DX100 OPTIONS
INSTRUCTIONS
FOR MULTI-LAYER WELDING FUNCTION

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

MOTOMAN INSTRUCTIONS
DX100 INSTRUCTIONS
DX100 OPERATOR’S MANUAL
DX100 MAINTENANCE MANUAL

The DX100 Operator’s instructions above corresponds to specific usage.
Be sure to use the appropriate instruction.

Part Number: 156446-1CD
Revision: 0
MANDATORY

- This manual explains the Multi-layer Welding Function of the DX100 system. Read this instruction carefully and be sure to understand its contents before handling the DX100 and available functions.
- Listed in Chapter 1 are general safety related items: Safety of the DX100 Instructions. To ensure correct and safe operation, carefully read the DX100 Instructions before reading this manual.

CAUTION

- Some drawings in this manual are shown with the protective covers or shields removed for clarity. Replace all covers and shields 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 modification occur, the revision number changes on the manual.
- 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 using the DX100.

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

⚠️ 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 "CAUTION" and "WARNING".
WARNING

• Before operating the manipulator, turn OFF the servo power by pressing the emergency stop button on the front door of the DX100 or the programming pendant. The SERVO ON LED is OFF when the servo power is OFF.

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

Fig. : Emergency Stop Button

• Clear the cell of all items that could interfere with the operation of the manipulator with the Emergency Stop button engaged.

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:
  – 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 P-point maximum envelope of the manipulator and that you are in a safe location before:
  – Turning ON the power for the DX100.
  – Moving the manipulator with the programming pendant.
  – Running the system in the check mode.
  – Performing automatic operations.

Injury may result if anyone enters the P-point maximum envelope of the manipulator during operation. Always press an emergency stop button immediately if there is a problem. The emergency stop buttons are located on the right of the front door of the DX100 and the programming pendant.
CAUTION

- Perform the following inspection procedures prior to conducting manipulator teaching. Repair any problems that are found immediately and make sure other necessary processing can be 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 DX100 cabinet after use.

Damage to the programming pendant can occur if left in the manipulator’s work area, on the floor, or near fixtures.

- Read and understand the Explanation of Warning Labels in the DX100 Instructions before operating the manipulator:

Definition of Terms Used Often in This Manual

The MOTOMAN is the YASKAWA industrial robot product.

The MOTOMAN usually consists of the manipulator, the controller, the programming pendant, and supply 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>DX100 controller</td>
<td>DX100</td>
</tr>
<tr>
<td>DX100 programming pendant</td>
<td>Programming pendant</td>
</tr>
<tr>
<td>Cable between the manipulator and the controller</td>
<td>Manipulator cable</td>
</tr>
</tbody>
</table>
Descriptions of the programming pendant, 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>[ ] indicate keys with characters printed on them. ex. [ENTER]</td>
</tr>
<tr>
<td>Character Keys</td>
<td>Symbol Keys: The keys which have a symbol printed on them are not denoted with [ ] but depicted with a small picture. ex. page key</td>
</tr>
<tr>
<td></td>
<td>The cursor key is an exception, and a picture is not shown.</td>
</tr>
<tr>
<td>Axis Keys</td>
<td>“Axis Keys” and “Number Keys” are generic names for the keys for axis operation and number input.</td>
</tr>
<tr>
<td>Number Keys</td>
<td>Keys pressed simultaneously: When two keys are to be pressed simultaneously, the keys are shown with a “+” sign between them, ex. [SHIFT]+[COORD]</td>
</tr>
<tr>
<td>Displays</td>
<td>{ } indicate menu displayed in the programming pendant. ex. {JOB}</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 the trademark (™) and register trademark (®) symbols have been omitted.
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1 Outline

1.1 Multi-layer Welding Function

The DX100 is used to weld a workpiece with multiple layers which, otherwise, cannot be satisfactorily welded with a single layer. The first layer is welded while the COMARC instruction executes the arc sensing for correcting the path. At the same time, the path is stored and jobs for the 2nd and following layers are created automatically based on the stored path by the memory and playback function.

Since the workpieces subjected to the multi-layer welding are generally thick and have problems such as “variations in welding accuracy”, “distortion during welding”, and “positioning errors due to setting error”, simply reproducing the taught path is not enough to attain high-quality welding. For the solution of these problems, the search function and the arc sensing function are used.

1.2 Features

The main features of multi-layer welding function are listed below.

<table>
<thead>
<tr>
<th>Items</th>
<th>Contents</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point variables</td>
<td>The taught position data on the 1st layer are registered in point variables. These point variables can be used for weldings on the 2nd and following layers.</td>
<td>By using the point variables where the taught position data on the first layer are registered, the time required for the teaching for the second and the following layers can be reduced.</td>
</tr>
<tr>
<td>Memory and playback function</td>
<td>Stores the corrected path of the first layer by the arc sensor and reproduces the stored path on the second and the following layers.</td>
<td>Reproducing the corrected path on the first layer for the second and the following layers realizes the high-quality welding. For reproducing the corrected path for the second and the following layers, either the same direction as the welding on first layer or the reversed direction can be selected.</td>
</tr>
<tr>
<td>Search and shift function</td>
<td>Four shift patterns are available. At the execution of the instruction, the amount of the deviation from the taught position is automatically calculated and the following steps are shifted accordingly.</td>
<td>One instruction executes search and shift functions, which simplifies the operation. Specifying the shift type such as shift in parallel or shift in rotation makes the correction of the workpiece positioning error easy.</td>
</tr>
<tr>
<td>Overriding Welding Condition Function</td>
<td>During playback operation, the welding conditions can be adjusted and changed.</td>
<td>Overriding the welding conditions such as arc sensing, weaving amplitude, realizes easy adjustment of the welding conditions.</td>
</tr>
<tr>
<td>Shift function</td>
<td>After the search and shift operations, the taught position can be modified during the shift operation in teach mode.</td>
<td>Since it is not necessary to change the target position on the master workpiece, the modification of the taught position is easy.</td>
</tr>
</tbody>
</table>
1.3 Customer Support Information

If you need assistance with any aspect of your DX100 system, please contact Yaskawa Motoman Customer Support at the following 24-hour telephone number:

(937) 847-3200

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

techsupport@motoman.com

When using e-mail to contact Yaskawa 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 Yaskawa Motoman Customer Support at the telephone number shown above.

Please have the following information ready before you call:

<table>
<thead>
<tr>
<th>Information</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>System</td>
<td>DX100</td>
</tr>
<tr>
<td>Robots</td>
<td>MH5L</td>
</tr>
<tr>
<td>Positioner</td>
<td>MH95</td>
</tr>
<tr>
<td>Primary Application</td>
<td>Welding</td>
</tr>
<tr>
<td>Controller</td>
<td>DXM100</td>
</tr>
<tr>
<td>Software Version</td>
<td>Access this information on the Programming Pendant’s LCD display screen by selecting {MAIN MENU} - {SYSTEM INFO} - {VERSION}</td>
</tr>
<tr>
<td>Robot Serial Number</td>
<td>Located on the robot data plate</td>
</tr>
<tr>
<td>Robot Sales Order Number</td>
<td>Located on the DX100 controller data plate</td>
</tr>
</tbody>
</table>
2 Basic Operations

2.1 Robot Posture Control by Euler Angles

2.1.1 Outline

Different from the robot control of the ordinary coordinate systems, Euler angles control the robot's optimum posture for welding. See fig. 2-1 for the robot posture using Euler angles.

The Euler angles in the base coordinate system are as follows:

A) The angle between the X-axis and the Z-axis of the tool coordinate system projected on the X-Y plane of the base coordinate system (-180° < A ≤ 180°)

B) The angle between the Z-axis of the tool coordinate system and the X-Y plane of the base coordinate system (-90° < B ≤ 90°)

C) The angle to move X and W-axis of the tool coordinate system on X' and Y'-axis where X', Y' and Z' are the axes in such coordinate system as Z-axis of the base coordinate system is moved on Z-axis of the tool coordinate system by rotating the base coordinate system around Z-axis and then around Y-axis (-180° < C ≤ 180°)

Fig. 2-1: Euler Angles
2.1.2 Operation

2.1.2.1 Cartesian coordinate system

When selecting the Cartesian coordinate system, pressing X, Y, or Z key moves the tool in parallel to the X, Y, or Z axis in the base coordinate system. Accordingly, pressing axis key changes the tool posture without changing the position of the tool center point as shown in Fig. 2-2.

Fig. 2-2: Jog Motion in Posture Control

A) Rotates around the Z-axis in the base coordinate system
B) Rotates the tool in horizontal and vertical motion to the X-Y plane
C) Rotates centering around the tool axis
2.1.2.2 Tool coordinate system

When selecting the tool coordinate system through the programming pendant, the robot moves as shown in fig. 2-3.

Changing the posture is the same as the Cartesian coordinate system.

Fig. 2-3: Jog Motion in Tool Coordinate System

2.2 Point Variables

2.2.1 Outline

The point variables store and manage the taught position data in the job. The point variables can be used to move the robot to the same position multiple times in one job.

Registering the taught position data to the point variables can reduce the time required for teaching within the job.

Difference between the point variables and the position variables (P***)

- The position variables can be read or written from/to all jobs while the point variables use only the job where these point variables are registered. Therefore, point variables may use identical numbers for other jobs.
- The taught position data and the shift amount can be stored in the position variable. In the point variables, only the taught position data can be stored.
- 128 position variables are available as a standard (can be expanded to 5,000). A point variable is created when a move instruction is registered in the job, and the point variable number can be set arbitrarily in the range of 0 to 9999.
- By using the instructions SET and SETE, a position variable can be used for a registered position; however, these instructions cannot be used to register a position to a point variable.
- The position variables cannot be deleted (can be left without position data). The point variables are deleted when the job where these point variables are registered is deleted.
2.2.2 Registering Point Variables

Replacing the taught position data of the move instruction with the point variable.

1. Move the cursor to the instruction area, and press [SELECT] twice on the desired move instruction
   - The detail edit display of the move instruction appears.
   
   ![Image of detail edit display]

2. Select “UNUSED” of “POINT VARIABLE,” and select “T”
3. Press [SELECT], and enter a point variable number
4. Press [ENTER]
   - The entered point variable number (T0000) appears in the input buffer line.

   ![Image of detail edit display with point variable number]

   ![Image of detail edit display with point variable number]
5. Press [ENTER]

- The entered contents are registered in the job. If another point variable with the same number has been already used in the same job, the already used point variable, even if no taught position data is specified in the point variable, is registered. Newly created and numbered point variable has no taught position data regardless of SERVO ON/OFF status.

2.2.2.1 Changing the number of the point variable

There are two operation methods to change the number of the point variable.

- **Operation method 1 for changing number of point variables**
  1. Move the cursor to the instruction area, and press [SELECT] on the desired move instruction
  2. Move the cursor to the point variable whose number to be changed, and press [SELECT]
     - A new number for the point variable can be typed.
  3. Press [SELECT], and enter a point variable number

- **NOTE**
  - When a point variable with no taught position data specified is registered, “★” is indicated for the TOOL number in the job content display.
  - The job in which the point variable with no taught position data specified is registered can not be loaded/saved by FC2 (same as for the position variables).
4. Press [ENTER]

   - The entered point variable number (T0011) appears in the input buffer line.

   ![Image of DX100 interface showing job content display]

5. Press [ENTER]

   - The entered contents are registered in the job. If another point variable with the same number has been already used in the same job, the already used point variable, even if no taught position data is specified in the point variable, is registered. Newly created and numbered point variable has no taught position data regardless of SERVO ON/OFF status.

   ![Image of DX100 interface showing point variable details]

   - When a point variable with no taught position data specified is registered, “★” is indicated for the TOOL number in the JOB CONTENT display.

   - The job in which the point variable with no taught position data specified is registered can not be loaded/saved by FC2 (same as for the position variables).
Operation method 2 for changing number of point variables

1. Move the cursor to the instruction area, and press [SELECT] twice on the desired move instruction
   – The detail edit display of the move instruction appears.

   ![Image 1]

2. Enter a point variable number
3. Press [ENTER]
   – The entered point variable number (T0011) appears in the input buffer line.

   ![Image 2]
4. Press [ENTER]

– The entered contents are registered in the job. If another point variable with the same number has been already used in the same job, the already used point variable, even if no taught position data is specified in the point variable, is registered. Newly created and numbered point variable has no taught position data regardless of SERVO ON/OFF status.

![Job Content Display](image)

**NOTE**

• When a point variable with no taught position data specified is registered, “★” is indicated for the TOOL number in the job content display.

• The job in which the point variable with no taught position data specified is registered can not be loaded/saved by FC2 (same as for the position variables).

### 2.2.2.2 Registering a move instruction together with a point variable

1. Press [MOTION TYPE] to select the desired move instruction

– Each time [MOTION TYPE] is pressed, the move instruction is switched in the following order: “MOVJ” → “MOVL” → “MOVC” → “MOVS” → “MOVJ.”

![Move Instruction Display](image)
2. Press [SELECT]
   – The detail edit display of the selected move instruction appears.

3. Select “UNUSED” of “POINT VARIABLE,” and select “T”

4. Enter a point variable number

5. Press [ENTER]
   – The entered point variable number appears in the input buffer line.
6. Press [ENTER]

- The entered contents are registered in the job. If another point variable with the same number has been already used in the same job, the already used point variable, even if no taught position data is specified in the point variable, is registered. Newly created and numbered point variable has no taught position data regardless of SERVO ON/OFF status.

2.2.3 Deleting a Point Variable

2.2.3.1 Deleting the move instruction

1. Move the cursor to the line number of the move instruction to be deleted

- When a point variable with no taught position data specified is registered, “*” is indicated for the TOOL number in the job content display.
- The job in which the point variable with no taught position data specified is registered can not be loaded/saved by FC2 (same as for the position variables).
2. Press [DELETE] and [ENTER]

2.2.3.2 Deleting the point variable designation

- When the deleted point variable is not used for other move instructions in the same job, it becomes in unused status, but retains the taught position data. However, the point variables in unused status will be deleted when another job is selected.

- A move instruction with the point variable that has no taught position data specified can be also deleted.

1. Move the cursor to the instruction area, and press [SELECT] twice on the desired move instruction

   - The detail edit display of the move instruction appears.

2. Select the point variable (T0010 in the explanation) to be deleted, and select “UNUSED” of “POS LEVEL,” “NWAIT,” and “UNTIL”
3. Press [ENTER]

– The modified contents appears in the input buffer line.

4. Press [ENTER]

– The entered modification is registered in the job. The taught position data of the deleted point variable is reregistered.
2.2.4 Editing the Point Variable (Taught Position Data)

The taught position data can be edited by entering a numerical value. Refer to DX100 OPTIONS INSTRUCTIONS FOR TEACHING POINT ADJUSTMENT FUNCTION WITH PROGRAMMING PENDANT (manual No.: HW0485569).

1. In JOB CONTENT display, select {POSITION ADJUSTMENT} from the pull-down menu of {UTILITY}
   – The position adjustment display appears.

2. Select an item to be changed in the position adjustment display
   – Selecting the point variable displays the list of point variables. Select a point variable whose position data is to be corrected.

3. Enter a numerical value, and press [ENTER]
   – Enter a value by using the number keys.

4. Select “COMPLETE”

   For the details of changing the taught position data, refer to YASNAC XRC Options Instructions for Teaching Point Adjustment Function with Programming Pendant.
2.3 Memory and Playback Function

2.3.1 Outline

The memory and playback function is used to correct the robot motion path for the correction amount measured by COMARC sensor and saved every sampling time set in the parameter. At the welding of the first layer, the result (correction amount) of the sensing by COMARC function is saved, and the saved correction amount is used at the welding of the second and following layers for correcting the robot motion path.

For the welding of the second and following layers, the corrected path can be reproduced in the reverse direction of the welding of the first layer.

NOTE

• COMARC function
  The COMARC function is necessary to use the memory and playback function.
  An expansion storage is needed to use the memory and playback function.

2.3.2 Instructions for Memory and Playback Function

The instructions used for the memory and playback function are listed below.

<table>
<thead>
<tr>
<th>Sensor Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEMON</td>
</tr>
<tr>
<td>Function</td>
</tr>
<tr>
<td>Instruction item</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>MEMOF</td>
</tr>
<tr>
<td>Function</td>
</tr>
<tr>
<td>Instruction items</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Arithmetic Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLEAR</td>
</tr>
<tr>
<td>Function</td>
</tr>
<tr>
<td>Instruction items</td>
</tr>
</tbody>
</table>
### 2.3.3 Application Example

Create a welding job with two layers and three paths.

Execute the sensing by using the COMARC function while welding the first layer, and weld the first path of the second layer in the reverse direction of the welding on the first layer, then weld the second path of the second layer in the same direction of the welding on the first layer.

<table>
<thead>
<tr>
<th>Job</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOP</td>
</tr>
<tr>
<td>MOVJ VJ=100</td>
</tr>
<tr>
<td>MOVJ VJ=60</td>
</tr>
<tr>
<td>MOVL T0000 V=200</td>
</tr>
<tr>
<td>ARCON AC=330 AV=30 V=40</td>
</tr>
<tr>
<td>COMARCON AMP=1.0 FREQ=3.5</td>
</tr>
<tr>
<td>MEMON REC MPF#(1)</td>
</tr>
<tr>
<td>MOVL T0001</td>
</tr>
<tr>
<td>MOVL T0002</td>
</tr>
<tr>
<td>MOVL T0003</td>
</tr>
<tr>
<td>MOVL T0004</td>
</tr>
<tr>
<td>MEMOF</td>
</tr>
<tr>
<td>COMARCOF</td>
</tr>
<tr>
<td>ARCOF AC=200 AV=25 T=0.1</td>
</tr>
<tr>
<td>GETS PX000 $PX040</td>
</tr>
<tr>
<td>SFTON P000 BF</td>
</tr>
<tr>
<td>'2Layer 1Path</td>
</tr>
<tr>
<td>MOVL T0005</td>
</tr>
<tr>
<td>SFTON P001 TF</td>
</tr>
<tr>
<td>MOVL T0004 V=200</td>
</tr>
<tr>
<td>ARCON AC=250 AV=28 V=40</td>
</tr>
<tr>
<td>MEMON BACKPLY MPF#(1)</td>
</tr>
<tr>
<td>MOVL T0003</td>
</tr>
<tr>
<td>MOVL T0002</td>
</tr>
<tr>
<td>MOVL T0001</td>
</tr>
</tbody>
</table>
### 2.3 Memory and Playback Function

<table>
<thead>
<tr>
<th>Job</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOVL T0000</td>
<td></td>
</tr>
<tr>
<td>MEMOF</td>
<td></td>
</tr>
<tr>
<td>ARCOF AC=180 AV=20 T=0.1</td>
<td></td>
</tr>
<tr>
<td>SFTOF</td>
<td>Cancels the shift function.</td>
</tr>
<tr>
<td>'2Layer 2path</td>
<td>(Welding on 2nd path of 2nd layer)</td>
</tr>
<tr>
<td>MOVL V=200</td>
<td>Move the robot to the approach position for 2nd layer.</td>
</tr>
<tr>
<td>SFTON P002 TF</td>
<td>Shifts the welding start position for 2nd path of 2nd layer.</td>
</tr>
<tr>
<td>MOVL T0000 V=200</td>
<td></td>
</tr>
<tr>
<td>ARCON AC=200 AV=25 T=0.1</td>
<td></td>
</tr>
<tr>
<td>MEMON PLY MPF#(1)</td>
<td>Starts the reproduction of the welding on the 1st layer in the forward direction.</td>
</tr>
<tr>
<td>MOVL T0001</td>
<td></td>
</tr>
<tr>
<td>MOVL T0002</td>
<td></td>
</tr>
<tr>
<td>MOVL T0003</td>
<td></td>
</tr>
<tr>
<td>MOVL T0004</td>
<td></td>
</tr>
<tr>
<td>MEMOF</td>
<td>Cancels the memory replay function.</td>
</tr>
<tr>
<td>ARCOF AC=180 AV=20 T=0.1</td>
<td></td>
</tr>
<tr>
<td>MOVL T0005</td>
<td></td>
</tr>
<tr>
<td>MOVJ VJ=100</td>
<td></td>
</tr>
</tbody>
</table>
2.4 Multi-layer Welding Tool Shift Function

2.4.1 Outline

For multi-layer welding, teaching the welding path on the 1st layer and shifting the taught positions to weld on the second and following layers can largely reduce the time required for teaching.

2.4.2 Tool Shift Coordinate System

The coordinates for the multi-layer welding tool shift function are determined by the positional relation between the robot coordinate and the tool coordinate.

Multi-layer welding tool shift coordinate X: Z-axis of the tool coordinate projected on X-Y plane of the robot coordinate system

Multi-layer welding tool shift coordinate Y: Direction to Z-axis of the tool coordinate

Multi-layer welding tool shift coordinate Z: Direction to Z-axis of the robot coordinate
Multi-layer welding tool shift coordinate B: The posture angle from X-axis of the multi-layer welding tool shift coordinate in the direction to Z-axis.

2.4.3 Registering

Specify the tag TF in SFTON (shift ON) instruction, and the taught positions for the move instructions after the SFTON instruction will be shifted for the shift amount set in the position variable (P***) in the multi-layer tool shift coordinate system.

Instruction: SFTON
Format: SFTON P000 TF

- Posture angle setting
With the multi-layer tool shift function, the multi-layer tool shift coordinates A and C can not be set.
2.5 Search and Shift Function

2.5.1 Outline

The search and shift function (SRSFT) detects the workpiece position error by using the search sensor and correct the taught position.

SRSFT instruction starts searching the tool end from the point the tool ends is not in contact with the workpiece and stops searching when the tool end contacts the workpiece. There are four motion patterns. Each motion pattern is shown below.

Pattern 1

Pattern 2

Pattern 3

Pattern 4
2.5.2 Items to be Set for SRSFT Instruction

Set the following items for SRSFT instruction.

<table>
<thead>
<tr>
<th>Item</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>PATTERN</td>
<td>Search motion pattern 1 to 4 (The numbers correspond to the patterns shown below)</td>
</tr>
<tr>
<td>SHIFT</td>
<td>0 (no shift), 1 (shift in parallel), 2 (shift in rotation)</td>
</tr>
<tr>
<td>VELOCITY</td>
<td>Search speed in units of cm/min</td>
</tr>
<tr>
<td>DIR_START (P1)</td>
<td>Position P1 in the figure below</td>
</tr>
<tr>
<td>DIR_END (P2)</td>
<td>Position P2 in the figure below</td>
</tr>
<tr>
<td>OFFSET 1 (L1)</td>
<td>The distance L1 in the figure below (in units of mm)</td>
</tr>
<tr>
<td>OFFSET 2 (L2)</td>
<td>The distance L2 in the figure below (in units of mm)</td>
</tr>
<tr>
<td>RETRACT AMOUNT</td>
<td>The distance B in the figure below (in units of mm)</td>
</tr>
<tr>
<td>MAX. SEARCH DISTANCE</td>
<td>An alarm occurs if the search is not ended within the set travel distance.</td>
</tr>
<tr>
<td>END_POINT (P3)</td>
<td>The search end position at teaching (position P3 in the figure below)</td>
</tr>
</tbody>
</table>

![Pattern 1](image1.png)  ![Pattern 2](image2.png)

![Pattern 3](image3.png)  ![Pattern 4](image4.png)
2.5.3 Registering

1. Move the cursor to the address area
2. Press [INFORM LIST]
3. Select “MACRO”

– The macro instruction list appears.

4. Select “SRSFT”

– The argument setting display for SRSFT instruction appears.
2 Basic Operations
2.5 Search and Shift Function

5. Move the manipulator to the travel start point (P1), and press [MODIFY] with the cursor on “UNREGIST” of P1, then press [ENTER] to register the position of P1.

6. Move the manipulator to the travel end point (P2), and press [MODIFY] with the cursor on “UNREGIST” of P2, then press [ENTER] to register the position of P2.

7. Press [ENTER] twice to return to the job content display.

8. With the job content display, press [INTERLOCK] + [TEST START] to execute the SRSFT instruction.
   – The manipulator starts searching and stops.

9. Register the manipulator stop position for END_POINT (P3) in the argument setting display.
### 2.5.4 Application Example of SRSFT Instruction

<table>
<thead>
<tr>
<th>Job</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SFTOF3D</td>
<td>Cancels the 3-dimension shift.</td>
</tr>
<tr>
<td>MOVJ VJ=60</td>
<td></td>
</tr>
<tr>
<td>SRSFT PTN=3 SFT=1 V=360</td>
<td>Searches for 1st point (Shift in parallel). ①</td>
</tr>
<tr>
<td>MOVJ VJ=60</td>
<td></td>
</tr>
<tr>
<td>SRSFT PTN=3 SFT=2 V=360</td>
<td>Searches for 2nd point (Shift in rotation). ②</td>
</tr>
<tr>
<td>MOVJ VJ=60</td>
<td></td>
</tr>
<tr>
<td>SRSFT PTN=1 SFT=1 V=360</td>
<td>Searches for 3rd point (Shift in parallel). ③</td>
</tr>
<tr>
<td>MOVJ VJ=60</td>
<td></td>
</tr>
<tr>
<td>MOVL V=200</td>
<td>Moves to the welding start point.</td>
</tr>
</tbody>
</table>

![Diagram of workpiece positions](image)

1. Workpiece actual position
2. Workpiece taught position
3. Shifts the start point in parallel

- Shift in parallel
- Shift in rotation
2.6 \textbf{Search Function for Sticking}

2.6.1 \textbf{Outline}

The search function for sticking (SRSTCK) detects the edge face of the workpiece. There are 6 searching patterns.

2.6.2 \textbf{Items to be Set for SRSTCK Instruction}

Set the following items for SRSTCK instruction.

<table>
<thead>
<tr>
<th>Item</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>PATTERN</td>
<td>Search pattern (See the patterns below)</td>
</tr>
<tr>
<td>SHIFT</td>
<td>Shift type 0 (no shift), 1 (shift in parallel), 2 (shift in rotation)</td>
</tr>
<tr>
<td>VELOCITY</td>
<td>Search speed in units of cm/min</td>
</tr>
<tr>
<td>DIR_START (P1)</td>
<td>Position P1 in the figure below</td>
</tr>
<tr>
<td>DIR_END (P3)</td>
<td>Position P2 in the figure below</td>
</tr>
<tr>
<td>OFFSET 1 (L1)</td>
<td>The distance L1 in the figure below (in units of mm)</td>
</tr>
<tr>
<td>OFFSET 2 (L2)</td>
<td>The distance L2 in the figure below (in units of mm)</td>
</tr>
<tr>
<td>RETRACT AMOUNT (B)</td>
<td>The retract distance after the search</td>
</tr>
<tr>
<td>INITIAL MAX. SEARCH DISTANCE (M1)</td>
<td>The distance M1 in the figure below (in units of mm)</td>
</tr>
<tr>
<td>STICK FEED (S)</td>
<td>The feed pitch S in the figure below (in units of mm)</td>
</tr>
<tr>
<td>MAX SEARCH DISTANCE</td>
<td>The maximum distance for searching (in units of mm)</td>
</tr>
<tr>
<td>EDGE DETECTING DISTANCE (M2)</td>
<td>If nothing is detected within this distance, the end of this distance is considered as the edge (in units of mm).</td>
</tr>
<tr>
<td>EDGE SEARCH SPEED</td>
<td>Final searching speed in units of cm/min</td>
</tr>
<tr>
<td>EDGE SEARCH OFFSET (M3)</td>
<td>The distance M3 in the figure below (in units of mm)</td>
</tr>
<tr>
<td>END_POINT (P3)</td>
<td>Search end position</td>
</tr>
</tbody>
</table>
2.6.3 Registering

1. Move the cursor to the address area
2. Press [INFORM LIST]
– The macro instruction list appears.

3. Select “MACRO”

– The argument setting display for SRSTCK instruction appears.

4. Select “SRSTCK”

– The argument setting display for SRSTCK instruction appears.

5. Move the manipulator to the travel start point (P1), and press [MODIFY] with the cursor on “UNREGIST” of P1, then press [ENTER] to register the position of P1.
6. Move the manipulator to the travel end point (P2), and press [MODIFY] with the cursor on “UNREGIST” of P2, then press [ENTER] to register the position of P2.

![Image of Peripheral Setting Display]

7. Press [ENTER] twice to return to the job content display.

8. With the job content display, press [INTERLOCK] + [TEST START] to execute the SRSTCK instruction.
   - The manipulator starts searching and stops.

9. Register the manipulator stop position for END_POINT (P3) in the argument setting display.

---

**2.7 Shift Function**

**2.7.1 Outline**

The shift function shifts the positions in the section between SFTON instruction and SFTOF instruction.

In SFTON instruction, specify a coordinate system for the shift amount. The coordinate systems that can be specified are BF, RF, TF, UF, BP (travelling axis), and EX (station axis). When two SFTON instructions with different coordinate systems specified are executed consecutively, the positions are shifted for the specified two shift amounts.

**Example:**

```
SFTON  P000  BF    (100.000 mm to X direction is specified in P000)
SFTON  P001  RF    (100.000 mm to Y direction is specified in P001)
MOV  V=100       (Shifts the position for 100.000 mm to X direction in the base coordinate system, and for 100.000 mm to Y direction in the robot coordinate system.)
```
When two SFTON instructions with the same coordinate system specified are executed, the last STFON instruction is valid.

Example:

: 
SFTON P000 BF  (100.000 mm to X direction is specified in P000.)
SFTON P001 BF  (100.000 mm to Y direction is specified in P001.)
MOVL V=100     (Shifts the positions for 100.000 mm to Y direction in the base coordinate system.)

:

In SFTOF instruction, the coordinate system for canceling shift function can be specified. When the coordinate system is not specified, all the coordinate systems for shift function are cancelled.

2.7.2 Continuity of Shift Function

The shift function can be cancelled by executing SFTOF instruction or selecting another job.

While editing the job such as changing or deleting the taught position data in SFTON status, the taught position data without the shift amount are registered. Accordingly, the taught position data can be corrected during the welding of the 2nd and following layers.

During the shift operation, “SFT” and the coordinate system that is specified in SFTON instruction are indicated on the job content display.
2.7.3 Shift Amount Display

1. Select {ROBOT} from the top menu
2. Select {SHIFT} from the sub menu
   – The shift amount display appears.

3. Select a shift type
   – Selecting a shift type, “PARALLEL” or “3D,” and a coordinate, “BASE,” “ROBOT,” “TOOL,” and “USER,” displays the shift amounts in the corresponding coordinate system.
2.8 Beveling Width Measuring Function

2.8.1 Outline

The beveling width measuring function measures the beveling width by using the search function. The measured width is stored in the specified variable number by using SRGAP instruction. According to the measured beveling width, the welding conditions will be changed.

The tool stop position after the search is the center of the beveling.

2.8.2 Items to be Set for SRGAP instruction

<table>
<thead>
<tr>
<th>Item</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHIFT</td>
<td>Shift type: 0: No shift, 1: Shift in parallel, 2: Shift in rotation</td>
</tr>
<tr>
<td>VELOCITY</td>
<td>Search speed in units of cm/min</td>
</tr>
<tr>
<td>VARIABLE_No.</td>
<td>Variable number to store the measured beveling width</td>
</tr>
<tr>
<td>DIR_START (P1)</td>
<td>Travel start point P1</td>
</tr>
<tr>
<td>DIR_START (P2)</td>
<td>Travel end point P2</td>
</tr>
<tr>
<td>END_POINT (P3)</td>
<td>Search end point P3</td>
</tr>
<tr>
<td>OFFSET 1 (L1)</td>
<td>Offset amount of the start position (in units of mm)</td>
</tr>
</tbody>
</table>
2.8.3 Registering

1. Move the cursor to the address area
2. Press [INFORM LIST]
3. Select “MACRO”

   – The macro instruction list appears.

4. Select “SRGAP”

   – The argument setting display for SRGAP instruction appears.
5. Move the manipulator to the travel start point (P1), and press [MODIFY] with the cursor on “UNREGIST” of P1, then press [ENTER] to register the position of P1.

6. Move the manipulator to the travel end point (P2), and press [MODIFY] with the cursor on “UNREGIST” of P2, then press [ENTER] to register the position of P2.

7. Press [ENTER] twice to return to the job content display.

8. With the job content display, press [INTERLOCK] + [TEST START] to execute the SRGAP instruction.
   – The manipulator starts searching and stops.

9. Register the manipulator stop position for END_POINT (P3) in the argument setting display.
2.9 Overriding Welding Condition Function

2.9.1 Outline

- During welding, each welding condition such as welding current, welding voltage, speed, weaving single amplitude, and sensing condition can be adjusted individually by using the specific keys shown below on the programming pendant.

- The adjusted welding conditions can be automatically set for the tag and condition file attached to the instruction to set the welding condition such as ARCON and ARCSET. However, when variables are used for the welding condition or the condition file, this function is invalid.

- For overriding the welding conditions, the following keys are used.

  ![TUNING](image)

- The units for adjusting the welding conditions by pressing the above keys can be set by the parameters listed in 2.10.5.

2.9.2 Operation

1. Select “WELD CND ADJ” from “UTILITY” in the job playback display
   - The welding condition adjustment display appears.

   ![Weld Condition Adjustment Display](image)

2. Move the cursor to the condition to be adjusted

3. Adjust the condition by using the specific keys
   - The welding is executed under the adjusted welding condition.

4. Press [ENTER]
   - The adjusted welding condition is overwritten in the condition file of the job.
5. Press [CANCEL]
- The job content display appears.

### NOTE
- Only the welding condition data that have been set are displayed.
  For example, when the weaving operation is not set, "**" is displayed for "WEAV AMPLITUDE."
  And, when COMARC function is not used, "U/D CONDITION" and "L/R CONDITION" are not displayed.
- When the instruction such as ARCOF are executed, the adjustment is disabled and "**" is displayed for each welding condition.

### 2.9.3 Welding Condition Adjustment Display

#### CURRENT
Move the cursor to the data and press the TUNING key to adjust the welding current value.

The welding current is specified by the following instructions:
- The instruction item (AC=) to ARCON instruction
- The current value set in the welding start condition file (ASF# (*) specified by ARCON instruction
  (When an enhanced type file is used, the data will not be overwritten.)
- The instruction item (AC=) to ARCSET instruction
- The instruction item (AC=) to ARCCUR instruction
- The set value by AWELD instruction

When ARCOF instruction is executed, the welding current adjustment is disabled.

When COMARC function is used, 3 “U/D CONDITION” will be changed in proportion to the welding current adjustment.
On the contrary, adjusting U/D CONDITION will not change the welding current value.
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2.9 Overriding Welding Condition Function

2. Voltage

Move the cursor to the data and press the TUNING key to adjust the welding voltage value.

The welding voltage is specified by the following instructions:

- The instruction items (AV=, and AVP=) to ARCON instruction
- The voltage value set in the welding start condition file (ASF# (*)) specified by ARCON instruction (when an enhanced type file is used, the data will not be overwritten.)
- The instruction items (AV=, and AVP=) to ARCSET instruction
- The instruction items (AV=, and AVP=) to ARCVOL instruction
- The set value by VWELD instruction

When ARCOF instruction is executed, the welding voltage adjustment is disabled.

3. Velocity

Move the cursor to the data and press the TUNING key to adjust the robot motion speed.

The speed is specified by the following instructions:

- The instruction item (V=) to ARCON instruction
- The speed set in the welding start condition file (ASF# (*)) specified by ARCON instruction
- The instruction item (V=) to ARCSET instruction
- The instruction item (V=) to MOVL (SMOVL), MOVC (SMOVC), or MOVS (SMOV$) instruction

When ARCOF instruction is executed, the robot motion speed adjustment is disabled.

4. Weave Amplitude

Move the cursor to the data and press the specific keys to adjust the weaving single altitude.

The weaving single altitude is specified by the following instructions:

- The weaving amplitude set in the weaving condition file (WEV# (*) specified by WVON instruction
- The weaving amplitude set in the weaving condition file (WEV# (*)) specified by COMARCON (SCOMARCON) instruction
- The instruction item (AMP=) to COMARCON (SCOMARCON) instruction
- The instruction item (AMP=) to COMARCSET (SCOMARCST) instruction

When COMARCOF (SCOMARCOF) or WVOF instruction is executed, the weaving amplitude adjustment is disabled.

5. U/D Condition

Move the cursor to the data and press the specific keys to adjust the sensing condition (upward/downward).

The upward/downward sensing condition is specified by the following instructions:

- The instruction item (U/D=) to COMARCON (SCOMARCON) instruction
2 Basic Operations
2.9 Overriding Welding Condition Function

- The instruction item (U/D=) to COMARCSET(SCOMARCST) instruction

When COMARCOF (SCOMARCOF) is executed, the upward/downward sensing adjustment is disabled.

**L/R CONDITION**
Move the cursor to the data and press the specific keys to adjust the sensing condition (left/right).
The left/right side sensing condition is specified by the following instructions:
- The instruction item (L/R=) to COMARCON (SCOMARCON) instruction
- The instruction item (L/R=) to COMARCSET (SCOMARCST) instruction

When COMARCOF (SCOMARCOF) is executed, the left/right side sensing adjustment is disabled.

**DATA EDITING**
Indicates whether the edition of a instruction or condition file is completed or not.
When the conditions set in the instruction or condition file agree with those set in the welding condition adjustment display, “DONE” is displayed. When not agree, “UNDONE” is displayed.
During adjustment of the welding conditions by pressing the specific key, “UNDONE” is displayed, and when [ENTER] is pressed and the adjusted conditions are registered, “DONE” is displayed.

**NOTE**
The welding current and voltage set in the enhanced type welding condition file can be adjusted by the overriding welding condition function, but the data in the welding condition file will not be overwritten: the data in the welding condition file will not be replaced by the adjusted data.
### 2.9.4 Parameters for the Units to Adjust Conditions

When using the specific keys to adjust a condition, the units for each condition can be set by the following parameters.

Set the multiplication of the minimum unit of each condition.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Meanings</th>
<th>Initial Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>S3C1200</td>
<td>The units for adjusting the welding current value (When the specific key is pressed once) Min. units for the current value: 1 A, Min. units for the command value: 0.01 V</td>
<td>1</td>
</tr>
<tr>
<td>S3C1201</td>
<td>The units for adjusting the welding current value (When the specific key is pressed consecutively) Min. units for the current value: 1 A, Min. units for the command value: 0.01 V</td>
<td>1</td>
</tr>
<tr>
<td>S3C1202</td>
<td>The units for adjusting the welding voltage value (When the specific key is pressed once) Min. units for the voltage value: 0.1 V or 1 %, Min. units for command value: 0.01 V</td>
<td>1</td>
</tr>
<tr>
<td>S3C1203</td>
<td>The units for adjusting the welding voltage value (When the specific key is pressed consecutively) Min. units for the voltage value: 0.1 V or 1 %, Min. units for the command value: 0.01 V</td>
<td>1</td>
</tr>
<tr>
<td>S3C1204</td>
<td>The units for adjusting the speed (When the specific key is pressed once) Min. units: 1 cm/min</td>
<td>1</td>
</tr>
<tr>
<td>S3C1205</td>
<td>The units for adjusting the speed (When the specific key is pressed consecutively) Min. units: 1 cm/min</td>
<td>1</td>
</tr>
<tr>
<td>S3C1206</td>
<td>The units for adjusting the weaving single amplitude (When the specific key is pressed once) Min. units: 0.1 mm</td>
<td>1</td>
</tr>
<tr>
<td>S3C1207</td>
<td>The units for adjusting the weaving single amplitude (When the specific key is pressed consecutively) Min. units: 0.1 mm</td>
<td>1</td>
</tr>
<tr>
<td>S1E51</td>
<td>The units for adjusting the sensing U/D condition (When the specific key is pressed once) Min. units: 1 A</td>
<td>1</td>
</tr>
<tr>
<td>S1E52</td>
<td>The units for adjusting the sensing U/D condition (When the specific key is pressed consecutively) Min. units: 1A</td>
<td>1</td>
</tr>
<tr>
<td>S1E53</td>
<td>The units for adjusting the sensing L/R condition (When the specific key is pressed once) Min. units: 0.1 A</td>
<td>1</td>
</tr>
<tr>
<td>S1E54</td>
<td>The units for adjusting the sensing L/R condition (When the specific key is pressed consecutively) Min. units: 0.1 A</td>
<td>1</td>
</tr>
</tbody>
</table>
2.10 Confirm the Welding Operation in Teach Mode

2.10.1 Outline

ARCON/ARCOF instructions can be executed by TEST RUN in the teach mode. By this operation, it is possible to confirm the welding conditions.

2.10.2 Operation

1. Press [WORK] to turn ON the LED
   - Press [WORK] and the LED is lit. Press [WORK] again and the LED is unlit.
2. Execute the test run (execute the welding)
3. Press [WORK] to turn OFF the LED

NOTE

If the check run is enabled, turning ON the WORK LED does not execute the welding.

2.10.3 Display

During the execution of the welding, “ARC” is indicated on the job content display.

Fig. 2-4: “ARC” Indication During Welding

CAUTION

Executing the test run while “ARC” is indicated on the display executes the welding.
2.11 How to Restart After an Emergency Stop in the Middle of Weaving

If the emergency stop in the middle of weaving, the robot stopped weaving operation in any position, and simply re-start, the robot runs through the next step to the position of any origin.

*A track when the robot restarted from the stopped position*

![Diagram of welding line and target step](image_url)
DX100 OPTIONS
INSTRUCTIONS
FOR MULTI-LAYER WELDING FUNCTION

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