

DX200 OPTIONS INSTRUCTIONS

FORM CUTTING FUNCTION
(FOR CUTTING DEVICE)

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
DX200 MAINTENANCE MANUAL

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

Part Number: 165266-1CD
Revision: 0



MANDATORY

- This manual explains the form cutting function of the DX200. Read this manual carefully and be sure to understand its contents before handling the DX200.
- General items related to safety are listed in Chapter 1: Safety of the DX200 Instructions. To ensure correct and safe operation, carefully read the DX200 Instructions before reading this manual.



CAUTION

- Some drawings in this manual are shown with the protective covers or shields removed for clarity. Be sure all covers and shields are replaced before operating this product.
- The drawings and photos in this manual are representative examples and differences may exist between them and the delivered product.
- YASKAWA may modify this model without notice when necessary due to product improvements, modifications, or changes in specifications.
- If such modification is made, the manual number will also be revised.
- If your copy of the manual is damaged or lost, contact a YASKAWA representative to order a new copy. The representatives are listed on the back cover. Be sure to tell the representative the manual number listed on the front cover.
- YASKAWA is not responsible for incidents arising from unauthorized modification of its products. Unauthorized modification voids your product's warranty.

Notes for Safe Operation

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

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.

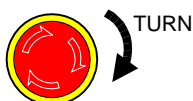
Figure 1: Emergency Stop Button



- 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.
 - 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 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 cabinet of the DX200 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 the manipulator 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, 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.

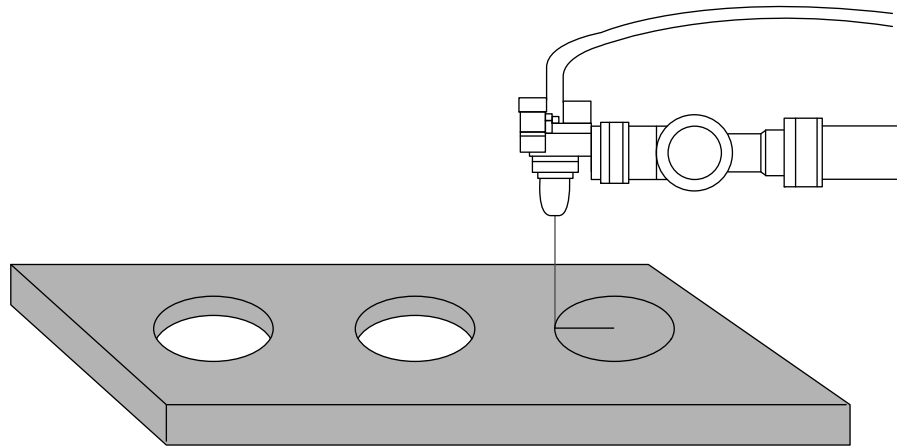
Registered Trademark

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

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1 Form Cutting Motion

The form cutting motion cuts workpieces according to a pattern with a tool such as a laser cutting machine handled by a manipulator.



In the form cutting function, there may be some differences between the set design and the actual cutting motion path, depending on the calibration, ambient temperature, and load applied to the manipulator.

Please understand this point, and then use this function.

In order to minimize the above explained differences, be sure to calibrate your tools before using this function.

2 Patterns for Cutting

With the cutting device, four patterns of cutting; circle, rectangle (including square), ellipse, and hexagon are available.

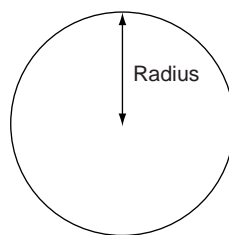
The minimum and maximum set values of each pattern can be set at the following parameters.

Parameter	Contents	Initial Value
S1CxG049	Minimum set value [Unit: 0.001 mm]	4000 (4.000 mm)
S1CxG050	Maximum set value [Unit: 0.001 mm]	30000 (30.000 mm)

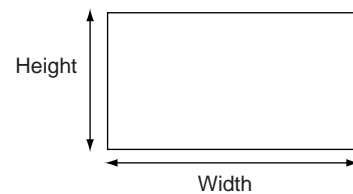
The minimum and maximum values of the data required for a pattern are set as follows.

Pattern	Item	Minimum Value	Maximum Value
Circle	Radius	$S1CxG49 / 2$	$S1CxG50 / 2$
Rectangle	Width	1	$(S1CxG50)^2 - (\text{Height})^2$
	Height	$S1CxG49 / 2$	$(S1CxG50)^2 - (\text{Width})^2$
Ellipse	Radius	$S1CxG49 / 2$	$(S1CxG50 / 2) - (\text{Width} / 2)$
	Width	0	$S1CxG50 - (2 * \text{Radius})$
Hexagon	Width	1	$(\text{Width} + 2L)^2 \leq S1CxG502 - (\text{Height})^2$
	Height	$S1CxG49 / 2$	$(\text{Height})^2 \leq S1CxG502 - (\text{Width} + 2L)^2$

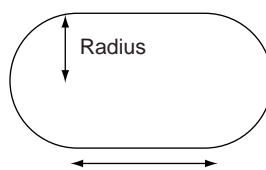
Note: $L = \text{Height} \times 0.866$



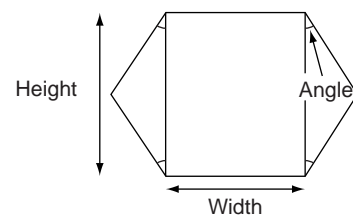
Circle



Rectangle



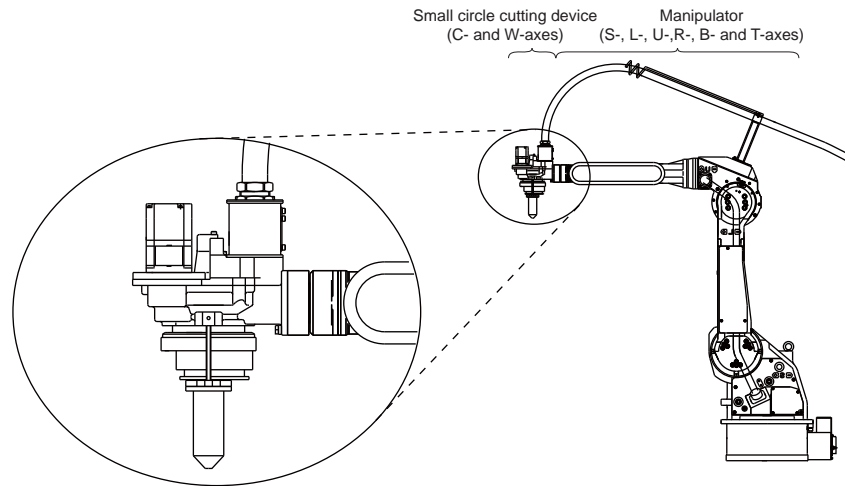
Ellipse



Hexagon

3 Cutting Device



This cutting device is a cutting control device that enables high-precision and high-speed pattern cutting in laser cutting. While laser is output, workpiece is cut after the manipulator and this device starts to move. This device has two movable axes; C- and W-axes.



3.1 Axes Operation

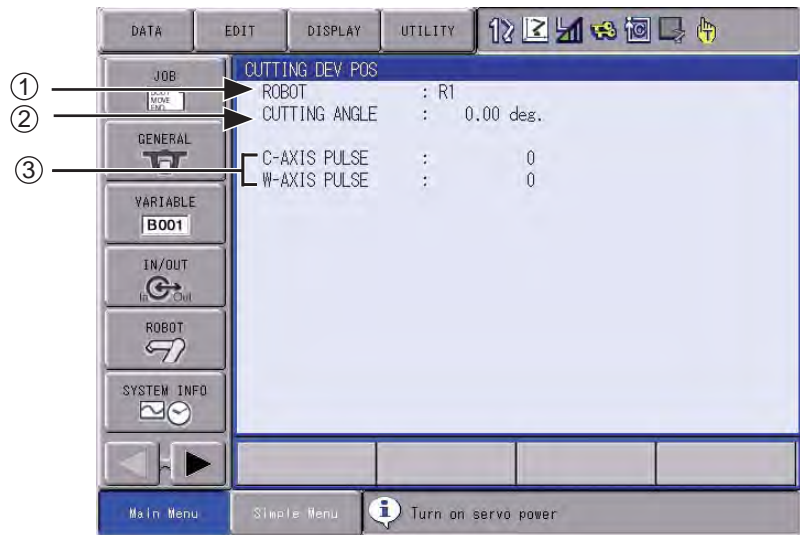
Each axis can be operated independently when the axis key is pressed in teach mode.

The selected axis moves while the key is pressed.

Axis	Axis key	Performance
C-axis		C-axis rotates.
W-axis		W-axis rotates.

3.2 Display for Cutting Device Position

On the display for cutting device position, each axis position and cutting direction are displayed. Also, the operation to make each axis return to its home position can be performed.



① ROBOT

Shows the robot to which the cutting device is installed.

② CUTTING ANGLE

Shows the direction of the cutting device from the reference point to the current direction

③ C- AXIS and W- AXIS PULSE

Shows C- and W- axes positions of the cutting device.

1. Select {GENERAL} under the main menu.

– Sub menu appears.

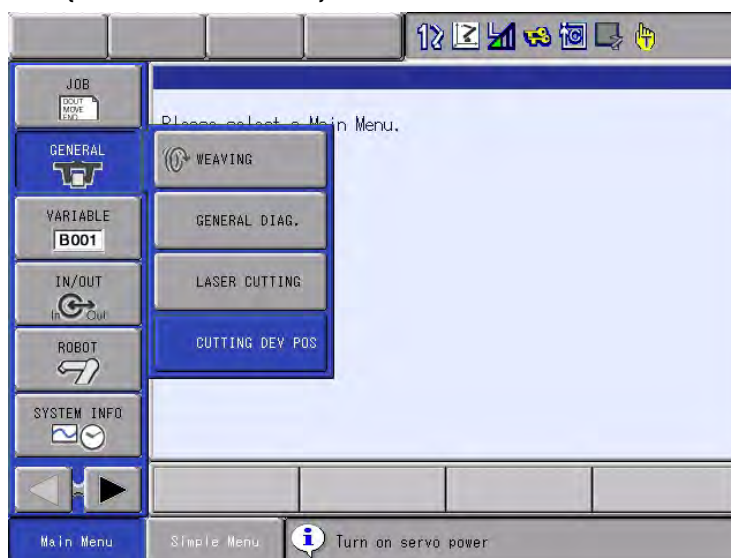


Main menu varies depending on the purpose of the robot.




- For arc welding purpose: {ARC WELDING}
- For handling purpose: {HANDLING}
- For general purpose: {GENERAL}
- For SPOT welding purpose: {SPOT WELDING}

2. Select {CUTTING DEV POS}.

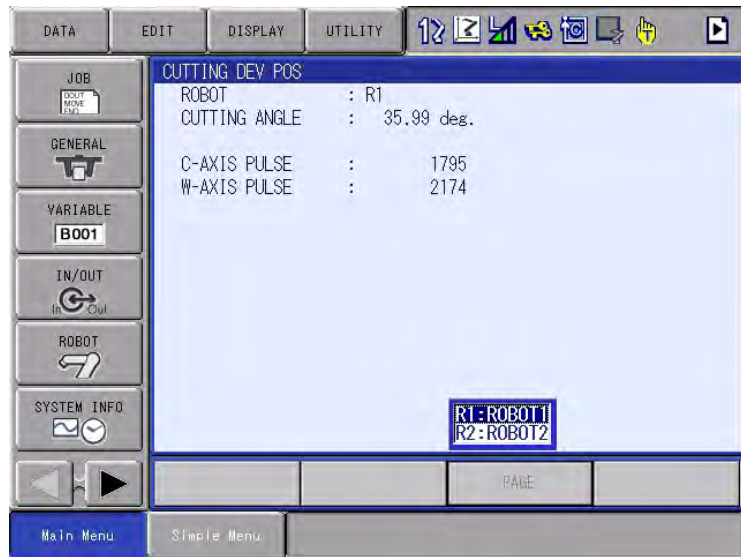


3 Cutting Device

3.2 Display for Cutting Device Position

3. Press page key  or [PAGE] to select a desired robot (cutting device installed).

– The desired robot is called out.

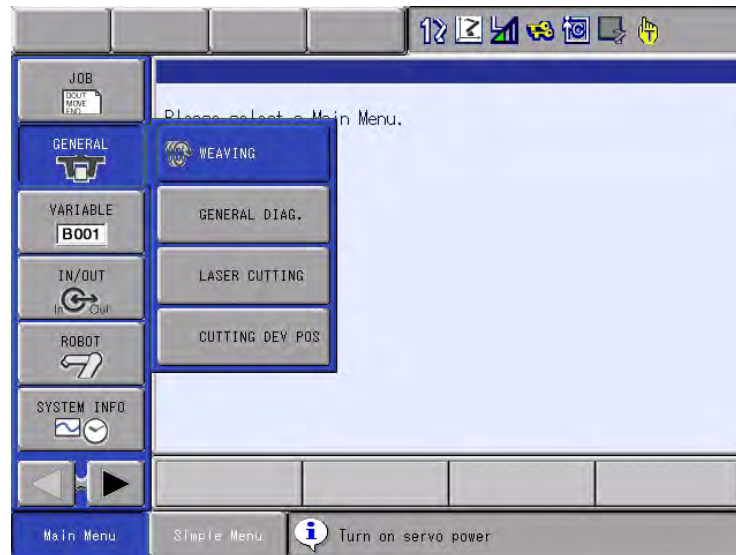


– Press [SHIFT] + [PAGE] to call out the previous robot.

3.2.1 Return to the Home Position

Return the shifted Oeach axis to the home position.

1. Select {GENERAL} under the main menu.
 - Sub menu appears.

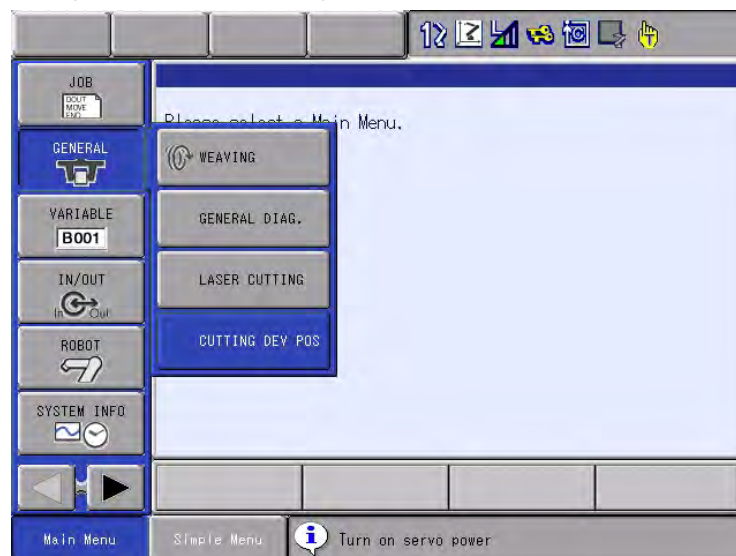


Main menu varies depending on the purpose of the robot.




- For arc welding purpose: {ARC WELDING}
- For handling purpose: {HANDLING}
- For general purpose: {GENERAL}
- For SPOT welding purpose: {SPOT WELDING}

2. Select {CUTTING DEV POS}.



3 Cutting Device

3.2 Display for Cutting Device Position

3. Press page key  or [PAGE] to select a desired robot (cutting device installed).

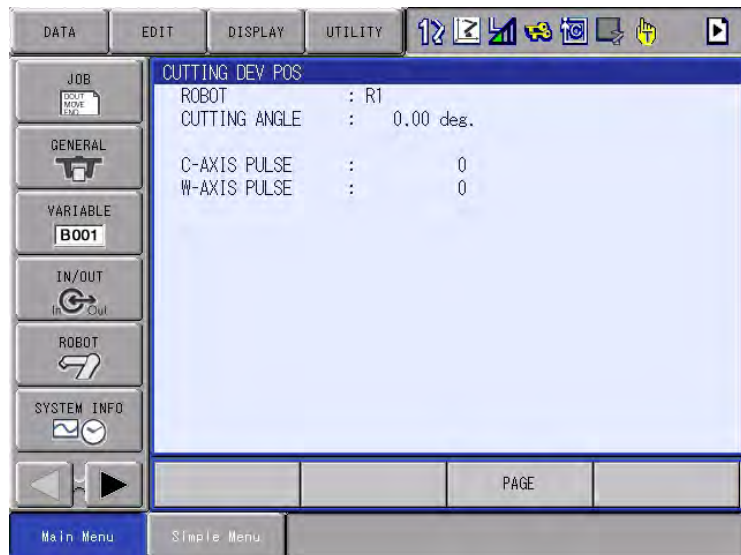
– The desired robot is called out.



– Press [SHIFT] + [PAGE] to call out the previous robot.

4. Press [Next].

– The value of each axis on the display returns to the home position.



4 Teaching

The teaching operation for the form cutting function by the cutting device is performed by registering two instructions; the moving instruction toward the center of a pattern and the cutting start instruction.

When teaching, please pay attention to the following points;

- Return to the cutting device home position before teaching the position.
- Teach the center of the cutting pattern as a cutting start point.

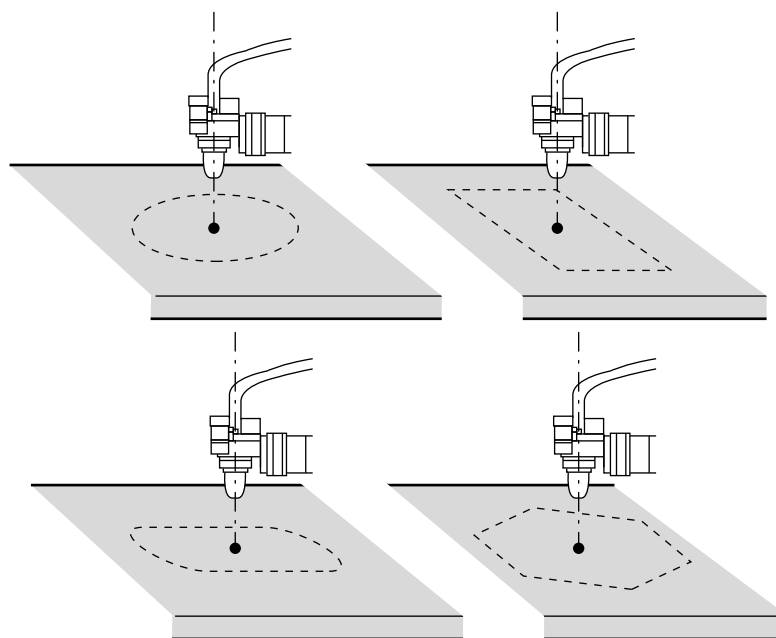
4.1 Return to the Cutting Device Home Position

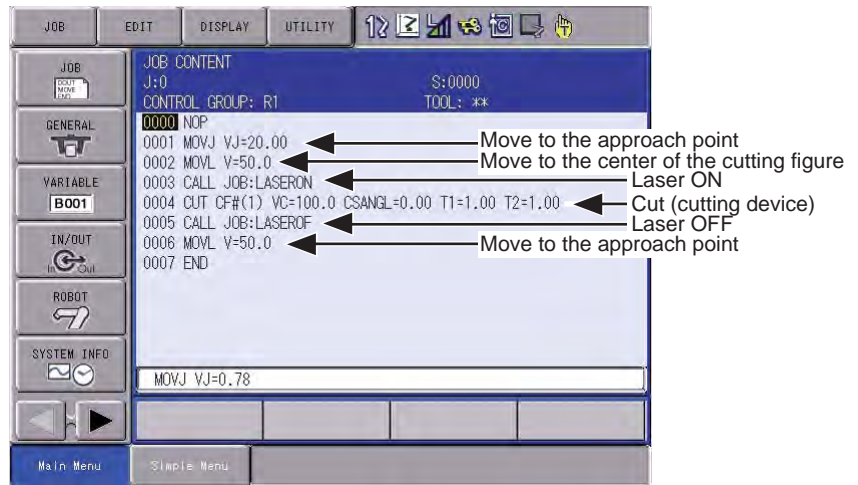
When teaching a robot which has cutting device, the device needs to be at its home position, otherwise, the position teaching is impossible. Or, an alarm occurs if the cutting instruction is executed while the cutting device is not at the home position. Refer to *Section 3.2.1 "Return to the Home Position"* on page 3-5 for returning methods to the home position.

4.2 Teaching the Pattern

Teach the center of the cutting pattern as the cutting start point.

Teaching point as a laser cutting start point

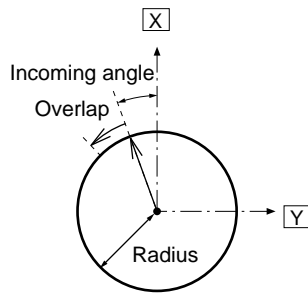




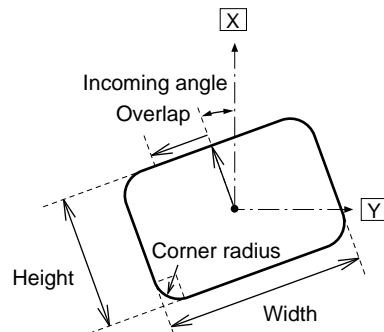
4.3 Tool Position and Form Cutting Pattern

The following patterns show the relation between the tool position and form cutting pattern when CUT instruction is executed.

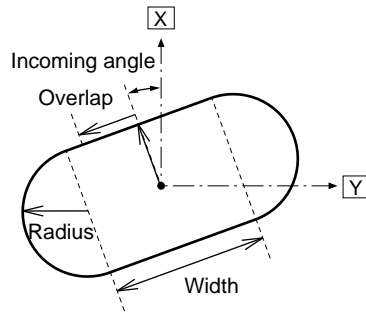
X : Tool coordinate system X-axis direction **Y** : Tool coordinate system Y-axis direction



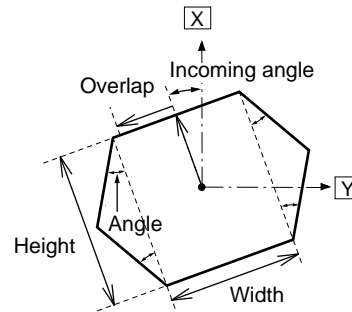
Circle



Rectangle



Ellipse

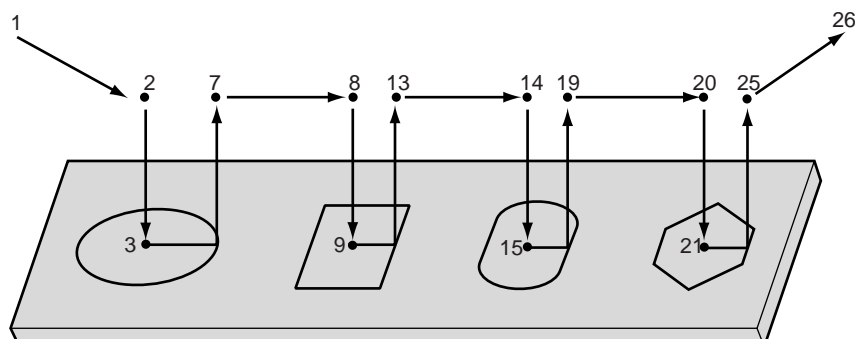


Hexagon

4.4 Example of Form Cutting Function

4.4.1 Example of a Job

Following is an example of a job for cutting the following pattern.



```

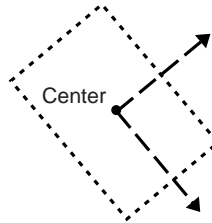
0000 NOP
0001 MOVJ VJ=100.00
0002 MOVJ VJ=100.00
0003 MOVL V=50 .....Move to the starting point (center)
0004 CALL LASERON.....Instruction to a laser, etc. to start motion
0005 CUT CF#(1) VC=100 CSANGL=0.00 ....Cutting motion (circle)
0006 CALL LASEROFF.....Instruction to a laser, etc. to end motion
0007 MOVL V=50
0008 MOVJ VJ=100.00
0009 MOVL V=50.....Move to the starting point (center)
0010 CALL LASERON.....Instruction to a laser, etc. to start motion
0011 CUT CF#(2) VC=100.0 CSANGL=0.00....Cutting motion (rectangle)
0012 CALL LASEROFF.....Instruction to a laser, etc. to end motion
0013 MOVL V=50
0014 MOVJ VJ=100.00
0015 MOVL V=50.....Move to the starting point (center)
0016 CALL LASERON.....Instruction to a laser, etc. to start motion
0017 CUT CF#(3) VC=100.0 CSANGL=0.00....Cutting motion (rectangle)
0018 CALL LASEROFF.....Instruction to a laser, etc. to end motion
0019 MOVL V=50
0020 MOVJ VJ=100.00
0021 MOVL V=50.....Move to the starting point (center)
0022 CALL LASERON.....Instruction to a laser, etc. to start motion
0023 CUT CF#(4) VC=100.0 CSANGL=0.00....Cutting motion (ellipse)
0024 CALL LASEROFF.....Instruction to a laser, etc. to end motion
0025 MOVL V=50
0026 MOVJ VJ=100.00
0027 END

```

4.4.2 Example of a Motion Path

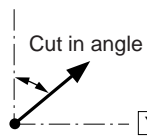
Here, an example when cutting a rectangle shape is shown.

When cutting other patterns, pursuant to this example.



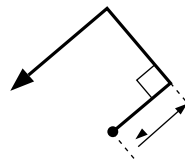
① Start from the center of the pattern

X Tool coordinate system X-axis direction



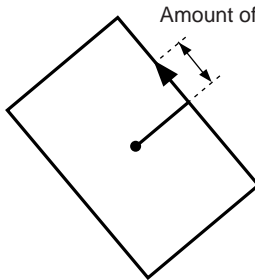
② Start moving to the incoming angle direction to the X-axis (positive direction) of the tool coordinate system.

1/2 of the width

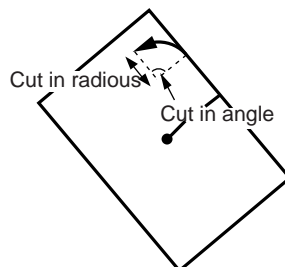


③ After proceeding the half of the width, the manipulator changes the cutting direction by 90-degree to start drawing the rectangle.

Amount of overlap



④ Execute overlapping for the length specified by AMOUNT OF OVERLAP



⑤ After finishing the overlapping, make a cut in at the end of the overlap. The following parameters are for the settings of the cut in.

SICxG054 cut in radius [μ]

SICxG055 cut in angle [0.1 degree]

5 Instruction

5.1 CUT Instruction (Cutting Device Start Instruction)

Cut instruction is an instruction that performs the form cutting with cutting device in the shape set to the laser cutting condition file.

The additional items to the CUT instruction are as follows. The additional items can be omitted except for the laser cutting condition file.

CUT RB1 CF#(10) VC=100.0 CSANGL=0.00 T1=1.00 T2=1.00

①
②
③
④
⑤
⑥

① Robot

Specifies a robot to execute the cutting.

When only one robot is registered in JOB control group, specification of the robot is not necessary.

② Laser Cutting Condition File

Shapes or dimensions for form cutting performance are registered to the laser cutting condition file.

Form cut operation is executed following the file condition whose number was specified by CUT instruction.

③ Cutting Speed (mm/min)

Sets the operational speed for cutting.

④ Incoming Angle (degrees)

Sets the direction from X-axis in the tool coordinate to start cutting. The degree is set to 0 when setting is omitted.

⑤ The 1st Stop Time

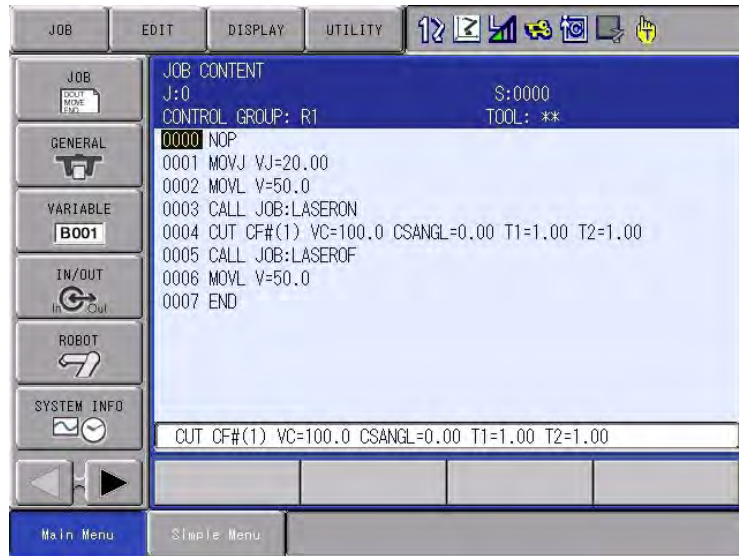
At the point where the laser is cutting in, the operation can be halted for specified period with the timer. The time is set to 0 second when setting is omitted.

⑥ The 2nd Stop Time

At the corner of the cutting shape, the operation can be halted for specified period with the timer. The time is set to 0 second when setting is omitted.

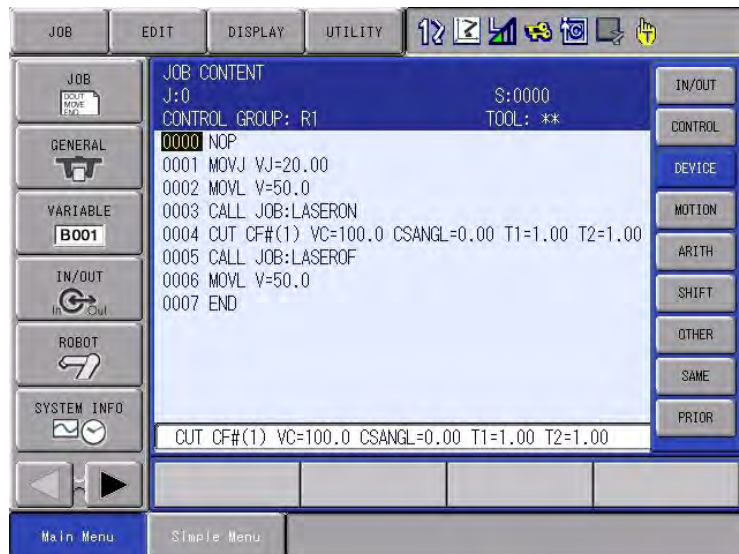
5.2 Register the Instructions

1. Move the cursor to the previous line where the CUT instruction to be registered.



2. Press [INFORM LIST].

– The instruction list dialog box opens



5 Instruction

5.2 Register the Instructions

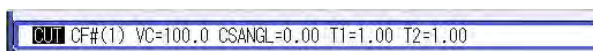
3. Select {DEVICE}.

- The CUT instruction is displayed.



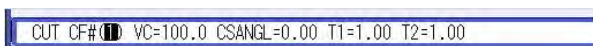
4. Select {CUT} instruction.

- The {CUT} instruction will be displayed in the input buffer line.

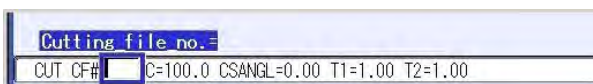


5. Change the numerical data.

- <Register the data as it is>
To register the instruction in the input buffer line without changing, move to step No.6.
- <Edit additional items>
To change the numerical data of the additional items, move the cursor to the number to be changed and press [SHIFT] and the cursor keys at the same time to raise or lower the number.



- To type the data from the number keys, select where to enter the data, and the input line will be displayed.
Type the desired number and press [ENTER] to change the number in the input buffer line.



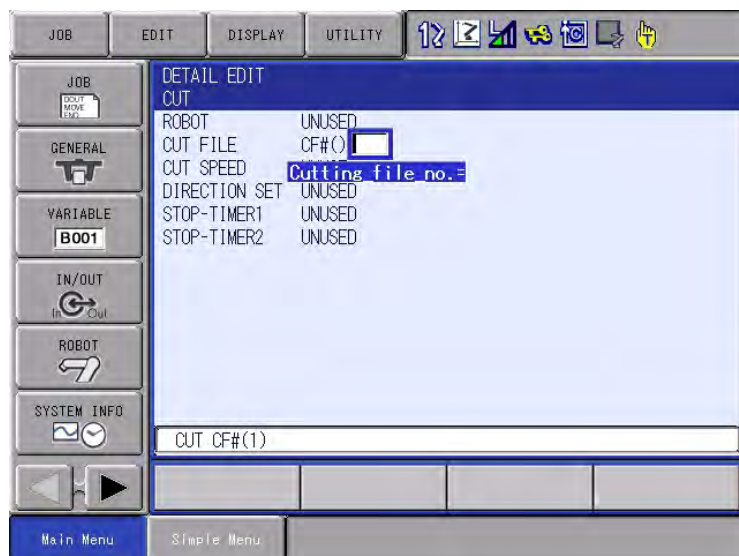
5 Instruction

5.2 Register the Instructions

- To add or change any additional items, move the cursor to the instruction in the input buffer line. Then press [SELECT] to call up the detailed editing dialog box.



- To change the laser cutting condition file, select the number of "CUTTING FILE".



5 Instruction

5.2 Register the Instructions

Type the file No. in the input buffer line, press [ENTER] and the number changes.



– To register the laser cutting condition file No. in variables, select .



5 Instruction

5.2 Register the Instructions

- The dialog box opens. Select the variable.



- To change a variable No., select the variable to be changed.



5 Instruction

5.2 Register the Instructions

- Type the new variable No., press [ENTER], and the number changes.



- To add the cutting speed, select {UNUSED} for {CUT SPEED}. A selection dialog box is displayed. Select {VC=}. Add or change any other items in the same manner.



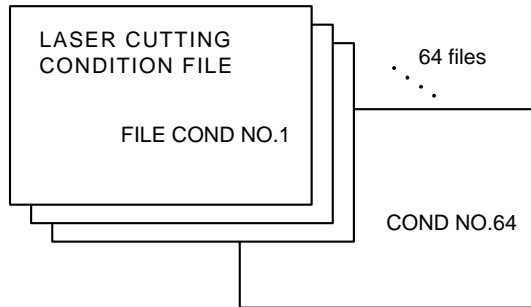
When the additional items are added or changed, press [ENTER]. The detailed editing dialog box closes, and the job text window opens.

6. Press [ADD] and then [ENTER].
 - The instruction displayed in the input buffer line is registered.

6 Laser Cutting Condition File

The laser cutting condition file is to set the conditions for a form cutting motion by the cutting device and used in the CUT instructions.

Up to 64 files can be registered.



Laser Cutting Condition File

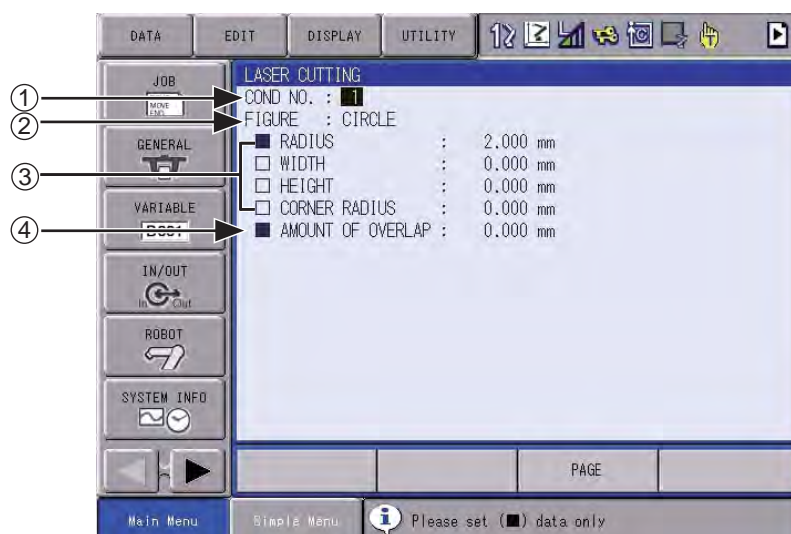
The form cutting by the cutting device is executed after the desired file number is set under CUT instruction.

6.1 Settings

The followings are the details of the settings in the laser cutting condition file:

CUT CF#(1) VC=120.0 CSANGL=0.00

Laser cutting condition file No. 1



① LASER CUTTING CONDITION FILE No. (1 to 64)

② PATTERN

Select the desired pattern.

A circle, rectangle, ellipse, or hexagon can be selected.

③ DIMENSIONS

Set the dimensions of the pattern.

The items to be set are marked with "■" while the items not to be set are marked with "□".

Set a numerical value in the items marked with "■".

④ AMOUNT OF OVERLAP

Set the length to be overlapped.

When a positive value is set here, cut in operation is executed.

(The cut in operation will not be executed if this parameter is NOTset)

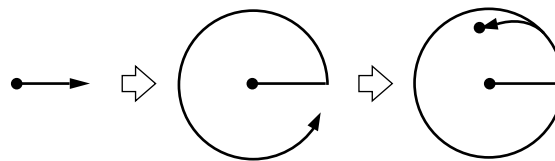
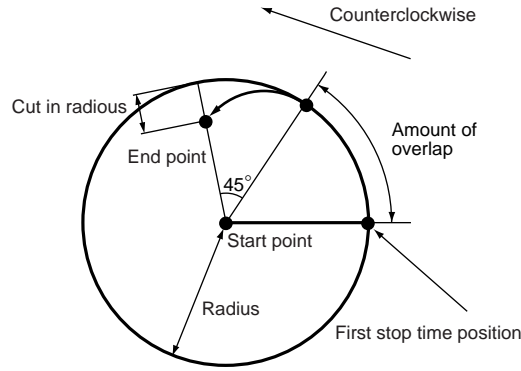
When a negative value is set here, the cutting operation ends before the end point of the pattern and the cut in operation will not be executed.

6.2 Examples of File Setting for Each Pattern

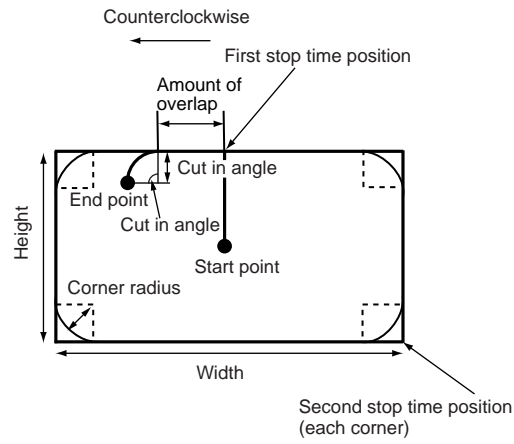
The examples of file setting for each pattern are shown.

6.2.1 Circle

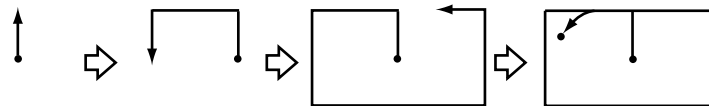
Items to be Set
RADIUS
AMOUNT OF OVERLAP



6.2.2 Rectangle Including Squares

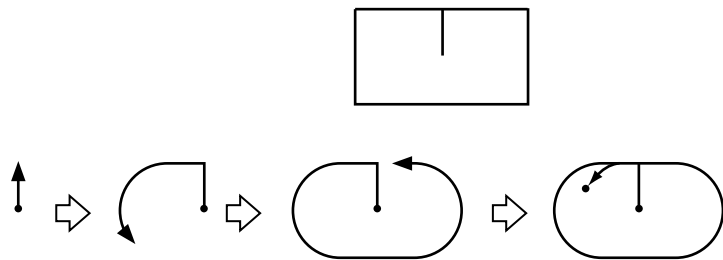
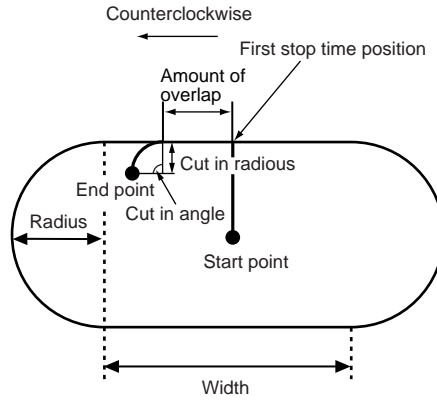


Items to be Set
WIDTH
HEIGHT
CORNER RADIUS
AMOUNT OF OVERLAP

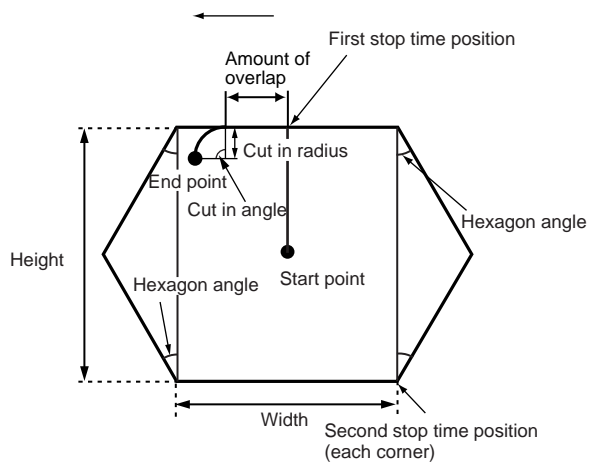


6.2.3 Ellipse

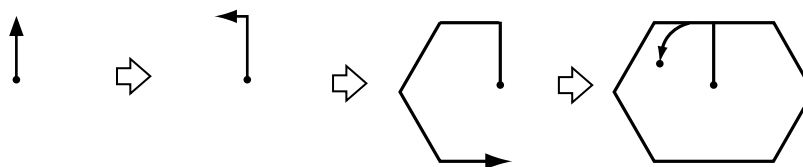
Items to be Set
RADIUS
WIDTH
AMOUNT OF OVERLAP



6.2.4 Hexagon

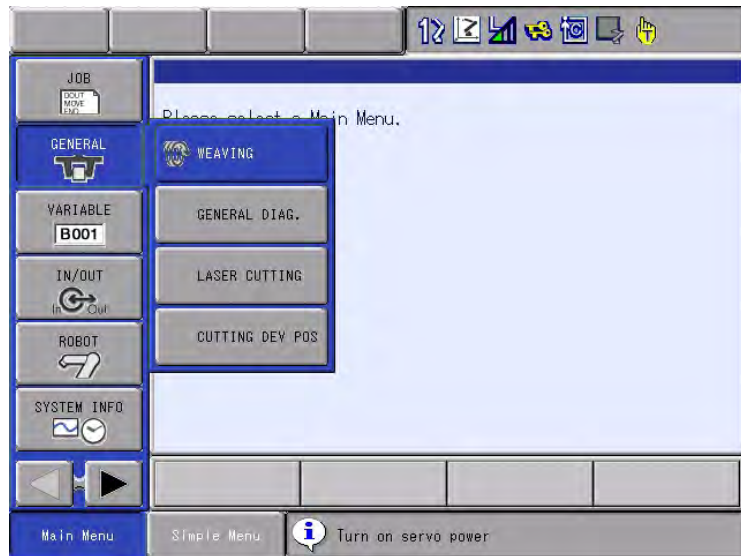


Items to be Set
WIDTH
HEIGHT
AMOUNT OF OVERLAP



6.3 Displaying and Editing File

1. Select {GENERAL} under the main menu.
 - Sub menu appears.




Main menu varies depending on the purpose of the robot.

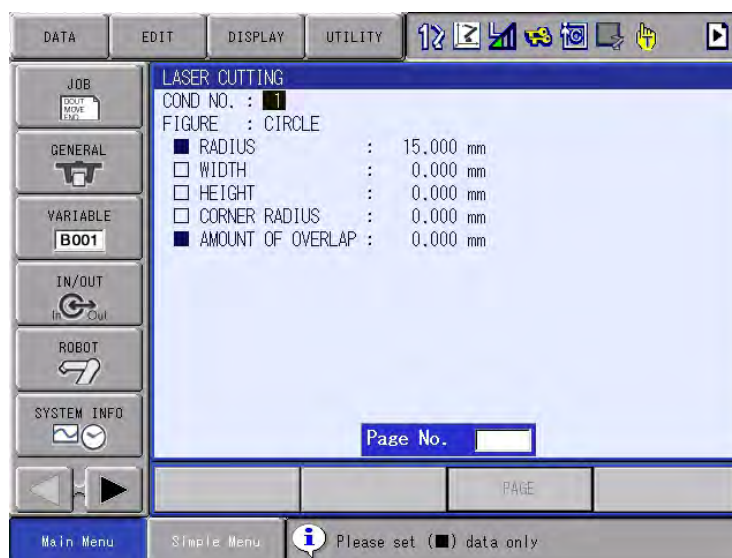


- For arc welding : {ARC WELDING}
- For handling : {HANDLING}
- For general-purpose : {GENERAL}
- For spot welding : {SPOT WELDING}

2. Select {LASER CUTTING}.



3. Press page key  or press [Page] to select a desired file No.
Press [SHIFT] + [PAGE] to call the previous robot.

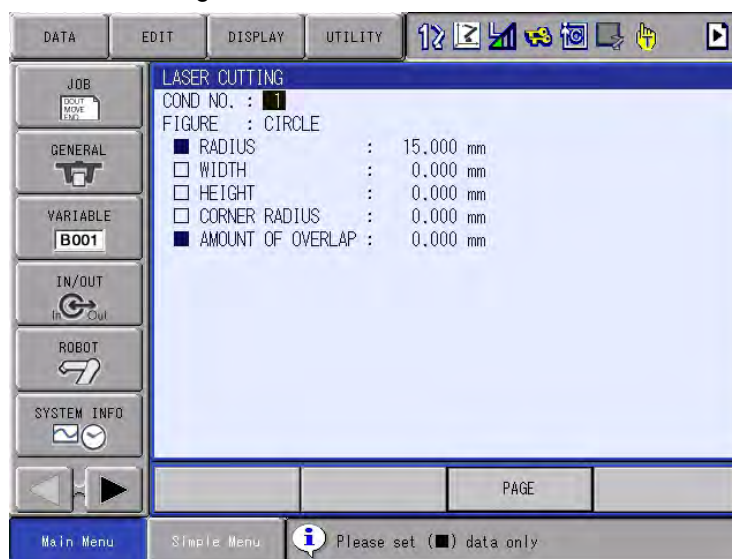


The following method can also call the desired file No.



- Enter the desired file No.
- Press [Select] after moving the cursor to the desired file No.
- Enter the desired file No. with the numeric keys, then press [ENTER].

4. Select each setting item and set.



7 Alarm Message List

Alarm Number	Message	Sub Code	Cause	Remedy
4489	DEFFECTIVE TAUGHT POINT (CUTTING)	Cannot execute CUT instruction		
		1	The pulse of C- and W-axes at the operation start point are not "0".	Teach the operation start point with "0" pulse.
		2	"0" is set to the cutting radius.	Set more than "0" value to the radius.
		3	The Cutting device is not mounted.	CUT instruction is valid only to the robot with cutting device. This robot is invalid.
		4	This robot cannot move in hexagon pattern.	Select other pattern.



DX200 OPTIONS INSTRUCTIONS

FORM CUTTING FUNCTION (FOR CUTTING DEVICE)

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