FS100 OPTIONS
INSTRUCTIONS

FOR EXTERNAL AXIS ENDLESS FUNCTION

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

• This instruction is applicable to both FS100 and FS100L controllers.

MOTOMAN INSTRUCTIONS

(FOR SMALL -SIZED MANIPULATORS)	(FOR LARGE AND MEDIUM-SIZED MANIPULATORS)
MOTOMAN-□□□ INSTRUCTIONS	MOTOMAN-□□□ INSTRUCTIONS
FS100 INSTRUCTIONS	FS100L INSTRUCTIONS
FS100 OPERATOR'S MANUAL	FS100 OPERATOR'S MANUAL
FS100 MAINTENANCE MANUAL	FS100L MAINTENANCE MANUAL

The FS100 OPERATOR'S MANUAL above is applicable to both FS100 and FS100L controllers.

Part Number: 160727-1CD
Revision: 1

YASKAWA

MOTOMAN ROBOTICS

MANUAL NO.

HW1480744①

![MANDATORY icon] MANDATORY

- This manual explains the external axis endless function for coordinated operation of two robots of the FS100 system. Read this manual carefully and be sure to understand its contents before handling the FS100.

- General items related to safety are listed in Chapter 1: Safety of the FS100 Instructions. To ensure correct and safe operation, carefully read the FS100 Instructions before reading this manual.

![CAUTION icon] 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.

> **NOTE**
>
> This instruction manual is applicable to both FS100 (a controller for small-sized manipulators) and FS100L (a controller for large and medium-sized manipulators).
>
> The description of "FS100" refers to both "FS100" and "FS100L" in this manual unless otherwise specified.

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Notes for Safe Operation

Read this manual carefully before installation, operation, maintenance, or inspection of the FS100.

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

⚠	**WARNING**	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury to personnel.
⚠	**CAUTION**	Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury to personnel and damage to equipment. It may also be used to alert against unsafe practices.
❗	**MANDATORY**	Always be sure to follow explicitly the items listed under this heading.
🚫	**PROHIBITED**	Must never be performed.

Even items described as "CAUTION" may result in a serious accident in some situations.

At any rate, be sure to follow these important items

NOTE	To ensure safe and efficient operation at all times, be sure to follow all instructions, even if not designated as "CAUTION" and "WARNING".

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⚠️ WARNING

- Before operating the manipulator, check that servo power is turned off when the emergency stop button on the programing pendant is pressed.
  When the servo power is turned off, the SERVO ON LED on the programing 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

- In the case of not using the programming pendant, be sure to supply the emergency stop button on the equipment. Then before operating the manipulator, check to be sure that the servo power is turned OFF by pressing the emergency stop button.
  Connect the external emergency stop button to the 5-6 pin and 16-17 pin of the robot system signal connector (CN2).

- Upon shipment of the FS100, this signal is connected by a jumper cable in the dummy connector. To use the signal, make sure to prepare a new connector, and then input it.

If the signal is input with the jumper cable connected, it does not function, which may result in personal injury or equipment damage.

- 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 EM

TURN

- Observe the following precautions when performing teaching operations within the P-point maximum envelope of the manipulator:

  – View the manipulator from the front whenever possible.

  – Always follow the predetermined operating procedure.

  – Ensure that you have a safe place to retreat in case of emergency.

Improper or unintended manipulator operation may result in injury.

The emergency stop button is located on the programing pendant.

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⚠ WARNING

- 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 FS100.

    – Moving the manipulator with the programming pendant.

    – Running the system in the check mode.

    – Performing automatic operations.

Injury may result if anyone enters the working envelope of the manipulator during operation. Always press an emergency stop button immediately if there are problems.

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⚠ 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 FS100 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 FS100 Instructions before operating the manipulator:

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Definition of Terms Used Often in This Manual

The MOTOMAN is the YASKAWA industrial robot product.

The MOTOMAN usually consists of the manipulator, the FS100 controller, manipulator cables, the FS100 programming pendant (optional), and the FS100 programming pendant dummy connector (optional).

In this manual, the equipment is designated as follows:

Equipment	Manual Designation
FS100 controller	FS100
FS100 programming pendant	Programming pendant
Cable between the manipulator and the controller	Manipulator Cable
FS100 programming pendant dummy connector	Programming pendant dummy connector

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Endless Function

Descriptions of the programming pendant keys, buttons, displays and keyboard of the PC 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 is an exception, and a picture is not shown.
	Axis Keys Numeric Keys	"Axis Keys" and "Numeric 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. SHIFTkey + COORD key
	Mode Key	Three kinds of modes that can be selected by the mode key are denoted as follows: REMOTE, PLAY, or TEACH
	Button	Three buttons on the upper side of the programming pendant are denoted as follows: HOLD button START button EMERGENCY STOP button
	Displays	The menu displayed in the programming pendant is denoted with { }. ex. {JOB}
PC Keyboard		The name of the key is denoted ex. Ctrl key on the keyboard

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   External Axis Endless Function

This function is used for endless rotation of an external axis. In order to prevent the external axis from rotating in the reversed direction for the endless rotating amount when the manipulator moves to the next step after the endless rotation has been performed, a function to reset the endless axis position to a position within one revolution is also available.

The following outlines the function.

1.1   Endless Rotation

By specifying "How many times the external axis is to be rotated" for a move instruction (MOVJ), the external axis rotates for "the specified rotating amount + the taught position pulses" during moving to the target position.

"How many times the external axis is to be rotated" is specified with "MTE" tag.

For the rotating amount, From -32768 to 32767 revolutions can be specified for one move instruction.

1.1.1   Relative motion and Absolute motion

Endless rotation has two types of motion; relative motion and absolute motion.

Relative motion enables the external axis to move to target position from taught position by rotating for the sum of the external axis rotating amount and the rotating amount of start postition.

target position = taught position

+ (external axis rotating amount + start position rotating amount)

To rotate the axis continuously, move instruction (same position) is to be registered consecutively.

When emergency stop is executed, and then restart is executed, the target position will be changed, and the external axis moves to the position from taught position by rotating from the sum of the external axis rotating amount and the rotating amount of restart position.

Absolute motion enables external axis to move to target position from taught position by rotating for the external axis rotating amount.

target position = taught position + external axis rotating amount

Even in case that the emergency stop is executed during endless rotation, and then the restart is executed, the target position is not changed.

■   **S2C710 External axis endless motion instruction**
Motion method for external axis endless function is to be set with this parameter

```
d7                      d0
┌──┬──┬──┬──┬──┬──┬──┐
│  │  │  │  │  │  │  │
└──┴──┴──┴──┴──┴──┴──┘
                    └── Endless rotation method
                         0: Relative motion
                         1: Absolute motion
```

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1.2　Resetting the Rotating Amount

To perform an interpolation after completion of endless rotation, re-create the external axis current value pulse and the motor feedback pulse at a position within one revolution in one of the following operations.

- • Execution of MRESET instruction

- • Operation from the programming pendant

The position of the endless axis after resetting the rotation angle is one of the following two areas depending on the position before reset.

When the position before reset is 0 degree or higher: 0 to 360 [degree]

When the position before reset is 0 degree or lower: -360 to 0 [degree]

<Example>
The position after reset when the endless axis is reset at a position of -120 degree between -3 to 3 revolutions.

Reset to -120 degree　　　　　　　Reset to 240 degree
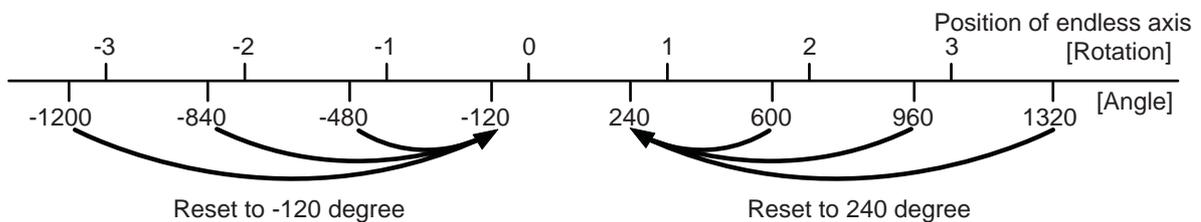
Perform teaching so that the rotation starts at a position between 0 to 360 degree when you want to rotate the axis in "+" direction or so that the rotation starts at a position between -360 to 0 degree when you want to rotate the axis in "-" direction.

When the axis is rotated "+" direction from a position between -360 to 0 degree or when the axis is rotated "-" direction from a position between 0 to 360 degree, the rotation angle and the reset rotation angle differs one rotation.
Therefore, note that the endless axis rotates one rotation when it is moved to the position before rotation or around the position.

<Example>
When the rotation angle is reset after it is rotated 4 rotations in "+" direction from the position at -120 degree:

4 rotations in "+" direction

Risetting rotation angle (3 rotations)
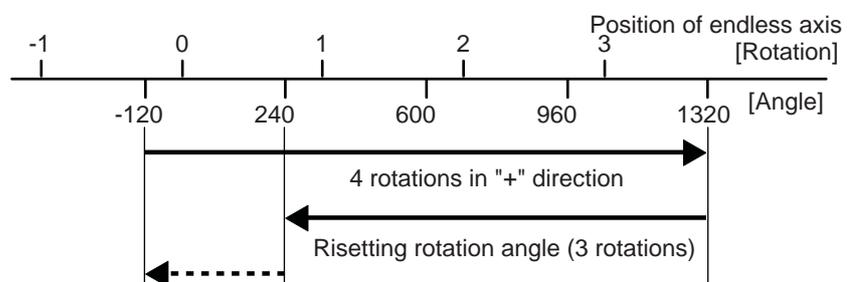
The axis rotates one rotation when the move command is executed.

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1.3   Job Example

The examples of making the job are as follows.

Line	Instruction	Contents
0000	NOP	
0001	MOVJ VJ=25.00	Normal move instruction
0002	MOVL V=500.0	Normal move instruction
0003	MOVJ VJ=25.00	Normal move instruction
0004	MOVJ VJ=25.00 MTE=100	The external axis rotates 100 times until reaching the step 4.
0005	MOVJ VJ=25.00 MTE=100	The external axis rotates 100 times until reaching the step 5. (If endless rotation method is set for absolute motion, it does not rotate.)
0006	MRESET	MRESET instruction is executed to reset the external axis position to a position within one revolution.
0007	MOVL V=500.0	Linear interpolation motion
0008	MOVJ VJ=25.00	Normal move instruction
0009	END	End of the job

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2   Instructions for external axis endless function

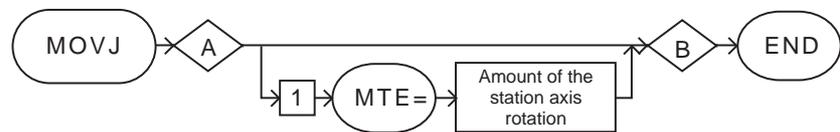## 2.1   Tag to specify the rotation axis rotation angle (MTE=)

2.1.1   Function

The endless rotation action of the station axis rotation angle is performed when the specified move command is executed.

It is set as an additional item to the move instruction.

- MOVJ

- MOVL

- MOVC

2.1.2   Construction

* Two or more tags can be set in portions ⟨A⟩ and ⟨B⟩, though the description is omitted here.

2.1.3   Explanation

No	Tag	Explanation	Note
15	MTE= Amount of the station axis rotation	Specifies the amount of the station axis rotation. The operation of the station axis can be specified by the number of rotations.	Amount of rotation:-32768 to 32767 Can be added or omitted.

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2   Instructions for external axis endless function
2.1 Tag to specify the rotation axis rotation angle (MTE=)

2.1.4   Setting of MTE

1. Move the cursor to the instruction area.

2. Select the move command to which you want to add the MTE tag.

    – The detailed edit screen will be displayed.

3. Set the station axis rotation angle.

    (1) Move the cursor to "Station axis rotation angle" and press "Select."

    (2) Move the cursor to "MTE=" and press "Select."

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2   Instructions for external axis endless function
2.1 Tag to specify the rotation axis rotation angle (MTE=)

(3) Move the cursor to the right, press "Select," enter the value using the numeric keypad, and press "Enter."

4. Press [ENTER] two times

– The set contents are registered in the job.

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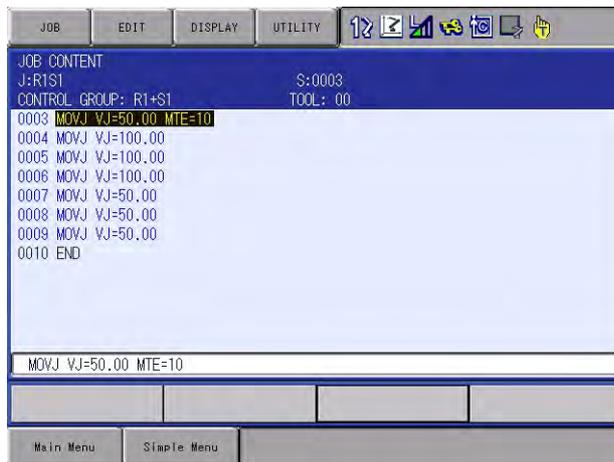
2.2 MRESET Instruction

2.2.1 Function

MRESET INST is used to reset the endless axis position to a position within one revolution.

2.2.2 Construction

```
  ┌─────────┐         ┌─────────┐
  │ MRESET  │────┬───────────┬──→│   END   │
  └─────────┘    ↓           ↑   └─────────┘
             ┌───┐  ┌──────┐
             │ 1 │→│  ST  │
             └───┘  └──────┘
```
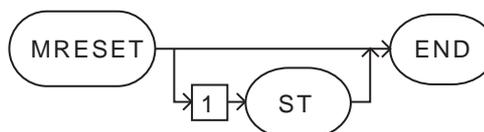
2.2.3 Explanation

No	Tag	Explanation	Note
1	Specification of external axis	Set to reset the external axis rotating amount.	No

2.2.4 Registration of MRESET instruction

Register a MRESET instruction to reset the rotating amount in the following manner.

1. Move the cursor to the address area

2. Press [INFORM LIST]

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2   Instructions for external axis endless function
2.2 MRESET Instruction

3. Select "MRESET"

(1)   Move the cursor to [OTHER] and press "Select."
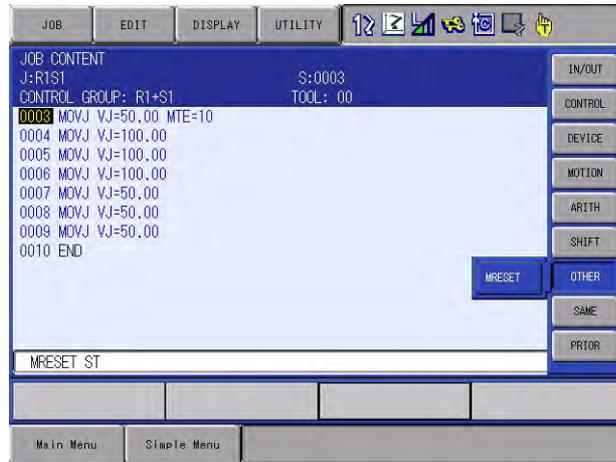
(2)   Move the cursor to [MRESET] and press "Select."

4. Press [ENTER]

– The set contents are registered in the job.

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3   Display of External Axis Rotation Amount

The rotation angle of the endless axis will be displayed.
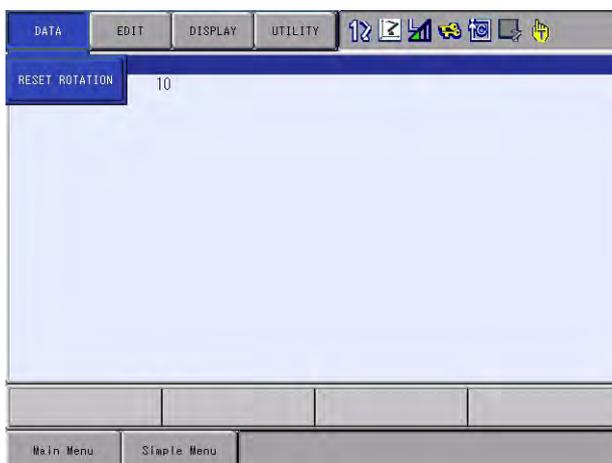
The rotation angle of the endless axis can also be reset.

3.1   Display of the rotation angle screen

1. Select {ROBOT} under the main menu

2. Select {ROTATION}

   – The rotation display window appears.

3.2   Resetting the Axis Rotation Amount

1. Select {ROBOT} under the main menu

2. Select {ROTATION}

3. Select {DATA} of the menu

   – A pull-down menu appears.

4. Select {RESET ROTATION}

   – The external rotation amount is reset to "0".

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4   Restrictions

The restrictions for the external axis endless function are as follows.

4.1   FWD and BACK Operations

During FWD and BACK operations, the external axis does not perform a continuous rotation motion.

Also when a playback is executed after having executed the FWD operation until 1 to 3 steps before the step where an endless operation is specified, the external axis does not perform a continuous rotation motion. This is because the status of FWD operation and BACK operation remains. In this case, after having executed the FWD and BACK operation, move the cursor and start the job in play mode. Thus, the external axis performs a continuous rotation motion.

Normally, when the manipulator current value coincides with the reference position value after having reached the target step by FWD or BACK operation, the cursor stops blinking. In FWD or BACK operation after the external axis continuous rotation by using playback operation, the external axis does not have the manipulator current position coincident with the reference position even after having reached the target position. Therefore, the cursor does not stop blinking. In this case, execute a MRESET instruction before FWD or BACK operation so that the cursor stops blinking when the manipulator reaches the target position.

4.2   When NWAIT is Specified

Normally, when a move instruction where a NWAIT is added is executed, the instructions that are registered before the next move instruction, are executed sequentially. However, for the MRESET instruction, NWAIT specification is not applied and the MRESET instruction is executed after completion of the move instruction.

4.3   Maximum Endless Rotating Amount

The maximum endless rotating amount can be obtained by the following equation. The amount differs depending on the endless axis resolution.

Maximum endless rotating amount = ±536870912 (pulse) / Resolution (pulse/revolution)

4.4   Execution of MRESET Instruction

Since the execution of MRESET instruction is processed for the manipulator feedback pulse, it is executed in the status that the manipulator is completely stopped.

Accordingly, it takes a several seconds to execute the MRESET instruction.

In the meantime, the manipulator does not stop and the start lamp is not unlit even by hold or changing mode operation.

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4.5   External Axis Position at Teaching

In a position where the external axis has rotated more than one time, the teaching is disabled. If teaching is executed in this state, the following error occurs.

Error 2110 : Over softlimit

When the above error occurs, reset the axis rotating amount manually.

4.6   Display of Rotating Amount

When the sign of the taught position of the MOVJ instruction where a rotating amount is specified and the sign of the rotating amount specification are different, the display value of rotating amount may be one revolution less than the specified rotating amount.

For example, when the taught position is at -1000 pulses and the rotating amount is specified to be 100 revolutions, the displayed value of rotating amount is 99 revolutions.

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5   Alarm Message List

Alarm No.	Message		Cause	
4490	DEFECTIVE TAUGHT POINT (ENDLESS)	1	One of the interpolation instructions (MOVL, MOVC, etc.) is executed after the endless rotation is completed and before MRESET is executed.	(1)Confirm the settings below. ・Execute MRESET if you want to perform one of the interpolation actions (MOVL, MOVC, etc.) after the endless rotation.
		2	The endless rotation axis is set to the basic axis. The endless function cannot be used for the basic axis.	(1)Confirm the settings below. ・Check the parameter setting for the specification of the endless rotation axis.
		3	The endless function is executed despite the endless axis has not specified.	(1)Confirm the settings below. ・Check the parameter setting for the specification of the endless rotation axis.
		4	The pulse number of the endless axis exceeds the max. pulse value (536870911).	(1)Confirm the settings below. ・Set the rotation angle so that the pulse value does not exceed the max. pulse number.

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