YASKAWA

YRC1000/YRC1000micro INSTRUCTIONS FOR Smart Pendant

(JZRCR-APP30-1)

Upon receipt of the product and prior to initial operation, read these instructions thoroughly, and retain for future reference.

MOTOMAN INSTRUCTIONS

YRC1000 INSTRUCTIONS
YRC1000 OPERATOR'S MANUAL (GENERAL) (SUBJECT SPECIFIC)
YRC1000 MAINTENANCE MANUAL
YRC1000 ALARM CODES (MAJOR ALARMS) (MINOR ALARMS)

YRC1000micro INSTRUCTIONS
YRC1000micro OPERATOR'S MANUAL
YRC1000micro MAINTENANCE MANUAL
YRC1000micro ALARM CODES (MAJOR ALARMS) (MINOR ALARMS)

YRC1000/YRC1000micro INSTRUCTIONS FOR Smart Pendant (JZRCR-APP30-1)

MANUAL NO.

HW1485509 8

NOTE

This instruction manual is applicable to both YRC1000 and YRC1000micro.

The description of “YRC Controller” refers to both“YRC1000” and “YRC1000micro”, and the descriptions of “the INSTRUCTIONS of the YRC Controller” refers to both “YRC1000 INSTRUCTIONS (RE-CTO-A221)” and “YRC1000micro INSTRUCTIONS (RE-CTO-A222)” in this manual unless otherwise specified.

DANGER

- This manual explains the Smart Pendant of the YRC Controller. Read this manual carefully and be sure to understand its contents before handling the YRC Controller. Any matter, including operation, usage, measures, and an item to use, not described in this manual must be regarded as “prohibited” or “improper”.
- General information related to safety are described in “Chapter 1. Safety” of “YRC CONTROLLER INSTRUCTIONS”. To ensure correct and safe operation, carefully read “Chapter 1. Safety” of “YRC CONTROLLER INSTRUCTIONS”.

CAUTION

- In some drawings in this manual, protective covers or shields are removed to show details. Make sure that all the covers or shields are installed in place before operating this product.
- YASKAWA is not responsible for incidents arising from unauthorized modification of its products. Unauthorized modification voids the product warranty.

NOTICE

- The drawings and photos in this manual are representative examples and differences may exist between them and the delivered product.
- YASKAWA may modify this model without notice when necessary due to product improvements, modifications, or changes in specifications. If such modification is made, the manual number will also be revised.
- If your copy of the manual is damaged or lost, contact your local YASKAWA representative to order a new copy. Be sure to tell the representative the manual number listed on the front cover.

Notes for Safe Operation

Read this manual carefully before installation, operation, maintenance, or inspection of the YRC Controller

In this manual, the Notes for Safe Operation are classified as “DANGER”, “WARNING”, “CAUTION”, or “NOTICE”.

DANGER	Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. Safety Signs identified by the signal word DANGER should be used sparingly and only for those situations presenting the most serious hazards.
WARNING	Indicates a potentially hazardous situation which, if not avoided, will result in death or serious injury. Hazards identified by the signal word WARNING present a lesser degree of risk of injury or death than those identified by the signal word DANGER.
CAUTION	Indicates a hazardous situation, which if not avoided, could result in minor or moderate injury. It may also be used without the safety alert symbol as an alternative to “NOTICE”.
NOTICE	NOTICE is the preferred signal word to address practices not related to personal injury. The safety alert symbol should not be used with this signal word. As an alternative to “NOTICE”, the word “CAUTION” without the safety alert symbol may be used to indicate a message not related to personal injury.

Even items described as “CAUTION” may result in a serious accident in some situations.

At any rate, be sure to follow these important items.

NOTE

To ensure safe and efficient operation at all times, be sure to follow all instructions, even if not designated as “DANGER”, “WARNING” and “CAUTION”.

DANGER

- Do not remove motors and do not release brakes except during an emergency or abnormality

Failure to observe these safety precautions may result in death or serious injury from unexpected turning of the manipulator's arm.

WARNING

- Maintenance and inspection must be performed by specified personnel.

Failure to observe this caution may result in electrical shock or injury.

- For Disassembly or repair, contact your YASKAWA representative.

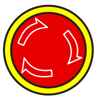
<YRC1000>

DANGER

- Before operating the manipulator, make sure the servo power is turned OFF by performing the following operations. When the servo power is turned OFF, the SERVO ON LED on the Smart Pendant is turned OFF.
  - Press the emergency stop buttons on the front door of the YRC1000, on the top of the Smart Pendant, on the external control device, etc.
  - Disconnect the safety plug of the safety fence. (when in PLAY (AUTOMATIC) mode or in REMOTE mode)

If operation of the manipulator cannot be stopped in an emergency, personal injury and/or equipment damage may result.

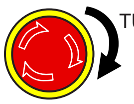
Fig. : Emergency Stop Button



- Before releasing the emergency stop, make sure to remove the obstacle or error caused the emergency stop, if any, and then turn the servo power ON.

Failure to observe this instruction may cause unintended movement of the manipulator, which may result in personal injury.

Fig. : Release of Emergency Stop



- Observe the following precautions when performing a teaching operation within the manipulator's operating range:
  - Be sure to perform lockout by putting a lockout device on the safety fence when going into the area enclosed by the safety fence. In addition, the operator of the teaching operation must display the sign that the operation is being performed so that no other person closes the safety fence.
  - View the manipulator from the front whenever possible.
  - Always follow the predetermined operating procedure.
  - Always keep in mind emergency response measures against the manipulator's unexpected movement toward a person.
  - Ensure a safe place to retreat in case of emergency.

Failure to observe this instruction may cause improper or unintended movement of the manipulator, which may result in personal injury.

- Confirm that no person is present in the manipulator's operating range and that the operator is in a safe location before:
  - Turning ON the YRC1000 power
  - Moving the manipulator by using the Smart Pendant
  - Running the system in the check mode
  - Performing automatic operations

Personal injury may result if a person enters the manipulator's operating range during operation. Immediately press an emergency stop button whenever there is a problem. The emergency stop buttons are located on the front panel of the YRC1000 and on the top of the Smart Pendant.

- Read and understand the Explanation of the Warning Labels before operating the manipulator

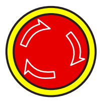
<YRC1000micro>

DANGER

- Before operating the manipulator, make sure the servo power is turned OFF by performing the following operations. When the servo power is turned OFF, the SERVO ON LED on the Smart Pendant is turned OFF.
  - Press the emergency stop button on the top of the Smart Pendant or on the external control device, etc.
  - Disconnect the safety plug of the safety fence. (when in play mode or in the REMOTE mode)

If operation of the manipulator cannot be stopped in an emergency, personal injury and/or equipment damage may result.

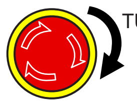
Fig. : Emergency Stop Button



- Before releasing the emergency stop, make sure to remove the obstacle or error caused the emergency stop, if any, and then turn the servo power ON.

Failure to observe this instruction may cause unintended movement of the manipulator, which may result in personal injury.

Fig. : Release of Emergency Stop



- Observe the following precautions when performing a teaching operation within the manipulator's operating range:
  - Be sure to perform lockout by putting a lockout device on the safety fence when going into the area enclosed by the safety fence. In addition, the operator of the teaching operation must display the sign that the operation is being performed so that no other person closes the safety fence.
  - View the manipulator from the front whenever possible.
  - Always follow the predetermined operating procedure.
  - Always keep in mind emergency response measures against the manipulator’s unexpected movement toward a person.
  - Ensure a safe place to retreat in case of emergency.

Failure to observe this instruction may cause improper or unintended movement of the manipulator, which may result in personal injury.

- Confirm that no person is present in the manipulator's operating range and that the operator is in a safe location before:
  - Turning ON the YRC1000micro power
  - Moving the manipulator by using the Smart Pendant
  - Running the system in the check mode
  - Performing automatic operations

Personal injury may result if a person enters the manipulator's operating range during operation. Immediately press an emergency stop button whenever there is a problem. The emergency stop button is located on the top of the Smart Pendant.

- Read and understand the Explanation of the Warning Labels before operating the manipulator.

<YRC1000micro only>

DANGER

- In the case of not using the Smart Pendant, be sure to supply the emergency stop button on the equipment. Then before operating the manipulator, check to be sure that the servo power is turned OFF by pressing the emergency stop button.
  Connect the external emergency stop button to the 4-14 pin and 5-15 pin of the Safety connector (Safety).
- Upon shipment of the YRC1000micro, this signal is connected by a jumper cable in the safety signal short circuit connector. To use the signal, make sure to supply a new connector, and then input it.

If the signal is input with the jumper cable connected, it does not function, which may result in personal injury or equipment damage.

<YRC1000/YRC1000micro>

WARNING

- Perform the following inspection procedures prior to conducting manipulator teaching. If there is any problem, immediately take necessary steps to solve it, such as maintenance and repair.
  - Check for a problem in manipulator movement.
  - Check for damage to insulation and sheathing of external wires.
- Always return the Smart Pendant to a safe place after use.

If the Smart Pendant is left unattended on the manipulator, on a fixture, or on the floor, etc., the Enable Switch may be activated due to surface irregularities of where it is left, and the servo power may be turned ON. In addition, in case the operation of the manipulator starts, the manipulator or the tool may hit the Smart Pendant left unattended, which may result in personal injury and/or equipment damage.

NOTICE

- When performing maintenance and inspection, make sure to connect the battery unit before removing the encoder connector.

Failure to observe this instruction may result in the loss of home position data.

General Safety on the Smart Pendant

CAUTION

- Be careful not to drop the Smart Pendant on the floor.
- Pay attention to the handling of the cable so that it will not stumble on the Smart Pendant cable.
- Handle carefully so as not to damage the cable.
- Do not place the Smart Pendant with the touch screen facing down.
- Do not place the Smart Pendant close to a heat source or in direct sunlight.
- Do not place the Smart Pendant in an environment with excessive dust, humidity or strong magnetic fields.
- Pay attention not to adhere chemicals, cutting oil (including coolant), rust preventive oil, organic solvent etc. to the Smart Pendant.
- Do not clean the Smart Pendant with scrubbing sponges. Use a soft cloth and a little water or diluted neutral detergent (mild cleaning liquids).
- Operate the touch screen with your fingers, or use a touch-pen designed for use with capacitive screens. Never use sharp objects (ex. screwdriver) for operating the touch screen. This could damage the touch screen.
- Be careful not to get foreign objects or liquid from the USB connector.
- Do not connect the Smart Pendant to anything except for the YRC Controller.

Definition of Terms Used Often in This Manual

<YRC1000>

The MOTOMAN is a YASKAWA industrial robot product.

The MOTOMAN usually consists of the manipulator, the YRC1000 Controller, the YRC1000 Smart Pendant, and supply cables.

In this manual, the equipment is designated as follows:

Equipment	Manual Designation
YRC1000 Controller	YRC1000
YRC Controller Smart Pendant	Smart Pendant
Cable between the manipulator and the YRC Controller	Manipulator cable

<YRC1000micro>

The MOTOMAN is the YASKAWA industrial robot product.

The MOTOMAN usually consists of the manipulator, the YRC1000micro controller, manipulator cables, the YRC1000micro Smart Pendant, and the YRC1000micro Smart Pendant safety signal short circuit connector (optional).

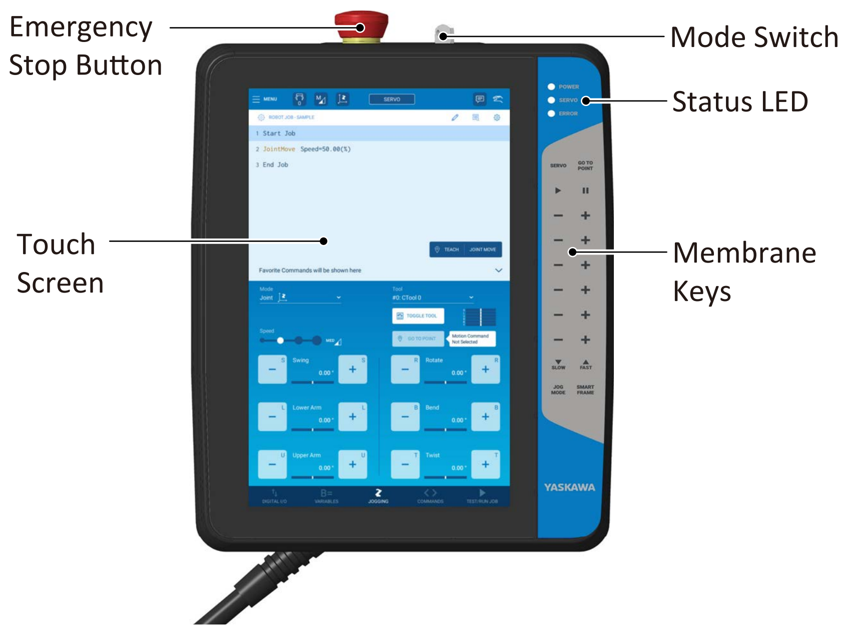
In this manual, the equipment is designated as follows:

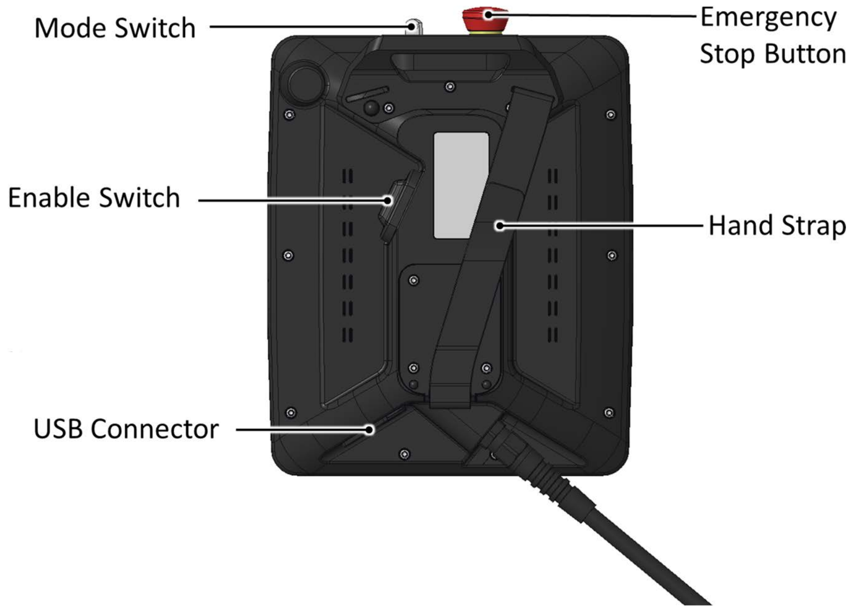
Equipment	Manual Designation
YRC1000micro Controller	YRC1000micro
YRC1000micro Smart Pendant	Smart Pendant
Cable between the manipulator and the YRC Controller	Manipulator cable
YRC1000micro Smart pendant safety signal short circuit connector	Smart Pendant safety signal short circuit connector (optional)

<YRC1000/YRC1000micro>

Descriptions of the Smart Pendant, buttons, and displays are shown as follows:

Equipment		Manual Designation
Smart Pendant	Emergency Stop button	This button on the Smart Pendant will be denoted as Emergency Stop button
	Mode Switch	Three kinds of modes that can be selected by the mode switch are denoted as follows: REMOTE, PLAY (AUTOMATIC), or TEACH (MANUAL)
	Displays	The buttons and items displayed in the Smart Pendant is denoted with { }. ex. {Save}
	Status LED	These LED indicators will be denoted as: POWER LED, SERVO LED, or ERROR LED
	Membrane Key	The membrane keys are denoted with [ ]. ex. [JOG MODE]
	Jog Keys	“Jog Keys” is a generic names for the jog operation keys.
	Keys pressed simultaneously (for membrane key only)	When two keys are to be pressed simultaneously, the keys are shown with a “+” sign between them, ex. [S+] + [L+].





Description of the Operation Procedure

<YRC1000/YRC1000micro>

In the explanation of the operation procedure, the expression “Select” means that the item is directly selected by touching the screen.

Registered Trademark

<YRC1000/YRC1000micro>

In this manual, names of companies, corporations, or products are trademarks, registered trademarks, or brand names for each company or corporation. The indications of (R) and TM are omitted.

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1 Smart Pendant

1.1 General Product Description

With this Smart Pendant, even users who have no experience of robot operation can easily perform teaching operation.

1.2 Smart Pendant Contents Confirmation

Confirm the contents of the delivery when the product arrives.

- Smart Pendant (JZRCR-APP30-1) (with 8 m cable connected)
- Two Switch Keys

1.3 Smart Pendant Specification

Material	Reinforced thermoplastic enclosure with a detachable suspending strap
Dimensions	215(W) × 284(H) × 69(D) mm (excluding protrusions)
Weight	Approx. 1120 g
Protection Class	IP54
Displayed Units	256.5 mm (10.1 inch) wide WXGA TFT Display 1280 x 800 pixel, LED back light, Touch panel
Operated Units	Three-position enable switch, mode switch (with key, three mode) Type of the key for the mode switch: KeTop EKY002 (manufactured by KEBA) * Two keys are shipped with the Smart Pendant.
Cable Length	Standard: 8 m maximum (optional): YRC1000 : 36 m (Standard 8 m + Extension 28 m) YRC1000micro: 20 m (Standard 8 m + Extension 12 m)
Others	USB connector (USB2.0) X 1 The software pendant installer built into the pendant can be downloaded to the USB memory and installed on the PC for use.

For environmental conditions, refer to the INSTRUCTIONS of the YRC Controller for installation environment.

The Smart Pendant uses the Ethernet function to communicate with the YRC controller, but if other Ethernet communication devices are also communicating at the same time, the Smart Pendant's screen display may be slow.

1.4 Smart Pendant Overview

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

Fig. 1-1: Smart Pendant Overview (Front)

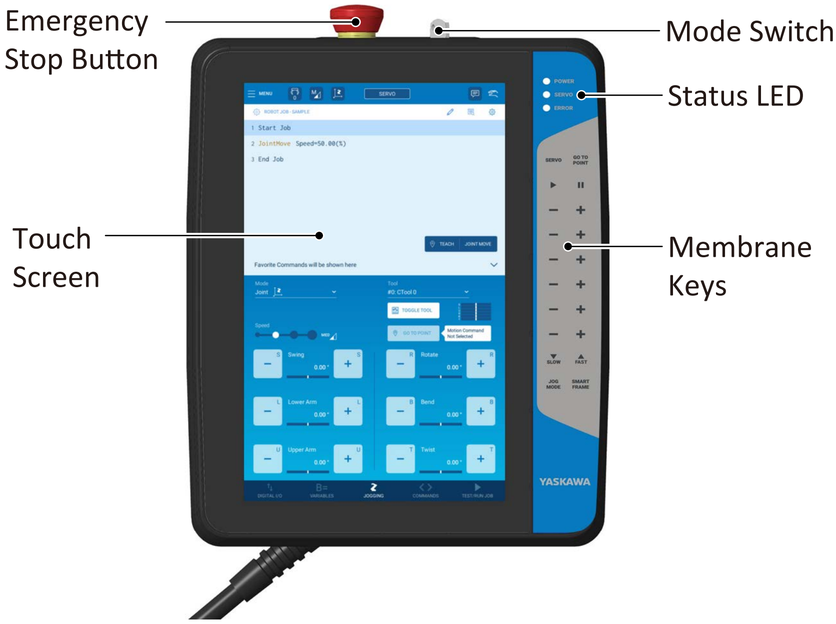
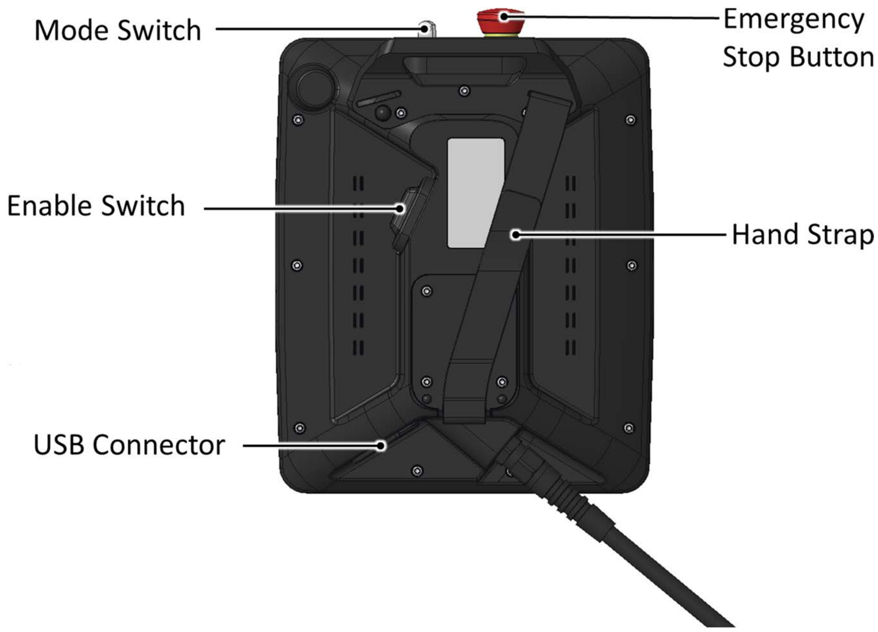


Fig. 1-2: Smart Pendant Overview (Back)



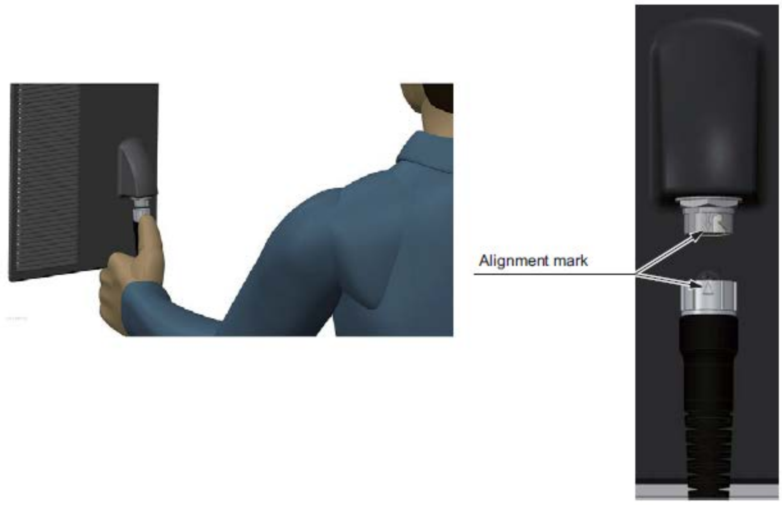
1.5 Connection of the Smart Pendant

For information on setup, installation, and connection of the YRC Controller, refer to the INSTRUCTIONS of the YRC Controller.

1.5.1 Connecting to the YRC1000 Controller

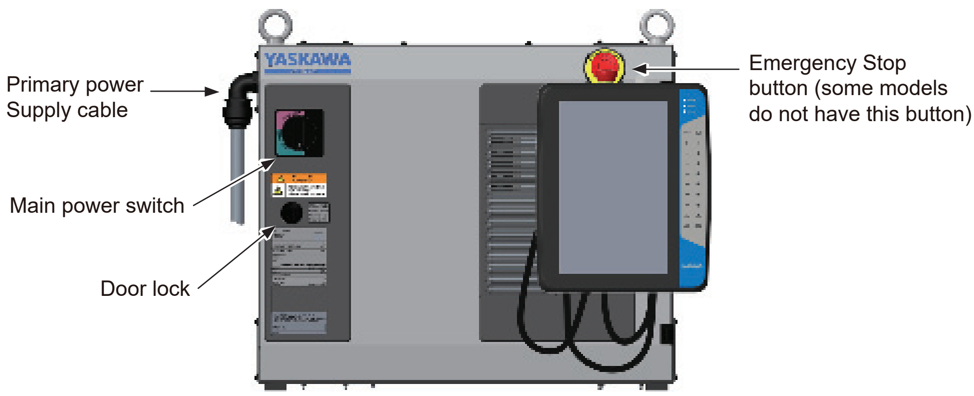
Connect the Smart Pendant cable to the connector (-X81) on the door lower right side of the YRC1000 Controller cabinet.

Fig. 1-3: Connection of Smart Pendant Cable to the YRC1000 Controller



The YRC1000 Controller has the main power switch and the door lock that are located in the upper left on the front panel. The Emergency Stop button is installed in the upper right of the front panel (some models do not have this button), and the Smart Pendant can be hung from a hook below the button.

Fig. 1-4: YRC1000 Front View with Smart Pendant



WARNING

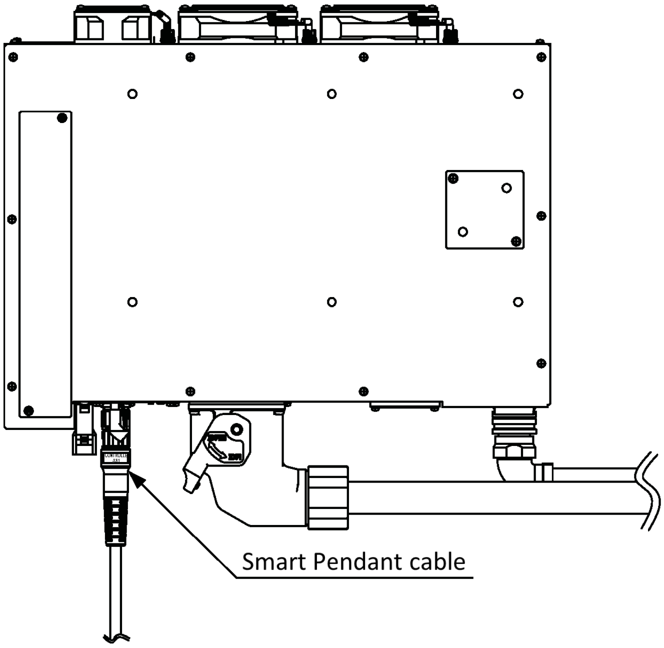
- Do not remove the Smart Pendant cable while the YRC Controller is powered ON.

Failure to observe this instruction may result in fire and/or electric shock.

1.5.2 Connecting to the YRC1000micro

Connect the Smart Pendant cable to the connector (-X81) on the front panel of the YRC1000micro.

Fig. 1-5: Connection of Smart Pendant Cable to the YRC1000micro



NOTE

If the Smart Pendant is not used, connect the Smart Pendant safety signal short circuit connector to connector (-X81).

WARNING

- Do not remove the Smart Pendant cable while the YRC Controller is powered ON.

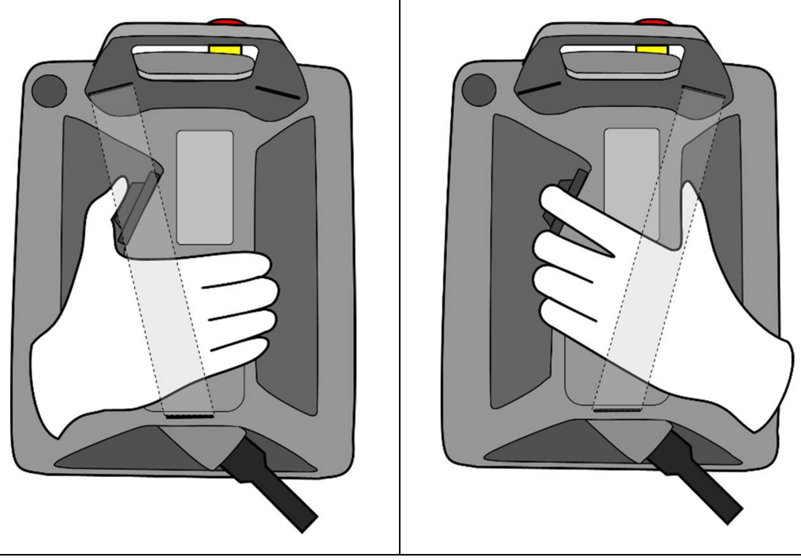
Failure to observe this instruction may result in fire and/or electric shock.

1.6 Holding the Smart Pendant

The Smart Pendant can be held in two ways: using the right hand, press the enable switch with the thumb or, using the left hand, press the enable switch with the index finger. Adjust the strip band to make the hand comfortable.

Fig. 1-6: Holding the Smart Pendant

Using the right hand	Using the left hand



1.7 Display and Operating Elements

Operating elements include:

- Status LED
- Membrane keypads
- Enable switch
- Mode key
- Touch screen
- Emergency Stop button

1.7.1 Status LED

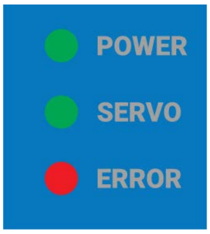
The status LEDs are found on the top right side of the Smart Pendant.

POWER: indicates the power status of the Smart Pendant.

SERVO: indicates the servo power status of the manipulator.

ERROR: indicates the alarm status of the YRC Controller.

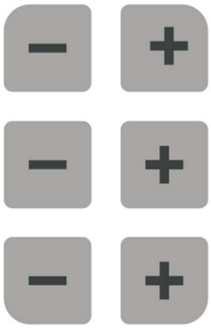
Fig. 1-7: Status LED



1.7.2 Key Description on Membrane Keypads

The membrane keypads are found on the right side of the Smart Pendant.

	– SERVO If the servo power supply is shut OFF due to overrun or Emergency Stop, press this key to enable the servo power supply to be turned ON. When this key is pressed: 1. in the AUTOMATIC (PLAY) mode, the servo power supply turns ON if the safeguarding is securely closed. 2. in the MANUAL (TEACH) mode, the {SERVO} turns to orange and the servo power supply turns ON with the Enable Switch turned ON; 3. while the servo power is ON, the [SERVO] indicator lights up as well as {SERVO} turns green on the screen. While the servo power is ON and the key is pressed, the servo power turns OFF.

	– GO TO POINT When the [GO TO POINT] is pressed and a motion instruction is selected in the Job Contents view, the manipulator moves to the selected position. Only available in MANUAL (TEACH) mode.
	– RUN When pressed in AUTOMATIC (PLAY) mode, a taught job is played back. In MANUAL (TEACH) mode, the taught job is played back as long as the button is pressed and held down.
	– PAUSE When pressed in AUTOMATIC (PLAY) mode, the playing job can be paused at the current position. Press [RUN] to restart.
	– Jog Key Moves a specific axis or Tool Center Point (TCP) coordinate of the manipulator. An indicator panel will show on the screen next to the jogging keys to show what each set of keys is controlling when the jog mode is changed. • The manipulator operates only while the key is pressed. • By pressing two or more keys simultaneously, multiple axes can be operated at the same time. (Except when Plus and Minus is for the same pair) • The manipulator operates in the selected coordinate system at the selected jogging speed. Before operating the axis, make sure that the selected coordinate system and the jogging speed are set as intended.
	– Jogging Speed Key The FAST and SLOW Keys toggle through the jogging speed settings; LOW, MED, HIGH, TOP. The user can see the jog speed setting change on the Status Bar. NOTE: Pressing the [FAST] and [SLOW] membrane keys simultaneously will trigger a screenshot if a USB storage device is present.

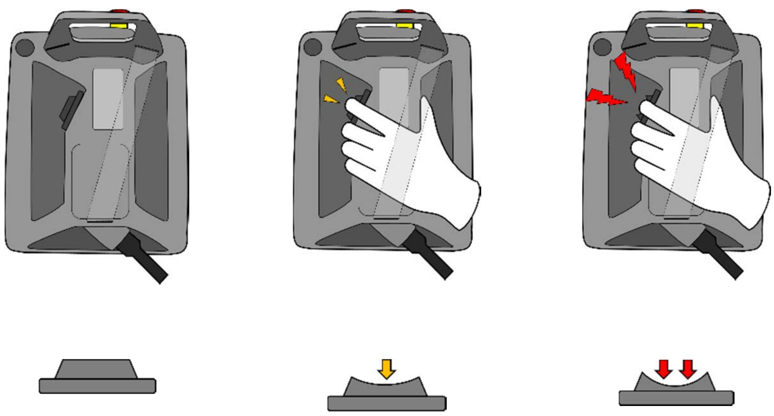
	– JOG MODE Selects the operation coordinate system when the manipulator is manually operated. • The coordinate system can be selected from the four coordinate systems: Joint, XYZ-World, XYZ-Tool, and XYZ-User. • Each time this key is pressed, the coordinate system is switched in the following order: Joint → XYZ-World → XYZ-Tool → XYZ-User • The selected coordinate system is shown in the Status Bar.
	– SMART FRAME Changes the Jog Mode to Smart Frame jogging.

1.7.3 Enable Switch

When the Mode Switch is in MANUAL (TEACH) mode and the Enable Switch is half pressed while the {SERVO} is in orange, the servo power turns ON.

If this switch is released or firmly squeezed while the power is turned ON, the servo turns OFF.

Fig. 1-8: Enable Switch



Release → OFF Squeeze → ON Squeeze Tightly → OFF

NOTE

MOTOMAN-HCxxDT does not require to squeeze the Enable Switch to turn ON the servos. The servos will turn ON when the {SERVO} on the screen is pressed and MOTOMAN-HCxxDT can be jogged.

1.7.4 Mode Switch

Mode switch is used for toggling between MANUAL (TEACH) mode, AUTOMATIC (PLAY) mode, and REMOTE Mode.

- **MANUAL (TEACH) mode**
  Axis can be operated. Job and other settings can be edited using the Smart Pendant. This mode is also called TEACH mode.
- **AUTOMATIC (PLAY) mode**
  Playback of a taught job can be performed. This mode is also called PLAY mode.
- **REMOTE mode**
  Operation by an external signal is enabled. The Software Pendant can only be used under the REMOTE mode. During the REMOTE mode, [GO TO POINT] of the Smart Pendant is disabled. Use of Servo OFF and pause are allowed.

If communication between the YRC Controller and the Smart Pendant is cut off, the mode of the YRC Controller cannot be changed. When the teaching process is completed, a qualified engineer should remove the mode switch key and keep it in a safe place. For more information, refer to *chapter 1.16 "Mode"* .

1.7.5 Touch Screen

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

1.7.6 Emergency Stop Button

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

When the servo power is turned OFF, the SERVO LED on the Smart Pendant turns OFF. Emergency Stop message is shown on the display.

WARNING

- When the Smart Pendant (JZRCR-APP30-1) is used, the Emergency Stop output signals (ESPOUT1 & ESPOUT 2) do not interface with the Smart Pendant's Emergency Stop button. Therefore, when configuring a safety circuit externally using the Emergency Stop output, confirm safety beforehand and make it an appropriate circuit configuration. Refer to *chapter 1.7.7 "Emergency Stop Output"* for further details.

1.7.7 Emergency Stop Output

1.7.7.1 Emergency Stop Output for YRC1000

When using the Smart Pendant, only the contact of the Emergency Stop button on the front of the door is output (some models do not have this button). These contact outputs are always valid regardless of the YRC1000 main power supply status ON or OFF (Status output signal: normally closed contact). These outputs are dual output.

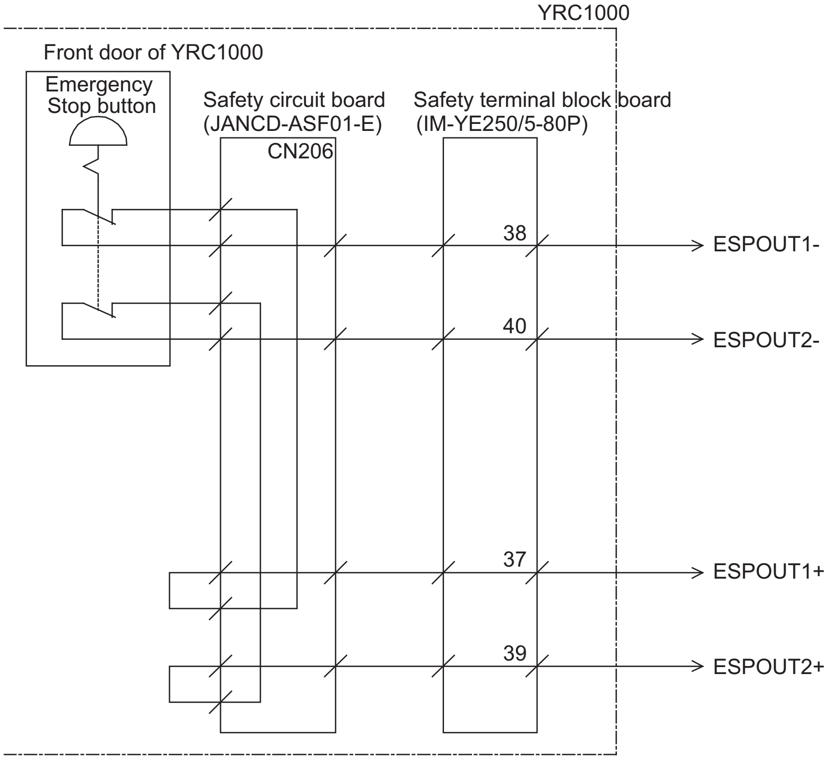
Table 1-1: Emergency Stop Output for YRC1000

Signal Name	Connection No. IM-YE250/5-80P	Function	Factory Setting
ESPOUT1+ ESPOUT1- ESPOUT2+ ESPOUT2-	-37 -38 -39 -40	Used to output a contact point of the Emergency Stop button on the Programming Pendant (JZRCR-APP01) and the front door of the YRC1000 Control panel.(Some models do not have this button) However, when using the Smart Pendant (JZRCR-APP30-1), it does not work with the Emergency Stop button of the Smart Pendant.	Open

WARNING

When the Smart Pendant (JZRCR-APP30-1) is used, the Emergency Stop output signals (ESPOUT1 & ESPOUT 2) do not interface with the Smart Pendant's Emergency Stop button. Therefore, when configuring a safety circuit externally using the Emergency Stop output, confirm safety beforehand and make it an appropriate circuit configuration.

Fig. 1-9: Emergency Stop Output Circuit for YRC1000



SUPPLE-MENT

If contact output that interlocks with the Emergency Stop button on the Smart Pendant it is necessary, refer to "YRC1000 INSTRUCTION (RE-CTO-A221)" for the section on "Safety Logic Circuit".

PPESP signal, and other signals can be combined and output to the general safety signal output (GSOUT 1, 2).

1.7.7.2 Emergency Stop Output for YRC1000micro

When using the Smart Pendant, it does not interlock with the Emergency Stop button of the Smart Pendant.

The contact Close status is output at all times. These outputs are dual output.

In case of YRC1000micro, it cannot be used as Emergency Stop output.

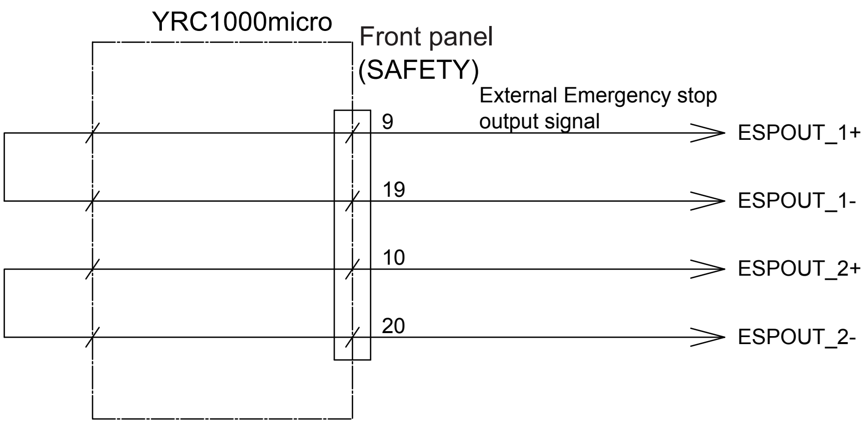
Table 1-2: Emergency Stop Output for YRC1000micro

Signal Name	Connection No. Robot Specific Signal Input Connector (SAFETY)	Function	Factory Setting
ESPOUT1+ ESPOUT1- ESPOUT2+ ESPOUT2-	-9 -19 -10 -20	While using a Programming Pendant (JZRCR-APP01), this signal is used to output the contact of the Emergency Stop button. However, when using the Smart Pendant (JZRCR-APP30-1), it does not work with the Emergency Stop button on the Smart Pendant.	Open

WARNING

When the Smart Pendant (JZRCR-APP30-1) is used, the Emergency Stop output signals (ESPOUT1 & ESPOUT 2) do not interface with the Smart Pendant's Emergency Stop button. Therefore, when configuring a safety circuit externally using the Emergency Stop output, confirm safety beforehand and make it an appropriate circuit configuration.

Fig. 1-10: Emergency Stop Output Circuit for YRC1000micro



SUPPLE-MENT

If contact output that interface with the Emergency Stop button of the Smart Pendant is necessary, refer to “YRC1000micro INSTRUCTION (RE-CTO-A222)” for the section on “Safety Logic Circuit”.

PPESP signal, and other signals can be combined and output to the functional safety board’s general purpose outputs (FSBOUT 1→8).

In this case the Functional Safety option must be enabled and the Expansion Safety I/O Board (JANCD-ASF32-E) must be installed in the YRC Controller. Refer to “YRC1000micro OPTION INSTRUCTIONS FOR FUNCTIONAL SAFETY FUNCTION” (HW1484544) for more information.

1.8 Smart Pendant Display

The Smart Pendant Display is a 10-inch color Touch Screen Display. The layout of each screen is different; however, there are two main screen layouts that will be described in this section:

- **Job Layout**
  This is the active view when editing or running a job
- **Configuration Layout**
  This is the active view when viewing or editing a configuration setting such as Tools, User Frames, Zones, etc.

1.8.1 Job Layout

This is the screen that will be displayed after opening a job or selecting {JOG} or {RUN} from the Home Screen. It is divided into four main display areas:

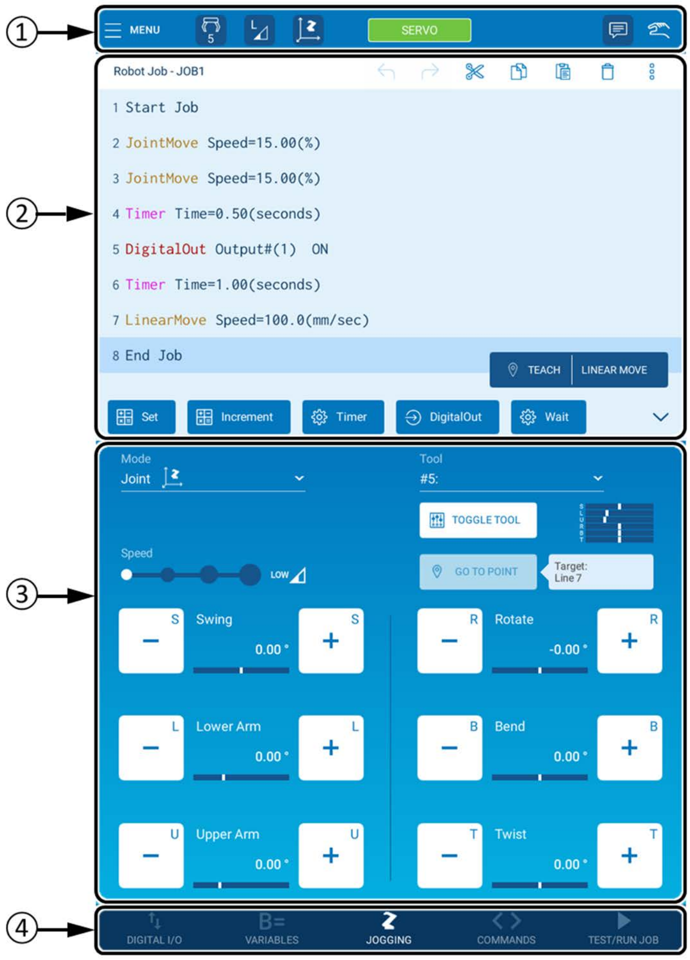
① **Status Bar**
View status and access common actions such as {MENU} and {SERVO}.

② **Job Contents View**
Contains the contents of the Current Job.
Basic job actions such as Teaching Positions, Copying/Pasting operation, and editing instruction parameters can be performed.

③ **Programming Panel**
Contents will change based on Navigation Bar.
For example, the Robot Jog panel is shown in *fig. 1-11 "Job Layout"*.

④ **Navigation Bar**
Use this to change the content of the Programming Panel.

Fig. 1-11: Job Layout



1.8.2 Configuration Layout

The screen is displayed in configuration layout when viewing or editing a setting (e.g. Tool, User Frame). The screen is divided into four main display areas:

① **Status Bar**

View status and access common actions such as Main Menu and Servo ON/OFF.

② **Configuration List**

This contains a list of configured items as well as controls for adding/ deleting and searching.

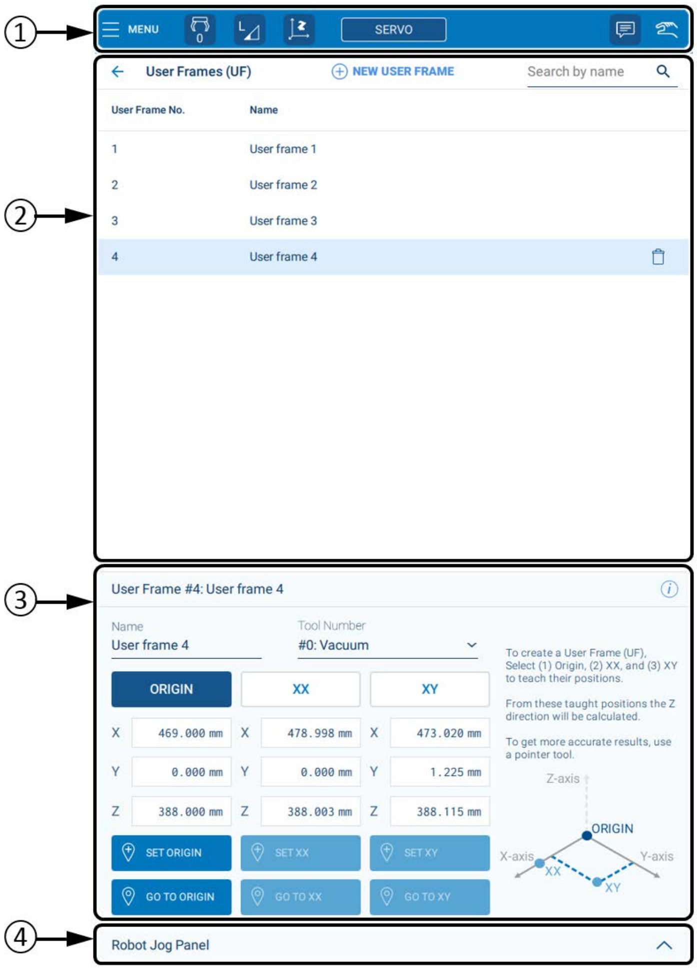
③ **Configuration Details**

This contains the details of the item selected in the Configuration List.

④ **Robot Jog Panel**

Press it to use the Robot Jog Panel during configuration.
Only Configuration (e.g. User Frames, Zones) that may require teaching positions shows this display area.

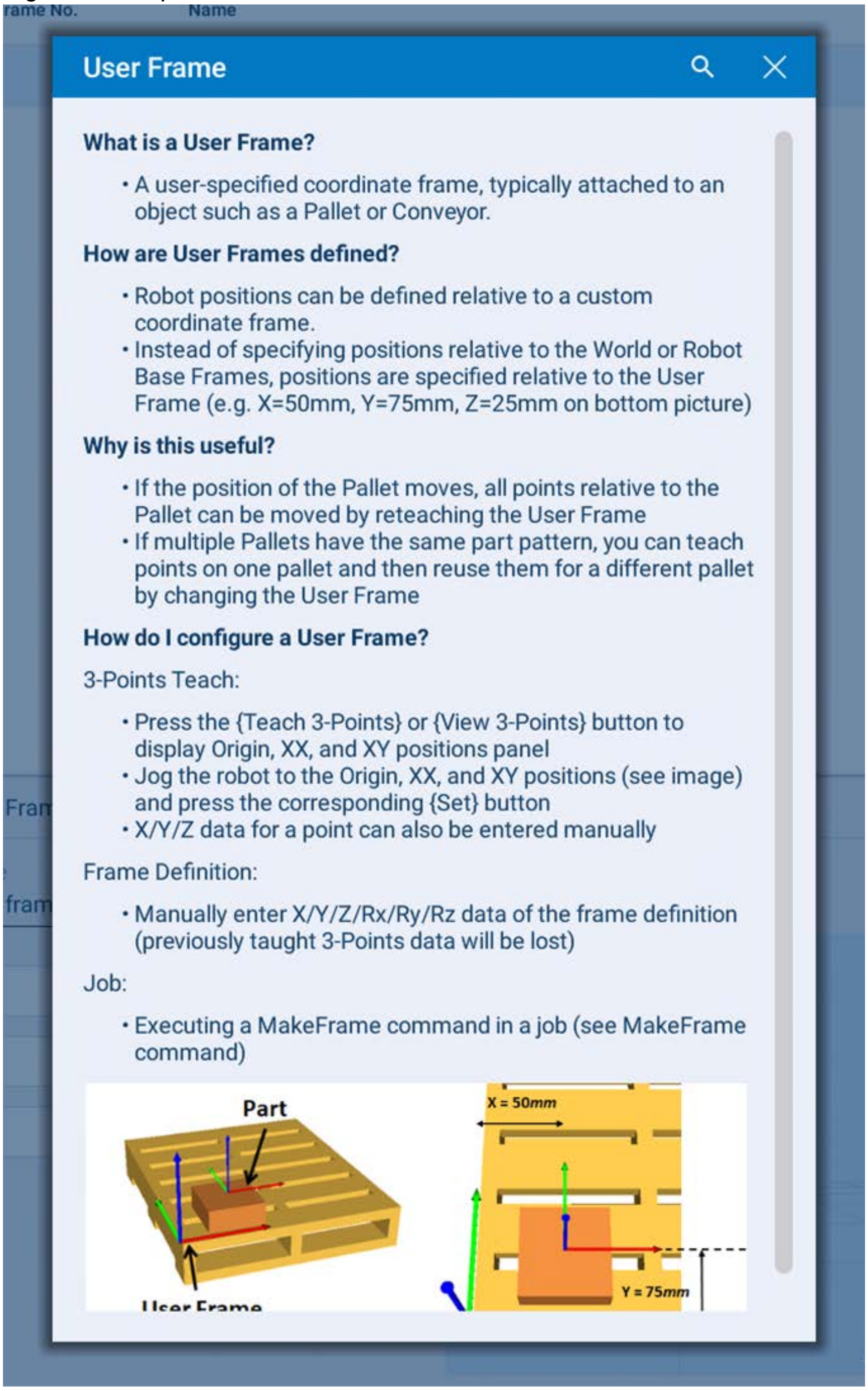
Fig. 1-12: Configuration Layout



1.8.3 Help Information

Smart Pendant has built-in Help files to help the user understand robot concepts without leaving the pendant. This information can be accessed by pressing the ⓘ icon that shows up on many screens. Use the Search icon in the header of an open Help file to search for keywords included in any help resource across the pendant. For example, the help icon on the User Frame Screen will display the following information:

Fig. 1-13: Help Information for User Frame Screen



1.9 Startup Window

The YRC Controller performs an initial diagnosis when the main power is turned ON. The startup window is shown on the Smart Pendant screen.

Fig. 1-14: Startup Window

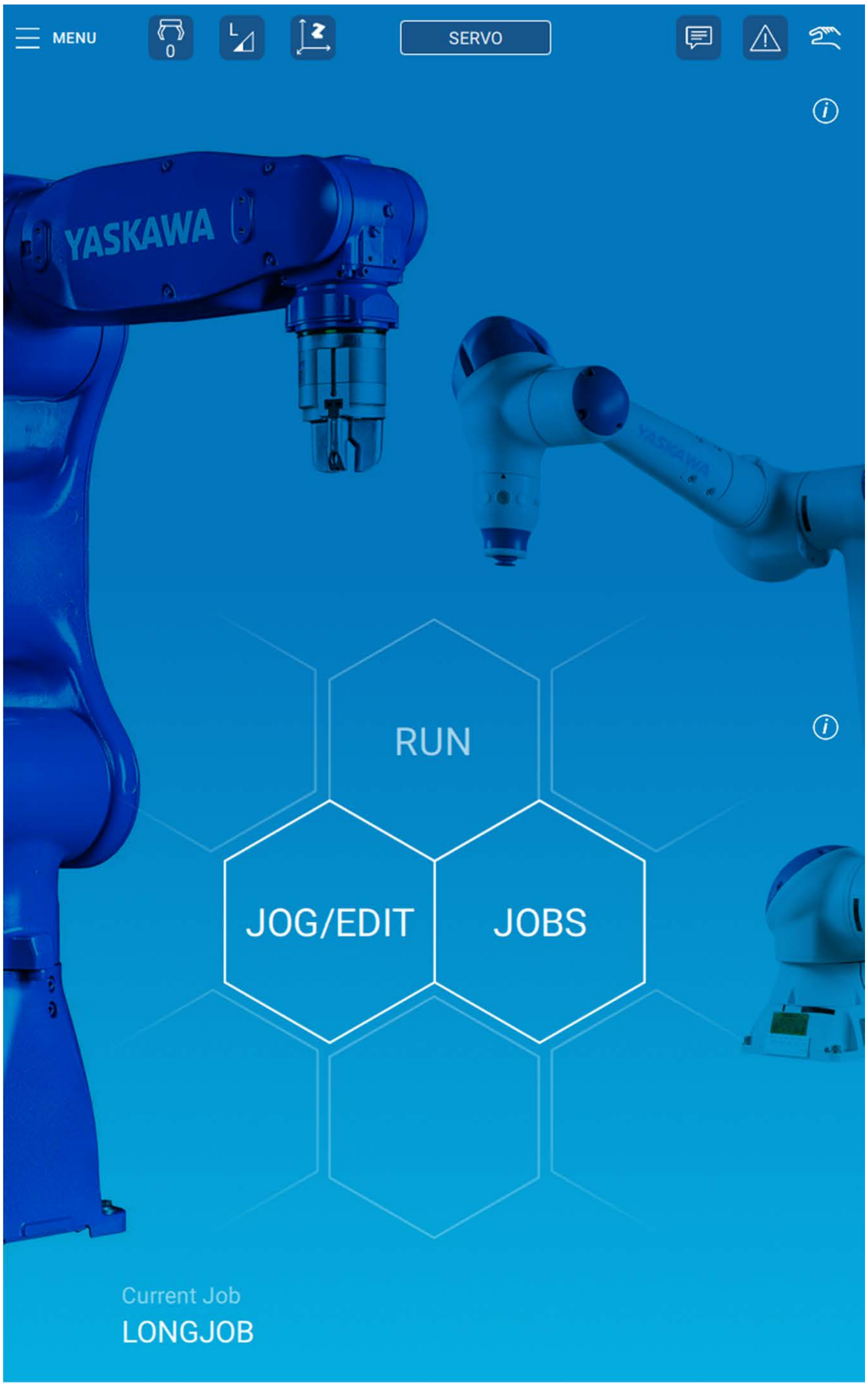
In case the Smart Pendant does not complete the startup sequence due to an error, such as YRC Controller incompatibility, an {Export Logs...} will appear. This button can be used to save internal logs to a USB storage device to aid troubleshooting by a YASKAWA Representative.

> NOTE
> The MODE switch will not work during Smart Pendant startup. MODE switch will work once the Smart Pendant startup is complete.

1.10 Home Screen

When the YRC Controller boots up, the Home Screen displays.

Fig. 1-15: Home Screen



The home screen contains short-cuts to three common actions for the manipulator:

	Use this button to view the Current Job (i.e. last Job opened) for editing/programming. To use this function, the Key Switch must be switched to the MANUAL (TEACH) position.
	Use this button to view the Current Job for running. To use this function, the Key Switch must be switched to the AUTOMATIC (PLAY) position. If a job is currently running, this button will change to “View Running Job”.
	Use this button to view a list of Jobs, choose a job to open, create a new job, lock a job, and set a Default job.

1.11 Main Menu

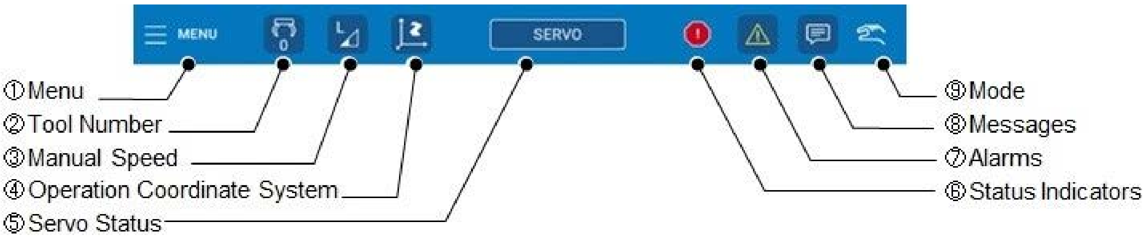
The main menu is accessed by pressing on the MENU button on the top left-hand side of the interface from any screen. After pressing this button, a menu tree will scroll from the left-hand side of the screen. This tree provides access to the Main Menu Items:

Table 1-3: Main Menu Items

Main Menu Item	Description
Security	Select Security Access Level and Enter Passcode
Home	Home Screen shortcut
Job List	Shows the list of jobs saved
Current Job	Open the Current Job
I/O and Variables	Contains sub-items related to programming the manipulator, such as {I/O}, {Variables} and {Variable and I/O Watch}
Robot Settings	Contains sub-items related to manipulator configuration such as {Tools}, {User Frames}, and {Zones}
Safety Settings	Contains sub-items of {Torque Sensor Calibration} and {Safety Function} which is related to limits and monitoring, such as {Axis Range Limit} and {Axis Speed Monitor}.
Utility	Contains sub-items such as {3D Viewer}, {System Backup}, and {File Transfer}
Alarms	Shows the Alarm History and Alarm Descriptions
System Settings	Contains sub-items of {General} and {Network}
Help / Support	Contains a YASKAWA contact list, and screenshot

1.12 Status Bar

The Status Bar shows the YRC Controller status.



The following configuration can be accessed from the Status Bar:

① Menu

Use this button to access the menu.

② Tool Number

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

③ Jogging Speed

Use this control to change the Jogging Speed.

Low Speed

Medium Speed

High Speed

Top Speed

④ Operation Coordinate System

The current Jogging Mode can be checked.

Smart Frame

Joint Coordinates

XYZ - World Coordinates

XYZ - Tool Coordinates

XYZ - User Frame Coordinates

Hand Guiding

Jogging Mode can be switched in MANUAL (TEACH) mode for Joint Coordinates, XYZ World Coordinates, and XYZ Tool Coordinates by pressing this button. XYZ User Frame Coordinates requires a User Frame be defined to select. Hand Guiding and Smart Frame cannot be selected via the Status Bar. They can be selected on the Robot Jog panel.

⑤ Servo Status

Shows the status of the current servo. Color of icon is:

- Blue when the servo is OFF.
- Orange when the servo is Servo ON Ready state.
- Green when the servo is ON.

⑥ Status LED

This section will display the indicators listed below. If none of these conditions are present, this area will be blank.

Emergency Stop

- Displays when the EMERGENCY STOP button (i.e. on Smart Pendant, YRC1000 remote button) is pressed.

Protection Stop by PFL Function

- Only for the manipulator that has PFL function which enables the human collaborative operation. Icon appears when PFL function has performed stop of motion, alerts user to reset the amber Resume Switch on the robot.

Motion Status

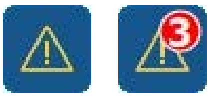
- This indicates that the robot is motion. This will be active during Job Execution or Jogging.

Pause Status

- This indicates that the robot is paused. This will be active after the PAUSE button is pressed during Job Execution.

⑦ Alarms

This section will display the alarm information shown below. If none of these conditions are present, this area will be blank.



Alarm Status

- Shows the number of active alarms when the YRC Controller has active alarms.

Low Battery

- This alerts the user to a lower battery condition of the YRC Controller CPU battery. Contact a YASKAWA representative when this occurs.

⑧ Messages

- Shows the number of messages when the YRC Controller has active messages

⑨ Mode

MANUAL (TEACH) mode

AUTOMATIC (PLAY) mode

REMOTE mode

1.13 Character Input Operation

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

1.13.1 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 (marked with an upward arrow).

The cursor is moved by tapping {LEFT} and {RIGHT} on the top of the keypad. Close the keyboard by tapping the keyboard icon.

Fig. 1-16: Keyboard for Switching Keypads and Moving the Cursor

NOTE: Alphanumeric values and symbols to be input are limited to certain content. When values cannot be input, the keys turn gray and cannot be selected.

1.13.2 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 {Enter} to enter the character.

Fig. 1-17: Keyboard for Numbers and Lower-Case Characters

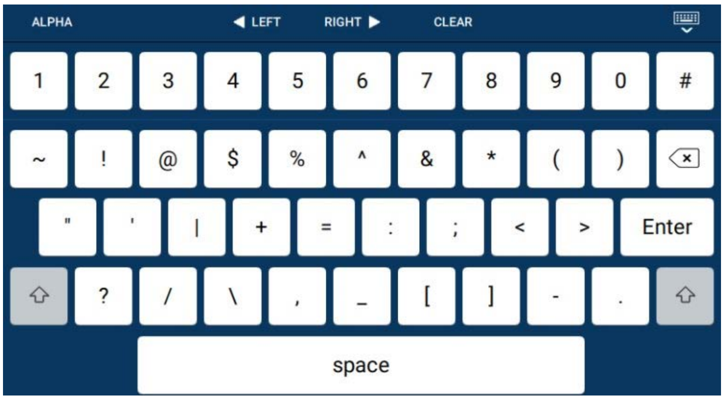
Fig. 1-18: Keyboard for Numbers and Upper-Case Characters

1.13.3 Symbol Input

Press the {SYMBOL} on the left top of the keypad to display the symbol keypad.

Tap the desired symbol and press {Enter} to enter the symbol.

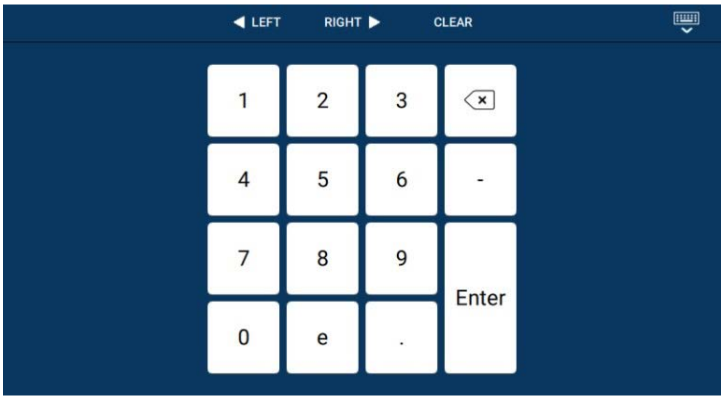
Fig. 1-19: Keyboard for Symbols



1.14 Numeric Value Input Operation

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

Fig. 1-20: Keypad for Numeric Value



Keypad	Key on the Smart Pendant	Description
Cancel	CANCEL	Clears all the characters being typed and closes the numeric value keypad
Clear	CLEAR	Clears all the characters being typed
Right	RIGHT ▶	Moves the cursor to the right
Left	◀ LEFT	Moves the cursor to the left
Backspace	⌫	Deletes one number at the cursor position
Enter	Enter / Enter (Save)	Enters the input numeric values
Numeric keys	0 to 9	Inputs number
Decimal point	.	Enters the decimal point
Minus	-	Enters the minus symbol
Scientific notation	e	Enters “e” as the real number

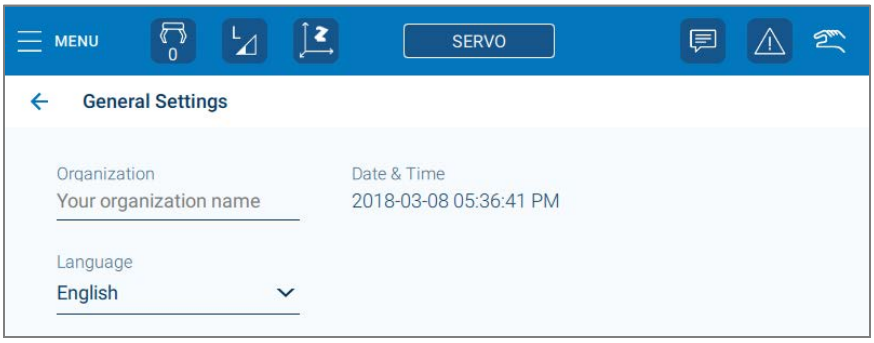
NOTE: Numeric values to be input are limited to certain content. When values cannot be input, the keys turn gray and cannot be selected.

1.15 Language Setting

Two languages can be displayed alternately.

1. Go to {HOME} → {System Setting} → {General}
2. Select the language from the pull-down list.
   The available languages are:
   – English
   – Japanese

Fig. 1-21: Language Setting in General Settings Screen



SUPPLE-MENT

The following terms cannot be translated even when the language setting is changed:

– Job name that is already created
– Other names created
– Comment

1.16 Mode

Three mode selections determine control of the manipulator system. These modes are MANUAL (TEACH), AUTOMATIC (PLAY) and REMOTE. Traditionally, MANUAL is also called TEACH, and AUTOMATIC is also called PLAY.

1.16.1 MANUAL (TEACH) Mode

In MANUAL (TEACH) mode, the following actions can be performed:

– Preparation and teaching of a job

– Modification of an existing job

– Setting of various manipulators and the YRC Controller settings and configurations

In MANUAL (TEACH) mode, the user has control for jogging the manipulator. Programming, editing, customizing, and other menu choices become available based on the level of Security.

1.16.2 AUTOMATIC (PLAY) Mode

In AUTOMATIC (PLAY) mode, the following can be done.

– Playback of a taught job

– Viewing of status, variables, I/O, Job, etc.

1.16.3 REMOTE Mode

In the REMOTE mode, certain operations can be commanded by external input signals. Classic Interface requires REMOTE mode to connect (refer to *chapter 13 “Classic Interface”*.

1.17 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.

1.17.1 Types of Security Level

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 jobs, 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 job operations, editing of jobs 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, time, changing the passcode, etc. This level requires a numeric password consisting of 4 to 16 numbers.

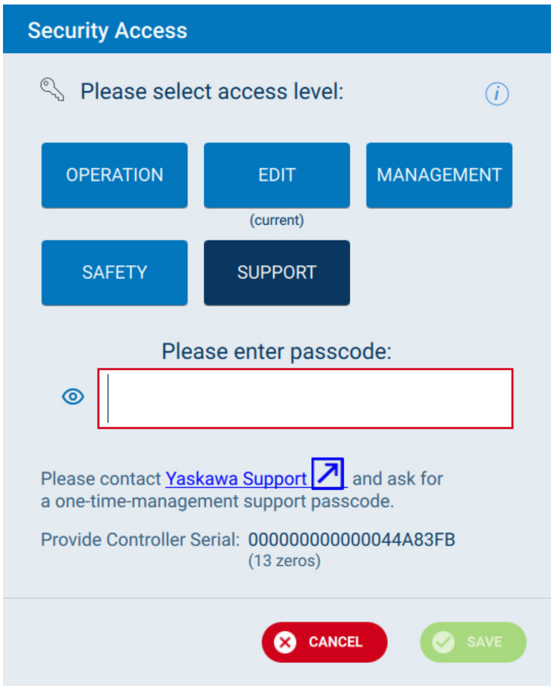
Safety:

In this level, an operator can edit the files related to the safety function in addition to the operations enabled in the Management level. Safety level is required to perform any functions associated with the optional Functional Safety Unit and Power & Force Limiting functions. This includes Tool Setting only for the manipulator with PFL function enabled (ex. MOTOMAN-HC10). This level requires a numeric password consisting of 9 to 16 numbers. For more details about the Safety level, refer to "YRC1000 OPTIONS INSTRUCTIONS FOR FUNCTIONAL SAFETY BOARD OPERATION (HW1483576)" / "YRC1000micro OPTIONS INSTRUCTIONS FOR FUNCTIONAL SAFETY BOARD OPERATION (HW1484544)".

Support:

The Support access level allows some additional abilities that are normally inaccessible. This aids a YASKAWA representatives in troubleshooting and addressing issues that may occur with the Smart Pendant or YRC Controller. Support can only be accessed with a one-time management passcode provided by a YASKAWA representative. The YRC Controller serial number is required to generate a valid one-time passcode, which displays on the Security Access Popup window. This access is to be used by a YASKAWA representative. Once accessed, Support access will persist until the Smart Pendant or YRC Controller is restarted.

Fig. 1-22: Security Support Access



1.17.2 Default Security Level Passcodes

Operation in **Edit**, **Management**, and **Safety level** require a passcode. The default passcodes for each security level are:

- Editing: 0000000000000000 (all 0s' - 16 digits)
- Managing: 9999999999999999 (all 9s' - 16 digits)
- Safety: 5555555555555555 (all 5s' - 16 digits)

NOTE

- In some regions, the YRC Controller may be shipped with a randomized Safety passcode, included with the shipment.
- When entering all the same digit, the numeric key can be held to automatically repeat to the maximum of 16 digits.

Passcodes for Edit and Management levels can be customized. For details, refer to *chapter 1.17.5 "Security Level Settings"*.

1.17.3 Security Level Access Information

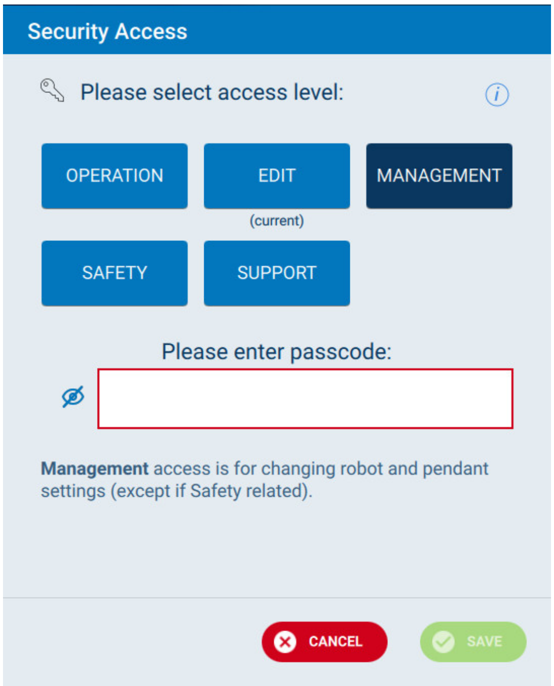
Various security levels with varying levels of system access are supported. These are summarized below:

Table 1-4: Security Mode

Items	**Lowest Accessible Security Level**
View System Status & Runtime	Operation
Jog Robot	Operation
Start/Stop Jobs	Operation
Simple System Reset / Repair	Operation
Teach Points and Edit Robot Setting	Edit
Edit Jobs and Variables	Edit
Edit Machine/Robot Control Parameters	Management
Edit Settings (System Time, Passcodes etc.)	Management
Ability to Create System Backup	Management
Safety Functions (FSU, PFL, Safety Logic)	Safety

1.17.4 Selecting Security Level

1. Go to {Security: ---} under the {MENU}.
2. Select the desired Security Access Level from {OPERATION}, {EDIT}, {MANAGEMENT}, or {SAFETY}.



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

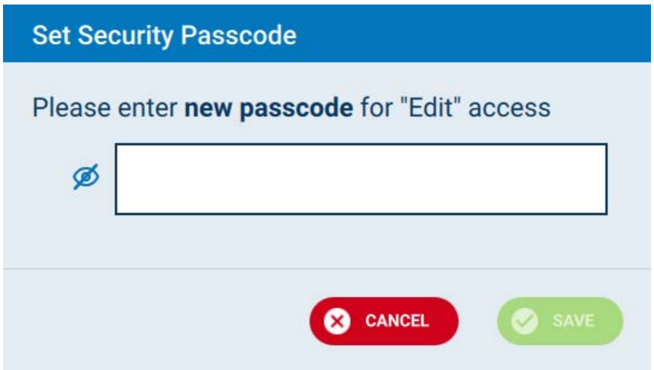
1.17.5 Security Level Settings

1.17.5.1 Changing Passcode

The passcode for Edit, Management and Safety level can be changed.

1. Operate in Management Level or higher.
2. Go to {MENU} → {System Settings} → {General}
3. Under {Security Level Settings}, select the security mode from the pull-down list below the “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.



1.17.5.2 Changing Startup Security Level

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

1. Operate in Management Level or higher.
2. Go to {MENU} → {System Settings} → {General}
3. Under {Security Level Settings}, select the Security Level from the pull-down list under the {Startup Level}.

2 Manipulator Coordinate Systems and Operations

2.1 Control Groups and Coordinate System

2.1.1 Control Group

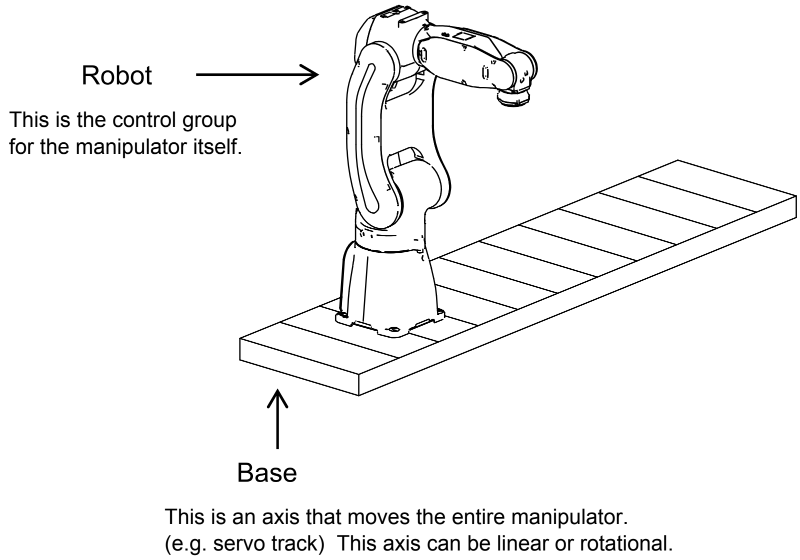
For the YRC Controller, a group of axes to be controlled is called a "Control Group". The Control Group is split into two units:

– "ROBOT" moves the joints of the manipulator itself

– "BASE" moves the entire manipulator

The "BASE" is called an "external axis", and is not supported by the Smart Pendant.

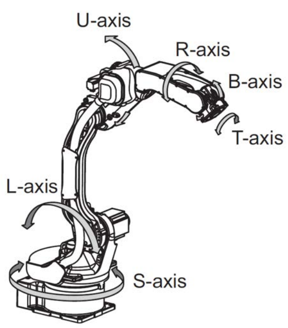
Fig. 2-1: Control Group



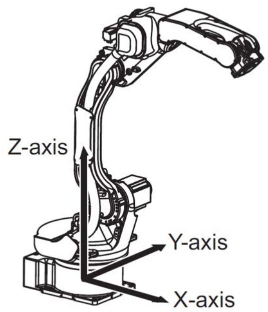
2.1.2 Types of Coordinate System

The following coordinate systems are used to operate the manipulator.

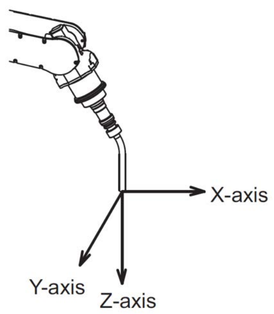
Type	Description
Joint Coordinate	Allows user to move each joint axis independently.
XYZ - World Coordinate	Allows user to move the manipulator in Cartesian directions relative to the manipulator base.
XYZ - Tool Coordinate	Allows user to move the manipulator in Cartesian directions relative to the tool. The direction of the tool attached to the wrist flange of the manipulator is defined as Z-axis, and Cartesian coordinates are defined at the tip of the tool.
XYZ - User Frame Coordinate	Allows user to move the manipulator in Cartesian directions relative to a “user frame.”



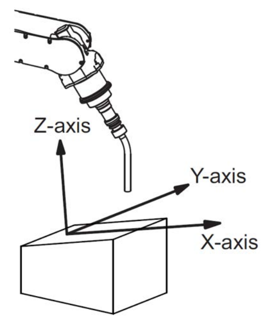
Joint Coordinate



XYZ World Coordinate



XYZ Tool Coordinate



XYZ User Coordinate

2.2 General Operations

2.2.1 Check Safety

Before operating the YRC Controller, read chapter 1 “Safety” of the INSTRUCTIONS of the YRC Controller. Always use caution around the manipulator system and peripherals.

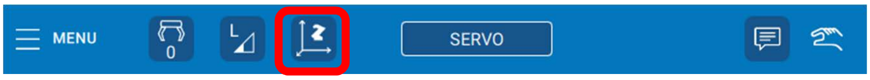
2.2.2 Select Operation Mode

Set the mode switch on the Smart Pendant to “MANUAL (TEACH)”.

2.2.3 Select Coordinate System

Select a coordinate system by:

– Tapping the Jog Mode on the Status Bar



– Changing the Jog Mode using the Robot Jog Panel

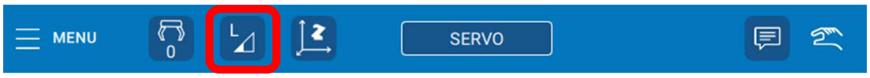
– Pressing [JOG MODE] membrane key

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

2.2.4 Select Jogging Speed

Select the jogging speed of operation by:

– Tapping the Jogging Speed on the Status Bar



– Changing the jogging speed using the Robot Jog Panel

– Pressing [FAST] and [SLOW] membrane keys

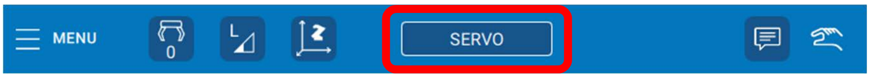
Four speeds are available for jogging speed: LOW, MID, HIGH, and TOP.

> **NOTE** MANUAL (TEACH) mode restricts the maximum speed of both the tool center point and the flange center point to 250 mm/s.

2.2.5 Servo ON

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

– Pressing the {SERVO} on the Status Bar

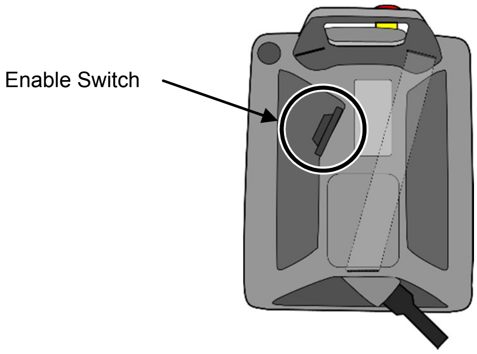


– Pressing the [SERVO] membrane key

If the system is in AUTOMATIC (PLAY) mode, the servos will turn ON.

NOTE

In MANUAL (TEACH) mode, the {SERVO} in the Status Bar turns orange after the {SERVO} is pressed. User must also activate the Enable Switch to turn the servo ON.

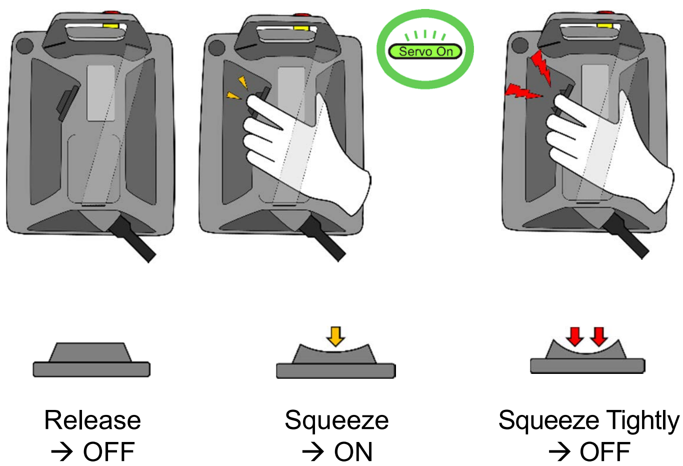


SUPPLE-MENT

Servo Power ON/OFF --- Enable Switch

The operator can turn ON servo power by gripping the Enable Switch. However, if the operator squeezes the switch tightly, a “click” will occur and servo power will turn OFF.

Back of the Smart Pendant and the Enable Switch:



Once servos' power is turned ON in MANUAL (TEACH) mode, jogging operations on the robot can be performed. Jogging can be accomplished using various methods in different coordinate frames. These are described in *chapter 2.4 "Coordinate Frames and Manipulator Jogging"*.

2.3 Operation Check for Emergency Stop Buttons

Before operating the manipulator, perform the following operations to ensure the Emergency Stop buttons on both the YRC Controller (some models do not have this button) and Smart Pendant are functioning correctly.

1. Press the {SERVO} on the touch screen.
   - The {SERVO} turns orange when the servo power supply is turned ON.
2. Press Emergency Stop button.
   - The Emergency Stop button is on the YRC1000 (some models do not have this button) or the Smart 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, and grip the Enable Switch.
   - The servo power can be turned ON by gripping the Enable Switch when the {SERVO} is in orange. The {SERVO} will turn to green and the [SERVO] status LED will turn ON. Verify that servo power turns OFF when the Enable Switch is released or when the Enable Switch is squeezed tightly as described in *chapter 2.2.5 "Servo ON"*.

WARNING

When the Smart Pendant (JZRCR-APP30-1) is used, the Emergency Stop output signals (ESPOUT1 & ESPOUT 2) do not interface with the Smart Pendant's Emergency Stop button. Therefore, when configuring a safety circuit externally using the Emergency Stop output, confirm safety beforehand and make it an appropriate circuit configuration. Refer to *chapter 1.7.7 "Emergency Stop Output"* for further detail.

2.4 Coordinate Frames and Manipulator Jogging

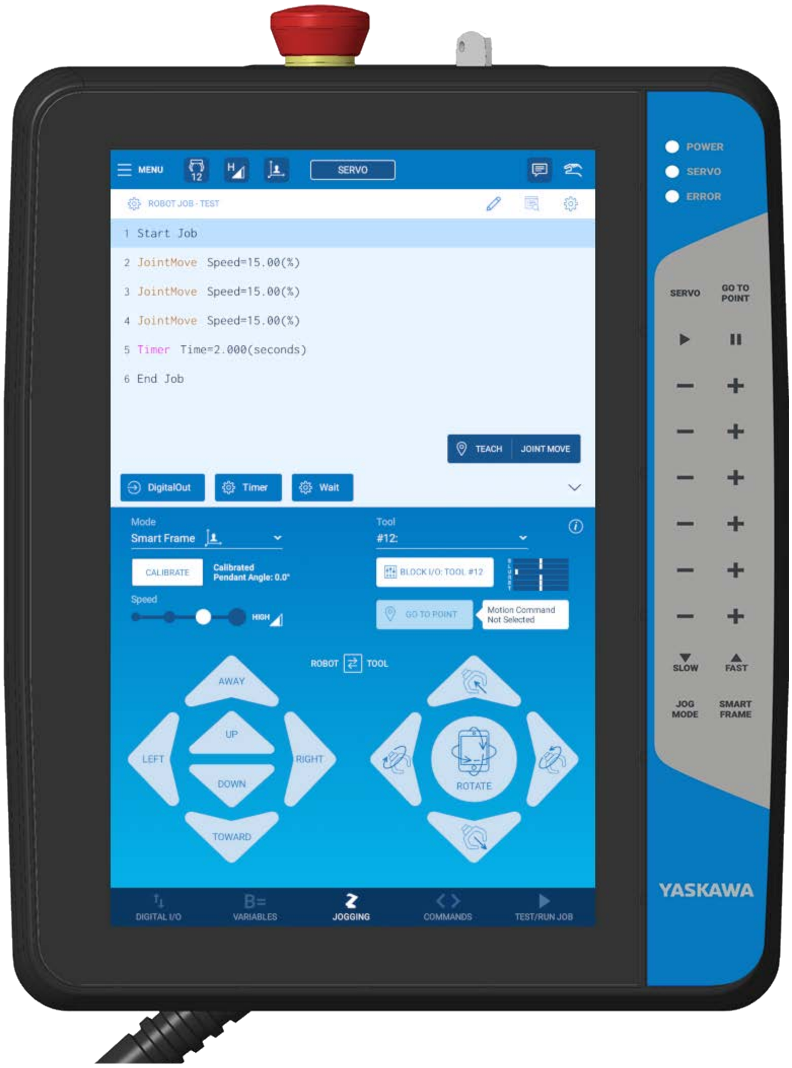
A manipulator can be jogged in MANUAL (TEACH) mode using different methods supported by the Smart Pendant. The various jogging modes can be selected using three different controls:

– {Operation Coordinate System} on Status Bar

– {Mode} on Robot Jog panel

– [Jog Mode] membrane key (can be used only for Joint, World, Tool, User and Hand Guiding mode selection)

Fig. 2-2: Changing Jogging Mode



All jogging modes have the following items in common on the Robot Jog panel apart from Item #3 (incremental jogging is not currently supported by Smart Frame or Hand Guiding)

Fig. 2-3: Common Items on Robot Jog Panel (Top)

① **Jogging Mode**

– Control for selecting jogging mode (MANUAL (TEACH) mode).

② **Continuous vs Step Type**

– Controls for specifying continuous (regular jogging) vs step (incremental or “inch-like” jogging).

③ **Jog Increment Type**

– Control for selecting the type of increment for jogging. There are two types, in Step Mode, the robot moves in increments of a user-defined step size while in Continuous, robot will move as long as jog button(s) are in a pressed state.

④ **Jog Speed**

– Control for selecting robot jogging speed (MANUAL (TEACH) mode). The user can select one of four different speeds.

⑤ **Active Tool**

– Control to select the active tool. The active tool stores physical parameters (input by the user) that are often critical to proper operation.

⑥ **Block I/O for Tool**

– Control used to toggle between user-defined ON & OFF Block I/O states for the active tool. The ON/OFF states are configured on the Block I/O screen.

⑦ **Current Axis Status Panel**

– Panel with interactive indicator bars that visually display the position of each axis.

⑧ **GO TO POINT Button**

– Control for moving the robot to programmed points in a job file. The user can highlight a “Move” command on the Job Contents view above the Robot Jog panel. Then press and hold the {GO TO POINT} to move to that command. An accompanying message will be displayed to the right of this button.

The following sections provide more detail on the different jogging modes and the coordinated systems they represent.

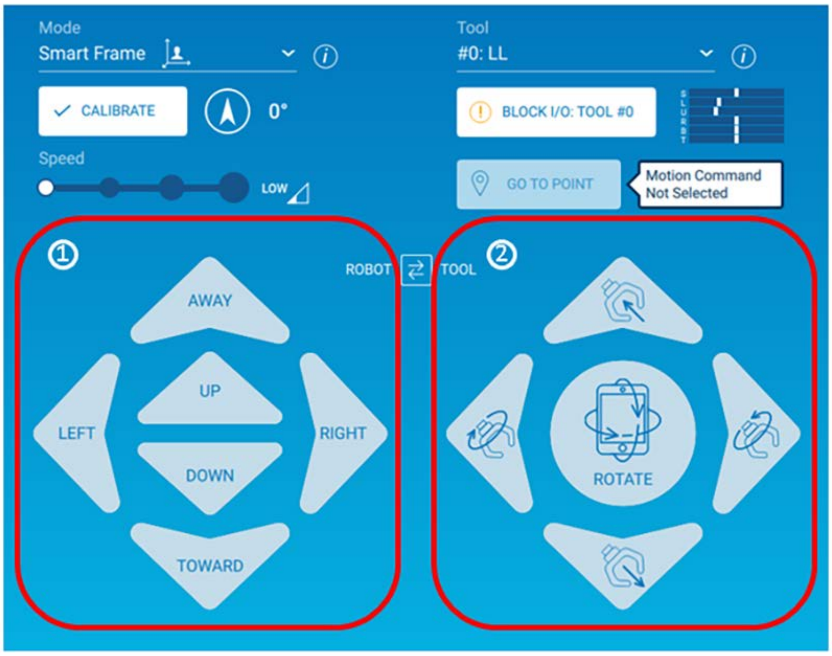
2.4.1 Smart Frame Mode

WARNING

Use of Smart Pendant in an area with strong geomagnetic disturbance or around metal objects (such as wire fences or steel frames) may result in manipulator motion directions not matching Smart Frame jogging directions.

Smart Frame Mode makes Cartesian jogging more intuitive to the user. In this mode, the manipulator moves in Cartesian directions relative to the position of the Smart Pendant with respect to the robot base. There are two panels in this mode as shown in *fig. 2-4 "Smart Frame Panel"* : ① Robot and ② Tool.

Fig. 2-4: Smart Frame Panel



① Robot Panel

This panel can be used to jog the position of the Robot TCP in directions relative to the Smart Pendant using the {LEFT}, {RIGHT}, {TOWARD}, {AWAY}, {UP} and {DOWN}. For example, pressing the {LEFT} will always move the robot in the left direction relative to the Smart Pendant even as the position of the Smart Pendant changes.

② Tool Panel

This panel can be used to jog the orientation of the Robot TCP as well as move/rotate it along the TCP Z direction. To jog the orientation, press and hold the {ROTATE} and then tilt the Smart Pendant in the desired directions of orientation.

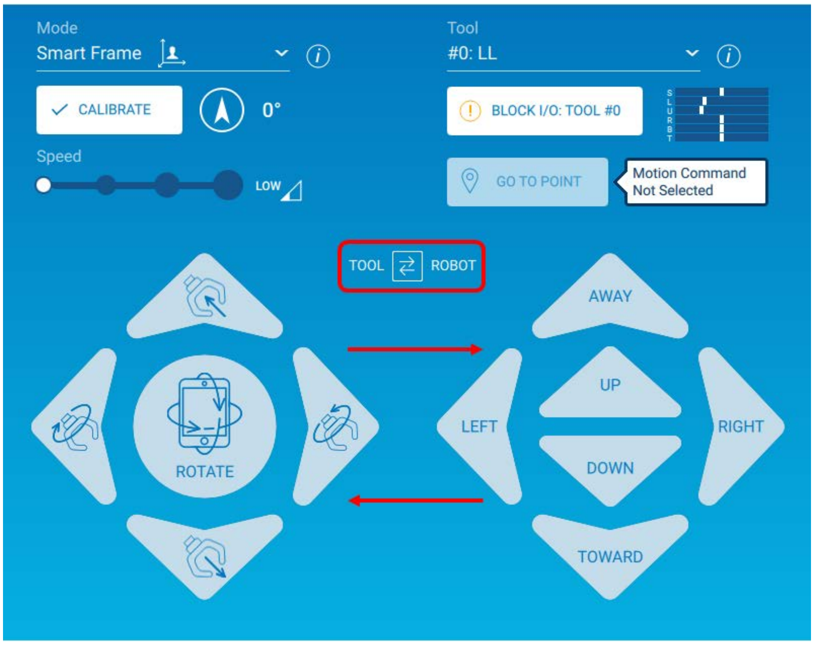
Fig. 2-5: Smart Frame Orientation

Table 2-1: Smart Frame Tool Buttons

Tool Button	Description
	Move robot TCP in +Z direction with respect to Tool Frame
	Move robot TCP in -Z direction with respect to Tool Frame
	Rotate robot TCP around +Z Tool Frame axis (+Rz)
	Rotate robot TCP around -Z Tool Frame axis (-Rz)

The Robot/Tool Toggle button in the middle of the screen can be used to flip the Robot/Tool Panels to the other side.

Fig. 2-6: Robot/Tool Toggle



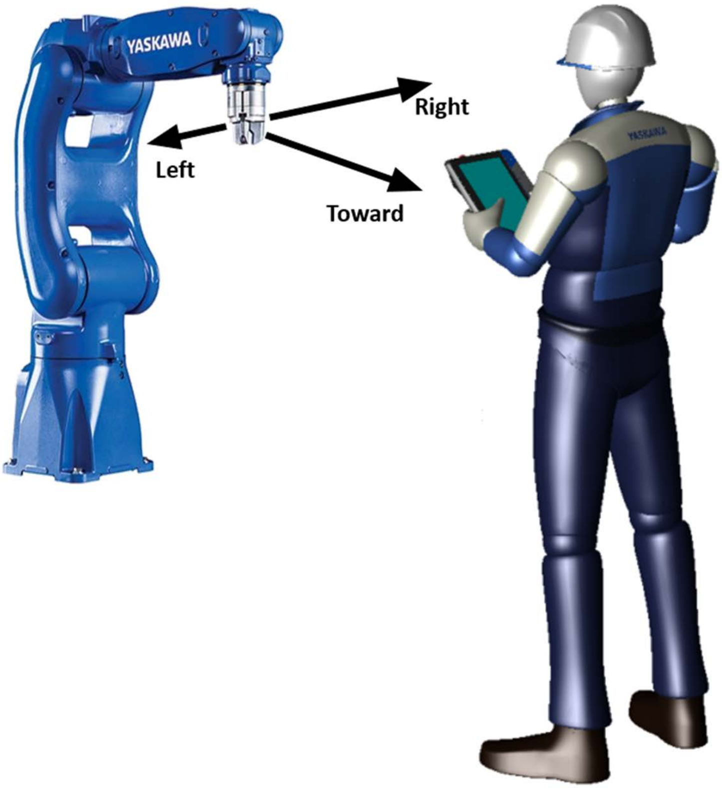
Additionally, the membrane [Jog Keys] can be used for Joint Axis jogging in Smart Frame Mode.

Each time the YRC Controller is turned OFF, Smart Frame will lose its calibration. This calibration is used to align the frame of the pendant to the base of the manipulator. For Smart Frame to accurately determine left, right, etc. directions, it must be calibrated.

CAUTION
If the accuracy of the sensor degrades during robot operation or the alignment is not correct, re-calibration is required. The sensor should be calibrated in any case where the pendant position does not appear to be reflected correctly.

To calibrate, the operator holding the pendant should stand facing the front of the robot and press the {CALIBRATE}. The calibration procedure can be repeated at any time if the robot TCP motion does not reflect the operator's physical position.

Fig. 2-7: Standing Position and Operation Direction

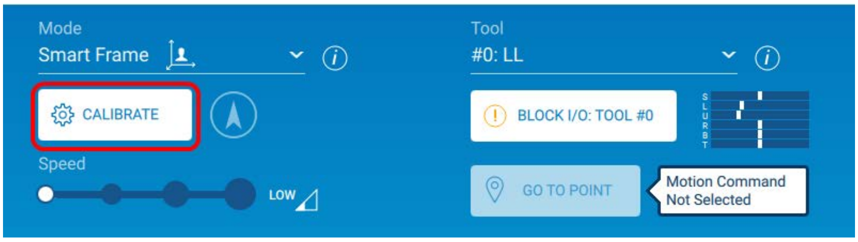


NOTE

The front of the Manipulator can be easily identified as the face of the Manipulator base that is on the opposite side of the cable connectors on the Manipulator base.

The robot can be in any position for sensor calibration.

1. Hold the Smart Pendant and stand facing the front of the robot.
   – The top edge of the Smart Pendant must be held parallel to the base of the manipulator.
2. Press {CALIBRATE} in the Smart Frame,

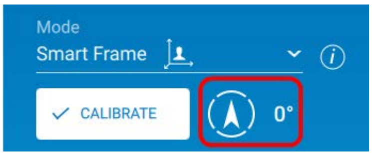


   – After the calibration completes:
      • {CALIBRATE} shows a check mark
      • pendant angle shows next to the heading indicator graphic.

NOTE

To aid with accurate jogging, the jogging directions can be locked to the Manipulator-base axis directions. This allows jogging the robot precisely along the manipulator X, Y, and Z axis while still using the smart frame directions.

- Toggle axis-locked and free jogging by clicking the angle indicator.
- When axis-locked, the indicator circle shows four quadrants and will snap to the directions -90, 0, 90, and 180 degrees.



2.4.2 Joint Mode

When the manipulator is operating in Joint Mode, each axis of the manipulator can be moved independently.

SUPPLE-MENT

Axis Operation in Joint Mode

When two or more [Jog Keys] are pressed at the same time on the membrane key, the manipulator performs a combined movement. However, if two different directional keys for the same axis are pressed at the same time (such as [S-] + [S+]), this axis will not operate. The touch screen {Jog Keys} only operate one button at a time.

Fig. 2-8: Joint Mode Axis Operation (6-axis manipulator)

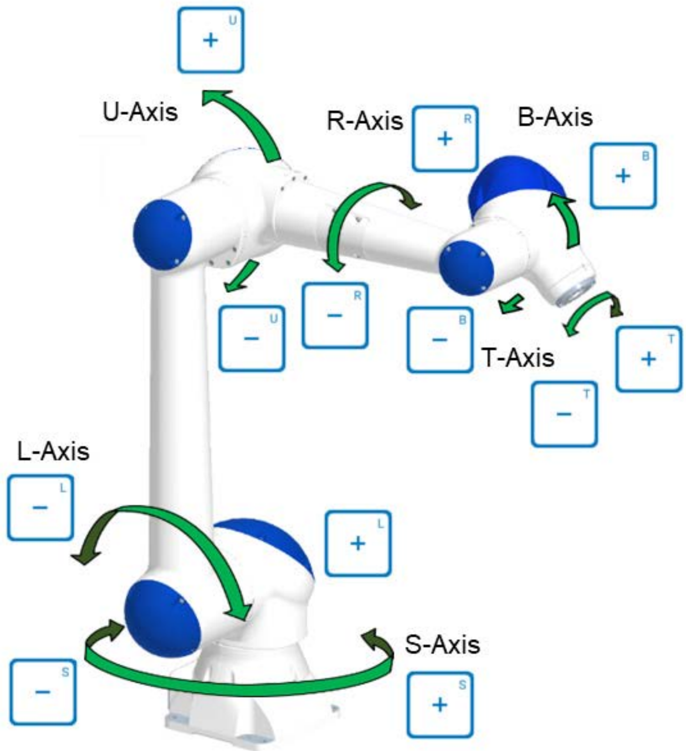
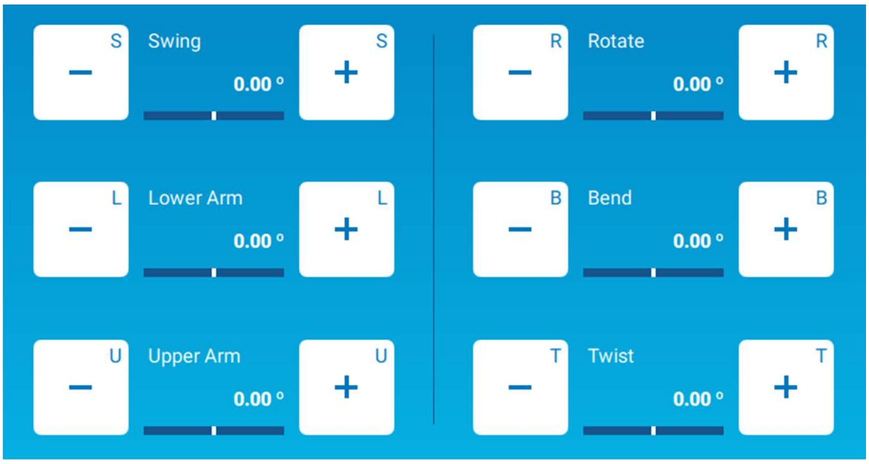


Fig. 2-9: Programming Panel of the Robot Jog Panel for Joint Mode



2.4.3 XYZ – World Mode

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

SUPPLE-MENT

Axis Operation in XYZ – World Mode

When two or more [Jog Keys] are pressed at the same time on the membrane keypad, the manipulator performs a combined movement. However, if two different directional keys for the same axis are pressed simultaneously (such as [X-] + [X+]), this axis will not operate. The touch screen {Jog Keys} only operate one button at a time.

Fig. 2-10: XYZ-World Mode Operation

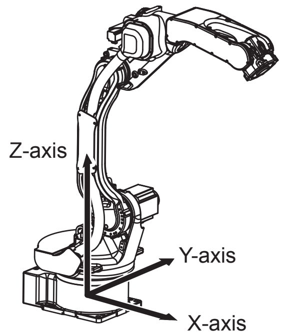
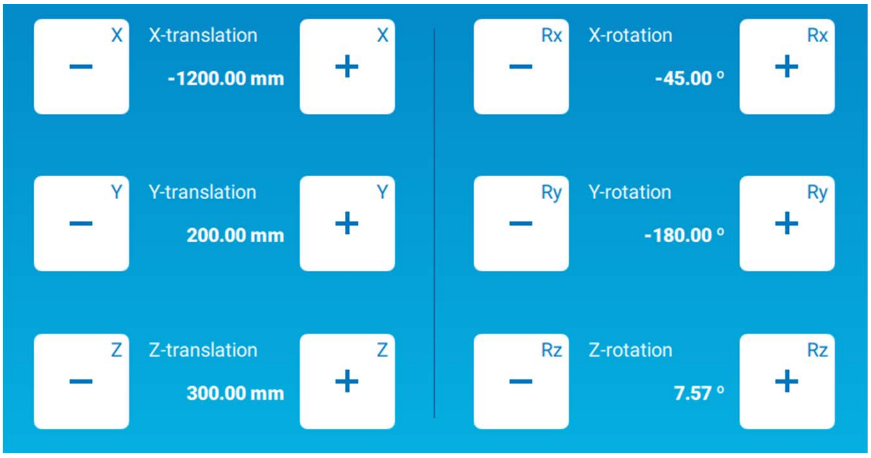


Fig. 2-11: Programming Panel of Robot Jog Panel for XYZ – World Mode



2.4.4 XYZ - Tool Mode

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

SUPPLE-MENT

Axis Operation in the XYZ - Tool Mode

When two or more [Jog Keys] are pressed at the same time on the membrane key, the manipulator performs a combined movement. However, if two different directional keys for the same axis are pressed simultaneously (such as [X-] + [X+]), this axis will not operate. The touch screen {Jog Keys} only operate one button at a time.

Fig. 2-12: XYZ-Tool Mode Operation

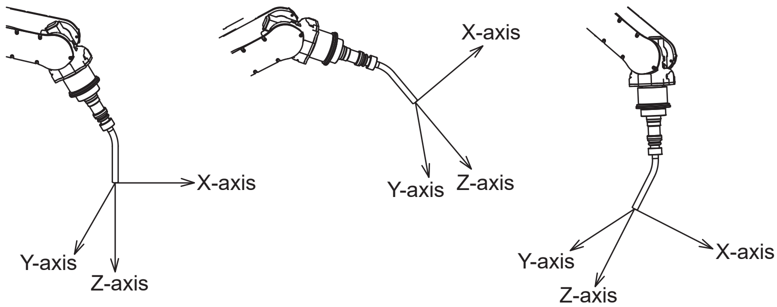
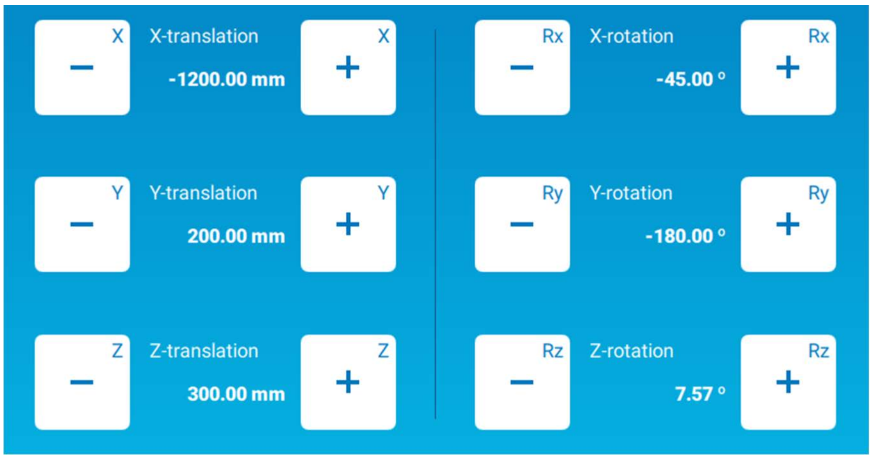
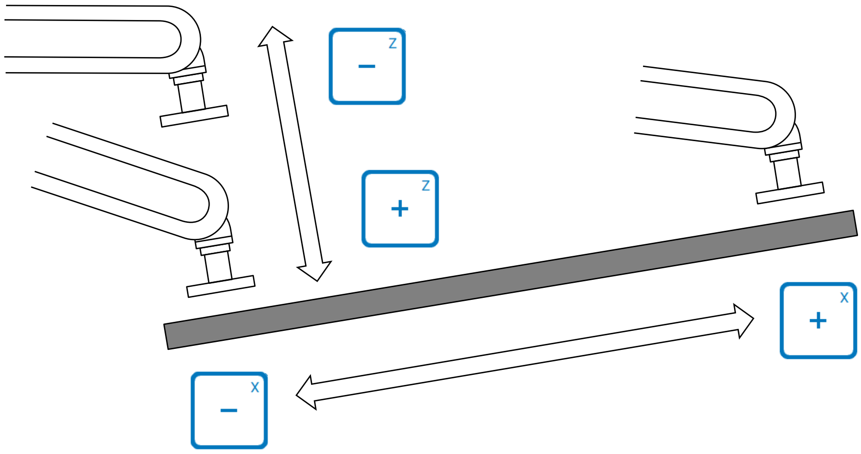


Fig. 2-13: Programming Panel of Robot Jog Panel for XYZ – Tool Mode



The tool coordinates are defined at the tip of the tool, assuming the effective direction of the tool mounted on the manipulator's tool flange is the Z-axis. Therefore, the tool coordinates axis direction moves with the wrist.

In tool coordinates, the manipulator can be moved using the effective tool direction as a reference, regardless of the manipulator's position or orientation. These motions are best suited for moving the manipulator parallel to the tool frame while maintaining tool orientation with respect to the workpiece.



> **NOTE** To use the tool frame, the tool file must be registered in advance. For further details, refer to *chapter 6.1 "Tool Settings"*.

2.4.4.1 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 Mode.

2. Select desired tool number.
   For more information on the tool setting, refer to *chapter 6.1 "Tool Settings"*.

2.4.5 XYZ - User Frame Mode

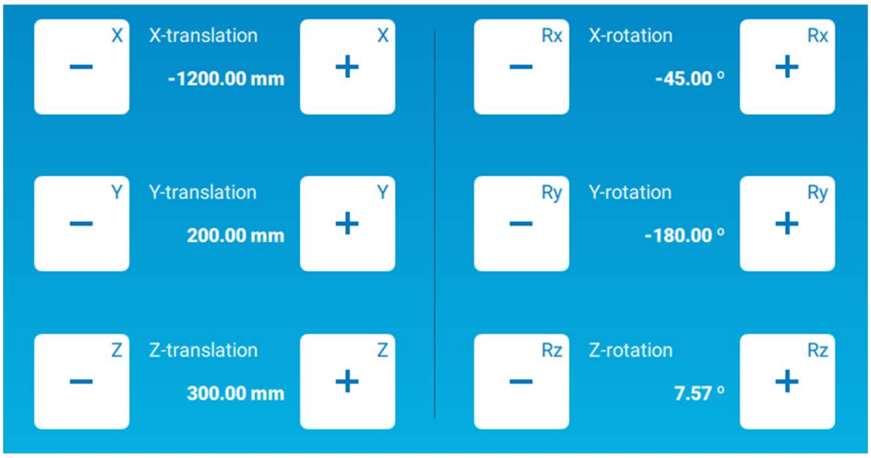
In XYZ – User Frame mode, the manipulator moves parallel to each axis of the user-defined coordinates. A user-specified coordinate frame is typically attached to an object such as a work surface, pallet, or conveyor. The user defines the X, Y, and Z axes with the desired slopes and positions available within the manipulator's motion range. Up to 63 user frames, each of which is registered with a unique number, can be configured.

SUPPLE -MENT

Axis Operation in the User Frame Mode

When two or more [Jog Keys] are pressed at the same time on the membrane key, the manipulator performs a combined movement. However, if two different directional keys for the same axis are pressed simultaneously (such as [X-] + [X+]), this axis will not operate. The touch screen {Jog Keys} operate only one button at a time.

Fig. 2-14: Programming Panel of Robot Jog Panel for XYZ – User Frame Mode



2.4.5.1 Selecting User Frame

1. Select {XYZ – User} for Jogging Mode
2. Select the desired User Frame number.

SUPPLE -MENT

To enable the user frame function, the User Frame must be configured before selecting User Frame mode. For further detail, refer to *chapter 6.3 "User Frames"*.

2.4.6 Hand Guiding Mode

Hand Guiding mode can be used on manipulators that have the PFL (Power and Force Limiting) function for human collaborative operation (ex. MOTOMAN-HC10) only. In this mode, the user can directly position the Manipulator by physically moving the arm by hand.

To use the Hand Guiding mode, set and verify the following:

– Verify PFL function is ON. The Collaborative Operation LED (green lamp) on the manipulator (ex. on the wrist for MOTOMAN-HC10) is turned ON when PFL function is ON/Enabled.

– Tool is correctly configured. Refer to *chapter 6.1 “Tool Settings”*.

– Current tool number matches with the currently attached tool. Check the Status Bar for the tool number.

– Jogging Speed is on High – initial speed setting can be changed for accuracy and ease of motion.

There are three sub-modes in Hand Guiding mode:

– ALL JOINTS

– TOOL JOINTS

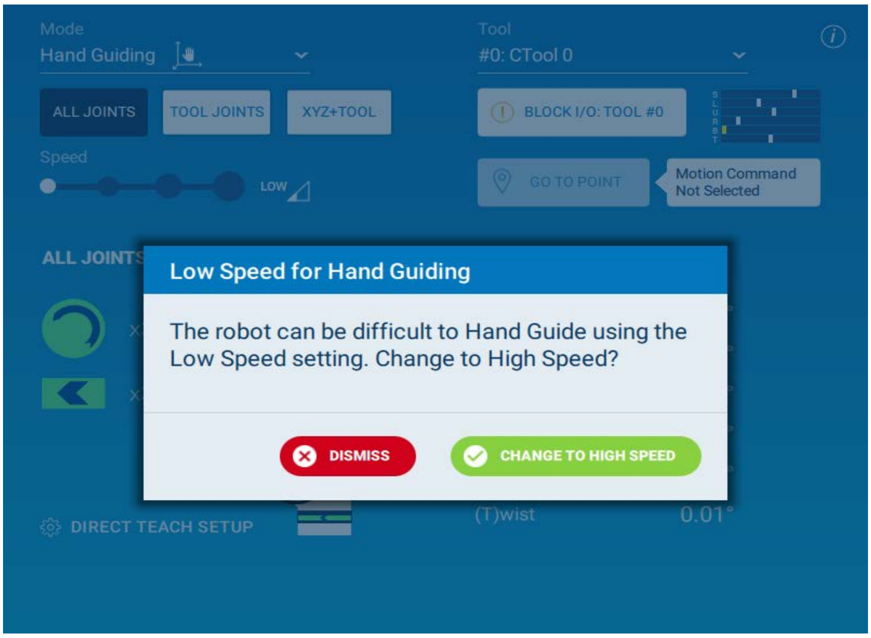
– XYZ+TOOL

When Hand Guiding mode is entered, the message shown in *fig. 2-15 “Low Speed for Hand Guiding”* will appear. In Low Speed, the robot can be difficult to move with Hand Guiding (especially for large motions) and can cause alarms if pressed too hard. Select {CHANGE TO HIGH SPEED} to change the jogging speed or select {DISMISS} to remain in Low Speed.

NOTE

Low Speed setting can still be useful for very fine motions.

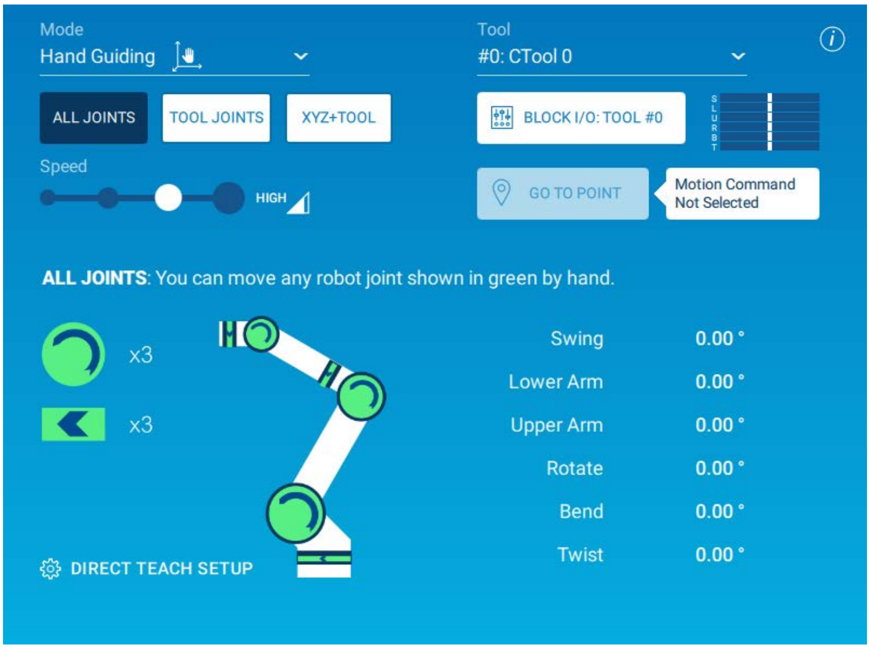
Fig. 2-15: Low Speed for Hand Guiding



2.4.6.1 ALL JOINTS

In this mode, all axes of the robot can be guided by hand. This mode is most useful for large motions and recovering from faults / collisions.

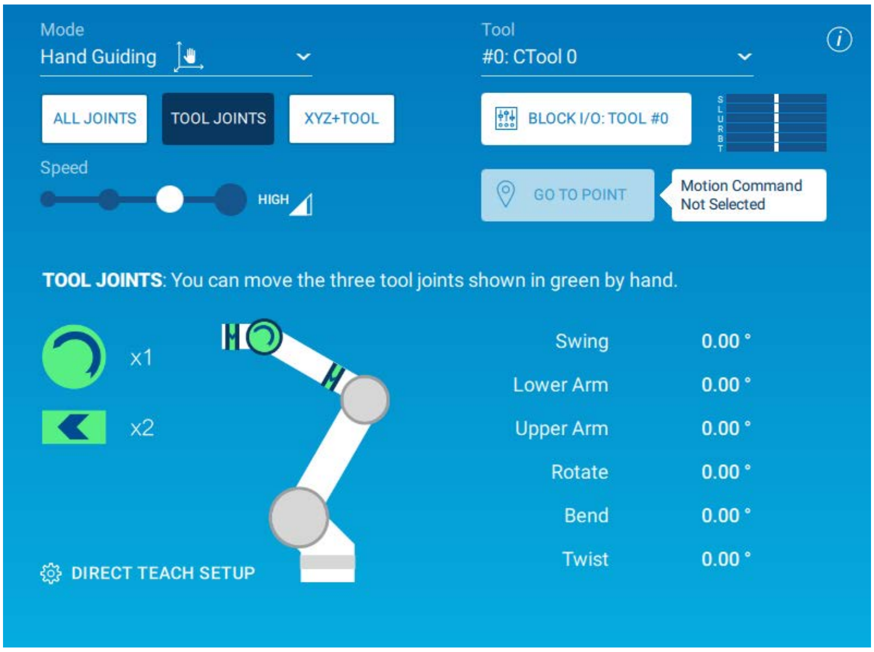
Fig. 2-16: Hand Guiding with All Joints



2.4.6.2 TOOL JOINTS

In this mode, the three axes on the wrist (R, B, T) of the robot can be moved by hand. This mode can be used to modify the tool orientation.

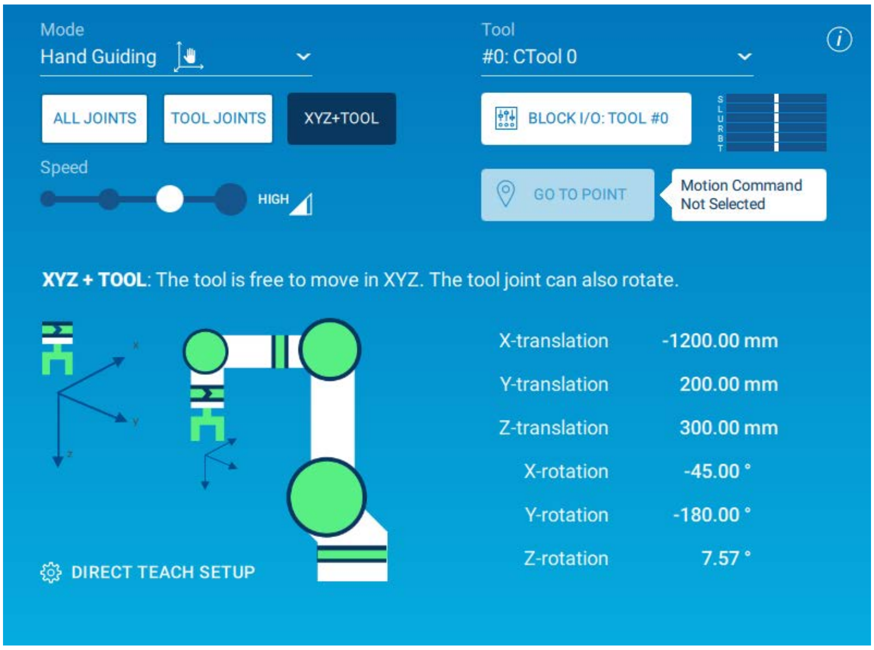
Fig. 2-17: Hand Guiding with Tool Joints



2.4.6.3 XYZ + TOOL

In this mode, the robot can be guided in the X, Y, Z directions by hand. This is the most useful mode for teaching robot positions. The tool axis of the robot (T-axis) can also be rotated to orient the tool.

Fig. 2-18: Hand Guiding with XYZ + Tool



2.4.7 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.

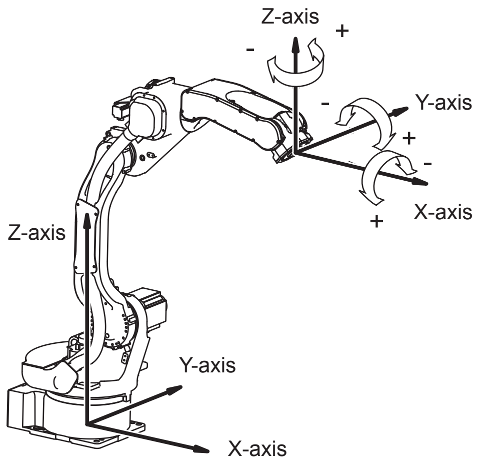
The motion of each axis is described in the table below.

Table 2-2: Axis Motion in Motion at TCP

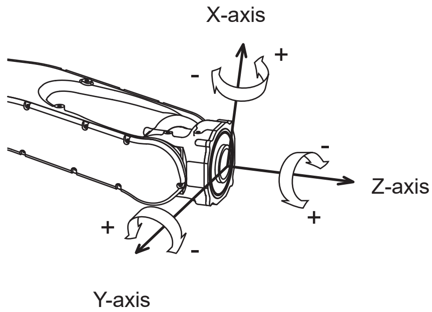
Axis	Axis Operation Key	Motion
Wrist Axes	Rx + Rx −	Only the tool's posture changes with the TCP fixed. The tool's posture changes around the axes of the specified coordinates.
	Ry + Ry −	
	Rz + Rz −	

Turning of each wrist axis differs in each coordinate system.

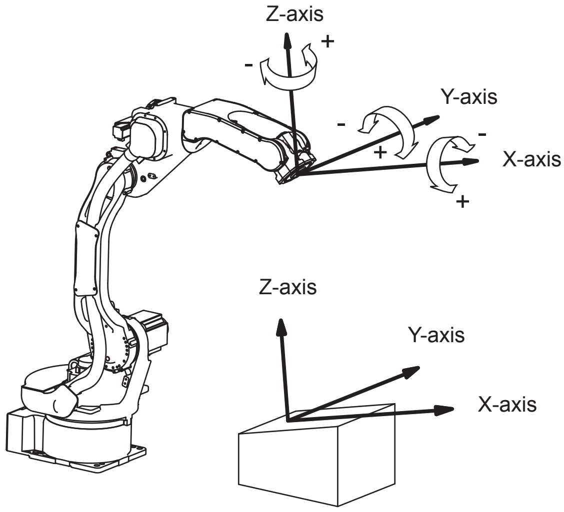
- In World Frame, wrist axis rotations are based on the X, Y, and Z axes of the manipulator.



– In Tool Frame, wrist axis rotations are based on the X, Y, and Z axes of the tool coordinates.



– In User Frame, wrist axis rotations are based on the X, Y, and Z axes of the user coordinates.



2.4.8 Move to Position Panel

The Move to Position Panel is a feature 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.

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

– Joint Panel

– TCP Position Panel

– TCP Orientation Panel.

2.4.8.1 Joint Panel

The Joint Panel can be used whenever the Jogging Mode is set to Joint. To open the Joint Panel, press any of the joint positions on the screen:

Fig. 2-19: Move to Position Panel (Joint Mode)

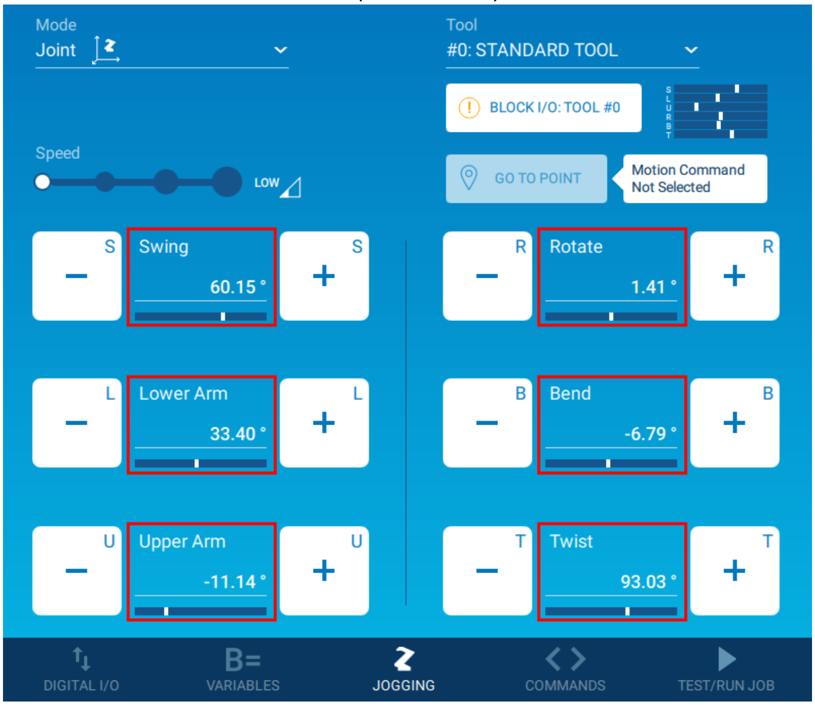
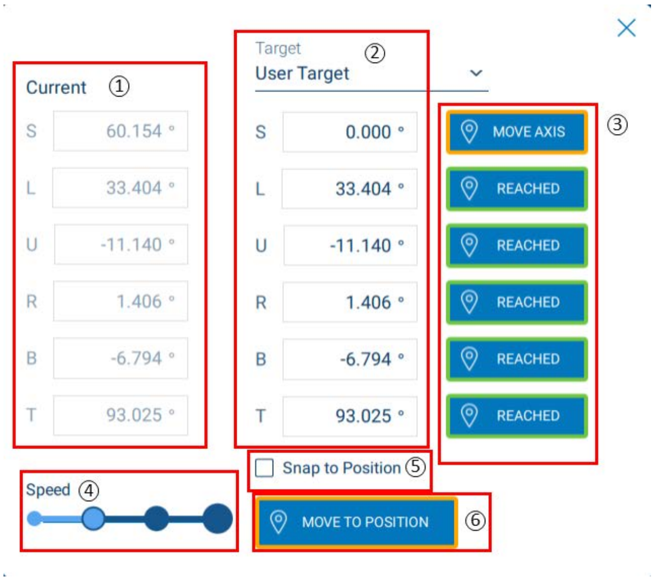


Fig. 2-20: Joint Position Panel



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.

NOTE

To change/configure these positions, refer to *chapter 6.6 “Robot Configuration Positions”*.

③ **Move to individual axis** - Each button jogs the specific axis to its target position. The button has an orange border if the Current Position of the axis is not equal to Target Position of the axis (e.g. S- Axis in *fig. 2-20*).

④ **Speed Jogging Selection**

⑤ **Snap to Position** - This will “snap” each axis to the nearest 10 degree increment. For example, the L-axis value above (33.404 degrees) would snap to 30.000 degrees.

⑥ **Move to Position button** - This will move all axes towards their target. This button will have an orange border if any the Current Position of any axis is not equal to it's Target Position.

2.4.8.2 TCP Position Panel

The TCP Position Panel can be used whenever the Jogging Mode is set to XYZ-World, XYZ-User, or XYZ-Tool. To open it, press any of the TCP XYZ positions on the screen:

Fig. 2-21: Move to Position Panel (XYZ-World)

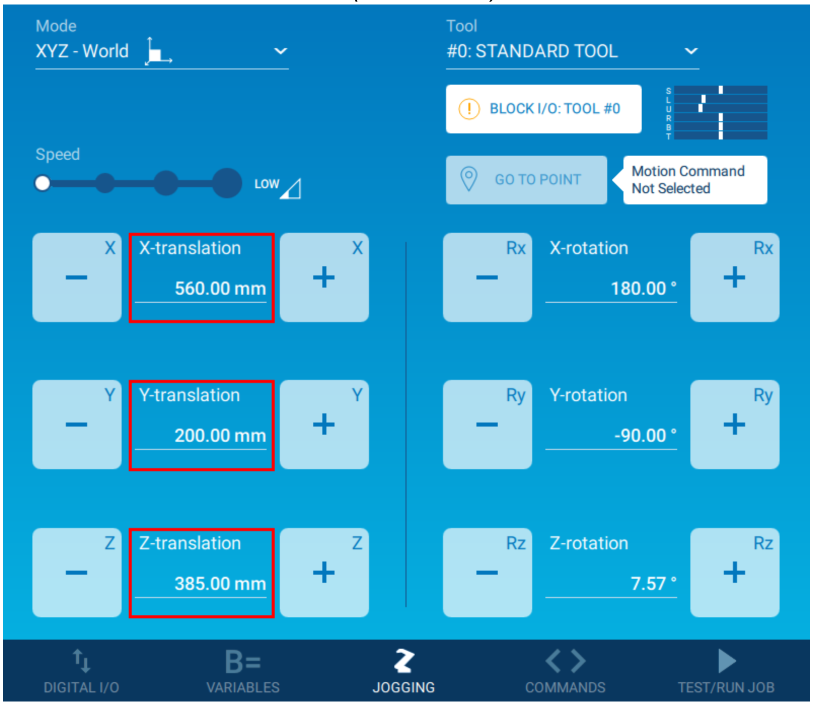
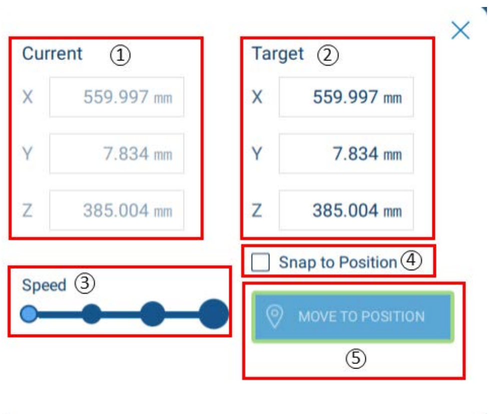


Fig. 2-22: TCP Position Panel



① **Current XYZ Position display.**

② **Target XYZ Position display** - The target X, Y, or Z position can be entered into the text fields.

③ **Jogging Speed Selection**

④ **Snap to Position** - This “snaps” each coordinate to the nearest 10 mm increment. For example, the Y value is above (7.834 mm) it will snap to 10.000 mm.

⑤ **Move to Position button** - This moves the robot towards the target X, Y, or Z position. These buttons will have an orange border if any of the Current X, Y, or Z Positions do not match the target X, Y, or Z Positions.

2.4.8.3 TCP Orientation Panel

The TCP Orientation Panel is used whenever the Jogging Mode is set to XYZ-World, XYZ-User, or XYZ-Tool. To open the TCP Orientation Panel, press any of the TCP Rx, Ry, or Rz positions on the screen.

Fig. 2-23: Move to Position Panel (XYZ-World)

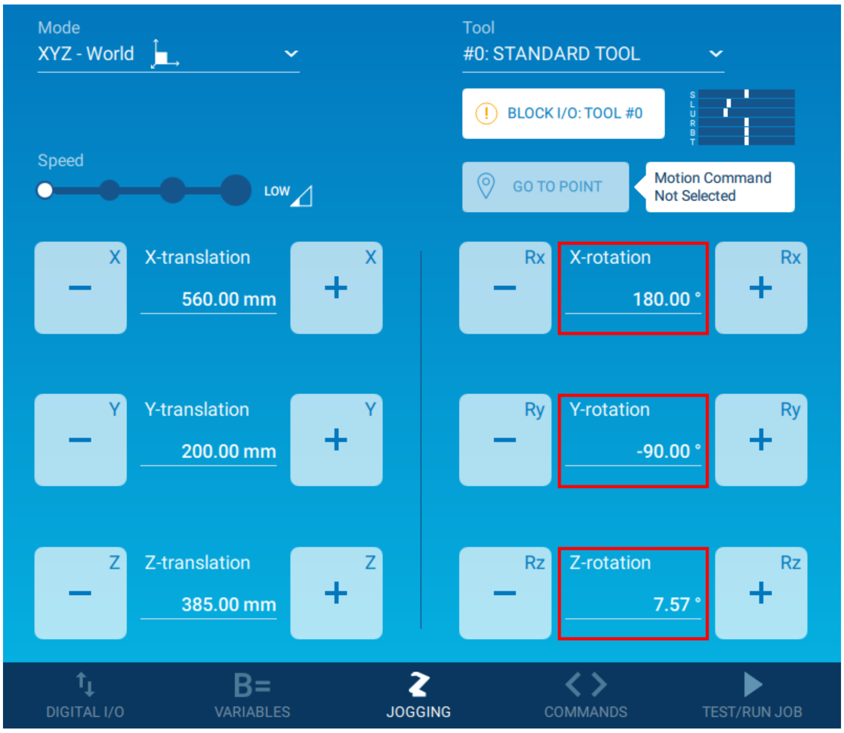
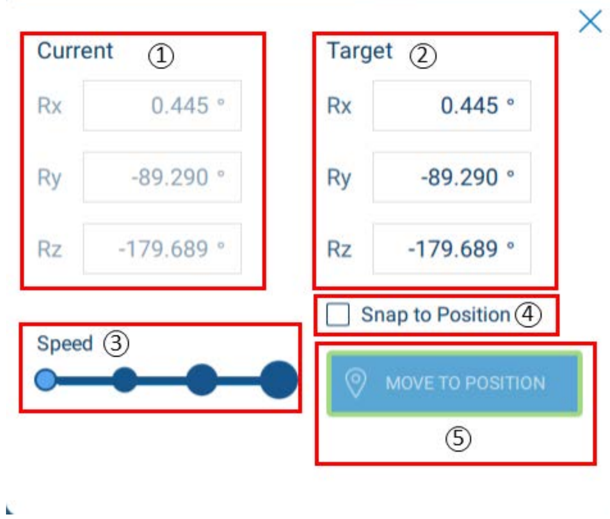


Fig. 2-24: TCP Orientation Panel



① **Current RxRyRz Position display**

② **Target RxRyRz Position display** - The target Rx, Ry, Rz positions can be entered into the Text Fields.

③ **Jogging Speed Selection**

④ **Snap to Position** - This “snaps” each rotation to the nearest five degree increment. For example, if the Ry value is above (-89.920 degrees) it will snap to -90.000 degrees.

⑤ **Move to Position button** - This moves the robot towards the target Rx, Ry, Rz positions. These buttons will have an orange border if any the Current Rx, Ry, Rz positions do not match the target positions.

3 Managing Jobs

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

> **NOTE** Edit operations on a job are restricted if an edit lock is applied to the job. Refer to *chapter 3.5.5 "Setting Edit Lock"* for details on an edit lock.

3.1 Preparation for Teaching

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

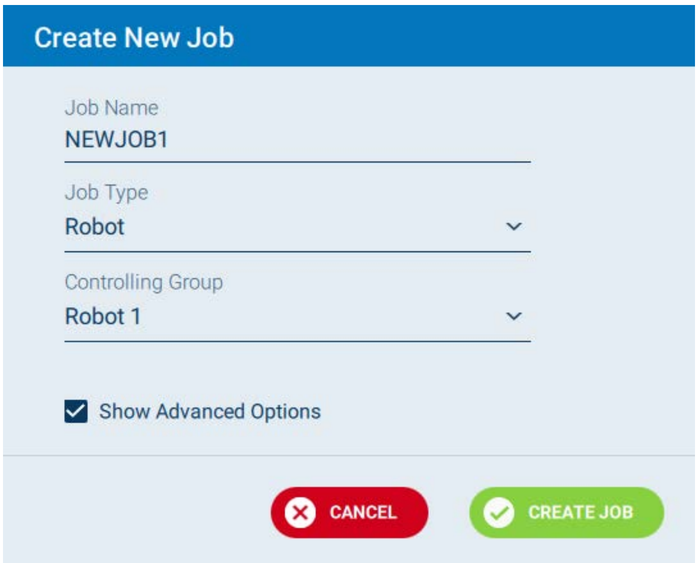
1. Check the Emergency Stop buttons to be sure they function properly.
2. Set the mode switch to "MANUAL (TEACH) Mode".
3. Create a job.

3.1.1 Create New Job

Follow the steps to create a new job:

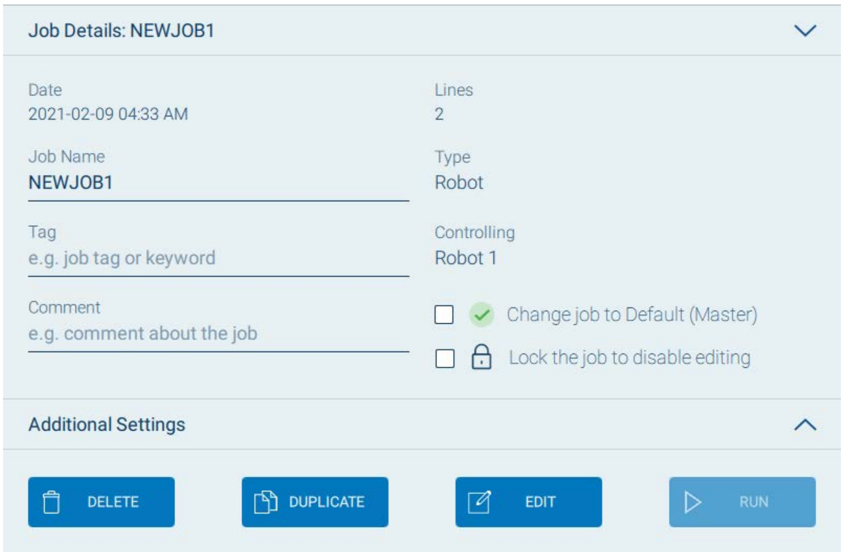
1. Set the mode switch to MANUAL {TEACH} mode.
2. Go to {Job List} under {MENU} or {JOBS} on the home screen.
3. Tap {+NEW JOB} at the top of the Job List screen.
   – A popup window appears allowing the job name to be entered.
   – The "Show Advanced Options" checkbox can be selected to display Job Type and Controlling options. The default values are "Robot" and "Robot 1". Changing the Job Type to "Concurrent" allows for running jobs in parallel tasks as per *chapter 4.10 "Parallel Tasks"*.

Fig. 3-1: Create New Job Screen



4. After entering a name, press {CREATE JOB}.
   – Automatically selects the job created (default name of job is “NEWJOB1”).
   – The job settings (e.g. Job Names, Comment, Tag) are editable from the Detail Panel at the bottom of the screen.

Fig. 3-2: Detail Panel Editable Screen



3.1.1.1 Setting the Job Name

The following rules apply to the job name:

– 1 to 32 alphanumeric characters can be used.

– Job names may be written with numerals only.

– Only upper-case letters can be used for alphabets.

– Symbols include: !, &, (,), ‘, - and _. Space cannot be used for a job name. Use an underscore (_) instead.

– Different types of characters can coexist within the same job name.

– If the job name is already used, an input error will occur.

<Examples>

001

JOB-1

WORK_A

3.1.1.2 Setting the Tag

The tag can be used to specify a group or category for a job. Sorting by tag can help see all jobs in a certain group/category. For example, if a job 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 1.13 "Character Input Operation"*.
2. Press {ENTER}.

3.1.1.3 Setting the Comment

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

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

– Symbols that are not grayed out can be used.

1. Insert a comment.
   For information on character input operation, refer to *chapter 1.13*.
2. Press {ENTER}.

To finish the setting, press the {Create Job}.

> NOTE
>
> Up to 10000 instructions can be registered per JOB.
> (Including "Start Job" and "End Job", line 1 to 10000).

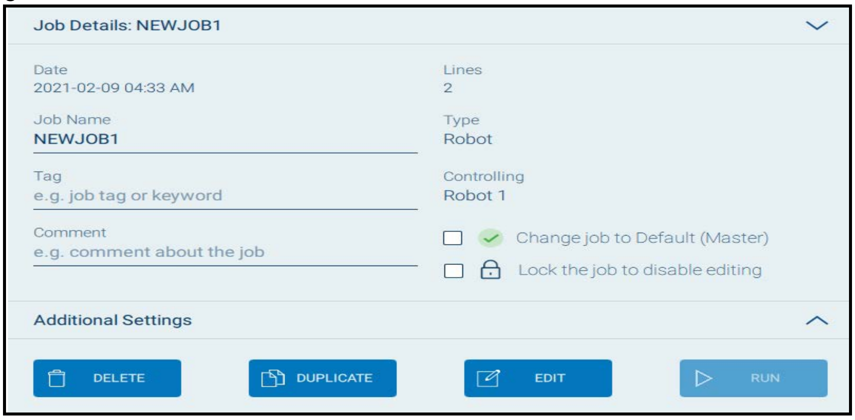
3.2 Job List

3.2.1 Default Job and Current Job

In the Job List, there are two specially designated jobs:

- **Default Job**
  The job designated as the default job can be opened and executed from external I/O signals. It is designated with a green “Check Mark” in the Attributes column and displays in bold font.
- **Current Job**
  The last job that was opened. It is a useful shortcut back to the most recent job the user was editing. It is designated with a “robot” icon in the Attributes column and displays in orange font.

Fig. 3-3: Default Job and Current Job



NOTE

- When creating a new job, the new job will become the current job.
- When duplicating a job, the newly created duplicate will become the current job.
- When deleting a current job, the default job will become the current job.

WARNING

- For the Human Collaborative manipulator (i.e. MOTOMAN-HC series), the job called “SYS_INT_AVOID_R1” is loaded as a default for the avoidance function. This job is used as an interrupt job. Do not change this job and its setting.

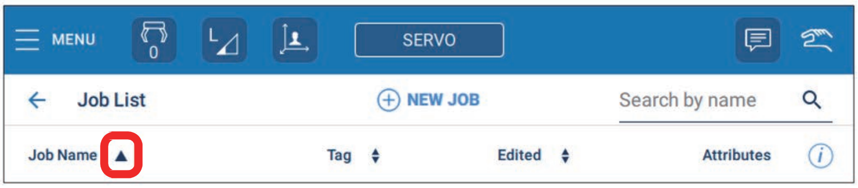
Failure to observe this precautions may result in death or serious injury from unexpected turning of the manipulator's arm.

3.2.2 Sorting Job

In the Job List, jobs can be sorted according to:

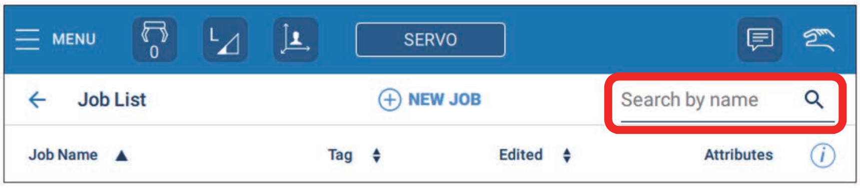
- Job Name
- Tag
- Edited date

To sort items, press the title of the item and the sorting order symbol will appear. Tap it again to flip the sorting order.



3.2.3 Searching Job

In the Job List, a job can be searched for using the search field. Type in the Job Name (or part of the Job Name) to search for it from the Job List.



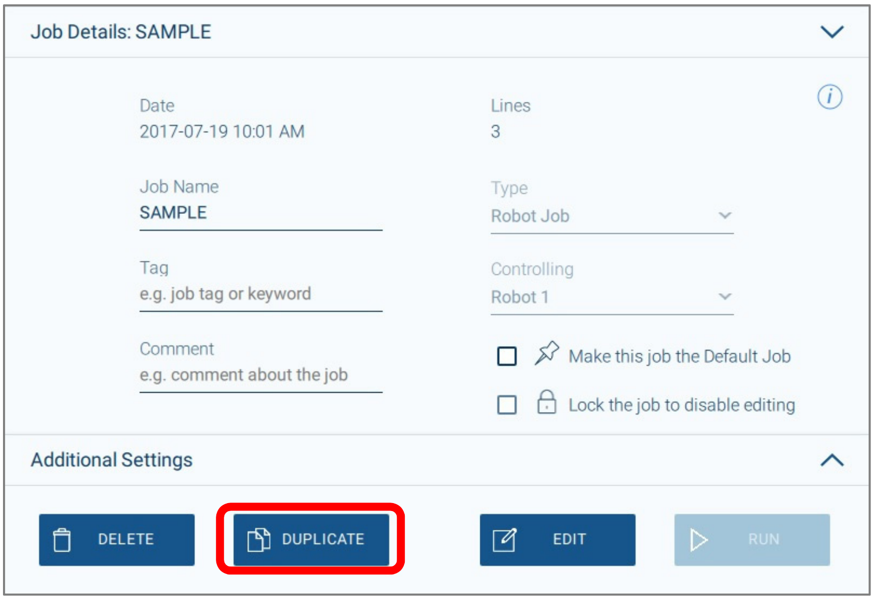
3.3 Copying Jobs

This operation is used to copy existing jobs, which are then used to create new jobs. It can be performed in the Job List.

On the Job List, select the job to be copied from the list.

1. Select {Job List} under {MENU}
   – The Job List appears.
2. Highlight the job to be copied.
3. Press {DUPLICATE} on the Job Details panel.
   – The duplicated job will be displayed on the Job List.
   – The job is named with "-COPY" at the end of the original job name.

Fig. 3-4: Copying Jobs



- There is a maximum of ten copies for the same job. If the limit has already been reached, duplication will fail, and show an error message.
- Job names have a 32 character limit. If the job name is longer than that, it will be shortened to 32 characters. If a job with that shortened name already exists, the duplication will fail and show an error message.

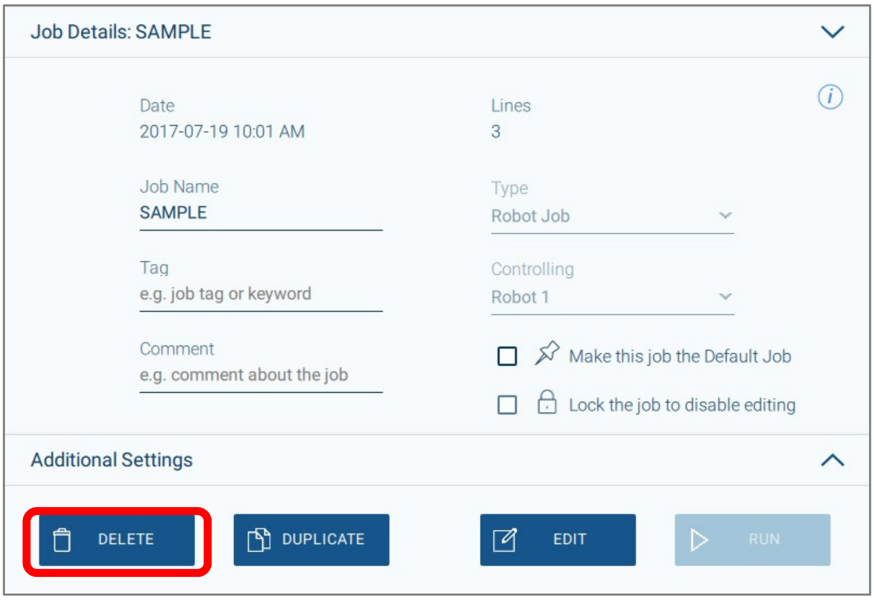
3.4 Deleting Jobs

This operation is used to delete jobs from the YRC Controller. It can be performed from the Job List.

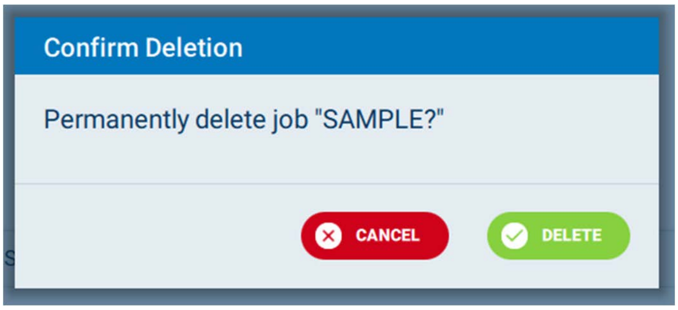
From the Job List, select the job to be deleted from the list of registered jobs.

1. Select {Job List} under {MENU}.
   – The Job List will appear.
2. Select the job from the list to delete it.
3. Press {DELETE} in the Job Details panel.
   – A confirmation pop-up window will appear.

Fig. 3-5: Deleting Jobs



4. Press {DELETE}.



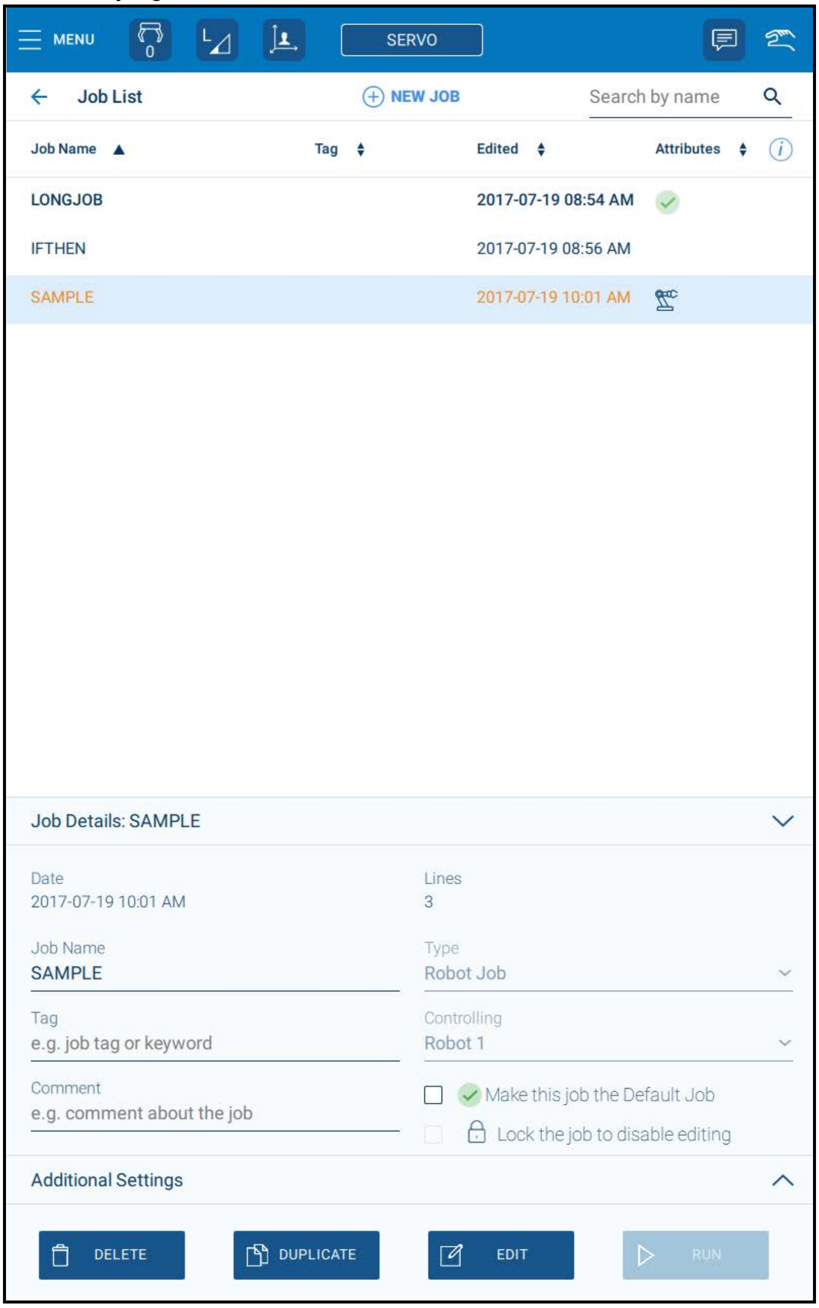
3.5 Modifying Job

This operation is performed to modify a job that has already been created. The operation is performed from the Job List.

From the Job List, select the job to be modified.

1. Select {Job List} under {MENU}.
   – The Job List will appear.
2. Select the job to modify.
   – The Job Details will appears as shown below.

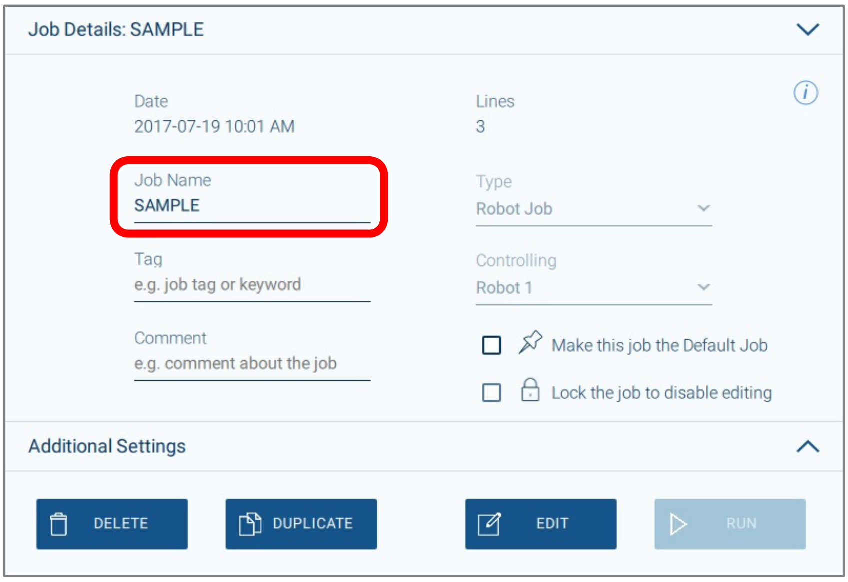
Fig. 3-6: Modifying Job



3.5.1 Modifying Job Names

1. Tap on the Job Name.

Fig. 3-7: Modifying Job Names



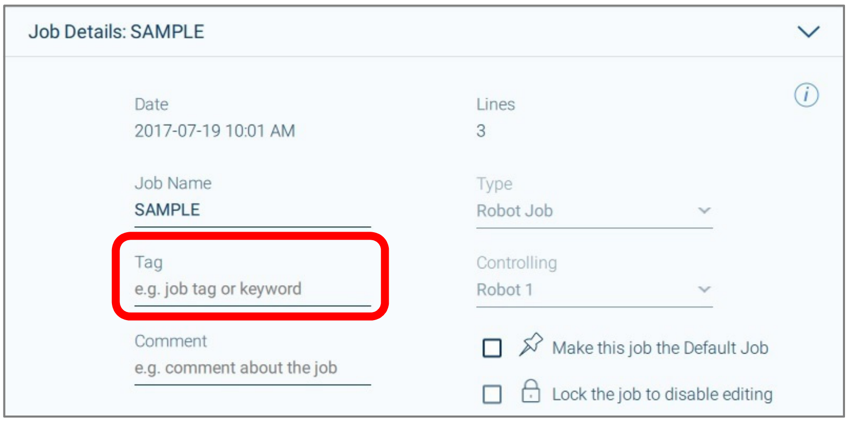
2. Edit using the alphanumeric keypad.
3. Press {Enter} on the keypad.

For detail on Job Names, refer to *chapter 3.1.1.1 “Setting the Job Name”*.

3.5.2 Modifying Tag

1. Tap on the Tag.

Fig. 3-8: Modifying Tag



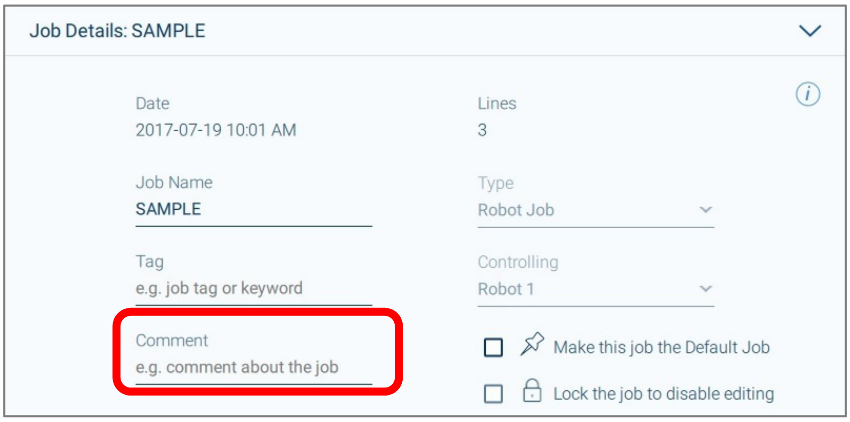
2. Edit using the alphanumeric keypad.
3. Press {Enter} on the keypad.

For details on Tag, refer to *chapter 3.1.1.2 “Setting the Tag”*.

3.5.3 Modifying Comment

1. Tap on the Comment

Fig. 3-9: Modifying Comment



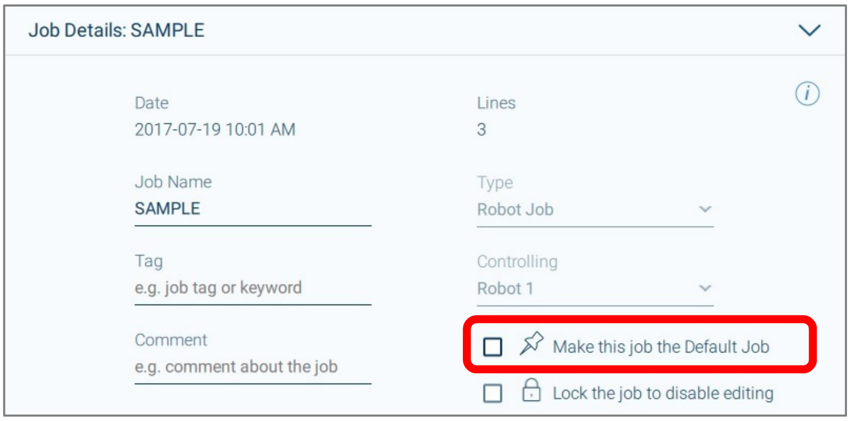
2. Edit using the entry popup.
3. Press {Enter} on the keypad.

For details on Comment, refer to *chapter 3.1.1.3 "Setting the Comment"*.

3.5.4 Setting Default Job

The Default Job is a job specially designated so that can be triggered by an external I/O signal. There can only be one Default Job per YRC Controller. The Default Job cannot be deleted. However, another job can be set as the new Default Job.

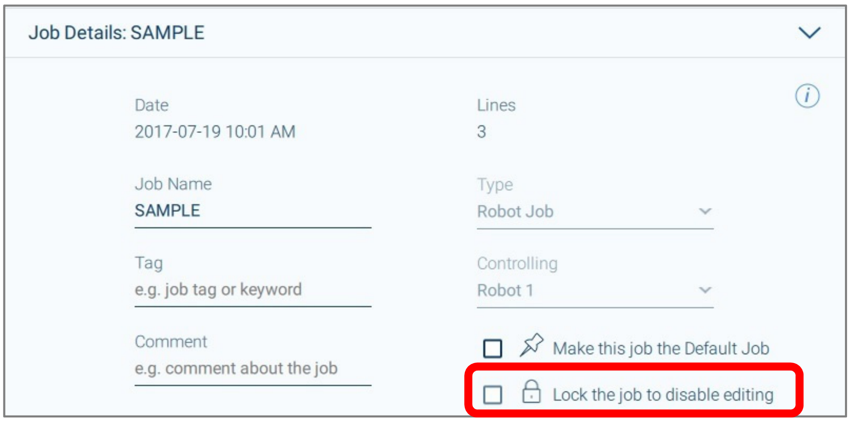
Fig. 3-10: Setting Default Job



3.5.5 Setting Edit Lock

The Edit Lock function is used to prevent accidental editing of the Job Contents or its name, tag or comments. Attempting to edit a job when “Lock the Job” is checked will result in a notice asking to unlock the Job. The Edit Lock function can be used in Management Level or higher.

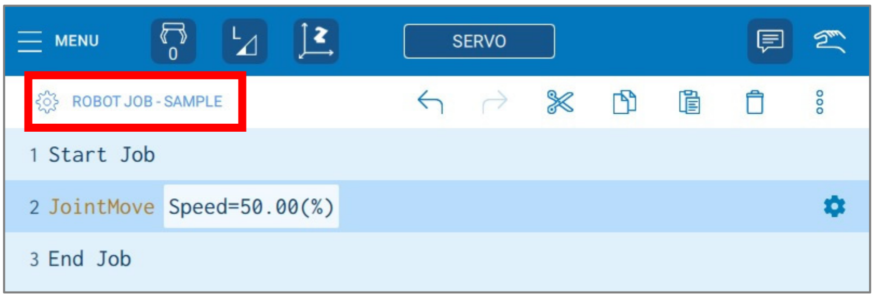
Fig. 3-11: Setting Edit Lock



3.5.6 Accessing Job Details

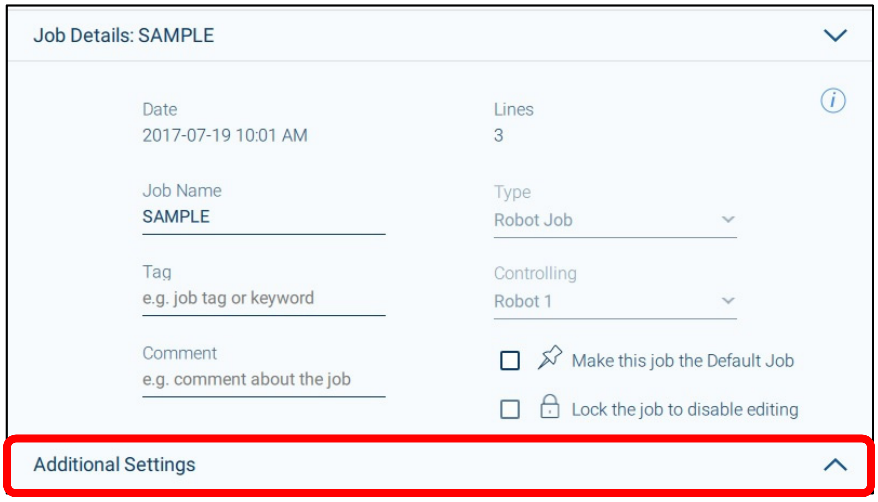
Job Detail panel and Additional Settings panel (refer to *chapter 3.6 “Additional Settings”*) can also be accessed from the Job Contents view. Press {ROBOT JOB} on the Job Contents view to open the Job Detail panel and Additional Settings panel for the Current Job.

Fig. 3-12: Job Contents View



3.6 Additional Settings

The Additional Settings can be accessed from Job Details panel. Refer to *chapter 4.8 “Local Variables”* and *chapter 4.9 “Teaching Coordinate”* for more information.



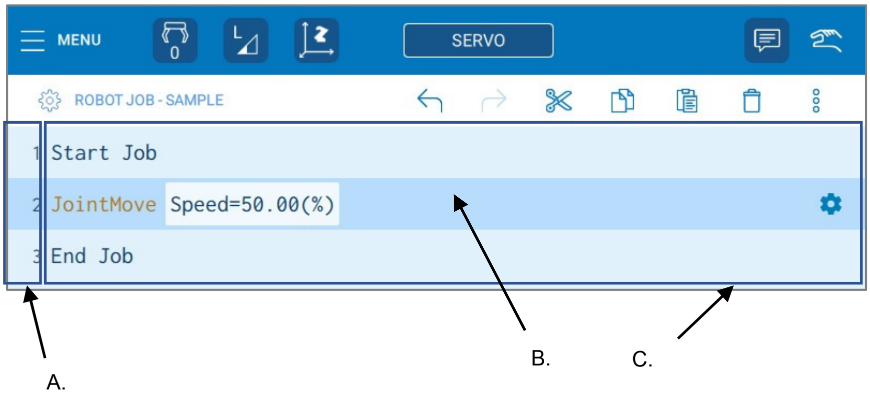
4 Teaching

4.1 Teaching Operation

4.1.1 Job Contents View

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

Fig. 4-1: Job Contents View



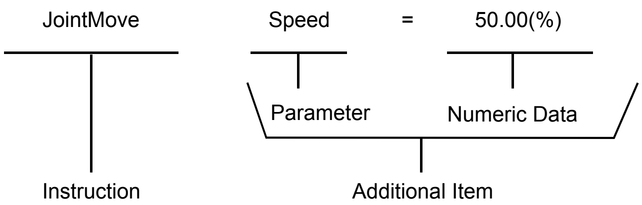
A. Line Numbers

The number of the job line is automatically displayed. Line numbers are automatically updated, if lines are inserted or deleted.

B. Cursor

The cursor for manipulator control. For test operation, the manipulator motion starts from this cursor point.

C. Instructions, Additional Items, Comments, Etc.



Instructions: These are the 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.

Additional items: Speed and time are set depending on the type of instruction. When required, numerical or character data is added to the condition-setting tags. For a full list of supported instructions and parameters, refer to YRC1000/YRC1000micro SUPPLEMENTAL INSTRUCTIONS FOR Smart Pendant (INSTRUCTIONS FOR INFORM LANGUAGE) (HW1485511).

4.1.2 Jogging the Robot for Teaching

Before teaching and recording a Robot motion in the INFORM job, 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 *chapter 2.4 "Coordinate Frames and Manipulator Jogging"*.

4.1.3 Motion Type (Interpolation Type)

Interpolation type determines the path along which the manipulator moves between playback steps. **Play speed** is the rate at which the manipulator moves.

Normally, the **position data, interpolation type** and **play speed** are registered together for a Robot motion step.

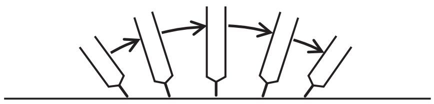
4.1.3.1 Joint Interpolation

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 instruction is JointMove. Use joint interpolation to teach the first step. This will avoid unintentional motion errors in the singularity posture at the beginning of the motion.

Play Speeds are indicated as percentages of the maximum rate of joint speed.

4.1.3.2 Linear Interpolation

When the manipulator TCP moves in a straight line path from one taught step to the next, it is described as linear interpolation. When linear interpolation is used to teach a Robot motion, the instruction to use is LinearMove. The manipulator will move automatically while changing the wrist position as shown in the figure below.



Play Speeds are indicated as mm/sec of the TCP speed. The maximum TCP speed is manipulator dependent.

4.1.3.3 Circular Interpolation

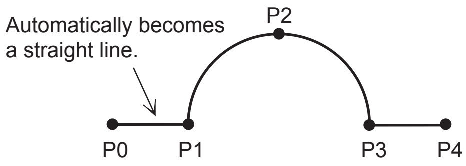
When the manipulator TCP moves in an arc that passes through three points, the movement is described as a circular interpolation. When circular interpolation is used for teaching a Robot motion, the instruction to use is CircleMove.

Play Speeds are indicated as mm/sec of the TCP speed. The maximum TCP speed is manipulator dependent.

Single Circular Arc

When a single circular movement is required, teach the circular interpolation for three points, P1 to P3, as shown in the following figure. If joint or linear interpolation is taught at P0, the point before starting the circular operation, the manipulator will move from P0 to P1 in a straight line.

Table 4-1: Interpolation Type for Single Circular Arc

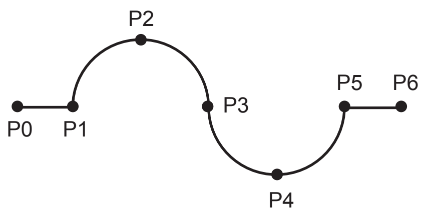


Point	Interpolation Type	Instruction
P0	Joint or Linear	JointMove LinearMove
P1 P2 P3	Circular	CircleMove
P4	Joint or Linear	JointMove LinearMove

Continuous Circular Arcs

When two or more successive circular movements with different curvatures are required, the movements can be continuously performed by adding an “FPT (Final Point)” tag to the step whose curvature needs to be changed.

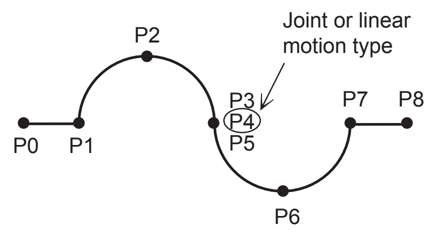
Table 4-2: Interpolation Type for Continuous Circular Arcs



Point	Interpolation Type	Instruction
P0	Joint or Linear	JointMove LinearMove
P1 P2	Circular	CircleMove
P3	Circular	CircleMove FPT
P4 P5	Circular	CircleMove
P6	Joint or Linear	JointMove LinearMove

If not adding a “FPT” tag, successive circular movements must be separated from each other. Do this by adding joint or linear interpolation step (P4) at a connecting point of the preceding movement and the following movement. However, when steps at the same connecting point are taught, movements cannot be continuously performed. For more information on the “FPT” tag, refer to YRC1000/YRC1000micro SUPPLEMENTAL INSTRUCTIONS FOR Smart Pendant (INSTRUCTIONS FOR INFORM LANGUAGE) (HW1485511).

Table 4-3: Interpolation Type for Continuous Circle Curve



Point	Interpolation Type	Instruction
P0	Joint or Linear	JointMove LinearMove
P1 P2 P3	Circular	CircleMove
P4	Joint or Linear	JointMove LinearMove
P5 P6 P7	Circular	CircleMove
P8	Joint or Linear	JointMove LinearMove

<Play Speed>

- The play speed set display is identical to that for the linear interpolation.
- The speed taught at P2 is applied from P1 to P2. The speed taught at P3 is applied from P2 to P3.
- If a circular operation is taught at high speed, the actual arc path will have a shorter radius than that taught.

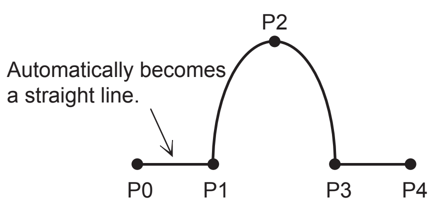
4.1.3.4 Spline Interpolation

When performing operations such as welding, cutting, and applying primer, using the spline interpolation simplifies the teaching process for workpieces with irregular shapes. The path of motion is a parabola passing through three points. When spline interpolation is used for teaching a robot motion, the instruction to use is SplineMove.

■ **Single Spline Curve**

When a single spline curve movement is required, teach the spline interpolation for three points, P1 to P3, as shown in the figure below. If joint or linear interpolation is taught at point P0, the point before starting the spline interpolation, the manipulator moves from P0 to P1 in a straight line.

Table 4-4: Interpolation Type for Single Spline Curve

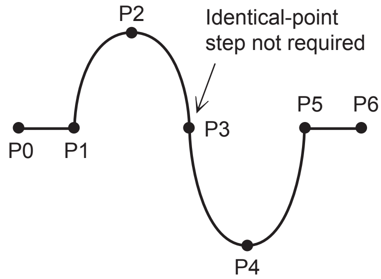


Point	Interpolation Type	Instruction
P0	Joint or Linear	JointMove LinearMove
P1 P2 P3	Spline	SplineMove
P4	Joint or Linear	JointMove LinearMove

■ Continuous Spline Curves

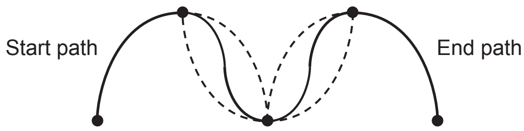
This describes a manipulator moving through a path created by combining parabolic curves. This differs from circular interpolation in that steps at an identical point or an FPT tag are not required at the connecting point between two spline curves.

Table 4-5: Interpolation Type for Continuous Spline Curves



Point	Interpolation Type	Instruction
P0	Joint or Linear	JointMove LinearMove
P1 to P5	Spline	SplineMove
P6	Joint or Linear	JointMove LinearMove

When the parabolas overlap, a composite motion path is created.



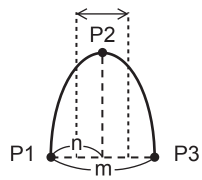
Play Speed

– The play speed setting window is identical to that for linear interpolation.

– As with circular interpolation, the speed taught at P2 is applied from P1 to P2, and the speed taught at P3 is applied from P2 to P3.

NOTE

Teach points so that the distances between the three points are roughly equal. If there is any significant difference, an error will occur on playback and the manipulator may operate in an unexpected, dangerous manner. Ensure that the ratio of distances between steps m:n is within the range of 0.25 to 0.75.



4.1.4 Teaching Steps

There are two basic teaching steps for the manipulator: move or stop. The following sections describe the method of how to teach Motion Instruction and Timer in the job.

4.1.4.1 Teaching Motion Instructions

Whenever one step is taught, a motion instruction is inserted. Steps can be taught in sequence as shown in *fig. 4-2 “Registering Motion Instruction”*. Steps can also be inserted between already registered steps, as shown in the right *fig. 4-3 “Inserting Motion Instructions”*

Fig. 4-2: Registering Motion Instruction

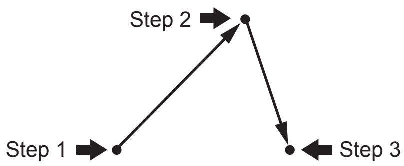
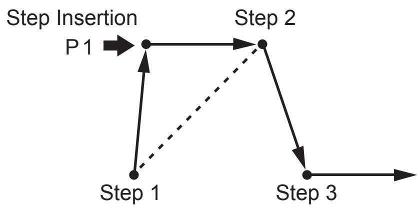
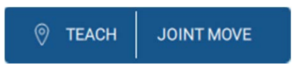


Fig. 4-3: Inserting Motion Instructions



1. Before jogging the Robot, select the desired Jogging Mode for easier movement. Refer to *chapter 4.1.3 “Motion Type (Interpolation Type)”* for details.
2. Use the jogging buttons on the touch screen or membrane keys to move the manipulator to the desired position.
3. Select the Inserting Line, Tool Number and Interpolation Type.
4. Hold the Enable Switch ON with Servo ON, and press {+ TEACH} to register. If long press {+ TEACH}, teaches the current position with Position Level = 0. This means that the manipulator will stop at this position.

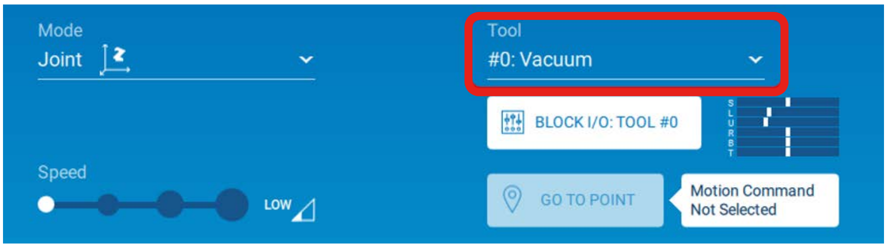


■ **Selecting the Inserting Line**

1. Select {Current Job} under {MENU}.
   – The contents of the currently-selected job are displayed.
2. Move the cursor to a line immediately before the position where a motion instruction is to be registered.
3. Grip the Enable switch to turn the servo power ON.
4. Move the manipulator to the desired position using {Jog Keys}.

■ Selecting the Tool Number

1. Before teaching the position, press the {Tool} text. Tool setting needs to be completed in advance. For tool setting instruction, refer to *chapter 6.1 “Tool Settings”*.



2. Select the Active Tool from the list and press {Select}.

■ Setting the Interpolation Type

1. Press {JOINT MOVE} next to the {+ TEACH} to change the interpolation type. The order will be shown as:

    1. Joint Move
    2. Linear Move
    3. Circle Move
    4. Spline Move

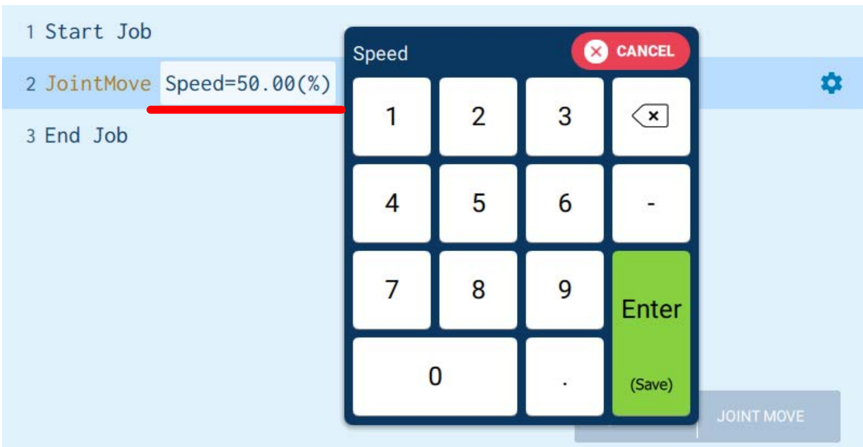
Each time the interpolation type button is pressed, the interpolation type switches in this order. If pressed again after it reaches Spline Move, it will return to the Joint Move.

■ Setting the Play Speed

The speed of the manipulator can be changed using the motion instruction.

1. Press {Speed}.

    – A numeric keypad appears.



2. Insert the desired speed and press {SAVE}.
   – If an entered value is outside the allowable range, the input value will be replaced to with the nearest value within the allowable range.
3. The speed is now registered.

4.1.4.2 Setting Timer Instruction

The timer instruction function stops the manipulator for a specified length of time.

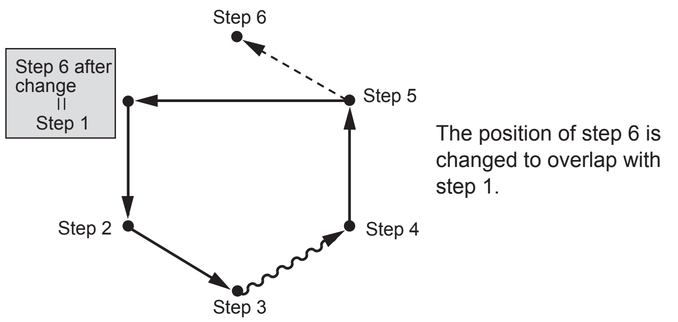
Follow these steps to register time instructions.

1. Select {Current Job} under {MENU}.
2. Move the cursor to the line before the position where the timer instruction is to be inserted.
3. Open the {COMMANDS} tab from the Navigation Bar.
4. Select the {Timer} under the {Control} Tab.
   – The timer instruction is now inserted to the line.
5. Change the timer value by pressing the highlighted time value.
   – The numeric keypad will appear.
6. Input the desired values and press {SAVE}.
   – The timer instruction is now registered.

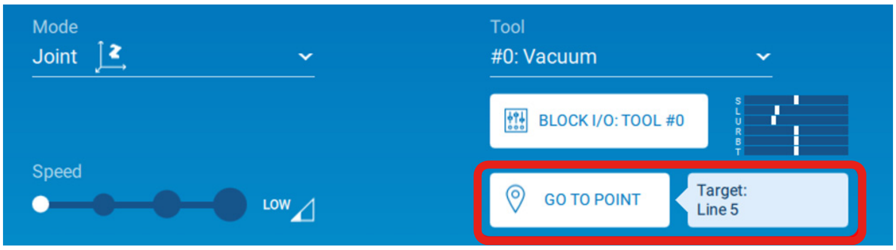
4.1.5 Overlapping: The First and Last Steps

Why is overlapping the first and last step necessary?

Assume that the job shown below is to be repeated. The manipulator moves from the last step (Step 6) to the first step (Step 1). If Step 6 and Step1 are the same position, the manipulator will move directly from Step 5 to Step 1, improving work efficiency.

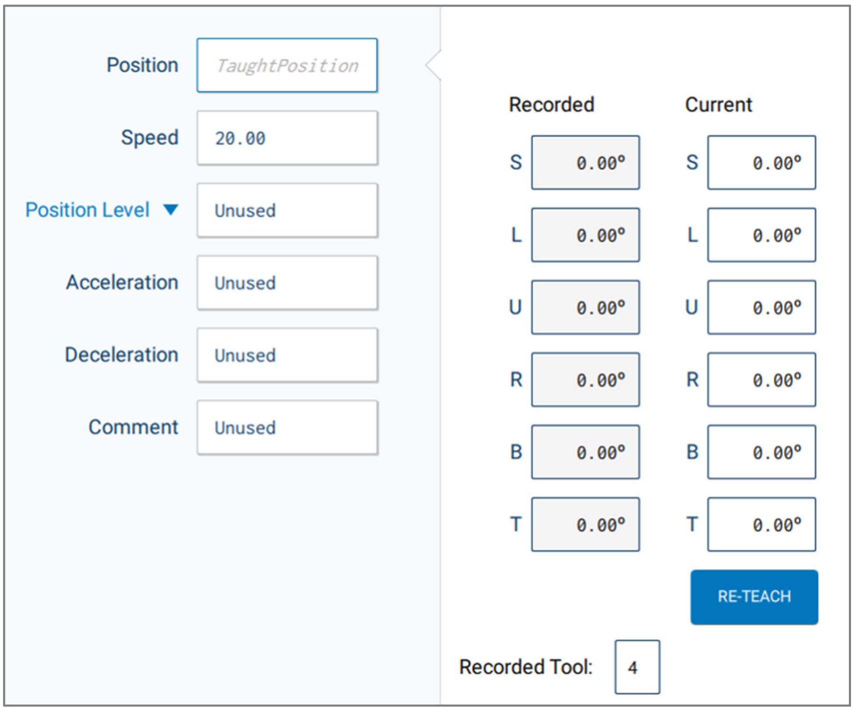


1. Move the cursor to the first step line.
2. Hold {GO TO POINT} until the manipulator reaches the first step position.



3. Move the cursor to the last step line.
4. Open the detail edit of the last step line, using the method described in *chapter 4.4.3 “Editing Commands”.*
5. Check that the {Position} is selected to the left.
   – Recorded position and current position are shown on the right.

6. Press {RE-TEACH}
   - The position data for the first step is registered on the last step.
   - This changes the position data in the last step ONLY. Interpolation type and play speed will not change.



4.2 Checking a Step

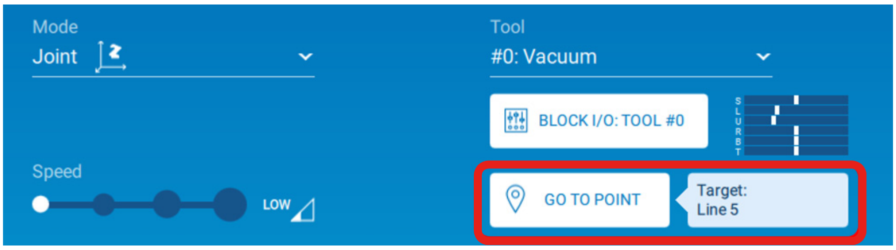
4.2.1 GO TO POINT Operation

To check the position of a taught reference point, move the manipulator to the reference point with the {GO TO POINT}.

CAUTION

- For safety, set jogging speed at Mid or below. Refer to *chapter 2.2.4 “Select Jogging Speed”* for setting the jogging speed.

1. Move the cursor to the step to be checked.
2. Hold {GO TO POINT} until it reaches the position.



3. When the manipulator reaches the target position, the box on the right will turn green and the manipulator will stop.

NOTE

For checking a whole job, refer to *chapter 4.3 “Test Job”*.

4.2.2 Circular Movements with the GO TO POINT Operation

– The manipulator will move in a straight line for the steps of the circular interpolation.

– To check the trajectory of the circular movement, use the test operation described in *chapter 4.3*.

4.2.3 Spline Curve Movements with the GO TO POINT Operation

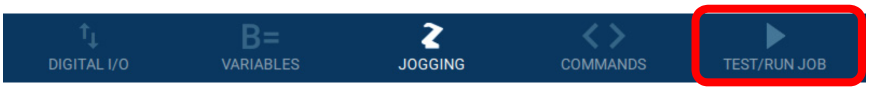
– The manipulator will move in a straight line for the steps of spline interpolation.

– To check the trajectory of the spline curve movement, use the test operation described in *chapter 4.3*.

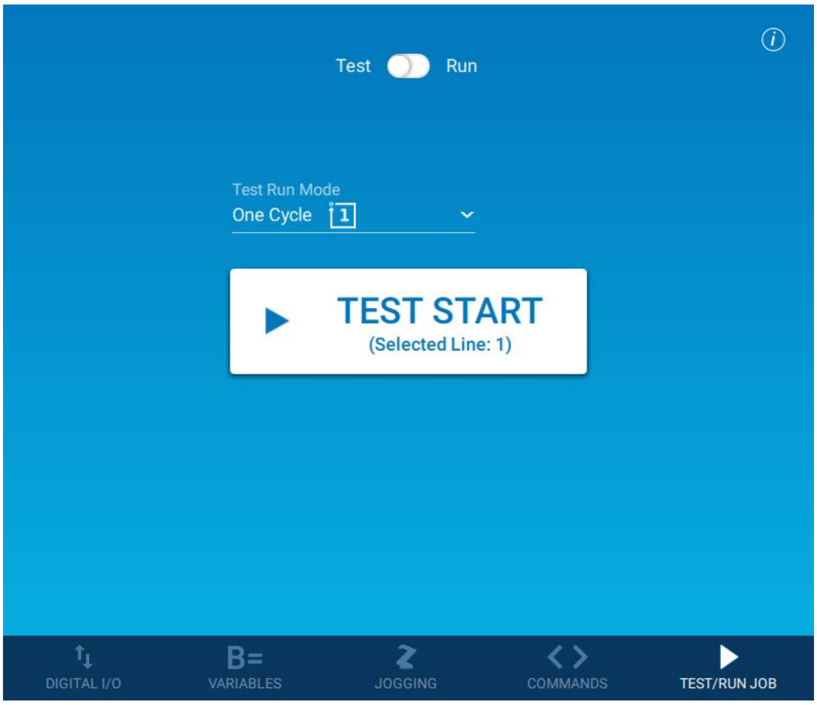
4.3 Test Job

Playback operations can be tested and verified in MANUAL (TEACH) mode.

1. Place operations in MANUAL (TEACH) mode.
2. Open the job from the {Job List} under {MENU}.
3. Go to {TEST/RUN JOB} from the Navigation Bar.



.

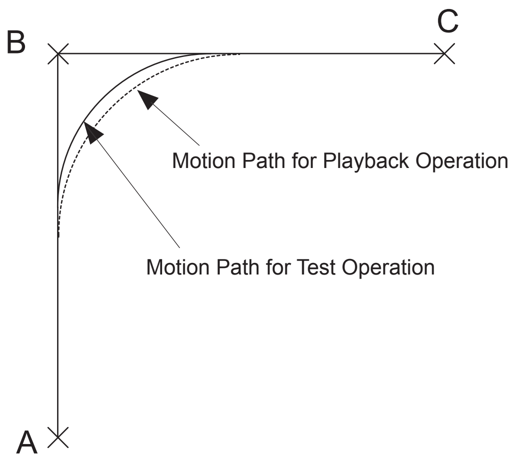


4.3.1 Test Start

Test Start simulates playback operation in MANUAL (TEACH) mode. This function is convenient for verifying operation instructions and motions, helping to achieve continuous paths. Test operation differs in the following ways from actual playback in the AUTOMATIC (PLAY) mode:

- Operation speeds greater than the maximum teaching speed (default setting: 250 mm/sec) are reduced to the maximum teaching speed by default.
- There may be a slight difference between the motion path for the test operation and the motion path for playback operation due to a mechanical error or control delay, etc.

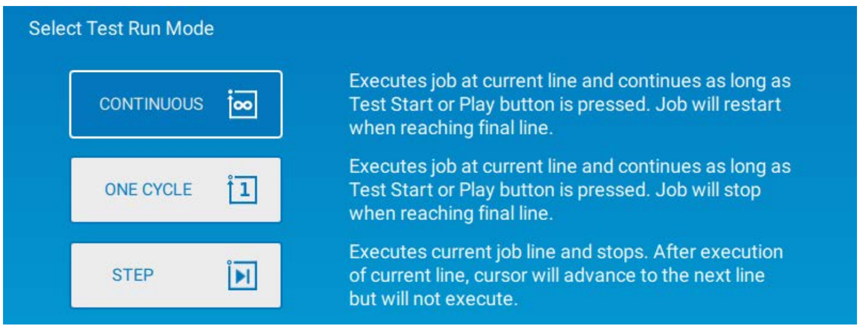
Fig. 4-4: Motion Path for Test Operation



Make sure that there are no obstacles around the manipulator.

1. Tap the {TEST/RUN JOB} icon on the Navigation Bar.

2. Turn Servo Power ON for the Robot.
3. Select the Test Run Mode by tapping the Test Run Mode Drop Down. Valid options are:



4. Press and hold {TEST START}.
   - The speed of the motion will be limited to 250 mm/sec.
   - Job execution will start from the selected line.

NOTE

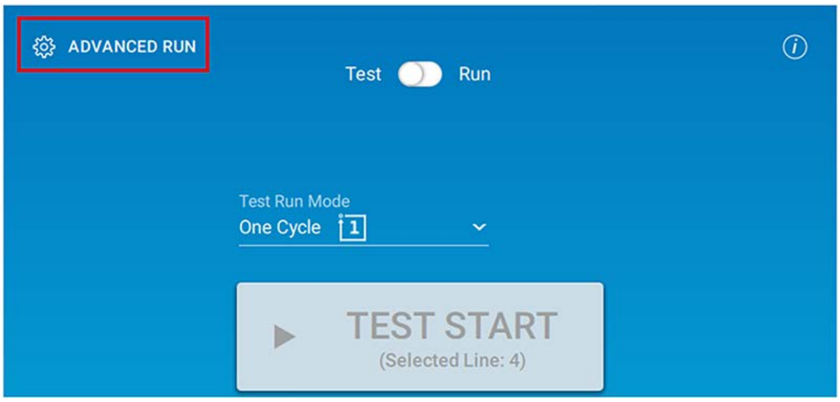
To run the job in full speed, switch to the AUTOMATIC (PLAY) position and press the {RUN}.

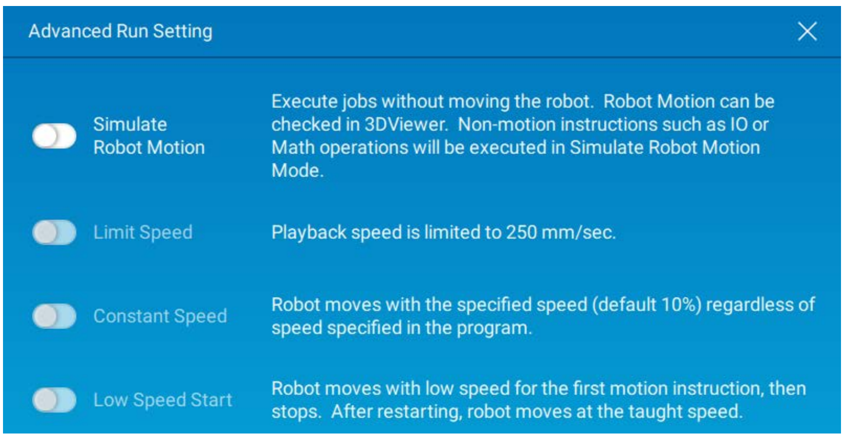
4.3.2 Simulate Robot Motion

Simulate robot motion can perform test run, jog operation, and go to point without moving the robot. This provides the benefit of checking robot motion using 3D simulation without moving the robot. While simulating robot motion, non-motion instructions such as IO or Math operations will be executed.

For using the 3D Viewer, go to *chapter 9.1 “3D Viewer”*

To use simulate robot motion, open {Advanced Run} setting and enable simulate robot motion.





SUPPLE-MENT

- The setting of “Simulate Robot Motion” is maintained even after the mode is switched: that is set to enabled in the Manual (Teach) mode, it will stay enabled after switching to Automatic (Play) mode.
  The same applies when the mode is switched from the Automatic (Play) mode to Manual (Teach) mode.
- The Simulate Robot Motion becomes disabled after controller is restarted.

4.4 Commands (INFORM)

The Smart Pendant User Interface supports a majority of Inform commands available on a YRC controller. See *table 4-7* for an overview of the commands supported with the Smart Pendant.

Fig. 4-5: Inform Example in Smart View

```
If ((B000>=5 Or D000≠-50) And Input#(1)=ON) Then
    JointMove  Speed= 50.00 (%)
    Add  B001  5
    DigitalOut  Output#( 7 )  Off
EndIf
```

A robot job with any combination of Inform commands can be loaded and executed on the Smart Pendant. Inform commands and parameters that do not have edit support in the UI will appear in italics. These commands can be edited using Classic Interface or deleted/suppressed from the Smart Pendant UI.

Fig. 4-6: Inform Commands and Parameters that Do Not Have Edit Support

```
LATESTJOB
DIALOG B000 DIALSB B001 B002 S000 B003 B004 S001
```

For more detail on Inform commands, refer to the following manuals:

- YRC1000/YRC1000micro Supplemental Instructions for Smart Pendant (Inform Language HW1485511)
  - Describes the parameter sets supported by commands added in early versions of Smart Pendant
- YRC1000/YRC1000micro INFORM Instructions
  - Describes full range of parameter sets supported by Smart Pendant + Classic Interface
- YRC1000/YRC1000micro General Operator's
  - Describes controller specific commands (e.g. high accuracy functions)
- YRC1000/YRC1000micro Collaborative Operation Instructions
  - Describes commands specific to HC-robots (e.g. Smooth)
- YRC1000/YRC1000micro Application-Specific
  - Describes commands specific to supported applications (e.g. Arc Welding)

4.4.1 Inform Command Overview

Inform commands can be accessed by pressing {COMMANDS} on the Navigation Bar to display the Command List panel with categorized tabs.

Select a category to display its list of available commands.

Inform commands are currently organized into seven categories:

Table 4-6: Inform Commands Categories

Display	Content	Example
Favorites	Frequently used commands selected and organized by the operator	User-defined
General	Enable/disable functions, add descriptive text	Comment, SetShockDetection, ResetShockDetection
Motion	Command robot motion	JointMove, LinearMove
I/O	Read controller Inputs and set controller Outputs	DigitalIn, PulseOut
Math	Numeric or string operations, retrieve or set elements	Add, Set, ValueToString
Control	Manage the processing and operationof INFORM jobs	Jump, Timer, StartParallelJob
Application	Commands specific to a particular application (Handling, Arc Welding, etc.)	WeavingOn, ArcWeldingOn
Macro[1)]	Predefined job for a specific reusable purpose	*Macro name*

1) The macro option must be enabled on the YRC Controller to display the “Macro” tab in the Commands List.

The Inform commands supported in the Smart Pendant are shown in *table 4-7*. Command names are shown both in “Smart View” and “Classic View. See *chapter 4.5.3.1* for more information on Classic View)

Table 4-7: Supported Commands

	Smart View	Classic View
General	Comment	COMMENT INST
	SetShockDetection	SHCKSET
	ResetShockDetection	SHCKRST
	AdvInit	ADVINIT
	AdvStop	ADVSTOP
	SkillSend	SKILLSND
	EnableAvoidance	EI LEVEL=1
	DisableAvoidance	DI LEVEL=1
Motion	JointMove	MOVJ
	LinearMove	MOVL
	CircleMove	MOVC
	SplineMove	MOVS
	Incremental	IMOV
	SetSpeed	SPEED
	ShiftOn	SFTON
	ShiftOff	SFTOF
	ShiftOn3D	SFTON3D
	ShiftOff3D	SFTOF3D
	MakeShift	MSHIFT
	HighAccuracyPathOn	HTRAJON
	HighAccuracyPathOff	HTRAJOF
	SpeedPriorityOn	HPVELON
	SpeedPriorityOff	HPVELOF
	MultiMoveOn	HPMMVON
	MultiMoveOff	HPMMVOF
	Smooth	SMOOTH
I/O	DigitalOut	DOUT
	DigitalIn	DIN
	PulseOut	PULSE
	Wait	WAIT
	AnalogOut	AOUT
	AOutRatioOfSpeedOn	ARATION
	AOutRatioOfSpeedOff	ARATIOF

	Smart View	Classic View
Math	Set	SET
	Increment	INC
	Decrement	DEC
	Add	ADD
	Subtract	SUB
	Multiply	MUL
	Divide	DIV
	Clear	CLEAR
	Convert	CNVRT
	And	AND
	Or	OR
	Not	NOT
	Xor	XOR
	SetElement	SETE
	GetElement	GETE
	GetSystemVar	GETS
	SquareRoot	SQRT
	Sine	SIN
	Cosine	COS
	ArcTanget	ATAN
	MultiplyMatrix	MULMAT
	Invert Matrix	INVMAT
	GetPosition	GETPOS
	MakeFrame	MFRAME
	StringToValue	VAL
	ValueToString	VAL2STR
	CharToInt	ASC
	IntToChar	CHR$
	SubString	MID$
	StringLength	LEN
	ConcatenateString	CAT$
	SearchString	STRSTR
	SetRegister	SETREG
	GetRegister	GETREG

	Smart View	Classic View
Control	Label	LABEL
	Jump	JUMP
	IfThen	IFTHEN
	ElseIf	ELSEIF
	Else	ELSE
	While	WHILE
	For	FOR
	Call	CALL
	GetArgument	GETARG
	Return	RET
	Timer	TIMER
	Pause	PAUSE
	Abort	ABORT
	SetUserAlarm	SETUALM
	Message	MSG
	Switch	SWITCH
	Case	CASE
	Default	DEFAULT
	StartParallelJob	PSTART
	WaitForParallelJob	PWAIT
	ThreadSync	TSYNC
Application	ArcWeldingOn	ARCON
	ArcWeldingOff	ARCOF
	WeldVoltage	VWELD
	WeldCurrent	AWELD
	SetWeldingCondition	ARCSET
	WeavingOn	WVON
	WeavingOff	WVOF
	SetpointAdjustFromStart	ARCCTS

4.4.2 Inserting Commands

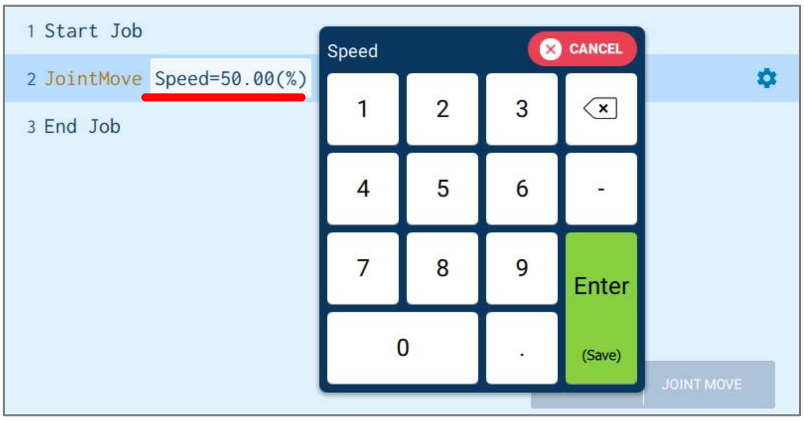
1. In MANUAL (TEACH) mode, move the cursor to the line immediately before where the command is to be inserted in the Job Contents view.
2. Press {COMMANDS}.
3. Select the command group from the Tab Bar.
   – The command list of the selected command group will appear.
4. Select the command.
   – Press the checkbox of “Show Advanced Commands” for further command options.
5. Change additional items or variables as required.
   – When nothing is to be changed, the process is complete.
   – When additional items are to be edited, refer to *chapter 4.4.3 “Editing Commands”*.

4.4.3 Editing Commands

Move the cursor to the command to be edited, in the MANUAL (TEACH) mode.

(1) Changing numeric data

I) Select the highlighted item on the instruction.



II) Input the value using the numeric keypad.

III) Press {SAVE} to register the edit.

(2) Adding, modifying, or deleting an additional item
Press Detail Edit icon on the right side of the Job Contents view.

Detail Edit panel appears.

I) To add an additional item, press “UNUSED”. Input the desired value for the item. Press {SAVE ALL}.

II) To modify an additional item, press the existing item. Input the desired value for the item. Press {SAVE ALL}.

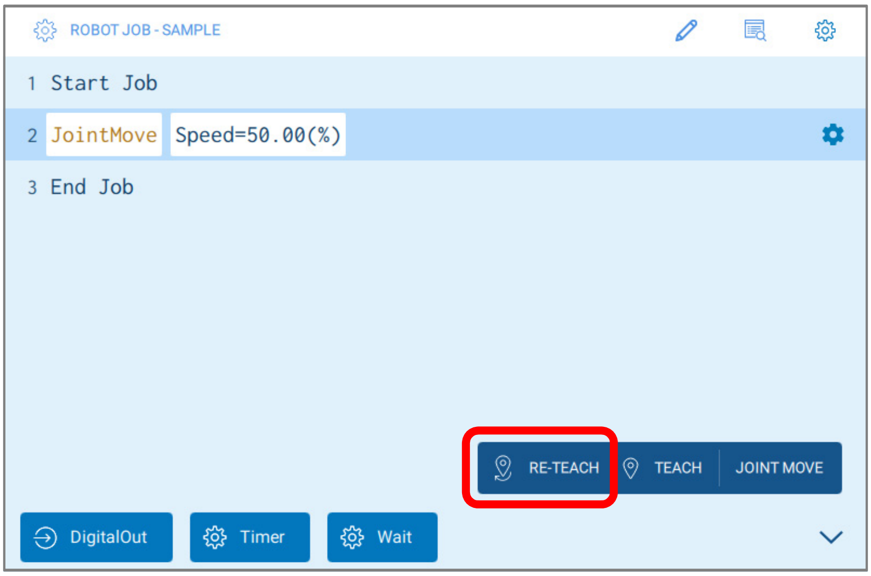
III) To delete an additional item, press the existing item and cross will appear on the right. Press the {X} and it will change to “UNUSED”. Press {SAVE ALL}.

The Detail Edit panel appears and shows each editable item. Items for motion command are shown as an example.

Modifying Position

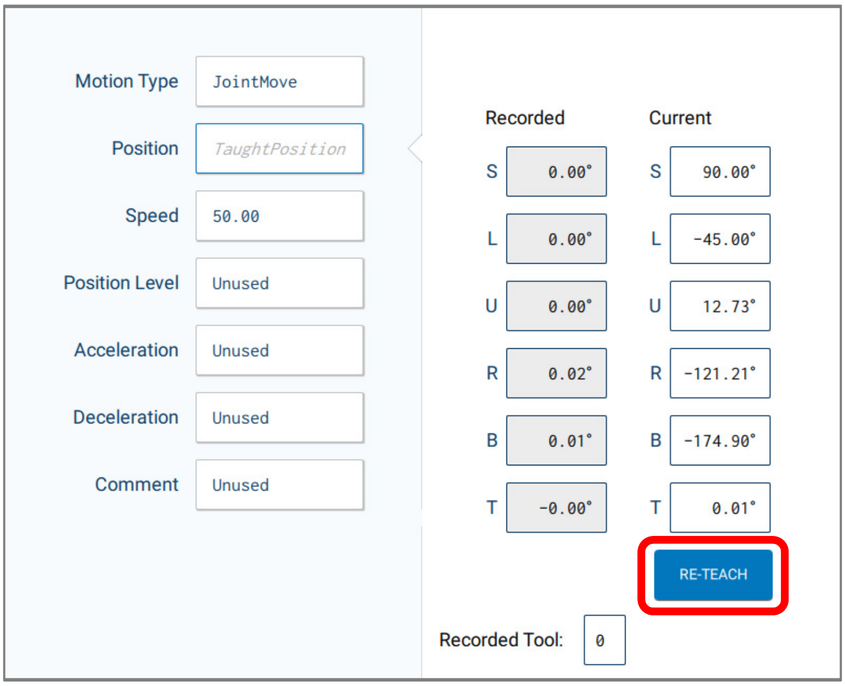
There are two methods for modifying (i.e. re-teaching) a position.

(1) Modifying from Job Contents View
The {RE-TEACH} inside the Job Contents View is visible when selecting a motion instruction. When pressing this button, the selected line blinks indicating the position is re-taught.



(2) Modifying from Detail Edit Panel

1. Jog the Robot to the new position and open the Detail Edit panel.
2. Select the Position.
3. Press {RE-TEACH} to modify the position.
   – After re-teaching, "Recorded" and "Current" positions should match.



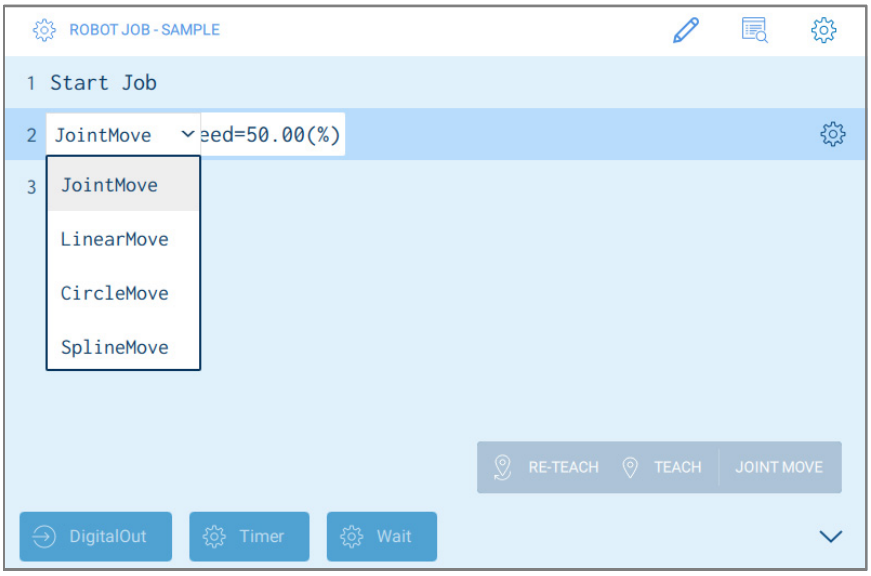
NOTE
The tool number is seen in the box. The tool number cannot be edited, because the TCP may change when changing the tool. To change the tool number teach a new step.

Modifying Motion Type

A motion instruction can be changed between all types (JointMove, LinearMove, CircleMove, SplineMove) from the Job Contents view or from the Detail Edit panel.

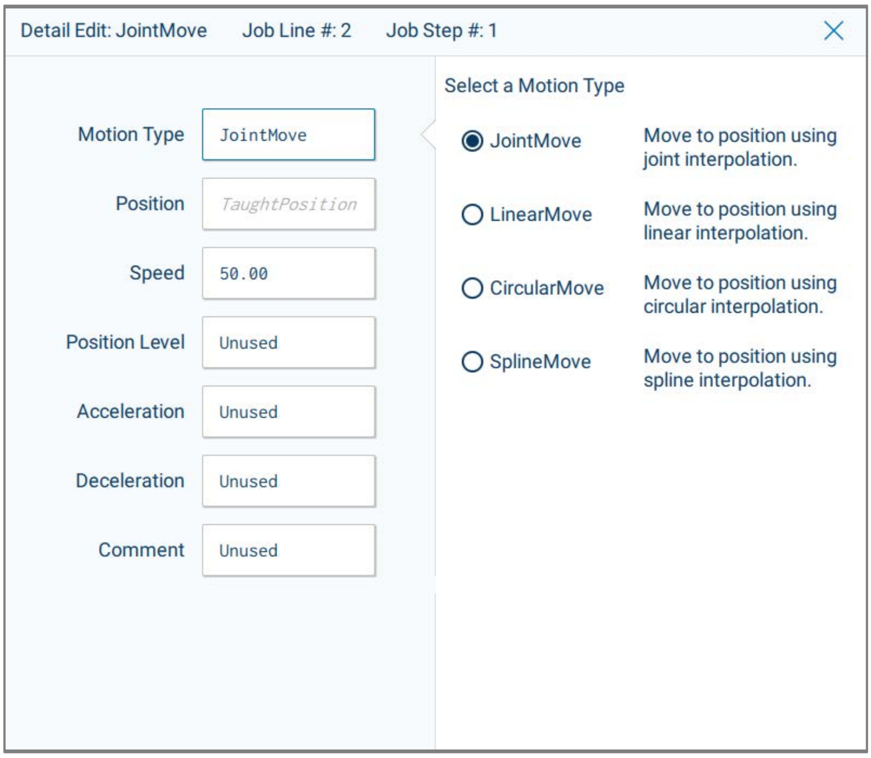
(1) Modifying from Job Contents View

1. Select the desired line
2. Press the motion instruction
   – A drop-down list will appear
3. Select the new motion type



(2) Modifying from Detail Edit Panel

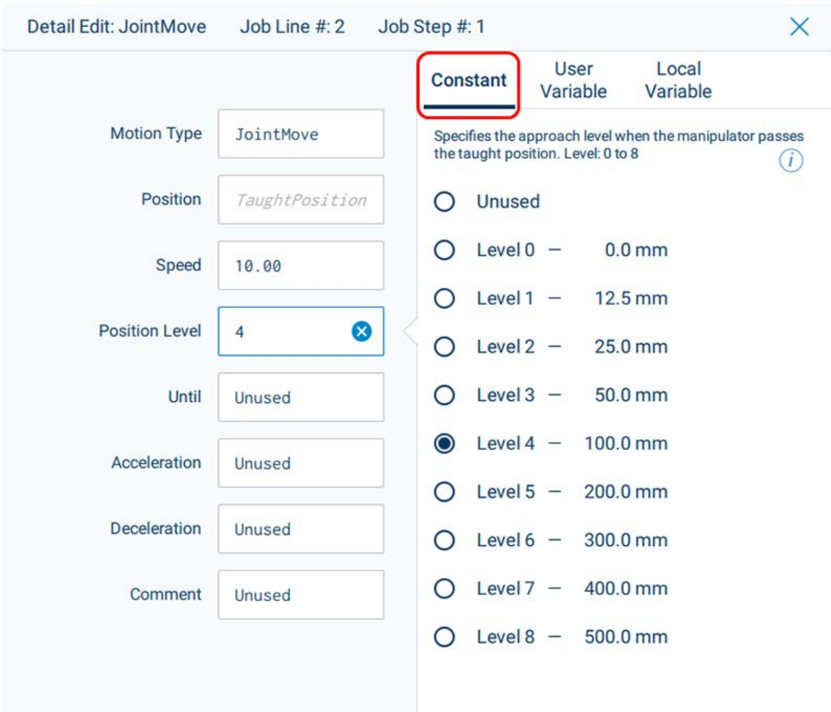
1. Select the motion instruction and open Detail Edit panel
2. Select the “Motion Type” parameter
3. Select the desired Motion Type from the list



Modifying Speed

1. Select the Speed.
   The number that can be entered are different among interpolation type.
   - Joint mode: specifies the Joint Speed, which is shown as a percentage of the Robot's highest speed.
     Speed: 0.01% to 100%
   - Linear mode: specifies the tool center point speed, using the Detail Edit screen. The maximum speed is unique for each Manipulator model.
     Units: mm/sec
   - Circle mode: specifies the tool center point speed, using the Detail Edit screen.
     Units: mm/sec
   - Spline mode: specifies the tool center point speed, using the Detail Edit screen.
     Units: mm/sec

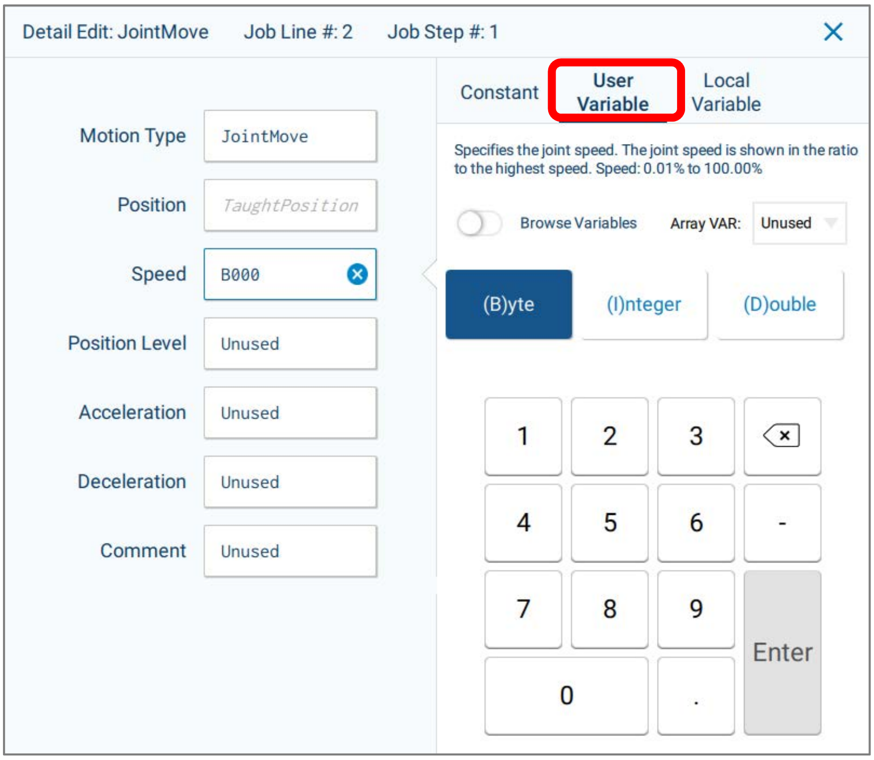
2a. For Constant, enter the preferred speed using the numeric keypad.



2b. For Variable, select the variable type from Byte, Integer, and Double type, and its number on the numeric keypad. Variable's content can be browsed from the {Browse Variable}.

NOTE

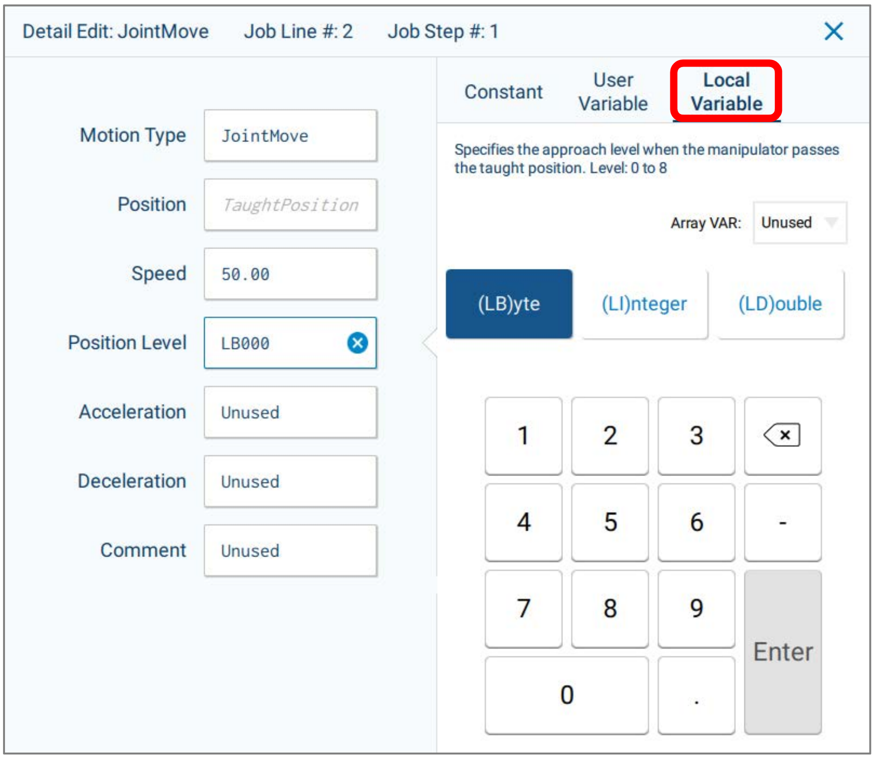
When the variable is used for speed with a LinearMove instruction, the unit is 0.1mm/s. When the variable is used for the speed with a JointMove instruction, the unit is 0.01%.



2c. For Local Variable, select the variable type and enter its number on the numeric keypad.

NOTE

Local Variable types will only be available if they have been allocated for the job. For more information on Local Variables, refer to *chapter 4.8 “Local Variables”*.



3. Press {SAVE} when the modification is completed.

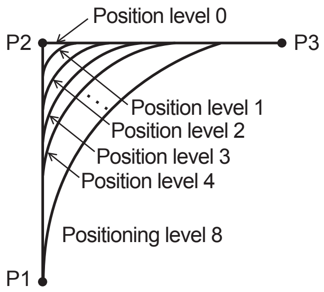
Setting Position Level

The position level can be changed after the motion instruction is registered.

Position Level: The position level is the degree of approximation of the Robot motion with respect to a taught position. The position level can be added to motion instructions JointMove (joint interpolation) and LinearMove (linear interpolation). If the position level is not set, precision will depend on the operating speed. Setting an appropriate operating speed level will ensure that the Robot moves in a path that is safe and suitable to circumferential conditions and the workpiece. The position level must be a whole number from 0 to 8, total of 9 levels.

The relationship between path and accuracy for position levels is as follows.

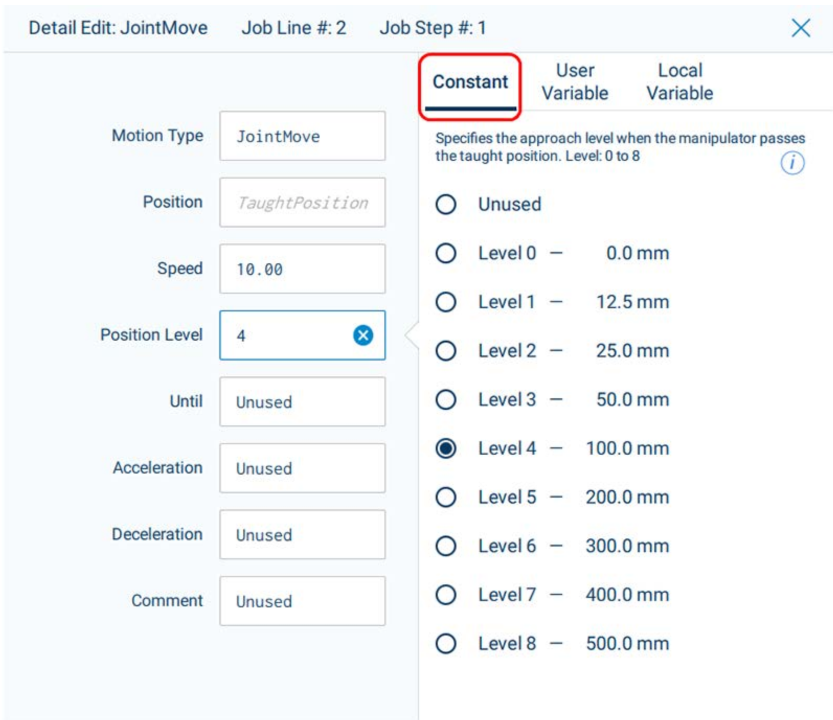
Fig. 4-7: Position Level



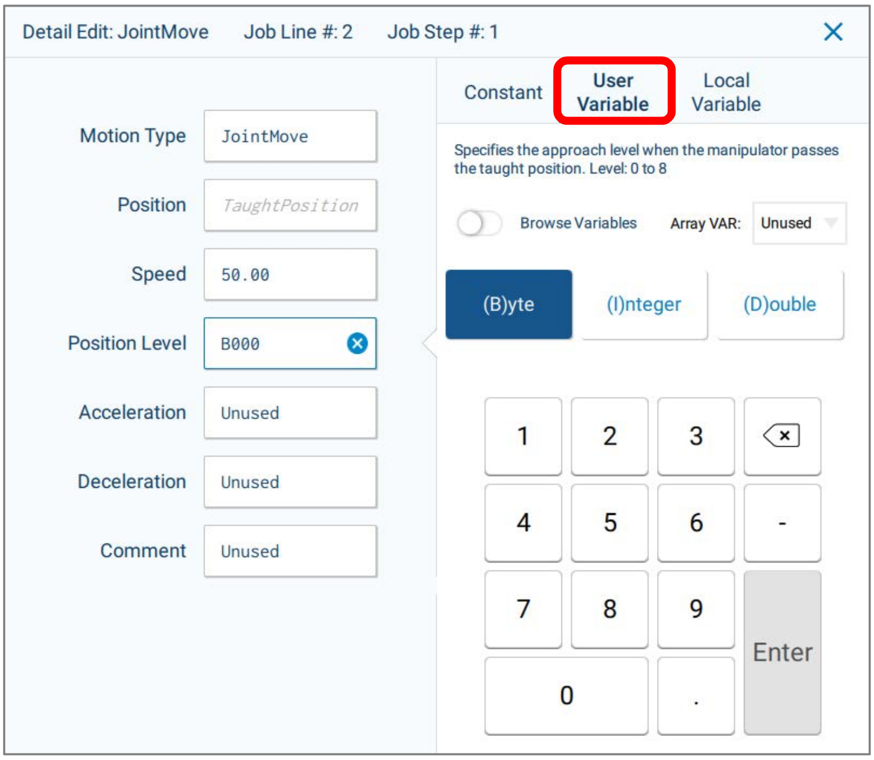
Position Levels	Accuracy
0	Teaching position
1 to 8	Fine Rough

1. Select the Position Level.

2a. For Constant, select the value of the Position Level from the displayed list.

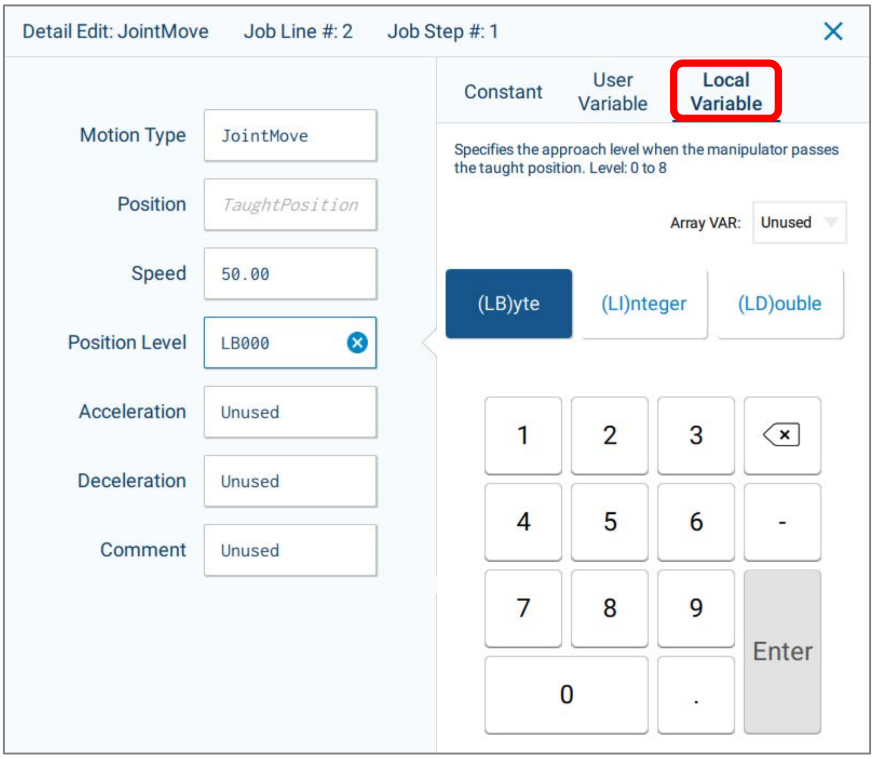


2b. For Variable, select the variable type from Byte, Integer, and Double type, and its number on the numeric keypad. The variable's content can be browsed from the {Browse Variable}. For array variables, refer to *chapter 4.6 “User Variables”*.



2c. For Local Variable, select the variable type and enter its number on the numeric keypad.

> **NOTE** Local Variable types will only be available if they have been allocated for the job. For more information on Local Variables, refer to *chapter 4.8 "Local Variables"*.



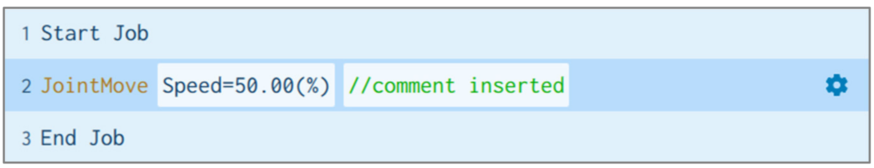
3. Press {SAVE} once the modification is complete.

Setting Comment

The comment is written next to the instruction. The comment can be from 0 to 32 alphanumeric and symbol characters in length.

1. Select {Comment}.
2. Enter the comment under "Enter Comment".
3. Press {SAVE} on the input keyboard.
4. Press {SAVE ALL} once the modification is completed.

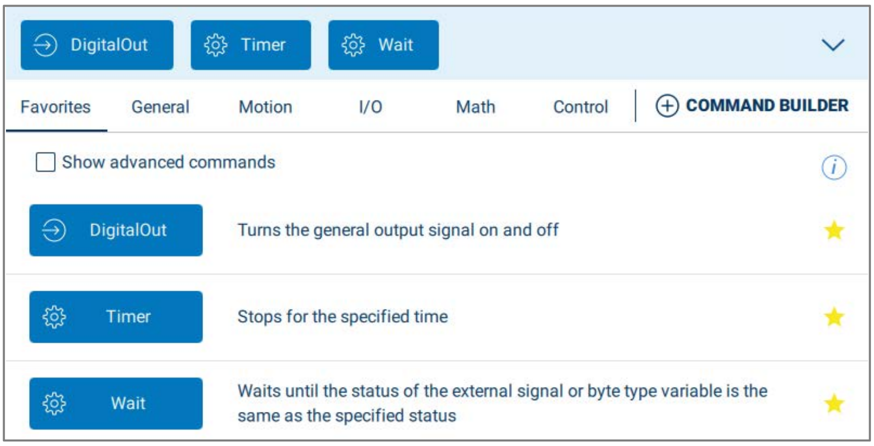
5. The comment is displayed in the job, next to the instruction.



4.4.4 Favorites

Frequently used commands can be saved to {Favorites} for quick access. To access favorites, open the {Favorites} tab in the command group. There is no limit on the amount of commands to save in {Favorites}.

1. Open any other command group.
2. Tap the star on the right side of the command.
   – Check the star's color has changed to yellow.
3. Check that the starred command is saved on Favorites, as well as above the command group.
   – The commands will be saved in the order they were tagged as favorites. To reorder the favorites list, press and hold on any command and then drag to a new position.



4.4.5 Command Builder

Command Builder is used to add basic commands to a job. Command Builder uses simple instructions to support ease of use for users.

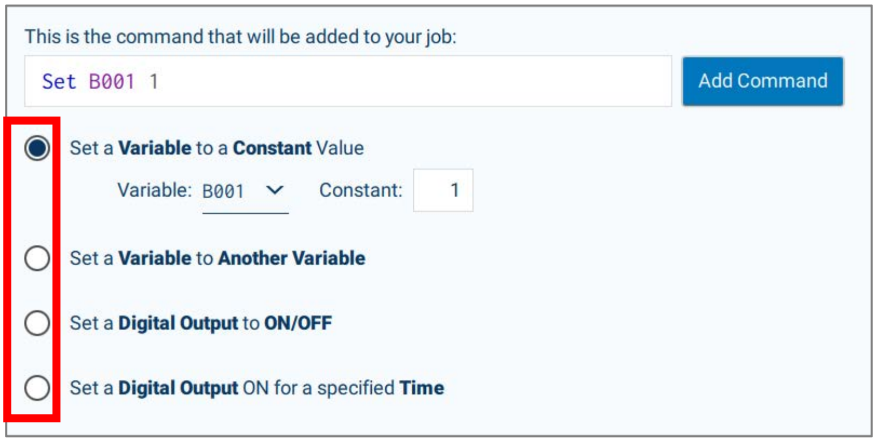
Command Builder can be used to add three basic types of command:

- SET
- READ
- WAIT

1. Open the Command Builder from the {COMMANDS} tab.

2. Select the command type from the tab.

3. Select the command from the list.

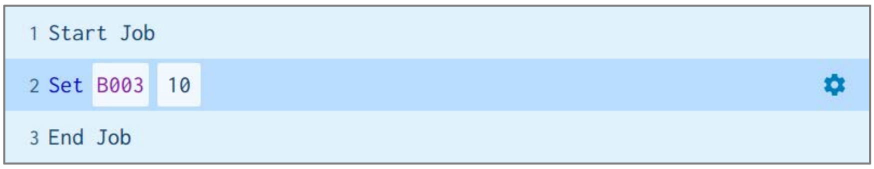


4. Select the variable from the list or insert the value in the box. (Ex. B003 and 10)

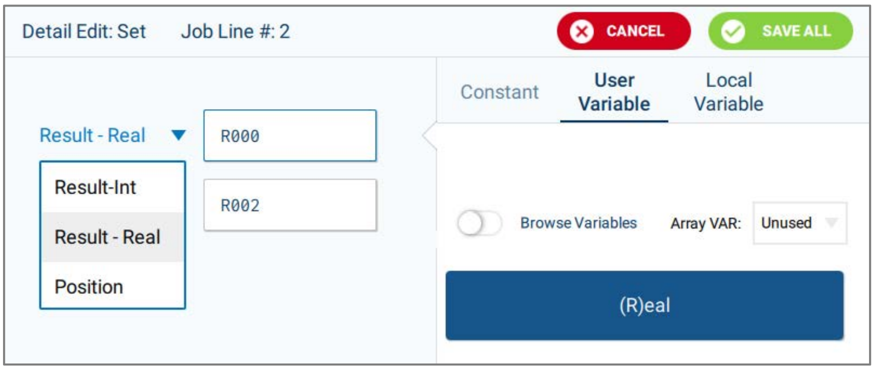
5. Press {Add Command}.

Command Builder limits the number of variables, I/O, etc. that can be modified. However, the commands generated by Command Builder can be modified in the Job Contents view to use any variable and I/O.

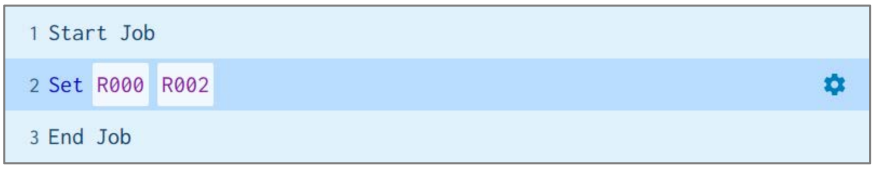
6. The added command is displayed in the Job Contents view. Press the {Detail Edit} icon to the right of the added line.



7. Other variables that were not listed in the Command Builder can also be selected. Replace the variables to desired variables, if a triangle ▼ is being displayed next to the input, other items are available for selection.
(Ex. R000 and R002)



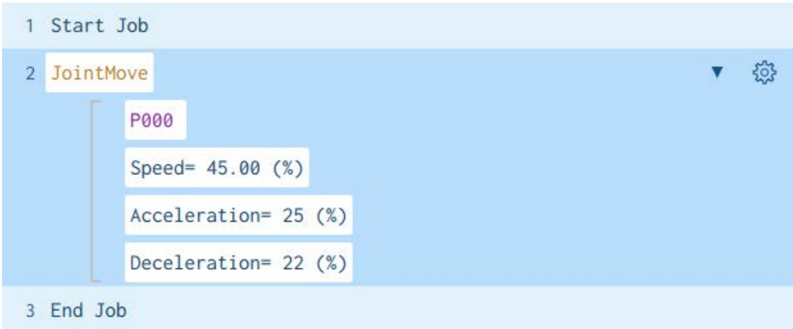
8. Press {SAVE ALL}, and the command is modified.



4.4.6 Expanded Inform Line

In cases where an instruction has more parameters than can be displayed in one line, an arrow indicator displays.

To view all of the parameters, press the arrow to expand the Inform line and press again to minimize the Inform line.



4.5 Editing Job

The Job Content Header provides access to three menus that make it easier to quickly navigate and edit the INFORM job:

- Edit
- Find
- Display

These menus are described in the following sections.

Fig. 4-8: Job Content Header

4.5.1 Edit Menu

Press the {Edit} to bring up the Edit Menu. The following operations can be used from this menu.

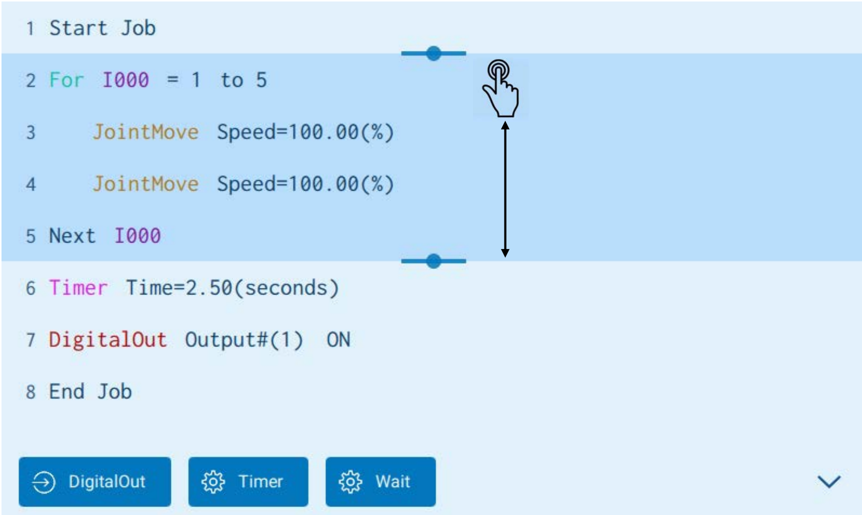
- Undo
- Redo
- Cut
- Copy
- Paste
- Delete
- Suppress

Fig. 4-9: Edit Menu

Bring the cursor to the line to be processed and press the desired button.

Additionally, some of these commands (Cut, Copy, Delete, Suppress) can be executed on multiple lines at one time. To select multiple lines, press and hold on the line and then drag to select more lines.

Fig. 4-10: Multi-Selection



4.5.1.1 Undo Operation

Toolbar button	Name	Description
	Undo	Undo reverses the most recent editing command from Commands tab.

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. The undo operation works for the last ten edited instructions only.

4.5.1.2 Redo Operation

Toolbar button	Name	Description
	Redo	Redo reverts the effects of the undo action

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

4.5.1.3 Cut Operation

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

4.5.1.4 Copy Operation

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

4.5.1.5 Paste Operation

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

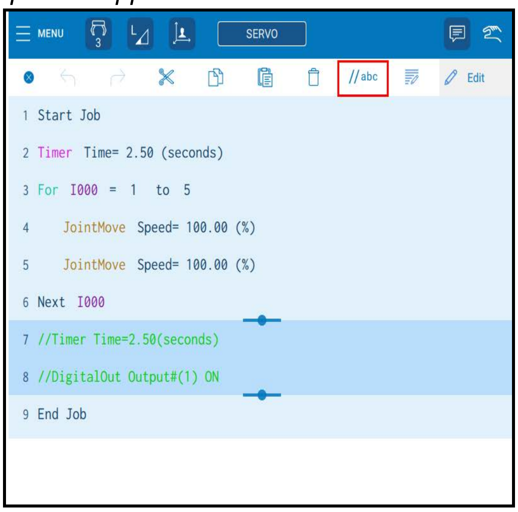
4.5.1.6 Delete Operation

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

4.5.1.7 Suppress Operation

Toolbar button	Name	Description
//abc	Suppress	Suppress the selected command(s). Suppressed commands will be skipped during job execution. For example, the Timer and DigitalOut command would not execute in *fig. 4-11 "Example of Suppressed Commands"*.

Fig. 4-11: Example of Suppressed Commands



4.5.1.8 Multi-Edit Operation

Toolbar button	Name	Description
	Multi-Edit	Change the value of multiple parameters at once. This is useful for bulk editing of motion instructions.

Pressing the Multi-Edit button will bring up a popup allowing a user to edit the parameters of all selected instructions. This button will only be available when multiple lines are selected. The following parameters can be edited through this popup:

- Joint Speed
- Linear Speed
- Rotation Speed
- Max Speed
- Acceleration
- Deceleration
- Position Level

To perform a Multi-Edit, follow these steps:

1. Select multiple lines of code containing some subset of the parameters listed above and press {Multi-Edit}.
   - This opens the Multi-Edit Panel that contains all supported parameters that appear in the selection.
     - For example, the selection in *fig. 4-12* contains Joint Speed, Linear Speed, Deceleration, and Position Level.

Fig. 4-12: Press {Multi-Edit}

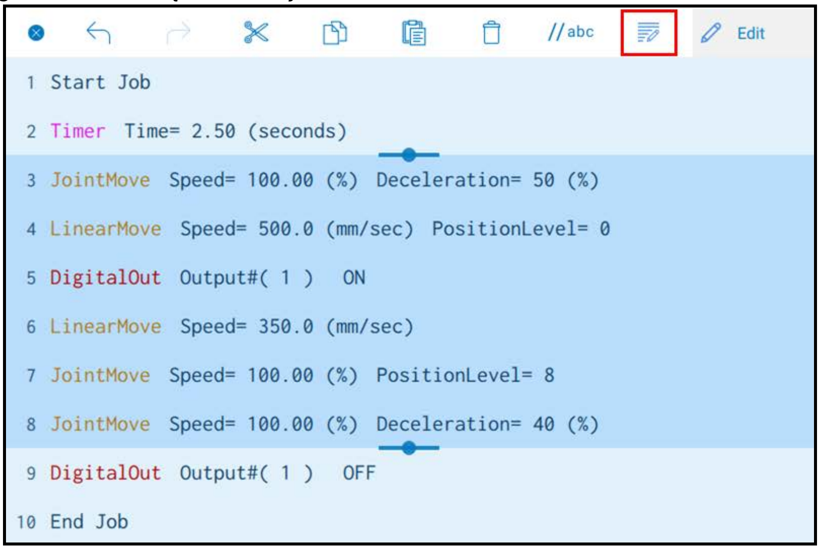
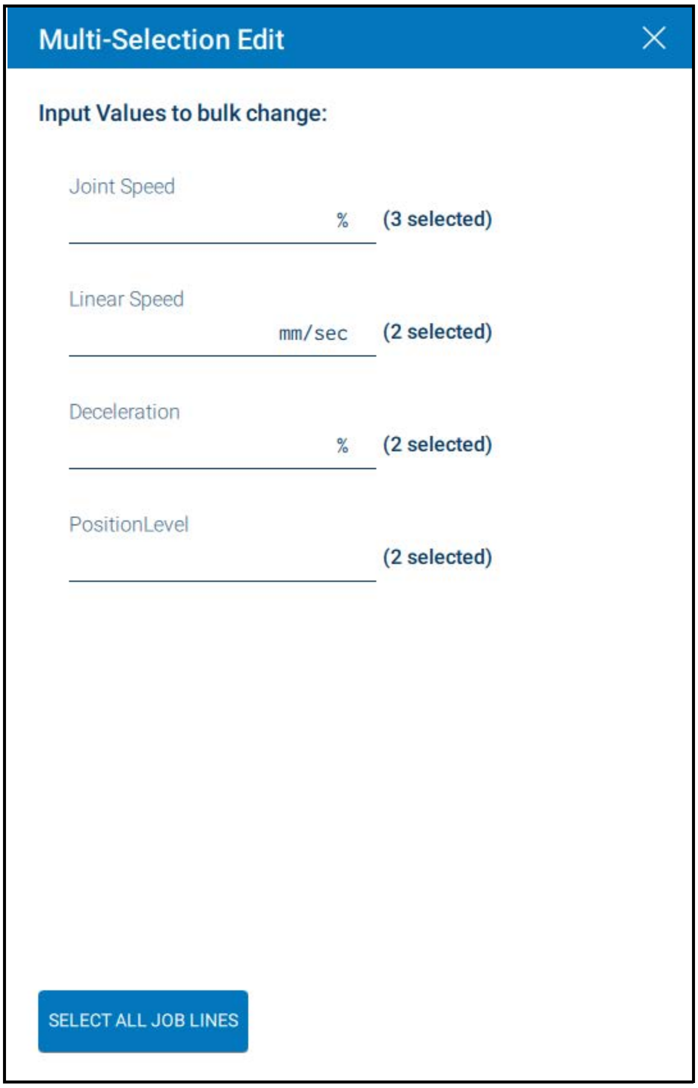


Fig. 4-13: Multi-Selection Edit Panel



NOTE

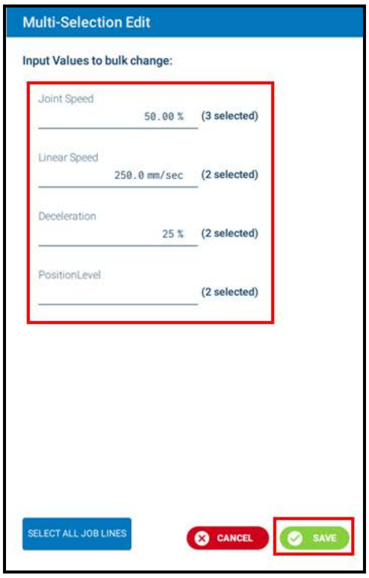
- Only constant parameters can be edited from this popup.
  - For example, “Speed=50.00” can be edited but “Speed=D001” cannot be edited.
- If selection does not contain any parameters that can be edited, a message displays indicating supported parameters.

2. Enter values for desired parameters and press {SAVE}.

   – In the following example, the Joint Speed is set to 50.00, the Linear Speed is set to 250.00, and the Deceleration is set to 25.

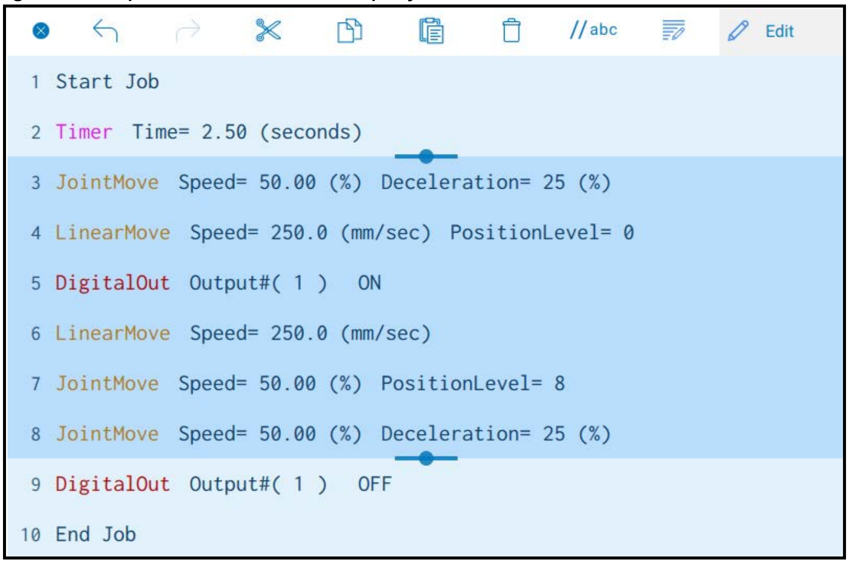
     • A value is not entered for Position Level which means this parameter will be unaffected by the changes.

Fig. 4-14: Multi-Selection Edit Parameter Values



   – The code displays the updated values.

Fig. 4-15: Updated Values in Displayed Code



NOTE

• The Multi-Edit popup contains {Select All Job Lines} which expands the Multi-Selection to include the entire job.

  – This is useful for quickly editing large jobs.

4.5.2 Find Menu

Press the {Find} to bring up the Find Menu. This menu can be used to quickly navigate a long INFORM program.

Fig. 4-16: Find Menu

The following operations can be performed from this menu:

4.5.2.1 To Start

Toolbar button	Name	Description
	To Start	Return to the first line of the job.

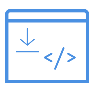
4.5.2.2 To End

Toolbar button	Name	Description
	To End	Navigate to last line of the job.

4.5.2.3 To Previous

Toolbar button	Name	Description
	To Previous	Return to the previously selected line.

4.5.2.4 Go To

Toolbar button	Name	Description
	Go To	Go to the line entered into the provided numerical input.

4.5.3 Display Menu

Press the {Display} to bring up the Display Menu. This menu can be used to change various settings that relate to the Job Contents view.

Fig. 4-17: Display Menu

The following settings can be changed:

4.5.3.1 Display Classic View

When the {Classic} option is turned ON, the original short-form INFORM language will be displayed on the Job Contents view. Classic INFORM is the language used in the YRC1000 Smart Pendant. For more information on the difference between Detail INFORM and Classic INFORM, refer to “YRC1000/YRC1000micro SUPPLEMENTAL INSTRUCTIONS FOR Smart Pendant (HW1485511)”. Display Classic View can be turned ON / OFF during both MANUAL (TEACH) and AUTOMATIC (PLAY) mode.

Fig. 4-18: Detail INFORM (with Classic View OFF)

```
3 JointMove Speed=75.00(%) Acceleration=50(%) Deceleration=20(%)
4 Timer Time=1.00(seconds)
5 DigitalOut Output#(5) ON
```

Fig. 4-19: Classic INFORM (with Classic View ON)

```
3 MOVJ VJ=75.00 ACC=50 DEC=20
4 TIMER T=1.00
5 DOUT OT#(5) ON
```

4.5.3.2 Display Tool Number

When {Tool #} option is turned ON, the tool number will be displayed on the Job Contents view. It displays next to the line number in [ ]. {Tool #} can be turned ON / OFF during both MANUAL (TEACH) and AUTOMATIC (PLAY) mode.

Fig. 4-20: Display Tool Number (when Display Tool # is ON)

```
3 [ 1] JointMove Speed=10.00(%) Acceleration=20(%)
4 [ 5] JointMove Speed=10.00(%) Deceleration=50(%)
```

4.5.3.3 Display Variable Names

When {Var. Name} option is turned ON, the variable number is replaced with variable names. The variable should be named beforehand, using the instruction in *chapter 4.6 "User Variables"*.

{Var. Name} can be turned ON / OFF during both MANUAL (TEACH) and AUTOMATIC (PLAY) mode.

Fig. 4-21: Display Variables Numbers (with Display Variable Names OFF)

```
3 JointMove Speed=B005(%)
4 JointMove P000 Speed=B010(%)
```

Fig. 4-22: Display Variables Names (with Display Variable Names ON)

```
3 JointMove Speed=data1(%)
4 JointMove TEST Speed=data2(%)
```

4.5.3.4 Display I/O Names

When {IO Name} is turned ON, the I/O number is replaced with I/O names. The I/O should be named beforehand, using the instruction in *chapter 4.6*.

{IO Name} can be turned ON / OFF during both MANUAL (TEACH) and AUTOMATIC (PLAY) mode.

Fig. 4-23: Display I/O Numbers (with Display IO Names OFF)

```
5 DigitalOut Output#(2) OFF
6 DigitalOut Output#(1) ON
```

Fig. 4-24: Display I/O Names (with Display IO Names ON)

```
5 DigitalOut Output#(BLOW OFF) OFF
6 DigitalOut Output#(SUCTION) ON
```

4.5.3.5 Display Favorites bar

When the {Favorites} option is turned ON, the bottom left of the Job Contents View will contain shortcuts to Favorite Commands. If a user wants to see more of the Job Contents View instead, this option can be turned OFF.

{Favorites} can be turned ON / OFF during both MANUAL (TEACH) and AUTOMATIC (PLAY) mode.

Fig. 4-25: Job Contents View (with Favorites turned ON)

Fig. 4-26: Job Contents View (with Favorites turned OFF)

4.5.3.6 Display Job Stack

When {Job Stack} is selected, a panel will display on the Job Contents View that will show the current Job Stack. As a job is executing, the “Call” instruction can be used to change to a new job. The Job Stack will show a list of jobs that have been called this way. For more information about Job Stack, refer to *chapter 5.4 “Job Stack”*.

This panel can be re-positioned inside the Job Contents View by pressing and dragging on the title bar.

The blue hyperlink is provided to quickly navigate to the top of the Job Stack in the case of an unexpected error or stoppage in Job playback.

Fig. 4-27: Job Stack Display

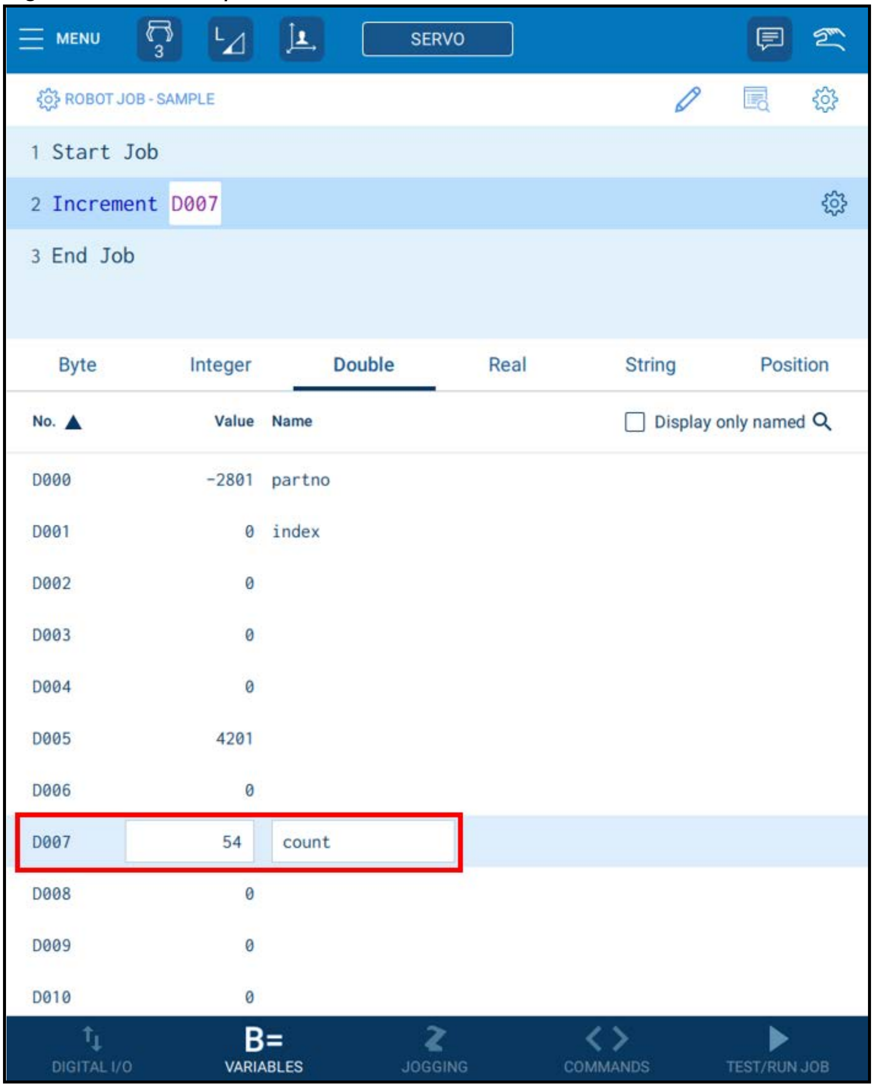
4.5.4 Direct Open

The Direct Open function provides an easy way to debug and navigate programs. The basic usage is to Press and Hold on a User Variable, Position Variable, I/O Number, or Job Name from the Job Contents view to provide quick access to information related to these items. The following sections will describe the usage of each of these.

4.5.4.1 User Variable

A User Variable (B, I, D, R, S) can be pressed to quickly access the name and value of the variable. For example, be Pressing and Holding on the D(ouble) Variable in the program below, the Variable Panel will automatically open in the bottom half of the screen with this variable highlighted.

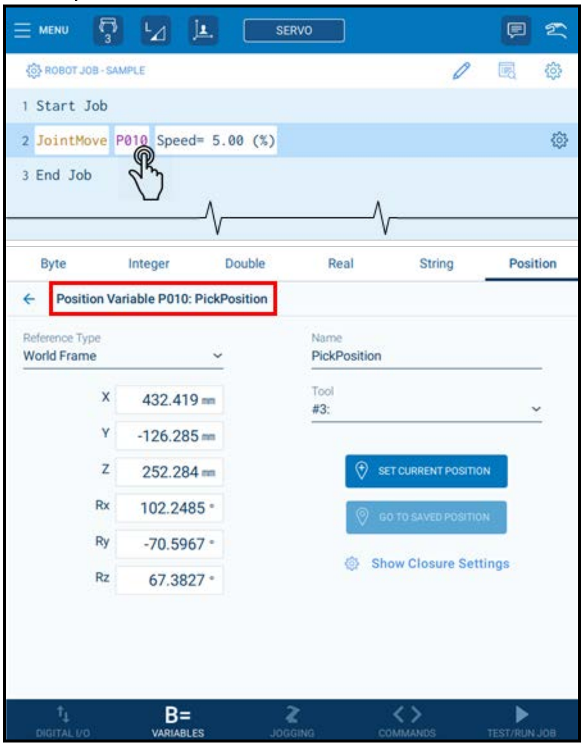
Fig. 4-28: Direct Open User Variable



4.5.4.2 Position Variable

Pressing and holding the (P)osition Variable, the Position Panel automatically opens in the bottom half of the screen with the selected position information. From this panel, the position can be modified or re-taught.

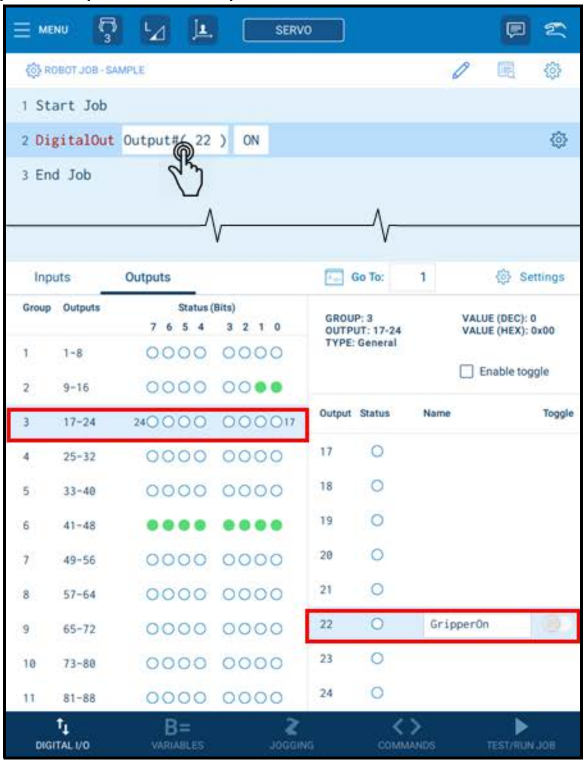
Fig. 4-29: Direct Open Position Variable



4.5.4.3 Input/Output Number Direct Open

Pressing and holding the Input/Output Number in the Job Contents View, the I/O Panel opens in the bottom half of the screen with the correct I/O Group and Number selected.

Fig. 4-30: Input/Output Direct Open



4.5.4.4 Job Name Direct Open

The functionality of Direct Open for the Job Name parameter in the Call instruction is slightly different. In this case, by Pressing and Holding the Job Name, the reference Job opens.

> **NOTE** When a job opens this way, a special button appears on the Job Header that gives a quick navigation back to the parent job (“SAMPLE” in this example).

4.6 User Variables

Variables are used to store counters, calculation results, or input signals in the job. The variables can be freely defined in the job. User variables have a global scope, which means that the same variable can be used in multiple jobs and its data value is common to all the jobs. A variable's value is maintained even when the power is turned OFF.

Variables have the following applications:

- Counting the amount of workpieces
- Managing the repeating count of jobs
- Sending/receiving of information between jobs

The data formats for variables are described in the following table.

Default number of available variables is shown in the table. Users can change the amount of variable allocation using Classic Interface (*chapter 13 "Classic Interface".*)

> **NOTE** Consider the data size of each variable and the amount of memory available in the YRC Controller when changing the amount of variable allocation.

Data Format	Variable No. (pcs.)	Functions
Byte type (unsigned 8-bit)	B000 to B099 (100 count)	Range of storable values is from 0 to 255. Can store I/O status. Can perform logical operations (AND, OR, etc.)
Integer type (16-bit)	I000 to I099 (100 count)	Range of storable values is from -32768 to 32767.
Double integer type (32-bit)	D000 to D099 (100 count)	Range of storable values is from -2147483648 to 2147483647.
Real type (32-bit float)	R000 to R099 (100 count)	Range of storable values is from -3.4E+38 to 3.4E38.
String type (character)	S000 to S099 (100 count)	Maximum storable number of characters is 32.
Position type	P000 to P127 (128 pcs.)	Can store position data in angle form or in XYZ form. XYZ type variables can be used as target position data for motion instructions, and as incremental values for parallel shift instructions. Teaching line coordinates cannot be used.

Below are some examples of using variables to specify motion speed and timer values:

- **Play LinearMove Speed:**
  LinearMove Speed = D000
  The variable D000 is used for speed with this motion instruction.
  The unit for speed is 0.1mm per second.
  For example, if D000 were set as 1000, the following would be true:
  D000 = 1000 → unit for speed is 0.1mm/s → speed = 100.0mm/s
  Note that, depending on the unit being used, the value of the variable and the value of the actual speed on occasion might not match.

- **Play JointMove Speed:**
  JointMove Speed = D000
  The unit for speed is 0.01%.
  For example, if D000 were set as 1000, the following would be true:
  D000 = 1000 → unit for speed is 0.01% → speed = 10.00%.

- **Timer Time:**
  Timer Time = D000
  For YRC1000, the unit for Time is 0.01 seconds.
  (For YRC1000micro, the unit for Time is 0.001 seconds.)
  For example, if D000 were set as 1000, the following would be true:
  D000 = 1000 → unit for Time is 0.01 seconds → Time = 10.00 seconds.

SUPPLE-MENT

Array Variable

An array variable can be used to dynamically change the variable number that is used in the program. The example below shows the relationship between the array variable and the variable number

Example:

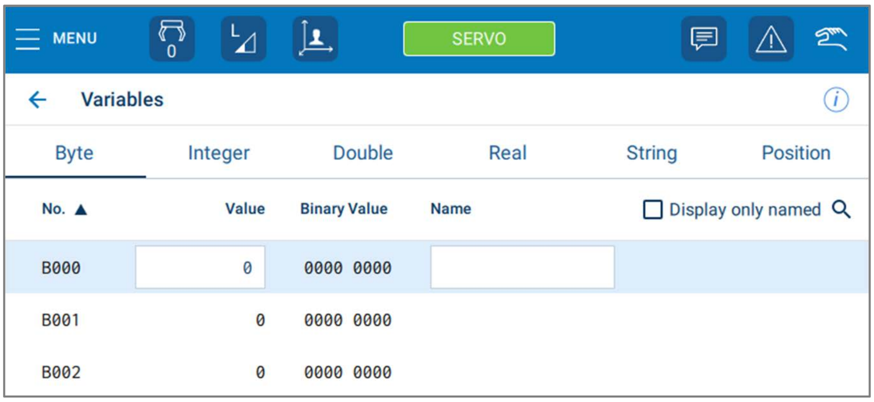
- B[0] is same as B000.
- If B001 = 2, then D[B001] is same as D002.

This is especially useful when used inside of FOR loops where the loop index can be used to change the variable. For example, the FOR loop shown below would shift by the value of P001 in the first loop, P002 in the second loop, P003 in the third loop, etc.…

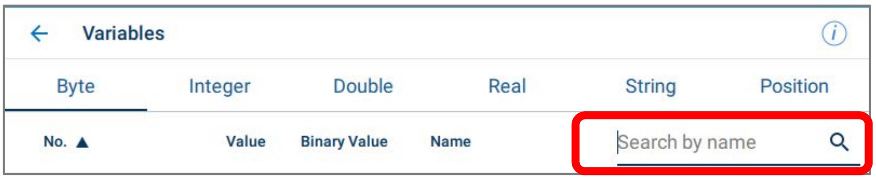
```
– FOR I002 = 1 to 10
    ShiftOn P[I002]
    …
    ShiftOff
  Next I002
```

4.6.1 Setting Byte, Integer, Double, and Real Type Variables

1. Select {I/O & Variables} -> {Variables} from the Main Menu.



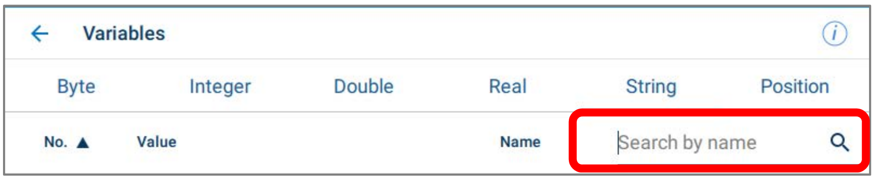
2. Select the desired variable type from {Byte}, {Integer}, {Double}, or {Real}.
   – The selected variable screen appears. (Following case is when {Byte} is selected.)
3. Tap the desired variable number.
   – If the desired variable number is not displayed on screen, swipe the screen downwards.
   – If the variable has been named, it can be searched by using the search function.



4. Tap the {Value} of the selected variable.
5. Insert the value to the variable using the numeric keypad.
6. Press {Enter}.
   – The input value is now set to the variable.
7. Insert the name for the variable as an option.

4.6.2 Setting String (Character) Type Variable

1. Select the {String} tab on the Variables screen.
   – The string variable screen will appear.
2. Tap the desired variable number.
   – When the desired variable number is not displayed on the screen, swipe the screen downwards.
   – If the variable is named, the variable can be searched by using the search function.



3. Tap the {Value} of the selected variable.
4. Insert the value to the variable using the alphanumeric keypad.
5. Press {Enter}.
   – The input value is now set to the variable.
6. Insert the name for the variable as an option.

4.6.3 Setting Position Variable with Variable Screen

4.6.3.1 Setting Position Variable by Moving the Manipulator

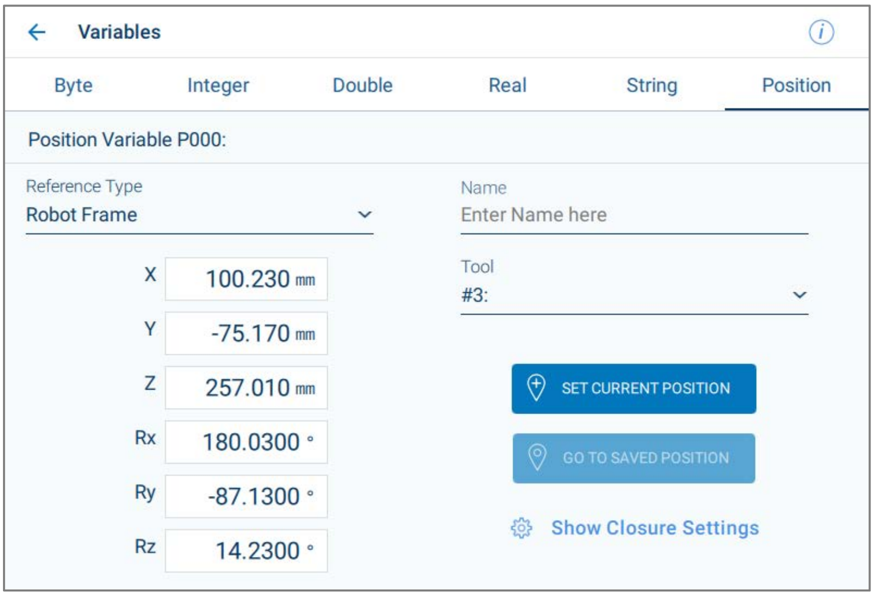
The following shows the position variables and setting methods.

NOTE

- The setting of position variables is performed in MANUAL (TEACH) mode.
- Turn the servo power ON when setting the variables using the [Jog Keys].

Position Variables and Setting Method

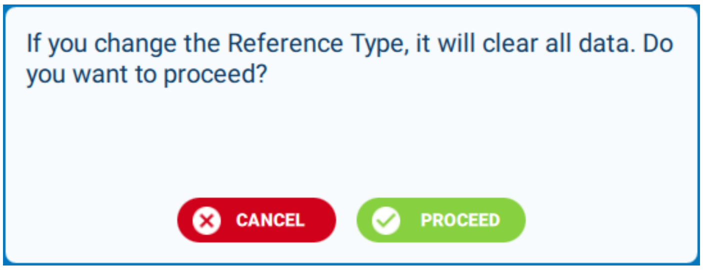
Type	**Pxxx (Robot)**	
	Angle type	XYZ type (world, tool, user, etc.)
Setting Method	Using jog keys (Robot Jog panel, Membrane)	



4.6.3.2 Setting Position Variable Using the Numeric Keypad

1. Select {Position} under {Variables}.
2. Select desired position variable type (ex. P000).
   – The data of the desired variable is shown below.
3. Select the {Reference Type}.
   – The selection panel on Reference Type will appear.

If the position variable has already been set, a confirmation pop-up window will appear. Select {PROCEED} to clear the data.



4. Select the reference type.
5. Tap the cursor to the desired data to be input.
6. Input the value for the position.
7. Press {ENTER}.
   – The value is set in the cursor position.
8. Tap {Save} to save the position variable.
9. Insert the variable name as an option.

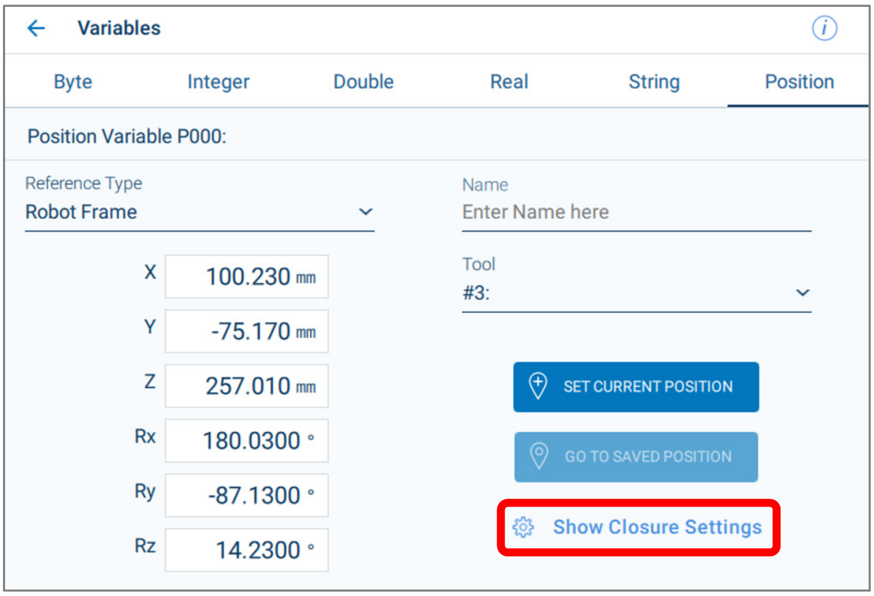
4.6.3.3 Closure Setting

When the position data for the job is described using the XYZ format, several postures may be adopted depending on the manipulator’s structure when moving it to the described position.

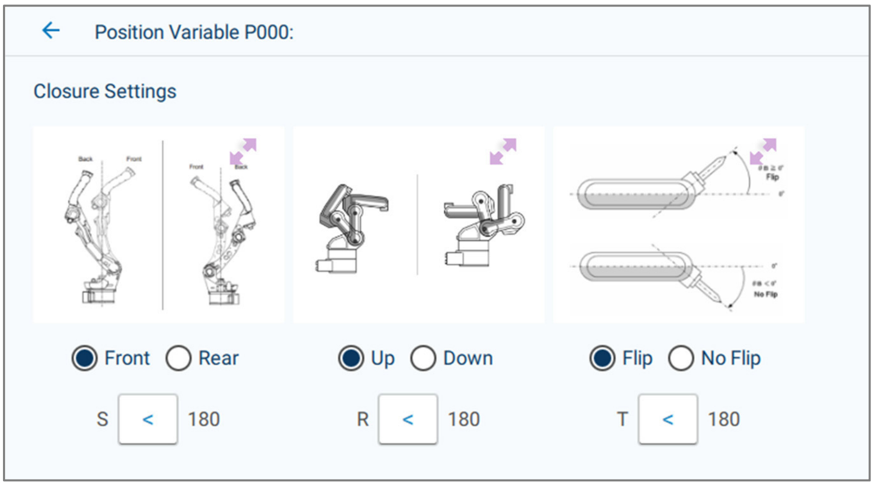
Although these postures have the same coordinates for TCP, they vary in angle for each axis.

For this reason, the manipulator’s posture cannot be uniquely defined by the coordinate value alone. It is necessary to specify data other than the coordinate value to define the manipulator’s posture.

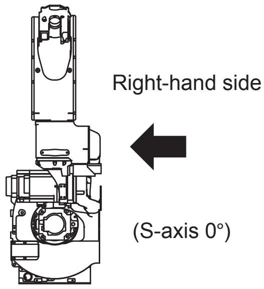
In Position Variable Details, press {Show Closure Settings}.



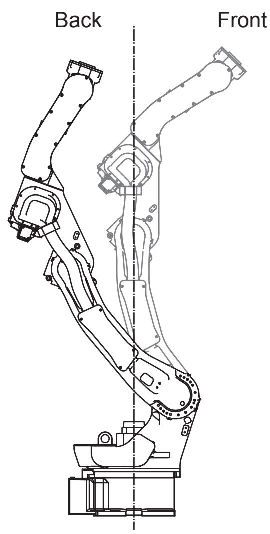
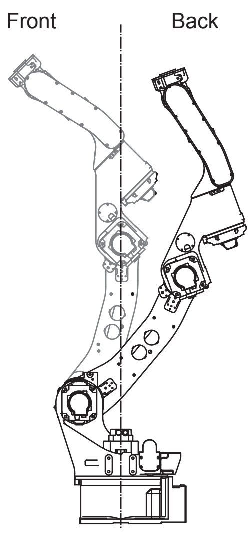
The Closure Settings panel will appear.



- **Front / Rear**
  This specifies where in the S-axis rotation center the B-axis rotation center is located when viewing the L-axis and U-axis from the right-hand side. Noted that when viewed from the right-hand side, the right of the S-axis rotation center is called the front, and the left is called the back.

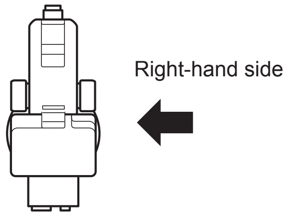


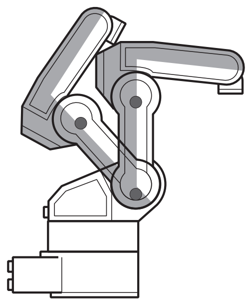
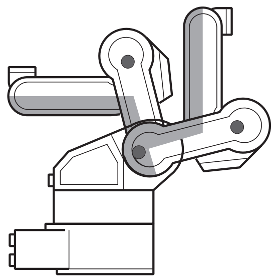
The diagram below shows the S-axis at 0° and at 180°. This is the configuration when the L-axis and the U-axis are viewed from the right-hand side.

S-axis 0°	S-axis 180°
	

■ **Up / Down**

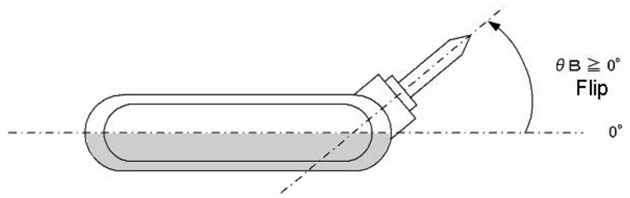
This specifies a type comprised of L-axis and U-axis when the L-axis and U-axis are viewed from the right-hand side.

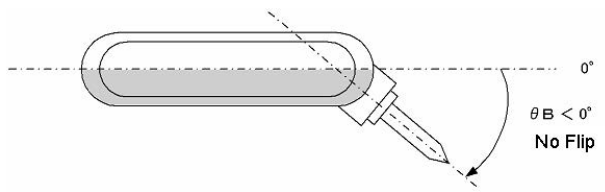


Upper Arm	Lower Arm
	

■ **Flip / No Flip**

When the angle of the B-axis is within (+) range (θB ≥ 0°), it is called “Flip”, and when within (-) range (θB < 0°), “No Flip”.

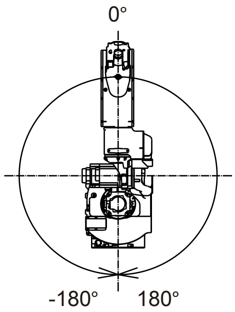
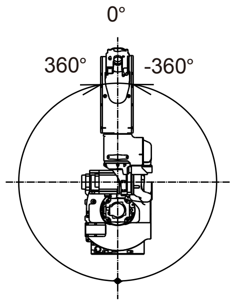




- **S-Axis Angle**

This designation is required for manipulators that have working envelopes greater than ±180°.

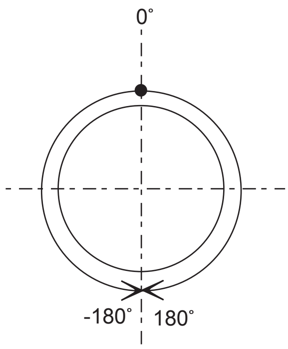
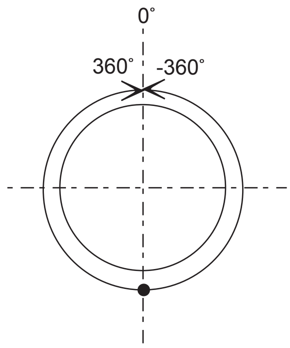
This specifies whether the S-axis angle is less than ±180° or greater than ±180°.

S<180°	**S ≥ 180°**
	
-180° < θS ≤ 180°	180° < θS or θS ≤ -180°

Note that θS is the angle when the S-axis home position is 0°.

- **R-Axis Angle**

This specifies whether the R-axis angle is less than ±180° or greater than ±180°.

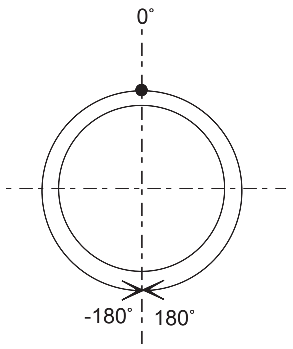
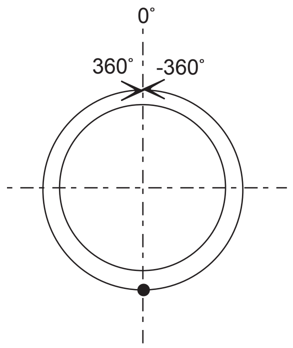
R < 180°	**R ≥ 180°**
	
-180° < θR ≤ 180°	180° < θR or θR ≤ -180°

Note that θR is the angle when the R-axis home position is 0°.

■ T-Axis Angle

This specifies positions of the R-, B- and T-axis.

For manipulators with wrist axes (three axes), this specifies whether the T-axis angle is less than ±180° or greater than ±180°.

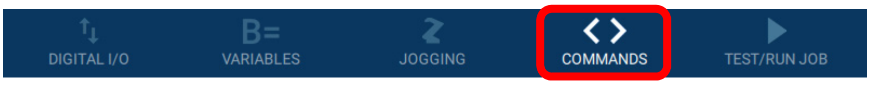
T <180°	**T ≥ 180°**
 -180° < θT ≤ 180°	 180° < θT or θT ≤ -180°

Note that θT is the angle when the T-axis home position is 0°.

4.6.4 Specifying Motion Commands using Position Variables

When the position variable is used for specifying its position during the movement, a Motion command can be used. Using this command allows operators to specify positions, using specific numerical values. Position values can easily be modified too. Position variables can also be used as target position data for motion instructions, and as incremental values for parallel shift instructions.

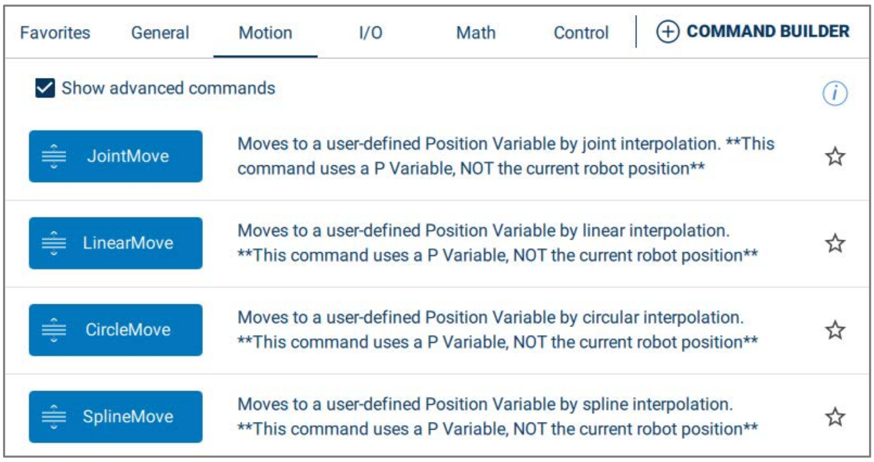
1. Open the job.
2. Go to {COMMANDS} from the Navigation Bar.



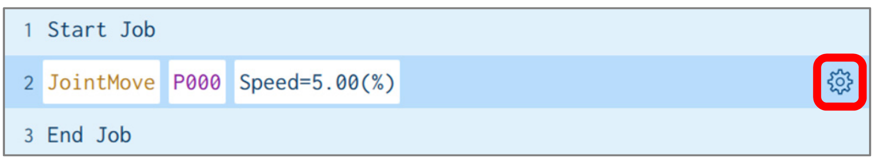
3. Select the {Motion} tab.
4. Insert check to the {Show advanced commands} checkbox.
5. Select the desired motion command. The options are:
   - JointMove
   - LinearMove
   - CircleMove
   - SplineMove

(JointMove is selected as an example step.)

- The motion command is added to the job.



6. Press the detail edit button on the job line to the right.
   - The Detail Edit panel will appear.



7. In the Position under Variable tab, insert the desired position variable number or select from the variable list using Browse Variables.

Fig. 4-31: Inserting Position Variable Number

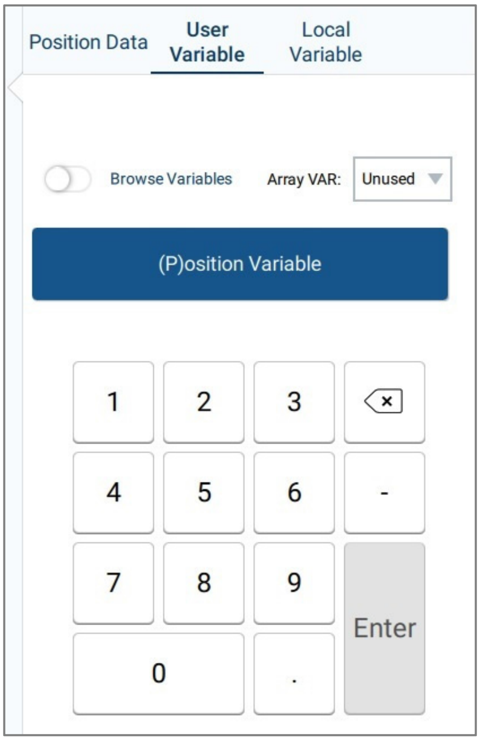
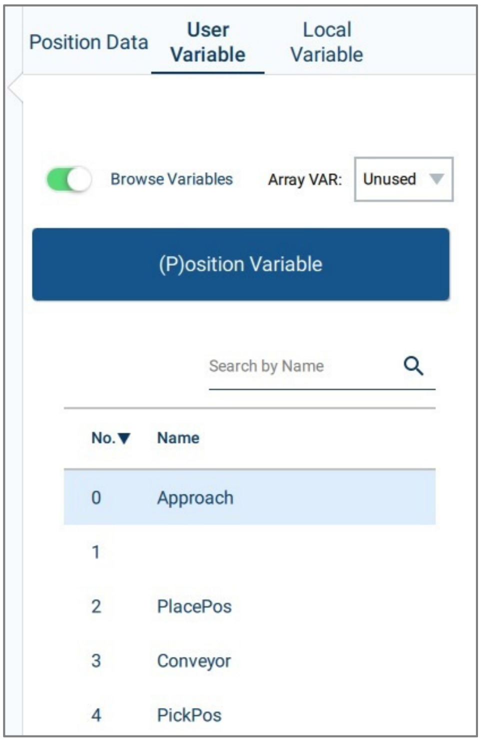
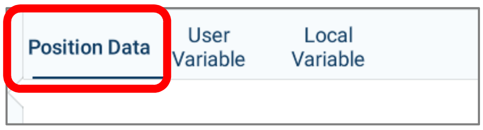


Fig. 4-32: Browsing Position Variable Number

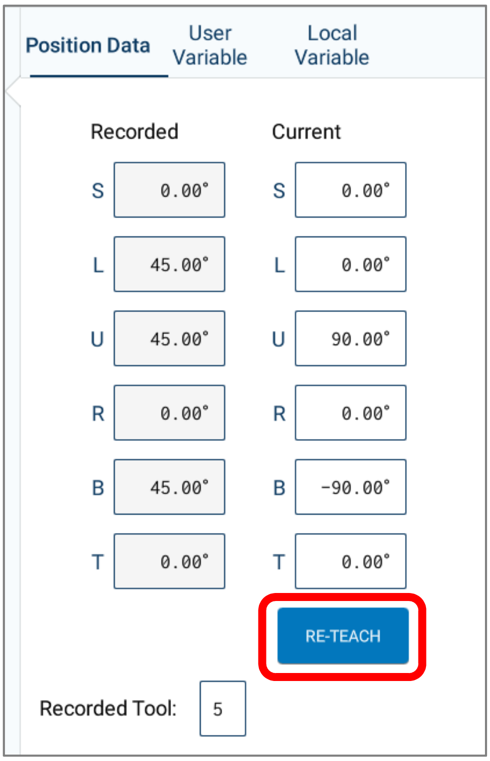


8. Change the tab from Variable to Position Data.



9. Move the manipulator to the desired position.

10. Press {RE-TEACH}
    – The current manipulator position will be registered.



4.6.5 Deleting Variable

Variables can be overwritten.

– For Byte, Integer, Double and Real Variable, insert “0” to the value and delete the name. Press {save}.

– For String Variable, clear the value and delete the name. Press {save}.

– For Position Variable, insert all “0” and press {save}

4.7 Monitoring Variables

4.7.1 Use Variable Watch to Monitor Variables

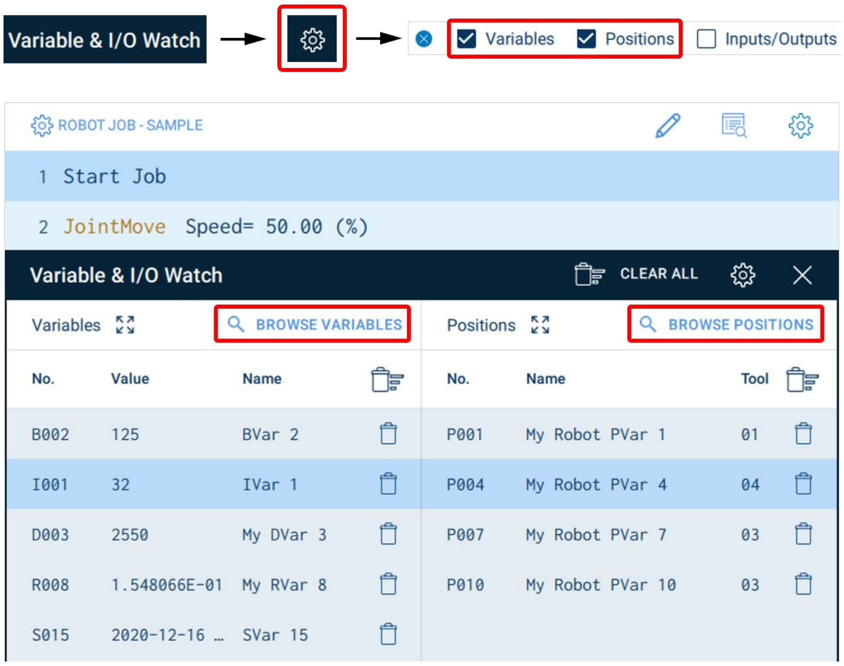
User Variables can be monitored using the Variable Watch feature accessed at {Menu}⟶ {I/O & Variables} ⟶ {Variable & I/O Watch}. The following global variable types can be monitored:

Register Items on the Watch Window for Variables:

- Byte (B-variable)
- Integer (I-variable)
- Double type (D-variable)
- Real (R-variable)
- String (S-variable)
- Position (P-variable)

To select and monitor User Variables, press the {Settings} button in the header to ensure “Variables” and/or “Positions” are checked. User Variables can be displayed with or without I/O signals.

Fig. 4-33: Variable Watch



Use {Browse Variables} and/or {Browse Positions} to open the respective list of variables, make selections, and press {Update} to populate the monitor. Several {Clear} options are provided to quickly edit monitored list(s).

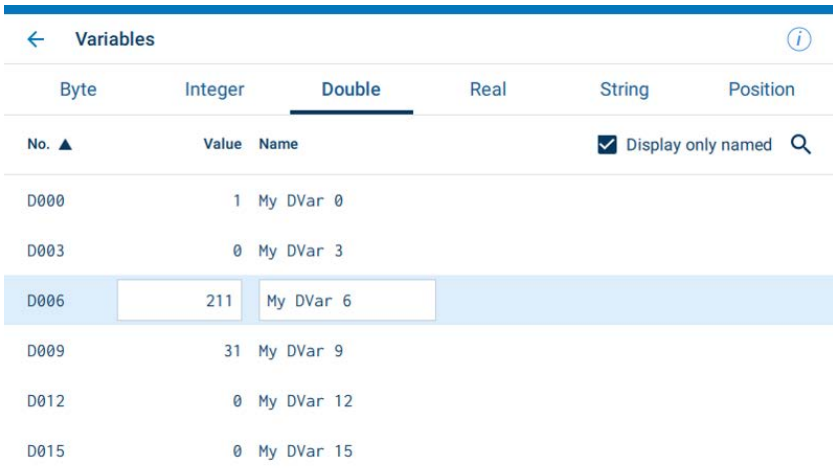
Select a Position Variable in the monitored list to display its Position data. Monitored values are refreshed every second.

> **NOTE** To use Variable & I/O Watch to monitor I/O signal(s), go to *chapter 4.6.3.3 “ Closure Setting”.*

4.7.2 Monitor Values on Variables Screen

The Variables screen can be used to monitor variable values

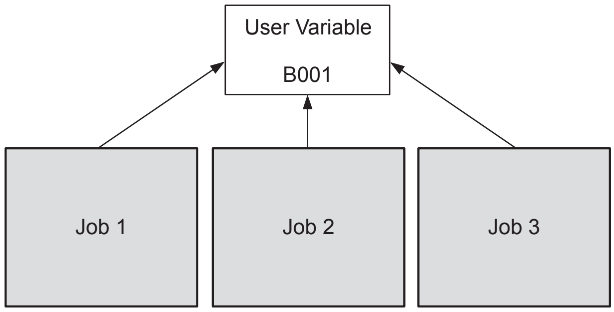
1. Navigate to Variables screen
   - **Full screen:** {Menu} ⟶ {I/O & Variables} ⟶ {Variables}
   - **Half screen:** {Menu} ⟶ {Current Job} … select {Variables} tab on the bottom
2. Use the tab bar to select Variable Type to view Byte, Integers, Double, Real, Position, or Local (half screen only)
   - "Display only named" and "Search" can be used to filter variable lists (not applicable to Local)



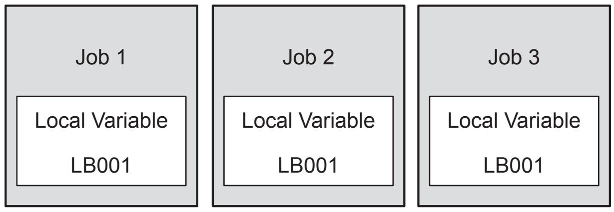
4.8 Local Variables

Local Variables are variables that are used only within its particular job. These are useful for temporary operations as they cannot be read or changed from other jobs, whereas User Variables can be read or changed. Some of its usage are for: loop counters, temporary calculations, and input signals storage. This section describes additional settings that are available relating to Local Variables

.



User Variables



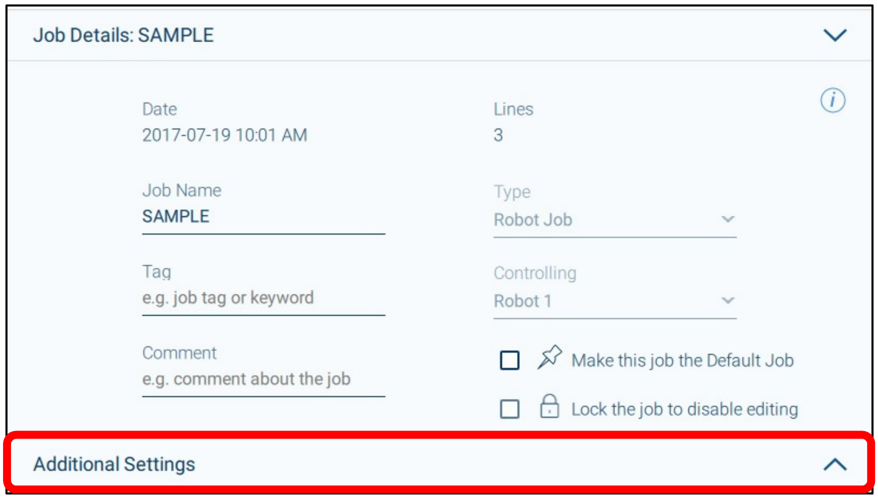
Local Variables

4.8.1 Local Variable

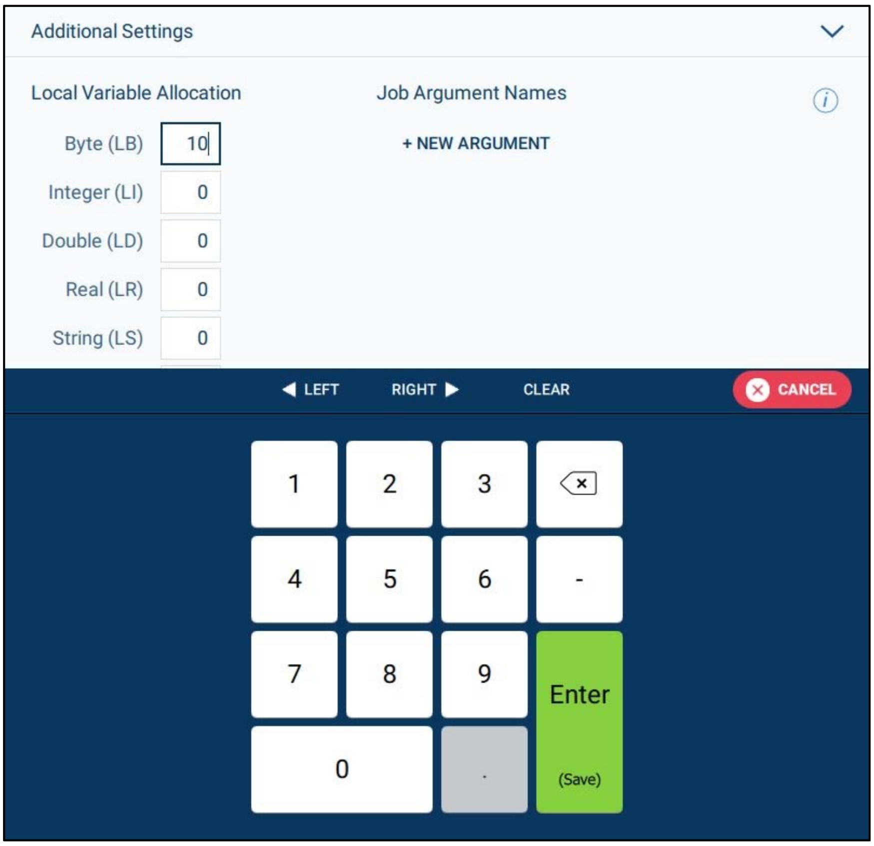
4.8.1.1 Allocation

Local Variables need to be configured at first to be used.

1. Select {Job List} under {MENU}.
2. Select the particular job from the list of job.
3. Press the {Additional Settings} expansion icon at the bottom of the Job Details panel.
   – This will pull up a new panel for Additional Settings.



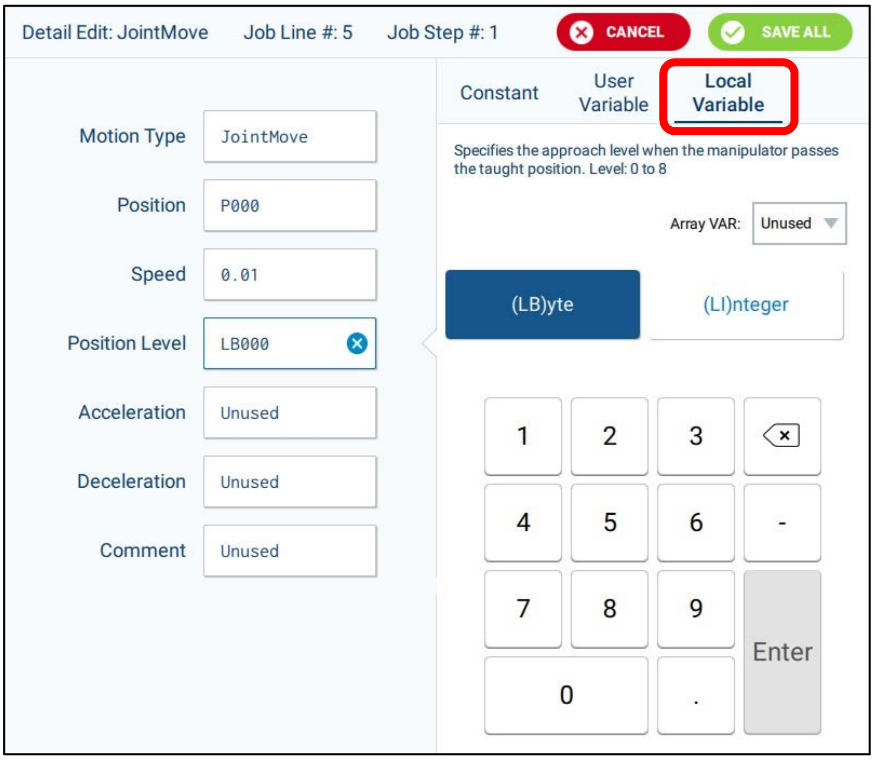
4. Under the {Local Variable Allocation}, enter a number between 0 and 255 for the amount of variable to allocate, next to the desired variable type.
   – Example: the figure shows allocating 10 Local Byte (LB) variables. Thus, LB000 to LB009 will be usable inside the job.



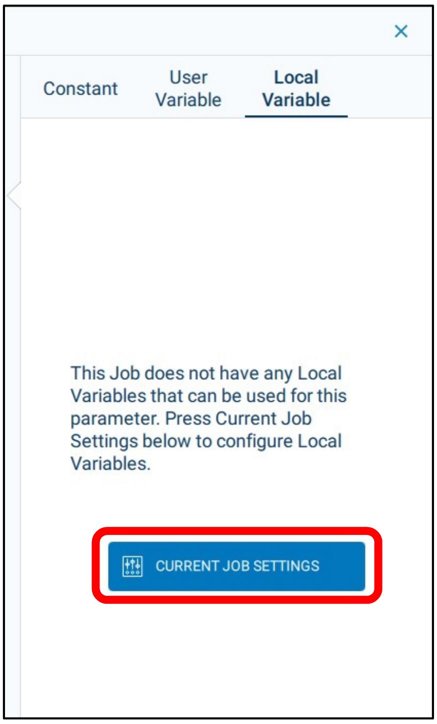
4.8.1.2 Entering Local Variables

After Local Variables have been allocated for a particular job, they can be used by changing variable type to Local Variable in the Detail Edit panel. Only available Local Variables types will be shown (i.e. types that have been allocated for a particular job).

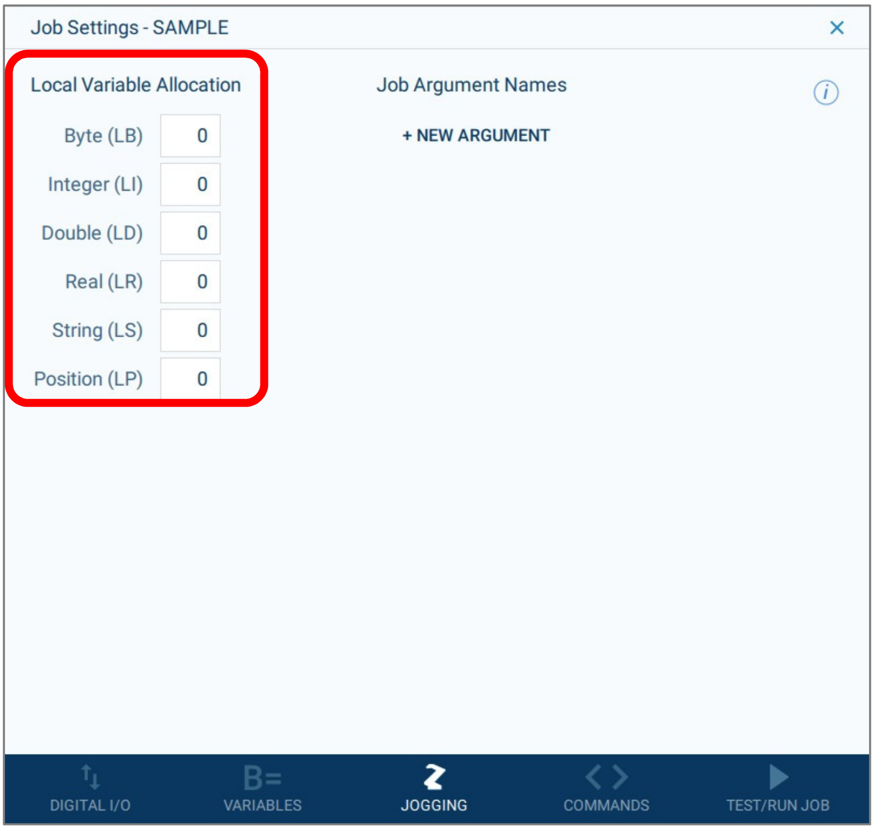
Example: the Position Level parameter can be set as B, I, or D User Variable type. However, only LB and LI Local Variables types are shown because no LD variables have been allocated for this job.



If no Local Variables that can be used with particular parameters are allocated, the following message will be displayed.



Press the {CURRENT JOB SETTINGS} to show a subpanel where the Local Variables can be allocated.



Because Local Variables only exist in its job they must be defined before being used. For example, to set the Position Level as an LB variable, this could first be initialized using the Set command:

```
Set LB000  5

JointMove P000  Speed=0.01(%)  PositionLevel=LB000
```

4.8.1.3 Usage of Local Variable

Some useful way to use Local Variable is shown below.

① User can guarantee to not accidentally modify a value that is used in a different job by using Local Variables.

– Example: Using a Local Variable for a For loop index
If I004 was used instead of LI004, the job would change the value of a Global Variable which could be used in another job.

```
For LI004 = 1 to 10

    // looped commands

Next LI004
```

② Use for temporary mathematic operations.

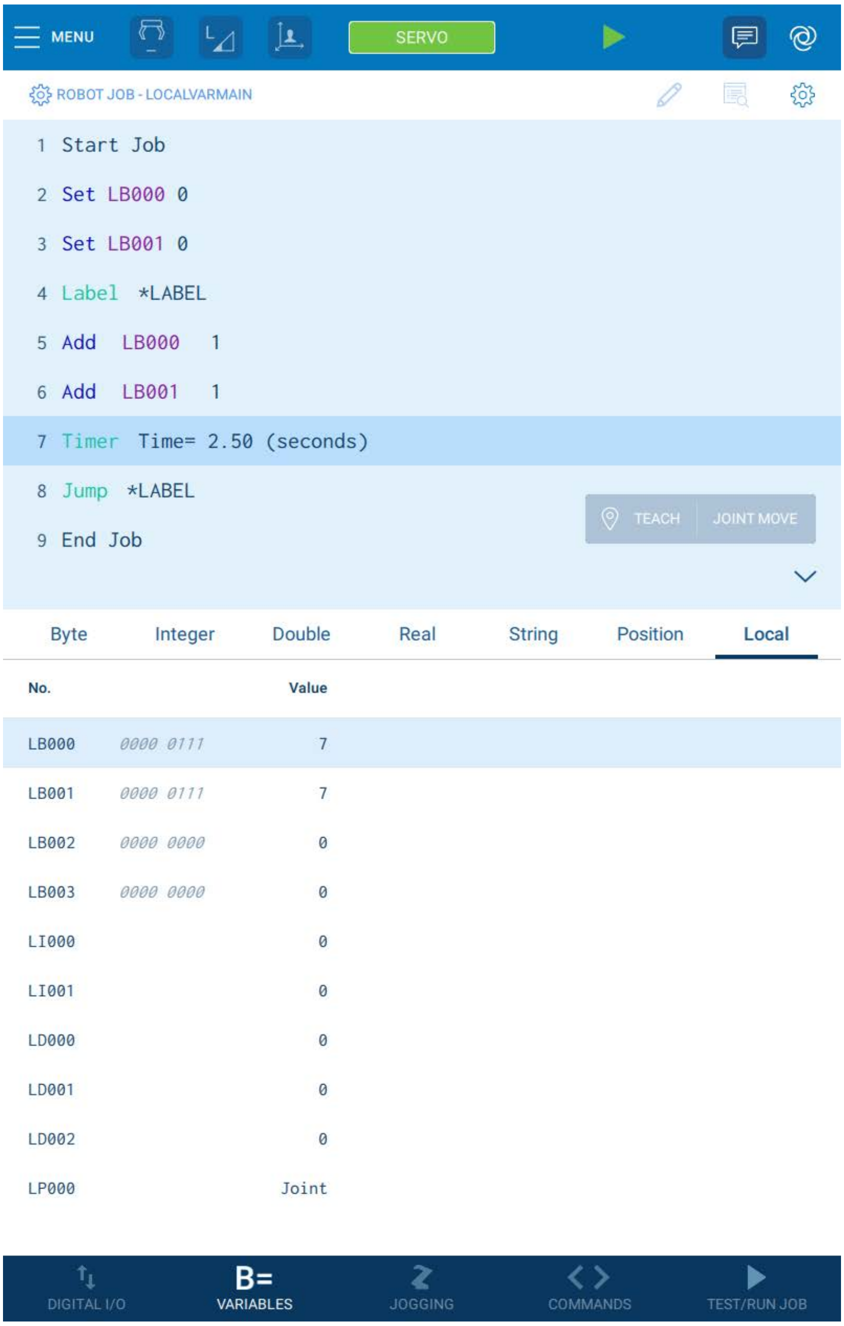
– Example: Set the JointMove speed to “B010*2” without overwriting any Global Variables.

```
Set LB001  0

Add LB001  B010

Multiply LB001  2

JointMove P000  Speed=LB001(%)
```

4.8.1.4 Monitoring Local Variables

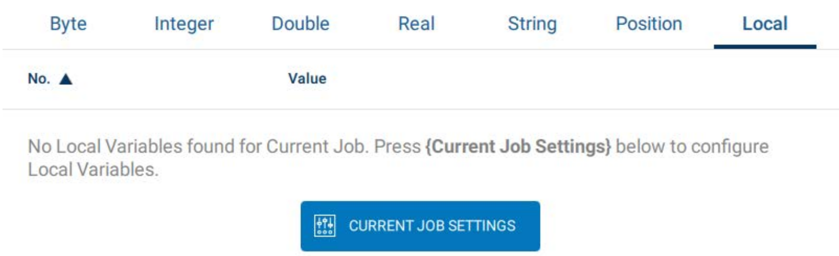
The values of Local Variables can be viewed from the Variables Tab from the Job Contents View. First, select {Variables} from the bottom navigation bar and then the {Local} tab.

Fig. 4-34: Local Variable Monitoring



On this tab, all Local Variables that are allocated for the current job are shown. For example, the job shown in *fig. 4-34* has 4 LB, 2 LI, 3 LD, and 1 LP variables. As the job is executed, the value of these variables will update to indicate any changes. If the job changes during execution, this panel will update to display the current job's local variable allocation.

In the case that no Local Variables are allocated in a job, the message below will be displayed.



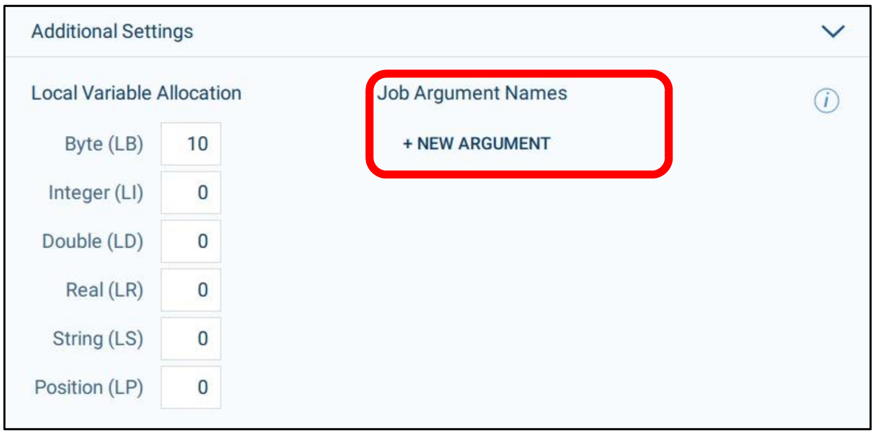
4.8.2 Job Arguments

Job Arguments are a way to pass variables and data from one job to another with a use of Call and GetArgument command. For example, a user may want to pass the position of a part to a subroutine (child job) that executes the picking motions. To use Job Arguments, the basic procedure is:

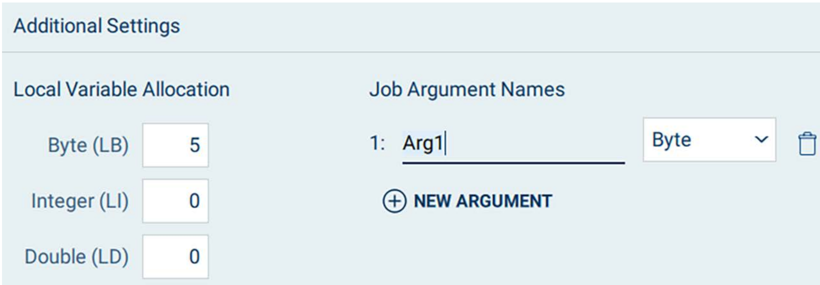
1. Configure the child job using the Additional Settings panel
2. Add the Call command with arguments in the parent job
3. Add the GetArgument command in the child job to get values
4. Store values in local variables

4.8.2.1 Configuration

1. Select {Job List} under {MENU}
2. Select the particular job from the list of job.
3. Press the {Additional Settings} expansion icon at the bottom of the Job Details panel.
   – Under the {Job Argument Configuration}, there will be no named Job Arguments by default.



4. Press the {+ NEW ARGUMENT} to configure a new argument.
   - A default argument named “Arg#” (e.g. Arg1, Arg2, Arg3) with type “Byte” is created.
   - A job can have up to 8 Job Arguments
   - Entering a name is optional
   - 0 to 16 characters can be used for a name
   - Type can be set to any Variable Type available on the pendant or “Unused”



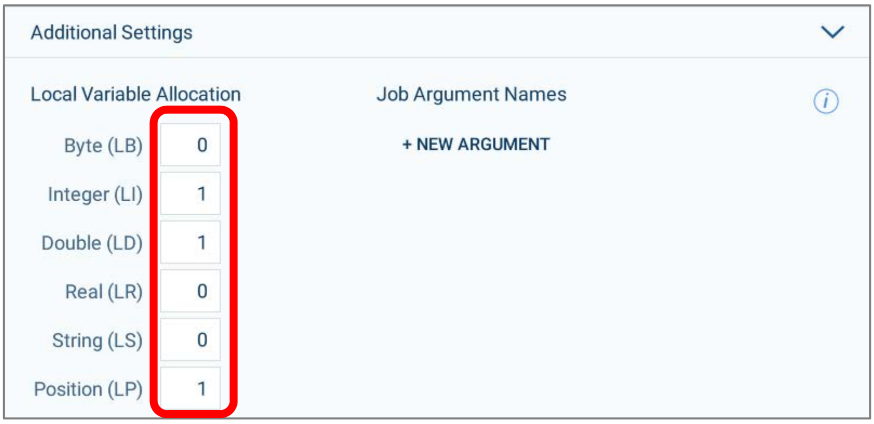
Argument name will be visible from the Job Contents view, so it is useful to give a descriptive and unique name.

4.8.2.2 Using Job Arguments

The following steps describes the basic procedure for using Job Arguments with an example. This involves a parent job (named as “PARENT_JOB1”) that will call into a child job (named as “CHILD_JOB1”) with arguments. The child job uses three arguments:

- 1 Double (D) value to be used as a Speed parameter
- 1 Integer (I) value to be used in a Timer
- 1 Position (P) value to be used as a Shift value

1. Configure the Local Variables allocation for the child job.
   – For using these parameters in the child job, at least one LD, LI, and LP variable will need to be allocated, as shown in the figure.
   – For more information on configurating the Local Variable, refer to *chapter 4.8.1.1 “Allocation”*.



2. Configure the Job Arguments for the child job.
   – Three arguments are named and configured with the desired Type.
   – For more information on configurating the Job Arguments, refer to *chapter 4.8.2.1 “Configuration”*.

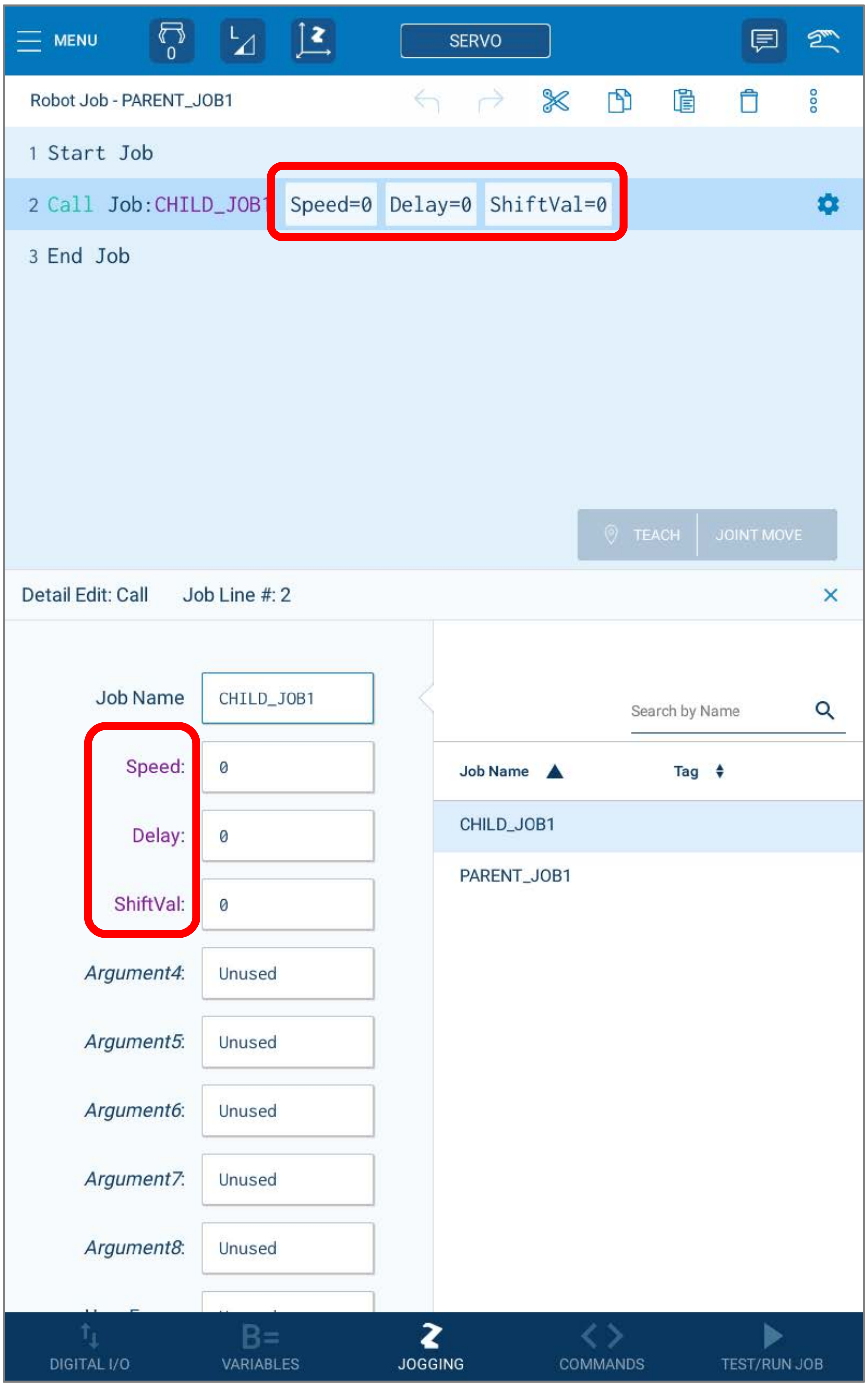
3. Open the parent job (PARENT_JOB1) from the Job List.
4. Under Navigation Bar, press {COMMANDS}.

5. Add a Call command, which can be found under {Control} command group as an advanced command.

   – Parameter names (i.e. Speed, Delay, ShiftVal) are shown on:

   • the Detail Edit panel (if configured)

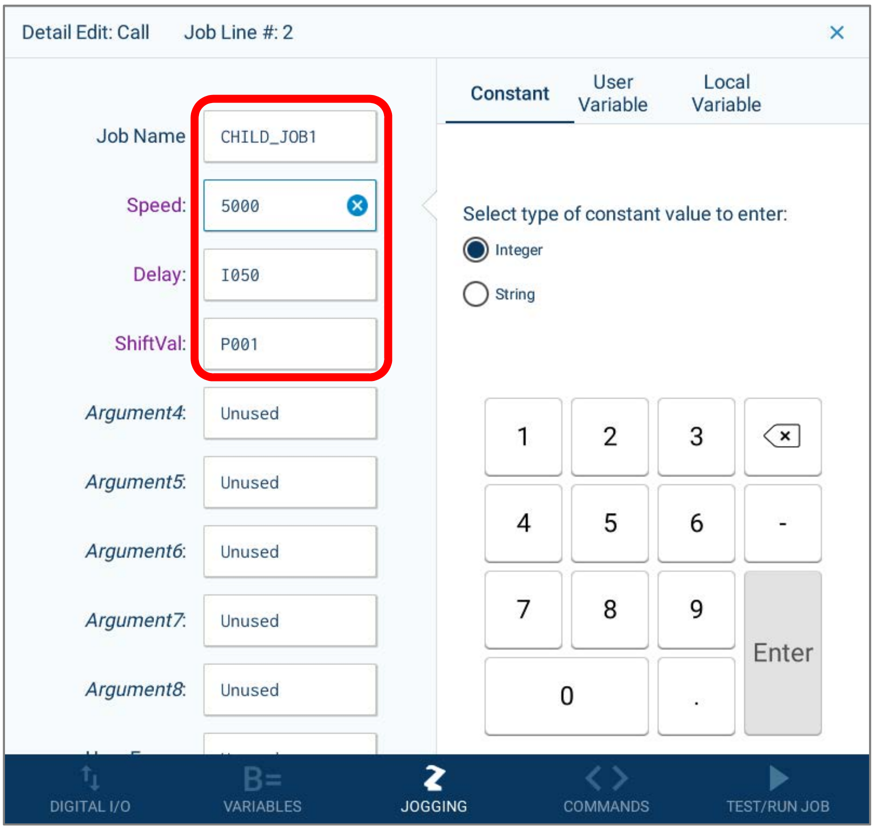
   • the Job Contents view (if configured)



6. Select the Job Name from the list on the right.

7. Insert values into arguments.

   – These values will be passed to the Child job's argument list.



8. Open the child job (CHILD_JOB1) from the Job List.
9. Under Navigation Bar, press {COMMANDS}.

10. Add a GetArgument, which can be found under {Control} command group as an advanced command.

    – GetArgument has two parameters:

      • "Result" parameter: stores the passed argument value. This value must be a Local Variable.

      • "Argument #" parameter: refers to which Argument to get. If this is entered as a constant (i.e. 1-8), the argument name will be displayed at the end of the line in the Job Contents view (shown as "Speed" below).

```
2 GetArgument LD000 InputArgument#(1) //Speed
```

If the argument # parameter is entered as a variable, the argument name will not be shown in the Job Contents view.

```
2 GetArgument LD000 InputArgument#(B000)
```

11. The Job Contents for both the Parent and Child Job is shown below.
    The result of these operations would be:
    - LD000 = 5000
    - LI000 = Value of I050
    - LP000 = Value of P001

Parent Job

```
Start Job
Call Job:EX_CHILD Speed=5000 Delay=I050 ShiftVal=P001
End Job
```

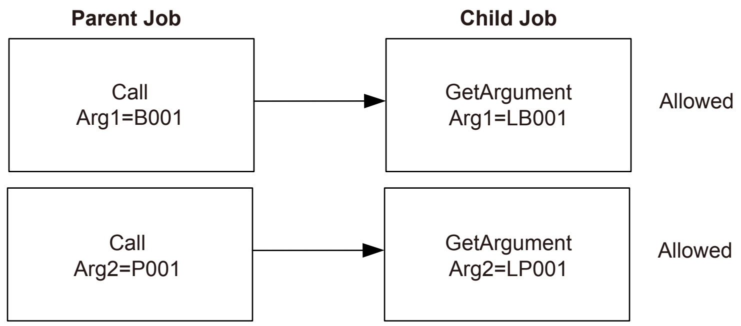
Child Job

```
Start Job
GetArgument LD000 InputArgument#(1) //Speed
GetArgument LI000 InputArgument#(2) //Delay
GetArgument LP000 InputArgument#(3) //ShiftVal
ShiftOn LP000
JointMove Speed=LD000(%)
Timer Time=LI000(seconds)
End Job
```

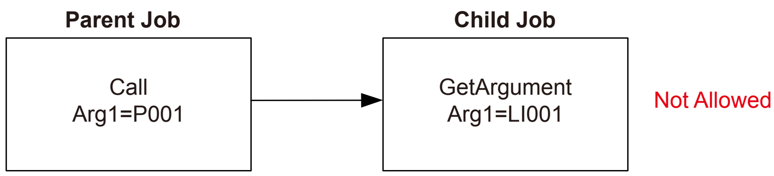
```
LD000=5000
LI000=Value of I050
LP000=Value of P001
```

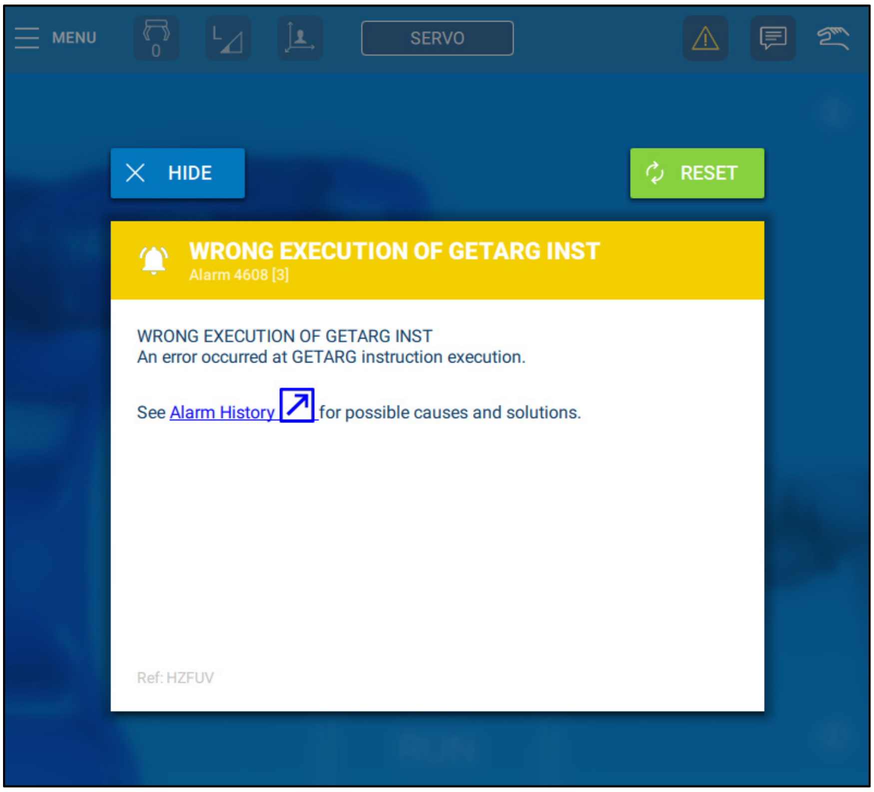
4.8.2.3 Job Argument Type Conversion

The safest way to use the Call and GetArgument instructions is to always make sure that the types match between the two instructions. For example, if Argument 1 in the Call instruction is a B variable, then the GetArgument should copy this value into an LB variable. Similarly, if Argument 2 in the Call Instruction is a P variable, then Get Argument should copy this value into an LP variable.

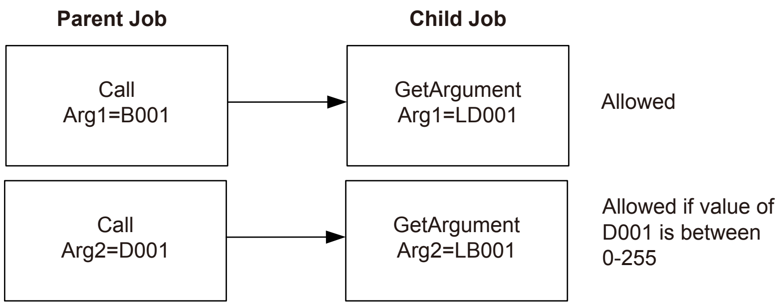


In the case where incompatible types are used (e.g. Argument 1 in the Call Instruction is a P variable and GetArgument tries to set this into an LI variable), the alarm below will be shown during job execution.





However, there are some cases where conversion of parameter types is allowed. For example, if a B Variable is passed in Call Instruction, it can always be copied into a LD Variable in GetArgument as the allowable range of the LD Variable is larger than the B Variable. If a D Variable is passed in Call Instruction, it can be copied into a LB Variable in GetArgument as long as the value of the D variable is between 0-255 which is the allowable range of a LB Variable. Otherwise, the same alarm shown above will be generated.



The following table shows the available type conversions.

		Argument Type passed from Call Instruction							
		Const String	**Const Integer**	**B/LB**	**I/LI**	**D/LD**	**R/LR**	**S/LS**	**P/LP**
Result Type in GetArgument Instruction	**LB**	NO	YES*	YES	YES*	YES*	NO	NO	NO
	LI	NO	YES*	YES	YES	YES*	NO	NO	NO
	LD	NO	YES	YES	YES	YES	NO	NO	NO
	LR	NO	YES	YES	YES	YES	YES	NO	NO
	LS	YES	NO	NO	NO	NO	NO	YES	NO
	LP	NO	NO	NO	NO	NO	NO	NO	YES

*Value of variable passed in Call Instruction must be within the range of the variable assigned in GetArgument.

4.9 Teaching Coordinate

NOTE

Teaching Coordinate (also known as Relative Job on the YRC Pendant) is a purchased option that may or may not be included with the system.

The Teaching Coordinate of a Job defines the coordinate system that is used for teaching positions. By default, the Teaching Coordinate is set to Joint; however, a user can change to the following values:

- Joint
- Robot
- World
- User

Changing the Teaching Coordinate converts all taught positions inside the job to a new type. For example, if changing the Teaching Coordinate from Joint to Robot, all current positions are converted to X/Y/Z/Rx/Ry/Rz data and any new positions are taught with X/Y/Z/Rx/Ry/Rz data.

The most common use case for changing Teaching Coordinate is to use User Frame Coordinates to define re-usable jobs relative to workspace objects such as pallets. An application example of this is shown in *chapter 4.9.2 "Application Example"*.

World and Robot coordinates are often useful as X/Y/Z/Rx/Ry/Rz data is easier to read and interpret than Joint positions. These coordinates are also used for offline teaching. For more details about offline teaching, please refer to "YRC1000 OPTIONS INSTRUCTIONS FOR RELATIVE JOB FUNCTION (HW1483390) chapter 4 or YRC1000micro OPTIONS INSTRUCTIONS FOR RELATIVE JOB FUNCTION (HW1484476) chapter 4. Interface with an Easy Offline Teaching System"

NOTE

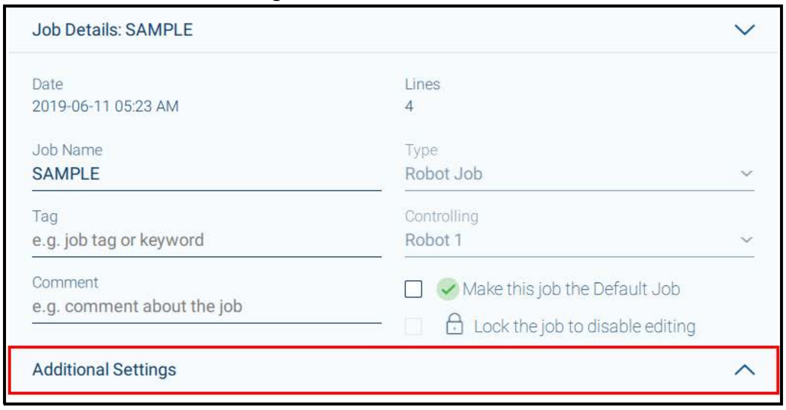
Changing Teaching Coordinate will only affect motion instructions taught using {TEACH} and not motion instructions inserted from Commands panel.

4.9.1 Changing Teaching Coordinate

Use the following steps to change Teaching Coordinate:

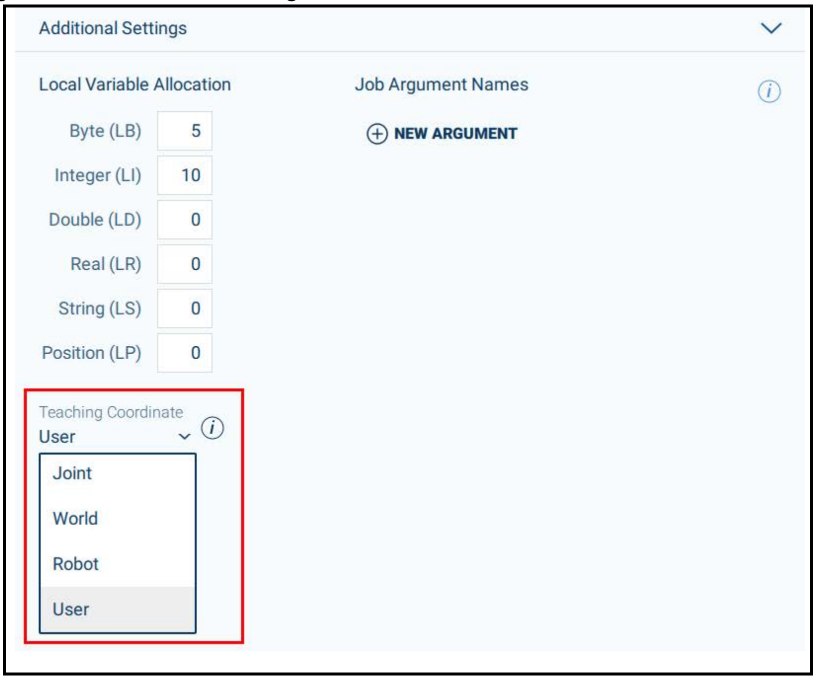
1. Select {Job List} under {MENU}
2. Select the particular job from the list of jobs.
3. Press the {Additional Settings} expansion icon at the bottom of the Job Details panel.

Fig. 4-35: Additional Settings



– This pulls up a new panel for Additional Settings

Fig. 4-36: Additional Settings Panel



NOTE

If Teaching Coordinate is not available on the system, this control is grayed out and a notification explains why it is unavailable when pressed

NOTE

When converting from World/Robot/User back to Joint, the YRC Controller will calculate the resulting joint positions by executing the motions internally starting from the current Robot position. Thus, when doing this conversion, the Robot should be moved to the expected starting position of job. If the Robot is not in the expected starting position, this operation may convert to the wrong path. Confirm the motion path before playing the job.

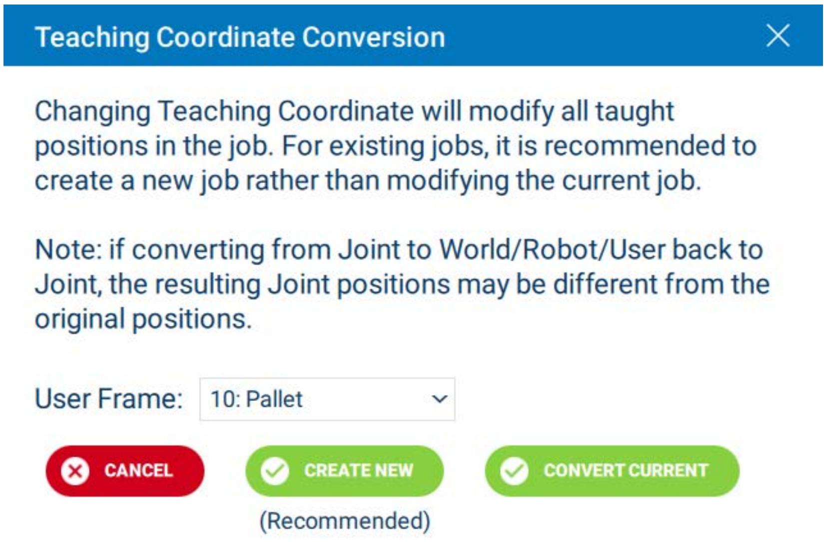
For more information, refer to the “YRC1000 OPTIONS INSTRUCTIONS FOR RELATIVE JOB FUNCTION (HW1483390)” or “YRC1000micro OPTIONS INSTRUCTIONS FOR RELATIVE JOB FUNCTION (HW1484476)”.

4. The popup menu opens with three buttons:
   - {Cancel} - do not change Teaching Coordinate
   - {Create New} - Create a new job with changed Teaching Coordinate. This new job will have “-CONV#” appended to the end (e.g. “SAMPLE” becomes “SAMPLE-CONV1”). This is the recommended action as some position information can be lost in the conversion between different coordinate types.
   - {Convert Current} - This will convert the current job without making a new job. Only perform this action if converting a new job or if the information in the job is no longer needed.

NOTE

When converting to a User Frame, there will be a Drop-down list to select the desired User Frame #. In *fig. 4-37*, User Frame #10 is selected.

Fig. 4-37: Selecting User Frame



NOTE

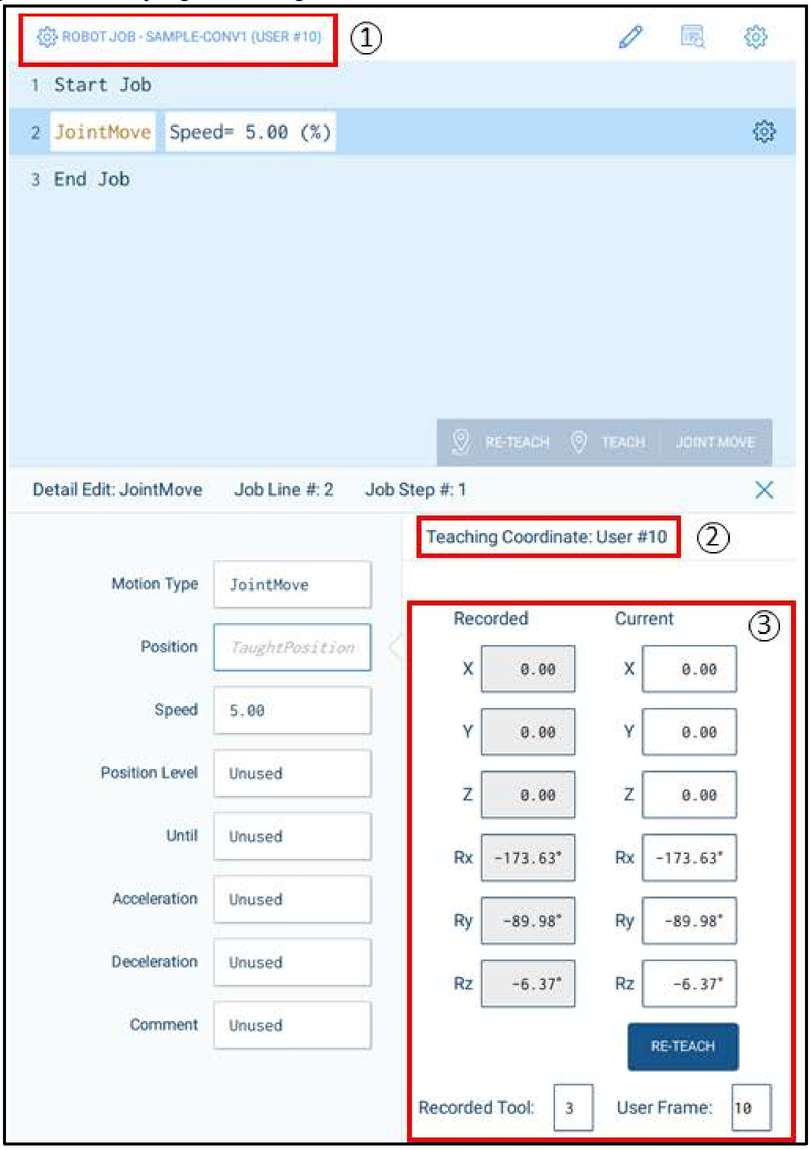
Converting from Joint to World/Robot/User and back to Joint may not result in the original Joint Positions being recovered. Because of this, it is recommended to make a copy of a job when converting Teaching Coordinate.

5. Teaching Coordinate is now changed.To verify, open the new job and check:
   – The new Teaching Coordinate displays on the Inform Header after the Job Name. In this example, the Teaching Coordinate is “User #10”.
   – The new Teaching Coordinate displays at the top of the Position Data panel.
   – When viewing the position data, the data should display in the correct format. In this example, the data is listed in X/Y/Z/Rx/Ry/Rz relative to User Frame #10.

NOTE

Changing Teaching Coordinate will not change the data in global Position Variables. Thus, motion instructions using Position Variables (e.g. “JointMove P001 Speed=50.00”) will not be modified.

Fig. 4-38: Verifying Teaching Coordinates

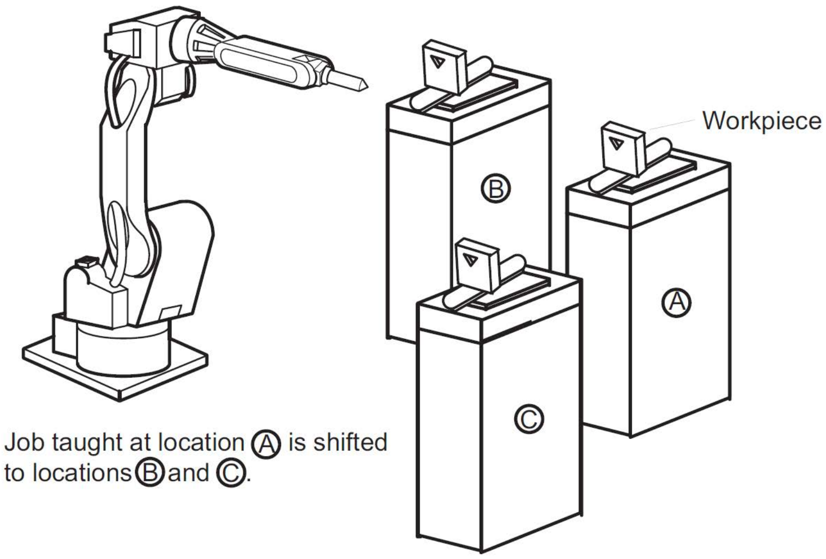


4.9.2 Application Example

The most common Teaching Coordinate to use is "User". This can be used in combination with User Frames and the "Call" instruction to re-use code to perform complex operations.

For example, consider the application in *fig. 4-39* where a Robot needs to perform the same actions for workpieces in three different locations.

Fig. 4-39: Robot with Three Workstations



The basic procedure for using Teaching Coordinate to accomplish this is as follows:

1. Create a job for a single Workpiece (e.g. "WORKPIECE")
2. Teach a User Frame (e.g. UF#1) for the workpiece in that location.
3. Change the Teaching Coordinate of the job created in *step 1* to the User Frame taught in *step 2*.
4. Move to another workpiece location and teach a new User Frame (e.g. UF#2).
5. Repeat *step 4* for all workpiece locations.

6. Specify the User Frame when calling the "WORKPIECE" job from the controlling job as shown in *fig. 4-40*. As long as the Teaching Coordinate of the called job is "User", this will override the internal User Frame # and use the User Frame # in the parameter instead.

Fig. 4-40: Sample Code

```
JointMove  P000  Speed= 25.00 (%)
Call  Job: WORKPIECE  UserFrame= 1
JointMove  P000  Speed= 25.00 (%)
Call  Job: WORKPIECE  UserFrame= 2
JointMove  P000  Speed= 25.00 (%)
Call  Job: WORKPIECE  UserFrame= 3
```

Teaching Coordinate: UserFrame #1
Playback Coordinate: UserFrame #1

Teaching Coordinate: UserFrame #1
Playback Coordinate: UserFrame #2

Teaching Coordinate: UserFrame #1
Playback Coordinate: UserFrame #3

NOTE

- To execute the JOB using the UserFrame parameter in Call Instruction, the Teaching Coordinate of the called JOB should be also User Frame. If Teaching Coordinate is not User Frame, the JOB will work on its own coordinate.
- Calling the JOB with UserFrame parameter also applies to Position Variables where the Ref.Coord is set to User coordinate.

4.10 Parallel Tasks

In normal operation, a single job will execute at a time. This job can use the Call instruction to jump into subroutines; however, these subroutines will run in series with the calling job (i.e. the calling job is suspended until the subroutine completes).

However, it is possible to run jobs in parallel by starting jobs in separate tasks using Concurrent Jobs. This allows the operation of the subroutine to run in parallel with the calling job. For information on how to create a Concurrent Job, see *chapter 3.1.1 "Create New Job"*. Note that the Job Type can only be set after creating a job.

To achieve control of the Concurrent Jobs use the three instructions:

– StartParallelJob

– WaitForParallelJob

– ThreadSync

The following sections will describe the use of these instructions.

NOTE

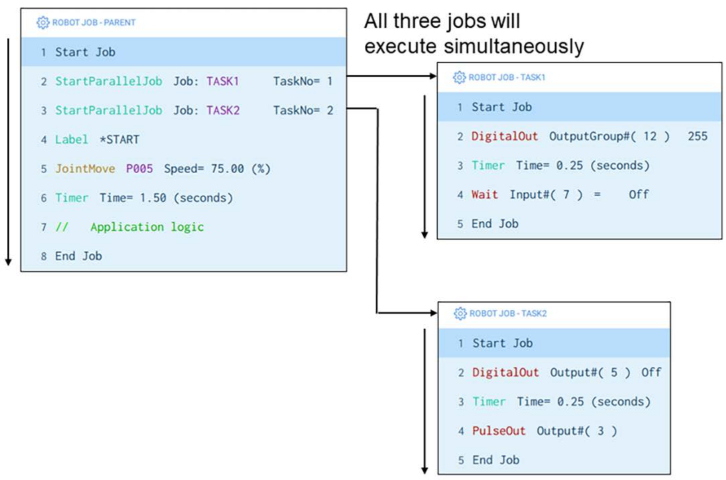
The number of parallel jobs available will vary based on Controller type and configuration settings.

4.10.1 StartParallelJob

Use a StartParallelJob instruction to start a Concurrent Job in a different Task. This instruction takes two parameters: a Job Name and a Task Number. The Job Name is simply the Concurrent Job that you wish to launch. The Task Number is used to specify which task the job will execute in. The main job will always execute in Task #0, and the subroutine's task can be changed between 1 and the max number of tasks allowed by the Controller.

Fig. 4-41 shows an example using a StartParallelJob. The job PARENT (running in Task #0) starts two Concurrent Jobs: TASK1 and TASK2 in Task # 1 and 2. In this case, all three of these jobs will run simultaneously and finish execution independently.

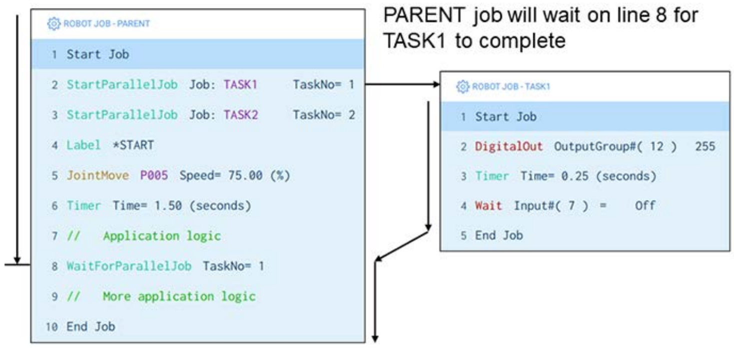
Fig. 4-41: StartParallelJob Example



4.10.2 WaitForParallelJob

The WaitForParallelJob instruction can be used to make an executing job wait for another task to complete. The only parameter to this instruction is the Task Number. For example, the PARENT job in *fig. 4-42* starts TASK1 on Line 2 and then has a WaitForParallelJob instruction on Line 8. Thus, the PARENT job will continue execution until Line 8 where it will pause and wait for TASK1 to be complete. If TASK1 is already complete by the time PARENT job reached Line 8, the PARENT job will not pause.

Fig. 4-42: WaitForParallelJob Example



4.10.3 ThreadSync

The ThreadSync command allows for synchronization between multiple tasks. It also allows these synchronizations to happen in the middle of tasks (whereas WaitForParallelJob can only synchronize with task completion).

This instruction uses two parameters:

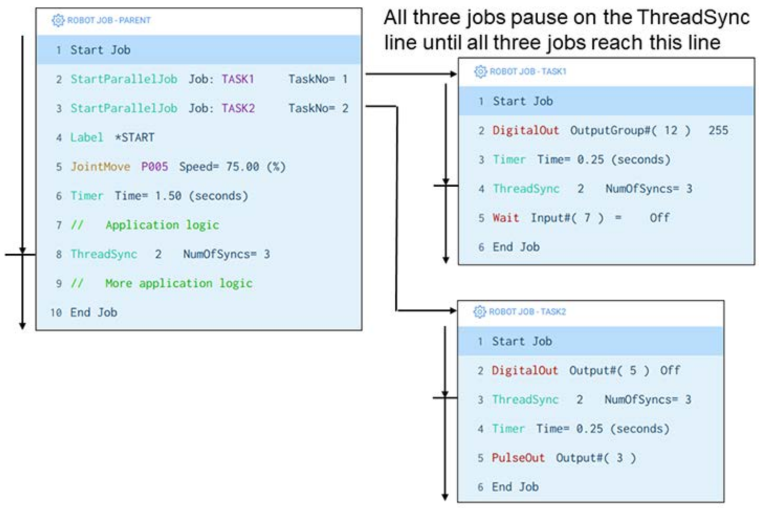
– The first number is a used-defined lvalue that corresponds to that synchronization group (1-32).

– The second number (NumOfSynchs) is the number of tasks that need to be synchronized with that synchronization group.

An example of this is shown in *fig. 4-43*. All three jobs have the same instruction: “ThreadSync 2 NumOfSyncs=3”. The first parameter (“2”) defines the synchronization group. Note that this value could be anything from 1-32 as long as it is the same for all places that require synchronization. The second parameter (“NumOfSyncs=3”) defines the number of places that are being synchronized. Because there are three jobs, this number is three.

When the PARENT job is executed, it will start TASK1 and TASK2 at the top using the StartParallelJob instruction. Then, all three jobs will execute until they reach the line with the ThreadSync instruction (line 8 for PARENT, line 4 for TASK1, and line 3 for TASK2). Once all three jobs reach this line, the execution of all jobs continues.

Fig. 4-43: ThreadSync Example



NOTE

When executing Parallel Tasks, the running tasks can be viewed and switched between. See *chapter 5.5 “Task List”* for more information.

5 Playback

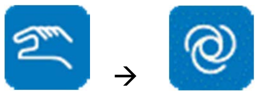
5.1 Preparation for Playback

5.1.1 Selecting a Job

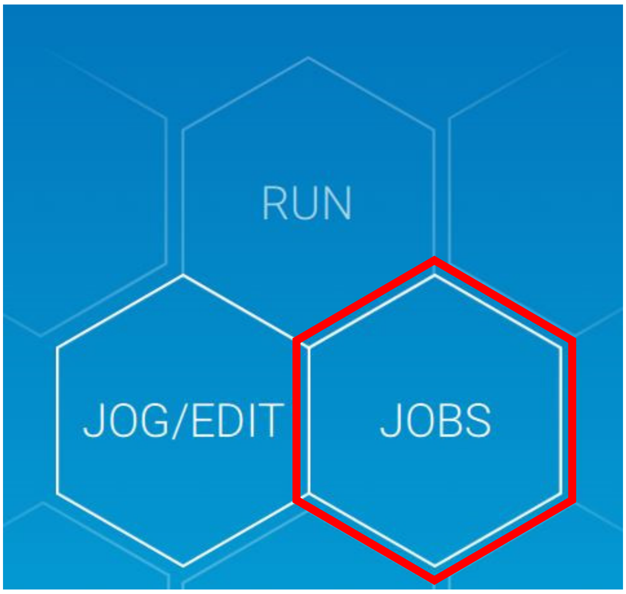
Playback is the act of executing a job. Begin by opening the job to be executed.

5.1.1.1 Open a Job

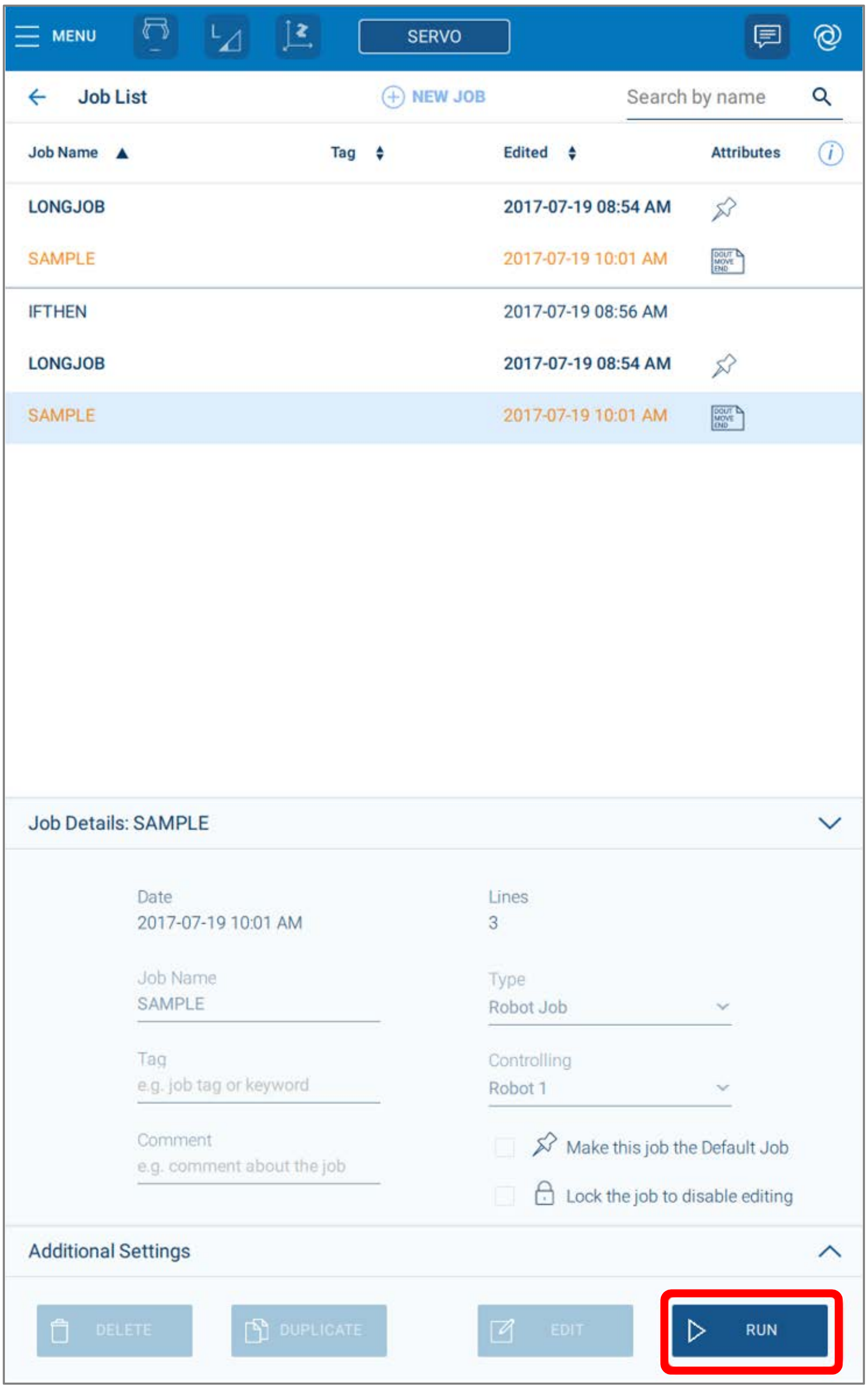
1. Change the mode switch from MANUAL (TEACH) mode to AUTOMATIC (PLAY) mode.
   – The mode icon on the Status Bar will change to the AUTOMATIC (PLAY) mode icon.



2. Select {JOBS} on the Home Screen.



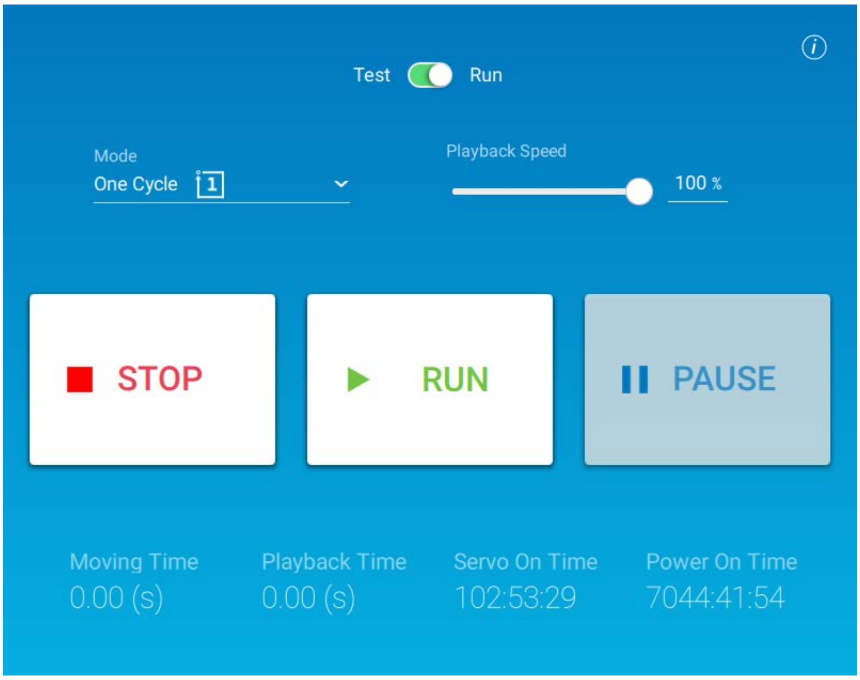
3. Select the desired job from the list and press {RUN}.



5.1.2 Test/Run Job Panel

When the mode switch on the Smart Pendant is switched to “AUTOMATIC (PLAY)” while displaying the Job Contents view, the Test/Run Job panel appears.

Fig. 5-1: Test/Run Job Panel



5.1.2.1 Operation Buttons

Press and hold the button for 2 seconds to execute the job with selected operation cycle.

Pauses at the current line of the job. The servo power will be kept ON. The job can be continued to run from the paused line by pressing the “RUN” button.

Stops the job at the current line. The servo power will be turned OFF.

5.1.2.2 Operation Cycle

There are three types of manipulator operation cycles:

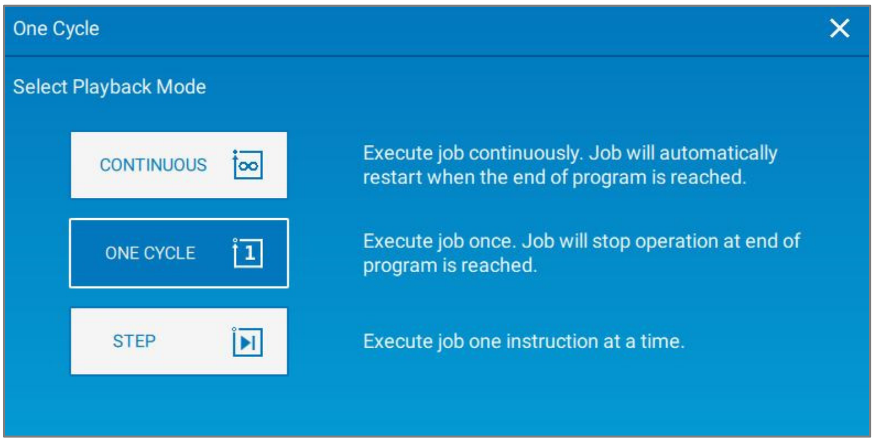
Executes job continuously. Job will automatically restart when the end is reached.

Executes job from current line to the “End Job” line. If {RUN} is pressed again, the job will start from the beginning.

Executes job one line of the program each time {RUN} is pressed.

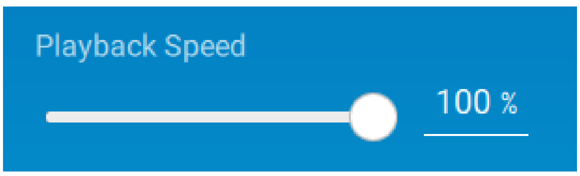
To change the operation cycle:

1. Tap {Mode} under Playback Controls.
2. Select the desired operation cycle.
   – The operation cycle is now changed.



5.1.2.3 Playback Speed

Use this slider to modify the Playback Speed from 10-100%. This will scale all programmed speeds by the specified amount. For example, if Playback Speed is set to “50%”, a linear motion of 1000 mm/sec would execute at 500 mm/sec and a joint motion of 60% would execute at 30%. User can use this to verify Robot motion at a slower speed before full speed execution. This can only be done in AUTOMATIC (PLAY) mode and will revert to 100% if mode is switched back to MANUAL (TEACH) mode.



5.1.2.4 Time Indicators

While the job is executing, these indicators will update with the values shown in this table.

Table 5-1: Time Indicators

Items	Description
Moving Time (seconds)	Total time that the manipulator has moved since job execution began.
Playback Time (seconds)	Total time that has elapsed since job execution began (including Manipulator Idle time)
Servo ON Time (seconds)	Cumulative time the manipulator servo power has been in the ON state since the YRC Controller was first used.
Power ON Time (seconds)	Cumulative time the YRC Controller power has been in the ON state since the YRC Controller was first used.

5.2 Playback

5.2.1 Playback Operation

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

NOTE

After checking to ensure that there is no one in the Robot's workspace, or user is using a human collaborative Robot with Power and Force Limiting (PFL) function active, start playback operation using the Smart Pendant by following the instructions below.

5.2.1.1 Selecting the Start Mode

Set the Mode Switch on the Smart Pendant to AUTOMATIC (PLAY) mode. The AUTOMATIC (PLAY) mode is enabled.

5.2.1.2 Servo ON

Press [SERVO].

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

5.2.1.3 Run Operation

Press {RUN}.

- The manipulator starts operation. The job will start from the selected line that the cursor is positioned. The selected line can be changed in MANUAL (TEACH) mode. A green Run icon will blink in the Menu Bar (top) while the system is running.

The job can be stopped or paused when the job 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. To cancel {Continuous}, switch to {One Cycle} while job is playing.

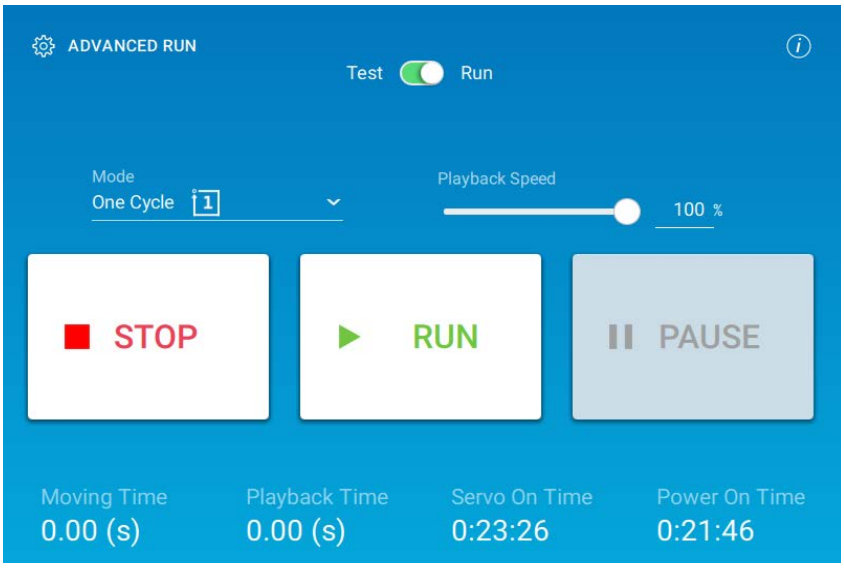
5.2.2 Advanced Run

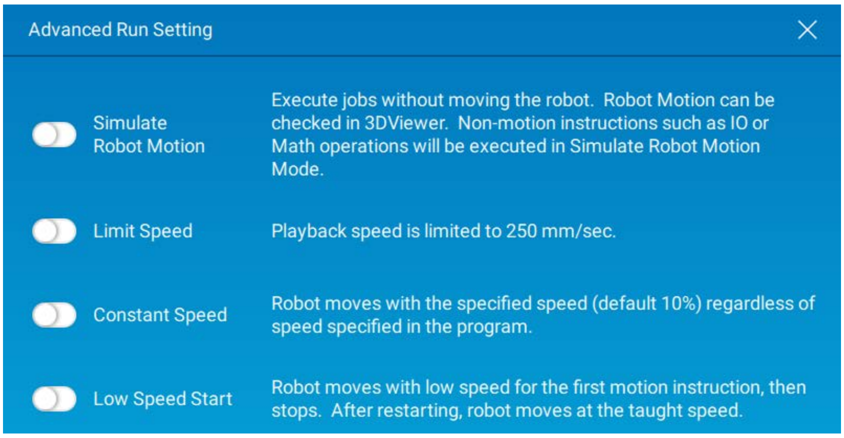
The following advanced run operations can be performed during playback:

– Simulate Robot Motion
– Limit Speed
– Constant Speed
– Low Speed Start

Two or more advanced run operations can be performed at the same time. If multiple operations are selected, the speed during playback is limited to the speed of the slowest operation.

To use advanced run, open {Advanced Run} setting and enable desired advanced run.





5.2.2.1 Simulate Robot Motion

Simulate robot motion can perform job playback without moving the robot. This provides the benefit of checking robot motion using 3D simulation without moving the robot. While simulating robot motion, non-motion instructions such as IO or Math operations will be executed.

For using the 3D Viewer, refer to *chapter 9.1 "3D Viewer"*

SUPPLE-MENT

- The setting of "Simulate Robot Motion" is maintained even after the mode is switched: that is, if it is set to enabled in the Manual (Teach) mode, it will stay enabled after switching to Automatic (Play) mode.

  The same applies when the mode is switched from the Automatic (Play) mode to Manual (Teach) mode.
- Note that the Simulate Robot Motion becomes disabled after controller is restarted.

5.2.2.2 Limit Speed

Playback speed is limited to the speed for Manual (Teach) mode. Usually, the limited speed is set to 250 mm/s at the TCP and the flange.

For the motion commands in which the speed at the TCP is 250 mm/s or less, operation is performed at the taught playback speed.

5.2.2.3 Constant Speed

Robot moves with the specified speed (default 10%) regardless of speed specified in the program.

The robot executes all the motion commands at the constant speed, which is convenient for quick check of a job consisting of slow operations.

NOTE

Be careful of motion command programmed at lower speeds than the constant speed, because they will be executed at greater speeds than that programmed.

5.2.2.4 Low Speed Start

Robot moves with low speed for the first motion instruction, then stops. After restarting, robot moves at the taught speed.

After low speed start, this setting will be automatically disabled.

SUPPLE-MENT

It is also possible to always perform low speed start.

To always perform low speed start, open {Menu} → {System Settings} → {Controller} screen, and set "Low Speed Start" setting to {Always}.

5.3 Stop and Restart

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

- Pause
- Emergency Stop
- Alarm
- Stop due to other causes

5.3.1 Pause

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

5.3.1.1 Using the Smart Pendant

■ **Pause**
Press {PAUSE} on the screen

Press [PAUSE] on the membrane key

■ **Release**
Tap {RUN} on the screen to restart the operation

Press [RUN] on the membrane key to restart the operation

Tap {STOP} on the screen

5.3.1.2 Using an External Input Signal (System Input)

■ **Pause**
Turn ON the HOLD signal from an external input (system input)

■ **Release**
Turn OFF the HOLD signal from an external input (system input)

5.3.2 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 front door of the YRC Controller (some models do not have this button)
- Emergency Stop button on the Smart Pendant
- External input signal (system input)

5.3.2.1 Emergency Stop

Press the Emergency Stop button.

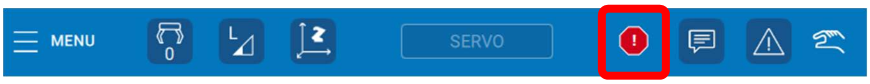
The servo power turns OFF and the manipulator stops immediately.

– Emergency Stop button on the YRC Controller (some models do not have this button)

– Emergency Stop button on the Smart Pendant

The Emergency Stop icon will appear on the Status Bar.

Fig. 5-2: Emergency Stop Icon



5.3.2.2 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] ON. If the system is in MANUAL (TEACH) mode, make sure to also grip the Enable switch.

5.3.2.3 Restart After an Emergency Stop

CAUTION

- Prior 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.
- If an Emergency Stop is performed during a high-speed operation involving consecutive steps, the manipulator may stop two or three steps before the displayed step. If operations are restarted under such conditions, the manipulator may interfere with its workspace.

5.3.3 Stop by Alarm

If an alarm occurs during operation, the manipulator stops immediately and the ALARM pop-up window appears on the Smart Pendant indicating that the machine 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 the Alarm icon on the status bar. To view previous alarms that are currently inactive, select {ALARM HISTORY} under {MENU}.

For more information, refer to *chapter 15 “Startup Error”* .

5.3.4 Others

5.3.4.1 Temporary Stop by Mode Change

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

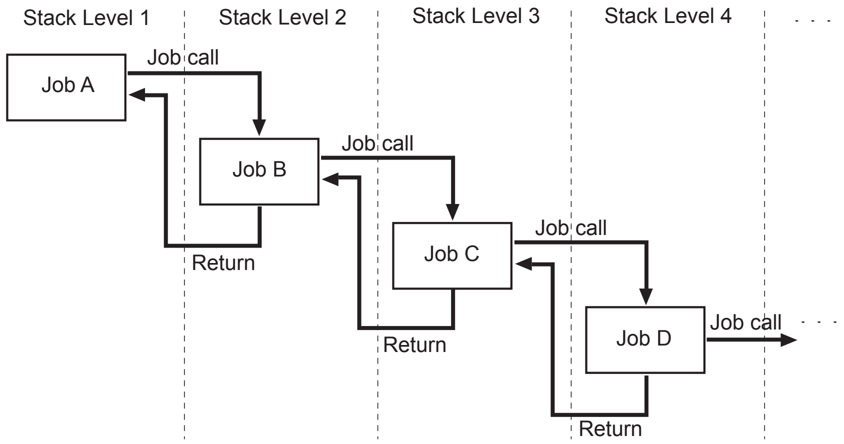
5.3.4.2 Temporary Stop by the PAUSE Instruction

When the PAUSE instruction is executed, the manipulator stops operating. To restart operation, perform a start operation. The manipulator restarts from the next instruction.

5.4 Job Stack

A job stack is saved as the Robot performs a series of jobs, provided the Call command is used. Job calls can be stacked up to 12 levels. As shown previously, a hyperlink is provided to quickly navigate to the top of the Job Stack in the case of an unexpected error or stoppage in Job playback. For more information on the Job Call, refer to *chapter 4.8.2 "Job Arguments"*. To display the stacked job, refer to *chapter 4.5.3.6 "Display Job Stack"*.

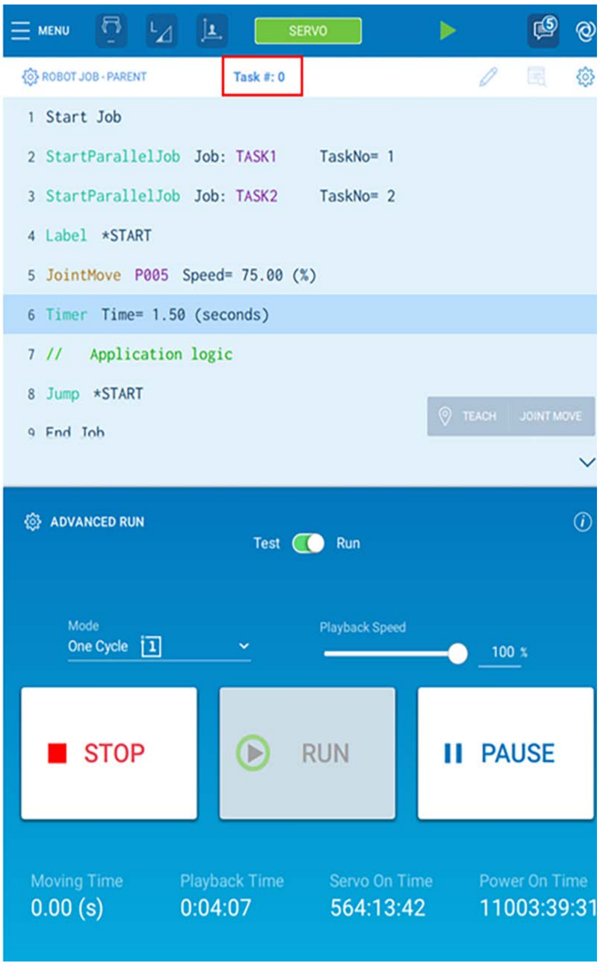
Fig. 5-3: Job Stack



5.5 Task List

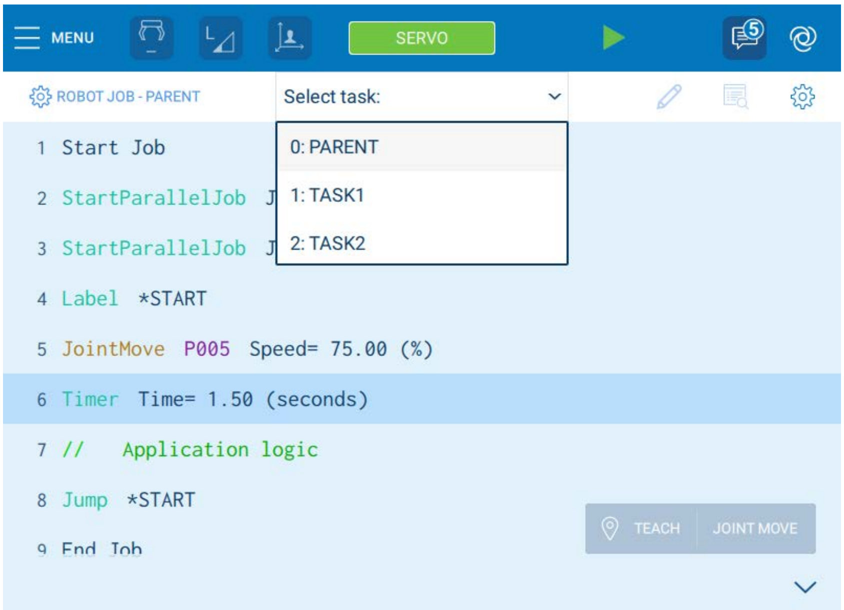
In the case of multiple tasks executing (see *chapter 4.10 "Parallel Tasks"*), the running tasks can be viewed and switched between from the Inform Header. A button showing the current task number appears in the Inform Header as shown in *fig. 5-1*.

Fig. 5-4: Task List Button



If this button is pressed, a Drop-Down showing the running tasks will appear as shown in *fig. 5-5*. In this case, there are three tasks running (0: PARENT, 1: TASK1, 2: TASK2). Selecting a different task will open that job and show its execution progress. Note: the task will automatically be set back to 0 if a task completes or the mode is changed to MANUAL (TEACH).

Fig. 5-5: Task List Drop-Down



6 Robot Settings

WARNING

- Data related to the system's basic functions can be modified; however, inappropriate modification may cause fatal incident or failure for the manipulator or the whole system.

Before performing Robot setting, carefully read and understand the instructions, and make sure to observe the precautions.

- Robot setting must be performed under the supervision of the administrator.

NOTICE

- Make sure to perform data storage and manage them whenever creating or modifying data.
- YASKAWA is not responsible for any incident or failure caused by inappropriate setting of data.

6.1 Tool Settings

CAUTION

- Ensure tool information (particularly mass properties) are set correctly.

Failure to observe this instruction will affect the performance of the Robot, particularly those with power and force limiting functions for human collaborative operation, which may result in personal injury.

Tool information is saved in tool files.

Each tool setting is broken down into three categories:

– Tool Mass Properties

– Tool Frame

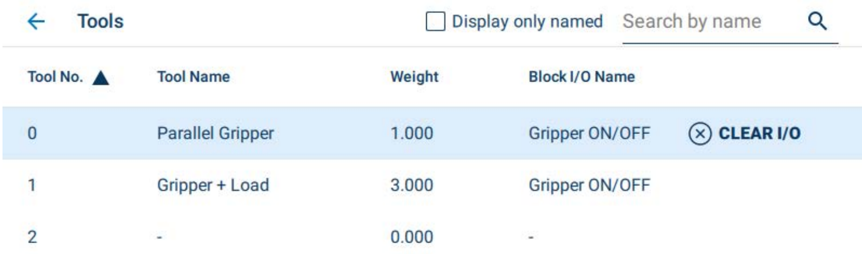
– Tool I/O

6.1.1 Tool Files

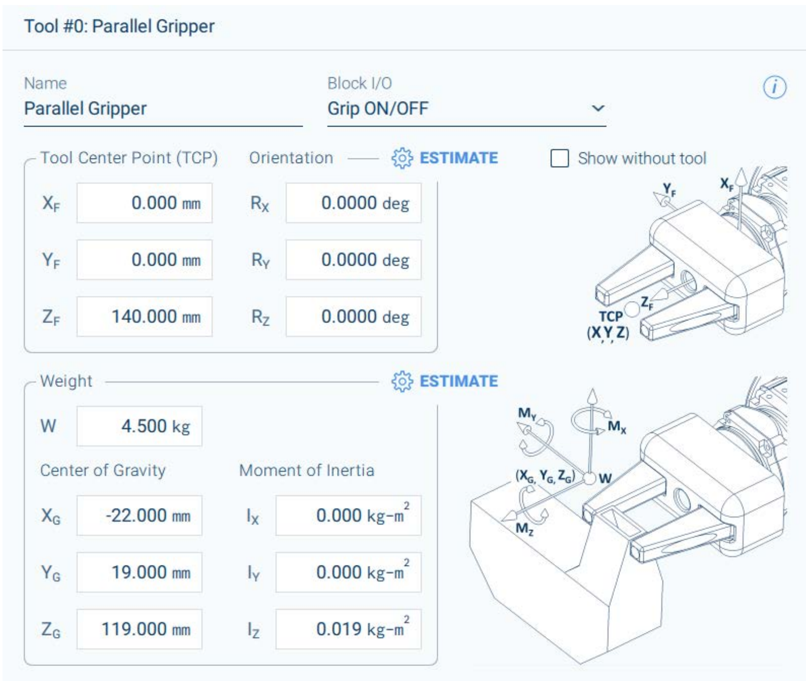
Tool files store definitions for its mass, orientation, and I/O.
There are 64 tool files available, numbered from 0 to 63. The active tool file must be switched if the Robot's load changes.

To set the tool information, open the tool file.

1. Go to {Robot Settings} under {MENU}.
2. Select Tools.
   – The Tools screen will appear.



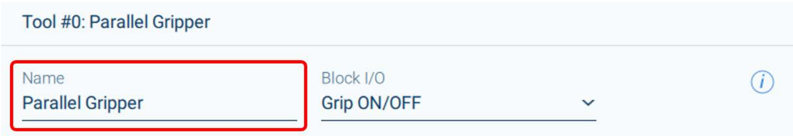
3. Select tool from the list by selecting the row associated with the desired tool number.
   – Tool Detail panel of the selected tool number will appear.



6.1.2 Tool Name

A tool name can be from 0 to 16 alphanumeric characters in length, including the minus (–) symbol. The Name must start with letters. The same tool name can be used multiple times.

Fig. 6-1: Tool Name

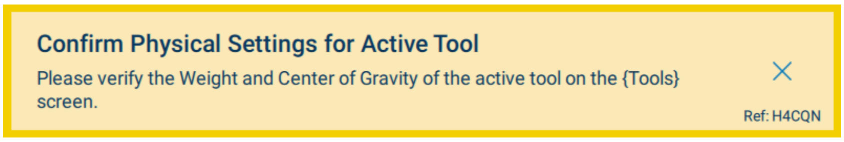


6.1.3 Tool Mass Properties

Setting the correct Tool Mass Properties is critical to maintain system performance. For the manipulators that have Power and Force Limiting functions (e.g. MOTOMAN-HC10), the Tool Mass Properties weight, center of gravity, and moment of inertia are used to calculate external force. Therefore, these values must be entered precisely and tool setting must be updated in any case where a tool and/or workpiece is changed. For manipulators without Power and Force Limiting functions, the Tool Mass Properties are used to optimize the manipulator's motion performance. Failure to set these properties may result in non-optimal motion times.

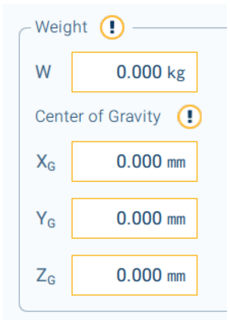
If the active tool number is changed to a tool setting with one or multiple Tool Mass Properties containing zero values, a notification will appear directing the user to the {Tools} screen.

Fig. 6-2: Confirm Physical Settings for Active Tool



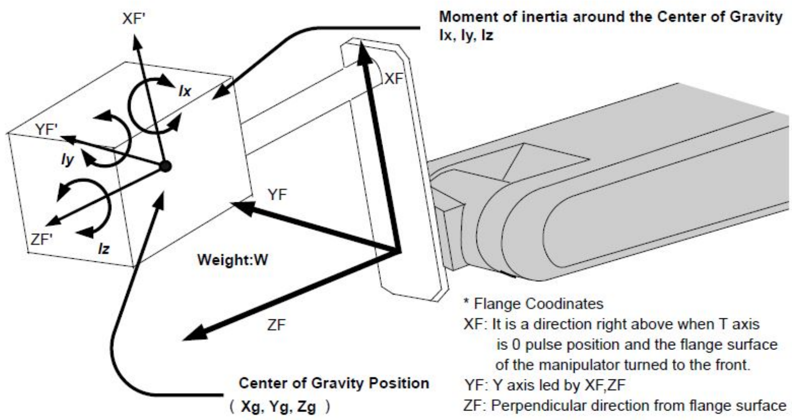
On the {Tools} screen, warning icons will appear near any setting(s) that may affect the performance of the manipulator. These values should be properly entered before finalizing the details of a job.

Fig. 6-3: Warnings for Critical Tool Settings Containing Zero Values



Tool Mass Properties include the weight, a center of gravity position, and moment of inertia at the center of gravity of the tool installed at the flange. A visual representation of each is provided in *fig. 6-4*.

Fig. 6-4: Visual Representation of Tool Mass Properties

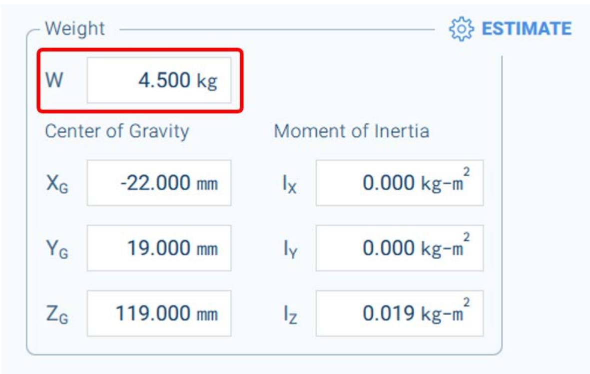


6.1.3.1 Weight

The total weight of the installed tool is set in kg. For a standard industrial Robot, it is recommended to set a value slightly greater than the actual load. Round up the value between 0.5 to 1.0 kg for small and medium size Manipulator. For a Collaborative Robot, use the weight of the tool assembly-as measured on an accurate scale.

If the weight changes during an application, multiple tools may need to be created. For example, if the “gripper (tool)” grasps and lifts a “box (work)” off a table, tool weight is “gripper only” until the “box” is grasped. Tool weight becomes “gripper + box” after box is lifted. To reflect this accurately, two tools must be created. The first tool represents the “gripper (tool)” only and the second tool represents the “gripper + box” combined.

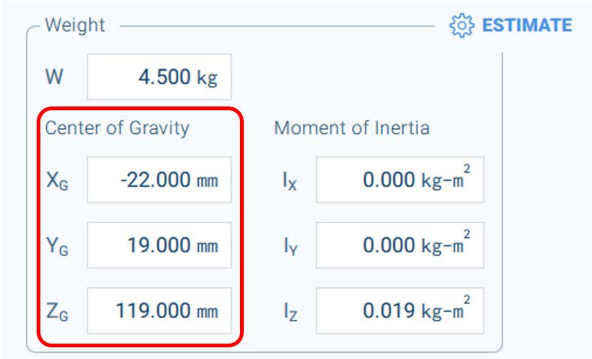
Fig. 6-5: Tool Weight



6.1.3.2 Center of Gravity

The tool’s center of gravity is defined in mm. Measurements are taken from the flange center point (FCP) in X, Y, Z direction. Enter this data as provided by the tool manufacturer or from an accurate CAD model. In the absence of this information, the center of gravity can be approximated using the Tool Load Estimation feature described in *chapter 6.1.3.4 “Automatic Estimation of Tool Mass Properties”*.

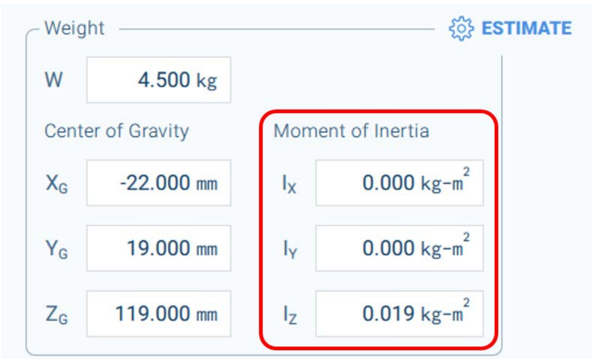
Fig. 6-6: Tool Center of Gravity



6.1.3.3 Moment of Inertia

The moment of inertia is calculated about the tool's center of gravity shown in *fig. 6-4*. The tool’s moment of inertia is inserted in kg•m². Enter this data as provided by the tool manufacturer or from an accurate CAD model. In the absence of this information, the moment of inertia can be approximated using the Tool Load Estimation feature described in *chapter 6.1.3.4*.

Fig. 6-7: Tool Moment of Inertia



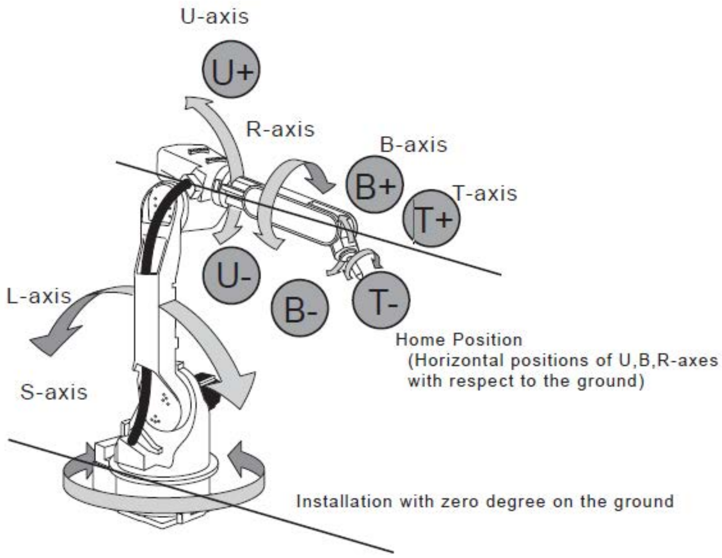
6.1.3.4 Automatic Estimation of Tool Mass Properties

To ensure a Robot can achieve the speeds and force levels intended, accurate mass properties for the installed tool (and workpiece if present) must be registered. In the absence of known mass properties, Tool Load Estimation is an operation approximates this data through Robot motion. After a series of motions are completed, the selected mass properties will be updated and can be sent to the {Tools} screen for the user to review and save.

> **NOTE** This function can only be used with floor-mounted Manipulator configurations. Also, this feature will not account for any loads applied to the upper arm (i.e. "ARM Control" on Classic Interface).

To estimate the mass properties of a tool load, move the manipulator to its home position (U-, B- and R-axes: horizontal to the ground) and operate the U-, B- and T-axes.

Fig. 6-8: Estimating Mass Properties of a Tool Load



> **NOTE** To correctly estimate tool weight, center of gravity, and/or inertia, remove any cables or wires connected to the tool to prevent unnecessary loads from being applied.

On Smart Pendant, the Tool Load Estimation screen can be accessed as follows:

1. Go to {MENU} → {Robot Settings} → {Tools}
2. Select the desired Tool from the list at the top.

3. Press {ESTIMATE} on the mass property section of the tool's detail panel at the bottom.

Fig. 6-9: {ESTIMATE} on Tool's Detail Panel

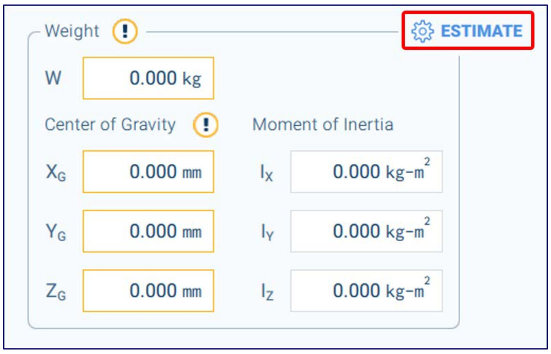
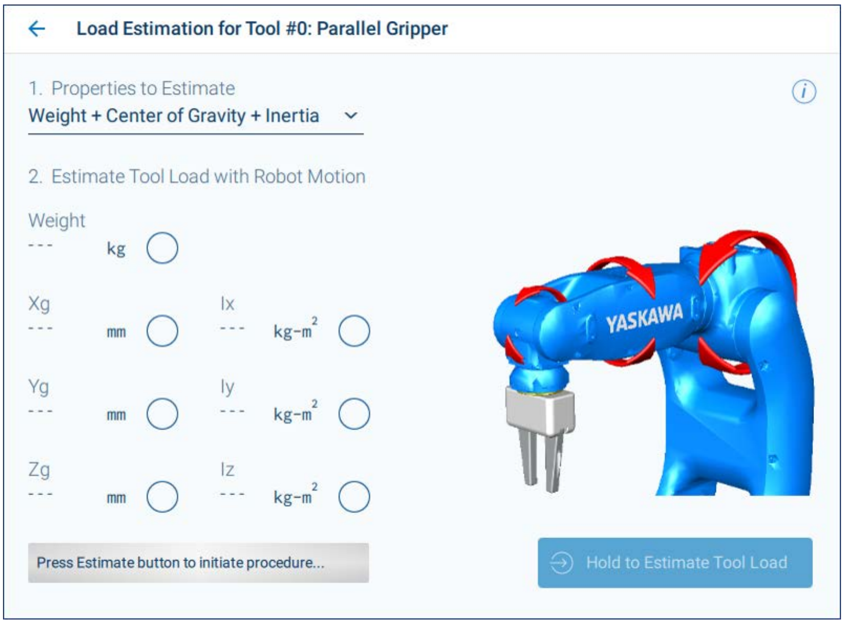
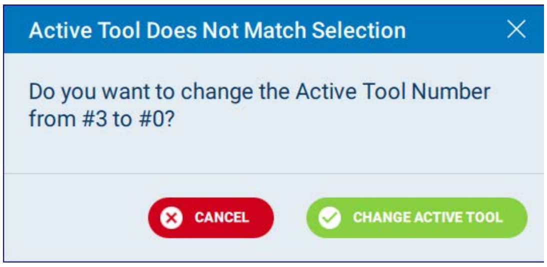


Fig. 6-10: Tool Load Estimation Screen



NOTE

A dialog appears if the Active Tool does not match the Tool selected from the list. These must match to perform the Tool Load Estimation procedure.



Tool Load Estimation Procedure

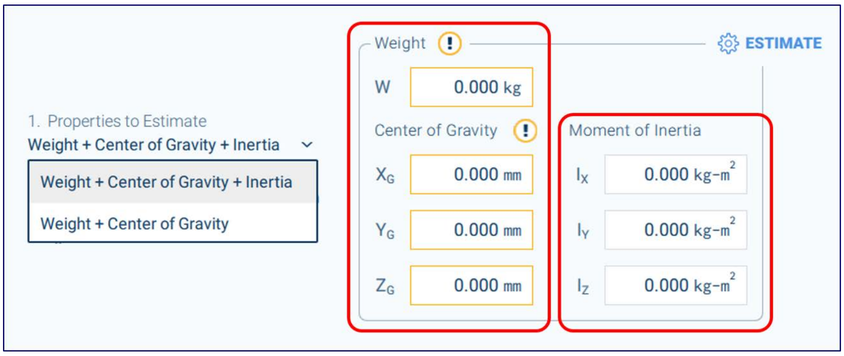
Three steps are required to successfully estimate the mass properties of the installed tool (and workpiece if present):

1. Selection of {Properties to Estimate}
2. Execute the motion sequences to estimate tool mass properties
3. Confirm, send, and save results on the {Tools} screen

Detailed instructions to complete these steps is provided in the following sections.

1. Selection of Physical Properties to Estimate
   – The user can select from one of two methods on the {Tool Load Estimation} screen:

Fig. 6-11: Tool Load Estimation Screen



- **Weight + Center of Gravity + Inertia**: Estimates all mass properties of the installed tool
  - Weight and Center of Gravity must be accurately entered for the system to perform as intended. Inertia is particularly important for large and/or non-symmetric tools.
- **Weight + Center of Gravity:** Estimates weight and center of gravity only
  - This option skips the inertia estimation, saving time for small, symmetric tools

2. Motion Sequence for Tool Load Estimation
   This procedure uses a series of Robot motions to estimate the properties selected. An image on the right side of the screen will dynamically update to indicate which axes are moving during each step of the process. Use the following components to successfully complete the estimation procedure:

CAUTION

- Make sure the installed tool does not interfere with the Robot.

Failure to observe this caution can result in equipment damage.

a) Press {Hold to Estimate Tool Load} to initiate and execute the estimation procedure.

① Holding button until notifications indicates.

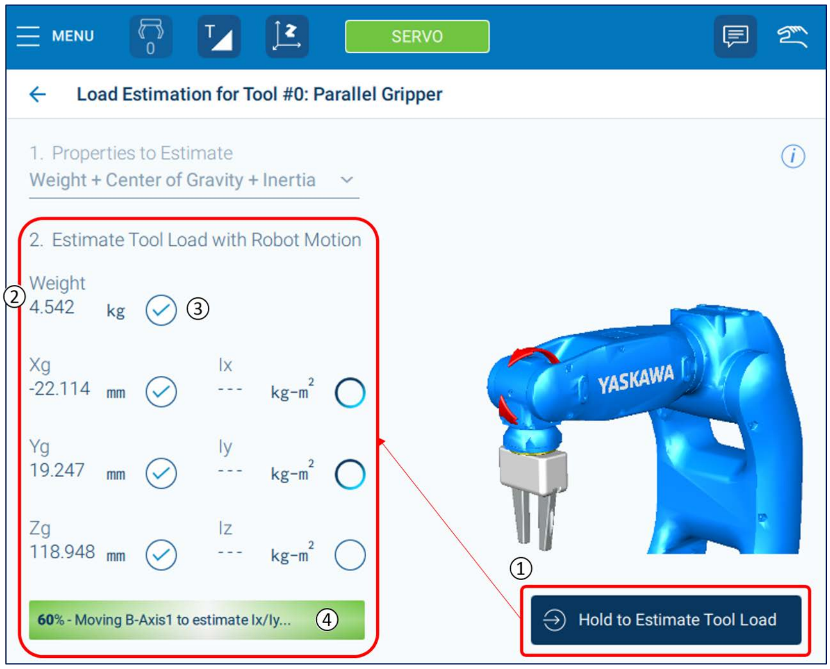
NOTE

The Estimation procedure requires an active Speed Limit settings and/or PFL settings to be temporarily disabled. A pop-up with instructions appears if these states are detected.

② The selected fields will update when the calculation is complete.

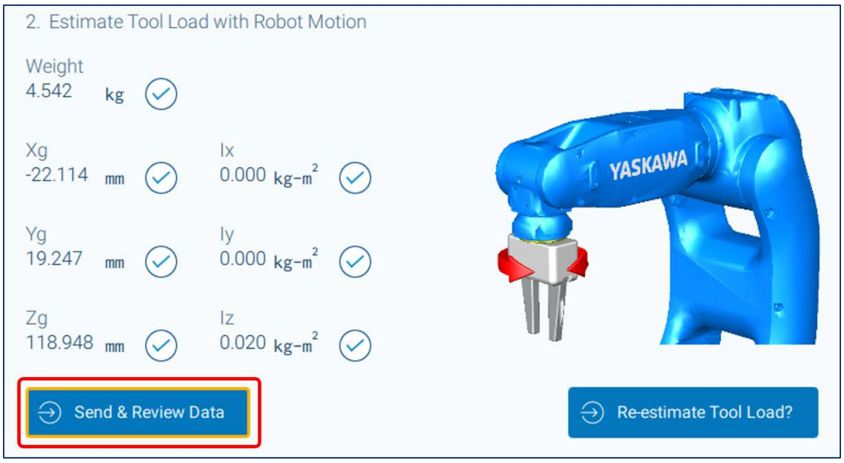
③ Each field has a status indicator that reads undefined, in progress, or completed.

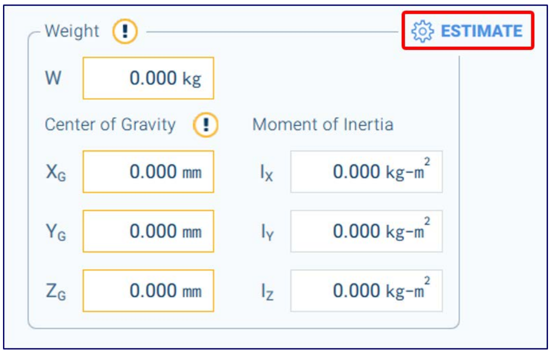
④ A progress bar with accompanying text provides the user with a status of the overall estimation procedure.



3. Send New Mass Property Data to Tools Screen

   Review the results for the chosen physical properties. If no errors in the estimation are present, press {Send & Review Data} to send the date to the {Tools} screen for saving. Refer to *chapter 6.1.5* for instructions to properly save the data.





4. Verification of Estimated Tool Mass Properties

   If using a non-collaborative Robot, run a job that contains motions programmed with the tool that now has newly saved property data. If the job runs at the desired speed with no collision detection alarms, the estimated mass property data is sufficient.

   If using a collaborative Robot, navigate to the {Safety Function Setting} → {Force/Torque Watch} to view the live torque sensor readings. Ensure the Active Tool # matches the tool setting with newly estimated mass property data. If “Current TCP” value(s) on the Force/Torque Watch screen exceed 30N while the Robot is not moving the Tool Load Estimation procedure should be repeated to obtain more accurate values.

6.1.4 Tool Frame

6.1.4.1 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 offsets can also be set (see *chapter 6.1.4.2 "Orientation of Tool Tip"*). Configuring the Tool Center Point will allow Cartesian jogging of the manipulator about the correct point and will also ensure the Taught Positions 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 described in *chapter 6.1.4.4*.

Fig. 6-12: Tool Center Point

6.1.4.2 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 degrees. Enter this data as provided by the tool manufacturer or from an accurate CAD model. In the absence of this information, the tool's orientation can be accurately calculated using the TCP Calibration feature described in *chapter 6.1.4.4*.

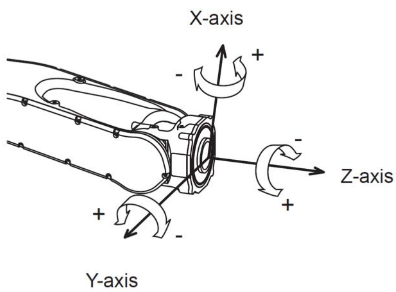
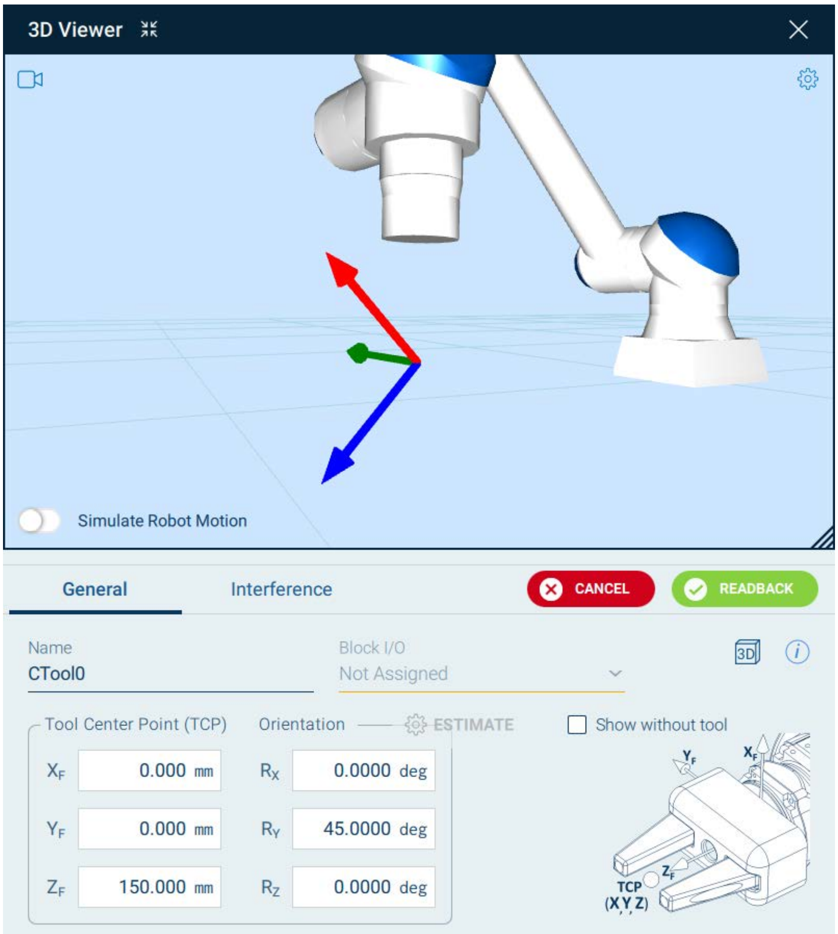


Fig. 6-13: Orientation of Tool Tip

6.1.4.3 Display in 3D Viewer

As the Tool Frame data is entered, the 3D Viewer will update and can be used to verify that the data is correct. For example, Figure 6.1 shows a tool with Z=150 mm and Ry=45 degrees being entered and the corresponding display on the 3D Viewer.

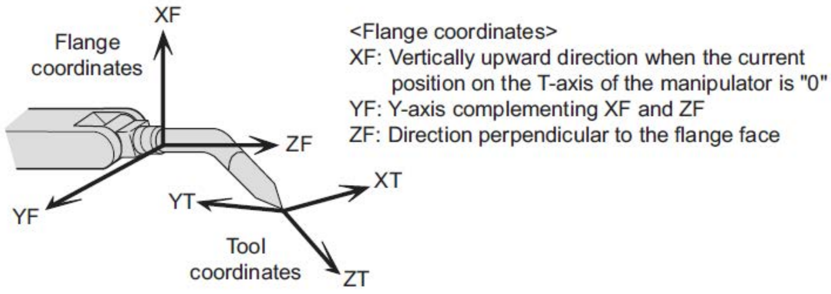
Fig. 6-14: Tool Frame in 3D Viewer



6.1.4.4 Tool Center Point (TCP) Calibration

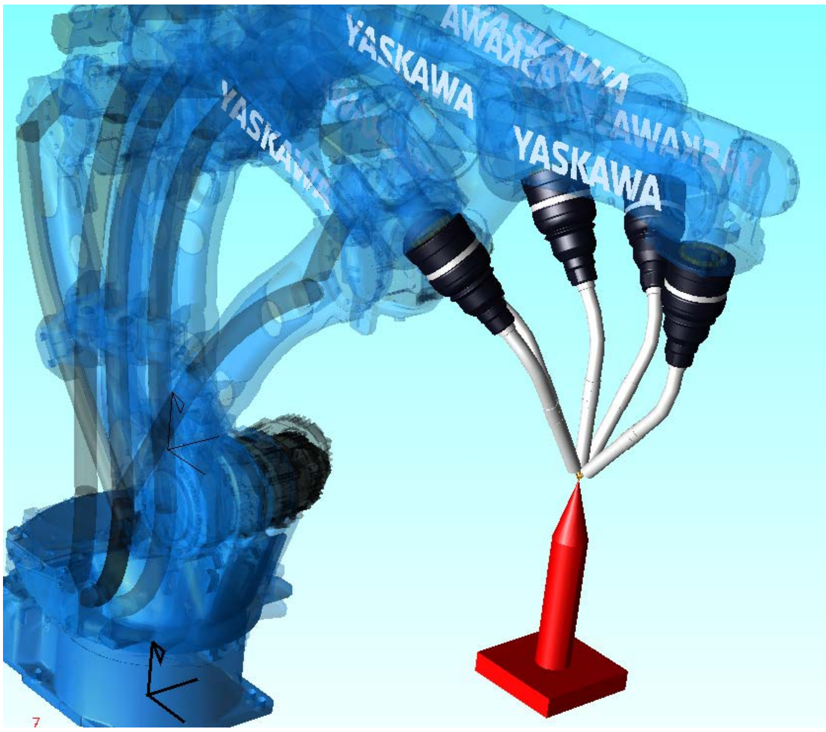
To ensure a Robot can properly perform linear and circular motions, the TCP introduced above must be fully defined. In the absence of known tool frame properties, TCP Calibration is an operation that accurately calculates this data through a series of recorded postures. This procedure can calculate the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

Fig. 6-15: TCP's XYZ Coordinates and/or Orientation Data in the Flange Coordinates



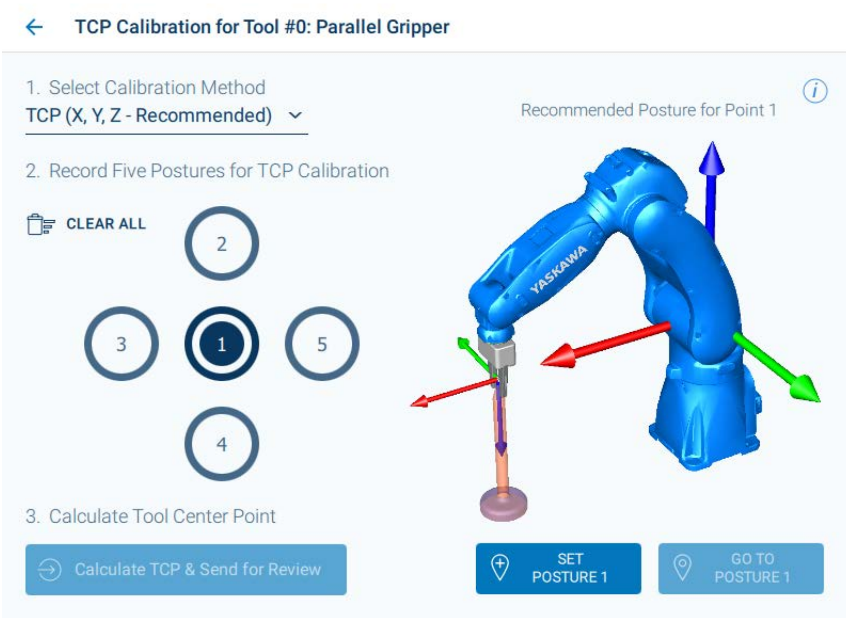
To calibrate the TCP's XYZ coordinates, five different postures must be registered about a reference point with a fine tip (example shown in red in *fig. 6-16*). YASKAWA recommends aligning the first posture of the tool with the center of the reference point and then rotating the tool around it with significant angle to define the remaining four postures. See *fig. 6-17 "Calibration Postures"* for detail on these postures.

Fig. 6-16: Reference Point with a Fine Tip

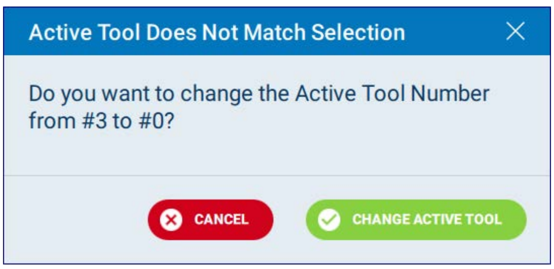


On Smart Pendant, the TCP Calibration screen can be accessed as follows:

1. Go to {MENU} → {Robot Settings} → {Tools}.
2. Select the desired Tool from the list at the top.
3. Press {ESTIMATE} on the tool frame section of the tool's detail panel at the bottom.



A dialog may appear if the active tool does not match the Tool selected from the list. These must match to accurately perform the TCP calibration procedure.



■ TCP Calibration Procedure

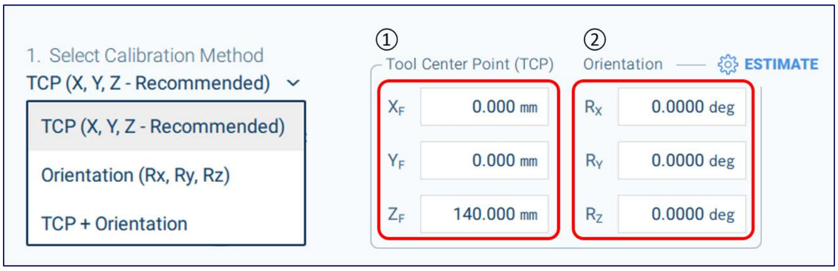
Three steps are required to successfully calibrate the Tool Center Point:

1. Selection of desired {Calibration Method}
2. Move to and {Set} Robot postures required to calibrate the TCP
3. Calculate, send, and save tool frame data on {Tools} screen

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

① Selection of Desired Calibration Method

The user can select from one of three methods on the {TCP Calibration} screen:



- **TCP (X, Y, Z):** Calibrates TCP's XYZ coordinates only, recommended for most users

  "TCP Coordinates" are calculated from five postures (1 to 5) set by the user. In this case, Tool Orientation will not be changed (previous values are maintained).

- **Orientation (Rx, Ry, Rz):** Calibrates tool orientation only

  Tool "Orientation" is calculated using a single posture (1) set by the user. In this case, TCP XYZ coordinates will not be changed (previous values are maintained).

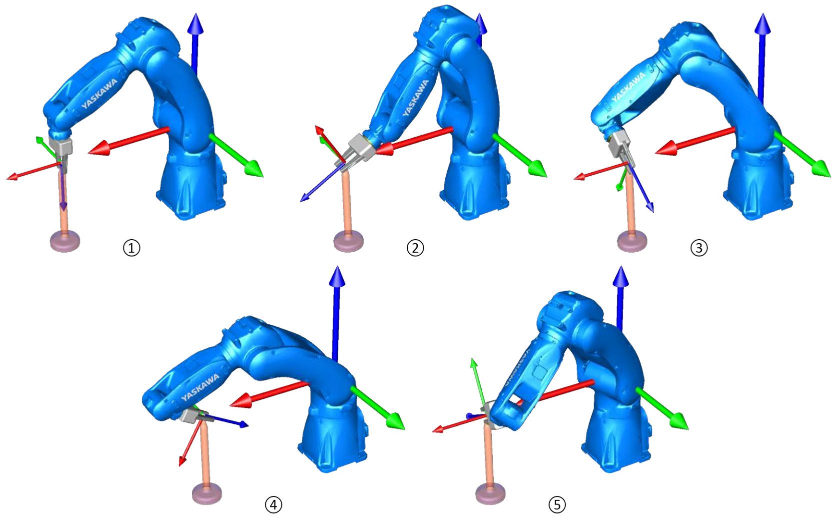
- **TCP + Orientation:** Calibrates both the TCP's XYZ coordinates and tool orientation

  "Orientation" is calculated from the first recorded posture (1) and "Coordinates" are calculated using all five recorded postures (1 to 5)

① Set and Move To Calibration Postures

YASKAWA recommends setting the five calibration postures in the following configuration for the best results. The easiest jogging mode to start with is XYZ-World while XYZ-Tool mode can be used to refine and verify the resulting TCP.

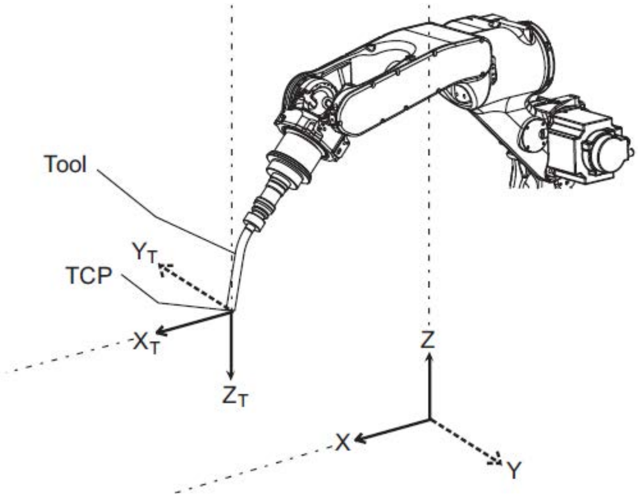
Fig. 6-17: Calibration Postures



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.

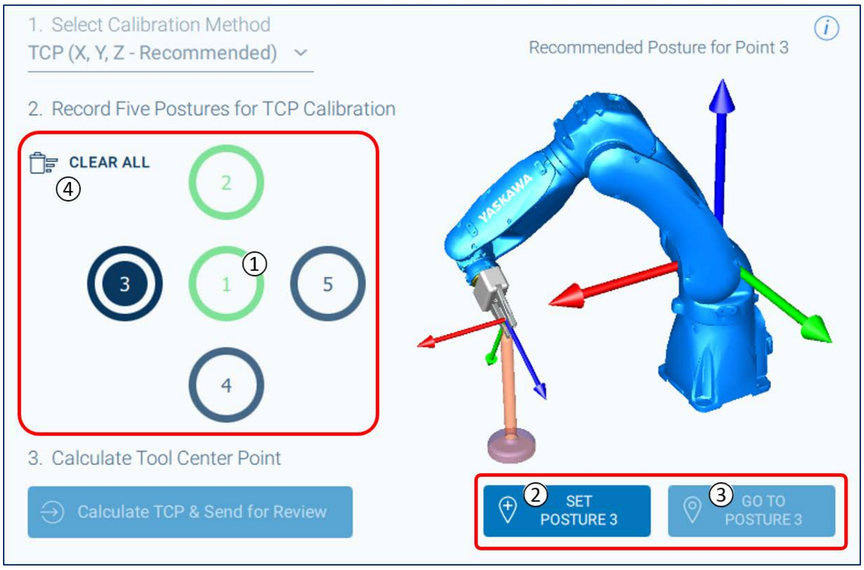
NOTE

If the selected calibration method includes tool orientation, the first posture recorded 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.



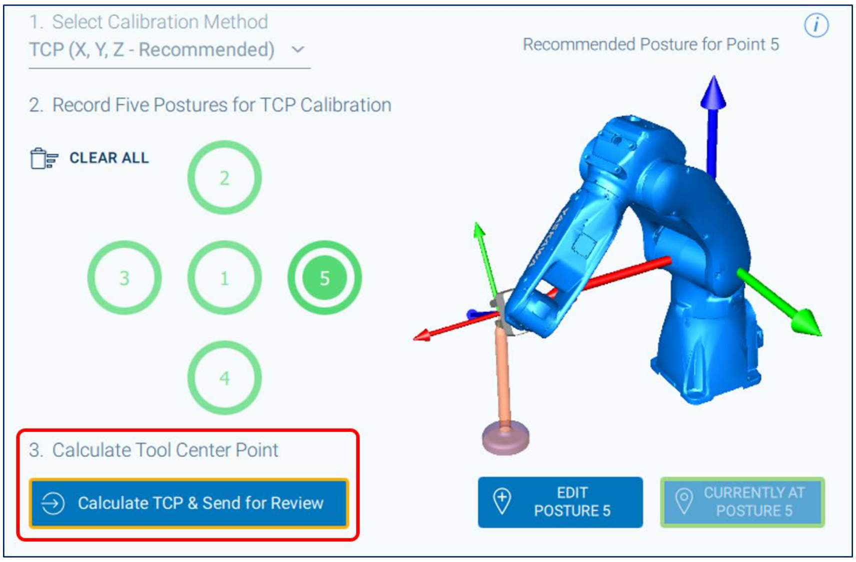
Use the following procedure to {Set} and {Go To} the recommended postures above:

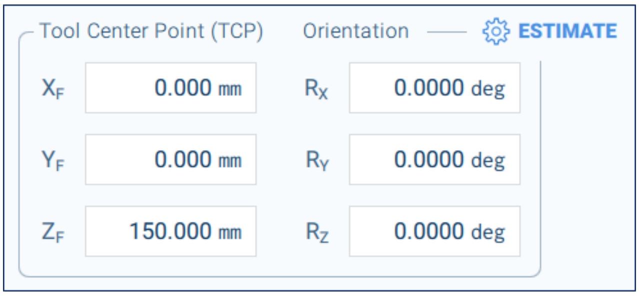
1. Select a Calibration Posture (1 to 5).
   – Check its status (Green = “Saved”, Blue = “Undefined”). If undefined, jog the Robot to approximately match the “Recommended Posture” using the Jogging Panel.
2. Once at the desired posture, press {Set} to record its position.
3. Move to previously saved postures using {Go To} buttons.
   – If calibrating TCP coordinates, repeat *step 1* through *step 4* until all Calibration Postures are green in color.
4. Use the {Clear All} button to remove all previously recorded postures to re-initialize the calibration process.



① Calculate and Confirm New TCP on Tools Screen

Press {Calculate TCP and Send for Review} to send the calculated TCP data to the {Tools} screen for review. Refer to *chapter 6.1.5* for instructions to properly save the data.





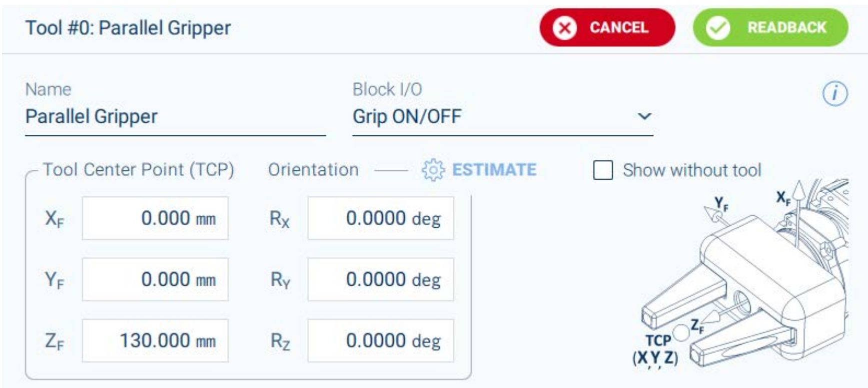
① **Verification of Calculated TCP**

Jog the Robot in XYZ-Tool mode to rotate the installed tool about the reference point used for the calibration procedure. The TCP should rotate nicely around the fine point. If the rotation motions are offset and appear to be rotating around another point, the calibration procedure should be repeated to increase accuracy.

6.1.5 Setting Tool with FSU

A final step is required in the tool setting process when the Functional Safety Unit (FSU) and/or Power and Force Limit (PFL) function is enabled on the YRC Controller. To ensure tool setup has been performed according to safety regulations, the data must be checked to ensure that the information in the YRC Controller matches that on the FSU/PFL safety boards.

1. Edit the tool data
   - {READBACK} will appear, to allow the operator to read data from both the YRC Controller and the FSU/PFL safety boards.



2. Press the {READBACK}

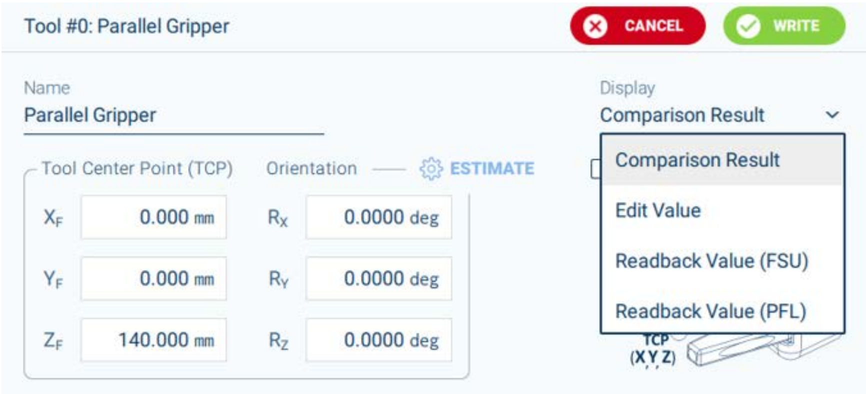
   – {Display} option appears. Options are provided for viewing the data.

   • Edit Value: values entered

   • READBACK VALUE (FSU): temporary values saved on the FSU board

   • READBACK VALUE (PFL): temporary values saved on the PFL board

   • COMPARISON RESULT (default): the result that are compared



3. Select {COMPARISON RESULT}.
4. Check the {READBACK} result

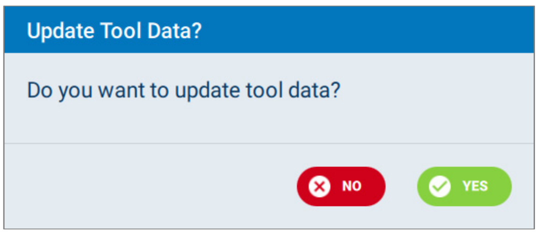
   – If {Comparison Result} data matches, then the setting was successful. But if the data differs, the value of the {Comparison Result} will be displayed as “***” instead of the value. At this point, the operator should check to see which data on which board was not updated.

5. Press {WRITE.}

   – The pop-up message appear for confirming the tool data update.

6. Press {YES}.

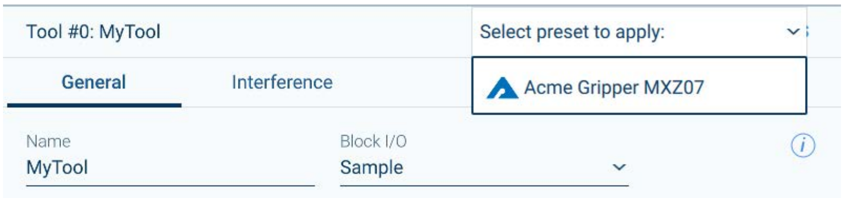
   – This will update the tool data, provided the data was updated correctly.



6.1.6 Applying Tool Presets

If Tool Presets have been installed, they may be applied to the currently selected tool.

1. Select the tool row from the list of tools for which you wish to apply the preset settings.
2. Press {PRESETS} on the right of the detail panel header.
   – A list of installed Tool Presets will drop-down for selection (- or a notice that none are installed).



3. Select the required preset to apply.
   – The tool property settings included in the selected preset will be immediately copied into the appropriate tool settings text fields (as if entered). {CANCEL}/{SAVE} or {CANCEL}/{READBACK} will be shown.
   – It is left to the preset creator which tool settings are included, so any settings not included in the selected preset will not be modified.
   – The properties will not be immediately applied and hence can be further manually edited before saving.
4. Press {SAVE} or {READBACK} and {WRITE} to permanently save the tool settings on the YRC Controller.

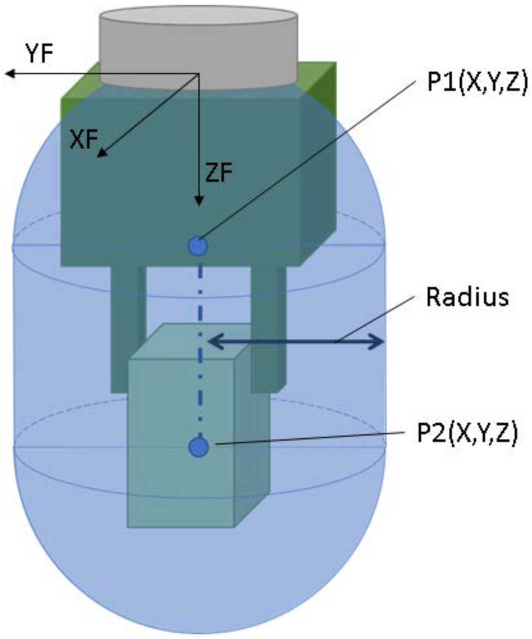
6.1.7 Tool Interference Model Settings

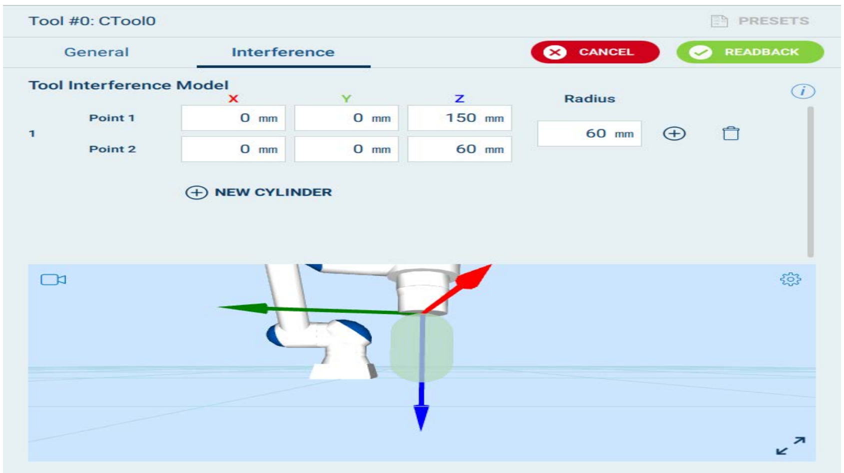
Tool Interference Model is used to specify an approximate three-dimensional shape of the robot end-effector (tool). This model is used by the Functional Safety Unit function and Robot Range Limit function to limit the robot and tool motion to within the monitoring area.

To edit the tool interference model, select {Menu} → {Robot Settings} → {Tools}, and select the {Interference} tab. This setting will be shown only when Functional Safety Function is enabled.

6.1.7.1 Model Settings

Tool Interference Model is specified by providing a combination of cylindrical shapes that approximate the tool shape. Each cylinder is specified by the two end points of the cylinder and its radius. The end points of the cylinder are computed as hemispheres with the same radius as the cylinder as shown below. A maximum of 5 cylinders can be used to specify a given tool's interference model.





① **Cylinder**

Up to 5 cylinders can be defined. A cylinder with zero length can be used to specify a sphere.

② **Point 1, 2 (X, Y, Z)**

Specifies both end points of a cylinder by inputting the coordinate value of X, Y, Z. The values are set as the distance from the center of T axis flange.

③ **Radius**

Specifies the radius of the cylinder. The specified radius should have a margin of at least 10 mm compared with the actual tool size.

④ **Insert Cylinder**

Insert new cylinder below the selected cylinder.

⑤ **Delete Cylinder**

Delete the selected cylinder.

⑥ **Add Cylinder**

Add new cylinder at the bottom.

⑦ **3D Viewer**

Current setting can be checked in the 3D Viewer. This view will be updated as cylinders are added to the Tool Interference Model. Refer *chapter 6.1.7 "Tool Interference Model Settings"* to see the operation of 3D Viewer.

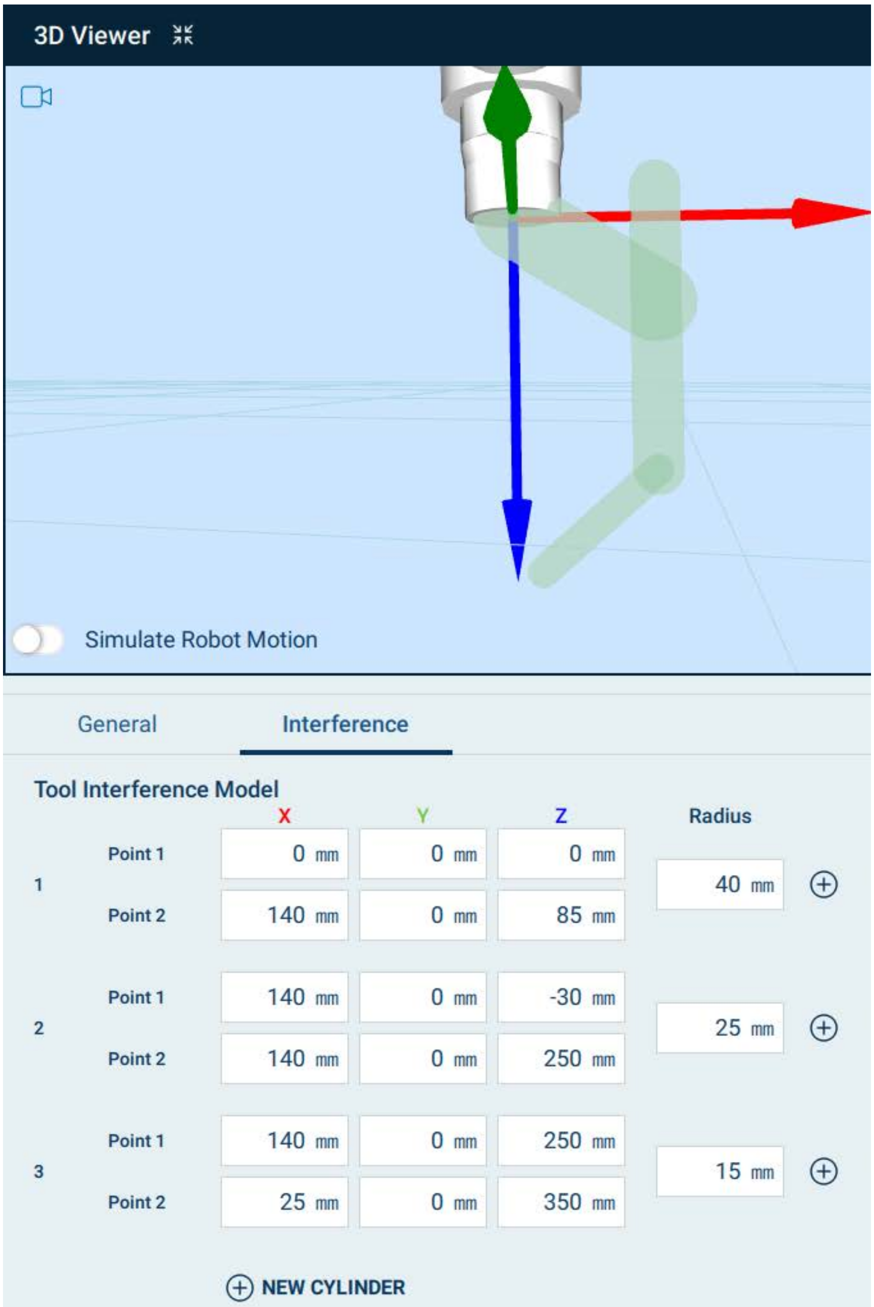
NOTE

When setting the radius of a tool model, it is recommended to set a little larger radius for cylinders that are further distance from the flange surface. This is to accommodate for robot speed. Recommended additional radius for max speed is shown below.

Distance from the flange surface	Recommended additional radius for max speed
0 mm	55 mm
100 mm	58 mm
200 mm	60 mm

6.1.7.2 Example Tool Interference Model

An example for setting the model of the tool is shown below.



Cylinder 1:

Set the flange surface to (X= 0, Z= 0) Point 1, and (X=140, Z=85) to Point 2.

Cylinder 2:

Set (X=140, Z=-30) to Point 1, and (X=140, Z=250) to Point 2.

This setting defines a model that is parallel to the Z direction of the tool coordinates.

Cylinder 3:

Set (X=140, Z=250) to Point 1, and (X=25, Z=350) to Point 2.

By setting the point 2 of model 2 and the point 1 of model 3 at the same position, model 2 and 3 are defined at consecutive positions.

6.2 I/O for Tool

A robotic tool (i.e. end-effector) typically has subcomponent(s) that are controlled by I/O. These I/O can be used to do the following example tasks:

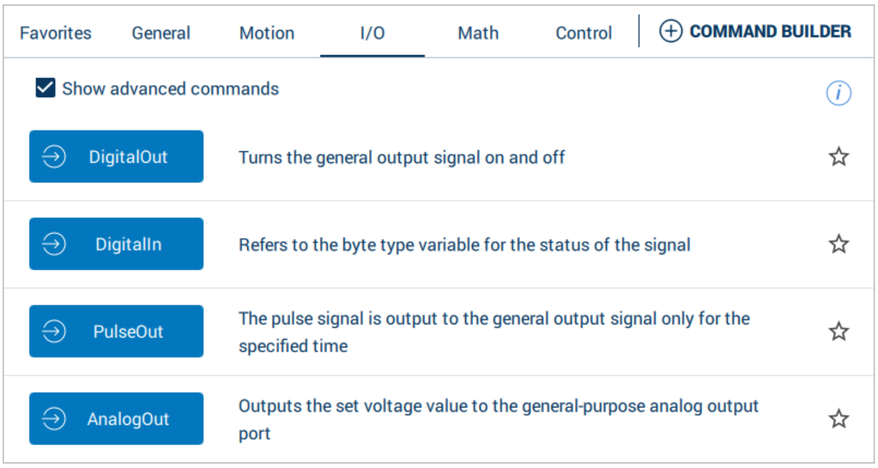
Fig. 6-18: Block I/O Sequence for Selected Tool

– Open/close a two-finger gripper.

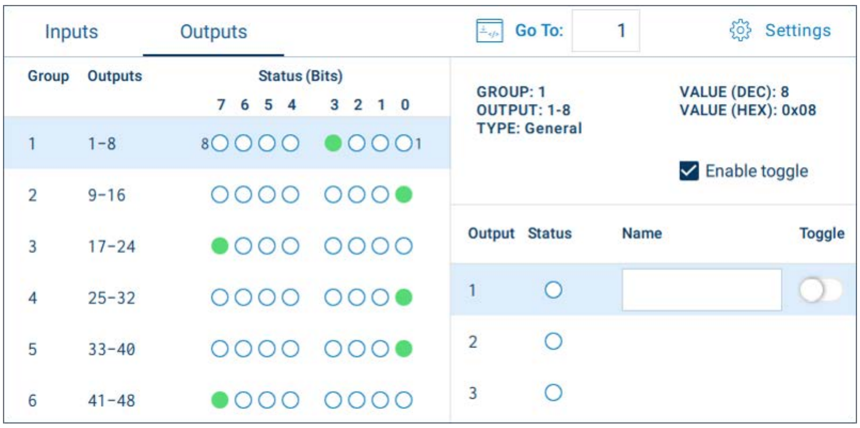
– Trigger an auxiliary action (e.g. blow-off for a vacuum gripper) to reliably release a part.

Smart Pendant provides the following methods to use I/O for tool operation:

– Program in an INFORM job using {I/O} commands (refer to *chapter 4.4.2 "Inserting Commands"* for more information).



– Toggle the general purpose output signal ON/OFF from the {I/O screen} (refer to *chapter 7.5.2.2 "I/O Screens"* for more information)



– Configure I/O sequences for tool on the {Block I/O screen} (refer to the *chapter 7.8 “Block I/O”* for more information). {Block I/O screen} can be used to:

- Physically open/close a gripper during teaching
- Quickly add INFORM command sequences that open/close a gripper to the Current Job

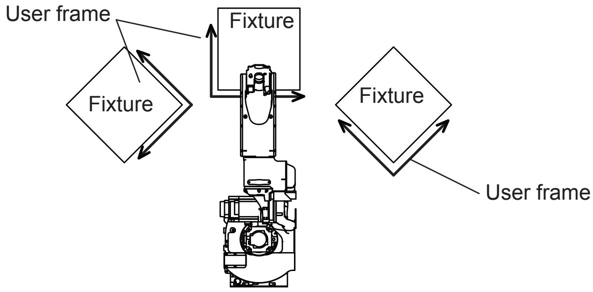
To configure the block I/O states for a tool, refer to *chapter 7.8 “Block I/O”*.

6.3 User Frames

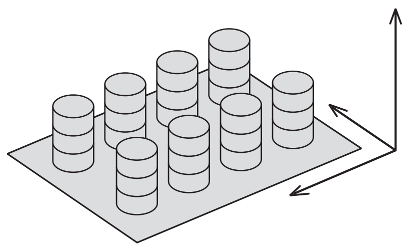
User Frames allow the programmer to specify positions relative to an object in the workcell (e.g work surface, pallet, or conveyor) as opposed to specifying positions relative to the World or Robot Frames. The manipulator moves parallel to each axis of the user-defined frame. The user defines the X, Y, and Z axes with the desired slopes and positions available within the manipulator’s motion range.

6.3.1 Example Usage of User Frames

– When two or more fixtures are used, manual operation is simplified by setting the user frames for each fixture.



– When performing arranging or stacking operations, the incremental value for the parallel shift is easily set by setting the user frame on a pallet.

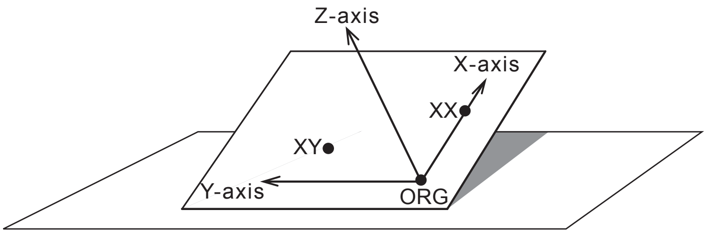


– When the position of a pallet moves, all points relative to a pallet can be moved simply by re-teaching the User Frame.

– When multiple pallets have the same part pattern, user can teach points on one pallet and then switch them to another by changing the User Frame.

6.3.2 Methods for User Frame Setting

User frames are defined by the coordinates and orientations of the user frame relative to the World Frame. The values can be entered directly or be calculated from three points (ORG, XX, and XY) that have been taught by the user. These three points are referenced from the World Frame and are shown in the diagram below.



User frame definition point
ORG: Origin position
XX: Point on the X-axis
XY: Point on the Y-axis

ORG is the origin position. XX is a point on the X-axis. XY is a point on the Y-axis side of the taught user coordinates. The directions of the Y- and Z-axes are determined by point XY.

NOTE It is important that ORG and XX are taught accurately.

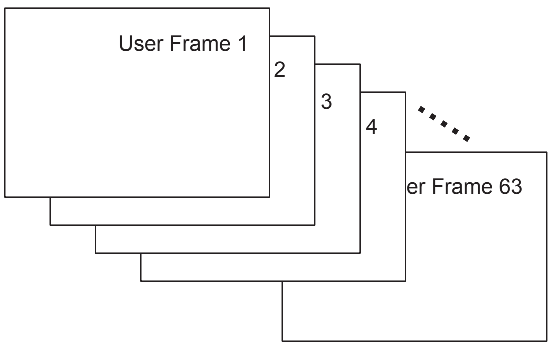
The method used will depend on the type of application and the available information. For example, a vision application may locate a part and return the associated user frame coordinates directly. For a palletizing application, it is typically easier and more accurate to manually move the robot and teach the three points on the pallet corners.

User frames can also be adjusted after creation – a frame created by the three-point method may need to be shifted by a few millimeters. In this case, the user could simply adjust the coordinates directly instead of moving the robot and reteaching the three associated points, but note that by doing so, the three points would be reset.

It is also possible to programmatically define a User Frame using the MakeFrame Inform command in a job. MakeFrame can generate a frame using the single point or three-point method described in *chapter 6.3.4*.

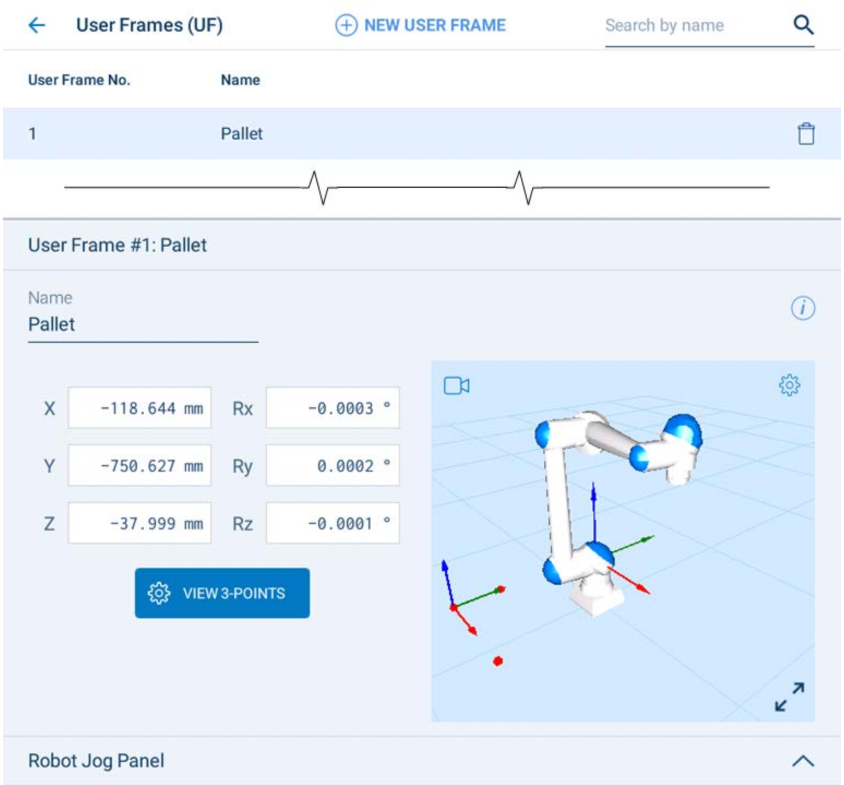
6.3.3 User Frame Number

63 user frames can be created, numbered from 1 to 63.

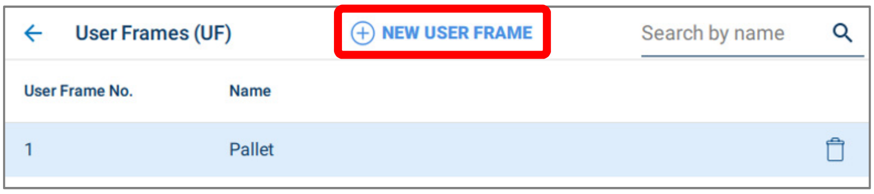


6.3.4 User Frame Setting

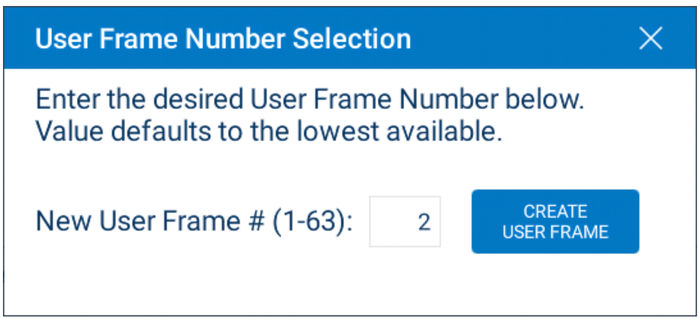
1. Navigate to {Menu} → {Robot Settings} → {User Frame}



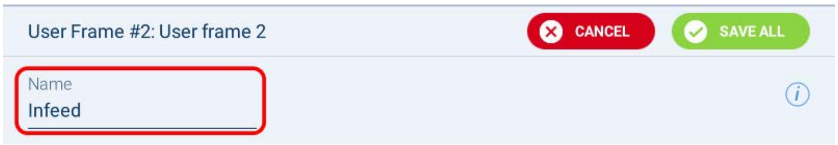
2. Press {+ NEW USER FRAME}



3. Enter a number for the new User Frame and press {CREATE USER FRAME}
   – The first undefined number is populated by default.
   – The new user frame will default to the robot's current position and orientation.

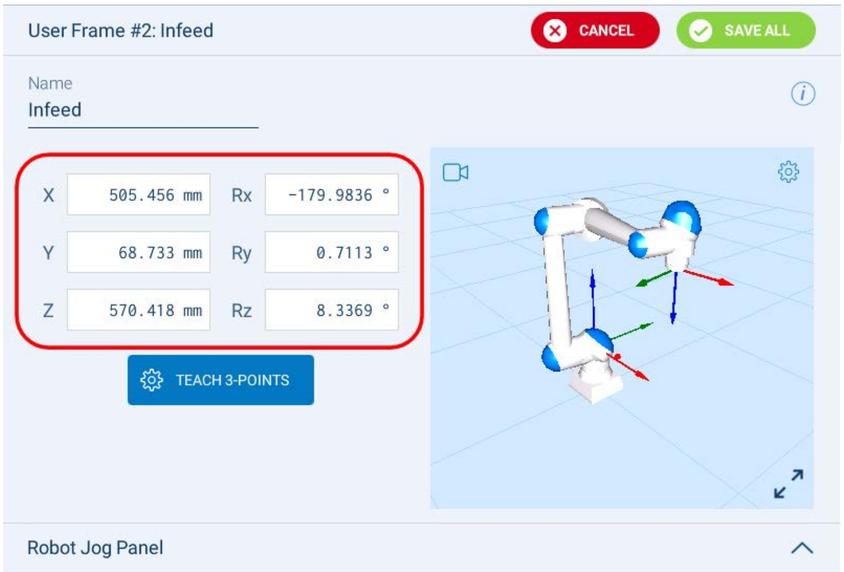


4. Enter the user frame's “Name”.



6.3.4.1 Editing User Frames

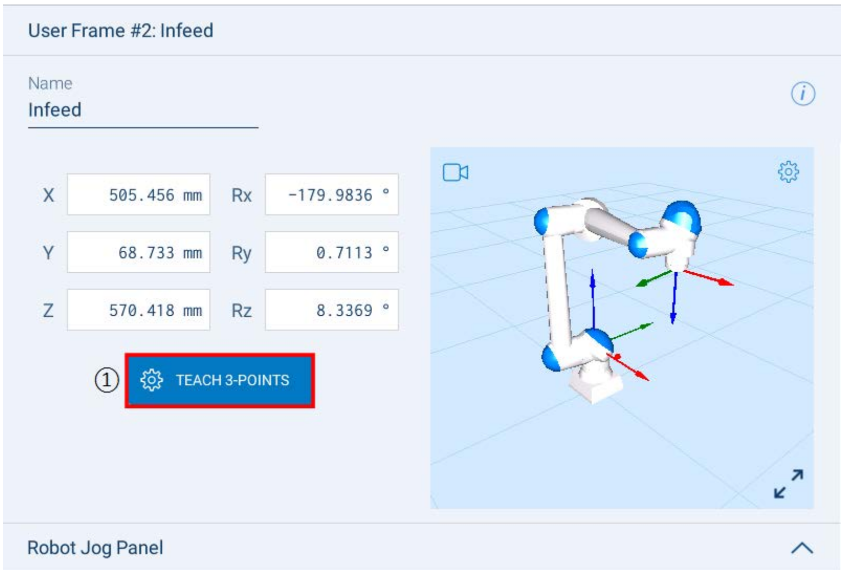
1. Enter the user frame coordinates (X, Y, Z) and orientations (Rx, Ry, Rz) relative to the World frame.



2. Press {SAVE ALL} to save change(s) to the user frame.

6.3.4.2 User Frame 3-Points Teach

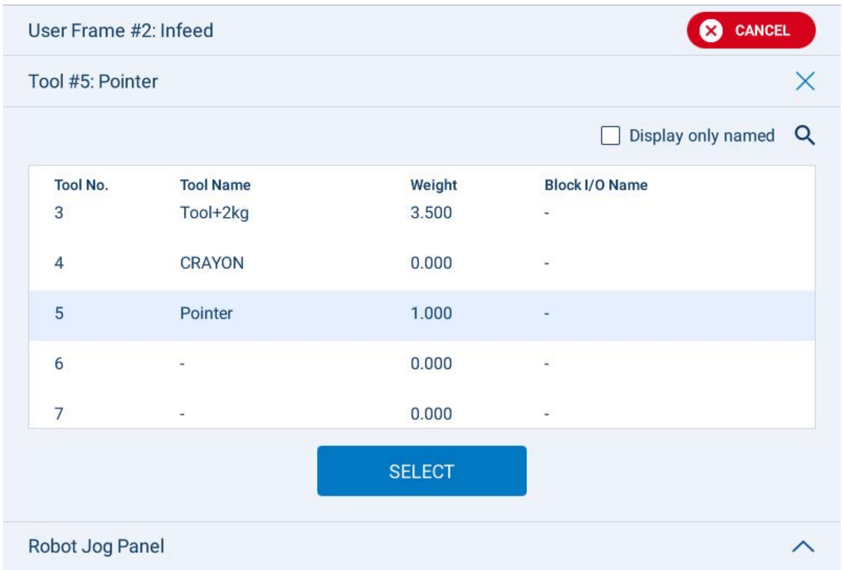
1. Press {TEACH 3-POINTS}, or {VIEW 3-POINTS} if the points are already defined.



– If the frame was previously taught using the 3-Points Teach method, the Origin, XX, XY values previously used will display.

2. Select the Tool Number for teaching the frame.
   a) Press {Tool Number}.
   - The list of Tools appears.
     - By default, the new User Frame uses the current (active) Tool number.

   b) Highlight the Tool from the Tool List and press {SELECT}.



3. Select {ORIGIN}.
   – Move the robot to the desired position using any of the Jog modes/ methods or type in the desired position in X, Y, Z format.
4. Press {SET ORIGIN}.
   – Taught position is registered.
5. Repeat *step 2* and *step 3* to teach {XX} and {XY}.
   – To check the taught positions,
     a) Press {GO TO ORIGIN}, {GO TO XX} or {GO TO XY}.

• The robot moves to the set position.

NOTE

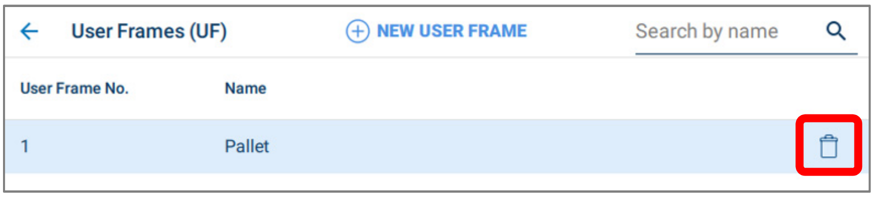
- Setting points have following constraints:
  - A User Frame cannot be created if manipulator is at singular position or on the edge of workspace
  - Two points cannot be the same (i.e. ORIGIN&XX, ORIGIN&XY, or XX&XY)
  - The three points cannot be on the same line.

If any of the above conditions are present, a warning notification will appear.

6. Press {Save All}.
   – User frame saves, and the resulting frame information is displays.

6.3.5 Deleting the User Frame

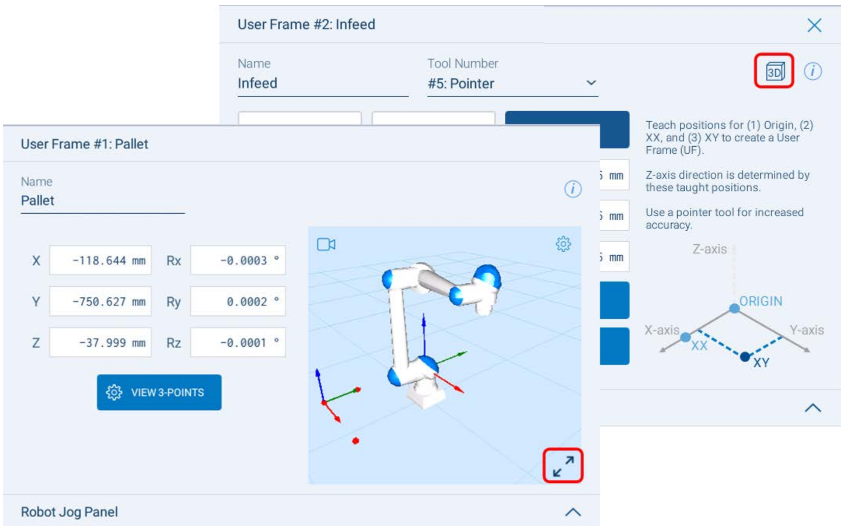
1. Select the trash can icon.
   – A confirmation pop-up window will appear.



2. Select {YES}.
   – User frame is deleted.

6.3.6 Display in 3D Viewer

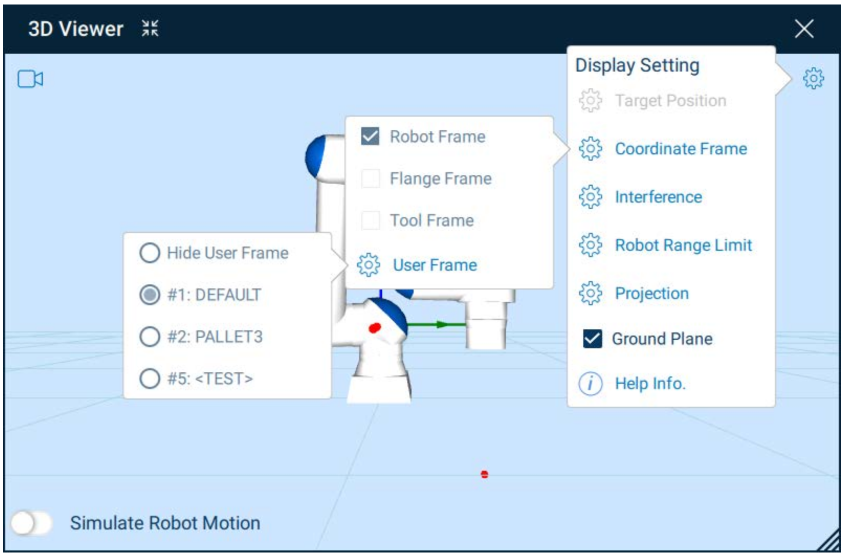
3D Viewer supports the display of User Frames to verify their location relative to the robot. The 3D Viewer is embedded in the User Frames screen, and can be expanded to half screen by pressing the arrows in the bottom-right. While viewing the 3-Points Teach panel, press {3D} to open the 3D Viewer.



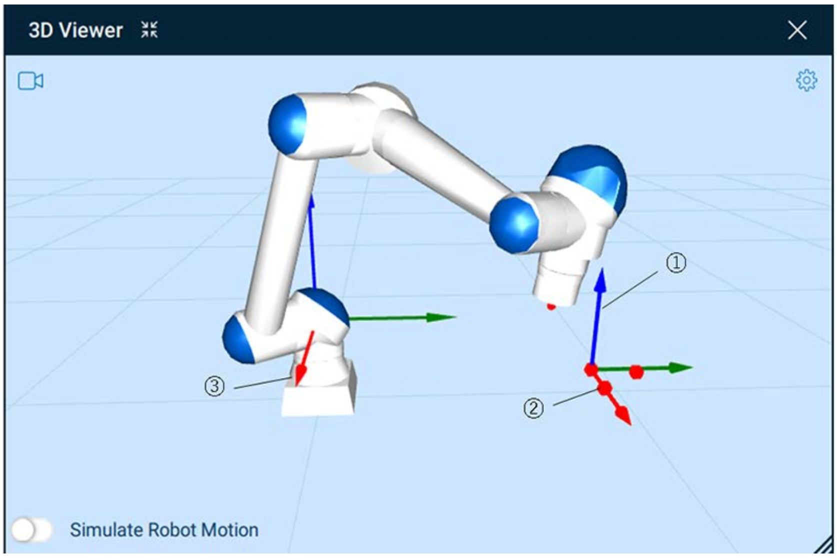
For the basic operation of the 3D Viewer, refer to *chapter 9.1 “3D Viewer”*.

Users can select which frame(s) to display in 3D Viewer (e.g. Display Settings → Coordinate Frame →User Frame). If the User Frame screen is open, the frame selected in the list automatically displays.

Fig. 6-19: User Frame Selection for 3D Viewer



User Frame is shown as follows in 3D Viewer.



① User Frame

The selected User Frame is displayed as positive directions of the X-axis (Red), Y-axis (Green), and Z-axis (Blue).

② Origin, XX, XY

The Origin, XX, XY points are displayed and updated while editing.

③ Reference Coordinate

Displays world (base) coordinate which can be used for reference.

6.4 Zones

The zone setting allows user to define spatial boundaries that can be used to restrict manipulator motion or to generate notifications for application control. The YRC Controller supports the creation of a maximum of 64 zones. There are two different types of zones:

– Cubic zones

– Axis zones

When the manipulator attempts to enter a zone, it can take two kinds of action.

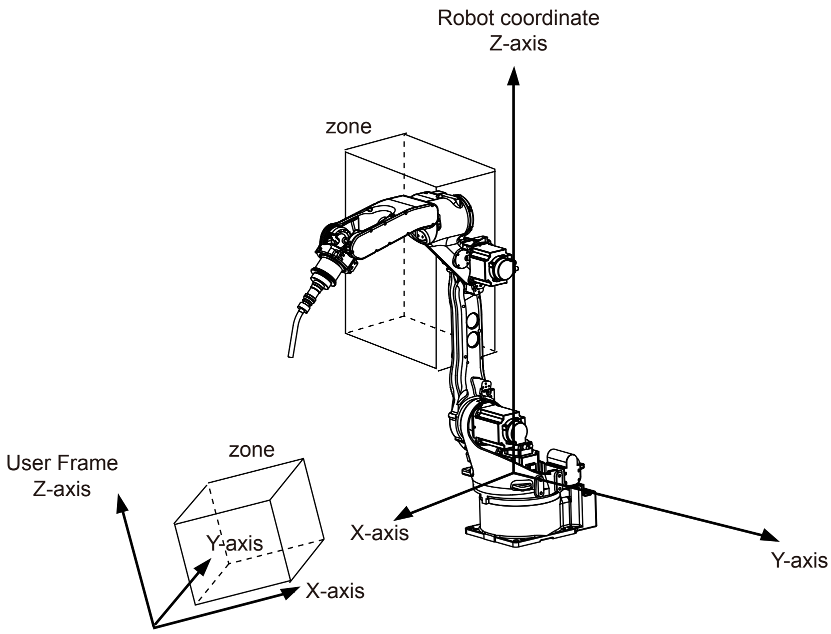
– **Status:** The status signal turns ON when the manipulator enters the zone. To determine status by application, refer to *chapter 6.4.3 “Zone Status”*.
Example use: set a zone when the manipulator is outside the metal working machine.

– **Alarm:** The alarm becomes active when the manipulator enters inside the zone.
Example use: set a zone not to interfere with the working table

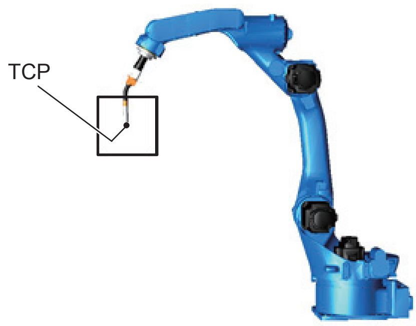
This signal is processed in the I/O section.

6.4.1 Cubic Zone

The cubic zone is a rectangular parallelepiped (a solid body of which each face is a rectangle) parallel to the base coordinate, robot coordinate, or user frame. The YRC Controller determines whether the manipulator’s TCP is inside or outside this zone, and outputs this status as a signal.



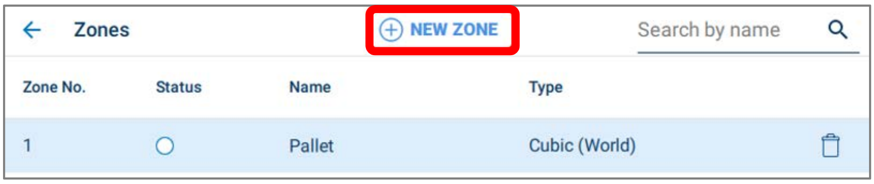
The area inside the specified cube is defined as the zone. When the manipulator's TCP is located inside the cube, the corresponding Specific Output signal is ON.



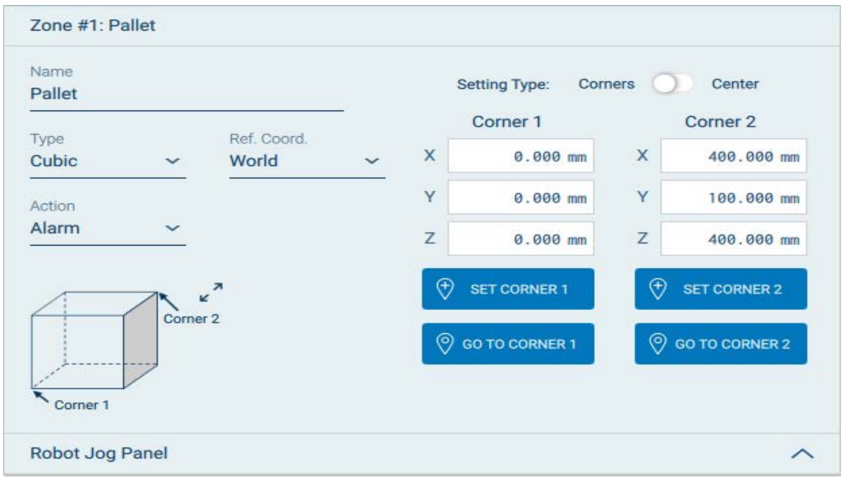
TCP is located inside the cube
- Inside of zone: Specified output signal = ON
- Outside of zone: Specified output signal = OFF

6.4.1.1 Cubic Zone Setting Operation

1. Go to {Zones} under {MENU}.
   – The Zone screen will appear.
2. Press {+ NEW ZONE}.



3. Press the number with new zone.
   – The Zone Detail panel will show for the selected zone.
4. Type the name of the zone in the {Name}.
   – Zone names can be from 0 to 32 alphanumeric characters and symbols in length.
   – Same zone name can be used.



5. Select {Cubic} from the pull-down list at Type.
6. Select the desired Action from the pull-down list.

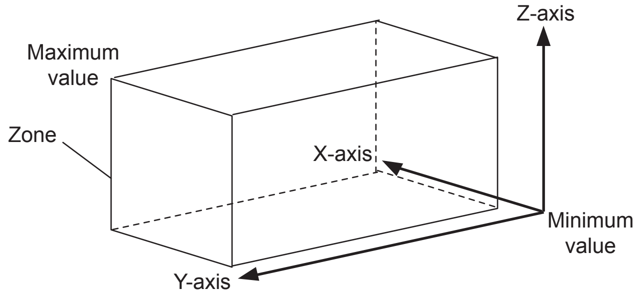
7. Select the Reference Coordinates from the pull-down list.
   - **World:** Currently, it is same as the Robot
   - **Robot:** This zone is referred to the Robot frame when it is created
   - **User:** This zone is referred to the user frame when it is created
8. Select the cubic zone teaching method with the “Setting Type” selector.
   - **Corners:** The zone is defined by two opposite corners of the cube.
   - **Center:** The zone is defined by the center of the cube and its dimensions.

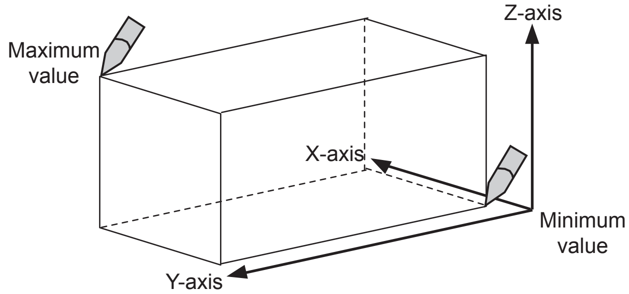
■ Corners methods

a) Select {Corners} on the “Setting Type” selector.

b) Enter the minimum (Corner 1) values of X, Y, Z by either moving the manipulator to the corner or by manually entering the data.

- To move the manipulator from the touch screen, press {Robot Jog Panel} on the bottom of the screen to display the jogging buttons.





c) Press {SET CORNER 1}

- The position of the corner can be checked visually by pressing {GO TO CORNER 1} after it is set.

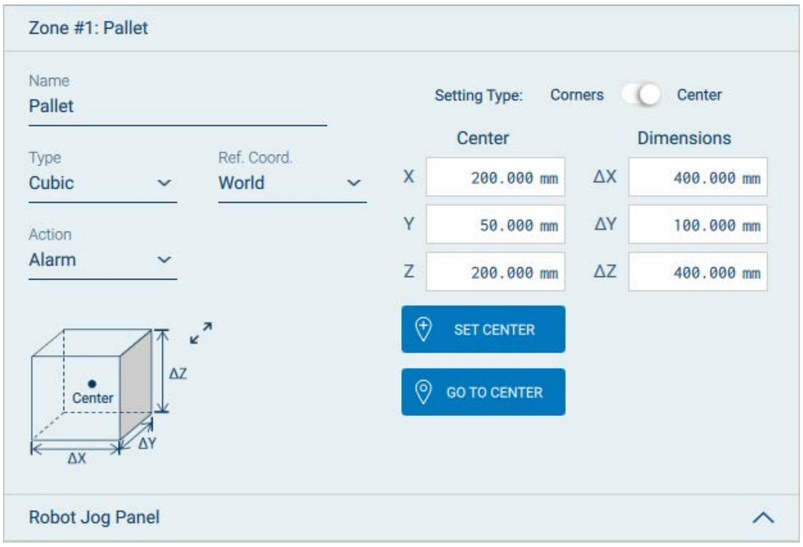
d) Enter the maximum (Corner 2) values of X, Y, Z by either moving the manipulator to the corner or by manually entering the data.

- To move the manipulator from the touch screen, press {Robot Jog Panel} on the bottom of the screen to display the jogging buttons.

e) Press {SET CORNER 2}

- The position of the corner can be checked visually by pressing {GO TO CORNER 2} after it is set.

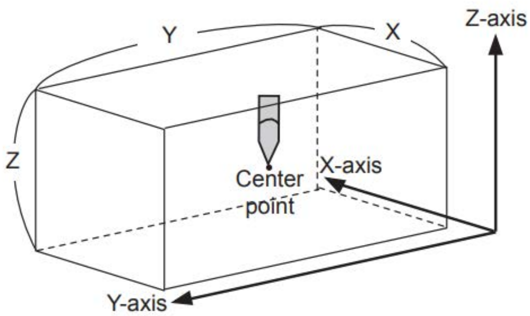
■ **Center Method:**



a) Select {Center} on the “Setting Type” selector.

b) Enter the center {Center} values of X, Y, Z by either moving the manipulator to the center or by manually entering the data.

- To move the manipulator from the touch screen, press {Robot Jog Panel} on the bottom of the screen to display the jogging buttons.

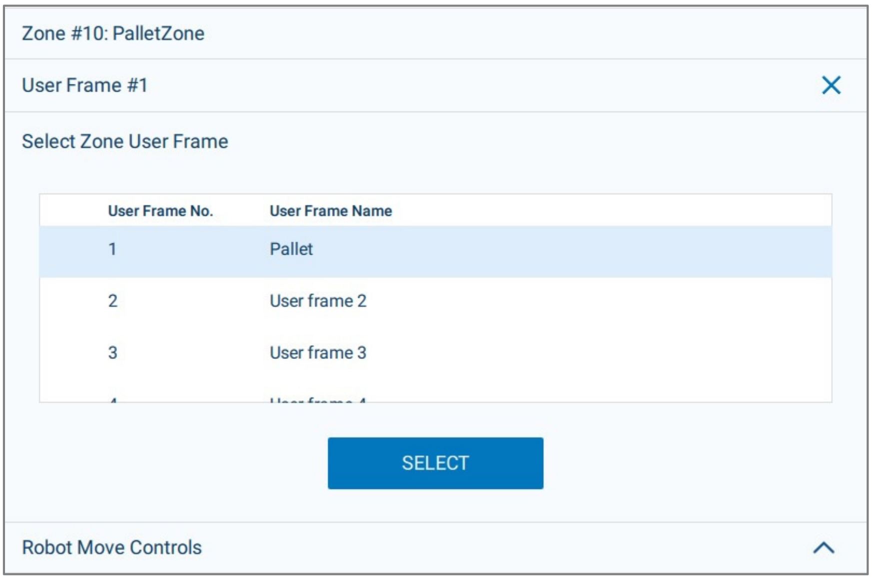


c) Press {SET CENTER}

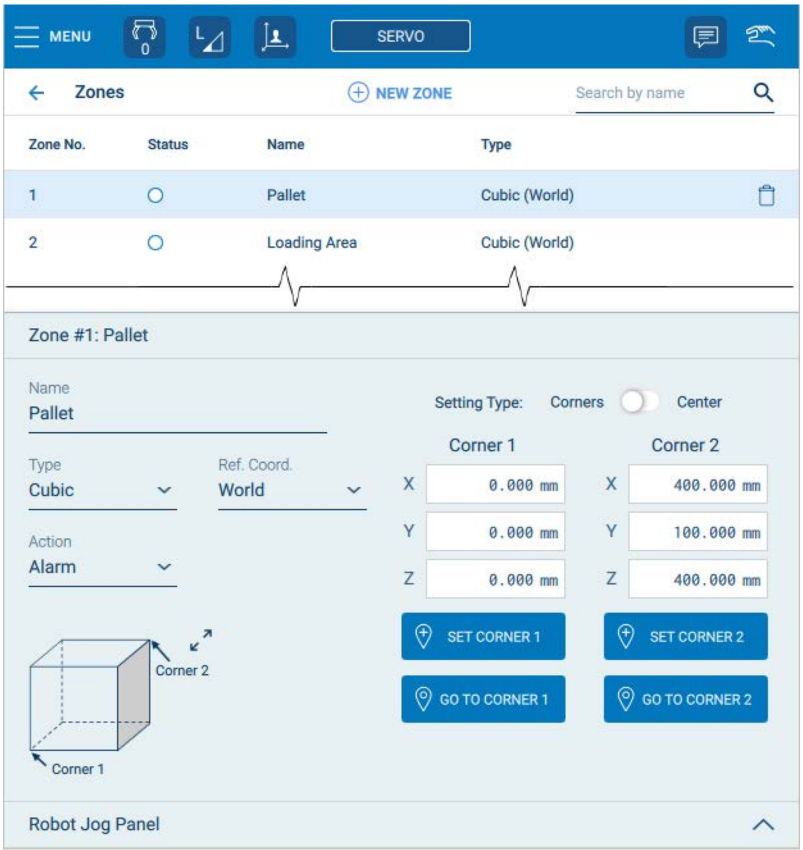
- The position of the corner can be checked visually by pressing {GO TO CENTER} after it is set.

d) Enter the zone dimensions {Dimensions} values of ΔX, ΔY, ΔZ by manually entering the data.

9. In the case of a Zone with “User” Reference Coordinate, the correct User Frame must also be set. Select {User Frame #} and select the proper User Frame from the list.



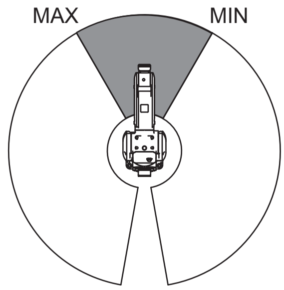
The current status is shown in the Status column. When the manipulator is inside the specified zone, the Status color will turn green. When the manipulator is outside the specified zone, the Status will be white.



6.4.2 Axis Zone

The axis zone is a function that determines the current position of the each axis and outputs a signal. Once the maximum and minimum values have been set at the axis to define the working range, a signal indicating whether the current position of the axis is inside or outside this range is output. (ON: inside, OFF: outside)

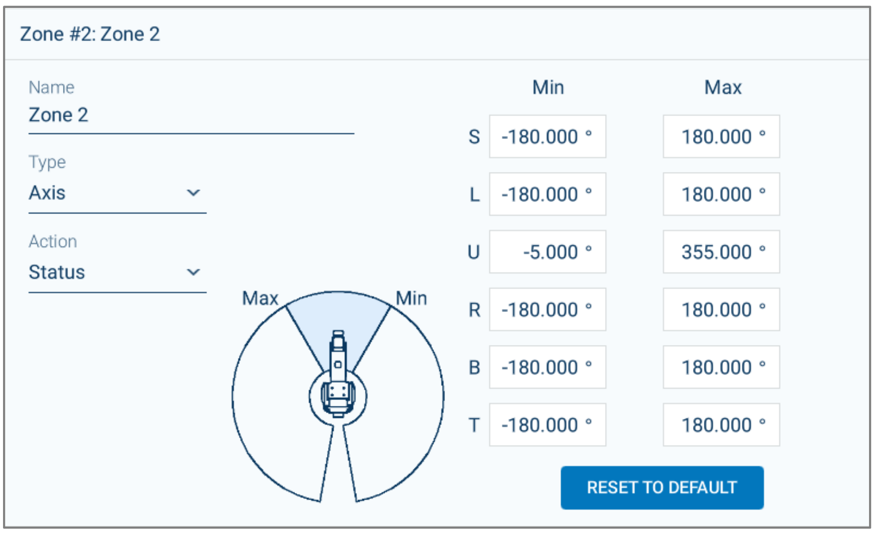
Fig. 6-20: Axis Zone



6.4.2.1 Axis Zone Setting Operation

1. Go to {Zones} under {MENU}.
   – Zone screen will appear.
2. Press {+NEW ZONE}.

3. Press the number with new zone.
   – The Zone Detail panel will show for the selected zone.
4. Type the name of the zone in the Name.
   – Zone names can be from 0 to 32 alphanumeric characters and symbols in length.
   – Same zone name can be used.

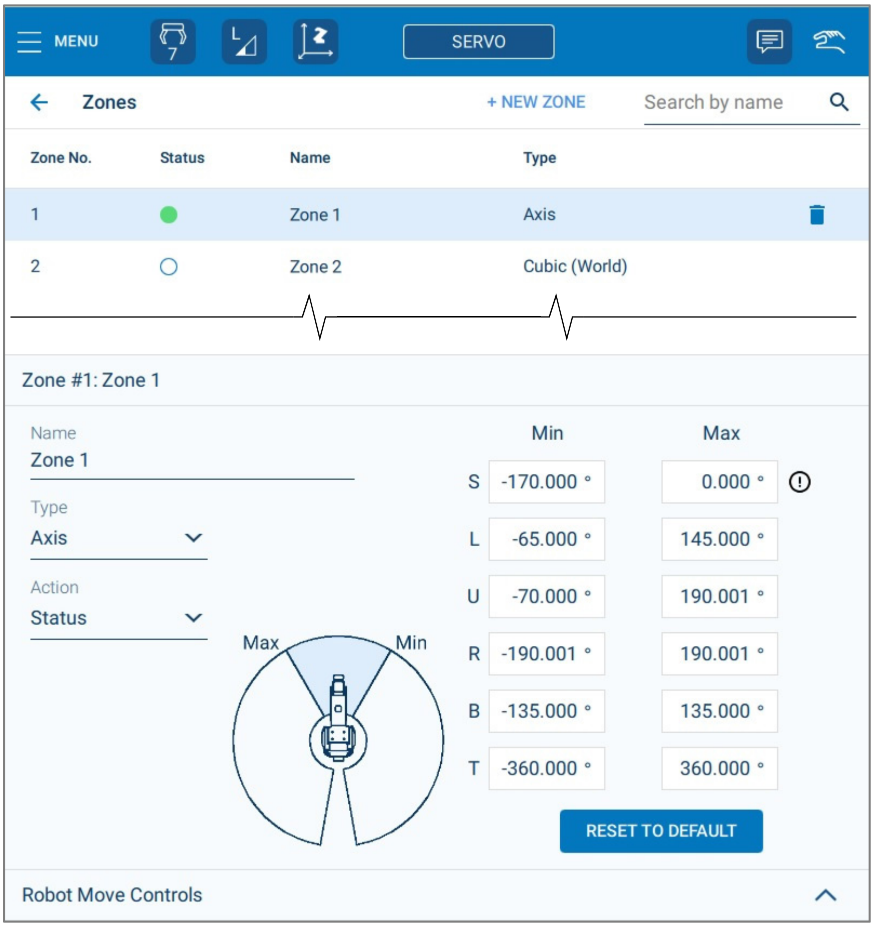


5. Select {Axis} from the pull-down list at Type.
6. Select the desired Action from the pull-down list.
7. Insert the minimum angle and maximum angle for each axis.
   – Each axis has a different range of motion. Check the manipulator's range of motion in the manual that came with the manipulator. The value that exceeds the manipulator's range of motion cannot be inserted.
   – Press {Robot Jog Panel} on the bottom of the screen to display the touch buttons and move the manipulator via the touch screen.
8. Press {RESET TO DEFAULT} to reset the angles on all axes.
   – The default values are the minimum and maximum limits for each axis.
9. Zone setting is complete.

For each zone, the status indicator shown in:
- green: inside zone
- white: outside zone

For Axis Zone, even if one axis is outside the zone, the manipulator is detected as outside the zone.

Fig. 6-21: Zone Setting Screen for Axis Zone



6.4.3 Zone Status

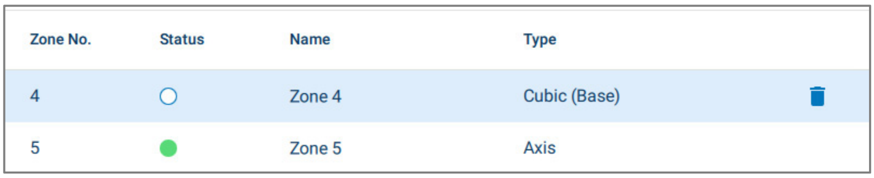
User can check the status of a zone from the Smart Pendant user interface.

For each zone, the status indicator shown in:

– green: inside zone

– white: outside zone

Fig. 6-22: Zone Status



For application programming and logic control, user can determine the status of a zone by monitoring the status of a given zone on a Specific Output. These zone status signals indicate the zone in which the current control or axis is positioned in the initially set area. These signals can be used to prevent interference with other manipulators or jigs.

The following table shows the Specific Output Numbers (SpecificOut#) for zone status.

Table 6-1: Cubic / Axis Zone Status

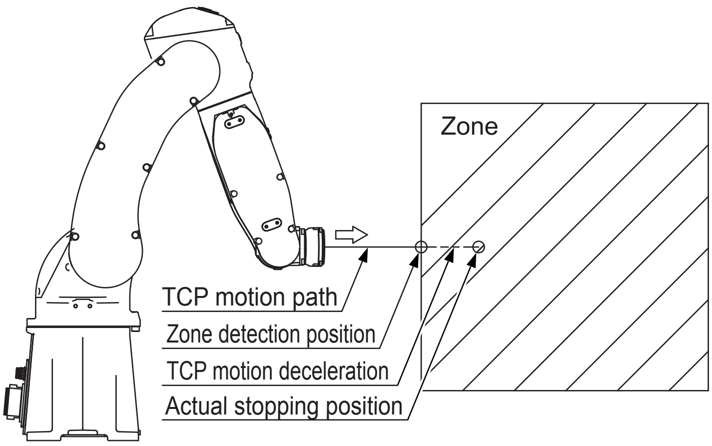
Cubic / Axis Zone Status								
Zone #	#8	#7	#6	#5	#4	#3	#2	#1
SpecificOut#	#064	#063	#062	#061	#060	#059	#058	#057
Zone #	#16	#15	#14	#13	#12	#11	#10	#9
SpecificOut#	#072	#071	#070	#069	#068	#067	#066	#065
Zone #	#24	#23	#22	#21	#20	#19	#18	#17
SpecificOut#	#080	#079	#078	#077	#076	#075	#074	#073
Zone #	#32	#31	#30	#29	#28	#27	#26	#25
SpecificOut#	#088	#087	#086	#085	#084	#083	#082	#081
Zone #	#40	#39	#38	#37	#36	#35	#34	#33
SpecificOut#	#096	#095	#094	#093	#092	#091	#090	#089
Zone #	#48	#47	#46	#45	#44	#43	#42	#41
SpecificOut#	#104	#103	#102	#101	#100	#099	#098	#097
Zone #	#56	#55	#54	#53	#52	#51	#50	#49
SpecificOut#	#112	#111	#110	#109	#108	#107	#106	#105
Zone #	#64	#63	#62	#61	#60	#59	#58	#57
SpecificOut#	#120	#119	#118	#117	#116	#115	#114	#113

SUPPLE-MENT

Precaution When Setting a Zone

The following must be considered in advance when setting a zone for cubic/axis.

The manipulator will not immediately stop when it reaches the boundary of a zone. It will decelerate to a stop from the position where it enters the zone. This means that the manipulator actual position after stopping will be inside the zone. As such, manipulator stopping distance should be considered while defining the size of the zone as shown in the figure below.



6.5 Shock Detection Setting

This function adds extra protection to the robot and surrounding equipment in the case of accidental collisions. This is accomplished by measuring motor torques encountered during an application and then setting a “Max Allowable” torque within an offset margin of the measured values. If measured value(s) exceed “Max Allowable”, an alarm will trigger that stops the robot in MANUAL (TEACH) or AUTOMATIC (PLAY) modes.

WARNING

- Shock Detection does not guarantee safety to humans or peripheral devices. Be sure to take appropriate safety measures (e.g. install a safety fence)

Failure to observe this warning may cause contact with the manipulator, which may result in personal injury and/or equipment damage.

6.5.1 Overview

Shock Detection is turned ON with a large margin by factory default. The user can edit these default values and create new settings to meet application requirements. In total, there are nine Shock Detection Settings:

- Default for **AUTOMATIC (PLAY)** mode
- Default for **MANUAL (TEACH)** mode
- Play Condition 1 to 7: Additional user-configurable settings available in **AUTOMATIC (PLAY)** mode

The following sections will describe how to configure these settings and to change them during operation.

6.5.2 Shock Detection Setting Screen

Access this screen at {Menu} → {Robot Settings} → {Shock Detection}, then press {View/Edit Shock Settings} in the upper-right corner.

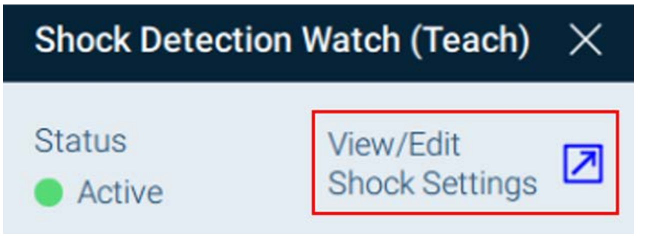


Fig. 6-23 provides an overview of the Shock Detection Setting Screen:

① Shock Detection Status Switch

Enable/Disable the Shock Detection function on the controller.

② Shock Detection Setting

Select 1 of 9 settings to view/edit.

③ Measured Max Torque

Displays current Measured Max Torque values - these update while the robot is running. Press {RESET MEASURED VALUES} to reset.

④ Allowable Max Torque

Displays Allowable Max Torque for the selected setting.

⑤ Reset Measured Values

Resets “Measured Max Torque” values to 0.

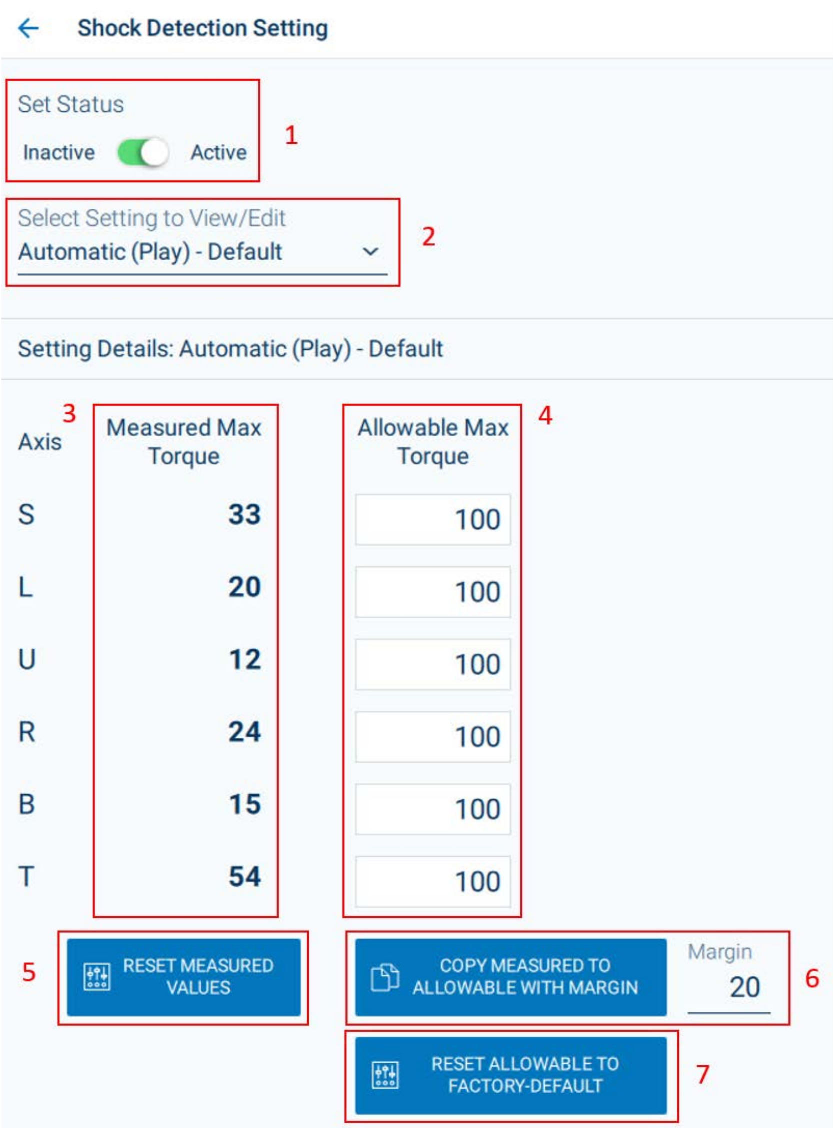
⑥ Copy Measured to Allowable with Margin

Copies the sum of “Measured Max Torque” and user-defined Offset to the “Allowable Max Torque” column.

⑦ Reset Allowable to FACTORY-DEFAULT

Resets “Allowable Max Torque” values to factory default settings.

Fig. 6-23: Shock Detection Setting Screen



The general procedure for configuring a Shock Detection Setting is:

1. Run application for ~1 hour to observe Measured Max Torques
   – Torque values will eventually stabilize
2. If wanting to set margins in bulk press {Copy Measured to Allowable with Margin}.

If a collision is detected during playback when Shock Detection is active, Alarm 4315 will appear.

> **NOTE**
>
> If the user attempts to reset Alarm 4315 while the robot is still in contact with an object, the collision may be detected again, triggering the same alarm.
>
> In this case, set Shock Detection Status to “Inactive”, or increase the detection level in MANUAL (TEACH) mode and carefully move the robot to a safe position.

For most cases, “AUTOMATIC (PLAY) - Default” is the only setting that should be configured. This setting is active by default to provide protection during operation. In some cases, the user may choose to use multiple settings in a single application (see next section).

> **NOTE**
>
> - Run all jobs for an extended period
> - For material handling applications, measure both pattern types (i.e. with & without workpiece.
> - In the event of a collision while measuring the Max Torque, press {Reset Measured Values} to clear the max values before trying again.
> - “Measured Max Torque” is cleared when power is turned ON/OFF. Therefore, **DO NOT** set level(s) based on Measured Max Torque values immediately after turning ON/OFF system power.
> - Re-measure Max Torque in the event of changes to application (modified taught points and/or operation speed(s), physical changes to tool and/or workpiece, etc.) to properly configure Shock Settings

6.5.3 Using Multiple Shock Detection Settings

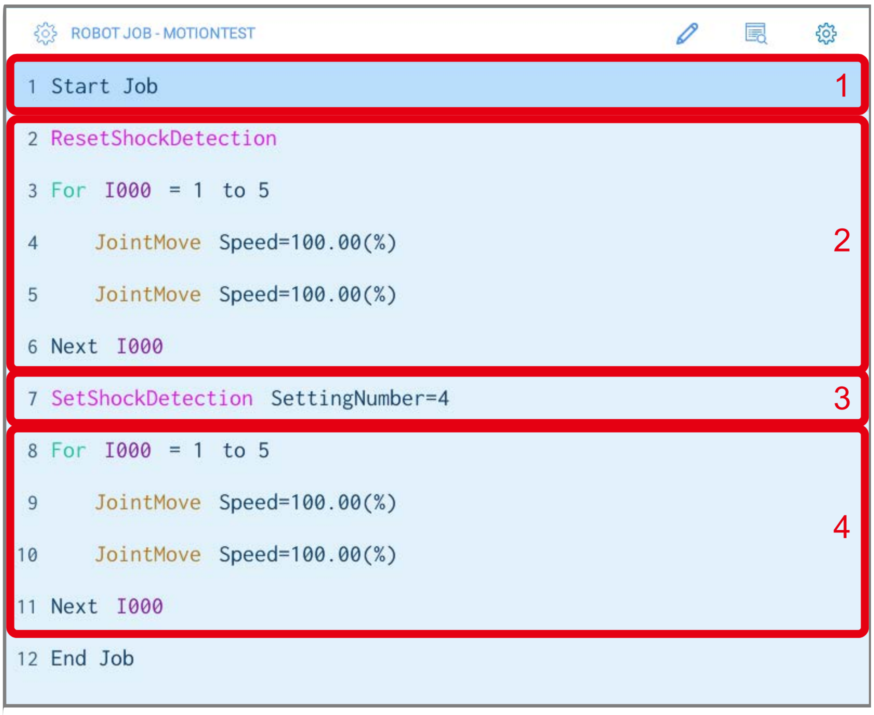
Users occasionally require multiple Shock Detection settings that can be changed during operation. For example, shock sensitivity can be lowered while making contact with the workpiece for a successful pick.

There are two INFORM commands that can be used to perform these actions:

- SetShockDetection
  Changes active Shock Detection Setting or overrides current settings
- ResetShockDetection
  Resets Shock Detection Setting to default (i.e. “AUTOMATIC (PLAY) -Default”)

Fig. 6-24 shows how to use these instructions. At the top of the program, ResetShockDetection is executed (1) to command motions in (2) to use the “AUTOMATIC (PLAY) - Default” setting. Next, SetShockDetection is used (3) to command motions in (4) to use the “AUTOMATIC (PLAY) - Condition 4” setting.

Fig. 6-24: Shock Detection INFORM Instructions



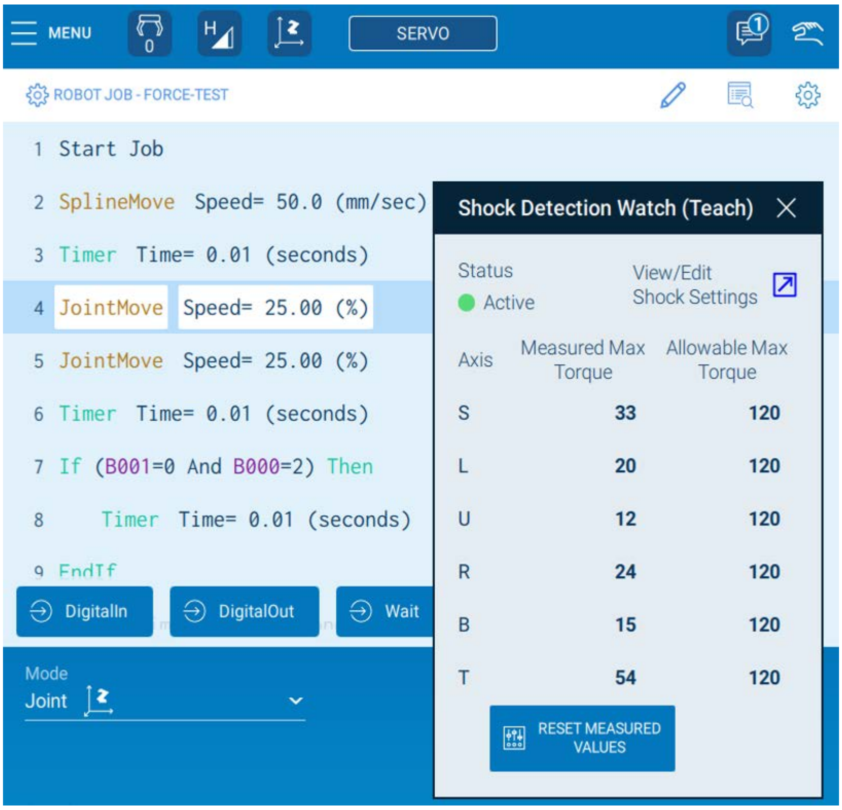
6.5.4 Shock Detection Watch

This feature is used to monitor Measured and Allowable Max Torque during operation. Access this screen at {Menu} → {Robot Settings} → {Shock Detection}.

NOTE

When robot operation first begins, the listed “Allowable Max Torque” may exceed values listed in the corresponding Shock Detection Setting. This is due to grease viscosity during cold start. After ~1 hour of operation, the values used by the system will match the Shock Detection Setting screen.

Fig. 6-25: Shock Detection Watch



6.6 Robot Configuration Positions

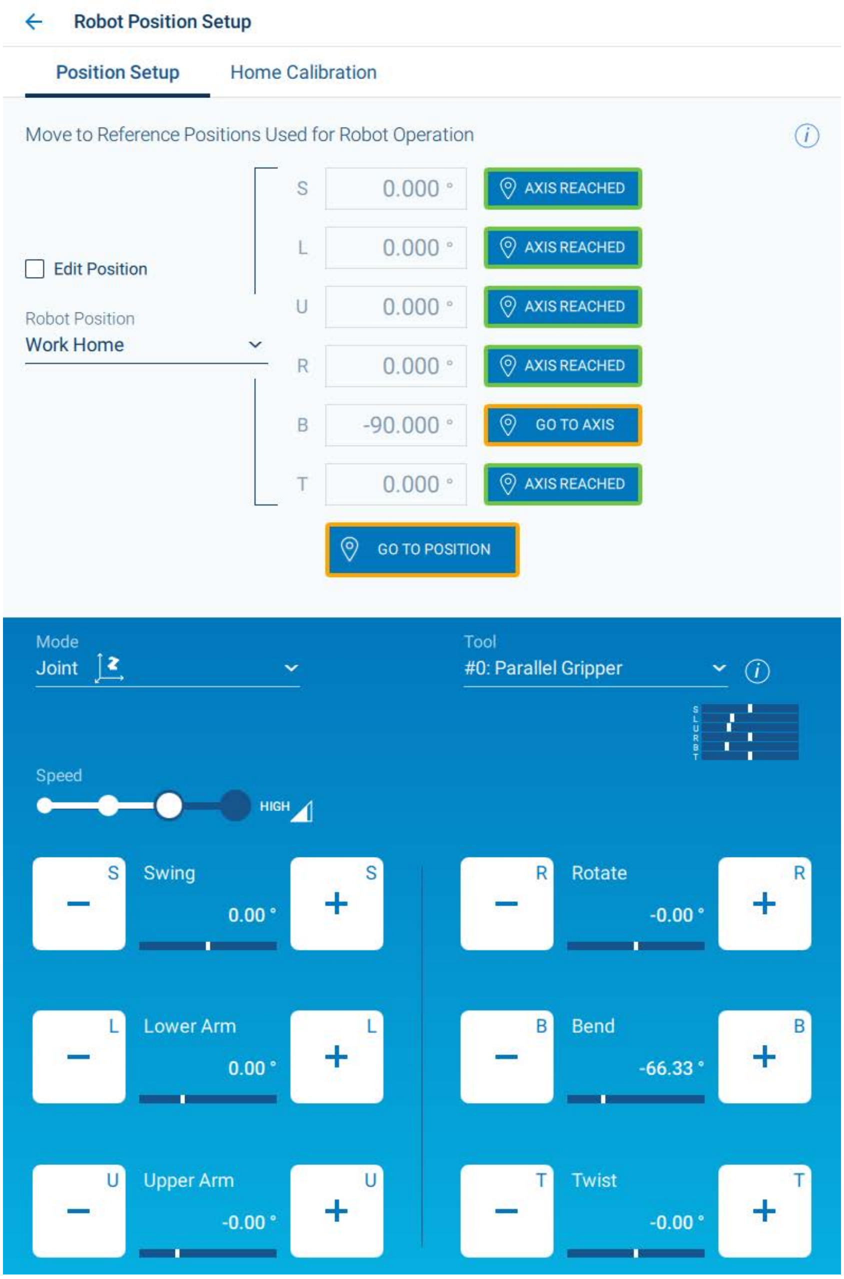
The {Robot Settings} → {Robot Configuration} screen allows the user to define and move the manipulator to positions helpful for certain tasks, such as:

– job start position (i.e. “Work Home Position”)

– manipulator setup & resolving alarms (i.e. “Robot Position Confirm”)

– torque sensor calibration postures for human collaborative Robots

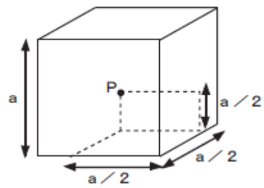
Fig. 6-26: Robot Configuration Screen - Position Setup Tab



6.6.1 Robot Position Types

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

- Work Home Position (user editable)
  - A manipulator posture often used as the “start” position in the default job to ensure the manipulator will not crash into its surroundings.
  - By default, this position is connected to Zone 64 (type = cubic) for ROBOT1. Point “P” in the figure below represents the TCP of the manipulator at the work home position. The size of the cube (“a”) is initially configured to be 100mm.



- Robot Position Confirm (user editable)
  - Used to verify the current posture of the Robot in the event of an alarm (e.g. 4107) when the YRC Controller is powered ON.
    - These alarms may occur 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 (all axes at pulse 0).

> **NOTE**
> If an installed tool/workpiece prevents the manipulator from reaching its default confirmation position, the user can edit this to a posture more accommodating of the tool's geometry.

- Temporary Position (user editable)
  - Used to move the manipulator to a user-editable posture by specifying the target axis values.

6.6.2 Move to a Robot Position

The procedure to move to Robot positions is similar to that of the panel described in *chapter 2.4.8 “Move to Position Panel”*.

NOTE

When approaching any position near other physical objects, reduce speed and use caution to prevent collisions. Pay close attention to the motion of the manipulator.

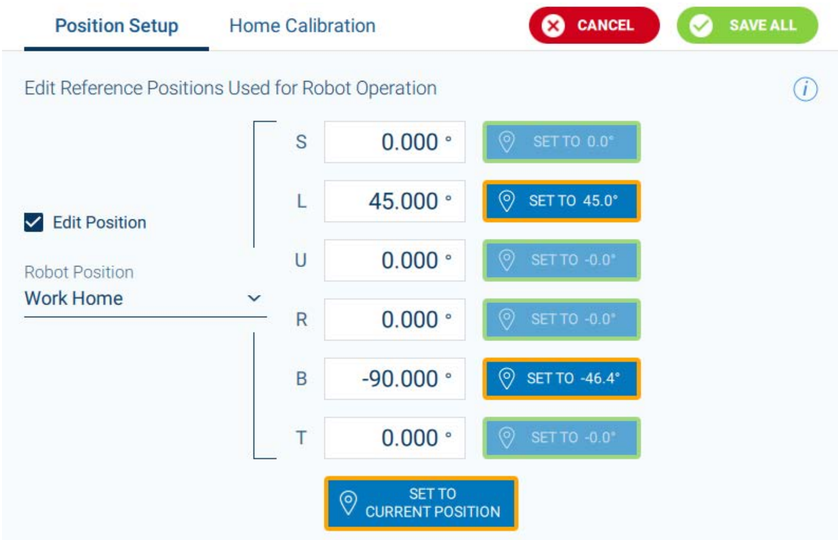
- In the event of “singularity” alarms, reduce speed and use individual {Move Axis} buttons to move to a target position without error.
- Failure to observe these instructions may result in personal injury or collisions with the manipulator.

6.6.3 Edit a Robot Position

Follow the steps below to edit a Robot Position:

1. Press the {Edit Position} checkbox. This will enable fields and controls according to:
   – Required security level.
   – Write access level of position (editable vs non-editable)
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 enabled field(s) using the numeric keyboard
   – 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, a {Save All/Cancel} control will appear. {Save All} will save changes to an edited position while Cancel will default to previously saved values.
   – The “Temporary” position is editable, but Save/Cancel does not apply. Axis values will default to zero on the YRC Controller reboot.

5. Uncheck {Edit Position} to exit “Edit” mode

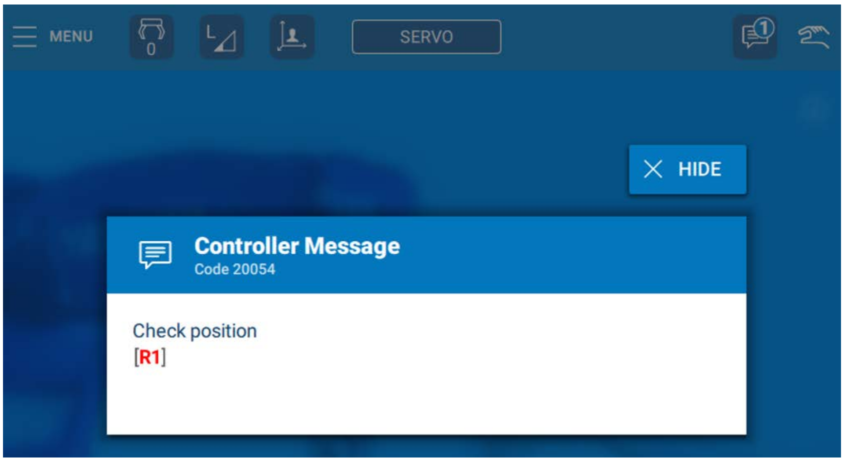


6.6.4 Robot Position Confirm Procedure

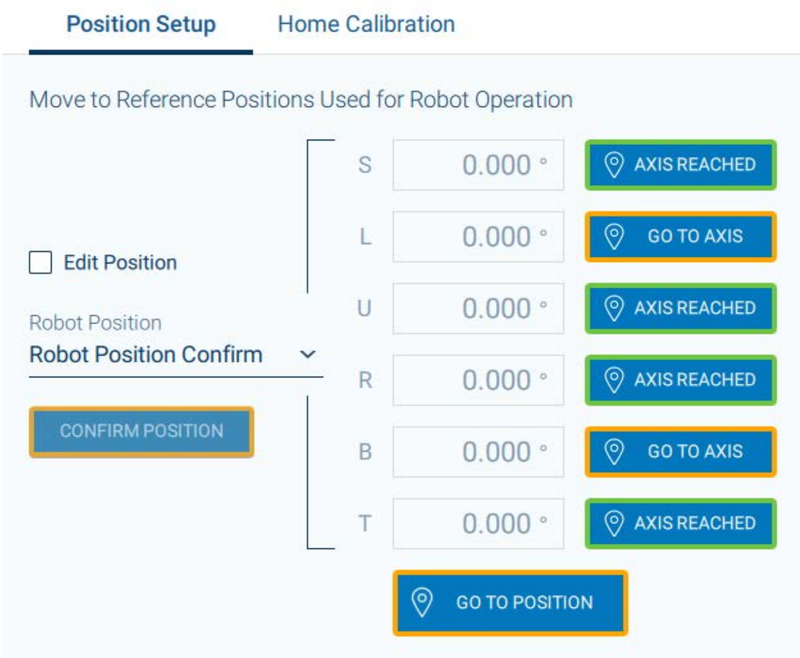
Encoder alarms (e.g. 4107 or 4511) may occur if the manipulator stops suddenly or collides during the operation, or if the manipulator is moved while the YRC Controller power is OFF.

In the event of an encoder alarm, a message will appear prompting the user to “check the position”. The ability to run a job and move to positions other than the “Robot Position Confirm” target will be disabled when this message is active.

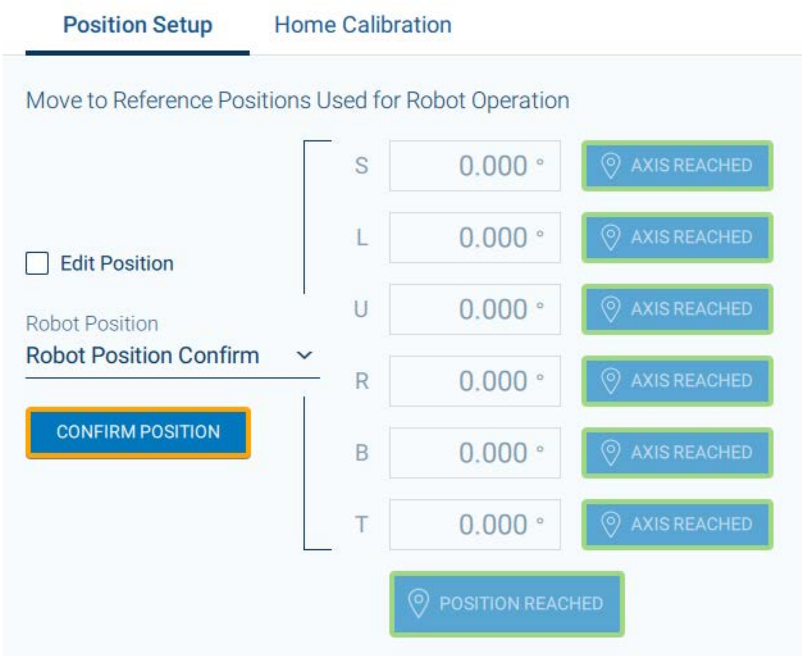
Fig. 6-27: Robot Position Confirm Message



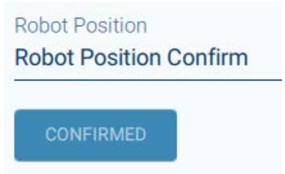
1. Navigate to {Robot Settings} → {Robot Configuration} → {Position Setup Tab}
   – Ensure {Robot Position Confirm} is selected. {Confirm Position} will be visible with a blinking orange border but will be disabled if the Robot is not at the proper position.



2. Press and hold {Go To Position}.
   – Robot moves to the Confirm Position, {Confirm Position} will be enabled once reached



3. Press {CONFIRM POSITION}.
   - The position of the Robot is verified.
   - A confirmation message will appear.



This will re-enable the ability to run a job and move to previously taught positions.

NOTE

If the manipulator's posture at its “Confirm Position” does not match the physical posture set by the user, Home Position Calibration may be required (refer to *chapter 6.7 “Home Position Calibration”*). This can occur, for example, if a motor or encoder is replaced. “Robot Position Confirm” is known as the “Second Home Position” in standard YRC Controller manuals.

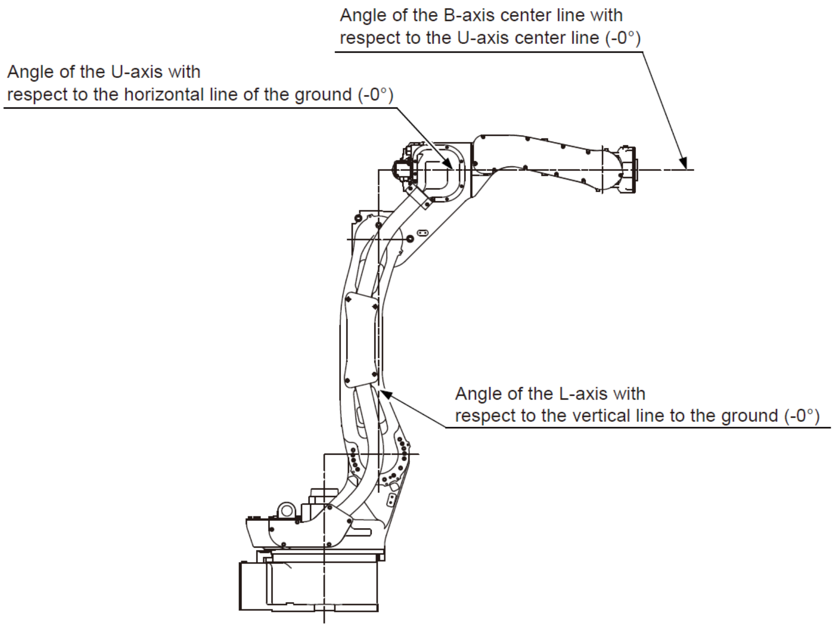
6.7 Home Position Calibration

The Home Position of a Robot is the position where all axes are “0” degrees. Home Position Calibration is the operation where the Home Position and Absolute Encoder Position coincide. Although this operation is performed prior to shipment at the factory, it must be repeated if:

- Home Position encoder deviation (e.g. caused by a crash with the Robot's surroundings)
- Stored memory is wiped (e.g. weak battery, etc.)
- Replacement of a Manipulator motor or absolute encoder
- A change in the combination of a Manipulator and its YRC Controller

The Home Position is commonly used for a 6-axis vertically articulated Robot is shown in *fig. 6-28*.

Fig. 6-28: Home Position of a Common Industrial Robot

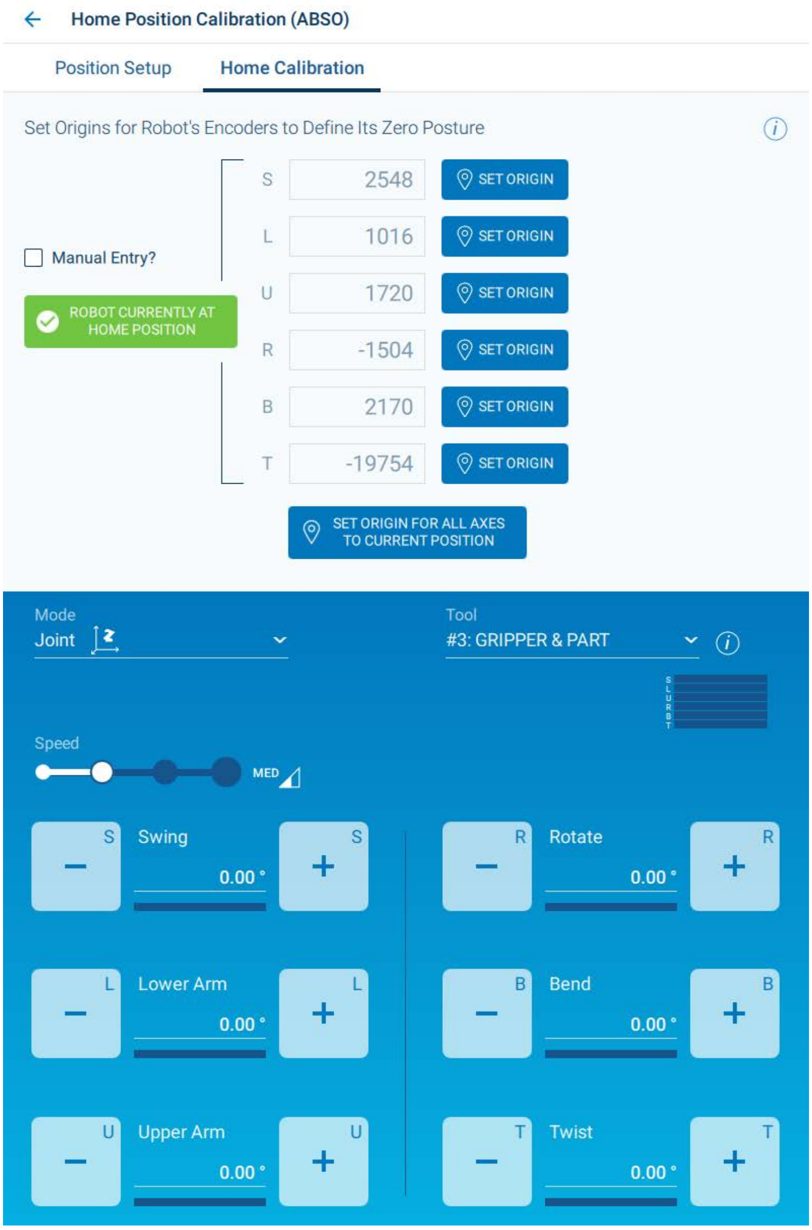


NOTE

The Home Position differs depending on Manipulator model. Refer to the INSTRUCTIONS that corresponds to the specific Manipulator model.

Editing the Home Position affects the stored physical position. Using the {Home Position Calibration} screen on the Smart Pendant, 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 YASKAWA.

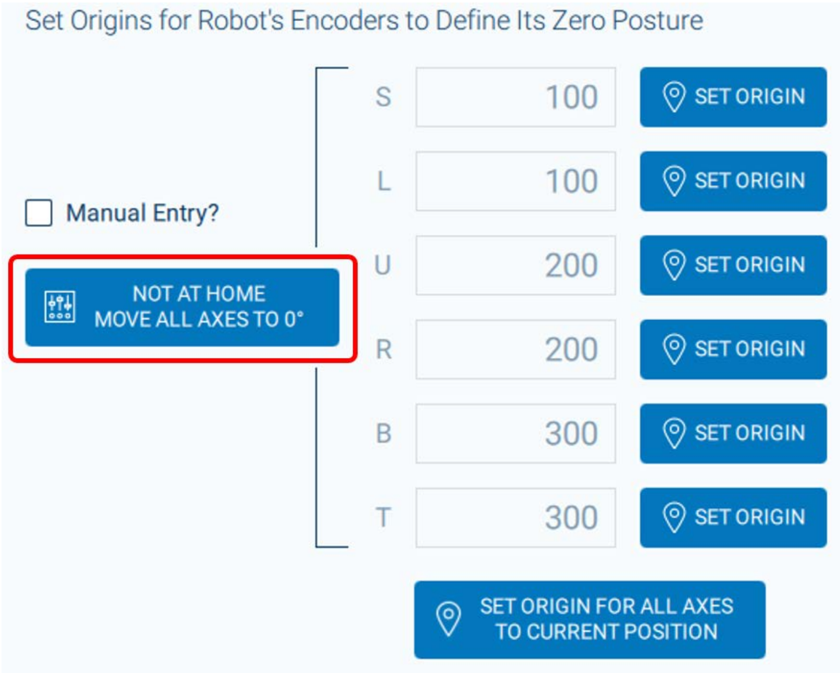
Fig. 6-29: Home Position Calibration Screen



6.7.1 Verification of Home Position Calibration

To verify the existing calibration of a Robot's Home Position, move all axes to their respective “0” degree positions. {Not at Home} will navigate to the {Temporary Position} with all zeros on the Move Robot screen to quickly accomplish this. Follow the instructions in *chapter 6.6.2 “Move to a Robot Position”* to perform this action.

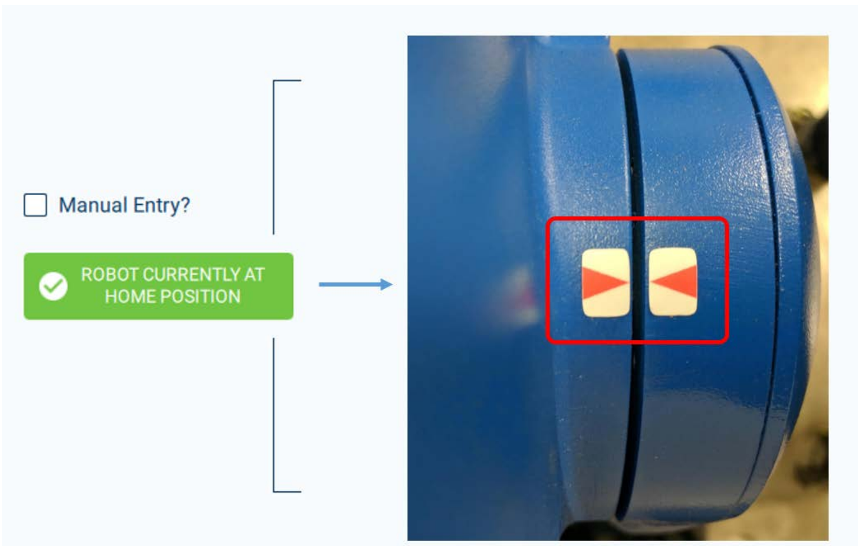
Fig. 6-30: Home Position Calibration Screen



When at “all zeros”, “Not at Home” will turn green and the “Robot is at Home Position” indicator confirming the existing Home Position is ready for verification.

The user should now visually confirm whether the physical arrows on the Manipulator (i.e. one pair for each axis) are precisely aligned to validate the calibration of Home Position.

Fig. 6-31: Robot at the Home Position



In the case of arrow misalignment for one or multiple axes, Home Position Calibration is required. The following sections discuss how to perform the calibration.

> **NOTE** The arrow labels on some Robot models may be hard to find. Refer to the INSTRUCTIONS for the Manipulator corresponding to its model to find each label and accurately perform the calibration.

6.7.2 Home Position Calibration Methods

There are three separate methods for Home Position Calibration:

- Calibrate Individual Axis to 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 these methods is provided in the following sections.

> **NOTE** All calibration methods change the zero-position of the desired axes. This can affect the physical position of the robot for any previously saved positions.

6.7.2.1 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 {MENU} ⟶ {Robot Settings} ⟶ {Home Position Calibration}.
2. Perform the verification procedure described in *chapter 6.7.1 "Verification of Home Position Calibration"*.
3. For any arrow(s) that are misaligned, jog the affected axis until they are aligned.
4. Press {Set Axis} to insert the robot's current pulse value for that axis.
5. Press {Save All} (or {Readback/Write} for FSU) to update the calibration data

Fig. 6-32: Individual Axis Home Position Calibration

6.7.2.2 All Axes Calibration Procedure

Use this method if multiple axes are misaligned after a robot crash.

1. Go to {MENU} ⟶ {Robot Settings} ⟶ {Home Position Calibration}.
2. Perform the verification procedure described in *chapter 6.7.1 "Verification of Home Position Calibration"*.
3. Jog all axes until each pair of arrows are aligned.
4. Press {Calibrate All Axes} to insert the robot's current pulse values for all axes.
5. Press {Save All} (or {Readback/Write} for FSU) to update the calibration data.

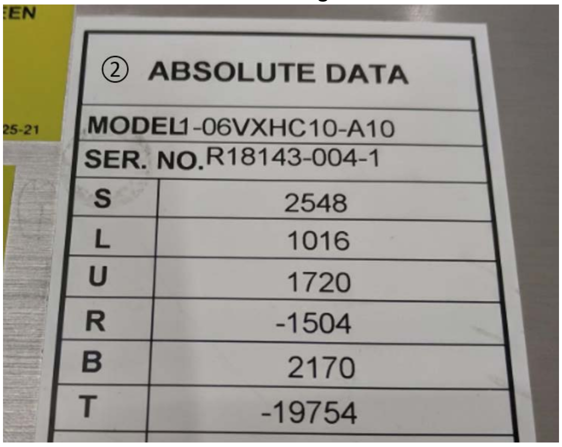
Fig. 6-33: All Axis Home Position Calibration

6.7.2.3 Manual Calibration Procedure

Use this method if the manipulator or YRC Controller is replaced with a new unit. This method is also used to re-enter the existing Home Position values that appear to be correct but are not “set”.

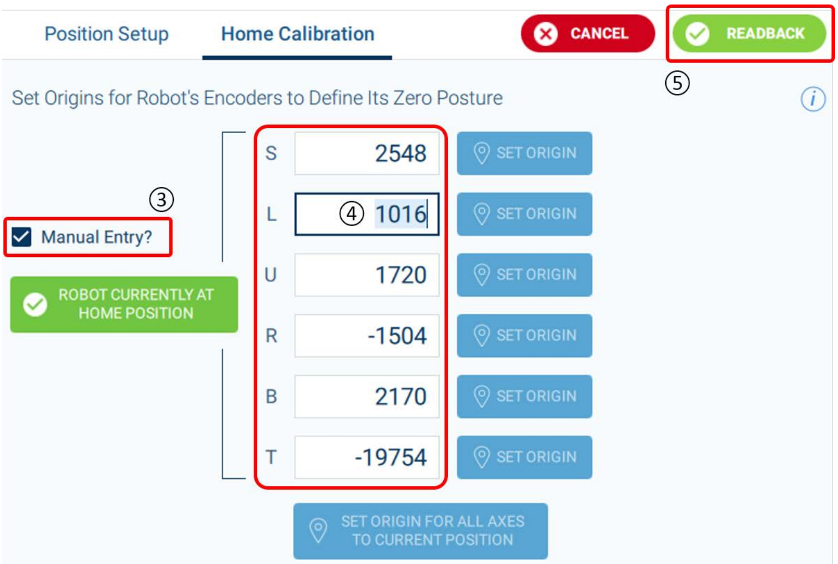
1. Go to {MENU} ⟶ {Robot Settings} ⟶ {Home Position Calibration}.
2. Locate the “ABSOLUTE DATA” white tag on the YRC Controller containing the factory default robot encoder calibration.

Fig. 6-34: “ABSOLUTE DATA” white tag



3. Check the {Manual Entry?} checkbox.

Fig. 6-35: Manual Axis Home Position Calibration



4. Manually enter the data for each axis using the keyboard.

5. Press {Save All} (or {Readback/Write} for FSU) to update the calibration data.

NOTE

- Alarms may occur if large changes are made to the Home Position.
  – In the case of Alarm 4511, reset the alarm and proceed normally.
- If large changes are made to the Home Position of a collaborative HC-series robot, Alarm 1933 may occur.
  – This major alarm will require a reboot of the YRC Controller to successfully clear the error.

6.8 Limit Release

The robot's operating range is monitored by the system software in order to stop the robot motion before its speed and force limits are exceeded. If the robot moves to an unexpected location due to system or operation errors, the operator can temporarily release the limit, and then move the robot back to the desired zone.

View the Limit Release screen at {MENU} ⟶ {Robot Settings} ⟶ {Limit Release}.

The Smart Pendant allows enabling and disabling three types of limit:

– All Limits

– Soft Limits

– Self-Interference (for applicable Robot models)

If the functional safety function (optional) is enabled, the Smart Pendant allows enabling and disabling additional five types of limit:

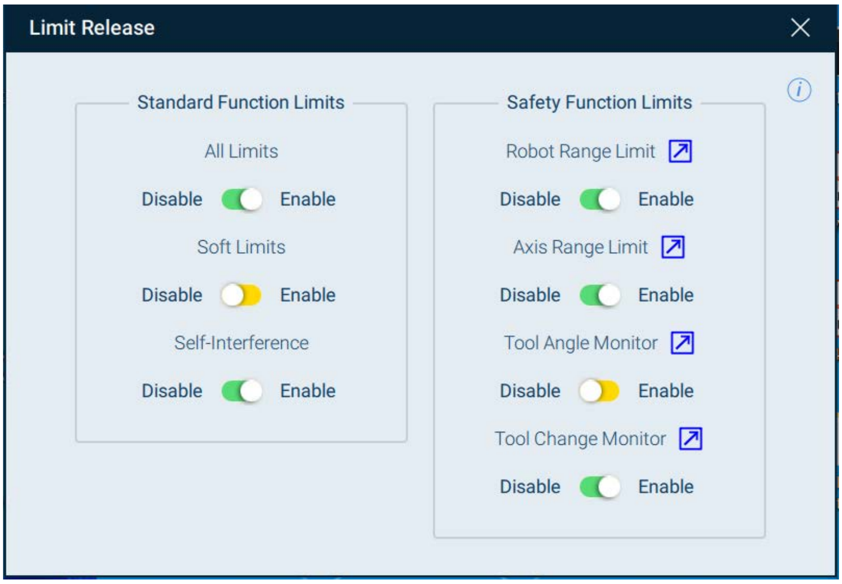
– Robot Range Limit

– Axis Range Limit

– Tool Angle Monitor

– Tool Change Monitor

– Tool Number Select



6.8.1 Standard Function Limits

Use this to disable/enable standard function limit checking.

NOTE

- When limits are disabled, motion command cannot be taught.
- The setting of limit release will automatically “Disable” when the mode is changed to AUTOMATIC (PLAY) mode.

6.8.1.1 All Limits

All limits include the following limit settings:

Table 6-2: All Limit Settings

Limit	Description
Mechanical Limit	Limit to check manipulator’s range of motion
L-U Interference	Limit to check L- and U-axis interference area
Soft Limit on Each Axis	Soft limit to check manipulator’s range of motion
Cubic Zone	Limit to check cubic zone set by user

CAUTION

- When operating the manipulator with all the limits released, make sure to pay close attention to the safety of the operation environment.

If all the limits are released, the manipulator may move beyond its range of motion, which may result in damage to the manipulator or other equipment.

6.8.1.2 Soft Limits

The operating range of the manipulator is controlled by two soft limits:

– The maximum motion range for each axis

– The cubic operation area set parallel to the Robot coordinate system

Robot axes can be reduced by editing “Soft Limits” using Classic Interface (refer to YRC Operator Manuals for more detail). Cubic Zones can also be set to prevent the manipulator from entering specific areas of the workspace.

6.8.1.3 Self-Interference

The manipulator that has self-interference function enabled (e.g. MOTOMAN-HC10) will have this feature. It is the function that controls prohibiting collisions between the manipulator and the attached tool.

NOTE Make sure to take safety measures when disabling self-interference. Failure to observe this instruction may cause contact with the manipulator, which may result in equipment damage.

6.8.2 Safety Function Limits

Use this to enable/disable limit checking associated with functional safety settings. This mode is used with the following functions marked with O

Table 6-3: Limiting Checking Safety Functions

Function	Available
Robot Range Limit	O
Axis Range Limit	O
Speed Limit	X
Axis Speed Monitor	X
Tool Angle Monitor	O
Tool Change Monitor	O
Tool Number Select	O
External Force Monitor	X

If a robot violates a limit setting due to system/operational error, an alarm will stop the robot. The user cannot move the robot or reset the active alarm until this violation has been resolved.

Use the Limit Release Utility to temporarily disable monitoring of violated limit(s). This will allow the user to reset alarm(s) and move the robot to a proper position. The limit(s) should be re-enabled once the alarms have been resolved.

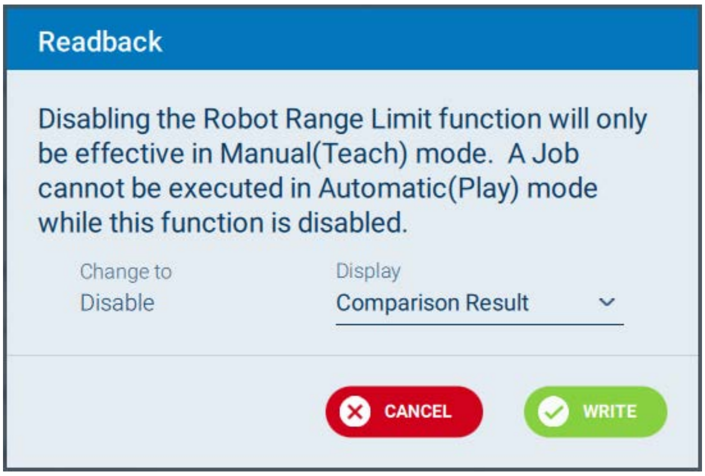
Follow the procedures below when recovering from the alarm.

1. Temporarily disable the safety function which is causing the alarm.
2. Reset the alarm.
3. Jog the manipulator or the external axis inside the safety range.
4. Re-enable the function.

As using this function requires a change to safety settings, readback operation is required.

When changing the switch of temporarily disable the safety function, the setting is transmitted to the safety circuit board, then the readback setting is shown on the {Change to}. If the readback result matches the edited data, it is successfully transferred. If the readback result does not match the edited data, the comparison result is shown as “***”. If so, the edited data or readback data can be seen by selecting {Edit Value} or {Readback

Value} in {Display} option. If comparison result does not match the edited data, the setting cannot be entered and saved.



Press {WRITE} to update the settings of the safety circuit board.

NOTE

- Restrictions are set to job playback, test run, etc. while the safety limits are disabled because this mode also disables monitoring and it is not safe. When moving the robot while the safety functions are temporarily disabled, only the jog operation using the pendant is available.
- Safety Function Limit settings that are set to “Disable” will cause alarm(s) when the mode is changed to Automatic (Play)

6.9 Robot Status Watch

Use this feature to view Robot information for debugging or verification in Automatic (Play) and Manual (Teach) modes.

Select {Main Menu} ⟶ {Robot Settings} ⟶ {Robot Status Watch}

Updates name & line number as Job is executed

① Active Tool

Displays number, name, & weight of the system's Active Tool

② System Status

Displays the current status of limit release (yellow = released)

③ Robot Current Position

Use “Ref. Coord.” to switch between Joint, World, Robot, & User coordinates

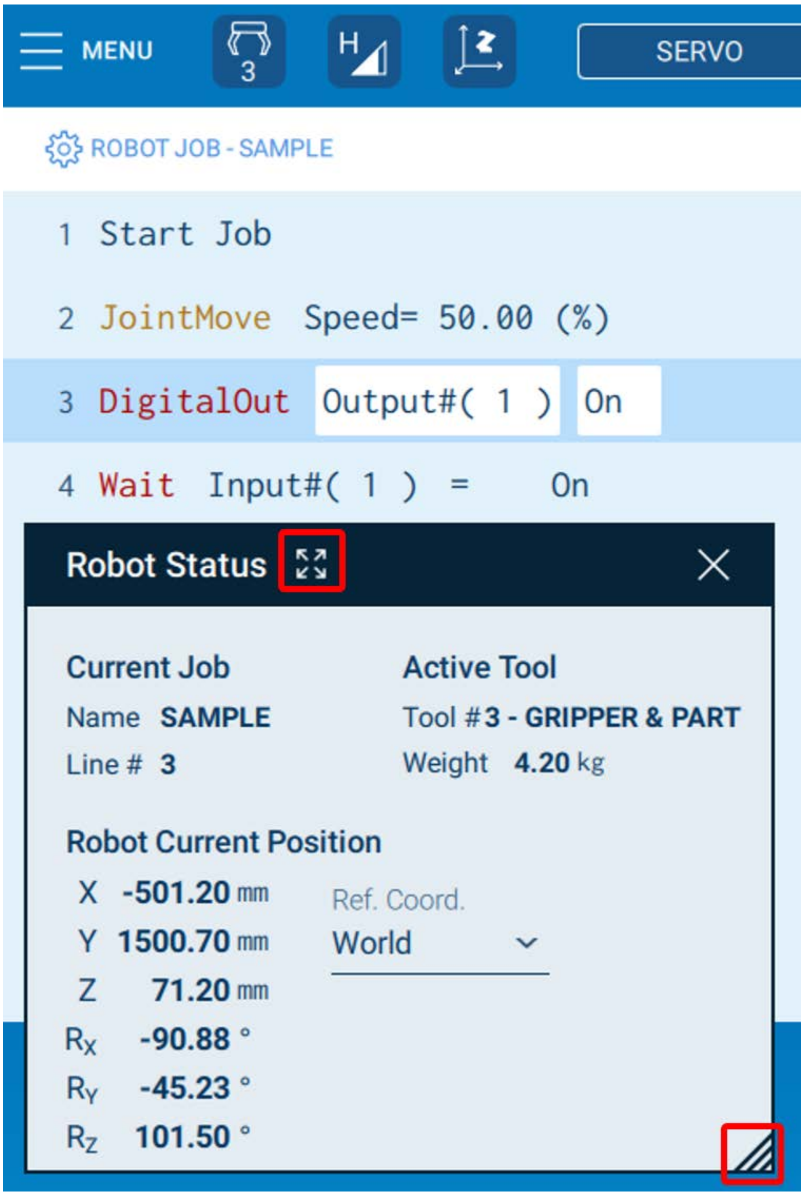
④ Shock Detection Levels

Displays the currently active Allowable Max Torque of Shock Detection - for more detail refer to *chapter 6.5* to view the following information (as labeled in *Fig. 6-36*):

Fig. 6-36: Robot Status Watch

Use the highlighted controls in *fig. 6-37* to adjust window sizing.

Fig. 6-37: Resizeable Robot Status Watch



6.10 Brake Release

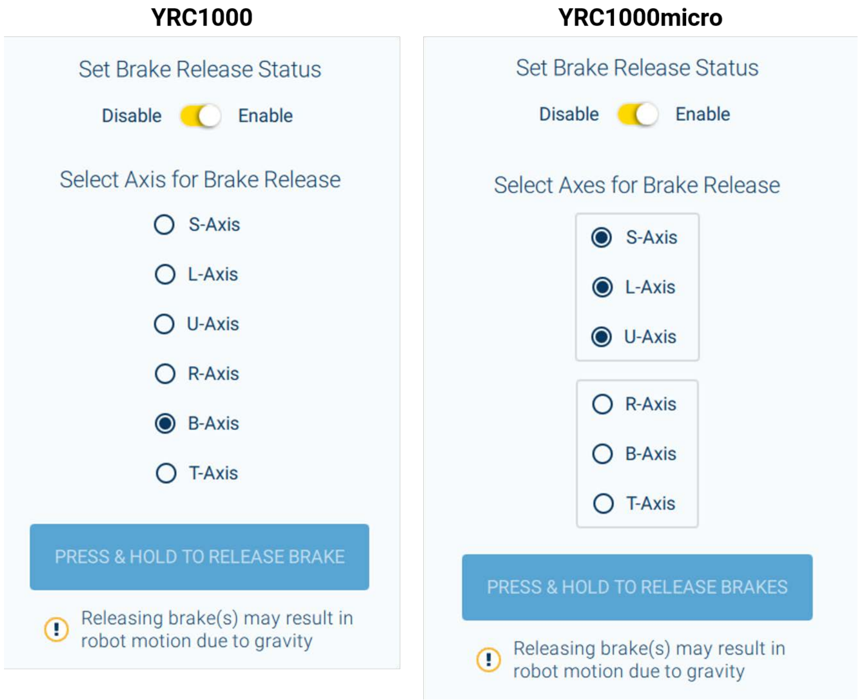
If a manipulator moves to an unexpected position because of system or operation errors and it cannot be moved using the Limit Release function, the Brake Release feature can be used to forcibly move axes.

If enabled on the YRC Controller, the user can access this feature {Main Menu} ⟶ {Robot Settings} ⟶ {Brake Release}

6.10.1 Brake Release Comparison - YRC1000 and YRC1000micro

YRC1000 allows the user to release one axis brake at a time while the YRC1000micro allows for the release of axis brakes in groups [S, L, U] or [R, B, T].

Fig. 6-38: Brake Release Comparison



6.10.2 Brake Release Procedure

CAUTION

- Securely fix selected axe(s) prior to a Brake Release Operation.

Released axes may move suddenly due to gravitational forces dependent on the robot's posture and the installed payload, which may result in personal injury and/or equipment damage.

To execute a brake release:

1. Turn Servos OFF
   – If Servos are ON or ON READY, this can be accomplished by pressing {SERVO} or the Emergency Stop button.
2. Enable Brake Release using the “Set Brake Release Status” switch
3. Select the desired axis (YRC1000) or axis group (YRC1000micro) to be released
4. Squeeze the Enable Switch to prepare for Brake Release
5. Press and hold {PRESS & HOLD RELEASE BRAKES}
   – Servos are OFF and can be manually moved for the selected axe(s)

NOTE

The brake release function works in both MANUAL (TEACH) and AUTOMATIC (PLAY) modes and is available to all Security Access Levels

7 Concurrent I/O (Input/Output)

Concurrent I/O is a technology used by the YRC controller to process I/O signals in parallel, but independent of, manipulator operation. Ladder logic programming is used to read and manipulate concurrent I/O signals, which can be routed to various subsystems in the YRC controller, including external I/O terminal blocks and inform variables. (Each controller ships with pre-configured ladder programming tailored to the application, but there is a portion of the ladder logic available for advanced users to edit).

Smart Pendant currently has limited interaction with Concurrent I/O (compared to standard pendant). On initialization, Smart Pendant scans the ladder logic and uses heuristics to map External I/O into General-Purpose I/O. This mapping is used to ease setup of external device(s). Interface Panel also provides access to Concurrent I/O signals for many of its user controls. (See Chapter 10)

7.1 Features of Concurrent I/O

Concurrent I/O technology provides a general approach for handing logical I/O signals related to robot control.

– Signals classified as External Input/output can read and write I/O signals from/to terminals and connectors and thus provides a means communicating with external devices.

– Signals classified as General-Purpose can be accessed from Inform and included in robot job logic.

– Concurrent I/O signals can be operated on, routed and combined using ladder logic.

– A reserved signal can be accepted while the manipulator is operating because the manipulator operation processing and I/O processing can be executed at the same time.

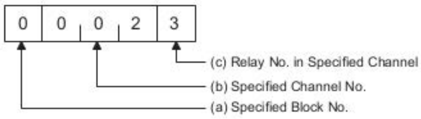
7.2 Classification of Concurrent I/O Signals

Classification	Description	Range
General-Purpose Input	Referenced with input instruction of the job	00010 - 05127 (4096 signals)
General-Purpose Output	Referenced with output instruction of the job	10010 - 15127 (4096 signals)
External Input	Signal corresponding to an input terminal	20010 - 25127 (4096 signals)
External Output	Signal corresponding to an output terminal	30010 - 35127 (4096 signals)
Specific Input	Signal to change the operating condition of the manipulator	40010 - 42567 (2048 signals)
Specific Output	Signal notifying the operating condition of the manipulator	50010 - 55127 (4096 signals)
Auxiliary Relay	Auxiliary relay signals	70010 - 79997 (7992 signals)
Control Status	Various robot control signal status values specified depending on the application	80010 - 85127 (4096 signals)
Pseudo Input	Reading system parameters	87010 - 87207 (2048 signals)
Network Input	Input signal from a network device	27010 - 29567 (2048 signals)
Network Output	Output signal from a network device	30010 - 39567 (4096 signals)
Register	16-bit data GP Registers M000-M559 AO M560-M599, AI M600-M639 System Registers M640-M999	M000-M999 (1000 signals)

7.3 Addressing I/O Signals

Concurrent I/O is accessed via the 5-digit System I/O address.

Table 7-1: 5-digit System I/O Address



– The first digits correspond to the signal classification. (See *table 7-1*)

- 0xxxx General Purpose Input
- 1xxxx General Purpose Output
- 2xxxx External Input
- 27xxx-29xxx Network Input
- 3xxxx External Output
- 37xxx-39xxx Network Output
- 4xxxx Specific Input
- 5xxxx Specific Output
- 6xxxx Interface Panel Input (not used by Smart Pendant)
- 7xxxx Auxiliary Relay
- 80xxx-85xxx Control Status
- 87xxx Pseudo Input
- 37xxx-39xxx Network Output
- Mxxx Register

– The next 3 digits correspond to the channel starting with 001

– The final digit corresponds to the individual bit 0-7 for individual I/O, and for group I/O are set to 0 or x (as the full byte is read).

7.4 I/O Instructions

A Robot system rarely works without having to interact with other devices. Most instances, the YRC Controller must communicate with external equipment, such as fixtures and sensors. Communication is accomplished using Universal Inputs and Outputs. The INFORM language supports I/O instructions for both digital input and output.

7.4.1 DigitalOut Output#( )

The DigitalOut instruction with the Output#( ) tag can only operate an individual Universal Output. It is used any time a device, such as a gripper, is to be turned ON or OFF.

The following is an example of the DigitalOut instruction used with a single Universal Output (Output#):

DigitalOut Output#(1) ON

JointMove Speed = 25%

DigitalOut Output#(1) OFF

To program a DigitalOut Output#( ) instruction in a job, perform the following steps:

1. In MANUAL (TEACH) mode, move the cursor to a line to insert the instruction in the Job Contents view.
2. Open {COMMANDS} from the Navigation Bar.
3. Select {DigitalOut} under {I/O}. The DigitalOut will be inserted in the Job Contents.
4. Open Detail Edit by tapping the right of the cursor.
5. Select the type of output as single universal output {OT#( )}.
6. Insert the output signal number (ex. insert 1 for output number 1).
7. Choose ON/OFF/INVERT.
8. Press {SAVE ALL}.

NOTE

By default, once an Output has been turned ON, it will remain ON it is turned OFF by a job instruction or manually turned OFF.

7.4.2 Digital Output for a Group

The Digital Output instruction with the OutputGroup#( ) tag commands all 8 output bits in the designated Universal Output Group to become the status of Byte range of 0-255. The decimal number is converted into a binary number, with each bit identifying the status for the individual outputs in the group.

For example, the result of DigitalOut OutputGroup#(1) = 162 would be Outputs 2, 6 and 8 ON (2 + 32 + 128 = 162), and Outputs 1, 3, 4, 5 and 7 would be OFF.

In the job example below, Outputs 1 and 5 would be turned ON (1 + 16 = 17) as all others in the group would be turned OFF. The DigitalOutput OuputGroup#(2) turns all 8 outputs in the group OFF.

DigitalOut OutputGroup #(1) 17

JointMove Speed = 25%

DigitalOut OutputGroup #(1) 0

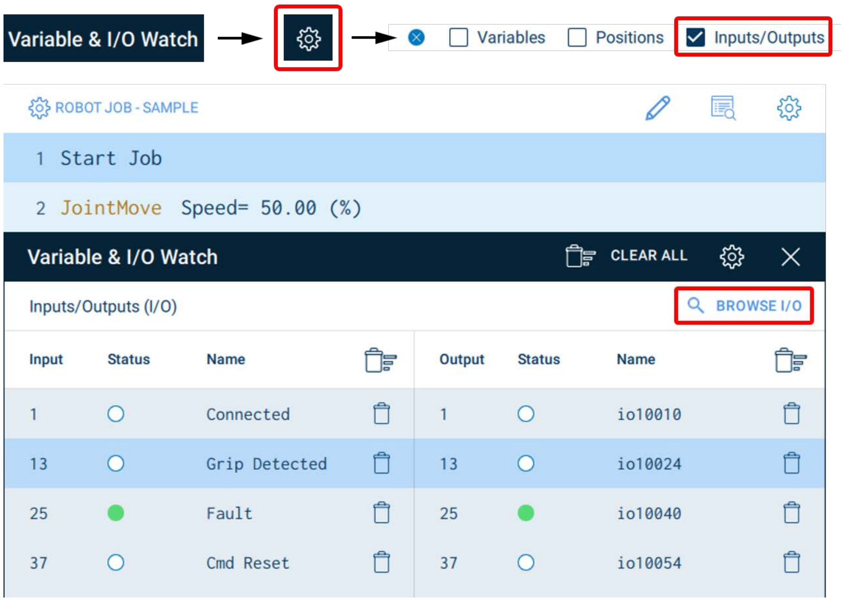
7.5 Monitoring I/O from Smart Pendant Interface

7.5.1 Monitoring I/O Signals by I/O Monitor

Use I/O Watch to Monitor Signals

I/O signals can be monitored using the I/O Watch feature accessed at {Menu} → {I/O & Variables} → {Variable & I/O Watch}

To select and monitor I/O, press {Settings} in the header to ensure “Inputs/ Outputs” is checked. I/O can be displayed with or independent of User Variables.



Use {Browse I/O} to open a list of I/O signals, make selections, and press {Update} to populate the monitor. Several {Clear} options are provided to quickly edit monitored list(s).

Monitored values are refreshed every second.

7.5.2 I/O Windows

Signal status can be monitored using the instructions described in this section.

7.5.2.1 Smart Pendant I/O Configuration

The YRC Controller has a total of 4096 signals available for both input and output. From the Classic Interface, these can be configured/mapped to a variety of physical or network devices. These signals can also be used as purely logical signals. In practice, only a small subset of these signals will be used in most applications.

The Smart Pendant will read the I/O configuration from the YRC Controller and display the configured data. There is also an option for displaying any "unmapped" signals so that the entire 4096 range can be viewed on Smart Pendant if desired. The following sections will describe the screens for monitoring these I/Os as well as how to configure the displays.

NOTE

Many I/O allocation/mapping tasks require the use of Classic Interface. Smart Pendant will use configuration already present on YRC Controller.

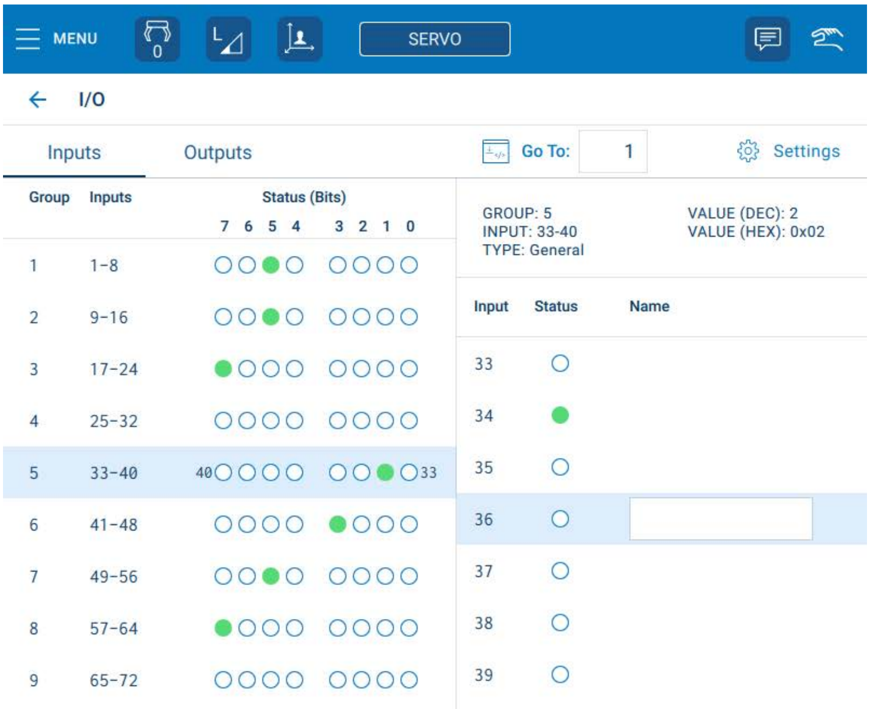
7.5.2.2 I/O Screens

I/O can be accessed at {I/O & Variables} → {I/O} or from the lower panel of the Current Job screen. This screen has two main views: Group View and Individual View. By default, the Group View will be visible. The Group/ Individual View can be changed from the I/O Setting panel described under *"I/O Settings"* section.

Group View

In Group View, the signals are displayed in groups of 8. ON status is shown as a green circle, and OFF status is shown as a white 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.

Fig. 7-1: I/O Group View



Go To an I/O Group Containing an I/O Number

1. Press the text field to the right of {Go To:}.
   - The keypad will appear.
2. Enter the I/O number and press {Enter}.
   - The view will go to the I/O group containing that I/O number and highlight it.

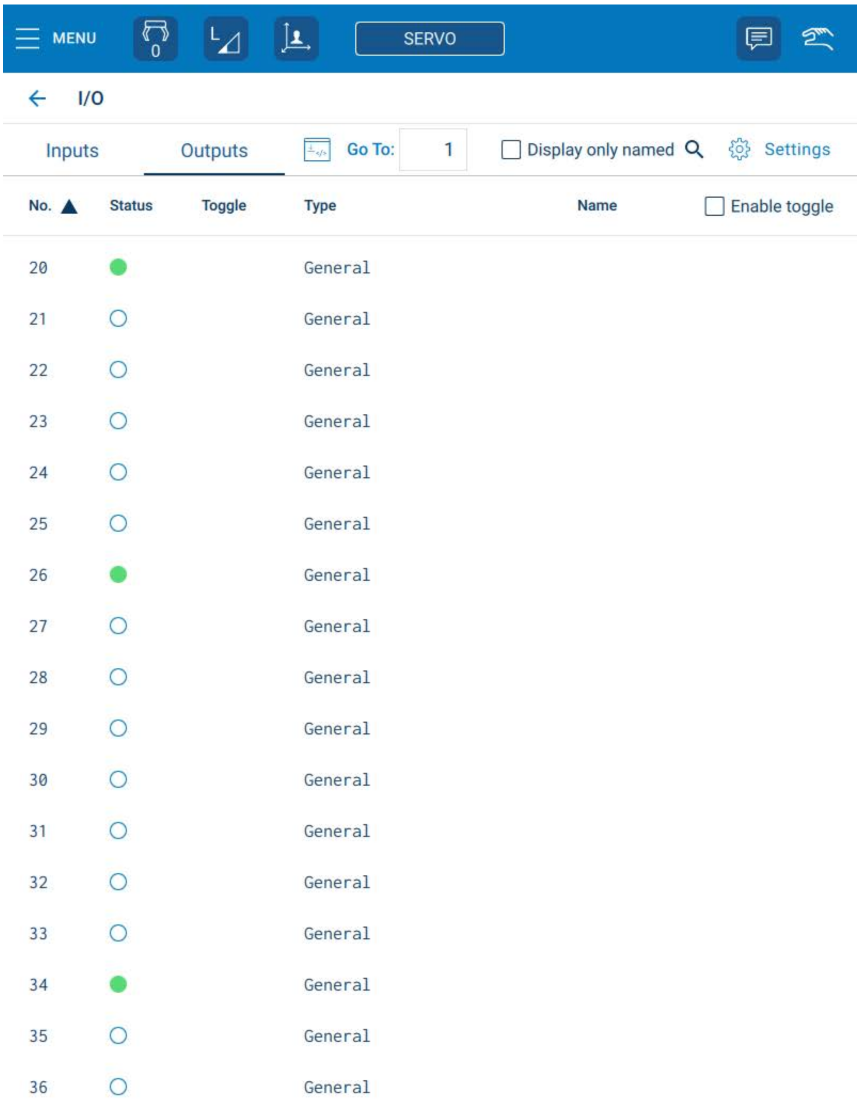
Additional information about the selected group is displayed on the top right of the screen. This information includes:

- GROUP: the group number of the inputs.
- INPUT: the 8 inputs within the specified group.
- TYPE: The input type as configured from the YRC Controller
- VALUE (DEC): the value of the group in decimal.
- VALUE (HEX): the value of the group is 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 is shown in *fig. 7-2 "Toggle Output from Group View"*.

Fig. 7-2: Toggle Output from Group View

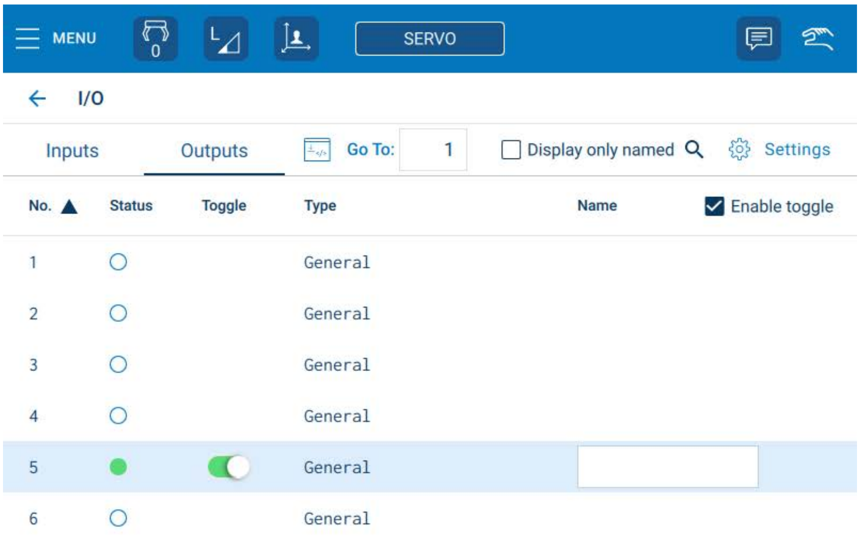
- **Individual View**
  In Individual View, each I/O signal is displayed on a separate line as shown in *fig. 7-3 "I/O Individual View"*.

Fig. 7-3: I/O Individual View



Output signals can also be toggled from the Individual View. 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 is shown in *fig. 7-4 "Toggle Output from Individual View"*.

Fig. 7-4: Toggle Output from Individual View



- **Go To an I/O Number**

1. Press the text field to the right of {Go To:}.
   – The keypad will appear.
2. Enter the I/O number and press {Enter}.
   – The view will go to the I/O number and highlight it.

- **I/O Settings**

To access I/O Settings, press the {SETTINGS} on the top of the panel. This will bring up the panel shown in *fig. 7-5 "I/O Display Settings"*.

This panel has two sections: Display Settings (1) and Types to Display (2).

In the {Display Settings}, the view can be switched between the Group View and Individual View that are mentioned in the previous sections.

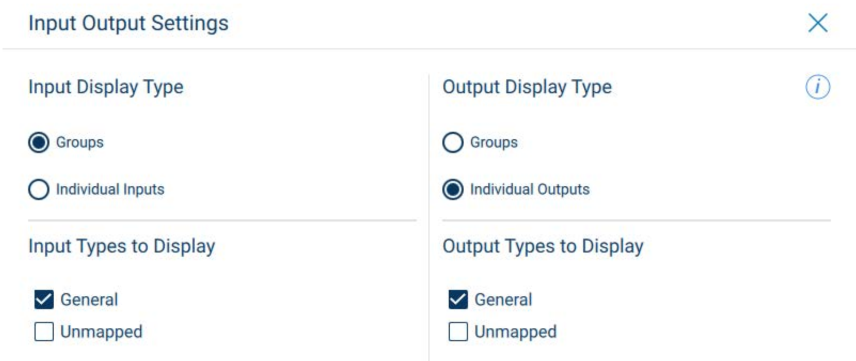
In the {Types to Display}, the I/O display can be filtered based on how the I/O are configured on the YRC Controller. For example, if all checkboxes were cleared except the "Terminal Block", then only the I/Os associated with the standard Terminal Blocks would be displayed
(i.e. 1-24 for YRC1000 and 1-8 for YRC1000micro).

The “Unmapped” checkbox is false by default. Checking this box will display all 4096 I/Os of the YRC Controller.

NOTE

I/O Display Type Settings are separate for Input and Output. For example, it is possible to set “Group View” for Inputs and “Individual View” for Outputs.

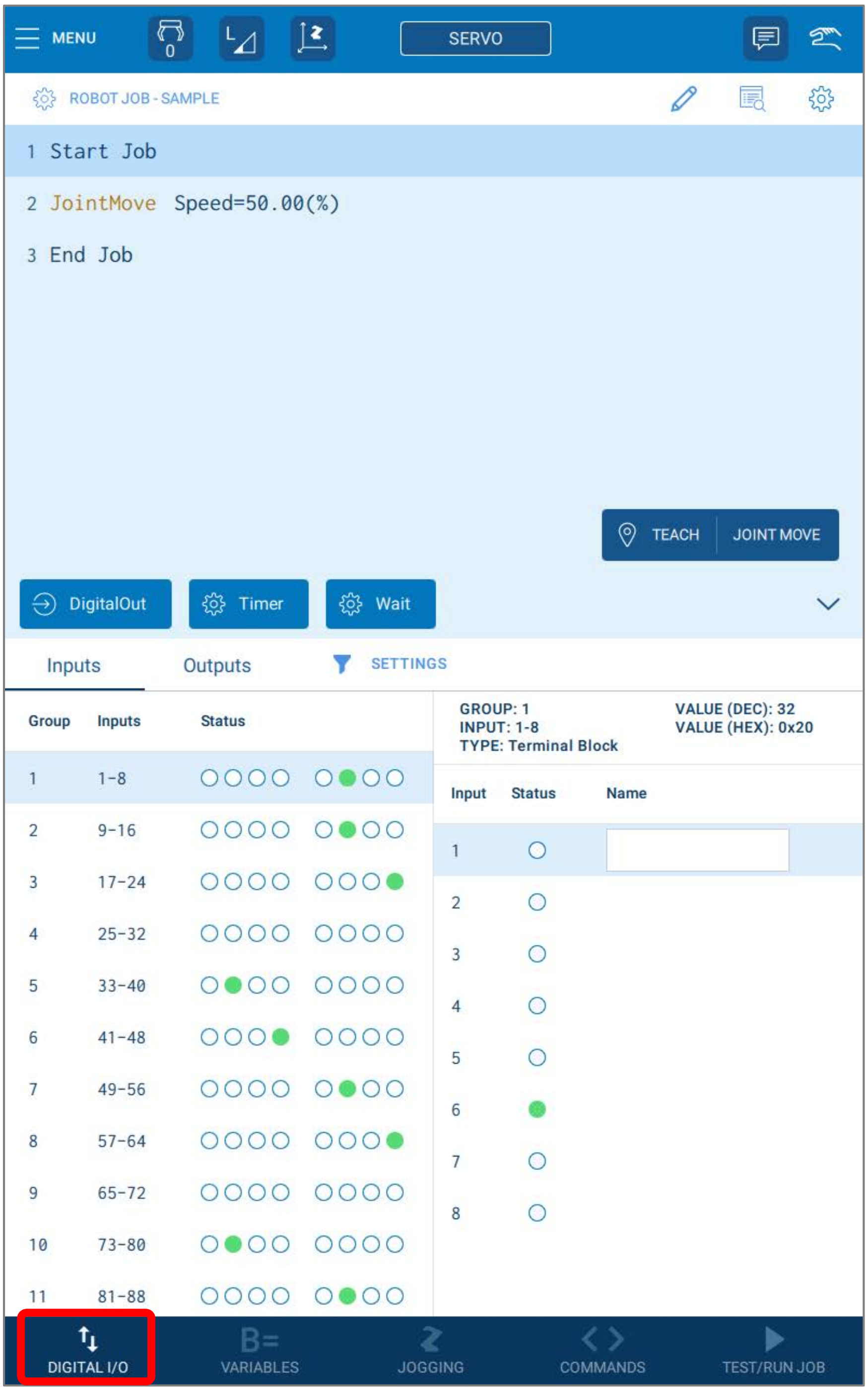
Fig. 7-5: I/O Display Settings



The “types” displayed in the above list will be dependent on the devices that have been configured for the system. These devices can either be extra I/O boards (refer to Chapter 12.2 of “YRC1000 INSTRUCTIONS (RE-CTO-A221)”) or network devices such as EtherNet/IP. For example, if an EtherNet/IP gripper were added with the name “Gripper”, then this would be displayed under the types as “Gripper”. For more information on configuring EtherNet/IP devices, refer to “YRC1000 OPTIONS INSTRUCTIONS EtherNet/IP COMMUNICATION FUNCTION (HW143560)”.

There is also a half-screen version of the I/O Screens located from the Programming Panel (*fig. 7-6 “Half Screen I/O Window”*). To access this, first select {Current Job} from the {MENU}. Then, select {Digital I/O} from the Navigation Bar. This screen has all the functionality of the full-screen I/O Windows in a half-screen form.

Fig. 7-6: Half Screen I/O Window



7.6 I/O Detailed View

7.6.1 I/O Detailed View Overview

The I/O Detailed View will appear on right panel of both {Inputs} and {Outputs} when an I/O group is long-pressed. It displays detailed information for a selected concurrent block of I/O groups.

- Selection size of 1, 2, 3 or 4 bytes. Each I/O group is one byte.
- Allows Output editing of the full selected I/O block in one step.
- Allows Output editing of individual half-bytes, or bytes in the selected I/O block in one step.

NOTE

The I/O Detailed View is not visible by default.

Fig. 7-7: Input Detailed View

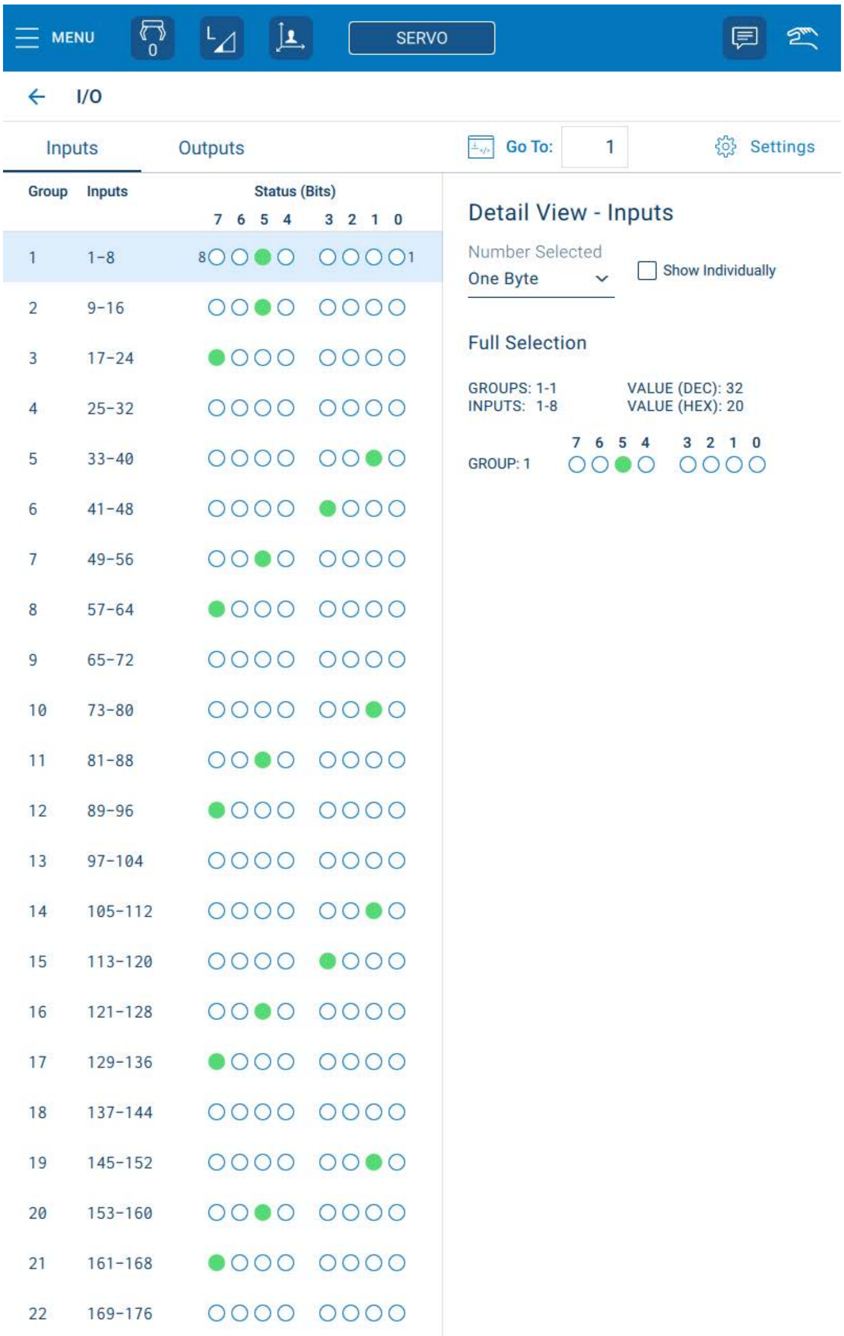
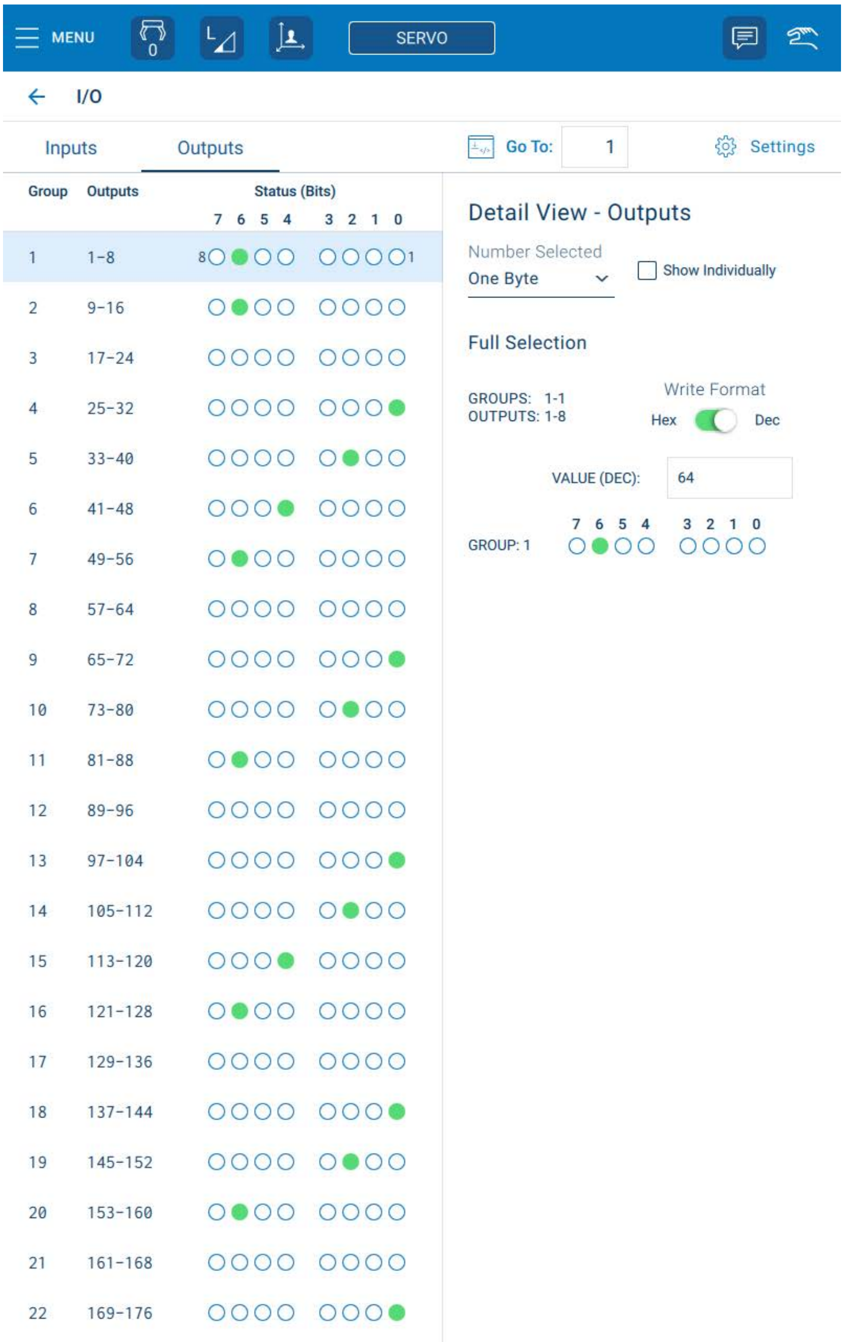


Fig. 7-8: Output Detailed View



■ Accessing the I/O Detailed View from the Main Menu

1. Go to {MENU} → {I/O & Variables} → {I/O}.
2. To view the Inputs Detailed View, press {Inputs} or to view the Outputs Detailed View, press {Outputs}.
3. Press and hold an I/O group row in the left panel for two seconds.
   – The I/O Detailed View will appear in the right panel.
   – The default number selected is one byte, the size of one I/O group.
4. To set the number of bytes selected, press {Number Selected} and select {One Byte}, {Two Bytes}, {Three Bytes} or {Four Bytes}.

Accessing the I/O Detailed View from the Current Job Screen

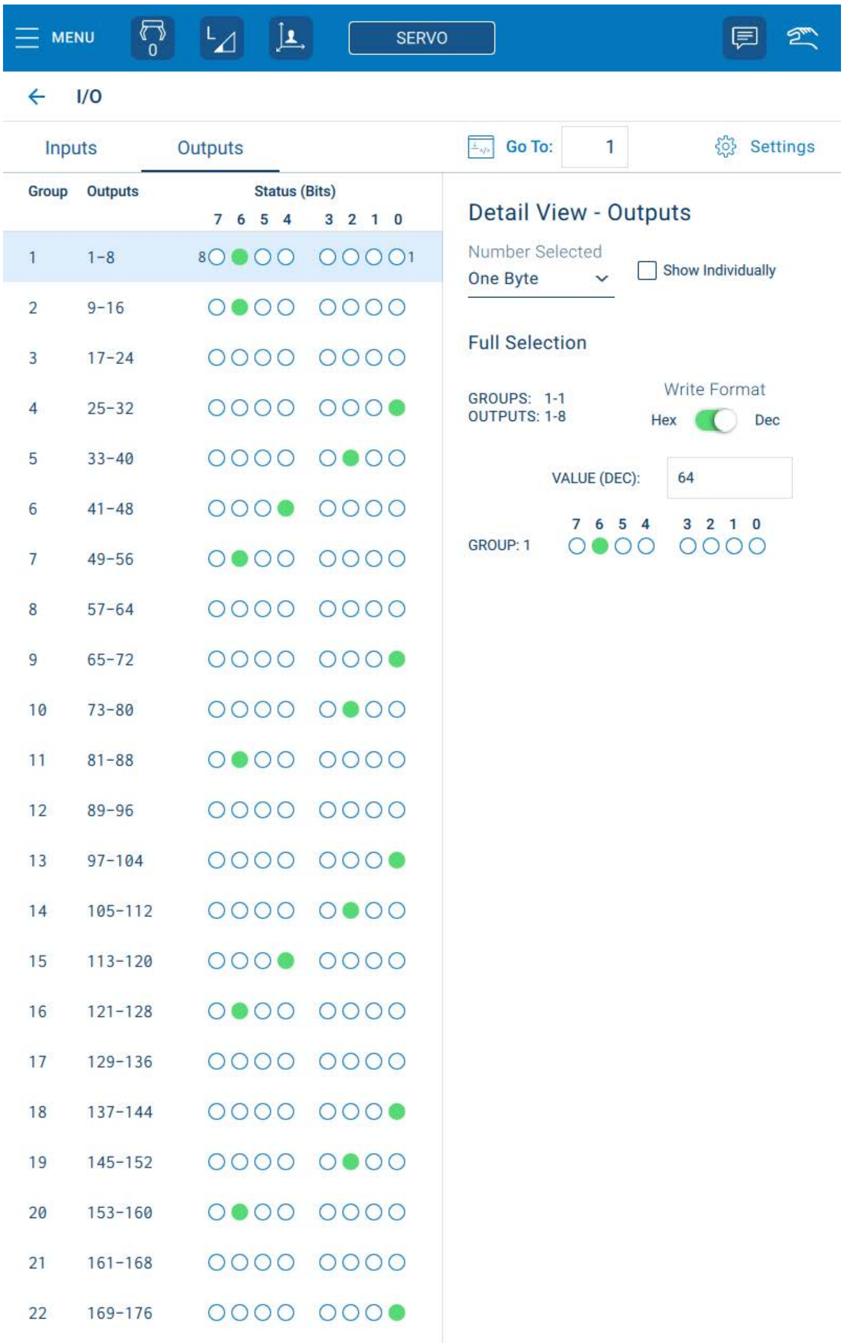
1. Go to {MENU} → {Current Job}.
2. Press {Digital I/O} in the lower left corner of the screen.
3. The I/O view will appear in the lower half of the screen.
4. To view the Inputs Detailed View, press {Inputs} or to view the Outputs Detailed View, press {Outputs}.
5. Press and hold an I/O group row in the left panel for two seconds.
   – The I/O Detailed View will appear in the right panel.
   – The default number selected is one byte, the size of one I/O group.
6. To set the number of bytes selected, press {Number Selected} and select {One Byte}, {Two Bytes}, {Three Bytes} or {Four Bytes}.

Fig. 7-9: I/O Detailed View from Current Job

■ Switching Between Output Decimal and Hexadecimal Write Formats

In {Outputs} I/O Detailed View, press the {Write Format} switch under {Full Selection}.

Fig. 7-10: Dec/Hex Write Format Switch



Input Full Selection Layout

Near the top of the input Detailed View. It has information for the selected input groups as a block.

{Full Selection} has:

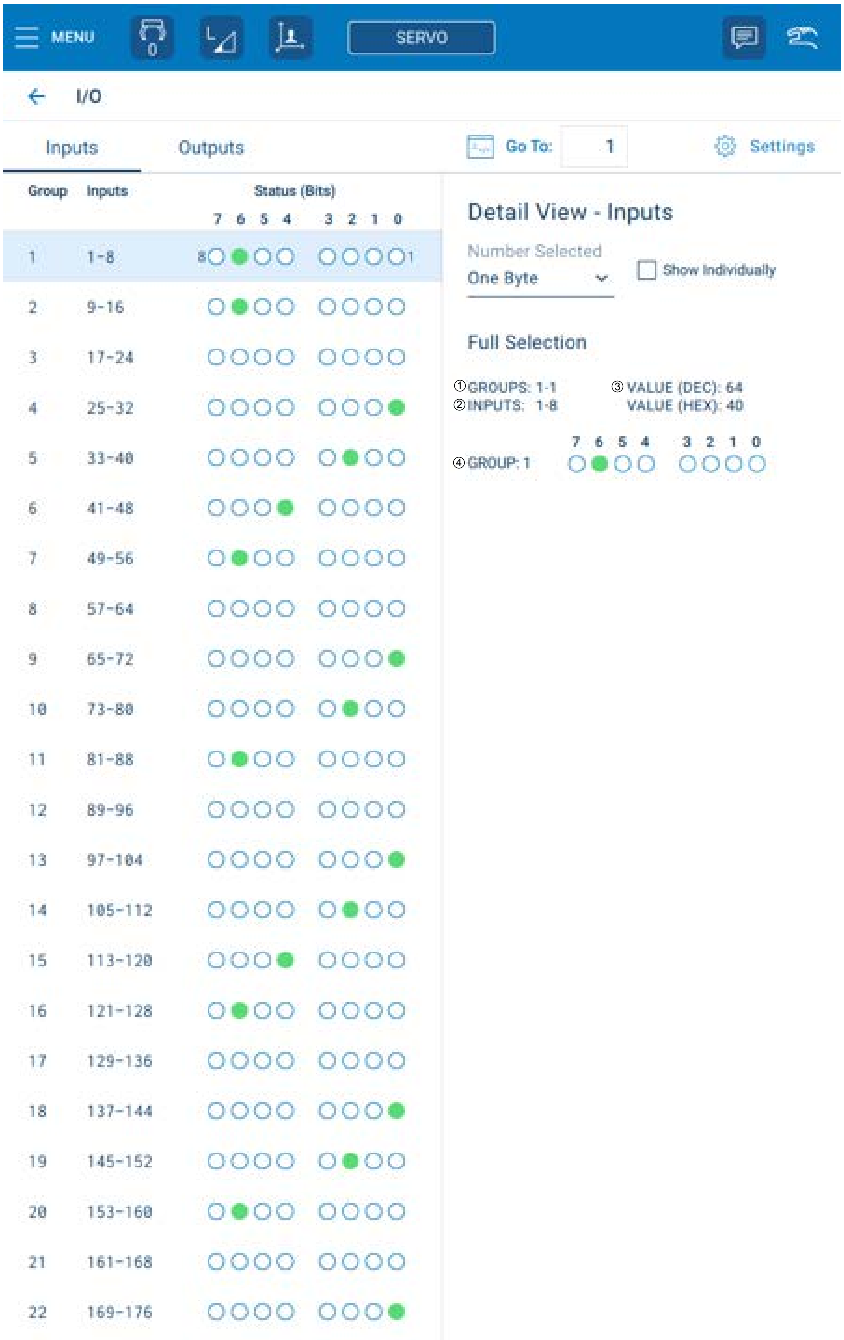
① Selected input group numbers.

② Selected input numbers.

③ Decimal or hexadecimal value for the entire block as one number.

④ Circles that show the status of each bit in the block, and the bit number above each circle. Green is on, white is off. Zero is the least significant bit.

Fig. 7-11: Input Detailed View Full Selection



■ Input Individual Sections Layout

Located under the {Full Selection} in the I/O Detailed View. It has information on each individual I/O group in the selected block.

> NOTE
>
> Individual Selections are not visible by default.

① Selected I/O group number.

② Selected I/O numbers.

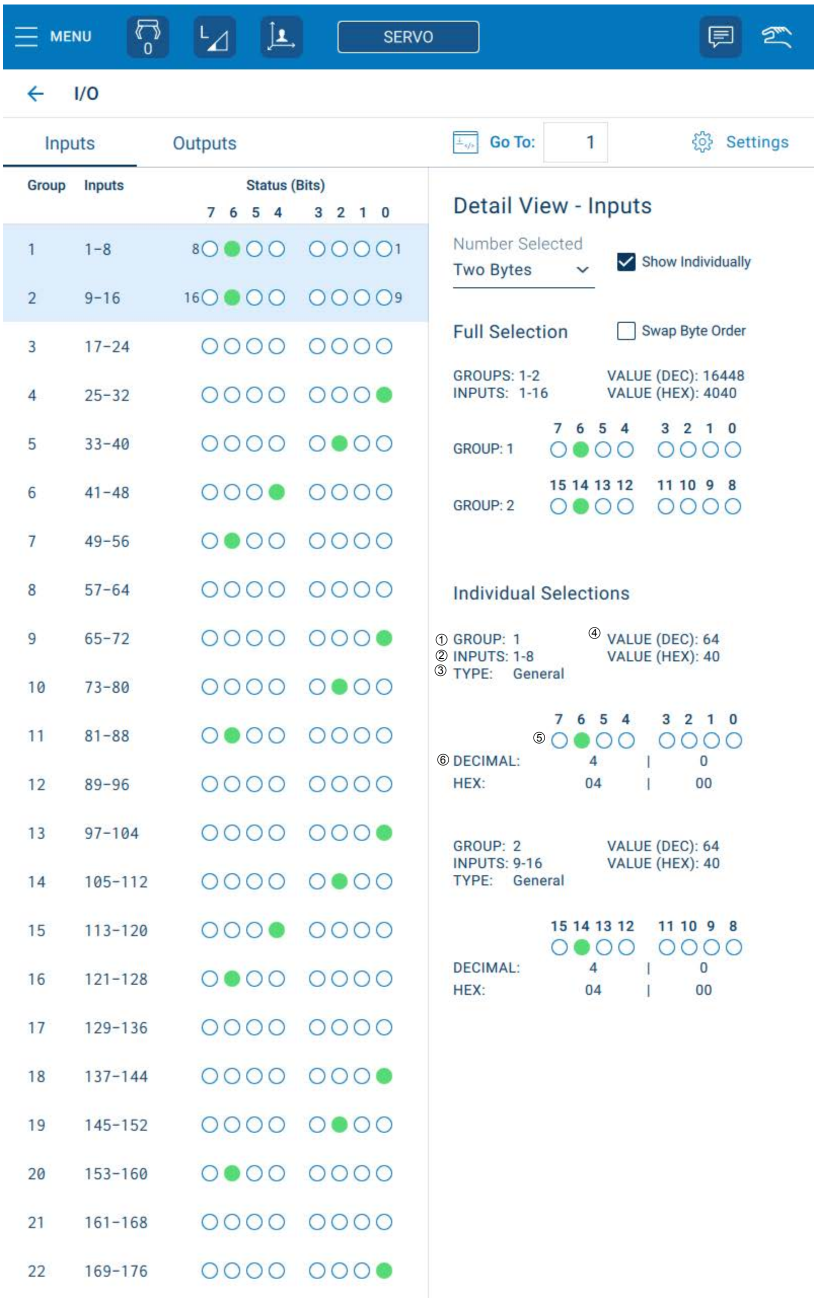
③ Selected I/O group type.

④ Decimal or hexadecimal value for the I/O group.

⑤ Circles that show the status of each bit in the block, and the bit number above each circle. Green is on, white is off. Zero is the least significant bit.

⑥ Decimal or hexadecimal value for the two half-bytes in the I/O group.

Fig. 7-12: Input Detailed View Individual Selection



■ Output Full Selection Layout

Near the top of the output Detailed View. It has information for the selected I/O groups as a block.

{Full Selection} has:

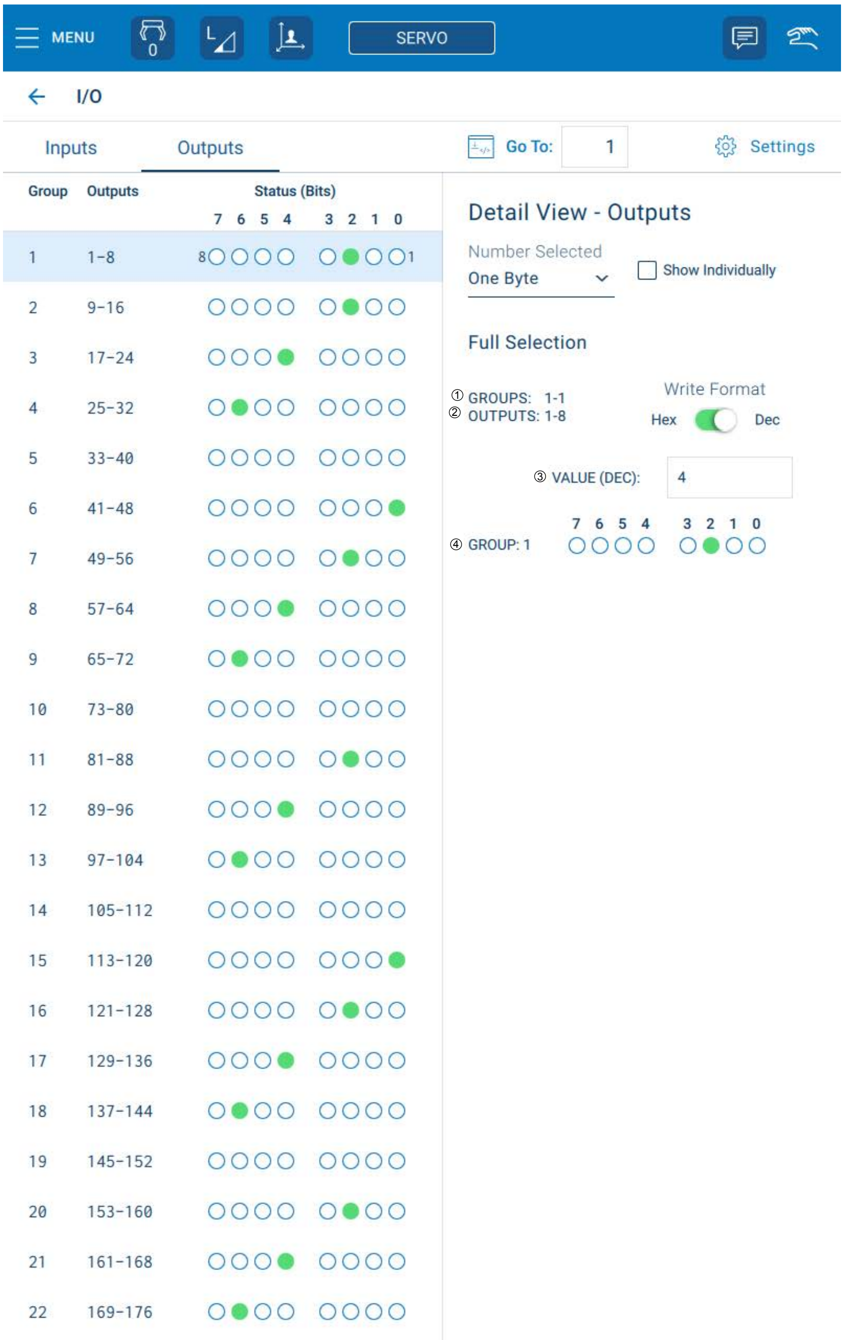
① Selected output group numbers.

② Selected output numbers.

③ Decimal or hexadecimal value for the entire block as one number.

④ Circles that show the status of each bit in the block, and the bit number above each circle. Green is on, white is off. Zero is the least significant bit.

Fig. 7-13: Output Detailed View Full Selection



■ Output Individual Sections Layout

Located under the {Full Selection} in the output Detailed View. It has information on each individual output group in the selected block.

> **NOTE** Individual selections are not visible by default.

① Selected output group number.

② Selected output numbers.

③ Selected output group type.

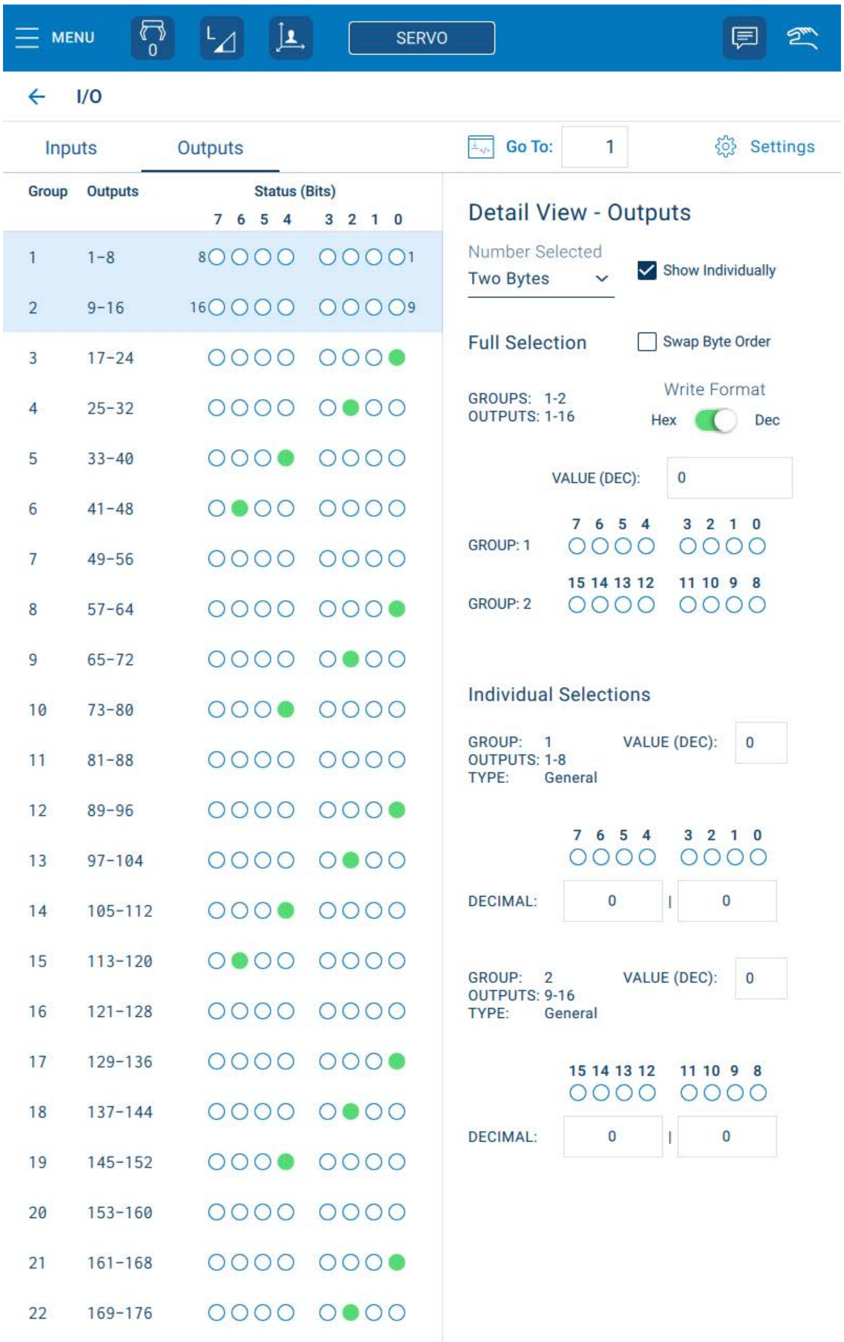
④ Decimal or hexadecimal value for the output group.

⑤ Circles that show the status of each bit in the block, and the bit number above each circle. Green is on, white is off. Zero is the least significant bit.

⑥ Decimal or hexadecimal value for the two half-bytes in the output group.

⑦ Dec/Hex write format switch.

Fig. 7-14: Output Detailed View Individual Selection

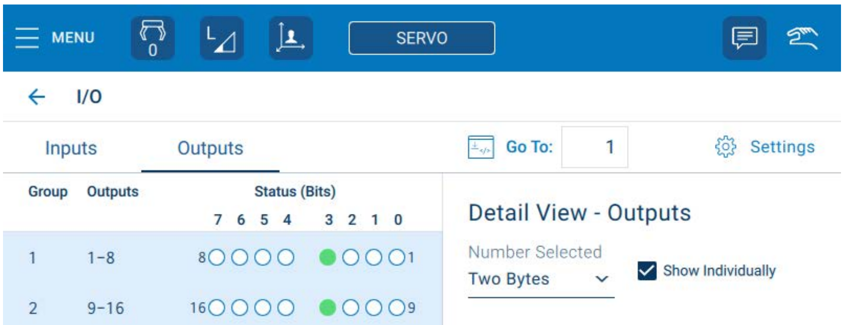


■ Accessing Individual Selections

> **NOTE** {Show Individually} checkbox is only visible if more than {One Byte} is selected in the {Number Selected} dropdown.

In {Inputs} or {Outputs} I/O Detailed View panel, press {Show Individually} checkbox in the upper right corner of the right panel.

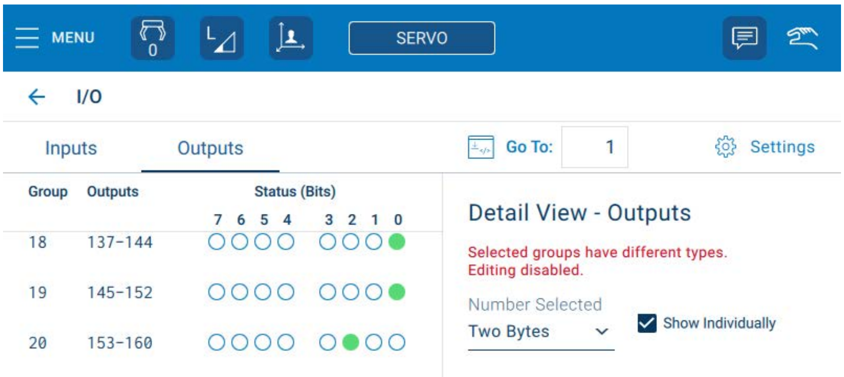
Fig. 7-15: I/O Detailed View Show Individually



7.6.2 Editing Output Values

- Editing requires Editing Security level or above.
- Editing output values is disabled if the selected I/O groups are of different types and a warning will appear. Change your selection so only I/O groups with the same type are selected.

Fig. 7-16: Output Detailed View Editing Warning



Press the text field for the value you wish to change.

– A keypad will appear for decimal values, or a keyboard will appear for hexadecimal values.

– Press the keys to set the value and press {Enter}.

Fig. 7-17: Output Detailed View Editing

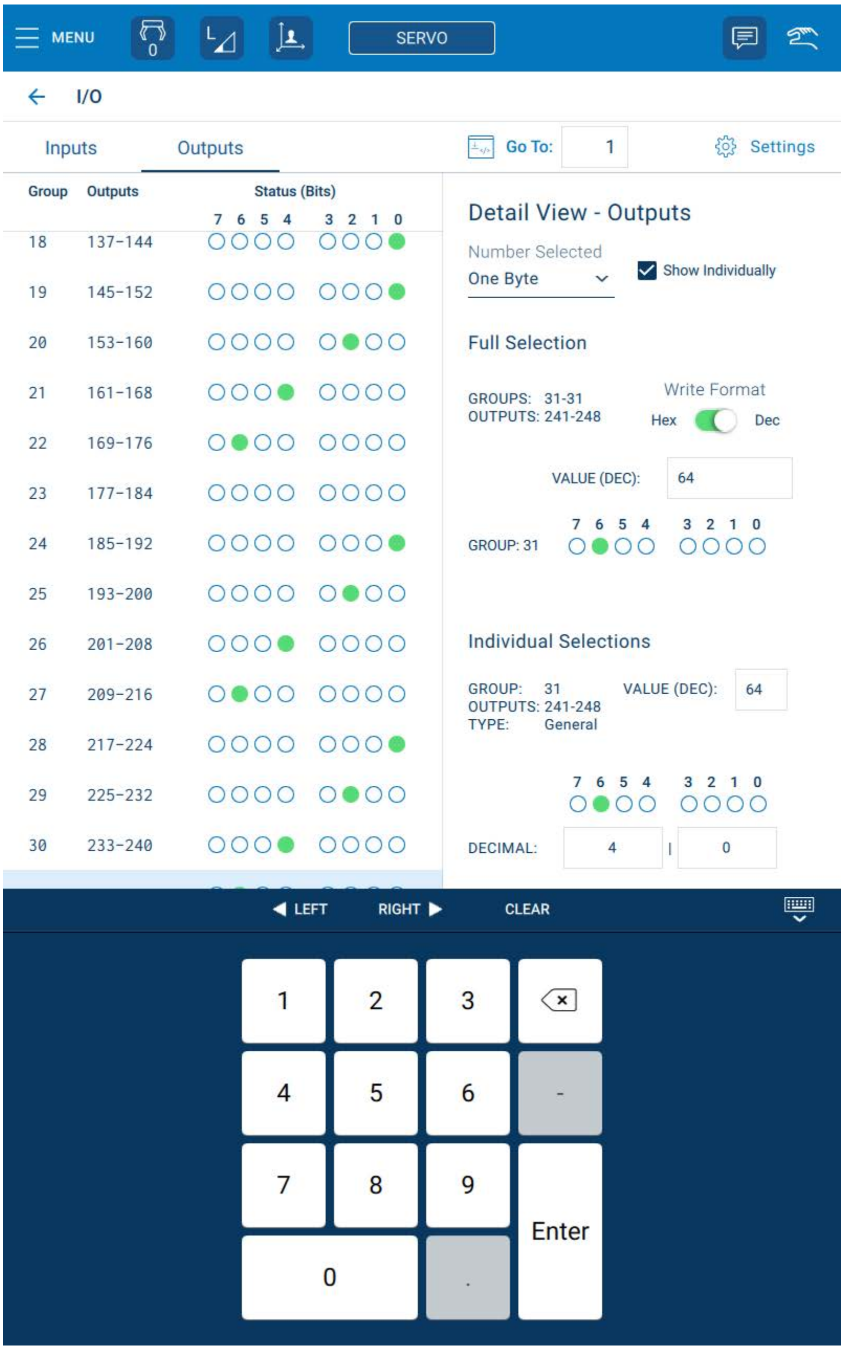


Table 7-2: Valid Decimal Ranges:

Size	Minimum Value	Maximum Decimal Value
Half Byte	0	15
One Byte	0	255
Two Bytes	0	65,535
Three Bytes	0	16,777,215
Four Bytes	0	4,294,967,295

Table 7-3: Valid Hexadecimal Ranges:

Size	Minimum Value	Maximum Hexadecimal Value
Half Byte	0	F
One Byte	0	FF
Two Bytes	0	FFFF
Three Bytes	0	FFFFFF
Four Bytes	0	FFFFFFFF

- **Swap Byte Order**

There are two different formats for combining multiple bytes into one multi-byte number.

– Smallest group number is the least significant byte, {Swap Byte Oder} not checked, default.

– Largest group number is the least significant byte, {Swap Byte Order} checked.

External devices connected to the Robotic system often use varying methods of data transfer. Try swapping the byte order if unexpected values appear while reading or writing multi-byte values.

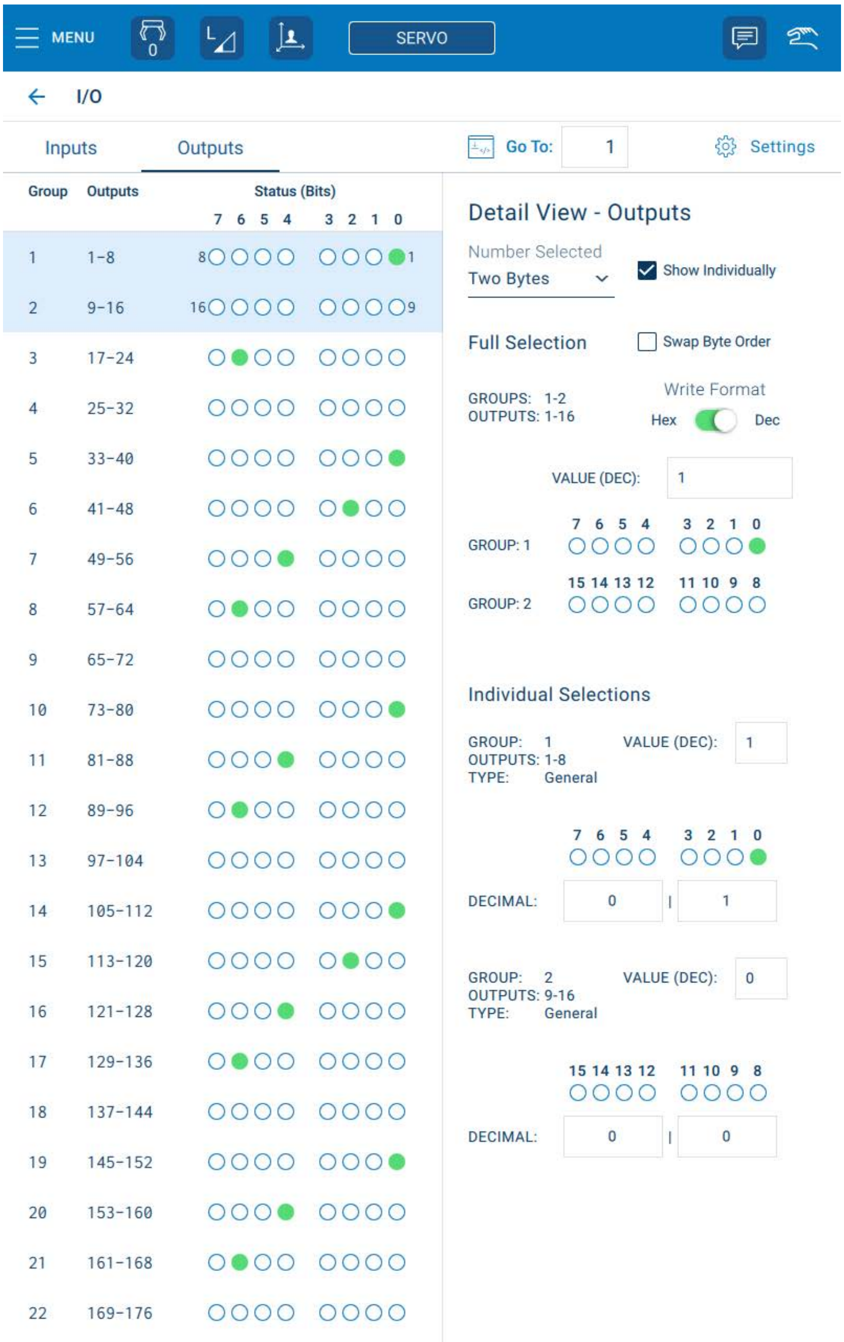
NOTE

{Swap Byte Order} is only available when more than {One Byte} is selected in {Number Selected} dropdown

■ **Swap Byte Order Example**

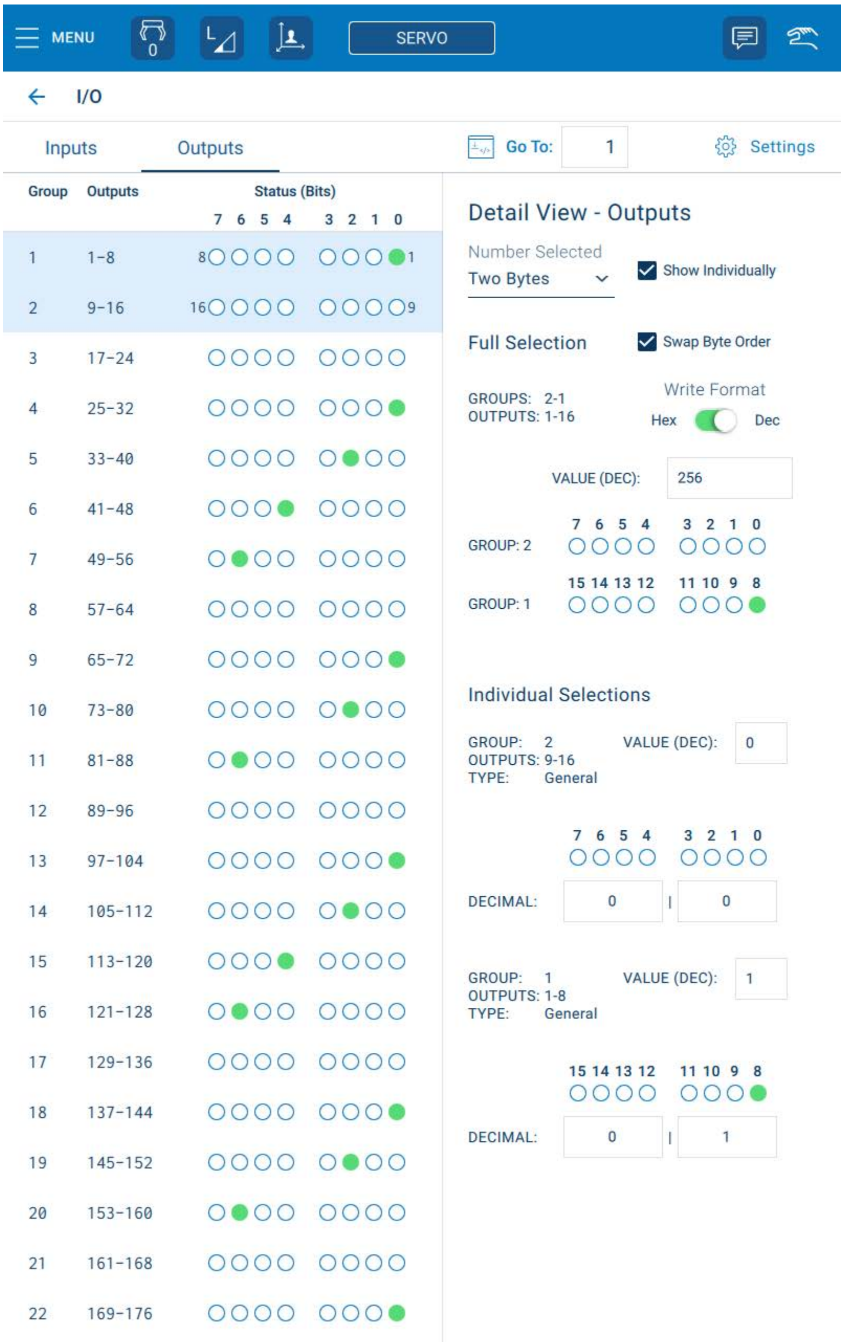
For example, if GROUP 1 has a value of one and GROUP 2 has a value of zero, and both are selected, then the full value is ((GROUP 2) (GROUP 1)), or in binary, (0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1) which has a value of 1.

Fig. 7-18: Swap Order Example Not Checked



Pressing the {Swap Byte Order} checkbox reverses the byte order, and the highest I/O group number is the least significant byte. In the previous example, swapping the byte order would change the full value to ((GROUP 1) (GROUP 2)) or in binary, (0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0) which has a decimal value of 256.

Fig. 7-19: Swap Order Example Checked



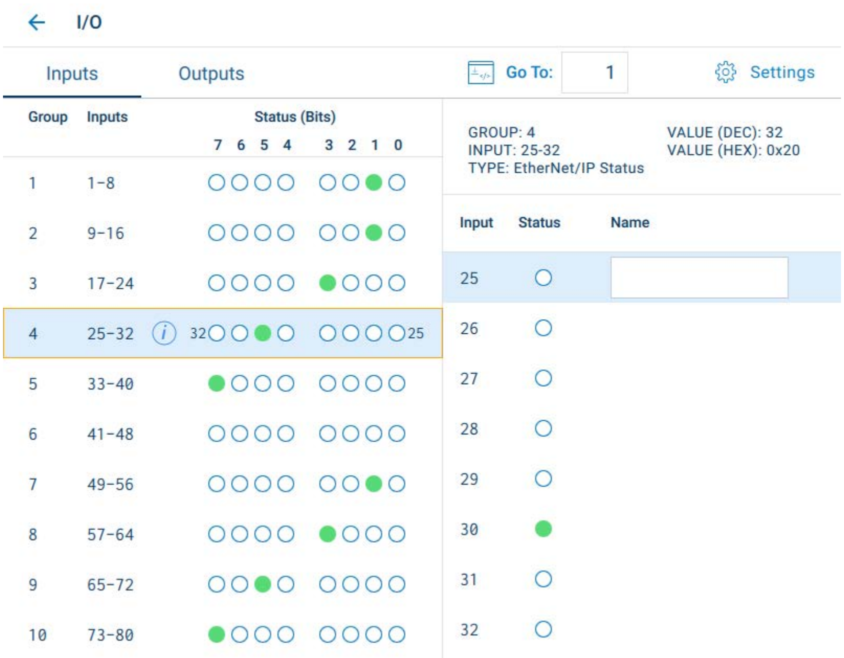
7.7 EtherNet/IP Status Warning

Problems with EtherNet/IP communication will be illuminated by a yellow warning box surrounding the EtherNet/IP Status byte in the {Inputs} panel. A help icon will appear containing descriptions for each bit in the EtherNet/IP Status byte.

How To View the EtherNet/IP Status Byte

1. Go to {MENU} → {I/O & Variables} → {I/O}.
2. Press {Settings}.
   – {Input Output Settings} panel will appear.
3. Under {Input Types to Display} check {EtherNet/IP Status}.
4. Click {X} in upper right of {Input Outputs Settings} panel.
   – {Input Output Settings} panel will close.
   – The {EtherNet/IP Status} input group will be in the left panel.

Fig. 7-20: EtherNet/IP Status Warning



Accessing the EtherNet IP/Status Warning From the Current Job Screen

1. Go to {MENU} → {Current Job}.
2. Press {Digital I/O} in the lower left corner of the screen.
   – The I/O view will appear in the lower half of the screen.
3. Press {Inputs}.
4. Press {Settings}.
   – {Input Output Settings} panel will appear.
5. Under {Input Types to Display} check {EtherNet/IP Status}.
6. Click {X} in upper right of {Input Outputs Settings} panel.
   – {Input Output Settings} panel will close.
   – The {EtherNet/IP Status} input group will be in the left panel.

EtherNnet/IP Status Warning Help

Pressing the help icon will display a help screen with info on what bits 4-7 represent to help troubleshoot.

Fig. 7-21: EtherNet/IP Status Warning Help

Use the table below to troubleshoot EtherNet/IP communication.

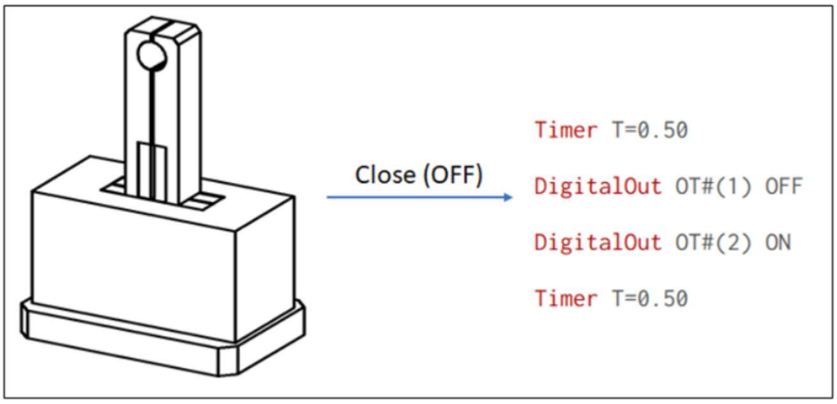
Signal	Description
bit 0 to 3	Vendor-reserved (not available)
bit 4	Indicates error in EtherNet/IP adapter (e.g. PLC) communication Normal status: OFF Communication error: ON
bit 5	Indicates presence of a non-connected EtherNet/IP device (scanner) Connecting to all devices normally: OFF Non-connected device(s) exist: ON
bit 6	Indicates the status of EtherNet/IP communication Normal status: OFF Communication error: ON
bit 7	Indicates the operating status of the EtherNet/IP CPU Board Normal status: OFF Communication error: ON

7.8 Block I/O

The Block I/O feature allows the user to quickly configure I/O sequences that can be used to communicate with a tool attached to a Robot or external devices (e.g. a machine tool or conveyor). This feature currently supports the basic INFORM commands (DigitalOut, Group DigitalOut, Timer) required to communicate with a device and provides a pair of states for each setting to perform two related tasks (e.g. OFF and ON). Block I/O settings can then be accessed from the Robot Jog panel via the {Block I/O} to either physically perform an action or to add the stored commands to the current Job. This enables quick programming for complicated external devices that require several commands to execute.

For example, a basic parallel gripper typically has two states: Open and Close. To close the gripper, Output #1 must be turned OFF, and Output #2 must be turned ON. A Timer can be added before and/or after the commands if needed to ensure a good pick. Thus the “OFF” (close) state could be configured as the following figure.

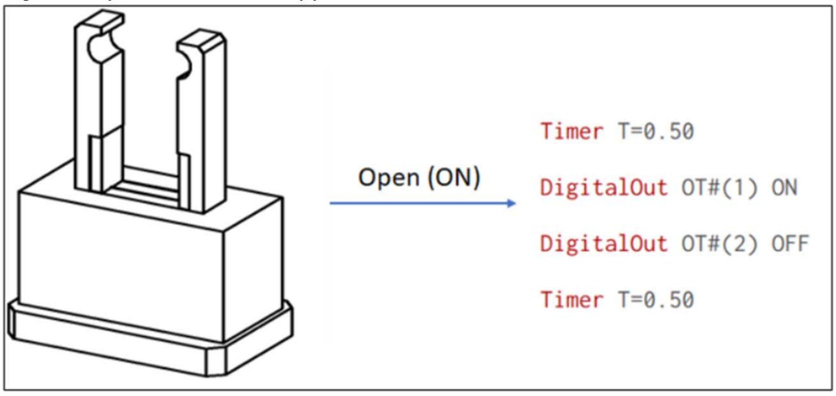
Fig. 7-22: Close State of a Gripper



Similarly, opening the gripper might have the inverse logic (turn ON Output #1 and OFF Output #2)

NOTE The interface currently only supports two states (ON and OFF).

Fig. 7-23: Open State of a Gripper



Block I/O Screen

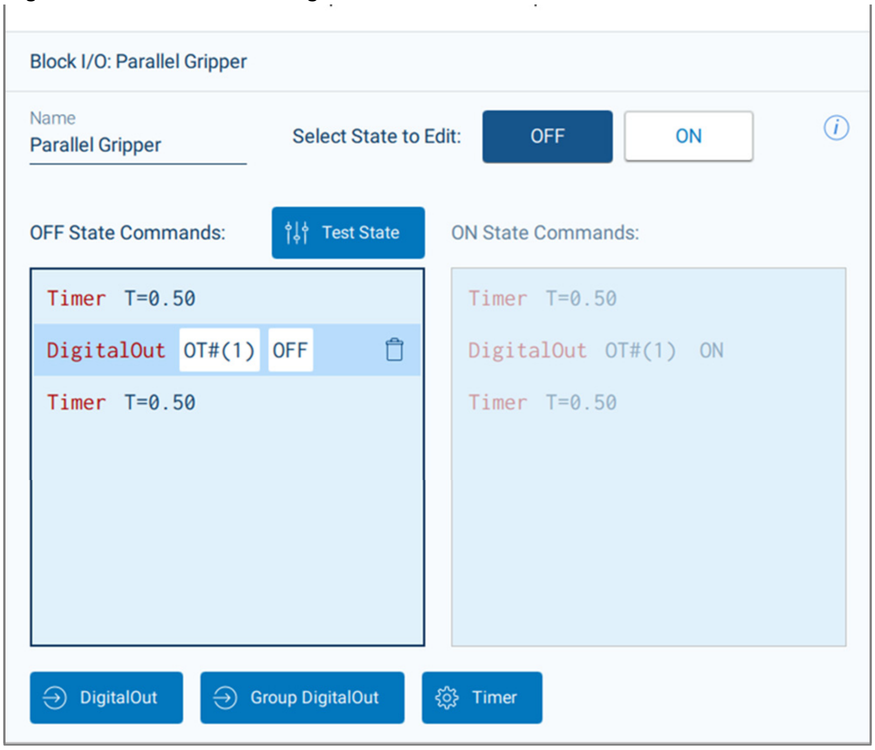
To create a new Block I/O Configuration:

CAUTION

Testing Block I/O will execute I/O commands that may cause a hazardous situation if not configured properly. Be careful before executing Block I/O.

1. Go to {MENU} → {I/O & Variables} → {Block I/O}.
   – Block I/O screen will appear.

Fig. 7-24: Block I/O Setting



2. Select a state to edit, {OFF} or {ON}
   – The selected state will be editable. The other state will appear disabled but is still visible for the user to compare the contents of both states. The list of commands can be edited in the same manner as an INFORM program, described in *chapter 7.4 "I/O Instructions"*.
3. Press the {Test State} to execute the commands in the active state.
   – A confirmation pop-up window will appear.

4. Press {PROCEED} after confirming the contents of the pop-up window.
   – INFORM commands associated with the active Block I/O state will be executed.

NOTE

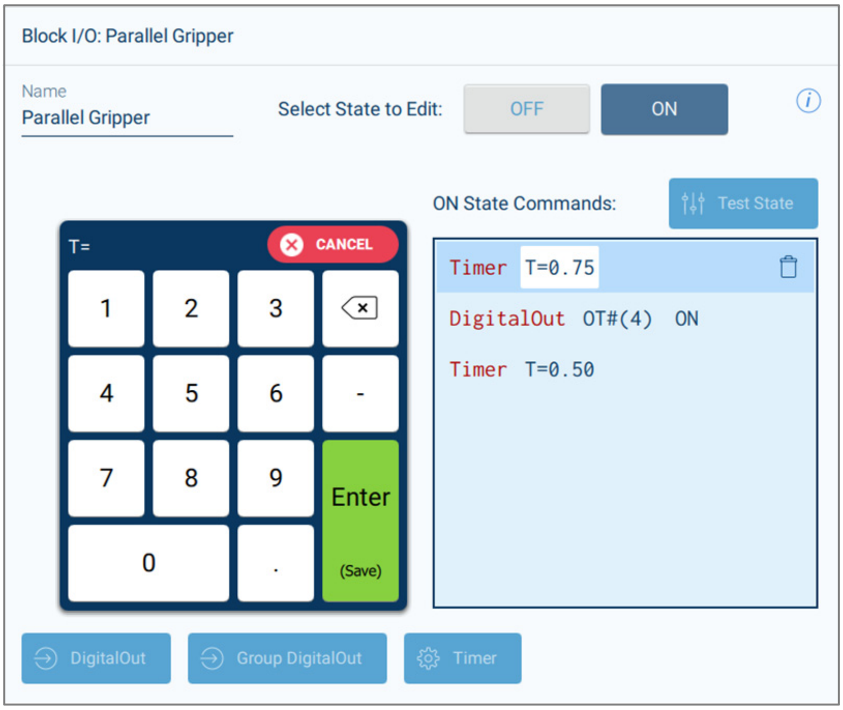
- During testing of a Block I/O state, its execution can be canceled.
  – This may be necessary if the Block I/O commands contain Timer(s) that are set to long durations.
- While Block I/O is executing, other pendant functions are not accessible
- On the Block I/O screen, the user can also view:
  – a list of all Block I/O settings
  – view & compare details for selected Block I/O states
  – create a new Block I/O setting
  – delete an existing Block I/O setting

7.8.1 Edit a Block I/O Setting

The Block I/O screen provides an interface through which output and timer commands can be added to the active state using buttons in the tab at the bottom of *fig. 7-24 "Block I/O Setting"*.

1. Press {Timer} to insert a Timer command.
2. Press {DigitalOut} to insert a DigitalOut command (output bit).
3. Press {Group DigitalOut) to add a DigitalOut command (output byte).
4. Enter the desired output number when an output command is added using the numeric keyboard (*fig. 7-25 "Editing a Block I/O State"*).
5. For DigitalOut, select the action for the output using the dropdown.
6. For Group DigitalOut, enter the value of the resulting byte:
   – Acceptable input range is 0 - 255.

Fig. 7-25: Editing a Block I/O State



7.8.2 Using Block I/O for Tool Operation

A Block I/O setting can be linked with the active tool to easily execute commands from the Robot Jog panel using the {Block I/O: Tool #}. If the link has not been established, a yellow warning symbol will appear on the button (*fig. 7-26 "Block I/O Not Linked with Tool on Robot Jog Panel"*). When pressed, a pop-up will appear that guides the user to the Tool Settings screen to establish the link (*fig. 7-27 "Block I/O Not Assigned on Tool Settings Screen"*).

Fig. 7-26: Block I/O Not Linked with Tool on Robot Jog Panel

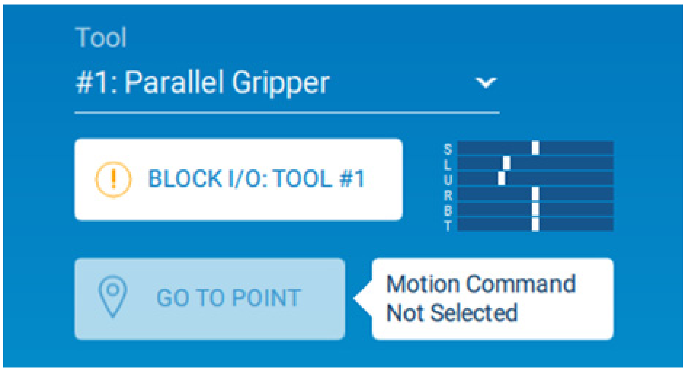


Fig. 7-27: Block I/O Not Assigned on Tool Settings Screen

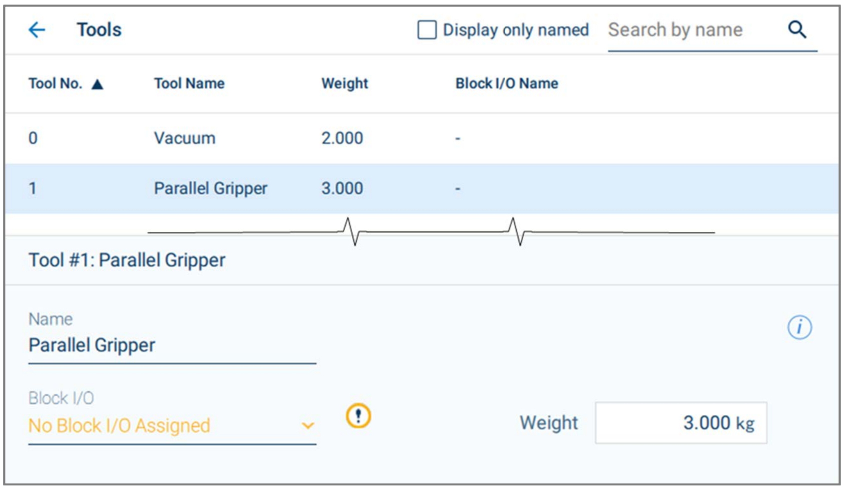


Fig. 7-28: Block I/O: Tool # Button Successfully Linked with Tool

Pressing the configured {Block I/O: Tool #} (*fig. 7-28 “Block I/O: Tool # Button Successfully Linked with Tool”*) will open the Toggle Block I/O panel (*fig. 7-29 “Toggle Block I/O Panel”*) where the following actions can be performed:

– {Tool # → OFF/ON} - takes the user to the Block I/O screen to view the contents of the setting that is linked to the active tool

– {TOGGLE OFF/ON} - executes the commands for the Active Tool's respective OFF/ON state

– {ADD TO JOB} - adds the commands of a desired Block I/O state to the current job at the position of the highlighted line above

– {Add Comments} - adds comments to the start and end of an inserted Block I/O state when added to a job (*fig. 7-30 “Add to Job with Comments”*). This option is checked by default.

Fig. 7-29: Toggle Block I/O Panel

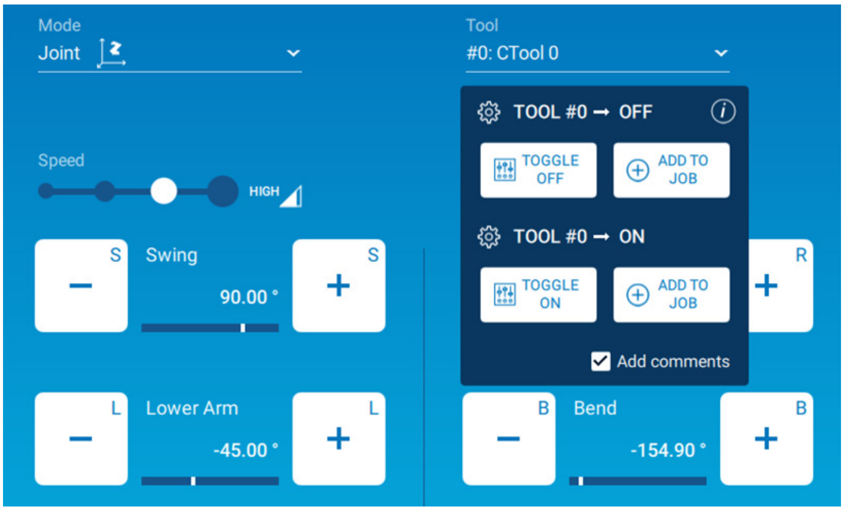
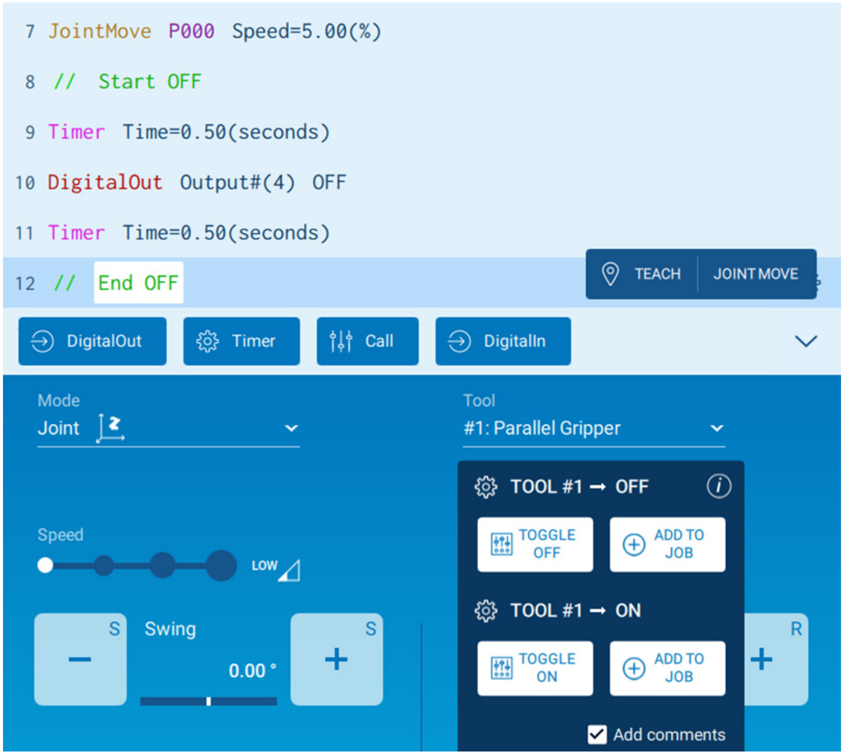


Fig. 7-30: Add to Job with Comments



■ **Block I/O Example For Programming a Job:**

1. Move the manipulator above the desired workpiece with the gripper ready for a pick.
2. Toggle the tool ON using Toggle Block I/O panel.
   – The workpiece will be picked.
3. Press {ADD TO JOB}.
   – The commands are added to pick the workpiece to the current job.

7.9 I/O Allocation and EtherNet/IP Configuration

The I/O Configuration screens can be used to perform the following actions:

WARNING

Changing I/O Settings and Allocations can affect the operation of peripheral devices. Make sure hardware is in safe state (e.g. no payloads in Grippers) before modifying configuration.

– View List of I/O Devices

– View I/O Allocation Data (i.e. what Input/Output Groups are used vs. available)

– Add/Delete/Modify EtherNet/IP Adapters and Scanners

To access this screen, select {Menu} → {System Settings} → {I/O Configuration}.

NOTE

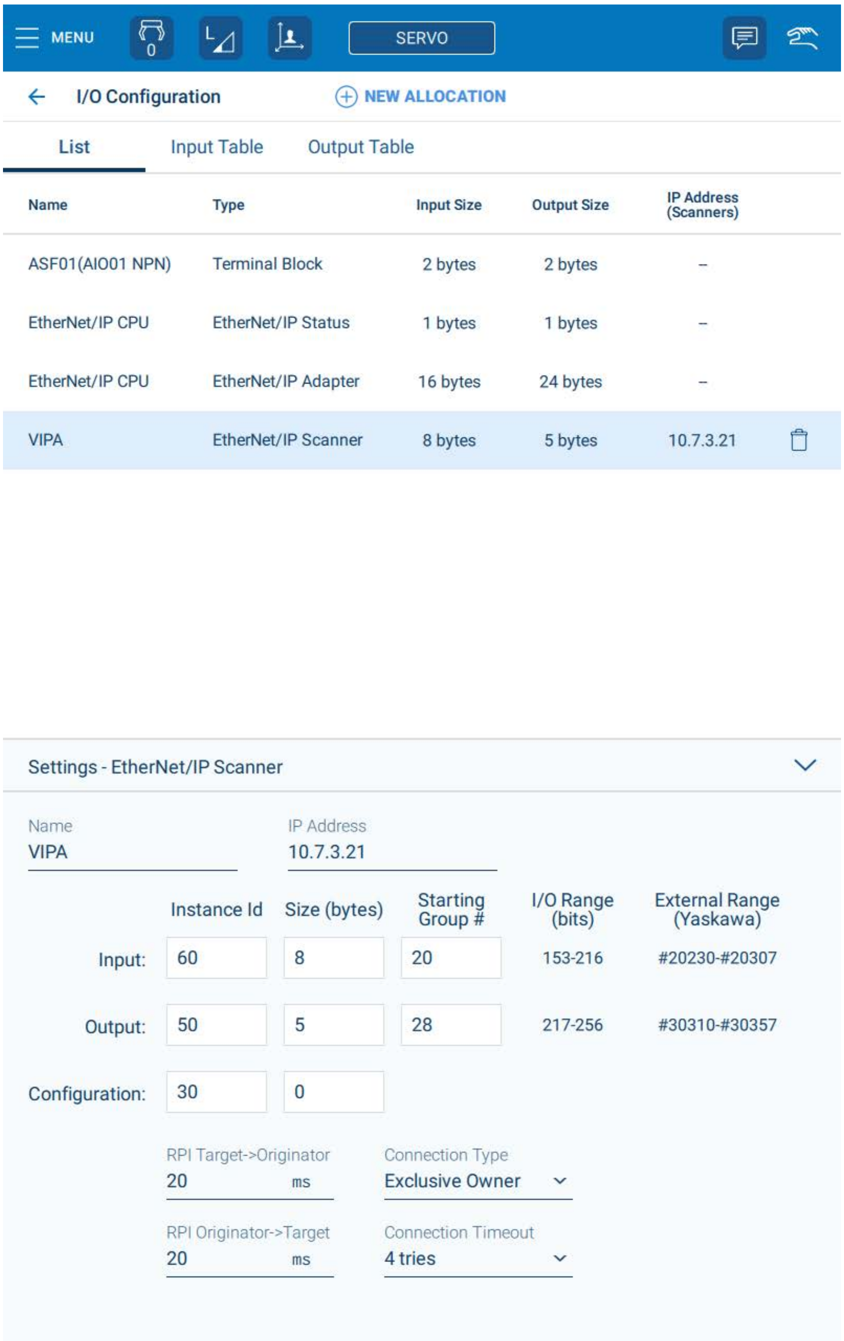
- All Input/Output #s and Group #s in this section and on these screens refer to the Universal Input/Output #s which also correspond to the numbers used in Inform commands. Thus, if a device is mapped to Starting Group # 20, then the first byte of the device's mapping can also be accessed by “DigitalOut OutputGroup#(20)”.
- If Concurrent I/O program has been changed from the default, some I/O may be marked as unavailable. If using a non-standard CIOPRG.LST file, use Classic Interface.

7.9.1 I/O Device List

The Device List is the default view when first navigating to the I/O Configuration Screen (or it can be selected by pressing the {List} tab at the top of the screen). This view is simply a list of the devices configured on the YRC Controller.

Selecting a device will display its details on the bottom panel as shown in *fig. 7-31*.

Fig. 7-31: I/O Device List



If a device has been modified, a (!) icon will appear next to its name prompting the user to reboot the YRC Controller (*fig. 7-32*).

Fig. 7-32: I/O Device List with Modified Device

List   Input Table   Output Table

Name	Type	Input Size	Output Size	IP Address (Scanners)
ASF01(AIO01 NPN)	Terminal Block	2 bytes	2 bytes	–
EtherNet/IP CPU	EtherNet/IP Status	1 bytes	1 bytes	–
EtherNet/IP CPU	EtherNet/IP Adapter	16 bytes	24 bytes	–
(!) VIPA	EtherNet/IP Scanner	8 bytes	5 bytes	10.7.3.21

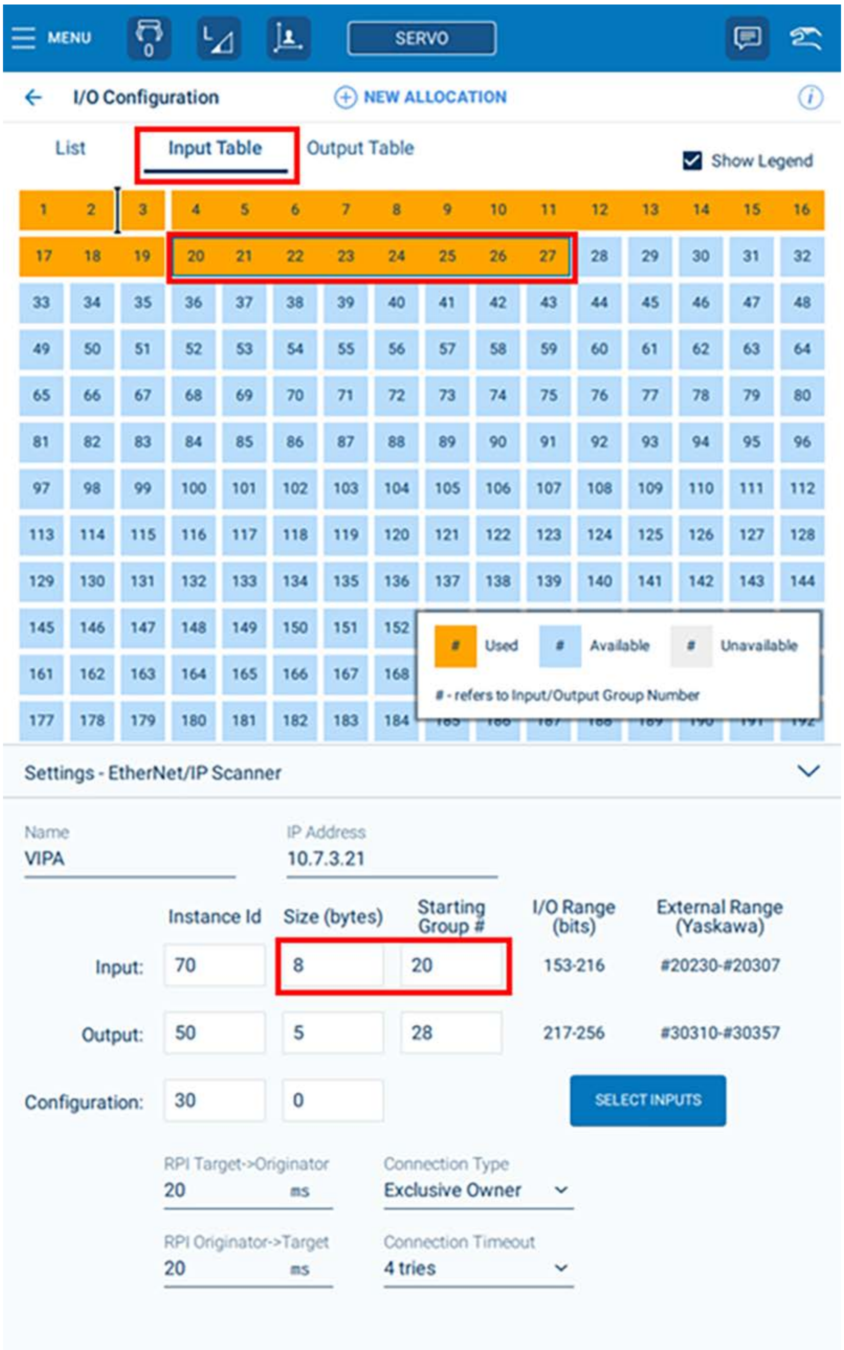
NOTE

Changing I/O Device Settings will require a YRC Controller reboot before becoming active.

7.9.2 Input/Output Table

The Input/Output table provides a visual representation of the Inputs and Outputs allocated for the YRC Controller. This is divided into two tables because the Input and Output properties do not always match (e.g. a device could have 16 bytes of Inputs but only 8 bytes of Outputs, etc…). On the Table View, each device is grouped together and selecting any group within a device will highlight the entire device and display the details in the panel below.

For example, the device selected below begins on Group 20 and is 8 bytes in length. Thus, pressing anywhere in the range of Group 20-27 will highlight the entire range and display the details on the panel below.



7.9.3 EtherNet/IP Adapter

Configuring the YRC Controller as an EtherNet/IP Adapter will allow the YRC Controller to communicate with a device that is configured as an EtherNet/IP Scanner. The most common use case for this is to communicate data with a PLC (e.g. Rockwell ControlLogix or CompactLogix).

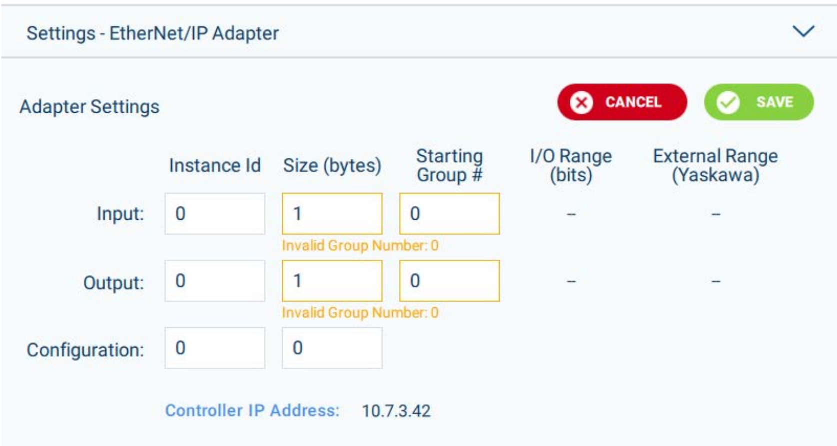
7.9.3.1 Creating an Adapter

To configure the YRC Controller as an Adapter, press the {NEW ALLOCATION} button on the top of the screen. From the dropdown menu that appears, select “EtherNet/IP Adapter”.

Fig. 7-33: Selecting EtherNet/IP Adapter

This will create a new entry in the device list for an EtherNet/IP Adapter. The detail panel will automatically start with the {Save}/{Cancel} buttons. Pressing {Cancel} will remove the new adapter. Note that the initial “Size” and “Starting Group #” are 1 and 0 respectively which is not a valid configuration. Valid data will need to be entered before saving.

Fig. 7-34: New EtherNet/IP Adapter



NOTE

- Only one “Adapter” can be configured on a YRC Controller. If the Adapter has already been configured, selecting “Adapter” again will display an error message.
- If an Adapter has been previously configured, the previous Instance and Size numbers will be auto-populated. Thus, Adapters can be deleted and then re-added without needing to manually re-enter the settings.

7.9.3.2 Configuring the Adapter

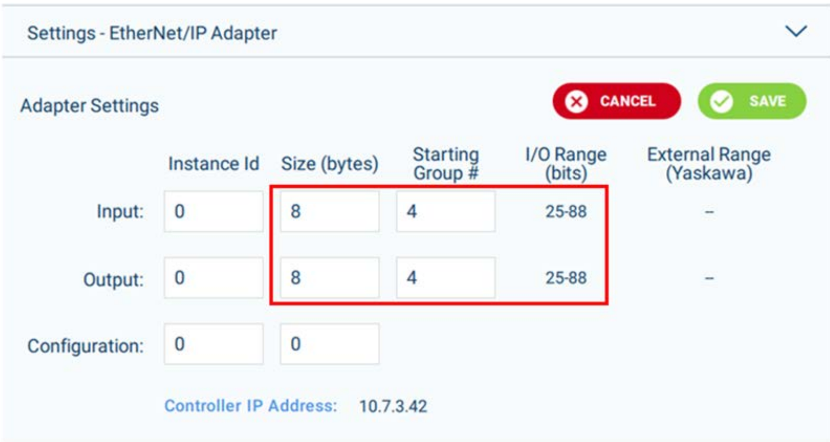
After the Adapter appears in the device list, the following information can be entered:

1. Enter the desired Instance Numbers for the Input, Output and Configuration sections.
   – These are used-defined numbers that are paired between the YRC Controller and the PLC.

NOTE: The Input/Output Instance Numbers should be opposite between the YRC Controller and PLC. For example, if the Input Instance is 50 and the Output Instance is 100 on the YRC Controller, then the Input Instance should be 100 and the Output instance should be 50 on the PLC. See *fig. 7-36* for an example.

2. Enter the desired size in bytes for the Input, Output and Configuration sections.
   – For a new Adapter, the Starting Group # will automatically be filled in after entering the size by finding the first Group # that can contain that size of an allocation. After saving a new Adapter, the Starting Group # can be entered manually here or the {Select Inputs} and {Select Outputs} buttons can be used to visually choose the allocation location (refer to *chapter 7.9.5*).

Fig. 7-35: Inputting Adapter Sizes

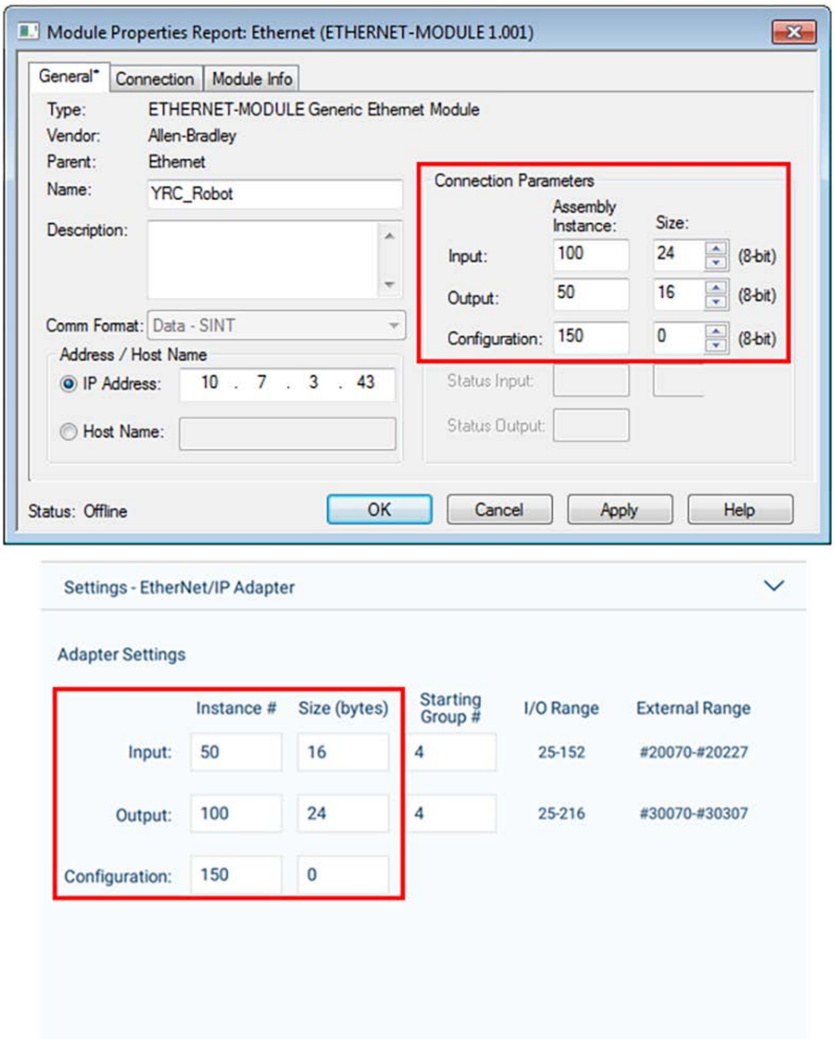


NOTE: The Input, Output, and Configuration Sizes must match exactly between the YRC Controller and the PLC for correct communications.

3. Reboot the YRC Controller to verify configuration.
   – Note that a reboot does not have to be done immediately, but the settings will not take effect until after a reboot.
   – An example of matched settings between a YRC Controller and a Rockwell PLC is shown in *fig. 7-36*. Note that the IP Address set on

the Rockwell PLC is the IP Address of the YRC Controller which is also shown on the Adapter Settings Panel.

Fig. 7-36: Example Rockwell PLC Settings



7.9.4 EtherNet/IP Scanner

Adding an EtherNet/IP Scanner to the YRC Controller allows the YRC Controller to communicate with devices such as Network I/O, Grippers, etc… Up to 32 Scanners can be added to the YRC Controller.

Before adding or configuring a Scanner, the following information is needed:

– IP Address of device (should be configured from the device, not Smart Pendant)

– Input/Output/Configuration Instance Numbers. These numbers will be provided by the device manufacturer.

– Input/Output/Configuration Sizes (in bytes). These numbers will be provided by the device manufacturer.

Before configuring the device, it is a good idea to “ping” both the YRC Controller and the device from the PC on the same network to ensure the network is configured properly.

7.9.4.1 Creating a Scanner

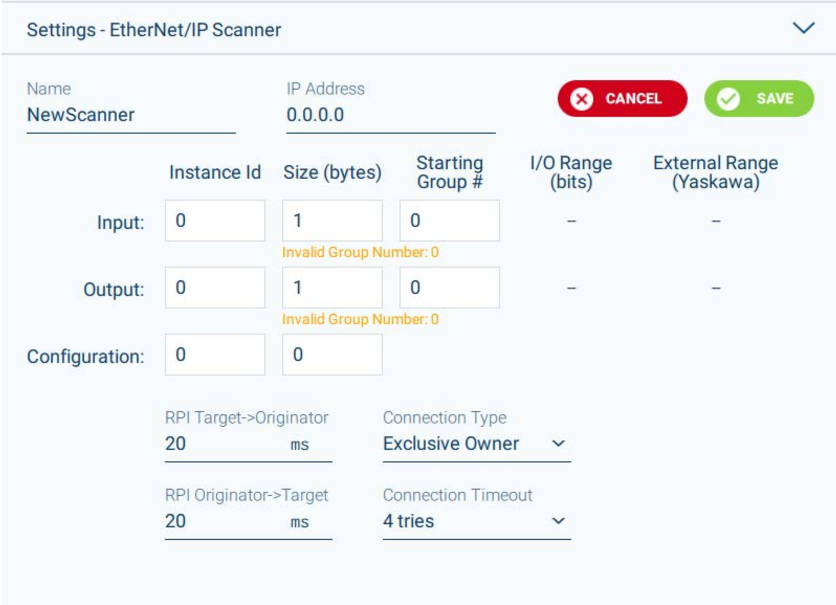
To configure a new Scanner, press the {NEW ALLOCATION} button on the top of the screen. From the dropdown menu that appears, select “EtherNet/IP Scanner”.

Fig. 7-37: Selecting EtherNet/IP Scanner

This will create a new entry in the device list for an EtherNet/IP Scanner with default name “NewScanner”. The detail panel will automatically start with the {Save}/{Cancel} buttons. Pressing {Cancel} will delete the new Scanner.

Note the initial “Size” and “Starting Group #” are 1 and 0 respectively which is not a valid configuration. Valid data will need to be entered before saving.

Fig. 7-38: New Scanner Settings

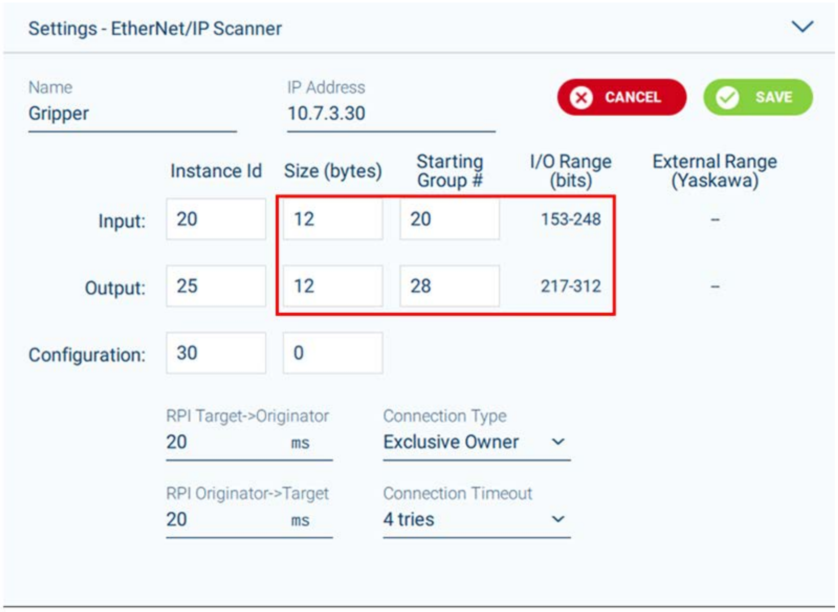


7.9.4.2 Configuring a Scanner

After the Scanner appears in the device list, the following information can be entered:

1. Enter a user-defined name for the Scanner.
2. Enter the IP Address of the Scanner.
3. Enter the Instance Numbers for the Input, Output and Configuration sections.
   – These are manufacturer-defined numbers that are paired between the YRC Controller and the device.
4. Enter the size in bytes for the Input, Output and Configuration sections.
   – These sizes are defined and provided by the device manufacturer. As the Input/Output sizes are entered, the Starting Group # will automatically be filled in by finding the first Group # that can contain that size of an allocation. After saving a new Scanner, the Starting Group # can be entered manually here or the {Select Inputs} and {Select Outputs} buttons can be used to visually choose the allocation location (see *chapter 7.9.5 "Modifying Allocations using Input/Output Table"*).

Fig. 7-39: Inputting Scanner Sizes



NOTE

The Input, Output, and Configuration Sizes must match exactly between the YRC Controller and the PLC for correct communications.

5. Enter the RPI and Connection information at the bottom of the screen.
   – These values should not be changed from their default values unless the instructions from the manufacturer say to do so.
6. Reboot the YRC Controller to verify configuration.
   – Note that a reboot does not have to be done immediately, but the settings will not take effect until after a reboot.

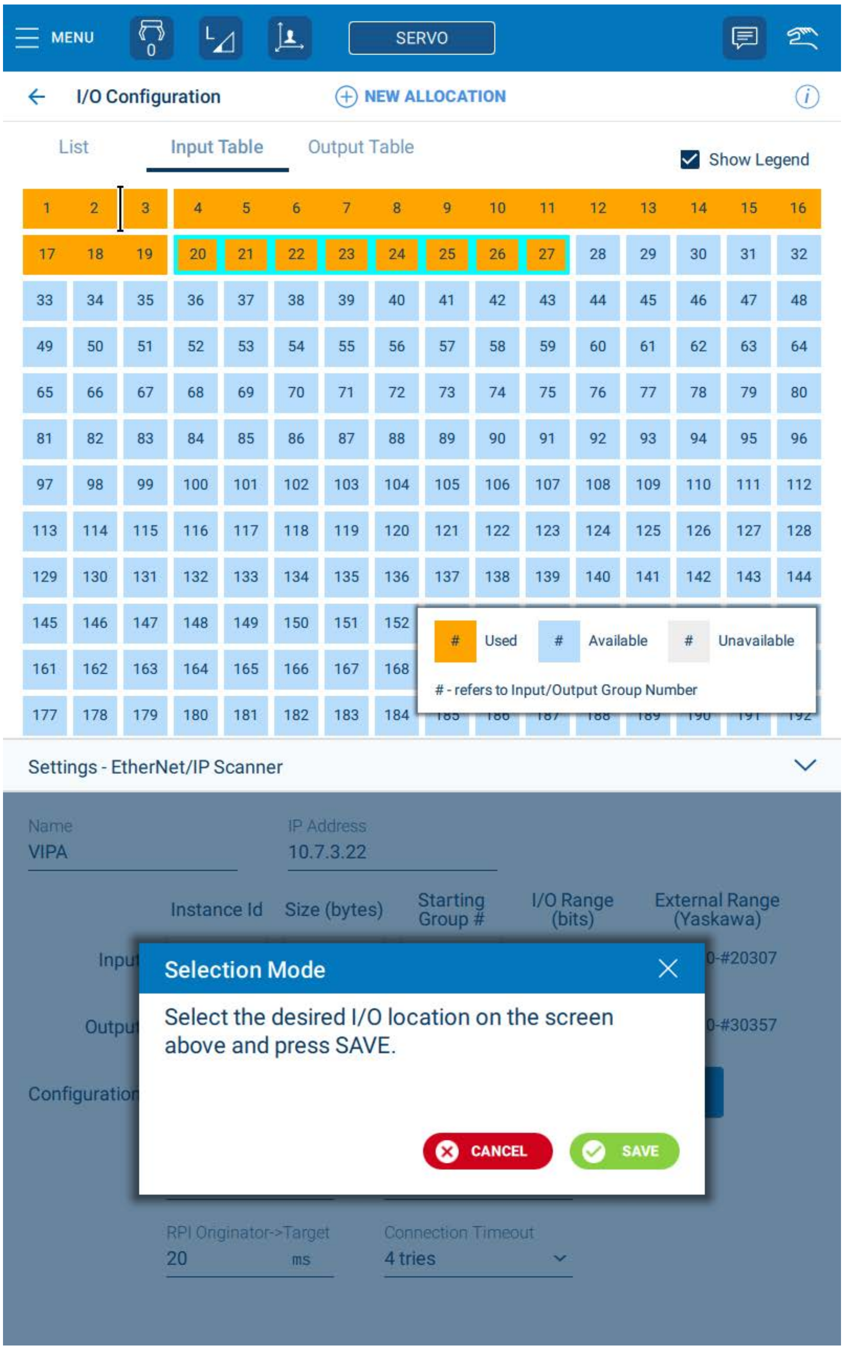
7.9.5 Modifying Allocations using Input/Output Table

After a device has been added, its allocation (i.e. “Starting Group #”) can be modified from the Input/Output Table by the following steps:

1. From the Input/Output table, press the {Select Inputs} or {Select Outputs} button.

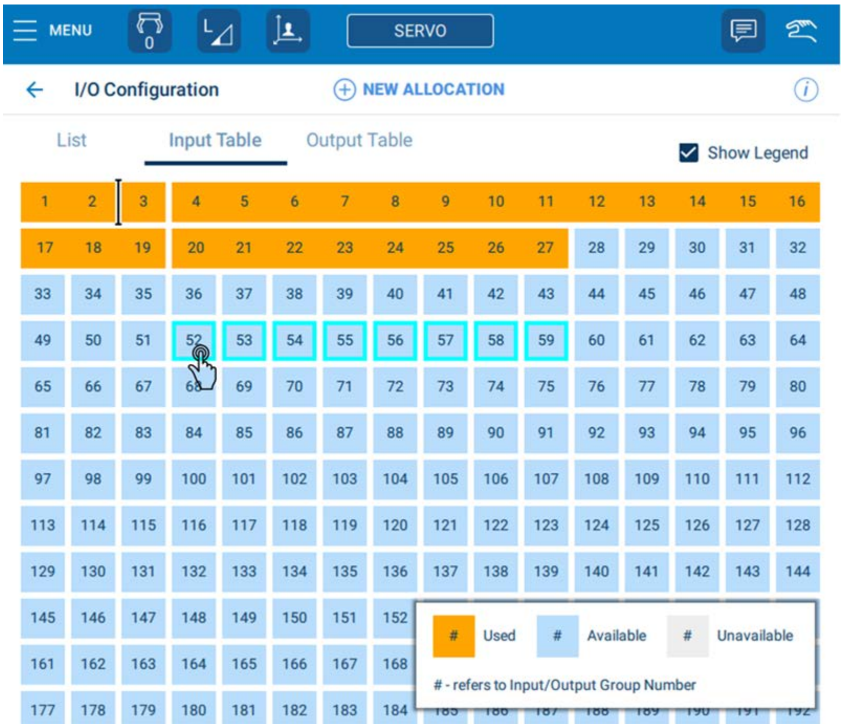
– This will enter a special “Selection Mode”, and the bottom detail panel will be disabled.

Fig. 7-40: Input Table Selection Mode



2. Press the desired Group # to move the allocation. Only Group #'s where the allocation will “fit” can be selected.
   – The allocation will show in the new allocation with a light blue highlight. For example, Group #52 is selected in the example below.

Fig. 7-41: Select New Input Group



3. To finalize the new allocation, press the {SAVE} button on the Selection Mode Popup
   – The allocation is now updated.

Fig. 7-42: Selection Mode Popup

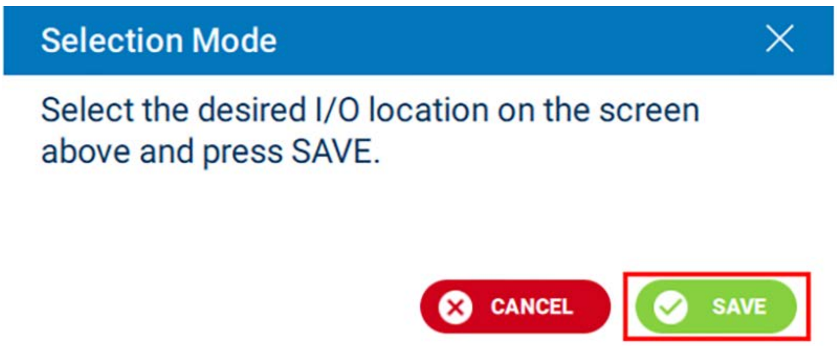
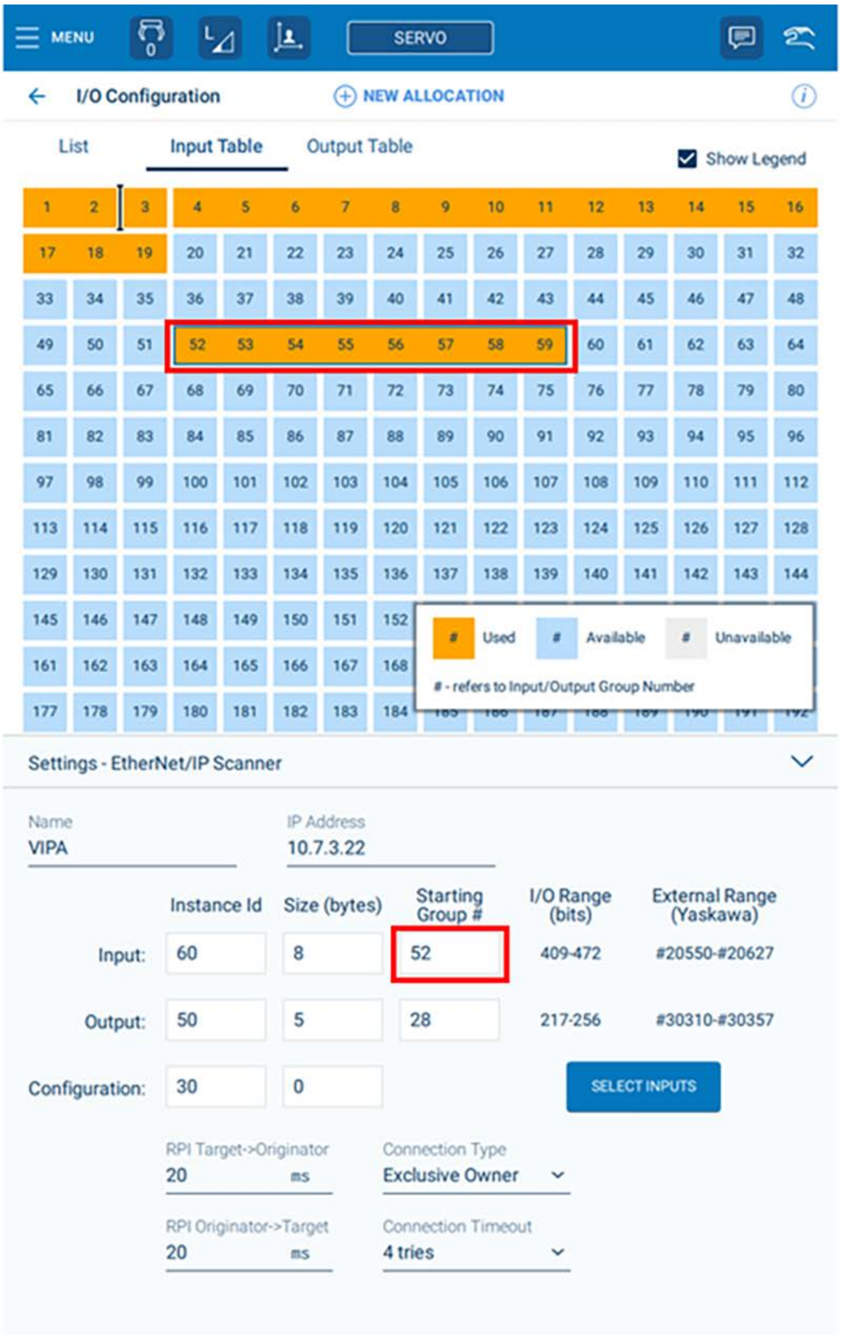


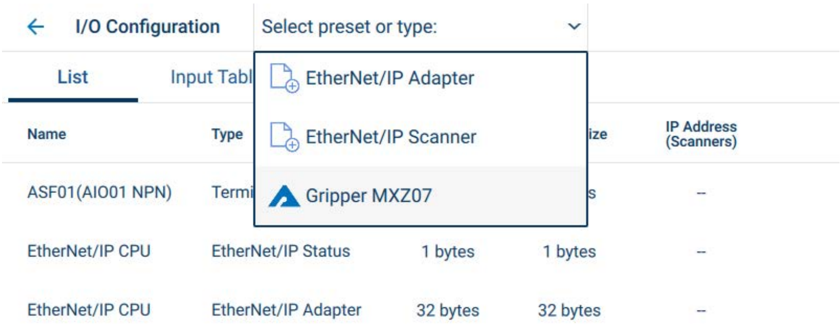
Fig. 7-43: New Allocation Saved



7.9.6 Applying EtherNet/IP Presets

If EtherNet/IP Presets have been installed, they may be used as a template to create a new EtherNet/IP Device.

1. Press {+NEW ALLOCATION} at the top of the I/O Configuration Screen.
   - A list of installed EtherNet/IP Presets will drop-down for selection. If none are installed, only the default empty adapter & scanner options are available.

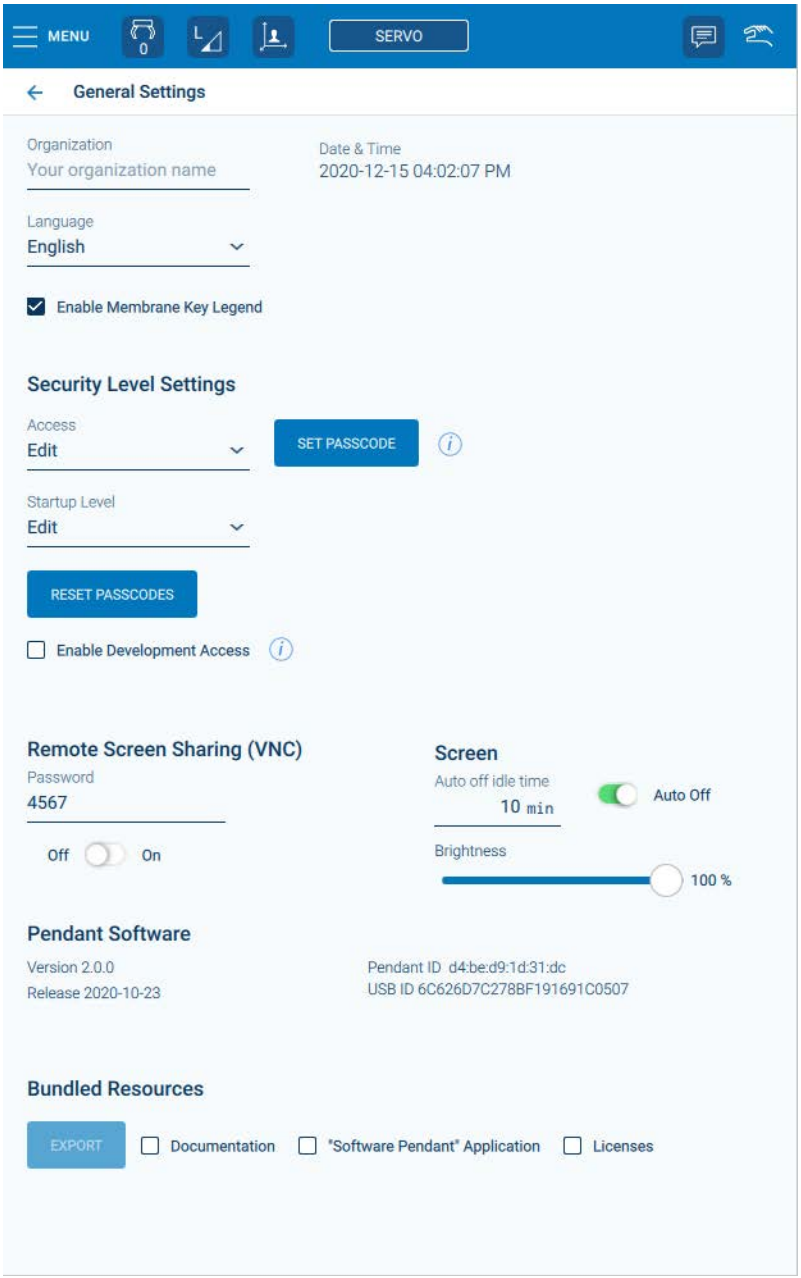


2. Select the required preset to apply.
   - The EtherNet/IP Adapter or Scanner property settings included in the selected preset will be used to pre-fill the appropriate device settings detail text fields (as if entered). {CANCEL}/{SAVE} will be shown.
   - It is left to the preset creator which settings are included, so any settings not included in the selected preset will have default values. For example, if the input & output group numbers are not present in the preset, they will need to be entered. If the numbers in the preset conflict with existing device allocations, they may also need to be edited to avoid conflict before saving.
   - The properties will not be immediately applied and hence can be further manually edited before saving.
3. Press {SAVE} as usual to permanently save the device settings on the YRC Controller.

8 System and YRC Controller Setting

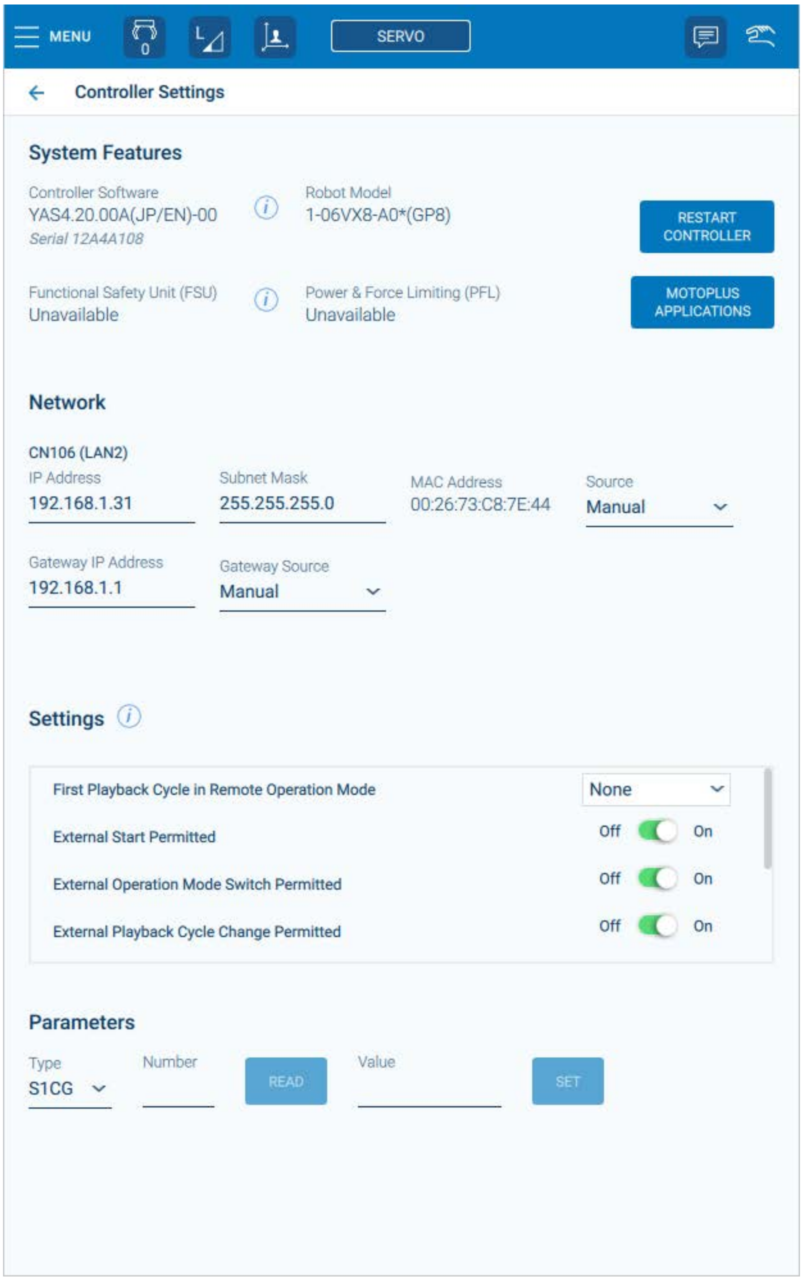
General System Settings allows setting language, changing passcodes for security levels, as well as getting important information on software versions and ID numbers. To access the General screen, go to {MENU} → {System Settings} → {General}.

Fig. 8-1: General Settings



YRC Controller Settings allows modification of YRC Controller settings and parameters, including network interfaces. YRC Controller software version, features and Robot model information is also shown. To access the YRC Controller Settings screen, go to {MENU} → {System Settings} → {Controller}.

Fig. 8-2: YRC Controller Settings



8.1 General

Under General, the following items are shown:

① Organization

② Date & Time

③ Language

④ Enable Membrane Key Legend

8.1.1 Organization

User can input the organization name here. Constraints on name are:

- 0 to 32 alphanumeric characters can be used.
- Both upper and lower case letters can be used.
- All symbols and space can be used.

8.1.2 Date & Time

The current date and time as set on the YRC Controller is shown here. Classic Interface is required to change the date and time in the YRC Controller. Date and Time can only be changed under Maintenance Mode.

8.1.3 Language

The current selected language appears here. User can change the language used on the Smart Pendant. Two languages can be displayed alternately. Select the language from the pull-down list to change the language.

The available languages are:

- English
- Japanese

The Smart Pendant requires a restart when changing the language.

8.1.4 Enable Membrane Key Legend

Using the membrane key legend enable function, the membrane key legend will display when pressing [SERVO].

8.2 Security Level Settings

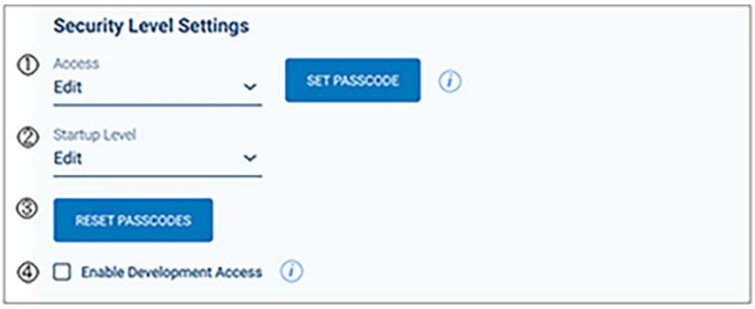
Under Security Level Settings, the following items can be set:

① Access

② Startup Level

③ Reset Passcodes

④ Enable Development Access



8.2.1 Access

The passcode for Security Access can be changed.

1. Select the security level from the drop-down list to change the passcode.
2. Press the {SET PASSCODE}.

For more information on Security Access and its procedures, go to *chapter 1.17.5 “Security Level Settings”*.

8.2.2 Startup Level

The Security Level at startup or restart can be set to Operation, Edit or Management level. Startup Level can be modified by operating in Management Level or higher.

8.2.3 Reset Passcodes

The Reset Passcodes button allows to reset passcodes to the factory default by contacting a YASKAWA representative.

8.2.4 Enable Development Access

Development Access provides additional permissions useful for software developers creating and debugging Smart Pendant Extension Apps and YASKAWA Install Packages.

These permissions potentially allow changes to be made to the pendant that may render it unsuitable for use in production applications. These changes cannot be undone.

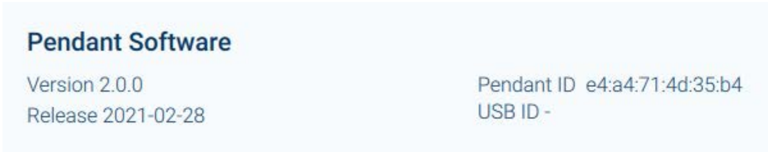
After enabling Development Access, it is recommended that this pendant not be used for production applications.

8.3 Software & Package Management

Additional software can be installed onto the pendant and the YRC Controller, such as pendant extension apps, packages containing controller files (- jobs and other settings) and update for the pendant software itself.

8.3.1 Pendant Software

The current version of the pendant software itself can be determined by navigating to {MENU} → {System Settings} → {General}.



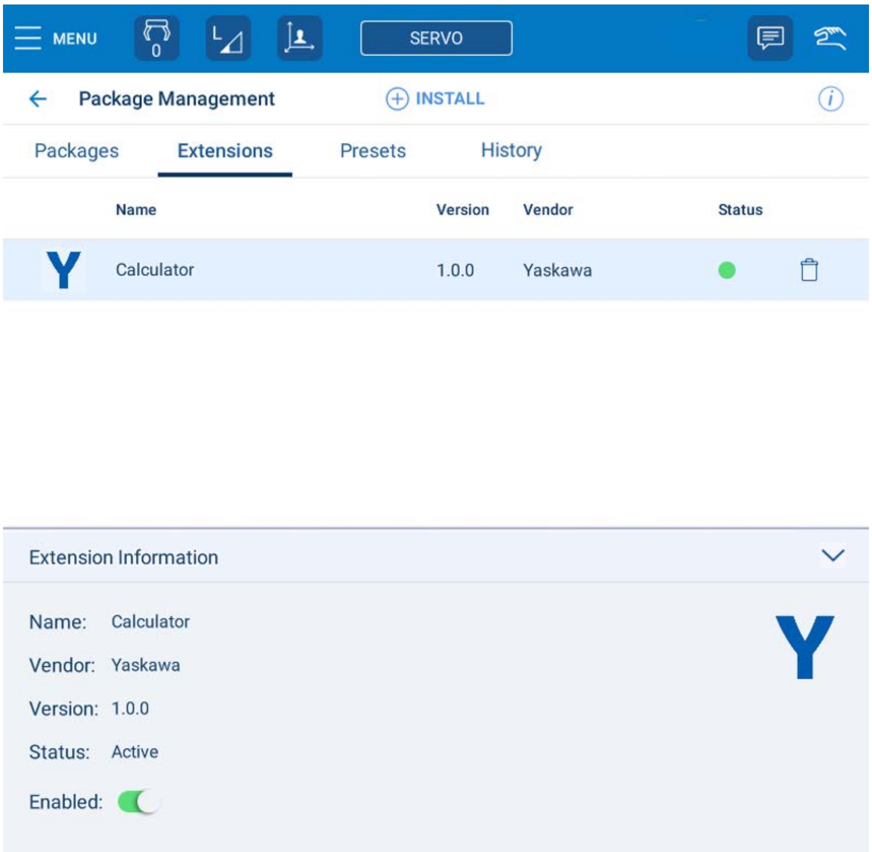
This shows the pendant app software version, the date of release and a unique ID that identifies the pendant hardware. With Management Access and with a USB storage device inserted, the serial ID number of the inserted USB storage device will also be shown.

The pendant software may be updated from the Package Management Screen ({MENU} → {System Settings} → {Package Management}) as described *chapter 8.3.2*.

8.3.2 Package Management

The Package Management screen is where software packages, such as pendant software updates, presets files, pendant extensions and controller files & settings packages may be installed and managed (viewed, deleted etc). The installation history of packages, extensions, and presets is displayed in the History tab. Access this screen via {MENU} → {System Settings} → {Packages}.

Fig. 8-3: Package Management Screen with Extensions Tab Selected



YASKAWA Install Package (.yip) files can be created by YASKAWA or third parties and may include components such as INFORM jobs, parameter settings, I/O Names, Variable names & values, network settings, presets for tool and EtherNet/IP settings, controller MotoPlus apps or Smart Pendant Extensions.

8.3.2.1 Updating the Smart Pendant Software

The Smart Pendant's software can be updated to a newer version by connecting a USB storage device containing official YASKAWA Smart Pendant Update files (either several files including one named yaskawa_update.sh, or a single .yip file).

1. Connect the USB storage device to the Smart Pendant.
   – USB port is located on the backside of the pendant (bottom-right corner).
2. Press {+INSTALL} at the top of the screen.
   – Select the “Smart Pendant Update” entry in the pop-up list and press {INSTALL}.

– The Pendant will start updating.

– Do not disconnect the USB storage device until prompted.

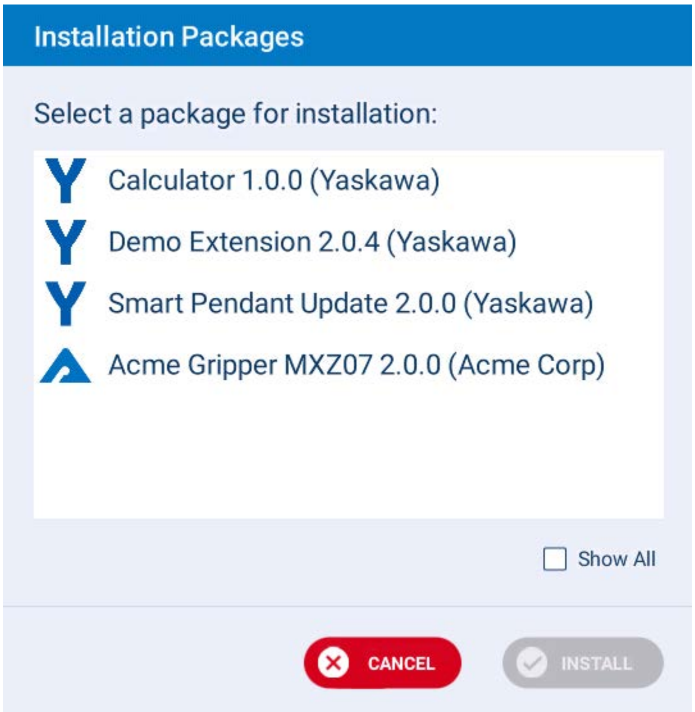
– Pendant will automatically restart.

For more information on an USB storage device, refer to *chapter 14.1 "Memory Device"*.

8.3.2.2 Installing Presets, Extensions, and other Packages

The {+INSTALL} button can be used to install Presets (.yps files) or YASKAWA Install Packages (.yip files), which may contain several types of YRC Controller files or pendant extensions, either from third parties or from YASKAWA.

1. Connect a USB storage device containing preset (.yps) or package (.yip) files to the Smart Pendant.
   – USB port is located on the backside of the pendant (bottom-right corner).
2. Press {+INSTALL} at the top of the screen. A pop-up dialog showing what is available for installation is shown:



3. Select the entry you would like to install and press {INSTALL}
   – A progress popup will provide details as the installation is being performed.
   – If the installation completes successfully, a confirmation notice will be shown and, if appropriate, the package, extension or preset will be added to the appropriate list.

The installation of packages may make changes to YRC Controller settings. In some cases, conflicts with existing controller settings will be detected and you will be prompted for which action to take. These prompts will appear before any controller changes are made and will provide the opportunity to abort the installation leaving all settings unchanged.

Precisely which conflicts trigger prompts is at the discretion of the package creator, though commonly prompts appear before overwriting jobs, I/O names, and similar settings.

NOTE

Some packages may require restarting the YRC Controller for changes to take effect or even to complete the installation. A prompt will be shown if that is necessary

If the package from your USB is not shown in the list as expected, it may be because it is not installable. To see why, check the {Show All} checkbox, locate the package and click the information icon to show details for the package-including any reasons why it cannot be installed.

8.3.3 Extensions

An Extension is custom software that can extend the functionality of the pendant, like smart-phone apps. Extensions may be created by YASKAWA or by third parties, as the function is open and available to everyone.

Extensions are installed with YASKAWA Install Package (.yip) files, which may include other components. They may add additional menu items, open custom utility windows and dialog popups, add buttons to the Navigation Bar and other integration points throughout the pendant interface.

For documentation on creating custom extensions, visit the smart.motoman.com and follow links to the Smart Pendant Extension SDK site.

8.3.3.1 Enabling and Disabling Extensions

Once an extension has been installed, its software runs in parallel with the pendant software. Each time the pendant starts, all installed and enabled extensions are also restarted.

If you wish to temporarily stop an extension, you can disable it from the detail panel (see *fig. 8-3*). With the Package Management Screen open:

1. Select the {Extensions} tab at top to show the list of currently installed extensions.
2. Select the extension entry of interest from the list.
3. Press the {Enable} switch to disable the extension.
   – The pendant will stop the extension software from running, which may take several seconds.
   – Any integration points of the extension with the pendant interface will be removed, such as menu items, buttons, and windows.

Once disabled, an extension will not be started when the pendant is started (after power-on of the YRC Controller). The extension may be re-enabled at any time by toggling the {Enable} switch on.

8.3.3.2 Deleting Extensions

To permanently remove (uninstall) an extension from the pendant, use the {Trash} icon next to a selected extension entry in the list. With the Package Management Screen open:

1. Select the {Extensions} tab at top to show the list of currently installed extensions.
2. Select the extension entry you wish to delete. A {Trash} icon will be visible on the right of the selected row.
3. Press the {Trash} icon.
   – The pendant will stop the extension software from running and remove it from the pendant. Once deleted, it will no longer show in the list of installed extensions.

NOTE

- While the extension is uninstalled from the pendant, it was installed via a YASKAWA Install Package (.yip file) that may have included other components that were installed on the YRC Controller, such as jobs. Any other such components will not be removed from the YRC Controller by removing the pendant extension.
- After being removed, an extension may be reinstalled from the original package at any time.

8.3.4 Presets

A presets file (.yps) may contain multiple presets. A preset is a collection of predefined settings that can be used to quickly fill out various settings across smart pendant screens. When a preset is installed, it is only stored on the pendant-no immediate changes to the YRC Controller are made. For example, a Tool preset collects some of the tool settings (weight, center-of-mass, etc.), which can be applied to a particular tool number on the YRC Controller by the user from the Tool Settings Screen.

The presets file format is text-based and freely editable. For further documentation on the format, visit the smart.motoman.com and follow links to the Smart Pendant Extension SDK site.

Install presets using {+INSTALL} from the Package Management Screen, as described in *chapter 8.3.2.2*.

The list of presets installed on the pendant is visible on the {Presets} tab of the Package Management Screen. Applying a preset to controller settings is performed via the settings screen corresponding to the type of preset.

– Tool presets are applied via the {Tools} screen. See *chapter 6.1.6 “Applying Tool Presets”*.

– EtherNet/IP presets are applied via the {I/O Configuration} Screen. See *chapter 7.9.6 “Applying EtherNet/IP Presets”*.

8.3.4.1 Deleting Presets

To delete a preset, use the {Trash} icon next to a selected preset entry in the list. With the Package Management Screen open:

1. Select the {Presets} tab at top to show the list of currently installed presets.
2. Select the preset entry you wish to delete. A {Trash} icon will be visible on the right of the selected row.
3. Press the {Trash} icon.
   – The pendant will immediately remove the preset from the pendant. It will no longer be available to be applied on the corresponding settings screen. No settings to which the preset was previously applied will be impacted (i.e. no YRC Controller settings changes are made).

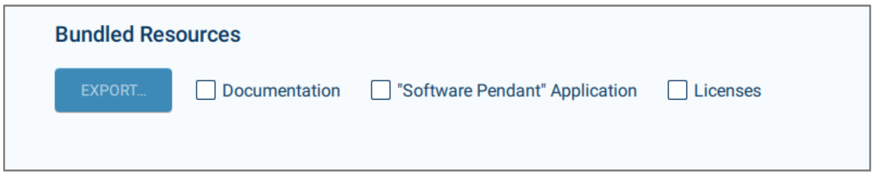
8.4 Bundled Resources

User can access and download related resources, which are:

– Documentation (Instruction manuals)

– Software Pendant Application

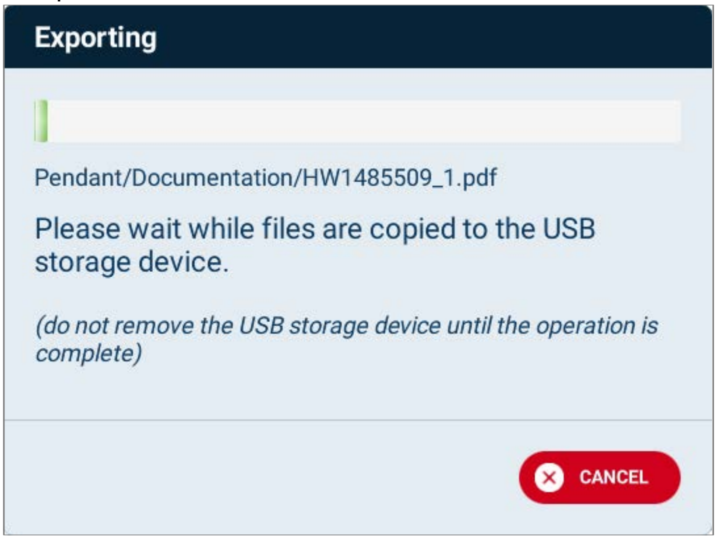
– Open Source Licenses



1. Check the checkbox of the desired resources to export to USB storage device.
2. Press {EXPORT…}.

   – Resources can be exported in Edit Level or higher security level.

   – Resources can be exported if an USB storage device with sufficient free space is inserted.



3. Remove the USB storage device after completing the export.
4. Connect the USB storage device to Windows PC.

   – Exported files can be read.

8.4.1 Documentation

Important documents can be obtained from the Smart Pendant.

1. Open the “Documentation” folder under USB storage folder.
2. Click the desired manuals to read.

NOTE Read these manuals before operating the manipulators.

8.4.2 Software Pendant Application

Software Pendant application software is an application that provides supplementary functions for using the Smart Pendant with the YRC Controller. The Software Pendant application should be installed on a Windows PC. Refer to *chapter 13 “Classic Interface”* for how to install the application on a computer.

8.4.3 Licenses

The list of the Open Source licenses for the software used are available here. For more information on the licenses, refer to the license documents that can be downloaded by exporting.

8.5 System Features

Information about the YRC Controller is shown in the System Features section on the YRC Controller Settings Screen. The following items are displayed:

① YRC Controller Software

② Robot Model

③ Functional Safety Unit

④ Power & Force Limiting

⑤ RESTART CONTROLLER

⑥ MOTOPLUS APPLICATIONS

8.5.1 YRC Controller Software

The version of the YRC Controller software that is used appears.

8.5.2 Robot Model

The model number of the manipulator that is set on the YRC Controller appears. The type number is shown at first, and model number is shown afterwards in the bracket.

8.5.3 Functional Safety Unit (FSU)

The status of whether Functional Safety Unit (FSU) is enabled or disabled is shown. For more information on FSU, refer to “YRC1000 OPTIONS INSTRUCTIONS FOR FUNCTIONAL SAFETY FUNCTION (HW1483576)” or “YRC1000micro OPTIONS INSTRUCTIONS FOR FUNCTIONAL SAFETY FUNCTION (HW1484544)”.

8.5.4 Power & Force Limiting (PFL)

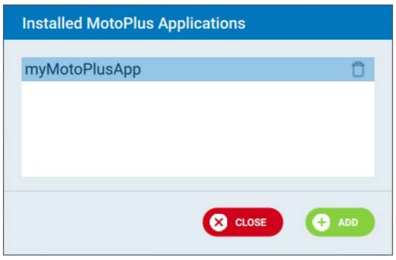
The availability of the PFL function is shown. For more information on PFL function, refer to “YRC1000/YRC1000micro Collaborative Operation Instructions (HW1484764)”.

8.5.5 Restart YRC Controller

If YRC Controller software supports it, the {Restart} button will be available. It allows restarting the YRC Controller, which also briefly interrupts power to the Smart Pendant, hence also restarting it.

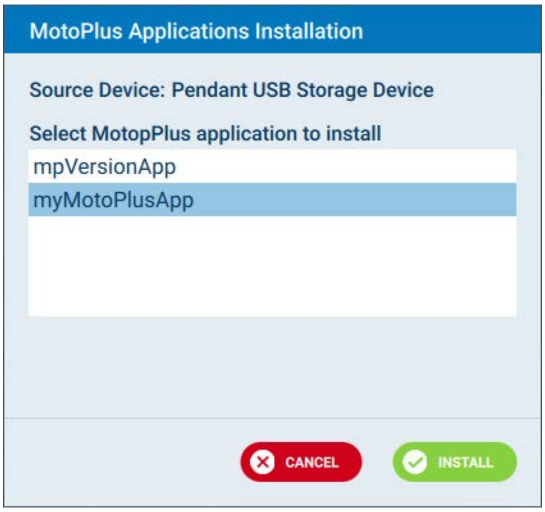
8.5.6 MotoPlus Applications

The MotoPlus applications installed on the controller can be managed by pressing the {MotoPlus Applications} button to display the list of installed applications.



8.5.6.1 Install MotoPlus Application Operation

1. Go to {Controller Settings} under {MENU}
   – The "Controller Settings" screen will appear.
2. Press the {MotoPlus Applications} button
   – The "Installed MotoPlus Applications" dialog will appear.
3. Connect to the Smart Pendant a USB storage device containing the MotoPlus application to install in its root.
4. Press the {ADD} button.
   – The "MotoPlus Applications Installation" dialog will appear and display the list of application in the root of the USB storage device.



5. Select the application from the list and press the {Install} button.
   – The "Confirm Installation" dialog will display.

> NOTE
> The controller will need to be restarted to complete the installation operation.

6. Press the {Install} button to proceed with the installation.

– The installation dialog will close, and the “Restart Controller is Required” dialog will appear. Restart the controller so that the MotoPlus changes are applied.

NOTE Other MotoPlus application cannot be installed or removed until the controller is restarted.

8.5.6.2 Remove MotoPlus Application Operation

1. Go to {Controller} under {MENU}
   – The “Controller” screen will appear.
2. Press the {MotoPlus Applications} button
   – The “Installed MotoPlus Applications” dialog will appear.
3. Select from the list the MotoPlus application to be removed.
4. Press the {Trash can} icon to the right of the MotoPlus application name.
   – The “Confirm Deletion” dialog will appear.

NOTE The controller will need to be restarted to complete the deletion operation.

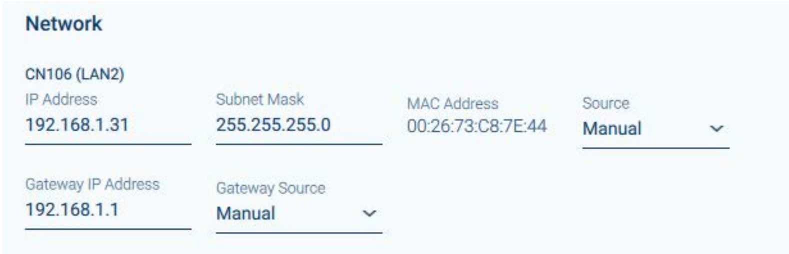
5. Press the {Delete} button to proceed with the deletion.
   – The “Restart Controller is Required” dialog will appear. Restart the controller so that the MotoPlus changes are applied.

NOTE Other MotoPlus application cannot be installed or removed until the controller is restarted.

8.6 Network

To access the Networking settings screen, go to
{MENU} → {System Settings} → {Controller}

Fig. 8-4: Network Setting Screen



8.6.1 YRC1000 Network

The YRC1000 has three network ports:

Table 8-1: Network Port for the YRC1000

Port	Channel	Description
LAN1	CN105	This port is used for pendant connection and is not available for application use.
LAN2	CN106	This port is for customer application use. The IP settings of this port can be configured as per user requirements.
LAN3	CN107	This port is for customer application use. The IP settings of this port can be configured as per user requirements. Classic Interface is required to view or configure the IP settings for CN107 (LAN3).

The network ports are located on the CPU Unit of the YRC1000. Refer to *chapter 13.5.3.1 “Network Setup”* for the location of the network ports in YRC1000.

8.6.2 YRC1000micro Network

The YRC1000micro has two network ports: CN105 (LAN1) and CN106 (LAN2). The functions supported by these ports are similar to YRC1000 as described in *chapter 8.6.1 “YRC1000 Network”*.

8.6.3 MAC Address

1. Go to {MENU} → {System Settings} → {Controller}.
2. {MAC Address} is under {Network}.

8.6.4 Setting IP Address

Requires Management Security

> **NOTE**
> Smart Pendant communicates with the YRC Controller over an Ethernet connection. In some cases, incorrectly changing Network Settings from Smart Pendant can cause connection issues with the YRC Controller. If this happens, refer to *chapter 8.6.6 "Resetting Controller Network Settings"*

The IP Address can be set manually (static) or automatically acquired. To have the IP address acquired automatically via the standard DHCP protocol, select {Auto (DHCP)} as the Source. To set the IP address and subnet mask manually, to a fixed static value, use the following.

1. Go to {MENU} → {System Settings} → {Controller}.
2. {IP Address} is under {Network}.
3. Select the {Source} as {Manual}.
4. Press {IP Address}.
   – The keypad will appear.
5. Enter the IP Address and press {Enter}.
   – IP Address must be 4 numbers 0-255 separated by decimals. Ex. 10.6.3.42.

> **NOTE**
> IP Addresses reserved for special use should not be used for the YRC Controller.
> – 0.0.0.0 (Current Network).
> – 255.255.255.255 (Limited Broadcast).
> – Any IP Address starting with 127 (Loopback Addresses).

6. Optionally set the {Subnet Mask} if the common default 255.255.255.0 is not appropriate.
7. Press the {Save} button.
   – A notice will appear stating that the YRC Controller will have to be restarted for the new IP Address to take effect.

8.6.5 Setting Gateway IP Address

Requires Management Security

The Gateway IP Address can be set manually (static) or automatically acquired. To have the Gateway IP address acquired automatically via the standard DHCP protocol, select {Auto (DHCP)} as the Source. To set the Gateway IP address to a fixed static value, use the same procedure as *chapter 8.6.4*.

> NOTE
>
> The Gateway IP Address must be on the same subnet as the IP Address following the defined by the Subnet Mask

8.6.6 Resetting Controller Network Settings

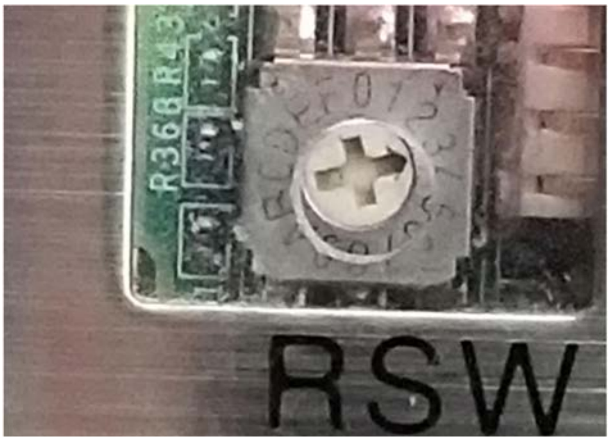
In some instances, the Controller will not be accessible over the network. This can occur from several issues including:

- Controller network settings were made incorrectly (e.g. mistyping desired IP or subnet)
- Controller network settings conflict with other network devices

In this case, the network settings of the YRC Controller can be reset to a default value by:

1. Power OFF the YRC Controller
2. Change Rotary Switch Position to 3 (*fig. 8-5*).
3. Power ON the YRC Controller

Fig. 8-5: Rotary Switch Setting for Resetting IP Address



After cycling power, the following default network settings will be applied to the YRC1000 (*table 8-2*) and YRC1000micro (*table 8-3*).

Table 8-2: YRC1000 Default Network Settings

		Settings
Host setting		MANUAL SETTING
	Host Name	MY HOST
Domain Setting		MANUAL SETTING
	Domain name	LOCAL.DOMAIN
IP Address Setting (LAN2)		MANUAL SETTING
	IP Address	192.168.255.1
	Subnet mask	255.255.255.0
IP Address Setting (LAN3)		MANUAL SETTING
	IP Address	172.16.0.1
	Subnet mask	255.255.255.0
Default Gateway Setting		NOT USED
Static Route (LAN2)		NOT USED
Static Route (Lan3)		NOT USED
DNS Setting		NOT USED
SNTP Setting		NOT USED

Table 8-3: YRC1000micro Default Network Settings

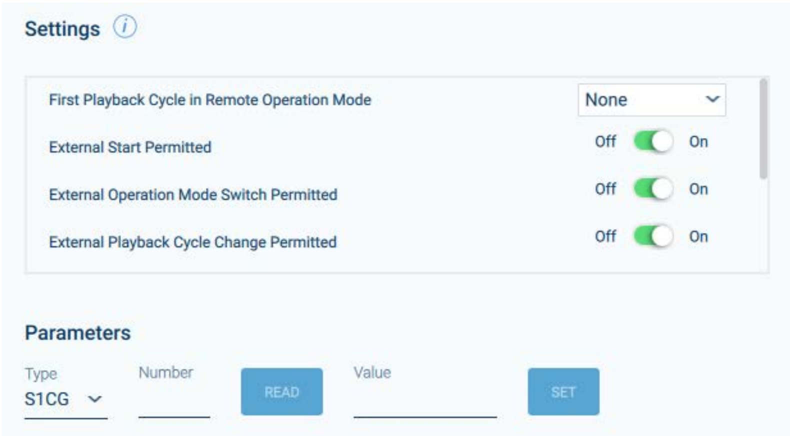
		Settings
Host setting		MANUAL SETTING
	Host Name	MY HOST
Domain Setting		MANUAL SETTING
	Domain name	LOCAL.DOMAIN
IP Address Setting (LAN2)		MANUAL SETTING
	IP Address	192.168.255.1
	Subnet mask	255.255.255.0
IP Address Setting (LAN3)		MANUAL SETTING
	IP Address	172.16.0.1
	Subnet mask	255.255.255.0
Default Gateway Setting		NOT USED
DNS Setting		NOT USED
SNTP Setting		NOT USED

After the above procedure is done, power OFF the YRC Controller, turn the rotary switch back to position 0, and power back ON. Smart Pendant should now be able to connect to the YRC Controller and appropriate network settings can be configured by following the procedure in *chapter 8.6.4*.

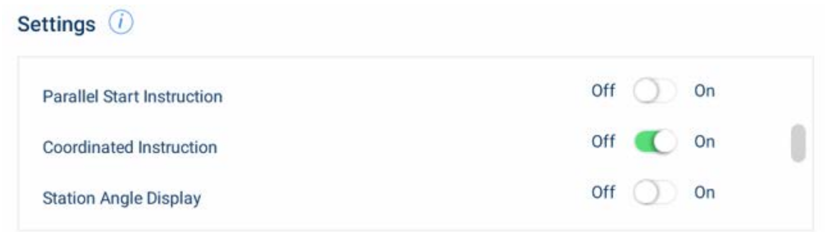
8.7 Settings and Parameters

Various YRC Controller parameter settings can be adjusted using these controls. The specific settings available may vary by region.

Fig. 8-6: Setting and Parameter Controls



Your local YASKAWA representative can also read the status of and/or enable many YRC Controller Options directly from Smart Pendant. Contact your local representative if the YRC controller option(s) are unexpectedly not available.



8.8 Remote Screen Sharing

The screen of the Smart Pendant can be shared via the network to a PC. This may be useful for allowing multiple people to simultaneously view the screen for demonstration or educational purposes, for example by displaying it on a large screen. The sharing uses the standard VNC (Virtual Network Computing) desktop sharing protocol, for which many viewer applications for many operating systems are available.

The Remote Screen Sharing settings are shown below:

Fig. 8-7: Remote Screen Sharing

Remote connections to view the Smart Pendant screen will require a password before being able to view the screen, for security. You must create a password to use for that purpose. It is good practice not to use the same password as used for security access. To enter a screen share password, ensure the pendant is in the Management security access level.

To start sharing the Smart Pendant screen, tap the switch into the {On} position. The remote viewing application you choose to use will require the IP address and port number, as displayed. The IP address will match that of the YRC Controller Ethernet port, which must be connected to the same LAN as your PC viewer (LAN2 for YRC1000 Controller or LAN for the YRC1000micro Controller).

When a remote viewer application attempts to connect, a prompt will appear on the Smart Pendant to allow the remote viewer. This ensures that the screen cannot be remotely viewed without the knowledge of the Smart Pendant operator.

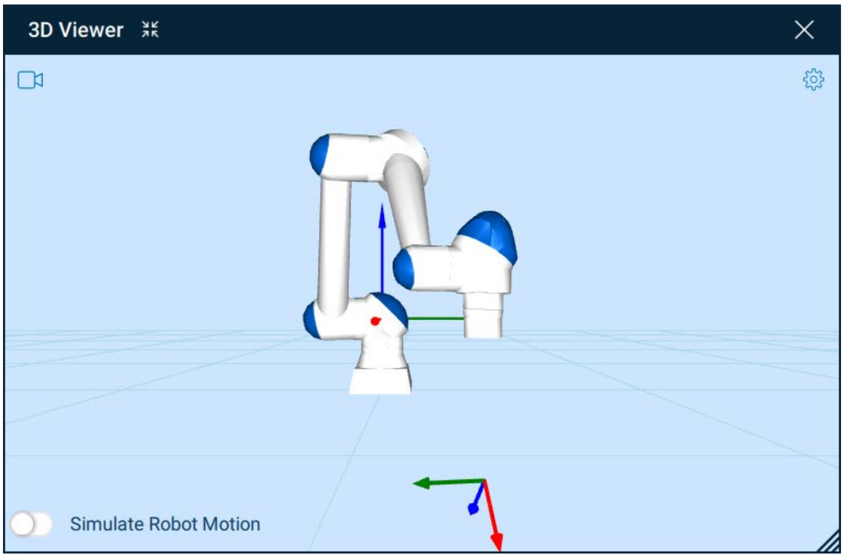
A popular PC application is VNC Viewer by RealVNC. This allows the user to mirror the Smart Pendant pendant display for demonstration, training, and support purposes.

The Remote Screen Sharing is stopped when the Smart Pendant is restarted and is not automatically restarted on startup.

9 Utility

9.1 3D Viewer

The 3D Viewer provides a graphical 3D representation of the robot and various coordinate frames. It can also be used to simulate robot motion without running the physical robot.



To show the 3D Viewer, select {MENU} → {Utility} → {3D Viewer}.

> SUPPLE-MENT
>
> Only the robot can be displayed. Displaying of peripheral devices is not supported.

9.1.1 Operation of the 3D Viewer

The operations for the 3D display function are described below.

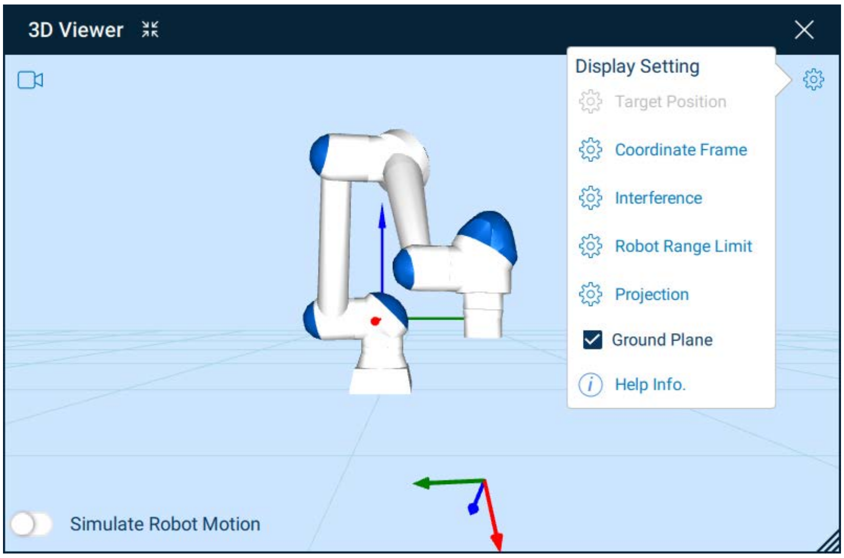
9.1.1.1 Basic Operation

The following operations can be performed on the 3D Viewer:

Function	Operation
Rotation	Rotate the view by swiping the screen.
Translation	Move the view by swiping the screen with 2 fingers.
Zoom Out/In	Pinch two fingers together or apart to adjust zoom.
Change size of the screen	Change the screen size by dragging the slash icon at the bottom right corner of the screen.
Simulate Robot Motion	When this setting is enabled, the 3D model will simulate robot motion without moving the physical robot. This function can be used in Manual (Teach) mode to jog the robot and in PLAY (AUTOMATIC) mode to execute jobs without moving the robot. During job execution, non-motion instructions such as IO or Math operations will still be executed in Simulate Robot Motion Mode.

9.1.1.2 Display Setting

Specifies what is displayed in addition to the robot model. To change the display setting, press the setting icon at the top right corner of the screen.

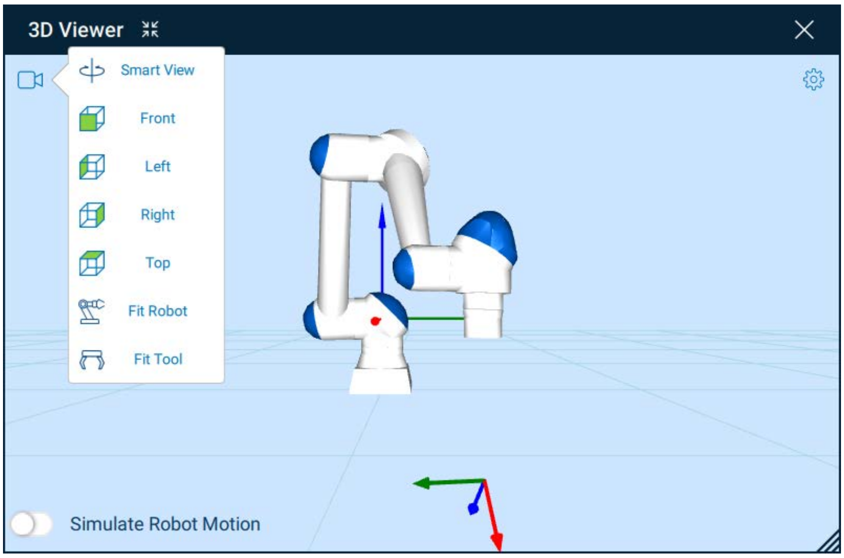


Name	Detail
Target Position	If the current line of the current job is a motion instruction, display the robot position. This position will update as different positions are selected. **Robot** Show the 3D model of the robot at the target position. **Tool Frame** Show tool frame at the target position.
Coordinate Frame	Show coordinate frames. **Robot Frame** Show Robot frame. **Flange Frame** Show Tool Flange frame. **Tool Frame** Show Tool frame associated with the active tool. **User Frame** Show specified user frame.
Interference	Show the interference model which is used in Robot Range Limit of Functional Safety Function. This setting will be shown when Functional Safety Function is enabled. **Robot Interference** Show the robot interference model. **Tool Interference** If defined, show the tool interference.
Robot Range Limit	Show the range limit settings which are specified in the Robot Range Limit Function of Functional Safety Function. This setting will be shown only when Functional Safety Function is enabled.

Name	Detail
Ground Plane	Show ground plane as a grid.
Projection	Specifies the projection type of the screen. **Perspective** Closest objects are shown larger and further away objects are shown smaller. Perspective display provides a more realistic image. **Orthographic** Display the same size, regardless of distance. Orthographic display makes it easier to compare size of objects.
Help Info	Show help information

9.1.1.3 Camera Position

Change the camera view position.

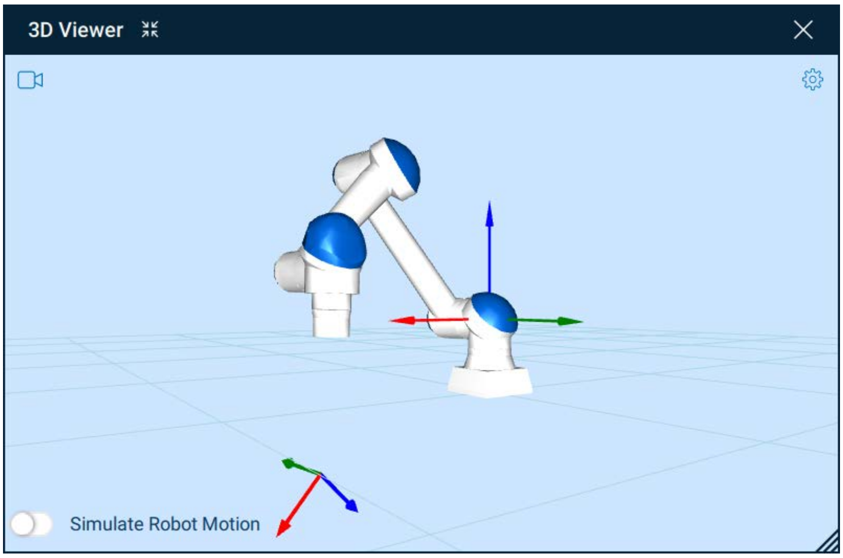


Name	Detail
Smart View	Change the camera position with the direction of the pendant. Smart Frame must be calibrated for this to work
Front/Left/Right/Top	Change the camera position to the selected orientation.
Fit Robot	Change the camera position to see the whole robot.
Fit Tool	Change the camera position to see the tool.

9.1.2 Display Contents

The model on the 3D Viewer will be updated to match the current robot position as the position changes.

Robot coordinate frame, or tool coordinate frame are show as three arrows. The directions of the arrows are the positive directions of the X-axis (Red), Y-axis (Green), and Z-axis (Blue)

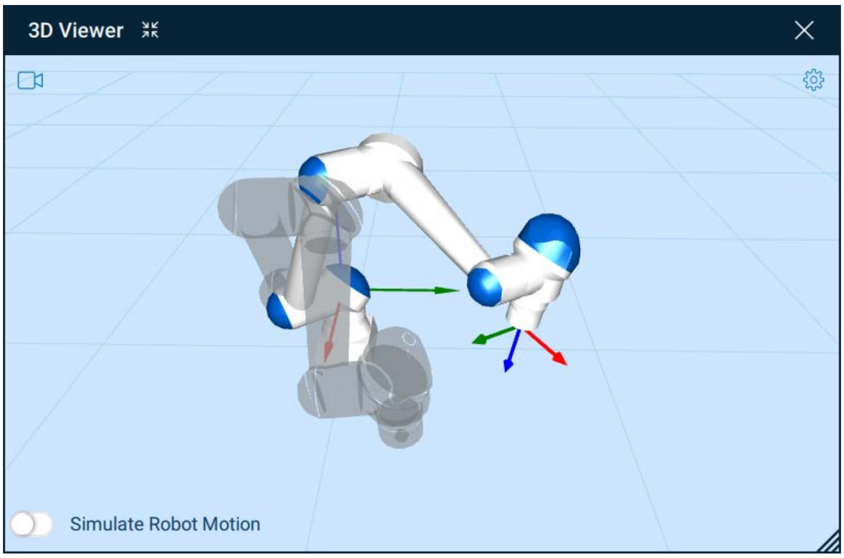


9.1.3 Simulate Robot Motion

When this setting is enabled, the 3D model will simulate robot motion without moving the physical robot. This function can be used in Manual (Teach) mode to jog the robot and in PLAY (AUTOMATIC) mode to execute jobs without moving the robot. During job execution, non-motion instructions such as IO or Math operations will still be executed.

9.1.4 Show Target Position

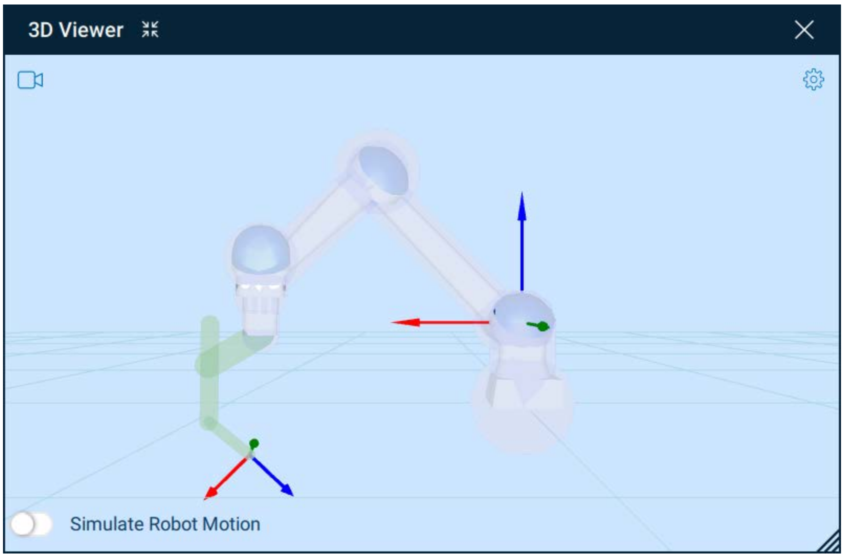
When current job is shown and a motion instruction is selected, the robot posture and the tool frame of the target taught position will be shown. Target position is shown as gray.



SUPPLE-MENT
Target Position cannot be shown in Automatic (Play) mode or during Test Run.

9.1.5 Display Interference Model

Display the interference model used in the robot range limit of the functional safety function. This setting will be shown only when Functional Safety Function is enabled.

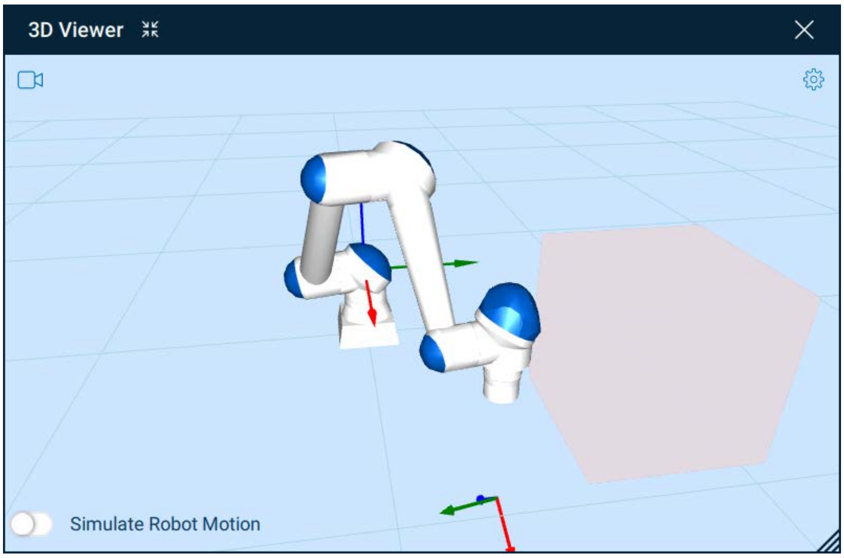


The robot interference model is shown as a transparent light blue.

If defined, the tool interference model is shown as light green.

9.1.6 Display Robot Range Limit

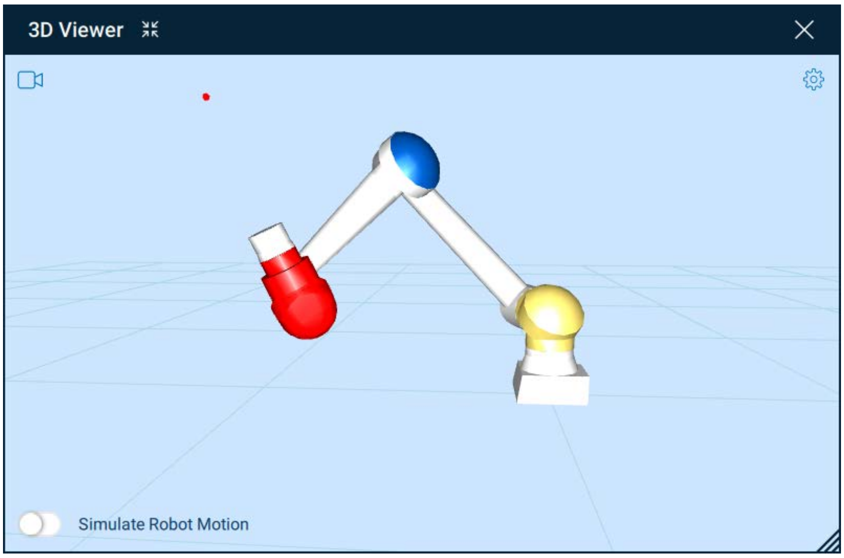
Displays the volumes/area specified in the robot range limit of the functional safety function. This setting will be shown only when Functional Safety Function is enabled.



9.1.7 Axis Limit Warning

If the robot is moved close to an Axis Limit, theses axes will change color to either yellow (close to limit) or red (at limit) in the 3D Viewer. This is shown below in *fig. 9-1* where the S-Axis is close to a limit and the B-Axis it at a limit.

Fig. 9-1: Axis Limit Warning



9.2 File Transfer & System Backup

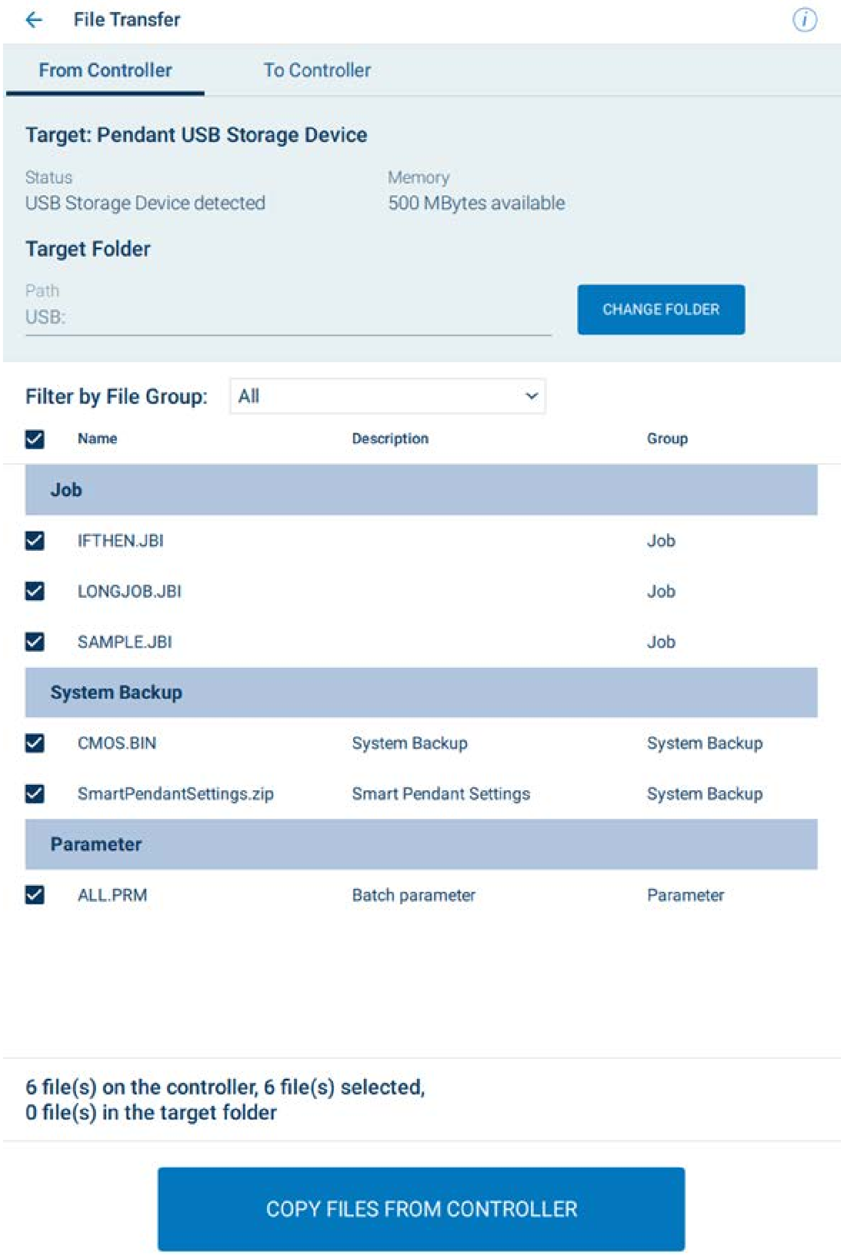
9.2.1 File Transfer Overview

The File Transfer screen allows the user to import and export files to/from the YRC Controller using a USB storage device. One of its primary functions is to save a System Backup to use as a “restore point” for the YRC Controller & Smart Pendant. The following sections describe the full scope of this utility.

File Transfer can be used to import/export the following files:

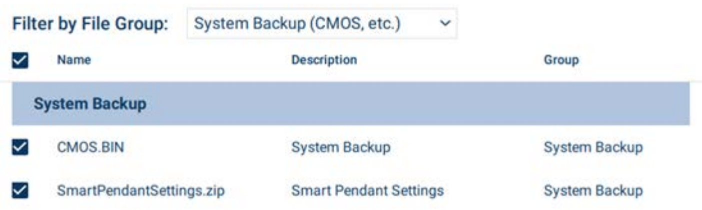
- Jobs
  - .JBI files
- System Backup
  - CMOS.BIN - a binary file that includes all YRC Controller parameters and data files
  - SmartPendantSettings.zip - Smart Pendant configuration files, log files, and Interface Panels (.ypn)
- General Data
  - e.g. tool data (TOOL.CND), user frame data (UFRAME.CND), variable value (VAR.DAT)
- I/O Data
  - e.g. CIO program (CIOPRG.LST) & I/O name data (IONAME.DAT)
- System Data
  - e.g. Home position calibration data (ABSO.DAT), Alarm history data (ALMHIST.DAT)
- Parameter
  - e.g. batch parameter (ALL.PRM) & system definition parameter (SD.PRM)

This utility can be accessed from {MENU} ⟶ {Utility} ⟶ {File Transfer}.


File Transfer
From Controller
To Controller
Target: Pendant USB Storage Device
Status
USB Storage Device detected
Memory
500 MBytes available
Target Folder
Path
USB:
CHANGE FOLDER
Filter by File Group:
All
Name
Description
Group
Job
IFTHEN.JBI
Job
LONGJOB.JBI
Job
SAMPLE.JBI
Job
System Backup
CMOS.BIN
System Backup
System Backup
SmartPendantSettings.zip
Smart Pendant Settings
System Backup
Parameter
ALL.PRM
Batch parameter
Parameter
6 file(s) on the controller, 6 file(s) selected,
0 file(s) in the target folder
COPY FILES FROM CONTROLLER

9.2.2 System Backup Procedure

1. Insert a USB storage device into Smart Pendant
   – ~40MB of free space is required for the backup
2. Navigate to {MENU} ⟶ {Utility} ⟶ {File Transfer}
3. Select {From Controller} tab
4. Change the Target directory (if necessary)
5. Select {System Backup (CMOS, etc.)} from the dropdown
6. Use the checkboxes to select “CMOS.BIN” and “SmartPendantSettings.zip”



7. Press {Copy Files from Controller} to export the system backup files to the USB storage device

NOTE

- The backup operation can fail under the following conditions:
  – USB drive is removed during the backup
  – Power failure during backup

If the backup fails, files with size = 0 will be removed from the target directory.

9.2.3 System Restore Procedure

System Restore is partially supported in the Smart Pendant interface. The File Transfer utility can successfully import “SmartPendantSettings.zip” to the pendant.

However, importing CMOS.BIN using the File Transfer screen is not yet supported. Use “Classic Interface” in Maintenance Mode to successfully restore CMOS.BIN. (see *chapter 13 “Classic Interface”* for details)

NOTE

Management security level is required for restoring a CMOS.BIN that was saved from the same controller. One Time Management or YASKAWA security level is required to load a CMOS.BIN from a different controller.

9.2.4 File Transfer Procedure

1. Insert a USB storage device into Smart Pendant
2. Navigate to {MENU} ⟶ {Utility} ⟶ {File Transfer}
3. Select tab for desired task (i.e. Import or Export)
   – {From Controller} is used to export files to the USB storage device

– {To Controller} is used to import files from the USB storage device

4. Change the Target / Source directory (if necessary)
5. Configure the filter to display files for import/export from the dropdown
6. Use the checkboxes to select desired files for import/export
   – The checkbox in the header selects/deselects ALL files
7. Perform the import/export
   – {Copy Files from Controller} exports the selected file(s) to a USB storage device
   – {Copy Files to Controller} imports the selected file(s) from a USB storage device
8. Press {YES} in the confirmation pop-up
   – The selected files are copied to their target destination.
   – {Overwrite or Skip Files Confirmation} pop-up appears if the target directory has conflicting files.

DANGER

- Import of Safety related files will override the Safety settings on the controller.
- Ensure all Safety related settings work properly after the import is complete.

NOTE

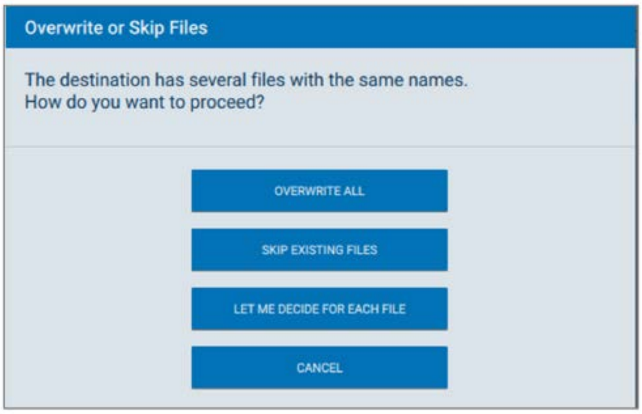
- The YRC Controller must be restarted for Safety related settings to take effect.
- “Enable Condition” of imported {Safety Functions} are set to “Always OFF”.

9.2.4.1 Overwrite or Skip File(s)

Smart Pendant will detect if the selected file(s) already exist and will provide options to proceed in a confirmation pop-up:

- **Overwrite**
  The copy process replaces existing file(s) in the target folder.
- **Skip Existing**
  The copy process skips existing file(s) in the target folder.
- **Let Me Decide for Each File**
  The copy process will show a separate confirmation pop-up window for the user to decide what to do for each existing file.

■ **Cancel**
Copy process will be canceled. The file(s) that have already been copied will be left in the target folder.



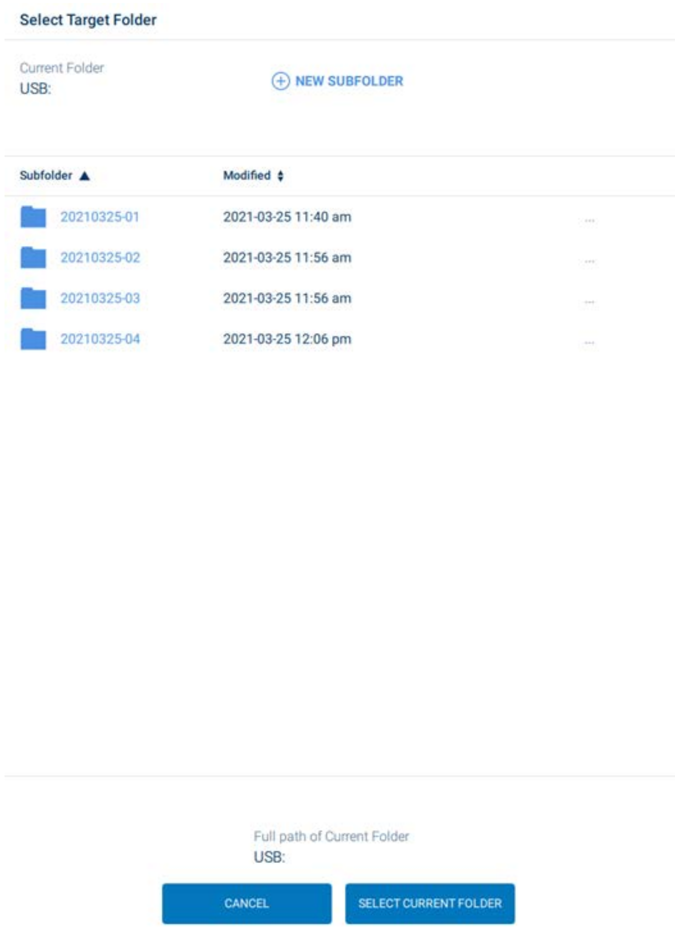
9.2.5 Selection of Target/Source Folder

The user can change the target/source folder using Select Folder screen. In this screen, the user can:

– create a new folder

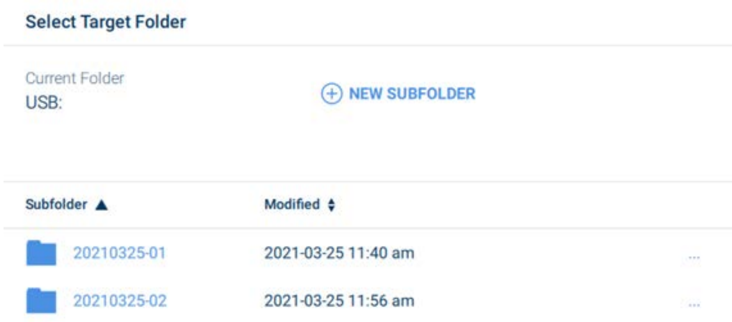
– rename an existing folder

– select the target/source folder

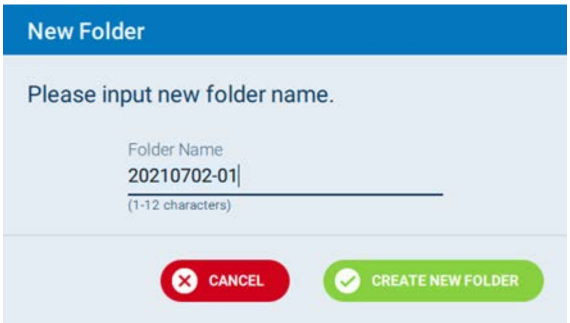


9.2.5.1 Create a New Folder

1. Press {+ New Sub-Folder}



2. Enter a new folder name

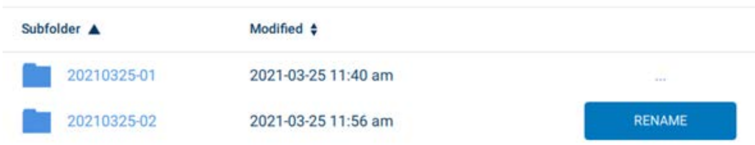


3. Press {Create New Folder}
   – The new folder is created unless a folder with the same name already exists.

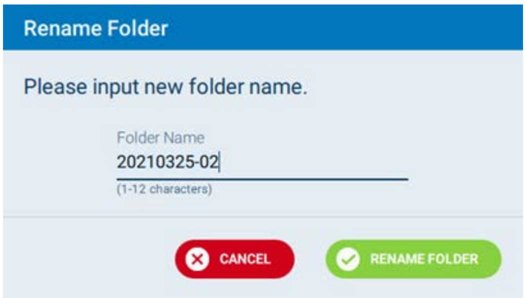
9.2.5.2 Rename An Existing Folder

1. Press {…} on the target sub-folder on the right-side of the folder list view to display {Rename}.

2. Press {Rename}



3. Enter a new folder name



4. Press {Rename Folder}
   – The new folder is renamed unless a folder with the same name already exists

9.2.5.3 Select the Target/Source Folder

1. Press the sub-folder name in the folder list view
2. Press {To Parent Folder}
   – If the current folder is the root directory, this button will not appear.
3. Press {Select Current Folder} if the current folder is the target/source folder

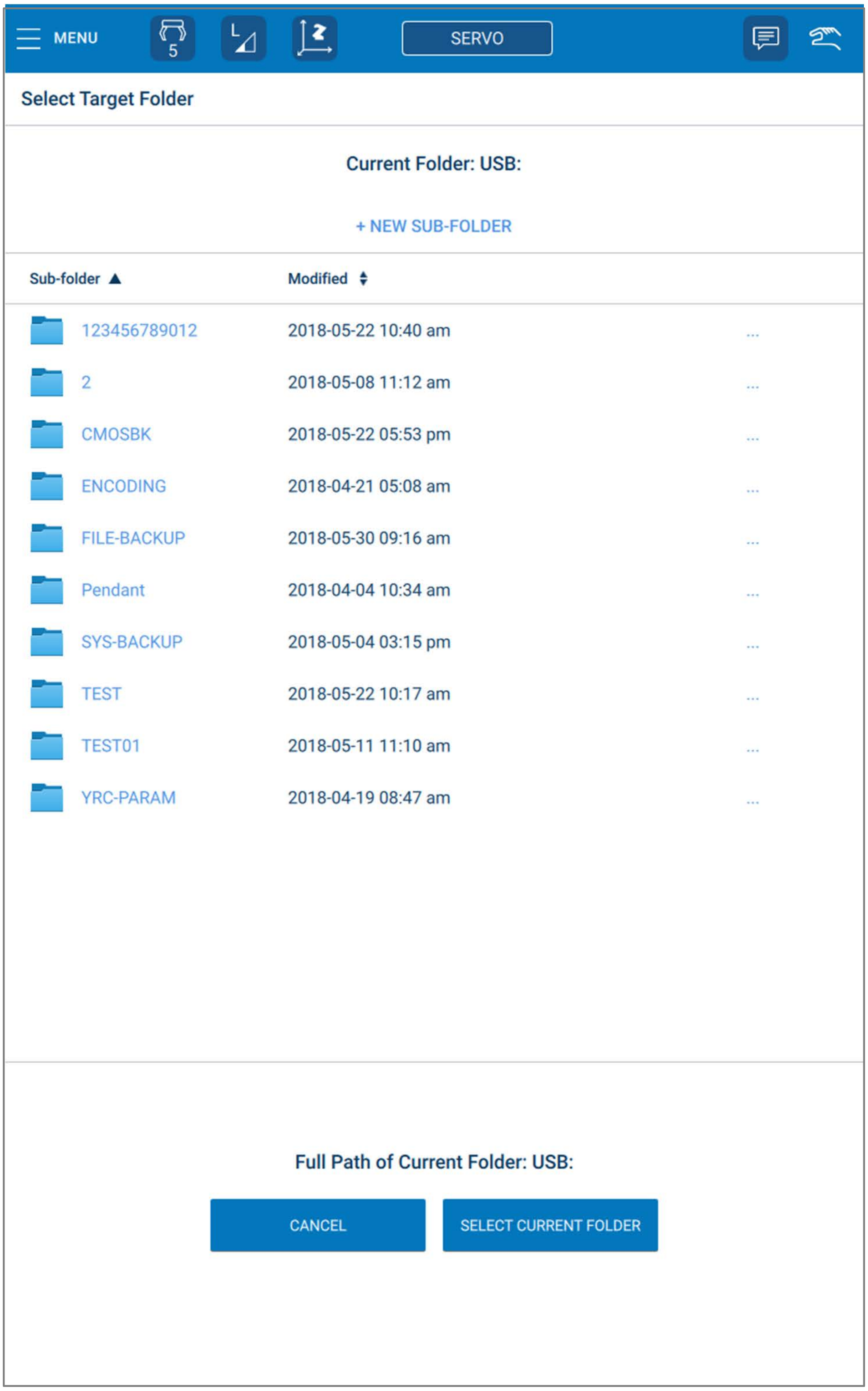
9.2.6 Selection of Target/Source Folder

The user can change the target/source folder using Select Folder screen.

In this screen, the user can:

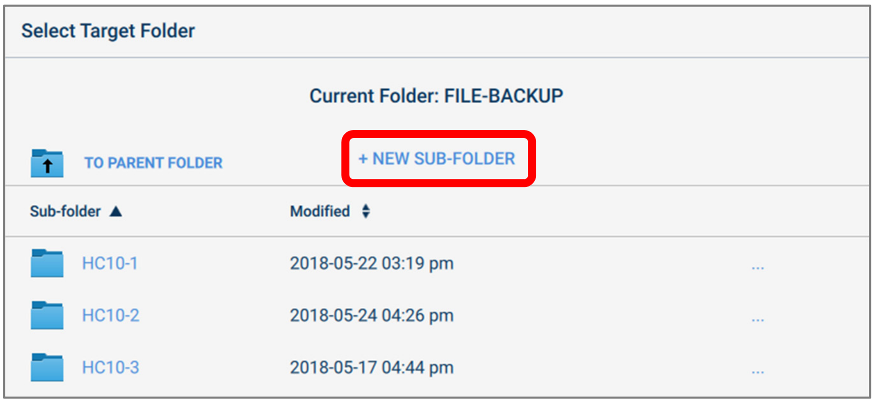
- create a new folder
- rename an existing folder
- select the target/source folder

Fig. 9-2: Select Folder Screen

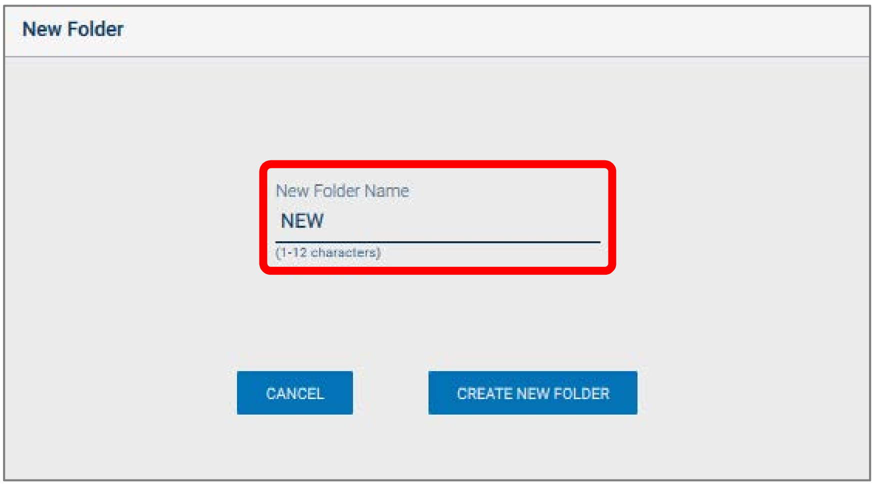


9.2.6.1 Create a New Folder

1. Press {+ NEW SUB-FOLDER}.
   - New Folder screen will appear.



2. Enter a new folder name.

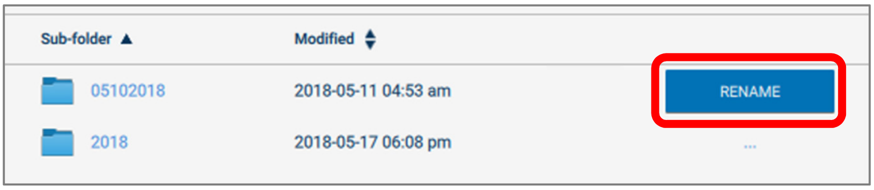


3. Press {CREATE NEW FOLDER}.
   - New folder is created unless a folder with the same name already exists.

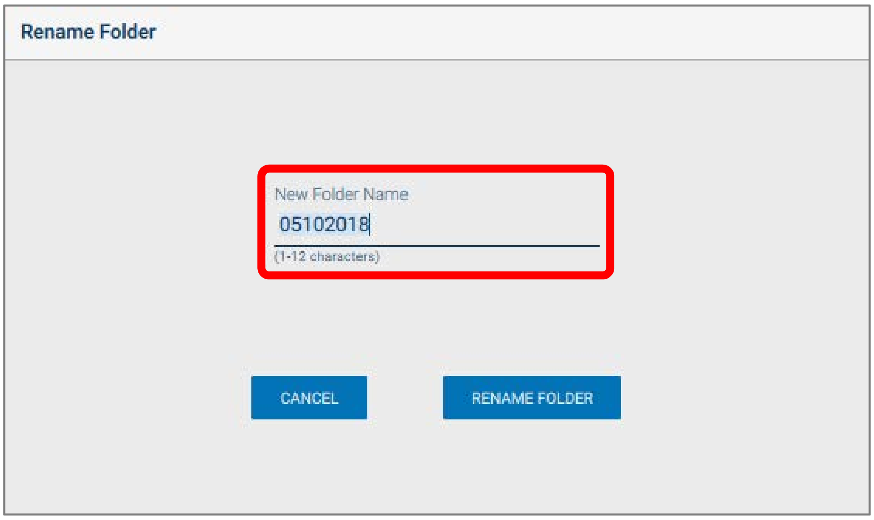
9.2.6.2 Rename an Existing Folder

1. Press {...} on the target sub-folder in the folder list view.
   – {RENAME} will appear.

2. Press {RENAME}.
   – Rename Folder screen will appear.



3. Enter a new folder name.



4. Press {RENAME FOLDER}.
   – Folder name is renamed unless a folder with the same name already exists.

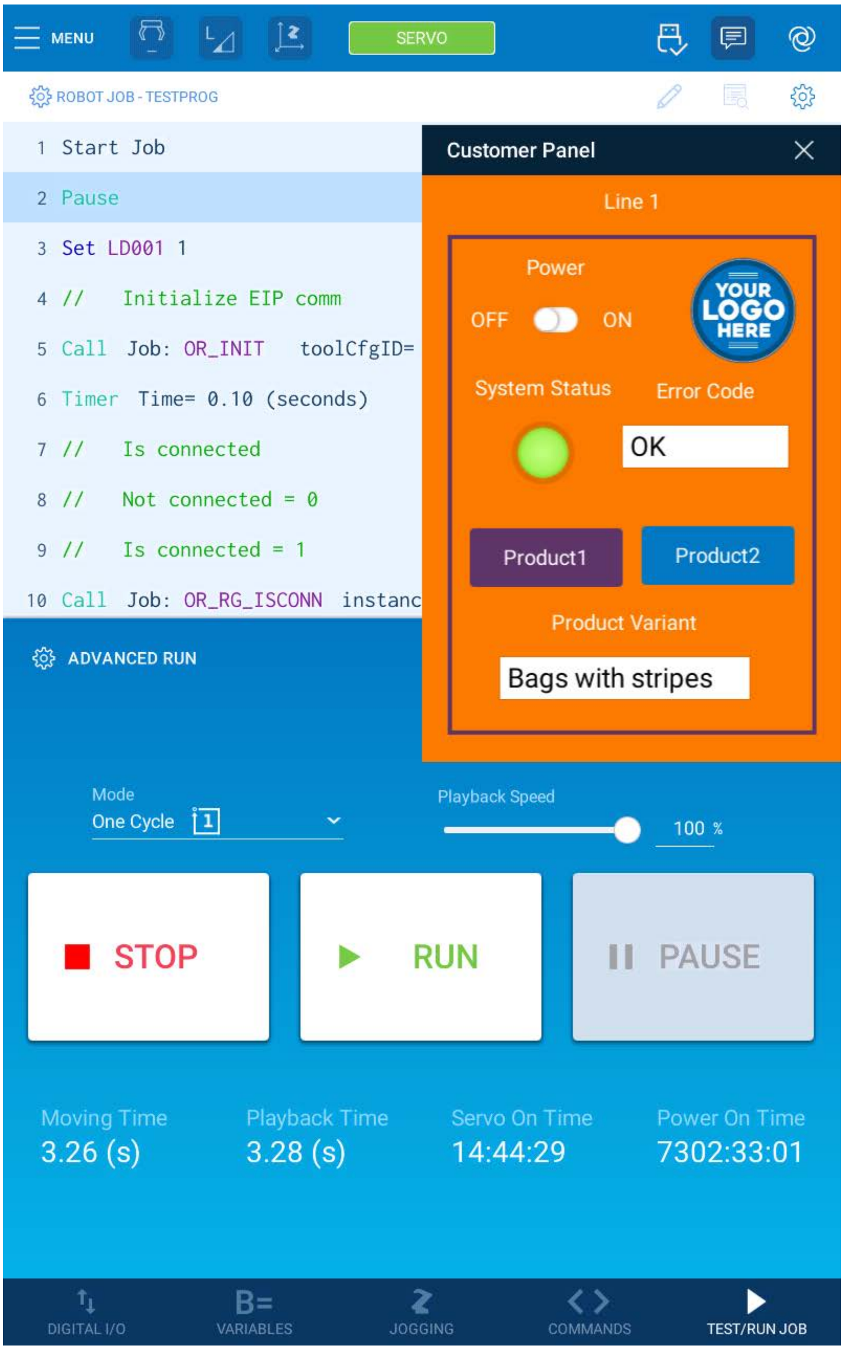
9.2.6.3 Select the Target/Source Folder

1. Press the sub-folder name in the folder list view.
   – A sub-folder will open.
2. Press {TO PARENT FOLDER}.
   – A parent folder will open.
   – If the current folder it the root folder, this button will not show up.
3. Press {SELECT CURRENT FOLDER}, if the current folder is the target/source folder.

10 Interface Panel

Interface Panel enables the creation of a custom user-interface with configurable controls (e.g. indicator lights, buttons, switches, images etc.). These controls can be linked to Global Variables and I/O Signals to reflect the state of the YRC controller for a particular application.

Fig. 10-1: Customer Panel

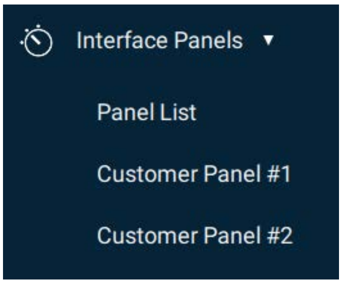


10.1 Interface Panel Access

Navigate to {Menu → Interface Panels}. {Panel List} opens the Interface Panel List Screen where new panels can be created, renamed, configured to run on startup etc.

Panel Shortcuts (if any) are listed in the sub-menu below {Panel List}. These entries will open a predefined Interface Panel.

Fig. 10-2: Panel List Sub-menu



10.2 Interface Panel List Screen

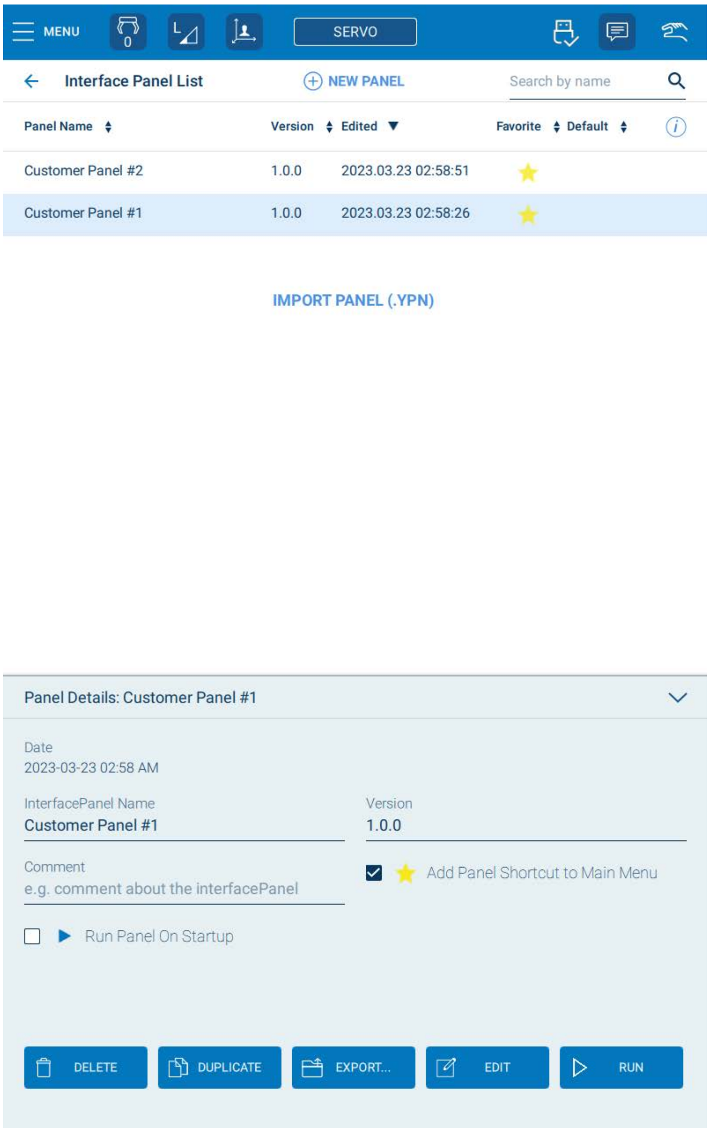
The Panel List screen is used to:

– View list of installed panels
– Create, delete, or duplicate panels
– Import/export panels to a USB device
– Change panel name, comments, and version
– View last panel edit time
– Set a panel to launch at Smart Pendant startup (i.e. boot)
– Add panel launch shortcuts to the Main Menu
– Launch Interface Panel Editor screen
– Sort panels by name, version, edited time, favorites, set to launch on startup
– Search for panel by name

10.2.1 Create a Panel

Press {+ New Panel} button to launch the New Panel Screen. Enter the desired name of the panel into the dialog and press {Create Panel}. The new panel will be added to the list.

Fig. 10-3: New Panel Screen



If desired, the {Run Panel on Startup} option will launch the selected panel after boot of Smart Pendant. Use {Edit} to open the Editor used to define the layout of the newly created Interface Panel.

The Interface Panel Editor Screen is used to:

– Set Panel background color

– Set Panel size

  • Full, Half, or Quarter

  • If set to Half or Quarter, the Panel is a floating window that can be dragged by the user to reposition

– Add New Control

  • ***Light*** - Two state (on or off) visual indicator. “Light” color and for which Target variable or I/O it should light can be customized

  • ***Button*** - When pressed, can set the value of a Target variable or output signal (or group/byte), or navigate to another Interface Panel

  • ***Switch*** - Toggle value of a Target between 0 (OFF state) and a user-defined value (ON state) or a specific Value. It also visually reflects the live value of the Target

  • ***Display*** - Show either static text, the live value of a Target variable or I/O, or to enter a value to update the Target

  • ***Frame*** - Decoration useful for grouping controls together

  • ***Image*** - Static image that can be imported from an image file (.png, .jpg, .svg) on a USB storage device and sized to suit

– Edit properties applicable to each Control

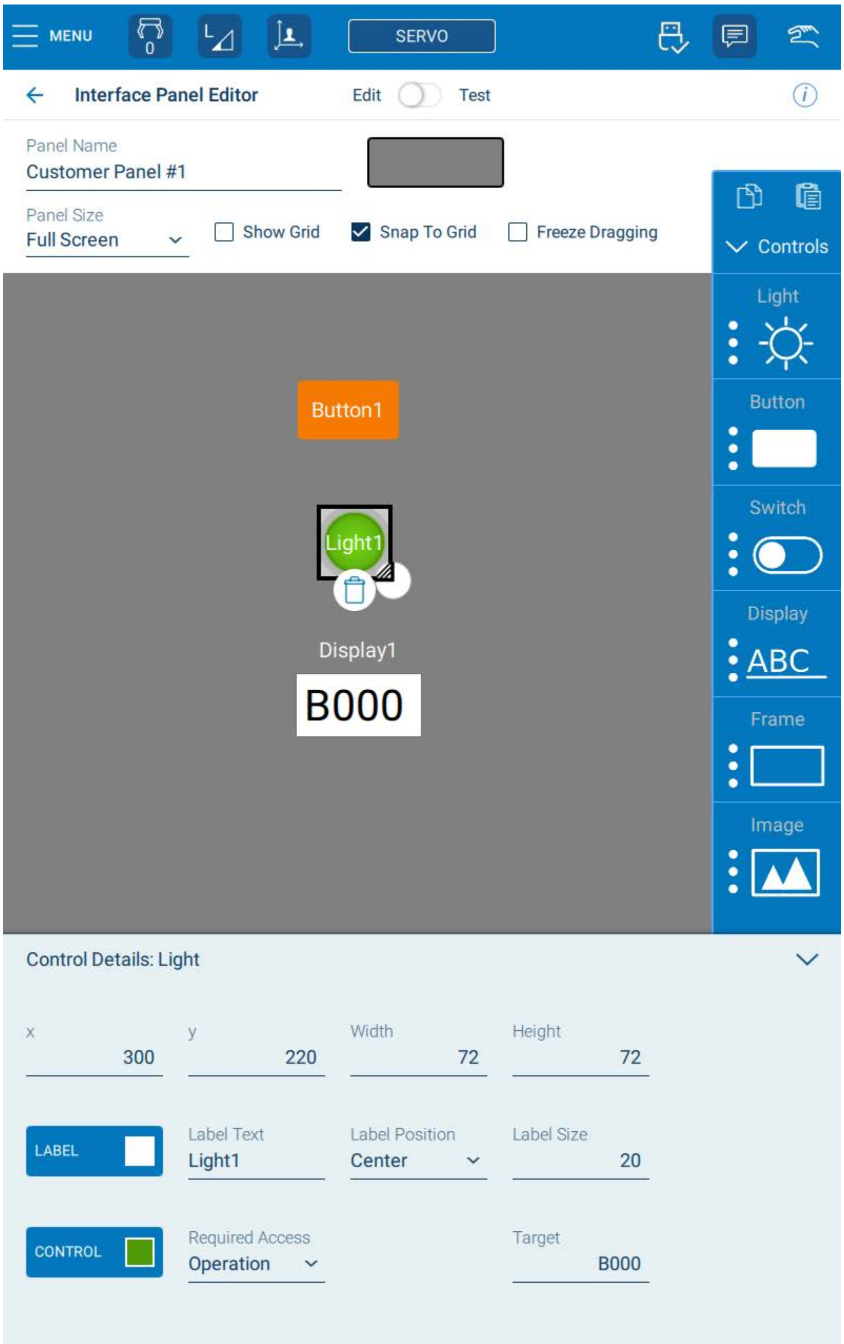
  • See *chapter 10.2.2*

– Copy, paste, & delete Controls

– Run panel in Test Mode

– Toggle Show Grid, Snap To Grid, and Freeze Dragging

Fig. 10-4: Interface Panel Editor Screen



To add a control to a panel, press and hold the desired control type from the {Controls} palette and drag it to the desired position in the Panel. The {Controls} palette can be shown/hidden as necessary. Once placed, a control can be resized by dragging the resize handle or deleted using the trash-can icon.

Each control has customizable properties, shown in the bottom detail panel when a control is selected. Control details can be display or hidden by pressing the bottom header. Double-tapping a control will auto-raise the details panel in addition to selecting it.

10.2.2 Control Properties

– **x, y** - Position of the control relative to the panel left (x), top (y), and its width/height.

– **Height, width** - A full screen panel is 800 units wide by 1152 units high.

– **Color** - Selected by the user with a popup dialog.

– **Label text, color, position, size** - If not blank, the control will have a text label, positioned as selected (left, right, top, bottom of center) and with the font size specified.

– **Target** - Global variable or I/O referenced by the control.

- ***Light*** - The light will be on if the target value is non-zero, otherwise off.
- ***Button*** - The target is set when pressed.
- ***Switch*** - The target's value determines the switch position and is also set when the switch is switched.
- ***Display*** - The target to be shown (view) or set (entry).

– **Value** - A value of the target variable of I/O that determines the control behavior (varies for each type of control).

- ***Button*** - The button will set the target to the specified value.
- ***Switch*** - When ON, the target is set to the specified value, otherwise to 0 if OFF. The switch will show as ON if the target matches the value, OFF otherwise.
- ***Display*** - When set to an entry type, upon entry of input into the control by the operator, the target is set to the value entered. If set to a view type, the displayed value will be that of the target.

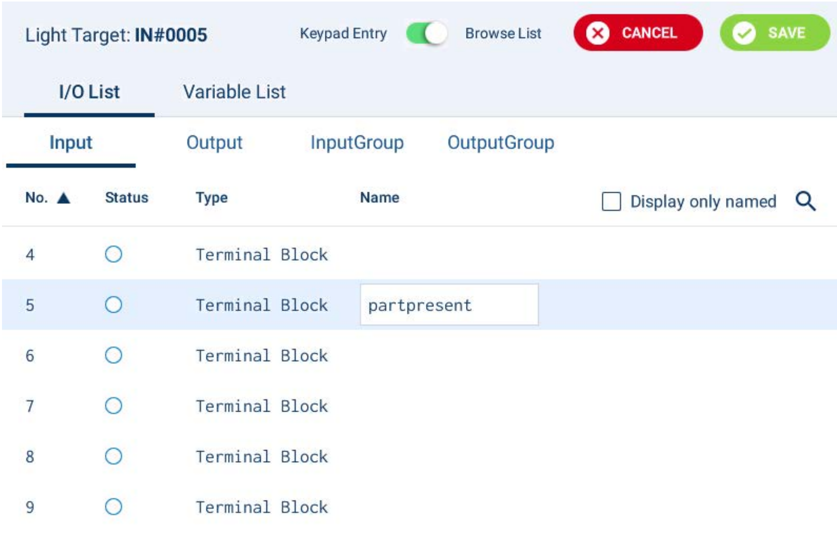
– **Button Type** - If “Set Value”, clicking the button will set the target to the specified value. If “Open Panel”, clicking will switch to the specified Interface Panel.

– **Display Type** - If “Text”, just the static text entered is shown. If “View” or “View/Entry” then the target value is shown in the control. If “Entry Only” or “View/Entry” then upon the user entering text, the target's value will be updated accordingly.

– **Required Access** - required security access level to use the control at runtime. (e.g. if set to “Management”, a notice will be displayed to the user that the operation requires Management access unless the current access is at or above Management access.)

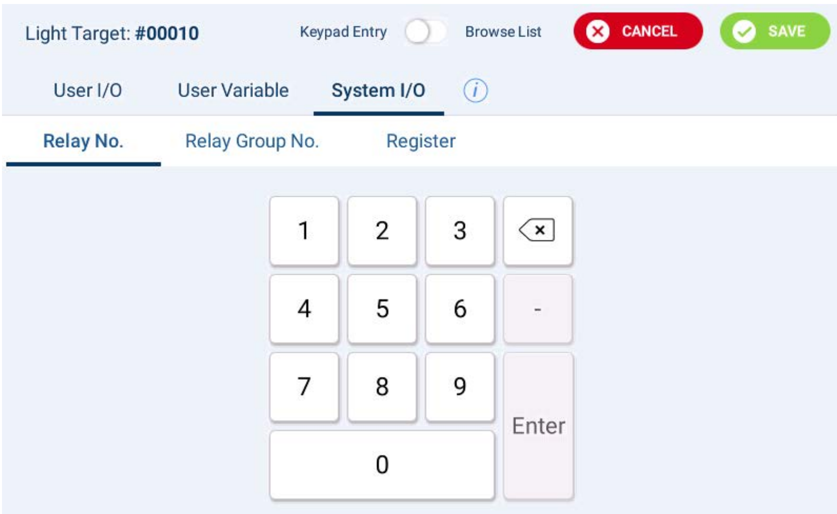
Target selection for Controls can be accomplished either by browsing Variable & I/O lists or by direct keypad entry. The bold text in the header will reflect the user's selection or entry.

Fig. 10-5: User Selection or Entry



Target assignment of System I/O is also available for traditional users. Refer to the available help file and Concurrent I/O manuals for more detail.

Fig. 10-6: Target Assignment Keypad

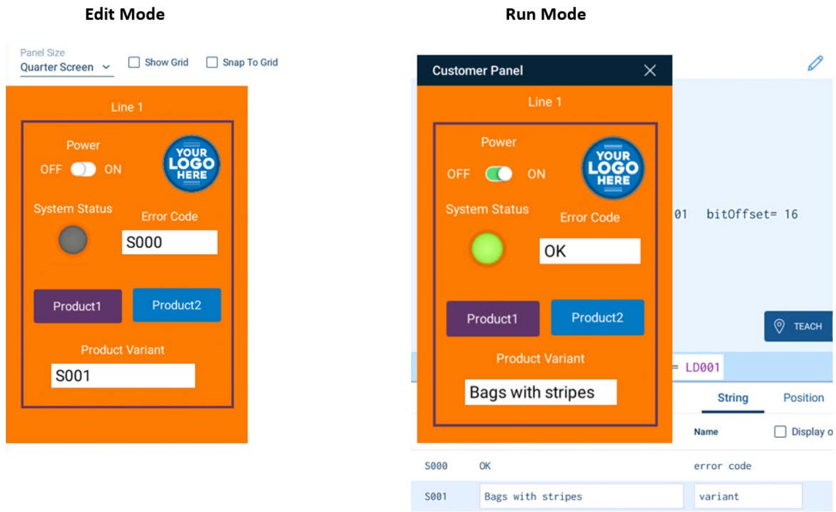


10.3 Interface Panel Operation

Panels can be launched on boot of Smart Pendant, from user-customizable shortcuts on the Main Menu, and from the Interface Panel List Screen.

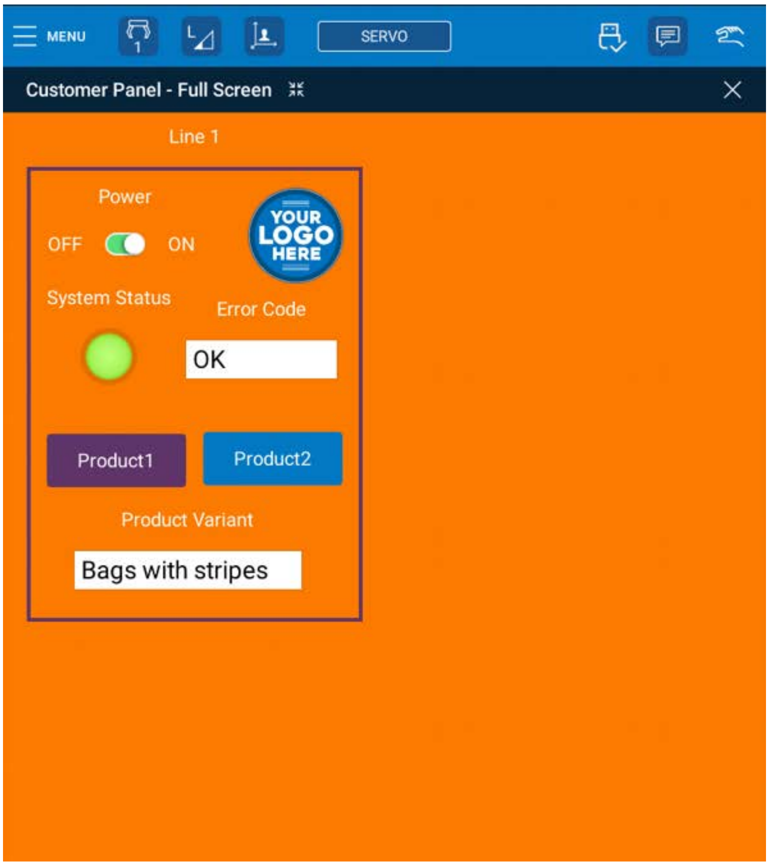
A 'running' panel will reflect the state of the Targets/Values assigned.

Fig. 10-7: Edit and Run Mode on Customer Panel



Running panels can be resized by dragging the lower right corner of the screen, or by pressing the resize button. An example full screen Interface Panel running after startup is shown below.

Fig. 10-8: Example of a Full Screen Interface Panel



11 Collaborative Operation

11.1 Direct Teach

11.1.1 Direct Teach Description

A manipulator equipped with Direct Teach (ex. MOTOMAN-HC10DT) supports automatic INFORM program generation with hand guiding. This is accomplished using the Direct Teach Hub on the tool flange of the manipulator. The Direct Teach Hub has three pairs of buttons, described below.

Table 11-1: Direct Teach Attachment Buttons

Button	Description
MOVE Button **OR** #1 Button	Press and hold this button to move the manipulator using hand guiding
TOOL UTILITY Button **OR** #2 Button	Use this button to activate the tool and automatically add commands to the job. The duration of the button pushes results in the following behavior: - **Short-push:** Change tool number and toggle Block - **Long-push**[1]**:** Teaches the current position and adds Block I/O commands
TEACH Button	Use this button to teach a position and automatically add a Motion command to the job. The duration of the button pushes results in the following behavior: - **Short-push:** Teaches the current position with no Position Level. - **Long-push**[1]**:** Teaches the current position with Position Level = 0. This means that the manipulator will stop at this position.

1 For a long-push, press and hold the button for more than 1 second.

Fig. 11-1: Direct Teach Hub

HC10DT **HC20DT**

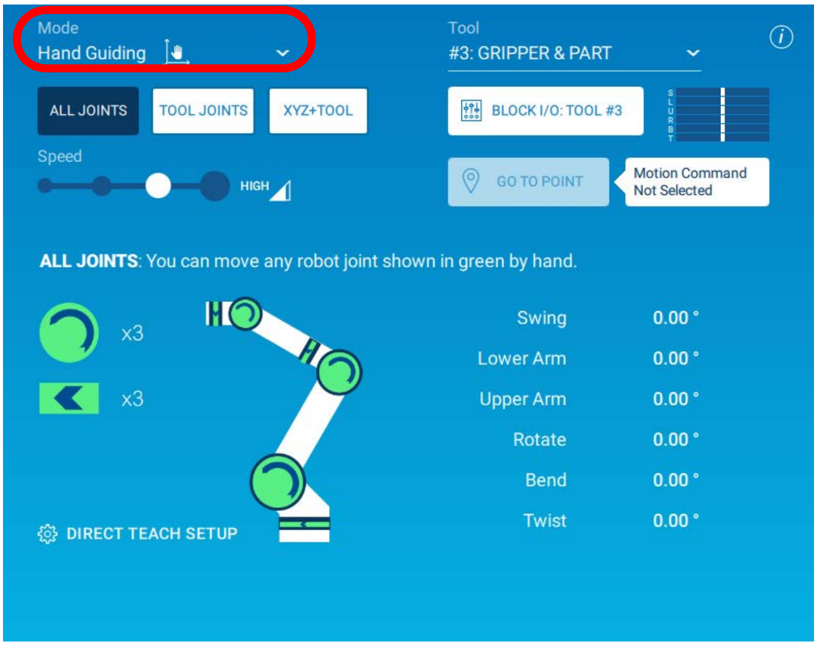
NOTE

Block I/O must be configured properly prior to use of the TOOL Button. Refer to *chapter 6.2 "I/O for Tool"* for more information.

11.1.2 Direct Teach Access and Setup Panel

To access Direct Teach, select Hand Guiding Mode on the Robot Jog panel.

Fig. 11-2: Hand Guiding Mode



11.1.2.1 Set Jog Mode

In the Hand Guiding Robot Jog panel, three sub-modes are provided:

- All JOINTS: User can move any Robot joint by hand
- TOOL JOINTS: User can move the outward-most 3 tool joints by hand
- XYZ+TOOL: The tool is free to move in XYZ. The tool joint can also rotate

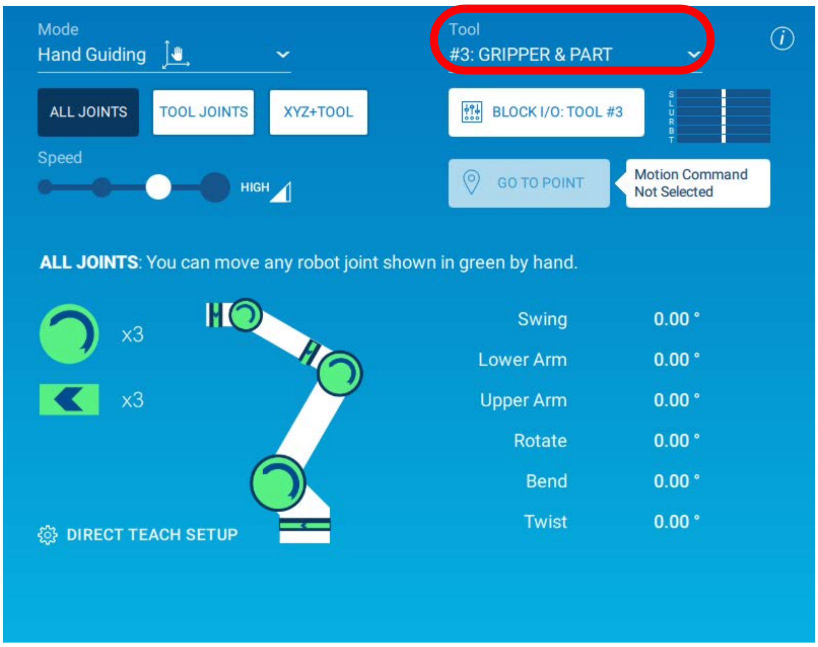
The Robot joints that can be moved in each respective mode will be displayed in green in the *fig. 11-2 “Hand Guiding Mode”*.

11.1.2.2 Select Motion Type

The motion type of a command taught by Direct Teach will follow the same pattern as a command taught using standard methods. Verify motion instruction type on the screen and change as necessary. Refer to *chapter 4.1.4.1 “Teaching Motion Instructions”* for more information on selecting the motion instruction type. Press [TEACH] on the Direct Teach Hub to teach the position.

11.1.2.3 Select Tool for Direct Teach

Change the tool to one of the entered number in the Robot Jog panel.



11.1.2.4 Enable Direct Teach

Press the Direct Teach Settings on the Hand Guiding Robot Jog panel. Once the settings are completed, the Direct Teach can be used. Refer to *chapter 11.1 "Direct Teach"* for the detail.

11.1.3 Direct Teach Settings

Open the Direct Teach Setup panel by tapping the link on the bottom-left of the Hand Guiding Robot Jog panel.

Fig. 11-3: Hand Guiding Screen

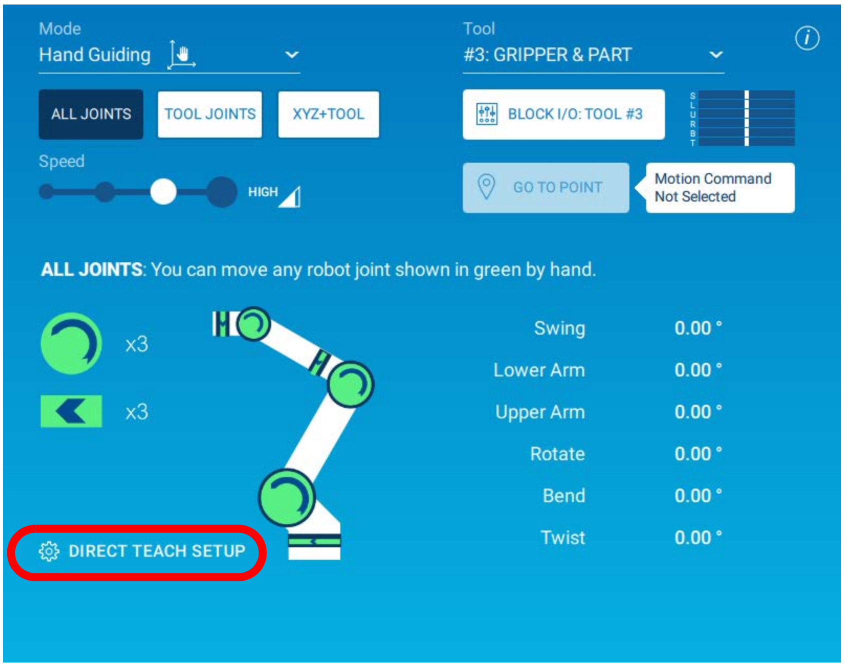
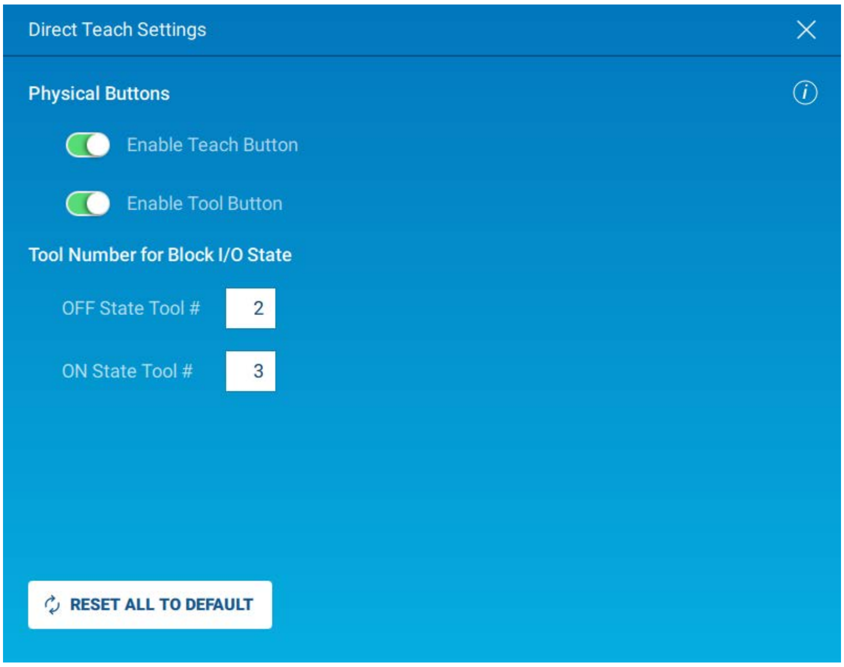


Fig. 11-4: Direct Teaching Setup Panel



11.1.3.1 Enable Teach Button and Enable Tool Button

If Direct Teach is only needed for hand guiding the manipulator, use the switch controls on the panel to disable teach and tool button operations.

11.1.3.2 Tool Number for Block I/O State

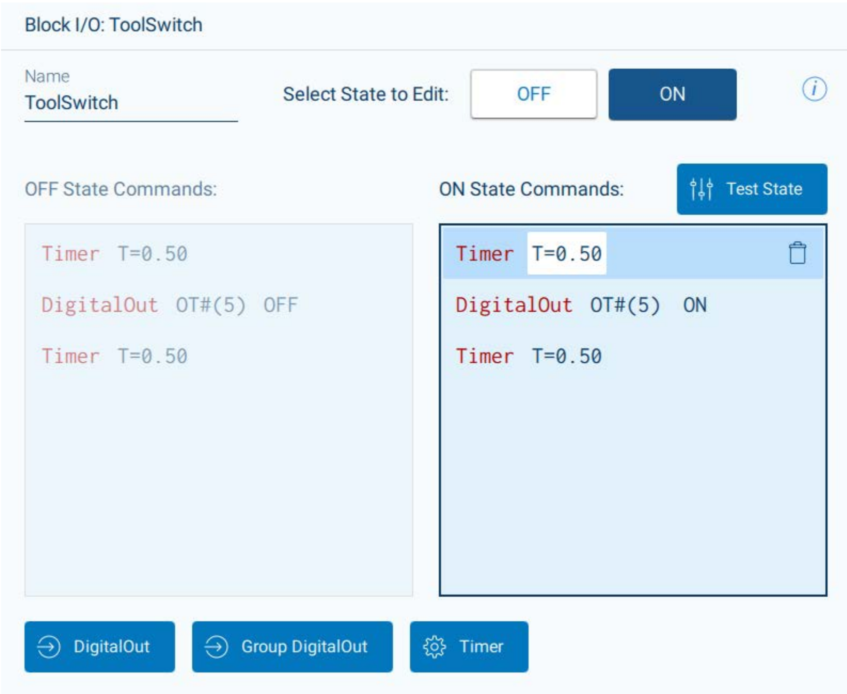
Use this option to specify which tool setting is used for each tool state (ON/OFF). For example, Tool 0 state should be used when specifying properties of a tool without a workpiece. Conversely, Tool 1 state should be used when specifying properties of a tool with a workpiece.

To Set Block I/O: Open the {Block I/O} screen under {I/O & Variables} in {MENU}

Create the program for both OFF and ON state, and this program will be operated and added to the program when Tool I/O button on the Direct Teach Hub is pushed (Button # 2 – long push)

Refer to *fig. 11-5 "Block I/O Screen"*, and *chapter 11.1.3 "Direct Teach Settings"*.

Fig. 11-5: Block I/O Screen



11.1.3.3 Example on Setting Direct Teach

Tool setting example is shown as following:

Tool	Description
Tool #0	Before pick of workpiece. Tool is OFF. Tool weight is set as weight of the tool.
Tool #1	After pick of workpiece. Tool is ON. Total weight is set as weight of the tool plus the weight of workpiece.

Further detail:

Set Tool number on Tool Setting screen. Refer to *chapter 6.1 "Tool Settings"*.

Create Block I/O on Block I/O screen. Refer to *chapter 6.2 "I/O for Tool"*.

Link Block I/O to Tool #0 and #1 on Tool screen.

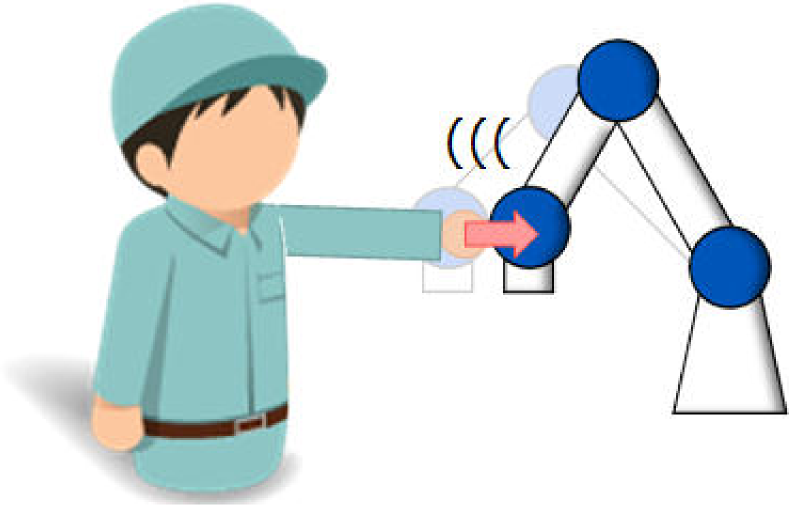
11.1.4 Direct Teach Example

The following INFORM program is an example of how to teach "pick and place" motion using Direct Teach.

Line	Tool	Instructions	Comment	Tasks
1	[0]	JointMove Speed=10.00%	Start position	Short-push Teach Button
2	[0]	JointMove Speed=10.00%	Approach position for pick	Short-push Teach Button
3	[0]	LinearMove Speed=50.0mm/s PositionLevel=0	Pick position	Long-push Teach Button
4	[1]	LinearMove Speed=50.0mm/s	Special Line for changing Tool number. (Same position as previous line)	Short-push Tool Utility Button Long-push Tool Utility Button
5		Toggle Tool #0 to #1	Toggle tool I/O	
6	[1]	LinearMove Speed=50.0mm/s		Short-push Teach Button
7	[1]	LinearMove Speed=50.0mm/s	Approach position for placing	Short-push Teach Button
8	[1]	LinearMove Speed=50.0mm/s PositionLevel=0	Place position	Long-push Teach Button
9	[0]	LinearMove Speed=50.0mm/s	Special Line for changing Tool number. (Same position as previous line)	Short-push Tool Utility Button Long-push Tool Utility Button
10		Toggle Tool #1 to #0	Toggle tool I/O	
11	[0]	LinearMove Speed=50.0mm/s		Short-push Teach Button
12	[0]	JointMove Speed=10.00%	Move back to start position	Short-push Teach Button

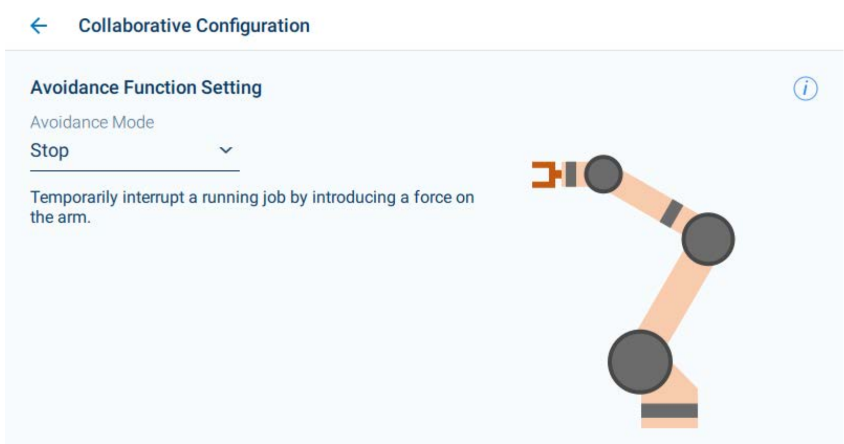
11.2 Avoidance Function

This feature is used to suspend a running job and initiate an avoidance motion relative to an external force. Once the external force is removed, the robot automatically returns to the location where the interrupt occurred to resume the suspended job.



11.2.1 Avoidance Function Settings

To show the setting screen of avoidance function, select {MENU} → {Safety Function} → {Collaborative}.



11.2.1.1 Avoidance Mode

Three modes are available to control the robot's behavior when an external force is applied.

Avoidance Mode	Detail
Stop Mode	Stops in place and does not move.
Joint Mode	Moves relative to externally applied torques on each axis.
Translation Mode	Moves relative to an external applied force on the robot's TCP, maintaining tool posture.

11.2.2 Enable Avoidance

Avoidance is enabled in INFORM by placing commands between “EnableAvoidance” and “DisableAvoidance” commands, as shown in the example:

```
      Start Job
[ 0]  JointMove  Speed= 5.00 (%)
      EnableAvoidance
[ 0]  JointMove  Speed= 5.00 (%)
[ 0]  JointMove  Speed= 5.00 (%)
      Timer  Time= 5.00 (seconds)
[ 0]  JointMove  Speed= 5.00 (%)
      DisableAvoidance
[ 0]  JointMove  Speed= 5.00 (%)
```

Avoidance Function is enabled in this block.

While enable avoidance, if estimated external force is higher than threshold of the specified mode, robot will start avoidance function.

> NOTE
>
> IMOV command cannot be used in the block avoidance.

To use the Avoidance Function, collaborative operation (PFL) must be enabled. The Avoidance block shown above will be ignored during playback if PFL is disabled.

Avoidance will only be successful in the range below active External Force (PFL) Monitors. If an externally applied force exceeds an active PFL Monitor setting, a Protective Stop of the robot will occur that requires a user reset. Avoidance is intended to operate in areas where PFL Monitor thresholds are high.

11.2.3 Execution Details

Avoidance function uses YRC1000/YRC1000micro's interrupt job function. EnabledAvoidance and DisableAvoidance command are respectively same as EI LEVEL=1 and DI LEVEL=1.

The Avoidance function uses an Interrupt Job (“SYS_INT_AVOID_R1”) to initiate behavior (Stop/Joint/Translation) defined by the user on the “Collaborative” screen.

> **WARNING**
>
> Users should not edit “SYS_INT_AVOID_R1” or the Interrupt Job function settings.

11.2.4 Advanced Settings

External force that starts the avoidance function and speed of avoidance function can be changed.

For details on advance settings of avoidance function, refer to the “YRC1000/YRC1000micro Collaborative Operation Instructions (HW1484764) chapter 3.5 Configuring the Avoidance Function.”

Classic Interface is required to set advanced avoidance function settings (refer to *chapter 13 “Classic Interface”*).

12 Safety Function

The following are safety functions of the YRC Controllers:

- Emergency Stop switch input (Robot Controller/Smart Pendant)
- Enable switch input (Smart Pendant)
- Safeguarding interlock signal input (safety plug)
- External Emergency Stop switch input
- Servo power enable input
- Overrun input (manipulator/external axis)
- General-purpose safety input (including external enable switch input)
- Safety Logic Circuit

These safety functions conform to the following safety standards:

- EN ISO 13849-1: 2015 Cat.3/PLe
- EN 62061 (IEC 61508) SIL CL3

Also, by using Functional Safety Function (Optional), the position and speed of the Robot as well as the posture of its tool can be monitored.

Functional Safety Function conform to the following safety standards.

- EN ISO 13849-1: 2015 Cat.3/PLd
- EN 62061 (IEC 61508) SIL CL2

12.1 System Structure

The functional safety function and collaborative operation function are performed by using the safety circuit board and PFL circuit board.

12.1.1 Safety Circuit Board (JANCD-ASF01-E)

For details on the safety circuit board, refer to “YRC1000 INSTRUCTIONS (RE-CTO-A221) chapter 14.6.1 Safety Circuit Board (JANCD-ASF01-E)”.

12.1.2 PFL Circuit Board (JANCD-ASF04-E)

For details on the PFL circuit board, refer to “YRC1000 SUPPLEMENTARY INSTRUCTIONS FOR HC10/HC10DT (HW1484756) chapter 4.1 PFL Board (JANCD-ASF04-E)”.

12.1.3 Expansion Safety I/O Board (JANCD-ASF02-E)

For details on the Expansion Safety I/O Board, refer to:

– “YRC1000 OPTIONS INSTRUCTIONS FOR FUNCTIONAL SAFETY FUNCTION (HW1483576) chapter 2.1.2 Expansion Safety I/O Board (JANCD-ASF02-E)”

– “YRC1000micro OPTIONS INSTRUCTIONS FOR FUNCTIONAL SAFETY FUNCTION (HW1484544) chapter 2.1 Outline”

– “YRC1000micro SUPPLEMENTARY INSTRUCTIONS FOR HC10/ HC10DT (HW1485285) chapter 4.2 Expansion Safety I/O Board”

12.1.4 Expansion Safety Terminal Block Board

For details on the Expansion Safety Terminal Block Board, refer to “YRC1000 OPTIONS INSTRUCTIONS FOR FUNCTIONAL SAFETY FUNCTION (HW1483576) chapter 2.1.3 Expansion Safety Terminal Block Board”.

12.2 Common Operation

12.2.1 Security Level

To use the PFL function, change the YRC Controller security access level to Safety level. Refer to chapter 1.17 “Security Level Setting” regarding how to change the security mode.

12.2.2 Readback Operation

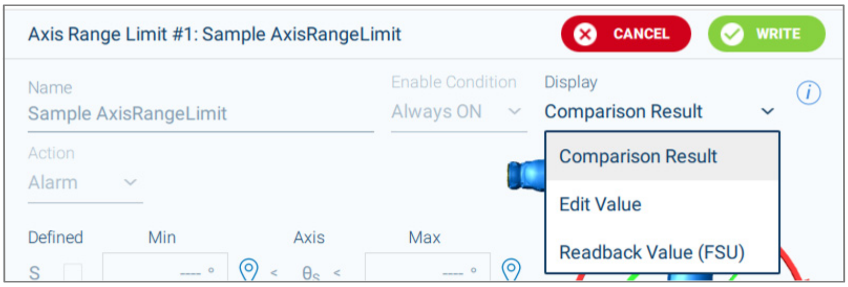
The data related to the safety function is copied to the safety circuit board’s memory or PFL circuit board’s memory for safety.
Readback is the operation to confirm whether the data saved in the safety circuit board or PFL circuit board is correct.

If the data for safety settings or tool settings changed, readback operation is required.

1. Edit the data related to the safety function.
   – {READBACK} and {CANCEL} appear on the screen.

{READBACK} :	Transmits the edited data to the safety circuit board.
{CANCEL} :	Deletes the edited data and returns to the previous settings.

2. Press {READBACK} to set the data.
   – The data transmits to the safety circuit board.
   – The readback data from the safety circuit board appears.
   – {WRITE} and {CANCEL} appear on the screen.



{WRITE} :	Stores the settings of the edited data in the safety circuit board.
{CANCEL} :	Deletes the edited data and returns to the previous settings.

3. Compare the readback result.

If the readback result matches the edited data, it is successfully transferred. But if the readback result does not matches the edited data, the comparison result is shown as "***". If so, the edited data or readback data can be seen by selecting {Edit Value} or {Readback Value} in {Display} option.

If comparison result does not match the edited data, the setting cannot be entered and saved.

4. Press {WRITE} to update the settings of the safety circuit board.
   – {CONFIRM} appears on the screen if the setting requires confirmation.
5. Press {CONFIRM} to enable the safety function after confirmation.

12.2.3 Tool Configuration

Specific safety functions read and use tool settings. The following table lists the safety functions and indicates which functions require tool settings before using the safety functions.

Table 12-1: Tool Configuration for Safety Functions

Safety Functions	Tool Settings Requirement
Robot Range Limit	O
Axis Range Limit	X
Speed Limit	O
Axis Speed Monitor	X
Tool Angle Monitor	O
Tool Change Monitor	X
Tool Number Select	O
External Force Monitor	O

O: tool setting required, X: tool setting not required

The tool setting must be properly specified for the precise monitoring of the safety function. To perform the tool setting properly refer to chapter 6.1 "Tool Settings".

12.2.4 Tool Interference Configuration

Specific safety functions read and use tool interference. The following table lists the safety functions and indicates which functions require tool interference before using the safety functions.

Table 12-2: Tool Interference Configuration for Safety Functions

Safety Functions	Tool Interference Requirement
Robot Range Limit	O
Axis Range Limit	X
Speed Limit	X
Axis Speed Monitor	X
Tool Angle Monitor	X
Tool Change Monitor	O
Tool Number Select	X
External Force Monitor	X

O: tool interference setting required,
X: tool interference setting not required

The tool interference setting must be properly specified for the precise monitoring of the safety function. To perform the tool interference setting, see chapter 6.1.7 “Tool Interference Model Settings”.

12.3 Safety Logic Circuit

12.3.1 Introduction

The safety logic circuit is a feature used for programming the basic safety logic of the system using a simple ladder logic programming interface. It enables to set up the logical operations, such as stopping the manipulator and outputting the servo ON signal.

The followings are the contents of this function:

- Executes the safety logic circuit by the safety circuit board in compliance with safety certification.
- The safety logic circuit consists of a “System” section and a “User” section.
- The System section of the safety logic circuit is the specific circuit of YASKAWA and cannot be edited. The User section allows users to add/edit their own safety logic.
- Both the System and User sections of the safety logic circuit consist of a circuit with two inputs and one output or a circuit with one input and one output.
- Both the System and User sections of the safety logic circuit consist of 128 lines.
- Both the System and User sections of the safety logic circuit are executed on a 2ms cycle.
- Both the System and User sections of the safety logic circuit can be viewed in all security modes; however, the user section can be edited only when the security mode is “SAFETY MODE”, and the system is in MANUAL (TEACH) mode with the servo power turned OFF.
- Conventionally, some functions were performed only by using hard-wired signals. With the YRC Controller, by using an optional safety PLC and an optional safety logic circuit, these functions can be controlled from the safety PLC. This enables less wiring. Meanwhile, the signals which have been controlled by hardware are always monitored. Thus, the safety function, which turns OFF the servo power supply when the error is detected, is maintained.

  The YRC Controller with an optional Safety PLC and optional Safety Logic Circuit can be controlled with the Ethernet Cable wiring. This is an improvement over previous conventional systems that required hard wired solutions.

  The signals that are controlled by hardware are always monitored so the safety function that turns OFF the servo power supply when errors are detected is maintained.

Fig. 12-1: Safety PLC Configuration with YRC1000 Controller Example:

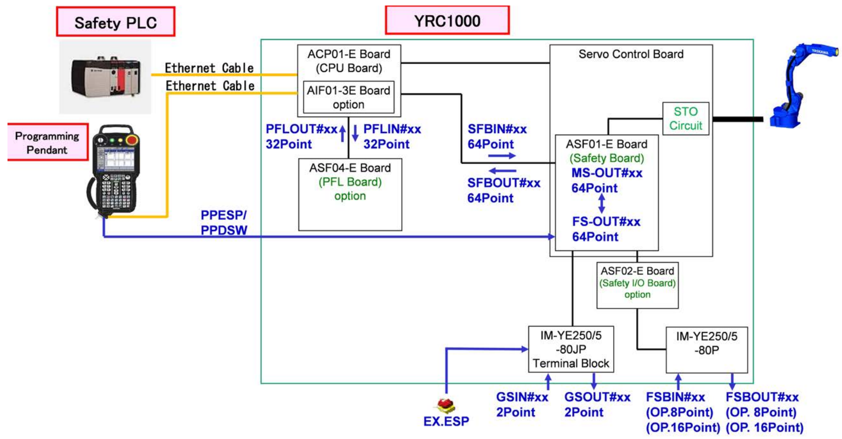
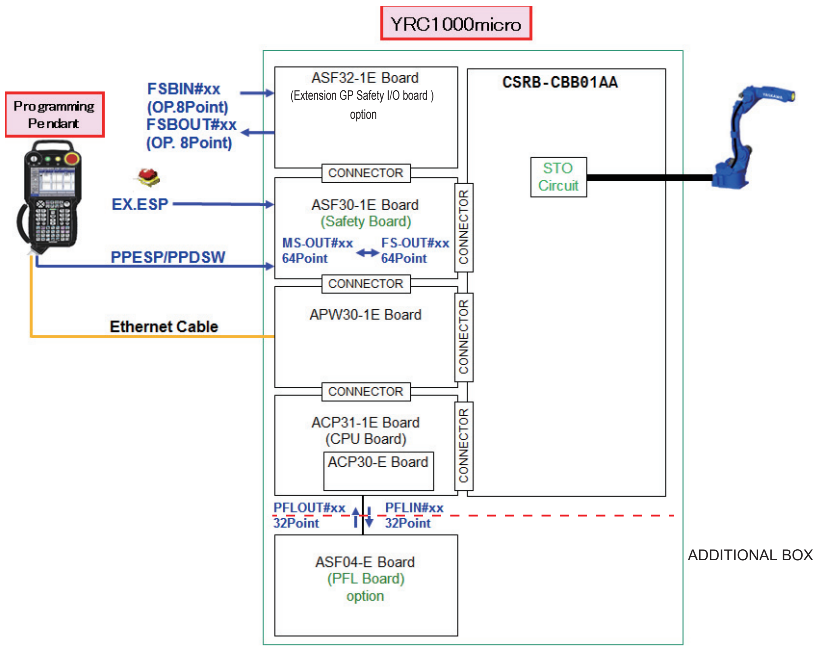


Fig. 12-2: Safety PLC Configuration with YRC1000micro Controller Example:



NOTE

In YRC1000, for the connection of the General Purpose Safety I/O board (Option), either the board of JANCD-ASF02-E (8 points available) or JANCD-ASU03-E(16 points available) can be connected to each safety circuit board (JANCD-ASF01-E).

JANCD-ASF02-E: For both input and output, 8 points of GP safety I/O signal can be used.

JANCD-ASU03-E: For both input and output, 16 points of GP safety I/O signal can be used.

In YRC1000micro, for the connection of the Extension GP Safety I/O board (optional), the board of JANCD-ASF32-1E (8 points available) can be connected to each safety circuit board (JANCD-ASF30-1E).

12.3.2 Available I/O Signals in Safety Logic Circuit

The following tables describe the input and output signals available in the safety logic circuit.

Table 12-3: Input Signals

No.	Kind	Display	Contents	Note
1	Physical Discrete Safety I/O	#n GSIN[x]	General Purpose safety input signal 2 points ● : OFF [release]/ ○ : ON [short circuit]	This signal is shown only in YRC1000
2		#n GSOUT[x]	General Purpose output signal 2 points ● : ON output/ ○ : OFF output	
3		#n FSBIN[x]	General Purpose safety input signal (8 or 16 points) ● : OFF [release]/ ○ : ON [short circuit]	This signal is shown when the optional GP safety I/O board is connected.
4		#n FSBOUT[x]	General Purpose safety output signal (8 or 16 points) ● : ON status/ ○ : OFF status	
5	Fieldbus Safety I/O	SFBIN[x]	Safety field bus input signal 64 points ● : ON status/ ○ : OFF status	This signal is shown when the optional safety fieldbus function is enabled.
6		SFBOUT[x]	Safety field bus output signal 64 points ● : ON status/ ○ : OFF status	
7	Virtual Discrete Safety I/O	MSOUT[x]	Machine safety output used in the safety logic circuit (64 points) ● : ON status/ ○ : OFF status	This signal is shown when the functional safety function (option) is enabled.
8		FSOUT[x]	Functional safety output used in the safety logic circuit 64 points ● : ON status/ ○ : OFF status	
9		#n PFLIN[x]	Output signal to PFL board (ASF04-E) 32 points ● : ON status/ ○ : OFF status	This signal is shown when the optional PFL board (ASF04-E) is connected.
10		#n PFLOUT[x]	Input signal from PFL board (ASF04-E) 32 points ● : ON status/ ○ : OFF status	
11		R[x]	Work area 128 points (auxiliary relay) ● : ON status/ ○ : OFF status	

No.	Kind	Display	Contents	Note
12	Other I/O Signals	SPIN[x]	Specific input signal 32 points ● : ON status/ ○ : OFF status	
13		#n ONEN[x]	Servo power supply individual control input signal 4 points ●: Individual servo OFF status/ ○ : Normal status	This signal is shown only on YRC1000
14		#n S-ONEN[x]	Servo power supply individual control input signal in the safety logic circuit 4 points ● : Individual control group servo OFF status/ ○ : Servo ON status/ servo ON enabled status	
15		#n SFRON[x]	Servo ON/OFF signal 4 points ● : Servo ON/ ○ : Servo OFF	
16		PPESP	Pendant Emergency Stop signal ● : Under Emergency Stop [release]/ ○ : Not under Emergency Stop [short circuit])	
17		PBESP	YRC Controller Emergency Stop signal ● : Under Emergency Stop [release]/ ○ : Not under Emergency Stop [short circuit]	This signal is shown only on YRC1000
18		EXESP	External Emergency Stop input signal ● : Under Emergency Stop [release]/ ○ : Not under Emergency Stop [short circuit]	
19		PPDSW	Pendant enable switch signal ● : Released [release]/ ○ : Grip [short circuit]	
20		MANUAL (TEACH)	MANUAL(TEACH) mode ● : MANUAL (TEACH) mode/ ○ : Not MANUAL (TEACH) mode	
21		AUTOMATIC (PLAY)	AUTOMATIC (PLAY) mode ●: AUTOMATIC (PLAY) mode/ ○ : Not AUTOMATIC (PLAY) mode	

No.	Kind	Display	Contents	Note
22	Other I/O Signals Cont.	REMOTE	REMOTE mode ● : REMOTE mode/ ○ : Not remote mode	
23		Hold	Hold ● : OFF (Hold signal is not input.)/ ○ : ON (Hold signal is being input.)	
24		PROFISafe	PROFISafe communication status ● : Communication OK/ ○ : Error communication	Appears only when the optional PROFISafe is enabled.
25		SVON	Servo ON/OFF status ● : Servo ON/ ○ : Servo OFF	
26		SVONRDY0	Servo ON ready ● : Servo ON available status/ ○ : Servo OFF	
27		SAFF	Safety fence signal ● : Open/ ○ : Close	
28		S-EXESP	External Emergency Stop signal in the safety logic circuit ● : Release/ ○ : Press (Emergency Stop status)	
29		S-EXDSW	External enable switch signal in the safety logic circuit ● : ON (servo ON enabled)/ ○ : OFF (servo OFF status)	
30		S-SVON_EN	Servo ON enable signal in the safety logic circuit ● : Servo ON enabled status/ ○ : Servo OFF	This signal is shown only when the enable switch link function is enabled. For details, refer to “YRC1000 INSTRUCTIONS (RE-CTO-A221) chapter 8.26.13 “Enable Switch Link Function ”.
31		S-SAFF	Safety fence signal in the safety logic circuit ● : Close/ ○ : Open (servo OFF status)	
32		S-FST	Full speed mode in the safety logic circuit ● : Full speed mode/ ○ : Safety speed	Refer to chapter 12.3.6.3 “Full Speed Mode”

No.	Kind	Display	Contents	Note
33	Other I/O Signals Cont.	CSCFG1	Safety data monitoring Monitoring result of the safety-related parameter files ● : Normal monitoring (Parameter is not changed.) ○ : Abnormal monitoring (Parameter is changed.) Compare the stored CRC for the safety-related parameter and the current CRC for the safety-related parameter, and show whether there is any change in the data.	This signal is shown only in YRC1000
34		CSCFG2	Safety data monitoring Monitoring result of the Safety Logic Circuit ● : Normal monitoring (Safety Logic Circuit is not changed.) ○ : Abnormal monitoring (Safety Logic Circuit is changed.) Compare the stored CRC for the machine safety data file and the current CRC for the machine safety data file, and show whether there is any change in the data.	This signal is shown only in YRC1000

No.	Kind	Display	Contents	Note
35	Other I/O Signals Cont.	CSCFG3	Safety data monitoring Monitoring result of the functional safety setting files ● : Normal monitoring (Data file is not changed.) ○ : Abnormal monitoring (Data file is changed.) Compare the stored CRC for the functional safety data file and the current CRC for the functional safety data file, and show whether there is any change in the data. When the functional safety function is disabled, it is always “ON” (Normal monitoring).	This signal is shown only in YRC1000
36		CSCFG4	Safety data monitoring Monitoring result of all safety related files ● : Normal monitoring (Parameter and the data file not changed.) ○ : Abnormal monitoring (Either of the parameter or the data file changed.) Compare the stored CRCs for the safety-related parameter and the data files of the machine safety and the functional safety and the current CRCs for the parameter and the data file. Show whether there is any change in the data. (Equivalent to AND of CSCFG01, CSCFG02, and CSCFG03)	This signal is shown only in YRC1000

n: The number of safety circuit boards (Maximum 8)

Table 12-4: Output Signals

No.	Kind	Display	Contents	Note
1	Discrete Safety I/O	#n GSOUT[x]	General Purpose output signal 2 points ● : ON output/ ○ : OFF output	This signal is shown only in YRC1000
2		#n FSBOUT[x]	General Purpose safety output signal (8 or 16 points) ● : ON status/ ○ : OFF status	This signal is shown when the optional GP safety I/O board is connected.
3		#n S-GSEDM[x]	General Purpose Safety Output Monitoring Signal 2 points	This signal is shown only in YRC1000
4		#n S-XEDM[x]	General Purpose Safety Output Monitoring Signal (8 or 16 points)	This signal is shown when the optional GP safety I/O board is connected.
5	Fieldbus Safety I/O	SFBOUT[x]	Safety field bus output signal 64 points ● : ON status/ ○ : OFF status	This signal is shown when the optional safety fieldbus function is enabled.
6	Safety Logic Signal	MSOUT[x]	Machine safety output used in the safety logic circuit (64 points) ● : ON status/ ○ : OFF status	This signal is shown when the functional safety function (option) is enabled.
7		#n PFLIN[x]	Output signal to PFL board (ASF04-E) 32 points ● : ON status/ ○ : OFF status	This signal is shown when the functional safety function (option) is enabled.
8		R[x]	Work area 128 points (auxiliary relay) ● : ON status/ ○ : OFF status)	
9	Other Signals	#n S-ONEN[x]	Servo power supply individual control input signal in the safety logic circuit 4 points ● : Individual control group servo OFF status/ ○ : Servo ON status/ servo ON enabled status	
10		SVOFF CAT0	Turns OFF the servo power supply to the Robot. (Category0 stopped) ● : Robot stop request/ ○ : Not Robot stop request	
11		SVOFF CAT1	Turns OFF the servo power supply to the Robot. (Category1 stopped) ● : Robot stop request/ ○ : Not Robot stop request	

No.	Kind	Display	Contents	Note
12	Other Signals Cont.	S-EXESP	External Emergency Stop signal in the safety logic circuit ● : Release/ ○ : Press (Emergency Stop status)	
13		S-EXDSW	External enable switch signal in the safety logic circuit ● : ON (servo ON enabled)/ ○ : OFF (servo OFF status)	
14		S-SVON_EN	Servo ON enable signal in the safety logic circuit ● : Servo ON enabled status/ ○ : Servo OFF)	This signal is shown only when the enable switch link function is enabled. For details, refer to “YRC1000 INSTRUCTIONS (RE-CTO-A221) chapter 8.26.13 “Enable Switch Link Function”.
15		S-SAFF	Safety fence signal in the safety logic circuit ● : Close/ ○ : Open (servo OFF status)	
16		S-FST	Full speed mode in the safety logic circuit ● : Full speed mode/ ○ : Safety speed	Refer to chapter 12.3.6.3 “Full Speed Mode”
17		SICFGTRG	Safety data monitoring Reset trigger for Monitoring result (CSCFG) When this signal falls (ON to OFF), each CRC of the safety related parameter, the machine safety data file, and the functional safety data file is stored. The safety data can be monitored by using the stored CRC. (For the monitoring result, refer to CSCFG01, CSCFG02, CSCFG03, CSCFG04.)	This signal is shown only in YRC1000

n: The number of safety circuit board (Maximum 8)

NOTE

When using the GSOUT signal and the FSBOUT signal, output signal for 20 ms or longer to execute the confirmation of the machine safety internal diagnosis function and the verification of wiring.

The confirmation of the machine safety internal diagnosis function and the verification of wiring is always executed. Confirm the ON time signal is 20 ms or longer prior to performing the automatic operation. When the ON time is less than 20 ms, the following alarms may be detected wrongly.

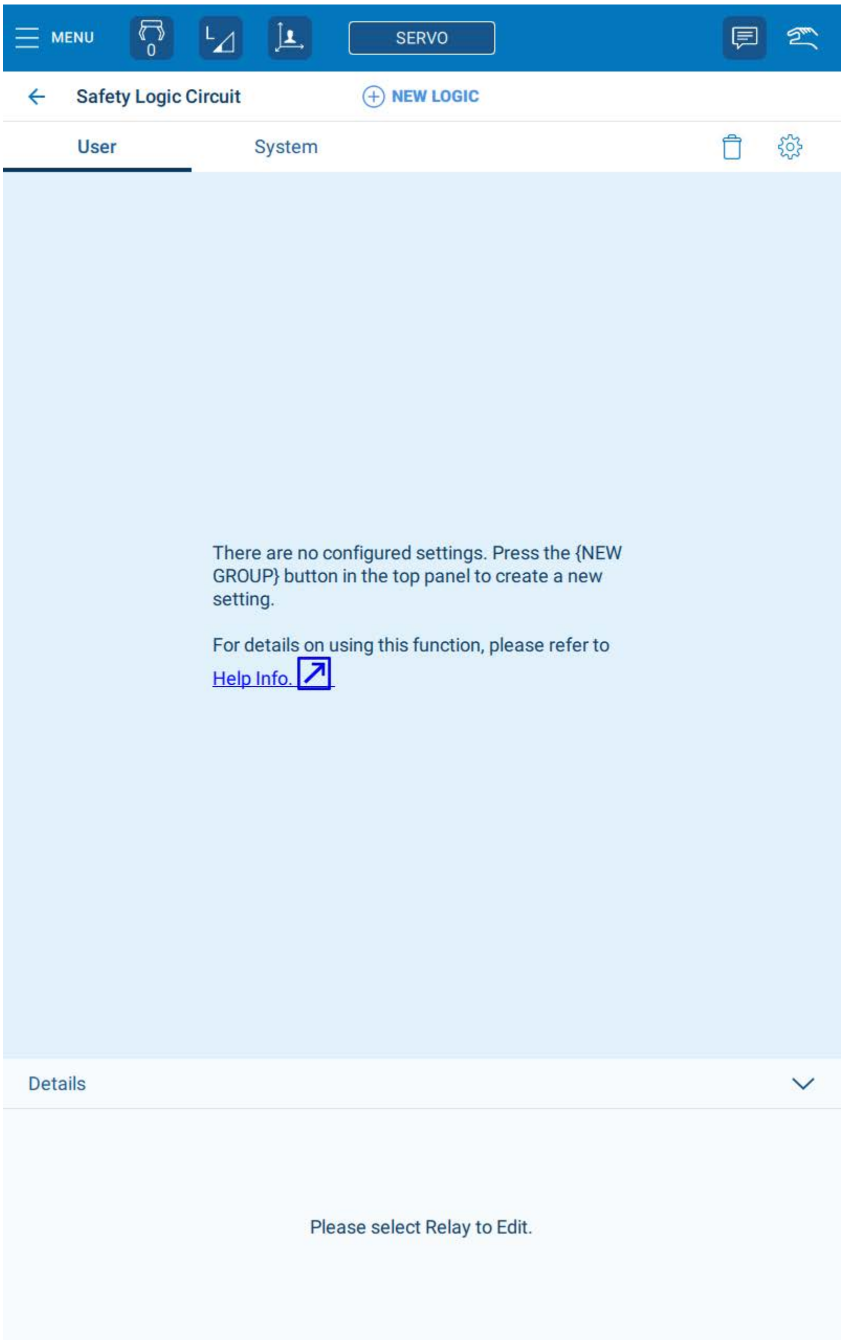
- Alarm 4771 M-SAF GENERAL OUTPUT DIAG. ERROR
- Alarm 4767 M-SAF GENERAL OUT FB DIAG. ERROR
- Alarm 4926 M-SAF GENERAL OUTPUT UNMATCH
- Alarm 4772 M-SAF GENERAL OUTPUT DIAG. ERROR2
- Alarm 4768 M-SAF GENERAL OUTPUT FB DIAG. ERROR2
- Alarm 4927 M-SAF GENERAL OUTPUT UNMATCH2

12.3.3 Operation of Safety Logic Circuit

12.3.3.1 Display the Screen

Select {MENU} ⟶ {Safety Functions} ⟶ {Safety Logic Circuit}.

– Safety Logic Circuit Screen is shown.



12.3.3.2 Selecting System and User Circuits

By pressing Tab shown on the pendant and selecting the “User” or “System”, the display can be switched between user and system safety logic circuit.

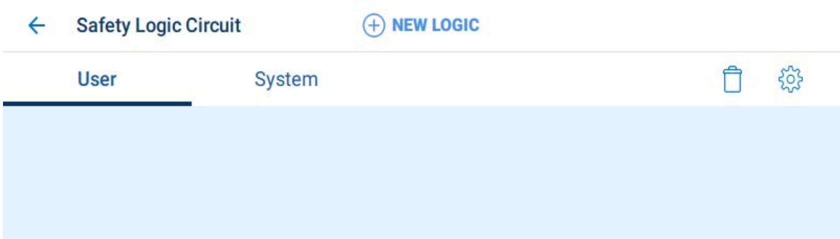
SYSTEM: The system section of the safety logic circuit is shown.

USER: The user section of the safety logic circuit is shown.

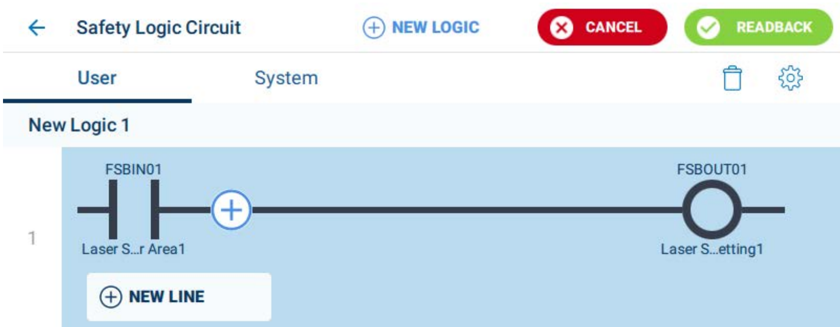
> SUPPLE-MENT
>
> In certain cases, system section of the safety logic circuit may not be defined at factory setting.

12.3.3.3 Create New Safety Logic Circuit

To create new safety logic circuit, press {NEW LOGIC}.



A new line is created with one input relay and one output relay as shown below.



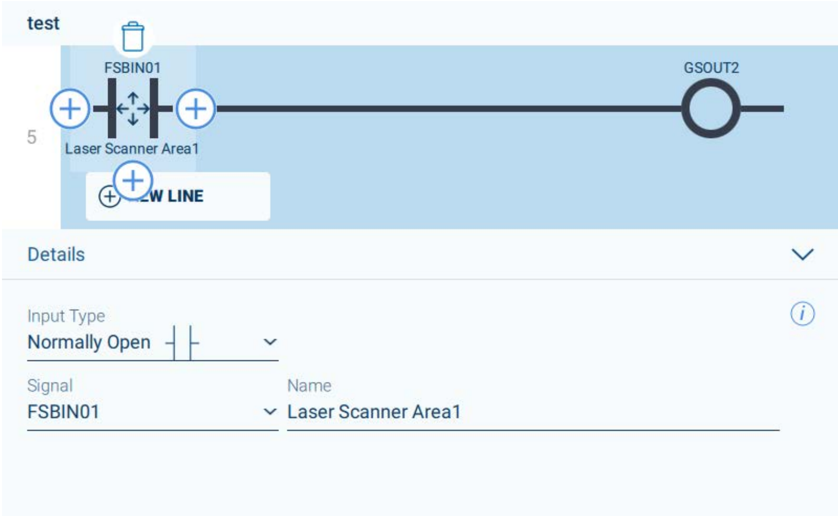
Each line can have one or more input relays. Each line can have only one output relay, and the same output signal cannot be set on multiple lines.

When the Safety Logic Circuit has been edited, the {Readback} shows on top of the screen.

12.3.3.4 Edit Input Relays

Press the input relay to edit.

– Detail of the input relay will be shown on the detail panel.



① If {Input Type} is pressed, the type of the input relay can be changed. To select “Detect OFF⟶ON” or “Detect ON⟶OFF”, the number of Input relay should be 2 or less.

② If {Signal} is pressed, the input signal can be changed. Refer to chapter 12.3.2 for list of available signals and their meanings.

③ If {Name} is pressed, the name of the signal can be edited. The name of the signal is also shown in the line of the Safety Logic Circuit. The name of the signal also can be edited in the Signal Setting screen. The name of signals which is not shown in the Signal Setting screen cannot be edited.

Input type can be selected from table 12-5.

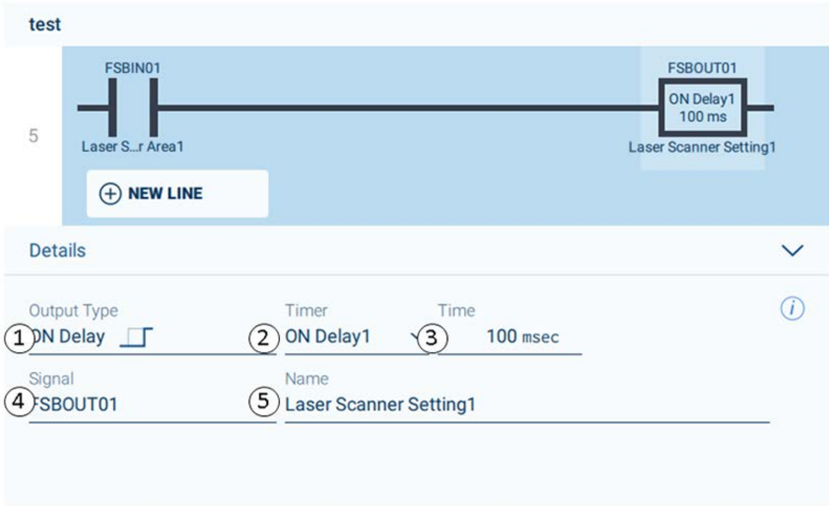
Table 12-5: Input Types

No.	Display	Contents
1		Normally Open contact. If the signal is TRUE (ON), then this expression is CLOSED (ACTIVE).
2		Normally Closed contact. If the signal is TRUE (ON), then this expression is OPEN (INACTIVE).
3		Detect OFF → ON Detect a rising edge of signal. If the signal changes from FALSE (OFF) to TRUE (ON) then this expression is CLOSED (ACTIVE) for only ONE cycle of the Safety Logic Circuit. Output to far right of this signal must be a PULSE output type.
4		Detect ON → OFF Detect a falling edge of signal. If the signal changes from TRUE (ON) to FALSE (OFF) then this expression is CLOSED (ACTIVE) for only ONE cycle of the Safety Logic Circuit. Output to far right of this signal must be PULSE output type.

12.3.3.5 Edit Output Relays

Press output relay to edit.

– Detail of the output relay will be shown on the detail panel.



① If {Output Type} is pressed, the type of the output relay can be changed. To select “Pulse”, the number of Input relay should be two or less.

② Timer number for the output relay can be changed. This item will be shown when the output type is “Pulse”, “ON Delay”, or “OFF Delay”. The same timer number cannot be used on multiple lines.

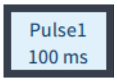
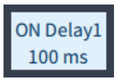
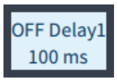
③ Specifies the timer value. Timer value should be multiple of 4. If the input value is not multiple of 4, the value will be changed to multiple of 4. This value can be changed in Timer Setting screen.

④ If {Signal} is pressed, the input signal can be changed. The same output signal cannot be set to the multiple line. Refer to chapter 12.3.2 for list of available signals and their meanings.

⑤ If {Name} is pressed, the name of the signal can be edited. The name of the signal is also shown in the line of the Safety Logic Circuit. The name of the signal also can be edited in the Signal Setting screen. The name of signals which is not shown in the Signal Setting screen cannot be edited.

> **NOTE**
>
> To use “Detect OFF⟶ON” or “Detect ON⟶OFF” for Input relay, Output relay should be “Pulse”. Also, to use “Pulse” for Output relay, one of the input relay should be “Detect OFF⟶ON” or “Detect ON⟶OFF”.
>
> Number of Input relay should be two or less.

Table 12-6: Output Types

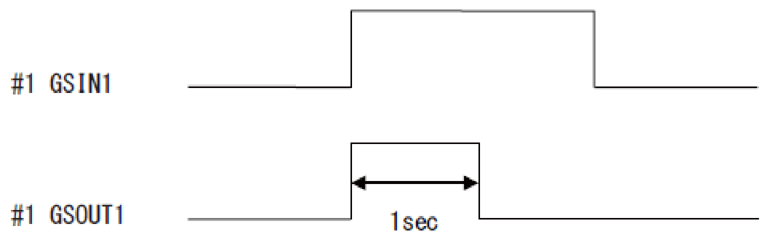
No.	Display	Contents
1		Output signal. When there is a path of CLOSED (ACTIVE) signals connecting the left side to this output then this expression is CLOSED (ACTIVE).
2		Pulse Output signal with a single pulse. When there is a path of CLOSED (ACTIVE) signals connecting the left side to this output then this expression is CLOSED (ACTIVE) for the specified time. This output should be used only when the input signals are DETECT OFF→ON or DETECT ON→OFF. Only 8 Pulse outputs may be used.
3		ON Delay Turn ON signal after specified delay. When there is a path of CLOSED (ACTIVE) signals connecting the left side to this output, this expression will be CLOSED (ACTIVE) after the specified delay amount. Only 4 ON DELAY outputs may be used.
4		OFF Delay Turn OFF signal after specified delay. When there is a path of CLOSED (ACTIVE) signals connecting the left side to this output, this expression will be CLOSED (ACTIVE) but when the input path is OPEN (INACTIVE) the signal wait for a specified delay amount before turning OFF. Only 4 ON DELAY outputs may be used.

■ **Pulse**

Output signal with Pulse.

Up to 8 “Pulse” Outputs can be set.

< When setting the 1 sec to Pulse>



NOTE

To use “Detect OFF⟶ON” or “Detect ON⟶OFF” for Input relay, Output relay should be “Pulse”. Also, to use “Pulse” for Output relay, one of the input relay should be “Detect OFF⟶ON” or “Detect ON⟶OFF”.

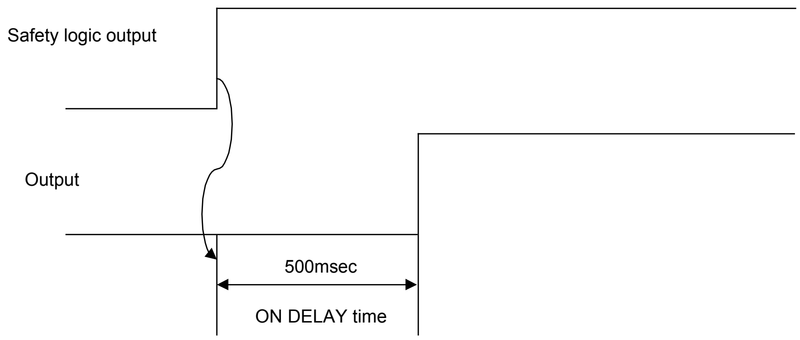
Number of Input relay should be two or less.

■ **ON Delay**

Turn ON signal after timer delay.

Up to four “Pulse” Outputs can be set.

< When setting the 500 msec to ON Delay>

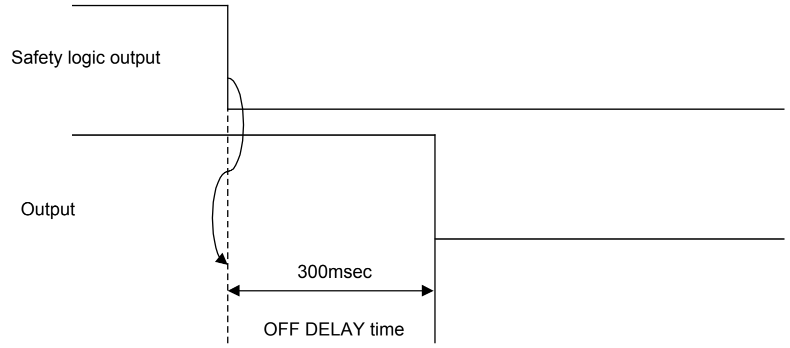


■ **OFF Delay**

Turn OFF signal after timer delay.

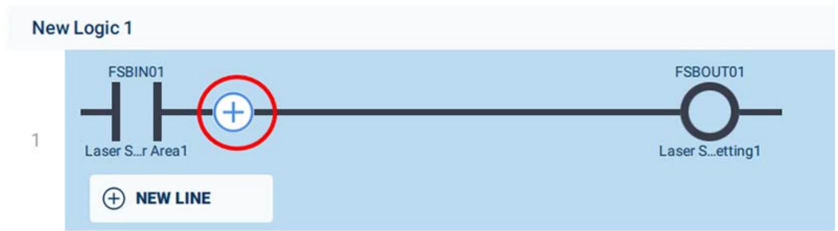
Up to four "Pulse" Outputs can be set.

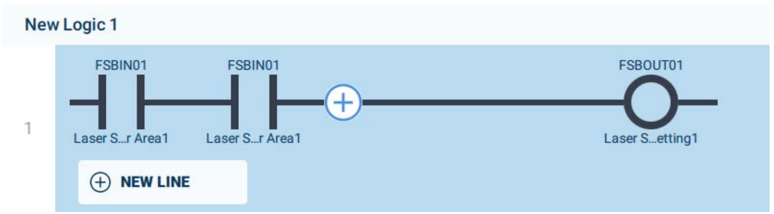
<When setting the 300 msec to OFF Delay>



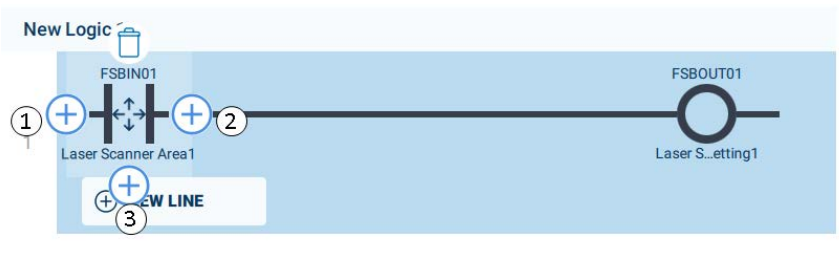
12.3.3.6 Add Relay

To add a new input relay, press {+} next to the input relay.





Or, press input relay, then press {+} on the input relay. New input relay will be added at the corresponding position.



① Add new input relay on the left side of the selected input relay.

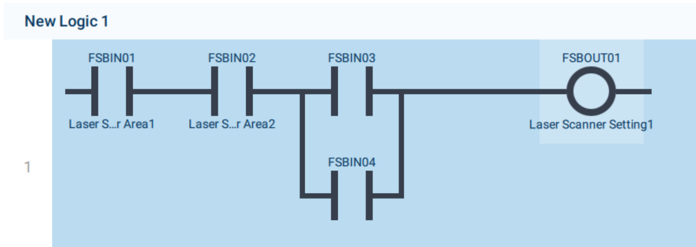
② Add new input relay on the right side of the selected input relay.

③ Add new input relay on the bottom side of the selected input relay.

NOTE

When the line has three or more input relays, it automatically divides the R signal (AUX Relay) internally. It uses the R signal in descending order from 128 for dividing.

For example, there is the line which has four input relays and one output relay.



This line will be divided into 3 lines with R signals. It will be shown in the YRC Controller.

	INPUT1	LOGIC	INPUT2	OUTPUT	TIMER	COMMENT
001	#1 FSBIN01	AND	#1 FSBIN02	R128		SEC1
002	#1 FSBIN03	OR	#1 FSBIN04	R127		SEC1
003	R128	AND	R127	#1 FSBOUT01		SEC1

Because of this, if all of the R signals are used, a new input relay cannot be added.

Also, R signals are referred in two places, it is not shown as one line and divided to different line.

12.3.3.7 Delete Relay

Press input relay to select, then press {Trash can} to delete the input relay.

– Selected input relay will be deleted.

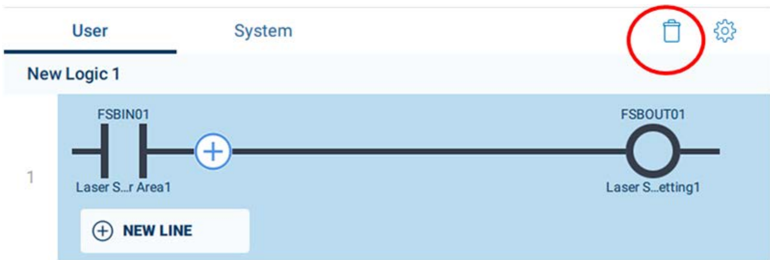
SUPPLE-MENT

- Each line must have at least one input relay.
  – If all the input relays are deleted, the line is also deleted.
- Each line must have at least one output relay.
  – Because of this, output relay cannot be deleted. To delete the output relay, delete the line.

12.3.3.8 Delete Line

Press the line to select, then press {Trash Can} to delete the line.

– Selected line is deleted.

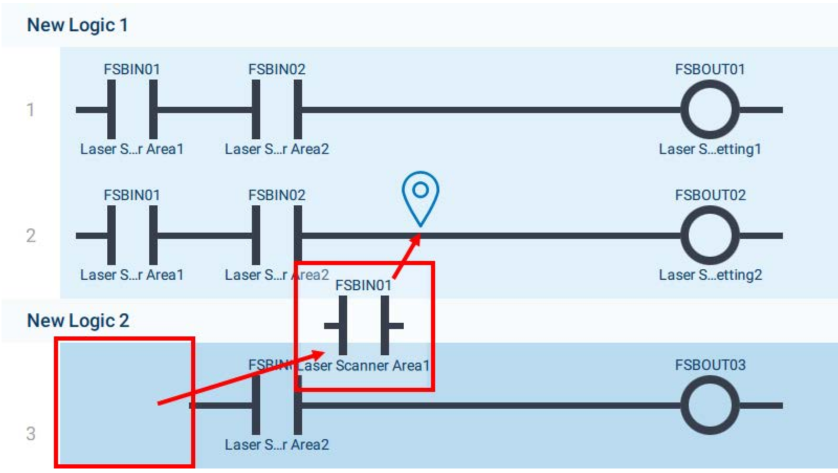


SUPPLE-MENT

- Each line must have at least one line.
  – If all the lines are deleted, the section is also deleted.

12.3.3.9 Move Relay

Press the input relay, and drag to move the input relay. An icon appears to show where the relay will be placed when dropped.



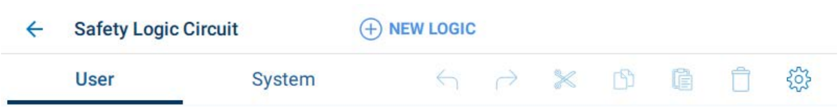
SUPPLE-MENT

- Each line must have at least one input relay.
  – If there are input relays in the line after moving the relay, the line is also deleted.
- Each line must have at least one output relay.
  – Because of this, output relay cannot be moved.

12.3.3.10 Edit Operation

The following operations can be used from the menu found at the top of the editor:

- Undo
- Redo
- Cut Line
- Copy Line
- Paste Line
- Delete Line



Select the line to edit and press the desired button. Additionally, these commands can be executed on multiple lines at once. To select multiple lines, press and hold on the line and then drag to select more lines.

SUPPLE-MENT

The Cut/Copy/Paste/Delete Line operations will be disabled if a relay is selected. Unselect the relay to use these operations.

■ Undo Operation

Toolbar Button	Name	Description
	Undo	Reverse the most recent edit

After inserting, deleting or modifying a relay, operations can be undone.

The undo operation works for the last ten edit operations.

NOTE

Undo operation's effect on the setting of the safety logic circuit includes the signal setting and status setting.

After undo operation, be sure to confirm that the safety logic circuit operates as expected.

■ Redo Operation

Toolbar Button	Name	Description
	Redo	Redo reverts the effects of the undo action

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

NOTE

Redo operation's effect on the setting of the safety logic circuit includes the signal setting and status setting.

After redo operation, be sure to confirm that the safety logic circuit operates as expected.

■ Cut Line Operation

Toolbar Button	Name	Description
	Cut Line	Copies the selected line(s) to a buffer and deletes line(s).

■ Copy Line Operation

Toolbar Button	Name	Description
	Copy Line	Copies the selected line(s) to a buffer.

■ Paste Line Operation

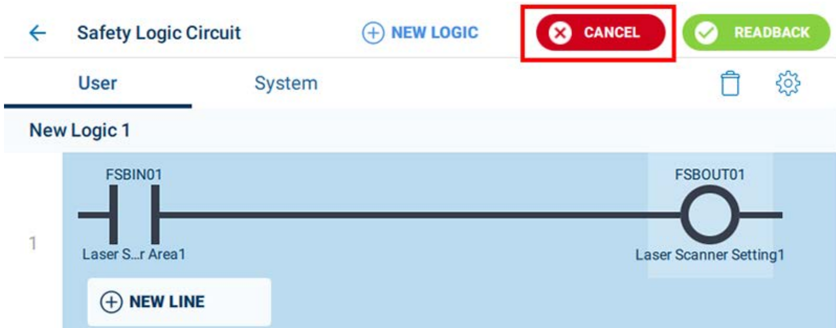
Toolbar Button	Name	Description
	Paste Line	Inserts the content of the buffer below the selected line.

■ Delete Line Operation

Toolbar Button	Name	Description
	Delete Line	Deletes the selected line(s)

12.3.3.11 Cancel Edit

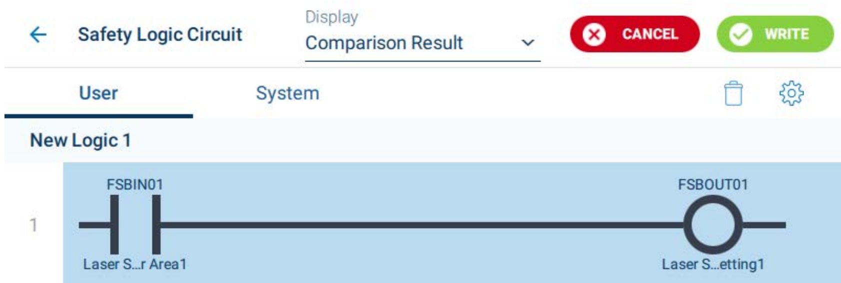
To cancel the edit, press {CANCEL}. This reverts any current changes.



12.3.3.12 Transferring and Updating Safety Logic Circuit File

① After creating the safety logic circuit, press {READBACK}.

- The safety logic circuit file is transferred to the safety circuit board.
- When transferring of the safety logic circuit file is successfully performed, the readback data from safety circuit board will show. Button changes to {WRITE}.



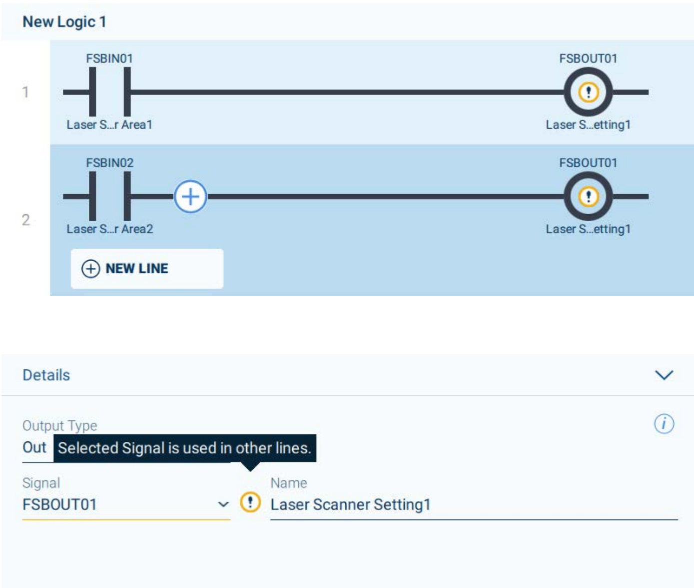
① Verify that there is no problem in readback data, then press {WRITE}.

– the file transferred to the safety circuit board is written in the FLASH ROM.

① If {CANCEL} is pressed, the file will not update. Edited data is discarded.

NOTE

- When selecting {READBACK}, all output signals that are outputted from the safety circuit board are turned OFF until the writing process is completed.
- When selecting {WRITE}, all information related to the safety logic circuit is transferred to the safety circuit board as the safety logic circuit file and written in the FLASH ROM of the safety circuit board.
- If the same output signal is used on multiple lines, an “!” will be shown as following. While “!” is shown, {READBACK} cannot proceed until the safety logic circuit is corrected.



12.3.3.13 Execute Safety Logic Circuit

When the write operation completes, the safety logic circuit executes. If the signal is ON, the relay is “green”. If the signal is OFF, the relay is “Blank”.

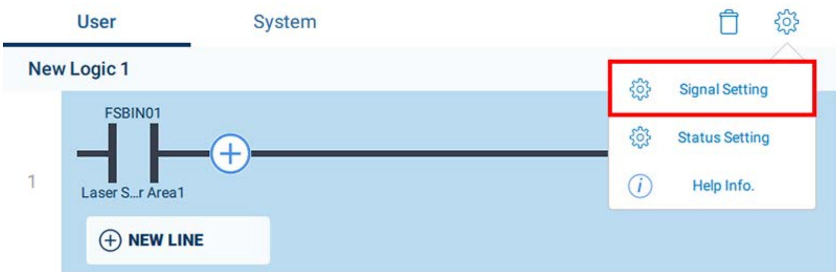
The safety logic circuit always executes except during the write operation.

12.3.4 Setting of Input/Output Signals

Input/Output signals used in safety logic circuit can be named.

These signals are used in both the Safety Logic Circuit and the Functional Safety Function. Safety Input signals can be referred from both Safety Logic Circuit and Functional Safety Function. However, Safety Output signals can only be outputted from one of the Safety Logic Circuit or Functional Safety Function. This can be configured in the Signal Setting screen.

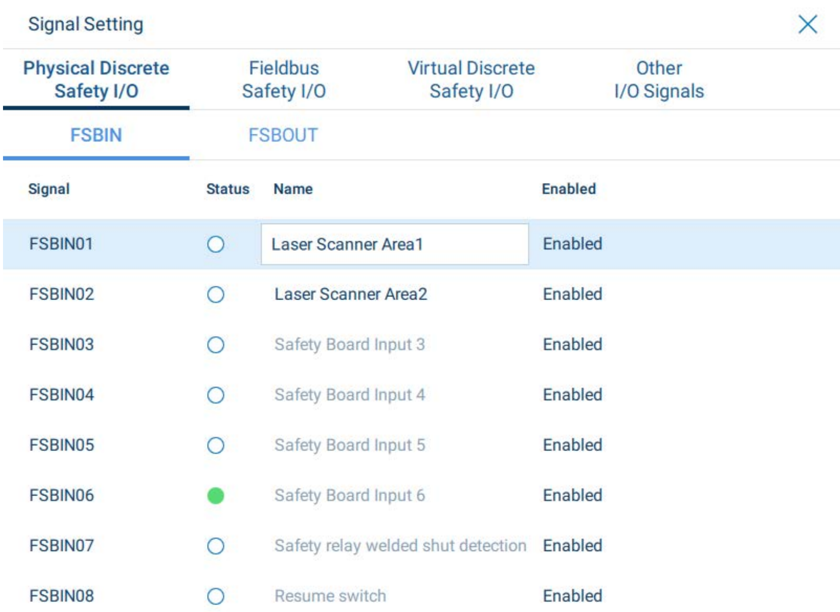
To open the Signal Setting screen, press {Setting} ⟶ {Signal Setting}.



12.3.4.1 Setting of General Purpose Input Signal (FSBIN)

These signals are shown when the optional General Purpose safety I/O board (ASF02, ASF03, or ASF32) is connected.

General Purpose Input signals can be named. These signals are always enabled.



12.3.4.2 Setting of General Purpose Output Signal (FSBOUT)

These signals are shown when the optional General Purpose safety I/O board (ASF02, ASF03, or ASF32) is connected.

General Purpose Output signal can be named, and also assigned to either Safety Logic Circuit or Safety Settings (Functional Safety Function).

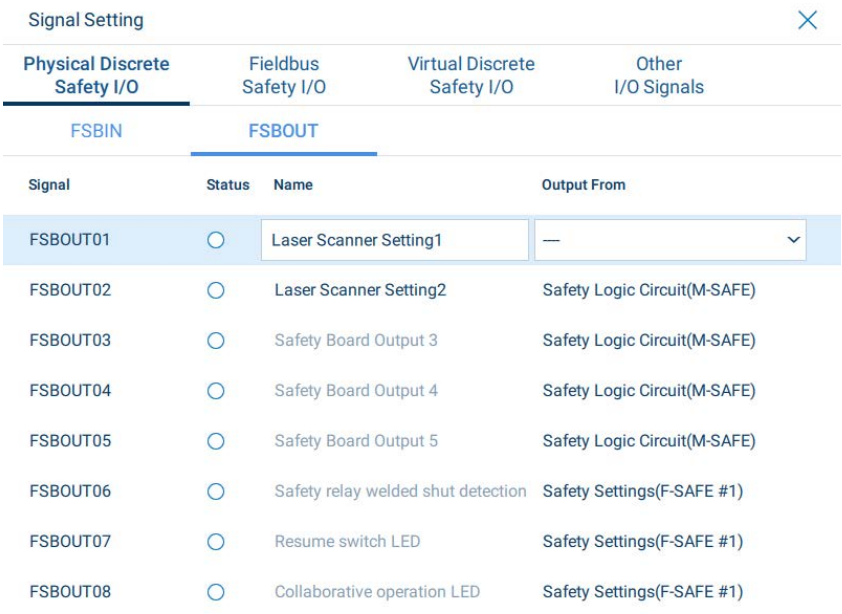


Table 12-7: General Purpose Output Signal

Item	Description
-	Signal is not specified
Safety Logic Circuit (M-SAFE)	The signal can be used in the safety logic circuit.
Safety Settings (F-SAFE #1 to #8)	The signal can be used in the Safety Settings (Functional Safety Function). Only the terminal which the safety I/O board is connected can be selected.

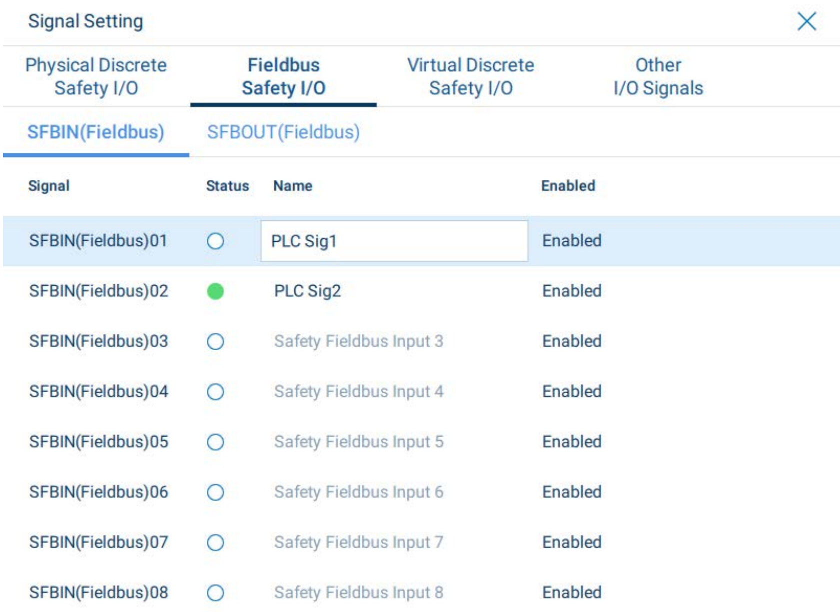
12.3.4.3 Setting of Safety Fieldbus Input Signals (SFBIN (Fieldbus))

These signals are shown when the optional safety fieldbus function is enabled.

Safety fieldbus signal transmits/receives the safety-guaranteed “safety data” through the fieldbus communication path. It has 64 input signal points and 64 output signal points.

Safety Fieldbus Input signal can be only named.

These signals are always enabled.



12.3.4.4 Setting of Safety Fieldbus Output Signals (SFBOUT (Fieldbus))

These signals are shown when the optional safety fieldbus function is enabled.

Safety fieldbus signal transmits/receives the safety-guaranteed “safety data” through the fieldbus communication path. It has 64 input signal points and 64 output signal points.

Safety fieldbus Output signal can be named, also assigned to either Safety Logic Circuit or Safety Settings (Functional Safety Function).

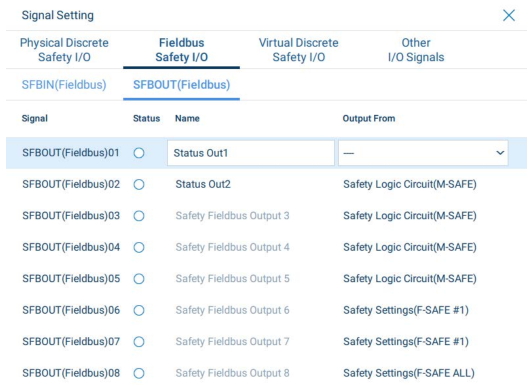


Table 12-8: Safety Fieldbus Output Signal

Item	Description
-	Signal is not specified
Safety Logic Circuit (M-SAFE)	The signal can be used in the safety logic circuit.
Safety Settings (F-SAFE #1 to #8)	The signal can be used in the Safety Settings (Functional Safety Function).
Safety Settings (F-SAFE ALL)	The signal can be used in the whole safety circuit board where the functional safety is enabled.

12.3.4.5 Setting of Safety Functions Output signals (FSOUT)

These signals are shown when the functional safety function (option) is enabled.

These signals allow to use the output signal of Safety Settings (Functional Safety Function) in Safety Logic Circuit.

Safety fieldbus output signal can be named, also assigned to either Safety Logic Circuit or Safety Settings (Functional Safety Function).

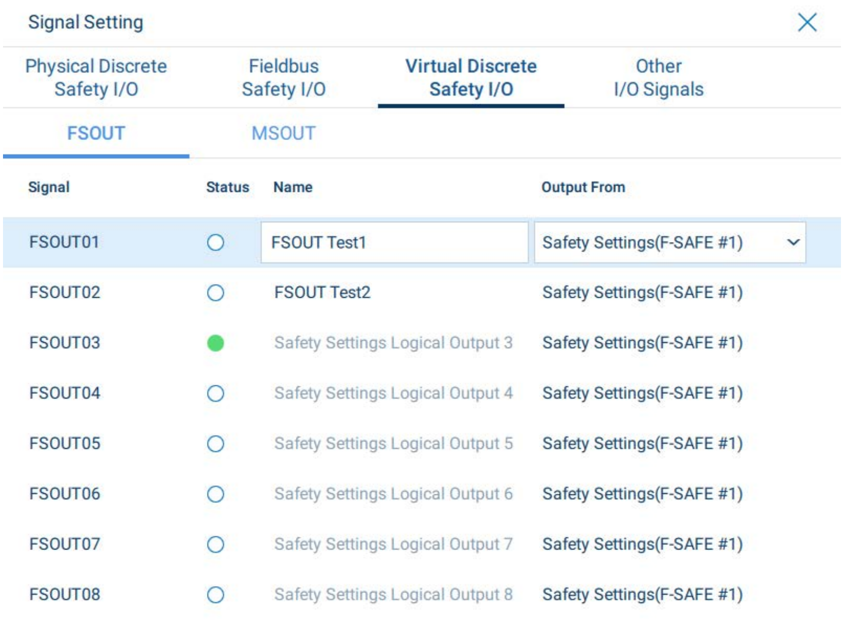


Table 12-9: Safety Function Output Signal

Item	Description
-	Signal is not specified
Safety Settings (F-SAFE #1 to #8)	The signal can be used in the Safety Settings (Functional Safety Function). Only the terminal which the safety I/O board is connected can be selected.

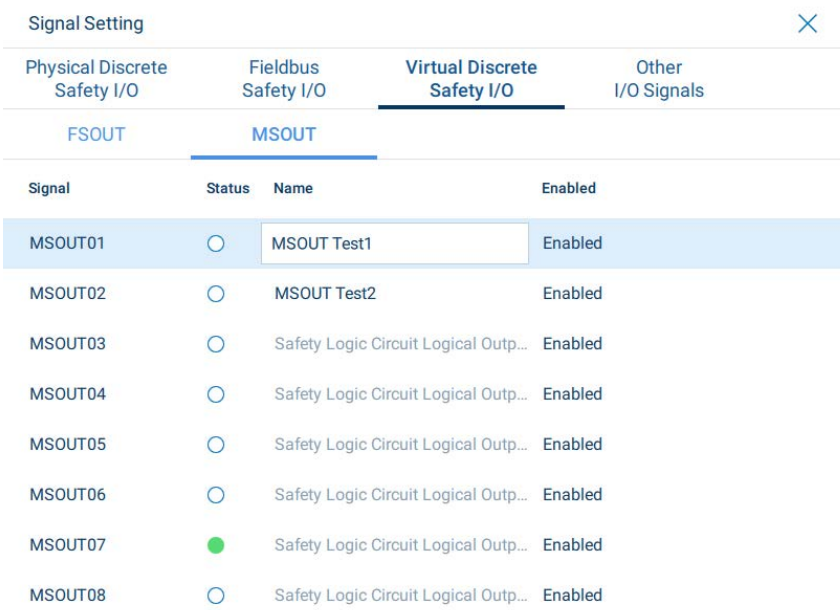
12.3.4.6 Setting of Safety Logic Circuit Output Signals (MSOUT)

These signals are shown when the functional safety function (option) is enabled.

These signals allow the use of output signal of Safety Logic Circuit in Safety Settings (Functional Safety function, PFL function).

Safety Logic Circuit Output can be named.

These signals are always enabled.



12.3.4.7 Settings of Specific Input Signals (SPIN)

WARNING

- SPIN is non-safety data. If a logic (AND, OR, etc.) is performed by using SPIN and another safety signal, the output result will be non-safety data.
- If SPIN is used for an application in which safety is required, the safety function will not be maintained. Thus, make sure to properly perform a risk evaluation of the Robot system before using SPIN.

The 32 specific input signals (#40780-#40817) are allocated to the SPIN[01] to SPIN[32] signals.

These signals are available in the safety logic circuit but are not safety-rated (i.e. they are non-safety data).

Specific Input Signals can be only named.

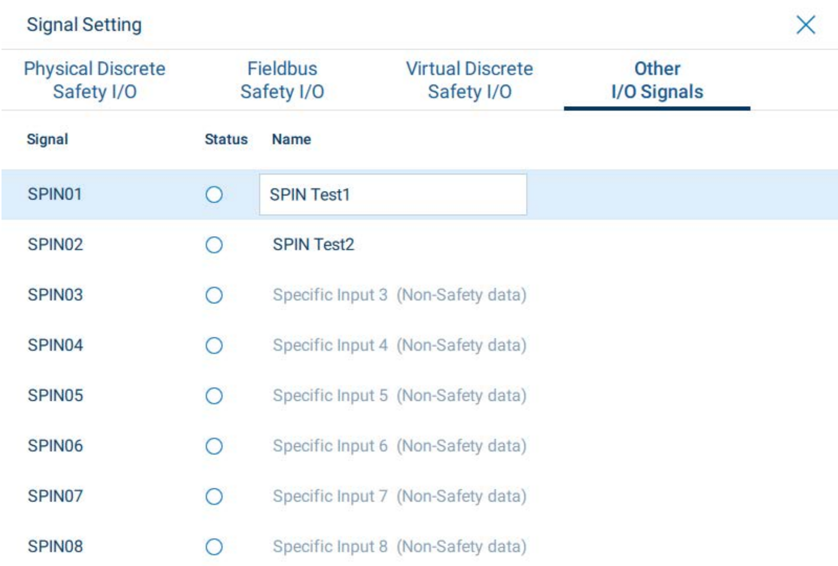


Table 12-10: Correspondence between the SPIN and Specific Input

40787	**40786**	**40785**	**40784**	**40783**	**40782**	**40781**	**40780**
Safety Logic Circuit Specific Input 8 SPIN08	Safety Logic Circuit Specific Input 7 SPIN07	Safety Logic Circuit Specific Input 6 SPIN06	Safety Logic Circuit Specific Input 5 SPIN05	Safety Logic Circuit Specific Input 4 SPIN04	Safety Logic Circuit Specific Input 3 SPIN03	Safety Logic Circuit Specific Input 2 SPIN02	Safety Logic Circuit Specific Input 1 SPIN01

40797	**40796**	**40795**	**40794**	**40793**	**40792**	**40791**	**40790**
Safety Logic Circuit Specific Input 16 SPIN16	Safety Logic Circuit Specific Input 15 SPIN15	Safety Logic Circuit Specific Input 14 SPIN14	Safety Logic Circuit Specific Input 13 SPIN13	Safety Logic Circuit Specific Input 12 SPIN12	Safety Logic Circuit Specific Input 11 SPIN11	Safety Logic Circuit Specific Input 10 SPIN10	Safety Logic Circuit Specific Input 9 SPIN09

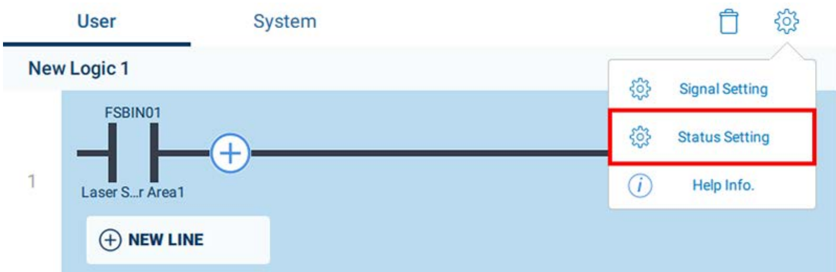
40807	**40806**	**40805**	**40804**	**40803**	**40802**	**40801**	**40800**
Safety Logic Circuit Specific Input 24 SPIN24	Safety Logic Circuit Specific Input 23 SPIN23	Safety Logic Circuit Specific Input 22 SPIN22	Safety Logic Circuit Specific Input 21 SPIN21	Safety Logic Circuit Specific Input 20 SPIN20	Safety Logic Circuit Specific Input 19 SPIN19	Safety Logic Circuit Specific Input 18 SPIN18	Safety Logic Circuit Specific Input 17 SPIN17

40817	**40816**	**40815**	**40814**	**40813**	**40812**	**40811**	**40810**
Safety Logic Circuit Specific Input 32 SPIN32	Safety Logic Circuit Specific Input 31 SPIN31	Safety Logic Circuit Specific Input 30 SPIN30	Safety Logic Circuit Specific Input 29 SPIN29	Safety Logic Circuit Specific Input 28 SPIN28	Safety Logic Circuit Specific Input 27 SPIN27	Safety Logic Circuit Specific Input 26 SPIN26	Safety Logic Circuit Specific Input 25 SPIN25

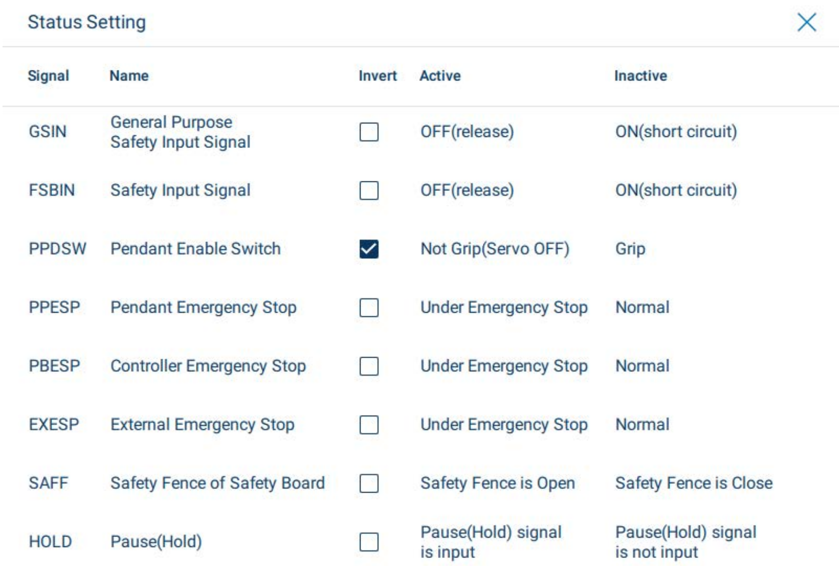
12.3.5 Setting ON/OFF Status to the Input Signals

The meaning of the ON/OFF status of input signals used in the safety logic circuit can be switched. For example, the meaning of PPESP (Pendant Emergency Stop) is usually Active = Under Emergency Stop, Inactive = Normal. This can be changed to Active = Normal, Inactive = Under Emergency Stop.

1. Select {Setting} icon - {Status Setting}



2. The meaning of the Active/Inactive status of input signals used in the safety logic circuit can be inverted by pressing checkbox.



Status Setting

Signal	Name	Invert	Active	Inactive
GSIN	General Purpose Safety Input Signal	☐	OFF(release)	ON(short circuit)
FSBIN	Safety Input Signal	☐	OFF(release)	ON(short circuit)
PPDSW	Pendant Enable Switch	☑	Not Grip(Servo OFF)	Grip
PPESP	Pendant Emergency Stop	☐	Under Emergency Stop	Normal
PBESP	Controller Emergency Stop	☐	Under Emergency Stop	Normal
EXESP	External Emergency Stop	☐	Under Emergency Stop	Normal
SAFF	Safety Fence of Safety Board	☐	Safety Fence is Open	Safety Fence is Close
HOLD	Pause(Hold)	☐	Pause(Hold) signal is input	Pause(Hold) signal is not input

Table 12-11: Status Setting

No.	Signal Name	Standard	Invert
1	GSIN	GP safety input signal (ASF01) ● : OFF [release]/ ○ : ON [short circuit]	GP safety input signal (ASF01) ● : ON [short circuit]/ ○ : OFF [release]
2	FSBIN	GP safety input signal (ASF02 or ASF03) ● : OFF [release]/ ○ : ON [short circuit])	GP safety input signal (ASF02 or ASU03) ● : ON [short circuit]/ ○ : OFF [release])
3	PPDSW	Pendant enable switch signal ● : Grip/ ○ : Not grip (servo OFF)	Pendant enable switch signal ● : Not grip (servo OFF)/ ○ : Grip)
4	PPESP	Pendant Emergency Stop signal ● : Under Emergency Stop/ ○ : Normal)	Pendant Emergency Stop signal ● : Normal/ ○ : Under Emergency Stop)
5	PBESP	YRC Controller Emergency Stop signal ● : Under Emergency Stop/ ○ : Normal	YRC Controller Emergency Stop signal ● : Normal/ ○ : Under Emergency Stop
6	EXESP	External Emergency Stop input signal ● : Under Emergency Stop/ ○ : Normal	External Emergency Stop input signal ● : Normal/ ○ : Under Emergency Stop
7	SAFF	Safety fence signal ● : Open (safeguarding opened)/ ○ : Close	Safety fence signal ● : Close/ ○ : Open (safeguarding opened))
8	HOLD	Hold ● : ON (Hold signal is being input.)/ ○ : ON (Hold signal is not input.)	Hold ● : OFF (Hold signal is not input.)/ ○ : ON (Hold signal is being input.)

3. For example, when the EXESP signal is changed from “Normal Open” to “Normal Close”, the mark “ ● ” indicates the external Emergency Stop signal is in the normal state (Normal Close) and the mark “ ○ ” indicates the external Emergency Stop signal is being input (Normal Open).
4. Select {READBACK} and then {WRITE} to enable changed settings.

NOTE

When the ON/OFF settings of the input signals are changed, outputting the signals that have been output normally may fail. This may lead to a serious accident.

After changing the ON/OFF settings of the input signals, be sure to confirm the safety logic circuit operates normally.

SUPPLE-MENT

Cannot change the ON/OFF status setting of the signal which is used in System Safety Logic Circuit.

12.3.6 About Output Signals

12.3.6.1 Correspondence with Hard Wire

The following functions can be controlled either by hard-wire or by the safety logic circuit.

Table 12-12: Hard-Wire Signal Name

Signal Name	Hard-Wire signal name	Explanation
S-EXDSW	None	• This is the external enable switch signal and functions only in teach mode. • When both the S-EXDSW signal and the enable switch on the Smart Pendant are ON, the servo power can be turned ON. • When the S-EXDSW signal is not used in the safety logic circuit, the safety circuit board regards this as the short-circuit status.
S-EXESP	EXESP	• This is the external Emergency Stop input signal. • When the S-EXDSW signal is turned OFF, the signal performs the same control as the EXESP signal is turned OFF. • The hard-wired EXESP signal is always monitored. When either the EXESP signal or the S-EXESP signal is OFF, the servo power supply is turned OFF. • When the S-EXESP signal is not used in the safety logic circuit, the safety circuit board regards this as the short-circuit status.
S-FST	None	This is the full speed mode signal. Refer to chapter 12.3.6.3.
#n S-ONEN[x]	#n ONEN[x]	This signal controls the servo power supply for each control group. (n indicates the number of the ASF01 board and x is 1 to 4. 4 points are available for one ASF01 board.) When the S-ONEN signal is input, the signal performs the same control as ON ENABLE signal. When the hard-wired signal (ON ENABLE) is input, the servo power supply for the appropriate control group is turned OFF. When the signal is turned ON, the servo ON is enabled.
S-SAFF	SAFF	When the S-SAFF signal is turned OFF, the signal performs the same control as the SAFF signal. The hard-wired SAFF signal is always monitored. When either the SAFF signal or the S-SAFF signal is OFF, the servo power supply is turned OFF.
S-SVON_EN	None	For details, refer to “YRC1000 INSTRUCTIONS (RE-CTO-A221) chapter 8.26.13 “Enable Switch Link Function ”.
MSOUT	None	This is the data to transfer the data created in the safety logic circuit to the functional safety function (optional).

NOTE

The signals which has been controlled by a hardware are also always monitored. Thus, the safety function, which turns OFF the servo power supply when the error is detected, is maintained.

12.3.6.2 Display of the Message on the Pendant

When the Robot's operation is stopped by one of these signals, the message on the pendant will recognize and display which signal (i.e. hard-wired signal of Safety Logic Circuit signal) stopped the Robot.

Table 12-13: Pendant Message

Signal Name	Message on the Pendant
None	-
S-EXDSW	EXDSW signal is OFF.(Safety Logical Circuit)
EXESP	Robot is stopped by external Emergency Stop.
S-EXESP	Robot is stopped by external Emergency Stop. (Safety Logical Circuit)
None	-
S-FST	Full-speed test mode. (Safety Logical Circuit)
#n ONEN[x]	Servo ON enable signal (ON-EN) is OFF.
#n S-ONEN[x]	Servo ON enable signal (ON-EN) is OFF. (Safety Logical Circuit)
SAFF	Safety guard is open.
S-SAFF	Safety guard is open. (Safety Logical Circuit)
None	-
S-SVON_EN	Servo ON enable signal is OFF. (Safety Logical Circuit)

NOTE

- The upper line: the message when the manipulator is stopped by the input of the hard-wired signal.
- The lower line: the message when the manipulator is stopped by the signals input from the safety logic circuit.
- None: The appropriate signals do not exist.

12.3.6.3 Full Speed Mode

DANGER

When using the full-speed test function, the Robot will move at a high speed. Thus, make sure the operator is in a secure place outside the Robot's operating range from where he/she can visually check the Robot's movement and perform operations by using the Smart Pendant from that place.

Full speed mode can be used to perform a test run or a forward/backward operation of the job at the full taught speed during the MANUAL (TEACH) mode.

When the S-FST signal is turned ON during the MANUAL (TEACH) mode, full speed mode is activated.

When the full speed mode is selected, the servo power is turned OFF, and then the manual speed setting is automatically switched to the inching mode. In the same way, when the Enable Switch is released in full speed mode, the manual speed setting is automatically switched to inching mode.

The operation speed while the mode is set to full speed test mode is specified according to the manual speed setting per table 12-14.

Table 12-14: Manual Speed Settings

Manual speed operation speed limit (initial value)		Parameter (unit: 0.01%)	
Inching	20%	S1CxG60 (initial value: 2000)	Limited to 250 mm/s
Low	50%	S1CxG61 (initial value: 5000)	
Mid	75%	S1CxG62 (initial value: 7500)	
High	100% (fixed value)	-	

NOTE

The operation speed limit values in the above table are the percentages with respect to the manipulator's maximum speed, not with respect to the taught speed. These are specified in order to control the operation speed so that it does not exceed the manipulator's maximum speed during a test run or a forward/backward operation.

12.3.7 General-Purpose Safety Output Monitoring Signal

General-Purpose Safety Output Monitoring Signal is used for detecting error (e.g. wire sticking, etc.) by monitoring the feedback signal of the devices (safety relay, contactor, etc.) driven by the General Purpose Safety output signal (GSOUT, FSBOUT).

When feedback signal is not monitored, error (wire sticking, etc.) of the devices (safety relay, contactor, etc.) driven by the General Purpose Safety output signal (GSOUT, FSBOUT) is not detected. Perform the error detection (signal mismatch) with the receiving peripheral devices (Safety PLC, etc.).

Supports the monitoring signal by using the safety logic circuit instead of the dedicated connection terminal.

NOTE

If the values of the functional safety general-purpose output signal and the general-purpose safety output monitoring signal are judged as NG for 500 ms or more, the following alarm occurs:

- When the GSOUT signal is NG
  Alarm 4767: M-SAF GENERAL OUT FB DIAG. ERROR
- When the FSBOUT signal is NG
  Alarm 4768: M-SAF GENERAL OUT FB DIAG. ERROR2

For monitoring of the contact point B, the judgment is made as follows.

Output value of the general-purpose safety output signal (GSOUT, FSBOUT)	**Input value of the general-purpose safety output monitoring signal (GSEDM, XEDM)**	**Judgement**
OFF	Close	Ok
OFF	Open	NG
ON	Close	NG
ON	Open	OK

12.3.7.1 Activate Signals

To activate General Purpose Safety Output Monitoring signals, Classic Interface is required (refer to chapter 13 “Classic Interface”)

For more information to set the General Purpose Safety Output Monitoring signals, refer to chapter 12.3.7.2.

12.3.7.2 Correspondence between General Purpose Output Signals and Monitoring Signals

Table 12-15: Correspondence Between General Purpose Output Signals and Monitoring Signals.

General-Purpose Safety Output Signal	General-purpose safety output monitoring signal (Feedback signal)
GSOUT1	S-GSEDM1
GSOUT2	S-GSEDM2

The following signals can be used only in the system where the safety I/O expansion board (optional) is enabled. Then number of signals depends on the circuit board.

Table 12-16: Correspondence Between General Purpose Output Signals and Monitoring Signals with Safety IO Expansion Board

General-Purpose Safety Output Signal	General-purpose safety output monitoring signal (Feedback signal)
FSBOUT1 (XOUT1)	S-XEDM1
FSBOUT2 (XOUT2)	S-XEDM2
FSBOUT3 (XOUT3)	S-XEDM3
FSBOUT4 (XOUT4)	S-XEDM4
FSBOUT5 (XOUT5)	S-XEDM5
FSBOUT6 (XOUT6)	S-XEDM6
FSBOUT7 (XOUT7)	S-XEDM7
FSBOUT8 (XOUT8)	S-XEDM8
FSBOUT9 (XOUT9)	S-XEDM9
FSBOUT10 (XOUT10)	S-XEDM10
FSBOUT11 (XOUT11)	S-XEDM11
FSBOUT12 (XOUT12)	S-XEDM12
FSBOUT13 (XOUT13)	S-XEDM13
FSBOUT14 (XOUT14)	S-XEDM14
FSBOUT15 (XOUT15)	S-XEDM15
FSBOUT16 (XOUT16)	S-XEDM16

12.3.7.3 Example of Setting for Monitoring Signals

Pendant Emergency Stop Signal (PPESP) is output to General Purpose Output signal1 (GSOUT1, FSBOUT1). To monitor these signals, use General Purpose Input signals (GSIN1, FSBIN01).

Example of this setting is as following.

12.3.8 Safety Data Monitoring

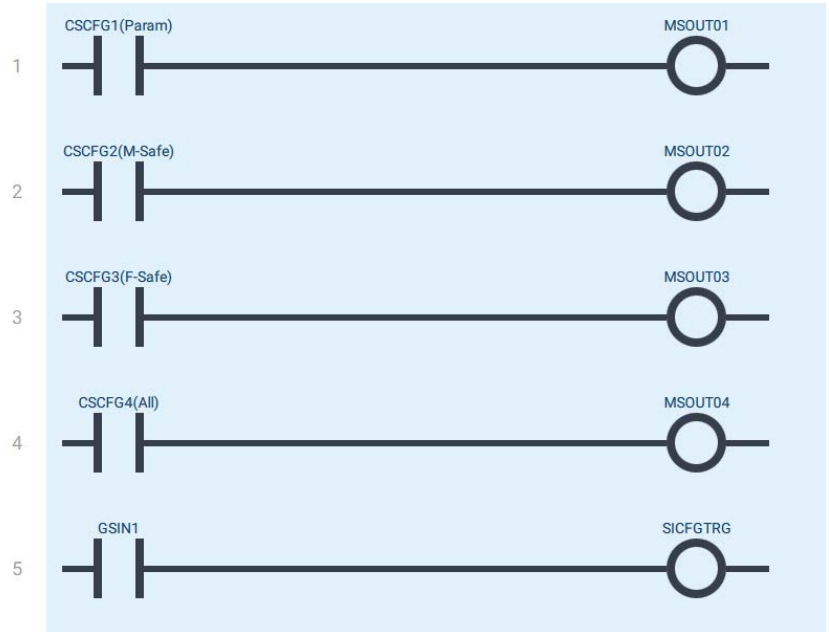
This function works only in YRC1000.

By using the signals for the safety data monitoring (CSCFG01, CSCFG02, CSCFG03, CSCFG04, SICFGTRG), the safety data (the safety-related parameter, the machine safety data file, and the functional safety data file) can be monitored to detect a change.

Monitoring is performed by comparing the CRC of the safety data, and if changed, that can be notified by the safety output.

When GSIN01 is the stored CRC updating trigger, the example of the monitoring results output to MS-OUT01 - 04 is shown below.

1. Editing the safety logic circuit
   – Correspond GSIN01 to the updating trigger SICFGTRG, and MSOUT01 - 04 to CSCFG01 - 04.



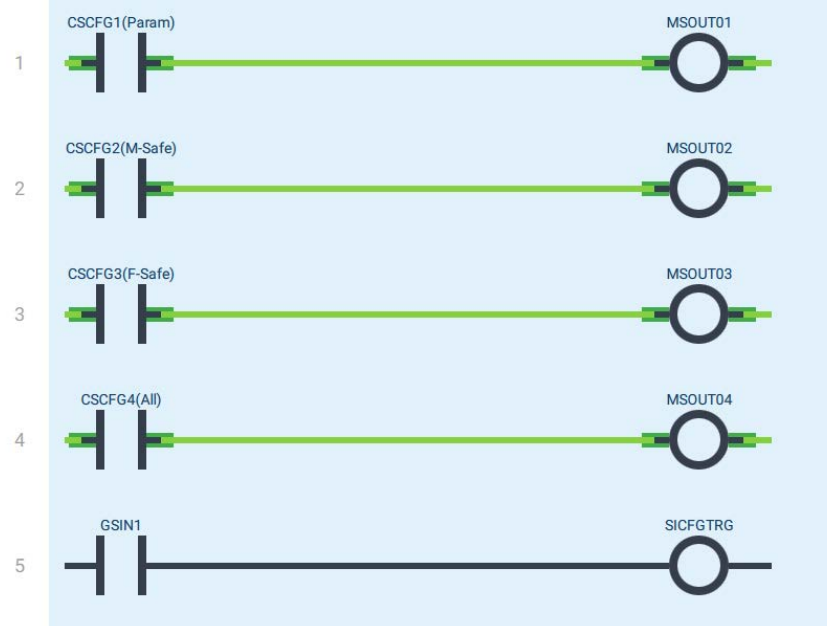
2. Write the Safety Logic Circuit
   – After editing, select {WRITE}.
   – When the transfer is done correctly, the confirmation dialog appears. Then select {YES}.

NOTE

Since the CRC for the safety data monitoring are stored by detecting falling edge of SICFGTRG(CRC updating trigger), the monitoring results are turned OFF (○: abnormal monitoring) until the stored CRC is updated by this signal.

3. Input of the stored CRC updating trigger
   – When the stored CRC updating trigger (signal name: SICFGTRG GSIN01 is set this time) is turned ON (●) to OFF(○), the stored CRC is updated.
   – When the stored CRC is updated, the monitoring result is turned ON (●: normal monitoring) until the safety data is changed.
   – The monitoring result (signal name: CSCFG01 - 04) can be output to any signal by using the safety logic circuit.

The monitoring result can be output to the external device by using the safety output.



4. Monitoring the safety data change

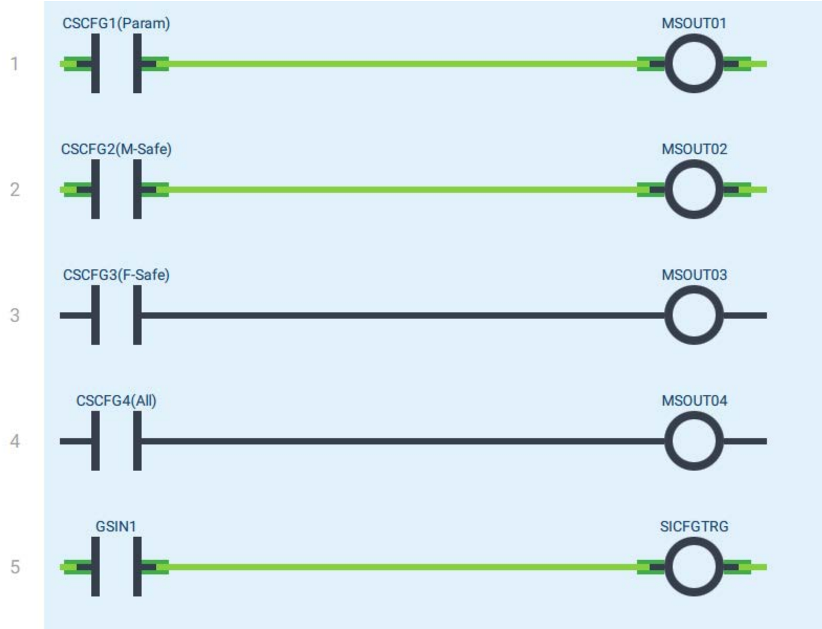
   – When any functional safety data file is changed, the following status appears.

   – Both CSCGF03 shown the monitoring result of the functional safety data file and CSCFG04 shown the monitoring result of changing either safety data (if any) will be turned OFF (○: abnormal monitoring).

   – Also when any safety related parameter is changed, both CSCFG01 and CSCFG04 will be turned OFF (○: abnormal monitoring).

   – Also when any machine safety data file is changed, both CSCFG02 and CSCFG04 will be turned OFF (○: abnormal monitoring).

– When the CRC updating trigger (signal name: SICFGTRG GSIN01 is set this time) is turned ON (●) to OFF(○) again, the stored CRC is updated and the monitoring result is turned ON (●: normal monitoring).



The safety parameter and the data file for monitoring are shown below.

Table 12-17: Safety-related parameter monitored by CSCFG1
These files are monitored when functional safety function is enabled.

File	File Name for External Memory Device
Function definition parameter	FD.PRM
System definition parameter	SD.PRM
Servo parameter	SV.PRM
Servo motor parameter	SVM.PRM
Robot matching parameter	RC.PRM
Coordinate home position parameter	RO.PRM
Motion function parameter	MF.PRM
Robot control expand parameter	RE.PRM
Safety function parameter	FMS.PRM
System matching parameter	SC.PRM

Table 12-18: Machine Safety Data File Monitored by CSCFG2

File	File Name for External Memory Device
Safety Logic Circuit	YSFLOGIC.DAT

Table 12-19: Functional safety data file monitored by CSCFG3.
These files are monitored when functional safety function is enabled.

File	File Name for External Memory Device
Tool data	TOOL.CND
Tool interfere data	TOOLINTF.DAT
Home position calibrating data	ABSO.DAT
Axis range limit data	AXRNGLMT.DAT
Axis speed monitor data	AXSPDMON.DAT
Robot range limit data	RBRNGLMT.DAT
Speed limit data	SPDLMT.DAT
Tool angle monitor data	TLANGMON.DAT
Tool change monitor data	TLCHGMON.DAT

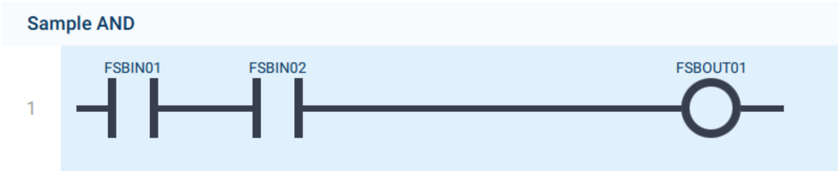
12.3.9 Example of Safety Logic Circuit

The followings are application examples that use safety logic circuit.

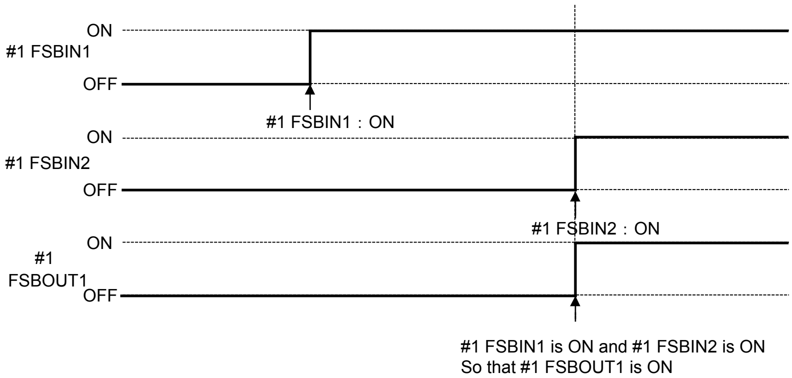
12.3.9.1 Example 1 (AND)

This is the example of the setting to output from the GP safety output signal1 (#1 FSBOUT1) while the GP safety input signal1 (#1 FSBIN1) and 2 (#2 FSBIN2) are ON.

1. Create the following Safety Logic Circuit.



2. The timing chart is as shown below:

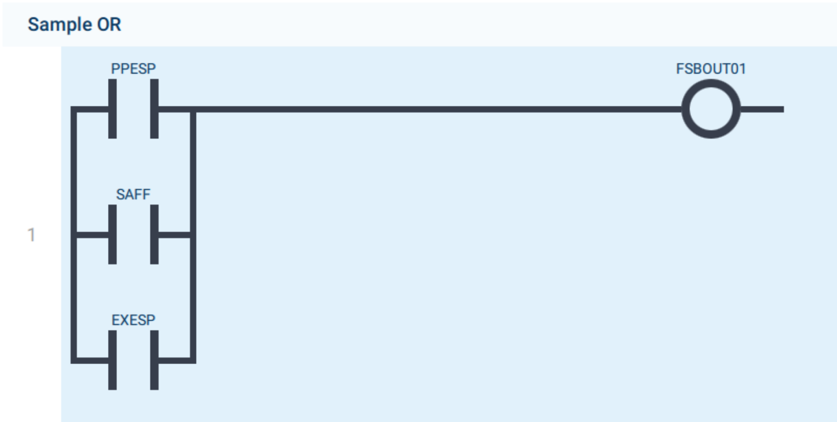


3. Verifying the safety logic circuit.
   – Switch ON the GP safety signal “1” and “2”. General Purpose Safety Output signal1 becomes ON.

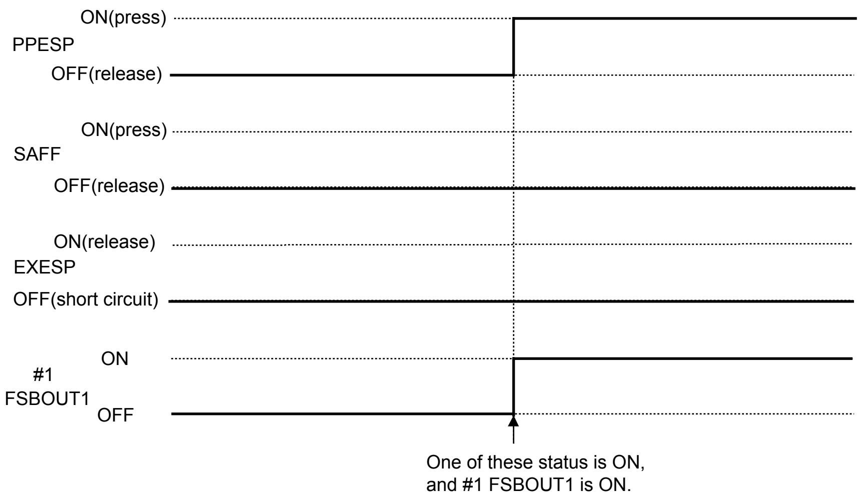
12.3.9.2 Example 2 (OR)

This is the example of the setting to output from the GP safety output signal1 (#1 FSBOUT1) while either status of the Smart Pendant Emergency Stop (PPESP), safety fence (SAFF) or external Emergency Stop (EXESP) is stopped.

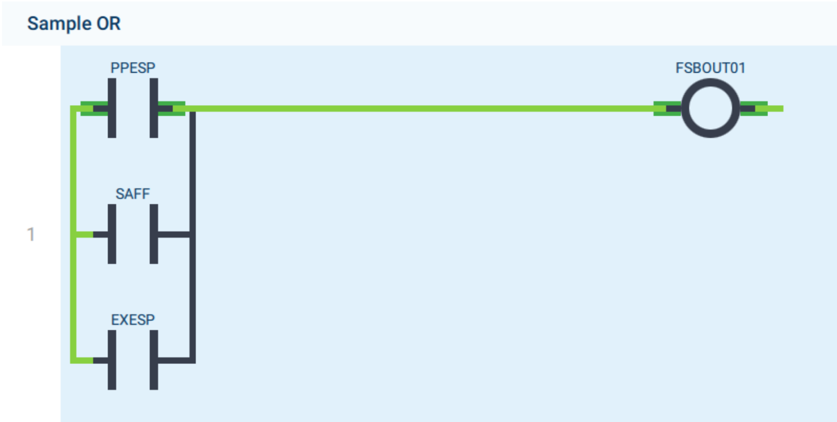
1. Create the following Safety Logic Circuit.



2. The timing chart is as shown below:



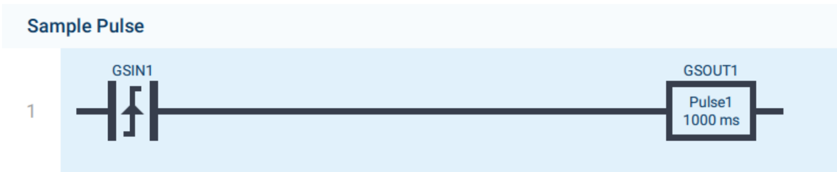
3. Verifying the safety logic circuit.
   – When either the pendant Emergency Stop, safety fence, or the external Emergency Stop is input, General Purpose Safety Output Signal 1 becomes ON.



12.3.9.3 Example 3 (Pulse)

The one-second one-shot output signal is created by the safety logic circuit. In the following example, the GP safety output signal (#1 GSOUT1) is ON for one second.

1. Create the following Safety Logic Circuit.

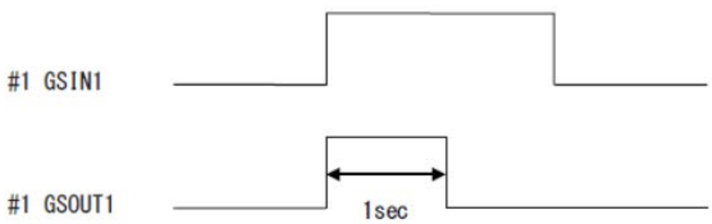


NOTE

To use “Detect OFF ⟶ ON” or “Detect ON ⟶ OFF” for Input relay, Output relay should be “Pulse”. Also, to use “Pulse” for Output relay, one of the input relay should be “Detect OFF ⟶ ON” or “Detect ON ⟶ OFF”.

Number of Input relay should be 2 or less.

2. The timing chart is as shown below:



3. Verifying the safety logic circuit.
When #1 GSIN 1 signal is turned ON, #1 GSOUT 1 is ON for one second.

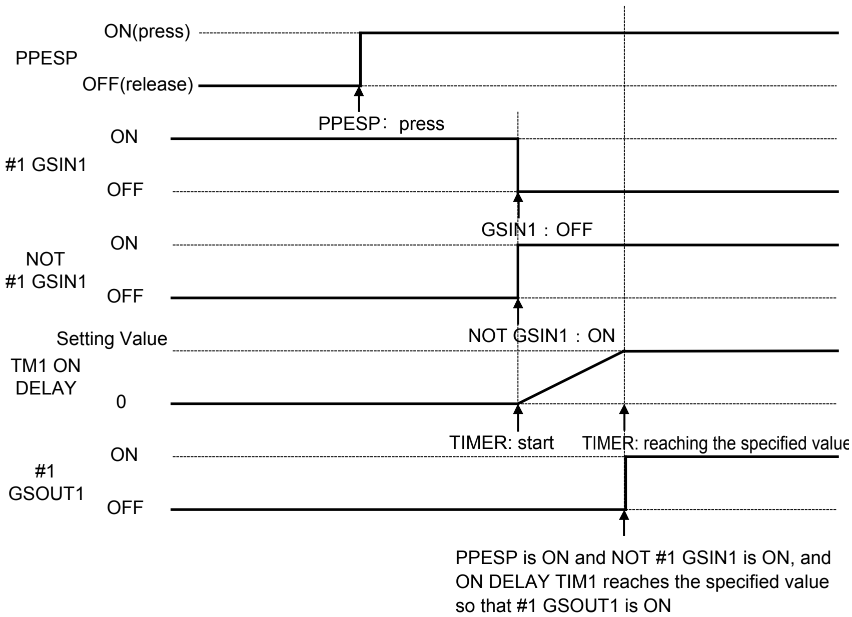
> **NOTE**
> When using the "Detect OFF ⟶ ON" or "Detect ON ⟶ ON" instruction, the signal status turns to ON only for 2 ms while the conditions are satisfied.
>
> Because pendant display update is slower than safety logic circuit, seeing the changing status in the display is difficult, or it may be displayed longer than the actual ON time.

12.3.9.4 Example 4 (ON Delay)

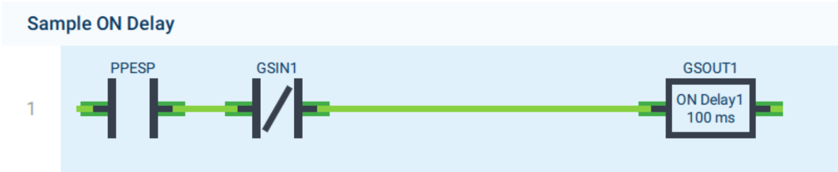
In the following example, one second after the emergency button of the pendant (PPESP) is pressed and the GP safety input signal 1 is OFF, the GP safety output signal1 (#1 GSOUT1) is turned ON.

1. Create the following Safety Logic Circuit.

2. The time chart is as following.



3. Verifying the safety logic circuit.
   – Confirm that the signal becomes ON when pressing the pendant Emergency Stop and switching the GP safety signal ON. GP safety output signal 1 becomes ON after one second has passed.

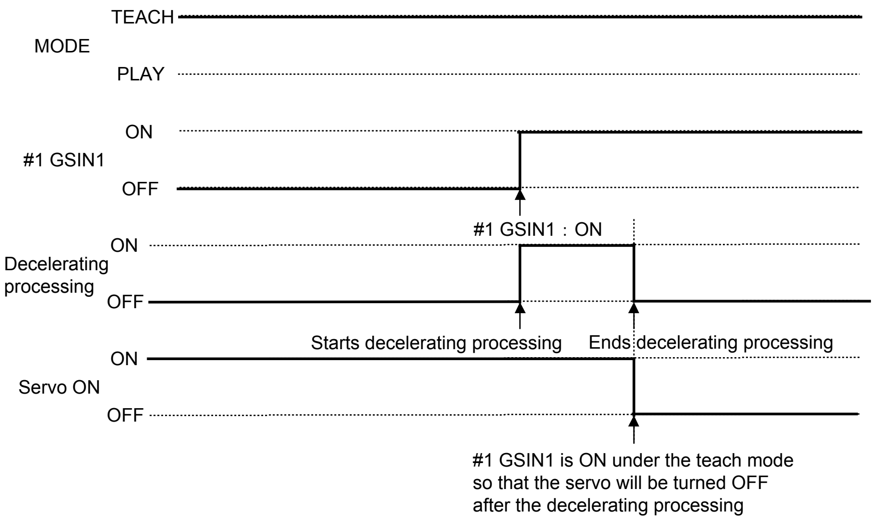


12.3.9.5 Example 5 (Decelerate and Stop the Robot)

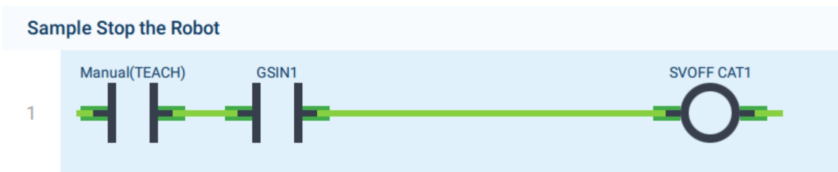
In the following example, when the GP safety input signal1 (#1 GSIN1) is ON under MANUAL (TEACH) mode, the Robot decelerates and stops its operation.

1. Create the following Safety Logic Circuit.

2. The time chart is as following.



3. Verifying the safety logic circuit.
   – Change the mode to MANUAL (TEACH) mode, and turn the servo ON. After that, when the GP safety signal 1 is turned ON, SFOFF CAT1 becomes ON, and the Robot decelerates and stops its operation.



If the manipulator stops its operation by the safety logic circuit, the message “Robot is stopped by safety logic circuit” is shown on the message area of the pendant.

NOTE

- For the safety logic circuit of the YRC Controller, even if the Robot deceleration to a stop (SVOFF CAT1) is turned ON, the robot stops its operation instantly without decelerating in MANUAL (TEACH) mode. Under the AUTOMATIC (PLAY) mode, if the manipulator deceleration to a stop (SVOFF CAT1) is turned ON, the Robot decelerates and stops its operation.
- When the Robot is stopped by the safety logic circuit signal, “Robot is stopped by safety logic circuit” is shown on the message area of the smart pendant.
  The control status signal #80343 (Robot stopped by safety logic circuit) is turned ON.

12.3.9.6 Example 6 (Temporarily Disable PFL for Human Collaborative Robots)

YASKAWA recommends temporarily disabling PFL to perform certain operations to improve usability/performance. Example scenarios could include:

– Moving the Robot at full speed

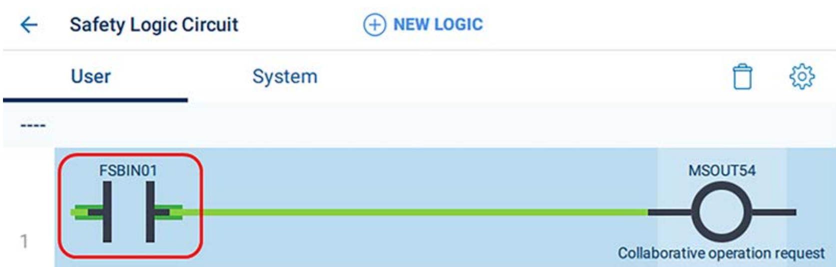
– Moving the Robot near singular positions (see *chapter 12.6.3*)

– When the Robot cannot be operated due to an error caused by recurring external force monitor setting violations

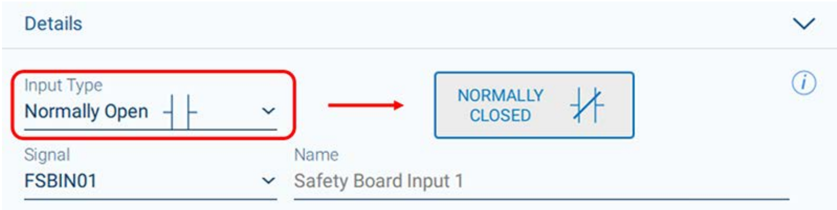
– Automatic estimation of tool load

Follow the steps below to temporarily disable PFL for a collaborative system in its factory state (i.e. prior to user additions/edits).

1. Navigate to {Safety Settings} → {Safety Logic Circuit}
2. Find the line that contains an output (right side of screen) set to “MSOUT54 (Collaborative Operation Request). (First line at the top of the circuit for system in its factory state.)
   – Select the left-most gate in this line (gate = FSBIN01 in the factory state)



3. Select the input relay and reverse its Input Type (i.e. change from Normally Open to Normally Closed) in the Details panel to turn OFF the MSOUT54 request signal.



4. Perform Readback → Write process to save changes. MSOUT54 should now be disabled (see below), signifying that PFL is disabled. The green light on the Robot's wrist should be OFF.

5. Perform *desired operation* with PFL disabled.
6. Restore PFL to its original state once the desired operation(s) are complete!

DANGER

- Disabling collaborative operation may cause harm to people and should only be done after thorough risk assessment.
- When presence detection sensor is used, safety distance as per ISO 13855 must be ensured.

12.4 Functional Safety Functions

12.4.1 Outline

By using the functional safety function, the position and speed of the Robot and the posture of its tool are monitored.

The power supply to the motor is suspended and the Robot is completely stopped when an error is detected on safety monitoring data.

With this function, the following items can be improved:

– improving the safety of the Robot's motion

– minimizing the equipment layout area where the manipulators are installed

12.4.2 List of Safety Functions

There are six different functional safety functions for monitoring purposes.

① **Robot Range Limit**

Monitors the manipulator arm or its tool to be inside the designated safety area.

② **Axis Range Limit**

Monitors each axis angle to be equal to or inside the designated safety area.

③ **Speed Limit**

Monitors the speed of manipulator TCP (Tool Center Point) and its FCP (Flange Center Point) when the Robot control group is monitored.

④ **Axis Speed Monitor**

Monitors each axis speed to be equal or slower than the designated speed.

⑤ **Tool Angle Monitor**

Monitors the manipulator tool angle to be inside the range of limited angle when the angle is centered on the designated standard posture.

⑥ **Tool Change Monitor**

Monitors the tool file used in the functional safety function to be consistent with the user specified tool file.

⑦ **Tool Number Select**

Select the tool number to be used for the functional safety function, regardless of the user specified tool number.

These safety functions conform to the following safety standards.

– EN ISO 13849-1: 2015 Cat.3 / PL d

– EN 62061(IEC 61508) SIL CL2

If the Robot has the collaborative operation function, the following additional function can also be used.

⑧ **External Force Monitor**

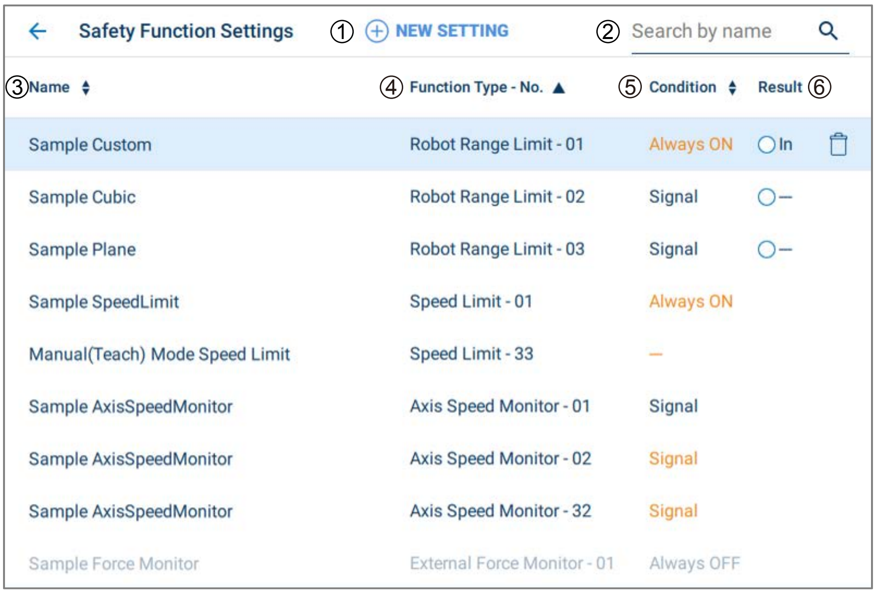
Monitors the external force applied to the manipulator's TCP and each joint axis by using PFL function.

12.4.3 Safety Functions List View

12.4.3.1 List View

Safety functions list view shows the safety function list which is set.

To show this list, select {MENU} → {Safety Function} → {Safety Functions}.



① **+ NEW SETTING**

Create new safety setting.

② **Search by Name**

Search the setting in the list by name.

③ **Name**

It shows name of the setting.
It can be sorted by name.

④ **ID Number**

It shows ID Number of the setting.
It can be sorted by ID Number.

⑤ **Condition**

It shows Enable Condition of the setting.
It can be sorted by Enable Condition.
The color of Enable Condition is changed as monitoring state.
Correspondence between the color and monitoring state is as following table.

Color	Monitoring State
Gray	Monitoring is always OFF.
Black	Monitoring is OFF. It does not match as the condition of safety input signal. Or the setting is temporary disabled.
Orange	Monitoring is ON.

⑥ Result

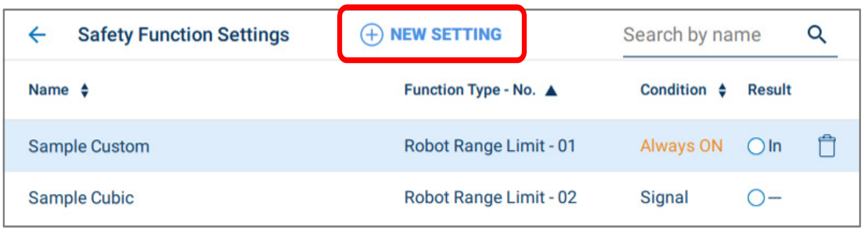
It shows the monitoring result.

Color	Monitoring Result
White	Not safe
Green	Safe

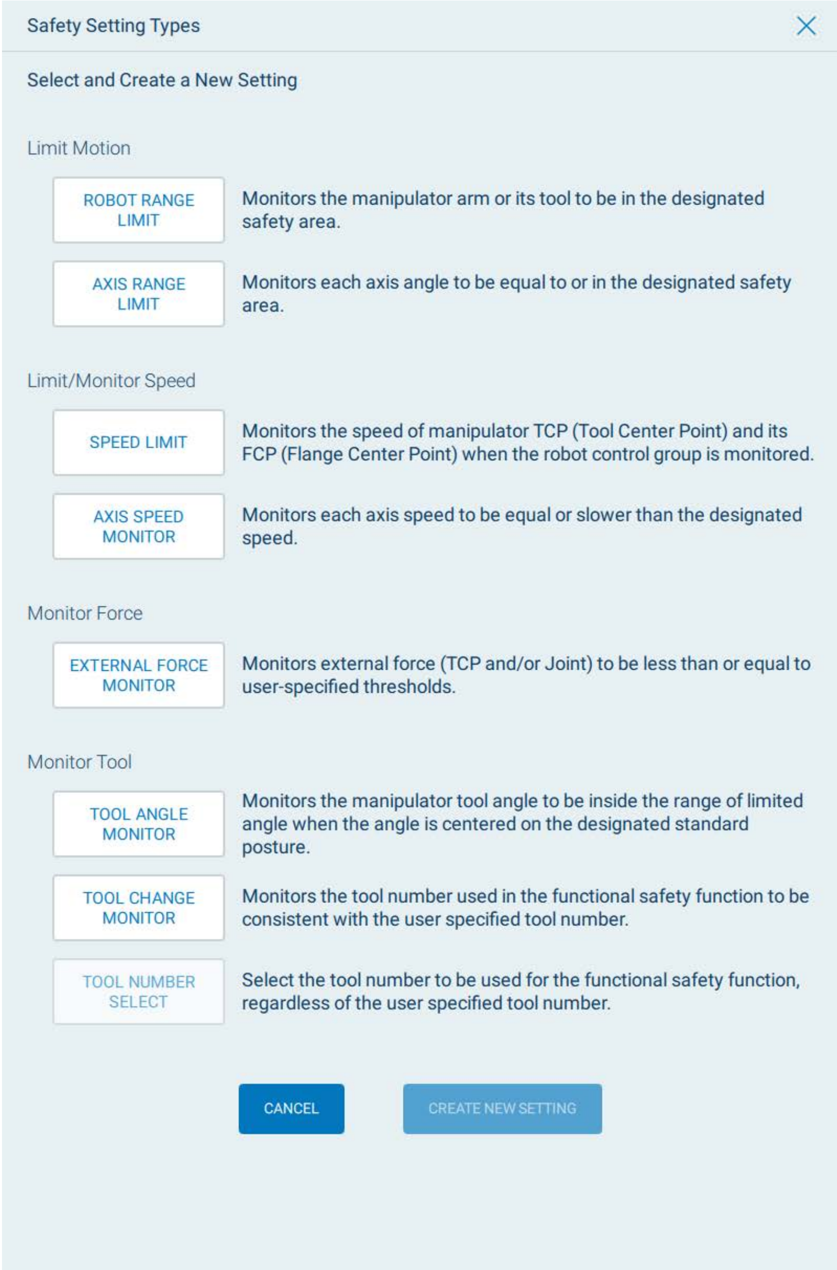
12.4.3.2 Create New Setting

The procedure to create new safety setting is as following.

1. Press {+ NEW SETTING}.



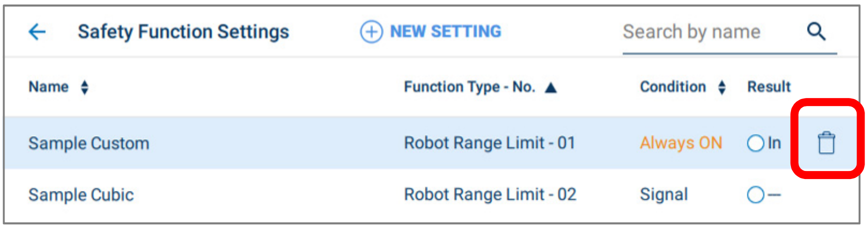
2. Select the safety setting type, and press {CREATE NEW SETTING}.



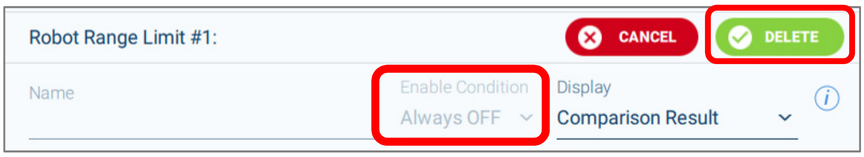
12.4.3.3 Delete Setting

The procedure to delete safety setting is as following.

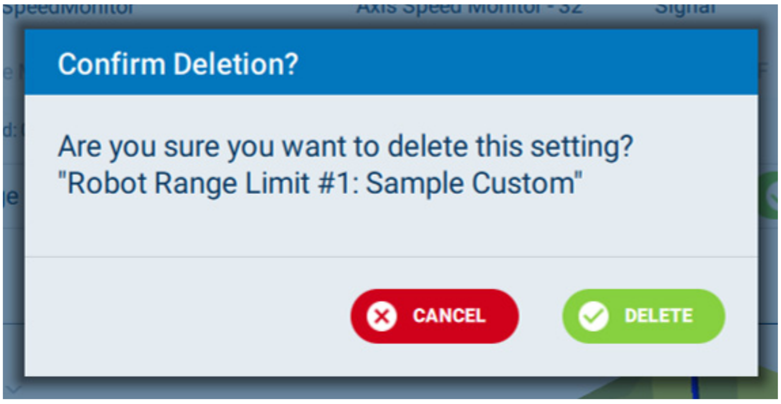
1. Go to {MENU} → {Safety Settings} → {Safety Functions}.
2. Select the safety setting from the Safety Functions List View.
3. Press Trash Can icon.
   – The setting will readback.



4. Confirm that the Enable condition is changed to “Always OFF”, and press {DELETE}.
   – Pop dialog shows.



5. Press {DELETE}.



12.4.4 Robot Range Limit

Robot Range Limit function is a function which monitors robot position using software.

Robot Range Limit define the Robot range of motion with 3 shapes as following, and then monitors the Robot's arm or its tool to be inside the range of motion.

1. Custom
2. Cubic
3. Plane

While Robot is in operation, based on the Robot motion speed, this function calculates the coasting value in case of the immediate stop by the alarm, and then, including this value, this function monitors the safety range. With this monitoring operation, the axes would not exceed the safety range even if a motion error is detected.

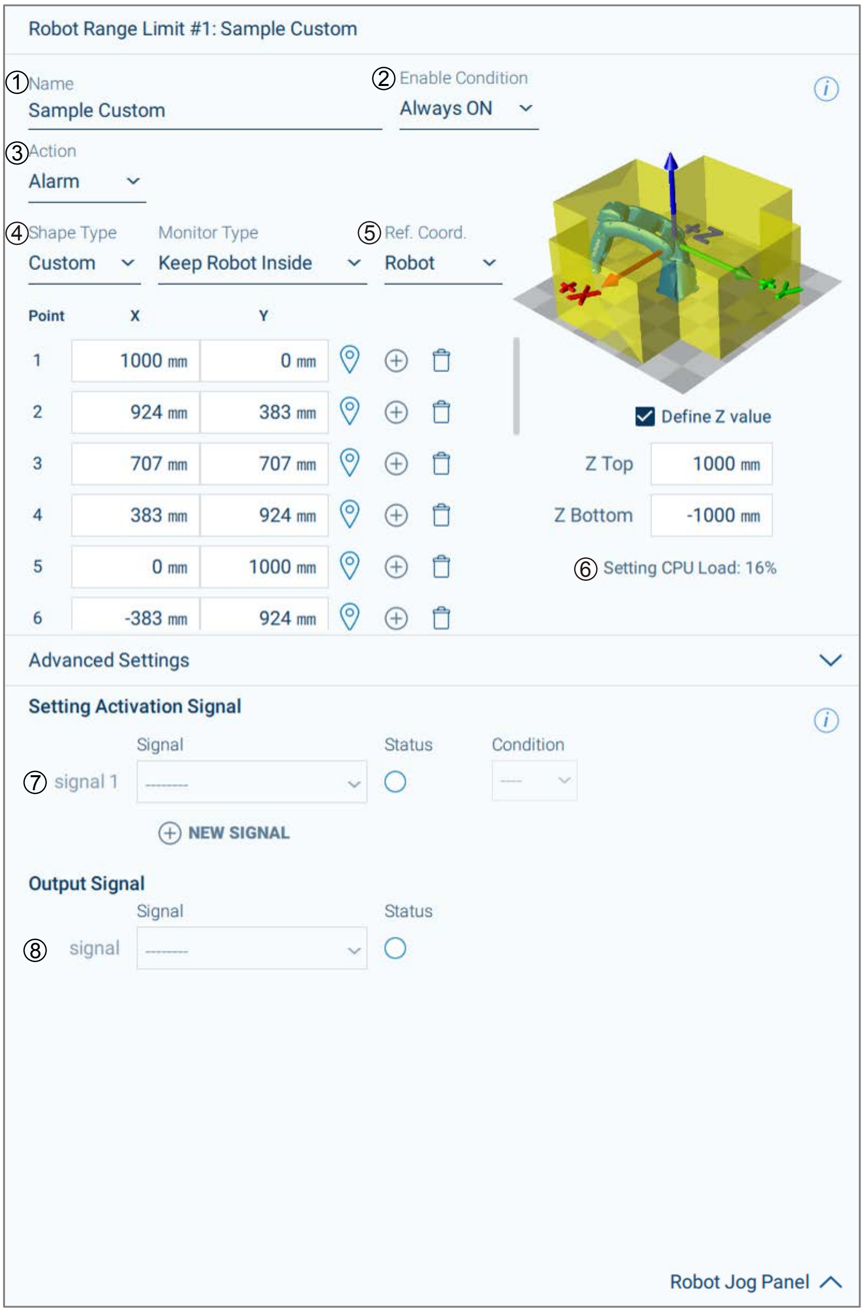
In case an error is detected, the power supply to the motor is stopped using the machine safety and the error is notified using an alarm.

Follow the procedures below when starting the Robot range limit function.

1. Set the Tool File.
   (Before using this function, execute tool file setting by referring to *chapter 6.1 "Tool Settings"*)
2. Set the Tool Interference File.
   (Before using this function, execute tool interference file setting by referring to "YRC1000 OPTIONS INSTRUCTIONS FOR FUNCTIONAL SAFETY FUNCTION (HW1483576)".)
3. Set the Robot Range Limit function.
4. Confirm the safety range.
5. Start the Robot range limit function.

12.4.4.1 Condition Setting

Contents are as following.



① Name

Set Name of the setting.

② Enable Condition

Set Enable Condition of the setting.
In order for the change to take effect, it is necessary to complete WRITE.

Value	Description
Always OFF	Always disable the monitoring.
Always ON	Always enable the monitoring.
Signal	Change the monitoring state by referencing the safety input signal. For the details of the safety signal usage, refer to chapter 12.4 “Functional Safety Functions”.

③ Action

Select alarm or not alarm (Status) to the monitoring result of the setting.

Value	Description
Alarm	Servo is turned OFF with an alarm when an error occurs under the monitoring condition.
Status	Although monitoring is performed under the condition, the alarm does not occur, and the servo is not turned OFF even if a monitoring error occurred. The monitoring result can be obtained by the safety output signal.

DANGER

When “Status” is set to Action, the functional safety function does not stop the manipulator operation even if a monitoring error is detected in the object file. In this regard, before operating the manipulator, sufficiently consider possible risks attributed to the no alarm operation (risk assessment) and take necessary safety measures.

④ Shape Type

Value	Description
Custom	Specifies the monitoring volume as a polygon on the X-Y plane with a height in Z-axis direction.
Cubic	Specifies the monitoring volume as a polygon on the X-Y plane with a height in Z-axis direction.
Plane	Specifies the monitoring area as a plane along either XY, YZ or ZX coordinates.

⑤ Ref. Coord.

Specifies the reference coordinate for the shape.

Value	Description
Robot	Define the monitoring area on the Robot coordinate system.
World	Define the monitoring area on the World (Base) coordinate system.

⑥ Estimated CPU Load

Displays the rate of CPU load for monitoring.

⑦ Setting Activation Signal

Specify the safety input signal for enable setting when “Enable Condition” is “Signal”.
For the details of the safety signal usage, refer to chapter 12.4 “Functional Safety Functions”.

⑧ Output Signal

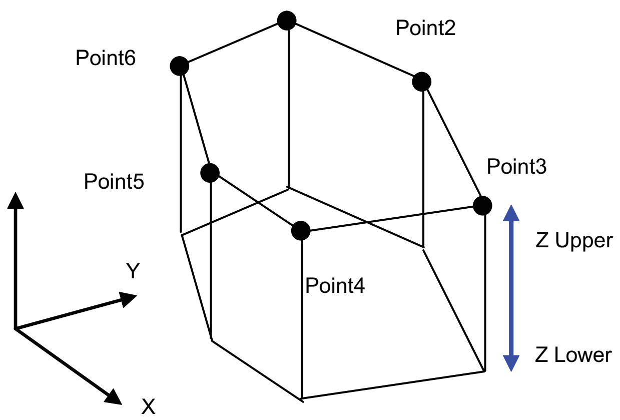
Specify the safety output signal for output the monitoring result.

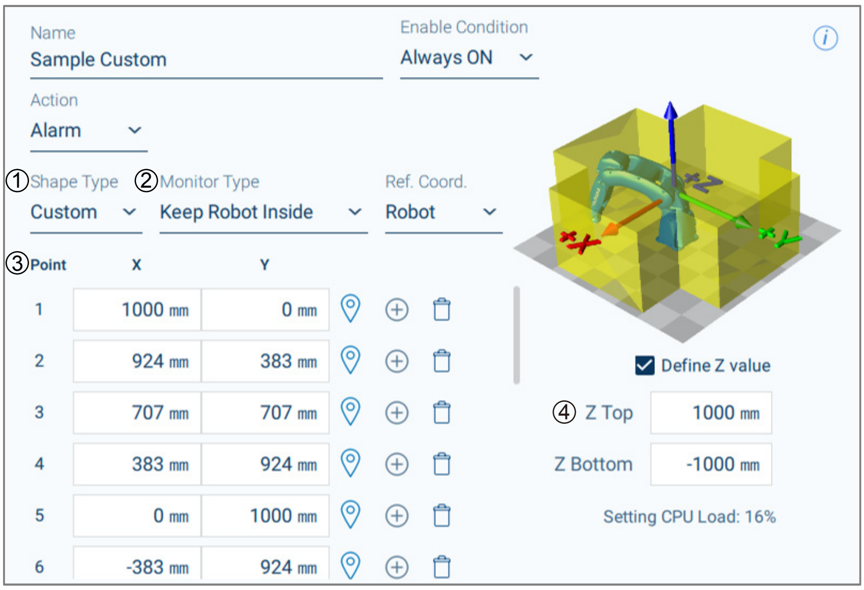
Signal output as following.

Monitoring State	Monitoring Result	Output
Disabled	----	OFF
Enabled	Object manipulator or tool is inside the safety range.	ON
	Object manipulator or tool is detected to be outside the safety range	OFF
	For the object manipulator or tool, the stop position to which coasting value is included are detected to be in error status when moving close to the border of the safety.	OFF

■ **Robot Range Limit as Custom Shape**

If Custom is selected in Shape Type, it specifies boundaries within which the Robot moves or boundaries that prevent Robot from entering with polygon on the X-Y plane with a height in Z-axis direction.





① **Shape Type**

To specifies the monitoring volume as a custom, select Custom in Shape Type.

② **Monitor Type**

When selecting the {Keep Robot Inside}, the polygon can be specified by 3 to 16 points. The space inside the area is defined as the safety range. When the result of the monitoring is safe, the object arm and the tool of the manipulator are kept inside the safety range.
When selecting the {Keep Robot Outside}, the polygon can be specified by 3 to 4 points. The space outside the area is defined as the safety range. When the result of the monitoring is safe, the object arm and tool of the manipulator are kept outside the range.
The area specified should be convex.

③ **Point (X,Y)**

Specifies the points on the X-Y plane to define the polygon.
The points are connected in ascending order like

Point 1 → Point2 → Point3 → ..... → Point1

And the line of these points becomes the wall of the range of motion.
Take this procedures into consideration before specifying the points.

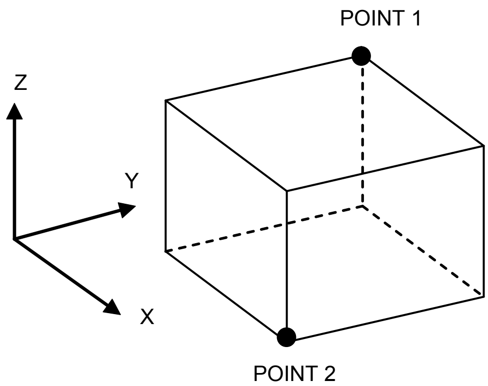
{ }: Set the point as the current TCP position.
{ }: Add new point before selected point.
{ }: Delete selected point.
{NEW POINT}: Add new point after the list.

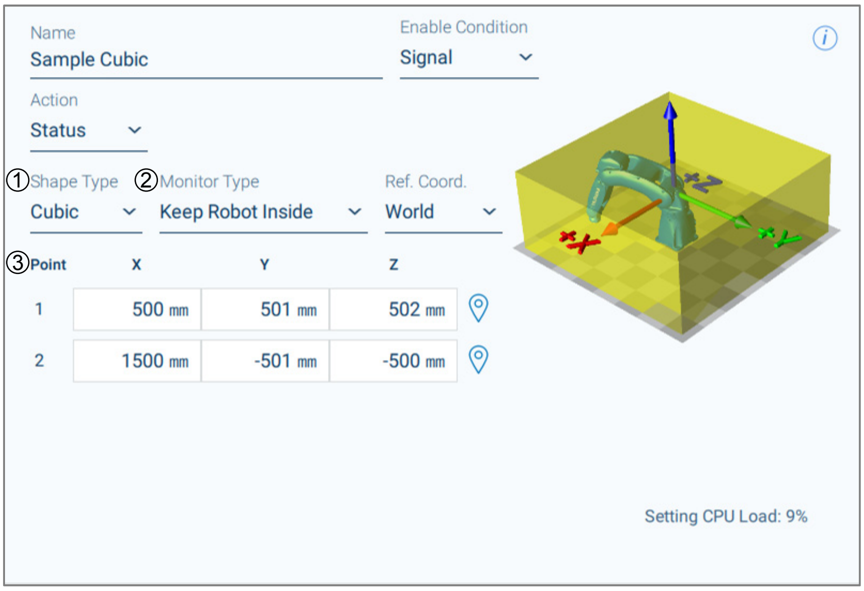
④ **Z Top, Z Bottom**

Specifies the height of the custom shape.
If it is not defined, the height in the Z-axis direction is set to infinite (polygon prism of infinite height).

■ **Robot Range Limit as Cubic Shape**

If Cubic is selected in Shape Type, it specifies boundaries within which the Robot moves or boundaries that prevent Robot from entering with cuboid whose diagonal line is specified by the points.





① Shape Type

To specifies the monitoring volume as a cubic, select Cubic in Shape Type.

② Monitor Type

When selecting the {Keep Robot Inside}, the space inside the area is defined as the safety range. When the result of the monitoring is safe, the object arm and the tool of the manipulator are kept inside the safety range.
When selecting the {Keep Robot Outside}, the space outside the area is defined as the safety range. When the result of the monitoring is safe, the object arm and tool of the manipulator are kept outside the range.
The area specified should be convex.

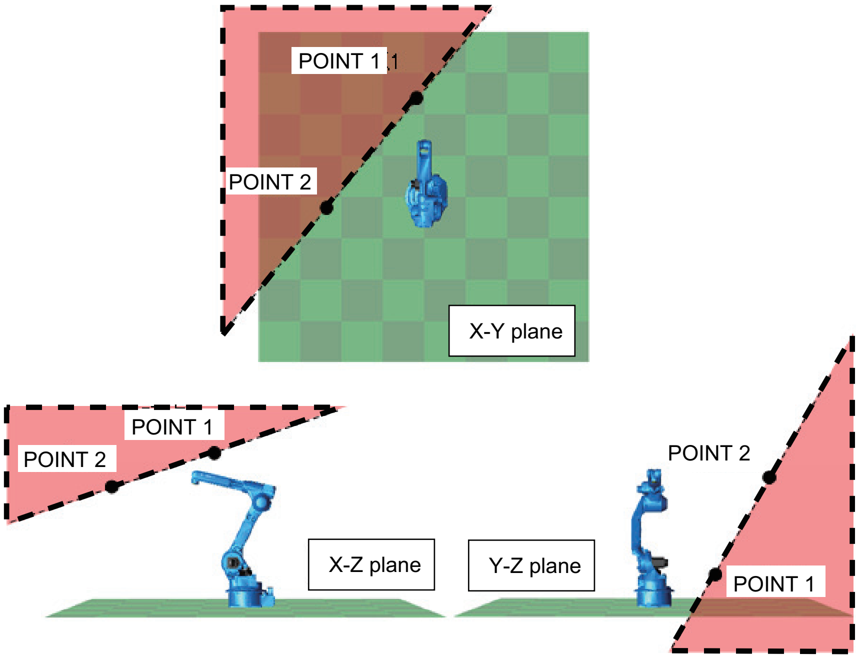
③ Point (X, Y, Z)

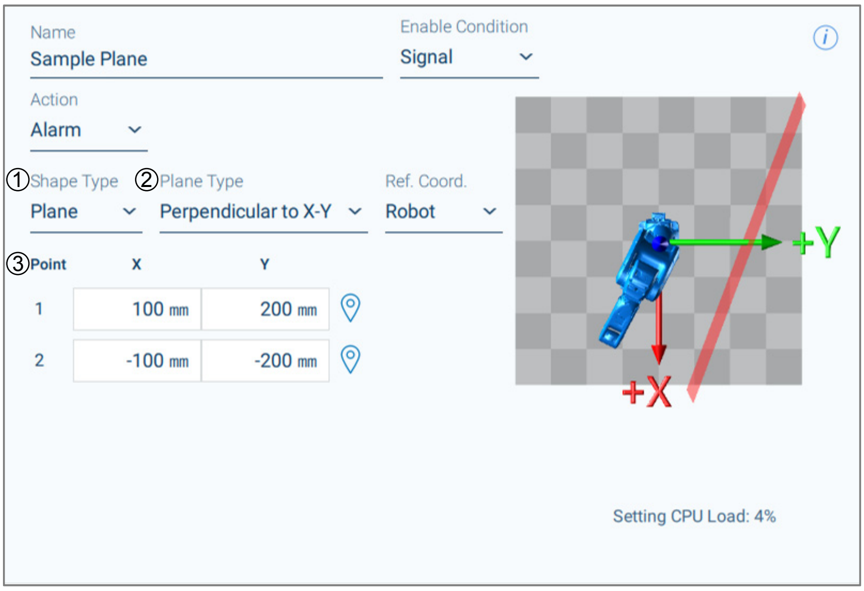
Specify two points on an object coordinates system, and then a cuboid is created whose diagonal line is specified by the points.
In case any two point values input in either X, Y or Z are overlapped, the setting is regarded as an error.

{}: Set the point as the current TCP position.

■ Robot Range Limit as Plane Shape

If Plane is selected in Shape Type, it specifies the monitoring area as a plane along either XY, YZ or ZX coordinates.





① Shape Type

To specifies the monitoring volume as a Plane, select Plane in Shape Type.

② Plane Type

Specifies the plane type to make.

Value	Description
Perpendicular to X-Y	Draw a line on either X-Y coordinate plane, and then, along the line, set a plane (wall) in the vertical direction.
Perpendicular to Y-Z	Draw a line on either Y-Z coordinate plane, and then, along the line, set a plane (wall) in the vertical direction.
Perpendicular to X-Z	Draw a line on either X-Z coordinate plane, and then, along the line, set a plane (wall) in the vertical direction.

③ Point (X, Y) (Y, Z) (X, Z)

Specify two points to draw a straight line on a coordinate plane. In case the coordinates of these two points overlapped, the setting is regarded as an error.

{}: Set the point as the current TCP position.

12.4.4.2 Confirming the Safety Range and Starting the Robot Range Limit

If “Always ON” or “Signal” for Enable Condition is selected, confirm that the monitoring works correctly in the safety range as the setting.

When confirming the safety range, move the axes of the object group into the safety range, and then enable the monitoring of the setting. If “Signal” for Enable Condition is selected, enable the setting by selecting input signals.

Move the axes of the object group to confirm that they stop within the specified safety range.

Confirm by jogging whether the set area is correct.

> **NOTE**
> In the functional safety function, the range of motion is monitored by calculating the coasting values of the manipulator. For this reason, the manipulator stops just before exceeding the safety range in case it moves to the teaching point near the safety range.

In case “Alarm 4783: F-SAFE ROBOT RANGE LIMIT INTF” or “Alarm 4784: ROBOT RANGE LIMIT INTF” appeared

<Cause>

The positions of the Robot and the tool are out of its safety area, or an axis range limit error is detected when the manipulator started moving.

Inside the Robot range limit, taking the feedback speed or the coasting value which were detected by the functional safety function, into consideration, calculation of the movement is executed so that the manipulator would not come out from the safety range. For this reason, when a manipulator moves close to the border of the range, this alarm occurs because the higher its teaching speed becomes, the more its coasting value increases.

<Countermeasure>

Check that the safety range is appropriately set.

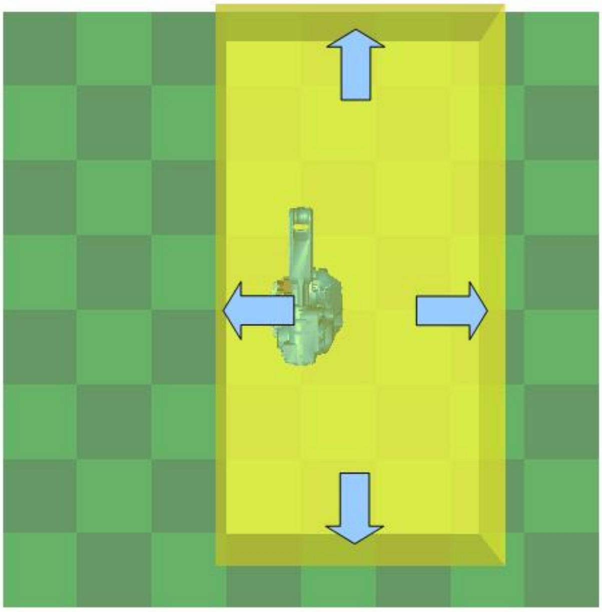
Execute the teaching operation so that the manipulator does not approach close to the border of the range.

Decrease the teaching speed near the border of the range.

■ **Confirming for Custom or Cubic**

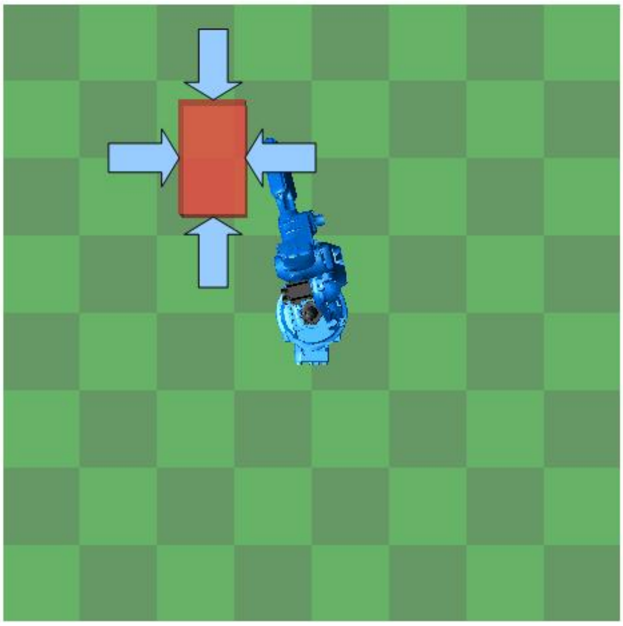
If the {Keep Robot Inside} is selected for Monitor Type, move the manipulator inside the specified four walls and check that it stops just in front of the wall. In case the area is not a cuboid, check that it stops just in front of all walls.

Fig. 12-3: Confirming for {Keep Robot Inside}



If the {Keep Robot Outside} is selected for Monitor Type, to the walls, move the manipulator toward all the direction where it can make approach and check that it stops just in front of each wall (test each wall).

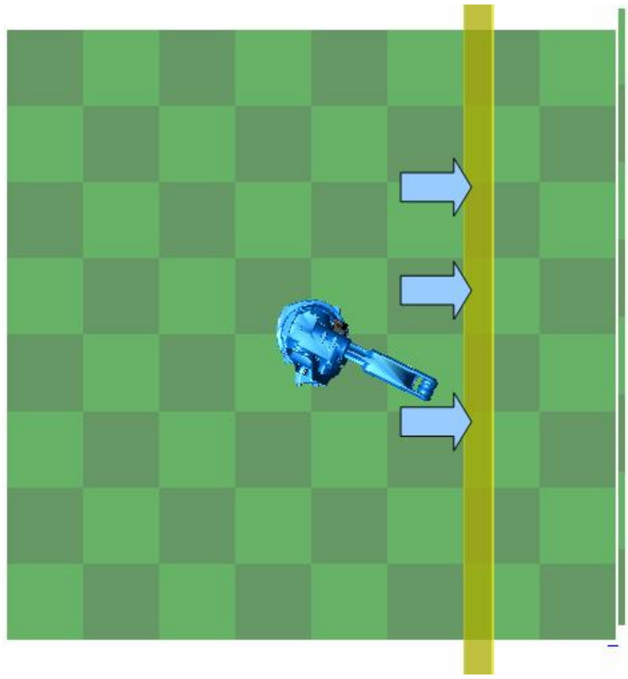
Fig. 12-4: Confirming for {Keep Robot Outside}



■ **Confirming for Plane**

To the specified plane, make the manipulator approach to it. And confirm that the manipulator stops at any three points on the plane.

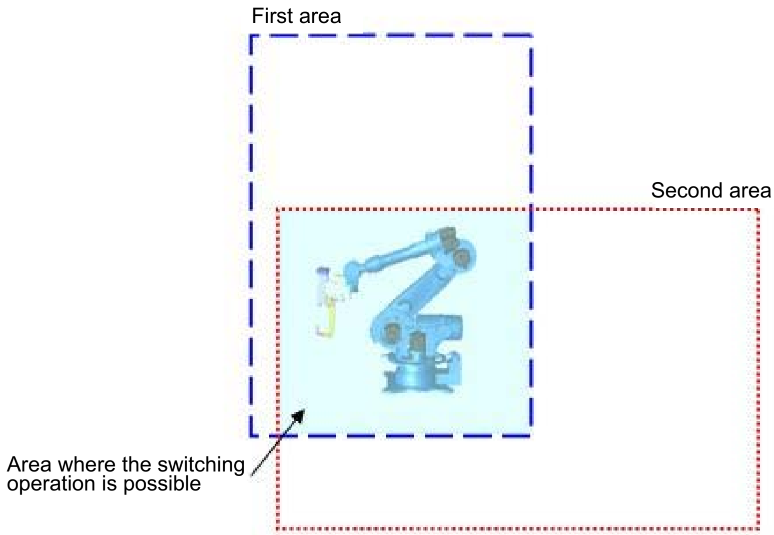
Fig. 12-5: Confirming for Plane



12.4.4.3 Switch the Monitoring Area

When switching the monitoring area using the safety signal input, execute the switching operation after moving the manipulator to be inside the next monitoring area and stopping it completely.

When executing inside the range monitoring at multiple ranges, set the overlapped range and execute the switching only when the manipulator is inside the overlapped area.



When monitoring operation is validated to multiple areas at a time, the overlapped area is regarded as the safety range.

Fig. 12-6: Simultaneous Monitoring: Multiple Areas (Inside the Monitoring Area + Inside the Monitoring Area)

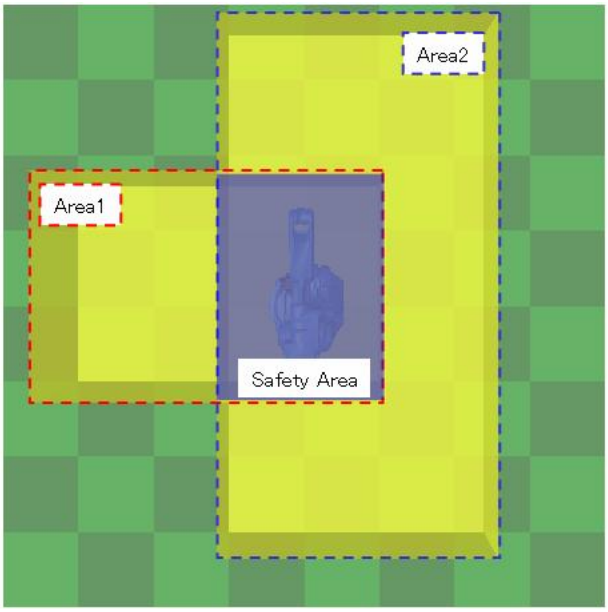
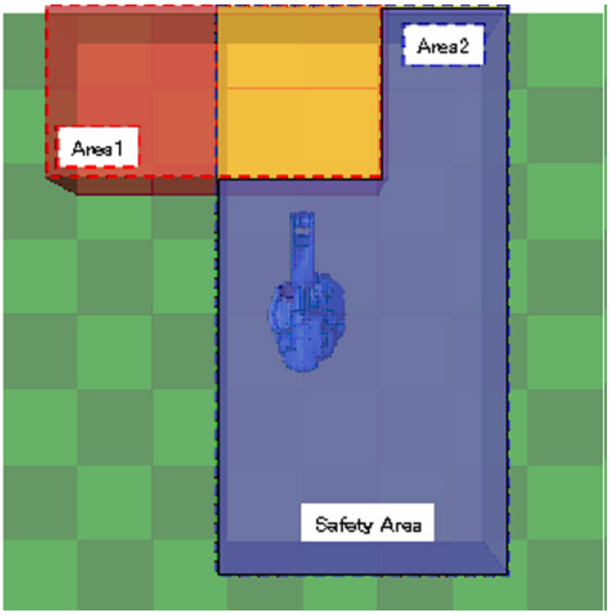


Fig. 12-7: Simultaneous Monitoring: Multiple Areas (Inside the Monitoring Area + Outside the Monitoring Area)



12.4.4.4 Estimated CPU Load

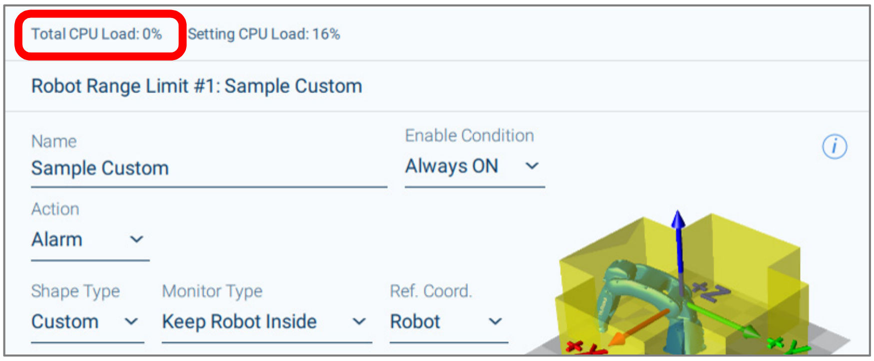
The Robot range limit function can, to some extent, freely define the shape as its range of motion. However, the time period needed for processing the monitoring varies depending on the shape or the method of monitoring.

Regard the allocated processing time for Robot range limit function as 100%. The ratio of necessary processing time for the area created in the object area is indicated to this item.

Followings are processing time for each area created in the object area.

Shape Type	Monitor Type	Number of Points	CPU Load
Custom	Keep Robot Inside	4	10%
		8	12%
		16	16%
	Keep Robot Outside	3	7%
		4	8%
Cubic	Keep Robot Inside	-	9%
	Keep Robot Outside	-	6%
Plane	-	-	4%

Displays the total {Estimated CPU Load} of the settings for which monitoring is enabled. Total CPU Load should be below 100%.



NOTE

When executing the Robot range limit function, even if the total CPU load has exceeded over 100%, following alarms may occur due to insufficient processing time.

Alarm 500 SEGMENT PROC NOT READY

Alarm 1899 F-SAFE MONITOR EXECUTE TIMEOVER

When an alarm has occurred, reduce the area where the monitoring is simultaneously validated to avoid the CPU load from exceeding 100%.

12.4.4.5 Display in 3D Viewer

Robot Range Limit can be displayed and verified using 3D Viewer.

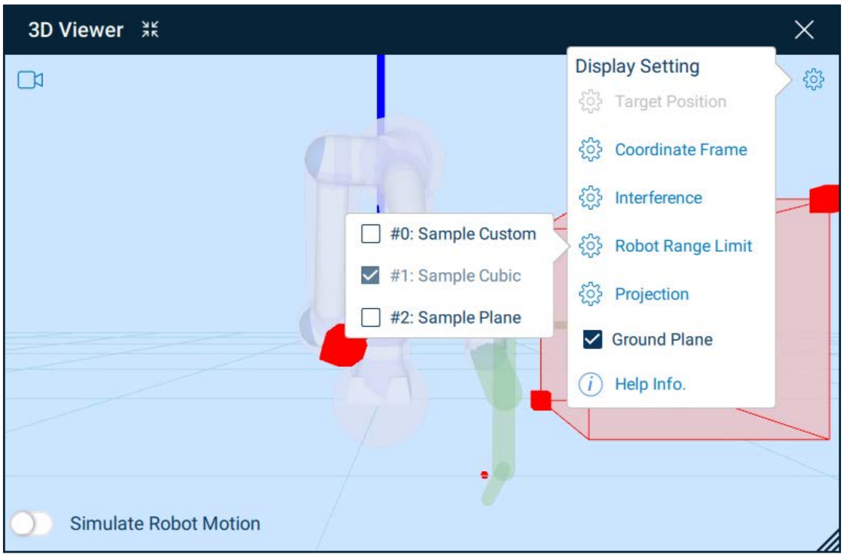
For the basic operation of the 3D Viewer, refer to chapter 9.1 “3D Viewer”.”

By default, the 3D Viewer will be embedded into the Robot Range Limit detail panel as shown in fig. 12-8. The expand arrows on the bottom right can be used to pop out the 3D Viewer Utility.

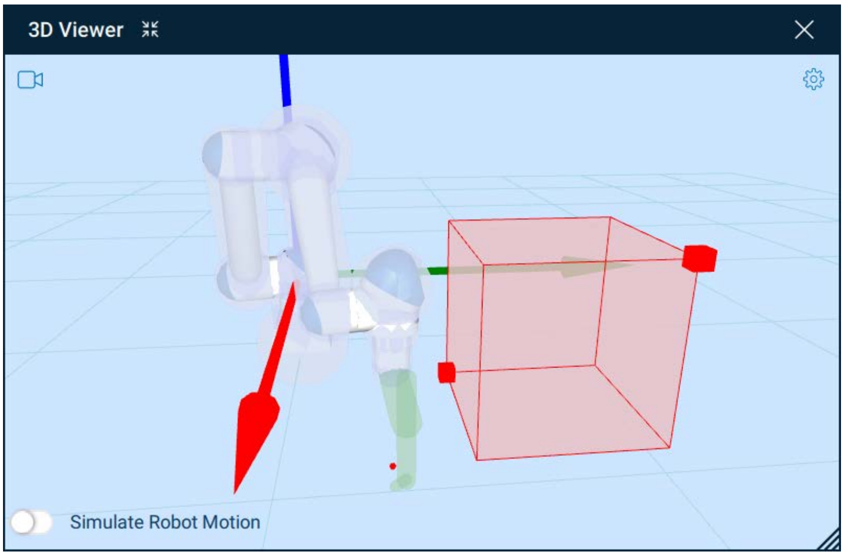
Fig. 12-8: 3D Viewer Inside Safety Settings Detail Panel

Using the 3D Viewer, the Robot Range Limit can be shown by selecting Display Setting → Robot Range Limit and then selecting the desired Robot Range Limit(s) from the list. When Safety Settings screen is open, the currently selected Robot Range Limit will be automatically selected as shown in fig. 12-9.

Fig. 12-9: Robot Range Limit in 3D Viewer



Robot range limit is shown as following in 3D Viewer.



① Current Setting
Displays current robot range limit setting.

② Ref.Coord
Displays reference coordinate.

③ Robot Interference Model
Robot interference model is shown with light blue color.
Robot range limit function uses this model and monitors that robot does not go outside of specified safety area.

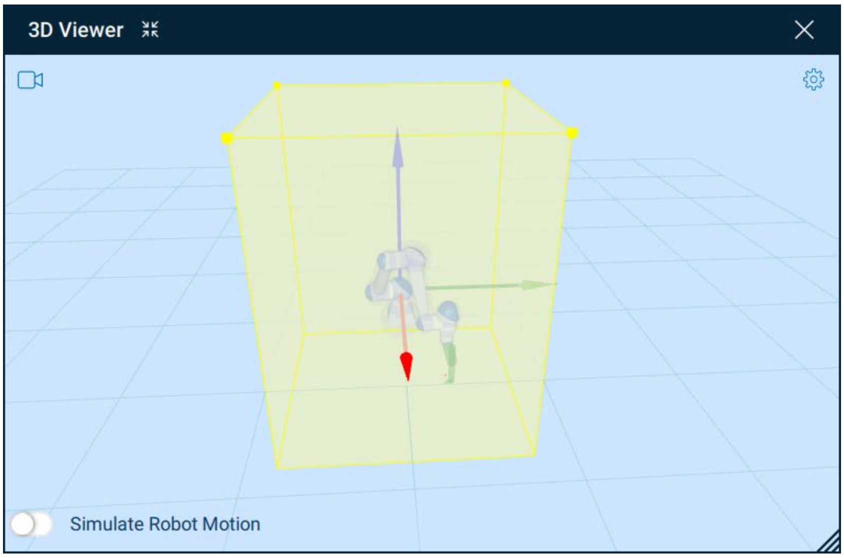
④ Tool Interference Model
Tool interference model is shown with green color.
Robot range limit function uses this model and monitors that tool does not go outside of specified safety area.

Tool interference model should be specified before using the robot range limit. For the setting of tool interference model, refer to chapter 6.1.7 “Tool Interference Model Settings”.

■ **Display of Custom/Cubic, Keep Robot Inside**

The specified range as well as the points used to specify the range are displayed in yellow.

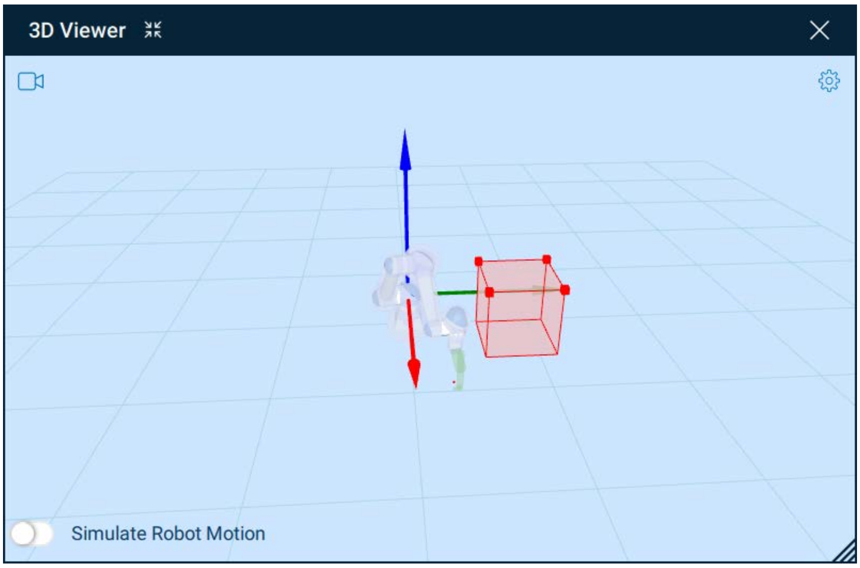
When the result of the monitoring is safe, the object arm and tool of the robot are kept inside the range.



■ **Display of Custom/Cubic, Keep Robot Outside**

The specified range as well as the points used to specify the range are displayed in red.

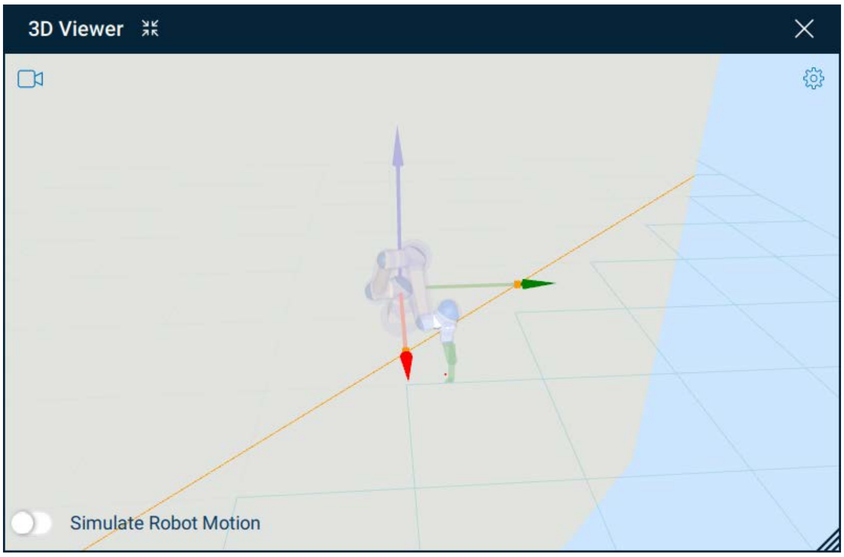
When the result of the monitoring is safe, the object arm and tool of the robot are kept outside the range.



■ **Display of Plane**

The specified range as well as the points used to specify the plane are displayed in yellow.

When the result of the monitoring is safe, the object arm and tool of the robot are kept nearside of the plane.



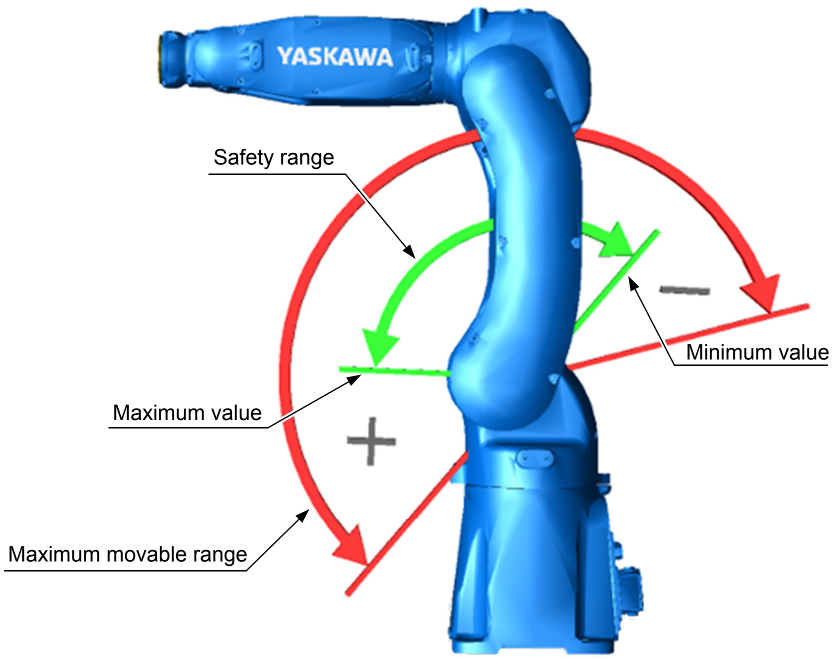
12.4.5 Axis Range Limit

Axis Range Limit function is a function which sets each axis range of motion for the Robot, and base group and monitors whether each axis is inside the already-fixed range of motion using a software.

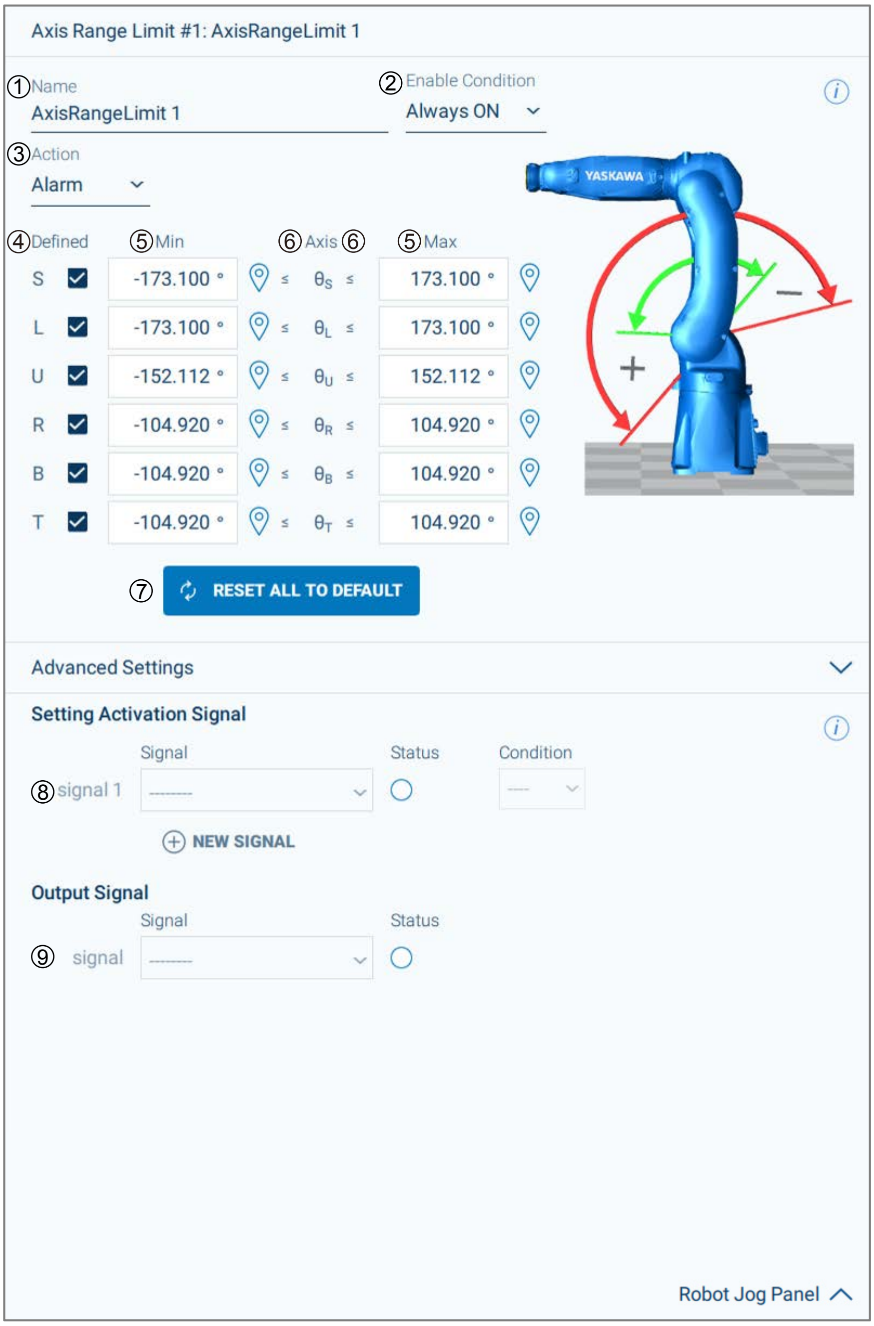
This function specifies the upper limit and the lower limit of the range of motion to those axes and the range inside the limits is defined as the safety range.

While an axis is in operation, based on the axis motion speed, this function calculates the coasting value in case of the immediate stop by the alarm, and then, including this value, it monitors the safety range. With this monitoring operation, the axes would not exceed the safety range even if a motion error is detected.

In case an error is detected, the power supply to the motor is stopped using the machine safety. And the error is notified using an alarm.



12.4.5.1 Condition Setting



① **Name**

Set Name of the setting.

② Enable Condition

Set Enable Condition of the setting.
In order for the change to take effect, it is necessary to complete WRITE.

Value	Description
Always OFF	Always disable the monitoring.
Always ON	Always enable the monitoring.
Signal	Change the monitoring state by referring the safety input signal. For the details of the safety signal usage, refer to chapter 12.4 “Functional Safety Functions”.

③ Action

Select alarm or not alarm to the monitoring result of the setting.

Value	Description
Alarm	Servo is turned OFF with an alarm when an error occurs under the monitoring condition.
Status	Although monitoring is performed under the condition, alarm does not occur, and the servo is not turned OFF even if a monitoring error has occurred. The monitoring result can be obtained by the safety output signal.

DANGER

When “Status” is set to Action, the functional safety function does not stop the manipulator operation even if a monitoring error is detected in the object file. In this regard, before operating the manipulator, sufficiently consider possible risks attributed to the NO alarm operation (risk assessment) and take necessary measures.

④ Defined

Specify Enable/Disable for a target axis.

This setting is referred when the setting is enabled and is not referred when it is disabled.

Followings show the combination of conditions.

Monitoring Status	Defined	Result
Enabled	Defined	O Monitoring for the target axis is enabled.
Enabled	Not Defined	X Monitoring for the target axis is disabled.
Disabled	Defined	
Disabled	Not Defined	

⑤ Min, Max

Values for maximum/minimum range of motion can be input for the object axis.
As their inputting range, the position value limited by the soft limit switch of the manipulator can be input.
This value can also be entered by jogging the Robot to the desired limit position and pressing {}.

Value	Description
Min	Expresses the minimum limited range in which an axis moves.
Max	Expresses the maximum limited range in which an axis moves.

⑥ Boundary

Displays whether the range of motion of the axis includes or excludes the maximum value and/or the minimum value.
The maximum value and the minimum value of each axis can be specified independently. To include the value in the range, displays ≤ (IN). To exclude the value from the range, displays < (EX).
This is set "≤ (IN)" as default. This can be changed in Classic Interface.

⑦ Reset All to Default

Reset all axes min, max value to soft limit. Range limit for all axes will be disabled (Defined will be unselected).

⑧ Setting Activation Signal

Specify the safety input signal for enable the setting when "Enable Condition" is "Signal".
For the details of the safety signal usage, refer to chapter 12.4 "Functional Safety Functions".

⑨ Output Signal

Specify the safety output signal for output the monitoring result.

Signal output as following.

Monitoring State	Monitoring Result	Output
Disabled	----	OFF
Enabled	All the axes monitoring is validated are inside the safety range.	ON
	Some of the axes monitoring are validated are detected to be outside the safety range.	OFF
	For some of the axes monitoring are validated, the stop position to which coasting value is included are detected to be in error status when moving close to the border of the safety range.	OFF

12.4.5.2 Confirming the Safety Range and Starting the Axis Range Monitor

If “Always ON” or “Signal” for Enable Condition is selected, confirm that the monitoring works correctly in the safety range as the setting.

When confirming the safety range, move the axes of the object group into the safety range, and then enable the monitoring of the setting. If “Signal” for Enable Condition is selected, enable the setting by selecting input signals.

Move the axes of the object group to confirm that they stop within the specified safety range.

Confirm by jogging whether the set area is correct.

> NOTE
>
> In the functional safety function, the range of motion is monitored by calculating the coasting values of the manipulator. For this reason, the manipulator stops just before exceeding the safety range in case it moves to the teaching point near the safety range.

After confirming that the object axis moves to reach the edge of the specified safety range, select {CONFIRM} on the screen. The axis range limit can be performed.

Execute playback operation to confirm the manipulator’s motion. An alarm may occur in case the teaching point or the settings are inappropriate.

When “Alarm 4780: F-SAFE AXIS RANGE LIMIT INTF” or “Alarm 4781: AXIS RANGE LIMIT INTF” appeared

<Cause>

The position of the axis is out of the safety range or a range of motion error is detected when the axis moved.
In the functional safety function, the axis position is monitored based on the feedback pulse from the motor. In this case, taking the axis speed or coasting value into consideration, calculation of the movement is executed so that the manipulator would not come out from the safety range.

For this reason, in case a teaching point is set close to the edge of the safety range, and when the teaching speed is high, this alarm occurs.

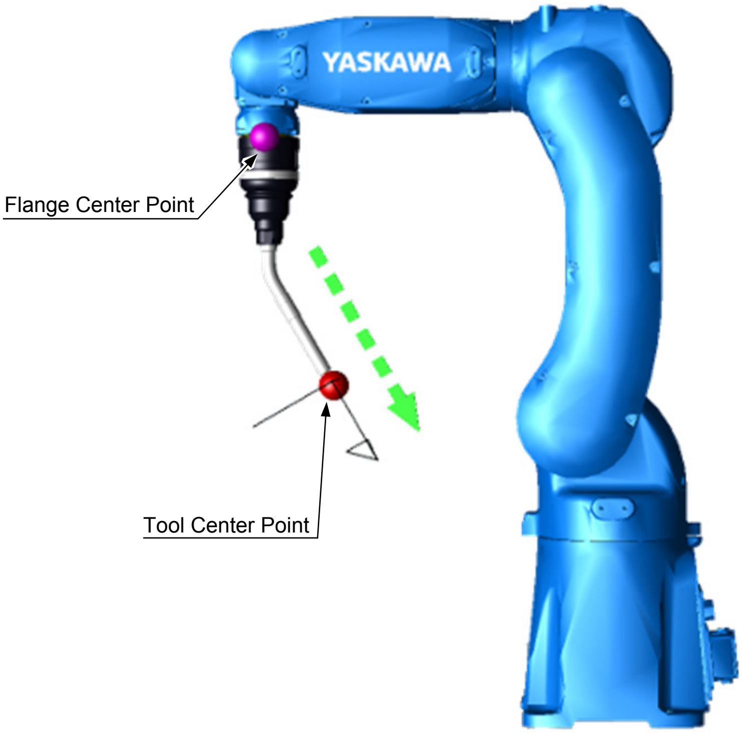
<Countermeasure>

Confirm the safety range.
Modify the teaching point so that it moves not to close to the safety range border.
Decrease the manipulator’s teaching speed when it passes by the border of the safety range.

12.4.6 Speed Limit

12.4.6.1 Outline of the Speed Limit

Speed Limit function is a function which monitors whether the speed of the Robot control points do not exceed the limit or not. Monitored Robot control points are TCP (Tool Center Point) and FCP (Flange Center Point).

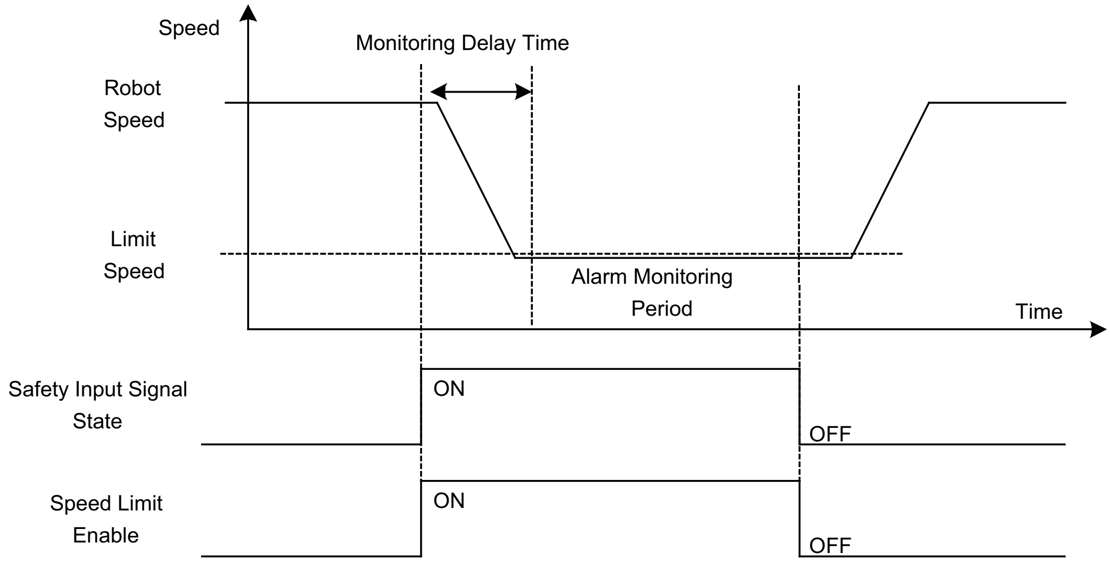


When “0” is set to the speed limit, it becomes the stop position monitoring. the stop position monitoring is performed to TCP or FCP to confirm each point does not move.

When the speed limit function setting is enabled and in case the taught speed is faster than the limited speed, the speed decreases. The actual motion speed will be smaller than the limited speed for safety reason. Once the speed is decreased, then the monitoring starts.

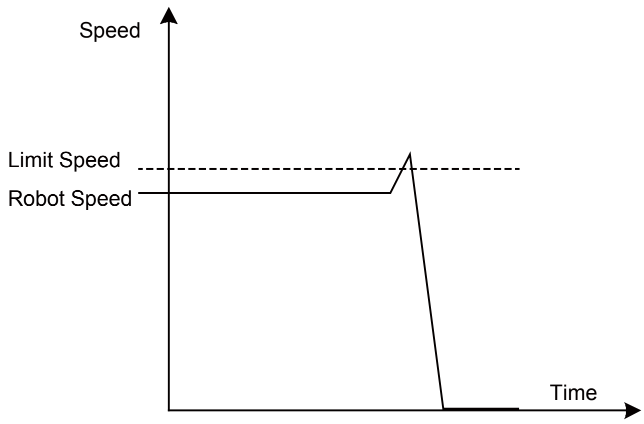
The time for decreasing the speed varies depending on the manipulator type or teaching conditions. For this reason, in the functional safety function, the period of time from validating the condition file to complete decreasing is regarded as the monitoring delay time and this can be set to the Speed Limit setting.

Fig. 12-10: Outline of Speed Limit Function



In case an abnormality is detected, the power supply to the motor is stopped using the machine safety, and alarm is notified. Press reset button on the alarm notification once the abnormality is solved.

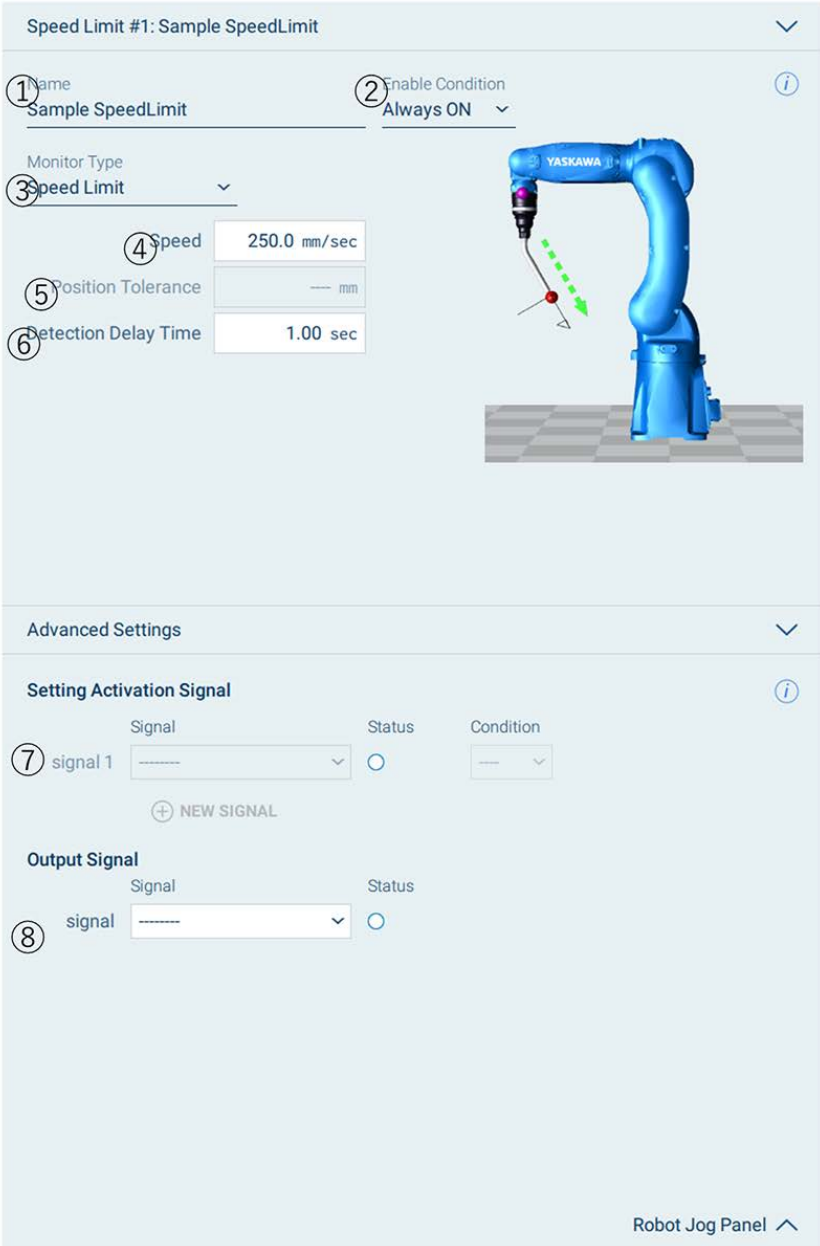
Fig. 12-11: Abnormality Detected on Speed Limit



Along with the above-mentioned monitoring, when it is in the MANUAL (TEACH) mode, the speed is always monitored to be 250 mm/sec as the MANUAL (TEACH) mode safety speed.

12.4.6.2 Condition Setting

Contents are as following.



① **Name**

Set Name of the setting.

② **Enable Condition**

Set Enable Condition of the setting.
In order for the change to take effect, it is necessary to complete WRITE.

Value	Description
Always OFF	Always disable the monitoring.
Always ON	Always enable the monitoring.
Signal	Change the monitoring state by referring the safety input signal. For the details of the safety signal usage, refer to chapter 12.4 “Functional Safety Functions”.

③ Monitor Type

Use this to select whether this function should limit the speed below the specified value or to monitor robot stop state (zero speed).

Value	Description
Speed Limit	Limits that control points speed to below the specified speed.
Stop Monitor	Monitor that control points don't move from the start of the stop monitoring.

④ Speed

Specify the speed limit to the motion speed.

This item can be specified when “Speed Limit” is set to “Monitor Type”.

NOTE

When limiting speed with low speed (0.1 to 5 [mm/sec] or 0.1 to 5 [%]), even during speed limit, F-SAFETY SPEED LIMIT ERROR alarms may occur due to tiny motions such as turning ON of the servo.

When required, take measures, such as review the limit speed, limit section, or use stop monitoring.

⑤ Position Tolerance

Specify the position tolerance for the stop position monitoring.
This item can be specified when “Stop Monitor” is set to “Monitor Type”.

Although the stop position monitoring monitors the difference between the stop position monitoring start position and the present position, to avoid any alarms from occurring due to tiny motions such as turning ON of the servo during the monitoring, “Position Tolerance” is specified. An alarm occurs when the axis moves to exceed the position where the acceptable range is added to the stop position monitoring start position.

⑥ Detection Delay Time

Specify a time frame from validating the condition file to start the alarm detection.

⑦ Setting Activation Signal

Specify the safety input signal for enable the setting when “Enable Condition” is “Signal”.
For the details of the safety signal usage, refer to chapter 12.4.

⑧ Output Signal

Specify the safety output signal for output the monitoring result.

Signal output as following.

Monitoring State	Monitoring Result	Output
Disabled	----	OFF
Enabled	Monitored group is normal within the speed limit.	ON
	Monitored group is detected the limited speed error.	OFF

12.4.6.3 Starting the Speed Limit

Specify the speed limit function and press {WRITE}, the speed limit function will be enabled.

12.4.6.4 Speed Limit in MANUAL (TEACH) Mode

While the MANUAL (TEACH) mode is selected, the speed is monitored at 250 [mm/sec] for safety under the functional safety function. Unlike other speed limit functions, this monitoring function cannot be disabled.

However, only when the full speed test is input by the external signal and when the manual brake is released, this monitoring function will be disabled. This allows the speed can be higher than 250 [mm/sec] even during the MANUAL (TEACH) mode.

For the full speed test, refer to “YRC1000 INSTRUCTIONS (RE-CTO-A221) chapter 8.26 Safety Logic Circuit”.

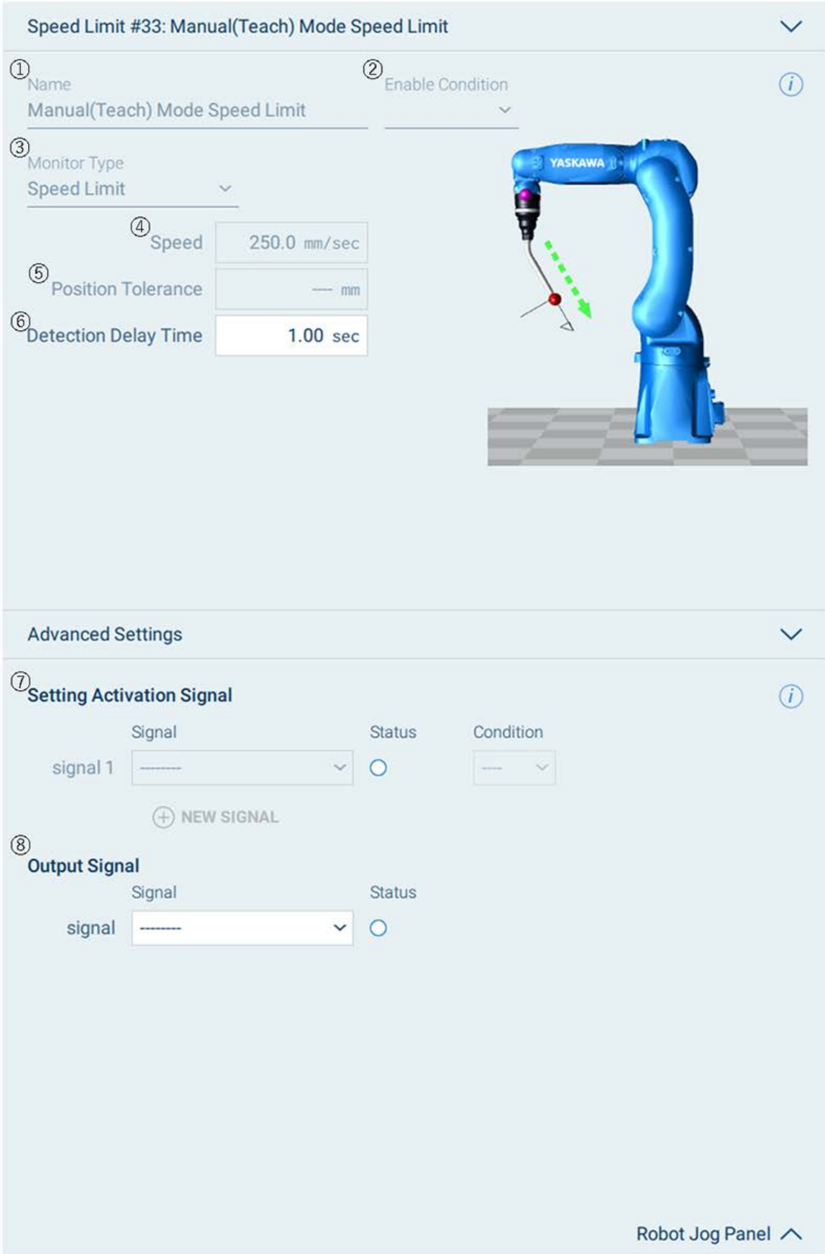
For the manual brake release function, refer to chapter 6.10 “Brake Release”.

NOTE

When using the full speed test or manual brake release functions, possible risks attributed to the speed limit release should be sufficiently considered (risk assessment) before operating the manipulator.

MANUAL (TEACH) mode speed limit is set in No.33 as “MANUAL (TEACH) Mode Speed Limit”.

In the MANUAL (TEACH) mode speed limit setting, editing parameter are limited as following.



① **Name**

It is set as MANUAL (TEACH) Mode Speed Limit”. It cannot be modified.

② **Enable Condition**

This monitoring function cannot be disabled.
But, only when the full speed test is input by the external signal and when the manual brake is released, this monitoring function will be disabled.

③ **Monitor Type**

It is set as Speed Limit. It cannot be modified.

④ **Speed**

It is set as 250mm/sec. It cannot be modified.

⑤ Position Tolerance

It cannot be modified.

⑥ Detection Delay Time

Specify a time frame from validating the condition of the speed limit to start the alarm detection. It is set as the time for decreasing the speed slower than 250 mm/sec when the full speed test function is released.

⑦ Setting Activation Signal

It cannot be specified.

⑧ Output Signal

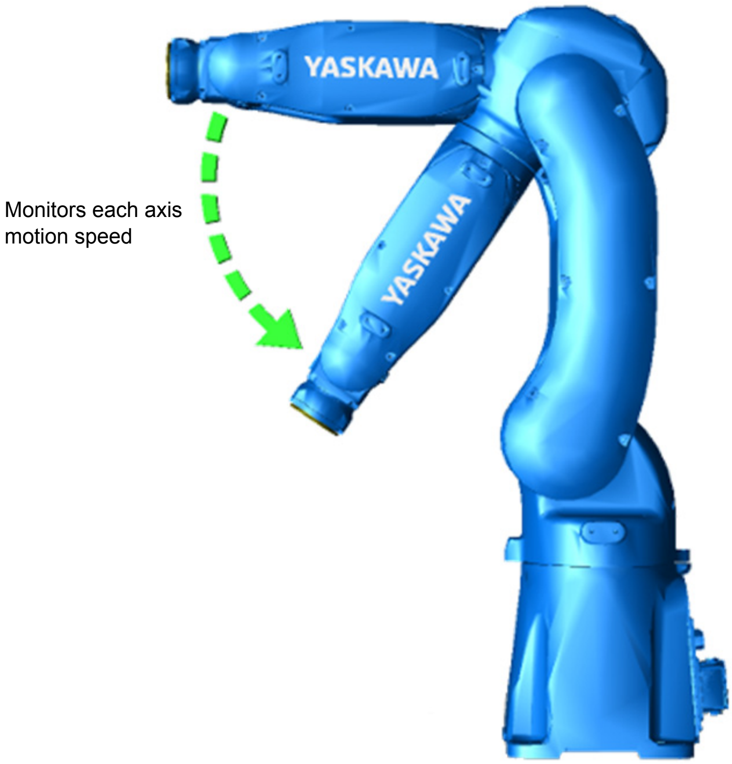
Specify the safety output signal for output the monitoring result.

12.4.7 Axis Speed Monitor

Axis speed monitor function is a function which monitors whether each axis does not exceed the limit.

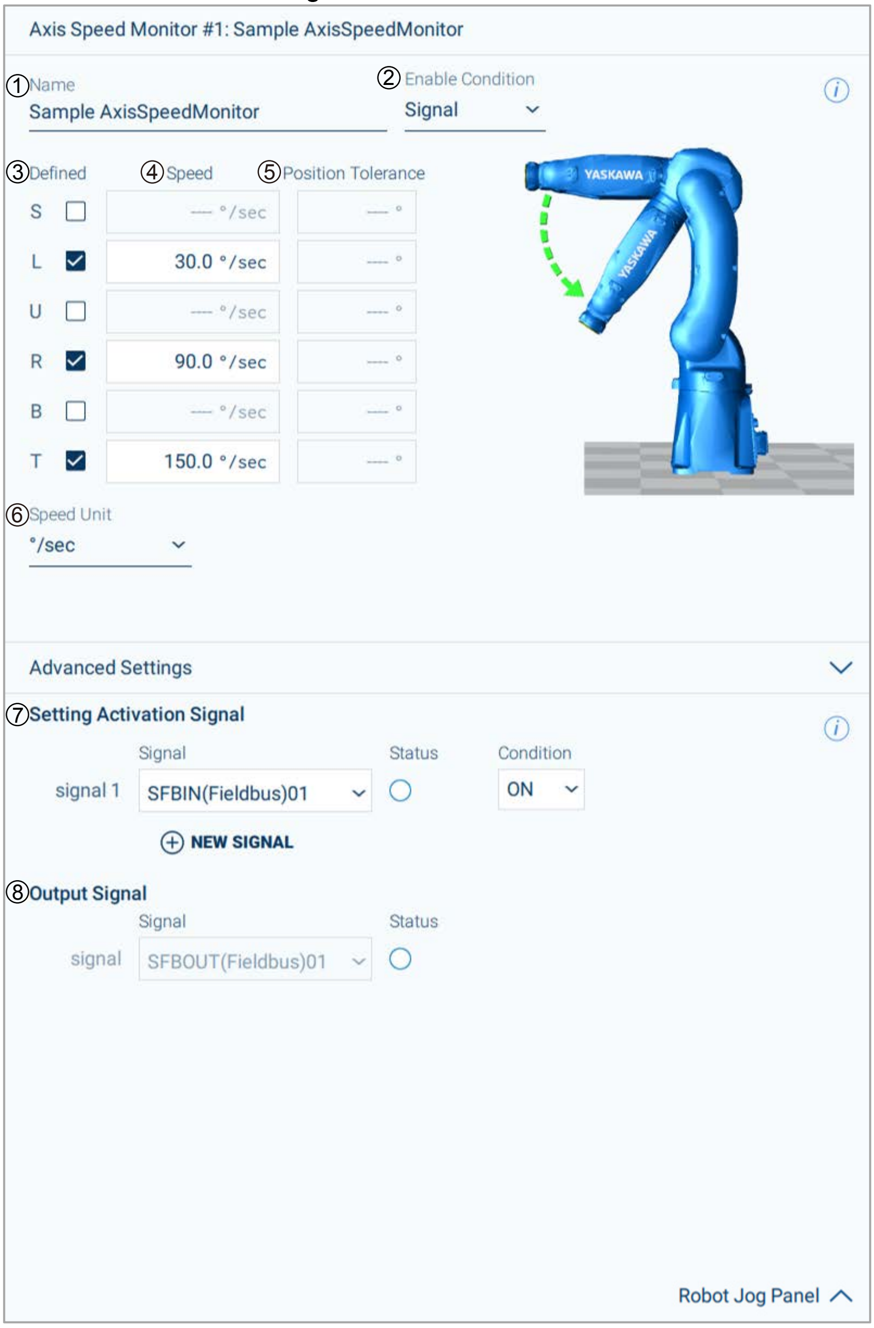
When “0” is set to the speed limit, it becomes the stop position monitoring. This monitors the axis whether it does not move to exceed the limit of specified range from the point where the monitoring is started.

In case an abnormality is detected, the power supply to the motor is stopped using the machine safety, and alarm is notified.



12.4.7.1 Condition Setting

Contents are as following.



① Name

Set Name of the setting.

② Enable Condition

Set Enable Condition of the setting.
In order for the change to take effect, it is necessary to complete WRITE.

Value	Description
Always OFF	Always disable the monitoring.
Always ON	Always enable the monitoring.
Signal	Change the monitoring state by referring the safety input signal. For the details of the safety signal usage, refer to chapter 12.4 “Functional Safety Functions”.

③ Defined

Specify Enable/Disable for a target axis.

This setting is referred when the setting is enabled and is not referred when it is disabled.

Followings show the combination of conditions.

Monitoring Status	Defined	Result
Enabled	Defined	O Monitoring for the target axis is enabled.
Enabled	Not Defined	X Monitoring for the target axis is disabled.
Disabled	Defined	
Disabled	Not Defined	

④ Speed

To each target axis, set the upper limit of motion speed.
When “°/sec” is set as the unit of the speed, “°/sec” is used for a rotating axis.
When “%” is set as the unit of the speed, calculate and set the upper limit by considering the maximum speed as 100%. This unit “%” is the same as the unit of the set value used when the target axis is independently operated by JointMove Speed=xx%.

⑤ Position Tolerance

Specify the position tolerance for the stop position monitoring.
This item can be specified when “0” is set to “Speed”.

Although the stop position monitoring monitors the difference between the stop position monitoring start position and the present position, to avoid any alarms from occurring due to tiny motions such as turning ON of the servo during the monitoring, “Position Tolerance” is specified. An alarm occurs when {ACCEP.RNG} is set in ± direction from the stop position monitoring starting position and the axis moves to exceed the position.

⑥ Speed Unit

Specify the unit of speed in the setting.
When “°/sec” is set, “°/sec” is used for a rotating axis.
When “%” is set, percentage is used.

⑦ Setting Activation Signal

Specify the safety input signal for enable the setting when “Enable Condition” is “Signal”.
For the details of the safety signal usage, refer to chapter 12.4 “Functional Safety Functions”.

⑧ Output Signal

Specify the safety output signal for output the monitoring result.

Signal output as following.

Monitoring State	Monitoring Result	Output
Disabled	----	OFF
Enabled	All monitoring axes are normal within the speed limit.	ON
	Some axes are detected the limited speed error.	OFF

12.4.7.2 Starting the Axis Speed Monitor

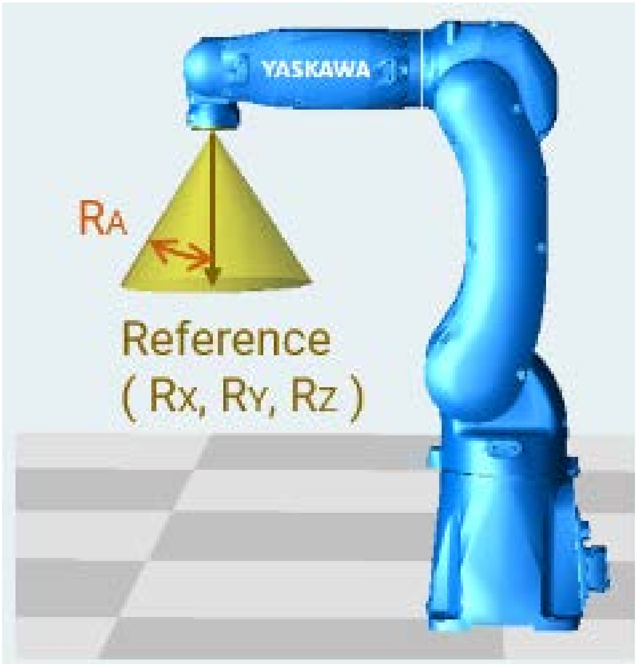
Specify the axis speed monitor function and press {WRITE}, the axis speed monitor function will be enabled.

12.4.8 Tool Angle Monitor

This function determines whether the angle of the active tool exceeds an acceptable angle about a reference posture (both specified by the user). If active tool properties are not defined, this function will monitor the tilt angle of the empty tool flange.

To the object robot group, the tool tilting angle which is regarded as the reference for the monitoring is defined as “Reference Posture”. At this time the tool posture is calculated on the basis of the base coordinates as its standard. While the condition file is validated, this function monitors whether the “Reference Posture”-centered angle of the tool does not exceed the specified acceptable angle.

In case an error is detected, the power supply to the motor is stopped using the machine safety.

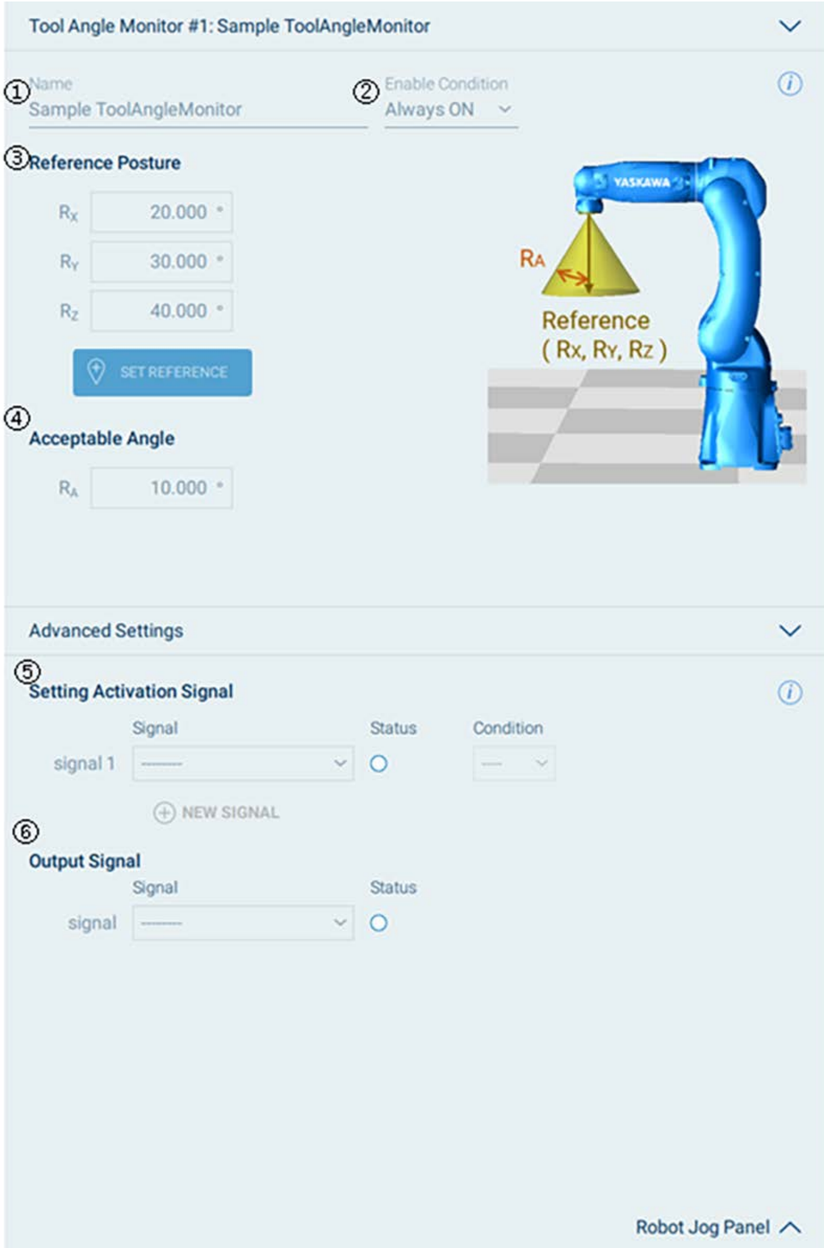


Follow the procedures below when starting the tool angle monitor function.

1. Set the tool setting. (Before using this function, execute tool setting by referring to *chapter 6.1 “Tool Settings”*.)
2. Set values to {Reference Posture} and {Acceptable Angle}.
3. Confirm the safety range.
4. Start the tool angle monitor function.

12.4.8.1 Condition Settings

Contents are as following.



① **Name**

Set Name of the setting.

② Enable Condition

Set Enable Condition of the setting.

For the change to take effect, it is necessary to complete WRITE.

Value	Description
Always OFF	Disables monitoring.
Always ON	Enables monitoring.
Signal	Change the monitoring state based on a safety input signal. For the details of the safety signal usage, refer to chapter 12.4 “Functional Safety Functions”.

③ Reference Posture

User-defined tool posture used to define the Acceptable Angle. Jog the robot to the desired tool posture and press {Set Reference} to easily configure this posture.

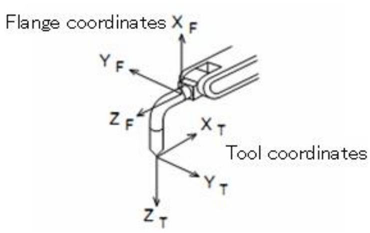
④ Acceptable Angle

Property monitored by this function, user-specified limit for tool angle (defined about the Reference Posture).

Regard the Reference Posture-centered tool angle, which is the object of monitoring, comprises of an appraising vector of the reference angle and the present tool angle. The approaching vector is indicated in the following ways.

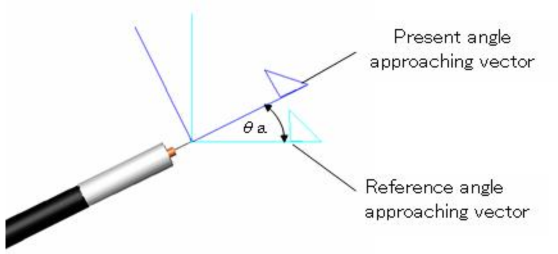
- When the tool is specified:
  The vector of ZT direction in the tool coordinates.
- When the tool is not specified:
  The vector of ZF direction in the flange coordinates.

Fig. 12-12: Approaching Vector



Input the upper limit of the angle θa which consists of the approaching vector of the reference angle over the approaching vector of the present position as the limit angle. The value from 0° to 90° can be input.

Fig. 12-13: Limit Angle of the Approaching Vector



⑤ **Setting Activation Signal**

Specify the safety input signal for enable the setting when “Enable Condition” is “Signal”.

For the details of the safety signal usage, refer to chapter 12.4.13.

⑥ **Output Signal**

Specify the safety output signal for outputting the monitoring result. Signal output as following.

Monitoring State	Monitoring Result	Output
Disabled	----	OFF
Enabled	The tool angle of the robot group for monitoring is inside the limited angle.	ON
	An error is detected in the tool angle of the robot group for monitoring.	OFF

12.4.8.2 Confirming the Acceptable Angle and Starting the Tool Angle Monitor

If “Always ON” or “Signal” for Enable Condition is selected, confirm that the monitoring works correctly in the safety range as the setting.

When confirming the safety range, move the tool posture of the object robot into the acceptable angle, and then enable the monitoring of the setting. If “Signal” for Enable Condition is selected, enable the setting by selecting input signals.

Move the tool of the object robot to confirm motion stops within the specified acceptable angle.

After confirming that the object axis moves to reach the edge of the specified acceptable angle, select {CONFIRM} on the screen. The tool angle monitor can be performed.

Execute playback operation to confirm the robot's motion.

There may be following causes, in case an alarm occurred during the play back operation of the operating job.

– Specified Reference Posture is not appropriate
– Specified Acceptable Angle is not appropriate
– Teaching positions are not appropriate

Reset Reference Posture or Acceptable Angle or correct the teaching positions.

In case “Alarm4792: TOOL ANGL MONITOR ERR” or “Alarm4793: F-SAFE SIGNAL SET ERR(GENERAL)” appeared

<Cause>

The robot's present posture exceeds the acceptable angle.

<Countermeasure>

Confirm the reference posture or the acceptable angle.

Modify the teaching point so that it moves inside the specified acceptable angle.

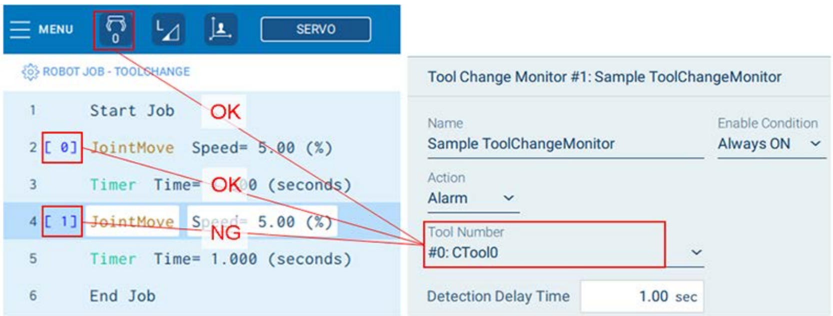
12.4.9 Tool Change Monitor

Tool change monitor is a function to monitor whether the tool settings are switched correctly.

Safety monitoring functions (e.g. robot range limit, speed limit) require correct tool information to operate as intended. The Tool Change Monitor compares the master CPU-specified tool number and the Tool Number configured by the user. If these numbers do not match, the monitor will generate an alarm when its condition is set to Enabled.

In case an error is detected, the power supply to the motor is stopped using the machine safety and the error is notified using an alarm.

While jogging, the master CPU uses active tool number. While job execution, the master CPU uses the tool number which is specified in the Move instruction. Tool Change Monitor function monitors that selected tool number is same as specified tool number in the tool number select setting.



In the above example image, jogging and job execution of line 2 JointMove instruction cab be done correctly. But line 4 JointMove instruction's tool number does not match the tool change monitor setting, job execution will cause alarm. To change the tool correctly, Tool Change Monitor enable condition {Enable Condition} has to be set to “Signal”, and then correct tool monitor setting should be selected by the safety signal at the time of tool change.

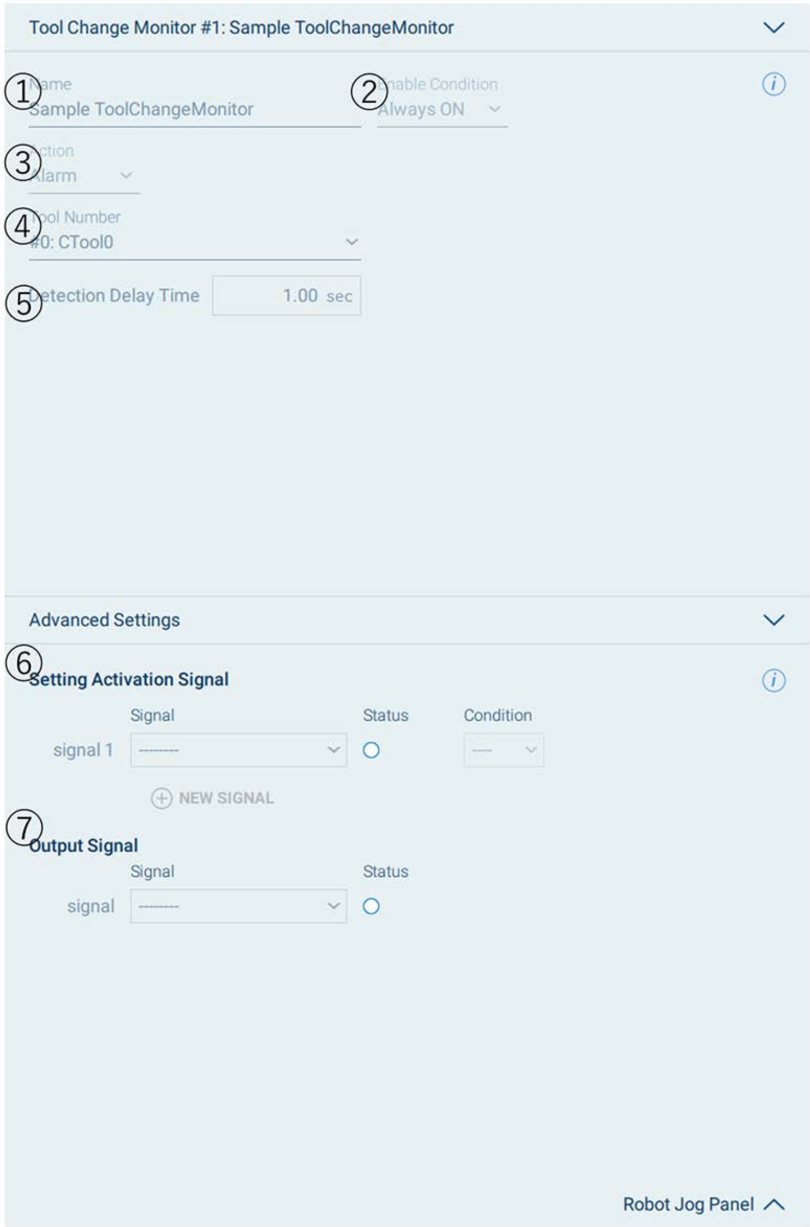
SUPPLE-MENT	Tool Change Monitor function cannot be used concurrently with the Tool Number Select function.

Follow the procedures below when starting the tool change monitor function.

1. Set the tool setting. (Before using this function, execute tool setting by referring to *chapter 6.1 “Tool Settings”*)
2. Set the tool interference model. (Before using this function, execute tool interference file setting by referring to *chapter 6.1.7 “Tool Interference Model Settings”*.)
3. Set the tool change monitor function.
4. Confirm the tool change.
5. Start the tool change monitor function.

12.4.9.1 Condition Settings

Contents are as following.



① **Name**

Set Name of the setting.

② **Enable Condition**

Set Enable Condition of the setting.

For the change to take effect, it is necessary to complete WRITE.

Value	Description
Always OFF	Disables monitoring.
Always ON	Enables monitoring.
Signal	Change the monitoring state based on a safety input signal. For the details of the safety signal usage, refer to fig. 12.4.13 “Safety Signal”.

③ Action

Select alarm or not alarm (Status) to indicate monitoring result of the setting.

Value	Description
Alarm	Servo is turned OFF with an alarm when an error occurs under the monitoring condition
Status	Although monitoring is performed under the condition, the alarm does not occur, and the servo is not turned OFF even if a monitoring error occurred. The monitoring result can be obtained by the safety output signal.

④ Tool Number

When enabled, this monitor verifies the Tool Number configured by the user is active.

⑤ Detection Delay Time

Specifies a user-configurable delay period prior to the enabling of the monitor.

⑥ Setting Activation Signal

Specify the safety input signal for enable the setting when “Enable Condition” is “Signal”.

For the details of the safety signal usage, refer to chapter 12.4.13.

⑦ Output Signal

Specify the safety output signal for outputting the monitoring result. Signal output as following.

Monitoring State	Monitoring Result	Output
Disabled	There is no valid setting.	OFF
Enabled	One condition setting is enabled and the value is consistent with the master CPU.	ON
	One condition setting is enabled but the value is inconsistent with the master CPU.	OFF the enabled setting
	Several condition settings are enabled	OFF the enabled setting

12.4.9.2 Confirming and Starting the Tool Change Monitor

If “Always ON” or “Signal” for Enable Condition is selected, confirm that the monitoring works correctly in the specified tool as the setting.

When confirming the, change the tool number to correct tool, and then enable the monitoring of the setting. If “Signal” for Enable Condition is selected, enable the setting by selecting input signals.

Move the object robot and confirm that no alarm occurs.

After confirming, select {CONFIRM} on the screen. The tool change monitor can be performed.

SUPPLE-MENT

An alarm for the tool change monitor function occurs only when the robot is in motion. (If it is in stop status, monitoring is still performed but the alarm will not occur.)

However, once an alarm occurs, it will stay active unless the problem is solved even if the robot is stopped.

CAUTION

- Make sure that the robot is in a stopped state when performing a tool change.
  - If the tool change is performed during a robot program operation, the following may result:
    - Danger caused by selecting an incorrect tool
    - The robot's motion speed exceeding the speed limit if the types of the tools before and after the change are significantly different
- By a tool change, an monitoring error may be detected in the robot range limit function due to the change of tool model or TCP. For this reason, when changing a tool, specify appropriate range of motions for the object tool.

12.4.9.3 When Using the Tool Change Monitor Function

The tool change monitor must be enabled in Maintenance Mode using Classic Interface (refer to chapter 13 “Classic Interface”.)

For details on enable Tool Change Monitor, refer to “YRC1000 OPTIONS INSTRUCTIONS FOR FUNCTIONAL SAFETY FUNCTION (HW1483576) chapter 4.6.6 When Using the Tool Change Monitor Function”.

12.4.10 Tool Number Select

Tool number select function selects the tool number used in the functional safety functions.

Selects the tool number used in the functional safety function. A “tool change” can refer to the literal change from one type to another or the difference between the empty and loaded states of the same tool.

Safety monitoring functions (e.g. robot range limit, speed limit) require correct tool information to operate as intended. Tool Number Select function selects the tool number used in functional safety based on the safety signal.

Functional safety uses the tool number set in the condition setting specified by the safety signal. It is judged as an error when a robot operates over a certain distance when the tool number is not selected or multiple tool numbers are selected.

SUPPLE-MENT

Tool Number Select function cannot be used concurrently with the Tool Change Monitor function.

NOTE

To maintain Safety Category 3 and PL-d in the safety monitoring in the functional safety function, the safety signal to be used must meet the requirements of Safety Level SIL2 and PL-d.

CAUTION

- Connect the safety signal used to select the tool number so that the tool connected to the manipulator can be specified by the pattern of the safety signal. When an alarm occurs, confirm the connection of the safety signal.
- Also, consider sufficiently that the correct tool number is selected based on the connection of the safety signal, and the robot range limit function and the speed limit function operate properly.

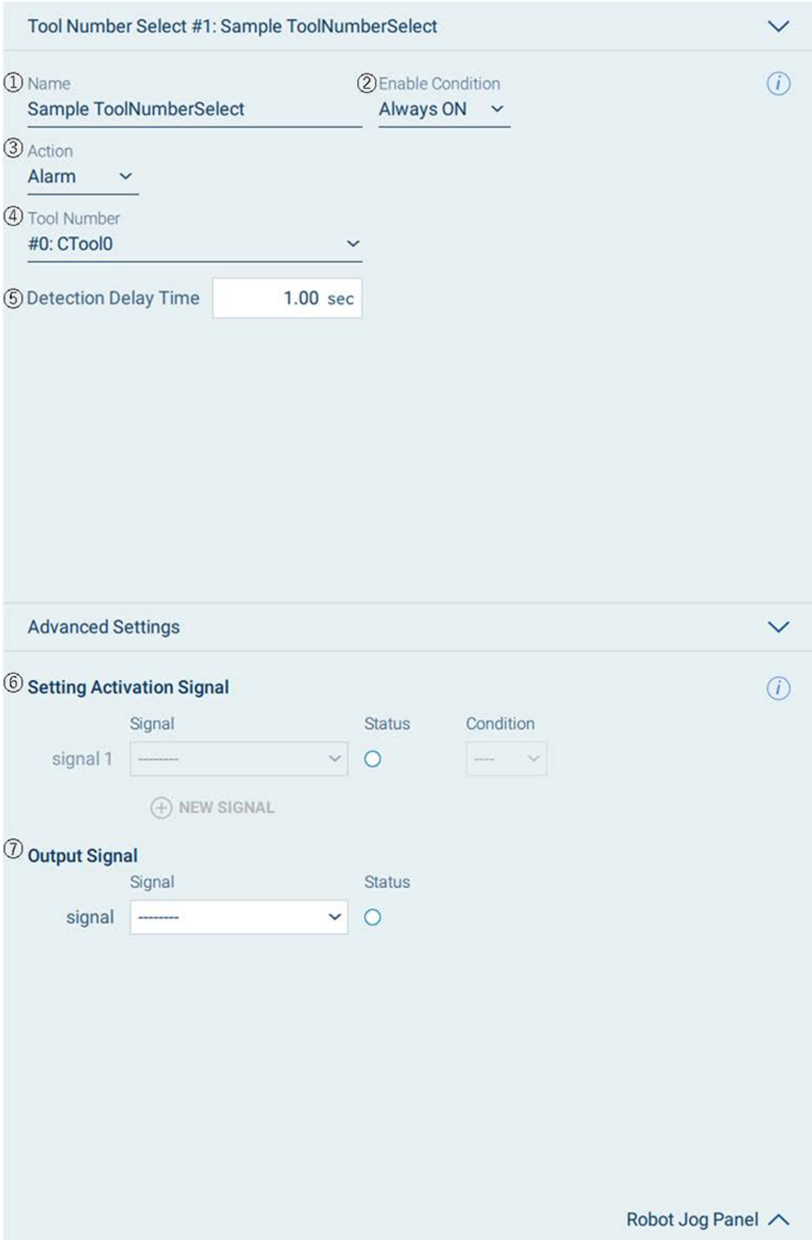
If an incorrect tool number is selected, the safety of the robot range limit function and the speed limit function may be impaired.

Follow the procedures below when starting the tool number select function.

1. Set the tool setting. (Before using this function, execute tool setting by referring to *chapter 6.1 “Tool Settings”*)
2. Set the tool interference model. (Before using this function, execute tool interference file setting by referring to *chapter 6.1.7 “Tool Interference Model Settings”*.)
3. Set the tool number select function.
4. Confirm the tool number select.
5. Start the tool number select function.

12.4.10.1 Condition Settings

Contents are as following.



① **Name**

Set Name of the setting.

② **Enable Condition**

Set Enable Condition of the setting.
In order for the change to take effect, it is necessary to complete WRITE.

Value	Description
Always OFF	Disables the monitoring.
Always ON	Enables the monitoring.
Signal	Change the monitoring state based on a safety input signal. For the details of the safety signal usage, refer to chapter 12.4.13 “Safety Signal”.

③ Action

Select alarm or not alarm (Status) to indicate monitoring result of the setting.

Value	Description
Alarm	Servo is turned OFF with an alarm when an error occurs under the monitoring condition
Status	Although monitoring is performed under the condition, the alarm does not occur, and the servo is not turned OFF even if a monitoring error occurred. The monitoring result can be obtained by the safety output signal.

④ Tool Number

Specifies the tool number which is used in the functional safety function when this setting is enabled.

⑤ Detection Delay Time

Specifies a user-configurable delay period prior to the enabling of the monitor.

⑥ Setting Activation Signal

Specify the safety input signal for enabling the setting when “Enable Condition” is “Signal”.

For the details of the safety signal usage, refer to chapter 12.4.13 “Safety Signal”.

⑦ Output Signal

Specify the safety output signal for outputting the monitoring result. Signal output is as follows.

Monitoring State	Monitoring Result	Output
Disabled	There is no valid setting	OFF
Enabled	One condition setting is enabled.	ON
	Several condition settings are enabled	OFF all the enabled setting

12.4.10.2 Confirming and Starting the Tool Number Select

If “Always ON” or “Signal” for Enable Condition is selected, confirm that the selection works correctly in the specified tool as the setting.

When confirming this, change the tool number to correct tool, and then enable the selection of the setting. If “Signal” for Enable Condition is selected, enable the setting by selecting input signals.

Move the object robot and confirm that no alarm occurs.

After confirming, select {CONFIRM} on the screen. The tool number select can be performed.

SUPPLE-MENT

An alarm for the tool number select function occurs only when the robot is in motion. (If it is in stop status, monitoring is still performed but the alarm does not occur.)

However, once an alarm occurs, it stays active unless the problem is solved and even if the robot is stopped.

CAUTION

- Make sure that the robot is in a stopped state when performing a tool change.
  - If the tool change is performed during a robot program operation, the following may result:
    - Danger caused by selecting an incorrect tool
    - The robot's motion speed exceeding the speed limit if the types of the tools before and after the change are significantly different
- By a tool change, an monitoring error may be detected in the robot range limit function due to the change of tool model or TCP. For this reason, when changing a tool, specify appropriate range of motions for the object tool.

12.4.10.3 When Using the Tool Number Select Function

Tool Number Select must be enabled in Maintenance Mode using Classic Interface (refer to chapter 13 “Classic Interface”.)

For details on enable tool number select, refer to “YRC1000 OPTIONS INSTRUCTIONS FOR FUNCTIONAL SAFETY FUNCTION (HW1483576) chapter 4.7.6 When Using the Tool Number Select Function”.

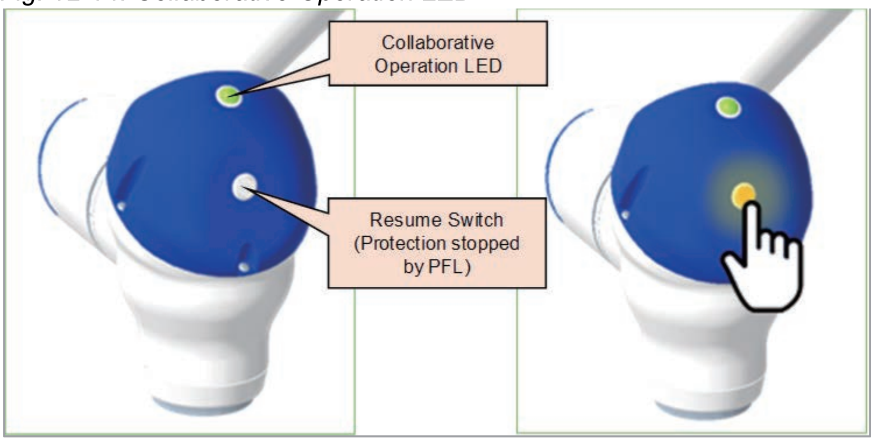
12.4.11 External Force Monitor

External Force Monitor function suspends the Robot according to the external force applied to the Robot when the collaborative operation is enabled.

External Force Monitor function monitors the external force applied to the manipulator's TCP and each joint axis. If the external force exceeds the limitation value that is preset, the Robot stops for protection with a Category 2 stop. After the manipulator stops, its stopped state is monitored by the functional safety unit to ensure that there is no motion of the manipulator. When the collaborative operation is enabled, the Collaborative Operation LED (green color) lights up.

Also, when the state of stop monitoring is valid, the resume switch (orange color) which is located below the LED lights up. Press the resume button to resume manipulator motion from the position at which the manipulator stopped.

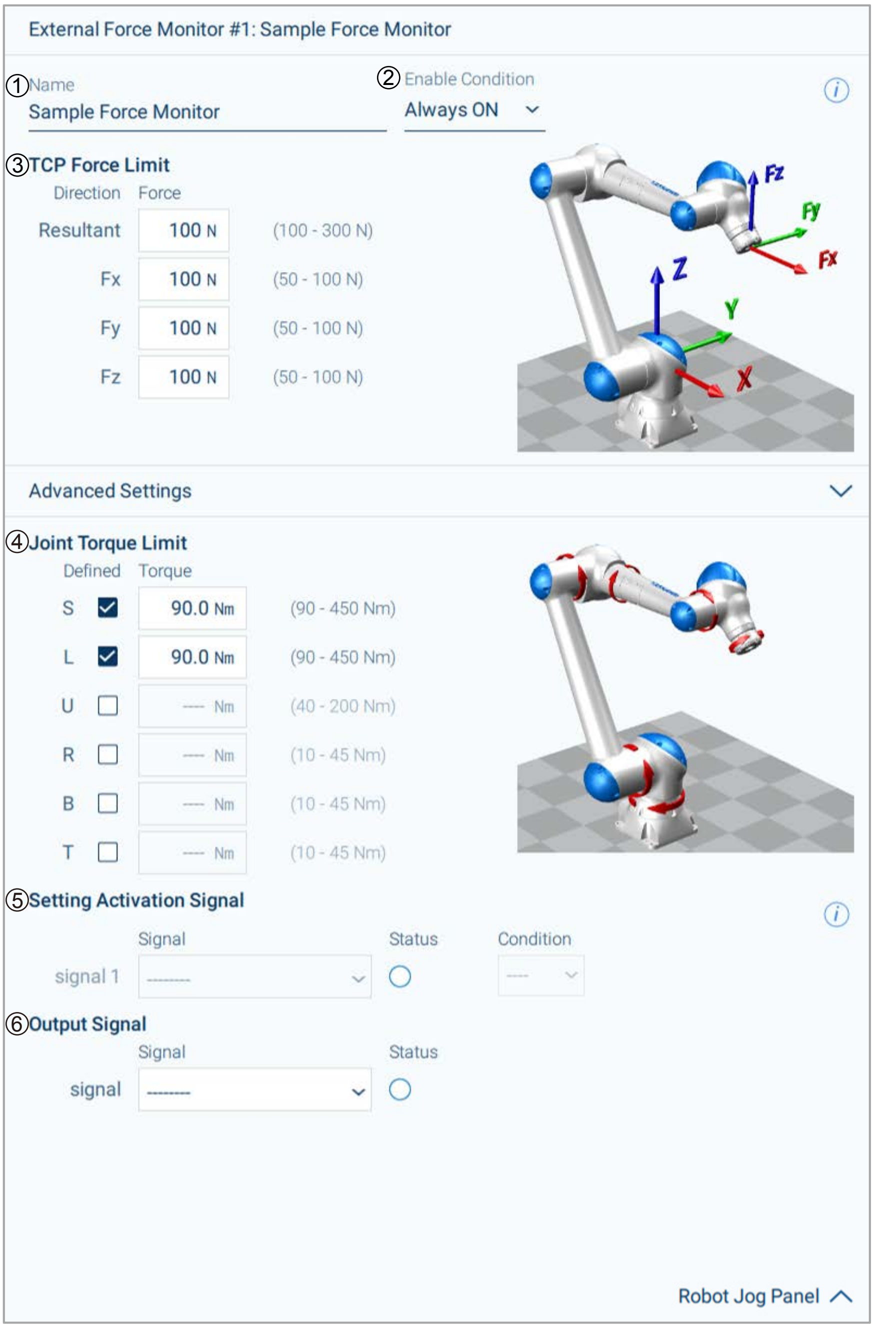
Fig. 12-14: Collaborative Operation LED



NOTICE
By default, each MOTOMAN-HC10 is shipped with one external force monitor with 100N to external force limitation value (TCP resultant force and each X/Y/Z axis direction external force).

12.4.11.1 Condition Setting

Contents are as following.



① Name

Set Name of the setting.

② Enable Condition

Set Enable Condition of the setting.
In order for the change to take effect, it is necessary to complete WRITE.

Value	Description
Always OFF	Always disable.
Always ON	Always enable.
Signal	Change the monitoring state by referring safety input signal. For the details of the safety signal usage, refer to chapter 12.4 “Functional Safety Functions”.

③ TCP Force Limit

Use this to specify the maximum value of the forces on the TCP of the manipulator in world coordinate frame. When external force exceeds these values, this safety monitor will get activated and will stop the manipulator. These forces must be specified in Newtons [N]. The value specified in {Resultant} must be greater than the maximum of X, Y, and Z values. Most applications may need the Resultant force equivalent to X, Y, Z forces. This value is specified as a force and in Newtons [N] (Allowable range: 0 – 300 [N], though a value below 50N should not be specified).
Specify Enable/Disable for a target axis.

④ Joint Torque Limit

Use this to specify the maximum value of external torques for each joint axis of the Robot. When external torque for any of the axes that has been set exceeds the defined value, this safety monitor will get activated and will stop the Robot. This value is specified as a moment and in Newton-Meters [N•m]. (The allowable range varies depending on the type of the manipulator.)

⑤ Setting Activation Signal

Specify the safety input signal for enable the setting when “Enable Condition” is “Signal”.
For the details of the safety signal usage, refer to chapter 12.4.

⑥ Output Signal

Use this to specify an output signal that will turn ON when external force applied to the Robot exceeds the value of external force monitor.

12.4.11.2 Confirming and Starting the External Force Monitor

After the {WRITE}, External Force Monitor requires to confirm. After confirming, press {CONFIRM}, the axis speed monitor function will be enabled.

12.4.11.3 Temporarily Disable All External Force Monitors

Refer to chapter 12.3.9.6 for the proper instructions to temporarily disable PFL. Any External Force Monitor settings that are ON will be disabled when PFL is OFF.

DANGER

- Disabling collaborative operation may cause harm to people and should only be done after thorough risk assessment.
- When presence detection sensor is used, safety distance as per ISO 13855 must be ensured.

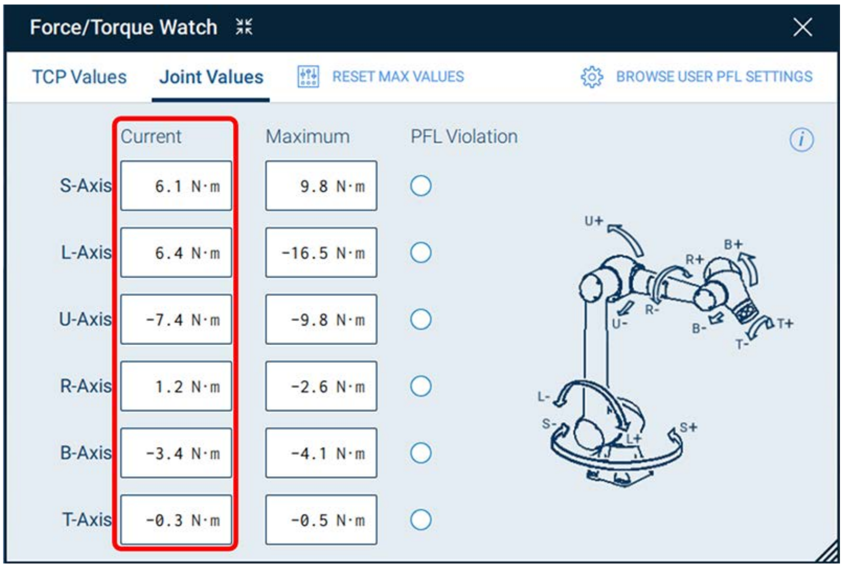
12.4.11.4 Daily Inspection

■ **Periodic Inspection of Torque Sensors**

MOTOMAN-HC10 torque sensors require periodic calibration, as their readings can drift due to environmental changes, accidental collisions between the manipulator and its surroundings, or general misuse of the manipulator.

One method to verify whether the manipulator's torque sensors require calibration is to use the Force/Torque Watch function that is accessible through {MENU} → {Utility} → {Force/Torque Watch}. This window shows the current and maximum readings of all joint torques and TCP forces. Current "Joint Data" (in fig. 12-15 "Force / Torque Watch") is most important for torque sensor inspection purposes.

Fig. 12-15: Force / Torque Watch



YASKAWA recommends maintaining a log of acceptable torque values for a MOTOMAN-HC10 installation. Each time the user makes a change to the system (e.g. swap a tool), the "Joint Data" values on the Force/Torque Watch window should be recorded with the manipulator at a position convenient for the user. This recorded data can be compared to "Current" values during an inspection.

This comparison between allowable and current torque values is valid only if the following four conditions are satisfied:

1. Active tool setting physically matches the currently installed tool
2. Accurate physical properties of the current tool are properly set
3. Posture of the manipulator during inspection matches the posture when the “acceptable torque values” were initially recorded.
4. Current “Joint Data” (in *fig. 12-15*) values do not exceed those in *table 12-20*.

If the current joint torques values exceed one or multiple values shown in table 12-20, the error in external force calculation increases (thereby negatively affecting PFL functionality). Thus, a re-calibration of torque sensor offset data is required. Refer to chapter 12.4.12.

Table 12-20: Torque Sensor Torque Value Inspection

Axis	S	L	U	R	B	T
HC10x	27.0 N•m	27.0 N•m	12.0 N•m	3.0 N•m	3.0 N•m	3.0 N•m
HC20x	72.0 N•m	96.0 N•m	48.0 N•m	27.0 N•m	12.0 N•m	12.0 N•m

Daily inspection is recommended.

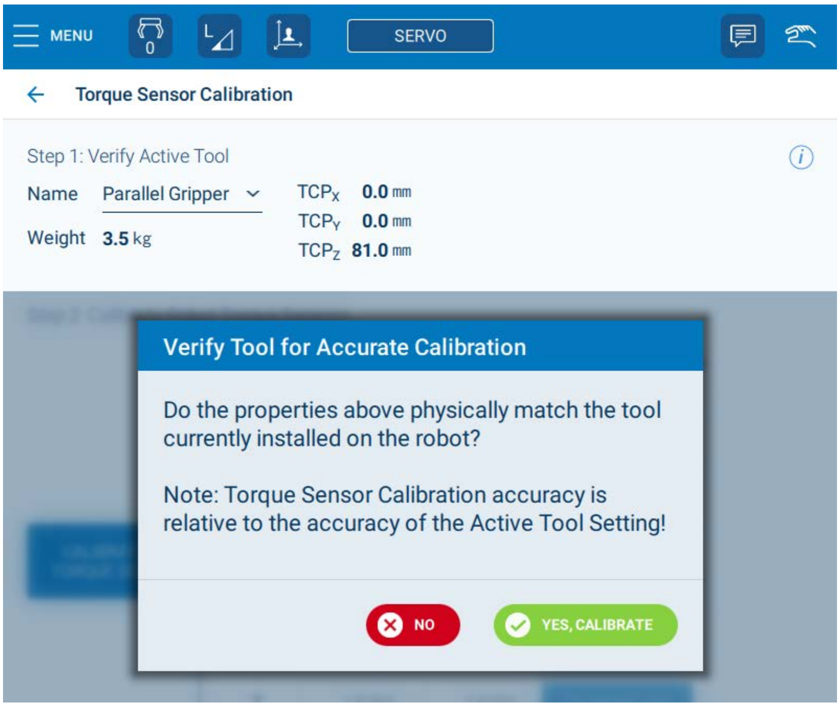
CAUTION

If any abnormalities related to the operation of PFL function(s) occur, calibrate torque sensor offset data.

12.4.12 Torque Sensor Calibration

Calibration can be performed in any robot posture, with or without a tool mounted. Active Tool properties are used to calculate the resulting torque sensor “offset values”. Follow the steps below to calibrate a MOTOMAN-Collaborative robot:

1. Navigate to {MENU} → {Safety Settings} → {Torque Sensor Calibration}.
2. Prior to calibration, the user must verify the Active Tool information located at the top of the Torque Sensor Calibration screen.



A pop-up will appear during the procedure to remind the user that properties set for the Active Tool will affect the accuracy of the resulting calibration. The user can select a new Active Tool from the dropdown list if the one shown does not match the currently installed tool.

3. After verifying the Active Tool setting, select one of the following methods to calibrate torque sensor offset value(s):

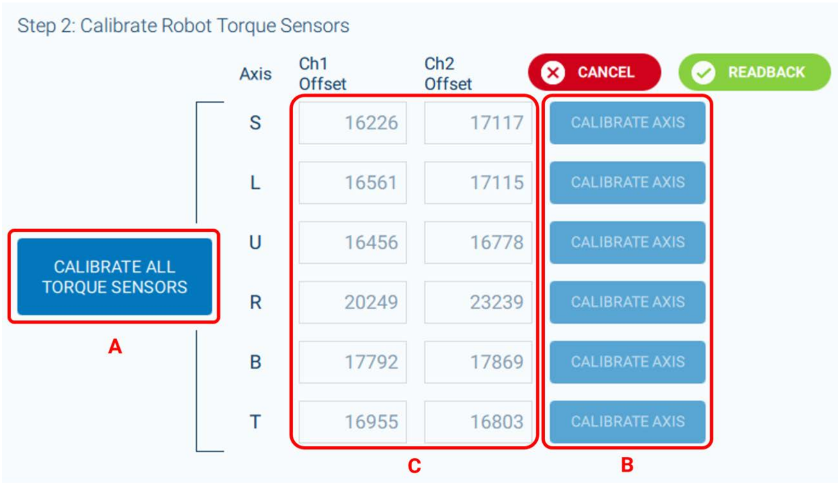
Ⓐ **Standard Option: All Axes Update**
Press the “Calibrate All Torque Sensors” button to update all torque sensor offset values. This method is recommended for most cases.

Ⓑ **Advanced Option: Single Axis Update**
Press a “Calibrate Axis” button to update the torque sensor offset values of a single axis. This method may be used when only a few axes require calibration.

Example: If a user swaps tools for one with different physical properties, the T-axis torque sensor may drift due to significant changes of the attached load. Thus, a single axis calibration for the T-axis can be performed by an expert user.

Ⓒ **Advanced Option: Manual Update**
Enter offset values manually. This method may be used if the YRC Controller or its internal boards (CPU or PFL) are replaced and the previously recorded offset values are available.

Fig. 12-16: Torque Sensor Calibration



4. Edit(s) to this panel will display buttons to finalize the process - {Readback} allows the user to read data from both the YRC Controller and PFL safety board. {Cancel} allows the user to abort editing.

5. Press {Readback}

   – {Write} and a “Display” control appears
   Display options are provided for viewing readback data:

   • Edit value: shows values entered by user.

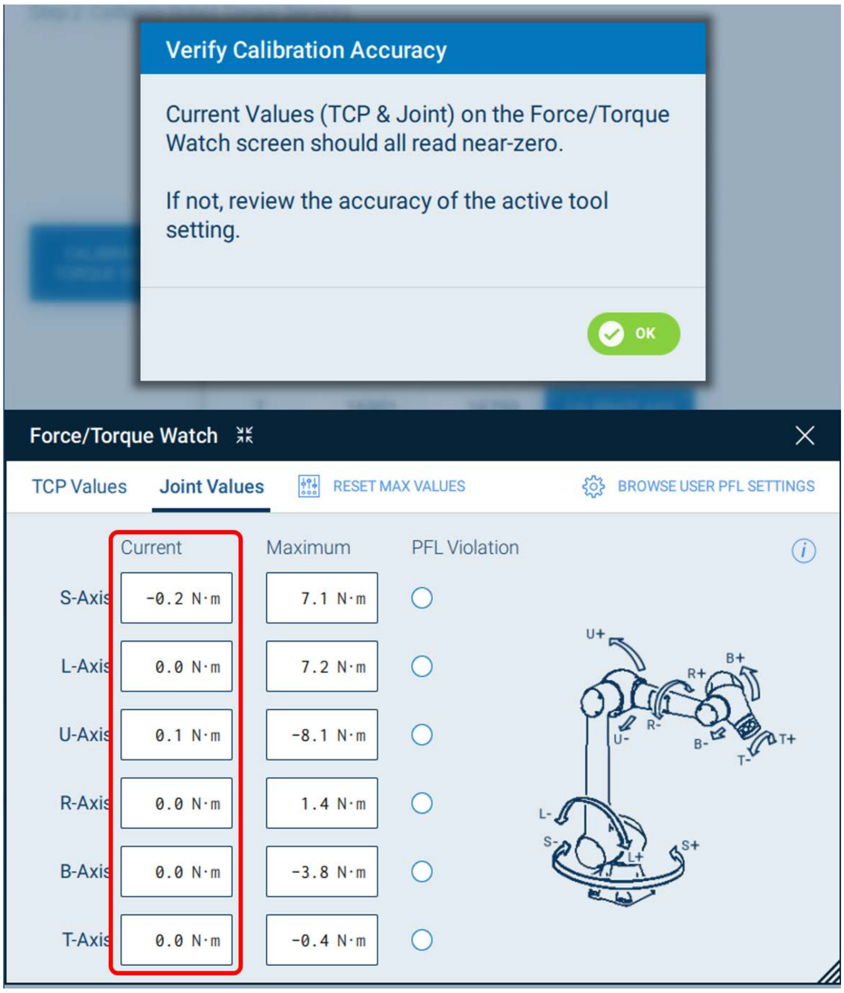
   • Readback Value (PFL): shows temporary values saved on the PFL board.

   • Comparison Result: (default)

6. Check the “Readback” result. The user should check the “Comparison Result” to determine if all values match, meaning the edit was successful. If value(s) differ, the “Comparison Result” will be displayed as ***. At this point, the user should check to see which data was not updated.

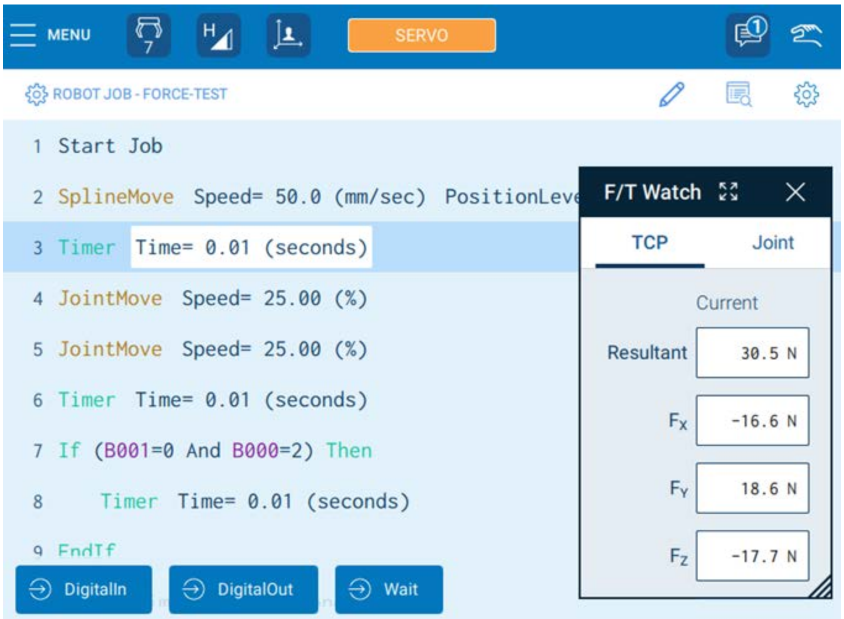
7. Press {Write} - a confirmation window appears, prompting the user to finalize the process, provided the data was updated correctly.
8. Press {Verify Calibration} with Servos ON. This opens the Force/Torque Watch screen - if the calibration was performed properly with an Active Tool that reflects the currently installed tool, all Current values should be minimal (< 10)

Fig. 12-17: Torque Calibration Accuracy



12.4.12.1 Monitor Forces During Programming

The resizable Force/Torque Watch screen can also be used to monitor forces while jogging in Manual (Teach) mode or during Job playback in Automatic (Play) mode.

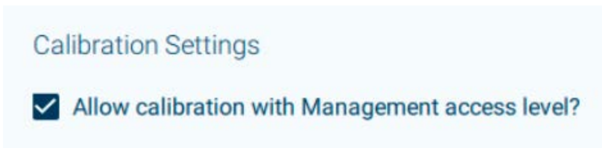


Maximum values display the peak forces and torques reached during a routine. PFL violation indicators show axe(s) that exceed active user-defined External Force Monitor settings on the Safety Functions screen.

12.4.12.2 Torque Sensor Calibration

Torque Sensor Calibration for HCXX robots historically requires “Safety” security level. A recent feature has been added enabling the Safety Manager to allow those with Management security level to perform the calibration, thus making the periodic task more accessible.

In “Safety” security level, use the checkbox at the bottom of the screen to allow those with “Management” security level to calibrate the robot's torque sensors.



12.4.13 Safety Signal

Functional Safety Function and Collaborative operation function can be Enabled/Disabled by safety input signal.

Also, these functions can output the monitoring result by safety output signal.

Followings are the safety signal available for the functional safety function.

Signal	Signal Point	Note
Functional safety general purpose signal	(for JANCD-ASF02-E) Input：8 points/terminal Output：8 points/terminal (for JANCD-ASF03-E) Input：16 points/terminal Output：16 points/terminal	The functional safety general-purpose signal is connected per safety circuit board. The number of the signals differ depending on the board: - when connecting to “JANCD-ASF02-E”, 8 input points and 8 output points - when connecting to “JANCD-ASF03-E”, 16 input points and 16 output points
Safety fieldbus signal	Input：64 points/system Output：64 points/system	The safety fieldbus signal is connected per system. Depending on the settings, up to 64 points can be used from one safety circuit board. The safety fieldbus is an optional function other than the functional safety.
Safety logic circuit extended signal	Input：64 points/system Output：64 points/system	The safety logic circuit extended signal (64 input points and 64 output points) is connected per system. The output of the safety logic circuit (MS-OUT) can be used as the input of the functional safety. The output of the functional safety (FS-OUT) can be used as the input of the safety logic circuit.

If the safety fieldbus signal and the safety logic circuit signal are included, up to 144 points can be used from one safety circuit board.

To condition files, as many safety signals as desired can be allocated within the possible signal points, thus signals are flexibly used even if the board has small numbers of signal points.

Followings are the safety signal available for the collaborative operation function.

Signal	Signal Point	Note
PFL function signal	Input：16 points/terminal Output：16 points/terminal	PFL function signal is connected per PFL circuit board.

12.4.13.1 Allocation of Safety Logic Circuit Extended Signal

The safety logic circuit extended signal can be used as the input signal or the output signal of the functional safety. The number of the signal points are 64 input points and 64 output points. These signals are shared by the whole system and can be used from any board of the safety circuit board.

Regarding the FS-OUT (safety logic circuit functional safety output signal), allocation of the signal and the board must be performed in advance.

To allocate Safety Logic Circuit Extended Signal, refer to chapter 12.3.4.5.

12.4.13.2 Allocation of Safety Fieldbus Signal

The safety fieldbus function is not a functional safety function but an optional function. When it is valid, the safety fieldbus signal can be used in the functional safety function.

Safety fieldbus signal transmits/receives the safety-guaranteed “safety data” through the fieldbus communication path. It has 64 input signal points and 64 output signal points.

These signals are commonly used in the whole system and thus they can be referred from both machine safety board and functional safety board.

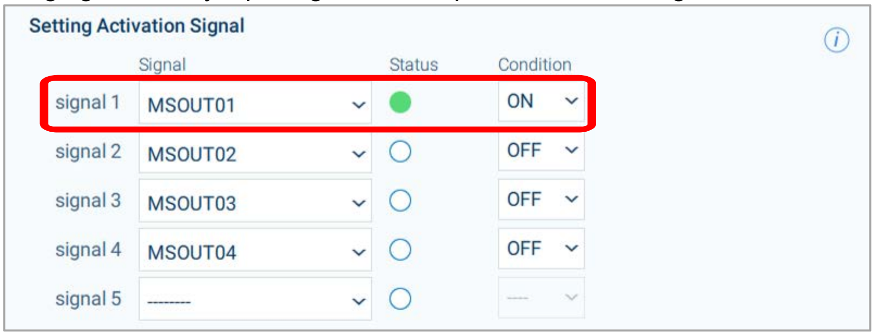
In this consequence, “SAFETY SIG. BOARD ALLOC” function is prepared to define which signal is to be used in which board.

To allocate Safety Fieldbus signal, refer to chapter 12.3.4.4.

12.4.13.3 Enable Condition of Safety Functions Setting

The setting of safety function, it can be enabled/disabled by safety input signal when Enable Condition is “Signal”.

Judging the safety input signals are explained as following.



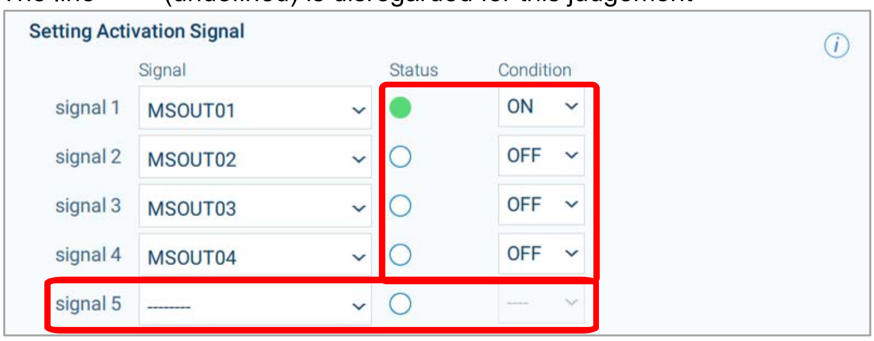
The input signal is judged line-by-line.

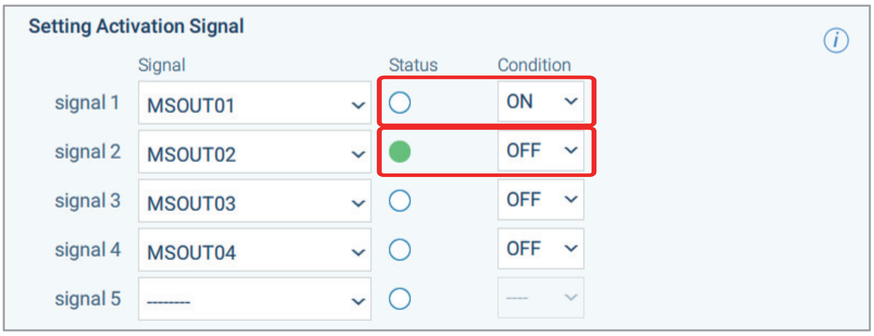
When performing a setting as marked with the red square, the condition of signal 1 line is defined as satisfied. because “ON” is set to {Condition} at the input signal {MSOUT01}, and ● (=ON)} is set to {Status}.

Up to 5 signals can be set to a setting (up to 4 for the tool change monitor function).

Conditions of the lines from signal 1 line to signal 5 line are judged by the safety input signal respectively, the setting is enabled only when all the conditions are satisfied.

The line “----” (undefined) is disregarded for this judgement





> **NOTE**
>
> There can be a time difference after the first signal and before the last signal. In the functional safety function, an interval of 32 [ms] is equipped to the system to be totally switched to internally settled after the last signal change.
>
> For this reason, please take this into consideration when performing the following operations.
>
> - When switching several signals, do not take more than 32 [ms].
>   - The signals may be settled with half-specified values.
> - Do not use signals that continue shifting ON/OFF within the interval of less than 32 [ms].
>   - Signals will not be settled.

Based on above mentioned judging methods, settings can be enabled/disabled by the multi signals.

For example, there are following methods when Enable/Disable settings by 3 signals (MSOUT1, MSOUT2, MSOUT3).

Example 1: Switching one file using 1 signal

Enable/Disable the setting individually by one signal.

Easy to configure the simultaneous monitoring.

Setting	Signal	Condition	Enable Condition
Setting1	MSOUT1	ON	MSOUT1: ●
Setting2	MSOUT2	ON	MSOUT2: ●
Setting3	MSOUT3	ON	MSOUT3: ●

Example 2: Switching multi files using 3 signals

Select one file out of several files by the condition of 3 signals.

Many files can be managed with less signals. This pattern is effective when simultaneous monitoring is not necessary.

Setting	Signal	Condition	Enable Condition
Setting1	MSOUT1 MSOUT2 MSOUT3	OFF OFF OFF	MSOUT1: ○ MSOUT2: ○ MSOUT3: ○
Setting2	MSOUT1 MSOUT2 MSOUT3	ON OFF OFF	MSOUT1: ● MSOUT2: ○ MSOUT3: ○
Setting3	MSOUT1 MSOUT2 MSOUT3	OFF ON OFF	MSOUT1: ○ MSOUT2: ● MSOUT3: ○
Setting4	MSOUT1 MSOUT2 MSOUT3	ON ON OFF	MSOUT1: ● MSOUT2: ● MSOUT3: ○
Setting5	MSOUT1 MSOUT2 MSOUT3	OFF OFF ON	MSOUT1: ○ MSOUT2: ○ MSOUT3: ●
Setting6	MSOUT1 MSOUT2 MSOUT3	ON OFF ON	MSOUT1: ● MSOUT2: ○ MSOUT3: ●
Setting7	MSOUT1 MSOUT2 MSOUT3	OFF ON ON	MSOUT1: ○ MSOUT2: ● MSOUT3: ●
Setting8	MSOUT1 MSOUT2 MSOUT3	ON ON ON	MSOUT1: ● MSOUT2: ● MSOUT3: ●

12.4.13.4 Safety Signal Output Value

The output signal outputs the status of safety or not safety over the monitoring conditions when the setting is enabled.

CAUTION

In case a major alarm occurred in the functional safety function, all the output signals are turned OFF.

12.5 Safety Caution

12.5.1 How to Restart the YRC Controller

CAUTION

For the human collaborative Robot (i.e. MOTOMAN-HC10), the CPU reset function is prohibited. To restart the YRC Controller, always use the main power switch.

To turn OFF and back ON the power to the YRC Controller, always use the main power switch.

Wait at least 10 seconds after turning OFF the main power switch until turning it ON.

12.5.2 Check Items before Operating the Manipulator

Before operating the manipulator in any mode, check the following items carefully:

- Whether collaborative operation is enabled or disabled
  Make sure that the collaborative operation enable/disable setting is correct.
- Operation check of the PFL function
  Make sure that the PFL function is correctly configured.
  In particular with collaborative operation enabled (i.e., with the collaborative operation lamp lit in green), make sure in advance that the PFL function works correctly by adding an external force to the manipulator.

12.5.3 About the Behavior near Singularity

With collaborative operation enabled, the behavior of the manipulator near singularity is limited to operating on an axis by axis basis.

An attempt to operate the manipulator along more than one axis at a time, in any operation mode, results in AL.6002 “NEAR SINGULARITY (PFL)”.

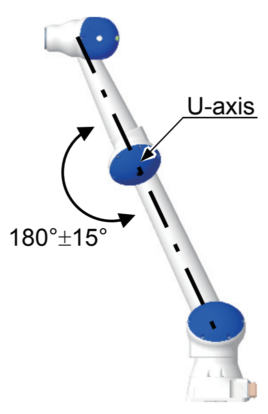
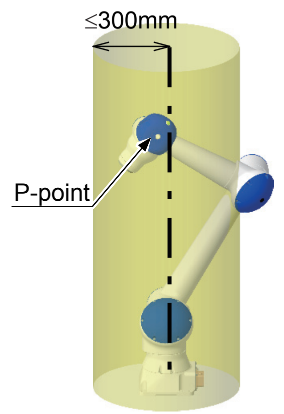
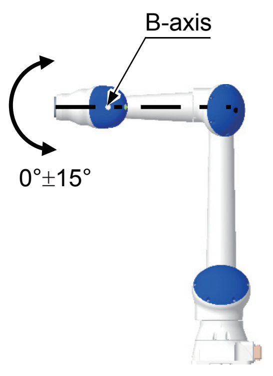
The MOTOMAN-HCxx or MOTOMAN-HCxxDT has the following three singularities.

Singularity 1: The U-axis is at an angle within the range of 0° or 180° ±15°.

Singularity 2: The rotation center of the B-axis (P-point) is near the vertical line of the S-axis (within 300 mm).

Singularity 3: The B-axis is at an angle within the range of 0° or 180° ±15°.

Table 12-21: Example of Singularity Postures

		
Singularity 1	Singularity 2	Singularity 3

12.6 Data Protection

12.6.1 Duplicate Data

The data related to the safety function is copied to the safety circuit board's memory or PFL circuit board's memory for safety.

When the control power is turned ON, check is performed to see that duplicate data are set the same. If they are different when the control power is turned ON, the following alarm occurs.

When there is difference in the Safety Circuit Board:

Alarm 0300: "VERIFY ERROR (SYSTEM CONFIG-DATA) [10]"

When there is difference in the PFL Circuit Board:

Alarm 0300: "VERIFY ERROR (SYSTEM CONFIG-DATA) [13]"

In the system with the functional safety function, a message "Select 'Safety Board FLASH Reset' in the maintenance mode" is displayed after the following operations.

Turning ON or OFF causes error without FLASH Data Reset.

- The data related to the safety function is loaded from an external storage in Classic Interface.
- A parameter related to the safety function is rewrote by setting operations in maintenance mode.
- The zeroing function is performed.
- Encoder is reset

In case one of the above-mentioned operations is performed, FLASH Data Reset is required.

In the maintenance mode, there are cases when parameters related to the safety function are rewritten by several setting operations.

For this reason, the message "Select 'Safety Board FLASH Reset'" may be displayed. Perform the safety board FLASH reset operation in this case.

12.6.2 Safety Board FLASH Reset

If the following alarm occurs when the control power supply is turned ON,

Alarm 0300: "VERIFY ERROR (SYSTEM CONFIG-DATA) [10]"

Alarm 0300: "VERIFY ERROR (SYSTEM CONFIG-DATA) [13]"

perform the Safety Board FLASH RESET to reset the data of the safety circuit board and PFL circuit board. To perform FLASH Data Reset, refer to chapter 13.4.4 "Safety Board Flash Reset".

> NOTE
>
> When FLASH Data reset is required, Smart Pendant cannot operate the YRC Controller. Use Classic Interface and perform Safety Board FLASH Reset.
>
> For detail on the Classic Interface, refer to *chapter 13 "Classic Interface"*.

12.6.3 Verify Safety Settings (CRC)

12.6.3.1 Overview

The Cyclic Redundancy Check (CRC) is an error-detecting code that is used for storage devices to detect accidental or intentional changes. Specific to the YRC Controller, the a CRC is added to files associated with functional safety settings. The value for the CRC is computed based on the contents of these files.

The CRC value, which is created based on the file data, is a fixed value unless the contents of the file are modified.

By verifying that the CRC value has not changed, the user can confirm that the data in the associated file has not changed.

Table 12-22: Files CRC Supports

File	File Name for External Memory Device
Safety Logic Circuit (System)	YSFLOGIC.DAT (System)
Safety Logic Circuit (User)	YSFLOGIC.DAT (User)

Table 12-23: Additional Files CRC Supports with Functional Safety Function Enabled

File	File Name for External Memory Device
Tool data	TOOL.CND
Tool interfere data	TOOLINTF.DAT
Home position calibrating data	ABSO.DAT
Axis range limit data	AXRNGLMT.DAT
Axis speed monitor data	AXSPDMON.DAT
Robot range limit data	RBRNGLMT.DAT
Speed limit data	SPDLMT.DAT
Tool angle monitor data	TLANGMON.DAT
Tool change monitor data	TLCHGMON.DAT
Function definition parameter	FD.PRM
System definition parameter	SD.PRM
Servo parameter	SV.PRM
Servo motor parameter	SVM.PRM
Robot matching parameter	RC.PRM
Coordinate home position parameter	RO.PRM
Motion function parameter	MF.PRM
Robot control expand parameter	RE.PRM
Safety function parameter	FMS.PRM
System matching parameter	SC.PRM

12.6.3.2 Verify Safety Settings (CRC) Screen

Verify Safety Settings (CRC) supports checking the CRC value and the Last modified date.

④ File

Show the setting file name.

④ CRC

CRC value calculated from file data. This value is same value as the file transferred using the File Transfer screen. If the file has not modified since the system started operating, “----” will be shown.

The file is usually updated simultaneously when modifying the data. However, when performing the modification in which the Functional Safety Board FLASH Reset is necessary, “----” will be shown, and then the value is shown after resetting the Functional Safety Board Flash.

④ Last Modified

The last modified (edited, loaded, initialized) date and time is shown. If the file has not modified since the system started operating, "----" will be shown.

④ Export CRC

Export the screen contents into a text file and a screenshot in to a PNG file. A USB drive must be attached to the Smart Pendant for this function.

12.6.3.3 Change of Condition File by an External Device

When using functional safety functions, the data used for the setting of safety monitoring must not be modified by an external device. Therefore, when loading the condition file from the external memory device, loading is allowed only when it is confirmed that the contents of the saved file have not been modified.

(e.g.) Tool file

```
//TOOL 0
///CRC 4294967294 (CRC value)
///NAME standard tool
0.000, 0. 000, 0. 000, 0. 0000, 0.0000, 0. 0000
0.000, 0. 000, 0. 000
0.000.
0.000, 0. 000, 0. 000
0.000, 0, 1
```

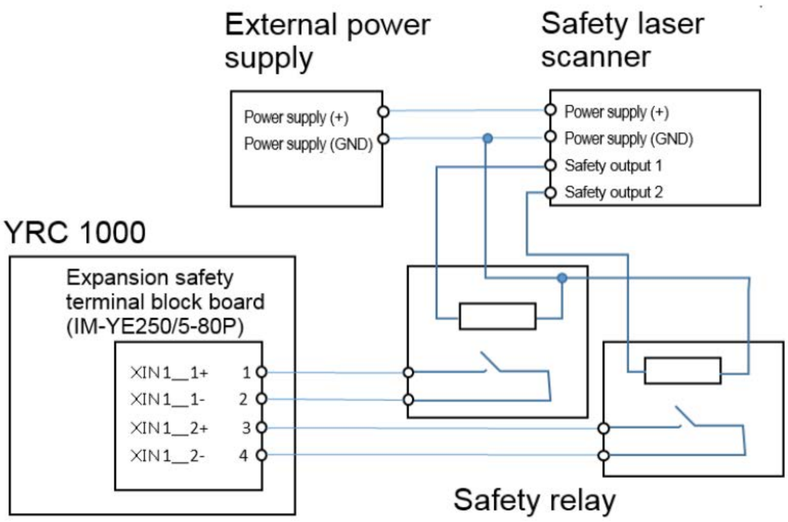
> NOTE
>
> Since the CRC value has not been added to the file saved in the system in which functional safety is invalid, the file cannot be loaded in the system in which functional safety is valid

12.7 Setting Example of the Safety Functions

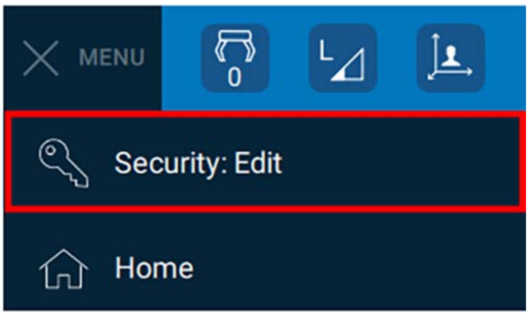
12.7.1 Single Safety Laser Scanner to Pause Robot Motion

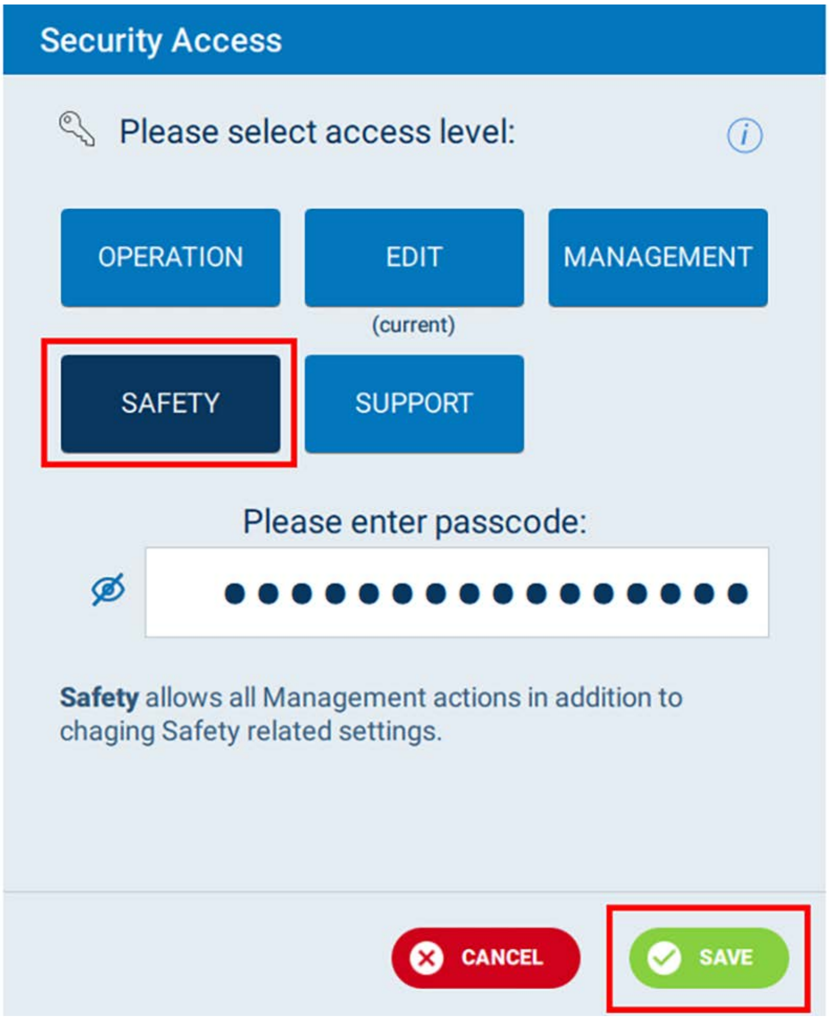
This is an example how to setup a single safety laser scanner to pause Robot motion with a Functional Safety Speed Limit when a person or object is inside the safety laser scanner area.

1. Connect the safety output of your safety laser scanner (it is written as OSSD etc.) to a safety relay then take the two pairs of outputs from the safety relay and properly connect them to the YRC Controller as per your YRC Controller's instruction manual. For this example, we will be using the Functional Safety Board Input #1 (FSBIN01). Note that wiring diagrams for this input may refer to the two pairs as XIN1_1-/XIN1_1+ and XIN1_2-/XIN1_2+.

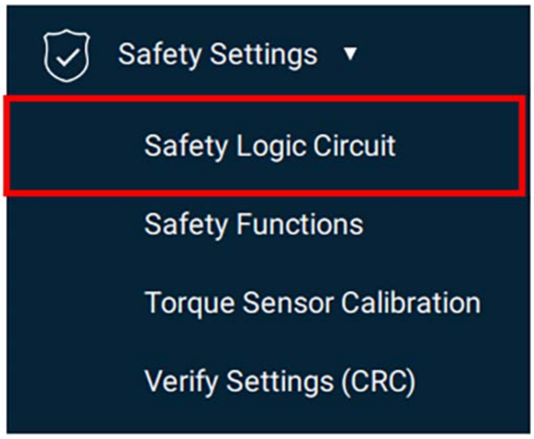


2. Prior to performing any changes to safety related settings, you must be in Safety level. Press the {MENU} button on the top left and open the {Security} screen. Select SAFETY level, enter in the current safety passcode, and press SAVE.

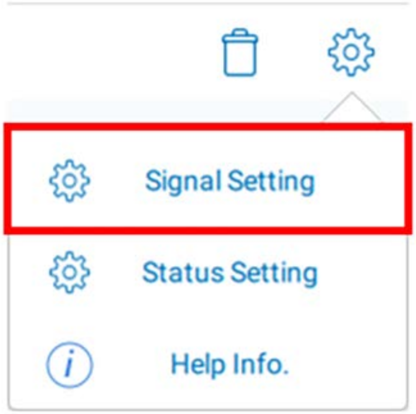




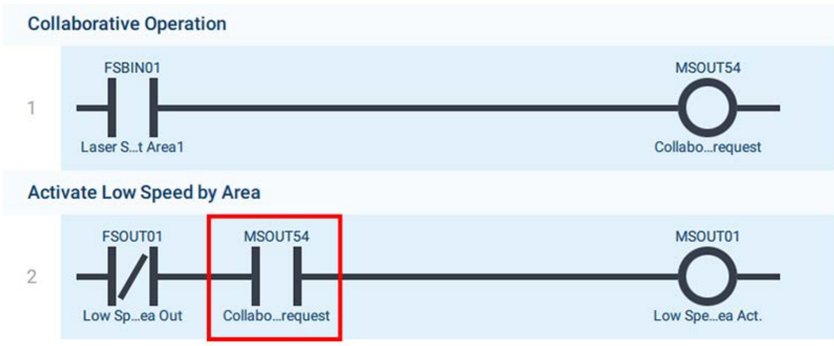
3. Press the {MENU} button on the top left, select {Safety Settings}, and select {Safety Logic Circuit}.



4. Press the {Setting} on the top right, select {Signal Setting} to open the screen.

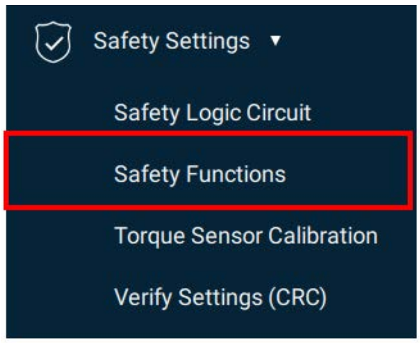


5. Select the {Physical Discrete Safety I/O} tab and then select the {FSBIN} tab. Give the FSBIN01 a relevant name such as "Laser Scanner Detect Area1"

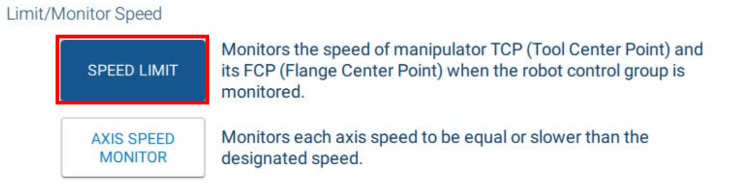


6. Once completing the changes press {READBACK} to readback the data. Check the readback data is correct, then press {WRITE} to save your setting.

7. Press the {MENU} button on the top left, select Safety Settings, and select Safety Functions.

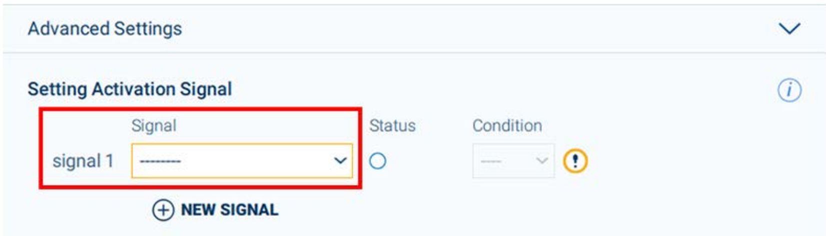


8. Select {+ NEW SETTING} at the top of the Safety Function Settings screen, select {SPEED LIMIT}, then press {CREATE NEW SETTING} to open a blank Robot speed limit

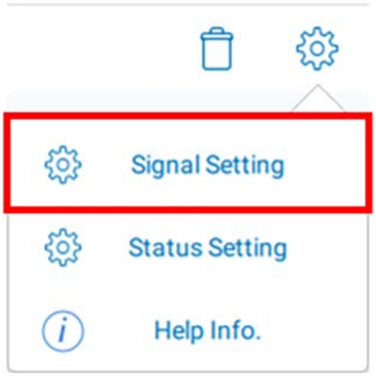


9. Give the speed limit a relevant name such as “Area Scanner Robot Pause”, change the speed limit to a speed of 0 mm/sec, then change the Enable Condition to Signal in the drop-down menu.

10. After changing the Enable condition to Signal, the “Advanced Settings” screen will pop-up and you can select a signal for your “Setting Activation Signal” drop-down.



11. Select the “Physical Discrete Safety I/O” tab and choose the input where your area scanner is wired. For this example, the area scanner is wired into FSBIN01. After selecting your area scanner input press the Select button. Please note that depending on your area scanner's polarity you may have to change the activation condition from the default “ON” to “OFF” next to the signal name.

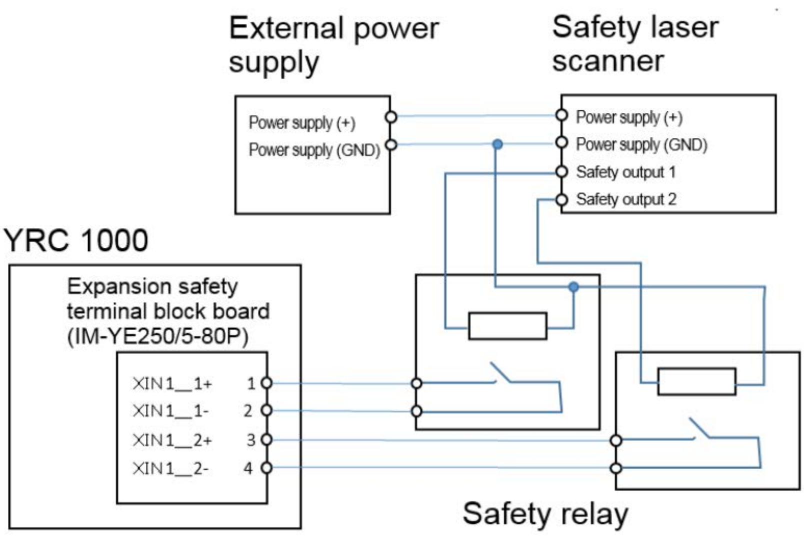


12. Once you have completed your changes press {READBACK} to readback the data. Check the readback data is correct, then press {WRITE} to save your setting.
13. You are now complete and the Robot will stop all motion while someone is within the area scanner range.

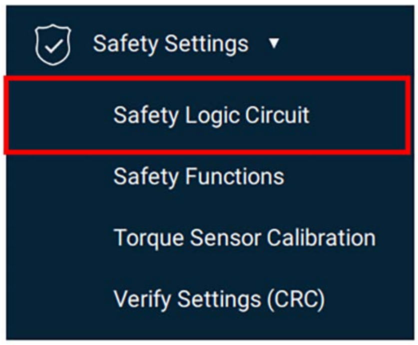
12.7.2 Single Safety Laser Scanner to Activate Collaborative Operation

This is an example for collaborative operation of HC10 Robot where a single safety laser scanner is used to activate the collaborative operation mode when a person or object is inside the safety laser scanner area.

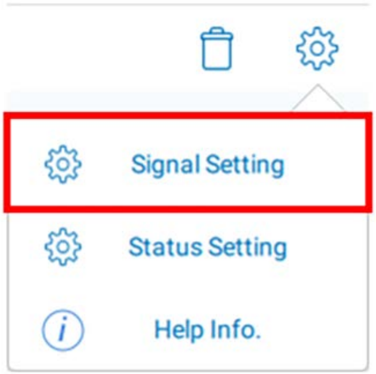
1. Connect the safety output of your safety laser scanner (it is written as OSSD etc.) to a safety relay then take the two pairs of outputs from the safety relay and properly connect them to the YRC Controller as per the controller's instruction manual. For this example, we will be using the Functional Safety Board Input #1 (FSBIN01). Please note that wiring diagrams for this input may refer to the two pairs as XIN1_1-/XIN1_1+ and XIN1_2-/XIN1_2+.



2. Press the {MENU} button on the top left, select {Safety Settings}, and select {Safety Logic Circuit}.



3. Press the {Setting} on the top right, select {Signal Setting} to open the screen.



4. Select the {Physical Discrete Safety I/O} tab and then select the {FSBIN} tab. Give the FSBIN01 a relevant name such as “Laser Scanner Detect Area1”

5. Close the signal setting screen by pressing {X} button on the top right.
6. Set the input relay to FSBIN01, and the output relay to MSOUT54. Please note that this setting is same as factory default. Depending on your laser scanner's polarity you may have to change the input relay to “Normally Open”, or “Normally Closed”.

7. Once you have completed your changes press {READBACK} to readback the data. Check the readback data is correct, then press {WRITE} to save your setting.

8. You are now complete and the Robot will be collaborative operation mode while someone is in the area scanner range.

CAUTION

When switching from collaborative operation disabled (muting) to collaborative operation enabled, there is a delay of about 1000 ms until the signal input actually switches.

DANGER

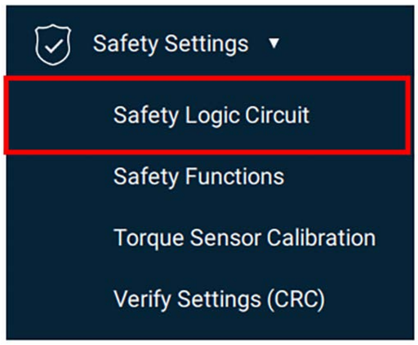
With collaborative operation disabled, the manipulator may harm workers. Implement sufficient risk assessment before disabling collaborative operation.

Whenever you use a presence detection sensor, ensure the safety distance based on ISO13855.

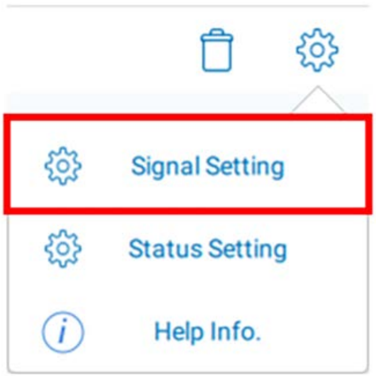
12.7.3 Reduce the Robot Speed by Robot Position

This is an example to reduce the Robot speed by the speed limit function when the Robot move into an area which is defined by Robot range limit function.

1. Press the {MENU} button on the top left, select {Safety Settings}, and select {Safety Logic Circuit}.

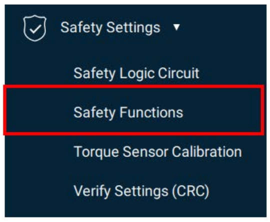


2. Press the {Setting} on the top right, select {Signal Setting} to open the screen.

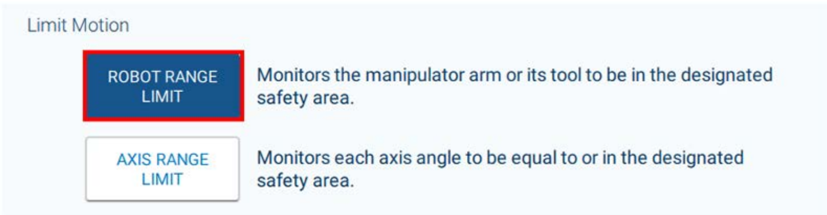


3. Select the {Physical Discrete Safety I/O} tab and then select the {FSBIN} tab. Change {Output From} to “Safety Setting(F-SAFE #1)”.

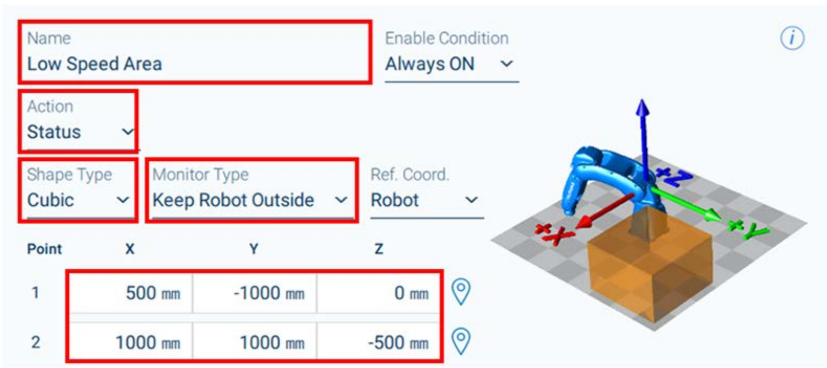
4. Once you have completed your changes press {READBACK} to readback the data. Check the readback data is correct, then press {WRITE} to save your setting.
5. Press the {MENU} button on the top left, select Safety Settings, and select Safety Functions.



6. Select {+ NEW SETTING} at the top of the Safety Function Settings screen, select {ROBOT RANGE LIMIT}, then press {CREATE NEW SETTING} to open a blank Robot range limit.

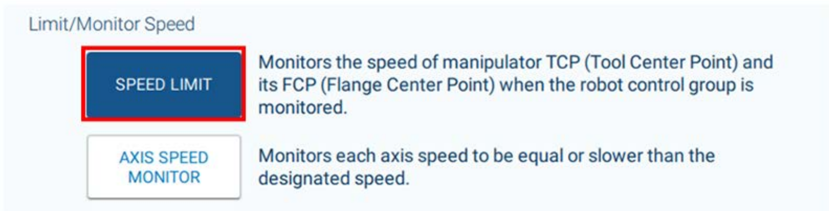


7. Give the Robot range limit a relevant name such as “Low Speed Area”. Change the {Action} to “Status” to mute the alarm even if the Robot move into this area. Change the shape type to cubic for this example. Change the {Monitor Type} to “Keep Robot Outside”. If you select “Keep Robot Outside”, outside of the specified will be defined as safe area, you can detect the Robot entering the area. Change X,Y,Z of the Point 1 and Point 2 to specify the area for reducing the Robot speed.



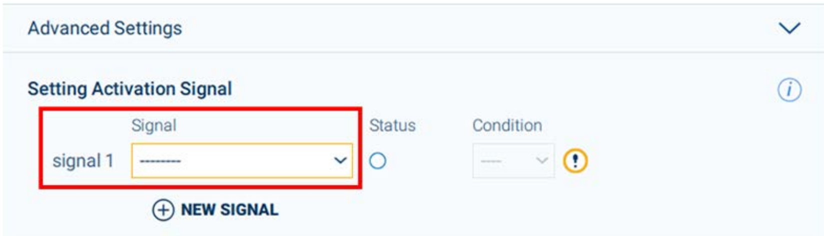
8. After changing the Action to Status, the “Advanced Settings” screen will pop-up and you can select a signal for your “Output Signal” drop-down.
9. Select the “Virtual Discrete Safety I/O” tab and choose the FSOUT01.
10. Once you have completed your changes press {READBACK} to readback the data. Check the readback data is correct, then press {WRITE} to save your setting.
11. Confirm the output signal is changed by Robot position as specified area. After confirmed, press {CONFIRM}.
12. Press the {MENU} button on the top left, select {Safety Settings}, and select {Safety Logic Circuit}.
13. Select {+ NEW LOGIC} at the top of the Safety Logic Circuit screen.
14. Give the setting a relevant name such as “Activate Low Speed by Area”. Change the input relay to FSOUT01 as Normally Closed, and the output relay to MSOUT01. By this setting, MSOUT01 will be ON when the Robot enter the specified area.

15. Once you have completed your changes press {READBACK} to readback the data. Check the readback data is correct, then press {WRITE} to save your setting.
16. Press the {MENU} button on the top left, select {Safety Settings}, and select {Safety Functions}.
17. Select {+ NEW SETTING} at the top of the Safety Function Settings screen, select {SPEED LIMIT} , then press {CREATE NEW SETTING} to open a blank Robot speed limit.

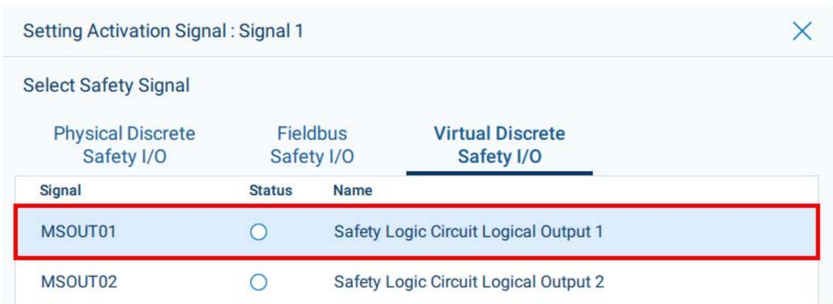


18. Give the speed limit a relevant name such as “Low Speed Area Speed Limit”, change the speed limit to a speed of 50 mm/sec for example, then change the {Enable Condition} to “Signal” in the drop-down menu.

19. After changing the Enable condition to Signal, the “Advanced Settings” screen will pop-up and you can select a signal for your “Setting Activation Signal” drop-down.



20. Select the “Virtual Discrete Safety I/O” tab. Choose the MSOUT01 which is connected from FSOUT01 in Safety Logic Circuit.



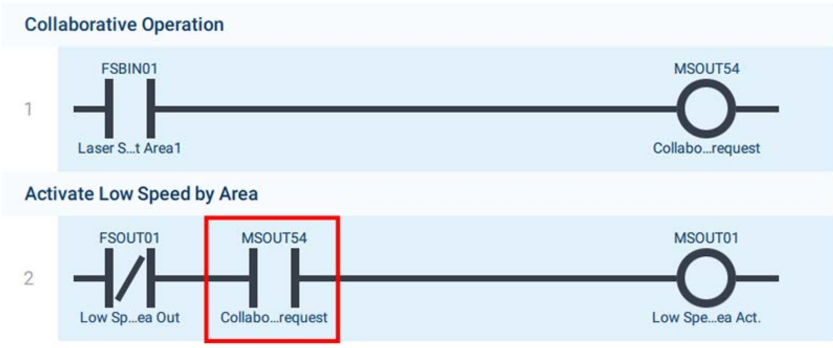
21. Once you have completed your changes press {READBACK} to readback the data. Check the readback data is correct, then press {WRITE} to save your setting.

22. You are now complete and the Robot will reduce the speed while someone is within specified area.

12.7.4 Reduce the Robot Speed by Robot Position only when Collaborative Operation Mode

For collaborative operation Robot such as HC10, this is an example to use safety laser scanner to activate the collaborative operation mode when a person or object is inside the safety laser scanner area. Also, reduce the Robot speed by the speed limit function when the Robot moves into the area which is defined by Robot range limit function. However, Robot will move at high speed even if the Robot is in the specified area when the Robot is not in collaborative operation mode.

1. Refer to *chapter 12.7.2 "Single Safety Laser Scanner to Activate Collaborative Operation"*, and *chapter 12.7.3 "Reduce the Robot Speed by Robot Position"*, to complete the setup.
2. In Safety Logic Circuit, add MSOUT54 as AND in the line that output to MSOUT01.

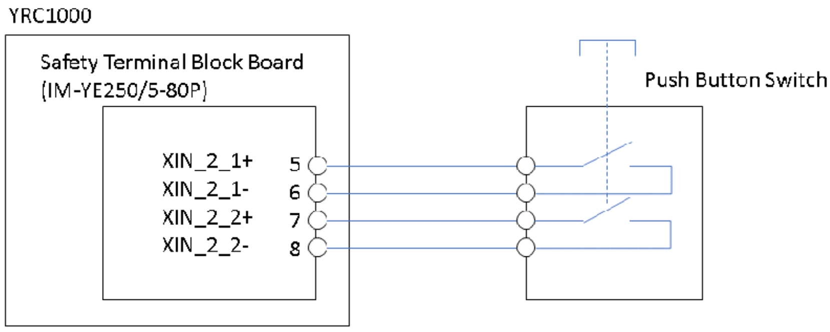


3. Once you have completed your changes press {READBACK} to readback the data. Check the readback data is correct, then press {WRITE} to save your setting.
4. You are now complete and the Robot will reduce the speed while someone is within specified area only when collaborative operation mode.

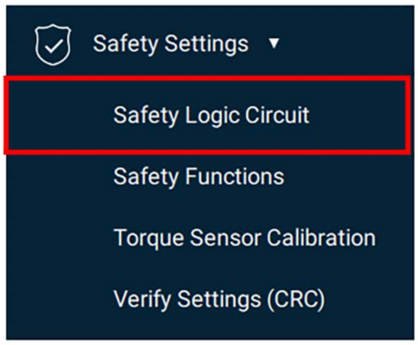
12.7.5 Add the Resume Switch for Collaborative Operation

For collaborative operation Robot such as HC10, this is an example to add the customer's resume switch in addition to the resume switch on the Robot.

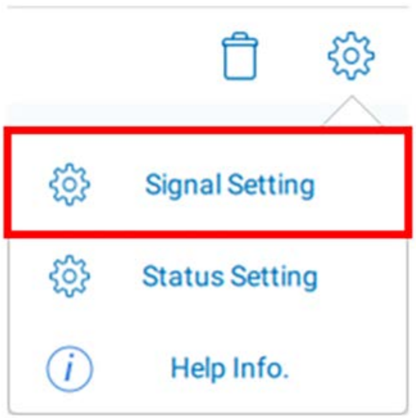
1. Connect your push button switch to the YRC Controller. For this example, we will be using the Functional Safety Board Input #2 (FSBIN02). Please note that wiring diagrams for this input may refer to the two pairs as XIN1_1-/XIN1_1+ and XIN1_2-/XIN1_2+.



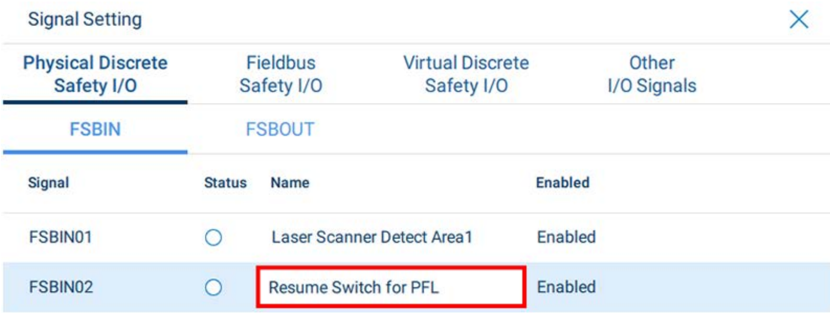
2. Press the {MENU} button on the top left, select {Safety Settings}, and select {Safety Logic Circuit}.



3. Press the {Setting} on the top right, select {Signal Setting} to open the screen.



4. Select the {Physical Discrete Safety I/O} tab and then select the {FSBIN} tab. Give the FSBIN02 a relevant name such as “Resume Switch”



5. Close the signal setting screen by pressing {X} button on the top right.
6. Select {+ NEW LOGIC} at the top of the Safety Logic Circuit screen.
7. Give the setting a relevant name such as “Resume PFL”. Change the input relay to FSBIN02 as Normally Closed, and the output relay to MSOUT57.
8. Once you have completed your changes press {READBACK} to readback the data. Check the readback data is correct, then press {WRITE} to save your setting.

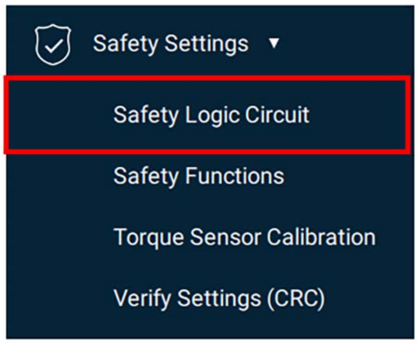
9. You are now complete and Robot will resume operation by pressing the push button switch.

12.7.6 Output Pendant Emergency Stop

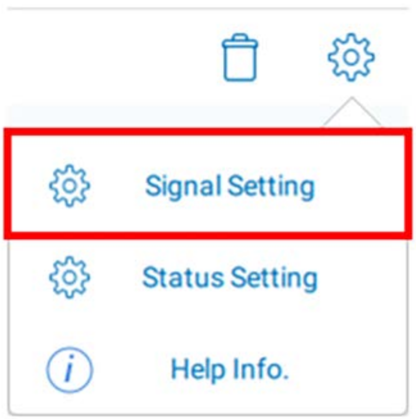
The Smart Pendant implements the E-Stop feedback circuitry to the robot controller differently from the standard Programming Pendant. Both pendants interface into the robot controller's dedicate Programming Pendant emergency stop (PPESP) input circuit. The deviation occurs with auxiliary contacts. The “Programming Pendant” includes two additional contact pairs that break-out inside the robot controller on the Expansion Safety Terminal Block board (for YRC1000 this is CN220 connected to JANCD-ASF02). This allows the customer to connect external devices to these normally closed contacts and enact emergency stops on the auxiliary machinery (conveyor, press, etc.) at any time when the Programming Pendant's emergency stop is pressed.

In the case of Smart Pendant, these additional contacts are not provided. If these are required the end user can resolve this by adding a line of logic to the Safety Logic Circuit screen and adding an appropriate safety relay to the output of the safety terminal block. An example of this implementation is shown:

1. Press the {MENU} button on the top left, select {Safety Settings}, and select {Safety Logic Circuit}.

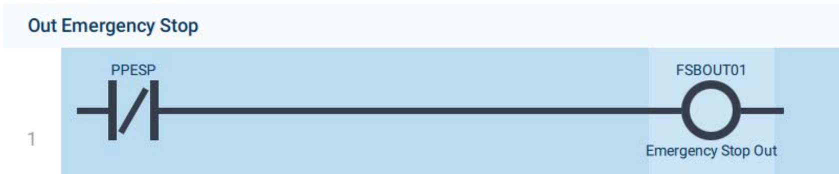


2. Press the {Setting} on the top right, select {Signal Setting} to open the screen.



3. Select the {Physical Discrete Safety I/O} tab and then select the {FSBOUT} tab. Give the FSBOUT01 a relevant name such as "Emergency Stop Out". Change {Output From} to "Safety Logic Circuit (M-SAFE)".

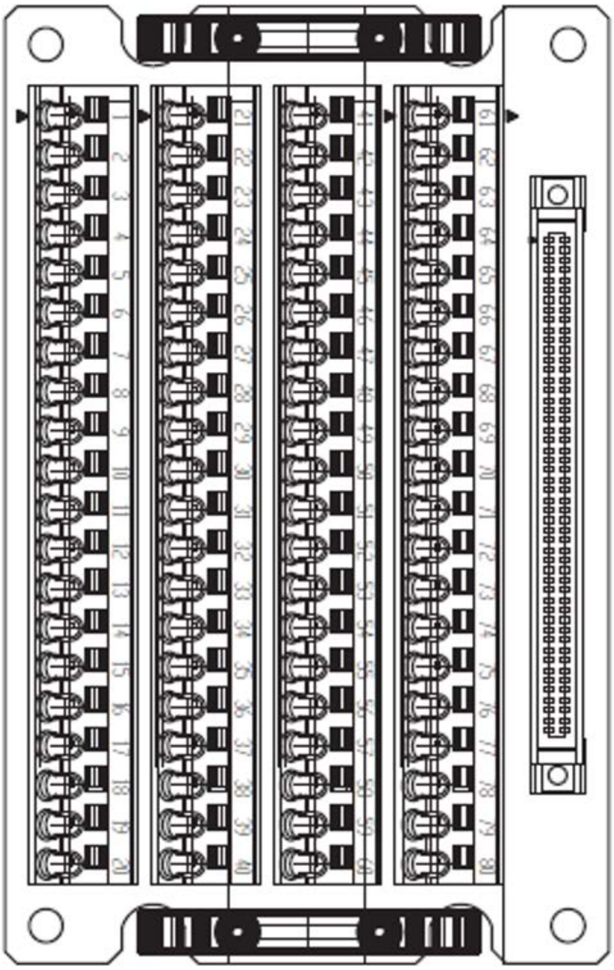
4. Close the signal setting screen by pressing {X}.
5. Select {+ NEW LOGIC} at the top of the Safety Logic Circuit screen.
6. Give the setting a relevant name such as "Out Emergency Stop". Change the input relay to PPESP as Normally Closed, and the output relay to FSBOUT01.



7. Once you have completed your changes, press {READBACK} to readback the data. Check the readback data is correct, then press {WRITE} to save your setting.
8. You are now complete and emergency stop will output by pressing the push emergency stop button on the Smart Pendant.

In this implementation a safety relay would be wired to the general purpose safety output signal FSBOUT01 on the Expansion Safety Terminal Block board of the YRC controller. The relay logic follows the chart below:

Pendant E-Stop Condition	**PPESP Signal Status**	**FSBOUT01 Status**	**Relay State**	**Safety Relay Outputs to Other Machinery**
Not Pressed	ON	ON	Activated	Closed - Other Machines OK to Operate
Pressed	OFF	OFF	Not Active	Open - Other Machines Not OK (NG) for Operation



13 Classic Interface

13.1 Introduction

13.1.1 Overview of Classic Interface

The Classic Interface on Smart Pendant provides supplementary functions for using the Smart Pendant with the YRC Controller. The Classic Interface is pre-installed on the Smart Pendant.

Classic Interface is compatible with Smart Pendant Version 2.1.2 or later. If the Smart Pendant is older than Version 2.1.2 refer to *chapter 13.5 "Software Pendant"*.

NOTE

When entering the Classic Interface, the Smart Pendant Interface is temporarily unavailable to the user. Alternatively, when disconnecting Classic Interface, Smart Pendant establishes communication with the YRC Controller again, and reloads information changed by Classic Interface.

13.1.2 Functions

The Classic Interface should be used for the following functions:

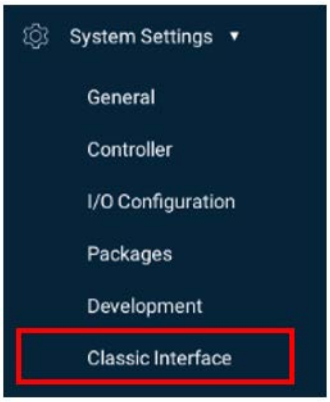
- Variable Allocation
- Concurrent I/O Editing
- Position Limit Setup
- Installation Angle
- I/O Allocation
- CMOSBK Load (Restore function for CMOS backup)
- All maintenance mode functions

13.2 Enter & Exit Classic Interface

13.2.1 Enter the Classic Interface

1. Press the {MENU} button on the top left, select {System Settings}, and select {Classic Interface}.

Fig. 13-1: Classic Interface Menu

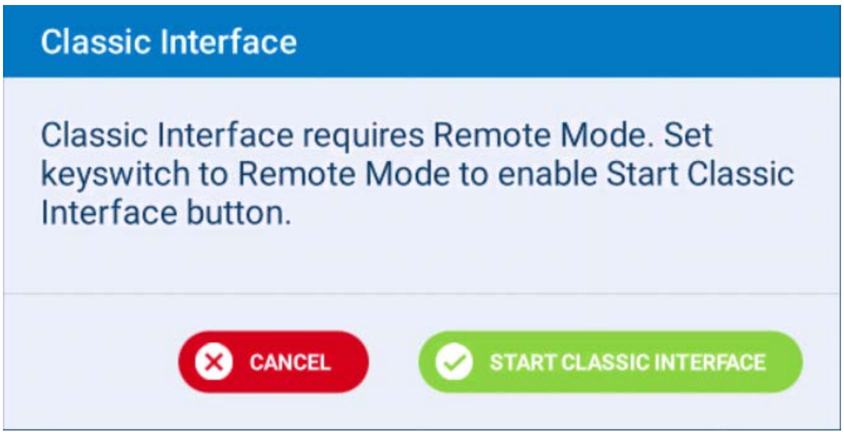


2. Press {START CLASSIC INTERFACE} in the Classic Interface popup window.

NOTE

Based on the version of the system software for YRC Controller, Remote Mode may be required to switch to Classic Interface. If this is required, a dialog box such as one shown below will popup. When this happens, switch the Mode Key to Remote and then press {START CLASSIC INTERFACE}

Fig. 13-2: Classic Interface Remote Mode Requirements

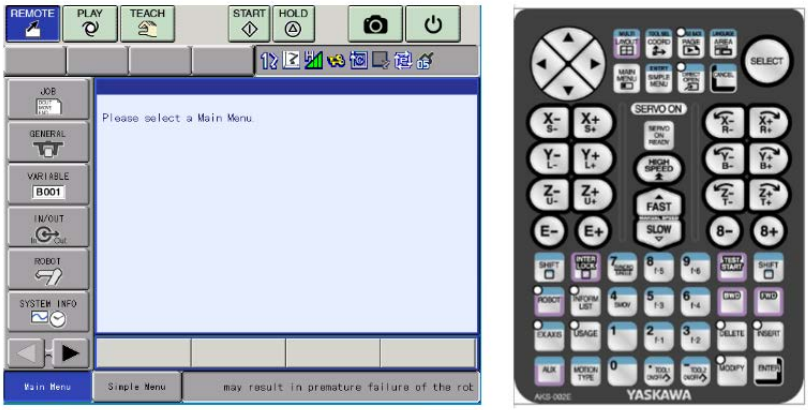


3. Press {Connect} on the Classic Interface startup window.

Fig. 13-3: Classic Interface Startup Window

– The programming pendant screen and the keyboard will display on the Smart Pendant once the Classic Interface has successfully connected to the YRC Controller.

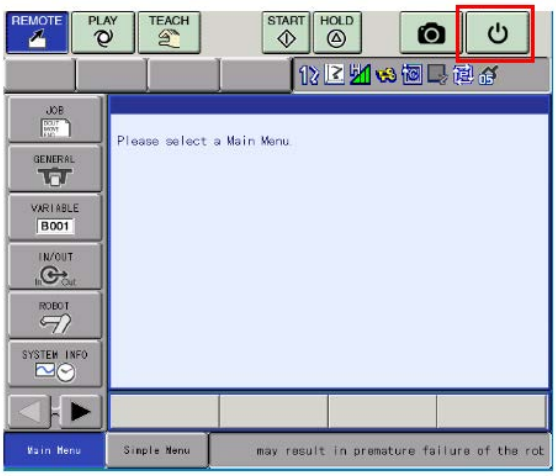
Fig. 13-4: Classic Interface Overview



13.2.2 Exit the Classic Interface

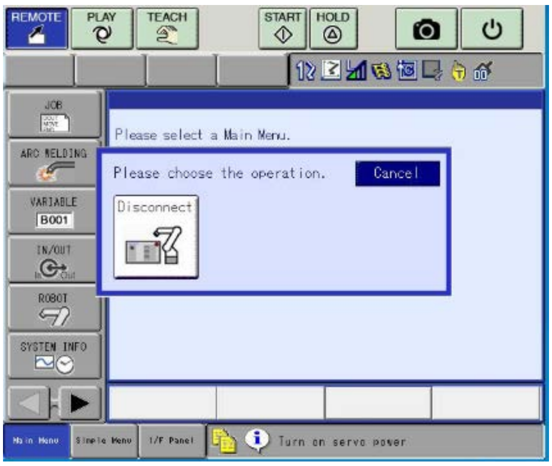
1. Press the {Power} button on the top right.

Fig. 13-5: Classic Interface Exit Button



2. Press the {Disconnect} button on the popup window.

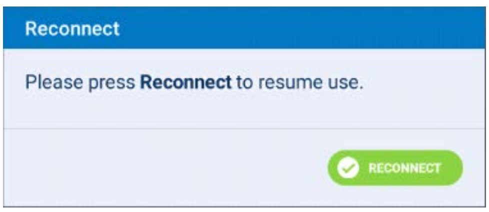
Fig. 13-6: Classic Interface Disconnect Button



   – The Classic Interface will disconnect, and the screen will switch back to the Smart Pendant interface.

3. Press {RECONNECT} and wait while information from the controller is reloaded.

Fig. 13-7: Smart Pendant Reconnect



13.3 Classic Interface Display and Operations

13.3.1 Classic Interface Operations

The Classic Interface is a nested application on the Smart Pendant with support of operating elements, including:

– Status LED

– Enable Switch

– Mode Switch

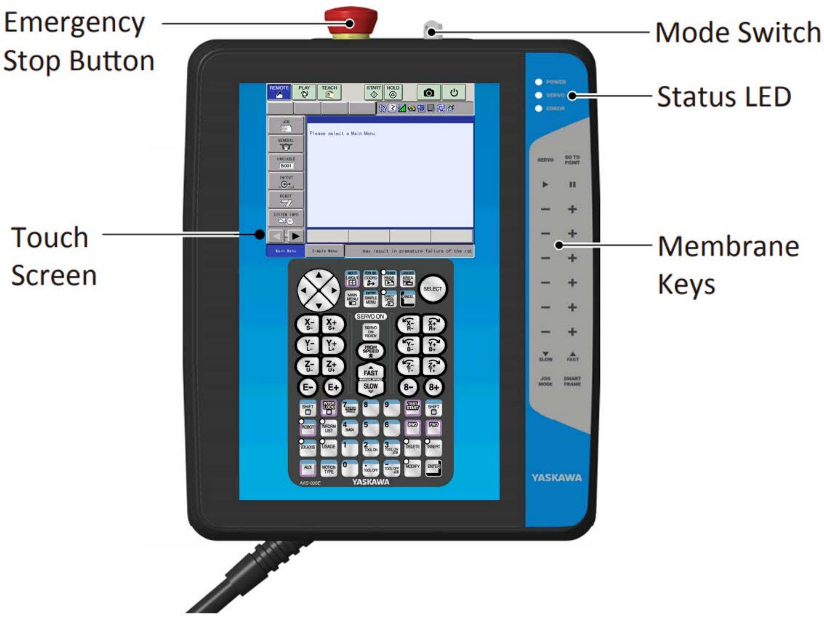
– Touch Screen

– Emergency Stop Button

The user can jog the manipulator using Classic Interface in the same way as the Smart Pendant Interface.

> **NOTE** Membrane Keys operation is not supported on the Classic Interface.

Fig. 13-8: Classic Interface Operations



13.3.2 Screen & Keyboard Display

There are six areas on the Classic Interface screen:

– Mode Status Display

– Menu Area

– Main Menu Area

– Status Display

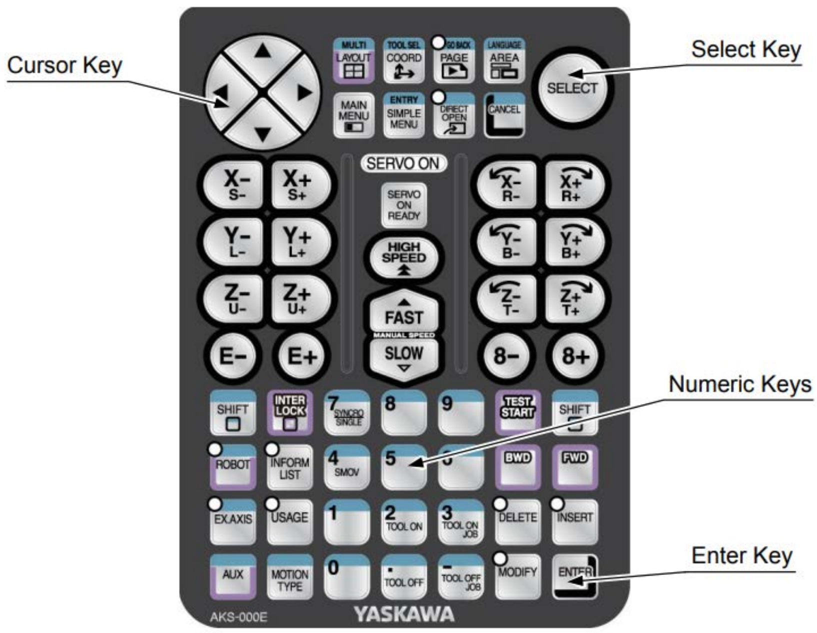
– General-Purpose Display Area

– Human Interface Display Area

Fig. 13-9: Classic Interface Screen

As Classic Interface is typically used for setting values in functions, the following keys will be used frequently: Cursor Key, Select Key, Enter Key, and Numeric Keys.

Fig. 13-10: Classic Interface Keys

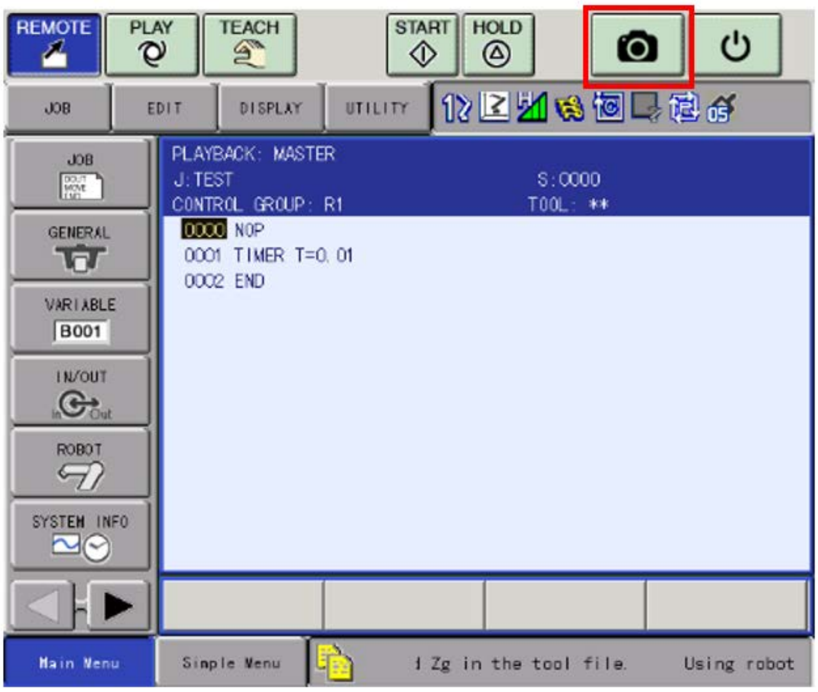


13.3.3 Screen Capture Function

Classic Interface provides the Screen Capture function for the user to take screenshots.

1. Insert a USB with sufficient free space into the Smart Pendant.
2. Press the “Camera” button at the right top corner.
3. Press {OK} in the popup window.

Fig. 13-11: Classic Interface Screenshot Feature



13.4 Application Examples on Classic Interface

The following examples of Classic Interface use are provided:

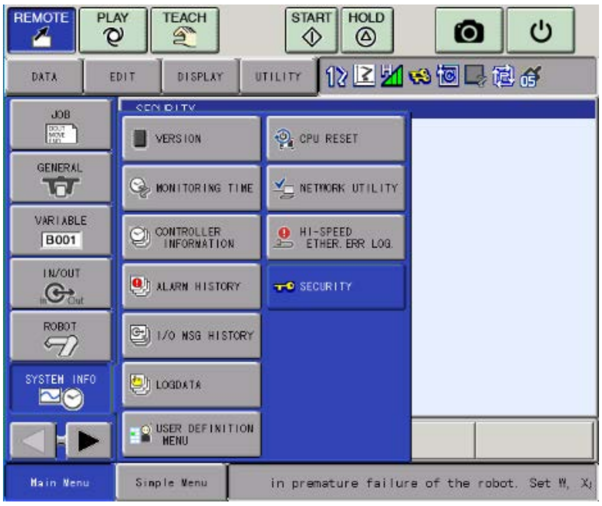
- Security Mode Change
- Concurrent I/O Editing
- Maintenance Mode Functions
- Safety Board Flash Reset
- CMOS Loading

13.4.1 Security Mode Change

To change the security mode on the Classic Interface:

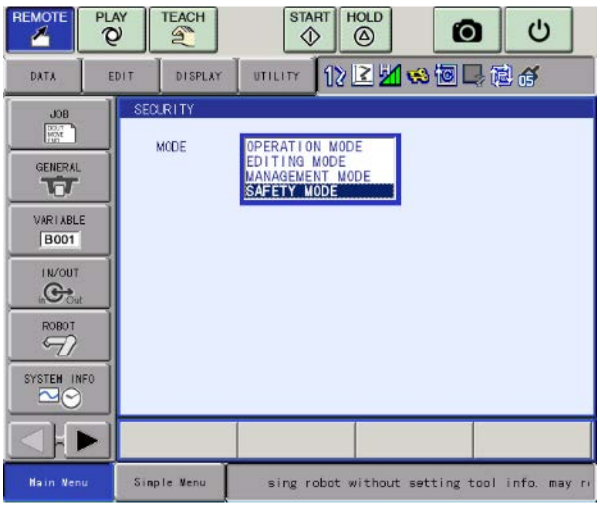
1. Select {SYSTEM INFO} from the Main Menu, and then select {SECURITY}.

Fig. 13-12: Classic Interface Security Menu



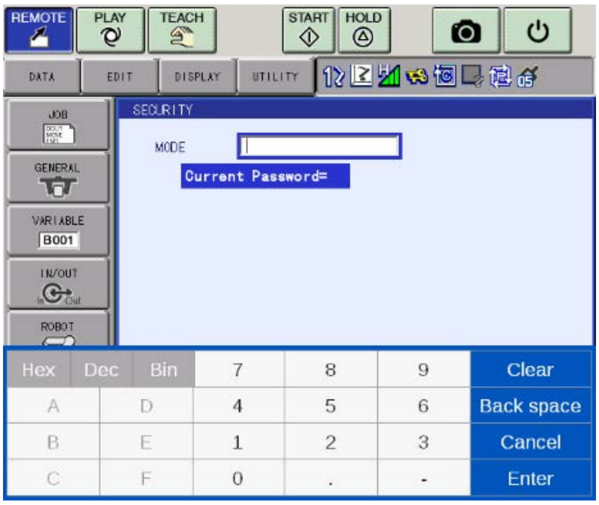
2. Select the target security mode.

Fig. 13-13: Classic Interface Security Mode Selection



3. Enter the respective password for the target security mode.
   - The default password for the security modes are:
     - **Editing Mode:** 0000000000000000 (16 digits of 0)
     - **Management Mode:** 9999999999999999 (16 digits of 9)
     - **Safety Mode:** 5555555555555555 (16 digits of 5)

Fig. 13-14: Classic Interface Security Mode Password



13.4.2 Concurrent I/O Editing

Concurrent I/O control is an I/O control function that processes controls relative to the YRC Controller I/O independent of the manipulator operation (in parallel with manipulator operation). This allows users to combine and customize system I/O signals. This section describes the basic procedures for editing Concurrent IO. For more details on the features and capabilities of Concurrent IO, refer to YRC1000 OPTIONS INSTRUCTIONS for Concurrent I/O (RE-CKI-A467), or YRC1000micro OPTIONS INSTRUCTIONS for Concurrent I/O (RE-CKI-A469).

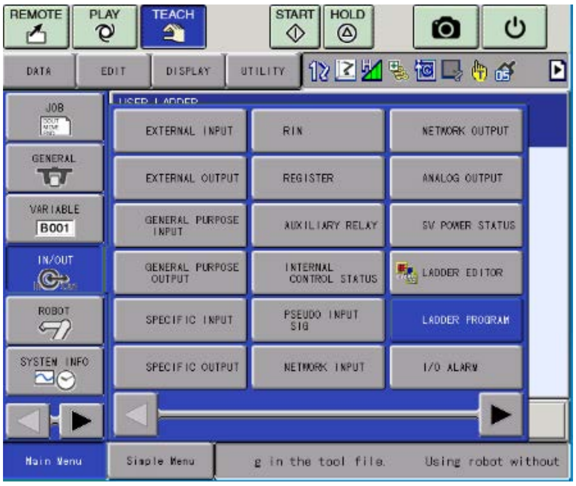
Users can set and edit the concurrent I/O settings through the {LADDER PROGRAM} on Classic Interface.

1. Change the security mode to Management Mode (or above), and the operation mode of the Classic Interface to Teach Mode.

Fig. 13-15: Classic Interface Operation Mode

2. Select {IN/OUT} under the main menu, and then select {LADDER PROGRAM}.

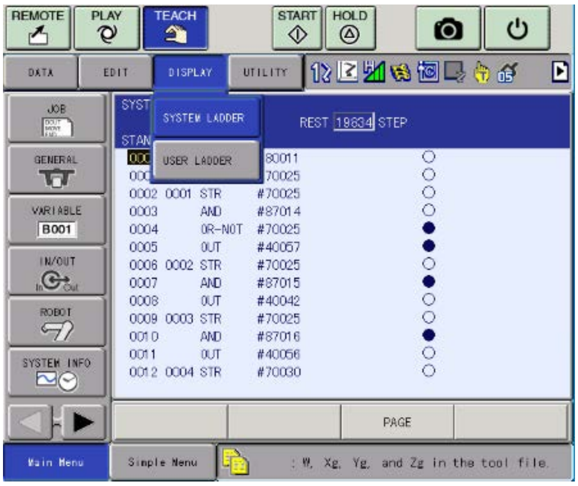
Fig. 13-16: Classic Interface Ladder Program Menu



3. Select {DISPLAY} in Menu Area, and then select {USER LADDER}.

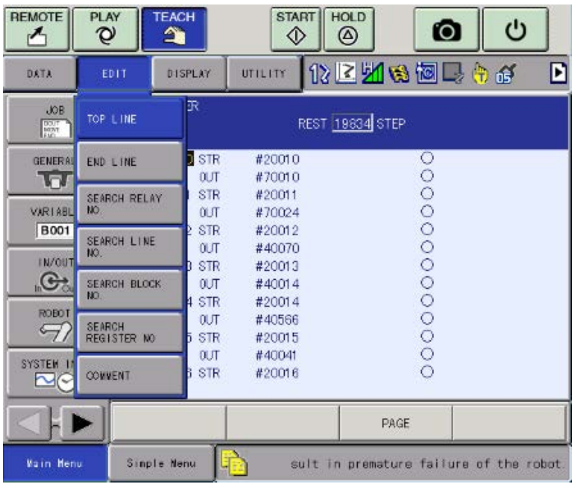
NOTE The {System Ladder} is prepared at the factory and cannot be edited by normal user.

Fig. 13-17: Classic Interface Ladder Program Display



4. Select {EDIT} in Menu Area to access functions that can help the users to locate specific signal numbers quickly.

Fig. 13-18: Classic Interface Ladder Program Edit

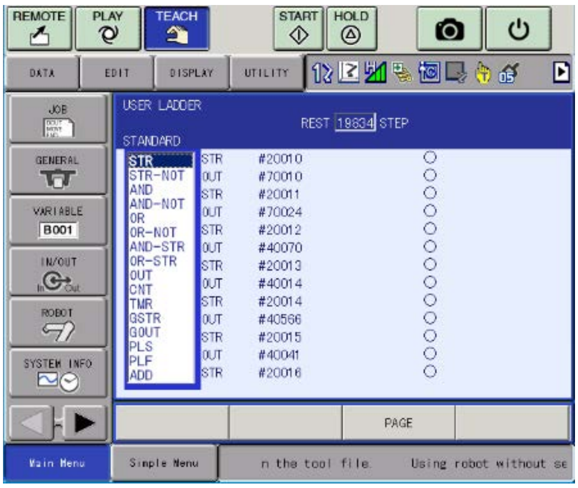


5. Editing Operation

– Users can edit the “Program Ladder” by inserting, modifying, and deleting the instructions.

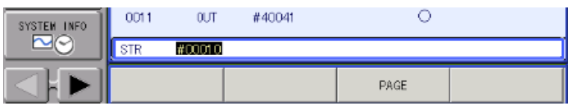
a) Insert Instruction - select the line (leave the cursor above the line number) before the line you wish to insert, and the instruction list dialog box displays.

Fig. 13-19: Classic Interface Ladder Program Editing



b) Select the instruction to be inserted and edit the relay# in the buffer line.

Fig. 13-20: Classic Interface Ladder Program Bufferline



c) Press {INSERT} and then {ENTER} to confirm.

Fig. 13-21: Classic Interface Keys

- **Modify Instruction** - Select the line to be modified, and do the modification in the buffer line, and then press {MODIFY} and then {ENTER} to confirm.
- **Delete Instruction** - Select the line to be deleted, and then press {DELETE} and then {ENTER} to confirm.

6. Select {DATA} in the Menu Area, and {COMPILE} to save.
   – To cancel all changes, just select {CANCEL EDIT})

Fig. 13-22: Classic Interface Ladder Program Compile

13.4.3 Maintenance Mode

On the YRC Controller the following functions can only be operated in Maintenance Mode:

– Modification of the CMOS data

– Initializing files

– Loading CMOS data (Saving is supported by Smart Pendant interface)

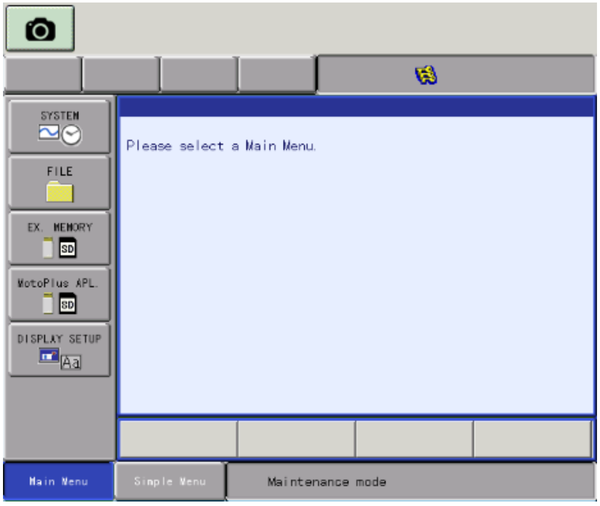
– Installing I/O Boards

NOTE	If requiring a Data Rebuild, the YRC Controller boots directly into maintenance mode automatically. This can potentially occur after updating the YRC Controller system software or after loading a CMOS of a different software version.

13.4.3.1 Entering Maintenance Mode On Classic Interface

1. In the Start Window (Exit the Classic Interface and restart, if smart pendant is already in the Classic Interface), select {Special Mode}, and then {Maintenance Mode}.
   a) The YRC Controller automatically reboots.
   b) The smart pendant goes to the Start Window of Classic Interface Directly

Fig. 13-23: Classic Interface Maintenance Mode

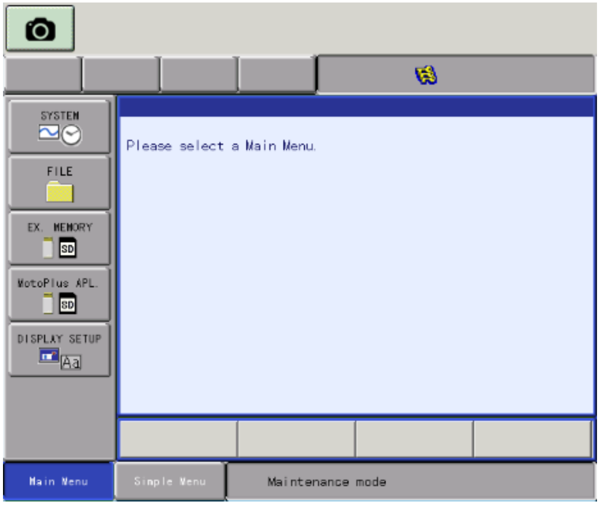


2. Click {Connect} to enter Maintenance Mode.

Fig. 13-24: Classic Interface Startup Window

3. To exit Maintenance Mode, reboot the YRC Controller manually.

Fig. 13-25: Classic Interface Maintenance Mode Window

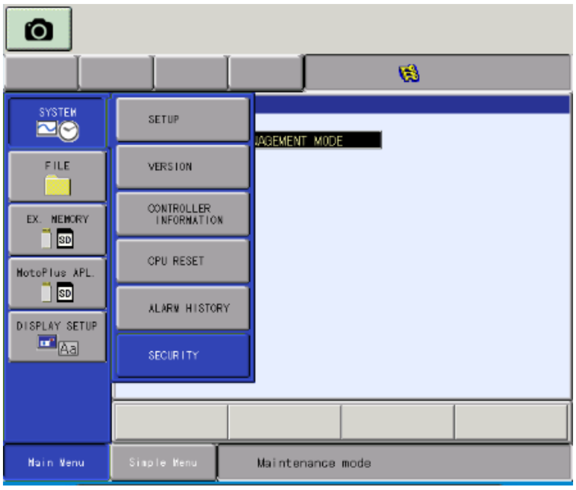


13.4.4 Safety Board Flash Reset

The YRC Controller must be in Maintenance Mode to do a Safety Board Flash Reset.

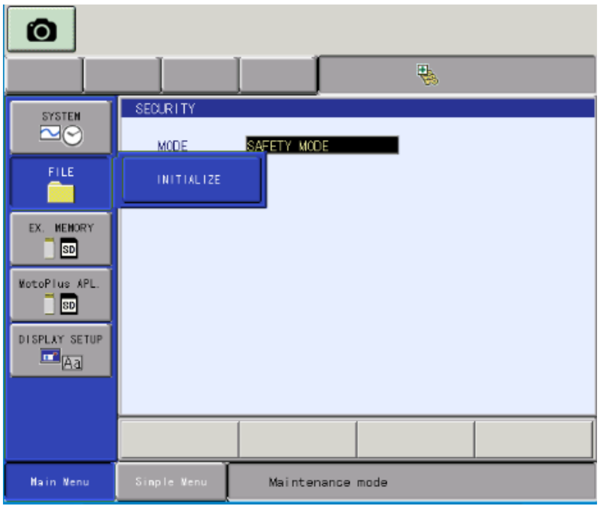
1. Enter Maintenance Mode
2. Select {SYSTEM} under the Main Menu, and then {SECURITY} to change the Security Mode to the safety mode.

Fig. 13-26: Classic Interface System Menu



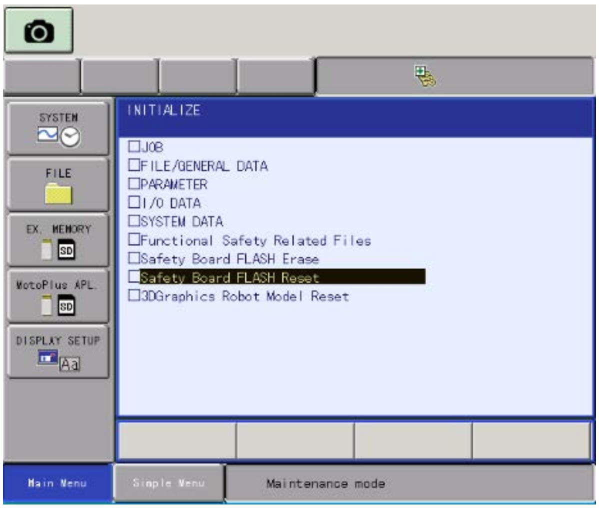
3. Select {FILE}, and then {INITIALIZE} under the Main Menu
   – The “INITIALIZE” window appears.

Fig. 13-27: Classic Interface Initialize Menu



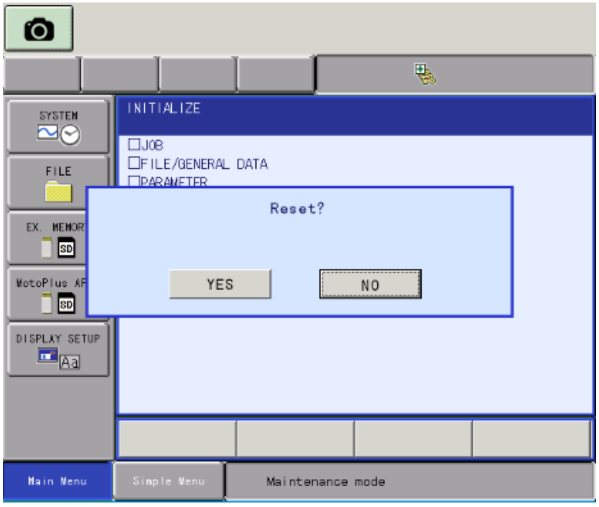
4. Move the cursor to the {Safety Board FLASH Reset} in the Initialize window, and press {SELECT}.
   – The dialog box {Reset?} displays

Fig. 13-28: Classic Interface Initialize Screen



5. Click {YES} to confirm.
   – The data of the safety circuit board is reset.
   – A few seconds later, a beep sounds, and the data setting is complete.

Fig. 13-29: Classic Interface Safety Board FLASH Reset



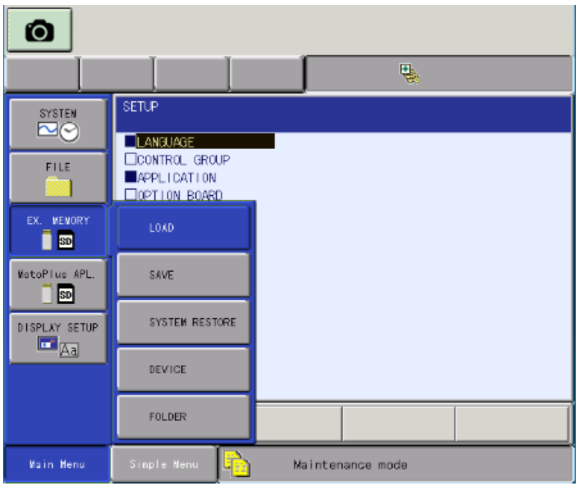
6. Perform a PFL FLASH Reset (Safety FLASH Reset) if the YRC Controller supports the collaborative operation function.
7. Turn the YRC Controller power OFF and back ON when the Safety Board FLASH Reset completes.

13.4.5 Loading CMOS

Loading of CMOS is only available under Maintenance Mode.

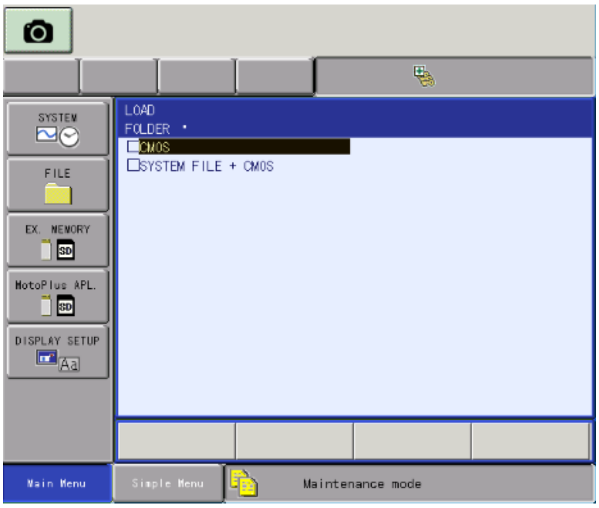
1. Change the Security Mode to Management Mode or above.
2. Select {EX. MEMORY} and then {LOAD} on the submenu.

Fig. 13-30: External Memory Load



3. Select {CMOS} on the LOAD screen.

Fig. 13-31: Loading CMOS



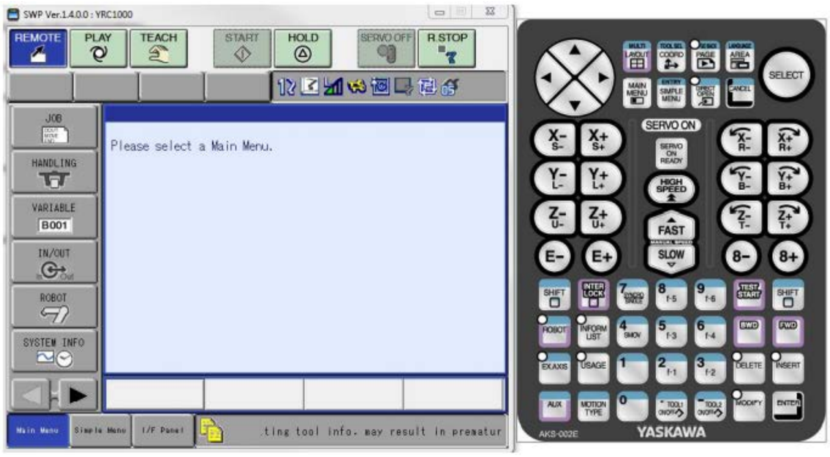
4. Press {YES} on the popup window, then wait for the CMOS loading process.

13.5 Software Pendant

13.5.1 Overview of Software Pendant

The Software Pendant is a Windows PC application that supplies the same functions as supported by the Classic Interface. Prior to Classic Interface being available on the Smart Pendant, maintenance functions required the use of the Software Pendant.

Fig. 13-32: Software Pendant Screen



13.5.2 Export Software Pendant Application from Smart Pendant

The Smart Pendant stores the Software Pendant application installer internally. To export the installer to a USB drive, complete the following steps.

1. Navigate to {Menu} → {System Settings} → {General}.
2. Switch Operation Mode to MANUAL (TEACH).
3. Insert a USB drive with sufficient free space into the Smart Pendant.
4. Toward the bottom of the {General Settings} screen is an {Export} under {Bundled Resources}.
5. Select the check box for “Software Pendant” Application and then press the {EXPORT...} per *fig. 13-33*.

Fig. 13-33: Download Software Pendant Application

– The Software Pendant installer copies to the USB drive.

6. Remove the USB drive and use it to install the Software Pendant on a PC.

13.5.3 Software Pendant Connection

13.5.3.1 Network Setup

Before connecting the Software Pendant to the YRC Controller, setup the IP address of the YRC Controller as described in *chapter 8.6.4 "Setting IP Address"*. Once setting up the IP address of the YRC Controller, the PC with the Software Pendant will be able to "ping" the YRC Controller. If the PC cannot "ping" the YRC Controller, verify the PC and YRC Controller are on the same subnet.

Fig. 13-34: YRC1000 (LAN2 (CN106) Connector)

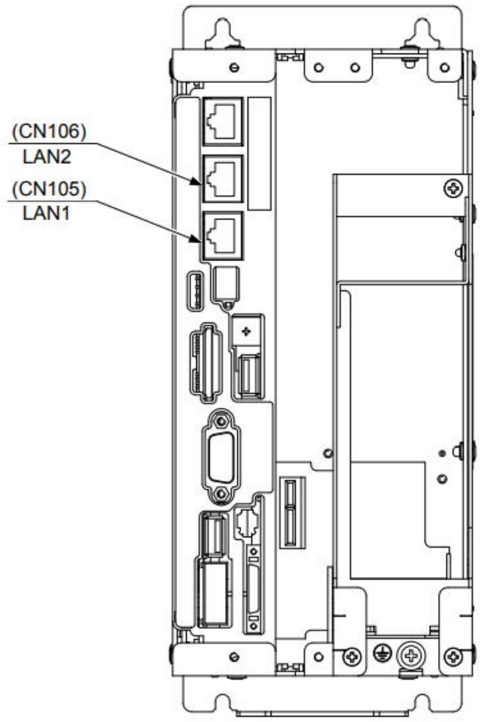
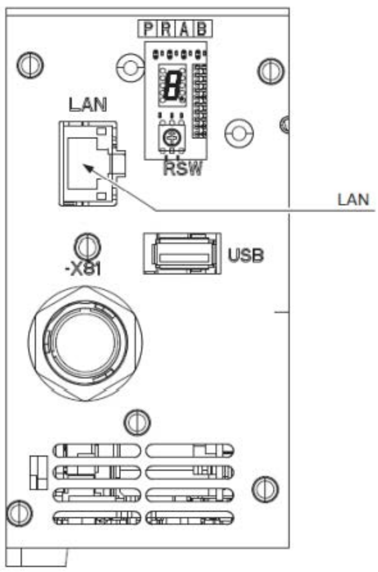


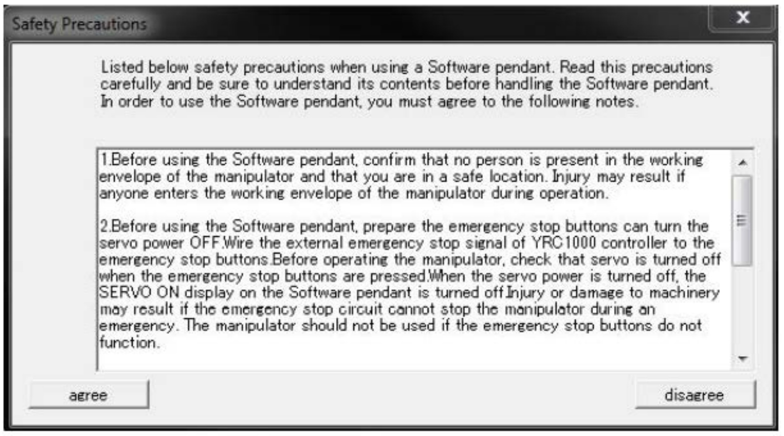
Fig. 13-35: YRC1000micro (LAN Connector)



13.5.3.2 Startup of Software Pendant

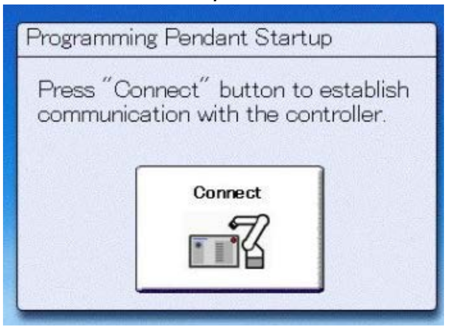
1. Startup the “Software Pendant”.
   – The “Safety Precautions” window appears.
2. Click “agree” all precautions listed are agreed upon.

Fig. 13-36: Software Pendant Safety Precautions



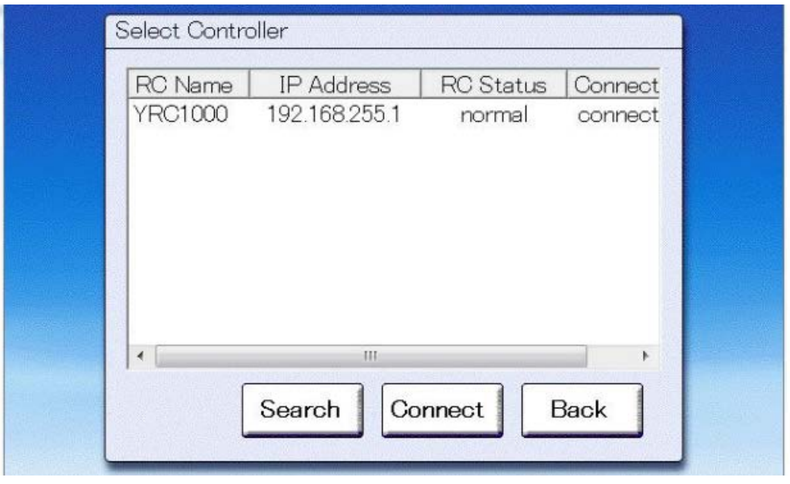
2. Click “Connect” on the Software Pendant startup window.

Fig. 13-37: Software Pendant Startup Window



3. Select the IP Address on the YRC Controller to connect to.

Fig. 13-38: Software Pendant Controller Selection

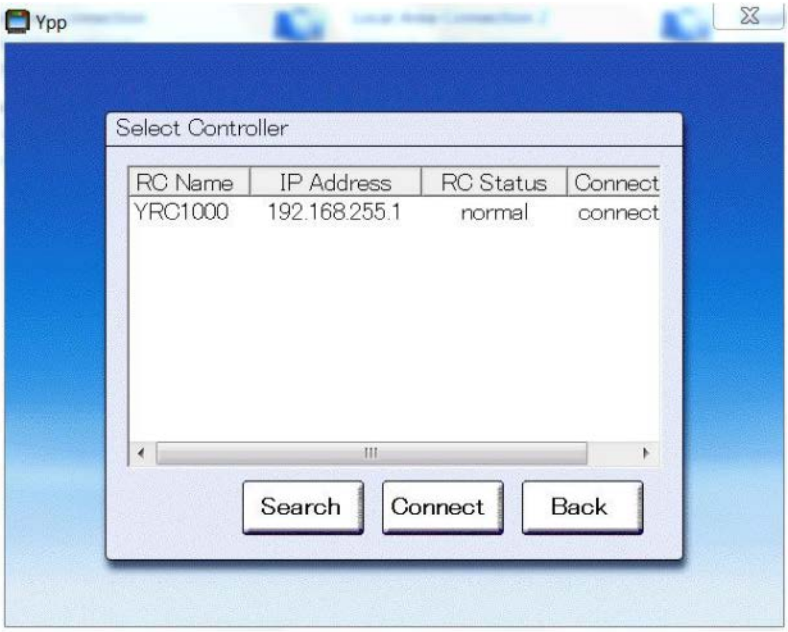


> **NOTE** If there are no YRC Controllers in the list, verify the Network Settings on both the YRC Controller and PC. If the problems persist, refer to *chapter 8.6.6 "Resetting Controller Network Settings"*.

4. Change the YRC Controller mode to REMOTE using the physical key switch on the Smart Pendant.

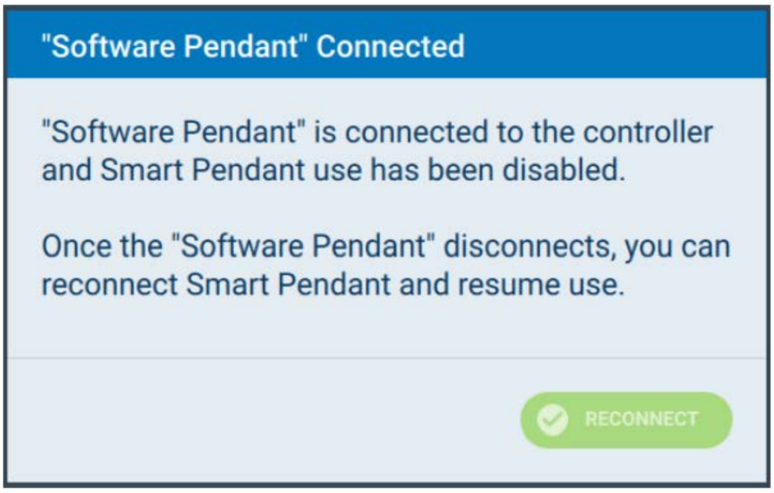
5. Click "Connect".

Fig. 13-39: Software Pendant Connection



5. Verify the Software Pendant connects to the Smart Pendant.
   – Once the Software Pendant successfully connects to the YRC Controller, the following message appears on the Smart Pendant.

Fig. 13-40: Software Pendant Connection on Smart Pendant



14 External Memory Device

14.1 Memory Device

Memory devices allow operators to save and load data such as jobs and parameters. The following memory devices can be used with the YRC Controller.

– USB memory stick to Smart Pendant
(The Smart Pendant is equipped with a connector.)

– USB memory stick to the YRC Controller
(The CPU board (JANCD-ACP01) is equipped with a connector.)

14.1.1 USB Memory Stick

The Smart Pendant and CPU board (JANCD-ACP01) is equipped with a USB connector. Use the FAT16 or FAT32 formatted USB memory stick for the CPU board, and use the FAT32 formatted USB memory stick only for the Smart Pendant.

14.1.2 Recommended USB Memory Stick

Refer to chapter 9.1.2 “Device” of the INSTRUCTIONS of the YRC Controller for recommended external memory devices to use with YRC Controller.

14.1.3 Notes on Handling USB Memory Stick

– Do not drop or bend or apply any electric shock or strong force to the USB memory stick.

– Keep away from water, oil, organic solvent, dust, dirt, and other potential contaminants.

– Do not use or keep the USB memory stick in places where strong static electricity or electronic noise may occur.

– Do not insert or remove the USB memory stick or turn the power OFF when reading or writing from the USB memory stick.

– To protect data, back it up regularly on other media. This will minimize damage to or loss of data due to operation errors and accidents.

*USB memory sticks have a limited life span, which varies by make and condition. Normal use of a USB memory stick as an external memory device for the YRC Controller does not adversely affect USB memory stick performance. For details, refer to the instruction manuals for each medium.

14.1.4 Rules for USB Connectors and USB Memory Sticks

This section contains rules and instructions on how to safely use USB connectors on the CPU board (JANCD-ACP01) and memory sticks.

1. **Do not insert/remove the USB memory stick on the YRC Controller when control power is ON**
   A device recognition process is executed when an USB memory stick is inserted. Do not insert or remove an USB memory stick when the control power supply is turned ON. Failure to observe this rule may affect the manipulator's cycle time.

2. **Do not disconnect control power or insert/remove an USB memory stick during file access**
   Failure to observe this rule may result in FAT file system corruption and data loss.

3. **Operating temperature range of USB memory stick**
   Use a USB memory stick that is guaranteed to function correctly in the same temperature range as the YRC Controller.

4. **USB memory stick's falling off by the YRC Controller vibration**
   To prevent the USB memory stick from falling off due to vibrations from the YRC Controller, consider countermeasures, such as fixing the USB stick with jigs to keep it in place.

5. **USB connector on the front surface of the CPU board (JANCD-ACP01)**
   The USB connector on the front surface of the CPU board (JANCD-ACP01) accepts only the USB memory stick. Do not connect a USB hub or other USB devices.

6. **Capacity of USB memory stick**
   The capacity of the memory stick is up to four Gigabyte in size for the CPU board, and no limit for the Smart Pendant.

14.1.5 Inserting a USB Memory Stick in Smart Pendant

When inserting a USB memory stick always position the Smart Pendant with its back side facing up. Hold the USB memory stick with its top surface facing up, and insert it into the USB memory stick connector on the bottom of the Smart Pendant.

Forcible insertion may cause damage to the USB memory stick or USB connector.

After inserting the USB memory stick, be sure to close the cover of the connector before starting operations.

14.1.6 Inserting a USB Memory Stick in the CPU Board (JANCD-ACP01)

Make sure to insert the USB memory stick in the right direction: Keep the USB memory stick with its top surface to the right, and insert it slowly into the connector on the CPU board.

Forcible insertion may cause damage to the USB memory stick or USB connector.

CAUTION

- Disconnect power to the YRC Controller before opening the YRC Controller door.

Failure to observe this may result in electric shock.

Fig. 14-1: USB Memory Stick Inserting Place (YRC1000 CPU Board JANCD-ACP01)

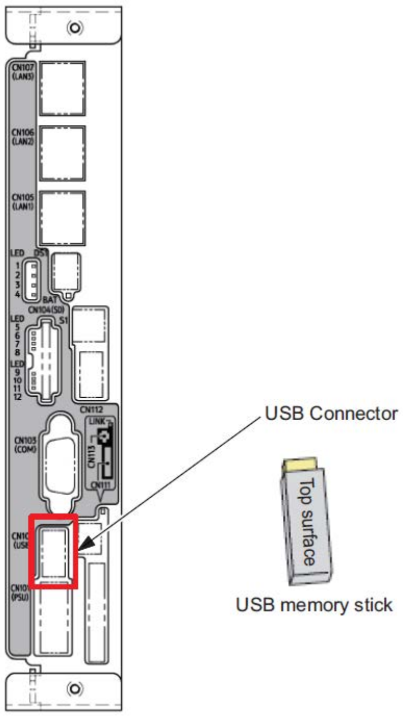
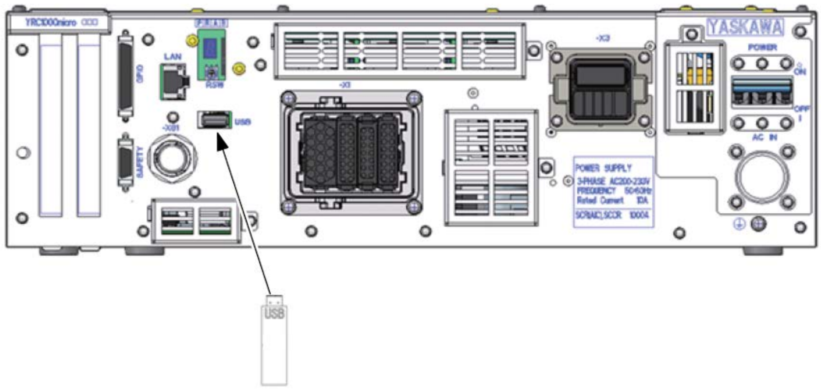


Fig. 14-2: USB Memory Stick Inserting Place (YRC1000micro CPU Board JANCD-ACP31)



NOTE

If the USB memory stick is not recognized or an error message is displayed even if it is inserted, remove the USB memory stick and insert it again slowly.

14.2 Handling Data

For the YRC Controller, data that can be saved externally, and are classified into six categories.

① **JOB**

② **GENERAL DATA**

③ **PARAMETER**

④ **I/O DATA**

⑤ **SYSTEM DATA**

⑥ **SYSTEM BACKUP (CMOS.BIN)**

Data saved on the external memory device can be loaded again into the YRC Controller.

NOTE

③ PARAMETER, ④ I/O DATA, ⑤ SYSTEM DATA, and ⑥ SYSTEM BACKUP (CMOS.BIN) (which contains the data of the former three data) have its unique information of each YRC Controller.

If data is loaded by other Controllers, unintended data overwriting, unexpected operation, or abnormal system startup may occur.

Do not load those backup data into other YRC Controller.

Even if two YRC Controllers are loaded with the same job, paths of the two manipulators are different due to the home positions or mechanical error of the component parts.

Be sure to check the motion of the manipulator before running the job.

Table 14-1: Data List (Sheet 1 of 4)

Data Classification			File name (Saved Data)	Save				Load			
				OPN	EDT	MNG	SFT	OPN	EDT	MNG	SFT
6. SYSTEM BACKUP (CMOS.BIN)			CMOS.BIN	○	○	○	○	×	×	×	×
	1. JOB	Single job	JOBNAME.JBI	○	○	○	○	×	○	○	○
	2. GENERAL DATA	Tool data[1)]	TOOL.CND	○	○	○	○	×	○	○	○
		User coordinate data	UFRAME.CND	○	○	○	○	×	○	○	○
		Zone setting data	CUBEINTF.CND	○	○	○	○	×	○	○	○
		Variable data	VAR.DAT	○	○	○	○	×	○	○	○
		Timer variable data	TMVAR.DAT	○	○	○	○	×	×	×	×
		Shock detection level data	SHOCKLVL.CND	○	○	○	○	×	○	○	○
		Interrupt job[1)]	INTJOB.DAT	○	○	○	○	×	○	○	○
		Tool interfere data[1)]	TOOLINTF.DAT	○	○	○	○	×	○	○	○
		Axis range limit data[1)]	AXRNGLMT.DAT	○	○	○	○	×	×	×	○
		Axis speed monitor data[1)]	AXSPDMON.DAT	○	○	○	○	×	×	×	○
		Robot range limit data[1)]	RBRNGLMT.DAT	○	○	○	○	×	×	×	○
		Speed limit data[1)]	SPDLMT.DAT	○	○	○	○	×	×	×	○
		Tool angle monitor data[1)]	TLANGMON.DAT	○	○	○	○	×	×	×	○
		Tool change monitor data[1)]	TLCHGMON.DAT	○	○	○	○	×	×	×	○
		External force monitor data[1)]	PFLFLMT.DAT	○	○	○	○	×	×	×	○
		Approval warning buzzer data[1)]	APPRBUZR.DAT	○	○	○	○	×	×	×	○
		User menu data	USERMENU.DAT	○	○	○	○	×	○	○	○
		Job registration data	JET.DAT	○	○	○	○	×	○	○	○

1) Safety level is required to load for FSU supporting manipulators
2) Classic Interface is required to load
○: Can be done, ×: Cannot be done
OPN: Operation level, EDT: Edit level,
MNG: Management level, SFT: Safety level

Table 14-1: Data List (Sheet 2 of 4)

Data Classification				File name (Saved Data)	Save				Load			
					OPN	EDT	MNG	SFT	OPN	EDT	MNG	SFT
6	3. PARAMETERS		Batch Parameter[1]	ALL.PRM	○	○	○	○	×	×	×	×
		PARAMETER	Robot matching parameter[1]	RC.PRM	○	○	○	○	×	×	×	×
			System definition parameter[1]	SD.PRM	○	○	○	○	×	×	×	×
			Coordinate home position parameter[1]	RO.PRM	○	○	○	○	×	×	×	×
			System matching parameter	SC.PRM	○	○	○	○	×	×	○	○
			CIO parameter	CIO.PRM	○	○	○	○	×	×	×	×
			Function definition parameter[1]	FD.PRM	○	○	○	○	×	×	×	×
			Application parameter	AP.PRM	○	○	○	○	×	×	○	○
			Transmission (general parameter)	RS.PRM	○	○	○	○	×	×	○	○
			Sensor parameter	SE.PRM	○	○	○	○	×	×	×	×
			Servo parameter[1]	SV.PRM	○	○	○	○	×	×	×	×
			Servomotor parameter[1]	SVM.PRM	○	○	○	○	×	×	×	×
			Operation control parameter	AMC.PRM	○	○	○	○	×	×	×	×
			Servo power block parameter	SVP.PRM	○	○	○	○	×	×	×	×
			Motion function parameter[1]	MF.PRM	○	○	○	○	×	×	×	×
			SERVOPACK parameter	SVS.PRM	○	○	○	○	×	×	×	×
			Converter parameter	SVC.PRM	○	○	○	○	×	×	×	×
			Robot control expand parameter[1]	RE.PRM	○	○	○	○	×	×	×	×
			Safety function parameter[1]	FMS.PRM	○	○	○	○	×	×	×	×

1) Safety Level is required to load for FSU supporting manipulators
2) Classic Interface is required to load
○: Can be done, ×: Cannot be done
OPN: Operation level, EDT: Edit level,
MNG: Management level, SFT: Safety level

Table 14-1: Data List (Sheet 3 of 4)

Data Classification			**File name (Saved Data)**	**Save**				**Load**			
				OPN	**EDT**	**MNG**	**SFT**	**OPN**	**EDT**	**MNG**	**SFT**
6	4. I/O DATA	I/O name data	IONAME.DAT	○	○	○	○	×	×	○	○
		External I/O name data	EXIONAME.DAT	○	○	○	○	×	×	○	○
		Register name data	IOMNAME.DAT	○	○	○	○	×	×	○	○
		Concurrent I/O program	CIOPRG.LST	○	○	○	○	×	×	○	○
		Pseudo input signals	PSEUDOIN.DAT	○	○	○	○	×	×	○	○
		Safety logic circuit data[2)]	YSFLOGIC.DAT	○	○	○	○	×	×	×	○
		User group input	USRGRPIN.DAT	○	○	○	○	×	×	○	○
		User group output	USRGRPOT.DAT	○	○	○	○	×	×	○	○
	5. SYSTEM DATA	Home position calibrating data[1)]	ABSO.DAT	○	○	○	○	×	×	○	○
		Work home position data	OPEORG.DAT	○	○	○	○	×	×	○	○
		Second home position	HOME2.DAT	○	○	○	○	×	×	○	○
		Torque sensor orgin position data[1)]	PFLORGP.DAT	○	○	○	○	×	×	×	○
		Variable name	VARNAME.DAT	○	○	○	○	×	×	○	○
		Flag variable name	FLNAME.DAT	○	○	○	○	×	×	○	○
		Timer variable name	TMNAME.DAT	○	○	○	○	×	×	○	○
		SETTM setup file	SETTM.DAT	○	○	○	○	×	×	○	○
		External IO allocation data	EIOALLOC.DAT	○	○	○	○	×	×	○	○
		IP network set data	IPNETCFG.DAT	○	○	○	○	×	×	○	○
		High-Speed Ethernet error log	HISPDLOG.DAT	○	○	○	○	×	×	×	×
		Ethernet/IP config data	EHTERIP.DAT	○	○	○	○	×	×	○	○
		I/F panel data	IFPANEL.DAT	○	○	○	○	×	×	○	○
		I/O message history data	IOMSGHST.DAT	○	○	○	○	×	×	×	×
		Alarm history data	ALMHIST.DAT	○	○	○	○	×	×	×	×
		Log data	LOGDATA.DAT	○	○	○	○	×	×	×	×
		Robot stop factor file	RBSTPFCT.DAT	○	○	○	○	×	×	×	×

1) Safety level is required to load for FSU supporting manipulators
2) Classic Interface is required to load
○: Can be done, ×: Cannot be done
OPN: Operation level, EDT: Edit level,
MNG: Management level, SFT: Safety level

Table 14-1: Data List (Sheet 4 of 4)

Data Classification			File name (Saved Data)	Save				Load			
				OPN	EDT	MNG	SFT	OPN	EDT	MNG	SFT
6	5. SYSTEM DATA	System information	SYSTEM.SYS	○	○	○	○	×	×	×	×
		YRC Controller information	PANELBOX.LOG	○	○	○	○	×	×	×	×
		Wear detection base position data	SGWEARBP.DAT	○	○	○	○	×	×	○	○
		Max / Min torque data	TRQDAT.DAT	○	○	○	○	×	×	×	×
		PM (reducer file)	PMTRQDB.DAT	○	○	○	○	×	×	○	○
		PM (reducer condition)	PMCOND.CND	○	○	○	○	×	×	○	○
		Inspection record file	PMLOG.DAT	○	○	○	○	×	×	×	×
		PM (Hardware file)	PMHARD.DAT	○	○	○	○	×	×	×	×
		PM time management data	PMTMMNG.DAT	○	○	○	○	×	×	×	×
		User word	UWORD.DAT	○	○	○	○	×	×	○	○
		Job monitor data	JOBMONI.DAT	○	○	○	○	×	×	×	×
		Step diagnosis data	STEPDIAG.DAT	○	○	○	○	×	×	×	×
		Robot monitor data	ROBOMONI.DAT	○	○	○	○	×	×	×	×
		SV monitor signal	SVMON.DAT	○	○	○	○	×	×	○	○
		Arc monitor data	ARCMON.DAT	○	○	○	○	×	×	×	×
		Encoder	ENCHEAT.DAT	○	○	○	○	×	×	×	×
		Function key allocation data	KEYALLOC.DAT	○	○	○	○	×	×	○	○
		Macro definitions	MACRO.DAT	○	○	○	○	×	×	○	○

1) Safety level is required to load for FSU supporting manipulators
2) Classic Interface is required to load
○: Can be done, ×: Cannot be done
OPN: Operation level, EDT: Edit level,
MNG: Management level, SFT: Safety level

14.3 Macro Installation

If macros are enabled, MACRO.DAT is available in the system data file list.

Copy the macro .JBI and MACRO.DAT files to the YRC Controller from the USB.

Once files are copied the macros are available in the command list.

15 Startup Error

15.1 Startup Errors and Notifications

15.1.1 Startup Error Overview

If an error occurs during startup, startup will stop, a red X will appear next to the startup step where the error occurred, and the STARTUP ERROR window will appear with information about the error. The {Export Logs…} button can be used to save internal logs to a USB storage device to aid troubleshooting by a local YASKAWA Representative.

Have the following information available when contacting a local YASKAWA Representative:

– System
– Primary Application
– YRC Controller and Smart Pendant Software Version:
– Smart Pendant Software Version is located on top left corner of startup screen
– Robot Serial Number (Located on Manipulator data plate)
– Robot Sales Order Number (Located on YRC Controller data plate)
– Warranty Identification Number
– Step that startup failed on
– Active YRC Controller Alarms, if any
– Smart Pendant startup Error Numbers, if any
– Extracted pendant.log file from startup screen

NOTE

The Smart Pendant startup errors are different from YRC Controller alarms.

Fig. 15-1: Startup Error Layout

① **Smart Pendant Software Version**

② **Failed Step**
A red X appears next to the startup step where the startup error occurred.

③ **Startup Error Window**
Contains the Startup Error Number in square brackets, a description of the error, possible causes and remedies.

④ **Restart App Button**
This button restarts the Smart Pendant application.

> **NOTE** The Restart App Button will not restart the YRC Controller.

⑤ **Export Resources Button**
This button saves Smart Pendant documentation to a USB storage device.

⑥ **Export Logs Button**
This button saves internal logs to a USB storage device.

⑦ **Scrollbar**
If the Startup Error details are too long, a scrollbar will appear along the right edge of the Startup Error Window to allow the user to read all content.

15.1.2 Startup Errors

Table 15-1: Startup Errors

Startup Error Number	Startup Error Message	Cause	Remedy
10	Pendant network configuration failed	Pendant network configuration failed.	Contact a YASKAWA Representative and provide pendant.log file.
20	Communication between pendant and YRC Controller failed.	Network cable may not be connected. IP settings may not be set correctly on Smart Pendant.	The Smart Pendant requires a fixed network address to communicate with the YRC Controller. Follow these steps to set the IP address: a) Reboot the YRC Controller and pendant b) When '...' appears on the screen, press a membrane key c) Select Network and then Ethernet 0 d) Ensure DHCP is not checked e) Set the entries: • IP address: 10.0.0.4 • Mask: 255.255.255.0 • Gateway: 10.0.0.2 f) Press OK to save g) Use Back and Exit to resume startup
			Unplug and re-plug Smart Pendant to the YRC Controller
30	YRC Controller Unresponsive.	“Smart Pendant Option” may be disabled. YRC Controller may be in Maintenance mode due to a YRC Controller alarm.	Make sure the YRC Controller “Smart Pendant Option” is enabled. Use the Classic Interface to troubleshoot or contact a YASKAWA Representative.
35	Software pendant is connected.	Software pendant is connected.	Disconnect “Software Pendant” and reboot the YRC Controller.
40	Some of the YRC Controller parameters are not compatible with Smart Pendant.	“Smart Pendant Option” is disabled.	Only a YASKAWA Representative can enable Smart Pendant Option. Contact a YASKAWA Representative and provide pendant.log file.
50	YRC Controller version incompatible with the Smart Pendant version.	YRC Controller version incompatible with Smart Pendant version.	Contact a YASKAWA Representative and provide pendant.log file. Refer to message in message box, consider upgrading YRC Controller system software to minimum required version.
52	Pendant software incompatible with configured YRC Controller languages.	Pendant software incompatible with configured YRC Controller languages.	Contact a YASKAWA Representative and provide pendant.log file. Only English and Japanese are supported.
55	Reading files from the YRC Controller for jobs, zones, or user frames has failed.	Reading files from YRC Controller for jobs, zones, or user frames has failed.	Contact a YASKAWA Representative and provide pendant.log file and failed step.

Startup Error Number	Startup Error Message	Cause	Remedy
57	Reading files from pendant failed.	Reading files from pendant failed.	Contact a YASKAWA Representative and provide pendant.log file.
58	Robot model not supported by Smart Pendant.	Manipulator model not supported by Smart Pendant.	Contact a YASKAWA Representative and provide pendant.log file.
60	Some of YRC Controller parameters are not correct.	“FTP Server Option” is not set.	Only a YASKAWA Representative can set the FTP Server option. Contact a YASKAWA Representative and provide pendant.log file.
80	YRC Controller setting is not correct.	FTP CMOS backup is disabled.	Only a YASKAWA Representative can enable the FTP CMOS Backup. Contact a YASKAWA Representative and provide pendant.log file.
90	Some of the YRC Controller parameters are not compatible with Smart Pendant.	YASKAWA Mode YRC Controller Parameters are not compatible with Smart Pendant.	Setup parameters need to be set correctly and can only be set by a YASKAWA Representative.
95	Some of the YRC Controller parameters are not compatible with Smart Pendant.	Normal Mode YRC Controller Parameters are not compatible with Smart Pendant.	Use the “Software Pendant” or launch “Classic Interface” to set the parameters listed on the startup screen to the recommended values or contact a YASKAWA Representative and provide pendant.log file.
96	Pseudo input signal #87015 (CMD REMOTE SEL) is not compatible with Smart Pendant.	Pseudo input signal #87015 (Command Remote Selection) is not compatible with Smart Pendant.	Use the “Software Pendant” or launch “Classic Interface” to set the value to ON or contact a YASKAWA Representative and provide pendant.log file.
110	Initialization of versions failed.	Initialization of versions failed.	Contact a YASKAWA Representative and provide pendant.log file.
111	Initialization of parameters failed.	Initialization of parameters failed.	Contact a YASKAWA Representative and provide pendant.log file.
112	Initialization of robots failed.	Initialization of robots failed. May have failed to initialize second home position, work home position, torque position 1, or torque position 2.	Contact a YASKAWA Representative and provide pendant.log file.
113	Initialization of zones failed.	Initialization of zones failed. A zone might have been configured as a station or external axis zone.	Contact a YASKAWA Representative and provide pendant.log file.
114	Initialization of tools failed.	Initialization of tools failed.	Contact a YASKAWA Representative and provide pendant.log file.
115	Initialization of user frames failed.	Initialization of user frames failed.	Contact a YASKAWA Representative and provide pendant.log file.
116	Initialization of tool settings failed.	Initialization of tool settings failed.	Contact a YASKAWA Representative and provide pendant.log file.
117	Initialization of safety settings failed.	Initialization of safety settings failed.	Contact a YASKAWA Representative and provide pendant.log file.
118	Initialization of variables failed.	Initialization of variables failed.	Contact a YASKAWA Representative and provide pendant.log file.
119	Initialization of jobs failed.	Initialization of jobs failed.	Contact a YASKAWA Representative and provide pendant.log file.

Startup Error Number	Startup Error Message	Cause	Remedy
120	Initialization of default job (master job) failed.	Initialization of default job (master job) failed.	Contact a YASKAWA Representative and provide pendant.log file.
121	Final initialization failed.	Final initialization failed.	Contact a YASKAWA Representative and provide pendant.log file.
125	YRC Controller is in Maintenance Mode.	YRC Controller is in Maintenance Mode.	If this was not intentionally set, use “Software Pendant” to troubleshoot or contact a YASKAWA Representative.

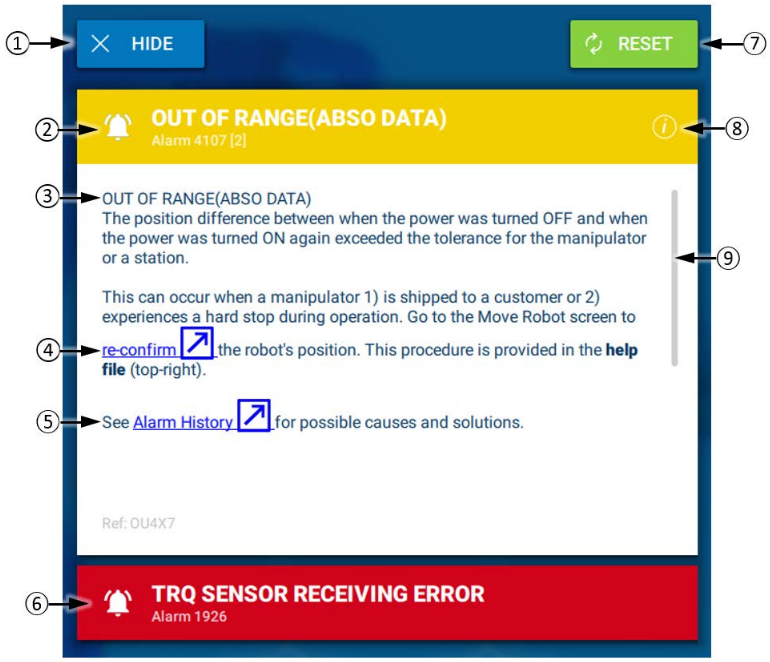
16 Alarms and Notifications

16.1 Alarms Details

16.1.1 Alarm Overview

Alarms will be displayed when an instruction cannot be processed. One or multiple alarms can occur at once. If multiple alarms exist, all pop-ups will be shown in a scrollable list. An overview of the alarm layout is provided below.

Fig. 16-1: Alarm Layout



① **Hide Button**
Allows the user to hide the alarm to continue performing restricted operations on the pendant

② **Alarm Title**
Contains the alarm title, code, and subcode. The title bar is also color coded (yellow = minor alarm, red = major alarm). The following sections contain more detail on alarm types.

③ **Alarm Details**
Contains why the alarm happened and possible solutions.

④ **Help Links**
Links located in alarm details will direct the user to screen(s) with actions required to resolve the alarm.

⑤ **Alarm History**
Directs the user to the Alarm History screen (*fig. 16-2 "Alarm History Screen"*).

⑥ **Multiple Alarms**
If multiple alarms are active, the subsequent alarms will appear collapsed in list form. Press the alarm title to expand the alarm to view its contents.

⑦ **Reset Button**
Allows the user to reset a Minor alarm. Major alarms cannot be reset.

⑧ **Help Icon**
Some alarms require background information to fully understand the problem. This information will be contained in a help file visible in the Alarm Title (top-right).

⑨ **Scrollbar**
If the alarm details are long, a scrollbar will appear to allow the user to read all content.

There are three types of alarms on Smart Pendant: Major, Minor, and User alarms. The following sections will explain the differences for each.

16.1.2 Major Alarm

When a major alarm occurs, the servo power supply will be turned OFF.

Table 16-1: Major Alarm Code Classification

Alarm Code	Alarm Type	Alarm Reset Method
0000 to 0999	Off line alarm: Initial diagnosis/ Hardware diagnosis alarm	It is not possible to reset by pressing the “RESET” button under the ALARM pop-up window or using the specific input signal (Alarm reset). Turn OFF the main power supply and correct the cause of the alarm. Then turn the main power supply ON again.
1000 to 3999	Major alarm	It is not possible to reset by pressing the “RESET” button under the ALARM pop-up window or using the specific input signal (Alarm reset). Turn OFF the main power supply and correct the cause of the alarm. Then turn the main power supply ON again.

Major alarms are shown in a red pop-up window.

Only one action can be performed on Major alarms:

– HIDE: User can hide the alarm to continue performing restricted operations on the pendant. Reset operation cannot be performed for a Major alarm and the YRC Controller restart is required.

Major alarms cannot be cleared until the problem has been solved. For further information on alarms, read “YRC1000 ALARM CODES (RE-CER-A600)” or “YRC1000micro ALARM CODES (RE-CER-A601)”. Use the alarm number (which is displayed under the alarm name) to find the matching alarm information in the document.

16.1.3 Minor Alarm

When a minor alarm occurs, the operator must reset the alarm after correcting the cause. This process does not require a restart of the YRC Controller.

Table 16-2: Minor Alarm Code Classification

Alarm Code	Alarm Type	Alarm Reset Method
4000 to 7999	Minor alarm	After correcting the cause, it is possible to reset by pressing the {RESET} in the ALARM pop-up window or the specific input signal (Alarm reset).
8000 to 8999	User alarm	After correcting the cause for which user has specified, it is possible to reset by pressing the {RESET} in the Alarm pop-up window or the specific input signal (Alarm reset).
9000 to 9999	I/O alarm	After correcting the cause for which the specific input signal for the system or user alarm request turns ON, it is possible to reset by pressing the {RESET} in the ALARM pop-up window or the specific input signal (Alarm reset).

Minor alarms are shown in yellow pop-up window.

Read the notification and follow the solution provided on the screen.

Two actions can be performed on Minor Alarm:

– CLOSE: User can close the alarm to continue performing restricted operations on the pendant.

  • Example 1: If a Zone alarm happens, user can close it and navigate to Zone screen and change the offending zone to status, so that the alarm can be reset.

  • Example 2: When the manipulator jogged over the Soft Limits, user can close the alarm. Open the Limit Release window and disable limits. After this, jogging of the manipulator can be performed to get it within its allowed position limits. Once this is done, Alarm can be Reset.

– RESET: This will reset the alarm. An alarm that is Reset may reappear if the conditions causing the alarm have not been remedied.

For further information about alarms, read YRC1000 ALARM CODES (RE-CER-A600)" or "YRC1000micro ALARM CODES (RE-CER-A601)". Use the alarm number (which is displayed under the alarm name) to find the matching alarm information.

16.1.4 User Alarm

User Alarms are created by a user. The alarm is displayed shown in a yellow pop-up window. One method to set the User Alarm is using the SetUserAlarm command in the job. For further information on User Alarms, refer to YRC1000/YRC1000micro SUPPLEMENTAL INSTRUCTIONS FOR Smart Pendant (INSTRUCTIONS FOR INFORM LANGUAGE) (HW1485511).

16.2 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.

Go to {Alarm} under {MENU}.

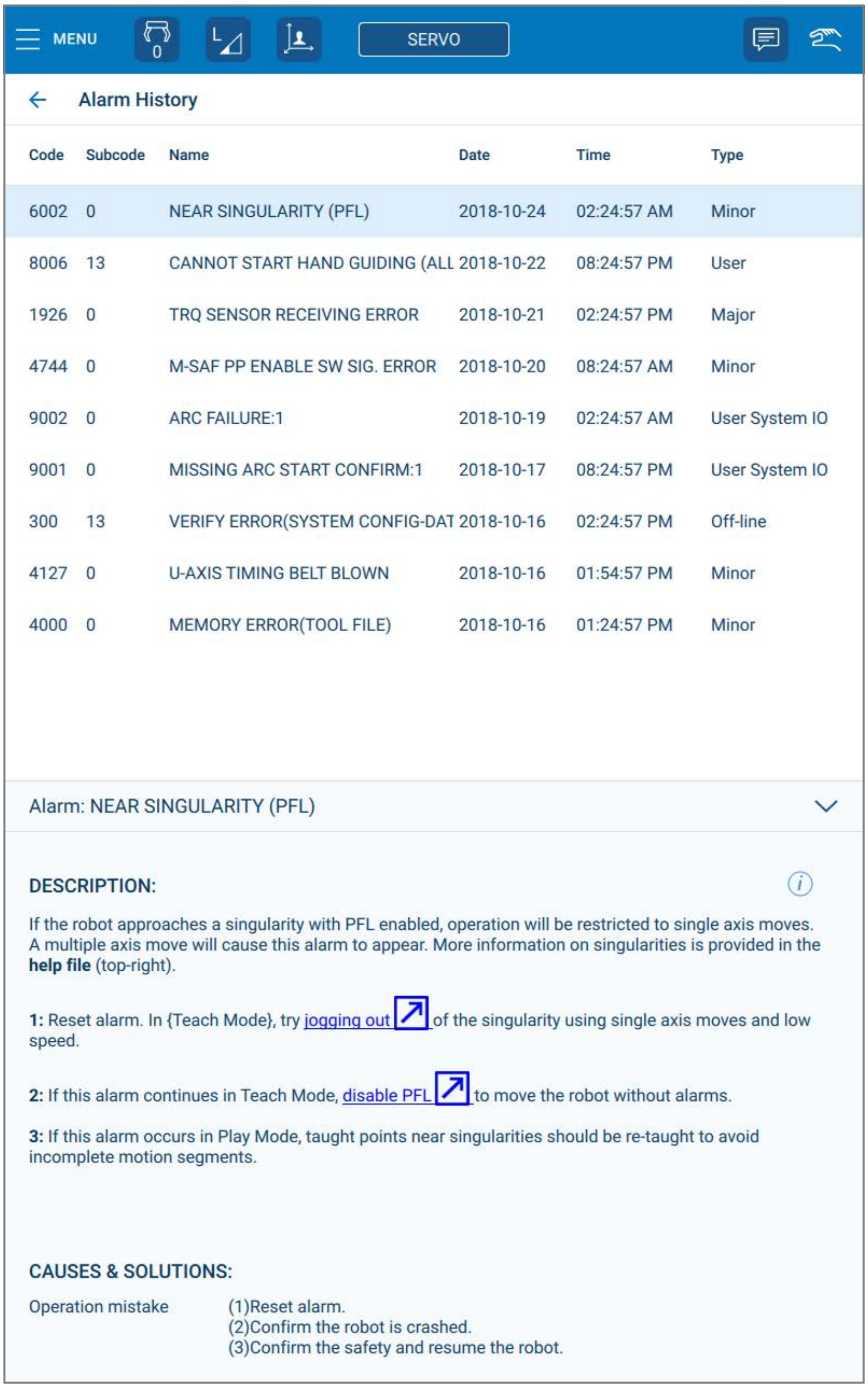
Table 16-3: Alarm History Information

Item	Description
Code	Alarm code is shown in 4-digits
Sub code	Alarm sub-code is shown
Name	Name of the alarm occurred
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
Type	Type of alarm is shown. For example, Major, Minor, User System I/O, Off-line etc.

Table 16-4: Alarm Detail

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.

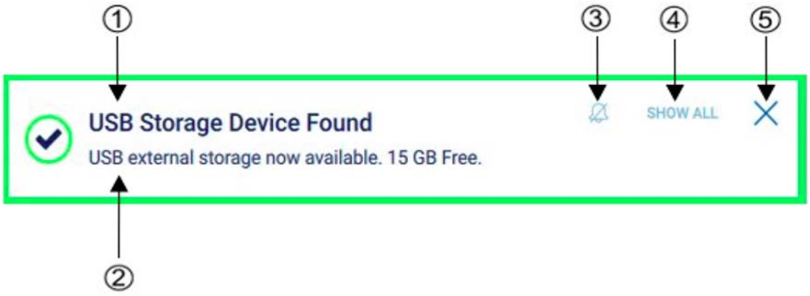
Fig. 16-2: Alarm History Screen



16.3 Notifications

Smart Pendant often displays notifications at the top of the screen to alert the user of certain pendant states and guide the user through incompatible/error conditions. A description of the notification layout is provided *fig. 16-3*

Fig. 16-3: Notification Layout



① **Title**
Summary of current notification.

② **Message**
Detailed description of current notification.

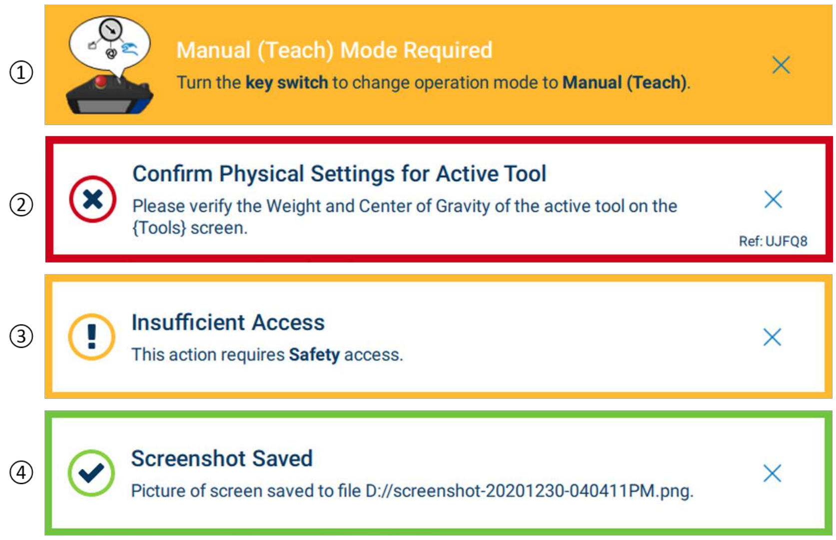
③ **Silence**
Icon for disabling future occurrence(s) of current notification. Disabled notification(s) can be re-enabled on the Notification History screen.

④ **Show All**
Icon for navigating to the Notification History screen.

⑤ **Dismiss**
Icon for dismissing current notification.

There are four primary types of notifications:

Fig. 16-4: Notification Types



① **High Priority**
Physical action is required to proceed - an image is provided to visually describe the intended action.

② **Error**
An error has occurred that can affect system performance and requires the user’s attention. This type of notification will remain open until the user taps it to close.

③ **Standard**
Notifies the user regarding incompatible states (e.g. insufficient access level,) user interactions (e.g. item copied/deleted, or screen-specific interactions.

④ **Success**
Confirmation of a successfully completed action.

NOTE

The “Ref:” code for errors are used by YASKAWA internally, it has no corresponding meaning.

All previous notifications can be viewed on the Notification History screen ({Menu} ⟶ {Notifications}).

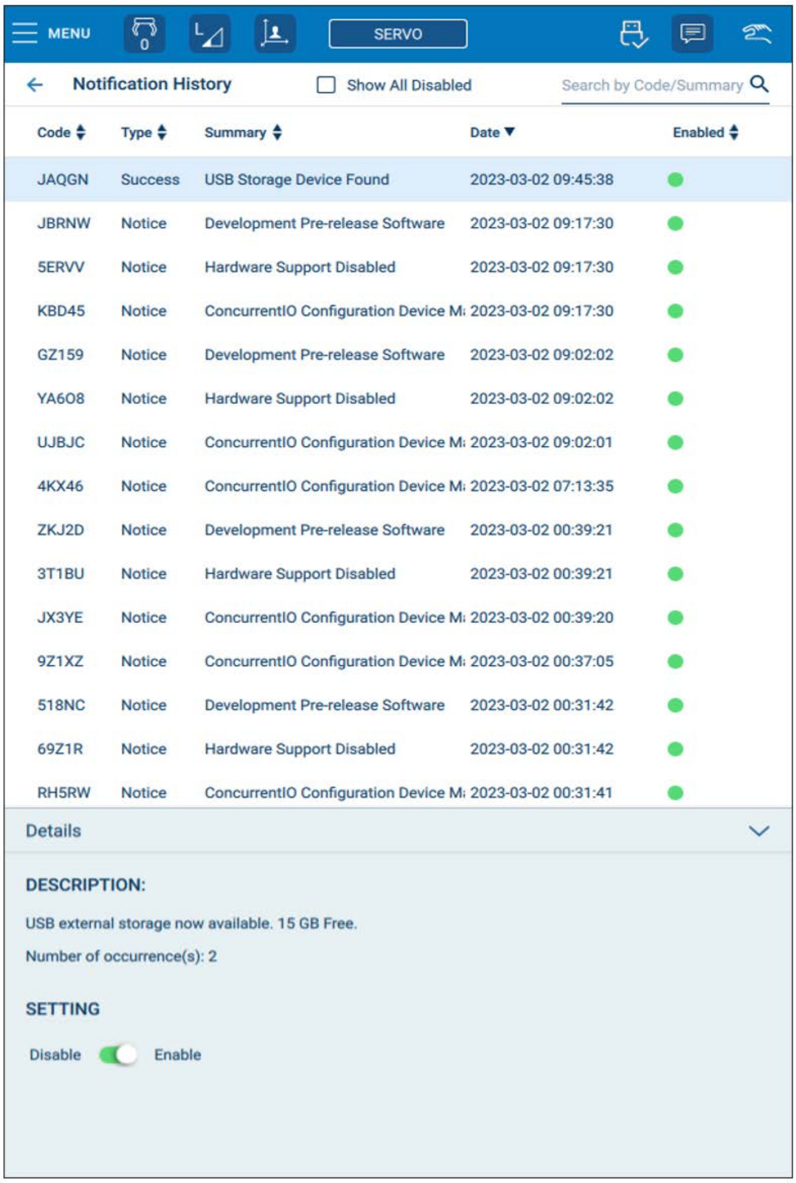
Table 16-5: Notification History List

Item	Description
Code	Random Generated Notification code is shown in 5-characters (for internal use by your YASKAWA representative)
Type	Notification type (e.g. Notice, Success, Error etc.)
Summary	Title of the notification
Date	Date and time of notification occurrence in YYYY-MM-DD hh:mm:ss
Enabled	Indicates whether popup is enabled

Table 16-6: Notification History Detail Panel

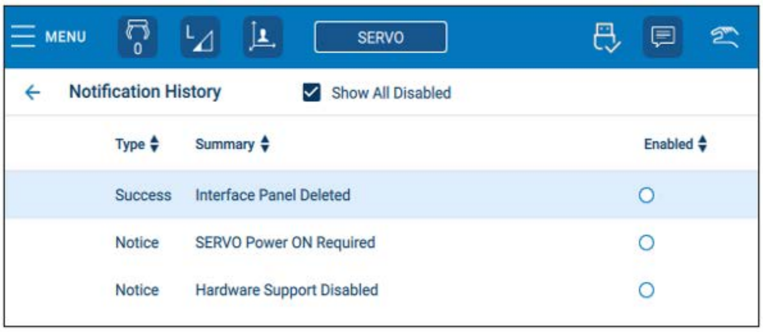
Item	Description
Description	Details of the selected notification in the list
Occurrences	Displays the number of times a notification occurred
Solution	Switch control for enabling/disabling the selected notification in the list

Fig. 16-5: Notification History Screen



Use the “Show All Disabled” checkbox in the header to quickly re-enable all previously disabled notifications to restore the pendant to its default state.

Fig. 16-6: Show All Disabled Notification(s)



17 Help / Support

17.1 Take Screenshot

Users can take a screenshot of the current screen's contents and save the screenshot as a graphics file in PNG format. Screenshots cannot be taken without the USB memory stick.

1. Insert USB memory stick
2. Navigate to {Menu} ⟶ {Help / Support}
3. Press {Screenshot} to capture the current screen.
4. Confirmation notification is displayed
5. Date and time of the screenshot will be included in the file name.

A screenshot can also be taken by pressing the membrane jogging speed [FAST] and [SLOW] keys together.

17.2 YASKAWA Representative

YASKAWA provides support for its products on a global basis. The technical phone and email list can be accessed from the Smart Pendant. Please contact your local YASKAWA Representative. A YASKAWA Representatives can be found on the back cover of this manual.

The YASKAWA Representatives may request log files from the Smart Pendant. Logs can be exported to a USB memory stick by pressing the button {EXPORT LOG FILES…} at the bottom left of the screen.

18 Maintenance

18.1 Cleaning the Smart Pendant

To clean the Smart Pendant safely and effectively, follow these tips:

– Use only soft, lint-free cloth for cleaning. Do not use scrubbing sponges, towels, paper towels or similar items that may cause damage.

– Switch OFF the power source.

– Use a small amount of water or a diluted neutral detergent as a washing liquid, if needed.

– Do not spray washing liquid etc. directly onto any surface of the Smart Pendant.

– Do not get moisture (including washing liquid etc.) or foreign substances into any openings.

– Pay attention not to adhere chemicals, cutting oil (including coolant), rust preventive oil, organic solvent etc. to the Smart Pendant.

18.2 Cleaning the Smart Pendant Cable

To clean the Smart Pendant cable, follow these tips.

– Do not submerge any parts of the cable.

– Wipe with a dry cloth.

YRC1000/YRC1000micro
INSTRUCTIONS
FOR Smart Pendant

(JZRCR-APP30-1)

Published by YASKAWA

YASKAWA

YASKAWA ELECTRIC CORPORATION

AUGUST 2023 20-04

MANUAL NO.

HW1485509 ⑧