YASKAWA

FS100L
INSTRUCTIONS

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

MOTOMAN INSTRUCTIONS

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

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

YASKAWA ELECTRIC CORPORATION

YASKAWA

MANUAL NO. RE-CTO-A219 ②

MANDATORY

- This manual explains setup, diagnosis, maintenance, hardware, etc. of the FS100L system. Read this manual carefully and be sure to understand its contents before handling the FS100L.
- General items related to safety are listed in *chapter 1 “Safety” at page 1-1*. To ensure correct and safe operation, carefully read the chapter.

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 FS100L .

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

 DANGER	Indicates an imminent hazardous situation which, if not avoided, could result in death or serious injury to personnel.
 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 “DANGER”, “WARNING” and “CAUTION” .

WARNING

- Confirm that no person is present in the manipulator's operating range and that you are in a safe location before:
  - Turning ON the FS100L power.
  - Moving the manipulator with the programming pendant.
  - Running the system in the check mode.
  - Performing automatic operations.

Injury may result if anyone enters the manipulator's operating range during operation. Always press the emergency stop button immediately if there is a problem. The emergency stop button is located on the right of the programming pendant.

- Observe the following precautions when performing teaching operations within the manipulator's operating range:
  - Be sure to use a lockout device to the safeguarding when going inside. Also, display the sign that the operation is being performed inside the safeguarding and make sure no one closes the safeguarding.
  - 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.

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

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

Fig. : 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 FS100L, this signal is connected by a jumper cable in the dummy connector. To use the signal, make sure to supply 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.

WARNING

- 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.

Fig. : Release of Emergency Stop Button

CAUTION

- Perform the following inspection procedures prior to conducting manipulator teaching. If a problem is found, correct it and take all other necessary actions immediately.
  - Check for problems in manipulator movement.
  - Check for damage to insulation and sheathing of external wires.
- Return the programming pendant to a safe place after use.

If the programming pendant is inadvertently left on the manipulator, on a fixture, or on the floor, the manipulator or a tool may collide with the programming pendant during manipulator movement, which may result in personal injury or equipment damage.

- 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 FS100L controller, manipulator cables, the FS100L programming pendant (optional), and the FS100L programming pendant dummy connector (optional).

In this manual, the equipment is designated as follows:

Equipment	**Manual Designation**
FS100L controller	FS100L
FS100L programming pendant	Programming pendant
Cable between the manipulator and the controller	Manipulator Cable
FS100L programming pendant dummy connector	Programming pendant dummy connector

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 [ ]. e.g. [ENTER]
	Symbol Keys	The keys which have a symbol printed on them are not denoted with [ ] but depicted with a small picture. e.g. PAGE key  The cursor key 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. e.g. SHIFT key  + 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 { }. e.g. {JOB}
PC Keyboard		The name of the key is denoted. e.g. 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 brand names for each company or corporation. The indications of (R) and ^{TM} are omitted.

Explanation of Warning Labels

The following warning labels are attached to the manipulator and FS100L.

Fully comply with the precautions on the warning labels.

DANGER

- The label described below is attached to the manipulator.

Observe the precautions on the warning labels.

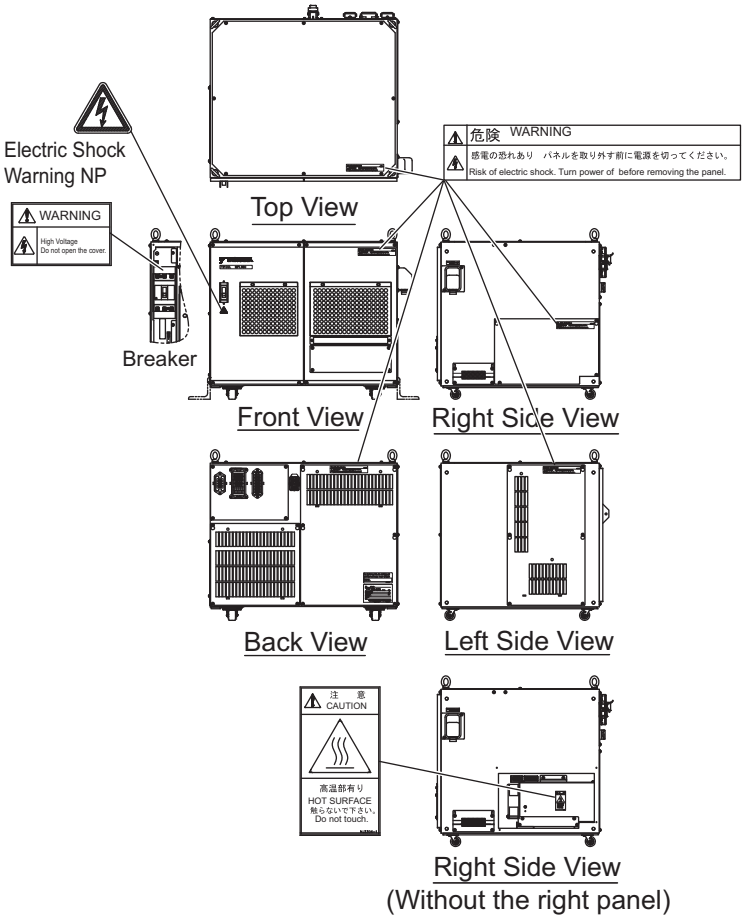
- Failure to observe this caution may result in injury or damage to equipment.

Refer to the manipulator manual for the warning label location.

- The following warning labels are attached to FS100L.

Observe the precautions on the warning labels.

Failure to observe this warning may result in injury or damage to equipment.



Contents

1 Safety 1-1

1.1 For Your Safety 1-1

1.2 Special Training 1-2

1.3 Motoman Manual List 1-2

1.4 Personnel Safety 1-3

1.5 Motoman Safety 1-5

1.5.1 Installation and Wiring Safety 1-5

1.5.2 Work Area Safety 1-10

1.5.3 Operation Safety 1-11

1.6 Notes for Moving and Transferring MOTOMAN 1-15

1.7 Notes on MOTOMAN Disposal 1-16

2 Product Confirmation 2-1

2.1 Contents Confirmation 2-1

2.2 Order Number Confirmation 2-2

3 Installation 3-1

3.1 Handling Procedure 3-1

3.1.1 When Using a Crane 3-1

3.1.2 When Using a Forklift 3-2

3.2 Place of Installation 3-3

3.3 Installation Location 3-4

3.4 Installation Method 3-5

4 Connection 4-1

4.1 Notes on Cable Connection 4-3

4.2 Power Supply 4-4

4.2.1 Three-Phase Power Supply 4-4

4.2.2 Noise Filter Installation 4-4

4.2.3 Leakage Breaker Installation 4-5

4.2.4 Primary Power Supply Breaker Installation 4-6

4.3 Connection Methods 4-7

4.3.1 Connecting Primary Power Supply 4-7

4.3.2 Connecting Manipulator Cable 4-12

4.3.3 Connecting Programming Pendant (Optional) 4-13

4.3.4 Connecting Cables for Peripheral Device 4-14

5 Turning ON and OFF Power Supply 5-1

5.1 Turning ON Main Power Supply 5-1

5.1.1 Initial Diagnosis 5-2

5.1.2 When Initial Diagnosis Is Complete 5-4

5.2 Turning ON Servo Power 5-5

5.2.1 During Play Mode 5-5

5.2.2 During Teach Mode 5-5

5.3 Turning OFF Power Supply 5-7

5.3.1 Turning OFF Servo Power (Emergency Stop) 5-7

5.3.2 Turning OFF Main Power 5-7

6 Test of Program Operation 6-1

6.1 Movement of Axes 6-3

7 Security System 7-1

7.1 Protection Through Security Mode Settings 7-1

7.1.1 Security Mode 7-1

7.1.1.1 Changing Security Mode 7-5

7.1.2 User ID 7-7

7.1.2.1 Changing User ID 7-7

8 System Setup 8-1

8.1 Home Position Calibration 8-2

8.1.1 Home Position Calibration 8-4

8.1.2 Calibrating Operation 8-5

8.1.2.1 Registering All Axes at One Time 8-5

8.1.2.2 Registering Individual Axes 8-8

8.1.2.3 Changing Absolute Data 8-9

8.1.2.4 Clearing Absolute Data 8-10

8.1.3 Home Position of Robot 8-12

8.2 Setting Second Home Position (Check Point) 8-13

8.2.1 Purpose of Position Check Operation 8-15

8.2.2 Procedure for Second Home Position Setting (Check Point) 8-17

8.2.3 Procedure After Alarm 8-19

8.3 Tool Data Setting 8-21

8.3.1 Registering Tool Files 8-21

8.3.1.1 Number of Tool Files 8-21

8.3.1.2 Registering Coordinate Data 8-22
8.3.1.3 Registering Tool Angle 8-24
8.3.1.4 Setting Tool Load Information 8-25
8.3.2 Tool Calibration 8-26
8.3.2.1 Tool Calibration 8-26
8.3.2.2 Setting of Tool Calibration Method 8-27
8.3.2.3 Teaching of Calibration Point 8-28
8.3.2.4 Clearing Calibration Data 8-34
8.3.2.5 Checking TCP 8-36
8.3.3 Automatic Measurement of Tool Load and Center of Gravity 8-38
8.3.3.1 Description of Automatic Measurement of Tool Load and Center of Gravity 8-38
8.3.3.2 Measurement of Tool Load and Center of Gravity 8-38
8.4 ARM Control 8-43
8.4.1 ARM Control 8-43
8.4.2 ARM CONTROL Window 8-43
8.4.2.1 Robot Setup Condition 8-44
8.4.3 Setting Tool Load Information 8-48
8.4.3.1 Tool Load Information 8-48
8.4.3.2 Calculating Tool Load Information 8-49
8.4.3.3 Registering Tool Load Information 8-55
8.5 Work Home Position 8-58
8.5.1 Description of Work Home Position 8-58
8.5.2 Setting Work Home Position 8-58
8.5.2.1 Work Home Position Window 8-58
8.5.2.2 Registering or Changing Work Home Position 8-60
8.5.2.3 Returning to Work Home Position 8-61
8.5.2.4 Outputting Work Home Position Signal 8-61
8.6 Interference Area 8-62
8.6.1 Description of Interference Area 8-62
8.6.2 Cubic Interference Area 8-62
8.6.2.1 Description of Cubic Interference Area 8-62
8.6.2.2 Cube Setting Method 8-63
8.6.2.3 Setting Operation 8-64
8.6.3 Axis Interference Area 8-73
8.6.3.1 Description of Axis Interference Area 8-73
8.6.3.2 Setting Operation 8-74
8.6.4 Clearing Interference Area Data 8-82
8.7 Shock Detection Function 8-84
8.7.1 Shock Detection Function 8-84
8.7.2 Shock Detection Function Setting 8-84

8.7.2.1 Shock Detection Level Setting 8-84
8.7.2.2 Tool Load Information Setting 8-89
8.7.2.3 U-Arm Payload Setting 8-89
8.7.2.4 Instruction of Shock Detection Function 8-90
8.7.2.5 Resetting Shock Detection Alarm 8-95
8.8 User Coordinate Setting 8-96
8.8.1 User Coordinates 8-96
8.8.1.1 Definition of User Coordinates 8-96
8.8.1.2 Number of User Coordinate Files 8-96
8.8.2 User Coordinate Setting 8-97
8.8.2.1 Selecting User Coordinate File 8-97
8.8.2.2 Teaching User Coordinates 8-98
8.8.2.3 Clearing User Coordinates 8-100
8.9 Releasing Overrun 8-101
8.10 Soft Limit Release Function 8-103
8.11 All Limit Release Function 8-104
8.12 Instruction Level Setting 8-106
8.12.1 Setting Contents 8-106
8.12.1.1 Instruction Set 8-106
8.12.1.2 Learning Function 8-107
8.12.2 Setting Instruction Set Level 8-108
8.12.3 Setting Learning Function 8-109
8.13 Setting Controller Clock 8-110
8.14 Setting Play Speed 8-111
8.15 Numeric Key Customize Function 8-113
8.15.1 Description of Numeric Key Customize Function 8-113
8.15.2 Allocatable Functions 8-113
8.15.2.1 Key Allocation (EACH) 8-113
8.15.2.2 Key Allocation (SIM) 8-114
8.15.3 Allocating Operation 8-115
8.15.3.1 Allocation Window 8-115
8.15.3.2 Instruction Allocation 8-116
8.15.3.3 Job Call Allocation 8-118
8.15.3.4 Display Allocation 8-119
8.15.3.5 Alternate Output Allocation 8-120
8.15.3.6 Momentary Output Allocation 8-121
8.15.3.7 Pulse Output Allocation 8-122
8.15.3.8 Group (4-bit/8-bit) Output Allocation 8-123
8.15.3.9 Analog Output Allocation 8-124
8.15.3.10 Analog Incremental Output Allocation 8-125

8.15.4 Allocation of I/O Control Instructions 8-126
8.15.5 Execution of Allocation 8-128
8.15.5.1 Executing Instruction/Output Control Allocation 8-128
8.15.5.2 Executing Job Call Allocation 8-128
8.15.5.3 Executing Display Allocation 8-128
8.15.5.4 Executing I/O Control Allocation 8-128
8.16 Changing Output Status 8-129
8.17 Changing Parameter Setting 8-131
8.18 File Initialization 8-134
8.18.1 Initializing Job File 8-134
8.18.2 Initializing Data File 8-135
8.18.3 Initializing Parameter File 8-137
8.18.4 Initializing I/O Data 8-139
8.18.5 Initializing System Data 8-141
8.19 Display Setting Function 8-143
8.19.1 Font Size Setting 8-143
8.19.1.1 Applicable Range for Font Size Change 8-143
8.19.1.2 Settable Font Size 8-143
8.19.1.3 Setting Font Size 8-144
8.19.2 Operation Button Size Setting 8-148
8.19.2.1 Applicable Range for Button Size Change 8-148
8.19.2.2 Settable Button Size 8-148
8.19.2.3 Setting Button Size 8-149
8.19.3 Initialization of Screen Layout 8-153
8.19.3.1 Initializing Screen Layout 8-153
8.19.4 Saving Layout 8-155
8.20 Hand Vibration Control Function 8-156
8.20.1 Description of Hand Vibration Control Function 8-156
8.20.2 Supported Models 8-156
8.20.3 Setting Hand Vibration Control Function 8-157
8.21 Manual Brake Release Function 8-159
8.21.1 Outline 8-159
8.21.2 Manual Brake Release Procedure 8-160
8.21.3 Warning Message 8-162
9 System Backup 9-1
9.1 System Backup with FS100L 9-1
9.1.1 Function Types of Data 9-1

9.1.1.1 CMOS.BIN 9-1
9.1.1.2 CMOSBK.BIN 9-1
9.1.1.3 CMOSxx.HEX 9-1
9.1.1.4 ALCMSxx.HEX 9-1
9.1.2 Device 9-2
9.2 Backup by CMOS.BIN 9-3
9.2.1 CMOS.BIN Save 9-4
9.2.2 CMOS.BIN Load 9-6
9.3 Automatic Backup Function 9-9
9.3.1 Automatic Backup Function 9-9
9.3.1.1 Objective 9-9
9.3.1.2 Outline 9-9
9.3.2 Settings for Automatic Backup 9-11
9.3.2.1 CompactFlash 9-11
9.3.2.2 USB Device of Main CPU Board 9-12
9.3.2.3 AUTO BACKUP SET Display 9-13
9.3.2.4 FS100L Status and Automatic Backup 9-17
9.3.2.5 Setting Examples 9-19
9.4 Restoring Backup Data 9-20
9.4.1 Restoring Procedure 9-20
9.5 Error List 9-23
9.5.1 Error Contents 9-23
9.6 Restoring FS100L Controller 9-24
9.6.1 Data Backup and Program Upload 9-24
9.6.1.1 Backup Medium Preparation 9-24
9.6.1.2 Backup by Batch Operation 9-27
9.6.1.3 Data Backup by Individual Operation 9-30
9.6.1.4 Program Upload 9-33
9.6.2 Restoration Procedure 9-36
9.6.2.1 Preparation of Programming Pendant 9-36
9.6.2.2 Preparation of Device for Writing System Program 9-36
9.6.2.3 Restoration by a Batch Operation 9-37
9.6.2.4 Writing System Program 9-39
9.6.2.5 Writing Backup Data 9-40
9.7 Error Indication 9-42

10 Upgrade Function 10-1
10.1 Functional Overview 10-1
10.2 Upgrade Procedure 10-1
10.2.1 Confirmation of Software Version of Main CPU and Programming Pendant ... 10-1

10.2.2 Automatic Upgrade 10-2

11 Modification of System Configuration 11-1

11.1 Addition of I/O Modules 11-1

11.2 Addition of Base and Station Axes 11-4

11.2.1 Base Axis Setting 11-6
11.2.1.1 Selection of Base Axis Type 11-6
11.2.1.2 Connection Setting 11-9
11.2.1.3 Axis Configuration Setting 11-12
11.2.1.4 Mechanical Specification Setting 11-14
11.2.1.5 Motor Specification Setting 11-16

11.2.2 Station Axis Setting 11-18
11.2.2.1 Selection of Station Axis Type 11-18
11.2.2.2 Connection Setting 11-20
11.2.2.3 Axis Configuration Setting 11-22
11.2.2.4 Mechanical Specification Setting 11-24
11.2.2.5 Motor Specification Setting 11-27

12 FS100L Specification 12-1

12.1 Specifications of FS100L 12-3

12.2 Functions of FS100L 12-4

12.3 Specifications of Programming Pendant 12-6

12.4 Equipment Configuration of FS100L 12-7

12.4.1 Arrangement of Units and Circuit Boards 12-7

12.5 Arrangement of FS100L when IP40 Specification (Optional) 12-8

13 Description of Units and Circuit Boards 13-1

13.1 CPU Unit 13-4

13.1.1 CPU Unit Configuration 13-4

13.1.2 Circuit Board in CPU Unit 13-5
13.1.2.1 Control Circuit Board 13-5
13.1.2.2 Power Relay Circuit Board (JEPMC-PSD3007R-E) 13-5
13.1.2.3 Circuit Board Rack (JEPMC-BUB3008R-E) 13-5

13.2 Machine Safety Circuit Board 13-6

13.2.1 Machine Safety Circuit Board (JAPMC-SF2300R-E) 13-6

13.2.2 Connection for Robot System Input/Output Signal 13-7
13.2.2.1 Connection for Protection Stop (PSTOP) Signal 13-8
13.2.2.2 Connection for Safeguarding (Safety Plug) (SAFF) Signal 13-9
13.2.2.3 Connection for External Emergency Stop (EXESP) Signal 13-11
13.2.2.4 Connection for Emergency Stop Output (ESPOUT) Signal 13-12
13.2.2.5 Connection for Programming Pendant Emergency Stop Contact Output

(PPESP) Signal 13-13
13.2.3 Connection for External Axis Overrun 13-14
13.3 CPS Unit (JZNC-YPS01-E) 13-15
13.4 Brake Control Board (JANCD-YBK01-2E) 13-16
13.4.1 Brake Control Board (JANCD-YBK01-2E) 13-16
13.5 Power Supply Contactor Unit (JZRCR-YPU31 □ -1) 13-17
13.6 Converter 13-18
13.7 SERVOPACK 13-19
13.7.1 PWM Amplifier 13-19
13.7.2 Major Axes Control Circuit Board (SRDA-EAXA01□) 13-22
13.7.3 Connection for Direct-in Signal 13-23
13.8 System I/O Circuit Board 13-24
13.9 User I/O Circuit Board 13-25
13.9.1 Connection for External Power Supply for Input/Output 13-27
13.9.2 Protection by External Fuse 13-28
13.9.2.1 Protection by External Fuse in Common Line of Output Signal 13-28
13.9.3 Input/Output Connector (CN1, CN2) 13-30
13.9.3.1 User Input/Output Connector (CN1) 13-30
13.9.3.2 System Input/Output Connector (CN2) 13-30
13.9.4 Enabling External Hold 13-34
13.10 User I/O Circuit Board (Optional) 13-37
13.10.1 Connection for External Power Supply for Input/Output 13-39
13.10.2 Protection by External Fuse 13-40
13.10.2.1 Protection by External Fuse in Common Line of Output Signal 13-40
13.10.3 Input/Output Connector (CN1, CN2) 13-42
13.10.3.1 User Input/Output Connector (CN1) 13-42
13.10.3.2 System Input/Output Connector (CN2) 13-42
13.10.4 Enabling External Hold 13-46

1 Safety

1.1 For Your Safety

Robots generally have requirements which are different from other manufacturing equipment, such as larger working areas, high-speed operation, rapid arm movements, etc., which can pose safety hazards.

Read and understand the instruction manuals and related documents, and observe all precautions in order to avoid the risk of injury to personnel and damage to equipment.

It is the user's responsibility to ensure that all local, state, and national codes, regulations rules, or laws relating to safety and safe operating conditions are met and followed.

MANDATORY

- Teaching maintenance of the robot must conform to:
  - Industrial Safety and Health Law
  - Enforcement Order of Industrial Safety and Health Law
  - Ordinance of Industrial Safety and Health Law

Other related laws are:

  - Occupational Safety and Health Act in USA
  - Factory Act (Gewerbeordnung) in Germany
  - Health and Safety at Work, etc. Act in UK
  - EC Machinery Directive 98/37/EC
- Prepare
  - Safety Work Regulations

based on concrete policies for safety management complying with related laws.

- Observe
  - Robots for Industrial Environments - Safety Requirements (ISO 10218)
  - Manipulating Industrial Robots - Safety (Japan only) (JIS B 8433)

for safe operation of the robot.

- Reinforce the
  - Safety Management System

by designating authorized workers and safety managers, as well as giving continuing safety education.

- Teaching and maintaining the robot are specified as "Hazardous Operations" in the Industrial Safety and Health Law (Japan only).

Workers employed in these above operations are requested to attend special training offered by YASKAWA.

1.2 Special Training

MANDATORY

- Persons who teach or inspect the manipulator must undergo required training before using the manipulator.
- For more information on training, inquire at the nearest YASKAWA branch office.

The telephone numbers are listed on the back cover of this manual.

1.3 Motoman Manual List

MANDATORY

- It is important to have and be familiar with all manuals concerning the MOTOMAN.

You should have the four manuals listed below:

– MOTOMAN-□□□ INSTRUCTIONS

– FS100L INSTRUCTIONS

– FS100L MAINENANCE MANUAL

– FS100 OPERATOR'S MANUAL

Confirm that you have all these manuals on hand.

If any manuals are missing, contact your salesman from YASKAWA's local branch office.

The relevant telephone numbers are listed on the back cover.

1.4 Personnel Safety

The entire manipulator's operating range is potentially dangerous.

All personnel working with the MOTOMAN (safety administration, installation, operation, and maintenance personnel) must always be prepared and "Safety First" minded, to ensure the safety of all personnel.

WARNING

- Avoid any dangerous actions in the area where the MOTOMAN is installed.

Failure to observe this caution may result in personal injury due to contact with the manipulator or peripheral equipment.

- Please take strict safety precautions by placing signs such as "Flammable", "High Voltage", "Warning", and "Off-limits to Unauthorized Personnel" in necessary areas in the factory.

Failure to observe this caution may result in fire, electric shock, or personal injury due to contact with the manipulator and other equipment.

- Strictly observe the following items:
  - Always wear approved work clothes (no loose-fitting clothes).
  - Do not wear gloves when operating the MOTOMAN.
  - Do not allow underwear, shirts, or neckties to hang out from the work clothes.
  - Do not wear large jewelry, such as earrings, rings, or pendants.

Always wear protective safety equipment such as helmets, safety shoes (with slip-proof soles), face shields, safety glasses, and gloves as necessary.

Improper clothing may result in injury.

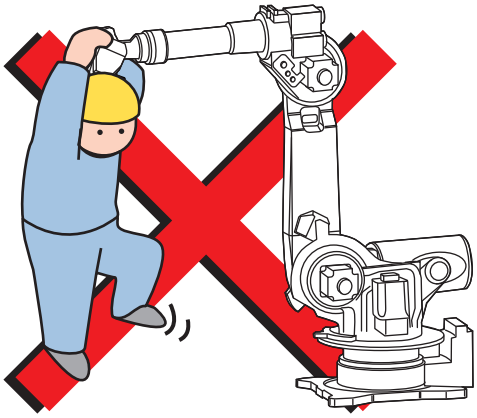
- Unauthorized persons should not approach the manipulator or associated peripheral equipment.

Failure to observe this caution may result in personal injury due to contact with the FS100L, controller, workpiece, positioner, etc.

CAUTION

- Never forcibly move the manipulator axes.

Failure to observe this caution may result in personal injury or equipment damage.

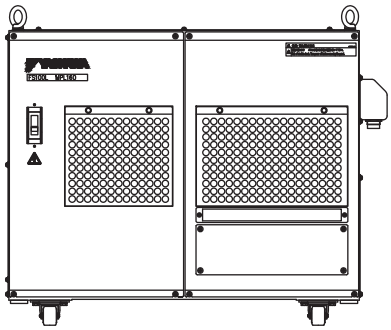


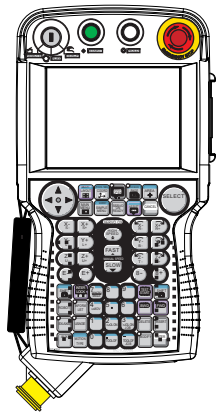
- Never climb/sit on the FS100L.

Failure to observe this caution may result in personal injury or equipment damage.

- Avoid inadvertently pushing switches/buttons of the FS100L/ programming pendant.

Failure to observe this caution may result in personal injury or equipment damage due to unexpected movement of the manipulator.





- Never allow unauthorized personnel to touch the FS100L during operation.

Failure to observe this caution may result in personal injury or equipment damage due to unexpected movement of the manipulator.

1.5 Motoman Safety

1.5.1 Installation and Wiring Safety

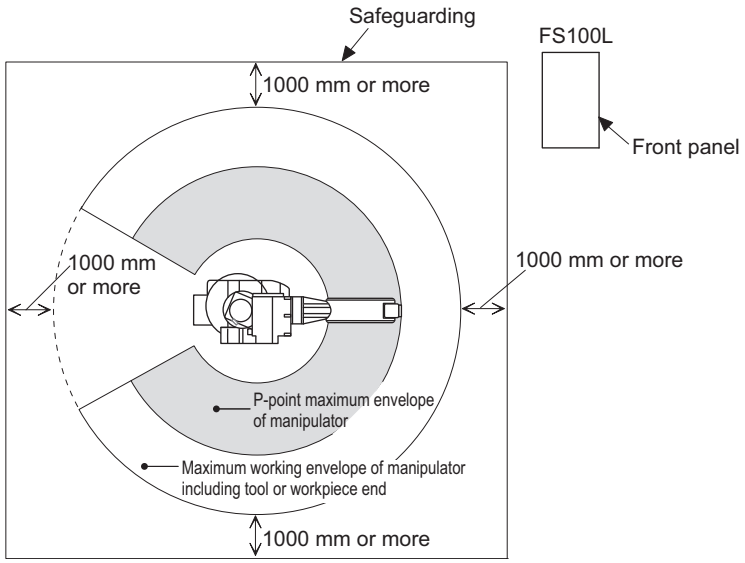
Refer to the MOTOMAN-□□□ Instructions manual and FS100L Instructions for details on installation and wiring.

In planning installation, adapt an easy to observe arrangement to ensure safety. Take safety into consideration when planning the installation. Observe the following when installing the manipulator:

WARNING

- Select an area such as that described below to install the manipulator:
  Confirm that the area is large enough so that the fully extended manipulator arm with tool will not reach a side wall, safeguarding, or the controller.

Failure to observe this warning may result in personal injury or equipment damage due to unexpected movement of the manipulator.



- Perform grounding in accordance with all applicable electrical codes.

Failure to observe this warning may result in fire or electric shock.

CAUTION

- Operation of the crane, sling, or forklift should only be performed by authorized personnel.

Failure to observe this caution may result in personal injury or equipment damage.

CAUTION

- As a rule, the manipulator should be lifted and moved by a crane.
  - Make sure to fix the manipulator with the shipping bolts and brackets, and lift it in the posture as shown in each manipulator's instruction manual.
  - Use wire ropes threaded through the shipping bolts and brackets or the attached eyebolts to lift up the manipulator.

Failure to observe this caution may cause the manipulator to fall, which may result in personal injury or equipment damage.

- As a rule, the FS100L should be lifted and moved by a crane.
- When moving the FS100L, use wire rope strings that are appropriate for its mass.

Table 1-1: Approximate Mass of FS100L

Built-in transformer	**Approx. Mass (kg)**
Equipped	100
Not equipped	170

- Use eyebolts for transporting the FS100L. Before lifting the FS100L up, check that the eyebolts are securely fastened.

Failure to observe these cautions may cause the FS100L to fall down, which may result in personal injury or equipment damage.

- Avoid excessive vibration or shock during handling and transporting.
  (Avoid the impact of 10G or more.)

Failure to observe this caution may result in equipment damage.

- If storing the manipulator temporarily before installation, make sure to place it on a stable and flat surface, and take precautions to prevent unauthorized personnel from touching it.

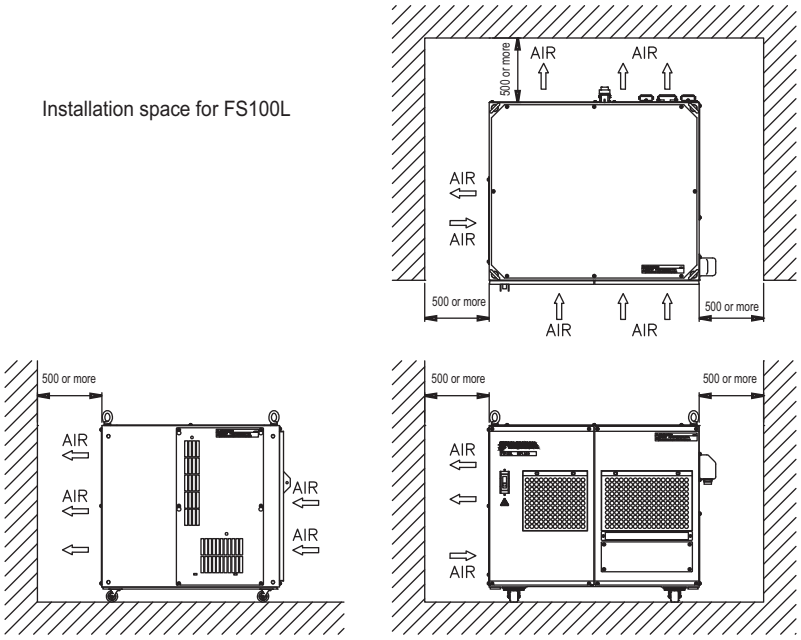
Failure to observe this caution may cause the manipulator to fall, which may result in personal injury.

CAUTION

- Make sure that there is sufficient room for maintenance on the manipulator, FS100L, and other peripheral equipment.

Failure to observe this caution may result in personal injury during maintenance.

Installation space for FS100L



Unit: mm

- To ensure safety, make sure to operate the controller from a location where the manipulator is easily visible.

Operation by unauthorized personnel may result in personal injury or equipment damage.

- Install the FS100L outside the safeguarding of the manipulator's safety enclosure.

Failure to observe this caution may result in personal injury or equipment damage due to contact with the manipulator.

- Do not get on top of the FS100L.

Failure to observe this caution may result in personal injury or equipment damage.

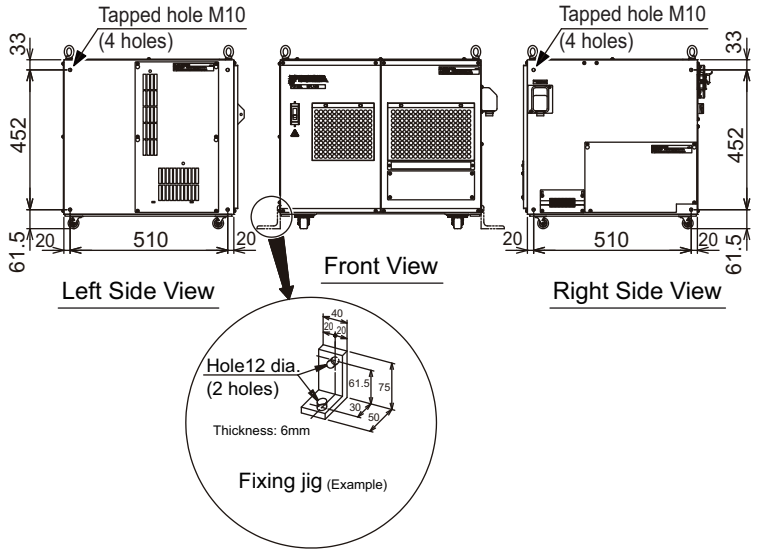
- Install the manipulator using bolts of the size and type specified in each manipulator's instruction manual.

Failure to observe this caution may cause the manipulator to fall, which may result in personal injury or equipment damage.

CAUTION

- After installation, fix the FS100L on the floor or base by using the screws shown below.

Failure to observe this caution may cause the FS100L to fall, which may result in personal injury or equipment damage.



- Up to 2 units of the FS100L can be stacked together on the flat floor. When stacking, remove casters attached to the upper side FS100L.
  Be sure to securely fix the upper and lower FS100Ls together by using the screws on the left and right sides so that the FS100Ls do not move apart.

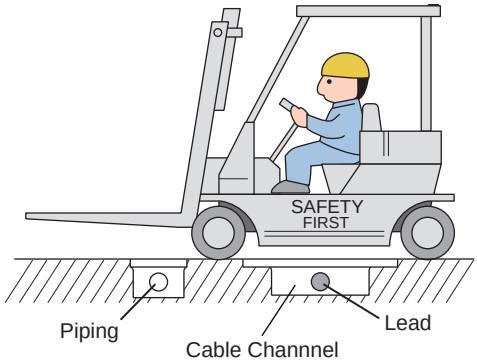
Failure to observe this caution may cause the FS100L to drop or fall, which may result in personal injury or equipment damage.

- Be familiar with the connection diagram before wiring the FS100L, and perform the wiring in accordance with the connection diagram.

Failure to observe this caution may result in personal injury or equipment damage due to miswiring or unexpected movement of the manipulator.

CAUTION

- Take precautions when wiring and piping between the FS100L, manipulator, and peripheral equipment. Run the piping, wiring, or cables through a pit or use a protective cover, so that they are not stepped on by personnel or run over by the forklift.



Operators and other personnel may stumble on exposed wiring or piping. Cable damage may cause unexpected manipulator motion resulting in personal injury or equipment damage.

1.5.2 Work Area Safety

Carelessness contributes to serious accidents in the work area.

To ensure safety, enforce the following precautions:

WARNING

- Install a safeguarding around the manipulator to prevent any accidental contact with the manipulator while the power is ON. Post a warning sign stating “Off-limits During Operation” at the entrance of the enclosure. The gate of the safeguarding must be equipped with a safety interlock. Be sure the interlock operates correctly before use.

Failure to observe this warning may result in a serious accident due to contact with the manipulator.

CAUTION

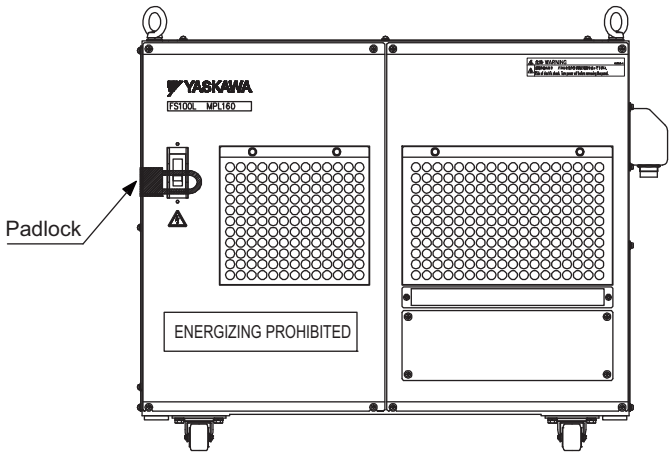
- Store tools and similar equipment in proper locations outside of the enclosure.

Tools and loose equipment should not be left on the floor around the manipulator, FS100L, or welding fixture, etc., as injury or damage to equipment can occur if the manipulator comes in contact with objects or equipment left in the work area.

1.5.3 Operation Safety

MANDATORY

- When connecting the FS100L and the manipulator or peripheral devices or when executing maintenance operation, do not fail to turn OFF the power supply of the FS100L and padlock the switch part.
  Also, put up a warning sign, such as “ENERGIZING PROHIBITED”.



Turning the power ON improperly during work may result in electric shock or personal injury due to unexpected movement of the manipulator.

WARNING

- Never exceed the rated capacity of the manipulator described in the specifications section of the manipulator manual.

Failure to observe this warning may result in personal injury or equipment damage.

- Teach jobs from outside the manipulator’s work area whenever possible.

- Observe the following precautions when performing teaching operations within the manipulator’s operating range:
  - Be sure to use a lockout device to the safeguarding when going inside. Also, display the sign that the operation is being performed inside the safeguarding and make sure no one closes the safeguarding.
  - Always view the manipulator from the front
  - Always follow the predetermined operating procedure.
  - Always have an escape plan in mind in case the manipulator comes toward you unexpectedly.
  - Ensure that you have a safe place to retreat in case of emergency.

Improper or unintentional manipulator operation may result in injury.

WARNING

- Before operating the manipulator, check that the SERVO ON lamp on the programming pendant turns OFF when the emergency stop button on the programming pendant or on the external control device, etc. is pressed.

Personal injury or equipment damage may result if the manipulator cannot be stopped in case of emergency.

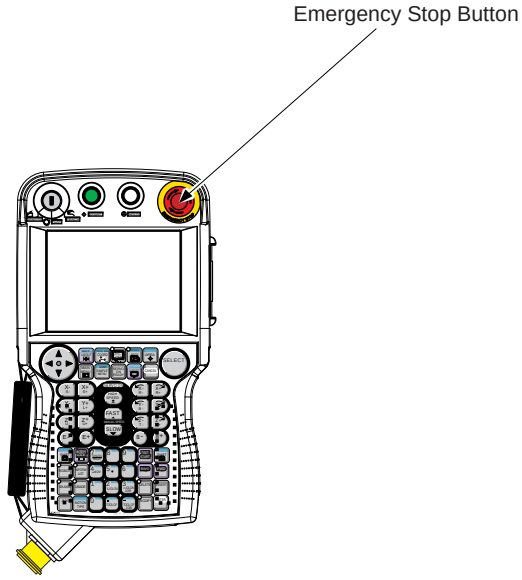
- In the case of not using the programming pendant, be sure to supply the emergency stop button on the equipment. Then before operating the manipulator, check to be sure that the servo power is turned OFF by pressing the emergency stop button.
  Connect the external emergency stop button to the 5-6 pin and 16-17 pin of the robot system signal connector (CN2).
- Upon shipment of the FS100L, this signal is connected by a jumper cable in the dummy connector. To use the signal, make sure to supply 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.

WARNING

- Confirm that no person is present in the manipulator's operating range and that you are in a safe location before:
  - Turning ON the FS100L power.
  - Moving the manipulator with the programming pendant.
  - Running the system in the check mode.
  - Performing automatic operations.

Injury may result if anyone enters the manipulator's operating range during operation. Always press the emergency stop button immediately if there is a problem. The emergency stop button is located on the top right of the programming pendant.



Programming Pendant

- 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 FS100L, this signal is connected by a jumper cable in the dummy connector. To use the signal, make sure to supply 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.

CAUTION

- Perform the following inspection procedures prior to conducting manipulator teaching. If a problem is found, correct it and implement all other necessary measures immediately.
  - Check for problems in manipulator movement.
  - Check for damage to insulation and sheathing of external wires.
- Alalways return the programming pendant to a safe place after use.

If the programming pendant is inadvertently left on the manipulator, on a fixture, or on the floor, the manipulator or a tool may collide with the programming pendant during manipulator movement, which may result in personal injury or equipment damage.

MANDATORY

- Persons operating or inspecting the manipulator should be trained as required by applicable laws and company policies.
  - Refer to *chapter 1.2 “Special Training” at page 1-2.*

1.6 Notes for Moving and Transferring MOTOMAN

When moving or transferring the Motoman, observe the following safety precautions:

CAUTION
• Attach the instructions to the controller cabinet so that all users have access to necessary manuals. See *chapter 1.3 "Motoman Manual List" at page 1-2* for a complete list of manuals. If any manual is missing, contact your Yaskawa representative.
• If the warning labels on the manipulator and FS100L are illegible, clean the labels so that they can be read clearly. Note that some local laws may prohibit equipment operation if safety labels are not in place. Contact your Yaskawa representative if you require new warning labels.
• When the MOTOMAN is transferred, it is recommended to check with Yaskawa Engineering Co. which is listed on the back cover of this manual. Incorrect installation or wiring may result in personal injury or equipment damage.

1.7 Notes on MOTOMAN Disposal

PROHIBITED

- Never modify the manipulator or FS100L.

Failure to observe this may result in personal injury or equipment damage due to fire, power failure, or operation error.

CAUTION

- When disposing of the MOTOMAN, follow the applicable national or local laws and regulations.
- Anchor the manipulator well, even when temporarily storing it before disposal.

Failure to observe this caution may result in injury due to the manipulator falling down.

2 Product Confirmation

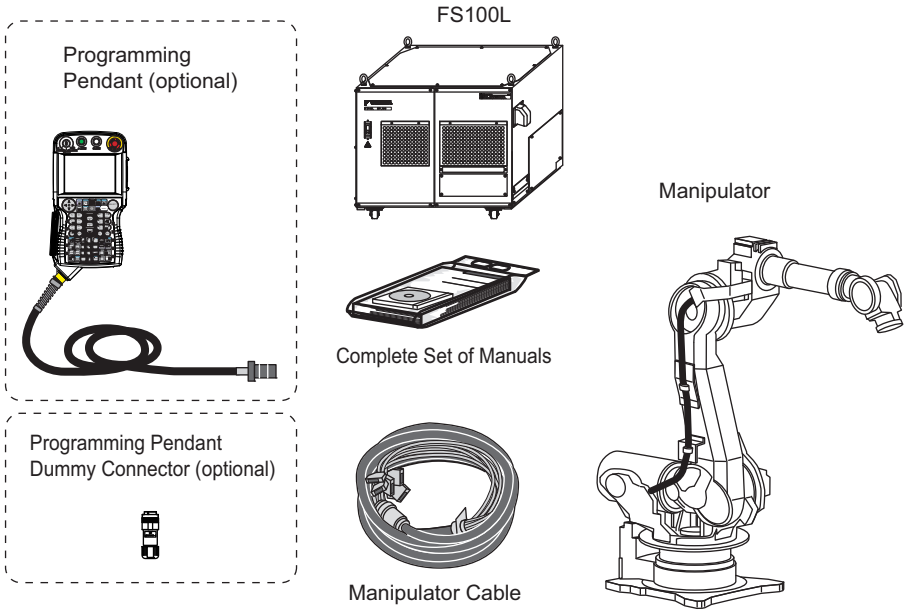
2.1 Contents Confirmation

Confirm the contents of the delivery when the product arrives.

Standard delivery includes the following four (five or six) items (information for the content of optional goods is given separately):

- Manipulator
- FS100L (including spare parts)
- Manipulator cable (between manipulator and FS100L)
- Complete set of manuals
- Programming pendant (optional)
- Programming pendant dummy connector (optional)

Fig. 2-1: Standard Four (Five or Six) Items

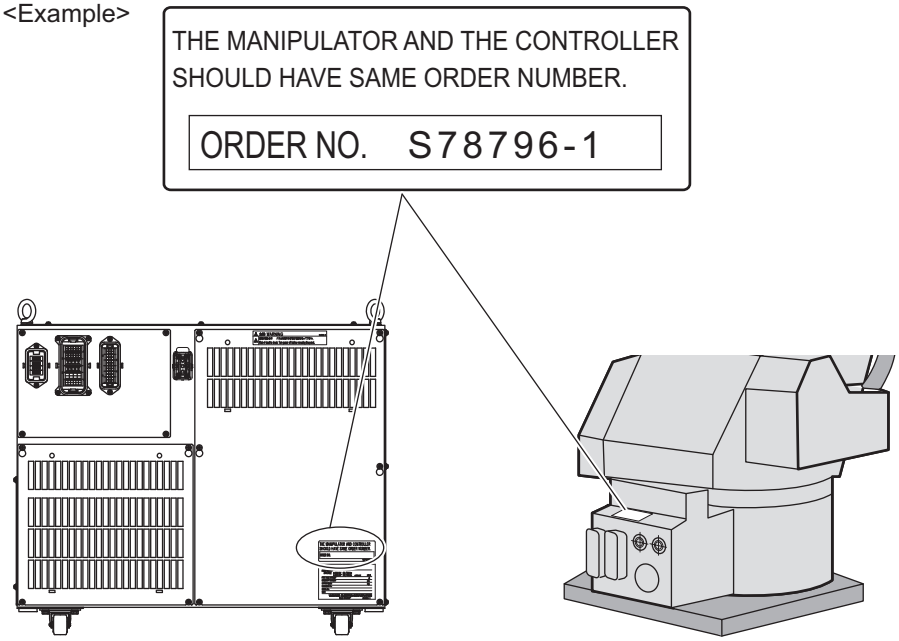


2.2 Order Number Confirmation

Confirm that the order number pasted on the manipulator and FS100L match.

The order number plates are affixed to the figure below.

<Example>



3 Installation

3.1 Handling Procedure

CAUTION

- Sling applications and crane or forklift operations must be performed by authorized personnel only.

Failure to observe this caution may cause the FS100L to fall down, which may result in personal injury or equipment damage.

- Avoid excessive vibration or shock during transporting. (Avoid the impact of 10G or more.)

Failure to observe this caution may result in equipment damage.

3.1.1 When Using a Crane

The FS100L should be lifted and moved by a crane.

Check the followings before transporting the FS100L.

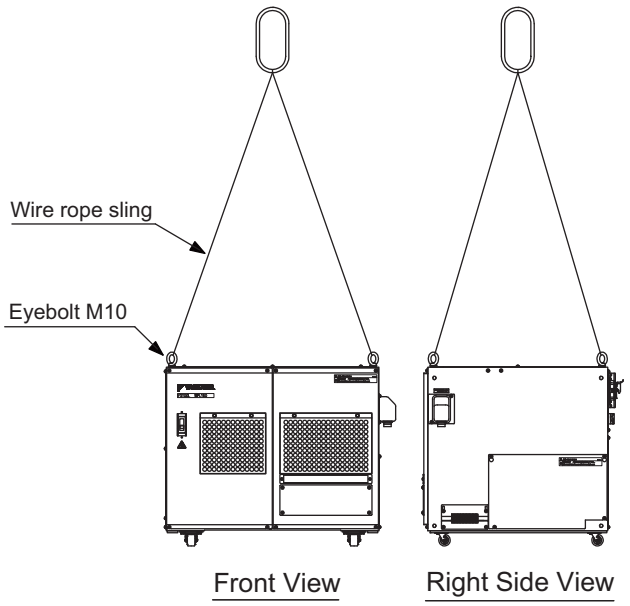
- When moving the FS100L, use wire rope strings that are appropriate for its mass.

Table 3-1: Approximate Mass of FS100L

Built-in transformer	Approx. Mass (kg)
Equipped	100
Not equipped	170

- Use eyebolts for transporting the FS100L. Before transport, check that the eyebolts are securely fastened.

Then, lift and move the FS100L.

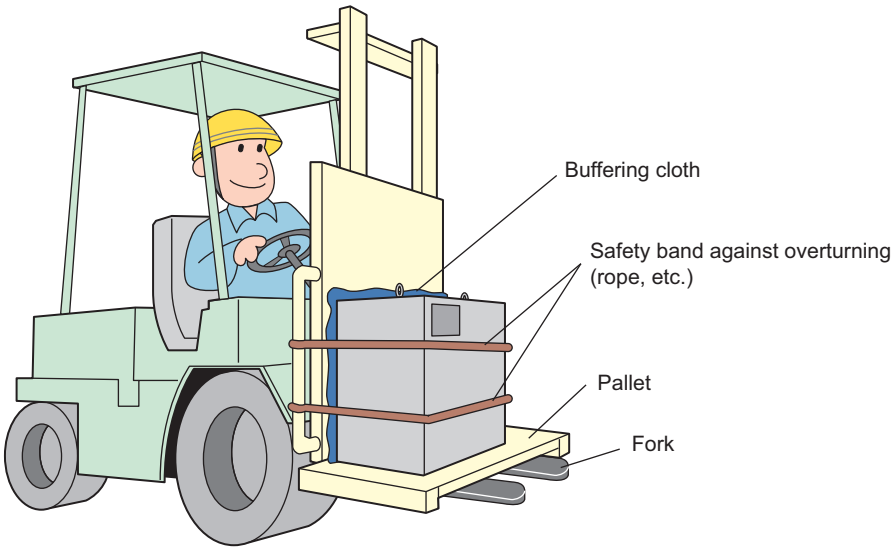


3.1.2 When Using a Forklift

When using the forklift for transporting the FS100L, keep the following precautions.

- Transport the FS100L to its installing place after ensuring the space for operations.
- After ensuring the operating space, sound a warning to the workers in the transporting course to evacuate them to a safer place.
- Fix the FS100L firmly in order to avoid overturning or slippage.
- Do not lift it up to high.
- The FS100L system consists of precision components. Avoid excessive vibration or shock during transporting.
- When carrying the controller, operate the forklift at a safe speed.

Fig. 3-1: Transport Using a Forklift



3.2 Place of Installation

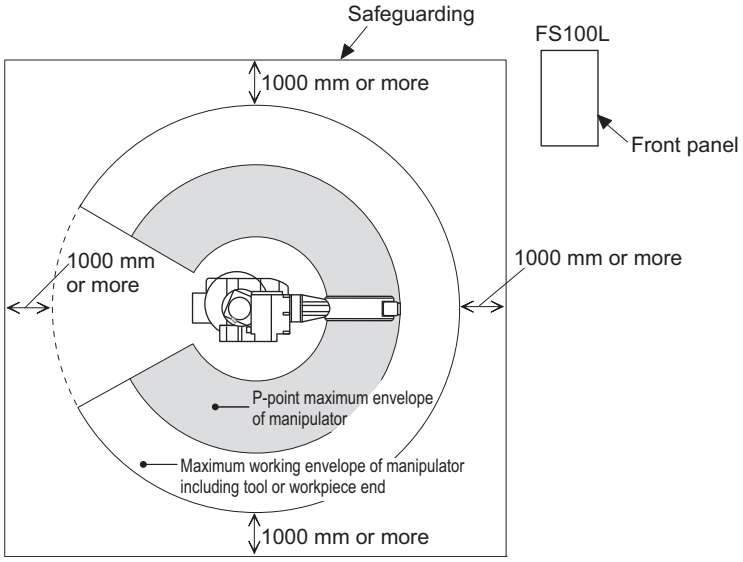
The conditions listed below must be met before installing the FS100L.

- Ambient temperature: 0° to +40°C during operation, and
  -10 to +60°C during transportation and maintenance
- Humidity: 10 to 90%RH (non-condensing)
- Free from exposure to dust, soot, oil, or water
- Free from corrosive gas or liquid, or explosive gas or liquid
- Free from excessive vibration
  (Vibration acceleration: 4.9 m/s^2 [0.5G] or less)
- Free from large electrical noise

3.3 Installation Location

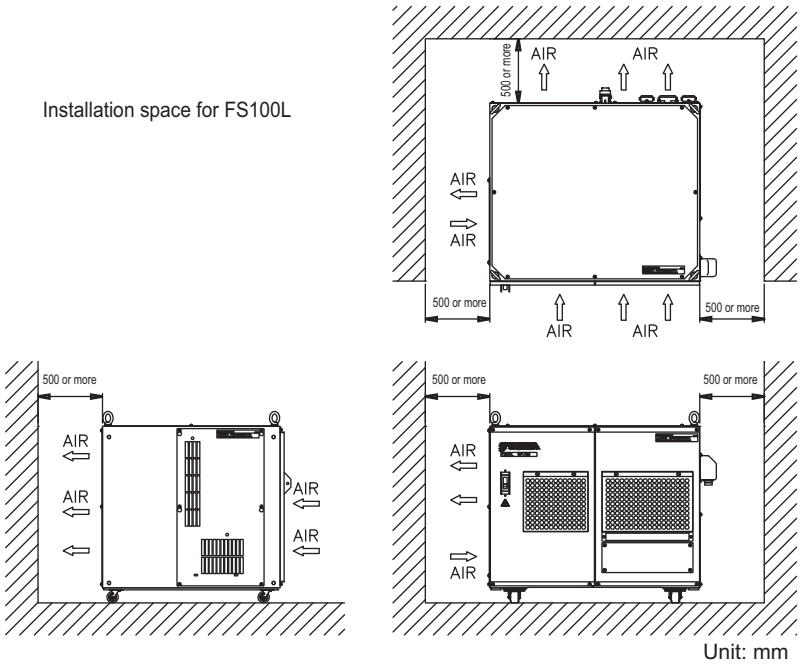
- Install the FS100L outside of the manipulator's operating range (outside of the safeguarding).

Fig. 3-2: Installation Location of FS100L



- Install the FS100L where the manipulator can be clearly seen during operation and can be operated safely.
- Install the FS100L where its front panel can be operated easily.
- Install the FS100L where it can be inspected easily. (Make sure to secure the maintenance area.)

Installation space for FS100L



Unit: mm

- When mounting the FS100L, keep the distance of 500mm or more from the wall for maintenance.

3.4 Installation Method

CAUTION

- The FS100L is free-standing type. Avoid jarring, dropping, or hitting the FS100L when installing it.

Failure to observe these cautions may result in personal injury or equipment damage.

- The FS100L is not dust-proof, drip-proof, or explosion-proof. Be sure to use it in the environment free from explosive gas, combustible gas, corrosive gas, condensation, and dust.

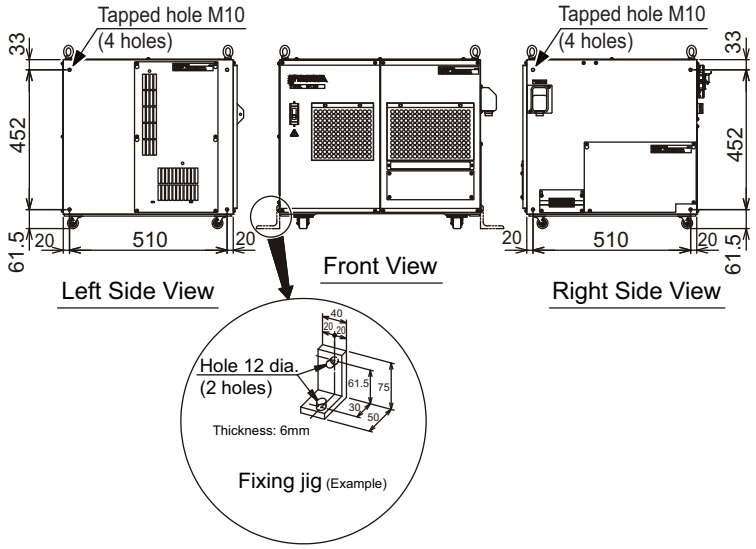
Failure to observe this caution may result in equipment damage.

- Do not get on top of the FS100L.

Failure to observe this caution may result in personal injury or equipment damage.

■ Fixing Method

Fix the FS100L on the floor or base by using the tapped holes (two or more holes) at the both sides of the bottom. Fixing jigs are prepared by customer.



■ Stacking Method

NOTE

Maintenance operation of the FS100L is performed from the top. When performing the maintenance operation to the lower one, the upper one should be unstacked if the FS100Ls are stacked.

WARNING

- Confirm that the lower level FS100L is firmly fixed to the floor or to the base.

Failure to observe this caution may cause the FS100L to fall, which may result in personal injury or equipment damage.

- When removing the casters from the upper level, place the FS100L on the stable base and do not get below it.

Failure to observe this caution may cause the FS100L to fall, which may result in personal injury or equipment damage.

- Keep the upper level FS100L lifted by the crane till both upper and lower level FS100Ls are firmly fixed.

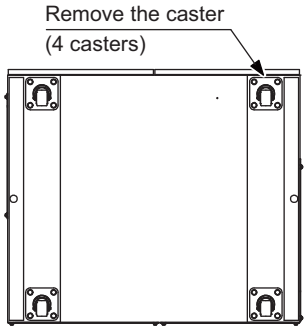
Failure to observe this caution may cause the FS100L to fall, which may result in personal injury or equipment damage.

- Do not lift the stacked FS100Ls by the crane together. Lift the FS100Ls one by one.

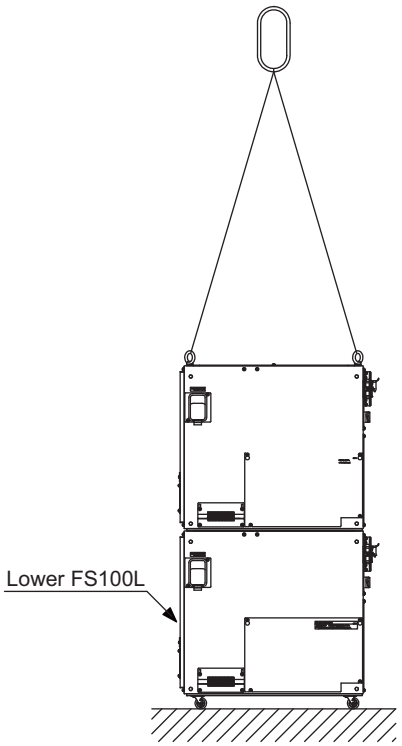
Failure to observe this caution may cause the FS100L to fall, which may result in personal injury or equipment damage.

Follow the procedures below when stacking the FS100Ls.

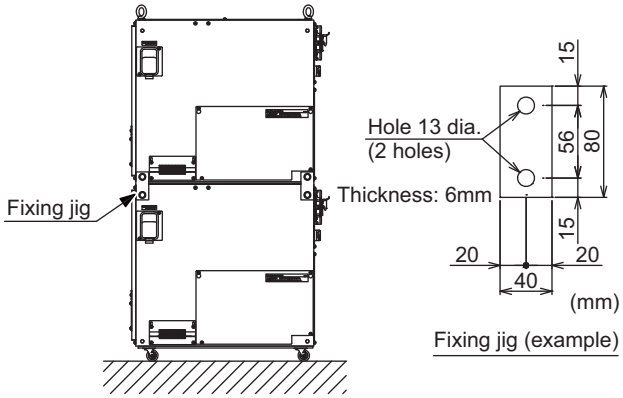
1. Remove four casters from the FS100L to be stacked upper level.



2. Stack the caster-removed FS100L on the lower level one by using a crane. Keep the upper level one lifted till it is fixed to the lower level one.



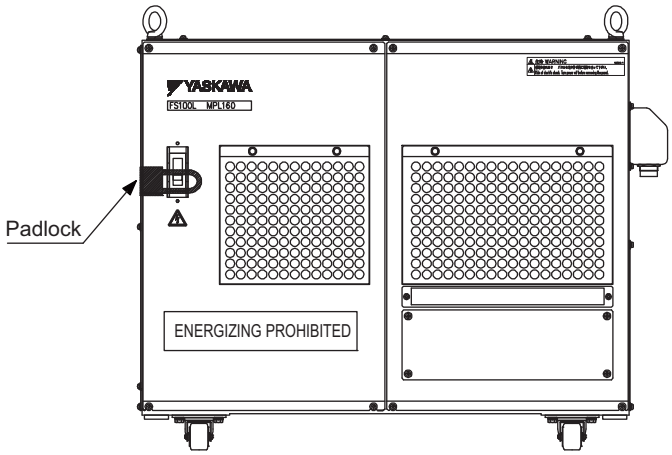
3. Firmly fix the tapped hole (4 holes) at both sides of the bottom of the upper level FS100L and at both sides of the top of the lower FS100L with fixing jigs. The fixing jigs are prepared by customer.



4 Connection

MANDATORY

- When connecting the FS100L and the manipulator or peripheral devices or when executing maintenance operation, do not fail to turn OFF the power supply of the FS100L and padlock the switch part.
  Also, put up a warning sign, such as “ENERGIZING PROHIBITED”.



Turning the power ON improperly during work may result in electric shock or personal injury due to unexpected movement of the manipulator.

WARNING

- The system must be grounded.

Failure to ground equipment may result in fire or electric shock.

- Before wiring, make sure to turn OFF the primary power supply, and put up a warning sign. (e.g. “ENERGIZING PROHIBITED”)

Failure to observe this warning may result in injury or electric shock.

- Do not touch any board inside the controller for five minutes after turning OFF the power supply.

Capacitors inside the controller store electricity after power is turned OFF. Exercise caution whenever handling circuit boards. Failure to observe this warning may result in injury or electric shock.

- Be sure to keep all the panels closed while the power is turned ON.

Failure to observe this warning may result in fire or electric shock.

- If the external emergency stop circuit wirings is done by the user, any occurrences due to the wirings are the user’s responsibility. Do an operation check once the wiring is completed.

Failure to observe this warning may result in personal injury or mechanical failure.

WARNING

- Wiring must be performed only by authorized personnel.

Incorrect wiring may result in fire or electric shock.

- Perform wiring in accordance with the rated capacity as specified in the Instructions.

Incorrect wiring may result in fire or mechanical failure.

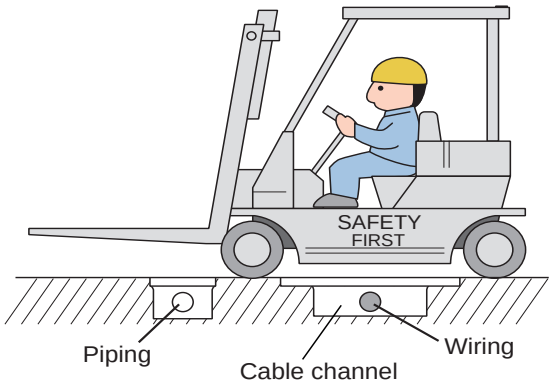
- Do not handle the circuit board directly by hand.

The IC board may malfunction due to electrostatics.

4.1 Notes on Cable Connection

- The cables that connect the FS100L and peripheral devices are low voltage circuits. Keep the cables away from the primary power circuit.
  Do not run high voltage power lines in parallel and close to the cables.
  If high voltage power lines must be run in parallel and close to the cables due to unavoidable circumstances, use metal ducts or conduit to avoid electrical interference. If the lines and cables must cross, ensure that they cross in a perpendicular fashion.
- Confirm the numbers of the connectors and cables so that there is no misconnection between the manipulator and FS100L, and the FS100L and peripheral devices.
  Misconnection may result in damage to electronic devices.
- Make sure to put the cables in the cable channel. Do not leave the cables uncovered while performing wiring between the manipulator and FS100L, or FS100L and peripheral devices. Uncovered cables may get in the way of people, forklifts, etc, and may result in an accident or cable damage.

Fig. 4-1: FS100L Cable Connection Diagram



4.2 Power Supply

4.2.1 Three-Phase Power Supply

NOTE

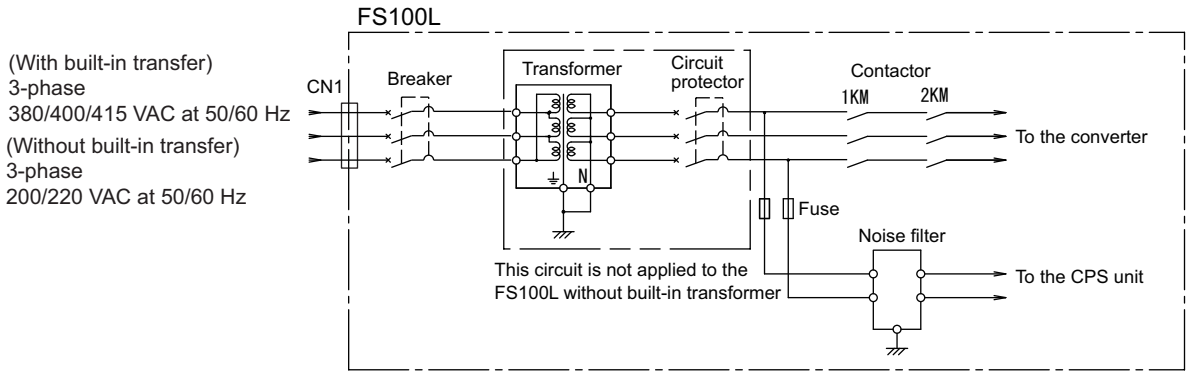
The power failure processing circuit operates when there is a black out or drop in voltage, and the servo power turns OFF.

Connect the power supply to a stable power source that is not prone to power fluctuations.

For the power supply, if a built-in transformer is

- equipped,
  the three-phase power supply comprising 380/400/415 VAC at 50/60 Hz is used.
- not equipped,
  the three-phase power supply comprising 200/220 VAC at 50/60 Hz is used.

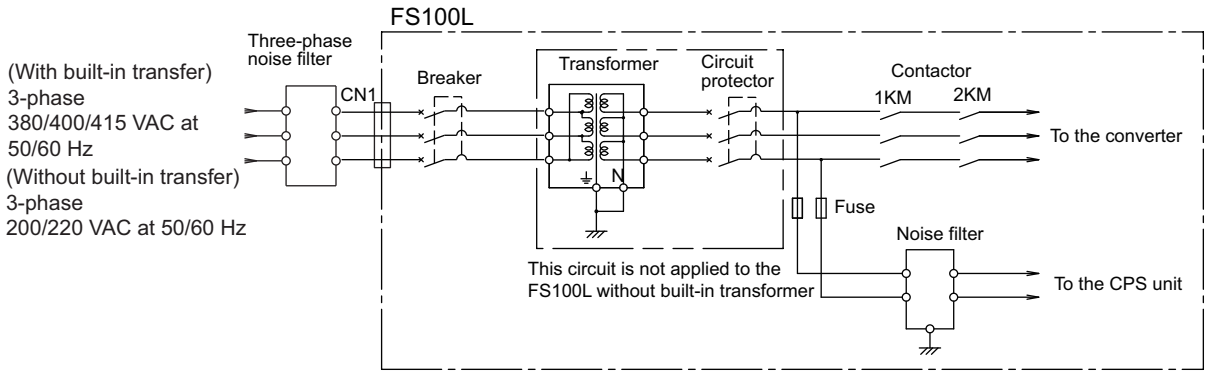
Fig. 4-2: Connection of Input Power



4.2.2 Noise Filter Installation

Insert the three-phase noise filter into the primary side of the FS100L if noise comes from the power source.

Fig. 4-3: Connection of Three-Phase Noise Filter



4.2.3 Leakage Breaker Installation

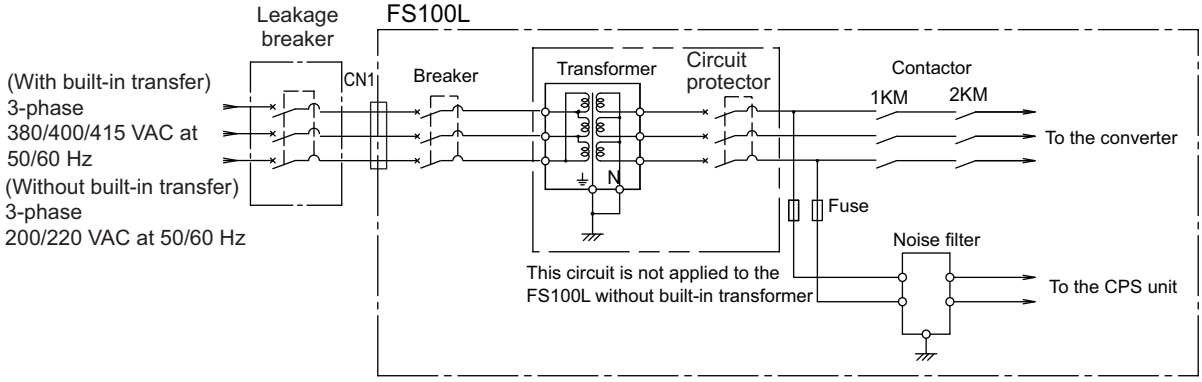
When connecting the leakage breaker to the controller power supply wiring, use a leakage breaker which can handle high frequencies from the FS100L inverter. Leakage breakers which cannot handle high frequencies may malfunction.

Table 4-1: Example of High Frequency Leakage Breaker

Maker	Model
Mitsubishi Electric Co., Ltd.	NV series (manufactured after 1988)
Fuji Electric Co., Ltd.	EG or SG Series (manufactured after 1984)

Even with a leakage breaker installed, there is still a possibility of some high frequency current leakage from the FS100L inverter. However, this current leakage presents no safety risks.

Fig. 4-4: Connection of the Leakage Breaker



4.2.4 Primary Power Supply Breaker Installation

Install the primary power supply breaker as shown below.

Fig. 4-5: Installation of Primary Power Supply Breaker

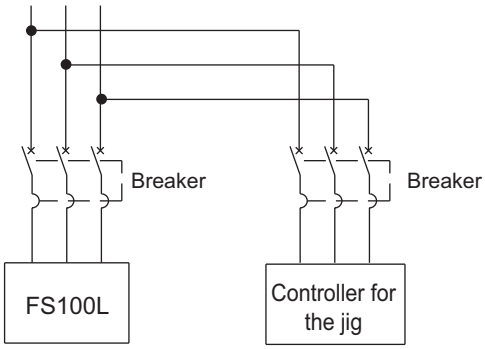


Table 4-2: FS100L Power Capacity, Cable Size, and Breaker

Manipulator	Power capacity (kVA)	Cable size (with cabtyre cable (three cores)) (mm^2)	Capacity of breaker in FS100L (A)	
			With built-in transformer	Without built-in transformer
MH50, MPL80	4.0	5.5	30	20
MPK50, MH80	4.5	5.5	30	20
MH165, MH200	5.0	5.5	30	20
MH215, MH250, MPL100, MPL160, MPL300	6.0	5.5	30	20

The maximum load value (payload, operation speed, and frequency, etc.) is displayed.
However, the power capacity is different depending on work conditions.

When selecting the transformer, contact your Yaskawa representative.

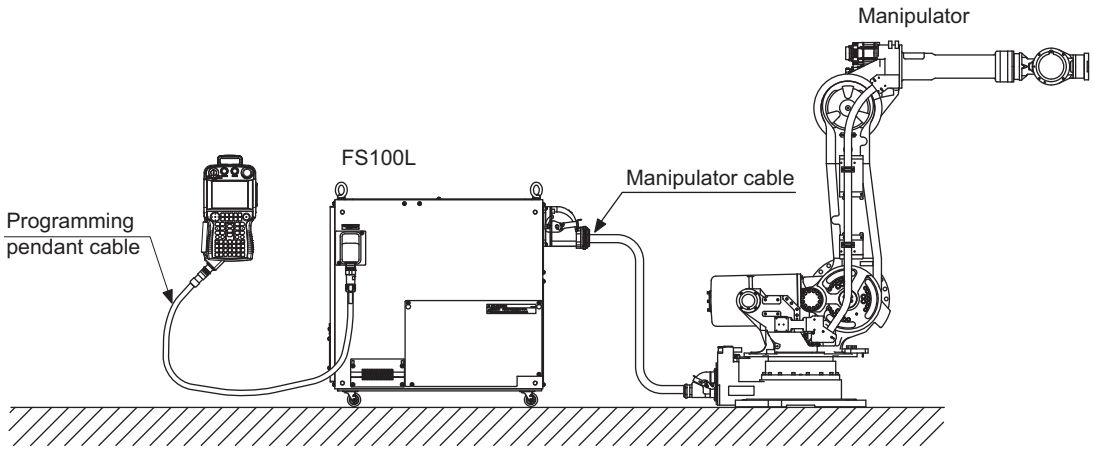
NOTE

The power capacity shown above is the continuous rating value.
When the robot is rapidly accelerated, the power capacity of several times the continuous rating value may be needed instantly.

4.3 Connection Methods

A connection diagram for the manipulator, manipulator cable, primary power cable and programming pendant is shown below.

Fig. 4-6: Connection of Cables



4.3.1 Connecting Primary Power Supply

■ **Preparation of Power Cable**

1. Prepare the power cable by following the specifications below.

Conductor size : 5.5mm^2

Number of cores : 4-wire
(for three-phase power supply wires + grounding wire)

Cable diameter : 13 to 20mm

Conductor : Equivalent to DIN EN60228 [Class 5]
(JIS C 3664 [Class 5])

Do not use the cable with thicker and less strands (equivalent to DIN EN60228 [Class 2] (JIS C 3664 [Class 2])) or the cable with thinner and more strands (equivalent to DIN EN60228 [Class 6] (JIS C 3664 [Class 6])).

NOTE The power supply cables are prepared by users.

Following connectors are shipped with the FS100L.

•Connector : 09 14 003 2701 HARTING Japan

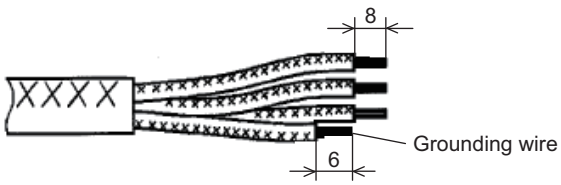
•Carrier hood : 09 14 001 0301 HARTING Japan

•Hood : 19 14 001 0402 HARTING Japan

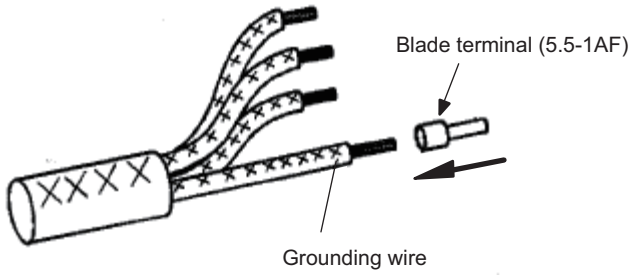
•Cable clamp : 19 00 000 5194 HARTING Japan

•Hexagonal screw driver : 09 99 000 0313 HARTING Japan

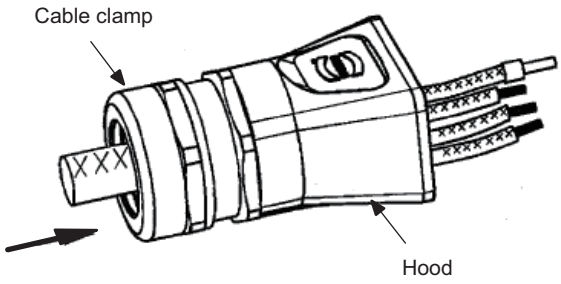
2. Strip the wire insultation as shown below.
   Note: Do not twist the strands.



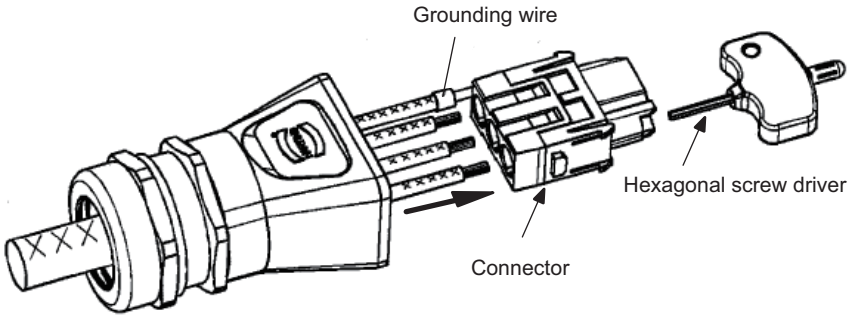
3. Swage the blade terminals (5.5-1AF(JST)) to the grounding wire.
   The blade terminals are prepared by customer.



4. Attach the cable clamp (19 00 000 5194) to the hood (19 14 001 0402) and run the cable through them.



5. Connect the connector (09 14 003 2701) to the wires.



   (1) From the side of connector mating part, insert the hexagonal screw driver to the center part of the contact.

CAUTION

- Do not use the hexagonal screw drivers other than delivered with the FS100L. (Size: 2mm)

Failure to observe this caution may cause the contacts to be damaged which may result in poor connection of the connector.

(2) Screw the hexagonal screw driver counterclockwise till it idles.

(3) Insert the stripped wires to the wire inlet on the connector, and hold them. Do not twist the strands.
For the connector allocation, please refer to the *table 4-3 "Pin Allocation of the Connector"* .

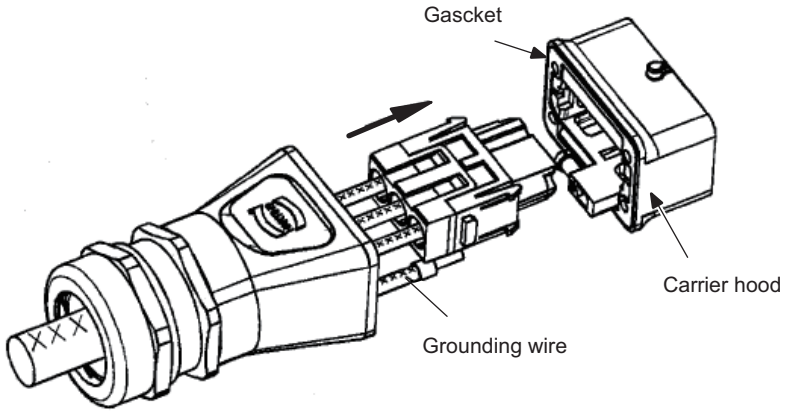
Table 4-3: Pin Allocation of the Connector

Pin No.	Signal name	Details
1	L1	AC input (L1/R-phase)
2	L2	AC input (L2/S-phase)
3	L3	AC input (L3/T-phase)

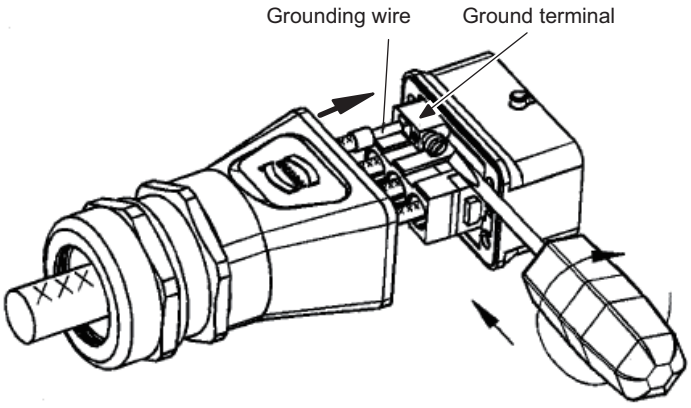
(4) Firmly screw the hexagonal screw driver clockwise.
(Tightening torque: 2N•m)
Screw the driver till, as a indicator, it starts twisting.

(5) After connecting the wires, check that the wires are firmly connected so that they would not be pulled out.

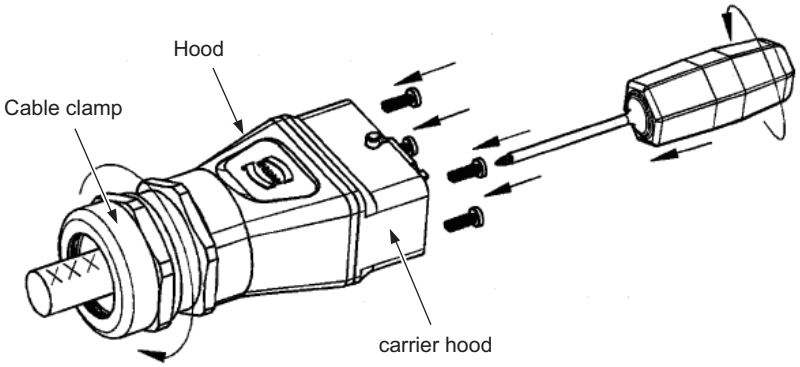
6. Insert the connector to the carrier hood (09 14 001 0301).



7. Insert the grounding wire to the earth terminal on the carrier hood and tighten the screw to fix. (Tightening torque: 1N•m)



8. Fix the carrier hood (09 14 001 0301) and hood (19 14 001 0402) with the delivered screws. (Tightening torque: 1N•m)
And then, tighten the cable clamp to fix the cable.



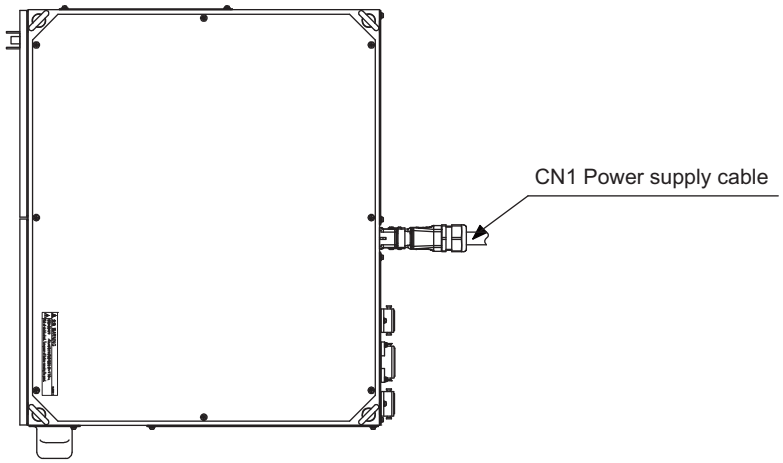
WARNING

- Attach delivered or same model connectors to the power cables.
- Firmly tighten the cable clamp to avoid disconnection of the power cable.

Failure to observe this caution may result in an electric shock or mechanical failure.

■ **Power Cable Connection Method**

1. Confirm that the breaker of the FS100L is turned OFF.
2. Also, check that the primary power supply is turned OFF.
3. Connect the prepared power cable (in the previous step) to the connector (CN1) on the back side of the FS100L.



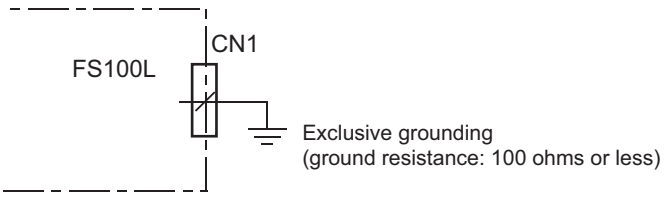
■ **Grounding method**

Perform grounding as countermeasures against noise and electric shock.

Follow the steps below:

1. Connect the grounding wire to the earth terminal of the FS100L power connector (CN1) as mentioned in *chapter 4.3.1 “Connecting Primary Power Supply” at page 4-7*.
2. Perform grounding in accordance with all relevant local and national electrical codes.

Fig. 4-7: Exclusive Grounding



NOTE

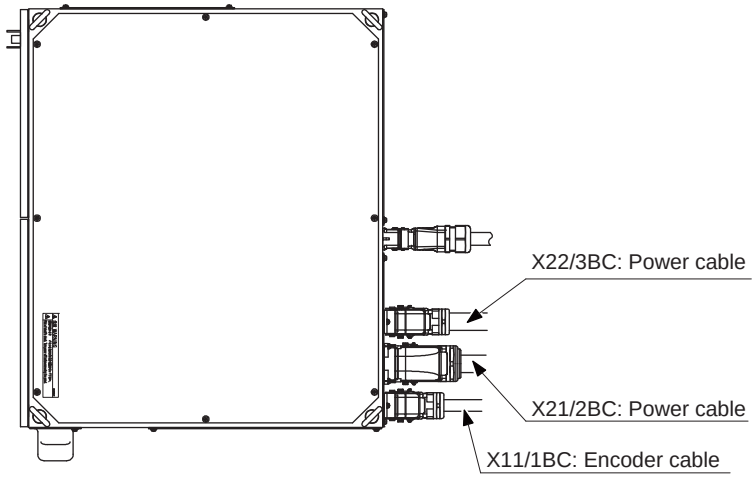
Do not connect the grounding wire with the wires for the electric power source, motor power, etc.

If using metallic ducts, metallic conduits, or cable trays for cabling, perform grounding in accordance with all relevant governmental regulations.

4.3.2 Connecting Manipulator Cable

1. Unpack the manipulator cable. Connect the cable to the connectors on the back side of FS100L.

Fig. 4-8: Connection of Manipulator Cable

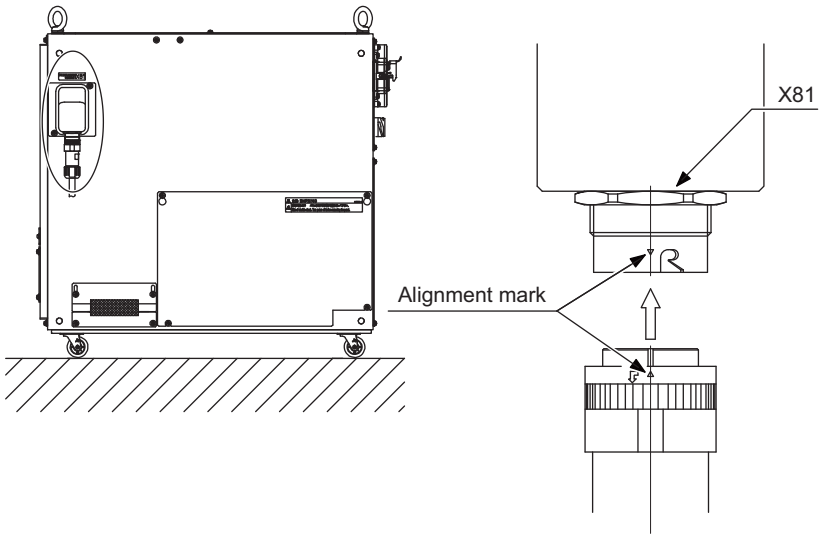


2. Connect the manipulator to the FS100L.
   – Confirm the number of the manipulator cable connector. Connect the manipulator cable connector to the manipulator-side connector firmly, and tighten it securely.

4.3.3 Connecting Programming Pendant (Optional)

1. Connect the programming pendant cable to the connector (X81) on the right side of FS100L.

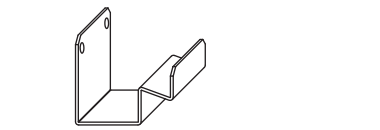
Fig. 4-9: Connection of Programming Pendant Cables

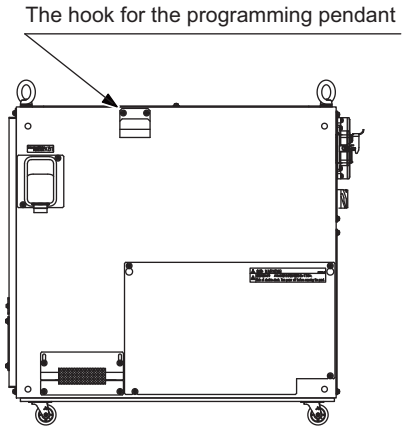


The manipulator, FS100L, and programming pendant connections are now complete.

> **NOTE** If the programming pendant is not used, connect the programming pendant dummy connector (CBL-FRC063-2) to the connector(X81).

A hook for the programming pendant is attached to FS100L. Mount this hook where the programming pendant is placed. It is also able to mount the hook to the right side of FS100L.

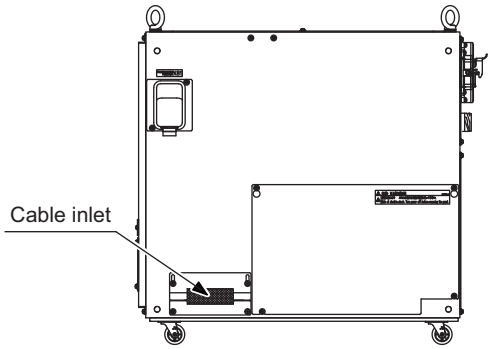




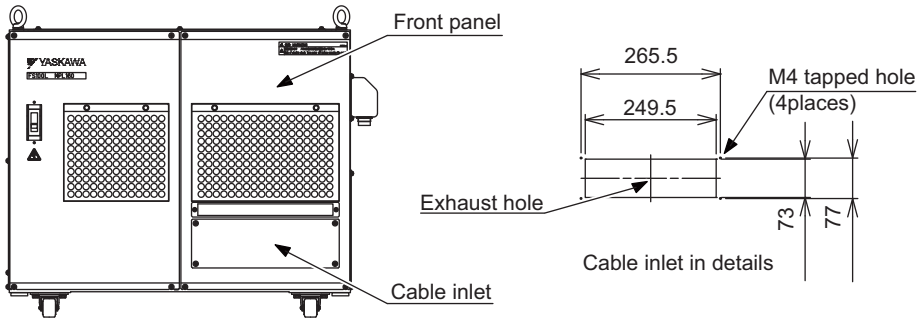
Right View
(When mount the hook)

4.3.4 Connecting Cables for Peripheral Device

If there is a I/O cable from the peripheral device, pull the cable into the cable inlet, which is located on the right side of FS100L., and connect to the connector of each unit or board.



It is also able to pull the cable into the cable inlet in the front panel. However, the cable inlet in the front panel of FS100L should be processed by a customer.



■ **Cable Clamp Reference**

- KEL cable entry frame (NEOFLEX)
- KT grommet (NEOFLEX)
  Select a cable entry frame and a grommet accordant to the number of the using cables and diameter.

5 Turning ON and OFF Power Supply

5.1 Turning ON Main Power Supply

WARNING

- Confirm that nobody is present in the manipulator's operating range when turning ON the FS100L power supply.

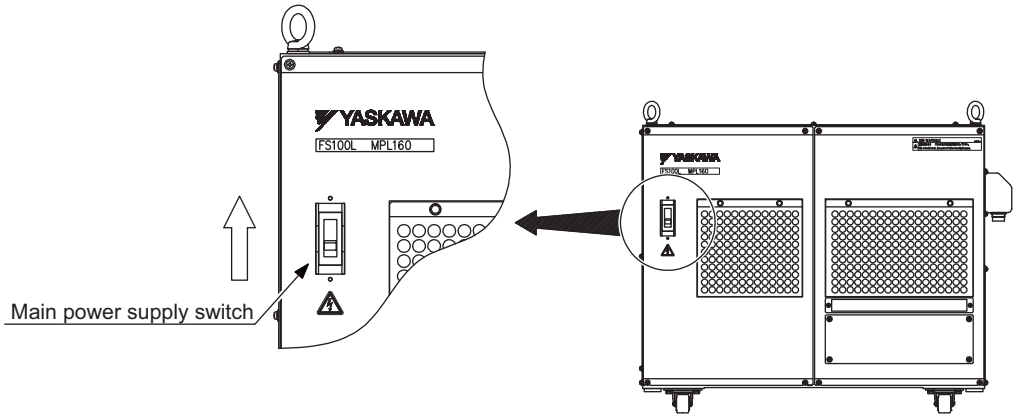
Failure to observe this warning may result in injury caused by accidental contact with the manipulator.

Press the emergency stop button immediately if any problem occurs.

The emergency stop button is located on the right of the programming pendant.

The main power supply is turned ON when the main power supply switch on the front of the FS100L is turned to the "ON" position, and the initial diagnosis and the current position setting begin.

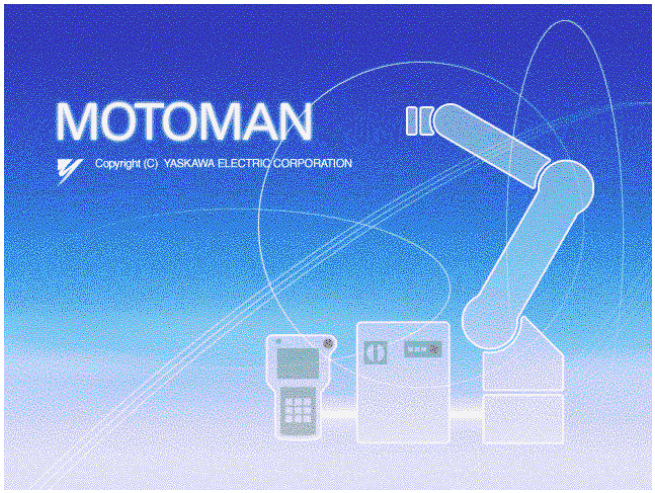
Fig. 5-1: Turning ON Main Power Supply

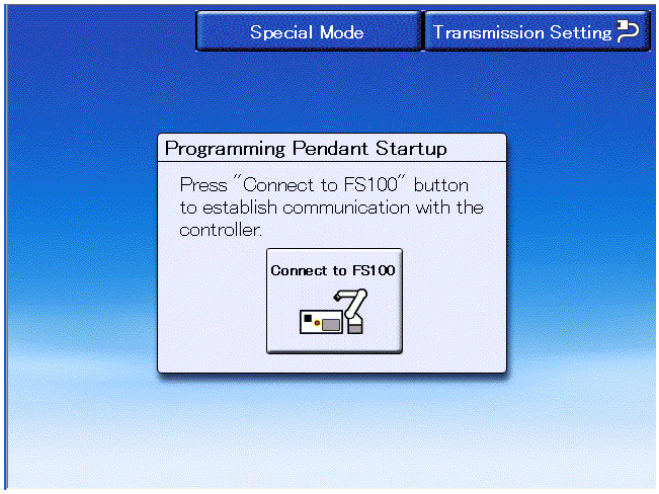


5.1.1 Initial Diagnosis

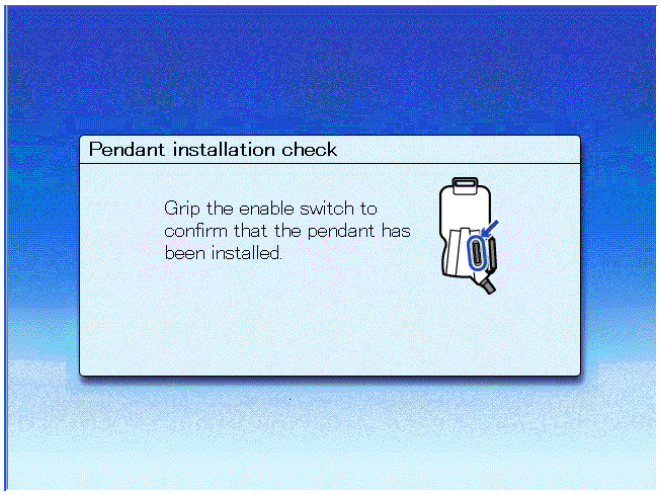
When the programming pendant is connected and the main power is turned ON, the initial diagnosis is performed in the FS100L.

1. Turn ON the power supply.
   – The screen switches.

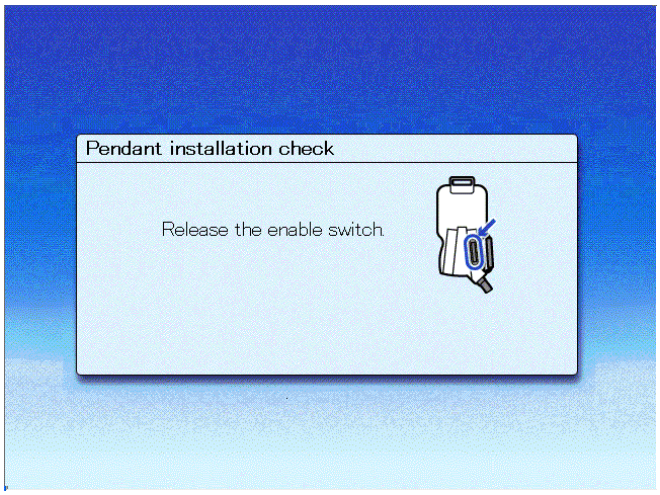




2. Press the {Connect to FS100} button.
   – The following “Pendant installation check” window appears.



3. Grip the enable switch.
   – The following “Pendant installation check” window appears.



4. Release the enable switch.
   – If the connection confirmation of the programming pendant is successful, the communication between the FS100L and the programming pendant is established.
   – If the connection confirmation of the programming pendant is failed, the following window appears.

SUPPLE-MENT

For details of the messages displayed during the communication connection between the FS100L and the programming pendant, and the network configuration of the programming pendant when connecting the FS100L via network, refer to *chapter 1.2 Programming Pendant* of “FS100 Operator’s Manual”.

5.1.2 When Initial Diagnosis Is Complete

When the power supply is turned OFF, the FS100L saves all condition data, including:

- Operation mode
- Called job (active job if the FS100L is in the play mode; edit job if the FS100L is in the teach mode) and cursor position in the job.

Fig. 5-2: Initial Window

CAUTION

- Make sure that a system manager stores the key of the mode select switch on the programming pendant.
  After operation, the key should be removed and stored by the system manager.

Improper or unintended manipulator operation may result in injury.

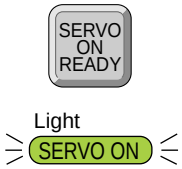
Also, the key or the mode select switch may be damaged if the programming pendant is dropped with the key inserted.

5.2 Turning ON Servo Power

5.2.1 During Play Mode

If the safety plug of safeguarding is turned OFF, the FS100L determines that the worker's safety is not secure.

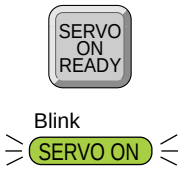
- When the safeguarding is closed, press [SERVO ON READY] on the programming pendant to turn ON the servo power supply. [SERVO ON] lamp lights when the servo power is turned ON.



NOTE When the safeguarding is open, the servo power supply cannot be turned ON.

5.2.2 During Teach Mode

1. Press [SERVO ON READY] on the programming pendant. [SERVO ON] lamp will blink.



2. The servo power is turned ON and [SERVO ON] lamp on the programming pendant lights when the operator grips the Enable Switch.

Servo Power ON/OFF --- Enable Switch

When the operator grips the Enable Switch, the servo power turns ON. However, if the operator squeezes the switch until a “click” is heard, the servo power will turn OFF.

SUPPLE -MENT

Release -> OFF

Squeeze -> ON

Squeeze tightly -> OFF

NOTE

When performing emergency stop with the programming pendant or by the external signal, the servo power-on operation from the Enable switch is cancelled.

When turning the power back ON, follow the steps 1 and 2 on the previous page.

5.3 Turning OFF Power Supply

5.3.1 Turning OFF Servo Power (Emergency Stop)

The manipulator cannot be operated when the emergency stop button is pressed and the servo power supply is turned OFF.

- Press the emergency stop button and the servo power supply is turned off.
  The emergency stop button is located on the right side of the programming pendant.
- The brake operates once the servo power supply is turned OFF, and the manipulator can no longer operate.
  The emergency stop mode can be operated at any mode. (Teach mode, Play mode, Remote mode)

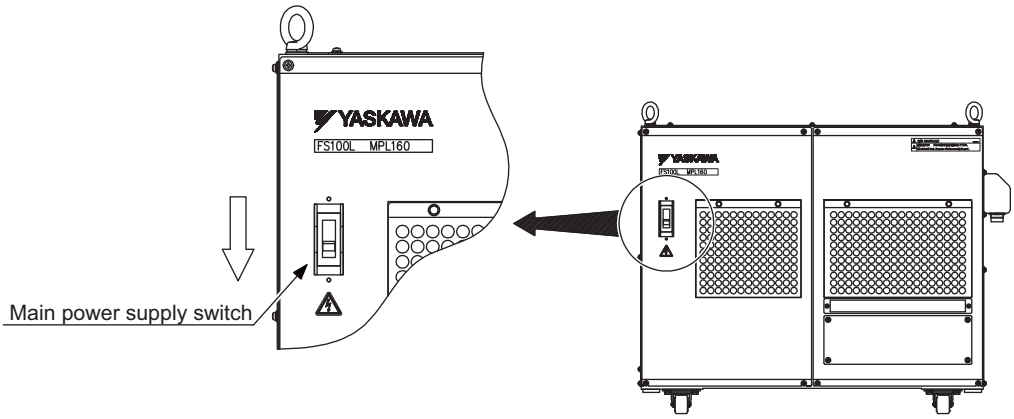
Programming pendant

- 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 FS100L, this signal is connected by a jumper cable in the dummy connector. To use the signal, make sure to supply 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.

5.3.2 Turning OFF Main Power

After turning OFF the servo power, turn OFF the main power.

1. Turn the main power switch on the front of FS100L to the “OFF“ position to turn OFF the main power.



6 Test of Program Operation

WARNING

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

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

- Press the emergency stop button immediately if any problem occurs. The emergency stop button is located on the right of the programming pendant.
- 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 FS100L, this signal is connected by a jumper cable in the dummy connector. To use the signal, make sure to supply 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.

- Observe the following precautions when performing teaching operations within the manipulator's operating range:
  - Be sure to use a lockout device to the safeguarding when going inside. Also, display the sign that the operation is being performed inside the safeguarding and make sure no one closes the safeguarding.
  - 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 unintentional manipulator operation may result in injury.

- Confirm that no person is present in the manipulator's operating range and that you are in a safe location before:
  - Turning ON the FS100L power.
  - Moving the manipulator with the programming pendant.
  - Running the system in the check mode.
  - Performing automatic operations.

Injury may result if anyone enters the manipulator's operating range during operation. Always press the emergency stop button immediately if there is a problem. The emergency stop button is located on the right of the programming pendant.

CAUTION

- Perform the following inspection procedures prior to conducting manipulator teaching. If a problem is found, correct it and implement all other necessary measures immediately.
  - 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 FS100L cabinet after use.

If the programming pendant is inadvertently left on the manipulator, on a fixture, or on the floor, the manipulator or a tool may collide with the programming pendant during manipulator movement, which may result in personal injury or equipment damage.

- Make sure that a system manager stores the key of the mode select switch on the programming pendant.
  After operation, the key should be removed and stored by the system manager.

Improper or unintended manipulator operation may result in injury.

Also, the key or the mode select switch may be damaged if the programming pendant is dropped with the key inserted.

6.1 Movement of Axes

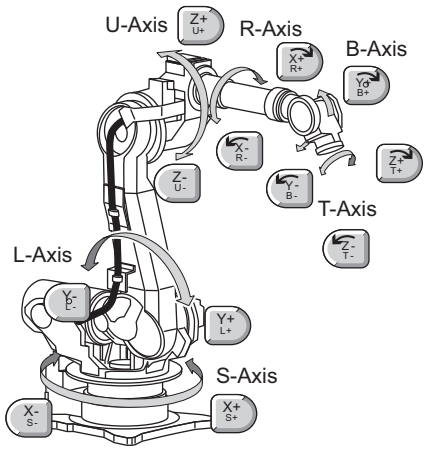
Move each axis of the manipulator by pressing the axis keys on the programming pendant.

This figure illustrates each axis of motion in the joint coordinates.

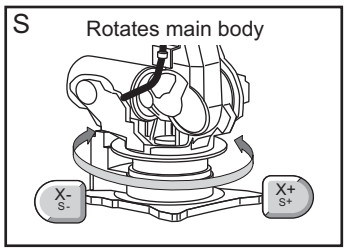
NOTE

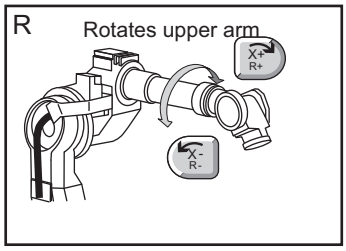
Be sure to remove all items from the area before moving the manipulator.
Refer to the INSTRUCTION MANUAL for the appropriate position of the fixture.

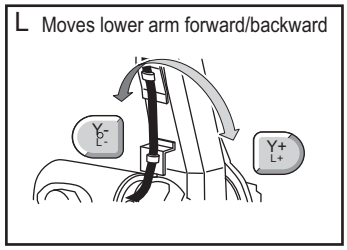
Axis Keys

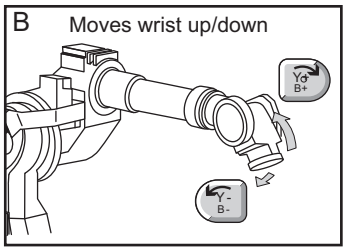


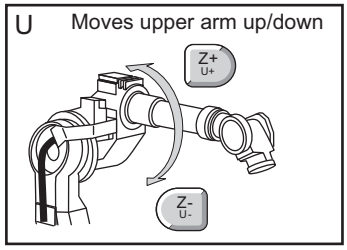
6-axis robot

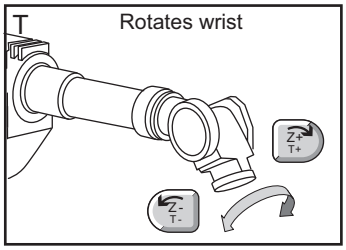












System Up

7 Security System

7.1 Protection Through Security Mode Settings

The FS100L modes setting are protected by a security system. The system allows operation and modification of settings according to operator clearance. Be sure operators have the correct level of training for each level to which they are granted access.

7.1.1 Security Mode

There are three security modes. Editing mode and management mode require a user ID. The user ID consists of numbers and letters, and contains no less than 4 and no more than 8 characters. (Significant numbers and signs: “0 to 9”, “-”, “.”.

Table 7-1: Security Mode Descriptions

Security Mode	Explanation
Operation Mode	This mode allows basic operation of the robot (stopping, starting, etc.) for people operating the robot work on the line.
Editing Mode	This mode allows the operator to teach and edit jobs and robot settings.
Management Mode	This mode allows those authorized to set up and maintain robot system: parameters, system time and modifying user IDs.

Table 7-2: Menu and Security Mode (Sheet 1 of 3)

Main Menu	Sub Menu	Allowed Security Mode	
		DISPLAY	EDIT
JOB	JOB	Operation	Edit
	SELECT JOB	Operation	Operation
	CREATE NEW JOB[1)]	Edit	Edit
	MASTER JOB	Operation	Edit
	JOB CAPACITY	Operation	-
	CYCLE	Operation	Operation
VARIABLE	BYTE	Operation	Edit
	INTEGER	Operation	Edit
	DOUBLE	Operation	Edit
	REAL	Operation	Edit
	STRING	Operation	Edit
	POSITION (ROBOT)	Operation	Edit
	POSITION (BASE)	Operation	Edit
	POSITION (ST)	Operation	Edit
	LOCAL VARIABLE[1)]	Operation	-
IN/OUT	EXTERNAL INPUT	Operation	Edit
	EXTERNAL OUTPUT	Operation	Edit
	UNIVERSAL INPUT	Operation	Operation
	UNIVERSAL OUTPUT	Operation	Operation
	SYSTEM INPUT	Operation	-
	SYSTEM OUTPUT	Operation	-
	RIN	Operation	-
	CPRIN	Operation	-
	REGISTER	Operation	Management
	AUXILIARY RELAY	Operation	-
	CONTROL INPUT	Operation	-
	PSEUDO INPUT SIG	Operation	Management
	NETWORK INPUT	Operation	-
	NETWORK OUTPUT	Operation	-
	ANALOG OUTPUT	Operation	-
	SV POWER STATUS	Operation	-
	TERMINAL	Operation	-
	LADDER PROGRAM	Management	Management
	I/O ALARM	Management	Management
	I/O MESSAGE	Management	Management

1) Displayed when “LANGUAGE LEVEL” is “EXPANDED”.

Table 7-2: Menu and Security Mode (Sheet 2 of 3)

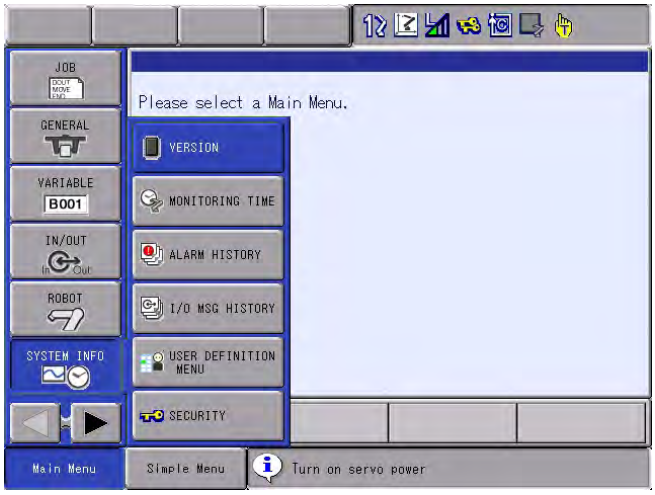
Main Menu	Sub Menu	Allowed Security Mode	
		DISPLAY	EDIT
ROBOT	CURRENT POSITION	Operation	-
	COMMAND POSITION	Operation	-
	SERVO MONITOR	Management	-
	WORK HOME POS	Operation	Edit
	SECOND HOME POS	Operation	Edit
	DROP AMOUNT	Management	Management
	POWER ON/OFF POS	Operation	-
	TOOL	Edit	Edit
	INTERFERENCE	Management	Management
	SHOCK SENS LEVEL	Operation	Edit
	USER COORDINATE	Edit	Edit
	HOME POSITION	Management	Management
	MANIPULATOR TYPE	Management	-
	ANALOG MONITOR	Management	Management
	OVERRUN&S-SENSOR	Edit	Edit
	LIMIT RELEASE	Edit	Edit
	ARM CONTROL	Management	Management
	SHIFT VALUE	Operation	-
	HAND VIBRATION CONTROL	Operation	Management
SYSTEM INFO	VERSION	Operation	-
	MONITORING TIME	Operation	Management
	ALARM HISTORY	Operation	Management
	I/O MSG HISTORY	Operation	Management
	NETWORK SERVICE	Management	-
	USER DEFINITION MENU	Operation	Operation
	SECURITY	Operation	Operation
FD/CF	LOAD	Edit	-
	SAVE	Operation	-
	VERIFY	Operation	-
	DELETE	Operation	-
	DEVICE	Operation	Operation
	FOLDER	Edit	Management

Table 7-2: Menu and Security Mode (Sheet 3 of 3)

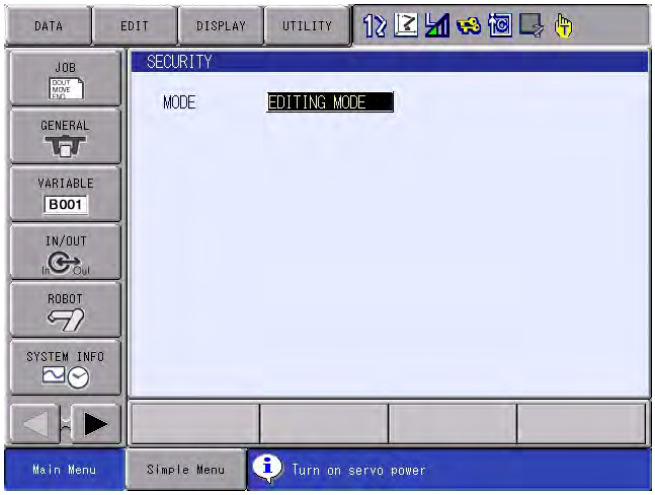
Main Menu	Sub Menu	Allowed Security Mode	
		DISPLAY	EDIT
PARAMETER	S1CxG	Management	Management
	S2C	Management	Management
	S3C	Management	Management
	S4C	Management	Management
	A1P	Management	Management
	A2P	Management	Management
	RS	Management	Management
	S1E	Management	Management
	S2E	Management	Management
	S3E	Management	Management
	S4E	Management	Management
	S5E	Management	Management
	S6E	Management	Management
	S7E	Management	Management
	S8E	Management	Management
SETUP	TEACHING COND.	Edit	Edit
	OPERATE COND.	Management	Management
	OPERATE ENABLE	Management	Management
	FUNCTION ENABLE	Management	Management
	JOG COND.	Management	Management
	PLAYBACK COND.	Management	Management
	FUNCTION COND.	Management	Management
	DISPLAYING COLOR COND.	Edit	Edit
	DATE/TIME	Management	Management
	GRP COMBINATION	Management	Management
	RESERVE JOB NAME	Edit	Edit
	USER ID	Edit	Edit
	SET SPEED	Management	Management
	KEY ALLOCATION	Management	Management
	JOG KEY ALLOC.	Edit	Management
	RES. START (CNCT)	Management	Management
	AUTO BACK SET	Management	Management
	WRONG DATA LOG	Edit	Management
	ENERGY SAVING FUNCTION	Edit	Management
	ENCODER MAINTENANCE	Edit	Management
DISPLAY SETUP	CHANGE FONT	Operation	Operation
	CHANGE BUTTON	Operation	Operation
	INITIALIZE LAYOUT	Operation	Operation
	CHANGE WINDOW PATTERN	Operation	Operation
GENERAL	GENERAL DIAG.	Operation	Edit

7.1.1.1 Changing Security Mode

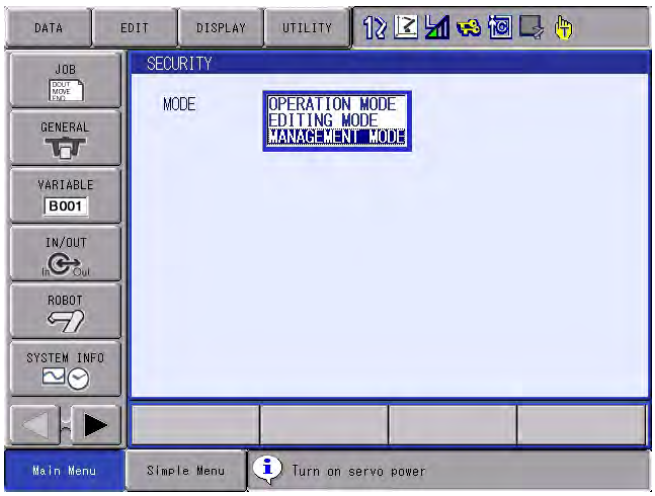
1. Select {SYSTEM INFO} under the main menu.
   – The sub menu appears.



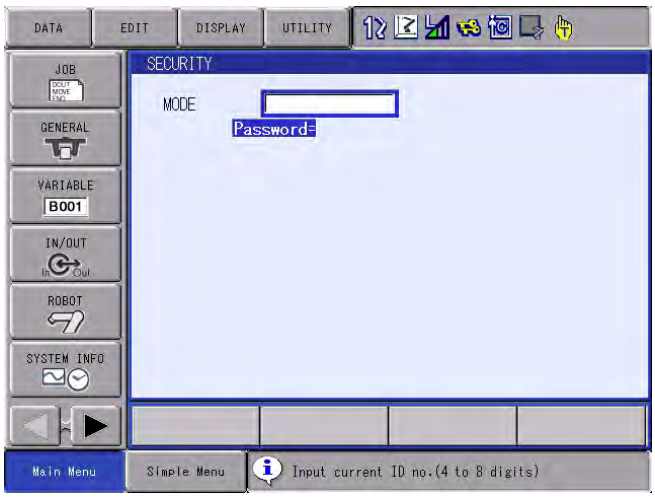
2. Select {SECURITY}.
   – The selection window of security mode appears.



3. Press [SELECT].
   – Select “SECURITY MODE”.



4. Input the user ID.
   – The user ID input window appears.



SUPPLE-MENT

The following user ID numbers are set by default.
• Editing Mode: [00000000]
Management Mode: [99999999]

5. Press [ENTER].
   – The input user ID is compared with the user ID of the selected security mode.
   – When the correct user ID is entered, the security mode is changed.

7.1.2 User ID

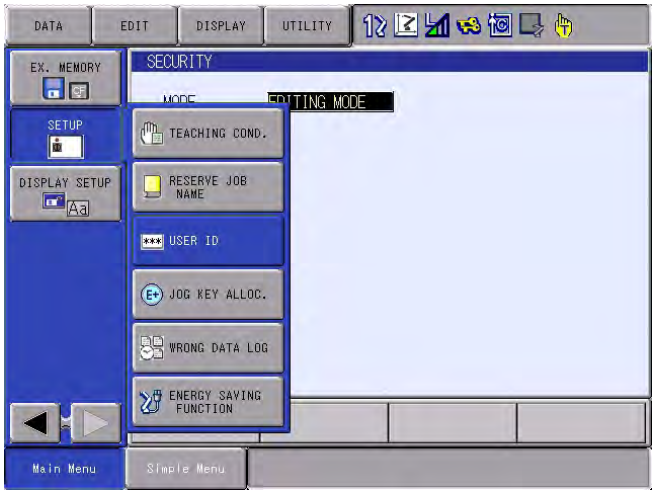
User ID is requested when Editing Mode or Management Mode is operated.

Create the user ID with four to eight numbers and symbols: the numbers 0 to 9; the symbols “-” and “.”.

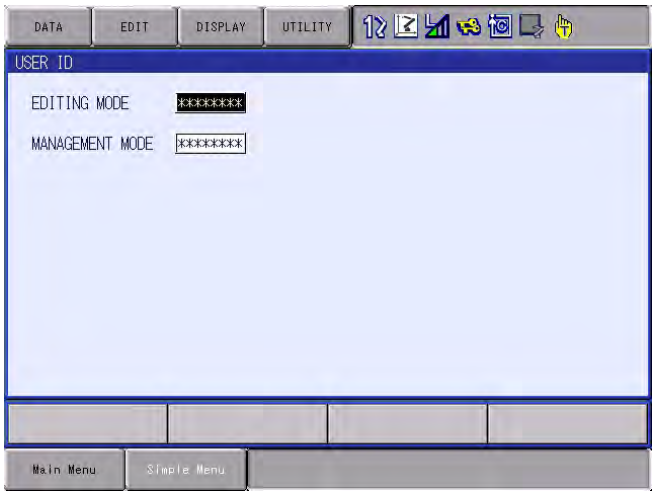
7.1.2.1 Changing User ID

In order to change the user ID, the FS100L must be in Editing Mode or Management Mode. Higher security modes can make changes the user ID of to lower security modes.

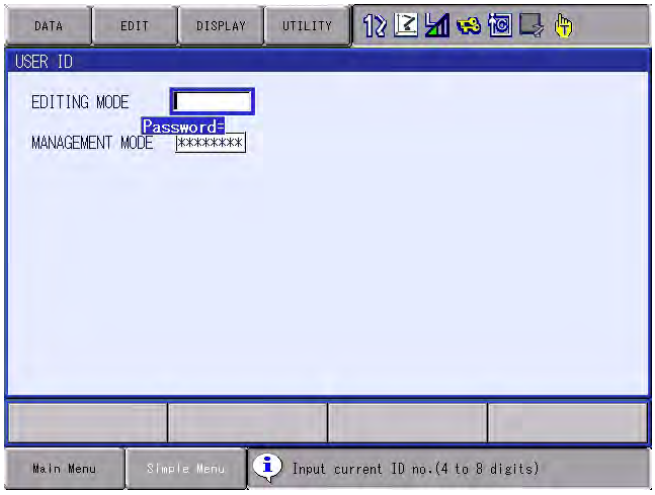
1. Select {SETUP} under the main menu.
   – The sub menu appears.



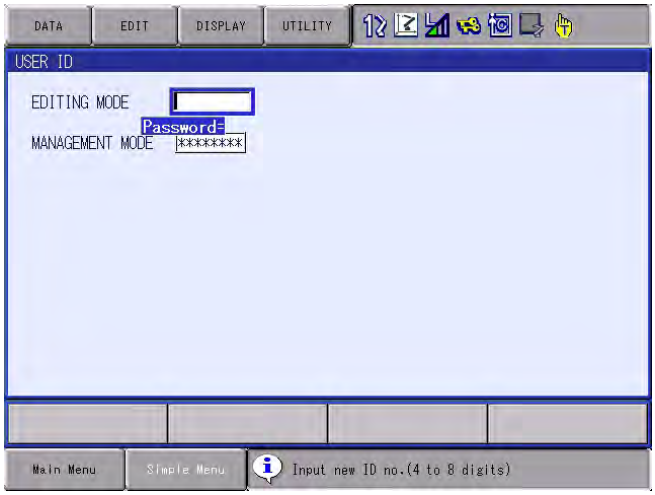
2. Select {USER ID}.
   – The USER ID window appears.



3. Select the desired ID.
   – The character input line appears, and a message “Input current ID no. (4 to 8 digits)” appears.



4. Input the current ID and press [ENTER].
   – When the correct user ID is entered, a new ID is requested to be input. “Input new ID no. (4 to 8 digits)” appears.



5. Input new ID and press [ENTER].
   – User ID is changed.

8 System Setup

WARNING

- Data related to the system's basic functions can be changed. However, improper change may result in a fatal error or failure of the manipulator or the whole system.

Observe the following warnings to safeguard system settings:

- Change the data under the supervision of the administrator.
- Make sure to save and manage the data each time you create or change it.
  (Supply a USB memory stick or CompactFlash (CF) card recommended by Yaskawa.)
- Yaskawa is not responsible for accidents or failures caused by incorrect data settings.

8.1 Home Position Calibration

WARNING

- Before operating the manipulator, check that the SERVO ON LED is turned OFF when the emergency stop button on the programming pendant is pressed.

Injury or damage to machinery may result if the manipulator cannot be stopped in case of an emergency.

- Observe the following precautions when performing teaching operations within the manipulator's operating range:
  - Be sure to use a lockout device to the safeguarding when going inside. Also, display the sign that the operation is being performed inside the safeguarding and make sure no one closes the safeguarding.
  - 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 manipulator's operating range and that you are in a safe location before:
  - Turning ON the FS100L power.
  - Moving the manipulator with the programming pendant.

Injury may result if anyone enters the manipulator's operating range during operation. Always press the emergency stop button immediately if there is a problem. The emergency stop button is located on the right of the programming pendant.

CAUTION

- Perform the following inspection procedures prior to conducting manipulator teaching. If a problem is found, correct it and implement all other necessary measures immediately.
  - 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 FS100L cabinet after use.

If the programming pendant is inadvertently left on the manipulator, on a fixture, or on the floor, the manipulator or a tool may collide with the programming pendant during manipulator movement, which may result in personal injury or equipment damage.

- Make sure that a system manager stores the key of the mode select switch on the programming pendant.
  After operation, the key should be removed and stored by the system manager.

Improper or unintended manipulator operation may result in injury.

Also, the key or the mode select switch may be damaged if the programming pendant is dropped with the key inserted.

8.1.1 Home Position Calibration

NOTE

Teaching and playback are not possible before the completion of the home position calibration.
In a system with two or more manipulators, the home position of all the manipulators must be calibrated before starting teaching or playback.

Home position calibration is an operation in which the home position and absolute encoder position coincide. Although this operation is performed prior to shipment at the factory, the following cases require this operation to be performed again.

- Change in the combination of the manipulator and FS100L
- Replacement of the motor or absolute encoder
- Clearing stored memory (by replacement of the main CPU board, weak battery, etc.)
- Home position deviation caused by hitting the manipulator against a workpiece, etc.

To calibrate the home position, use the axis keys to calibrate the home position mark on each axis so that the manipulator can take its posture for the home position. There are two operations for home position calibration:

- All the axes can be moved at the same time: Recalibrate the home position by moving all the axes together if changing the combination of manipulator and circuit board.
- Axes can be moved individually: Recalibrate the home position for the individual axes that were affected by the replacement, if replacing the motor or absolute encoder.

If the absolute data of its posture for the home position is already known, set the absolute data again after completing home position registration.

Home Position

SUPPLE -MENT

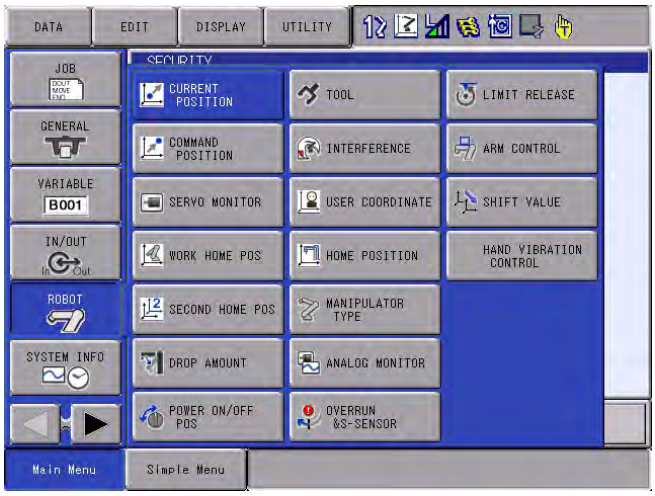
The home position is the pulse value “0” for each axis and its posture. See *chapter 8.1.3 “Home Position of Robot” at page 8-12*.

8.1.2 Calibrating Operation

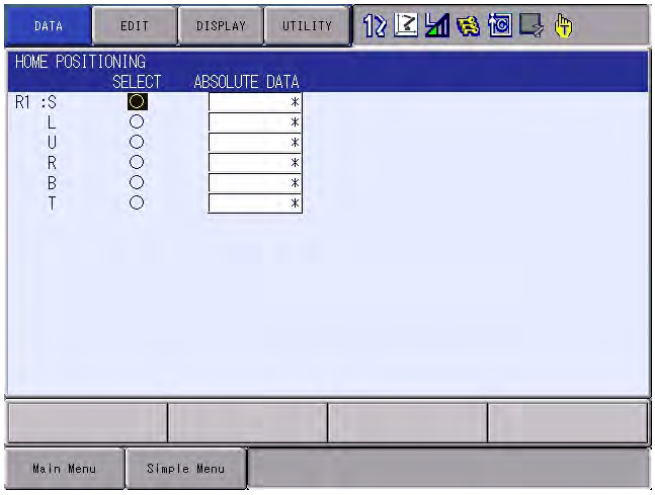
NOTE Home position calibration screen is displayed only when the security mode is set to the management mode.

8.1.2.1 Registering All Axes at One Time

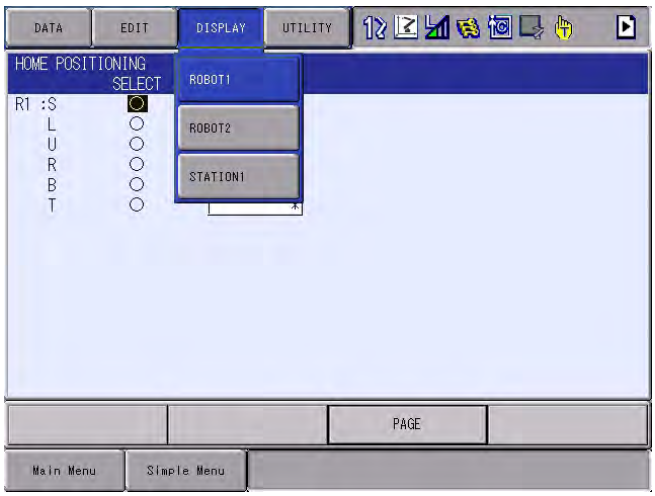
1. Select {ROBOT} under the main menu.
   – The sub menu appears.



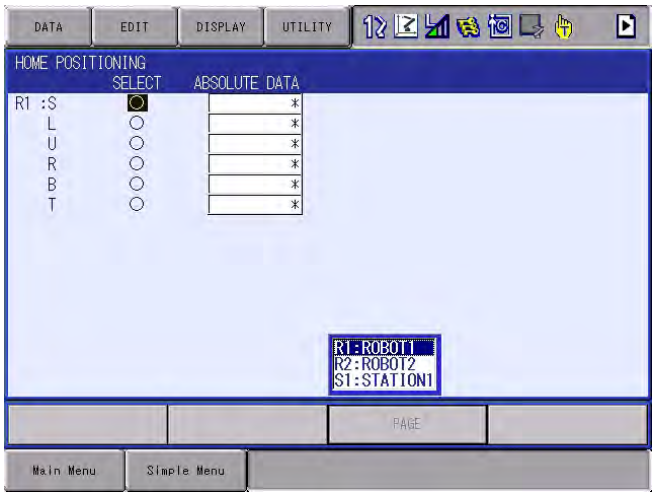
2. Select {HOME POSITION}.
   – The HOME POSITIONING window appears.



3. Select {DISPLAY} under the menu.
   – The pull-down menu appears.

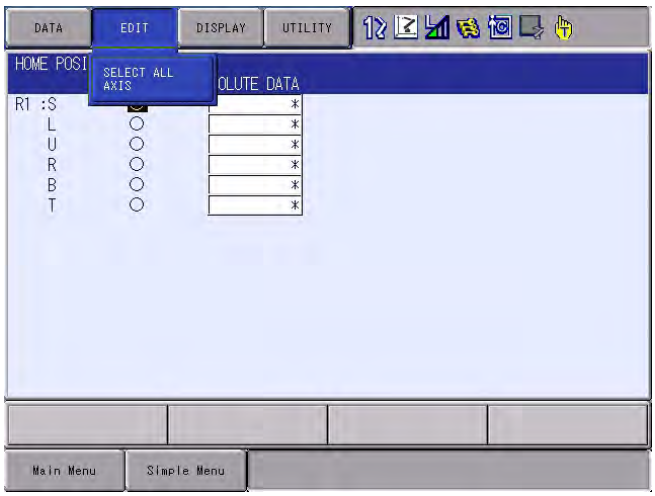


   – The same operation as the instruction 3 can also be performed by selecting {PAGE}, and selection box appears.

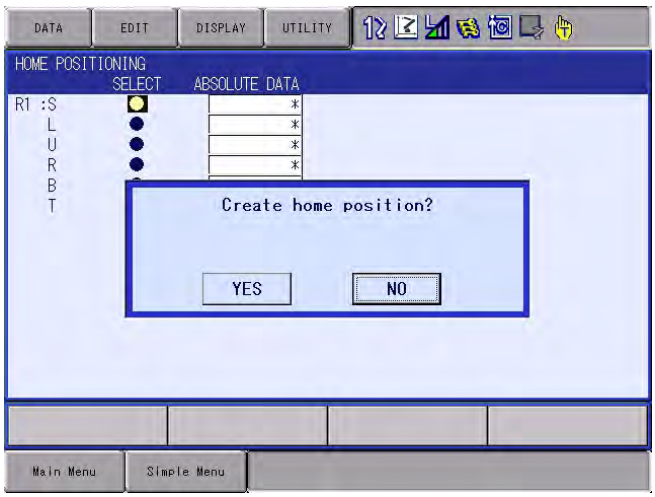


4. Select the desired control group.
   – Select the control group for HOME POSITIONING.
   – The control group can also be selected by pressing page key  .

5. Select {EDIT} under the menu.
   – The pull-down menu appears.



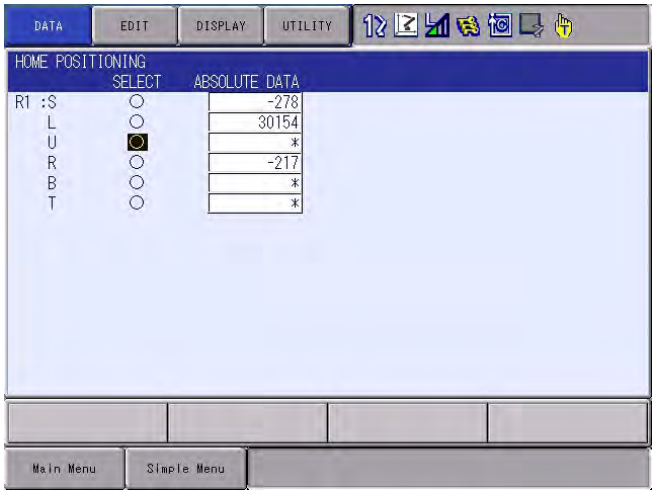
6. Select {SELECT ALL AXES}.
   – The confirmation dialog box appears.



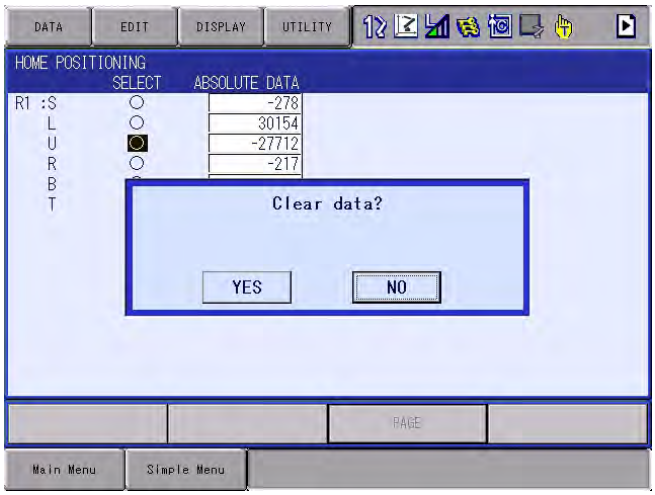
7. Select {YES}.
   – Displayed position data of all axes are registered as home position. When {NO} is selected, the registration will be canceled.

8.1.2.2 Registering Individual Axes

1. Select {ROBOT} under the main menu.
   – The sub menu appears.
2. Select {HOME POSITION}.
3. Select the desired control group.
   – Perform the steps 3 and 4 of the “Registering All Axes at One Time” to select the desired control group.
4. Select the axis to be registered.
   – Move the cursor to the axis to be registered, and select it.



   – A confirmation dialog box appears.

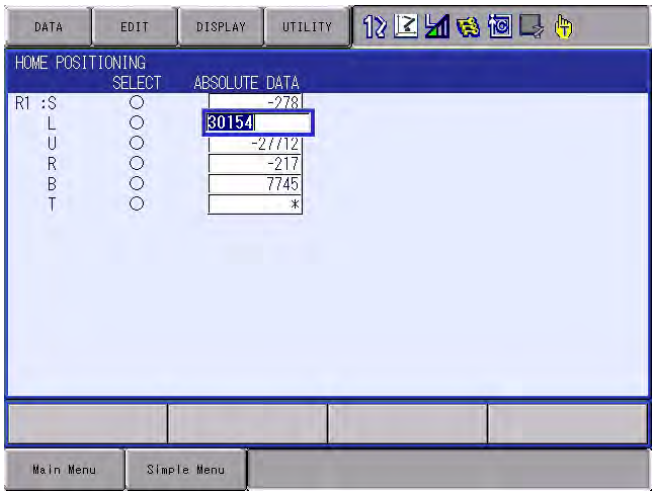


5. Select {YES}.
   – Displayed position data of the axis is registered as home position. When {NO} is selected, the registration will be canceled.

8.1.2.3 Changing Absolute Data

To change the absolute data of the axis when home position calibration is completed, perform the following:

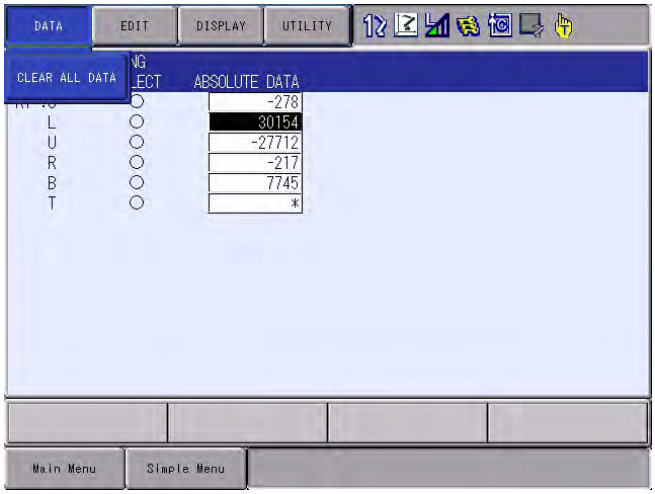
1. Select {ROBOT} under the main menu.
2. Select {HOME POSITION}.
3. Select the desired control group.
   – Perform the step 3 and 4 of the “Registering All Axes at One Time” to select the desired control group.
4. Select the absolute data to be registered.
   – The number can now be entered.



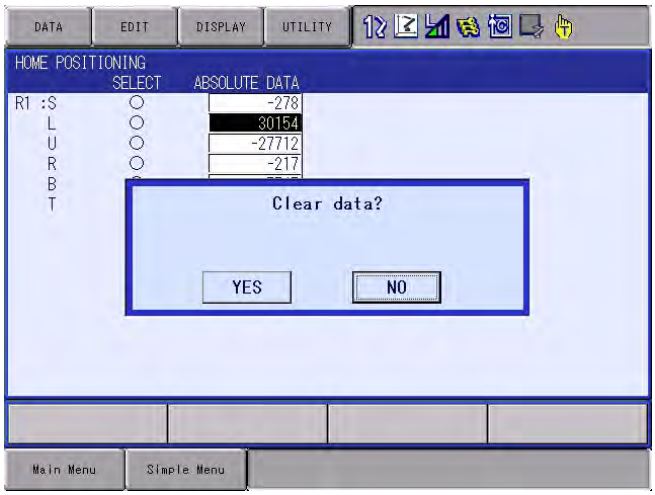
5. Enter the absolute data using the numeric keys.
6. Press [ENTER].
   – Absolute data is modified.

8.1.2.4 Clearing Absolute Data

1. Select {ROBOT} under the main menu.
   – The sub menu appears
2. Select {HOME POSITION}.
   – Perform the step 3 and 4 of the “Registering All Axes at One Time” to select the desired control group.
3. Select {DATA} under the main menu.
   – The pull-down menu appears

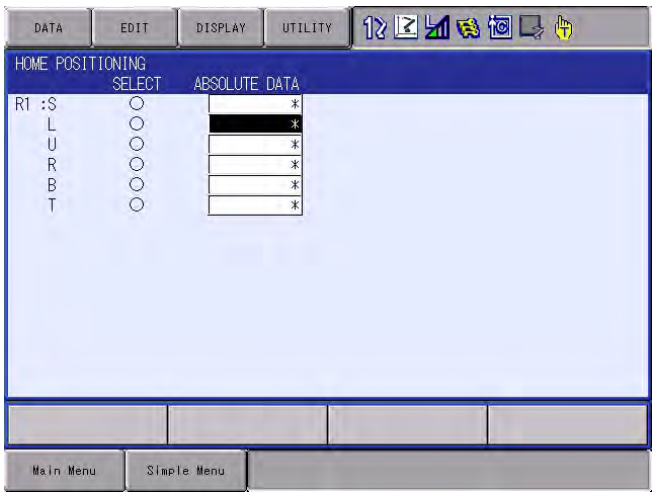


4. Select [CLEAR ALL DATA].
   – A confirmation dialog box appears.



5. Select {YES}.

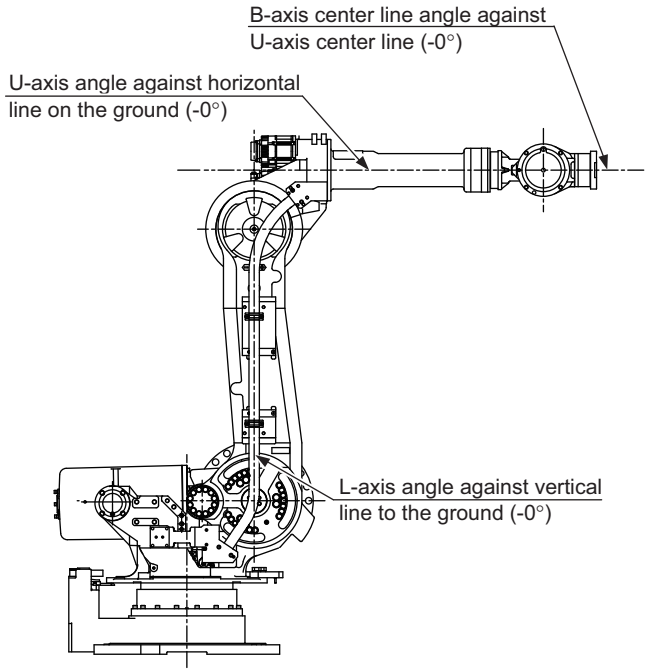
– All absolute data are cleared.



– When {NO} is selected, the registration will be canceled.

8.1.3 Home Position of Robot

In the case of MH165, the home position is as follows:



NOTE Other manipulator models have different positions. Always refer to “MANIPULATOR INSTRUCTIONS” for the correct manipulator model.

8.2 Setting Second Home Position (Check Point)

WARNING

- Be aware of safety hazards when performing the position confirmation of the second home position (check point).

When “OUT OF RANGE (ABSO DATA)” alarm occurs, abnormality of the PG system may be a cause of the alarm. The manipulator may operate in an unexpected manner, and there is a risk of damage to equipment or injury to personnel.

- Before operating the manipulator, check that the SERVO ON LED is turned OFF when the emergency stop button on the programming pendant is pressed.

Injury or damage to machinery may result if the manipulator cannot be stopped in case of an emergency.

- Observe the following precautions when performing teaching operations within the manipulator’s operating range:
  - Be sure to use a lockout device to the safeguarding when going inside. Also, display the sign that the operation is being performed inside the safeguarding and make sure no one closes the safeguarding.
  - 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 manipulator’s operating range and that you are in a safe location before:
  - Turning ON the FS100L power.
  - Moving the manipulator with the programming pendant.

Injury may result if anyone enters the manipulator’s operating range during operation. Always press the emergency stop button immediately if there is a problem. The emergency stop button is located on the right of the programming pendant.

CAUTION

- Perform the following inspection procedures prior to conducting manipulator teaching. If a problem is found, correct it and implement all other necessary measures immediately.
  - 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 FS100L cabinet after use.

If the programming pendant is inadvertently left on the manipulator, on a fixture, or on the floor, the manipulator or a tool may collide with the programming pendant during manipulator movement, which may result in personal injury or equipment damage.

- Make sure that a system manager stores the key of the mode select switch on the programming pendant.
  After operation, the key should be removed and stored by the system manager.

Improper or unintended manipulator operation may result in injury. Also, the key or the mode select switch may be damaged if the programming pendant is dropped with the key inserted.

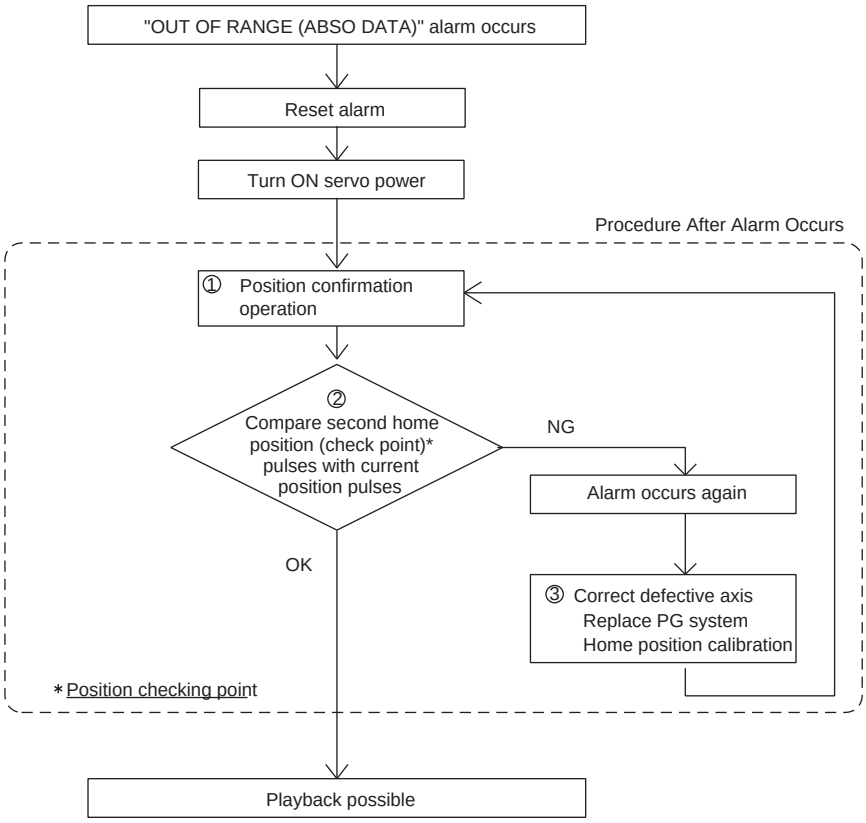
8.2.1 Purpose of Position Check Operation

If the absolute number of rotation detected at power supply ON does not match the data stored in the absolute encoder the last time the power supply was turned OFF, an alarm is issued when the controller power is turned ON.

There are two possible causes of this alarm:

- Error in the PG system
- The manipulator was moved after the power supply was turned OFF.

If there is an error with the PG system, the manipulator may stall when playback is started. If the absolute data allowable range error alarm has occurred, playback and test runs will not function and the position must be checked.



① Position Check

After the “OUT OF RANGE (ABSO DATA)” alarm occurs, move to the second home position using the axis keys and perform the position confirmation. Playback, test runs, and FWD operation will not function unless “CONFIRM POSITION” is performed.

② Pulse Difference Check

The pulse number at the second home position is compared with that at the current position. If the difference is within the allowable range, playback is enabled. If not, the alarm occurs again.

- The allowable range pulse is the number of pulses per rotation of the motor (PPR data).
- The initial value of the second home position is the home position (where all axes are at pulse 0). The second home position can be changed. For details, refer to *chapter 8.2.2 “Procedure for Second Home Position Setting (Check Point)” at page 8-17*.

③ Alarm Occurrence

If the alarm occurs again, there may be an error in the PG system. Check the system. After adjusting the erroneous axis, calibrate the home position of the axis, then check the position again.

NOTE

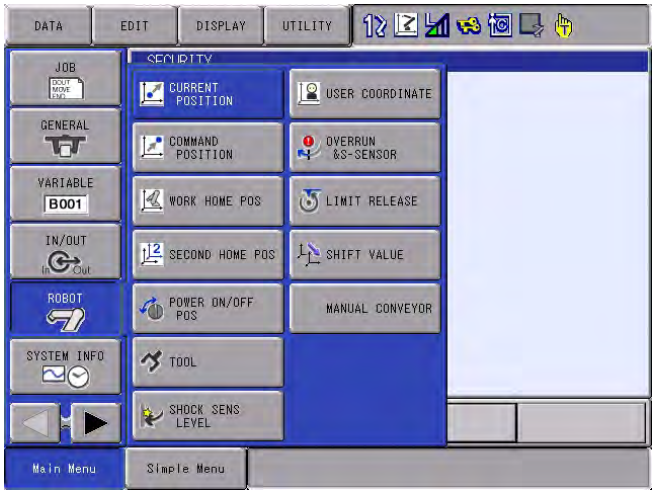
- Home position calibration of all the axes at the same time enables playback operations without having to check the position.
- Sometimes in a system with a manipulator with no brake, it is possible to enable playback without position checking after the alarm occurs. However, as a rule, always perform "CONFIRM POSITION". Under the above special conditions, the manipulator moves as follows:
  After the start, the manipulator moves at low speed (1/10 of the maximum speed) to the step indicated by the cursor. If it stops and restarts during this motion, the low speed setting is retained until the step at cursor is reached.
  Regardless of cycle setting, the manipulator stops after reaching to the step indicated by cursor. Starting the manipulator again then moves it at the programmed speed and cycle of the job.

8.2.2 Procedure for Second Home Position Setting (Check Point)

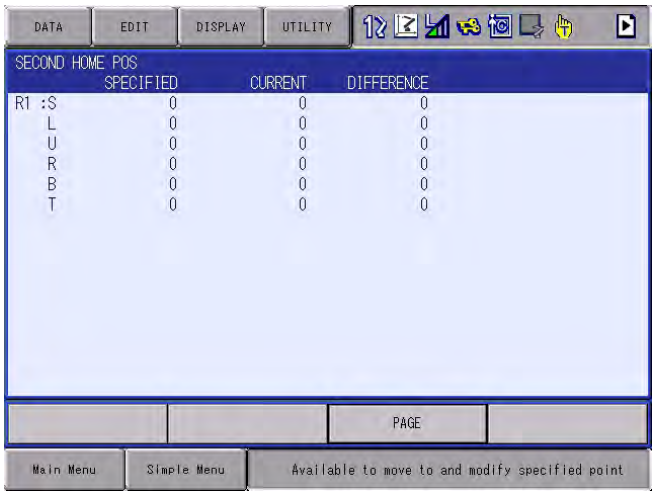
Apart from the “home position” of the manipulator, the second home position can be set up as a check point for absolute data. Use the following steps to set the specified point.

If two or more manipulators or stations are controlled by one controller, the second home position must be set for each manipulator or station.

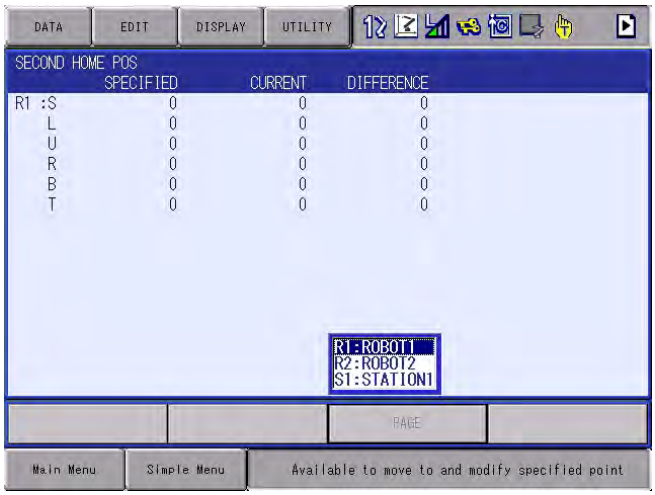
1. Select {ROBOT} under the main menu.
   – The sub menu appears.



2. Select {SECOND HOME POS}.
   – The SECOND HOME POS window appears.
   A message “Available to move to and modify specified point” is displayed.



3. Press the page key , or select {PAGE} to display the selection window for the control group.
   – When there are two or more group axes, select the group axes to which the second home position is to be specified.



4. Press the axis keys.
   – Move the manipulator to the new second home position.
5. Press [MODIFY], then [ENTER].
   – The second home position is changed.

8.2.3 Procedure After Alarm

WARNING

- Be aware of safety hazards when performing the position confirmation of the specified point.

Abnormality of the PG system may be the cause of the alarm. The manipulator may operate in an unexpected manner, and there is a risk of damage to equipment or injury to personnel.

If the “OUT OF RANGE (ABSO DATA)” alarm occurs:

- Reset the alarm;
- Turn ON the servo power;

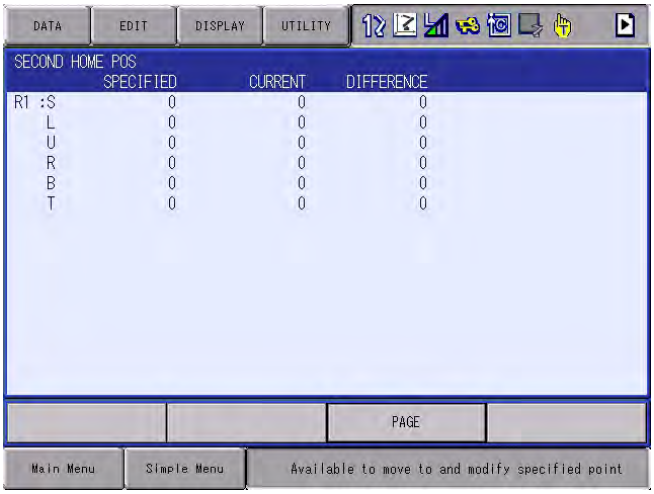
then confirm the second home position. After the confirmation, if the PG system is found to be the cause of the alarm, perform the necessary operation, such as replacing the PG, etc.

The robot current position data when turning main power supply OFF and ON can be confirmed in “POWER ON/OFF POS” window.

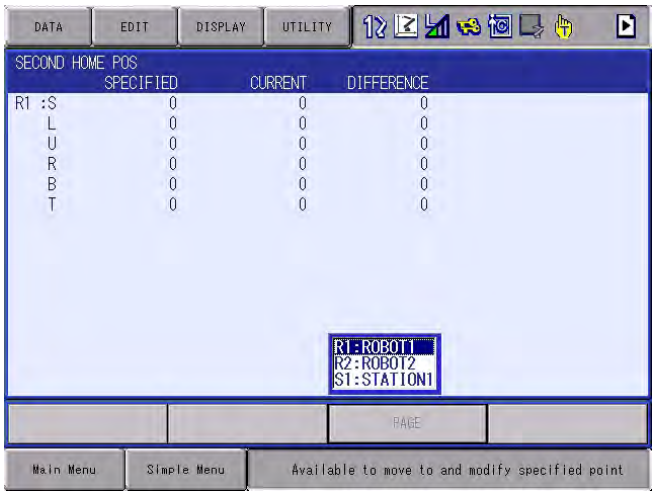
SUPPLE -MENT

For details on the “POWER ON/OFF POS” window, refer to “8.7 Position Data When Power is Turned ON/OFF” in FS100L MAINTENANCE MANUAL.

1. Select {ROBOT} under the main menu.
   – The sub menu appears.
2. Select {SECOND HOME POS}.
   – The SECOND HOME POS window appears.



3. Press the page key , or select {PAGE} to display the selection window for the control group.
   – When there are two or more group axes, select the group axes to which the second home position is to be specified.



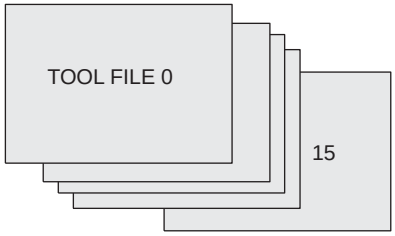
4. Press [FWD].
   – TCP moves to the second home position. The robot moving speed is set as selected manual speed.
5. Select {DATA} under the menu.
6. Select {CONFIRM POSITION}.
   – A message “Home position checked” appears.
   – Pulse data of the second home position and current pulse data are compared. If the compared error is in allowed range, playback operation can be done.
   – If the error is beyond the allowed range, the alarm occurs again.

8.3 Tool Data Setting

8.3.1 Registering Tool Files

8.3.1.1 Number of Tool Files

There are 16 tool files numbered 0 to 15. Each file is called as a tool file.

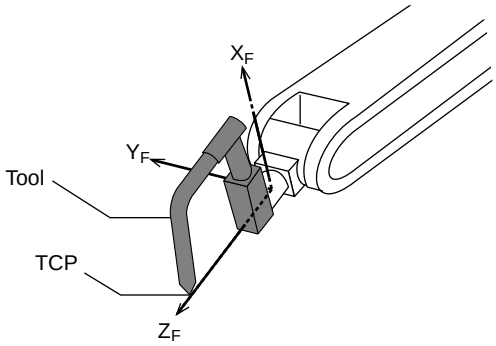


SUPPLE-MENT

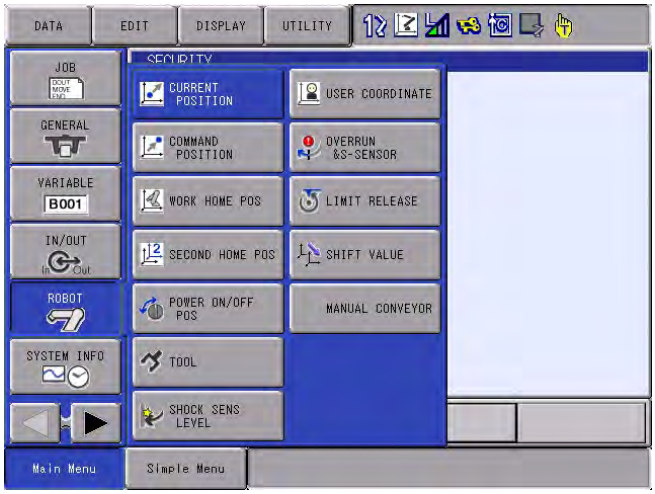
Tool File Extension Function
Normally, one robot uses one kind of tool file. The tool file extension function can change many tool files to be used by one robot. Use the following parameter to set this function.
S2C333: TOOL NO. SWITCHING (1: enabled; 0: disabled)
For more details, refer to “8 Parameter” in FS100 OPERATOR’S MANUAL.

8.3.1.2 Registering Coordinate Data

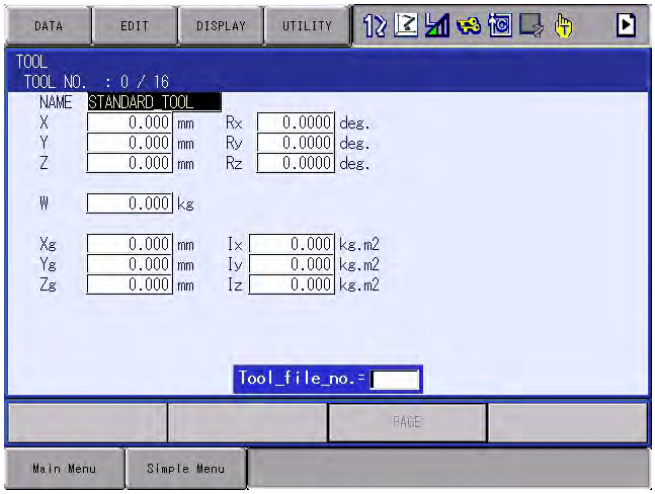
When the number input operation is used for registering the tool file, input the TCP of the tool on the flange coordinates.



1. Select {ROBOT} under the main menu.
   – The sub menu appears.

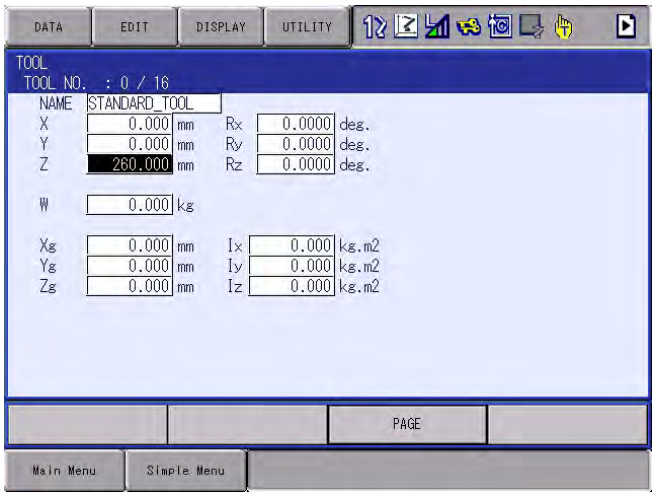


2. Select {TOOL}.
   (1) Move the cursor to the number of the desired tool, and press {SELECT} in the tool list window.
   (2) The tool coordinate window of the selected number appears.
   – In the tool coordinate window, the tool number can be changed by pressing the page key  or selecting {PAGE}.

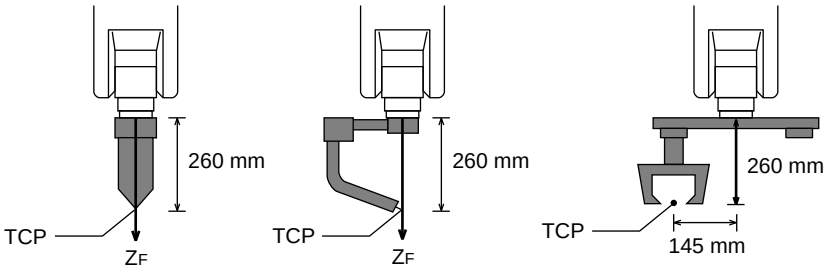


– To switch the tool list window and the tool coordinate window, press {DISPLAY} → {LIST} or {DISPLAY} → {COORDINATE DATA}.

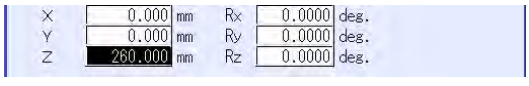
3. Select the desired tool number.
4. Place the cursor in the part to register the desired coordinate data and press [SELECT].
   – The number is ready to input.
5. Input the coordinate data.
6. Press [ENTER].
   – The coordinate data is registered.



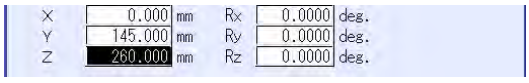
<Setting Example>



• In case of Tool A, B



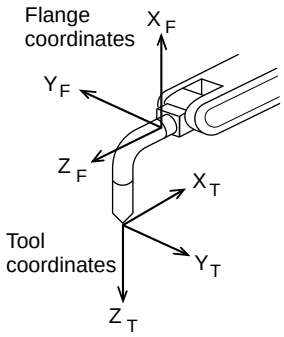
• In case of Tool C



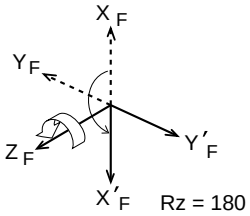
8.3.1.3 Registering Tool Angle

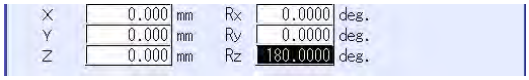
The tool pose data is angle data which shows the relation between the flange coordinates and the tool coordinates. The angle when the flange coordinates are rotated to meet to the tool coordinates becomes an input value. Clockwise toward the arrow is the positive direction. Register in the order of Rz → Ry → Rx.

In the following case, register Rz=180, Ry=90, Rx=0



1. Select {ROBOT} under the main menu.
2. Select {TOOL}.
3. Select the desired tool number.
   – In the same way as shown in Explanation 2, 3 in *chapter 8.3.1.2 “Registering Coordinate Data” at page 8-22*, display the desired tool coordinate window.
4. Select the desired coordinate axis to modify.
   – First, select Rz.
5. Input the tool pose data.
   – Input rotation angle around Z_F of the flange coordinates.

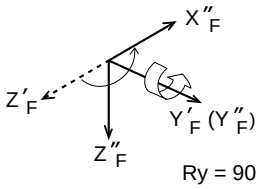


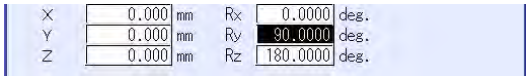


6. Press [ENTER].

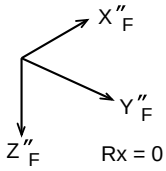
– The rotation angle of Rz is registered.

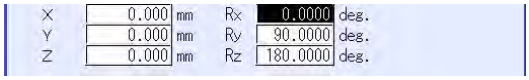
In the same way, register the angle of Ry, Rx.
Ry must be the input rotation angle around Y'_F flange coordinates.





– Rx must be the input rotation angle around X'_F of flange coordinates.





8.3.1.4 Setting Tool Load Information

The tool load information includes weight, a center of gravity position, and moment of inertia at the center of gravity of the tool installed at the flange.

SUPPLE -MENT

For more details on the tool load information, refer to *chapter 8.4.3 “Setting Tool Load Information” at page 8-48*.

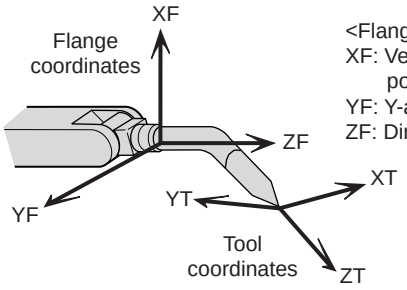
8.3.2 Tool Calibration

8.3.2.1 Tool Calibration

To ensure that the manipulator can perform motion type operations such as linear and circular motion type correctly, accurate dimensional information on tools such as hands must be registered and the position of the TCP must be defined.

Tool calibration is a function that enables this dimensional information to be registered easily and accurately. When this function is used, the TCP is automatically calculated and registered in the tool file.

What is registered in tool calibration is the coordinates of the TCP and the tool posture data in the flange coordinates.



<Flange coordinates>
XF: Vertically upward direction when the current position on the T-axis of the manipulator is "0"
YF: Y-axis complementing XF and ZF
ZF: Direction perpendicular to the flange face

8.3.2.2 Setting of Tool Calibration Method

There are three tool calibration methods, which are selected by setting parameter.

S2C432: Designation of tool calibration method

0: Calibrates only the coordinates.
"Coordinates" calculated from 5 calibration teaching points is registered in the tool file.
In this case "Tool Posture Data" is all cleared to be 0.

1: Calibrates only the posture.
"Tool Posture Data" calculated from the first calibration teaching point is registered in the tool file.
In this case, "Coordinates" will not be changed. (the prior value is maintained.)

2: Calibrates the coordinates and the posture.

"Coordinates" calculated from 5 calibration teaching points and "Tool Posture Data" calculated from the first calibration teaching point are registered in the tool file.

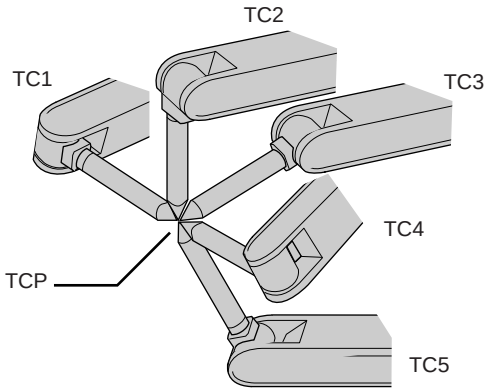
NOTE

- In case of S2C432=0 (only coordinates is calibrated), tool posture data is overwritten with 0.
  (When the coordinates calculated from tool calibration is registered in the tool file in which the tool posture data is already registered, the tool posture data will be deleted.)
- In case of S2C432=1 (only posture is calibrated), the coordinates are maintained.
- In case of S2C432=1, 5 teaching points need to be registered though only the first point is used for calculation.

8.3.2.3 Teaching of Calibration Point

■ **Teaching for defining coordinates**

In order to calibrate coordinates, five different postures (TC1 to 5) must be taught with the TCP as the reference point. The tool dimensions are automatically calculated on the basis of these five points.



Each posture must be arbitrary. Accuracy may decrease when pose setting is rotated in a constant direction

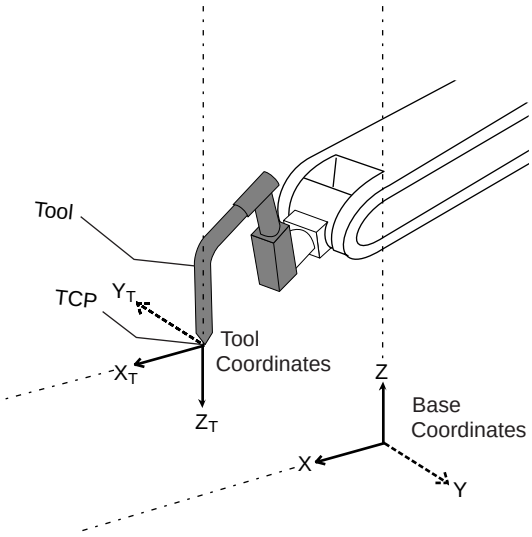
■ **Teaching for defining posture**

The calibration of tool posture data is performed with the first calibration teaching point (TC1).

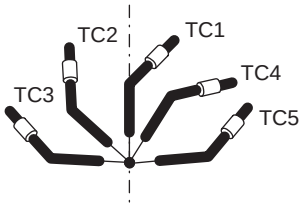
Teach TC1 with Z-axis of the desired tool coordinates downward vertically to the ground. (the Z-axis of the tool coordinates is parallel to the Z-axis of the base tool and points to the opposite direction.)

Tool posture data is automatically calculated with this TC1 posture.

The X-axis of the tool coordinates is defined in the same direction as the X-axis of the base coordinates.

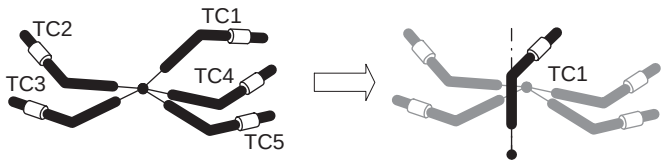


In case of calibrating with S2C432=2, teach TC1 with Z-axis of the desired tool coordinates downward vertically to the ground. Then teach the other calibration teaching points (TC2~TC5) with the all tool points meet at the TC1's tool point as shown in the figure below.



SUPPLE -MENT

If teaching in one place as the figure above is impossible due to the interference of peripheral equipment and so on, perform calibration of coordinates with S2C432=0 or 2, and then change to S2C432=1, teach only TC1 in a different position and register the tool posture data.

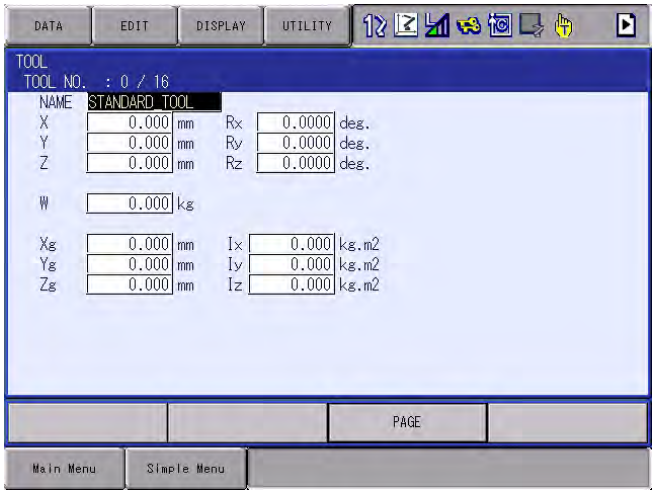


[S2C432 = 0 or 2] [S2C432 = 1]

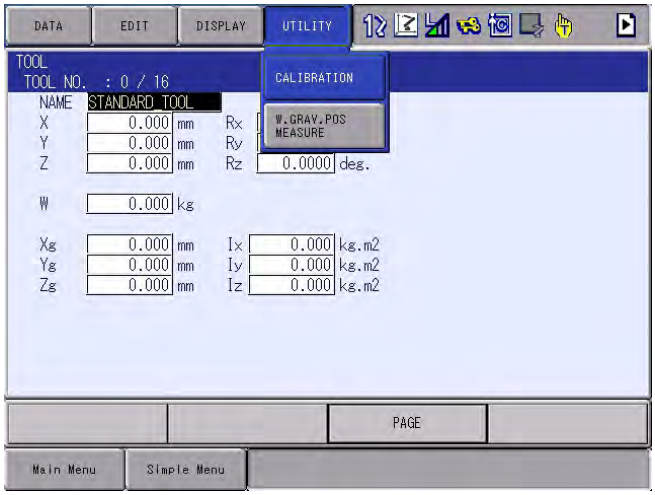
SUPPLE -MENT

- There are 16 tool files numbered 0 to 15.
- In a basic system with one manipulator and one tool, the tool file for tool No. 0 is used.
- If there is more than one tool, for example when using a multihand, use the tool numbers in the order of 0, 1, 2, etc.

1. Select {ROBOT} under the main menu.
2. Select {TOOL}.
3. Select the desired tool number.
   – In the same way as shown in the steps 2 and 3 of the *chapter 8.3.1.2 “Registering Coordinate Data” at page 8-22*, display the desired tool coordinate window.

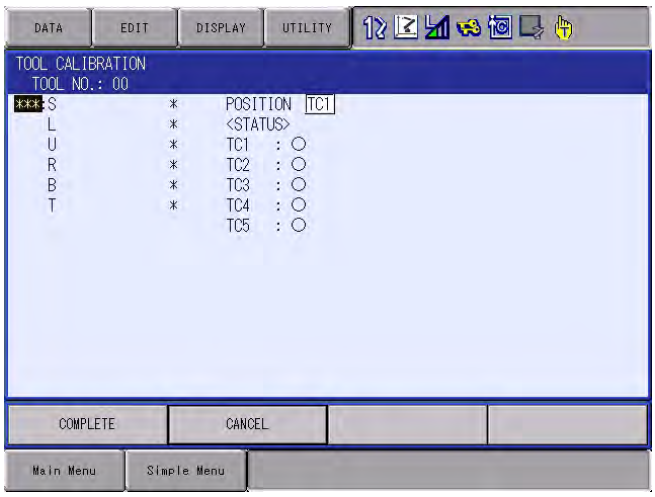


4. Select {UTILITY} under the menu.
   – The pull-down menu appears.



5. Select {CALIBRATION}.

   – The TOOL CALIBRATION window is shown.

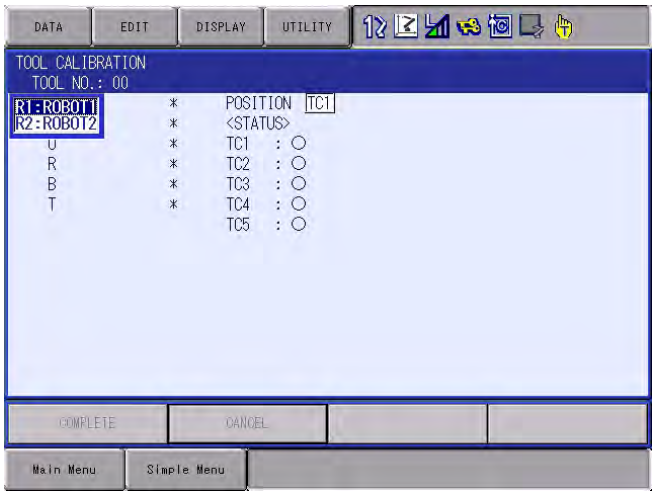


6. Select the robot.

   (1) Select the robot to calibrate.
   (When the robot has already been selected or there is only one of robot, this operation should not be performed.)

   (2) Select “**” in the TOOL CALIBRATION window and select the robot in the shown selection dialog box.

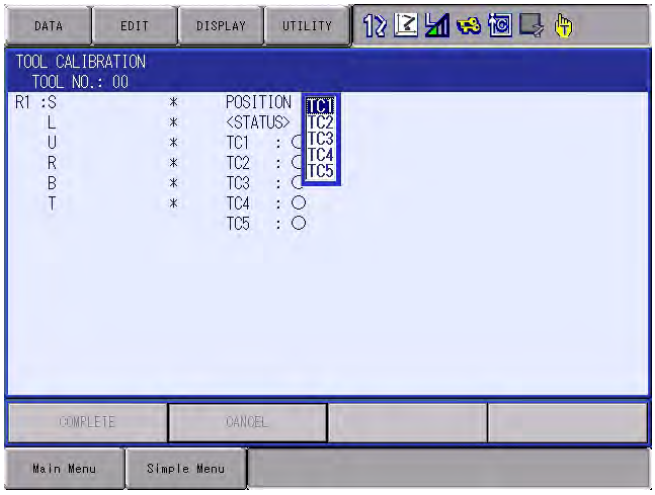
   (3) The robot is set.



7. Select “POSITION”.

   – The selection dialog box is shown.

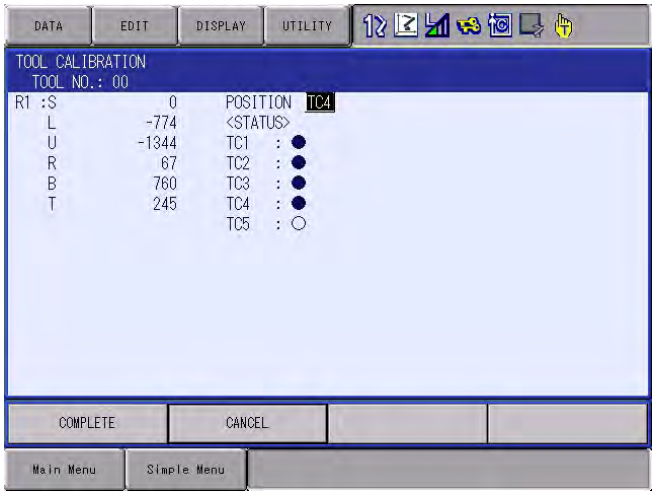
   (1) Select the teaching point for calibration.



8. Move the manipulator using the axis key.

9. Press [MODIFY] and [ENTER].

   – Taught position is registered.
   Repeat 7 to 9 operation to teach TC1 to TC5.
   “●” denotes that teaching is completed and “○” denotes that it is not completed.

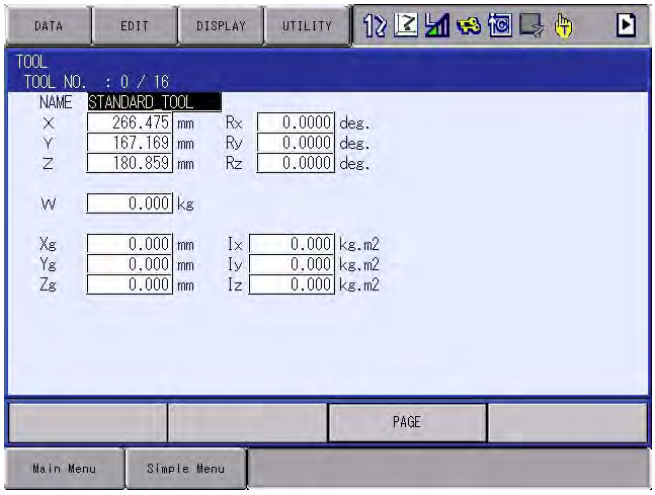


   – To check the taught positions, call up the required window among TC1 to TC5 and press [FWD]. The manipulator moves to the set position.

   – If there is a difference between the current position of the manipulator and the shown position data, “TC□” next to “POSITION” in the window flashes.

10. Select “COMPLETE”.

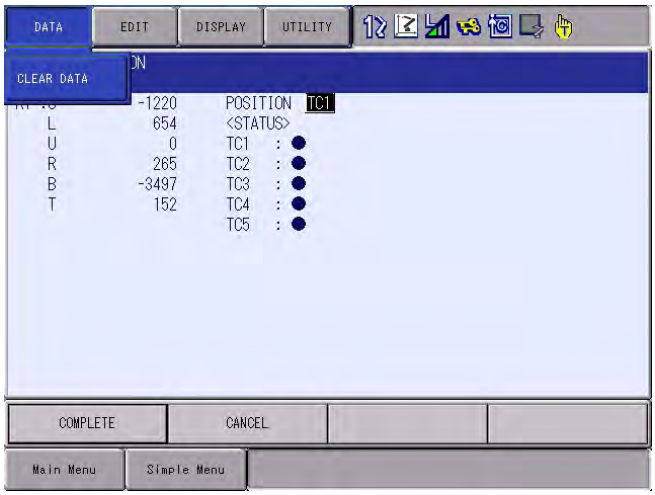
– Calibration data is registered in the tool file. Once the calibration is completed, the tool coordinate window is displayed on the screen.



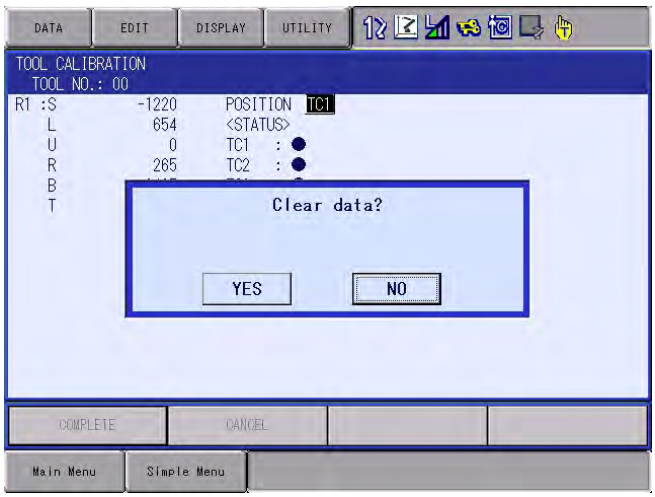
8.3.2.4 Clearing Calibration Data

Before the calibration of a new tool, clear the robot information and calibration data.

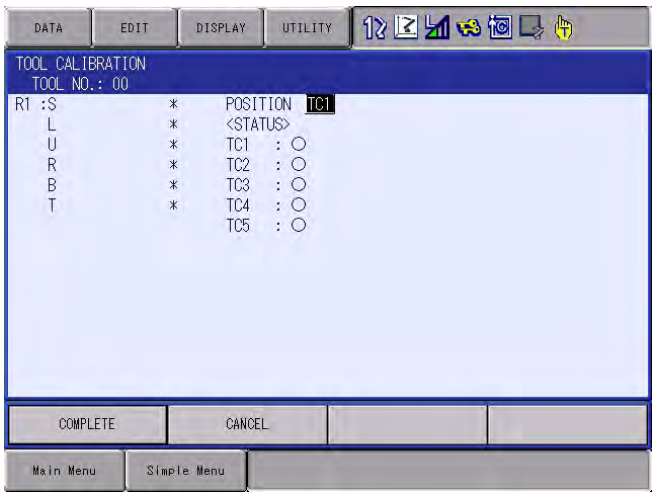
1. Select {DATA} under the pull-down menu.
   – The pull-down menu appears.



2. Select {CLEAR DATA}.
   – The confirmation dialog box is shown.



3. Select {YES}.
   – All data is cleared.

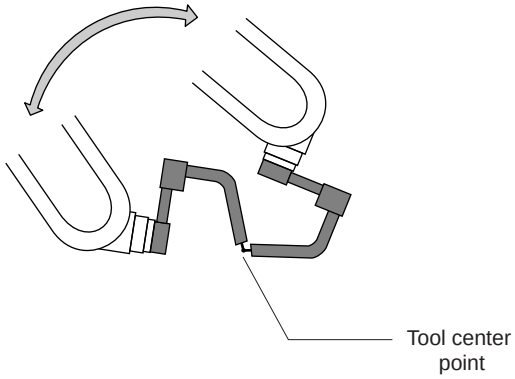


SUPPLE-MENT

If tool angle data is required, input the data number in the tool coordinate window.
Refer to *chapter 8.3.1.3 "Registering Tool Angle" at page 8-24* for the operating instructions.

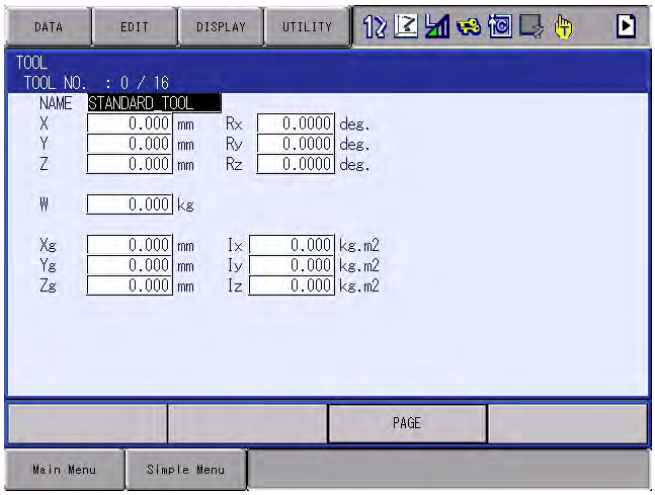
8.3.2.5 Checking TCP

After registering the tool file, check if the TCP is correctly registered by performing a TCP fixed operation like the one shown below, in any coordinate system other than the joint.



1. Press the COORD key  .

   – Select any coordinate system except “  JOINT” by pressing the COORD key  .

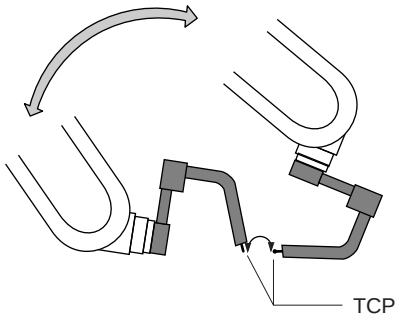


2. Select desired tool number.

   –Show the tool coordinate window of the desired tool by pressing the page key  or selecting it in the tool list window.

3. Move the R, B, or T axes using the axis key.

   – By pressing the axis keys for the R, B, and T axes, change the manipulator pose without changing the TCP position.
   If this operation shows a large TCP error, adjust the tool data.



SUPPLE -MENT

For details on the TCP fixed operation, see “2.3.7 Motion about TCP” in FS100 OPERATOR’S MANUAL.

8.3.3 Automatic Measurement of Tool Load and Center of Gravity

8.3.3.1 Description of Automatic Measurement of Tool Load and Center of Gravity

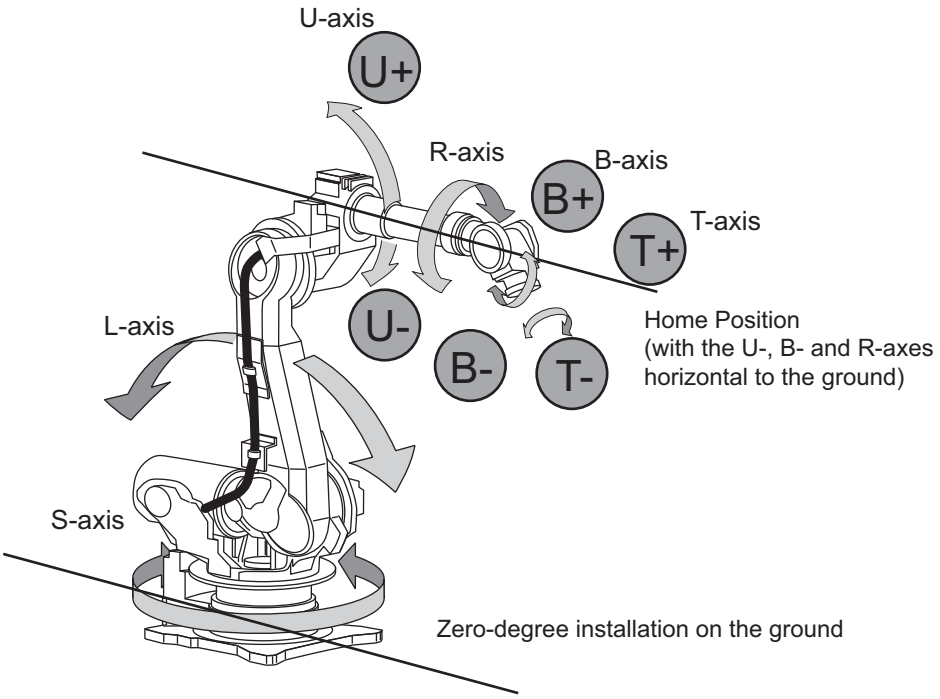
With this function, the user can register the load of tool and the position of the tools center of gravity.

The tool load and the position of it's center of gravity are measured and registered in a tool file.

NOTE This function can be used where the manipulator is installed level on the ground.
For the conditions required for manipulator installation, refer to *chapter 8.4 "ARM Control" at page 8-43*.

8.3.3.2 Measurement of Tool Load and Center of Gravity

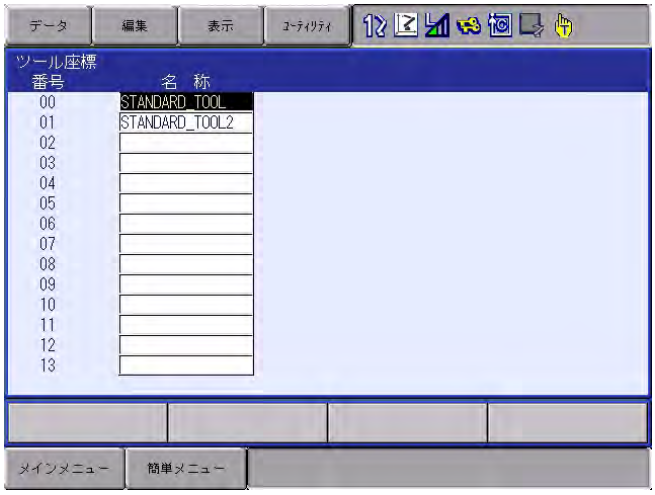
To measure the tool load and the center of gravity, move the manipulator to its home position (with the U-, B- and R-axes horizontal to the ground) and operate the U-, B- and T-axes.

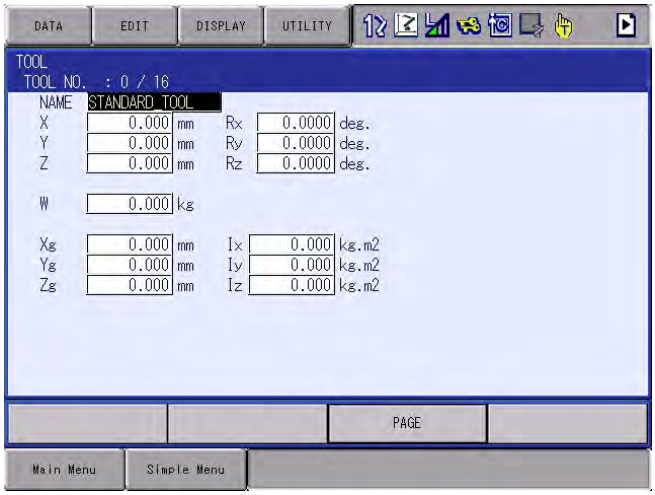


NOTE To correctly measure the tool load or the center of gravity, remove the cables or wires connected to the tool.

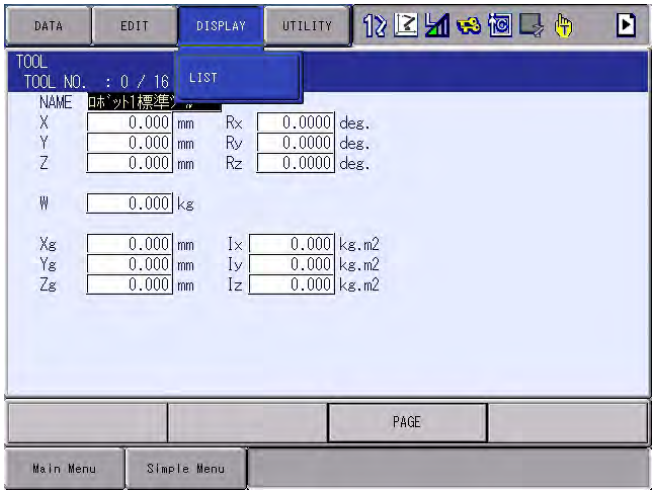
1. Select {ROBOT} under the main menu.
2. Select {TOOL}.
   – The tool list window appears.
   – The tool list window is called up only when the file extension function is valid.

If the file extension function is invalid, the tool coordinate window appears.

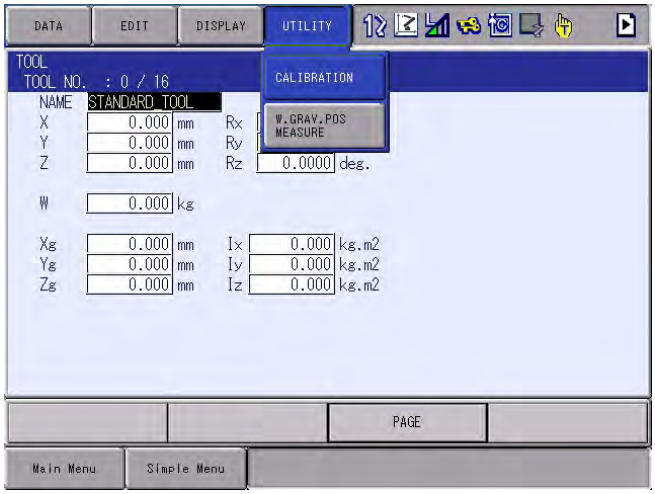




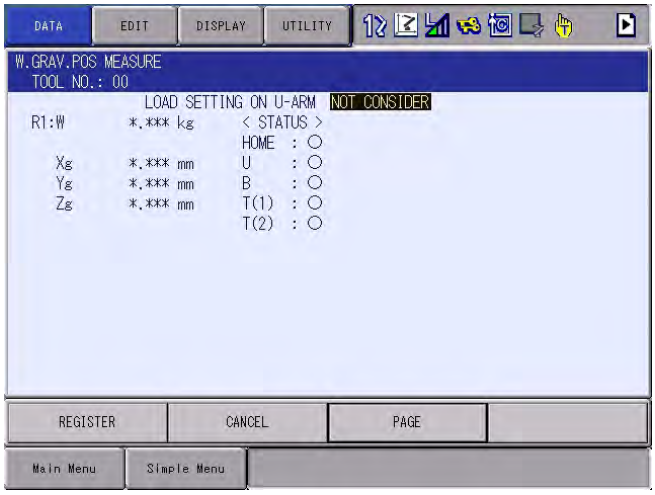
3. Select the desired tool number.
   - Move the cursor to the desired number in the tool list window and press [SELECT].
   - The tool coordinate window of the selected number is shown.
   - In the tool coordinate window, the number can be changed by pressing the page key or selecting {PAGE}.
   - To switch the tool list window and the tool coordinate window, press {DISPLAY} → {LIST} or {DISPLAY} → {COORDINATE DATA}.



4. Select {UTILITY} under the menu.



5. Select {W.GRAV.POS MEASURE}.
   – The window for the automatic measurement of the tool load and the center of gravity is shown.



6. Press the page key  .
   – In a system with several manipulators, use the page key  to change the group to be controlled.
7. Press [FWD].
   – Press [FWD] once, and the manipulator moves to the home position (horizontal to the U-, B- and R-axes).
8. Press [FWD] again.
   – Press [FWD] again, and measurement starts. Keep the button pressed until measurement is completed.

The manipulator moves in the order listed below. Once measurement is completed, "○" changes to "●".

① Measurement of the U-axis: U-axis home position +4.5 degrees → -4.5 degrees

② Measurement of the B-axis: B-axis home position +4.5 degrees → -4.5 degrees

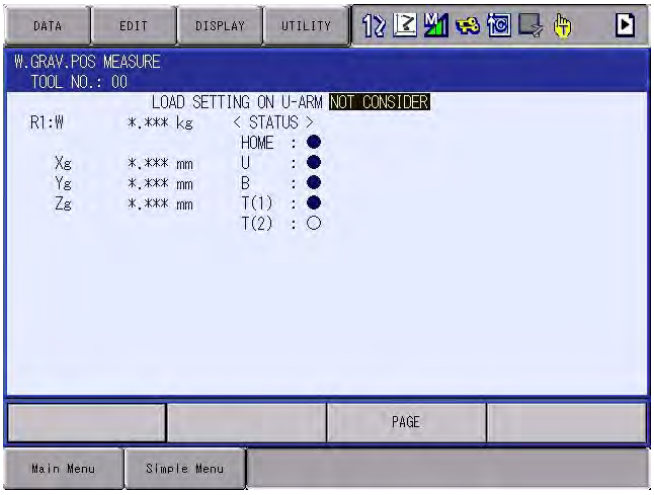
③ First measurement of the T-axis: T-axis home position +4.5 degrees → -4.5 degrees

④ Second measurement of the T-axis: T-axis home position +60 degrees → +4.5 degrees → -4.5 degrees

SUPPLE-MENT

- The speed during measurement automatically changes to "Medium".
- During the measurement, "HOME" or "U" blinks on the screen.
- During the measurement, the [FWD] button has to be kept pressed. If the button is released during the measurement or if it is released before "○" changes into "●", the measurement is aborted and the following message appears: "Stopped measurement"
- The measurement starts again from the first home position.

– When all the measurements are completed or when all the “○” marks have changed into “●”, the measured data appears on the screen.



9. Select “REGISTER”.

– The measured data is registered in the tool file, and the tool coordinate window appears.

– Select “CANCEL” to call up the tool list window without registering the measured data in the tool file.

8.4 ARM Control

8.4.1 ARM Control

ARM Control, a control system originally developed by Yaskawa, achieves an enhanced robot motion performance such as improved path accuracy or reduced cycle time.

The moment of inertia and the gravity moment etc. of each axis are calculated by the ARM control function, and FS100L controls robot motion according to the result. It is necessary to set the robot setup condition and the tool load information to request these accurately.

The robot setup condition is robot installation angle relative to ground and the weight and a center of gravity position of the load installed at each part of robot, etc.

The tool load information is weight, a center of gravity position, and moment of inertia at the center of gravity, of the tool installed at the flange.

It is necessary to set these information correctly to do a better operation control by the ARM control.

8.4.2 ARM CONTROL Window

CAUTION

- Correctly set the robot setup condition.

Make sure to avoid any mistake in setting the unit indication or specifying positive and negative values. Failure to observe this caution may lead to improper control of the manipulator, resulting in error occurrence or short life span of speed reducer.

- Confirm the operation path of robot of each job when modifying settings.

Set the robot setup condition when setting up the manipulator.

Confirm the operation path of manipulator of each job afterwards when the setting should be modified after the installation.

Modifying the settings of the ARM control may slightly change the operation path. To avoid injury or damage to machinery caused by collision between tool and positioner, make sure to check the operation path before executing a job.

8.4.2.1 Robot Setup Condition

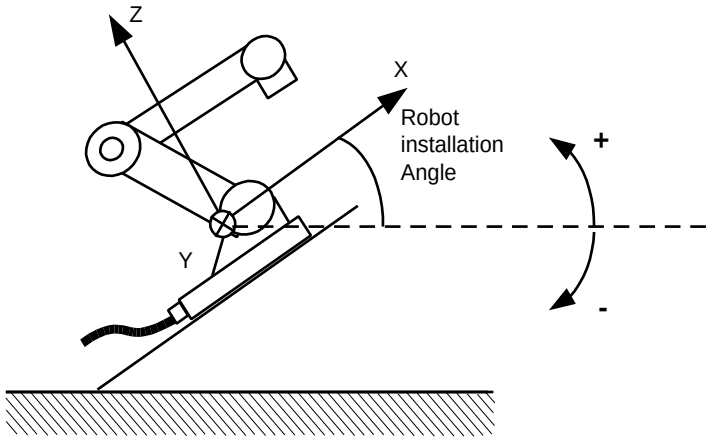
Fulfill the following robot setup condition to enable the ARM control.

- Robot installation angle
- S-head payload
- U-arm payload

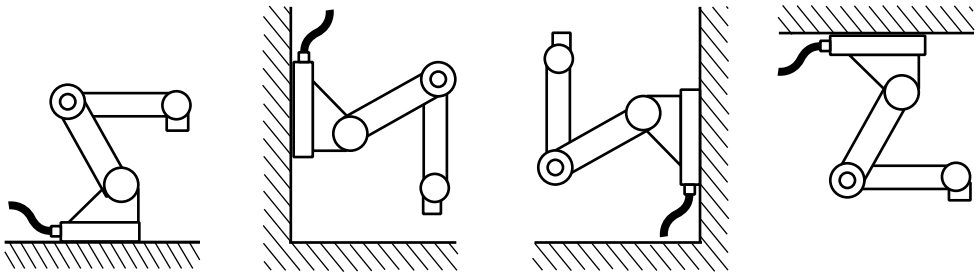
■ **Robot installation angle**

The angle of the manipulator installed relative to ground is set in ANGLE REL. TO GROUND to calculate the gravity moment which loads to each axis of the manipulator.

The robot installation angle sets how much X axis of the robot coordinates has inclined with the ground around Y axis of the robot coordinates. The direction of + in the U-axis operation from the home position posture of the manipulator becomes direction of + of the robot installation angle. Therefore, the robot installation angle for a vertical downward wall mount specification becomes -90 degrees.



<Example>



0 degrees -90 degrees +90 degrees 180 degrees

If the robot installation angle is not correctly set, the manipulator cannot be properly controlled. Therefore, make sure to set the value correctly, paying special attentions to the direction “+” or “-”.

NOTE

Only rotation angle around Y axis of the robot coordinates can be set in the robot installation angle.
Contact Yaskawa representative when the robot is installed to incline Y axis of the robot coordinates relative to the ground.

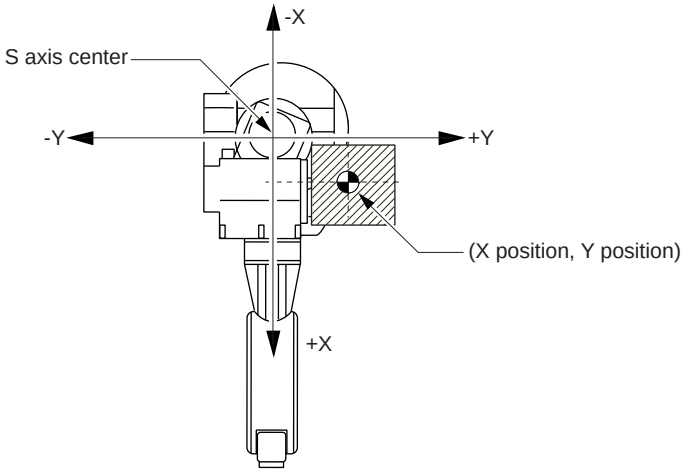
S-head payload

Set the weight and the center of gravity position roughly when a device is installed at the S-head.

It is not necessary to set these values when there is no installed load on the S-head.

- WEIGHT (unit: kg)
  The weight of the installed load is set.
  It is not required to set a correct value, however, it is recommended to set a value slightly larger than the actual load. (Round up the value with each fraction between 0.5 to 1 kg.)
- X (from the S-axis), Y (from the S-axis) (unit: mm)
  The center of gravity position of the installed load is set by the distance in the direction of X and the direction of Y from the S-axis center here. It can be set with a rough value.
  The direction of X and Y applies to the robot coordinates. The value is set by a negative number when the position is in "-" direction.

Fig. 8-1: Load on S-Head (Top View)



■ U-arm payload

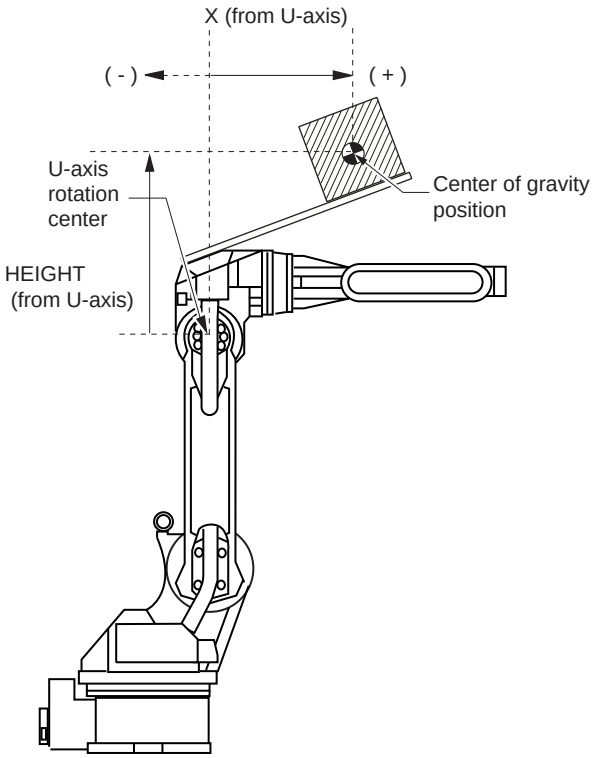
Set the weight and the center of gravity position roughly when a device is installed on the U-arm.

A standard value is set when shipping from the factory.

Set the weight in “0” if there is no installing equipment on the U-arm.

- WEIGHT (unit: kg)
  The weight of the installed load is set.
  It is not required to set a correct value, however, it is recommended to set a value slightly larger than the actual load. (Round up the value with each fraction between 0.5 to 1 kg.)
- X (from the U-axis), HEIGHT (from the U-axis) (unit: mm)
  The center of gravity position of the installing load is set here. It does not care by a rough value.
  X (from the U-axis) is horizontal distance from the U-axis rotation center to the center of gravity position of the load. Set negative number when there is mass side in the back from the U-axis rotation center.
  HEIGHT (from the U-axis) is height of the vertical direction from the U-axis rotation center to the center of gravity position of the load.

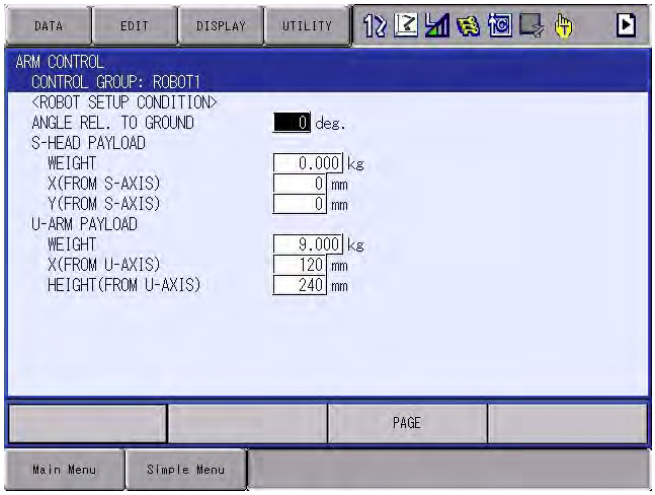
Fig. 8-2: Load on U-Arm: Center of Gravity Position (Side View)



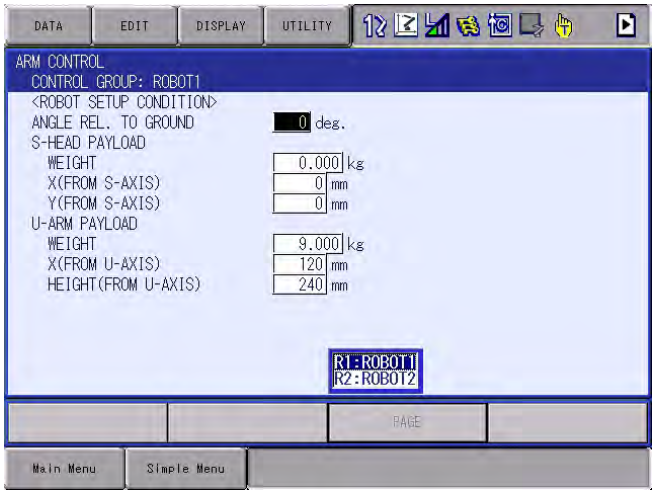
NOTE ARM CONTROL window is displayed only when the security mode is set to the management mode.

1. Select {ROBOT} under the main menu.

2. Select {ARM CONTROL}.
   – The ARM CONTROL window appears.



3. Press the page key , or select {PAGE}.
   – Select the desired control group when there are two or more group axes.



4. Select the desired item.
5. Input the value and press [ENTER].

8.4.3 Setting Tool Load Information

CAUTION

- Set the tool load information correctly.

The speed reducer longevity might decrease or the alarm might occur when the tool load information is not set correctly.

To set the tool load information correctly, following message appears when inputting the information.

“Input correct tool information. Using robot with wrong tool information may result in premature failure of the robot.”

- Confirm the operation path of robot of each job which uses the tool file after the tool load information is changed.

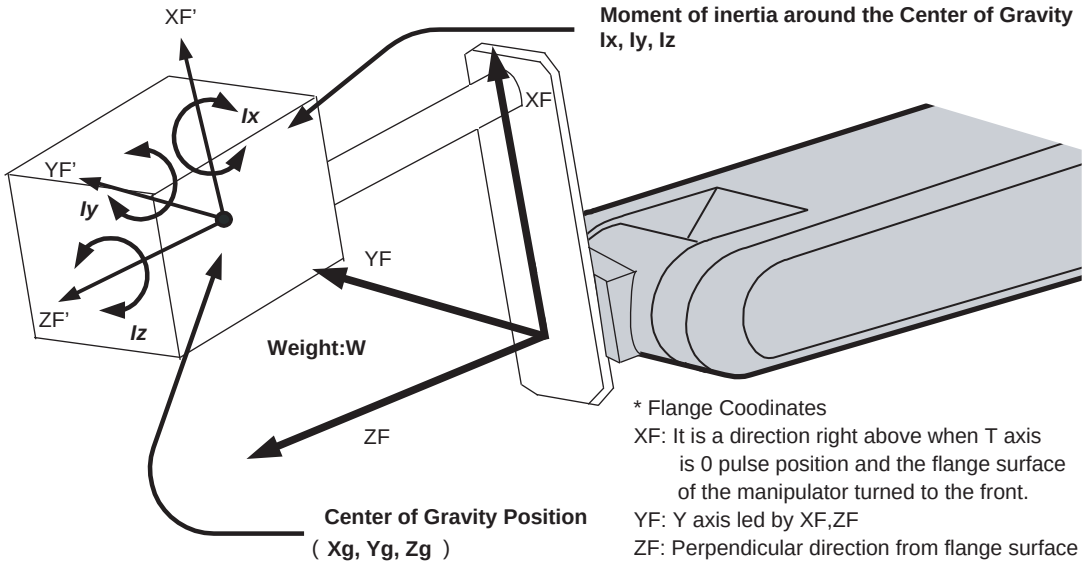
Set the tool load information before teaching the job after the tool is installed.

Confirm the operation path of each job which uses the tool file when the tool load information should be modified after teaching.

Modifying the tool load information may slightly change the operation path. To avoid injury or damage to machinery caused by collision between tool and positioner, make sure to check the operation path before executing a job.

8.4.3.1 Tool Load Information

Tool load information includes weight, a center of gravity position, and moment of inertia at the center of gravity of the tool installed at the flange. These are registered in the tool file.



8.4.3.2 Calculating Tool Load Information

- **Weight: W (Unit: kg)**

  The total weight of the installing tool is set.

  It is not required to set a correct value, however, it is recommended to set a value slightly larger than the actual load. (Round up the value with each fraction between 0.5 to 1 kg.)

- **Position of center of gravity: xg, yg, zg (Unit: mm)**

  The position of the center of gravity of the installed tool is set as the position in the flange coordinates.

  Since it is usually difficult to get a strict position of the center of gravity, it can be set with a rough value. Presume and set a position of the center of gravity roughly from outline of the tool.

  Set the value when the position of the center of gravity of the installed tool is clear from specifications, etc.

- **Moment of inertia at the center of gravity: Ix, Iy, Iz (Unit: kg·m^2)**

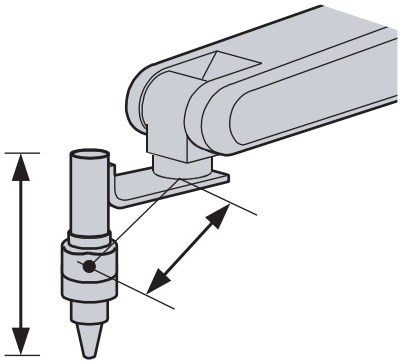
  It is an moment of inertia of the tool at the position of the center of gravity.

  The value is calculated around the each axis of the coordinates which is in parallel to the flange coordinates and which home position is the position of the center of gravity of the tool.

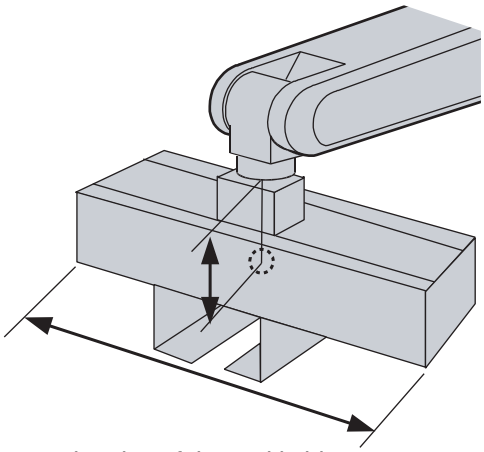
  It is not required to set a correct value, however, it is recommended to set a value slightly larger than the actual value.

  This setting is used to calculate the moment of inertia which loads to each axis of the manipulator. However, the moment of inertia at the center of gravity does not need to be set when this data is small enough for the moment of inertia calculated from weight and the position of the center of gravity.

  However, the setting is required when the moment of inertia of the tool is large (as a rough guide, the tool is considered to be large when the tool size is about more than 2-times the distance between the flange and the center of gravity).



The size of the tool is not too big.
Setting the moment of inertia at center of gravity is not necessary.



The size of the tool is big.
Setting the moment of inertia at center of gravity is necessary.

Rough value of the moment of inertia at the center of gravity can be calculated by the following methods.

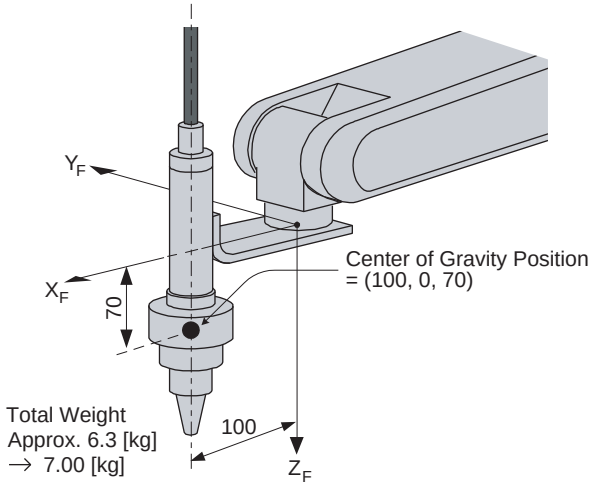
- Method to approximate the entire tool in hexahedron or cylinder.
- Method to calculate from each weight and center of gravity position of plural mass.

Refer to the following setting examples for details.

<Example 1>

For the example shown below, the center of gravity is set on the flange coordinates assuming that the center of gravity is positioned slightly inclined to the head from the center.

There is no need to set the moment of inertia at the center of gravity since the size of the tool is not so large.



<Setting>

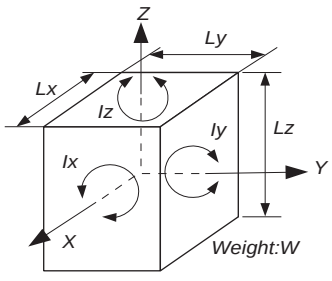
- W : 7.000 kg
- Xg : 100.000 mm
- Yg : 0.000 mm
- Zg : 70.000 mm
- Ix : 0.000 kg •m²
- Iy : 0.000 kg •m²
- Iz : 0.000 kg •m²

SUPPLE -MENT

- The own moment of inertia calculation for hexahedron and cylinder

The own moment of inertia of hexahedron and cylinder can be calculated by the next expression when the center of gravity is at the center.

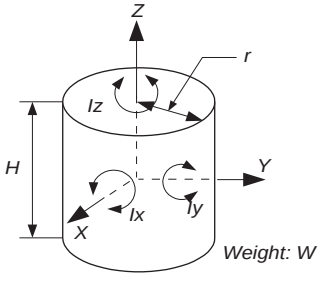
Refer to the expression when the calculation of the moment of inertia at the center of gravity.



$$Ix = \frac{Ly^2 + Lz^2}{12} * W$$

$$Iy = \frac{Lx^2 + Lz^2}{12} * W$$

$$Iz = \frac{Lx^2 + Ly^2}{12} * W$$



$$Ix = Iy = \frac{3r^2 + H^2}{12} * W$$

$$Iz = \frac{r^2}{2} * W$$

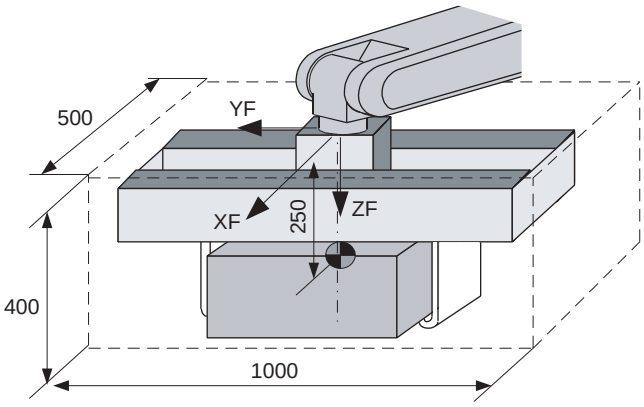
* Unit of Weight : [kg]
* Unit of Length : [m]
* Unit of Ix, Iy, Iz : [kg·m²]

<Example 2>

It is necessary to set the moment of inertia at the center of gravity when the entire size of the tool and workpiece is large compared to the distance from the flange to the center of gravity position.

Calculate the moment of inertia at the center of gravity roughly from the expression (refer to the forementioned supplement: “The own moment of inertia calculation for hexahedron and cylinder”), by approximating the entire tool in the shape of the hexahedron or the cylinder.

If the weight of held workpiece is greatly different, it is more effective to set tool load information on each workpiece and to switch the tool on each step according to the held workpiece. Set the tool load information in the state to hold the heaviest workpiece when using the tools without switching them.



Weight: W = 55 + 40 = 95

= approx. 100[kg]

Center of gravity: Position at flange right under 250mm almost

(Xg, Yg, Zg) = (0,0,250)

Moment of inertia at the center of gravity:

The hexahedron of 0.500 x 0.400 x 1.000[m] which encloses the entire tool + workpiece is assumed.

By the expression to calculate the own moment of inertia of hexahedron,

$Ix = (Ly^2 + Lz^2 / 12) * W$
$= ((0.400^2 + 1.000^2) / 12) * 100 = 9.667 = \text{approx. } 10.000$

$Iy = (Lx^2 + Lz^2 / 12) * W = ((0.500^2 + 0.400^2) / 12) * 100 = 3.417$
$= \text{approx. } 3.500$

$Iz = (Lx^2 + Ly^2 / 12) * W = ((0.500^2 + 1.000^2) / 12) * 100 = 10.417$
$= \text{approx. } 10.500$

<Setting>

- W : 100.000 kg
- Xg : 0.000 mm
- Yg : 0.000 mm
- Zg : 250.000 mm
- Ix : 10.000 kg.m^2
- Iy : 3.500 kg.m^2
- Iz : 10.500 kg.m^2

How to calculate “Center of gravity position” and “moment of inertia at center of gravity” for plural mass

The center of gravity position and the moment of inertia at the center of gravity of the entire tool can be calculated by the weight and the center of gravity position of each mass when the tool can be thought that the tool consists of two or more big mass.

1. Divide the tool into some parts as the weight and the center of gravity position can be roughly presumed. It is not necessary to divide in detail. The tool is approximated in construction of rough parts.
2. Calculate the weight and the center of gravity position of the each parts on flange coordinates. It does not care by a rough value. Calculate the own moments of inertia of the big parts. (If parts are small, it is not necessary to calculate the own moments of inertia. Refer to above-mentioned supplement: “The own moment of inertia calculation for hexahedron and cylinder” for how to calculate the own moment of inertia.)

   wi : Weight of the i-th parts [kg]

   (xi, yi, zi) : Center of gravity position of the i- th parts (On flange coordinates) [mm]

   Icxi, Icyi, Iczi : Own moments of inertia of the i-th parts [kg*m^2]

SUPPLE -MENT

3. The center of gravity position of the entire tool is calculated by the next expression.

$$xg = \{w1 * x1 + w2 * x2 + ... + wi * xi\} / (w1 + w2 + ... + wi)$$

$$yg = \{w1 * y1 + w2 * y2 + ... + wi * yi\} / (w1 + w2 + ... + wi)$$

$$zg = \{w1 * z1 + w2 * z2 + ... + wi * zi\} / (w1 + w2 + ... + wi)$$

4. The moment of inertia at the center of gravity position of the entire tool is calculated by the next expression.

$$Ix = \{w1 * ((y1 - yg)^2 + (z1 - zg)^2) * 10^{-6} + Icx1\} + \{w2 * ((y2 - yg)^2 + (z2 - zg)^2) * 10^{-6} + Icx2\}$$
$$.....$$
$$+ \{wi * ((yi - yg)^2 + (zi - zg)^2) * 10^{-6} + Icxi\}$$

$$Iy = \{w1 * ((x1 - xg)^2 + (z1 - zg)^2) * 10^{-6} + Icy1\} + \{w2 * ((x2 - xg)^2 + (z2 - zg)^2) * 10^{-6} + Icy2\}$$
$$.....$$
$$+ \{wi * ((xi - xg)^2 + (zi - zg)^2) * 10^{-6} + Icyi\}$$

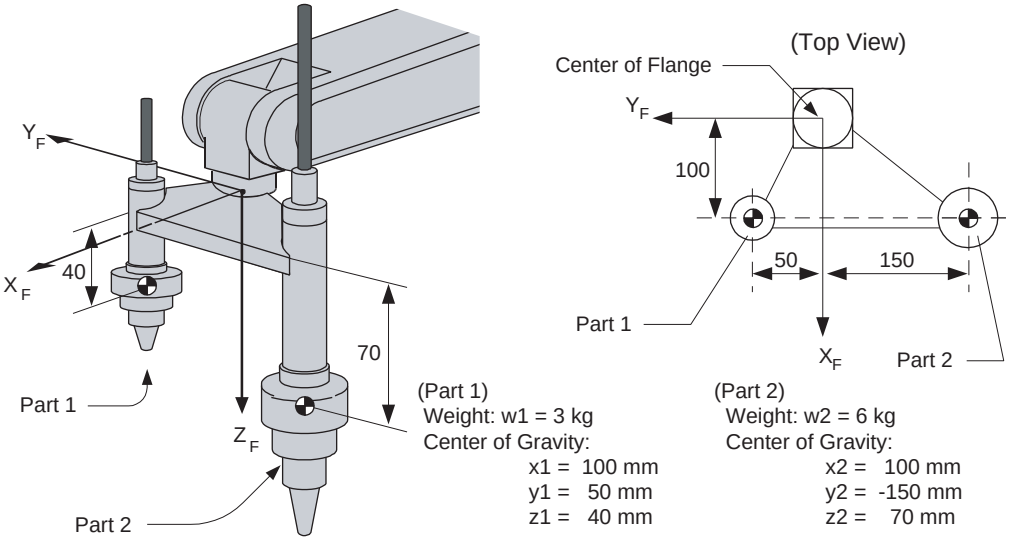
$$Iz = \{w1 * ((x1 - xg)^2 + (y1 - yg)^2) * 10^{-6} + Icz1\} + \{w2 * ((x2 - xg)^2 + (y2 - yg)^2) * 10^{-6} + Icz$$
$$.....$$
$$+ \{wi * ((xi - xg)^2 + (yi - yg)^2) * 10^{-6} + Iczi\}$$

<Example 3>

When there are two or more big mass as shown in the figure below, perform:

1. Set the center of gravity position when the center of gravity position of the entire tool is roughly understood, and set the moment of inertia at the center of gravity calculated by approximating the entire tool in the shape of hexahedron or cylinder. (It is enough in this setting usually.); or
2. When weight in each mass and the center of gravity position are understood, the center of gravity position and the moment of inertia at the center of gravity of the entire tool can be calculated. (Refer to forementioned supplement column: “How to calculate “Center of gravity position” and “moment of inertia at the center of gravity” for plural mass”.)

This example shows the calculation with the method 2.



(Part 1)
Weight: w1 = 3 kg
Center of Gravity:
x1 = 100 mm
y1 = 50 mm
z1 = 40 mm

(Part 2)
Weight: w2 = 6 kg
Center of Gravity:
x2 = 100 mm
y2 = -150 mm
z2 = 70 mm

Weight: $W = w1 + w2$

$= 3 + 6 = 9$ = approx. 10[kg]

Center of gravity: $Xg = (w1 * x1 + w2 * x2) / (w1 + w2)$

$= (3 * 100 + 6 * 100) / (3+6) = 100.0$ [mm]

$Yg = (3 * 50 + 6 * (-150)) / (3+6) = -83.333$ [mm]

$Zg = (3 * 40 + 6 * 70) / (3+6) = 60.0$ [mm]

The moment of inertia at the center of gravity position:

$Ix = \{w1 * ((y1 - Yg)^2 + (z1 - Zg)^2) * 10^{-6} + Icx1\}$

$+ \{w2 * ((y2 - Yg)^2 + (z2 - Zg)^2) * 10^{-6} + Icx2\}$

$= 3 * ((50 - (-83))^2 + (40 - 60)^2) * 10^{-6}$

$+ 6 * (((-150) - (-83))^2 + (70 - 60)^2) * 10^{-6}$

$= 0.082$ = approx. 0.100

$Iy = 3 * ((100 - 100)^2 + (40 - 60)^2) * 10^{-6}$

$+ 6 * ((100 - 100)^2 + (70 - 60)^2) * 10^{-6}$

$= 0.002$ = approx. 0.010

$$Iz = 3 * ((100 - 100)^2 + (50 - (-83))^2) * 10^{-6}$$
$$+ 6 * ((100 - 100)^2 + ((-150) - (-83))^2) * 10^{-6}$$
$$= 0.080 = \text{approx. } 0.100$$

* The own moment of inertia (Icxi, Icyi, Iczi) of the part is disregarded in this example, since each part is smaller than the entire tool.

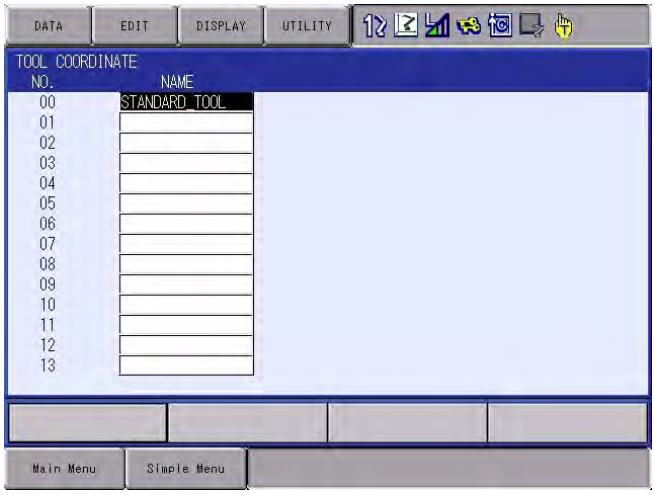
<Setting>

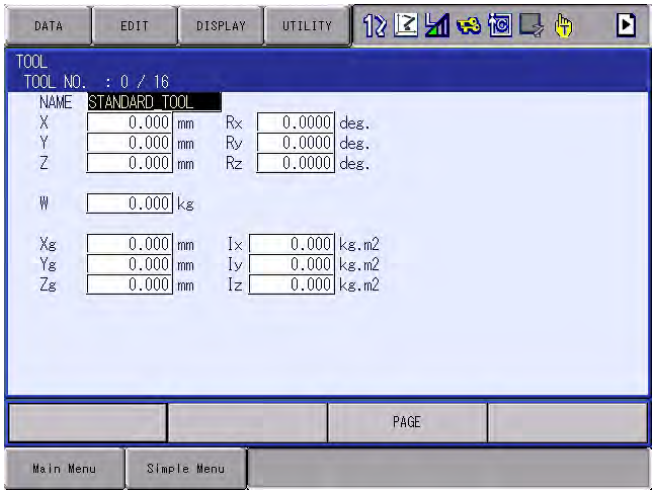
- W : 10.000 kg
- Xg : 100.000 mm
- Yg : -83.333 mm
- Zg : 60.000 mm
- Ix : 0.100 $kg.m^2$
- Iy : 0.010 $kg.m^2$
- Iz : 0.100 $kg.m^2$

8.4.3.3 Registering Tool Load Information

Tool load information is registered in the tool file.

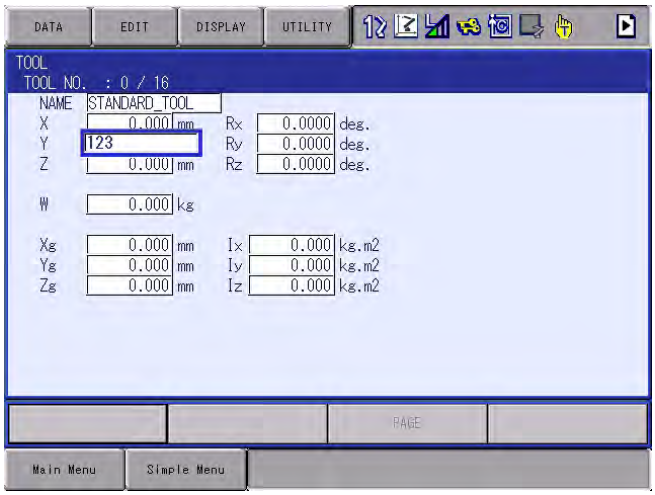
1. Select {ROBOT} under the main menu.
2. Select {TOOL}.
   - The tool coordinate list window appears.
   - The tool coordinate list window appears only when TOOL NO. SWITCH in the TEACHING CONDITION window is set to PERMIT.
   - When TOOL NO. SWITCH in the TEACHING CONDITION window is set to PROHIBIT, the tool window appears.





3. Select the desired tool number.
   (1) Move the cursor to the number of the desired tool, and press [SELECT] in the tool list window.
   (2) The tool coordinate window of the selected number appears.
   (3) Select the desired number in the tool coordinate window by pressing the page key  or clicking on the {PAGE} button.
   (4) To switch the tool list window and the tool coordinate window, press {DISPLAY} → {LIST} or {DISPLAY} → {COORDINATE DATA}.

4. Select the desired item to register and input the value.
   – The window can be scrolled with the cursor.
   – The menu enters the state of a numeric input if the cursor is on the desired item to register and the [SELECT] is pressed.



5. Press [ENTER].
   – The input value is registered.
   – The servo power is automatically turned OFF when editing the value while the servo power is ON, followed by a message “Servo off by changing data” displayed for three seconds.

NOTE

• When the data setting is not done

It is considered that data is not set correctly in tool load information in the following cases.

- When the weight (W) is “0”.
- When the center of gravity position (Xg, Yg, Zg) are all “0”.

In these cases, the manipulator is controlled by the initial setting values (vary according to each robot model) which were set to the parameter before shipping.

Initial Setting Value:

Weight: W = Payload

Center of gravity position: (Xg, Yg, Zg) =
(0, 0, Allowed value of B-axis for payload)

In this case, when an actual tool load is not large enough, the manipulator cannot sufficiently exert its function (speed and acceleration or deceleration).

Especially, when operating the manipulator with the initial setting value, a large difference in the load between the actual tool load and the initial setting value may cause vibrations in the manipulator motion. Thus, it is essential to correctly set the tool load information for the proper operation of the manipulator.

Moreover, when the tool which an actual tool center of gravity position greatly offsets in X-direction or Y-direction is installed the generated moment by the tool cannot be compensated.

To set the tool load information correctly, following message appears when the playback operation is executed by using the initial setting value.

“Using robot without setting tool info. may result in premature failure of the robot. Set W, Xg, Yg, and Zg in the tool file.”

• Switch of the tool file

In case that two or more tool files are used, information on an effective tool file is referred for tool load information used by the ARM control at that time in according to switch tool file.

Set the same value of tool load information in each tool file when the tool file is switched to change only TCP (when neither the weight nor the center of gravity position of the entire tool installed in the flange is changed).

Moreover, set tool load information to the corresponding tool file respectively when total weight and the center of gravity position etc. of the tool is changed (when the system which exchange the tool by automatic tool changer).

8.5 Work Home Position

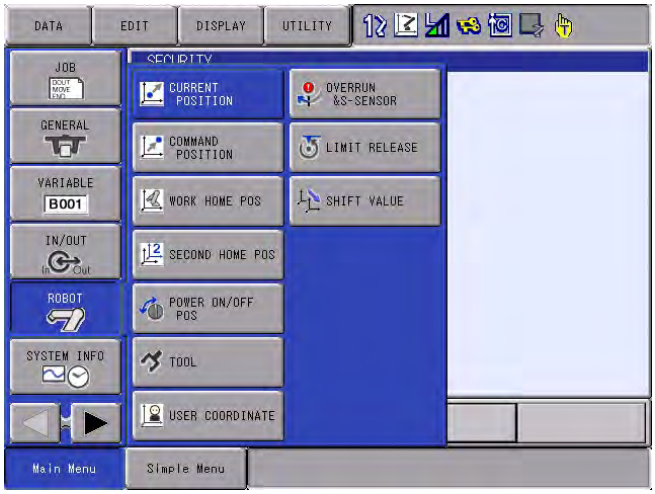
8.5.1 Description of Work Home Position

The work home position is a reference point for manipulator operations. It prevents interference with peripheral device by ensuring that the manipulator is always within a set range as a precondition for operations such as starting the line. The manipulator can be moved to the set work home position by operation from the programming pendant, or by signal input from an external device. When the manipulator is in the vicinity of the work home position, the work home position signal turns ON.

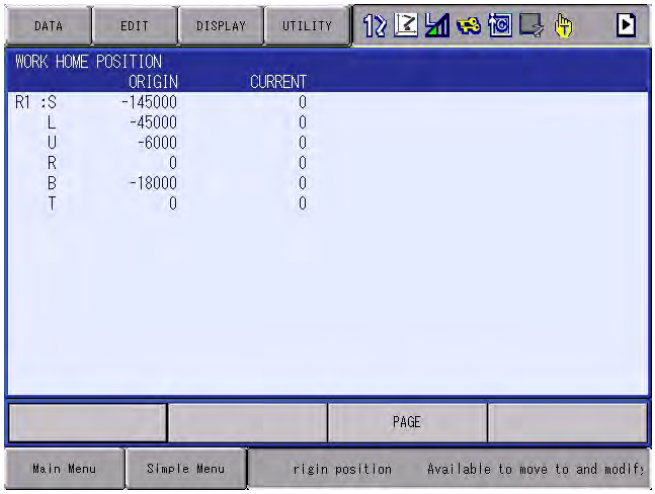
8.5.2 Setting Work Home Position

8.5.2.1 Work Home Position Window

1. Select {ROBOT} under the main menu.

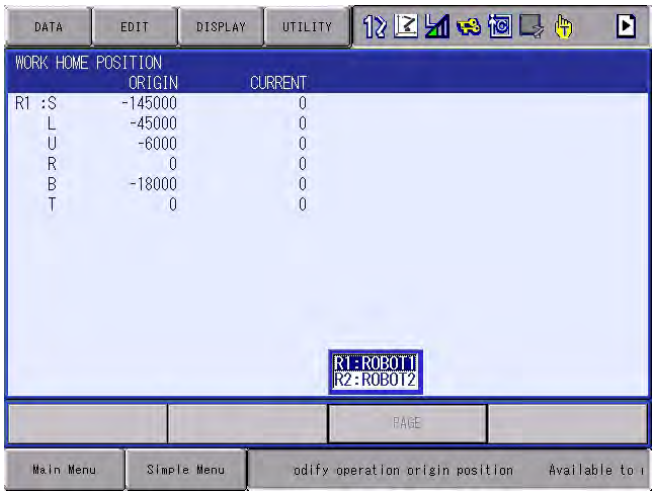


2. Select {WORK HOME POS}.
   – The WORK HOME POSITION window is appears.



3. Press the page key .

– When two or more manipulators exist in the system, use the page key to change the control group, or click on {PAGE} to select the desired control group.



8.5.2.2 Registering or Changing Work Home Position

1. Press the axis keys in the work home position display.
   – Move the manipulator to the new work home position.
2. Press [MODIFY], [ENTER].
   – New work home position is set.

NOTE

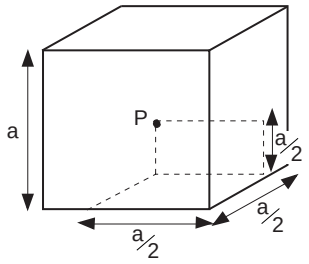
When the work home position is changed, the cubic interference area is automatically set as cube 64 and 63 in the base coordinate system.

• The cube 64 is for ROBOT1

• The cube 63 is for ROBOT2

The work home position cube is a cube like the one shown in the figure below; the length of its sides is determined by a parameter setting made by the user (units: µm).
By changing this parameter setting, the size of the cube can be changed.

Fig. 8-3: S3C1097: Length of Each Side of Work Home Position Cube (µm)



Specify whether “COMMAND POSITION” or “FEEDBACK POSITION” is to be set to the work home position cube signal’s CHECK MEASURE in the interference area settings. “COMMAND POSITION” is the default setting.

8.5.2.3 Returning to Work Home Position

■ **In the teach mode**

1. Press [FWD] in the work home position display.
   – The manipulator moves to the new work home position. The moving speed is the selected manual speed.

■ **In the play mode**

When the work home position return signal is input (detected at leading edge), the TCP of the manipulator is moved to the work home position. When the manipulator moves, a message “Manipulator is moving to work home position” is displayed. In this case, the move interpolation is MOVJ, and the speed applied is the one set in the parameters. (S1CxG56; units: 0.01%.)

8.5.2.4 Outputting Work Home Position Signal

This signal is output any time the current position of the TCP of the manipulator is checked and found to be within the work home position cube.

8.6 Interference Area

8.6.1 Description of Interference Area

The interference area is a function that prevents interference between multiple manipulators or the manipulator and peripheral device.

The areas can be set up to 64 areas. There are two types of interference areas, as follows:

- Cubic Interference Area
- Axis Interference Area

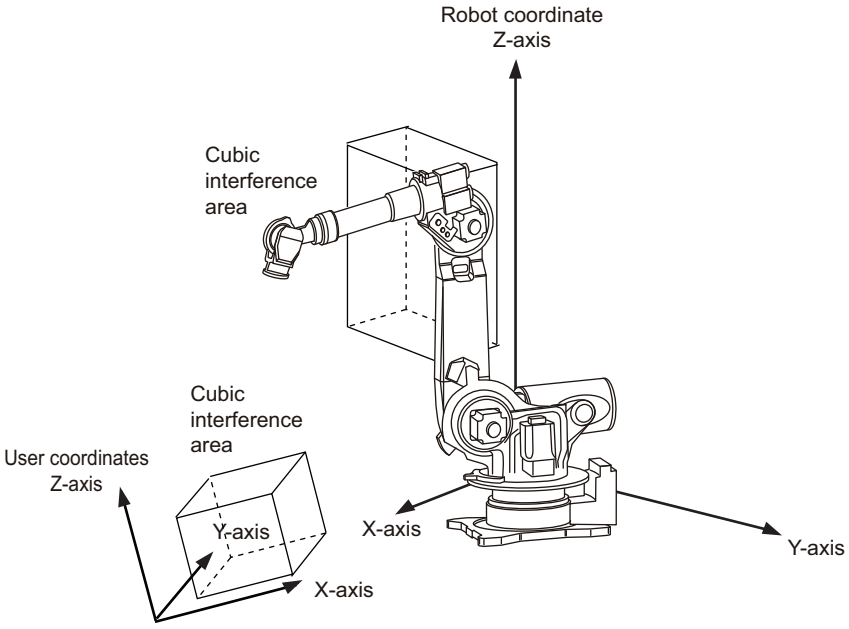
The FS100L judges whether the TCP of the manipulator is inside or outside this area, and outputs this status as a signal.

8.6.2 Cubic Interference Area

8.6.2.1 Description of Cubic Interference Area

This area is a rectangular parallelepiped which is parallel to the base coordinate, robot coordinate, or user coordinate.

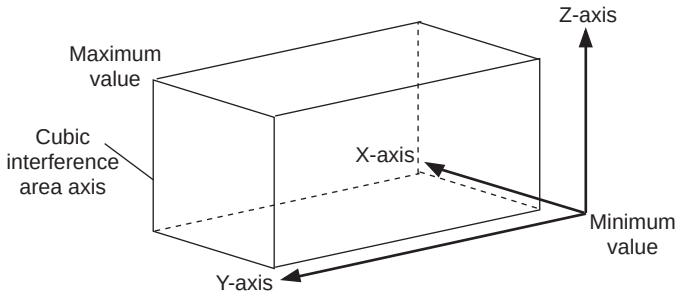
The FS100L judges whether the current position of the manipulator's TCP is inside or outside this area, and outputs this status as a signal.



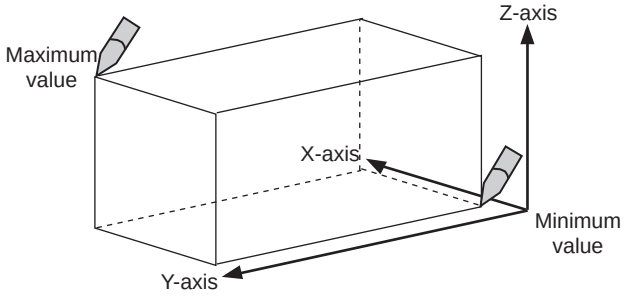
8.6.2.2 Cube Setting Method

There are three ways to set cubic a interference area as described in the following sections:

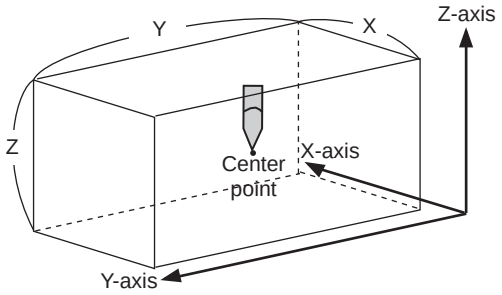
1. Enter the maximum and minimum values for the cube coordinates.



2. Move the manipulator at the maximum and minimum value positions of the cube corner using the axis keys.

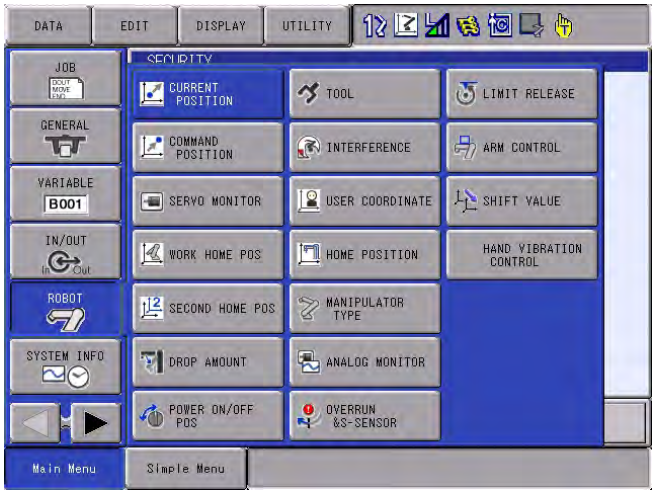


3. After entering the lengths of the three faces of the cube (axial length) using the Numeric keys, move the manipulator to the center point of the cube using the axis keys.

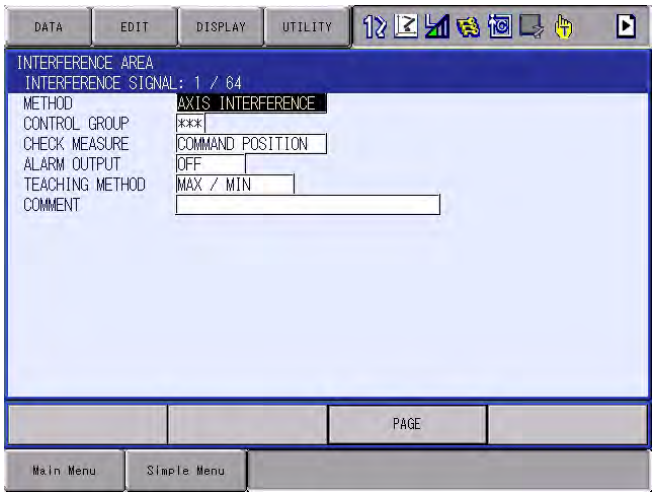


8.6.2.3 Setting Operation

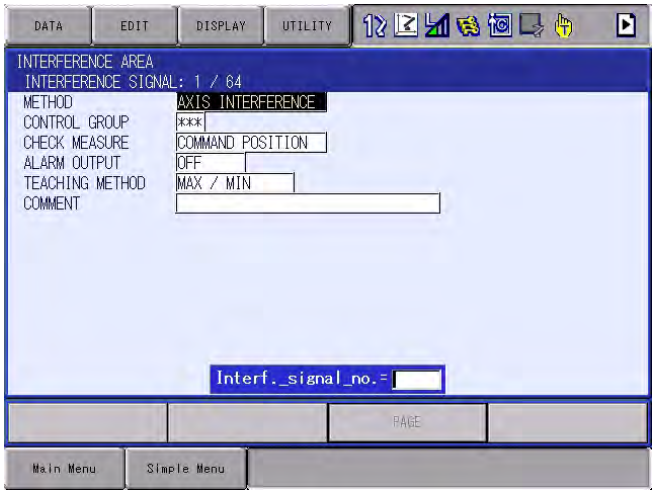
1. Select {ROBOT} under the main menu.



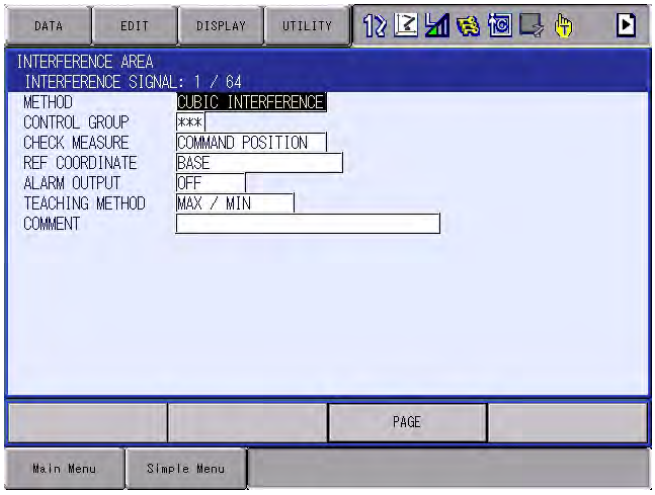
2. Select {INTERFERENCE}.
   – The INTERFERENCE AREA window is shown.



3. Select the desired cube number.
   – Select the desired cube number with the page key or by number input.
   – When selecting the cube number by number input, select {PAGE} to input the desired signal number.



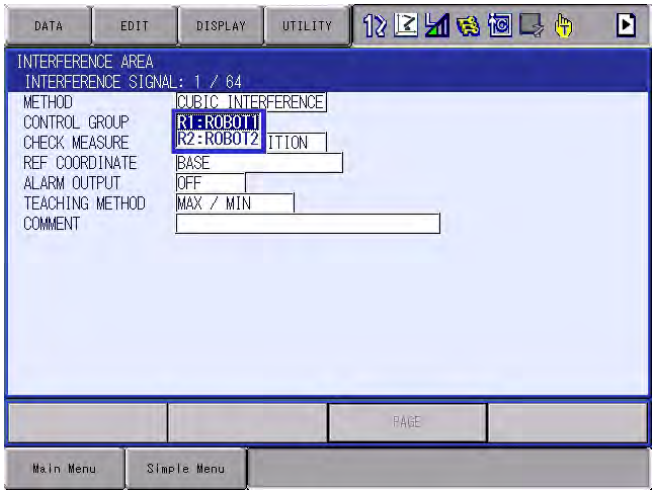
4. Select “METHOD”.
   – ”AXIS INTERFERENCE” and “CUBIC INTERFERENCE” are displayed alternately every time [SELECT] is pressed. If “CUBIC INTERFERENCE” is selected, the window is changed.



5. Select “CONTROL GROUP”.

   – A selection dialog box appears.

   (1) Select the desired control group.

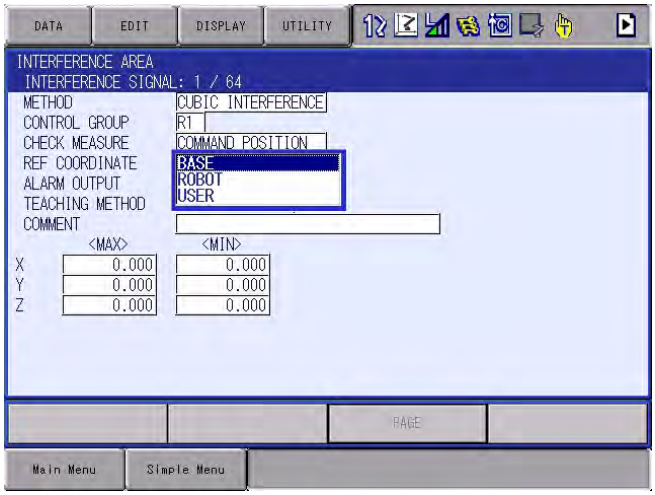


6. Select “REF COORDINATES”.

   – A selection dialog box appears.

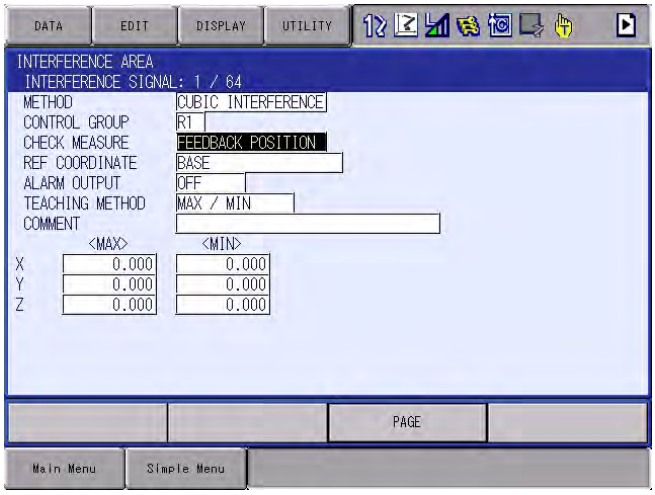
   (1) Select the desired coordinate.

   (2) If the user coordinates are selected, the number input line is displayed. Input the user coordinate number and press [ENTER].



7. Select “CHECK MEASURE”.

   – Press [SELECT] to alternate between “COMMAND POSITION” and “FEEDBACK POSITION”.



NOTE

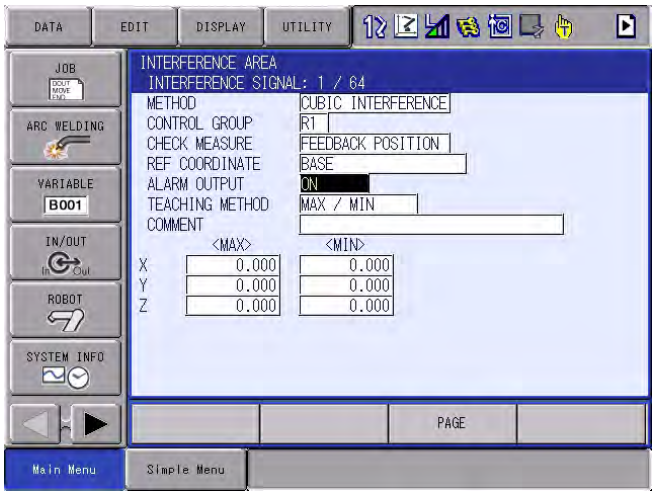
To stop the manipulator movement using the interference signal (use the cube interference signal for mutual interference between robots), set CHECK MEASURE to “COMMAND POSITION”.

When set to the “FEEDBACK POSITION”, the manipulator decelerates to a stop after entering the interference area.

When using the interference signal to inform an external unit of the actual manipulator position, use the “FEEDBACK POSITION” setting to enable the signal output in more accurate timing.

8. Select “ALARM OUTPUT”.

   – Press [ENTER] to alternate between “ON” and “OFF”.



   – When “ALARM OUTPUT” is “ON”, the alarm below occurs if the manipulator’s TCP enters the set interference area, and the manipulator stops its motion immediately.

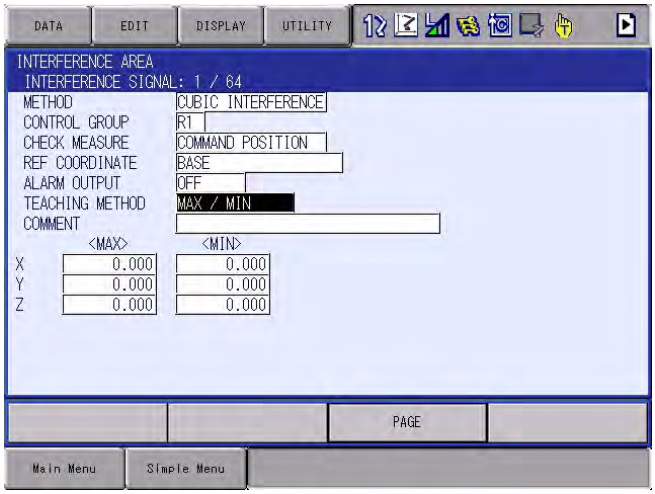
     AL4902: CUBE INTERFERENCE (TCP)

■ **Number input of cube coordinates**

1. Select “METHOD”.

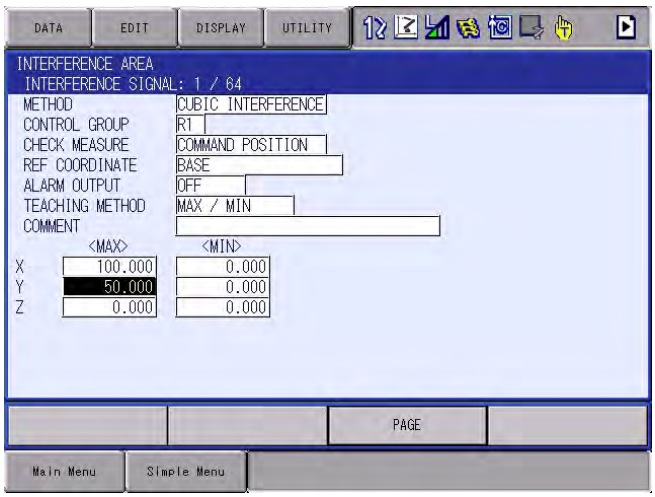
   (1) Press [SELECT] to alternate between “MAX/MIN” and “CENTER POS”.

   (2) Select “MAX/MIN”.



2. Input number for “MAX” and “MIN” data and press [ENTER].

   – The cubic interference area is set.

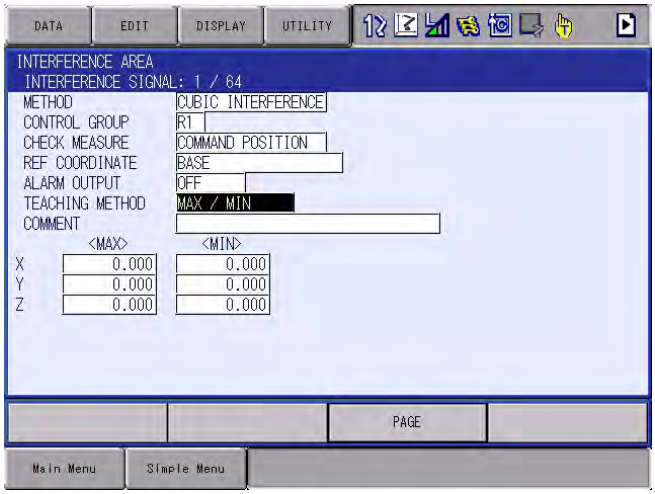


■ **Teaching corners**

1. Select “METHOD”.

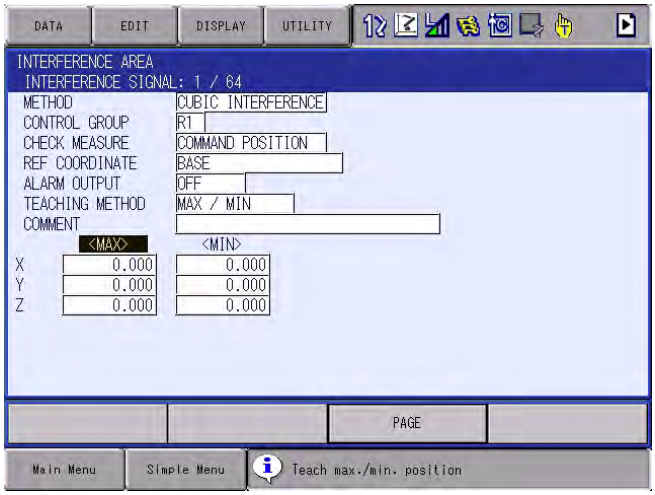
   (1) Press [SELECT] to alternate between “MAX/MIN” and “CENTER POS”.

   (2) Select “MAX/MIN”.



2. Press [MODIFY].

   – The message “Teach max./min. position” appears.



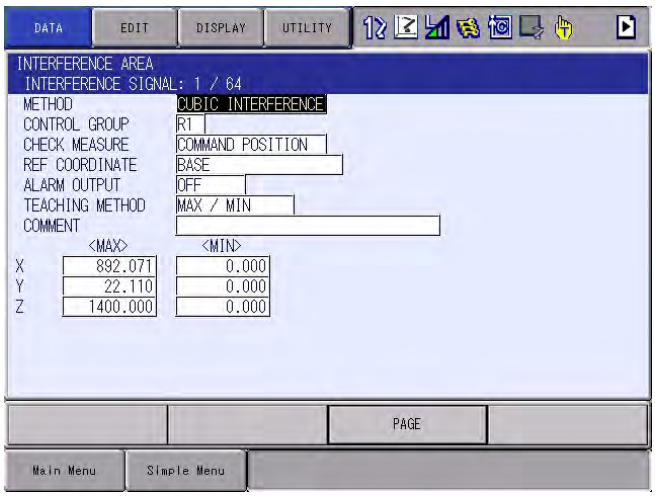
3. Move the cursor to “<MAX>” or “<MIN>”.

   – Move the cursor to “<MAX>” when changing the maximum value, and move cursor to “<MIN>” when changing the minimum value. The cursor only moves to either “<MIN>” or “<MAX>” at this time.

4. Move the manipulator using the axis keys.

   – Move the manipulator to the maximum or minimum position of the cube using the axis keys.

5. Press [ENTER].
   – The cubic interference area is registered.

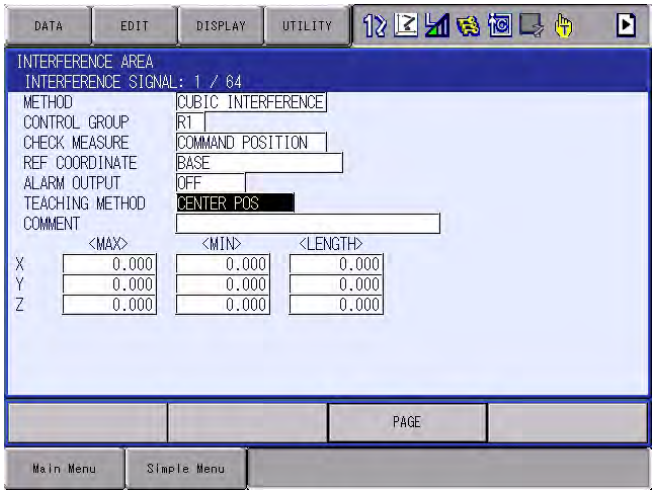


■ **Number input of cube side length and teaching center**

1. Select “METHOD”.

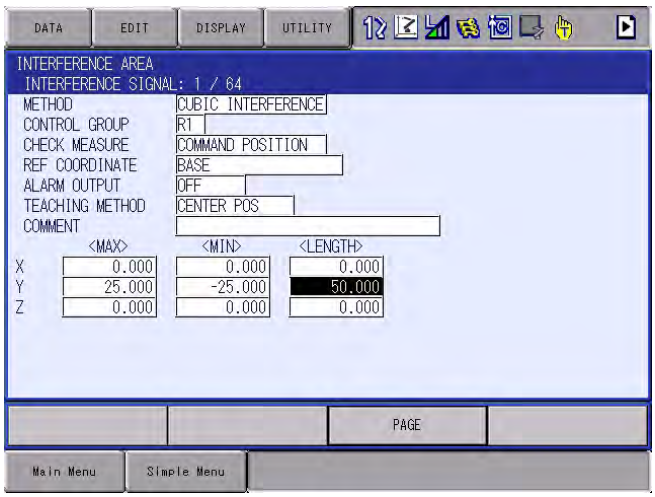
   (1) Press [SELECT] to alternate between “MAX/MIN” and “CENTER POS”.

   (2) Select “CENTER POS”.

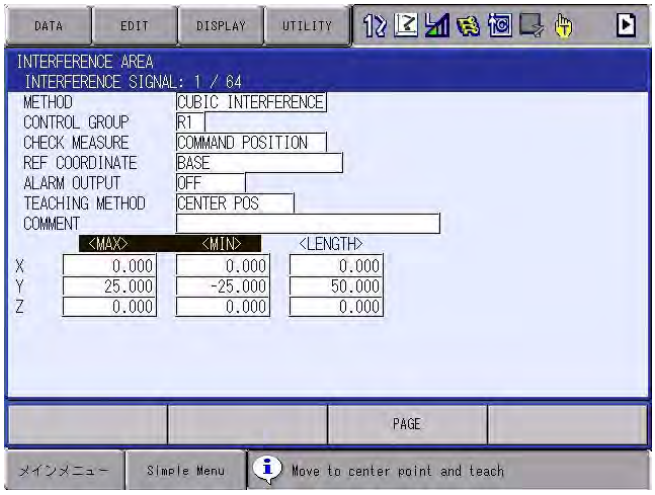


2. Input data for length of the cube, then press [ENTER].

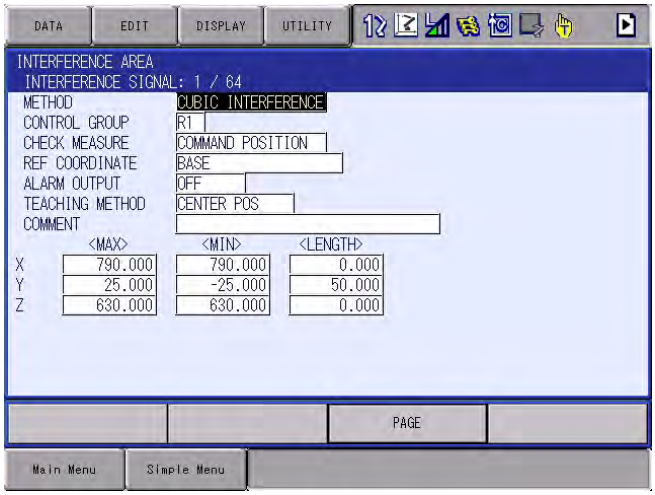
   – The length is set.



3. Press [MODIFY].
   – The message “Move to center point and teach” appears. The cursor only moves to either “<MIN>” or “<MAX>” at this time.



4. Move the manipulator using the axis keys.
   – Move the manipulator to the center point of the cube using the axis keys.
5. Press [ENTER].
   – The current position is registered as the center point of the cube.

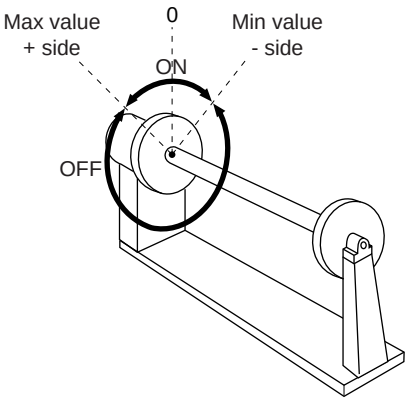


8.6.3 Axis Interference Area

8.6.3.1 Description of Axis Interference Area

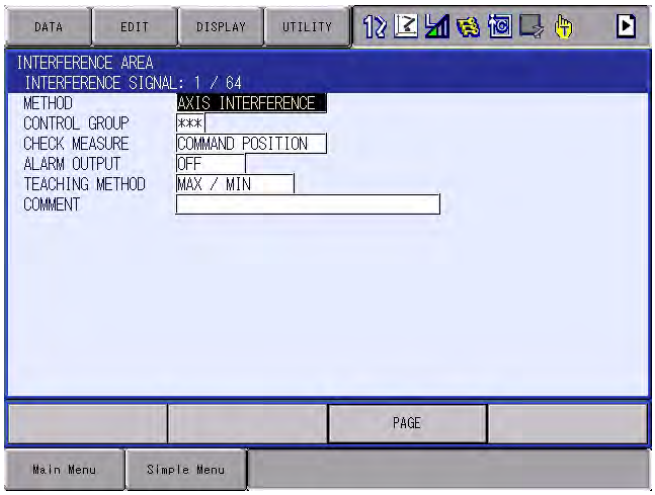
The axis interference area is a function that judges the current position of the each axis and outputs a signal. Once the maximum and minimum values have been set at the plus and minus sides of the axis to define the working range, a signal indicating whether the current position of the axis is inside or outside this range is output. (ON: inside, OFF: outside)

Fig. 8-4: Axis Interference Signal for Station Axis

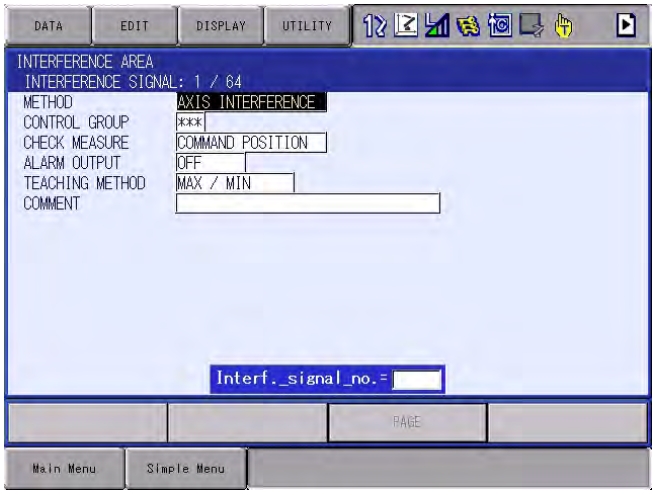


8.6.3.2 Setting Operation

1. Select {ROBOT} under the main menu.
2. Select {INTERFERENCE}.
   – The INTERFERENCE AREA window appears.

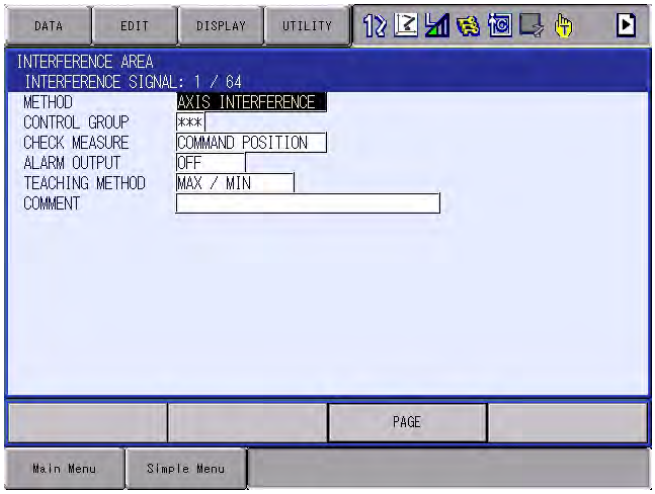


3. Select the desired interference signal number.
   – Select the desired interference signal number using the page key  or by number input.
   – When selecting the desired interference signal number by number input, select {PAGE} to input the desired signal number.



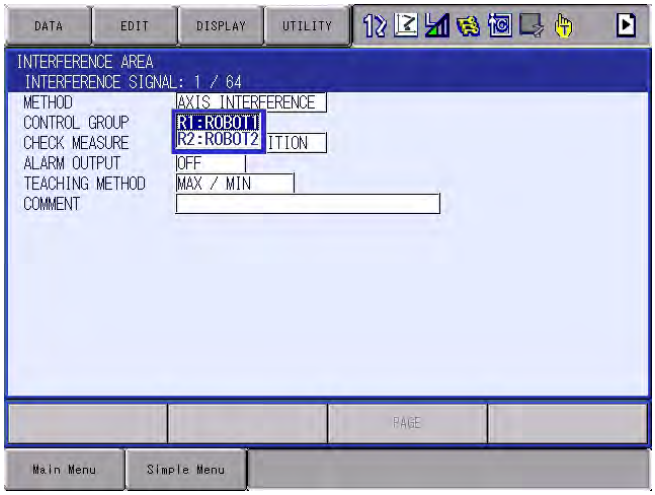
4. Select “METHOD”.

   – Press [SELECT] to alternate between ”AXIS INTERFERENCE” and “CUBIC INTERFERENCE”. In this case, select “AXIS INTERFERENCE”.



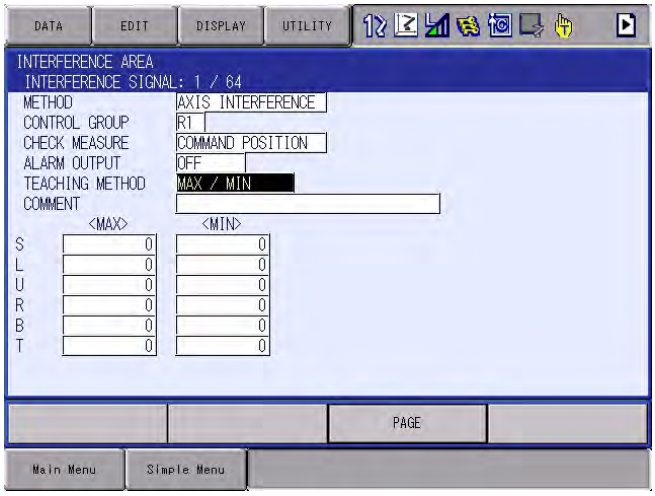
5. Select “CONTROL GROUP”.

   – A selection box appears. Select the desired control group.

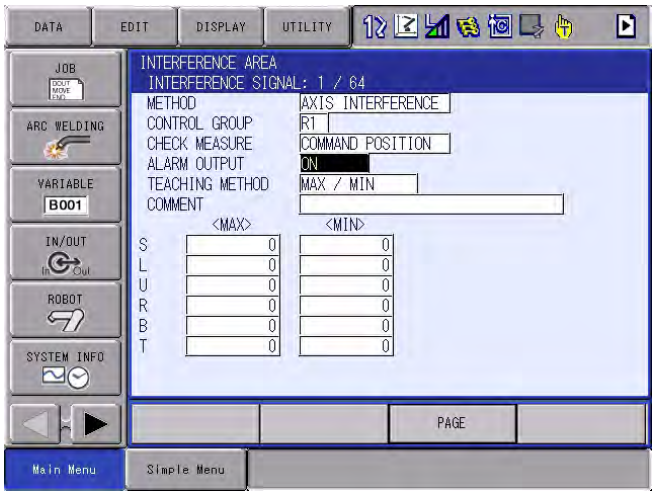


6. Select “CHECK MEASURE”.

   – Press [SELECT] to alternate between “COMMAND POSITION” and “FEEDBACK POSITION”.



7. Select “ALARM OUTPUT”.



– Press [SELECT] to alternate between “ON” and “OFF”.

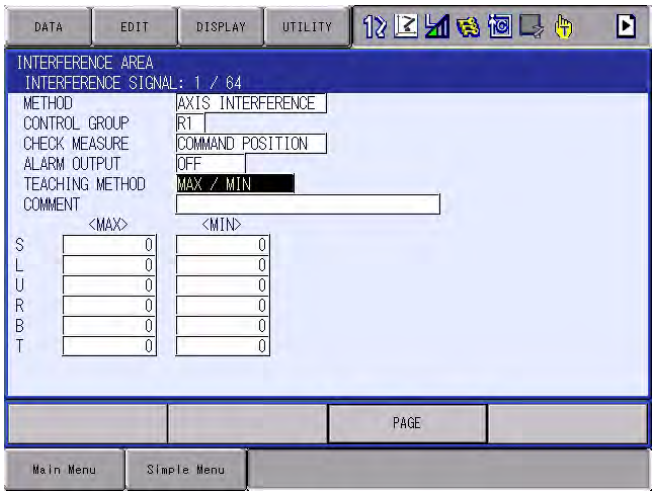
– When “ALARM OUTPUT” is “ON”, the alarm below occurs if the manipulator’s TCP enters the set interference area, and the manipulator stops its motion immediately.

  AL4901: AXIS INTERFERENCE

■ **Number input of axis data coordinates**

1. Select “METHOD”.

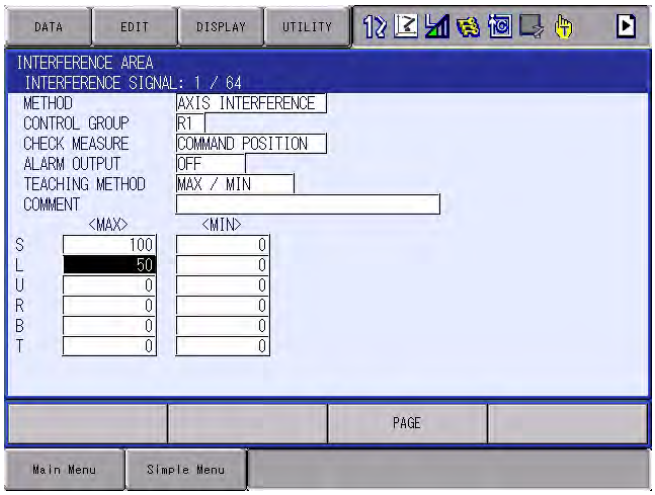
   (1) Press [SELECT] to alternate between “MAX/MIN” and “CENTER POS”.



   (2) Select “MAX/MIN”.

2. Input number for “MAX” and “MIN” data and press [ENTER].

   – The axis interference area is set.

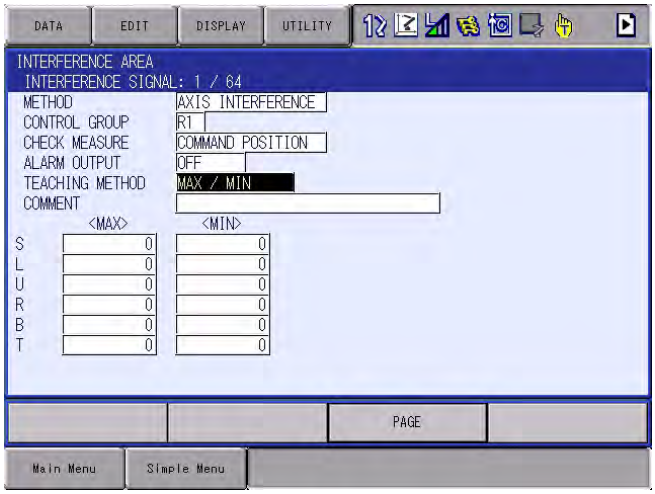


■ **Teaching corners**

1. Select “METHOD”.

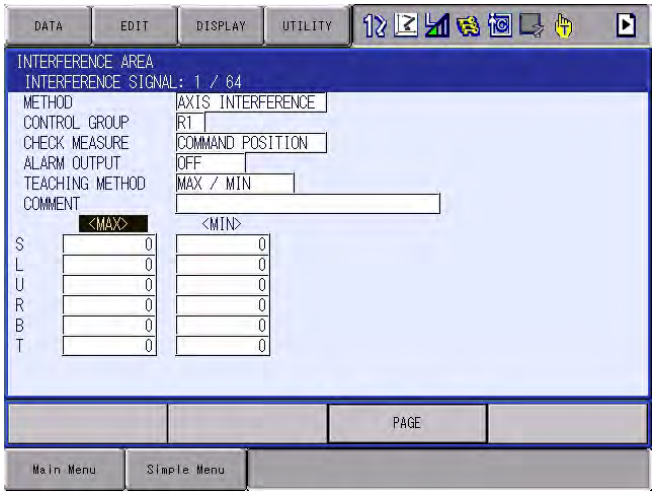
   (1) Each time [SELECT] is pressed, “MAX/MIN” and “CENTER POS” switch alternately.

   (2) Select “MAX/MIN”.



2. Press [MODIFY].

   – A message “Teach max./min. position” appears.



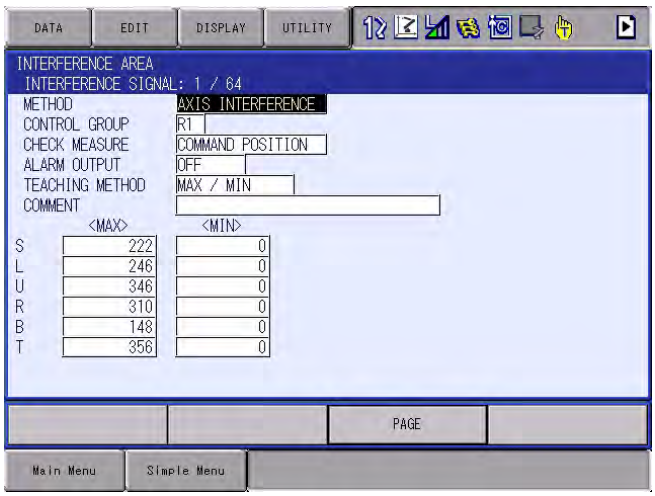
3. Move the cursor to “<MAX>” or “<MIN>”.

   – Move the cursor to “<MAX>” when changing the maximum value, and move cursor to “<MIN>” when changing the minimum value. The cursor only moves to either “<MIN>” or “<MAX>” at this time.

4. Move the manipulator using the axis keys.

   – Move the manipulator to the maximum or minimum position of the cube using the axis keys.

5. Press [ENTER].
   – The cubic interference area is registered.

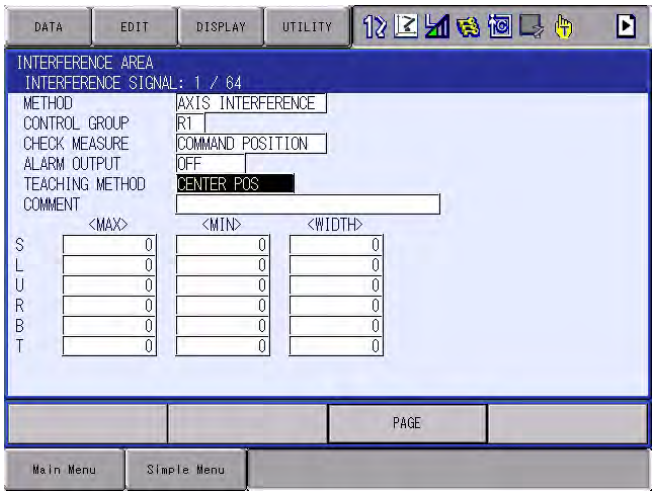


■ **Number input of center position (WIDTH) and teaching center**

1. Select “METHOD”.

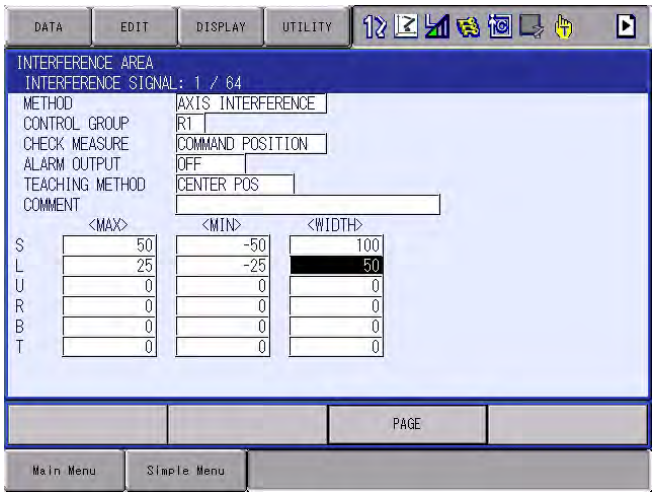
   (1) Press [SELECT] to alternate “MAX/MIN” and “CENTER POS”.

   (2) Select “CENTER POS”.

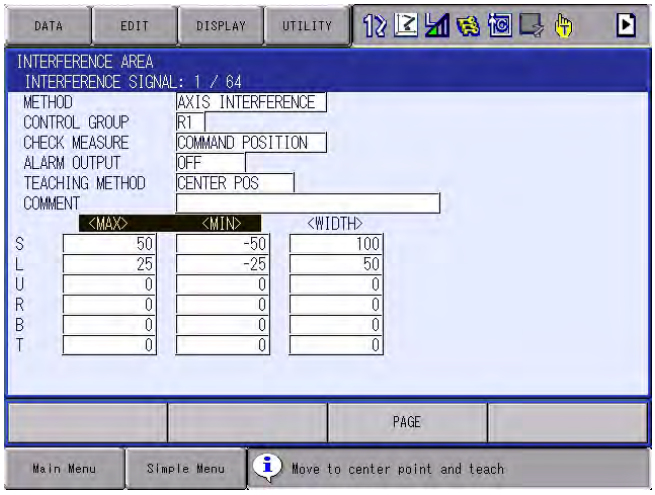


2. Input number for “WIDTH” data and press [ENTER].

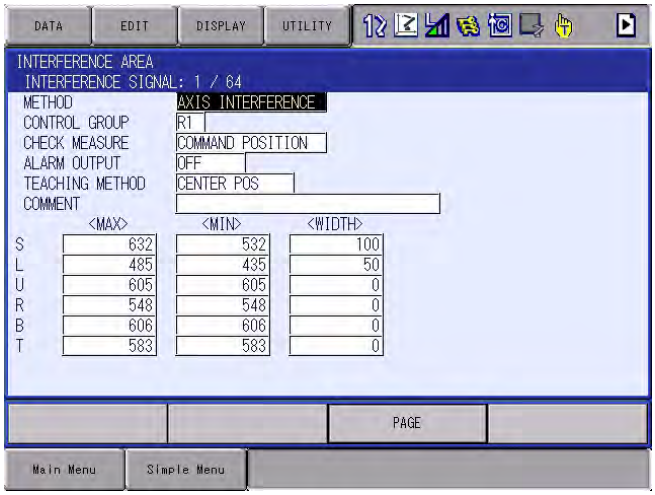
   – “WIDTH” is set.



3. Press [MODIFY].
   – A message “Move to the center point and teach” appears.
   The cursor only moves to either “<MIN>” or “<MAX>” at this time.

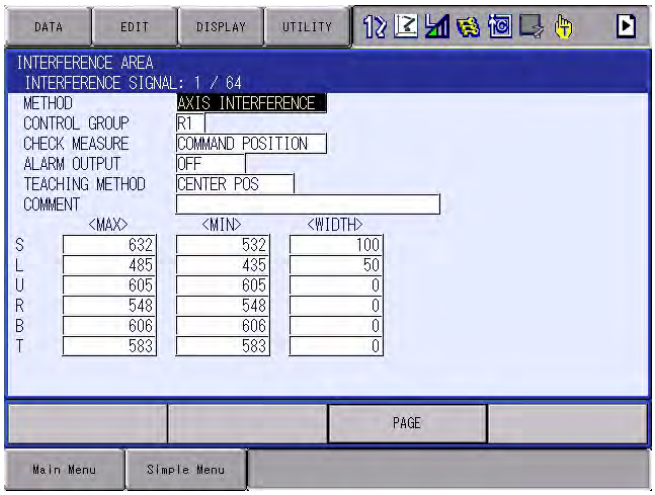


4. Move the manipulator using the axis keys.
   – Move the manipulator to the center position of the cube using the axis keys.
5. Press [ENTER].
   – The center position of the cube is registered.

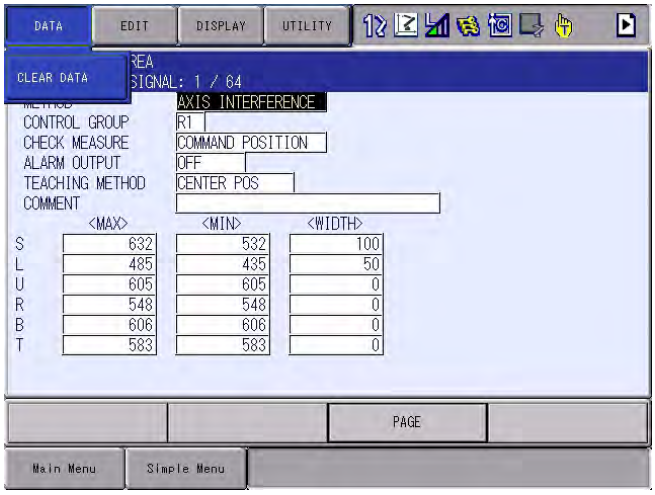


8.6.4 Clearing Interference Area Data

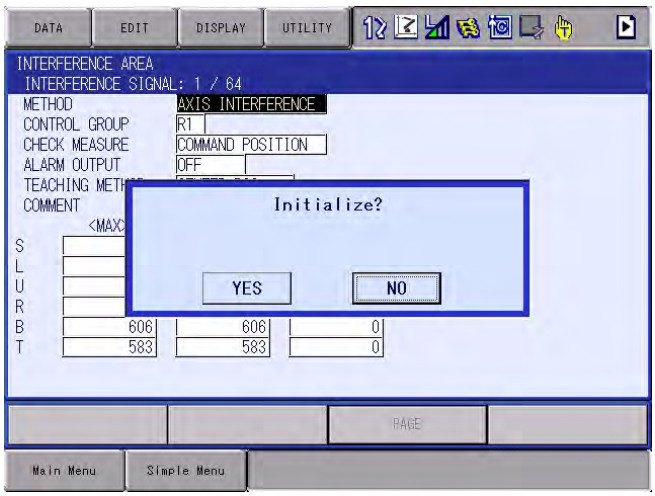
1. Select {ROBOT} under the main menu.
2. Select {INTERFERENCE}.
   – The INTERFERENCE AREA window is shown.



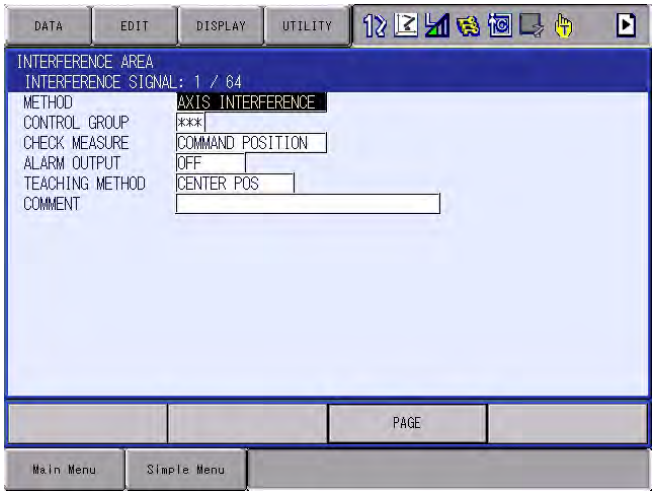
3. Select interference signal to be cleared.
   (1) Select the desired interference signal number to be cleared using the page key  or by number input.
   (2) When selecting the desired interference signal number by number input, select {PAGE} to input the desired signal number.
4. Select {DATA} under the menu.
   – The pull-down menu appears.



5. Select {CLEAR DATA}.
   – The confirmation dialog box appears.



6. Select {YES}.
   – All the data of the interference signal number are cleared.



8.7 Shock Detection Function

8.7.1 Shock Detection Function

The shock detection function is a function to decrease damage due to the collision by stopping the manipulator without any external sensor when the tool or the manipulator collide with peripheral device.

When the shock is detected either in teach mode or in play mode, the manipulator is stopped immediately.

WARNING

- This function does not completely avoid damage to the peripheral devices; moreover, it does not guarantee the user's safety.
- Make sure to supply the safety measures such as the safeguarding etc. Refer to *chapter 1 "Safety" at page 1-1* to *chapter 6 "Test of Program Operation" at page 6-1* for the safety measures in details.

Failure to observe this warning may result in Injury or damage to machinery caused by contact with the manipulator.

8.7.2 Shock Detection Function Setting

At the factory default setting, the threshold value is set to detect a collision without a miss even when the manipulator is operating at the maximum speed, on the assumption that the tool file is correctly set. To detect a collision during normal operation, check the following points:

- The tool's load and moment do not exceed the rated values.
- The actual tool load and the tool file setting value are the same.
- The U-arm payload information and the set weight of U-arm payload in the ARM CONTROL window are the same.

In addition, detection sensitivity can be decreased for only a specific section where a contact task is performed.

The detection sensitivity is set by setting the detection level.

8.7.2.1 Shock Detection Level Setting

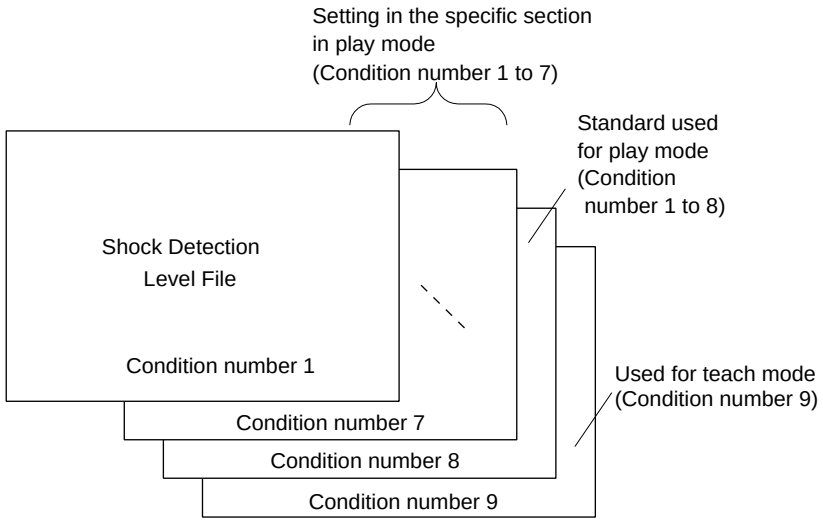
The shock detection level is set in the shock detection level set file.

The shock detection level set file are nine condition files as following figure.

- Condition numbers 1 to 7 are used when the detection level is changed in a specific section in play mode.
- Condition number 8 is used as standard in play mode: this function is operated by the detection level set in this file during playback operation.
- Condition number 9 is for teach mode: the shock detection function applies the detection level set here when the manipulator is operated in teach mode.
- Condition numbers 1 to 8 are set for each axis and condition 9 is set for each group.

The detection level is changed by a job instruction SHCKSET.

- After the instruction is executed, the shock will be detected by the specified detection level when the condition number is specified with the SHCKSET instruction.
- The detection level is returned to standard level when the SHCKRST instruction is executed.



SUPPLE-MENT

The detection level of condition number 8 (a standard in play mode) is adopted in play mode excluding the range between SHCKSET and SHCKRST in the job.

SUPPLE-MENT

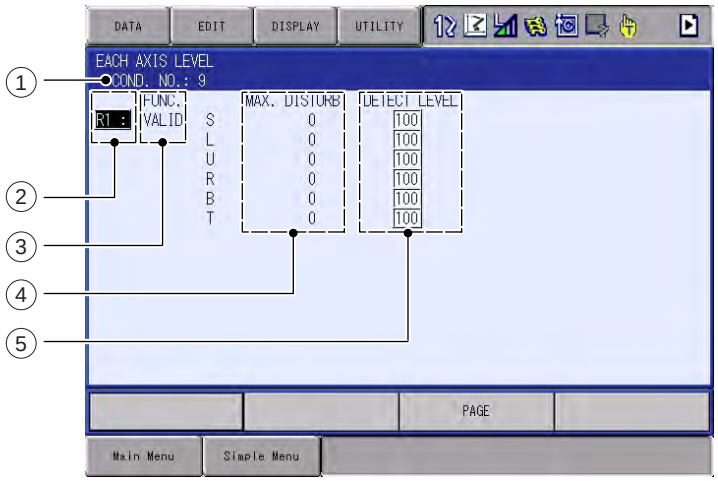
Teach Mode Each Axis Setting Function

Usually, the detection level setting of teach mode is set for each group.

By using this function, the detection level can be set for each axis.

S2C869: Teach Mode Each Axis Setting Function

(1: VALID, 0: INVALID)



① Condition Number (1 to 9)

1 to 7: for changing detection level in play mode.
8: for standard detection level in play mode.
9: for detection level in teach mode.

② Robot Select

Select the manipulator whose detection level is to be changed.

③ Function Select

Specifies VALID/INVALID of the shock detection function. The shock detection function is specified for each manipulator.

1. Select the manipulator whose function is to be enabled or disabled.
2. Move the cursor to “VALID” or “INVALID” and press [SELECT]. Each time [SELECT] is pressed, “INVALID” and “VALID” are displayed alternately. The change is available for all the condition numbers.

④ Max. Disturbance Force

Indicates the maximum disturbance force to the manipulator when the manipulator is moved in play back operation or axis operation.

Refer to this value when inputting the detection level value in ⑤.
The maximum disturbance force can be cleared by selecting {DATA} → {CLEAR MAX VALUE} in the menu.

⑤ Detection Level (Level range: 1 to 500)

Specifies the shock detection level. Set a value larger than the maximum disturbance force.
The value set by default (the level 100) enables the function without false detection even if the manipulator is operated at the maximum speed.
To change DETECT LEVEL, move the cursor to the subject manipulator, and press [SELECT] to display the numeric input status; input the value with a numeric key and press [ENTER]. To increase the detection sensitivity, set the level to small value, and to decrease the sensitivity, set the level to large value.

■ **Method of shock detection level file setting**

1. Select {ROBOT} under the main menu.
2. Select {SHOCK SENS LEVEL}.
   – The EACH AXIS LEVEL window appears.
   – Perform either of the following operations to display the page of desired condition number:
   (1) Press {PAGE} in the window. Enter the desired condition number using numeric keys and press [ENTER]. Then the page of the condition number appears.
   (2) Press the page key  to change the condition number.
3. Level setting for the condition numbers 1 to 8.
   Level setting values can be set for each axis on the EACH AXIS LEVEL window.
   Perform the following “Disturbance force measurement”, then perform “Setting all levels at once”.

■ **Disturbance force measurement**

① Mount the tool, workpiece, external equipment, and equipment on the arm to the manipulator.

② Set the tool file correctly.
Set the load information (weight and center of gravity) of the tool.

③ Set the detection level values of all the axes to 100.

(1) Open the SHOCK DETECT LEVEL window.

(2) Select {DATA}, then {CLEAR MAX VALUE}.

④ Perform the JOB.

■ **Setting all levels at once**

① Open the SHOCK DETECT LEVEL window.

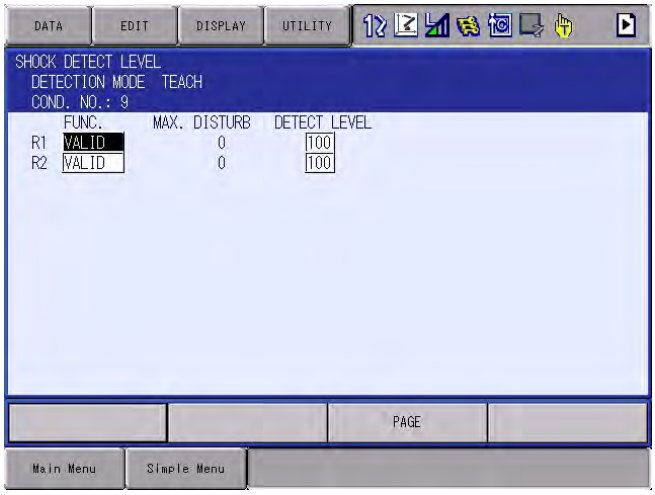
② Select {DATA}, then {CHANGE EVERY LEVEL}.

③ Enter 120 in the coefficient (%) by which the max. disturbance force is multiplied.

The following calculated value A or B, whichever is larger, is set to the DETECT LEVEL.
A: (Max. disturbance force) x (coefficient = 120%)
B: (Max. disturbance force) + 15

<Example>
When the max. disturbance force is 80, the DETECT LEVEL is 96.
When the max. disturbance force is 10, the DETECT LEVEL is 25.

4. Level setting for the condition number 9.
   The level setting for the condition number 9 is for the teach mode.
   This setting is made for each group.
   Refer to the max. disturbance force to set the DETECT LEVEL.



NOTE

- Perform all the jobs to use for 5 to 6 hours.
- If a work job is performed both with holding a workpiece and without holding a workpiece, measure both patterns.
- In the event of a collision while measuring the max. disturbance force, clear the max. disturbance force by selecting {DATA}, then {CLEAR MAX VALUE}. Then try again.
- The max. disturbance force is cleared when the power is turned ON/OFF. Therefore, DO NOT set the level based on the max. disturbance force immediately after turning ON/OFF the power.
- When the teaching point, operation speed, operation position, etc. of a job are greatly changed due to teaching modification, etc., measure the max. disturbance force and set the DETECT LEVEL again.
- When the load of tool or workpiece is greatly modified, measure the max. disturbance force and set the DETECT LEVEL again.

NOTE

To avoid false detection during manipulator operation, set the following calculated value A or B, whichever is larger, to the DETECT LEVEL. An emergency stop of the manipulator due to the false detection may become a factor to damage the speed reducers and tools.

A: (Max. disturbance force) x (coefficient = 120%)
B: (Max. disturbance force) + 15

<Example>
When the max. disturbance force is 80, set the DETECT LEVEL to 96 or more.
When the max. disturbance force is 10, set the DETECT LEVEL to 25 or more.

NOTE

To adjust to the change in the grease viscosity at a cold start, the offset value is automatically added to DETECT LEVEL until the robot has operated for a certain period of time.
Thus, at a cold start, the shock detection will be performed only when the value is more than or equal to the sum of DETECT LEVEL and the offset value.
The offset value varies depending on the manipulator type.

NOTE

DETECT LEVEL can be modified only when the security mode is set to the management mode.

8.7.2.2 Tool Load Information Setting

To increase the accuracy of shock detection, set the tool load information in the tool file. Refer to *chapter 8.4.3 "Setting Tool Load Information" at page 8-48* for details of the tool load information setting.

8.7.2.3 U-Arm Payload Setting

To perform shock detection more accurately, set the U-arm payload.

See *chapter 8.4.2 "ARM CONTROL Window" at page 8-43* for details of the U-arm payload setting.

8.7.2.4 Instruction of Shock Detection Function

■ **SHCKSET instruction**

The SHCKSET instruction changes the shock detection level to the value set in the shock detection level file during play back operation.

The additional items of the SHCKSET instruction are as follows.

SHCKSET R1 SSL#(1)
① ②

① Robot Setting

Specifies the manipulator (R1, R2) or the station (ST1, ST2, ST3) of which shock detection level is to be modified.
If nothing is specified, the modification is applied to the shock detection level of the job control group in this instruction.
However, in the case of coordinated job, the modification is applied to the shock detection level of the slave axis group.

② Shock Detection Level Condition Number (1 to 7)

Specifies the shock detection level condition number in which the detection level in playback mode is set.

■ **SHCKRST instruction**

The shock detection level changed by the SHCKSET instruction is reset and returned to the detection level of the standard (value set in condition number 8) by the SHCKRST instruction.

The additional item of the SHCKRST instruction is as follows.

SHCKRST R1
①

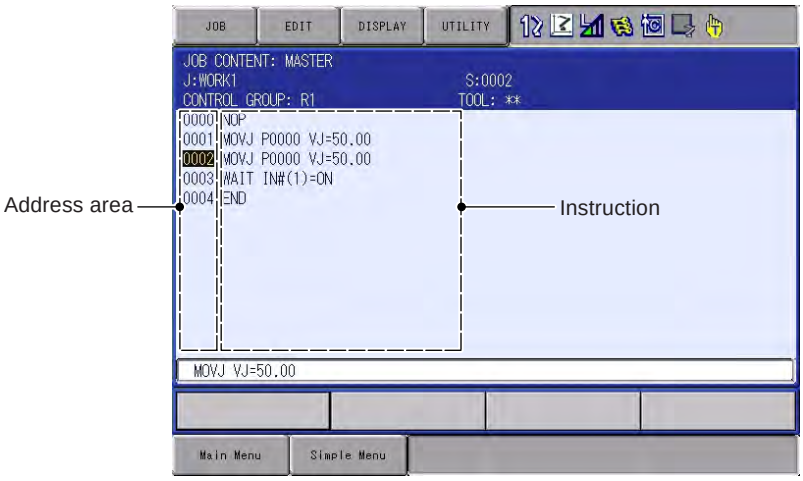
① Robot Setting

Specifies the manipulator (R1, R2) or the station (ST1, ST2, ST3) of which shock detection level is to be reset.
If nothing is specified, the modification will be applied to the shock detection level of the job control group of this instruction.
However, in the case of coordinated job, the modification is applied to the shock detection level of the slave axis group.

■ **Instruction registration**

The instruction is registered when the cursor is in the address area in the JOB CONTENT window in teach mode.

1. Select {JOB} under the main menu.



2. Select {JOB}.
3. Move the cursor in the address area.

■ **SHCKSET**

1. Move the cursor to the immediately preceding line where the SHCKSET instruction is to be registered.
2. Press [INFORM LIST].
   – The inform list dialog box is shown.

3. Select SHCKSET instruction.
   (1) SHCKSET instruction is shown in the input buffer line.

4. Change the value of additional item and numerical data.

– < When registering the instruction as it is >
Operate the step 5 when registering the instruction in the input buffer line as it is.

– < When adding or changing the additional item >

• When changing the shock detection level

(1) When changing the shock detection level, move the cursor to the shock detection level condition number; hold down [SHIFT] and press the up/down cursor key to change the condition number.

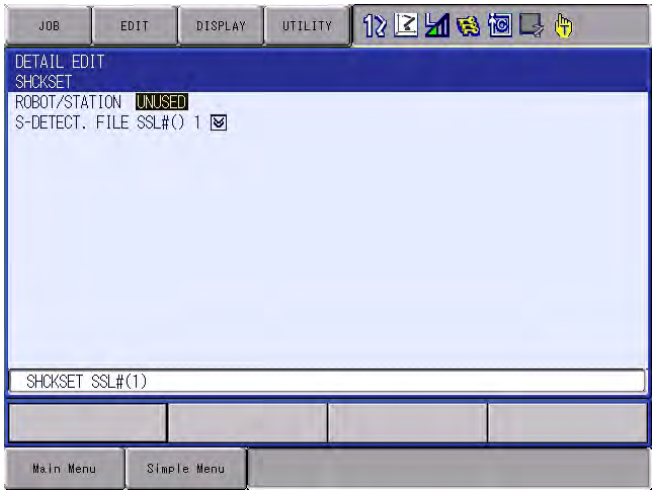
• When the value is input with the numeric key

I) When the value is input with the numeric key, press [SELECT] to display the input buffer line.

II) Press [ENTER] to change the number in the input buffer line.

• When robot specification is added

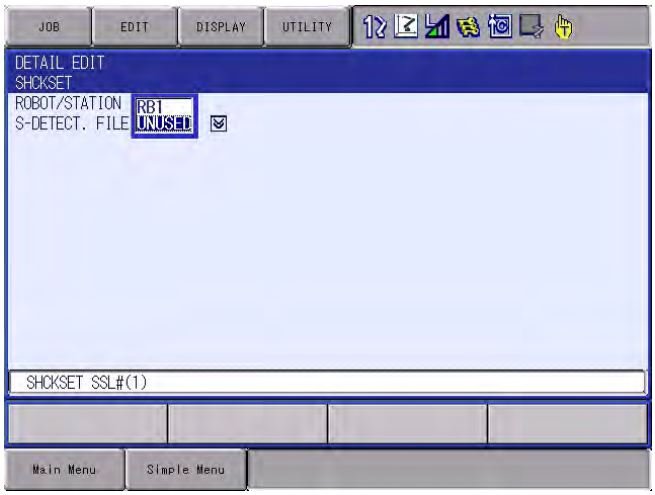
I) When robot specification is added, move the cursor to the instruction in the input buffer line and press [SELECT] to display the DETAIL window.



II) Move the cursor to “UNUSED” of “ROBOT/STATION”, and press [SELECT].

III) The selection box appears.

IV) Point the cursor to the robot to be added and press [SELECT].



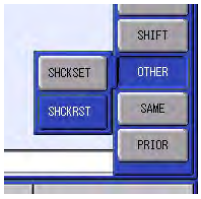
V) When the addition of robot is completed, press [ENTER].

VI) The DETAIL window closes and the JOB CONTENT window appears.

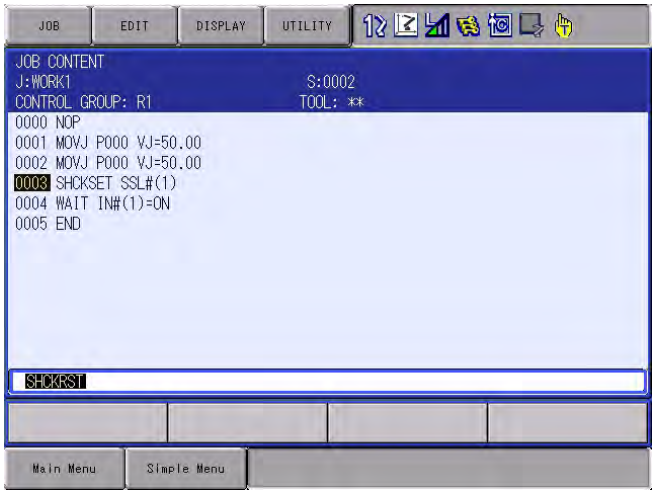
5. Press [INSERT] then [ENTER].
   – The instruction displayed in the input buffer line is registered.

■ **SHCKRST**

1. Move the cursor to the immediately preceding line where the SHCKRST instruction is to be registered.
2. Press [INFORM LIST].
   – The inform list appears.



3. Select SHCKRST instruction.
   – SHCKRST instruction appears in the input buffer line.

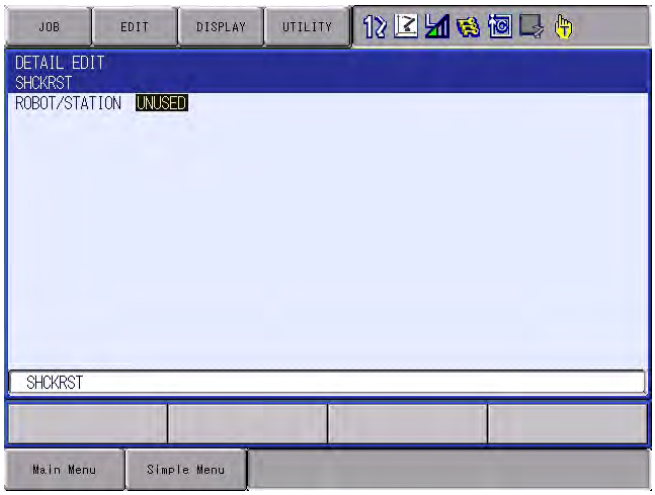


4. Change the value of the additional item.

   – < When registering the instruction as it is >
   Operate the step 5 when registering the instruction in the input buffer line as it is.

   – < When adding or changing the additional item >

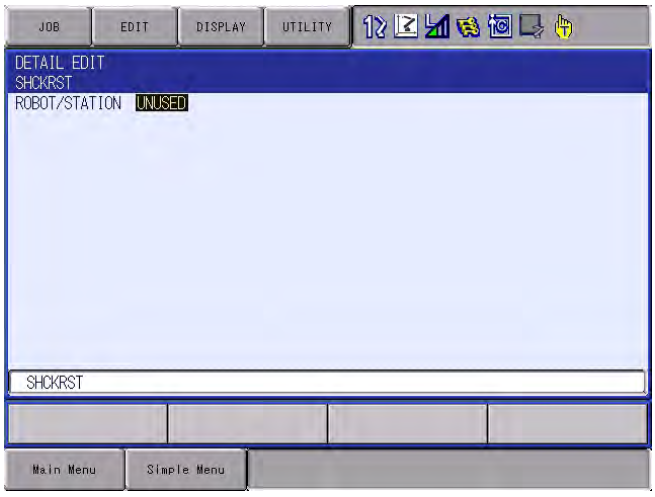
   (1) When adding the robot specification, move the cursor to instruction in the input buffer line and press [SELECT] to display the DETAIL window.



   (2) Move the cursor to “UNUSED” of “ROBOT/STATION”, and press [SELECT].

   (3) The selection box appears.

   (4) Point the cursor to the robot to be added and press [SELECT].



   (5) When the addition of robot is completed, press [ENTER].

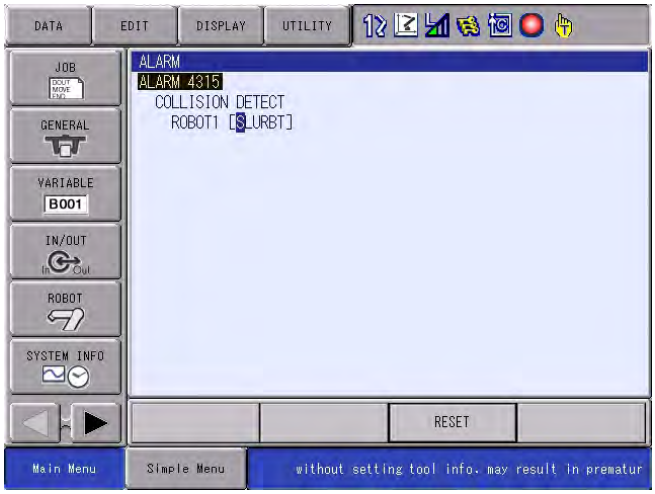
   (6) The DETAIL window closes and the JOB CONTENT window appears.

5. Press [INSERT] then [ENTER].

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

8.7.2.5 Resetting Shock Detection Alarm

When the collision of tool/manipulator and peripheral device is detected with the shock detection function, the manipulator stops instantaneously with alarm output. In this case, the shock detection alarm is displayed.



The shock detection alarm in teach mode and play mode can be reset by the following operation.

1. Press [SELECT].
   – The alarm is reset when “RESET” is selected on the alarm display, and the shock detection status is released.
2. Operation after resetting the detection status.
   – In teach mode, the JOG operation of the manipulator is enabled by resetting the status.
   – In the play mode, move the manipulator once to the safety position in the teach mode to check the damage though the playback operation is possible after resetting the status.

NOTE

When manipulator is stopped instantaneously while having contact with the object and the detection alarm is tried to reset on the alarm window, the situation in which the alarm cannot be reset may occur since the collision may be detected again after resetting.

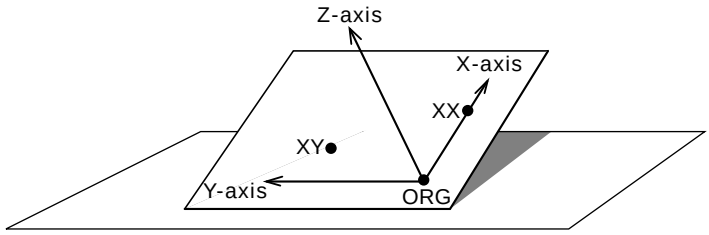
In this case, set the shock detection function “INVALID”, or increase the detection level in teach mode and retreat the manipulator to a safety position.

8.8 User Coordinate Setting

8.8.1 User Coordinates

8.8.1.1 Definition of User Coordinates

User coordinates are defined by three points that have been taught to the manipulator through axis operations. These three defining points are ORG, XX, and XY, as shown in the diagram below. These three points of positional data are registered in a user coordinate file.



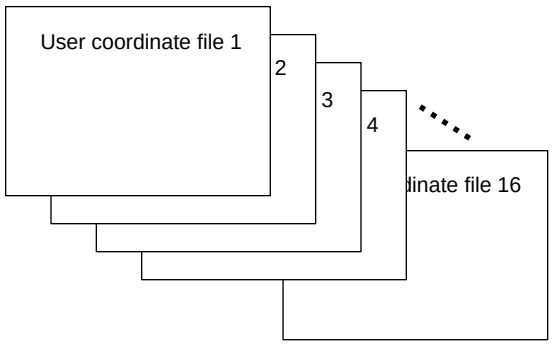
User coordinate definition point
ORG: Home position
XX: Point on the X-axis
XY: Point on the Y-axis

ORG is the home position, and XX is a point on the X-axis. XY is a point on the Y-axis side of the user coordinates that has been taught, and the directions of Y- and Z-axes are determined by point XY.

NOTE It is important that the two points ORG and XX be taught accurately.

8.8.1.2 Number of User Coordinate Files

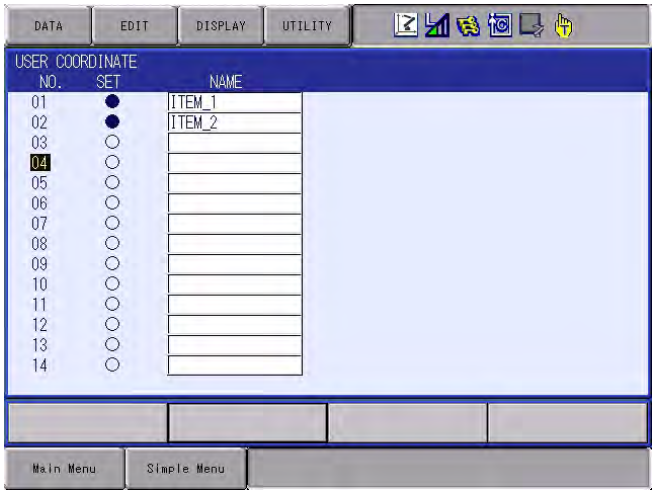
Up to 16 kinds of user coordinates can be registered. Each coordinate has a user coordinate No. and is called a user coordinate file.



8.8.2 User Coordinate Setting

8.8.2.1 Selecting User Coordinate File

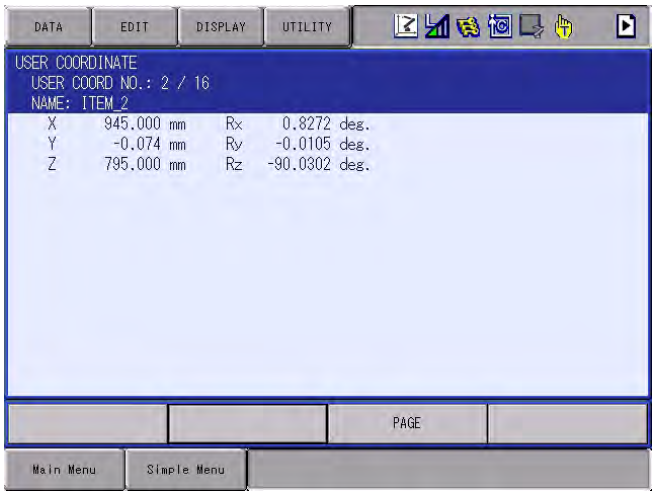
1. Select {ROBOT} under the main menu.
2. Select {USER COORDINATE}.
   (1) The USER COORDINATE window appears.



   (2) The "●" denotes that the user coordinates is completed to set and the "O" denotes that it is not completed.

   (3) To check the position of the user coordinates select {DISPLAY} → {COORDINATE DATA}.

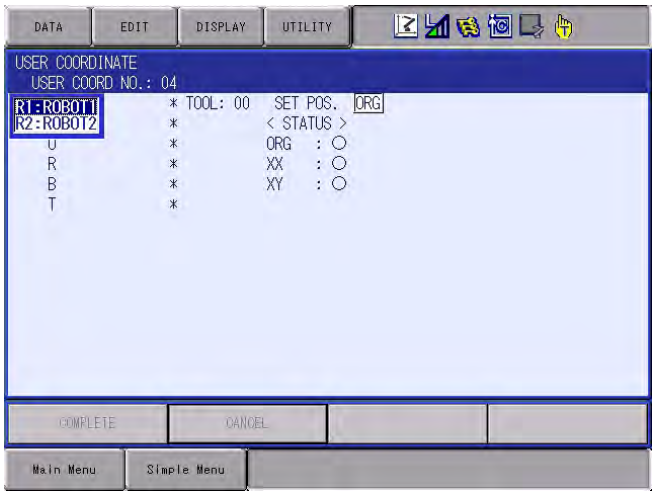
   (4) The following window appears.



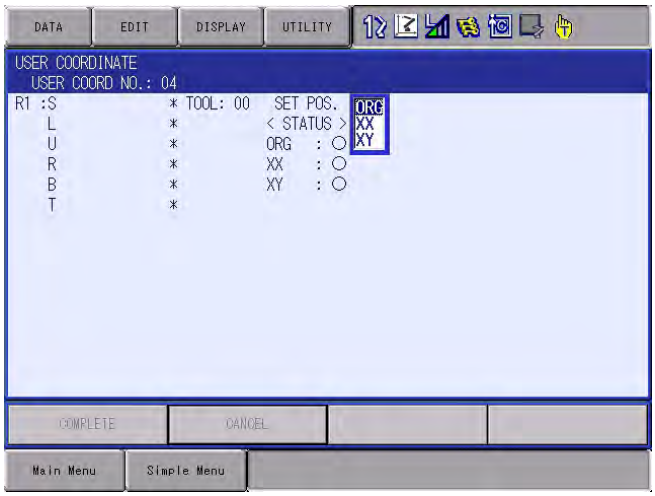
3. Select the user coordinate number.

8.8.2.2 Teaching User Coordinates

1. Select the robot.
   – Select “**” on the upper left of the window to select the subject robot. (This operation can be omitted if the robot selection has already been made or if there is only one robot.)

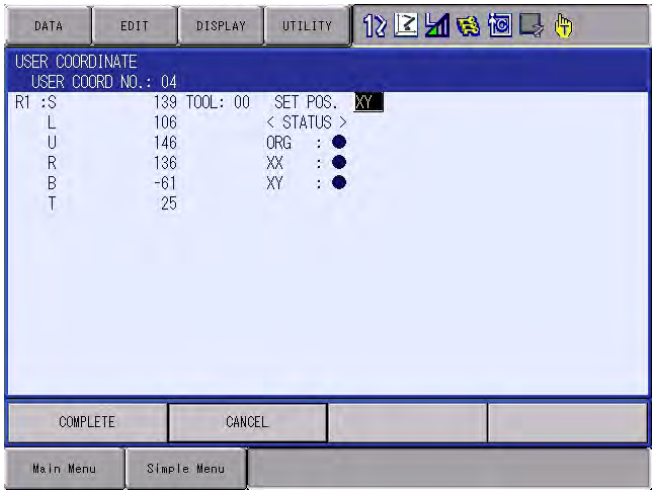


2. Select “SET POS”.
   – Select the teaching point.



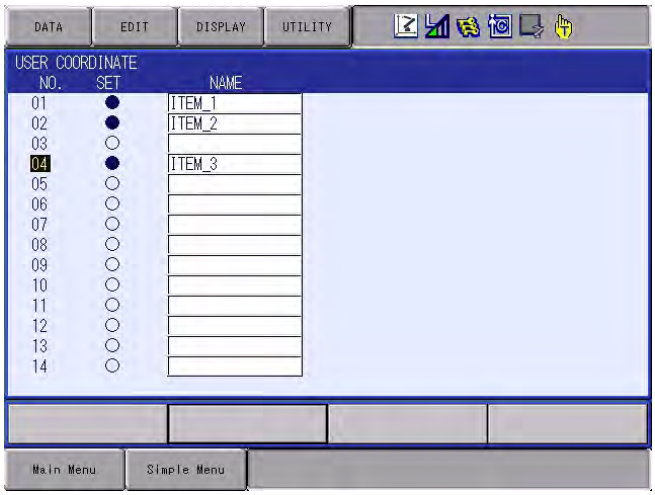
3. Move the manipulator to the desired position with the axis keys.

4. Press [MODIFY] then [ENTER].
   - Taught position is registered.
   - Repeat the steps 2 to 4 to teach ORG, XX and XY.
   - "●" denotes that teaching is completed and "○" denotes that it is not completed.



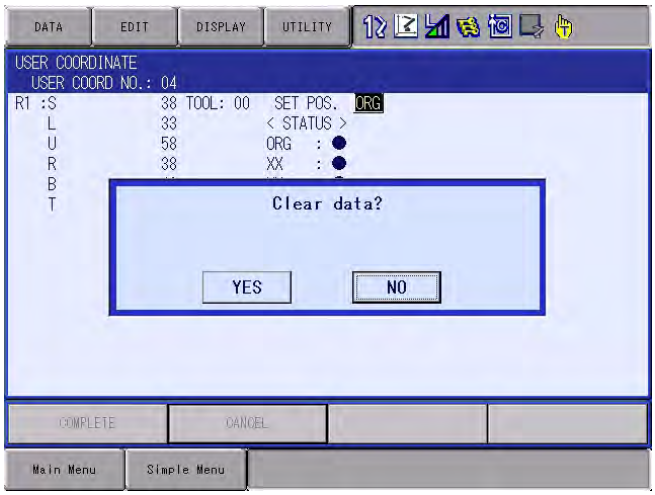
   - To check the taught positions, call up the required window among ORG to XY and press [FWD]. The manipulator moves to the set position.
   - If there is a difference between the current position of the manipulator and the displayed position data, "ORG", "XX", or "XY" flashes.

5. Select "COMPLETE".
   - User coordinates are registered in the file.
   - Once the user coordinate setting is completed, the following window appears.

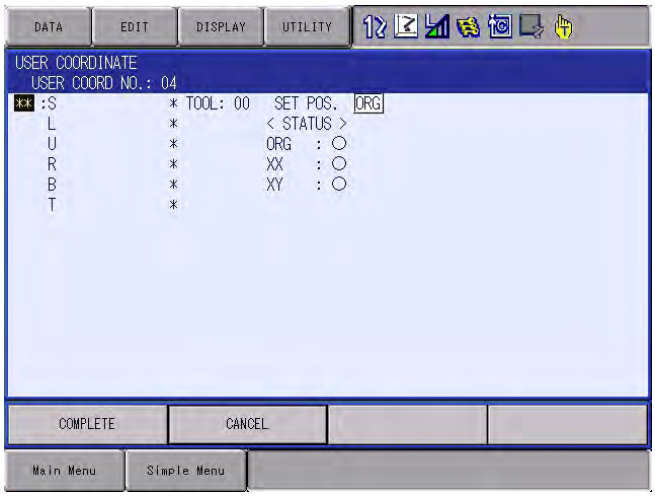


8.8.2.3 Clearing User Coordinates

1. Select {DATA} under the pull-down menu.
2. Select {CLEAR DATA}.
   – The confirmation dialog box appears.



3. Select {YES}.
   – All data is cleared.



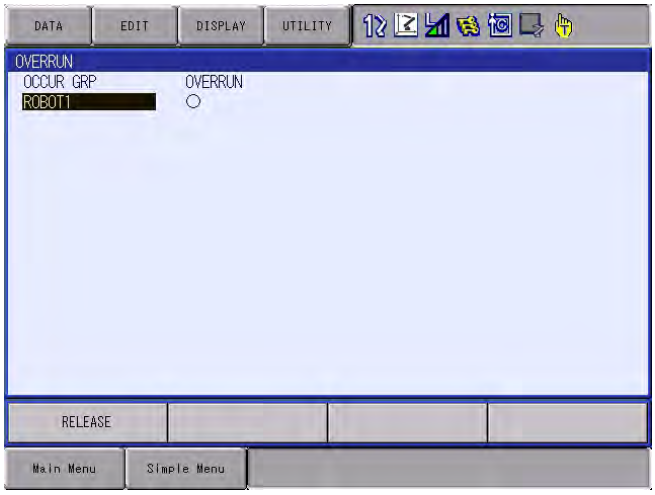
8.9 Releasing Overrun

CAUTION

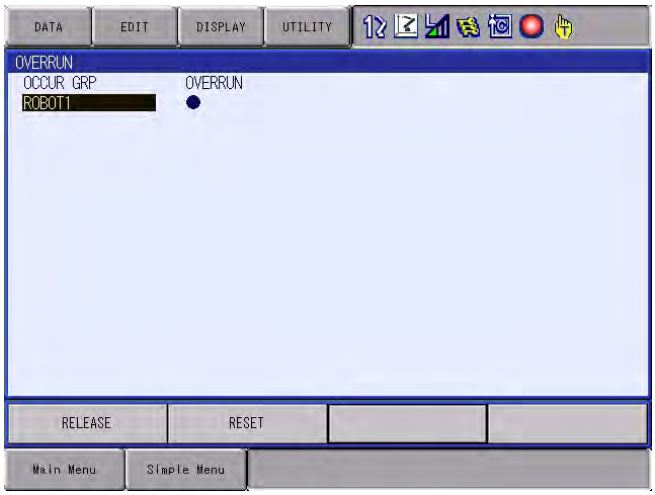
To operate the manipulator with the overrun released, pay extra attention to the safety of the surrounding operation environment.

If the manipulator stops by overrun detection, it by the following procedure and reset the alarm and move the manipulator with the axis keys.

1. Select {ROBOT} under the main menu.
2. Select {OVERRUN}.
   – The OVERRUN window appears.



3. Select “RELEASE”.
   – The control group in which overrun is detected is indicated with “●”.
   – If “RELEASE” is selected, overrun is released and “CANCEL” indication will be displayed.



4. Select “ALM RST”.
   – The alarm is reset and manipulator can be moved with the axis keys.

NOTE After releasing the overrun, if “CANCEL” is selected or the window is changed to the other one, the release of the overrun will be canceled.

8.10 Soft Limit Release Function

The switches that are set to detect the motion range of the manipulator are called limit switches. The operating range is monitored by the software in order to stop motion before these limit switches are reached. These software limits are called “soft limits”. The operating range of the manipulator is controlled by the following two soft limits.

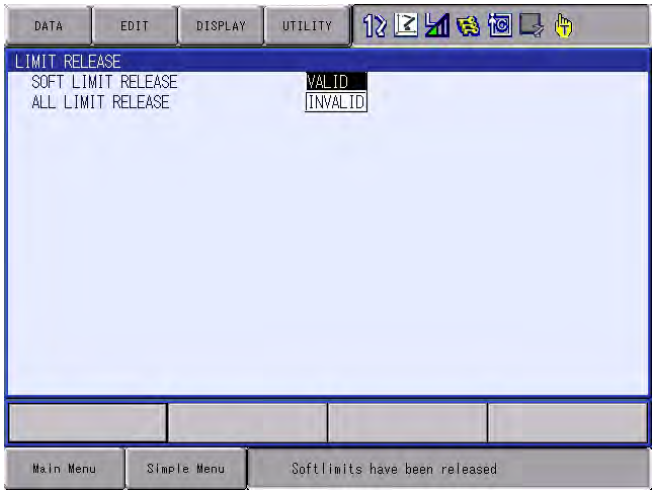
- Maximum motion range for each axis
- Cubic operation area set parallel to the robot coordinate system

These soft limits are continually monitored by the system, and the manipulator automatically stops when the its TCP reaches a soft limit.

When the manipulator is stopped at a soft limit, temporarily release the soft limit by the following procedure, then move the manipulator away from the soft limit in a direction opposite to the earlier operation direction.

1. Select {ROBOT} under the main menu.
2. Select {LIMIT RELEASE}.
   – The LIMIT RELEASE window appears.

3. Select “SOFT LIMIT RELEASE”.
   – Press [SELECT] to alternate between “VALID” and “INVALID”.
   – When “SOFT LIMIT RELEASE” is set to “VALID”, the message “Soft limits have been released” appears.



   – When “SOFT LIMIT RELEASE” is set to “INVALID”, the message “Softlimits off released” is displayed for a few seconds.

NOTE

- The taught data cannot be registered when the soft limit is being released.
- The setting of “SOFT LIMIT RELEASE” becomes “INVALID” when the mode is changed to the play mode.

8.11 All Limit Release Function

CAUTION

- To operate the manipulator with all limits released, pay extra attention to ensure the safety of the surrounding operation environment.

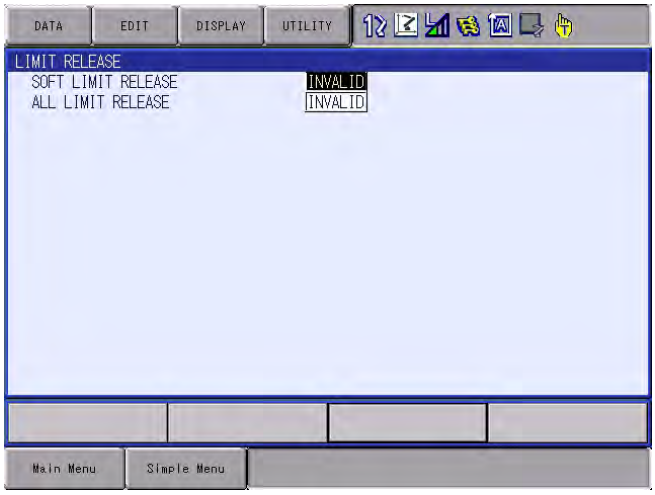
Failure to observe this caution may result in injury or damage to equipment due to the unexpected manipulator motion exceeding its range of motion.

The following limits can be released with the all limit release function:

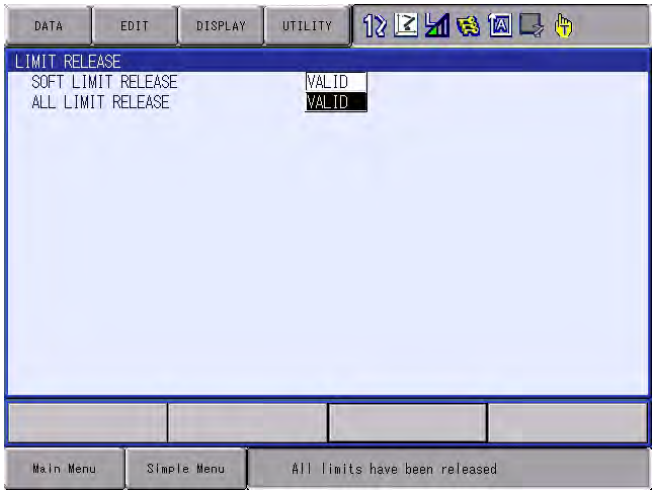
Limit Type	Contents
Mechanical Limit	Limit to check manipulator's range of motion.
L-U Interference	Limit to check L- and U-axis interference area.
Soft Limit on Each Axis	Soft limit to check manipulator's range of motion.
Cube Interference	Limit to check cube interference area set by user.

NOTE The all limit release function is available only when the security mode is set to the management mode. Refer to *chapter 7 "Security System" at page 7-1* for details on the security modes.

1. Select {ROBOT} under the main menu.
2. Select {LIMIT RELEASE}.
   – The LIMIT RELEASE window appears.



3. Select “ALL LIMITS RELEASE”.
   – Press [SELECT] to alternate between “VALID” and “INVALID”.
   – When ALL LIMIT RELEASE is changed to “VALID”, the message “All limits have been released” is displayed. When the setting changes to “INVALID”, the message “All limits off released” is displayed for a few seconds.



8.12 Instruction Level Setting

8.12.1 Setting Contents

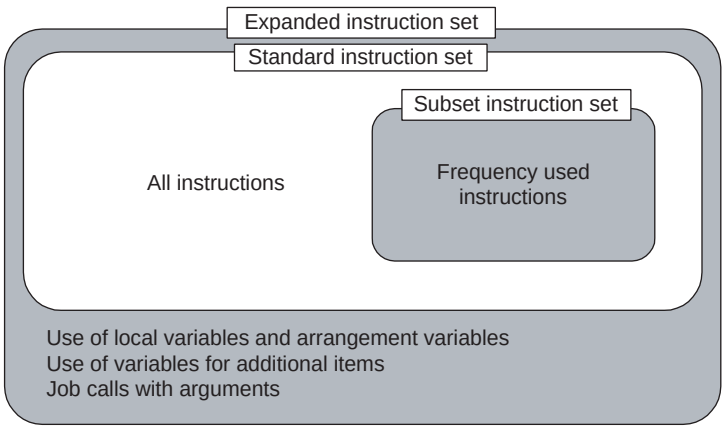
8.12.1.1 Instruction Set

There are three instruction sets that can be used when registering the instructions for the robot programming language (INFORM III): the subset instruction set, the standard instruction set, and the expanded instruction set.

- Subset Instruction Set:
  The instructions displayed in the instruction list are limited to just those that are most frequently used, reducing the number of instructions that can be registered. Since few instructions are shown, selection and input are simple.
- Standard Instruction Set/Expanded Instruction Set:
  All the INFORM III instructions can be used. The number of additional items to be used in each instruction differ in the standard instruction set and expansion instruction set.
  In the standard instruction set, the following functions cannot be used. However, operation becomes easier because the number of data items decreases when registering an instruction.
  - Use of local variables and arrangement variable
  - Use of variables for additional items (Example: MOVJ VJ = I000)

When instructions are executed, for example during playback, all the instructions can be executed regardless of the instruction set used.

Fig. 8-5: Instruction Set

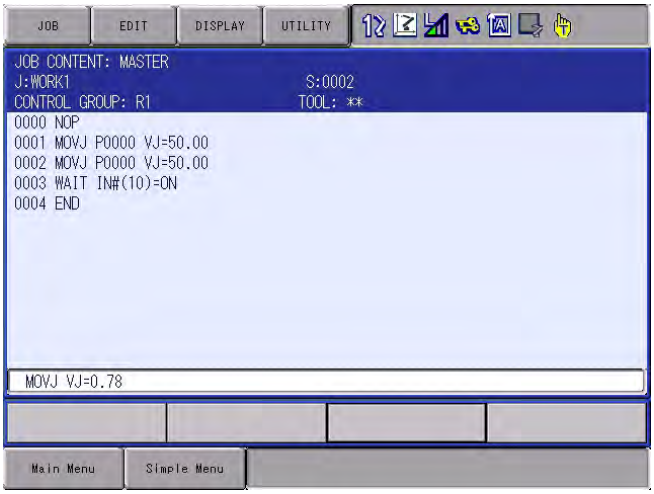


8.12.1.2 Learning Function

When an instruction is entered from the instruction list, the additional items that were entered last time are also shown. This function can simplify instruction input.

To register the same additional items as those in the former operation, register them without changing.

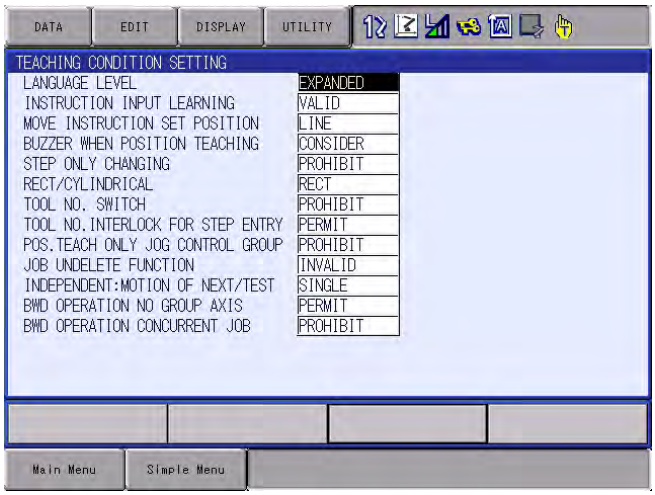
1. Register an instruction.



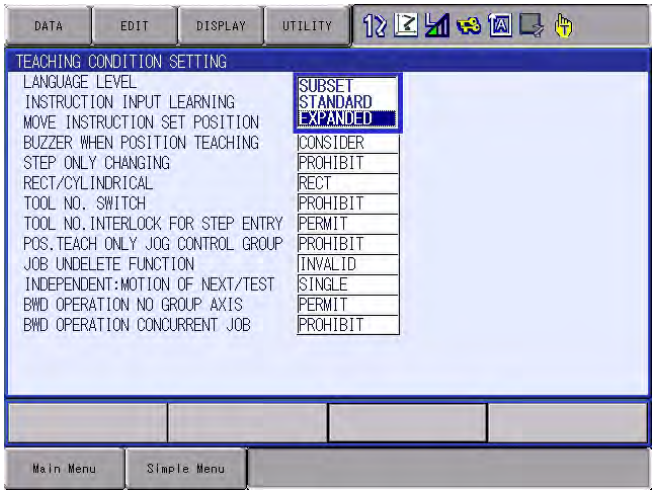
2. The next time an attempt is made to register the same instruction as in 1, the same additional items as were registered last time are also shown in the input buffer line.

8.12.2 Setting Instruction Set Level

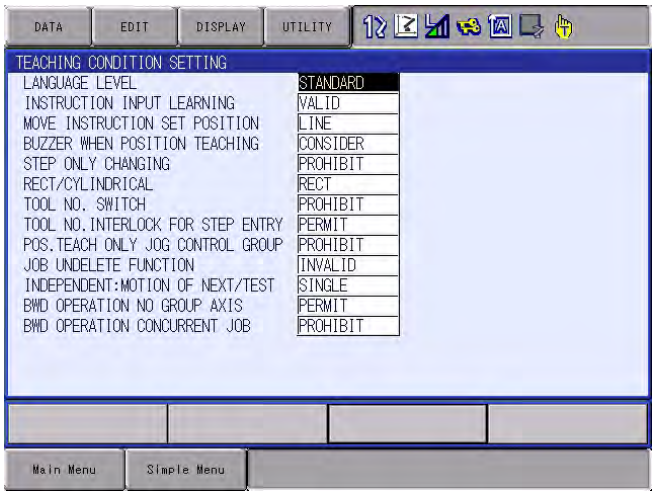
1. Select {SETUP} under the main menu.
2. Select {TEACHING CONDITION SETTING}.
   – The TEACHING CONDITION SETTING window appears.



3. Select “LANGUAGE LEVEL”.
   – The selection list appears.



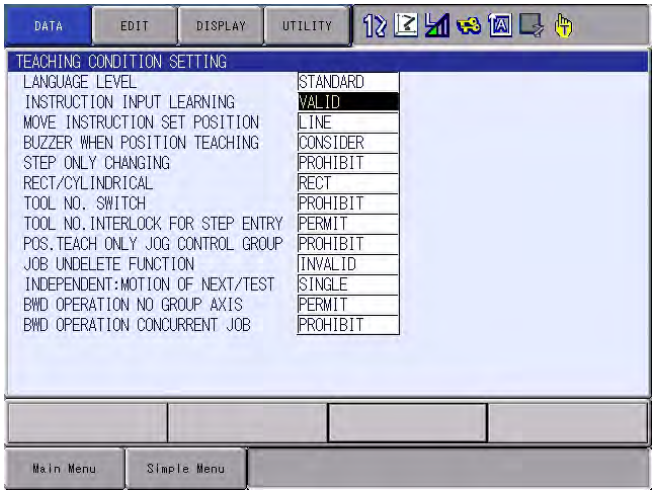
4. Select desired language level.
   – Language level is set.



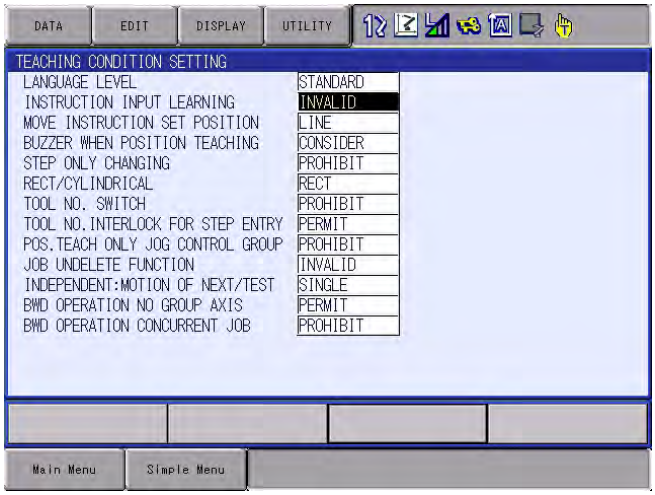
8.12.3 Setting Learning Function

The learning function is set at “VALID” by default.

1. Select {SETUP} under the main menu.
2. Select {TEACHING CONDITION SETTING}.
   – The TEACHING CONDITION SETTING window appears.



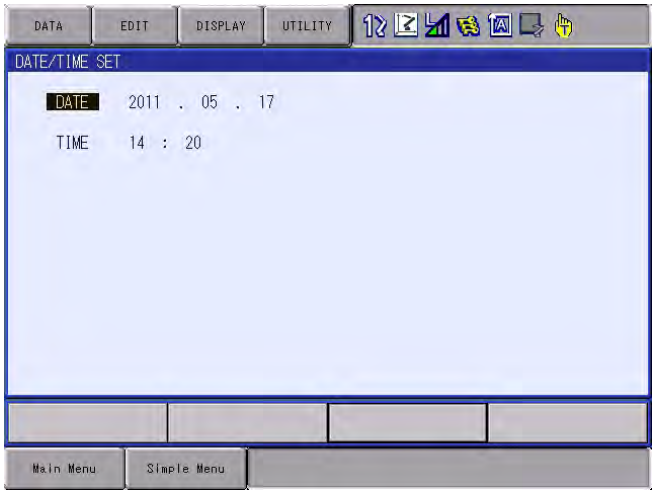
3. Select “INSTRUCTION INPUT LEARNING”.
   – Press [SELECT] to alternate between “VALID” and “INVALID”.



8.13 Setting Controller Clock

To check the current date and time, follow the procedure below.

1. Select {SETUP} under the main menu.
2. Select {DATE/TIME}.
   – The DATE/TIME SET window appears.

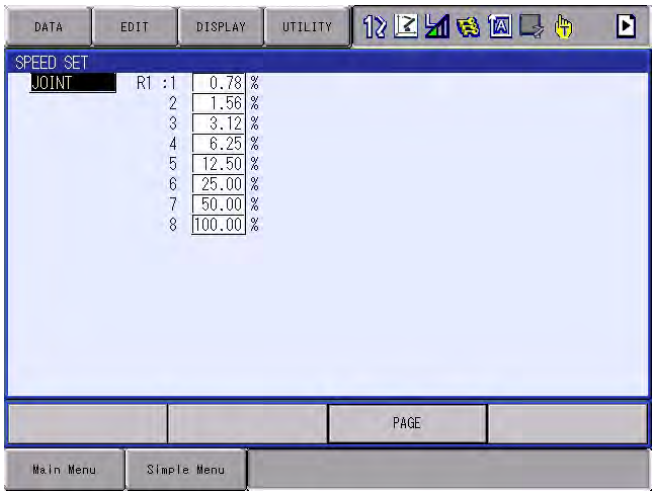


To set the current date and time, follow the procedure below.

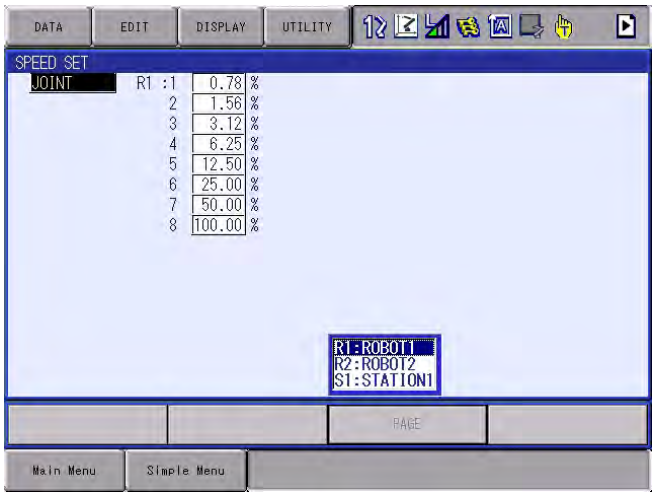
1. While pressing the main menu key (MAIN MENU), turn the power OFF then back ON.
2. Select {SYSTEM}, then {SETUP}. Then, select “DATE” or “TIME”.
   – The DATE/TIME SET window appears.
3. Select “DATE” or “TIME”.
   – The input buffer line appears.
4. Input the new date/time.
   – For instance, to set the date to September 1, 2010, input “2010.9.1”. To set the time at twelve o’clock, enter “12.00”.
5. Press [ENTER].
   – The date or time is changed.

8.14 Setting Play Speed

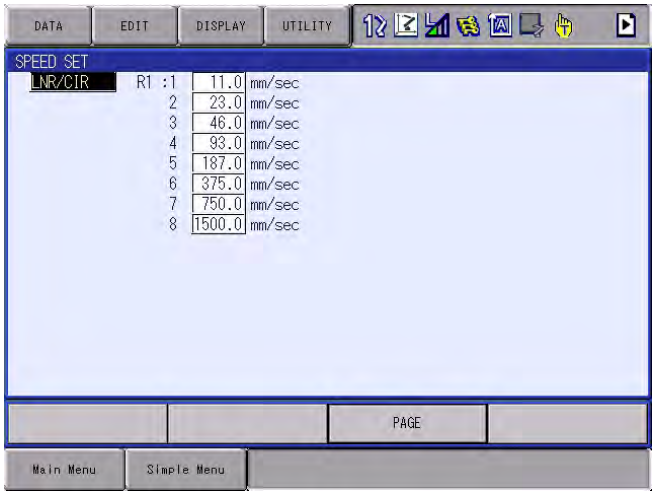
1. Select {SETUP} under the main menu.
2. Select {SET SPEED}.
   – The SPEED SET window is shown.



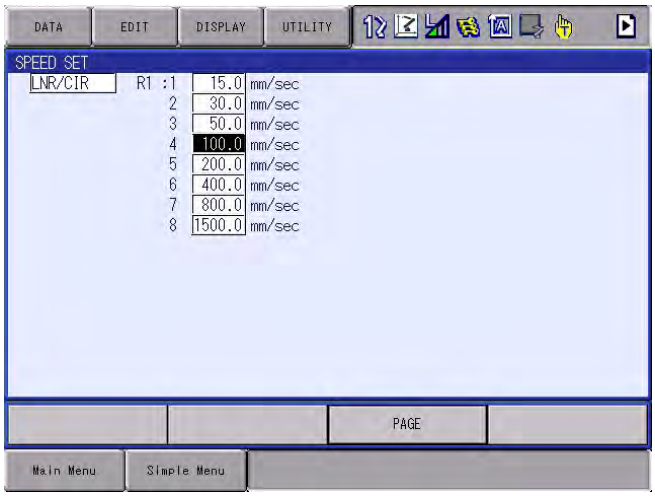
3. Press the page key  .
   – When two or more manipulators and stations exist in the system, use the page key  to change the control group, or click on {PAGE} to select the desired control group.



4. Select “JOINT” or “LNR/CIR”.
   – The type of speed alternately changes from “JOINT” to “LNR/CIR”.



5. Select the speed to modify.
   – The input buffer line appears.
6. Input the speed value.
7. Press [ENTER].
   – The speed is modified.



8.15 Numeric Key Customize Function

8.15.1 Description of Numeric Key Customize Function

With this function, the user can set the function of an application that has been allocated to the numeric keys of the programming pendant to the other function.

Since any frequently used operation can be allocated to the numeric keys on the programming pendant, decreased key operations reduce the teaching time.

The Numeric Key Customize Function is allowed to set only when the security mode is set to the management mode.

8.15.2 Allocatable Functions

There are two allocation methods as follows:

- Key Allocation (EACH)
- Key Allocation (SIM)

8.15.2.1 Key Allocation (EACH)

With key allocation (EACH), the manipulator operates according to the allocated function when the numeric key is pressed. The allocatable functions are listed below.

Function	Description
Manufacturer allocation	Allocated by Yaskawa. Allocating another function invalidates the function allocated by the manufacturer.
Instruction allocation	Allocates any instructions assigned by the user.
Job call allocation	Allocates job call instructions (CALL instructions). The jobs to be called are only those registered in the reserved job names. (Specified by the registration No.)
Display allocation	Allocates any displays assigned by the user.

8.15.2.2 Key Allocation (SIM)

With key allocation (SIM), the manipulator operates according to the allocated function when the interlock key and the numeric key are pressed at the same time. The allocatable functions are listed below.

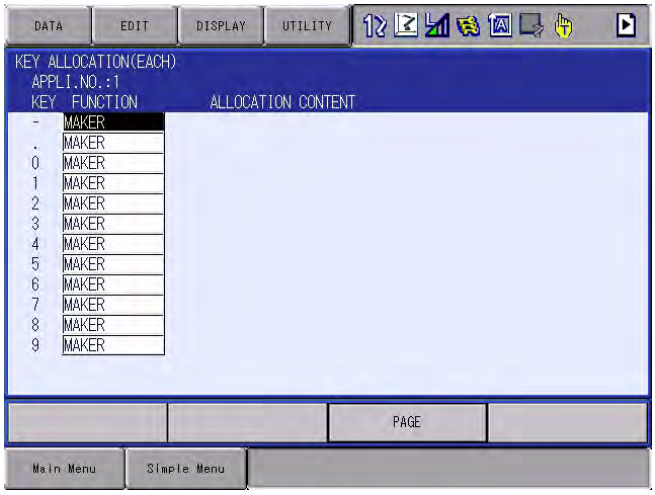
Function	Description
Alternate output allocation	Turns ON/OFF the specified user output signal when the interlock key and the allocated Numeric key are pressed at the same time.
Momentary output allocation	Turns ON the specified user output signal user when the interlock key and the allocated user key are pressed at the same time.
Pulse output allocation	Turns ON the specified user output signal only for the specified period when the interlock key and the allocated Numeric key are pressed at the same time.
Group output allocation (4-bit/8-bit)	Sends the specified output to the specified general group output signals when the interlock key and the allocated Numeric key are pressed at the same time.
Analog output allocation	Sends the specified voltage to the specified output port when the interlock key and the allocated Numeric key are pressed at the same time.
Analog incremental output allocation	Sends the voltage increased by the specified value to the specified output port when the interlock key and the allocated Numeric key are pressed at the same time.

SUPPLE-MENT In a system for multiple applications, a numeric key can be allocated for each application.

8.15.3 Allocating Operation

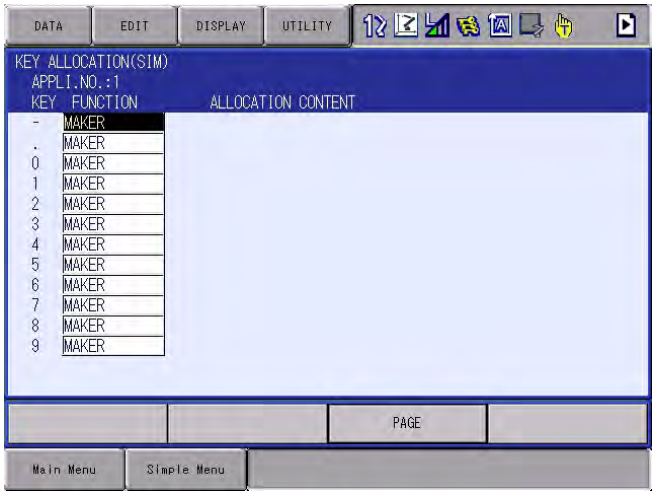
8.15.3.1 Allocation Window

1. Select {SETUP} under the main menu.
2. Select {KEY ALLOCATION}.
   – The KEY ALLOCATION (EACH) window appears.



3. Select {DISPLAY}.
   – Pull-down menu appears.
   – To call up the KEY ALLOCATION (SIM) window, select {ALLOCATE SIM. KEY}.

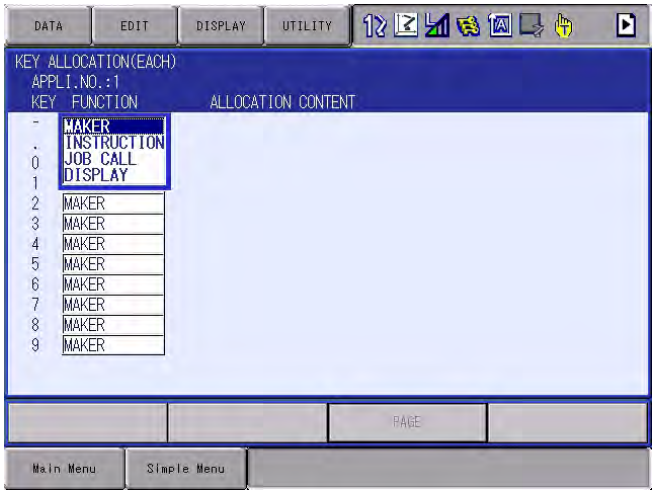
4. Select {ALLOCATE SIM. KEY}.
   – The KEY ALLOCATION (SIM) window appears.
   – In a system with multiple applications, press the page key to change the window to the allocation window for each application, or click on {PAGE} to select the desired application number.



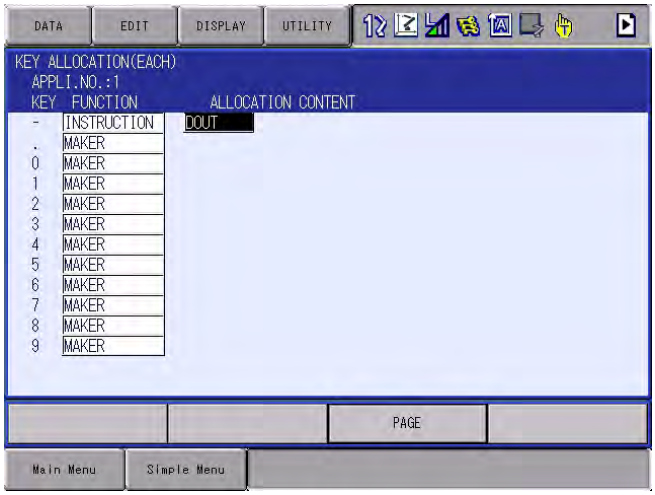
8.15.3.2 Instruction Allocation

Set this function in the KEY ALLOCATION (EACH) window.

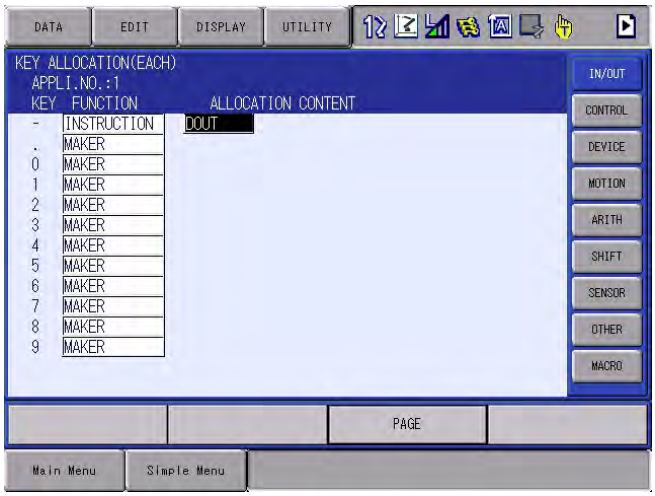
1. Move the cursor to “FUNCTION” of the key to be allocated and press [SELECT].
   – Selection list appears.



2. Select “INSTRUCTION”.
   – The instruction is shown in the “ALLOCATION CONTENT”.

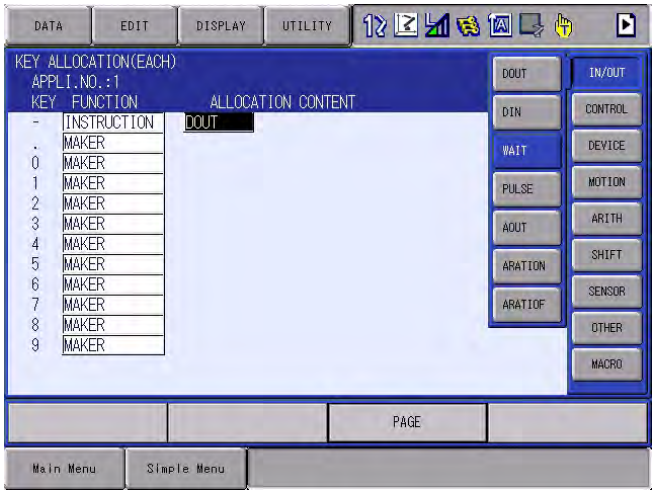


   (1) To change the instruction, move the cursor to the instruction and press [SELECT]. Then the instruction group list appears.



(2) Select the group which contains the instruction to modify.

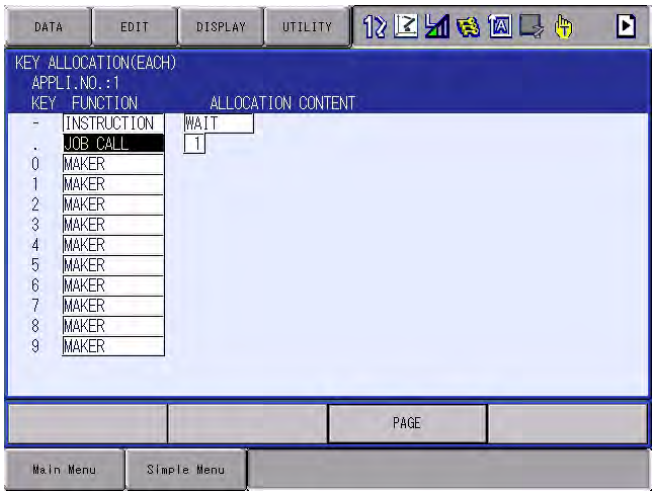
(3) When the instruction list dialog box is shown, select the instruction to be changed.



8.15.3.3 Job Call Allocation

Set this function in the KEY ALLOCATION (EACH) window.

1. Move the cursor to the “FUNCTION” of the key to be allocated and press [SELECT].
   – A selection list appears.
2. Select “JOB CALL”.
   – The reserved job registration No. is shown in the “ALLOCATION CONTENT” (reserved job registration No.: 1 to 10).



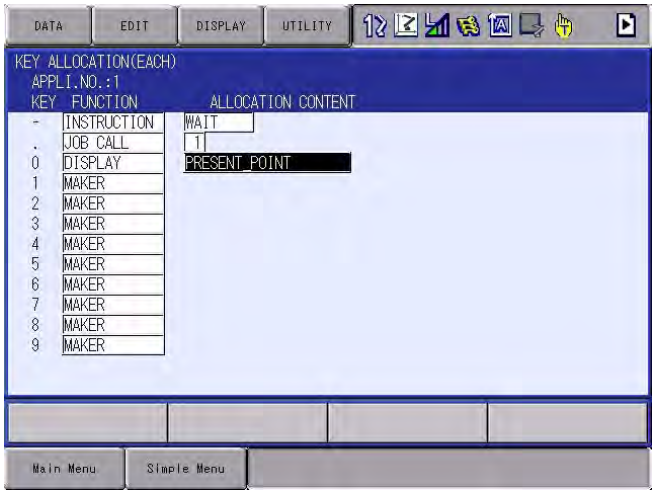
(1) To change the reserved job registration No. move the cursor to the No. and press [SELECT]. Then input buffer line appears.

(2) Input the number to be changed, and press [ENTER].

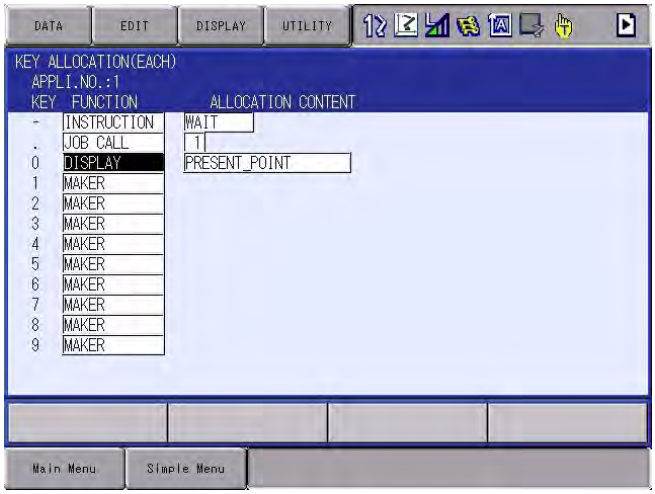
8.15.3.4 Display Allocation

Set this function in the KEY ALLOCATION (EACH) window.

1. Move the cursor to the “FUNCTION” of the key to be allocated and press [SELECT].
   – Selection list appears.
2. Select [DISPLAY].
3. Move the cursor to “ALLOCATION CONTENT” and press [SELECT].
   – Character input is available.
4. Input the name of the reserved window and press [ENTER].
   – The reserved name input to the “ALLOCATION CONTENT” is shown.



5. Open the window for allocation.
6. Press the interlock key and the allocated key at the same time.
   – A message “Reserved display registered” appears, and the window is registered.
   – In this case, the CURRENT POSITION window is registered by pressing the interlock key + [0] with the CURRENT POSITION window displayed on the screen.

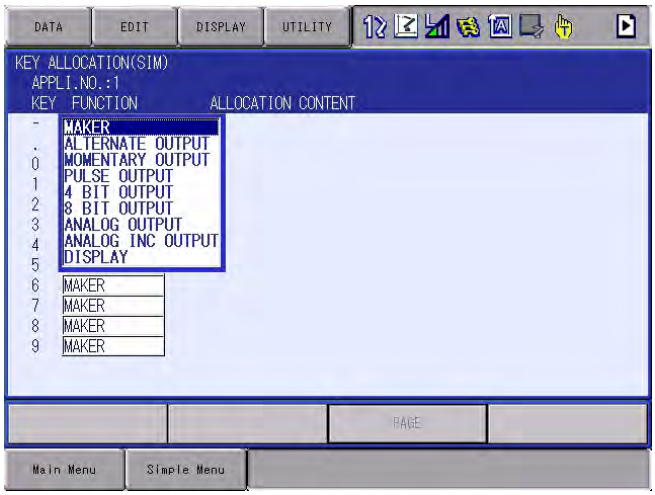


8.15.3.5 Alternate Output Allocation

Set this function in the KEY ALLOCATION (SIM) window.

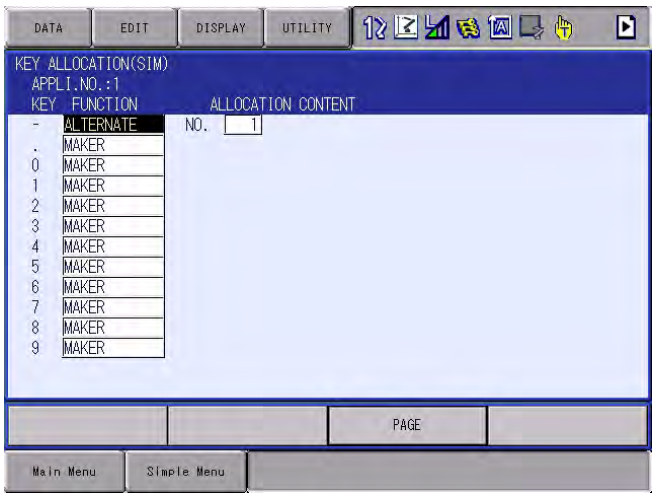
1. Move the cursor to the “FUNCTION” of the key to be allocated and press [SELECT].

   – Selection list appears.



2. Select “ALTERNATE OUTPUT”.

   – The output No. is displayed in the “ALLOCATION CONTENT”.



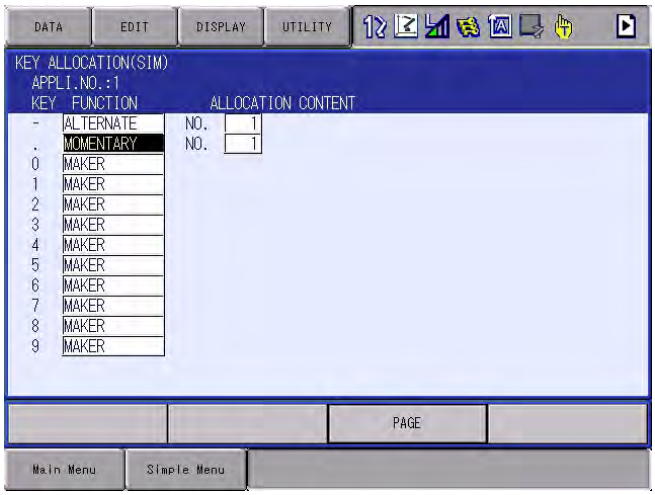
   (1) To change the output No., move the cursor to the No. and press [SELECT]. Then numeric value can be entered.

   (2) Input the number to be changed, and press [ENTER].

8.15.3.6 Momentary Output Allocation

Set this function in the KEY ALLOCATION (SIM) window.

1. Move the cursor to the “FUNCTION” of the key to be allocated and press [SELECT].
   – A selection list appears.
2. Select “MOMENTARY OUTPUT”.
   – The output No. is displayed in the “ALLOCATION CONTENT”.



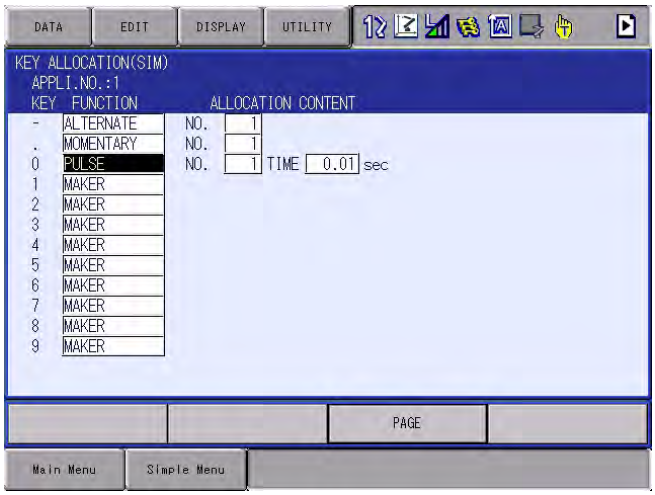
(1) To change the output No., move the cursor to the No. and press [SELECT]. Then numeric value can be entered.

(2) Input the number to be changed, and press [ENTER].

8.15.3.7 Pulse Output Allocation

Set this function in the KEY ALLOCATION (SIM) window.

1. Move the cursor to the “FUNCTION” of the key to be allocated and press [SELECT].
   – A selection list appears.
2. Select “PULSE OUTPUT”.
   – The output No. and output time are displayed in the “ALLOCATION CONTENT”.



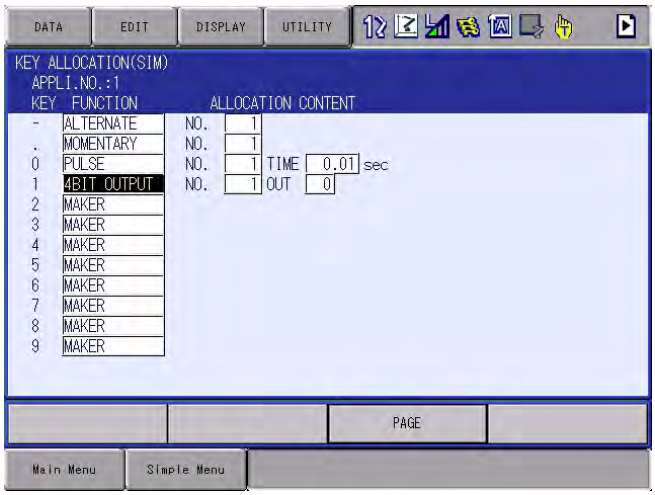
(1) To change the output No. or output time, move the cursor to the No. or time and press [SELECT]. Then numeric value can be entered.

(2) Input the number or time to be changed, and press [ENTER].

8.15.3.8 Group (4-bit/8-bit) Output Allocation

Set this function in the KEY ALLOCATION (SIM) window.

1. Move the cursor to the “FUNCTION” of the key to be allocated and press [SELECT].
   – A selection list appears.
2. Select “4 BIT OUTPUT” or “8 BIT OUTPUT”.
   – The output No. and output value are displayed in the “ALLOCATION CONTENT”.



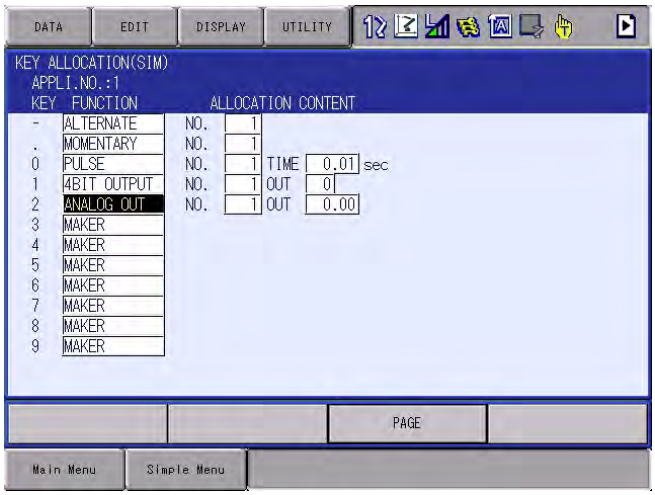
(1) To change the output No. or output value, move the cursor to the No. or value and press [SELECT]. Then numeric value can be entered.

(2) Input the number or value to be changed, and press [ENTER].

8.15.3.9 Analog Output Allocation

Set this function in the KEY ALLOCATION (SIM) window.

1. Move the cursor to the “FUNCTION” of the key to be allocated and press [SELECT].
   – A selection list appears.
2. Select “ANALOG OUTPUT”.
   – The output port number and the output voltage value are displayed in the “ALLOCATION CONTENT”.



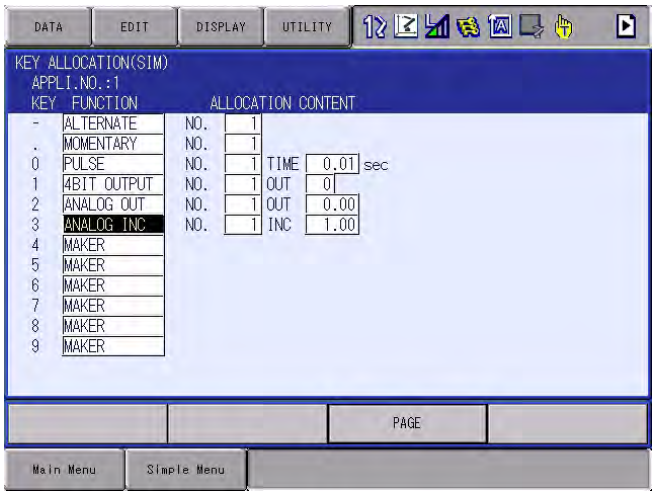
(1) To change the output port No. or output voltage value, move the cursor to the No. or voltage value and press [SELECT]. Then numeric value can be entered.

(2) Input the number or voltage value to be changed, and press [ENTER].

8.15.3.10 Analog Incremental Output Allocation

Set this function in the KEY ALLOCATION (SIM) window.

1. Move the cursor to the “FUNCTION” of the key to be allocated and press [SELECT].
   – A selection list appears.
2. Select “ANALOG INC OUTPUT”.
   – The output port No. and incremental value are displayed in the “ALLOCATION CONTENT”.



(1) To change the output port No. or incremental value, move the cursor to the No. or incremental value and press [SELECT]. Then numeric values can be entered.

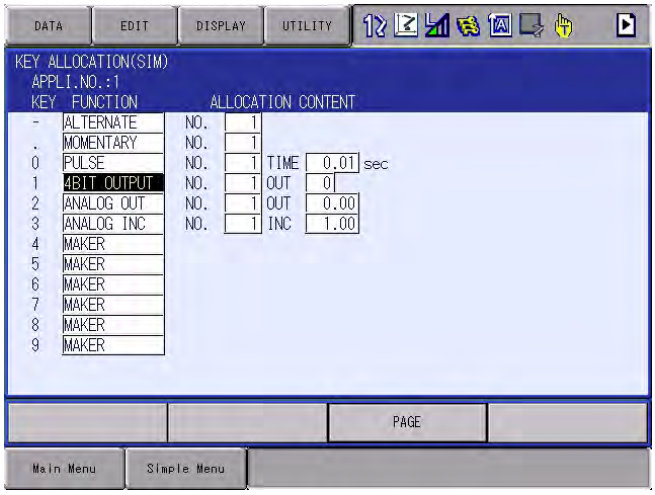
(2) Input the number or incremental value to be changed, and press [ENTER].

8.15.4 Allocation of I/O Control Instructions

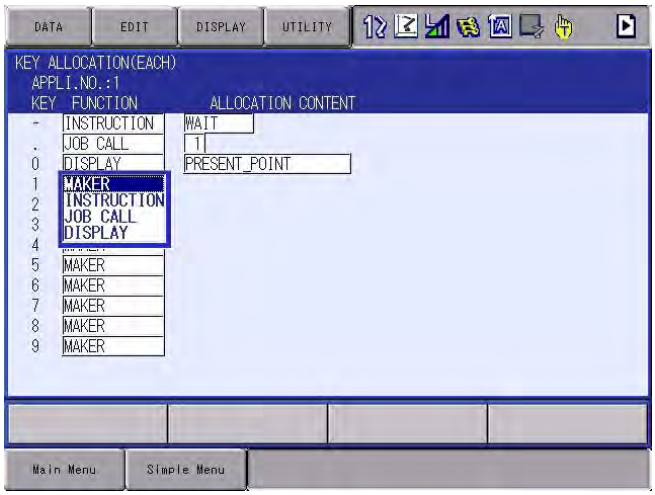
In key allocation (SIM), output control instructions can be allocated to the numeric keys that have been allocated one of the following I/O controls with key allocation (EACH).

Function	Output Control Instruction allowed to be Allocated
Alternate output allocation	DOUT OT# (No.) ON
Momentary output allocation	
Pulse output allocation	PULSE OT# (No.) T = output time
Group output allocation (4-bit)	DOUT OGH (No.) output value
Group output allocation (8-bit)	DOUT OG# (No.) output value
Analog output allocation	AOUT AO# (No.) output voltage value

1. Allocation of I/O control instruction.
   – Allocate the I/O control instruction with key allocation (SIM) following the forementioned procedure.



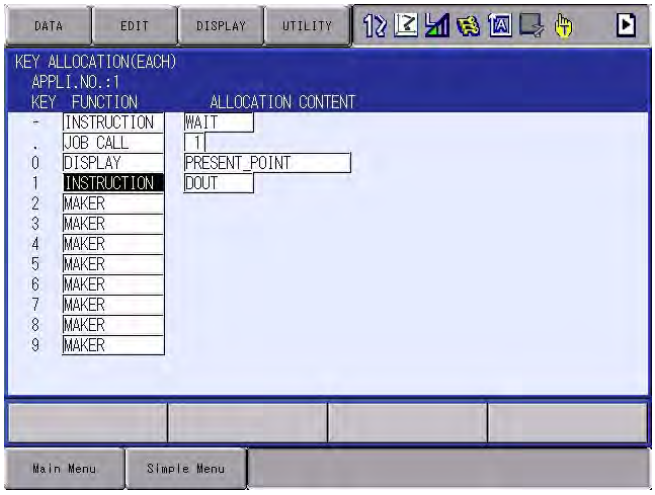
2. Move the cursor to the “FUNCTION” of the key that has been allocated with I/O control with key allocation (SIM) and press [SELECT].



   – Selection list appears.

3. Select “OUTPUT CONTROL INST”.

   – The instruction corresponding to the I/O control allocated by key allocation (SIM) is displayed in the “ALLOCATION CONTENT”.

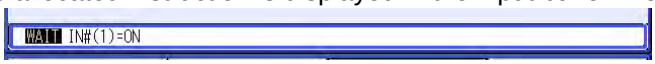


   – The allocated instruction changes automatically when “ALLOCATION CONTENT” is changed by key allocation (SIM). Even if the I/O control allocation is changed to the default setting allocated by the manufacturer with key allocation (SIM), the settings for key allocation (EACH) remain the same.

8.15.5 Execution of Allocation

8.15.5.1 Executing Instruction/Output Control Allocation

1. Press the key allocated for instruction allocation or output control allocation.
   – The allocated instruction is displayed in the input buffer line.



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

8.15.5.2 Executing Job Call Allocation

1. Press the key allocated for the job call allocation.
   – The CALL instruction is displayed in the input buffer line.
2. Press [INSERT] then [ENTER].
   – The CALL instruction shown in the input buffer line is registered.

8.15.5.3 Executing Display Allocation

1. Press the key allocated for the display allocation.
   – The allocated display appears.

8.15.5.4 Executing I/O Control Allocation

Alternate output allocation, momentary output allocation, pulse output allocation, group output allocation (4-bit/8-bit), analog output allocation, analog incremental output allocation are executed by the following operation.

1. Press the interlock key 

and the key allocated for I/O control allocation at the same time.
   – Allocated functions are executed.

8.16 Changing Output Status

The status of external output signals can be changed from the programming pendant by using either of the following two methods.

- On the user output status window
- On the RELAY ON window

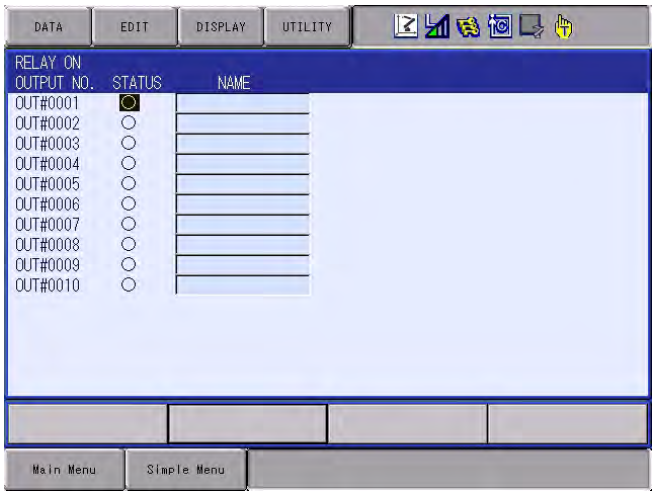
The method that uses the RELAY ON window, which is described here, simplifies the operation for changing the status of signals that are used frequently.

NOTE

A maximum of 64 output signals can be shown on the RELAY ON window and they must be set in advance to parameters S4C327 to S4C390.

If they are not set, the sub menu in the RELAY ON window will not be displayed.

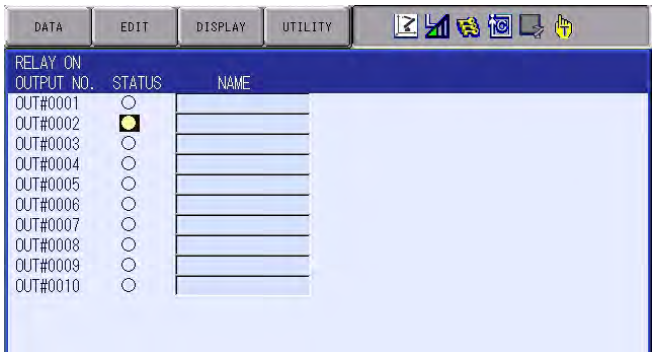
1. Select {IN/OUT} under the main menu.
2. Select {RELAY ON}.
   – The RELAY ON window appears.



3. Select the desired signal to change the output status.
   – Select the status (● or ○) of the desired signal.

4. Press the interlock key +[SELECT].

   – The output status is changed. (●: status ON; ○: status OFF.)



SUPPLE-MENT

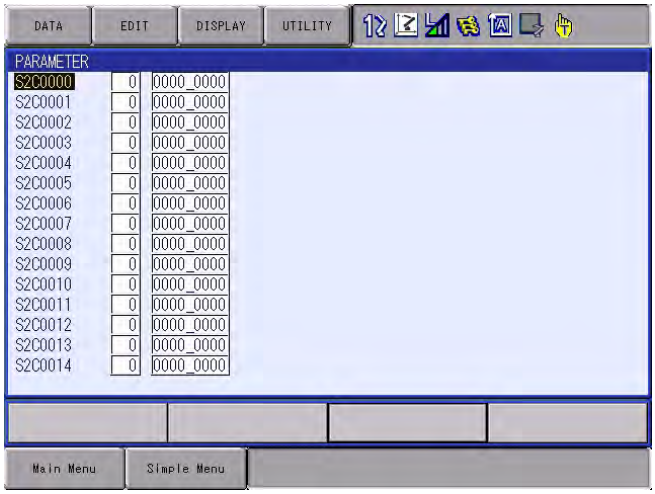
It is also possible to turn the relevant external output signal on only for the duration that the interlock key + [SELECT] are pressed.

This selection is made in advance by setting the parameters (S4C391 to 454) to “1”.

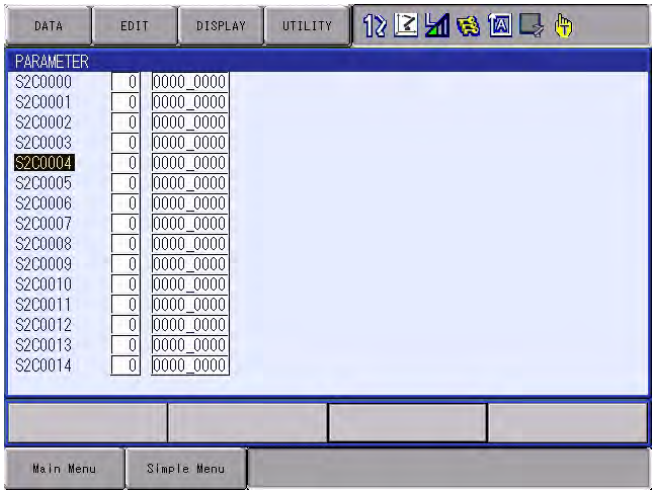
8.17 Changing Parameter Setting

The parameter settings can be changed only by the operator who has the correct user ID number for the management mode.

1. Select {PARAMETER} under the main menu.
2. Select the parameter type.
   – The PARAMETER window appears. Select the desired parameter.

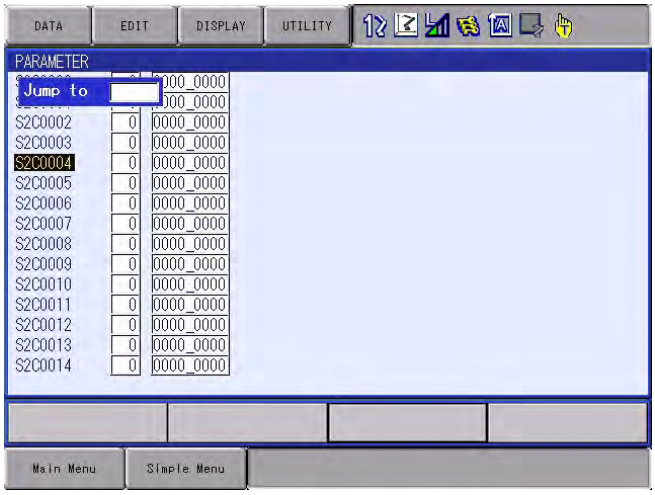


3. Move the cursor to the desired parameter number.

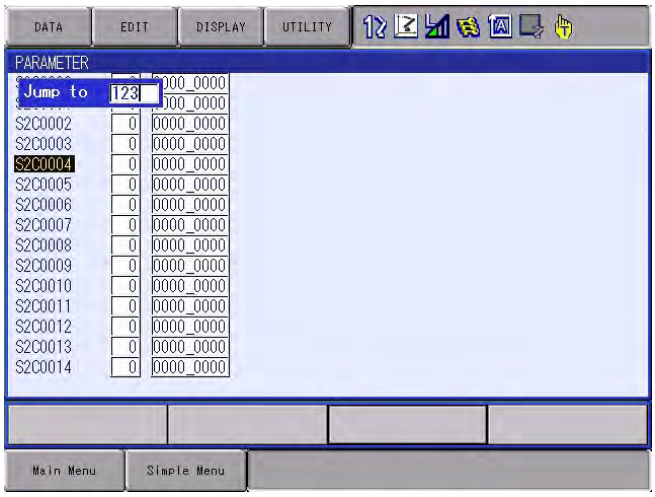


– When the desired parameter number is not in the current window, move the cursor in the following way:

(1) Move the cursor to a parameter number and press [SELECT].

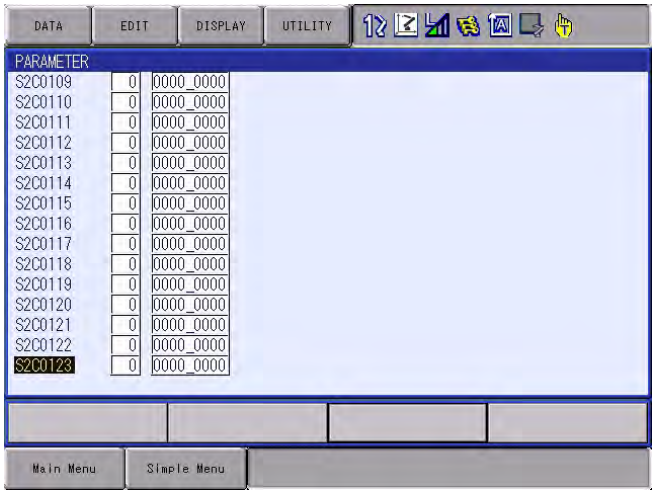


(2) Enter the desired parameter number with the numeric keys.



(3) Press [ENTER].

(4) The cursor moves to the selected parameter number.



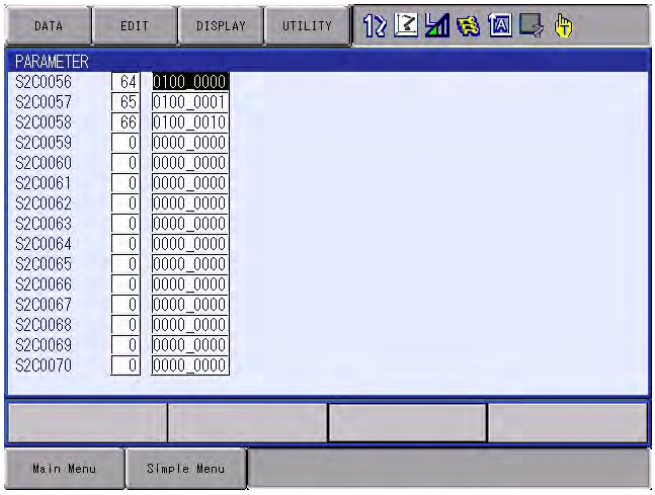
Set the parameters in the following manner.

1. Select the parameter data to be set.

   (1) Move the cursor to the parameter number data (decimal or binary) in the PARAMETER window, and press [SELECT].

   (2) To enter a decimal setting, select the decimal figure.

   (3) To enter a binary setting, select the binary figure.



2. Enter the value.

   – If a decimal figure is selected, enter a decimal value with the numeric keys.

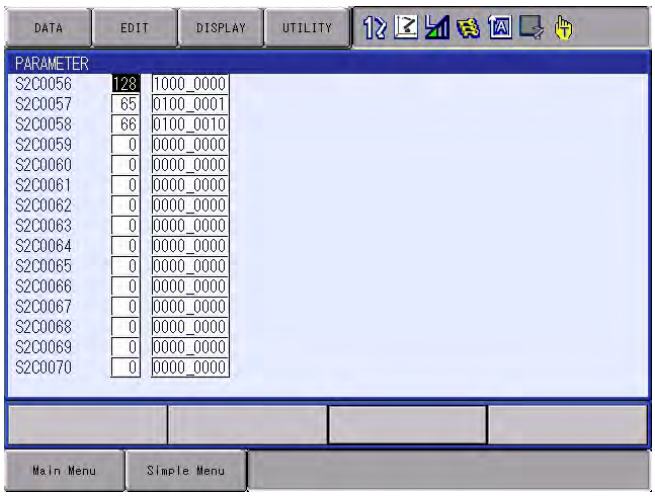
   – If a binary figure is selected, move the cursor to the binary figure data in the input buffer line, and press [SELECT].

   – Each time [SELECT] is pressed, “0” and “1” alternate in the window.

   – “0” or “1” can also be entered with the numeric keys.

3. Press [ENTER].

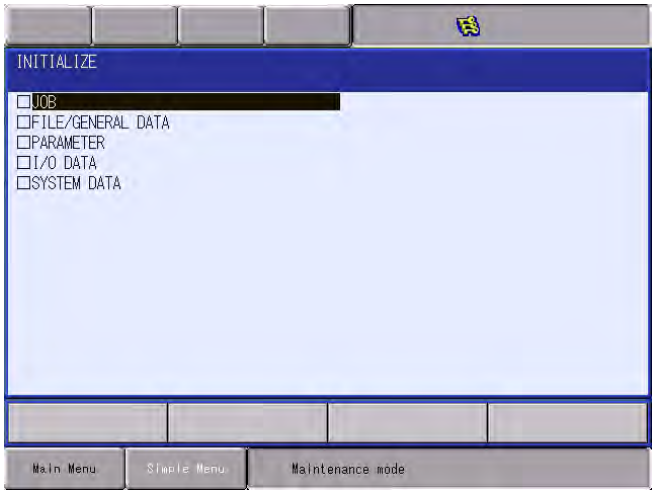
   – The new setting appears in the position where the cursor is located.



8.18 File Initialization

8.18.1 Initializing Job File

1. While pressing the main menu key (MAIN MENU), turn the power OFF then back ON.
2. Change the security mode to the management mode.
3. Select {FILE} under the main menu.
4. Select {INITIALIZE}.
   – The INITIALIZE window appears.



5. Select {JOB}.
   – A confirmation dialog box appears.

6. Select {YES}.
   – The job data is initialized.

NOTE

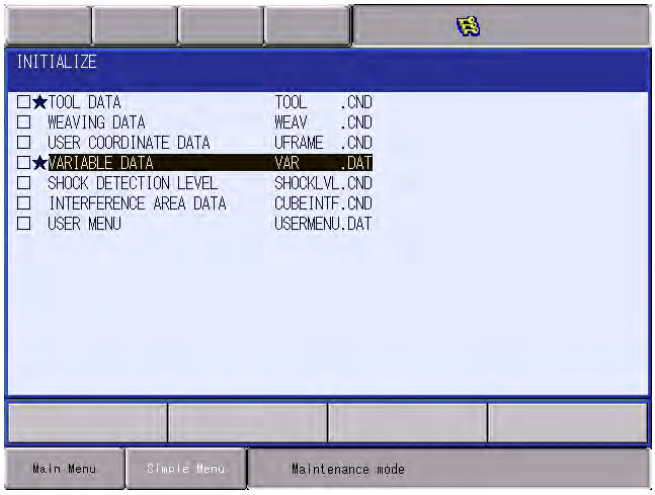
When JOB is initialized, the following files are reset at the same time.
Be careful when initializing JOB.

- User coordinates
- Variable data
- System definition parameter (S4D)
- Robot calibration data
- Conveyor calibration data

8.18.2 Initializing Data File

1. While pressing the main menu key (MAIN MENU), turn the power OFF then back ON.
2. Change the security mode to the management mode.
3. Select {FILE} under the main menu.
4. Select {INITIALIZE}.
5. Select {FILE/GENERAL DATA}.
   – The INITIALIZE window appears.

6. Select the data file to be initialized.
   – The selected data file/general data are marked with "★".
   – The parameters marked with "■" cannot be selected.



7. Press [ENTER].
   – A confirmation dialog box appears.

8. Select {YES}.
   – The selected data file/general data are initialized.

8.18.3 Initializing Parameter File

1. While pressing the main menu key (MAIN MENU), turn the power OFF then back ON.
2. Change the security mode to the management mode.
3. Select {FILE} under the main menu.
4. Select {INITIALIZE}.
5. Select {PARAMETER}.
   – The parameter selection window appears.

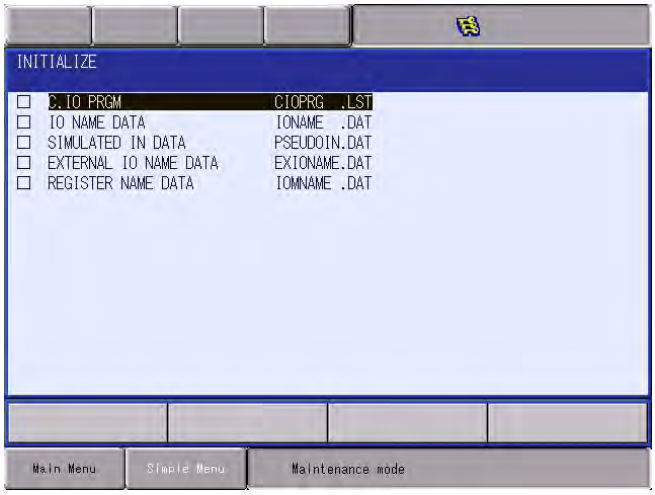
6. Select the parameter to be initialized.
   – The selected parameter is marked with "★".
   – The parameters marked with "■" cannot be selected.

7. Press [ENTER].
   – A confirmation dialog box appears.

8. Select {YES}.
   – The selected parameter is initialized.

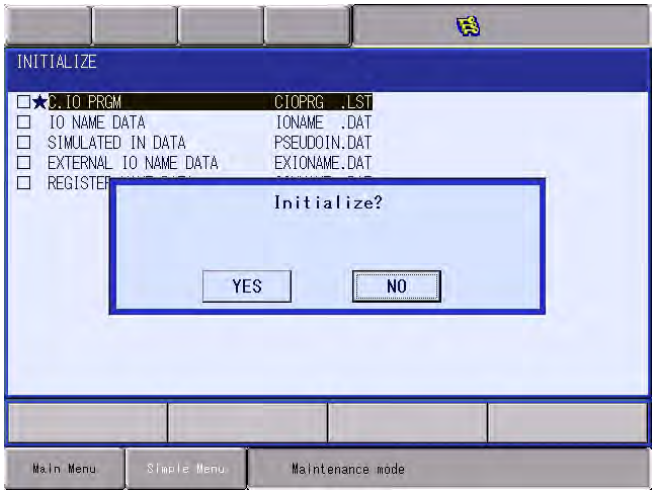
8.18.4 Initializing I/O Data

1. While pressing the main menu key (MAIN MENU), turn the power OFF then back ON.
2. Change the security mode to the management mode.
3. Select {FILE} under the main menu.
4. Select {INITIALIZE}.
5. Select {I/O DATA}.
   – The I/O data selection window appears.



6. Select data to be initialized.
   – The selected data is marked with "★".
   – The I/O data marked with "■" cannot be selected.

7. Press [ENTER].
   – A confirmation dialog box appears.



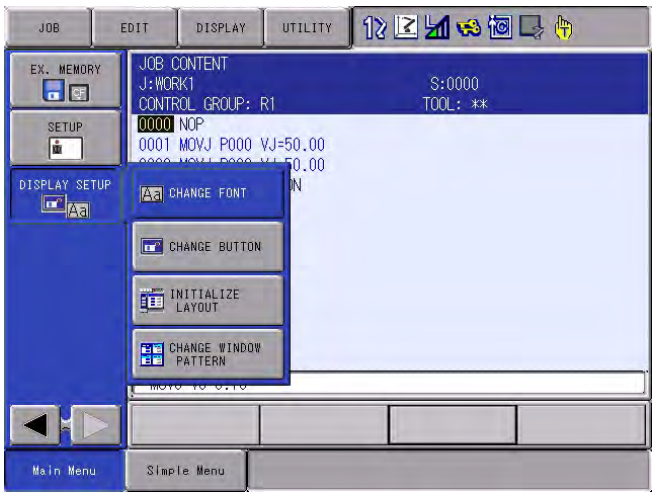
8. Select {YES}.
   – The selected data is initialized.

8.18.5 Initializing System Data

1. While pressing the main menu key (MAIN MENU), turn the power OFF then back ON.
2. Change the security mode to the management mode.
3. Select {FILE} under the main menu.
4. Select {INITIALIZE}.
5. Select {SYSTEM DATA}.
   – The system data selection window appears.

6. Select the parameter to be initialized.
   – The selected data is marked with "★".
   – The system data marked with "■" cannot be selected.

7. Press [ENTER].
   – A confirmation dialog box appears.



8. Select {YES}.
   – The selected data is initialized.

8.19 Display Setting Function

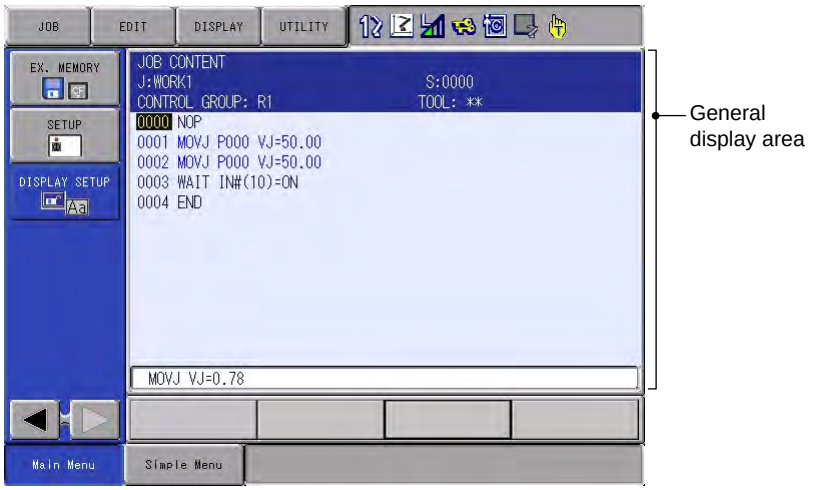
8.19.1 Font Size Setting

FS100L enables changing the font size displayed on the screen.

The fonts displayed on the screen can be selected from eight patterns of fonts in the font size setting dialog box.

8.19.1.1 Applicable Range for Font Size Change

Changing the font size is allowed in the general display area indicated in the following figure:



8.19.1.2 Settable Font Size

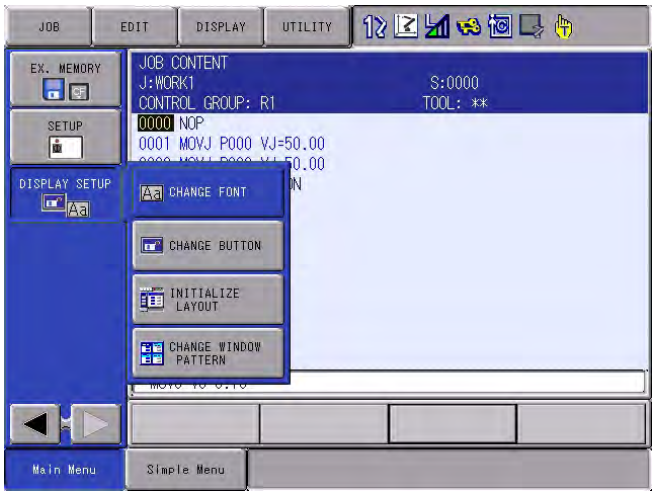
The following eight patterns of fonts are available in setting the size of fonts displayed on the screen.

	Font Size	Font Style
1	Small	Regular
2	Small	Bold
3	Regular	Regular
4	Regular	Bold
5	Large	Regular
6	Large	Bold
7	Extra large	Regular
8	Extra large	Bold

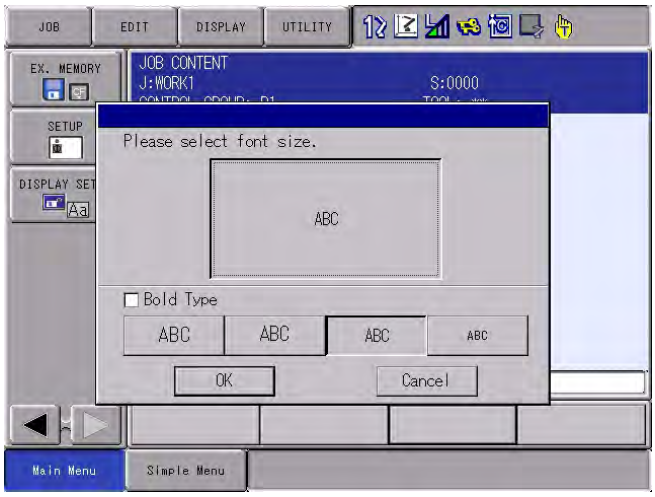
8.19.1.3 Setting Font Size

To set the font size, first off display the font size setting dialog box as follows.

1. Select {DISPLAY SETUP} then {CHANGE FONT} under the main menu.



2. The font size setting dialog box appears on the center of the current window.

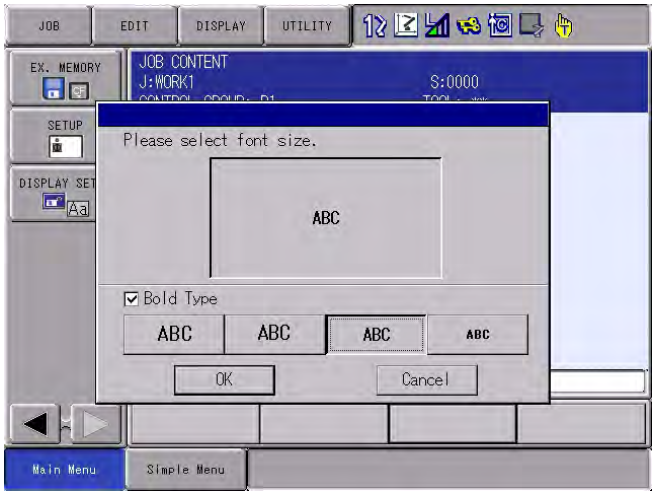


■ **To set the font size in the font size setting dialog box, follow the procedure below.**

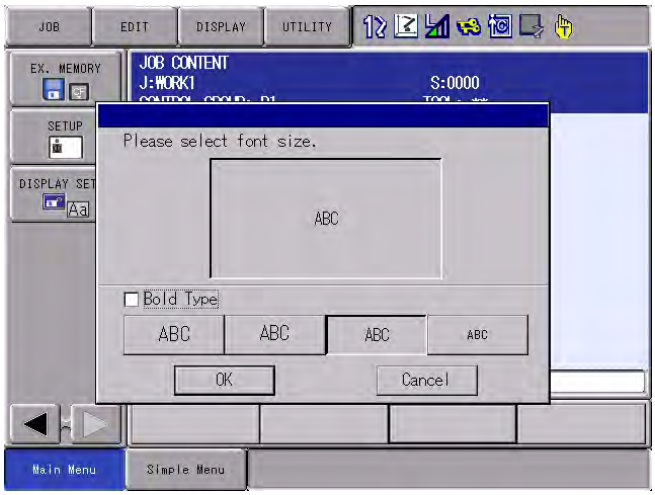
1. Specify the font style.

– The {Bold Type} check box can be checked or unchecked alternately each time the check box is selected.

• Check the {Bold Type} check box as follows to set the font to the bold style.

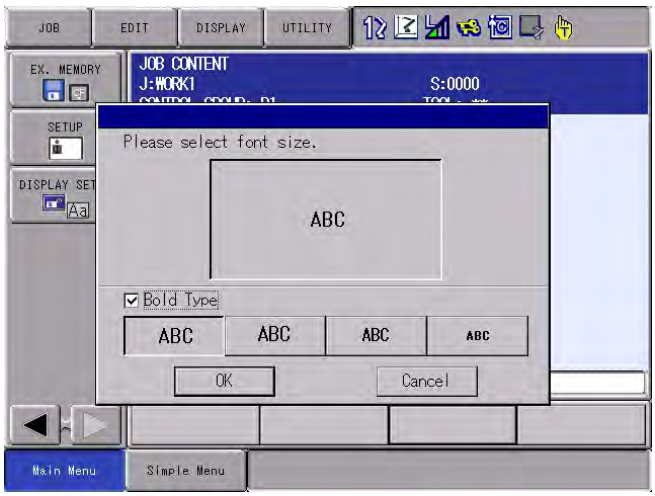


• Clear the {Bold Type} check box as follows to set the font to the regular style.

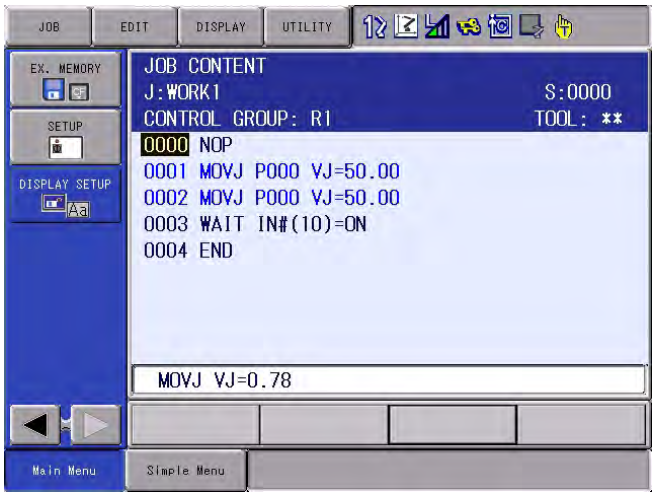


2. Specify the font size.

   – Select a button from the four buttons in the dialog box.

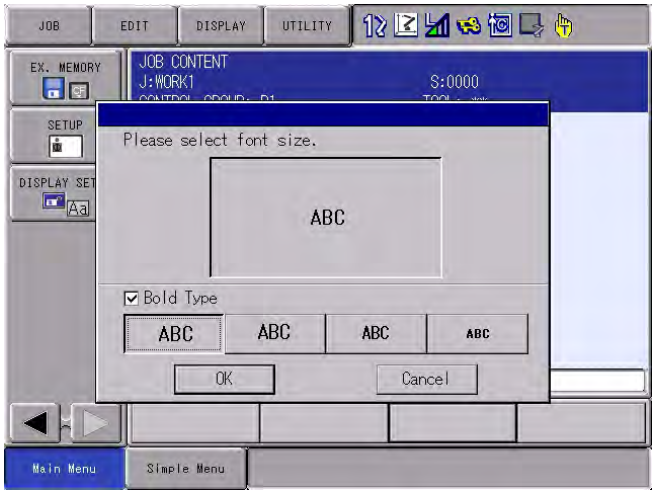


3. The font size setting dialog box is closed, and the screen displays the font specified in the dialog box.

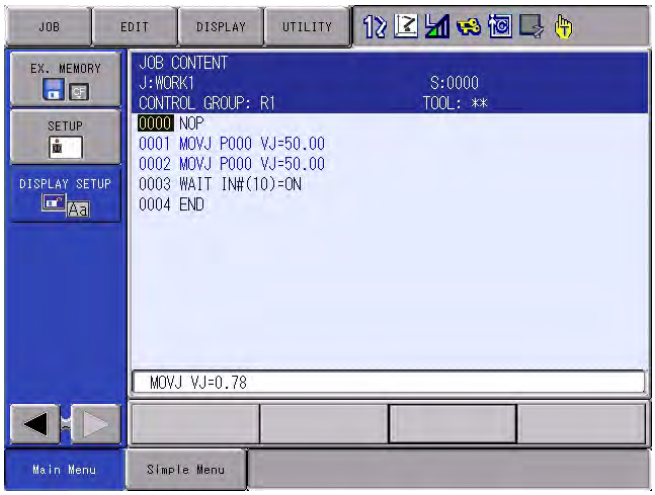


■ **To cancel the setting of the font size, follow the procedure below.**

1. Select {Cancel} in the font size setting dialog box.

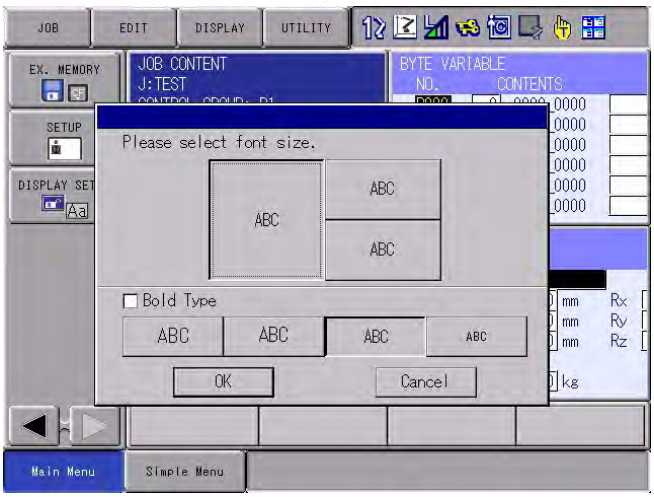


2. The dialog box closes without changing the font size.



SUPPLE-MENT

When the general display area is in the multi-window mode, the font size for each window can be set by using the font size setting dialog box. To change the font size, select one of the windows and set the font size.



NOTE

Do not turn OFF the FS100L power supply when the font size is being changed (when the font size setting dialog box is on the screen).

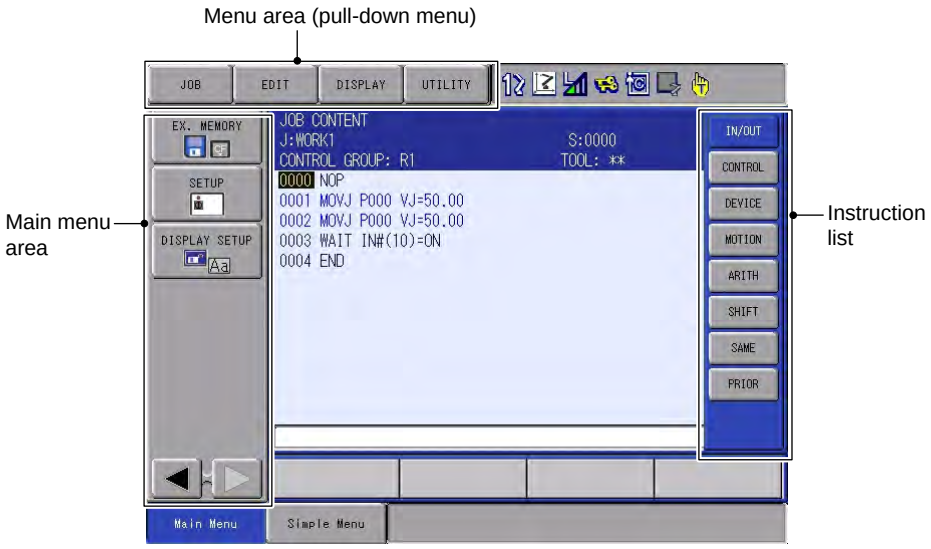
8.19.2 Operation Button Size Setting

FS100L enables changing the size of operation buttons.

The button size in the main menu area, menu area, and instruction list can be respectively selected from three sizes.

8.19.2.1 Applicable Range for Button Size Change

Changing the button size is allowed in the main menu, menu (pull-down menu), and instruction list indicated in the following figure:



8.19.2.2 Settable Button Size

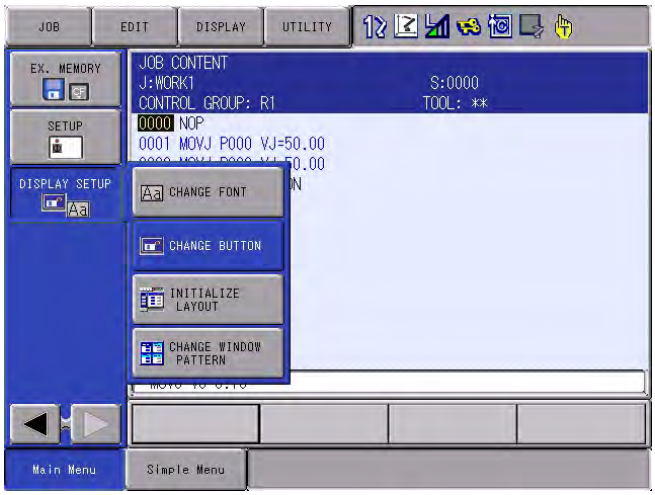
The following three sizes of buttons are available in setting the size of each operation button; the font style of the character string on buttons can also be specified.

	Button Size	Font Style
1	Small	Regular
		Bold
2	Regular	Regular
		Bold
3	Large	Regular
		Bold

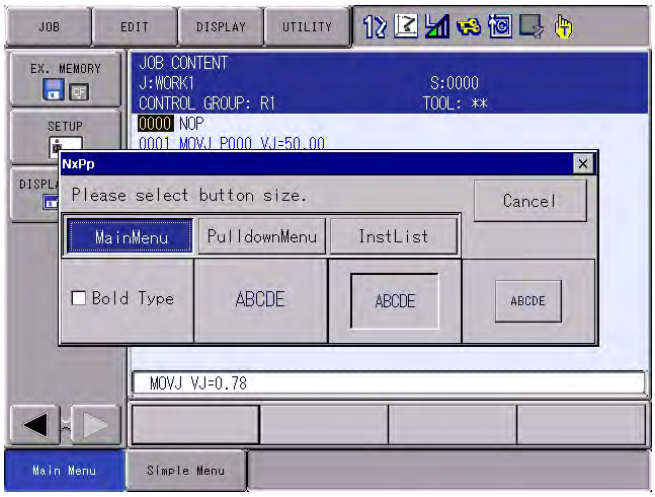
8.19.2.3 Setting Button Size

To set the button size, first off display the button size setting dialog box as follows.

1. Select {DISPLAY SETUP} then {CHANGE BUTTON} under the main menu.



– The font size setting dialog box appears on the center of the current window.



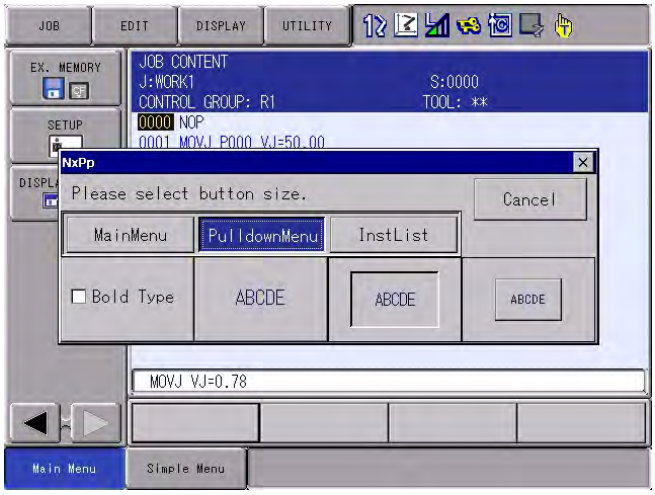
■ **To set the button size in the button size setting dialog box, follow the procedure below.**

1. Specify the area to set the button size.

   (1) Select the desired area from the area setting buttons.

   (2) The buttons in the selected area is subject to size setting.

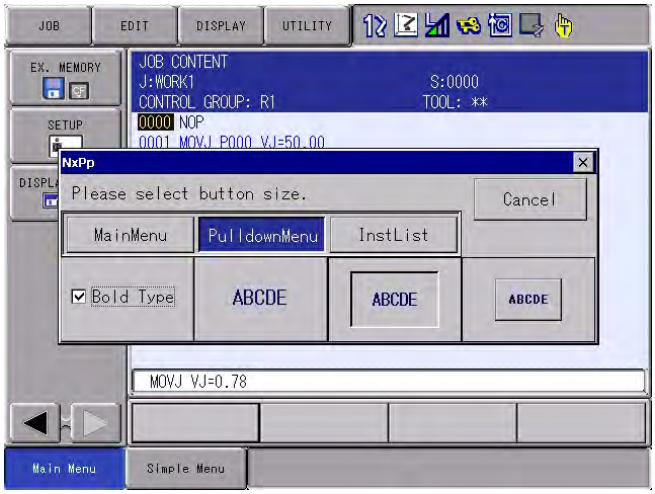
   (3) Note that only the last-selected button determines the area subject to size setting, even if settings are performed several times before then.



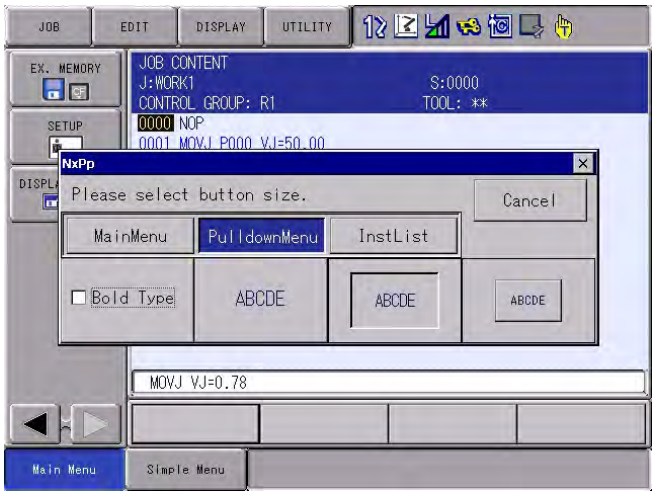
2. Specify the font style.

   – The {Bold Type} check box can be checked or unchecked alternately each time the check box is selected.

   • Check the {Bold Type} check box as follows to set the font to the bold style.

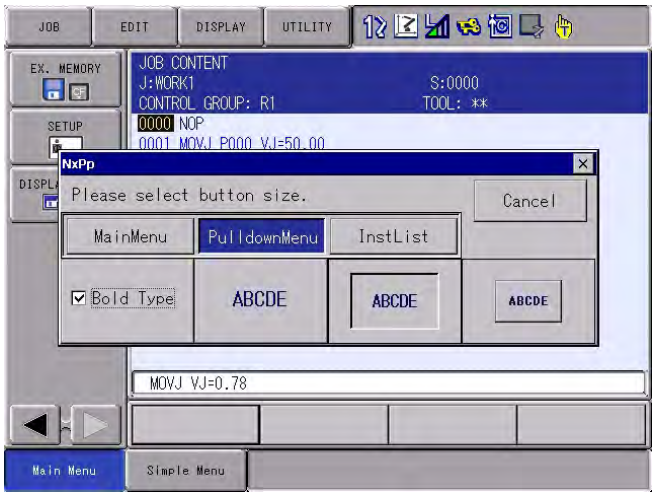


• Clear the {Bold Type} check box as follows to set the font to the regular style.



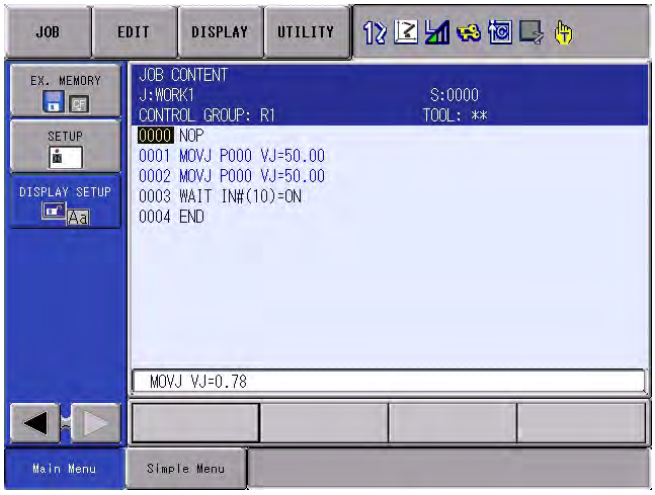
3. Specify the button size.

– Select a button from the three buttons in the dialog box.



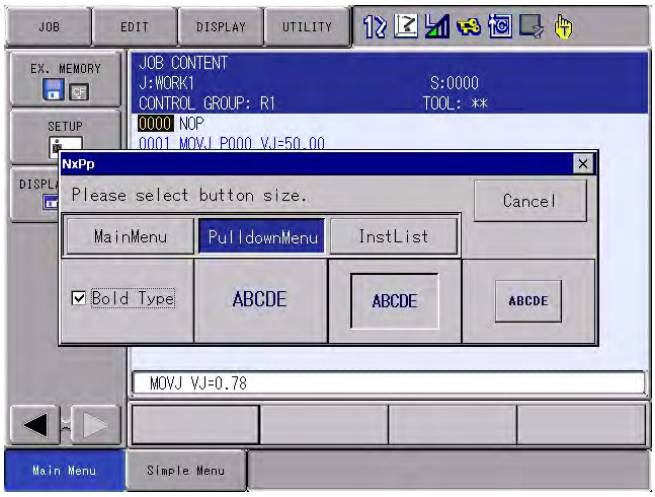
4. The font size setting dialog box is closed, and the screen displays the buttons specified in the dialog box.

– The modification is applied only to the buttons in the area selected with the area setting button. (In this example, the change is applied only to the pull-down menu buttons in the menu area.)

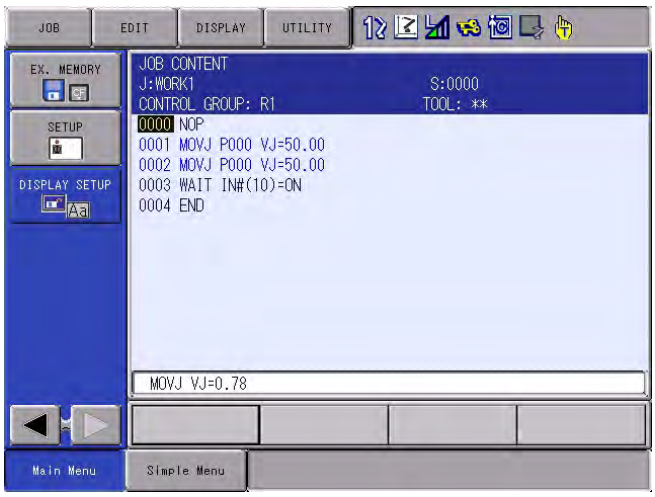


■ **To cancel the setting of the button size, follow the procedure below.**

1. Select {Cancel} in the button size setting dialog box.



– The dialog box closes without changing the button size.



NOTE

Do not turn OFF the FS100L power supply when the button size is being changed (when the button size setting dialog box is on the screen, or when an hourglass is indicated in the middle of the screen).

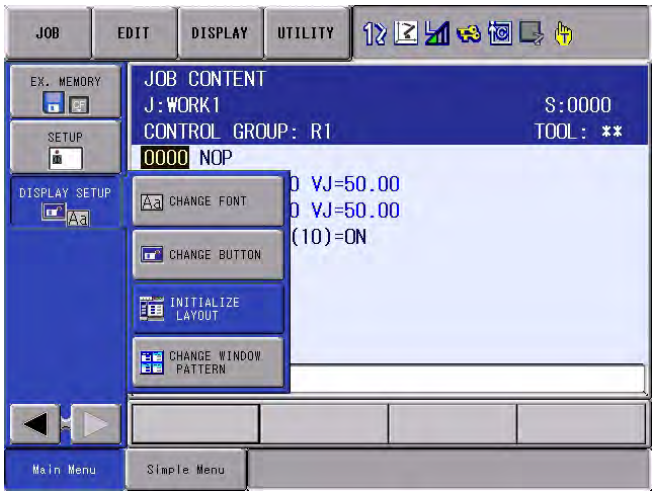
8.19.3 Initialization of Screen Layout

The font/button size changed with the font/button size setting function can be collectively changed back to the regular size.

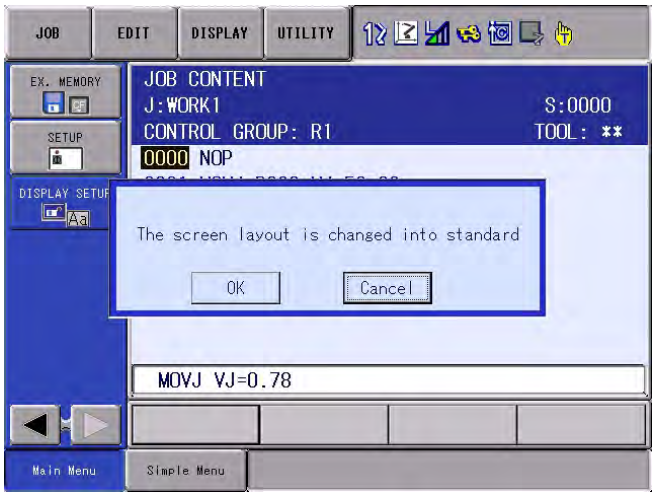
8.19.3.1 Initializing Screen Layout

To initialize the screen layout, follow the procedure below.

1. Select {DISPLAY SETUP} then {INITIALIZE LAYOUT} under the main menu.

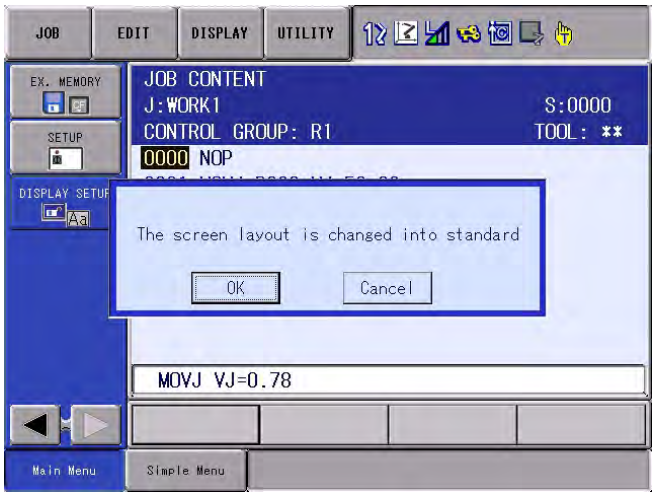


– A confirmation dialog box appears on the center of the current window.

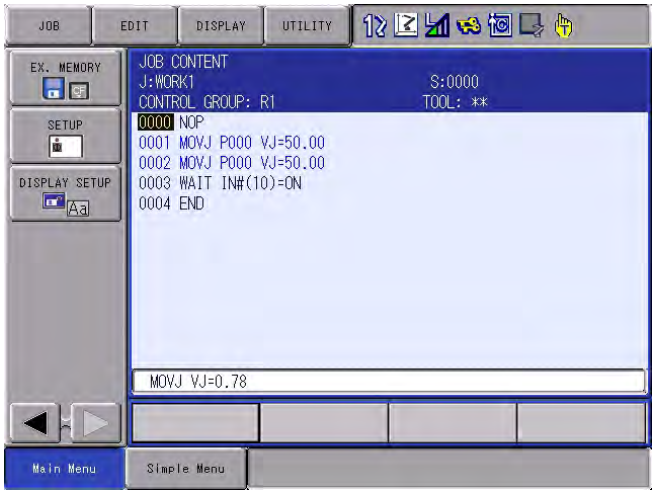


■ **To initialize the screen layout, follow the procedure below.**

1. select {OK}.

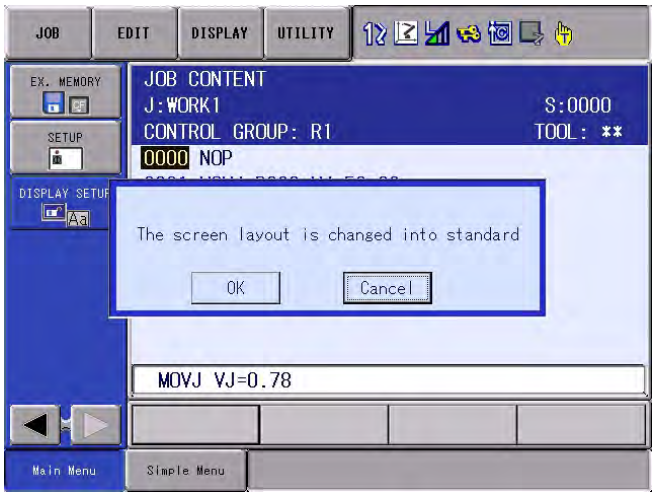


– The dialog box is closed, and the font/button sizes are collectively changed to the regular size.

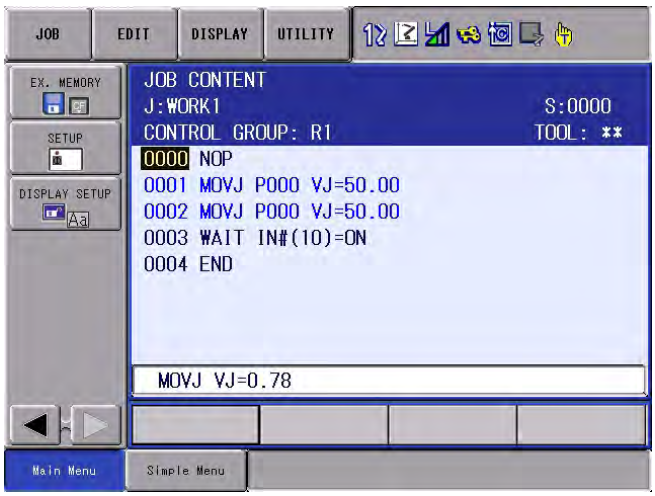


■ **To cancel the initialized screen layout, follow the procedure below.**

1. Select {CANCEL}.



– The dialog box closes without changing the current screen layout.



NOTE Do not turn OFF the FS100L power supply when the screen layout is being initialized (when the confirmation dialog box is on the screen, or when an hourglass is indicated in the middle of the screen).

8.19.4 Saving Layout

The settings of the font size and button size are saved. The screen is displayed with the font size and button size specified last time by the current controller.

NOTE In the maintenance mode, the screen is displayed with the standard font size and button size regardless of the settings of them. The font size and button size can be changed in the maintenance mode, but the settings are not saved.

8.20 Hand Vibration Control Function

8.20.1 Description of Hand Vibration Control Function

With this function, vibration caused by the hand or workpiece can be reduced.

The reduction of vibration eliminates the need to improve the accuracy of and to reduce the speed of picking-up or placing motion for handling application, which reduces cycle time.

NOTE

Make correct settings to make the best of the hand vibration control function.

For settings, refer to *chapter 8.20.3 “Setting Hand Vibration Control Function” at page 8-157*.

CAUTION

- The path and cycle time of the robot changes depending on the settings of the hand vibration control function. Make sure to check operation after changing the settings.

8.20.2 Supported Models

The following high-speed handling models support the hand vibration control function:

- MPK2
- MPP3

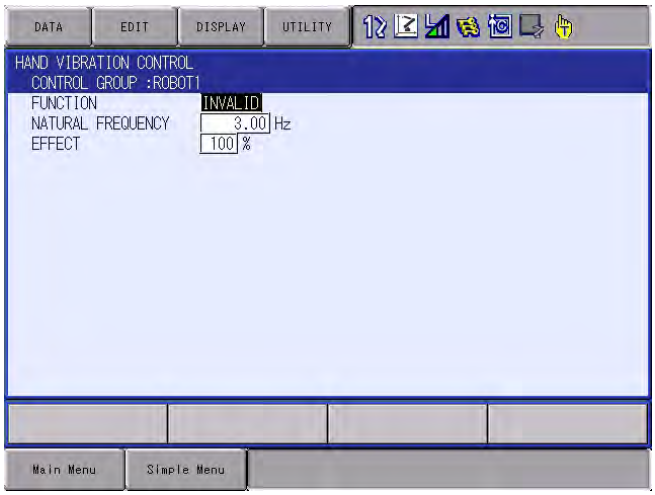
NOTE

The hand vibration control function can be supported by the system with one manipulator.

It cannot be supported by the system with an external axis and/or station.

8.20.3 Setting Hand Vibration Control Function

1. Select {ROBOT} under the main menu.
2. Select {HAND VIBRATION CONTROL}.
   – The HAND VIBRATION CONTROL window appears.



①FUNCTION
Specifies VALID or INVALID of the hand vibration control function.
Move the cursor to “VALID/INVALID”, then press [SELECT]. Press [SELECT] to alternate between VALID and INVALID.

②NATURAL FREQUENCY [Hz]
Specifies the natural frequency of the hand or workpiece.
Move the cursor to “NATURAL FREQUENCY” and press [SELECT] to enter a numeric value. Enter a setting value by using the numeric keys, then press [ENTER].

③EFFICIENCY [%] (Range: 1 to 100)
Specifies the efficiency of the hand vibration control function.
Move the cursor to “EFFICIENCY” and press [SELECT] to enter a numeric value. Enter a setting value by using the numeric keys, then press [ENTER].

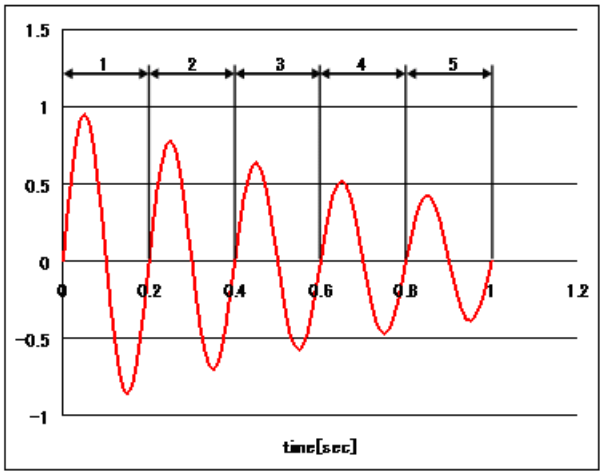
3. Enable the function by setting “FUNCTION” to “VALID”.
4. Set the natural frequency.
   – If the natural frequency of the hand or workpiece is known, set the value.
   If the natural frequency of the hand or workpiece is not known, set the value with which vibration is minimized when the manipulator operates. It is acceptable to set this value even if the natural frequency of the hand or workpiece is known.

SUPPLE-MENT

Any object vibrates with its own frequency and with its own waveform, and the frequency is called “natural frequency”.

Natural frequency is expressed by the number of vibration repeated in one second.

With the waveform below, the natural frequency is “5 Hz”.



5. Set the efficiency.

   – Set the efficiency of the hand vibration control function.
   Normally, there is no need to change it from 100%.
   However, by changing the value, the efficiency of hand vibration control and the cycle time can be adjusted.

SUPPLE-MENT

The efficiency of hand vibration control and the cycle time are changed according to the adjustment of the efficiency as shown below.

Efficiency	1% ← →	100%
Efficiency of hand vibration control	Low ← →	High
Cycle time	Short ← →	Long

NOTE

The settings of the hand vibration control function can be changed only when the security mode is set to the management mode.

8.21 Manual Brake Release Function

8.21.1 Outline

With this function, the brake of each motor of the manipulator and the external axis can be forcibly released by using the programming pendant.

Note that the following operating conditions must be met:

- Operating conditions

  (1)FS100L condition
  The FS100L must be started up normally.

  (2)Mode
  All modes (REMOTE, PLAY, TEACH)

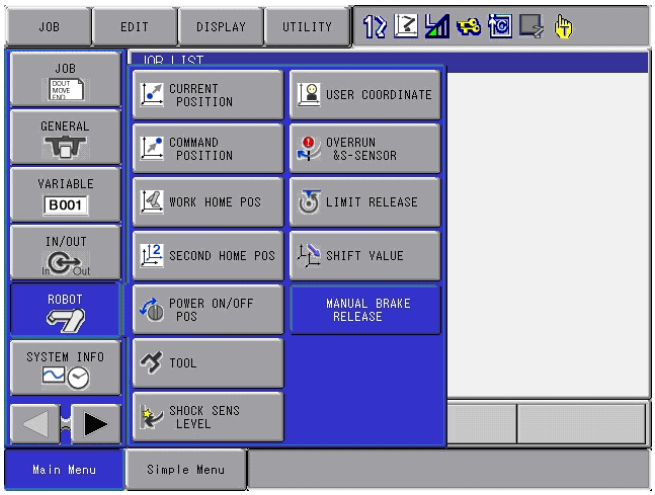
  (3)Security
  All security modes (Operation, Edit, Management)

  (4)Others

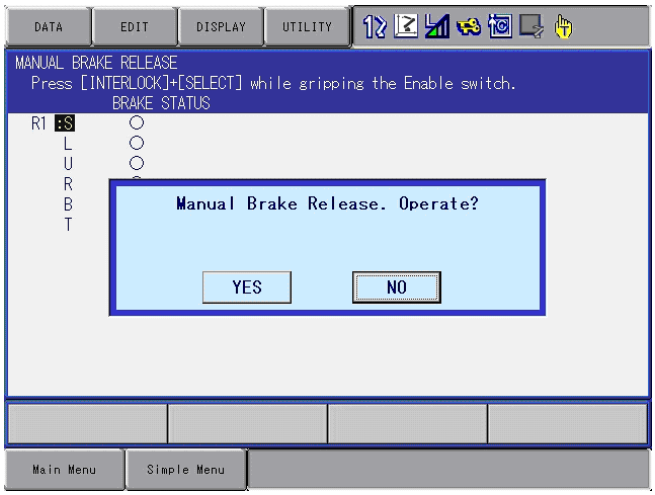
  - The servo is not turned ON.
  - The emergency stop is not incoming. (programming pendant, external signal, controller (optional))

8.21.2 Manual Brake Release Procedure

1. Select {ROBOT} under the main menu, then select the submenu {MANUAL BRAKE RELEASE}.
   – The submenu {MANUAL BRAKE RELEASE} is displayed under the main menu {ROBOT}.

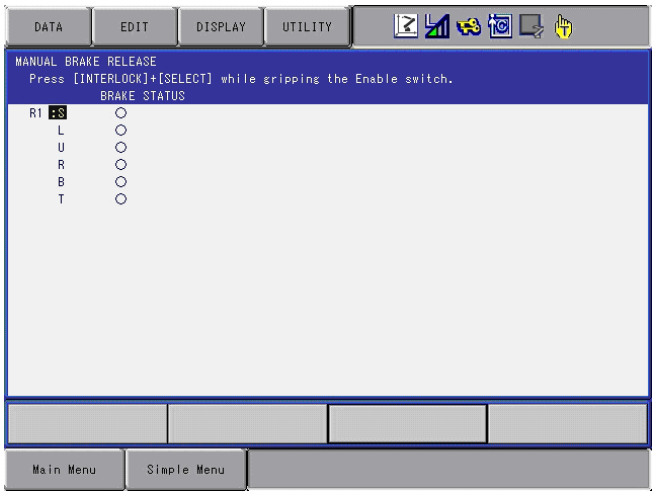


2. Select {YES}.



   – When the manual brake release menu is selected, a warning message appears to prevent improper operation.

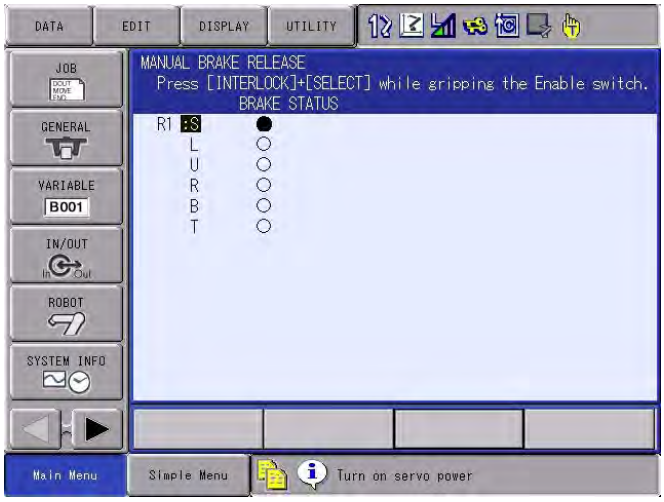
– Select {YES} to display the MANUAL BRAKE RELEASE window.



– Select {NO} to display the following window.

3. Move the cursor to the axis whose brake is to be released. Then press the interlock key + [SELECT] while gripping the enable switch.

– The brake of the axis to which the cursor is pointing is released and the BRAKE STATUS is displayed.



BRAKE STATUS ○: Brake locked ●:Brake released

– The brake is locked with one of the following conditions:

- [SELECT] is released. (See the CAUTION box below.)
- The emergency stop button on the programming pendant, the FS100L (optional), or the external device is pressed.
- The enable switch is released, or gripped more tightly to press it further.
- The window is switched from the MANUAL BRAKE RELEASE window to another.

CAUTION

- The brake is released by pressing the interlock key + [SELECT] while gripping the enable switch. At this time, note that the brake remains released when only the interlock key is released.

8.21.3 Warning Message

If the manual brake release is performed under one of the following conditions, a warning message appears in the message area on the screen.
In this case, note that the brake cannot be released.

- The servo is turned ON.
- The emergency stop button on the programming pendant is pressed.
- The emergency stop button on the FS100L (optional) is pressed.
- The external emergency stop signal is incoming.

9 System Backup

For the FS100L, the system data can be collectively backed up in advance so that the data can be immediately loaded and restored in case of an unexpected trouble such as data loss.

9.1 System Backup with FS100L

For the FS100L, four types of backup data is available: CMOS.BIN, CMOSBK.BIN, ALCMSxx.HEX, and CMOSxx.HEX.

9.1.1 Function Types of Data

9.1.1.1 CMOS.BIN

For the normal backup, use this data.

Save: Perform in the maintenance mode (the editing mode or higher.)

Load: Perform in the maintenance mode (the management mode.)

As for the load/save procedures, refer to *chapter 9.2 “Backup by CMOS.BIN” at page 9-3*.

Target Area: All areas of the internally stored data.

9.1.1.2 CMOSBK.BIN

This data is used in the automatic backup function.

Save: Saves with the preset conditions in the normal mode.

Load: Perform for the system restoration in the maintenance mode (the management mode.)

For details, refer to *chapter 9.3 “Automatic Backup Function” at page 9-9*.

Target Area: All areas of the internally stored data.

9.1.1.3 CMOSxx.HEX

This data is loaded/saved in the FD/CF menu in the normal mode.

Save: Perform in the normal mode (the editing mode or higher.)

Load: Perform in the normal mode (the management mode.)

For details, refer to “FS100 OPERATOR’S MANUAL”.

Target Area: The collected data including “Job File”, “Data File”, “Parameter File”, “System Data”, and “I/O Data” which can be individually loaded/saved in the FD/CF menu. Because the setting information of robot etc. are not included in this collected data, the system cannot be completely restored.

9.1.1.4 ALCMSxx.HEX

This data is for the manufacturer only. Users can save but cannot load this data.

9.1.2 Device

For the backup of the FS100L system, a CompactFlash card or a USB memory stick can be used.
(For the automatic backup function, memory cannot be backuped to the USB memory in the programming pendant.)

The following tables show the recommended CompactFlash and USB memory.

<Recommended CompactFlash>

No.	Manufacturer	Model	Remarks
1	Hagiwara Solutions Co., Ltd.	MCF10P-256MS	256MB
2	Hagiwara Solutions Co., Ltd.	MCF10P-512MS	512MB
3	Hagiwara Solutions Co., Ltd.	MCF10P-A01GS	1GB
4	Hagiwara Solutions Co., Ltd.	MCF10P-A02GS	2GB

< Recommended USB Memory>

No.	Manufacturer	Model	Remarks
1	Hagiwara Solutions Co., Ltd.	UDG4-*GBRJS	* denotes the capacity: 1GB, 2GB, 4GB

In order to save the batch data, 8 MBytes per file is needed in the medium.

Note that the free space for one working file is needed in addition to the free space for the stored files when using the automatic backup function.

Also, it is recommended to store the backup data in two or more media to minimize problems if the medium is damaged.

The water-proof function of the programming pendant is not effective while a USB memory stick is connected to the programming pendant.
Also, if a USB memory stick is connected constantly, it may drop off.

Use a CompactFlash card instead if there is no means to maintain the water-proof function or to prevent a USB memory stick from dropping off.

To use a USB memory stick, connect it to the USB device of the main CPU board.

9.2 Backup by CMOS.BIN

Perform the backup by CMOS.BIN in the maintenance mode.

The chart below shows the availability of CMOS save and CMOS load in each security mode in the maintenance mode.

Security	CMOS Save	CMOS Load
Operation Mode	Not available	Not available
Editing Mode	Available	Not available
Management Mode	Available	Available
Yaskawa Mode	Available	Available

9.2.1 CMOS.BIN Save

Follow the procedures below to save CMOS.BIN.

1. While pressing the main menu key (MAIN MENU), turn ON the FS100L power supply.
2. Insert a CompactFlash card into the CompactFlash slot on the programming pendant.
   – When using USB memory instead of CompactFlash, mount a USB memory stick to the programming pendant, select {DEVICE}, then select "USB: PENDANT".
   To connect a USB memory stick to the USB device of the main CPU board, mount a USB memory stick to the USB device, select {DEVICE}, then select "USB: CONTROLLER".
3. Select {EX. MEMORY} under the main menu.
   – The sub menu appears.

4. Select {SAVE}.
   – The save display appears.

   – The items marked with "■" cannot be selected.

5. Select {CMOS}.
   – The confirmation dialog box appears.

6. Select {YES}.
   – Select {YES} to save the CMOS data into a CompactFlash card.
   – When saving the file, if the CMOS.BIN file already exists in the CompactFlash card, the following confirmation dialog box appears.

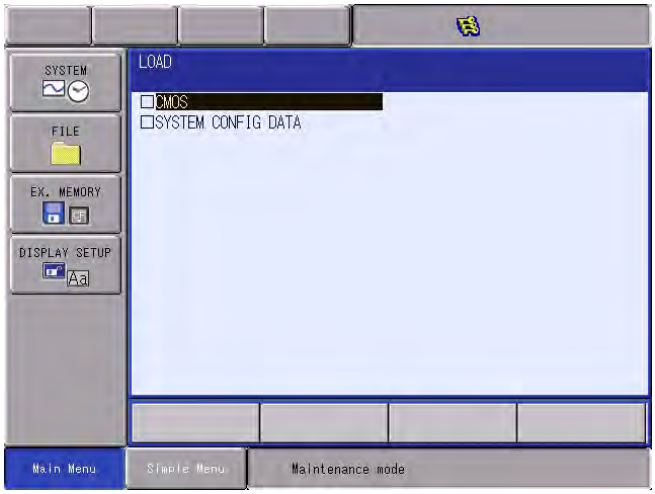
7. Select {YES}.
   – The CMOS.BIN file is overwritten in the CompactFlash card.

9.2.2 CMOS.BIN Load

Follow the procedures below to load CMOS.BIN.

1. While pressing the main menu key (MAIN MENU), turn ON the FS100L power supply.
2. Change the security mode to the maintenance mode.
3. Insert a CompactFlash card into the CompactFlash slot on the programming pendant.
   – When using USB memory instead of CompactFlash, mount a USB memory stick to the programming pendant, select {DEVICE}, then select ”USB: PENDANT”.
   To connect a USB memory stick to the USB device of the main CPU board, mount a USB memory stick to the USB device, select {DEVICE}, then select ”USB: CONTROLLER”.
4. Select {EX. MEMORY} under the main menu.
   – The sub menu appears.

5. Select {LOAD}.
   – The load display appears.



   – The items marked with “■” cannot be selected.

6. Select {CMOS}.
   – The confirmation dialog box appears.

7. Select {YES}.
   – The dialog box “Overwrite network configuration?” appears.

8. Select {YES} or {NO}.
   – If {YES} is selected, the network configuration in the controller is overwritten and the contents of the loaded “CMOS.BIN” file are reflected to the CMOS in the controller.
   – If {NO} is selected, the network configuration in the controller is not updated and the other data are reflected to the CMOS in the controller.

CAUTION

When the “CMOS load” is performed, the current CMOS data is replaced with the CMOS data (the contents of “CMOS.BIN”) in the selected device. Therefore, before performing the load, make sure to perform the “CMOS Save” of the CMOS data to be loaded.

After the “CMOS load”, check if the contents written in the FS100L are the same as before, and check to be sure that safety is confirmed with the current manipulator position. After that, start the manipulator’s operation.

CAUTION

When the network configuration is updated, the IP address in the controller is also updated. After the update, the settings of IP address and subnet mask are changed, which may make it impossible to communicate with the programming pendant or computer. Make sure to record the network configuration of the programming pendant, computer, etc. in advance.

9.3 Automatic Backup Function

9.3.1 Automatic Backup Function

9.3.1.1 Objective

With the automatic backup function, the data saved in the FS100L such as system setting or operational condition are collectively backed up in the specified device.

In case of an unexpected trouble such as data loss, the backup data saved in the CompactFlash card by the automatic backup function can be loaded to the FS100L memory to restore the file data.

The automatic backup function is enabled only while the FS100L power supply is ON whereas it isn't while in the maintenance mode or the power supply is OFF.

9.3.1.2 Outline

The automatic backup function saves the internally stored data in a single file in advance for the smooth restoration from unexpected troubles of the FS100L.

The teaching operation is one of the factors that changes the internally stored data. Thus, a mode which backs up the latest data after the teaching operation is prepared. To confirm the termination of the teaching operation, check the mode key whether it is changed from teach mode to play mode.

Other than the teaching operation, the present position of the robot or the value of a variable can be pointed out as the factors to change the internally stored data. These data, however, are changed after each operation and have very little need to be retained permanently. Accordingly, backing up these data at regular interval should be well enough to operate and the mode to back up the data at regular interval is also prepared.

Furthermore, the mode to back up the data when starting up the FS100L and when inputting signals are also available for some specific versions.

With the automatic backup function, all the part where the internal data is stored in the physical memory area is collectively saved. If there is any data which is in the middle of changing while executing the automatic backup function, the data might not be usable for restoration because of its inconsistency. Therefore, the function is terminated with an error during the play back operation or while the manipulator is in motion so that the automatic backup cannot be operated. Set the automatic backup function to be executed while the manipulator is not in the playback status and while the manipulator is stopped.

The automatic backup function has the following functions and features.

No.	Function/Feature	Explanation
1	Cyclic backup In the teach mode, the data in memory is backed up in a specified cycle from a specified starting time.	This function backs up as much of the latest data as possible during editing. The backup data saved in the CompactFlash card can be loaded to the FS100L in case of data loss so that the damage can be minimized.
2	Backup when switching modes When switching the mode from the teach mode to the play mode, the data in memory is backed up.	The editing data is backed up when editing is completed. The latest data is automatically backed up with this mode.
3	Backup when start-up When the FS100L starts up, the data in memory is backed up.	When the FS100L starts up, the data in memory is backed up. Since the editing/playback operation is usually completed when the FS100L power is turned OFF, the latest data is automatically backed up with this mode.
4	Backup when inputting specified signals The data in memory is backed up when a specified signal (#40560) is input.	The data in memory is backed up by the signal from the host at the intended timing. Although the above mentioned items 1 to 3 are designed to back up the data automatically, this function backs up the data in accordance with the instruction from the host.
5	Backup while robot program is stopped The backup during playback is disabled. However, in the play mode, the backup is enabled if the robot is stopped. (“Cyclic backup” and “Backup when inputting specified signals”)	Backs up the variables for essential data.
6	Backup and retry at low priority The data in memory is backed up at low priority so that this operation does not affect the other operations. When other operations affect the backup operation, the backup is suspended and retried later.	The backup operation hardly affects the other operations so that the programming pendant can be used even during the backup operation.
7	Backup in binary The data is saved as binary data. The range is same as that of the “ALL CMOS AREA” in {FD/CF}, but the data type is different.	Backup in binary allows the system to be easily and speedily restored.
8	Setting of items Parameters can limit the settings of the backup condition.	Unnecessary settings can be avoided with this setting.

9.3.2 Settings for Automatic Backup

To set the automatic backup function, insert a CompactFlash card into the CompactFlash slot on the programming pendant or connect a USB memory stick to the USB device of the main CPU board, then set each item on the AUTO BACKUP SET display.

NOTE

Four ways to perform the automatic backup are available: “Cyclic backup”, “Backup when switching modes”, “Backup when start-up”, and “Backup when inputting specified signals”.

The automatic backup can be performed only when the robot is not during playback and the robot is stopped.

To use the automatic backup function, insert a CompactFlash card into the CompactFlash slot on the programming pendant or insert a USB memory stick into *chapter 9.3.2.2 “USB Device of Main CPU Board”* .

9.3.2.1 CompactFlash

When the data could not be saved in a CompactFlash card during an automatic backup due to the absence or insufficient capacity of the CompactFlash card, an error message “Cannot backup the media” appears.
(At the same time, the signal “occurrence of error” is output, but the robot program will not stop.)
Check if the CompactFlash card is inserted and if it has enough capacity, and take the necessary measures.

Yaskawa recommends that the data be saved in two or more CompactFlash cards to minimize problems if the CompactFlash card is damaged.
Regarding CompactFlash card, refer to <Recommended CompactFlash> in *chapter 9.1.2 “Device” at page 9-2*.

Storage capacity needed for the CompactFlash card is as follows:
(The number of stored files + 1) X 8 MByte

The number of storable files is automatically calculated and the MAX value is shown when AUTO BACKUP SET display appears.
(Up to 100 files can be stored.)

9.3.2.2 USB Device of Main CPU Board

When the data could not be saved in a USB memory stick during an automatic backup due to the absence or insufficient capacity of the USB memory stick, an error message “Cannot backup the media” appears. (At the same time, the signal “occurrence of error” is output, but the robot program will not stop.)
Check if the USB memory stick is inserted and if it has enough capacity, and take the necessary measures.

Yaskawa recommends that the data be saved in two or more USB memory sticks to minimize problems if the USB memory stick is damaged. Regarding USB memory stick, refer to < Recommended USB Memory> in *chapter 9.1.2 “Device” at page 9-2*.

Storage capacity needed for the USB memory stick is as follows:
(The number of stored files + 1) X 8 MByte

The number of storable files is automatically calculated and the maximum number is shown when AUTO BACKUP SET display appears.
(Up to 100 files can be stored.)

9.3.2.3 AUTO BACKUP SET Display

■ **Settings**

Select the following items on the AUTO BACKUP SET display and set values for the automatic backup.

- RESERVE TIME BACKUP (VALID/INVALID of the cyclic backup)
- BASE TIME
- BACKUP CYCLE
- RETRY CYCLE
- MODE CHANGE BACKUP (VALID/INVALID of the backup when switching the mode from teach mode to play mode)
- STARTUP AUTO BACKUP (VALID/INVALID of the backup when the FS100L starts up)
- SPECIFIC INPUT BACKUP (VALID/INVALID of the backup when inputting specified signals)
- UNIV.OUT NO. ON ERROR
- DISPLAY AT EMERGENCY
- DURING ALARM OCCURENCE
- STORED FILE SETTING
- DEVICE

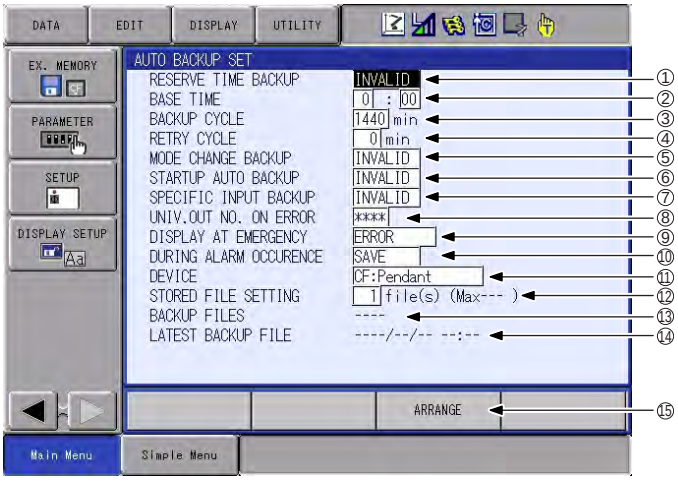
NOTE

- With the version in which “STORED FILE SETTING” is settable, the capacity of a CompactFlash card inserted into the programming pendant is checked when the setting window appears. Therefore, a few seconds may be needed to open the setting window and an error may occur if no CompactFlash card is inserted.
- When changing the settings of “STORED FILE SETTING” or executing “ARRANGE”, the files “CMOSBK.BIN” and “CMOSBK??.BIN” (? is a number) in the CompactFlash card are changed in name or deleted. If a certain file of this type is needed to be saved before changed in name or deleted, evacuate it into a PC, etc. beforehand.

NOTE

Each item’s setting cannot be changed in the AUTO BACKUP SET display during alarm occurrence.

1. Turn ON the FS100L.
   – If the auto backup function is already set valid, insert a CompactFlash card.
2. Insert a CompactFlash card into the CompactFlash slot on the programming pendant.
3. Change the security mode to the management mode.
4. Select {SETUP} under the main menu.
5. Select {AUTO BACKUP SET}.
   – The AUTO BACKUP SET display appears.



① RESERVE TIME BACKUP

Sets the backup function to valid or invalid in a specified cycle from a specified starting time.
Press [SELECT] to alternate between “INVALID” and “VALID”.

The reserve time can be set by inputting values in ②, ③, and ④ in the display.
Every time values are set to these three items, reset the RESERVE TIME BACKUP to VALID.
If these settings are incorrect, the RESERVE TIME BACKUP cannot be reset to VALID.
If so, check and then change the values to the correct settings.

② BASE TIME

Specifies the reference time to start reserve time backup.
The time elapsed from the reference time for a BACKUP CYCLE period is recognized as the BACKUP TIME.
The first automatic backup is performed at the first BACKUP TIME after the power of the FS100L is turned ON.
The automatic backup after the first time, is performed at the interval of BACKUP CYCLES.
The reference time ranges from 0:00 to 23:59.

③ BACKUP CYCLE

Specifies the length of time for a cycle to back up.
After the first backup, the next backup is performed automatically in the time specified in the BACKUP CYCLE.
Set the backup cycle in minutes. The cycle setting ranges from 10 to 9999 minutes, and is longer than the RETRY CYCLE.

④ RETRY CYCLE

Specifies the length of time for a cycle to retry backing up when the backup operation is suspended.
After being suspended, the backup is retried in the time specified in the RETRY CYCLE.
Set the retry cycle in minutes. The cycle setting ranges from 0 to 255, and is shorter than the BACKUP CYCLE.
When it is set to 0, retry will not be performed.

⑤ MODE CHANGE BACKUP

Sets the automatic backup function to be valid or invalid when the mode is switched from teach mode to play mode.
Press [SELECT] to alternate between “INVALID” and “VALID”.

⑥ STARTUP AUTO BACKUP

Sets the backup function to be valid or invalid when the power of the FS100L is turned ON.
Press [SELECT] to alternate between “INVALID” and “VALID”.

⑦ SPECIFIC INPUT BACKUP

Sets the backup function to be valid or invalid when specific input signal (# 40560) is input (rising edge from 0 to 1).
Press [SELECT] to alternate between “INVALID” and “VALID”.

⑧ UNIV.OUT NO. ON ERROR

Outputs “1” to the specified user output signal which was specified in this chapter when the automatic backup error occurs.
The term “automatic backup error” here means that the backup is not performed successfully before the next backup (including retry operation) starts.

⑨ DISPLAY AT EMERGENCY

Sets the method of notification of the automatic backup error to “ERROR” or “MESSAGE”.
Press [SELECT] to alternate between “ERROR” and “MESSAGE”.

⑩ DURING ALARM OCCURENCE

Sets the backup function to be valid or invalid when an alarm occurs.
Press [SELECT] to alternate between “INVALID” and “VALID”.

⑪ DEVICE

Specifies the device to store data.
Press [SELECT] to specify the device.
When the device is set to “CF: PENDANT”, the automatic backup is performed only if communication is established between the programming pendant and the FS100L, and one of the four settings (RESERVE TIME BACKUP, MODE CHANGE BACKUP, STARTUP AUTO BACKUP, and SPECIFIC INPUT BACKUP) in the AUTO BACKUP SET display is set to “VALID”.

⑫ STORED FILE SETTING

Sets the number of files to be stored by the automatic backup function.
The number mentioned on the right side of this item with “(Max)” indication is the maximum number of files (up to 100) that can be stored in the CompactFlash card inserted when this window is displayed.
The settings range from 1 to (Max). When this setting value is changed, the backup file arrangement starts.

⑬ BACKUP FILES
Indicates the existence of the files or the number of backup files stored in the CompactFlash card inserted when this window is displayed.

⑭ LATEST BACKUP FILE
Indicates the date of the latest file in the CompactFlash card inserted when this window is displayed.

⑮ ARRANGE
When the setting of maximum number of stored files is changed, the file arrangement of the backup files in the CompactFlash card is executed. With this operation, the file arrangement can be performed without changing the maximum number of stored files.

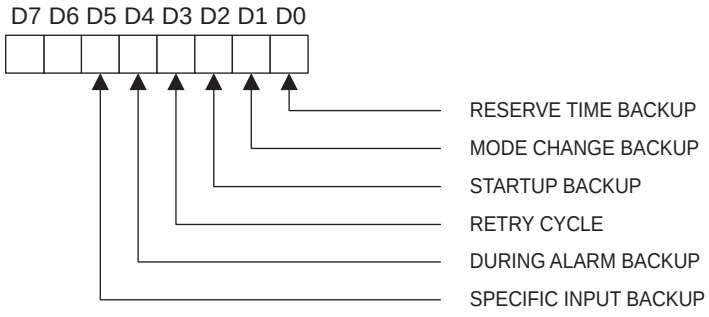
6. Set the desired item, and press [ENTER].

■ **Window setting restrictions**

RS parameter can restrict the settings of some items in the automatic backup window.

When setting the bit of RS096 parameter shown below to “1”, the corresponding items are restricted. The restricted items are indicated with “INVALID” in the display and input and modification to the item become impossible. Also, the automatic backup does not function with the restricted items.

<RS096>



9.3.2.4 FS100L Status and Automatic Backup

Backup Timing	FS100L Status		Automatic Backup	
			Compact Flash ready to save the data	Absence or insufficient capacity of the CompactFlash
From a specified starting time	Teach mode	Editing (Accessing to the memory)	Retry	Retry
		When editing is interrupted	Backup	Error
	Play mode Remote mode	Executing jobs	Disabled	Disabled
		When stopped	Backup	Error
When a specified signal (#40560) is input	Teach mode	Editing (Accessing to the memory)	Error	Error
		When editing is interrupted	Backup	Error
	Play mode Remote mode	Executing jobs	Disabled	Disabled
		When stopped	Backup	Error
When switching the mode from the teach mode to the play mode	-		Backup	Error
When the FS100L starts up	-		Backup	Error

* Retry is not performed when an error occurs.
* An error can be indicated by a message depending on setting.

■ **Reserve time backup**

While the data in the FS100L memory is being edited or overwritten, the automatic backup is not performed at the specified backup starting time and is suspended and retried later. To start the backup at the reserved time, set to the time when the robot program is stopped and no job or file is edited.

■ **Backup when switching from teach mode to play mode**

When the mode is switched from the teach mode to the play mode, backup starts.

This switch is ignored if executed during backup operation.

■ **Backup when FS100L starts up**

Since the automatic backup process is added to the FS100L start-up process, a few extra seconds are needed to start up the FS100L.

■ **Backup when specific signal is input**

While the FS100L memory is edited such as overwriting, the backup operation becomes an error even if there is an input to a specific signal (#40560). To start the specific input backup, perform it while the robot program is stopped and a job or file is not being modified.

Also, since the signal input is executed at rising detection, turn the signal to “0” if it is already “1”, then return to “1” again.

■ **Overwriting limit in CompactFlash**

The number of times to overwrite the CompactFlash card is limited. Because frequent backup operations may shorten the life of CompactFlash card, minimize the number of backup times.

■ **Overwriting limit in USB memory**

The number of times to overwrite the USB memory stick is limited. Because frequent backup operations may shorten the life of USB memory stick, minimize the number of backup times.

9.3.2.5 Setting Examples

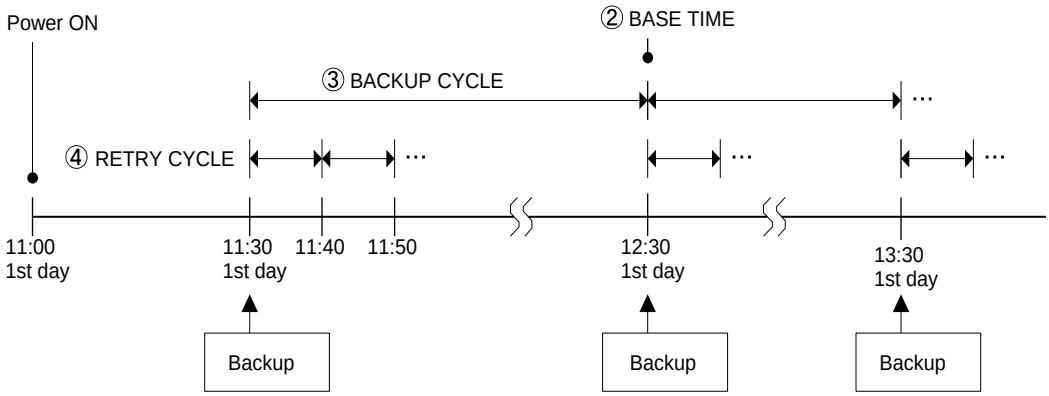
■ **Setting Example 1**

The following diagram shows a setting example with the following conditions:

BASE TIME: 12:30

BACKUP CYCLE: 60 (minutes)

RETRY CYCLE: 10 (minutes)



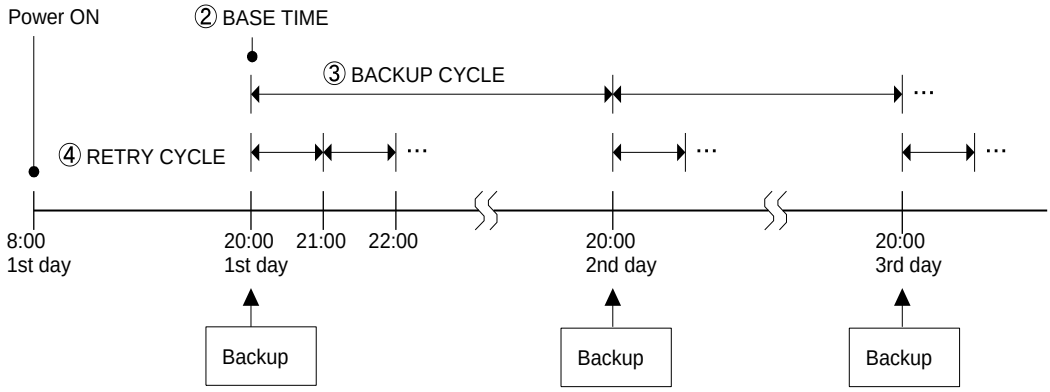
■ **Setting Example 2**

The following diagram shows a setting example with the following conditions:

BASE TIME: 20:00

BACKUP CYCLE: 1440 (minutes) (24 hours)

RETRY CYCLE: 60 (minutes)



NOTE While a job is being executed, the automatic backup or retry is not performed. Also, after an error occurs in writing into the selected device, the retry is not performed until the next backup starting time.

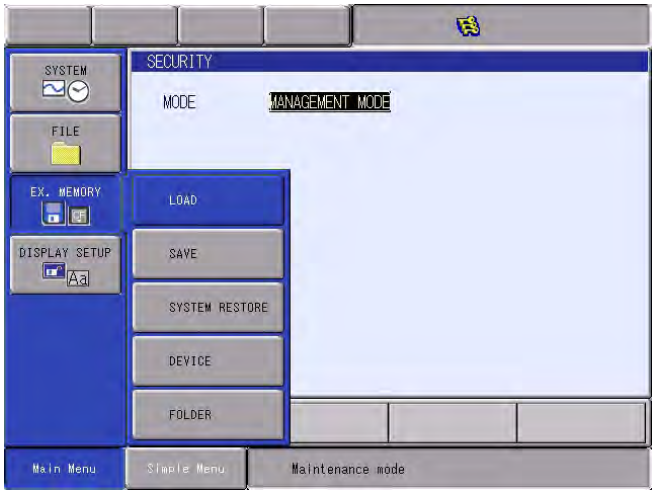
9.4 Restoring Backup Data

Restore the backup data saved in the CompactFlash card to the FS100L in the maintenance mode.

9.4.1 Restoring Procedure

1. Insert the CompactFlash card with the backup data into the CompactFlash slot on the programming pendant.
   – The backup data is stored under the file name “CMOSBK.BIN” or “CMOSBK??.BIN” (? is a number).
2. While pressing the main menu key 

, turn ON the FS100L power supply.
3. Change the security mode to the management mode.
4. Select {EX. MEMORY} under the main menu.
   – The sub menu appears.



5. Select {SYSTEM RESORE}.
   – The SYSTEM RESTORE display appears.
6. Select {SYSTEM RESTORE}.
   – The BACKUP FILE LIST display appears.

7. Select the file to be loaded.
   – The confirmation dialog box “Initialize monitoring time?” appears.

   – Select {YES} to initialize the system monitoring time.
   Select {NO} to continue counting the current system’s monitoring time.

8. Select {YES} in the confirmation dialog box.

   – The confirmation dialog box “Overwrite network configuration?” appears.

9. Select {YES}.
   – The network configuration set in the FS100L is overwritten, and the loaded contents of “CMOS.BIN” or “CMOSBK??.BIN” (? is a number) are loaded.
   – When the load of “CMOSBK.BIN” or “CMOSBK??.BIN” (? is a number) starts, the message “Loading system data. Don’t turn the power off.” appears.

CAUTION

When “SYSTEM RESTORE” is performed, the internally stored data in the FS100L is replaced with the contents of “CMOSBK.BIN” or “CMOSBK??.BIN” (? is a number).
Give due consideration to it before performing “SYSTEM RESTORE”.

After “SYSTEM RESTORE”, check if the contents written in the FS100L are the same as before, and check to be sure that safety is confirmed with the current manipulator position. After that, start the manipulator’s operation.

9.5 Error List

9.5.1 Error Contents

Error No.	Data	Message	Cause
0770	*	The robot or the station is in motion.	The automatic backup would not work when the robot or a manipulator is in motion.
3390		File not found	The file to be loaded no longer exists.
3460	*	Check storage medium	
	1		Insufficient capacity of the storage medium. Check the medium.
	2		Cannot access to the storage medium. Check the medium.
3501	*	Cannot backup to medium	Cannot access to the storage medium. Check the medium.
3550	*	The automatic backup is executed. Try it later.	The automatic backup window cannot be called to display while the automatic backup is being processed.
3551	*	The automatic backup is executed. Arrange the file after it is finished.	The file arrangement cannot be operated during the automatic backup operation.
3560	*	Failed to re-arrange the backup file.	Failed to re-arrange the backup file in the storage medium for a reason other than access.
3580	*	Accessing to backup file. Try it later.	To display another window and then display the automatic backup window again after “ARRANGE” operation, “ARRANGE” process must be completely finished.
3581	*	Accessing to backup file. Try “ARRANGE” operation later.	The previous “ARRANGE” process must be completely finished to perform the next “ARRANGE” operation.

9.6 Restoring FS100L Controller

Acquire the FS100L system program and the FS100L batch data (file name: CMOS.BIN) in advance by following the procedures below.
This enables rapid and easy restoration of the system in case of system failure.

9.6.1 Data Backup and Program Upload

In the FS100L system, the system program and the backup data can be backuped by either collective operation or individual operation. When executing the backup, following devices can be used.

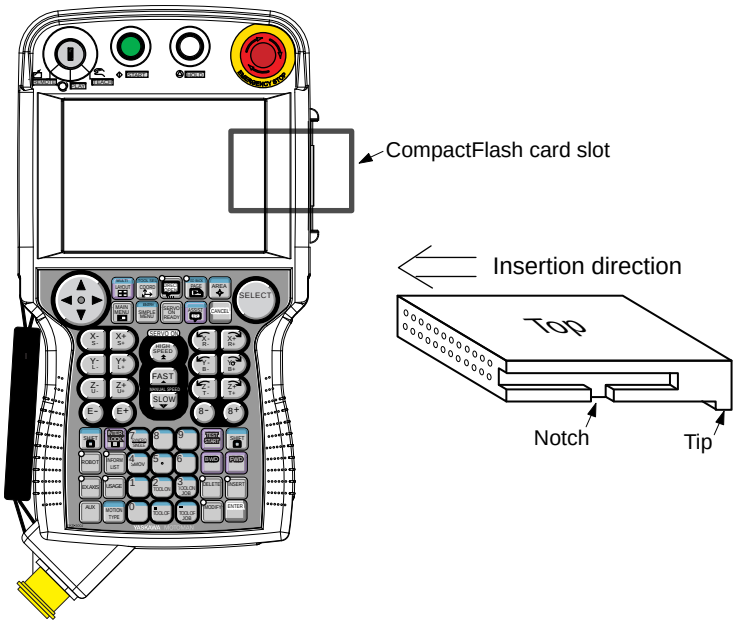
- FS100L : USB memory
- Programming pendant: USB memory
- Programming pendant: CompactFlash card

9.6.1.1 Backup Medium Preparation

For saving the FS100L system program, supply a CompactFlash card or a USB memory stick with free space of 50 MB or more, and follow the procedure below.

1. Connect the prepared device (CompactFlash card or USB memory stick) to the PC.
2. Delete all data in the device by using Windows Explorer, etc.
3. Remove the device from the PC, then insert it into the programming pendant or the main CPU board.

Fig. 9-1: Inserting CompactFlash Card into Programming Pendant

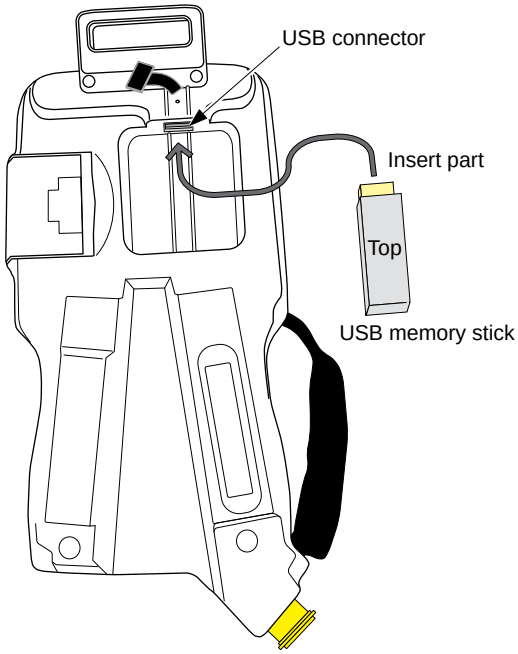


Make sure to insert a CompactFlash card to the correct direction.
Make the programming pendant face up, and make the center notches of both sides and the tip of the CompactFlash card face down, then insert it slowly.

If the CompactFlash card is inserted forcibly, the card or the CF card slot may be damaged.

After inserting the card into the slot, make sure to close the cover of the slot before use.

Fig. 9-2: Inserting USB Memory Stick into Programming Pendant

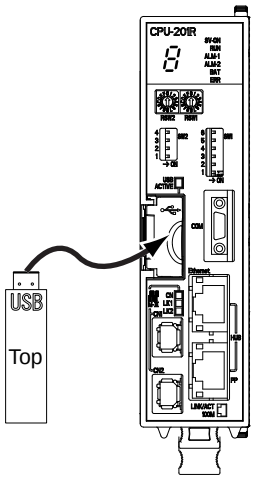


Make sure to insert a USB memory stick to the correct direction.
Make the programming pendant face down, and make the top of the USB memory stick face up and make the connector point upward, then insert it slowly.

If the USB memory stick is inserted forcibly, the stick or the USB connector may be damaged.

After removing the stick from the connector, make sure to close the cover of the connector before use.

Fig. 9-3: Inserting USB Memory Stick into Main CPU Board



Make sure to insert a USB memory stick to the correct direction.
Make the top of the USB memory stick face to the left, then insert it slowly.

If the USB memory stick is inserted forcibly, the stick or the USB connector may be damaged.

After removing the stick from the connector, make sure to close the cover of the connector before use.

■ **File system of device**

Use an FAT 16 or FAT 32 formatted USB memory stick.

■ **Precautions for handling device**

- Do not subject the device to excessive force or shock by dropping it, bending it, etc.
- Do not subject it to water, oil, organic solvent, dust, or soot.
- Do not use or store it in a location where excessive static electricity or electrical noise is present.
- During data writing or reading, do not remove or insert the device and do not turn the power OFF.
- Backup the data regularly to another medium for data protection. This can minimize the impact of data damage or loss in case of improper operation or accident.

■ **Recommended device**

It is recommenced to use the CompactFlash cards or USB memory sticks listed in *chapter 9.1.2 “Device” at page 9-2*.

9.6.1.2 Backup by Batch Operation

Backup function by a batch operation is performed in the maintenance mode. Prepare a device with 50MB or more capacity for backup and follow the instructions below.

1. While pressing the main menu key (MAIN MENU), turn ON the FS100L power supply.
2. Insert a CompactFlash card into the programming pendant.
   - When using a USB memory in stead of a CompactFlash card, insert the USB memory to the programming pendant, and then select {EX.DEVICE} - {DEVICE} - {USB: PENDANT}.
   - When using a USB memory and attaching it to the USB device on the main CPU board, insert the USB memory to the device, and then select {EX.DEVICE} - {DEVICE} - {USB: CONROLLER}.
3. Select {EX.DEVICE} under the main menu.
   - EX.DEVICE sub menu window appears.
4. Select {SAVE}.
   - SAVE window appears.

5. Select {ALL FILE + CMOS}
   – A confirmation dialog box appers.

   – Item marked with "■" cannot be selected.

6. Select {YES}.
   – When {YES} is slected in the dialog box, the system program and the backup data are saved in the specified device.
   – Following dialog box appears in case the system program and the backup data are already saved in the specified device.

7. Select {YES}.

   – When {YES} is selected in the dialog box, the system program and the backup data are overwritten in the specified device

   – Do not turn OFF the power supply while following messages are appeared in the human interface area:
   “Saving system data. Don't turn the power off.” or
   “(File name) is being executed.” Don't turn the power off.”.
   Should the power is turned OFF, deleted the device data used in the PC and do the same operation again.

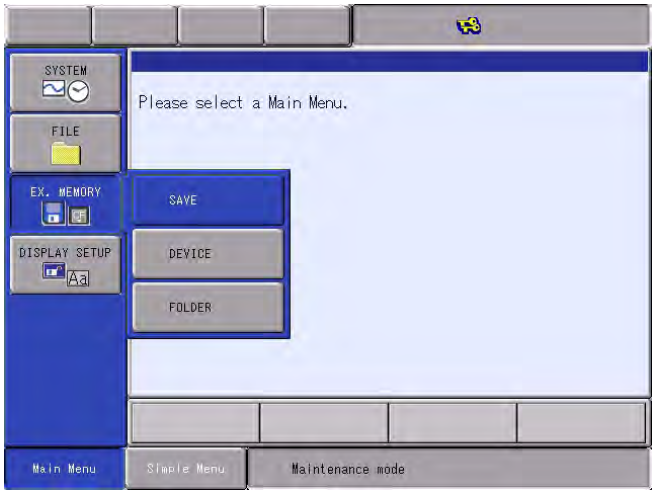
9.6.1.3 Data Backup by Individual Operation

Backup the FS100L batch data (file name: CMOS.BIN) by following the procedure below.

When using the programming pendant, perform the steps 1 to 6, and when not using the programming pendant, perform the steps 7 to 9.

1. While pressing the main menu key (MAIN MENU), turn ON the FS100L power supply.
   – The maintenance mode starts.
2. Select {DEVICE}.
   – Select the device to save data.

3. Select {EX. MEMORY} under the main menu.
   – The sub menu appears.

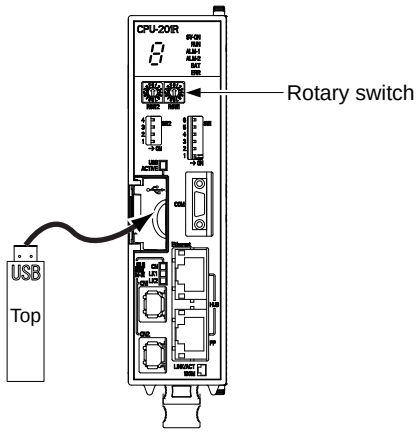


4. Select {SAVE}.
   – The following menu appears.

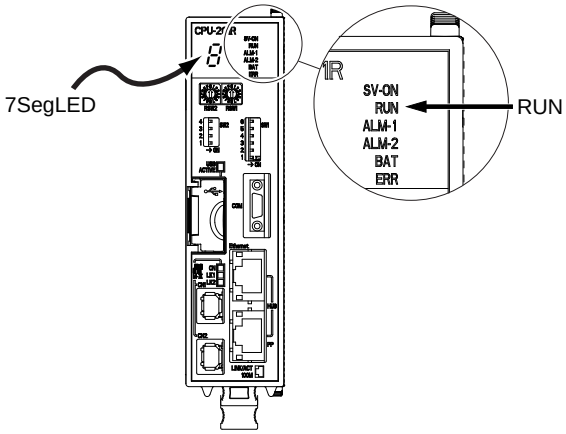
5. Select {CMOS}.
   – A confirmation dialog box appears.

6. Select {YES}.
   – CMOS save starts.
   – The process is completed when the message “Saving system data. Don’t turn the power off.” at the human interface display area disappears.

7. Open the door of the FS100L controller. Turn the rotary switch of the main CPU board from “0” to “E” by using a precision screwdriver (flathead, 2 mm), and insert a USB memory stick into the main CPU board.



8. Turn ON the FS100L power supply.
   – CMOS save starts.
   – While saving data, “J” lights up on the 7SegLED of the main CPU board, and the LED of RUN blinks.
   – When data save is finished, the LED of RUN of the main CPU board lights up.



CAUTION

- If CMOS data exists in the root directory of the USB memory stick, it will be forcibly overwritten.
- Do not remove the USB memory stick while saving data.
  Failure of the stick may result if it is removed while saving data.

9. After data save is finished, turn OFF the FS100L power supply.
   – Turn the rotary switch of the main CPU board from “E” to “0”.
   – Remove the USB memory stick.

9.6.1.4 Program Upload

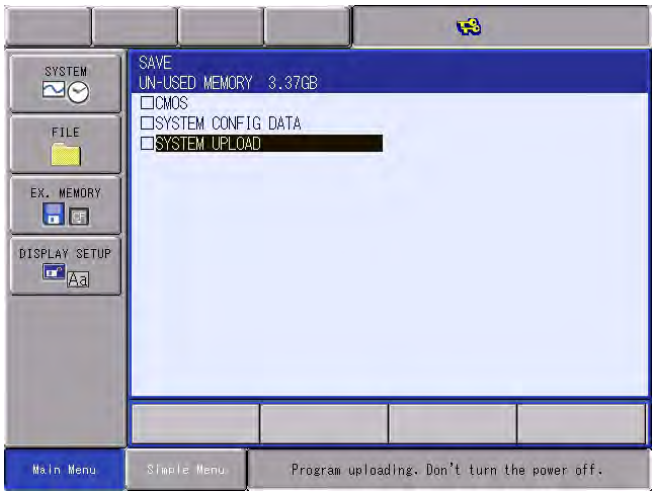
After finishing data backup, subsequently upload the program.

When using the programming pendant, perform the steps 1 to 8, and when not using the programming pendant, perform the steps 9 to 11.

1. While pressing the main menu key (MAIN MENU), turn ON the FS100L power supply.
   – The maintenance mode starts.
2. Select {DEVICE}.
   – Select the device to save the system program.
3. Select {EX. MEMORY} under the main menu.
   – The sub menu appears.
4. Select {SAVE}.
5. Select {SYSTEM UPLOAD}.
   – A confirmation dialog box appears.

6. Select {YES}.
   – The confirmation dialog box “Overwrite?” appears.
   Select {YES} to overwrite.
   Select {NO} to change the device to another.

7. Select {YES}.
   – Program upload starts.
   – The process is completed when the message “Program uploading. Don’t turn the power off.” at the human interface display area disappears.



8. Turn OFF the FS100L power supply, and remove the device.
   – For restoration, make sure to store the device to which the FS100L batch data (file name: CMOS.BIN) is backed up and the program is uploaded by following the procedures above.
   When a job is created, added, or modified, or a parameter, etc. is changed, perform *chapter 9.6.1.3 “Data Backup by Individual Operation” at page 9-30*.
   When the system software is upgraded, perform *chapter 9.6.1.4 “Program Upload” at page 9-33*.

<Procedure without using the programming pendant>

9. Open the door of the FS100L controller. Turn the rotary switch of the main CPU board from “0” to “F” by using a precision screwdriver (flathead, 2 mm), and insert a USB memory stick into the main CPU board.
10. Turn ON the FS100L power supply.
    – Program upload starts.
    – While uploading the program, “u (lowercase)” lights up on the 7SegLED of the main CPU board, and the LED of RUN blinks.
    – When program upload is finished, the LED of RUN of the main CPU board lights up.
11. After program upload is finished, turn OFF the FS100L power supply.
    – Turn the rotary switch of the main CPU board from “F” to “0”.

– Remove the USB memory stick from the main CPU board.

CAUTION

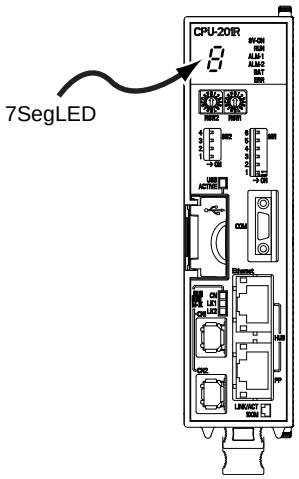
- The root folder of the USB memory stick is forcibly overwritten.
- Do not remove the USB memory stick while uploading the program. Failure of the stick may result if it is removed while uploading the program.

9.6.2 Restoration Procedure

Check whether the replacement of the main CPU board is necessary. If the replacement is necessary, follow the procedure below to restore the FS100L.

Failure of the FS100L is suspected when

- The 7SegLED of the main CPU board does not light up after turning ON the FS100L power supply.
- The 7SegLED of the main CPU board fully lights up after turning ON the FS100L power supply, but it does not count up after that.
- After turning ON the FS100L power supply, the programming pendant keeps showing the startup window (showing the robot) for more than one minute, and the 7SegLED of the main CPU board stays turned off or fully lit up.



- After turning ON the FS100L power supply, an error described in *chapter 9.7 "Error Indication" at page 9-42* occurs, and the error occurs again even after a retry.

CAUTION

- After the main CPU board is replaced, it is impossible to operate the manipulator normally before writing the system program, and loading the batch file or performing initialization in the maintenance mode.
  Give due consideration to it before replacing the main CPU board.

NOTE

The restoration cannot be performed by using the optional software pendant (PC version).
Make sure to use the programming pendant.

9.6.2.1 Preparation of Programming Pendant

For the FS100L in which a dummy connector inserted, prepare the programming pendant.

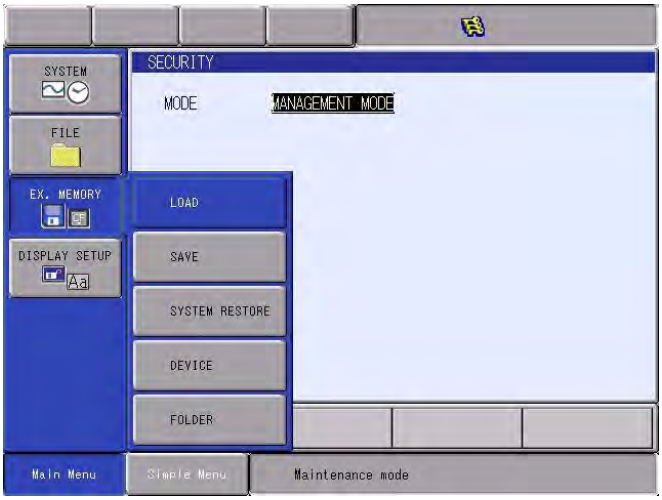
9.6.2.2 Preparation of Device for Writing System Program

Insert the device used in *chapter 9.6.1 "Data Backup and Program Upload" at page 9-24* into the programming pendant.

9.6.2.3 Restoration by a Batch Operation

Restoring operation by a batch operation is performed in the maintenance mode. Refer to the following procedures.

1. While pressing the main menu key (MAIN MENU), turn ON the FS100L power supply.
2. Insert the device used for backup operation.
3. Change the security to management mode.
4. Select {EX.DEVICE} under the main menu.
   – EX.DEVICE window sub menu appears.



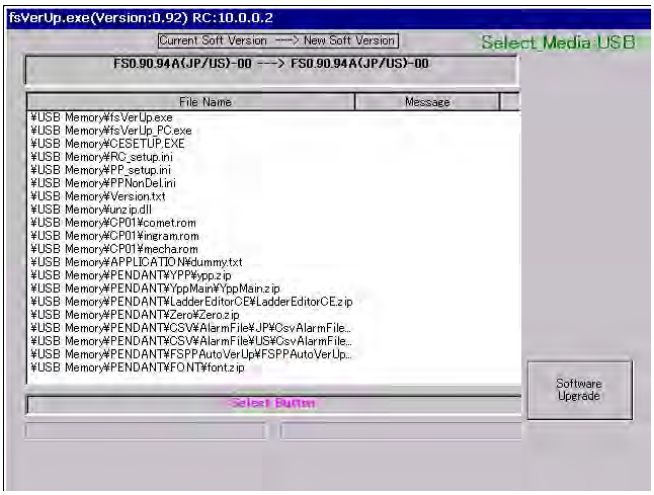
5. Select {LOAD}.
   – LOAD window appears.

6. Select {ALL FILE + CMOS}.
   – A confirmation dialog box appears.

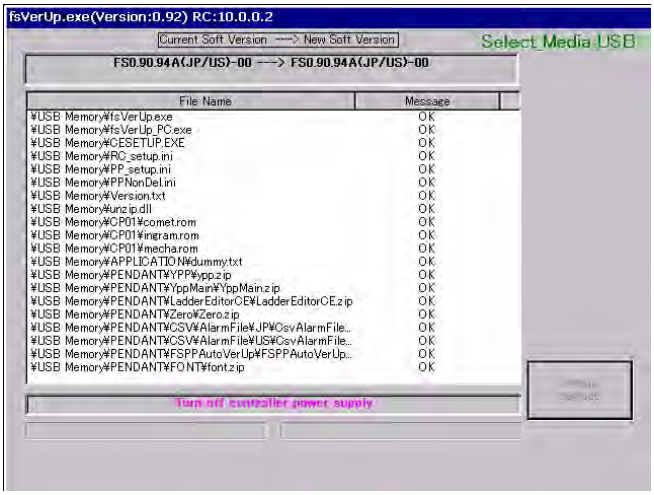
7. Select {YES}.
   – Loading operation starts and FS100L memory is updated.
   – Do not turn OFF the power supply while following messages are appeared in the human interface area:
   “Saving system data. Don't turn the power off.” or
   “(File name) is being executed.” Don't turn the power off.”
   Should the power is turned OFF, do the same operation again. Still it does not restore, try the procedures in *chapter 9.6.2.4 “Writing System Program” at page 9-39* again.

9.6.2.4 Writing System Program

1. While pressing the interlock key + [8] + [SELECT], turn ON the FS100L power supply.
   – The upgrading tool starts.



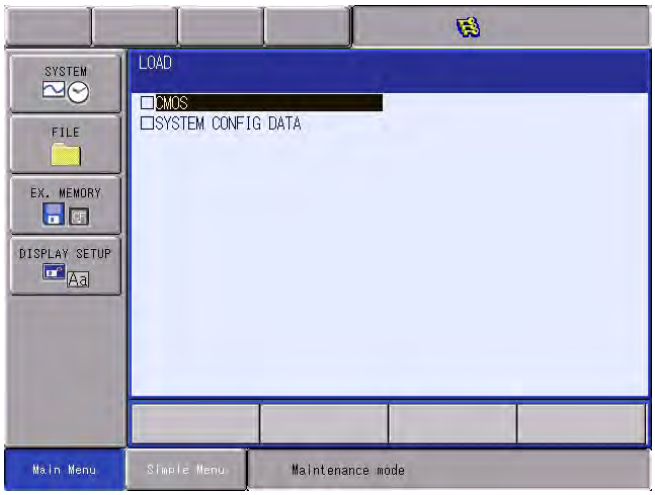
2. Select {Software Upgrade}.
   – Upgrade starts.
   – The upgrade is completed when the message “Turn off controller power supply” appears at the bottom of the screen.



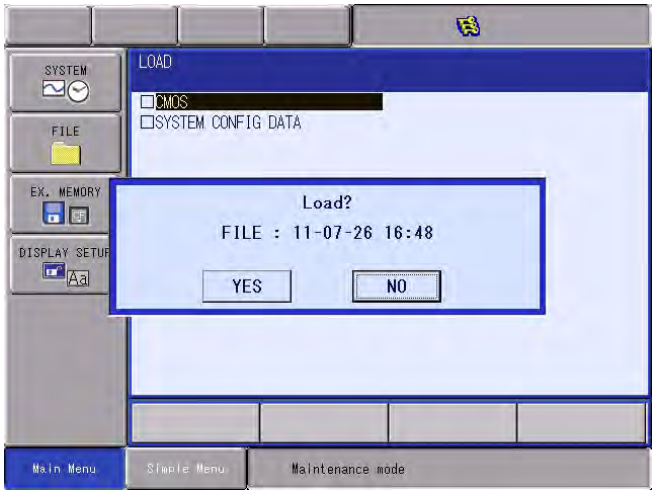
9.6.2.5 Writing Backup Data

Write the data by following the procedure below.

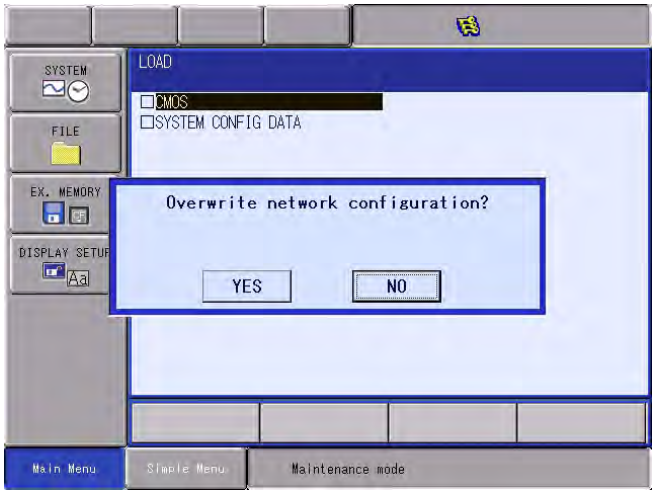
1. While pressing the main menu key (MAIN MENU), turn ON the FS100L power supply.
   – The maintenance mode starts.
2. Change the security mode to the management mode.
3. Select {EX. MEMORY} under the main menu.
   – The sub menu appears.
4. Select {LOAD}.
   – The LOAD window appears.



5. Select {CMOS}.
   – A confirmation dialog box appears.



6. Select {YES}.
   – The confirmation dialog box “Overwrite network configuration?” appears. If this step is performed after replacing the main CPU board, select {YES}.



7. Select {YES}.
   – Load starts, and the data inside FS100L is updated.
   – The loading process is completed when the message “Loading system data. Don’t turn the power off.” at the human interface display area disappears.
   Turn the FS100L power supply OFF then back ON to start it normally.

9.7 Error Indication

If an error number is indicated on the 7SegLED of the main CPU board, check the error content and correct the error. The error number is repeatedly indicated.

<Example of repeated indication>

The indication repeats every second in the order of [☐] -> [0] -> [0] -> [0] -> [,].

☐: The alphabet (“J”, “L”, “u”, or “b”) of the selected function is indicated.
- J: System batch data save process
- L: Language file load/save process
- u: Program upload process
- b: Boot program executing process

7SegLED indication	**Error content and countermeasure**
☐ 0001.	No USB memory stick. Insert a USB memory stick, and retry.
☐ 0010.	The RC_SETUP.INI file needed for upgrading does not exist. Retry according to *chapter 9.6 “Restoring FS100L Controller” at page 9-24*. If the error occurs again, replace the USB memory stick, then retry according to *chapter 9.6 “Restoring FS100L Controller” at page 9-24*.
☐ 0011.	The file needed for upgrading does not exist. Retry according to *chapter 9.6 “Restoring FS100L Controller” at page 9-24*. If the error occurs again, replace the USB memory stick, then retry according to *chapter 9.6 “Restoring FS100L Controller” at page 9-24*.
☐ 0012.	The system file does not exist. Retry according to *chapter 9.6 “Restoring FS100L Controller” at page 9-24*. If the error occurs again, replace the USB memory stick, then retry according to *chapter 9.6 “Restoring FS100L Controller” at page 9-24*.
☐ 0013.	The language file does not exist. Copy the language file to the USB memory stick, then retry.
☐ 0014.	Failed in updating. Turn the FS100L power supply OFF then back ON. If the error occurs again, replace the main CPU board.
☐ 0020.	CRC error occurred. Turn the FS100L power supply OFF then back ON. If the error occurs again, replace the main CPU board.
☐ 0021.	Expanded in memory, but verification error occurred. Turn the FS100L power supply OFF then back ON. If the error occurs again, replace the main CPU board.
☐ 0022.	Writing failed because the maximum writing size was exceeded. Replace the USB memory stick to a new one, or delete files in it.
☐ 0024.	The USB memory stick does not have enough free space. Replace the USB memory stick to a new one, or delete files in it.

7SegLED indication	Error content and countermeasure
☐ 0030.	Failed to ERASE or format the Flash Rom. Turn the FS100L power supply OFF then back ON. If the error occurs again, replace the main CPU board.
☐ 0041.	File open error occurred in a file stored in the USB memory stick. Turn the FS100L power supply OFF then back ON. If the error occurs again, replace the USB memory stick, then retry according to *chapter 9.6 "Restoring FS100L Controller" at page 9-24*.
☐ 0042.	File read error occurred in a file stored in the USB memory stick. Turn the FS100L power supply OFF then back ON. If the error occurs again, replace the USB memory stick, then retry according to *chapter 9.6 "Restoring FS100L Controller" at page 9-24*.
☐ 0043.	File write error occurred in a file stored in the USB memory stick. Turn the FS100L power supply OFF then back ON. If the error occurs again, replace the USB memory stick, then retry according to *chapter 9.6 "Restoring FS100L Controller" at page 9-24*.
☐ 0044.	File close error occurred in a file stored in the USB memory stick. Turn the FS100L power supply OFF then back ON. If the error occurs again, replace the USB memory stick, then retry according to *chapter 9.6 "Restoring FS100L Controller" at page 9-24*.
☐ 0045.	File creation failed in a file stored in the USB memory stick. Turn the FS100L power supply OFF then back ON. If the error occurs again, replace the USB memory stick, then retry according to *chapter 9.6 "Restoring FS100L Controller" at page 9-24*.
☐ 0046.	File directory creation failed in a file stored in the USB memory stick. Turn the FS100L power supply OFF then back ON. If the error occurs again, replace the USB memory stick, then retry according to *chapter 9.6 "Restoring FS100L Controller" at page 9-24*.
☐ 0047.	File directory deletion failed in a file stored in the USB memory stick. Turn the FS100L power supply OFF then back ON. If the error occurs again, replace the USB memory stick, then retry according to *chapter 9.6 "Restoring FS100L Controller" at page 9-24*.
☐ 0048.	File deletion failed in a file stored in the USB memory stick. Turn the FS100L power supply OFF then back ON. If the error occurs again, replace the USB memory stick, then retry according to *chapter 9.6 "Restoring FS100L Controller" at page 9-24*.
☐ 0049.	File rename failed in a file stored in the USB memory stick. Turn the FS100L power supply OFF then back ON. If the error occurs again, replace the USB memory stick, then retry according to *chapter 9.6 "Restoring FS100L Controller" at page 9-24*.

7SegLED indication	Error content and countermeasure
☐ 004F.	File open error occurred in a file stored in the USB memory stick. Turn the FS100L power supply OFF then back ON. If the error occurs again, replace the USB memory stick, then retry according to *chapter 9.6 "Restoring FS100L Controller" at page 9-24*.
☐ 0051.	Access error occurred in a file stored in the Flash Rom. Turn the FS100L power supply OFF then back ON. If the error occurs again, replace the main CPU board.
☐ 0052.	File read error occurred in a file stored in the Flash Rom. Turn the FS100L power supply OFF then back ON. If the error occurs again, replace the main CPU board.
☐ 0053.	File write error occurred in a file stored in the Flash Rom. Turn the FS100L power supply OFF then back ON. If the error occurs again, replace the main CPU board.
☐ 0054.	File close error occurred in a file stored in the Flash Rom. Turn the FS100L power supply OFF then back ON. If the error occurs again, replace the main CPU board.
☐ 0055.	File creation error occurred in a file stored in the Flash Rom. Turn the FS100L power supply OFF then back ON. If the error occurs again, replace the main CPU board.
☐ 0056.	File directory creation error occurred in a file stored in the Flash Rom. Turn the FS100L power supply OFF then back ON. If the error occurs again, replace the main CPU board.
☐ 0057.	File directory deletion error occurred in a file stored in the Flash Rom. Turn the FS100L power supply OFF then back ON. If the error occurs again, replace the main CPU board.
☐ 0058.	File deletion error occurred in a file stored in the Flash Rom. Turn the FS100L power supply OFF then back ON. If the error occurs again, replace the main CPU board.
☐ 0059.	File rename error occurred in a file stored in the Flash Rom. Turn the FS100L power supply OFF then back ON. If the error occurs again, replace the main CPU board.
☐ 005F.	Access error occurred in a file stored in the Flash Rom. Turn the FS100L power supply OFF then back ON. If the error occurs again, replace the main CPU board.
☐ 0090.	Error code only for the manufacturer. Turn the FS100L power supply OFF then back ON. If the error occurs again, replace the main CPU board.
☐ 0091.	Error code only for the manufacturer. Turn the FS100L power supply OFF then back ON. If the error occurs again, replace the main CPU board.
☐ 0092.	Error code only for the manufacturer. Turn the FS100L power supply OFF then back ON. If the error occurs again, replace the main CPU board.
☐ 0999.	An error other than the above occurred. Turn the FS100L power supply OFF then back ON. If the error occurs again, replace the main CPU board.

10 Upgrade Function

10.1 Functional Overview

For the CPU configuration, the FS100L has two pieces of software: the software for the main CPU board and the software for the programming pendant. Due to the compatibility of each software's version, the system runs only with the specified combination of the software versions.

Thus, the FS100L can upgrade the software for the programming pendant if the combination of the software for the main CPU and the programming pendant is invalid.

10.2 Upgrade Procedure

10.2.1 Confirmation of Software Version of Main CPU and Programming Pendant

The combination of the software versions for the main CPU and the programming pendant is automatically checked in 25 seconds after the FS100L power supply is turned on.

Only if the combination is invalid, automatic upgrade will be performed. If the combination is compatible, automatic upgrade will not be performed.

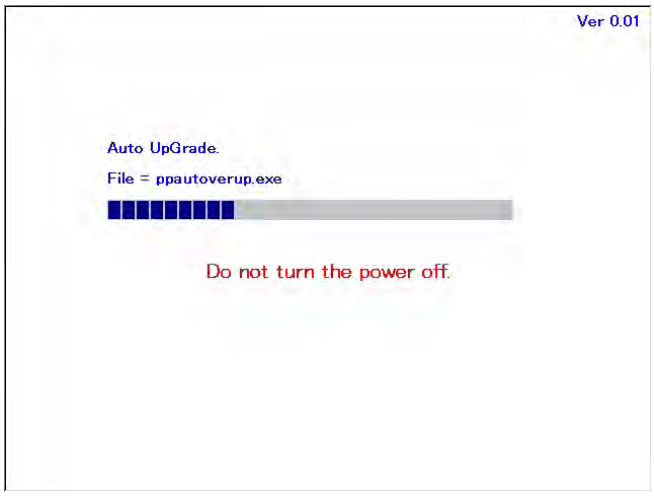
- If the software versions of the main CPU and the programming pendant are compatible:

– The initial window appears.

10.2.2 Automatic Upgrade

If the programming pendant software is older than the one stored in the main CPU memory, or if the software version is incompatible, automatic upgrade will be performed.

Note that the OS of the programming pendant will not be upgraded. (OS: operating system)



1. After the automatic upgrade process is completed, the programming pendant reboots and the main CPU stops communication processing.
2. After the programming pendant reboots, the main CPU restarts the communication processing and the initial window appears on the programming pendant screen.

SUPPLE -MENT

To avoid the automatic upgrade, turn ON the FS100L power supply while pressing the interlock key + [5] + [SELECT].

NOTE

DO NOT turn off the main power supply during automatic upgrade process.

In case the main power supply is turned off, exercise the following process.

- Turn on the main power supply of FS100L.
  - – Automatic upgrade might be exercised again.
- In case error occurs during automatic upgrade process.
  - (1) Supply CF for upgrading or USB memory.
  - (2) Press [2] + [8] + [HIGH SPEED].
    -Upgrade of the OS of Programming Pendant
  - (3) Press the interlock key + [8] + [SELECT].
  - (4) Exercise manual upgrading.
    - Refer to “FS100L Upgrade Procedure”
- If no recovery is made with all the procedure above, replace the pendant.

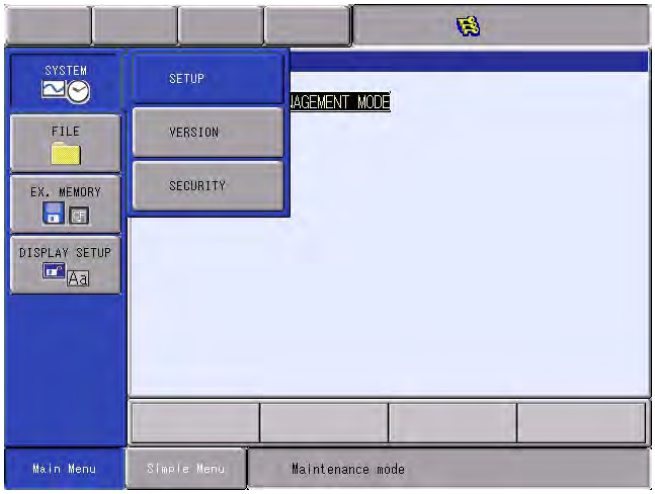
11 Modification of System Configuration

11.1 Addition of I/O Modules

To add I/O modules, turn OFF the power supply.

> SUPPLE -MENT
>
> Addition operation must be performed in the management mode.
> In the operation mode or editing mode, only reference of status setting is possible.

1. While pressing the main menu key (MAIN MENU), turn the FS100L power supply OFF then back ON.
2. Change the security mode to the management mode.
3. Select {SYSTEM} under the main menu.
   – The system window appears.



4. Select {SETUP}.
   – The SETUP window appears.
   – The items marked with "■" cannot be selected.

5. Select {IO MODULE}.
   – The current status of the mounted I/O module is shown.

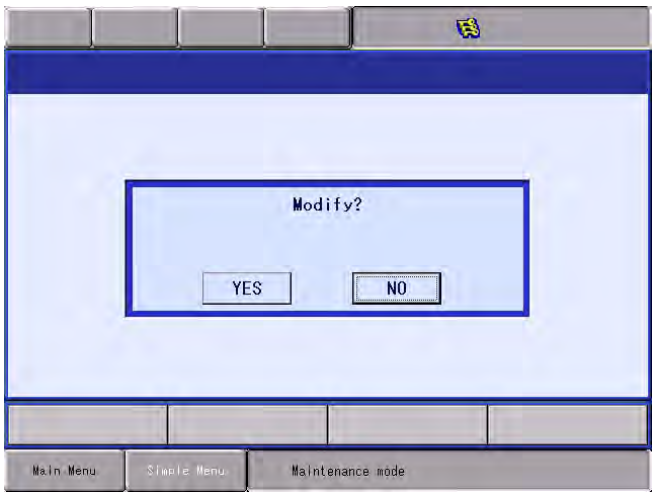
6. Confirm the status of mounted I/O module.
   – Confirm that each station (ST#) window is the same as the I/O module's actual mounting status.
   – The following information is shown for each station.

ST#	Station address of I/O module
DI	Number of contact input points[1)]
DO	Number of contact output points[1)]
BOARD	Circuit board type[2)]

1) A hyphen, -, indicates that the corresponding I/O section is not mounted.
2) If the system cannot recognize the circuit board type, a row of stars (*****) are shown. No problem will occur as long as the values displayed in DI and DO are correct.

7. Press [ENTER].
   – Confirm the statuses of the mounted I/O modules for the other stations.

8. Press [ENTER].
   – The confirmation dialog box appears.



9. Select {YES}.
   – The system parameters are then set automatically according to the current mounted hardware status. The procedure for the addition of the I/O module is complete.

NOTE If there is a difference between the displayed contents and the actual mounted status, confirm the status again. If the status is correct, the I/O module may be defective: in such a case, contact your Yaskawa representative.

11.2 Addition of Base and Station Axes

To add the base and station axes, mount all hardware correctly and then execute maintenance mode.

Addition operation must be performed in the management mode.
In the operation mode or editing mode, only reference of status setting is possible.

When adding a base and a station axis, set the following items:

- TYPE
  Select one in the type list.
  - In case of base axis (B1, B2)
    Select one of RECT-X, -Y, -Z, -XY, -XZ, -YZ or -XYZ.
  - In case of station axis (S1, S2, S3)
    Select UNIV-* (“*” represents the number of axes) when using a mechanism other than the registered type as a station axis.
- CONNECTION
  In the CONNECTION window, specify the SERVOPACK which is connected with each axis group, the contactor which is used for the SERVOPACK, and the overrun signal (OT).
- AXIS TYPE
  Select from the axis type list.
  - In case of TURN-* type
    No need to select (The axis type is set as TURN type.)
  - In case of RECT-* type
    Select BALL-SCREW type or RACK & PINION type.
  - In case of UNIV-* type
    Select BALL-SCREW type, RACK & PINION type or TURN type.
- MECHANICAL SPECIFICATION
  - If axis type is ball-screw type, set the following items:
    - MOTION RANGE (+) [mm]
    - MOTION RANGE (-) [mm]
    - REDUCTION RATIO (numerator)
    - REDUCTION RATIO (denominator)
    - BALL-SCREW PITCH [mm/r]
  - If axis type is rack & pinion type, set the following items.
    - MOTION RANGE (+) [mm]
    - MOTION RANGE (-) [mm]
    - REDUCTION RATIO (numerator)
    - REDUCTION RATIO (denominator)
    - PINION DIAMETER [mm]

• If axis type is turn type, set the following items.

- MOTION RANGE (+) [deg]
- MOTION RANGE (-) [deg]
- REDUCTION RATIO (numerator)
- REDUCTION RATIO (denominator)
- OFFSET (1st and 2nd axis) [mm]

- MOTOR SPECIFICATION
  Set the following items.

  - MOTOR
  - SERVO AMP
  - CONVERTER
  - ROTATION DIRECTION [normal/reverse]
  - MAX. RPM [rpm]
  - ACCELERATION SPEED [sec]
  - INERTIA RATIO

* Select MOTOR, AMPLIFIER and CONVERTER from each type list on the display.

11.2.1 Base Axis Setting

11.2.1.1 Selection of Base Axis Type

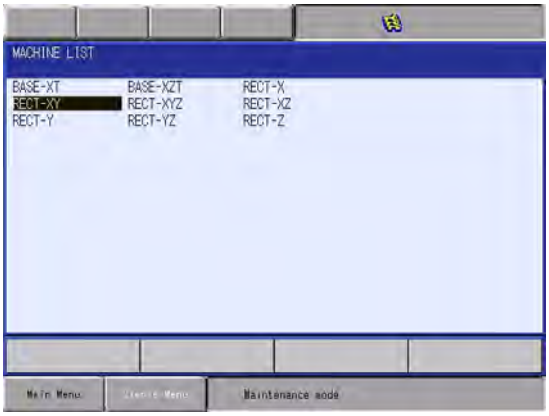
Select the type of base axis to be added or modified.

1. While pressing the main menu key (MAIN MENU), turn the FS100L power supply OFF then back ON.
2. Change the security mode to the management mode.
3. Select {SYSTEM} under the main menu.
   – The system window appears.

4. Select {SETUP}.
   – The SETUP window appears.
   – Note that the items marked with "■" cannot be set.

5. Select {CONTROL GROUP}.
   – The current control group type is displayed.

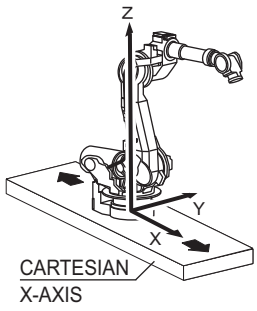
6. Move the cursor to the type of control group to be modified, and press [SELECT].
   – The MACHINE LIST window is displayed.



RECT-X: traverse X-axis base
RECT-Y: traverse Y-axis base
RECT-Z: traverse Z-axis base
RECT-XZ: traverse XZ-axis base
RECT-XY: traverse XY-axis base
RECT-YZ: traverse YZ-axis base
RECT-XYZ: traverse XYZ-axis base
(See the figures on the next page)

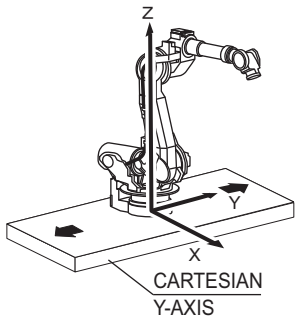
7. Select one in the type list.
   – After the type selection, the window changes to the CONNECTION window.

RECT-X



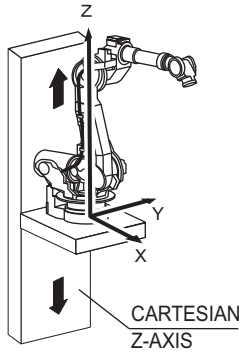
Base axis direction of travel coincides with robot coordinate X-Axis.

RECT-Y



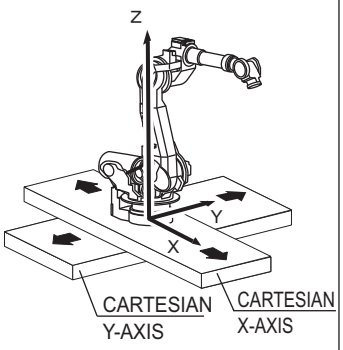
Base axis direction of travel coincides with robot coordinate Y-Axis.

RECT-Z



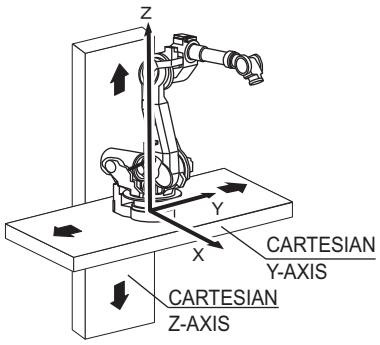
Base axis direction of travel coincides with robot coordinate Z-Axis.

RECT-XY



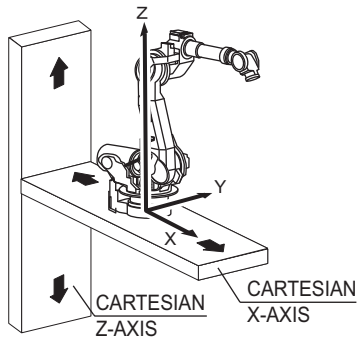
Base 1st and 2nd axes directions of travel coincide with robot coordinate X-Axis and Y-Axis, respecitively.

RECT-YZ



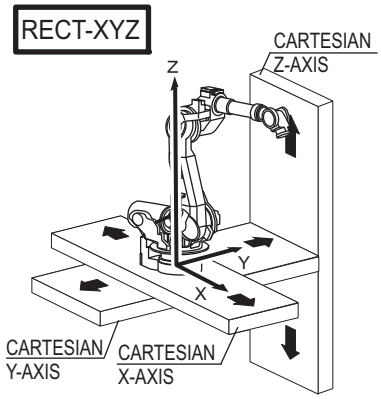
Base 1st and 2nd axes directions of travel coincide with robot coordinate Y-Axis and Z-Axis, respectively.

RECT-XZ



Base 1st and 2nd axes directions of travel coincide with robot coordinate X-Axis and Z-Axis,respectively.

RECT-XYZ

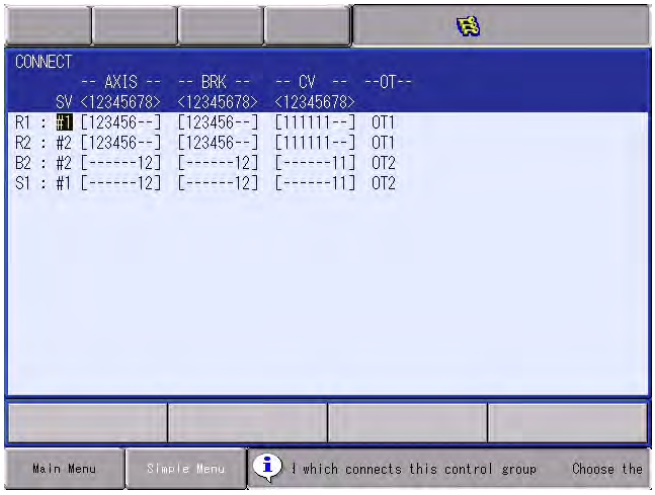


Base 1st, 2nd, and 3rd axes directions of travel coincide with robot coordinate X-Axis, Y-Axis, and Z-Axis, respectively.

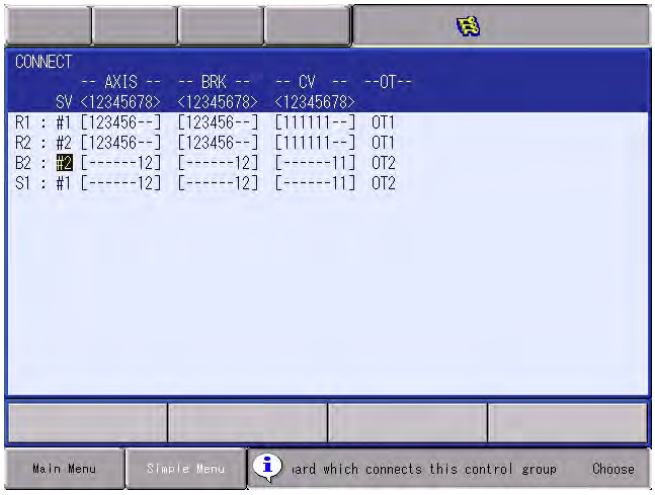
11.2.1.2 Connection Setting

In the CONNECT window, it is specified that each axis of each control group is connected to which connector of the SERVO board, which brake of the contactor unit, which converter, and which overrun signal.

1. Confirm the type of each control group in the CONNECT window.
   – The connection status of each control group is displayed.



2. Select the connection item of a desired control group.
   – The settable items are displayed.
   – Select an item to change the setting. Select {Cancel} to return to the CONNECT window.



   – Specify which connector (CN) of the SERVO board each axis of each control group is connected to.
   The numbers in [ ] represent axis numbers, and indicate which axis is connected to which connector.
   – Specify which brake (BRK) each axis of each control group is connected to.
   The numbers in [ ] represent the axis numbers, and indicate which axis is connected to which brake.
   – Specify which converter (CV) each axis of each control group is connected to.
   The numbers in [ ] represent the converter numbers, and indicate which axis is connected to which converter.

– Specify which overrun signal (OT) each control group is connected to.

– In this example, B2 (Base) is connected in the following manner:

1st axis	→	SERVO Board (SV #2),	Connector (7CN),
		Brake Connector (BRK7),	Converter (CV #1)
2nd axis	→	SERVO Board (SV #2),	Connector (8CN)
		Brake Connector (BRK8)	Converter (CV #2)
Overrun	→	(OT2)	

3. An overrun signal is allocated to a control group. Thus, when an overrun alarm occurs, the subcode is indicated by the control group. (With software of a version before DS1.20.00(A)-00, the subcode is indicated in binary.)
However, select “NOT CONNECT” if an overrun switch is not installed to the control group or the allocation of the external axis overrun signal is not needed.
Regarding the connection of the external axis overrun signal, refer to *chapter 13.2.3 “Connection for External Axis Overrun” at page 13-14*.
4. Select a desired item.
5. Press [ENTER] in the CONNECT window.

– The setting in the CONNECT window is completed, the window changes to the CONTROL GROUP window, and a confirmation dialog box appears.

– Select {YES} to set the system parameters automatically according to the selected items in the windows so far.

6. Initialize related files.

11.2.1.3 Axis Configuration Setting

Select “DETAIL” in the CONTROL GROUP window to select “INIT (initialization)”, “MODIFY”, “DELETE”, or “DETAIL”.

– Select “INIT” to initialize parameters according to the current settings.

– Select “MODIFY” to see the MACHINE LIST window.

– Select “DELETE” to delete the selected axis’s type.

– Select “DETAIL” to move to the AXIS CONFIG window.

The axis type is specified in the AXES CONFIG window.

1. Confirm axis type of each axis in the AXES CONFIG window.

   – The axis type of each axis is displayed.

2. Select the axis type to be modified.

   (1) The settable axis type is displayed.

   (2) Select “BALL-SCREW” when the servo track is ball-screw type, and “RACK&PINION” when the servo track is rack-and-pinion type. After the selection, the window returns to the AXES CONFIG window.

   (3) Select the axis type.

3. Press [ENTER] in the AXES CONFIG window.

4. The setting in the AXES CONFIG window is completed and the window moves to the MECHANICAL SPEC window.

11.2.1.4 Mechanical Specification Setting

The mechanical data is specified in the MECHANICAL SPEC window.

1. Confirm specification of each axis in the MECHANICAL SPEC window.
   – The mechanical specification of axis is shown.

MECHANICAL SPEC window (BALL-SCREW type)

– MOTION RANGE : Input maximum moving position (positive (+) direction and negative (-) direction) from home position when setting the home position to 0. (Unit: mm)

– REDUCTION RATIO : Input the numerator and the denominator. <e.g.> If the reduction ratio is 1/2, the numerator should be set as 1.0 and the denominator should be set as 2.0.

– BALL-SCREW PITCH: Input the traveling length when the ball-screw rotates once. (Unit: mm/r)

MECHANICAL SPEC window (RACK & PINION type)

– MOTION RANGE : Input maximum moving position (positive (+) direction and negative (-) direction) from home position when setting the home position to 0. (Unit: mm)

– REDUCTION RATIO: Input the numerator and the denominator.
<e.g.>If the reduction ratio is 1/120, the numerator should be set as 1.0 and the denominator should be set as 120.0.

– PINION DIAMETER : Input the diameter of a pinion. (Unit: mm)

2. Select the item to be modified.

   – Point the cursor to the item subject for setting value modification, and press [SELECT].

3. Modify the settings.

   – The selected item is in the input status.
   Input the setting value, and press [ENTER].

4. Press [ENTER] in the MECHANICAL SPEC window.

   – After the setting, the current window moves to the window for the next axis setting. Complete the settings for all axes in the same manner.

   – When [ENTER] is pressed in the MECHANICAL SPEC window for the last axis, the setting in the MECHANICAL SPEC window is completed and the window moves to the MOTOR SPEC window.

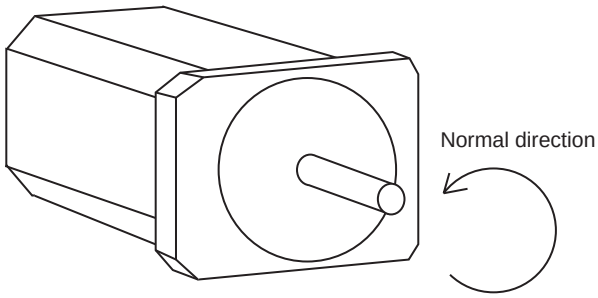
11.2.1.5 Motor Specification Setting

The motor data is specified in the MOTOR SPEC window.

1. Confirm specification of each axis in the MOTOR SPEC window.
   – The motor specification of each axis is displayed.

2. Select the desired item.
   – When a numerical value is selected, the number input buffer line appears.
   – When MOTOR (or SERVO AMP or CONVERTER) is selected, the list window of MOTOR (SERVO AMP, or CONVERTER) appears.
   – ROTATION DIRECTION: Set the rotation direction to which the current position is increased. (The counterclockwise view from the loaded side is the normal rotation.)

Fig. 11-1: AC Servo Motor



   – MAX. RPM: Input maximum rotation speed of a motor. (Unit: rpm)
   – ACCELARATION TIME: Input time between 0.01 and 1.00 to reach maximum speed from stopping status at 100% JOINT speed. (Unit: sec)
   – INERTIA RATIO: The initial value is set at 300 in case of servo track; 0 in case of rotation axis.
   However, if the following phenomenon occurs in motion, deal with the followed procedure.
   – <Phenomenon 1>
   During motion, the axis moves unsteadily to the direction of travel.
   → Check the motion by increasing this ratio in increments of 100.
   – <Phenomenon 2>
   During pause, the motor makes a strange noise.
   → Check the motion by decreasing this ratio in increments of 100.

3. Modify the settings.
4. Press [ENTER] in the MOTOR SPEC window.
   – After the setting, the current window moves to the window for the next axis setting. Complete the settings for all axes in the same manner.
   – When [ENTER] is pressed in the MOTOR SPEC window for the last axis, the setting in the MOTOR SPEC window is completed and the confirmation dialog box appears.

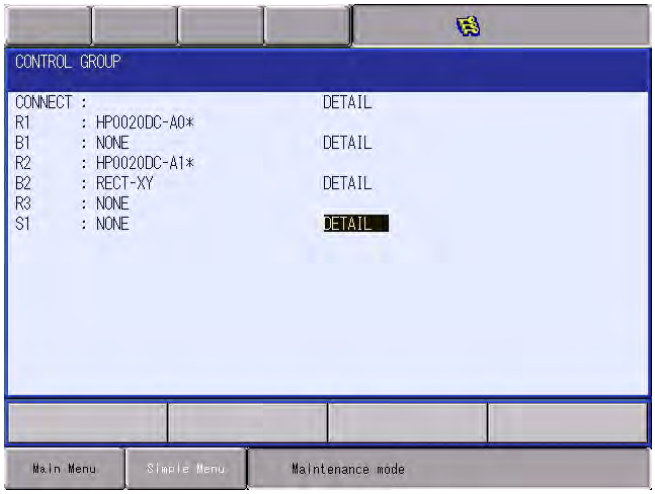
   – Select {YES} to set the system parameters automatically according to the selected items in the windows so far.
5. Initialize related files.
   – Addition or modification of the base axis is completed.

11.2.2 Station Axis Setting

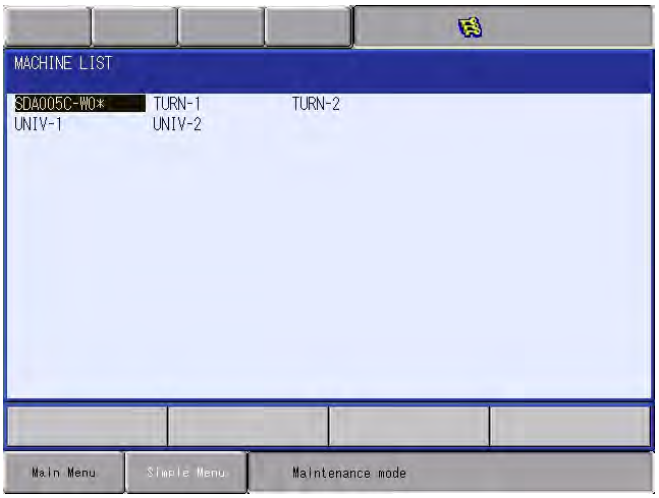
11.2.2.1 Selection of Station Axis Type

Select the type of station axis to be added or modified.

1. Confirm the type of control group in CONTROL GROUP window.
   – The CONTROL GROUP window appears.

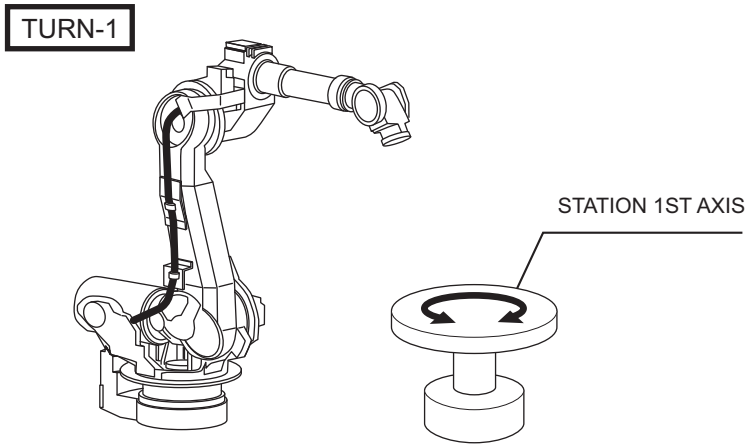


2. Select the type of control group to be modified.
   – The MACHINE LIST window appears.



TURN-1: TURN 1 AXIS STATION
TURN-2: TURN 2 AXIS STATION
UNIV-1: UNIVERSAL 1 AXIS STATION
UNIV-2: UNIVERSAL 2 AXIS STATION
...

3. Select desired type in the type list.
   – After the type selection, the window changes to the CONNECT window.
   – Select “UNIV” (universal) when using a mechanism other than the registered type (such as a servo track) as a station axis. When “UNIV” is selected, interpolation motion (linear, circular, etc.) is not supported.

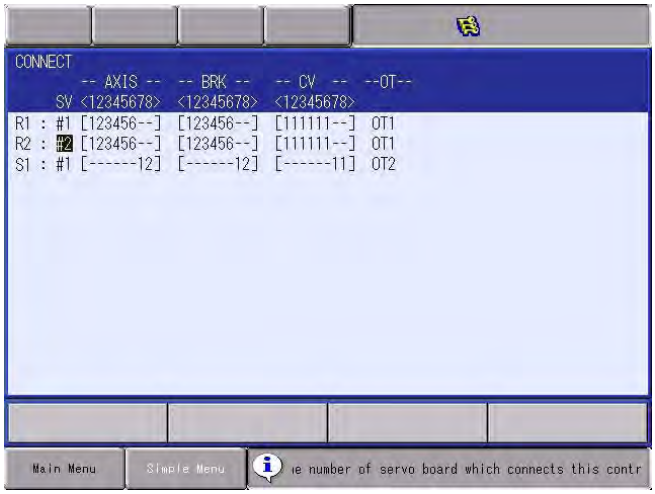


11.2.2.2 Connection Setting

In the CONNECT window, it is specified that each axis of each control group is connected to which connector of the SERVO board, which brake, which converter, and which overrun signal.

Note that the software version should be DS1.20.00(A)-00 or higher to set the overrun signal.

1. Confirm the type of each control group in the CONNECT window.
   – Connection status of each control group is displayed.



2. Select the connection item of desired control group.
   – The settable items are displayed.
   – Select an item to change the setting. Select {Cancel} to return to the CONNECT window.
   – Specify which connector (CN) of the SERVO board each axis of each control group is connected to.
   The numbers in [ ] represent axis numbers, and indicate which axis is connected to which connector.
   – Specify which brake (BRK) each axis of each control group is connected to.
   The numbers in [ ] represent the axis numbers, and indicate which axis is connected to which brake.
   – Specify which converter (CV) each axis of each control group is connected to.
   The numbers in [ ] represent the converter numbers, and indicate which axis is connected to which converter.
   – Specify which overrun signal (OT) each control group is connected to.
   – In this example, S1 (Station) is connected in the following manner:

1st axis	→	SERVO Board (SV #1),	Connector (7CN),
		Brake Connector (BRK7),	Converter (CV #1)
2nd axis	→	SERVO Board (SV #1),	Connector (8CN),
		Brake Connector (BRK8),	Converter (CV #3)
Overrun	→	(OT2)	

3. In software of the version DS1.20.00(A)-00 or higher, an overrun signal is allocated to a control group. Therefore, when an overrun alarm occurs, the subcode is indicated by the control group. (With software of a version before DS1.20.00(A)-00, the subcode is indicated in binary.)
   However, select “NOT CONNECT” if an overrun switch is not installed to the control group or the allocation of the external axis overrun signal is not needed.
   Regarding the connection of the external axis overrun signal, refer to *chapter 13.2.3 “Connection for External Axis Overrun” at page 13-14*.
4. Select a desired item.
5. Press [ENTER] in the CONNECT window.
   – The setting in the CONNECT window is completed, the window changes to the CONTROL GROUP window, and the confirmation dialog box appears.
   – Select {YES} to set the system parameters automatically according to the selected items in the windows so far.
6. Initialize related files.

11.2.2.3 Axis Configuration Setting

Select “DETAIL” in the CONTROL GROUP window to select “INIT (initialization)”, “MODIFY”, “DELETE”, or “DETAIL”.

– Select “INIT” to initialize parameters according to the current settings.

– Select “MODIFY” to see the MACHINE LIST window.

– Select “DELETE” to delete the selected axis’s type.

– Select “DETAIL” to move to the AXIS CONFIG window.

The axis type and motor type are specified in the AXES CONFIG window.

1. Confirm axis type of each axis in the AXES CONFIG window.

– The axis type of each axis is displayed.

• AXES CONFIG window (TURN type)

• AXES CONFIG window (UNIVERSAL type)

2. Select the axis type to be modified.
   – The settable axis type is displayed.

3. Select the desired axis type.
4. Press [ENTER] in the AXES CONFIG window.
   – The setting in the AXES CONFIG window is completed and the window moves to the MECHANICAL SPEC window.

11.2.2.4 Mechanical Specification Setting

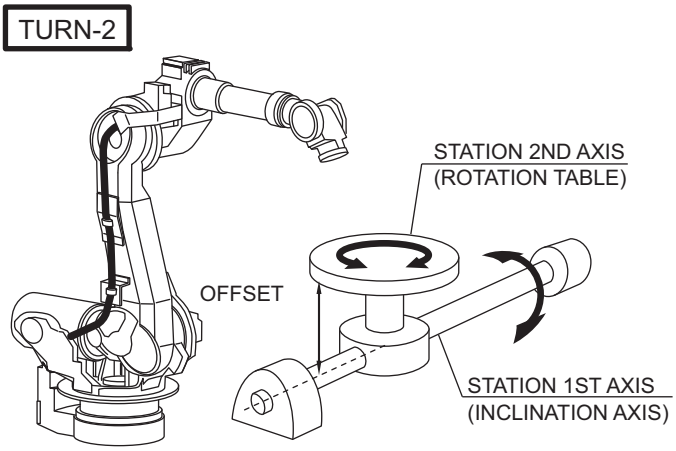
The mechanical data is specified in the MECHANICAL SPEC window.

1. Confirm specification of each axis in the MECHANICAL SPEC window.
   – The mechanical specification of axis is shown.

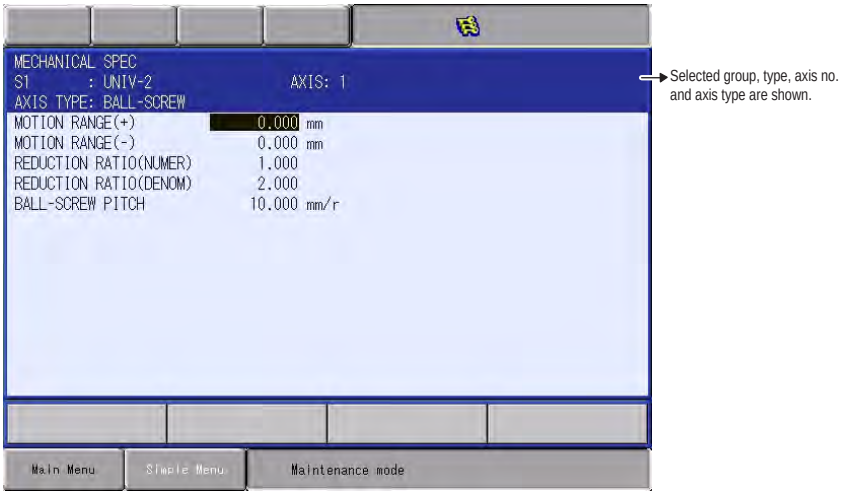
   – MOTION RANGE : Input maximum moving position (positive (+) direction and negative (-) direction) from home position when setting the home position to 0. (Unit: deg)

   – REDUCTION RATIO: Input the numerator and the denominator.
   <e.g.> If the reduction ratio is 1/120, the numerator should be set as 1.0 and the denominator should be set as 120.0.

   – OFFSET : Offset should be specified at “TURN-2” type only.
   Input length between the center of bending axis (1st axis) and the turning table (2nd axis). (Unit: mm)



• MECHANICAL SPEC window (BALL-SCREW type)

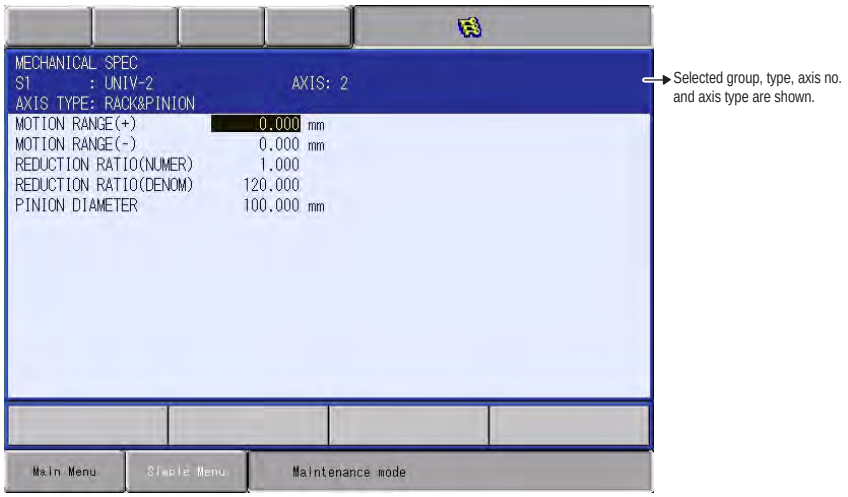


– MOTION RANGE : Input maximum moving position (positive (+) direction and negative (-) direction) from home position when setting the home position to 0. (Unit: mm)

– REDUCTION RATIO : Input the numerator and the denominator. <e.g.> If the reduction ratio is 1/2, the numerator should be set as 1.0 and the denominator should be set as 2.0.

– BALL-SCREW PITCH: Input the traveling length when the ball-screw rotates once. (Unit: mm/r)

• MECHANICAL SPEC window (RACK & PINION type)



– MOTION RANGE : Input maximum moving position (positive (+) direction and negative (-) direction) from home position when setting the home position to 0. (Unit: mm)

– REDUCTION RATIO: Input the numerator and the denominator. <e.g.>If the reduction ratio is 1/120, the numerator should be set as 1.0 and the denominator should be set as 120.0.

– PINION DIAMETER : Input the diameter of a pinion. (Unit: mm)

• MECHANICAL SPEC window (ROTATION type)

– MOTION RANGE: Input maximum moving position (positive (+) direction and negative (-) direction) from home position when setting the home position to 0. (Unit: deg)

– REDUCTION RATIO: Input the numerator and the denominator. <e.g.> If the reduction ratio is 1/120, the numerator should be set as 1.0 and the denominator should be set as 120.0.

2. Modify the settings.

3. Press [ENTER] in the MECHANICAL SPEC window.

– After the setting, the current window moves to the window for the next axis setting. Complete the settings for all axes in the same manner.When [ENTER] is pressed in the MECHANICAL SPEC window for the last axis, the setting in the MECHANICAL SPEC window is completed and the window moves to the MOTOR SPEC window.

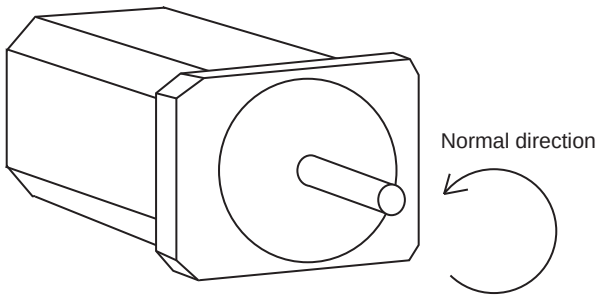
11.2.2.5 Motor Specification Setting

The motor data is specified in the MOTOR SPEC window.

1. Confirm specification of each axis in the MOTOR SPEC window.
   – The motor specification of each axis is displayed.

2. Select a desired item.
   – When a numerical value is selected, the number input buffer line appears.
   When MOTOR (or SERVO AMP or CONVERTER) is selected, the list window of MOTOR (SERVO AMP or CONVERTER) appears.
   – When the type is selected, the window returns to the AXES CONFIG window.
   – ROTATION DIRECTION: Set the rotation direction to which the current position is increased. (The counterclockwise view from the loaded side is the normal rotation.)

Fig. 11-2: AC Servo Motor



   – MAX. RPM: Input maximum rotation speed of a motor. (Unit: rpm)
   – ACCELARATION SPEED: Input time between 0.01 and 1.00 to reach maximum speed from stopping status at 100% JOINT speed. (Unit: sec)
   – INERTIA RATIO: The initial value is set at 300 in case of servo track; 0 in case of rotation axis.
   However, if the following phenomenon occurs in motion, deal with the followed procedure.

– <Phenomenon 1>
During motion, the axis moves unsteadily to the direction of travel.
→ Check the motion by increasing this ratio in increments of 100.

– <Phenomenon 2>
During pause, the motor makes a strange noise.
→ Check the motion by decreasing this ratio in increments of 100.

3. Modify the settings.

CAUTION

- If the control axis configuration is changed by addition of a base axis or station axis, the internal data of the job file are also changed so that the job file data should be initialized.
  Initialize the job file data with procedure “File Initialize” in this manual after changing the construction.
- When the data, motion range for example, should be changed after the addition of a base axis or station axis, the change can be done in the same procedure as shown above.
  In this case, the control axis configuration is not changed so the job file data should not be initialized.

12 FS100L Specification

WARNING

- Make sure that there is no one within the manipulator's operating range and that you are in a safe place before turning ON the FS100L power.

Injury may result from collision with the manipulator to anyone entering the manipulator's operating range. Always press the emergency stop button immediately if there are problems.

- Observe the following precautions when performing teaching operations within the manipulator's operating range:
  - Be sure to use a lockout device to the safeguarding when going inside. Also, display the sign that the operation is being performed inside the safeguarding and make sure no one closes the safeguarding.
  - Always view the manipulator from the front
  - Always follow the predetermined operating procedure.
  - Always have an escape plan in mind in case the manipulator comes toward you unexpectedly.
  - Ensure that you have a safe place to retreat in case of emergency.

Improper or unintentional manipulator operation can result in injury.

- Before operating the manipulator, check that the SERVO ON lamp goes out when the emergency stop button on the programming pendant is pressed.

Injury or damage to machinery may result if the manipulator cannot be stopped in case of an emergency.

The emergency stop button is located on the right of the programming pendant.

CAUTION

- Perform the following inspection procedures prior to performing teaching operations. If problems are found, correct them immediately, and be sure that all other necessary processing has been performed.
  - Check for problems in manipulator movement.
  - Check for damage to the insulation and sheathing of external wires.
- Always return the programming pendant to a safe place after use.

If the programming pendant is inadvertently left on the manipulator, fixture, or on the floor, the manipulator or a tool could collide with it during manipulator movement, possibly causing injuries or equipment damage.

- Make sure that a system manager stores the key of the mode select switch on the programming pendant.
  After operation, the key should be removed and stored by the system manager.

Improper or unintended manipulator operation may result in injury. Also, the key or the mode select switch may be damaged if the programming pendant is dropped with the key inserted.

12.1 Specifications of FS100L

Structure	Free-standing, open type
Dimensions	650 (W) × 500 (H) × 550 (D) mm ((H) does not include the height of caster)
Approximate mass	100kg (without built-in transformer) 170kg (with built-in transformer)
Ambient temperature	0° C to +40° C (during operation) -10° C to +60° C (during transportation and maintenance)
Relative humidity	10 to 90% RH (non-condensing)
Power supply	Without three-phase built-in transformer -Three-phase power supply 200/220 VAC (+10% to -15%) 50/60 Hz (±2%) With three-phase built-in transformer -Three-phase power supply 380/400/415 VAC (+10% to -15%) 50/60 Hz (±2%) (380 VAC when shipped)
Cooling system	Direct cooling
Grounding	Grounding resistance: 100 Ω or less, exclusive grounding[1)]
Protection class	IP20 (Optional IP40)
Digital I/O	NPN
	Specific signals (hardware): 10 inputs and 2 outputs
	General signals (standard, maximum): 28 inputs, 28 outputs (transistor: 28 outputs)
Positioning system	By serial communication (absolute encoder)
Drive unit	SERVOPACK for AC servomotors
Acceleration/deceleration	Software servo control
Memory capacity	20000 steps, 2000 instructions
CIO ladder	Max. 1500 step
Brake release	The brake of each axis can be released individually by the programming pendant.

1 Perform grounding in accordance with all relevant local and national electrical codes.
The size of the ground wire must be equal to the size listed in *table 4-2 “FS100L Power Capacity, Cable Size, and Breaker” at page 4-6*.

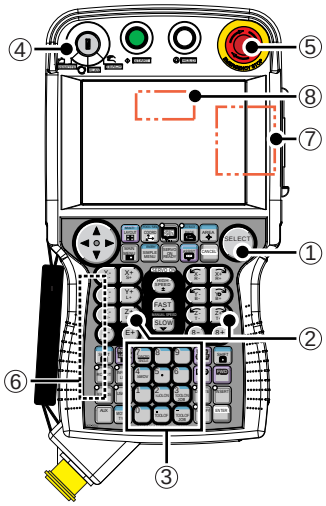
12.2 Functions of FS100L

Programming Pendant Operation	**Coordinate System**	Joint, Rectangular/Cylindrical, Tool, User Coordinates
	Modification of Teaching Points	Adding, Deleting, Correcting (Robot axes and external axes respectively can be corrected.)
	Inching Operation	Possible
	Path Confirmation	Forward/Reverse step, Continuous feeding
	Speed Adjustment	Fine adjustment possible during operating or pausing
	Timer Setting	Possible every 0.001 s
	Short-cut Function	Direct-open function, Multi-window
	Interface	CF (CompactFlash) card slot, USB port (USB1.1) (on programming pendant), USB port (2.0) (on control circuit board), RS232C (on control circuit board), LAN (100 BASE-TX/10BASE-T) (on control circuit board) (optional)
Safety Feature	**Essential Measures**	JIS (Japanese Industrial Standard)
	Running Speed Limit	User definable
	Enable Switch	3 position type. Servo power can be turned on at the middle position only. (Located on programming pendant)
	Collision proof Frames	Cubic frame, Axis frame
	Self-Diagnosis	Classifies error and two types of alarms (major and minor) and displays the data
	User Alarm Display	Possible to display alarm messages for peripheral device
	Machine Lock	Test-run of peripheral devices without robot motion
Maintenance Function	**Operation Time Display**	Control power-on time, Servo power-on time, Playback time, Operation time, Work time
	Alarm Display	Alarm message, troubleshooting, previous alarm records
	I/O Diagnosis	Simulated enabled/disabled output possible
	T.C.P. Calibration	Automatically calibrates parameters for end effectors using a master positioner

Programming	**Programming Type**	Interactive programming
	Language	Robot language: INFORM III
	Robot Motion Control	Joint coordinates, Linear/Circular interpolations, Tool coordinates
	Speed Setting	Percentage for joint coordinates, 0.1mm/s units for interpolations, Angular velocity for T.C.P. fixed motion
	Program Control Instructions	Jumps, Calls, Timer, Robot stop, Execution of some instructions during manipulator motion
	Variable	Global variable, Local variable
	Variable Type	Byte type, Integer-type, Double precision-type, Real type, Position type, String type
	I/O Instructions	Discrete I/O, Pattern I/O processing

12.3 Specifications of Programming Pendant

Item	Specifications
Type	JZRCR-YPP03-1 or JZRCR-YPP13-1
Dimensions	169 (W) × 314.5 (H) × 50 (D) mm (excluding protrusions)
Approximate mass	990 g
Material	Reinforced plastic
Control device	(1) Select key (2) Axis keys (3) Numeric/application keys (4) Mode switch with a key (mode: teach, play, remote) Key type: AS6-SK-132 (manufactured by IDEC) 1) (5) Emergency stop button (6) Enable switch (7) CompactFlash card slot (CompactFlash is optional.) (8) USB port (1 port)
Display	640 × 480 pixel color LCD, touch panel (Alphanumeric characters, Chinese characters, Japanese letters, etc.)
IEC protection class	IP65
Cable length	Standard: 8 m, Max.: 20 m (optional)
Key sheet	General (1 sheet only)



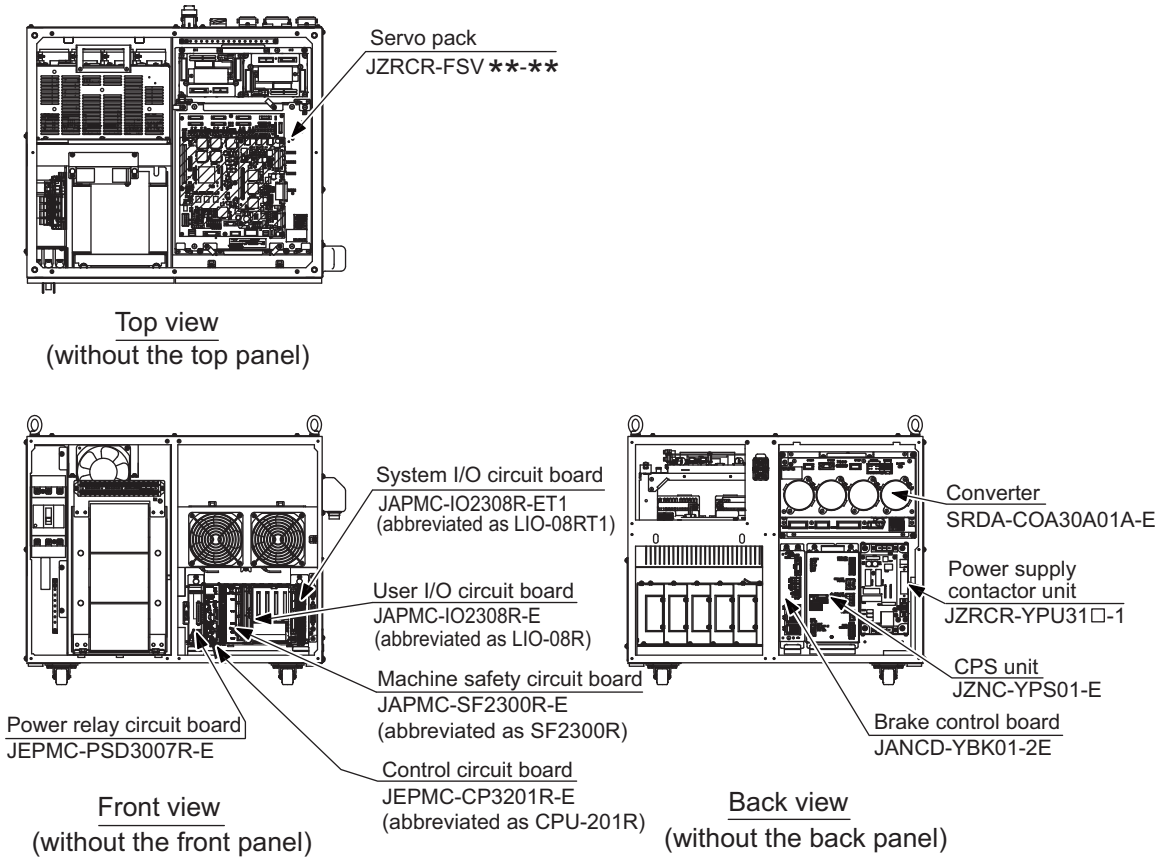
1 Two keys are supplied with the programming pendant.

12.4 Equipment Configuration of FS100L

The equipment configuration of the FS100L is described below.

12.4.1 Arrangement of Units and Circuit Boards

Fig. 12-1: Equipment Configuration of FS100L



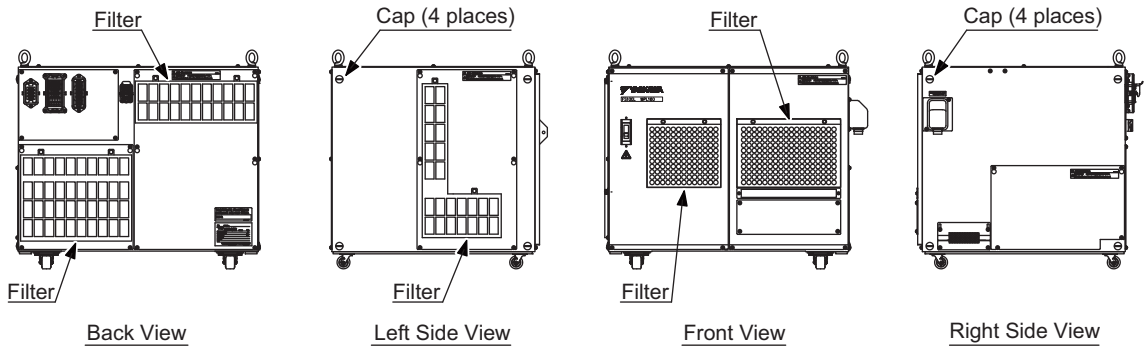
12.5 Arrangement of FS100L when IP40 Specification (Optional)

Following parts are added when IP40 specification (optional).

- Filters to the FS100L air inlets and exhausts.
- Caps to the FS100L fixing nuts at its side part.

For the maintenance (inspection, cleaning or filter replacement) of those added filters, refer to “FS100L MAINTENANCE MANUAL” (Manual No.: RE-CHO-A112).

Fig. 12-2: Equipment Configuration of FS100L when IP40 Specification (Optional)



13 Description of Units and Circuit Boards

WARNING

- When turning ON the power to FS100L, be sure that there is no one within the manipulator's operating range, and that you are in a safe place.

Injury may result from collision with the manipulator to anyone entering the manipulator's operating range. Always press the emergency stop button immediately if there are problems.

- Observe the following precautions when performing teaching operations within the manipulator's operating range:
  - Be sure to use a lockout device to the safeguarding when going inside. Also, display the sign that the operation is being performed inside the safeguarding and make sure no one closes the safeguarding.
  - Always view the manipulator from the front
  - Always follow the predetermined operating procedure.
  - Always have an escape plan in mind in case the manipulator comes toward you unexpectedly.
  - Ensure that you have a safe place to retreat in case of emergency.

Improper or unintended manipulator operation may result in injury.

- Before operating the manipulator, check that the SERVO ON lamp goes out when the emergency stop button on the programming pendant is pressed.

Injury or damage to machinery may result if the manipulator cannot be stopped in case of an emergency. The emergency stop button is located on the right of the programming pendant.

CAUTION

Perform the following inspection procedures prior to performing teaching operations. If problems are found, correct 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 its specified position after use.

If the programming pendant is inadvertently left on the manipulator or fixture, or on the floor, the manipulator or a tool could collide with it during manipulator movement, possibly causing injuries or equipment damage.

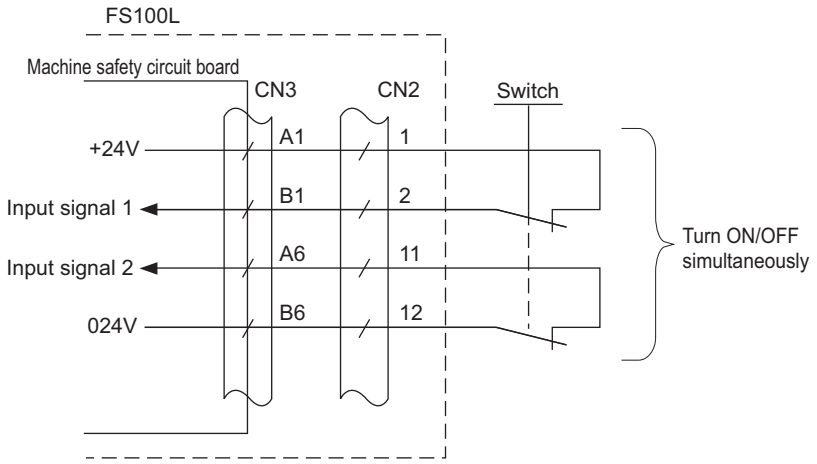
- Make sure that a system manager stores the key of the mode select switch on the programming pendant.
  After operation, the key should be removed and stored by the system manager.

Improper or unintended manipulator operation may result in injury. Also, the key or the mode select switch may be damaged if the programming pendant is dropped with the key inserted.

■ Cautions on Connection for Dual Input Signals

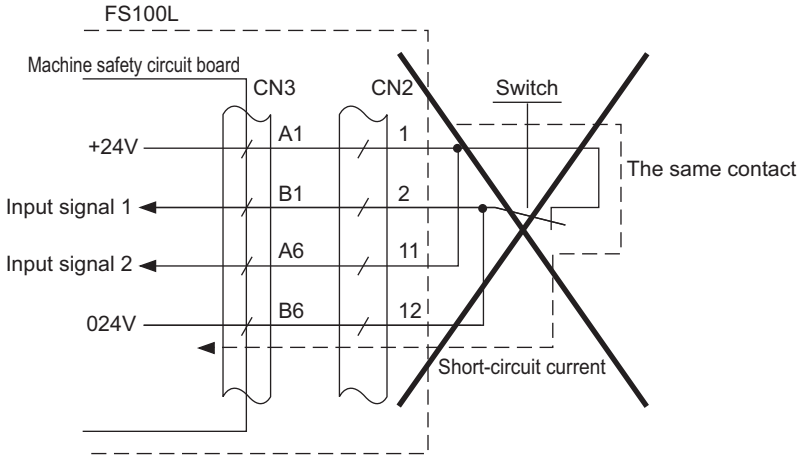
CAUTION

- Connect the switch (contact) that turns the dual signals ON and OFF simultaneously.
- If the timing that turns the two signals ON and OFF is not right, a disagreement alarm occurs. Refer to the figure below.



CAUTION

- Do not connect two signals to the same contact point. (Prepare two individual contact points)
- Since the power supply for each signal is reversed, it will short-circuit and may cause breakdown of FS100L Unit if the signals are connected to the same contact point.



13.1 CPU Unit

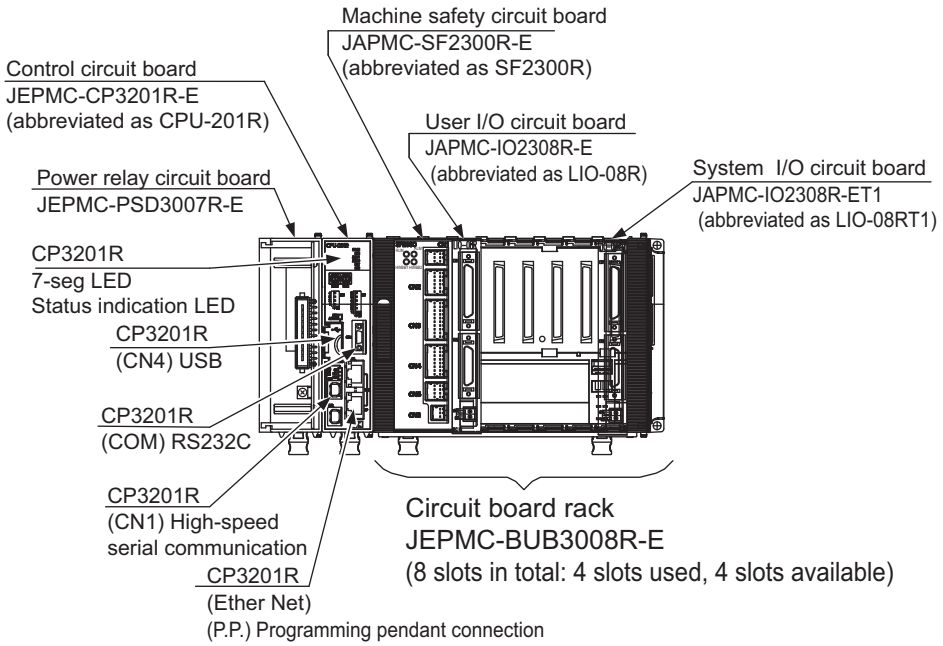
13.1.1 CPU Unit Configuration

CPU unit consists of a power relay circuit board, control circuit board, circuit board rack, machine safety circuit board, user I/O circuit board and system I/O circuit board.

The machine safety circuit board, user I/O circuit board and system I/O circuit board are mounted on the circuit board rack.

The power relay circuit board, control circuit board, and circuit board rack are connected by using the connectors on the side.

Fig. 13-1: CPU Unit Configuration



13.1.2 Circuit Board in CPU Unit

13.1.2.1 Control Circuit Board

(JEPMC-CP3201R-E, Abbreviated as CPU-201R)

This board performs to control the entire system, display to the programming pendant, control the operating keys, control operation, and calculate interpolation.

The operation status of the FS100L is indicated by the 7-seg LED and status indication LED.
(For details of the 7-seg LED and status indication LED, refer to *chapter 11 "LED Indicator on Each Circuit Board"* of "FS100L MAINTENANCE MANUAL".)

This board is connected with the major axes control circuit board (SRDA-EAXA01A) via high-speed serial communication, and has a USB port (2.0) and Ethernet (100BASE-TX/10-BASE-TX).

and Ethernet (100BASE-TX/10-BASE-TX).

Please do not change the factory setting of RSW1 except operations which are described at chapter 9.
(Factory setting is [0])

Please do not change the factory setting of RSW2.

(Factory setting is [0])

Please do not change the DIP switch settings of SW1 and SW2.

(Factory settings are all "OFF")

13.1.2.2 Power Relay Circuit Board (JEPMC-PSD3007R-E)

This is the relay board to receive the control power supply for the entire CPU unit from the CPS unit (JZNC-YPS01-E).

13.1.2.3 Circuit Board Rack (JEPMC-BUB3008R-E)

This is the rack to mount the circuit boards including optional circuit boards.

This rack is connected with the control circuit board (JEPMC-CP3201R-E) by using the connectors on the side.

The total number of slots is 8, but the circuit boards (machine safety circuit board, user I/O circuit board and system I/O circuit board) are mounted as standard. Thus, the number of available slots is 4, i.e., 4 optional circuit boards can be mounted.

13.2 Machine Safety Circuit Board

(JAPMC-SF2300R-E, Abbreviated as SF2300R)

13.2.1 Machine Safety Circuit Board (JAPMC-SF2300R-E)

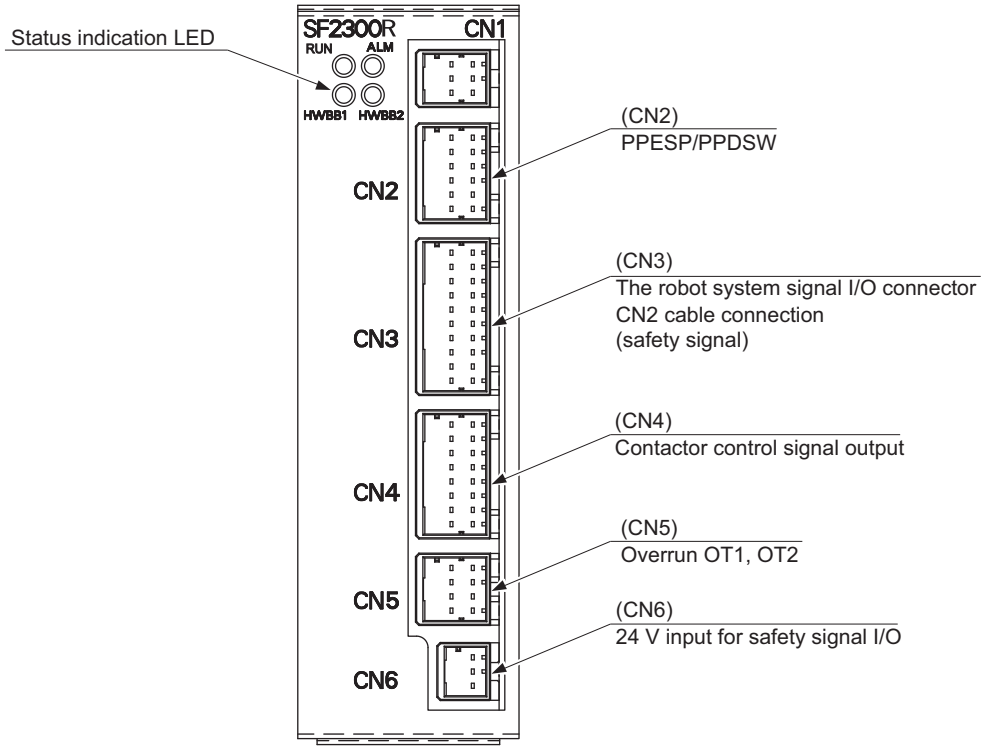
This unit contains dual processing circuits for safety signal.

It processes external safety signals with the dual processing circuits and, according to conditions, controls turning ON/OFF of the contactors for the servo power supply in the power supply contactor unit (JZRCR-YPU31□-1).

The functions of the machine safety circuit board include the following:

- Robot system input circuit (safety signal dual circuits)
- Protection stop (PSTOP) input circuit (dual circuits)
- Programming pendant signal PPESP, PPDSW input circuit (dual circuits)

For details of the status indication LED, refer to *chapter 11 "LED Indicator on Each Circuit Board"* of "FS100L MAINTENANCE MANUAL".



13.2.2 Connection for Robot System Input/Output Signal

A connector to input/output the robot system signal is prepared on the right side of the CPU unit of the FS100L. (Connector number: CN2)

For connection, refer to the connection diagram of each item.

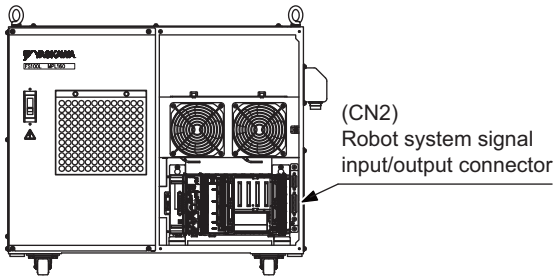


Table 13-1: Pin Assignment of Robot System Signal Input/Output Connector (CN2)

Controller-side connector: 17JE-13250-02(D4A)A, manufacturer: DDK
Note: fitting stud M2.6
Mating connector: 17JE-23250-02(D8A)-CG (connector with hood), manufacturer: DDK

* Upon shipment of the FS100L, a dummy connector which short-circuits each system signal is attached.

Pin No.	Signal Name	Description
1	SAFF_1+	Safeguarding (safety plug) (first system) * Upon shipment of the FS100L, this is short-circuited with a jumper cable in the dummy connector.
2	SAFF_1-	
3	PSTOP_1+	Protection stop (first system) * Upon shipment of the FS100L, this is short-circuited with a jumper cable in the dummy connector.
4	PSTOP_1-	
5	EXESP_1+	External emergency stop (first system) * Upon shipment of the FS100L, this is short-circuited with a jumper cable in the dummy connector.
6	EXESP_1-	
7	ESPOUT_1+	Emergency stop output (first system) *Do not short-circuit.
8	ESPOUT_1-	
9	PPESP3+	Programming pendant emergency stop output (first system)
10	PPESP3-	
11	SAFF_2+	Safeguarding (safety plug) (second system) * Upon shipment of the FS100L, this is short - circuited with a jumper cable in the dummy connector.
12	SAFF_2-	
13	Not used	
14	PSTOP_2+	Protection stop (second system) * Upon shipment of the FS100L, this is short - circuited with a jumper cable in the dummy connector.
15	PSTOP_2-	
16	EXESP_2+	External emergency stop (second system) * Upon shipment of the FS100L, this is short - circuited with a jumper cable in the dummy connector.
17	EXESP_2-	
18	ESPOUT_2+	Emergency stop output (second system) *Do not short-circuit.
19	ESPOUT_2-	

Pin No.	Signal Name	Description
20	PPESP4+	Programming pendant emergency stop output (second system)
21	PPESP4-	
22	Not used	
23	Not used	
24	Not used	
25	Not used	

* To input a system signal, supply a new connector for the signal. To a signal not used, connect a jumper cable similarly to when the FS100L is shipped.

13.2.2.1 Connection for Protection Stop (PSTOP) Signal

Connect this signal line when using the function to immediately turn OFF the servo power for safety protection when the servo power of the FS100L robot system is turned ON. (Stop category 0)

This signal is not used as standard, and a jumper cable is connected in the dummy connector.

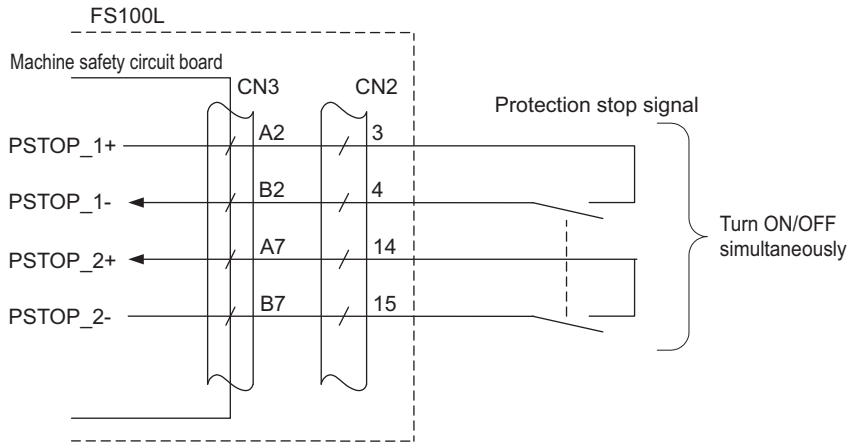
To use this signal, supply a new connector and perform wiring.

To a robot system signal which is not used, connect a jumper cable similarly to when the FS100L is shipped.

The dual inputs of the protection stop signal are used for safety. Thus, connect the switch (contact) that turns the dual signals ON and OFF simultaneously.

If only one of the signals is turned ON, an alarm occurs.

Fig. 13-2: Connection for Protection Stop Signal



13.2.2.2 Connection for Safeguarding (Safety Plug) (SAFF) Signal

This is the signal to turn OFF the servo power when the safeguarding opens. (Stop category 1)

Connect the interlock signal of the safety plug, etc. mounted on the door of safeguarding.

When the interlock signal is input, the servo power turns OFF, and the servo power cannot be turned ON after that.

This is disabled in the teach mode.

Upon shipment of the FS100L, a jumper cable is connected in the dummy connector.

To use the robot, supply a new connector and perform wiring of the safeguarding signal.

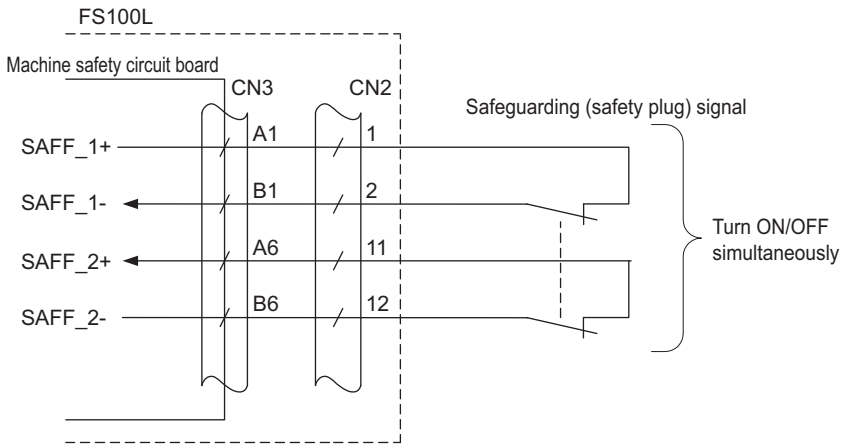
To a robot system signal which is not used, connect a jumper cable similarly to when the FS100L is shipped.

CAUTION

- Upon shipment of the FS100L, this signal is connected by a jumper cable in the dummy connector. To use the signal, make sure to supply 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.

Fig. 13-3: Connection for Safeguarding (Safety Plug) Signal

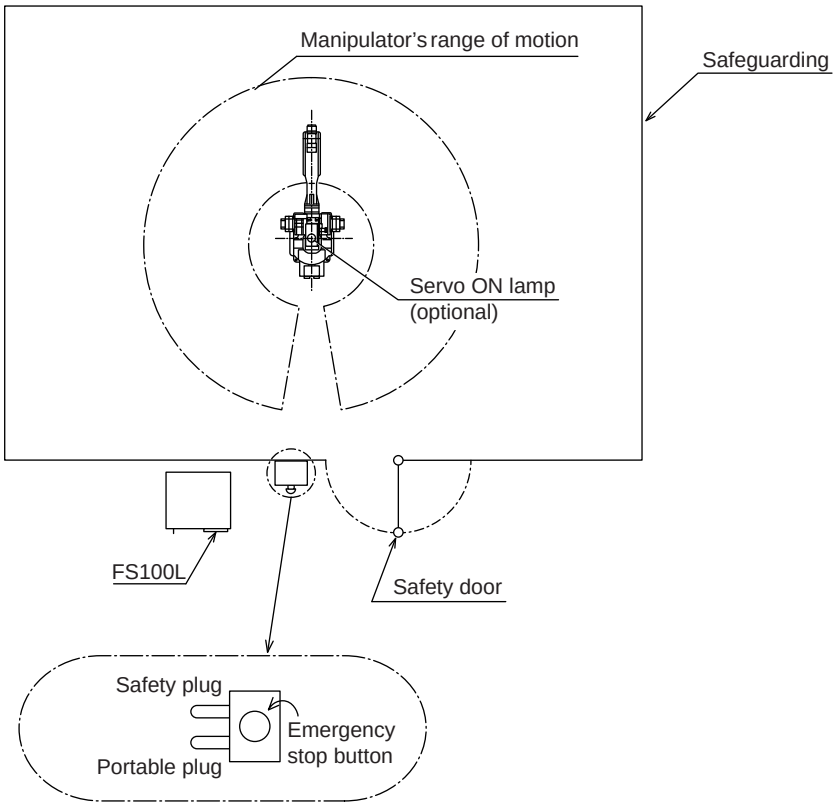


■ Installation example of safety plug

Install a safeguarding and a door with the interlock function around the manipulator so that an operator must open the door to enter and the interlock function stops the robot operation when the door opens.

The safety plug input signal is the signal to connect this interlock signal.

Fig. 13-4: Installation Example of Safety Plug



When the servo power is ON, input the interlock signal to turn OFF the servo power.
(The servo power cannot be turned ON while the interlock signal is input.)

Note that the servo power does not turn OFF in the teach mode.
(The servo power can be turned ON even while the interlock signal is input.)

13.2.2.3 Connection for External Emergency Stop (EXESP) Signal

This signal is used to connect the emergency stop switch of an external device, etc.

If the signal is input, the servo power is turned OFF and the job is stopped. (Stop category 1)
While the signal is input, the servo power cannot be turned ON.

Upon shipment of the FS100L, a jumper cable is connected in the dummy connector.

To use the this signal, supply a new connector and perform wiring of the external emergency stop signal.

To a robot system signal which is not used, connect a jumper cable similarly to when the FS100L is shipped.

CAUTION

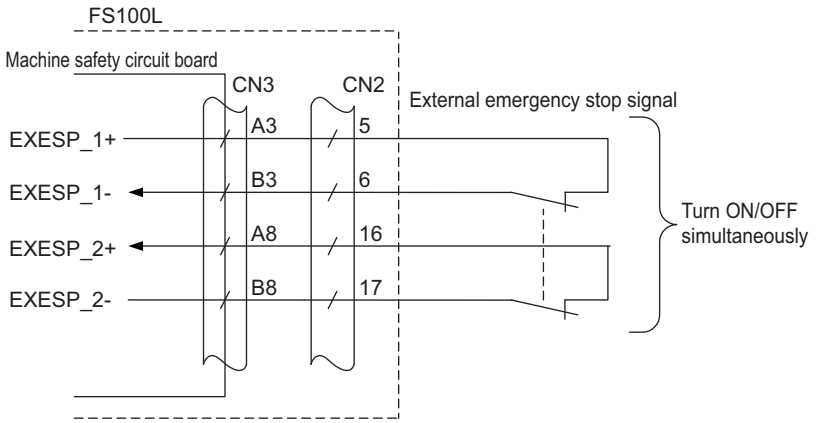
- Upon shipment of the FS100L, this signal is connected by a jumper cable in the dummy connector. To use the signal, make sure to supply a new connector, and then input it.

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

- In case the programming pendant is not used, an emergency stop button should be prepared in the system and wire the extenral emergency stop signal.

Injury or damage to machinery may result if the manipulator dose not stop due to the failure in preparatin of the emergency stop button.

Fig. 13-5: Connection for External Emergency Stop Signal



13.2.2.4 Connection for Emergency Stop Output (ESPOUT) Signal

This signal outputs, as dual signals, the signal status of the emergency stop of the programming pendant, the external emergency stop, and the safeguarding (safety plug) in the automatic operation mode.

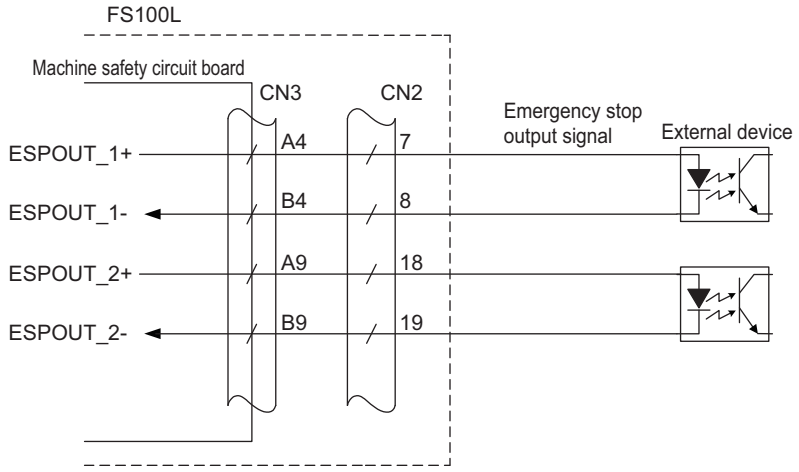
This signal can be used to check the signal status of the emergency stop of the programming pendant, the external emergency stop, and the safeguarding (safety plug) in the automatic operation mode by using an external safety device, etc. (for monitor use only)

CAUTION

- This signal is for monitor use.
  Unable to use the power shutdown for the external devices as safety signal.

To use this signal, supply a new connector and perform wiring.

Fig. 13-6: Connection for Emergency Stop Output Signal



* Output capacity: 24 VDC, 50 mA max.

13.2.2.5 Connection for Programming Pendant Emergency Stop Contact Output (PPESP) Signal

To an external device, a programming pendant emergency stop button contact signal is output.

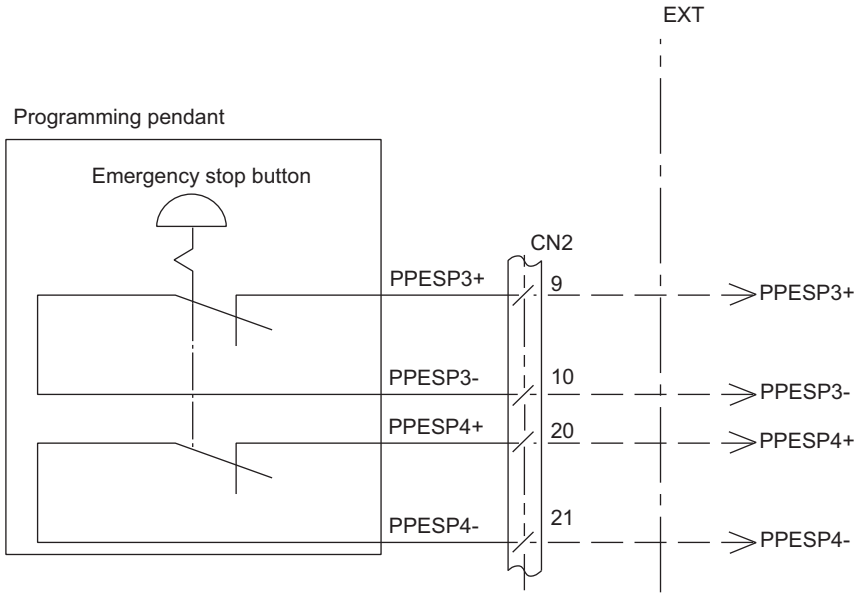
This emergency stop output is always valid despite ON/OFF of the main power supply of the FS100L. (status output signal: normally closed contact)

CAUTION

- Apply less voltage of 24VDC and less current of 0.5A .

Failure to observe this caution may damage to machinery.

Fig. 13-7: Connection of Emergency Stop Button Contact Output Signal



13.2.3 Connection for External Axis Overrun

If the overrun input of an external axis, etc. other than the manipulator is needed, perform connection as shown in *fig. 13-8 "Connection for External Axis Overrun Signal (1-External Axis)"* .

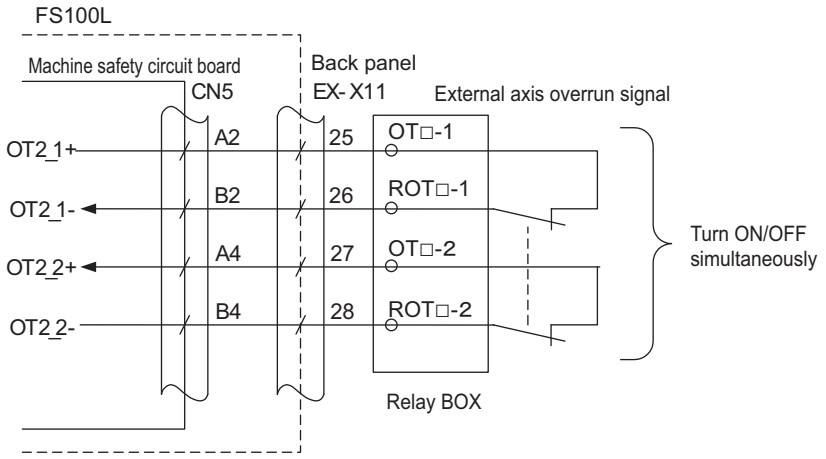
If the signal is input, the servo power is turned OFF and the job is stopped. While the signal is input, the servo power cannot be turned ON.

The dual inputs of the external axis overrun signal are used for safety. Thus, connect the switch (contact) that turns the dual signals ON and OFF simultaneously.

If only one of the signals is turned ON, an alarm occurs.

For the standard specification (without external axis), this signal cannot be used because the connectors for input (EX-X11, EX-X12) are not mounted.

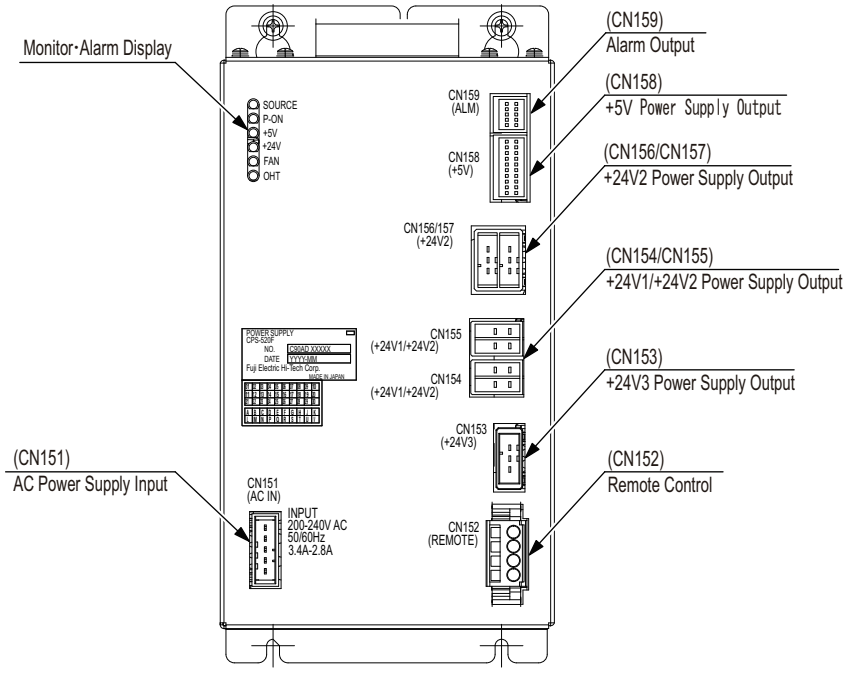
Fig. 13-8: Connection for External Axis Overrun Signal (1-External Axis)



13.3 CPS Unit (JZNC-YPS01-E)

This unit (JZNC-YPS01-E) supplies the DC power (DC5V, DC24V) for control (system, I/O, brake).

Fig. 13-9: CPS Unit JZNC-YPS01-E



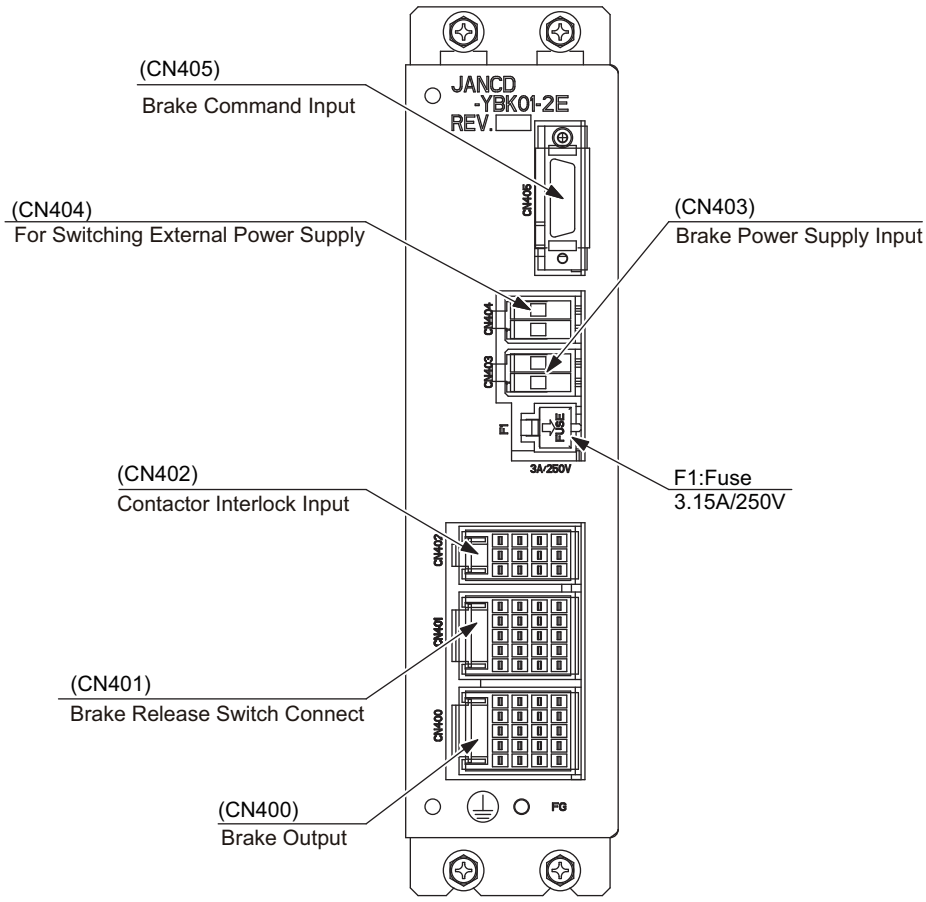
Items	Specifications
Input	Rating Input Voltage: 200/220VAC Voltage Fluctuation Range: +10% to -15% (170 to 242VAC) Frequency: 50/60Hz ± 2Hz (48 to 62Hz)
Output Voltage	DC + 5V DC +24V (24V1: System, 24V2: I/O, 24V3: Brake)
Indicator	

DISPLAY	Color	Status
SOURCE	Green	Lights with power supply input. Lights out when internal live part completes discharge. (Power supply status: being input)
POWER ON	Green	Lights when PWR_OK output signal is ON. (Power supply status: being output)
+5V	Red	Lights with +5V over-current (ON when abnormal)
+24V	Red	Lights with +24V over-current (ON when abnormal)
FAN	Red	Lights when FAN error occurs.
OHT	Red	Lights when unit interior overheats

13.4 Brake Control Board (JANCD-YBK01-2E)

13.4.1 Brake Control Board (JANCD-YBK01-2E)

Brake Control Board controls ON/OFF of the brakes (Robot + external axes) according to the command signal from Major Axes Control Circuit Board (SRDA-EAXA01□).

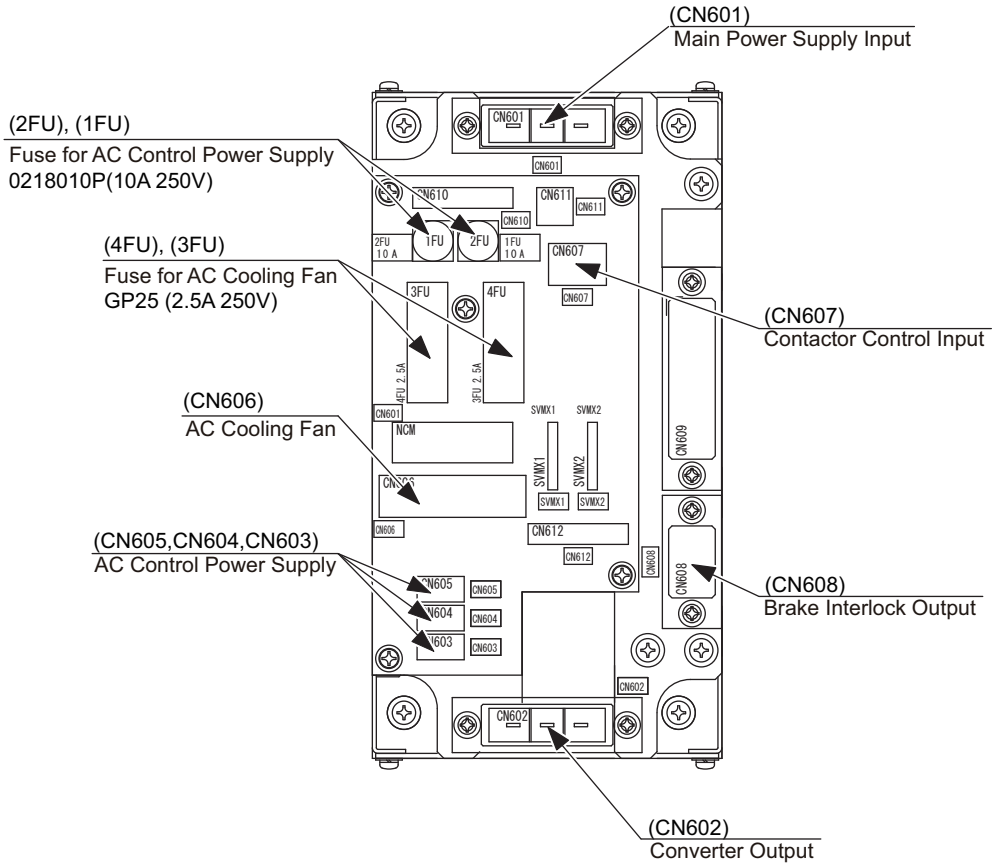


13.5 Power Supply Contactor Unit (JZRCR-YPU31 □ -1)

The power supply contactor unit (JARCR-YPU31 □ -1) consists of the power supply contactor circuit board (JARCR-YPC01-1), the contactor (1KM, 2KM) for servo power and the line filter (1Z). It turns the contactor servo power ON and OFF using the signal for servo power control from the machine safety circuit board and supplies power (3-phase AC200/220V) to the converter.

The power supply (single phase AC200/220V) is supplied to the CPS unit via the line filter.

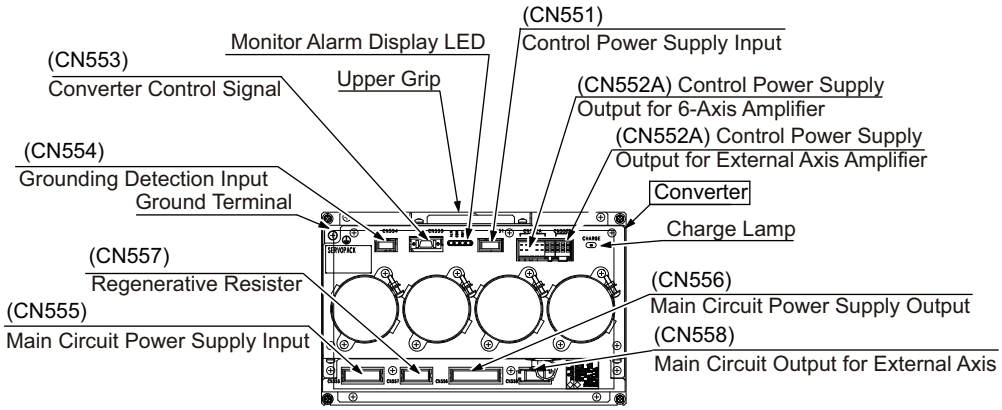
Fig. 13-10: Power Supply Contactor Unit Configuration (JZRCR-YPU31 □ -1)



13.6 Converter

This exchanges the power supply (3-phase: AC200/220V) supplied by the power supply contactor unit for DC power supply and supplies the power to PWM amplifiers for each axis.

Fig. 13-11: Converter



13.7 SERVOPACK

A SERVOPACK consists of a PWM amplifier and the major axes control circuit board. PWM amplifiers vary depending on the type of the manipulators.

13.7.1 PWM Amplifier

This exchanges the DC power supply supplied by the converter for a 3-phase motor power source and outputs to each servo motor.

Table 13-2(a): Configuration of PWM Amplifier

Configuration Device		**MH50**	**MH80**
		Model	Model
SERVOPACK		JZRCR-FSV04-11	JZRCR-FSV05-11
PWM Amplifier	S	SRDA-SDA71A01A-E	SRDA-SDA71A01A-E
	L	SRDA-SDA71A01A-E	SRDA-SDA71A01A-E
	U	SRDA-SDA35A01A-E	SRDA-SDA71A01A-E
	R	SRDA-SDA14A01A-E	SRDA-SDA14A01A-E
	B	SRDA-SDA14A01A-E	SRDA-SDA14A01A-E
	T	SRDA-SDA14A01A-E	SRDA-SDA14A01A-E

Table 13-2(b): Configuration of PWM Amplifier

Configuration Device		**MH165 MH200**	**MH215 MH250**
		Model	Model
SERVOPACK		JZRCR-FSV06-11	JZRCR-FSV06-11
PWM Amplifier	S	SRDA-SDA71A01A-E	SRDA-SDA71A01A-E
	L	SRDA-SDA71A01A-E	SRDA-SDA71A01A-E
	U	SRDA-SDA71A01A-E	SRDA-SDA71A01A-E
	R	SRDA-SDA35A01A-E	SRDA-SDA35A01A-E
	B	SRDA-SDA21A01A-E	SRDA-SDA35A01A-E
	T	SRDA-SDA21A01A-E	SRDA-SDA35A01A-E

Table 13-2(c): Configuration of PWM Amplifier

Configuration Device		**MPL80**
		Model
SERVOPACK		JZRCR-FSV04-11
PWM Amplifier	S	SRDA-SDA71A01A-E
	L	SRDA-SDA71A01A-E
	U	SRDA-SDA35A01A-E
	-	SRDA-SDA14A01A-E
	B	SRDA-SDA14A01A-E
	T	SRDA-SDA14A01A-E

Table 13-2(d): Configuration of PWM Amplifier

Configuration Device		**MPK50**	**MPL100 MPL160 MPL300**
		Model	Model
SERVOPACK		JZRCR-FSV05-11	JZRCR-FSV06-11
PWM Amplifier	S	SRDA-SDA71A01A-E	SRDA-SDA71A01A-E
	L	SRDA-SDA71A01A-E	SRDA-SDA71A01A-E
	U	SRDA-SDA71A01A-E	SRDA-SDA71A01A-E
	R	SRDA-SDA14A01A-E	SRDA-SDA35A01A-E
	-	SRDA-SDA14A01A-E	SRDA-SDA21A01A-E
	-	SRDA-SDA14A01A-E	SRDA-SDA21A01A-E

Fig. 13-12: Configuration of Servo Pack: MH50, MH80, MPL80, MPK50

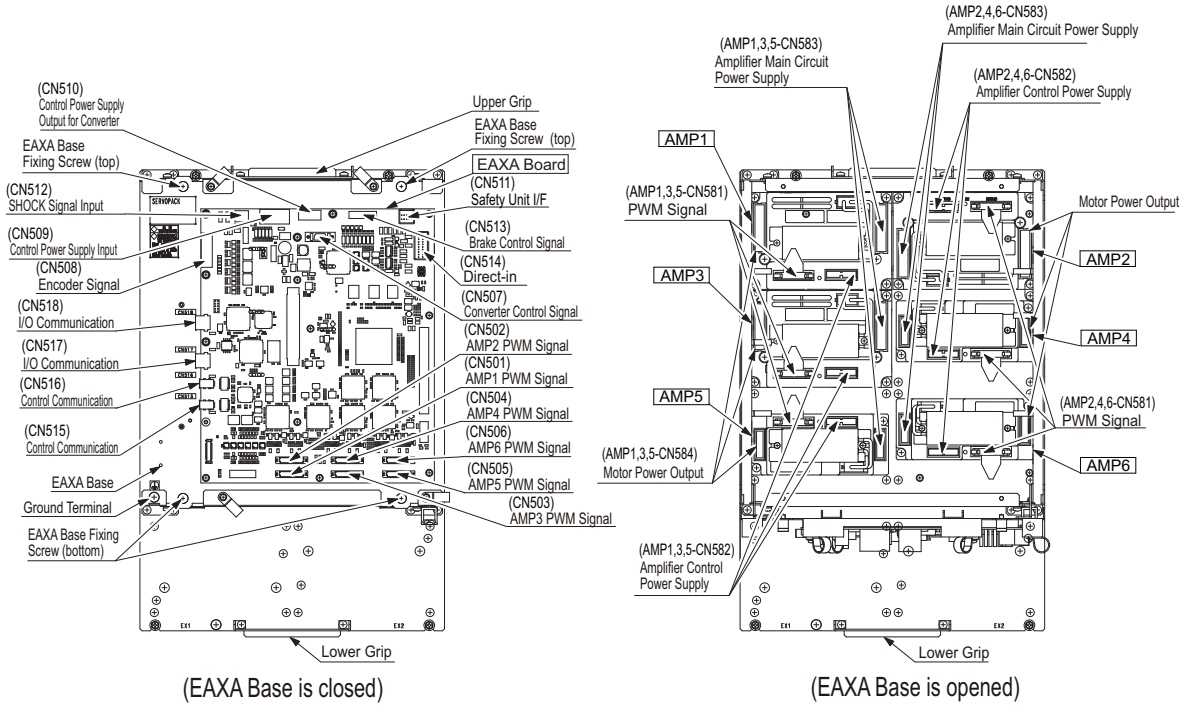


Fig. 13-13: Configuration of Servo Pack: MH165, MH200, MPL100, MPL160, MPL300

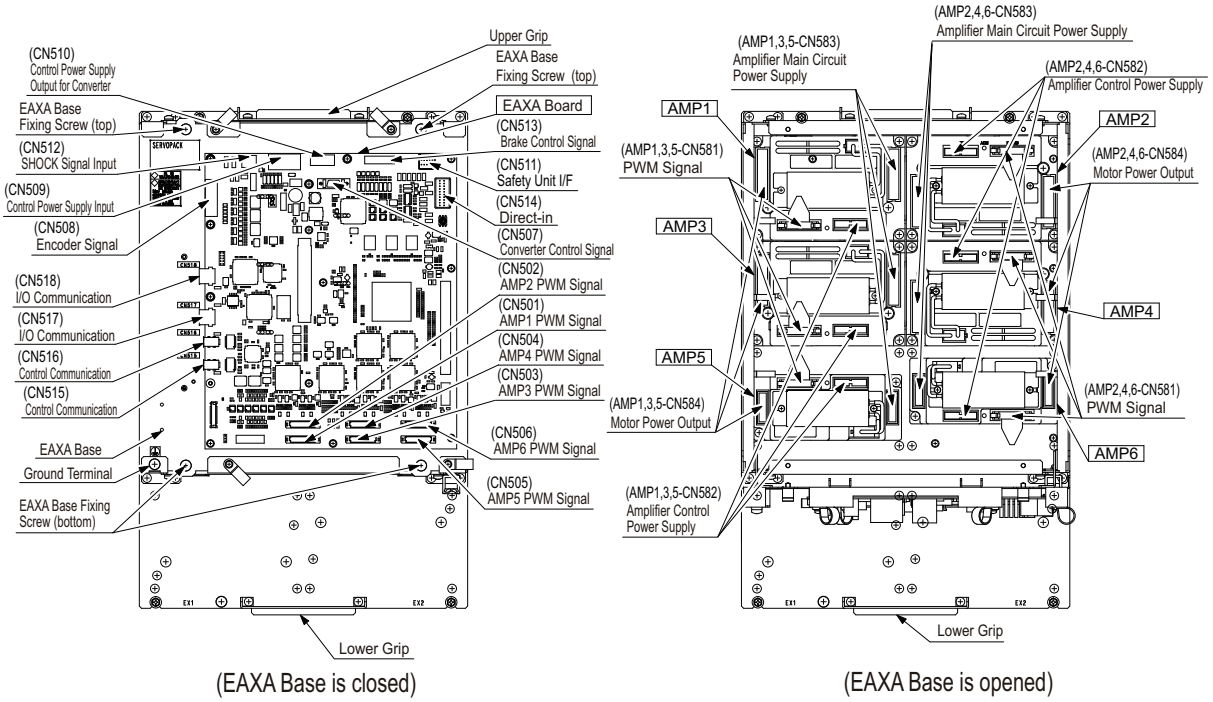
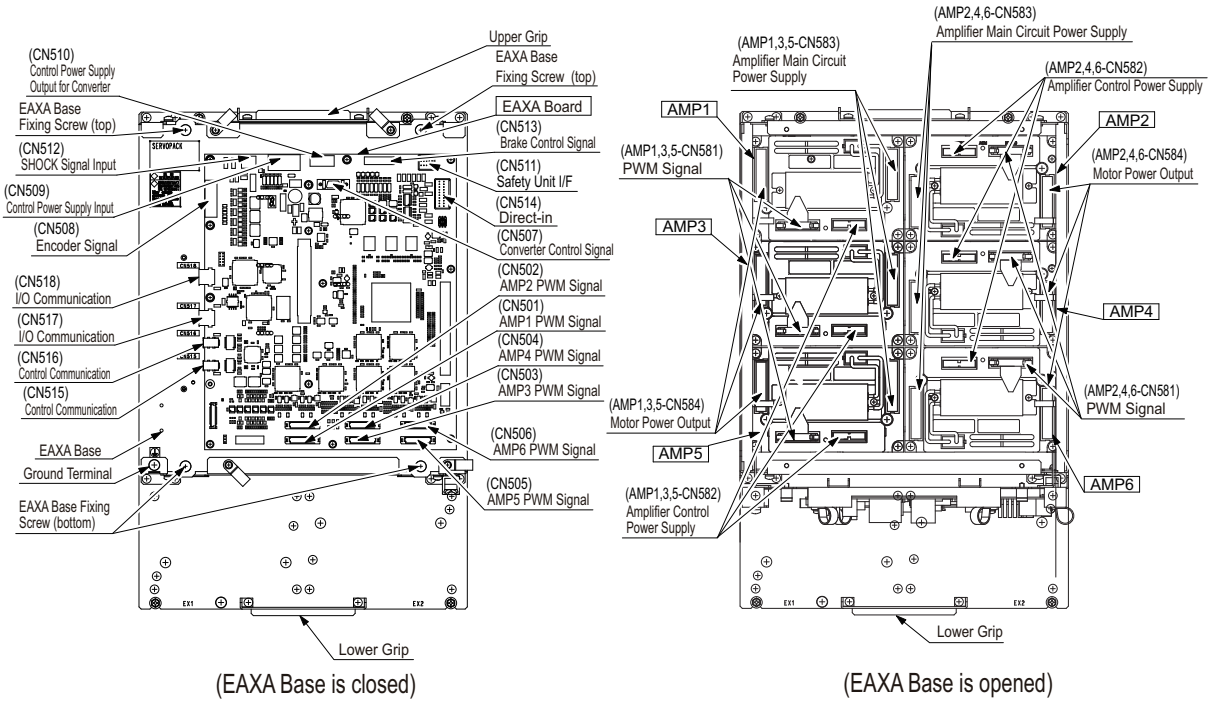


Fig. 13-14: Configuration of Servo Pack: MH215, MH250



13.7.2 Major Axes Control Circuit Board (SRDA-EAXA01□)

The major axes control circuit board (SRDA-EAXA01□) controls the servomotors of the manipulator's six axes.

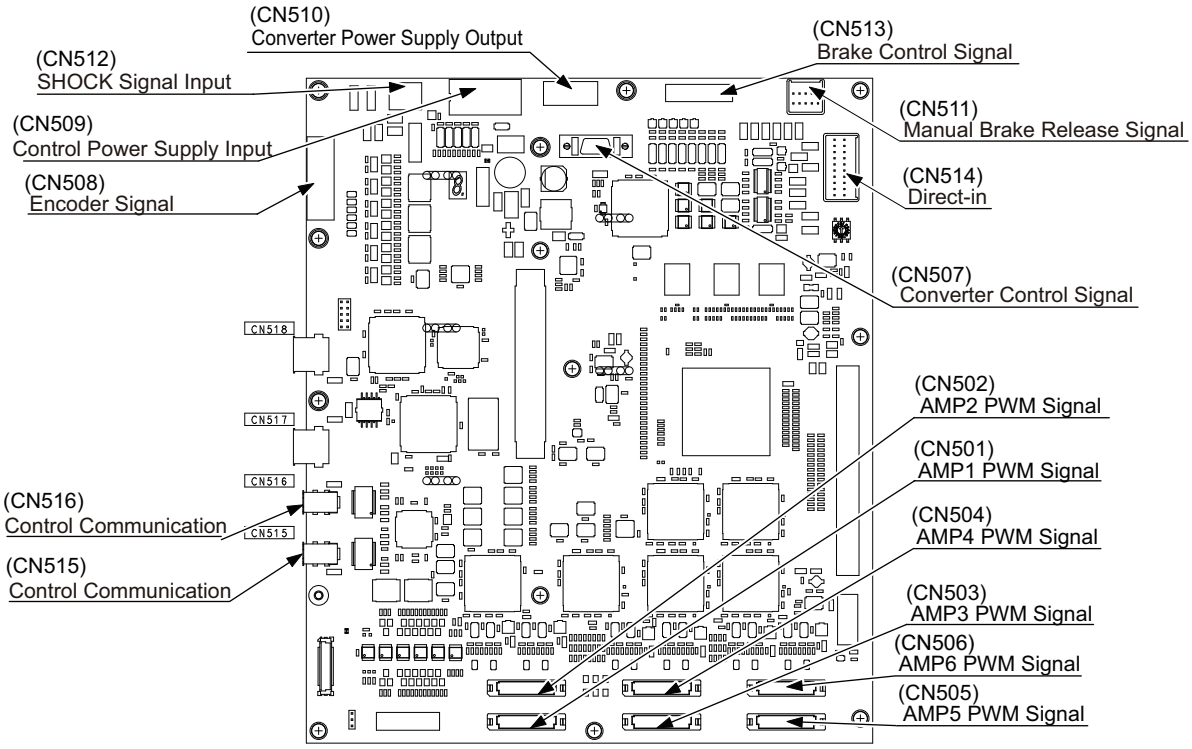
It also controls the converter and the PWM amplifiers.

Mounting an optional external axes control circuit board (SRDA-EAXB01□) makes it possible to control the servomotor of up to eight axes, including the robot axes.

The major axes control circuit board (SRDA-EAXA01□) also has the following functions.

- Brake Power Supply Control Circuit
- Shock sensor (shock) input circuit
- Direct-in circuit

Fig. 13-15: Major Axes Control Circuit Board (SRDA-EAXA01□)



13.7.3 Connection for Direct-in Signal

This signal is used to input responsive signals when using the search function, etc.

A connector (connector No.: CN211) for inputting Direct-in signal is prepared at the right side of the CPU unit of FS100L.

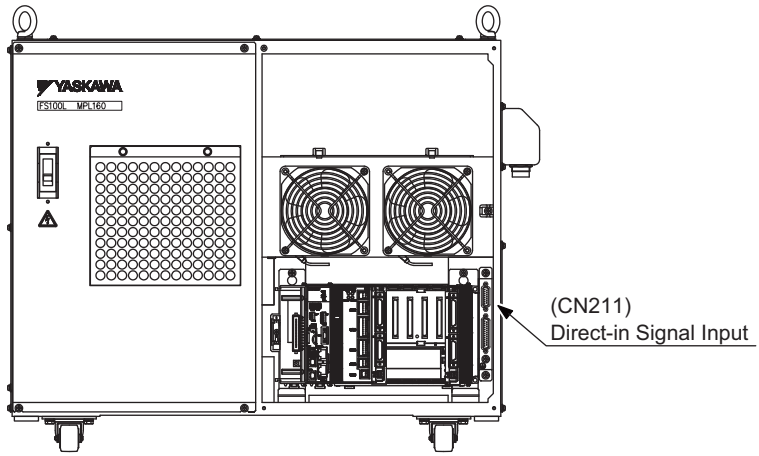
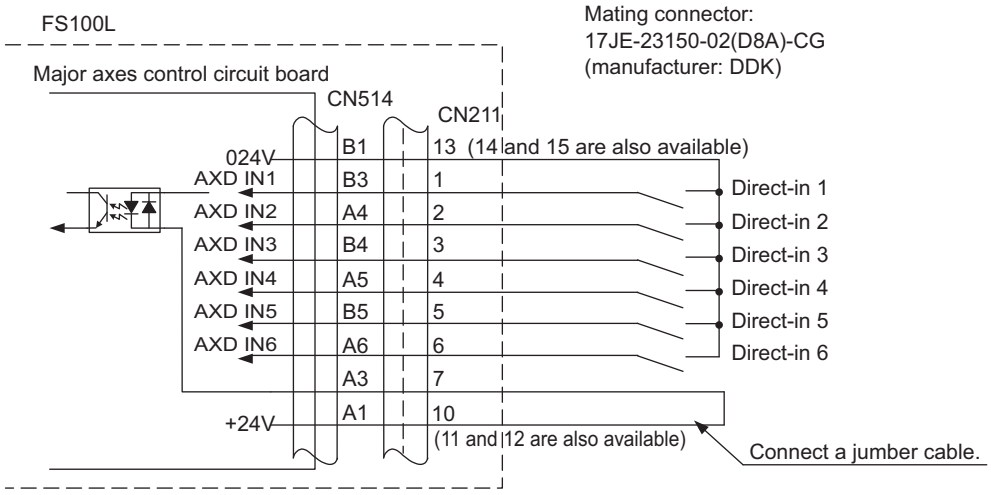


Figure below shows an example of Direct-in signal.
Prepare the accordant connector when input the signal to Direct-in.

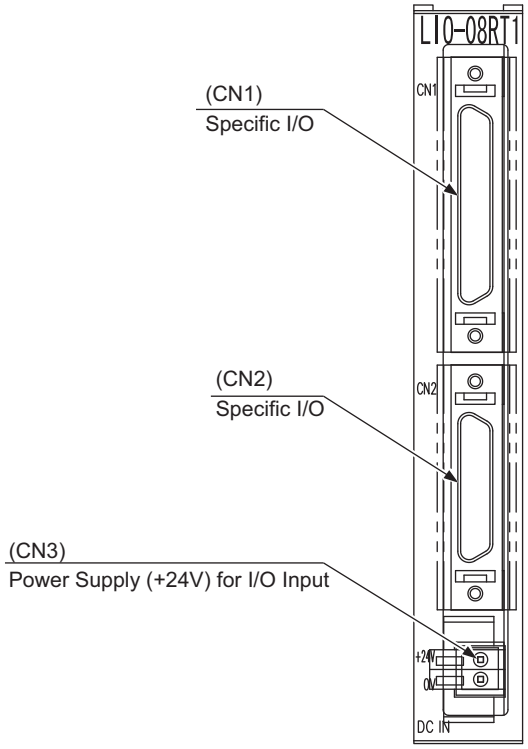
Fig. 13-16: Example Connection for Direct-in Signal (AXDIN1 to AXDIN6)



13.8 System I/O Circuit Board

(JAPMC-IO2308R-ET1, Abbreviated as LIO-08RT1)

The System I/O circuit board processes system I/O signals such as alarm signal of the CPS unit, motor cooling fan control signal and servo ON lamp signal.



13.9 User I/O Circuit Board

JAPMC-IO2308R-E, Abbreviated as LIO-08R)

NOTE Regarding the user I/O circuit board for the FS100L (JAPMC-IO2309R-E, abbreviated as LIO-09R), refer to *chapter 13.10 "User I/O Circuit Board (Optional)" at page 13-37*.

The FS100L has one user I/O circuit board (JAPMC-IO2308R-E) in its CPU unit as standard.

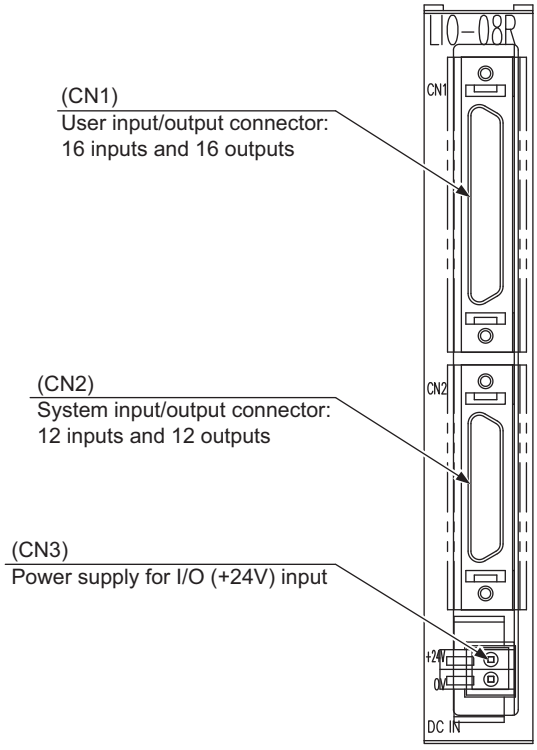
The user I/O circuit board (JAPMC-IO2308R-E) has 2 connectors for digital input/output (robot user input/output).

28 inputs and 28 outputs are available.
System input/output and user input/output can be used when allocating these inputs and outputs.

The system input/output is the signal with a function specified in advance. It is mainly used to control the manipulator and related devices as a system from the external control device such as a jig controller or a integrated controller, etc.

The user input/output is mainly used in the job of manipulator motion as the timing signal between the manipulator and peripheral devices.

For the details of allocation, refer to *fig. 13-19(a) "Connection Diagram of User Input/Output Connector (CN1) of User I/O Circuit Board (JAPMC-IO2308R-E)" at page 13-31* and *fig. 13-19(b) "Connection Diagram of System Input/Output Connector (CN2) of User I/O Circuit Board (JAPMC-IO2308R-E)" at page 13-32*.



In addition to user input/output, status of LIO-08R can be entered to the external input signal.

Logical number	Signal name	Description		
		Bit content	'1'	'0'
20050	24V_CHK[1)]	DC24V Low voltage detection	Normal	Abnormal (Voltage drop or disconnection of external fuse)
20051	1 (FIXED)		1 (FIXED)	
20052	1 (FIXED)		1 (FIXED)	
20053	1 (FIXED)		1 (FIXED)	
20054	1 (FIXED)		1 (FIXED)	
20055	1 (FIXED)		1 (FIXED)	
20056	MOST1	Module status1	Normal	Abnormal
20057	OSC_CHK	Oscillator stop detection	Abnormal	Normal
20060	MOST	Module status	Abnormal	Normal
20061	1 (FIXED)		1 (FIXED)	
20062	1 (FIXED)		1 (FIXED)	
20063	1 (FIXED)		1 (FIXED)	
20064	1 (FIXED)		1 (FIXED)	
20065	1 (FIXED)		1 (FIXED)	
20066	1 (FIXED)		1 (FIXED)	
20067	1 (FIXED)		1 (FIXED)	

1 There is an lower voltage detection for the blown detection of DC24V power supply external fuse. When the input voltage is lower than 15V, DC24V lower voltage detection of the status input signal would be an error.

13.9.1 Connection for External Power Supply for Input/Output

As standard, the input/output power supply is the internal power supply.

The FS100L can use the internal power supply of approx. 1 A, 24 VDC for input/output.
This internal power supply is protected by the fuse (F14: 1 A) on the inside left of the FS100L.

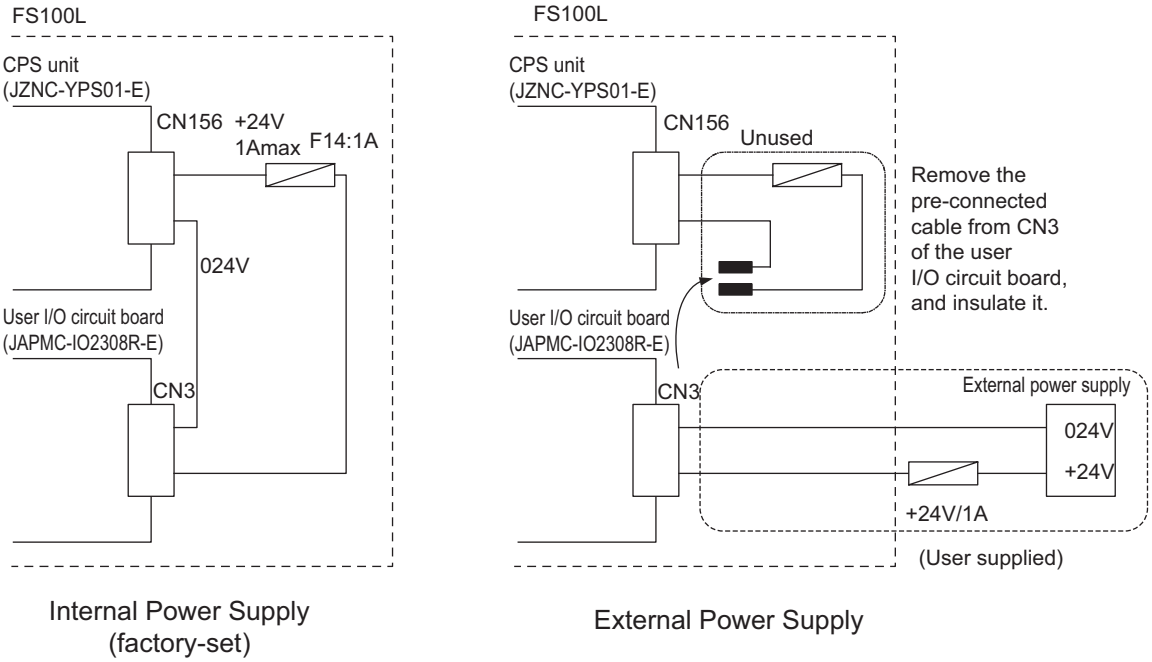
To use the FS100L with an external power supply, perform connection as follows:

1. Remove the cable connected to the power supply connector (CN3) of the user I/O circuit board from the connector.
   Make sure to insulate the removed cable.
2. Connect the external power supply to the power supply connectors of the user I/O circuit board by connecting +24V to CN3-2 and 0V to CN3-1.

To prevent burnout at short circuit of the 24V power supply or short circuit of the output, use an external fuse in the 24V line.

For the details of external fuse, refer to *chapter 13.9.2 “Protection by External Fuse” at page 13-28*.

Fig. 13-17: Connection for Power Supply for Input/Output



NOTE

- The FS100L can use the internal power supply of approx. 1 A, 24 VDC for input/output.
  To use current exceeding the above, or to insulate between the inside and the outside, use the external 24 V power supply.
- Install the external power supply outside the controller to prevent external noise from entering the inside of the controller.

Do not connect the power lines from the external power supply to the terminals CN3-1 and CN3-2 if the connection is set for using the internal power supply (with the pre-connected cable connected).
The internal power supply and the external power supply interfere with each other, which may result in equipment failure.

13.9.2 Protection by External Fuse

The user I/O circuit board (JAPMC-IO2308R-E) does not have a built-in protection device (fuse) for short circuit of the 24 VDC power supply or short circuit of the output, etc.

To prevent burnout, use an external fuse (rated current: 1 A, fast-blow fuse) in the +24V line of external power supply.

The user I/O circuit board has a built-in circuit to detect if the external fuse for the 24 VDC power supply is blown.

Voltage drop of the 24 VDC power supply or a blown external fuse, etc. is detected as an error.

13.9.2.1 Protection by External Fuse in Common Line of Output Signal

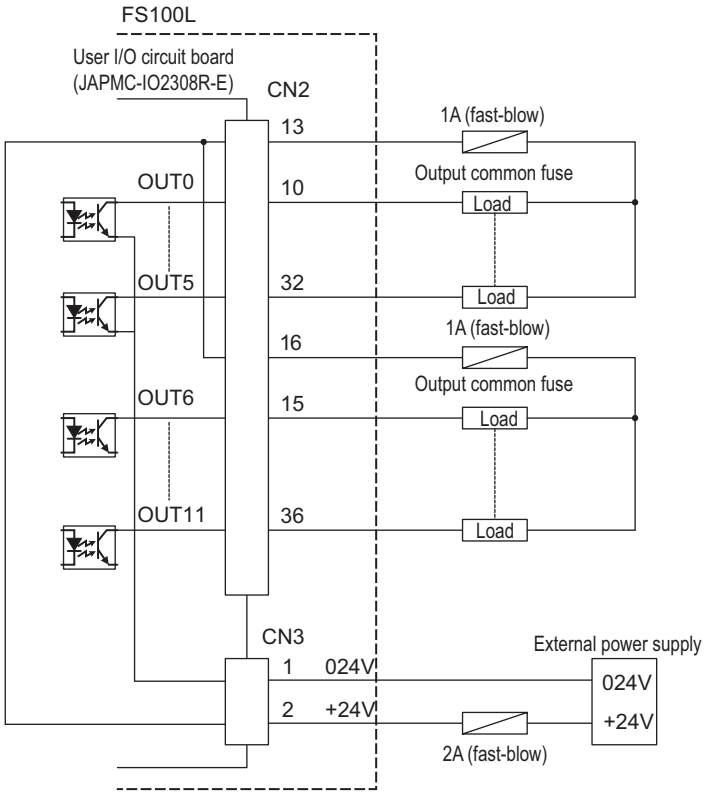
If the output current is too large for the rated current (1 A) of the external fuse for the 24 VDC power supply, perform the followings:

- Increase the capacity of the external fuse for the 24 VDC power supply up to the maximum of 2 A. (Use a fast-blow fuse.)
- Add an external fuse in the common line of the output signal.

For CN1, connect an external fuse (fast-blow fuse) with the rated current of 1 A for every 8 outputs.

For CN2, connect an external fuse (fast-blow fuse) with the rated current of 1 A for every 6 outputs.

Fig. 13-18: Example Connection for External Fuse in Common Line of Output Signal



13.9.3 Input/Output Connector (CN1, CN2)

Followings are the types of the input/output connectors (CN1, CN2) of the user I/O circuit board (JAPMC-IO2308R-E).

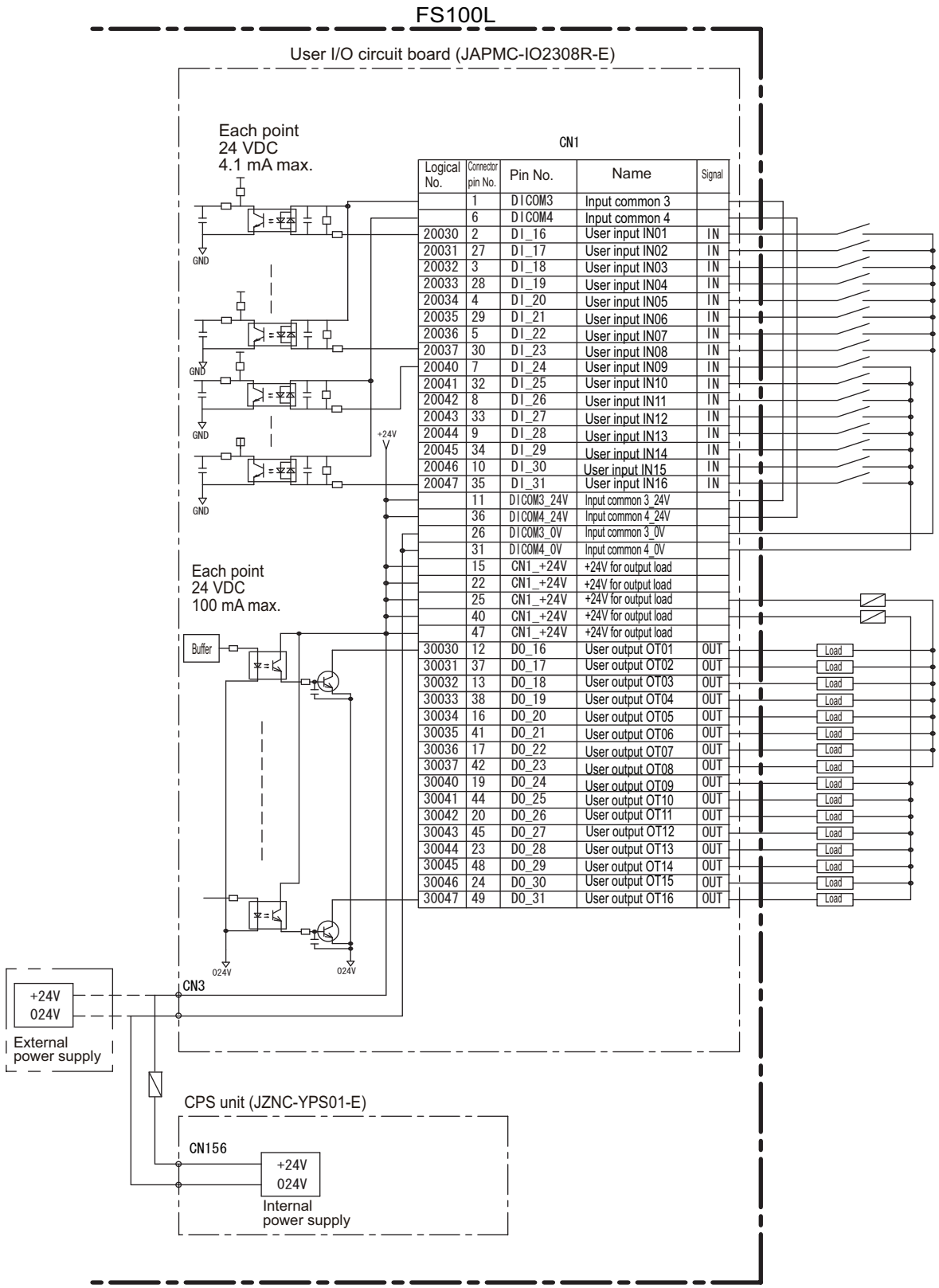
13.9.3.1 User Input/Output Connector (CN1)

Item	Description	
Used connector	10250-52A3PL (manufacturer: Sumitomo 3M Limited)	
Mating connector	10150-3000PE (manufacturer: Sumitomo 3M Limited) 10350-52A0-008 (manufacturer: Sumitomo 3M Limited) 10350-52F0-008 (manufacturer: Sumitomo 3M Limited)	Connector body Shell, thumbscrew lock type Shell, quick-release latching type

13.9.3.2 System Input/Output Connector (CN2)

Item	Description	
Used connector	10236-52A3PL (manufacturer: Sumitomo 3M Limited)	
Mating connector	10136-3000PE (manufacturer: Sumitomo 3M Limited) 10336-52A0-008 (manufacturer: Sumitomo 3M Limited) 10336-52F0-008 (manufacturer: Sumitomo 3M Limited)	Connector body Shell, thumbscrew lock type Shell, quick-release latching type

Fig. 13-19(a): Connection Diagram of User Input/Output Connector (CN1) of User I/O Circuit Board (JAPMC-IO2308R-E)

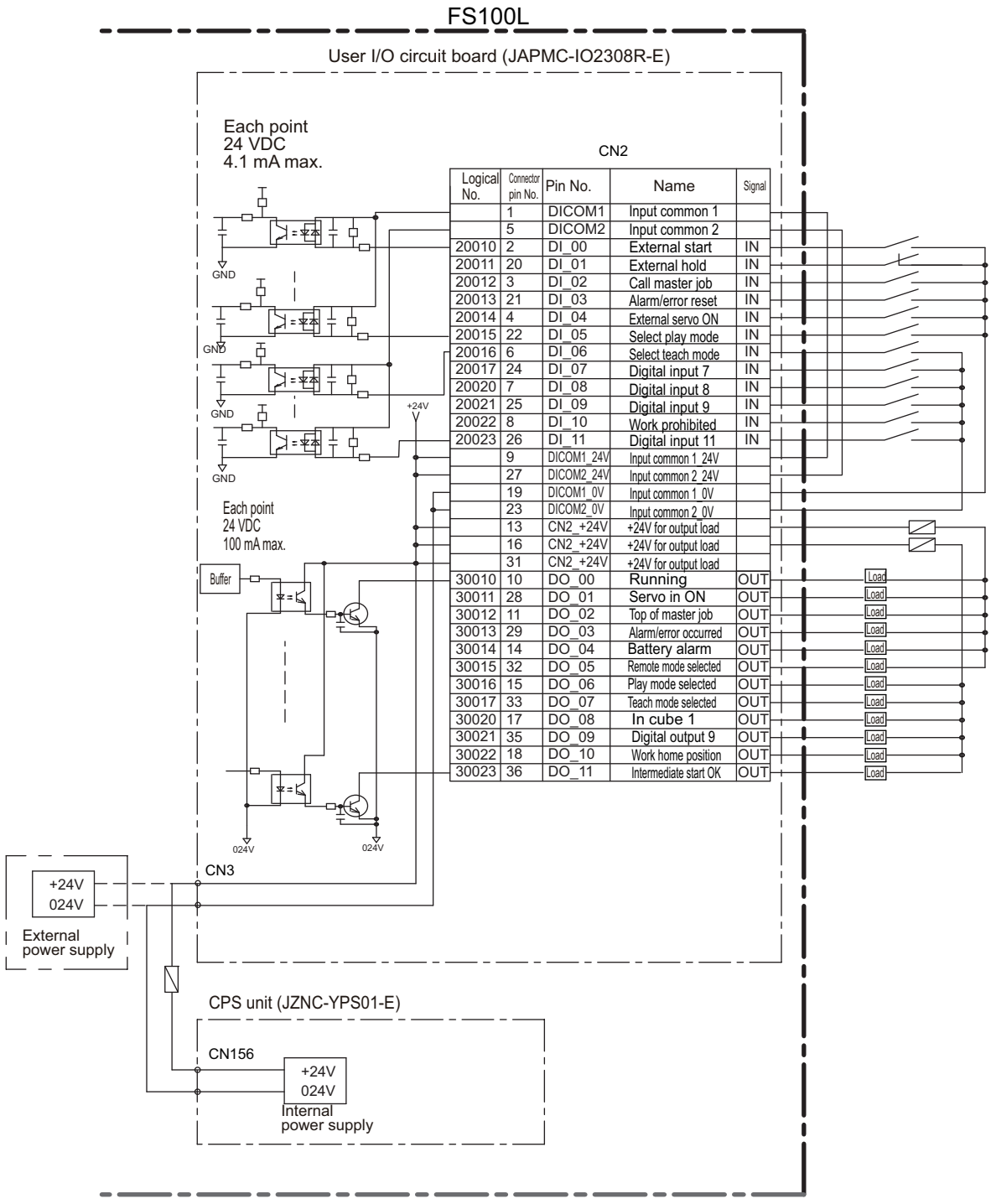


CN1

Logical No.	Connector pin No.	Pin No.	Name	Signal
	1	DICOM3	Input common 3	
	6	DICOM4	Input common 4	
20030	2	DI_16	User input IN01	IN
20031	27	DI_17	User input IN02	IN
20032	3	DI_18	User input IN03	IN
20033	28	DI_19	User input IN04	IN
20034	4	DI_20	User input IN05	IN
20035	29	DI_21	User input IN06	IN
20036	5	DI_22	User input IN07	IN
20037	30	DI_23	User input IN08	IN
20040	7	DI_24	User input IN09	IN
20041	32	DI_25	User input IN10	IN
20042	8	DI_26	User input IN11	IN
20043	33	DI_27	User input IN12	IN
20044	9	DI_28	User input IN13	IN
20045	34	DI_29	User input IN14	IN
20046	10	DI_30	User input IN15	IN
20047	35	DI_31	User input IN16	IN
	11	DICOM3_24V	Input common 3_24V	
	36	DICOM4_24V	Input common 4_24V	
	26	DICOM3_0V	Input common 3_0V	
	31	DICOM4_0V	Input common 4_0V	
	15	CN1_+24V	+24V for output load	
	22	CN1_+24V	+24V for output load	
	25	CN1_+24V	+24V for output load	
	40	CN1_+24V	+24V for output load	
	47	CN1_+24V	+24V for output load	
30030	12	DO_16	User output OT01	OUT
30031	37	DO_17	User output OT02	OUT
30032	13	DO_18	User output OT03	OUT
30033	38	DO_19	User output OT04	OUT
30034	16	DO_20	User output OT05	OUT
30035	41	DO_21	User output OT06	OUT
30036	17	DO_22	User output OT07	OUT
30037	42	DO_23	User output OT08	OUT
30040	19	DO_24	User output OT09	OUT
30041	44	DO_25	User output OT10	OUT
30042	20	DO_26	User output OT11	OUT
30043	45	DO_27	User output OT12	OUT
30044	23	DO_28	User output OT13	OUT
30045	48	DO_29	User output OT14	OUT
30046	24	DO_30	User output OT15	OUT
30047	49	DO_31	User output OT16	OUT

* To use the external power supply, remove the cable connected to the power supply connector (CN3) of the user I/O circuit board from the connector.
Make sure to insulate the removed cable.

Fig. 13-19(b): Connection Diagram of System Input/Output Connector (CN2) of User I/O Circuit Board (JAPMC-IO2308R-E)



Logical No.	Connector pin No.	Pin No.	Name	Signal
	1	DICOM1	Input common 1	
	5	DICOM2	Input common 2	
20010	2	DI_00	External start	IN
20011	20	DI_01	External hold	IN
20012	3	DI_02	Call master job	IN
20013	21	DI_03	Alarm/error reset	IN
20014	4	DI_04	External servo ON	IN
20015	22	DI_05	Select play mode	IN
20016	6	DI_06	Select teach mode	IN
20017	24	DI_07	Digital input 7	IN
20020	7	DI_08	Digital input 8	IN
20021	25	DI_09	Digital input 9	IN
20022	8	DI_10	Work prohibited	IN
20023	26	DI_11	Digital input 11	IN
	9	DICOM1_24V	Input common 1_24V	
	27	DICOM2_24V	Input common 2_24V	
	19	DICOM1_0V	Input common 1_0V	
	23	DICOM2_0V	Input common 2_0V	
	13	CN2_+24V	+24V for output load	
	16	CN2_+24V	+24V for output load	
	31	CN2_+24V	+24V for output load	
30010	10	DO_00	Running	OUT
30011	28	DO_01	Servo in ON	OUT
30012	11	DO_02	Top of master job	OUT
30013	29	DO_03	Alarm/error occurred	OUT
30014	14	DO_04	Battery alarm	OUT
30015	32	DO_05	Remote mode selected	OUT
30016	15	DO_06	Play mode selected	OUT
30017	33	DO_07	Teach mode selected	OUT
30020	17	DO_08	In cube 1	OUT
30021	35	DO_09	Digital output 9	OUT
30022	18	DO_10	Work home position	OUT
30023	36	DO_11	Intermediate start OK	OUT

* To use the external power supply, remove the cable connected to the power supply connector (CN3) of the user I/O circuit board from the connector.
Make sure to insulate the removed cable.

Table 13-3: System Input

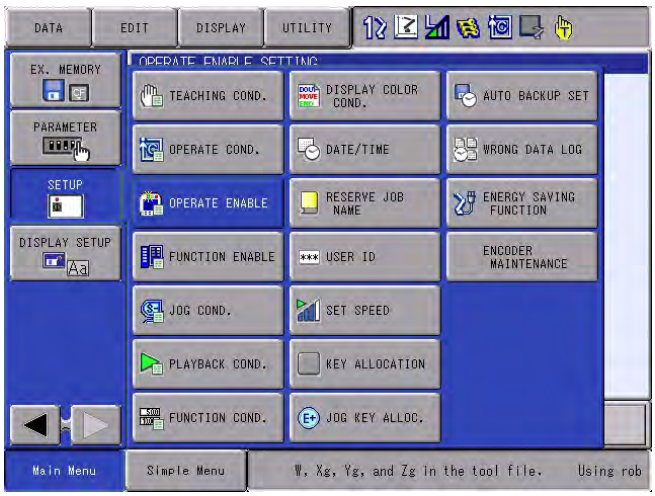
Logical Number	Input Name/Function
20010	EXTERNAL START Functions the same as the [START] button on the programming pendant. Only the rising edge of the signal is valid. It starts robot operation (playback). This signal is invalid if external start is prohibited from the playback condition display.
20011	EXTERNAL HOLD Functions the same as the [HOLD] button on the programming pendant, and is used when connecting a temporary stop switch of an external control device, etc. Connect a break-contact switch to this signal. When this signal is input (OFF), the JOB is stopped. During the input, the operation cannot be started and the axes cannot be operated. Also, while this signal is OFF, the [HOLD] button on the programming pendant lights up. Note that this signal is disabled as the default setting. To enable this signal, enable “EXTERNAL HOLD” in the {OPERATE ENABLE} under the main menu {SETUP} of the programming pendant in the management mode. For details, refer to *chapter 13.9.4 “Enabling External Hold” at page 13-34*.
20012	CALL MASTER JOB Only the rising edge of the signal is valid. It calls up the top of the robot program, that is the top of the master job[1)]. This signal is invalid during playback, during teach-lock and when play master or call is prohibited (set from the playback operation condition display).
20013	ALARM/ERROR RESET After an alarm or error has occurred and the cause been corrected, this signal resets the alarm or error.
20014	EXTERNAL SERVO ON Turns ON the servo power supply. Only the rising edge of the signal is valid.
20015	SELECT PLAY MODE The play mode is selected when the mode key on the programming pendant is set at “REMOTE”. Only the rising edge of the signal is valid. When this selection signal assigned concurrently with other mode selection signal, the teach mode is selected on a priority basis. The signal is invalid while EXTERNAL MODE SWITCH is prohibited.
20016	SELECT TEACH MODE The teach mode is selected when the mode key of the programming pendant is set at “REMOTE”. The other mode selection is unavailable when this signal is ON; the signal is selected by priority even when the other selection signal is ON, enabling the teach mode selection.

1 A master job is a job (program) which can be called by CALL MASTER JOB.
Other functions are the same as for normal jobs. Normally, the parent job, which manages the child jobs called up immediately after the power is turned ON, is set as the master job.

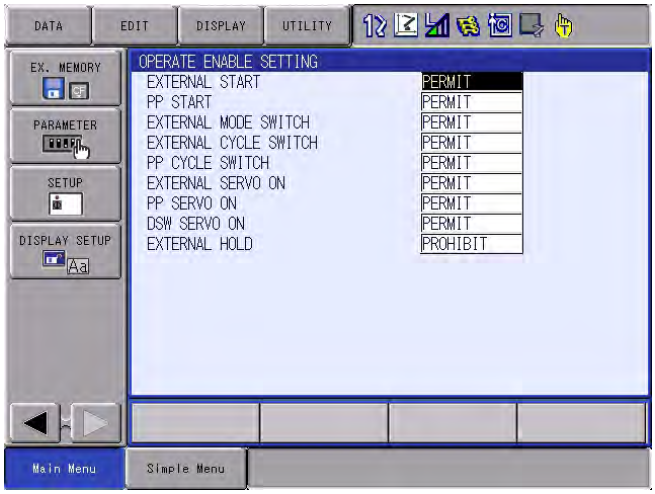
13.9.4 Enabling External Hold

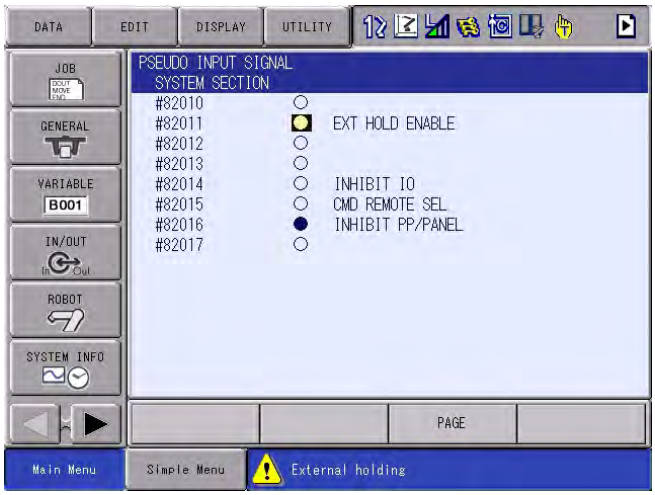
The external hold signal is disabled as the default setting so that the manipulator can be operated without the I/O cable connected. To enable the external hold signal, follow the procedure below.

1. In the management mode, select {OPERATE ENABLE} under the main menu {SETUP}.

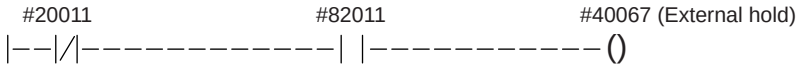


2. Switch “EXTERNAL HOLD” from “PROHIBIT” to “PERMIT”. By doing so, the pseudo input signal #82011 “EXT HOLD ENABLE” changes from “OFF” to “ON.





The initial value of the concurrent I/O is as shown below, so the system input #40067 can be controlled by the break-contact switch connected to #20011.



NOTE

- Be sure to use the break-contact switch for the external hold switch.
- After the setting of the external hold, check to be sure that the external hold functions properly. While the external hold switch is in operation, the [HOLD] button on the programming pendant lights up.

Table 13-4: System Output

Logical Number	Output Name/Function
30010	RUNNING This signal signifies that the job is running. (Signifies that the job is running, system status is waiting reserved start, or test run is running.) This signal status is the same status as [START] in the programming pendant.
30011	SERVO IS ON This signal signifies that the servo power is turned ON, internal processing such as current position creation is complete, and the system is able to receive the START command. This signal turns OFF when the servo power supply turns OFF. It can be used for FS100L status diagnosis for an external start.
30012	TOP OF MASTER JOB This signal signifies that the execution position is the top of the master job. This signal can be used to confirm that the master job has been called.[1)]***1***
30013	ALARM/ERROR OCCURRED This signal signifies that an alarm or an error occurred. If a major error occurs, this signal remains ON until the main power is turned OFF.
30014	BATTERY ALARM This signal turns ON to notify that the battery requires replacing when the voltage drops from the battery for backup memory of the encoder. Major problems may result if memory data is lost because of an expired battery. It is recommended to avoid these problems by using this signal as a warning signal.
30015 to 30017	REMOTE/PLAY/TEACH MODE SELECTED This signal notifies the current mode setting. These signals are synchronized with the mode select switch in the programming pendant. The signal corresponding to the selected mode turns ON.
30020	WORK COMMAND This signal provides the command for the general tool to operate. TOOL ON instruction execution or the [TOOL ON] key in the programming pendant turns this signal ON and TOOL OFF instruction execution or the [TOOL OFF] key in the programming pendant turns it OFF. However, it remains OFF while the WORK PROHIBITED signal (2022) is input or while the robot is stopped.
30022	WORK HOME POSITION (IN CUBE 64)[2)] This signal turns ON when the current TCP lies inside the work home position area. Use this signal to evaluate whether the robot is in the start position.
30023	INTERMEDIATE START OK This signal turns ON when the manipulator operates. It turns OFF when the currently executed line is moved with the cursor or when editing operation is carried out after HOLD is applied during operation. Therefore, this signal can be used as a restart interlock after a HOLD is applied. However, it also turns ON in the teach mode and TEACH MODE SELECTED signal must be referred together.

1 This signal is not output during operation.
2 The work home position cube and Cube 64 are the same.

13.10 User I/O Circuit Board (Optional)

(JAPMC-IO2309R-E, Abbreviated as LIO-09R)

NOTE

Regarding the user I/O circuit board for the FS100L (JAPMC-IO2308R-E, abbreviated as LIO-08R), refer to *chapter 13.9 "User I/O Circuit Board" at page 13-25*.

The user I/O circuit board (JAPMC-IO2309R-E) is available in the FS100L system as an optional.

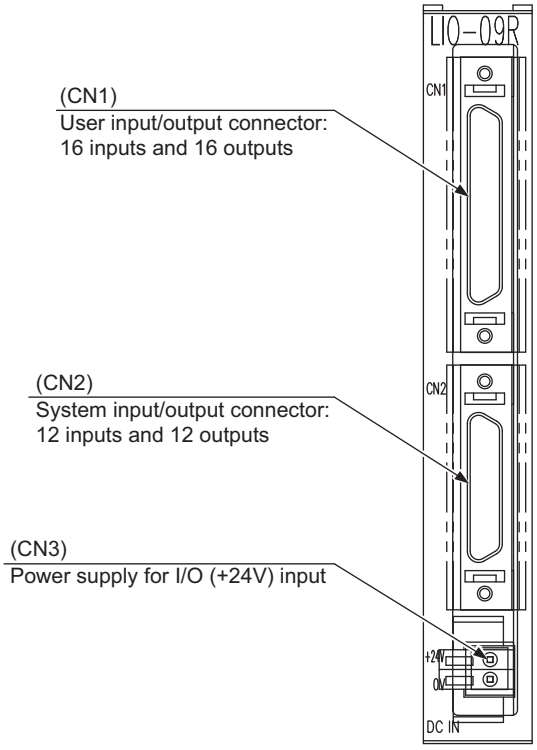
And this circuit board (JAPMC-IO2309R-E) has 2 connectors for digital input/output (robot user input/output).

28 inputs and 28 outputs are available.
System input/output and user input/output can be used when allocating these inputs and outputs.

The system input/output is the signal with a function specified in advance. It is mainly used to control the manipulator and related devices as a system from the external control device such as a jig controller or a integrated controller, etc.

The user input/output is mainly used in the job of manipulator motion as the timing signal between the manipulator and peripheral devices.

For the details of allocation, refer to *fig. 13-22(a) "Connection Diagram of User Input/Output Connector (CN1) of User I/O Circuit Board (JAPMC-IO2309R-E)" at page 13-43* and *fig. 13-22(b) "Connection Diagram of System Input/Output Connector (CN2) of User I/O Circuit Board (JAPMC-IO2309R-E)" at page 13-44*.



In addition to user input/output, status of LIO-09R can be entered to the external input signal of the FS100L system.

Logical number	Signal name	Description		
		Bit content	'1'	'0'
20050	24V_CHK[1)]	DC24V Low voltage detection	Normal	Abnormal (Voltage drop or disconnection of external fuse)
20051	1 (FIXED)		1 (FIXED)	
20052	1 (FIXED)		1 (FIXED)	
20053	1 (FIXED)		1 (FIXED)	
20054	1 (FIXED)		1 (FIXED)	
20055	1 (FIXED)		1 (FIXED)	
20056	MOST1	Module status1	Normal	Abnormal
20057	OSC_CHK	Oscillator stop detection	Abnormal	Normal
20060	MOST	Module status	Abnormal	Normal
20061	1 (FIXED)		1 (FIXED)	
20062	1 (FIXED)		1 (FIXED)	
20063	1 (FIXED)		1 (FIXED)	
20064	1 (FIXED)		1 (FIXED)	
20065	1 (FIXED)		1 (FIXED)	
20066	1 (FIXED)		1 (FIXED)	
20067	1 (FIXED)		1 (FIXED)	

1 There is an lower voltage detection for the blown detection of DC24V power supply external fuse. When the input voltage is lower than 15V, DC24V lower voltage detection of the status input signal would be an error.

13.10.1 Connection for External Power Supply for Input/Output

As standard, the input/output power supply is the internal power supply.

The FS100L can use the internal power supply of approx. 1 A, 24 VDC for input/output.
This internal power supply is protected by the fuse (F14: 1 A) on the inside left of the FS100L.

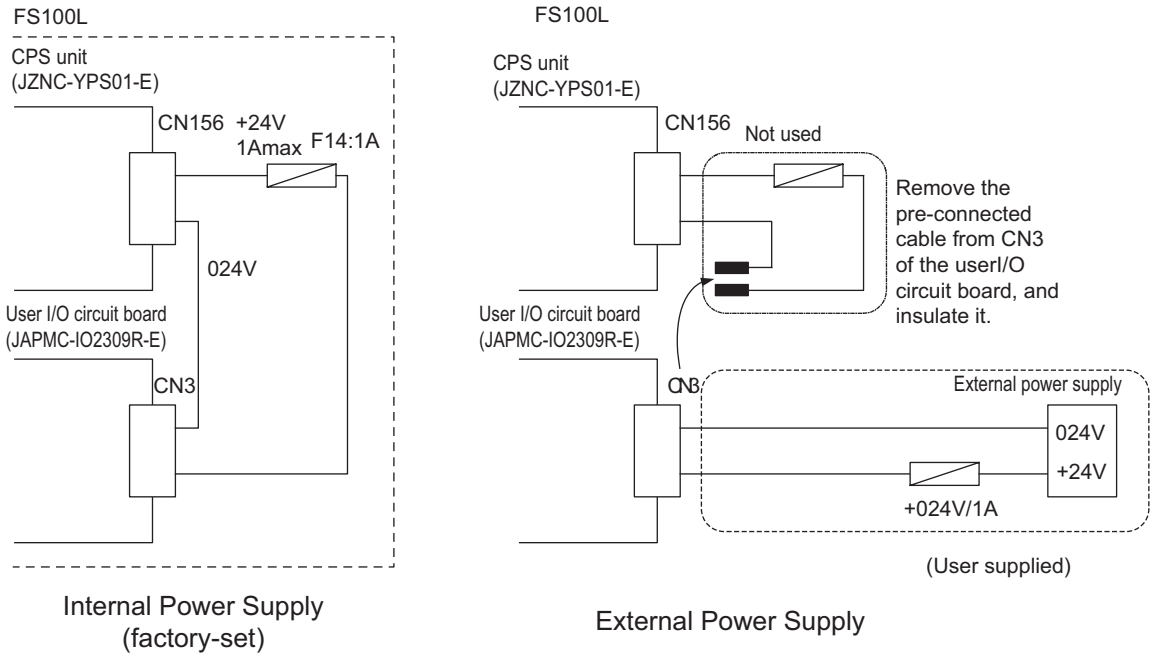
To use the FS100L with an external power supply, perform connection as follows:

1. Remove the cable connected to the power supply connector (CN3) of the user I/O circuit board from the connector.
   Make sure to insulate the removed cable.
2. Connect the external power supply to the power supply connectors of the user I/O circuit board by connecting +24V to CN3-2 and 0V to CN3-1.

To prevent burnout at short circuit of the 24V power supply or short circuit of the output, use an external fuse in the 24V line.

For the details of external fuse, refer to *chapter 13.9.2 "Protection by External Fuse" at page 13-28*.

Fig. 13-20: Connection for Power Supply for Input/Output



NOTE

- The FS100L can use the internal power supply of approx. 1A, 24 VDC for input/output.
  To use current exceeding the above, or to insulate between the inside and the outside, use the external 24 V power supply.
- Install the external power supply outside the controller to prevent external noise from entering the inside of the controller.

Do not connect the power lines from the external power supply to the terminals CN3-1 and CN3-2 if the connection is set for using the internal power supply (with the pre-connected cable connected).
The internal power supply and the external power supply interfere with each other, which may result in equipment failure.

13.10.2 Protection by External Fuse

The user I/O circuit board (JAPMC-IO2309R-E) does not have a built-in protection device (fuse) for short circuit of the 24 VDC power supply or short circuit of the output, etc.

To prevent burnout, use an external fuse (rated current: 1 A, fast-blow fuse) in the +24V line of external power supply.

The user I/O circuit board has a built-in circuit to detect if the external fuse for the 24 VDC power supply is blown.

Voltage drop of the 24 VDC power supply or a blown external fuse, etc. is detected as an error.

13.10.2.1 Protection by External Fuse in Common Line of Output Signal

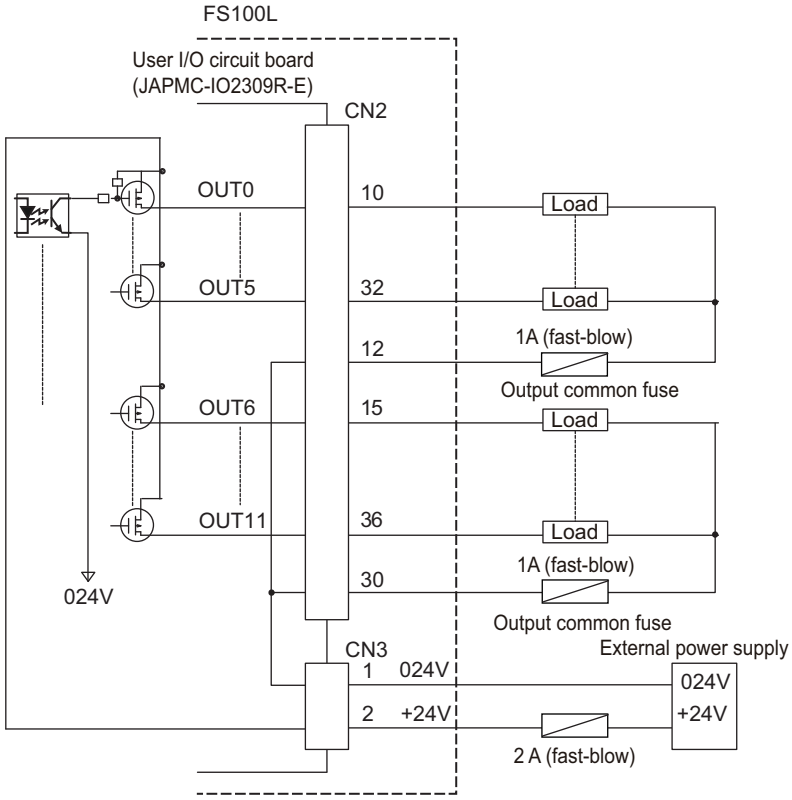
If the output current is too large for the rated current (1 A) of the external fuse for the 24 VDC power supply, perform the followings:

- Increase the capacity of the external fuse for the 24 VDC power supply up to the maximum of 2 A. (Use a fast-blow fuse.)
- Add an external fuse in the common line of the output signal.

For CN1, connect an external fuse (fast-blow fuse) with the rated current of 1 A for every 8 outputs.

For CN2, connect an external fuse (fast-blow fuse) with the rated current of 1 A for every 6 outputs.

Fig. 13-21: Example Connection for External Fuse in Common Line of Output Signal



13.10.3 Input/Output Connector (CN1, CN2)

When wiring, refer to the types of the input/output connectors (CN1, CN2) of the user I/O circuit board (JAPMC-IO2309R-E) shown below.

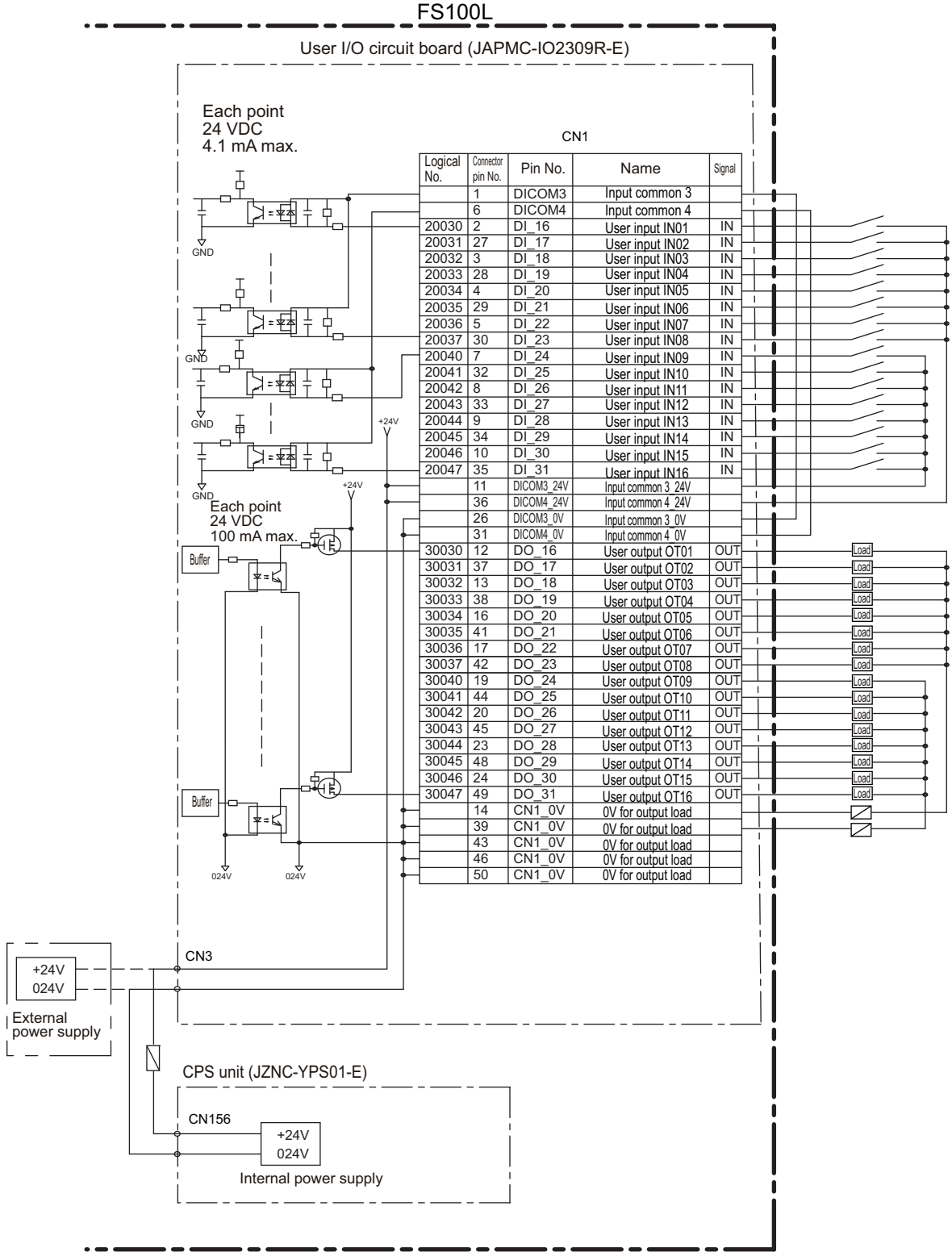
13.10.3.1 User Input/Output Connector (CN1)

Item	Description	
Used connector	10250-52A3PL (manufacturer: Sumitomo 3M Limited)	
Mating connector	10150-3000PE (manufacturer: Sumitomo 3M Limited) 10350-52A0-008 (manufacturer: Sumitomo 3M Limited) 10350-52F0-008 (manufacturer: Sumitomo 3M Limited)	Connector body Shell, thumbscrew lock type Shell, quick-release latching type

13.10.3.2 System Input/Output Connector (CN2)

Item	Description	
Used connector	10236-52A3PL (manufacturer: Sumitomo 3M Limited)	
Mating connector	10136-3000PE (manufacturer: Sumitomo 3M Limited) 10336-52A0-008 (manufacturer: Sumitomo 3M Limited) 10336-52F0-008 (manufacturer: Sumitomo 3M Limited)	Connector body Shell, thumbscrew lock type Shell, quick-release latching type

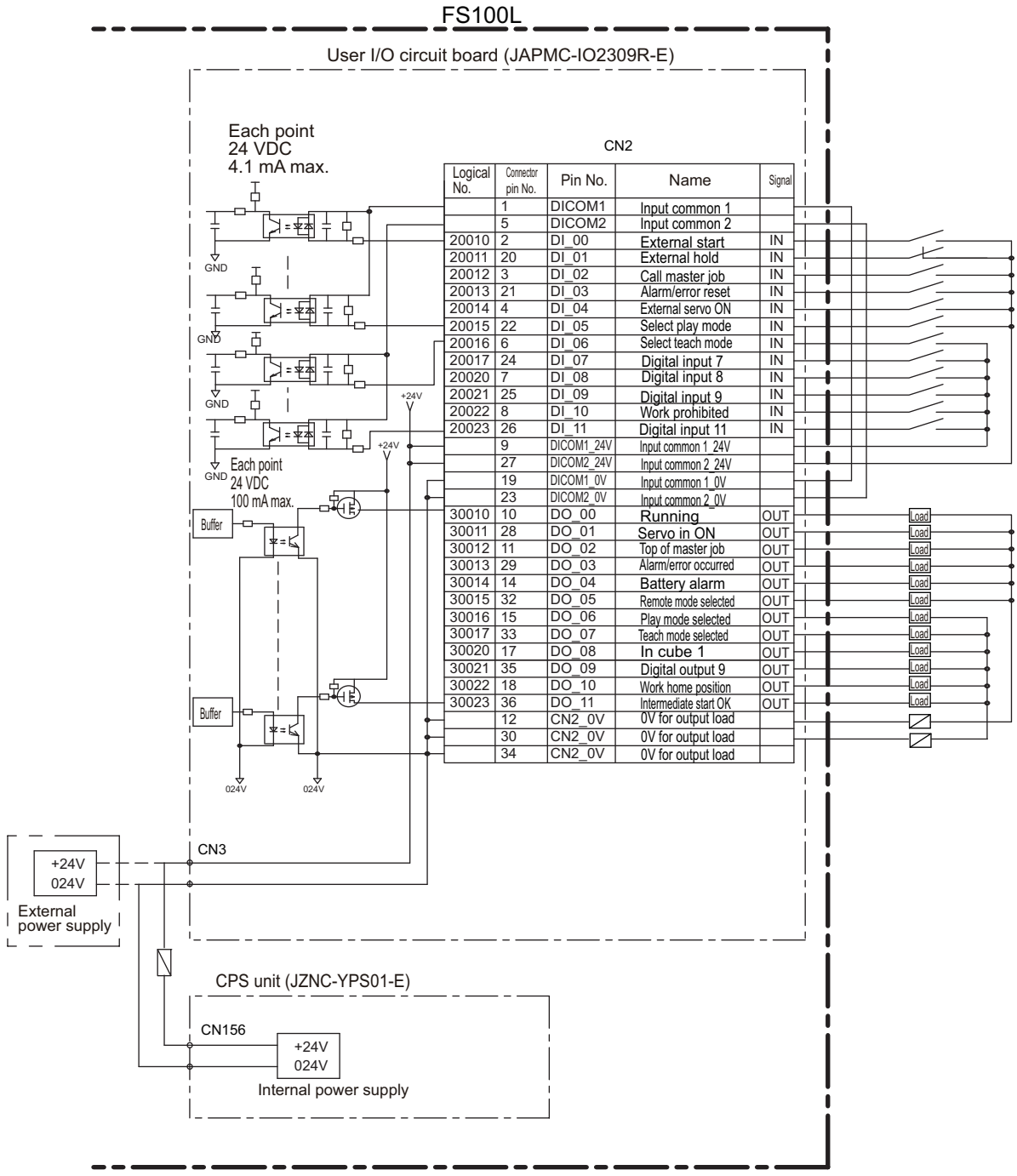
Fig. 13-22(a): Connection Diagram of User Input/Output Connector (CN1) of User I/O Circuit Board (JAPMC-IO2309R-E)



Logical No.	Connector pin No.	Pin No.	Name	Signal
	1	DICOM3	Input common 3	
	6	DICOM4	Input common 4	
20030	2	DI_16	User input IN01	IN
20031	27	DI_17	User input IN02	IN
20032	3	DI_18	User input IN03	IN
20033	28	DI_19	User input IN04	IN
20034	4	DI_20	User input IN05	IN
20035	29	DI_21	User input IN06	IN
20036	5	DI_22	User input IN07	IN
20037	30	DI_23	User input IN08	IN
20040	7	DI_24	User input IN09	IN
20041	32	DI_25	User input IN10	IN
20042	8	DI_26	User input IN11	IN
20043	33	DI_27	User input IN12	IN
20044	9	DI_28	User input IN13	IN
20045	34	DI_29	User input IN14	IN
20046	10	DI_30	User input IN15	IN
20047	35	DI_31	User input IN16	IN
	11	DICOM3_24V	Input common 3_24V	
	36	DICOM4_24V	Input common 4_24V	
	26	DICOM3_0V	Input common 3_0V	
	31	DICOM4_0V	Input common 4_0V	
30030	12	DO_16	User output OT01	OUT
30031	37	DO_17	User output OT02	OUT
30032	13	DO_18	User output OT03	OUT
30033	38	DO_19	User output OT04	OUT
30034	16	DO_20	User output OT05	OUT
30035	41	DO_21	User output OT06	OUT
30036	17	DO_22	User output OT07	OUT
30037	42	DO_23	User output OT08	OUT
30040	19	DO_24	User output OT09	OUT
30041	44	DO_25	User output OT10	OUT
30042	20	DO_26	User output OT11	OUT
30043	45	DO_27	User output OT12	OUT
30044	23	DO_28	User output OT13	OUT
30045	48	DO_29	User output OT14	OUT
30046	24	DO_30	User output OT15	OUT
30047	49	DO_31	User output OT16	OUT
	14	CN1_0V	0V for output load	
	39	CN1_0V	0V for output load	
	43	CN1_0V	0V for output load	
	46	CN1_0V	0V for output load	
	50	CN1_0V	0V for output load	

* To use the external power supply, remove the cable connected to the power supply connector (CN3) of the user I/O circuit board from the connector.
Make sure to insulate the removed cable.

Fig. 13-22(b): Connection Diagram of System Input/Output Connector (CN2) of User I/O Circuit Board (JAPMC-IO2309R-E)



CN2

Logical No.	Connector pin No.	Pin No.	Name	Signal
	1	DICOM1	Input common 1	
	5	DICOM2	Input common 2	
20010	2	DI_00	External start	IN
20011	20	DI_01	External hold	IN
20012	3	DI_02	Call master job	IN
20013	21	DI_03	Alarm/error reset	IN
20014	4	DI_04	External servo ON	IN
20015	22	DI_05	Select play mode	IN
20016	6	DI_06	Select teach mode	IN
20017	24	DI_07	Digital input 7	IN
20020	7	DI_08	Digital input 8	IN
20021	25	DI_09	Digital input 9	IN
20022	8	DI_10	Work prohibited	IN
20023	26	DI_11	Digital input 11	IN
	9	DICOM1_24V	Input common 1 24V	
	27	DICOM2_24V	Input common 2 24V	
	19	DICOM1_0V	Input common 1_0V	
	23	DICOM2_0V	Input common 2_0V	
30010	10	DO_00	Running	OUT
30011	28	DO_01	Servo in ON	OUT
30012	11	DO_02	Top of master job	OUT
30013	29	DO_03	Alarm/error occurred	OUT
30014	14	DO_04	Battery alarm	OUT
30015	32	DO_05	Remote mode selected	OUT
30016	15	DO_06	Play mode selected	OUT
30017	33	DO_07	Teach mode selected	OUT
30020	17	DO_08	In cube 1	OUT
30021	35	DO_09	Digital output 9	OUT
30022	18	DO_10	Work home position	OUT
30023	36	DO_11	Intermediate start OK	OUT
	12	CN2_0V	0V for output load	
	30	CN2_0V	0V for output load	
	34	CN2_0V	0V for output load	

* To use the external power supply, remove the cable connected to the power supply connector (CN3) of the user I/O circuit board from the connector.
Make sure to insulate the removed cable.

Table 13-5: System Input

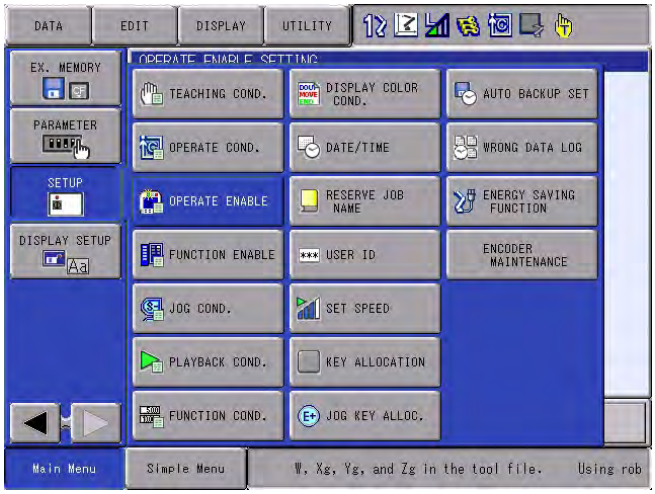
Logical Number	Input Name/Function
20010	EXTERNAL START Functions the same as the [START] button in the programming pendant. Only the rising edge of the signal is valid. It starts robot operation (playback). This signal is invalid if external start is prohibited from the playback condition display.
20011	EXTERNAL HOLD Functions the same as the [HOLD] button on the programming pendant, and is used when connecting a temporary stop switch of an external control device, etc. Connect a break-contact switch to this signal. When this signal is input (OFF), the JOB is stopped. During the input, the operation cannot be started and the axes cannot be operated. Also, while this signal is OFF, the [HOLD] button on the programming pendant lights up. Note that this signal is disabled as the default setting. To enable this signal, enable “EXTERNAL HOLD” in the {OPERATE ENABLE} under the main menu {SETUP} of the programming pendant in the management mode. For details, refer to *chapter 13.10.4 “Enabling External Hold” at page 13-46*.
20012	CALL MASTER JOB Only the rising edge of the signal is valid. It calls up the top of the robot program, that is the top of the master job[1)]. This signal is invalid during playback, during teach-lock and when play master or call is prohibited (set from the playback operation condition display).
20013	ALARM/ERROR RESET After an alarm or error has occurred and the cause been corrected, this signal resets the alarm or error.
20014	EXTERNAL SERVO ON Turns ON the servo power supply. Only the rising edge of the signal is valid.
20015	SELECT PLAY MODE The play mode is selected when the mode key on the programming pendant is set at “REMOTE”. Only the rising edge of the signal is valid. When this selection signal assigned concurrently with other mode selection signal, the teach mode is selected on a priority basis. The signal is invalid while EXTERNAL MODE SWITCH is prohibited.
20016	SELECT TEACH MODE The teach mode is selected when the mode key of the programming pendant is set at “REMOTE”. The other mode selection is unavailable when this signal is ON; the signal is selected by priority even when the other selection signal is ON, enabling the teach mode selection.

1 A master job is a job (program) which can be called by CALL MASTER JOB.
Other functions are the same as for normal jobs. Normally, the parent job, which manages the child jobs called up immediately after the power is turned ON, is set as the master job.

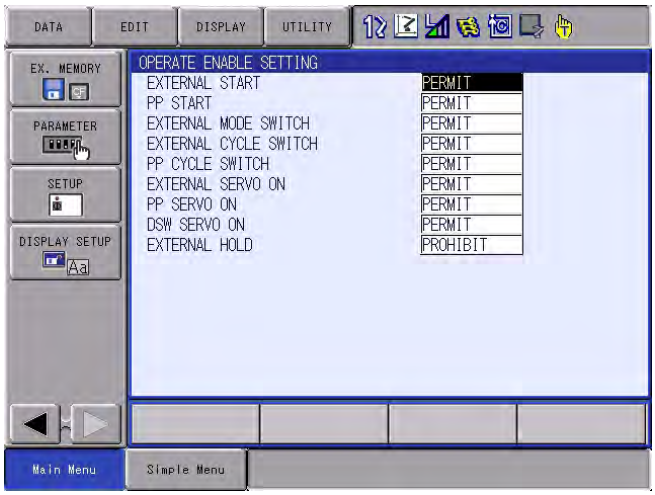
13.10.4 Enabling External Hold

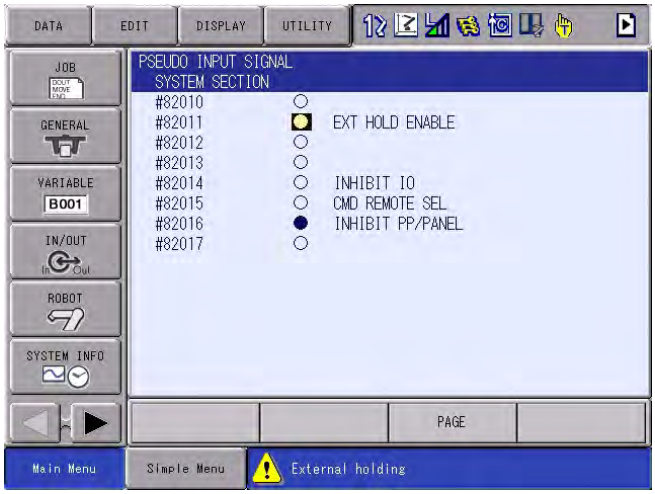
The external hold signal is disabled as the default setting so that the manipulator can be operated without the I/O cable connected. To enable the external hold signal, follow the procedure below.

1. In the management mode, select {OPERATE ENABLE} under the main menu {SETUP}.

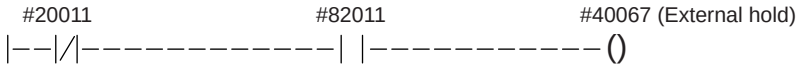


2. Switch “EXTERNAL HOLD” from “PROHIBIT” to “PERMIT”. By doing so, the pseudo input signal #82011 “EXT HOLD ENABLE” changes from “OFF” to “ON.





The initial value of the concurrent I/O is as shown below, so the system input #40067 can be controlled by the break-contact switch connected to #20011.



NOTE

- Be sure to use the break-contact switch for the external hold switch.
- After the setting of the external hold, check to be sure that the external hold functions properly. While the external hold switch is in operation, the [HOLD] button on the programming pendant lights up.

Table 13-6: System Output

Logical Number	Output Name/Function
30010	RUNNING This signal signifies that the job is running. (Signifies that the job is running, system status is waiting reserved start, or test run is running.) This signal status is the same status as [START] in the programming pendant.
30011	SERVO IS ON This signal signifies that the servo power is turned ON, internal processing such as current position creation is complete, and the system is able to receive the START command. This signal turns OFF when the servo power supply turns OFF. It can be used for FS100L status diagnosis for an external start.
30012	TOP OF MASTER JOB This signal signifies that the execution position is the top of the master job. This signal can be used to confirm that the master job has been called.[1)]***1***
30013	ALARM/ERROR OCCURRED This signal signifies that an alarm or an error occurred. If a major error occurs, this signal remains ON until the main power is turned OFF.
30014	BATTERY ALARM This signal turns ON to notify that the battery requires replacing when the voltage drops from the battery for backup memory of the encoder. Major problems may result if memory data is lost because of an expired battery. It is recommended to avoid these problems by using this signal as a warning signal.
30015 to 30017	REMOTE/PLAY/TEACH MODE SELECTED This signal notifies the current mode setting. These signals are synchronized with the mode select switch in the programming pendant. The signal corresponding to the selected mode turns ON.
30020	WORK COMMAND This signal provides the command for the general tool to operate. TOOL ON instruction execution or the [TOOL ON] key in the programming pendant turns this signal ON and TOOL OFF instruction execution or the [TOOL OFF] key in the programming pendant turns it OFF. However, it remains OFF while the WORK PROHIBITED signal (2022) is input or while the robot is stopped.
30022	WORK HOME POSITION (IN CUBE 64)[2)] This signal turns ON when the current TCP lies inside the work home position area. Use this signal to evaluate whether the robot is in the start position.
30023	INTERMEDIATE START OK This signal turns ON when the manipulator operates. It turns OFF when the currently executed line is moved with the cursor or when editing operation is carried out after HOLD is applied during operation. Therefore, this signal can be used as a restart interlock after a HOLD is applied. However, it also turns ON in the teach mode and TEACH MODE SELECTED signal must be referred together.

1 This signal is not output during operation.
2 The work home position cube and Cube 64 are the same.

A

absolute data 8-4
absolute encoder 8-4
ACCELARATION SPEED 11-27
ACCELARATION TIME 11-16
acceleration/deceleration 12-3
Addition of Base and Station Axes 11-4
Addition of I/O Modules 11-1
Alarm Display 12-4
ALARM HISTORY 7-3
All Limit Release Function 8-104
Allocating an Operation 8-115
Allocation of I/O Control Instructions 8-126
Allocation Window 8-115
Alternate Output Allocation 8-120
alternate output allocation 8-114
Analog Incremental Output Allocation 8-125
analog incremental output allocation 8-114
ANALOG MONITOR 7-3
analog output allocation 8-114, 8-124
approximate mass 12-3
ARM CONTROL 7-3
ARM control 8-43
Automatic Measurement of the Tool Load and the Center of Gravity 8-38
AXES CONFIG window 11-12
Axis Interference Area 8-73
Axis keys 6-3

B

BALL-SCREW PITCH 11-14, 11-25
base coordinate 8-62
B-Axis 6-3
Brake release 12-3

C

Cable Junctions 4-3
Cautions for Connection of Dual Input Signals 13-3
Changing the Absolute Data 8-9
Changing the Output Status 8-129
Changing the Parameter Setting 8-131
Checking the TCP 8-36
CIO ladder 12-3
circuit board rack 13-4
circuit board rack (JEPMC-BUB3008R-E) 13-5
Clearing Absolute Data 8-10
Clearing Calibration Data 8-34
Clearing the Interference Area Data 8-82
Clearing the User Coordinates 8-100
Collision proof Frames 12-4
COMMAND POSITION 7-3
Condition Number 8-86
Connecting the Manipulator Cable 4-12
Connecting the Primary Power Supply 4-7
Connecting the Programming Pendant 4-13

Connection 4-1
Contents Confirmation 2-1
control circuit board 13-4
control circuit board (JEPMC-CP3201R-E) 13-5
control group 11-7
cooling system 12-3
Coordinate System 12-4
CPU Unit Configuration 13-4
CPU-201R 13-5
CREATE NEW JOB 7-2
cube 8-63
Cube Interference 8-104
cube number 8-65
Cubic Interference Area 8-62
CURRENT POSITION 7-3

D

DATE/TIME 7-4
Definition of the User Coordinates 8-96
DELETE 7-3
detection level (level range 1 to 500) 8-86
DEVICE 7-3
digital I/O 12-3
dimensions 12-3
direct-in signal 13-23
display allocation 8-113, 8-119
drive unit 12-3
DROP AMOUNT 7-3

E

E-Axis 6-3
Editing Mode 7-1
emergency stop 5-7
emergency stop output (ESPOUT) signal 13-12
Enable Switch 5-6, 12-4
Essential Measures 12-4
Executing the Display Allocation 8-128
Executing the I/O Control Allocation 8-128
Executing the Instruction/Output Control Allocation 8-128
Executing the Job Call Allocation 8-128
Execution of Allocation 8-128
Expanded Instruction Set 8-106
external axis overrun 13-14
external emergency stop (EXESP) signal 13-11
external power supply for input/output 13-27, 13-39

F

FD/CF 7-3
File Initialization 8-134
Function List 12-4
Function Select 8-86

G

Grounding 1-5
grounding 12-3
Group (4-bit/8-bit) Output Allocation 8-123
group output allocation (4-bit/8-bit) 8-114
GRP COMBINATION 7-4

H

HAND VIBRATION CONTROL 7-3
Handling Procedure 3-1
HOME POSITION 7-3
Home Position 8-4
Home Position Calibration 8-2
How to Calculate Tool Load Information 8-49

I

I/O Diagnosis 12-4
I/O Instructions 12-5
I/O modules 11-1
I/O MSG HISTORY 7-3
IN/OUT 7-2
Inching Operation 12-4
INERTIA RATIO 11-16, 11-27
Initial Diagnosis 5-2
Initializing Data File 8-135
Initializing I/O Data 8-139
Initializing Job File 8-134
Initializing Parameter File 8-137
Initializing System Data 8-141
Installation and Wiring Safety 1-5
Instruction Allocation 8-113, 8-116
Instruction of Shock Detection Function 8-90
Instruction Set 8-106
Interface 12-4
INTERFERENCE 7-3
Interference area 8-62

J

JOB 7-2
Job Call Allocation 8-113, 8-118
JOB CAPACITY 7-2

K

KEY ALLOCATION 7-4
Key Allocation (EACH) 8-113
Key Allocation (SIM) 8-113

L

Language 12-5
L-axis 6-3
Leakage Breaker Installation 4-5
Learning Function 8-107
LIMIT RELEASE 7-3
limit switch 8-103
LIO-08R 13-25
LIO-09R 13-37
LOAD 7-3
L-U Interference 8-104

M

Machine Lock 12-4
machine safety circuit board 13-4
machine safety circuit board (JAPMC-SF2300R-E) 13-6
Management Mode 7-1
MANIPULATOR TYPE 7-3
Manufacturer allocation 8-113
MASTER JOB 7-2
Max. Disturbance Force 8-86
MAX. RPM 11-16, 11-27
Measurement of the Tool Load and the Center of Gravity 8-38
Mechanical Limit 8-104
MECHANICAL SPEC window 11-14, 11-25, 11-26
memory capacity 12-3
Modification of System Configuration 11-1
Modification of Teaching Points 12-4
momentary output allocation 8-114, 8-121
MONITORING TIME 7-3
MOTION RANGE 11-14, 11-24, 11-25, 11-26
MOTOR SPEC window 11-16
Moving the MOTOMAN 1-15

N

Noise Filter 4-4
Number of Tool Files 8-21
Numeric Key Customize Function 8-113

O

OPERATE COND 7-4
Operation Mode 7-1
Operation Time Display 12-4
Order Number 2-2
ORG 8-96
Output of the Work Home Position Signal 8-61
Overrun 8-101
OVERRUN&S-SENSOR 7-3

P

PARAMETER 7-4
Path Confirmation 12-4
PINION DIAMETER 11-15, 11-25
positioning system 12-3
POWER ON/OFF POS 7-3
power relay circuit board 13-4
power relay circuit board (JEPMC-PSD3007R-E) 13-5
Power Supply 4-4
Power Supply Contactor Unit 13-17
Primary Power Supply Breaker Installation 4-6
Program Control Instructions 12-5
Programming 12-5
Programming Pendant 12-6
protection stop (PSTOP) signal 13-8
pulse output allocation 8-114, 8-122

R

R-Axis 6-3
REDUCTION RATIO 11-14, 11-15, 11-24, 11-25, 11-26
Registering/Changing the Work Home Position 8-60
RES. START (CNCT) 7-4
RESERVE JOB NAME 7-4
Resetting the Shock Detected 8-95
Returning to the Work Home Position 8-61
ROBOT 7-3
robot coordinate 8-62
Robot installation angle 8-44
Robot Motion Control 12-5
robot programming language (INFORM III) 8-106
Robot Select 8-86
Robot Setup Condition 8-44
Running Speed Limit 12-4

S

safeguarding 5-5
safeguarding (safety plug) (SAFF) signal 13-9
Safety 1-3
safety plug 13-10
SAVE 7-3
S-Axis 6-3
SECOND HOME POS 7-3
Security Mode 7-1
SELECT JOB 7-2
Selecting the User Coordinate File 8-97
Self-Diagnosis 12-4
SERVO MONITOR 7-3
SERVO ON 5-5
SERVO ON READY 5-5
SERVOPACK 13-17
SET SPEED 7-4
Setting Contents 8-106
Setting the Controller Clock 8-110
Setting the Play Speed 8-111

Setting the Tool Load Information 8-25
Setting Work Home Position 8-58
SETUP 7-4
SF2300 13-6
SHCKRST instruction 8-90
SHCKSET 8-85
SHCKSET instruction 8-90
S-head payload 8-45
Shock Detection Function 8-84
Shock Detection Function Setting 8-84
SHOCK SENS LEVEL 7-3
Short-cut Function 12-4
Soft Limit on Each Axis 8-104
Soft Limit Release Function 8-103
software limit 8-103
Special Training 1-2
Specification List 12-3
Speed Adjustment 12-4
Speed Setting 12-5
Standard Instruction Set 8-106
Station Axis Setting 11-18
structure 12-3
Subset Instruction Set 8-106
Switch of the tool file 8-57
SYSTEM INFO 7-3

T

T.C.P. Calibration 12-4
T-Axis 6-3
TEACHING COND 7-4
Teaching the User Coordinates 8-98
three-phase noise filter 4-4
Three-Phase Power Supply 4-4
Timer Setting 12-4
TOOL 7-3
Tool Calibration 8-26
Tool Data Setting 8-21
Tool File 8-21
Tool Load Information 8-48
Tool Load Information Registering 8-55
Tool Load Information Setting 8-48, 8-89
Transferring the MOTOMAN 1-15
Turning OFF the Main Power 5-7
Turning OFF the Servo Power 5-7
Turning ON the Main Power Supply 5-1
Turning ON the Servo Power 5-5

U

U-arm payload 8-46
U-Axis 6-3
User Alarm Display 12-4
USER COORDINATE 7-3
User Coordinate 8-62, 8-96
User Coordinate Files 8-96
User Coordinate Setting 8-96
user I/O circuit board 13-4

user I/O circuit board (JAPMC-IO2308R-E) 13-25
user I/O circuit board (JAPMC-IO2309R-E) 13-37
user ID 7-4, 7-6

V

VARIABLE 7-2
Variable 12-5
Variable Type 12-5
VERIFY 7-3
VERSION 7-3

W

WORK COMMAND 13-36, 13-48
WORK HOME POS 7-3
Work Home Position 8-58
work home position cube length of its sides 8-60

X

XX 8-96
XY 8-96

FS100L
INSTRUCTIONS

HEAD OFFICE
2-1 Kurosakishiroishi, Yahatanishi-ku, Kitakyushu 806-0004, Japan
Phone +81-93-645-7703 Fax +81-93-645-7802

YASKAWA America Inc. (Motoman Robotics Division)
100 Automation Way, Miamisburg, OH 45342, U.S.A.
Phone +1-937-847-6200 Fax +1-937-847-6277

YASKAWA Europe GmbH（Robotics Divsion ）
Yaskawastrasse 1, 85391 Allershausen, Germany
Phone +49-8166-90-100 Fax +49-8166-90-103

YASKAWA Nordic AB
Bredbandet 1 vån. 3 varvsholmen 392 30 Kalmar, Sweden
Phone +46-480-417-800 Fax +46-480-417-999

YASKAWA Electric (China) Co., Ltd.
22/F One Corporate Avenue No.222, Hubin Road, Huangpu District, Shanghai 200021, China
Phone +86-21-5385-2200 Fax ＋86-21-5385-3299

YASKAWA SHOUGANG ROBOT Co. Ltd.
No7 Yongchang North Road, Beijing E&T Development Area, China 100176
Phone +86-10-6788-2858 Fax +86-10-6788-2878

YASKAWA India Private Ltd. (Robotics Division)
#426, Udyog Vihar, Phase- IV, Gurgaon, Haryana, India
Phone +91-124-475-8500 Fax +91-124-475-8542

YASKAWA Electric Korea Co., Ltd
9F, Kyobo Securities Bldg., 26-4, Yeouido-dong, Yeongdeungpo-gu, Seoul 150-737, Korea
Phone +82-2-784-7844 Fax +82-2-784-8495

YASKAWA Electric Taiwan Corporation
12F, No.207, Sec. 3, Beishin Rd., Shindian District, New Taipei City 23143, Taiwan
Phone +886-2-8913-1333 Fax +886-2-8913-1513

YASKAWA Electric (Singapore) PTE Ltd.
151 Lorong Chuan, #04-02A, New Tech Park, Singapore 556741
Phone +65-6282-3003 Fax +65-6289-3003

YASKAWA Electric (Thailand) Co., Ltd.
252/125-126 27th Floor, Tower B Muang Thai-Phatra Complex Building,
Rachadaphisek Road, Huaykwang, Bangkok 10320, Thailand
Phone +66-2693-2200 Fax +66-2693-4200

PT. YASKAWA Electric Indonesia
Menara Anugrah Lantai 1, Kantor Taman E.3.3, Jl Mega Kuningan Lot 8.6-8.7, Kawasan
Mega Kuningan, Jakarta, Indonesia
Phone +62-21-57941845 Fax +62-21-57941843

YASKAWA ELECTRIC CORPORATION

MANUAL NO. RE-CTO-A219 ②
© Printed in Japan August 2014 13-11