VAS CORPORATION

XMC-ROBOT

EtherCAT Master Robot Controller User's Manual

Table of Contents

1. Safety

1.1. About this section

This section describes safety principles and procedures to be used when a robot or robot system is operated.
It does not cover how to design for safety nor how to install safety related equipment.

1.2. Applicable standards

1.3. Safety actions

1.3.1. Stop the system

1.3.1.1. Overview

Press any of the emergency stop buttons immediately if:

- There are many personnel in the robot manipulator area, while the manipulator is working.
- The manipulator causes harm to personnel or mechanical equipment.

1.3.1.2. The controller emergency stop button

The controller emergency stop button is located on the top-middle of the teach pendant.

1.3.1.3. External emergency stop signal

Beside the controller emergency stop button, user can configure external emergency stop through input signal.

1.3.2. Extinguishing fires

1.3.2.1. Precautions

In case of fire always, make sure both you and co-workers are safe and before performing any fire extinguishing activities. In case of injury always make sure these are treated first.

1.3.2.2. Select fire extinguisher

Always use carbon dioxide extinguishers when extinguishing fire electrical equipment such as the robot or the controller. Do not use water or foam.

1.3.3. Make sure that the main power has been switched off

Working with high voltage is potentially lethal. Persons subjected to high voltage may suffer cardiac arrest, burn injuries, or other severe injuries. To avoid these personal injuries, switch off the main power on the controller before proceeding work.

1.3.4. Moving robots are potentially lethal

1.3.4.1. Description

Any moving robot is a potentially lethal machine.
When running, the robot may perform unexpected and sometimes irrational movements. Moreover, all movements ae performed with great force and may seriously injure any personnel and/or damage any piece of equipment located within the working range of the robot.

1.3.4.2. Safe handling

- Before attempting to run the robot, make sure all emergency stop equipment is correctly installed and connected.
- Make sure no personnel are present within the working range of the robot before pressing start button.

1.3.5. Recover from emergency stops

1.3.5.1. Overview

Recovering from an emergency stop is a simple but important procedure. This procedure ensures that the robot system is not returned to production while maintaining a hazardous condition.

1.3.5.2. Reset the latch of emergency stop button

All push-button style emergency stop devices have a latching feature that must be released in order to remove the emergency stop condition of the device.
In many cases this is done by twisting the push-button as marked, but there are also devices where you pull the button to release the latch.

1.3.5.3. Recover from emergency stops

- Make sure the hazardous situation that resulted in the emergency stop condition no longer exist.
- Locate and reset the device or devices that initiated the emergency stop condition.
- Turn motor power on to recover from the emergency stop condition.

1.4. Safety in manual mode

- **Speed in manual mode**
  In manual mode, the movement is limited to 250 mm/s. In addition, there is a limitation on the maximum allowed speed for each axis. These axis limitations are robot dependent and cannot be changed. The maximum speed in manual mode is configured to be slower than maximum speed which a motor can operate. It is desired such as a way to prevent damages to humans and environments due to unexpected movements.
- **Debug**
  Debug is a feature to test whether written program works properly. This feature operates in 2 modes: Line by Line or Step by Step. Program will

run line by line or step by step to check robot's operation. Robot may be immediately stopped by using Emergency Stop button.

1.5. Safety in automatic mode

- Robot must operate without any user interruptions.
- Emergency stop button is used to stop the robot in automatic mode.

1.6. Handling and cleaning the Teach Pendant

- Handle with care. Do not drop, throw, or give the controller strong shock. It can cause breakage or failure.
- When not using the device, place it so it does not accidentally fall.
- Never use sharp objects (such as screwdriver or pen) for operating the touch screen.
- Clean the touch screen regularly. Dust and small particles can clog the touch screen and cause it to malfunction.
- Never clean the teach pendant with solvents, scouring agent, or scrubbing sponges

1.7. Cabling and power supply

- Turn off the power supply before opening the entrance area of pendant cable.
- Take care not to squeeze and thus damage the cable with any object.
- Do not lay the cable over the sharp edges since this can damage the cable sheath.

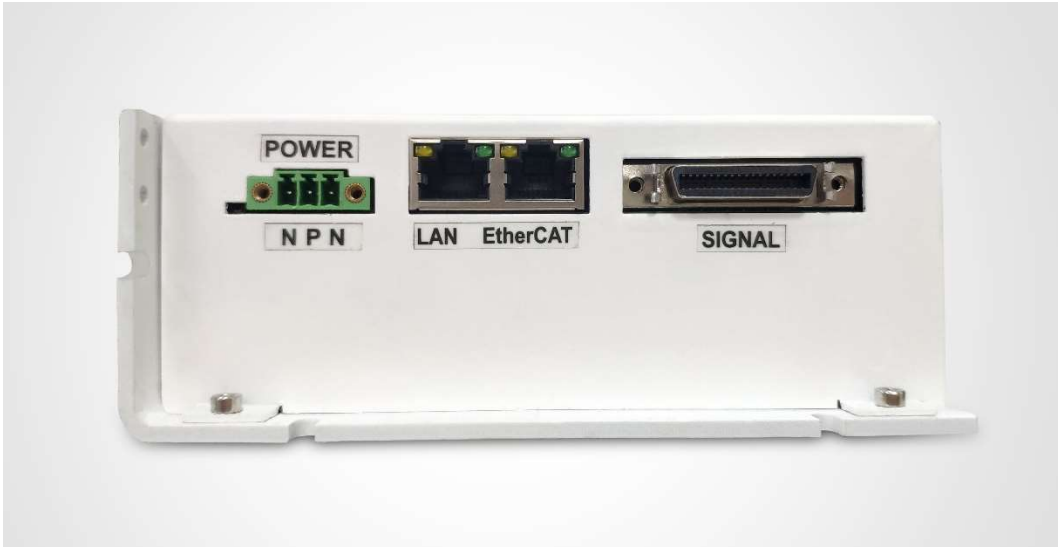
2. Introduction

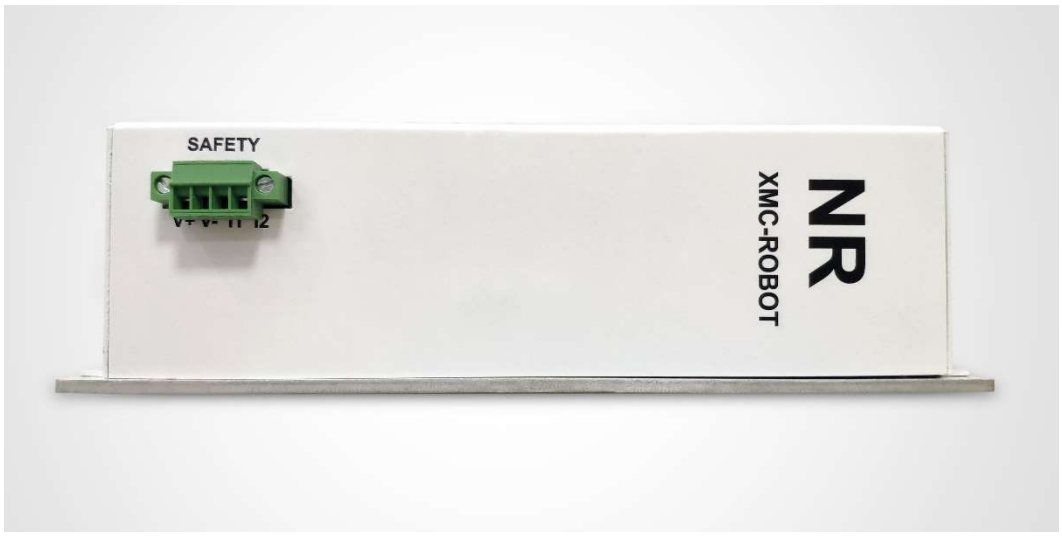
This section describes rules and procedures to follow when controlling manipulator via EtherCAT Master Robot Controller. For safety requirements related to manipulator operation, please refer to the document inside the product.

2.1. EtherCAT Master Robot Controller Overview

EtherCAT Master Robot Controller (XMC-ROBOT) contains two parts: Controller Unit and Teach Pendant.

2.2. Controller Unit





Controller Unit is the main unit of the controller, all tasks of manipulator will be executed here. It is equipped with high performance Intel Celeron J4105 processor and real-time operating.

A	Power Supply Port
B	EtherCAT Port
C	EtherNet/IP Port
D	Teach Pendant Connection Port
E	System I/O Interface Terminal

2.2.1. Power Supply Port

It is used to provide XMC-ROBOT with power.
Operation power supply: 12 VDC

2.2.2. EtherCAT Port

It is a RJ45 port. In the network, EtherCAT Master Robot Controller plays master role and establishes connection with all EtherCAT slave. The EtherCAT port on controller is connected to the EtherCAT IN port of the first slave in the network.

2.2.3. EtherNet Port

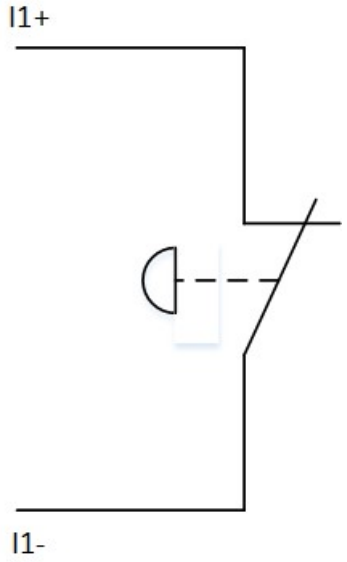
EtherCAT Master Robot Controller also support EtherNet/IP communication. With TCP/IP protocol, it can interface with external device such as: camera, PLC (Programmable Logic Controller) …

2.2.4. Teach Pendant Connection Port

Controller Unit is connected with Teach Pendant by plugging cable to this port.

2.2.5. System I/O Interface Terminal

Use this terminal to connect Emergency Stop button on Teach Pendant with safety function.



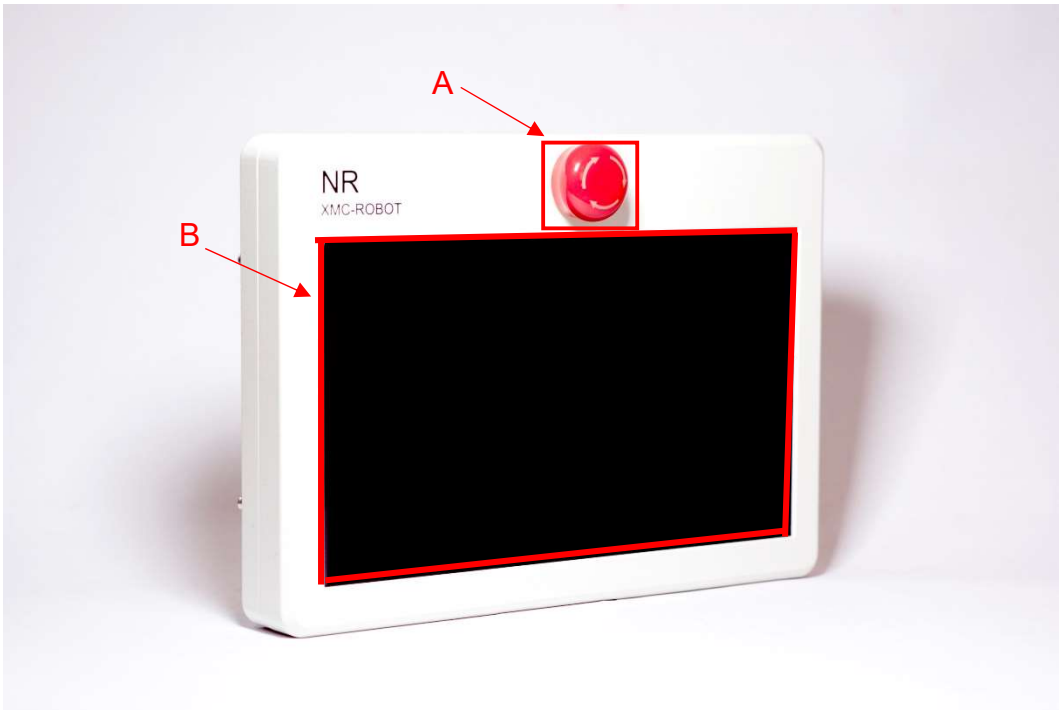
2.3. Teach Pendant

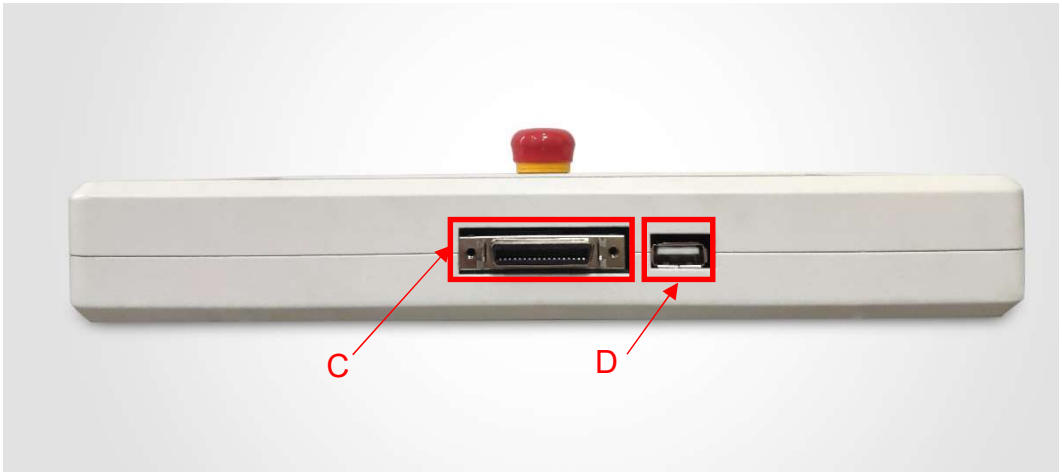
2.3.1. Introduction

Teach Pendant is a handheld operator unit that is used for many of the tasks when operating a manipulator: running programs, jogging the manipulator, modifying programs, and so on. With this Teach Pendant, even users who have no experience of robot operation can easily perform teach operation.

2.3.2. Hardware

Teach Pendant has several physical characteristics that a user will interact with. These are shown below.





These are the main parts of the teach pendant.

A	Emergency Stop Button
B	Touch Screen
C	Controller Connector
D	USB port

2.3.2.1. Emergency Stop Button

The Emergency Stop button is used to turn OFF the servo power.

When the servo power is turned OFF, the {SERVO} will change to blue. Emergency Stop message is shown on the display.

2.3.2.2. Touch Screen

A Projected Capacitive Touch (PCT) screen is used for the Teach Pendant. The touch screen may be operated with fingers that is specifically designed for PCT use.

2.3.2.3. Controller Connector

A connection port is used to connect with control unit through cable.

2.3.2.4. USB Port

When the Teach Pendant need updating the version of software, it can be updated via USB port.

2.3.3. Teach Pendant Display

The following picture shows important elements of the teach pendant touch screen.

A	Navigation Bar
B	Status Bar
C	General-purpose area
D	Jogging buttons

2.3.3.1. Navigation Bar

The following items can be switched by using Navigation Bar:

Item	Description
Jog	Check the current robot position and change the jogging specification.
Program	Teach the robot program, test program in TEACH mode and run in AUTOMATIC mode.
Data	Monitor, Edit Point List in the program.
I/O	Monitor the status and interface with all I/Os.
Tracking	All settings relate to conveyor tracking application.
Monitor	Monitor position of robot axes.
History	Store history about Operation and Alarm.
Setting	Set up the robot and controller parameters.

2.3.3.2. Status Bar

The Status Bar shows controller status. The displayed information will vary depend on the controller mode (TEACH/AUTOMATIC).

The following configuration can be accessed from the Status Bar:

- **Tool Number:**

  - Use this control to change the current Active Tool in TEACH mode. The tool numbers are from 0 to 63. In AUTOMATIC mode, this button is disabled.

- **Jogging Speed:** Use this control to change the Jogging Speed.

  - Low Speed

  - Medium Speed

  - High Speed

- Top Speed

- **Operation Coordinate System:**
  The current Jogging Coordinate can be checked.

- Joint Coordinates

- XYZ-World Coordinates

- XYZ-Tool Coordinates

- XYZ-User Frame Coordinates

Jogging Coordinate can be switched in TEACH mode for Joint Coordinates, XYZ-World Coordinates, XYZ-Tool Coordinates, XYZ-User Coordinates by pressing this button. XYZ-User Frame Coordinates requires a User Frame be defined to select. It can be selected in the Jog panel.

- **Servo Status:**
  Shows the status of the current servo. Color of icon is:
  - Blue when the servo is OFF.
  - Green when the servo is ON.

- **System Status:**
  This section will display the indicators listed below.

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- OK Status: Displays when there is no error

- Alarm: Displays when an error occurs.

- Run: The robot program is running.

- Pause: The robot program is paused.

- **Lock/Unlock Controller:** Displays the current status of controller.

- The status of controller is locked.

- The status of controller is unlocked.

Use this control to lock or unlock robot motion.

- **Mode:** Displays the current mode of controller.

- TEACH mode

- AUTOMATIC mode

Use this control to switch mode of controller.

- **Security Level:** Displays the current Security Level and use this control to change Security Level.

- OPERATION mode

- EDIT mode

- MANAGEMENT mode

2.3.3.3. General-purpose display area

On the general-purpose display area, various settings and contents such as operation, programs, setting interface can be displayed and edited.

2.3.3.4. Jogging Buttons

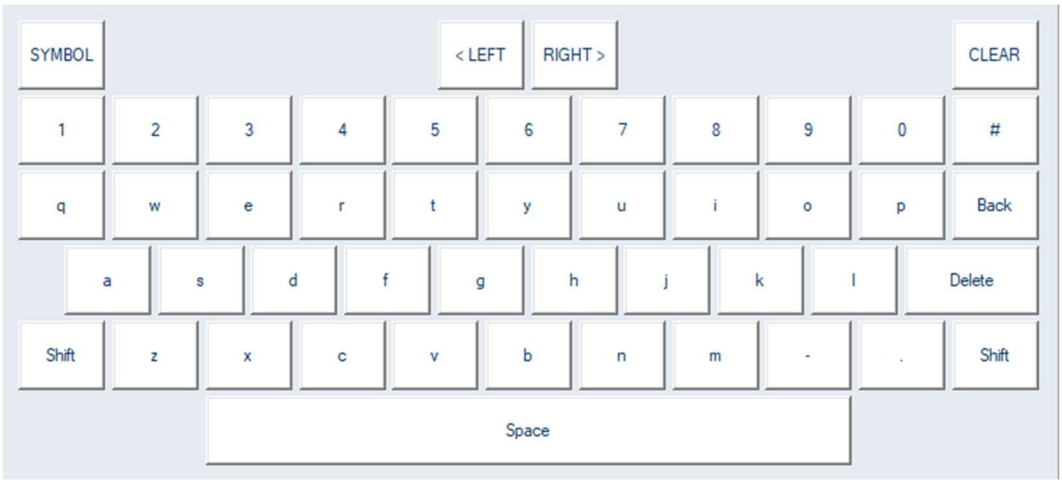
There are twelve buttons to operate jogging in TEACH mode and their name are changed based on the selected coordinate.
These buttons are only enabled in TEACH mode. In AUTOMATIC mode, all jogging buttons will be disabled.

2.4. Character Input Operation

Tap on the data or text for which characters are to be input and the software keypad will be displayed.

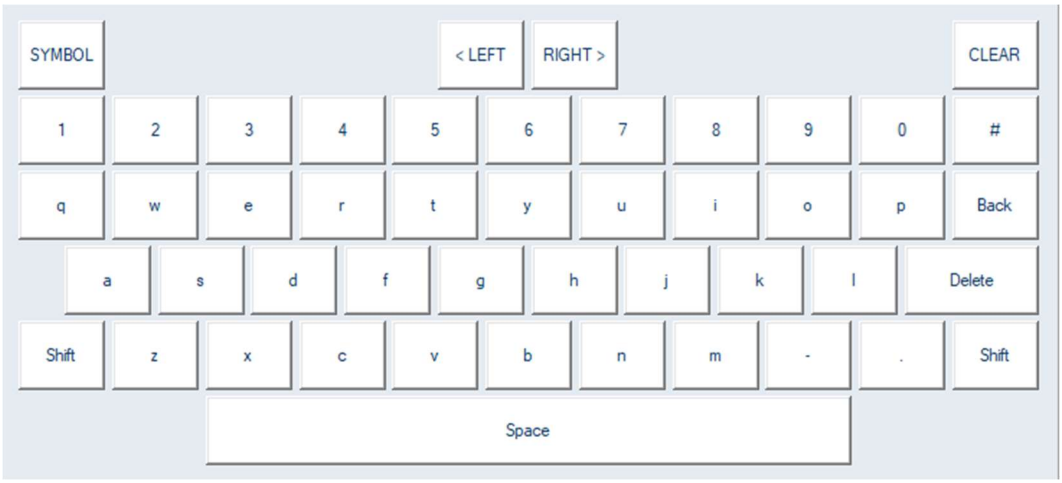
2.4.1. Character Input

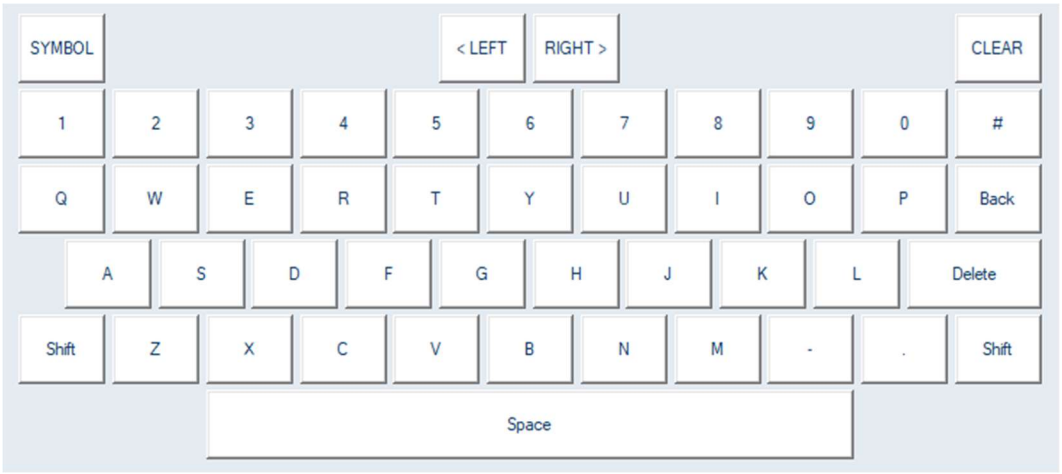
There are two types of software keypads: alphanumeric keypads and symbol keypads. To switch between the alphanumeric and symbol keypads, tap the button on left top of the keyboard. To switch the alphanumeric keypad between upper-case and lower-case characters, tap the “Shift” key.
The cursor is moved by tapping {<LEFT} and {RIGHT>} on the keypad.



2.4.2. Alphanumeric Input

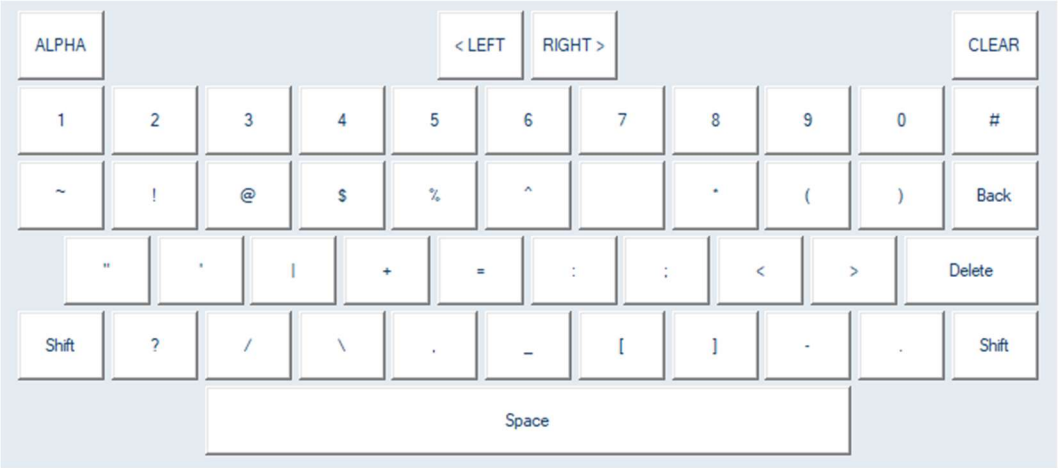
Number input is performed with the Numeric Value Keypad or on the alphanumeric input keypad. Numbers include 0 to 9, the decimal point (.), the minus sign/hyphen (-), and the hash sign (#).
Tap the desired character and tap {OK} to enter the character.





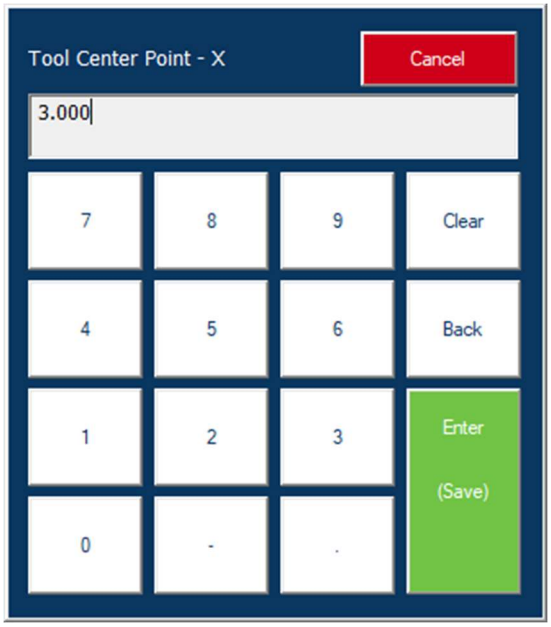
2.4.3. Symbol Input

Press the {SYMBOL} on the keypad to display the symbol keypad.
Tap the desired symbol and press {OK} to enter the symbol.

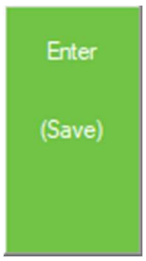


2.5. Numeric Value Input Operation

Press the numeric value input area to display the numeric value keypad.



Keypad	Key on the Teach Pendant	Description
Cancel	Cancel	Clears all the characters being typed and closes the numeric value keypad

Clear		Clears all the characters being typed
Back		Deletes one number at the cursor position
Enter		Enter the input numeric values
Numeric keys	 to 	Inputs number
Decimal point		Enters the decimal point
Minus		Enters the minus symbol

2.6. Mode

The following two modes are available for EtherCAT Master Robot Controller.

- TEACH Mode
- AUTOMATIC Mode

2.6.1. TEACH Mode

In TEACH mode, the following actions can be performed:

- Preparation and teaching of a program.
- Modification of an existing program.

- Setting of various manipulators and the controller settings and configurations.

In TEACH mode, the user has control for jogging the manipulator. Programming, editing, customizing, and others become available based on the level of Security.

2.6.2. AUTOMATIC Mode

In the AUTOMATIC mode, the following can be done.

- Running a saved program.
- Viewing of status, I/O, program, etc.

2.7. Security Level Setting

Permissions are controlled through the Security Access Level. This allows to change the operation and settings according to the operator's level of knowledge and training. User should operate and perform tasks with appropriate security level.

2.7.1. Types of Security Level

The following three types of security modes are available for XMC-ROBOT. Any operation in the edit mode and management mode requires a password. The password must contain between 4 and 8 letters, numbers, or symbols.

- **Operation:**
  Users at the Operation level can operate the manipulator, but it does not allow editing jobs or changing settings. A user on this level, can start and stop programs, repair and jog the manipulator, but cannot modify programs, variables or settings. Repairs, etc. can be performed if any abnormalities are detected. This level does not require a passcode.
- **Edit:**
  Users at the Edit level can perform teaching, manipulator program operations, editing of programs and various robot settings, in addition to operations enabled in the Operation level. This level requires a numeric passcode consisting of 4 to 16 numbers.
- **Management:**
  In addition to the functions enabled in the Edit level, this level allows setup and maintenance of the system, setting of machine control parameters, changing the passcode, etc. This level requires a numeric passcode consisting of 4 to 16 numbers.

2.7.2. Default Security Level Passcodes

Operation in **Edit**, **Management** requires a passcode. The default passcode for each security level is:

- Edit: 0000000000000000 (all 0s' – 16 digits)
- Management: 9999999999999999 (all 9s' – 16 digits)

Passcodes for Edit and Management levels can be customized. For more details, refer to chapter "Security Level Settings".

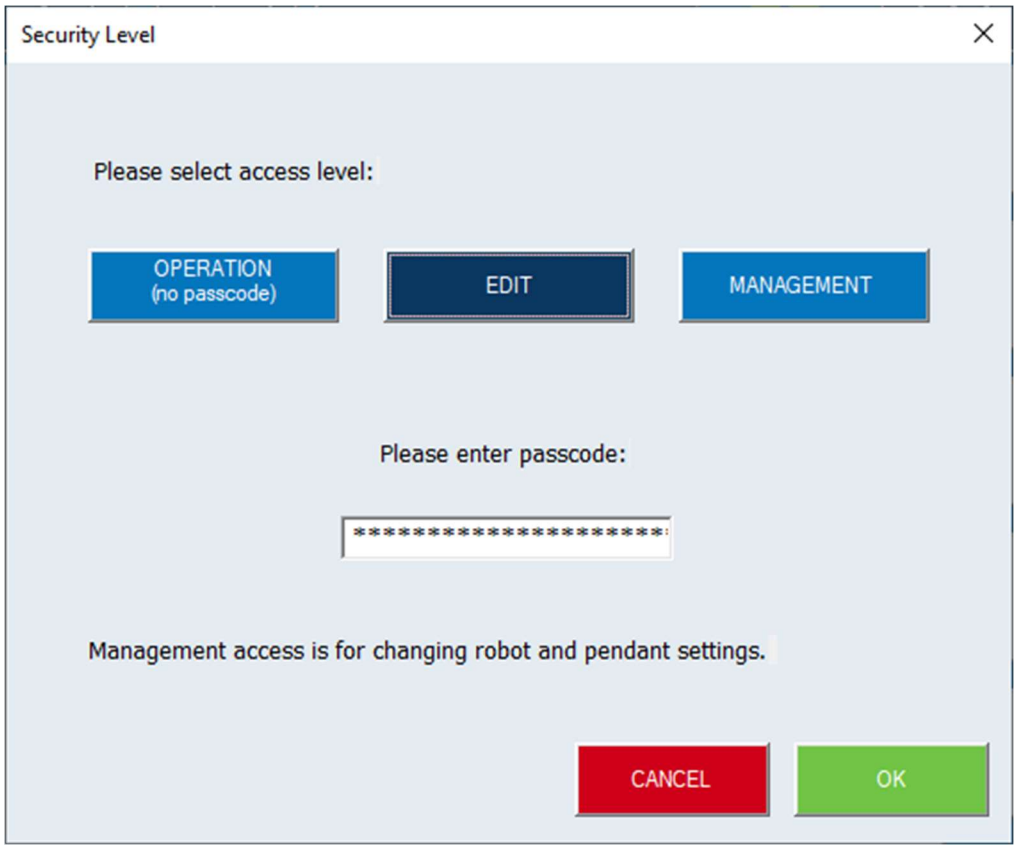
2.7.3. Security Level Access Information

Various security levels with varying levels of system access are supported. These are summarized below:

Items	Lowest Accessible Security Level
View System Status & Runtime	Operation
Jog Robot	Operation
Start/Stop Programs	Operation
Simple System Reset/Repair	Operation
Teach Points and Edit Robot Setting	Edit
Edit Programs and Variables	Edit
Edit Robot Control Parameters	Management
Edit Settings (EtherCAT Network, Passcode etc)	Management

2.7.4. Selecting Security Level

1. Tap {Security Level} in Status Bar.
   - The Security Level window appears.
2. Select the desired Security Access Level from {OPERATION}, {EDIT} or {MANAGEMENT}.



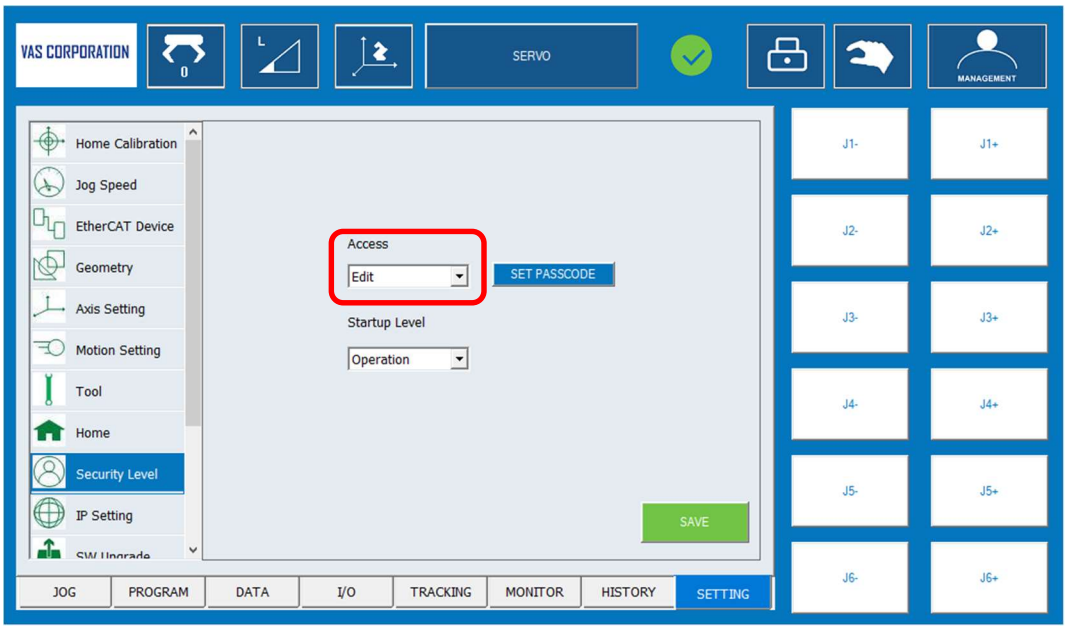
3. Insert passcode, if require.
   - Switching to a lower-level access does not require inserting a passcode.
4. Tap {OK}.
   - The Security Level changes when the correct passcode is inserted.

2.7.5. Security Level Settings

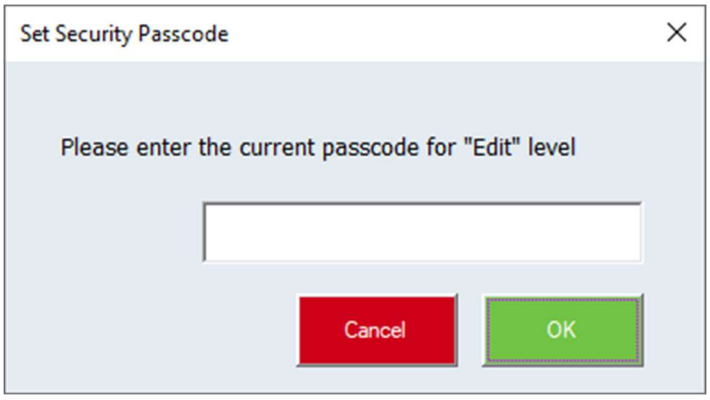
2.7.5.1. Changing Passcode

The passcode for Edit and Management level can be changed.

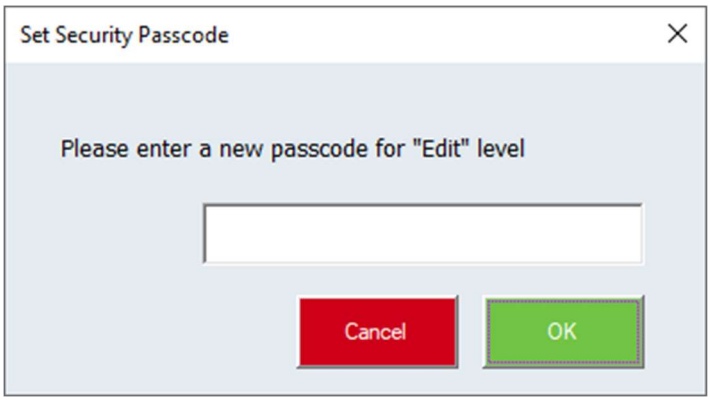
1. Operate in Management Level.
2. Go to {SETTING} → {Security Level} → {Security Setting}.
3. Under {Security Level Settings}, select the security mode from the pull-down list below “Access”.



4. Tap {SET PASSCODE}.
   - The entry popup appears.



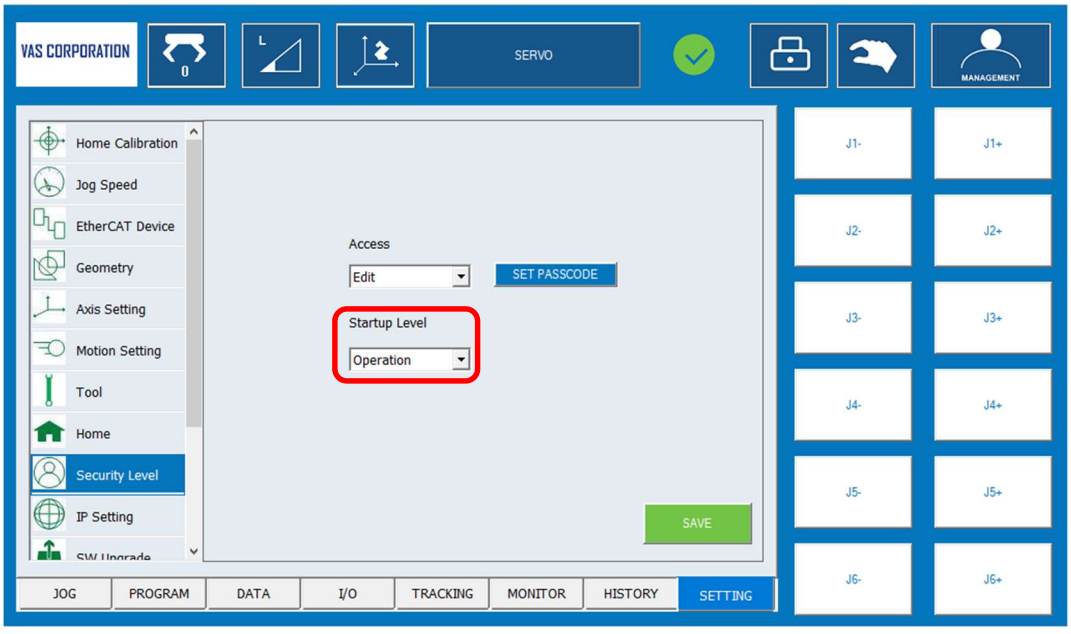
5. Type in the current passcode and tap {Enter}.
   - The entry popup appears again if the current passcode is correct.
6. Type in the new passcode and tap {Enter}.
   - The passcode is now changed.



2.7.5.2. Changing Startup Security Level

The Security Level at startup/restart can be set to Operation, Edit or Management level.

1. Operate in Management Level.
2. Go to {SETTING} → {Security Level} → {Security Setting}.
3. Under {Security Level Settings}, select the Security Level from the pull-down list under the {Startup Level}.
4. Tap {OK} to save changes.

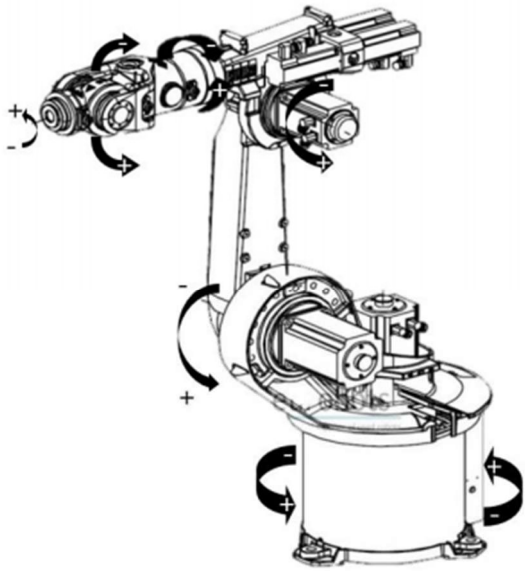


3. Manipulator Coordinate Systems and Operations

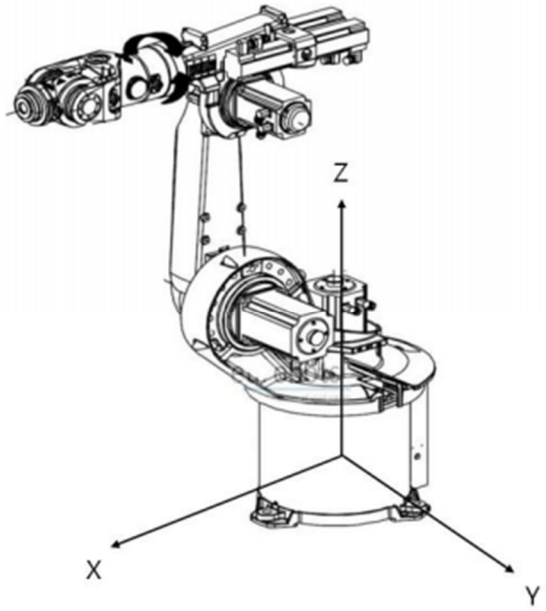
3.1. Manipulator Coordinate Systems

The following coordinate systems can be used to operate the manipulator:

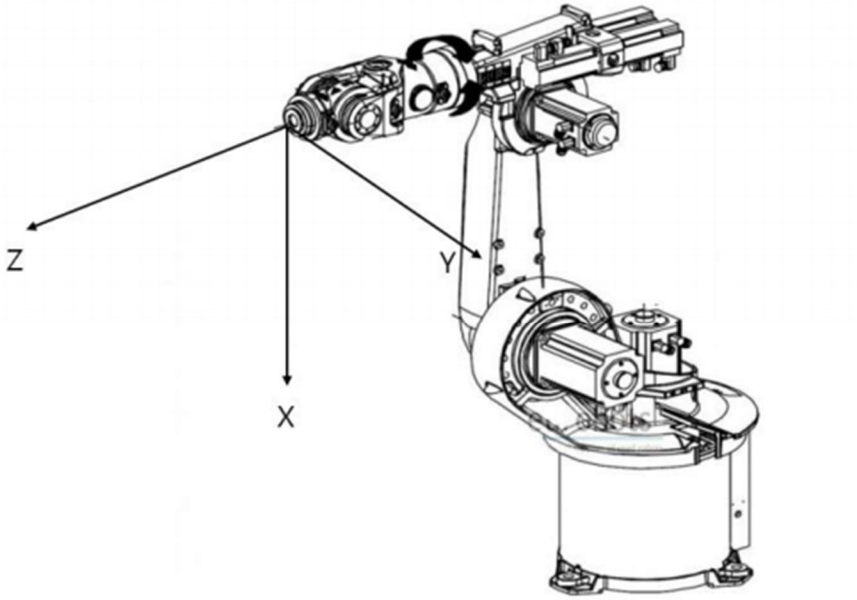
- **Joint Coordinate:**
  Allows user to move each joint axis independently.



- **XYZ-World Coordinate:**
  Allows user to move the manipulator in Cartesian directions relative to the manipulator base.



- **XYZ-Tool Coordinates:**
  Allows user to move the manipulator in Cartesian directions relative to the tool.



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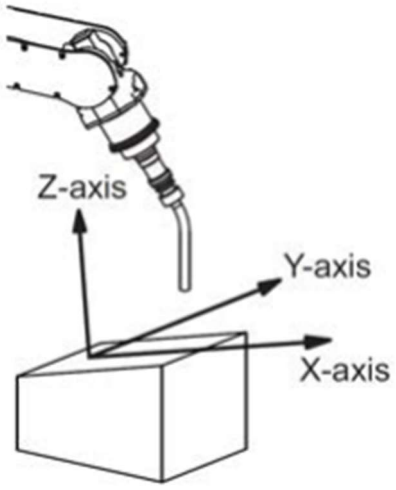
- **XYZ-User Frame Coordinate:**
  Allows user to move the manipulator in Cartesian directions relative to a “user frame”.



3.2. General Operations

3.2.1. Check Safety

Before any operation of the XMC-ROBOT controller, read Section “Safety” again and keep safe around the robot system or peripherals.

3.2.2. Select Operation Mode

Set the mode of the controller to “TEACH” by pressing {Mode}.

3.2.3. Select Coordinate System

Select a coordinate system by:

- Tapping the Jogging Coordinate on the Status Bar.

- Going to {JOG} and changing Jog Mode from pull-down list under {Coordinate}.

Verify the selected coordinate on the status display area of the Teach Pendant.

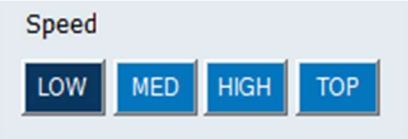
3.2.4. Select Jogging Speed

Select the jogging speed of operation by:

- Tapping the Jogging Speed on the Status Bar.

There are four jogging speed levels: LOW, MID, HIGH, and TOP.
Each time this button is pressed, jogging speed level is switched in the following order: LOW → MED → HIGH → TOP. If pressed again after it reaches TOP level, it will return to the LOW level.

- Going to {JOG} and changing Jog Speed.

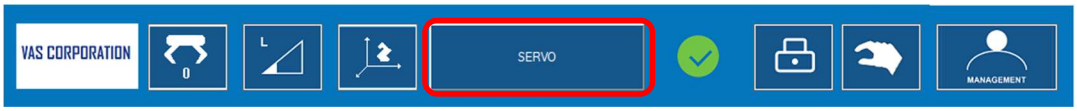


Four speeds are available for jogging speed: LOW, MID, HIGH, and TOP. Press the corresponding speed to select.

3.2.5. Servo ON

Before the manipulator can be moved in TEACH mode or AUTOMATIC mode, the servos must be turned ON. This can be accomplished by:

- Pressing the {SERVO} on the Status Bar.



Once servos' power is turned ON in TEACH mode, jogging operations on the robot can be performed. Jogging can be accomplished using various methods in different coordinate frames.

3.2.6. Unlock Controller

After servos' power is turned ON, the controller must be unlocked to execute manipulator's motion.

To unlock controller:

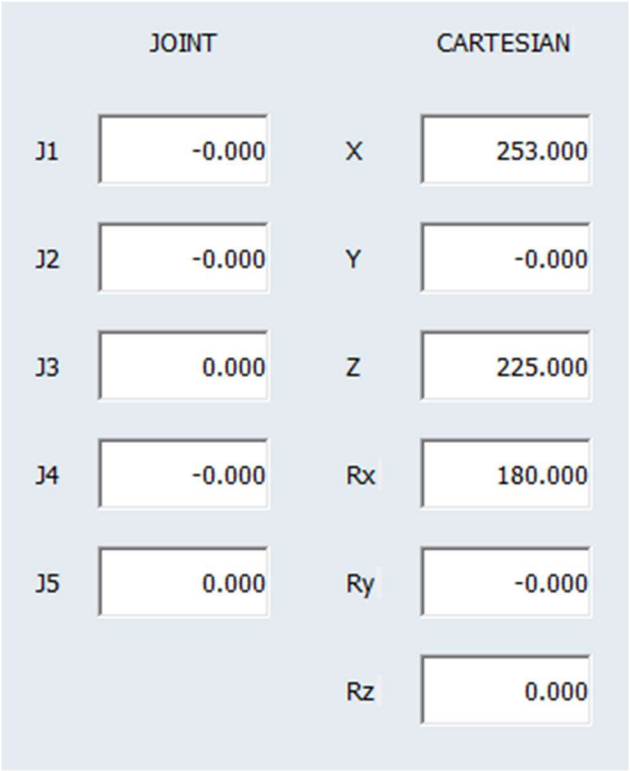
- Pressing {Unlock} to unlock controller. The controller will be unlocked.

3.2.7. Axis Operation

Make sure of safety around the manipulator. Press and hold Jogging buttons then axis moves according to the selected coordinates and manual speed. See section 2.3 "Coordinate Systems and Axis Operation".

3.2.8. Position Display

In Jog panel, there is an area for displaying joint value of each axis and robot's position in World Coordinate. These values are updated continuous while robot is moving.



3.3. Operation Check for Emergency Buttons

Before operating the manipulator, perform the following operations to ensure the Emergency Stop buttons on both electric box and Teach Pendant are functioning correctly.

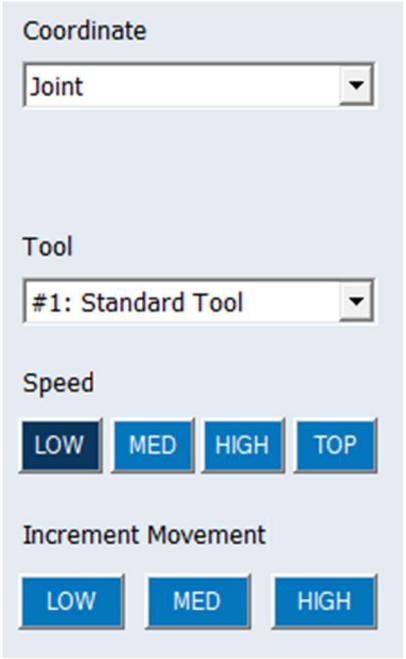
1. Press the {SERVO} on the touch screen.
   - The {SERVO} turns green.
2. Press Emergency Stop button.
   - The Emergency Stop button is on electric box or Teach Pendant.
3. Confirm servo power is turned OFF.
   - When the Emergency Stop button is pressed and the servo power is turned OFF, the {SERVO} will be deactivated (grayed out).
   - After confirming the step above, turn the Emergency Stop button to release it.
4. Press {SERVO} on the touch screen again.

3.4. Coordinate Frames and Manipulator Jogging

A manipulator can be jogged in TEACH mode using different methods supported by the Teach Pendant. The various jogging coordinates can be selected using two different controls:

- {Operation Coordinate System} on Status Bar
- {Coordinate} on {JOG} page

All jogging coordinates have the following items in common on the {JOG} page.



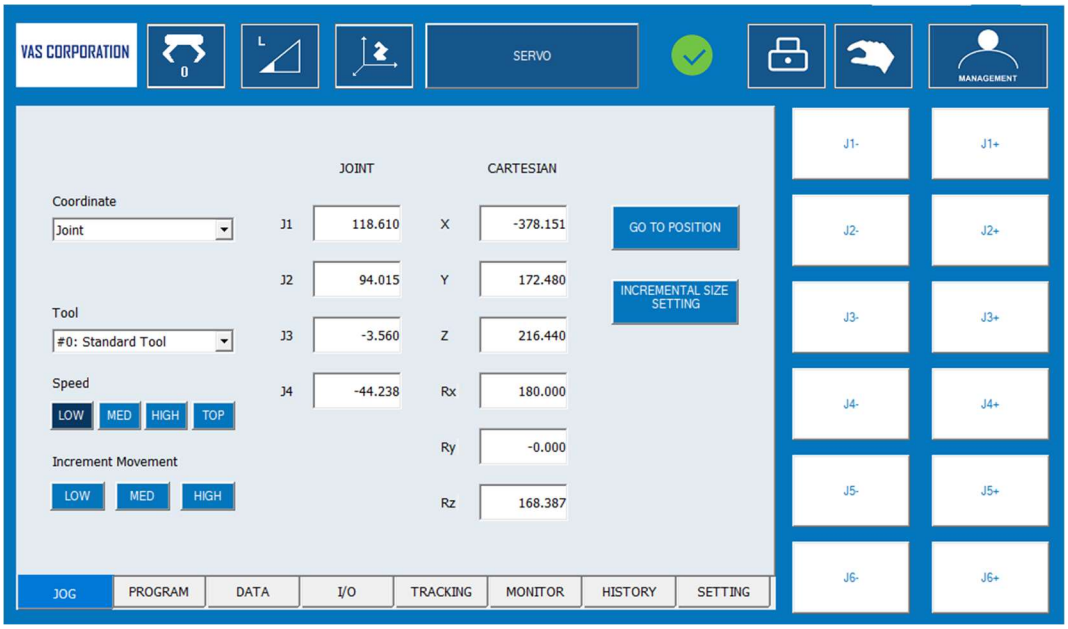
- **Jogging Coordinate**
  Control for selecting jogging coordinate (TEACH mode).
- **Jogging Speed**
  Control for selecting robot jogging speed (TEACH mode). The user can select one of four different speeds.
- **Increment Level**
  Control for selecting robot incremental movement (TEACH mode). The user can activate this mode with three levels or deactivate.
- **Active Tool**
  Control to select the active tool. The active tool stores physical parameters (input by user) that are often critical to proper operation.

The following sections provide more detail on the different jogging coordinates.

3.4.1. Joint Coordinate

When the manipulator is operating in Joint Coordinate, each axis of the manipulator can be moved independently. It can be used to check moving direction of motor.

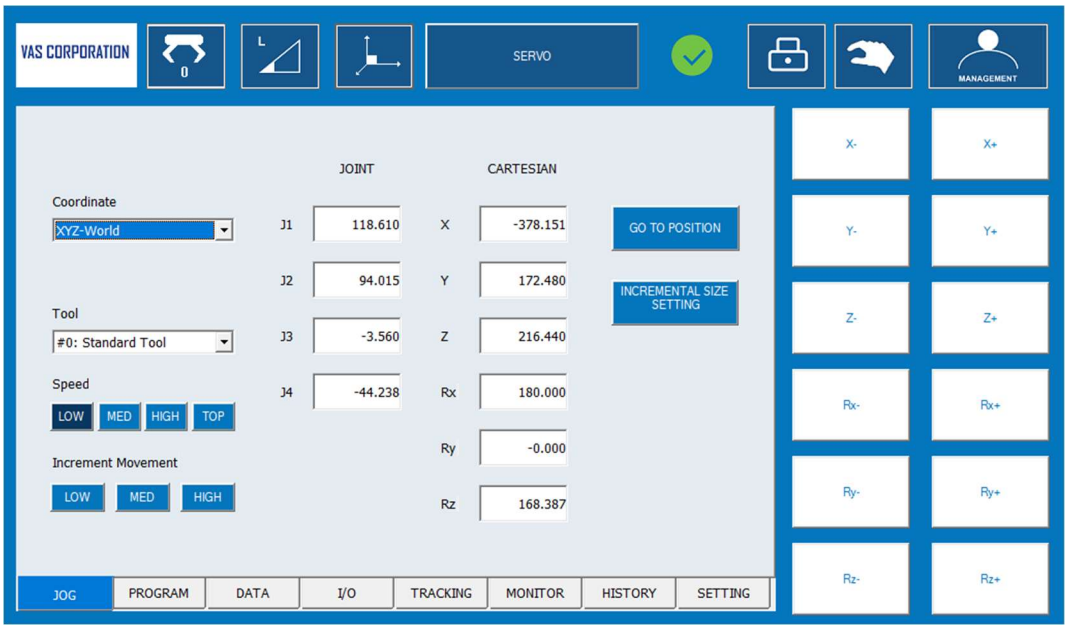
SUPPLEMENT
Axis Operation in Joint Coordinate
When a jogging button is pressed, the other direction of this axis will be disabled. The jogging buttons only operate one button at a time.



3.4.2. XYZ-World Coordinate

In the XYZ-World Coordinate, the manipulator moves parallel to the X, Y or Z axes defined with respect to the manipulator base.

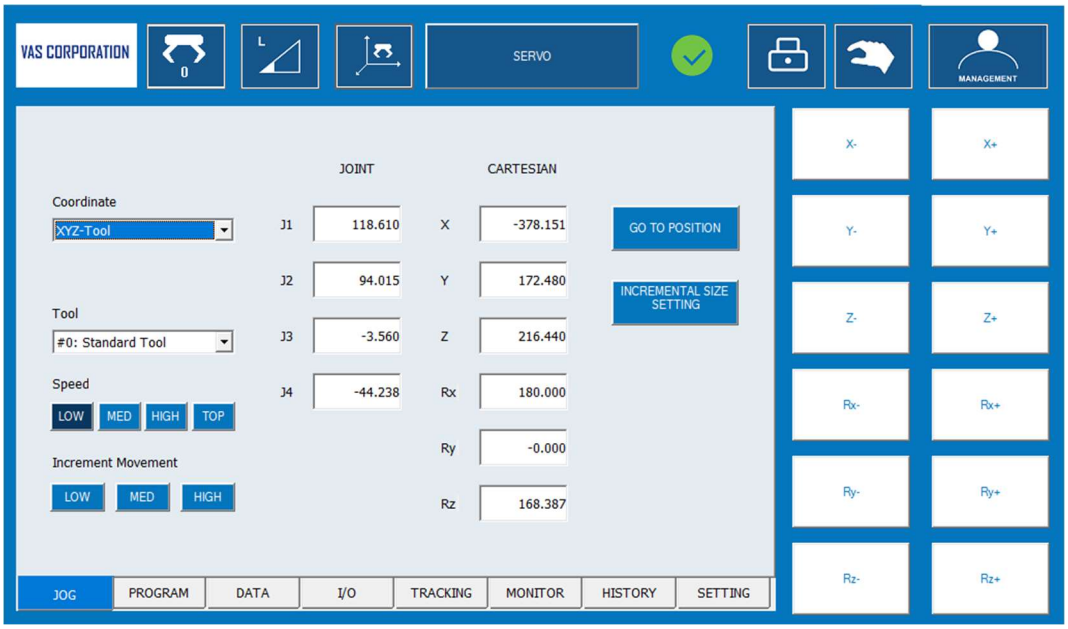
SUPPLEMENT
Axis Operation in XYZ-World Coordinate
When a jogging button is pressed, the other direction of this axis will be disabled. The jogging buttons only operate one button at a time.



3.4.3. XYZ-Tool Coordinate

In XYZ-Tool Coordinate, the manipulator moves parallel to the X-, Y-, and Z- axes defined with respect to the tip of the tool.

> SUPPLEMENT
> **Axis Operation in XYZ-Tool Coordinate**
> When a jogging button is pressed, the other direction of this axis will be disabled. The jogging buttons only operate one button at a time.



3.4.3.1. Selecting Tool

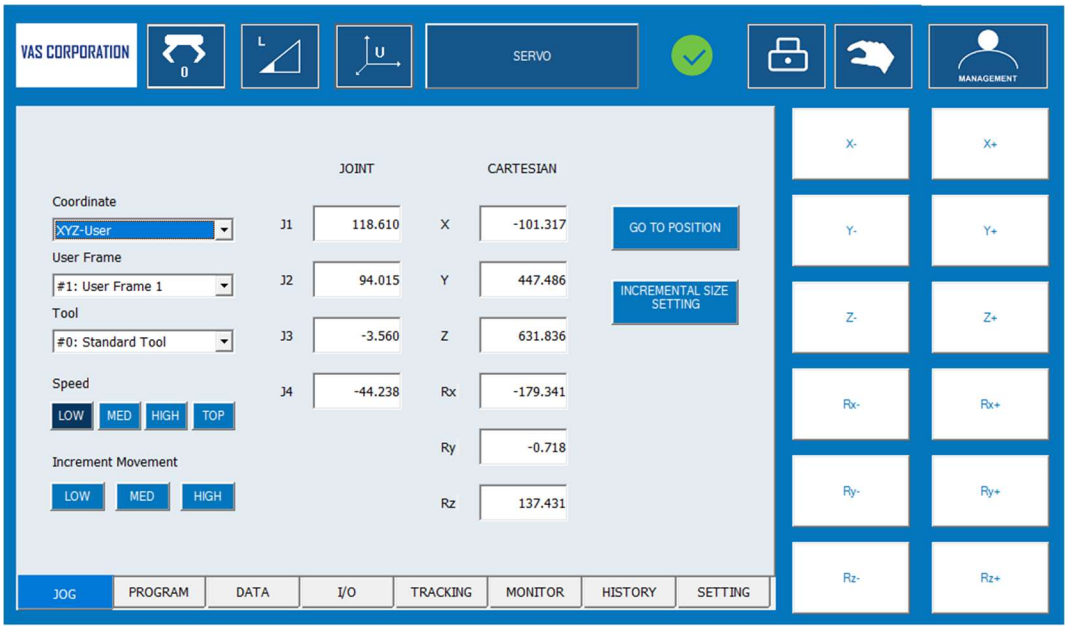
Tool numbers are allocated to tools. When two or more tools are used in the system, each tool is allocated a tool number. User can then select the desired tool number from tools.

1. Select {XYZ-Tool} for Jogging Coordinate.
2. Select desired tool number.

3.4.4. XYZ – User Frame Coordinate

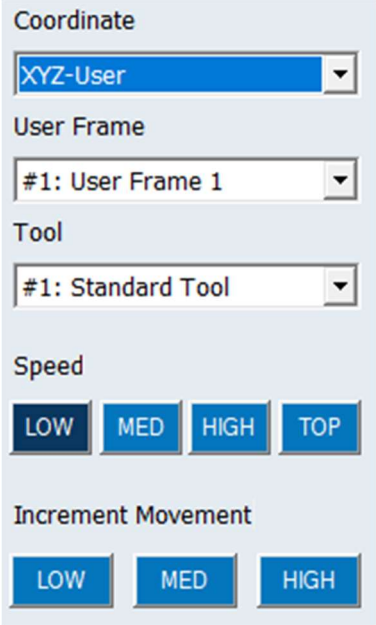
In XYZ-User Frame Coordinate, the manipulator moves parallel to each axis of the user-defined coordinates. A user-specified coordinate frame is typically attached to an object such as works surface, pallet, or conveyor.

SUPPLEMENT
Axis Operation in XYZ-User Coordinate
When a jogging button is pressed, the other direction of this axis will be disabled. The jogging buttons only operate one button at a time.



3.4.4.1. Selecting User Frame

1. Select {XYZ-User} for Jogging Coordinate.



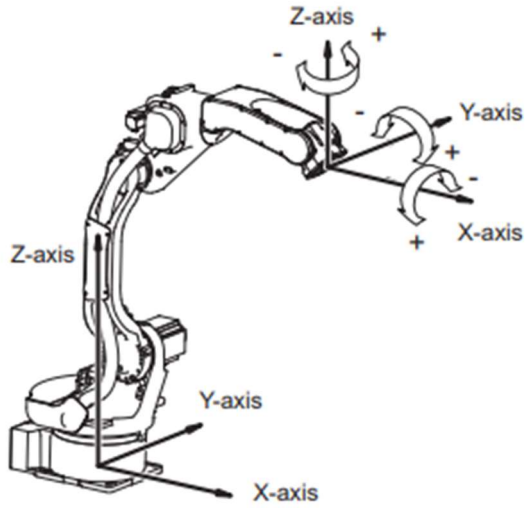
2. Select the desired User Frame number.

3.4.5. Motion at Robot TCP

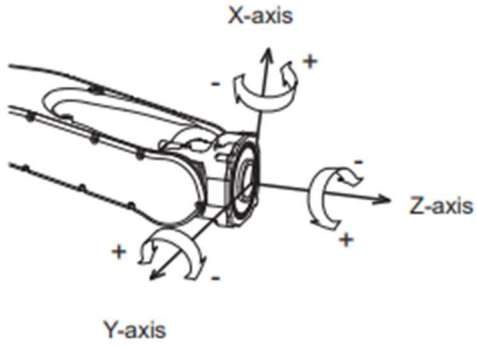
For motion at the TCP (Tool Center Point), the manipulator's posture can be modified without changing the position of the tool's tip (TCP). The motion at TCP is available in the World Coordinate Frame, Tool Coordinate Frame, and User Coordinate Frame.
The motion of each axis is described in the table below.

Axis Operation Key	Motion
	Only the tool's posture changes with the TCP fixed. The tool's posture changes around the axes of the specified coordinates.
	
	

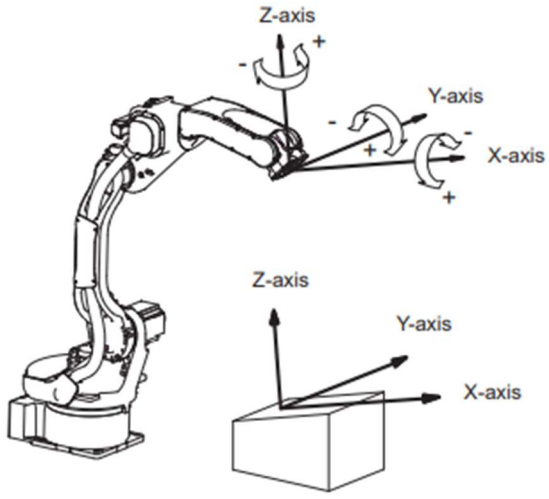
- In World Frame, TCP rotations are based on the X, Y, and Z axes of the manipulator.



- In Tool Frame, TCP rotations are based on the X, Y, and Z axes of the tool coordinates.



- In User Frame, TCP rotations are based on the X, Y, and Z axes of the user coordinates.



3.4.6. Incremental movement for precise positioning

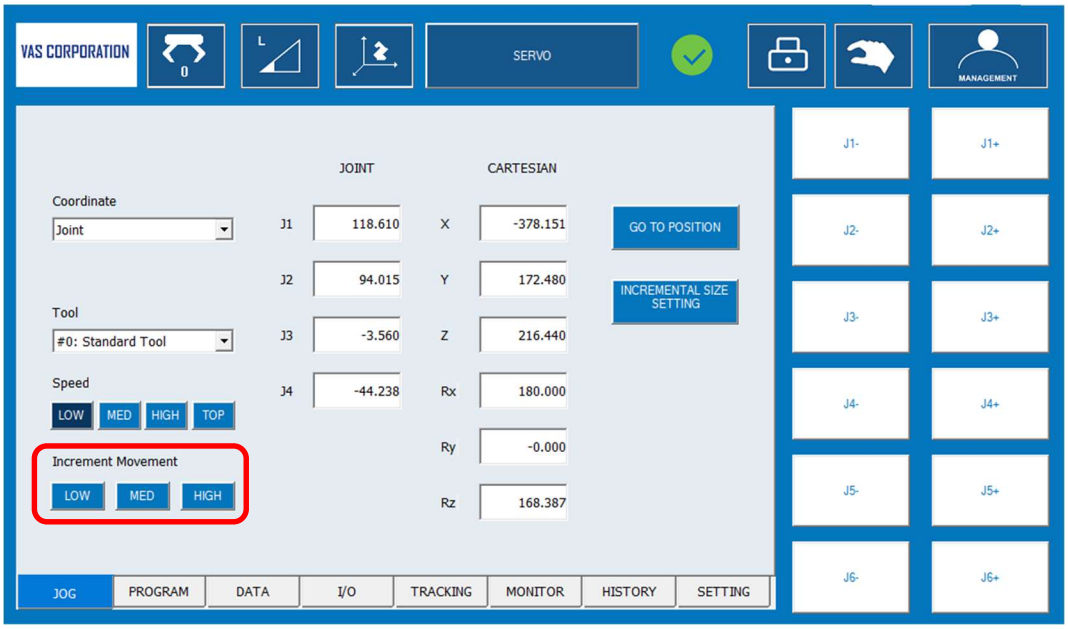
3.4.6.1. Incremental movement

Use incremental movement to jog the robot in small step, which enables very positioning. This means that each time jog button is tapped, the robot moves one step (increment). Increment mode is deactivated by default, then the robot moves continuously when the jogging button is tapped.

3.4.6.2. Selecting Increment level

There are three levels of increment mode: LOW, MID, HIGH.

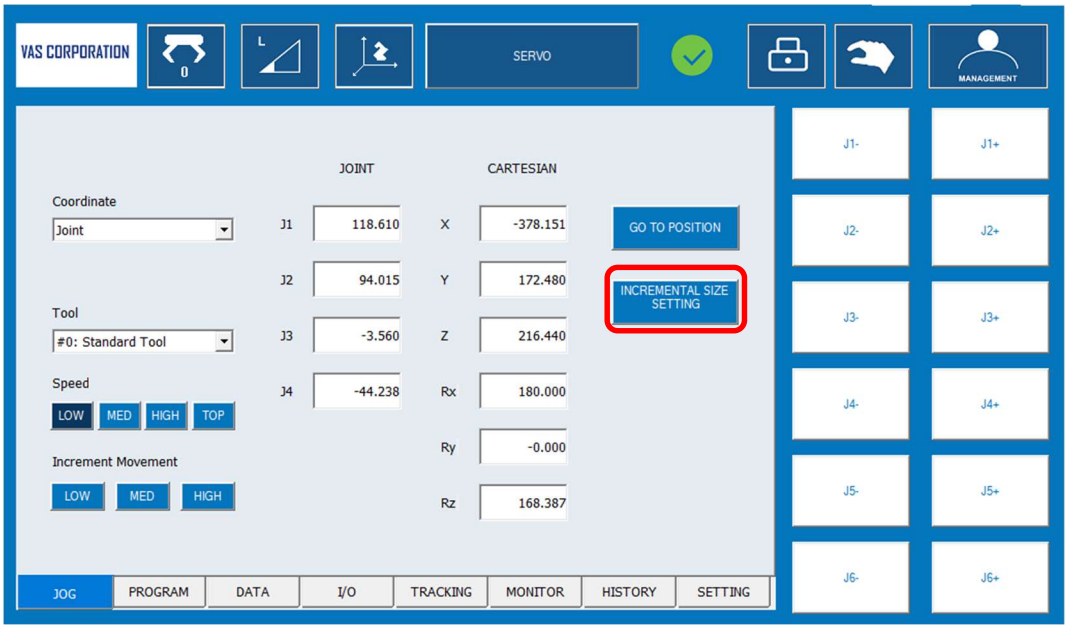
- Tap the desire level to select.
- The selected increment level will be highlighted.
- Tap the selected level again to deactivate increment mode.



3.4.6.3. Setting Increment Level

To set value for increment level, please follow these steps:

- Tap {INCREMENTAL SIZE SETTING} in Jog panel, Increment Size Setting window appears.



- Tap the desired incremental size and input value through numeric input operation.
  Unit of distance is mm for linear motion or degree for rotary motion.
  For linear motion, the maximum value can be set is 10mm. For angular motion, the maximum value can be set is 5 deg.
- Tap {OK} to save changes.

3.4.7. Move to Position Panel

The Move to Position Panel is a utility that can be used to more precisely position a robot while jogging. This feature will let the user enter the desired position and jog directly to the entered coordinates as well as “snapping” the positions for accurate alignment.

These are three separate panels which will be described in the following sections:

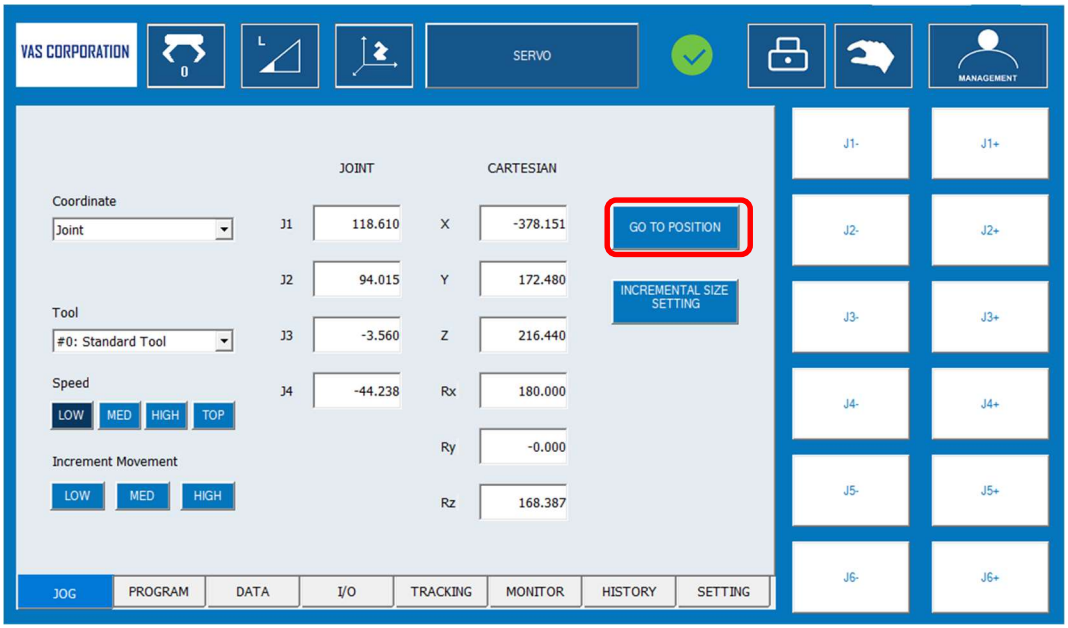
- Joint Panel
- TCP Position Panel

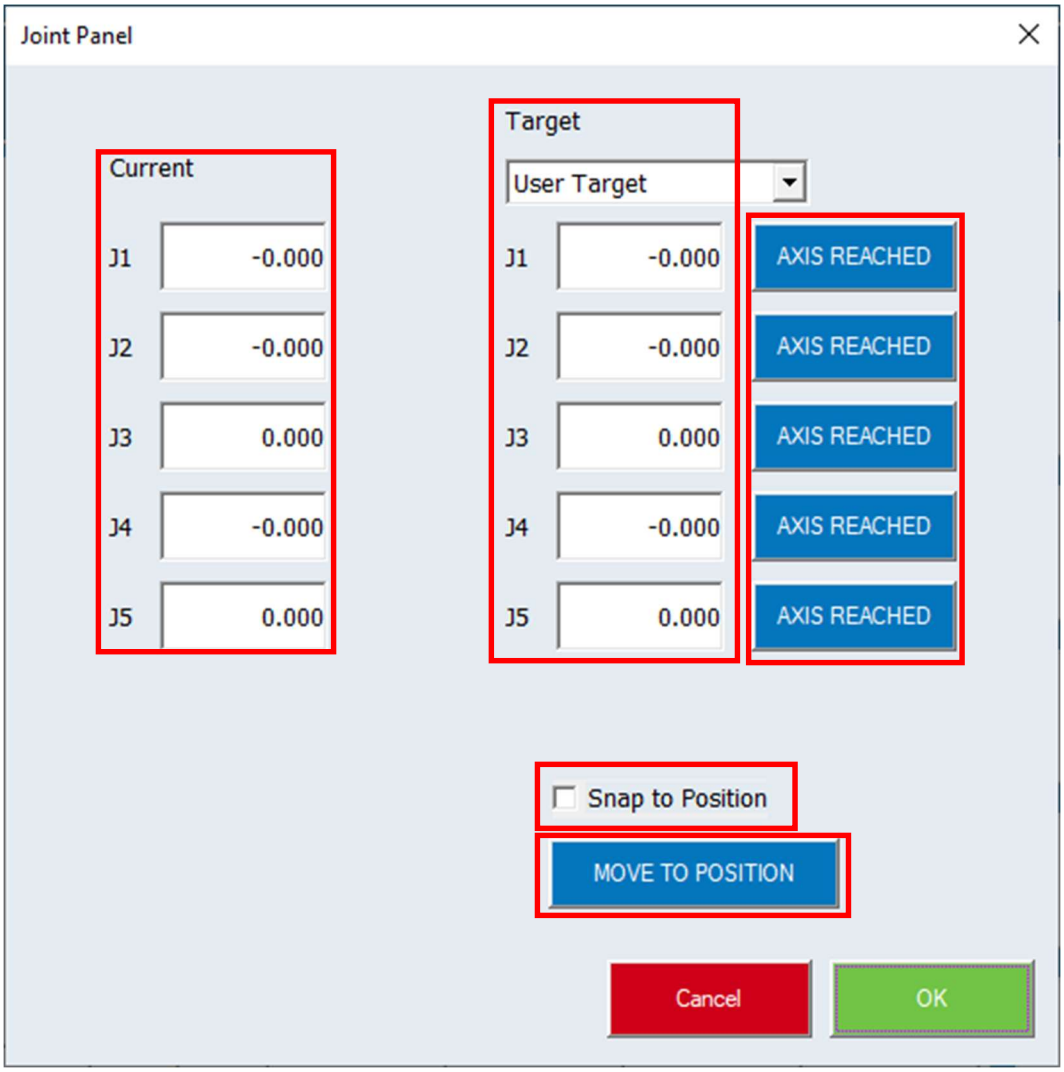
3.4.7.1. Joint Panel

The Joint Panel can be used whenever the Jogging Coordinate is set to Joint.

To open the Joint Panel, press {GO TO POSITION} in the JOG panel.

- Joint Panel appears.



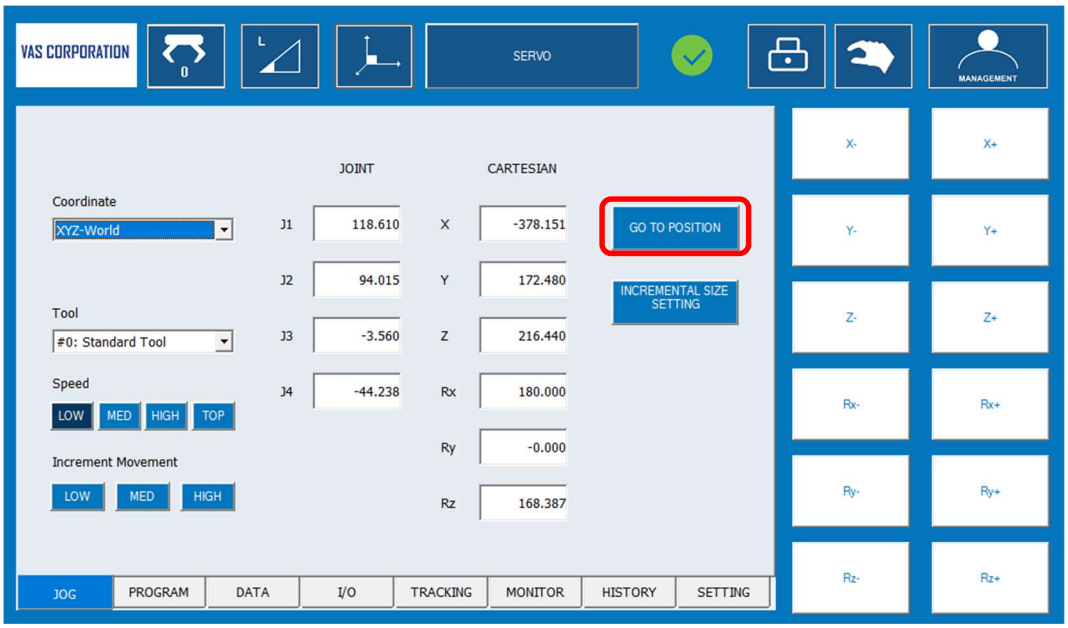


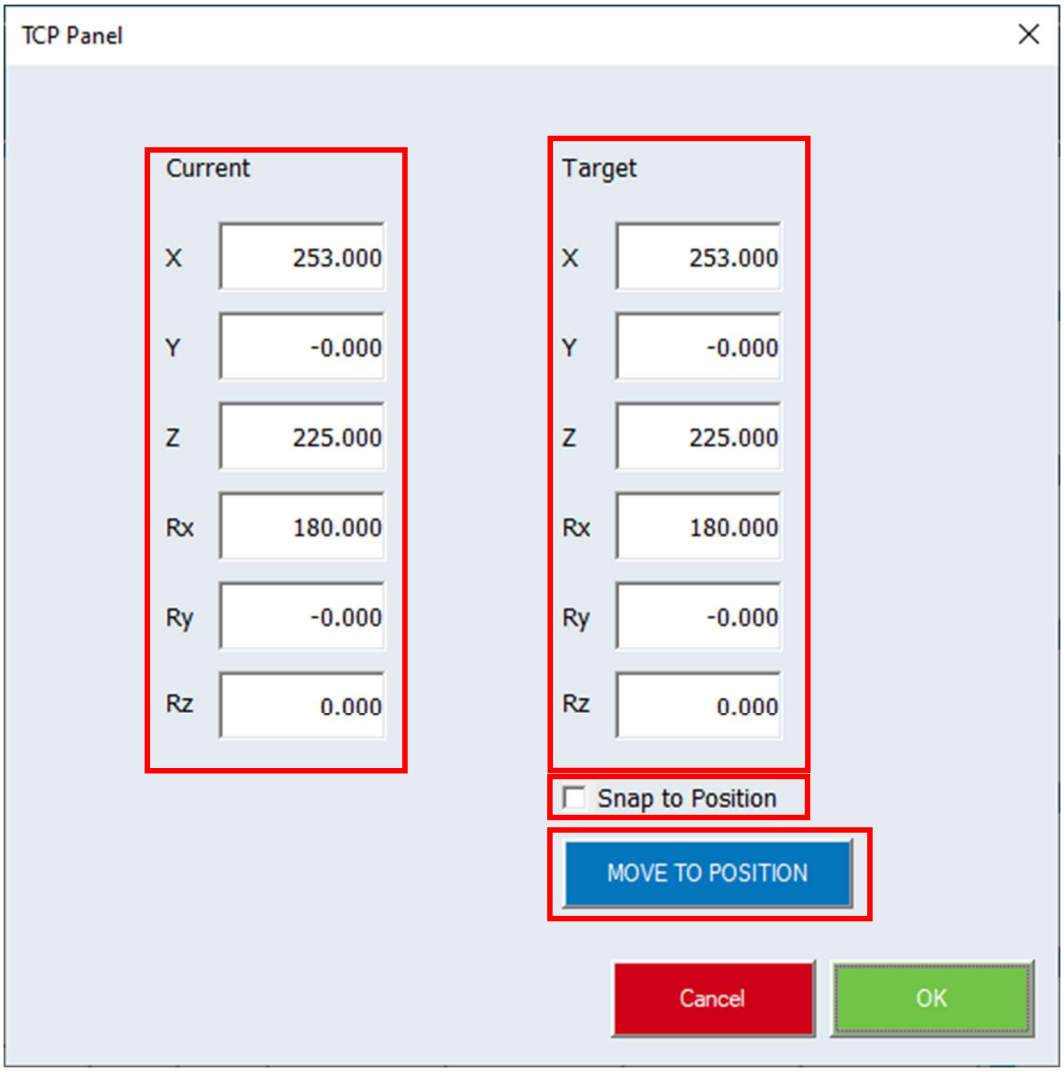
1. **Current Axis Position Display**
2. **Target Position Selection/Display**
   By default, this value is the "User Target" which allows for entering custom positions. The drop-down selection contains standard robot configurations such as Work Home and Robot Position Confirmation.
3. **Move to individual axis**
   Press and hold each button to move the specific axis to its target position. The button has name "MOVE AXIS" if the Current Position of the axis is not equal to Target Position of the axis.
4. **Snap to Position**
   This will "snap" each axis to the nearest 10 degree increment.
5. **Move to Position button**
   This will move all axes towards their target. This button has name "MOVE TO POSITION" if any the Current Position of any axis is not equal to its Target Position.

3.4.7.2. TCP Panel

The TCP Panel can be used whenever the Jogging Coordinate is set to XYZ-World, XYZ-Tool, or XYZ-User. To open it, press {GO TO POSITION} in the JOG panel.

- TCP Panel appears.





1. **Current TCP Position and Orientation display**
2. **Target TCP Position and Orientation display**
   The target values can be entered into the text fields.
3. **Snap to Position**
   This “snaps” each coordinate to the nearest 10 mm/5 degree increment.
4. **Move to Position button**
   This moves the robot towards the target TCP. This button will have name “MOVE TO POSITION” if any of the current position value do not match the target position.

4. Managing Programs

This section explains how to manage programs without moving the manipulator. Copying, deleting, and modifying programs can only be done in TEACH mode.

4.1. Preparation for Teaching

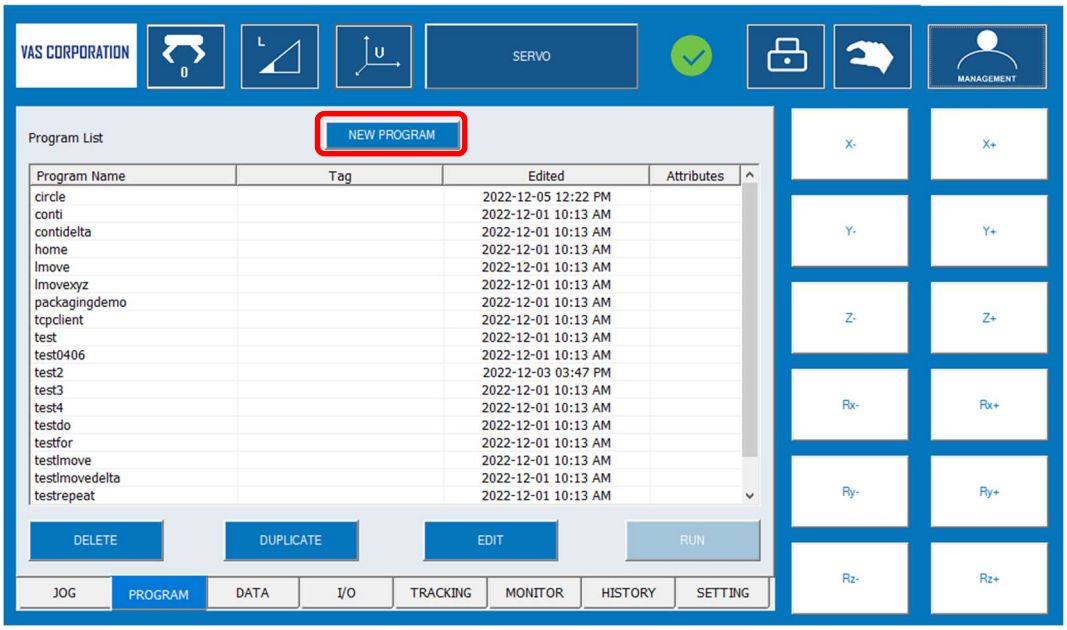
To ensure safety, the following operations should always be performed before teaching:

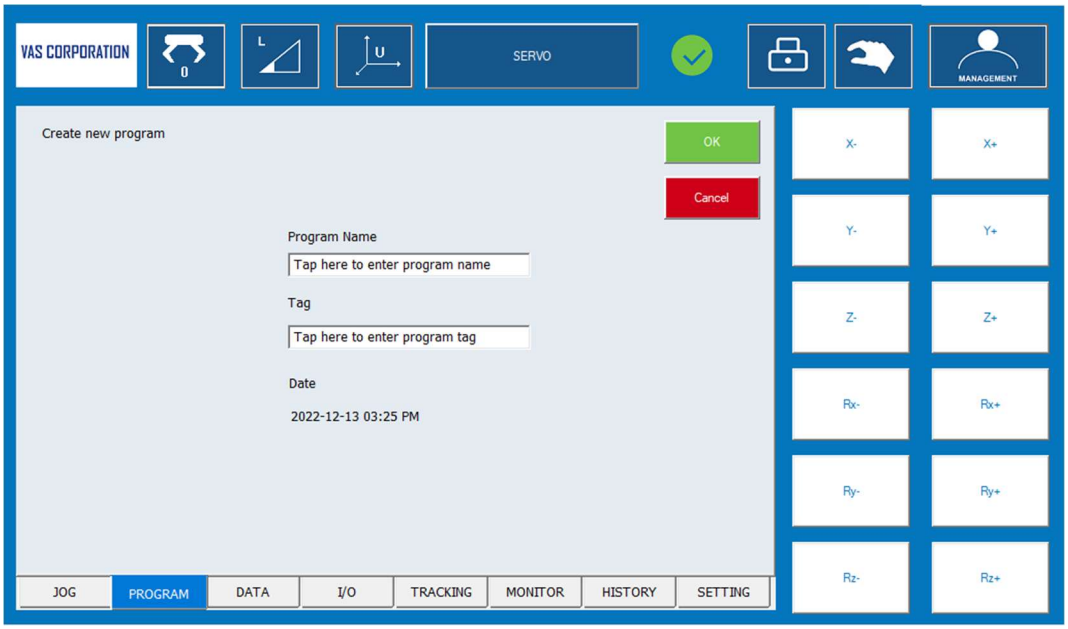
1. Check the Emergency Stop buttons to be sure they function properly.
2. Set the mode of controller to “TEACH”.
3. Create a program.

4.1.1. Create New Program

Follow the steps to create a new program:

1. Set the mode of controller to TEACH mode.
2. Go to PROGRAM panel from Navigation Bar.
3. Tap {NEW PROGRAM} at the top of the screen to create a new program.
   - The Create New Program window appears.
   - The program settings can be edited.





4.1.1.1. Setting the Program Name

The following rules apply to the program name:

- 1 to 32 alphanumeric characters can be used.
- Program names may be written with numerals only.
- Symbols include: !, &, (,), ‘, - and _. Space cannot be used for a program name. Use an underscore (_) instead.
- Different types of characters can coexist within the same program name
- If the program name is already used, an input error will occur.

<Example>
VAS_DEMO
001
JOB-12

4.1.1.2. Setting the Tag

The tag can be used to specify a group or category for a program. Sorting by tag can help see all programs in a certain group/category. For example, if a program is tagged by workpiece name, or operator’s name, they will be grouped together when sorting by tag name is used. Enter an optional tag value. Constraints on tag name are:

- 0 to 32 alphanumeric characters can be used.
- Letters can only be entered in upper-case.
- Only the underscore (_) and dash (-) can be used as a symbol.

1. Insert a tag
   For information on character input operation, refer to chapter “Character Input Operation”.
2. Press {OK}

4.1.1.3. Setting the Comment

Comments are a means to provide description about the program's purpose. Constraints on the comment are:

- 0 to 32 alphanumeric and symbol characters can be used.

1. Insert a comment.
2. For information on character input operation, refer to chapter "Character Input Operation".
3. Press {OK}.

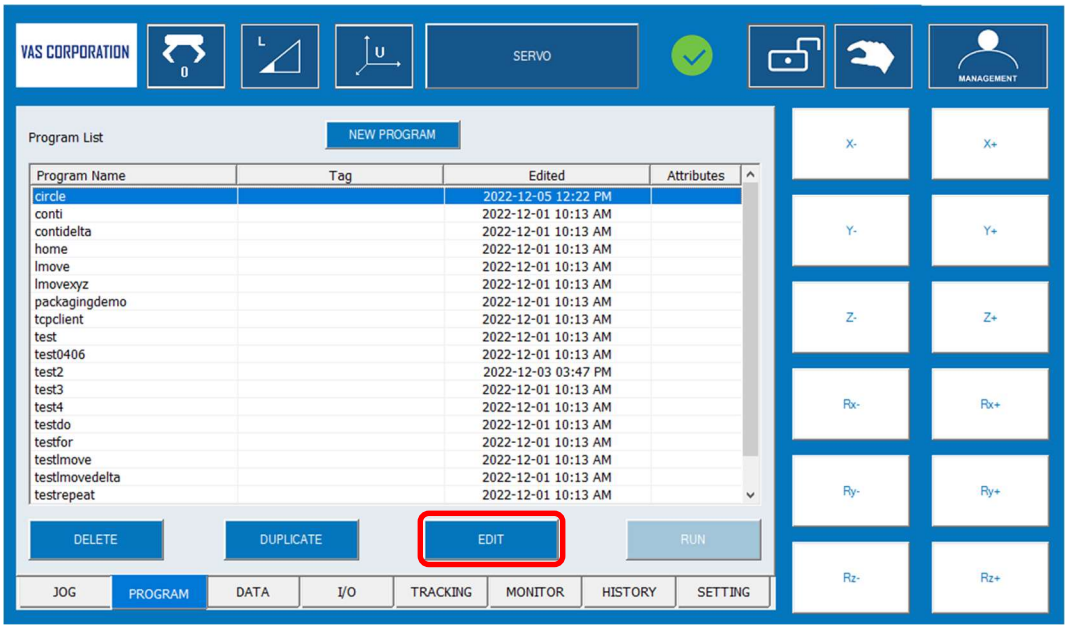
To finish the setting, press {OK}.

4.2. Edit Program

This operation is used to open existing programs for editing or preparing for playback.

From the Program List, select the program to open from the list.

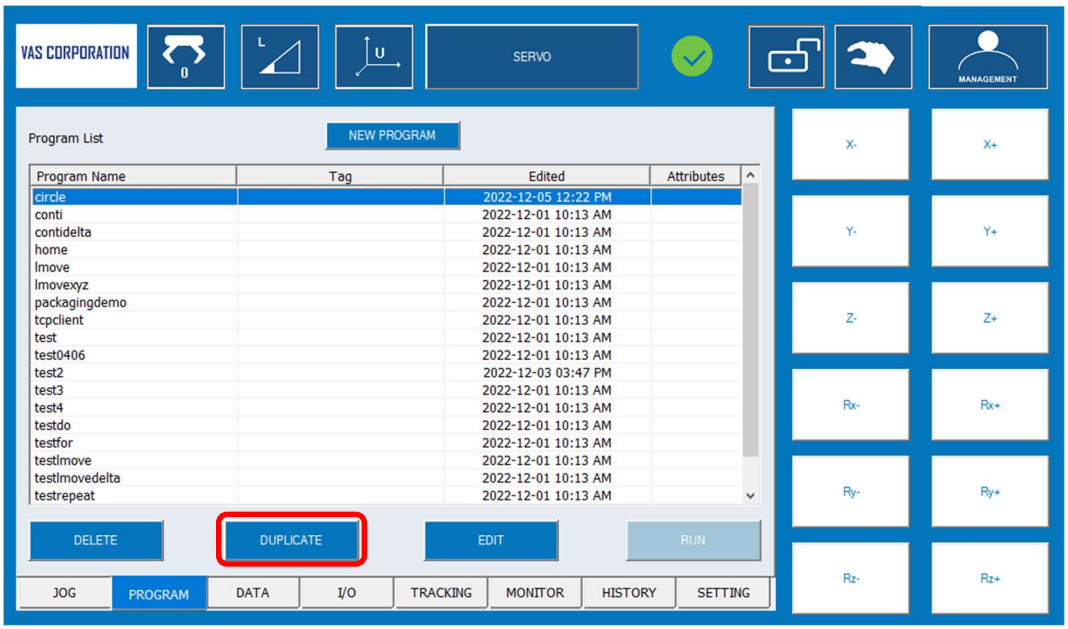
1. Go to PROGRAM panel from Navigation Bar or {MANAGE} in Program Editor.
   - The Program List windows appears.
2. Select the program to open.
3. Tap {EDIT} on the screen.
   - The Program Contents will display.



4.3. Copying Programs

This operation is used to copying existing programs, which are then used to create new program. It can be performed in the Program List.
From the Program List, select the program to be copied from the list.

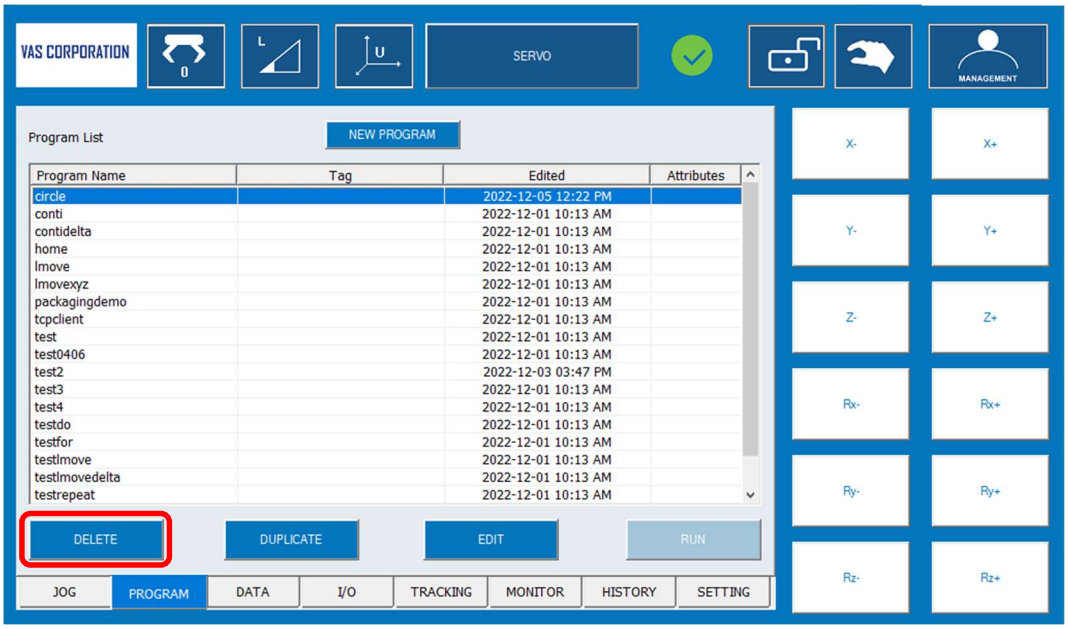
1. Go to PROGRAM panel from Navigation Bar or {MANAGE} in Program Editor.
   - The Program List windows appears.
2. Select the program to be copied.
3. Tap {DUPLICATE} on the screen.
   - The duplicated program will be displayed on the Program List.
   - The program is named with “- COPY” at the end of the original program name.



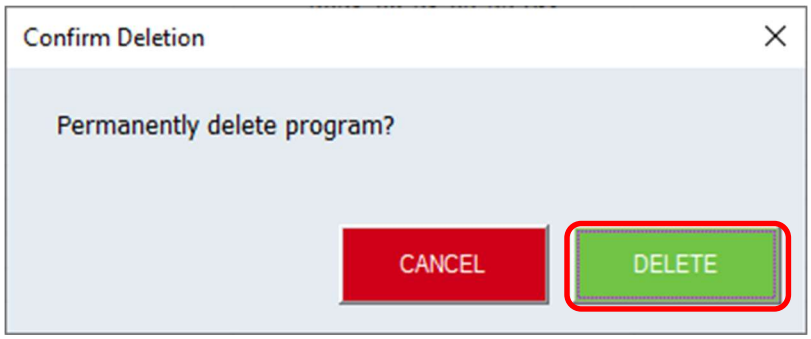
4.4. Deleting Programs

This operation is used to delete programs from XMC-ROBOT controller. It can be performed from the Program List.
From the Program List, select the program to be deleted from the list of programs.

1. Select PROGRAM panel from Navigation Bar.
   - The Program List will appear.
2. Select the program from the list to delete it.
3. Tap {DELETE} on the screen.
   - A confirmation pop-up window will appear.



4. Tap {DELETE}.



4.5. Modifying Program

This operation is performed to modify a program that has already been created. The operation is performed from the Program List.
From the Program List, select the program to be modified.

1. Go to {PROGRAM} panel from Navigation Bar.
   - The Program List will appear.
2. Select the program to modify.
3. Press {MODIFY} to modify program.
   - The Modify Program window appears.
4. Modify Program Names, Tag and Comment using Character Input Operation.

4.5.1. Modifying Program Names

1. Tap on the Program Names.
2. Edit using the alphanumeric keypad.

3. Press {OK} on the keypad.

4.5.2. Modifying Tag

1. Tap on the Tag.
2. Edit using the alphanumeric keypad.
3. Press {OK} on the keypad.

4.5.3. Modifying Comment

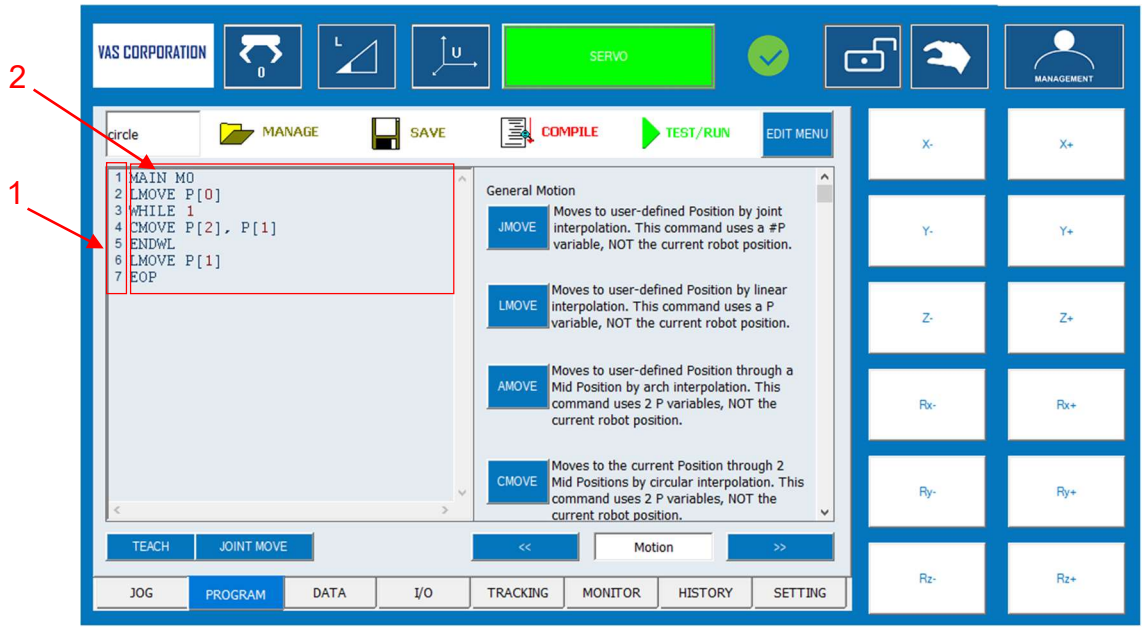
1. Tap on the Tag.
2. Edit using the alphanumeric keypad.
3. Press {OK} on the keypad

5. Teaching

5.1. Teaching Operation

5.1.1. Program Contents View

Teaching is conducted in the Program Contents view. The Program Contents view contains the following items:



1. **Line Numbers**
   The number of the program line is automatically displayed. Line numbers are automatically updated if lines are inserted or deleted.
2. **Instructions, Comments**
   Instructions: These are instructions needed to process or perform an operation. In the case of Motion instructions, the instruction corresponding to the interpolation type is automatically displayed at the time the position is taught.
   Comments: These lines are not operated in program.

5.1.2. Jogging the Robot for Teaching

Before teaching and recording a robot motion, the Robot needs to be moved to the position of interest. This motion is manually performed by the operator using any of the methods described in “Coordinate Frame and Manipulator Jogging”.

5.1.3. Motion Type (Interpolation Type)

Interpolation type determines the path along which the manipulator moves between running steps.
Normally, the position data and interpolation type are registered together for a robot motion step.

5.1.3.1. Joint Interpolation

Joint interpolation is used when the manipulator does not need to move in a specific path toward the next step position. When the joint interpolation is used for teaching a robot motion, the instructions is MOVEJ. Use joint interpolation to teach the first step. This will avoid unintentional motion errors in the singularity posture at the beginning of the motion.
PlaySpeed is percentage of the maximum rate of joint speed.

5.1.3.2. Linear Interpolation

When the manipulator TCP moves in a straight-line path from one taught step to the next step, it is described as linear interpolation. When linear interpolation is used to teach a robot motion, the instruction is MOVEL.
PlaySpeed of this instruction is percentage of the maximum rate of TCP speed (mm/s).

5.1.3.3. Circular Interpolation

When the manipulator TCP moves in an arc that passes through three points, the movement is described as a circular interpolation. When circular interpolation is used for teaching a robot motion, the instruction to use is MOVEC.
PlaySpeed of this instruction is percentage of the maximum rate of TCP speed (mm/s).

5.1.4. Teaching Steps

5.1.4.1. Teaching Motion Instructions

Whenever one step is taught, a motion instruction is inserted.

1. Before jogging the Robot, select the desired Jogging Coordinate for easier movement.
2. Use the jogging buttons on the touch screen to move the manipulator to the desired position.
3. Select the Inserting Line and Interpolation Type.
4. Press {TEACH} to teach the current position.

Selecting the Inserting Line

1. In the Program List, select the desired program and tap {EDIT} to open.
   - The content of the currently-selected program is displayed.
2. Move the cursor to a line immediately before the position where a motion instruction is to be registered.
3. Press {SERVO} to turn the servo power ON.
4. Move the manipulator to the desired position using Jogging Buttons.

Setting the Interpolation Type

- Press {JOINT MOVE} next to the {TEACH} to change the interpolation type. The order will be shown as:
  - Joint Move
  - Linear Move
  - Circle Move

Each time the interpolation type button is pressed, the interpolation type switches in this order. If pressed again after it reaches Circle Move, it will return to the Joint Move.

5.2. Commands

5.2.1. Command Group

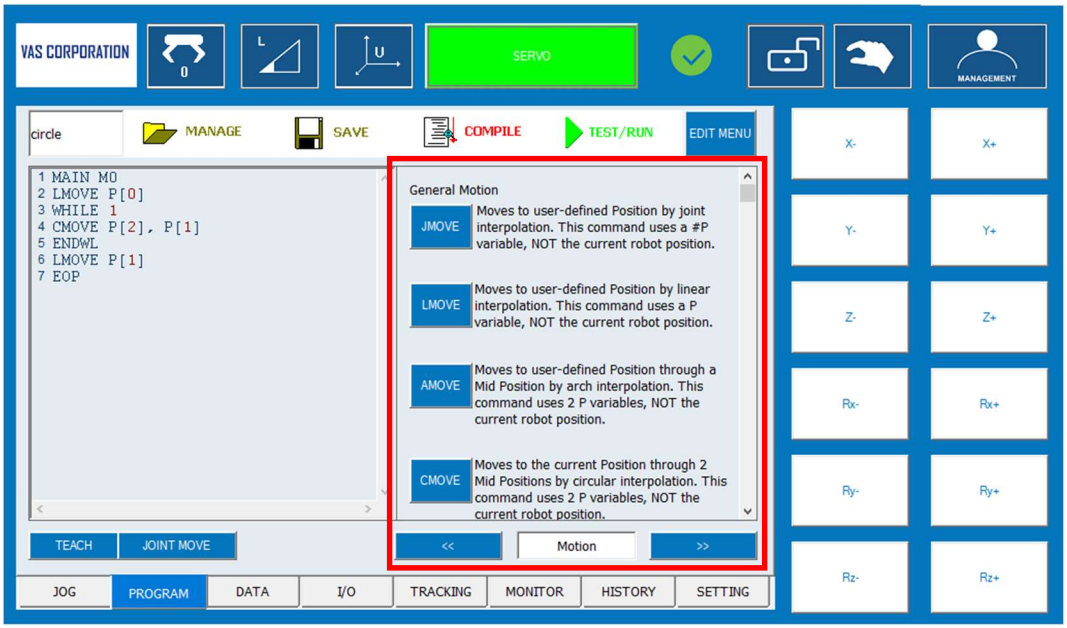
The commands are divided into five groups by processing or each work.

Display	Content	Example
Motion	Moves the manipulator	MOVEJ, MOVEL, MOVEC
I/O	Controls input and output	DigitalOut, PulseOut
Control	Controls processing and each work	WHILE, LOOP, FOR
Math	Performs arithmetic calculation	ABS, SQRT, SIN
Configuration	Sets the parameters for motion	SPEED, ACCEL
Conveyor	Conveyor Tracking functions	TKMOVE

Command List

Command List is next to the Program Contents view

Press {<<} or {>>} to select a command group and display its command list.



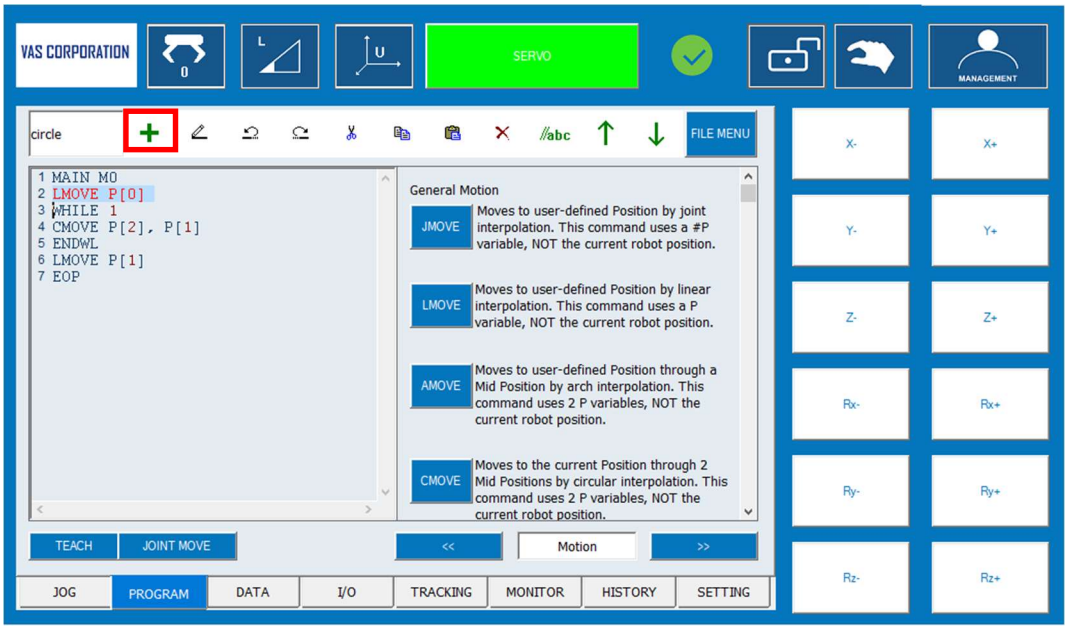
5.2.2. Inserting Command

5.2.2.1. Inserting Command from Command List

1. In TEACH mode, move the cursor to the line immediately before where the command is to be inserted in the Program Contents view.
2. Select the command group by using navigation buttons.
   - The command list of the selected command group will appear.
3. Select the command.
   - The character input is displayed for completing all parameters relate to command.
4. Tap {OK} to finish inserting command to Program Contents view.

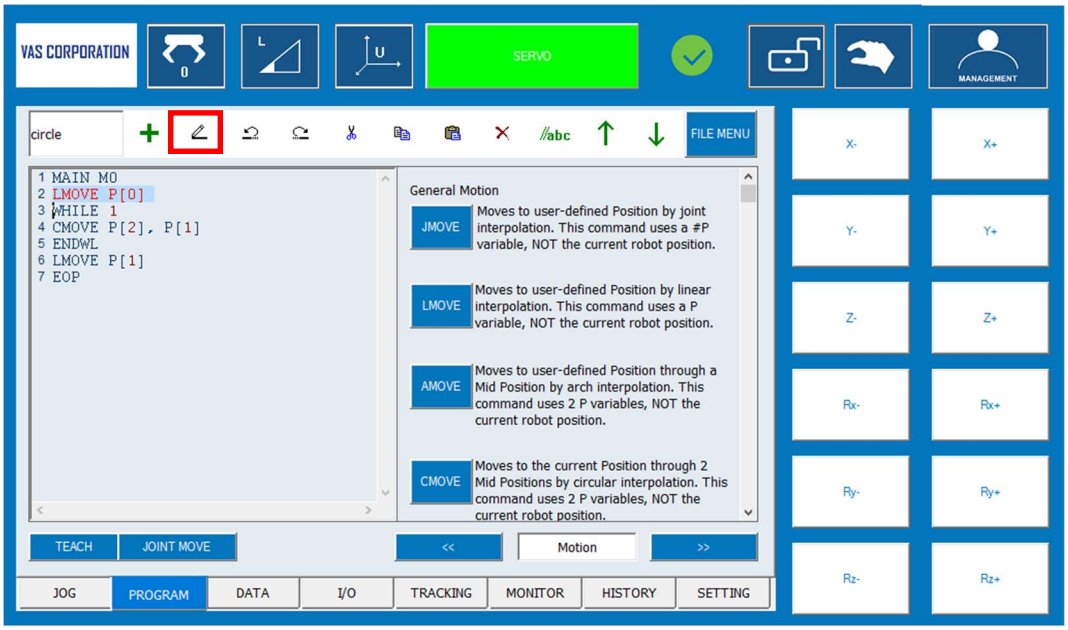
5.2.2.2. Inserting Command directly

1. In TEACH mode, move the cursor to the line immediately before where the command is to be inserted in the Program Contents view.
2. Press {INSERT} in the Edit Menu to insert a command directly.
   - The character input is displayed for inputting command.
3. Tap {OK} to finish inserting command to Program Contents view.



5.2.3. Editing Command

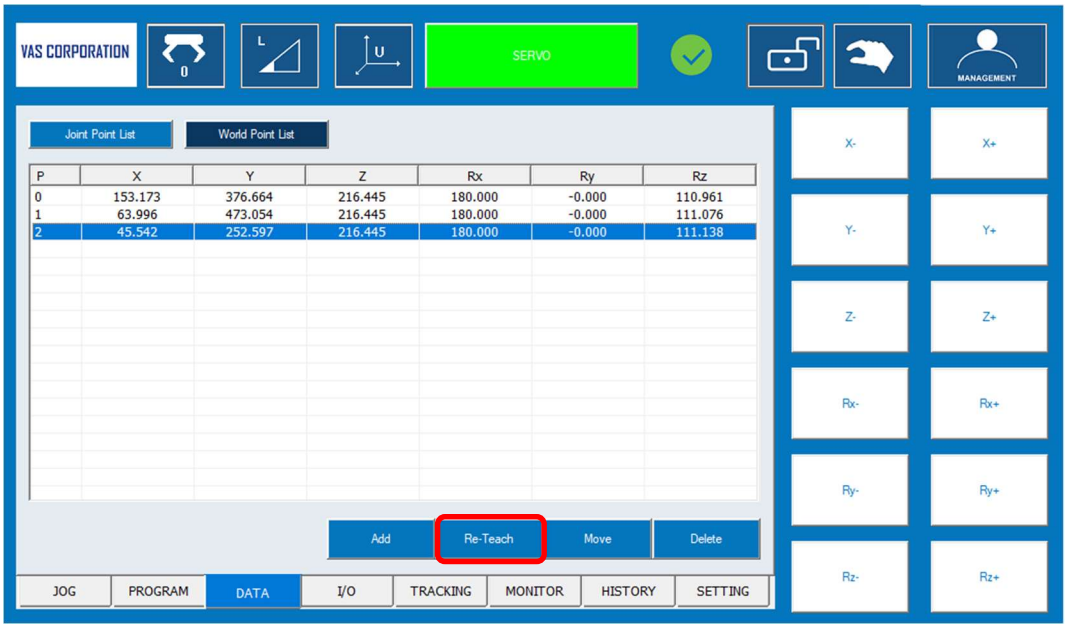
1. In the TEACH mode, select the command to be edited.
2. Tap {EDIT} in the Edit Menu to edit the selected command.
   - The character input is displayed for editing the selected command.
3. Tap {OK} to finish editing command.



Modifying Position

1. Go to {DATA} panel from Navigation Bar.
2. Select the Position need modifying.

3. Press {Re-Teach} to modify the position. The current position of robot will be recorded to the selected position.



5.3. Editing Program

The following operations can be used from Edit Menu.

- Insert
- Edit
- Cut
- Copy
- Paste
- Delete
- Undo
- Redo
- Comment
- Up
- Down

Bring the cursor to the line to be processed and press the desired button. Additionally, some of these commands (Cut, Copy, Delete, Comment) can be executed on multiple lines at one time. To select multiple lines, press and hold on the line number and drag to select more lines.

5.3.1. Undo Operation

Toolbar button	Name	Description
	Undo	Undo reverses the most recent editing program.

After inserting, deleting or modifying an instruction, operations can be undone. The undo operation can be performed even after the manipulator is moved by the test operation.

5.3.2. Redo Operation

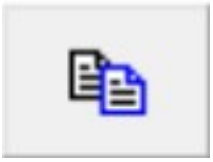
Toolbar button	Name	Description
	Undo	Redo reverts the effect of the undo action.

Redo can only be used after the undo operation has been used.

5.3.3. Cut Operation

Toolbar button	Name	Description
	Cut	Deletes the selected command(s) from a program and copies command(s) to a buffer.

5.3.4. Copy Operation

Toolbar button	Name	Description
	Copy	Copies the selected command(s) to the buffer.

5.3.5. Paste Operation

Toolbar button	Name	Description
	Paste	Inserts the content of the buffer on a line below the selected step.

5.3.6. Delete Operation

Toolbar button	Name	Description
	Delete	Deletes the selected command(s).

5.3.7. Comment Operation

Toolbar button	Name	Description
	Comment	Comment the selected command(s). Commented commands will be skip during program execution.

5.3.8. Up Operation

Toolbar button	Name	Description
	Up	Move the selected command to the previous command position

5.3.9. Down Operation

Toolbar button	Name	Description
	Down	Move the selected command to the next command position

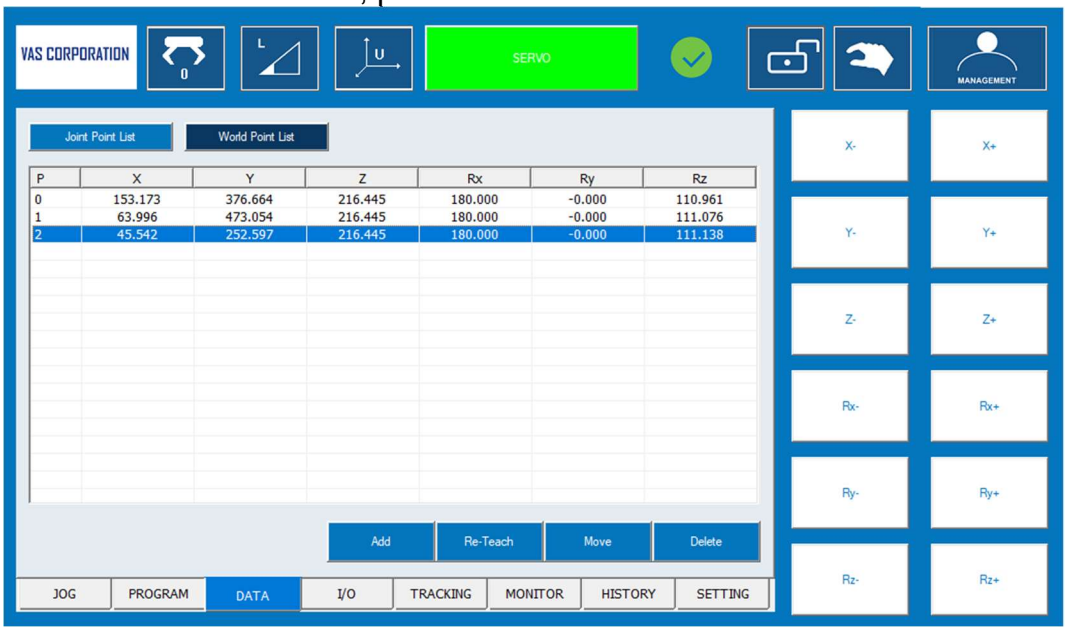
5.4. Position Variables

Position variables can store position data in angle form (Joint) or in XYZ form (Translation). DATA panel from Navigation Bar help user monitor position variables defined in the program.

DATA panel contains two point-lists:

- Joint Point List: store all position variables in angle form.
- World Point List: store all position variables in XYZ form.

To switch between 2 lists, press the desired button.



From this panel, the user can:
- Define a new point.
- Modify an existing point.
- Move to an existing point for checking.
- Delete an existing point.

5.4.1. Define a New Point

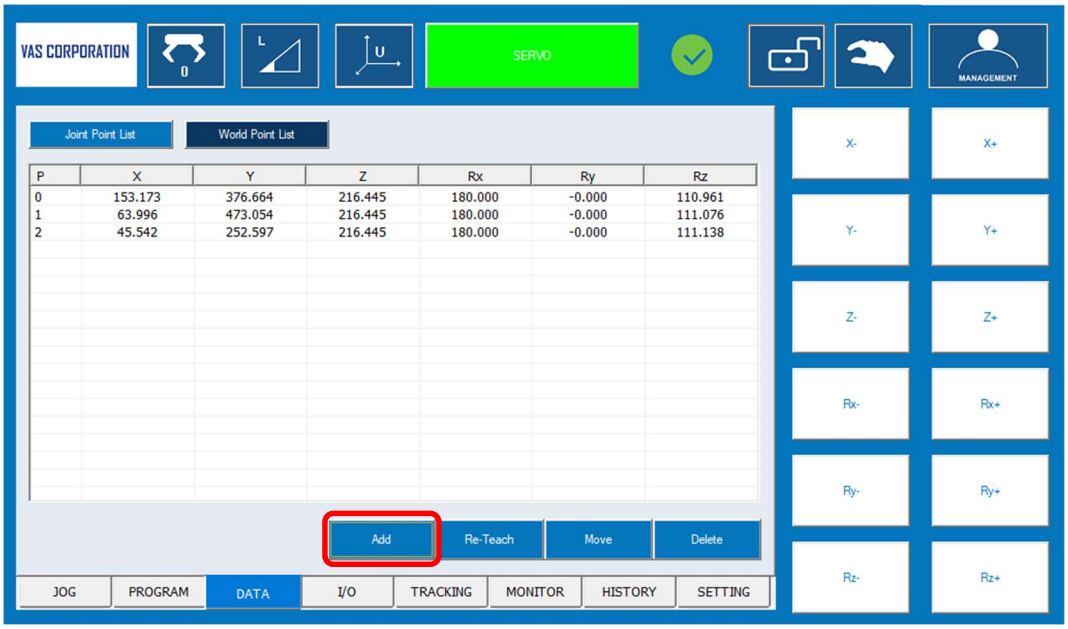
Before defining a new point, select the desired Position variable type (Joint or World).
There are two methods to define a new point:
- Moving the Manipulator
- Using Numeric Keypad.

5.4.1.1. Setting Position Variable by Moving the Manipulator

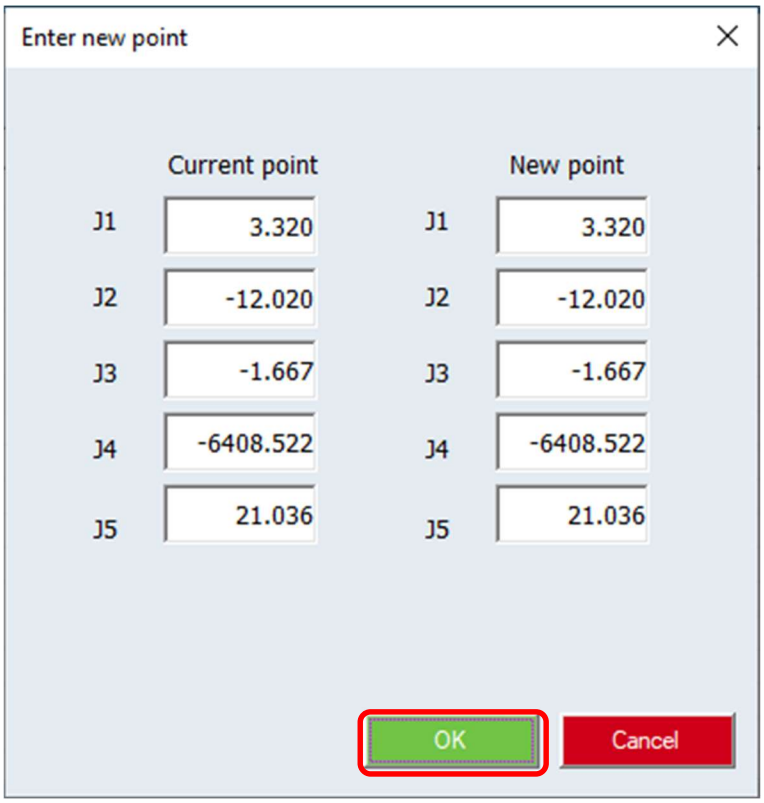
The following shows the position variables and setting methods.

Type	#P[xxx]	P[xxx]
	Angle Type	XYZ Type (world, tool, user)
Setting Method	Using Jogging buttons	

After moving the manipulator to the target position:
1. Press {Add} to open New Point window.

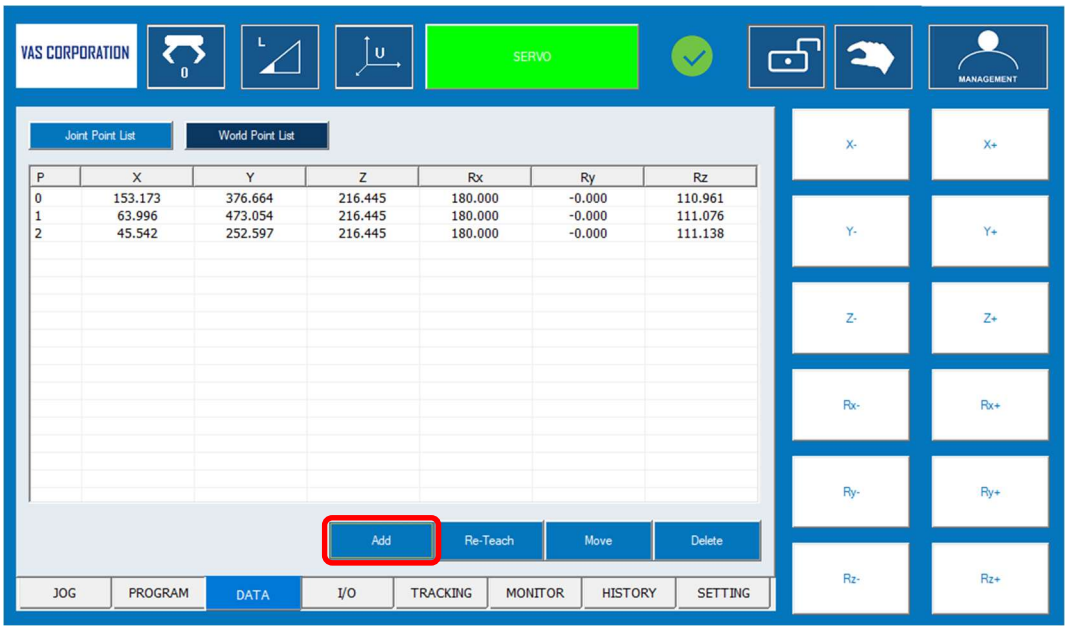


2. Press {OK} to add the current point to point list.

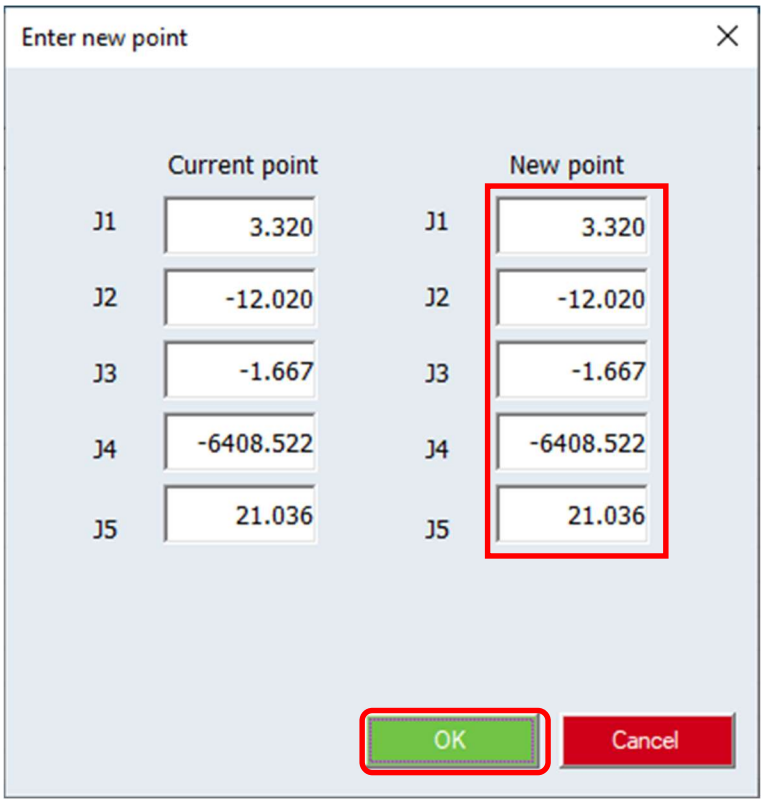


5.4.1.2. Setting Position Variable by Using Numeric Keypad

1. Press {Add} to open New Point window.



2. Tap on the new point text fields to enter new value by using numeric keypad.
   Press {OK} to add new point to point list.



5.4.2. Modify an Existing Point

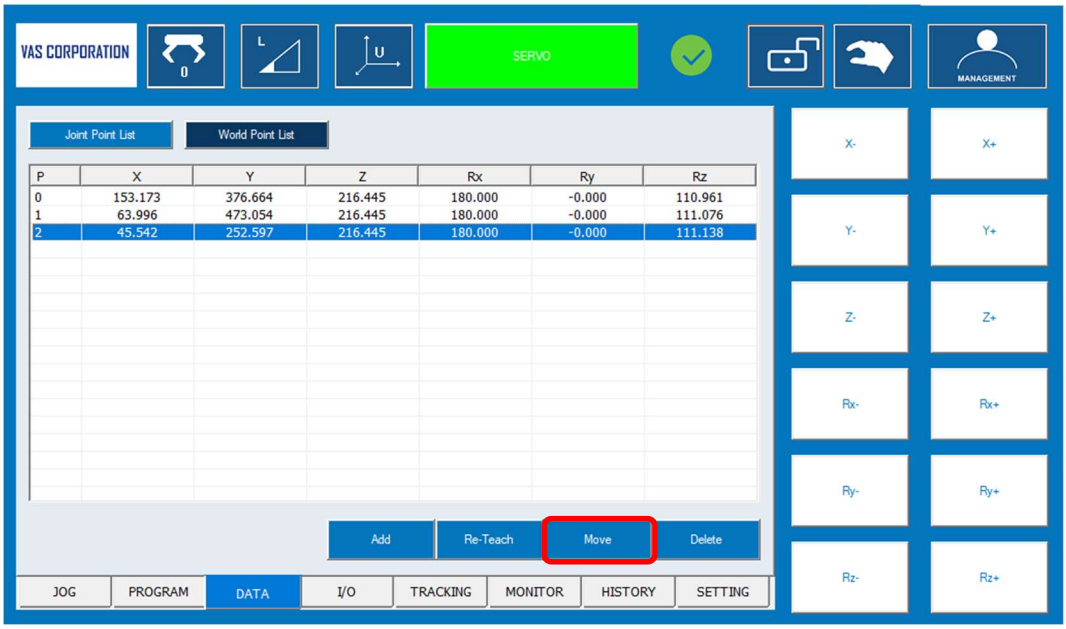
1. Select the point needs modifying from the lists.
2. Press {Re-Teach} to modify the selected point.

After {Re-Teach} is pressed, the selected point is replaced by the current position.

5.4.3. Move to Point

User can check the taught point by using Move to Point function.
Follow these steps to move manipulator from the current position to the target point.

1. Select the point from the point list.
2. Press {Move} to execute motion for checking.

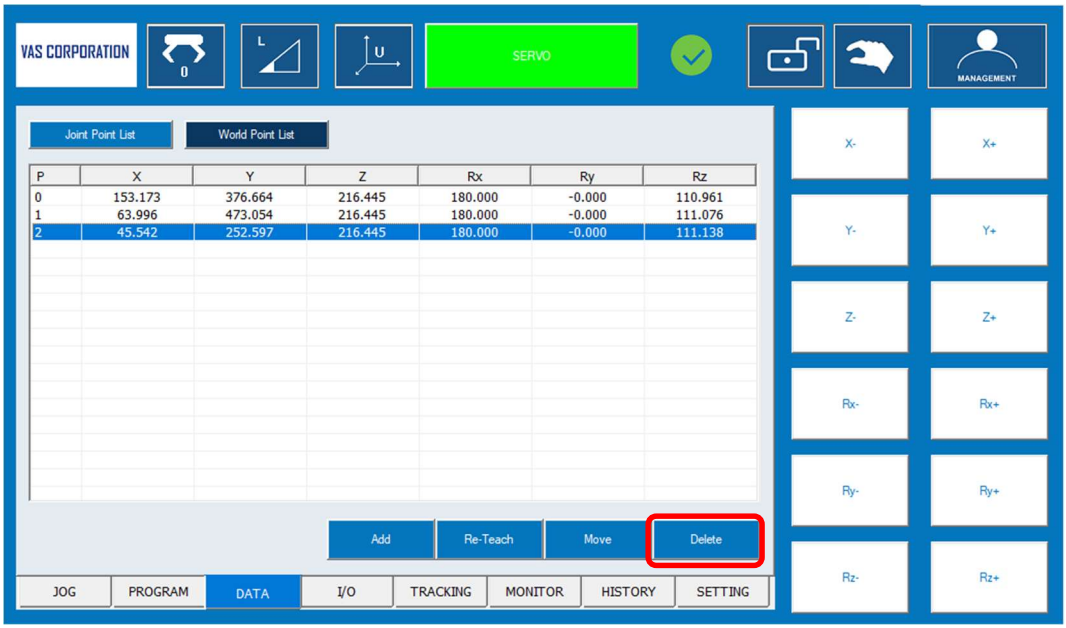


5.4.4. Delete an Existing Point

This operation is used to delete an existing point from the point list if it is not necessary for the robot task.

A point can be deleted from the point list by the following steps:

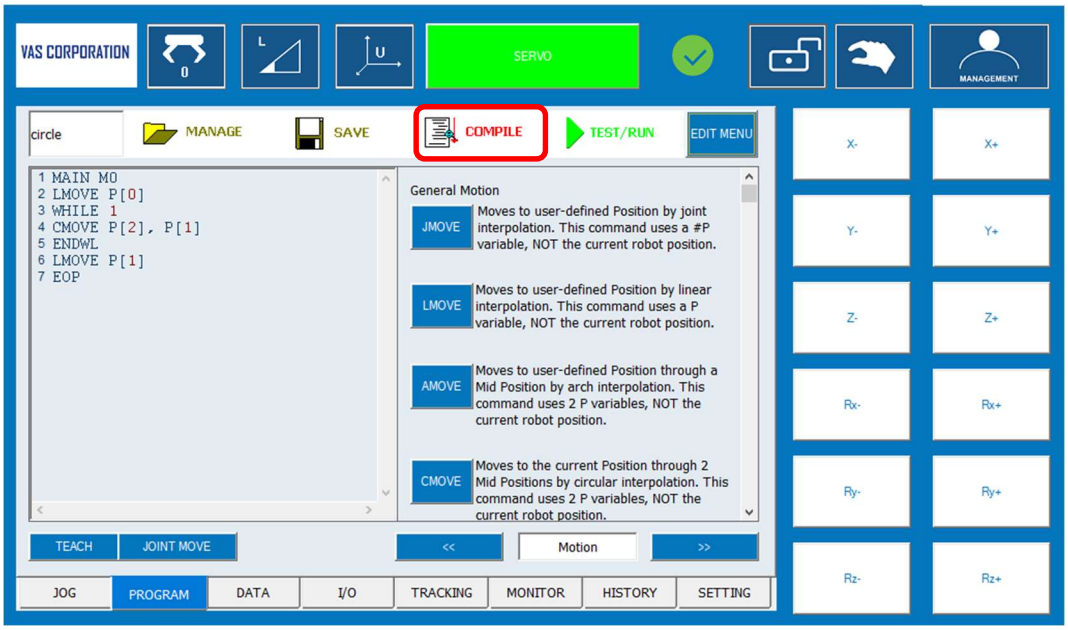
1. Select the point need deleting.
2. Press {Delete} to delete it.
   After deleting, all values are changed to "…" characters.



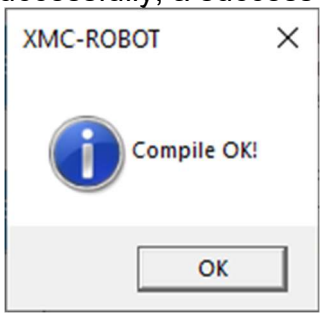
5.5. Compile Program

After teaching, program need checking to ensure invalid syntax.
Follow these steps to compile the program:

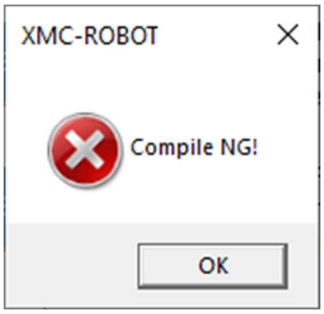
1. Go to PROGRAM panel from Navigation Bar.
2. Press {COMPILE} to compile the current program.



3. If program is compiled successfully, a success message will appear.



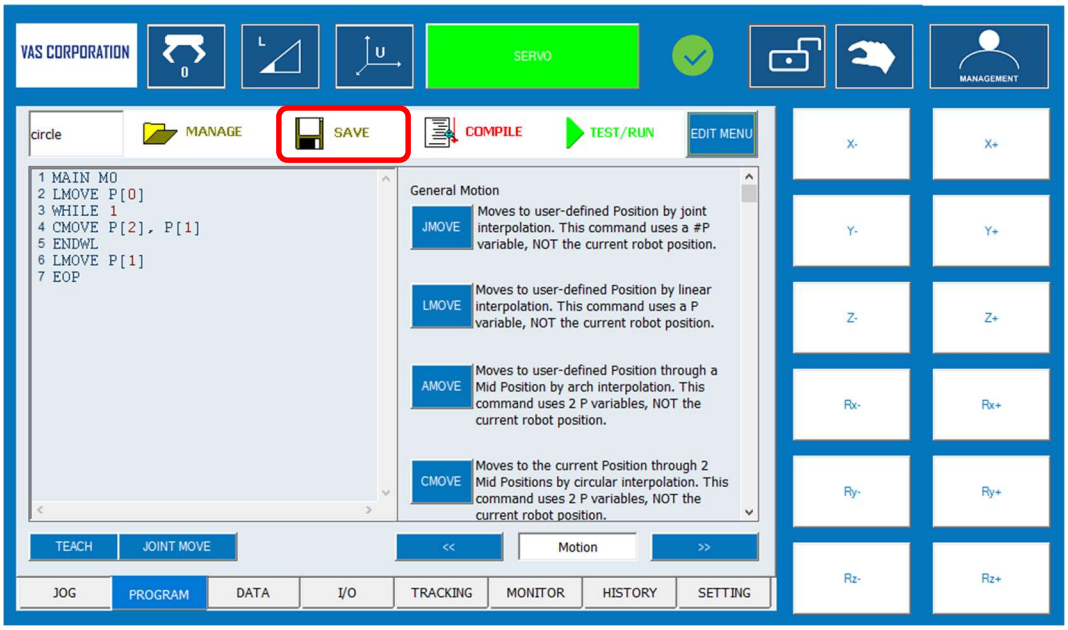
If not, an error message will display.



5.6. Save Program

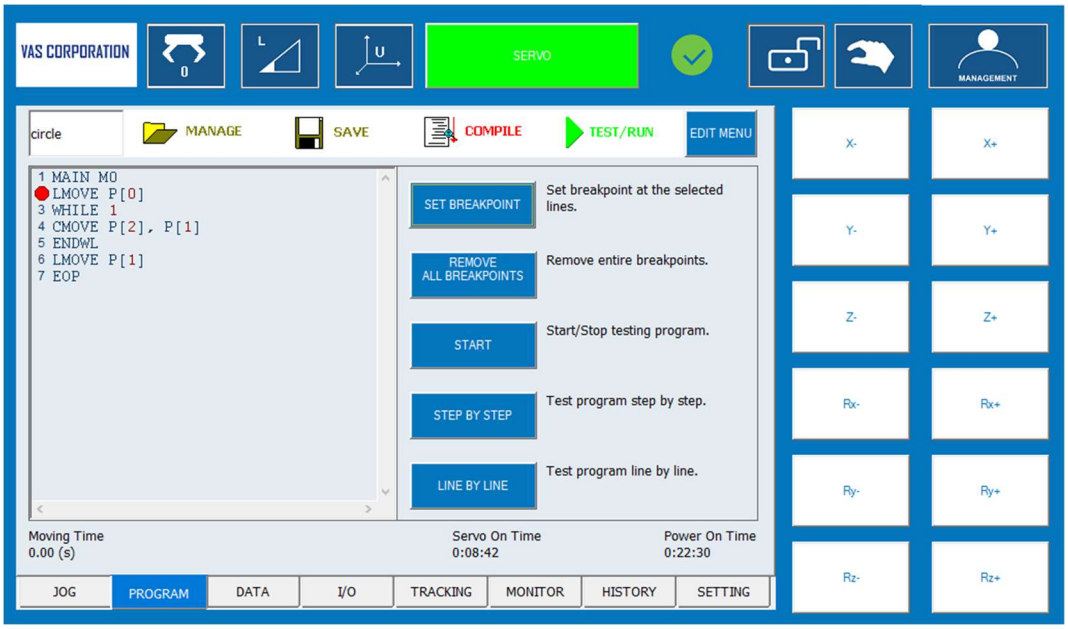
After programming done, it must be saved to the controller for using in the next time. Please follow these steps to save the current program:

1. Go to PROGRAM panel from Navigation Bar.
2. Press {SAVE} to save the current program.



5.7. Test Program

Playback operation can be tested and verified in TEACH mode.



5.7.1. Testing Operation Buttons

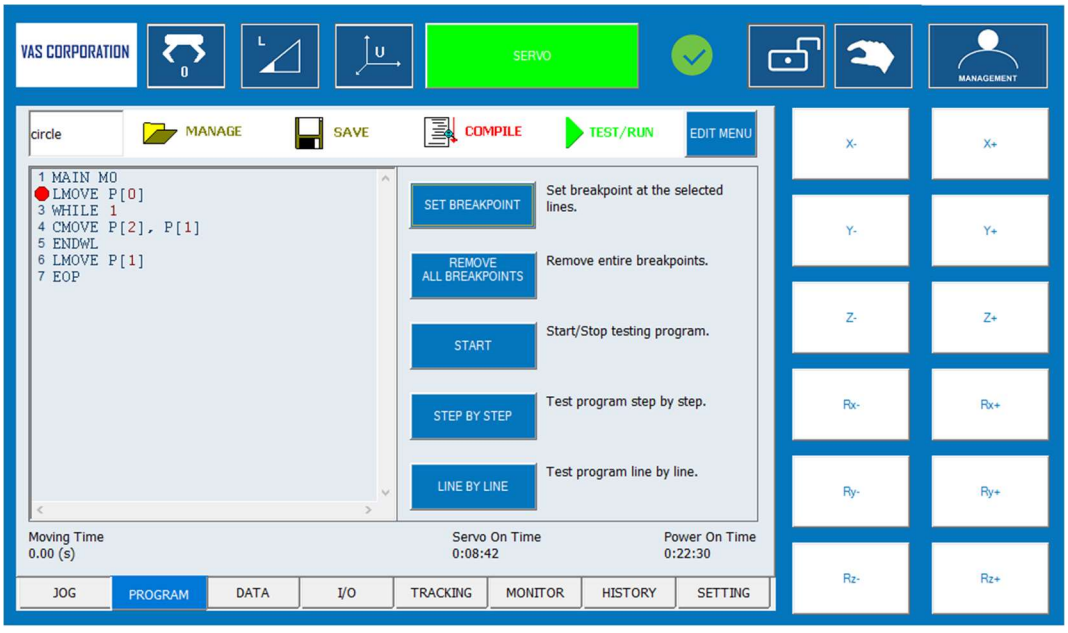
There are some operation buttons support Program Testing described in the following table.

Name	Description
Test Start	Start the Program Testing Operation.
Set breakpoint	Set the breakpoint at the program step.
Remove all breakpoints	Remove the entire breakpoints.
Step by Step	Program executes from the current breakpoint to next breakpoint.
Line by Line	Program executes line by line from the current breakpoint to the end of program

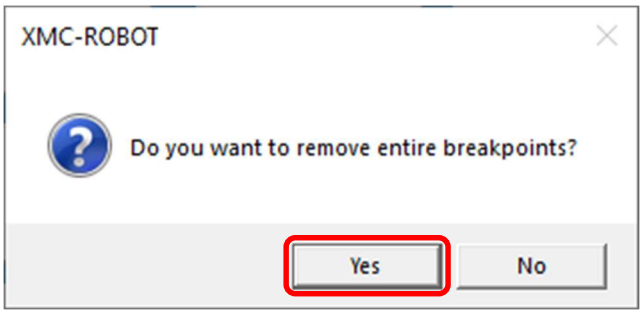
5.7.2. Test Start

This operation is used to test and verify program in the TEACH mode before playback operation. Follow these steps to start program test:

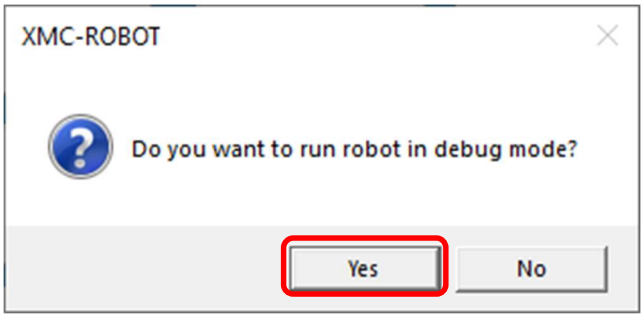
1. Place operation mode in TEACH mode.
2. Turn Servo Power ON.
3. Open program from the {Program List}.
4. Compile the program to ensure valid syntax.
5. Select the program step you want to start testing.
6. Press {Set Breakpoint} to set breakpoint at the selected step.



To remove all entire breakpoints, press {Remove all breakpoints}.
- A pop-up window appears, select {Yes} to remove.



7. Press {START} to start program test.
   - The following window appears, press {Yes} to confirm start testing.



8. Press the test mode buttons (StepbyStep or LinebyLine) to run robot and verify the program.

6. Playback

6.1. Preparation for Playback

6.1.1. Selecting a Program

Playback is the act of executing a program. Begin by opening the program to be executed.

1. Select PROGRAM panel from Navigation Bar.
2. Select the desired program from the list and press {RUN}.

6.1.2. Open a Program

1. Change the mode of controller from TEACH mode to AUTOMATIC mode.

6.1.3. Compile Program

After opening program, it needs to compile to ensure valid syntax before playback.
The program cannot be executed if not compiled.
Press {COMPILE} to compile the current program.

6.1.4. Controller Mode

Switch controller mode from TEACH mode to AUTOMATIC mode for playback.

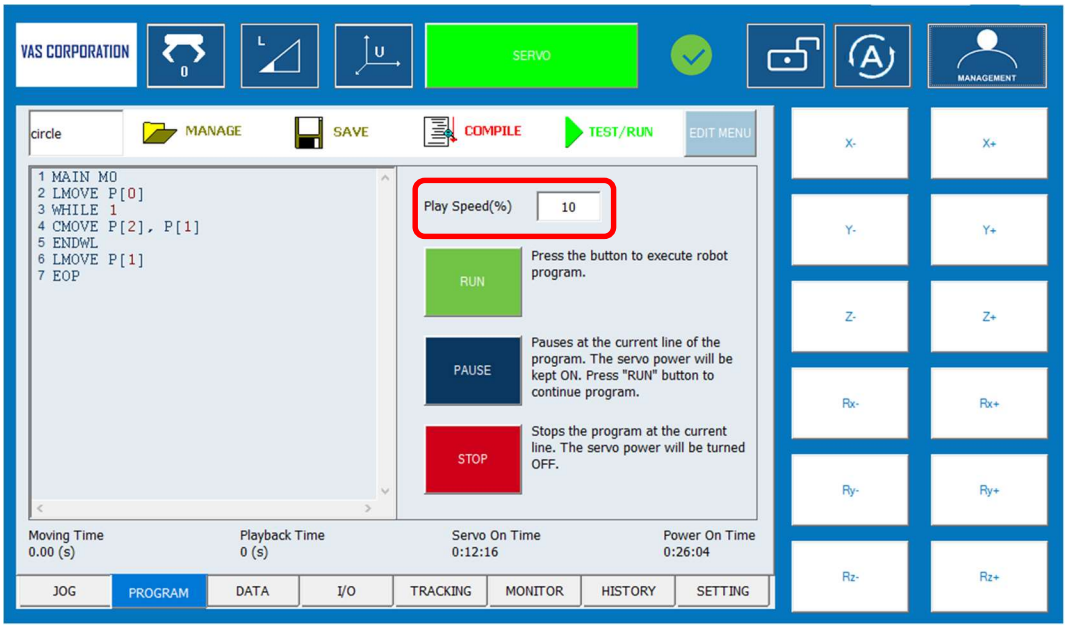
6.1.5. Operation Buttons

Button	Name	Description
	Run	Executes the program.
	Pause	Pauses at the current line of the program. The servo power will be kept ON. The program can be continued to run from the paused line by pressing the “RUN” button.
	Stop	Stops the program at the current line. The servo motor power will be turned OFF.

6.1.5.1. Playback Speed

Enter play speed value to modify the Playback Speed from 10-100%. This will scale all setting speeds by the specified amount. For example, if Playback Speed is set to “50%”, the linear motion would execute at 50% of

max linear speed and joint motion would execute at 50% of max joint velocity.



6.2. Playback

Playback is the operation by which the taught program is played back.

6.2.1. Selecting the Mode

Set the Mode of controller to AUTOMATIC mode.
The AUTOMATIC mode is enabled.

6.2.2. Servo ON

Press {SERVO}.

- The servo power turns ON and the {SERVO} ON button will turn green.

6.2.3. Run Operation

Press {RUN}.

- The manipulator starts operation. The program will start from the beginning of the program.

The program can be stopped or paused when the program is running by pressing {STOP} or {PAUSE}. The servo power will not turn OFF when {PAUSE} is pressed, but will turn OFF when the {STOP} is pressed.

6.3. Stop and Restart

The following situations stops or automatically stops the running program or manipulator:

- Pause
- Emergency Stop

- Alarm
- Stop due to other causes.

6.3.1. Pause

By the hold operation, the program stops temporarily. “Pause” is also called “hold”.

Pause

Press {PAUSE} on the screen.

Release

Tap {RUN} on the screen to continue the operation.
Tap {STOP} on the screen.

6.3.2. Emergency Stop

During an Emergency Stop, the servo power supply that drives the manipulator is turned OFF and the manipulator stops immediately. An Emergency Stop can be performed using the following tools:

- Emergency Stop button on the Teach Pendant.
- Emergency Stop button on the electric box.

6.3.2.1. Release

Turn the Emergency Stop button in the direction of the arrows.
Emergency Stop button should lift up and indicator on Status bar should disappear. To turn the servo power supply ON again, press {SERVO}.

6.3.2.2. Restart After an Emergency Stop

Priority to restarting operations after an Emergency Stop, confirm the position of the manipulator and make sure that there is no interference between the manipulator and its workspace.

6.3.3. Stop by Alarm

If an alarm occurs during operation, the manipulator stops immediately and the ALARM pop-up window appears on the Teach Pendant indicating that the manipulator was stopped by an alarm. Follow the instructions shown on the screen to release the alarm.
To display the ALARM pop-up window again during alarm occurrence, press Alarm icon on the status bar. To view previous alarms that are currently inactivate, go to Navigation Bar and select {HISTORY} → {Alarm History}.

6.3.4. Others

6.3.4.1. Temporarily Stop by Mode Change

When the AUTOMATIC mode is switched to the TEACH mode during playback, the manipulator stops immediately. To restart operation, return to AUTOMATIC mode and perform a start operation.

7. Input / Output

To access the I/O screens, press {I/O} panel from Navigation Bar. This will open the I/O screen.

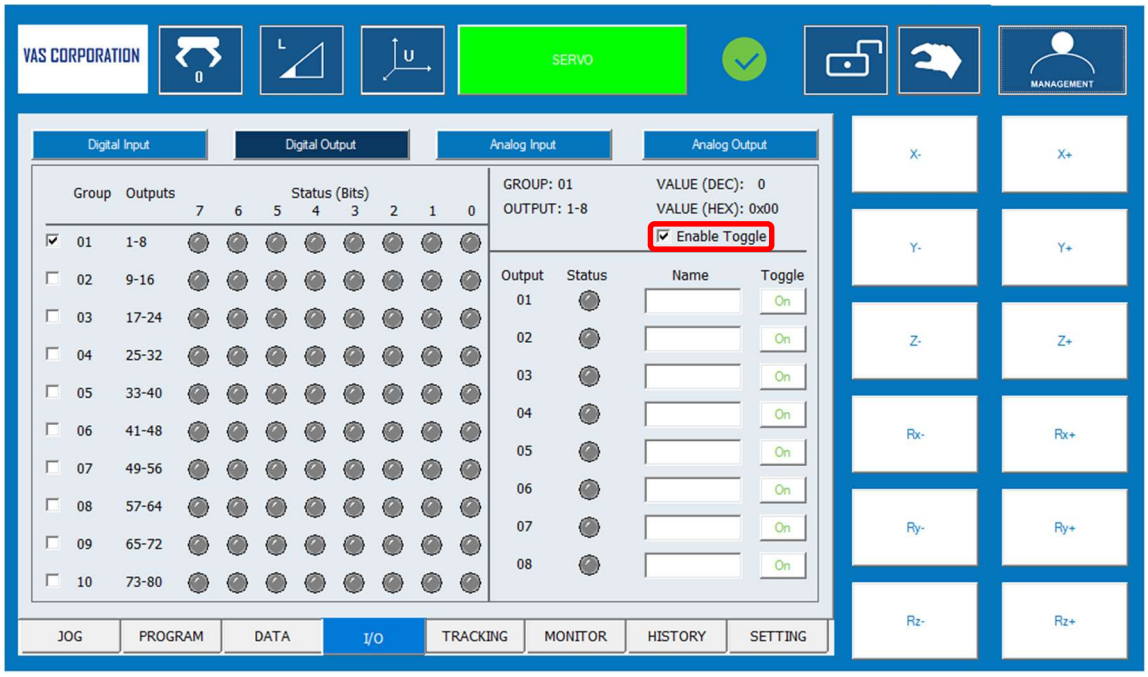
I/O screen contains two pages:

- Digital Input
- Digital Output

Each signal type can be accessed by pressing the corresponding button.

The digital signals are displayed in groups of 8. ON status is shown as a green circle, and OFF status is shown as a gray circle. The status is shown from 1 to 8 with a bit order reading from right to left. When the group is selected on the left side, the status of each I/O number will be displayed on the right side of the screen.

1. Check the {Group No} checkbox to select an I/O group.
2. Additional information about the selected group is displayed on the top right of the screen. This information includes:
   - GROUP: the group number of the inputs.
   - INPUTS: the 8 inputs within the specified group.
   - VALUE (DEC): the value of the group in decimal.
   - VALUE (HEX): the value of the group in hexadecimal.
   - Enable Toggle (for Outputs only): Output signals can be toggled with toggle switches. When {Enable Toggle} checkbox is not checked, the output toggle switch is disabled. When {Enable Toggle} checkbox is checked, the output toggle switch is enabled for individual outputs. This shown in the following picture.

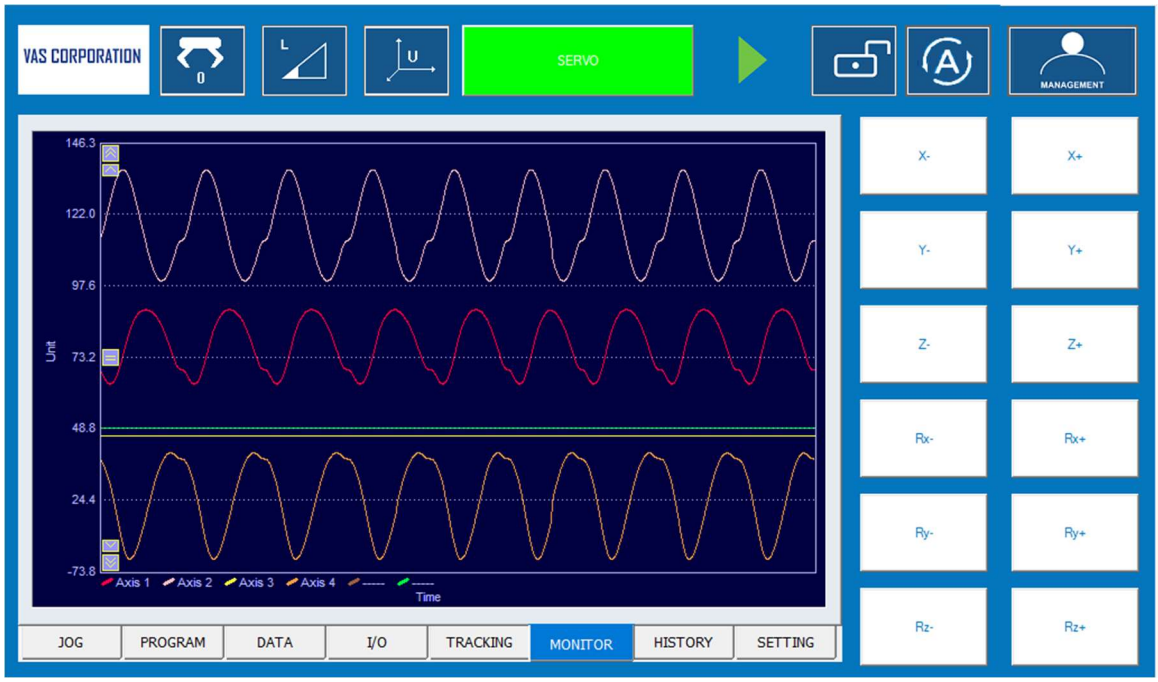

VAS CORPORATION
SERVO
MANAGEMENT
Digital Input
Digital Output
Analog Input
Analog Output
Group
Outputs
Status (Bits)
7 6 5 4 3 2 1 0
01 1-8
02 9-16
03 17-24
04 25-32
05 33-40
06 41-48
07 49-56
08 57-64
09 65-72
10 73-80
GROUP: 01
OUTPUT: 1-8
VALUE (DEC): 0
VALUE (HEX): 0x00
Enable Toggle
Output
Status
Name
Toggle
On
JOG
PROGRAM
DATA
I/O
TRACKING
MONITOR
HISTORY
SETTING
X-
X+
Y-
Y+
Z-
Z+
Rx-
Rx+
Ry-
Ry+
Rz-
Rz+

8. Conveyor Tracking

XMC-ROBOT supports conveyor tracking application.
To modify movement and location of the installed conveyor, go to {TRACKING} panel from Navigation Bar. For more detail information, please refer to manual about Conveyor Setting.

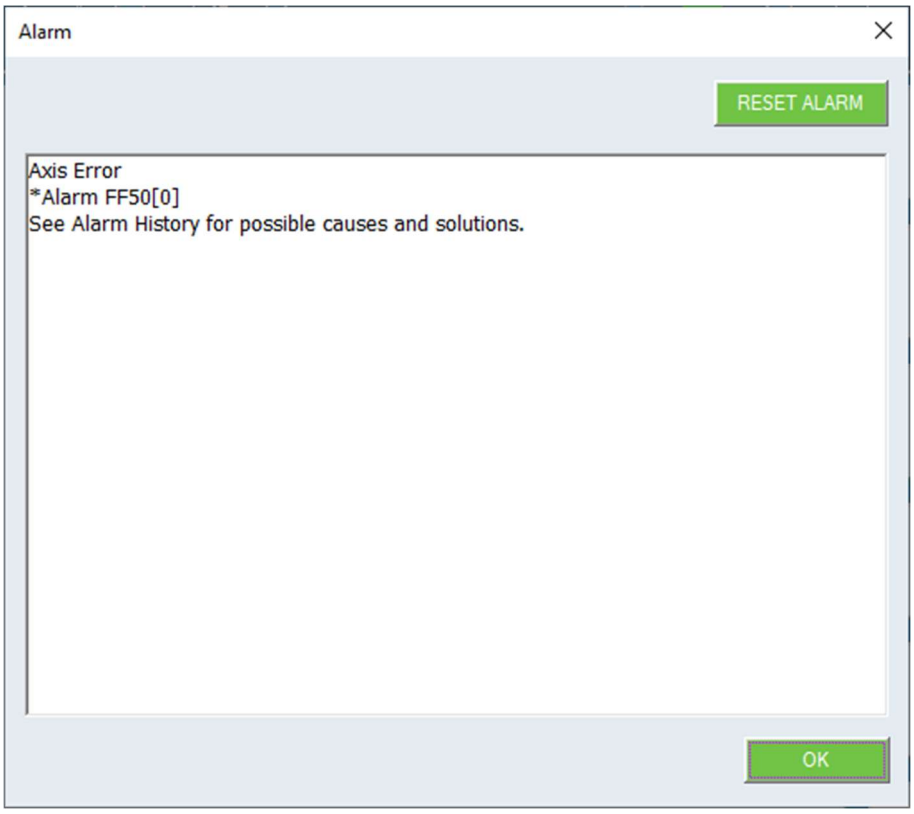
9. Monitor

In this page, robot axis positions are displayed in graph to monitor.



10. Alarm

If an alarm occurs during operation, the manipulator stops immediately and the ALARM pop-up window appears on the pendant.



To reset the current alarms, press {RESET ALARM}.
Press {OK} to close ALARM pop-up window.
For more details about alarms, go to Alarm History screen.

11. History

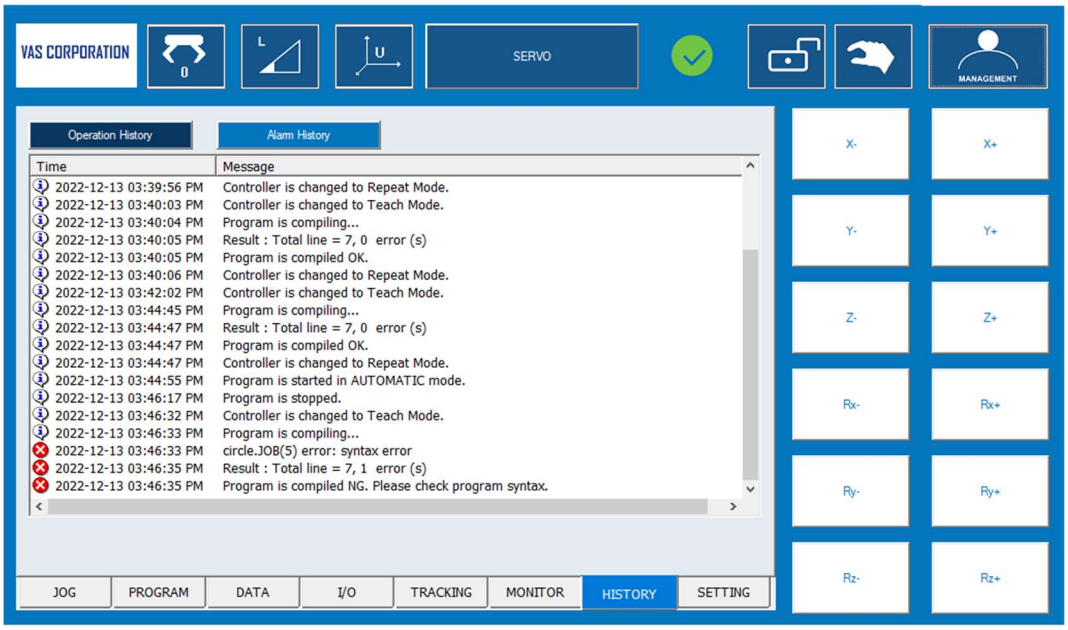
History screen includes:

- Operation History: Display all operations of user.
- Alarm History: Display, show more details about alarms, help user diagnostic and solve the alarms.

To access History screen, select {HISTORY} from the Navigation Bar.

11.1. Operation History

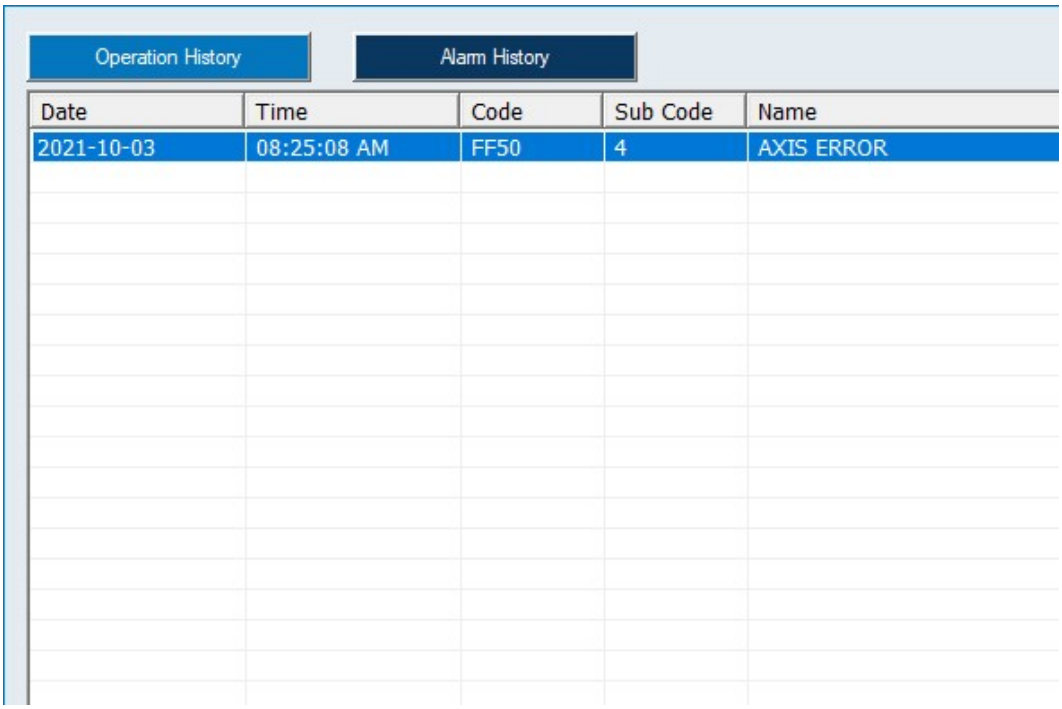
This screen displays all operations of user. It can help user monitor their operations on controller.



11.2. Alarm History

If an alarm occurs during operation, the manipulator stops immediately and the ALARM pop-up window appears on the pendant. All previous alarms can be viewed on the Alarm History screen.

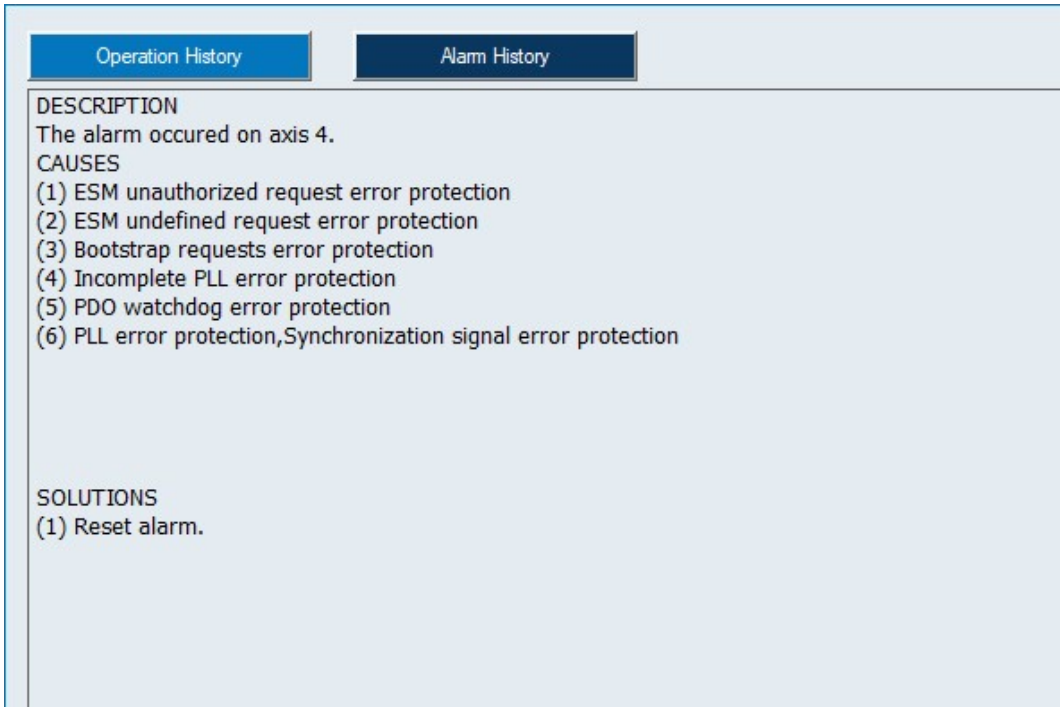
Item	Description
Date	Date of alarm is shown in YYYY-MM-DD format
Time	Time of alarm is shown in hh:mm:ss with AM/PM format
Code	Alarm code is shown in 4-digits
Sub Code	Alarm sub-code is shown
Name	Name of the alarm occurred



For more details about alarm:

1. Select the alarm in the alarm list.
2. Press {SHOW DETAIL} to show more details about the selected alarm
   - The Alarm Detail window appears.

Item	Description
Description	Description of the alarm is shown here.
Possible causes	Possible causes of the alarm are shown here.
Solution	Solutions are shown here. Follow the steps to solve the issue that is causing the alarm.


Operation History
Alarm History
DESCRIPTION
The alarm occured on axis 4.
CAUSES
(1) ESM unauthorized request error protection
(2) ESM undefined request error protection
(3) Bootstrap requests error protection
(4) Incomplete PLL error protection
(5) PDO watchdog error protection
(6) PLL error protection,Synchronization signal error protection
SOLUTIONS
(1) Reset alarm.

12. Robot Setting

Robot Setting allows setting:

- EtherCAT device
- Geometry
- Axis Setting
- Motion
- Robot Configuration Position
- Home Position Calibration
- Tool
- Jogging Speed

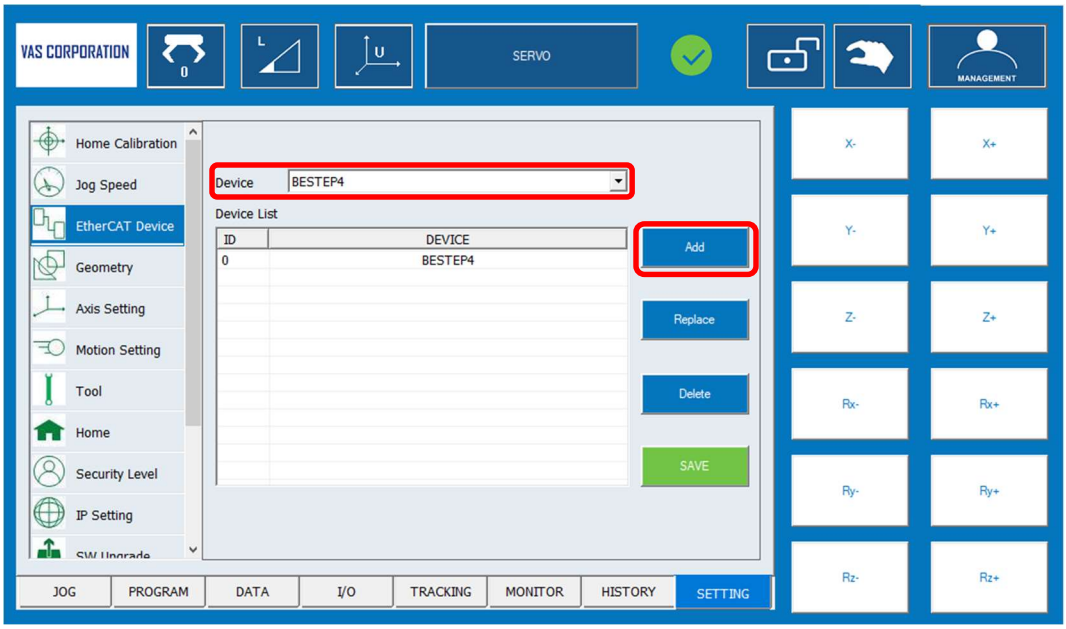
12.1. EtherCAT Device

In the network, XMC-ROBOT connects with slave devices in a certain order. This screen describes the list of EtherCAT devices in the network. The order of slaves in the list requires matching with the order in the actual network.

12.1.1. Append a Device

A device can be appended to the list by:

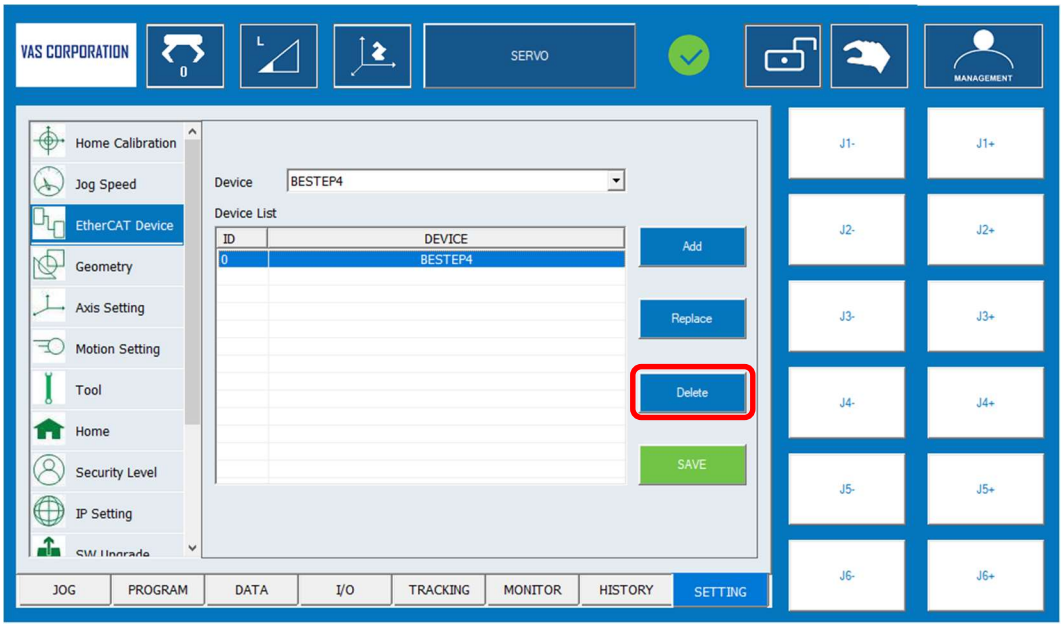
- Selecting a {Device} to be added from the dropdown list.
- Tapping {Add} to add the device to the last index of the list.



12.1.2. Delete a Device

A device can be deleted from the list by:

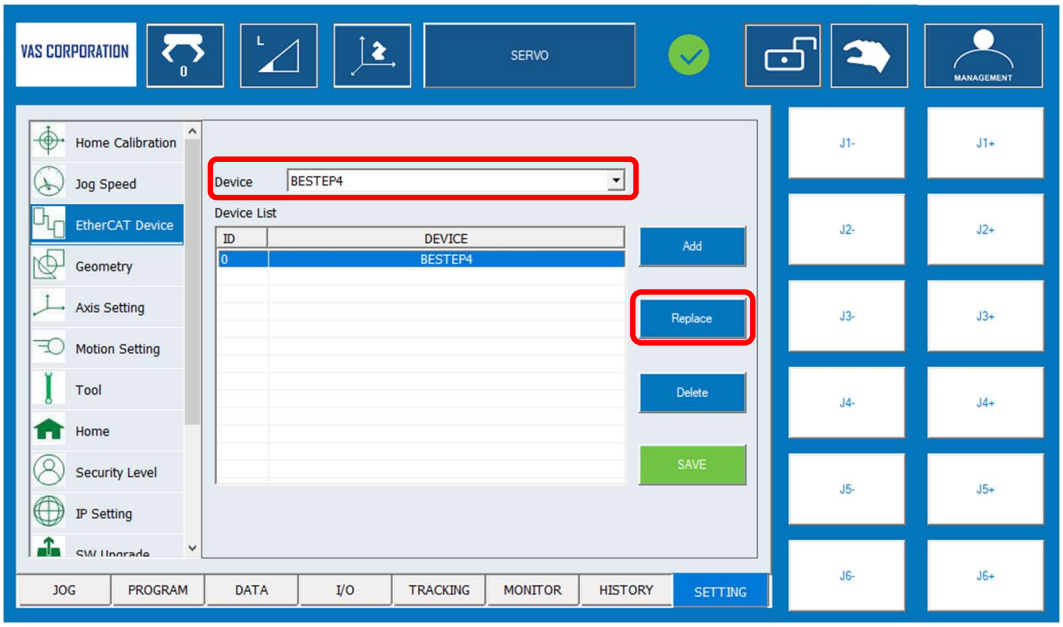
- Selecting the device to be deleted in the list.
- Tap {Delete} to delete the selected device.



12.1.3. Edit a Device

A device in the list can be replaced by another device by:

- Selecting the device in the list for editing.
- Selecting {Device} to replace the selected device from the dropdown list.
- Tapping {Apply} to edit.

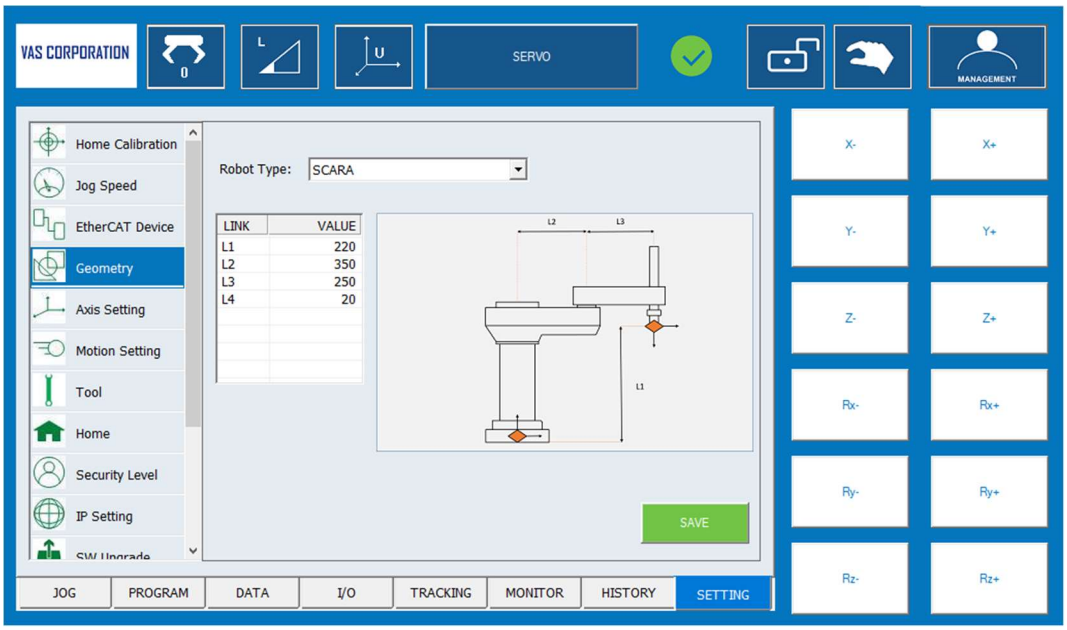


Tap {SAVE} to apply changes.

> **WARNING**
> If configured device list is not correct, the system may not operate properly.

12.2. Geometry

This screen help set up robot type and dimension of robot.



12.2.1. Robot Type

Robot Type can be selected by:

- Selecting {Robot Type} from the dropdown list.

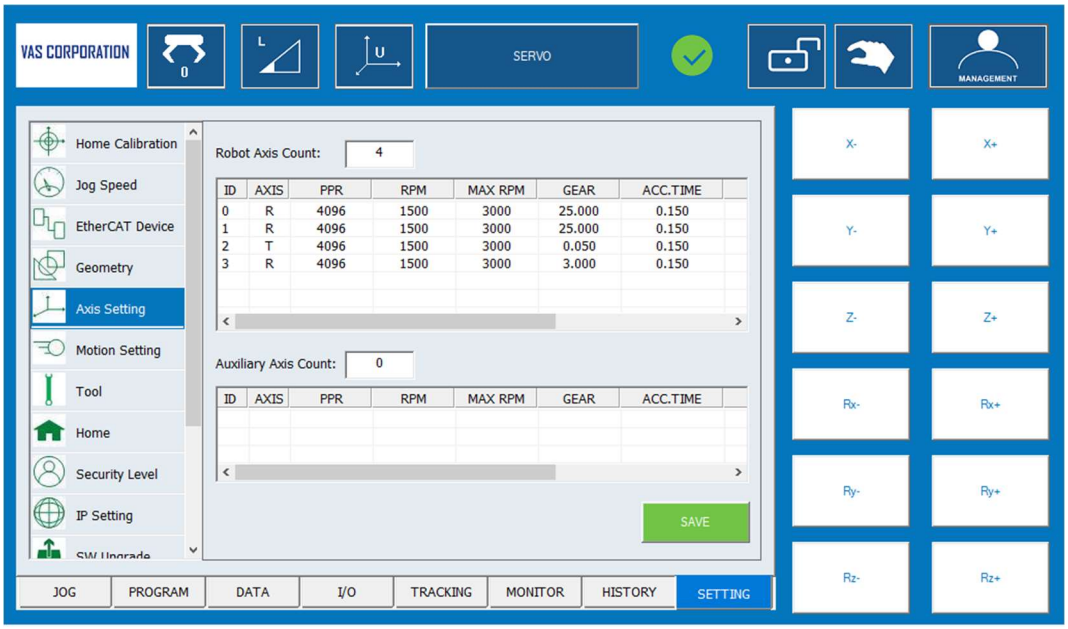
12.2.2. Dimension

Dimension can be set up by:

- Selecting the link to be set.
- Enter the value by using numeric keypad.

After setting all parameters, tap {SAVE} to apply changes.

12.3. Axis Setting



In this screen, all parameters related to each servo must be configured. This will affect robot's operations.
Parameters are described below.

- **Robot Axis Count:** Number of robot axes
- **Auxiliary Axis Count:** Number of auxiliary axes
- **Axis Type**: There are T and R types.
  - R: Rotational
  - T: Prismatic.
- **Axis PPR:** Pulse Per Round, which means the number of pulses per revolution. To change direction of axis, set a negative value for this parameter.
- **Axis Gear:**
  For rotational axis, it means the number of revolutions required to make arm rotate one round.
  For prismatic axis, it means the number of revolutions needed to move 1 mm.
  Example:
  If the gear is 50 and the axis type is R. The axis can make one rotation after motor rotates 50 revolutions.
  If the axis type is T, can judge to lead specification such as ball screw which converts to linear motion. If the lead of the ball screw is 12, axis moves 12 mm when motor rotates 1 revolution. It means 1/12 revolution is needed to move 1 mm.
  Gear = 1/12

- **Axis RPM:** Revolution per Minute, which means the number of revolutions per minute and is set to the rated RPM value of the motor. Max Speed of Joint Move is set to this value.
- **Axis Max RPM:** Set the maximum RPM at which the motor can operate instantaneously. If the input value exceeds this value, the operation is stopped.
- **Axis Acc Time:**
  It is the minimum acceleration time of each axis. This is the time it take to reach to max speed. Unit of acceleration time is second (s).
- **Axis Macc Time:** This is the acceleration/deceleration time of each axis when jogging. Unit is second (s).
- **Axis Negative Limit, Axis Positive Limit:** They indicate the movable range as the operation limit value.

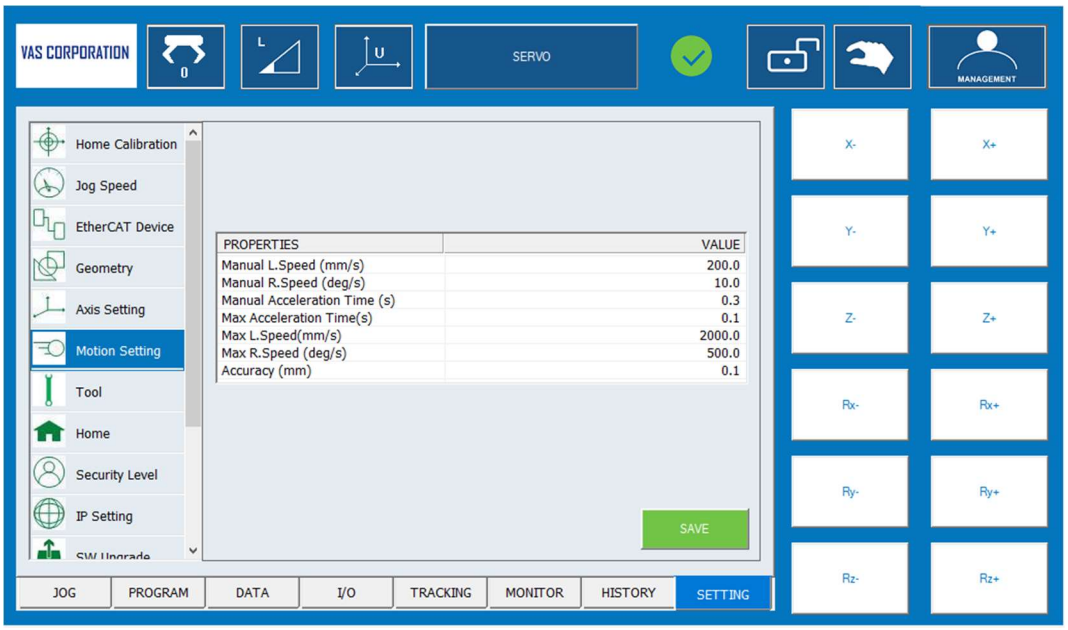
Any of parameters can be set up by:

- Selecting the parameter to be configured.
- Using numeric keypad to enter value.

After configuring all parameters, tap {SAVE} to apply changes.

DANGER
Improper parameters on this page may result in unexpected movements or accidents.

12.4. Motion



Velocity and acceleration for motions in the world coordinate (XYZ-World, XYZ-Tool and XYZ-User) can be configured in this screen.

- **Max L.Speed:** The maximum linear velocity of TCP in the World Coordinate. Unit is mm/s.
- **Max R.Speed:** The maximum angular velocity of TCP in the World Coordinate. Unit is deg/s.
- **Acc Time:** Acceleration/deceleration time in World Coordinate on AUTOMATIC mode, in second (s).
- **M.Acc Time:** Acceleration/deceleration time in World Coordinate on TEACH mode, in second (s).
- **Max Manual L.Speed:** The maximum linear velocity of TCP when jogging in the World Coordinate. Unit is mm/s.
- **Max Manual R.Speed:** The maximum angular velocity of TCP when jogging in the World Coordinate. Unit is deg/s.
- **Accuracy:** The accuracy for continuous motion. Unit is mm.

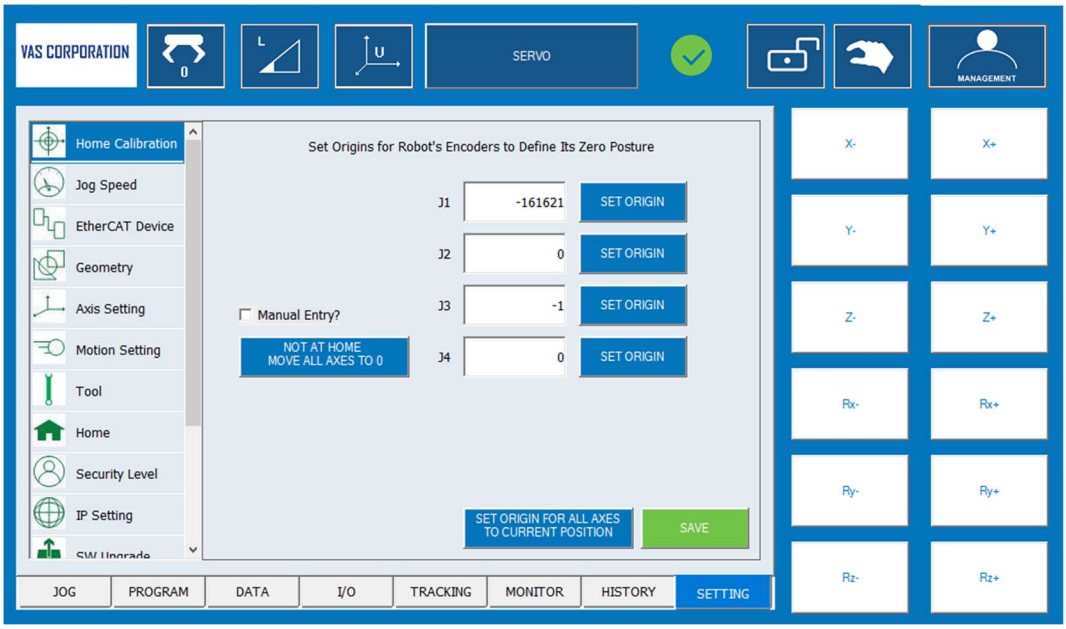
Any of parameters can be configured by:
- Selecting the parameter to be configured.
- Using numeric keypad to enter value.

After configuring all parameters, tap {OK} to apply changes.

DANGER
If the speed and acceleration are configured improperly, the robot may be overloaded and unexpected speed may cause accidents.

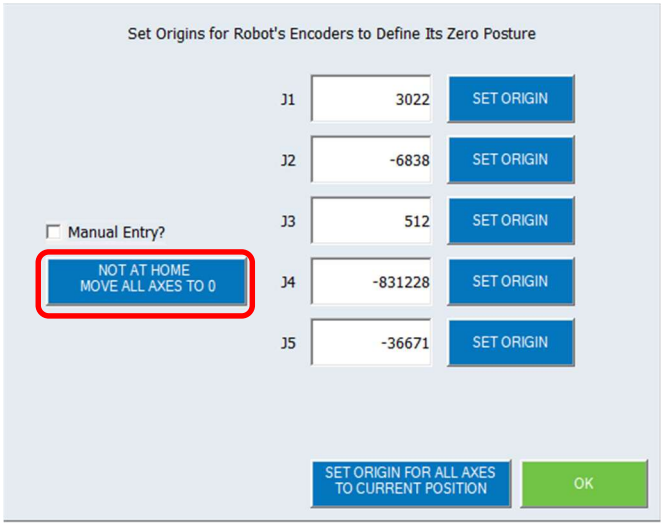
12.5. Home Position Calibration

The Home Position of a Robot is the position where all axes are “0”. Home Position Calibration is the operation where the Home Position and Absolute Encoder Position coincide. The Home Position differs depending on manipulator model.
Editing the Home Position affects the stored physical position. Using the Home Position Calibration screen, the user can set one axis at a time or all axes simultaneously to the robot’s current position (unit: pulse). The user can also enter values manually using information provided by manufacturer.



12.5.1. Verification of Home Position Calibration

To verify the existing calibration of a Robot's Home Position, move all axes to their respective "0" positions. {NOT AT HOME} will open Joint Panel with all zeros to quickly accomplish this.



When at "all zeros", {NOT AT HOME} will turn green and the {ROBOT IS AT HOME POSITION} indicator confirming the existing Home Position is already for verification.

The user should now visually confirm whether the posture of robot is at home position to validate the calibration of Home Position.

In case of incorrect home position on one or multiple axes, Home Position Calibration is required. The following sections discuss how to perform the calibration.

12.5.2. Home Position Calibration Methods

There are three separate methods for Home Position Calibration:

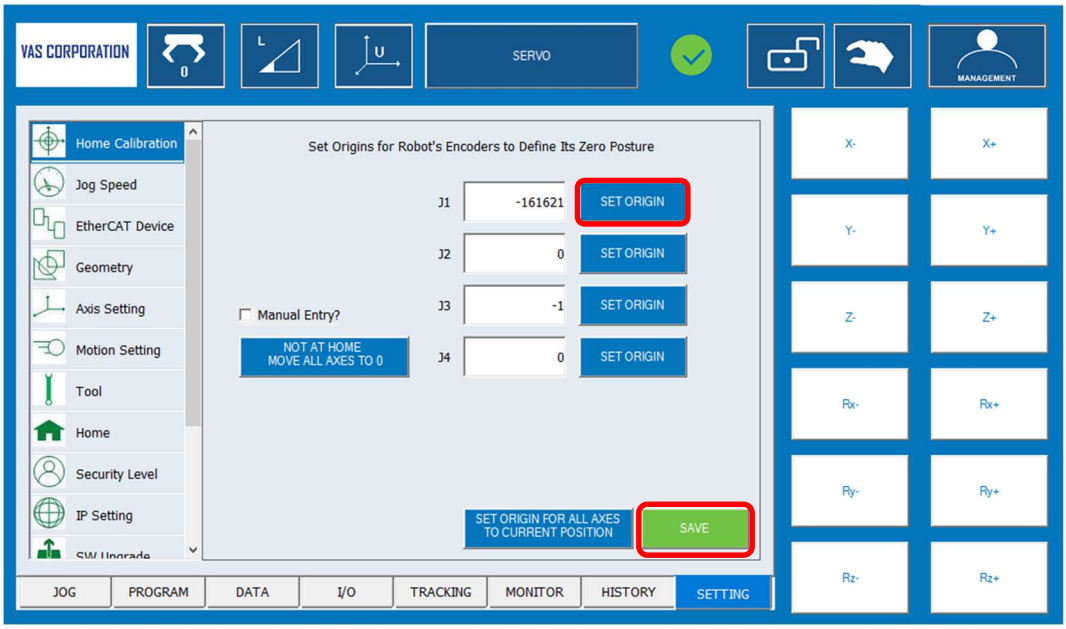
- Calibrate Individual Axis robot's current axis position.
- Calibrate All Axes to Robot's current position.
- Manually Calibrate one or multiple axes to known encoder values.

The procedure for each of three methods is provided in the following sections:

12.5.2.1. Individual Axis Calibration Procedure

Use this method if a single axis experiences a hard crash or if a single motor/encoder is replaced.

1. Go to {SETTING} → {Home Position Calibration}.
2. Perform the verification procedure.
3. For any axis(s) that are not at "0" position, jog the affected axis until they are at "0" position.
4. Press {SET ORIGIN} to insert the robot's current pulse value for that axis.
5. Press {SAVE} to update calibration data.

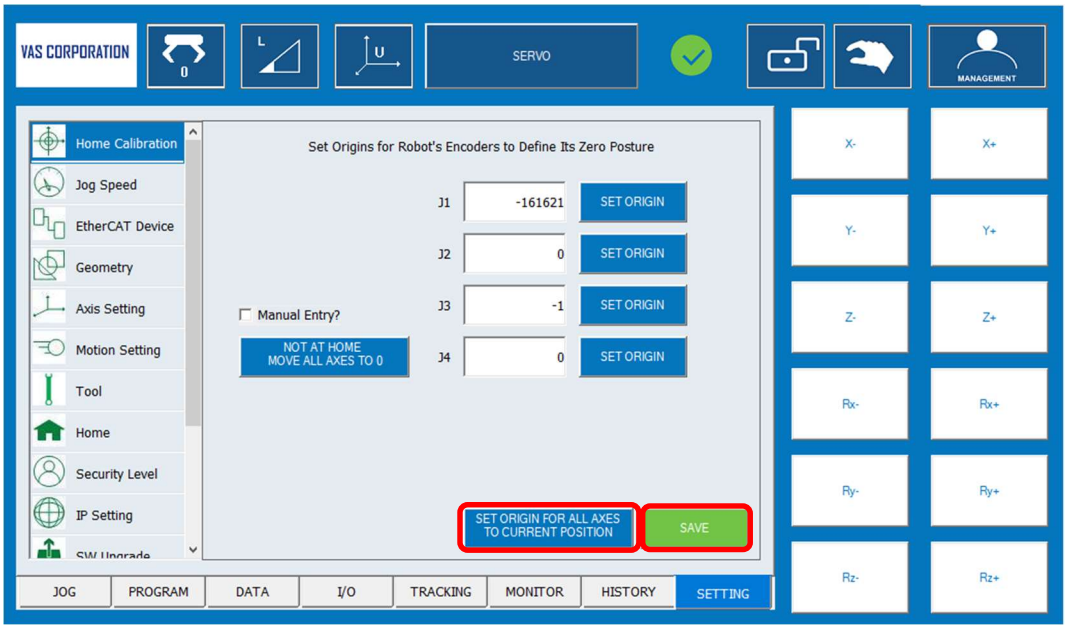


12.5.2.2. All Axes Calibration Procedure

Use this method if multiple axes are not "0" position after a robot crash.

1. Go to {SETTING} → {Home Position Calibration}.
2. Perform the verification procedure.
3. Jog all axes until they are at "0" position.

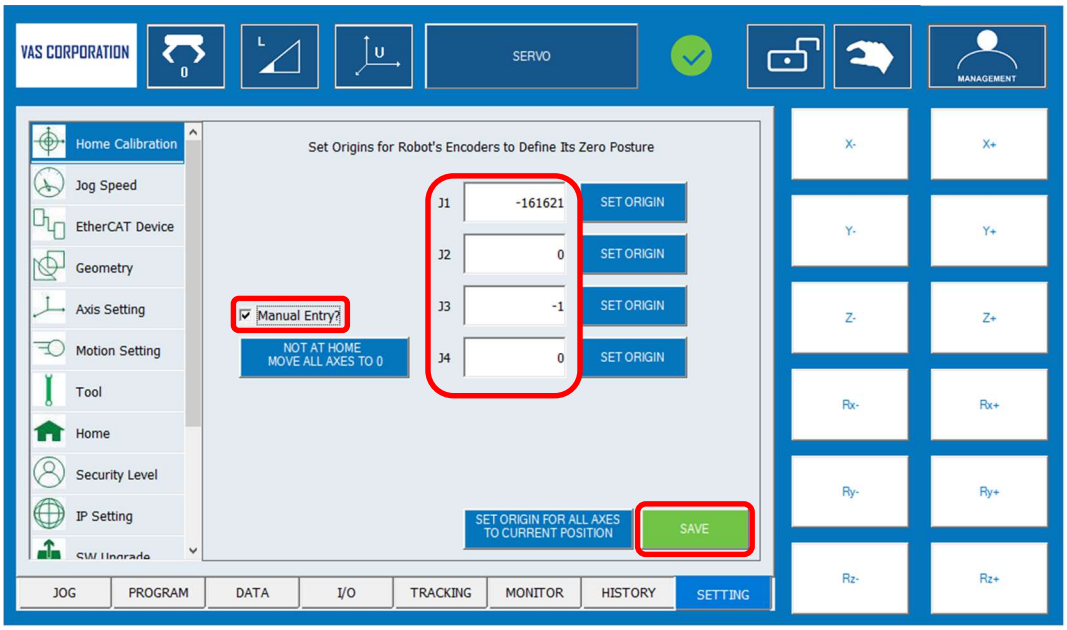
4. Press {SET ORIGIN FOR ALL AXES TO CURRENT POSITION} to insert the robot's current pulse values for all axes.
5. Press {SAVE} to update calibration data.



12.5.2.3. Manual Calibration Procedure

Use this method if any encoder values of each axis is provided by manufacture.

1. Go to {SETTING} → {Home Position Calibration}.
2. Check the {Manual Entry?} checkbox.

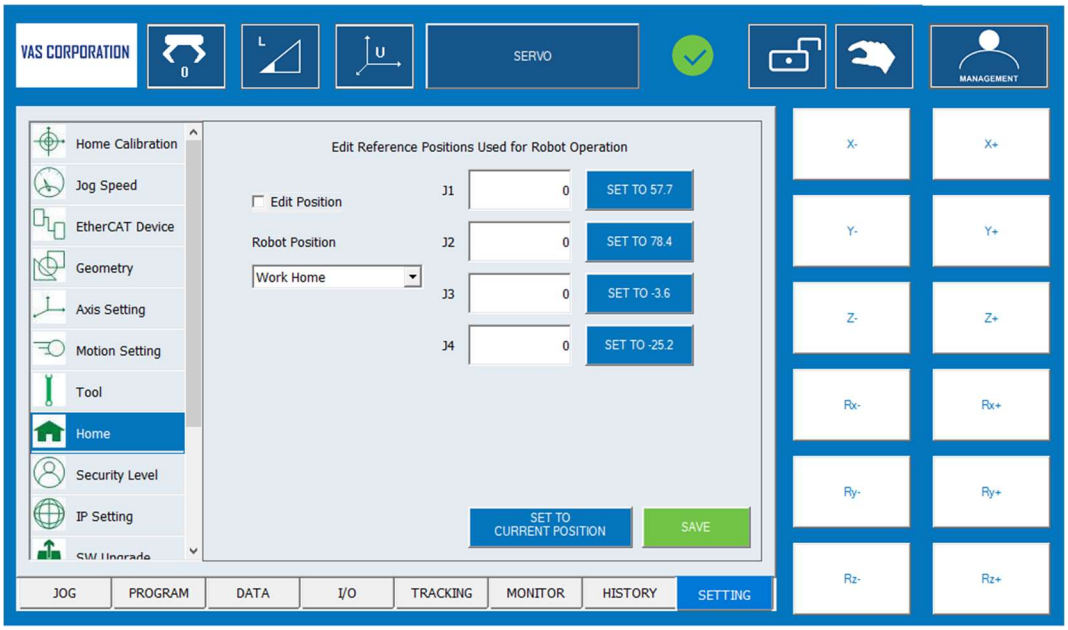


3. Manually enter the data for each axis using the numeric keyboard.
4. Press {SAVE} to update the calibration data.

12.5.3. Robot Configuration Position

The {SETTING} → {Robot Configuration Position} screen allows the user to define and move the manipulator to positions helpful for certain tasks, such as:

- Program start position (i.e. “Work Home Position”)
- Manipulator setup & resolving alarms (i.e. “Robot Position Confirm”)



12.5.3.1. Robot Position Type

Common robot position types available to the user are described below. Axis position values will vary depending on the manipulator model.

- Work Home Position

A manipulator posture often used as the “start” position in program to ensure the manipulator will not crash into its surroundings.

- Robot Position Confirm

Used to verify the current posture of the robot if there is an error in encoder communication or the manipulator was moved after the power supply was turned off.

The initial value of robot position confirm is also the manipulator’s home position.

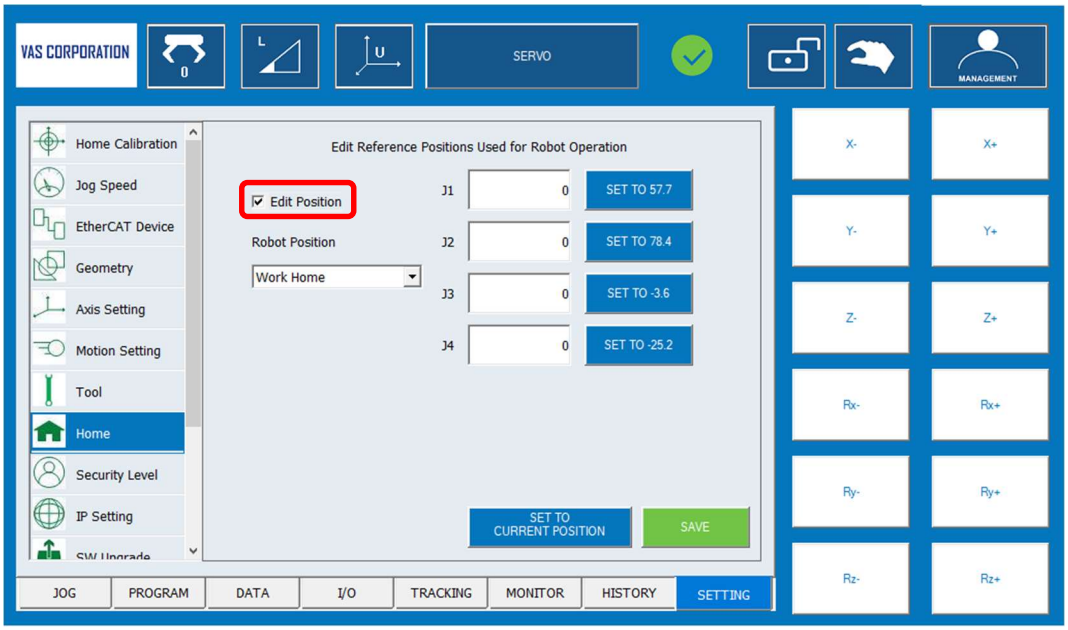
- Temporary Position

Used to move the manipulator to a user-editable posture by specifying the target axis value.

12.5.3.2. Edit a Robot Position

Follow the steps below to edit a Robot Position:

1. Press {Edit Position} checkbox.
2. Select a {Robot Position} from the dropdown list
   - Current axis values will update accordingly.
3. Edit the position using one of the methods below:
   - Enter values into field(s) using the numeric keypad.
   - Use {SET TO X.X} button(s) to set individual axes to the current position of the manipulator.
   - Use {SET TO CURRENT POSITION} to set all axes to the current position of the manipulator.
4. Once change(s) are present, press {OK} to save changes.
5. Uncheck {Edit Position} to exit “Edit” mode.



12.6. Tool Setting

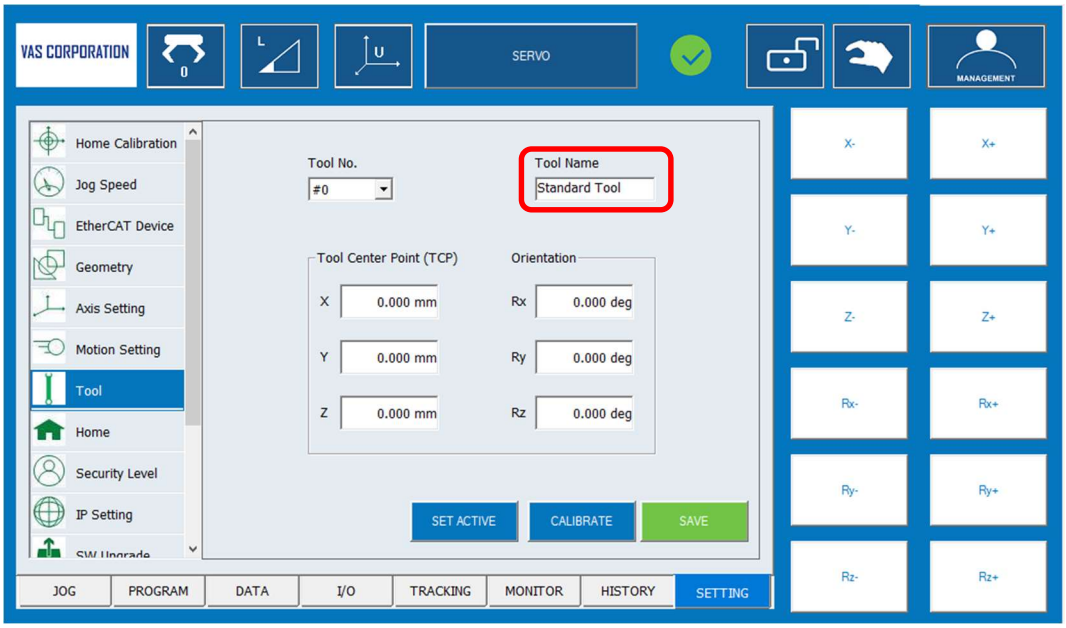
12.6.1. Tool No

A tool can be selected from {Tool No.} dropdown list.

12.6.2. Tool Name

User can change tool’s name by:

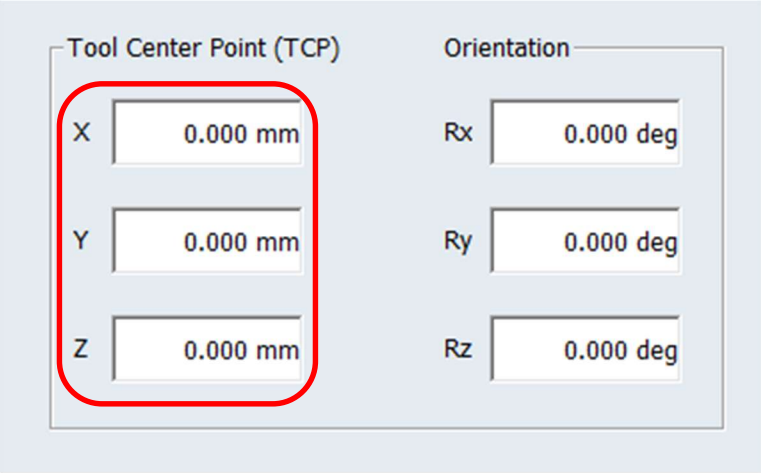
- Tapping on Tool Name text field.
- Using character input operation to enter tool name.



12.6.3. Tool Frame

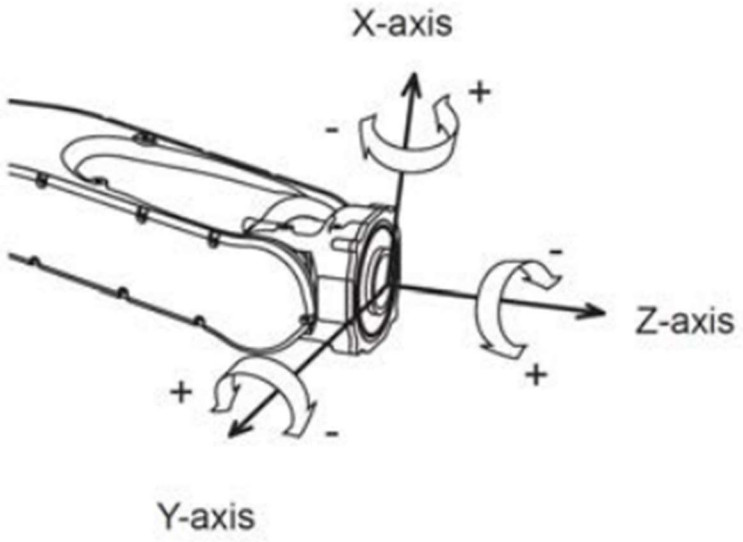
12.6.3.1. Tool Center Point

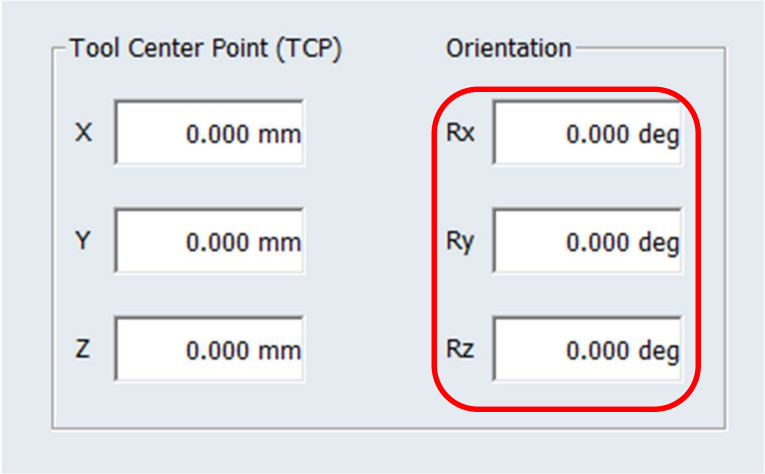
The Tool Center Point is the offset of the Tool's Tip from the tool flange. Most simple tools will only have offsets in the XYZ direction; however, rotational offset can also be set. Configuring the Tool Center Point will allow Cartesian jogging of manipulation about the correct point and will also ensure the taught points have the correct offset from the manipulator base. Enter this data as provided by the tool manufacturer or from an accurate CAD model. In the absence of this information, the TCP coordinates can be calculated using the TCP Calibration feature.



12.6.3.2. Orientation of Tool Tip

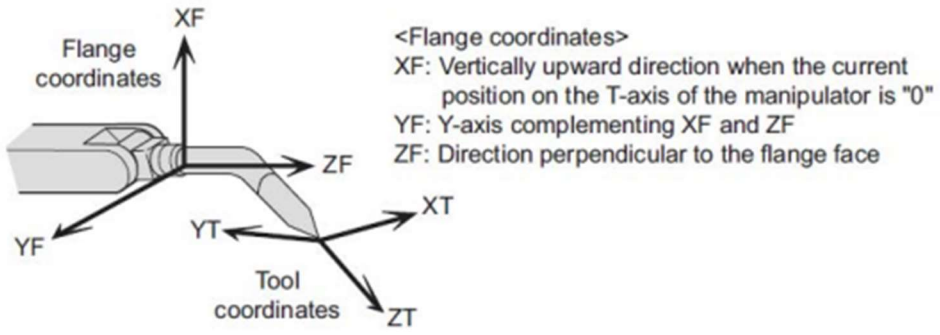
The orientation of tool tip is the rotation of the TCP from the tool flange. The rotation of the tool is input in degree. Enter this data as provided by the tool manufacturer or from accurate CAD model. In the absence of this information, the tool's orientation can be accurately calculated using the TCP Calibration feature.



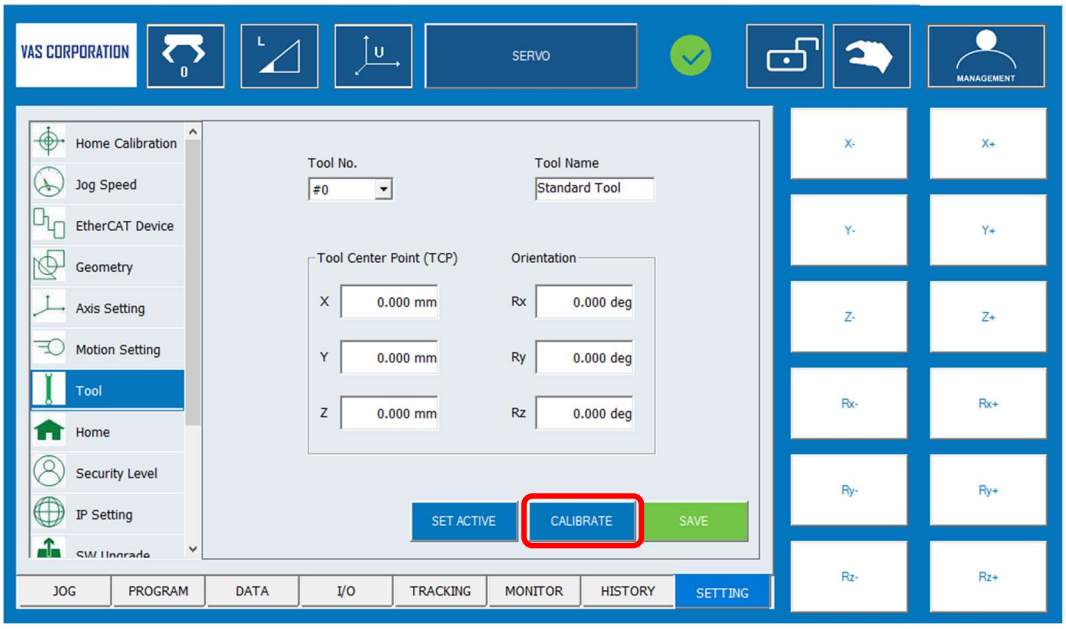


12.6.3.3. Tool Center Point (TCP) Calibration

To ensure a robot can properly perform linear and circular motions, the TCP introduced above must be defined. In the absence of known tool frame properties, TCP calibration is an operation that accurately calculates this data through a series of recorded postures. This procedure can calculate the TCP's XYZ coordinate and orientation data in the flange coordinates.



To calibrate the TCP's coordinates, four different postures must be registered about a reference point with a fine tip.
On Teach Pendant, the TCP Calibration screen can be accessed as follows:
1. Go to {SETTING} → {Tool}.
2. Press {Calibrate}.



TCP Calibration Procedure
Two steps are required to successfully calibrate the Tool Center Point:
1. Move to and {Set} robot postures required to calibrate the TCP.
2. Calculate, send, and save tool frame data on Tool screen.

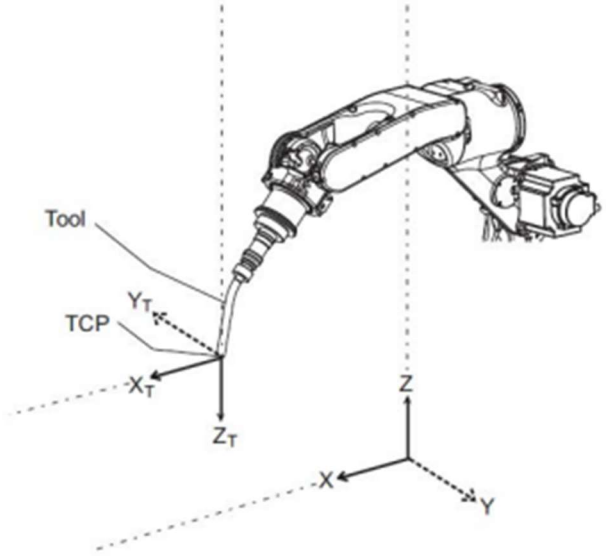
Detailed instructions to complete this procedure is provided in the following sections.

"Orientation is calculated from the first recorded posture (1) and "Coordinates" are calculated using all four recorded postures (1 to 4)

1. **Set and Move To Calibration Postures**
   The easiest jogging mode to start with is XYZ-World while XYZ-Tool mode can be used to refine and verify the resulting TCP.

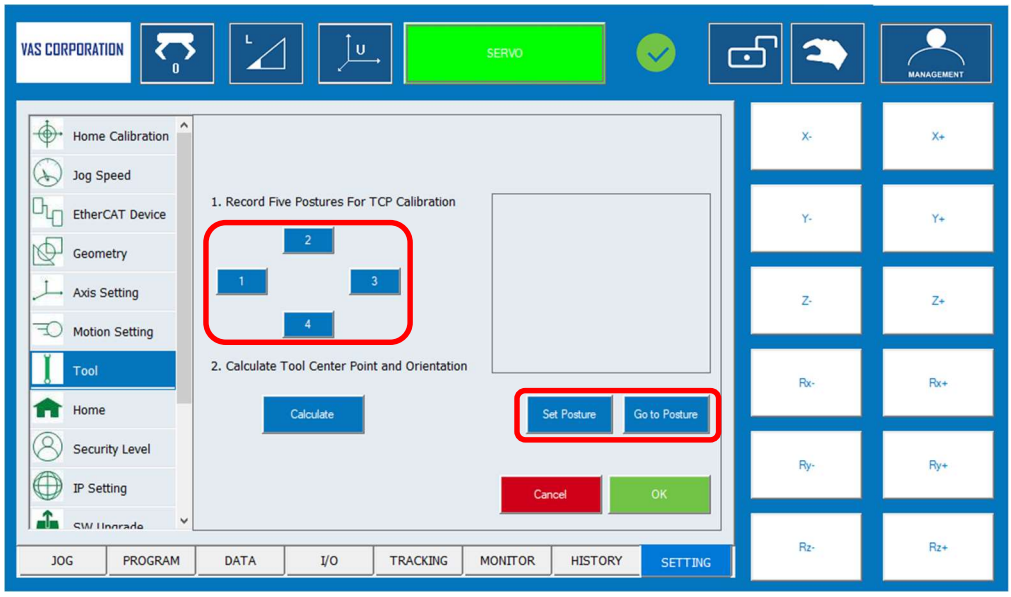
   The greater the difference between the five postures, the better. No two recorded postures can match and calibration accuracy will decrease if multiple poses are similar or rotated in a constant direction. Repeating this procedure multiple times may increase the accuracy of the resulting TCP.

NOTE:
The first posture will determine the resulting orientation. Set this posture with Z-axis of the desired tool coordinates downward vertically to the ground (parallel the Z-axis of the manipulator's base frame). The resulting X-axis of the tool coordinates will be registered in the same direction as the X-axis of the base coordinates.



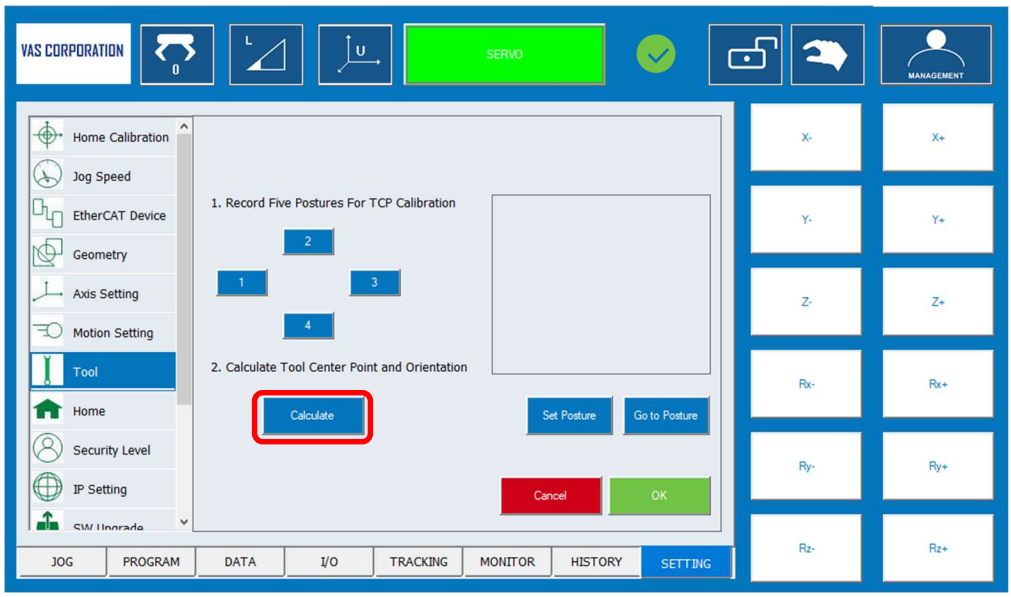
Use the following procedure to {Set} and {Go To} the postures above:

1. Select a Calibration Posture (1 to 4).
   - Check its status (Green = "Saved", Blue = "Undefined"). If undefined, jog the robot to approximately match the desired posture.
2. Once at the desired posture, press {Set} to record its position.
3. Move to previously saved postures using {Go To} buttons.
   - Repeat Step 1 through Step 3 until all Calibration Postures are green in color.



2. Calculate and Confirm New TCP

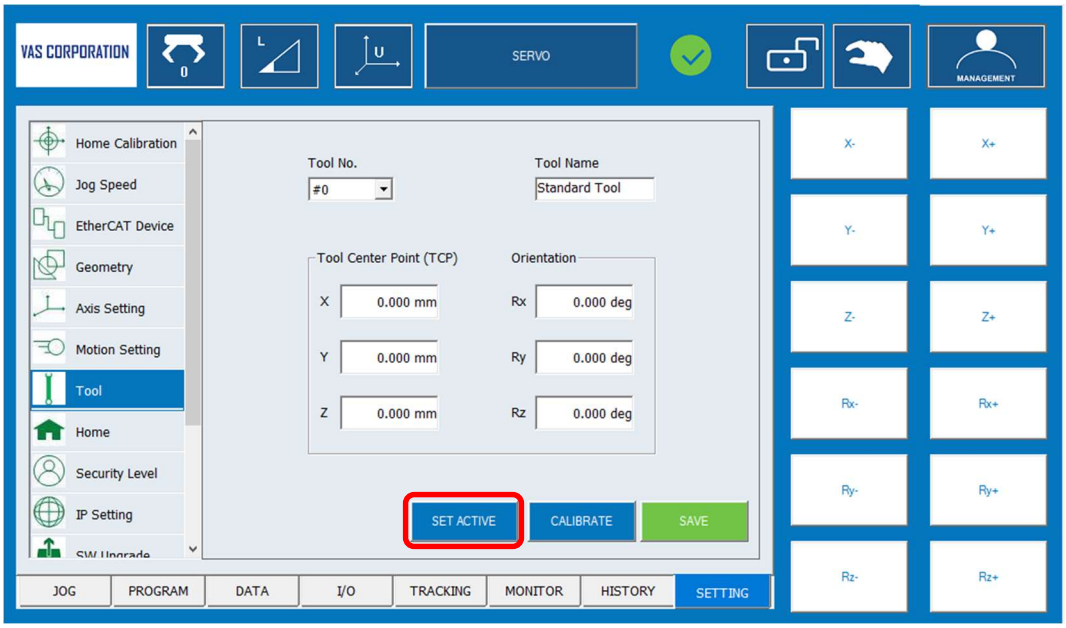
Press {Calculate TCP} to send the calculated TCP data to the Tool screen for review.



Press {OK} on the screen to save data of the tool frame and send to Tool screen.

12.6.4. Set Active Tool

After selecting and setting up the desired tool, press {Set Active} to use these tool parameters for robot operations.



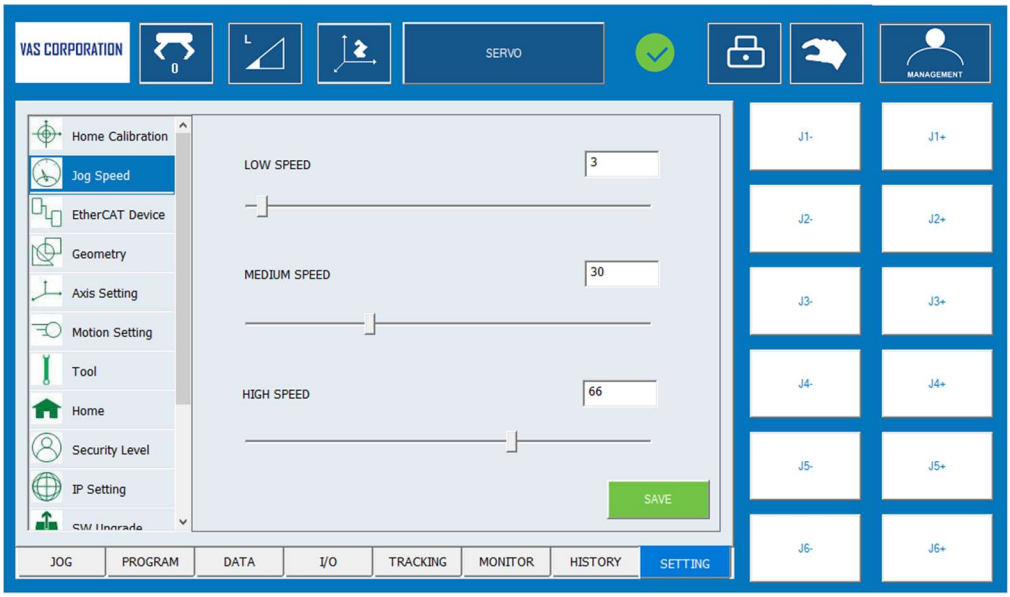
12.6.5. Jogging Speed

Each speed level can be changed within a range of 1(%) to 100(%). The value of each level cannot be greater than the next level or lower than the previous level. After setting these values, robot can operate jogging with the predefined speed on TEACH mode.

The Jogging Speed level can be set under {SETTING} → {Jog Speed}. To edit jogging speed level, use one of the following methods:

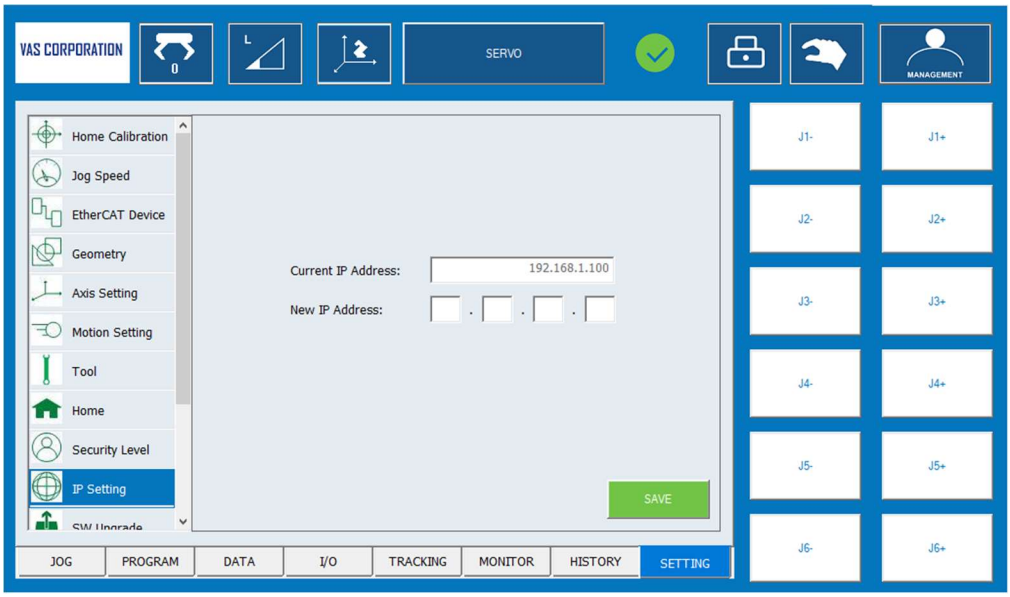
- Use these sliders to set value for each jogging level speed.
- Tap on the field(s) and using numeric keyboard to enter value.

Press {OK} to apply changes.



12.7. Controller Setting

12.7.1. IP Address Setting



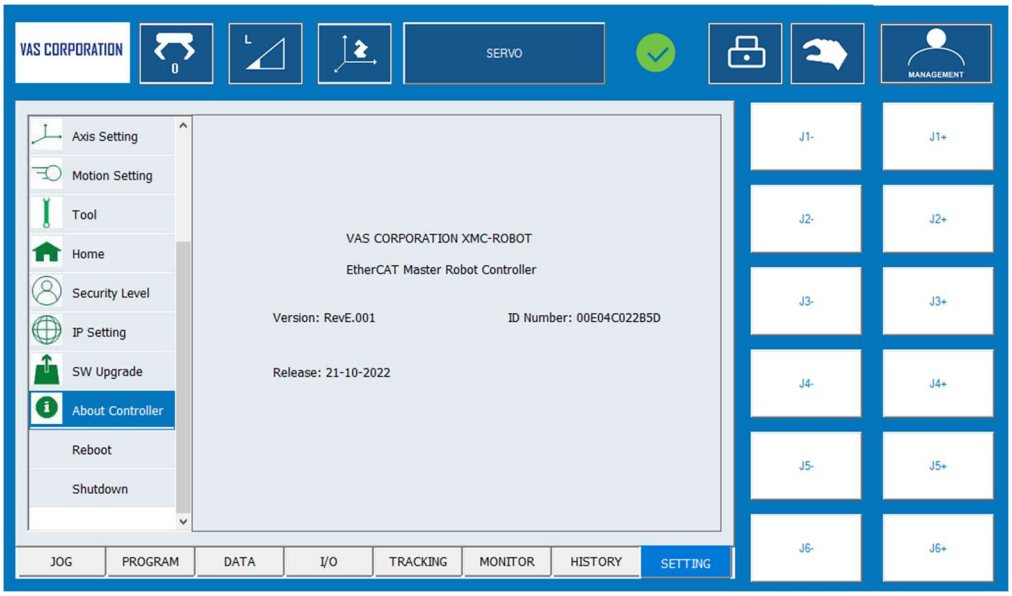
Requires Management Security
To set IP address, follow these steps:

1. Go to {SETTING} → {IP Setting}
2. Press {New IP Address} text field to enter new IP address.
   - The keypad will appear.
3. Enter the IP address and press {SAVE}.
   - IP address's format is xxx.xxx.xxx.xxx
   - A notice will appear starting that the controller will have to be restarted for the new IP address to take effect.

12.7.2. About

The information on the Teach Pendant is shown under this page.
The following items are displayed:

- Version
- Release
- Pendant ID



12.7.2.1. Version

The version of the Teach Pendant that is used appears.

12.7.2.2. Release

The released date of the installed pendant software version is shown.

12.7.2.3. Pendant ID

Each Teach Pendant has a unique ID number, useful for identifying it to support personnel.

Revision History

Revision	Date	Description	Author
RevA.001	25.01.2021	Initial version	TD.LB
RevB.001	30.06.2021		TD.LB
RevC.001	09.10.2021		TD.LB
RevD.001	21.06.2022		TD.LB
RevE.001	14.12.2022		TD.LB