YRC1000 OPTIONS
INSTRUCTIONS
FOR FORM CUTTING FUNCTION

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

MOTOMAN INSTRUCTIONS

MOTOMAN-□□□ INSTRUCTIONS
YRC1000 INSTRUCTIONS
YRC1000 OPERATOR'S MANUAL (GENERAL) (SUBJECT SPECIFIC)
YRC1000 MAINTENANCE MANUAL
YRC1000 ALARM CODES (MAJOR ALARMS) (MINOR ALARMS)

The YRC1000 operator’s manual above corresponds to specific usage. Be sure to use the appropriate manual. The YRC1000 operator’s manual above consists of “GENERAL” and “SUBJECT SPECIFIC”. The YRC1000 alarm codes above consists of “MAJOR ALARMS” and “MINOR ALARMS”.

Please have the following information available when contacting Yaskawa Customer Support:

- System
- Primary Application
- Software Version (Located on Programming Pendant by selecting: (Main Menu) - (System Info) - (Version))
- Robot Serial Number (Located on robot data plate)
- Robot Sales Order Number (Located on controller data plate)

Part Number: 178664-1CD
Revision: 0
**DANGER**

- This manual explains the form cutting function of the YRC1000 system. Read this manual carefully and be sure to understand its contents before handling the YRC1000. Any matter, including operation, usage, measures, and an item to use, not described in this manual must be regarded as “prohibited” or “improper”.
- General information related to safety are described in “Chapter 1. Safety” of the YRC1000 INSTRUCTIONS. To ensure correct and safe operation, carefully read “Chapter 1. Safety” of the YRC1000 INSTRUCTIONS.

**CAUTION**

- In some drawings in this manual, protective covers or shields are removed to show details. Make sure that all the covers or shields are installed in place before operating this product.
- YASKAWA is not responsible for incidents arising from unauthorized modification of its products. Unauthorized modification voids the product warranty.

**NOTICE**

- 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.
NOTES FOR SAFE OPERATION

Read this manual carefully before installation, operation, maintenance, or inspection of the YRC1000.

In this manual, the Notes for Safe Operation are classified as “DANGER”, “WARNING”, “CAUTION”, or “NOTICE”.

DANGER
Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. Safety Signs identified by the signal word DANGER should be used sparingly and only for those situations presenting the most serious hazards.

WARNING
Indicates a potentially hazardous situation which, if not avoided, will result in death or serious injury. Hazards identified by the signal word WARNING present a lesser degree of risk of injury or death than those identified by the signal word DANGER.

CAUTION
Indicates a hazardous situation, which if not avoided, could result in minor or moderate injury. It may also be used without the safety alert symbol as an alternative to “NOTICE”.

NOTICE
NOTICE is the preferred signal word to address practices not related to personal injury. The safety alert symbol should not be used with this signal word. As an alternative to “NOTICE”, the word “CAUTION” without the safety alert symbol may be used to indicate a message not related to personal injury.

Even items described as “CAUTION” may result in a serious accident in some situations. At any rate, be sure to follow these important items.

NOTE
To ensure safe and efficient operation at all times, be sure to follow all instructions, even if not designated as “DANGER”, “WARNING” and “CAUTION”.
• Before operating the manipulator, make sure the servo power is turned OFF by performing the following operations. When the servo power is turned OFF, the SERVO ON LED on the programming pendant is turned OFF:
  – Press the emergency stop buttons on the front door of the YRC1000, on the programming pendant, on the external control device, etc.
  – Disconnect the safety plug of the safety fence. (when in the play mode and the remote mode)

If operation of the manipulator cannot be stopped in an emergency, personal injury and/or equipment damage may result.

Fig. : Emergency Stop Button

• Before releasing the emergency stop, make sure to remove the obstacle or error caused the emergency stop, if any, and then turn the servo power ON.

Failure to observe this instruction may cause unintended movement of the manipulator, which may result in personal injury.

Fig. : Release of Emergency Stop

• Observe the following precautions when performing a teaching operation within the manipulator's operating range:
  – Be sure to perform lockout by putting a lockout device on the safety fence when going into the area enclosed by the safety fence. In addition, the operator of the teaching operation must display the sign that the operation is being performed so that no other person closes the safety fence.
  – View the manipulator from the front whenever possible.
  – Always follow the predetermined operating procedure.
  – Always keep in mind emergency response measures against the manipulator’s unexpected movement toward a person.
  – Ensure a safe place to retreat in case of emergency.

Failure to observe this instruction may cause improper or unintended movement of the manipulator, which may result in personal injury.

• Confirm that no person is present in the manipulator's operating range and that the operator is in a safe location before:
  – Turning ON the YRC1000 power
  – Moving the manipulator by using the programming pendant
  – Running the system in the check mode
  – Performing automatic operations

Personal injury may result if a person enters the manipulator's operating range during operation. Immediately press an emergency stop button whenever there is a problem. The emergency stop buttons are located on the front panel of the YRC1000 and on the right of the programming pendant.

• Read and understand the Explanation of the Warning Labels 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>YRC1000 controller</td>
<td>YRC1000</td>
</tr>
<tr>
<td>YRC1000 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 keys, 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>Character Keys /Symbol Keys</td>
</tr>
<tr>
<td>Axis Keys /Numeric Keys</td>
<td>[Axis Key] and [Numeric Key] are generic names for the keys for axis operation and number input.</td>
</tr>
<tr>
<td>Keys pressed simultaneously</td>
<td>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>The menu displayed in the programming pendant is denoted with { }. 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 [SELECT] 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 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.

NOTE

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

Five patterns, circle, rectangle (including square), ellipse, pentagon, and hexagon are available.

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Contents</th>
<th>Initial Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1C □G63</td>
<td>Minimum set value</td>
<td>1,000 μm</td>
</tr>
<tr>
<td>S1C □G64</td>
<td>Maximum set value</td>
<td>1,000,000 μm</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Item</th>
<th>Minimum Value</th>
<th>Maximum Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circle</td>
<td>Radius</td>
<td>S1C□G63 / 2</td>
<td>S1C□G64 / 2</td>
</tr>
<tr>
<td>Rectangle</td>
<td>Width</td>
<td>1</td>
<td>( \sqrt{(S1C□G64)^2 - (Height)^2} )</td>
</tr>
<tr>
<td></td>
<td>Height</td>
<td>S1C□G63 / 2</td>
<td>( \sqrt{(S1C□G64)^2 - (Width)^2} )</td>
</tr>
<tr>
<td>Ellipse</td>
<td>Radius</td>
<td>S1C□G63 / 2</td>
<td>(S1C□G64 / 2) - (Width / 2)</td>
</tr>
<tr>
<td></td>
<td>Width</td>
<td>0</td>
<td>S1C□G64 - (2 * Radius)</td>
</tr>
<tr>
<td>Pentagon</td>
<td>Radius</td>
<td>S1C□G63 / 2</td>
<td>S1C□G64 / 2</td>
</tr>
<tr>
<td>Hexagon</td>
<td>Radius</td>
<td>S1C□G63 / 2</td>
<td>S1C□G64 / 2</td>
</tr>
</tbody>
</table>
3 Teaching

3.1 How to Teach a Pattern

Follow the example of teaching shown below to teach a motion instruction for cutting a form

* The items to be set in the form cut setting file are shown in “ “.

Teaching Position of the FORMAPR Instruction

The FORMAPR instruction is a move instruction to move to the cutting motion’s starting point, and the FORMCUT instruction is a cutting motion instruction.

Move the manipulator axis in the step where the manipulator moves to the cutting motion’s starting point and use the FORMAPR instruction to register the position which is the center of the form’s pattern to be set.

Register the FORMCUT instruction in the step where the cutting motion starts (the next step after the FORMAPR instruction).
3 Teaching
3.1 How to Teach a Pattern

By setting the “START POINT” of the form cut setting file to the center or the specified point, the FORMCUT instruction can start a cutting motion from the center of the pattern or any point near the pattern.

By pressing PLAYBACK, TEST RUN, or INTERLOCK and NEXT at the same time, the FORMAPR instruction is carried out and the manipulator moves to the center of the pattern when the center is set as the “START POINT”; or it moves to the specified point near the pattern when a specific point is set as the “START POINT”.

By pressing the NEXT or BACK, the FORMAPR instruction is carried out and the manipulator disregards the “START POINT” setting and moves to the center of the pattern.

Do not register any move instruction (MOVJ, MOVL, etc.) between the FORMAPR and FORMCUT instructions. If any move instruction is registered, normal operation is disabled or an alarm occurs.

Set the same value for both the FORMAPR and FORMCUT instruction tag values (form cut setting file No., etc.) except for “SPEED”. If the values are different, the FORMAPR instruction tag value is validated.

The speed in the FORMAPR instruction is for the speed when moving to the starting point, and the FORMCUT instruction is for the speed when cutting.
When the center is set as the “START POINT”

When a specified point is set to as the “START POINT”

When a specified point is set as the “START POINT”, the position is set with “CUT IN LENGTH” and “CUT IN ANGLE” of the form cut setting file for the starting point (a point near the pattern). Refer to Section chapter 6.2.2 “Specifying the CUT IN LENGTH and the CUT IN ANGLE”.
3 Teaching
3.1 How to Teach a Pattern

Only when the center is set as the “START POINT”, the starting point position (the center of the pattern) can be set by a move instruction (MOVL, MOVJ, etc.) other than FORMAPR instruction. If so, the FORMCUT instruction can be carried out with the registered position as the center.

* A job including a conventional FORMCUT instruction can be used by setting the center as the “START POINT”. The following shows an example of a job.

To carry out a FORMCUT instruction, in which PLACE-MENT is set as the “START POINT”, by pressing PLAYBACK, TEST RUN, or INTERLOCK and NEXT at the same time after a NEXT or BACK operation, be sure to carry out the NEXT or BACK operation several steps before the FORMCUT instruction. All the instructions between the instruction carried out by pressing the NEXT or BACK and the FORMCUT instruction must be carried out by pressing PLAYBACK, TEST RUN, or INTERLOCK and NEXT at the same time.
3.2 Tool Position and Cutting Pattern

The following figures show the relation between the tool position and the cutting pattern.

- Circle: Tool coordinate system
  - X-axis direction
  - Y-axis direction
- Rectangle: Tool coordinate system
  - Corner radius
  - Height
  - Width
- Ellipse: Tool coordinate system
  - Radius
  - Width
- Pentagon: Tool coordinate system
  - Radius
  - Y-axis
- Hexagon: Tool coordinate system
  - Radius
  - Y-axis
3.3 Cutting Width Correction Function

The cutting width correction function shifts the scale of the cutting width of the laser for the cutting path when cutting the form according to the pattern. The following parameter is used for the setting.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Contents</th>
<th>Initial Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>S3C1191</td>
<td>Cutting width correction (in units of 0.001 mm)</td>
<td>0 mm</td>
</tr>
</tbody>
</table>

Set the cutting width of the laser to 1/2 of its value. When cutting, the path is corrected by the parameter set values.

The following illustration is an example of the path correction when cutting the ellipse pattern. The correction for the motion path is similar when using the other patterns.

The center of the circle does not change before and after the cutting width correction.
### 3.4 Example of Form Cutting Function

#### 3.4.1 Example of a Job

An example of a job for cutting the following pattern is shown.

```
0000 NOP
0001 MOVJ VJ=100.00
0002 MOVJ VJ=100.00
0003 FORMAPR FCF#(1) Move to the starting point (center)
0004 CALL LASERON Instruction to a laser, etc. to start motion
0005 FORMCUT FCF#(1) Cutting motion (circle)
0006 CALL LASEROFF Instruction to a laser, etc. to end motion
0007 MOVL V=50
0008 MOVJ VJ=100.00
0009 FORMAPR FCF#(2) R=10.000 Move to the starting point (specified point)
0010 CALL LASERON Instruction to a laser, etc. to start motion
0011 FORMCUT FCF#(2) R=10.000 Cutting motion (circle)
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 FORMCUT FCF#(3) 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 FORMCUT FCF#(4) Cutting motion (ellipse)
```
3.4 Example of Form Cutting Function

0024 CALL LASEROFF·····Instruction to a laser, etc. to end motion
0025 MOVL V=50
0026 MOVJ VJ=100.00
0027 END

* Set the same file No.

3.4.2 Example of a Motion Path

By setting the "END POINT" to PATH or to PLACEMENT in the form cut setting file, the FORMCUT instruction can be used to cut in on the pattern path or inwards from the path to complete a cutting motion.

Also, the "ROTATION DIRECTION", and the "ROTATION ANGLE", etc. of the pattern can be set in the form cut setting file. (Refer to Section chapter 6 "Form Cut Setting File".)
3.4.2.1 Motion Example 1

**Conditions**

<table>
<thead>
<tr>
<th>FIGURE</th>
<th>RECTANGLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>START POINT</td>
<td>CENTER</td>
</tr>
<tr>
<td>END POINT</td>
<td>PATH</td>
</tr>
<tr>
<td>ROTATION</td>
<td>CW</td>
</tr>
</tbody>
</table>

1. The starting point is the center of pattern.

2. The manipulator moves in the direction of the Xaxis on the tool coordinate system in the positive direction.

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

4. Performs overlapping for the length specified in "AMOUNT OF OVERLAP".
3.4.2.2 Motion Example 2

**Conditions**

- FIGURE: RECTANGLE
- START POINT: PLACEMENT
- END POINT: PLACEMENT
- ROTATION: CW

1. The starting point is the point near the form cutting pattern.

2. The manipulator moves to the intersection of the cutting pattern and the X-axis direction on the tool coordinate system in the positive direction.

3. After proceeding up to the edge of the form cutting pattern, the manipulator starts drawing the specified rectangle.

4. Performs overlapping for the length specified in "AMOUNT OF OVERLAP".

5. When overlapping is completed, the manipulator moves to the end point specified by "CUT IN LENGTH" and "CUT IN ANGLE".
4 Form Cutting Start Motion Instruction

4.1 FORMAPR Instruction (Form Cutting Start Motion Instruction)

The FORMAPR instruction is to move the manipulator to the position where the form cutting motion starts according to the conditions set in the form cut setting file.

The additional items to the FORMAPR instruction are as follows. The additional items can be omitted except for “FORM CUT SETTING”.

```
FORMAPR P000 FCF#(10) R=10 W=50 H=100 V=100 ROT=90
```

1. **POSITION VARIABLES IN CENTER OF PATTERN**
   Set when the center of the form cutting pattern is registered as position variables.
   The variable number is omitted when the center of the form cutting pattern is taught to be registered.

2. **FORM CUT SETTING**
   The manipulator moves to the starting point of the cutting motion according to the conditions of the file No. specified by the FORMAPR instruction.

3. **RADIUS (mm)**
   Specifies the radius when the radius in the file conditions specified in ② should be changed.
   The radius specified in ① has a priority.

4. **WIDTH (mm)**
   Specifies the width when the width in the file conditions specified in ② should be changed.
   The width specified in ① has a priority.

5. **HEIGHT (mm)**
   Specifies the height when the height in the file conditions specified in ② should be changed.
   The height specified in ③ has a priority.

6. **APPROACH SPEED (cm/min) (mm/min) (inch/min)**
   Specifies the approach speed when the approach speed in the file conditions specified in ② should be changed.
   The approach speed in ⑥ has a priority.

7. **ROTATION ANGLE (degrees)**
   Specifies the rotational angle when the rotational angle in the file conditions specified in ② should be changed.
   The rotational angle in ⑦ has a priority.
Set the same value for both the FORMAPR and FORMCUT instruction tag values (form cut setting file No., etc.) except for “SPEED”.

If the values are different, the FORMAPR instruction tag value is validated.

The speed in the FORMAPR instruction is for the speed when moving to the starting point, and the FORMCUT instruction is for the speed when cutting.
4.2 Registering Instructions

You can register the FORMAPR instruction in two different ways depending on how the position was specified:

Registration by teaching the center position and registration by variables.

4.2.1 Registering by Teaching

1. Move the cursor to the previous line where the FORMCUT instruction to be registered.
2. Press [SHIFT] and [MOTION TYPE].
   - The FORMAPR instruction is displayed in the input buffer line.

3. Change the numerical data.
   - <Register without changing>
     Press [ADD] and then [ENTER] to register the instruction in the input buffer line without changing it.
   
   - <Edit additional items>
     - To change the numerical data of the additional items, press [SELECT] and move the cursor to the input buffer line. Then move the cursor to the number to be changed and the number is highlighted. 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.
4 Form Cutting Start Motion Instruction
4.2 Registering 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 form cut setting file, select the number of “FORM CUT FILE”.

Type the file No. in the input buffer line, press [ENTER] and the number changes.
4 Form Cutting Start Motion Instruction
4.2 Registering Instructions

- To register the form cut file No. in variables, select □.

The dialog box opens. Select the variable.
4 Form Cutting Start Motion Instruction
4.2 Registering Instructions

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

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

– To add the radius, select {UNUSED} for {RADIUS}.
A selection dialog box is displayed. Select {R=}.
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 display opens.

4. Press [ADD] and then [ENTER].
4.2.2 Registering in Variables

1. Move the cursor to the previous line where the FORMCUT instruction to be registered.
2. Press [INFORM LIST].
   - The instruction list dialog box opens.

3. Select (DEVICE).
   - The FORMAPR instruction is displayed.

4. Select (FORMAPR).
   - The (FORMAPR) instruction will be displayed in the input buffer line.
4. Form Cutting Start Motion Instruction
4.2 Registering Instructions

5. Change the numerical data.
   - Refer to Section chapter 4.2 “Registering Instructions” for how to change the numbers.

   ![Diagram]

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

   **NOTE**
   To register the center of the pattern in position variables, select the FORMAPR instruction from the [INFORM LIST].
5 Form Cutting Instruction

5.1 FORMCUT (Form Cutting Motion Instruction)

The FORMCUT instruction is to execute the form cutting motion according to the conditions set in the form cut setting file.

The additional items to the FORMCUT instruction are as follows. The additional items can be omitted except for "FORM CUT SETTING".

```
FORMCUT RB1 FCF#(10) R=10 W=50 H=100 V=100 FCR=3 ROT=90
```

1. **MANIPULATOR**
   Specifies the manipulator.

2. **FORM CUT SETTING**
   In the form cut setting file, the patterns for the form cutting motion and its dimensions, etc. are to be registered.
   The form cutting motion is executed according to the conditions of the file No. specified by the FORMCUT instruction.

3. **RADIUS (mm)**
   Specifies the radius when the radius in the file conditions specified in 1 should be changed.
   The radius specified in 3 has a priority.

4. **WIDTH (mm)**
   Specifies the width when the width in the file conditions specified in 2 should be changed.
   The width specified in 4 has a priority.

5. **HEIGHT (mm)**
   Specifies the height when the height in the file conditions specified in 2 should be changed.
   The height specified in 5 has a priority.

6. **CUTTING SPEED (cm/min) (mm/min) (inch/min)**
   Specifies the cutting speed when the cutting speed in the file conditions specified in 2 should be changed.
   The cutting speed specified in 6 has a priority.

7. **CORNER RADIUS (mm)**
   Specifies the corner radius when the corner radius in the file conditions specified in 2 should be changed.
   The corner radius in 7 has a priority.

8. **ROTATION ANGLE (degrees)**
   Specifies the rotational angle when the rotational angle in the file conditions specified in 2 should be changed.
   The rotational angle in 8 has a priority.
5 Form Cutting Instruction
5.1 FORMCUT (Form Cutting Motion Instruction)

Set the same value for both the FORMAPR and FORMCUT instruction tag values (form cut setting file No., etc.) except for “SPEED”.

If the values are different, the FORMAPR instruction tag value is validated.

The speed in the FORMAPR instruction is for the speed when moving to the starting point, and the FORMCUT instruction is for the speed when cutting.

```
0001 MOVJ VJ=100,00
0004 MOVU VU=100,00
0005 MOVU VU=100,00
0008 FORMAPR S3 F50 R=10,000 M=50,000 V=100
0007 FORMCUT S3 F50 R=10,000 M=50,000 V=50
0008 INCL V=50
0009 END
```

Move to the shelter point
Move to the starting point of the pattern
Move to the starting point
CUTTING
Move to the shelter point
5.2 Registering Instructions

1. Move the cursor to the previous line of which FORMCUT instruction to be registered.

2. Press [INFORM LIST].
   - The instruction list dialog box opens.

3. Select {DEVICE}.
   - The FORMCUT instruction is displayed.

4. Select {FORMCUT}.
   - The (FORMCUT) instruction will be displayed in the input buffer line.
5. Change the numerical data.

- <Register without changing>
  
  Press [ADD] and then [ENTER] to register the instruction in the input buffer line without changing it.

- <Edit additional items>
  
  To change the numerical data of the additional items, move the cursor to the number to be changed and the number is highlighted. 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.

- 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.
5 Form Cutting Instruction
5.2 Registering Instructions

– To change the form cut setting file, select the number of “FORM CUT FILE”.

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

The dialog box opens. Select the variable.
To change a variable No., select the variable to be changed.

To register the form cut file No. in variables, select `☑`.

Type the new variable No., press [ENTER], and the number changes.
When the additional items are added or changed, press [ENTER]. The detailed editing dialog box is closes, and the job text display opens.

To add the radius, select {UNUSED} for {RADIUS}. A selection dialog box is displayed. Select {R=}. Add or change any other items in the same manner.

6. Press [ADD] and then [ENTER].
   – The instruction displayed in the input buffer line has been registered.
6 Form Cut Setting File

The form cut setting file is to set the conditions for a form cutting motion and used in the FORMAPR and FORMCUT instructions.

Up to 200 files can be registered.

*Fig. 6-1: Form Cut Setting Files*

Set the desired form cut setting file condition No. in the FORMAPR and FORMCUT instructions.
6.1 Settings

The details of the settings in the form cut setting file are:

FORMAPR FCF#(1) V=66

Form cut setting file No. 1

FORMCUT FCF#(1)

Form cut setting file No. 1

1. FORM CUT SETTING COND NO. (1 to 200)
2. FIGURE
   Select the desired pattern.
   A circle, rectangle, ellipse, pentagon, or hexagon can be selected.
3. CUTTING SPEED
   Set the cutting speed.
4. 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 "■".
**START POINT**
Select the starting point.
The “CENTER”, “PLACEMENT” or “AUTO” are choices for selecting a starting point.
When “CENTER” is selected, the cutting motion starts from the center of the cutting pattern.
When “PLACEMENT” is selected, the cutting motion starts from a point near the cutting pattern that is defined by “CUT IN LENGTH” and “CUT IN ANGLE”.
When “AUTO” is selected, the cutting motion starts from either the point used for “CENTER” or the point used for “PLACEMENT”, depending on the dimensions of the pattern.
When the “FIGURE” is a circle, an ellipse, a pentagon or a hexagon:
The starting point is the CENTER where \( (\text{Radius} \times 2) \leq S1C \times 10^{-3} \).
The starting point is the PLACEMENT where \( (\text{Radius} \times 2) > S1C \times 10^{-3} \).
When the “FIGURE” is a rectangle:
The starting point is the CENTER where \( \text{height} \leq S1C \times 10^{-3} \).
The starting point is the PLACEMENT where \( \text{height} > S1C \times 10^{-3} \).

**END POINT**
Select the end point.
“PATH” or the “PLACEMENT” can be selected.
When “PATH” is selected, a point on the cutting pattern becomes the end point.
When the “PLACEMENT” is selected, a point near the cutting pattern that is defined by “CUT IN LENGTH” and “CUT IN ANGLE” becomes the end point.

**CUT IN LENGTH**
Set the cut in length for the cutting motion.
Valid only when “START POINT” or “END POINT” is the PLACEMENT.

**CUT IN ANGLE**
Set the cut in angle for the cutting motion.
Valid only when “START POINT” or “END POINT” is the PLACEMENT.

**AMOUNT OF OVERLAP**
Set the length to be overlapped.

**FIRST STOP TIME (sec)**
Using a timer, the manipulator can be stopped at the position to start cutting.
The first stop timer can be set for all the pattern (circle, rectangle, ellipse, pentagon, or hexagon).

**SECOND STOP TIME (sec)**
When the pattern “RECTANGLE” is selected without specification of the “CORNER RADIUS”, or when the pattern “PENTAGON” or “HEXAGON” is selected, the manipulator can be stopped at each corner.
This timer is not available for cutting other patterns.

**ROTATION DIRECTION**
Select the rotational direction.
CW or CCW can be selected.
The “ROTATION DIRECTION” defines if the rotation is clockwise or counterclockwise for the Z-axis of the tool coordinate in the positive direction when the center point of the cutting pattern is registered.
6.1 Settings

3 ROTATION ANGLE
Set the rotational angle. The “ROTATION ANGLE” uses the center point of the cutting pattern as the center of rotation. The forward direction is clockwise for the Z-axis of the tool coordinate in the positive direction when the center point of the cutting pattern is registered.
6.2 Details of File Settings

6.2.1 Specifying the ROUNDNESS ERR

The manipulator operates within the set value of “ROUNDNESS ERR” and completes a cutting motion inward from the taught path as shown by the dashed line circle in the figure below. Because the cutting speed is automatically adjusted according to the value of “ROUNDNESS ERR”, users do not need to adjust the taught speed confirming the path. To this extent, the teaching operations can be reduced.

6.2.2 Specifying the CUT IN LENGTH and the CUT IN ANGLE

When the “START POINT” or the “END POINT” of the form cut setting file is PLACEMENT, the starting point or end point of the form cutting motion is a point near the pattern.

This point is defined by the “CUT IN LENGTH” and the “CUT IN ANGLE” of the form cut setting file.
6.2.3 Specifying the ROTATION DIRECTION

Specify the rotational direction (cutting direction) for a form cutting motion. Specify the direction in “ROTATION DIRECTION”.

Pattern: Rectangle

![Clockwise and Counterclockwise patterns](image)

6.2.4 Specifying the ROTATION ANGLE

Specify the rotational angle for the center of the cutting pattern. Specify the angle in “ROTATION ANGLE”.

Figure: Rectangle
Rotation angle: 90 degrees

![Rotation by 90 degrees](image)
6.3 Examples of File Setting for Each Pattern

The examples of file setting for each pattern are shown.

6.3.1 Circle

Fig. 6-2: Example of {START POINT}: PLACEMENT, {END POINT}: PLACEMENT, {ROTATION DIRECTION}: CLOCKWISE

<table>
<thead>
<tr>
<th>Items to be Set</th>
</tr>
</thead>
<tbody>
<tr>
<td>CUTTING SPEED</td>
</tr>
<tr>
<td>RADIUS</td>
</tr>
<tr>
<td>ROUNDESS ERR</td>
</tr>
<tr>
<td>START POINT</td>
</tr>
<tr>
<td>END POINT</td>
</tr>
<tr>
<td>CUT IN LENGTH</td>
</tr>
<tr>
<td>CUT IN ANGLE</td>
</tr>
<tr>
<td>AMOUNT OF OVERLAP</td>
</tr>
<tr>
<td>FIRST STOP TIME</td>
</tr>
<tr>
<td>ROTATION DIRECTION</td>
</tr>
<tr>
<td>ROTATION ANGLE</td>
</tr>
</tbody>
</table>
6.3.2 Rectangle Including Squares

**Fig. 6-3:** Example of (START POINT): PLACEMENT, (END POINT): PLACEMENT, (ROTATION DIRECTION): COUNTERCLOCKWISE

**Items to be Set**
- CUTTING SPEED
- WIDTH
- HEIGHT
- CORNER RADIUS
- START POINT
- END POINT
- CUT IN LENGTH
- CUT IN ANGLE
- AMOUNT OF OVERLAP
- FIRST STOP TIME
- SECOND STOP TIME
- ROTATION DIRECTION
- ROTATION ANGLE
6.3.3 Ellipse

Fig. 6-4: Example of (START POINT): CENTER, (END POINT): PATH, (ROTATION DIRECTION): CLOCKWISE
6.3.4 Pentagon

Fig. 6-5: Example of {START POINT}: CENTER, {END POINT}: PLACEMENT, {ROTATION DIRECTION}: COUNTERCLOCKWISE

<table>
<thead>
<tr>
<th>Items to be Set</th>
</tr>
</thead>
<tbody>
<tr>
<td>CUTTING SPEED</td>
</tr>
<tr>
<td>RADIUS</td>
</tr>
<tr>
<td>START POINT</td>
</tr>
<tr>
<td>END POINT</td>
</tr>
<tr>
<td>CUT IN LENGTH</td>
</tr>
<tr>
<td>CUT IN ANGLE</td>
</tr>
<tr>
<td>AMOUNT OF OVERLAP</td>
</tr>
<tr>
<td>FIRST STOP TIME</td>
</tr>
<tr>
<td>SECOND STOP TIME</td>
</tr>
<tr>
<td>ROTATION DIRECTION</td>
</tr>
<tr>
<td>ROTATION ANGLE</td>
</tr>
</tbody>
</table>
6.3.5 Hexagon

Fig. 6-6: Example of {START POINT}: CENTER, {END POINT}: PLACEMENT, {ROTATION DIRECTION}: COUNTERCLOCKWISE

<table>
<thead>
<tr>
<th>Items to be Set</th>
</tr>
</thead>
<tbody>
<tr>
<td>CUTTING SPEED</td>
</tr>
<tr>
<td>RADIUS</td>
</tr>
<tr>
<td>START POINT</td>
</tr>
<tr>
<td>END POINT</td>
</tr>
<tr>
<td>CUT IN LENGTH</td>
</tr>
<tr>
<td>CUT IN ANGLE</td>
</tr>
<tr>
<td>AMOUNT OF OVERLAP</td>
</tr>
<tr>
<td>FIRST STOP TIME</td>
</tr>
<tr>
<td>SECOND STOP TIME</td>
</tr>
<tr>
<td>ROTATION DIRECTION</td>
</tr>
<tr>
<td>ROTATION ANGLE</td>
</tr>
</tbody>
</table>
6.4 Displaying and Editing File

1. Select the application menu under the main menu.
   - The application menu differs depending on the robot application:
     • For arc welding: {ARC WELDING}
     • For handling: {HANDLING}
     • For general-purpose: {GENERAL}
     • For spot welding: {SPOT WELDING}

2. Select {FORM CUT SETTING FILE}.

3. Display the file of desired condition No.
   - There are two methods to display the file of desired condition No.
     • Call the file of desired condition No. using [PAGE].
       Press [PAGE] to call the next condition No.
       Press [SHIFT]+[PAGE] to call the previous condition No.
     • Enter the desired condition No.
       Enter the desired condition No. with number keys, then press [ENTER].

4. Select each setting item and set.
## Alarm Message List

<table>
<thead>
<tr>
<th>Alarm Number</th>
<th>Alarm Name</th>
<th>Sub Code</th>
<th>Meaning</th>
<th>Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>4595</td>
<td>CAN'T DO FIXED FORM CUT MOTION</td>
<td>1</td>
<td>The setting for radius is incorrect. (1) For a circle, it is incorrectly set as: radius ≤ 0, radius &lt; minimum radius value, or radius &gt; maximum radius value. (2) For an ellipse, it is incorrectly set as: radius ≤ 0, radius &lt; minimum radius value/2, or radius &gt; (maximum radius/2 - width/2).</td>
<td>Setting error</td>
<td>(1) Check the following settings.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>· Setting of the radius data</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>2</td>
<td>The setting for width is incorrect. (1) For a rectangle, it is incorrectly set as: width &lt; 1.0, width &gt; sqrt (maximum diameter^2 - height^2), or width &gt; maximum diameter. (2) It is incorrectly set as: width &lt; 0, width &gt; maximum diameter -2 * radius.</td>
<td>Setting error</td>
<td>(1) Check the following settings.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>· Setting of the width data</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>3</td>
<td>The setting for height is incorrect. (1) For a rectangle, it is incorrectly set as: height &gt; maximum diameter, height &lt; minimum diameter/2, or height &gt; sqrt (maximum diameter^2 - width^2).</td>
<td>Setting error</td>
<td>(1) Check the following settings.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>· Setting of the height data</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>4</td>
<td>The setting for the corner radius is incorrect. (1) For a rectangle, it is incorrectly set as: corner radius &gt; width/2 or corner radius &gt; height/2.</td>
<td>Setting error</td>
<td>(1) Check the following settings.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>· Setting of the corner radius</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>5</td>
<td>The setting for overlap is incorrect. (1) For a rectangle, it is incorrectly set as overlap &gt; width/2. (2) For a circle, it is incorrectly set as overlap &gt; ABS (2π * radius). (3) For an ellipse, it is incorrectly set as overlap &gt; π * radius + ABS (width/2).</td>
<td>Setting error</td>
<td>(1) Check the following settings.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>· Setting of the overlap data</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>6</td>
<td>The setting for the cutting speed is incorrect. It is set as the cutting speed &gt; maximum linear speed.</td>
<td>Setting error</td>
<td>(1) Check the following settings.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>· Setting of the cutting speed</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>7</td>
<td>Coordinated motion cannot be used with the Form Cutting motion.</td>
<td>Setting error</td>
<td>(1) Check the following settings.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>· Do not use the coordinated motion.</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>8</td>
<td>Zero or a negative value is set in the minimum diameter parameter (S1CxG063) for the Form Cutting motion.</td>
<td>Setting error</td>
<td>(1) Check the following settings.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>· The setting of the minimum diameter parameter (S1CxG063) for the Form Cutting motion.</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>9</td>
<td>Zero or a negative value is set in the maximum diameter parameter (S1CxG064) for the Form Cutting motion.</td>
<td>Setting error</td>
<td>(1) Check the following settings.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>· The setting of the maximum diameter parameter (S1CxG063) for the Form Cutting motion.</td>
</tr>
<tr>
<td>Alarm Number</td>
<td>Alarm Name</td>
<td>Sub Code</td>
<td>Meaning</td>
<td>Cause</td>
<td>Remedy</td>
</tr>
<tr>
<td>--------------</td>
<td>------------</td>
<td>----------</td>
<td>---------</td>
<td>-------</td>
<td>--------</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td>Although “PLACEMENT” or “AUTO” is set for the start point designation on the FORM CUT SETTING window, the FORMAPR instruction was not executed.</td>
<td>Setting error</td>
<td>(1)Check the following settings. -Execute the FORMAPR instruction.</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td>The Cut file setting of the FORMAPR instruction is different from that of the FORMCUT instruction.</td>
<td>Setting error</td>
<td>(1)Check the following settings. -The Cut file settings of FORMAPR and FORMCUT instructions must be same.</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td>A FORMAPR instruction was used for the conventional FORMCUT instruction.</td>
<td>Setting error</td>
<td>(1)Check the following settings. -The FORMAPR instruction cannot be used for the conventional FORMCUT instruction. -Validate the new FORMCUT instruction.</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
<td>A form other than a circle, rectangle, and ellipse was designated for the conventional FORMCUT instruction.</td>
<td>Setting error</td>
<td>(1)Check the following settings. -A form other than a circle, rectangle, and ellipse cannot be designated for the conventional FORMCUT instruction. -Validate the new FORMCUT instruction.</td>
</tr>
<tr>
<td>90</td>
<td></td>
<td></td>
<td>The radius data setting for special circular interpolation is incorrect. It is incorrectly set as the radius ≤ 0.</td>
<td>Setting error</td>
<td>(1)Check the following settings. -Setting of the radius data</td>
</tr>
<tr>
<td>91</td>
<td></td>
<td></td>
<td>The arc center coordinates could not be calculated at special circular interpolation. Incorrect teaching may be the cause.</td>
<td>Setting error</td>
<td>(1)Check the following settings. -Setting of the teaching</td>
</tr>
<tr>
<td>93</td>
<td></td>
<td></td>
<td>The averaging time at special circular interpolation motion is too short.</td>
<td>Setting error</td>
<td>(1)Check the following settings. -Moving distance -Motion speed</td>
</tr>
<tr>
<td>94</td>
<td></td>
<td></td>
<td>Because the designated plane included reference points at special circular interpolation motion, the arc center coordinates could not be calculated. Incorrect teaching of the reference point 2 may be the cause.</td>
<td>Setting error</td>
<td>(1)Check the following settings. -Setting of the reference point 2</td>
</tr>
<tr>
<td>100</td>
<td></td>
<td></td>
<td>The arc center position is not set for the special circular interpolation motion.</td>
<td>Setting error</td>
<td>(1)Check the following settings. -Check the settings for the reference point 1 as the arc center position.</td>
</tr>
</tbody>
</table>
YRC1000 OPTIONS
INSTRUCTIONS
FOR FORM CUTTING FUNCTION

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