same as the gripper tip offset, and select the robot as the Parent.

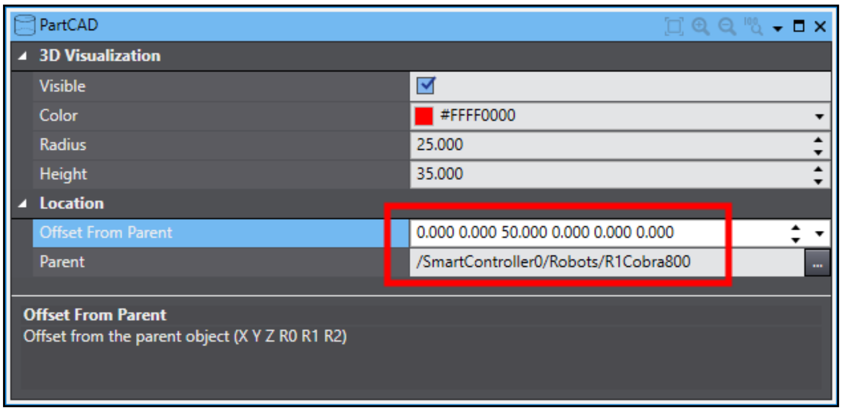


Figure A-109 Select the Robot as the PartCAD Parent

2. Create a new C# program named "GripperPartVis" as shown in the figure below.

   Additional Information: Lines 18 and 19 can be created by dragging and dropping the PartCAD object and I/O EndEffector0 object into the C# Editor. The example renames these items "part" and "gripper" respectively, as shown in the figure below.

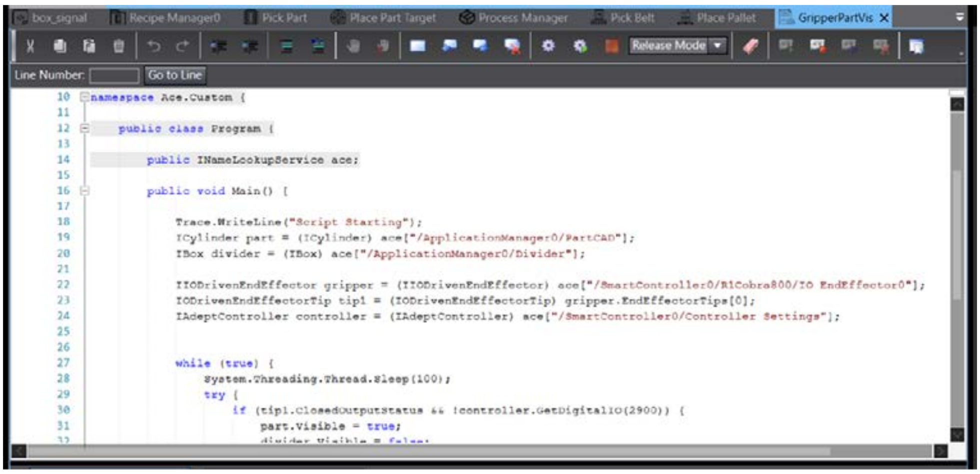


Figure A-110 Create the GripperPartVis C# Program

3. To confirm correct functionality and complete this procedure, observe the part (jar) visibility in the 3D Visualizer by clearing all instances, starting the GripperPartVis C# program, and starting the Process Manager.

Visualize the Divider on the Gripper

This section demonstrates how to visualize the divider on the gripper in the 3D Visualizer by editing the GripperPartVis C# program and the place_divider V+ program.

The following procedure will provide steps to view the Divider item as a 3D Visualizer object on the gripper tip when the gripper signal is turned ON.

> **NOTE:** This procedure requires that all previous steps for creating the Pack Manager Packaging Application Sample are completed.

1. Open the GripperPartVis C# program and make the edits as shown in the figure below.

   Additional Information: Lines 20 and 24 can be created by dragging and dropping the Divider object and Controller Settings object into the C# Editor. The example renames these items "divider" and "controller" respectively, as shown in the figure below.

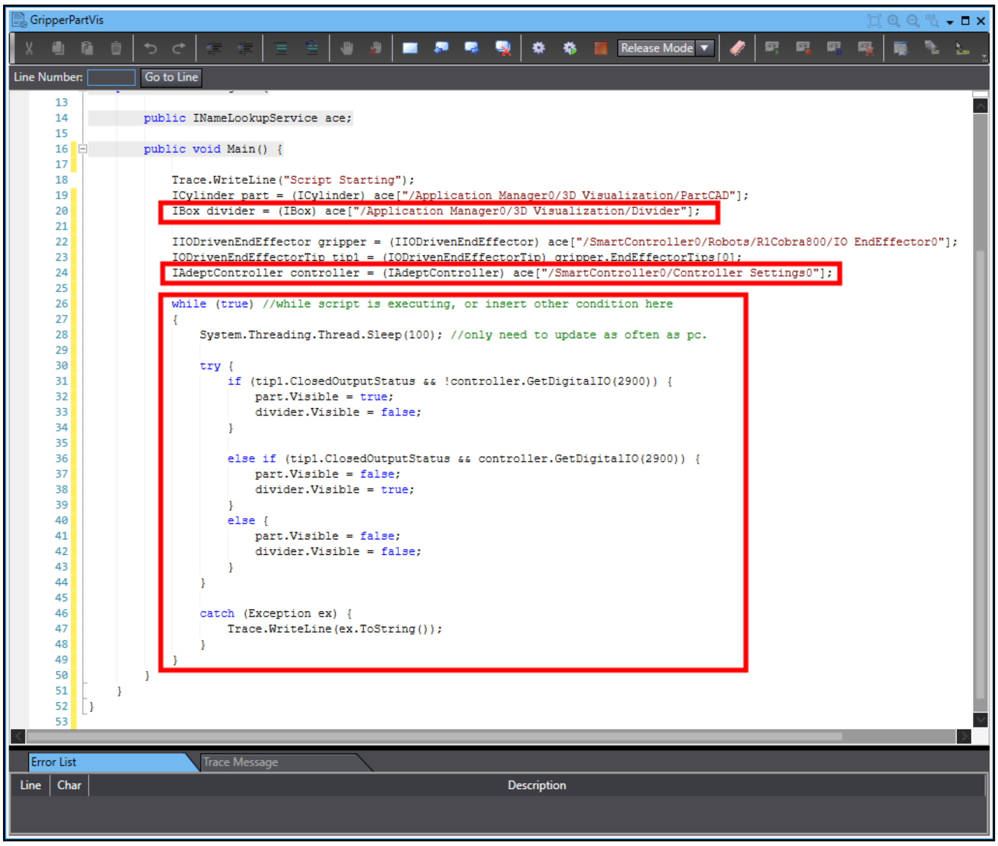


Figure A-111 Edit the GripperPartVis C# Program

2. Open the place_divider V+ program and make the edits as shown in the figure below.

   Additional Information: You can expand upon this idea and turn ON a soft signal during the place_divider() V+ program, to enable visualization of a divider on the tip during that program, and use a part for the other pick operations. Refer to the following program edits, which now provide visualization of a part on the gripper or a divider on the gripper, depending on what operation the robot is performing.

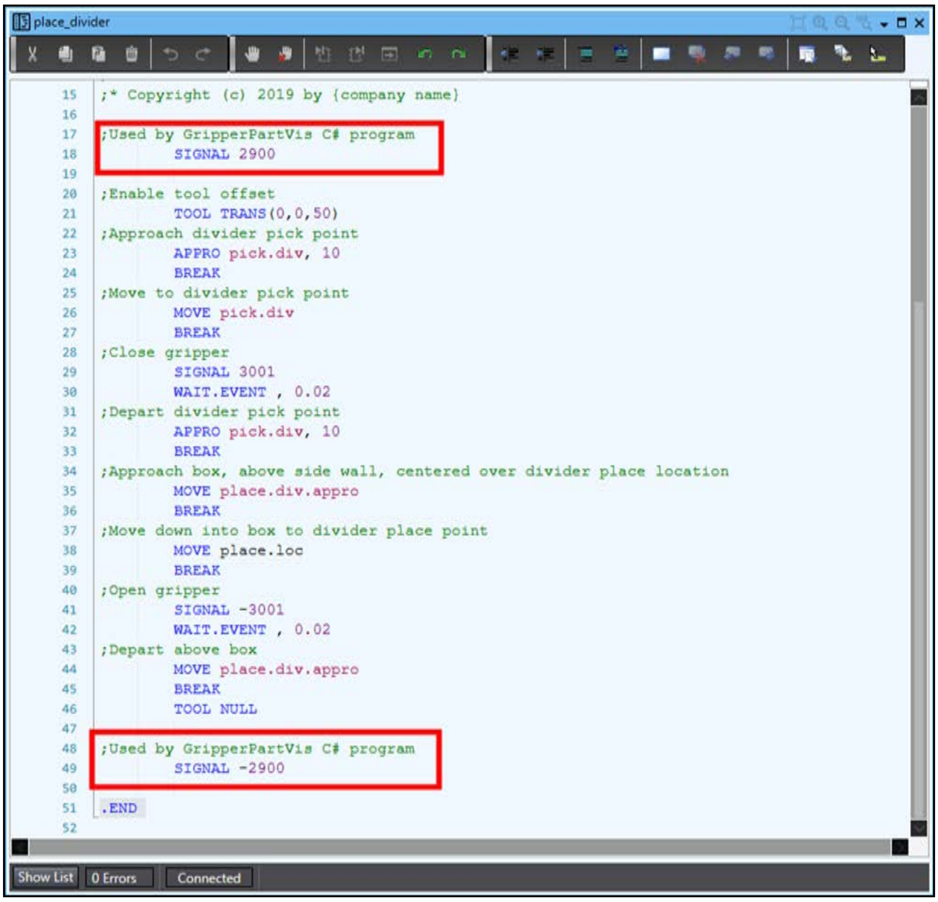


Figure A-112 Edit the place_divider V+ Program

3. To confirm correct functionality and complete this procedure, confirm the divider visibility in the 3D Visualizer by clearing all instances, starting the GripperPartVis C# program, and starting the Process Manager.

Enable Active Control for the Belt

If the upstream process allows for the conveyor belt to be turned OFF, you can enable Active Control in the Pick Belt object. This will allow the robot to turn OFF the belt to prevent any jars crossing the downstream process limit while the robot is waiting for a new box (per the application summary requirements).

Use the following procedure to enable Active Control for the belt.

1. Access the Pick Belt object and select Active Control and select the Controller Settings0 object as a reference. Set the Drive Output values as shown in the following figure.

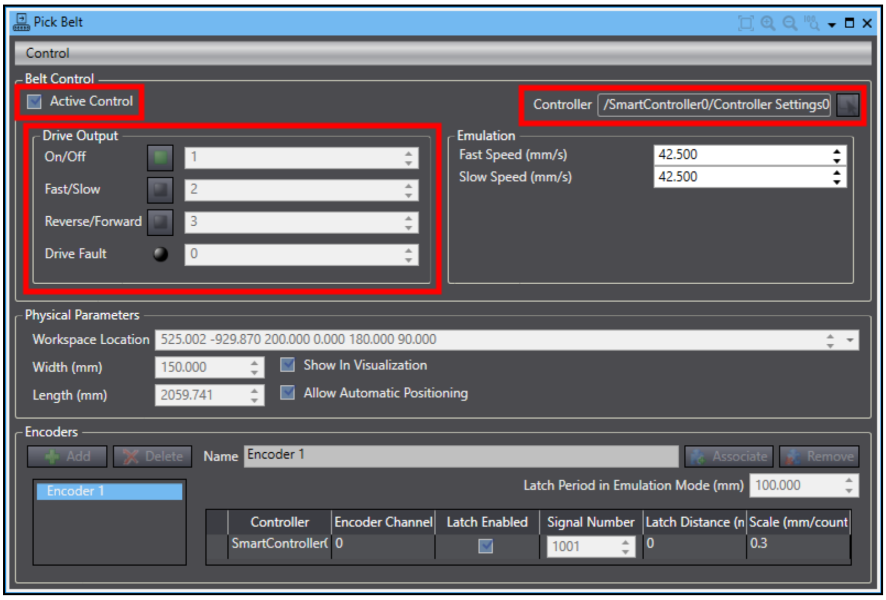


Figure A-113 Enable Active Control

2. Access the Process Strategy Editor and adjust the Pick Belt Control Threshold parameters as shown in the following figure.

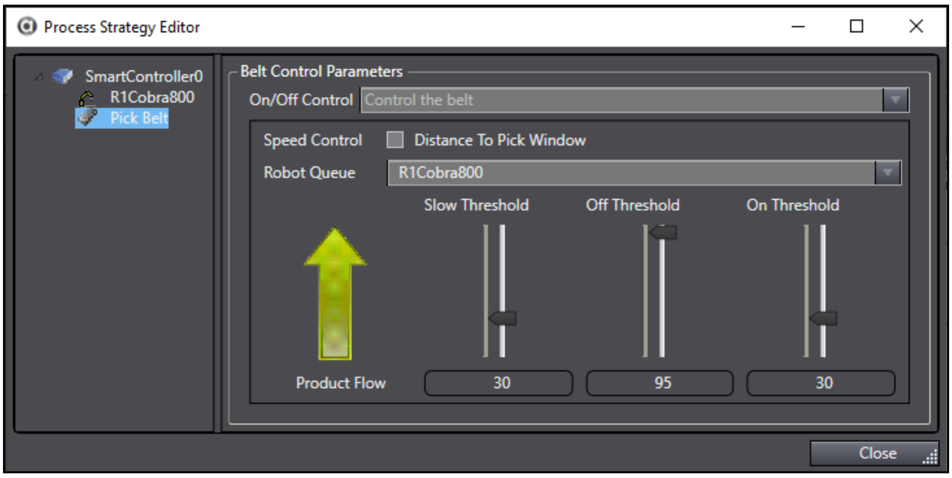


Figure A-114 Set the Belt Control Threshold Parameters

3. To confirm correct functionality and complete this procedure, clear all instances, start the GripperPartVis C# Program, and start the Process Manager with the 3D Visualizer open. You will see the belt stop when the jars reach the downstream limit during the simulated box replacement function.

Commissioning on Physical Hardware

To transition from Emulation Mode to physical hardware during system commissioning, use the following steps.

1. Ensure all hardware is properly installed according to the reference documentation.
2. Connect to the controller and configure all necessary network and controller parameters. Test communication with all other devices such as cameras, PLCs, etc.

   NOTE: The project created in Emulation Mode cannot transfer its configuration to the physical controller.

3. Test any latch signals and latch configurations.
4. Open the project with Emulation Mode disabled.
5. Set the IP address in the Controller Settings to match the physical controller and verify communication with the controller.
6. Perform any necessary Virtual Camera calibrations.
7. Perform any necessary Robot-to-Belt calibrations.
8. Perform any necessary Robot-to-Sensor calibrations.
9. Train any Locator Models and Locator tools to locate parts.
10. Link any Part objects to Locator tools (rather than using the Custom Vision tool).
11. Teach all processes.
12. Teach any global V+ location variables as needed.
13. Test, debug, and troubleshoot the application.
14. Program system start-up functions as required for the application.

Additional Information: Calibrations are typically performed with calibration pointers and disks, while Teach Process wizards and teaching V+ locations should be performed with the gripper or end of arm tooling used for the process.

A.6 Version Control Introduction

The ACE project version control function (called version control function hereafter) controls the change record of an ACE project by recording "who changed what and when."

This function enables various control capabilities by combining the ACE projects with an open source software version control system that is commonly used in software development. The version control function effectively solves problems such as the following, which you may encounter in large-scale development of production machines.

• The complexity of source code management due to increase in the scale of program development

• The increase in the workload of change management due to the increased variation of production machines

• The increase in the complexity of source code management due to the increased opportunities of development by multiple developers

The version control function enables you to leave a change record of a project at any time. You can return to the desired project by tracing back the change record and comparing the present version with past projects. The version control function provides the capability to check the difference and merge the changes when you apply them to the master project.

When you use the version control function to control projects, you can effectively manage and develop programs by multiple developers. This facilitates the management of developing derived machines.

The following software is needed besides the ACE software. Download the latest edition of software from their official Web sites.

- "Git" (32-bit or 64-bit edition) https://git-scm.com/downloads
- "TortoiseGit" (32-bit or 64-bit edition) https://tortoisegit.org/download/

Git Software Installation

Download the latest installer from the Git download site and install it as a user with administrator rights. Depending on the operating system installed on the computer, download the 32-bit or 64-bit edition of the installer, as defined by the computer. 64 bit is preferred for Windows 10.

Follow the instructions in the Git installer wizard. Although the wizard displays several pages during the installation, the description below covers the steps requiring your input. The pages on which you must select a specific item are shown with figures. You can leave other pages as default.

Locate the downloaded installer and double click it. When the Installer window opens, click **Next** and follow the steps below, after accepting the license, default installation destination and default components.

1. Select **Editor**, **Nano**

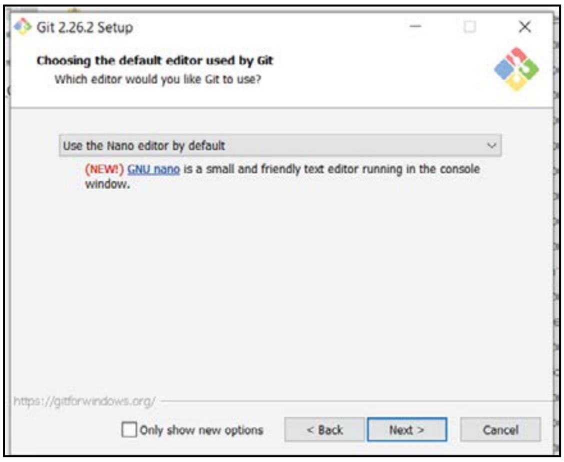


Figure A-115 Git Editor, Nano Selected

2. Adjust the PATH environment

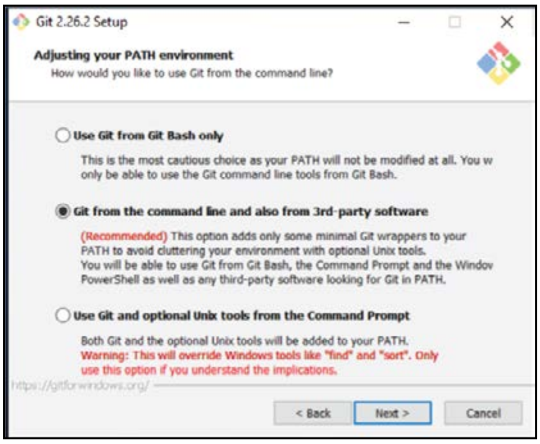


Figure A-116 PATH Environment, Command Line

3. Click **Next** and select **HTTPS back end transport.**

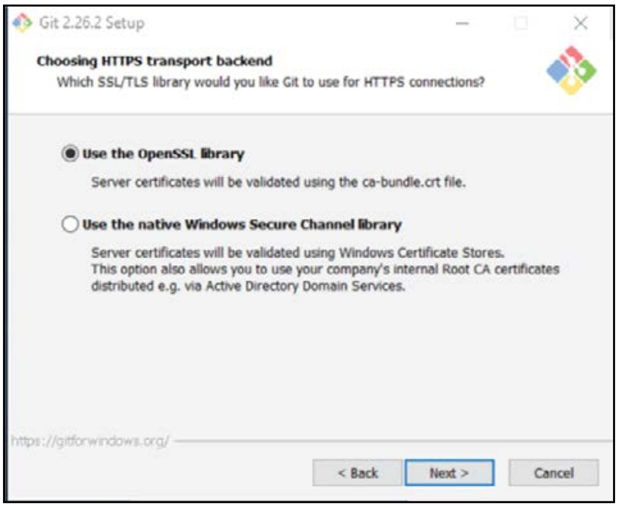


Figure A-117 Back End Transport Layer, OpenSSL

4. Click **Next** and select **Checkout as-is, commit as-is** for Line ending conversions

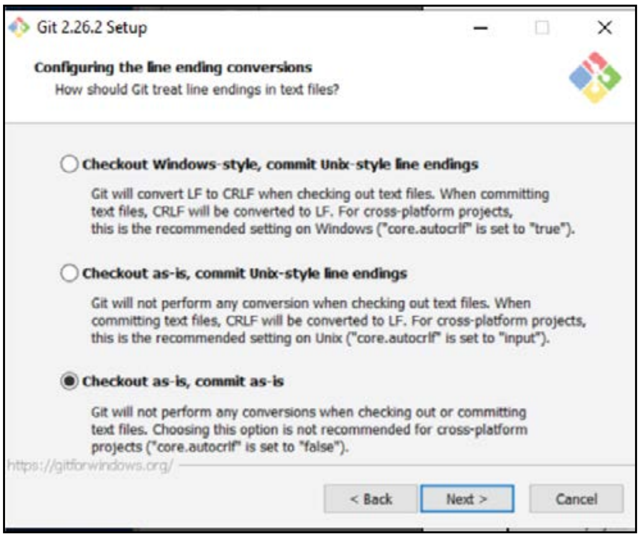


Figure A-118 Line Ending Conversions, Checkout

5. Click **Next** and set the terminal emulator, See "Terminal Emulator, Windows Default"

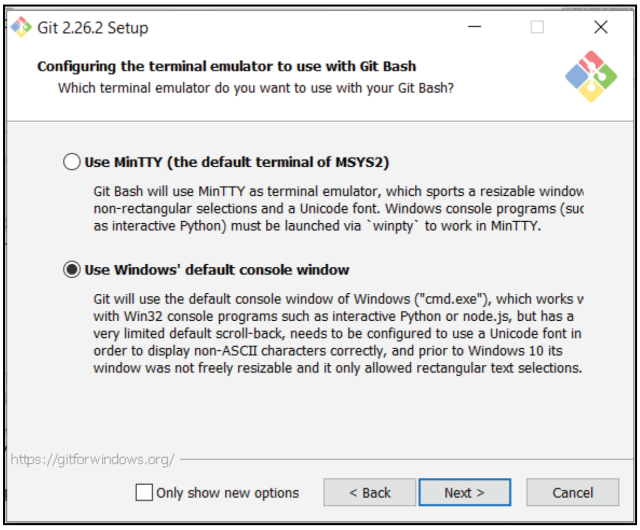


Figure A-119 Terminal Emulator, Windows Default

6. Click **Next** to configure Extra Options. Select top two options only.

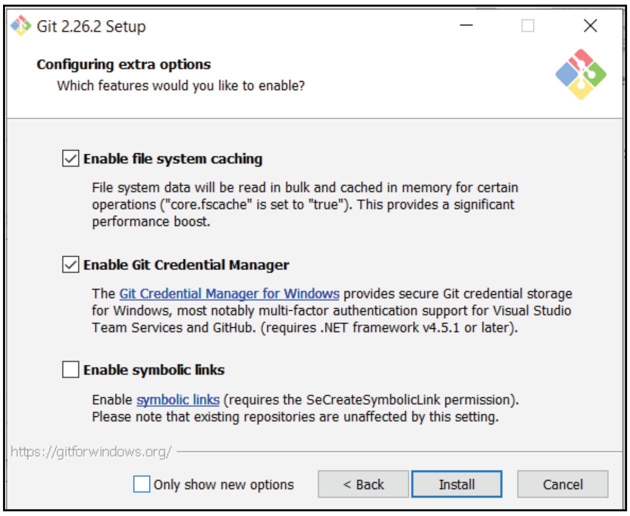


Figure A-120 Git Extra Options

7. Click **Install** and allow the program to run to completion.

Installing TortoiseGit

Download the latest installer from the TortoiseGit download site and install it as a user with administrator rights. Depending on the operating system installed on the computer, download the 32-bit or 64-bit edition of the installer, as defined by the computer. 64 bit is preferred for Windows 10.

Follow the instructions in the TortoiseGit installer wizard. Although the wizard displays several pages during the installation, the description below covers all the steps. The pages on which you must select a specific item are shown with figures. You can leave other pages as default

Locate the downloaded installer and double click it. When the Installer window opens, click **Next** and follow the steps below, after accepting the license, default installation destination and default components.

1. Accept license
2. Accept the default install location
3. Install the application
4. When completed, run the start wizard
5. Select **Language**
6. Configure git path

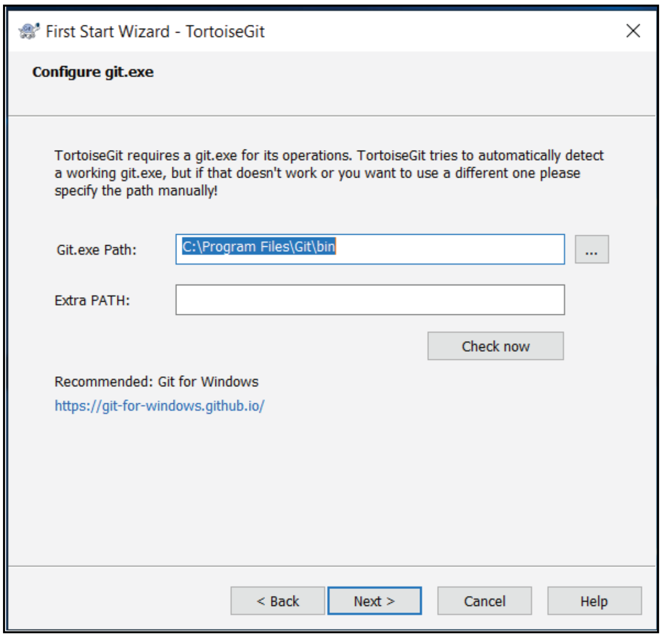


Figure A-121 Configure Git Path

7. Click **Next** to configure user. Enter your user name and e-mail

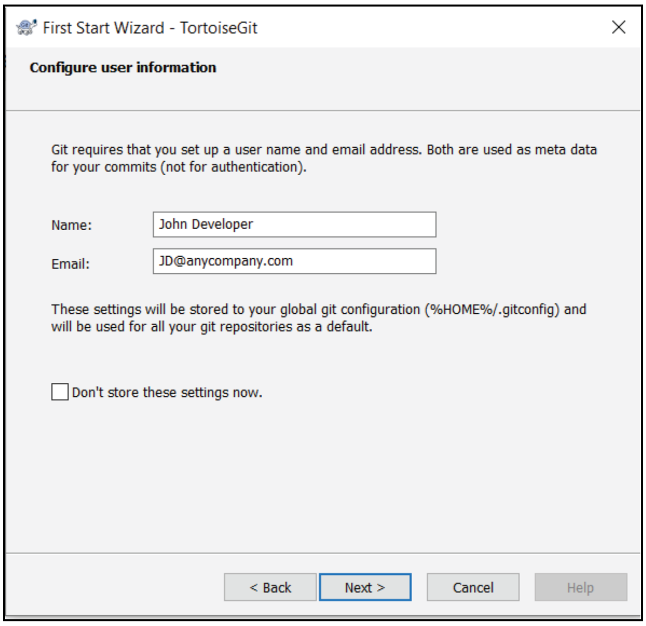


Figure A-122 Configure TortoiseGit User

8. Click **Next** to authenticate and credential TortoiseGit

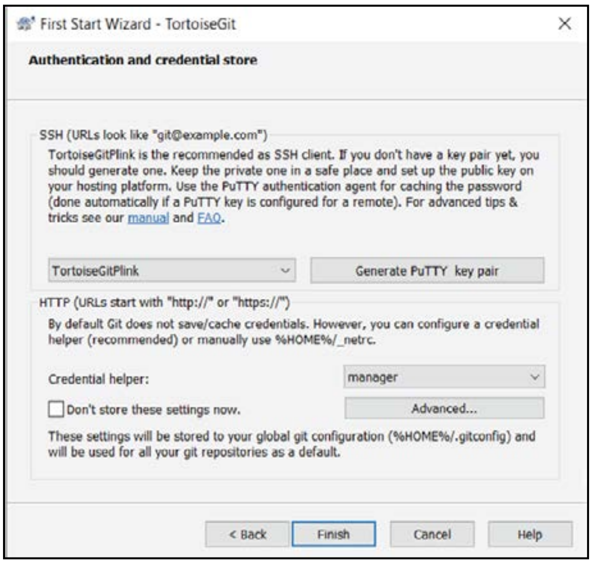


Figure A-123 Authenticate and Credential

9. Click **Finish.**

Both Git and TortoiseGit are now installed onto the computer and ready for use as a single repository.

A.7 Version Control Configuration

ACE stores projects in two methods. The first is integral to a single user, a local directory created upon installation found at C:\OMRON\Ace\Data\VC, and as shared or shared remote directories. The shared and shared remote directories require version control. The ACE version control function is an environment that consists of the ACE Manager, "Git™" (version control system), "TortoiseGit" (client software for Git), and "repositories" (folders managed by Git). Both Git and TortoiseGit are open source .

Single User Configuration

The following figure shows the minimum configuration for a single user to access the ACE project repository.

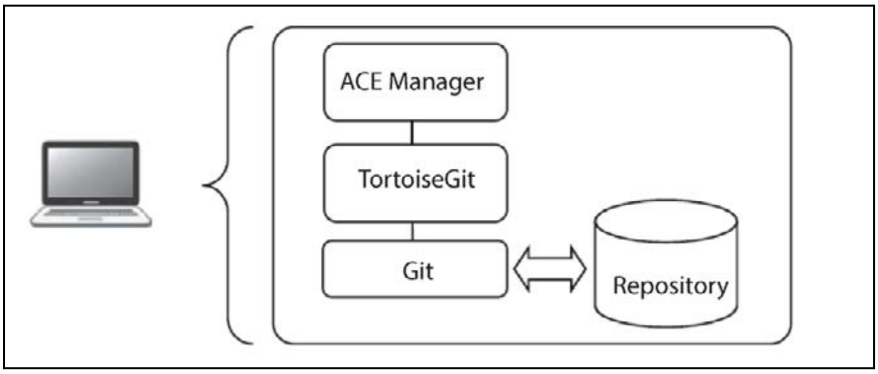


Figure A-124 Single User Configuration

A.8 Creating a Shared Folder and Remote Repository

The remote repository is used to store version controlled files data, generated from ACE Manager.

Create Shared Folder

Open Windows Explorer and create a new folder. You can create this folder in any location with any name. As an example, go to C: drive and create a folder Git, in C:\OMRON\Ace\Data\VC\Git.

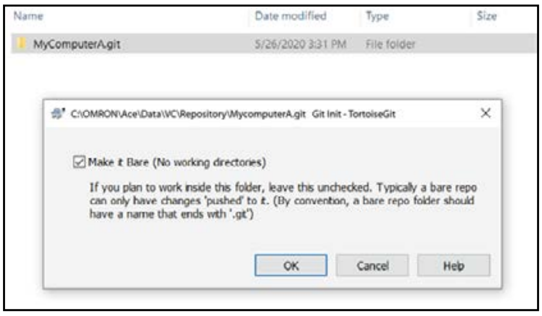
Right-click the folder that you created and select **Properties** from the pop-up menu. Then, in the dialog box that is displayed, click the **Share** tab to perform the sharing settings. Here, you configure the folder to allow full access from other users' computers on which the Multiview Explorer version control function is used. You can share with specific users that are selected or share with Everyone.

Create a Remote Repository

Under the shared folder you created, C:\OMRON\Ace\Data\VC\Git, create a new folder. According to the Git conventions, it is required that you name the folder to use as a remote repository to the repository name followed by ".git". For example, if the repository name is

"MyComputerA" then name the folder "MyComputerA.git". Then Right-click the created folder and select Git Create repository here from the pop-up menu.

A pop-up will display, check the box and click **OK**. The repository is created.



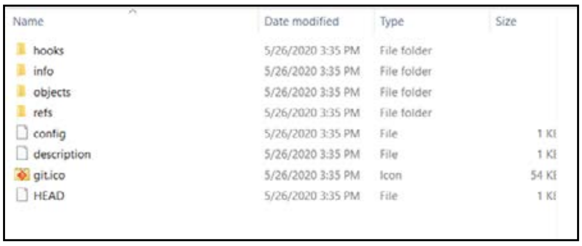


Figure A-125 Git Repository

NOTE: You can control only one ACE project per repository. Create a directory for each project to use version control function.

A.9 Multiple User Configuration

The ACE Manager version control function works with Git which has distributed version control system. Git also has a mechanism to share the repository with multiple users. The configuration consists of local repositories registered in the computers of each user and the remote repository shared by multiple users. At a certain time for each user, the local repository and remote repository can be synchronized. This is done through either a push or pull synchronization.

To share changes in the local repository with other users, perform a push operation to the remote repository. To apply changes made by other users to the local repository, perform a pull operation from the remote repository.

There are the following three practical configurations depending on the difference in how the remote repository is shared.

1. Using a shared repository on the user's computer to share it as the remote repository
2. A dedicated Git server to share it as the remote repository
3. Utilizing a Git server service on the Internet to share the remote repository

Shared Computer Repository

This is the easiest way to build a remote repository. In this method, you use a Windows shared folder to publish a remote repository that is synchronized with the local repository to the local network so that it can be accessed from other computers. In the following See "Shared Repository, Computer Source", you use a remote repository that is built in this way.

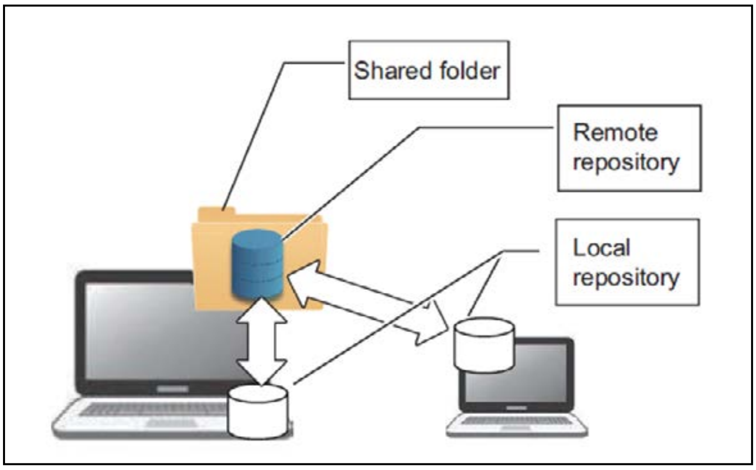


Figure A-126 Shared Repository, Computer Source

Dedicated Git Server

You can build a dedicated Git server,See "Repository Server, In Company", to share the remote repository. This is done using Git server software, Gitbucket (for Windows) or if you are using Linux; GitLab, Gitbucket, Gitblit, Gogs. Although this configuration has costs for building and maintaining the server, it has an advantage in reducing the risk of data leakage because the system is closed within the company.

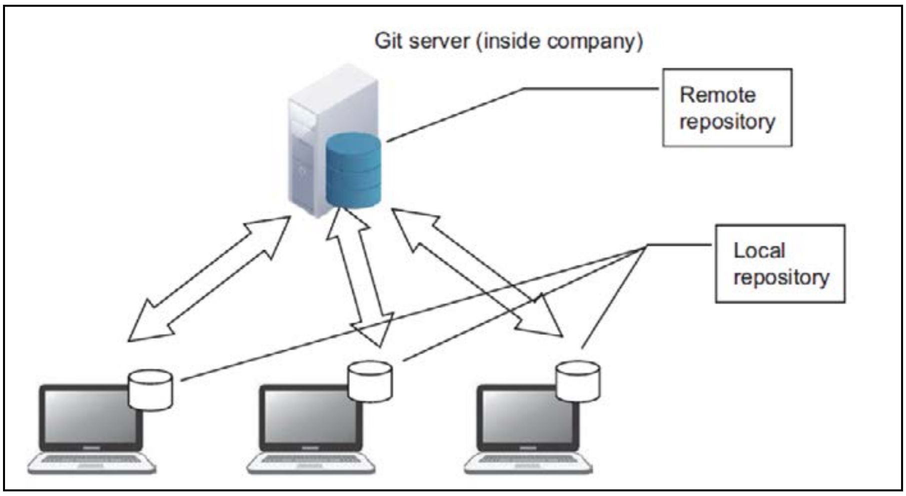


Figure A-127 Repository Server, In Company

Internet Git Server Service

There are Internet based Git server services such as GitHub. Although these,See "Internet Git Server", are commercial paid services that incur a cost, there are advantages that they require no server maintenance and allow development in parallel with external developers.

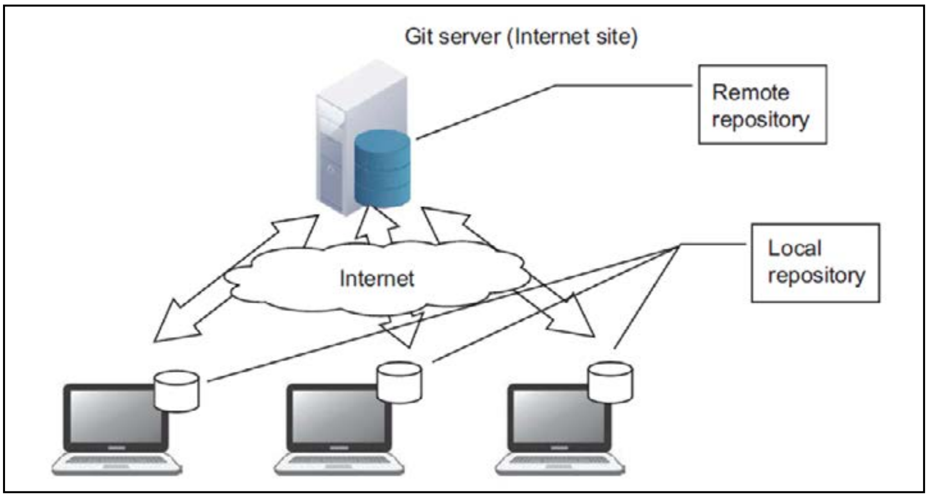


Figure A-128 Internet Git Server

A.10 Exporting ACE Projects

Open and example project or create a new project within ACE. When completed it can be Saved, by clicking **File** and then **Save**, placing it into the C:\OMRON\Ace\Data\VC directory.

To place a project into either a shared or remote Git directory, use the following steps.

Save in Shared Directory

With the project opened in ACE, select **File_ Export** andthe Git repository opens in an Explorer view. Confirm the name of the project and click **Save**. The project is within the shared directory, enabling other users or developers access for quality analysis or development purposes.

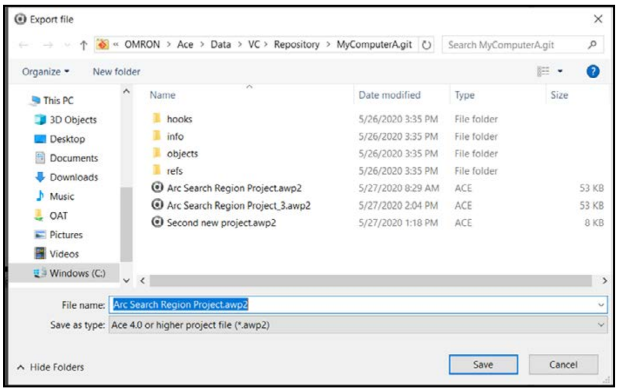


Figure A-129 Shared Git Directory

Import a Shared Project

There are two options to import a shared project. The first is detailed in Importing from the Menu Bar in the Application Window on page 67. The importing from a shared repository is done with the following steps.

Open ACE and click the Version Control Explorer bar in the Version Control section of the left menu. The Version Control Projects panel opens.

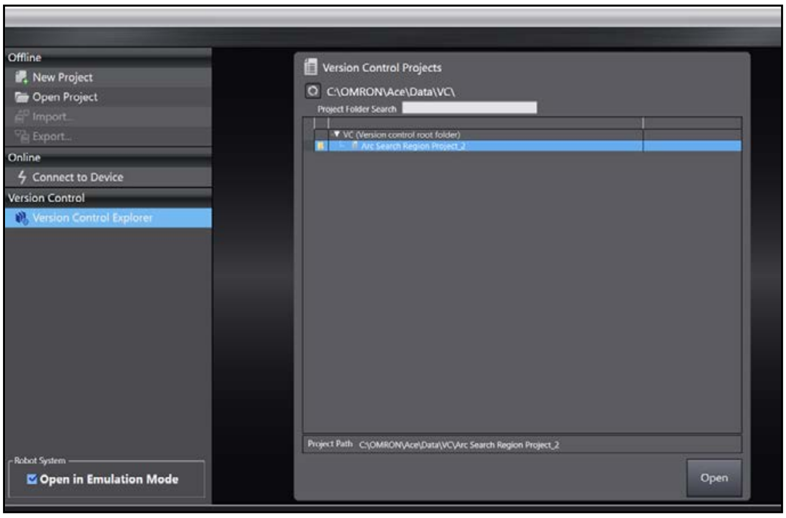


Figure A-130 Version Control Panel

Right click the folder icon in the Version Control Panel and scroll to ***Tortoise*** to view the import options.

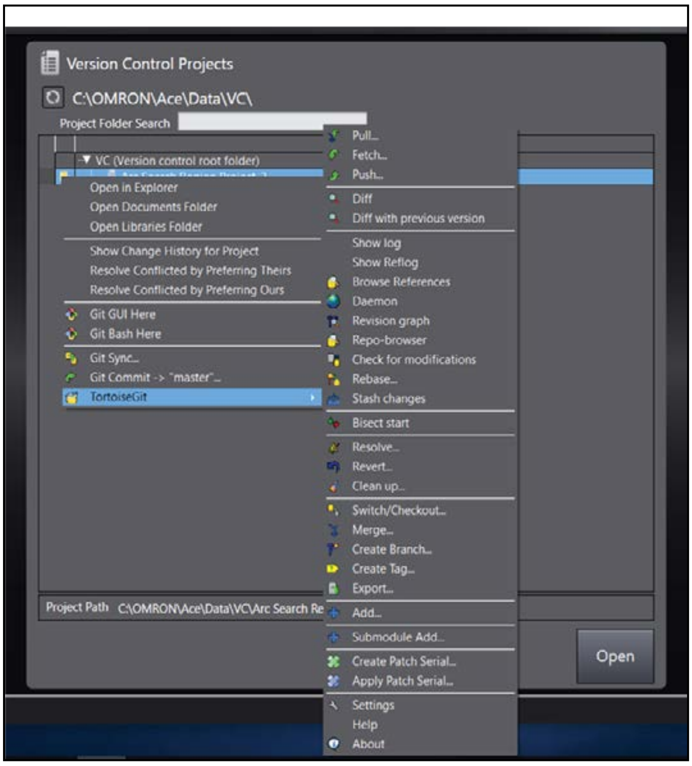


Figure A-131 Tortoise Options and Import

For detailed information about using TortoiseGit double click the desktop icon and select **Help**, to open the user manual.

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