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

MOTOMAN INSTRUCTIONS
MOTOMAN-INSTRUCTIONS
FS100 INSTRUCTIONS
FS100 OPERATOR’S MANUAL
FS100 MAINTENANCE MANUAL

Part Number:  174118-1CD
Revision: 0
MANDATORY

- This manual explains maintenance procedures of the FS100 system. Read this manual carefully and be sure to understand its contents before handling the FS100.
- General items related to safety are listed in Chapter 1: Safety of the FS100 INSTRUCTIONS. To ensure correct and safe operation, carefully read the FS100 Instructions before reading this manual.

CAUTION

- The drawing in this manual are shown with the protective covers or shields removed for clarity. Be sure all covers and shields are replaced before operating this product.
- The drawing 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.
- YASKAWA is not responsible for incidents arising from unauthorized modification of its products. Unauthorized modification voids your product’s warranty.
We suggest that you obtain and review a copy of the ANSI/RIA National Safety Standard for Industrial Robots and Robot Systems (ANSI/RIA R15.06-2012). You can obtain this document from the Robotic Industries Association (RIA) at the following address:

Robotic Industries Association
900 Victors Way
P.O. Box 3724
Ann Arbor, Michigan 48106
TEL: (734) 994-6088
FAX: (734) 994-3338
www.roboticsonline.com

Ultimately, well-trained personnel are the best safeguard against accidents and damage that can result from improper operation of the equipment. The customer is responsible for providing adequately trained personnel to operate, program, and maintain the equipment. NEVER ALLOW UNTRAINED PERSONNEL TO OPERATE, PROGRAM, OR REPAIR THE EQUIPMENT!

We recommend approved Yaskawa training courses for all personnel involved with the operation, programming, or repair of the equipment.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.
Notes for Safe Operation

Read this manual carefully before installation, operation, maintenance, or inspection of the FS100.

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

⚠️ DANGER

Indicates an imminent hazardous situation which, if not avoided, could result in death or serious injury to personnel.

⚠️ WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury to personnel.

⚠️ CAUTION

Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury to personnel and damage to equipment. It may also be used to alert against unsafe practices.

⚠️ MANDATORY

Always be sure to follow explicitly the items listed under this heading.

⚠️ PROHIBITED

Must never be performed.

Even items described as “CAUTION” may result in a serious accident in some situations. At any rate, be sure to follow these important items.

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

• Before operating the manipulator, check that servo power is turned OFF when the emergency stop button on the programming pendant is pressed. When the servo power is turned OFF, the SERVO ON LED on the programming pendant is turned OFF.

Injury or damage to machinery may result if the emergency stop circuit cannot stop the manipulator during an emergency. The manipulator should not be used if the emergency stop button does not function.

*Figure 1: Emergency Stop Button*

• In the case of not using the programming 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 5-6 pin and 16-17 pin of the robot system signal connector (CN2).

• Upon shipment of the FS100, this signal is connected by a jumper cable in the dummy 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.

• Once the emergency stop button is released, clear the cell of all items which could interfere with the operation of the manipulator. Then turn the servo power ON.

Injury may result from unintentional or unexpected manipulator motion.

*Figure 2: Release of Emergency Stop Button*

• Observe the following precautions when performing teaching operations within the manipulator’s operating range:
  – Be sure to use a lockout device to the safeguarding when going inside. Also, display the sign that the operation is being performed inside the safeguarding and make sure no one closes the safeguarding.
  – View the manipulator from the front whenever possible.
  – Always follow the predetermined operating procedure.
  – Keep in mind the emergency response measures against the manipulator’s unexpected motion toward you.
  – Ensure that you have a safe place to retreat in case of emergency.

Improper or unintended manipulator operation may result in injury.
Definition of Terms Used Often in This Manual

The MOTOMAN is the YASKAWA industrial robot product.

The MOTOMAN usually consists of the manipulator, the FS100 controller, manipulator cables, the FS100 programming pendant (optional), and the FS100 programming pendant dummy connector (optional).

In this manual, the equipment is designated as follows:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Manual Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>FS100 controller</td>
<td>FS100</td>
</tr>
<tr>
<td>FS100 programming pendant</td>
<td>Programming pendant</td>
</tr>
<tr>
<td>Cable between the manipulator and the controller</td>
<td>Manipulator Cable</td>
</tr>
<tr>
<td>FS100 programming pendant dummy connector</td>
<td>Programming pendant dummy connector</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></td>
</tr>
<tr>
<td>Character Keys</td>
<td>The keys which have characters printed on them are denoted with [ ].</td>
</tr>
<tr>
<td>Symbol Keys</td>
<td>The keys which have a symbol printed on them are not denoted with [ ] but depicted with a small picture.</td>
</tr>
<tr>
<td></td>
<td>ex. [ENTER]</td>
</tr>
<tr>
<td>Axis Keys</td>
<td><em>Axis Keys</em> and <em>Numeric Keys</em> are generic names for the keys for axis operation and number input.</td>
</tr>
<tr>
<td>Numeric Keys</td>
<td></td>
</tr>
<tr>
<td>Keys pressed simultaneously</td>
<td>When two keys are to be pressed simultaneously, the keys are shown with a “+” sign between them.</td>
</tr>
<tr>
<td></td>
<td>ex. SHIFT key +COORD key</td>
</tr>
<tr>
<td>Mode Key</td>
<td>Three kinds of modes that can be selected by the mode key are denoted as follows:</td>
</tr>
<tr>
<td></td>
<td>REMOTE, PLAY, or TEACH</td>
</tr>
<tr>
<td>Button</td>
<td>Three buttons on the upper side of the programming pendant are denoted as follows:</td>
</tr>
<tr>
<td></td>
<td>HOLD button</td>
</tr>
<tr>
<td></td>
<td>START button</td>
</tr>
<tr>
<td></td>
<td>EMERGENCY STOP button</td>
</tr>
<tr>
<td>Displays</td>
<td>The menu displayed in the programming pendant is denoted with { }.</td>
</tr>
<tr>
<td></td>
<td>ex. {JOB}</td>
</tr>
<tr>
<td>PC Keyboard</td>
<td>The name of the key is denoted</td>
</tr>
<tr>
<td></td>
<td>ex. Ctrl key on the keyboard</td>
</tr>
</tbody>
</table>

**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 the SELECT key 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 indication of (R) and ™ are omitted.
Customer Support Information

If you need assistance with any aspect of your Arm Interference with Cubic Area Check system, please contact Motoman Customer Support at the following 24-hour telephone number:

(937) 847-3200

For routine technical inquiries, you can also contact Motoman Customer Support at the following e-mail address:

techsupport@motoman.com

When using e-mail to contact Motoman Customer Support, please provide a detailed description of your issue, along with complete contact information. Please allow approximately 24 to 36 hours for a response to your inquiry.

Please use e-mail for routine inquiries only. If you have an urgent or emergency need for service, replacement parts, or information, you must contact Motoman Customer Support at the telephone number shown above.

Please have the following information ready before you call:

- System: Arm Interference with Cubic Area Check
- Robots: ___________________________
- Primary Application: ___________________________
- Controller: FS100
- Software Version: Access this information on the Programming Pendant’s LCD display screen by selecting {MAIN MENU} - {SYSTEM INFO} - {VERSION}
- Robot Serial Number: Located on the robot data plate
- Robot Sales Order Number: Located on the FS100 controller data plate
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1 Arm Interference with Specified Cubic Area Check Function

1.1 Outline of this Function

The “check function of tool center point interferences with specified cubic areas”, which is a standard feature of the FS100, it turns ON the corresponding system output signals “#50080 to #50157:CUBE INTERFERENCE Signal” when the tool center point interferes with a specified cubic areas.

*Fig. 1-1: Tool Center Point Interference with Specified Cubic Area*

On the other hand, the “check function of arm interferences with specified cubic areas”, turns ON the corresponding system output signals “#50080 to #50157:CUBE INTERFERENCE Signal” when the manipulator’s arm including its tool center point interfered with specified cubic areas.

*Fig. 1-2: Arm Interference with Specified Cubic Area*
1.2 Setting of Arm Interference with Specified Cubic Area Check Function

1.2.1 Cubic Interference Area

Up to 64 cubic interference areas can be registered. Of these 64, up to eight areas can be registered as interference areas to the arm.

Fig. 1-3: Numbers of Cubic Interference Area

The cubic interference areas are displayed by pressing (Main Menu) → (ROBOT) → (INTERFERENCE AREA).

For the settings of the cubic interference area, refer to section 8.6.2 “Cubic Interference Area” in chapter 8 “System Setup” of the “FS100 INSTRUCTIONS” (159644-1CD).

On the cubic interference area setting window, display an INTERFERENCE SIGNAL window to be the subject of the arm interference with specified cubic areas check function. Move the cursor key to the (MONITOR POSITION). Press [ENTER] to alternate “TOOL CENTER POINT” and “ENTIRE.” Select “ENTIRE” and this interferences signal is set as one of the subject cubic areas of the arm interference.
1. Arm Interference with Specified Cubic Area Check Function

1.2. Setting of Arm Interference with Specified Cubic Area Check Function

Out of 64 possible interference areas, eight cubic interference areas can be set to "ENTIRE" at "MONITOR POSITION" at maximum. If more than eight areas are trying to be set, the following alarm occurs.

**ERROR 1510: Cannot edit. The maximum number of cubic interference that is able to be set to "ENTIRE" is exceeded.**

Under the condition that "ENTIRE" is set to "MONITOR POSITION", if 0.000[mm] is set as one of the cubic interference area side length, the FS100 will automatically regards the length as 0.001 [mm] to define the cubic interference area. Then, it starts checking the interferences with the arm.

For example, set an interference area with the length of X-axis direction as 0.000 [mm] and other directions follows.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>X:</td>
<td>0.000</td>
</tr>
<tr>
<td>Y:</td>
<td>50.000</td>
</tr>
<tr>
<td>Z:</td>
<td>50.000</td>
</tr>
</tbody>
</table>

Taking the settings mentioned above, the FS100 will automatically define the cubic interference area as follows.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>X:</td>
<td>0.0005</td>
</tr>
<tr>
<td>Y:</td>
<td>50.000</td>
</tr>
<tr>
<td>Z:</td>
<td>50.000</td>
</tr>
</tbody>
</table>
1 Arm Interference with Specified Cubic Area Check Function

1.2 Setting of Arm Interference with Specified Cubic Area Check Function

Set “ON” to {ALARM OUTPUT} after setting “ENTIRE” to {MONITOR POSITION}. The following alarm occurs and the manipulator stops immediately when the robot arm including the tool center point interferes with the already specified cubic interference areas.

AL 4903: CUBE INTERFERENCE (ENTIRE)

The alarm occurs only under the following conditions after “ON” is set to {ALARM OUTPUT}.

**NOTE**

When the robot is operated by JOG operation or move instruction.

However, the alarm would not occur when the manipulator is already inside of the interference cubic area before setting “ON” to {ALARM OUTPUT}.
1.2.2 Tool Interfere File

The manipulator’s tool part shape must be registered by the customer because its tool shape varies depending on the work that the manipulator performs. The shape can be registered with TOOL INTERFERE file.

Press {Main Menu} → {ROBOT} → {TOOL INTERFERENCE} to display the TOOL INTERFERE file.

- A maximum of 16 tool interfere files, which is the same numbers as the tool files, can be set. The same numbered tool number and tool interference number are allocated one-on-one. In accordance with the tool number specified in the operation, a file is selected out of 16 files.
- A maximum of 5 cylinders and spheres can be specified for registering the shape of the tool.
- Values for cylinders and spheres can be input to No.1 to No.5 by moving the cursor key downward.
- Values input to Point 1 and 2 specify the either ends position of the cylinder. Like the setting of the tool dimensions, the setting values are set with the center of T-axis flange regarded as the starting point (X=0, Y=0, Z=0).
- The values input to “RADIUS” set the radius of the cylinders specified by Point 1 and 2. Also, the spheres with their center points at Point 1 and 2 are set with their radius specified by the values input to “RADIUS.”
1.2.3 Example of Setting Tool Interfere File

*No offset shall be set in Y direction.*

**Table: Tool Interfere**

<table>
<thead>
<tr>
<th>TOOL INTERFERE TOOL NO.: 0</th>
<th>POINT1 (mm)</th>
<th>POINT2 (mm)</th>
<th>RADIUS (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. X</td>
<td>0</td>
<td>140</td>
<td>73</td>
</tr>
<tr>
<td>Y</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Z</td>
<td>0</td>
<td>95</td>
<td></td>
</tr>
<tr>
<td>2. X</td>
<td>140</td>
<td>140</td>
<td>59</td>
</tr>
<tr>
<td>Y</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Z</td>
<td>-250</td>
<td>250</td>
<td></td>
</tr>
<tr>
<td>3. X</td>
<td>140</td>
<td>0</td>
<td>29</td>
</tr>
<tr>
<td>Y</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Z</td>
<td>250</td>
<td>400</td>
<td></td>
</tr>
<tr>
<td>4. X</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Y</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Z</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>5. X</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Y</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Z</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
1.3 Recovery from Interference

When {ALARM OUTPUT} is set to “ON” and {CHECK MEASURE} is set to “FEED BACK”, still the alarm occurs if the manipulator interferes with the interference area. Despite this alarm, the manipulator may not be put outside of the interference area. It is because that the manipulator is still inside of the area even after resetting the alarm and, furthermore, the alarm occurs again. Then, it becomes impossible to reset the alarm any more.

To put the manipulator outside of the interference area, refer to the following procedures.

1.3.1 Releasing Limit

The alarm status mentioned above can be released on LIMIT RELEASE window.

To display LIMIT RELEASE window, select {Main Menu} → {ROBOT} → {LIMIT RELEASE}.

Move the cursor key to {CUBIC/AXIS INTERFERENCE RELEASE} and press [SELECT] to alternate “VALID” and “INVALID.”

Monitoring of the interference can be released temporarily by setting “VALID” to {CUBIC/AXIS INTERFERENCE RELEASE} only when the mode is in teach mode. However, {CUBIC/AXIS INTERFERENCE RELEASE} is set to “INVALID” again automatically when the mode is changed to play mode or to remote mode.

The user can release the alarm occurrence by following the procedures below.

1. Select {Main Menu} → {ROBOT} → {LIMIT RELEASE}.
2. Change the setting of {CUBIC/AXIS INTERFERENCE RELEASE} from “INVALID” to “VALID.”
3. Select {Main Menu} → {SYSTEM INFORMATION} → {ALARM}.
4. Press {ALARM RESET} button on the window.
5. Move the manipulator to outside of the interference area by JOG operation.
6. Select {Main Menu} → {ROBOT} → {LIMIT RELEASE}.
7. Change the setting of {CUBIC/AXIS INTERFERENCE RELEASE} from “VALID” to “INVALID.”
1.3.2 Editing Interference Area Setting While Alarming

On the CUBIC/AXIS INTERFERENCE setting window, the interference area can be edited even when the alarm is occurring. The user can recover the manipulator from the alarm status by following the procedure below.

1. Select {Main Menu} → {ROBOT} → {INTERFERENCE AREA}.
2. Display the interference area specified by the alarm number.
3. Change the setting of {ALARM OUTPUT} from "ON" to "OFF."
4. Select {Main Menu} → {SYSTEM INFORMATION} → {ALARM}.
5. Press down "ALARM RESET" button.
6. Move the manipulator to outside of the interference area by JOG operation.
7. Select {Main Menu} → {ROBOT} → {INTERFERENCE AREA}.
8. Change the setting of {ALARM OUTPUT} from "OFF" to "ON."

1.4 Notes

1. When using the check function of arm interference with specified cubic areas, to avoid any interferences with the manipulator including its tool, set "COMMAND POSITION" to {CHECK MEASURE} on INTERFERENCE AREA window. Set the radius of the tool interfere file with allowances because there are position errors between the command position and the feed back position for the moving manipulator.

2. Determine the setting value of the TOOL INTERFERE file in accordance with the drawing.
FS100 OPTIONS
INSTRUCTIONS
FOR ARM INTERFERENCE WITH SPECIFIED CUBIC AREA CHECK FUNCTION

Specifications are subject to change without notice for ongoing product modifications and improvements.