DX200 OPTIONS
INSTRUCTIONS

FOR SERVOFLOAT FUNCTION

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 MAINTENACE MANUAL

The DX200 operator's manual above corresponds to specific usage. Be sure to use the appropriate manual.

Part Number: 165475-1CD
Revision: 0

YASKAWA
MOTOMAN ROBOTICS

MANUAL NO.
HW1482007◈

MANDATORY

- This manual explains the servofloat function of the DX200 system and general operations. Read this manual carefully and be sure to understand its contents before handling the DX200.
- General items related to safety are listed in Section 1: Safety of the DX200 Instructions. To ensure correct and safe operation, carefully read the DX200 Instruction 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.

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.

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, check that servo power is turned OFF pressing the emergency stop buttons on the front door of the DX200 and the programming pendant.
  When the servo power is turned OFF, the SERVO ON LED on the programming pendant is turned OFF.

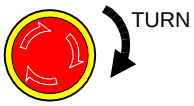
Injury or damage to machinery may result if the emergency stop circuit cannot stop the manipulator during an emergency. The manipulator should not be used if the emergency stop buttons do not function.

Figure 1: Emergency Stop Button

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

Injury may result from unintentional or unexpected manipulator motion.

Figure 2: Release of Emergency Stop



- 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.
  - 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 DX200.
  - 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 front door of the DX200 and the 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 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 Warning Labels in the DX200 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:

Equipment	**Manual Designation**
DX200 controller	DX200
DX200 programming pendant	Programming pendant
Cable between the manipulator and the controller	Manipulator cable

Descriptions of the programming pendant keys, buttons, and displays are shown as follows:

Equipment		Manual Designation
Programming Pendant	Character Keys /Symbol Keys	The keys which have characters or its symbol printed on them are denoted with [ ]. ex. [ENTER]
	Axis Keys /Numeric Keys	[Axis Key] and [Numeric Key] are generic names for the keys for axis operation and number input.
	Keys pressed simultaneously	When two keys are to be pressed simultaneously, the keys are shown with a “+” sign between them, ex. [SHIFT]+[COORD]
	Displays	The menu displayed in the programming pendant is denoted with { }. ex. {JOB}

Description of the Operation Procedure

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

Registered Trademark

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

Table of Contents

1 Servofloat Function

The servofloat function of the DX200 consists of the link servofloat function and the linear servofloat function. The link servofloat function controls the torque independently for each axis; and the linear servofloat function controls the torque on the Cartesian coordinates. Select these two functions by setting the servofloat instructions accordingly.

1.1 Link Servofloat Function

The link servofloat function works in combination with the position control and the torque control, whereas an ordinary control is a position control that generates torque to keep the taught position regardless of the applied external force. “Torque control” keeps the taught position only by using the torque against the gravitational and frictional forces. Therefore, a manipulator moved by an external force will not return to its original position.

With the servofloat function, external force moves the manipulator since the torque control has priority over the position control.

For example, when removing a workpiece from the die-casting machine, a large external force is applied to the manipulator by the extruding cylinder when a workpiece is grasped and pulled out. The servofloat function is used to protect the manipulator from excessive external force, and the manipulator moves according to the force applied from the die-casting machine.

Note that the manipulator does not move exactly to the taught position or along the taught path, because complete position control is not performed during execution of the servofloat function.

1.2 Linear Servofloat Function

When a manipulator pushes a workpiece or visa-versa, a movement to one predetermined direction may be desirable. With the link servofloat function, a servofloat motion in one direction is not possible since torque control is performed independently for each axis.

This function can specify the control of force in one direction within a space.[1)]When unloading a die-casting machine, this function is useful for considerably long ejection distances or when polishing or grinding.

1.3 Using the Link Servofloat Function and the Linear Servofloat Function

Use the link servofloat function when high-ferquency noise, motor vibration, or unsteady manipulator motion occur depending on the manipulator posture, speed, and movement direction.

Tool load information setting

- The servofloat function compensates for gravity in real-time in order to prevent the arms from dropping due to gravity even when the generated torque is limited. For this purpose, the tool load information used for gravity compensation must be set correctly. Otherwise, the servofloat function cannot be performed properly and the arms may drop down or rise up.
- For the tool load information, refer to Section 8.4.3 “Tool Load Information Setting” in the DX200 INSTRUCTIONS (part number: 165292-1CD) to correctly set the tool load information.

1 When external force is applied, the R, B, and T-axes move the same as in the link servo-float function.
Only the end of the U-axis moves in a linear motion.

2 The Servofloat Function

Enable the servofloat function with the servofloat function start instruction FLOATON. It remains enabled until one of the following conditions is established.

- Performing the a servofloat function end instruction FLOATOF
- Performing the FWD/BWD key operation, jogging, or a job startup after the cursor is moved
- Performing the FWD/BWD key operation, jogging, or a job startup after a job call, job selection, or job editing
- Turning the servo ON again

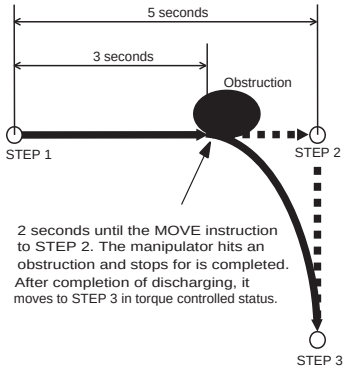
When the function is enabled, the manipulator generates only the torque that is less that the value set to the servofloat condition file. The manipulator uses the torque to operate and keep the position. If a large external force is applied, the manipulator moves according to this force.

2.1 Moving with the Move Instruction

If an external force prevents manipulator operation, the manipulator does not reach the taught position when the servofloat function is enabled. Even though the manipulator does not actually reach the taught position, the instruction that would be activated at that position are nonetheless enabled, so the move instruction terminated.

Therefore, when the manipulator cannot reach the taught position because of an external force, the manipulator performs the next instruction.

The following figure shows an example where the operation time is 5 seconds from STEP 1 to STEP 2. If the manipulator hits an obstruction 3 seconds after STEP 1 and stops there, it remains stopped at the position for the remaining 2 seconds, and then moves to STEP 3 without moving to STEP 2 when moving with the torque control.

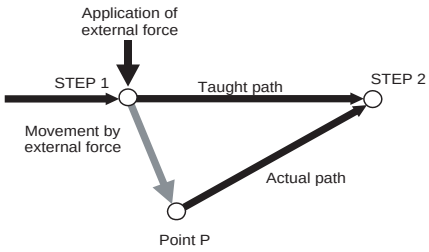



```
STEP 1   MOVL  V=100.0
         FLOATON  FL#(1)
STEP 2   MOVL  V=100.0
STEP 3   MOVL  V=100.0
         FLOATOF
```

2.2 Moving with the TIMER and WAIT Instructions

When the servofloat function is enabled, torque control can be performed even during the TIMER and WAIT instructions. These instructions end when time is up or when a condition described in page 2-1 is established.

For example, in the following figure, the manipulator reaches STEP 1, and the FLOATON instruction enables the servofloat function. Then the manipulator waits for the input of IN#1 by the WAIT instruction. In this state, if an external force is applied to the manipulator, the manipulator moves to the point P and stops. If the FLOATOF instruction is performed at this point, the servofloat function is disabled and the manipulator moves from point P to STEP 2.




```
STEP 1   MOVL  V=100.0
         FLOATON  FL#(1)
         WAIT  IN#(1)=ON
         FLOATOF
STEP 2   MOVL  V=100.0
```

2.3 Operation Check

When the servofloat function is enabled, the soft limit, cube interference, and the S-axis interference are checked at the actual position of the manipulator even though external force moved the manipulator.

2.4 When an Alarm Occurs

If an alarm occurs when the servofloat function is enabled, the servofloat function may remain effective depending on the type of alarm.

To disable the servofloat during an alarm, enter “external emergency stop” or “servo OFF signal” during the “alarm occurrence” signal output. This turns OFF the servo power supply and applies the brakes.

2.5 Display during Servofloat Operation

When the servofloat function is enabled, the message “Servo float activated” appears at the bottom of the programming pendant display, and the specific output #50510 to #50517 “SERVOFLOAT ON R1 to R8” is output.

2.6 Turning Servo ON Again During Servofloat Operation

When the servo power has been turned OFF due to an emergency stop during servofloat operation and turns ON again, press the [SERVO ON READY] on the playback panel until this servo recognizes that the power supply is turned ON. If the button is not pressed for a long enough time, the message “depress servo power ON” appears and the servo power cannot be turned ON.

3 Servofloat Condition Files

CAUTION

- If the values for the maximum force and maximum torque are set too low, gravity may cause an arm to drop.

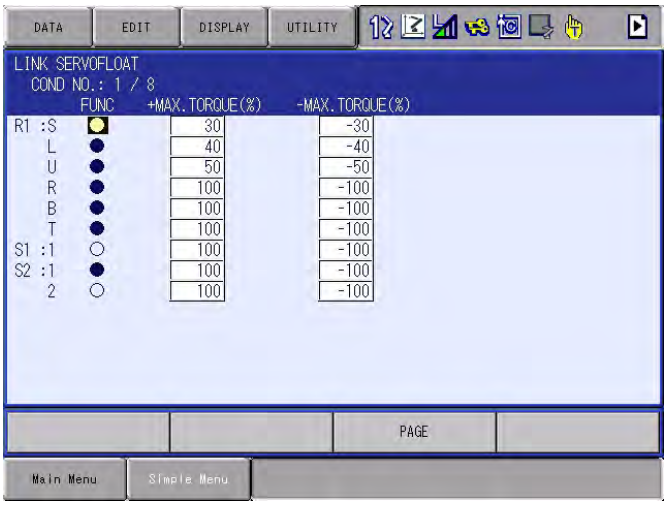
The arm drop may cause an accident or damage to the devices.

There are two kinds of servofloat condition files: the link servofloat condition file specified for the link servofloat function, and the linear servofloat condition file specified for the linear servofloat function.

3.1 Link Servofloat Condition File

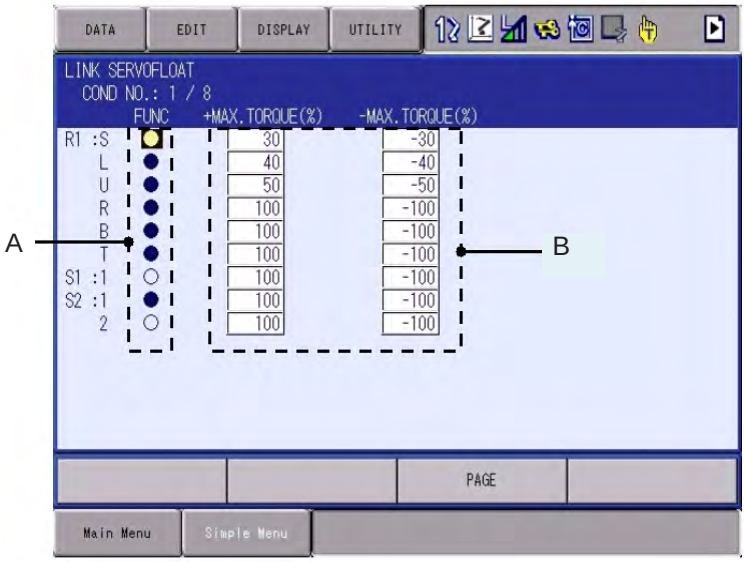
3.1.1 Procedures

1. Select {ROBOT} from the main menu.
2. Select {LINK SERVOFLOAT}
   – The link servofloat window appears.



3. Select an item to be set, and set the value.
   (1) The display enters the number input status.
   (2) Enter a value for “MAX. TORQUE” by pressing the numeric keys.
4. Press [ENTER].

3.1.2 Link Servofloat Condition Setting



A. FUNC

Enables/Disables the link servofloat function for each axis.

"●" indicates that the function is enabled; "○" indicates that the function is disabled.

Pressing [SELECT] switches between "●" and "○".

B. (+) MAX. TORQUE / (-) MAX. TORQUE

Limits the amount of torque generated for keeping control of the position of each axis.

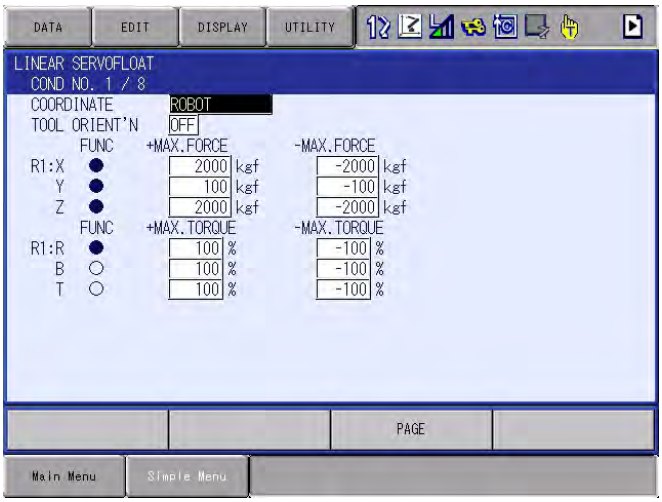
Set the value for each axis using the ratios (%) of the positive and negative sides of the motor to the motor rated torque.

The smaller the value is set, the more easily an axis can be moved by an external force.

3.2 Linear Servofloat Condition File

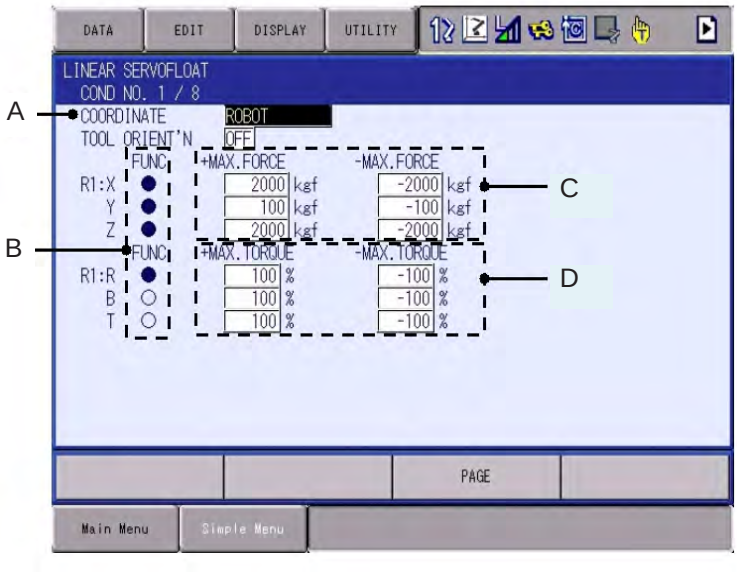
3.2.1 Procedures

1. Select {ROBOT} from the main menu.
2. Select {LNR. SERVOFLOAT}
   – The linear servofloat window appears.



3. Select an item to be set, and set the value.
   (1) The display enters the number input status.
   (2) Enter a value for “MAX. TORQUE” by pressing the numeric keys. Then, press [ENTER].
4. Press [ENTER]

3.2.2 Linear Servofloat Condition Setting



A. COORDINATE

Sets a coordinate system for the linear servofloat function.

Select the ROBOT coordinates, BASE coordinates, USER coordinates or TOOL coordinates.

The selection dialog box appears by pressing [SELECT]. Select a coordinate system to be set.

B. FUNC

Enables/Disables the linear servofloat function for each axis.

"●" indicates that the function is enabled; "○" indicates that the function is disabled.

Pressing [SELECT] switches between "●" and "○".

C. (+) MAX. FORCE / (-) MAX. FORCE

Limits the amount of force generated for keeping control of the position of each axis.

When the linear servofloat is enabled, a force bigger than this set value is not generated.

The smaller the value is set, the more easily a set coordinate axis can be moved by an external force.

However, if the set value is less than the manipulator friction, the manipulator may not move.

D. (+) MAX. TORQUE / (-) MAX. TORQUE

Limits the amount of torque generated for keeping control of the position of R-, B-, and T-axes.

Set the value for each axis using the ratios (%) of the positive and negative sides of the motor to the motor rated torque.

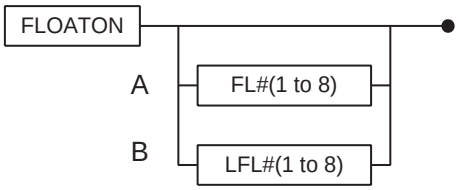
The smaller the value is set, the more easily an axis can be moved by an external force.

4 Instructions for the Servofloat Function

4.1 FLOATON Instruction

FLOATON is an instruction to enable and start the link servofloat function or the linear servofloat function.

Additional items for the FLOATON instruction are as follows:



A. FL# ( ) (Setting range: 1 to 8)

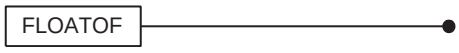
Sets the link servofloat condition file number.

B. LFL# ( ) (Setting range: 1 to 8)

Sets the linear servofloat condition file number.

4.2 FLOATOF Instruction

FLOATOF is an instruction to disable and end the link servofloat function or the linear servofloat function. The servofloat function can be also disabled by performing servo OFF.



4.3 SPDL Tag

The SPDL tag is a stop confirmation tag with which a motion is completed when the number of speed feedback pulses of all the axes becomes less than a constant value.

Use an SPDL tag to confirm the end of a motion caused by an external force. Add it to the move instruction immediately before the FLOATOF instruction.

If the move instruction is completed with a SPDL tag added, the next instruction will not be performed as long as the manipulator is being moved by an external force.

Only “0” can be set for the SPDL tag.

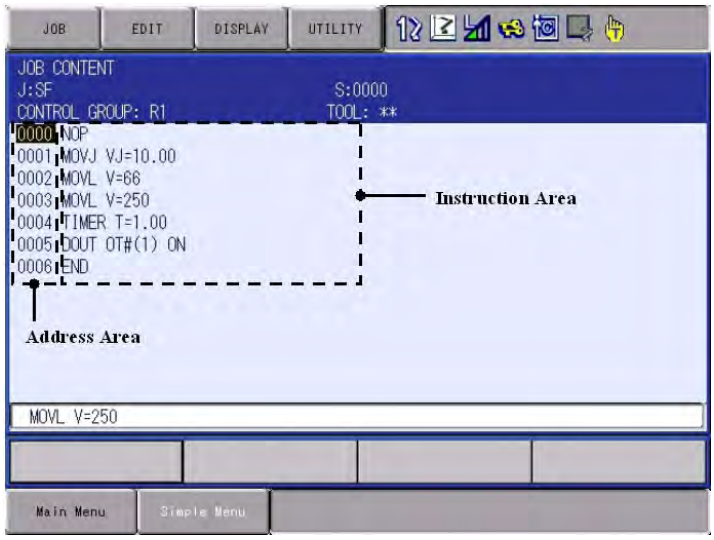
An example of an SPDL tag added to a move instruction is shown as follows:

MOVJ VJ=50.00 SPDL=0

5 Registration of Instruction

When in the job content display in teach mode, register an instruction with the cursor in the address area.

1. Select {JOB} from the main menu.
2. Select {JOB CONTENT}
   – The job content window appears.



3. Move the cursor to the address area.

5.1 FLOATON Instruction

1. Move the cursor to the line where “FLOATON” is to be registered.
2. Press [INFORM LIST]
   – The instruction dialog box appears.

3. Select “FLOATON”
   – The “FLOATON” instruction appears in the input buffer line.

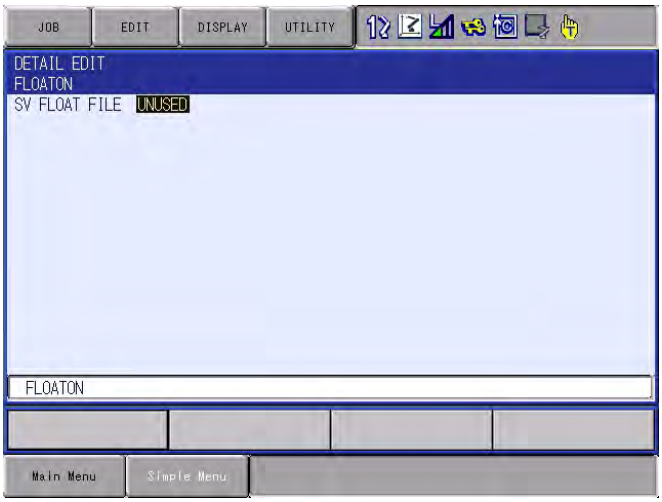
4. Change any additional items and numerical values.

   – < To register without change>
   To register the instruction displayed in the input buffer line without any changes, go to step 5.

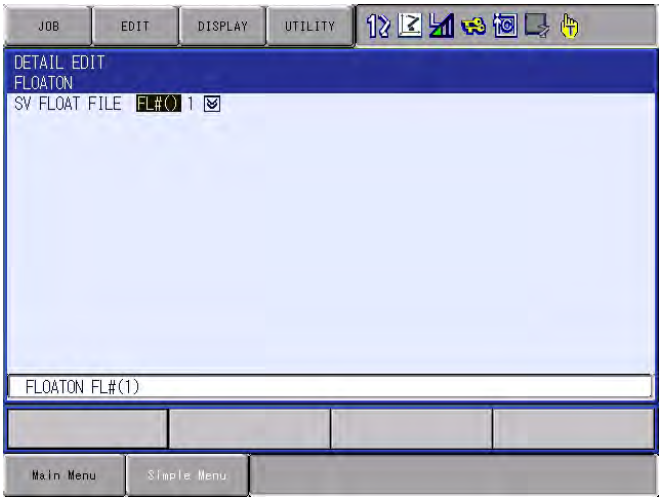
   – < To edit the additional items>

   (1) To add an additional item, with the cursor on the instruction in the input buffer line, press [SELECT] to call the detail edit display.

   (2) With the cursor on “UNUSED” for the “SV FLOAT FILE”, press [SELECT].



   – The selection dialog box appears with the choices “FL# ( )” or “LFL# ( )”. Select one.



   (3) After adding an additional item, press [ENTER].

   – The detail edit display closes, and the job content display reappears.

5. Press [INSERT] and [ENTER]

   – The instruction displayed in the input buffer line is registered.

5.2 FLOATOF Instruction

1. Move the cursor to the line where “FLOATOF” is to be registered.
2. Press [INFORM LIST]
   – The instruction dialog box appears.

3. Select “FLOATOF”
   – The “FLOATOF” instruction appears in the input buffer line.

4. Press [INSERT] and [ENTER]
   – The instruction displayed in the input buffer line is registered.

5.3 Addition of SPDL Tag to a Move Instruction

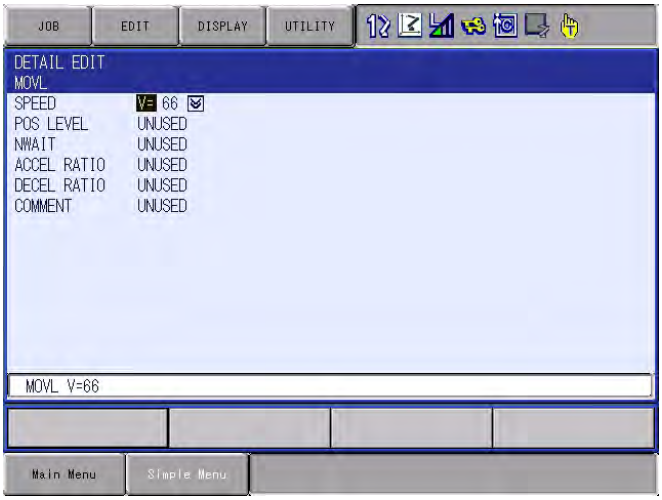
When in the job content display in teach mode, add an SPDL tag to a move instruction, with the cursor in the instruction area.

1. Select the line of the move instruction where the SPDL tag is to be added.

   – The move instruction appears in the input buffer line.

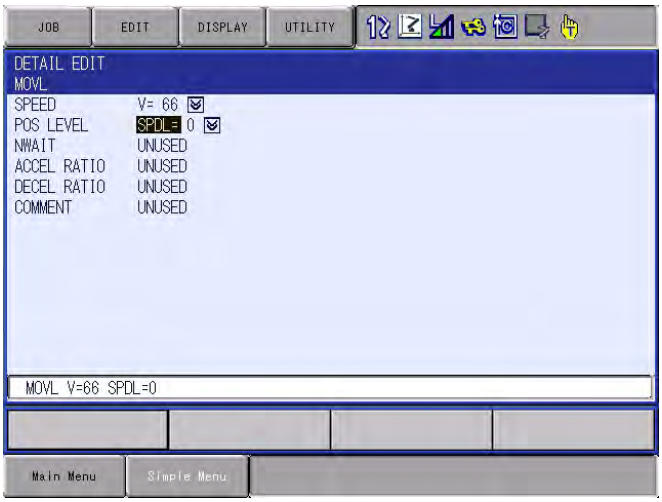
2. Press [SELECT]

   – The detail edit window appears.



   (1) With the cursor on “UNUSED” for the “POS LEVEL”, press [SELECT].

   – The selection dialog box appears with the choice, “SPDL=”.



   (2) After adding “SPDL=” to the move instruction, press [ENTER].

   – The detail edit window closes, and the job content window reappears.

3. Press [INSERT] and [ENTER]

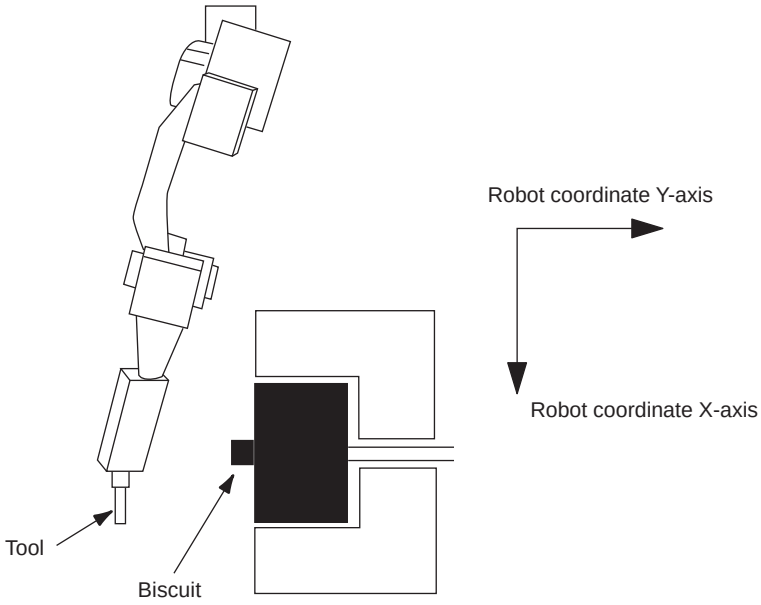
   – The instruction displayed in the input buffer line is registered.

6 Application Example of the Servofloat Function

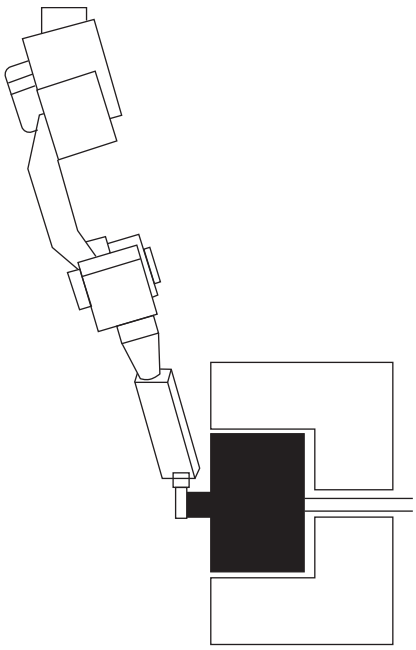
When removing a workpiece from a die-casting machine, a large external force is applied to the manipulator during extraction after grasping it. In such a case, the following example is applicable using the servofloat function.

6.1 Movement Example

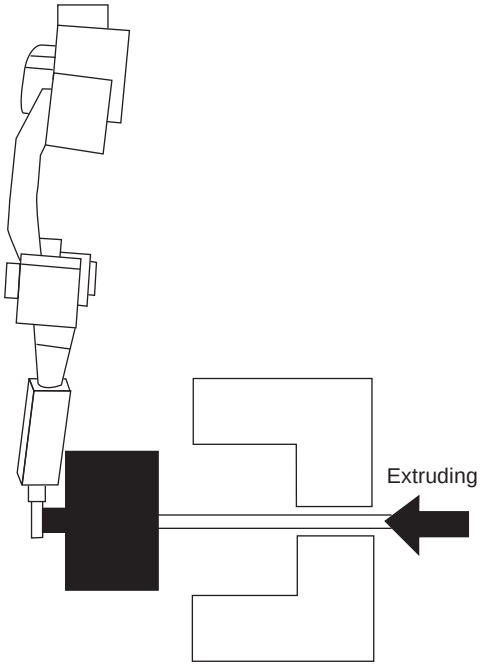
1. Moves to the waiting point.



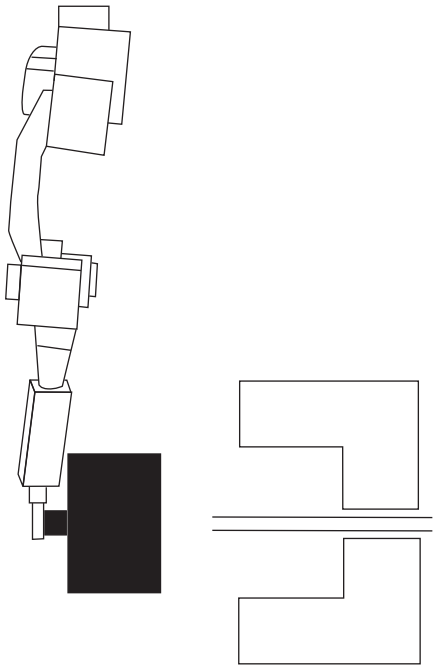
2. Moves to the grasping starting point and performs the TIMER instruction, and then starts the servofloat function.
3. When function enabled, the manipulator grasps a “biscuit”.



4. After having grasped a workpiece, the “start extraction instruction” signal is output, and the manipulator performs an extracting motion.
5. The “start extraction instruction” signal starts the extraction operation of the die-casting machine.
   – Thereby, the manipulator performs an extracting motion.
6. The die-casting machine outputs the “end extraction instruction” signal when the manipulator reaches the completion position.
   – The manipulator ends the servofloat function.



7. The manipulator returns to its normal motion and performs an extraction motion with the workpiece.
8. Then, it returns to the home position.



6.2 Job Example

No.	Explanation	Instruction
1[1)]	Moves to the waiting point.	MOVJ VJ=50.0
2	Moves to the workpiece grasping point.	MOVL V=300.0
	Stops and waits for 0.5 seconds.	TIMER T=0.50
	Starts the linear servofloat function.	FLOATON LFL#(1)
3	Turns ON the “grasping instruction” signal. (general output No. 10)	DOUT OT#(10)=1
	Waits for the “grasping answer” signal. (general input No. 10)	WAIT IN#(10)=1
4	Turns ON the “start extraction instruction” signal. (general output No. 11).	DOUT OT#(11)=1
5	Performs the extraction motion. Ends the motion when the “end extraction instruction” signal (general input No. 11) is input during the motion.	MOVL V=50.0 UNTIL IN#(11)
	Stops and waits for 0.5 seconds.	TIMER T=0.50
6	Completes the servofloat function.	FLOATOF
7	Starts the extracting.	MOVL V=300.0
	Returns to the waiting point.	MOVJ VJ=50.0

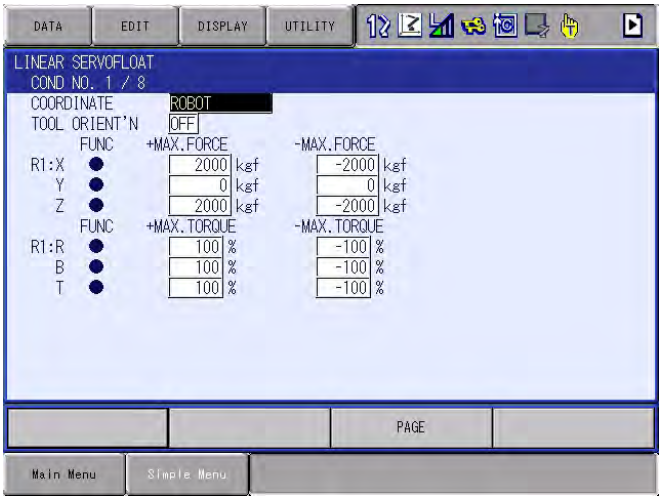
1 The numbers represent the procedure numbers in *Section 6.1 “Movement Example” on page 6-1*”.

6.3 A Setting Example in the Linear Servofloat Condition File

For the example described in *Section 6.1 “Movement Example” on page 6-1*.

In the example, the extracting direction corresponds to that of the Y-axis of the robot coordinates.

If the direction does not correspond to the robot coordinates, define the extracting direction with the user coordinates and set “COORDINATE” to “USER#01”.

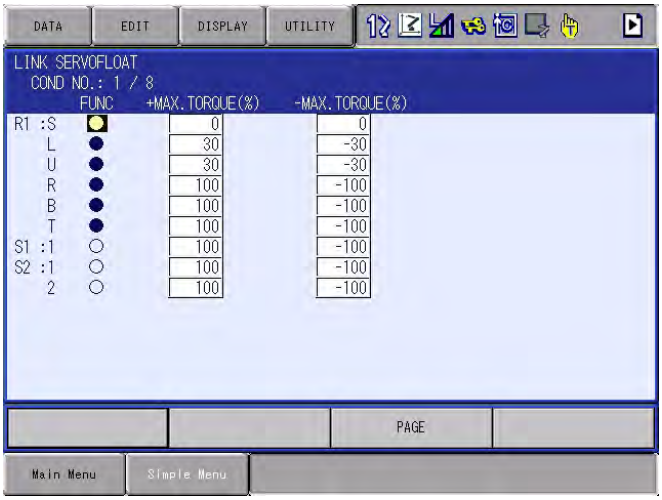


6.4 A Setting Example for the Link Servofloat Condition File

For the example described in *Section 6.1 “Movement Example” on page 6-1*, specify the link servofloat condition file by specifying LF# as the FLOATON instruction file. In this case, a setting example is as follows.

Since the S-axis moves according to the force applied by the extruding cylinder of the die-casting machine, set the “MAX. TORQUEs” of the S-axis to “0”. Set the “MAX. TORQUEs” of the L- and U-axes to “30” to prevent the arms from dropping or rising up due to the load variation. To orientate the tool posture, set the “MAX. TORQUEs” of the R-, B-, and T-axes to “100”.

Using the above settings as a guide, adjust the ratio of each set value according to the circumstances.



DX200 OPTIONS
INSTRUCTIONS

FOR SERVOFLOAT FUNCTION

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