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

MOTOMAN INSTRUCTIONS
(FOR SMALL-SIZED MANIPULATORS)

MOTOMAN-□□□ INSTRUCTIONS
FS100 INSTRUCTIONS
FS100 OPERATOR’S MANUAL
FS100 MAINTENANCE MANUAL

FS100 INSTRUCTIONS SUPPLEMENTARY FOR BMDA3
FS100 OPERATOR’S MANUAL SUPPLEMENTARY FOR BMDA3
FS100 MAINTENANCE MANUAL SUPPLEMENTARY FOR BMDA3

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

Part Number: 170530-1CD
Revision: 0
MANDATORY

• This manual explains setup, diagnosis, maintenance, hardware, etc. of the FS100 system. Read this manual carefully and be sure to understand its contents before handling the FS100.

• General items related to safety are listed in Chapter 1 “Safety”. 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 FS100.

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

**WARNING**

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury to personnel.

**CAUTION**

Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury to personnel and damage to equipment. It may also be used to alert against unsafe practices.

**MANDATORY**

Always be sure to follow explicitly the items listed under this heading.

**PROHIBITED**

Must never be performed.

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

At any rate, be sure to follow these important items.

To ensure safe and efficient operation at all times, be sure to follow all instructions, even if not designated as “CAUTION” and “WARNING.”
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 FS100 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 buttons are located on the right of the programming pendant and on the front right of the controller.

• Observe the following precautions when performing teaching operations within the manipulator’s operating range:
  – 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. 1: Emergency Stop Button

• Once the emergency stop button is released, clear the cell of all items which could interfere with the operation of the manipulator. Then turn the servo power ON.
Injury may result from unintentional or unexpected manipulator motion.

Fig. 2: Release of Emergency Stop
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 FS100 controller, manipulator cables, the FS100 programming pendant (optional), and the FS100 programming pendant dummy connector (optional).

In this manual, the equipment is designated as follows:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Manual Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>FS100 controller</td>
<td>FS100</td>
</tr>
<tr>
<td>FS100 programming pendant</td>
<td>Programming pendant</td>
</tr>
<tr>
<td>Cable between the manipulator and the controller</td>
<td>Manipulator Cable</td>
</tr>
<tr>
<td>FS100 programming pendant dummy connector</td>
<td>Programming pendant dummy connector</td>
</tr>
</tbody>
</table>
Descriptions of the programming pendant, buttons, and displays are shown as follows:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Manual Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programming Pendant</td>
<td>Character Keys: The keys which have characters printed on them are denoted with [ ]. e.g. [ENTER]</td>
</tr>
<tr>
<td></td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>Axis Keys and Numeric Keys: “Axis keys” and “Numeric keys” are generic names for the keys for axis operation and number input.</td>
</tr>
<tr>
<td></td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>Mode Key: Three kinds of modes that can be selected by the mode key are denoted as follows: REMOTE, PLAY, or TEACH</td>
</tr>
<tr>
<td></td>
<td>Button: Three buttons on the upper side of the programming pendant are denoted as follows: HOLD button, START button, EMERGENCY STOP button</td>
</tr>
<tr>
<td></td>
<td>Displays: The menu displayed in the programming pendant is denoted with { }. e.g. {JOB}</td>
</tr>
<tr>
<td></td>
<td>PC Keyboard: The name of the key is denoted. e.g. Ctrl key on the keyboard</td>
</tr>
</tbody>
</table>

**Description of the Operation Procedure**

In the explanation of the operation procedure, the expression “Select • • •” means that the cursor is moved to the object item and 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 FS100. Fully comply with the precautions on the warning labels.

- 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 FS100. Observe the precautions on the warning labels. Failure to observe this warning may result in injury or damage to equipment.
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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 corresponding 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.

<table>
<thead>
<tr>
<th>MANDATORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Teaching maintenance of the robot must conform to:</td>
</tr>
<tr>
<td>– Industrial Safety and Health Law</td>
</tr>
<tr>
<td>– Enforcement Order of Industrial Safety and Health Law</td>
</tr>
<tr>
<td>– Ordinance of Industrial Safety and Health Law</td>
</tr>
<tr>
<td>Other related laws are:</td>
</tr>
<tr>
<td>– Occupational Safety and Health Act in USA</td>
</tr>
<tr>
<td>– Factory Act (Gewerbeordnung) in Germany</td>
</tr>
<tr>
<td>– Health and Safety at Work, etc. Act in UK</td>
</tr>
<tr>
<td>– EC Machinery Directive 98/37/EC</td>
</tr>
<tr>
<td>• Prepare</td>
</tr>
<tr>
<td>– Safety Work Regulations</td>
</tr>
<tr>
<td>based on concrete policies for safety management complying with related laws.</td>
</tr>
<tr>
<td>• Observe</td>
</tr>
<tr>
<td>– Robots for Industrial Environments - Safety Requirements (ISO 10218)</td>
</tr>
<tr>
<td>– Manipulating Industrial Robots - Safety (Japan only) (JIS B 8433)</td>
</tr>
<tr>
<td>for safe operation of the robot.</td>
</tr>
<tr>
<td>• Reinforce the</td>
</tr>
<tr>
<td>– Safety Management System</td>
</tr>
<tr>
<td>by designating authorized workers and safety managers, as well as giving continuing safety education.</td>
</tr>
<tr>
<td>• Teaching and maintaining the robot are specified as “Hazardous Operations” in the Industrial Safety and Health Law (Japan only).</td>
</tr>
</tbody>
</table>

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

This manual is a supplementary instruction for the FS100 controller. This supplementary instruction manual describes the differences from the FS100 Instructions. For the instructions other than the differences, refer to the FS100 Instructions (159644-1CD).

**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
- FS100 INSTRUCTIONS
- FS100 OPERATOR’S MANUAL
- FS100 MAINTENANCE MANUAL
- FS100 INSTRUCTIONS SUPPLEMENTARY FOR BMDA3
- FS100 OPERATOR’S MANUAL SUPPLEMENTARY FOR BMDA3
- FS100 MAINTENANCE MANUAL SUPPLEMENTARY FOR BMDA3

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.

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Avoid any dangerous actions in the area where the MOTOMAN is installed.</td>
</tr>
<tr>
<td>Failure to observe this caution may result in personal injury due to contact with the manipulator or peripheral equipment.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Please take strict safety precautions by placing signs such as “Flammable”, “High Voltage”, “Waiting”, and “Off-limits to Unauthorized Personnel” in necessary areas in the factory.</td>
</tr>
<tr>
<td>Failure to observe this caution may result in fire, electric shock, or personal injury due to contact with the manipulator and other equipment.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Strictly observe the following items:</td>
</tr>
<tr>
<td>– Always wear approved work clothes (no loose-fitting clothes).</td>
</tr>
<tr>
<td>– Do not wear gloves when operating the MOTOMAN.</td>
</tr>
<tr>
<td>– Do not allow underwear, shirts, or neckties to hang out from the work clothes.</td>
</tr>
<tr>
<td>– Do not wear large jewelry, such as earrings, rings, or pendants.</td>
</tr>
<tr>
<td>Always wear protective safety equipment such as helmets, safety shoes (with slip-proof soles), face shields, safety glasses, and gloves as necessary.</td>
</tr>
<tr>
<td>Improper clothing may result in injury.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Unauthorized persons should not approach the manipulator or associated peripheral equipment.</td>
</tr>
<tr>
<td>Failure to observe this caution may result in personal injury due to contact with the FS100, controller, workpiece, positioner, etc.</td>
</tr>
</tbody>
</table>
CAUTION

• Never forcibly move the manipulator axes.
  Failure to observe this caution may result in personal injury or equipment damage.

• Never lean on FS100 or other controllers, and avoid inadvertently pushing buttons.
  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 FS100 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 FS100 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.

![Diagram of installation area](image)

- 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.
# 1.5 Motoman Safety

## CAUTION

- As a rule, the manipulator should be lifted 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.

- Lift, move, or install the FS100 by two or more persons.
  - Approx. mass of FS100: 76 kg per unit
- Use a platform truck to carry the FS100.
  - Avoid jarring, dropping, or hitting the FS100 during handling.

Failure to observe these cautions may cause the FS100 to fall down, which may result in personal injury or 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 or equipment damage.
CAUTION

- Make sure that there is sufficient room for maintenance on the manipulator, FS100, and other peripheral equipment. Failure to observe this caution may result in personal injury during maintenance.

- 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 FS100 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 FS100. 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.
1. Safety
1.5 Motoman Safety

CAUTION

• After installation, fix the FS100 on the floor or base depending on its way of installation by using the screws shown below. Failure to observe this caution may cause the FS100 to fall, which may result in personal injury or equipment damage.

• Be familiar with the connection diagram before wiring the FS100, 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.

• Take precautions when wiring and piping between the FS100, 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, FS100, 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**

- Make sure to incorporate the robot system into the user’s system which has lockout/tagout function. That is to say, supply one or more devices to turn OFF the power supply of the manipulator, servo track, and controller, and install them outside the enclosure in which the manipulator and servo track are installed. The devices must be able to be locked out and tagged out.

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:
  - 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.
**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.

**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 FS100 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 buttons are located on the right of the programming pendant and on the front right of the controller.

- 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.
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 its hook on the FS100 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.

MANDATORY

• Persons operating or inspecting the manipulator should be trained as required by applicable laws and company policies.
  – Refer to Section 1.2 “Special Training”.
1.6 Notes for Moving and Transferring MOTOMAN

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

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Attach the instructions to the controller cabinet so that all users have access to necessary manuals. See Section 1.3 “Motoman Manual List” for a complete list of manuals. If any manual is missing, contact your Yaskawa representative.</td>
</tr>
<tr>
<td>• If the warning labels on the manipulator and FS100 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.</td>
</tr>
<tr>
<td>• When the MOTOMAN is transferred, it is recommended to check with Yaskawa which is listed on the back cover of this manual. Incorrect installation or wiring may result in personal injury or equipment damage.</td>
</tr>
</tbody>
</table>
1.7 Notes on MOTOMAN Disposal

**PROHIBITED**

- Never modify the manipulator or FS100.
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
- FS100 (including spare parts)
- Manipulator cable (between manipulator and FS100)
- 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 FS100 match.

The order number plates are affixed to the figure below.

<Example>

THE MANIPULATOR AND THE CONTROLLER SHOULDN'T HAVE SAME ORDER NUMBER.

ORDER NO. S78796-1
3.1 Handling Procedure

**CAUTION**

- Lift, move, or install the FS100 by two or more persons.
  - Approx. mass of FS100: 76 kg per unit
- Use a platform truck to carry the FS100.
  - Avoid jarring, dropping, or hitting the FS100 during handling.

Failure to observe these cautions may cause the FS100 to fall down, which may result in personal injury or equipment damage.

The mass of the FS100 is indicated on the nameplate. The location and content of the nameplate is shown below.

Unpack and move the FS100 by two or more persons.

Use a lifter to lift the FS100 up to or put it down from the rack.

Also, use a platform truck to carry the FS100.

If the FS100 must be manually carried, lifted up, or put down, two persons must hold the bottom of the FS100 firmly.
3.2 Place of Installation

The conditions listed below must be met before installing the FS100.

- Ambient temperature: 0°C to +35°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/s² [0.5G] or less)
- Free from large electrical noise (plasma)
3.3 Installation Location

- Install the FS100 outside of the manipulator’s operating range (outside of the safeguarding).

*Fig. 3-1: Installation Location of FS100*

- Install the FS100 where the manipulator can be clearly seen during operation and can be operated safely.
- Install the FS100 where its front panel can be operated easily.
- Install the FS100 where it can be easily taken out of the rack for maintenance.
- Install the FS100 where it can be inspected easily. (Make sure to secure the maintenance area.)
- Do not place any obstacles in the following:
  - within 200 mm from the rear panel (air inlet and air outlet) of the FS100
  - within 150 mm from the front panel (air outlet) of the FS100
  - within 100 mm from the side panel (air outlet) of the FS100

---

**Diagram:**

- FS100
- Front panel
- Safeguarding
- P-point maximum envelope of manipulator
- Maximum working envelope of manipulator including tool or workpiece end
- 1000 mm or more
- 1000 mm or more
- 1000 mm or more
- 1000 mm or more
- Min 200 mm
- Min 100 mm
- Air in
- Air out
- Air in
- Air in
- Air out
3.4 Installation Method

CAUTION

• After installation, fix the FS100 on the floor or base depending on its way of installation by using the screws shown below. Failure to observe this caution may cause the FS100 to fall, which may result in personal injury or equipment damage.

• Be familiar with the connection diagram before wiring the FS100, 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.
3.4 Installation Method

- Take precautions when wiring and piping between the FS100, 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.
4 Connection

MANDATORY

• Make sure to incorporate the robot system into the user’s system which has lockout/tagout function. That is to say, supply one or more devices to turn OFF the power supply of the manipulator, servo track, and controller, and install them outside the enclosure in which the manipulator and servo track are installed. The devices must be able to be locked out and tagged out.

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. DO NOT TURN THE POWER ON) 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.
• Power cannot be turned ON unless the door is closed. Interlocks prevent power from being turned ON. Failure to observe this warning may result in fire or electric shock.
• Any occurrence during wiring while the FS100 is in the emergency stop mode is 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.
4 CAUTION

- 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 FS100 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 FS100, and the FS100 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 FS100, or FS100 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: FS100 Cable Connection Diagram
4.2 Power Supply

4.2.1 Three-Phase Power Supply

The single-phase power and the three-phase power supply comprising 200/220 VAC at 50/60 Hz are used.

*Fig. 4-2: Connection of Input Power*

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.

4.2.2 Noise Filter Installation

Insert the three-phase noise filter into the primary station of the non-fuse breaker filter if you hear noise coming from the power source. Seal up each cable opening so that dust does not enter.

*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 FS100 inverter. Leakage breakers which cannot handle high frequencies may malfunction.

Table 4-1: Example of High Frequency Leakage Breaker

<table>
<thead>
<tr>
<th>Maker</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mitsubishi Electric Co., Ltd.</td>
<td>NV series (manufactured since 1988)</td>
</tr>
<tr>
<td>Fuji Electric Co., Ltd.</td>
<td>EG or SG Series (manufactured since 1984)</td>
</tr>
</tbody>
</table>

Even with a leakage breaker installed, there is still a possibility of some high frequency current leakage from the FS100 inverter. However, this current leakage presents no safety risks.

Fig. 4-4: Connection of the Leakage Breaker
4.2 Power Supply

4.2.4 Primary Power Supply Breaker Installation

Install the primary power supply breaker as shown below.

MANDATORY

- Make sure to incorporate the robot system into the user’s system which has lockout/tagout function. That is to say, supply one or more devices to turn OFF the power supply of the manipulator, servo track, and controller, and install them outside the enclosure in which the manipulator and servo track are installed. The devices must be able to be locked out and tagged out.

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

Table 4-2: FS100 Power Capacity, Cable Size, and Circuit Protector

<table>
<thead>
<tr>
<th>Manipulator</th>
<th>Power capacity (kVA)</th>
<th>Cable size (with Cabtyre cable (three cores)) (mm²)</th>
<th>Capacity of circuit protector in FS100 (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMDA3</td>
<td>1.5</td>
<td>3.5</td>
<td>15</td>
</tr>
</tbody>
</table>

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.

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

- Power Cable Connection

1. Prepare the power cable by using the power connector of the FS100. Refer to Table 4-3(a) "For Three-Phase Power Supply (CN1)" and Table 4-3(b) "For Single-Phase Power Supply (CN1)" for the pin assignment of the FS100 power connector (CN1), and prepare the power cable.

2. Confirm that the circuit protector of the FS100 is turned OFF.
   - CN1 INPUT AC (for AC power input)
   - Controller-side connector: CE05-2A18-10PD-B (manufactured by DDK Ltd.)
   - Cable-side connector (supplied with controller): CE05-6A18-10SD-B-BSS (manufactured by DDK Ltd.)

Table 4-3(a): For Three-Phase Power Supply (CN1)

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Signal Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>L1</td>
<td>AC input (L1/R-phase)</td>
</tr>
<tr>
<td>B</td>
<td>L2</td>
<td>AC input (L2/S-phase)</td>
</tr>
<tr>
<td>C</td>
<td>L3</td>
<td>AC input (L3/T-phase)</td>
</tr>
<tr>
<td>D</td>
<td>P.E.</td>
<td>Protective grounding</td>
</tr>
</tbody>
</table>

Table 4-3(b): For Single-Phase Power Supply (CN1)

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Signal Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>L1</td>
<td>AC input (L1/R-phase)</td>
</tr>
<tr>
<td>B</td>
<td>N.C.</td>
<td>Not available</td>
</tr>
<tr>
<td>C</td>
<td>L3</td>
<td>AC input (L3/T-phase)</td>
</tr>
<tr>
<td>D</td>
<td>P.E.</td>
<td>Protective grounding</td>
</tr>
</tbody>
</table>
3. Confirm that the primary power supply is turned OFF.
4. Connect the primary power supply cable.

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
</table>
| • Make sure to use the supplied connector for the primary power supply connection.  
• Tighten the cable clamp to prevent the cable from breaking.  
Failure to observe these cautions may result in electric shock or equipment failure. |

(1) Grounding method:
– Perform grounding as countermeasures against noise and electric shock.
– Follow the steps below:
  I) Connect the ground wire to the D terminal of the FS100 power connector (CN1).
  II) Perform grounding in accordance with all relevant local and national electrical codes. The size of ground wire must the same as listed in Table 4-2 "FS100 Power Capacity, Cable Size, and Circuit Protector".

<table>
<thead>
<tr>
<th>NOTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>The ground wire must be supplied by the user.</td>
</tr>
</tbody>
</table>

**Fig. 4-7: Exclusive Grounding**

<table>
<thead>
<tr>
<th>NOTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do not connect the ground wire with the wires for the electric power source, the welder, etc.</td>
</tr>
<tr>
<td>If using metallic ducts, metallic conduits, or cable trays for cabling, perform grounding in accordance with all relevant governmental regulations.</td>
</tr>
</tbody>
</table>
4.3.2 Connecting Manipulator Cable

1. Unpack the manipulator cable. Connect the cable to the connectors on the back side of FS100.

*Fig. 4-8: Connection of Manipulator Cable*

2. Connect the manipulator to the FS100.
   - Confirm the number of the manipulator cable connector. Push the manipulator cable connector into the manipulator-side connector firmly, and tighten it securely.

3. Fix the cables after connecting them.

*Fig. 4-9: Fixation of the cables*
4.3.3 Connecting Programming Pendant (Optional)

1. Remove the front cover. For the procedure to remove the front cover, refer to Section 5.4 “Method of Removing Controllers” of the “FS100 MAINTENANCE MANUAL SUPPLEMENTARY FOR BMDA3 (170531-1CD)”.

2. Connect the programming pendant cable to the connector connection (X81) of the FS100.

*Fig. 4-10: Connection of Programming Pendant Cables*

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

---

**NOTE**
3. Fix the programming pendant cable after connecting it.

*Fig. 4-11: Fixation of the programming pendant cable*

4. Install the front cover.

For the procedure to install the front cover, refer to Section 5.4 "Method of Removing Controllers" of the "FS100 MAINTENANCE MANUAL SUPPLEMENTARY FOR BMDA3 (170531-1CD)".

The manipulator, FS100, and programming pendant connections are now complete.
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 FS100 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 buttons are located on the right of the programming pendant and on the front right of the controller.

The main power supply is turned ON when the main power supply switch on the front of the FS100 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 FS100.

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

2. Press the {Connect to FS100} button.
   - The following "Pendant installation check" window appears.
5. Turning ON and OFF Power Supply

5.1 Turning ON Main Power Supply

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 FS100 and the programming pendant is established.
   - If the connection confirmation of the programming pendant is failed, the following window appears.

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

5-3
5.1.2 When Initial Diagnosis Is Complete

When the power supply is turned OFF, the FS100 saves all condition data, including:

- Operation mode
- Called job (active job if the FS100 is in the play mode; edit job if the FS100 is in the teach mode) and cursor position in the job.

![Fig. 5-2: Initial Window](image)

**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 FS100 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.

![SERVO ON READY Light](image)

**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 to turn ON the servo power supply. [SERVO ON] lamp will blink when the servo power is turned ON.

![SERVO ON READY Blink](image)

2. The servo power is turned ON and [SERVO ON] lamp on the programming pendant lights when the operator grips the Enable Switch.
5 Turning ON and OFF Power Supply
5.2 Turning ON Servo Power

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.

Release -> OFF  Squeeze -> ON  Squeeze tightly -> OFF

When performing emergency stop on the front door of the FS100, programming pendant, or external signal, the servo power-on operation from the Enable switch is cancelled.

When turning the power back ON, follow the steps in Section 5.2.2 “During Teach Mode”
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 buttons are located on the right of the programming pendant and on the front right of the controller.
- 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)

- 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.

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 FS100 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 buttons are located on the right of the programming pendant and on the front right of the controller.

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

• Upon shipment of the FS100, this signal is connected by a jumper cable in the dummy connector. To use the signal, make sure to 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:
  – 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 FS100 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 FS100 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.
7 FS100 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 FS100 power.

Injury may result from collision with the manipulator to anyone entering the manipulator’s operating range.

- Always set the teach lock before starting teaching.

- Observe the following precautions when performing teaching operations within the manipulator’s operating range:
  - View the manipulator from the front whenever possible.
  - 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 place to retreat to 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 buttons are located on the right of the programming pendant and on the front right of the controller.
• 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 its specified position 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.
### 7.1 Specifications of FS100

<table>
<thead>
<tr>
<th>Item</th>
<th>For Japan and North America</th>
<th>For Europe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structure</td>
<td>Free-standing, open type</td>
<td></td>
</tr>
<tr>
<td>Dimensions</td>
<td>540 (W) × 720 (H) × 580 (D) mm</td>
<td></td>
</tr>
<tr>
<td>Approximate mass</td>
<td>76 kg or less</td>
<td></td>
</tr>
<tr>
<td>Cooling system</td>
<td>Direct cooling</td>
<td></td>
</tr>
<tr>
<td>Power supply specification</td>
<td>1-phase AC200V/230V (+10%, -15%)</td>
<td>3-phase AC200V/220V (+10%, -15%)</td>
</tr>
<tr>
<td>Grounding</td>
<td>Grounding resistance: 100 Ω or less, exclusive grounding&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Ambient Temperature</td>
<td>0 ℃〜 35 ℃ (during electrification) 0 ℃〜 35 ℃ (during electrification)</td>
<td></td>
</tr>
<tr>
<td>Relative Humidity</td>
<td>90%RH at maximum (no condensation)</td>
<td></td>
</tr>
<tr>
<td>Digital I/O</td>
<td>NPN</td>
<td>PNP</td>
</tr>
<tr>
<td>Positioning system</td>
<td>By serial communication (absolute encoder)</td>
<td></td>
</tr>
<tr>
<td>Drive unit</td>
<td>SERVOPACK for AC servomotors</td>
<td></td>
</tr>
<tr>
<td>Acceleration/deceleration</td>
<td>Software servo control</td>
<td></td>
</tr>
<tr>
<td>Memory capacity</td>
<td>10000 steps, 1000 instructions</td>
<td></td>
</tr>
<tr>
<td>CIO ladder</td>
<td>Max. 1500 step</td>
<td></td>
</tr>
<tr>
<td>Built-in transformer</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Brake release</td>
<td>The brake of each system can be released individually by the programming pendant.</td>
<td></td>
</tr>
</tbody>
</table>

1 Perform grounding in accordance with all relevant local and national electrical codes. The size of the ground wire must be equal to or larger than the size listed in *Table 4-2 "FS100 Power Capacity, Cable Size, and Circuit Protector" on page 4-6.*
# Functions of FS100

## Programming Pendant Operation

<table>
<thead>
<tr>
<th>Programming Pendant Operation</th>
<th>Coordinate System</th>
<th>Modification of Teaching Points</th>
<th>Inching Operation</th>
<th>Path Confirmation</th>
<th>Speed Adjustment</th>
<th>Timer Setting</th>
<th>Short-cut Function</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Joint, Rectangular/Cylindrical, Tool, User Coordinates</td>
<td>Adding, Deleting, Correcting (Robot axes and external axes respectively can be corrected.)</td>
<td>Possible</td>
<td>Forward/Reverse step, Continuous feeding</td>
<td>Fine adjustment possible during operating or pausing</td>
<td>Possible every 0.01 s</td>
<td>Direct-open function, Multi-window</td>
</tr>
</tbody>
</table>

| 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

<table>
<thead>
<tr>
<th>Essential Measures</th>
<th>Running Speed Limit</th>
<th>Enable Switch</th>
<th>Collision proof Frames</th>
<th>Self-Diagnosis</th>
<th>User Alarm Display</th>
<th>Machine Lock</th>
<th>Door Interlock</th>
</tr>
</thead>
<tbody>
<tr>
<td>JIS (Japanese Industrial Standard)</td>
<td>User definable</td>
<td>3 position type. Servo power can be turned on at the middle position only. (Located on programming pendant)</td>
<td>Cubic frame, Axis frame</td>
<td>Classifies error and two types of alarms (major and minor) and displays the data</td>
<td>Possible to display alarm messages for peripheral device</td>
<td>Test-run of peripheral devices without robot motion</td>
<td>A door can be opened only when a circuit breaker is OFF.</td>
</tr>
</tbody>
</table>

## Maintenance Function

<table>
<thead>
<tr>
<th>Operation Time Display</th>
<th>Alarm Display</th>
<th>I/O Diagnosis</th>
<th>T.C.P. Calibration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control power-on time, Servo power-on time, Playback time, Operation time, Work time</td>
<td>Alarm message, troubleshooting, previous alarm records</td>
<td>Simulated enabled/disabled output possible</td>
<td>Automatically calibrates parameters for end effectors using a master positioner</td>
</tr>
</tbody>
</table>
### Functions of FS100

<table>
<thead>
<tr>
<th>Programming Type</th>
<th>Interactive programming</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language</td>
<td>Robot language: INFORM II</td>
</tr>
<tr>
<td>Robot Motion Control</td>
<td>Joint coordinates, Linear/Circular interpolations, Tool coordinates</td>
</tr>
<tr>
<td>Speed Setting</td>
<td>Percentage for joint coordinates, 0.1mm/s units for interpolations, Angular velocity for T.C.P. fixed motion</td>
</tr>
<tr>
<td>Program Control Instructions</td>
<td>Jumps, Calls, Timer, Robot stop, Execution of some instructions during manipulator motion</td>
</tr>
<tr>
<td>Variable</td>
<td>Global variable, Local variable</td>
</tr>
<tr>
<td>Variable Type</td>
<td>Byte type, Integer-type, Double precision-type, Real type, Position type, String type</td>
</tr>
<tr>
<td>I/O Instructions</td>
<td>Discrete I/O, Pattern I/O processing</td>
</tr>
</tbody>
</table>
### 7.3 Specifications of Programming Pendant

<table>
<thead>
<tr>
<th>Item</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
<td>JZRCR-YPP03-1</td>
</tr>
<tr>
<td><strong>Dimensions</strong></td>
<td>169 (W) × 314.5 (H) × 50 (D) mm (excluding protrusions)</td>
</tr>
<tr>
<td><strong>Approximate mass</strong></td>
<td>990 g</td>
</tr>
<tr>
<td><strong>Material</strong></td>
<td>Reinforced plastic</td>
</tr>
<tr>
<td><strong>Control device</strong></td>
<td></td>
</tr>
<tr>
<td>(1) Select key</td>
<td></td>
</tr>
<tr>
<td>(2) Axis keys</td>
<td></td>
</tr>
<tr>
<td>(3) Numeric/application keys</td>
<td></td>
</tr>
<tr>
<td>(4) Mode switch with a key (mode: teach, play, remote)</td>
<td></td>
</tr>
<tr>
<td>Key type: AS6-SK-132 (manufactured by IDEC)</td>
<td></td>
</tr>
<tr>
<td>(5) Emergency stop button</td>
<td></td>
</tr>
<tr>
<td>(6) Enable switch</td>
<td></td>
</tr>
<tr>
<td>(7) CompactFlash card slot (CompactFlash is optional.)</td>
<td></td>
</tr>
<tr>
<td>(8) USB port (1 port)</td>
<td></td>
</tr>
<tr>
<td><strong>Display</strong></td>
<td>640 × 480 pixel color LCD, touch panel (Alphanumeric characters, Chinese characters, Japanese letters, etc.)</td>
</tr>
<tr>
<td><strong>IEC protection class</strong></td>
<td>IP65</td>
</tr>
<tr>
<td><strong>Cable length</strong></td>
<td>Standard: 8 m, Max.: 20 m (optional)</td>
</tr>
<tr>
<td><strong>Key sheet</strong></td>
<td>General (1 sheet only)</td>
</tr>
</tbody>
</table>

1 Two keys are supplied with the programming pendant.
7.4 Equipment Configuration of FS100

The equipment configuration of the FS100 is described below.

### 7.4.1 Arrangement of Units and Circuit Boards

**Fig. 7-1: Equipment Configuration of FS100**
8 Description of Units and Circuit Boards

**WARNING**

- When turning ON the power to FS100, 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.

- Always set the teach lock before starting teaching.

- Observe the following precautions when performing teaching operations within the manipulator’s operating range:
  - 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 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 buttons are located on the right of the programming pendant and on the front right of the controller.
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.
8.1 CPU Unit

8.1.1 CPU Unit Configuration

CPU unit consists of a power relay circuit board, control circuit board, circuit board rack, machine safety circuit board, and user I/O circuit board.

The machine safety circuit board and user 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 back.

Fig. 8-1: CPU Unit Configuration
8.1.2 Circuit Board in CPU Unit

8.1.2.1 Control Circuit Board (JEPMC-CP3201R-E)

The Control Circuit Board (JEPMC-CP3201R-E) is 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 FS100 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 Indication on Circuit Board” of the “FS100 MAINTENANCE MANUAL”.)

This board is connected with the major axes control circuit board (CSTR- IFBM3LA) via high-speed serial communication, and has a USB port (2.0) and Ethernet (100BASE-TX/10-BASE-TX).

**NOTE**

Please do not change the factory setting of RSW1 except operations which are described at Chapter 9 of the FS100 INSRTURTIONS.

(Factory setting is [0])

**NOTE**

Please do not change the factory setting of RSW2.

(Factory setting is [0])

**NOTE**

Please do not change the DIP switch settings of SW1 and SW2.

(Factory settings are all "OFF")

8.1.2.2 Power Relay Circuit Board (JEPMC-PSD3007R-E)

This is the relay board to receive the control power supply for the entire CPU rack from the converter unit (CSTR-COB02AA).

8.1.2.3 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 back.

The total number of slots is 8, but the circuit boards (machine safety circuit board and user I/O circuit board) are mounted as standard. Thus, the number of available slots is 5, i.e., 5 optional circuit boards can be mounted.
8.2 Machine Safety Circuit Board

The Machine Safety Circuit Board (JAPMC-SF2300R-E) is abbreviated as SF2300.

8.2.1 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 control ON/OFF of the output of the PWM amplifier module according to conditions.

The functions of the machine safety circuit board include the following:

- Robot system input circuit (safety signal dual circuits)
- Servo-ON enable (ONEN) input circuit (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 10 “LED Indicator on Each Circuit Board” of the “FS100 MAINTENANCE MANUAL”.

![Status indication LED diagram](image)
8.3 Converter Unit

8.3.1 Converter Unit (CSTR-COB02AA)

The converter unit (CSTR-COB02AA) has the following functions:

1. Supplies the DC power (5V, 24V) for control (system, I/O, brake).
2. Converts the main power supply (three-phase 200/220 VAC at 50/60 Hz, single-phase 200/230 VAC at 50/60 Hz) to DC power, and supplies it to the PWM amplifier module for each axis.

Use the converter unit (CSTR-COB02AA) with the capacitor circuit board (CSTR-CRBCC22AAA).

<table>
<thead>
<tr>
<th>Item</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input power supply</td>
<td>Main power supply: three-phase 200/220 VAC at 50/60 Hz</td>
</tr>
<tr>
<td></td>
<td>single-phase 200/230 VAC at 50/60 Hz</td>
</tr>
<tr>
<td></td>
<td>Control power supply: single-phase 200 to 230 VAC at 50/60 Hz</td>
</tr>
<tr>
<td></td>
<td>Range of voltage regulation: +10% to -15%</td>
</tr>
<tr>
<td>Output voltage</td>
<td>DC power supply for PWM amplifier module: Input voltage $\times \sqrt{2}$</td>
</tr>
<tr>
<td></td>
<td>Control power supply: 16.5V (for PWM amplifier module)</td>
</tr>
<tr>
<td></td>
<td>5V (for CPU rack control power supply)</td>
</tr>
<tr>
<td></td>
<td>24V (24V1: for system, 24V3: for I/O, 24V4: for brake)</td>
</tr>
<tr>
<td>Monitor and alarm function</td>
<td>Source Green Lights up with the input of control power supply.</td>
</tr>
<tr>
<td></td>
<td>+5VC Green Lights up with the output of +5VC.</td>
</tr>
</tbody>
</table>
8.4 SERVOPACK

A SERVOPACK consists of a mounting base unit, PWM amplifier module, and major axes control circuit board. The configuration of PWM amplifier module differs depending on the manipulator model.

8.4.1 Description of Each Unit

8.4.1.1 Mounting Base Unit (CSTR-MBB08AAA)

A mounting base unit consists of a base circuit board (CSTR-MBBCA08AAA) and a motherboard (CSTR-MBBCB08AAA). The major axes control circuit board (CSTR-IFBM3LA) and up to 8 PWM amplifier modules (CSTR-SDB***AAA) can be mounted to the mounting base unit.

The main power supply (280 VDC) and the control power supply (16.5 V, 5 V, 24 V) of the PWM amplifier module are received from the converter unit (CSTR-COB02AA).

Also, the mounting base unit receives the output ON/OFF signal of the PWM amplifier module from the machine safety circuit board (JAPMC-SF2300R-E), and distributes it to each PWM amplifier module.
8.4.1.2 PWM Amplifier Module (CSTR-SDB***AAA)

This module converts the main power supply (DC, input voltage $\times \sqrt{2}$) supplied from the converter to three-phase motor current, and outputs to each servomotor.

8.4.1.3 Major Axes Control Circuit Board (CSTR-IFBM3LA)

This is the circuit board to control the servomotor for the manipulator.

It controls the converter unit and the PWM amplifier modules.

Also, it connects to the I/O relay circuit board (CSTR-FBBCA8R03CAA), and controls the brake of each servomotor.

In addition to the control of the manipulator’s major axes, this circuit board has the following functions:

- Can be used by connecting the brake power supply control circuit to the I/O relay circuit board (CSTR-FBBCA8R03CAA)

8.4.1.4 Configuration of PWM Amplifier Module

The configurations of the PWM amplifier module for each manipulator are shown below.

Table 8-1: Configurations of PWM Amplifier Module

<table>
<thead>
<tr>
<th>S-axis(AMP1)</th>
<th>L-axis(AMP2)</th>
<th>U-axis(AMP3)</th>
<th>R-axis(AMP4)</th>
<th>B-axis(AMP5)</th>
<th>T-axis(AMP6)</th>
<th>E-axis(AMP7)</th>
<th>Rotation-axis(AMP8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MH3BM</td>
<td>CSTR-SDBR90</td>
<td>CSTR-SDBR90</td>
<td>CSTR-SDBR90</td>
<td>CSTR-SDBR90</td>
<td>CSTR-SDBR90</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>BMDA3</td>
<td>CSTR-SDBR90</td>
<td>CSTR-SDBR90</td>
<td>CSTR-SDBR90</td>
<td>CSTR-SDBR90</td>
<td>CSTR-SDBR90</td>
<td>CSTR-SDBR90</td>
<td>CSTR-SDBR90</td>
</tr>
<tr>
<td></td>
<td>CSTR-SDBR90</td>
<td>CSTR-SDBR90</td>
<td>CSTR-SDBR90</td>
<td>CSTR-SDBR90</td>
<td>CSTR-SDBR90</td>
<td>CSTR-SDBR90</td>
<td>CSTR-SDBR90</td>
</tr>
</tbody>
</table>
8.5 I/O Relay Circuit Board (CSTR-FBBCA8R03CAA)

This circuit board transmits and receives the encoder signals and the control I/O signals to and from the SERVOPACK. Also, it controls the ON/OFF of brake relay by the control signal from the major axes control circuit board (CSTR-IFBM3LA).
### Revision History

<table>
<thead>
<tr>
<th>Date</th>
<th>CEN / ECN</th>
<th>Revision No.</th>
<th>Reason For Revision</th>
<th>Initials</th>
</tr>
</thead>
<tbody>
<tr>
<td>7/21/2014</td>
<td>53609/M2094</td>
<td>0</td>
<td>Original Release</td>
<td>JFC</td>
</tr>
</tbody>
</table>
Specifications are subject to change without notice
for ongoing product modifications and improvements.