15. Conveyor Tracking

15.1 Overview

Conveyor Tracking is a process in which a robot picks up parts from a stationary or moving conveyor that are found by a vision system or sensor.

The EPSON RC+ 6.0 Conveyor Tracking option supports both tracking and indexed conveyor systems.

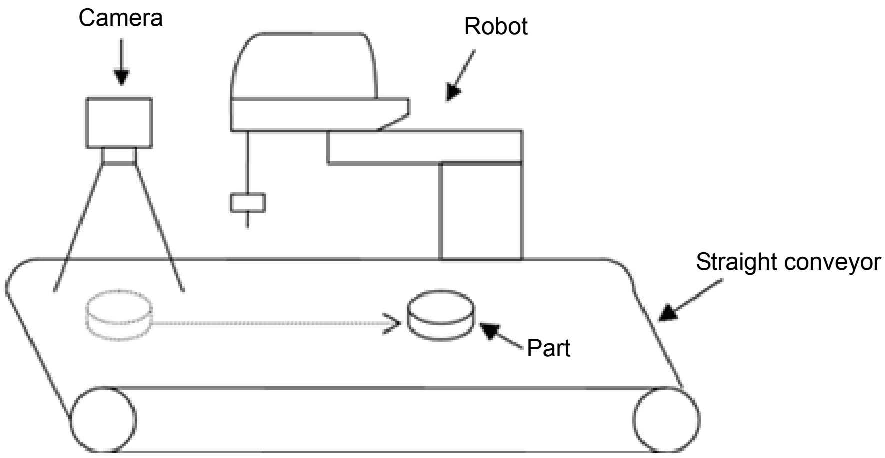
- **Tracking conveyor system**
  Conveyor moves constantly. Vision system or sensor system finds the parts on it and robot picks them up as they move. During tracking, the robot can move along with the part as it picks up parts.
- **Indexed conveyor system**
  Conveyor moves a specified distance and then stops. The vision system finds the parts and robot picks up each part. After finding and picking up all parts, the conveyor moves again.

A total of 16 physical conveyors can be defined on each system. A physical conveyor has one encoder whose signals are received by an encoder board.

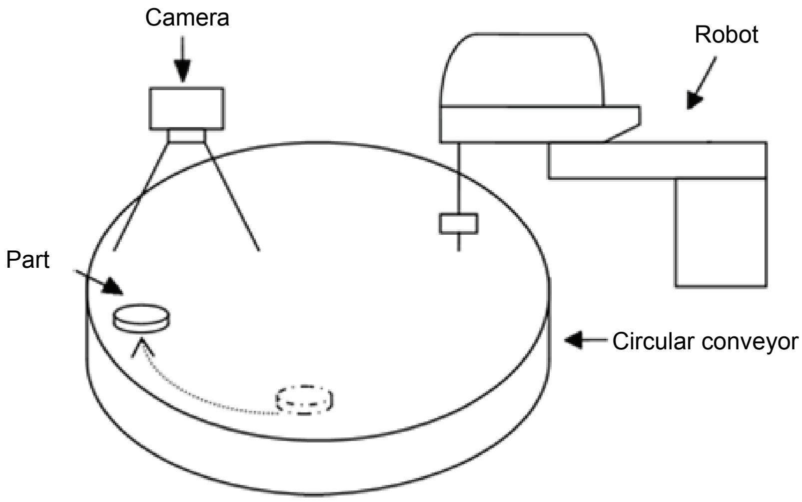
Up to 16 logical conveyors can be defined in each project. To define a logical conveyor, set a conveyor number, a robot number, encoder number and select vision or sensor.

Multiple robots and multiple conveyors are supported. For example, 2 robots can be used to pick parts from one physical conveyor.

The Conveyor Tracking option is available for straight conveyors and circular conveyors, as shown in the figures below. These conveyors have different calibration and programming methods. For details, refer to *15.11 Vision Conveyors* and *15.12 Sensor Conveyors*.



Straight conveyor tracking system



Circular conveyor tracking system

15.2 Conveyor Tracking Processes

Tracking conveyor system

1. Vision system or sensor system finds the parts on a continuously moving conveyor.
2. Robot picks up the parts on the conveyor as they move.

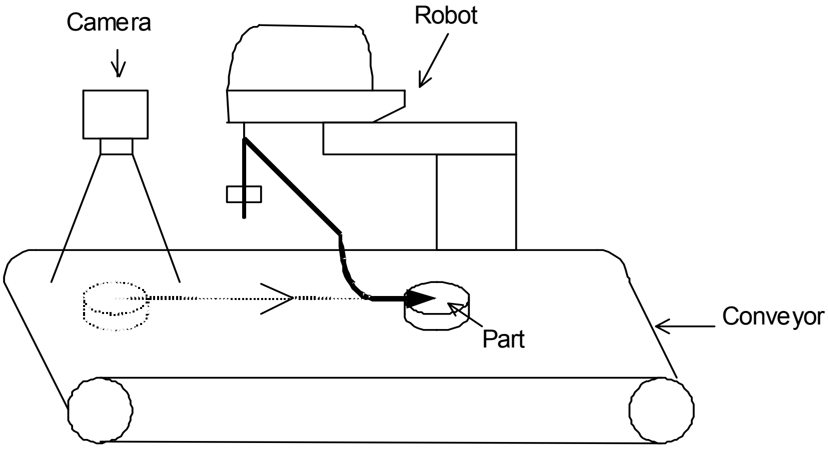


Fig 2.1 Tracking Conveyor System

Indexed conveyor system

1. Conveyor moves a specified distance.
2. Vision system or sensor system finds the parts on the conveyor when it stops.
3. Robot picks up the parts found by vision system.
4. After finding and picking up all parts, conveyor moves by the specified distance again.

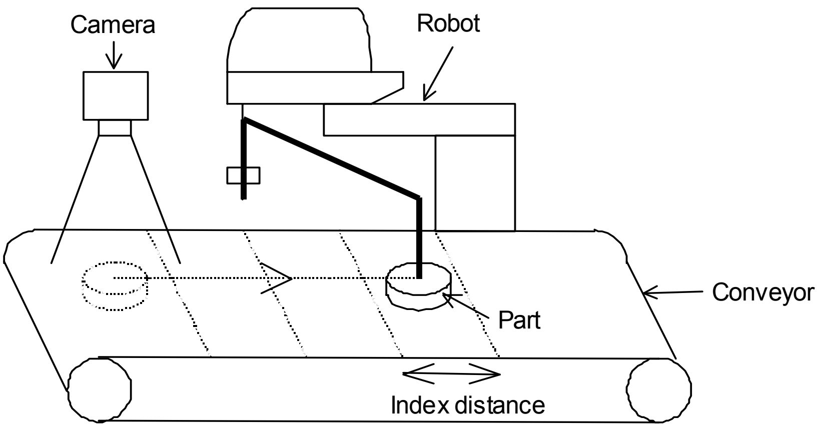


Fig 2.2 Indexed Conveyor System

15.3 Hardware Installation

To use conveyor tracking, you must install encoders for each physical conveyor on the system. Each encoder is wired to a single channel on a PG (Pulse Generator) board. Each board can accommodate up to 4 encoders. A trigger input is also provided for each encoder to latch position, such as when used with a strobed vision camera.

PG board specifications

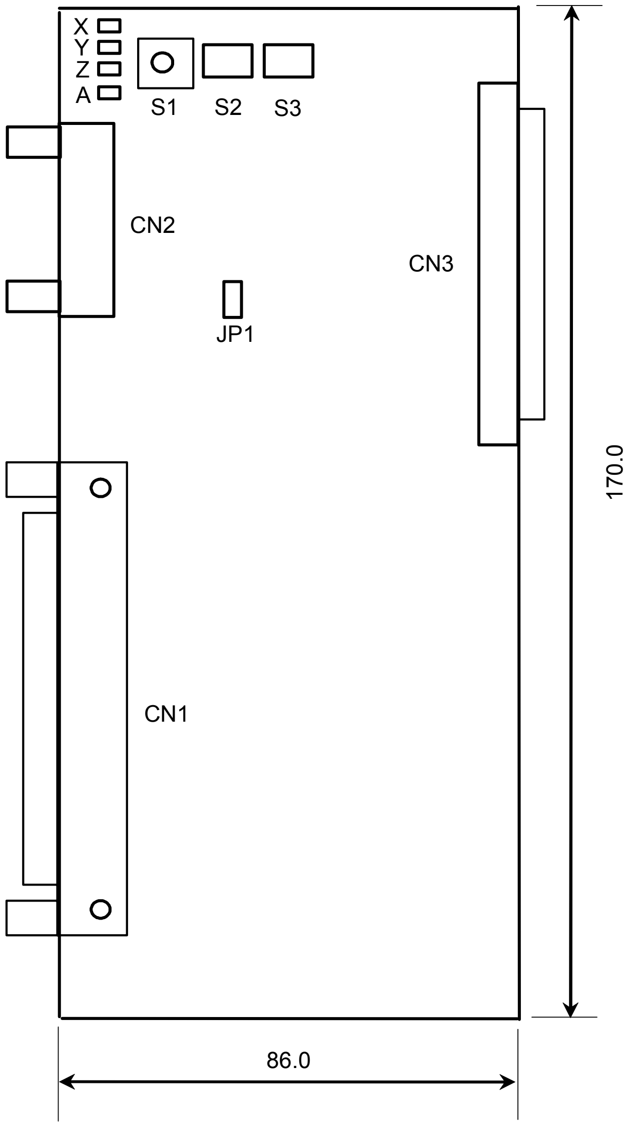
The table below shows the specification for the PG board.

Board Name	H745
Compatible Controller	RC620
Board Extension Capability	4 boards maximum
Encoder channels	4 channels / board
Encoder Type	ABZ phase differential input (RS-422 line receiver)
Input Pulse Rate	Max. 5 MPPS
Input Signal	Conveyor pulse latch input
Board Address	Set the DIP switch according the board number. (See DIP Switch Settings later in this chapter).
connector	DX10A - 100S (Hirose Electric Co.,Ltd.)
Power Supply	24V ±2V 200mA or under

The following encoder models have been tested:

OMRON	E6B2-CWZ1X
TAMAGAWA	TS5312N512-2000C/T

The figure below shows the layout of the PG board.



DIP switch settings

The board address is set by DIP switch (S2, S3) on the PG Board according to the board number, as shown in the following table.

Board #	Address	S2				S3			
		1 (A15)	2 (A14)	3 (A13)	4 (A12)	1 (A11)	2 (A10)	3 (A9)	4 (A8)
1	1000h	OFF	OFF	OFF	ON	OFF	OFF	OFF	ON
2	1100h	OFF	OFF	OFF	ON	OFF	OFF	ON	OFF
3	1200h	OFF	OFF	OFF	ON	OFF	OFF	ON	ON
4	1300h	OFF	OFF	OFF	ON	OFF	ON	OFF	OFF

If you purchased the PG board separately, place the attached Board No. Label sticker on the board panel prior to installation of the board in the Control Unit and keep a written record of the address setting and the board number.

If you have purchased the PG Board with the Control Unit, the board address has been set properly before shipment and further settings should not be necessary.

Jumper settings

The jumpers are reserved and should not be changed.

Rotary switch settings

The rotary switch S1 is reserved and should not be changed.

S1 : Position of 1

Signal Connections

The table below lists the connectors on the PG board and the compatible connectors for wiring:

Receptacle on the Board		DXA10A-100S (manufacturer: Hirose Electric Co.,Ltd.)
Wiring Plug Connectors	Individually pressed-in type	DX30-100P (for AWG#30) DX30A-100P (for AWG#28)
	Pressed-in-as-a-whole type	DX31-100P (for AWG#30) DX31A-100P (for AWG#28)
	Soldered type	DX40-100P
Connector for Wiring to the Cover		DX-100-CV1

Signal Assignments: PG board connector (DX10A-100S)

The signals on the PG board connector are assigned as shown in the table below.

Pin	Dir	Signal	Description	Pin	Dir	Signal	Description
1	-	-	Not used	51	-	-	Not used
2	-	-	Not used	52	-	-	Not used
3	-	-	Not used	53	-	-	Not used
4	-	-	Not used	54	-	-	Not used
5	-	-	Not used	55	-	-	Not used
6	-	-	Not used	56	-	-	Not used
7	-	-	Not used	57	-	-	Not used
8	-	-	Not used	58	-	-	Not used
9	-	-	Not used	59	-	-	Not used
10	In	TRG1	Trigger input for Counter1	60	-	-	Not used
11	In	TRG2	Trigger input for Counter2	61	-	-	Not used
12	In	TRG3	Trigger input for Counter3	62	-	-	Not used
13	In	TRG4	Trigger input for Counter4	63	-	-	Not used
14	In	EXTV	External power supply for Input circuit	64	In	EXTV GND	External power supply GND for Input circuit
15	In	EXTV	External power supply for Input circuit	65	In	EXTV GND	External power supply GND for Input circuit
16	-	-	Not used	66	-	-	Not used
17	-	-	Not used	67	-	-	Not used
18	-	-	Not used	68	-	-	Not used
19	-	-	Not used	69	-	-	Not used
20	-	-	Not used	70	-	-	Not used
21	-	-	Not used	71	-	-	Not used
22	-	-	Not used	72	-	-	Not used
23	-	-	Not used	73	-	-	Not used
24	-	-	Not used	74	-	-	Not used
25	In	+A1	Phase +A signal for Counter 1	75	In	+A3	Phase +A signal for Counter 3
26	In	–A1	Phase –A signal for Counter 1	76	In	–A3	Phase –A signal for Counter 3
27	In	+B1	Phase +B signal for Counter 1	77	In	+B3	Phase +B signal for Counter 3
28	In	–B1	Phase –B signal for Counter 1	78	In	–B3	Phase –B signal for Counter 3
29	In	+Z1	Phase +Z signal for Counter1	79	In	+Z3	Phase +Z signal for Counter 3
30	In	–Z1	Phase –Z signal for Counter 1	80	In	–Z3	Phase –Z signal for Counter 3
31	-	-	Not used	81	-	-	Not used
32	-	-	Not used	82	-	-	Not used
33	-	-	Not used	83	-	-	Not used
34	-	-	Not used	84	-	-	Not used
35	-	-	Not used	85	-	-	Not used
36	-	-	Not used	86	-	-	Not used
37	-	-	Not used	87	-	-	Not used
38	-	-	Not used	88	-	-	Not used
39	-	-	Not used	89	-	-	Not used
40	-	-	Not used	90	-	-	Not used
41	In	+A2	Phase +A signal for Counter 2	91	In	+A4	Phase +A signal for Counter 4
42	In	–A2	Phase –A signal for Counter 2	92	In	–A4	Phase –A signal for Counter 4

Pin	Dir	Signal	Description	Pin	Dir	Signal	Description
43	In	+B2	Phase +B signal for Counter 2	93	In	+B4	Phase +B signal for Counter 4
44	In	−B2	Phase −B signal for Counter 2	94	In	−B4	Phase −B signal for Counter4
45	In	+Z2	Phase +Z signal for Counter 2	95	In	+Z4	Phase +Z signal for Counter 4
46	In	−Z2	Phase −Z signal for Counter 2	96	In	−Z4	Phase −Z signal for Counter 4
47	-	-	Not used	97	-	-	Not used
48	-	-	Not used	98	-	-	Not used
49	-	-	Not used	99	-	-	Not used
50	-	GND	GND	100	-	GND	GND

Pin # 25 ~ 30, 41 ~ 46, 75 ~ 80, 91 ~ 96

Connect the pin numbers shown above with encoder output (+A, −A, +B, −B, +Z, −Z).

Pins # 10 ~ 13

When the conveyor pulse is latched by external signal, connect the pin numbers shown above with latch signal. Exactly when the signal is turned OFF to ON, the encoder pulse is latched.

Pins # 14, 15, 64 and 65

When using the pin # 10 ~ 13, connect external power with the pin numbers shown above.

When not using the pin # 10 ~ 13, it is not necessary to connect external power with the pin numbers shown above.

Signal Assignments: PG board connector terminal block 1

The signals on the PG board connector terminal block #1 are assigned as shown in the table below. The pin numbers in parentheses are the pins on the PG board connector.

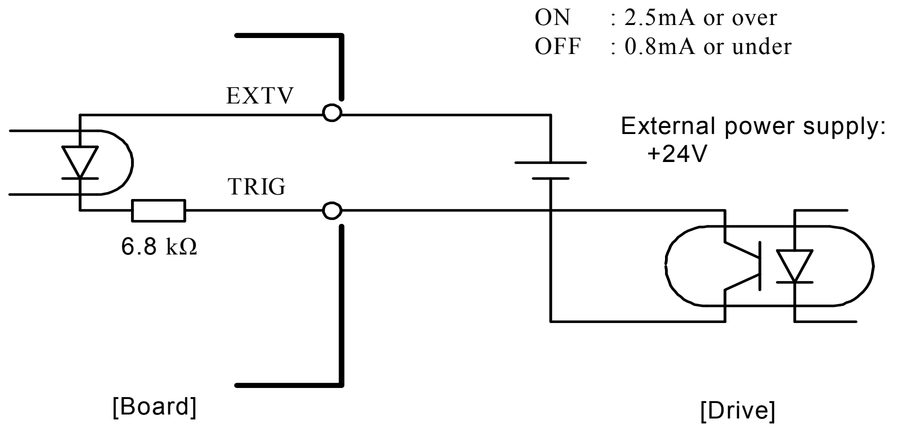
Pin	Signal	Description	Pin	Signal	Description
1 (16)	-	Not used	26 (32)	-	Not used
2 (17)	-	Not used	27 (33)	-	Not used
3 (18)	-	Not used	28 (34)	-	Not used
4 (19)	-	Not used	29 (35)	-	Not used
5 (20)	-	Not used	30 (36)	-	Not used
6 (21)	-	Not used	31 (37)	-	Not used
7 (22)	-	Not used	32 (38)	-	Not used
8 (23)	-	Not used	33 (39)	-	Not used
9 (24)	-	Not used	34 (40)	-	Not used
10 (25)	+A1	Phase +A signal for Counter 1	35 (41)	+A2	Phase +A signal for Counter 2
11 (26)	–A1	Phase –A signal for Counter 1	36 (42)	–A2	Phase –A signal for Counter 2
12 (27)	+B1	Phase +B signal for Counter 1	37 (43)	+B2	Phase +B signal for Counter 2
13 (28)	–B1	Phase –B signal for Counter 1	38 (44)	–B2	Phase –B signal for Counter 2
14 (29)	+Z1	Phase +Z signal for Counter 1	39 (45)	+Z2	Phase +Z signal for Counter 2
15 (30)	–Z1	Phase –Z signal for Counter 1	40 (46)	–Z2	Phase –Z signal for Counter 2
16 (31)	-	Not used	41 (47)	-	Not used
17 (48)	-	Not used	42 (49)	-	Not used
18 (9)	-	Not used	43 (50)	GND	Ground
19 (60)	-	Not used	44 (61)	-	Not used
20 (10)	TRG1	Trigger input for Counter 1	45 (11)	TRG2	Trigger input for Counter 2
21 (1)	-	Not used	46 (5)	-	Not used
22 (2)	-	Not used	47 (6)	-	Not used
23 (3)	-	Not used	48 (7)	-	Not used
24 (4)	-	Not used	49 (8)	-	Not used
25 (14)	EXTV	External power supply	50 (64)	EXTV GND	External power supply ground

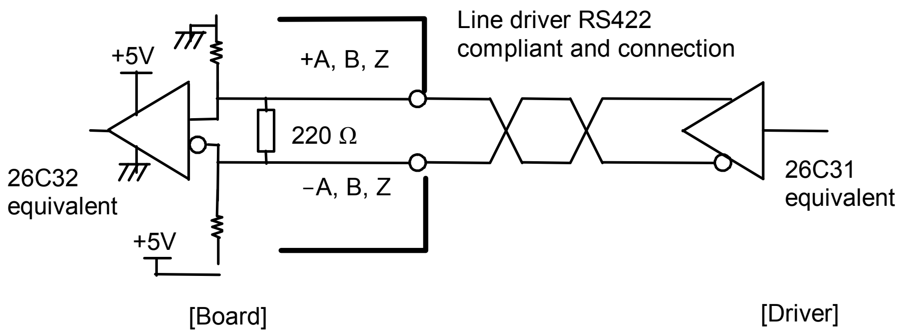
Signal Assignments: PG board connector terminal block 2

The signals on the PG board connector terminal block #2 are assigned as shown in the table below. The pin numbers in parentheses are the pins on the PG board connector.

Pin	Signal	Description	Pin	Signal	Description
1 (66)	-	Not used	26 (82)	-	Not used
2 (67)	-	Not used	27 (83)	-	Not used
3 (68)	-	Not used	28 (84)	-	Not used
4 (69)	-	Not used	29 (85)	-	Not used
5 (70)	-	Not used	30 (86)	-	Not used
6 (71)	-	Not used	31 (87)	-	Not used
7 (72)	-	Not used	32 (88)	-	Not used
8 (73)	-	Not used	33 (89)	-	Not used
9 (74)	-	Not used	34 (90)	-	Not used
10 (75)	+A3	Phase +A signal for Counter 3	35 (91)	+A4	Phase +A signal for Counter 4
11 (76)	−A3	Phase −A signal for Counter 3	36 (92)	−A4	Phase −A signal for Counter 4
12 (77)	+B3	Phase +B signal for Counter 3	37 (93)	+B4	Phase +B signal for Counter 4
13 (78)	−B3	Phase −B signal for Counter 3	38 (94)	−B4	Phase −B signal for Counter 4
14 (79)	+Z3	Phase +Z signal for Counter 3	39 (95)	+Z4	Phase +Z signal for Counter 4
15 (80)	−Z3	Phase −Z signal for Counter 3	40 (96)	−Z4	Phase −Z signal for Counter 4
16 (81)	-	Not used	41 (97)	-	Not used
17 (98)	-	Not used	42 (99)	-	Not used
18 (59)	-	Not used	43 (100)	GND	Ground
19 (62)	-	Not used	44 (63)	-	Not used
20 (12)	TRG3	Trigger input for Counter 3	45 (13)	TRG4	Trigger input for Counter 4
21 (51)	-	Not used	46 (55)	-	Not used
22 (52)	-	Not used	47 (56)	-	Not used
23 (53)	-	Not used	48 (57)	-	Not used
24 (54)	-	Not used	49 (58)	-	Not used
25 (15)	EXTV	External power supply	50 (65)	EXTV GND	External power supply ground

Encoder Input Circuit





15.4 System Structure

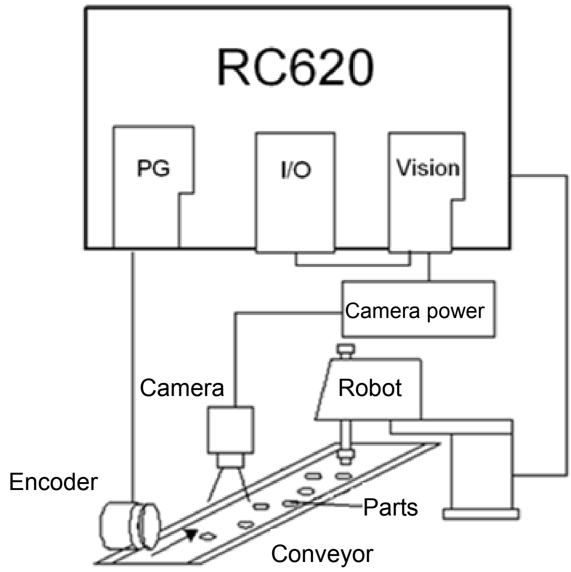
Structure of Vision Conveyor Tracking System

The structure of a vision conveyor tracking system is shown in the figures below.

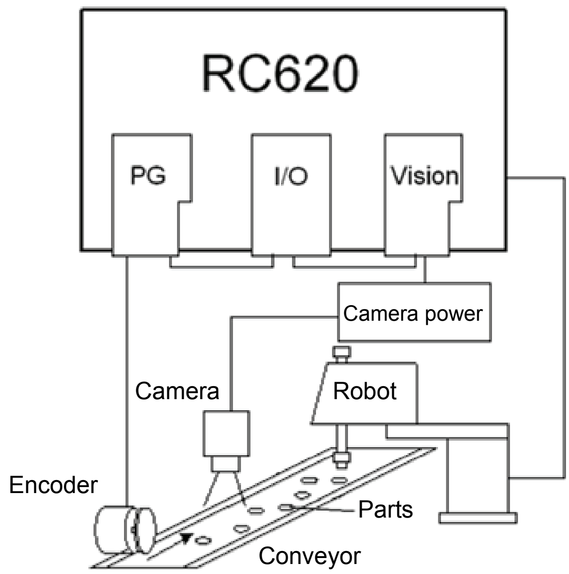
For this system, you need to set the same timing for the vision system to search for parts on the conveyor and for the encoder on the conveyor to latch position. To set the same timing, use the asynchronous reset mode in the vision system (if you don't use asynchronous reset mode, the timing of image acquisition is different from the encoder latch timing and the pickup precision will decrease).

Asynchronous reset mode allows the camera to acquire an image at the moment of trigger input and transfers the image to the vision sequence.

This section inputs the trigger using I/O and shows the wiring example using a frame grabber camera in the vision system.



Vision Conveyor Tracking Overview (using a software trigger)



Vision Conveyor Tracking Overview (using a hardware trigger)

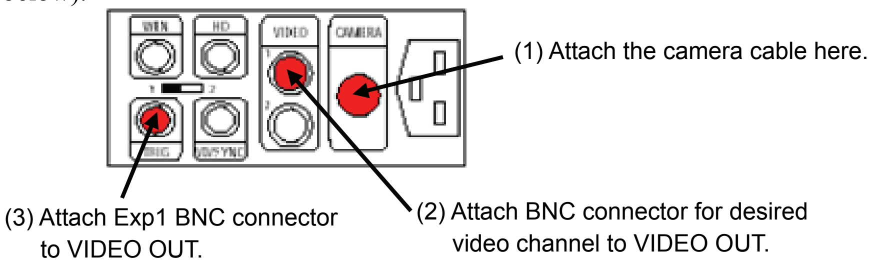
Wiring Example of Vision System

The wiring of the vision system (using a frame grabber camera) is described below.

Vision System Wiring

(Example: Sony XC-HR50)

(1) Attach one end of the camera 1 cable to the camera to be used as camera 1 and the other end of the cable to the front of the Camera Power Junction box (see the figure below).

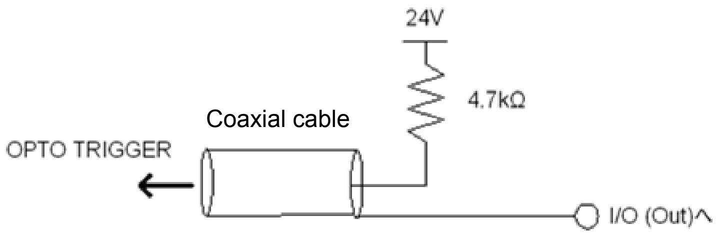


DC-700 Camera Power Junction Box (Rear View)

(2) Pick up the BNC to D-Sub cable that is now attached to the frame grabber. Locate the cable to the Camera Power Junction box. Attach the Video 1 BNC connector cable to the VIDEO OUT BNC female connector on the Camera Power Junction box.

(3) Attach the Exp 1 BNC connector cable to the TRIG connector on the Camera Power Junction box.

(4) Connect the OPTO TRIGGER BNC connector cable and the coaxial cable as shown below.



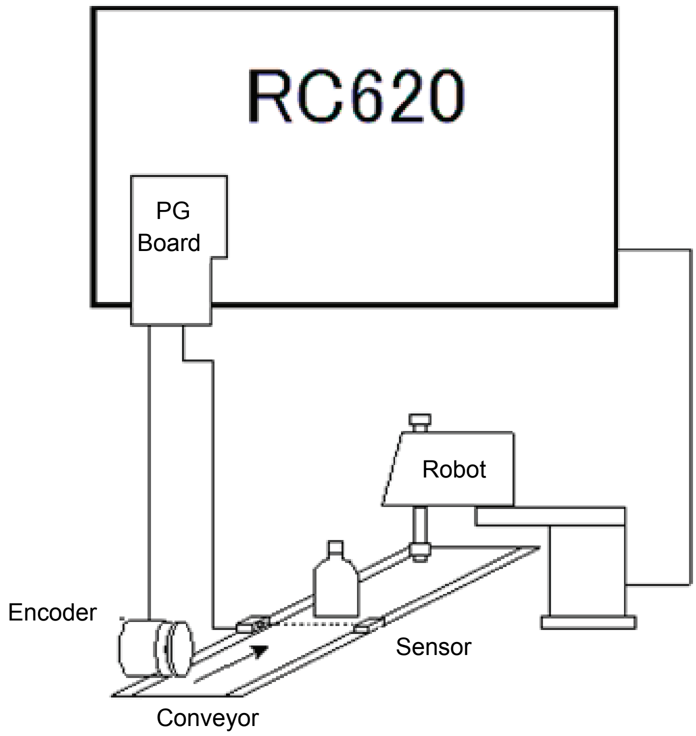
(5) Refer to the option manual, *Vision Guide 6.0 - Appendix A: Camera Interfaces* and set the camera external setting to asynchronous reset mode.

NOTE

When you use the other cameras such as Smart Camera, refer to *Vision Guide 6.0 - 2. Installation* and *Appendix A: Camera Interface* to attach the cables.

Structure of Sensor Conveyor Tracking System

The structure of Sensor Conveyor Tracking System is shown in the figure below. This system uses a hardware trigger. The hardware trigger signals the counter trigger input on the PG board and latches the encoder on the conveyor using the signals from the sensor or I/O.



Sensor Conveyor Tracking Overview

Wiring of PG Board

The following describes the procedures to connect the encoder to the Axis #1 and to use the hardware trigger.

(1) Encoder wiring
Connect the encoder output +A, −A, +B, −B, +Z, −Z to pins 25 to 30.

(2) Hardware trigger wiring
Connect pin 14 and I/O (Out). For sensor conveyor tracking, connect pin 14 to the sensor trigger.
Connect the 24V external power supply to the pin 14 and 64 .

NOTE

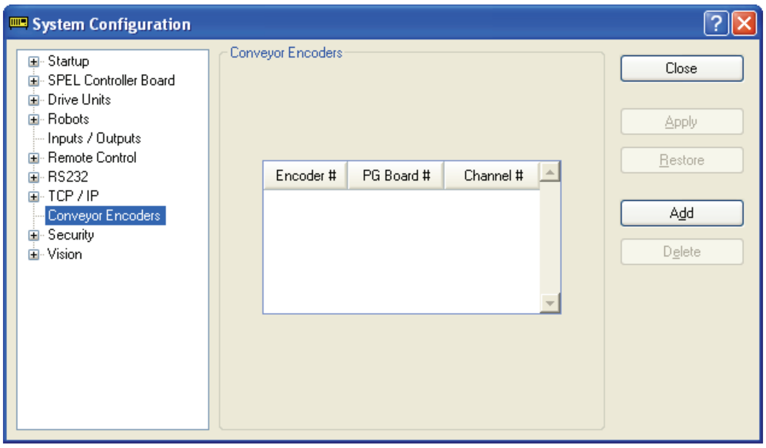
- The pin number indicates the number on the PG board connector.
- The hardware trigger latches the encoder pulse when the signal turns from OFF to ON.
- When you use vision conveyor tracking, the software trigger is available in stead of the hardware trigger.
  When you use a software trigger, you need only the encoder wiring with the PG board and use the Cnv_Trigger command in the SPEL+ program. For the command usage, refer to the sample program.
- The software trigger uses the Cnv_Trigger command and latches the encoder on the conveyor.

15.5 Conveyor Encoder Configuration

Before you can create any conveyors in a project, you must first add conveyor encoders to the system. Each physical conveyor must have an encoder.

First, you must install one PG board for every four encoders in the PC Control Unit and wire the encoders to the board(s). Please refer to the Hardware Installation section of this chapter for details.

To define system encoders in EPSON RC+, select Setup | System Configuration and select the **Conveyor Encoders**.



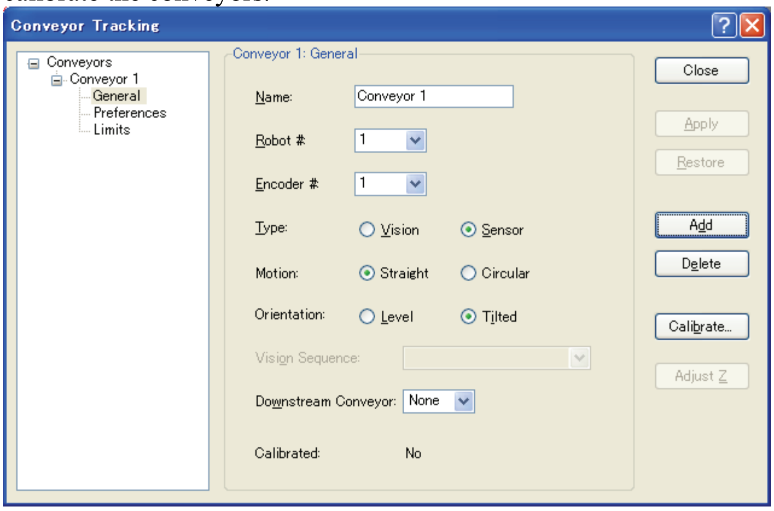
Click the **Add** button to add an encoder. Encoders are added in the order of Axis number.

You can delete the last encoder in the list. Select it, then click the **Delete** button.

15.6 Verifying New Encoder Operation

After wiring one or more new encoders and adding them to RC+ (as described in the previous section), follow these steps to verify operation.

1. Start RC+.
2. Create a new project called “TestCnv”.
3. Create a conveyor by reference to the previous section.
   Conveyor 1: Encoder
   Type : Sensor
   Make sure to perform the calibration, otherwise the conveyor tracking system cannot work properly. When you only check the encoder operation, it is not necessary to calibrate the conveyors.



4. Now you can use the Cnv_Pulse function to read pulses from Encoder 1 from a program or from the monitor window.

For example, execute this print statement from the monitor window to read the pulses from encoder 1. Then move the conveyor and execute the command again.

```
>print cnv_pulse(1)
```

You can also use a simple program as shown below. Start the program and move the conveyor. When the conveyor starts moving, the value of Cnv_Pulse will be changed.

```
Function main
  Do
    Print Cnv_Pulse(1)
    Wait .5
  Loop
Fend
```

15.7 Conveyor Tracking Commands

All Conveyor Tracking commands begin with the same prefix: "Cnv_". Here is a list of all of the commands. For details, please see the *EPSON RC+ Online Help* or *SPEL+ Language Reference manual*.

Command	Description / Usage
Cnv_AbortTrack	Aborts a motion command to a conveyor queue point.
Cnv_DownStream	Returns the downstream limit for the specified conveyor.
Cnv_Fine Function	Returns the setting of the range to judge if the tracking motion is completed or not for the specified conveyor.
Cnv_Fine	Sets / returns the value of Cnv_Fine for one conveyor.
Cnv_LPulse Function	Returns the pulse latched by a conveyor trigger.
Cnv_Name$ Function	Returns the name of the specified conveyor.
Cnv_Number Function	Returns the number of a conveyor specified by name.
Cnv_OffsetAngle	Sets the angle offset. Usage: This command is available only for the circular conveyor.
Cnv_OffsetAngle Function	Returns the offset anglet.
Cnv_Point Function	Returns a robot point in the specified conveyor's coordinate system derived from sensor coordinates. Usage: Use this function when registering a point in the queue.
Cnv_PosErr Function	Returns deviation in current tracking position compared to tracking target.
Cnv_Pulse Function	Returns the current position of a conveyor in pulses.
Cnv_QueAdd	Adds a robot point to a conveyor queue. Usage: Use this command to register a point in the queue.
Cnv_QueGet Function	Returns a point from the specified conveyor's queue. Usage: Use this command for robot tracking motion.
Cnv_QueLen Function	Returns the number of items in the specified conveyor's queue. Usage: Use this command to keep the robot waiting until the part (queue) enters the tracking area.
Cnv_QueList	Displays a list of items in the specified conveyor's queue.
Cnv_QueMove	Moves data from upstream conveyor queue to downstream conveyor queue. Usage: Use this command for the multi conveyor system.
Cnv_QueReject	Sets / displays the minimum distance to prevent the double conveyors register.
Cnv_QueReject Function	Sets / returns and displays the queue reject distance for a conveyor.
Cnv_QueRemove	Removes items from a conveyor queue.
Cnv_QueUserData Function	Sets / returns and displays user data associated with a queue entry.
Cnv_RobotConveyor Function	Returns the conveyor being tracked by a robot.
Cnv_Speed Function	Returns the current speed of a conveyor.
Cnv_Trigger	Latches current conveyor position for the next Cnv_QueAdd statement. Usage: Use this command when using the software trigger.
Cnv_Upstream	Returns the upstream limit for the specified conveyor.

Cnv_Mode	Sets the tracing mode.
Cnv_Mode Function	Returns the tracking mode

NOTE

To track a part as the conveyor moves, you must use Cnv_QueGet in a motion command statement. For example:

```
Jump Cnv_QueGet(1) ' this tracks the part
```

You cannot assign the result from Cnv_QueGet to a point and then track it by moving to the point.

```
P1 = Cnv_QueGet(1)
Jump P1  ' this does not track the part!
```

When you assign the result from Cnv_QueGet to a point, the coordinate values correspond to the position of the part when the point assignment was executed.

15.8 Key Terms

Here explains key terms used in this section.

Queue
Waiting queue of the FIFO (First-In, First-Out) type for each conveyor.

With the queue, you can register the pose data of work pieces running on the conveyor and user data. When you add data, it will be registered to the end of the queue. When you delete data from the queue, the remaining data in the queue will be moved up automatically.

Queue depth
The number of data entries registered in a queue.
Maximum number of queue data is 1000.

Queue user data
Optional real value that can be registered in a queue.

You can store additional information such as sorted data or part type determined by the image processing.

Downstream Conveyor
Use this when using multiple conveyors and you run them continuously. By making an association (upstream/downstream) between conveyors, you can move a queue using the Cnv_QueMove command. “Multiple conveyors” is not necessarily more than one conveyor. You can use one long physical conveyor and set upstream side and downstream side as different logical conveyors. This enables the robots cooperative work, for instance, robot at the downstream side can pick up the work pieces that the robot at upstream fails to pick in time.

Upstream Limit
Dividing line in the upstream side of the Pickup Area.

Downstream Limit
Dividing line in the downstream side of the Pickup Area.

Pickup Area
The area between the upstream limit and downstream limit.

The robot picks parts which flow in the Pickup Area.
The robot starting pickup near the downstream limit continues its operation over the downstream limit.
Make sure that the Pickup Area covers the whole robot motion range.

For details, refer to *15.15 Pickup Area*.

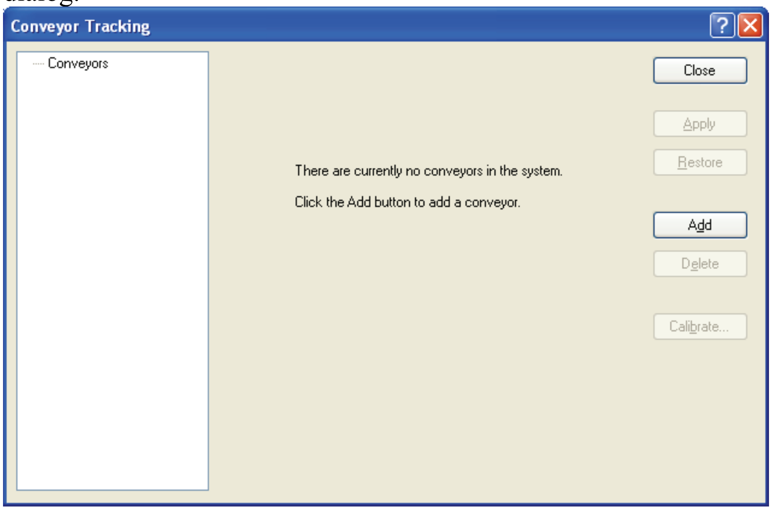
15.9 Creating Conveyors in a Project

Conveyors are configured for each EPSON RC+ project. Up to 16 conveyors can be created per project. A conveyor is a logical entity that combines a robot with one or more conveyors.

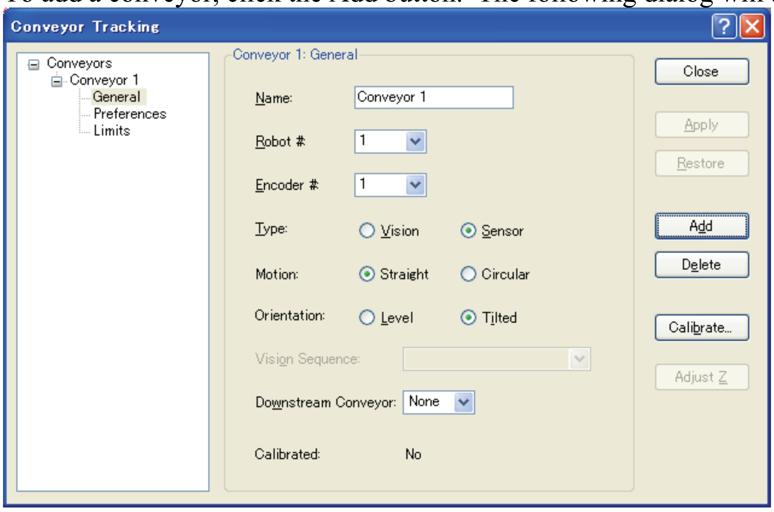
There are two types of conveyors: vision and sensor. If you will be using a vision camera to find the parts on the conveyor, you must first create a vision sequence to find the parts. This vision sequence is required when you define the conveyor.

To add a conveyor to a project

1. Select Tools | Conveyor Tracking to open the Conveyor Tracking configuration dialog.



2. To add a conveyor, click the Add button. The following dialog will appear.



3. Enter a name for the conveyor, then specify the Robot #, Encoder #, Type, Motion, and Orientation.

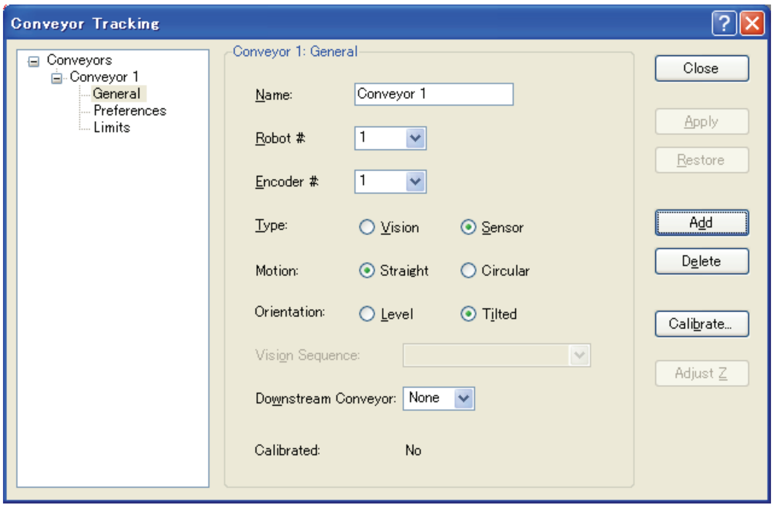
NOTE

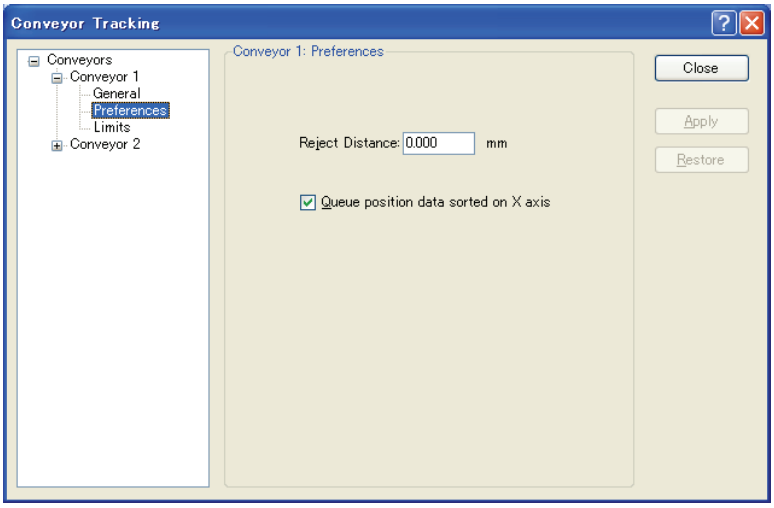
- A default conveyor name is created automatically when a new conveyor is added.
  You can change the name as desired.
- When you use a straight conveyor, select “Straight” for [Motion].
- When you use a circular conveyor, select “Circular” for [Motion].

15.10 Configuring Conveyors

After a conveyor has been created, you can change its parameters.

1. Select Tools | Conveyor Tracking.
2. Click on the conveyor you want to change.
3. There are three setup pages shown in the tree under each conveyor: **General, Preferences**, and **Limits**.
   To change the parameters for the upstream and downstream limits, click on [Limits].
   For details on the **Limits** settings, refer to *15.15 Pickup Area - Changing the Upstream / Downstream limits positions*.
   To change the settings of Reject Distance and queue position data sort, click on **Preferences**.
   To change other parameters, click on **General**.
4. Click on **General** or **Preferences**.
   The following dialog appears. Edit any of the configuration options.





5. Click **Apply** to save changes.

NOTE

If you changed Robot #, Encoder #, Orientation, Type, or Vision Sequence, then you need to calibrate the conveyor again.

The following table explains the parameters you can edit in the **General** and **Preferences** pages.

Name	You can name conveyors.
Robot #	You can select a robot number from the robots currently configured in the controller..
Encoder #	You can select an encoder number from the encoders currently configured in the controller.
Type	Vision: Detects work pieces using vision search. Sensor: Detects work pieces using a sensor.
Motion	You can select the conveyor motion; Straight conveyor or Circular conveyor.
Orientation	When you selected Straight conveyor, you can specify if the conveyor is level or tilted. <Tilted> is selected by default and normally you don't have to change it. Tilted: Conveyor slope is detected during the calibration. Level: Conveyor slope is not detected during the calibration. You need to observe the following: The conveyor must be level with the robot X and Y planes.
Vision Sequence	Select a vision sequence for the calibration. This is only necessary when using the vision type.
Downstream Conveyor	When two or more conveyors have been set, you can select a conveyor number for the downstream conveyor.
Calibrate…	Click this button to execute the calibration. The calibration procedure is different for each type and conveyor orientation.
Adjust Z	After the calibration is completed, you can calibrate the Z coordinate value of the conveyor again.
Reject Distance	You can set a minimum distance to prevent the registration of duplicate conveyors. ・The distance also can be set from the SPEL program using the Cnv_QueReject command. ・If the distance is different from the one set by Cnv_QueReject command, the Cnv_QueReject command setting has precedence.
Queue position data sorted on X axis	You can select whether to sort the queue or not.

15.11 Vision Conveyors

A vision conveyor uses a camera to locate parts that will be retrieved by one or more robots. In this section, instructions are provided for vision conveyor calibration and programming.

The straight conveyor and circular conveyor have different calibration and programming methods.

Vision conveyor camera and lighting

It is important to choose the correct camera and lighting for the vision conveyors used in your application.

For applications with a slow moving conveyor and non-critical pick up constraints, you may be able to use a Vision Guide camera and simple lighting with no strobe.

For applications with fast moving parts, you will need to use a camera that is capable of asynchronous reset along with a strobe lamp. This method is more expensive.

If you are using multiple asynchronous reset cameras in multiple tasks, you must use SyncLock to lock the vision system during VRun and waiting until the picture is acquired.

For example:

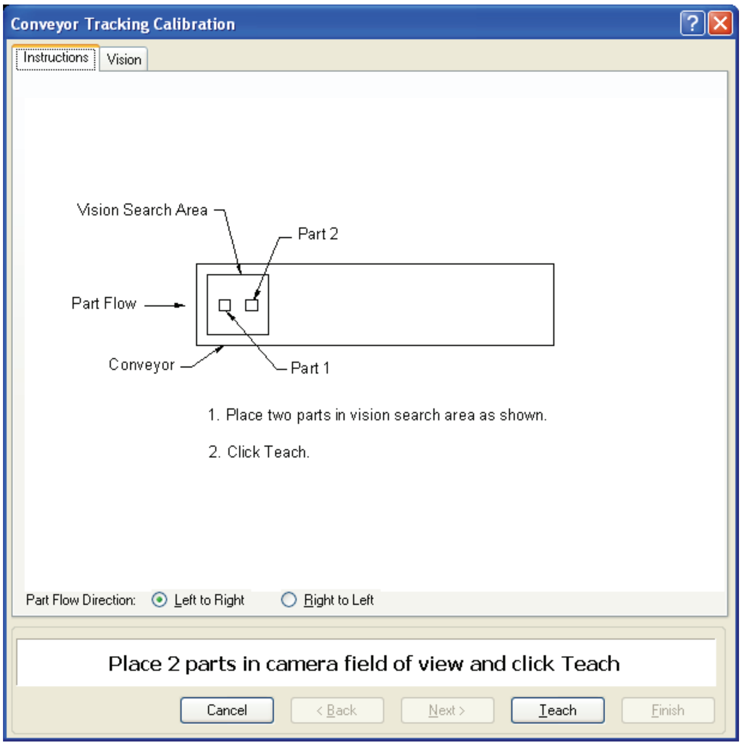
```
SyncLock 1     ' Lock vision for this task
VRun FindPart
On strobe, .2
Do
  VGet FindPart.AcquireState, state
Loop Until state = 3
SyncUnlock 1 '  Unlock vision
```

Vision calibration sequence

Before you can calibrate a vision conveyor, you must first create a calibration sequence. This sequence is used by the system during the calibration process and must be linked to a camera calibration. The conveyor system commands use camera coordinates in millimeters. Although you can use any type of Vision Guide camera calibration, you only need to use a Standalone calibration.

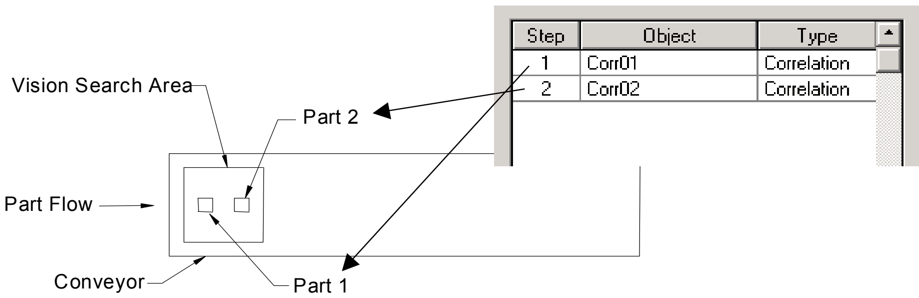
The calibration sequence needs a sequence that uses one object for each work piece.

Place two work pieces on the conveyor as shown below.



The two parts can be anywhere in the field of view. However, the first object of a sequence must be taught with the robot as Part 1. The second object of a sequence must be taught with the robot as Part 2.

Also, the two parts can be anywhere in the field of view. However, to make it as easy as possible for operators to calibrate the conveyor, the parts that will be found in the vision sequence should be located such that part 2 is after part 1 in the direction of part flow. In the figure below, object 1 in the vision sequence is Corr01, which locates Part 1. Object 2 is Corr02, which locates Part 2.



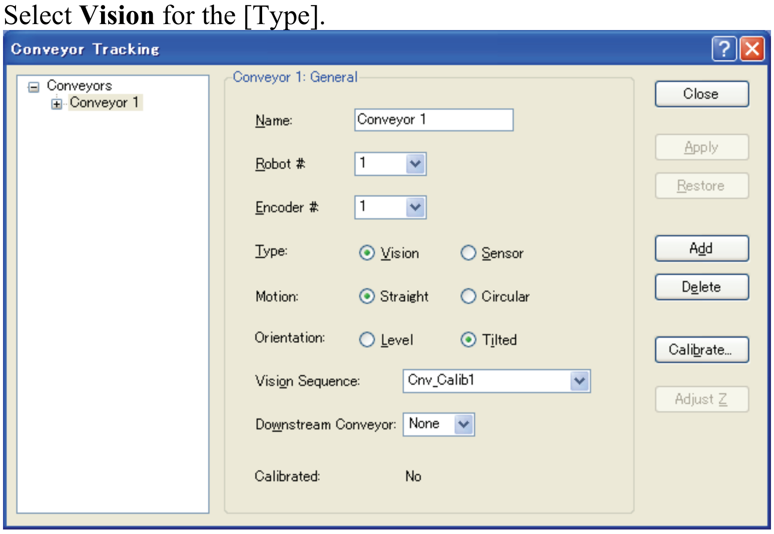
Vision conveyor calibration (Straight conveyor)

Follow these steps to calibrate a straight vision conveyor:

NOTE

- When teaching part positions with the robot during calibration, it is important to position X, Y, and Z of each point accurately. The conveyor is calibrated in X, Y, Z, U, V, and W.
- To perform the fine calibration, in the step 15 and 17, set as wide distance as possible between the upstream limit and downstream limit. After the calibration, adjust the Pickup Area by resetting the upstream / downstream limits.
- For the level orientation, it determines the conveyor height with the position of robot end effector taught in the step 12. It cannot be used for the tilted conveyor for it does not detect the conveyor slope. The steps 19 to 20 are not displayed.
- For the tilted orientation, it calibrates the conveyor slope with the position of robot end effector taught in the steps 12, 14, 16, 18, and 20.

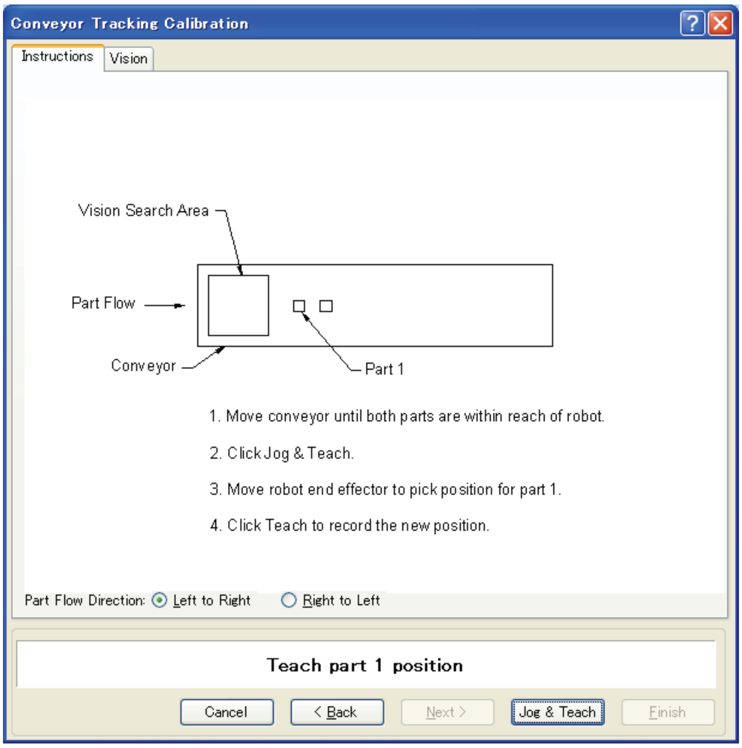
1. Select Tools | Conveyor Tracking.
2. Select the conveyor you want to calibrate.
3. Select **Vision** for the [Type].



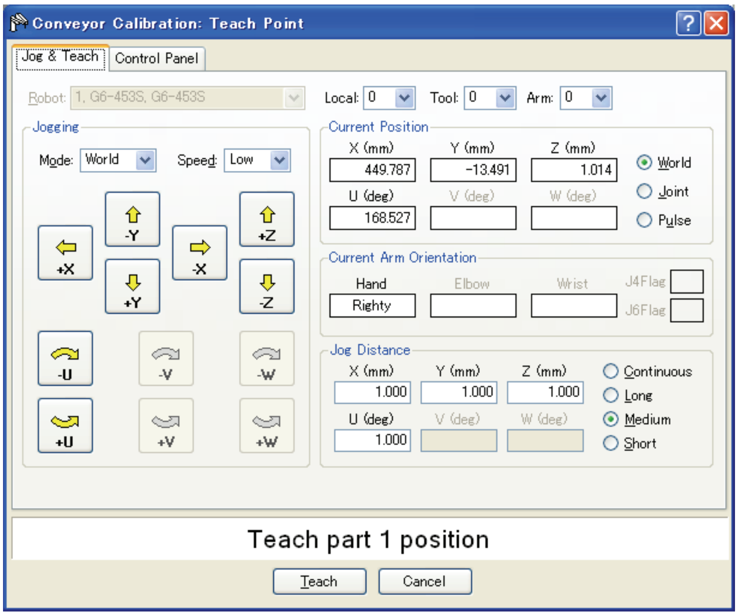
4. Set the [Vision Sequence].
5. Click the **Apply** button.
6. Click the **Calibrate** button. The Conveyor Tracking Calibration wizard will appear. Follow the instructions for each step. Before you can proceed to the next step, you must click the **Teach** button. You can go back to previous steps using the **Back** button.
7. Select the Part Flow Direction to best match the conveyor you are calibrating. The instruction pictures will change according to the setting. Part Flow Direction is only used to aid in the instructions. It has no affect on the calibration.
8. Place two parts on the conveyor as shown in the figure in the wizard.
9. Select the Vision tab to see live video. The camera orientation may not be the same as the picture.

10. Arrange the parts to be inside the range correctly and click **Teach** button. Use the camera video to ensure that the parts are within the correct search area for each. Click the **Teach** button. If the Vision tab is selected when you click **Teach**, you will see the vision sequence graphical results displayed. In this case, the wizard will not advance to the next step and you must click the **Next** button to view the next step. This allows you to click **Teach** more than one time in case you want to adjust the parts.

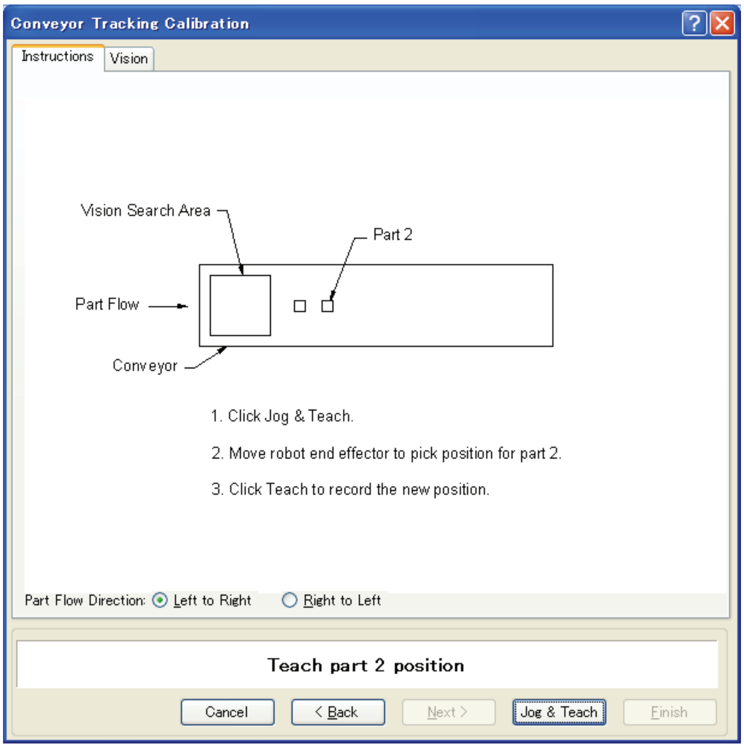
11. Move the conveyor by hand until both parts are within reach of the robot. Do not move the parts, only the conveyor. Click the **Jog & Teach** button.



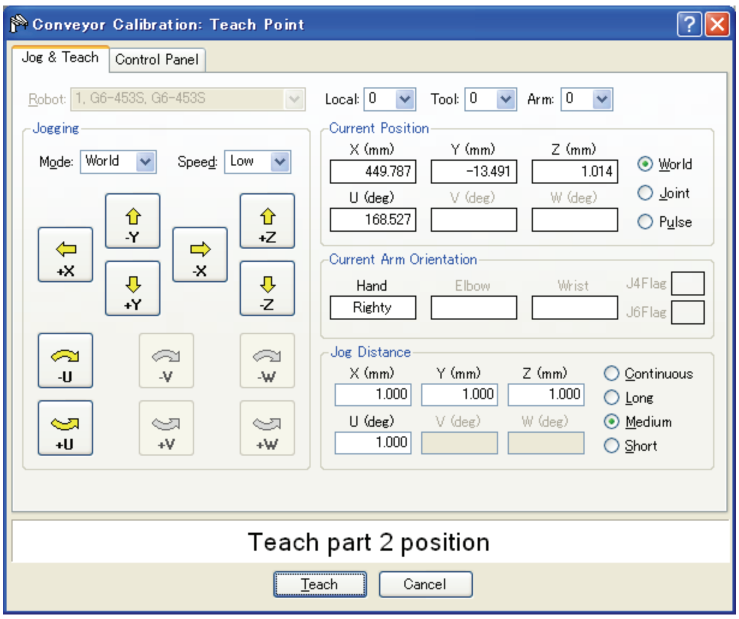
12. The Jog & Teach dialog will appear. Click the jog buttons to move the robot end effector to the pick position for Part 1. Click the **Teach** button.



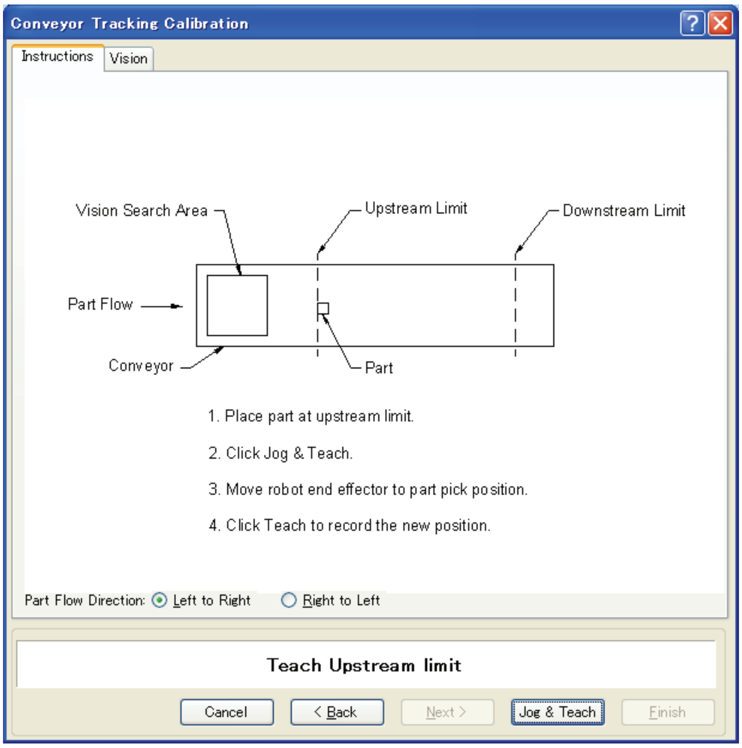
13. Click the **Jog & Teach** button.



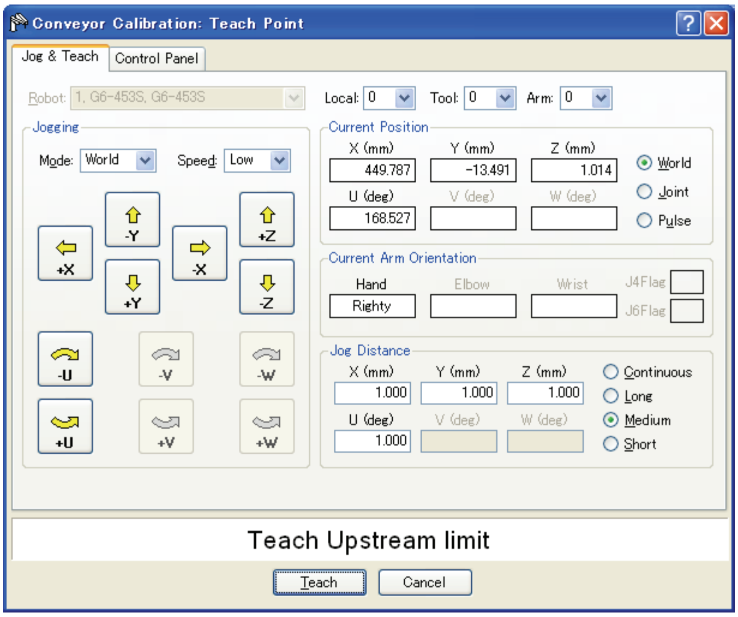
14. The Jog & Teach dialog will appear. Click the jog buttons to move the robot end effector to the pick position for Part 2. Click the **Teach** button.



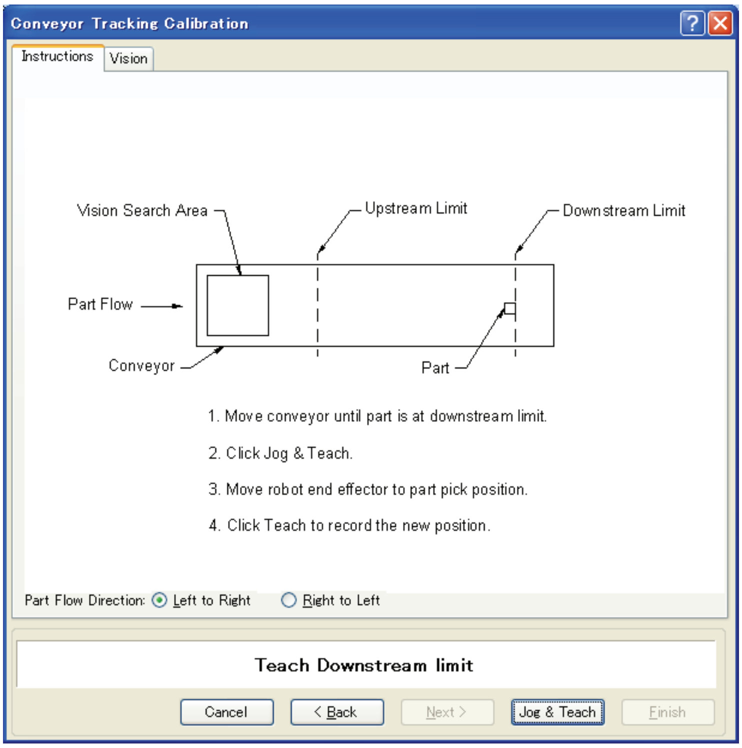
15. Now move or place the part at the upstream limit. Click the **Jog & Teach** button.



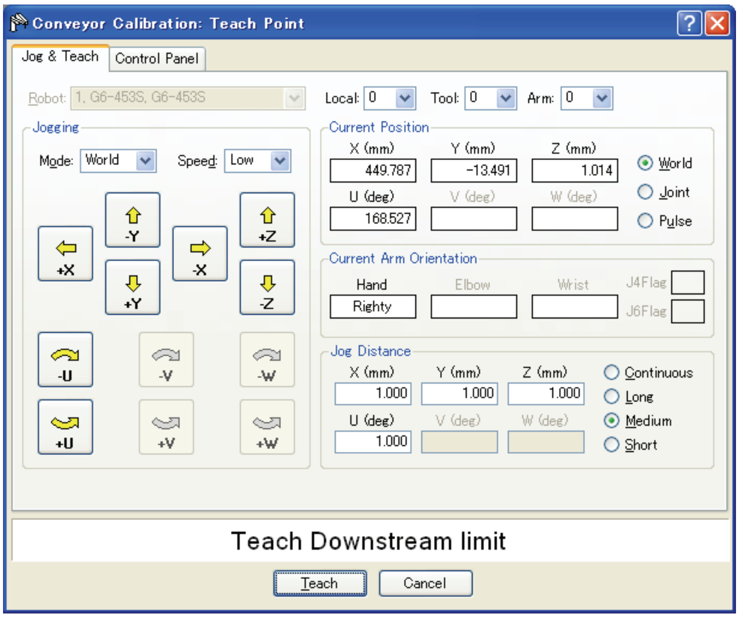
16. The Jog & Teach dialog will appear. Click the jog buttons to move the robot end effector to the pick position. Click the **Teach** button.



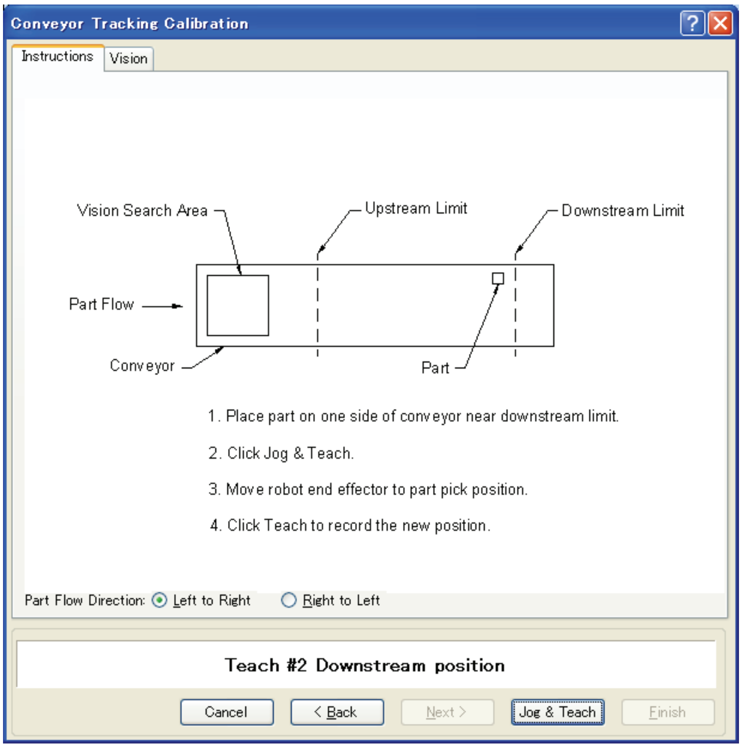
17. Move the conveyor so the part is at the downstream limit. Do not move the part, only the conveyor. Click the **Jog & Teach** button.



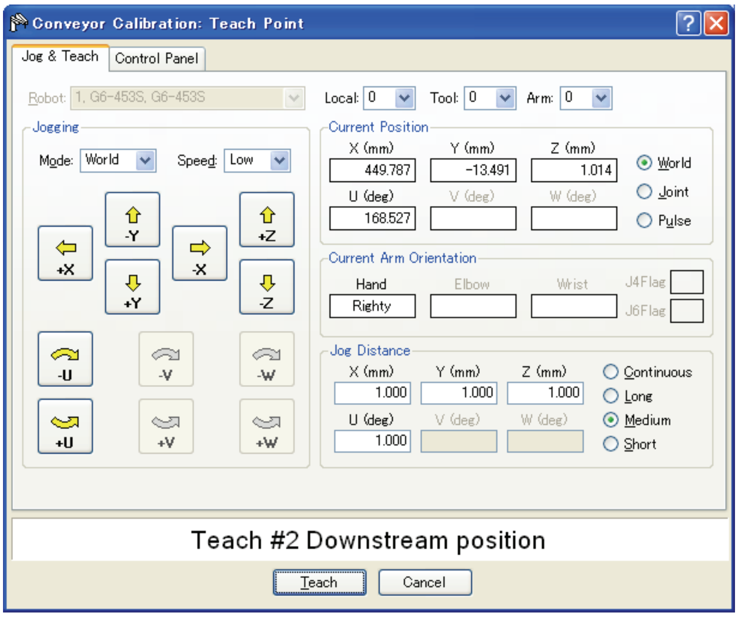
18. The Jog & Teach dialog will appear. Click the jog buttons to move the robot end effector towards the part. Click the **Teach** button.



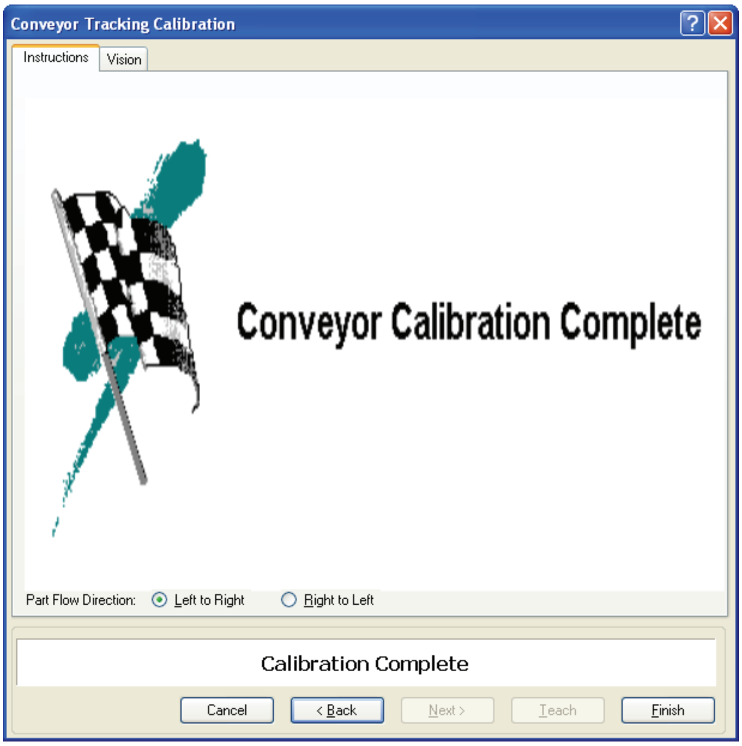
19. Place a part on one side of the conveyor near the downstream limit. This point is used to determine the tilt of the conveyor from side to side. Click the **Jog & Teach** button.



20. The Jog & Teach dialog will appear. Click the jog buttons to move the robot end effector to the part position. Click the **Teach** button.



21. The calibration complete picture will be displayed. Click the Finish button.



Vision conveyor calibration (Circular conveyor)

Follow these steps to calibrate a circular vision conveyor:

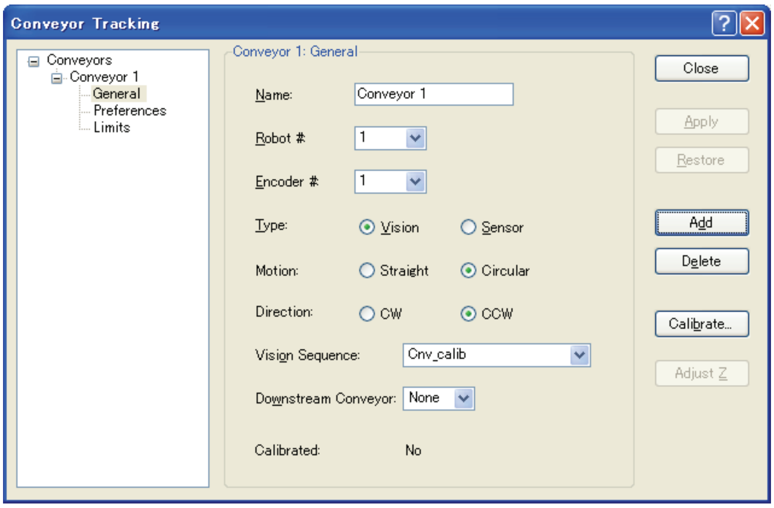
NOTE

- When teaching part positions with the robot during calibration, it is important to position X, Y, and Z of each point accurately. The conveyor is calibrated in X, Y, Z, U, V, and W.
- To perform the fine calibration, in steps 13, 17, and 19, teach the position when the robot is directly above the parts 1 and set as wide a distance as possible between the points to be taught.

1. Select Tools | Conveyor Tracking.
2. Select the conveyor you want to calibrate.
3. Select **Vision** for the [Type].
4. Select **Circular** for the [Motion].
5. Select the conveyor rotating direction for the [Direction].

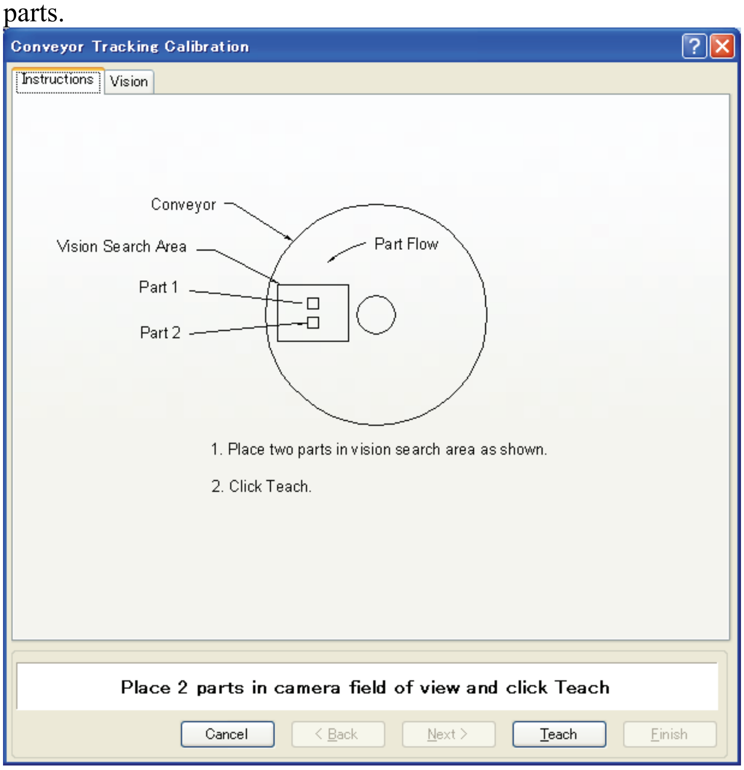
NOTE

Be careful not to calibrate with a wrong direction, otherwise, the robot will not track the parts.

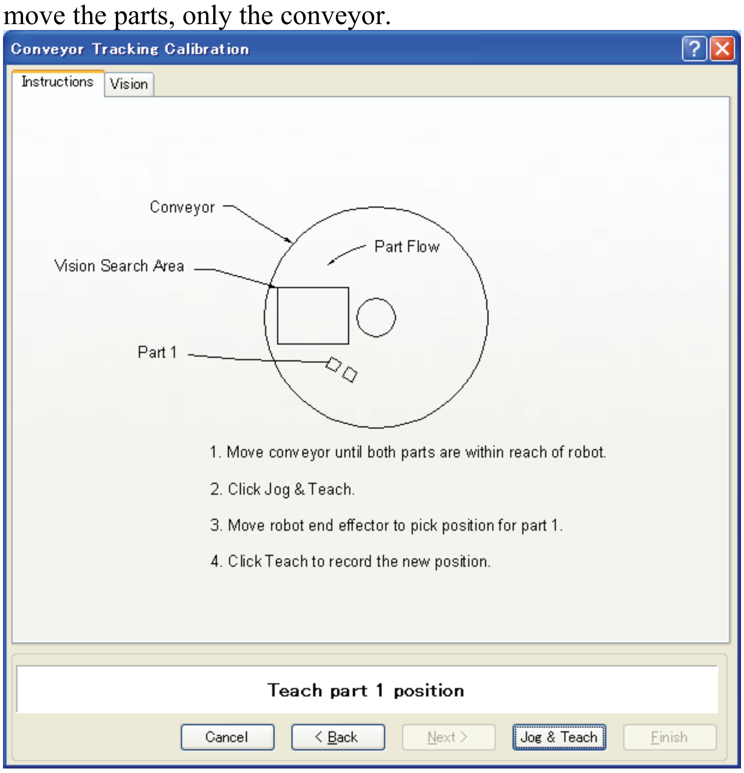


6. Select the [Vision Sequence].
7. Click the **Apply** button.
8. Click the **Calibrate** button. The Conveyor Tracking Calibration wizard will appear. Follow the instructions for each step. Before you can proceed to the next step, you must click the **Teach** button. You can go back to previous steps using the **Back** button.
9. Check if the conveyor direction shown in the wizard is the same as the conveyor you want to use.
10. Place two parts on the conveyor as shown in the figure in the wizard.
11. Select the Vision tab to see live video. The camera orientation may not be the same as the picture.

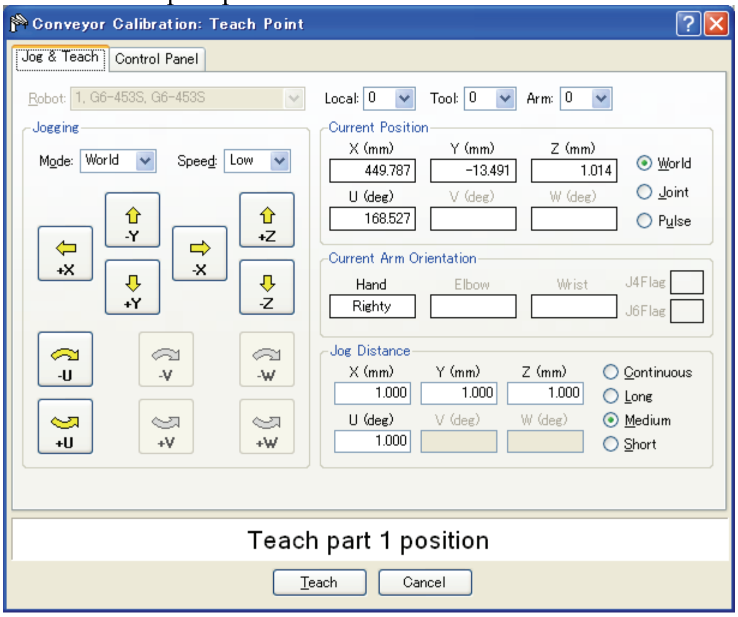
12. Arrange the parts to be inside the range correctly and click the **Teach** button. If the Vision tab is selected when you click **Teach**, you will see the vision sequence graphical results displayed. In this case, the wizard will not advance to the next step and you must click the **Next** button to view the next step. This allows you to click **Teach** more than one time in case you want to adjust the parts.



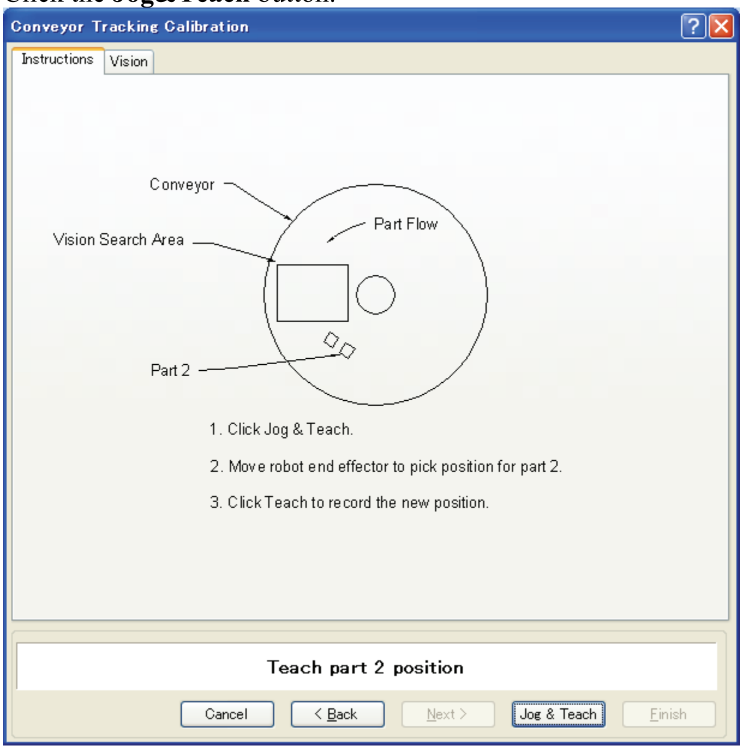
13. Move the conveyor by hand until both parts are within reach of the robot. Do not move the parts, only the conveyor.



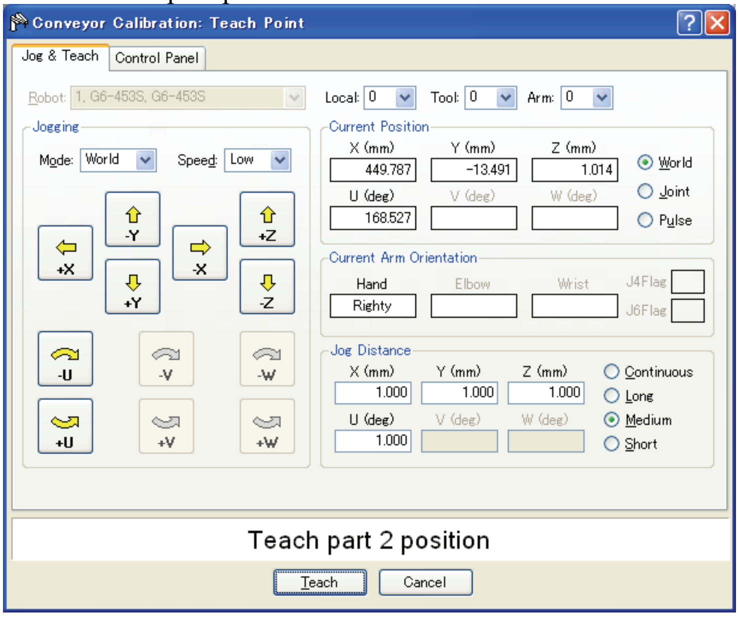
14. The Jog & Teach dialog will appear. Click the jog buttons to move the robot end effector to the pick position for Part 1. Click the **Teach** button.



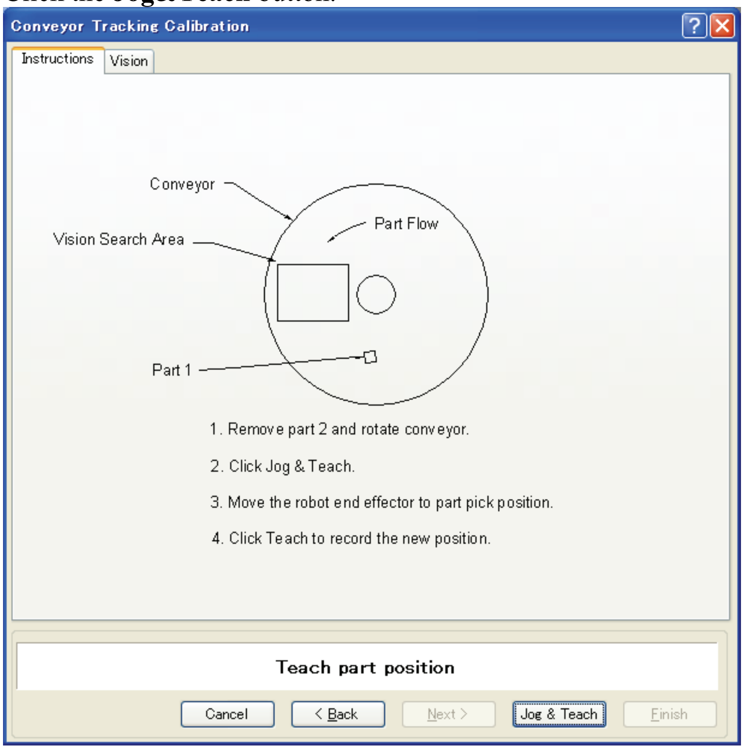
15. Click the **Jog&Teach** button.



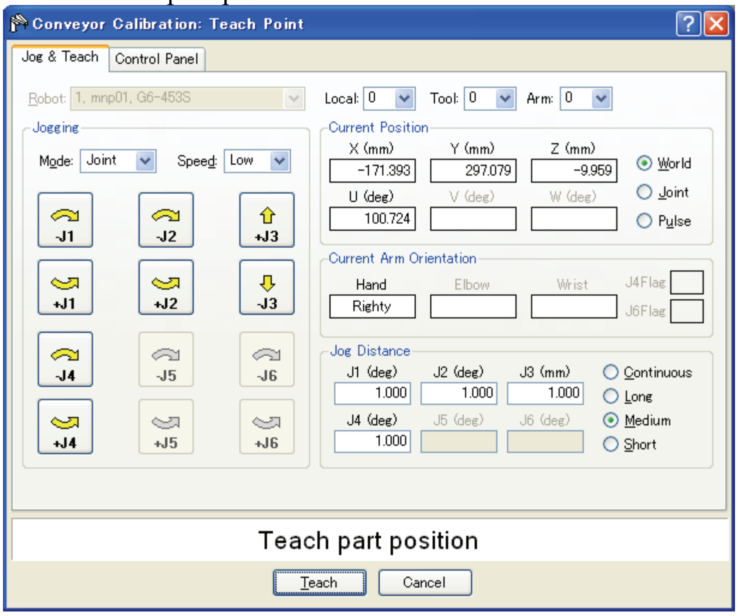
16. The Jog & Teach dialog will appear. Click the jog buttons to move the robot end effector to the pick position for Part 2. Click the **Teach** button.



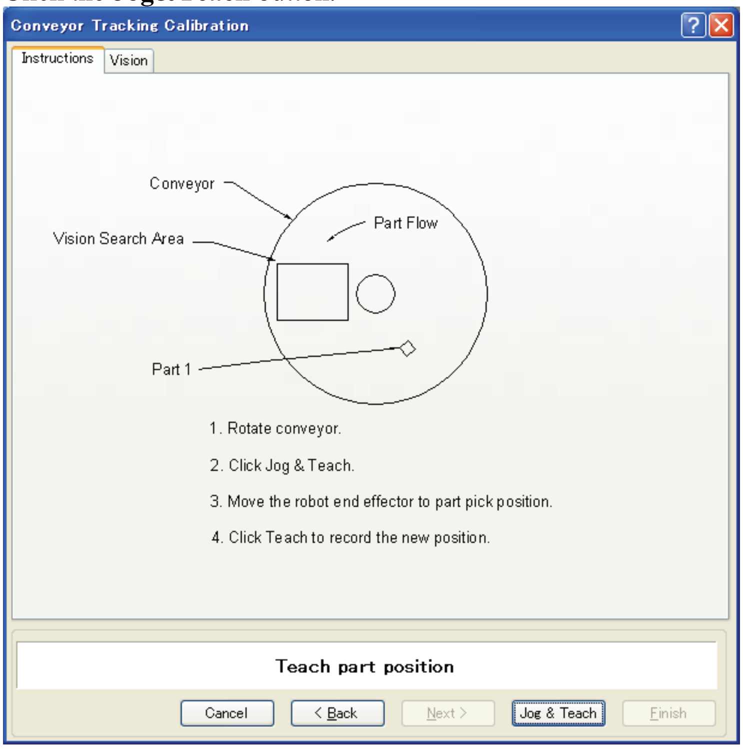
17. Remove Part 2. Move the conveyor by hand to move Part 1. Click the **Jog&Teach** button.



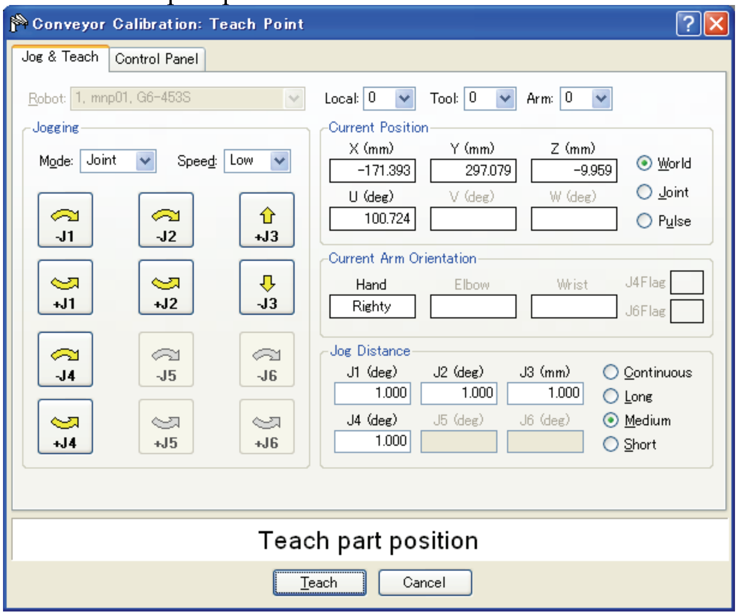
18. The Jog & Teach dialog will appear. Click the jog buttons to move the robot end effector to the pick position. Click the **Teach** button.



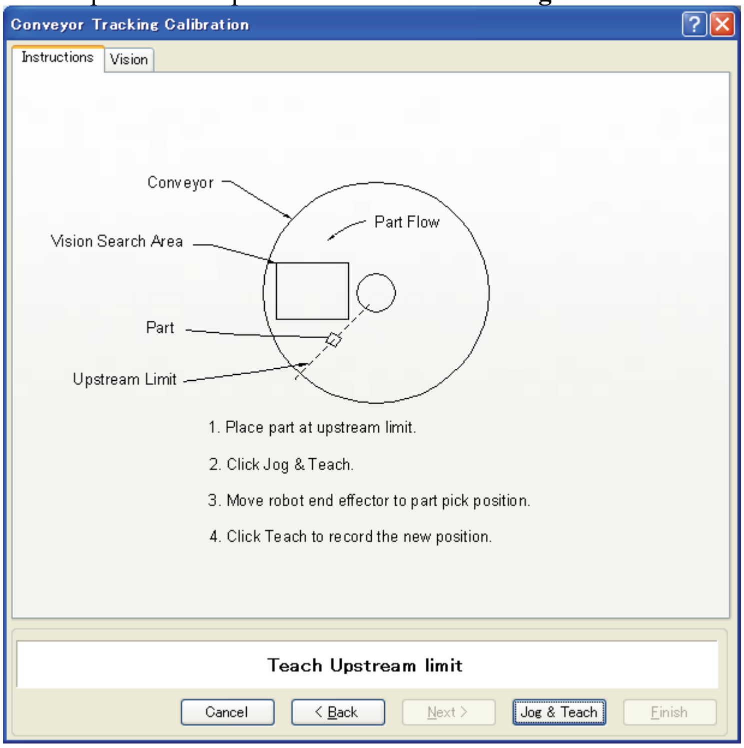
19. Move the conveyor by hand to move Part 1.
Click the **Jog&Teach** button.



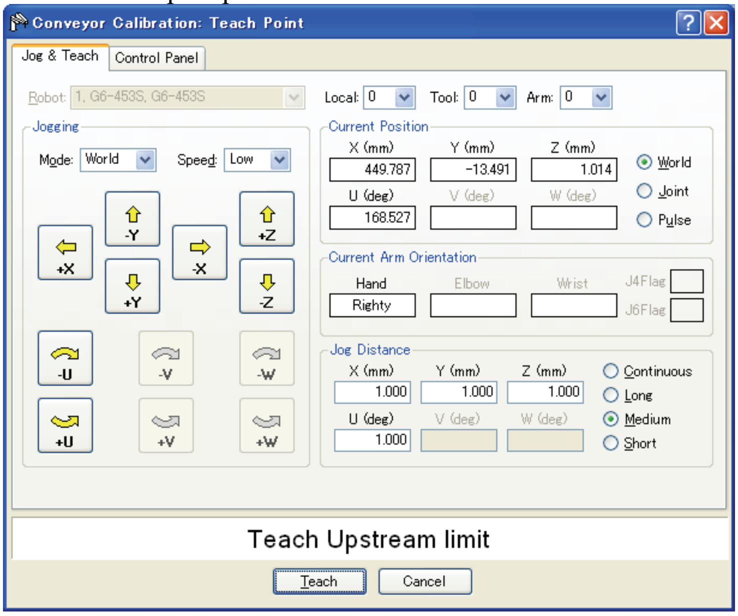
20. The Jog & Teach dialog will appear. Click the jog buttons to move the robot end effector to the pick position. Click the **Teach** button.



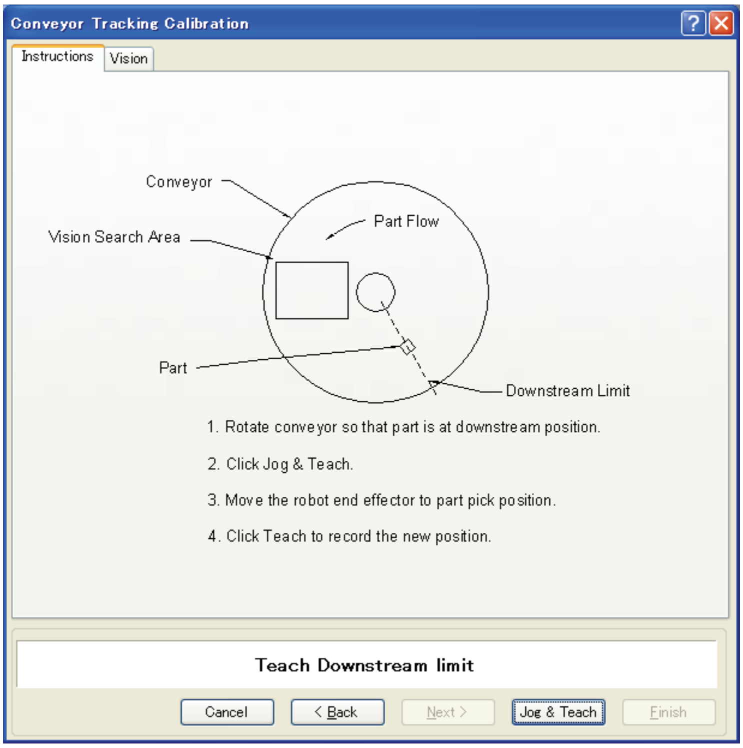
21. Place a part on the upstream limit. Click the **Jog & Teach** button.



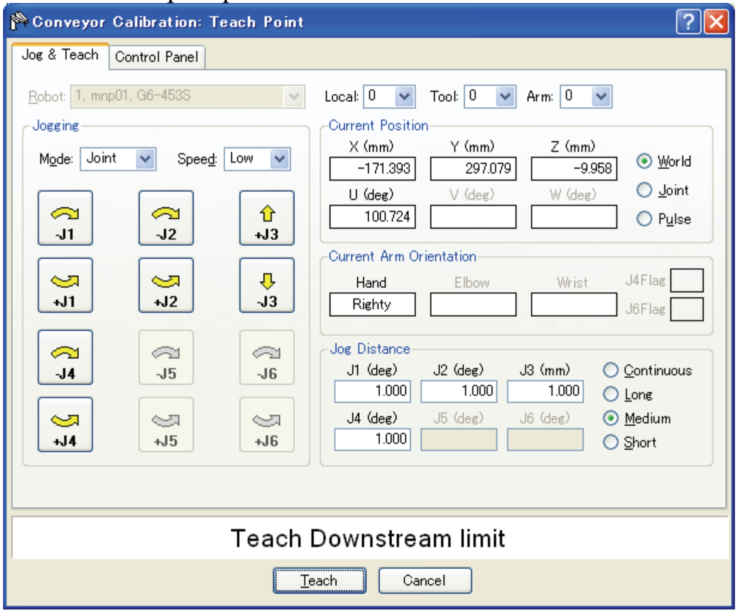
22. The Jog & Teach dialog will appear. Click the jog buttons to move the robot end effector to the pick position. Click the **Teach** button.



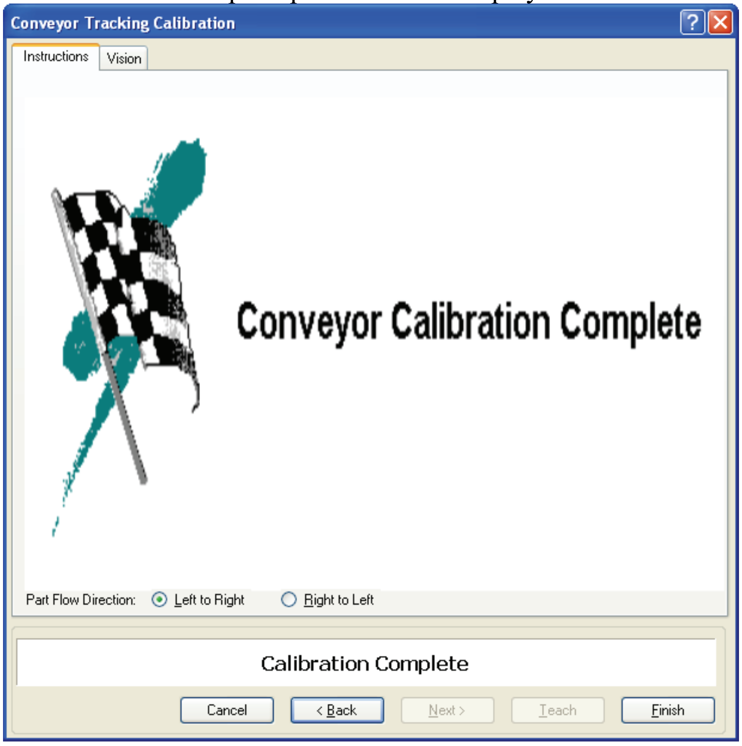
23. Move the conveyor so the part is on the downstream limit. Click the **Jog & Teach** button.



24. The Jog & Teach dialog will appear. Click the jog buttons to move the robot end effector to the pick position. Click the **Teach** button.



25. The calibration complete picture will be displayed. Click the Finish button.



Vision conveyor operation check

After the calibration, we recommend that you check if the vision conveyor works properly. Use the sample program "ScanConveyorStrobed" and the Command Window and follow the procedure below.

In this section, the operation of Conveyor #1 will be checked.

1. Clear the all queue data registered to the conveyor.
   ```
   >Cnv_QueRemove 1,all
   ```
2. Place parts in the vision search area.
3. Execute the program "ScanConveyorStrobed" to register a queue.
4. Halt the program "ScanConveyorStrobed" and move the conveyor until parts reach the Pickup Area.
5. Pick up parts.
   ```
   >Jump Cnv_Queget(1)
   ```
6. Check if the robot end effector is over the center of the part to pick.
7. Move the conveyor and check if the robot follows the part. At this point, the end effector will be off the center of part but this is no problem.
8. Stop the tracking motion.
   ```
   >Cnv_AbortTrack
   ```

In case the following symptoms occur, the Vision Guide or conveyor calibration was not executed correctly. Perform the calibration again.

- Robot cannot pick a part in the center.
- Robot cannot follow parts when the conveyor is moving.

Vision conveyor programming

Typically, two tasks are used to operate a vision conveyor. One task finds parts with the vision system and adds them to the conveyor queue.

The other task checks for parts in the Pickup Area of the conveyor queue. When a part is in the Pickup Area, the robot is commanded to pick up the part and place it to the specified position.

The following example shows two tasks. The scanning task uses the vision system to find parts and add them to the conveyor queue. There are two examples for the scanning task. "ScanConveyorNonStrobed" does not use a strobe lamp and hardware trigger. In this case, "Cnv_Trigger" must be called before running the vision sequence. "ScanConveyorStrobed" uses a strobe lamp and hardware conveyor trigger. "PickParts" waits for parts to be present in the Pickup Area and commands the robot to pick and place each part.

If you are using an asynchronous reset camera and strobe, then the strobe trigger should also be wired to the trigger on the PG board. In this case, the vision sequence "RuntimeAcquire property" must be set to "Strobed".

The following program is a sample with Conveyor #1.

```
Function main
  Xqt ScanConveyorStrobed      'Task that registers queues
  Xqt PickParts                'Task that tracks parts (queue)
Fend

Function ScanConveyorNonStrobed
  Integer i, numFound
  Real x, y, u
  Boolean found
  Cnv_OffsetAngle 1,xx         'Command used for only circular conveyors
                            'Adjust the tracking error with an offset value in xx
  Do
    Cnv_Trigger 1              'Latch the encoder with software trigger
    '  Search for parts on the conveyor
    VRun FindParts
    VGet FindParts.Parts.NumberFound, numFound
    'Register the part as a queue
    For i = 1 to numFound
      VGet FindParts.Parts.CameraXYU(i), found, x, y, u
      Cnv_QueAdd 1, Cnv_Point(1, x, y)
    Next i
    Wait .1
  Loop
Fend

Function ScanConveyorStrobed
  Integer i, numFound, state
  Real x, y, u
  Boolean found
  Cnv_OffsetAngle 1,xx         'Command used for only circular conveyors
                            'Adjust the tracking error with an offset value in xx
```

```
 'Turn OFF the camera shutter and I/O (conveyor trigger)
 Off trigger; off Cv_trigger
 Do
   'Search for parts on the conveyor
   VRun FindParts
   'Turn ON the camera shutter and I/O (conveyor trigger)
   On Trigger; On Cv_Trigger
   Do
     VGet FindParts.AcquireState, state
 Loop Until state = 3
 VGet FindParts.Parts.NumberFound, numFound
 'Register the part that has been shot as a queue
 For i = 1 to numFound
     VGet FindParts.Parts.CameraXYU(i), found, x, y, u
     Cnv_QueAdd 1, Cnv_Point(1, x, y)
 Next I
 'Turn OFF the camera shutter and I/O (conveyor trigger)
 Off Trigger; Off Cv_Trigger
 Wait .1
 Loop
Fend

Function PickParts
  OnErr GoTo ErrHandler
  Integer ErrNum
  WaitParts:
  Do
    'Wait until a part (queue) enters the Pickup Area
    Wait Cnv_QueLen(1, CNV_QUELEN_PICKUPAREA) > 0
    'Start tracking the parts
    Jump Cnv_QueGet(1)
    On gripper
    Wait .1
    'Move the picked part to a specified place
    Jump place
    Off gripper
    Wait .1
    'Clear the picked part (queue)
    Cnv_QueRemove 1, 0
  Loop
  'Clear the parts (queue) in the downstream side from the Pickup Area
  'When error 4406 occurs, restore automatically
  ErrHandler:
    ErrNum = Err
    If ErrNum = 4406 Then
      Cnv_QueRemove 1, 0
```

```
      EResume WaitParts
    'When an error except error 4406 occurs, display the error
    Else
      Print "Error!"
      Print "No.", Err, ":", ErrMsg$(Err)
      Print "Line :", Erl(0)
    EndIf
Fend
```

NOTE

When you use the strobe light and software trigger, use the “ScanConveyorStrobed” function shown below.

```
Function ScanConveyorStrobed
  Integer i, numFound, state
  Real x, y, u
  Boolean found
  Cnv_OffsetAngle 1,xx        ' Command used only for circular conveyors
                              'Adjust the tracking error with an offset value in xx
  'Turn OFF the camera shutter
  Off trigger
  Cnv_Trigger 1               'Latch the encoder with software trigger
  Do
    '  Search for parts on the conveyor
    VRun FindParts
    'Turn ON the camera shutter
    On Trigger; On Cv_Trigger
    Do
      VGet FindParts.AcquireState, state
  Loop Until state = 3
  VGet FindParts.Parts.NumberFound, numFound
  'Register the part that has been shot as a queue
  For i = 1 to numFound
    VGet FindParts.Parts.CameraXYU(i), found, x, y, u
    Cnv_QueAdd 1, Cnv_Point(1, x, y)
  Next I
  ' Turn OFF the camera shutter
  Off Trigger
  Wait .1
  Loop
Fend
```

15.12 Sensor Conveyors

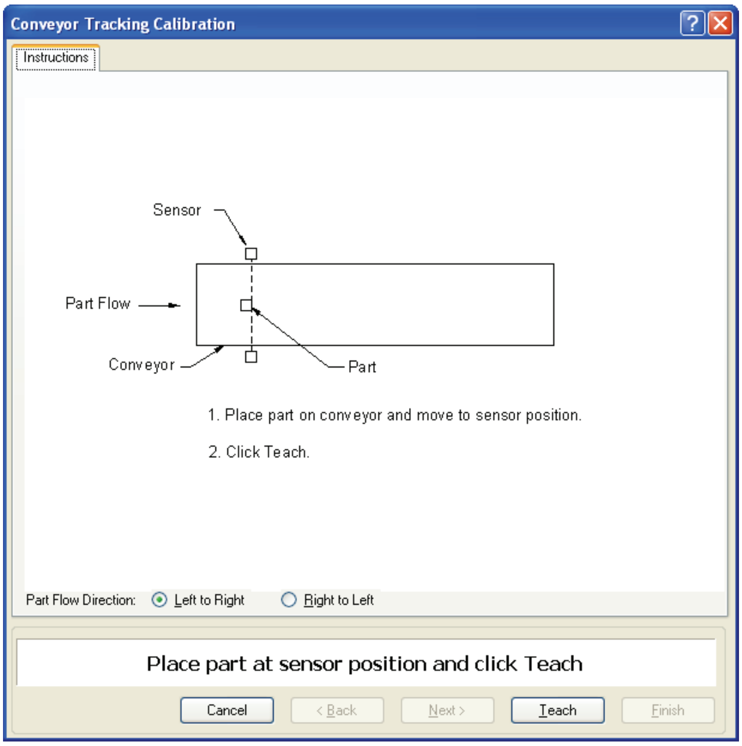
Sensor conveyor calibration (Straight conveyor)

Follow these steps to calibrate a straight sensor conveyor:

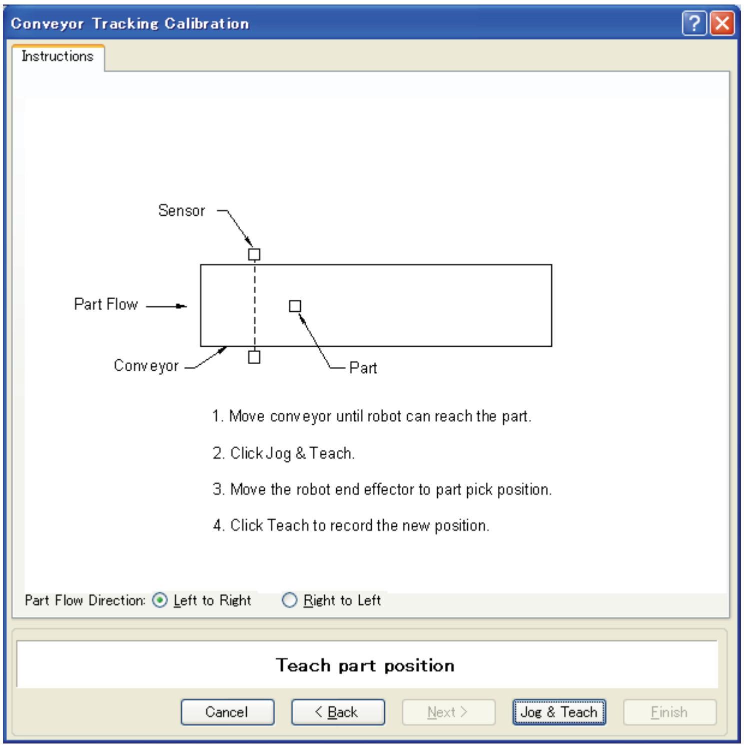
NOTE

- When teaching part positions with the robot during calibration, it is important to position X, Y, and Z of each point accurately. The conveyor is calibrated in X, Y, Z, U, V, and W.
- To perform the fine calibration, in steps 9 and 11, set as wide a distance as possible between the upstream limit and the downstream limit. After calibration, adjust the Pickup Area by resetting the upstream / downstream limits.
- For the level orientation, the conveyor height is determined by the position of the robot end effector taught in step 8. It cannot be used for the tilted conveyor for it does not detect the conveyor slope. Steps 19 to 20 are not displayed.
- For the tilted orientation, it calibrates the conveyor slope with the position of robot end effector taught in the steps 8, 10, 12, and 14.

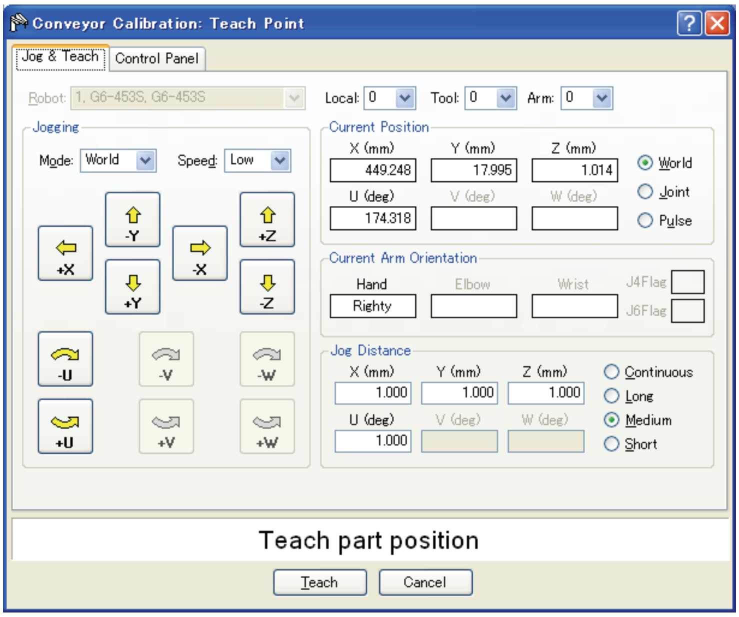
1. Select Tools | Conveyor Tracking.
2. Select the conveyor you want to calibrate.
3. Click the **Calibrate** button. The Conveyor Tracking Calibration wizard will appear.
4. Follow the instructions for each step. Before you can proceed to the next step, you must click the **Teach** button. You can go back to previous steps using the **Back** button.
5. Select the Part Flow Direction to best match the conveyor you are calibrating. The instruction pictures will change according to the setting. Part Flow Direction is only used to aid in the instructions. It has no affect on the calibration.
6. For the first wizard step, place a part on the conveyor and move the conveyor toward the sensor until the sensor just turns on. Click the **Teach** button.



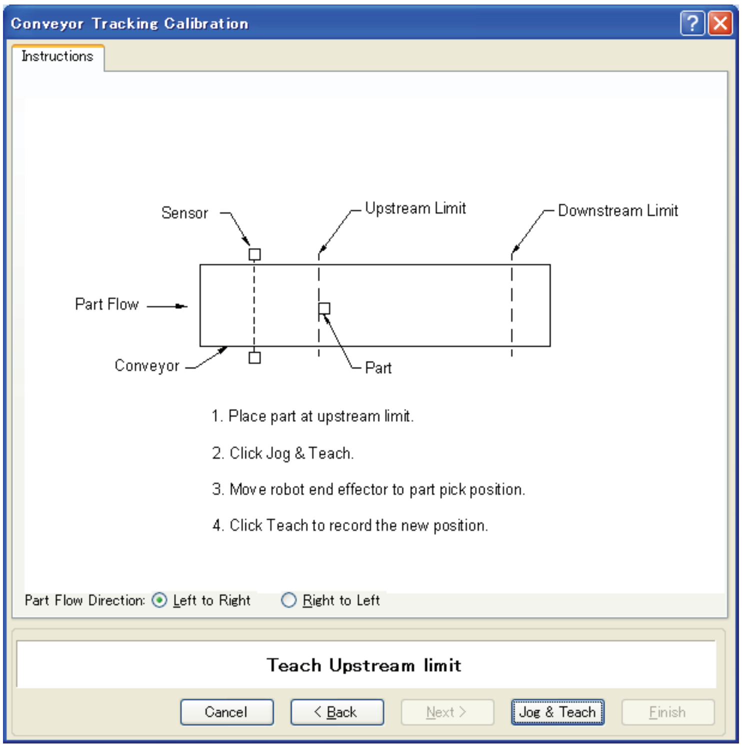
7. Move the conveyor by hand until the part is within reach of the robot. Do not move the part itself, only the conveyor. Click the **Jog & Teach** button.



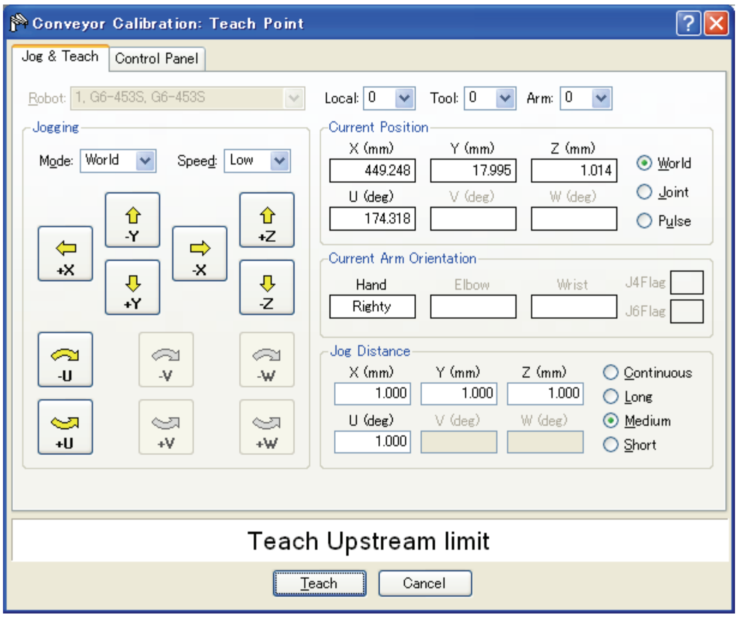
8. The Jog & Teach dialog will appear. Click the jog buttons to move the robot end effector to the pick position. Click the **Teach** button.



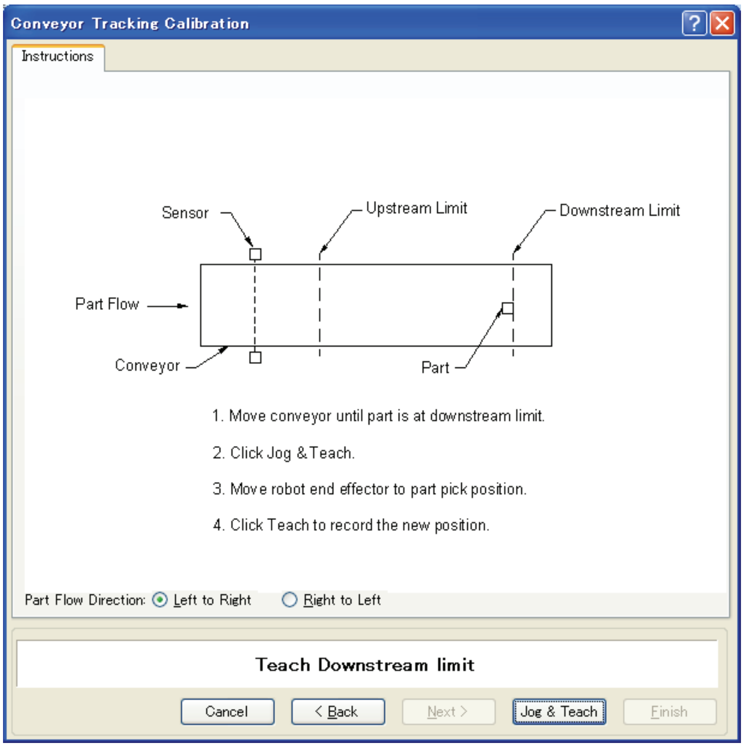
9. Now move or place the part at the upstream limit. Click the **Jog & Teach** button.



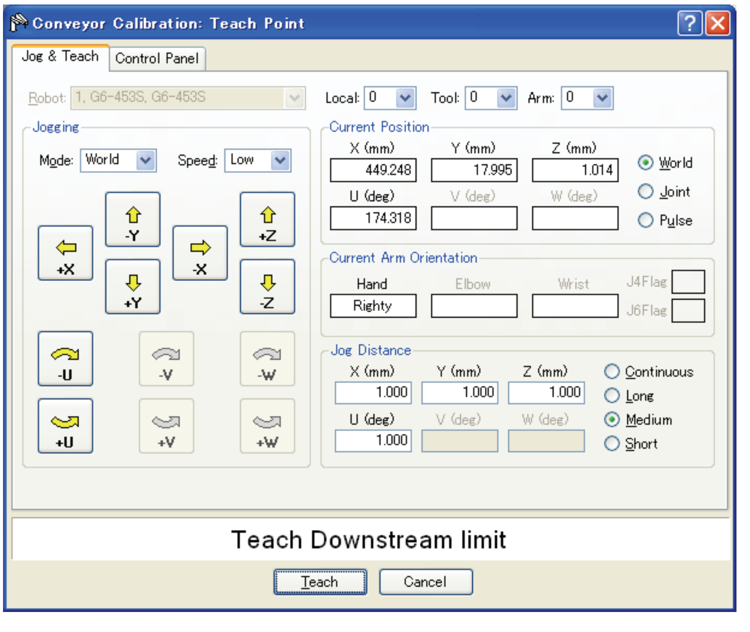
10. The Jog & Teach dialog will appear. Click the jog buttons to move the robot end effector to the pick position. Click the **Teach** button.



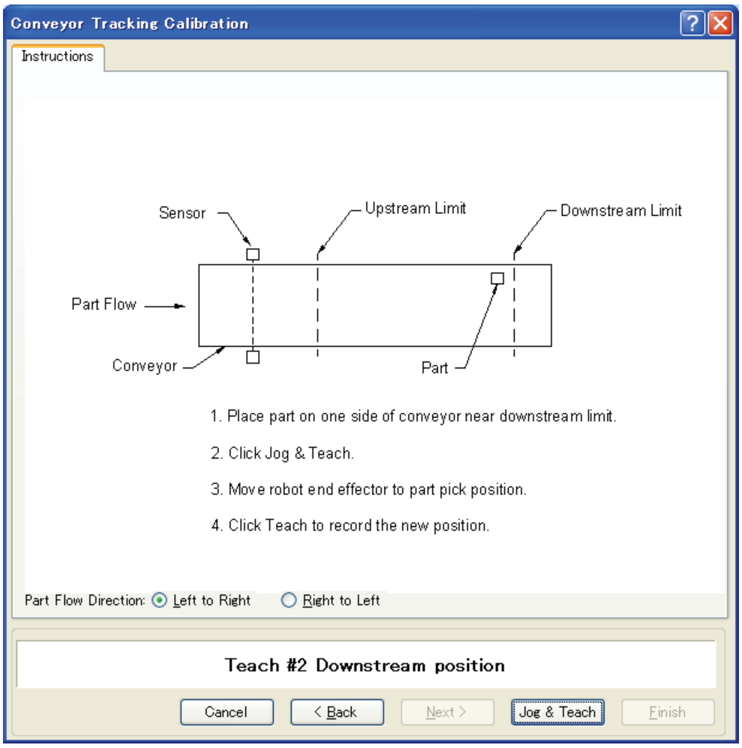
11. Move the conveyor so the part is at the downstream limit. Do not move the part, only the conveyor. Click the **Jog & Teach** button.



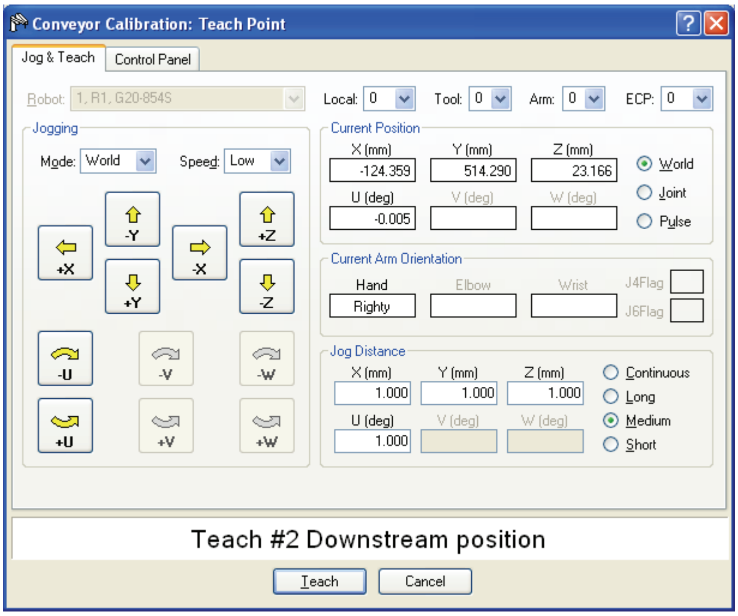
12. The Jog & Teach dialog will appear. Click the jog buttons to move the robot end effector to the pick position. Click the **Teach** button.



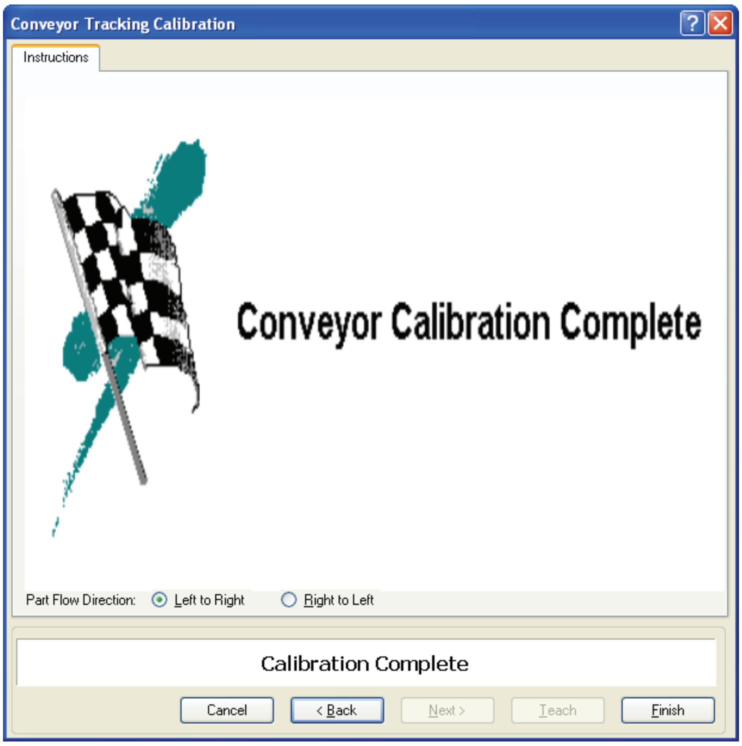
13. Place a part on one side of the conveyor near the downstream limit. This point is used to determine the tilt of the conveyor from side to side. Click the **Jog & Teach** button.



14. The Jog & Teach window will appear. Click the jog buttons to move the robot end effector to the pick position. Click the **Teach** button.



15. The calibration complete picture will be displayed. Click the **Finish** button.



Sensor Conveyor Calibration (Circular conveyor)

Follow these steps to calibrate a circular sensor conveyor:

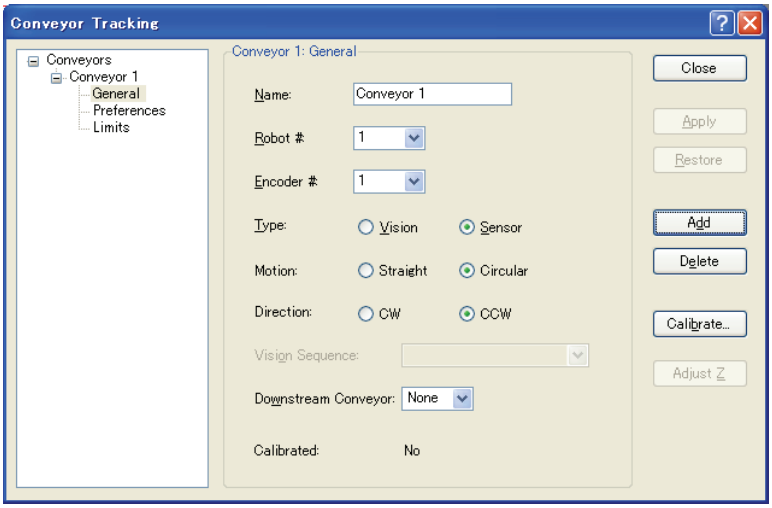
NOTE

- When teaching part positions with the robot during calibration, it is important to position X, Y, and Z of each point accurately. The conveyor is calibrated in X, Y, Z, U, V, and W.
- To perform the fine calibration, in steps 10, 12, and 14, teach the position when the robot is directly above the parts and set as wide a distance as possible between the points being taught.

1. Select Tools | Conveyor Tracking.
2. Select the conveyor you want to calibrate.
3. Select **Sensor** for the [Type].
4. Select **Circular** for the [Motion].
5. Select the conveyor rotating direction for the [Direction].

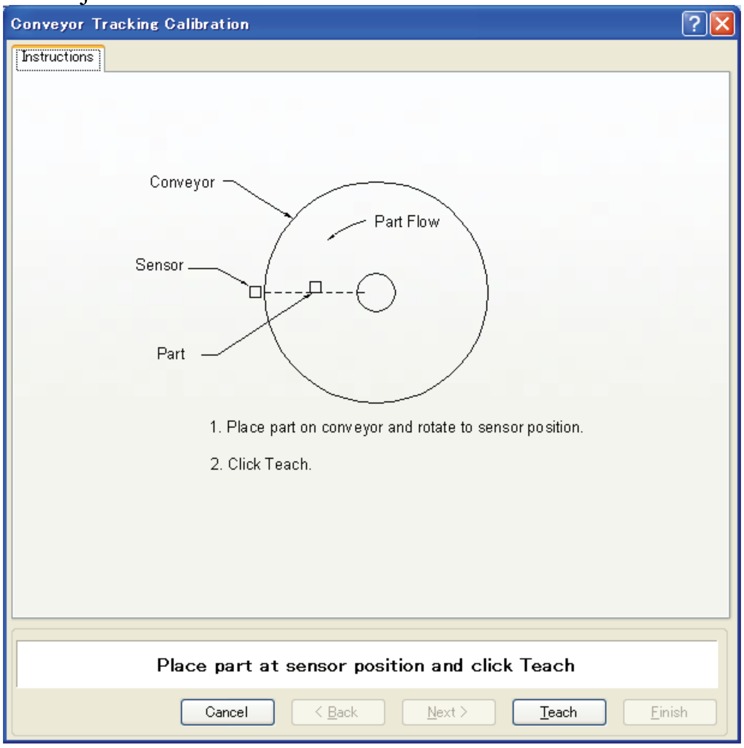
NOTE

Be careful not to calibrate with a wrong direction, otherwise, the robot will not track the parts.

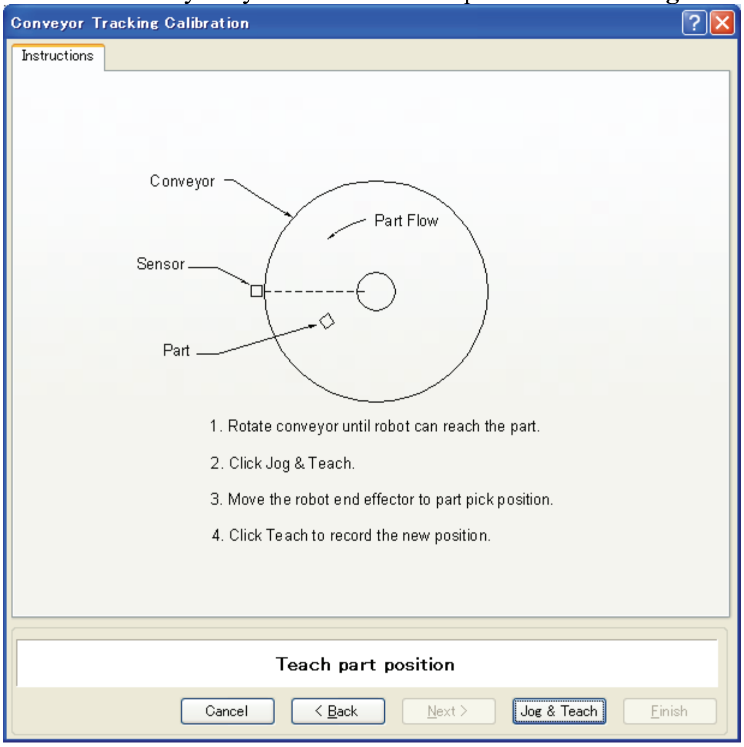


6. Click the **Apply** button.
7. Click the **Calibrate** button. The Conveyor Tracking Calibration wizard will appear. Follow the instructions for each step. Before you can proceed to the next step, you must click the **Teach** button. You can go back to previous steps using the **Back** button.
8. Check if the conveyor direction shown in the wizard is the same as the conveyor you want to use.

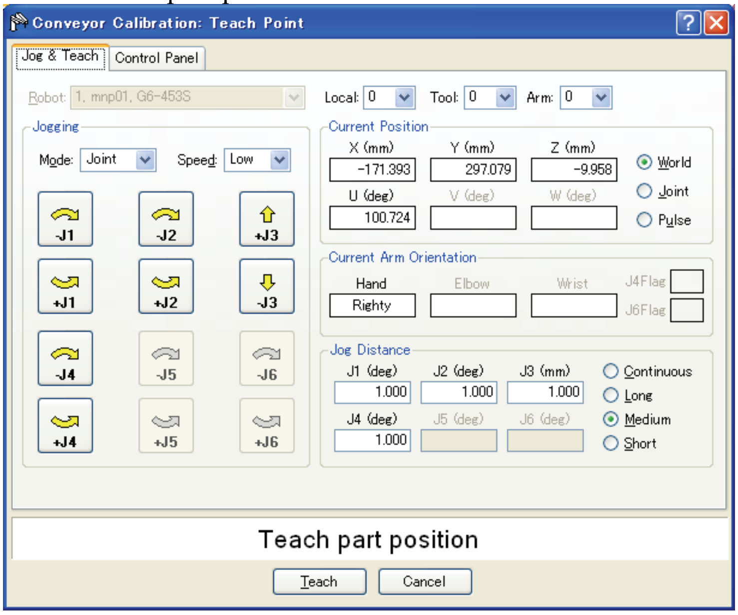
9. Place a part on the conveyor and move the conveyor toward the sensor until the sensor just turns on. Click the **Teach** button.



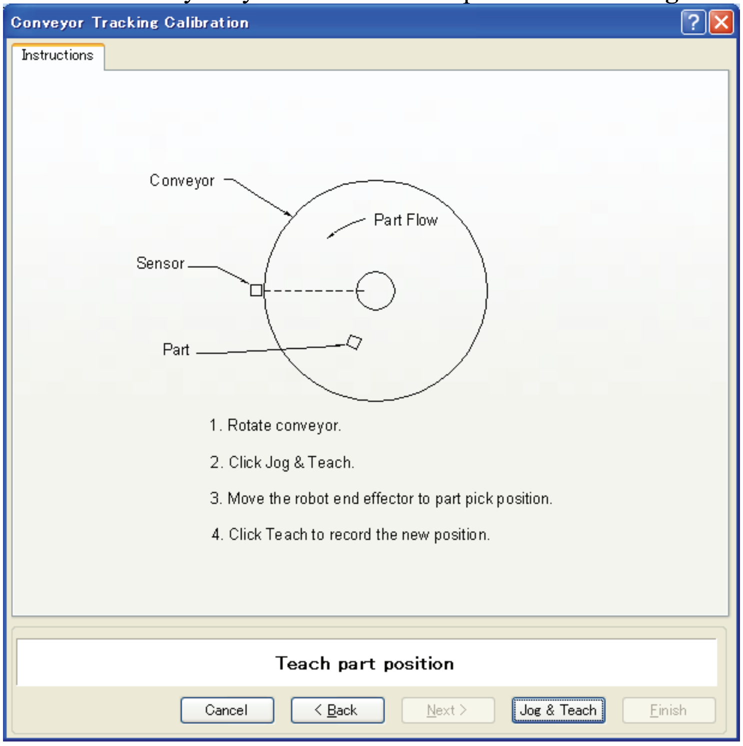
10. Move the conveyor by hand to move the part. Click the **Jog & Teach** button.



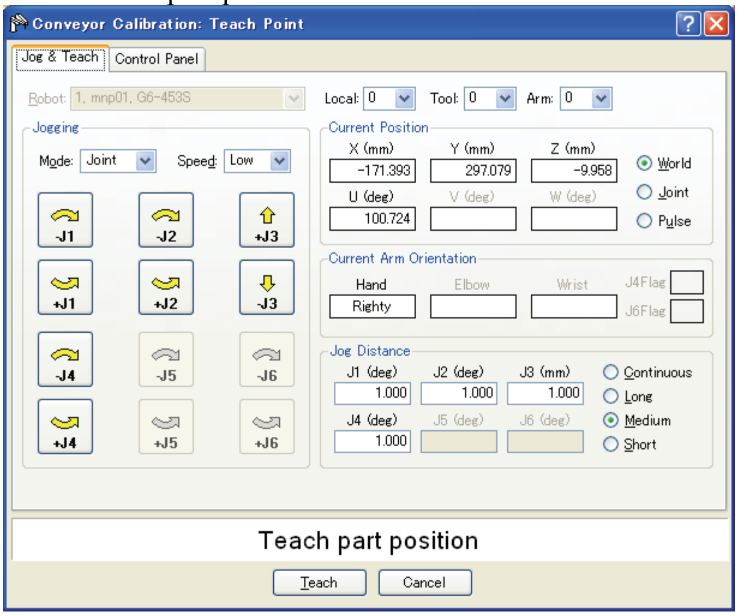
11. The Jog & Teach dialog will appear. Click the jog buttons to move the robot end effector to the pick position. Click the **Teach** button.



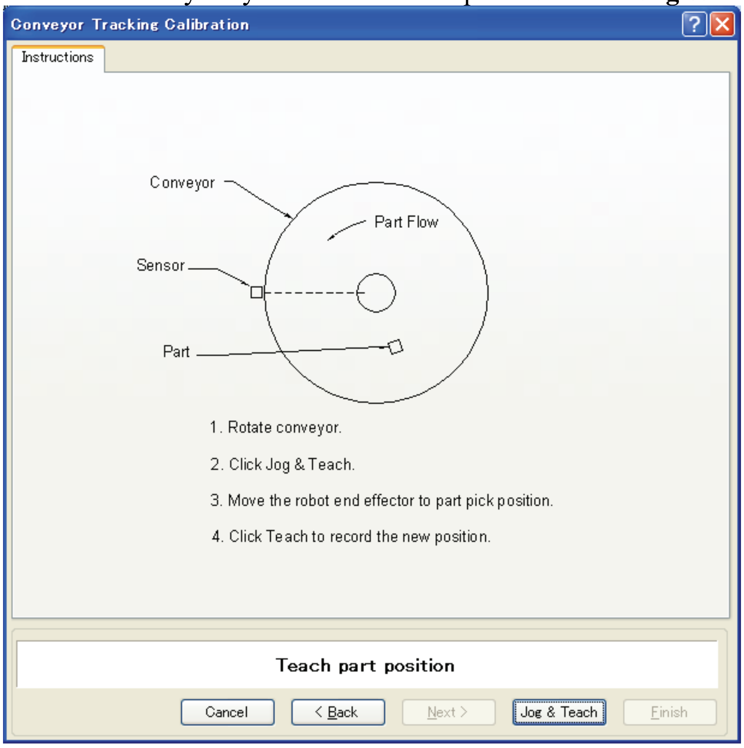
12. Move the conveyor by hand to move the part. Click the **Jog & Teach** button.



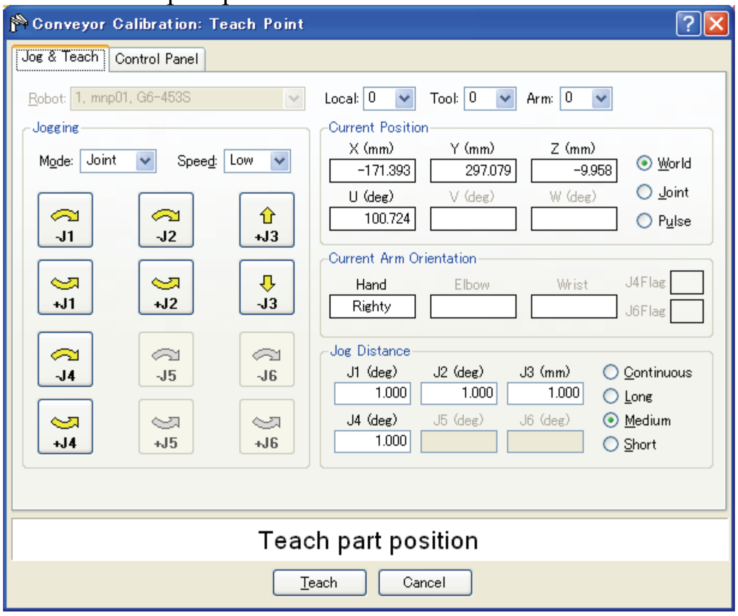
13. The Jog & Teach dialog will appear. Click the jog buttons to move the robot end effector to the pick position. Click the **Teach** button.



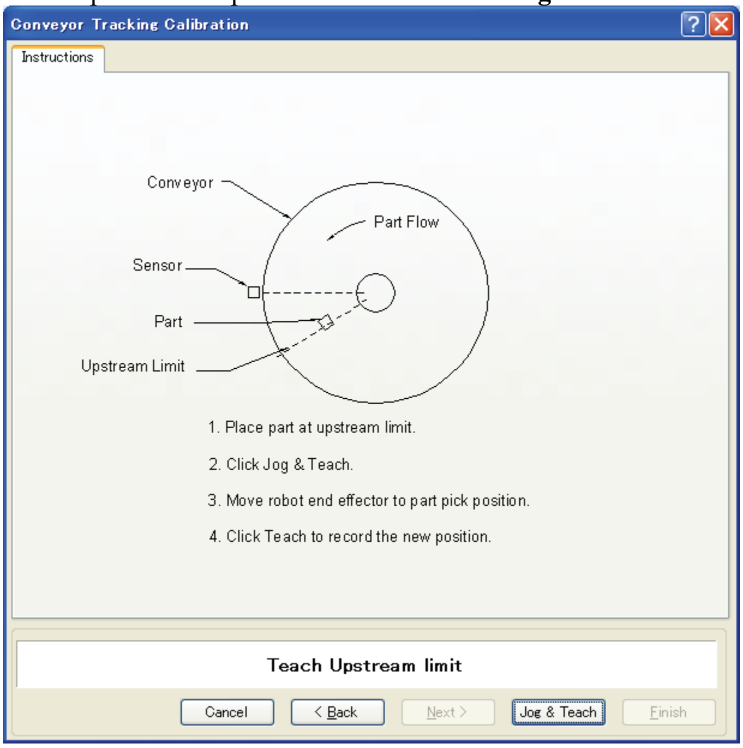
14. Move the conveyor by hand to move the part. Click the **Jog & Teach** button.



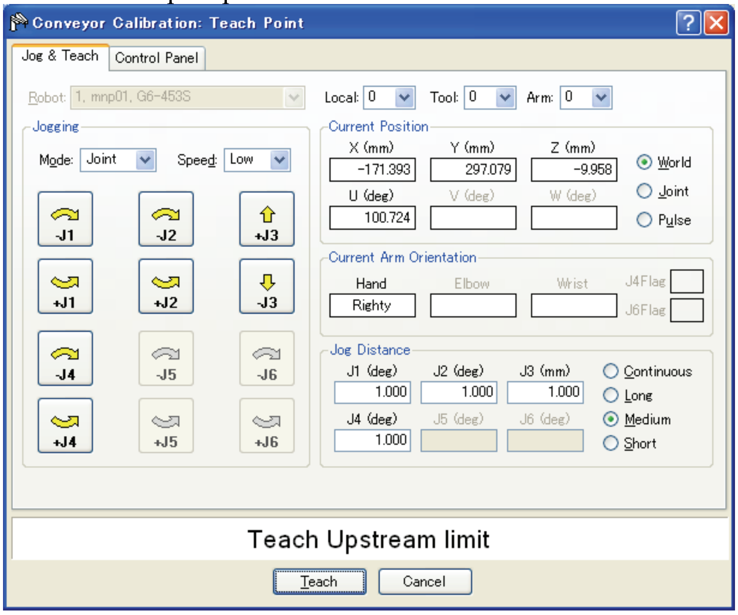
15. The Jog & Teach dialog will appear. Click the jog buttons to move the robot end effector to the pick position. Click the **Teach** button.



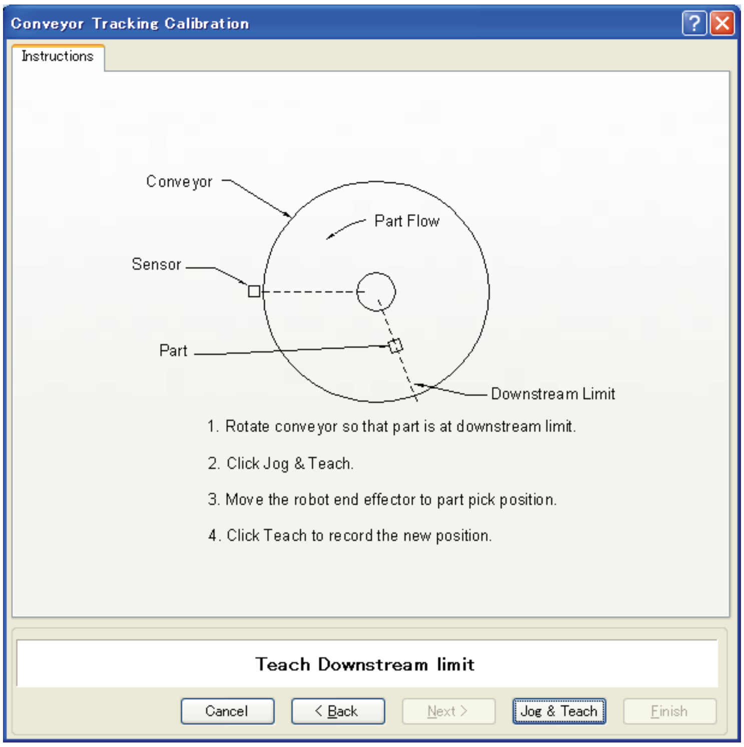
16. Place a part on the upstream limit. Click the **Jog & Teach** button.



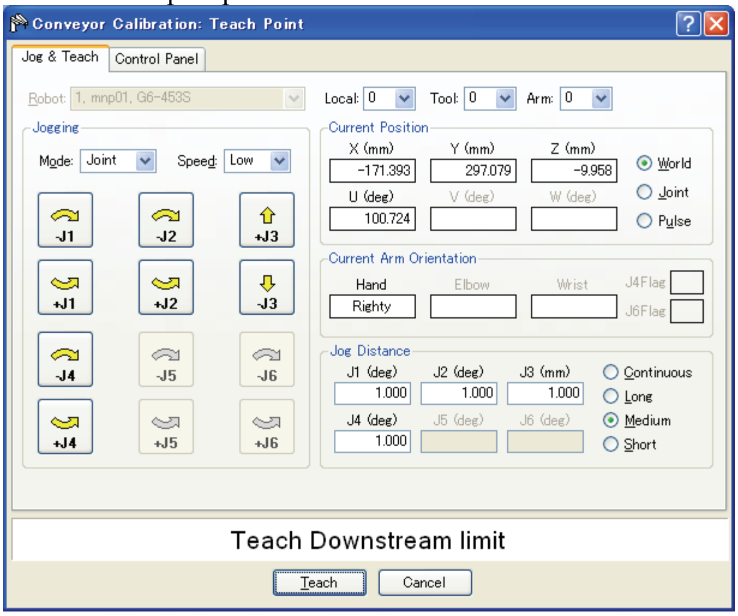
17. The Jog & Teach dialog will appear. Click the jog buttons to move the robot end effector to the pick position. Click the **Teach** button.



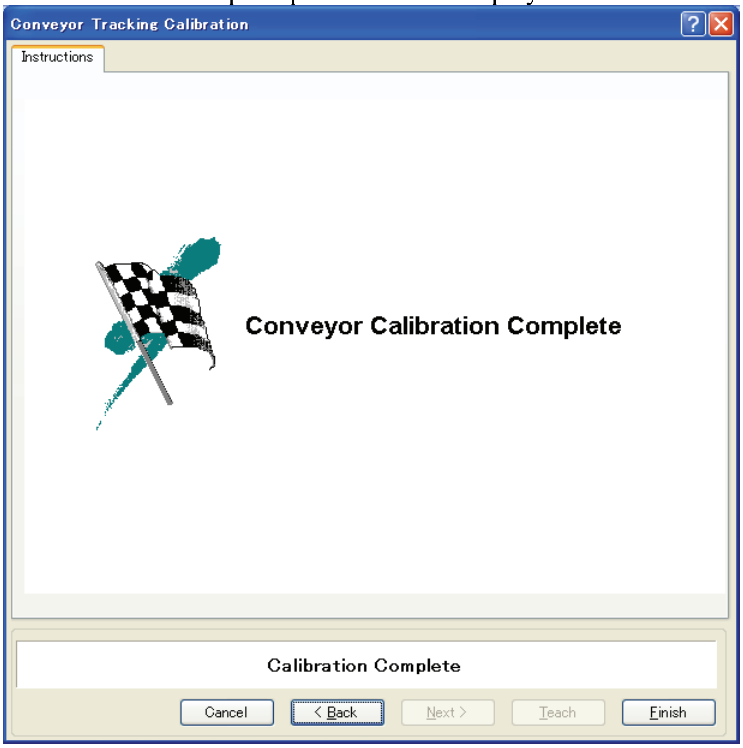
18. Move the conveyor so the part is at the downstream limit. Click the **Jog & Teach** button.



19. The Jog & Teach dialog will appear. Click the jog buttons to move the robot end effector to the pick position. Click the **Teach** button.



20. The calibration complete picture will be displayed. Click the **Finish** button.



Sensor conveyor operation check

After the calibration, we recommend that you check if the sensor conveyor works properly. Use the Command Window and follow the procedure below.

In this section, the operation of Conveyor #1 is checked.

1. Clear the all queue data registered to the conveyor.
```
>Cnv_QueRemove 1,all
```
2. Place parts before the sensor area. Move the conveyor until the sensor turns ON.
3. Register a queue data.
```
>Cnv_QueAdd 1,Cnv_Point(1,0,0)
```
4. Move the conveyor until the parts reach the Pickup Area.
5. Pick up parts.
```
>Jump Cnv_QueGet(1)
```
6. Check if the robot end effector is over the center of the part to pick.
7. Move the conveyor and check if the robot follows the part. At this point, the end effector will be off the center of the part but this is no problem.
8. Stop the tracking motion.
```
>Cnv_AbortTrack
```

In case the following symptoms occur, perform the calibration again.

- Robot cannot pick parts in the center.
- Robot cannot follow parts while the conveyor is moving.

Sensor conveyor programming

Typically, two tasks are used to operate a sensor conveyor. One task waits for a part to trip the sensor and add it to the conveyor queue. The other task checks for parts in the Pickup Area of the conveyor queue. When a part is in the Pickup Area, the robot is commanded to pick up the part and place it to the specified position.

```
Function main
  Xqt ScanConveyor        'Task that registers queues
  Xqt PickParts           'Task that tracks parts (queue)
Fend

Function ScanConveyor
  Double lpulse1                  'Previous latch pulse
    lpulse1 = Cnv_LPulse(1)       'Register the latch pulse as lpulse1
    Do
      'Register a part as a queue only when it passes the sensor
      If lpulse1 <> Cnv_LPulse(1) Then
        Cnv_QueAdd 1, Cnv_Point(1, 0, 0)
        lpulse1 = Cnv_LPulse(1)   'Update lpulse1
      EndIf
    Loop
Fend

Function PickParts
  OnErr GoTo ErrHandler
  Integer ErrNum
  WaitParts:
  Do
    'Wait until a part (queue) enters the Pickup Area
    Wait Cnv_QueLen(1, CNV_QUELEN_PICKUPAREA) > 0
    'Start tracking the parts
    Jump Cnv_QueGet(1)
    On gripper
    Wait .1
    'Move the picked part to a specified place
    Jump place
    Off gripper
    Wait .1
    'Clear the picked part (queue)
    Cnv_QueRemove 1, 0
  Loop
  'Clear the parts (queu) in the downstream side from the Pickup Area
  'When error 4406 occurs, restore automatically
  ErrHandler:
    ErrNum = Err
    If ErrNum = 4406 Then
```

```
      Cnv_QueRemove 1, 0
      EResume WaitParts
    'When an error other than error 4406 occurs, display the error
    Else
    Print "Error!"
    Print "No.", Err, ":", ErrMsg$(Err)
    Print "Line :", Erl(0)
    EndIf
Fend
```

15.13 Multiple Conveyors

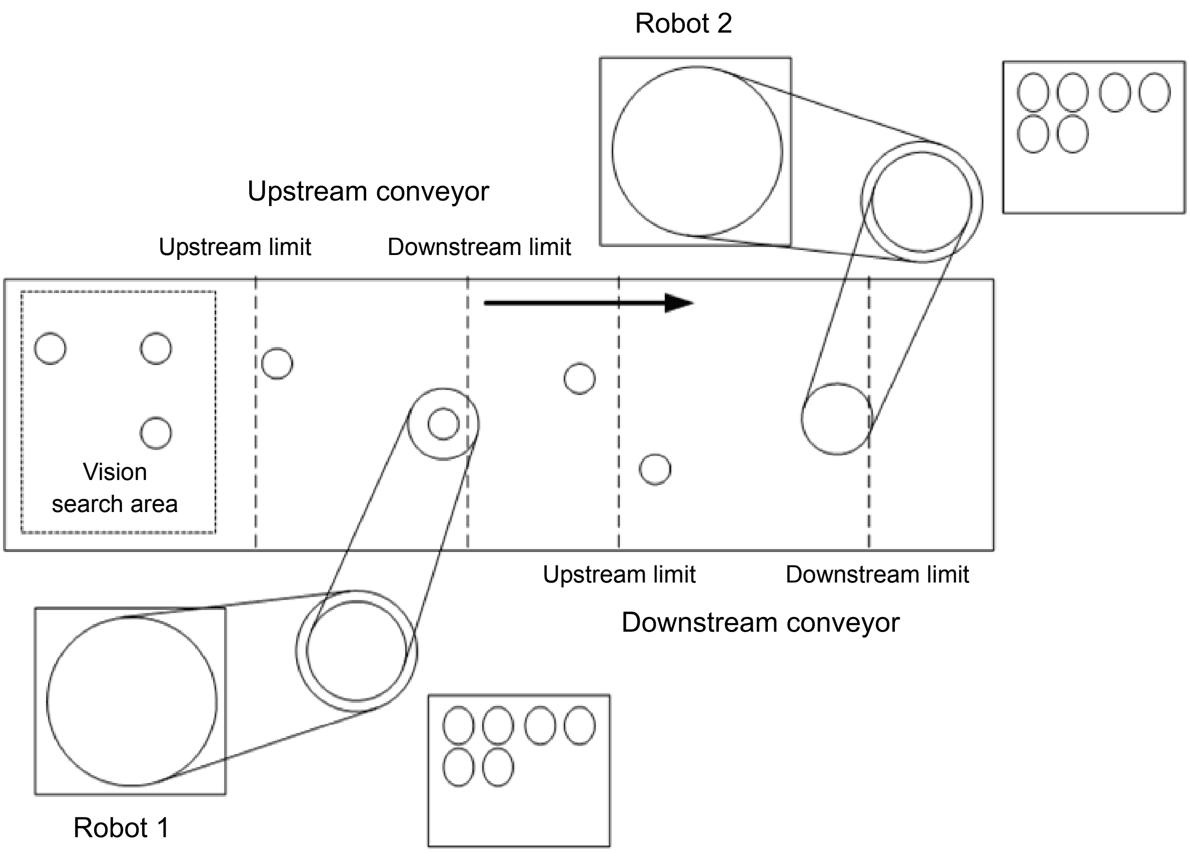
EPSON RC+ 6.0 supports multiple logical conveyors and robots. You can use multiple robots on one conveyor, or multiple robots with multiple conveyors.

This section describes a conveyor system that uses two or more robots with one conveyor and a conveyor system that uses one robot with two or more conveyors.

Multiple Conveyors

A system that uses multiple conveyors is a system that:

- Uses two or more robots and logical conveyors with one physical conveyor as shown below, and the parts that are not picked up by the first robot (upstream) can be picked up by the second robot (downstream).
- Uses several robots with one camera or sensor, one encoder, and one conveyor.

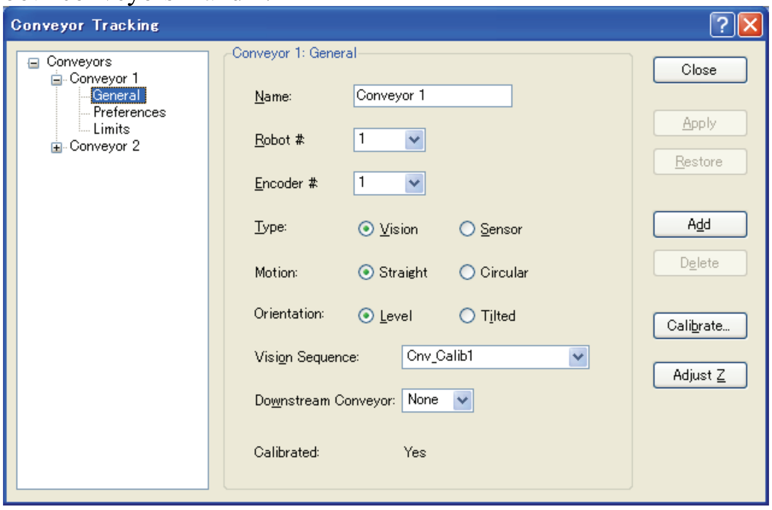


How to Use Multiple Conveyors

When using multiple conveyors, set the upstream conveyor and downstream conveyor. Instructions for using multiple conveyors are described below.

1. Refer to *15.9 Creating Conveyors in a Project* and create conveyor 1 and conveyor 2. (Set the robot in the upstream side to Conveyor 1.)

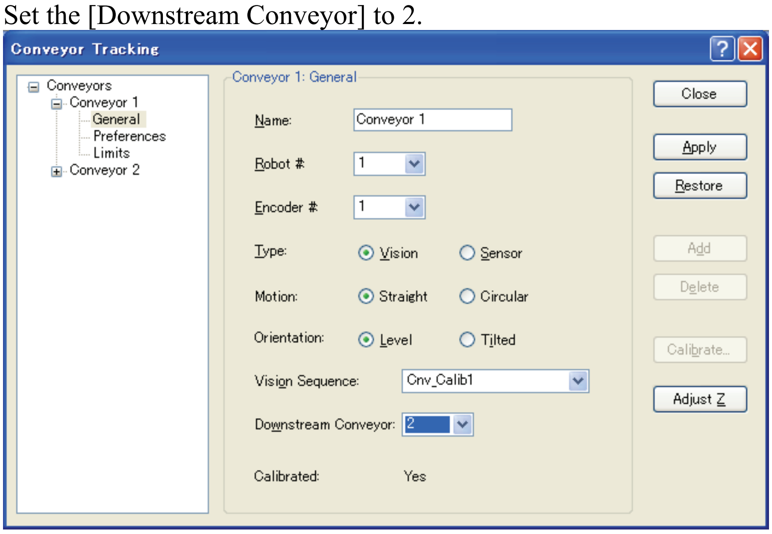
2. For the [Encoder] and [Vision Sequence], set the same number and sequence for both conveyors 1 and 2.



3. Calibrate Conveyor 1.

4. Refer to *15.11 Vision Conveyors* or *15.12 Sensor Conveyors* and check the conveyor operation.

5. Set the [Downstream Conveyor] to 2.



6. Calibrate Conveyor 2.

7. Check the operation of Conveyor 2.

   (7)-1 Clear the all queue data registered to each conveyor.

   ```
   >Cnv_QueRemove 1,all
   >Cnv_QueRemove 2,all
   ```

   (7)-2 Place parts in the vision search area.

   (7)-3 Execute the program "ScanConveyorStrobed(ScanConveyor)" and register a queue.

(7)-4 Halt the program “ScanConveyorStrobed” and move the conveyor until the parts reach the Pickup Area.

(7)-5 Stop the program “ScanConveyorStrobed” and move the conveyor until the part reaches the Pickup Area of the conveyor 2.

(7)-6 Execute the command below to move the queue data from conveyor 1 to conveyor 2.

```
>Cnv_QueMove 1,0
```

(7)-7 Pick up the parts.

```
>Jump Cnv_Queget(2)
```

(7)-8 Check if the robot end effector is over the center of a part to pick. If the robot end effector is not over the center of a part, perform the calibration again.

(7)-9 Move the conveyor and check if the robot follows the part. At this point, the end effector will be off the center of part but this is not a problem.

(7)-10 Stop the tracking motion.

```
>Cnv_AbortTrack
```

8. The following program is a sample.

```
Function main
  Xqt ScanConveyorStrobed     'Task that registers queues
  'Task for the upstream robot to track parts (queue)
  Xqt PickParts1
  'Task for the downstream robot to track parts (queue)
  Xqt PickParts2
Fend

Function ScanConveyorStrobed
  Integer i, numFound, state
  Real x, y, u
  Boolean found
  'Turn OFF the camera shutter and I/O (conveyor trigger)
  Off trigger; off Cv_trigger
  Do
    'Search for a part on the conveyor
    VRun FindParts
    'Turn ON the camera shutter and I/O (conveyor trigger)
   On Trigger; On Cv_Trigger
    Do
      VGet FindParts.AcquireState, state
  Loop Until state = 3
  VGet FindParts.Parts.NumberFound, numFound
  'Register the part that has been found in the queue of conveyor 1
  For i = 1 to numFound
    VGet FindParts.Parts.CameraXYU(i), found, x, y, u
    Cnv_QueAdd 1, Cnv_Point(1, x, y)
```

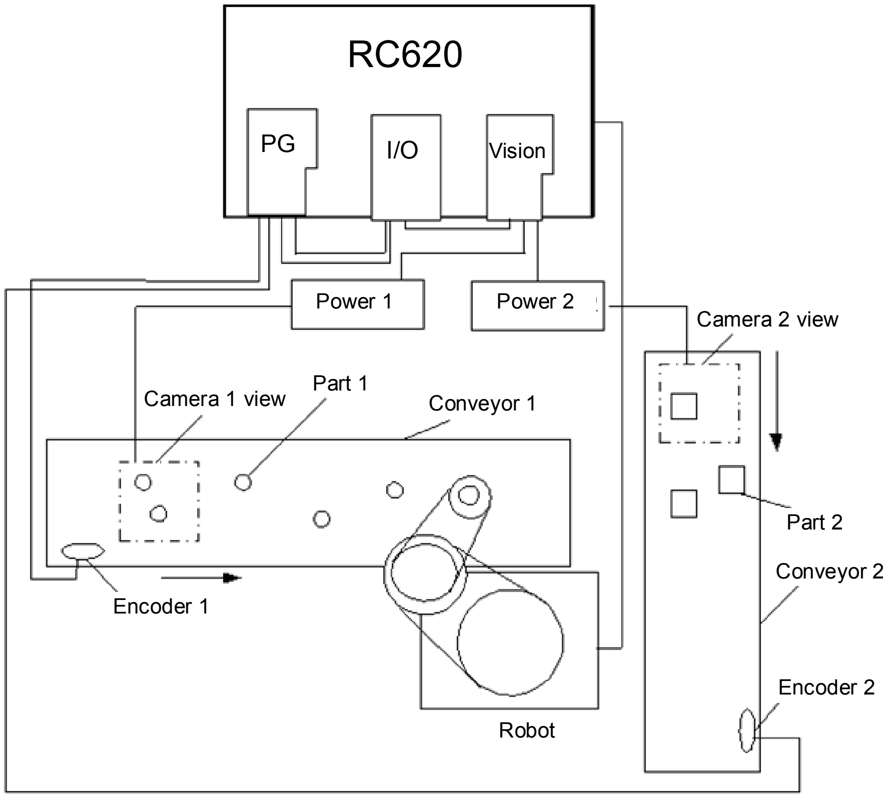
```
    Next I
    'Turn OFF the camera shutter and I/O (conveyor trigger)
    Off Trigger; Off Cv_Trigger
    Wait .1
    Loop
Fend

Function PickParts1
    OnErr GoTo ErrHandler
    Integer ErrNum
    WaitParts:
    Do
        'Wait until a part (queue) enters the Pickup Area
        Wait Cnv_QueLen(1, CNV_QUELEN_PICKUPAREA) > 0
        'Start tracking the part
        Jump Cnv_QueGet(1)
        On gripper
        Wait .1
        'Move the picked part to a specified place
        Jump place
        Off gripper
        Wait .1
        'Clear the picked part (queue)
        Cnv_QueRemove 1, 0
    Loop
    'Move the parts (queue) in the downstream side from the Pickup Area of conveyor
     1 to the conveyor 2
    'When error 4406 occurs, restore automatically
    ErrHandler:
        ErrNum = Err
        If ErrNum = 4406 Then
            Cnv_QueMove 1, 0
            EResume WaitParts
        'When an error except error 4406 occurs, display the error
        Else
            Print "Error!"
            Print "No.", Err, ":", ErrMsg$(Err)
            Print "Line :", Erl(0)
        EndIf
Fend

Function PickParts2
    OnErr GoTo ErrHandler
    Integer ErrNum
    WaitParts:
    Do
```

```
    'Wait until a part (queue) enters the Pickup Area
    Wait Cnv_QueLen(2, CNV_QUELEN_PICKUPAREA) > 0
    'Start tracking the part
    Jump Cnv_QueGet(2)
    On gripper
    Wait .1
    'Move the picked part to a specified place
    Jump place
    Off gripper
    Wait .1
    'Clear the picked part (queue)
    Cnv_QueRemove 2, 0
  Loop
  'Clear the parts (queue) in the downstream side from the Pickup Area of conveyor 2
  'When error 4406 occurs, restore automatically
  ErrHandler:
    ErrNum = Err
    If ErrNum = 4406 Then
      Cnv_QueRemove 2, 0
      EResume WaitParts
    'When an error except error 4406 occurs, display the error
    Else
      Print "Error!"
      Print "No.", Err, ":", ErrMsg$(Err)
      Print "Line :", Erl(0)
    EndIf
Fend
```

Conveyor Tracking for Several Conveyors

This section describes a conveyor system where one robot picks up “Part 1” from Conveyor 1 and puts the picked parts above “Parts 2” on Conveyor 2 as shown in the figure below.

In this conveyor system, each conveyor needs one encoder and camera (sensor).



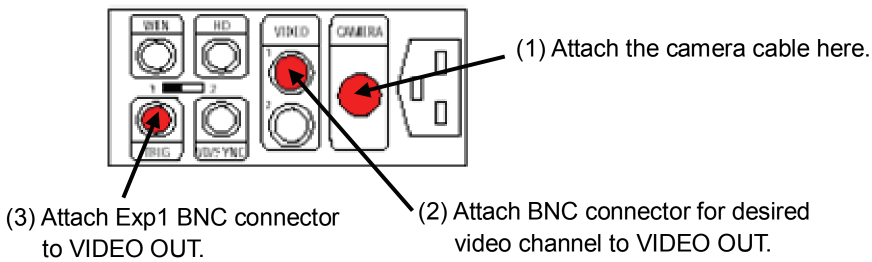
Wiring Two Asynchronous Reset Cameras

The wiring for a vision system using two asynchronous cameras (Frame Grabber) is described below.

Vision System Wiring

(Example: Sony XC-HR50)

(1) Attach one end of the camera 1 cable to the camera to be used as camera 1 and the other end of the cable to the rear panel receptacle of the Camera Power Junction box 1 (see the figure below).
Next, attach one end of the camera 2 cable to the camera to be used as camera 2 and the other end of the cable to the rear panel receptacle of the Camera Power Junction box 2.

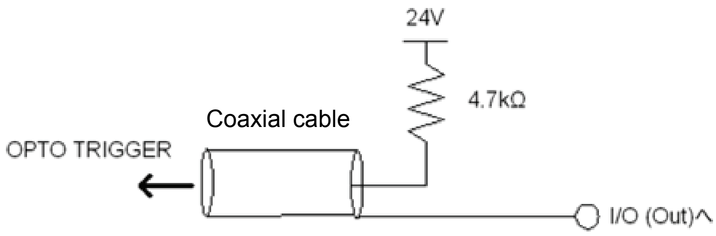


DC-700 Camera Power Junction Box (Rear View)

(2) Pick up the BNC to D-Sub cable that is now attached to the frame grabber. Locate the cable to the Camera Power Junction box 1. Attach the Video 1 BNC connector cable to the VIDEO OUT BNC female connector on the Camera Power Junction box 1.
Attach the Video 2 BNC connector cable to the VIDEO OUT BNC female connector on the Camera Power Junction box 2.

(3) Attach the Exp 1 BNC connector cable branching to the TRIG connectors on the Camera Power Junction boxes 1 and 2.

(4) Connect the OPTO TRIGGER BNC connector cable and the coaxial cable as shown below.



(5) Refer to the option manual, *Vision Guide 6.0 - Appendix A: Camera Interfaces* and set the camera external setting to the asynchronous reset mode.

NOTE

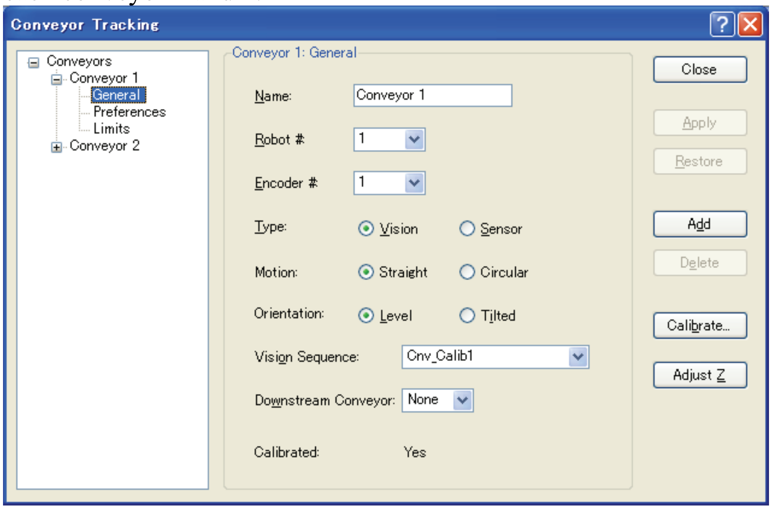
When you use the Smart Camera that needs the wiring not described above, refer to *Vision Guide 6.0 - 2. Installation* and attach the cables.

How to Use Several Conveyors

The usage of several conveyors is described below.

1. Refer to *15.9 Creating Conveyors in a Project* and create Conveyor 1 and Conveyor 2. (Set the robot in the upstream side to the Conveyor 1.)

2. For the [Encoder] and [Vision Sequence], set the different number and sequence for each conveyor 1 and 2.



3. Calibrate Conveyor 1.

4. Refer to *15.11 Vision Conveyors* or *15.12 Sensor Conveyors* and check the conveyor operation.

5. Calibrate Conveyor 2.

6. Check the operation of Conveyor 2.

7. The following program is a sample.

```
Function main
  'Task that registers parts in the queues
  Xqt ScanConveyorStrobed
  'Task that tracks parts (queue)
  Xqt PickParts
Fend

Function ScanConveyorStrobed
  Integer i, j, numFound, state
  Real x, y, u
  Boolean found
  'Turn OFF the camera shutter and I/O (conveyor trigger)
  'Cv_trigger1: Conveyor 1, Cv_trigger2: Conveyor 2
  Off trigger; off Cv_trigger1; off Cv_trigger2
  Do
  'Register the parts (queue) of the Conveyor 1
    'Search for a part on the conveyor
    VRun FindParts1
    'Turn ON the camera shutter and I/O (conveyor trigger)
   On Trigger; On Cv_Trigger1
```

```
    Do
      VGet FindParts1.AcquireState, state
  Loop Until state = 3
  VGet FindParts1.Parts.NumberFound, numFound
  'Register the part that has been shot as a queue
  For i = 1 to numFound
    VGet FindParts.Parts.CameraXYU(i), found, x, y, u
    Cnv_QueAdd 1, Cnv_Point(1, x, y)
  Next I
  'Turn OFF the camera shutter and I/O (conveyor trigger)
  Off Trigger; Off Cv_Trigger
  Wait .1

  'Register the parts (queue) of the Conveyor 2
    'Search for part on the conveyor
    VRun FindParts2
    'Turn ON the camera shutter and I/O (conveyor trigger)
    On Trigger; On Cv_Trigger1
    Do
      VGet FindParts2.AcquireState, state
  Loop Until state = 3
  VGet FindParts2.Parts.NumberFound, numFound
  'Register the part that has been shot as a queue
  For j = 1 to numFound
    VGet FindParts2.Parts.CameraXYU(j), found, x, y, u
    Cnv_QueAdd 2, Cnv_Point(2, x, y)
  Next J
  'Turn OFF the camera shutter and I/O (conveyor trigger)
  Off Trigger; Off Cv_Trigger2
  Wait .1

  Loop
Fend

Function PickParts
  OnErr GoTo ErrHandler
  Integer ErrNum
  MemOff 1
  MemOff 2
  Do
  WaitPickup1:
    'Tracking of Conveyor 1
  'Turn ON the memory I/O when the Conveyor 1 tracking phase starts
    MemOn 1
    'Clear the parts (queue) in the downstream side from the downstream limit
```

```
Do While Cnv_QueLen(1 CNV_QUELEN_DOWNSTREAM) > 0
  Cnv_QueRemove 1, 0
Loop
'Move to the standby position when  there is no part (queue) in the Pickup Area
If Cnv_QueLen(1, CNV_QUELEN_PICKUPAREA) = 0 Then
  Jump place
EndIf
'Wait until a part (queue) enters the Pickup Area
Wait Cnv_QueLen(1, CNV_QUELEN_PICKUPAREA) > 0
'Start tracking the parts
Jump Cnv_QueGet(1)
On gripper
Wait .1
'Clear the picked part (queue)
Cnv_Queremove 1,0
'Finish the Conveyor 1 tracking phase
MemOff 1

'Tracking of the Conveyor 2
WaitPickup2:
'Start the Conveyor 2 tracking phase
MemOn 2
'Clear the parts (queue) in the downstream side from the downstream limit
Do While Cnv_QueLen(2, CNV_QUELEN_DOWNSTREAM) > 0
  Cnv_QueRemove 2, 0
Loop
'Move to the standby position when  there is no part (queue) in the Pickup Area
If Cnv_QueLen(2, CNV_QUELEN_PICKUPAREA) = 0 Then
  Jump place
EndIf
'Wait until a part (queue) enters the Pickup Area
Wait Cnv_QueLen(2 CNV_QUELEN_PICKUPAREA) > 0
'Start tracking the parts
Jump Cnv_QueGet(2)
Off gripper
Wait .1
'Clear the picked part (queue)
Cnv_QueRemove 2, 0
'Finish the Conveyor 2 tracking phase
  MemOff 2
Loop
'Parts (queue) in the downstream side from the Pickup Area
'When error 4406 occurs, restore automatically
ErrHandler:
  ErrNum = Err
```

```
          If ErrNum = 4406 Then
            If MemSw(1) = On Then
              Cnv_QueRemove 1
              EResume WaitPickup1
            EndIf
            If MemSw(2) = On Then
              Cnv_QueRemove 2
              EResume WaitPickup2
            EndIf
          ' When error 4406 occurs, restore automatically
          Else
          Print "Error!"
          Print "No.", Err, ":", ErrMsg$(Err)
          Print "Line :", Erl(0)
          EndIf
Fend
```

To pick up the same parts with multiple robots

When both robots are handling the same type of parts, you will want to move the parts in the conveyor 1 downstream to the conveyor 2 upstream. This allows parts that were not picked up by robot 1 to be picked up by robot 2.

The following example is of Vision conveyor and Multi-conveyor using two robots in one conveyor.

1. Set one conveyor for each robot.
   (Robot 1 - Conveyor 1, Robot 2 - Conveyor 2)
2. Set the downstream conveyor to the Conveyor 1.
3. Create the following program.

```
Function main

  Xqt ScanConveyorStrobed
  Xqt PickParts1
  Xqt PickParts2

Fend

Function ScanConveyorStrobed

  Integer i, numFound, state
  Real x, y, u
  Boolean found
  Off Trigger; Off Cv_trigger
  Do
     VRun FindParts
        On Trigger; On Cv_Trigger    'Turn on the external
                                      trigger of camera and
                                      conveyor
     Do
        VGet FindParts.AcquireState, state
     Loop Until state = 3
     VGet FindParts.Parts.NumberFound, numFound
     For i = 1 to numFound
       VGet FindParts.Parts.CameraXYU(i), found, x, y, u
       Cnv_QueAdd 1, Cnv_Point(1, x, y)
     Next i
     Off Trigger; Off Cv_Trigger    'Trigger OFF
     Wait .1
  Loop
Fend
```

```
    Function PickParts1

        Robot 1
        OnErr GoTo ErrHandler
        Integer ErrNum

    WaitParts:
        Do
               Wait Cnv_QueLen(1, CNV_QUELEN_PICKUPAREA) > 0
               Jump Cnv_QueGet(1)
               On gripper
               Wait .1
               Jump place
            Off gripper
            Wait .1
            Cnv_QueRemove 1, 0
        Loop

 ErrHandler:
    ErrNum = Err
    If ErrNum = 4406 Then
                Cnv_QueMove 1, 0
                EResume WaitParts
    Else
                Print "Erro occurs!"
                Print "No.", Err, ":", ErrMsg$(Err)
                Print "Line :", Erl(0)
    EndIf
    Fend
```

```
Function PickParts2
     Robot 2
     OnErr GoTo ErrHandler
     Integer ErrNum
WaitParts:
     Do
          Wait Cnv_QueLen(2, CNV_QUELEN_PICKUPAREA) > 0
          Jump Cnv_QueGet(2)
          On gripper
          Wait .1
          Jump place
       Off gripper
       Wait .1
       Cnv_QueRemove 2, 0
     Loop
ErrHandler:
ErrNum = Err
If ErrNum = 4406 Then
            Cnv_QueRemove 2, 0
            EResume WaitParts
Else
           Print "Error occurs!"
           Print "No.", Err, ":", ErrMsg$(Err)
           Print "Line :", Erl(0)
EndIf
Fend
```

To pick up different part types with multiple robots

When both robots are handling different types of parts, you can create a conveyor for each robot. When the vision system finds parts, it adds the part positions to the correct queue, depending on the part type.

15.14 Adjusting the Z value

You can adjust the conveyor Z value after the calibration is completed.

Adjusting the Z value is a function to change the work pickup height that has been determined during calibration.

In the following cases, adjust the Z value:

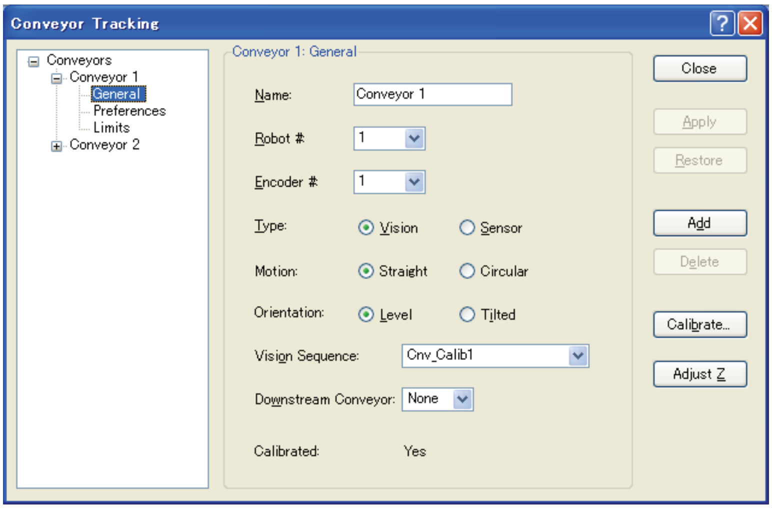
- To use a pickup area that is different from the one defined during calibration.

- The tool has been changed on the robot after calibration.

To adjust the Z value:

1. Select Tools | Conveyor Tracking.
2. Select the conveyor you want to edit.
3. Click on **General**.
4. The dialog shown below appears.

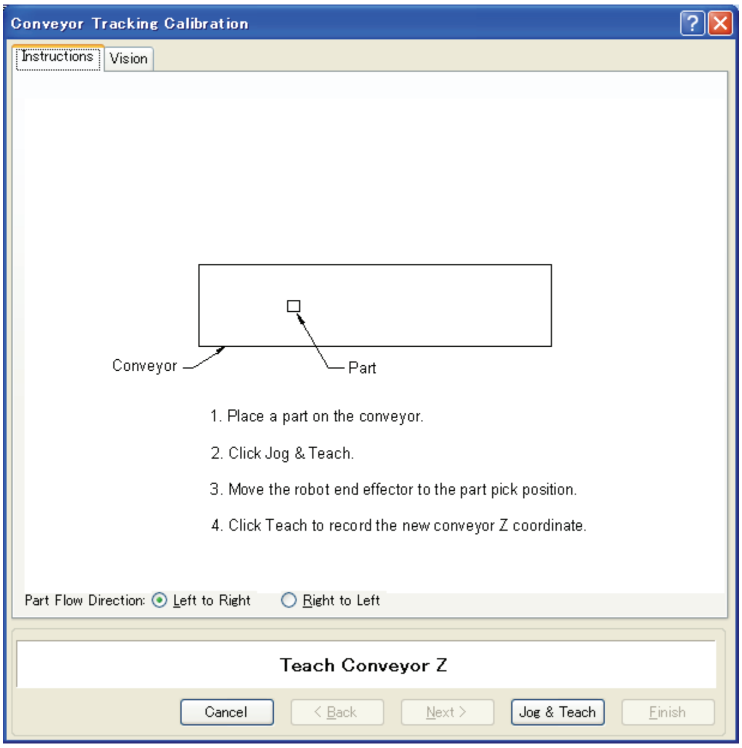
   Click on the **Adjust Z** button.



5. The dialog shown below appears.

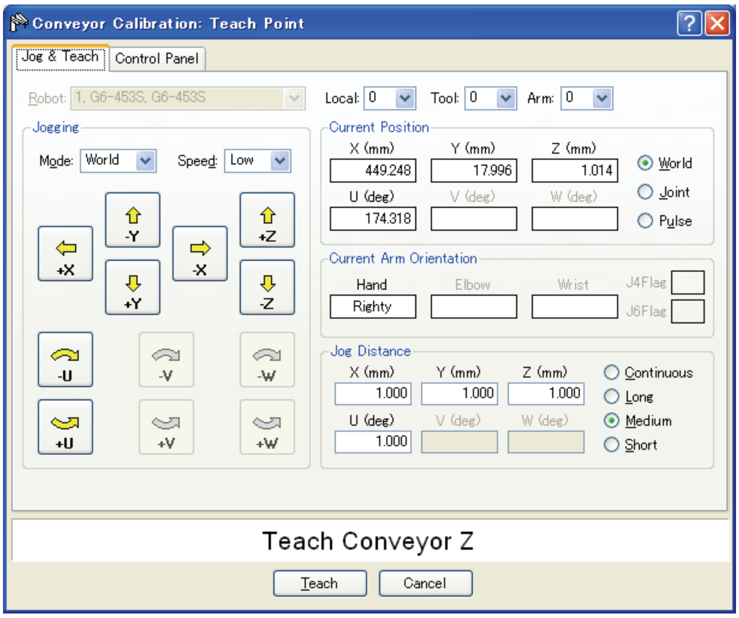
   Place a part on the conveyor in the robot motion range.

   Click on the **Jog & Teach** button.



6. The Jog & Teach dialog will appear. Click the jog buttons to move the robot end effector to the pick position.

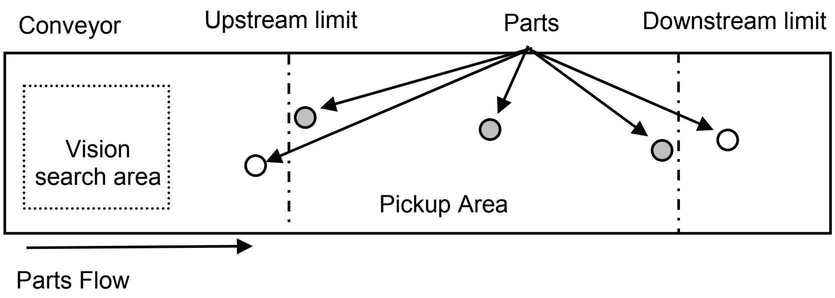
   Click the **Teach** button.



15.15 Pickup Area

The Pickup Area is the range where the robot can pick up parts.

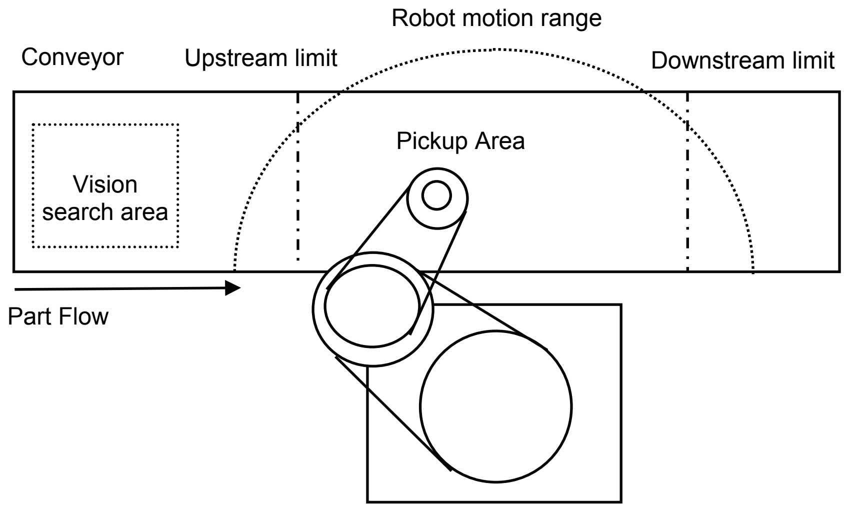
In the figure below, the robot can pick up the parts in gray.



If the Pickup Area is not appropriate, the robot cannot pick up parts. Follow the steps and cautions below to carefully set the Pickup Area.

To define the Pickup Area:

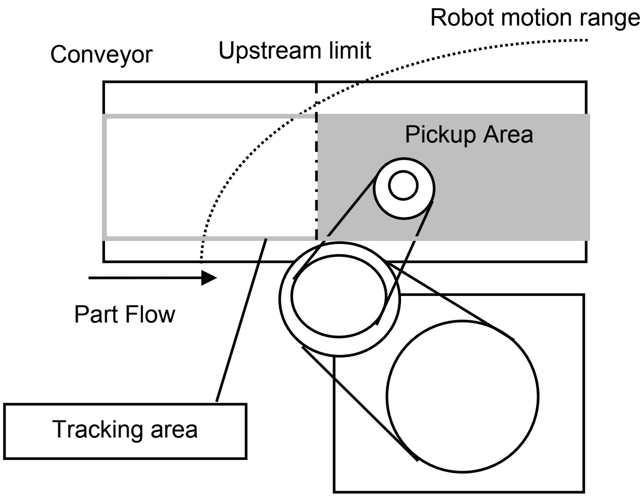
1. After calibration, the Pickup Area will be defined as shown in the following figure. Note that the positions of upstream limit and downstream limit depend on the positions you teach during the calibration.



2. Decide the upstream limit position.

   The robot starts pickup from the line defined by the upstream limit. The Pickup Area from the upstream limit must be within the robot motion range. (See the figure below.)

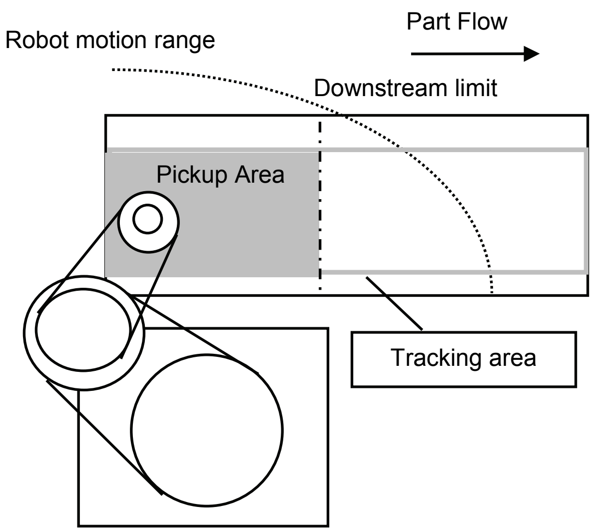
NOTE The robot does not start pickup until parts cross the upstream limit. If you set the upstream limit in uppermost position, you can reduce the robot standby time.



3. Decide the downstream limit position.

   Once the robot starts pickup, it continues its operation even over the downstream limit to complete the whole operation. Therefore, set the downstream limit in uppermost possible position so that the robot can operate within its motion range until it completes the operation. (See the figure below.)

NOTE The downstream limit position depends on the conveyor speed and robot position when it starts pickup. If the robot goes over the motion range during the operation, move the downstream limit to upper side.



Changing the Upstream / Downstream limits positions

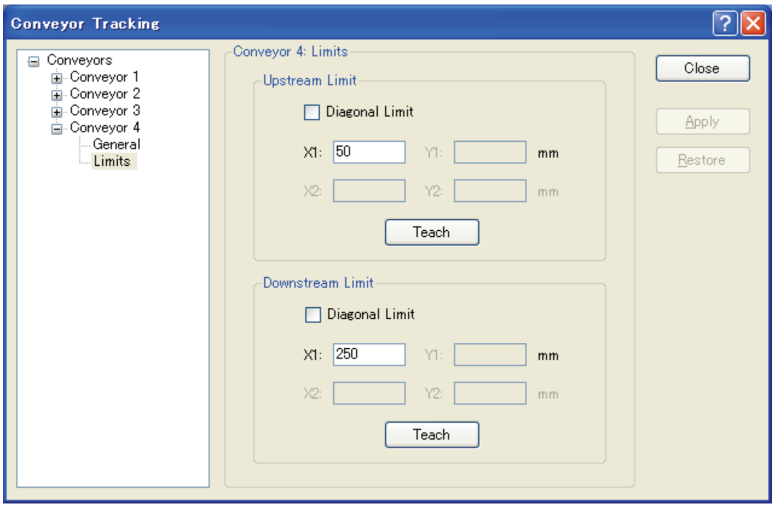
To change the upstream limit and downstream limit positions, follow the steps below.

To change the Upstream Limit:

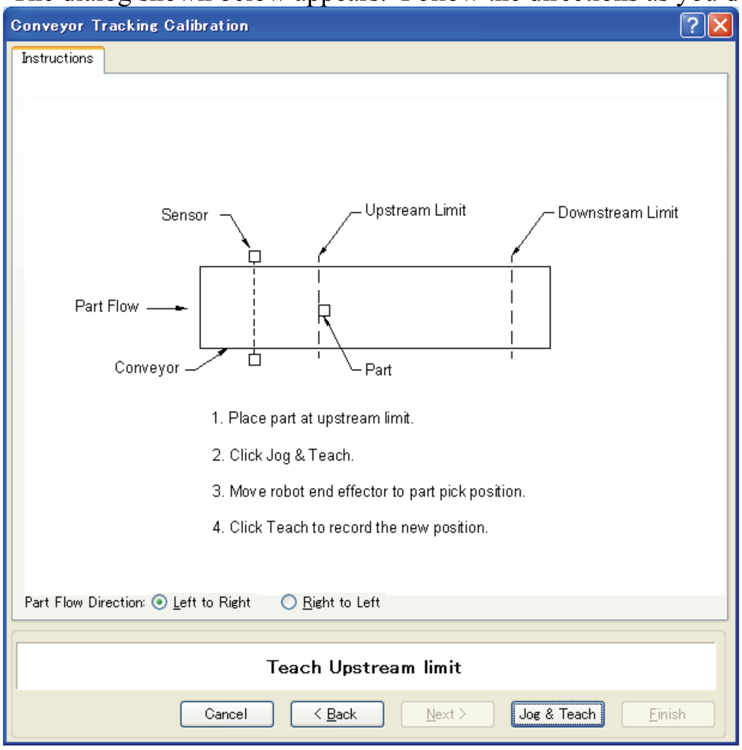
1. Select Tools | Conveyor Tracking.
2. Select the conveyor you want to edit.
3. Click **Limits**.
4. The dialog shown below appears.

   Edit the [Upstream Limit] value.

   To define the X1 value, enter a value directly or use Jog & Teach. Entering values directly is for fine adjustment.



5. When you directly specify the value, enter the value in the box and click **Apply**.
6. When you use Jog & Teach, click the **Teach** button.
7. The dialog shown below appears. Follow the directions as you do during calibration.

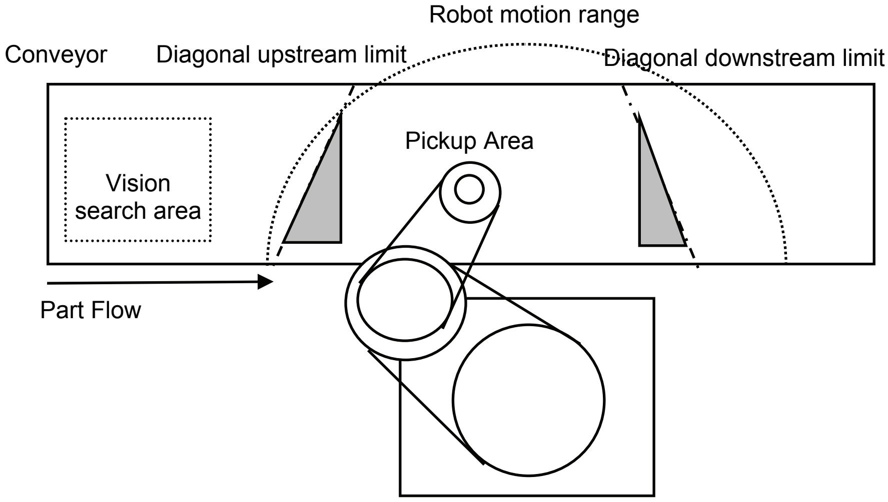


To change the downstream limit, edit the [Downstream Limit] value the same as described for the upstream limit.

Diagonal Upstream / Downstream Limits

After the calibration, you can set the dividing lines for the Pickup Area (upstream limit / downstream limit) directed diagonally to the part flow.

When you change the dividing lines to diagonal positions, the Pickup Area also changes as shown below. The area indicated in gray is widened by changing the dividing lines to diagonal positions. In addition, diagonal dividing lines are called the diagonal upstream / downstream limits.



The following are the advantages you can get by widening the Pickup Area.

- Reduce robot standby time by widening the upper side Pickup Area.

- Less possibility of missing parts which flow longer after the downstream limit.

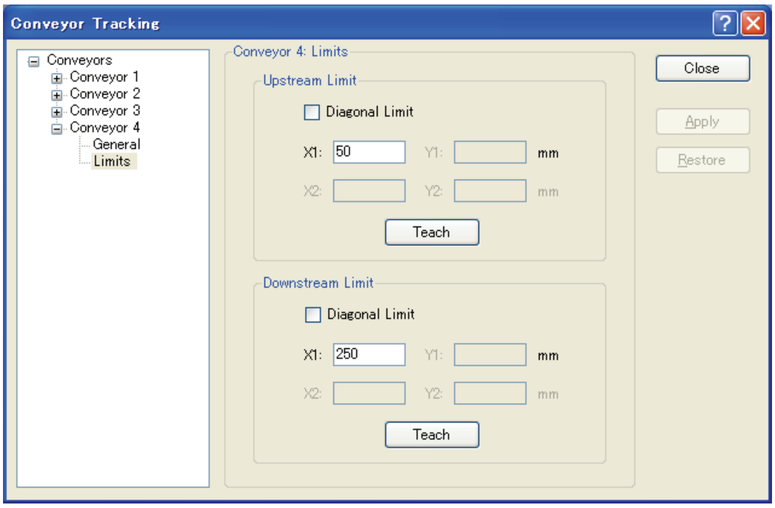
NOTE

If there are too many parts on the conveyor for the robot to pick up, it only makes the robot move for longer distance and longer time and the number of parts the robot can pick up may decrease, even in a widened Pickup Area. For such a case, you may want to consider using the multiple conveyors system. To use the multiple conveyors system, set a short Pickup Area in the upstream conveyor and wide Pickup Area in the downstream conveyor.

The robot capacity (how fast or how many parts robot can pick up) depends on the Pickup Area width, robot standby position, and conveyor speed.

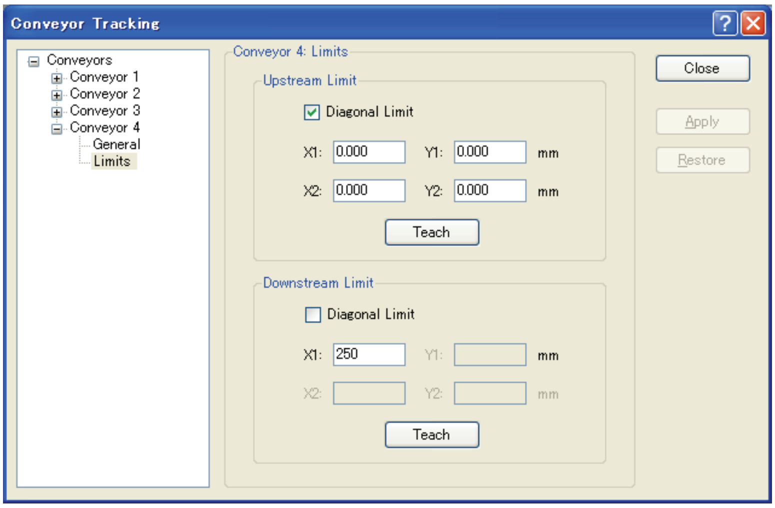
To set the diagonal upstream limit:

1. Select Tools | Conveyor Tracking.
2. Select the conveyor you want to edit.
3. Click on **Limits**.
4. The dialog shown below appears.



Check the <Diagonal Limit> check box in the [Upstream Limit] area and click **Apply**.

The following dialog appears.

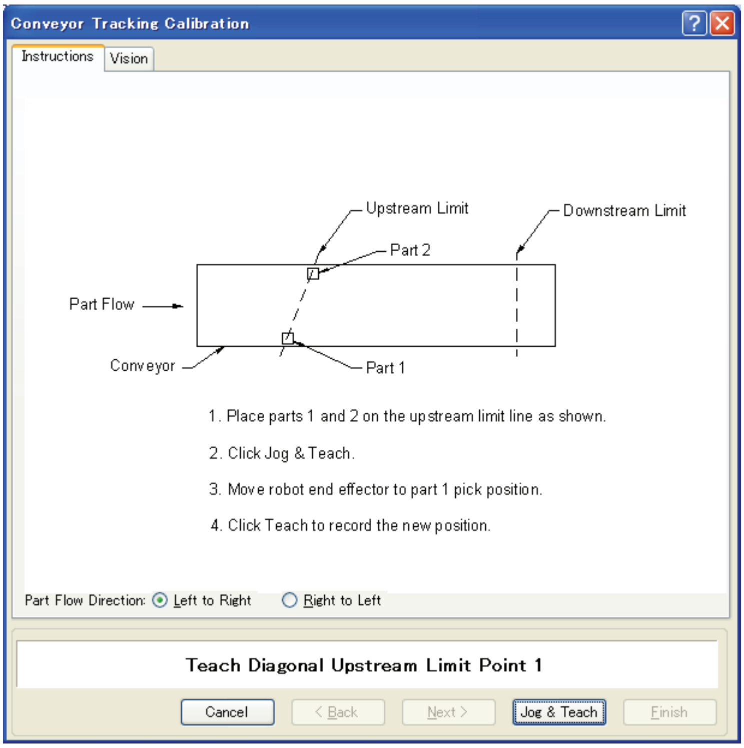


To define the values for X1, Y1, X2, Y2, enter the values directly or use Jog & Teach. Entering values directly is for fine adjustment.

5. When you directly specify the values, enter the values in the boxes and click **Apply**.

6. When you use Jog & Teach, click **Teach**.

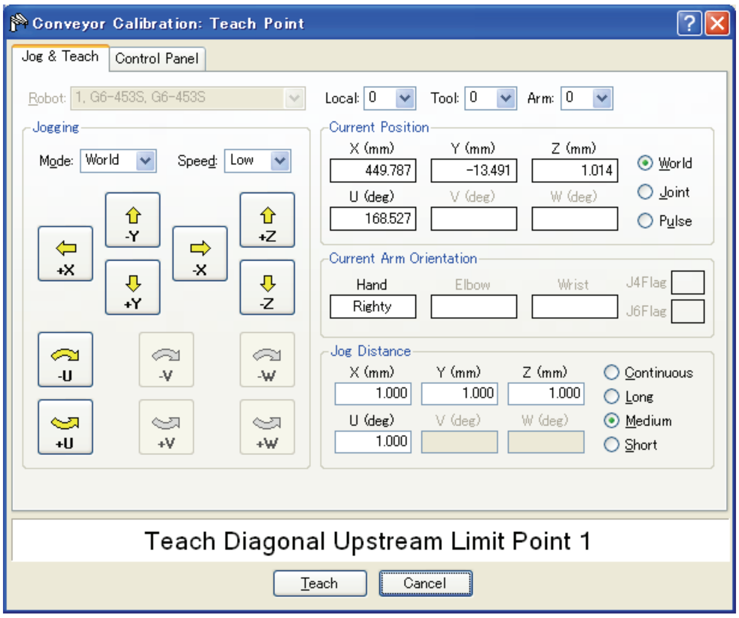
   The dialog shown below appears.



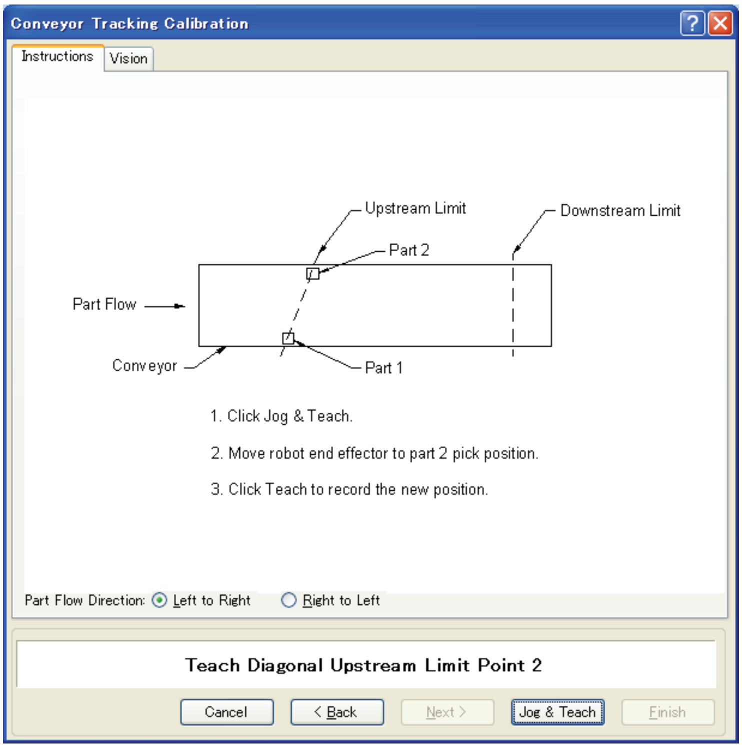
7. Place two parts on the conveyor.

   Click the **Jog & Teach** button.

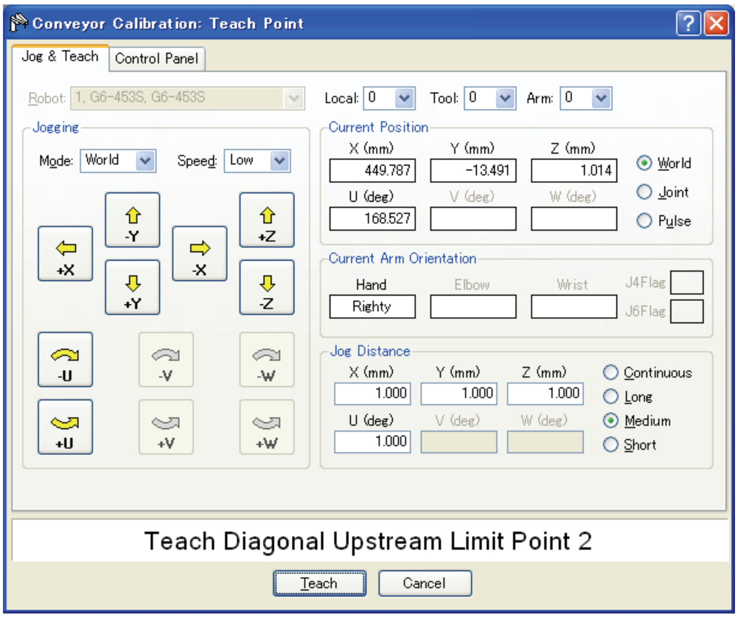
8. The Jog & Teach dialog appears. Click the jog buttons to move the robot end effector to the pick position. Click the **Teach** button.



9. The dialog shown below appears. Click the **Jog & Teach** button.

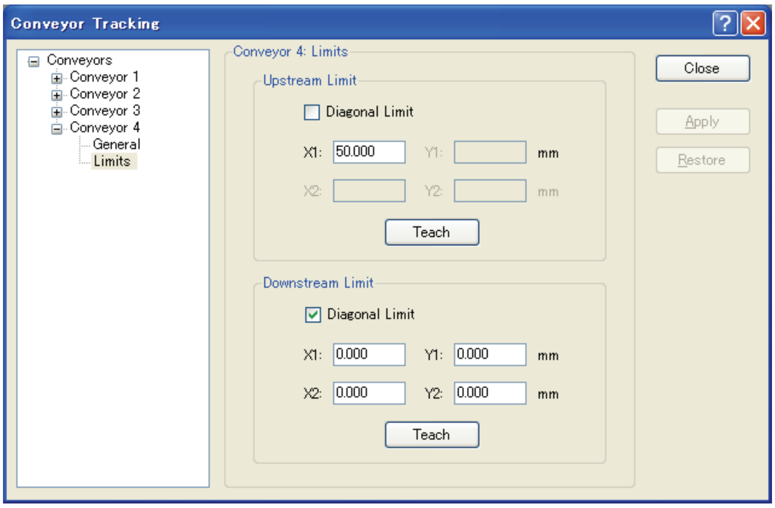


10. The Jog & Teach dialog appears. Click the jog buttons to move the robot end effector to the pick position. Click the **Teach** button.



To set the diagonal downstream limit, check the <Diagonal Limit> check box in the [Downstream Limit] area and click **Apply**.

The following dialog appears. Click the **Teach** button and follow the directions in the wizard.



Note that error 4415 occurs when the diagonal upstream / downstream limits are defined as in the following cases.

- They are perpendicular to the part flow direction.
- They are parallel to the part flow direction.
- The diagonal upstream limit and downstream limit cross on the conveyor.

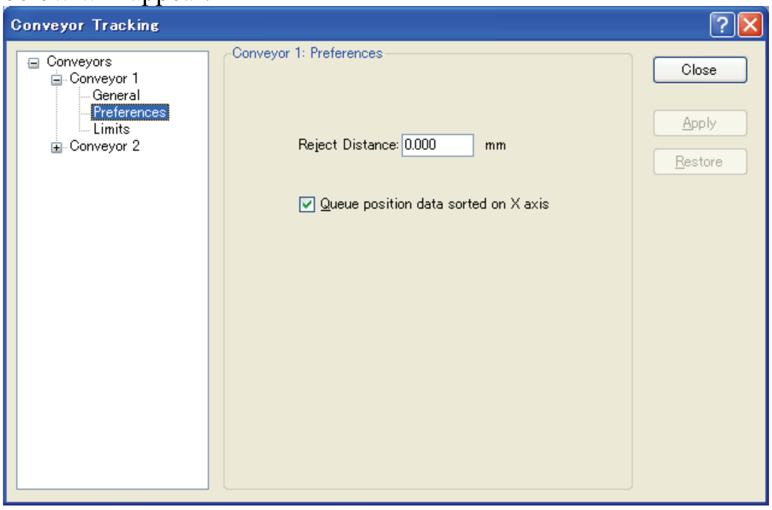
15.16 Queue Sorting

When you set the queue sorting, it registers the queue data in the order of position along the X axis in the conveyor local coordinate system.

Set 0 for the index number of Cnv_QueGet command. If you set nothing, the robot picks up parts from the downstream side.

To set the queue sorting

1. Select Tools | Conveyor Tracking.
2. Click the conveyor you want to configure and select the [Preferences]. The dialog below will appear.



3. Set the [Queue position data sorted on X axis] box.
4. Click the **Apply** button.

NOTE

When you set a diagonal upstream limit, register the queue data in the order of entering the Pickup Area.

Also, when you set a diagonal upstream limit, note that the queue sorting cannot be canceled.

15.17 Abort Tracking

There are some situations when you want to abort tracking a part that moves out of the Pickup Area while the robot is tracking the part. In this case, use the Cnv_AbortTrack command in a separate task that monitors the conveyor queue.

```
Function MonitorDownstream
  Robot 1
  Do
    If Cnv_QueLen(1, CNV_QUELEN_DOWNSTREAM) > 0 Then
      Cnv_AbortTrack 0
    EndIf
    Wait .1
  Loop
Fend
```

15.18 Conveyor Tracking with 6-Axis Robot

When you use a 6-axis robot in a conveyor tracking system, you need to set the values of U, V, and W. For this, use the Cnv_QueGet command.

The following shows the case where the robot end effector moves toward a part during the pickup.

```
Go Cnv_Queget(Conveyor number,[Index]):U(90):V(0):W(180)
```

15.19 Tracking Mode

There are two tracking modes: picking quantity-priority mode and picking accuracy-priority mode. The mode can be selected by Cnv_Mode command.

Tracking mode selection is only available for linear conveyors. For circular conveyors, the picking quantity-priority mode is only available.

Picking quantity-priority mode

Picking quantity-priority mode prioritizes reducing time to catch up with the work piece (queue) over the picking accuracy. This mode is suitable for the conveyor tracking system in which space between the work pieces is narrow.

NOTE

When the picking quantity-priority mode is selected, tracking delay (situation in which the Manipulator does the picking motion at the posterior part of the work piece to the direction of the conveyor motion) may occur. If the tracking delay occurs, write the program as follows.

```
Go Cnv_Queget(Conveyor number,[Index])+X(**)
```

Picking accuracy-priority mode

Picking accuracy-priority mode improves the picking accuracy while it takes more time to catch up with the work piece. This mode is suitable for the conveyor tracking system for small work pieces.

Picking accuracy-priority mode should be used for the conveyors of 350mm/sec or less.

NOTE

When the conveyor of 350mm/sec or more is used, the tracking mode will be picking quantity-priority mode regardless of the setting of Cnv_Mode.

NOTE

Although the tracking delay does not occur in the picking accuracy-priority mode, the Manipulator may slide to the direction of the conveyor motion in Go, Move, or Jump3 motions after the downward motion of the Z-axis. If this occurs, take following countermeasures (these may not be effective for Go and Move motions)

- For Go motion: Change to Jump motion. Or, reduce the values of Accel and Speed.
- For Move and Jump3 motions: Reduce the values of AccelS and SpeedS.

15.20 Manipulator Posture

Manipulator posture during the tracking motion is always the default posture regardless of the posture at the conveyor tracking calibration. To specify the posture for the tracking, write a program as follows.

Example: tracks the work piece with Lefty arm position

```
jump Cnv_Queget(Conveyor number,[ndex])/L
```

NOTE

During the tracking motion, singularity avoiding function cannot be used. Therefore, set the positions of the Manipulator and the conveyor so that the Manipulator does not pass through the singularity.