Manual Version 2.0

Software Version 2.8

Doosan Robot

M0609 I M0617 I M1013 I M1509
A0509 I A0509s I A0912 I A0912s
H2017 I H2515

Reference Manual

This manual is composed of four parts.Part 1 describes Workcell Item Setting options, part 2 describes Task program commands and Template Setting options, part 3 describes the operation and use of the Smart Vision module, and part 4 describes how to operate conveyor tracking.

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This manual is a detailed manual for a specific software version of the robot. For details on updated manuals, refer to the Robot LAB website (https://robotlab.doosanrobotics.com/).

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Part 1
Workcell Item

1. Workcell Item Summary

Workcell Item refers to the robot and all peripherals used together with the robot.

Workcell items can be configured in the Workcell Manager screen before use. Also, the Workcell Manager can set commands for peripherals and can configure commands for the robot to perform certain patterns and actions.

This manual describes the Workcell Item Setting options in the Workcell Manager for the end effector, machine and peripherals.

Item	Description
End Effector	End effectors can be added to the robot, and the added end effector is displayed.
Machine	Machines compatible with the robot can be added, and the added machine is displayed.
Peripherals	Peripherals connected to the robot can be added, and the added peripheral is displayed.

1.1 Workcell Item Common Setting Options

Common setting options for Workcell Items are as follows:

Item	Description
Output Signal	It selects the output signal type.
Input Signal	It selects the input signal type.

2. End Effector

2.1 Gripper

There are double-action and single-action grippers. If the gripper is equipped with a sensor that checks input signals, input signal check is available. The standard gripper WCI can only be operated using the flange IO.

2.1.1 Double-Action Gripper (Gripper DA)

This is a gripper that operates with two digital IO signals.

Item	Description
out_Grasp	This sets the output signal for grasping the target. A motion is executed when the grasp output signal is on and the release output signal is off.
out_Release	This sets the output signal for releasing the target. A motion is executed when the release output signal is on and the grasp output signal is off.
Grasp_in	This configures an input signal that checks whether the grasping of the target is complete. This item is optional.
Release_in	This configures an input signal that checks whether the releasing of the target is complete. This item is optional.

This is a test function for the double-action gripper WCI.

Test Function	Description
Grasp	[Mandatory Action] It performs a grasp motion with the out_Grasp signal on and the out_Release signal off.
Release	[Mandatory Action] It performs a release motion with the out_Release signal on and the out_Grasp signal off.

2.1.2 Single-Action Gripper (Gripper SA)

This is a gripper that operates with one digital IO signal.

Item	Description
out_Grasp	This sets the output signal for grasping the target. A grasp motion is executed when the signal is on and a release motion is executed when the signal is off.
Grasp_in	This configures an input signal that checks whether the grasping of the target is complete. This item is optional.

This is a test function for the single-action gripper WCI.

Test Function	Description
Grasp	[Mandatory Action] It performs a grasp motion with the out_Grasp signal on.
Release	[Mandatory Action] It performs a release motion with the out_Grasp signal off.

2.2 Tool

This is a tool that operates with a single-action digital IO signal. If the tool is equipped with a sensor that checks input signals, input signal check is available. The standard tool WCI can only be operated using the flange IO.

Item	Description
out_Run	This configures the signal that turns the tool on and off. The tool operates when a signal is received, and it does not operate when a signal is not received.
On_Off_in	This configures the input signal that checks whether the tool is being operated. This item is optional.

These are test functions of tool WCI.

Test Function	Description
Run	[Mandatory Action] It operates the tool with out_Run signal on.
Stop	[Mandatory Action] It stops the tool with out_Run signal off.

2.3 Screwdriver (Screwdriver: Tool Category)

This is a tool that tightens bolts. If the tool supports reverse mode, it is possible to perform bolt removal tasks. If the tool supports a vacuum function, it can receive bolts supplied from an external feeder. If the tool has an auto-tightening torque check function, the successful tightening status is delivered via electrical signals. The standard screwdriver WCI can only be operated using the controller IO.

Item	Description
out_Run	This configures the signal that operates the screwdriver tool. The tool operates when a signal is received, and it does not operate when a signal is not received.
out_Reverse_Mode	This configures the reverse mode signal of tools that support reverse mode with external signals.
out_Vacuum_On	This configures the vacuum on signal to pick up a screw when a screw is supplied from an external feeder if a separate vacuum tool is installed.

Item	Description
out_Vacuum_Off	This configures the vacuum off signal to pick up a screw when a screw is supplied from an external feeder if a separate vacuum tool is installed.
Torque_OK_in	This configures the input signal of the tightening torque OK status if the tool has an auto tightening torque check function.

This is a test function for the screwdriver WCI.

Test Function	Description
Run	[Mandatory Action] It operates the tool with out_Run signal on.
Stop	[Mandatory Action] It stops the tool with out_Run signal off.
Reverse_Mode_On	It enables reverse mode with the out_Reverse_Mode signal on.
Reverse_Mode_Off	It disables reverse mode with the out_Reverse_Mode signal off.
Vacuum_On	It operates the vaccum with the out_Vacuum_On signal on and the out_Vacuum_Off signal off.
Vacuum_Off	It stops the vaccum with the out_Vacuum_On signal off and the out_Vacuum_Off signal on.
Check_TorqueOK_Input	It waits for an input signal related to reaching the target t orque (end task). (Timeout = 10 seconds)

3. Machine

3.1 Press Machine

This is a press machine, which is generally a device that compresses a flat material to form desired shapes. If the machine is equipped with a sensor that checks input signals, input signal check is available. The standard machine WCI can only be operated with the controller IO.

Item	Description
out_Machine_Start	This configures the output signal for starting the press machine.
Machine_Ready_in	This configures the input signal for authorizing press machine operation.

This is a test function for the press machine WCI.

Test Function	Description
Machine_Start	It operates the machine with the out_Machine_Start signal on.
Reset_IO	It is a function that turns off an output signal that is turned on.
Check_Machine_Input	It waits for the machine ready input signal. (Timeout = 10 seconds)

3.2 Turning Center

This is type of machine tool that turns cylindrical material to allow the material to be cut to the desired form using a tool turret. If the machine is equipped with a sensor that checks input signals, input signal check is available. The standard machine WCI can only be operated with the controller IO.

Item	Description
out_INTLK_On	This sets the output signal for grasping the target.
out_INTLK_Off	This sets the output signal for releasing the target.
out_Machine_Start	This configures the output signal for starting the machine tool.
out_Door_Open	This configures the output signal for opening the door of the machine tool.
out_Door_Close	This configures the output signal for closing the door of the machine tool.
out_Machine_Reset	This configures the output signal for resetting the machine tool.
out_Robot_Online	This configures the output signal for the robot connection initialization signal sent to the machine tool.

Item	Description
out_Workpiece_Clean	This configures the output signal for operating the air blow device installed on the machine tool to clean the workpiece.
out_TS_Forward	This configures the output signal for moving the machine tool's tailstock forward.
out_TS_Backward	This configures the output signal for moving the machine tool's tailstock backward.
out_SR_Unclamp	This configures the output signal for opening the steady rest.
out_SR_Clamp	This configures the output signal for closing the steady rest.
Machine_Ready_in	This configures the input signal for authorizing the machine tool operation.
Chuck_Open_in	This configures the input signal for checking whether the chuck is properly closed.
Chuck_Close_in	This configures the input signal for checking whether the chuck is properly opened.
Door_Open_in	This configures the input signal for checking whether the door is properly closed.
Door_Close_in	This configures the input signal for checking whether the door is properly opened.
Workpiece_Clean_in	This configures the input signal for checking whether the air blow device installed on the machine tool has completed its operation.
TS_Forward_in	This configures the input signal for checking whether the tailstock forward movement is complete.
TS_Backward_in	This configures the input signal for checking whether the tailstock backward movement is complete.
SR_Unclamp_in	This configures the input signal for checking whether the steady rest is opened.
SR_Clamp_in	This configures the input signal for checking whether the steady rest is closed.

This is a test function for turning the center WCI.

Test Function	Description
INTLK_On	[Mandatory Action] It performs a chuck close motion with the out_INTLK_On signal on and the out_INTLK_Off signal off.

Test Function	Description
INTLK_Off	[Mandatory Action] It performs a chuck open motion with the out_INTLK_On signal off and the out_INTLK_Off signal on.
Machine_Start	It operates the machine with the out_Machine_Start signal on.
Door_Open	It performs a door open motion with the out_Door_Open signal on.
Door_Close	It performs a door close motion with the out_Door_Close signal on.
Machine_Reset	It resets the machine with the out_Machine_Reset signal on.
Robot_Online	It performs a robot online motion with the out_Robot_Online signal on.
Workpiece_Clean	It performs a workpiece clean motion with the out_Workpiece_Clean signal on.
Tailstock_Forward	It performs a tailstock forward motion with the out_TS_Forward signal on.
Tailstock_Backward	It performs a tailstock backward motion with the out_TS_Backward signal on.
Steady_Rest_Unclamp	It performs a steady rest unclamp motion with the out_SR_Unclamp signal on.
Steady_Rest_Clamp	It performs a steady rest clamp motion with the out_SR_Clamp signal on.
Reset_IO	It is a function that turns off an output signal that is turned on.
Check_Machine_Input	It waits for the machine ready input signal. (Timeout = 10 seconds)

3.3 Molding Machine

The molding machine is a device that molds shapes by injecting materials such as plastic into a mold. If the machine is equipped with a sensor that checks input signals, input signal check is available. The standard machine WCI can only be operated with the controller IO.

Item	Description
out_Machine_Start	This configures the output signal for starting the injection molding machine.
Machine_Ready_in	This configures the input signal for authorizing injection molding machine operation.

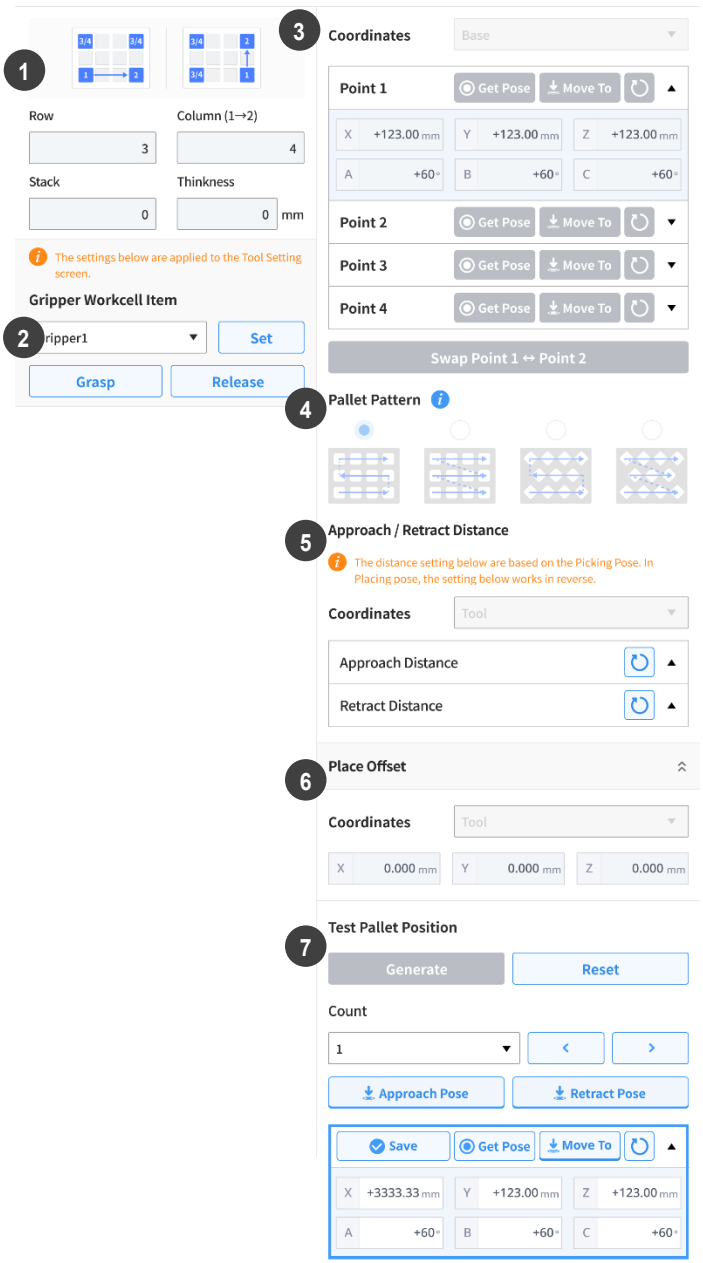
This is a test function for the molding machine WCI.

Test Function	Description
Machine_Start	It operates the machine with the out_Machine_Start signal on.
Reset_IO	It is a function that turns off an output signal that is turned on.
Check_Machine_Input	It waits for the machine ready input signal. (Timeout = 10 seconds)

4. Peripherals

4.1 Pallet

This is a type of cradle that allows the target to be placed in a set formation. All targets on a pallet can be handled with minimum (4-point) instructions. Workpieces can be approached sequentially by entering the row, column, stack and thickness.



No.	Item	Description
1	**Pallet Row/Column/Stack/Thickness**	This is for entering the number of the row/column/stack and the stack height. Row: default 3 / range 1-200 Column: default 4 / range 1-200 Stack: default 1 / range 1-9999 Thickness: default 0 / range 0-10000 [mm]
2	**Select/Operate Gripper**	This is used to select and operate the gripper to be used on the pallet.
3	**Save Pose**	This selects a reference coordinate and saves a reference point. The pattern starts in the direction of Point 1->Point 2. (If necessary, Point 1/2 can be swapped) Point 3 and Point 4 do not affect the order.
4	**Pallet Pattern**	This selects the robot's movement pattern. Snake, zigzag, rhombus snake, rhombus zigzag
5	**Approach/Retract Distance**	This is for entering the approach/retract distance in x, y and z values from the tool. In general, to retract 100 mm in the z-direction, "0, 0, -100" must be entered.
6	**Release Offset**	This enters the offset values to apply to the points created based on the 4 poses (positions). This value can be used to prevent friction between the workpiece and pallet wall during release pallet teaching.
7	**Pallet Point Test**	Generate can be used to check the created pallet point. Reset can be used to reset modified values. Enter/select the count or select the point to check using < or >. The order of points is created based on the selected pattern information. Use the Approach Pose button to move to the approach pose. Use the Retract Pose button to move to the retract pose. Use the Move To button to move to the calculated pallet point.

No.	Item	Description
		Use the Get Pose button to load the current position. Use the Save button to save the position loaded using the get pose (including the cockpit) or manually entered position information in the current count.

4.2 Bolt Feeder

This is a device that supplies bolts. It supports pick-up and shooting types. In the case of a shooting bolt feeder, the bolt shooting signal can be configured. If the bolt feeder is equipped with a sensor that checks input signals, input signal check is available.

Item	Description
out_Bolt_Shooting	This configures the bolt shooting signal.
Bolt_Ready_in	This selects the input signal for checking whether a bolt is prepared in the bolt feeder.

This is a test function for the bolt feeder WCI.

Test Function	Description
Bolt_Shooting	It performs a bolt shooting motion with the out_Bolt_Shooting signal on.
Reset_IO	It is a function that turns off an output signal that is turned on.
Check_Feeder_Input	It waits for the bolt ready input signal. (Timeout = 10 seconds)

5. Additional Workcell Items

Additional Workcell Items provided by Doosan Robots will no longer be updated. Inst ead, companies and users can create various Workcell Items using the App Builder. The created Workcell Items are registered in the Doosan Robotics Developer LAB an d can be easily downloaded and installed (Workcell Items created using the App Buil der can be installed and used on Software version V2.7.3 or higher). For more infor mation, refer to the Doosan Robotics Developer LAB.

- [Developer LAB] https://devlab.doosanrobotics.com

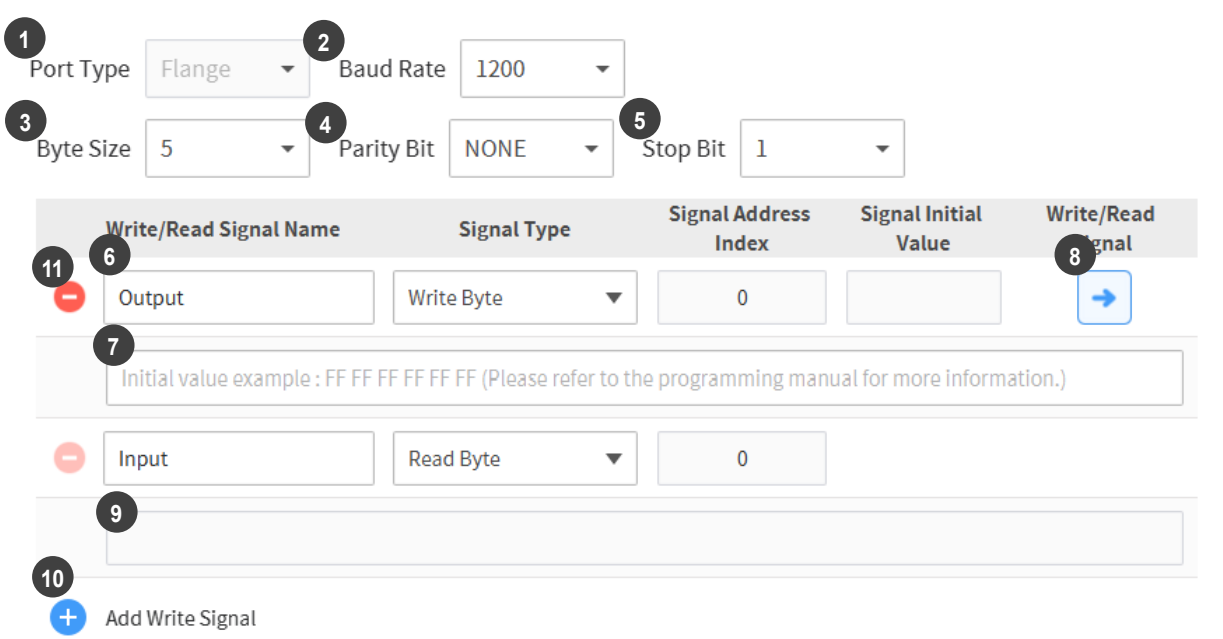
5.1 Common Setting Options

Additional common setting options for Workcell Items are as follows:

Item	Description
Output Signal	It selects the output signal type.
Input Signal	It selects the input signal type.

5.1.1 Flange Serial Setting

When the communication component of the Workcell Item in the App Builder is created with a flange serial, the corresponding Workcell Item Setting screen appears as follows:



No.	Item	Description
1	**Port Type**	A different type cannot be set for the flange serial.
2	**Communication Speed**	Sets the communication speed.
3	**Byte Size**	Sets the byte size.
4	**Parity Bit**	Sets the parity bit.
5	**Stop Bit**	Sets the stop bit.
6	**Signal Name**	Sets the name of the signal to exchange.
7	**Output Value**	Sets the flange serial output value. Only a hexadecimal value can be entered.
8	**Signal Transmission**	Transmits the entered output value to the connected equipment.
9	**Input Value**	Displays the input value from the equipment.
10	**Add Signal**	Adds a signal to output.
11	**Delete Signal**	Deletes an I/O signal.

5.2 Additional Workcell Item List

Note

- Additional Workcell Items provided by Doosan Robots will no longer be updated. Instead, companies and users can create various Workcell Items using the App Builder.
- The created Workcell Items are registered in the Doosan Robotics Developer LAB and can be easily downloaded and installed.
- Workcell Items created using the App Builder can be installed and used on Software version V2.7.3 or higher.
- For more information, refer to the Doosan Robotics Developer LAB.
- [Developer LAB] https://devlab.doosanrobotics.com

5.2.1 Schmalz - FXCB

Item	Description
Type	This selects the gripper type. Normally Open / Normally Close (must check the current gripper option)
Suction On/Off	This sets the output signal for turning the vacuum on/off. - Normally Open: Pressing the Off button creates a vacuum. - Normally Close: Pressing the On button creates a vacuum. This selects the input signal type.
Vent On/Off	This sets the output signal for turning on/off the air. This item is optional. This configures an input signal that checks whether grasping of the target has been performed. This item is optional. This sets the output signal for turning on/off the air. This item is optional.
Gripper Close Sensor	This configures an input signal that checks whether the grasping of the target has been performed. This item is optional.

This Workcell item is a vacuum gripper operated with digital I/Os. The following list contains skills and commands that can be used in conjunction .

- Grasp
- Release
- Pick
- Place
- Pick Pallet
- Place Pallet

5.2.2 Shumalz - ECBPi (CobotPump)

Item	Description
Grasp	It configures the output signal for grasping the target.
Release	It configures the output signal for releasing the target.
Gripper Close Sensor	It configures an input signal that checks whether the grasping of the target is performed. This item is optional.
Gripper Open Sensor	It configures an input signal that checks whether the releasing of the target is performed. This item is optional.

This Workcell item is a vacuum gripper operated with digital I/Os. The following list contains skills and commands that can be used in conjunction .

- Grasp
- Release
- Pick
- Place
- Destacking
- Stacking
- Pick Pallet / Line / Pallet(Rhombus)
- Place Pallet / Line / Pallet(Rhombus)
- Destacking Pallet / Line / Pallet(Rhombus)
- Stacking Pallet / Line / Pallet(Rhombus)

5.2.3 Shunk - PGN

Item	Description
Grasp	It configures the output signal for grasping the target.
Release	It configures the output signal for releasing the target.
Gripper Close Sensor	It configures an input signal that checks whether the grasping of the target is performed. This item is optional.
Gripper Open Sensor	It configures an input signal that checks whether the releasing of the target is performed. This item is optional.

This Workcell item is a pneumatic gripper operated with digital I/Os. The gripper closed/open sensor can be used after connecting a separate sensor. The following list contains skills and commands that can be used in conjunction.

- Grasp
- Release
- Pick
- Place
- Pick Pallet
- Place Pallet
- Insert
- Destacking
- Stacking
- Pick Pallet / Line / Pallet(Rhombus)
- Place Pallet / Line / Pallet(Rhombus)
- Destacking Pallet / Line / Pallet(Rhombus)
- Stacking Pallet / Line / Pallet(Rhombus)

5.2.4 Shunk - Co-act EGP-C

Item	Description
Grasp	It configures the output signal for grasping the target.
Release	It configures the output signal for releasing the target.
Gripper Close Sensor	It configures an input signal that checks whether the grasping of the target is performed. This item is optional.
Gripper Open Sensor	It configures an input signal that checks whether the releasing of the target is performed. This item is optional.

This Workcell item is an electric gripper operated with digital I/Os. The following list contains skills and commands that can be used in conjunction .

- Grasp
- Release
- Pick
- Place
- Insert
- Destacking
- Stacking
- Pick Pallet / Line / Pallet(Rhombus)
- Place Pallet / Line / Pallet(Rhombus)
- Destacking Pallet / Line / Pallet(Rhombus)
- Stacking Pallet / Line / Pallet(Rhombus)

5.2.5 Zimmer - GEP2000

Item	Description
Grasp	It configures the output signal for grasping the target.
Release	It configures the output signal for releasing the target.

This Workcell item is an electric gripper operated with digital I/Os. The following list contains skills and commands that can be used in conjunction .

- Grasp
- Release
- Pick
- Place
- Insert
- Destacking
- Stacking
- Pick Pallet / Line / Pallet(Rhombus)
- Place Pallet / Line / Pallet(Rhombus)
- Destacking Pallet / Line / Pallet(Rhombus)
- Stacking Pallet / Line / Pallet(Rhombus)

5.2.6 Zimmer - HCR03

Item	Description
Modbus Address	It selects the predefined Modbus address. The IP address and name configured by the user for the Modbus slave equipment are displayed. To add new items, go to Setting > Network > Predefined Modbus menu, and configure.
Connect	Equipment is connected to the selected Modbus address, and buttons used to test gripper motion are activated.
Initialize	This performs gripper reset.
Teaching Pose	The gripper position when the corresponding workpiece is grasped. It can be configured from a minimum of 0.00 mm to a maximum of 20.00 mm.
Tolerance	This is the teaching pose tolerance deviation. It can be configured from a minimum of 0.00 mm to a maximum of 2.55 mm.
Force	This is the force the gripper applies to grasp an item. It can be configured from Lv1 up to Lv4.
Device Mode	This is the pose when the gripper grasps an item. Select one from inward, outward and universal.
Actual Position	It is the area displaying the current position measured through the gripper's grasp/release motion tests.
Add New Workpiece	A new workpiece can be added. Up to 32 workpieces can be added.
Gripper Status	This is the input signal for the gripper's status code. The following are the meanings of each status code. 0x06: Gripper PLC Active, 0x08: Base Position, 0x09: Teach Position, 0x0a: Work Position, 0x0b: Undefined Position, 0x0c: Data transfer ok, 0x0d: ControlWord 0x100, 0x0e: ControlWord 0x200, 0x0f: Error
Diagnosis	This is the input signal for the gripper's diagnosis code.

This Workcell item is an electric gripper operated with Modbus TCP. The following list contains skills and commands that can be used in conjunction .

- Grasp
- Release
- Pick
- Place
- Pick Pallet
- Place Pallet
- Insert

5.2.7 Robotiq - 2F-85

Item	Description
Modbus Address	It selects the predefined Modbus address. The IP address and name configured by the user for the Modbus slave equipment are displayed. To add new items, go to Setting > Network > Predefined Modbus menu, and configure.
Connect	Equipment is connected to the selected Modbus address, and buttons used to test gripper motion are activated.
Auto Release Option	It selects the gripper's release option during a robot undergoing emergency stop. The definition of each option is as follows: Auto Release Close: Gripper closes to maximum upon robot emergency stop Auto Release Open: Gripper opens to maximum upon robot emergency stop.
Initialize	It sends an initialization signal to the gripper to perform gripper initialization.
Grasp	The gripper position when the corresponding workpiece is grasped.
Release	The gripper position when the corresponding workpiece is released.
Velocity	Gripper movement speed.
Force	The gripper's force.
Current Position	It is the area displaying the current position measured through the gripper's grasp/release motion tests.
Add New Motion	A new motion can be added. Up to eight motions can be added.
Grasp Status Sensing	This is the input signal for the gripper's status.
Fault Status Sensing	This is the input signal for the gripper's error status.
Requested Position Sensing	This is the input signal for the position value sent to the gripper.
Current Position Sensing	This is the input signal for the current position of the gripper.
Current Sensing	This is the input signal for the current current value of the gripper.

This Workcell item is an electric gripper operated with Modbus TCP. The following list contains skills and commands that can be used in conjunction .

- Grasp
- Release
- Pick
- Place
- Pick Pallet
- Place Pallet
- Insert

5.2.8 Robotiq - 2F-140

Item	Description
Modbus Address	It selects the predefined Modbus address. The IP address and name configured by the user for the Modbus slave equipment are displayed. To add new items, go to Setting > Network > Predefined Modbus menu, and configure.
Connect	Equipment is connected to the selected Modbus address, and buttons used to test gripper motion are activated.
Auto Release Option	It selects the gripper's release option during a robot undergoing emergency stop. The definition of each option is as follows: Auto Release Close: Gripper closes to maximum upon robot emergency stop Auto Release Open: Gripper opens to maximum upon robot emergency stop.
Initialize	It sends an initialization signal to the gripper to perform gripper initialization.
Grasp	The gripper position when the corresponding workpiece is grasped.
Release	The gripper position when the corresponding workpiece is released.
Velocity	Gripper movement speed.
Force	The gripper's force.
Current Position	It is the area displaying the current position measured through the gripper's grasp/release motion tests.
Add New Motion	A new motion can be added. Up to eight motions can be added.
Grasp Status Sensing	This is the input signal for the gripper's status.
Fault Status Sensing	This is the input signal for the gripper's error status.
Requested Position Sensing	This is the input signal for the position value sent to the gripper.
Current Position Sensing	This is the input signal for the current position of the gripper.
Current Sensing	This is the input signal for the current current value of the gripper.

This Workcell item is an electric gripper operated with Modbus TCP. The following list contains skills and commands that can be used in conjunction. Refer to each skill's manual for the operation of the skill.

- Grasp
- Release
- Pick
- Place
- Pick Pallet
- Place Pallet
- Insert

5.2.9 Robotiq - Hand-E

Item	Description
Modbus Address	It selects the predefined Modbus address. The IP address and name configured by the user for the Modbus slave equipment are displayed. To add new items, go to Setting > Network > Predefined Modbus menu, and configure.
Connect	Equipment is connected to the selected Modbus address, and buttons used to test gripper motion are activated.
Auto Release Option	It selects the gripper's release option during a robot undergoing emergency stop. The definition of each option is as follows: Auto Release Close: Gripper closes to maximum upon robot emergency stop Auto Release Open: Gripper opens to maximum upon robot emergency stop.
Initialize	It sends an initialization signal to the gripper to perform gripper initialization.
Grasp	The gripper position when the corresponding workpiece is grasped.
Release	The gripper position when the corresponding workpiece is released.
Velocity	Gripper movement speed.
Force	The gripper's force.
Current Position	It is the area displaying the current position measured through the gripper's grasp/release motion tests.
Add New Motion	A new motion can be added. Up to eight motions can be added.
Grasp Status Sensing	This is the input signal for the gripper's status.
Fault Status Sensing	This is the input signal for the gripper's error status.
Requested Position Sensing	This is the input signal for the position value sent to the gripper.
Current Position Sensing	This is the input signal for the current position of the gripper.
Current Sensing	This is the input signal for the current current value of the gripper.

This Workcell item is an electric gripper operated with Modbus TCP. The following list contains skills and commands that can be used in conjunction .

- Grasp
- Release
- Pick
- Place
- Pick Pallet
- Place Pallet
- Insert

5.2.10 Robotiq - 3-Finger

Item	Description
Modbus Address	It selects the predefined Modbus address. The IP address and name configured by the user for the Modbus slave equipment are displayed. To add new items, go to Setting > Network > Predefined Modbus menu, and configure.
Connect	Equipment is connected to the selected Modbus address, and buttons used to test gripper motion are activated.
Initialize	It sends an initialization signal to the gripper to perform gripper initialization.
Grasp	The gripper position when the corresponding workpiece is grasped.
Release	The gripper position when the corresponding workpiece is released.
Mode	Selects the gripper's operation mode. Select one from Basic Mode, Pinch Mode, Wide Mode and Scissor Mode.
Velocity	Gripper movement speed.
Force	The gripper's force.
Current Position	It is the area displaying the current position measured through the gripper's grasp/release motion tests.
Add New Motion	A new motion can be added. Up to eight motions can be added.
Finger A Position	This is the input signal for the position of gripper finger A.
Finger B Position	This is the input signal for the position of gripper finger B.
Finger C Position	This is the input signal for the position of gripper finger C.
Scissor Position	This is the input signal for the position of the gripper scissor.
Finger A Current	This is the signal for the present current value of gripper finger A.
Finger B Current	This is the signal for the present current value of gripper finger B.
Finger C Current	This is the signal for the present current value of gripper finger C.

Item	Description
Scissor Current	This is the input signal for the current current value of the gripper scissor.
Gripper Status	This is the input signal for the gripper’s status.
Item Status	This is the input signal for the item detected by the gripper.
Defect Status	This is the input signal code for the gripper defect status.

This Workcell item is an electric gripper operated with Modbus TCP. The following list contains skills and commands that can be used in conjunction.

- Grasp
- Release
- Pick
- Place
- Pick Pallet
- Place Pallet
- Insert

5.2.11 Doosan - Lynx Series

Item	Description
Modbus Address	It selects the predefined Modbus address. The IP address and name configured by the user for the Modbus slave equipment are displayed. To add new items, go to Setting > Network > Predefined Modbus menu, and configure.
Connect	Equipment is connected to the selected Modbus address, and buttons used to test gripper motion are activated.
Motion	It sends the signal of the corresponding output.
Robot Online	It sends the Robot Online status to MC. The interface signal operates normally only if this signal is on.
Robot in the inside of machine	It goes on when the Robot Arm enters the equipment interior.
Open M/C Door	Front or Top Door opens automatically.
Close M/C Door	Front or Top Door closes automatically.
Start program	When the corresponding signal is On, the MC starts the NC-program.
Open chuck#1 (LH Spindle)	When the corresponding signal is On, the MC unclamps the Chuck.
Close chuck#1 (LH Spindle)	When the corresponding signal is On, the MC clamps the Chuck.
Clean LH spindle	When the corresponding signal is On, the MC air blows the Spindle.
LH Chuck loaded	When the corresponding signal is On, the MC finishes the load signal and executes the next block.
LH Chuck unloaded	When the corresponding signal is On, the MC finishes the Service M-code request signal and executes the next block.
Tailstock forward	When the corresponding signal is On, the MC finishes the Service M-code request signal and executes the next block.
Tailstock backward	When the corresponding signal is On, the MC finishes the Service M-code request signal and executes the next block.
Machine Online	When Serve & MC Ready is set in MEM Mode, it outputs this signal through the Robot.

Item	Description
Permission to Robot	It is the signal allowing Robot arm approach, and the signal is outputted under the following conditions: - MC Home position - Spindle stop - Robot uses - MEM Mode - No Machine lock - Door open
Cycle on	This signal is outputted when the NC-program is in auto operation.
M/C Door opened	This signal is outputted when the Robot Approach Door is opened.
M/C Door closed	This signal is outputted when the Robot Approach Door is closed.
Program end	When processing is complete, M02 or M30 is executed and then this signal is outputted. This signal is maintained until NC is reset, auto mode changes to manual mode, or auto operation begins.
Open chuck#1 (LH Spindle)	It is the Main Chuck unclamp check signal.
Close chuck#1 (LH Spindle)	It is the Main Chuck clamp check signal.
Clean LH spindle	It is the Spindle air blow completion signal.
Load LH Chuck	It is the Robot arm approach request signal for new workpiece approach. The signal must be outputted under the following conditions: - MC Home position - Spindle stop - Robot uses - MEM Mode - No Machine lock - Door open - No Robot alarm
Unload LH Chuck	It is the Robot arm approach request signal for new workpiece discharge. The signal must be outputted under the following conditions: - MC Home position

Item	Description
	- Spindle stop - Robot uses - MEM Mode - No Machine lock - Door open - No Robot alarm
Tailstock forward	It is the Tailstock forward/backward completion signal.
Tailstock backward	It is the Tailstock forward/backward completion signal.

This Workcell item is a turning center operated with Modbus TCP. The following list contains skills and commands that can be used in conjunction.

- Open TC Door
- Close TC Door
- Open TC Chuck
- Close TC Chuck
- Start TC
- Check TC Ready
- Robot Online
- Workpiece Clean
- Tailstock Forward
- Tailstock Backward
- Pick TC Chuck
- Place TC Chuck

5.2.12 Doosan - Puma Series

Item	Description
Modbus Address	It selects the predefined Modbus address. The IP address and name configured by the user for the Modbus slave equipment are displayed. To add new items, go to Setting > Network > Predefined Modbus menu, and configure.
Connect	Equipment is connected to the selected Modbus address, and buttons used to test gripper motion are activated.
Motion	It sends the signal of the corresponding output.
Robot Online	It sends the Robot Online status to MC. The interface signal operates normally only if this signal is on.
Robot in the inside of machine	It goes on when the Robot Arm enters the equipment interior.
Open M/C Door	Front or Top Door opens automatically.
Close M/C Door	Front or Top Door closes automatically.
Start program	When the corresponding signal is On, the MC starts the NC-program.
Open chuck#1 (LH Spindle)	When the corresponding signal is On, the MC unclamps the Chuck.
Close chuck#1 (LH Spindle)	When the corresponding signal is On, the MC clamps the Chuck.
Clean LH spindle	When the corresponding signal is On, the MC air blows the Spindle.
LH Chuck loaded	When the corresponding signal is On, the MC finishes the load signal and executes the next block.
LH Chuck unloaded	When the corresponding signal is On, the MC finishes the Service M-code request signal and executes the next block.
Tailstock forward	When the corresponding signal is On, the MC finishes the Service M-code request signal and executes the next block.
Tailstock backward	When the corresponding signal is On, the MC finishes the Service M-code request signal and executes the next block.
Machine Online	When Serve & MC Ready is set in MEM Mode, it outputs this signal through the Robot.

Item	Description
Prermission to Robot	It is the signal allowing Robot arm approach, and the signal is outputted under the following conditions: - MC Home position - Spindle stop - Robot uses - MEM Mode - No Machine lock - Door open
Cycle on	This signal is outputted when the NC-program is in auto operation.
M/C Door opened	This signal is outputted when the Robot Approach Door is opened.
M/C Door closed	This signal is outputted when the Robot Approach Door is closed.
Program end	When processing is complete, M02 or M30 is executed and then this signal is outputted. This signal is maintained until NC is reset, auto mode changes to manual mode, or auto operation begins.
Open chuck#1 (LH Spindle)	It is the Main Chuck unclamp check signal.
Close chuck#1 (LH Spindle)	It is the Main Chuck clamp check signal.
Clean LH spindle	It is the Spindle air blow completion signal.
Load LH Chuck	It is the Robot arm approach request signal for new workpiece approach. The signal must be outputted under the following conditions: - MC Home position - Spindle stop - Robot uses - MEM Mode - No Machine lock - Door open - No Robot alarm

Item	Description
Unload LH Chuck	It is the Robot arm approach request signal for new workpiece discharge. The signal must be outputted under the following conditions: - MC Home position - Spindle stop - Robot uses - MEM Mode - No Machine lock - Door open - No Robot alarm
Tailstock forward	It is the Tailstock forward/backward completion signal.
Tailstock backward	It is the Tailstock forward/backward completion signal.

This Workcell item is a turning center operated with Modbus TCP. The following list contains skills and commands that can be used in conjunction with this Workcell item.

- Open TC Door
- Close TC Door
- Open TC Chuck
- Close TC Chuck
- Start TC
- Check TC Ready
- Robot Online
- Workpiece Clean
- Tailstock Forward
- Tailstock Backward
- Pick TC Chuck
- Place TC Chuck

5.2.13 OnRobot RG2

Item	Description
Modbus Address	It selects the predefined Modbus address. The IP address and name configured by the user for the Modbus slave equipment are displayed. To add new items, go to Setting > Network > Predefined Modbus menu, and configure.
Connect	Equipment is connected to the selected Modbus address, and buttons used to test gripper motion are activated.
Grasp	Enter the gripper position value when the corresponding workpiece is grasped.
Release	Enter the gripper position value when the corresponding workpiece is released.
Force	Enter the force value to apply during operation.
Add New Motion	A new motion can be added. Up to eight motions can be added.
Actual depth	It is the current gripper depth that will be used to compensate for the gripper's depth. The depth is based on the completely closed position set in 1/10 mm increments. The value is displayed in 2's complements.
Actual relative depth	It is the current gripper depth that will be used to compensate for the gripper's depth. The depth is based on the recent motion start position set in 1/10 mm increments. The value is displayed in 2's complements.
Actual width	The current width between gripper fingers is displayed in 1/10 mm increments.
Status	It displays the current state and motion of the gripper.

This Workcell item is an electric gripper operated with Modbus TCP. The following list contains skills and commands that can be used in conjunction .

- Grasp
- Release
- Pick
- Place
- Pick Pallet
- Place Pallet
- Insert

5.2.14 OnRobot RG6

Item	Description
Modbus Address	It selects the predefined Modbus address. The IP address and name configured by the user for the Modbus slave equipment are displayed. To add new items, go to Setting > Network > Predefined Modbus menu, and configure.
Connect	Equipment is connected to the selected Modbus address, and buttons used to test gripper motion are activated.
Grasp	The gripper position when the corresponding workpiece is grasped.
Release	The gripper position when the corresponding workpiece is released.
Force	The gripper's force.
~~**Grasp**~~	~~Performs tests for grasping a target item.~~
~~**Release**~~	~~Performs tests for releasing a target item.~~
Add New Motion	A new motion can be added. Up to eight motions can be added.
Actual depth	It is the current gripper depth that will be used to compensate for the gripper's depth. The depth is based on the completely closed position set in 1/10 mm increments. The value is displayed in 2's complements.
Actual relative depth	It is the current gripper depth that will be used to compensate for the gripper's depth. The depth is based on the recent motion start position set in 1/10 mm increments. The value is displayed in 2's complements.
Actual width	The current width between gripper fingers is displayed in 1/10 mm increments.
Status	It displays the current state and motion of the gripper.

The following list contains skills and commands that can be used in conjunction with this Workcell Item.

- Grasp
- Release
- Pick
- Place
- Pick Pallet
- Place Pallet
- Insert

5.2.15 Zimmer_HCR-03-DIO

Item	Description
Grasp	It configures the output signal for grasping the target.
Release	It configures the output signal for releasing the target.
Gripper Close Sensor	It configures an input signal that checks whether the grasping of the target is complete. This item is optional.
Gripper Open Sensor	It configures an input signal that checks whether the releasing of the target is complete. This item is optional.

The following list contains skills and commands that can be used in conjunction with this Workcell Item.

- Grasp
- Release
- Pick
- Place
- Pick Pallet
- Place Pallet
- Insert
- Destacking
- Stacking
- Pick Pallet / Line / Pallet(Rhombus)
- Place Pallet / Line / Pallet(Rhombus)
- Destacking Pallet / Line / Pallet(Rhombus)
- Stacking Pallet / Line / Pallet(Rhombus)

5.2.16 Dynabrade Robotic Sanders

Item	Description
Polish	It configures the signal that operates the Polishing tool. The tool operates when a signal is received, and it does not operate when a signal is not received.

The following list contains skills and commands that can be used in conjunction with this Workcell Item.

- Start Polish
- End Polish
- Run Polish
- Stop Polish
- Polish (Hole)
- Polish (Hole) Line
- Polish (Hole) Pallet
- Polish (Hole) Pallet (Rhombus)

Part 2
Task Programming Commands and Templates

1. Skill Command

1.1 Skill Command Summary

This is a function programmed through the robot and peripherals, and to use skills, it is necessary to configure the work and related Workcell Items. Necessary Workcell Items are indicated in each skill description.

The user input range of each skill varies according to the robot. Refer to Appendix A of the User Manual. The input range of the Skill Command List (Section 1.5) is based on the largest value among the M (1013, 1509, 0609, 0617), A (0509(S), 0912(S)) and H (2515, 2017) models.

Note

If an alarm popup message appears continuously while using the Skill command, continuing by pressing the OK button may cause the skill to operate abnormally. Press the “Task Stop” button to stop the program.

Version A Series

If FTS is not installed when using the A-Series, the following functions and skills cannot be used:

- The Stiffness Setting function for compliance control and the Contact Detection function
- Insert
- Push
- Touch

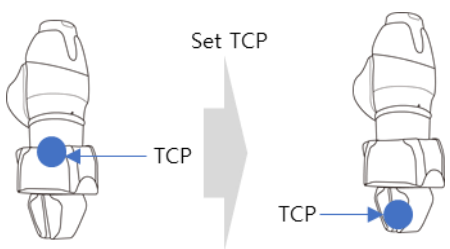
Refer to the **Note** of each skill to check whether the skill can be used.

1.2 Understanding Basic Principles of Skill Commands

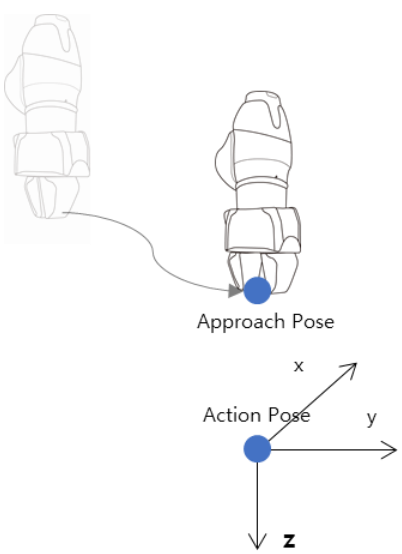
Skill commands are based on a few operation patterns.

For a robot to begin operation, the weight and tool center point (TCP) of the tool equipped on the robot must be configured, and the basic operation pattern of a skill command is to have an approach pose and retract pose that are perpendicular to the reference pose.

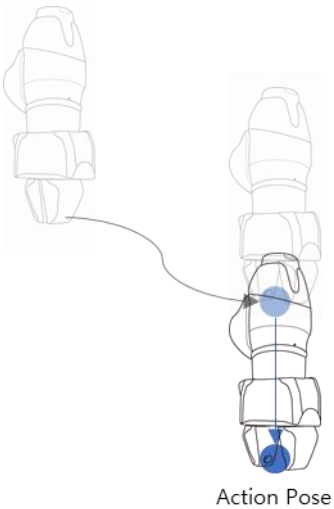
TCP Setting: Using an End Effector skill command will automatically change the TCP offset setting. The End Effector skill command execution stage includes an offset setting suited for the TCP of the End Effector. If the TCP offset changes, the Blending Motion function, which smoothly connects the previous motion command, cannot be used.



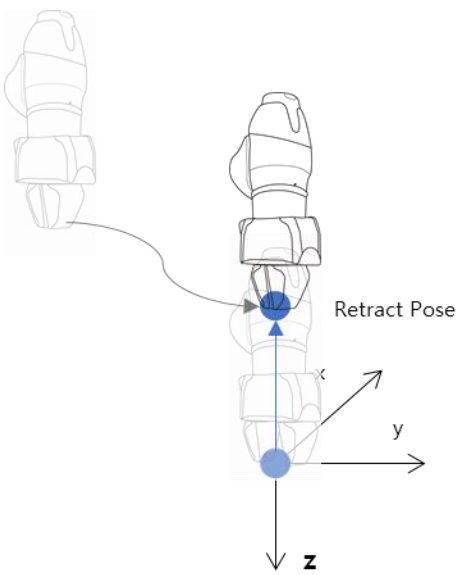
Move to **Approach Pose**: This is a point available to move to the Approach Pose. It is set in the Z direction from the approach pose, but a different direction can also be selected. The Approach Distance entered is automatically calculated for the Action Pose and moves to the corresponding point.



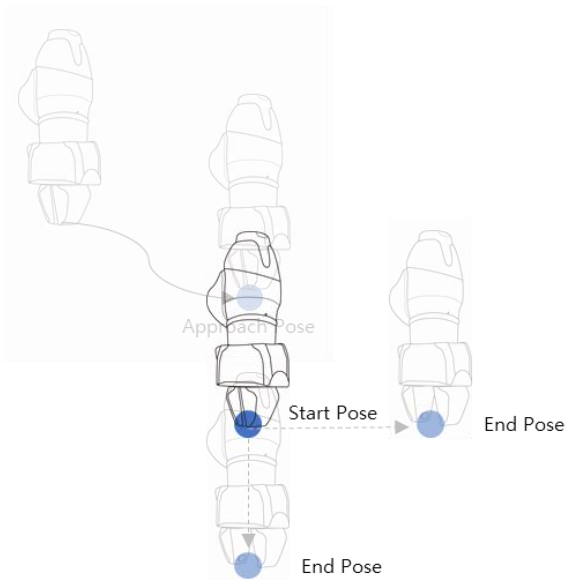
Move to Reference Pose: This is the point on the workpiece where the End Effector performs work. To set detailed coordinates other than the velocity and acceleration for the reference pose, press the button on the right side of t reference pose. However, using the relative coordinate tab during detailed motion setting can cause a malfunction during skill execution, so make sure to use the absolute coordinates for reference pose teaching.



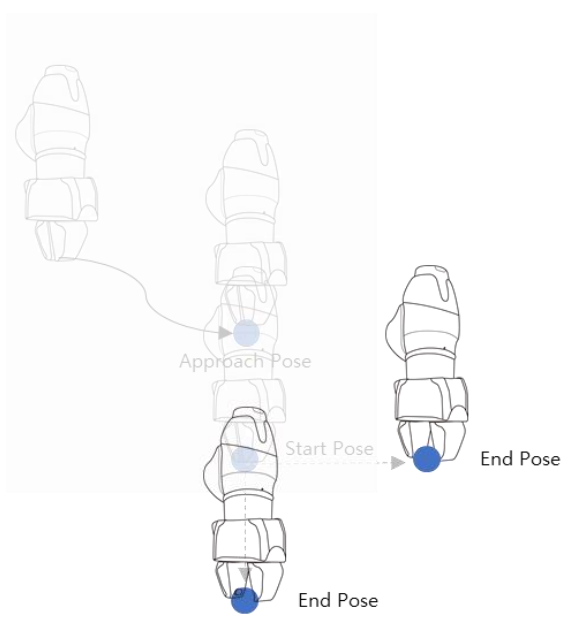
Move to Retract Pose: This is the point to pick up the workpiece and move it safely to another point. It is the –Z direction from the approach pose, but a different direction can also be selected. The Retract Distance entered is automatically calculated for the Action Pose and moves to the corresponding point.



Move to Start Pose: If the End Effector execution target does not end with a single motion, there may be an intermediate point and an end point, and the Action Start Pose is the point where the work starts. (i.e. Door_OpenClose Skill – Start Pose)



Move to End Pose: If the End Effector execution target does not end with a single motion, there may be an intermediate point and an end point, and the Action End Pose is the point where the work ends. (i.e. Door_OpenClose Skill – End Pose)



Note

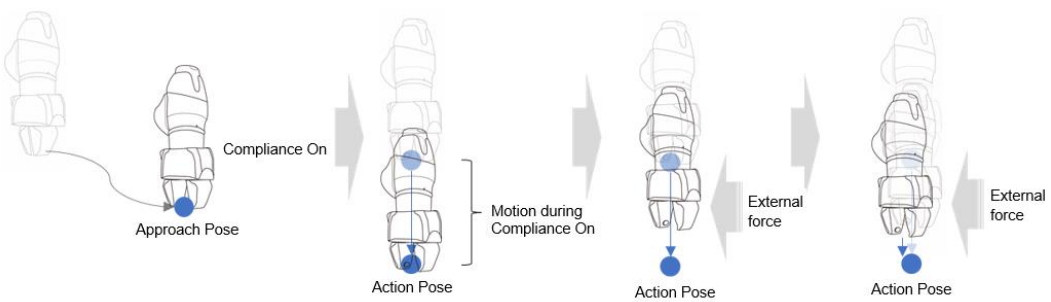
When teaching the reference pose, be cautious of default skill malfunctions if detailed options are modified.

- The relative position option of the tool coordinates or other coordinates must not be used.
- Also, maintain the default values as blending radius-related options are not supported.
- The velocity/acceleration values are not applied if the time is set in task setting.

1.3 Compliance Control and Contact Check

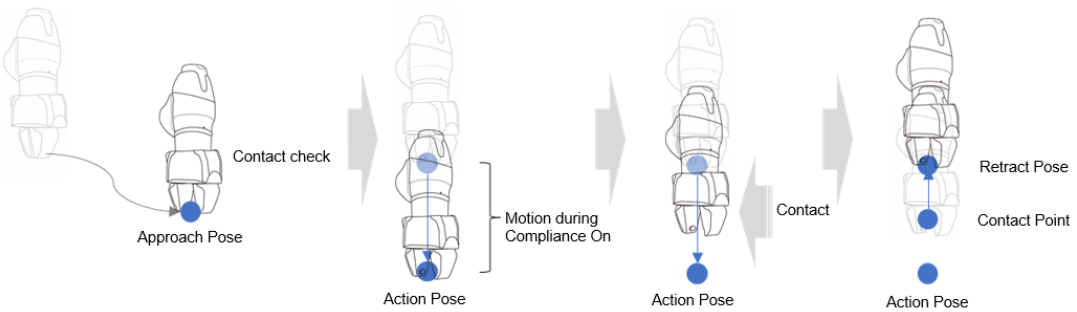
With the Compliance Control and Contact Sensing functions, which are unique force control technologies of Doosan Robotics, it is possible to easily perform teaching without repeated operation for accurate point designation since it allows position deviation within a tolerance range between the workpiece and surrounding items during robot operation.

Compliance Control: If force is applied during Approach, Action → and Retract, → it allows deviation from the set position with some level of buffering, like a spring.



Contact Check: The function detects contact with the target, stops at a corresponding position and activates the gripper to grab the target based on the **Contact Force**, **Contact Determination Range** and **Authorized Force** values entered.

- This function must be used with the Compliance Control Function. If a **Force** value is entered and Compliance Control is not enabled, an error occurs.
- Contact is a function that detects contact with an external force, so the sensitivity of Collision Detection must be set at low levels or Collision Detection must be disabled.
- Pick skills (INTLK_Pick) to set **offset (Offset Margin for Contact)** values to prevent friction with the ground or object.
- Be careful when using this function, as excessive force can be generated when contacting the external environment if the Compliance Control option stiffness (e.g., z-direction) value is too large or the work speed is too high. (It is necessary to make adjustments according to the situation by lowering the stiffness value if the work speed is too high or by increasing the stiffness if work speed is too low.)



Note

- When using Compliance Control / Force Control, it is necessary to preset the End-Effector Tool weight and TCP.

Version A Series

- If FTS is not installed when using the A-Series, contact sensing and force control cannot be used. Also, the use of compliance control is limited. Only the stiffness value of the translation (X, Y, Z) direction can be modified.

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1.4 Common Skill Screen Layout

- The user input section is separated into setting items.
- Each setting item is separated into accordian or accordian toggle UI components.
- In the case of accordian toggle, disabling the toggle button will disable user input during skill execution.
- The acceleration value input by the user is in the unit of m/s2 like the current T/P setting, but internally the value is converted into the unit of mm/s2 for calculations.

Item	Description
Basic Setting	This sets the default UI and teaching pose of the skill.
Task Setting	This sets task related information of the skill. Various inputs can be set according to the skill type. - Polishing, Deburring Skill: Enabling the One Point Task option allows for pattern selection, but force control cannot be used.
Gripper Setting	This sets gripper-related information.
Tool Setting	This sets too- related information.
Machine Setting	This sets machine-related information.
Feeder Setting	This sets feeder-related information.
Approach Pose Setting	This sets approach pose-related information. (On/Off) - Default: On - This calculates the direction of the distance between the teaching pose and the approach pose based on the tool coordinates, and moves to movel.
Retract Pose Setting	This sets retract pose-related information. (On/Off) - Default: On - This calculates the direction of the distance between the teaching pose and the retract pose based on the tool coordinates, and moves to movel.
Compliance Control Setting	This sets compliance control-related information. - The reference coordinates during compliance control operation are the changed to the tool coordinates.
Contact Sensing Setting	This sets contact sensing-related information. (On/Off) - Default: Off - The reference coordinates for force control during contact sensing are the tool coordinates, and it can be used with compliance control enabled.

Item	Description
Force Control Setting	It sets force control-related information. (On/Off) - Default: Off - The reference coordinates for force control are the tool coordinates, and it can be used with compliance control enabled. - Insert, Contact Skill: The On/Off function is not provided as force control is mandatory.
Spiral Motion Setting	This sets spiral search motion information. (On/Off) - Default: On - The reference coordinates for the hole search motion at a random location and the hole search motion are the tool coordinates.
Periodic Motion Setting	It sets rotation search motion information. (On/Off) - Default: On - The reference coordinates for move to teaching pose motion with the hole stuck condition and hole search motion are the tool coordinates.
Output Setting: Single Type	This sets the single-action output information. (On/Off) - Default: On - The output setting must only set to either single or double.
Output Setting: Double Type	This sets double-action output information. (On/Off) - Default: Off - The output setting must only set to either single or double.
Input Setting	This sets input information. (On/Off) - Default: Off

1.5 Skill Command List

1.5.1 Pick

This skill operates the gripper and picks up the target when the robot moves to a specific point or approaches and contacts a target.

(1) Recommended Default WCI: Gripper (GripperDA, GripperSA)

(2) Create Skill: TaskBuilder → Add Gripper (Skill Type: End-Effector & Pattern)

(3) Optional Features: Add pattern, approach pose and retract pose settings, Compliance Control and Contact Sensing functions

(4) Confirm Condition:

A. Select Gripper and Pattern and press the Set button (Pattern selection can be omitted).

B. Save Teaching Pose

C. Even if a pattern is not used, gLoopCountRev must be selected under Repeat Conditi on.

- **Default Motion Sequence**

Move to Approach Pose → Move to Teaching Pose (if a pattern is added, move to Pattern Calculation Pose) → Gripper Motion (Grasp) → Move to Retract Pose

- **Definition of Skill Screen**

Item		Description	Default Value and Input Range
Basic Setting	**Gripper**	I/O test available upon gripper selection	
	Pattern	Select if a pattern is used	
	Reference Pose	Teaching Pose - This is the point where the workpiece is grasped with the gripper. - Reference Pose changes to Position Referenced during pattern setting.	
Task Setting	**Repeat Condition**	Select Repeat Index - The repeat condition is used as the pattern index when a pattern is used.	
	Task Velocity	This is the velocity from the approach pose to teaching pose.	100 mm/s [0.001 ~ 8000]

Item		Description	Default Value and Input Range
		- During pattern use, Task Velocity is the velocity until each pattern point.	
	Task Acceleration	This is the acceleration from the approach pose to teaching pose. - During pattern use, Task Acceleration is the velocity until each pattern point.	0.1 m/s^2 [0.001 ~ 20]
Gripper Setting	**Set TCP (Option)**	Select TCP Setting Status - When Set TCP is set to True, it configures the TCP of the End-Effector used by the skill.	True [True, False]
	Gripper Wait Time	This is the standby time after a release or grasp motion.	0.5 s [0 ~ 10000]
	Tool Weight	If a workpiece is grasped, apply the weight information. - To apply tool weight to a skill, save the tool weight with a workpiece grasped under the WCM Tool Weight.	
	Gripper Release (Option)	Select Gripper Release Status before Pick Motion - Use the Gripper Release option to perform the gripper release motion after moving to the approach Ppse and before moving to the teaching pose. (Applies on Gripper Wait Time as well.)	True [True, False]
Approach Pose Setting (Option)	**Approach Distance**	Distance from the teaching pose in x, y and z directions - The approach distance must be entered in a 1 x 3 array (i.e. [x, y, z]). - During pattern setting, the approach distance set in the pallet UI is applied.	[0, 0, -100] mm [Individually -1000 ~ 1000]

Item		Description	Default Value and Input Range
	Velocity for App. Pose	This is the motion velocity to the approach pose.	250 mm/s [0.001 ~ 8000]
	Acceleration for App. Pose	This is the motion acceleration to the approach pose.	250 mm/s^2 [0.001 ~ 20000]
	Motion Time for App. Pose	This is the motion time to the approach pose. - If a motion time of greater than 0 is entered, the Velocity/Acceleration values are ignored.	0 s [0 ~ 10000]
	Blending Radius for App. Pose	This is the blending radius connecting the movement between the approach pose and the teaching pose. - If a blending radius of greater than 0 is entered, all optional items (Set TCP / Gripper Release / Compliance Control / Contact Sensing Setting) must be set as False.	0 mm [0 ~ 1000]
Retract Pose Setting (Option)	**Retract Distance**	Distance from the teaching pose in x, y and z directions - The retract distance must be entered in a 1 x 3 array (i.e. [x, y, z]). - During pattern setting, the retract distance set in the pallet UI is applied.	[0, 0, -100] mm [Individually -1000 ~ 1000]
	Velocity for Ret. Pose	This is the motion velocity to the retract pose.	100 mm/s [0.001 ~ 8000]
	Acceleration for Ret. Pose	This is the motion acceleration to the retract pose.	100 mm/s^2 [0.001 ~ 20000]
	Motion Time for Ret. Pose	This is the motion time to the retract pose. - If a motion time of greater than 0 is entered, the	0 s [0 ~ 10000]

Item		Description	Default Value and Input Range
		Velocity/Acceleration values are ignored.	
	Blending Radius for Ret. Pose	This is the blending radius connecting the movement between the teaching pose and the retract pose.	0 mm [0 ~ 1000]
Compliance Control Setting	**Compliance control (Option)**	Select Compliance Control Status	False [True, False]
	Stiffness	Stiffness Setting	x=y=z= 3000 N/m [0 ~ 20000] rx=ry=rz= 200 Nm/rad [0 ~ 1000]
Contact Sensing Setting (Option)	**Task Direction**	Orientation setting during force control - Orientation is based on Tool Coordinates.	Z [X, Y, Z]
	Contact Margin	Margin for contact sensing section setting - The contact sensing section is configured by adding the +/- contact sensing margin from the teaching point.	2 mm [0 ~ 100]
	Desired Force	Target Force Value - Target force must be greater than the sense value, and the absolute value must be greater than 10 N(In the case of A series, there is no limit to the desired force value).	12 N [-1200 ~ 1200]
	Contact Force	This is the reference force for contact sensing.	10 N [0 ~ 1200]
	Timeout	This is the contact sensing time.	10 s [0 ~ 10000]
	Offset Margin for Contact	This is the fine retract distance after contact sensing.	0.5 mm [0 ~ 100]

1.5.2 Place

This skill operates the gripper and releases the target when the robot moves to a specific point or approaches and contacts the work table.

(1) Recommended Default WCI: Gripper (GripperDA, GripperSA)

(2) Create Skill: TaskBuilder → Add Gripper (Skill Type: End-Effector & Pattern)

(3) Optional Features: Add pattern, approach pose and retract pose settings, Compliance Control and Contact Sensing functions

(4) Confirm Condition:

A. Select Gripper and Pattern and press the Set button (Pattern selection can be omitted).

B. Save Teaching Pose

C. Even if a pattern is not used, gLoopCountRev must be selected under Repeat Conditi on.

- **Default Motion Sequence**

Move to Approach Pose → Move to Teaching Pose (if a pattern is added, move to Pattern Calculation Pose) → Gripper Motion (Release) → Move to Retract Pose

- **Definition of Skill Screen**

Item		Description	Default Value and Input Range
Basic Setting	**Gripper**	I/O test available upon gripper selection	
	Pattern	Select if a pattern is used	
	Reference Pose	Teaching Pose - This is the point where the workpiece is released from a gripper. - Reference Pose changes to Position Referenced during pattern setting.	
Task Setting	**Repeat Condition**	Select Repeat Index - The repeat condition is used as the pattern index when a pattern is used.	
	Task Velocity	This is the velocity from the approach pose to teaching pose. - During pattern use, Task Velocity is the velocity until each pattern point.	100 mm/s [0.001 ~ 8000]

Item		Description	Default Value and Input Range
	Task Acceleration	This is the acceleration from the approach pose to teaching pose. - During pattern use, Task Acceleration is the velocity until each pattern point.	0.1 m/s^2 [0.001 ~ 20]
Gripper Setting	**Set TCP (Option)**	Select TCP Setting Status - When Set TCP is set to True, it configures the TCP of the End-Effector used by the skill.	True [True, False]
	Gripper Wait Time	Standby time after release motion.	0.5 s [0 ~ 10000]
	Tool Weight	If a workpiece is released, apply the weight information. - To apply tool weight to a skill, save the tool weight with a workpiece grasped under the WCM Tool Weight.	
Approach Pose Setting (Option)	**Approach Distance**	Distance from the teaching pose in x, y and z directions - The approach distance must be entered in a 1 x 3 array (i.e. [x, y, z]). - During pattern setting, the approach distance set in the pallet UI is applied.	[0, 0, -100] mm [Individually -1000 ~ 1000]
	Velocity for App. Pose	This is the motion velocity to the approach pose.	250 mm/s [0.001 ~ 8000]
	Acceleration for App. Pose	This is the motion acceleration to the approach pose.	0.25 m/s^2 [0.001 ~ 20]
	Motion Time for App. Pose	This is the motion time to the approach pose. - If a motion time of greater than 0 is entered, the	0 s [0 ~ 10000]

Item		Description	Default Value and Input Range
		Velocity/Acceleration values are ignored.	
	Blending Radius for App. Pose	This is the blending radius connecting the movement between the approach pose and the teaching pose. - If a blending radius of greater than 0 is entered, all optional items (Set TCP / Compliance Control / Contact Sensing Setting) must be set as False.	0 mm [0 ~ 1000]
Retract Pose Setting (Option)	**Retract Distance**	Distance from the teaching pose in x, y and z directions - The retract distance must be entered in a 1 x 3 array (i.e. [x, y, z]). - During pattern setting, the retract distance set in the pallet UI is applied.	[0, 0, -100] mm [Individually -1000 ~ 1000]
	Velocity for Ret. Pose	This is the motion velocity to the retract pose.	100 mm/s [0.001 ~ 8000]
	Acceleration for Ret. Pose	This is the motion acceleration to the retract pose.	0.1 m/s^2 [0.001 ~ 20]
	Motion Time for Ret. Pose	This is the motion time to the retract pose. - If a motion time of greater than 0 is entered, the Velocity/Acceleration values are ignored.	0 s [0 ~ 10000]
	Blending Radius for Ret. Pose	This is the blending radius connecting the movement between the teaching pose and the retract pose.	0 mm [0 ~ 1000]
Compliance Control Setting	**Compliance control (Option)**	Select Compliance Control Status	False [True, False]
	Stiffness	Stiffness Setting	x=y=z= 3000 N/m

Item		Description	Default Value and Input Range
			[0 ~ 20000] rx=ry=rz= 200 Nm/rad [0 ~ 1000]
Contact Sensing Setting **(Option)**	**Task Direction**	Orientation setting during force control - Orientation is based on Tool Coordinates.	Z [X, Y, Z]
	Contact Margin	Margin for contact sensing section setting - The contact sensing section is configured by adding the +/- contact sensing margin from the teaching point.	2 mm [0 ~ 100]
	Desired Force	Target Force Value - Target force must be greater than the sense value, and the absolute value must be greater than 10N(In the case of A series, there is no limit to the desired force value).	12 N [-1200 ~ 1200]
	Contact Force	This is the reference force for contact sensing.	10 N [0 ~ 1200]
	Timeout	This is the contact sensing time.	10 s [0 ~ 10000]

1.5.3 Insert

This is a skill that finds the target point by searching with a spiral motion near the target point when the workpiece must be inserted into a hole and inserts it with a periodic search motion when a stuck condition occurs. Insert skill requires contact with external forces, so it requires Compliance Control by default.

- The spiral search motion and periodic search motion for finding holes must be configured.
- Spiral Search Motion options, Spiral Interval, Max. Radius, Velocity and Acceleration can be configured.
- For the periodic search motion, amplitude, period and repeat can be configured.
- The user can configure timeout as a method for notifying failures of the two motions.

(1) Recommended Default WCI: Gripper (GripperDA, GripperSA)

(2) Create Skill: TaskBuilder → Add Gripper (Skill Type: End-Effector)

(3) Optional Features: Approach pose and retract pose settings, Compliance Control (must be set as True), hole search motion settings (spiral search motion & periodic search motion)

(4) Confirm Condition:

A. Select a gripper and press the Set button.

B. Save Teaching Pose

- **Default Motion Sequence**

Move to Approach Pose → Move to Hole Surface (Pose excluding Hole Depth + Contact Margin at Teaching Pose) → External Force Sensing → Hole Search Motion → Insert → Gripper Motion (Release) → Move to Retract Pose

- **Definition of Skill Screen**

Item		Description	Default Value and Input Range
Basic Setting	**Gripper**	I/O test available upon gripper selection	
	Reference Pose	Teaching Pose - This is the point where the gripper grasps a workpiece and inserts it in a hole.	
Task Setting	**Hole Depth**	This is the depth of the hole.	20 mm [0 ~ 200]
	Insert Velocity	This is the velocity at the final insert.	30 mm/s [0.001 ~ 8000]
	Insert Acceleration	This is the acceleration at the final insert.	0.03 m/s^2 [0.001 ~ 20]

Item		Description	Default Value and Input Range
	Task Velocity	This is the velocity from the approach pose to the hole surface.	100 mm/s [0.001 ~ 8000]
	Task Acceleration	This is the acceleration from the approach pose to the hole surface.	0.1 m/s^2 [0.001 ~ 20]
Gripper Setting	**Set TCP (Option)**	Select TCP Setting Status - When Set TCP is set to True, it configures the TCP of the End-Effector used by the skill.	True [True, False]
	Gripper Wait Time	Standby time after release motion.	0.5 s [0 ~ 10000]
	Tool Weight	If a workpiece is released, apply the weight information. - To apply tool weight to a skill, save the tool weight with a workpiece grasped under the WCM Tool Weight.	
	Gripper Release (Option)	Select Gripper Release Status after insert completion - If the gripper release option is not used, the gripper does not perform the gripper release motion and moves to the retract pose after insert completion.	True [True, False]
Approach Pose Setting (Option)	**Approach Distance**	Distance from the teaching pose in x, y and z directions - The approach distance must be entered in a 1 x 3 array (i.e. [x, y, z]).	[0, 0, -100] mm [Individually -1000 ~ 1000]
	Velocity for App. Pose	This is the motion velocity to the approach pose.	250 mm/s [0.001 ~ 8000]
	Acceleration for App. Pose	This is the motion acceleration to the approach pose.	0.25 m/s^2 [0.001 ~ 20]
	Motion Time for App. Pose	This is the motion time to the approach pose.	0 s

Item		Description	Default Value and Input Range
		- If a motion time of greater than 0 is entered, the Velocity/Acceleration values are ignored.	[0 ~ 10000]
Retract Pose Setting (Option)	**Retract Distance**	Distance from the teaching pose in x, y and z directions - The retract distance must be entered in a 1 x 3 array (i.e. [x, y, z]).	[0, 0, -100] mm [Individually -1000 ~ 1000]
	Velocity for Ret. Pose	This is the motion velocity to the retract pose.	100 mm/s [0.001 ~ 8000]
	Acceleration for Ret. Pose	This is the motion acceleration to the retract pose.	0.1 m/s^2 [0.001 ~ 20]
	Motion Time for Ret. Pose	This is the motion time to the retract pose. - If a motion time of greater than 0 is entered, the Velocity/Acceleration values are ignored.	0 s [0 ~ 10000]
	Blending Radius for Ret. Pose	This is the blending radius connecting the movement between the teaching pose and the retract pose.	0 mm [0 ~ 1000]
Compliance Control Setting	**Compliance control (Option)**	Select Compliance Control Status	True [True, False]
	Stiffness	Stiffness Setting	x=y= 500 N/m, z = 1500 N/m [0 ~ 20000] x=ry=rz= 50 Nm/rad [0 ~ 1000]
Force Control Setting	**Task Direction**	Orientation setting during force control - Orientation is based on Tool Coordinates.	Z [X, Y, Z]

Item		Description	Default Value and Input Range
	Contact Margin	Margin for contact sensing section setting - The contact sensing section is configured by adding the +/- contact sensing margin from the teaching point.	3 mm [0 ~ 100]
	Desired Force	Target Force Value - Target force must be greater than the sense value, and the absolute value must be greater than 10N(In the case of A series, there is no limit to the desired force value).	15 N [-1200 ~ 1200]
	Contact Force	This is the reference force for contact sensing.	10 N [0 ~ 1200]
	Timeout	This is the contact sensing time.	10 s [0 ~ 10000]
Spiral Motion Setting (Option)	**Spiral Interval**	Spiral Interval	0.5 mm [0 ~ 100]
	Maximum Radius	Max Radius	10 mm [0 ~ 200]
	Velocity of Spiral Motion	Spiral Search Motion Velocity	12 mm/s [0.001 ~ 8000]
	Acceleration of Spiral Motion	Spiral Search Motion Acceleration	0.012 m/s^2 [0.001 ~ 20]
Periodic Motion Setting (Option)	**Maximum Amplitude**	Max Distance - Rotation angle of the orientation - Rx, Ry and Rz values are applied depending on the orientation during Force Control. The default orientation is Z, so the default direction of Max Distance is Rz.	5 deg [0 ~ 360]

Item		Description	Default Value and Input Range
	Maximum Period	Max Period	2 s [0 ~ 10000]
	Maximum Repeat Value	Max Repeat Count	10 [0 ~ 10000]

Note

- The insert skill is influenced by the workpiece, hole and the deviation between the two, so it is difficult to select a setting that can succeed in all cases. The stiffness, force and margin values must be adjusted according to the environment, and the settings must be adjusted considering search motion information.

Version A Series

- If A-Series is not installed with FTS, the Insert skill cannot be used.

1.5.4 Polishing

This is a skill that polishes the target's surface with a polishing tool. It must be used together with the End_Task skill, and a task motion command can be inserted.

The polishing skill provides One-Point Task mode which is a mode that polishes the interior of a hole using a polishing tool. This mode must be used with the End_Task skill, but a task motion command is not inserted in between. This mode allows patterns to be added for tasks, but it does not provide force control.

(1) Recommended Default WCI: Tool

(2) Create Skill: TaskBuilder → Add Tool (Skill Type: End-Effector & Pattern)

(3) Optional Features: Add pattern (One-Point Task mode setting), approach pose setting, Compliance Control, Force Control

(4) Confirm Condition:

A. Select Tool and Pattern and press the Set button (pattern selection can be omitted).

B. Save Teaching Pose

C. Even if a pattern is not used, gLoopCountRev must be selected under Repeat Conditi on.

- **Default Motion Sequence**

1. Default Mode

Move to Approach Pose → Tool Motion (Run) → Move to Teaching Pose (→ Task Motion → End_Task)

2. One-Point Task Mode

Move to Approach Pose → Tool Motion (Run) → Move to Teaching Pose (if a pattern is added, move to Pattern Calculation Pose) → Repeat Motion (→ End_Task)

- **Definition of Skill Screen**

Item		Description	Default Value and Input Range
Basic Setting	**Tool**	I/O test available upon tool selection	
	Pattern	Select if a pattern is used	
	Reference Pose	Teaching Pose - This is the polishing start position. - Reference Pose changes to Position Referenced during pattern setting.	
Task Setting	**One Point Task (Option)**	This configures One Point Repetition Status.	False [True, False]
	Hole Depth	This is the orientation depth from the teaching pose.	10 mm [0 ~ 200]
	Repeat Value	Repetition Count	0 [0 ~ 10000]
	Repeat Velocity	Repetition Velocity	30 mm/s [0.001 ~ 8000]
	Repeat Acceleration	Repetition Acceleration	0.03 m/s^2 [0.001 ~ 20]
	Repeat Condition	Select Repeat Index - The repeat condition is used as the pattern index when a pattern is used.	
	Task Velocity	This is the velocity from the approach pose to teaching pose. - During pattern use, Task Velocity is the velocity until each pattern point.	100 mm/s [0.001 ~ 8000]
	Task Acceleration	This is the acceleration from the approach pose to teaching pose.	0.1 m/s^2 [0.001 ~ 20]

Item		Description	Default Value and Input Range
		- During pattern use, Task Acceleration is the velocity until each pattern point.	
Tool Setting	**Set TCP (Option)**	Select TCP Setting Status - When Set TCP is set to True, it configures the TCP of the End-Effector used by the skill.	True [True, False]
	Tool Wait Time	Standby time after tool run motion.	0.5 s [0 ~ 10000]
Approach Pose Setting (Option)	**Approach Distance**	Distance from the teaching pose in x, y and z directions - The approach distance must be entered in a 1 x 3 array (i.e. [x, y, z]). - During pattern setting, the approach distance set in the pallet UI is applied.	[0, 0, -100] mm [Individually -1000 ~ 1000]
	Velocity for App. Pose	This is the motion velocity to the approach pose.	250 mm/s [0.001 ~ 8000]
	Acceleration for App. Pose	This is the motion acceleration to the approach pose.	0.25 m/s^2 [0.001 ~ 20]
	Motion Time for App. Pose	This is the motion time to the approach pose. - If a motion time of greater than 0 is entered, the Velocity/Acceleration values are ignored.	0 s [0 ~ 10000]
	Blending Radius for App. Pose	This is the blending radius connecting the movement between the approach pose and the teaching pose. - If a blending radius of greater than 0 is entered, all optional items (Set TCP / Compliance Control / Force Control Setting) must be set as False.	0 mm [0 ~ 1000]

Item		Description	Default Value and Input Range
Compliance Control Setting	**Compliance control (Option)**	Select Compliance Control Status	True [True, False]
	Stiffness	Stiffness Setting	x=y= 3000 N/m, z= 900 N/m [0 ~ 20000] rx=ry=rz= 200 Nm/rad [0 ~ 1000]
Force Control Setting **(Option)**	**Task Direction**	Orientation setting during force control - Orientation is based on Tool Coordinates.	Z [X, Y, Z]
	Contact Margin	Margin for contact sensing section setting - The contact sensing section is configured by adding the +/- contact sensing margin from the teaching point.	2 mm [0 ~ 100]
	Desired Force	Target Force Value - Target force must be greater than the sense value, and the absolute value must be greater than 10N(In the case of A series, there is no limit to the desired force value).	12 N [-1200 ~ 1200]
	Contact Force	This is the reference force for contact sensing.	10 N [0 ~ 1200]
	Timeout	This is the contact sensing time.	10 s [0 ~ 10000]

Note

- Freely teach the routine using motion commands that can be used between polishing and End_Task. The available motion commands are as follows: movel, movec, movesx, moveb

1.5.5 Deburring

This is a skill for removing burrs on the target's surface with a deburring tool. It must be used together with the End_Task skill, and a task motion command can be inserted.

The deburring skill includes a One-Point Task mode, which deburrs the interior of a hole using a deburring tool. This mode must be used with the End_Task skill, but a task motion command is not inserted in between. This mode allows patterns to be added for tasks, but it does not provide force control.

(1) Recommended Default WCI: Tool

(2) Create Skill: TaskBuilder → Add Tool (Skill Type: End-Effector & Pattern)

(3) Optional Features: Add pattern (One-Point Task mode setting), approach pose setting, Compliance Control, Force Control

(4) Confirm Condition:

A. Select Tool and Pattern and press the Set button (pattern selection can be omitted).

B. Save Teaching Pose

C. Even if a pattern is not used, gLoopCountRev must be selected under Repeat Condition.

- **Default Motion Sequence**

1. Default Mode

Move to Approach Pose → Tool Motion (Run) → Move to Teaching Pose (→ Task Motion → End_Task)

2. One-Point Task Mode

Move to Approach Pose → Tool Motion (Run) → Move to Teaching Pose (if a pattern is added, move to Pattern Calculation Pose) → Repeat Motion (→ End_Task)

- **Definition of Skill Screen**

Item		Description	Default Value and Input Range
Basic Setting	**Tool**	I/O test available upon tool selection	
	Pattern	Select if a pattern is used	
	Reference Pose	Teaching Pose - This is the deburring start position. - Reference Pose changes to Position Referenced during pattern setting.	
Task Setting	**One Point Task (Option)**	It configures One Point Repetition Status.	False [True, False]
	Hole Depth	This is the orientation depth from the teaching pose.	10 mm [0 ~ 200]

Item		Description	Default Value and Input Range
	Repeat Value	Repetition Count	0 [0 ~ 10000]
	Repeat Velocity	Repetition Velocity	30 mm/s [0.001 ~ 8000]
	Repeat Acceleration	Repetition Acceleration	0.03 m/s^2 [0.001 ~ 20]
	Repeat Condition	Select Repeat Index - The repeat condition is used as the pattern index when a pattern is used.	
	Task Velocity	This is the velocity from the approach pose to teaching pose. - During pattern use, Task Velocity is the velocity until each pattern point.	100 mm/s [0.001 ~ 8000]
	Task Acceleration	This is the acceleration from the approach pose to teaching pose. - During pattern use, Task Acceleration is the velocity until each pattern point.	0.1 m/s^2 [0.001 ~ 20]
Tool Setting	**Set TCP (Option)**	Select TCP Setting Status - When Set TCP is set to True, it configures the TCP of the End-Effector used by the skill.	True [True, False]
	Tool Wait Time	Standby time after tool run motion.	0.5 s [0 ~ 10000]
Approach Pose Setting (Option)	**Approach Distance**	Distance from the teaching pose in x, y and z directions - The approach distance must be entered in a 1 x 3 array (i.e. [x, y, z]). - During pattern setting, the approach distance set in the pallet UI is applied.	[0, 0, -100] mm [Individually -1000 ~ 1000]

Item		Description	Default Value and Input Range
	Velocity for App. Pose	This is the motion velocity to the approach pose.	250 mm/s [0.001 ~ 8000]
	Acceleration for App. Pose	This is the motion acceleration to the approach pose.	0.25 m/s^2 [0.001 ~ 20]
	Motion Time for App. Pose	This is the motion time to the approach pose. - If a motion time of greater than 0 is entered, the Velocity/Acceleration values are ignored.	0 s [0 ~ 10000]
	Blending Radius for App. Pose	This is the blending radius connecting the movement between the approach pose and the teaching pose. - If a blending radius of greater than 0 is entered, all optional items (Set TCP / Gripper Release / Compliance Control / Contact Sensing Setting) must be set as False.	0 mm [0 ~ 1000]
Compliance Control Setting	**Compliance control (Option)**	Select Compliance Control Status	True [True, False]
	Stiffness	Stiffness Setting	x=y= 3000 N/m, z= 900 N/m [0 ~ 20000] rx=ry=rz= 200 Nm/rad [0 ~ 1000]
Force Control Setting (Option)	**Task Direction**	Orientation setting during force control - Orientation is based on Tool Coordinates.	Z [X, Y, Z]
	Contact Margin	Margin for contact sensing section setting - The contact sensing section is configured by adding the +/-	2 mm [0 ~ 100]

Item		Description	Default Value and Input Range
		contact sensing margin from the teaching point.	
	Desired Force	Target Force Value - Target force must be greater than the sense value, and the absolute value must be greater than 10N(In the case of A series, there is no limit to the desired force value).	12 N [-1200 ~ 1200]
	Contact Force	This is the reference force for contact sensing.	10 N [0 ~ 1200]
	Timeout	This is the contact sensing time.	10 s [0 ~ 10000]

Note

- Freely teach the routine using motion commands that can be used between deburring and End_Task. The available motion commands are as follows: movel, movec, movesx, moveb

1.5.6 Gluing

This is a skill for applying glue on the target's surface with a gluing tool. It must be used together with the End_Task skill, and a task/joint motion command can be inserted. However, if a pattern is used, a task/joint motion command is not inserted.

(1) Recommended Default WCI: Tool

(2) Create Skill: TaskBuilder → Add Tool (Skill Type: End-Effector & Pattern)

(3) Optional Features: Add pattern, Approach Pose Setting

(4) Confirm Condition:

A. Select Tool and Pattern and press the Set button (pattern selection can be omitted).

B. Save Teaching Pose

C. Even if a pattern is not used, gLoopCountRev must be selected under Repeat Condition.

- **Default Motion Sequence**

1. Default Mode

Move to Approach Pose → Move to Teaching Pose → Tool Motion (Run) (→ Task/Joint Motion → End_Task)

2. Pattern Added

Move to Approach Pose → Tool Motion (Run) → Move to Pattern Calculation Pose (→ End_Task)

- **Definition of Skill Screen**

Item		Description	Default Value and Input Range
Basic Setting	**Tool**	I/O test available upon tool selection	
	Pattern	Select if a pattern is used	
	Reference Pose	Teaching Pose - This is the gluing start position. - Reference Pose changes to Position Referenced during pattern setting.	
	Repeat Condition	Select Repeat Index - The repeat condition is used as the pattern index when a pattern is used.	
	Task Velocity	This is the velocity from the approach pose to teaching pose. - During pattern use, Task Velocity is the velocity until each pattern point.	100 mm/s [0.001 ~ 8000]

Item		Description	Default Value and Input Range
	Task Acceleration	This is the acceleration from the approach pose to teaching pose. - During pattern use, Task Acceleration is the velocity until each pattern point.	0.1 m/s^2 [0.001 ~ 20]
Tool Setting	**Set TCP (Option)**	Select TCP Setting Status - When Set TCP is set to True, it configures the TCP of the End-Effector used by the skill.	True [True, False]
	Tool Wait Time	Standby time after tool run motion.	0.5 s [0 ~ 10000]
Approach Pose Setting (Option)	**Approach Distance**	Distance from the teaching pose in x, y and z directions - The approach distance must be entered in a 1 x 3 array (i.e. [x, y, z]). - During pattern setting, the approach distance set in the pallet UI is applied.	[0, 0, -100] mm [Individually -1000 ~ 1000]
	Velocity for App. Pose	This is the motion velocity to the approach pose.	250 mm/s [0.001 ~ 8000]
	Acceleration for App. Pose	This is the motion acceleration to the approach pose.	0.25 m/s^2 [0.001 ~ 20]
	Motion Time for App. Pose	This is the motion time to the approach pose. - If a motion time of greater than 0 is entered, the Velocity/Acceleration values are ignored.	0 s [0 ~ 10000]
	Blending Radius for App. Pose	This is the blending radius connecting the movement between the approach pose and the teaching pose. - If a blending radius of greater than 0 is entered, the optional	0 mm [0 ~ 1000]

Item		Description	Default Value and Input Range
		item (Set TCP) must be set as False.	

Note

- Freely teach the routine using motion commands that can be used between gluing and End_Task. The available motion commands are as follows: movel, movec, movesx, moveb, movej, movejx, movesj

1.5.7 Airblowing

This is a skill for cleaning the target or equipment with an airblowing tool. It must be used together with the End_Task skill, and a task/joint motion command can be inserted. However, if a pattern is used, a task/joint motion command is not inserted.

(1) Recommended Default WCI: Tool

(2) Create Skill: TaskBuilder → Add Tool (Skill Type: End-Effector & Pattern)

(3) Optional Features: Add pattern, Approach Pose Setting

(4) Confirm Condition:

A. Select Tool and Pattern and press the Set button (pattern selection can be omitted).

B. Save Teaching Pose

C. Even if a pattern is not used, gLoopCountRev must be selected under Repeat Condition.

- **Default Motion Sequence**

1. Default Mode

Move to Approach Pose → Move to Teaching Pose → Tool Motion (Run) (→ Task/Joint Motion → End_Task)

2. Pattern Added

Move to Approach Pose → Tool Motion (Run) → Move to Pattern Calculation Pose (→ End_Task)

- **Definition of Skill Screen**

Item		Description	Default Value and Input Range
Basic Setting	**Tool**	I/O test available upon tool selection	
	Pattern	Select if a pattern is used	
	Reference Pose	Teaching Pose - This is the airblowing start position. - Reference Pose changes to Position Referenced during pattern setting.	
	Repeat Condition	Select Repeat Index - The repeat condition is used as the pattern index when a pattern is used.	
	Task Velocity	This is the velocity from the approach pose to teaching pose.	100 mm/s [0.001 ~ 8000]

Item		Description	Default Value and Input Range
		- During pattern use, Task Velocity is the velocity until each pattern point.	
	Task Acceleration	This is the acceleration from the approach pose to teaching pose. - During pattern use, Task Acceleration is the velocity until each pattern point.	0.1 m/s^2 [0.001 ~ 20]
Tool Setting	**Set TCP (Option)**	Select TCP Setting Status - When Set TCP is set to True, it configures the TCP of the End-Effector used by the skill.	True [True, False]
	Tool Wait Time	Standby time after tool run motion.	0.5 s [0 ~ 10000]
Approach Pose Setting (Option)	**Approach Distance**	Distance from the teaching pose in x, y and z directions - The approach distance must be entered in a 1 x 3 array (i.e. [x, y, z]). - During pattern setting, the approach distance set in the pallet UI is applied.	[0, 0, -100] mm [각각: -1000 ~ 1000]
	Velocity for App. Pose	This is the motion velocity to the approach pose.	250 mm/s [0.001 ~ 8000]
	Acceleration for App. Pose	This is the motion acceleration to the approach pose.	0.25 m/s^2 [0.001 ~ 20]
	Motion Time for App. Pose	This is the motion time to the approach pose. - If a motion time of greater than 0 is entered, the Velocity/Acceleration values are ignored.	0 s [0 ~ 10000]
	Blending Radius for App. Pose	This is the blending radius connecting the movement	0 mm [0 ~ 1000]

Item		Description	Default Value and Input Range
		between the approach pose and the teaching pose. - If a blending radius of greater than 0 is entered, the optional item (Set TCP) must be set as False.	

Note

- Freely teach the routine using motion commands that can be used between airblowing and End_Task. The available motion commands are as follows: movel, movec, movesx, moveb, movej, movejx, movesj

1.5.8 EndTask

This is a skill that ends the task with a tool. It is used to end tasks of the polishing, deburring, gluing and airblowing skills. It must be used with polishing, deburring, gluing or airblowing. When selecting a pattern with the polishing, deburring, gluing of airblowing skill, End_Task must also be selected.

(1) Recommended Default WCI: Tool

(2) Create Skill: TaskBuilder → Add Tool (Skill Type: End-Effector & Pattern)

(3) Optional Features: Add Pattern, Retract Pose Setting

(4) Confirm Condition:

A. Select Tool and Pattern and press the Set button (pattern selection can be omitted).

- **Default Motion Sequence**

(Polishing, Deburring, Gluing, Airblowing → Task/Joint Motion (or Move to Pattern Calculation Pose) → Tool Motion (Stop) → Save Current Pose → Move to Retract Pose

- **Definition of Skill Screen**

Item		Description	Default Value and Input Range
Basic Setting	**Tool**	I/O test available upon tool selection	
	Pattern	Select if a pattern is used	
Retract Pose Setting (Option)	**Retract Distance**	Distance from the teaching pose in x, y and z directions - The retract distance must be entered in a 1 x 3 array (i.e. [x, y, z]). - During pattern setting, the retract distance set in the pallet UI is applied.	[0, 0, -100] mm [Individually -1000 ~ 1000]
	Velocity for Ret. Pose	This is the motion velocity to the retract pose.	100 mm/s [0.001 ~ 8000]
	Acceleration for Ret. Pose	This is the motion acceleration to the retract pose.	0.1 m/s^2 [0.001 ~ 20]
	Motion Time for Ret. Pose	This is the motion time to the retract pose. - If a motion time of greater than 0 is entered, the Velocity/Acceleration values are ignored.	0 s [0 ~ 10000]

Item		Description	Default Value and Input Range
	Blending Radius for Ret. Pose	This is the blending radius connecting the movement between the teaching pose and the retract pose.	0 mm [0 ~ 1000]

1.5.9 Door_OpenClose

This is a command that manually opens/closes the door with a direct robot motion. Teach the start pose and end pose to perform a door open/close motion. The default setting is Open and if Close is selected, the teaching poses of the start pose and end pose change. (However, the teaching pose change is not reflected in the UI.)

(1) Recommended Default WCI: None

(2) Create Skill: TaskBuilder → No Add WCI (Skill Type: Basic)

(3) Optional Features: Approach pose and retract pose setting, Compliance Control, robot motion direction (Open or Close) selection

(4) Confirm Condition:

A. Save 2 Teaching Poses

- **Default Motion Sequence**

Move to Approach Pose → Move to Start Pose → Move to End Pose → Move to Retract Pose

- **Definition of Skill Screen**

Item		Description	Default Value and Input Range
Basic Setting	**Start Pose**	Teaching Pose - This is the pose the open/close door motion starts (ends) in.	
	End Pose	Teaching Pose - This is the pose the open/close door motion ends (starts) in.	
Task Setting	**Select Task (Option)**	Select Orientation - If Close is selected, the start pose and end pose change. (No change in the UI)	"Open" ["Open", "Close"]
	Wait Time	This is the standby time before moving to the start pose and after moving to the end pose.	0.5 s [0 ~ 10000]
	First Velocity	This is the velocity from the approach pose to the first teaching pose.	100 mm/s [0.001 ~ 8000]
	First Acceleration	This is the acceleration from the approach pose to the first teaching pose.	0.1 m/s^2 [0.001 ~ 20]
	Second Velocity	This is the velocity from the approach pose to the second teaching pose.	100 mm/s [0.001 ~ 8000]

Item		Description	Default Value and Input Range
	Second Acceleration	This is the acceleration from the approach pose to the second teaching pose.	0.1 m/s^2 [0.001 ~ 20]
Approach Pose Setting **(Option)**	**Approach Distance**	Distance from the teaching pose in x, y and z directions - The approach distance must be entered in a 1 x 3 array (i.e. [x, y, z]).	[0, 0, -100] mm [Individually -1000 ~ 1000]
	Velocity for App. Pose	This is the motion velocity to the approach pose.	250 mm/s [0.001 ~ 8000]
	Acceleration for App. Pose	This is the motion acceleration to the approach pose.	0.25 m/s^2 [0.001 ~ 20]
	Motion Time for App. Pose	This is the motion time to the approach pose. - If a motion time of greater than 0 is entered, the Velocity/Acceleration values are ignored.	0 s [0 ~ 10000]
	Blending Radius for App. Pose	This is the blending radius connecting the movement between the approach pose and the teaching pose. - If a blending radius of greater than 0 is entered, the optional item (Compliance Control) must be set as False.	0 mm [0 ~ 1000]
Retract Pose Setting **(Option)**	**Retract Distance**	Distance from the teaching pose in x, y and z directions - The retract distance must be entered in a 1 x 3 array (i.e. [x, y, z]).	[0, 0, -100] mm [Individually -1000 ~ 1000]
	Velocity for Ret. Pose	This is the motion velocity to the retract pose.	100 mm/s [0.001 ~ 8000]
	Acceleration for Ret. Pose	This is the motion acceleration to the retract pose.	0.1 m/s^2 [0.001 ~ 20]

Item		Description	Default Value and Input Range
	Motion Time for Ret. Pose	This is the motion time to the retract pose. - If a motion time of greater than 0 is entered, the Velocity/Acceleration values are ignored.	0 s [0 ~ 10000]
	Blending Radius for Ret. Pose	This is the blending radius connecting the movement between the teaching pose and the retract pose.	0 mm [0 ~ 1000]
Compliance Control Setting	**Compliance control (Option)**	Select Compliance Control Status	False [True, False]
	Stiffness	Stiffness Setting	x=y=z= 3000 N/m [0 ~ 20000] rx=ry=rz= 200 Nm/rad [0 ~ 1000]

Item	Description
Motion Start Pose	This configures the start pose of the motion for opening/closing the door.
Motion End Pose	This configures the end pose of the motion for opening/closing the door.

Note

- To use the Door_OpenClose skill, an external handle (protruding) must be present on the machine door at a position the robot can grab. There must be no obstacles present in the surrounding area when the door is opened/closed.

1.5.10 INTLK_Pick

This is a skill for operating the gripper and picking up the target when the robot moves to a point instructed in the machine chuck or approaches and contacts a target held by the chuck.

(1) Recommended Default WCI: Gripper (GripperDA, GripperSA), Machine (TurningCenter, PressMachine, MoldingMachine)

(2) Create Skill: TaskBuilder → Add Gripper and Machine (Skill Type: End-Effector & Machine)

(3) Optional Features: Approach Pose and Retract Pose setting, Compliance Control, Contact Sensing

(4) Confirm Condition:

A. Select a Gripper and Machine and press the Set button.

B. Save Teaching Pose

- **Default Motion Sequence**

Move to Approach Pose → Move to Teaching Pose → Gripper Motion (Grasp) → Chuck Motion (Chuck Open (INTLK_Off)) → Move to Retract Pose

- **Definition of Skill Screen**

Item		Description	Default Value and Input Range
Basic Setting	**Gripper**	I/O test available upon gripper selection	
	Machine	I/O test available upon machine selection	
	Reference Pose	Teaching Pose - This is the point where the workpiece on a machine chuck is grasped with a gripper.	
Task Setting	**Task Velocity**	This is the velocity from the approach pose to teaching pose.	100 mm/s [0.001 ~ 8000]
	Task Acceleration	This is the acceleration from the approach pose to teaching pose.	0.1 m/s^2 [0.001 ~ 20]
Gripper Setting	**Set TCP (Option)**	Select TCP Setting Status - When Set TCP is set to True, it configures the TCP of the End-Effector used by the skill.	True [True, False]
	Gripper Wait Time	This is the standby time after a release or grasp motion.	0.5 s [0 ~ 10000]

Item		Description	Default Value and Input Range
	Tool Weight	If a workpiece is grasped, apply the weight information. - To apply tool weight to a skill, save the tool weight with a workpiece grasped under the WCM Tool Weight.	
	Gripper Release (Option)	Select Gripper Release Status before Pick Motion - Use the Gripper Release option to perform the gripper release motion after moving to the approach Ppse and before moving to the teaching pose. (Applies on Gripper Wait Time as well.)	True [True, False]
Machine Setting	**Check Machine Ready (Option)**	Select machine ready signal standby status	False [True, False]
	Machine Wait Time	Standby time after machine ready signal completion	0.5 s [0 ~ 10000]
	Chuck Wait Time	Standby time after chuck open motion	0.5 s [0 ~ 10000]
Approach Pose Setting (Option)	**Approach Distance**	Distance from the teaching pose in x, y and z directions - The approach distance must be entered in a 1 x 3 array (i.e. [x, y, z]).	[0, 0, -100] mm [Individually -1000 ~ 1000]
	Velocity for App. Pose	This is the motion velocity to the approach pose.	250 mm/s [0.001 ~ 8000]
	Acceleration for App. Pose	This is the motion acceleration to the approach pose.	0.25 m/s^2 [0.001 ~ 20]
	Motion Time for App. Pose	This is the motion time to the approach pose. - If a motion time of greater than 0 is entered, the Velocity/Acceleration values are ignored.	0 s [0 ~ 10000]

Item		Description	Default Value and Input Range
	Blending Radius for App. Pose	This is the blending radius connecting the movement between the approach pose and the teaching pose. - If a blending radius of greater than 0 is entered, all optional items (Set TCP / Gripper Release / Check Machine Ready / Compliance Control / Contact Sensing Setting) must be set as False.	0 mm [0 ~ 1000]
Retract Pose Setting (Option)	**Retract Distance**	Distance from the teaching pose in x, y and z directions - The retract distance must be entered in a 1 x 3 array (i.e. [x, y, z]).	[0, 0, -100] mm [각각: -1000 ~ 1000]
	Velocity for Ret. Pose	This is the motion velocity to the retract pose.	100 mm/s [0.001 ~ 8000]
	Acceleration for Ret. Pose	This is the motion acceleration to the retract pose.	0.1 m/s^2 [0.001 ~ 20]
	Motion Time for Ret. Pose	This is the motion time to the retract pose. - If a motion time of greater than 0 is entered, the Velocity/Acceleration values are ignored.	0 s [0 ~ 10000]
	Blending Radius for Ret. Pose	This is the blending radius connecting the movement between the teaching pose and the retract pose.	0 mm [0 ~ 1000]
Compliance Control Setting	**Compliance control (Option)**	Select Compliance Control Status	False [True, False]
	Stiffness	Stiffness Setting	x=y=z= 3000 N/m [0 ~ 20000] rx=ry=rz= 200 Nm/rad [0 ~ 1000]

Item		Description	Default Value and Input Range
Contact Sensing Setting (Option)	**Task Direction**	Orientation setting during force control - Orientation is based on Tool Coordinates.	Z [X, Y, Z]
	Contact Margin	Margin for contact sensing section setting - The contact sensing section is configured by adding the +/- contact sensing margin from the teaching point.	2 mm [0 ~ 100]
	Desired Force	Target Force Value - Target force must be greater than the sense value, and the absolute value must be greater than 10N(In the case of A series, there is no limit to the desired force value).	12 N [-1200 ~ 1200]
	Contact Force	This is the reference force for contact sensing.	10 N [0 ~ 1200]
	Timeout	This is the contact sensing time.	10 s [0 ~ 10000]
	Offset Margin for Contact	This is the fine retract distance after contact sensing.	0.5 mm [0 ~ 100]

1.5.11 INTLK_Place

This is a skill for operating the gripper and releasing the target when the robot moves to a point instructed on the machine chuck or approaches and contacts the chuck.

(1) Recommended Default WCI: Gripper (GripperDA, GripperSA), Machine (TurningCenter, PressMachine, MoldingMachine)

(2) Create Skill: TaskBuilder → Add Gripper and Machine (Skill Type: End-Effector & Machine)

(3) Optional Features: Approach Pose and Retract Pose setting, Compliance Control, Contact Sensing

(4) Confirm Condition:

A. Select a Gripper and Machine and press the Set button.

B. Save Teaching Pose

- **Default Motion Sequence**

Move to Approach Pose → Move to Teaching Pose → Chuck Motion (Chuck Close (INTLK_On)) → Gripper Motion (Release) → Move to Retract Pose

- **Definition of Skill Screen**

Item		Description	Default Value and Input Range
Basic Setting	**Gripper**	I/O test available upon gripper selection	
	Machine	I/O test available upon machine selection	
	Reference Pose	Teaching Pose - This is the point where the workpiece on a machine chuck is released from a gripper.	
Task Setting	**Task Velocity**	This is the velocity from the approach pose to teaching pose.	100 mm/s [0.001 ~ 8000]
	Task Acceleration	This is the acceleration from the approach pose to teaching pose.	0.1 m/s^2 [0.001 ~ 20]
Gripper Setting	**Set TCP (Option)**	Select TCP Setting Status - When Set TCP is set to True, it configures the TCP of the End-Effector used by the skill.	True [True, False]
	Gripper Wait Time	Standby time after release motion.	0.5 s [0 ~ 10000]

Item		Description	Default Value and Input Range
	Tool Weight	If a workpiece is released, apply the weight information. - To apply tool weight to a skill, save the tool weight with a workpiece grasped under the WCM Tool Weight.	
Machine Setting	**Check Machine Ready (Option)**	Select machine ready signal standby status	False [True, False]
	Machine Wait Time	Standby time after machine ready signal completion	0.5 s [0 ~ 10000]
	Chuck Wait Time	Standby time after chuck close motion	0.5 s [0 ~ 10000]
	Chuck Open (Option)	Select chuck open status before INTLK place motion	True [True, False]
Approach Pose Setting (Option)	**Approach Distance**	Distance from the teaching pose in x, y and z directions - The approach distance must be entered in a 1 x 3 array (i.e. [x, y, z]).	[0, 0, -100] mm [Individually -1000 ~ 1000]
	Velocity for App. Pose	This is the motion velocity to the approach pose.	250 mm/s [0.001 ~ 8000]
	Acceleration for App. Pose	This is the motion acceleration to the approach pose.	0.25 m/s^2 [0.001 ~ 20]
	Motion Time for App. Pose	This is the motion time to the approach pose. - If a motion time of greater than 0 is entered, the Velocity/Acceleration values are ignored.	0 s [0 ~ 10000]
	Blending Radius for App. Pose	This is the blending radius connecting the movement between the approach pose and the teaching pose. - If a blending radius of greater than 0 is entered, all optional	0 mm [0 ~ 1000]

Item		Description	Default Value and Input Range
		items (Set TCP / Check Machine Ready / Compliance Control / Contact Sensing Setting) must be set as False.	
Retract Pose Setting (Option)	**Retract Distance**	Distance from the teaching pose in x, y and z directions - The retract distance must be entered in a 1 x 3 array (i.e. [x, y, z]).	[0, 0, -100] mm [Individually -1000 ~ 1000]
	Velocity for Ret. Pose	This is the motion velocity to the retract pose.	100 mm/s [0.001 ~ 8000]
	Acceleration for Ret. Pose	This is the motion acceleration to the retract pose.	0.1 m/s^2 [0.001 ~ 20]
	Motion Time for Ret. Pose	This is the motion time to the retract pose. - If a motion time of greater than 0 is entered, the Velocity/Acceleration values are ignored.	0 s [0 ~ 10000]
	Blending Radius for Ret. Pose	This is the blending radius connecting the movement between the teaching pose and the retract pose.	0 mm [0 ~ 1000]
Compliance Control Setting	**Compliance control (Option)**	Select Compliance Control Status	False [True, False]
	Stiffness	Stiffness Setting	x=y=z= 3000 N/m [0 ~ 20000] rx=ry=rz= 200 Nm/rad [0 ~ 1000]
Contact Sensing Setting (Option)	**Task Direction**	Orientation setting during force control - Orientation is based on Tool Coordinates.	Z [X, Y, Z]
	Contact Margin	Margin for contact sensing section setting	2 mm [0 ~ 100]

Item		Description	Default Value and Input Range
		- The contact sensing section is configured by adding the +/- contact sensing margin from the teaching point.	
	Desired Force	Target Force Value - Target force must be greater than the sense value, and the absolute value must be greater than 10N(In the case of A series, there is no limit to the desired force value).	12 N [-1200 ~ 1200]
	Contact Force	This is the reference force for contact sensing.	10 N [0 ~ 1200]
	Timeout	This is the contact sensing time.	10 s [0 ~ 10000]

1.5.12 Bolting

This is a skill for teaching the target pose with a screwdriver and installing bolts while moving from the start pose to the teaching pose, considering bolt length. If the screwdriver supports Reverse Mode, it can remove bolts while moving from the teaching pose (bolt installation position) to the start pose.

(1) Recommended Default WCI: Tool (ScrewDriver)

(2) Create Skill: TaskBuilder → Add ScrewDriver (Skill Type: End-Effector & Pattern)

(3) Optional Features: Add pattern, approach pose and retract pose setting, Compliance Control

(4) Confirm Condition:

A. Select ScrewDriver and Pattern and press the Set button (pattern selection can be omitted).

B. Save Teaching Pose

C. Even if a pattern is not used, gLoopCountRev must be selected under Repeat Condition.

- **Default Motion Sequence**

1. Default Mode

Move to Approach Pose → Move to Start Pose (point from Teaching Pose - bolt length) → Move to Teaching Pose (if a pattern is added, move to Pattern Calculation Pose) → Tool Motion (Run) (in case of Vacuum Type, Vacuum_Off) → Move to Retract Pose

2. Reverse Mode

Move to Approach Pose → Move to Teaching Pose (if a pattern is added, move to Pattern Calculation Pose) → Move to Start Pose (point from Teaching Pose - bolt length) → Tool Motion (Run) → Move to Retract Pose

- **Definition of Skill Screen**

Item		Description	Default Value and Input Range
Basic Setting	**Tool**	I/O test available upon screwdriver selection	
	Pattern	Select if a pattern is used	
	Reference Pose	Teaching Pose - This is the bolting start position. - Reference Pose changes to Position Referenced during pattern setting.	
Task Setting	**Reverse Mode (Option)**	Reverse Mode Setting	False [True, False]
	Task Direction	Bolt Installation Orientation	Z [X, Y, Z]
	Bolt Length	Bolt Length	10 mm [0 ~ 200]

Item		Description	Default Value and Input Range
	Bolting Velocity	Bolting Velocity	30 mm/s [0.001 ~ 8000]
	Bolting Acceleration	Bolting Acceleration	0.03 m/s^2 [0.001 ~ 20]
	Timeout	Bolting End Time	3 s [0 ~ 10000]
	Repeat Condition	Select Repeat Index - The repeat condition is used as the pattern index when a pattern is used.	
	Task Velocity	This is the velocity from the approach pose to teaching pose. - During pattern use, Task Velocity is the velocity until each pattern point.	100 mm/s [0.001 ~ 8000]
	Task Acceleration	This is the acceleration from the approach pose to teaching pose. - During pattern use, Task Acceleration is the velocity until each pattern point.	0.1 m/s^2 [0.001 ~ 20]
Tool Setting	**Set TCP (Option)**	Select TCP Setting Status - When Set TCP is set to True, it configures the TCP of the End-Effector used by the skill.	True [True, False]
	Vacuum Type (Option)	Select Vacuum Support Status	False [True, False]
	Tool Wait Time	Standby time after tool run motion.	0.5 s [0 ~ 10000]
	Check TorqueOK (Option)	Select Bolt Installation Completion Status Check	False [True, False]
Approach Pose Setting	**Approach Distance**	Distance from the teaching pose in x, y and z directions	[0, 0, -100] mm

Item		Description	Default Value and Input Range
(Option)		- The approach distance must be entered in a 1 x 3 array (i.e. [x, y, z]). - During pattern setting, the approach distance set in the pallet UI is applied.	[Individually -1000 ~ 1000]
	Velocity for App. Pose	This is the motion velocity to the approach pose.	250 mm/s [0.001 ~ 8000]
	Acceleration for App. Pose	This is the motion acceleration to the approach pose.	0.25 m/s^2 [0.001 ~ 20]
	Motion Time for App. Pose	This is the motion time to the approach pose. - If a motion time of greater than 0 is entered, the Velocity/Acceleration values are ignored.	0 s [0 ~ 10000]
	Blending Radius for App. Pose	This is the blending radius connecting the movement between the approach pose and the teaching pose. - If a blending radius of greater than 0 is entered, all optional items (Set TCP / Compliance Control / Reverse Mode) must be set as False.	0 mm [0 ~ 1000]
Retract Pose Setting **(Option)**	**Retract Distance**	Distance from the teaching pose in x, y and z directions - The retract distance must be entered in a 1 x 3 array (i.e. [x, y, z]). - During pattern setting, the retract distance set in the pallet UI is applied.	[0, 0, -100] mm [각각: -1000 ~ 1000]
	Velocity for Ret. Pose	This is the motion velocity to the retract pose.	100 mm/s [0.001 ~ 8000]
	Acceleration for Ret. Pose	This is the motion acceleration to the retract pose.	0.1 m/s^2 [0.001 ~ 20]]

Item		Description	Default Value and Input Range
	Motion Time for Ret. Pose	This is the motion time to the retract pose. - If a motion time of greater than 0 is entered, the Velocity/Acceleration values are ignored.	0 s [0 ~ 10000]
	Blending Radius for Ret. Pose	This is the blending radius connecting the movement between the teaching pose and the retract pose.	0 mm [0 ~ 1000]
Compliance Control Setting	**Compliance control (Option)**	Select Compliance Control Status	False [True, False]
	Stiffness	Stiffness Setting	x=y=z= 3000 N/m [0 ~ 20000] rx=ry=rz= 200 Nm/rad [0 ~ 1000]

1.5.13 PickBolt

This is a skill for picking up a bolt placed in a specific position by the bolt feeder using a screwdriver. If the screwdriver supports a vacuum, it can ensure stable bolt pick up.

(1) Recommended Default WCI: Tool (ScrewDriver), Feeder (BoltFeeder)

(2) Create Skill: TaskBuilder → Add ScrewDriver and BoltFeeder (Skill Type: End-Effector & Feeder)

(3) Optional Features: Approach Pose and Retract Pose setting, Compliance Control

(4) Confirm Condition:

A. Select a ScrewDriver and BoltFeeder and press the Set button.

B. Save Teaching Pose

- **Default Motion Sequence**

Move to Approach Pose → Move to Teaching Pose → ScrewDriver Motion (in the case of a Vacuum Type, Vacuum_On) (in the case of ScrewDriver, no separate motion) → Move to Retract Pose

- **Definition of Skill Screen**

Item		Description	Default Value and Input Range
Basic Setting	**Tool**	I/O test available upon screwdriver selection	
	Feeder	I/O test available upon bolt feeder selection	
	Reference Pose	Teaching Pose - This is the position in which the screwdriver picks up a bolt	
Task Setting	**Task Velocity**	This is the velocity from the approach pose to teaching pose.	100 mm/s [0.001 ~ 8000]
	Task Acceleration	This is the acceleration from the approach pose to teaching pose.	0.1 m/s^2 [0.001 ~ 20]
Tool Setting	**Set TCP (Option)**	Select TCP Setting Status - When Set TCP is set to True, it configures the TCP of the End-Effector used by the skill.	True [True, False]
	Vacuum Type (Option)	Select Vacuum Support Status	False [True, False]
	Tool Wait Time	Standby time after tool run motion.	0.5 s [0 ~ 10000]

Item		Description	Default Value and Input Range
Feeder Setting	**Check Bolt ready (Option)**	Select Bolt Ready signal standby	False [True, False]
	Bolt Wait Time	Standby time after bolt ready signal completion	0.5 s [0 ~ 10000]
	Feeder Type (Option)	Select Feeder type	“PickUP” [“PickUP”, “Shooting”]
Approach Pose Setting (Option)	**Approach Distance**	Distance from the teaching pose in x, y and z directions - The approach distance must be entered in a 1 x 3 array (i.e. [x, y, z]).	[0, 0, -100] mm [각각: -1000 ~ 1000]
	Velocity for App. Pose	This is the motion velocity to the approach pose.	250 mm/s [0.001 ~ 8000]
	Acceleration for App. Pose	This is the motion acceleration to the approach pose.	0.25 m/s^2 [0.001 ~ 20]
	Motion Time for App. Pose	This is the motion time to the approach pose. - If a motion time of greater than 0 is entered, the Velocity/Acceleration values are ignored.	0 s [0 ~ 10000]
	Blending Radius for App. Pose	This is the blending radius connecting the movement between the approach pose and the teaching pose. - If a blending radius of greater than 0 is entered, all optional items (Set TCP / Compliance Control / Check Bolt ready) must be set as False.	0 mm [0 ~ 1000]
Retract Pose Setting (Option)	**Retract Distance**	Distance from the teaching pose in x, y and z directions - The retract distance must be entered in a 1 x 3 array (i.e. [x, y, z]).	[0, 0, -100] mm [Individually -1000 ~ 1000]

Item		Description	Default Value and Input Range
	Velocity for Ret. Pose	This is the motion velocity to the retract pose.	100 mm/s [0.001 ~ 8000]
	Acceleration for Ret. Pose	This is the motion acceleration to the retract pose.	0.1 m/s^2 [0.001 ~ 20]
	Motion Time for Ret. Pose	This is the motion time to the retract pose. - If a motion time of greater than 0 is entered, the Velocity/Acceleration values are ignored.	0 s [0 ~ 10000]
	Blending Radius for Ret. Pose	This is the blending radius connecting the movement between the teaching pose and the retract pose.	0 mm [0 ~ 1000]
Compliance Control Setting	**Compliance control (Option)**	Select Compliance Control Status	False [True, False]
	Stiffness	Stiffness Setting	x=y=z= 3000 N/m [0 ~ 20000] rx=ry=rz= 200 Nm/rad [0 ~ 1000]

1.5.14 Contact

This is a skill for moving a target distance after reaching the teaching pose or stopping movement if an external force is sensed during Force Control movement. The contact skill requires force control in a specific direction, so it requires the Compliance Control by default.

(1) Recommended Default WCI: None

(2) Create Skill: TaskBuilder → No Add WCI (Skill Type: Basic)

(3) Optional Features: Approach pose and retract pose setting, Compliance Control, select stop method (force or distance)

(4) Confirm Condition:

A. Save Teaching Pose

- **Default Motion Sequence**

1. Force Setting

Move to Approach Pose → Move to Teaching Pose (position excluding Contact Margin) → Move with Force Control until External Force occur → Move to Retract Pose

2. “Distance” Setting

Move to Approach Pose → Move to Teaching Pose → Move Maximum Distance value with Force Control while checking External Force → Move to Retract Pose

- **Definition of Skill Screen**

Item		Description	Default Value and Input Range
Basic Setting	**Reference Pose**	Teaching Pose - This is a random position.	
Task Setting	**Select Task (Option)**	Select Check Method (Force or Distance)	“Force” [“Force”, ”Distance”]
	Maximum Distance	Max Distance - This is applied only with the Distance setting.	50 mm [0 ~ 5000]
	Wait Time	Standby time before/after move to teaching pose	0.5 s [0 ~ 10000]
	Task Velocity	This is the velocity from the approach pose to teaching pose.	100 mm/s [0.001 ~ 8000]
	Task Acceleration	This is the acceleration from the approach pose to teaching pose.	0.1 m/s^2 [0.001 ~ 20]
Approach Pose Setting	**Approach Distance**	Distance from the teaching pose in x, y and z directions	[0, 0, -100] mm

Item		Description	Default Value and Input Range
(Option)		- The approach distance must be entered in a 1 x 3 array (i.e. [x, y, z]).	[Individually -1000 ~ 1000]
	Velocity for App. Pose	This is the motion velocity to the approach pose.	250 mm/s [0.001 ~ 8000]
	Acceleration for App. Pose	This is the motion acceleration to the approach pose.	0.25 m/s^2 [0.001 ~ 20]
	Motion Time for App. Pose	This is the motion time to the approach pose. - If a motion time of greater than 0 is entered, the Velocity/Acceleration values are ignored.	0 s [0 ~ 10000]
Retract Pose Setting **(Option)**	**Retract Distance**	Distance from the teaching pose in x, y and z directions - The retract distance must be entered in a 1 x 3 array (i.e. [x, y, z]).	[0, 0, -100] mm [Individually -1000 ~ 1000]
	Velocity for Ret. Pose	This is the motion velocity to the retract pose.	100 mm/s [0.001 ~ 8000]
	Acceleration for Ret. Pose	This is the motion acceleration to the retract pose.	0.1 m/s^2 [0.001 ~ 20]
	Motion Time for Ret. Pose	This is the motion time to the retract pose. - If a motion time of greater than 0 is entered, the Velocity/Acceleration values are ignored.	0 s [0 ~ 10000]
	Blending Radius for Ret. Pose	This is the blending radius connecting the movement between the teaching pose and the retract pose.	0 mm [0 ~ 1000]
Compliance Control Setting	**Compliance control (Option)**	Select Compliance Control Status	False [True, False]
	Stiffness	Stiffness Setting	x=y=z= 3000 N/m

Item		Description	Default Value and Input Range
			[0 ~ 20000] rx=ry=rz= 200 Nm/rad [0 ~ 1000]
Force Control Setting	**Task Direction**	Orientation setting during force control - Orientation is based on Tool Coordinates.	Z [X, Y, Z]
	Contact Margin	Margin for contact sensing section setting - The contact sensing section is configured by adding the +/- contact sensing margin from the teaching point.	3 mm [0 ~ 100]
	Desired Force	Target Force Value - Target force must be greater than the sense value, and the absolute value must be greater than 10N(In the case of A series, there is no limit to the desired force value).	15 N [-1200 ~ 1200]
	Contact Force	This is the reference force for contact sensing.	10 N [0 ~ 1200]
	Timeout	This is the contact sensing time.	10 s [0 ~ 10000]

Version A Series

- If an A-series is not installed with FTS, the contact skill cannot be used.

1.5.15 Set_Digital_IO

This is a skillfor operating the digital input/output. In the case of output, if the SA option is selected, configure one port, and if the DA option is selected, configure two ports to be used as a pair. In the case of input, only one port can be selected. Set_Digital_IO skill is not related to robot motion.

(1) Recommended Default WCI: None

(2) Create Skill: TaskBuilder → No Add WCI (Skill Type: Basic)

(3) Optional Features: Select IO type (Flange or Controller), output (single/double) setting, input setting

(4) Confirm Condition: None

- **Default Motion Sequence**

1. Output (Single Type) Setting: 1 output signal operates
2. Output (Double Type) Setting: 2 output signals operate
3. Input Setting: Checks 1 input signal

- **Definition of Skill Screen**

Item		Description	Default Value and Input Range
Basic Setting	**DIO Type**	Select Digital I/O Connection - If Flange is selected, the I/O terminal must be connected to the flange for operation. - If Controller is selected, the I/O terminal must be connected to the controller for operation.	“Controller” [“Flange”, ” Controller”]
	Wait Time	Standby time after I/O motion	0.5 s [0 ~ 10000]
	Timeout	Max input signal standby time	10 s [0 ~ 10000]
Output Setting: Single Type (Option)	**Output Port**	Output Port Input - If Flange is selected, ports 1-6 can be used. - If Controller is selected, ports 1-16 can be used.	1 [1 ~ 16]
	Output Value	Output Value Input - Value must be either 1 or 0. (1: ON, 2: OFF)	1 [0, 1]
Output Setting:	**Output Port1**	Output Port 1 Input - If Flange is selected, ports 1-6 can be used.	1 [1 ~ 16]

Item		Description	Default Value and Input Range
Double Type (Option)		- If Controller is selected, ports 1-16 can be used.	
	Output Port2	Output Port2 Input - If Flange is selected, ports 1-6 can be used. - If Controller is selected, ports 1-16 can be used.	1 [1 ~ 16]
	Output Value1	Output Value1 Input - Value must be either 1 or 0. (1: ON, 2: OFF)	1 [0, 1]
	Output Value2	Output Value2 Input - Value must be either 1 or 0. (1: ON, 2: OFF)	1 [0, 1]
Input Setting (Option)	**Input Port**	Input Port Input - If Flange is selected, ports 1-6 can be used. - If Controller is selected, ports 1-16 can be used.	1 [1 ~ 16]
	Target Value	Target Value Input - Value must be either 1 or 0. (1: ON, 2: OFF)	1 [0, 1]

2. Task Template

Task Template is a bundle of skills that compose a work procedure used with a combination of Workcell Items when a particular Workcell Item is registered. It is possible to easily create a task with the settings of skills already in the template without worrying about the work process.

- Software version V2.7.3 does not support this function. The Task Template function will be updated and will be offered again in a new software version.

2.1 Part Handling

It is the template for handling the target. It is fundamentally composed of Pick and Place skills. A template is recommended depending on whether a single gripper or two grippers are installed on the robot flange. Related Workcell Items are as follows:

- Pneumatic Gripper
- Electric Gripper

2.1.1 Single Gripper

Work Procedure	Command
Grasp the workpiece	Pick
Release the workpiece	Place

2.1.2 Double Gripper

Work Procedure	Command
Grasp workpiece #1	Pick
Grasp workpiece #2	Pick
Release workpiece #1	Place
Release workpiece #2	Place

2.2 CNC Machine Tending

It is the template for secondary work of the machine tool. The machine tool template recommends a template depending on whether a single gripper or two grippers are installed on the robot flange. Related Workcell Items are as follows:

- Pneumatic Gripper
- Electric Gripper
- Turning Center
- Air blow Nozzle
- Pallet

2.2.1 Single Gripper

Work Procedure	Type 1	Type 2	Type 3	Type 4
	Command			
Grasp the workpiece	Pick Pallet	Pick Pallet	Pick Pallet	Pick Pallet
Chuck air blowing	-	-	Air blow	Air blow
Load the workpiece	Place TC	Place TC	Place TC	Place TC
Close door	Close TC Door	Close Manual TC Door	Close TC Door	Close Manual TC Door
Start processing	Start TC	Start TC	Start TC	Start TC
TC ready check	Check TC Ready	Check TC Ready	Check TC Ready	Check TC Ready
Open door	Open TC Door	Open Manual TC Door	Open TC Door	Open Manual TC Door
Finished Piece Air blowing	-	-	Air blow	Air blow
Unload finished p iece	Pick TC	Pick TC	Pick TC	Pick TC
Release finished piece	Place Pallet	Place Pallet	Place Pallet	Place Pallet

2.2.2 Double Gripper

Work Procedure	Type 1	Type 2	Type 3	Type 4
	Command			
Grasp the workpiece	Pick Pallet	Pick Pallet	Pick Pallet	Pick Pallet
TC ready check	Check TC Ready	Check TC Ready	Check TC Ready	Check TC Ready
Open door	Open Auto TC Door	Open Manual TC Door	Open Auto TC Door	Open Manual TC Door
Finished piece air blowing	-	-	Air blow	Air blow
Unload finished piece	Pick TC	Pick TC	Pick TC	Pick TC
Chuck air blowing	-	-	Air blow	Air blow
Load the workpiece	Place TC	Place TC	Place TC	Place TC
Close door	Close Auto TC Door	Close Manual TC Door	Close Auto TC Door	Close Manual TC Door
Start processing	Start TC	Start TC	Start TC	Start TC
Release finished piece	Place Pallet	Place Pallet	Place Pallet	Place Pallet

2.3 Press Machine Tending

It is the template for secondary work of the machine tool. The machine tool template recommends a template depending on whether a single gripper or two grippers are installed on the robot flange. Related Workcell Items are as follows:

- Vacuum Gripper
- Press Machine

2.3.1 Single Gripper

Work Procedure	Command
Grasp the workpiece	Pick
Load the workpiece	Place Press Machine
Start processing	Start Press Machine
Press Machine Ready Check	Check Press Machine Ready
Unload finished piece	Pick Press Machine
Release finished piece	Place

2.3.2 Double Gripper

Work Procedure	Command
Grasp the workpiece	Pick
Press Machine Ready Check	Check Press Machine Ready
Unload finished piece	Pick Press Machine
Load the workpiece	Place Press Machine
Start processing	Start Press Machine
Release finished piece	Place

2.4 Injection Molding Machine Tending

It is the template for secondary work of the machine tool. The machine tool template recommends a template depending on whether a single gripper or two grippers are installed on the robot flange. Related Workcell Items are as follows:

- Vacuum Gripper
- Injection Molding Machine

Work Procedure	Command
Press Machine Ready Check	Check Press Machine Ready
Unload finished piece	Pick Press Machine
Start processing	Start Press Machine

2.5 Screw Drive

It is the template for screw assembly work. A template is recommended depending on the Pick-up bolt Feeder or Shooting bolt Feeder Workcell Item settings. Related Workcell Items are as follows:

- Screwdriver
- Shooting Bolt Feeder
- Pickup Bolt Feeder

Work Procedure	Type 1	Type 2
	Command	
Feeder ready check	Check Feeder Ready	N/A
Feed bolt	Pick-up bolt Feeder	Shoot Bolt
Grasp workpiece #2	Screw Drive	Screw Drive

2.6 Gluing

It is the template for continuous routine gluing work. Related Workcell Items are as follows:

- Gluing Tool

Work Procedure	Command
Start Gluing	Start Glue
End Gluing	End Glue

2.7 Deburring

It is the template for continuous routine deburring work. Related Workcell Items are as follows:

- Deburring Tool

Work Procedure	Command
Start Deburring	Start Deburr
End Deburring	End Deburr

2.8 Polishing

It is the template for continuous routine deburring work. Related Workcell Items are as follows:

- Polishing Tool

Work Procedure	Command
Start Polishing	Start Polish
End Polishing	End Polish

2.9 Insert

This template inserts the item in the target hole. It consists of Insert and Insert skills. Related workcell items are as follows:

- Pneumatic/Electric Gripper

Work Procedure	Command
Grasp the workpiece	Pick
Insert the item	Insert

Part 3
Smart Vision Module

1. Precautions Before Use

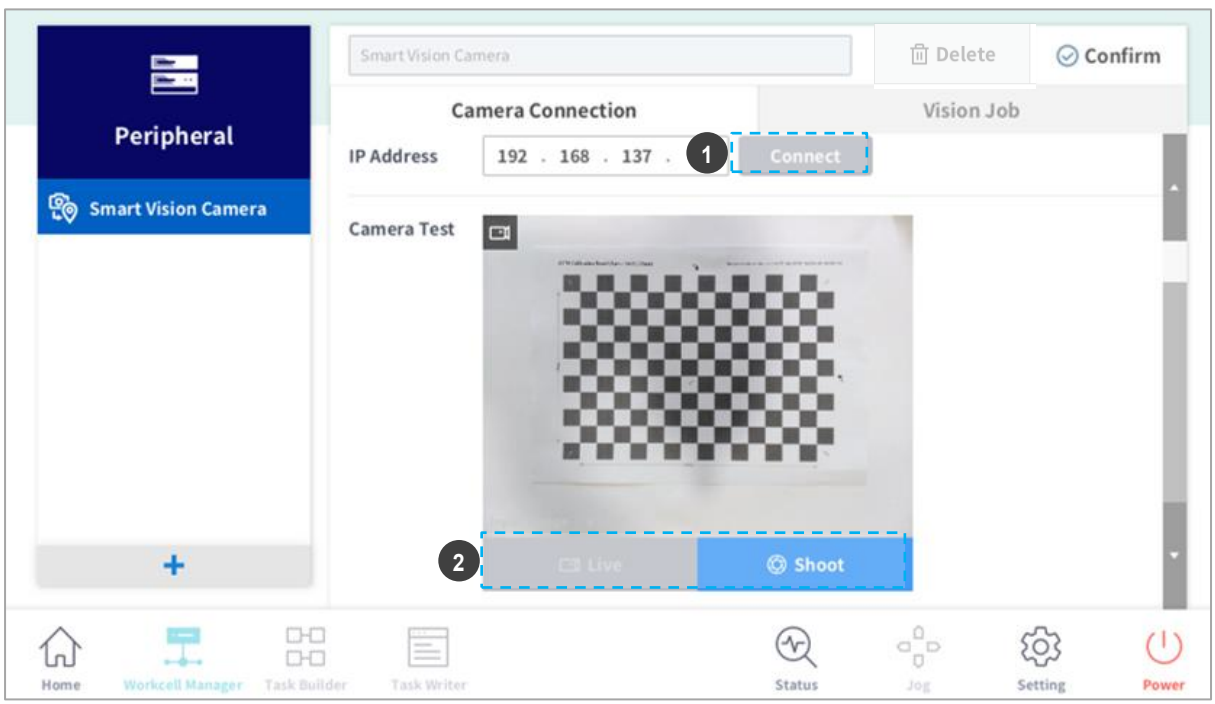
- The camera lens must be as parallel to the work surface as possible. The camera's line of view must be as perpendicular to the work surface as possible.
- Reflections from work items and the surrounding environment within the camera's measurement area must be avoided.
- The camera must measure the top view of the target item. If the item is slanted during measurement, distortion and incorrect measurement may occur due to perspective views.
- All cameras are strongly effected by ambient illumination. Establish and maintain work conditions with an illumination of 300 lux or higher in the camera measurement area using an illumination measuring instrument.
- For detailed information about measurable distance, field of view, and measurable item size and height, please refer to corresponding sections describing product specifications.
- When replacing SVM, create a job after deleting the Task Vision Command with Vision Job Command stored in the TB (Task Builder) or TW (Task Writer) on the TP. Vision Command can be deleted after deleting a Command depending on Vision Command.
- In order to update SVM firmware, make sure the current version is **DRST v1.2.0.2.6 version** or higher. Updating at a lower version can cause serious issues for the SVM OS. Please be careful.
- The SVM operates properly in version M2.2.1 or higher. In versions lower than M2.2.1, the robot must be updated.
- Match the robot version and the SVM version.
- The SVM firmware must match the controller SW version of the robot controller.
- The SVM firmware can be updated separately through DART-Vision or DART-Studio (v2.0.1), which are provided by Doosan Robotics.

2. Setting with Workcell Manager

Add the Smart Vision Module to the Workcell Manager and configure the Smart Vision Module referring to the following setting options.

2.1 Testing the Camera Connection

2.1.1 Camera Connection



No.	Item	Description
1	**Connect**	The camera IP address is a static IP, and the default address (192.168.137.5) is used for connection. After connection is successful, the Connect button is disabled.
2	**Live – Shoot**	Check the image in the camera's viewfinder to see if the camera is working properly. Live: Displays the streaming image. Shoot: Displays the static image in the camera’s field of view.

If the LAN/communication cable physically disconnects the SVM

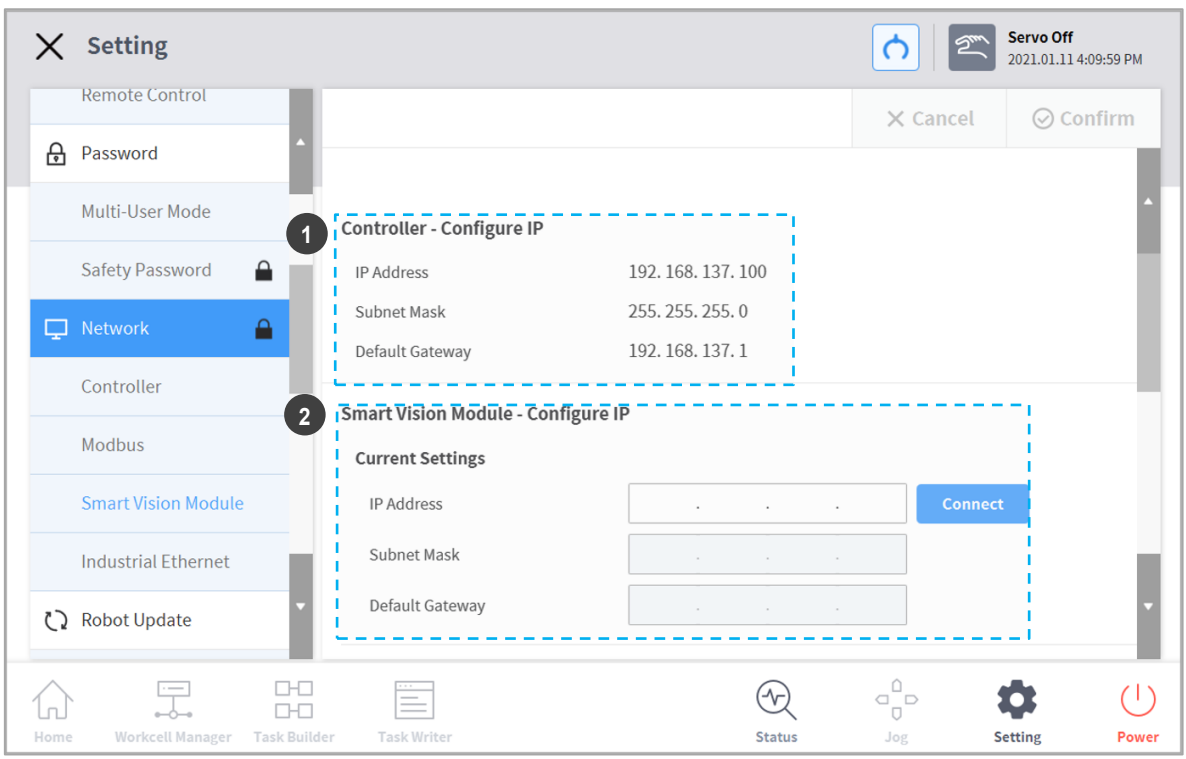
- When the cable is physically removed while the Smart Vision Module (SVM) and Teach Pendant (TP) are connected, the power to the SVM and TP must be turned OFF/ON.

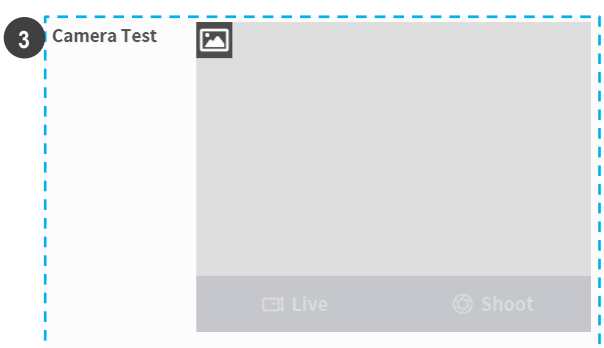
Status indicator LED function

- The status indicator LED on top of the SVM module operates in five modes: power not connected, power supplied, connection standby, communication connected and processing.

	Smart Vision Module Status Indicator LED	LED Operation	
1	Power not connected	Power off	
2	Power connected – OS booting	Solid Red	
3	Normal operation – Connection standby – Communication not connected	Solid Green	
4	Normal operation – Standby – Communication connected	Solid Blue	
5	Normal operation – Processing – (item recognition, teaching/save/loading)	Blink Blue	

2.1.2 Checking IP address and Camera Test

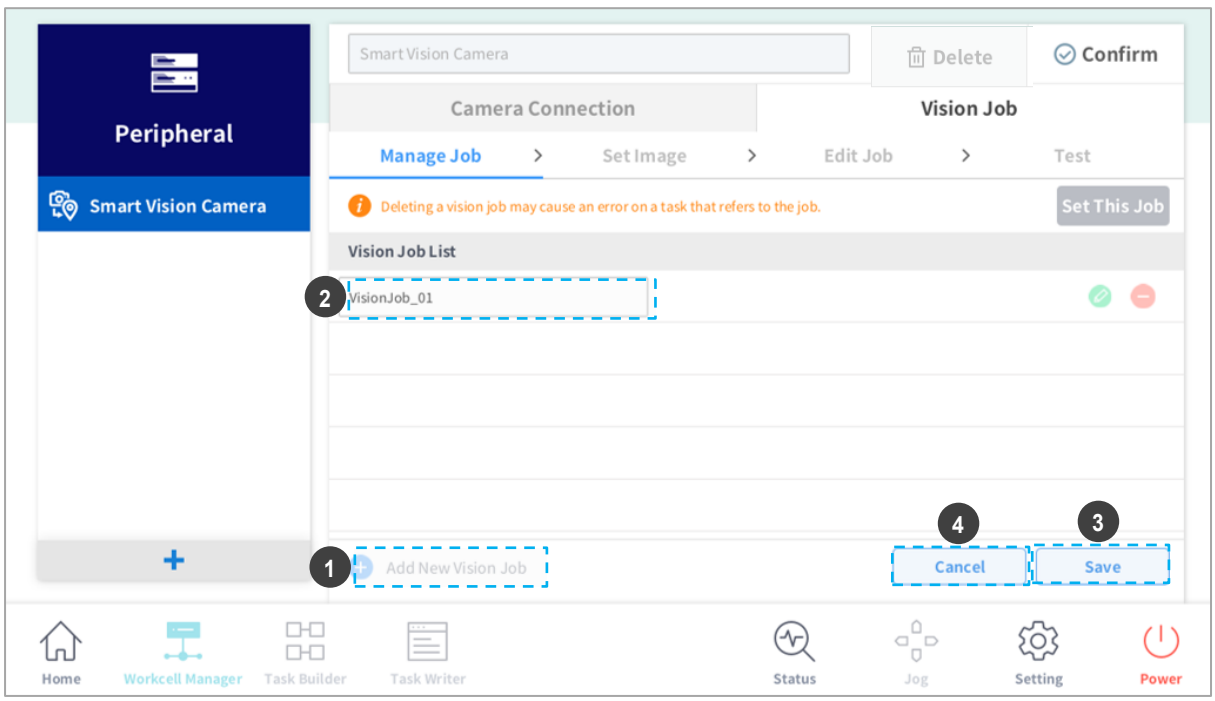




No.	Item	Description
1	**Controller – Configure IP**	Displays IP address of the controller
2	**Smarst Vision Module – Configure IP**	Enter and connect the IP address of the camera. • Connect: After entering IP address and select the Connect button, the set subnet mask and default gateway are displayed.
3	**Camera Test**	Check that the controller and the cemera are properly connected. • Live: Displays live images of the cemera. • Shoot: Displays stop image of the camera.

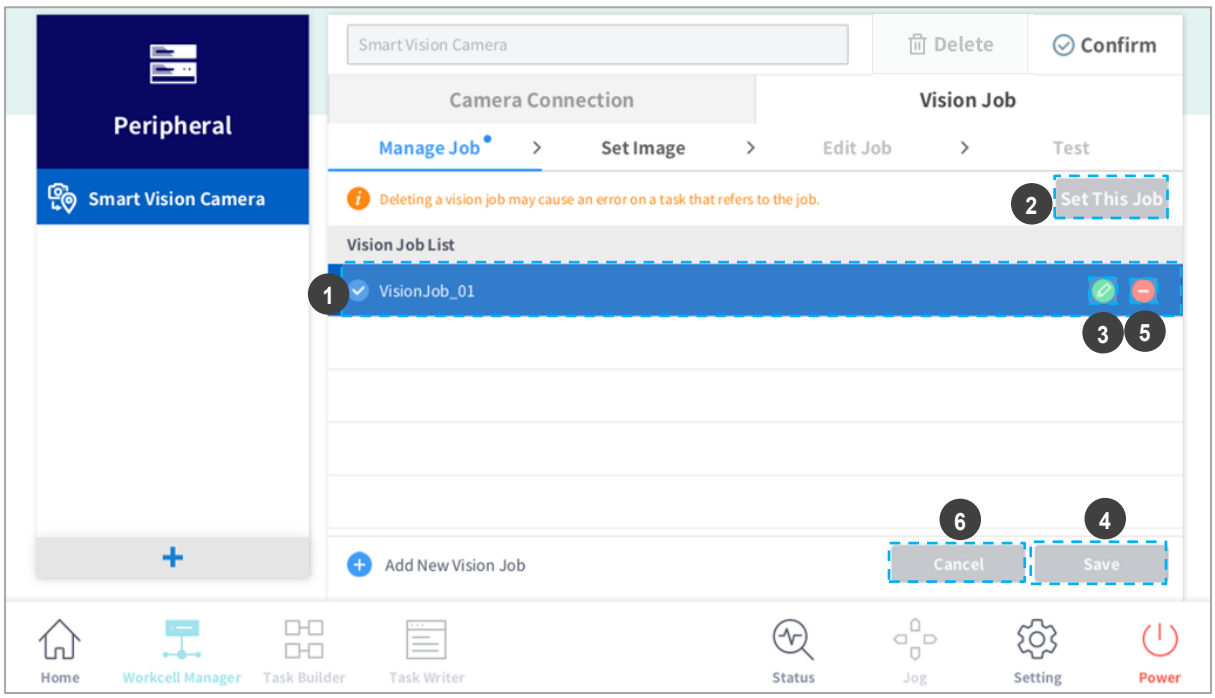
2.2 Vision Job > Manage Job

2.2.1 Create Vision Job



No.	Item	Description
1	**Add New Vision Job**	If there is no existing job, create a new job with the job name “VisionJob_01,” and if there is an existing job, create a new job with the job name with the following number of the existing job. (e.g., VisionJob_02)
2	**Vision Job List**	A virtual keyboard is displayed, and the job name can be edited.
3	**Save**	This saves changes made to the job name.
4	**Cancel**	Cancels the Vision job creation.

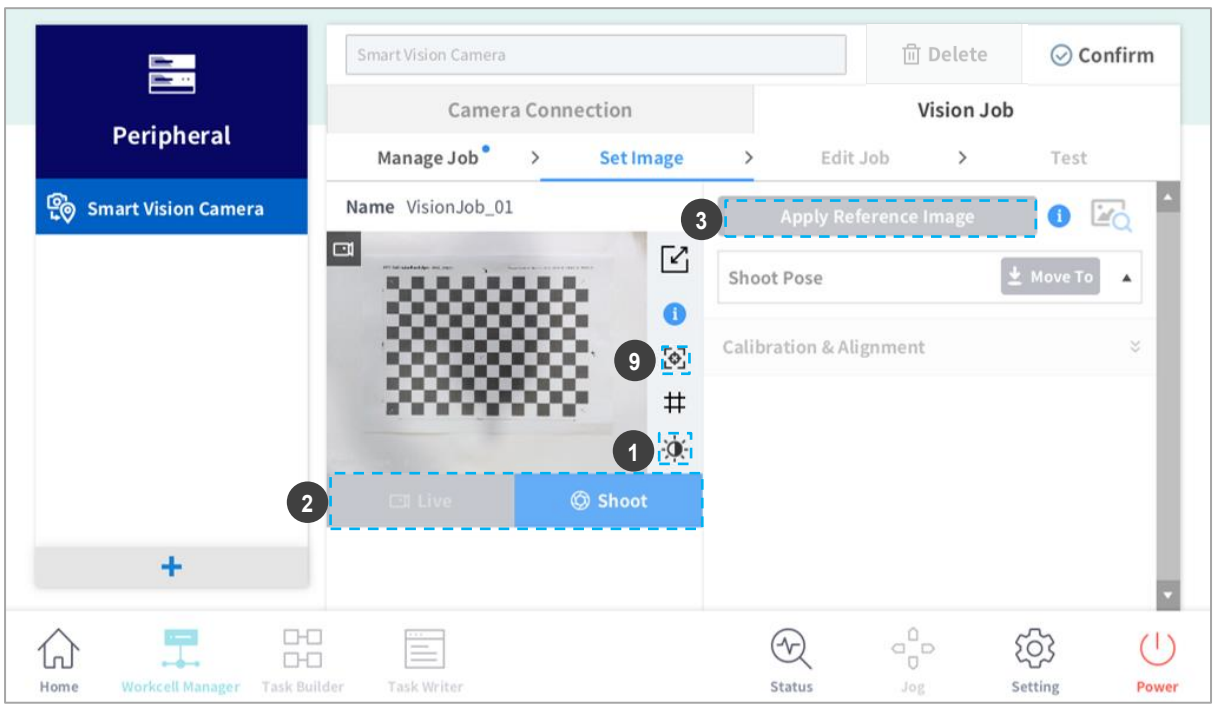
2.2.2 Edit and Delete Vision Job

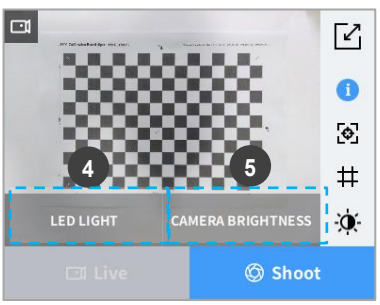


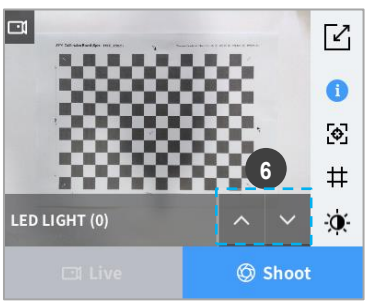
No.	Item	Description
1	**Vision Job List**	The selected vision job is highlighted in blue.
2	**Set This Job**	The job selected from the Vision Job List is set as the Setting job.
3	**Edit**	The job selected from the Vision Job List triggers the edit window where the “Job Name” can be edited.
4	**Save**	Saves the edited vision job name.
5	**Delete**	The selected job from the Vision Job List is deleted.
6	**Cancel**	This cancels changes made to the name.

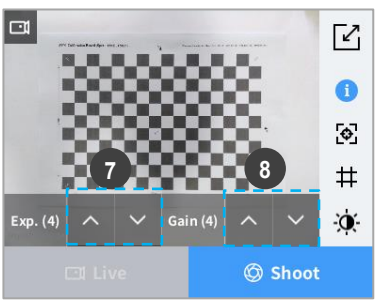
2.3 Vision Job > Set Image

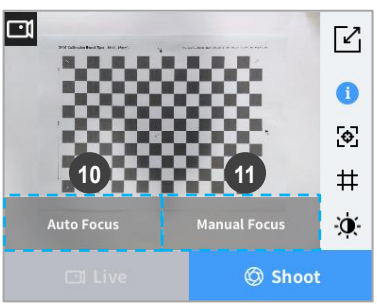
2.3.1 Save and Load Lighting/Exposure/Gain/Focus Setting

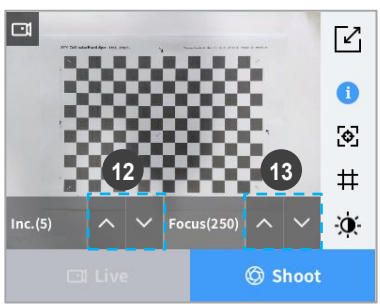


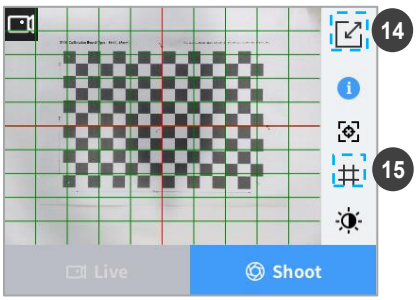












No.	Item	Description
1	**Image Brightness Setting**	Displays the LED LIGHT/CAMERA BRIGHTNESS select button.
2	**Live/Shoot**	• Displays the image from the Live/Shoot mode, and the button changes to gray. • Live: Displays the Live image of the camera. • Shoot: Displays the image obtained from the current camera with edge information.
3	**Apply Reference Image**	• It is enabled in blue in the Shoot mode. • A Reference Image is the reference information for the Vision Job setting. Select the item information to detect from the Reference Image, and then set default values for various tests. (Setting is made in the Edit Job tab) • Sets the current camera image as the Reference Image. • Saves the current camera focus/lighting/brightness information. • Saves the current robot Joint Pose as the Shoot Pose.
4	**LED Light**	Displays buttons that adjust the brightness of the lighting.
5	**Camera Brightness**	Displays buttons that adjust the Exposure/Gain levels.
6	**Lighting Brightness Setting**	The brightness of the lighting can be adjusted from 0 to 10.
7	**Exposure Time Setting**	• The exposure time of the camera can be adjusted from 0 to 10. • Higher numbers create a brighter image.
8	**Gain Level Setting**	• The gain level can be adjusted from 0 to 10. • Higher numbers increase image brightness, but this also increases image noise.
9	**Focus Control**	• Camera focus can be adjusted in a range from 0 to 500. • The focus must be set clearly prior to Robot-Vision Calibration.
10	**Auto Focus**	• The focus of the camera is adjusted automatically.
11	**Manual Focus**	• Camera focus can be adjusted in a range from 0 to 500.
12	**Inc**	• The value changes in the order of 1, 5, 10, 50, and 100.
13	**Focus**	• The focus increases or decreases by the amount of Inc.

No.	Item	Description
14	**Full Screen**	Displays the image in the full screen.
15	**Grid**	Displays a grid on the image. Each grid represents 10% of the screen.

Camera Brightness Adjustment (Exposure / Gain)

It is recommended to start with Gain set at level 1, adjust the Exposure to set the desired brightness, and then adjust Gain to make minor adjustments.

Conditions for a Good Reference Image

- The edge information of the item to detect must be clear.
- The size of the item to detect must be within 5%-70% of the overall screen size. It is recommended to set the size of the item to detect to 20%-40%. Use the grid pattern to check the size.
- The item to detect must be positioned in the center of the screen.
- Items/patterns other than the item to detect must not be on the screen.
- The background must have a clear difference in color from the item to detect, and it must not have patterns.

2.3.2 Camera Calibration

Camera - Robot Calibration is the process of synchronizing the coordinate information measured by the camera with the coordinate information of the robot.

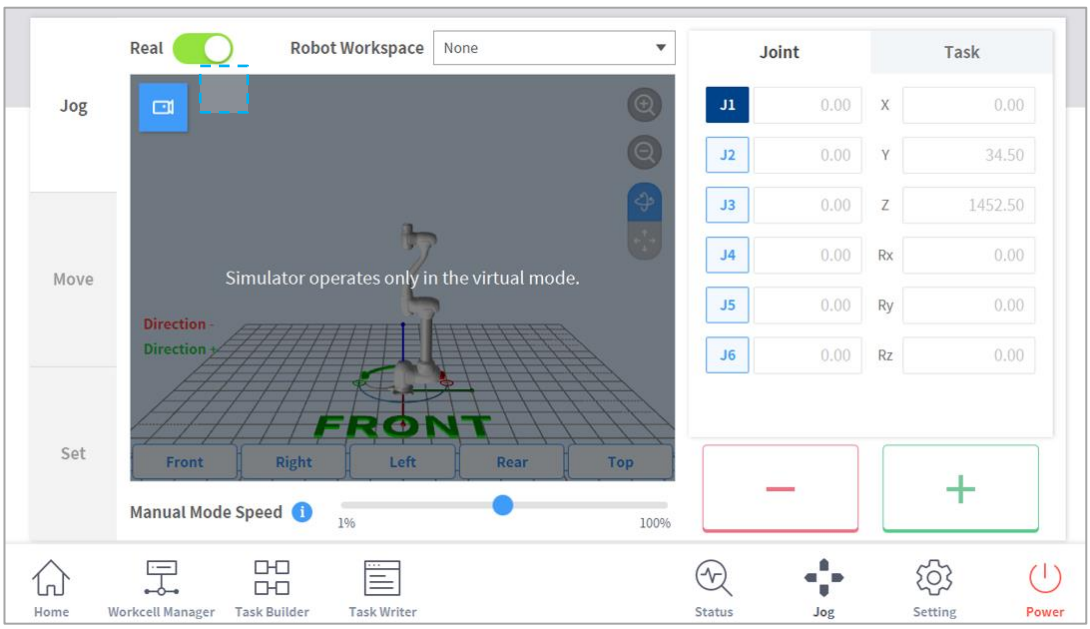
With Calibration, the camera can accurately move to the location of the measured item, and it can accurately measure dimensions in terms of length. During Calibration, a checkerboard with predefined design information is used. The method currently offered by Doosan Robotics is StandAlone calibration, and the elements required for this calibration are four robot poses taught based on the camera image of the checkerboard shot from the shooting position and tool tip.

Caution

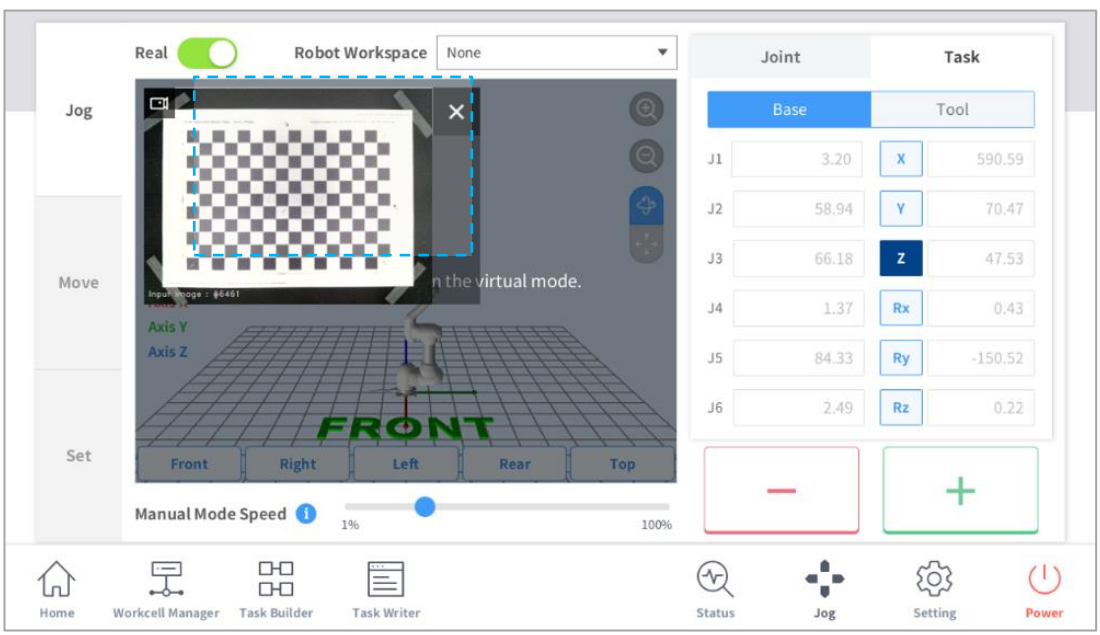
During calibration, it is necessary to align the camera lens and the checkerboard in parallel as much as possible. In addition, when performing calibration, the calibration board must be placed at the surface height of the item to be measured. If the height of the checkerboard during calibration differs from the surface height of the item to be measured, it can cause failure to detect the item or decrease measurement accuracy.

Additional Functions available with the SVM

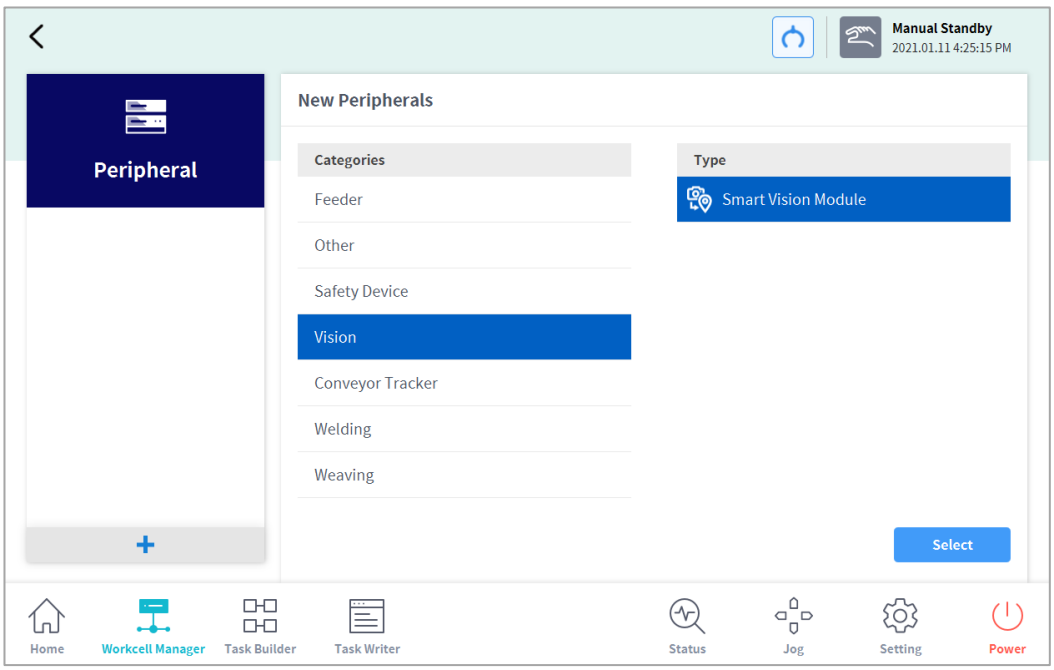
- The Live screen is displayed on the Jog



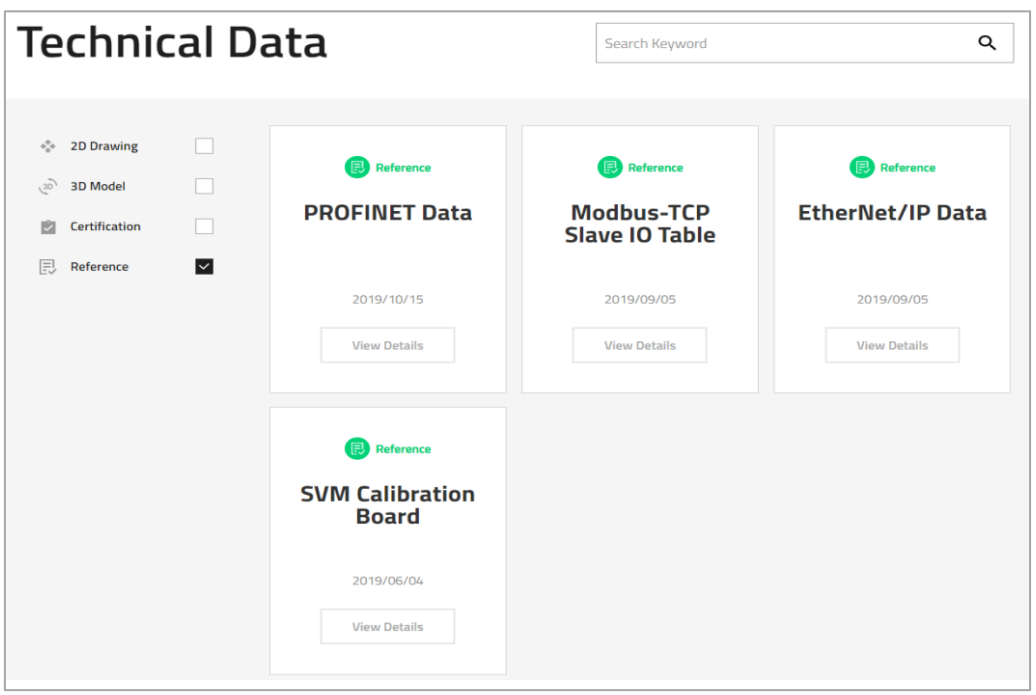
If the Vision license is entered, a live image can be viewed in the Jog tab. The user can operate the robot while viewing the live image.



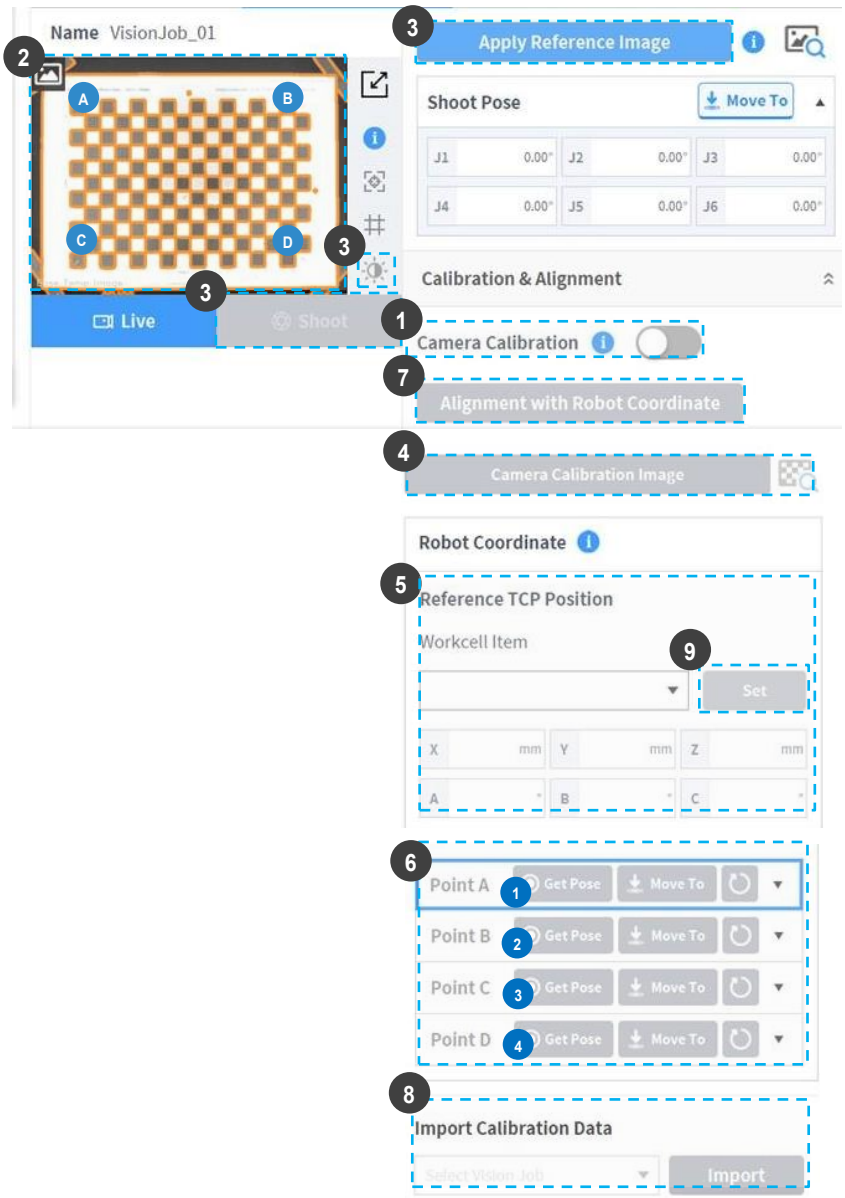
- Added Vision category to Peripheral



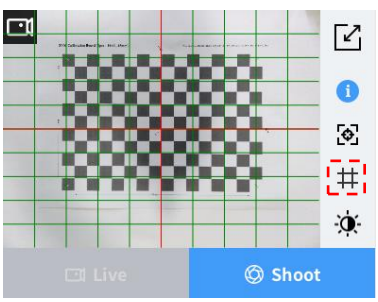
SVM Calibration Board Download

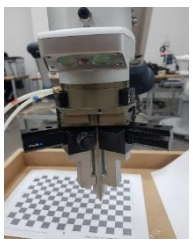


- The SVM Calibration Board can be downloaded from [https://lab.doosanrobotics.com/en/Index Robot LAB – Resources – Tech Data – Reference] after logging in.



No.	Item	Description
1	**Camera Calibration**	Enables Camera - Robot Calibration function. • After the Camera Calibration function is enabled, the Camera Calibration Image button is enabled.

No.	Item	Description
2	**Live/Shoot Image**	The Live/Shoot Image can be checked. To ensure proper camera calibration, a checkerboard is placed as follows: • The calibration image provided by Doosan Robotics is a 15 mm checkerboard. [Download Page] • Place the checkerboard at a distance of 300 mm~600 mm from the SVM. • The checkerboard and the camera must be parallel (less than 1°). • Use the Grid function of the image to position the checkerboard as follows:  • Place the center point where the center arrow “O” is pointing on the red cross at the center of the camera image. • Align the checkerboard vertically and horizontally along the green guide lines to prevent rotation.
3	**Lighting Setting/ Save Shoot Image/ Shoot Pose**	Adjust the focus, brightness and lighting to display the edge of the checkerboard clearly. • Press the Shoot button to check edge information. • Press the Apply Reference Image button to save the camera information and Shoot Pose.
4	**Camera Calibration Image**	Run checkerboard corner point detection. • Press the View Image button to check the detection results. • If detection fails, the checkerboard pattern is not displayed on the View Image button.

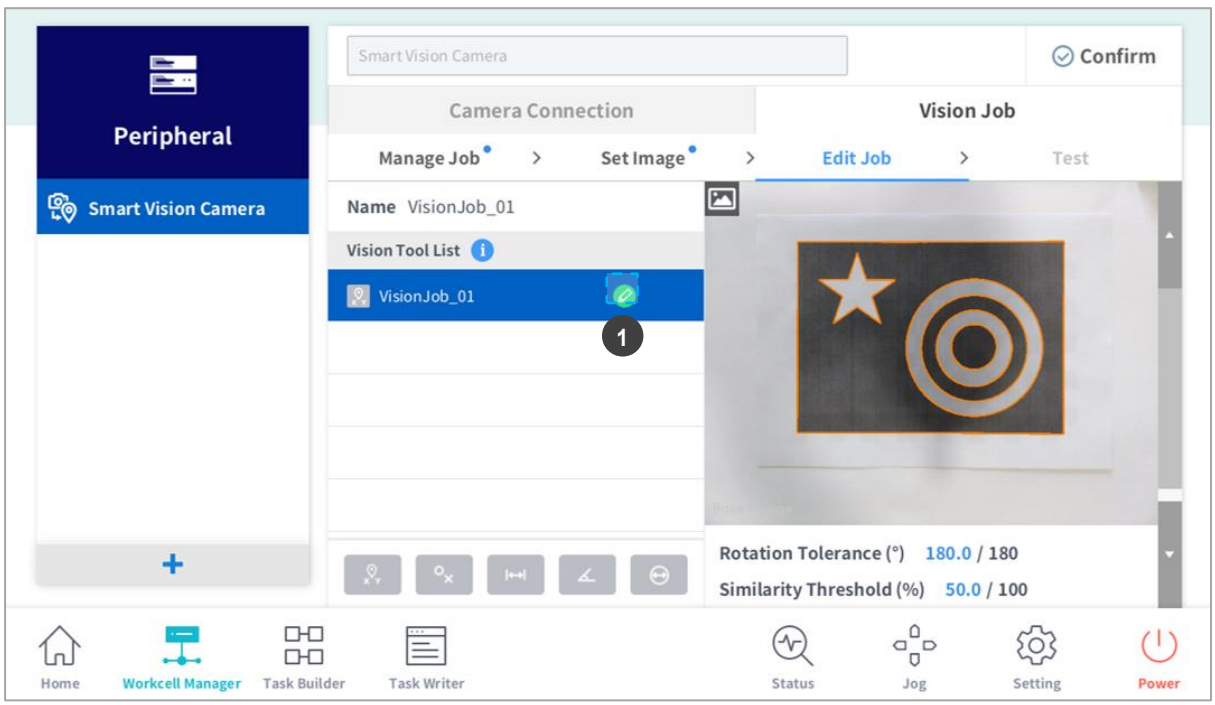
No.	Item	Description
5	**Load TCP Setting**	Sets the information of the Tool currently equipped on the robot as TCP. • A probe type Tool is recommended. If a gripper is used, it is recommended to make measurements with a probe-shaped item grabbed as in the following image: • For information about measuring the tool center position, refer  to the Workcell Manager End Effector Management section of the User Manual.
6	**Obtain PointA - PointD Points**	Obtains the robot pose [x, y, z, rx, ry, rz] of PointA - PointD. • If the base plane of the robot and the workspace are on the same plane, the tool center point of the robot is aligned based on the base axis. Robot poses corresponding to PointA-PointD are acquired with the aligned axis unchanged using plane lock and axis lock of the Constraints Motion button in the robot cockpit. Refer to Robot User Manual - Jog - Setting Screen - Align according to Base Axis for how to align the base axis with the TCP end. If the workspace where the target item located is slanted, unlike the base plane of the robot, align the tool center point according to a virtual vector area. Refer to Robot Manual – Jog – Setting Screen – Align according to Target Point. • Perform direct teaching of corner points on the checkerboard in the order of Ⓐ, Ⓑ, Ⓒ and Ⓓ with the end of the robot tool to enter the coordinates of each point. • Tap the Move To button to move to the corresponding point. • Press the Reset button to reset robot coordinates. • If the end of the tool fails to accurately pinpoint the corner points of the checkerboard, point deviation occurs.

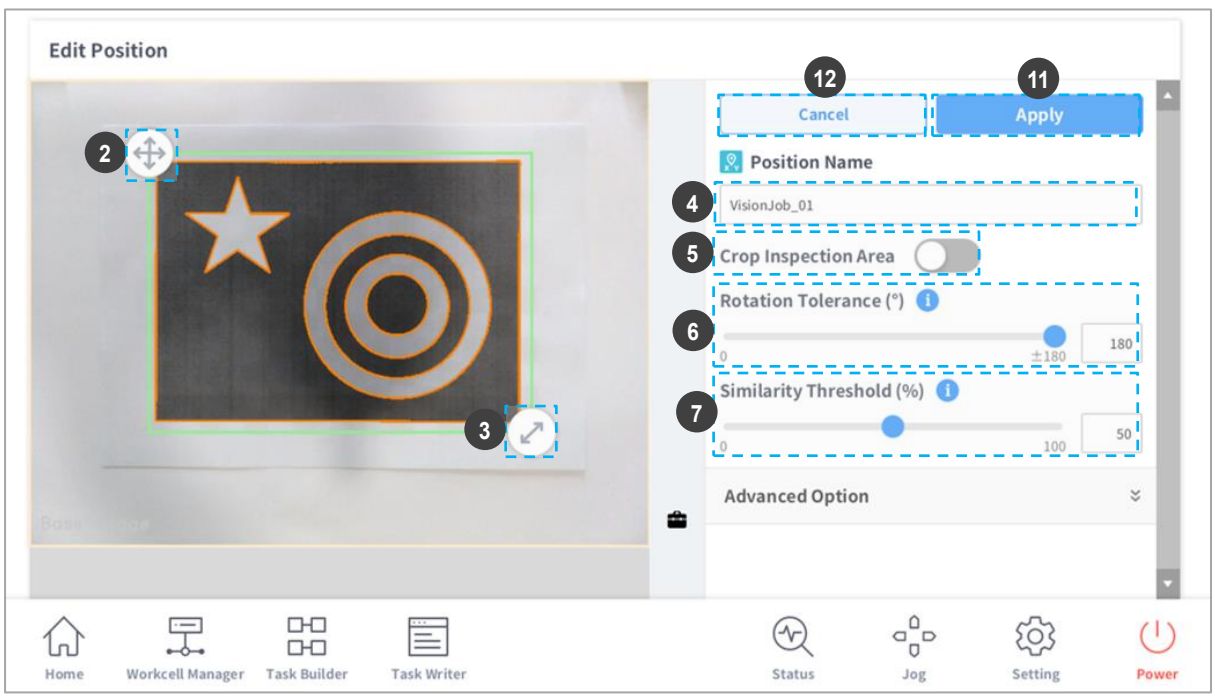
7	**Alignment with Robot Coordinate**	Run the camera - robot coordinate matching calculation. After calculation is completed, the results are displayed. If successful,save the Calibration information in the camera. To save the Calibration information in the UI, press the Confirm button on the top of the Workcell Manager. Success (Success) / Failure (Failure) **Success Criteria** • All grid patterns of the checkerboard must be displayed on the image. • Dark grid patterns of the checkerboard must be positioned on the top/bottom left. • Check whether all corner points are detected using View Image. • TCP information identical to the information of the tool equipped must be set. • Enter corner points of ABCD of the checkerboard with direct teaching to the robot. • Teach the robot tool the exact positions of ABCD corner points of the checkerboard. • The checkerboard position must not change during direct teaching. **Failure Criteria** • If all corner points of the checkerboard are not detected. • If the direct teaching order of ABCD corner points of the checkerboard is incorrect. • If the set TCP information does not match the information of the Tool equipped. • If the direct teaching of corner points of the checkerboard is not accurate. • If the ABCD coordinates measured by the camera are different from the ABCD coordinates taught to the robot by direct teaching (calibration fails if a deviation of more than 5 mm occurs). **Items to Check Upon Failure** • Check the position/direction of the checkerboard. • Check whether edges of the checkerboard are clearly displayed. • Check whether direct teaching was performed in the order of ABCD. • Check whether the TCP setting is correct. • Check whether the checkerboard print was moved after Camera Calibration Image. • Check whether the ABCD corner points of the checkerboard were taught accurately.

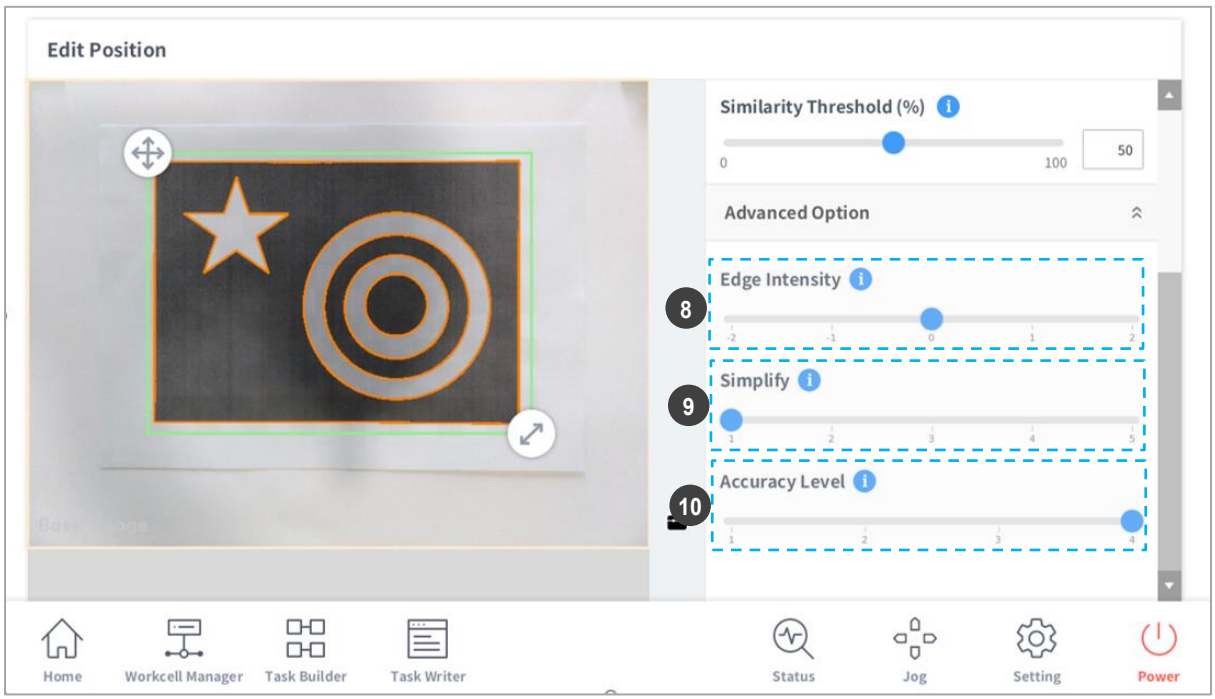
No.	Item	Description
8	**Import Calibration Data**	Imports calibration data that succeeded in existing vision works. • Select a vision work to import the calibration data and press the import button to save the corresponding calibration data.
9	**Set**	Sets the Workcell Item loaded on the left of the Set button to the current tool center point.

2.4 Vision Job > Edit Job

2.4.1 Vision Tool Teaching Area Setting



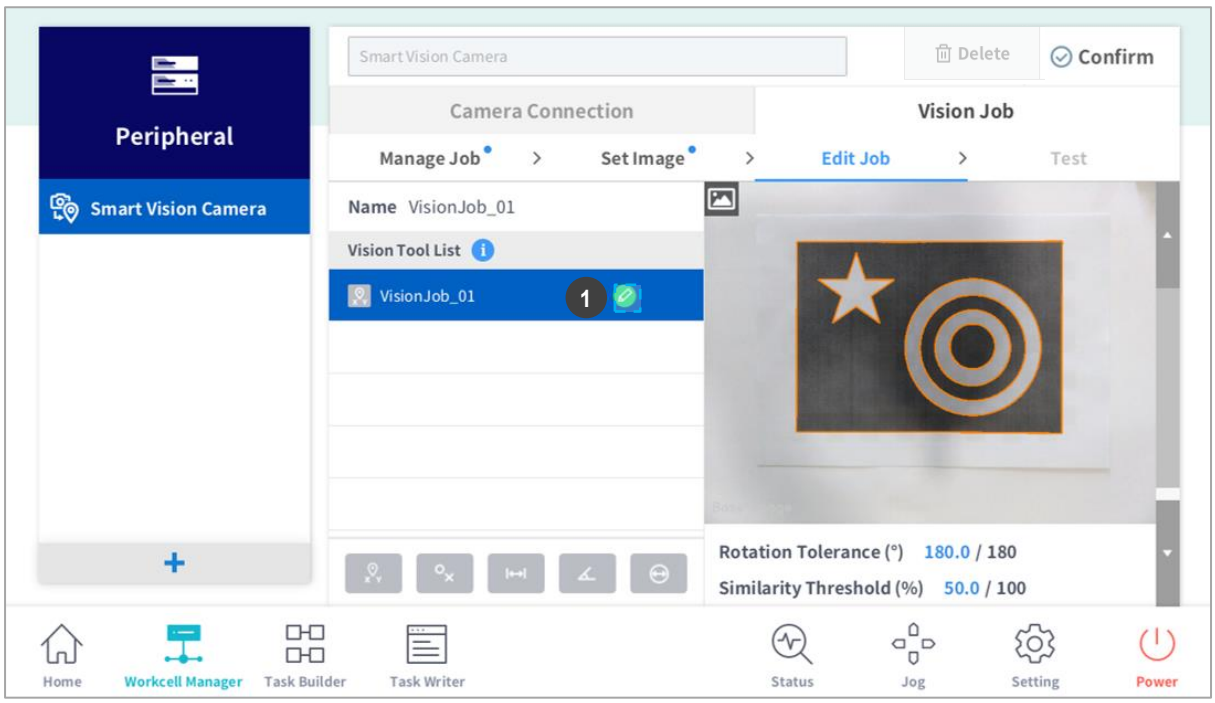


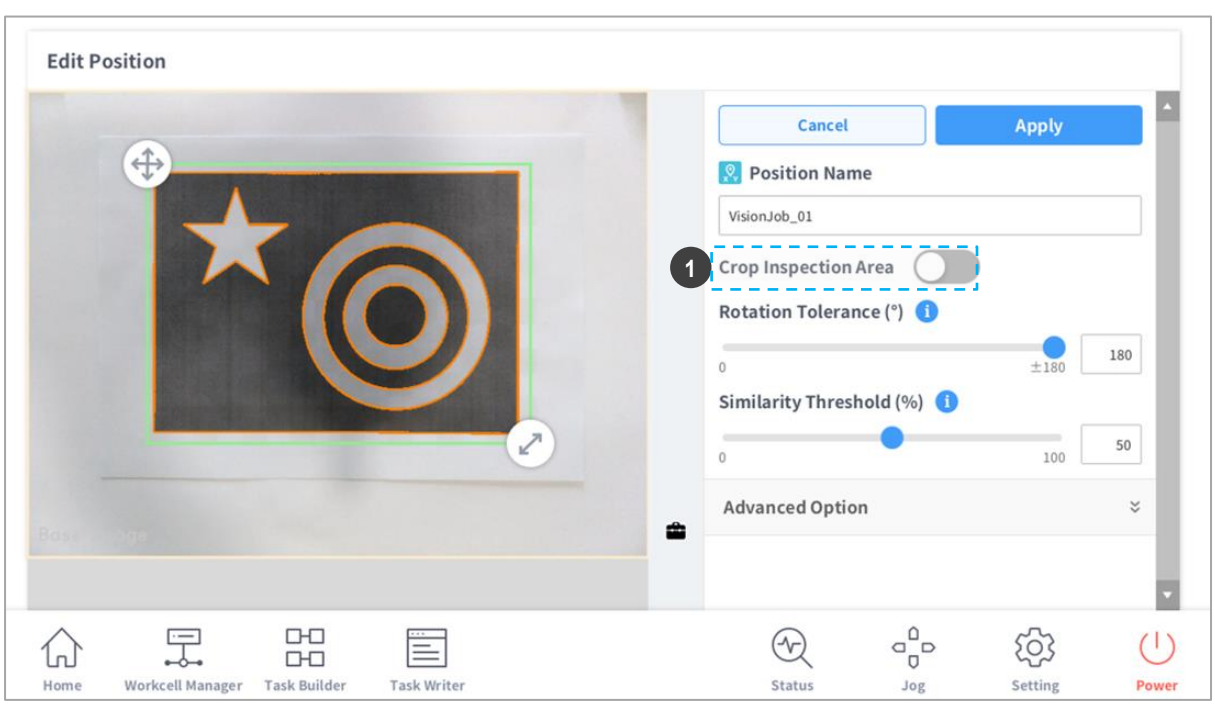


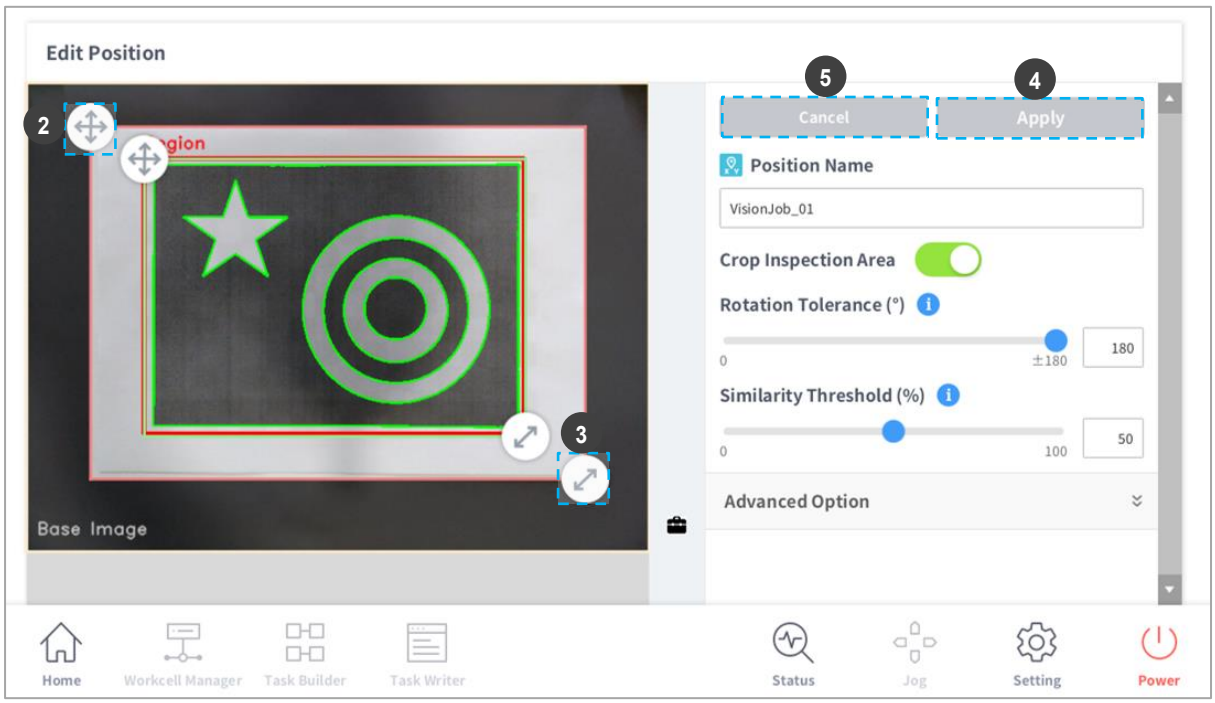
No.	Item	Description
1	**Edit**	The settings popup window for the job selected from the Vision Tool List is displayed.
2	**Move Teaching Area (green area)**	Press and hold the arrow to move the teaching area. • Press the Apply button to set the selected area.
3	**Adjust Teaching Area Size (green area)**	Press and hold the arrow to adjust the teaching area size. • Press the Apply button to set the selected area.
4	**Edit Job Name**	A virtual keyboard is displayed, and the job name can be edited. • Press the Apply button to apply the name to the camera.
5	**Crop Inspection Area**	A window limiting the teaching area is displayed. The set area is... • saved to the camera when the Apply button is pressed.
6	**Rotation Tolerance**	Configures the angle tolerance from the reference angle. (input range: 0~180°) • Sets the acceptance range for items rotated at an angle deviating from the Reference Image. • For example, if the Rotation Tolerance is 180 (-180~+180), it detects items in all rotation angle ranges, and if the Angle Tolerance is 10 (-10~+10), it only detects items rotated within 10˚ from the Reference Image. Setting a larger Angle Tolerance value increases detection speed, and a smaller value decreases detection speed. • The tolerance is immediately applied when the scroll is moved.

No.	Item	Description
7	**Similarity Threshold**	Configures the similarity threshold from the reference value. (0~100%) • Similarity is the level of matching between the edge of the item image and the edge in the Reference Image. • The similarity of the item to detect can be set by adjusting the Similarity Threshold. • For example, if the Similarity Threshold is 50, the system only detects items matching a Reference Image of 50% or more. • Higher Similarity Threshold values increase the level of distinguishing similar items, but fail to measure items if there are items with small changes, camera distortions or light reflection changes. • Lower Similarity Threshold values allow flexibility in responding to item/environment changes, but this can cause incorrect measurements of similar items within the measurement area. • Setting a proper Similarity Threshold to match the measuring item/environment is crucial to the success of the Vision Job. • The tolerance is immediately applied when the scroll is moved.
8	**Edge Intensity**	Sets the intensity of edges detected. • Larger color differences in the area surrounding the edge result in higher edge intensity, and smaller color differences result in lower edge intensity. • If the intensity is set as [+2] from the default [0], only edges with high intensity appear, and edges with low intensity are removed. Setting [-2] will display edges with both high and low intensities. • The tolerance is immediately applied when the scroll is moved.
9	**Simplify**	Clean up edges by simplifying them. • Small, noise-like edges among measured edges disturb the teaching of shapes. Changing the value from 1 to 5 will remove small edges. • Larger values remove smaller edges and improve calculation speed. • The tolerance is immediately applied when the scroll is moved.
10	**Accuracy Level**	Adjust the Accuracy Level if you want to detect items more accurately or faster. • Larger values improve shape detection accuracy. • Smaller values improve detection speed, but decrease shape detection accuracy. • The tolerance is immediately applied when the scroll is moved.
11	**Apply**	Applies Vision Job settings.
12	**Cancel**	Cancels Vision Job settings.

2.4.2 Vision Tool Teaching Limit Area Setting



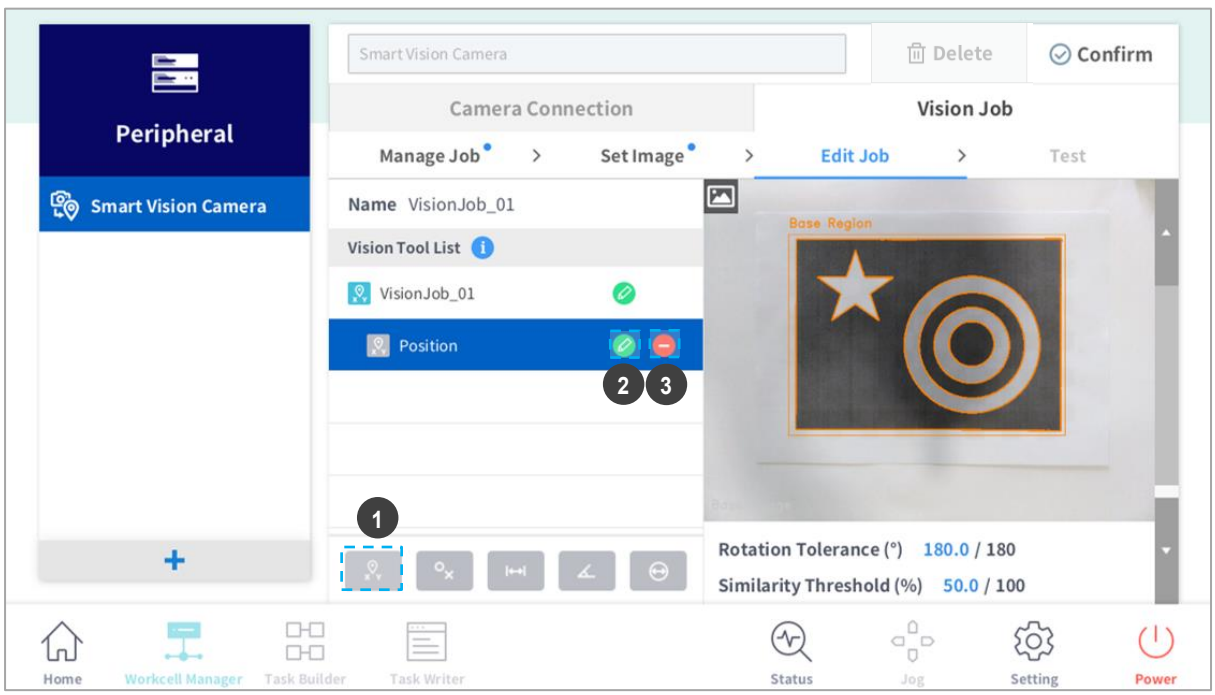


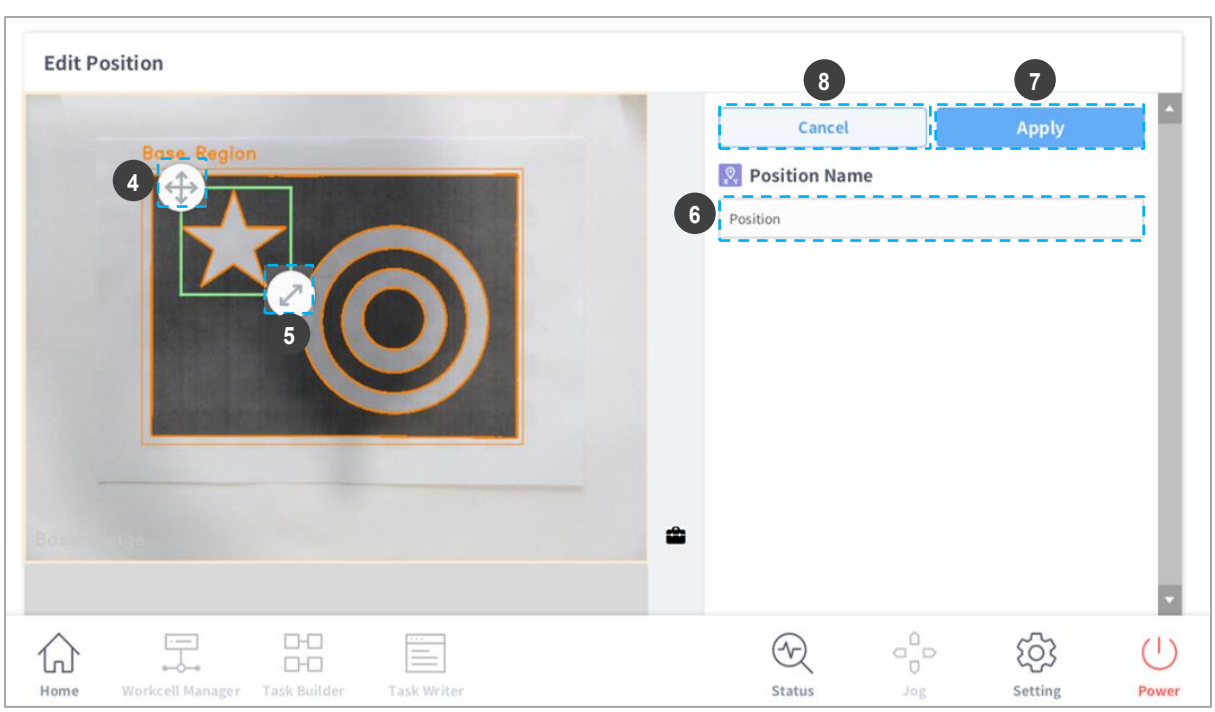


No.	Item	Description
1	**Crop Inspection Area**	Displays an area setting tool that limits the teaching area. • The set area is saved by pressing the Apply button.
2	**Move the Teaching Limit Area (red area)**	Press and hold the arrow to move the area. • The set area is saved by pressing the Apply button.
3	**Adjust the Teaching Limit Area (red area)**	Press and hold the arrow to adjust the size of the area. • The set area is saved by pressing the Apply button.
-	**Scale/Move**	Press the briefcase icon to display the Scale/Move selection window. • Fine adjustments to the Teaching Area position of the image can be made with Move. • Fine adjustments to the Teaching Area size of the image can be made with Scale. • UP/DOWN Scale buttons and UP/DOWN Move buttons are displayed. • Select A: Selects the Teaching Area setting. • Select B: Selects the Teaching Limit Area setting.
4	**Apply**	Applies Vision Job settings.
5	**Cancel**	This clears Vision Job settings.

2.4.3 Create Position Tool and Set Teaching Area

The Position Tool is used for measuring the position and angle of an object (shape). Teach the item (shape) area to measure from the Reference Image, and set related parameters. The Position Tool measures the amount of rotation (angle) from the center point of the teaching area and the teaching area.

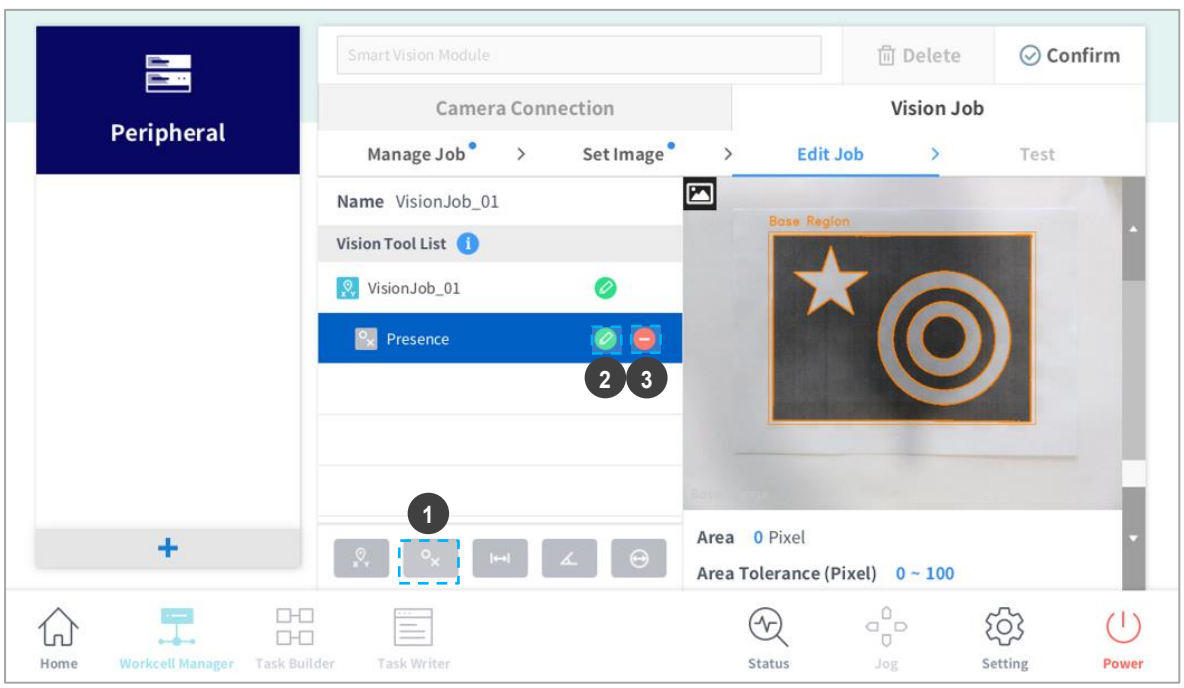


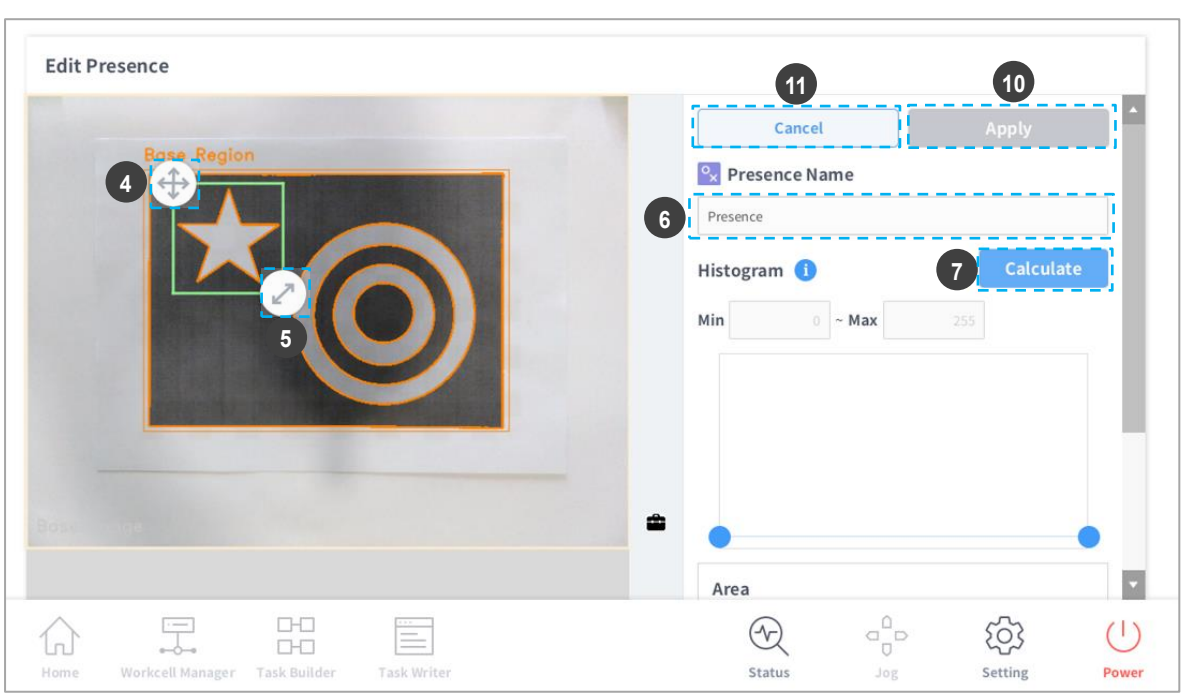


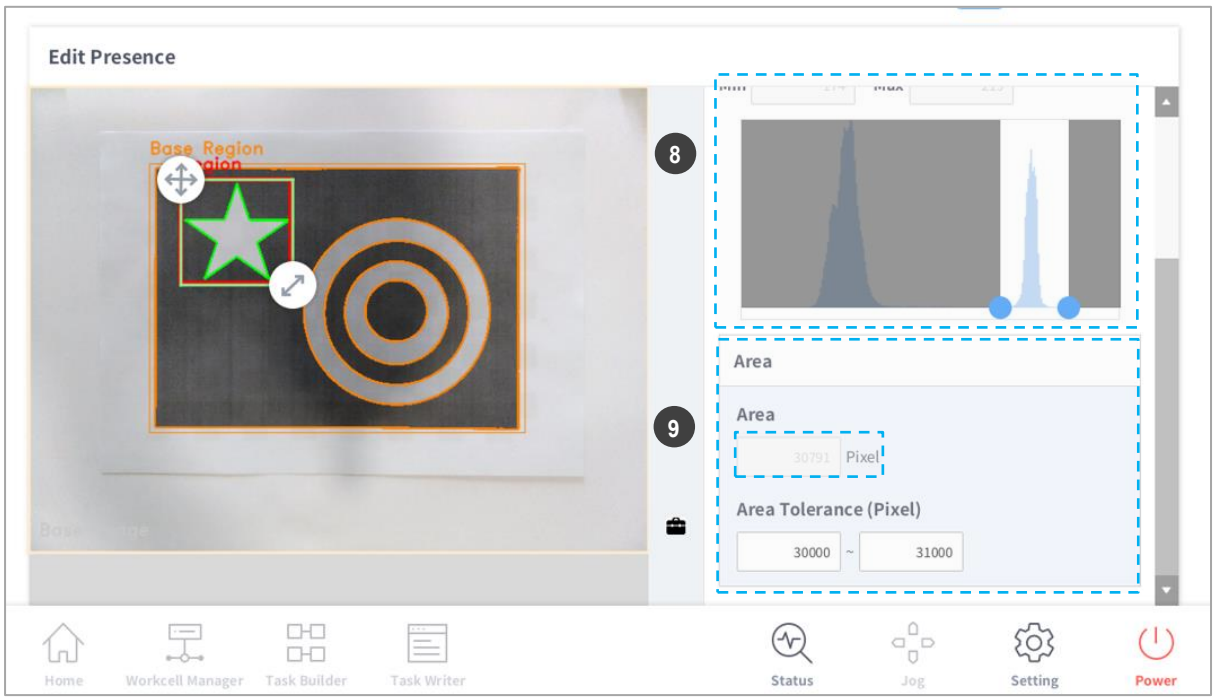
No.	Item	Description
1	**Add Position Tool**	Adds a Position Tool to the Vision Tool List.
2	**Edit**	A setting window of the job selected from the Vision Tool List is displayed.
3	**Delete**	The selected job from the Vision Job List is deleted.
4	**Move Teaching Area**	Press and hold the arrow to move the teaching area. • The set area is saved by pressing the Apply button.
5	**Adjust Teaching Area Size**	Press and hold the arrow to adjust the teaching area size. • The set area is saved by pressing the Apply button.
6	**Edit Job Name – Edit Window**	A virtual keyboard is displayed, and the job name can be edited. • Press the Apply button to apply the setting.
7	**Apply**	Applies Vision Job settings.
8	**Cancel**	Cancels Vision Job Tool settings.

2.4.4 Create Presence Tool and Set Teaching Area

The Presence Tool checks the histogram of shapes. The histogram of brightness (level 1-256) of each pixel in the teaching area is calculated (frequency table) to be used as default information for the presence check. Set the brightness range corresponding to the shape to check and press the Calculate button to measure the area of the shape (Pixel Count) by detecting pixels corresponding to the set brightness range. Adjust the acceptance range (Tolerance) of the check based on measured area values to set the presence check.





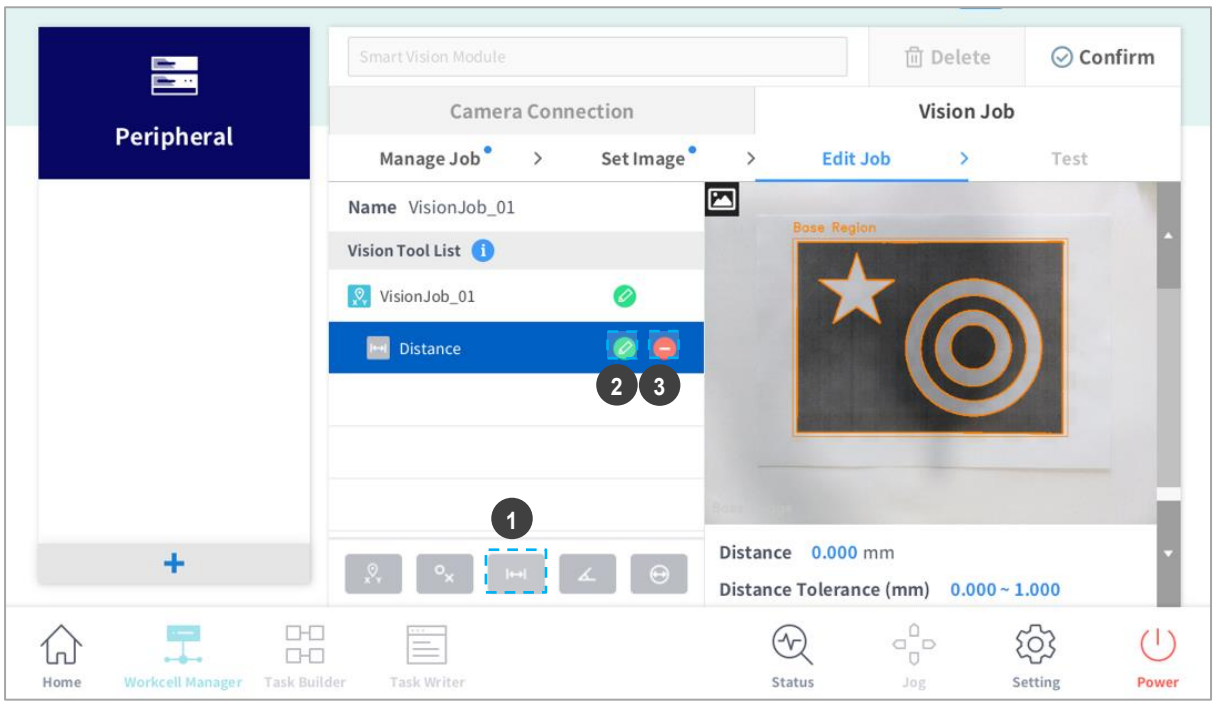


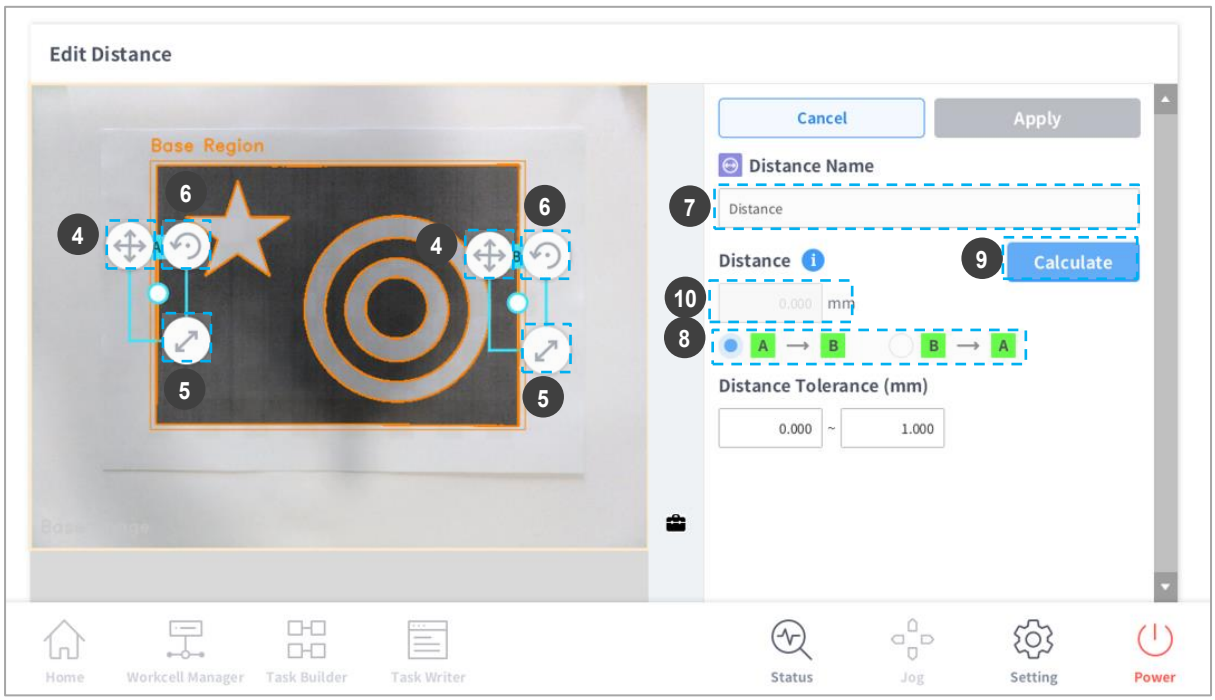
No.	Item	Description
1	**Add Presence Tool**	Adds a Presence Tool to the Vision Tool List.
2	**Edit**	A setting window of the job selected from the Vision Tool List is displayed.
3	**Delete**	The selected job from the Vision Job List is deleted.
4	**Move Teaching Area**	Press and hold the arrow to move the teaching area.
5	**Adjust Teaching Area Size**	Press and hold the arrow to adjust the teaching area size.
6	**Edit Job Name – Edit Window**	A virtual keyboard is displayed, and the job name can be edited. • Press the Apply button to apply the setting.
7	**Calculate**	Checks the histogram distribution of edges within the Presence Tool teaching area.

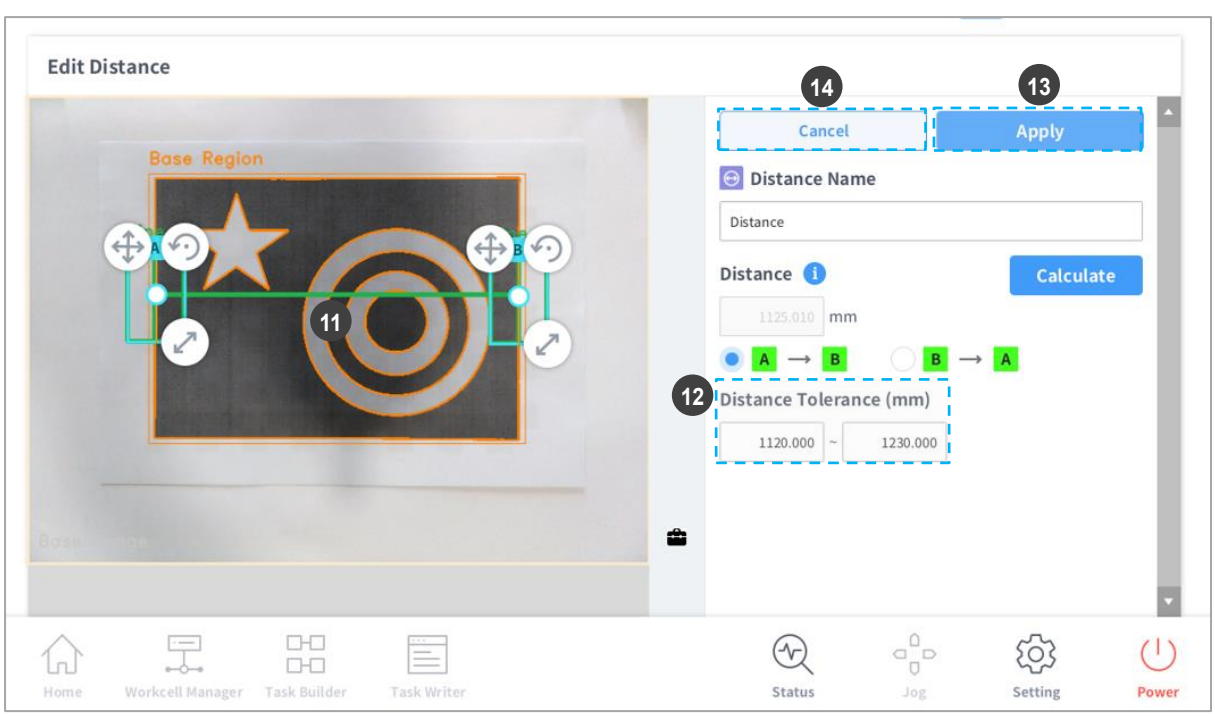
No.	Item	Description
8	**Histogram Min/Max Setting**	Slide the horizontal Histogram Min/Max bar to adjust the detection level of desired edges. • Presence check uses histogram check. A histogram is list of the distribution of brightness of pixels within a measurement area from 0 to 255. If the measurement area is completely white, the brighter area (255) value in the histogram becomes larger, and if the measurement area is completely black, the darker area (0) value becomes larger. • You can adjust the range of pixels to the desired brightness using the blue button. If the button reaches the end points (0, 255), it obtains all pixel values within the measurement area. • For example, positioning the blue button between 1 and 2 will only obtain pixels with brightness corresponding to 1 and 2. • The tolerance is immediately applied when the button is pressed.
9	**Area Tolerance Limit Setting**	Enter the pixel value allowed within the detected area in the edit window. Values exceeding the value range entered are not detected. • Area displays the number of pixels corresponding to the brightness value set using the blue button (0-255). • If the value exceeds the Area Tolerance range, it is considered that the histogram is not similar, and the measurement fails. If a value exceeds the Test tolerance range, the inspection result outputs 0. • Press the Apply button to apply the setting.
10	**Apply**	Applies Vision Job settings.
11	**Cancel**	Cancels Vision Job Tool settings.

2.4.5 Create Distance Tool and Set Teaching Area

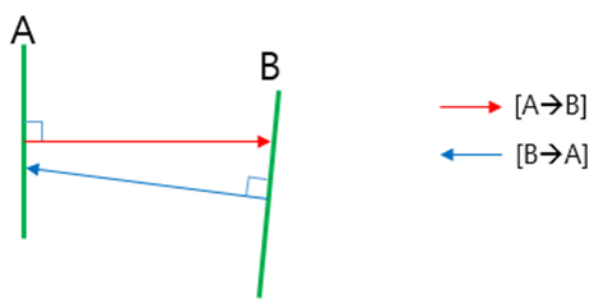
The Distance Tool measures the distance between two lines. Place areas A and B on a line you want to measure and press the Calculate button to measure the distance between A and B. Adjust the acceptance range (Tolerance) of the check based on measured distance values to set the distance check. [A→B] measurement refers to the length of the line connecting the center of line A to line B or an extension line of line B.







No.	Item	Description
1	**Add Distance Tool**	Adds a Distance Tool to the Vision Tool List.

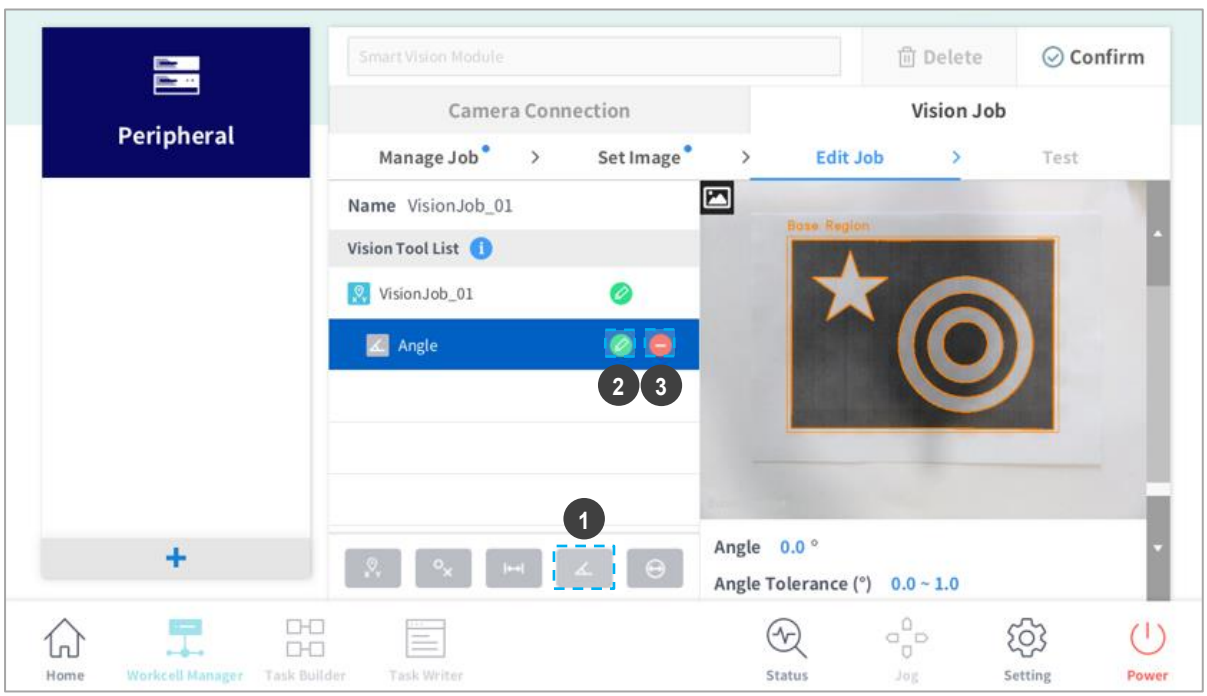
No.	Item	Description
2	**Edit**	A setting window of the job selected from the Vision Tool List is displayed.
3	**Delete**	The selected job from the Vision Job List is deleted.
4	**Move Teaching Area**	Press and hold the arrow to move the teaching area.
5	**Adjust Teaching Area Size**	Press and hold the arrow to adjust the teaching area size. • Adjust the area to allow one edge to be captured in it.
6	**Adjust Teaching Area Size (circular arrow)**	Press and hold the arrow to rotate the teaching area.
7	**Edit Job Name**	A virtual keyboard is displayed, and the job name can be edited. Press the Apply button to apply the setting.
8	**Select Directions of Line (A, B)**	Select the directions for A > B and B >A. • The direction is immediately applied when the button is pressed. • [A→B] measurement refers to the length of the line connecting the center of line A to line B or an extension line of line B. 
9	**Calculate**	Creates a line that connects the center position of lines A and B when lines exist in the two teaching areas (A, B). The direction is immediately applied when the button is pressed.
10	**Distance Display**	Enter the pixel value allowed within the detected area in the edit window. Values exceeding the value range entered are not detected.
11	**Distance Image Display**	Displays the distance between lines detected in two teaching areas in the edit window.
12	**Distance Tolerance Setting**	Sets the line tolerance from the reference line value. • If a value exceeds the Test tolerance range, the inspection result outputs 0. Press the Apply button to apply the setting..
13	**Apply**	• Applies Vision Job settings.

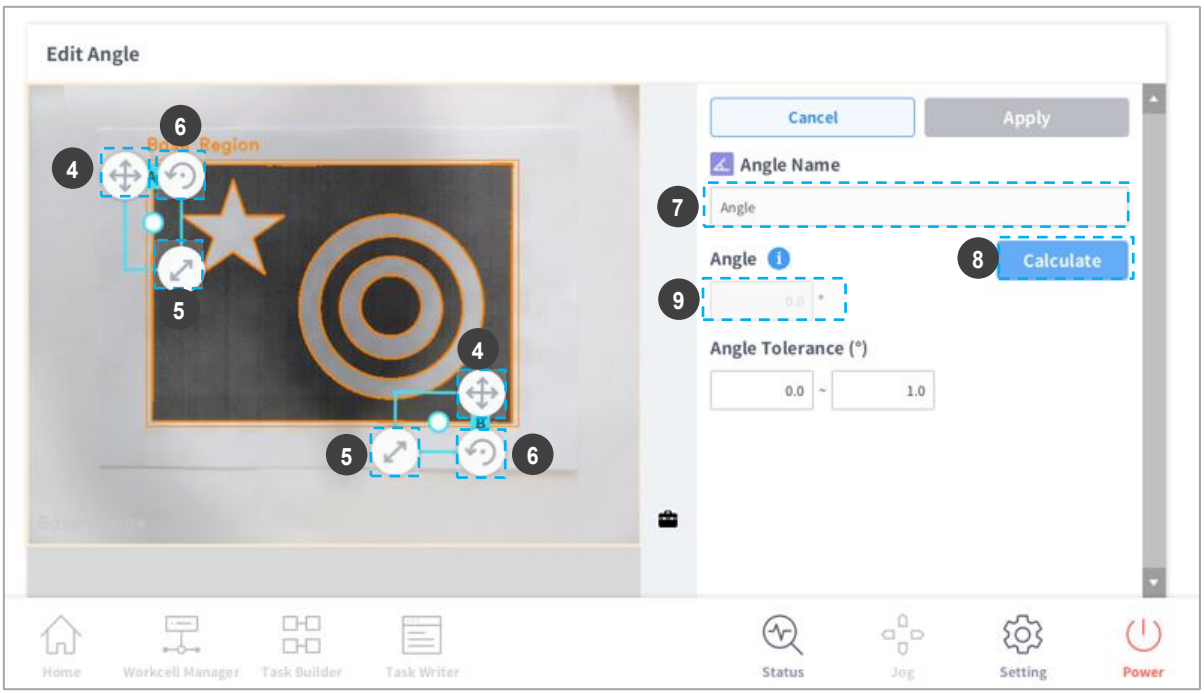
No.	Item	Description
14	**Cancel**	Cancels Vision Job Tool settings.

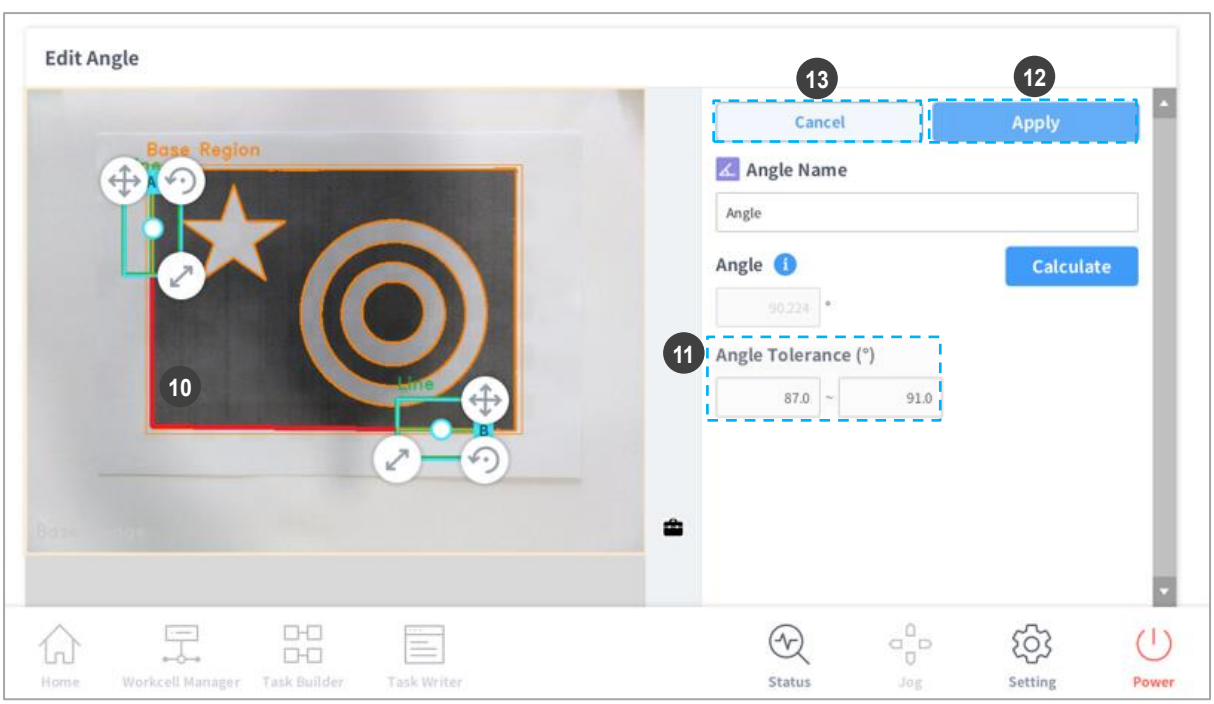
The center of Line A and Line B refers to the detected line center rather the guideline of the teaching area box.

2.4.6 Create Angle Tool and Set Teaching Area

The Angle Tool measures the angle between two lines. Place areas A and B on a line you want to measure and press the Calculate button to measure the angle between A and B. Adjust the acceptance range (Tolerance) of the check based on measured angle values to set the angle check.




Edit Angle
Cancel
Apply
Angle Name
Angle
Angle
Calculate
Angle Tolerance (°)
0.0
1.0
Home
Workcell Manager
Task Builder
Task Writer
Status
Jog
Setting
Power

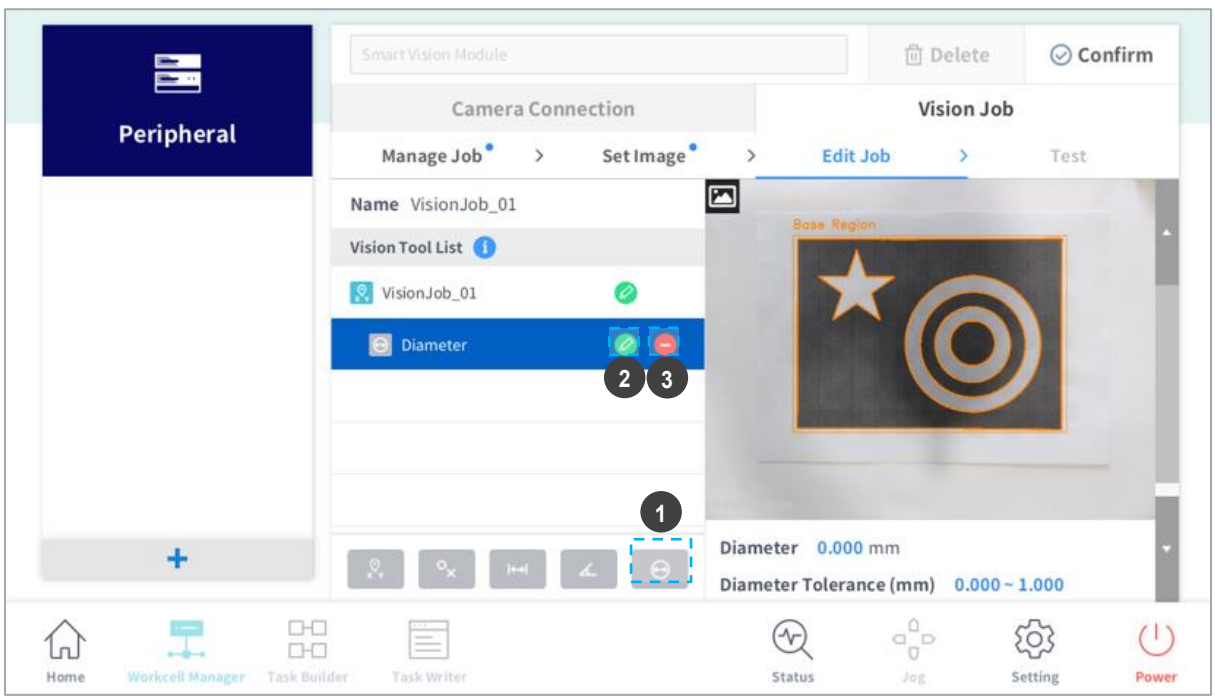

Edit Angle
Cancel
Apply
Angle Name
Angle
Angle
Calculate
Angle Tolerance (°)
87.0
91.0
Base Region
Line
Home
Workcell Manager
Task Builder
Task Writer
Status
Jog
Setting
Power

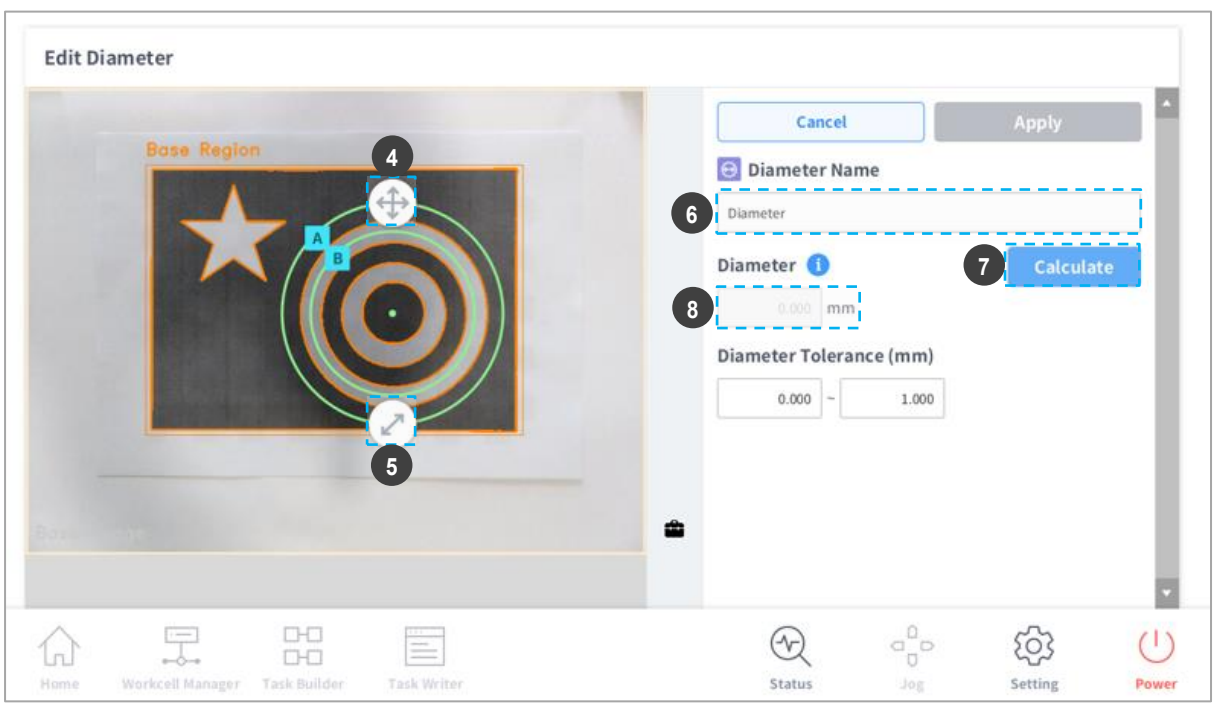
No.	Item	Description
1	**Add Angle Tool**	Adds an Angle Tool to the Vision Tool List.
2	**Edit**	A setting window of the job selected from the Vision Tool List is displayed.
3	**Delete**	The selected job from the Vision Job List is deleted.
4	**Move Teaching Area**	Press and hold the arrow to move the teaching area.
5	**Adjust Teaching Area Size**	Press and hold the arrow to adjust the teaching area size. • Adjust the area to allow one edge to be captured in it.
6	**Adjust Teaching Area Size (circular arrow)**	Press and hold the arrow to rotate the teaching area.
7	**Edit Job Name – Edit Window**	A virtual keyboard is displayed, and the job name can be edited. • Press the Apply button to apply the setting.
8	**Calculate**	Measures the angle at which the extension lines of each line meet when lines exist in the two teaching areas (A, B).
9	**Angle Display**	Displays the angle between lines detected in two teaching areas in the edit window.
10	**Angle Image Display**	Displays the angle between lines detected in two teaching areas on the image.
11	**Angle Tolerance Setting**	Configures the angle tolerance from the reference angle. • If a value exceeds the Test tolerance range, the inspection result outputs 0. • Press the Apply button to apply the setting.
12	**Apply**	Applies Vision Job settings.
13	**Cancel**	Cancels Vision Job Tool settings.

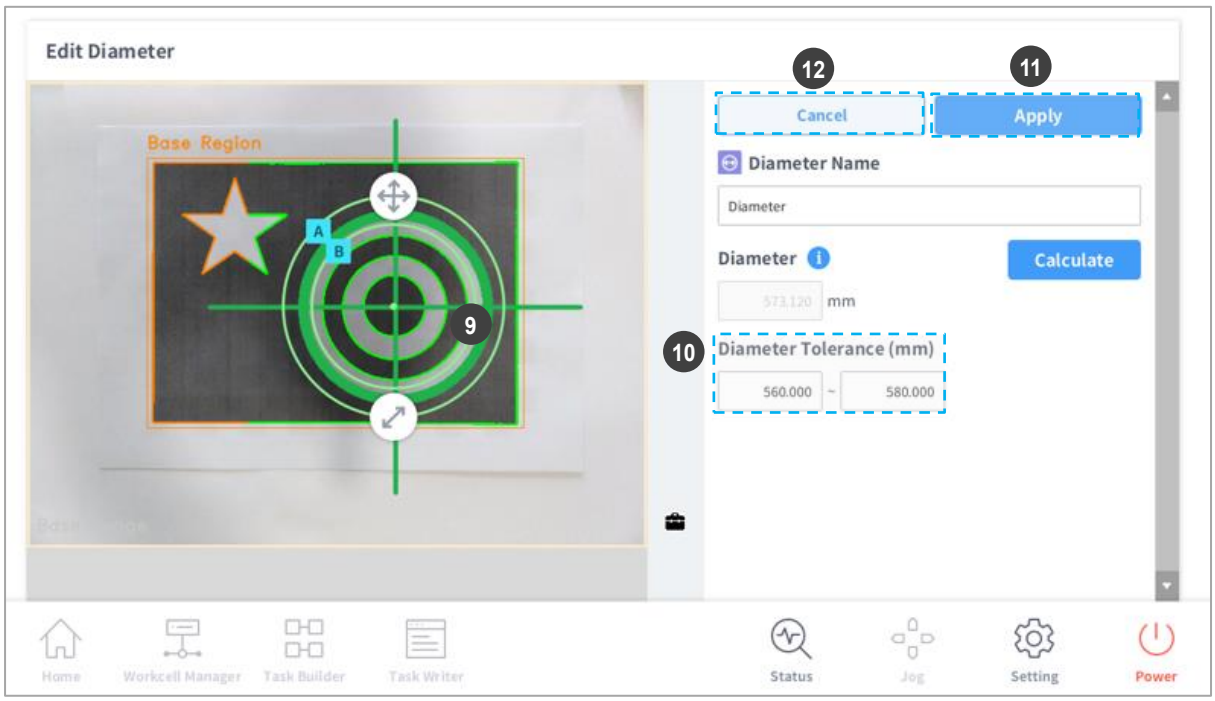
⚠ **The center of Line A and Line B refers to the detected line center rather the guideline of the teaching area box.**

2.4.7 Create Diameter Tool and Set Teaching Area

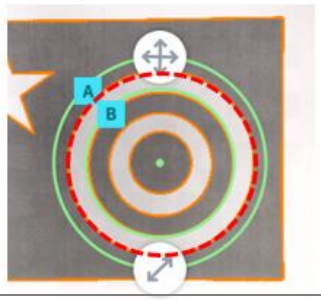
The Diameter Tool measures the diameter and the center point position of the measured circle. Align the circle center with the center of the circular item, position circle A outside the circular item to be measured, and position circle B inside the circular item. Press Calculate to measure the circle, and the diameter and center point of the circle are displayed. Adjust the acceptance range (Tolerance) of the check based on measured diameter values to set the diameter check.







No.	Item	Description
1	**Add Diameter Tool**	Adds a Distance Tool to the Vision Tool List.
2	**Edit**	A setting window of the job selected from the Vision Tool List is displayed.
3	**Delete**	The selected job from the Vision Job List is deleted.
4	**Move Teaching Area**	Press and hold the arrow to move the teaching area.
5	**Adjust Teaching Area Size**	Press and hold the arrow to adjust the teaching area size.
6	**Edit Job Name – Edit Window**	A virtual keyboard is displayed, and the job name can be edited. • Press the Apply button to apply the setting.
7	**Calculate**	Detects circles that exist between two teaching areas (A, B). Move circle A to be positioned outside the circular item, and move circle B to be positioned inside the circular item. Place the green center point in the center of the item. After calculation is performed, the circle between circle A and B is identified, and its diameter and center point positions are displayed.

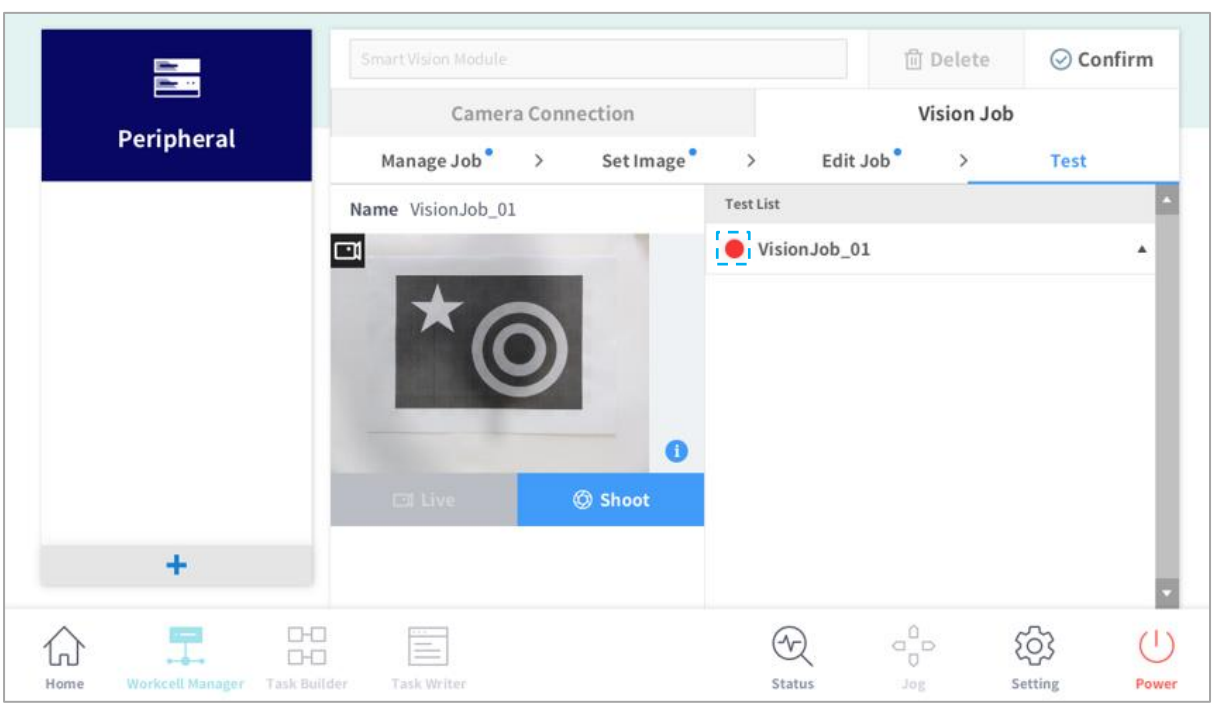
No.	Item	Description
		 Detected Target Circle
8	**Diameter Display (after #7)**	Displays the diameter of the measured circle in the edit window.
9	**Circle Display (after #7)**	Displays the measured circle on the image.
10	**Diameter Tolerance Length Setting - Edit Window**	Configures the length threshold from the reference length value. • If a value exceeds the Test tolerance range, the inspection result outputs 0. • Press the Apply button to apply the setting.
11	**Apply**	Applies Vision Job settings.
12	**Cancel**	Cancels Vision Job Tool settings.

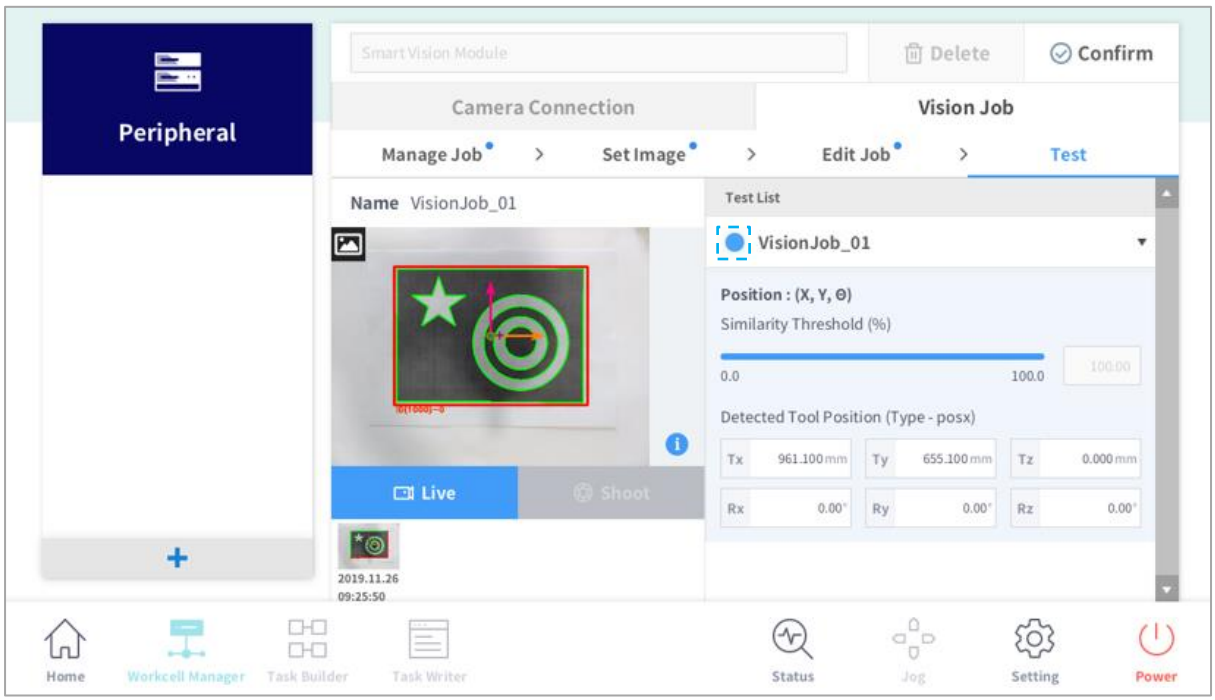
2.5 Vision Job > Test

Recognition tests for Vision Job, Position Tool, Presence Tool, Distance Tool, Angle Tool and Diameter Tool can be performed.

Item	Description
Live/Shoot Mode	Displays the image from the Live/Shoot mode, and the button changes to gray. The captured image is displayed beneath the Live/Shoot button. If the measurement is successful, the red circle ( ) next to the Name changes to blue ( ).

Tap the Confirm button after all tests are complete.



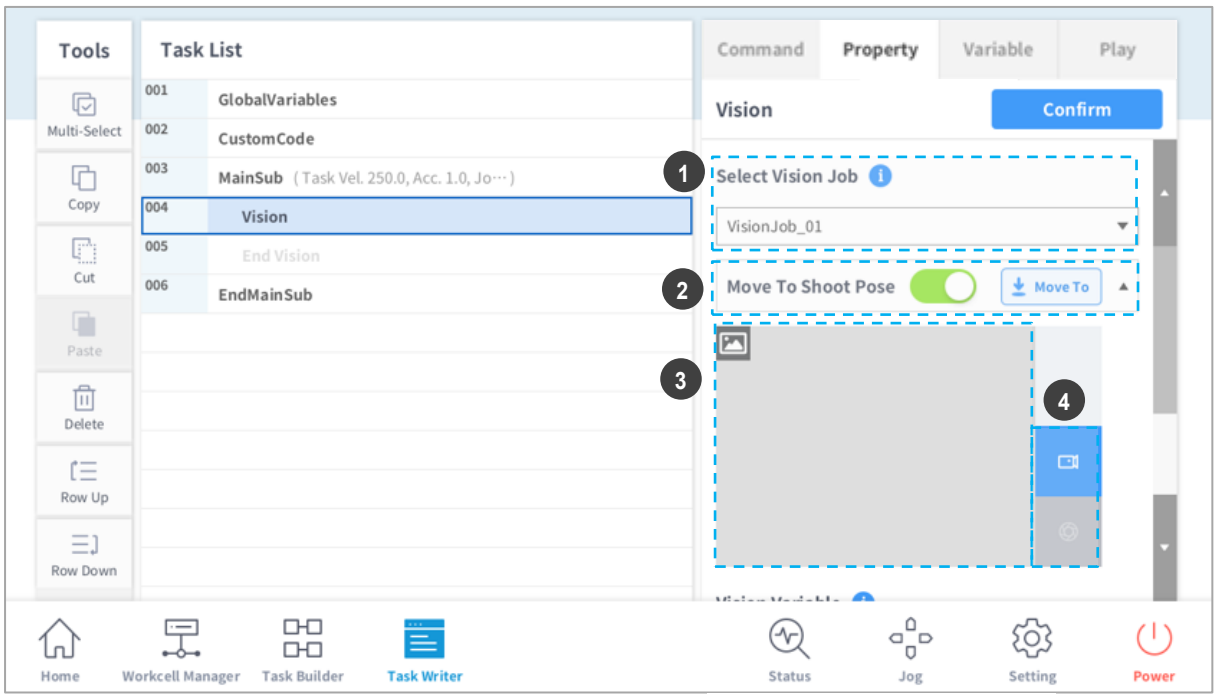

Peripheral
Smart Vision Module
Delete
Confirm
Camera Connection
Vision Job
Manage Job
Set Image
Edit Job
Test
Name VisionJob_01
Test List
VisionJob_01
Position : (X, Y, Θ)
Similarity Threshold (%)
0.0
100.0
100.00
Detected Tool Position (Type - posx)
Tx 961.100 mm
Ty 655.100 mm
Tz 0.000 mm
Rx 0.00°
Ry 0.00°
Rz 0.00°
Live
Shoot
2019.11.26
09:25:50
Home
Workcell Manager
Task Builder
Task Writer
Status
Jog
Setting
Power

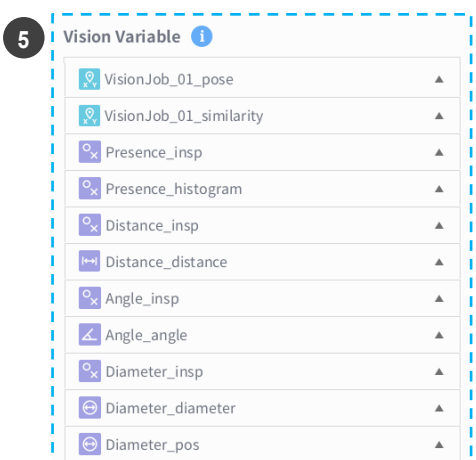
3. Programming

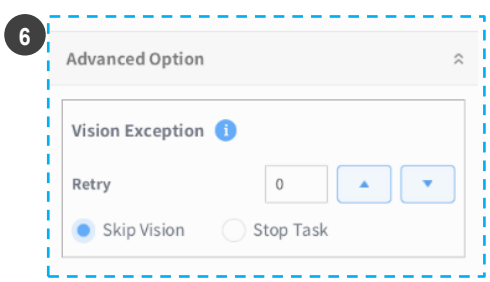
Adding a Vision Command in the Task Builder will add Vision and End Vision.

Adding a Vision Command in the Task Writer will add Vision and End Vision.

3.1 Vision Command Setting Options



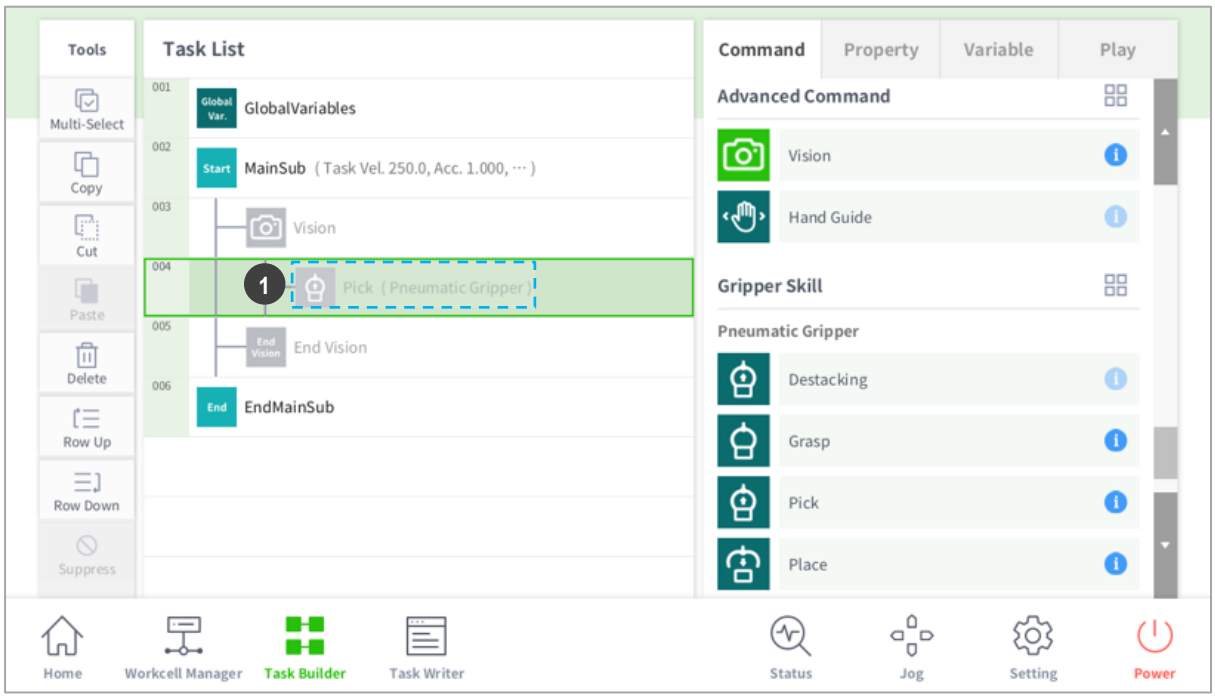


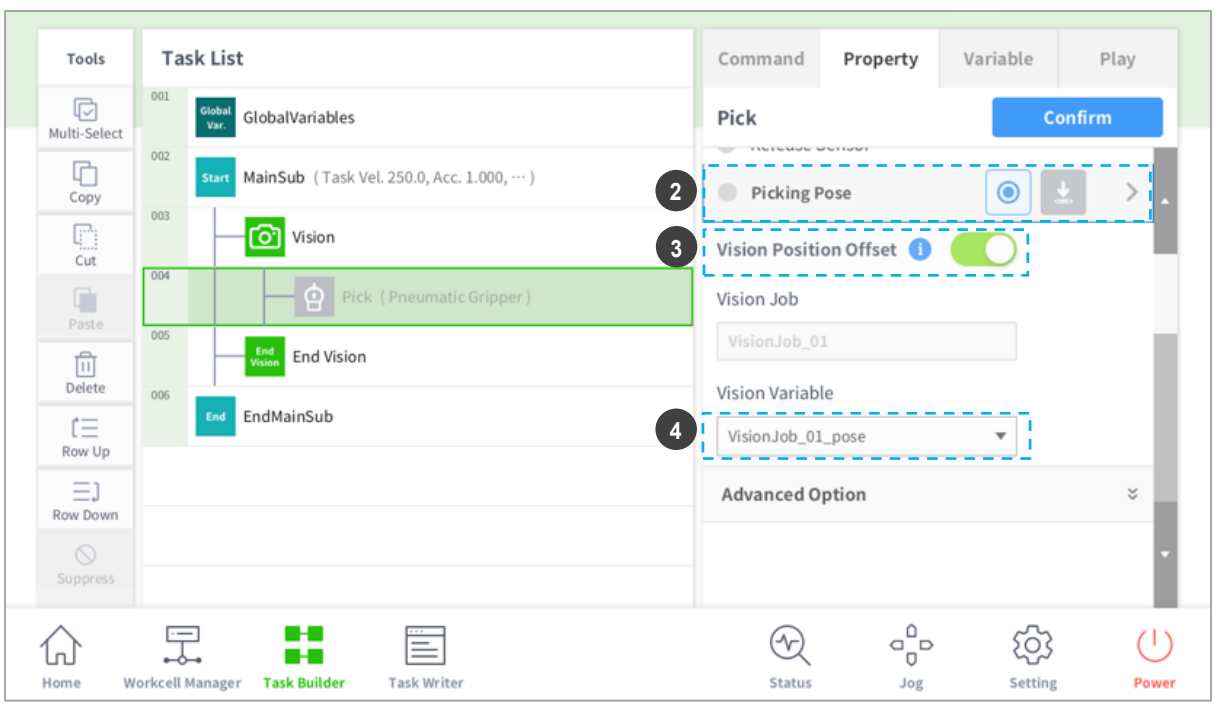


No.	Item	Description
1	**Select Vision Job**	The Vision Job List configured in the Workcell Manager displays the image of the Vision Job selected from the popup list. • Selecting a Vision Job using Select Vision Job enables Vision-related functions. • The Vision Variables of Tools included in the Vision Job can be obtained. A Vision Job can be selected.
2	**Move to Shoot Pose**	Move to the Shoot Pose of the job selected with Select Vision Job. Disabling this option means that the Shoot Pose configured for the Vision Job will not be used.
3	**Display Image**	Default image, Live image and Shoot image are displayed.
4	 **Live/ Shoot**	Tap the Live button to display the live image. Tap the Shoot button to display the test result image. • Obtains data of the Vision Tool added to the Vision Job with the Workcell Manager, and adds it to the Vision Variable list. Live mode ends after 5 minutes of no action.
5	**Vision Variable**	Displays the data list of the Vision Tools added to the Vision Job. Press each item to view the values of the current Tool.
6	**Advanced Option > Vision Exception**	Select an action if Vision measurement fails. **Retry**: Set the number of Retry attempts if measurement fails. (Initial measurement + up to three retry attempts) **Skip Vision**: Skips the failed measurement stage and retries measurements according to the number of Retry attempts. **Stop Task**: Stops the Vision Task if measurement fails.

If an object is measured after the Shoot button is clicked, the object must not move until MoveL completes Get_pose. If the object is moved before Get_pose is complete, the robot will not move to a desired point during Vision offset.

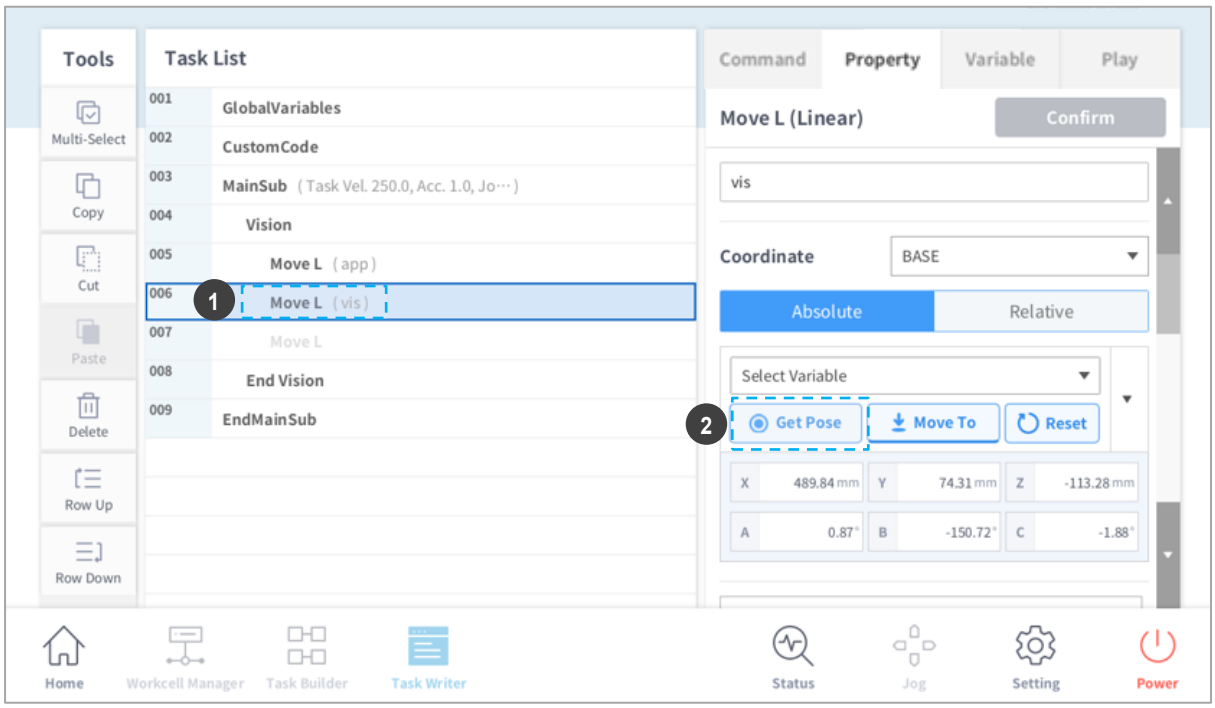
3.2 Task Builder: Using Vision in Skill Commands

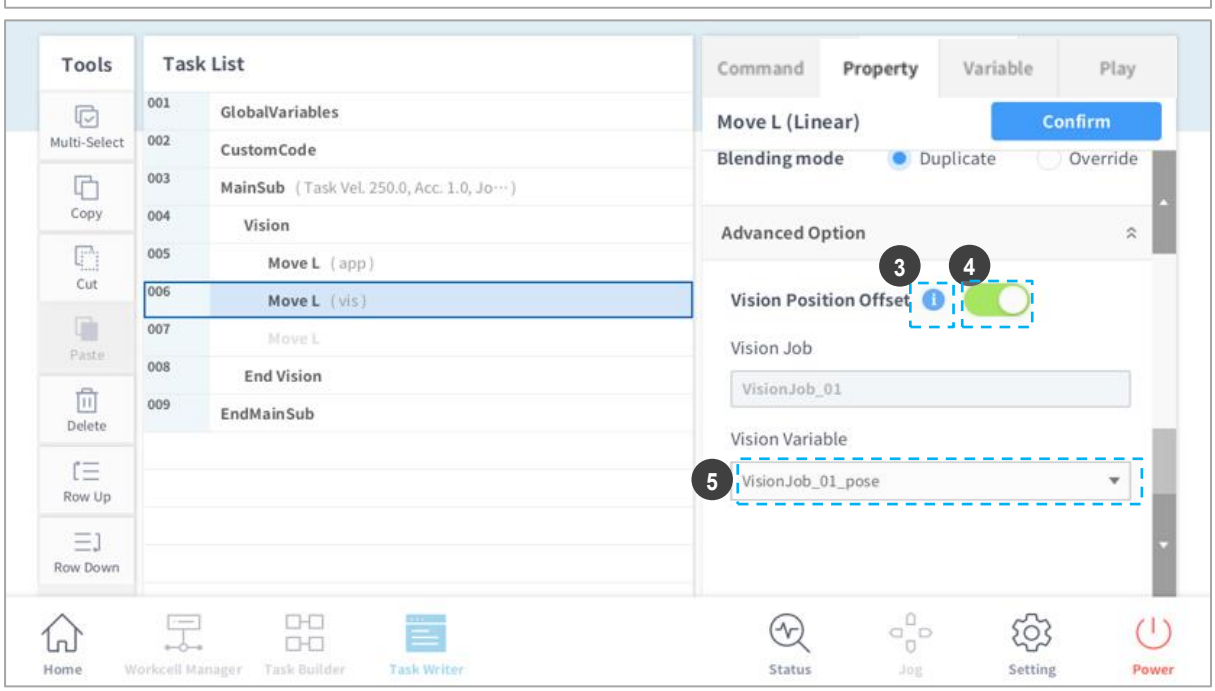




No.	Item	Description
1	**Add Skill Command after Vision Shoot and before Teaching Position Entry**	Enter the desired robot position. Inserting a Skill Command (Pick, Place, etc.) between Vision and End Vision in the Task List will create a toggle button for the skill command to use **Vision Position Offset**. (The button is not displayed if there is no Skill Command between VisionStart and VisionEnd.) Caution: To use **Vision Position Offset**, it is necessary to perform calibration in the Workcell Manager. Without calibration, the robot cannot be moved to a desired position.
2	**Picking Pose**	Acquires the pose after moving the pose to pick based on the Vision Pose using direct teaching.
3	**Vision Position Offset**	Match the Vision measurement pose and robot pose. The Vision measurement pose can be moved based on the robot.
4	**Vision Variable**	Select a pose to match the Vision and robot coordinates.

3.3 Task Writer: Using Vision in Motion Commands





No.	Item	Description
1	**Add Motion Command after Vision Shoot and before Teaching Position Entry**	Enter the desired robot position with Move L.
2	**Get pose**	Acquires the pose after moving the pose to pick based on the Vision Pose using direct teaching.
3	**Add Motion Command for Vision Offset Pose**	If you insert a Motion Command (Move L, Move B, etc.) between Vision and End Vision in the Task List, a toggle button for **Vision Position Offset** will appear, as shown in ③ in the last line of Move L. (The button is not displayed if there is no Motion Command between Vision and End Vision.) Caution: To use **Vision Position Offset**, it is necessary to perform calibration in the Workcell Manager. Without calibration, the robot cannot be moved to a desired position.
4	**Vision Position Offset**	Match the Vision measurement pose and robot pose. The Vision measurement pose can be moved based on the robot.
5	**Vision Variable**	Select a pose to match the Vision and robot coordinates.

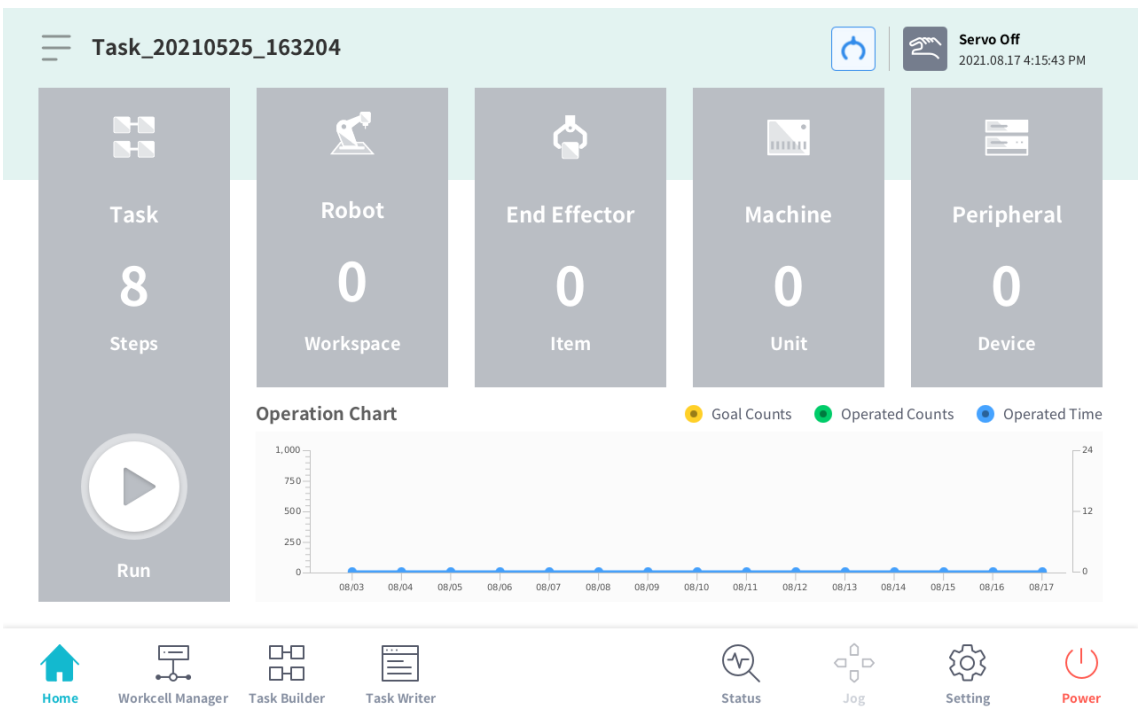
3.4 Vision Skill: Installing the Vision Skill

To effectively utilize some of the features of the newly released DART-Vision, you can make use of t he Vision skill. In order to use the Vision skill, you'll need to have completed SVM set-up using DA RT-Vision beforehand. The DART-Vision setup can be performed easily by following the instructions i n the DART-Vision manual.

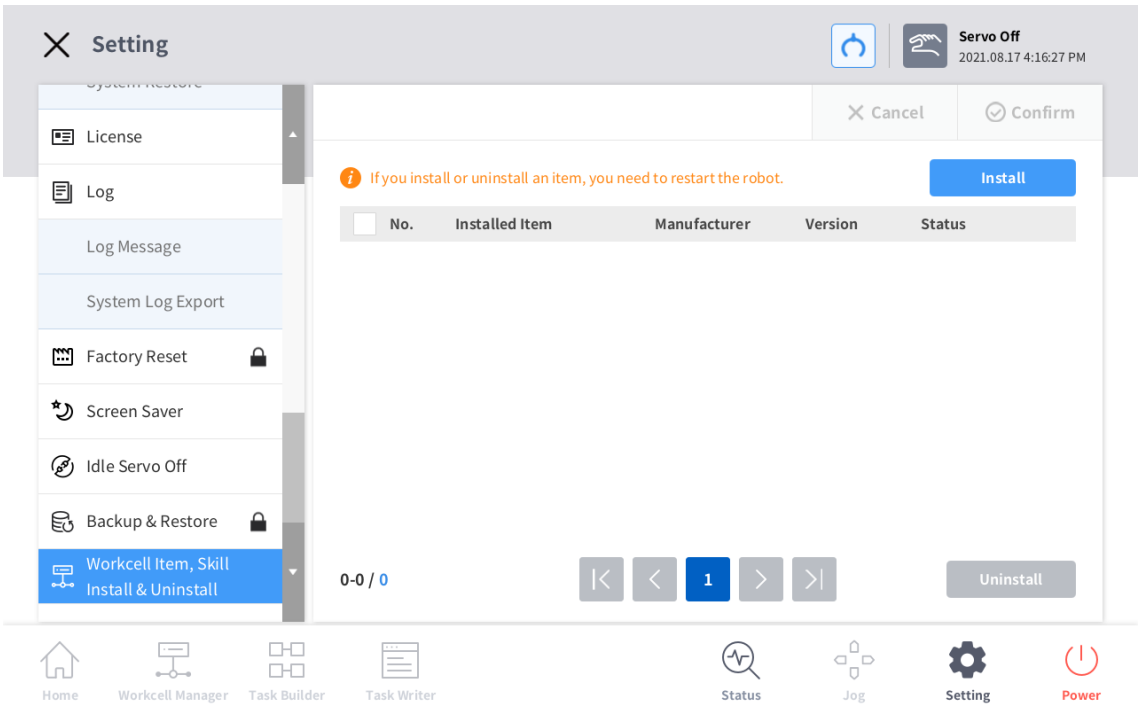
- The Vision skill installation file provided by Doosan Robotics can be found in the Doosan R obotics Robot Lab (https://robotlab.doosanrobotics.com).
- The Vision skill can be created directly through the App Builder. You can find the App Buil der manual and materials in the Doosan Robotics Developer Lab (https://devlab.doosanrobot ics.com).

Follow the images below to install theVision skill.

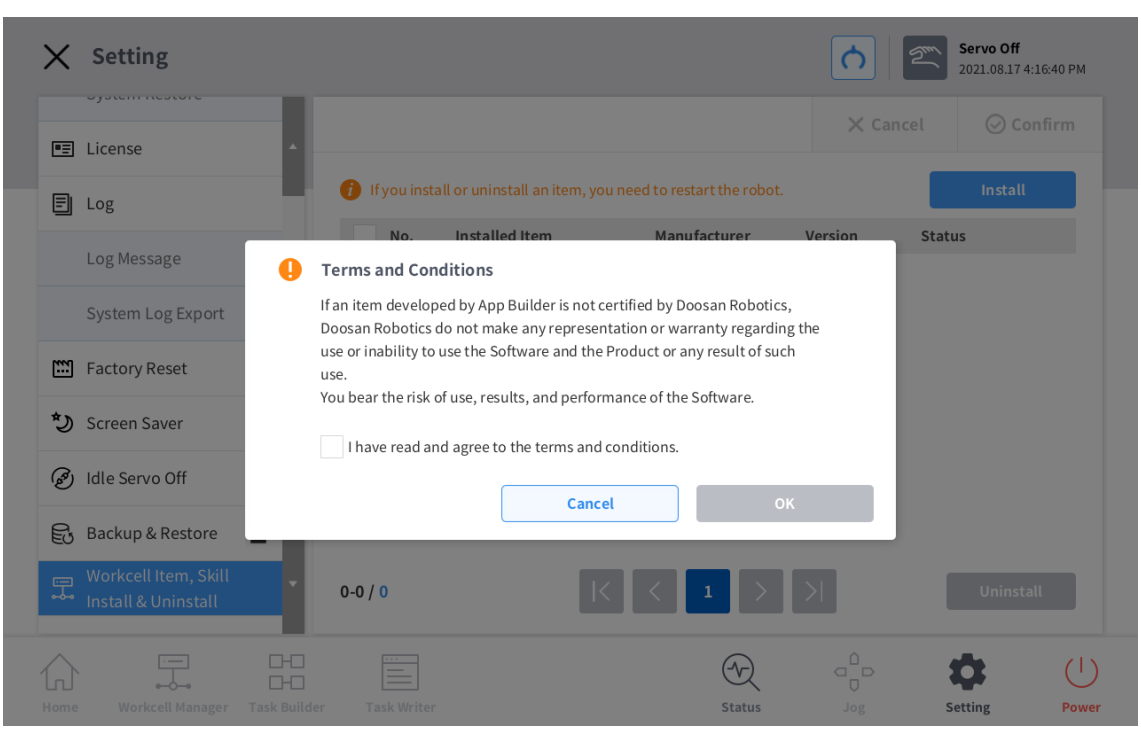
1. This is the initial entry screen.

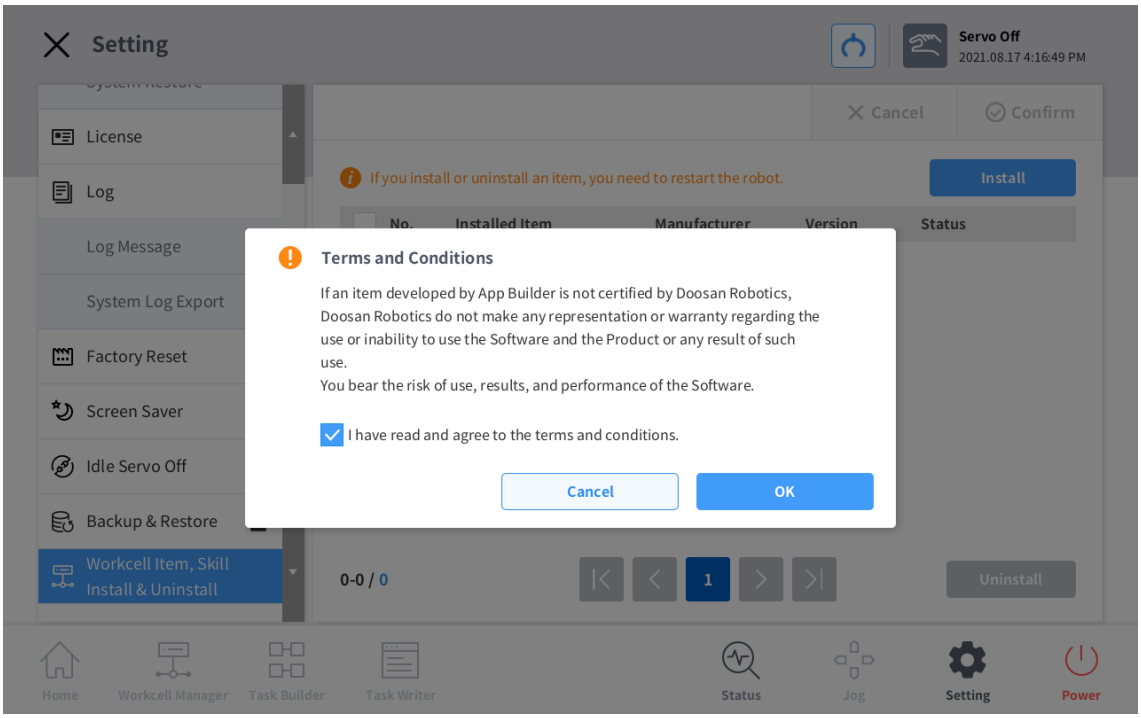


2. Enter the Settings menu and click Workcell Item, then Skill Install & Uninstall menu.

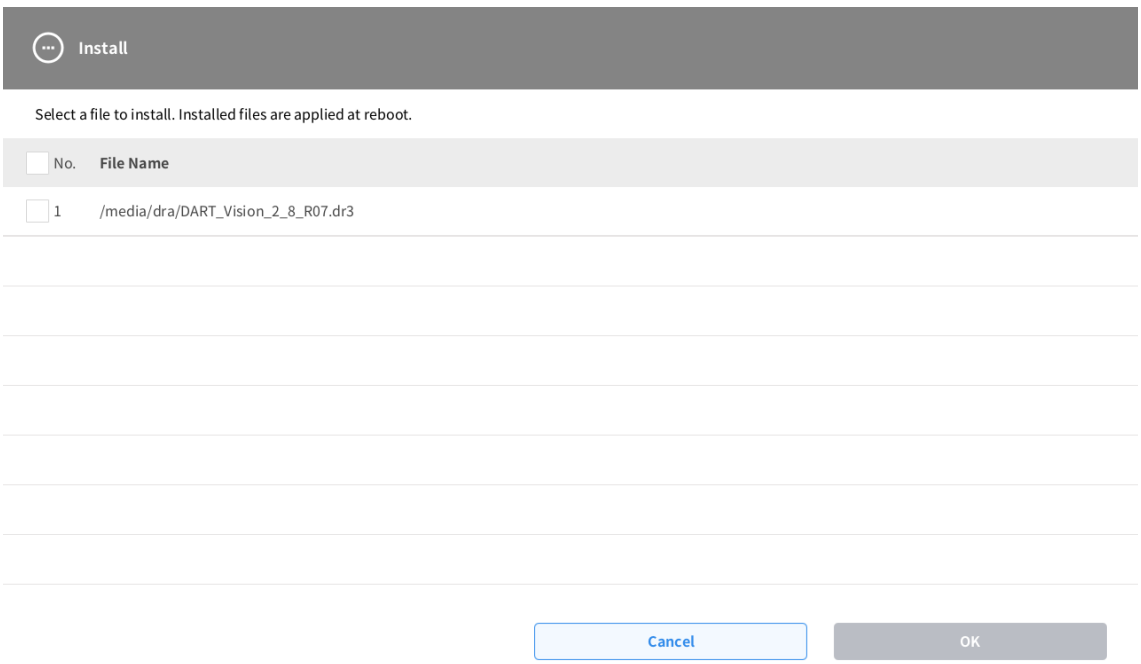


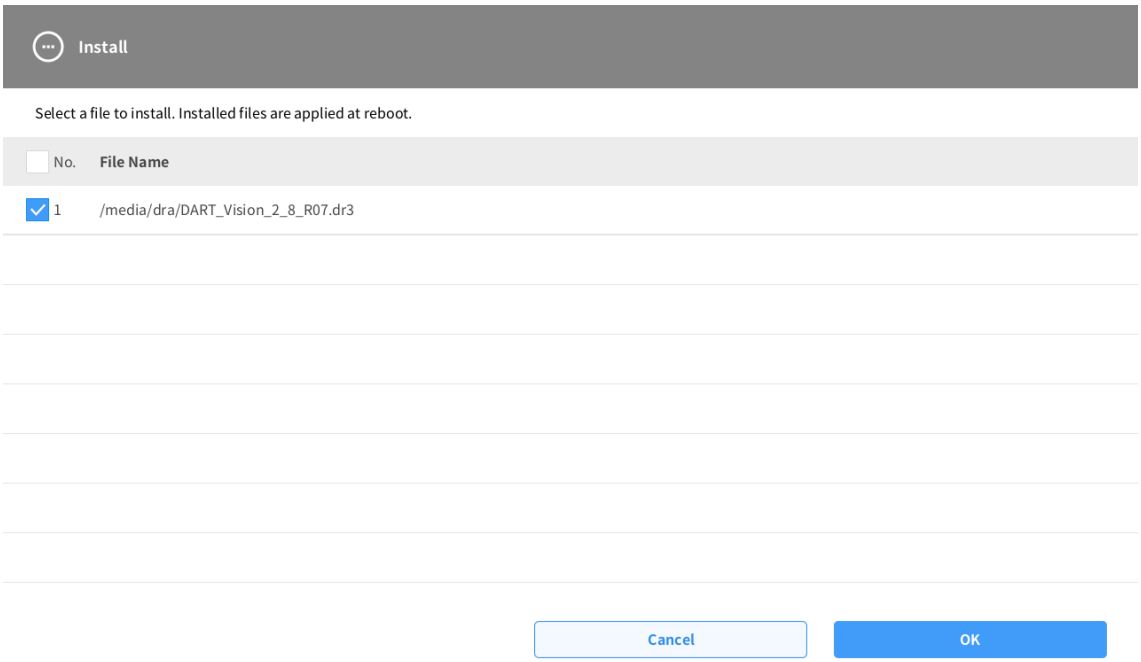
3. Press the Install button. The below popup will appear. Click the check button and press OK.

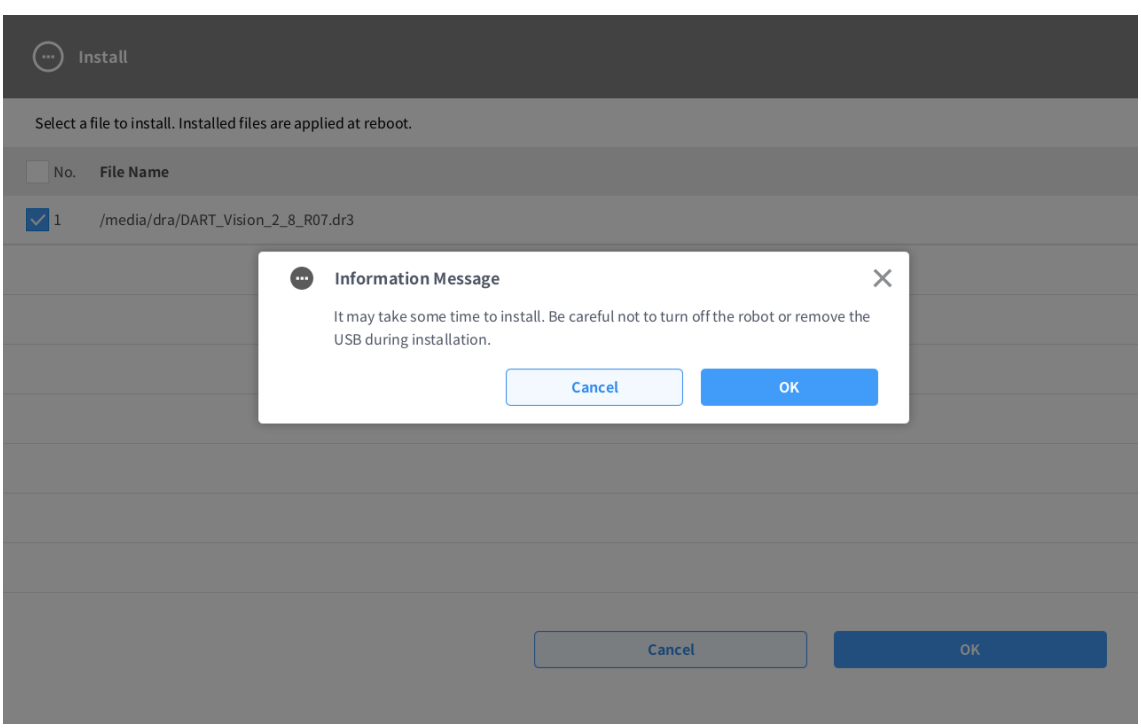




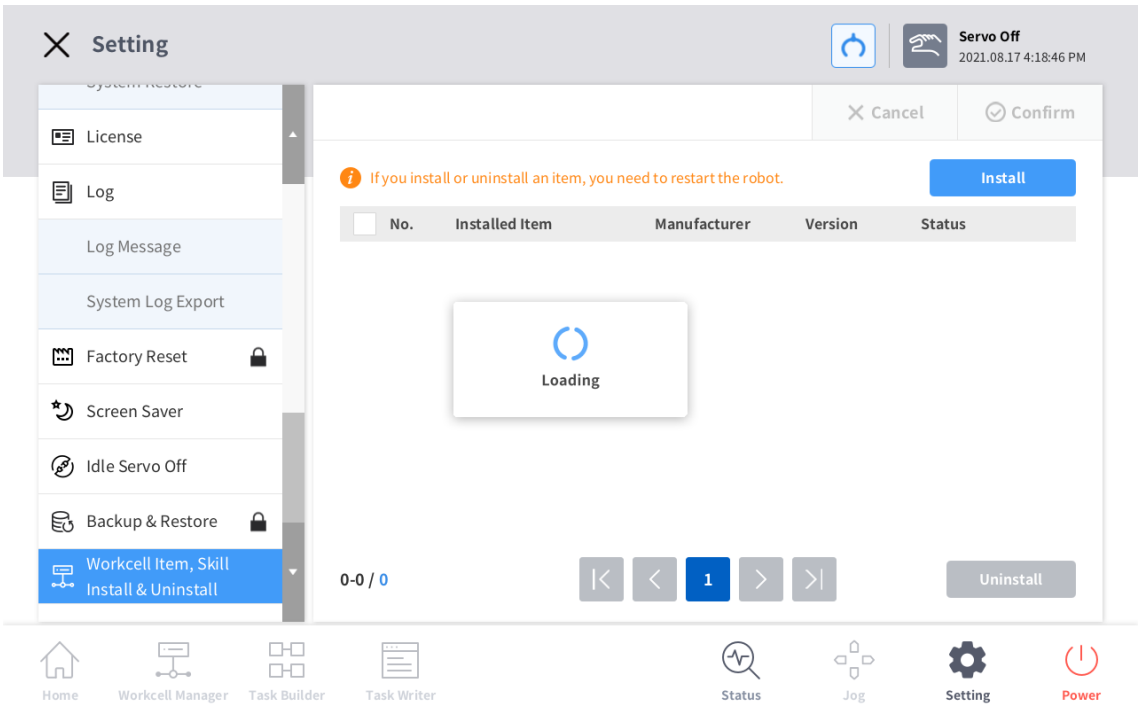
4. Check the Vision skill file DART_Vision_2_8_R07.dr3, which was loaded on the USB, and click O K.

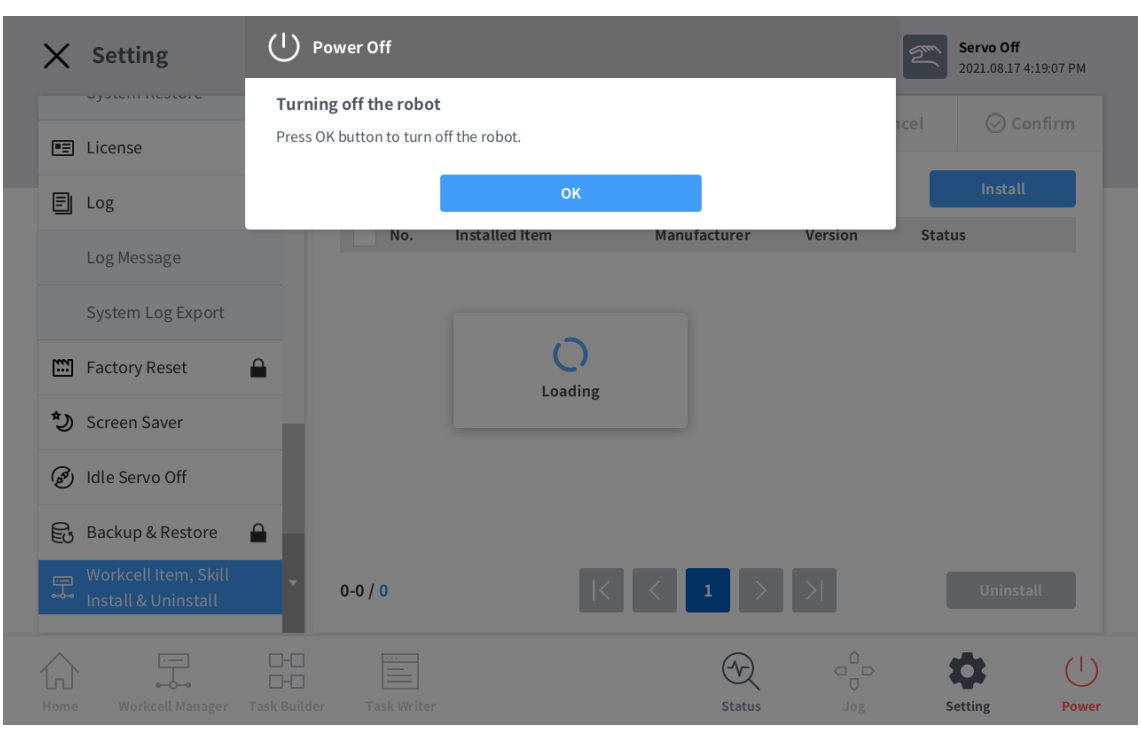



Install
Select a file to install. Installed files are applied at reboot.
No.
File Name
1
/media/dra/DART_Vision_2_8_R07.dr3
Cancel
OK

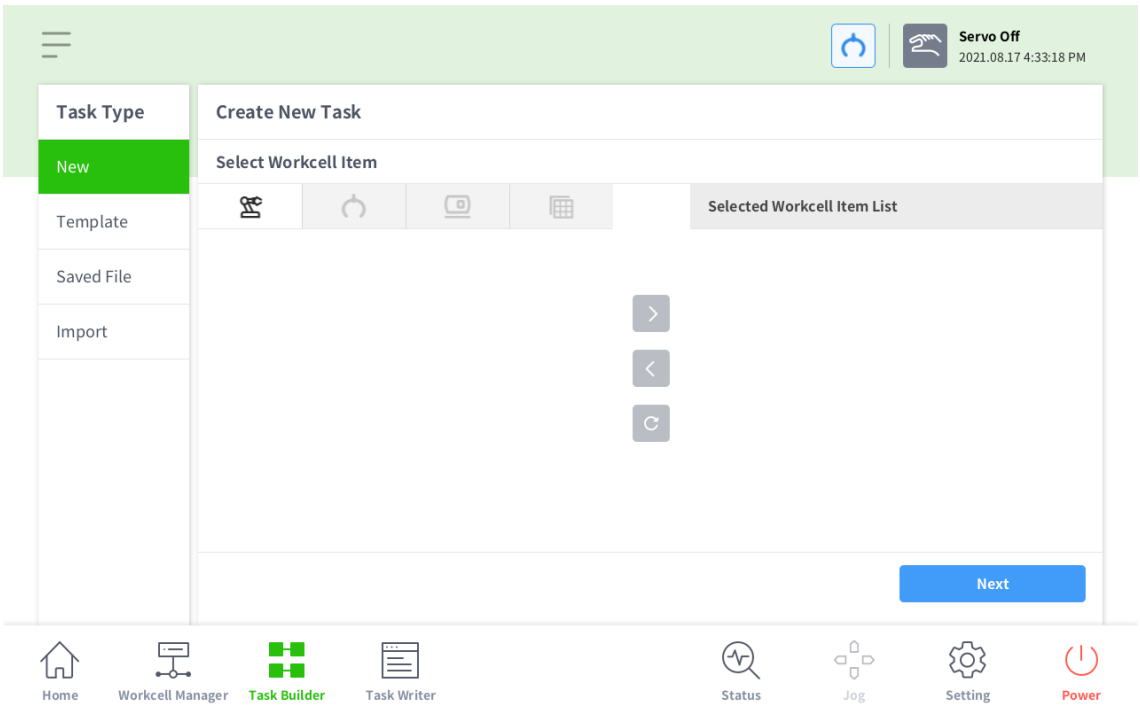

Install
Select a file to install. Installed files are applied at reboot.
No.
File Name
1
/media/dra/DART_Vision_2_8_R07.dr3
Information Message
It may take some time to install. Be careful not to turn off the robot or remove the USB during installation.
Cancel
OK
Cancel
OK

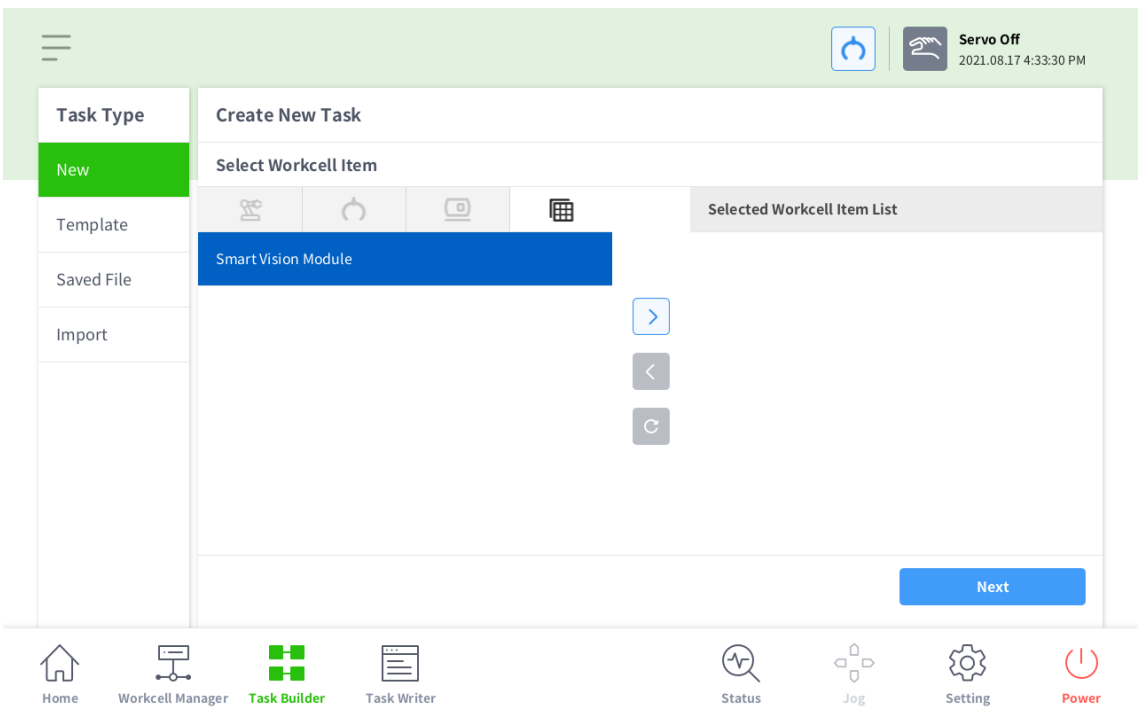
5. After installation, you'll be told to reboot the robot. Reboot the robot.

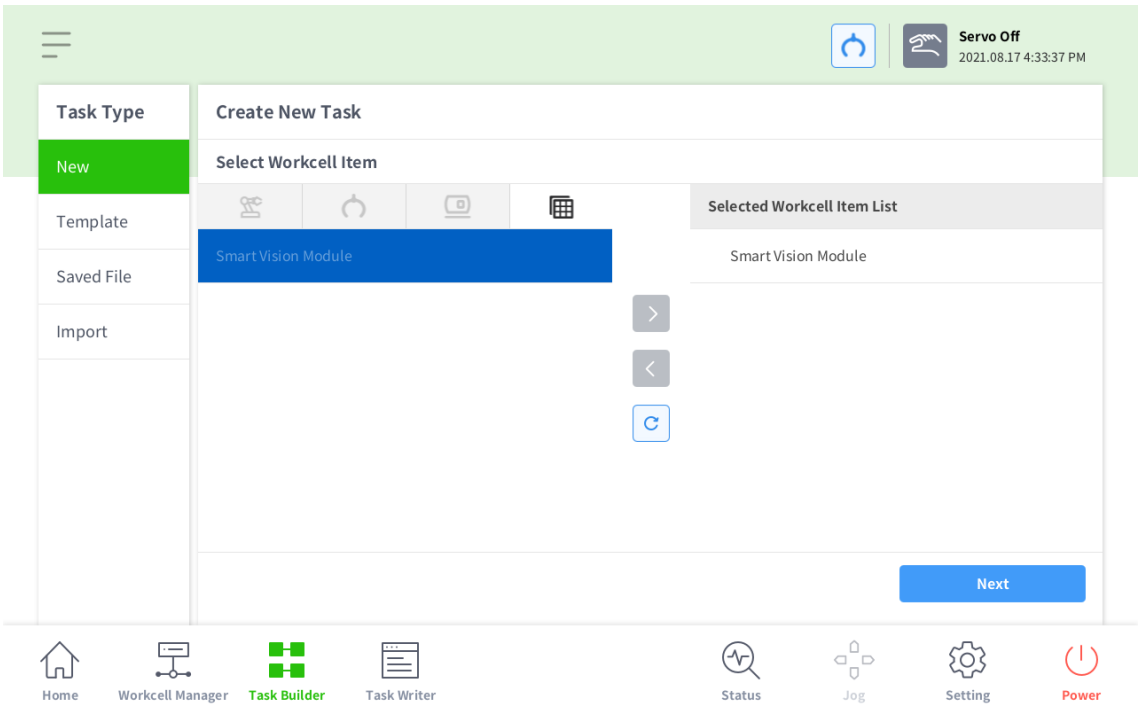


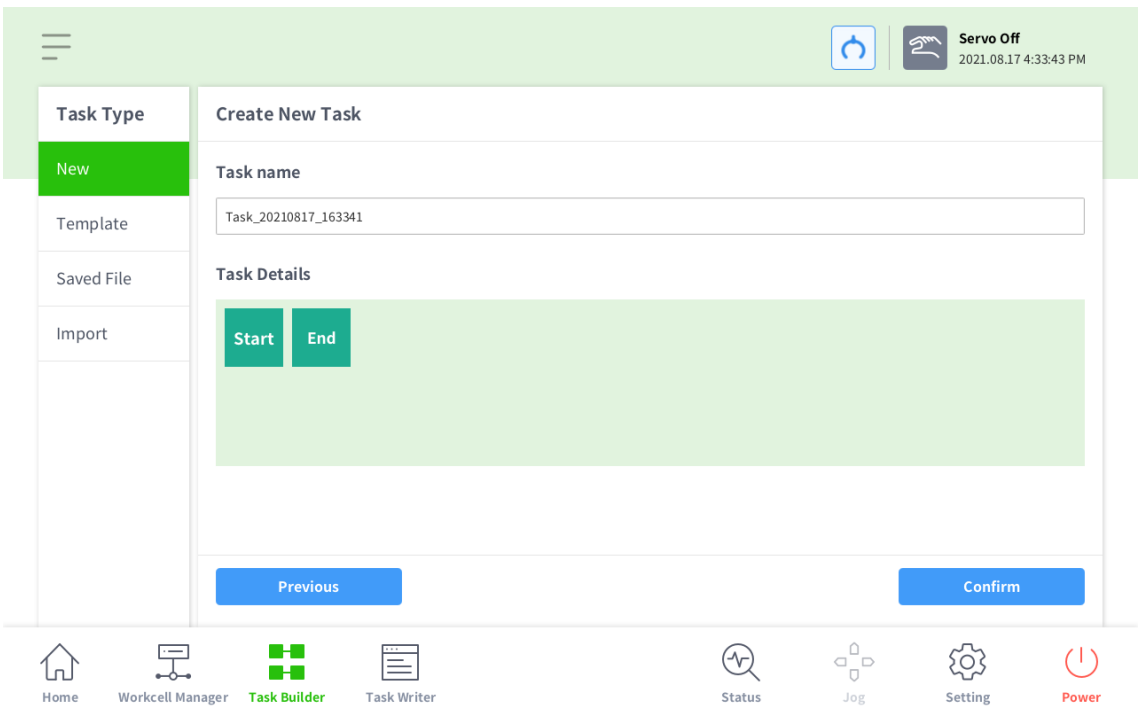


6. After rebooting, add the Smart Vision module in the Task Builder. Preparations for use are now c
omplete.






Servo Off
2021.08.17 4:33:37 PM
Task Type
New
Template
Saved File
Import
Create New Task
Select Workcell Item
Smart Vision Module
Selected Workcell Item List
Smart Vision Module
Next
Home
Workcell Manager
Task Builder
Task Writer
Status
Jog
Setting
Power

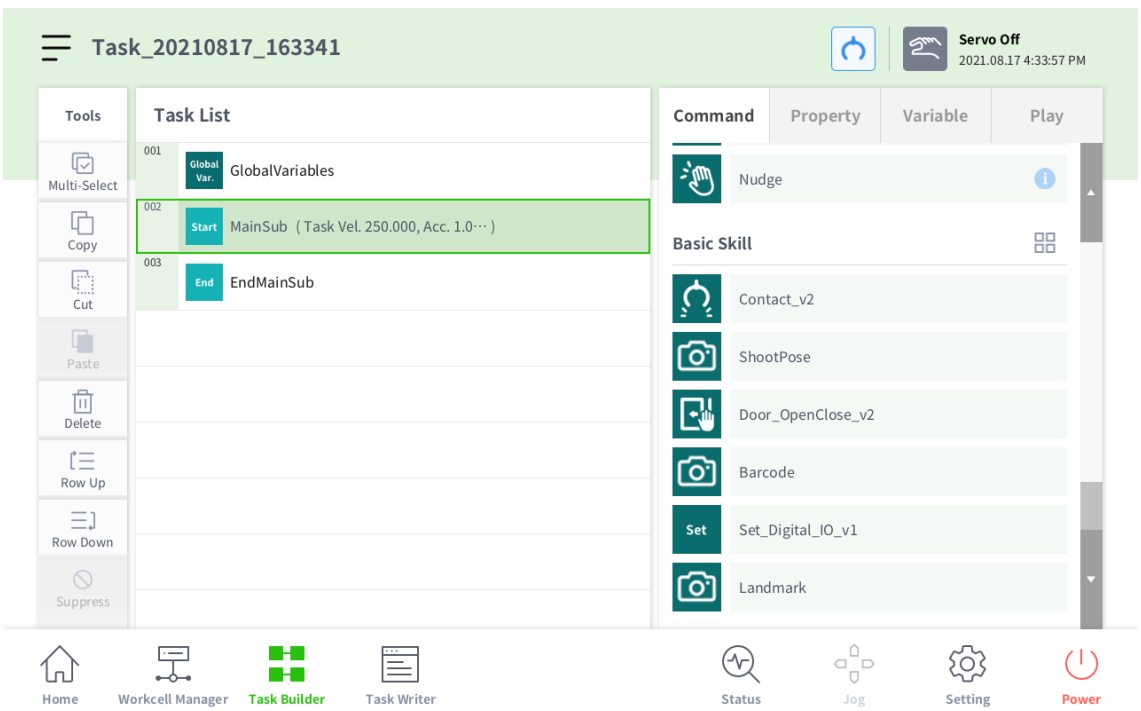

Servo Off
2021.08.17 4:33:43 PM
Task Type
New
Template
Saved File
Import
Create New Task
Task name
Task_20210817_163341
Task Details
Start
End
Previous
Confirm
Home
Workcell Manager
Task Builder
Task Writer
Status
Jog
Setting
Power

3.5 Vision Skill: Using the Shoot Pose skill

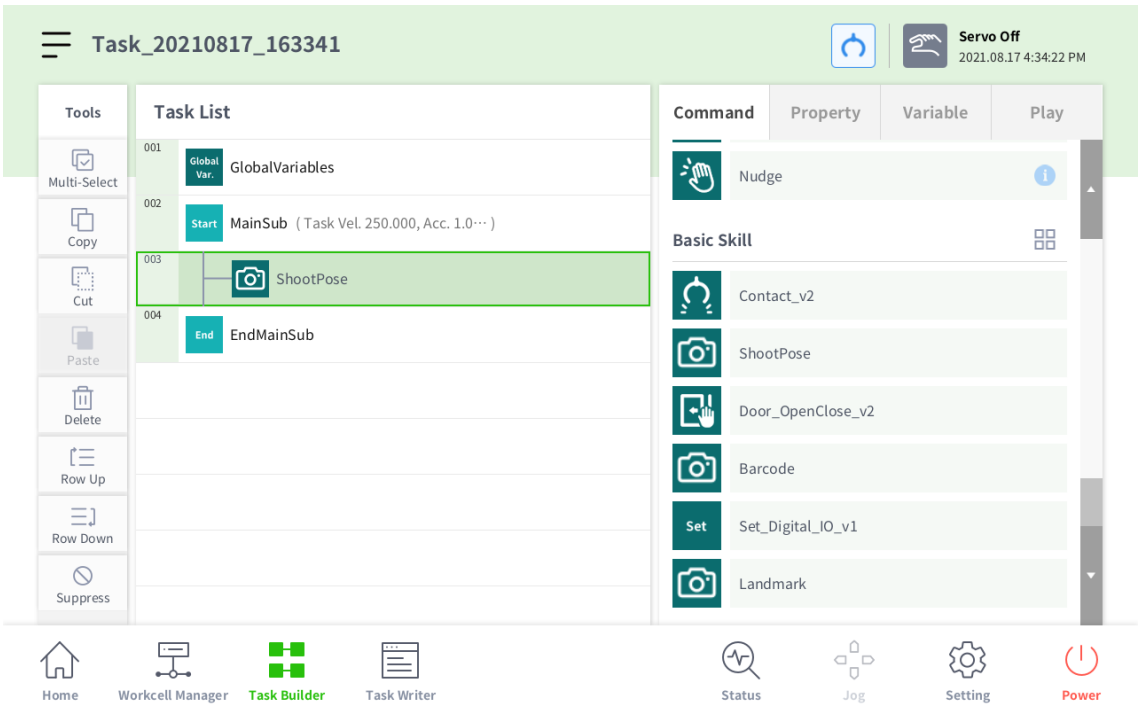
The Shoot Pose skill returns the robot pose with the shooting height set via DART-Vision. This skill utilizes the returned pose to move the robot to the shooting position.

The Shoot Pose skill must be used after carrying out hand-eye calibration or auto calibration under t he DART-Vision Calibration tab and saving the calibration data in the SVM. If you have not performe d calibration, please refer to the DART-Vision manual to do so.

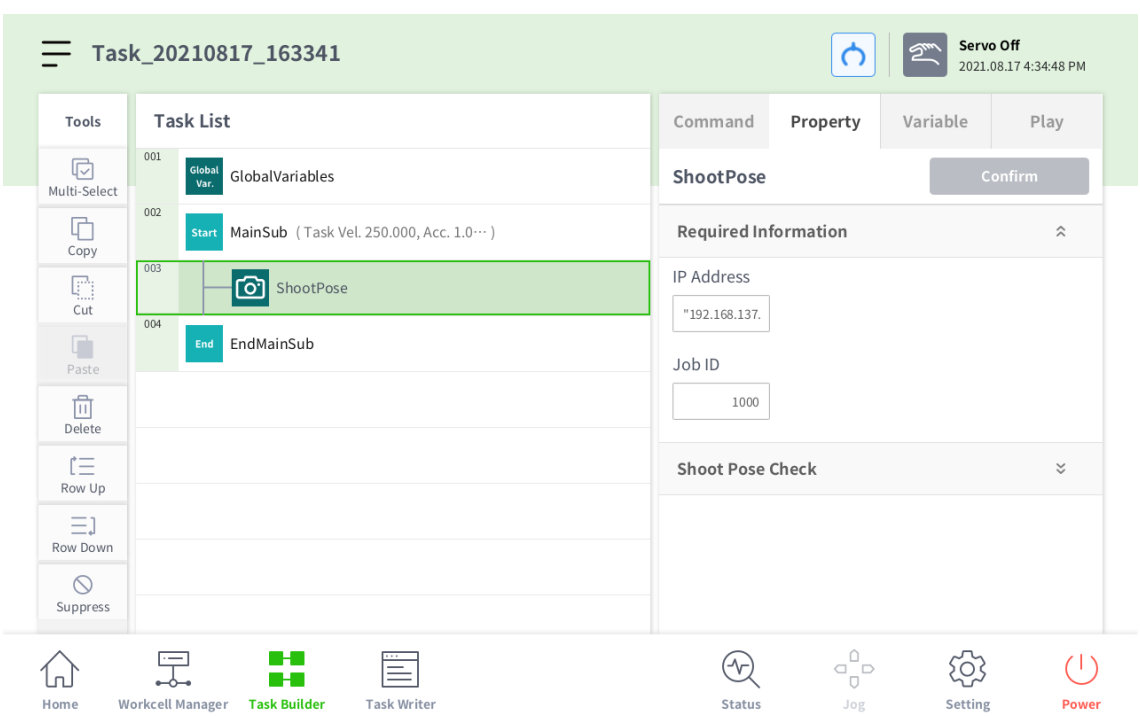
After completing 3.4, move the command scroll bar downward to check whether the Shoot Pose skill is present. If it is, follow the order in the image.



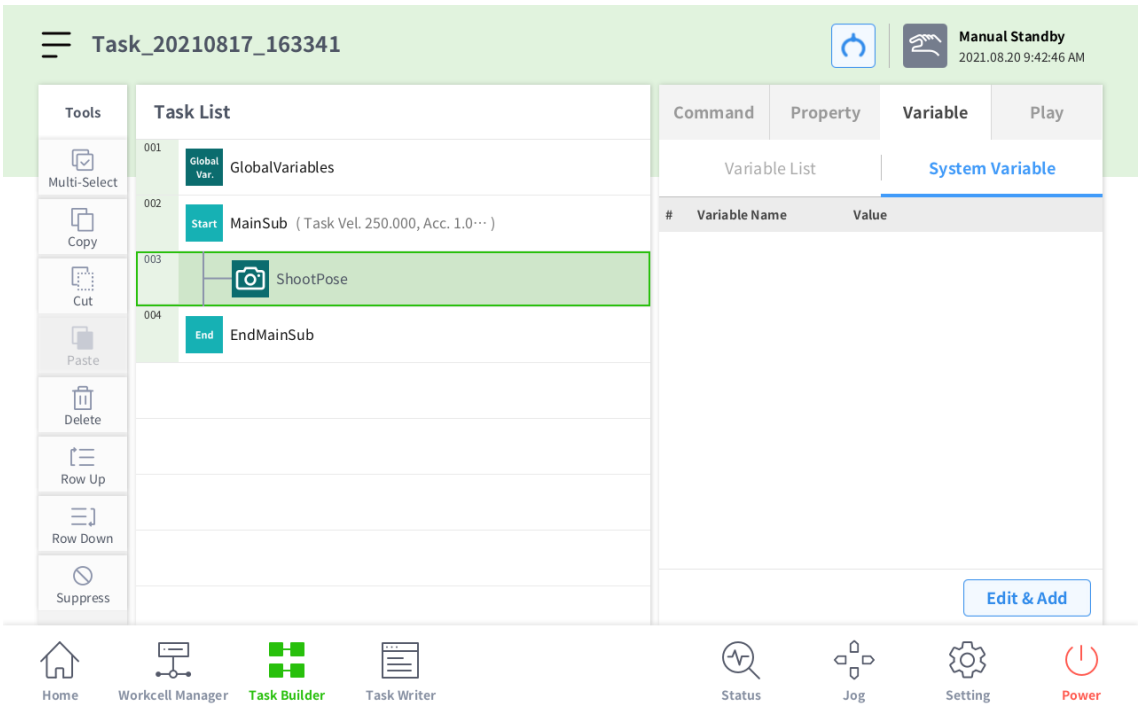
1. Click the Shoot Pose button under the Command tab to add the Shoot Pose skill.



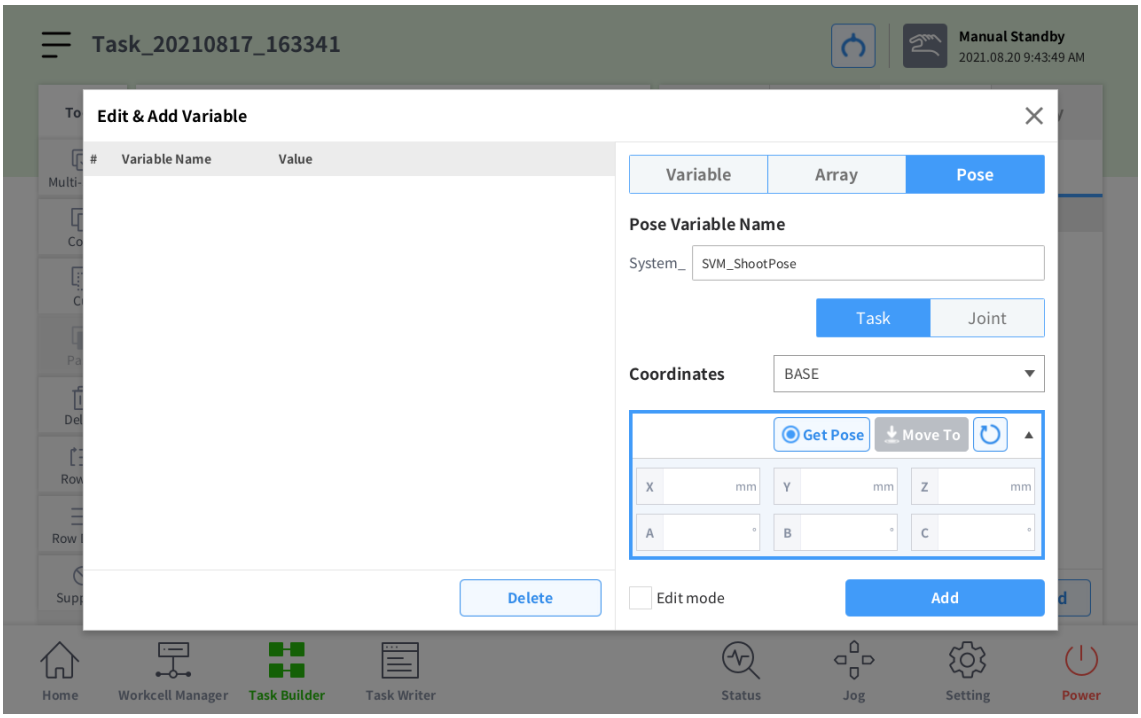
2. Open up Required Information in the Property tab and input the IP address and job ID of the sho oting pose.



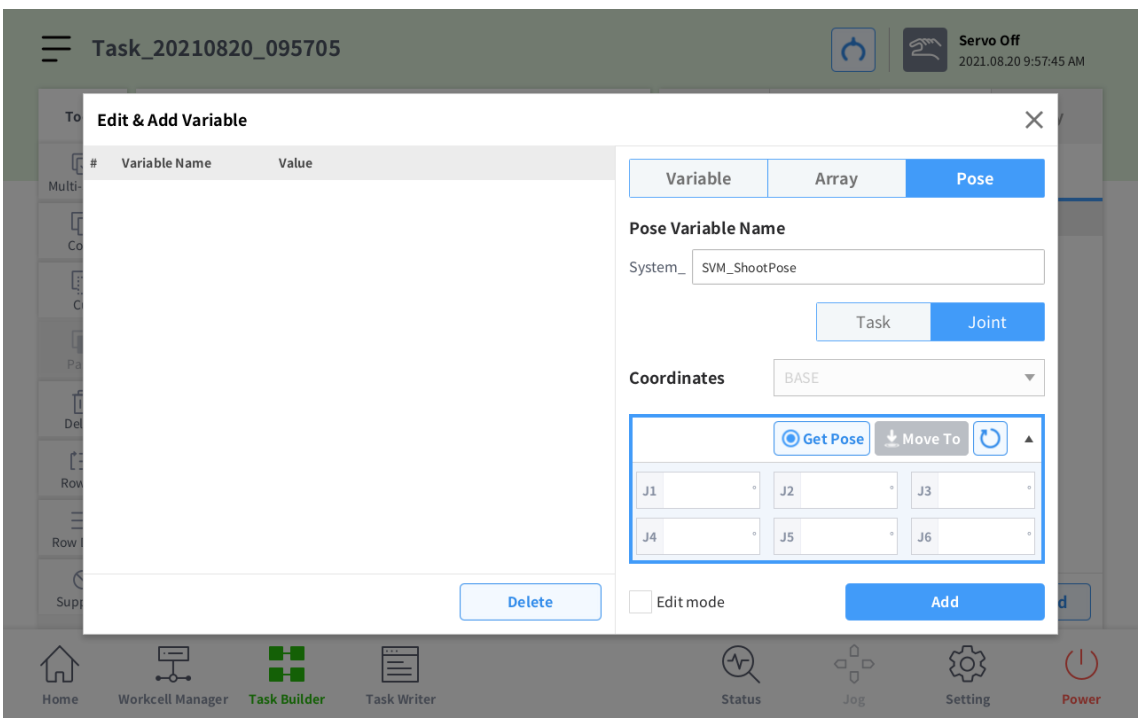
3. Press the Edit & Add button under the Variable tab.



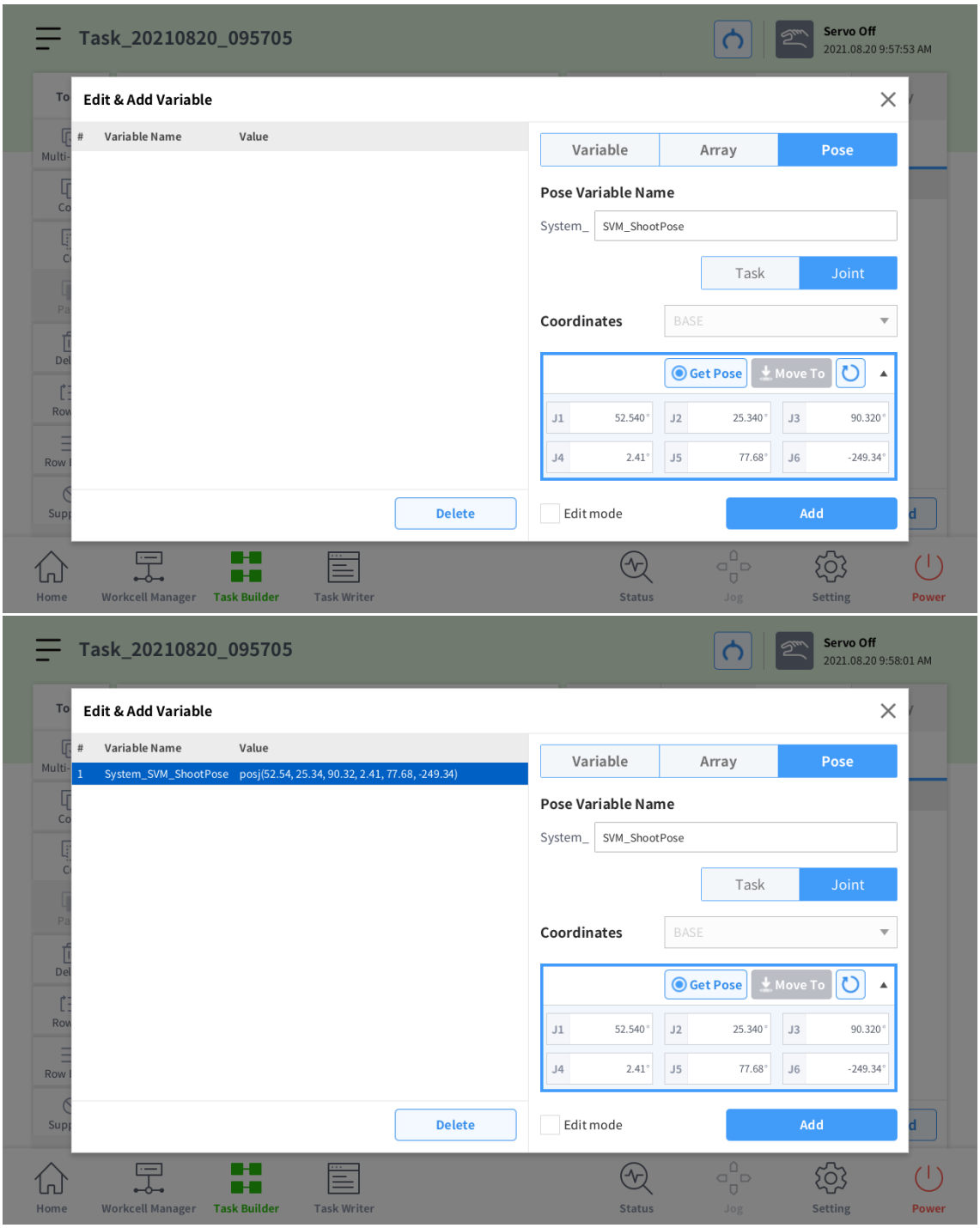
4. Add in System_SVM_ShootPose.



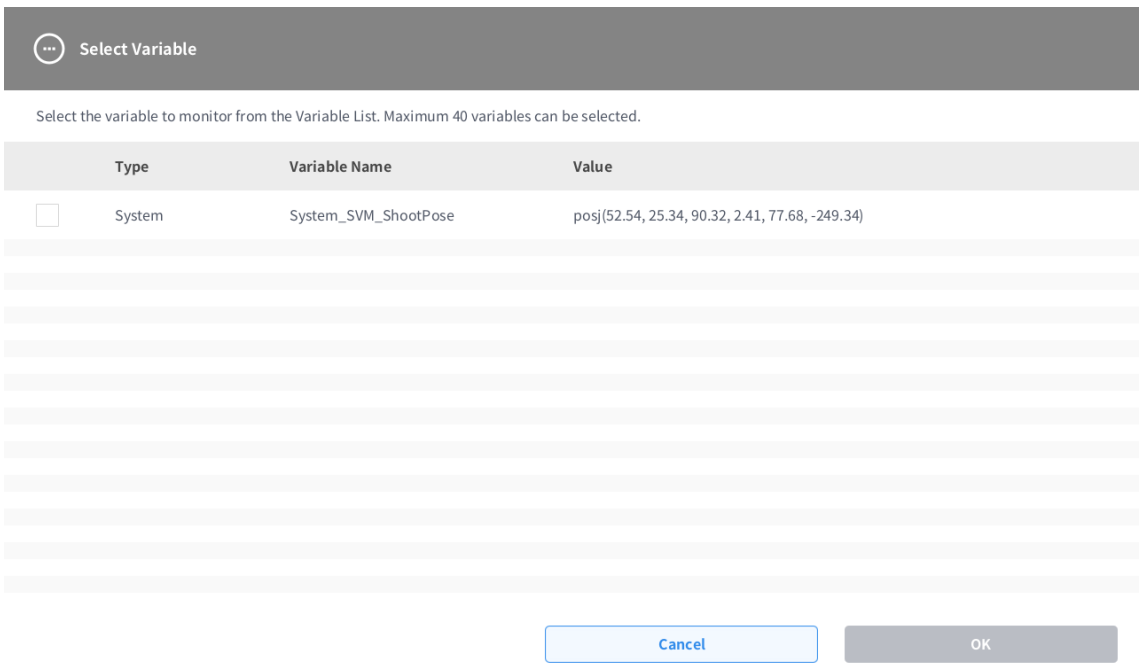
5. Because the Shoot Pose is a joint coordinate, press the Joint button.



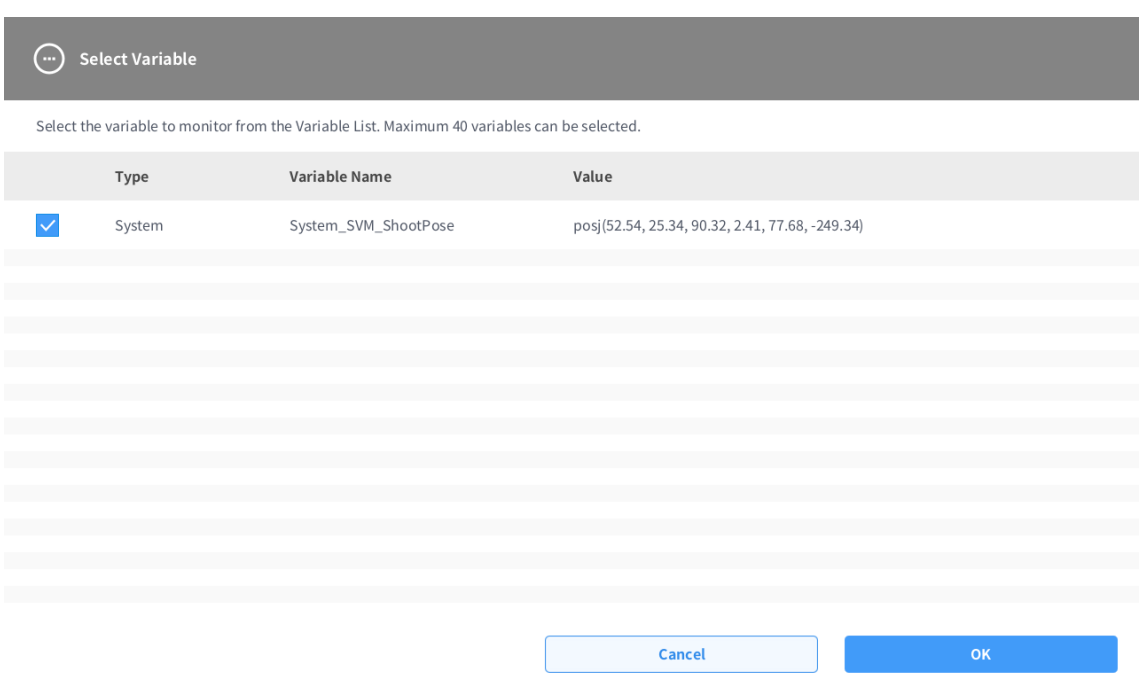
6. Press Get Pose. Pressing the Add button will add a variable.

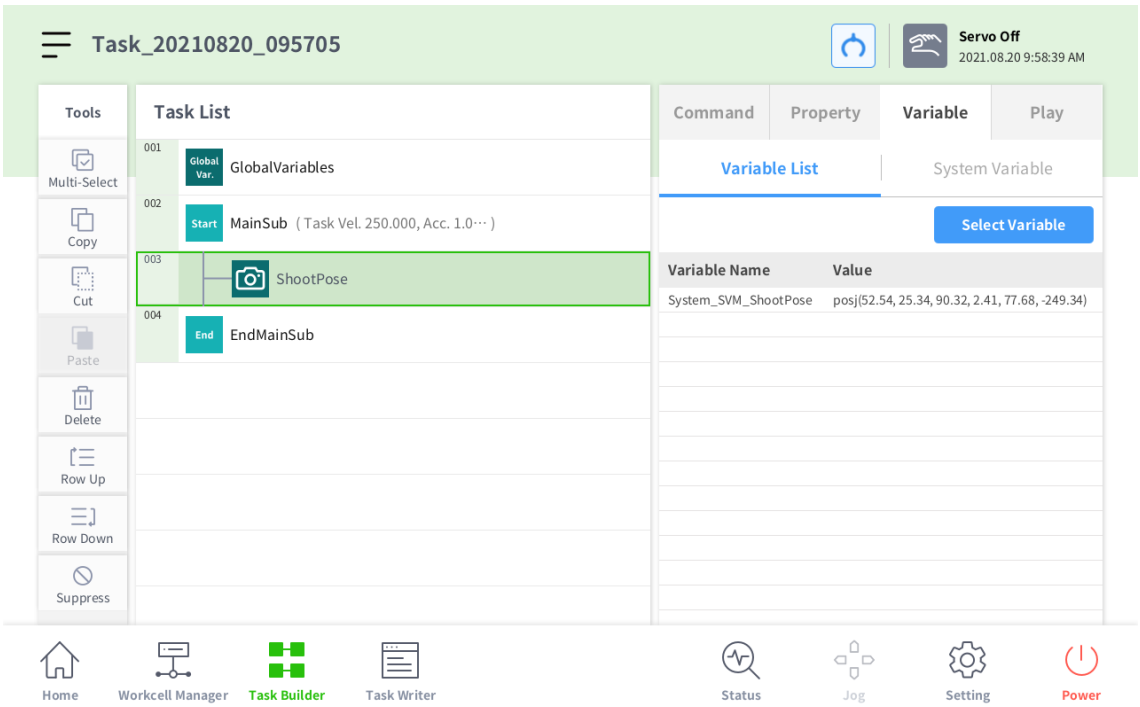


7. Close the window, press the Variable List button, then press the Variable.

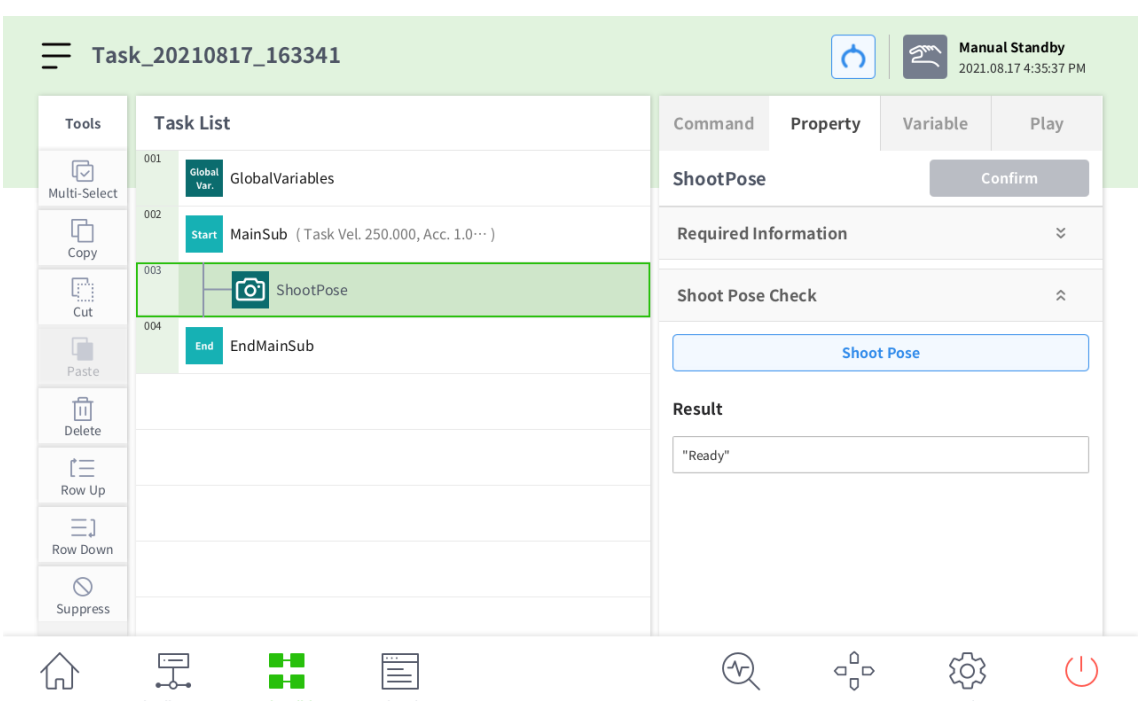


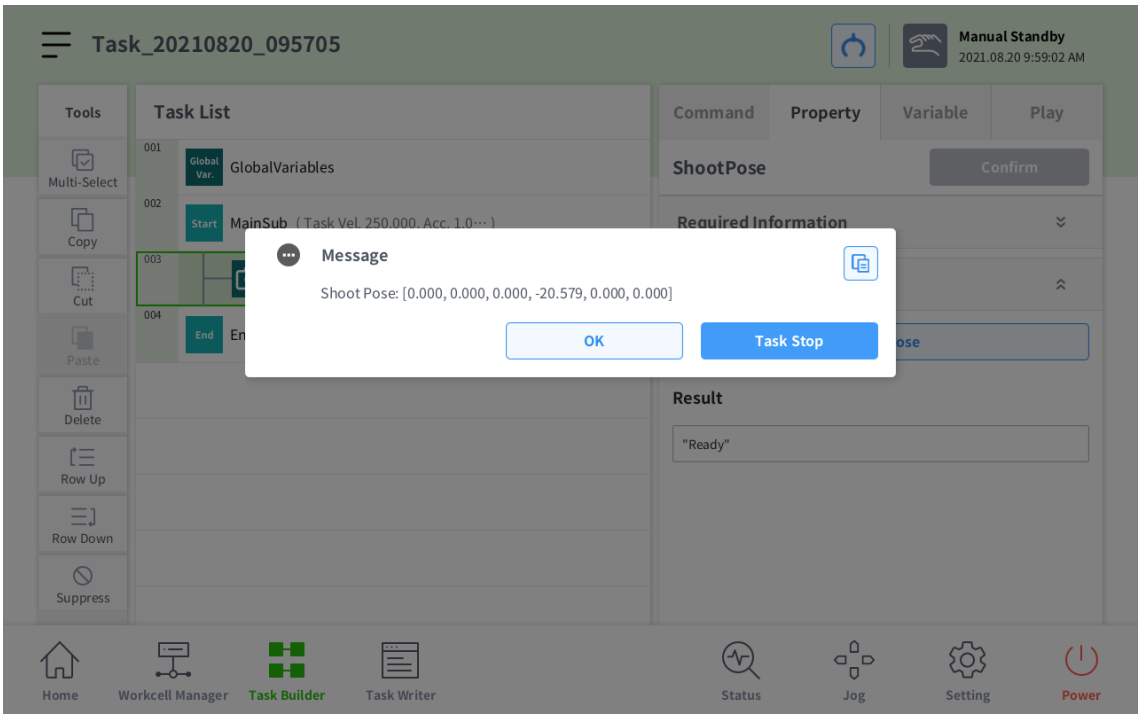
8. Check the System_SVM_ShootPose checkbox and press Confirm to select the Variable.

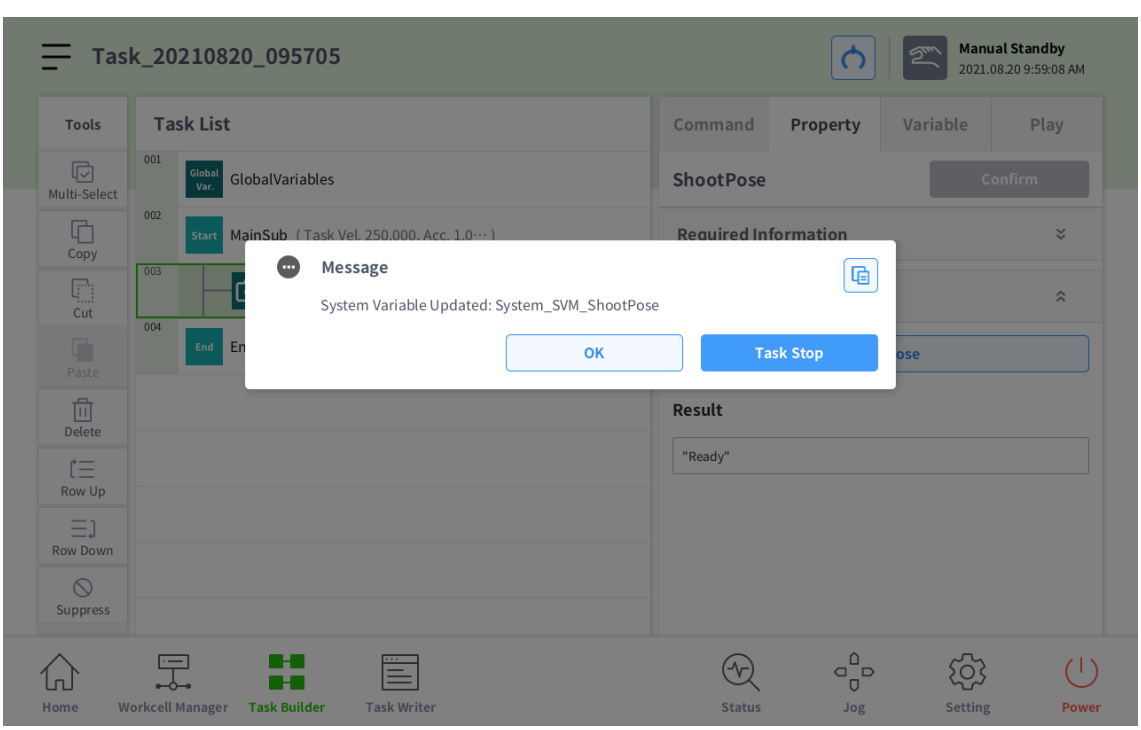


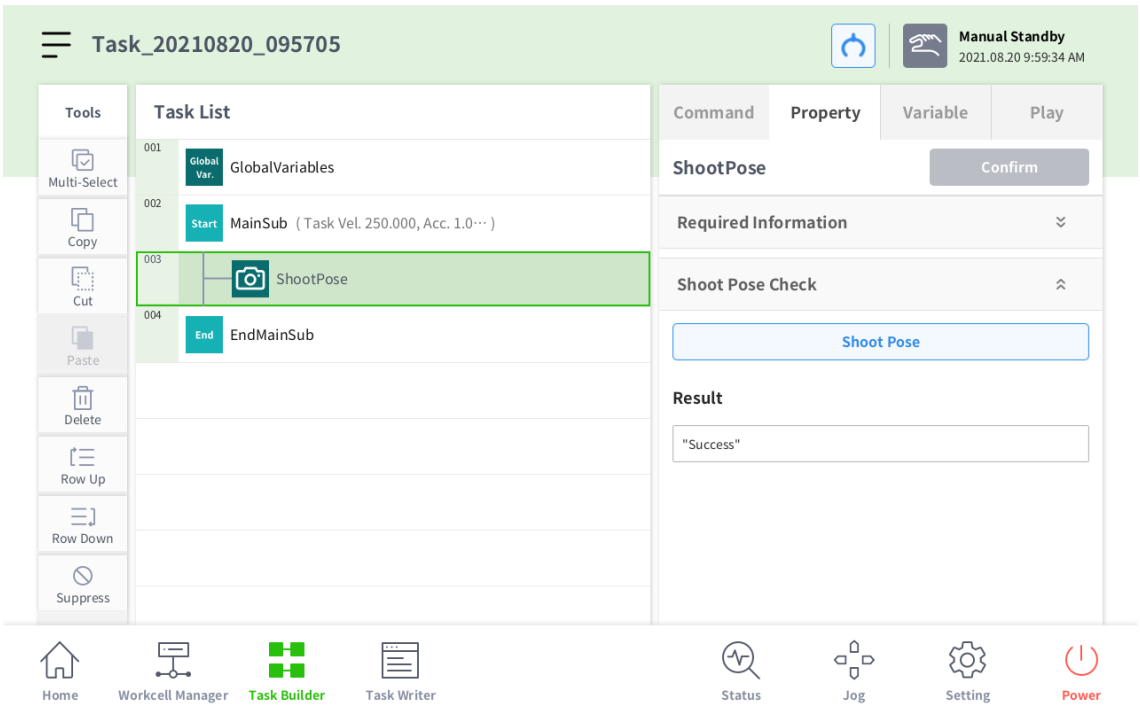


9. Return to the Property tab, open up Shoot Pose Check, and click the Shoot Pose button.

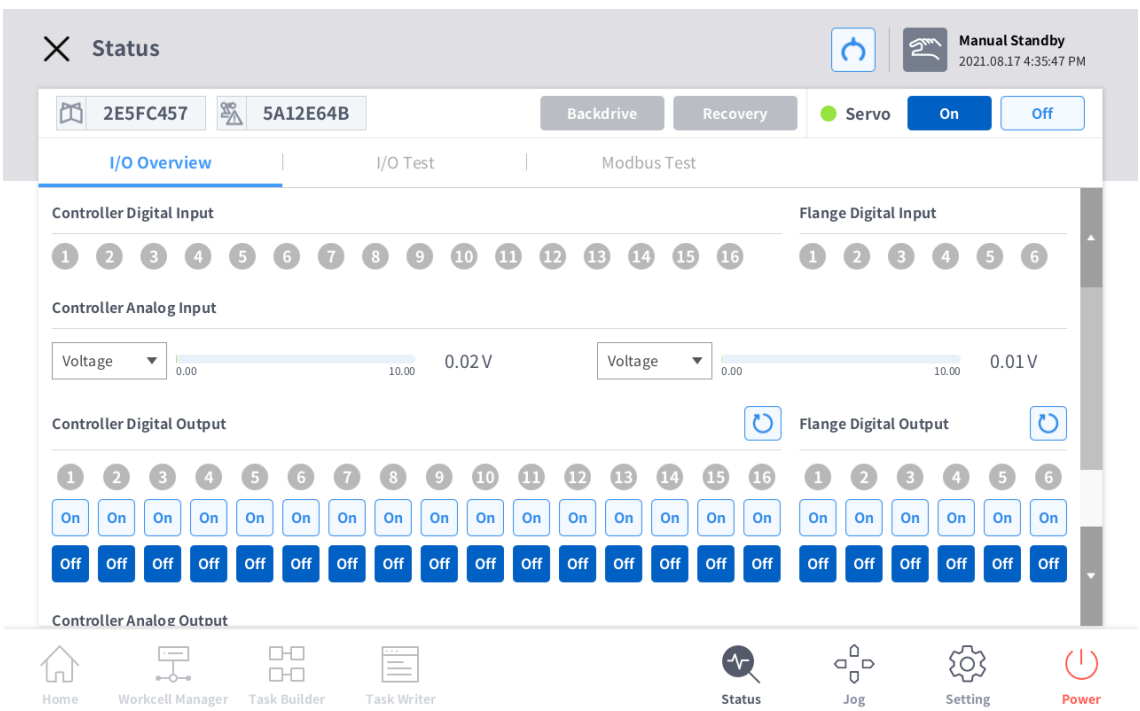



Task_20210820_095705
Manual Standby
2021.08.20 9:59:02 AM
Tools
Task List
Command
Property
Variable
Play
Multi-Select
Copy
Cut
Paste
Delete
Row Up
Row Down
Suppress
001
GlobalVariables
002
MainSub (Task Vel. 250.000, Acc. 1.0···)
003
004
ShootPose
Confirm
Required Information
Result
"Ready"
Message
Shoot Pose: [0.000, 0.000, 0.000, -20.579, 0.000, 0.000]
OK
Task Stop
Home
Workcell Manager
Task Builder
Task Writer
Status
Jog
Setting
Power

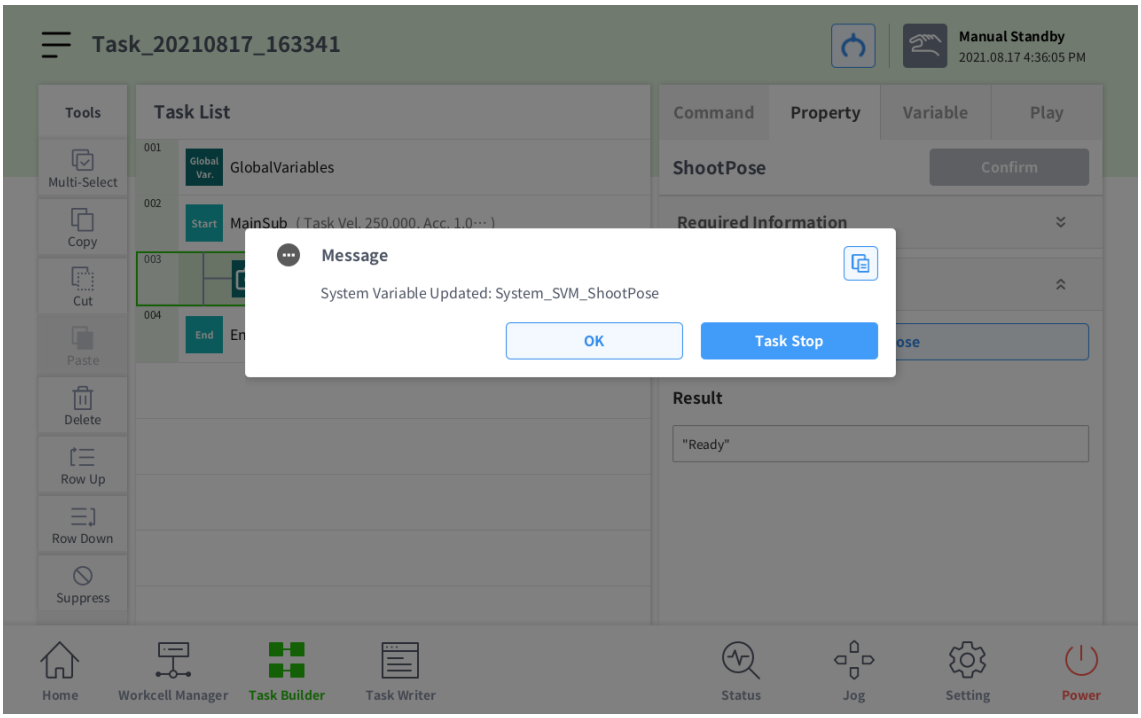

Task_20210820_095705
Manual Standby
2021.08.20 9:59:08 AM
Tools
Task List
Command
Property
Variable
Play
Multi-Select
Copy
Cut
Paste
Delete
Row Up
Row Down
Suppress
001
GlobalVariables
002
MainSub (Task Vel. 250.000, Acc. 1.0···)
003
004
ShootPose
Confirm
Required Information
Result
"Ready"
Message
System Variable Updated: System_SVM_ShootPose
OK
Task Stop
Home
Workcell Manager
Task Builder
Task Writer
Status
Jog
Setting
Power

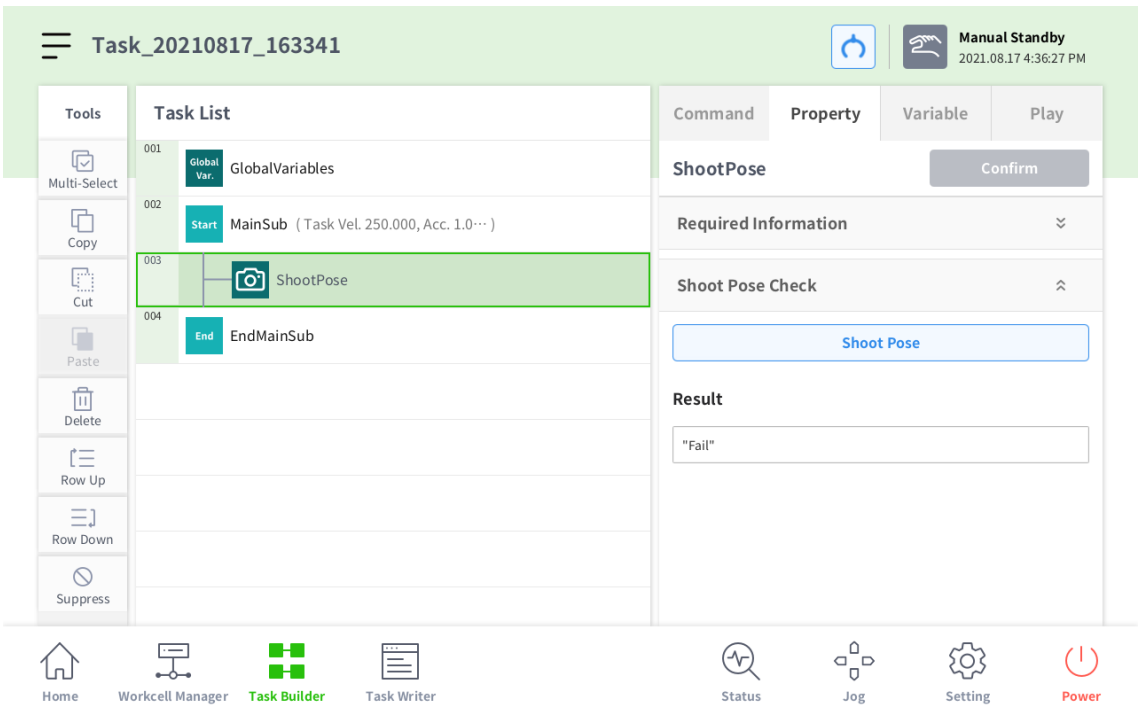


- In order to perform property check testing, the robot must be in Servo On status.

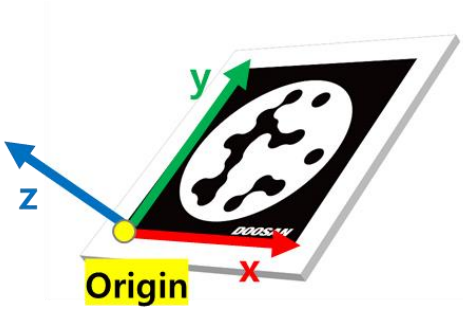


- You cannot use this without first adding the system parameter System_SVM_ShootPose.





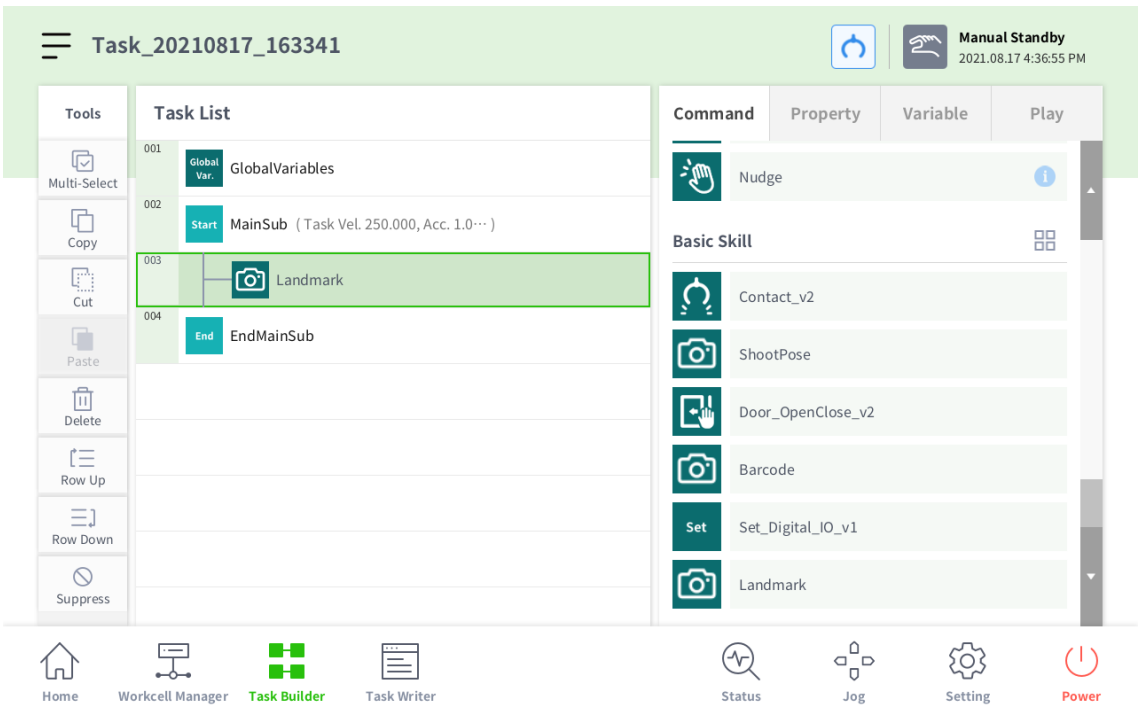
3.6 Vision Skill: Using the Landmark skill



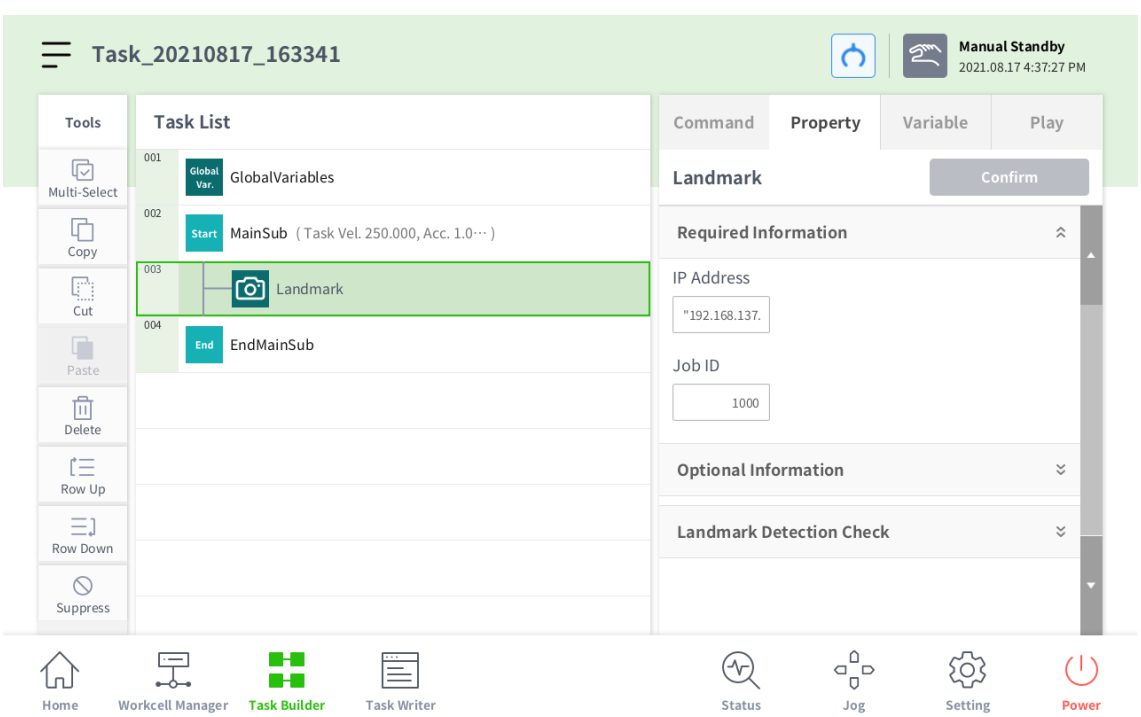
The Landmark skill returns the landmark's origin pose and the pose offset from the origin pose. You can use the returned Robot pose for various tasks. You can move from the landmark to an object pose at the distance of the offset value. In addition, you can use a constant Landmark pose to correct the pose. Please use the Landmark skill freely.

The Landmark skill's Offset pose must be used after carrying out hand-eye calibration and auto calibration under the DART-Vision Calibration tab and saving the calibration data in the SVM. If you have not performed Calibration, please refer to the DART-Vision manual to do so.

1. Click the Landmark button under the Command tab and add the Landmark skill.

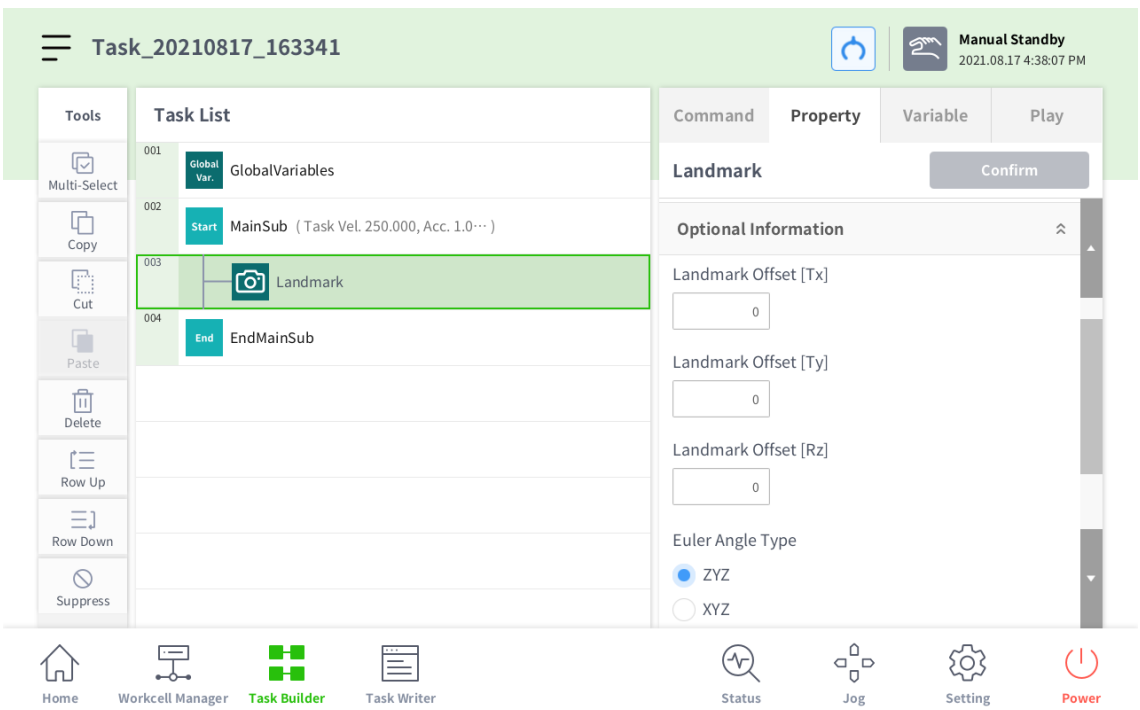


2. Open up Required Information in the Property Tab and input the IP address and job ID.

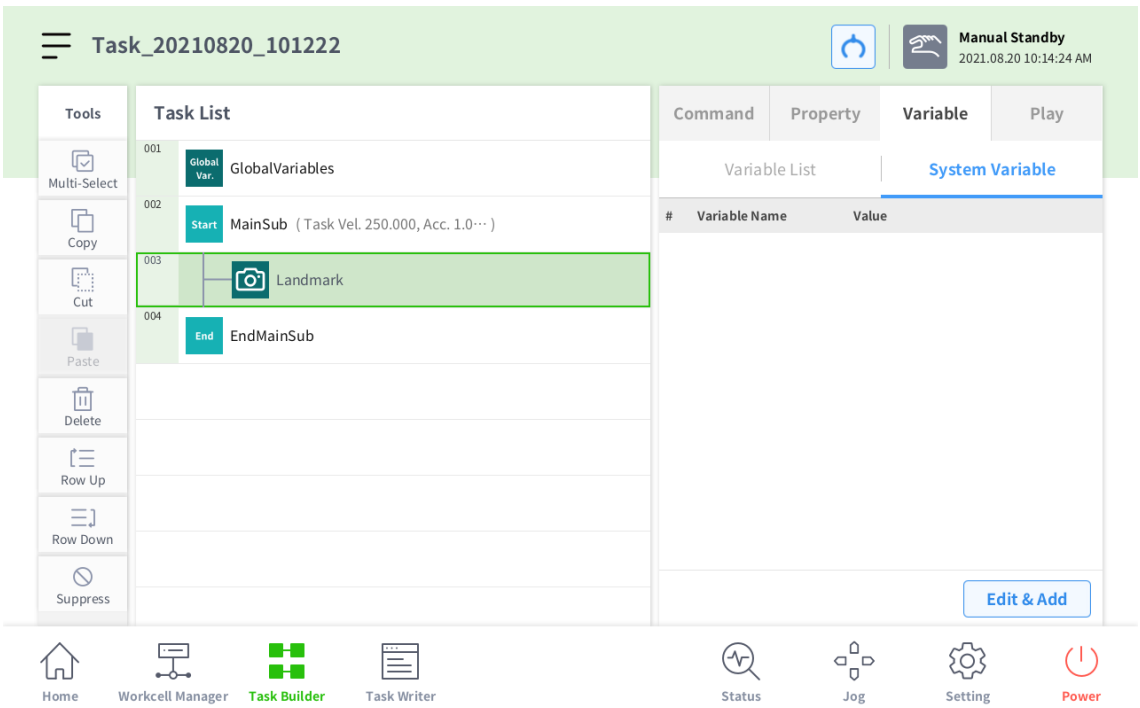


3. Open up Optional Information to input the movement offset from the origin.

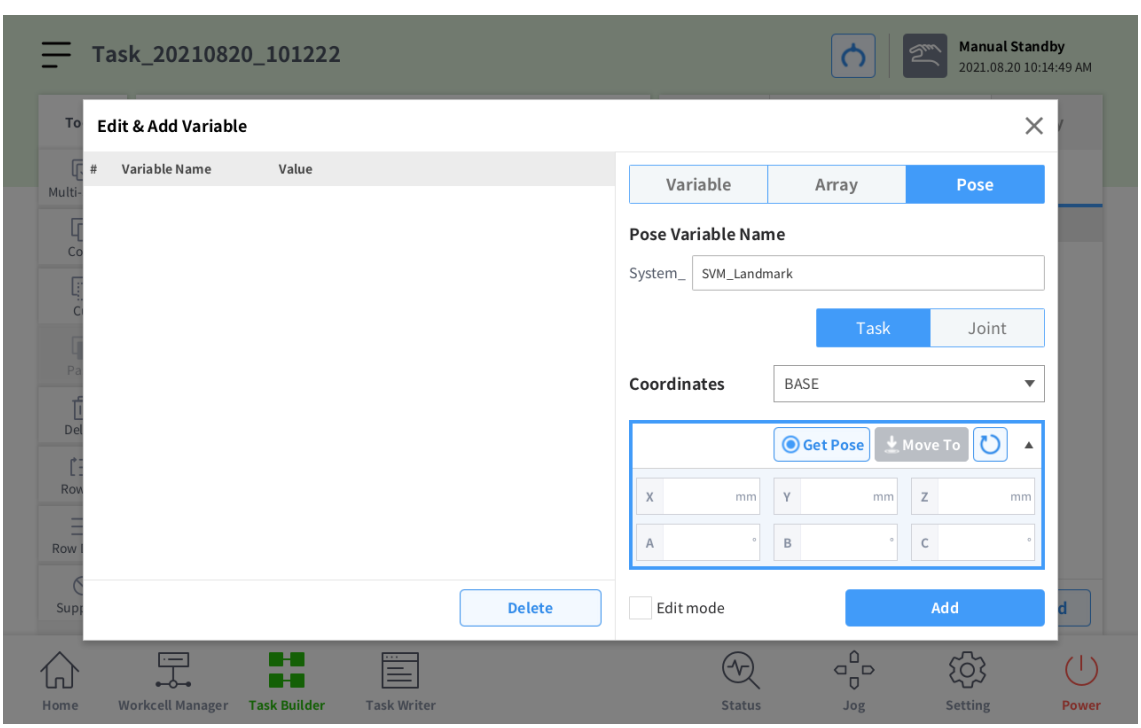
- The direction Euler angle type employed by Doosan Robotics is Euler ZYZ. Selecti ng the default value of Euler ZYZ allows immediate utilization for the Posx format used for MoveL, MoveB, etc.
- If you wish to convert to Euler XYZ in the options for the output of the coordinate s, additional coordinate system conversion calculations are necessary.



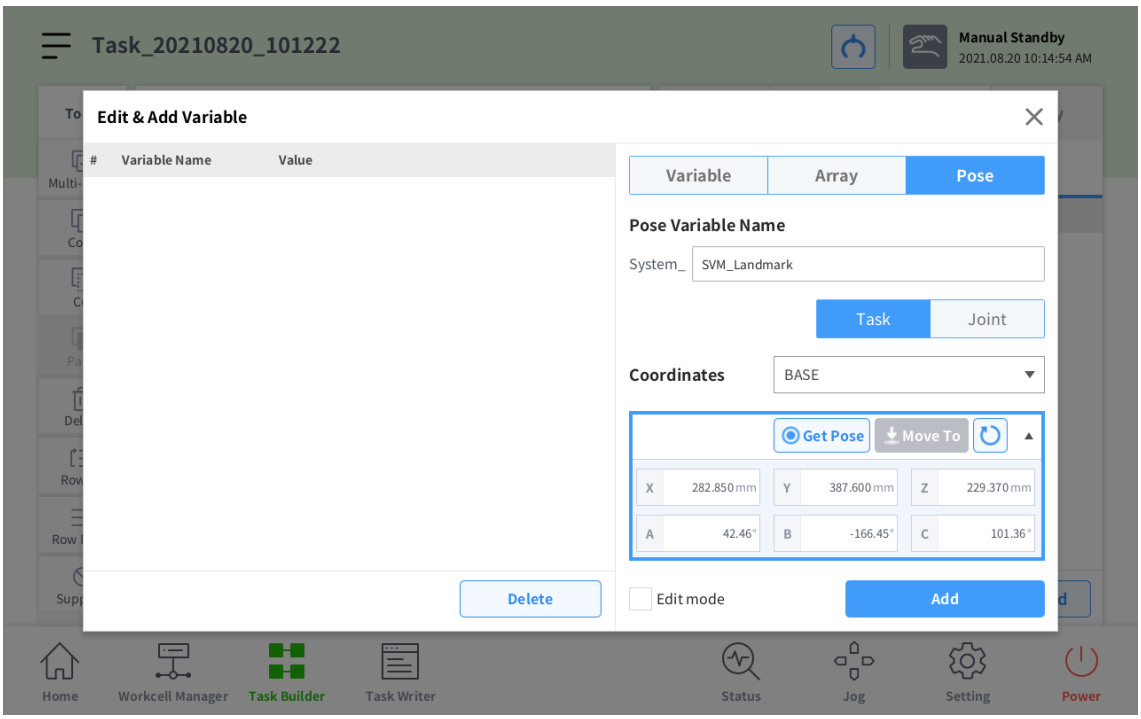
4. Click the Edit & Add button under the Variable Tab.

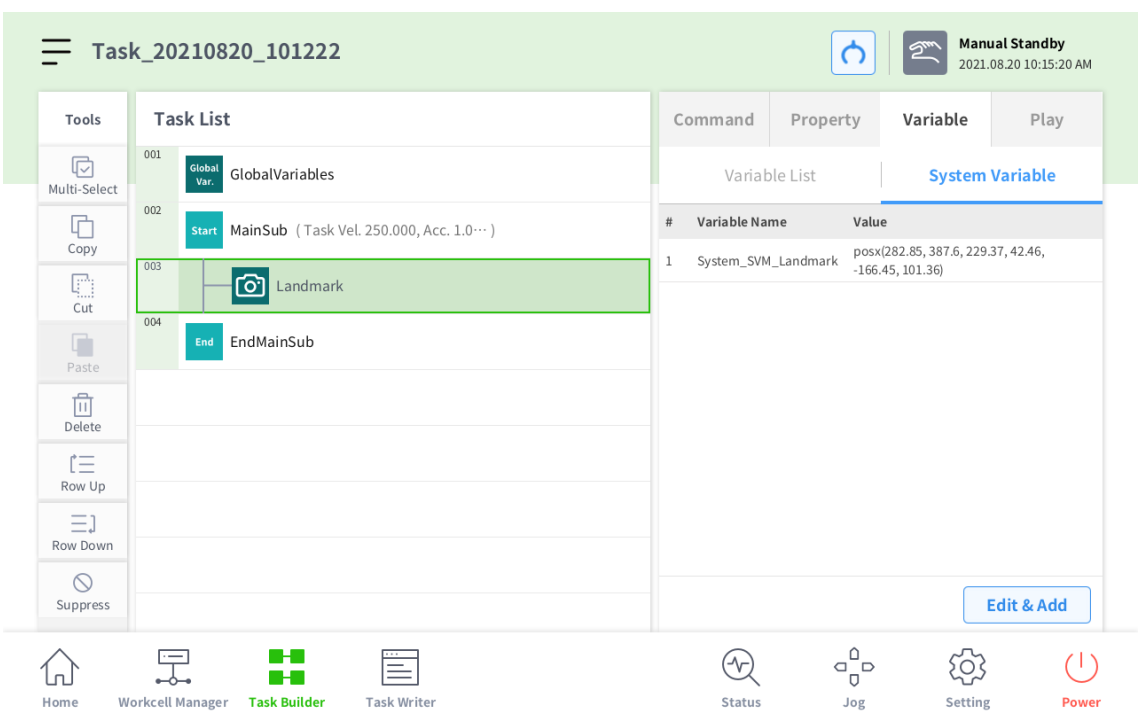


5. Add in System_SVM_Landmark.

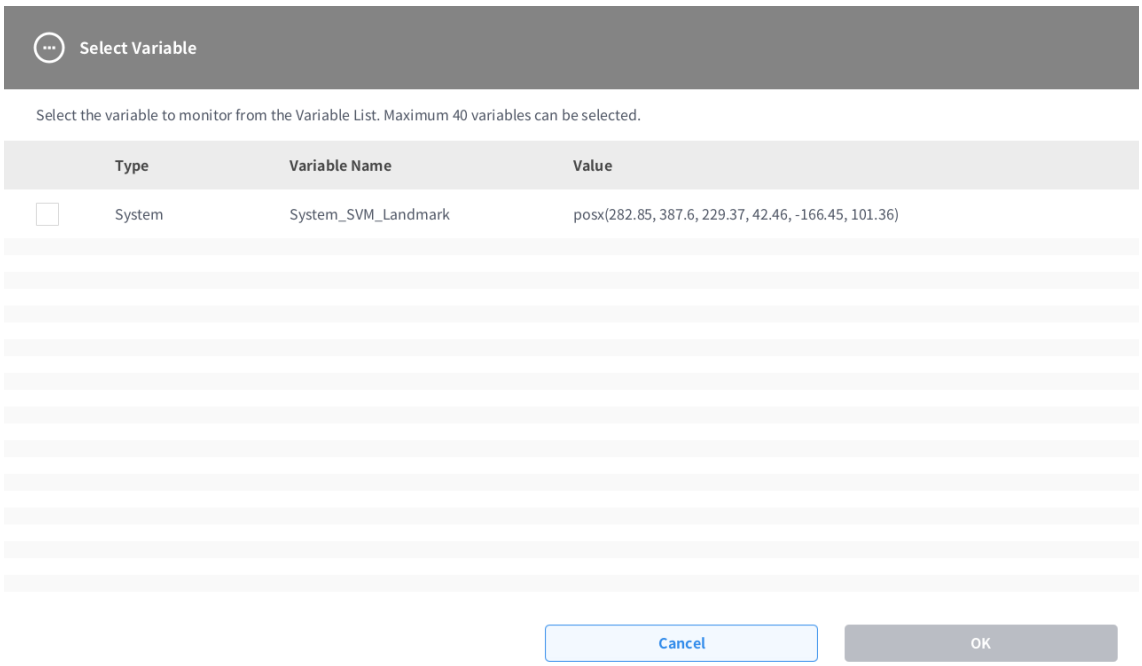


6. Press Get Pose. Pressing the Add button will add a variable.

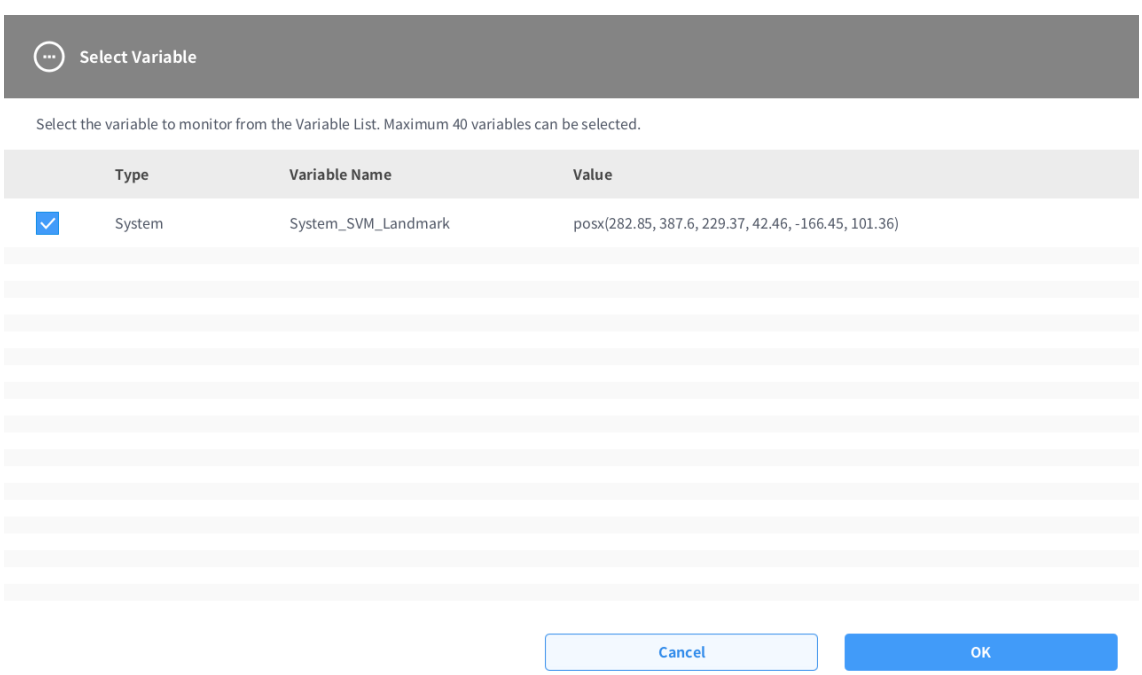


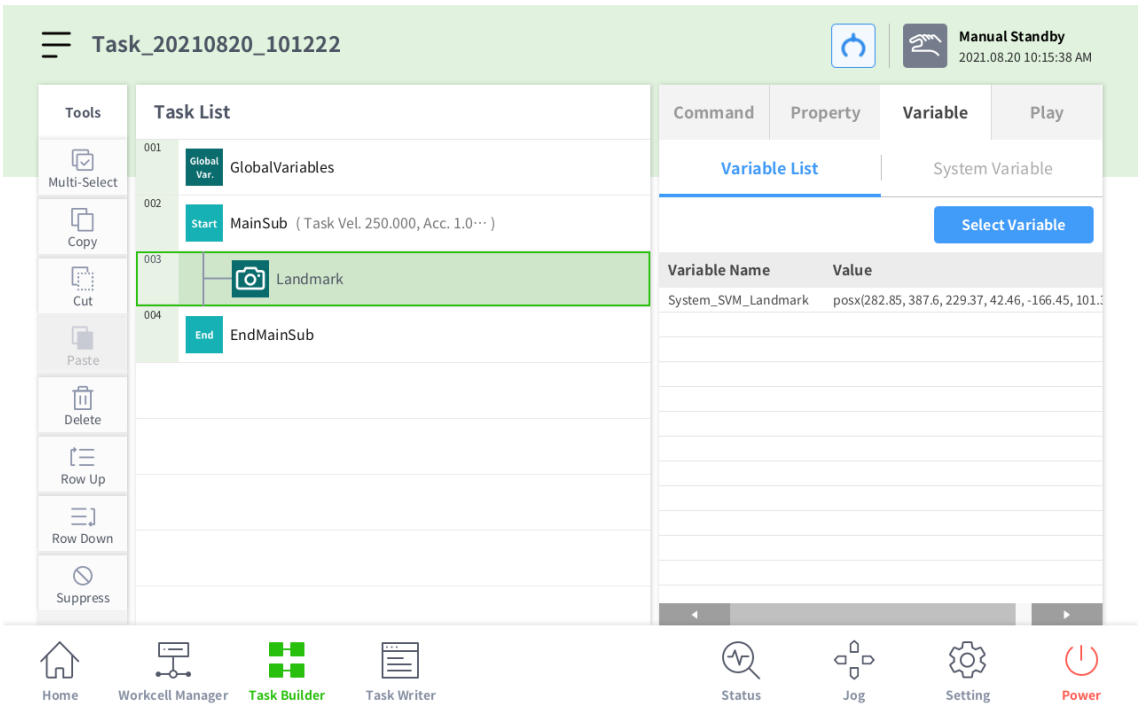


7. Close the window, press the Variable List button, then press the Variable.

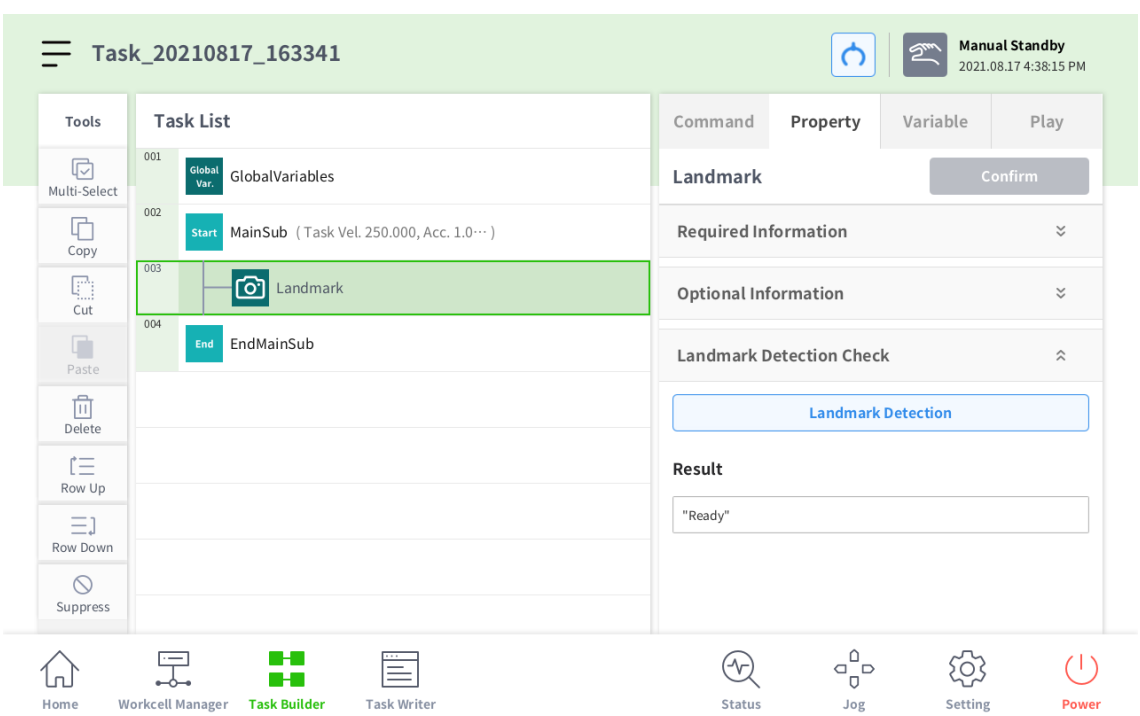


8. Check the System_SVM_Landmark checkbox and press Confirm to select the variable.

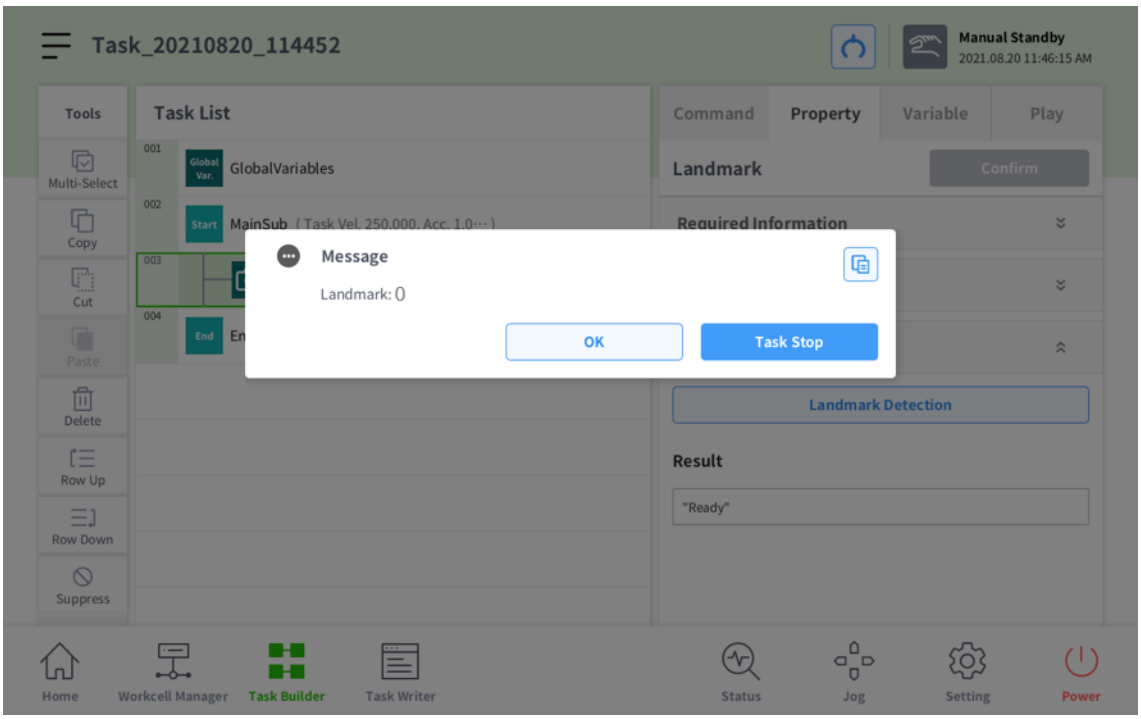




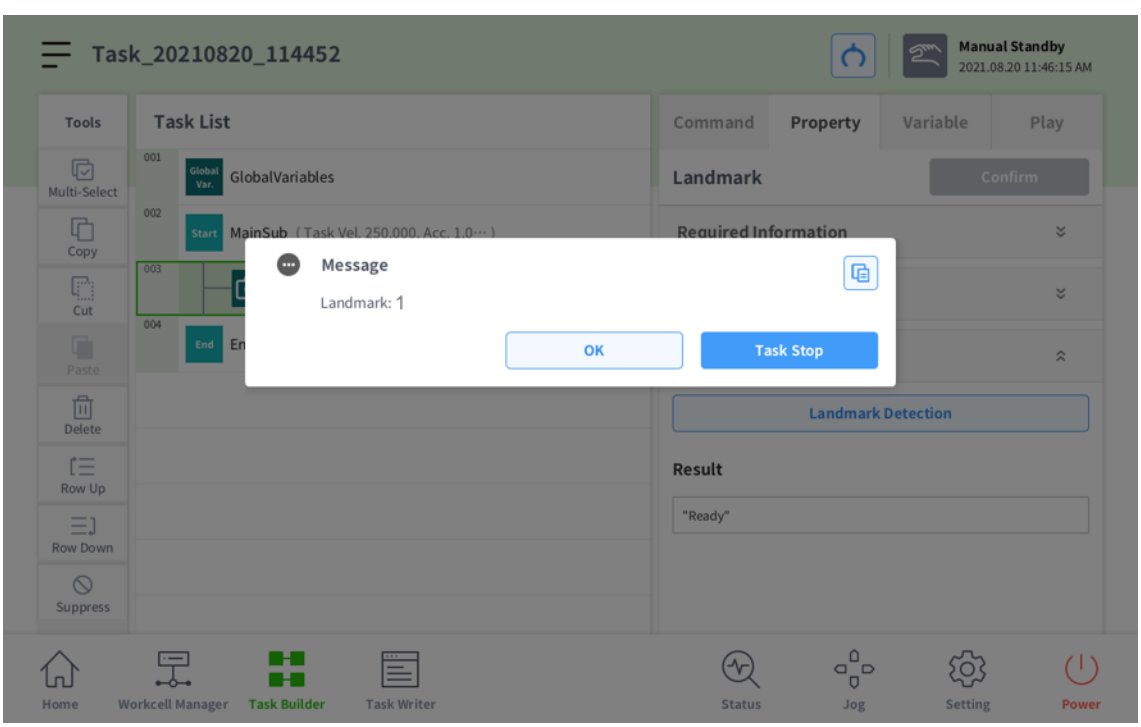
9. Use the Landmark Detection button to check that the values are normal.

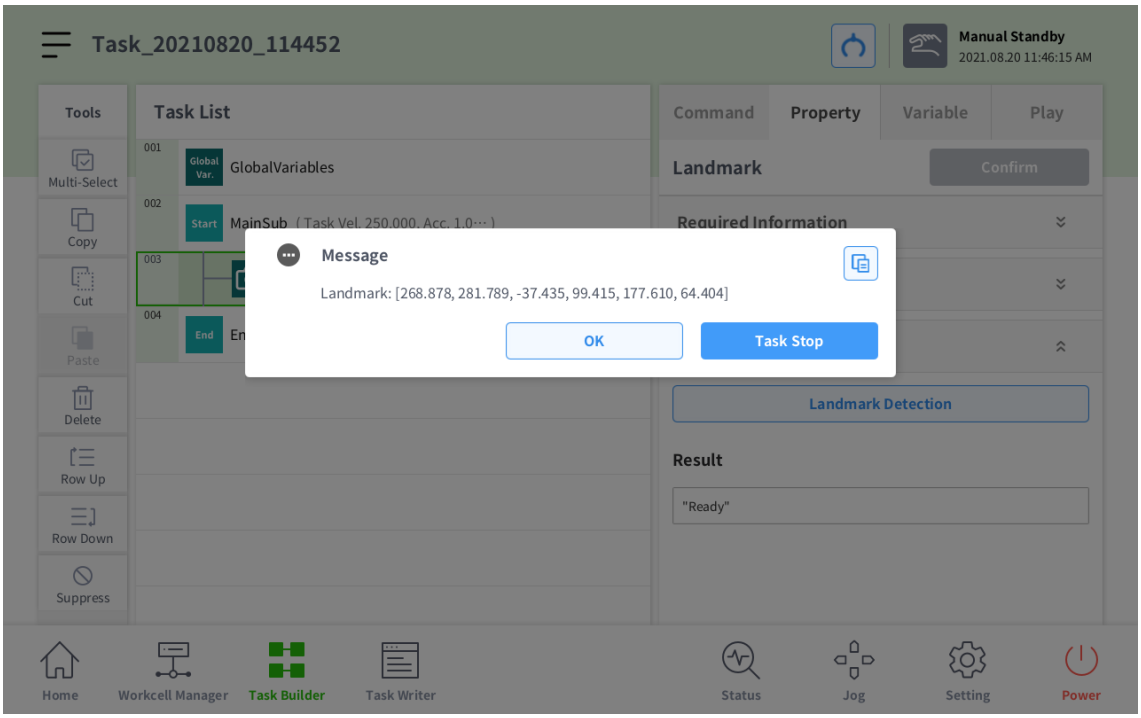


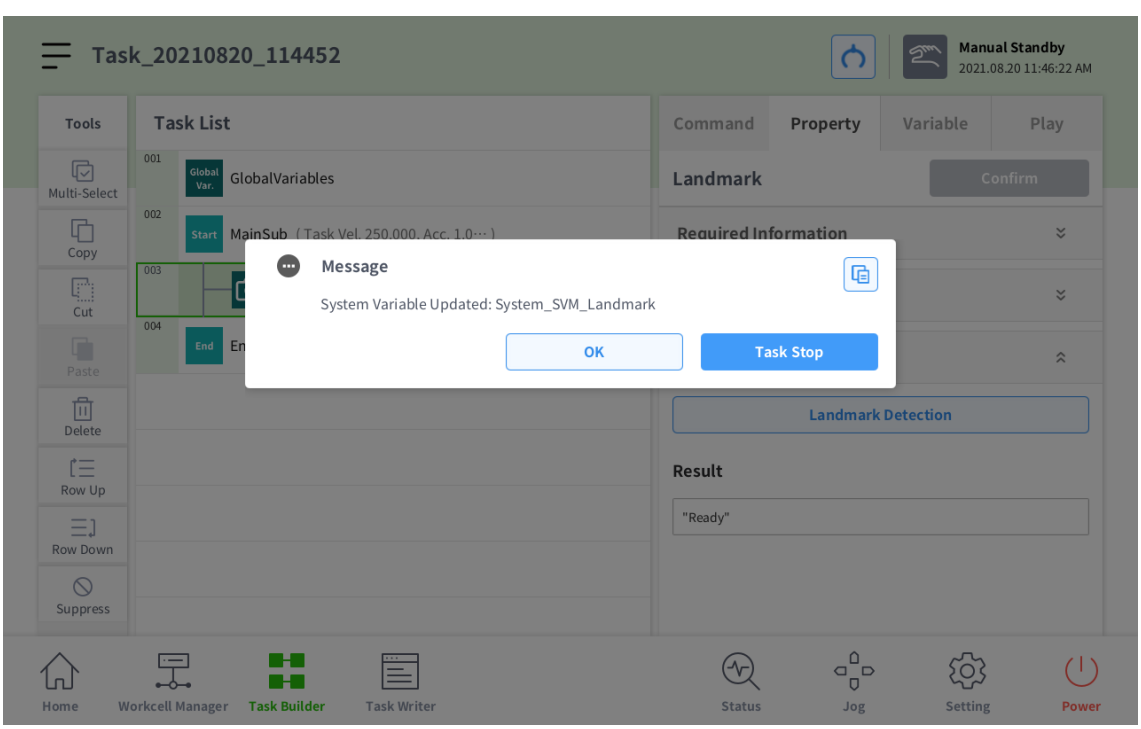
- In case of not detecting landmark:



- In case of detecting landmark:




Task_20210820_114452
Manual Standby
2021.08.20 11:46:15 AM
Tools
Task List
Command
Property
Variable
Play
Multi-Select
Copy
Cut
Paste
Delete
Row Up
Row Down
Suppress
001
GlobalVariables
002
MainSub (Task Vel. 250.000, Acc. 1.0···)
003
004
Landmark
Confirm
Required Information
Message
Landmark: [268.878, 281.789, -37.435, 99.415, 177.610, 64.404]
OK
Task Stop
Landmark Detection
Result
"Ready"
Home
Workcell Manager
Task Builder
Task Writer
Status
Jog
Setting
Power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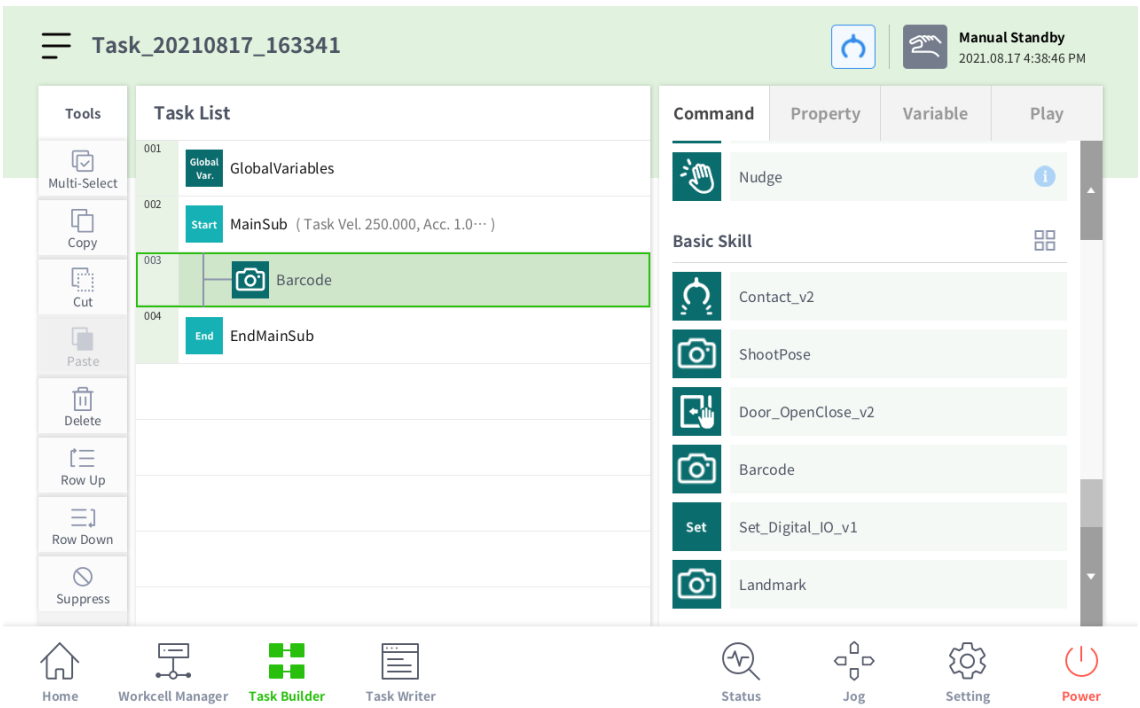
Manual Standby
2021.08.20 11:46:22 AM
Tools
Task List
Command
Property
Variable
Play
Multi-Select
Copy
Cut
Paste
Delete
Row Up
Row Down
Suppress
001
GlobalVariables
002
MainSub (Task Vel. 250.000, Acc. 1.0···)
003
004
Landmark
Confirm
Required Information
Message
System Variable Updated: System_SVM_Landmark
OK
Task Stop
Landmark Detection
Result
"Ready"
Home
Workcell Manager
Task Builder
Task Writer
Status
Jog
Setting
Power

3.7 Vision Skill: Using the Barcode Skill

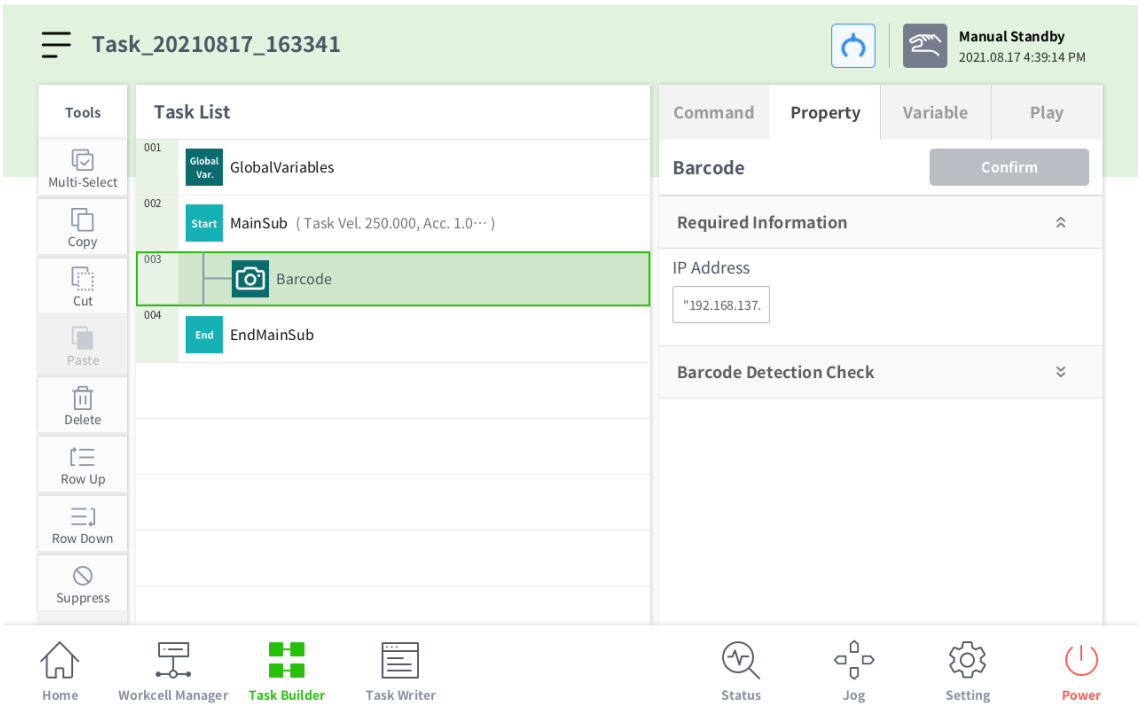
The Barcode skill is capable of detecting 1D/2D barcode data. You can compare barcode data already registered in the SVM with the currently detected barcode. Please use the Barcode skill freely.

In order to use the Barcode skill, you must first carry out barcode registration in Barcode Detection under the DART-Vision Detection tab and save the barcode data in the SVM. Please refer to the DART-Vision manual for instructions on barcode data registration.

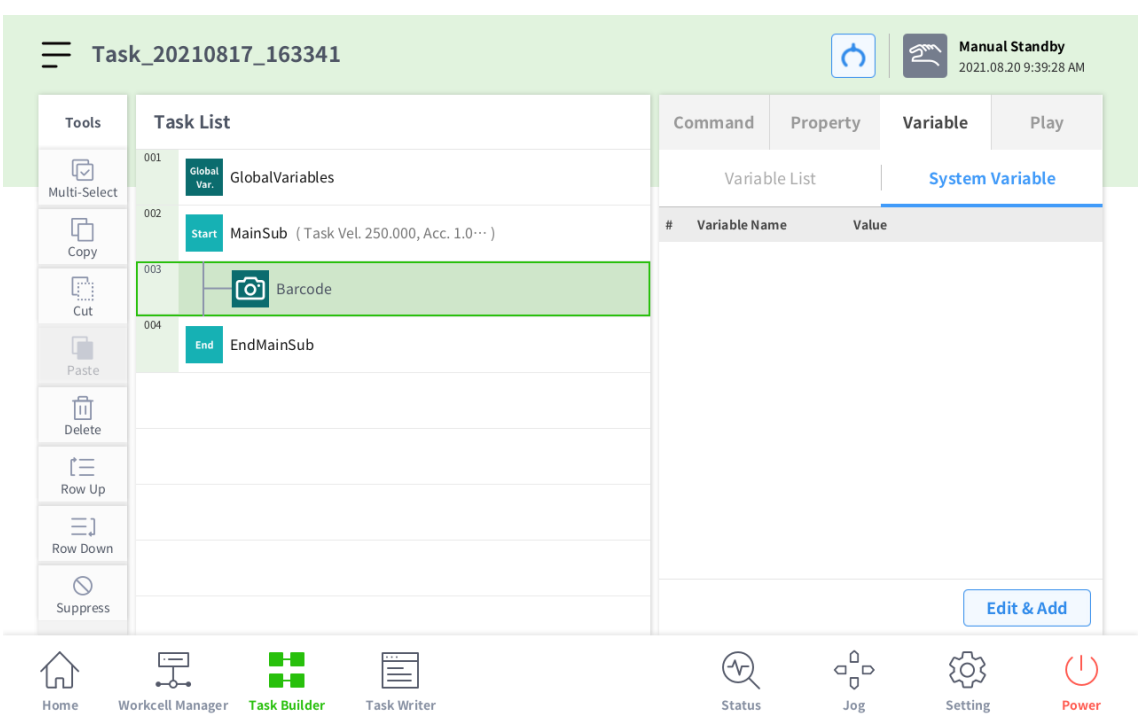
1. Click the Barcode button under the Command tab and add the Barcode skill.



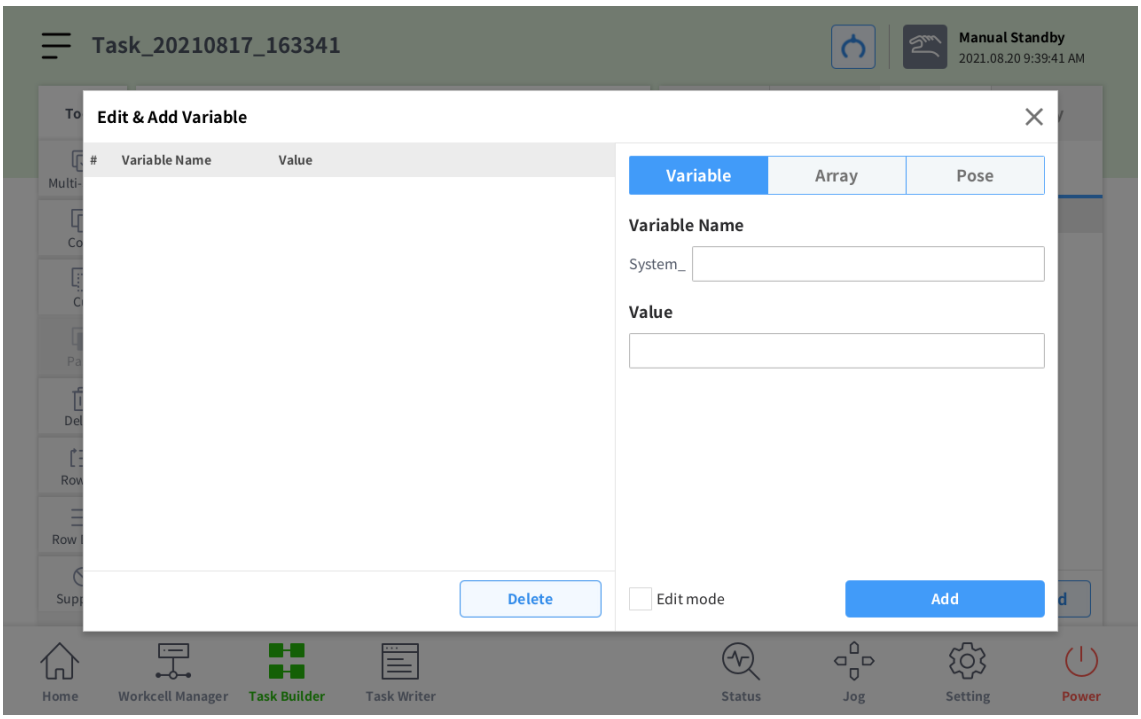
2. Open up Required Information in the Property Tab and input the IP Address and Job I D.

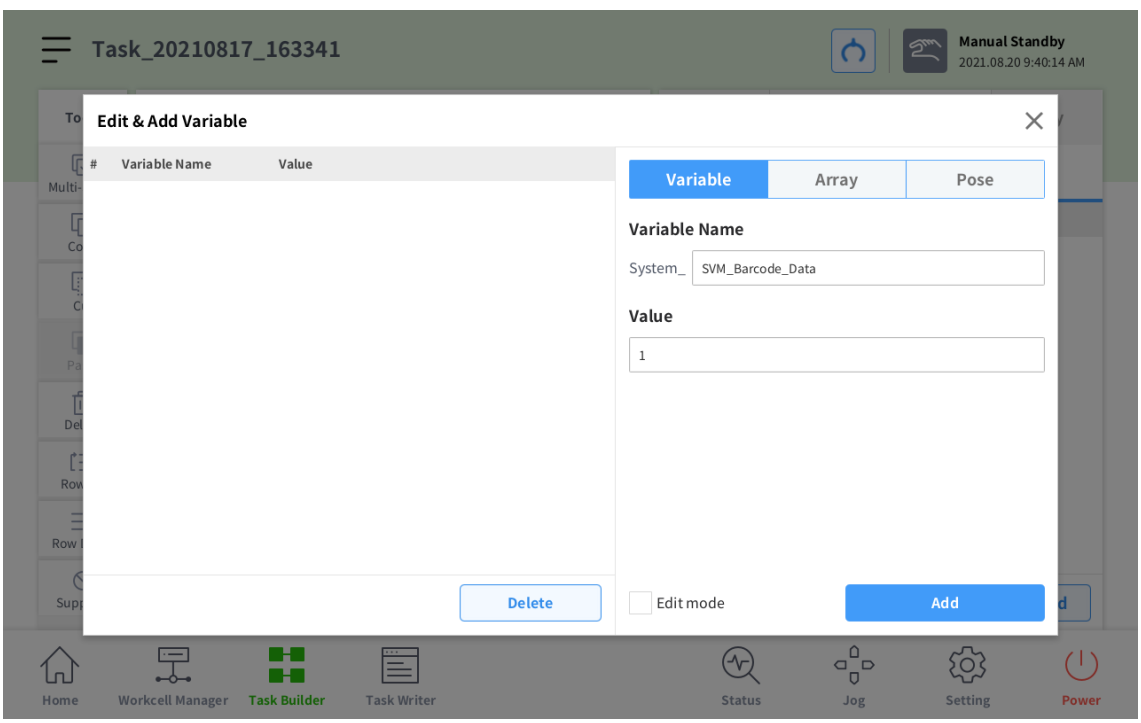


3. Click the Edit & Add button under the Variable Tab.

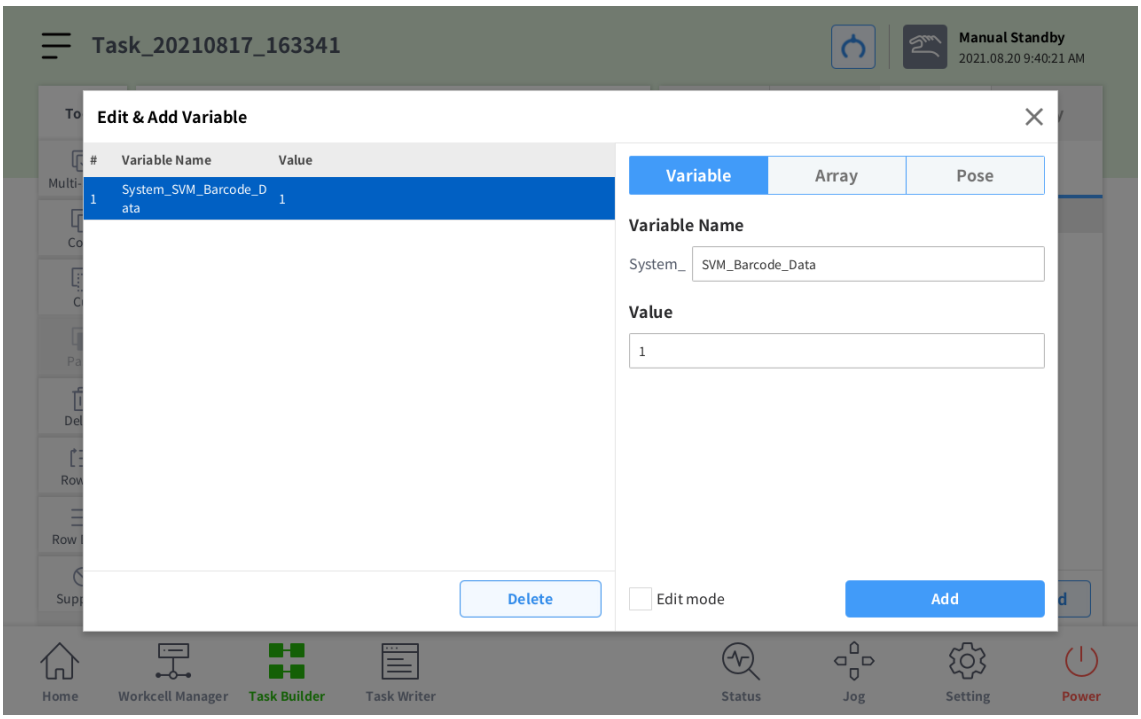


4. Click Variable, add System_SVM_Barcode_Data, and input the value.

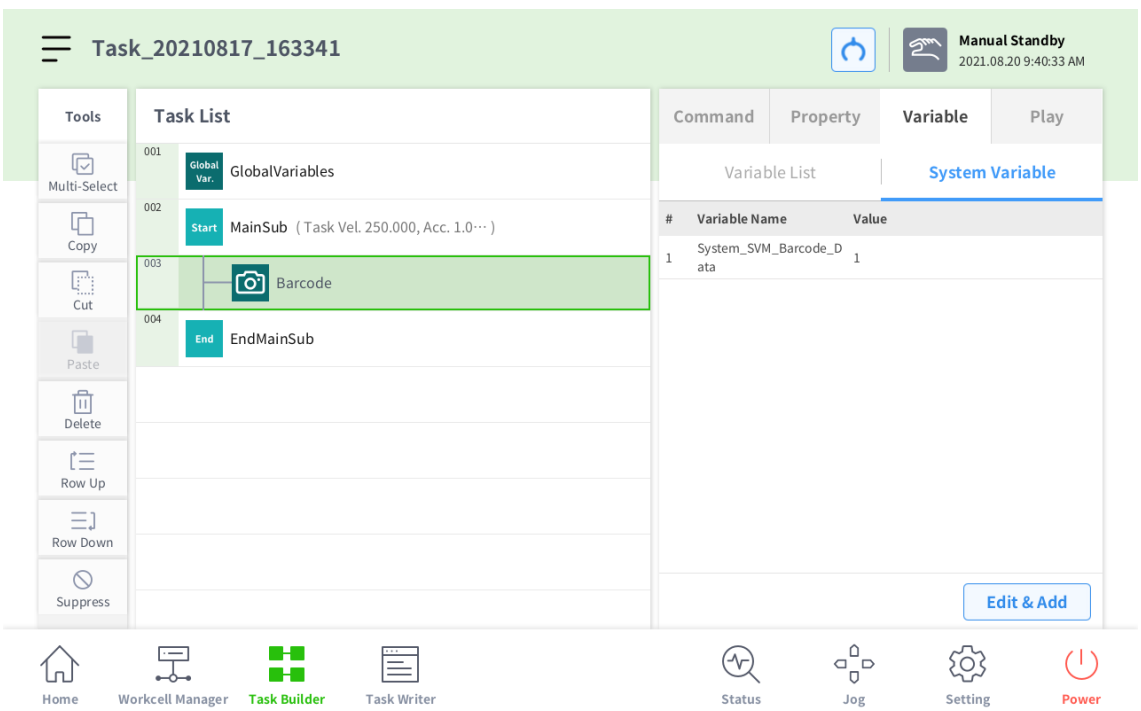


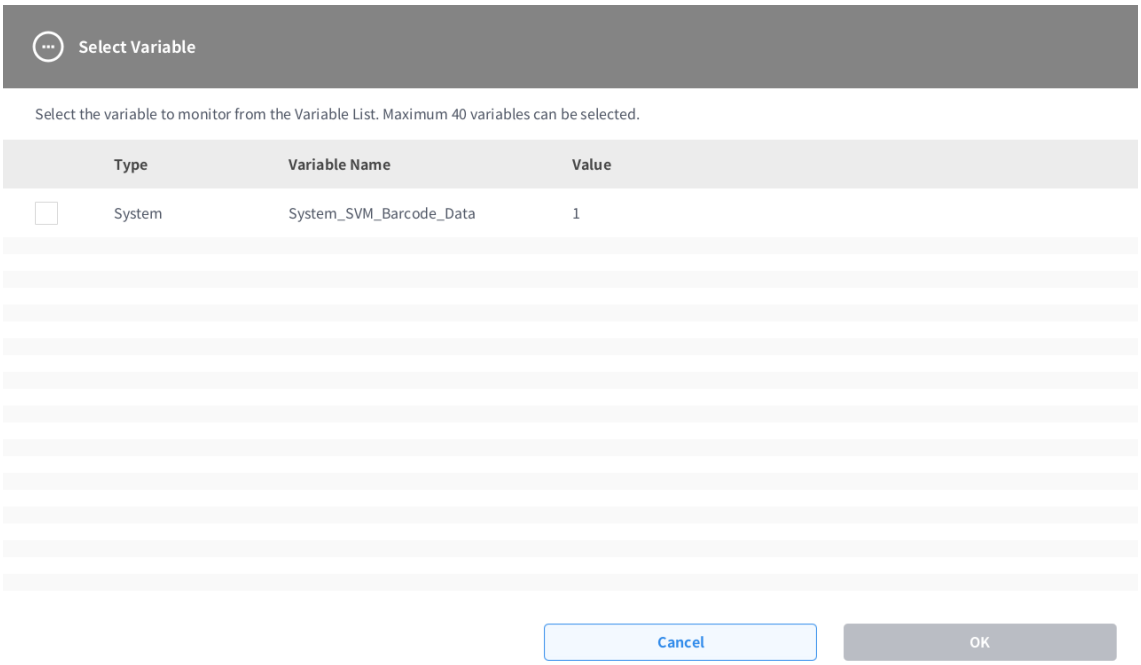


5. Click the Add button to add the variable.

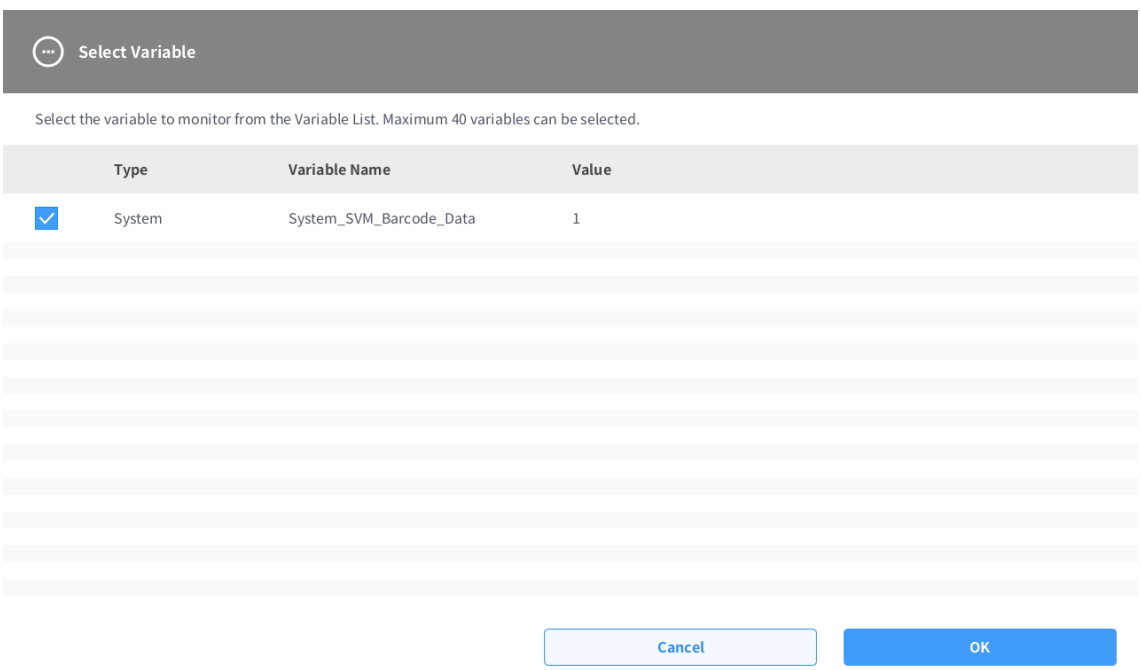


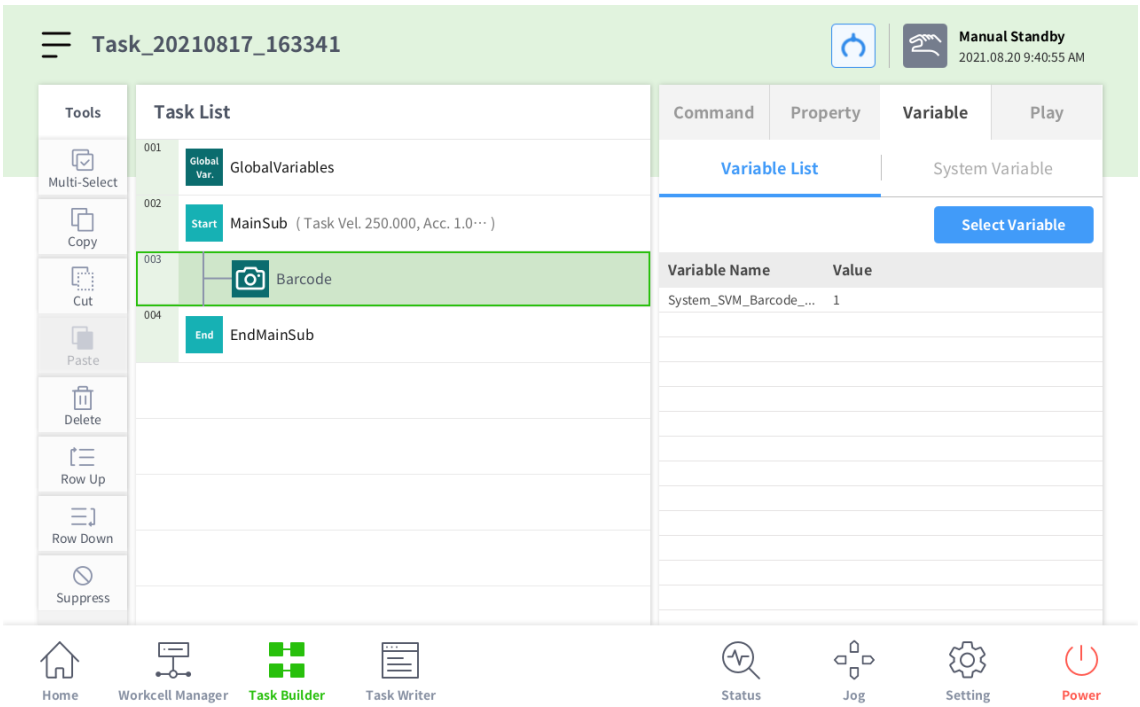
6. Close the window, press the Variable List button, then press the Variable.



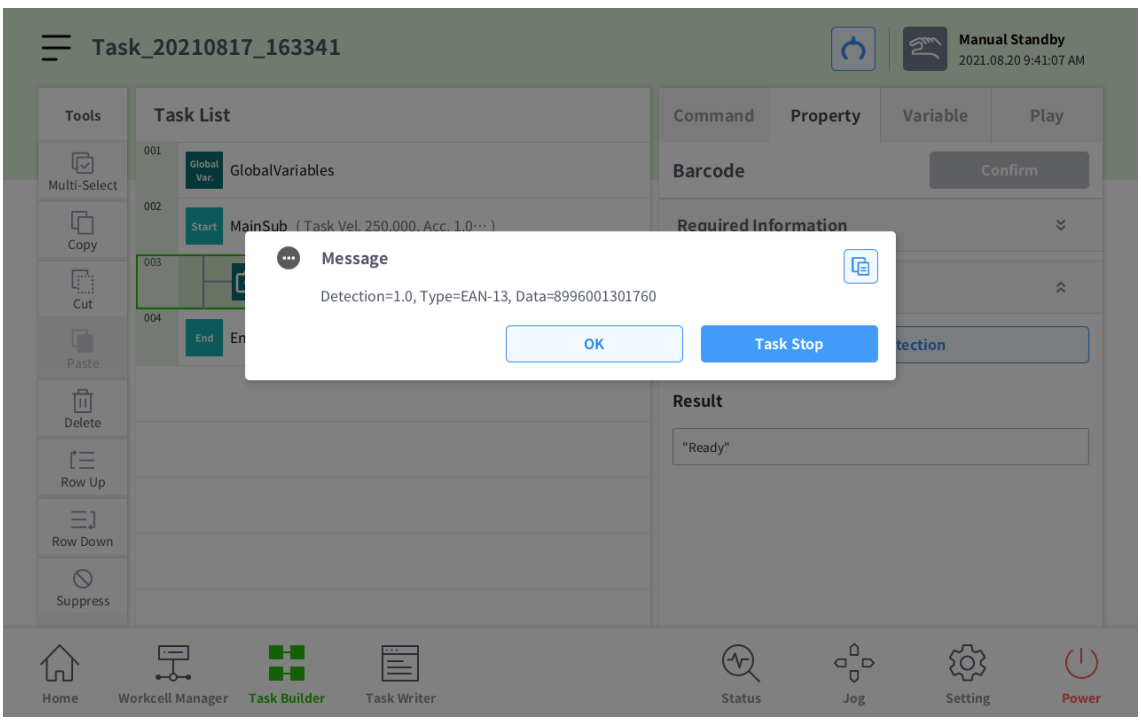


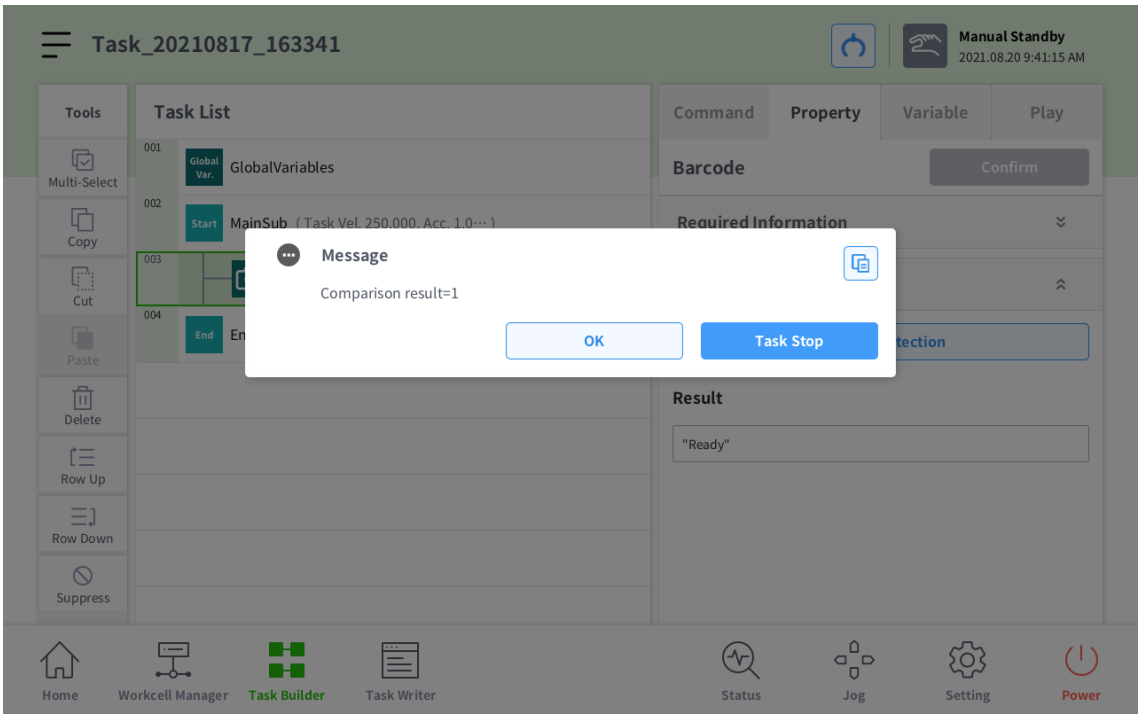
7. Check the System_SVM_Barcode_Data checkbox and press Confirm to select the Variable.

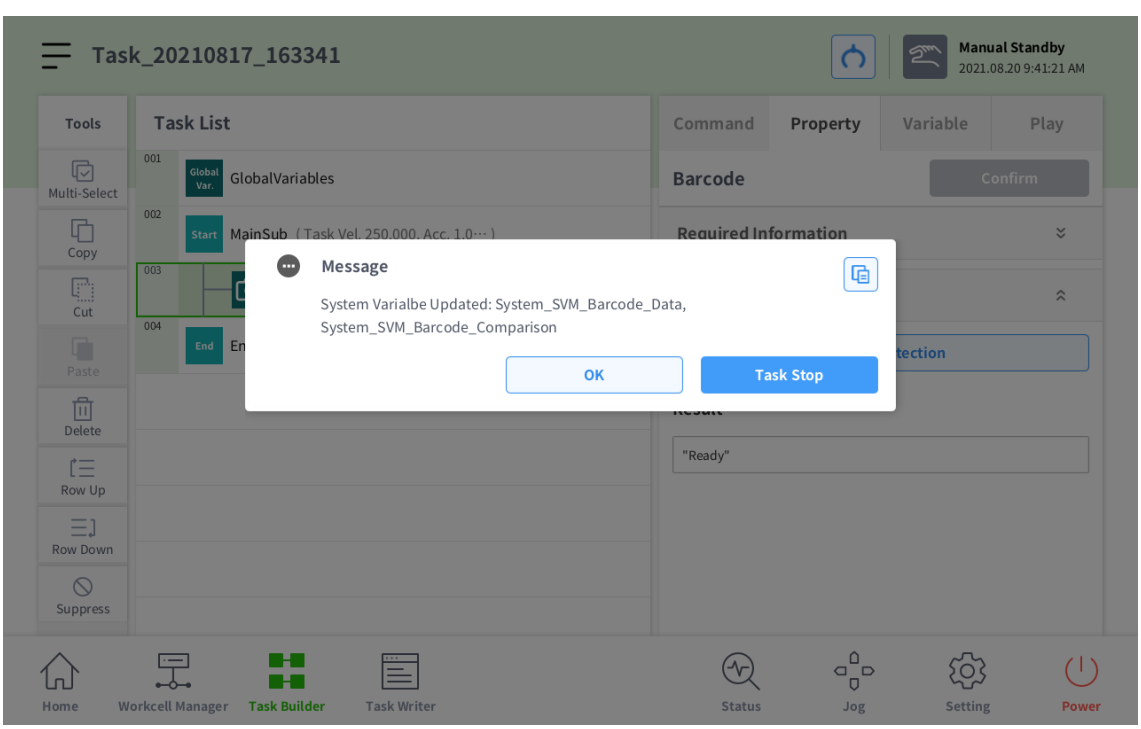




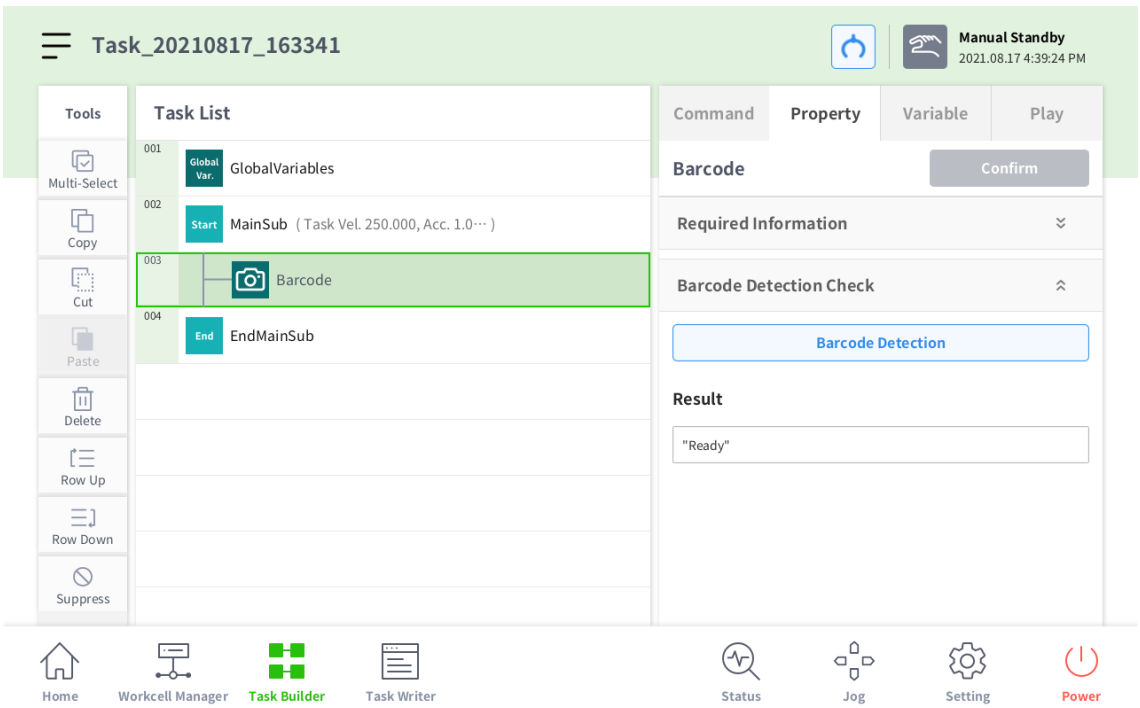
8. Open up Barcode Detection Check under the Property tab and click the Barcode Detecti on button.




Task_20210817_163341
Manual Standby
2021.08.20 9:41:15 AM
Tools
Task List
Command
Property
Variable
Play
Multi-Select
Copy
Cut
Paste
Delete
Row Up
Row Down
Suppress
001
GlobalVariables
002
MainSub (Task Vel. 250.000, Acc. 1.0···)
003
004
Barcode
Confirm
Required Information
Result
"Ready"
Message
Comparison result=1
OK
Task Stop
Home
Workcell Manager
Task Builder
Task Writer
Status
Jog
Setting
Power


Task_20210817_163341
Manual Standby
2021.08.20 9:41:21 AM
Tools
Task List
Command
Property
Variable
Play
Multi-Select
Copy
Cut
Paste
Delete
Row Up
Row Down
Suppress
001
GlobalVariables
002
MainSub (Task Vel. 250.000, Acc. 1.0···)
003
004
Barcode
Confirm
Required Information
"Ready"
Message
System Varialbe Updated: System_SVM_Barcode_Data,
System_SVM_Barcode_Comparison
OK
Task Stop
Home
Workcell Manager
Task Builder
Task Writer
Status
Jog
Setting
Power

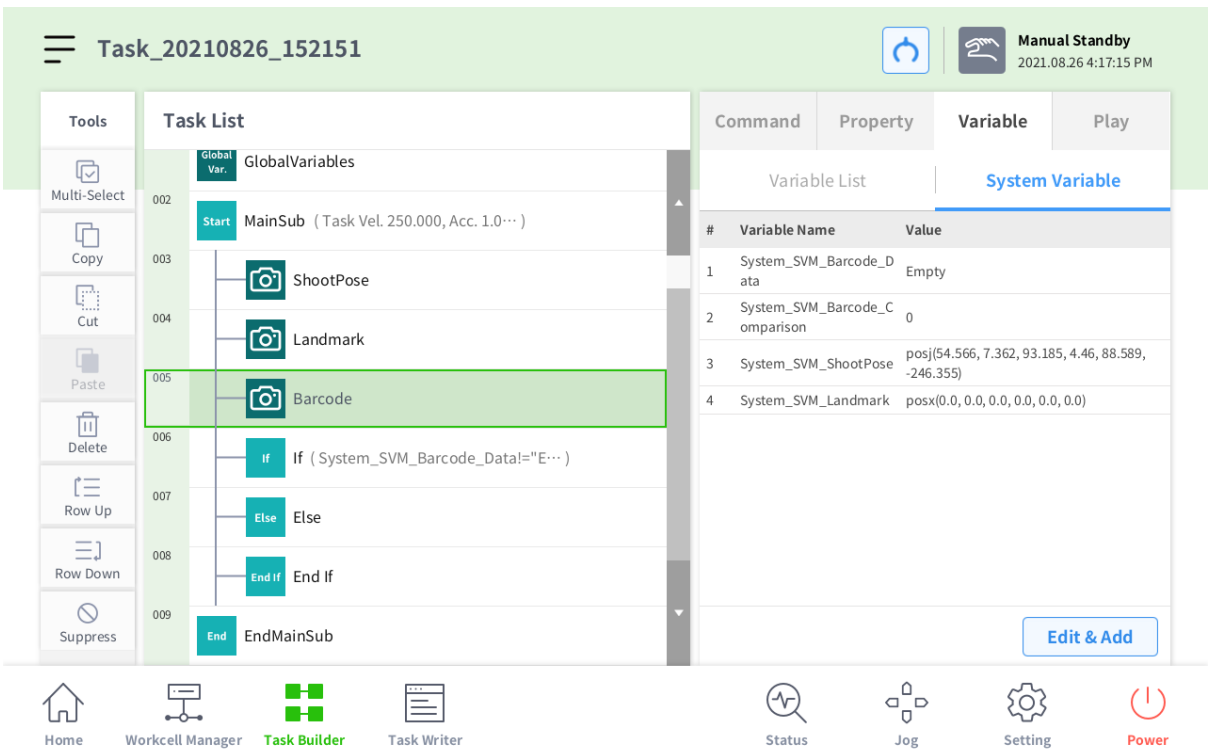
9. Use the Barcode Detection button to check that the values are normal.



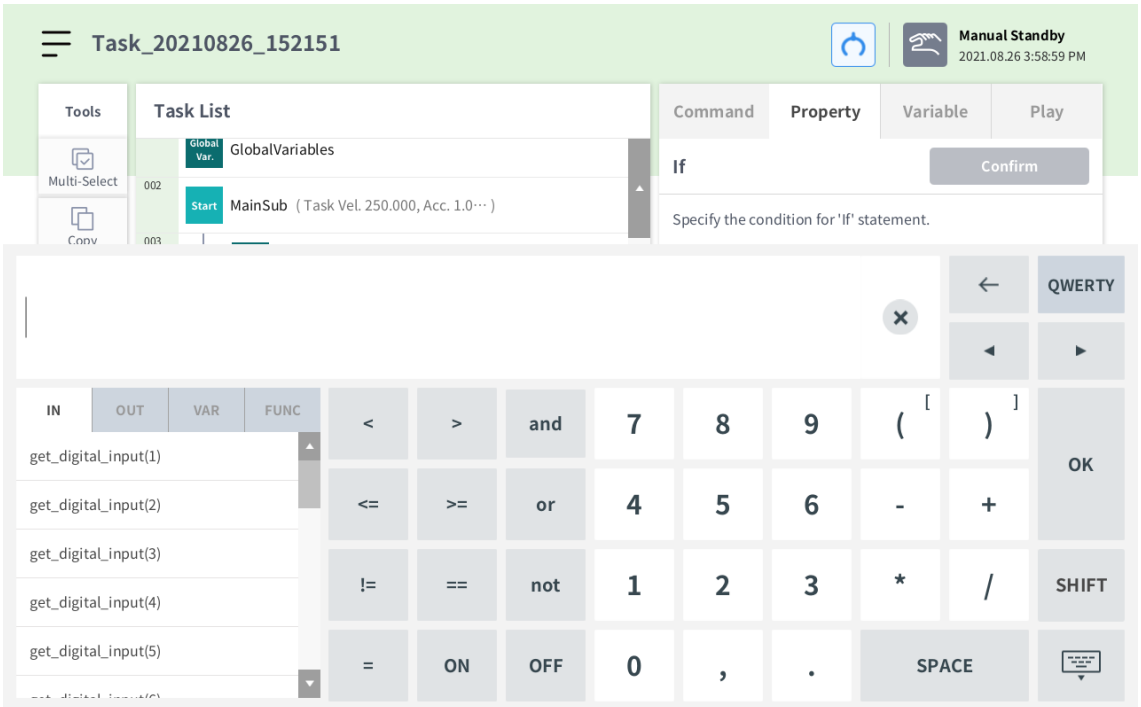
3.8 Vision Skill: Utilizing IF statements

In order to utilize the Vision Skill, the system parameters including System_SVM_ShootPose, System_SVM_Landmark, System_SVM_Barcode_Data, and System_SVM_Barcode_Comparison must be utilized.

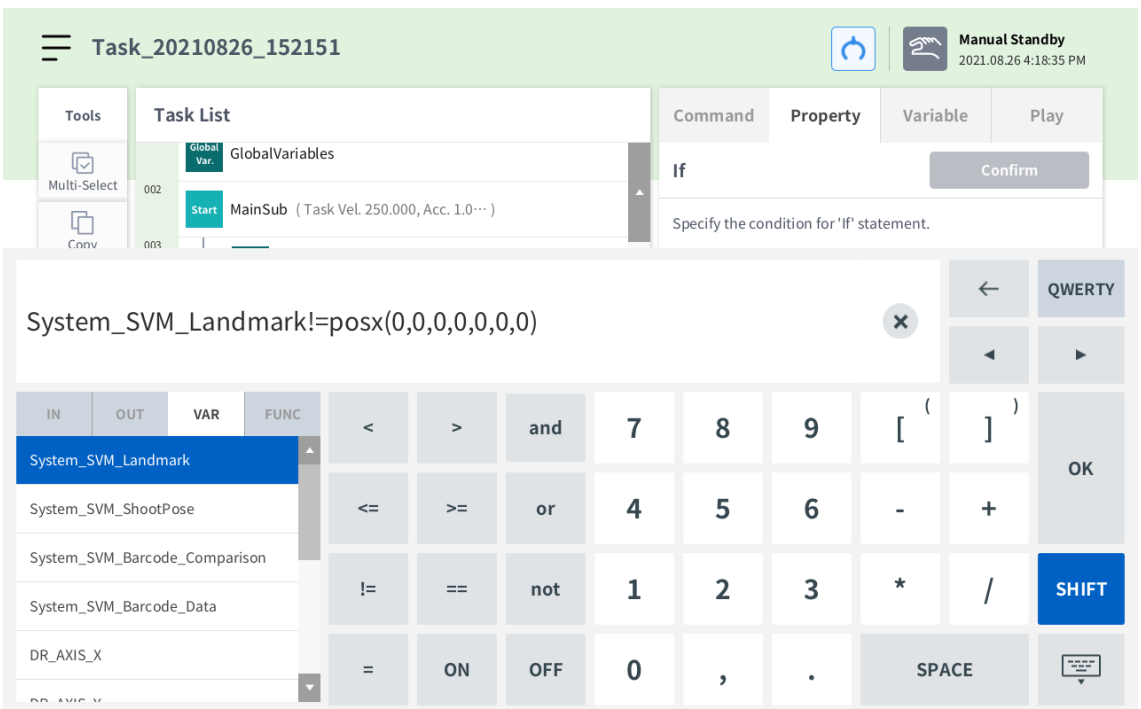
- System_SVM_ShootPose cannot be used without calibration.
- System_SVM_Landmark will be output as posx(0,0,0,0,0,0) if no detection occurs.
- System_SVM_Barcode_Data will be output as Empty if no detection occurs.
- System_SVM_Barcode_Comparison will be output at 0 if no values are saved in the SVM, or 1 otherwise.



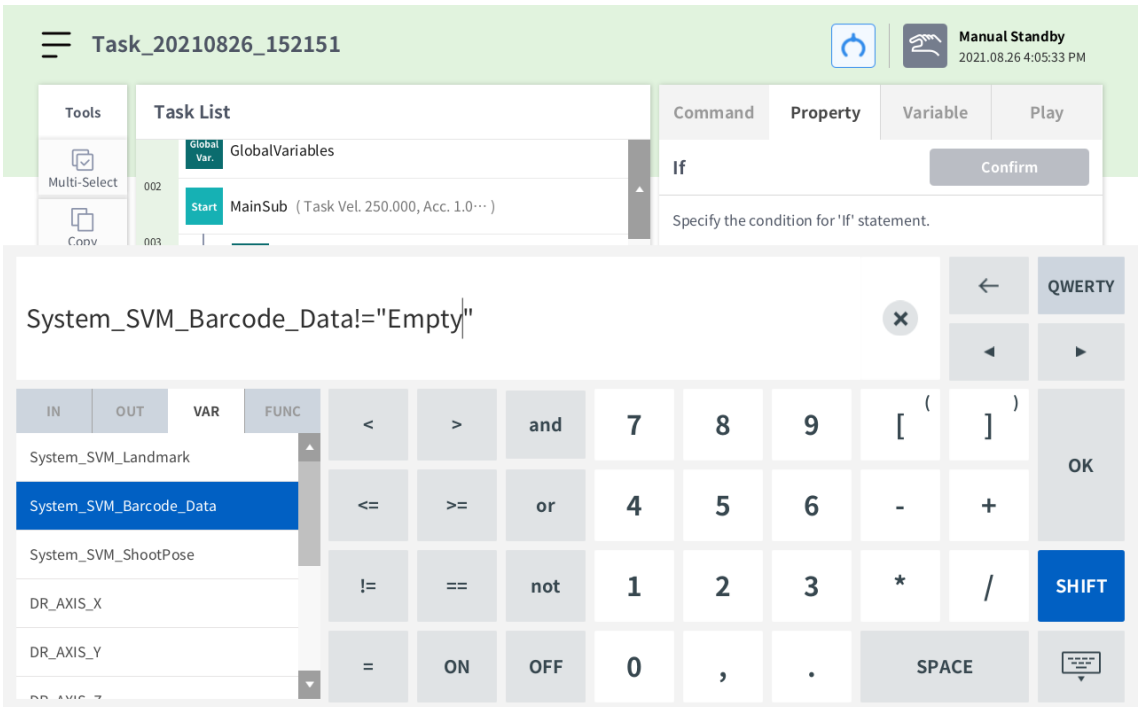
1. You can add an IF statement under Command and system parameters in VAR under Property.



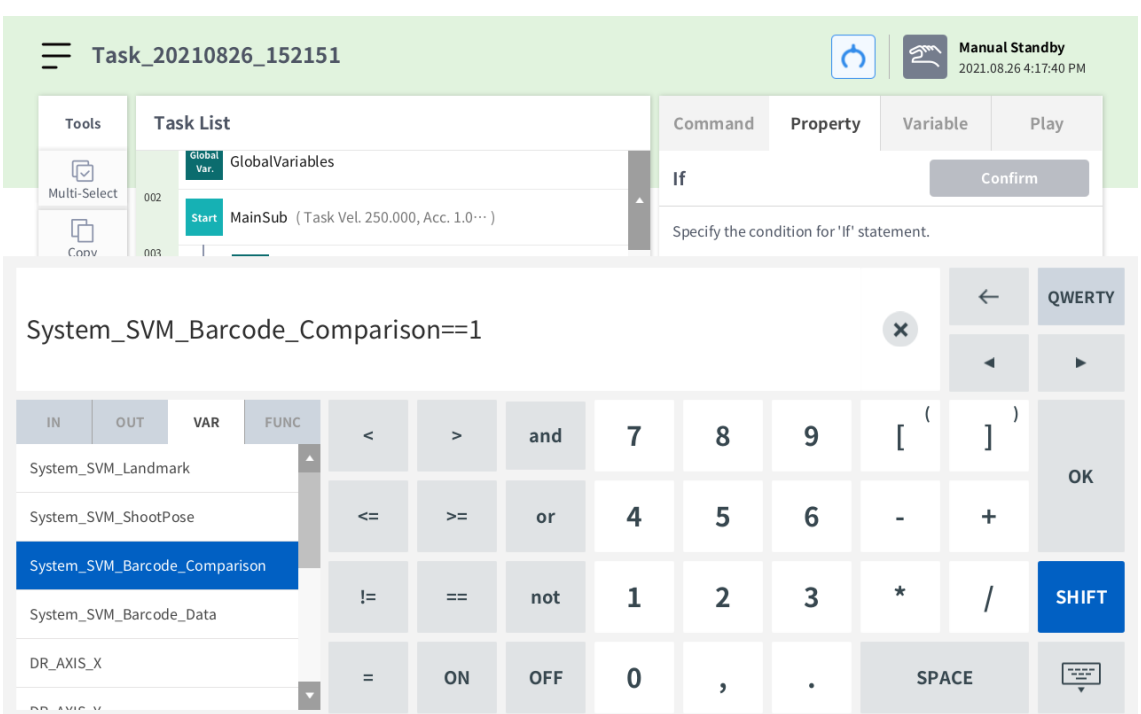
2. In the case of System_SVM_Landmark, the output will be posx(0,0,0,0,0,0) if no detection occurs. This should be dealt with as shown below.



3. In the case of System_SVM_Barcode_Data, the output will be Empty if no detection occurs. This should be dealt with as shown below.



4. In the case of System_SVM_Barcode_Comprison, 1 will be output if there is data in the SVM. This should be dealt with as shown below.



4. Product Specifications

Dimensions (W x D x H)	92 mm X 132 mm X 25.6 mm
Weight	348 g
Resolution	CMOS 2.5 M pixel (1920 X 1440)
Camera	Manual Focus
Brightness	White LED X 2 EA (800 Lux@WD500 mm)
Communication	TCP/IP, 100 Mbps
Power	24 W (24 V, 1 A)

4.1 Measurement Distance

The camera measurement area varies according to the distance from the camera. The measurement area of the camera according to distance is as follows: If the distance is shorter than the recommended distance or the camera is outside the measurement area, the measurement accuracy will decrease or there may be misrecognition. When used in areas outside the measurement areas below, configure the work area after performing a sufficient number of tests.

Distance from the Camera (mm)		300	400	500	600
Measurement Area	W (Horizontal)	300	396	494	593
	D (Vertical)	220	293	367	440
Length / 1pixel (mm)		0.19	0.25	0.319	0.384

4.2 Size and Height of Measuring Items

The size of items to measure is limited by the size of the measurement area according to distance, and the system recognizes items with a size from 10% to 70% of the measurement area.

Distance from the Camera (mm)		300	400	500	600
Size of Item	Min. (WxH)	30x22	40x29	49x37	59x44
	Max. (WxH)	180x130	238x176	296x220	356x264
Max. Height of Item		22	29	37	44

All 2D Visions, including Vision by Doosan Robotics, can have misrecognition due to distortions created by perspective view. The maximum height of the item to be measured is recommended to not exceed the smallest surface dimension. Even if the measurement height is lower than the maximum height, misrecognitions can still occur due to perspective views created according to the camera view, and if the view is close to Top View, misrecognitions can be minimized even if the measurement height is higher than the maximum height.

4.3 Measuring Item and Background

Light reflected by surfaces of the measuring item or the background can cause misrecognition and hinder measurement accuracy. Also, if the measuring item and background have similar colors, this can also cause misrecognition and hinder measurement accuracy.

Part 4
Conveyor Tracking

1. Precautions Before Use

- Currently, only the Linear Conveyor is supported.
- One robot can support up to two conveyors.
- When connecting one conveyor, it is necessary to have one encoder, which can measure the traveling distance of the conveyor, and one triggering switch, which detects objects passing through a particular starting point.
- The encoder signal and triggering switch can only be used in one robot. In other words, one conveyor cannot be connected to more than two robots.
- The encoder and triggering switch are connected to the encoder terminals (TBEN1, TBEN2) of the controller. Connect the encoder with A phase or A/B phase depending on the specifications, and connect the triggering switch to S phase. For details about sensor selection and connection, refer to Installation Manual 4.2.6.
- The encoder resolution is selected by taking into account the resolution of the encoder itself and every reduction ratio from encoder input up to workpiece traveling mechanism. Select an encoder resolution that allows the entire system resolution to be at least 5000 count/m. If the entire system resolution is greater than 10000 count/m, there is no point in upgrading system performance.
- If the above recommended resolution is maintained, the conveyor speed supports a range of 10 mm/s ~ 500 mm/s.
- All task motions are supported during conveyor tracking. However, Absolute motion only allows Base, World and Conveyor Coordinates, and Relative motion allows all.
- The Compliance Control command can be executed during conveyor tracking.
- In the current version, the Force Control command cannot be executed during conveyor tracking.
- If no task motion is present during Conveyor Tracking, both Set Tool Weight and Set Tool Center Position commands are allowed.
- A pattern cannot be added from a skill during conveyor tracking. Skills requiring skill and force control integrated with the machine/boltfeeder are not supported. The skill functions Contact Sensing or Force Control are not supported.
    - Skills not supported:
        - ◆ Skills including the machine/boltfeeder: INTLK_Pick, INTLK_Place, PickBolt
        - ◆ Skills requiring Force Control: Insert, Contact

2. Settings with Workcell Manager (WCI)

Set the external encoder in the Workcell Manager, check the hardware connection and signal settings, and set the conveyor tracker.

2.1 External Encoder Settings

The external encoder sets the encoder channel according to the encoder connection, sets the A-B phase according to the encoder specification, and sets the S Phase mode according to the triggering switch sensor specifications and configurations.

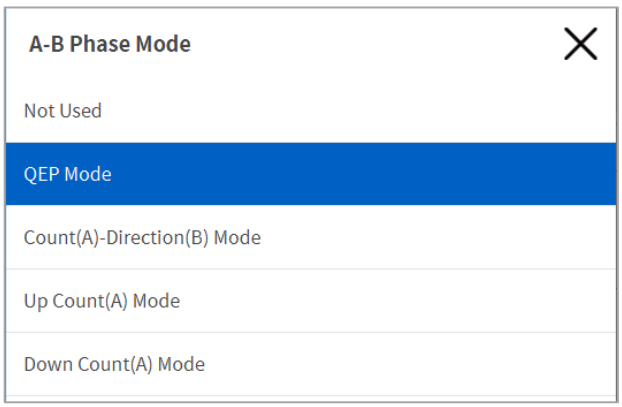
2.1.1 Encoder Channel Settings

Up to two encoder channels can be set. Check the port connected to the controller and set the channel.

2.1.2 A-B Phase Mode Settings

Set the A-B Phase. The A-B phase is a channel related to the encoder resolution. If the encoder supports two channels, a connection is made to the A-B phase, but if the encoder only supports one channel, the connection is made to the A phase.

There are four options in the A-B Phase Settings. QEP mode and Count(A)-Direction(B) mode are options that use two channels, and Up Count(A) mode and Down Count(A) mode are options that use 1 channel.

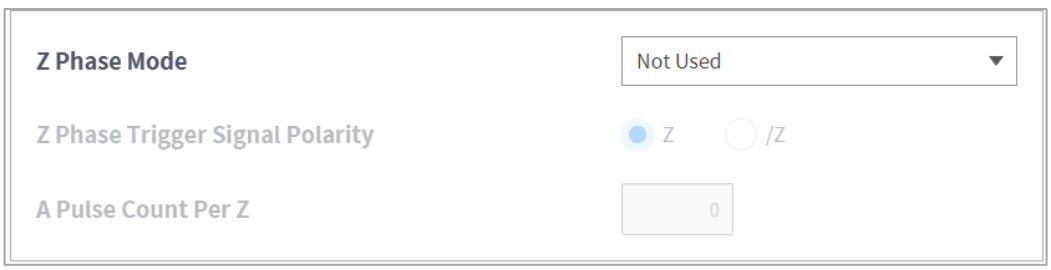


A-B Phase Mode	Description
QEP Mode	Quadrature Encoder Pulse Mode. This combines the counts of channels A and B to expand the resolution by four times. For example, if A and B phases have 500 counts each, the overall resolution will be 2000 = 500×4 counts.
Count(A)-Direction(B) Mode	A phase is an option for counts, and B phase is an option determining the direction. Depending on the high/low status of the B phase, the count of the A phase is adjusted up or down.
Up Count(A) Mode	This uses the A phase signal as an up count.
Down Count(A) Mode	This uses the A phase signal as a down count.

The A Phase Polarity and B Phase Polarity settings determine whether to use each phase as is or in reverse. Reversing each phase can change the up and down counts, so if changing the direction is the objective, using Inverse mode allows more intuitive settings.

2.1.3 Z Phase Mode Setting

Z Phase mode uses the Z phase signal to compensate the encoder count. Conveyor tracking uses the incrementation of the encoder rather than its absolute value, so Z Phase mode is normally not used.



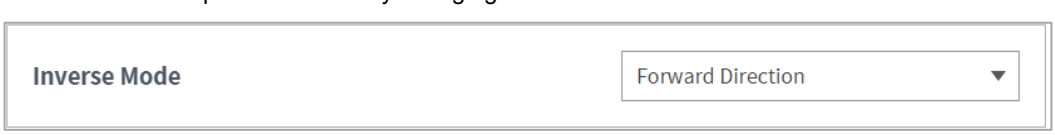
2.1.4 S Phase Mode Settings

The S Phase is the channel connected to the triggering switch. This sets the Encoder Count as 0 if an object passes the triggering switch and triggers Sensing when count clear mode is set.

The S phase trigger signal polarity determines which edge of the S phase signal will execute clearing.

2.1.5 Inverse Mode Settings

Inverse mode is capable of intuitively changing the count direction forward/backward.

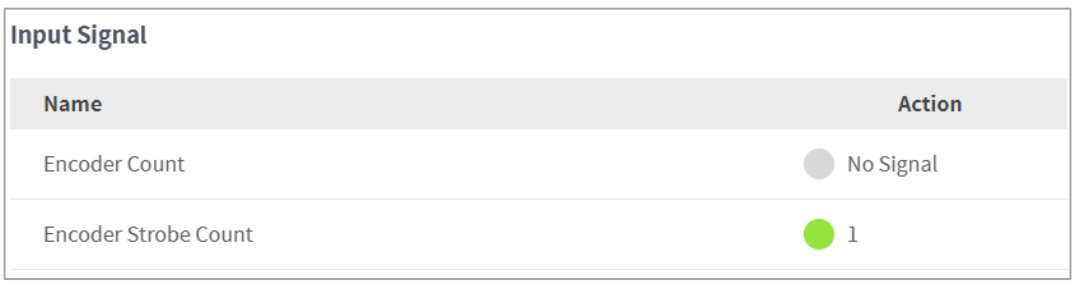


2.1.6 Setting Check

After setting is complete, check the setting while operating the conveyor. Monitor the input signal to monitor the encoder count increase or decrease as the conveyor moves. The encoder count is only displayed in positive numbers from 0 to the maximum value. While it is not mandatory, it is recommended that the count be set to increase as the conveyor moves.

Encoder Strobe Count is a counter that increases each time an item is detected by the triggering switch. Block the triggering switch and check whether the accumulative count increases and the encoder count decreases to 0 at the desired edge.

Ideally, the encoder strobe count of the corresponding edge shall only increase by 1. However, there are cases where multiple counts are made at the edge due to signal noise. It is possible to compensate for such multiple counts accumulated at the edge with triggering_mute_time during conveyor tracking, but as noise can also influence the encoder count, it is recommended that the cause be eliminated by checking the hardware.



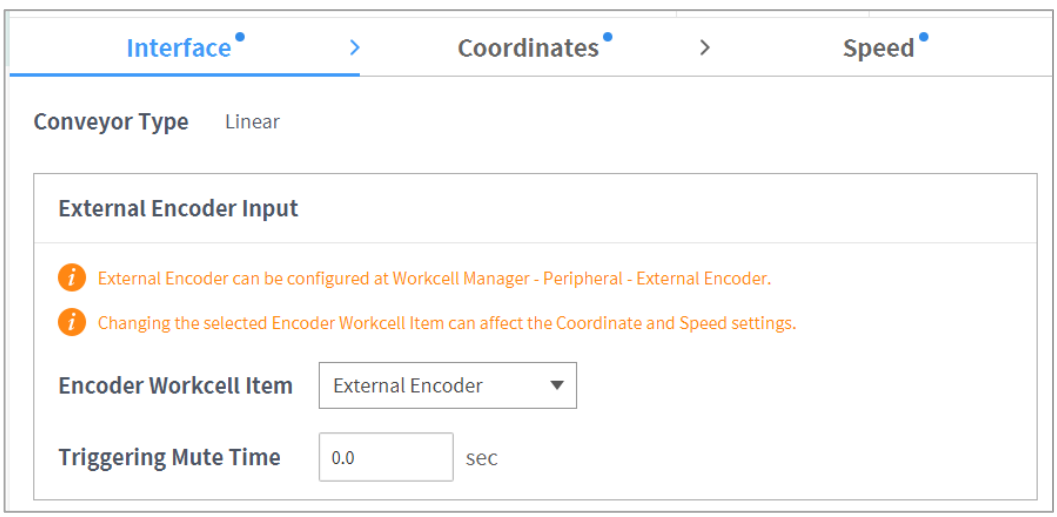
2.2 Conveyor Tracker Settings

The conveyor tracker is set in the order of Interface > Coordinates > Speed tab.

2.2.1 Interface Settings

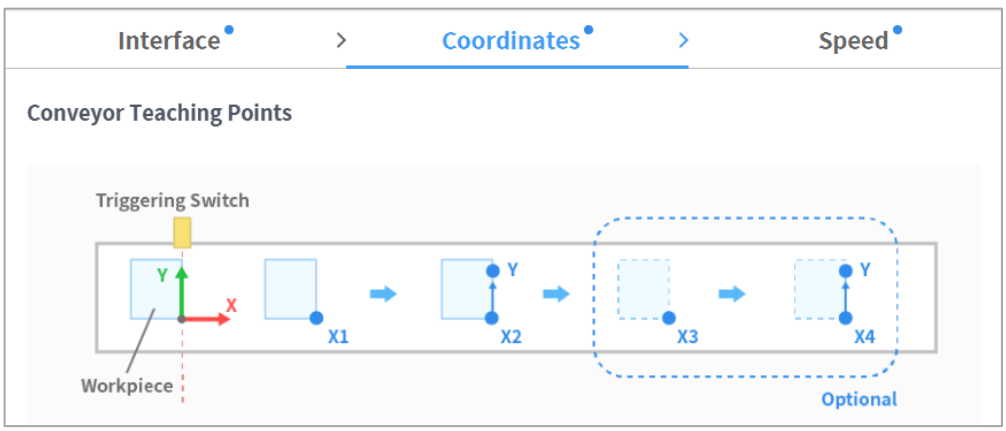
Load the external encoder configured under Encoder Workcell Item.

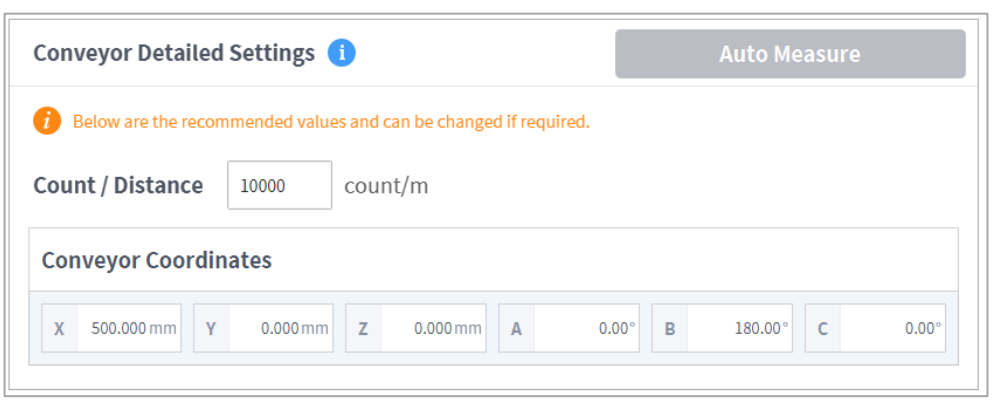
Triggering Mute Time is used when the noise in the triggering switch sensor is at an acceptable level. For example, when a workpiece passes through the triggering switch, an edge may be detected, but additional samples of the edge may be detected within a short period of time after detection due to the electric noise generated during signal switching. In such cases, set the mute time to allow the first edge detected to be recognized as a workpiece and subsequent edge detections after the first detection to be ignored for the set time. This setting is used when the workpiece interval can be estimated and electrical noise cannot be controlled due to poor conditions in the work environment.



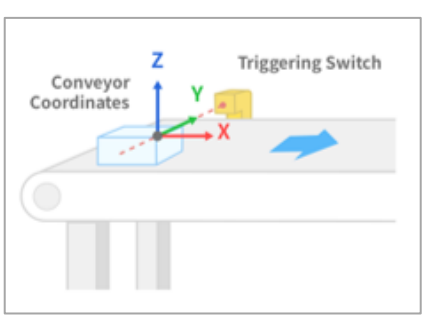
2.2.2 Coordinate Settings

The purpose of the Coordinates tab is to set the Count/Distance values and the conveyor coordinates under Conveyor Detailed Settings. This calculates the converted value, which indicates how much the encoder count increases when the conveyor moves, and which point the conveyor is fixed to in a particular space.





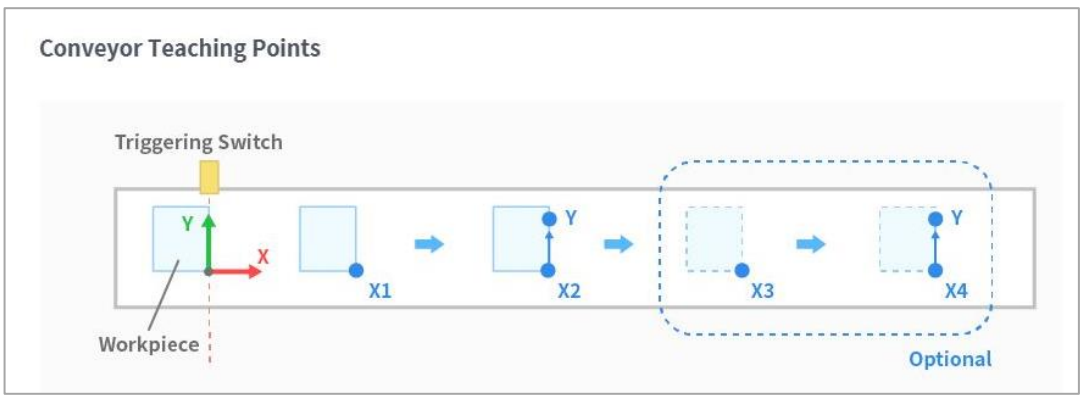
The x-axis of the conveyor coordinates is the direction of the conveyor's movement in terms of the reference coordinates (Base or World).



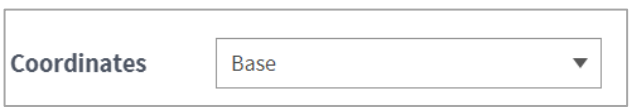
Methods to calculate these values are Auto Measure, after teaching the conveyor teaching points to the robot, and Manual Calculation from the system design specifications. It is possible to use Manual Calculation if it is difficult to teach the robot about the workpiece, but Auto Measure is recommended in most scenarios.

Auto Measure

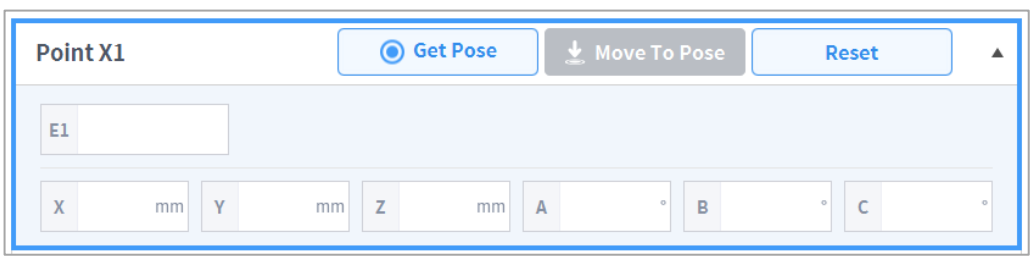
Teaching consists of placing the workpiece before the workpiece detection switch, operating the conveyor, and stopping the conveyor intermittently to teach the robot to obtain position information. Check that the TCP is identically set in the program to be used before teaching.



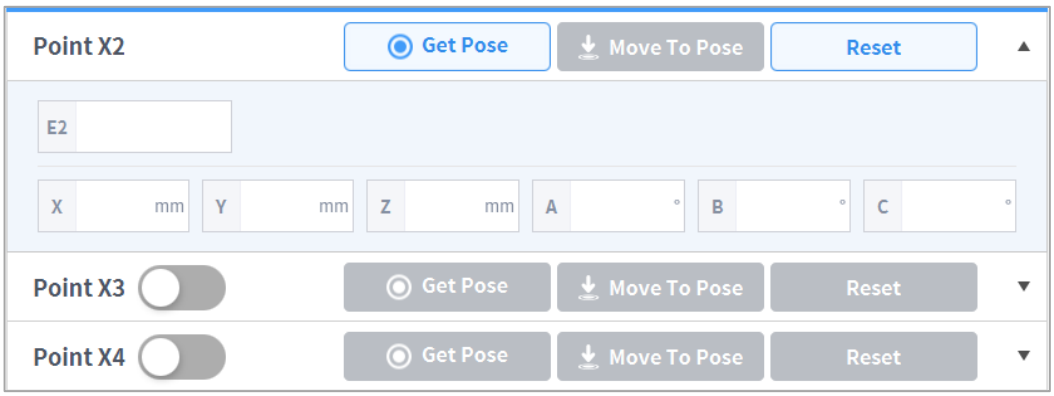
Base Coordinates and World Coordinates can be selected as the reference coordinates during teaching. World Coordinates is helpful as it allows two robots to share a single conveyor without re-teaching.



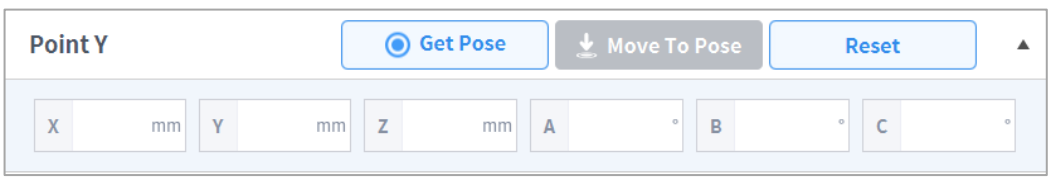
Place a workpiece on the conveyor before the workpiece detection switch in the same way it is done during actual work. Turn on the conveyor and stop it after the workpiece passes the conveyor's triggering switch. Teach the reference point of the workpiece at this moment, and press Save Pose to acquire the current encoder count and robot location of Point X1.



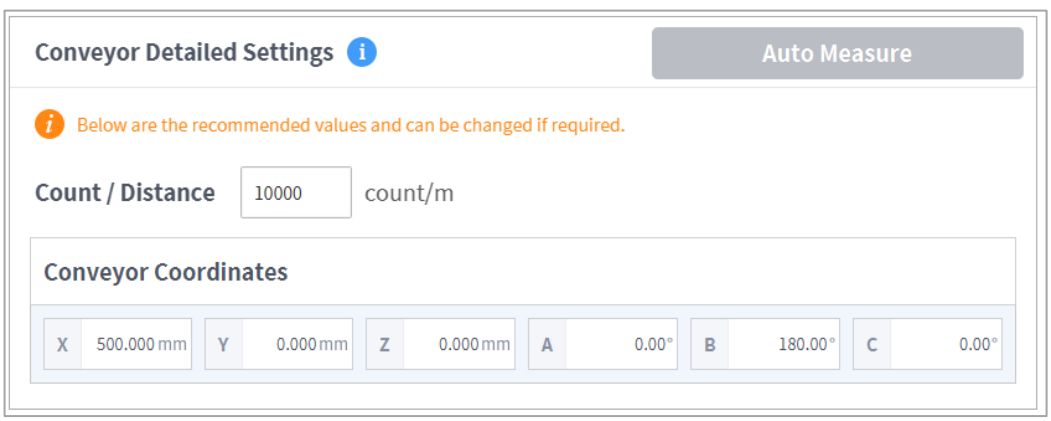
Turn on the conveyor again and stop it in the same way to acquire a location for Point X2. Point X is used to calculate the x-axis of the conveyor coordinates. While just X1 and X2 are sufficient, up to four points can undergo teaching to improve accuracy. Depending on the number of teachings, spread the position within the range where the robot can undergo teaching.



Point Y is used to calculate the y-axis of the conveyor coordinates, so it is acquired by teaching a workpiece placed on an X-Y plane to generate a y-axis in addition to Point X.

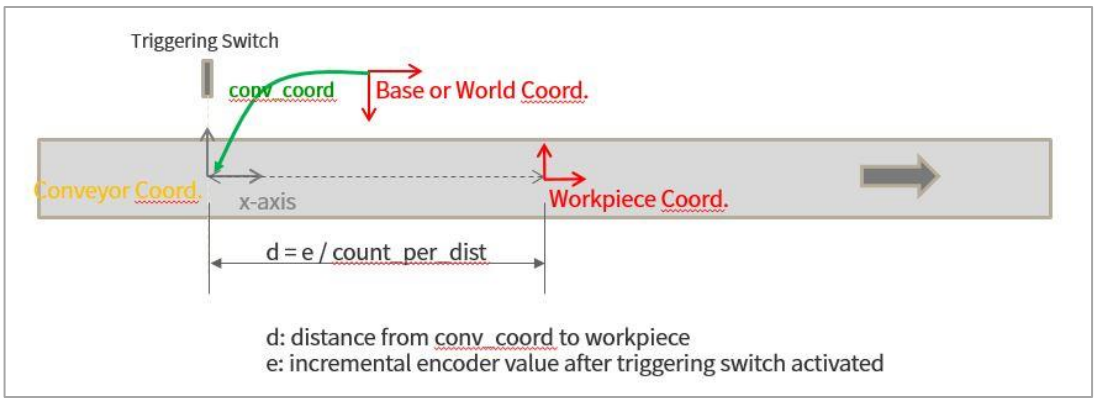


Acquire a teaching point and press Auto Measure to automatically calculate Conveyor Detailed Settings. Check whether the conveyor coordinates are calculated to a point near the physical location of the triggering switch. (Depending on the detected edge, offset may exist in the direction of the conveyor)



Manual Settings

The workpiece's location is calculated by applying the encoder count, increasing in the direction of x for the conveyor coordinates, when the workpiece passes the triggering switch. The setting is set based on the triggering switch, conveyor position and workpiece reference point, and even in situations where it is difficult to identify the exact position, setting the correct x-axis direction for Conveyor Coordinates will allow the remaining offset to be accurately entered in Task Motion under TB/TW, so it is acceptable to not enter the exact value.



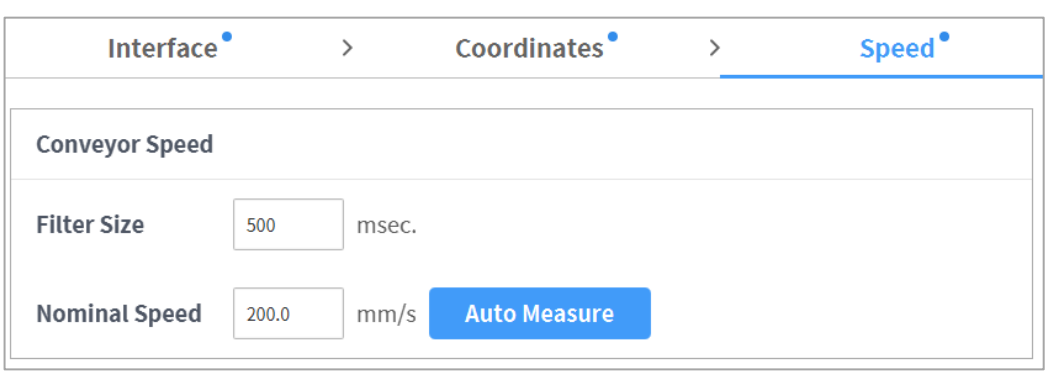
Count and Distance are conveyor tracking commands in TB/TW, and entering the Wait command without a task motion will result in the tracking of conveyor movement from the current position. The user can adjust this while monitoring the speed trend. If the robot moves more slowly than the conveyor, reduce the Count/Distance, and if the robot moves faster, increase the Count/Distance.

2.2.3 Speed Settings

The conveyor speed and section settings are under the Speed tab.

The filter size under Conveyor Speed is the size of the conveyor speed filter. Select an intuitive moving-average filter under Conveyor Tracking. Increase the filter value if there is vibration in the robot and reduce the value if the tracking performance in the conveyor acceleration section is low.

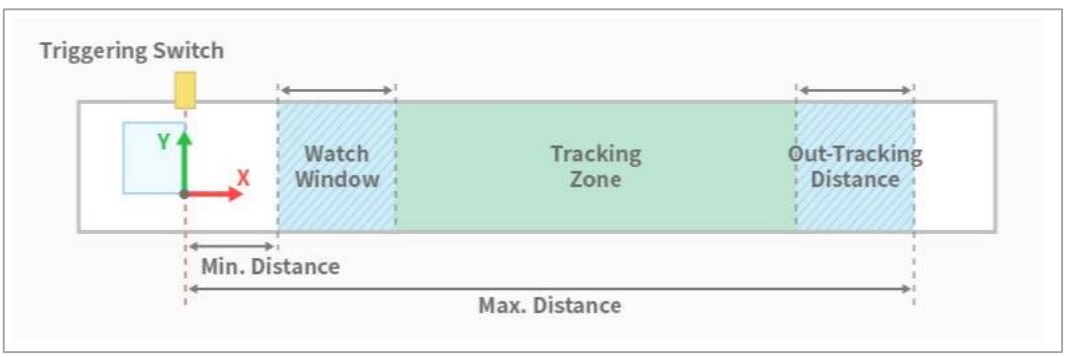
Measure Nominal Speed using the Auto Calculate button while operating the conveyor. If the conveyor speed is 200% higher than Nominal Speed, it can be used to provide information. It does not require an accurate value, so entering a design specification value without actual measuring is acceptable.



Next, set up Conveyor Section. Min Distance and Max Distance are related to the work section of Conveyor Tracking. A larger Min Distance value allows the work to begin at a location further away from the workpiece detection switch. The robot can conduct conveyor tracking up to an area the size of the Max Distance value, but not that of the Out-Tracking Distance.

If the robot enters the out-tracking distance, it generates an error and decelerates. Increase the out-tracking distance to apply gradual deceleration.

The watch window is the area where work candidates are determined. Workpieces in this area can only become work targets once the work begins. Starting from the minimum distance, setting a wider area will increase the number of work targets. However, in a worst-case scenario, this can cause workpieces at the end of the watch window to become targets, so it is recommended that the watch window size be adjusted to allow all work in the tracking zone to be completed.

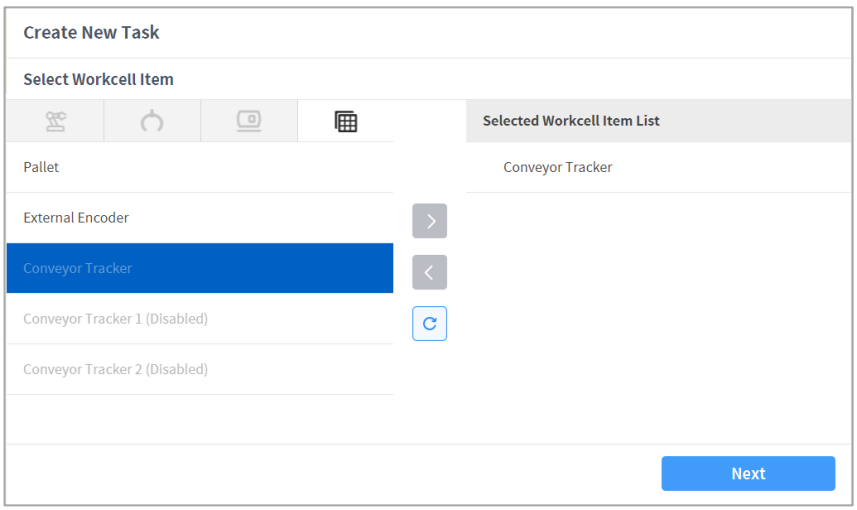


Min. Distance	0.000	mm
Max. Distance	1000.000	mm
Watch Window	200.000	mm
Out-Tracking Distance	50.000	mm

3. Programming (TB/TW)

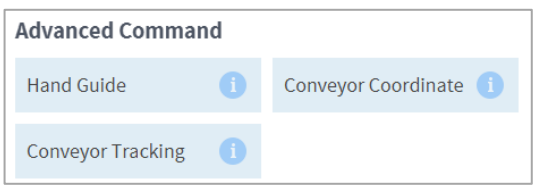
Programming of conveyor tracking is done through the Conveyor Coordinates command and Conveyor Tracking command in TB/TW. Coordinate information of the workpiece is obtained with the Conveyor Coordinates command, and conveyor tracking motions are performed with the Conveyor Tracking command. The Conveyor Tracking command also offers a function for acquiring a teaching point from the conveyor coordinates.

Select Conveyor Tracker from Workcell Item when creating a task on TB.



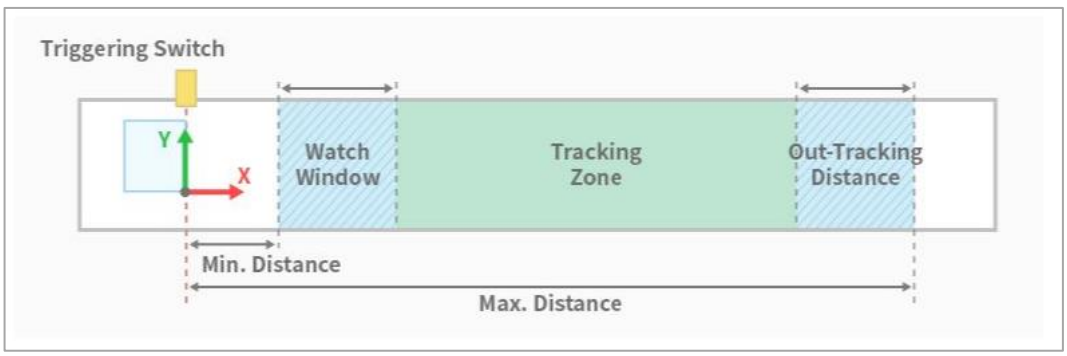
Then, the Conveyor Coordinates and Conveyor Tracking commands will be available under Advanced Commands.

TW will make the Conveyor Coordinates and Conveyor Tracking commands available under Advanced Commands.

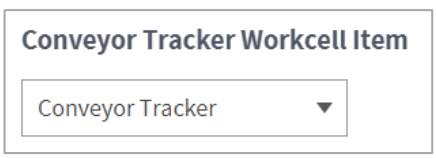


3.1 Conveyor Coordinates

This command acquires the coordinate information of the moving workpiece. This command returns the coordinates information of a workpiece in the watch window at the time the command is executed.

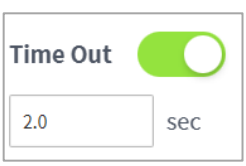


This selects the set conveyor workcell item.



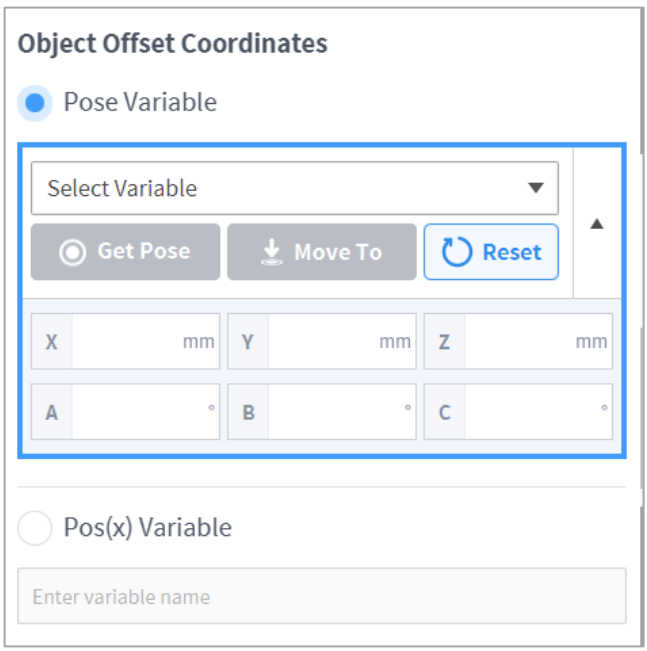
This enters a name for the conveyor coordinates. This saves the conveyor coordinate numbers (121-150) on the entered variable.

Time Out sets the standby time until workpiece information is received. Setting it as Disable or as 0 will put it on standby indefinitely until a workpiece is delivered. If a workpiece is not delivered within the set time, it skips to the next program line.



Picking Rules determines whether to work on workpieces received first or workpieces received last. First In First Out or Last In Last Out can be selected.

This is used to offset Object Offset Coordinates. If the corresponding variable requires it, this updates the program in real time with Pose Variable, which is used to give a static offset, and Pos(x) Variable, which is used to dynamically change the offset.



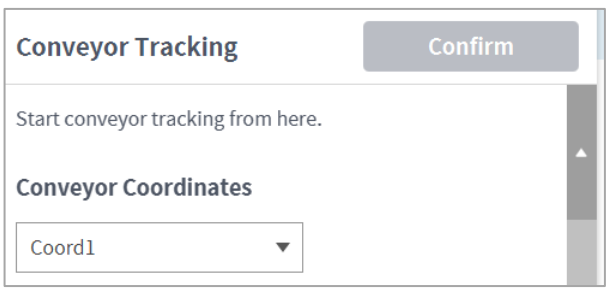
3.2 Conveyor Tracking

Inserting the Conveyor Tracking command into the programming creates a Conveyor Tracking line and an End Conveyor Tracking line. At this time, the robot will perform the conveyor tracking motion. It is possible to insert the Wait command to check whether tracking is being performed well, or insert various other Task Motion commands to develop the desired work.

The Conveyor Tracking line accelerates to allow the robot to track the conveyor speed. Default acceleration time is 0.3 s, and to adjust it, the drl command tracking_conveyor must be used under Custom Code. As it proceeds to the next line as soon as it accelerates to reduce takt time, when a task motion is encountered, it overlaps with the acceleration motion. Task motion deviation can be present in the acceleration area, but once acceleration ends, tracking can be performed accurately.

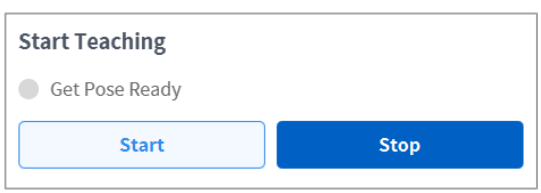
The End Conveyor Tracking line decelerates to allow the robot to stop conveyor tracking. Default acceleration time is 0.3 s, and to adjust it, the drl command tracking_conveyor must be used under Custom Code. As it proceeds to the next line as soon as it accelerates to reduce takt time, when a task motion is encountered, it overlaps with the deceleration motion. However, as Joint Motion cannot be performed during deceleration, if Joint Motion is required immediately after End Conveyor Tracking, perform Wait for 0.3 s or perform Task Motion for more than 0.3 s before performing Joint Motion.

Conveyor Coordinates gives the workpiece coordinates used to execute conveyor tracking. The coordinates set using the Conveyor Coordinates command are listed.

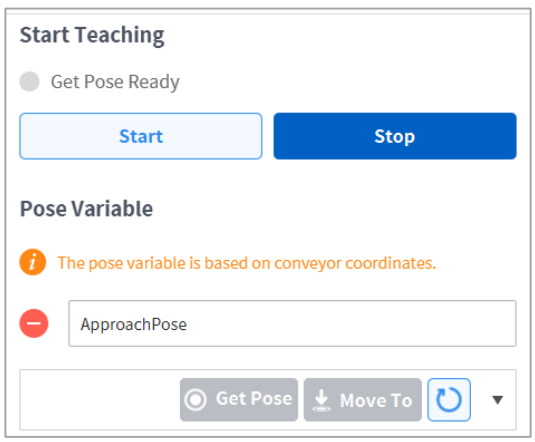


Also, it is possible to obtain a teaching point for using Task Motion. The teaching point for Conveyor Tracking must be entered based on the workpiece coordinates, so in order to obtain an accurate teaching point, the coordinates must be entered manually based on CAD information or be obtained through the following procedure: This step can be omitted if the coordinates can be obtained with only the designed value.

- With the Start button pressed, let workpieces flow through like during an actual workflow.



- When a workpiece enters the monitoring section, a green indicator lights goes on at Get Pose Ready. After the indicator light goes on, stop the conveyor in a position where the robot can perform teaching properly. If the green indicator light does not go on, press Stop and restart the process.



- After teaching the robot based on a workpiece during the stop, press Save Pose to obtain as many teaching points as necessary. (up to 20 points)

Teaching points can be loaded using Task Motion between the Conveyor Tracking commands by referring to the entered pose variable name.

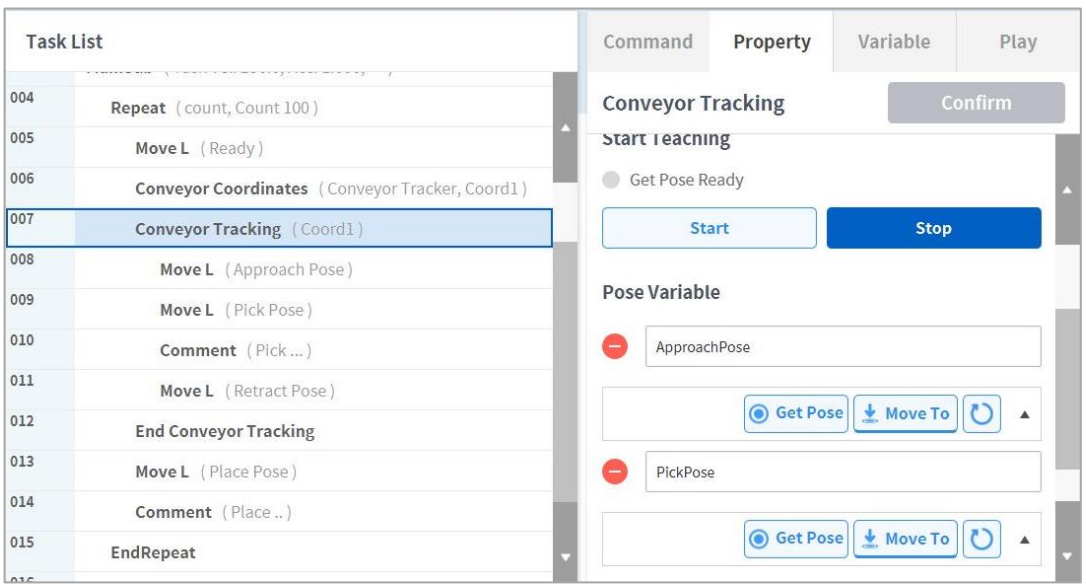
In addition to workpiece coordinates, the teaching point supports teaching points in Base or World coordinates. In order to use them, it is necessary to obtain the teaching points of the corresponding coordinates in the Task Motion Property window.

4. Other Items to Note

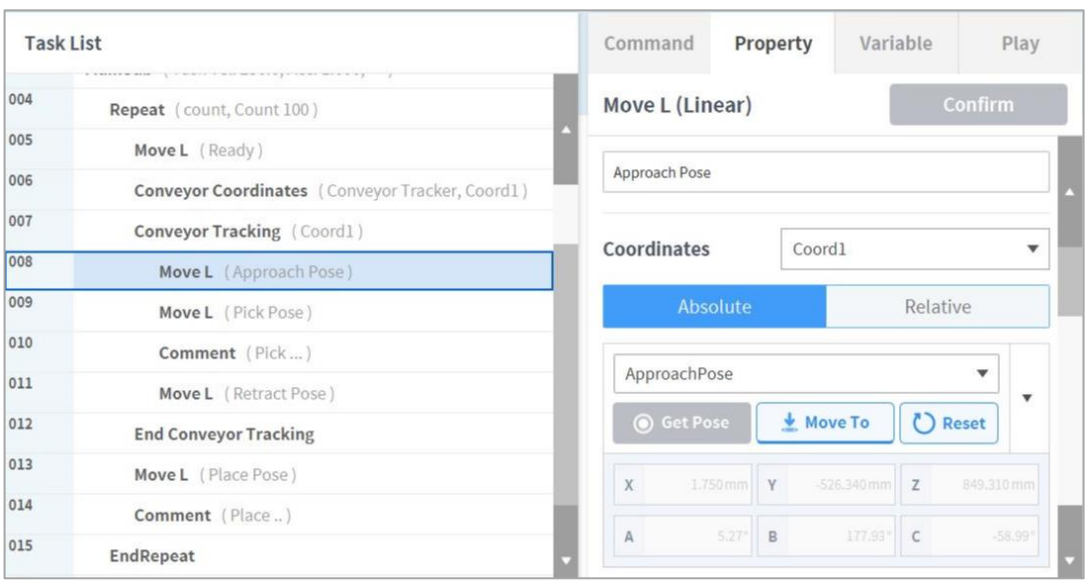
Here are the program templates commonly used.

4.1 Pick & Place (One Conveyor)

This example picks a workpiece moving on one conveyor and places it outside the conveyor. Perform teaching of ApproachPose and PickPose at Conveyor Tracking Property.

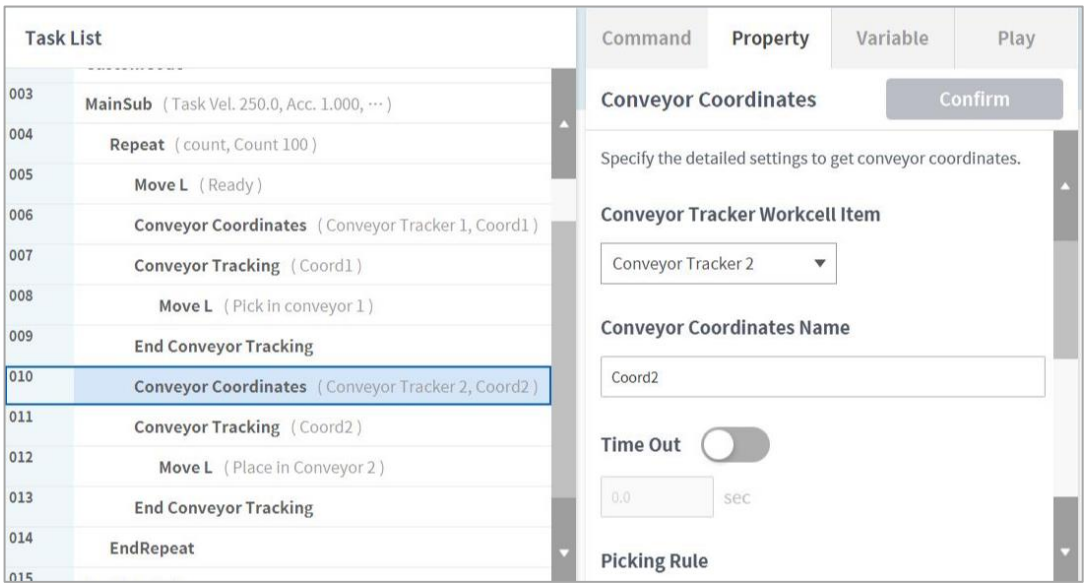


By selecting Conveyor Coordinates (Coord1 in the example) as the coordinates at MoveL in the Conveyor Tracking node, it is possible view teaching points that underwent teaching at Conveyor Tracking. Select a teaching point (ApproachPose, PickPose) to complete programming.



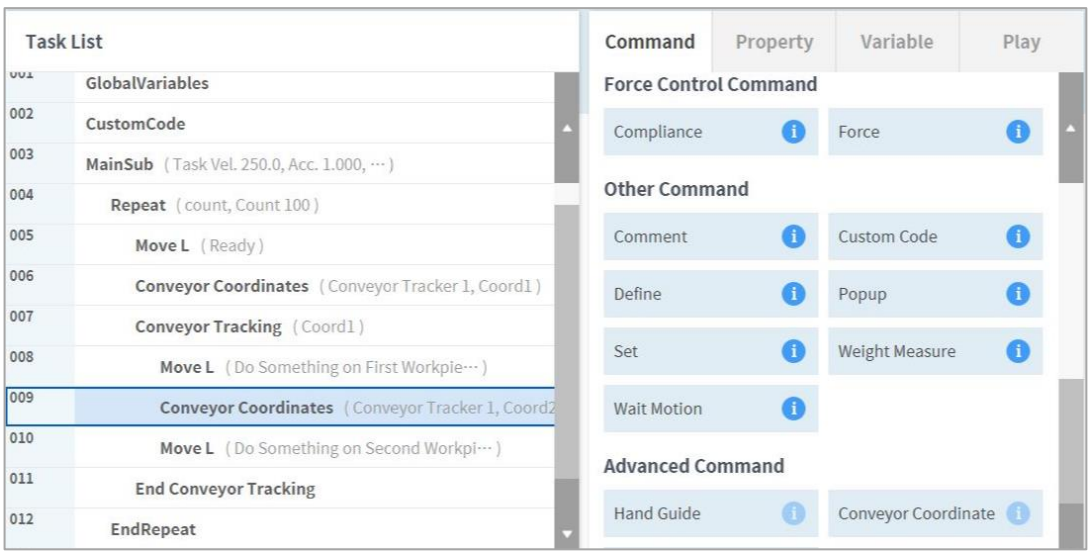
4.2 Pick & Place (Two Conveyors)

This example picks a workpiece moving on one conveyor and places it on another conveyor. While the method is identical to the example in 4.1, it requires two pairs of Conveyor Coordinates and Conveyor Tracking commands, and each must be programmed at different conveyors.

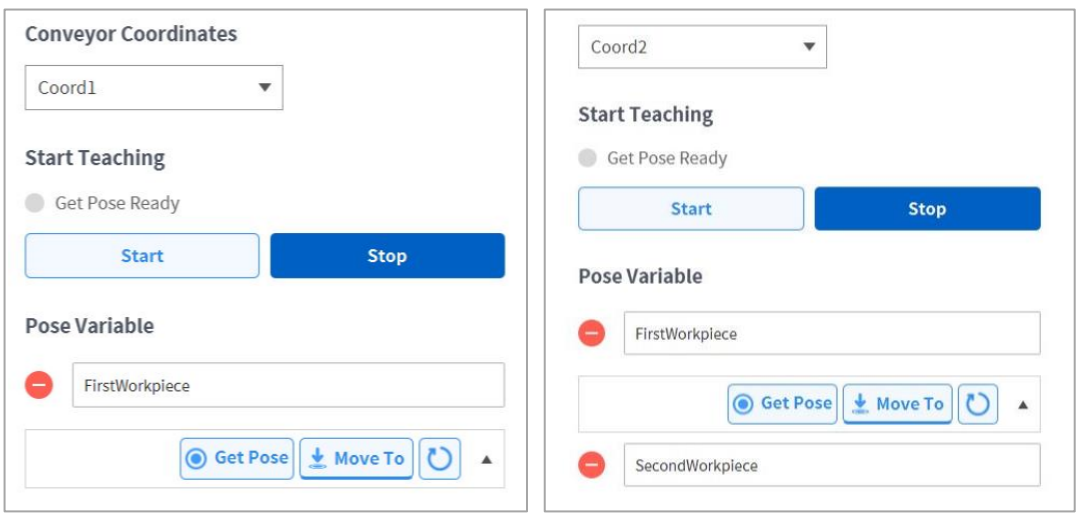


4.3 Multiple Workpiece Handling

This example handles workpieces continuously supplied by one conveyor. If a workpiece is handled between Conveyor Tracking and End Conveyor Tracking, and if the overall work time is not sufficient, obtain Conveyor Coordinates information rather than performing End Conveyor Tracking to continue the work.



Note that it is necessary to differentiate the first coordinates and the second coordinates when teaching. Select coordinates suited for the workpiece, perform Start Teaching, and perform Get Pose to obtain teaching points suited for each coordinate. If the workpiece is identical, it is acceptable to share identical teaching points.



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