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

MOTOMAN INSTRUCTIONS

MOTOMAN-□□□ INSTRUCTIONS
DX200 INSTRUCTIONS
DX200 OPERATOR’S MANUAL (for each purpose)
DX200 MAINTENANCE MANUAL

FS100 INSTRUCTIONS
FS100 OPERATOR’S MANUAL
FS100 MAINTENANCE MANUAL

The DX200 operator’s manual above corresponds to specific usage. Be sure to use the appropriate manual. The FS100 OPERATOR’S MANUAL above is applicable to both FS100 and FS100L controllers.

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)
MANDATORY

• This manual explains MotoFit function engineering support tool. Read this manual carefully and be sure to understand its contents before handling the DX200/FS100.

• General items related to safety are listed in the Chapter 1: Safety of the DX200/FS100 Instructions. To ensure correct and safe operation, carefully read the DX200/FS100 Instructions before reading this manual.

CAUTION

• Some drawings 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 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.

• YASKAWA is not responsible for incidents arising from unauthorized modification of its products. Unauthorized modification voids your product’s warranty.
NOTES FOR SAFE OPERATION

Read this manual carefully before installation, operation, maintenance, or inspection of the DX200/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.

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”.
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 buttons do not function.

*Fig. : 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 DX200, 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.

*Fig. : Release of Emergency Stop*

- Observe the following precautions when performing teaching operations within the P-point maximum envelope of the manipulator:
  - 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.
<FS100>

**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.

*Fig. : 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.

*Fig. : Release of Emergency Stop*

- 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.

- Confirm that no person is present in the manipulator’s operating range and that you are in a safe location before:
  - Turning ON the FS100 power.
  - Moving the manipulator with the programming pendant.
  - Running the system in the check mode.
  - Performing automatic operations.

Injury may result if anyone enters the manipulator’s operating range during operation. Always press the emergency stop button immediately if there is a problem. The emergency stop button is located on the right of the programming pendant.
**WARNING**

- Confirm that no person is present in the manipulator’s operating range and that you are in a safe location before:
  - Turning ON the power for the controller
  - Moving the manipulator with the programming pendant.
  - Running the system in the check mode.
  - Performing automatic operations.

Injury may result if anyone enters the manipulator’s operating range during operation. Always press an emergency stop button immediately if there are problems.

The emergency stop button is located on the right side of the DX200/FS100 programming pendant.

---

**CAUTION**

- Perform the following inspection procedures prior to conducting manipulator teaching. If problems are found, repair them immediately, and be sure that all other necessary processing has been performed.
  - Check for problems in manipulator movement.
  - Check for damage to insulation and sheathing of external wires.

- Always return the programming pendant to the hook on the DX200/FS100 cabinet after use.

The programming pendant can be damaged if it is left in the manipulator’s work area, on the floor, or near fixtures.

- Read and understand the Explanation of the Warning Labels in the DX200/FS100 Instructions before operating the manipulator.
Definition of Terms Used Often in This Manual (DX200)

The MOTOMAN is the YASKAWA industrial robot product.

The MOTOMAN usually consists of the manipulator, the controller, the programming pendant, and the manipulator 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</td>
<td>DX200</td>
</tr>
<tr>
<td>DX200 programming pendant</td>
<td>Programming pendant</td>
</tr>
<tr>
<td>Cable between the manipulator and the DX200 controller</td>
<td>Manipulator cable</td>
</tr>
</tbody>
</table>

Definition of Terms Used Often in This Manual (FS100)

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>Robot</td>
<td>Manipulator</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, displays and keyboard of the PC are shown as follows:

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

**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 TM are omitted.
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6.2 Adjustment Condition Data ................................................................................................ 6-2
6.3 MotoFit Command Argument Data ....................................................................................6-3
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7 Error of Automatic Adjustment Function of Force Control Parameter...............................7-1
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9 How to Check the Version.....................................................................................................9-1
10 Precautions ............................................................................................................................10-1
   10.1 Operation during Force Control ................................................................................. 10-1
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1 Outline of Function

1.1 MotoFit Function Engineering Support Tool

The MotoFit function is an application using force control, attaching with the 6-axis force sensor. It realizes the optimum fit operation by the combination of commands as “TOUCH (Push of workpiece)”, “FIT (Search)”, and “INSERT (Insertion)” (refer to DX200/FS100 OPTIONS INSTRUCTIONS for MotoFit (HW1481732)).

During the force control, the robot moves based on the force condition file in DX200/FS100. On the other hand, during the operation of each command, the robot moves based on the command argument.

The MotoFit Function Engineering Support Tool (abbreviated as FSE-Tool) is a tool to support teaching the MotoFit function. It operates on the PC connected with the robot controller.

*Fig. 1-1: Operation of MotoFit Function*

In FSE-Tool, operation according to the teach guidance on the PC screen will create the force condition file and a JOB added MotoFit command. The guidance is mainly on the automatic adjustment of force control parameters in the force condition file, and argument setting of the MotoFit command. The former function is called as the automatic adjustment function of force control parameter, and the latter function is called as the MotoFit teach guidance function. They adjust to the optimum parameters suitable for the robot configuration or workpiece form and materials in operation, realizing a precise fit operation. Note that, however, adjustment may be hard to apply to such a workpiece of unstable shape due to its insufficient hardness.

*Fig. 1-2: System Configuration*
1.2 Automatic Adjustment Function of Force Control Parameter

1.2.1 Force control

In the MotoFit function, the impedance control is used as a model of force control. The impedance control parameter has M (Mass parameter) [kg, kgm²], D (Damping parameter) [Ns/m, Nms] and K (Spring parameter) [N/m, Nm] as shown in the following figure. The behavior of the robot is different depending on these values. In the MotoFit function, the damping parameter, D, is automatically adjusted. The values of M and K are fixed as M = 1 [kg, kgm²] and K = 0 [N/m, Nm]. For the units described in the parentheses, the former indicates the translational direction and the latter indicates the rotational direction.

*Fig. 1-3: Impedance Control Model*
1.2 Automatic Adjustment Function of Force Control Parameter

1.2.2 Adjustment Method

The operation of the automatic adjustment function of force control parameter consists of the following two steps.

1. Tuning Step 1

   Obtains a limit value of damping parameter to maintain the stable contact condition of the workpiece with a small force, without divergent.

   *Fig. 1-4: Operation of Tuning Step 1*

2. Tuning Step 2

   In this step, the force command is given to allow repetitive contact of workpiece, enabling to automatically adjust to the damping parameter so that the response of force FB, the force toward the force command at that time, becomes excellent. As for the operation, the pressing with constant force is repeated.

   *Fig. 1-5: Operation of Tuning Step 2*
1 Outline of Function

1.2 Automatic Adjustment Function of Force Control Parameter

By executing the Tuning Steps 1 and 2, adjust three translational axes (X, Y, Z) and three rotational axes (Rx, Ry, Rz). Both adjustment operations, translational and rotational, are shown in the figure below. In the rotational adjustment, the side of the workpiece contacts to another.

Fig. 1-6: Translational and Rotational Adjustment Operation

When there is no workpiece and accordingly no contact occurs, the robot stops its operation.

Fig. 1-7: Operation of Stop
1.3 MotoFit Teach Guidance Function

In the parameters of MotoFit function commands, the following values should be set (for details, refer to DX200/FS100 OPTIONS INSTRUCTIONS for MotoFit (HW1481732). Among them, the parameters with the asterisk mark* need to be the values suitable for the shape of workpiece. Follow the guidance, and determine the set value by executing the MotoFit command and performing the measurement.

(1) TOUCH
Arg1: Force condition file No.
Arg2: Touch force threshold
Arg3: Approach speed
Arg4: Force command value
Arg5: Insertion length threshold
Arg6: Touch length* (See the right figure)
Arg7: After - TOUCH, time - out time

Fig. 1-8: TOUCH

(2) FIT
Arg1: Force condition file No.
Arg2: Force command value
Arg3: Insertion length threshold
Arg4: Search operation pattern
Arg5: Search force command value
Arg6: Search vibration cycle*
   (See the right figure)
Arg7: Search operation start direction designation
Arg8: Search operation time

Fig. 1-9: FIT

(3) INSERT
Arg1: Force condition file No.
Arg2: Force command value
Arg3: Insertion length threshold 1*
   (See the right figure)
Arg4: Insertion length threshold 2*
   (See the right figure)
Arg5: Unchoke operation designation
Arg6: Unchoke operation force command
Arg7: Unchoke operation force command cycle
Arg8: Unchoke operation start direction designation
Arg9: Unchoke operation time

Fig. 1-10: INSERT
1.4 Function for Calculation of Force Detection Threshold

Force sense basic command is a command which targets relatively simple tasks such as pressing with constant force or stopping the operation when detecting the force which exceeds the specified force. This can be used for the error detection such as the case that the different force from the normal state is applied as described below. For details, refer to DX200/FS100 OPTIONS INSTRUCTIONS for MotoFit (HW1481732).

By using the Engineering Support Tool, the threshold of the force detection is calculated from the log data and it's shown as the recommended value.

Fig. 1-11: Error Detection

[Diagram showing the process of error detection with labels for Robot arm head, Force sensor, Tool, Movement, Tape, Pressing with constant force, OK, NG, Plate, X, Z, Protrusion]
2 System Configuration

2.1 System Configuration

The MotoFit function consists of the robot, the robot controller, the 6-axis force sensor, the Interface panel on the programming pendant and PC for teaching which is prepared by user.

Fig. 2-1: System Configuration of MotoFit Function

Table 2-1: Components

<table>
<thead>
<tr>
<th>Device</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robot (Manipulator)</td>
<td></td>
</tr>
<tr>
<td>Robot controller</td>
<td>The setting of MotoFit function is completed</td>
</tr>
<tr>
<td>Power supply cable</td>
<td></td>
</tr>
<tr>
<td>Programming pendant</td>
<td>Interface panel for MotoFit The setting is completed</td>
</tr>
<tr>
<td>6-axis force sensor</td>
<td>Rated 200N, Rated 1000N</td>
</tr>
<tr>
<td>Sensor cable</td>
<td></td>
</tr>
<tr>
<td>Manipulator side</td>
<td></td>
</tr>
<tr>
<td>Robot Controller side</td>
<td></td>
</tr>
<tr>
<td>PC for teaching¹)</td>
<td>OS: Windows 7, Windows 8, Windows 10</td>
</tr>
<tr>
<td>LAN cable for PC connection¹)</td>
<td></td>
</tr>
<tr>
<td>Tool for the manipulator’s tip¹)</td>
<td></td>
</tr>
</tbody>
</table>

¹ PC, LAN cable and Tool are prepared by user.
3 Operation Procedure

3.1 Installing / Uninstalling FSE-Tool

3.1.1 Installing FSE-Tool

1. Copy the FSE-Tool folder in the CD-ROM to the PC.

2. Execute setup.exe in the FSE-Tool folder and install FSE-Tool according to the guidance.

3. When starting FSE-Tool, connect the DX200/FS100 (CPU board: ANCD-YCP21-E(CN104(LAN))) and the PC by LAN cable and double-click the FSE-Tool icon created on the desktop.

**NOTE**

If the DX200/FS100 and the PC is not connected by LAN cable or the setting of IP address is inappropriate, the message “Communication error” is shown when using the FSE-Tool.

3.1.2 Uninstalling FSE-Tool

*Below is the procedure for Windows 7. For other OSs, please refer to the general uninstallation method from external document.

1. Select in the following order: {Start}, {Control Panel}, “Add or Remove Programs”


3. Delete the FSE-Tool folder copied from the CD to the PC.
3.2 Setting the IP address

1. Make sure the IP address of PC is in the same network of the IP address of the DX200/FS100.

**NOTE**
The network service screen is displayed only when the security mode is management mode.

- Select [SYSTEM INFO] - [NETWORK SERVICE] on the main menu.

- IP address can be confirmed.
3 Operation Procedure

3.2 Setting the IP address

*Below is the procedure for Windows 7. For other OSs, please refer to the general setting method of the IP address from external document.

2. Change the PC's IP address so that the robot controller and the PC are in the same network.
   Select [Start] - [Control Panel] - [Network and Sharing Center] - [Change adapter settings].
   In case items to be selected are difficult to find, select "Small Icon" to change the icon display.

3. From the adapter setting change item, find a port to which Ethernet cable is connected and right-click it. The property window opens.
3. Operation Procedure
3.2 Setting the IP address

4. On the Network tab, select "Internet Protocol Version 4 (TCP/IPv4)" in "This connection uses the following items:" box, and then press {Properties}. On the General tab, select "Use the following IP address" and input a value into IP address and subnet mask item. However, leave "Use the following DNS server addresses" blank. Press (OK) to close the window.

![Image of Network Properties dialog](image1)

5. Switch to "Use the following IP address" on the general tab and enter the IP address and subnet mask. Change the IP address so that it differs from the IP address of the robot controller only by the last digit. In this case the PC's IP address is 192.168.255.2. Also leave the "Use next DNS server address" blank and press the OK button to close the window.

![Image of IP Address properties](image2)

6. After inputting, click [OK] and close the screen.
3.3 Operation for Creating Fitting JOB

3.3.1 Outline of Operation Step

The outline of teach operation step is shown in the following flow schematic diagram. For details, refer to the next section. All the teach operations are given in the Teach mode.

*Fig. 3-1: Outline of Operation Step*

1) Startup of FSE-Tool
   - For details, refer to the section 3.3.2.1.
2) Setting of force condition file
   - For details, refer to the section 3.3.2.2.
3) Automatic adjustment of force control parameter
   (Automatic adjustment function of force control parameter)
   - For details, refer to the section 3.3.2.3.
4) TOUCH command teach
   (MotoFit command teach guidance function)
   - For details, refer to the section 3.3.2.4.
5) FIT command teach
   (MotoFit command teach guidance function)
   - For details, refer to the section 3.3.2.5.
6) INSERT command teach
   (MotoFit command teach guidance function)
   - For details, refer to the section 3.3.2.6.
7) Creating MotoFit JOB
   - For details, refer to the section 3.3.2.7.
3.3.2 Detailed Operation Step

3.3.2.1 Startup of FSE-Tool

1. Double-click the FSE-Tool icon created on the desktop.

2. The Main Menu of FSE-Tool opens.
   There are two modes prepared: Standard and Extension. In the Standard mode, teaching of simple fit operation is available. The teaching operation used by this tool is the operation executing TOUCH, FIT, and INSERT each once in this order.
To change the operation condition arbitrarily to allow further complicated teaching operation, the Extension mode is useful. In this mode, items on the screen (within the frame of chain line in the later figures) can be changed. The password is "99999999".
3.3 Operation for Creating Fitting JOB

3.3.2 Setting Force Condition File

1. Operate the system according to the instruction on the Guidance Menu. On the Guidance Menu, pages can be switched by the {Back} / {Next} buttons. Check the display on the Guidance Menu, execute necessary operations, and click the {Next} button to advance to the next operation.

   Clicking the {Save} button enables to save the current setting. Clicking the {Load} button enables to use the data previously saved. For details, refer to chapter 6.4 “Backup of Teach Data”. To end the operation, click the {End} button.

2. Select the force condition file No. to use (from 1 to 24).
3. Click the {Receive} button. The force condition data of the selected No. is received from the force condition file in DX200/FS100. The received data is output to the force condition file data in the right part of the screen.

4. Maximum 24 force condition files can be set. In order to differentiate them, use the comment box if needed. Input a comment freely (Maximum 32 alphanumerical characters).
5. Select the target robot to use the fit function (R1/R2).

6. Select the coordinate when using the fit function (Robot/Tool). Based on the coordinate selected here, the force control parameter automatic adjustment and MotoFit command argument setting will be executed later.
7. Select the Tool No. when using the fit function. In advance, register the tool information of the status when the workpiece is being held.

8. Select the Insert direction (X+, X-, Y+, Y-, Z+, Z-).
3. Operation Procedure

3.3 Operation for Creating Fitting JOB

9. Select the axis in which the force control is valid (X, Y, Z, Rx, Ry, Rz). Plural axes can be selected.

10. Click the {Open Auto Tuning Menu} button. The operation screen for the automatic adjustment function of force control parameter appears.
3.3.2.3 Automatic Adjustment of Force Control Parameter

1. According to the instruction on the Guidance Menu, perform operations. On the Guidance Menu, pages can be switched by the {Back} / {Next} buttons. Check the display on the Guidance Menu, execute necessary operations, and click the {Next} button to advance to the next operation.
3. Operation Procedure
3.3 Operation for Creating Fitting JOB

2. From now, perform the auto tuning of the force control parameter by contacting the workpiece, which is held by the robot, with the flat table. Programming Pendant will be hereinafter referred to as "PP", and the interface panel "I/F Panel". For the coordinate system, the Coordinate specified in the Main Menu is selected.

3. Select the Tuning Direction (X+, X-, Y+, Y-, Z+, Z-, Rx+, Rx-, Ry+, Ry-, Rz+, Rz-). Select the direction to contact with the workpiece as shown in the figure on the screen.
3 Operation Procedure

3.3 Operation for Creating Fitting JOB

4. Input the force command value. Input the approximate force value to be used for the fit operation. Input both translational force and rotational force values ([Reference Force] and [Reference Moment]). For a metal workpiece fit operation, for example, typical values are 20 [N] for [Reference Force] and 0.5 [Nm] for [Reference Moment]. Note that however, alarm of excessive force may be issued according to the combination of force command value and tool length. (Especially for the force sensor of rated value of 200 N, it may be regarded as an excessive force of the moment.) In this case, decrease the force command value.

5. Move the robot to the adjustment start position. It is the position just before the workpiece is to be contacted. Refer to the figure on the screen. Perform the adjustment in the Teach mode and PC mode (I/F Panel). The followings are the example of adjustment directions Z- and Ry+ in the robot coordinate. For the adjustment of rotational direction, contact the side of workpiece.
3 Operation Procedure
3.3 Operation for Creating Fitting JOB

6. Execution of Tuning Step 1

– Switch the Tuning Step to 1, and click the {Complete Setting} button.

– The message "Operate from PP." appears. Click the {OK} button.
3 Operation Procedure
3.3 Operation for Creating Fitting JOB

- The [TUNESTEP1 COMP SET] LED lights up in the I/F Panel of PP.
3 Operation Procedure
3.3 Operation for Creating Fitting JOB

- Turn the servo ON by the enable switch of PP, and press the {START} button on the I/F Panel. The adjustment operation starts. At this time, the {START} button does not activate unless the OPERATION is set to PERM. To set to PERM, press the switch by pressing [Interlock].

The operation by FSE-Tool is not available unless the [PC MODE] is valid.

When no operation is given from the I/F Panel after 20 seconds from pressing the (Complete Setting) button on PC, the message "PP wasn't operated." appears on the PC, and the operation is terminated. This time can be changed at "Waiting time until PP operated" in the Main Menu described in chapter 3.3.2 "Detailed Operation Step". To execute the adjustment, click the (Complete Setting) button from PC again.

The Tuning Step 2 and MotoFit execution follows the same operation described as above.
3 Operation Procedure

3.3 Operation for Creating Fitting JOB

– During the adjustment operation, the [RUNNING] LED on the I/F Panel turns ON. To stop the operation such as when changing the adjustment condition, press the (STOP) button. To resume the adjustment, first return to the start position, and execute the operation. For the emergency stop, release the enable switch. The Tuning Step 2 and MotoFit execution follows the same operation described as above.

– When the adjustment operation completes, the [TUNESTEP1 COMP SET] LED and the [RUNNING] LED turn OFF.
3 Operation Procedure

3.3 Operation for Creating Fitting JOB

– When the adjustment is completed, the {STEP1} LED of the adjustment direction on the <Tuning Status> turns ON, and the “Minimum of Damping Param” is output as the result of adjustment. When the amplitude of force becomes constant or converged into force command, the adjustment is correctly completed. When the force is diverged and an excessive force is added, it causes an error. In this case the [TUNESTEP1 COMP SET] LED does not turn ON.

– Move the robot to the adjustment start position. It is the position just before the work piece is to be contacted. Refer to the figure on the screen. Perform the adjustment in the Teach mode and PC mode (I/F Panel). The followings are the example of adjustment directions Z- and Ry+ in the robot coordinate. For the adjustment of rotational direction, contact the side of work piece.
3.3 Operation for Creating Fitting JOB

7. Execution of Tuning Step 2
   - Switch the Tuning Step to 2, and click the (Complete Setting) button.

   - The message "Operate from PP." appears. Click the (OK) button.
3 Operation Procedure
3.3 Operation for Creating Fitting JOB

– The [TUNESTEP2 COMP SET] LED turns ON on the I/F Panel of PP.

– Turn the servo ON by the enable switch of PP, and press the {START} button on the I/F Panel. The adjustment operation starts.

– During the adjustment operation, the [RUNNING] LED on the I/F Panel turns ON.
3 Operation Procedure
3.3 Operation for Creating Fitting JOB

- When the adjustment operation completes, the [TUNESTEP2 COMP SET] LED and the [RUNNING] LED turn OFF.

- When the adjustment is completed, the [TUNESTEP2 COMP SET] LED of the adjustment direction turns ON, and "Damping Param, Settling time, Stop time threshold, Stop speed threshold" are output as a result. "Settling time, Stop time threshold, Stop speed threshold" are output only at the adjustment to the Z direction.
3. Operation Procedure
3.3 Operation for Creating Fitting JOB

8. Execute the automatic adjustment in the same way for six axes. Adjustment can be given to the number of axes for actual use (for example, translational three axes). When the adjustment is completed, click the {Close} button.

9. Return to Main Menu, and check that the result of the latest adjustment is reflected. Click the {Send} button to send the force condition file data that has completed the adjustment to DX200/FS100. There are two {Send} buttons, and both can be used.
3.3.4 TOUCH Command Teach

1. Performs the MotoFit setting. Click the {Creating MotoFit JOB} tab, and the {Open MotoFit Command Setup Menu} button.

2. The [MotoFit Command Setup Menu] appears. Sets the arguments of TOUCH. According to the guidance, perform the settings in Tuning operation at the lower part of the screen. Switch the page on the Guidance Menu by the {Back} / {Next} buttons. Check the display on the Guidance Menu, execute necessary operations, and click the {Next} button to advance to the next operation.
3. Operation Procedure
3.3 Operation for Creating Fitting JOB

3. Note that the force condition file No. of Arg1 has the number selected in chapter 3.3.2 “Detailed Operation Step”, step (2).

4. The values displayed on the Guidance Menu are set as initial values. However, when the values are changed in Main Menu, the changed values are reflected.
3. Operation Procedure

3.3 Operation for Creating Fitting JOB

5. Teach the fitting start position P1 (a few mm above the hole) by PP. This position will be used while setting TOUCH, FIT, and INSERT. Also teach the posture visually.

6. Teach the position P2 horizontally displaced from P1 about a few mm (the position out of the hole). This position will be used while setting TOUCH.
3. Operation Procedure
3.3 Operation for Creating Fitting JOB

7. Teach the position P3 horizontally displaced from P1 (within 2 mm) by PP in consideration of the position differences at the operation. This position will be used whole setting FIT.

8. Measurement of the touch length of Arg6
   - Move the robot to P2, and click the {Completion of setting} button.
3.3 Operation for Creating Fitting JOB

- The message "Operate from PP." appears. Click the {OK} button.

- The [TOUCH COMP SET] LED turns ON on the I/F Panel of PP.

- Turn the servo ON by the enable switch of PP, and press the {START} button on the I/F Panel. The TOUCH operation starts.
3 Operation Procedure
3.3 Operation for Creating Fitting JOB

– During the TOUCH operation, the [RUNNING] LED turns ON on the I/F Panel.

– When the TOUCH operation completes, the [TOUCH COMP SET] LED and the [RUNNING] LED turn OFF.
3 Operation Procedure

3.3 Operation for Creating Fitting JOB

- When the TOUCH is completed, the touch length is output as the measurement result. This result is set as Arg6. When the [Detect contact] LED is not turned ON, increase the force command value and execute the sequence again. To measure the contact distance, execute the operation in page 7 of the {TOUCH} tab.

9. TOUCH operation check 1 (the same operation as (8))

- Move the robot to P1, and click the {Completion of setting} button.
- The message "Operate from PP." appears. Click the {OK} button.
- The [TOUCH COMP SET] LED turns ON on the I/F Panel of PP.
- Turn the servo ON by the enable switch of PP, and press the {START} button on the I/F Panel. The TOUCH operation starts.
- Check that the [Completion of TOUCH] LED turns ON. It means that the insertion length reaches the threshold and the sequence ends.
10. TOUCH operation check 2 (the same operation as (8))
   - Move the robot to P2, and click the {Completion of setting} button.
   - The message "Operate from PP." appears. Click the {OK} button.
   - The [Completion of setting] LED turns ON on the I/F Panel of PP.
   - Turn the servo ON by the enable switch of PP, and press the {START} button on the I/F Panel. The TOUCH operation starts.
   - Check that the [Completion of TOUCH] LED does not turn ON. It means that the sequence has ended while the insertion length did not reach the threshold.
   - When the LED turns ON, two cases are possible; Case1: the workpiece has slipped, or Case2: the workpiece may be in the hole. Actions to take are as follows:
     Case1: increase the holding force of the hand.
     Case2: Teach P2 again to the position where the workpiece does not enter into the hole.

11. The setting of the TOUCH command arguments are completed. Next, how to set the FIT command is described in the next section. Click the {FIT} tab.
3.3.2.5 FIT Command Teach

1. Sets the arguments of FIT. According to the guidance, perform the settings in Tuning operation at the lower part of the screen. Check the display on the Guidance Menu, execute necessary operations, and click the {Next} button to advance to the next operation.

2. Note that the force condition file No. of Arg1 has the number selected in chapter 3.3.2 “Detailed Operation Step”, step (2).
3. Operation Procedure
3.3 Operation for Creating Fitting JOB

3. The values displayed on the Guidance Menu are set as initial values. However, when the values are changed in Main Menu, the changed values are reflected.

4. Setting of search vibration cycle of Arg6
   - Move the robot to P3, and click the {Completion of setting} button.
3.3 Operation for Creating Fitting JOB

- The message “Operate from PP.” appears. Click the {OK} button.

- The [TOUCH COMP SET] LED and the [FIT COMP SET] LED turn ON on the I/F Panel of PP.
3 Operation Procedure
3.3 Operation for Creating Fitting JOB

– Turn the servo ON by the enable switch of PP, and press the {START} button on the I/F Panel. Operations of TOUCH and FIT start. In the sequence, after TOUCH is completed, FIT is executed continuously.

– During the operations of TOUCH and FIT, the [RUNNING] LED on the I/F Panel turns ON.
3 Operation Procedure
3.3 Operation for Creating Fitting JOB

- When the TOUCH operation ends, the [TOUCH COMP SET] LED turns OFF. When the FIT operation ends, the [FIT COMP SET] LED and the [RUNNING] LED turn OFF.

- Adjust the search vibration cycle so that the workpiece enters into the hole. Larger searching cycle enables larger searching width. The search vibration cycle can be changed even during the operation. When the workpiece enters into the hole, the [Completion of FIT] LED turns ON.

   The reference value of searching width is the one when the operation is given with the specified search vibration cycle in the state where the workpiece is pressed with the force 10 [N]. Note that this is a reference only; it depends on the friction due to the pressing force or the material of workpiece.
5. FIT operation check (the same operation as (4))
   - Move the robot to P3, and click the {Completion of setting} button.
   - The message "Operate from PP." appears. Click the {OK} button.
   - The [TOUCH COMP SET] LED and the [FIT COMP SET] LED turn ON on the I/F Panel of PP.
   - Turn the servo ON by the enable switch of PP, and press the {START} button on the I/F Panel. Operations of TOUCH and FIT start.
   - Check that the [Completion of FIT] LED turns ON. It means that the insertion length reaches the threshold and the sequence ends.

6. The setting of the FIT command arguments are completed. Next, how to set the INSERT command is described in the next section. Click the {INSERT} tab.
3.3.2.6 INSERT Command Teach

1. Sets the arguments of INSERT. According to the guidance, perform the settings in Tuning operation at the lower part of the screen. Check the display on the Guidance Menu, execute necessary operations, and click the {Next} button to advance to the next operation.

2. Note that the force condition file No. of Arg1 has the number selected in the chapter 3.3.2 “Detailed Operation Step”, step (2).
3. The values displayed on the Guidance Menu are set as initial values. However, when the values are changed in Main Menu, the changed values are reflected.

4. Setting of insertion length threshold 1 of Arg3 and insertion length threshold 2 of Arg4
   – Move the robot to P3, and click the {Completion of setting} button.
3 Operation Procedure
3.3 Operation for Creating Fitting JOB

- The message "Operate from PP." appears. Click the {OK} button.

- The [TOUCH COMP SET] LED, the [FIT COMP SET] LED, and the [INSERT COMP SET] LED turn ON on the I/F Panel of PP.
3 Operation Procedure
3.3 Operation for Creating Fitting JOB

– Turn the servo ON by the enable switch of PP, and press the {START} button on the I/F Panel. Operations of TOUCH, FIT, and INSERT start. In the sequence, after TOUCH is completed, FIT is executed continuously, and then INSERT is executed continuously.

– During the operations of TOUCH, FIT, and INSERT, the [RUNNING] LED on the I/F Panel turns ON.
3 Operation Procedure
3.3 Operation for Creating Fitting JOB

- When the TOUCH operation ends, the [TOUCH COMP SET] LED turns OFF. When the FIT operation ends, the [FIT COMP SET] LED and the [RUNNING] LED turn OFF. When the INSERT operation ends, the [INSERT COMP SET] LED and the [RUNNING] LED turn OFF.

- When the workpiece is inserted to the bottom of the hole, the insertion length is output on the screen.
3 Operation Procedure
3.3 Operation for Creating Fitting JOB

– Set the threshold so that the output insertion length is within the range of thresholds 1 and 2, in consideration of the variance. When the sequence stops during the insertion operation, increase the Force command value. If the workpiece still does not reach the bottom of the hole, set the Unchoke Pattern to OMNI.

5. INSERT operation check
– Move the robot to P3, and click the {Completion of setting} button.
– The message "Operate from PP." appears. Click the {OK} button.
– The [TOUCH COMP SET] LED, the [FIT COMP SET] LED, and the [INSERT COMP SET] LED turn ON on the I/F Panel of PP.
– Turn the servo ON by the enable switch of PP, and press the {START} button on the I/F Panel. Operations of TOUCH, FIT, and INSERT start.
– Check that the [Completion of INSERT] LED turns ON. It means that the insertion length reaches the threshold and the sequence ends.
6. INSERT operation check

- Move the robot to P1, and click the {Completion of setting} button.
- The message "Operate from PP." appears. Click the {OK} button.
- The [TOUCH COMP SET] LED, the [FIT COMP SET] LED, and the [INSERT COMP SET] LED turn ON on the I/F Panel of PP.
- Turn the servo ON by the enable switch of PP, and press the {START} button on the I/F Panel. Operations of TOUCH, FIT, and INSERT start.
- Check that the [Fitting task status] LEDs turn ON. It means that the workpiece enters into a hole by the TOUCH operation. If the workpiece did not enter into a hole by the TOUCH operation, all the LEDs other than the [Completion of TOUCH] turn ON.

7. The workpiece could have been slipped if the Insertion length set on PC is significantly different from the actual hole depth. Increase the holding force of the hand.
3. Operation Procedure
3.3 Operation for Creating Fitting JOB

8. The setting of the INSERT command arguments are completed. Click the {Close} button to close the screen.
3.3.2.7 Creating MotoFit JOB

1. In closing the MotoFit Command Setup Menu, setting result of TOUCH, FIT, and INSERT is reflected on the center of screen.

![Image of MotoFit setup menu]

![Image of MotoFit setup menu details]

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3 Operation Procedure
3.3 Operation for Creating Fitting JOB

2. Add the MotoFit command to the JOB in the DX200/FS100. Input the JOB name, and click the {Receive} button. Only single-byte alphanumeric character is available for the JOB name. The JOB contents received are displayed on the JOB Screen. The JOB receiving capacity is limited to 2 kByte. When larger capacity is required, use the CALL instruction. Note that the addition is limited to 50 lines at maximum.
3. Click the {TOUCH} tab. Change the insertion line, and click the {INSERT} button. The commands of SET, TOUCH, and WAIT are added in the JOB Screen. Change the output number of WAIT command by referring to DX200/FS100 OPTIONS INSTRUCTIONS for MotoFit (HW1481732). When the TOUCH command is added, the existed line will be moved to the next line automatically. The SET command is used for the judgment when the fit operation is failed.

4. Click the {FIT} tab. Change the insertion line, and click the {Insert} button. The FIT command is added in the JOB Screen. When the FIT is successful, 1 is output to the B variable 98.
3 Operation Procedure
3.3 Operation for Creating Fitting JOB

5. Click the {INSERT} tab. Change the insertion line, and click the {Insert} button. The INSERT command is added in the JOB Screen. When the INSERT is successful, 1 is output to the B variable 99.

6. Click the {IMPOFF} tab. Change the insertion line, and click the {Insert} button. The IMPOFF command is added in the JOB Screen. If the FIT or INERT is failed, the sequence can stop by PAUSE.
3.3 Operation for Creating Fitting JOB

7. To delete the MotoFit command, specify the line with the tab which command is to delete selected, and click the {Delete} button. If there is no command selected in the specified line, deletion is not available.

8. The JOB added with the MotoFit command is sent to the DX200/FS100. Click the {Send} button. The message "The JOB of the same name already exists. Do you want to replace it?" appears. Press the {Yes} button. If the job is not to be overwritten, press the {No} button, change the JOB Name, and send the job.
9. The MotoFit JOB is created in the DX200/FS100.
3.3.2.8 Change of Unit Scale (only for the FS100)

When a desired operation is not executed within the normally set range for the MotoFit Command Argument, the scale of each unit can be changed.

Set the mode to “Extension”, and move to page 1 on the (Creating MotoFit JOB) tab. Select a desired scale for the force and position, press (Open MotoFit Command Setup Menu). Teaching can be executed in the desired scale. With the procedures above, “Force Scale” and “Position Scale” can be changed. (Refer to chapter 6.3 “MotoFit Command Argument Data”.) To change the scale, a command which changes the scale is also added when TOUCH Command is newly added to JOB. (For the details of scale changing command, refer to DX200/FS100 OPTIONS INSTRUCTIONS for MotoFit HW1481732).

<table>
<thead>
<tr>
<th>Item</th>
<th>Initial value</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Force Scale</td>
<td>1</td>
<td>0.01, 0.1, 1, 10</td>
</tr>
<tr>
<td>Position Scale</td>
<td>1</td>
<td>0.01, 0.1, 1, 10</td>
</tr>
</tbody>
</table>
3.4 Teach of Force Sense Basic Command

3.4.1 Outline of Teach Operation of Force Sense Basic Command

The outline of the teach operation is shown in the following flow schematic diagram. For details, refer to the next section. Perform the teach operation in the Teach mode after the initial settings described in the chapter 3.2 “Setting the IP address”.

Start

1. Startup of FSE-Tool

2. Setting of force condition file

3. Automatic adjustment function of force control parameter

4. Creating JOB

5. Threshold setting by data logging

6. Operation check

End

For details, refer to the chapter 3.3.2.1
For details, refer to the chapter 3.3.2.2
For details, refer to the chapter 3.3.2.3
For details, refer to the chapter 3.4.2.1
For details, refer to the chapter 3.4.2.2
For details, refer to the chapter 3.4.2.3

3.4.2 Details of Teach Operation of Force Sense Basic Command

3.4.2.1 Creating JOB

The creating method is explained using an example of JOB to attach a tape by pressing with a constant force in the same procedures in chapter 1.4 “Function for Calculation of Force Detection Threshold”. For this JOB, if a protrusion is detected, it's judged as fault and the operation stops. The JOB is shown as following.

Fig. 3-2: Error Detection
1. Teach the initial position P1.

2. Teach the end position P2. Use UNTIL to set the manipulator to stop when the general output is turned ON. The general input No. is 991 for R1, and 992 for R2.

3. Perform settings of the force condition file as described in the chapter 3.3.2.2 “Setting Force Condition File”.

4. Add the IMPON command. Set the argument of the IMPON command.

5. Add the FREF command. Set the argument of the FREF command.

6. Add the FDET command. Modify the Arg1 of the FDET command to 0 (invalid). For the other argument settings, log the data and set the recommended value. It is explained in the chapter 3.4.2.2 “Threshold Setting by Data Logging” and later. If the force variations of the normal and error states are apparently different, the chapter 3.4.2.2 “Threshold Setting by Data Logging” can be omitted to set the argument. In that case, set 1 (force detection) or 2 (impulse) for the Arg1 of FDET, and move on to chapter 3.4.2.3 “Operation Check”.

7. Add the IMPOFF command.
3.4.2.2 Threshold Setting by Data Logging

In this section, it is explained how to set the argument of the FDET command based on the logged data.

1. Start the FSE-Tool on the PC.
2. Press the [Setting detection threshold] tab.
3. When monitoring the force in the X direction, set X in the direction.
3 Operation Procedure
3.4 Teach of Force Sense Basic Command

4. Press the {Monitor} tab.

5. After pressing the {Start monitoring} button, execute the JOB consecutively in the normal state (without any protrusions under the tape). The maximum and minimum value of the force and the impulse are stored as the log data. As up to 50 data can be logged. Even if the JOB is performed more than 50 times, only the data up to 50 can be logged.
3 Operation Procedure
3.4 Teach of Force Sense Basic Command

6. Press the {Stop monitoring} button, and then press the {Setting detection threshold} tab.

7. The log data is displayed in the graph, and Average of Fmax, Standard Deviation, and Recommended value of the log data are output. For the details of the data to be output, refer to the chapter 6.5 “Data for Setting Detection Threshold“. When deleting the log data, press the {Reset} button.
8. Set the output Recommended value as the argument of the FDET command.
For the force detection, set the Recommended value (+ Side) of Fmax as the argument. This value is the maximum force value in consideration of the tolerance during the normal operation. Therefore, since the force over this Recommended value is applied in the error state, it is considered to be detected.
3 Operation Procedure
3.4 Teach of Force Sense Basic Command

For the Impulse detection, set the Recommended value (+ Side) of Impulse as the argument. This value is the maximum Impulse value in consideration of the tolerance during the normal operation. Therefore, since the force over this Recommended value is applied in the error state, it is considered to be detected. The Recommended values of Fmax, Fmin, and Impulse have both + and - sides respectively. The value to be used as the threshold depends on the operation. So beforehand, it needs to monitor the applied force during the operation to judge it.
3 Operation Procedure

3.4 Teach of Force Sense Basic Command

3.4.2.3 Operation Check

1. Set 1 (force detection) or 2 (impulse) for the Arg1 of FDET in the JOB. Execute the JOB. When there are no protrusions under the tape, the manipulator reaches to the end position P2. The universal output 991 remains OFF.

2. If there are any protrusions, it detects the force and stops. The universal output 991 turns ON.
The interface screen is configured as in the following figure. For I/O assignment of the button switches and status display LEDs, refer to the table below. Do not use the general output No. in the table if FSE-Tool is used.

1. Button switch

<table>
<thead>
<tr>
<th>General Output No.</th>
<th>Signal Name</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>11250</td>
<td>Start</td>
<td>Operation start (Tuning Step 1, 2, TOUCH, FIT, INSERT)</td>
</tr>
<tr>
<td>11251</td>
<td>Stop</td>
<td>Operation stop (Tuning Step 1, 2, TOUCH, FIT, INSERT)</td>
</tr>
<tr>
<td>11252</td>
<td>Mode switch</td>
<td>ON: Operation from PC (FSE-Tool) valid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OFF: Operation from PP (JOB) valid</td>
</tr>
<tr>
<td>11230</td>
<td>Zero reset</td>
<td>Zero reset of the sensor value</td>
</tr>
<tr>
<td>11231</td>
<td>Coordinate system switch</td>
<td>The coordinate system while monitoring</td>
</tr>
</tbody>
</table>

2. Status display LED

<table>
<thead>
<tr>
<th>General Output No.</th>
<th>Signal Name</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>11260</td>
<td>Running</td>
<td>With button depressed: LED ON</td>
</tr>
<tr>
<td>11262</td>
<td>Mode switch</td>
<td>ON: [PC MODE] LED ON</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OFF: [PP MODE] LED ON</td>
</tr>
<tr>
<td>11263</td>
<td>TOUCH Setting completed</td>
<td>With the (TOUCH COMP SET) button pressed on PC: LED ON</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Operation end: LED OFF</td>
</tr>
<tr>
<td>11264</td>
<td>FIT Setting completed</td>
<td>With the (FIT COMP SET) button pressed on PC: LED ON</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Operation end: LED OFF</td>
</tr>
<tr>
<td>11265</td>
<td>INSERT Setting completed</td>
<td>With the (INSERT COMP SET) button pressed on PC: LED ON</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Operation end: LED OFF</td>
</tr>
</tbody>
</table>
## Interface Panel

### General Output No.

<table>
<thead>
<tr>
<th>Signal Name</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>11266 Tuning Step 1 Setting completed</td>
<td>With the (TUNESTEP1 COMP SET) button pressed on PC: LED ON Operation end: LED OFF</td>
</tr>
<tr>
<td>11267 Tuning Step 2 Setting completed</td>
<td>With the (TUNESTEP2 COMP SET) button pressed on PC: LED ON Operation end: LED OFF</td>
</tr>
<tr>
<td>11241 Coordinate system switch</td>
<td>ON: Robot coordinate OFF: Tool coordinate</td>
</tr>
</tbody>
</table>

### Numeric value

<table>
<thead>
<tr>
<th>Variable No.</th>
<th>Signal Name</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>B96</td>
<td>R1 Tool No.</td>
<td>Tool number (R1) which is used when the coordinate system is used as a tool during the monitoring.</td>
</tr>
<tr>
<td>B97</td>
<td>R2 Tool No.</td>
<td>Tool number (R2) which is used when the coordinate system is used as a tool during the monitoring.</td>
</tr>
</tbody>
</table>
5 Monitor Information

In executing the adjustment operation, the MotoFit operation or Force Sense Basic Command operation, status is displayed on the screen by LED and graph waveform. The common items of each graph are shown as follows.

<table>
<thead>
<tr>
<th>Name</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>① Graph legend</td>
<td>Graph legend can be selected by clicking the arrow mark. Display/non-display of the graph can be switched by ticking or clearing the check-box.</td>
</tr>
<tr>
<td>② Graph pallet</td>
<td>Enlargement/reduction of the graph and scrolling action are possible.</td>
</tr>
</tbody>
</table>
Details of the graph pallet is the following.

<table>
<thead>
<tr>
<th>Item</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Cross Cursor" /></td>
<td>When the mouse cursor is placed on the graph, the mouse cursor changes to a cross cursor.</td>
</tr>
<tr>
<td><img src="image" alt="Menu" /></td>
<td>The menu of enlargement/reduction of the graph is shown.</td>
</tr>
<tr>
<td><img src="image" alt="Cursor" /></td>
<td>The area selected by the cursor is enlarged.</td>
</tr>
<tr>
<td><img src="image" alt="Horizontal Enlargement" /></td>
<td>The selected area is enlarged only in the direction of the horizontal axis.</td>
</tr>
<tr>
<td><img src="image" alt="Vertical Enlargement" /></td>
<td>The selected area is enlarged only in the direction of the vertical axis.</td>
</tr>
<tr>
<td><img src="image" alt="Reset" /></td>
<td>The enlarged/reduced graph is reset.</td>
</tr>
<tr>
<td><img src="image" alt="Click Enlargement" /></td>
<td>The area selected by clicking is enlarged.</td>
</tr>
<tr>
<td><img src="image" alt="Click Reduction" /></td>
<td>The area selected by clicking is reduced.</td>
</tr>
<tr>
<td><img src="image" alt="Scroll" /></td>
<td>The graph can be scrolled in any direction by dragging.</td>
</tr>
</tbody>
</table>
The following shows details of the monitor information.

1. When a JOB of the MotoFit or the force sensor basic command is executed, the execution status of R1 and R2 can be monitored.

<table>
<thead>
<tr>
<th>Name</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start monitoring</td>
<td>Starts monitoring</td>
</tr>
<tr>
<td>Stop monitoring</td>
<td>Stops monitoring</td>
</tr>
<tr>
<td>Save R1(R2)</td>
<td>Status, Force, Position, Impulse waveform data can be saved in csv format.</td>
</tr>
<tr>
<td>Clear R1(R2)</td>
<td>Status, Force, Position, Impulse waveform data is cleared.</td>
</tr>
</tbody>
</table>
5 Monitor Information

– Status display LED

<table>
<thead>
<tr>
<th>Name</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller Status</td>
<td>Servo ON: LED ON, Servo OFF: LED OFF</td>
</tr>
<tr>
<td></td>
<td>Force Control ON: LED ON, Force Control OFF: LED OFF</td>
</tr>
<tr>
<td>Fitting Status</td>
<td>Detected: LED ON, Undetected: LED OFF</td>
</tr>
<tr>
<td>Detect contact</td>
<td></td>
</tr>
<tr>
<td>Completion of TOUCH</td>
<td>Insertion length satisfied: LED ON,</td>
</tr>
<tr>
<td></td>
<td>Insertion length unsatisfied: LED OFF</td>
</tr>
<tr>
<td>Completion of FIT</td>
<td>Insertion length satisfied: LED ON,</td>
</tr>
<tr>
<td></td>
<td>Insertion length unsatisfied: LED OFF</td>
</tr>
<tr>
<td>Completion of INSERT</td>
<td>Insertion length satisfied: LED ON,</td>
</tr>
<tr>
<td></td>
<td>Insertion length unsatisfied: LED OFF</td>
</tr>
</tbody>
</table>

Status1: Status of MotoFit

- TOUCH operation
  10: Approaches to the workpiece with a constant speed
  12: Presses with the specified force command after contact
  14: Ends as the insertion length reaches the threshold
  -12: Ends by timeout before the insertion length reaches the threshold

- FIT
  20: Running search operation
  22: Ends as the insertion length reaches the threshold
  -20: Ends by timeout before the insertion length reaches the threshold

- INSERT
  30: Running insertion operation
  32: Under suspension
  34: Running unchoke operation
  36: Ends as the insertion length reaches the threshold
  -30: Ends by timeout before the insertion length reaches the threshold

Status2: Status of the force sense basic command

D0: Zero reset starts (0 → 1).
  Zero reset completes (1 → 0).
D1: Force control starts (0 → 1).
  Force control ends (1 → 0).
D2: Force command starts (0 → 1).
  Force command ends (1 → 0).
D3: FDET command starts (0 → 1).
  FDET command ends (1 → 0).
D4: Force detection (0 → 1).
  Force detection ends (1 → 0).
### Graph waveform

<table>
<thead>
<tr>
<th>Name</th>
<th>Contents</th>
</tr>
</thead>
</table>
| ③ Force (Horizontal axis: Sampling, Minimum value of communication cycle DX200: 12ms FS100: 10ms) | Fref(X)[N]: Force command to the X direction  
  Fref(Y)[N]: Force command to the Y direction  
  Fref(Z)[N]: Force command to the Z direction  
  Fref(RX)[Nm]: Force command to the RX direction  
  Fref(RY)[Nm]: Force command to the RY direction  
  Fref(RZ)[Nm]: Force command to the RZ direction  
  Ffb(X)[N]: Force feedback to the X direction  
  Ffb(Y)[N]: Force feedback to the Y direction  
  Ffb(Z)[N]: Force feedback to the Z direction  
  Ffb(RX)[Nm]: Force feedback to the RX direction  
  Ffb(RY)[Nm]: Force feedback to the RY direction  
  Ffb(RZ)[Nm]: Force feedback to the RZ direction  
  Ffb(XYZ)[N]: Composition of force feedback to the X, Y, and Z directions  
  Ffb(RxRyRz)[Nm]: Composition of force feedback to the Rx, Ry, and Rz directions |
| ⑤ Position (Horizontal axis: Sampling, Minimum value of communication cycle DX200: 12 ms FS100: 10 ms) | Pos(X)[mm]: Position of X direction (coordinate standard at operation start)  
  Pos(Y)[mm]: Position of Y direction (coordinate standard at operation start)  
  Pos(Z)[mm]: Position of Z direction (coordinate standard at operation start)  
  During the execution of MotoFit or the force sense basic command on the JOB, the coordinate system of the force condition file is displayed. While they are not executed, the coordinate system of I/F Panel is displayed. Tool No. is the designated number in the force condition file. |
| ⑥ Impulse (Horizontal axis: Sampling, Minimum value of communication cycle DX200: 12 ms FS100: 10 ms) | Impulse(X)[Ns]: Impulse of Ffb(X)  
  Impulse(Y)[Ns]: Impulse of Ffb(Y)  
  Impulse(Z)[Ns]: Impulse of Ffb(Z)  
  Impulse(RX)[Nm]: Impulse of Ffb(Rx)  
  Impulse(RY)[Nm]: Impulse of Ffb(Ry)  
  Impulse(RZ)[Nm]: Impulse of Ffb(Rz)  
  Impulse(XYZ)[Nm]: Impulse of Ffb(XYZ)  
  Impulse(RxRyRz)[Nm]: Impulse of Ffb(RxRyRz) |
| ⑦ Communication cycle | FS100: 10, 20, ..., 100 ms (increases by 10 ms)  
  DX200: 12, 24, ..., 120 ms (increases by 12 ms) |
2. Tuning Step 1
The force response during the adjustment of the force control parameters and the searching status of the damping parameters can be monitored.

- Status display LED

<table>
<thead>
<tr>
<th>Name</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller Status</td>
<td>Servo ON: LED ON, Servo OFF: LED OFF</td>
</tr>
<tr>
<td>Force Control</td>
<td>Force Control ON: LED ON, Force Control OFF: LED OFF</td>
</tr>
<tr>
<td>Error</td>
<td>With error: LED ON, Without error: LED OFF, Error No.: Refer to chapter 8.</td>
</tr>
<tr>
<td>Running</td>
<td>In process: LED ON, Process end: LED OFF</td>
</tr>
<tr>
<td>Tuning Status</td>
<td>Adjustment completed: LED ON, Adjustment incomplete: LED OFF</td>
</tr>
</tbody>
</table>

- Graph waveform

<table>
<thead>
<tr>
<th>Name</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Force (Horizontal axis: Sampling, Minimum value of communication cycle DX200: 12ms FS100: 10ms)</td>
<td>Fref[N,Nm]: Force command to adjustment direction Ffb [N, Nm]: Force feedback to adjustment direction</td>
</tr>
<tr>
<td>Tuning Process</td>
<td>Damping parameter [Ns/m,Ns]</td>
</tr>
</tbody>
</table>
3. Tuning Step 2
The force response during the adjustment of the force control parameters and the searching status of the damping parameters can be monitored.

### Status display LED

<table>
<thead>
<tr>
<th>Name</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller Status</td>
<td>Servo ON: LED ON, Servo OFF: LED OFF</td>
</tr>
<tr>
<td>Force Control</td>
<td>Force Control ON: LED ON, Force Control OFF: LED OFF</td>
</tr>
<tr>
<td>Error</td>
<td>With error: LED ON, Without error: LED OFF, Error No.: Refer to chapter 8.</td>
</tr>
<tr>
<td>Running</td>
<td>In process: LED ON, Process end: LED OFF</td>
</tr>
<tr>
<td>Tuning Status</td>
<td>Adjustment completed: LED ON, Adjustment incomplete: LED OFF</td>
</tr>
</tbody>
</table>

### Graph waveform

<table>
<thead>
<tr>
<th>Name</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Force (Horizontal axis: Sampling, Minimum value of communication cycle DX200: 12ms FS100: 10ms)</td>
<td>Fref[N,Nm]: Force command to adjustment direction Ffb [N,Nm]: Force feedback to adjustment direction</td>
</tr>
<tr>
<td>Tuning Process</td>
<td>Damping parameter [Ns/m,Ns], Frequency of Ffb [count], Settling time of Ffb [ms]</td>
</tr>
</tbody>
</table>
4. Arguments Setting of MotoFit command

When setting the arguments of MotoFit command, the status of the force, position data and fitting operation can be monitored.

- Status display LED

<table>
<thead>
<tr>
<th>Name</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller Status</td>
<td>Servo ON: LED ON, Servo OFF: LED OFF</td>
</tr>
<tr>
<td></td>
<td>Force Control ON: LED ON, Force Control OFF: LED OFF</td>
</tr>
<tr>
<td></td>
<td>Error With error: LED ON,</td>
</tr>
<tr>
<td></td>
<td>Without error: LED OFF</td>
</tr>
<tr>
<td></td>
<td>Error No.: Refer to chapter 8.</td>
</tr>
<tr>
<td>Running</td>
<td>In process: LED ON, Process end: LED OFF</td>
</tr>
<tr>
<td>Fitting task Status</td>
<td>Detect contact: Detected: LED ON, Undetected: LED OFF</td>
</tr>
<tr>
<td></td>
<td>Completion of TOUCH Insertion length satisfied: LED ON,</td>
</tr>
<tr>
<td></td>
<td>Insertion length unsatisfied: LED OFF</td>
</tr>
<tr>
<td></td>
<td>Completion of FIT Insertion length satisfied: LED ON,</td>
</tr>
<tr>
<td></td>
<td>Insertion length unsatisfied: LED OFF</td>
</tr>
<tr>
<td></td>
<td>Completion of INSERT Insertion length satisfied: LED ON,</td>
</tr>
<tr>
<td></td>
<td>Insertion length unsatisfied: LED OFF</td>
</tr>
</tbody>
</table>
### Monitor Information

#### Graph waveform

<table>
<thead>
<tr>
<th>Name</th>
<th>Contents</th>
</tr>
</thead>
</table>
| Force      | - Frf(X)[N]: Force command to the X direction  
- Frf(Y)[N]: Force command to the Y direction  
- Frf(Z)[N]: Force command to the Z direction  
- Frf(RX)[Nm]: Force command to the RX direction  
- Frf(RY)[Nm]: Force command to the RY direction  
- Frf(RZ)[Nm]: Force command to the RZ direction |
| Position   | - Ffb(X)[N]: Force feedback to the X direction  
- Ffb(Y)[N]: Force feedback to the Y direction  
- Ffb(Z)[N]: Force feedback to the Z direction  
- Ffb(RX)[Nm]: Force feedback to the RX direction  
- Ffb(RY)[Nm]: Force feedback to the RY direction  
- Ffb(RZ)[Nm]: Force feedback to the RZ direction |
| State transition | - TOUCH operation  
10: Approaches to the workpiece with a constant speed  
12: Presses with the specified force command after contact  
14: Ends as the insertion length reaches the threshold  
-12: Ends by timeout before the insertion length reaches the threshold  
- FIT  
20: Running search operation  
22: Ends as the insertion length reaches the threshold  
-20: Ends by timeout before the insertion length reaches the threshold  
- INSERT  
30: Running insertion operation  
32: Under suspension  
34: Running unchoke operation  
36: Ends as the insertion length reaches the threshold  
-30: Ends by timeout before the insertion length reaches the threshold |

*Horizontal axis: Sampling, Minimum value of communication cycle DX200: 12ms FS100: 10ms*
6 Operation Condition Data

6.1 Force Condition File Data

The range of each data for the force condition file is shown in the table below. In the automatic adjustment function of force control parameter, Settling time, Stop time threshold, Stop speed threshold, and Damping Param are the target of auto tuning.

Table 6-1: Force Condition File Data

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Initial value</th>
<th>Range</th>
<th>Remarks</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: File No.</td>
<td>-</td>
<td>1</td>
<td>1 to 24</td>
<td></td>
<td>Standard</td>
</tr>
<tr>
<td>2: Comment</td>
<td>-</td>
<td>NONE</td>
<td>Up to 32</td>
<td></td>
<td>Standard</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>alphanumerical</td>
<td>characters</td>
<td></td>
</tr>
<tr>
<td>3: Robot</td>
<td>-</td>
<td>R1</td>
<td>0: R1, 1: R2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4: Coordinate</td>
<td>-</td>
<td>Robot</td>
<td>1: Robot,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2: Tool</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5: Tool No.</td>
<td>-</td>
<td>0</td>
<td>FS100: 0 to 15</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>DX200: 0 to 63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6: Insert Dir.</td>
<td>-</td>
<td>Z-</td>
<td>0: X+, 1: X-,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2: Y+, 3: Y-,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4: Z+, 5: Z-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7: Force control activate</td>
<td>-</td>
<td>0</td>
<td>D0: X, D1: Y,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>D2: Z, D3: Rx,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>D4: Ry, D5: Rz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8: Settling time</td>
<td>ms</td>
<td>1000</td>
<td>0 to 5000</td>
<td></td>
<td>Extension</td>
</tr>
<tr>
<td>9: Stop Speed threshold</td>
<td>mm/s</td>
<td>2.0</td>
<td>0.0 to 9.9</td>
<td></td>
<td>Extension</td>
</tr>
<tr>
<td>10: Stop time threshold</td>
<td>ms</td>
<td>200</td>
<td>0 to 5000</td>
<td></td>
<td>Extension</td>
</tr>
<tr>
<td>11: Mass Param (X, Y, Z,</td>
<td>kg</td>
<td>1.00</td>
<td>0 to 9999</td>
<td>Target of auto tuning</td>
<td>Extension</td>
</tr>
<tr>
<td>Rx, Ry, Rz)</td>
<td>kgm²</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12: Damping Param (X, Y,</td>
<td>Ns/m</td>
<td>3000</td>
<td>100 to 99990</td>
<td>Target of auto tuning</td>
<td>Extension</td>
</tr>
<tr>
<td>Z, Rx, Ry, Rz)</td>
<td>Nms</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13: Spring Param (X, Y,</td>
<td>N/m</td>
<td>0</td>
<td>0 to 9999</td>
<td>Zero is applied during</td>
<td>Extension</td>
</tr>
<tr>
<td>Z, Rx, Ry, Rz)</td>
<td>Nm</td>
<td></td>
<td></td>
<td>adjustment even when the value other</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>than zero is input.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 6-2: Adjustment Condition Data

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Initial value</th>
<th>Range</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Tuning Dir. (Common to Step1, Step2)</td>
<td>-</td>
<td>Z-</td>
<td>X+, X-, Y+, Y-, Z+, Z-, Rx+, Rx-, Ry+, Ry-, Rz+, Rz-</td>
<td>Auto Tuning Menu</td>
</tr>
<tr>
<td>2. Reference Force (translational direction) Fref_trans (Step2)</td>
<td>N</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Reference Moment (rotational direction) Fref_rot (Step2)</td>
<td>Nm</td>
<td>0.50</td>
<td>0 to 2.00</td>
<td></td>
</tr>
<tr>
<td>4. Tuning Step</td>
<td>-</td>
<td>1</td>
<td>1, 2</td>
<td></td>
</tr>
</tbody>
</table>
6.3 MotoFit Command Argument Data

The range of MotoFit command argument data is shown in the table below. For the meaning of each parameter, refer to DX200/FS100 OPTIONS INSTRUCTIONS for MotoFit (HW1481732).

1. TOUCH

<table>
<thead>
<tr>
<th>Variable</th>
<th>Initial value</th>
<th>Range (Normal)</th>
<th>Range (0.01 times)</th>
<th>Range (0.1 times)</th>
<th>Range (10 times)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOUCH Arg2 (Touch force threshold [N])</td>
<td>3.0</td>
<td>0.0 to 99.9</td>
<td>0.000 to 0.999</td>
<td>0.00 to 9.99</td>
<td>0 to 999</td>
<td>Force</td>
</tr>
<tr>
<td>TOUCH Arg3 (Approach speed [mm/s])</td>
<td>3.0</td>
<td>0.0 to 50.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOUCH Arg4 (Force command value [N])</td>
<td>10.0</td>
<td>0.0 to 99.9</td>
<td>0.000 to 0.999</td>
<td>0.00 to 9.99</td>
<td>0 to 999</td>
<td>Force</td>
</tr>
<tr>
<td>TOUCH Arg5 (Insertion length threshold [mm])</td>
<td>2.0</td>
<td>0.0 to 99.9</td>
<td>0.000 to 0.999</td>
<td>0.00 to 9.99</td>
<td>0 to 999</td>
<td>Position</td>
</tr>
<tr>
<td>TOUCH Arg6 (Touch length [mm])</td>
<td>50.0</td>
<td>0.0 to 50.0</td>
<td>0.000 to 0.500</td>
<td>0.00 to 5.00</td>
<td>0 to 500</td>
<td>Position</td>
</tr>
<tr>
<td>TOUCH Arg7 (After-TOUCH time-out time [s])</td>
<td>2.0</td>
<td>0.0 to 99.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 6 Operation Condition Data

#### 6.3 MotoFit Command Argument Data

### 2. FIT

![MotoFit Interface](image)

#### Table 6-4: FIT Command Argument

<table>
<thead>
<tr>
<th>Variable</th>
<th>Initial value</th>
<th>Range (Normal)</th>
<th>Range (0.01 times)</th>
<th>Range (0.1 times)</th>
<th>Range (10 times)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIT Arg2 (Force command value [N])</td>
<td>10.0</td>
<td>0.0 to 99.9</td>
<td>0.000 to 0.999</td>
<td>0.00 to 9.9</td>
<td>0 to 999</td>
<td>Force</td>
</tr>
<tr>
<td>FIT Arg3 (Insertion length threshold [mm])</td>
<td>3.0</td>
<td>0.0 to 99.9</td>
<td>0.000 to 0.999</td>
<td>0.00 to 9.9</td>
<td>0 to 999</td>
<td>Position</td>
</tr>
<tr>
<td>FIT Arg4 (Search operation pattern)</td>
<td>OMNI</td>
<td>XYZ, ROTATE, OMNI</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FIT Arg5 (Search force command value [N], [Nm])</td>
<td>Translation: 20.0</td>
<td>Rotation: 9.9</td>
<td>Translation: 0.00 to 99.9</td>
<td>Rotation: 0.00 to 9.9</td>
<td>Translation: 0.00 to 999</td>
<td>Rotation: 0.00 to 99</td>
</tr>
<tr>
<td>FIT Arg6 (Search vibration cycle [ms])</td>
<td>400</td>
<td>2 to 999</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FIT Arg7 (Search operation start direction designation)</td>
<td>X+</td>
<td>X+, X-, Y+, Y-, Z+, Z-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FIT Arg8 (Search operation time [s])</td>
<td>10.0</td>
<td>0.0 to 99.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### INSERT Command Argument Data

#### Table 6-5: INSERT Command Argument

<table>
<thead>
<tr>
<th>Variable</th>
<th>Initial value</th>
<th>Range (Normal)</th>
<th>Range (0.01 times)</th>
<th>Range (0.1 times)</th>
<th>Range (10 times)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>INSERT Arg2 (Force command value [N])</td>
<td>20.0</td>
<td>0.0 to 99.9</td>
<td>0.000 to 0.999</td>
<td>0.00 to 9.99</td>
<td>0 to 999</td>
<td>Force</td>
</tr>
<tr>
<td>INSERT Arg3 (Insertion length threshold 1 [mm])</td>
<td>90.0</td>
<td>0.0 to 99.9</td>
<td>0.000 to 0.999</td>
<td>0.00 to 9.99</td>
<td>0 to 999</td>
<td>Position</td>
</tr>
<tr>
<td>INSERT Arg4 (Insertion length threshold 2 [mm])</td>
<td>99.9</td>
<td>0.0 to 99.9</td>
<td>0.000 to 0.999</td>
<td>0.00 to 9.99</td>
<td>0 to 999</td>
<td>Position</td>
</tr>
<tr>
<td>INSERT Arg5 (Unchoke operation designation)</td>
<td>No value</td>
<td>No value</td>
<td>XYZ, OMNI</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INSERT Arg6 (Unchoke operation force command [N])</td>
<td>5</td>
<td>0 to 99</td>
<td>0.00 to 0.99</td>
<td>0.0 to 9.9</td>
<td>0 to 990</td>
<td>Force</td>
</tr>
<tr>
<td>INSERT Arg7 (Unchoke operation force command cycle [ms])</td>
<td>200</td>
<td>2 to 999</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INSERT Arg8 (Unchoke operation start direction designation)</td>
<td>X+</td>
<td>X+, X-, Y+, Y-, Z+, Z</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INSERT Arg9 (Unchoke operation time [sec])</td>
<td>3</td>
<td>0 to 99</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6.4 Backup of Teach Data

During the teach operation of FSE-Tool, the force condition file data and the MotoFit command argument data can be saved.

1. Saving the data
   - Click the {Save} button in the [Main Menu] screen.
   - Specify the destination to save, input the file name, and then click the {OK} button.
2. Loading the data

– To use the data previously saved, click the {Load} button.

– Select the file, and click the {OK} button.
6.5 Data for Setting Detection Threshold

The data of the number of JOB execution can be logged (up to 50 data). Contents to be logged are Fmax, Fmin, and Impulse. Pressing the [Stop monitoring] button will output the respective Average, Standard Deviation, Recommended value on the screen. The following table are the detail of each parameter.

Table 6-6: Data for Setting Detection Threshold

<table>
<thead>
<tr>
<th>Item</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Fmax [N,Nm]</td>
<td>Maximum force value from FDET to IMPOFF</td>
</tr>
<tr>
<td>2. Average of Fmax [N,Nm]</td>
<td>Average value of Fmax log data</td>
</tr>
<tr>
<td>3. Standard Deviation [N,Nm]</td>
<td>Standard deviation of Fmax log data</td>
</tr>
<tr>
<td>4. Recommended value (+ Side) [N,Nm]</td>
<td>Recommended value for setting threshold of Fmax: Average + 6 x Standard Deviation</td>
</tr>
<tr>
<td>5. Recommended value (- Side) [N,Nm]</td>
<td>Recommended value for setting threshold of Fmax: Average - 6 x Standard Deviation</td>
</tr>
<tr>
<td>6. Fmin [N,Nm]</td>
<td>Minimum force value from FDET to IMPOFF</td>
</tr>
<tr>
<td>7. Average of Fmin [N,Nm]</td>
<td>Average value of Fmin log data</td>
</tr>
<tr>
<td>8. Standard Deviation [N,Nm]</td>
<td>Standard deviation of Fmin log data</td>
</tr>
<tr>
<td>9. Recommended value (+ Side) [N,Nm]</td>
<td>Recommended value for setting threshold of Fmin: Average + 6 x Standard Deviation</td>
</tr>
<tr>
<td>10. Recommended value (- Side) [N,Nm]</td>
<td>Recommended value for setting threshold of Fmin: Average - 6 x Standard Deviation</td>
</tr>
<tr>
<td>11. Impuls [Ns,Nms]</td>
<td>Impulse from FDET to IMPOFF</td>
</tr>
<tr>
<td>12. Average of Impuls [Ns,Nms]</td>
<td>Average value of Impulse log data</td>
</tr>
<tr>
<td>13. Standard Deviation [Ns,Nms]</td>
<td>Standard deviation of Impulse log data</td>
</tr>
<tr>
<td>14. Recommended value (+ Side) [Ns,Nms]</td>
<td>Recommended value for setting threshold of Impulse: Average + 6 x Standard Deviation</td>
</tr>
<tr>
<td>15. Recommended value (- Side) [Ns,Nms]</td>
<td>Recommended value for setting threshold of Impulse: Average - 6 x Standard Deviation</td>
</tr>
</tbody>
</table>
6 Operation Condition Data
6.5 Data for Setting Detection Threshold
7 Error of Automatic Adjustment Function of Force Control Parameter

Error description is shown in the table below. The alarms and errors related to the MotoFit function are displayed on the PP. For details, refer to DX200/FS100 OPTIONS INSTRUCTIONS for MotoFit (HW1481732).

Table 7-1: Error List

<table>
<thead>
<tr>
<th>Error No.</th>
<th>Error Contents</th>
<th>Countermeasure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ended with insufficient adjustment (Tuning Step 2)</td>
<td>Increase the upper limit of contact count for the adjustment condition, and retry the operation. (The setting can be changed only in the Extension mode.)</td>
</tr>
<tr>
<td>2</td>
<td>Excessive travel distance</td>
<td>Move the operation start position close to the workpiece, and retry the operation.</td>
</tr>
<tr>
<td>3</td>
<td>Excessive force</td>
<td>For Tuning Step 1, increase the initial value of Damping parameter, and retry the operation. For Tuning Step 2, decrease the force command value, and retry the operation.</td>
</tr>
<tr>
<td>4</td>
<td>[STOP] button is pressed during operation</td>
<td>Move to the operation start position, and retry the operation.</td>
</tr>
<tr>
<td>5</td>
<td>Servo OFF occurs during operation</td>
<td>Move to the operation start position, and retry the operation.</td>
</tr>
<tr>
<td>6</td>
<td>An alarm occurs during operation</td>
<td>Take appropriate action to the alarm, move to the operation start position, and then retry the operation.</td>
</tr>
<tr>
<td>7</td>
<td>Mode enters into PP mode during operation</td>
<td>Switch to the PC mode, move to the operation start position, and then retry the operation.</td>
</tr>
</tbody>
</table>
## 8 Alarm List of FSE-Tools

<table>
<thead>
<tr>
<th>Alarm Number</th>
<th>Alarm Name</th>
<th>Sub Code</th>
<th>Meaning</th>
<th>Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>8001</td>
<td>ALM FSETOOL PKT ENDMARK</td>
<td></td>
<td>When the controller receives the data from PC with using FSE-Tool, the endmark of the packet has an error.</td>
<td>Software (Setting error)</td>
<td>(1) Check the followings and then turn ON the power again.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Connection status of the communication cable</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Force sensor type being connected</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(2) If this alarm occurs again, save CMOS.BIN in the maintenance mode and tell the situation of the alarm occurrence (such as the operation procedures) to your YASKAWA representative.</td>
</tr>
<tr>
<td>8003</td>
<td>ALM FSETOOL RECV DATA</td>
<td></td>
<td>When the controller receives the data from PC with using FSE-Tool, the received data has an error.</td>
<td>Software (Setting error)</td>
<td>(1) Check the followings and then turn ON the power again.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Connection status of the communication cable</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Force sensor type being connected</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(2) If this alarm occurs again, save CMOS.BIN in the maintenance mode and tell the situation of the alarm occurrence (such as the operation procedures) to your YASKAWA representative.</td>
</tr>
<tr>
<td>8007</td>
<td>ALM FSE-TOOL OPEN FCONCND</td>
<td></td>
<td>Software cannot read the force condition file.</td>
<td>Software (Setting error)</td>
<td>Road the force condition file to the controller.</td>
</tr>
<tr>
<td>8015</td>
<td>ALM IF MODE</td>
<td>[0]: PP mode [1]: PC mode</td>
<td>Mode is error in the I/F panel.</td>
<td>Software (Setting error)</td>
<td>Execute again, after changing mode in the I/F panel.</td>
</tr>
<tr>
<td>8018</td>
<td>ALM TOOLNO ERR</td>
<td></td>
<td>Tool no range over in the I/F panel.</td>
<td>Software (Setting error)</td>
<td>Change tool no within allowance.</td>
</tr>
<tr>
<td>8026</td>
<td>ALM FSETOOL CMD PHASE</td>
<td></td>
<td>When executing the force control parameter adjustment or MotoFit from FSE-Tool, the processing flow has an error.</td>
<td>Software (Setting error)</td>
<td>(1) Check the followings and then turn ON the power again.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Connection status of the communication cable</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Force sensor type being connected</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(2) If this alarm occurs again, save CMOS.BIN in the maintenance mode and tell the situation of the alarm occurrence (such as the operation procedures) to your YASKAWA representative.</td>
</tr>
</tbody>
</table>
## Alarm List of FSE-Tools

<table>
<thead>
<tr>
<th>Alarm Number</th>
<th>Alarm Name</th>
<th>Sub Code</th>
<th>Meaning</th>
<th>Cause</th>
<th>Remedy</th>
</tr>
</thead>
</table>
| 8027         | ALM FSETOOL JOB SIZE (JOB size error) | [0]: 2KBytes over [1]: 51 lines over | When the controller receives the JOB from PC with using FSE-Tool, the JOB size exceeds the allowable size. | Software (Setting error) | [0]: The JOB to be received should be within 2 KBytes. 
[1]: The JOB to be received should be within 50 lines. |
| 8028         | ALM FSETOOL PALAM (Adjustment condition parameter error) | | When executing the force control parameter adjustment from PC with using FSE-Tool, the adjustment condition parameter has an error. | Software (Setting error) | Then turn ON the power again. 
- Connection status of the communication cable 
- Force sensor type being connected 
(2) If this alarm occurs again, save CMOS.BIN in the maintenance mode and tell the situation of the alarm occurrence (such as the operation procedures) to your YASKAWA representative. |
| 8805         | ALM SEND COMM ALARM | | Communication interrupted. | Hardwar e | Confirm Ethernet connection. |
9 How to Check the Version

In the user's PC, right-click on the FSE-Tool.exe and click [Properties]. Select "General" tab, and the version is shown in "Description":
10 Precautions

10.1 Operation during Force Control

During the execution of adjustment operation or MotoFit function, the position compensation function works by the force sense feedback; the operation does not necessarily follow the teach position or teach track.

10.2 Cancel Operation during Execution of Adjustment Operation or MotoFit Function

Operate in the Teach mode in FSE-Tool. For emergency stop, release the enable switch to turn the servo OFF. In cancelling the robot operation, the force control function becomes invalid, and the state of normal position control is returned. To resume the operation, move the robot to the position before starting the force control, and retry the operation.

10.3 Communication Error

When the message "Communication error" appears on PC, the Ethernet to connect the robot controller and PC may be unconnected.

10.4 Limitation due to Using Environment

The using environment should be limited to the assembly line; it cannot be used in the welding line.
DX200/FS100 OPTIONS
INSTRUCTIONS
For MotoFit Function Engineering Support Tool

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

YASKAWA ELECTRIC CORPORATION

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MANUAL NO. HW1481731 104/104