

VISION-GUIDED ROBOTICS ROBOT CONNECTION MANUAL

Universal Robots A/S EDITION

This manual provides support for the necessary robot-side settings that must be configured to establish connections and communication between the XG/CV-X/XG-X Series and a robot.

1	Startup Flow
2	Connecting to Robots
3	Robot Communication Settings
4	Writing the Communication Program
5	Running the Communication Program (Only during Setting)
6	Vision controller Output Settings
7	Running the Sample Program for 2D Vision-Guided Robotics (Only during Operation)
8	Operation Program (Path Generation) for 3D Vision-Guided Robotics

- Robot controller: UR3/UR5/UR10
(* For the latest information, see the company's website.)
- Communication method: Ethernet

English

Japanese(日本語)





Simplified Chinese(简体中文)


- Secondary damages (such as equipment damage, opportunity loss, and lost profit) and any and all other damages arising from the settings and programs introduced in this manual are not covered by the warranty.
- You have to separately create robot movement programs such as those used during actual operations.
- Proper nouns such as product names included in this manual are trademarks or registered trademarks of their respective companies. Note that the TM and ® marks are not written in this manual.
- The contents of this manual may be changed without notice in the interest of improving the manual.


Introduction


Symbols


The following symbols are used in this manual to enable you to recognize important information at a glance. Be sure to read this section carefully.

	It indicates a hazardous situation which, if not avoided, will result in death or serious injury.
	It indicates a hazardous situation which, if not avoided, could result in death or serious injury.
	It indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
	It indicates a situation which, if not avoided, could result in product damage as well as property damage.

	It indicates precautions and limitations that must be followed during operation.
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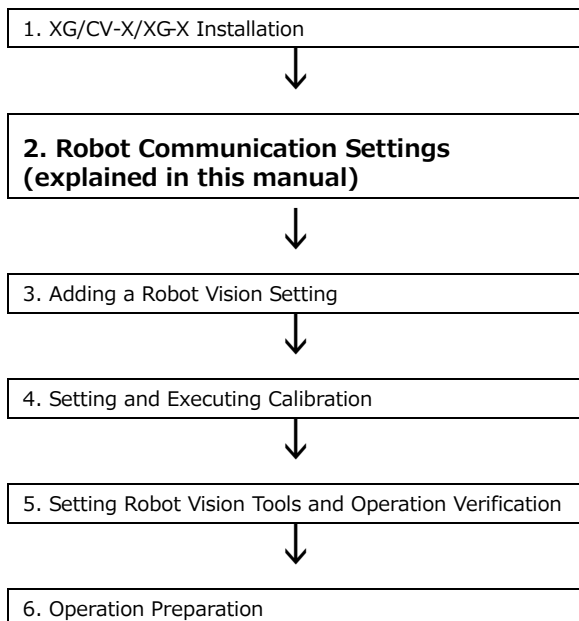
	It indicates additional information on proper operation.
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	It indicates tips for better understanding or useful information.
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 It indicates items and pages in this manual to be referenced.

Vision-Guided Robotics Setup Flow

This manual explains step "2. Robot Communication Settings."
For all other steps, see the "Vision-Guided Robotics Easy Installation Guide."



Items to Prepare

The items to prepare before connecting the XG/CV-X/XG-X Series controller (hereinafter referred to as "vision controller" in this manual) to the robot controller are listed below.

- ☐ Ethernet cable
 - • • Connects the vision controller and the robot controller
- ☐ USB memory device
 - • • Used to copy the robot program for communication

About Coordinate Systems

You cannot change the robot coordinate system from the vision controller.

The coordinate values and angles handled by the vision controller are the values that are displayed when the following items are selected for a UNIVERSAL ROBOTS device.

- "Feature" "Base"
- "Tool Position" "RPY[°]"

1. Startup Flow

1-1 2D Vision-Guided Robotics

Performing advance preparation and configuring settings

[Advance preparation (1)] Checking the robot operation (preparation without using an image device)

1. Robot preparation

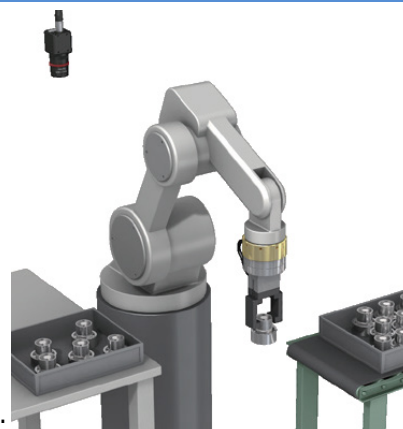
Enable jog operation on the robot.

(Create the user coordinates and tool coordinates to use.)

2. Program startup preparation

Create and check the operation of the program that will be used to grip the target at the specified position and place the target at the specified position.

* The opening and closing of the hand are also required, so the corresponding wiring and operation checks must also be performed.



1

Startup Flow

[Advance preparation (2)] Attaching the camera and lighting

Attach the camera and wire the devices.

[Advance preparation (3)] Checking the communication

Carry out the work described starting in chapter 2 of this manual.

[Image processing settings] Configure the image processing settings.

Link and configure the settings of the camera and robot, and then verify the operations with the actual devices.

- Image capturing and lighting settings, calibration, search settings, and master position registration

Checking operation using the sample program and creating the program for actual operation

Start the sample program and check the operation.

The following operations are written in the sample program.

- (1) Issue the trigger. → Receive the data.
- (2) Move to the target's position.

Communication (command I/O) can be checked and movement to the acquired position can be checked by starting the program.

(Caution: The arm moves in a straight line from the current position to the detected position.)

However, the hand operations as well as the preceding and subsequent operations are not written in the program. Therefore, as shown below, when not using image processing it is necessary to add the sample program instructions to the program or to add to the sample program those operations that it does not already include to create the program for operation.



Move P1 (Move to standby position P1.)

↓
Apply a trigger to the camera.

↓
Write the output coordinates to P3.

↓
Move P2 (Move to above the target.)

↓
Move P3 (Lower to the height of the target.)

↓
Hand operation (Grip the target.)

↓
Move P4 (Move to above the pick position.)

↓
Move P5 (Move to above the place position.)

↓
Move P6 (Lower to the place position.)

↓
Hand operation (Release the target.)

↓
Move P7 (Move to above the place position.)

↓
Move P1 (Return to the standby position.)

The difference in the robot program compared to when not using vision-guided robotics is the part written in red on the left. These details are written in the sample program.

When changing the text of the sample program, specify items such as:

- The preceding and subsequent operations.
- The opening and closing operations of the hand.
- The path when moving to the target's position.

Specify these items to ensure the operations are appropriate for the device.

Performing advance preparation and configuring settings

[Advance preparation (1)] Checking the robot operation (preparation without using an image device)

1. Robot preparation

Enable jog operation on the robot.

Create the tool coordinates of the hand to use.

2. Program startup preparation

Create and check the operation of the program that will be used to grip the target at the specified position and place the target at the specified position.

* The opening and closing of the hand are also required, so the corresponding wiring and operation checks must also be performed.

[Advance preparation (2)] Attaching and warming up the RB

Attach the RB and supply 24 V to it.

(The center projector lights and switches to the warming up state.)

The orientation in the image is such that receiver T faces up.

[Advance preparation (3)] Checking the communication

Carry out the work described starting in chapter 2 of this manual.

[Image processing settings] Refer to the Easy Configuration Manual and configure the image processing settings.

<<Configuring settings in advance on a PC (in Picking Simulator)>>

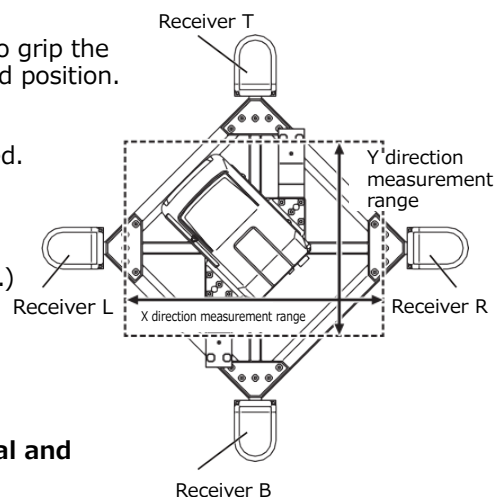
Use the image created in CAD software or Picking Simulator to configure settings and perform verification. Configure calibration and other such settings related to the robot and image capturing during on-site startup.

- 3D search, path generation, Picking Simulator, etc.

<<Configuring settings at the worksite>>

Link and configure the settings of the camera and robot, and then verify the operations with the actual devices.

- Camera calibration, robot calibration, 3D search, path generation, etc.



Checking operation using the operation program and creating the program for actual operation

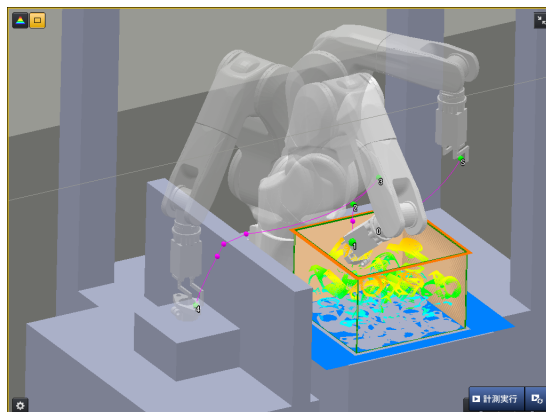
Start the operation program and check the operation (details are written in chapter 7).

The following operations are written in the operation program.

- (1) Move to the image capture standby position.
- (2) Issue the trigger. → Receive the data.
- (3) Move to the target's position (approach position → grip position).
- (4) Hand operation (Grip the target.) * Write the hand operations in the program designed for gripping.
- (5) Move to the place position.
- (6) Hand operation (Release the target.) * Write the hand operations in the program designed for releasing.
- (7) Move to the image capture standby position.

The sequence of operations can be checked without having to change the program.

If necessary, add information such as movements and operation control signals before and after this sequence.



2. Connecting to Robots

Connecting to the vision controller by Ethernet

Use an Ethernet cable to connect the LAN connectors of the vision controller and the robot controller.



- We recommend that you use a category 5e or higher STP cable.
- If you are using a direct connection (not a hub), we recommend that you use a crossover cable.
- The KEYENCE genuine cable is a 3m, STP type, crossover cable (OP-66843).

3. Robot Communication Settings

Use the teach pendant to configure the robot controller's communication settings.

3-1 Configuring the Network Settings of the Robot Controller

1. On the initial screen (Robot User Interface), press "SETUP Robot."
2. On the "SETUP Robot" screen, press "Setup NETWORK."
3. Select "Static Address," and then enter the "IP address," Subnet mask," and "Default gateway" of the robot controller.

Setting example

IP address:	192.168.0.1
Subnet mask:	255.255.255.0
Default gateway:	0.0.0.0



Ensure that the IP address is not the same as that of another device.



Set the IP address and subnet mask so that the robot controller is within the same network as the vision controller.

If necessary, set the default gateway.

Example) Subnet mask: 255.255.255.0 (default value)

If the IP address of the XG/CV-X is 192.168.0.10

Only the fourth octet of the IP address ("10" in the above example) can be changed to a value in the range of 1 to 254.

4. Press "Apply settings."



When you press "update," all the values will be cleared.

5. Press "BACK."

You will return to the initial screen.

4. Writing the Communication Program

Write "Robot Vision Setup Program," the robot program for communicating with the vision controller, onto the robot controller.

4-1 Downloading the Communication Program

1. Download "Robot Vision Setup Program" for the relevant robot model from the "Vision-Guided Robotics User Support" page on the KEYENCE website, and then decompress the downloaded file.

4-2 Loading the Communication Program

1. Copy "KeyenceRobotVisionSetup.urp," the Robot Vision Setup Program that you have decompressed, to the USB memory device.
2. Insert the USB memory device to which you have copied the Robot Vision Setup Program into the USB port of the teach pendant.
3. On the initial screen, press "PROGRAM Robot."
4. On the "New Program" screen, press "Load Program."
5. Press the USB memory device icon, and then select the copied file.
6. Press "Open."
7. Select "Yes" in the dialog box that is displayed.

The program will open.

4-3 Configuring the Settings of the vision controller to Connect To

Set the IP address and port number of the vision controller to connect to.

1. In the program tree on the left side of the screen, select "Before Start," and then select "CUR_SetupCamera."
2. Edit the IP address and port number of the vision controller in the displayed "Script Code."

```
CUR_SetupCamera("Cam1","192.168.0.10",8500)
```

Item	Value
IP address	192.168.0.10
Port number	8500

The above details indicate the default values on the vision controller side. Unless otherwise necessary, configure the settings with these details.



Ensure that the IP address is not the same as that of another device.

3. On the "File" menu, select "Save."
4. To run the program as-is, press "▶" in the lower part of the screen. If you do not want to run the program, select "Exit" on the "File" menu at the top of the screen.

5. Running the Communication Program (Only during Setting)

Run the communication robot program "Robot Vision Setup Program."

In advance, follow the procedure in "3-3 Configuring the Settings of the vision controller to Connect To" to set the IP address and port number.



Point

Be sure to run "Robot Vision Setup Program" before you perform operations on the robot vision setting and before you execute communication commands.

5-1 Running Robot Vision Setup Program

Run "Robot Vision Setup Program."

1. On the initial screen, press "RUN Program."
2. From the menu at the top of the screen, select "Load...."
3. Press the USB memory device icon, and then select the copied file.
4. Press "Open."
5. Press "▶" in the lower part of the screen.
6. Select "Yes" in the dialog box that is displayed.

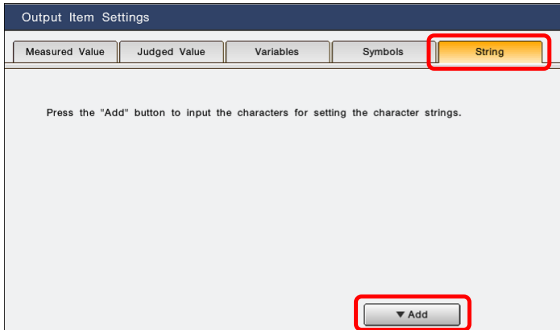
The "status" display changes from "Stopped" to "Running."

6. Vision controller Output Settings

Add the following character strings at the start and end of the settings to output during operation.
If these strings are not added, the output data from the vision controller cannot be received on the robot controller side.

6-1 Adding "(" at the Start

1. On the "Output Item Settings" screen, select the "String" tab, and then press "Add."



2. Enter "(" (opening parenthesis).

If this is not added at the start, press "↑" or "↓" to set the character string "(" at the start.

6-2 Adding Judged Values and Measured Values

When you are using the sample program, add the following.

- "Juded Value" of the Robot Vision Tool
- "Measured Value: Robot Coordinates XYZRxRyRz" of the Robot Vision Tool (Not required for 3D vision-guided robots)

6-3 Adding "0)" at the End

1. In the same manner as "5-1 Adding '(' at the Start," enter "0)" (zero + closing parenthesis).

If this is not added at the end, press "↑" or "↓" to set the character string "0)" at the end.



Point Note that the text will not be identified correctly if it is entered with full-width characters.

Setting example

No.	Output Data
0	(
1	T101: Picking Using 1 Camera Judged Value
2	T101: Picking Using 1 CameraRobot Coordinates XYZRxRyRz
3	0)

Setting example (3D vision-guided robots when using the path generation tool)

<input checked="" type="checkbox"/> Output	No.	Output Data
<input checked="" type="checkbox"/>	0	(
<input checked="" type="checkbox"/>	1	T101: Path PlanningDetected Count
<input checked="" type="checkbox"/>	2	0)

Setting example (3D vision-guided robots when using the 3D picking tool)

<input checked="" type="checkbox"/> Output	No.	Output Data
<input checked="" type="checkbox"/>	0	(
<input checked="" type="checkbox"/>	1	T101: 3D Pick Judged Value
<input checked="" type="checkbox"/>	2	0)

7. Running the Sample Program for 2D Vision-Guided Robotics (Only during Operation)

This chapter explains the procedures for running the sample program during operation.



Point When using a robot made by UNIVERSAL ROBOTS, you cannot use the sample program creation function within the robot vision setting to create sample programs.
Download the "sample program" from the "Vision-Guided Robotics User Support" page on the KEYENCE website.

7-1 Downloading the Sample Program

1. Download the "sample program" for the relevant robot model from the "Vision-Guided Robotics User Support" page on the KEYENCE website, and then decompress the downloaded file.

7-2 Writing the Sample Program onto the Robot Controller

1. Copy "KeyenceRobotVisionSample.urp," the sample program that you have decompressed, to the USB memory device.
(The sample program for 3D vision-guided robots is "KeyenceRobotVisionSample3D.urp.")
2. Insert the USB memory device to which you have copied the sample program into the USB port of the teach pendant.
3. On the initial screen, press "PROGRAM Robot."
4. On the "New Program" screen, press "Load Program."
5. Press the USB memory device icon, and then select the copied file.
6. Press "Open."
7. Select "Yes" in the dialog box that is displayed.

The program will open.

7-3 Configuring the Settings of the vision controller to Connect To

Set the IP address and port number of the vision controller to connect to.

1. In the program tree on the left side of the screen, select "Before Start," and then select "CUR_SetupCamera."
2. Edit the IP address and port number of the vision controller in the displayed "Script Code."

```
CUR_SetupCamera("Cam1","192.168.0.10",8500)
```

Item	Value
IP address	192.168.0.10
Port number	8500

The above details indicate the default values on the vision controller side.
Unless otherwise necessary, configure the settings with these details.



Point Ensure that the IP address is not the same as that of another device.

3. On the "File" menu, select "Save."
4. To run the program as-is, press "▶" in the lower part of the screen.
If you do not want to run the program, select "Exit" on the "File" menu at the top of the screen.

7-4 Running the Sample Program

Run a the "sample program."

1. On the initial screen, press "RUN Program."
2. From the menu at the top of the screen, select "Load...."
3. Press the USB memory device icon, and then select the copied file.
4. Press "Open."
5. Press "▶" in the lower part of the screen.
6. Select "Yes" in the dialog box that is displayed.

The "status" display changes from "Stopped" to "Running."

8. Operation Program (Path Generation) for 3D Vision-Guided Robotics

This chapter describes the communication commands that can be used when performing operations using the path generation tool.



The program "Robot Vision Setup Program (KEYENCESETUP)" is not executed during operation but is required to use communication commands.

8-1 Operation Program Files and Their Descriptions

An overview of the files used by the operation program is shown below.

File name	Description	Change needed?
OperationProgramPP.urp	This is the main program of the operation program that uses the path generation tool. For the program flow, see "8-4 Time Chart."	✓
OperationProgramUtil.script	This file contains the subprogram called from the main program. Normally, no changes are required.	

8-2 Locations That Need to Be Changed in This Program

The following labels are written as comments in the locations where changes are required in OperationProgramPP.urp. Robot operations can be written in an arbitrary manner in these locations.

Label name	Description
KEY_ACT_AT_CAPTURE_WAIT_POS	Write in this location the operations that the robot will execute at the image capture standby position.
KEY_ACT_AT_APPROACH_POS	Write in this location the operations that the robot will execute when it reaches the approach position.
KEY_ACT_AT_GRIP_POS	Write in this location the operations that the robot will execute when it reaches the grip position.*1
KEY_ACT_AT_DEPART_DEST_POS	Write in this location the operations that the robot will execute when it reaches the depart position.*1
KEY_ACT_AT_PLACE_POS	Write in this location the operations that the robot will execute when it reaches the place position.
KEY_ACT_AT_EACH_POS	If there are operations to be executed each time the robot reaches the end point of a segment, write said operations in this location. To write an operation that you want to execute at an arbitrary segment end point, establish the IF statement of the corresponding segment number. If adding a segment in the CV-X path settings offsets the segment numbers that were already present, also correct the operations that have been written.

*1 A separate operation can be written for grip settings where "Pull close" is specified for the depart operation.

BLOCK A: Writing location for the "Lift up" operation

BLOCK B: Writing location for the "Pull close" operation

8-3 Global Variables Used by This Program and Their Descriptions

The following global variables are initialized in BeforeStart of OperationProgramPP.urp.

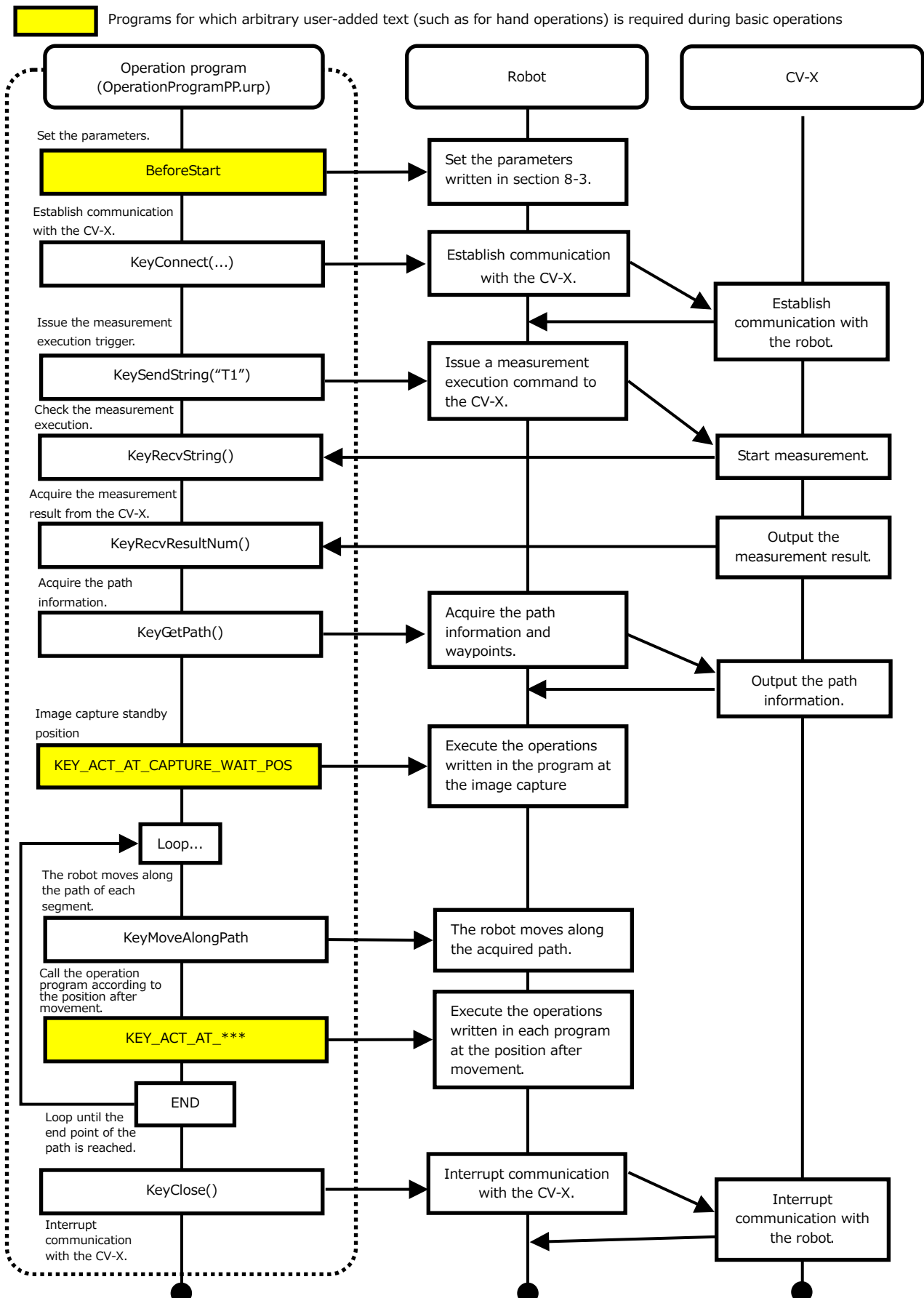
Enter values according to the CV-X settings and the operating conditions of the system.

Variable name	Setting item	Description
g_key_ip_addr	IP address of the CV-X	Set the IP address of the CV-X.
g_key_port_no	CV-X port number	Set the port number of the CV-X.
g_key_tool_id	Path generation tool ID	Enter the ID of the path generation tool.
g_key_label_no	Path label number	Specify the label number of the path acquired from the path generation tool. Normally, one label is output, so specify 0 as the label number.
g_key_speed	Robot operation movement speed (rad/s)	Specifies the movement speed during joint interpolation (PTP) operation instructions used by this program. Specify the rotation speed (unit: rad/s) of each axis. The robot operation format with this program is only configured to use joint interpolation operation.

8-4 Time Chart

The time chart between the robot and the CV-X is shown below. Operations follow the flow shown below when the operation program is run.

*** Move the robot to the image capture standby position before the operation program starts.**



Revision History

Date	Version	Revision details
May 2015	First edition	
July 2015	2nd edition	XG Series has been added.
April 2016	3rd edition	XG-X Series has been added.
October 2017	4th edition	Text has been added and changed.
March 2018	Revised 1st edition	Text has been added and changed.
March 2020	Revised 2nd edition	Support has been added for the path generation tool.

Specifications are subject to change without notice.

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SINGAPORE

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