

DX100 OPTIONS INSTRUCTIONS

FOR LEARNING CONTROL FUNCTION

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

MOTOMAN INSTRUCTIONS

MOTOMAN-□□□ INSTRUCTIONS
DX100 INSTRUCTIONS
DX100 OPERATOR'S MANUAL
DX100 MAINTENANCE MANUAL

The DX100 Operator's manual above corresponds to specific usage.
Be sure to use the appropriate manual

Part Number: 169280-1CD
Revision: 0



MANDATORY

- This manual explains the learning control function of the DX100. Read this manual carefully and be sure to understand its contents before handling the DX100.
- General items related to safety are listed in the Chapter 1: 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. 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 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.



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 when the emergency stop buttons on the front door of the DX100 and programming pendant are 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.

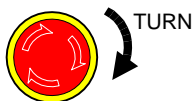
Figure 1: Emergency Stop Button



- 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 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 DX100 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 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. 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 DX100 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 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 the supply cables.

In this manual, the equipment is designated as follows:

Equipment	Manual Designation
DX100 Controller	DX100
DX100 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	The keys which have characters printed on them are denoted with []. ex. [ENTER]
	Symbol Keys	The keys which have a symbol printed on them are not denoted with [] but depicted with a small picture. ex. page key  The cursor key is an exception, and a picture is not shown.
	Axis Keys Number Keys	"Axis Keys" and "Number Keys" 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 brand names for each company or corporation. The indications of (R) and TM are omitted.

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1 Learning Control Function

This function aims to shorten the cycle time of the spot welding robot by repeatedly executing the job in the Play Mode to learn the optimal motion control command of the robot.



Be sure to set high speed spot welding function available before using the learning control function.
For details of setting high speed spot welding function, refer to Section 9.12 “High Speed Spot Welding Function” of the “DX100 OPERATOR’S MANUAL FOR SPOT WELDING USING MOTOR GUN” (Part No. 155509-1CD).



Use this function without workpieces.
The robot cannot learn the optimal motion control command if this function is used with workpieces around the robot.
Also, the workpiece may be damaged because of the robot vibration in the learning process.

2 Objective Motion for Learning Control

When there are multiple consecutive SVSPOTMOVs, the motion between SVSPOTMOV and the next SVSPOTMOV is learnt.

In the following example, the learning control is performed against the motions (1), (2), and (3). The learning control validation tag (LRNCTR) is added to the SVSPOTMOV to which the result of learning control is reflected.

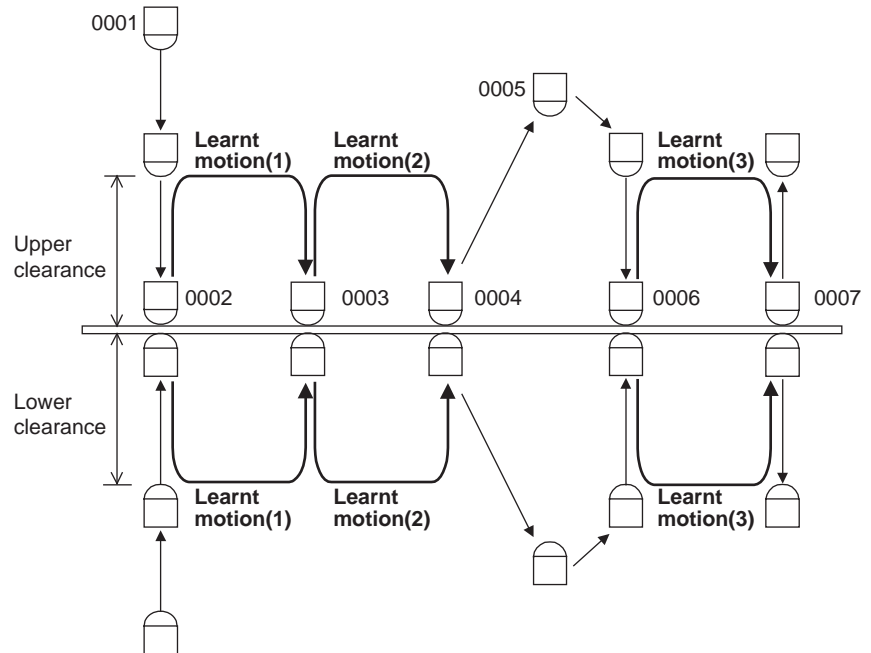
Job example:

```

0000  NOP
0001  MOVJ VJ=100.0
0002  SVSPOTMOV V=1600.0 CLF#(1) GUN#(1) PRESS#(1) LRNCTR=ON ← The result of learnt motion (1) is
                                                                    reflected.
0003  SVSPOTMOV V=1600.0 CLF#(1) GUN#(1) PRESS#(1) LRNCTR=ON ← The result of learnt motion (2) is
                                                                    reflected.
0004  SVSPOTMOV V=1600.0 CLF#(1) GUN#(1) PRESS#(1)
0005  MOVJ VJ=100.0
0006  SVSPOTMOV V=1600.0 CLF#(1) GUN#(1) PRESS#(1) LRNCTR=ON ← The result of learnt motion (3) is
                                                                    reflected.
0007  SVSPOTMOV V=1600.0 CLF#(1) GUN#(1) PRESS#(1)
0008  END

```

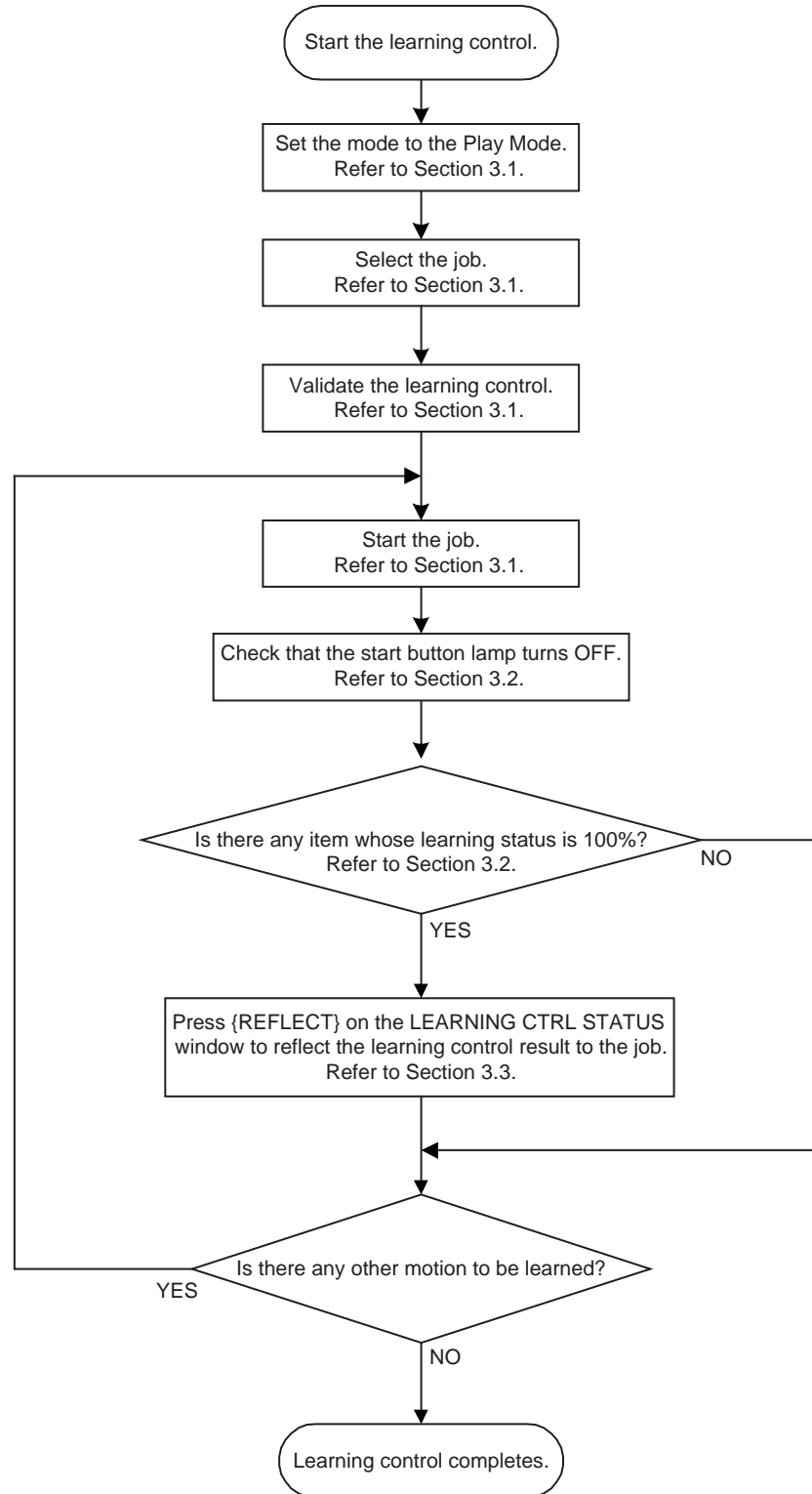
Fig. 2-1: Objective Motion for Learning Control



3 Execution Procedure of Learning Control

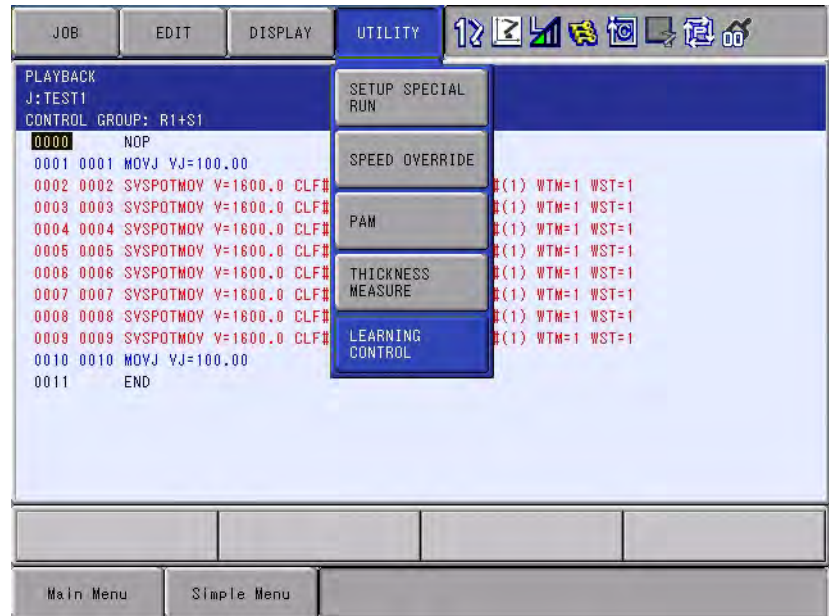
Execute the learning control according to the following procedure:

Fig. 3-1: Flow Diagram

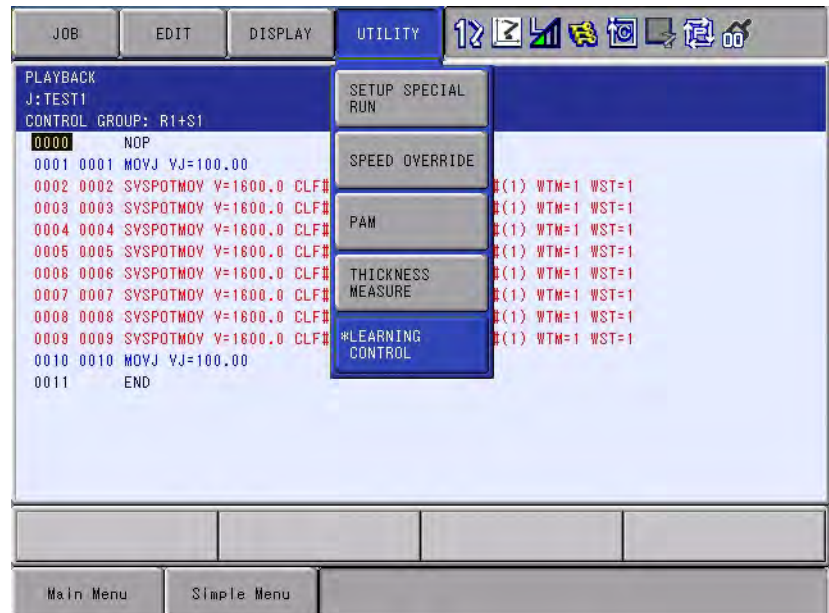


3.1 Validating Function and Executing Learning Control

1. Set the mode to the play mode.
2. Select the PLAYBACK window.
3. Select {UTILITY} in the main menu.
 - The pull-down menu appears.



4. Select {LEARNING CONTROL}.
 - "*" is added and the learning control is validated.



- To invalidate the function, select {LEARNING CONTROL} again. "*" disappears and the learning control is invalidated.

3 Execution Procedure of Learning Control

3.1 Validating Function and Executing Learning Control

5. Turn ON the servo power to start the job.
 - The confirmation dialog box appears.
 - Select "YES" to start the job again. The message "Learning control is in execution." is displayed.
 - If "NO" is selected, the operation is aborted.

The amount of inward turning of the motion during the learning control may slightly vary compared to that before the learning control.



{LEARNING CONTROL} in {UTILITY} is displayed in the play mode only.

While "STARTING" is displayed, the switching between validation and invalidation of the learning control cannot be performed.

If the mode is switched from the play mode to the teach mode, the learning control is invalidated.



When this learning control function and the optional function "Pendant oscilloscope function" are valid, both functions cannot be used at the same time.

When use one of these functions, don't use the other function. If both functions are selected for use at the same time, following error messages are displayed.

"ERROR1220: Cannot enable the learning control function since data measuring is being performed by pendant oscilloscope."

"ERROR1221: Cannot start data measuring by pendant oscilloscope since the learning control function is enabled."

To stop data measuring by the pendant oscilloscope function, select {ROBOT} → {PENDANT OSCILLOSCOPE} → {STOP}.

To invalidate the learning control function, refer to *Section 3.1 "Validating Function and Executing Learning Control"*.



While the learning control is being executed, pressuring motion and welding are not performed in executing SVSPOTMOV.

3.2 Checking the Status

The implementation status can be checked with the following procedure:

1. Select {JOB} in the main menu.
2. Select {LEARNING CTRL STATUS}.
 - The learning control status appears.

JOB NAME	LINE NO.	STATUS(%)
1 TEST1	2	100
2 TEST1	3	100
3 TEST1	4	2
4 TEST1	5	100
5 TEST1	6	2
6 TEST1	7	2
7 TEST1	8	2
8 *****		***
9 *****		***
10 *****		***
11 *****		***
12 *****		***
13 *****		***
14 *****		***
15 *****		***
16 *****		***

Each item on the window respectively has the following meaning:

- **MEMORY**

Indicates the usage condition of the memory for learning control. The number of SVSPOTMOV for which the learning can be performed at one time is limited. If this value reaches 100%, the learning cannot be performed for SVSPOTMOV newly executed after the value reaches 100%.

- **LINE NUM**

Indicates the number of lines of SVSPOTMOV during the learning.

- **JOB NUM**

Indicates the number of jobs during the learning.

- **JOB NAME**

Indicates the job name during the learning.

- **LINE NO.**

Indicates the No. of the line of SVSPOTMOV during the learning.

- **STATUS(%)**

Indicates the implementation status of learning. 100% means that the learning control of SVSPOTMOV on the line is completed.

■ {REFLECT}

Pressing this button reflects the learning control result of the items with 100% to the job's SVSPOTMOV. Refer to *Section 3.3 "Reflecting the Learning Control Result"*

■ {CLEAR}

Pressing this button deletes the item currently selected with the cursor from the LEARNING CTRL STATUS window. Refer to *Section 3.4 "Clearing the Data of Learning Control Result"*



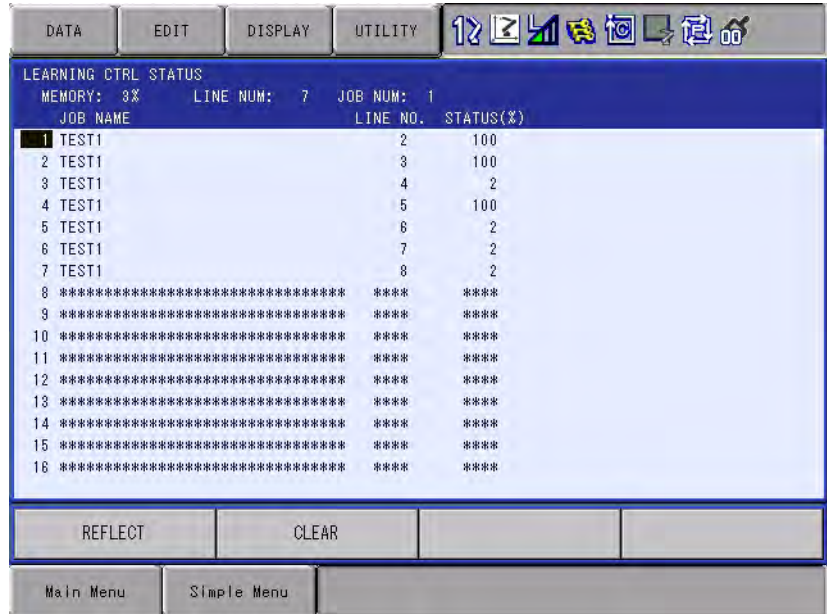
Basically, for the learning control, terminate the playback of the job for one cycle.

The data of the learning control is updated when the start button lamp turns OFF. Even when the SVSPOTMOVs on the same job and the same line are executed multiple times, the learning control result is equivalent to that executed one time. After the job is executed, terminate the playback at a timing to update the learning control data.

3.3 Reflecting the Learning Control Result

The result of learning control can be reflected with the following procedure:

1. Select {JOB} in the main menu.
2. Select {LEARNING CTRL STATUS}.
 - The learning control status appears.



3. Press {REFLECT}.

– When there is any item with 100% while "STARTING" is not displayed, {REFLECT} appears.

Pressing this button reflects the learning control result of the items with 100% to the job's SVSPOTMOV. Items to which the learning control result is reflected will be deleted from the LEARNING CTRL STATUS window.

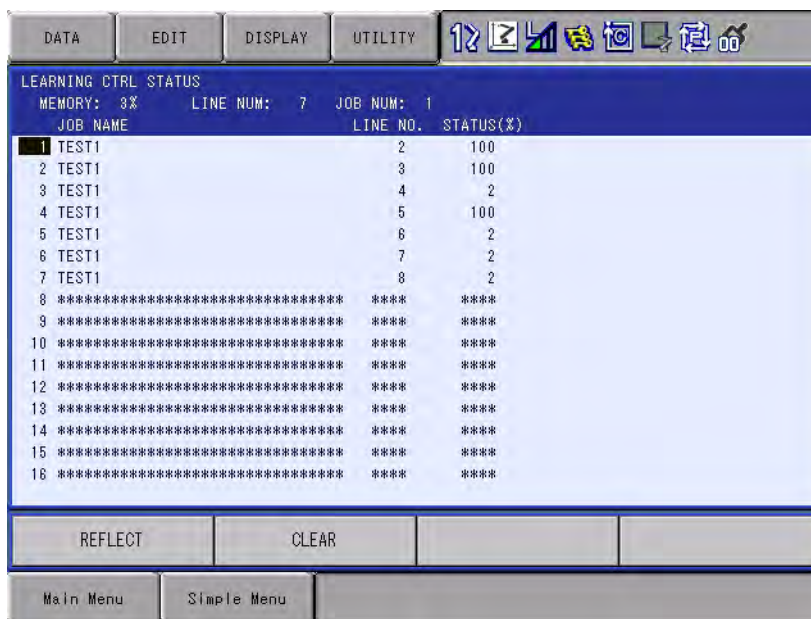


- When the job is executed and the robot operates, only the SVSPOTMOV's which completed reflection are operated according to learning control result.
- When the learning control judges that the motion before the learning is optimal rather than after the learning, the robot operates with the motion before the learning.

3.4 Clearing the Data of Learning Control Result

It is available that clearing the data before the learning control result is reflected and starting the learning control from the beginning. Perform the data clearing with the following procedure:

1. Select {JOB} in the main menu.
2. Select {LEARNING CTRL STATUS}.
 - The learning control status appears.



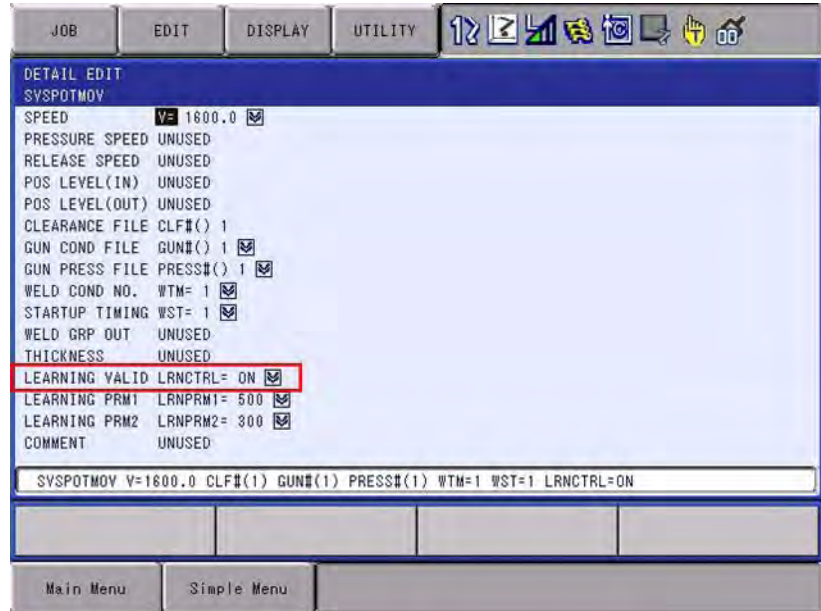
3. Move the cursor to the data to be cleared, and press {CLEAR}.
 - The selected data is cleared.
4. Select {DATA} → {CLEAR ALL DATA}.
 - The confirmation dialog box "Clear all learning data?" appears.
 - When selecting "YES", all data is cleared.
 - When selecting "NO", the operation is aborted.



Turning OFF the control power clears the data.

3.5 Checking the Learning Control Result

The learning control validation tag (LRNCTR) is added to the SVSPOTMOV to which the result of learning control is reflected. When LRNCTR is ON, in performing the playback of a job, the robot operates according to learning control result. When LRNCTR is OFF, the robot operates with the motion before the learning.



Selecting {EDIT} → {CLEAR ALL LEARNING} in the JOB window can invalidate all the learning control validation tags of the job which is currently selected.

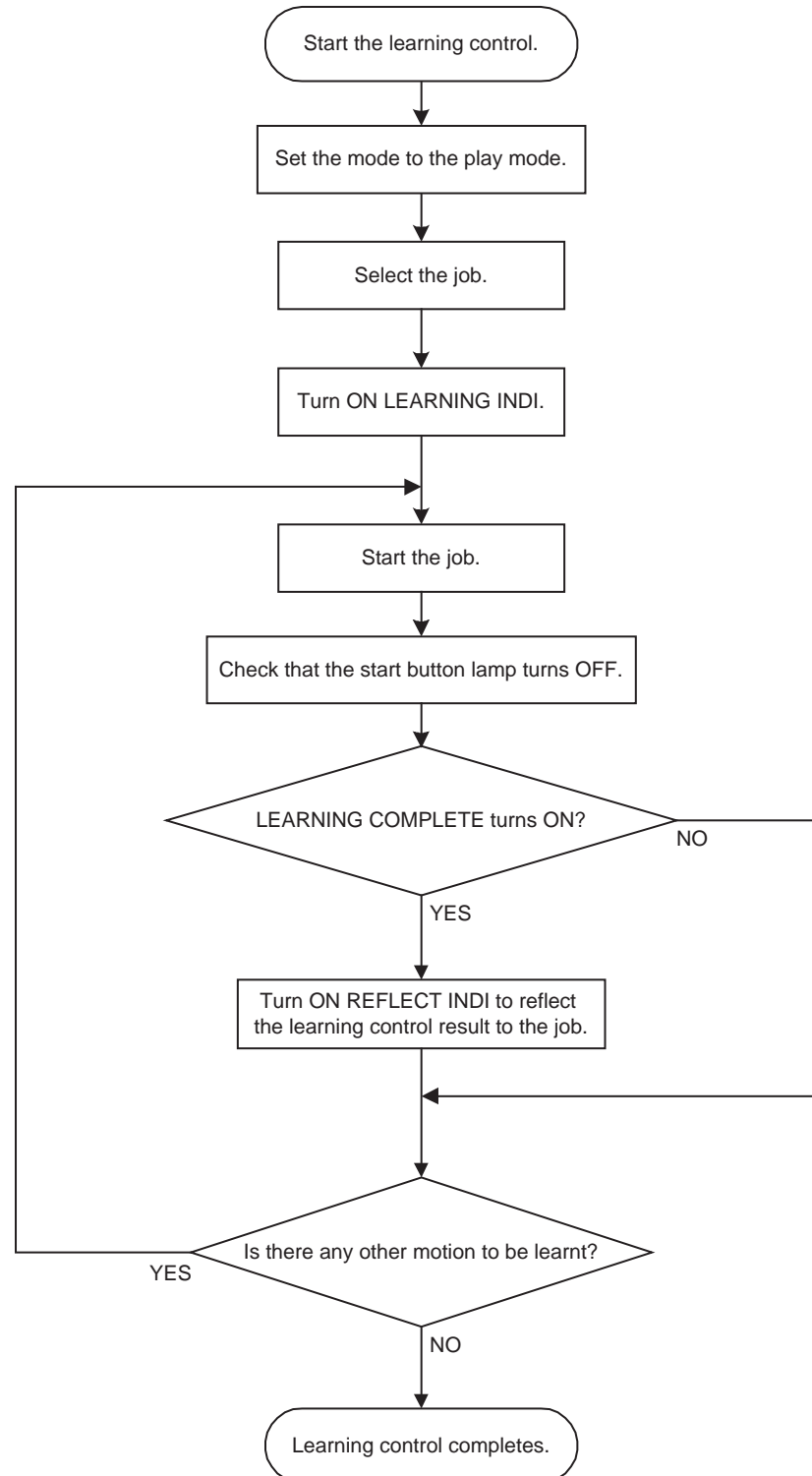


- When LRNCTR is OFF, the learning is performed again in executing the learning control. When LRNCTR is ON, the learning is not performed for the SVSPOTMOV even when the learning control is executed.
- Even when the job is edited such as copying and pasting the SVSPOTMOV line with LRNCTR=ON, LRNCTR of the SVSPOTMOV cannot be changed from ON to OFF. After editing the job, perform the operation check.
- When the teaching modification is performed to the SVSPOTMOV with LRNCTR=ON, LRNCTR of the SVSPOTMOV cannot be changed from ON to OFF. After the teaching modification, perform the operation check.
- When the move instruction is added immediately after the SVSPOTMOV with LRNCTR=ON, the robot operates with the motion before the learning regardless of LRNCTR=ON.

3.6 Execution Procedure of Learning Control by Universal I/O Signals

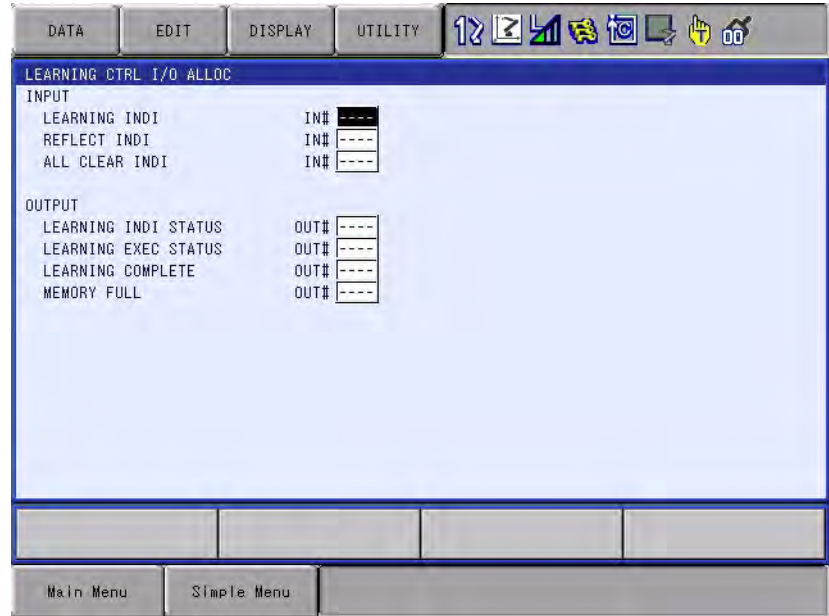
Learning control can be performed with using the universal I/O signals. Execute the learning control according to the following procedure:

Fig. 3-2: Flow Diagram



3.6.1 Universal I/O Signal

1. Select {CONTROLLER SETTING} in the main menu.
2. Select {LEARNING CTRL I/O ALLOC}.
 - The learning control I/O allocation appears.
 - Move the cursor and select the item, and then a numerical value can be input. Set a universal input signal number to IN#, and a universal output signal number to OUT#.



Each item on the window respectively has the following meaning:

3.6.1.1 Universal Input Signal

■ LEARNING INDI

Turn ON this signal to execute the learning control. The input status at the start is used for the judgement.

■ REFLECT INDI

The same processing as that by pressing {REFLECT} on the LEARNING CTRL STATUS window is performed. This signal is valid at the rising edge. While "STARTING" is displayed, this signal is invalid.

■ ALL CLEAR INDI

The same processing as that by selecting {DATA} → {CLEAR ALL DATA} on the LEARNING CTRL STATUS window is performed. This signal is valid at the rising edge. While "STARTING" is displayed, this signal is invalid.

3.6.1.2 Universal Output Signal

■ LEARNING INDI STATUS

When the LEARNING INDI input signal turns ON, this signal turns ON.

■ LEARNING EXEC STATUS

This signal turns ON while the learning control is being executed. When the job stops, this signal turns OFF.

■ LEARNING COMPLETE

When there is any item whose STATUS is 100%, this signal turns ON.

■ MEMORY FULL

When MEMORY reaches 100%, this signal turns ON. The learning cannot be performed for SVSPOTMOV's newly executed after this signal turns ON.

3.6.2 Save/Load (to external memory devices) the Universal I/O Signal

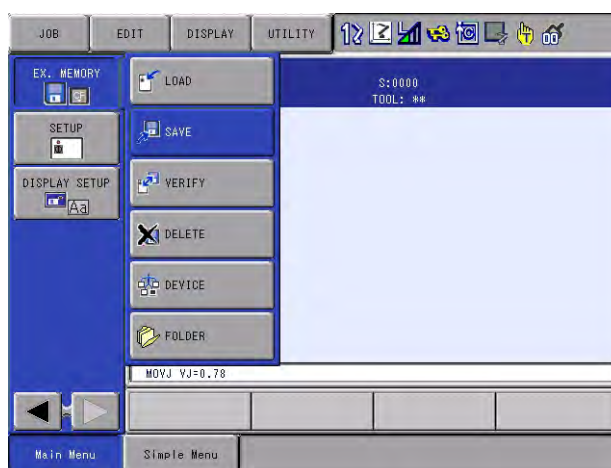
The data registered to "LEARNING CTRL I/O ALLOC" can be saved to and loaded from the external memory device.

In this case, the name of the file is "LRNCTLIO.DAT".

3.6.2.1 Saving the Universal I/O Signal

The universal I/O signal can be saved at the security level of operation mode or more.

1. Select {EX. MEMORY} under the main menu.
 - {EX. MEMORY} sub menu appears.

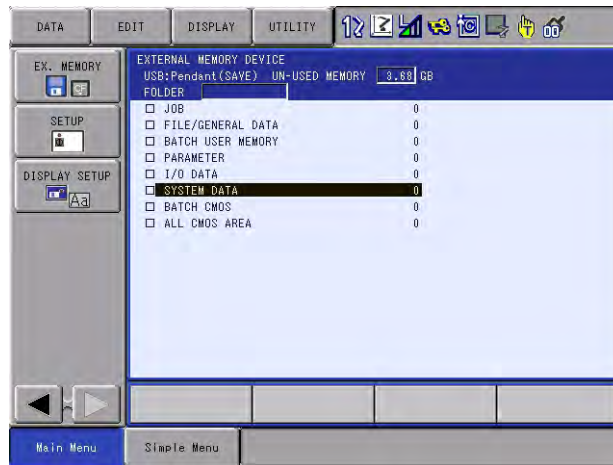


3 Execution Procedure of Learning Control

3.6 Execution Procedure of Learning Control by Universal I/O Signals

2. Select {SAVE}.

- {SAVE} window of external memory device appears.

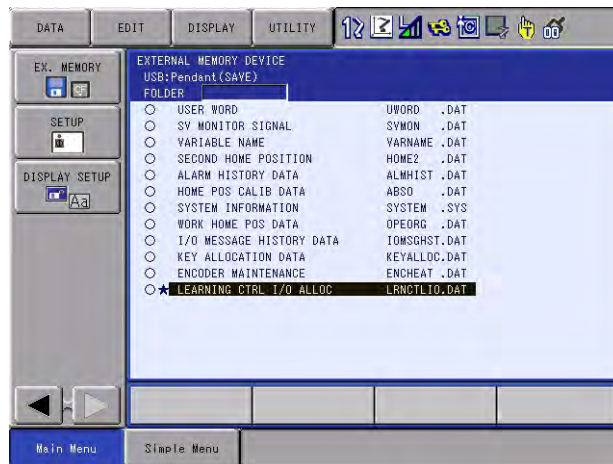


3. Select {SYSTEM DATA}.

- {SYSTEM DATA} window of external memory device appears.

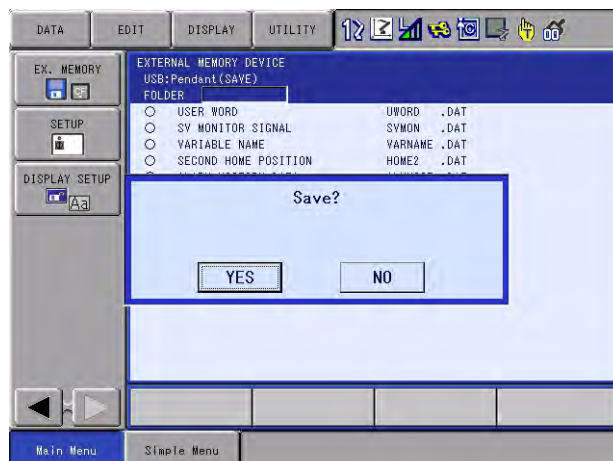
4. Select {LEARNING CTRL I/O ALLOC}.

- “★” mark is indicated at the head of {LEARNING CTRL I/O ALLOC}.



5. Press [ENTER].

- The confirmation dialog box with a message “Save?” appears.



3 Execution Procedure of Learning Control

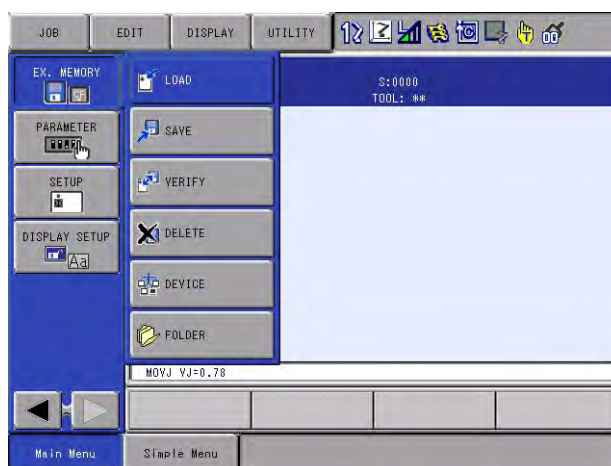
3.6 Execution Procedure of Learning Control by Universal I/O Signals

6. Select {YES} in the dialog box.
 - {LEARNING CTRL I/O ALLOC} is saved.
 - * It will not be saved if {NO} in the dialog box is selected.

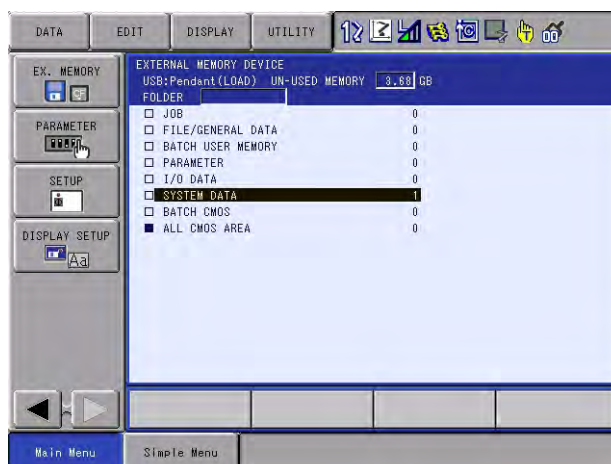
3.6.2.2 Loading the Universal I/O Signal

The universal I/O signal can be loaded at the security level of management mode or more.

1. Select {EX. MEMORY} under the main menu.
 - {EX. MEMORY} sub menu appears.



2. Select {LOAD}.
 - {LOAD} window of external memory device appears.



3. Select {SYSTEM DATA}.
 - {SYSTEM DATA} window of external memory device appears.

3 Execution Procedure of Learning Control

3.6 Execution Procedure of Learning Control by Universal I/O Signals

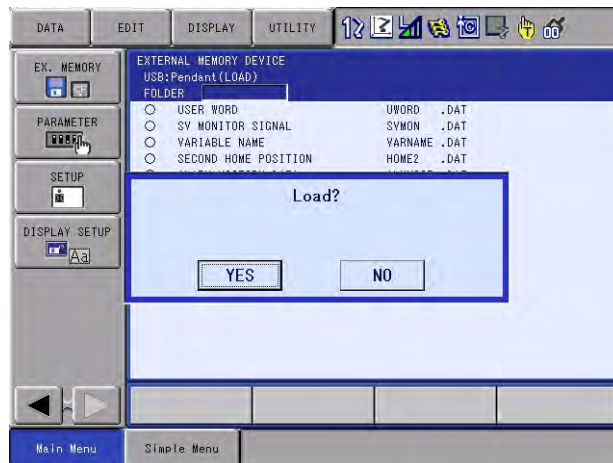
4. Select {LEARNING CTRL I/O ALLOC}.

- “★” mark is indicated at the head of {LEARNING CTRL I/O ALLOC}.



5. Press [ENTER].

- The confirmation dialog box with a message “Load?” appears.



6. Select {YES} in the dialog box.

- {LEARNING CTRL I/O ALLOC} is loaded.
- * It will not be loaded if {NO} in the dialog box is selected.

DX100 OPTIONS INSTRUCTIONS

FOR LEARNING CONTROL FUNCTION

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