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

MOTOMAN INSTRUCTIONS

MOTOMAN-□□□ INSTRUCTIONS
DX200/YRC1000 OPTIONS INSTRUCTIONS FOR HAND GUIDING FUNCTION
DX200 INSTRUCTIONS
DX200 OPERATOR’S MANUAL (for each purpose)
DX200 MAINTENANCE MANUAL
DX200 OPTIONS INSTRUCTIONS FOR FUNCTIONAL SAFETY BOARD OPERATION
YRC1000 INSTRUCTIONS
YRC1000 OPERATOR’S MANUAL (GENERAL) (SUBJECT SPECIFIC)
YRC1000 MAINTENANCE MANUAL
YRC1000 OPTIONS INSTRUCTIONS FOR FUNCTIONAL SAFETY FUNCTION
YRC1000 ALARM CODES (MAJOR ALARMS) (MINOR ALARMS)

Please have the following information available when contacting Yaskawa Customer Support:

- System
- Primary Application
- Software Version (Located on Programming Pendant by selecting: {Main Menu} - {System Info} - {Version})
- Robot Serial Number (Located on robot data plate)
- Robot Sales Order Number (Located on controller data plate)

Part Number: 186984-1-CD
Revision: 1
DANGER

- This manual explains the hand guiding function of the DX200/YRC1000 system. Read this manual carefully and be sure to understand its contents before handling the DX200/YRC1000. Any matter not described in this manual must be regarded as "prohibited" or "improper".
- General information related to safety are described in "Chapter 1. Safety" of the DX200/YRC1000 INSTRUCTIONS. To ensure correct and safe operation, carefully read "Chapter 1. Safety" of the DX200/YRC1000 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 a YASKAWA representative to order a new copy. The representatives are listed on the back cover. 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 DX200/YRC1000.

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”. 

---
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 programming pendant is turned OFF.

- Press the emergency stop buttons on the front door of the DX200/YRC1000, on the programming pendant, on the external control device, etc.
- Disconnect the safety plug of the safety fence. (when in the 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.

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.

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 DX200/YRC1000 power
- Moving the manipulator by using the programming 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 DX200/YRC1000 and on the right of the programming pendant.

Read and understand the Explanation of the Warning Labels before operating the manipulator.
Definition of Terms Used Often in This Manual

The MOTOMAN is the YASKAWA industrial robot product.

The MOTOMAN usually consists of the manipulator, the DX200/YRC1000 controller, the DX200 programming pendant or the YRC1000 programming pendant, and the power cables.

In this manual, the equipment is designated as follows:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Manual Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>DX200 controller or YRC1000 controller</td>
<td>Controller</td>
</tr>
<tr>
<td>DX200 programming pendant or YRC1000 programming pendant</td>
<td>Programming pendant</td>
</tr>
<tr>
<td>Cable between the manipulator and the controller</td>
<td>Power cable</td>
</tr>
</tbody>
</table>
Descriptions of the programming pendant keys, buttons, and displays are shown as follows:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Manual Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programming Pendant</td>
<td>Character Keys /Symbol Keys &lt;br&gt; The keys which have characters or symbols printed on them are denoted with []. &lt;br&gt; E.g. [ENTER]</td>
</tr>
<tr>
<td>Axis Keys /Numeric Keys</td>
<td>[Axis Key] and [Numeric Key] are generic names for the keys for axis operation and number input.</td>
</tr>
<tr>
<td>Keys pressed simultaneously</td>
<td>When two keys are to be pressed simultaneously, the keys are shown with a &quot;+&quot; sign between them, e.g. [SHIFT]+[COORD].</td>
</tr>
<tr>
<td>Mode Switch</td>
<td>Mode Switch can select three kinds of modes that are denoted as follows: REMOTE, PLAY or TEACH. &lt;br&gt; (For YRC1000, the switch names are denoted as symbols)</td>
</tr>
<tr>
<td>Button</td>
<td>The three buttons on the upper side of the programming pendant are denoted as follows: START, HOLD, or EMERGENCY STOP. &lt;br&gt; (For YRC1000, the button names are denoted as symbols)</td>
</tr>
<tr>
<td>Displays</td>
<td>The menu displayed in the programming pendant is denoted with {}. &lt;br&gt; E.g. {JOB}</td>
</tr>
</tbody>
</table>

<DX200> <YRC1000>
Description of the Operation Procedure

In the explanation of the operation procedure, the expression “Select • • •” means that the cursor is moved to the object item and [SELECT] is pressed, or that the item is directly selected by touching the screen.

Registered Trademark

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 ™ are omitted.
4.4.2.1 Translation Mode .................................................................................... 4-5
4.4.2.2 Rotation Mode ......................................................................................... 4-5
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4.4.3.1 Force Sensor Input Mode ........................................................................ 4-6
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4.5 Calibration of Force Sensor ................................................................................ 4-7
4.6 Register Output Function ................................................................................... 4-8
5 Risk Assessment ........................................................................................................ 5-1
5.1 Assumed Risk ........................................................................................................ 5-1
5.2 Risk Reduction Measures ...................................................................................... 5-2
6 User Variables and General I/O Signals to be Used with Hand Guiding Function ................. 6-1
6.1 User Variable List .................................................................................................. 6-1
6.2 General I/O Signal List .......................................................................................... 6-3
6.3 Ladder Program .................................................................................................... 6-4
7 Troubleshooting ......................................................................................................... 7-1
7.1 Robot Operating Method when Force Sensor Disconnected ........................................ 7-1
7.1.1 Disabling Force Sensor .................................................................................. 7-1
7.1.2 Enabling Force Sensor .................................................................................. 7-4
7.2 Robot Operating Method When Hand Guiding Device Disconnected ......................... 7-7
7.3 Troubleshooting .................................................................................................... 7-8
8 Alarm List ................................................................................................................ 8-1
9 Specification for Collaborative Robot ........................................................................ 9-1
9.1 General I/O signals ............................................................................................... 9-1
9.2 Execution Conditions of Hand Guiding Function .................................................. 9-2
9.3 Job Creation for Hand Guiding Function Execution .............................................. 9-3
1 Introduction

The hand guiding function enables to realize the collaboration work between people and robots. Therefore, make sure to perform the risk assessment for the whole robot system before using this function since the safety for the collaborative operation depends on the robot system.

For the risk assessment, refer to chapter 5 “Risk Assessment”.

**DANGER**

In order to enable the collaborative work between people and robots, perform the risk assessment for the whole robot systems for considering to worker’s safety to reduce the risk level of the workers to the acceptable risk level, or to perform measures for the standards of the industrial robot (ISO 10218-1:2011 and ISO 10218-2:2011) by the ISO (International Organization for Standardization).
2 Hand Guiding Function

This chapter describes the overview and the system configuration of the hand guiding function.

2.1 Usage Conditions of Hand Guiding Function

The usage conditions of the hand guiding function are as follows.

• Install the hand guiding device near the end effector.
• The hand guiding device and cables are installed by the customer. Confirm that cables are not caught in or excessive tension at the robot operation at this time.
• Do not apply the pressure of 100 [N] or more on the hand guiding device. The sensor may be damaged.
• This function cannot be used with other Motoplus applications.
• This function cannot be used with the conveyor synchronized function.

2.2 Overview of Hand Guiding Function

The hand guiding function is a function that operates the robot, approaching the robot by operating the hand guiding device equipped with a force sensor.

The function can switch between an operation mode, a movement mode, and an input mode.

<table>
<thead>
<tr>
<th>Mode</th>
<th>Overview</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation mode</td>
<td>Orlando (Initial state)</td>
</tr>
<tr>
<td></td>
<td>Inching</td>
</tr>
<tr>
<td>Movement mode</td>
<td>Translation (Initial state)</td>
</tr>
<tr>
<td></td>
<td>Rotation</td>
</tr>
<tr>
<td>Input mode</td>
<td>Force sensor input (Initial state)</td>
</tr>
<tr>
<td></td>
<td>I/O input</td>
</tr>
</tbody>
</table>
2.3 System Configuration of Hand Guiding Function

The hand guiding function consists of two patterns depending on the hand guiding device to use.

1. Hand guiding device of the handle type with both hands operation
2. Hand guiding device of the grip type with one-hand operation

The location of the screw holes on the hand guiding device and the force sensor is as shown in the figure below.

The handle type of the hand guiding device can be installed at an angle of 45°, 135°, 225°, and 315° to the force sensor.

The grip type of the hand guiding device can be installed at an angle of 0°, 90°, 180°, and 270° to the force sensor.
2 Hand Guiding Function
2.3 System Configuration of Hand Guiding Function

Locations of the screw holes on the force sensor
2.3.1 System Configuration for Using Hand Guiding Device of Handle Type

The jig ⑥, the presence detection sensor ⑦, and the robot stand in the figure are prepared by the customer.

<table>
<thead>
<tr>
<th>No.</th>
<th>Device name</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>①</td>
<td>Controller</td>
<td>DX200/YRC1000</td>
</tr>
<tr>
<td>②</td>
<td>Robot</td>
<td>Robot for handling</td>
</tr>
<tr>
<td>③</td>
<td>Power cable</td>
<td></td>
</tr>
<tr>
<td>④</td>
<td>Jig</td>
<td>This jig connects the robot with the force sensor and the hand guiding device. *Prepared by the customer.</td>
</tr>
<tr>
<td>⑤</td>
<td>Force sensor</td>
<td>Force sensor designated by YASKAWA</td>
</tr>
<tr>
<td>⑥</td>
<td>Hand guiding device</td>
<td>Hand guiding device of the handle type</td>
</tr>
<tr>
<td>⑦</td>
<td>Presence detection sensor</td>
<td>A safety laser scanner and a light curtain, etc. *Prepared by the customer depending on the purpose and then connected with the controller.</td>
</tr>
<tr>
<td>⑧</td>
<td>Force sensor cable (controller side)</td>
<td>*Wired by the customer.</td>
</tr>
<tr>
<td>⑨</td>
<td>Force sensor cable (robot side)</td>
<td>*Wired by the customer.</td>
</tr>
<tr>
<td>⑩</td>
<td>Hand guiding cable (controller side)</td>
<td>*Wired by the customer.</td>
</tr>
<tr>
<td>⑪</td>
<td>Hand guiding cable (robot side)</td>
<td>*Wired by the customer.</td>
</tr>
</tbody>
</table>
2.3.2 System Configuration for Using Hand Guiding Device of Grip Type

The jig ⊙, the presence detection sensor ⊙, and the robot stand in the figure are prepared by the customer.

<table>
<thead>
<tr>
<th>No.</th>
<th>Device name</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>①</td>
<td>Controller</td>
<td>DX200/YRC1000</td>
</tr>
<tr>
<td>②</td>
<td>Robot</td>
<td>Robot for handling</td>
</tr>
<tr>
<td>③</td>
<td>Power cable</td>
<td></td>
</tr>
<tr>
<td>④</td>
<td>Jig</td>
<td>This jig connects the robot with the force sensor and the hand guiding device. *Prepared by the customer.</td>
</tr>
<tr>
<td>⑤</td>
<td>Force sensor</td>
<td>Force sensor designated by YASKAWA</td>
</tr>
<tr>
<td>⑥</td>
<td>Hand guiding device</td>
<td>Hand guiding device of the grip type</td>
</tr>
<tr>
<td>⑦</td>
<td>Presence detection sensor</td>
<td>A safety laser scanner and a light curtain, etc. *Prepared by the customer depending on the purpose and then connected with the controller.</td>
</tr>
<tr>
<td>⑧</td>
<td>Force sensor cable (controller side)</td>
<td>*Wired by the customer.</td>
</tr>
<tr>
<td>⑨</td>
<td>Force sensor cable (robot side)</td>
<td>*Wired by the customer.</td>
</tr>
<tr>
<td>⑩</td>
<td>Hand guiding cable (controller side)</td>
<td>*Wired by the customer.</td>
</tr>
<tr>
<td>⑪</td>
<td>Hand guiding cable (robot side)</td>
<td>*Wired by the customer.</td>
</tr>
</tbody>
</table>
## 2.4 Connection for Hand Guiding Device

Each switch of the hand guiding device in the controller is connected as follows.

The signals of the following table cannot be used for other purposes.

<table>
<thead>
<tr>
<th>Switch</th>
<th>Connection terminal block</th>
<th>Terminal No.</th>
<th>Signal name</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency stop switch</td>
<td>Machine safety terminal block board (YFC22)</td>
<td>DX200 5</td>
<td>EXESP1+</td>
<td>External emergency stop</td>
</tr>
<tr>
<td></td>
<td>Safety terminal block board</td>
<td>YRC1000 6</td>
<td>EXESP1-</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>DX200 7</td>
<td>EXESP2+</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>YRC1000 8</td>
<td>EXESP2-</td>
<td></td>
</tr>
<tr>
<td>Enable switch</td>
<td>Functional safety terminal block board (YFC24)</td>
<td>DX200 1</td>
<td>XIN1_1+</td>
<td>Functional safety general I/O signal 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>YRC1000 2</td>
<td>XIN1_1-</td>
<td>(corresponds to FSBIN01)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DX200 3</td>
<td>XIN1_2+</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>YRC1000 4</td>
<td>XIN1_2-</td>
<td></td>
</tr>
<tr>
<td>Illuminated switch ᵋ</td>
<td>I/O terminal block (CN309)</td>
<td>DX200 B3</td>
<td>IN 01</td>
<td>General input</td>
</tr>
<tr>
<td>Input</td>
<td></td>
<td>YRC1000 A3</td>
<td>IN 02</td>
<td>General input</td>
</tr>
<tr>
<td>Illuminated switch ᵋ</td>
<td>I/O terminal block (CN309)</td>
<td>DX200 B10</td>
<td>OUT 01</td>
<td>General output</td>
</tr>
<tr>
<td>Input</td>
<td></td>
<td>YRC1000 A10</td>
<td>OUT 02</td>
<td>General output</td>
</tr>
<tr>
<td>Illuminated switch ᵋ</td>
<td>LED</td>
<td>DX200 B4</td>
<td>IN 03</td>
<td>General input</td>
</tr>
<tr>
<td>LED</td>
<td></td>
<td>YRC1000 A4</td>
<td>IN 04</td>
<td>General input</td>
</tr>
<tr>
<td>Reserve input ᵋ</td>
<td></td>
<td>DX200 B11</td>
<td>OUT 03</td>
<td>General output</td>
</tr>
<tr>
<td>Reserve output ᵋ</td>
<td></td>
<td>YRC1000 A11</td>
<td>OUT 04</td>
<td>General output</td>
</tr>
</tbody>
</table>

*The reserve inputs and reserve outputs are not connected to hand guiding device switches, but are connected to cables inside the controller.
2 Hand Guiding Function
2.5 Connection for Presence Detection Sensor

The hand guiding function is recommended to use in the status with monitoring the area with the safety laser scanner as a presence detection sensor for the robot controller.

When a worker or an object is in the monitoring area, perform the stop monitoring by the functional safety function and the operation of the robot is limited.

Follow the procedures below to set the setting of the presence detection sensor.

1. Connecting the output signal of the presence detection sensor

Connect the output signal of the presence detection sensor to the functional safety general input signal 2 of the functional safety terminal block.

Connect them by using the safety relay, etc. depending on the output signal specifications of the presence detection sensor.

<table>
<thead>
<tr>
<th>Device</th>
<th>Connection terminal block</th>
<th>Terminal No.</th>
<th>Signal name</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence detection sensor</td>
<td>Functional safety terminal block board (YFC24)</td>
<td>5</td>
<td>XIN2_1+</td>
<td>Functional safety general I/O signal 2 (corresponds to FSBIN02)</td>
</tr>
<tr>
<td></td>
<td>Expansion safety terminal block board</td>
<td>6</td>
<td>XIN2_1-</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>XIN2_2+</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>XIN2_2-</td>
<td></td>
</tr>
</tbody>
</table>

2. Setting the monitoring area of the presence detection sensor

Perform the monitoring setting of the operating range of the robot in accordance with the manual of the presence detection sensor.

If using the other presence detection sensor except for the safety laser scanner, perform sufficient risk assessment, and then use the hand guiding function while ensuring safety.
2.6 Speed Limiting Function

The hand guiding function limits the manipulator’s operation speed (TCP speed) by “speed limiting function” which is a part of the functional safety function.

**NOTE**
The speed limit for the hand guiding function is set beforehand upon shipment.

### 2.6.1 Setting of Speed Limiting Function

For details of setting procedures for the functional safety, refer to the following instruction manuals.

DX200: DX200 OPTIONS INSTRUCTIONS FOR FUNCTIONAL SAFETY
BOARD OPERATION (HW1481991)

YRC1000: YRC1000 OPTIONS INSTRUCTIONS FOR FUNCTIONAL
SAFETY FUNCTION (HW1483576)

**NOTE**
Only the safety manager can change the setting of the speed limiting function.

### WARNING
If the condition file of the functional safety function is changed from the setting upon shipment, the hand guiding function may not be able to use safely or may not operate normally.

### 2.6.2 Setting Details Upon Shipment

Upon shipment, the speed limit is set to switch depending on the status of safety general input signals FSBIN01 to connect with the enable signal of the hand guiding device and FSBIN02 to connect with the output signal of the presence detection sensor.

**Table 2-1: Setting of Speed Limit Upon Shipment**

<table>
<thead>
<tr>
<th>Status of Safety General Input Signal</th>
<th>Status of Machine Safety Output Signal</th>
<th>Available Operation</th>
<th>Enabled Speed Limit File Number</th>
<th>Details of Speed Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FSBIN01</strong></td>
<td><strong>FSBIN02</strong></td>
<td><strong>MS-OUT01</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ON (No intruding object in the area)</td>
<td>OFF (During TEACH mode)</td>
<td>Automatic operation Jog</td>
<td>None</td>
<td>No speed limit</td>
</tr>
<tr>
<td>OFF (During PLAY mode)</td>
<td>ON (Enable OFF)</td>
<td>Not available</td>
<td>2</td>
<td>Stop monitoring (0 [mm/s] speed limit)</td>
</tr>
<tr>
<td>OFF (Enable ON)</td>
<td>OFF (With intruding object in the area)</td>
<td>Hand guiding</td>
<td>1</td>
<td>Speed limit for the collaborative operation (250 [mm/s] speed limit)</td>
</tr>
<tr>
<td>OFF (Enable ON)</td>
<td>OFF (With intruding object in the area)</td>
<td>Hand guiding</td>
<td>1</td>
<td>Speed limit for the collaborative operation (250 [mm/s] speed limit)</td>
</tr>
</tbody>
</table>
3 Setup of Hand Guiding Function

This chapter describes the setup procedures of the hand guiding function. The following items to setup are required to be prepared by the customers.

<table>
<thead>
<tr>
<th>Item</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Filter setting</td>
<td>Setting of the smoothing filter coefficient to the force sensor value</td>
</tr>
<tr>
<td>2 Setting of speed upper limit</td>
<td>Setting of the moving speed limit of the hand guiding function</td>
</tr>
<tr>
<td>3 Setting of speed coefficient</td>
<td>Setting of the moving speed coefficient of the hand guiding function</td>
</tr>
<tr>
<td>4 Setting of operation angle limit</td>
<td>Setting of the operation angle limit of the rotation at the hand guiding</td>
</tr>
<tr>
<td>5 Setting of area limiting function</td>
<td>Setting of the translation area at the hand guiding</td>
</tr>
<tr>
<td>6 Tool setting</td>
<td>Setting of the tool file for using at the hand guiding function</td>
</tr>
<tr>
<td>7 Setting of sensor mounting angle</td>
<td>Setting of the force sensor angle to the tool coordinate system</td>
</tr>
</tbody>
</table>
3.1 Filter Setting

When using the hand guiding function, the robot may repeat unintentional acceleration or deceleration caused by unstable input value of the force sensor because of the time differences which occur in starting a robot operation after applying force by the user or the influence of the force sensor interlocking with the hand operation.

To avoid this phenomenon, the value which is input by using the filter function is smoothed.

A filter coefficient can be set by variables.

**[Filter Coefficient: Large]**

Effect of smoothing: Large, Delay in changing the robot moving speed by changing force: Large

**[Filter Coefficient: Small]**

Effect of smoothing: Small, Delay in changing the robot moving speed by changing force: Small

<table>
<thead>
<tr>
<th>User variable</th>
<th>Variable name</th>
<th>Possible value</th>
<th>Initial value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I073</td>
<td>Filter coefficient setting</td>
<td>1 - 50</td>
<td>50</td>
</tr>
</tbody>
</table>

If the value except for the possible values is input, when the general output 4081 (#15110) of the hand guiding function enable signal is turned ON, the following alarm is displayed.

8001: Parameter Setting error, Sub-code: Variable number

3.2 Setting of Speed Upper Limit

An upper limit of the robot moving speed of the hand guiding function can be set by variables.

<table>
<thead>
<tr>
<th>User variable</th>
<th>Variable name</th>
<th>Possible value</th>
<th>Initial value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I087</td>
<td>X limit speed</td>
<td>0 - 250 [mm/s]</td>
<td>100</td>
</tr>
<tr>
<td>I088</td>
<td>Y limit speed</td>
<td>0 - 250 [mm/s]</td>
<td>100</td>
</tr>
<tr>
<td>I089</td>
<td>Z limit speed</td>
<td>0 - 250 [mm/s]</td>
<td>100</td>
</tr>
<tr>
<td>I090</td>
<td>Rx limit speed</td>
<td>0 - 200 [0.1 deg/s]</td>
<td>200</td>
</tr>
<tr>
<td>I091</td>
<td>Ry limit speed</td>
<td>0 - 200 [0.1 deg/s]</td>
<td>200</td>
</tr>
<tr>
<td>I092</td>
<td>Rz limit speed</td>
<td>0 - 200 [0.1 deg/s]</td>
<td>200</td>
</tr>
</tbody>
</table>

If the value except for the possible values is input, when the general output 4081 (#15110) of the hand guiding function enable signal is turned ON, the following alarm is displayed.

8001: Parameter Setting error, Sub-code: Variable number
3.3 Setting of Speed Coefficient

A coefficient of the robot moving speed of the hand guiding function can be set by variables.

[Speed Coefficient: Large] A robot moves in a large force.


<table>
<thead>
<tr>
<th>User variable</th>
<th>Variable name</th>
<th>Possible value</th>
<th>Initial value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I093</td>
<td>X speed coefficient</td>
<td>0 - 100</td>
<td>50</td>
</tr>
<tr>
<td>I094</td>
<td>Y speed coefficient</td>
<td>0 - 100</td>
<td>50</td>
</tr>
<tr>
<td>I095</td>
<td>Z speed coefficient</td>
<td>0 - 100</td>
<td>50</td>
</tr>
<tr>
<td>I096</td>
<td>Rx speed coefficient</td>
<td>0 - 100</td>
<td>8</td>
</tr>
<tr>
<td>I097</td>
<td>Ry speed coefficient</td>
<td>0 - 100</td>
<td>8</td>
</tr>
<tr>
<td>I098</td>
<td>Rz speed coefficient</td>
<td>0 - 100</td>
<td>8</td>
</tr>
</tbody>
</table>

If the value except for the possible values is input, when the general output 4081 (#15110) of the hand guiding function enable signal is turned ON, the following alarm is displayed.

8001: Parameter Setting error, Sub-code: Variable number
3.4 Setting of Operation Angle Limit

The operation angle to the rotation can be limited so that the robot is prevented from contacting the external device when operating a robot by using the hand guiding function.

When the angle reaches the limit value, the operation beyond over the limit value is limited.

The operation angle limit is limited within the setting value of the user variable I075-I080 as a relative angle from the time that the hand guiding function is enabled.

<table>
<thead>
<tr>
<th>User variable</th>
<th>Variable name</th>
<th>Possible value</th>
<th>Initial value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I075</td>
<td>Rx+ limit angle</td>
<td>0 - 180 [deg]</td>
<td>0 [deg]</td>
</tr>
<tr>
<td>I076</td>
<td>Rx- limit angle</td>
<td>0 - 180 [deg]</td>
<td>0 [deg]</td>
</tr>
<tr>
<td>I077</td>
<td>Ry+ limit angle</td>
<td>0 - 180 [deg]</td>
<td>0 [deg]</td>
</tr>
<tr>
<td>I078</td>
<td>Ry- limit angle</td>
<td>0 - 180 [deg]</td>
<td>0 [deg]</td>
</tr>
<tr>
<td>I079</td>
<td>Rz+ limit angle</td>
<td>0 - 180 [deg]</td>
<td>0 [deg]</td>
</tr>
<tr>
<td>I080</td>
<td>Rz- limit angle</td>
<td>0 - 180 [deg]</td>
<td>0 [deg]</td>
</tr>
</tbody>
</table>

As shown in the setting of the initial value, when all settings of I075-I080 are 0, the operation angle is not limited. When any one or more of I075-I080 is set, all setting values are enabled.

If the value except for the possible values is input, when the general output 4081 (#15110) of the hand guiding function enable signal is turned ON, the following alarm is displayed.

8001: Parameter Setting error, Sub-code: Variable number

When the robot is in the limit angle position, the following signal is turned ON.

<table>
<thead>
<tr>
<th>General output</th>
<th>Logical number</th>
<th>Signal contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1017</td>
<td>#11280</td>
<td>RX+ signal of angle limit exceeded</td>
</tr>
<tr>
<td>1018</td>
<td>#11281</td>
<td>RX- signal of angle limit exceeded</td>
</tr>
<tr>
<td>1019</td>
<td>#11282</td>
<td>RY+ signal of angle limit exceeded</td>
</tr>
<tr>
<td>1020</td>
<td>#11283</td>
<td>RY- signal of angle limit exceeded</td>
</tr>
<tr>
<td>1021</td>
<td>#11284</td>
<td>RZ+ signal of angle limit exceeded</td>
</tr>
<tr>
<td>1022</td>
<td>#11285</td>
<td>RZ- signal of angle limit exceeded</td>
</tr>
</tbody>
</table>

(e.g.) When the operation angle in the Rx- direction is limited to 90 [deg]

① Sets 90 for the variable I076.
② For the rotation operation, the rotation to Rx- direction is limited when the rotation angle in the Rx direction is over -90 [deg].
3.5 Setting of Area Limit

The area to the translation can be limited so that the robot is prevented from contacting the external device when operating a robot by using the hand guiding function.

When the following area intrusion signal is turned ON, the robot cannot be operated further in the direction of intrusion.

<table>
<thead>
<tr>
<th>Signal type</th>
<th>Relay</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auxiliary relay</td>
<td>#70200</td>
<td>+X direction exceeded</td>
</tr>
<tr>
<td></td>
<td>#70201</td>
<td>-X direction exceeded</td>
</tr>
<tr>
<td></td>
<td>#70202</td>
<td>+Y direction exceeded</td>
</tr>
<tr>
<td></td>
<td>#70203</td>
<td>-Y direction exceeded</td>
</tr>
<tr>
<td></td>
<td>#70204</td>
<td>+Z direction exceeded</td>
</tr>
<tr>
<td></td>
<td>#70205</td>
<td>-Z direction exceeded</td>
</tr>
</tbody>
</table>

The area intrusion signal can be set together with the cubic interference area.

1. Setting the cubic interference area

Follow the procedures below to set the cubic interference area.

1. Press (ROBOT) under the main menu, and then (INTERFERENCE) under the sub menu.

2. Since the interference signal window is displayed, select the interference signal to use with (PAGE).

3. Set the cubic interference area.

(Setting example in the X-direction)

<table>
<thead>
<tr>
<th>Item</th>
<th>Setting value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method</td>
<td>Cubic interference</td>
</tr>
<tr>
<td>Control group</td>
<td>R1</td>
</tr>
<tr>
<td>Check method</td>
<td>Command position</td>
</tr>
<tr>
<td>Reference coordinate</td>
<td>Base</td>
</tr>
<tr>
<td>Alarm output</td>
<td>OFF</td>
</tr>
<tr>
<td>Teaching method</td>
<td>Maximum value/Minimum value</td>
</tr>
<tr>
<td>Comment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt;Maximum value&gt; &lt;Minimum value&gt;</td>
</tr>
<tr>
<td>X</td>
<td>-500 -10000</td>
</tr>
<tr>
<td>Y</td>
<td>10000 -10000</td>
</tr>
<tr>
<td>Z</td>
<td>10000 -10000</td>
</tr>
</tbody>
</table>

For the detail setting method of the cubic interference area, refer to DX200 INSTRUCTIONS or YRC1000 INSTRUCTIONS.

2. Ladder setting

Connect the set cubic interference area specific output signal (#50080 - #50157) and the auxiliary relay (#70201 - #70206) for the area limit with the concurrent ladder setting.
3 Setup of Hand Guiding Function

3.6 Tool Setting

(Setting example when the area in the X-direction is limited using the cubic interference area 1)

When the TCP (tool center point) intrudes the cubic interference area 1, the hand guiding function stops the robot from moving to X-direction.

### 3.6 Tool Setting

The hand guiding function operates in the tool coordinate system. The tool file can be set with the following variables.

<table>
<thead>
<tr>
<th>User variable</th>
<th>Variable name</th>
<th>Possible value</th>
<th>Initial value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I081</td>
<td>Tool file No.</td>
<td>0 - 63</td>
<td>0</td>
</tr>
</tbody>
</table>

If the value except for the possible values is input, when the general output 4081 (#15110) of the hand guiding function enable signal is turned ON, the following alarm is displayed.

8001: Parameter Setting error, Sub-code: Variable number

---

**CAUTION**

As a precondition for the hand guiding function, the tool information need to be set correctly.

### 3.7 Setting of Sensor Mounting Angle

Since the hand guiding function matches the force direction applied to the sensor and the operation direction of the robot, the relative angles of the tool coordinate system and the sensor coordinate system are required to set.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Variable name</th>
<th>Possible value</th>
<th>Initial value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I084</td>
<td>Sensor mounting angle _X</td>
<td>-360 - 360 [deg]</td>
<td>0 [deg]</td>
</tr>
<tr>
<td>I085</td>
<td>Sensor mounting angle _Y</td>
<td>-360 - 360 [deg]</td>
<td>0 [deg]</td>
</tr>
<tr>
<td>I086</td>
<td>Sensor mounting angle _Z</td>
<td>-360 - 360 [deg]</td>
<td>0 [deg]</td>
</tr>
</tbody>
</table>
Perform chapter 3.6 “Tool Setting” before this setting.

If the value except for the possible values is input, when the general output 4081 (#15110) of the hand guiding function enable signal is turned ON, the following alarm is displayed.

8001: Parameter Setting error, Sub-code: Variable number

### 3.7 Tool Coordinate System and Sensor Coordinate System

#### [Tool Coordinate System]

The tool coordinate is defined for the tool tip, and the Z-axis is the effective direction of the tool mounted on the wrist flange of the manipulator.

#### [Sensor Coordinate System]

The sensor coordinate is defined for the force sensor. The coordinate system can be confirmed by the engraving on the bottom surface of the sensor.

Bottom surface of the sensor  Upper surface of the sensor  Side of the sensor
3.7.2 Calculating Setting Value of Sensor Mounting Angle

The angle when the tool coordinate is rotated so as to match the sensor coordinate is the input value. The clockwise viewed from the arrow is the forward direction. Calculate in order Rz - Ry - Rx.

Set the angles to the following variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Variable name</th>
<th>Possible value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I084</td>
<td>Sensor angle Rx</td>
<td>-360 - 360 [deg]</td>
</tr>
<tr>
<td>I085</td>
<td>Sensor angle Ry</td>
<td>-360 - 360 [deg]</td>
</tr>
<tr>
<td>I086</td>
<td>Sensor angle Rz</td>
<td>-360 - 360 [deg]</td>
</tr>
</tbody>
</table>

(Calculating example of the setting value)
Calculation method when the relationship between the tool coordinate and the sensor coordinate is as follows.

Set the following value.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Variable name</th>
<th>Setting value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I084</td>
<td>Sensor angle Rx</td>
<td>-90</td>
</tr>
<tr>
<td>I085</td>
<td>Sensor angle Ry</td>
<td>0</td>
</tr>
<tr>
<td>I086</td>
<td>Sensor angle Rz</td>
<td>-90</td>
</tr>
</tbody>
</table>

Calculating procedures are as follows.

[Calculating Procedures]
① Rotate the tool coordinate to -90 [deg] around the Z-axis.
   (Tool coordinate to Tool coordinate')
② Rotate the tool coordinate' to 0 [deg] around the Y'-axis.
③ Rotate the tool coordinate' to -90 [deg] around the X'-axis.
   (Tool coordinate' to Sensor coordinate)
3.7.3 Setting Example of Sensor Mounting Angle

<table>
<thead>
<tr>
<th>Angle Settings</th>
<th>Diagram</th>
</tr>
</thead>
<tbody>
<tr>
<td>I084 (X): 0</td>
<td><img src="image1.jpg" alt="Diagram 1" /></td>
</tr>
<tr>
<td>I085 (Y): 0</td>
<td><img src="image2.jpg" alt="Diagram 2" /></td>
</tr>
<tr>
<td>I086 (Z): 45</td>
<td><img src="image3.jpg" alt="Diagram 3" /></td>
</tr>
<tr>
<td>I084 (X): 0</td>
<td><img src="image4.jpg" alt="Diagram 4" /></td>
</tr>
<tr>
<td>I085 (Y): 0</td>
<td><img src="image5.jpg" alt="Diagram 5" /></td>
</tr>
<tr>
<td>I086 (Z): 135</td>
<td><img src="image6.jpg" alt="Diagram 6" /></td>
</tr>
<tr>
<td>I084 (X): 0</td>
<td><img src="image7.jpg" alt="Diagram 7" /></td>
</tr>
<tr>
<td>I085 (Y): 0</td>
<td><img src="image8.jpg" alt="Diagram 8" /></td>
</tr>
<tr>
<td>I086 (Z): -135</td>
<td><img src="image9.jpg" alt="Diagram 9" /></td>
</tr>
<tr>
<td>I084 (X): 0</td>
<td><img src="image10.jpg" alt="Diagram 10" /></td>
</tr>
<tr>
<td>I085 (Y): 180</td>
<td><img src="image11.jpg" alt="Diagram 11" /></td>
</tr>
<tr>
<td>I086 (Z): 45</td>
<td><img src="image12.jpg" alt="Diagram 12" /></td>
</tr>
</tbody>
</table>
3 Setup of Hand Guiding Function

3.7 Setting of Sensor Mounting Angle

<table>
<thead>
<tr>
<th>X-axis</th>
<th>Y-axis</th>
<th>Z-axis</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>180</td>
<td>135</td>
</tr>
<tr>
<td>180</td>
<td>0</td>
<td>45</td>
</tr>
<tr>
<td>180</td>
<td>0</td>
<td>135</td>
</tr>
<tr>
<td>-90</td>
<td>45</td>
<td>0</td>
</tr>
<tr>
<td>-90</td>
<td>135</td>
<td>0</td>
</tr>
</tbody>
</table>

I084 (X): [values]
I085 (Y): [values]
I086 (Z): [values]
3.7 Setting of Sensor Mounting Angle

<table>
<thead>
<tr>
<th>Sensor coordinate</th>
<th>Tool coordinate</th>
</tr>
</thead>
<tbody>
<tr>
<td>I084 (X): -90</td>
<td>I084 (X): 90</td>
</tr>
<tr>
<td>I085 (Y): -135</td>
<td>I085 (Y): 45</td>
</tr>
<tr>
<td>I086 (Z): 0</td>
<td>I086 (Z): 0</td>
</tr>
<tr>
<td>I084 (X): -90</td>
<td>I084 (X): 90</td>
</tr>
<tr>
<td>I085 (Y): -45</td>
<td>I085 (Y): 45</td>
</tr>
<tr>
<td>I086 (Z): 0</td>
<td>I086 (Z): 0</td>
</tr>
<tr>
<td>I084 (X): 90</td>
<td>I084 (X): 90</td>
</tr>
<tr>
<td>I085 (Y): 135</td>
<td>I085 (Y): 135</td>
</tr>
<tr>
<td>I086 (Z): 0</td>
<td>I086 (Z): 0</td>
</tr>
<tr>
<td>I084 (X): 90</td>
<td>I084 (X): 90</td>
</tr>
<tr>
<td>I085 (Y): -135</td>
<td>I085 (Y): -135</td>
</tr>
<tr>
<td>I086 (Z): 0</td>
<td>I086 (Z): 0</td>
</tr>
</tbody>
</table>
3 Setup of Hand Guiding Function

3.7 Setting of Sensor Mounting Angle

I084 (X): 90
I085 (Y): -45
I086 (Z): 0

I084 (X): 90
I085 (Y): 45
I086 (Z): 90

I084 (X): 90
I085 (Y): -45
I086 (Z): 90

I084 (X): -90
I085 (Y): -45
I086 (Z): -90

I084 (X): -90
I085 (Y): 45
I086 (Z): -90

I084 (X): -90
I085 (Y): 45
I086 (Z): -90
3 Setup of Hand Guiding Function

3.7 Setting of Sensor Mounting Angle

<table>
<thead>
<tr>
<th>Settings</th>
<th>Diagram</th>
</tr>
</thead>
<tbody>
<tr>
<td>I084 (X): -90</td>
<td>![Diagram 1]</td>
</tr>
<tr>
<td>I085 (Y): 45</td>
<td>![Diagram 2]</td>
</tr>
<tr>
<td>I086 (Z): 90</td>
<td>![Diagram 3]</td>
</tr>
<tr>
<td>I084 (X): -90</td>
<td>![Diagram 4]</td>
</tr>
<tr>
<td>I085 (Y): 135</td>
<td>![Diagram 5]</td>
</tr>
<tr>
<td>I086 (Z): 90</td>
<td>![Diagram 6]</td>
</tr>
<tr>
<td>I084 (X): -90</td>
<td>![Diagram 7]</td>
</tr>
<tr>
<td>I085 (Y): -135</td>
<td>![Diagram 8]</td>
</tr>
<tr>
<td>I086 (Z): 90</td>
<td>![Diagram 9]</td>
</tr>
<tr>
<td>I084 (X): 0</td>
<td>![Diagram 10]</td>
</tr>
<tr>
<td>I085 (Y): 180</td>
<td>![Diagram 11]</td>
</tr>
<tr>
<td>I086 (Z): 0</td>
<td>![Diagram 12]</td>
</tr>
</tbody>
</table>
3.7.4 Setting Confirmation of Sensor Mounting Angle

Refer to the following procedures to confirm whether the sensor mounting angle is set correctly.

1. Refer to chapter 4.6 “Register Output Function” to enable the register output function.

2. Refer to chapter 3.2 “Setting of Speed Upper Limit” to set the speed upper limit in each direction to 0.

3. Start the hand guiding function by following the procedures of chapter 4.2 “Hand Guiding Function Execution Procedures”.

4. Apply the force to X+ direction of the tool coordinate system, and confirm that the value of the register 501 fluctuates to + direction.

5. Apply the force to Y+ direction of the tool coordinate system, and confirm that the value of the register 502 fluctuates to + direction.

6. Apply the force to Z+ direction of the tool coordinate system, and confirm that the value of the register 503 fluctuates to + direction.
4 Hand Guiding Function Execution Procedures

This chapter describes the execution procedures of the hand guiding function.

4.1 Execution Conditions of Hand Guiding Function

Executing the hand guiding function is required to satisfy the following conditions. These conditions are common to the translation mode and the rotation mode.

1. The speed limit (250mm/s) is enabled by functional safety.
2. It is in the servo ON. (Not in the energy saving mode)
3. It is in the job playback.
4. The hand guiding function enable signal (general output #15110) is ON.
5. The job is executing the WAIT command.
6. The enable switch signal (general input #05101) is ON.

4.2 Hand Guiding Function Execution Procedures

The hand guiding function can start in the following procedures. These procedures are common to the translation mode and the rotation mode.

1. Turn to the play mode (or the remote mode).
2. Turn to the servo ON state.
3. Execute the job for the hand guiding function execution.
4. Confirm that the job is executing the WAIT command.
5. Turn ON both enable switches of the hand guiding device.
   *An enable switch is a three-position switch.
   Lightly pushing will be in ON state.
4.3 Job Creation for Hand Guiding Function Execution

There are two commands in the job necessary for executing the hand guiding function.

- Turn the general output 4081 (#15110) OFF to ON.
- Turn the WAIT state.

The JOB examples to execute the hand guiding function are as follows.

(JOB example)

<table>
<thead>
<tr>
<th>Line</th>
<th>Command</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000</td>
<td>NOP</td>
<td></td>
</tr>
<tr>
<td>0001</td>
<td>DOUT OT#(4081) OFF</td>
<td></td>
</tr>
<tr>
<td>0002</td>
<td>MOVL V=500.0</td>
<td>• Automatic operation</td>
</tr>
<tr>
<td>0003</td>
<td>TIMER T=0.5</td>
<td></td>
</tr>
<tr>
<td>0004</td>
<td>DOUT OT#(4081) ON</td>
<td>• Enables the hand guiding function</td>
</tr>
<tr>
<td>0005</td>
<td>TIMER T=0.5</td>
<td></td>
</tr>
<tr>
<td>0006</td>
<td>WAIT OT#(4081)= OFF</td>
<td>• Hand guiding</td>
</tr>
<tr>
<td>0007</td>
<td>TIMER T=0.5</td>
<td></td>
</tr>
<tr>
<td>0008</td>
<td>DOUT OT#(4081) OFF</td>
<td></td>
</tr>
<tr>
<td>0009</td>
<td>MOVL V=500.0</td>
<td>• Automatic operation</td>
</tr>
<tr>
<td>0010</td>
<td>END</td>
<td></td>
</tr>
</tbody>
</table>

In this JOB example, the hand guiding operation is available when executing the command line 0006.

To skip the 0006 line and finish the hand guiding, turning the general output 4081(#15110) OFF externally is required.
4.4 Mode

There are following three mode switching functions in the hand guiding function.

The robot operation methods and moving methods differ depending on the combination of each mode.

Table 4-1: Mode

<table>
<thead>
<tr>
<th>Signal name</th>
<th>Signal status</th>
<th>Mode</th>
<th>Overview</th>
</tr>
</thead>
<tbody>
<tr>
<td>General input 4075 (#05102)</td>
<td>OFF</td>
<td>Jog</td>
<td>Continuously moving operation during the hand guiding operation</td>
</tr>
<tr>
<td></td>
<td>ON</td>
<td>Inching</td>
<td>Set amount moving operation during the hand guiding operation</td>
</tr>
<tr>
<td>General input 4076 (#05103)</td>
<td>OFF</td>
<td>Translation</td>
<td>Translation motion of the robot control point</td>
</tr>
<tr>
<td></td>
<td>ON</td>
<td>Rotation</td>
<td>Posture changing operation with fixing the position of the control point</td>
</tr>
<tr>
<td>General input 4077 (#05104)</td>
<td>OFF</td>
<td>Force sensor input</td>
<td>Robot moving operation by a force sensor input</td>
</tr>
<tr>
<td></td>
<td>ON</td>
<td>I/O input</td>
<td>Robot moving operation by an I/O input</td>
</tr>
</tbody>
</table>

4.4.1 Jog/Inching

The robot operation methods in the hand guiding function can be selected from two types: jog operation and inching operation.

4.4.1.1 Jog Mode

The jog mode allows the robot to move when applying force to the hand guiding device or while the I/O for the moving operation is ON by an I/O input.

<Force sensor input mode>

While the force applied to the hand guide is exceeding the dead-zone (translation direction: 20[N], rotation direction: 0.8[N•m]), the robot moves.

![Force sensor input mode diagram]

<I/O input mode>

While the I/O for the move operation is ON, the robot moves.

(For the I/O for the move operation, refer to chapter 4.4.3 “Force Sensor/I/O Input”.)

![I/O input mode diagram]
4.4 Mode

4.4.1.2 Inching Mode

The inching mode allows the robot to move only for the set moving amount when applying force to the hand guiding device or when the I/O for the moving operation is ON by an I/O input. The followings describe each input mode.

<Force sensor input mode>

When the force applied to the hand guide increases from below the dead-zone (translating direction: 20 [N], rotating direction: 0.8 [Nm]) to over the inching start threshold (translation direction: 40 [N], rotation direction: 1.6 [Nm]), the robot moves for the set moving amount.

<\(\text{I/O input mode}\)>

When the I/O for the move operation is switched from OFF to ON, the robot moves for the set moving amount.

(For the I/O for the move operation, refer to chapter 4.4.3 “Force Sensor/ \(\text{I/O Input}\)”.)

The moving amount of the inching operation is set by the following variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Contents</th>
<th>Setting range</th>
<th>Initial value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I082</td>
<td>Moving amount of the translation [0.1 mm]</td>
<td>0 - 100</td>
<td>10</td>
</tr>
<tr>
<td>I083</td>
<td>Moving amount of the rotation [0.01 deg]</td>
<td>0 - 100</td>
<td>10</td>
</tr>
</tbody>
</table>

If the value except for possible values is input, when the general output signal 4081 (#15110) is turned ON, the following alarm is displayed.

8001: Parameter Setting error, Sub-code: Variable number
4.4 Mode

4.4.2 Translation/Rotation

The robot operation method can be switched in the translation and the rotation.

It is not possible to use the translation and the rotation simultaneously.

4.4.2.1 Translation Mode

Follow the input (the force sensor input and the I/O input) to move the robot to the translation direction.

4.4.2.2 Rotation Mode

Follow the input (the force sensor input and the I/O input) to move the robot to the rotation direction.
4.4 Mode

4.4.3 Force Sensor/ I/O Input

The command method to the robot can be selected from the input from the force sensor and the I/O input such as a switch.

4.4.3.1 Force Sensor Input Mode

Follow the force sensor input operation mounted on the hand guiding device to move the robot.

The force sensor input operation mode determines the operation speed of the robot depending on the force sensor value and the speed coefficient. (Refer to chapter 3.3 “Setting of Speed Coefficient”.)

4.4.3.2 I/O Input Mode

Move the robot by operating the input signal for the moving operation.

The enable switch needs to be turned ON also in operation by the I/O input mode.

The I/O input mode fixes the operation speed of the robot.

(Translation: 50 [mm/s], Rotation: 5 [deg/s])

The signals for the moving operation are as follows.

<table>
<thead>
<tr>
<th>General input</th>
<th>Logical number</th>
<th>Signal contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>4081</td>
<td>#05110</td>
<td>X+ direction operation signal</td>
</tr>
<tr>
<td>4082</td>
<td>#05111</td>
<td>X- direction operation signal</td>
</tr>
<tr>
<td>4083</td>
<td>#05112</td>
<td>Y+ direction operation signal</td>
</tr>
<tr>
<td>4084</td>
<td>#05113</td>
<td>Y- direction operation signal</td>
</tr>
<tr>
<td>4085</td>
<td>#05114</td>
<td>Z+ direction operation signal</td>
</tr>
<tr>
<td>4086</td>
<td>#05115</td>
<td>Z- direction operation signal</td>
</tr>
<tr>
<td>4089</td>
<td>#05120</td>
<td>Rx+ direction operation signal</td>
</tr>
<tr>
<td>4090</td>
<td>#05121</td>
<td>Rx- direction operation signal</td>
</tr>
<tr>
<td>4091</td>
<td>#05122</td>
<td>Ry+ direction operation signal</td>
</tr>
<tr>
<td>4092</td>
<td>#05123</td>
<td>Ry- direction operation signal</td>
</tr>
<tr>
<td>4093</td>
<td>#05124</td>
<td>Rz+ direction operation signal</td>
</tr>
<tr>
<td>4094</td>
<td>#05125</td>
<td>Rz- direction operation signal</td>
</tr>
</tbody>
</table>
4.5 Calibration of Force Sensor

Even if not applying force to the hand guiding device, the value of the force sensor will not be 0 due to the influence of gravity. Measure the value of the force sensor with not applying force to the hand guiding device. The calibration of the force sensor is required to set the force sensor to 0 points.

The timing to execute the calibration is the following two cases.

1. Calibration with automatic
   The timing when hand guiding function enable signal general output signal 4081 (#15110) is turned OFF to ON

2. Calibration with arbitrary timing
   The timing when calibration signal general input signal 4073 (#05100) is turned OFF to ON

**NOTE**

The time required to execute the calibration is 0.2 [s]. During the time, the normal offset calculation is not possible if applying force to the hand guiding device. Therefore, put your hands off the hand guiding device during calibration.

When the rotation process was performed, turn the general output signal 4073 (#05100) ON, and then perform the calibration again.
4.6 Register Output Function

Setting the variable I074 to 1 allows the following information to output to the register.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Variable name</th>
<th>Value range</th>
<th>Initial value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I074</td>
<td>Register output</td>
<td>0 - 1</td>
<td>0</td>
</tr>
</tbody>
</table>

If the value except for possible values is input, when the general output signal 4081 (#15110) is turned ON, the following alarm is displayed.

8001: Parameter Setting error, Sub-code: Variable number
### Table 4-2: Register output list

<table>
<thead>
<tr>
<th>Register No.</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>501</td>
<td>Current X direction external force value (Calibration result is reflected.) [N] + 10000</td>
</tr>
<tr>
<td>502</td>
<td>Current Y direction external force value (Calibration result is reflected.) [N] + 10000</td>
</tr>
<tr>
<td>503</td>
<td>Current Z direction external force value (Calibration result is reflected.) [N] + 10000</td>
</tr>
<tr>
<td>504</td>
<td>Current Rx direction external force value (Calibration result is reflected.) [N•m] + 10000</td>
</tr>
<tr>
<td>505</td>
<td>Current Ry direction external force value (Calibration result is reflected.) [N•m] + 10000</td>
</tr>
<tr>
<td>506</td>
<td>Current Rz direction external force value (Calibration result is reflected.) [N•m] + 10000</td>
</tr>
<tr>
<td>507</td>
<td>X direction external force value after filtering (Calibration result is reflected.) [N] + 10000</td>
</tr>
<tr>
<td>508</td>
<td>Y direction external force value after filtering (Calibration result is reflected.) [N] + 10000</td>
</tr>
<tr>
<td>509</td>
<td>Z direction external force value after filtering (Calibration result is reflected.) [N] + 10000</td>
</tr>
<tr>
<td>510</td>
<td>Rx direction external force value after filtering (Calibration result is reflected.) [N•m] + 10000</td>
</tr>
<tr>
<td>511</td>
<td>Ry direction external force value after filtering (Calibration result is reflected.) [N•m] + 10000</td>
</tr>
<tr>
<td>512</td>
<td>Rz direction external force value after filtering (Calibration result is reflected.) [N•m] + 10000</td>
</tr>
<tr>
<td>513</td>
<td>X direction external force value at calibration ([0.1 N] + 10000)</td>
</tr>
<tr>
<td>514</td>
<td>Y direction external force value at calibration ([0.1 N] + 10000)</td>
</tr>
<tr>
<td>515</td>
<td>Z direction external force value at calibration ([0.1 N] + 10000)</td>
</tr>
<tr>
<td>516</td>
<td>Rx direction external force value at calibration ([0.1 N•m] + 10000)</td>
</tr>
<tr>
<td>517</td>
<td>Ry direction external force value at calibration ([0.1 N•m] + 10000)</td>
</tr>
<tr>
<td>518</td>
<td>Rz direction external force value at calibration ([0.1 N•m] + 10000)</td>
</tr>
<tr>
<td>519</td>
<td>Rx direction rotation angle (Cumulative when the hand guiding enable signal is ON) [deg] + 10000</td>
</tr>
<tr>
<td>520</td>
<td>Ry direction rotation angle (Cumulative when the hand guiding enable signal is ON) [deg] + 10000</td>
</tr>
<tr>
<td>521</td>
<td>Rz direction rotation angle (Cumulative when the hand guiding enable signal is ON) [deg] + 10000</td>
</tr>
</tbody>
</table>
5 Risk Assessment

This chapter describes the assumed risk and risk reduction measures in an application of the hand guiding function.

5.1 Assumed Risk

This chapter describes the assumed risk on the collaborative operation of the hand guiding function.

Other risks may also occur depending on the conditions such as a tool or environment. Therefore, be sure to perform the risk assessment throughout the system before using the hand guiding function.

[Assumed risk]

- A human body (hand, arm, leg, body, head) is clamped between the robot and the workpiece.
- A human body is clamped between the robot and environment (wall, floor, etc.).
- A human body is clamped between robot arms.
- A human body is clamped between the hand chucks.
- A hand or fingers are clamped between the hand chuck and the workpiece.
- The robot drops the grasped workpiece, and it hits a human body.
- Other worker intrudes to the work area and collides with the robot during the hand guiding operation.
- A worker approaches the operating robot during the automatic operation and collides with the robot.
- The robot status is switched to the automatic operation after the hand guiding operation, and a worker collides with the robot.
- Due to fallen the hand guiding device, it collides with a human body.
- Due to fallen the end effector, it collides with a human body.
5 Risk Assessment
5.2 Risk Reduction Measures

Additional safety measures to reduce risk are determined and implemented based on factors, levels, and frequency of risk.

This chapter describes additional safety measures examples and their effects.

The effects are described on the conditions that the safety measures are properly implemented.

<table>
<thead>
<tr>
<th>Example of additional safety measure</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robot area limit by the functional safety function</td>
<td>The distance between the environment and the robot is ensured to prevent a human body from clamping between the environment and the robot.</td>
</tr>
<tr>
<td>Robot each axis area limit by the functional safety function</td>
<td>The distance between the robot arms is ensured to prevent a human body from clamping between the robot arms.</td>
</tr>
<tr>
<td>Monitoring the robot's surroundings with a presence detection sensor</td>
<td>When a worker intrudes to the work area during the automatic operation, the robot is stopped. If a worker remains in the work area when switching to the automatic operation from the hand guiding operation, the robot is made not to operate.</td>
</tr>
<tr>
<td>Monitoring the robot's surroundings with a safety light curtain</td>
<td>When a worker intrudes to the work area during the automatic operation, the robot is stopped. An intrusion of other workers to the work area during the hand guiding operation is detected, and the robot can be stopped.</td>
</tr>
</tbody>
</table>

NOTE
The safety measures described here are only examples. YASKAWA does not guarantee safety.
6 User Variables and General I/O Signals to be Used with Hand Guiding Function

6.1 User Variable List

The user variables to be used with the hand guiding function are shown in table 6-1 “User Variable List”.

The timing to be reflected is as follows.

[1] The timing when the hand guiding function is switched from disable to enable
   (The timing when the general output 4081 (#15110) is switched from OFF to ON)

[2] While the enable switch is pressed during the hand guiding function is enabled
   (The state that the general output 4081 (#15110) is ON and the general input 4074 (#05101) is ON)
   *In the [2] state, the variable value is always read.

The variables I073 to I098 are used in the hand guiding function, and therefore they should not be used for other purposes.
### Table 6-1: User Variable List

<table>
<thead>
<tr>
<th>Variable No.</th>
<th>Variable name</th>
<th>Contents</th>
<th>Unit</th>
<th>Range</th>
<th>Initial value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I073</td>
<td>Filter coefficient</td>
<td>Force value filtering coefficient</td>
<td>-</td>
<td>1 - 50</td>
<td>50</td>
</tr>
<tr>
<td>I074</td>
<td>Register output</td>
<td>Register output switching</td>
<td>-</td>
<td>0 - 1</td>
<td>0</td>
</tr>
<tr>
<td>I075</td>
<td>Rx+ limit angle</td>
<td>Rx+ direction operation limit angle</td>
<td>[deg]</td>
<td>0 - 180</td>
<td>0</td>
</tr>
<tr>
<td>I076</td>
<td>Rx- limit angle</td>
<td>Rx- direction operation limit angle</td>
<td>[deg]</td>
<td>0 - 180</td>
<td>0</td>
</tr>
<tr>
<td>I077</td>
<td>Ry+ limit angle</td>
<td>Ry+ direction operation limit angle</td>
<td>[deg]</td>
<td>0 - 180</td>
<td>0</td>
</tr>
<tr>
<td>I078</td>
<td>Ry- limit angle</td>
<td>Ry- direction operation limit angle</td>
<td>[deg]</td>
<td>0 - 180</td>
<td>0</td>
</tr>
<tr>
<td>I079</td>
<td>Rz+ limit angle</td>
<td>Rz+ direction operation limit angle</td>
<td>[deg]</td>
<td>0 - 180</td>
<td>0</td>
</tr>
<tr>
<td>I080</td>
<td>Rz- limit angle</td>
<td>Rz- direction operation limit angle</td>
<td>[deg]</td>
<td>0 - 180</td>
<td>0</td>
</tr>
<tr>
<td>I081</td>
<td>Tool file No.</td>
<td>Tool file No.</td>
<td>-</td>
<td>0 - 63</td>
<td>0</td>
</tr>
<tr>
<td>I082</td>
<td>Inching rotation angle</td>
<td>Inching rotation angle</td>
<td>[0.01 deg]</td>
<td>0 - 100</td>
<td>10</td>
</tr>
<tr>
<td>I083</td>
<td>Inching moving amount</td>
<td>Inching moving amount</td>
<td>[0.1 mm]</td>
<td>0 - 100</td>
<td>10</td>
</tr>
<tr>
<td>I084</td>
<td>Sensor mounting angle_X</td>
<td>Sensor mounting angle around the X-axis</td>
<td>[deg]</td>
<td>-360 - 360</td>
<td>0</td>
</tr>
<tr>
<td>I085</td>
<td>Sensor mounting angle_Y</td>
<td>Sensor mounting angle around the Y-axis</td>
<td>[deg]</td>
<td>-360 - 360</td>
<td>0</td>
</tr>
<tr>
<td>I086</td>
<td>Sensor mounting angle_Z</td>
<td>Sensor mounting angle around the Z-axis</td>
<td>[deg]</td>
<td>-360 - 360</td>
<td>0</td>
</tr>
<tr>
<td>I087</td>
<td>X limit speed</td>
<td>X direction maximum speed</td>
<td>[mm/s]</td>
<td>0 - 250</td>
<td>100</td>
</tr>
<tr>
<td>I088</td>
<td>Y limit speed</td>
<td>Y direction maximum speed</td>
<td>[mm/s]</td>
<td>0 - 250</td>
<td>100</td>
</tr>
<tr>
<td>I089</td>
<td>Z limit speed</td>
<td>Z direction maximum speed</td>
<td>[mm/s]</td>
<td>0 - 250</td>
<td>100</td>
</tr>
<tr>
<td>I090</td>
<td>Rx limit speed</td>
<td>Rx direction maximum speed</td>
<td>[0.1 deg/s]</td>
<td>0 - 200</td>
<td>200</td>
</tr>
<tr>
<td>I091</td>
<td>Ry limit speed</td>
<td>Ry direction maximum speed</td>
<td>[0.1 deg/s]</td>
<td>0 - 200</td>
<td>200</td>
</tr>
<tr>
<td>I092</td>
<td>Rz limit speed</td>
<td>Rz direction maximum speed</td>
<td>[0.1 deg/s]</td>
<td>0 - 200</td>
<td>200</td>
</tr>
<tr>
<td>I093</td>
<td>X speed coefficient</td>
<td>X direction speed calculation coefficient</td>
<td>-</td>
<td>0 - 100</td>
<td>50</td>
</tr>
<tr>
<td>I094</td>
<td>Y speed coefficient</td>
<td>Y direction speed calculation coefficient</td>
<td>-</td>
<td>0 - 100</td>
<td>50</td>
</tr>
<tr>
<td>I095</td>
<td>Z speed coefficient</td>
<td>Z direction speed calculation coefficient</td>
<td>-</td>
<td>0 - 100</td>
<td>50</td>
</tr>
<tr>
<td>I096</td>
<td>Rx speed coefficient</td>
<td>Rx direction speed calculation coefficient</td>
<td>-</td>
<td>0 - 100</td>
<td>8</td>
</tr>
<tr>
<td>I097</td>
<td>Ry speed coefficient</td>
<td>Ry direction speed calculation coefficient</td>
<td>-</td>
<td>0 - 100</td>
<td>8</td>
</tr>
<tr>
<td>I098</td>
<td>Rz speed coefficient</td>
<td>Rz direction speed calculation coefficient</td>
<td>-</td>
<td>0 - 100</td>
<td>8</td>
</tr>
</tbody>
</table>
6.2 General I/O Signal List

The general I/O signals to be used with the hand guiding function are shown in Table 6-2 “General I/O List”.

**NOTE**

The I/O signals described in Table 6-2 are used in the hand guiding function, and therefore they should not be used for other purposes.

### Table 6-2: General I/O List

<table>
<thead>
<tr>
<th>Signal type</th>
<th>No.</th>
<th>Signal name</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>General input</td>
<td>#05100</td>
<td>Calibration</td>
<td>Re-calibration signal</td>
</tr>
<tr>
<td></td>
<td>#05101</td>
<td>Enable switch</td>
<td>Enable switch signal</td>
</tr>
<tr>
<td></td>
<td>#05102</td>
<td>Operating mode</td>
<td>Operation mode switching (Jog/Inching)</td>
</tr>
<tr>
<td></td>
<td>#05103</td>
<td>Movement mode</td>
<td>Movement mode switching (Translation/Rotation)</td>
</tr>
<tr>
<td></td>
<td>#05104</td>
<td>Input mode</td>
<td>Input mode (Force sensor/ I/O Input)</td>
</tr>
<tr>
<td></td>
<td>#05110</td>
<td>X+ input</td>
<td>X direction + (For I/O input mode)</td>
</tr>
<tr>
<td></td>
<td>#05111</td>
<td>X- input</td>
<td>X direction - (For I/O input mode)</td>
</tr>
<tr>
<td></td>
<td>#05112</td>
<td>Y+ input</td>
<td>Y direction + (For I/O input mode)</td>
</tr>
<tr>
<td></td>
<td>#05113</td>
<td>Y- input</td>
<td>Y direction - (For I/O input mode)</td>
</tr>
<tr>
<td></td>
<td>#05114</td>
<td>Z+ input</td>
<td>Z direction + (For I/O input mode)</td>
</tr>
<tr>
<td></td>
<td>#05115</td>
<td>Z- input</td>
<td>Z direction - (For I/O input mode)</td>
</tr>
<tr>
<td></td>
<td>#05120</td>
<td>Rx+ input</td>
<td>Rx direction + (For I/O input mode)</td>
</tr>
<tr>
<td></td>
<td>#05121</td>
<td>Rx- input</td>
<td>Rx direction - (For I/O input mode)</td>
</tr>
<tr>
<td></td>
<td>#05122</td>
<td>Ry+ input</td>
<td>Ry direction + (For I/O input mode)</td>
</tr>
<tr>
<td></td>
<td>#05123</td>
<td>Ry- input</td>
<td>Ry direction - (For I/O input mode)</td>
</tr>
<tr>
<td></td>
<td>#05124</td>
<td>Rz+ input</td>
<td>Rz direction + (For I/O input mode)</td>
</tr>
<tr>
<td></td>
<td>#05125</td>
<td>Rz- input</td>
<td>Rz direction - (For I/O input mode)</td>
</tr>
<tr>
<td>General output</td>
<td>#11280</td>
<td>Rx+ exceeded</td>
<td>Angle limiting signal (Rx+ direction)</td>
</tr>
<tr>
<td></td>
<td>#11281</td>
<td>Rx- exceeded</td>
<td>Angle limiting signal (Rx- direction)</td>
</tr>
<tr>
<td></td>
<td>#11282</td>
<td>Ry+ exceeded</td>
<td>Angle limiting signal (Ry+ direction)</td>
</tr>
<tr>
<td></td>
<td>#11283</td>
<td>Ry- exceeded</td>
<td>Angle limiting signal (Ry- direction)</td>
</tr>
<tr>
<td></td>
<td>#11284</td>
<td>Rz+ exceeded</td>
<td>Angle limiting signal (Rz+ direction)</td>
</tr>
<tr>
<td></td>
<td>#11285</td>
<td>Rz- exceeded</td>
<td>Angle limiting signal (Rz- direction)</td>
</tr>
<tr>
<td></td>
<td>#15120</td>
<td>Hand guiding state</td>
<td>Hand guiding function monitor</td>
</tr>
<tr>
<td></td>
<td>#15121</td>
<td>Calibration completed</td>
<td>Calibration complete signal</td>
</tr>
<tr>
<td></td>
<td>#15122</td>
<td>Operating mode</td>
<td>Operation mode monitor signal</td>
</tr>
<tr>
<td></td>
<td>#15123</td>
<td>Movement mode</td>
<td>Movement mode monitor signal</td>
</tr>
<tr>
<td></td>
<td>#15124</td>
<td>Input mode</td>
<td>Input mode monitor signal</td>
</tr>
<tr>
<td></td>
<td>#15125</td>
<td>Hand guiding operating</td>
<td>Hand guiding function operating monitor signal</td>
</tr>
<tr>
<td>Auxiliary relay</td>
<td>#70200</td>
<td></td>
<td>Cubic 1 interference (X+ direction exceeded)</td>
</tr>
<tr>
<td></td>
<td>#70201</td>
<td></td>
<td>Cubic 2 interference (X- direction exceeded)</td>
</tr>
<tr>
<td></td>
<td>#70202</td>
<td></td>
<td>Cubic 3 interference (Y+ direction exceeded)</td>
</tr>
<tr>
<td></td>
<td>#70203</td>
<td></td>
<td>Cubic 4 interference (Y- direction exceeded)</td>
</tr>
<tr>
<td></td>
<td>#70204</td>
<td></td>
<td>Cubic 5 interference (Z+ direction exceeded)</td>
</tr>
<tr>
<td></td>
<td>#70205</td>
<td></td>
<td>Cubic 6 interference (Z- direction exceeded)</td>
</tr>
</tbody>
</table>
6.3 Ladder Program

In addition to the standard ladder program, the ladder program for the hand guiding function is added upon shipment.

The added ladder program for the hand guiding is as follows.

This ladder program is a part of the system ladder, and therefore it cannot be edited.

```
#52130   #05101
```
7 Troubleshooting

This chapter describes the trouble handling method to be assumed for the hand guiding function.

7.1 Robot Operating Method when Force Sensor Disconnected

When retracting the robot while Alarm 0831 "force sensor communication state error" occurs, or when operating the robot with the force sensor not connected, follow the chapter 7.1.1 “Disabling Force Sensor” and disable the force sensor.

To re-enable the force sensor, activate the force sensor according to chapter 7.1.2 “Enabling Force Sensor”.

7.1.1 Disabling Force Sensor

1. Start up the controller in the maintenance mode, and set the mode to the management mode. Select in the following order: {SYSTEM} - {SETUP} - {OPTION BOARD}. Move the cursor to “Interface466102” to open the Interface466102 setting window.

2. On the Interface466102 setting window, move the cursor to “DETAIL”, and press [ENTER] to open the ROBOT SENSOR OPTION setting window.
7 Troubleshooting
7.1 Robot Operating Method when Force Sensor Disconnected

3. Change the setting of “FORCE SEONSOR” for R1 from "○" (valid) to "-" (invalid).

4. After pressing [ENTER], the confirmation dialog shows up. Select {YES} and press [ENTER].

5. After setting to the safety mode, select in the following order: {FILE} - {INITIALIZE} - 'Functional Safety Board FLASH Reset'.

![Diagram showing the setting process](image-url)
7. Troubleshooting

7.1 Robot Operating Method when Force Sensor Disconnected

6. After pressing [ENTER], the confirmation dialog shows up. Select {YES} and press [ENTER].

![Reset dialog](image)

7. After setting to the safety mode, select in the following order: {FILE} - {INITIALIZE} - 'Machine Safety Board FLASH Reset'.

![Initialization screen](image)

8. After pressing [ENTER], the confirmation dialog shows up. Select {YES} and press [ENTER].

![Reset dialog](image)

9. The disabling procedure for the port is completed. Restart the controller.
7 Troubleshooting
7.1 Robot Operating Method when Force Sensor Disconnected

7.1.2 Enabling Force Sensor

1. Start up the controller in the maintenance mode, and set the mode to the management mode. Select in the following order: (SYSTEM) - (SETUP) - (OPTION BOARD). Move the cursor to "Interface466102" to open the Interface466102 setting window.

2. On the Interface466102 setting window, after confirming “USED” is shown, move the cursor to “DETAIL” and press [ENTER] to open the ROBOT SENSOR OPTION setting window.
7 Troubleshooting

7.1 Robot Operating Method when Force Sensor Disconnected

3. Change the setting of “FORCE SENSOR” for R1 from “-” (invalid) to “○” (valid).

4. After pressing [ENTER], the confirmation dialog shows up. Select {YES} and press [ENTER].

5. After setting to the safety mode, select in the following order: {FILE} - {INITIALIZE} - 'Functional Safety Board FLASH Reset'.
7 Troubleshooting
7.1 Robot Operating Method when Force SensorDisconnected

6. After pressing [ENTER], the confirmation dialog shows up. Select {YES} and press [ENTER].

7. After setting to the safety mode, select in the following order: {FILE} - {INITIALIZE} - 'Machine Safety Board FLASH Reset'.

8. After pressing [ENTER], the confirmation dialog shows up. Select {YES} and press [ENTER].

9. The enabling procedure for the port is completed. Restart the controller.
7.2 Robot Operating Method When Hand Guiding Device Disconnected

When the hand guiding device is not connected, the external emergency stop signal is always open and becomes in an emergency stop state.

When operating the robot in the state that the hand guiding device is disconnected, follow the procedures below to short-circuit the emergency stop signal.

When the hand guiding device is connected again, make sure to remove the jumper lead, and then the connection of the external emergency stop signal is returned to the initial state.

To undo the wiring, refer to chapter 2.4 “Connection for Hand Guiding Device”.

1. Turn OFF the controller power supply, and short-circuit 5 (EXESP1+) and 6 (EXESP1-), 7 (EXESP2+) and 8 (EXESP2-) of the machine safety terminal block board (JANCD-YFC22-E) in the controller with the jumper lead.

2. Turn ON the controller again.
   The emergency stop signal is a short-circuit state, and then the robot operation will be available.

---

**WARNING**

After the hand guiding device is connected, make sure to press the emergency stop button of the hand guiding device before operating the manipulator to confirm that the servo power is turned OFF.

When the servo power is turned OFF, the SERVO ON LED on the programming pendant is turned OFF.

If an operation of the manipulator cannot be stopped in an emergency, that may result in injury or device damage.
7.3 Troubleshooting

If the robot does not operate in the hand guiding function, confirm the following items.

<table>
<thead>
<tr>
<th>No.</th>
<th>Assumed cause</th>
<th>Confirmation method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The speed limit of the functional safety function is not enabled.</td>
<td>Refer to chapter 2.6 “Speed Limiting Function” to confirm that the speed limit is enabled.</td>
</tr>
<tr>
<td>2</td>
<td>Servo OFF state</td>
<td>Confirm that the state is servo ON.</td>
</tr>
<tr>
<td>3</td>
<td>Not job playback state</td>
<td>Confirm that the robot is in the job playback state.</td>
</tr>
<tr>
<td>4</td>
<td>General output signal 4081 (#15110) is OFF.</td>
<td>Confirm the general output signal 4081 (#15110).</td>
</tr>
<tr>
<td>5</td>
<td>The job is not executing the WAIT command.</td>
<td>Confirm that the WAIT command is performed on the job detail screen.</td>
</tr>
<tr>
<td>6</td>
<td>The enable switch is not pressed.</td>
<td>Confirm the signal of the enable switch (FSBIN(#1)).</td>
</tr>
<tr>
<td>7</td>
<td>The force is applied to the limited direction of the rotation by the</td>
<td>Confirm the value of the user variables (I075 to I080).</td>
</tr>
<tr>
<td></td>
<td>operation angle limiting function.</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>The force is applied to the limited direction of the operation by the</td>
<td>Confirm the range intrusion signals (#70200 to #70205).</td>
</tr>
<tr>
<td></td>
<td>area limiting function.</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>The limit speed parameter is set to 0.</td>
<td>Confirm the value of the user variables (I087 to I092).</td>
</tr>
<tr>
<td>10</td>
<td>The speed coefficient parameter is set to 0.</td>
<td>Confirm the value of the user variables (I093 to I098).</td>
</tr>
<tr>
<td>11</td>
<td>MotoPlus is deleted.</td>
<td>Select {SYSTEM} - {VERSION} under the main menu, and press [PAGE] to confirm that the following MotoPlus is registered.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HandGuiding AP018MP □□□□□□A(JP)□□□ □ represents the version number.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If the MotoPlus is deleted, contact your YASKAWA representatives.</td>
</tr>
</tbody>
</table>
# 8 Alarm List

This chapter describes alarms which are output to the pendant screen.

<table>
<thead>
<tr>
<th>Alarm No.</th>
<th>Alarm name</th>
<th>Details</th>
<th>Cause</th>
<th>Countermeasure</th>
</tr>
</thead>
<tbody>
<tr>
<td>0830</td>
<td>Force sensor status error</td>
<td>Sub-code: Option board No. ×1000 + Channel ×100 + Cause are shown. Cause: 1: ROM error 16: Watch-dog Timeout is detected.</td>
<td>Software (Operation error)</td>
<td>(1) Turn ON the controller power supply again. (2) If an alarm occurs again, save the CMOS.BIN on the maintenance mode and contact your YASKAWA representative about the situation such as operating procedures when the problem occurred.</td>
</tr>
<tr>
<td>0831</td>
<td>Force sensor communication error</td>
<td>Sub-code: Option board No. ×1000 + Channel ×100 + Cause are shown. Cause: 1: Send error 2: Sending timeout 3: Receive error 4: Receiving timeout 5: Protocol error 0: Other errors</td>
<td>Software (Operation error)</td>
<td>(1) Confirm the following items and turn ON the controller power supply again. -Communication cable connection -Connected force sensor type (2) The servo power cannot be turned ON at this alarm happening. When retracting the robot, follow chapter 7.1.1 “Disabling Force Sensor” to disable the sensor. (3) If an alarm occurs again, save the CMOS.BIN on the maintenance mode and contact your YASKAWA representative about the situation such as operating procedures when the problem occurred.</td>
</tr>
<tr>
<td>0832</td>
<td>Force sensor command execution error</td>
<td>Sub-code: Option board No. ×1000 + Channel ×100 + Cause are shown. Cause: 1: Undefined command 2: Undefined parameter 3: Unspecified sensor 4: Port in use</td>
<td>Software (Setting error)</td>
<td>(1) Turn ON the controller power supply again. (2) If an alarm occurs again, save the CMOS.BIN on the maintenance mode and contact your YASKAWA representative about the situation such as operating procedures when the problem occurred.</td>
</tr>
<tr>
<td>4751</td>
<td>YSF24 Input signal disagreement</td>
<td>The machine safety general input signal is an input for the duplicated signal, and this alarm occurs when there is disagreement continuously 500 ms or more to input.</td>
<td>Hardware (Operation error)</td>
<td>Clear the alarm, and then press the enable switch again. If the alarm frequently occurs, the cable for the hand guiding may be disconnected.</td>
</tr>
<tr>
<td>8000</td>
<td>Parameter Setting error</td>
<td>Sub-code: xx The number Ox of the I-variable is shown as the incorrect setting value.</td>
<td>Software (Setting error)</td>
<td>Refer to chapter 6.1 “User Variable List”, and set the variable to the correct value.</td>
</tr>
</tbody>
</table>
### Table 8-1: Alarm List (Sheet 2 of 2)

<table>
<thead>
<tr>
<th>Alarm No.</th>
<th>Alarm name</th>
<th>Details</th>
<th>Cause</th>
<th>Countermeasure</th>
</tr>
</thead>
<tbody>
<tr>
<td>8001</td>
<td>Calibration Error</td>
<td>Sub-code: The cause of the calibration error is shown.</td>
<td>Software (Operation error)</td>
<td>Enable the hand guiding function without exerting a load on the hand guiding device.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0: The average force value during calibration exceeded the acceptable value.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1: The force value fluctuation range during calibration exceeded the acceptable range.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8002</td>
<td>HandGuiding unready</td>
<td>The enable switch turned ON while the hand guiding function was disabled.</td>
<td>Operation (Error)</td>
<td>Enable the hand guiding function, and then press the enable switch of the hand guiding device.</td>
</tr>
<tr>
<td>8003</td>
<td>SensorType NG</td>
<td>This alarm occurs if the parameter of sensor type is wrong.</td>
<td>Software (Setting error)</td>
<td>Save the CMOS.BIN on the maintenance mode and contact your YASKAWA representative about the situation such as operating procedures when the problem occurred.</td>
</tr>
</tbody>
</table>
9 Specification for Collaborative Robot

This chapter describes the specification for collaborative robot.
(model: MOTOMAN-HC**)

9.1 General I/O signals

In case of the collaborative robot, the general I/O signals used by hand guiding function are different from the general I/O allocation described in chapter 6.2 “General I/O Signal List”.

The general I/O signals used for hand guiding function with collaborative robot are shown in Table 9-1 “General I/O List (Collaborative Robot (model: MOTOMAN-HC**))”.

**NOTE**

The I/O signals described in Table 9-1 are used in the hand guiding function, and therefore they should not be used for other purposes.

<table>
<thead>
<tr>
<th>Signal type</th>
<th>No</th>
<th>Signal name</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>General input</td>
<td>#05100</td>
<td>Calibration</td>
<td>Re-calibration signal</td>
</tr>
<tr>
<td></td>
<td>#05101</td>
<td>Enable switch</td>
<td>Enable switch signal</td>
</tr>
<tr>
<td></td>
<td>#05102</td>
<td>Operating mode</td>
<td>Operation mode switching (Jog/Inching)</td>
</tr>
<tr>
<td></td>
<td>#05103</td>
<td>Movement mode</td>
<td>Movement mode switching (Translation/Rotation)</td>
</tr>
<tr>
<td></td>
<td>#05104</td>
<td>Input mode</td>
<td>Input mode (Force sensor/ I/O Input)</td>
</tr>
<tr>
<td></td>
<td>#05080</td>
<td>X+ input</td>
<td>X direction + (For I/O input mode)</td>
</tr>
<tr>
<td></td>
<td>#05081</td>
<td>X- input</td>
<td>X direction - (For I/O input mode)</td>
</tr>
<tr>
<td></td>
<td>#05082</td>
<td>Y+ input</td>
<td>Y direction + (For I/O input mode)</td>
</tr>
<tr>
<td></td>
<td>#05083</td>
<td>Y- input</td>
<td>Y direction - (For I/O input mode)</td>
</tr>
<tr>
<td></td>
<td>#05084</td>
<td>Z+ input</td>
<td>Z direction + (For I/O input mode)</td>
</tr>
<tr>
<td></td>
<td>#05085</td>
<td>Z- input</td>
<td>Z direction - (For I/O input mode)</td>
</tr>
<tr>
<td></td>
<td>#05090</td>
<td>Rx+ input</td>
<td>Rx direction + (For I/O input mode)</td>
</tr>
<tr>
<td></td>
<td>#05091</td>
<td>Rx- input</td>
<td>Rx direction - (For I/O input mode)</td>
</tr>
<tr>
<td></td>
<td>#05092</td>
<td>Ry+ input</td>
<td>Ry direction + (For I/O input mode)</td>
</tr>
<tr>
<td></td>
<td>#05093</td>
<td>Ry- input</td>
<td>Ry direction - (For I/O input mode)</td>
</tr>
<tr>
<td></td>
<td>#05094</td>
<td>Rz+ input</td>
<td>Rz direction + (For I/O input mode)</td>
</tr>
<tr>
<td></td>
<td>#05095</td>
<td>Rz- input</td>
<td>Rz direction - (For I/O input mode)</td>
</tr>
</tbody>
</table>
9.2 Execution Conditions of Hand Guiding Function

Executing the hand guiding function with Collaborative robot (model: MOTOMAN-HC**) is required to satisfy the following conditions.

These conditions applies for both the translation mode and the rotation mode.

1. The speed limit (250mm/s) is enabled by functional safety function.
2. Servo is ON. (Not in the energy saving mode)
3. Operation mode is PLAY.
4. The hand guiding function enable signal (general output #15080) is ON.
5. The job is executing the WAIT command.
6. The enable switch signal (general input #05101) is ON.

Table 9-1: General I/O List (Collaborative Robot (model: MOTOMAN-HC**)) (Sheet 2 of 2)

<table>
<thead>
<tr>
<th>Signal type</th>
<th>No</th>
<th>Signal name</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>General output</td>
<td>#11280</td>
<td>Rx+ exceeded</td>
<td>Angle limiting signal (Rx+ direction)</td>
</tr>
<tr>
<td></td>
<td>#11281</td>
<td>Rx- exceeded</td>
<td>Angle limiting signal (Rx- direction)</td>
</tr>
<tr>
<td></td>
<td>#11282</td>
<td>Ry+ exceeded</td>
<td>Angle limiting signal (Ry+ direction)</td>
</tr>
<tr>
<td></td>
<td>#11283</td>
<td>Ry- exceeded</td>
<td>Angle limiting signal (Ry- direction)</td>
</tr>
<tr>
<td></td>
<td>#11284</td>
<td>Rz+ exceeded</td>
<td>Angle limiting signal (Rz+ direction)</td>
</tr>
<tr>
<td></td>
<td>#11285</td>
<td>Rz- exceeded</td>
<td>Angle limiting signal (Rz- direction)</td>
</tr>
<tr>
<td></td>
<td>#15080</td>
<td>Hand guiding enable</td>
<td>Hand guiding function enable signal</td>
</tr>
<tr>
<td></td>
<td>#15090</td>
<td>Hand guiding state</td>
<td>Hand guiding function monitor</td>
</tr>
<tr>
<td></td>
<td>#15091</td>
<td>Calibration completed</td>
<td>Calibration complete signal</td>
</tr>
<tr>
<td></td>
<td>#15092</td>
<td>Operating mode</td>
<td>Operation mode monitor signal</td>
</tr>
<tr>
<td></td>
<td>#15093</td>
<td>Movement mode</td>
<td>Movement mode monitor signal</td>
</tr>
<tr>
<td></td>
<td>#15094</td>
<td>Input mode</td>
<td>Input mode monitor signal</td>
</tr>
<tr>
<td></td>
<td>#15095</td>
<td>Hand guiding operating</td>
<td>Hand guiding function operating monitor signal</td>
</tr>
<tr>
<td>Auxiliary relay</td>
<td>#70200</td>
<td>—</td>
<td>Cubic 1 interference (X+ direction exceeded)</td>
</tr>
<tr>
<td></td>
<td>#70201</td>
<td>—</td>
<td>Cubic 2 interference (X- direction exceeded)</td>
</tr>
<tr>
<td></td>
<td>#70202</td>
<td>—</td>
<td>Cubic 3 interference (Y+ direction exceeded)</td>
</tr>
<tr>
<td></td>
<td>#70203</td>
<td>—</td>
<td>Cubic 4 interference (Y- direction exceeded)</td>
</tr>
<tr>
<td></td>
<td>#70204</td>
<td>—</td>
<td>Cubic 5 interference (Z+ direction exceeded)</td>
</tr>
<tr>
<td></td>
<td>#70205</td>
<td>—</td>
<td>Cubic 6 interference (Z- direction exceeded)</td>
</tr>
</tbody>
</table>
9.3 Job Creation for Hand Guiding Function Execution

There are two commands in the job that is necessary for executing the hand guiding function with Collaborative robot. (Model: MOTOMAN-HC**)

- Turn the general output 4057 (#15080) OFF to ON.
- Turn the WAIT state.

The JOB examples to execute the hand guiding function are as follows.

(JOB example)

<table>
<thead>
<tr>
<th>Line</th>
<th>Command</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000</td>
<td>NOP</td>
<td></td>
</tr>
<tr>
<td>0001</td>
<td>DOUT OT#(4057) OFF</td>
<td></td>
</tr>
<tr>
<td>0002</td>
<td>MOVL V=500.0</td>
<td>• Automatic operation</td>
</tr>
<tr>
<td>0003</td>
<td>TIMER T=0.5</td>
<td></td>
</tr>
<tr>
<td>0004</td>
<td>DOUT OT#(4057) ON</td>
<td>• Enables the hand guiding function</td>
</tr>
<tr>
<td>0005</td>
<td>TIMER T=0.5</td>
<td></td>
</tr>
<tr>
<td>0006</td>
<td>WAIT OT#(4057)= OFF</td>
<td>• Hand guiding</td>
</tr>
<tr>
<td>0007</td>
<td>TIMER T=0.5</td>
<td></td>
</tr>
<tr>
<td>0008</td>
<td>DOUT OT#(4057) OFF</td>
<td></td>
</tr>
<tr>
<td>0009</td>
<td>MOVL V=500.0</td>
<td>• Automatic operation</td>
</tr>
<tr>
<td>0010</td>
<td>END</td>
<td></td>
</tr>
</tbody>
</table>

In this JOB example, the hand guiding operation is available when executing the command line 0006.

To skip the 0006 line and finish the hand guiding, turning the general-purpose output 4057(#15080) OFF externally is required.
DX200/YRC1000 OPTIONS
INSTRUCTIONS
FOR HAND GUIDING FUNCTION

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