THE NATIONAL ROBOTARIUM

PEOPLE CENTRED :: INTELLIGENCE DRIVEN

ABB YuMi Dual Arm Robot and ABB RobotStudio Hands-On Training Part 1

Provided By,

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Agenda

I. Getting Started with ABB YuMi Dual Arm

II. Jogging of the ABB YuMi Dual Arm

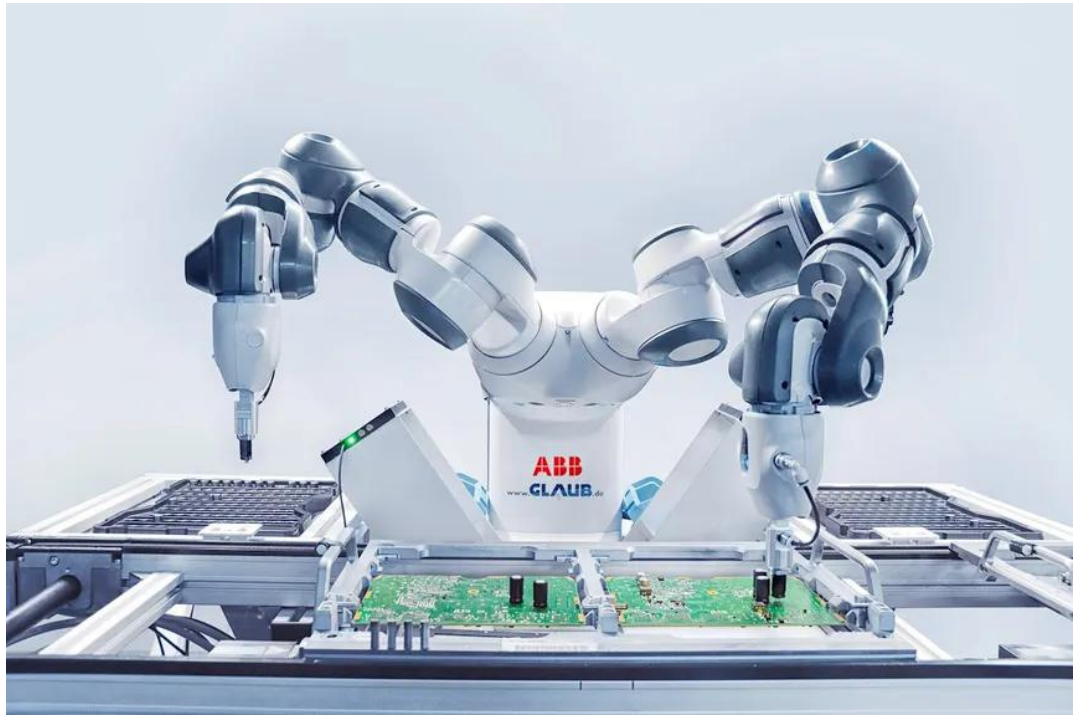
III. Online Programming of the ABB YuMi using FlexPendant

IV. Offline Programming of the ABB YuMi using RobotStudio

Getting Started with ABB YuMi Dual Arm

Topics Covered:

1. Introduction
2. Main Components
3. FlexPendant
4. Error messages
5. Smart Gripper



Getting Started with ABB YuMi Dual Arm

1. Introduction

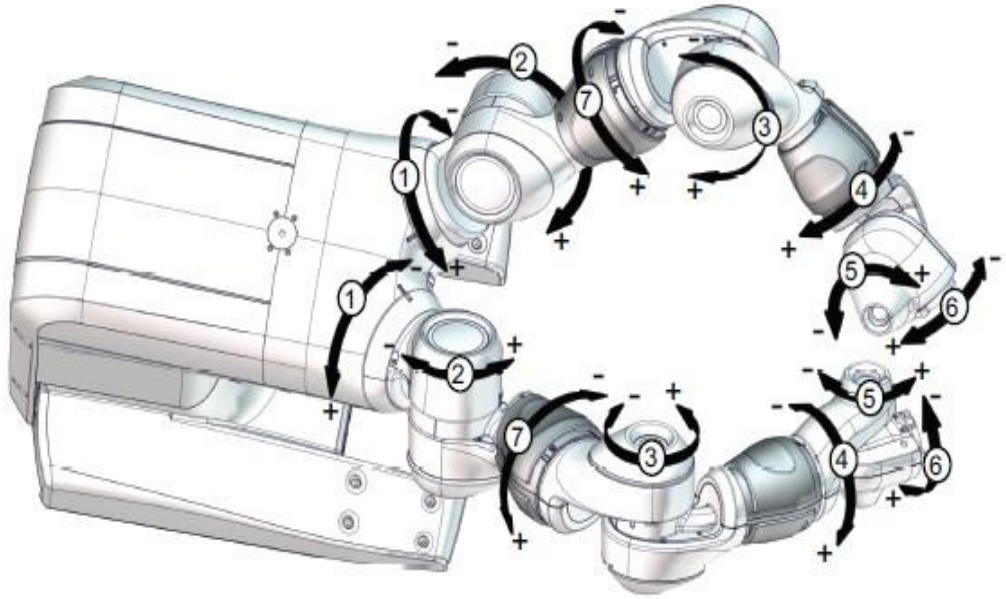
- YuMi is ABB's first dual robotic arm for collaborative applications.
- It adds flexibility to assembly processes with small parts and lots of highly individualized products while working alongside other robots or people.
- It is the smallest and agile collaborative robot, making it easier than ever to put into production.
- The 7-axis degrees of freedom also opens a world of flexible possibilities.
- The YuMi is designed to be easy to setup and use, thanks to its intuitive lead-through programming. This means that even people without specialized training or prior experience can successfully use the robot.

Getting Started with ABB YuMi Dual Arm

2. Main Components

Joints

The YuMi robot has 7 joints on each arm. The positive and negative of motions of each joint are shown in the diagram. Note that joint 7 is located between joints 2 and 3 (not at the end of the arm).

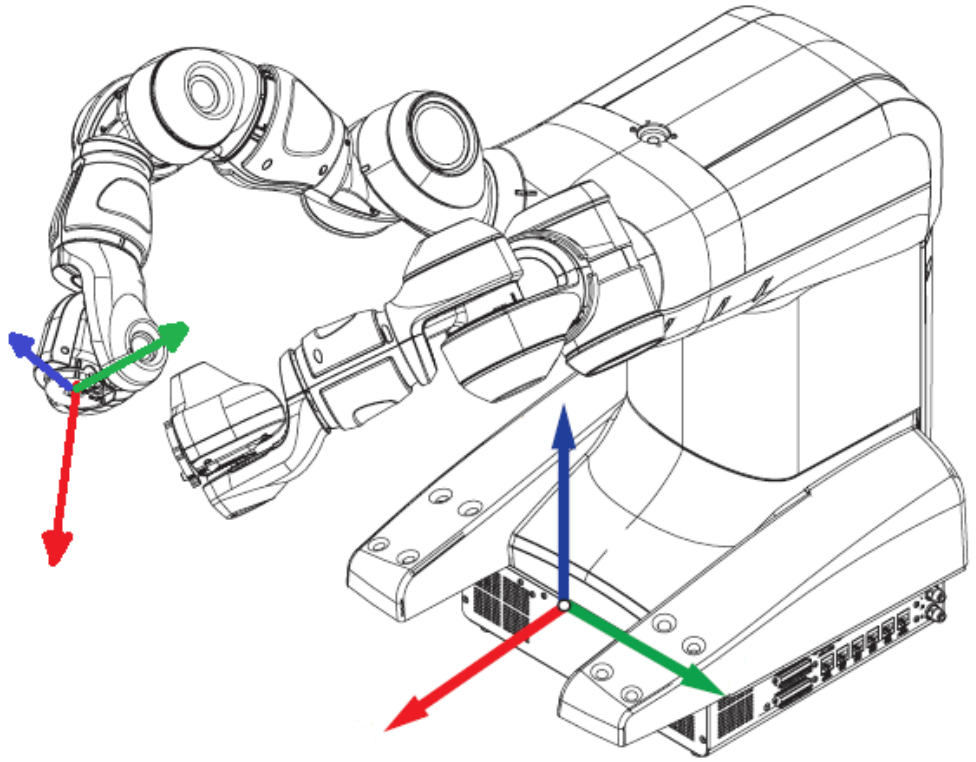


Getting Started with ABB YuMi Dual Arm

2. Main Components

Coordinate systems

- The YuMi robot has multiple coordinate systems.
- The **base coordinate system** has its origin at the base of the robot.
- The **tool coordinate system** has its origin at joint 6 by default, but it can be modified.
- **Work object coordinate systems** can be defined to program the robot's motions.
- The location and orientation of the **base** and **tool coordinate systems** are shown below using the following color convention for the axes: x - red, y - green, z - blue.

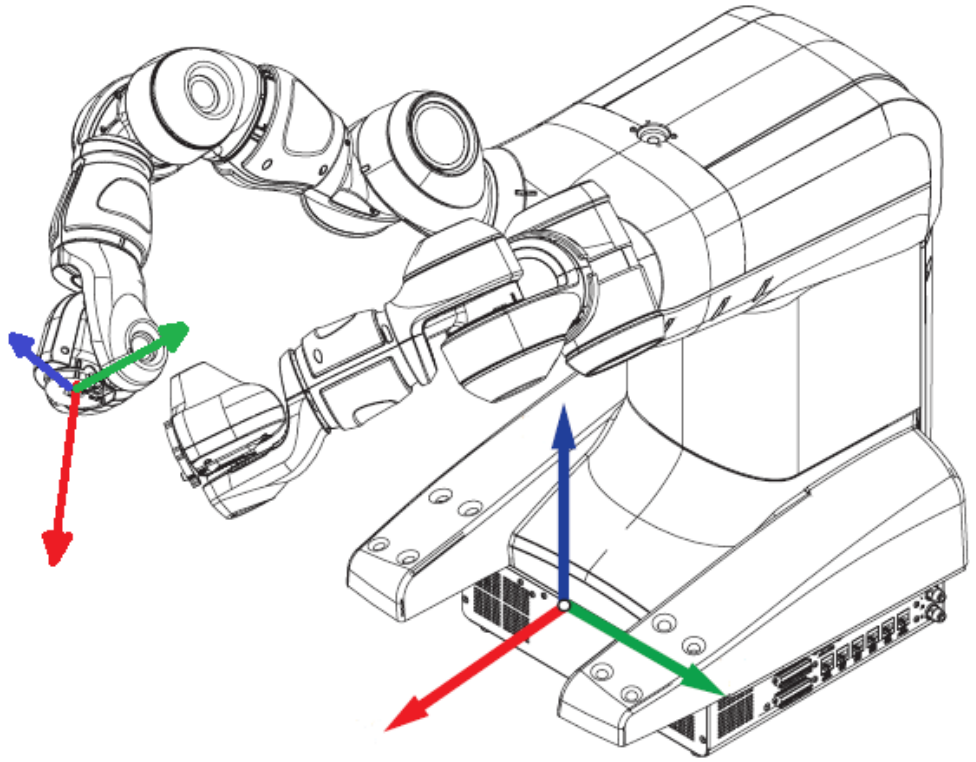


Getting Started with ABB YuMi Dual Arm

2. Main Components

Coordinate systems

- The **world coordinate system** that defines the robot cell, all other coordinate systems are related to the world coordinate system, either directly or indirectly. It is useful for jogging, general movements and for handling stations and cells with several robots or robots moved by external axes.
- The **user coordinate system** is useful for representing equipment that holds other coordinate systems, like work objects.



Getting Started with ABB YuMi Dual Arm

2. Main Components

<u>Turning the YuMi On/Off</u>

To turn on the YuMi:

- The power switch is located on the right side of the robot; turning it clockwise will start the YuMi and the FlexPendant.

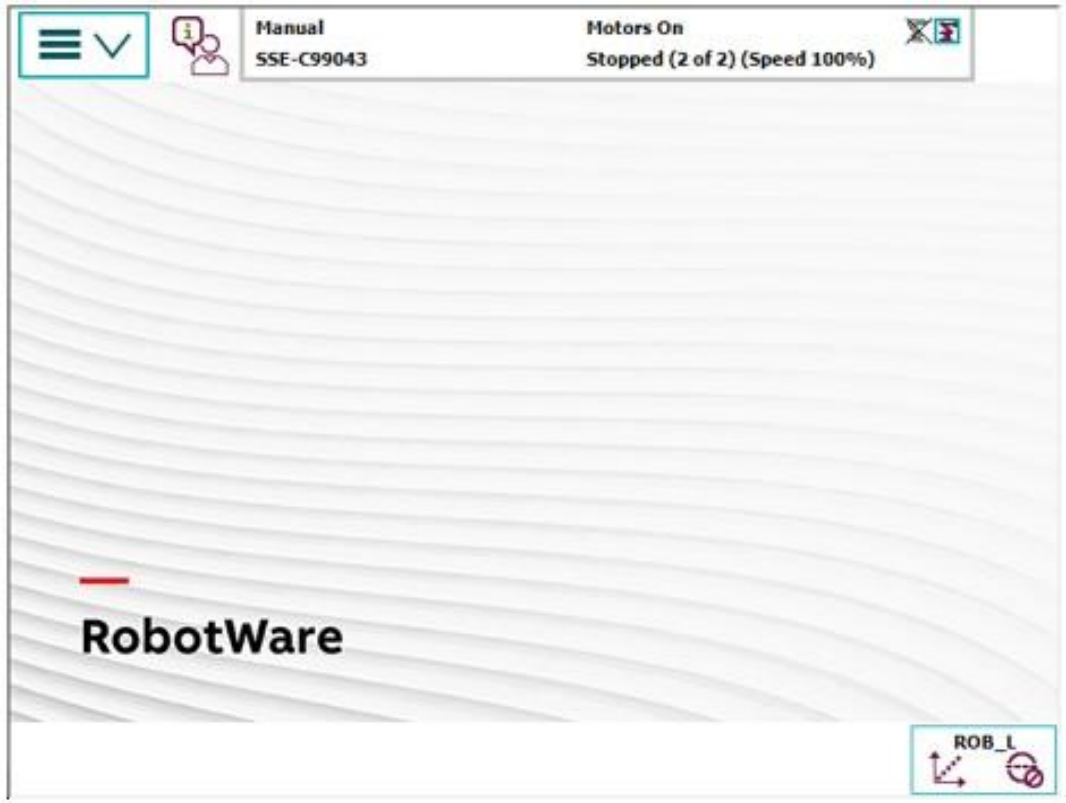
Getting Started with ABB YuMi Dual Arm

2. Main Components

<u>Turning the YuMi On/Off</u>

To turn on the YuMi:

- The FlexPendant will turn on and start to initialize. Wait about two minutes until it has finished booting. The FlexPendant screen should looks like this (right side image).
- Default user is logged in



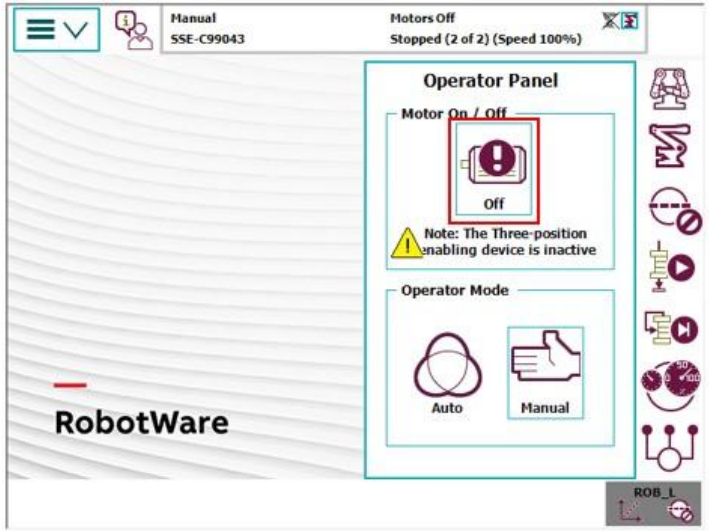
Getting Started with ABB YuMi Dual Arm

2. Main Components

Turning the YuMi On/Off

To turn on the YuMi:

- Uncheck the E-STOP button by twisting it clockwise.
- Go to the operator panel on the quickset menu > tap on Motor to turn it on.



Getting Started with ABB YuMi Dual Arm

2. Main Components

Turning the YuMi On/Off

To turn off the YuMi:

- Make sure the arms are clear of any walkway and objects.
- Press the E-STOP button.
- Turn the power switch counterclockwise.

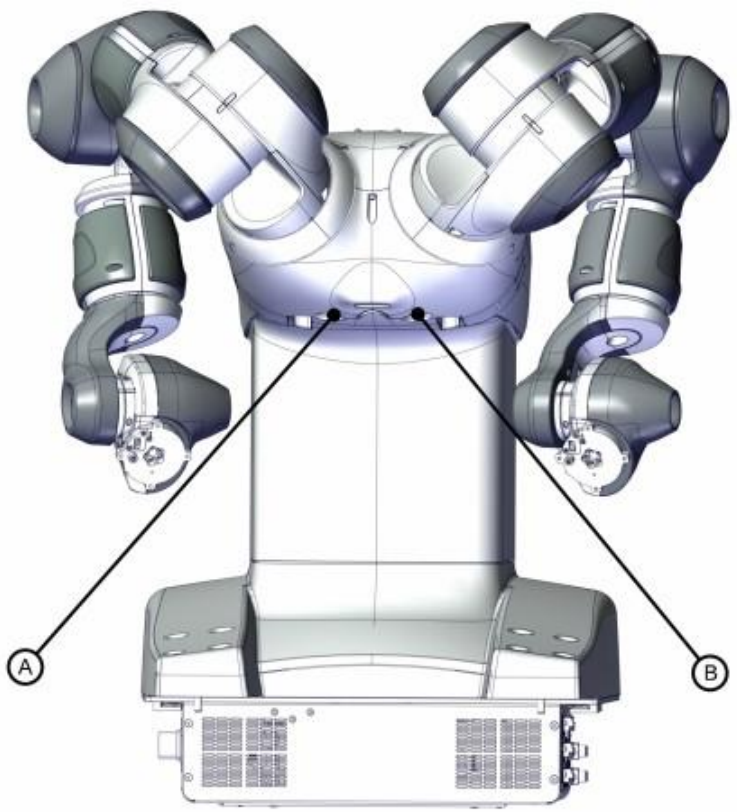
Getting Started with ABB YuMi Dual Arm

2. Main Components

Break release buttons

The arms of the robot can be moved manually; this allows for an easy and quick way to change the position of the arms. To do so, first release the brakes by pressing the brake release buttons on the underside of the Yumi (see image below). This can be done only when the FlexPendant is on, and motors are off (motors can be turned off through the quickset menu).

CAUTION: Grab the arm before pressing the brake release button to prevent it from hitting the table.



Getting Started with ABB YuMi Dual Arm

3. FlexPendant

The FlexPendant is a handheld operator unit used to control the ABB Yumi. It consists of both the software and hardware which is needed for performing any operations of the ABB YuMi, changing and executing programs, and so on.

a. Main Parts
b. Control Panel
c. FlexPendant Screen
d. Main Menu

Refer Operating manual - IRC5 with FlexPendant

Getting Started with ABB YuMi Dual Arm

3. FlexPendant

Main Parts

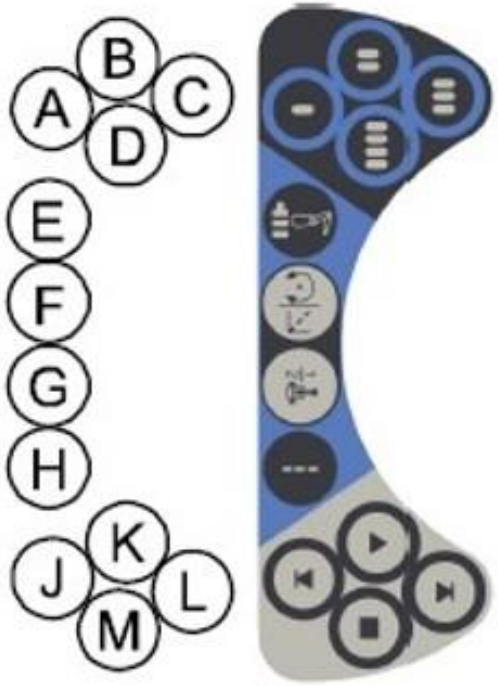
A	Connector
B	Touch screen
C	Emergency stop button
D	Joystick
E	USB port
F	Three-position enabling device
G	Stylus pen
H	Reset button

Getting Started with ABB YuMi Dual Arm

3. FlexPendant

Control Panel

A - D. Programmable keys, 1-4. Assign Input and Output signals.
E. Switch between the left and right arm.
F. Switch between the motion modes; linear, reorient, or arm. (More details covered in the Jogging section).
G. Switch between the motion modes; axis 1-3, axis 4-6, or axis 7. (More details covered in the Jogging section).
H. Toggle increments. (Allows the robot to jog in steps).
J. Backward step button. Executes the previous instruction when pressed.
K. Start button. Starts the program execution when pressed.
L. Forward step button. Executes the next instruction when pressed.
M. Stop button. Stops the program execution when pressed.



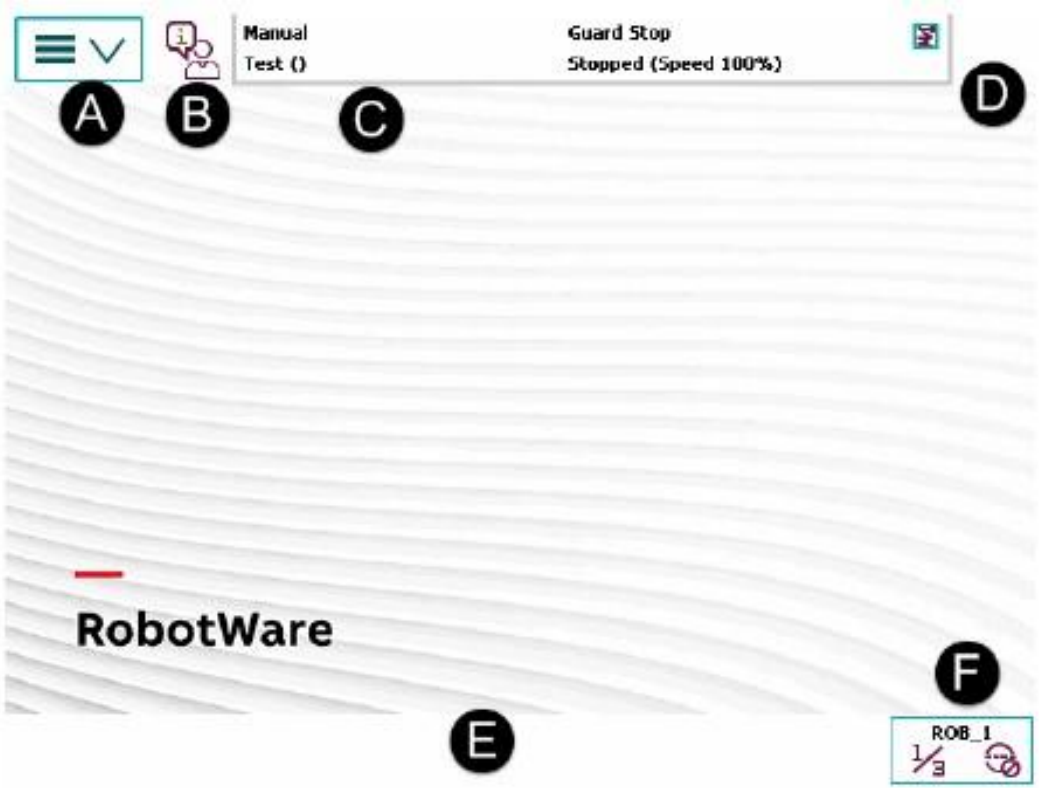
Getting Started with ABB YuMi Dual Arm

3. FlexPendant

FlexPendant Screen

Refer Manual Page 78 - for additional information

A	Main menu
B	Operator window
C	Status bar
D	Close button
E	Task bar
F	Quickset menu



Getting Started with ABB YuMi Dual Arm

3. FlexPendant

FlexPendant Screen

Status Bar:

The status bar lets you check the logs of the robot. It displays important information about system status, such as operating mode, motors on/off, program state, and shows any errors that occur. The errors will show what happened as well as the possible causes, it must be acknowledged before moving on by clicking acknowledge at the bottom right of the error.

Quickset Menu:

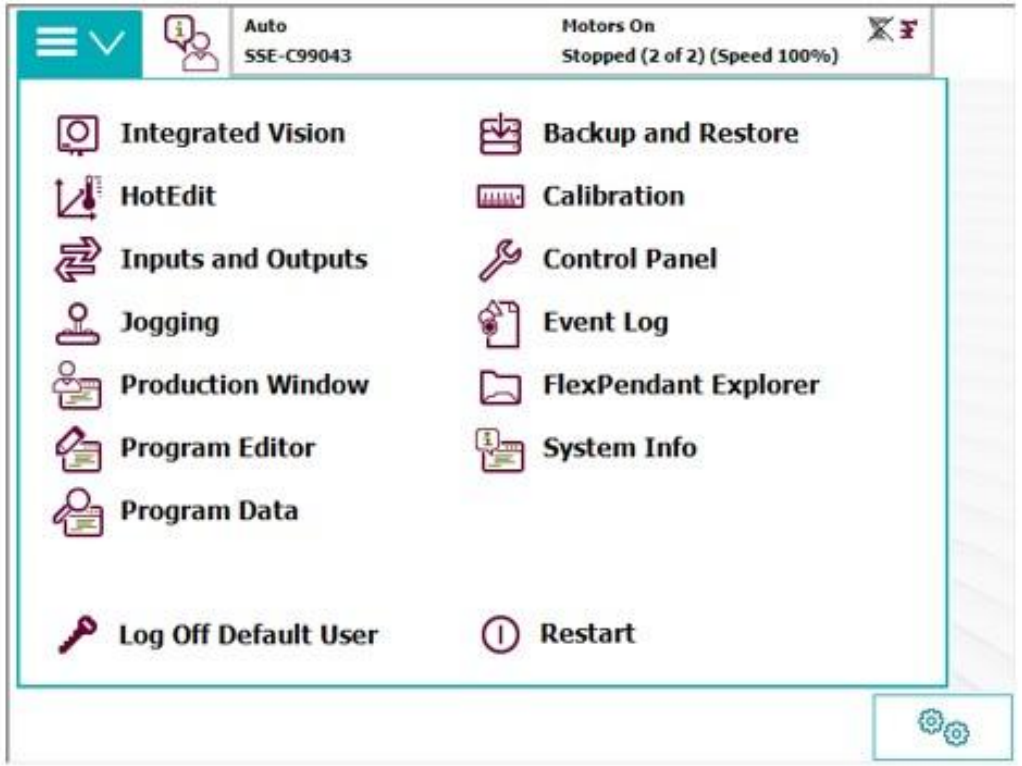
The quickset menu lets you use the operator panel, the coordinate system and the tool and work data for each arm, the increments, the run mode, the step mode, the speed, and the tasks to stop and start. The menu can be pulled up at any time and is used to change settings easier and quickly. The operator panel in the quickset menu allows to turn the motors on and off, as well as switch between manual and auto mode.

Getting Started with ABB YuMi Dual Arm

3. FlexPendant

Main Menu

The main menu has all the screens needed to control the robot, change data and values, load and edit programs, and so on.

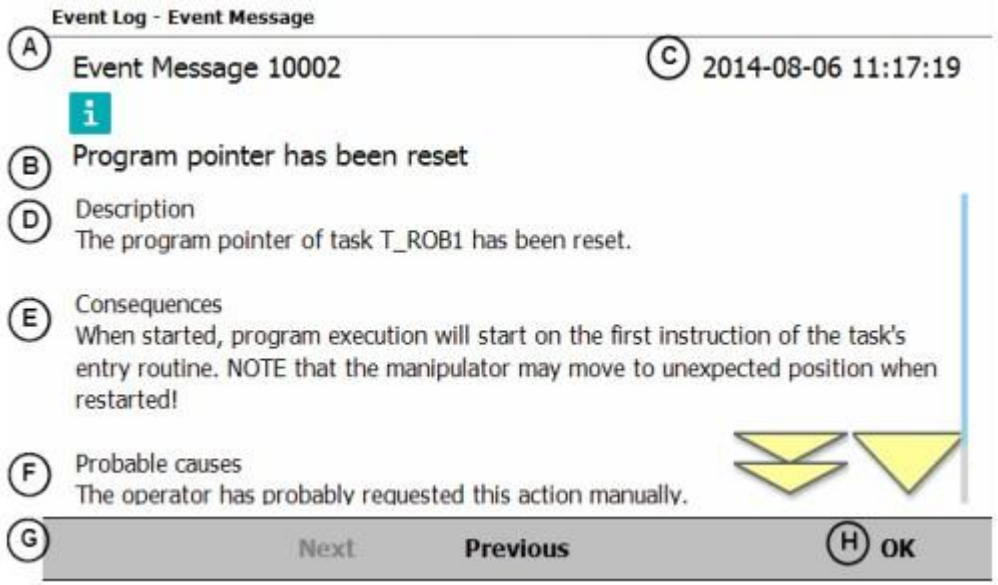


Getting Started with ABB YuMi Dual Arm

4. Error messages

Error messages include a description, consequences, and probable causes:

A	Event number. All errors are listed by numbers.
B	Event title. Briefly states what has happened.
C	Event time marker. Specifies exactly when the event occurred.
D	Description. A brief description of the event. Intended to assist in understanding the causes and implications of the event.
E	Consequences. A brief description of any consequences inflicted on the system, transition to other operation mode, emergency stop, caused by the particular event. Intended to assist in understanding the causes and implications of the event.
F	Probable causes. A list of probable causes, listed in order of probability.
G	Recommended actions. A list of the recommended correcting actions, based on the "Probable causes" specified above. These may range from "Replace the xx..." to "Run test program xx...", i.e. may be actions to isolate the problem as well as fixing it.
H	Acknowledge or OK button.



When an error message comes up on the screen:

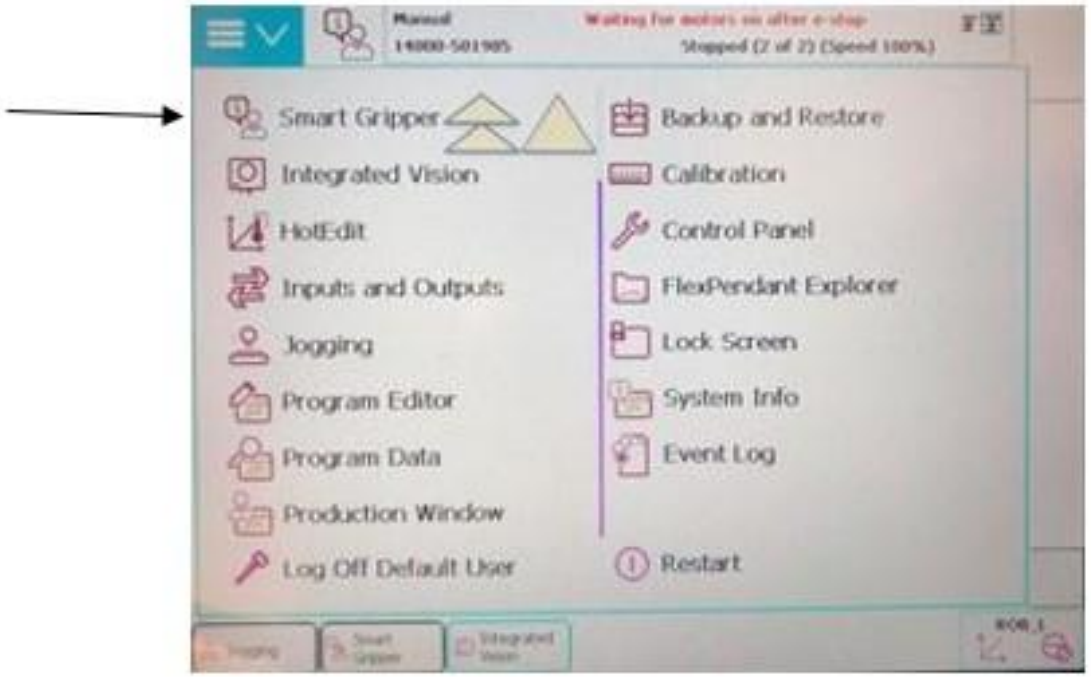
1. Read it carefully
2. Acknowledge it by tapping the OK button
3. Perform the appropriate/recommended action before doing anything else

Getting Started with ABB YuMi Dual Arm

5. Smart Gripper

- The Smart Gripper screen is located in the Main Menu.
- The Smart Gripper screen is used to manually control the grippers.

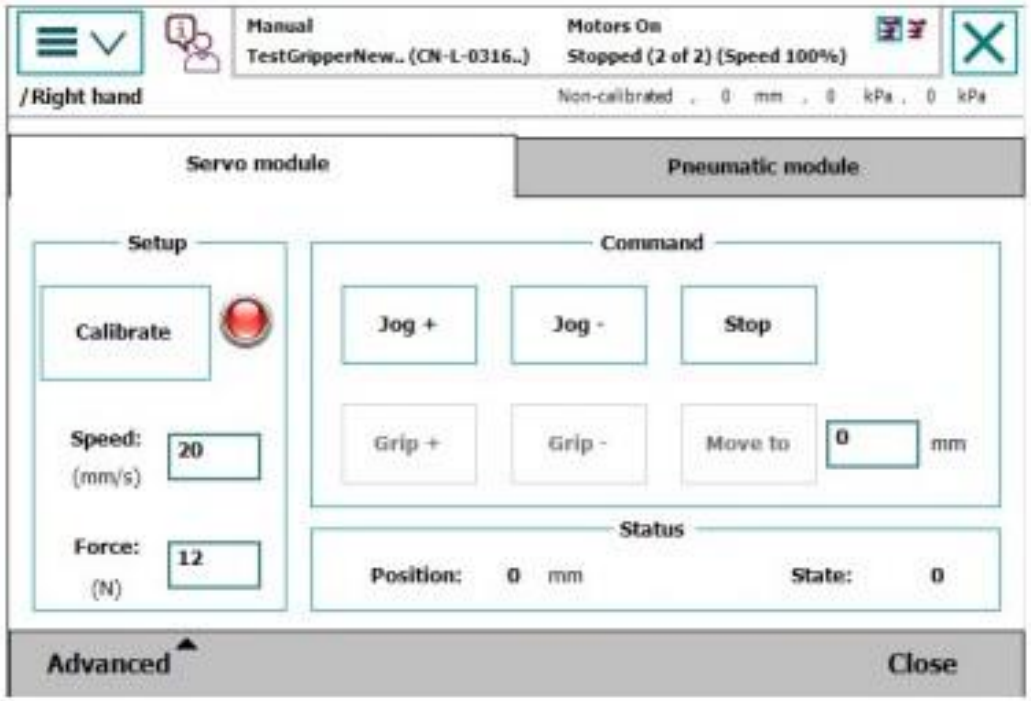
Refer Product manual - Grippers for IRB 14000



Getting Started with ABB YuMi Dual Arm

5. Smart Gripper

- Pressing Calibrate sets the current position of the gripper as zero
- Motion speed and grasping force are defined in the Speed and Force fields. Their maximum values are 20mm/s and 20N, respectively.
- Pressing and holding Jog – closes the gripper
- Pressing and holding Jog + opens the gripper
- Tapping Grip + once closes the gripper up to the position set as zero during calibration (see above)
- Tapping Grip - once fully opens the grippers
- Move to moves the grippers to the position entered in the textbox.



Jogging of the ABB YuMi Dual Arm

Topics Covered:

1. Introduction
2. Robot Setup
3. Robot Calibration
4. Jogging of the robotic arm

Jogging of the ABB YuMi Dual Arm

1. Introduction

- Jogging means to manually position or move a robot. Jogging the ABB YuMi is done through the joystick on the FlexPendant.

- You can only jog in manual mode, but not during program execution. Jogging is disabled in automatic mode.

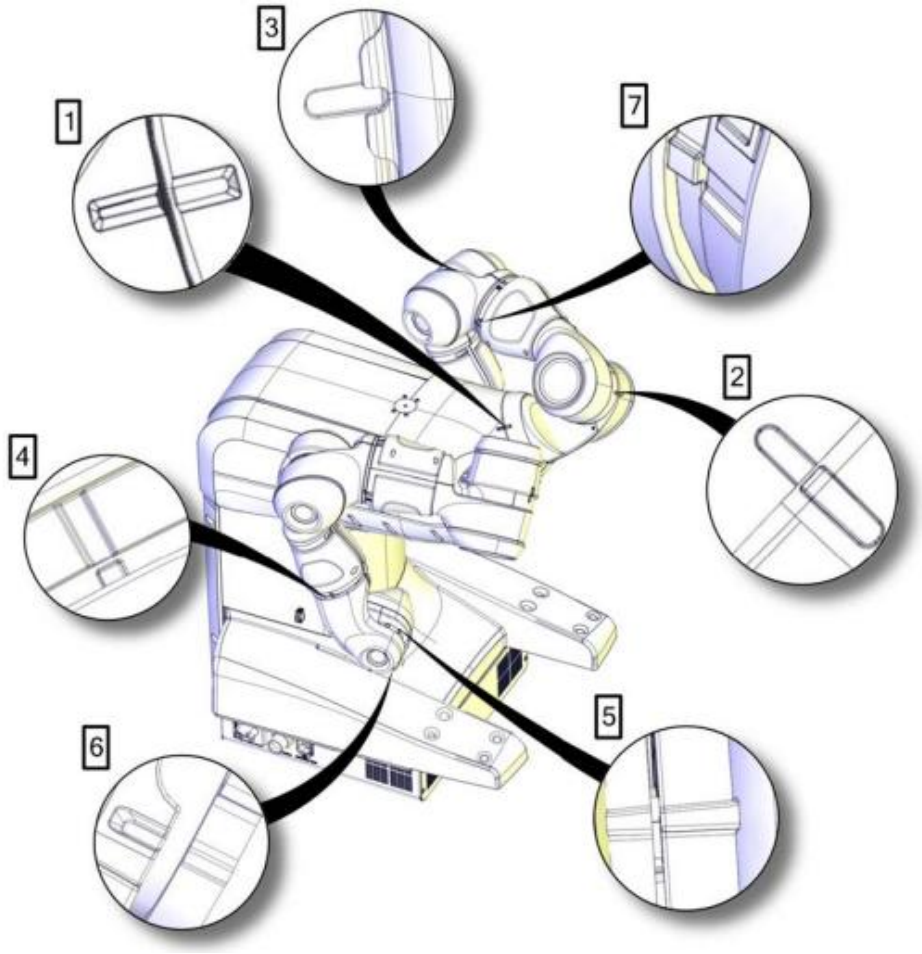
- The selected motion mode and/or coordinate system determines the way the robot moves. For more information on how to jog robots, see the Jogging section in Operating manual - IRC5 with FlexPendant.

See the Jogging section in Operating manual - IRC5 with FlexPendant for more information.

Jogging of the ABB YuMi Dual Arm

2. Robot Setup

- Before we can Calibrate the robotic arms, we need to setup both arms in the home position.
- This illustration on the right side shows the positions of the calibration scales and marks on the robot. The number aside of the enlargement corresponds to the axis number.



Jogging of the ABB YuMi Dual Arm

2. Robot Setup

- The figure on the right shows the robot in its calibration position.
- The table below specifies the exact axis positions in degrees.

Axis	IRB 14000 ROB_R	IRB 14000 ROB_L
1	0°	0°
2	-130°	-130°
3	30°	30°
4	0°	0°
5	40°	40°
6	0°	0°
7	-135°	135°

Jogging of the ABB YuMi Dual Arm

3. Robot Calibration

Updating Revolution Counters

- This section describes how to do a rough calibration of each robot axis, which updates the revolution counter value for each axis using the FlexPendant.

- The procedure can be summarized accordingly:

    a. Manually move the manipulator to the calibration position.
    b. Select the Calibration with hall sensors (CalHall) routine.
    c. Select the function Update of revolution counters.
    d. Store the revolution counter setting.

Jogging of the ABB YuMi Dual Arm

3. Robot Calibration

Updating Revolution Counters

Manually move the manipulator to the calibration position.

	Action	Note
1	**CAUTION** When releasing the holding brakes, the robot axes may move very quickly and sometimes in unexpected ways!	
2	Release the brakes of the robot arm to be calibrated and move the arm manually so that the synchronization mark of each joint is aligned. The robot now stands in its calibration position.	The synchronization marks are shown in *Calibration scale and correct axis position on page 38*. There is a tolerance for the joint position. The edge of a mark should be at least within the area of the opposite mark.

Jogging of the ABB YuMi Dual Arm

3. Robot Calibration

Updating Revolution Counters

Select the Calibration with hall sensors (CalHall) routine.

	Action	Note
1	Open the **Program Editor** on the FlexPendant.	
2	Select the task that corresponds to the robot arm to be calibrated. Tap **Open**.	
3	If necessary, create a new program. This needs to be done if no existing program is available.	
4	Select **Debug** and tap **PP to Main**.	
5	Select **Debug** and tap **Call Routine...**	
6	Select **CalHall**.	
7	Go to **Motor On** and press the **Start button**.	

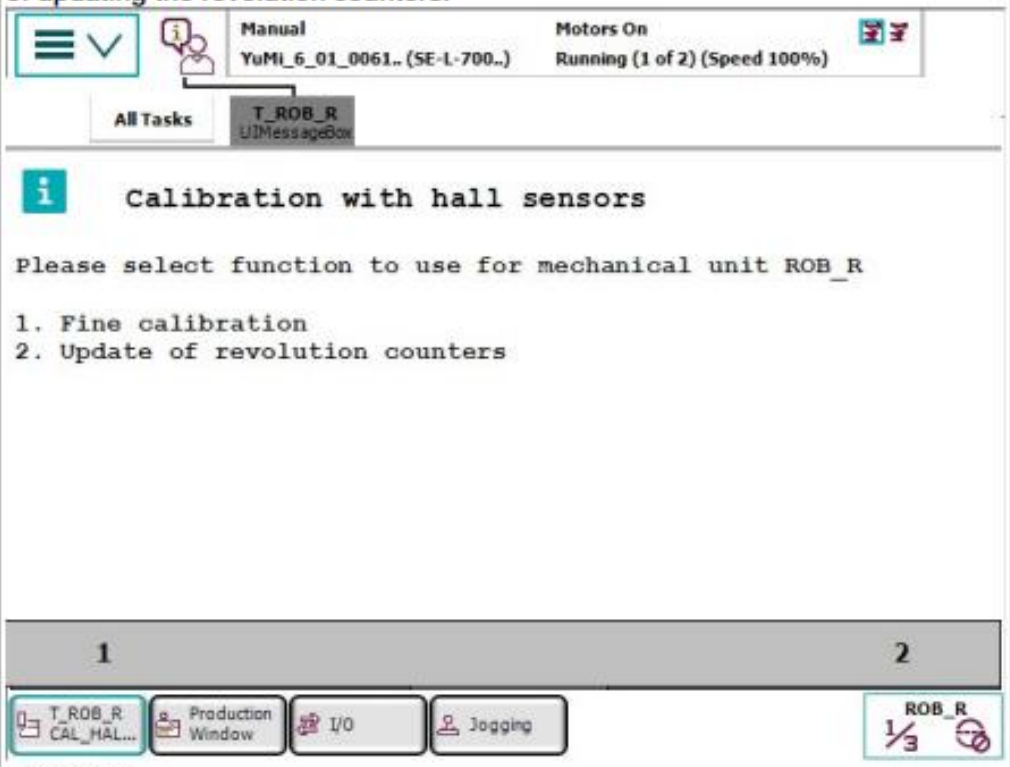
Jogging of the ABB YuMi Dual Arm

3. Robot Calibration

Updating Revolution Counters

Select the function Update of revolution counters.

	Action
1	In the calibration with hall sensors routine (CalHall), tap 2 to select the function of updating the revolution counters.



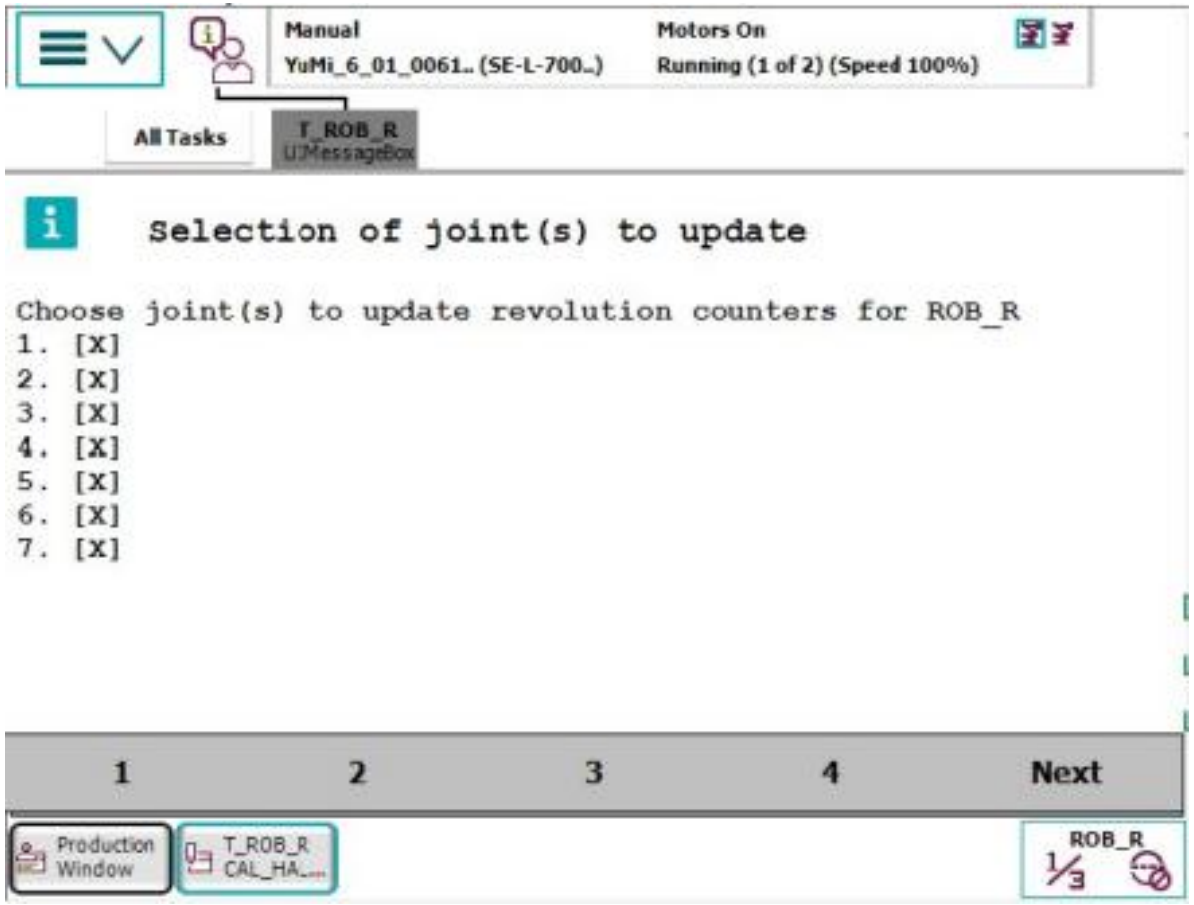
Jogging of the ABB YuMi Dual Arm

3. Robot Calibration

Updating Revolution Counters

Select the function Update of revolution counters.

Tap to select which joint(s) to update revolution counters for. Joints 1, 2, 3 and 4 are selectable in the first window. Tap Next to open the second window where joints 5, 6 and 7 are selectable.



Jogging of the ABB YuMi Dual Arm

3. Robot Calibration

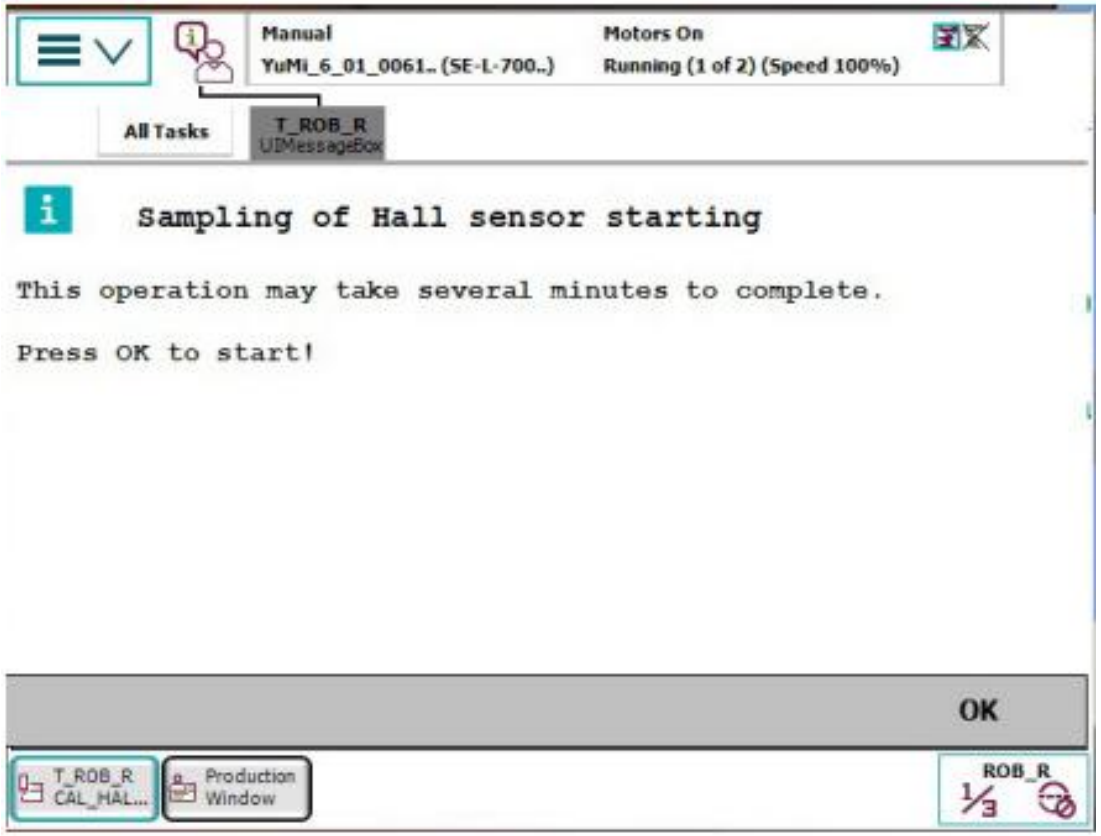
Updating Revolution Counters

Store the revolution counter setting.

Tap OK to start the sampling procedure of the hall sensor.

One at a time, each selected joint now rotates back and forth several times to calculate and find the exact position where the hall sensor is aligned with the magnet.

Calibration order: axis 1-2-3-4-5-6-7.
Note: This procedure may take several minutes



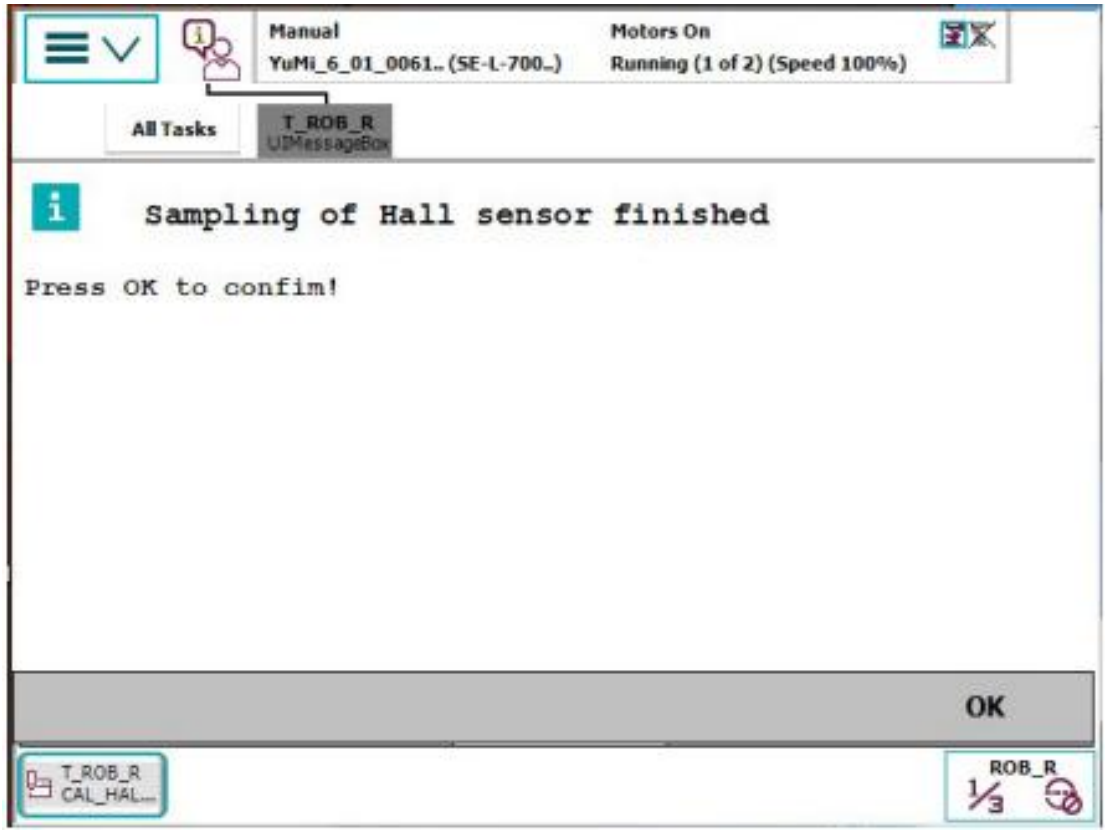
Jogging of the ABB YuMi Dual Arm

3. Robot Calibration

Updating Revolution Counters

Store the revolution counter setting.

When the sampling of hall sensors is finished, tap OK to confirm.



Jogging of the ABB YuMi Dual Arm

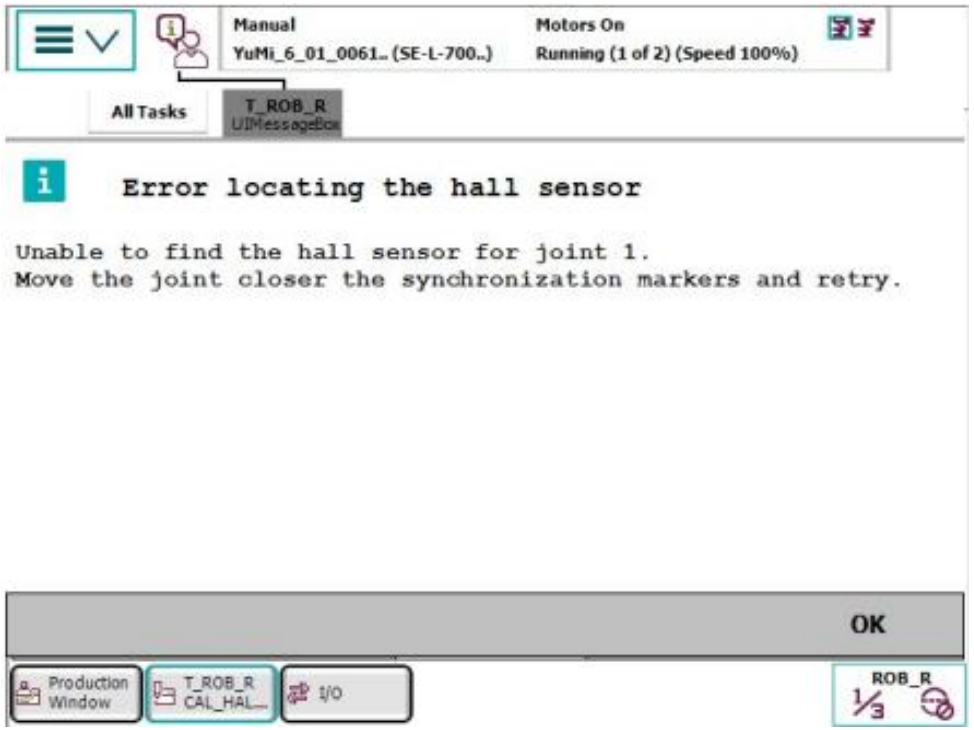
3. Robot Calibration

Updating Revolution Counters

If the hall sensor can not be found, following error message is displayed.

There can be several causes for this error.

- The joints are not sufficiently aligned according to the synchronization marks. Move the joints so that the synchronization marks are aligned. Tap OK and restart the fine calibration procedure. The joints prior to the joint that stopped the calibration procedure are calibrated and do not need to be calibrated again. Joints coming after the joint that stopped the calibration procedure has not been calibrated. (Calibration order: axis 1-2-3-4-5-6-7.)
- The hall sensor is defect. Perform troubleshooting of I/O signals. Possible replacement of hall sensor may be required.



Jogging of the ABB YuMi Dual Arm

3. Robot Calibration

Verifying the calibration position

Verify the calibration position of the robot before beginning any programming of the robot system. This may be done:

- Using a MoveAbsJ instruction with argument according to calibration position degrees on all axes.
- Using the Jogging window on the FlexPendant.

Jogging of the ABB YuMi Dual Arm

3. Robot Calibration

Verifying the calibration position

Using a MoveAbsJ instruction:

Use this procedure to create a program that runs all the robot axes to their calibration position.

	Action	Note
1	On ABB menu tap **Program editor**.	
2	Create a new program.	
3	Use **MoveAbsJ** in the **Motion&Proc** menu.	

4	Create the following program for the right arm:
	`MoveAbsJ [[0,-130,30,0,40,0], [-135,9E9,9E9,9E9,9E9,9E9]] \NoEOffs, v1000, fine, tool0;`
	Create the following program for the left arm:
	`MoveAbsJ [[0,-130,30,0,40,0], [135,9E9,9E9,9E9,9E9,9E9]] \NoEOffs, v1000, fine, tool0;`	

5	Run the program in manual mode.	
6	Verify that the calibration marks for the axes align correctly. If they do not, then update the revolution counters.	See *Calibration scale and correct axis position on page 38* and *Updating revolution counters on page 40*.

Jogging of the ABB YuMi Dual Arm

3. Robot Calibration

Verifying the calibration position

Using the jogging window:

Use this procedure to jog the robot to the calibration position for all axes.

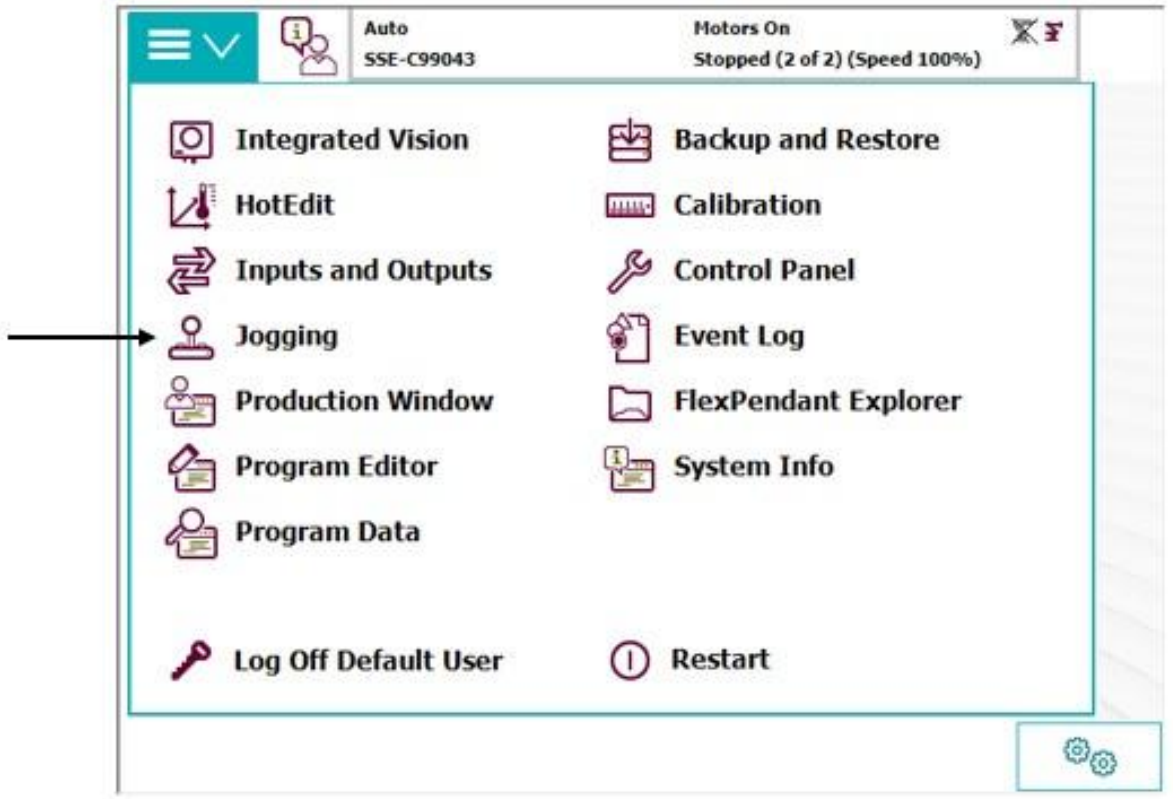
	Action	Note
1	On the **ABB** menu, tap **Jogging**.	
2	Tap **Motion mode** to select group of axes to jog.	
3	Tap to select the axis to jog, axis 1, 2, or 3.	
4	Manually run the robots axes to a position where the axis position value read on the FlexPendant, is equal to the calibration position degrees.	Degrees are specified in *Exact axis positions in degrees on page 39*.
5	Verify that the calibration marks for the axes align correctly. If they do not, then update the revolution counters!	See *Calibration scale and correct axis position on page 38* and *Updating revolution counters on page 40*.

Jogging of the ABB YuMi Dual Arm

4. Jogging of the Robotic arm

Accessing the jogging screen

The jogging screen is located in the main menu.

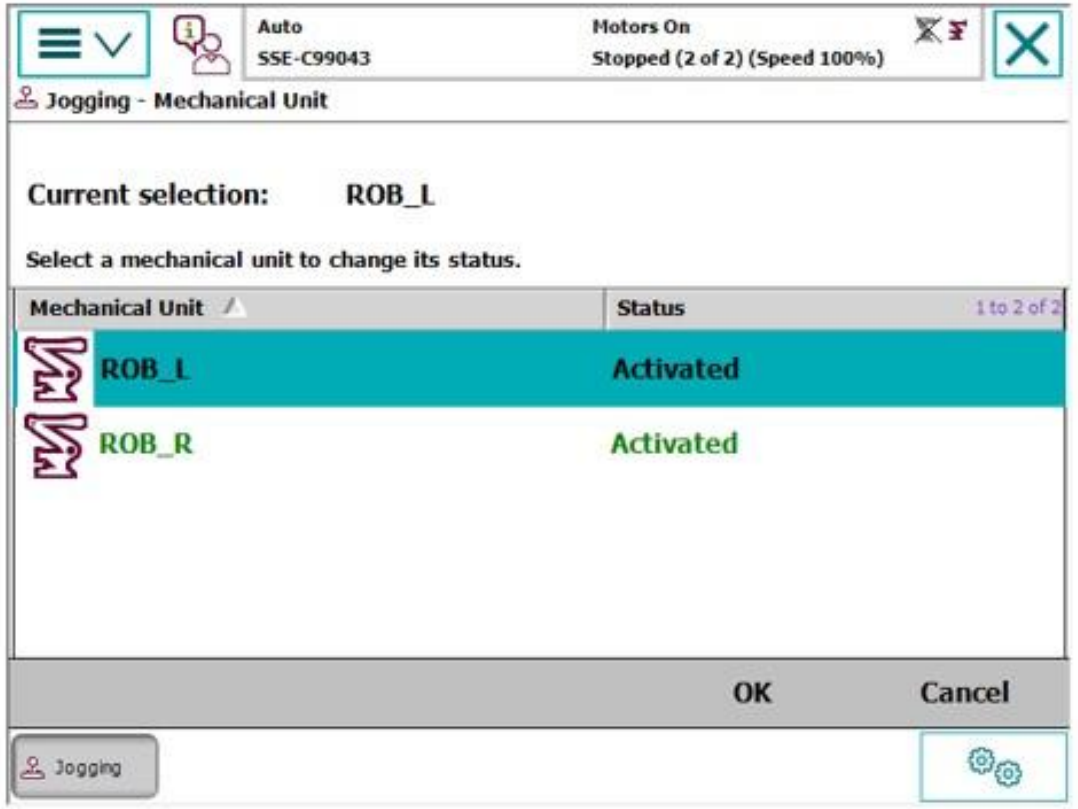


Jogging of the ABB YuMi Dual Arm

4. Jogging of the Robotic arm

Properties: *Mechanical Unit*

ROB_L is the left arm of the robot
ROB_R is the right arm of the robot

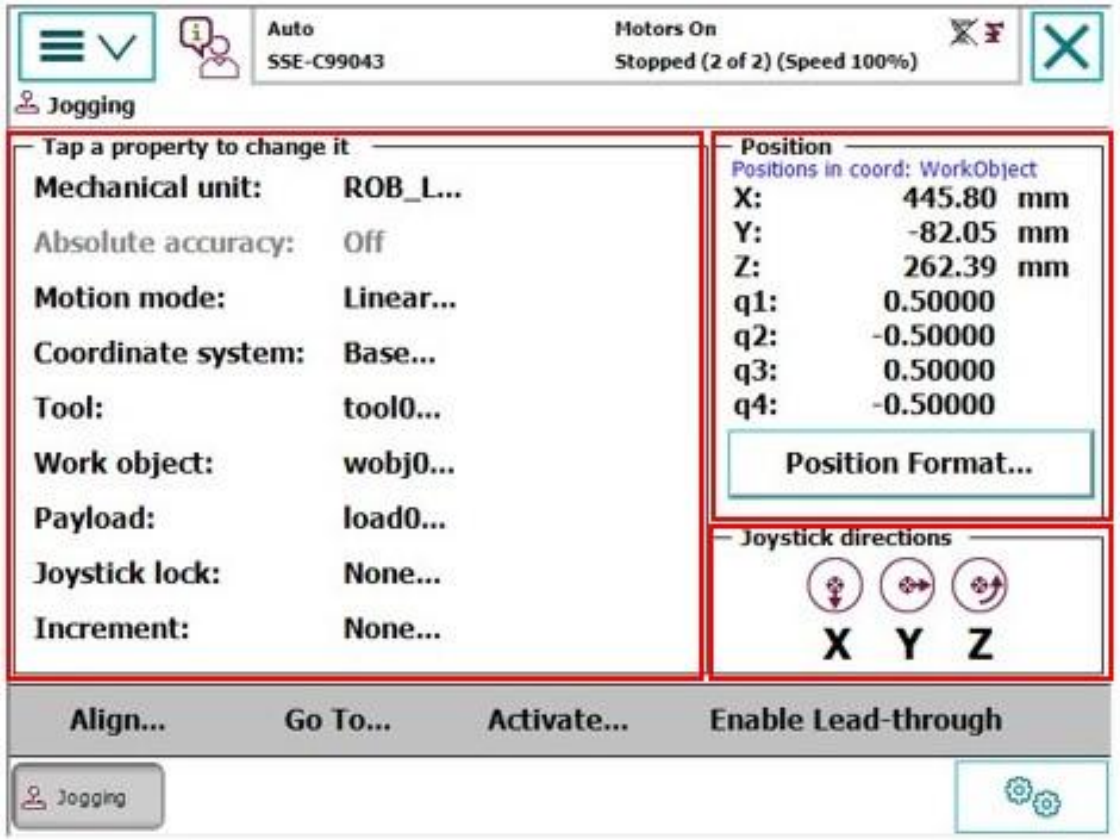


Jogging of the ABB YuMi Dual Arm

4. Jogging of the Robotic arm

Accessing the jogging screen

The jogging screen, shown below, is divided into three regions: properties, position, and joystick directions.

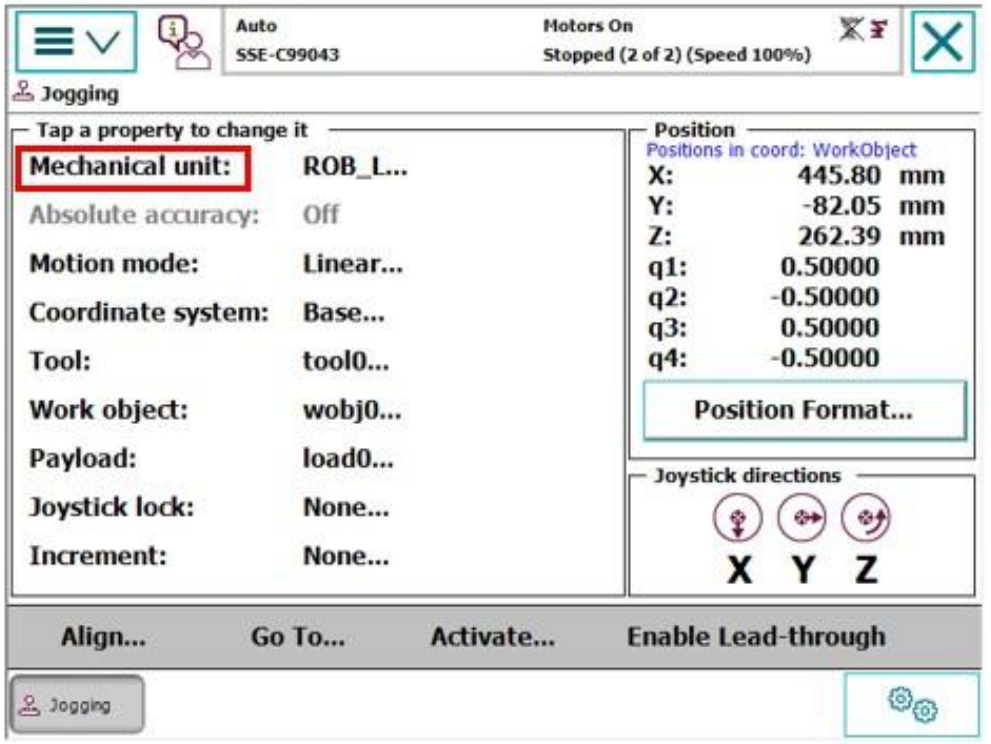


Jogging of the ABB YuMi Dual Arm

4. Jogging of the Robotic arm

Properties: *Mechanical Unit*

Changing the arms can be done by tapping the Mechanical unit in the Jogging screen and selecting whichever you would like to control.

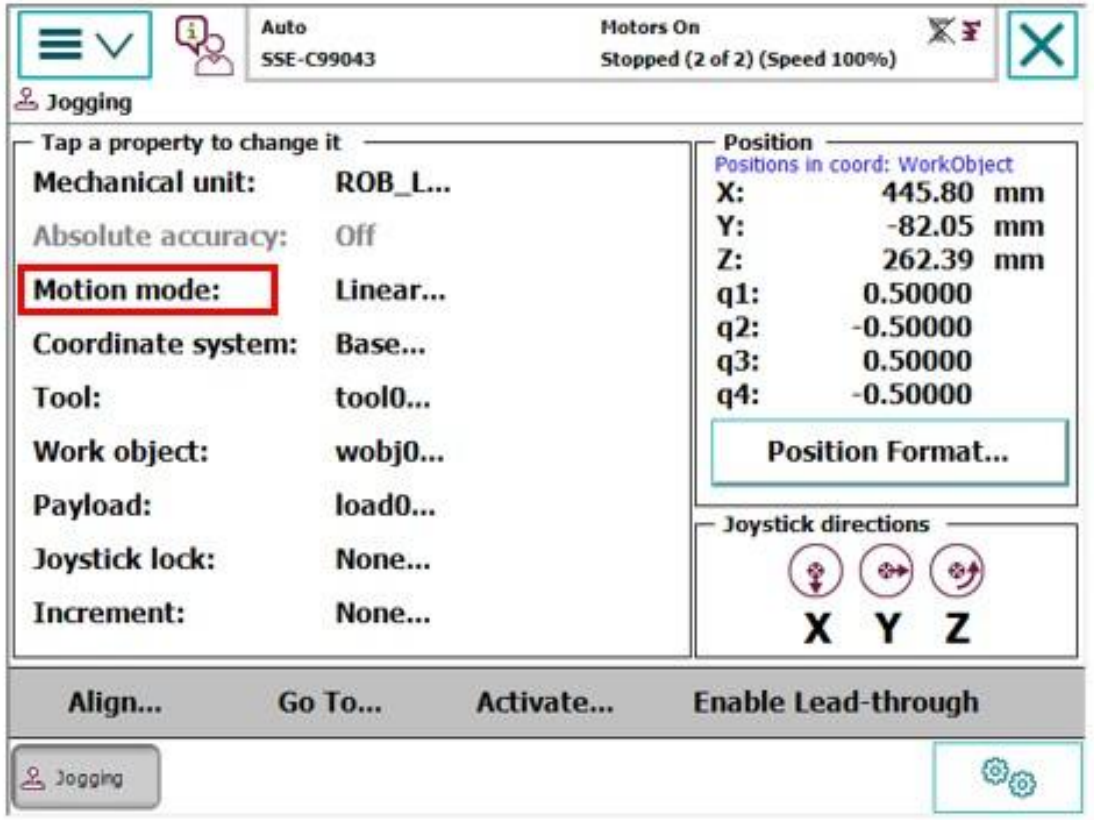


Jogging of the ABB YuMi Dual Arm

4. Jogging of the Robotic arm

Properties: *Motion Mode*

There are multiple motion modes that can be selected by tapping on the Motion mode in the jogging screen.



Jogging of the ABB YuMi Dual Arm

4. Jogging of the Robotic arm

Properties: *Motion Mode*

- **Axis by axis modes** are used to move individual joints independently.
- **Linear mode** is used to move the tool center point linearly from point A to point B.
- **Reorient mode** is used to reorient the entire arm while keeping the tool center point fixed.
- **Arm mode** is used to change the arm angle while keeping the tool center point and the orientation of the tool fixed.

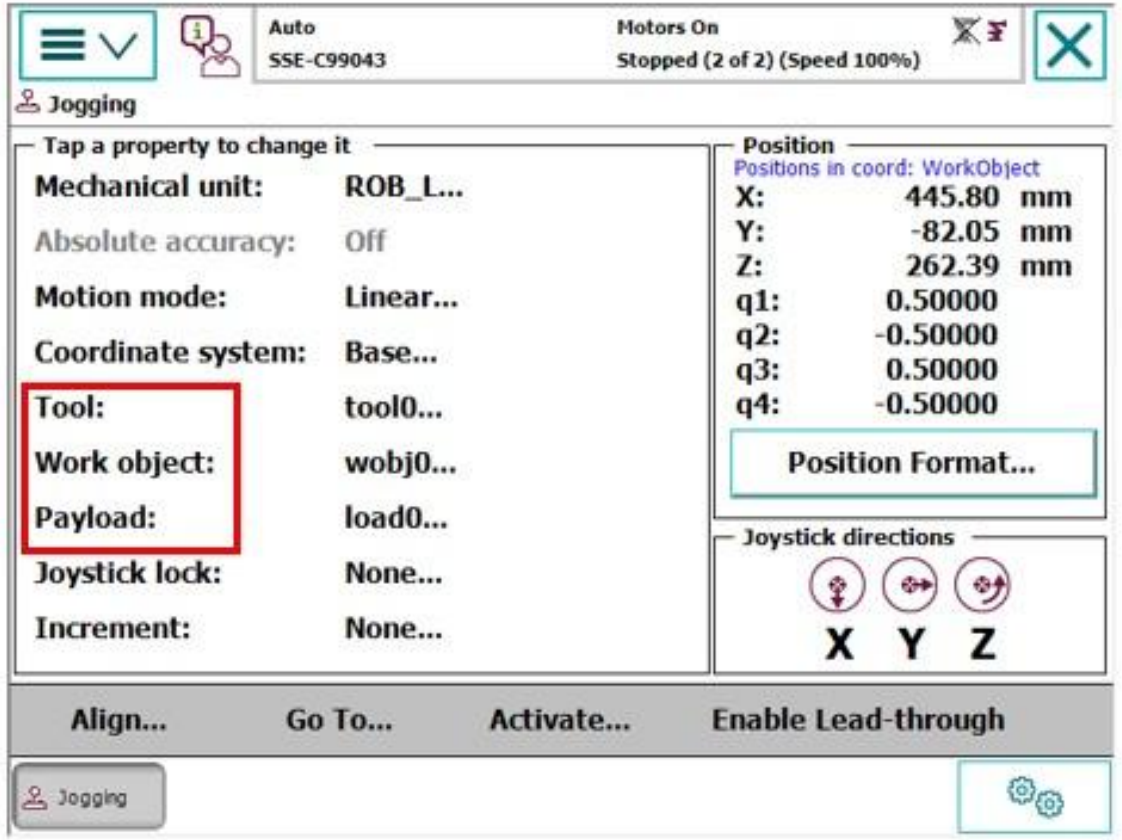
Refer FlexPendant manual page 122 - for additional information.

Jogging of the ABB YuMi Dual Arm

4. Jogging of the Robotic arm

Properties: ***Data***

Tool data, work object data, and payload data can be declared and selected in the jogging screen.



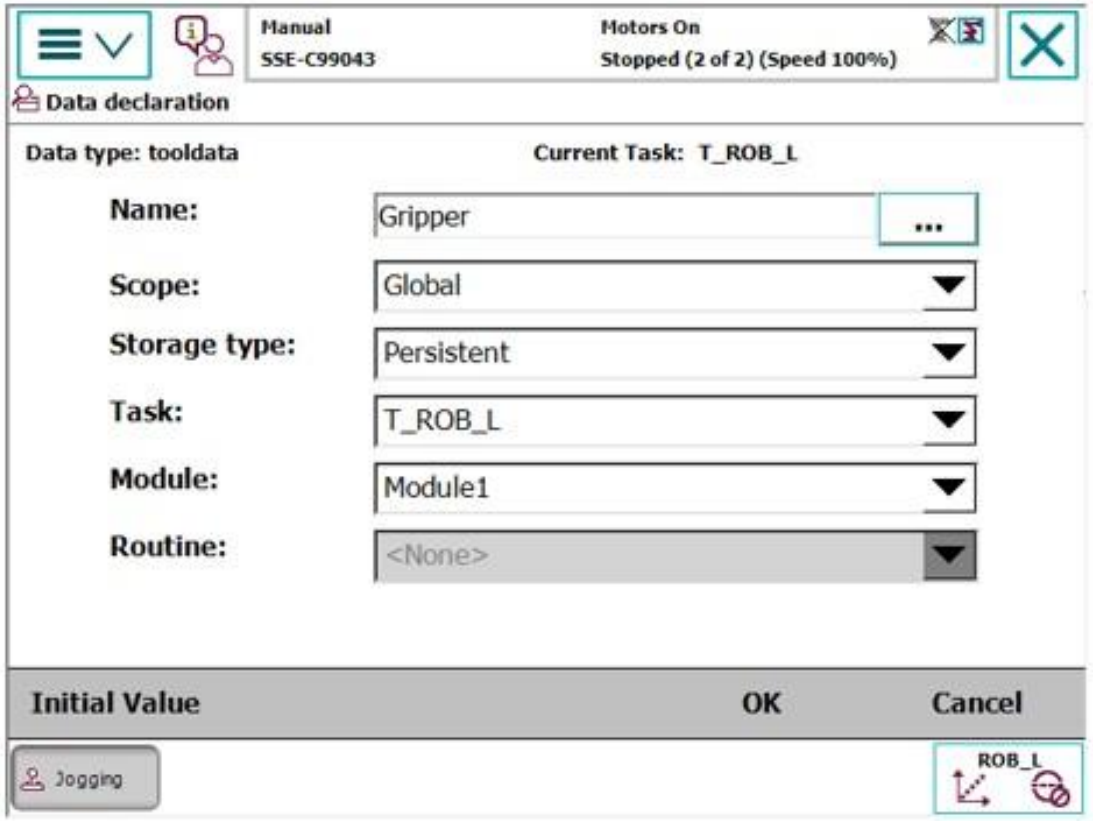
Jogging of the ABB YuMi Dual Arm

4. Jogging of the Robotic arm

Properties: ***Tool Data***

- New tool data is used when there is a tool attached to joint 6 of the robot, for example the smart gripper. The tool data helps you set a new center point based on the tool and a coordinate system for the tool. Declaration data of the tool can be defined such as scope, storage type, task, and module. The scope should always be global, and the storage type should always be persistent unless instructed otherwise.

- Tapping on Initial Value will let you define the offset and orientation of the tool compared to tool0/joint 6, the weight, and the load data. The deceleration and the value of the tool can be changed at any moment by tapping on the tool and tapping Edit.

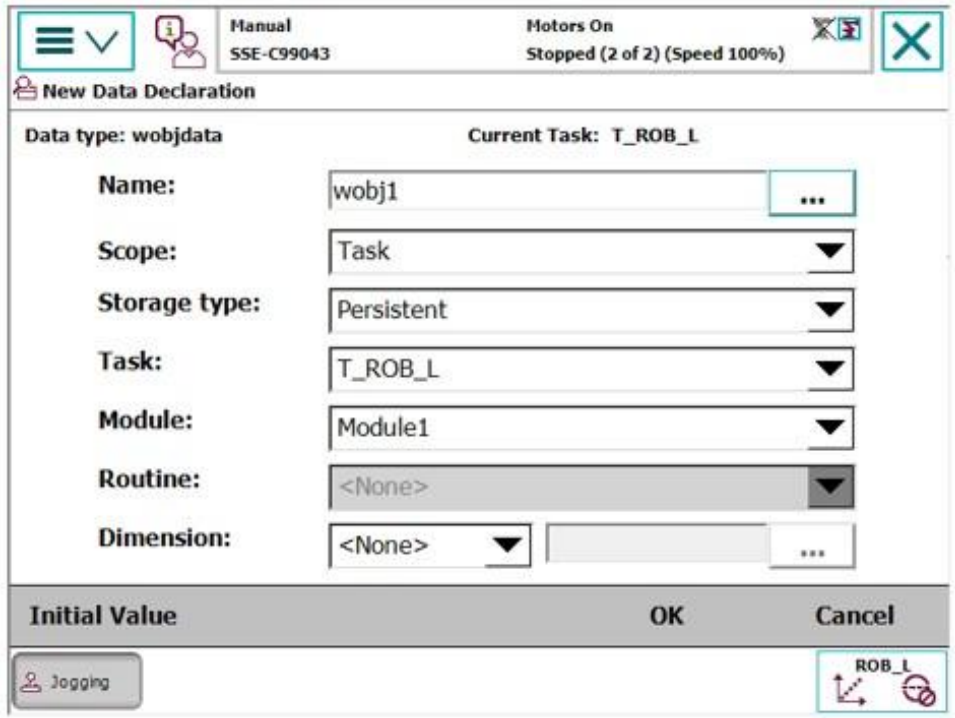


Jogging of the ABB YuMi Dual Arm

4. Jogging of the Robotic arm

Properties: ***Work Object Data***

- New work object data is used to create a coordinate system around an object that is being used for specific tasks. Declaration data of the tool can be defined, such as scope, storage type, task, and module. The scope should always be global, and the storage type should always be persistent unless instructed otherwise.
- Tapping on Initial Value will let you define the position and orientation of the object. It also lets you define robhold which is whether the arm is holding the object during the task, ufprog which is whether a fixed user coordinate system is used, and ufmec which is to define the mechanical unit that the arm is coordinating with. The deceleration and the value of the work object can be changed at any moment by tapping on the work object and tapping Edit.

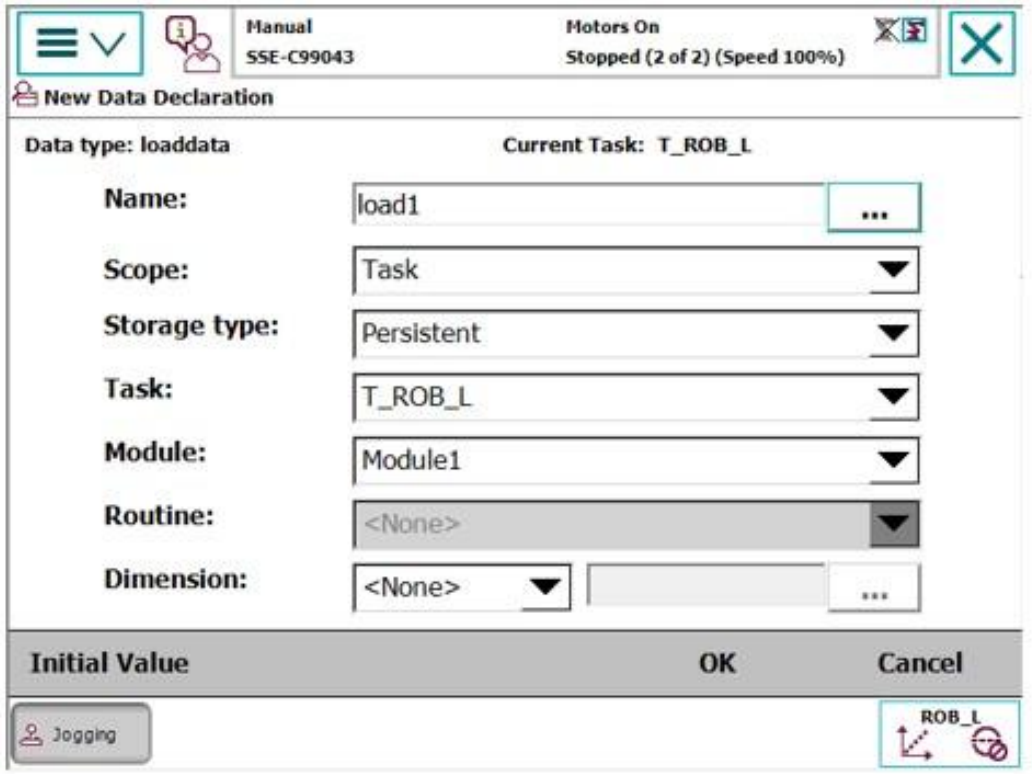


Jogging of the ABB YuMi Dual Arm

4. Jogging of the Robotic arm

Properties: ***Payload Data***

- New payload data is used to create a coordinate system around a payload and to set the physical properties of the payload. Declaration data of the payload can be defined, such as scope, storage type, task, and module. The scope should always be global, and the storage type should always be persistent unless instructed otherwise.
- Tapping on Initial Value lets you define its mass, center of gravity, orientation, and moment of inertia. The deceleration and the value of the work object can be changed at any moment by tapping on the payload and tapping Edit.



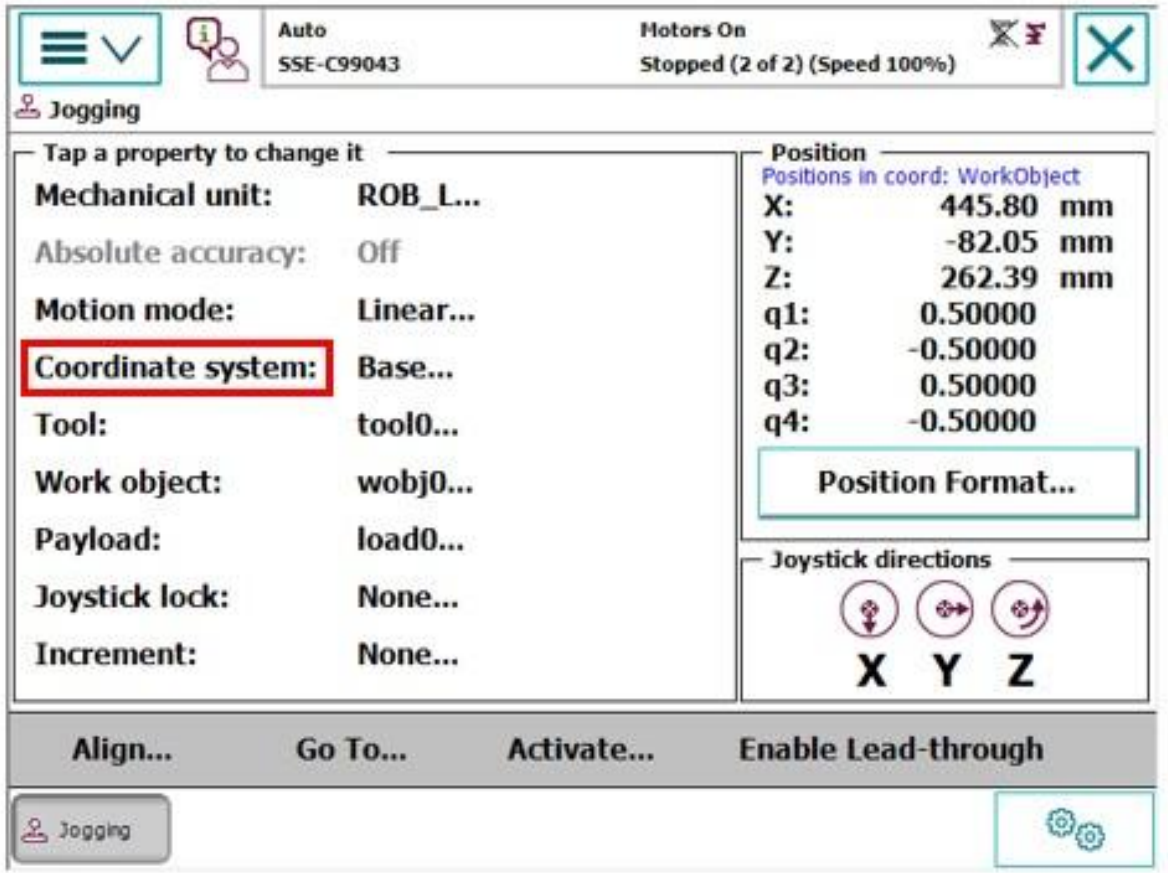
Refer FlexPendant manual page 171-205 for additional information.

Jogging of the ABB YuMi Dual Arm

4. Jogging of the Robotic arm

Coordinate system

Different coordinate systems can be selected for the linear, reorient, and arm modes.



Jogging of the ABB YuMi Dual Arm

4. Jogging of the Robotic arm

Coordinate system

- **World**: Coordinate system that defines the robot cell, all other coordinate systems are related to the world coordinate system, useful for jogging and general movements.
- **Base**: Coordinate system zero at the base of the Yumi, it is the easiest one for just moving the robot from one position to another.
- **Tool**: Coordinate system zero at the tool center point (TCP).
- **Work Object**: Coordinate system zero at any work object created.

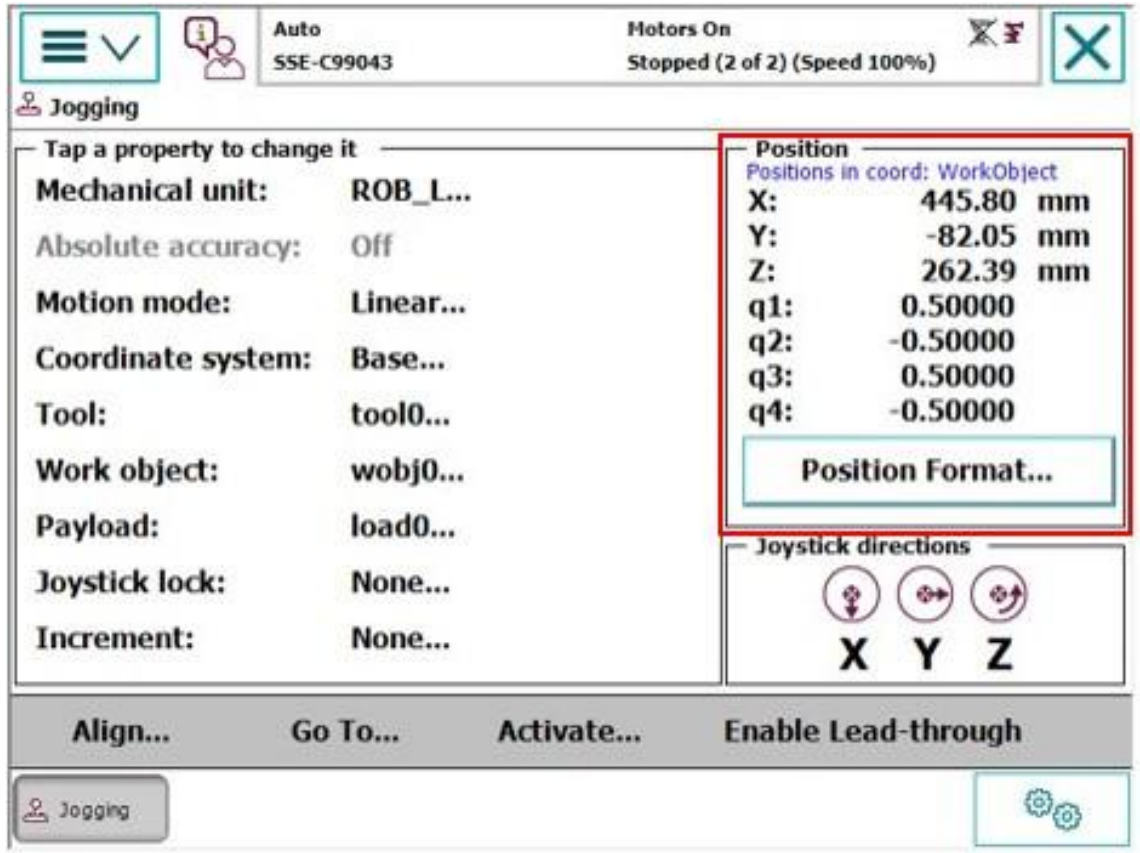
Jogging of the ABB YuMi Dual Arm

4. Jogging of the Robotic arm

Position

The position box shows the position of the tool center point (TCP).

It shows the coordinates (in x, y, and z) and the orientation of the TCP when in linear and reorient mode. It will only show the arm angle when in arm mode.

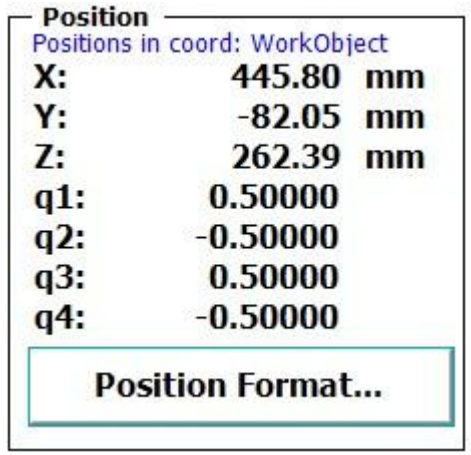


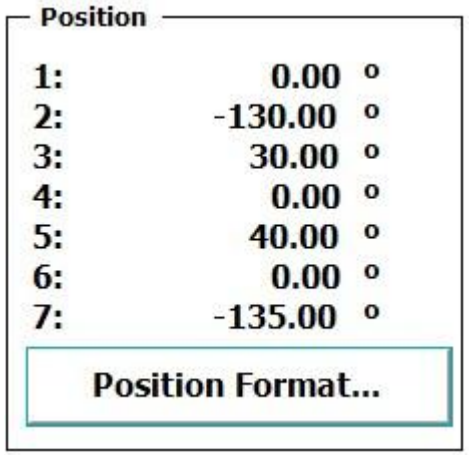
Jogging of the ABB YuMi Dual Arm

4. Jogging of the Robotic arm

Position

It shows the angles of the joints when in axis 1-3, axis 4-6, or axis 7 mode.





Jogging of the ABB YuMi Dual Arm

4. Jogging of the Robotic arm

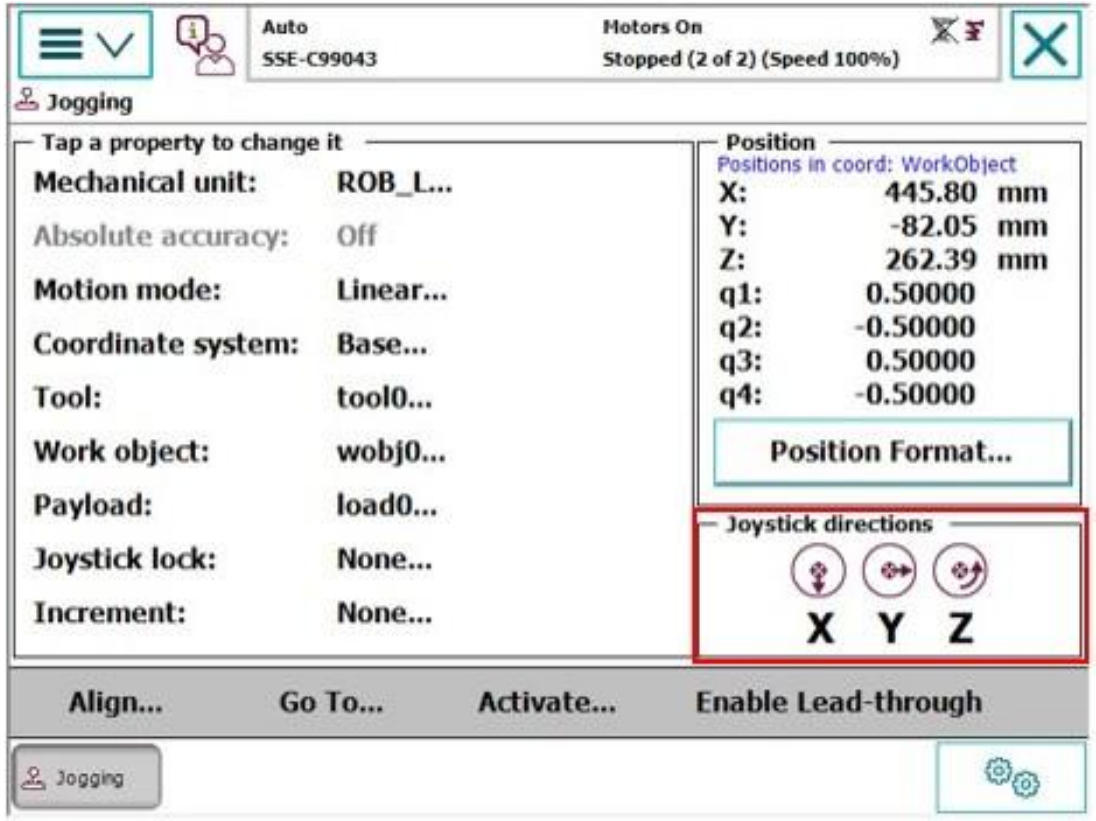
Joystick Directions

When you select a motion mode the joystick directions will appear on the bottom right of the screen.

The joystick has 3 directions of motions:

- Up and down
- Left and right
- Twisting: clockwise or counterclockwise

The joystick directions will indicate what type of axis or joint each motion will control.

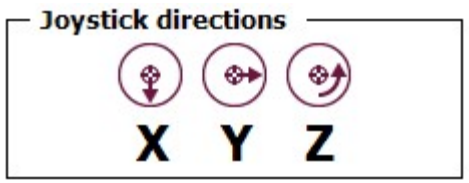


Jogging of the ABB YuMi Dual Arm

4. Jogging of the Robotic arm

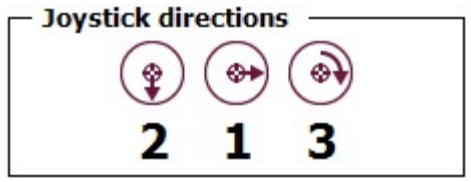
Joystick directions

- For the linear and reorient modes, each motion of the joystick controls each axis as shown:



- For the arm mode there is only one motion controlling the arm angle.

- For the axis-by-axis modes, each motion of the joystick controls each axis (Axis 1-3 mode) as shown:



- Since the robot has only 7 axes of rotation, Axis 7 mode will only have one motion controlling axis 7.

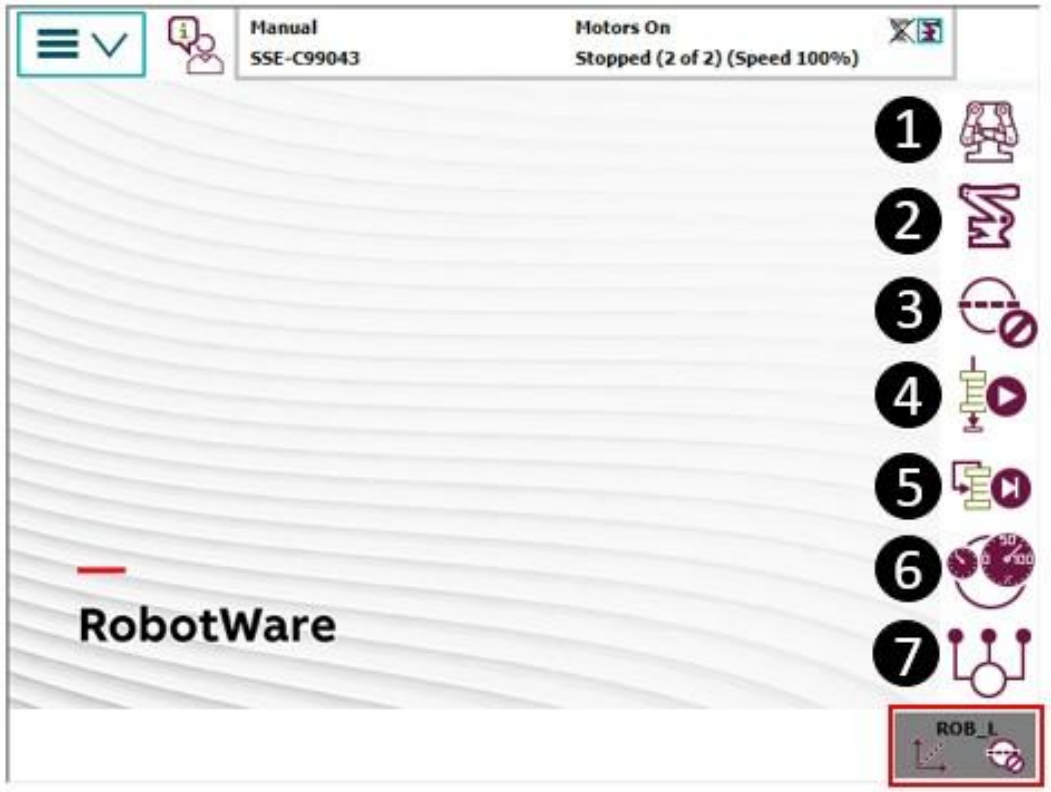
Jogging of the ABB YuMi Dual Arm

4. Jogging of the Robotic arm

Quickset Menu

The quickset menu provides a convenient way to change most common jog properties and few other things. It is accessed by tapping on the quickset menu in the bottom right of the screen.

1. Operator Panel
2. Mechanical Unit
3. Increment
4. Run Mode
5. Step Mode
6. Speed
7. Tasks

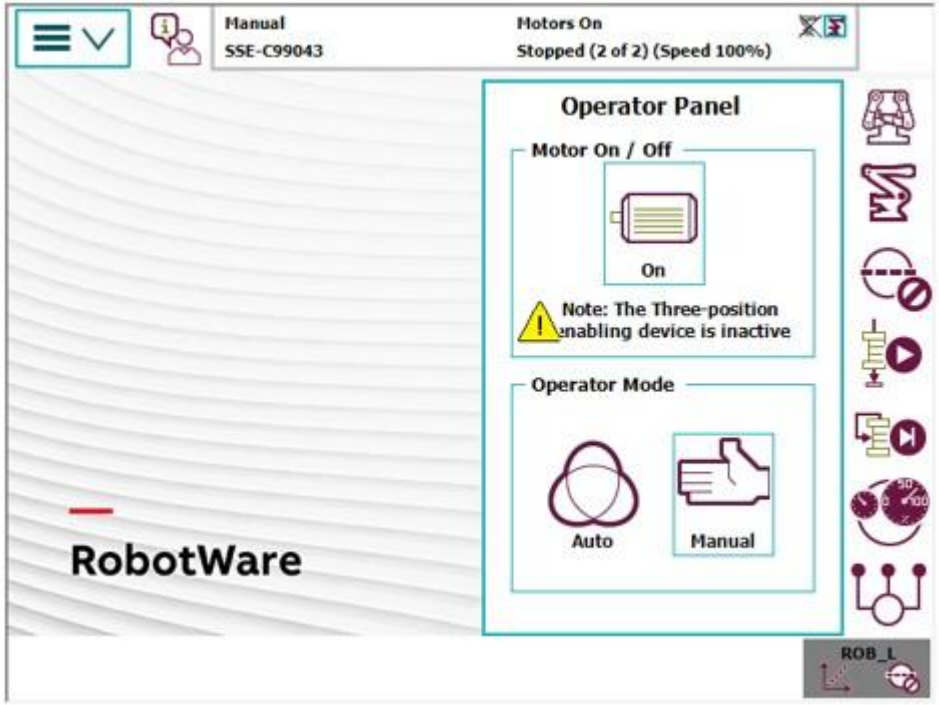


Jogging of the ABB YuMi Dual Arm

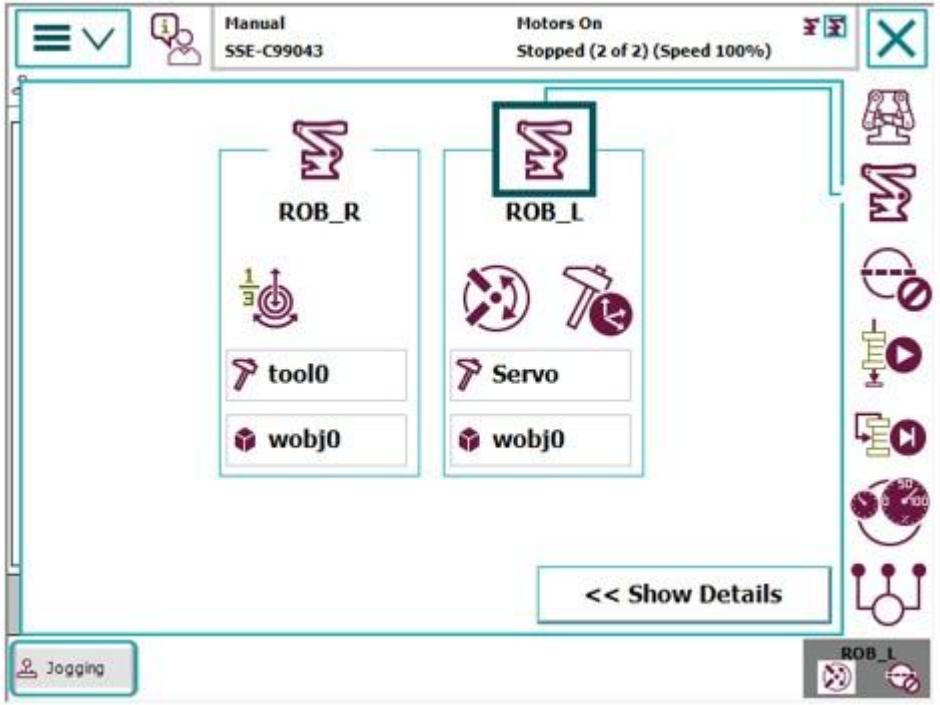
4. Jogging of the Robotic arm

Quickset Menu

Operator Panel: Allows for change between the operator modes and the motor's on and off state.



Mechanical Unit: Allows for a quick change of the arm, motion mode, coordinate system, tool data, and work object data.

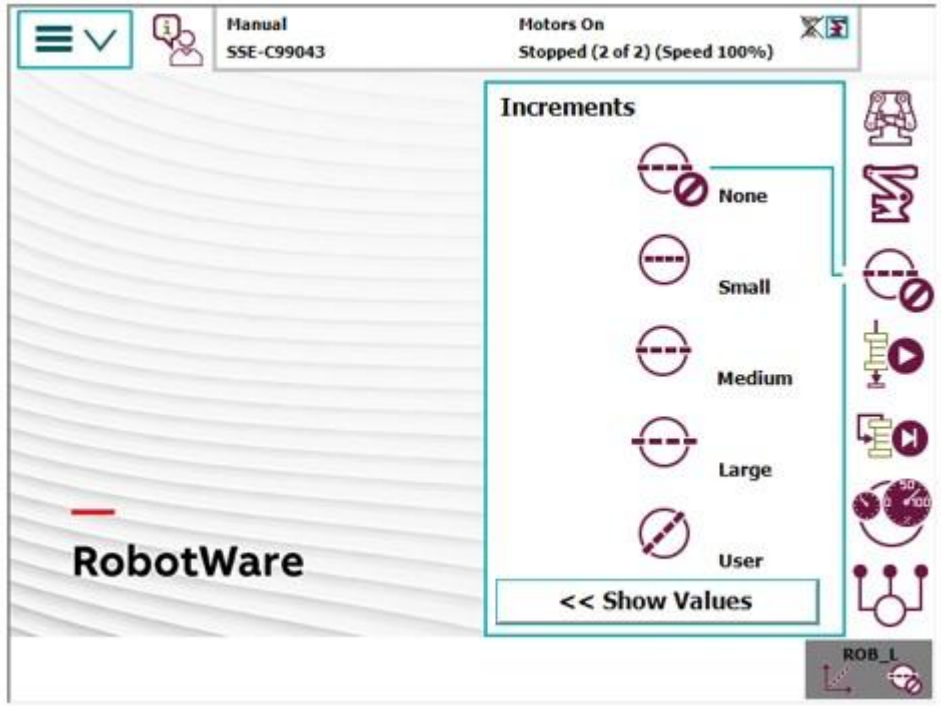


Jogging of the ABB YuMi Dual Arm

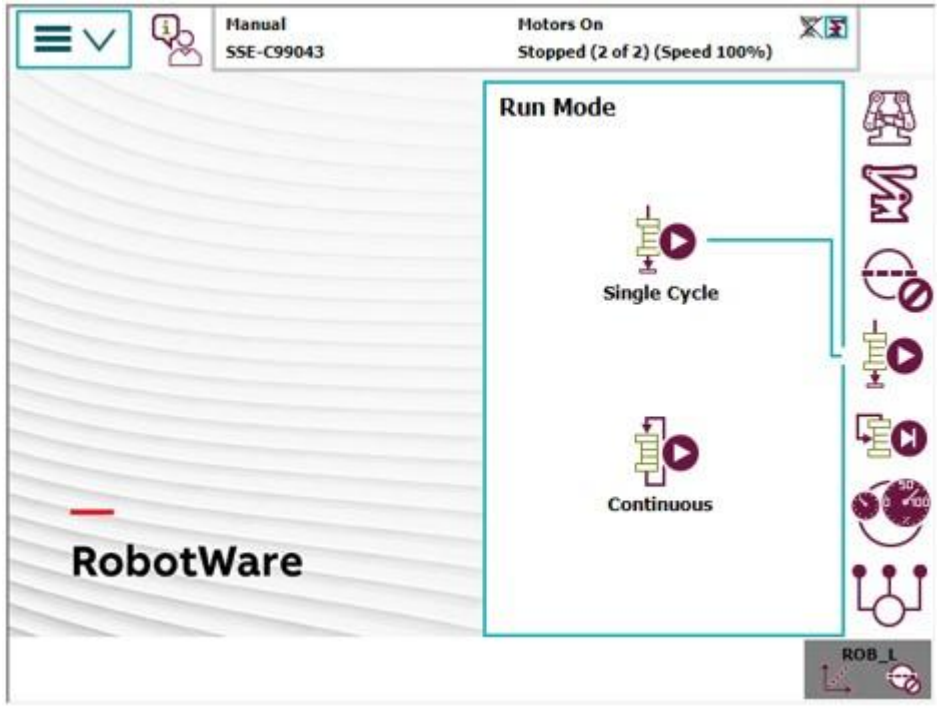
4. Jogging of the Robotic arm

Quickset Menu

Increments: Allows for incremental movement selection which allows the robot to jog in small steps, which enables very precise positioning.



Run Mode: By setting run mode you define if the program execution should run once and then stop or run continuously.



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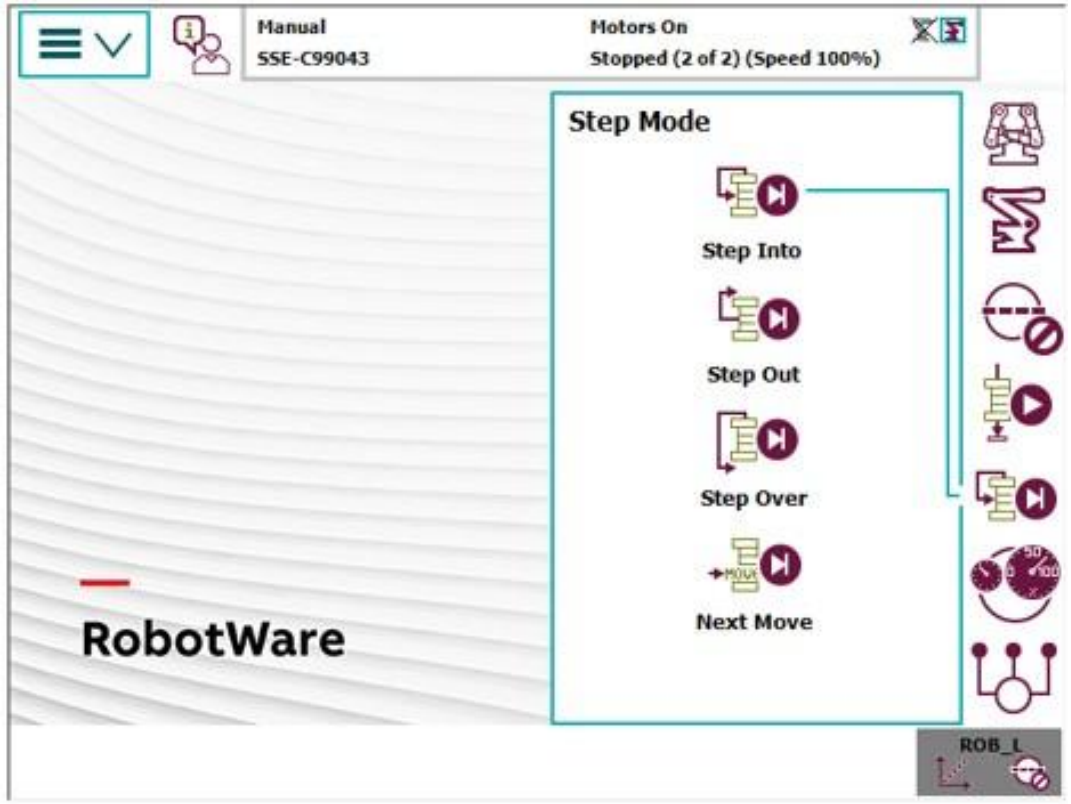
Jogging of the ABB YuMi Dual Arm

4. Jogging of the Robotic arm

Quickset Menu

Step Mode: Allows for change between how the step-by-step program execution should function.

Step Into	Steps into called routines and executes them step-by-step.
Step Out	Executes the remains of the current routine and then stops at the next instruction in the routine from which the current routine was called. Not possible to use in the Main routine.
Step Over	Called routines are executed in one single step.
Next Move	Steps to the next move instruction. Stops before and after movement instructions, for example, to modify positions.

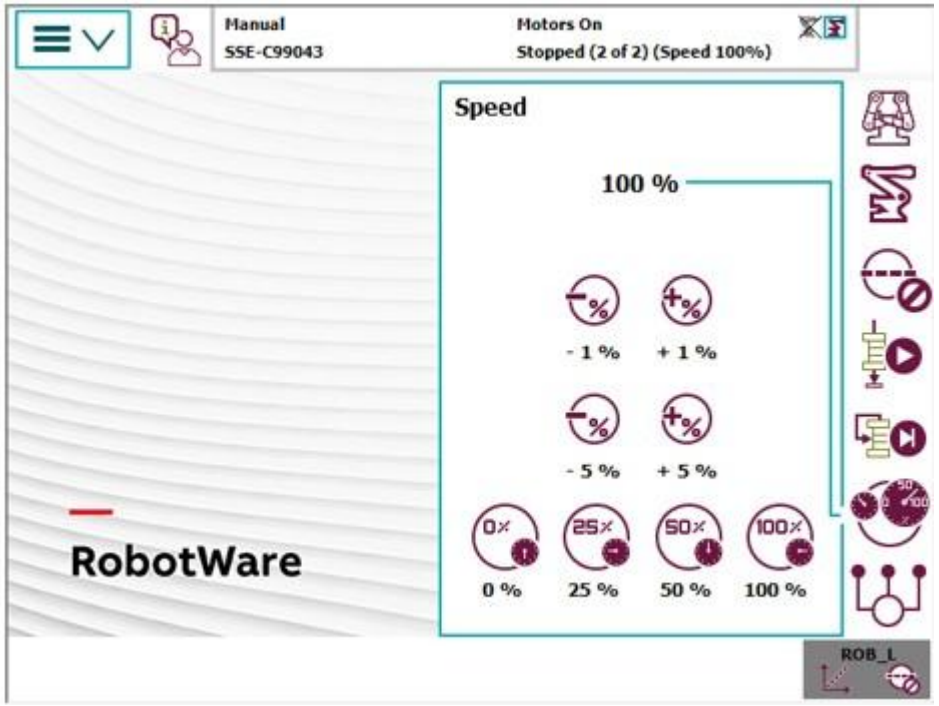


Jogging of the ABB YuMi Dual Arm

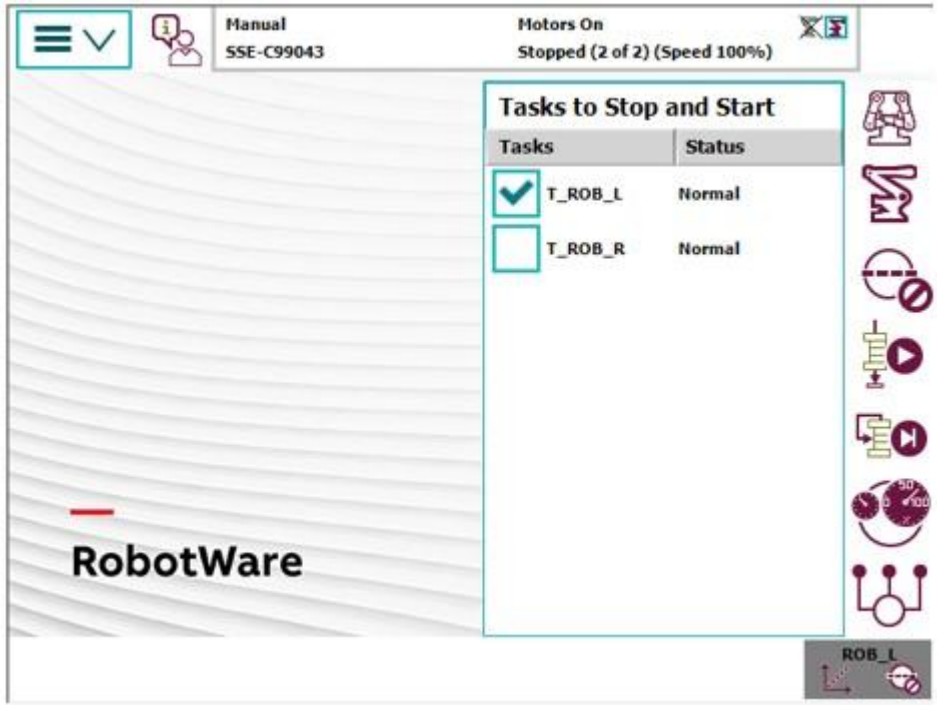
4. Jogging of the Robotic arm

Quickset Menu

Speed: The speed (related to max speed) can be seen and changed in this tab.



Tasks: Allows for activation/deactivation of Normal tasks.

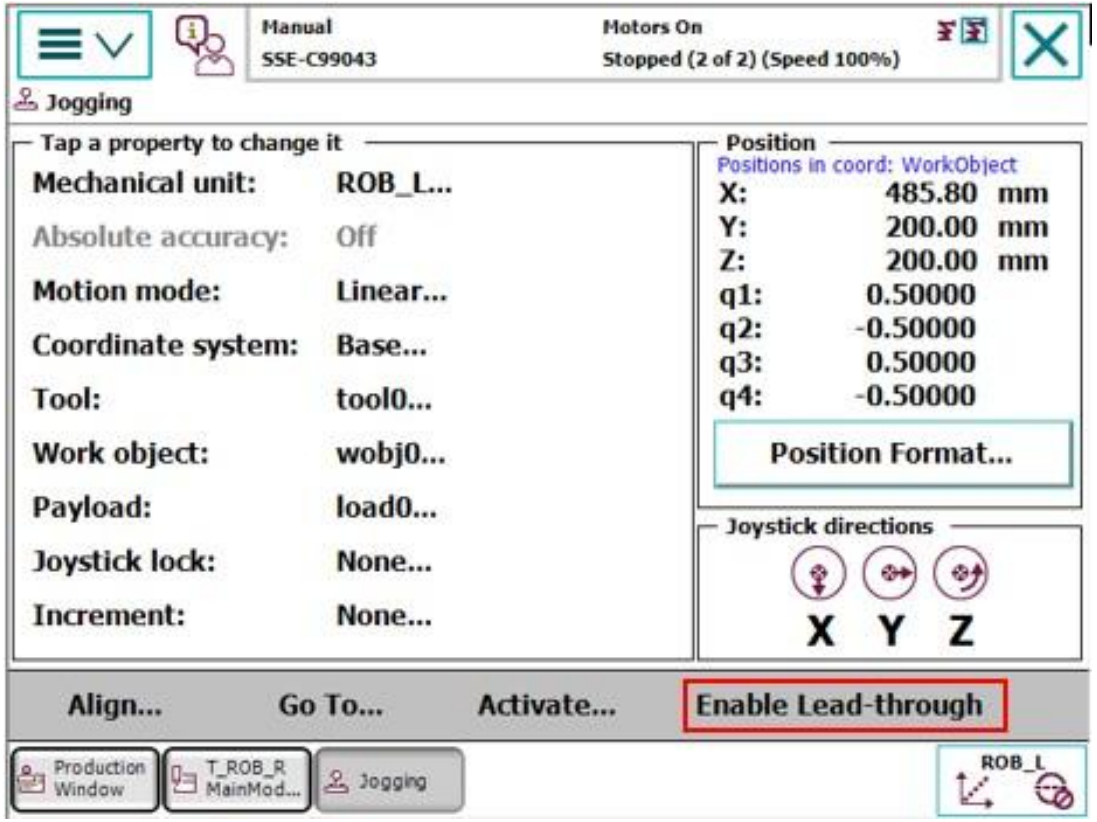


Jogging of the ABB YuMi Dual Arm

4. Jogging of the Robotic arm

<u>Bottom Tab</u>: Enable lead-through

The Enable Lead-through button allows you to deactivate the brakes of the arm and move it manually, it will work even when the motors are on. The brakes will stay inactive until Disable Lead-through is pressed.



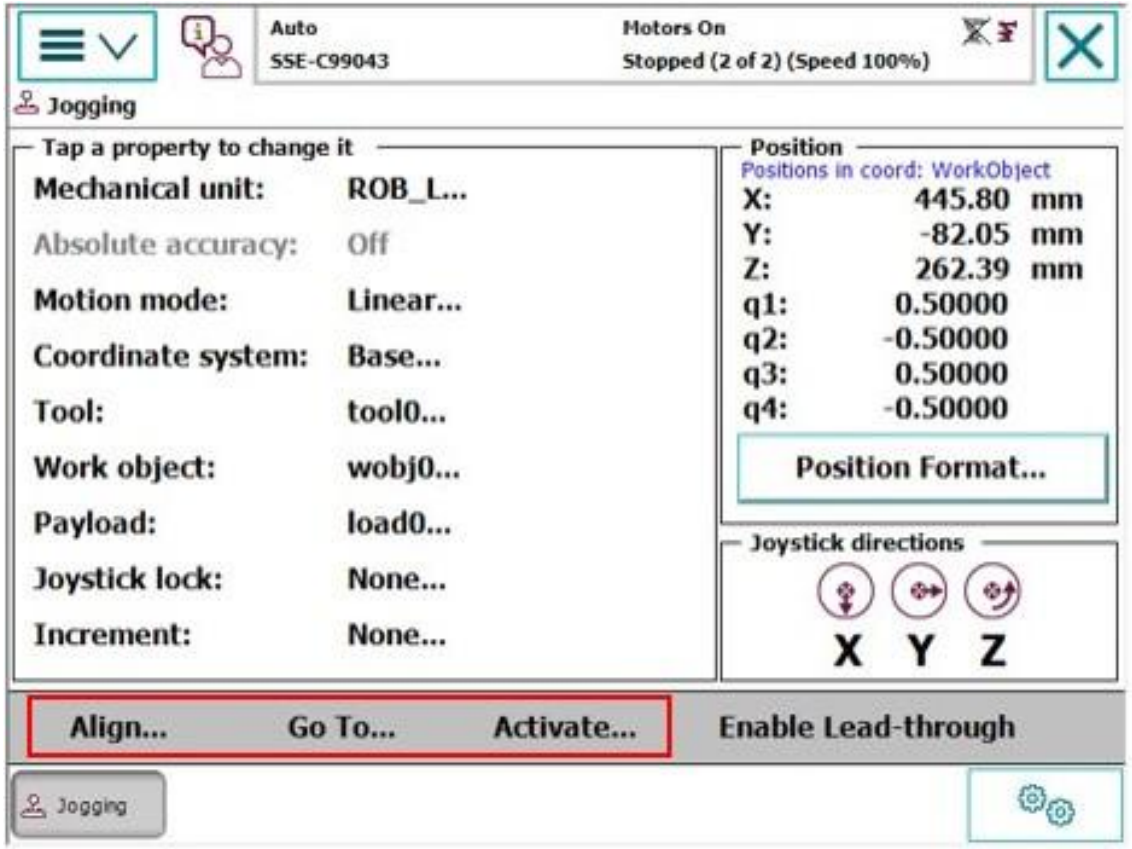
Jogging of the ABB YuMi Dual Arm

4. Jogging of the Robotic arm

<u>Bottom Tab</u>: Enable lead-through

The other three features are unnecessary for the jogging features, they will be talked about in future guides or could be found out about through the manuals as well.

ABB YuMi Operating Manual Page 36 - for additional information.



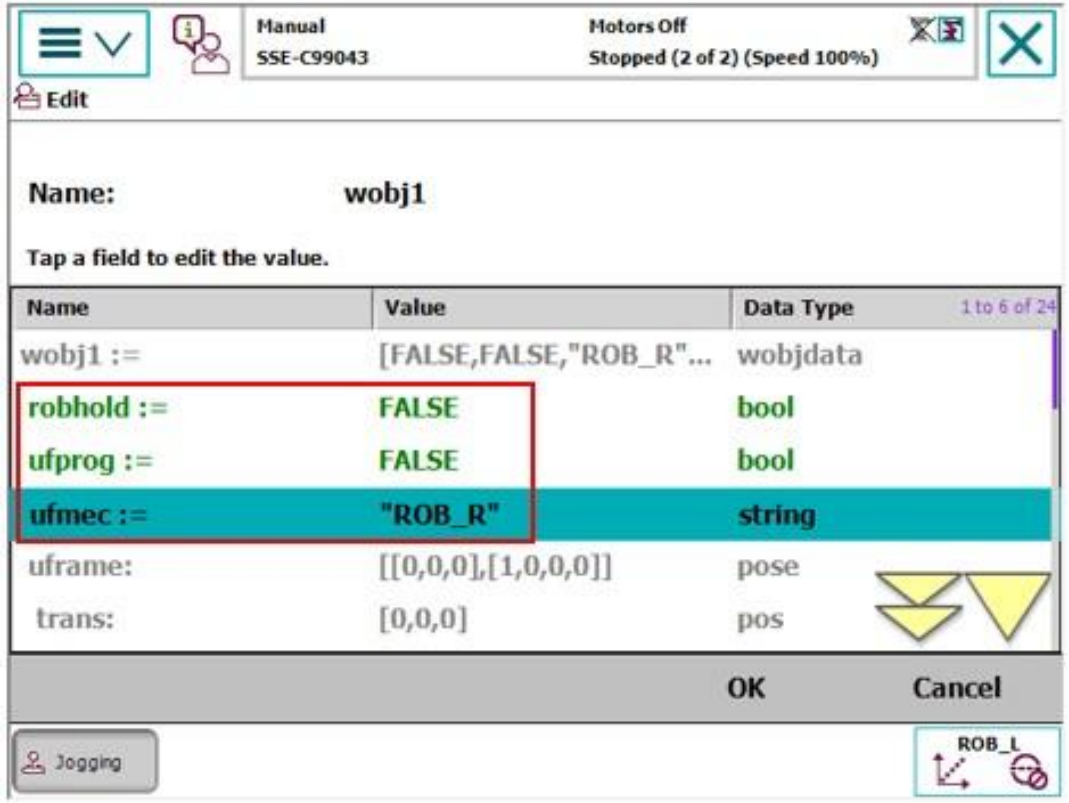
Jogging of the ABB YuMi Dual Arm

4. Jogging of the Robotic arm

Synchronized Jogging

The two arms of YuMi can be jogged simultaneously using coordinated mode. To move both arms together, follow these steps:

- Create a work object for the arm that will be coordinated (the other arm will lead its motion maintaining the relative position between the two).
- Define the data of the work object.
  Set hobhold and ufprog to FALSE, set ufmec to the other arm.



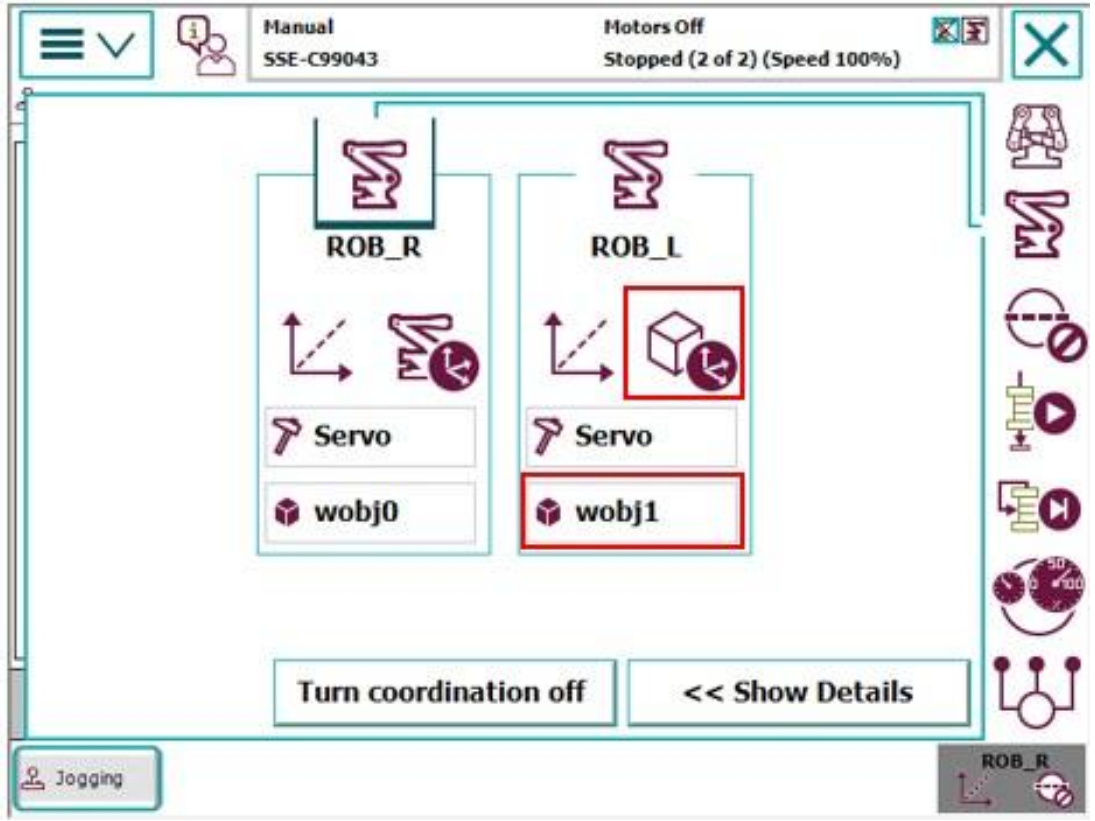
Jogging of the ABB YuMi Dual Arm

4. Jogging of the Robotic arm

Synchronized Jogging

- In the jogging or the quickset menu, select the synchronized work object and the work object coordination system for the arm that is to be coordinated.
- Switch to leading arm. Now when jogging the leading arm, both arms will move together.

ABB YuMi Operating Manual Page 34-35 for additional information.



Thank You

Looking to Collaborate, let's connect

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