

# **INSTRUCTION MANUAL**

## **TOSHIBA MACHINE'S FA SCHOOL TEXTBOOK FOR ROBOT TRAINING COURSE**

**INDUSTRIAL ROBOT SR-H SERIES  
(ROBOT CONTROLLER: SR7000)**

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**TOSHIBA MACHINE CO., LTD.**

TOKYO, JAPAN

## Preface

The training session you are going to attend this time is the FA school robot course. This textbook describes the robot language and basic operating procedures for the user who will operate the SR–H series industrial robot (robot controller SR7000) in his plant or factory.

For the detailed specifications and usage of the robot, see the appropriate specifications manual and instruction manual. When the shipment has reached your office, confirm the following instruction manuals which are attached to the robot. You are also requested to read through them before the use.

### List of instruction manuals

- |                              |  |       |   |
|------------------------------|--|-------|---|
| • Industrial robot SR series | Startup manual                         | ..... | Simple operating procedures             |
| • Industrial robot SR series | Operating manual                       | ..... | Detailed operating procedures           |
| • Industrial robot SR series | Robot language manual                  | ..... | Descriptions of SCOL language           |
| • Industrial robot SR series | Interface manual                       | ..... | External I/O, electrical specifications |
| • Industrial robot SR series | Transportation and installation manual | ..... | Mounting hand and wiring & piping       |
| • Industrial robot SR series | Maintenance manual                     | ..... | Regular inspection and maintenance      |
| • Industrial robot SR series | Communication manual                   | ..... | Communication protocol                  |
| • Industrial robot SR series | Safety manual                          | ..... | Safety measures                         |

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The information contained in this manual is subject to change without prior notice to effect improvements of the robot functions and training details.

## Industrial Robot Training Schedule

C Course (SR–H Robot): 2.5 Days

	Time	Descriptions	Place
1st day	13:30 ~ 13:40	Greetings at starting the course.	Classroom
	13:40 ~ 15:00	Explaining the outline.	Classroom
	15:00 ~ 15:15	Break	
	15:15 ~ 16:25	Explaining the programming.	Classroom
	16:25	End	
2nd day	8:30 ~ 9:30	Explaining the programming.	Classroom
	9:30 ~ 10:15	Instructing the safety.	Classroom
	10:15 ~ 10:25	Move to the training room.	
	10:25 ~ 11:50	Explaining the operation.	Training room
	11:50 ~ 12:00	Move to the classroom.	
	12:00 ~ 13:00	Lunch	
	13:00 ~ 13:10	Move to the training room.	
	13:10 ~ 14:45	Training the operation.	Training room
	14:45 ~ 15:00	Break	
	15:00 ~ 16:15	Training the operation.	
	16:15 ~ 16:25	Move to the classroom.	
	16:25	End	Classroom
3rd day	8:30 ~ 8:40	Move to the training room.	Classroom
	8:40 ~ 9:45	Training the programming.	Training room
	9:45 ~ 10:00	Break	
	10:00 ~ 11:50	Training the programming	Training room
	11:50 ~ 12:00	Move to the classroom.	
	12:00 ~ 13:00	Lunch	
	13:00 ~ 13:10	Move to the practical training room.	
	13:10 ~ 14:45	Training the programming	Training room
	14:45 ~ 15:00	Break	
	15:00 ~ 15:50	Explaining the maintenance.	Training room
	15:50 ~ 16:00	Move to the classroom.	
	16:00 ~ 16:15	Questions and answers	Classroom
	16:15 ~ 16:25	Awarding a certificate of completing the course and greetings at finishing the course.	
	16:25	End	

Robot SR-654HSP

Robot controller SR7000

Teach pendant

STE 58769

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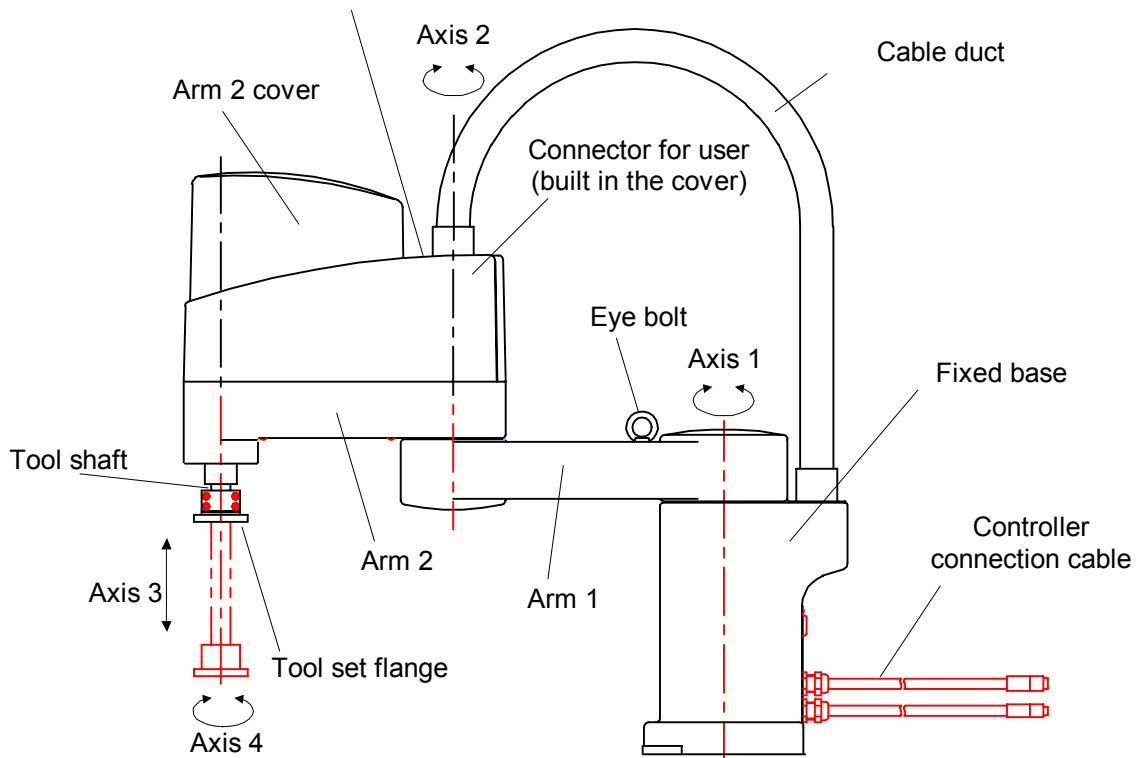
## 1. General Descriptions

### 1.1 Basic Robot and Controller

a) Names of the parts of the robot

The SR-H series is a group of robots having four degrees of freedom. Having two degrees of freedom for positioning in a horizontal plane, one degree of freedom for positioning in a vertical direction and one for the rotation of the tool mounting flange, it is good at assembling and handling parts.

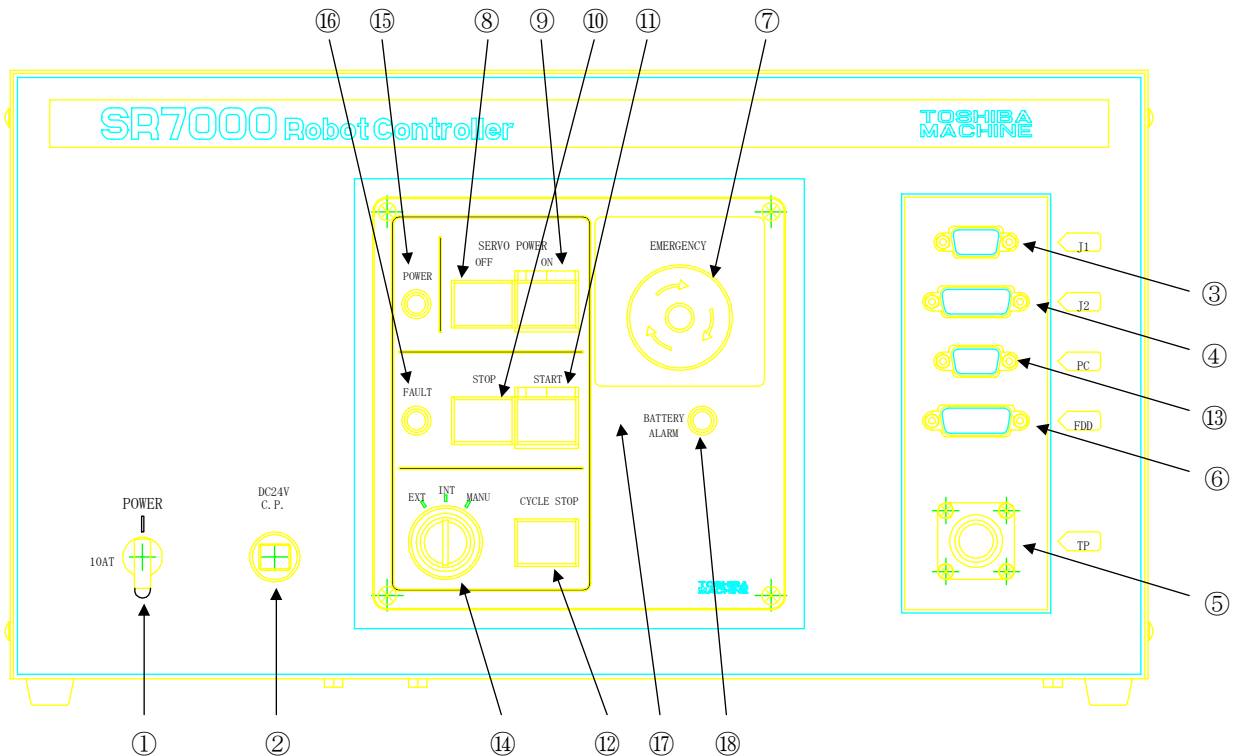
- Tool wiring intake port
- Air fitting for user



SR-654HSP

b) Names of the parts of the controller

(1) Controller

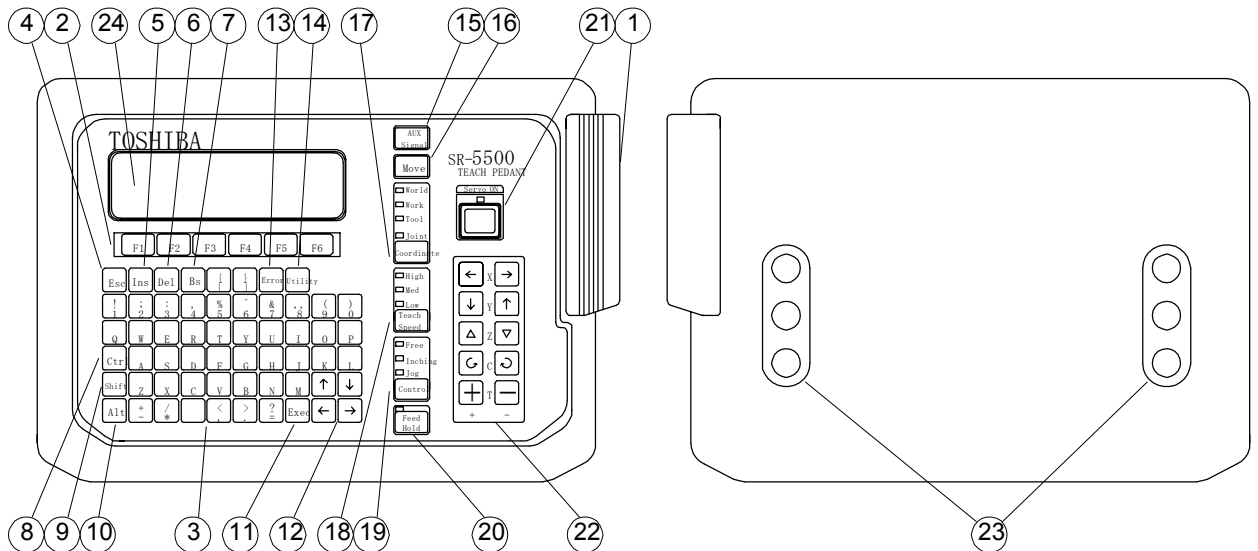


- 1) Main power switch
- 2) Circuit protector
- 3) J1 connector: connector for communication channel 1
- 4) J2 connector: connector for communication channel 2
- 5) TP connector: connector for connecting the teaching pendant
- 6) FDD connector: connector for connecting the floppy disk drive unit
- 7) Emergency switch
- 8) Servo power off switch
- 9) Servo power on switch
- 10) Stop switch: switch to stop automatic operation
- 11) Start switch: switch to start automatic operation
- 12) Cycle stop switch: switch to select the mode of performing 1 cycle of automatic operation
- 13) PC connector: connector to connect a PC



- 14) Master mode key switch: switch to select a robot mode  
 EXT: External automatic mode  
 INT: Internal automatic mode  
 MANU: Manual mode
- 15) Power lamp
- 16) Fault lamp: controller's fault lamp
- 17) Buzzer: it sounds continuously when a fault is detected (since built in, it is not visible from outside).
- 18) Battery alarm lamp: turns on or blinks when replacement of batteries is necessary.

(2) Teaching pendant

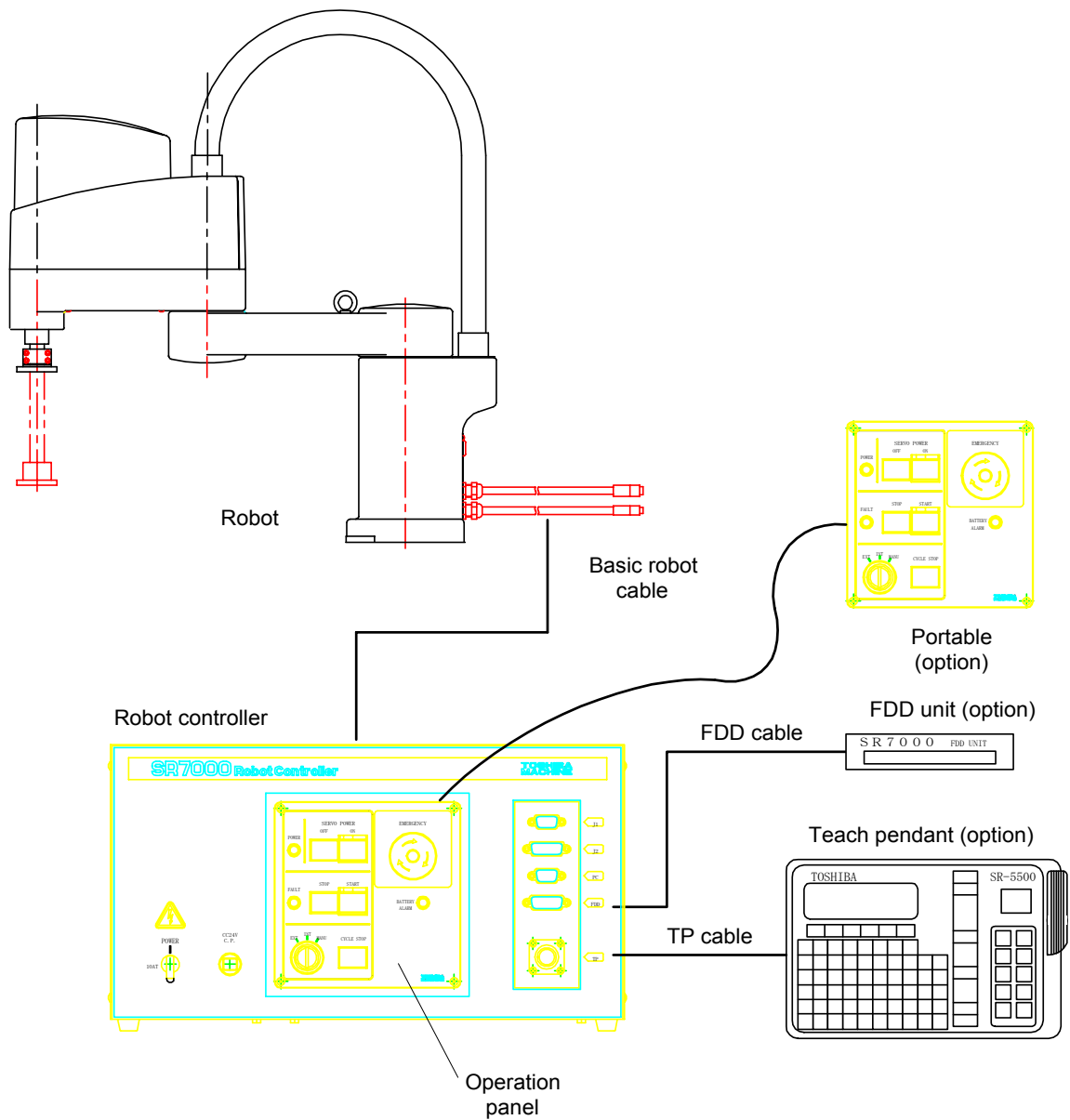


- 1) Emergency stop switch
- 2) Function keys: Keys to select functions displayed at the lowermost section of the liquid crystal display
- 3) Alphanumeric keys
- 4) Esc (escape) key: Key to cancel an inputted letter and operation
- 5) Insert key: Key to switch between the insert mode and the replace mode  
 Insert mode: Inserts a letter anew between already inserted letters.  
 Replace mode: A newly-inserted letter replaces one inputted before.

- 6) Delete key: Key to delete a letter on which the cursor is placed.
- 7) Bs (backspace) key: Key to delete a letter just before the cursor.
- 8) Ctrl (control) key:
- 9) Shift key
- 10) Alt key
- 11) Run key
- 12) Cursor keys
- 13) Error display key: Key to display the description of an error on the liquid crystal display
- 14) Utility key: Key to use auxiliary functions of the controller
- 15) Auxiliary signal key: Key to operate the hand and pneumatic- control shaft of the robot
- 16) Move key: Key to move the robot to a position which is taught to the robot
- 17) Guide coordinate key: Key to select a coordinate system along which the robot is guided
- 18) Guide rate key: Key to select a traveling speed of the robot when it is guided manually.
- 19) Guide mode key: To select a method for guiding the robot
  - Free: Mode to move the robot manually
  - Inching: Mode to move the robot by a certain amount every time the guide key is pressed.
  - Jogging: Mode to move the robot while the guide key is depressed
- 20) Feed hold key: Key to stop the operation of the robot temporarily
- 21) Servo power on switch
- 22) Guide key: Key to guide the robot manually
- 23) Deadman switch:
- 24) Liquid crystal display

c) Composition of robot system

Basic composition: Composed of the robot body, controller, teaching pendant, and the FDD unit



Operating panel: Panel for starting and stopping automatic operation. Detachable from the controller (optional), it is convenient when the controller is stored under a rack. The CP cable (cable between the operating panel and the controller) is less than 30 m long.

Teach pendant:	Detachable from the connector and usable for multiple robots commonly. Inserting a dummy plug (accessory) allows automatic operation without the teaching pendant.
Body cable:	3 cables. Standard cable is 5 m long. Optional cables can be 30 m at the maximum.
TP cable:	Standard cable is 7 m long and a 30 m cable is available as optional.
FDD cable:	Standard cable is 2 m long and a 50 m cable is available as optional.

## 1.2 Coordinate System of the Robot

Coordinate systems include the world, base, tool and workpiece coordinate systems. In the initial state, the world and workpiece coordinate systems match the base coordinate system, and the tool coordinate system is a coordinate system whose origin is a hand mounting flange. The world coordinate system, workpiece coordinate system and the tool coordinate systems are set in accordance with work and used. When coordinate systems are set, the robot is guided along the set coordinate system and can be operated with the same position data to different tools. There is no need for setting coordinate systems when the robot is guided to positions where it actually operates and taught the positions. Setting coordinate systems unnecessarily complicates position teaching operations. If there is no trouble, the robot should be used at the initial condition without setting coordinate systems.

a) World coordinate system (absolute coordinate system)

Only one coordinate system for the whole of a work area where a robot is installed.

Generally, it is matched to the base coordinate system whose origin is the cardinal point of installation of the robot.

b) Base coordinate system (machine coordinate system)

The coordinate system based on the center of the robot. Based on the origin posture where each joint axis is zero. The base coordinate system is the natural coordinate system determined from the structure of the robot.

c) Workpiece coordinate system (work coordinate system)

The coordinate system to be set for workpieces the robot work on and pallets. Different workpiece coordinate systems are set for different workpieces.

d) Tool coordinate system

The coordinate system based on the hand mounting flange of the robot.

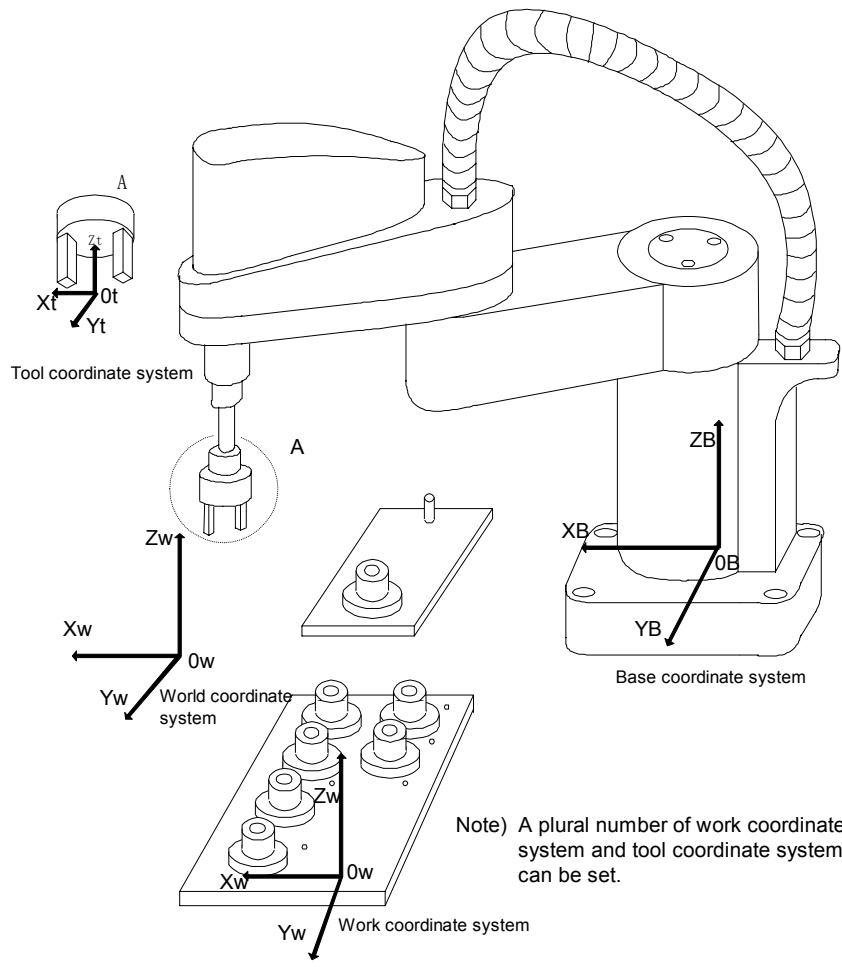
Depending on hands mounted on the robot, a tool coordinate system can be set in a manner of matching it to the work point of the robot. The coordinate system also moves with the operation of the robot.

Positions of the robot are expressed by X, Y, Z, C and T.

X, Y, Z: X, Y, Z coordinate values in an orthogonal coordinate system (in mm)

C: Rotation of the head of the tool (in degrees)

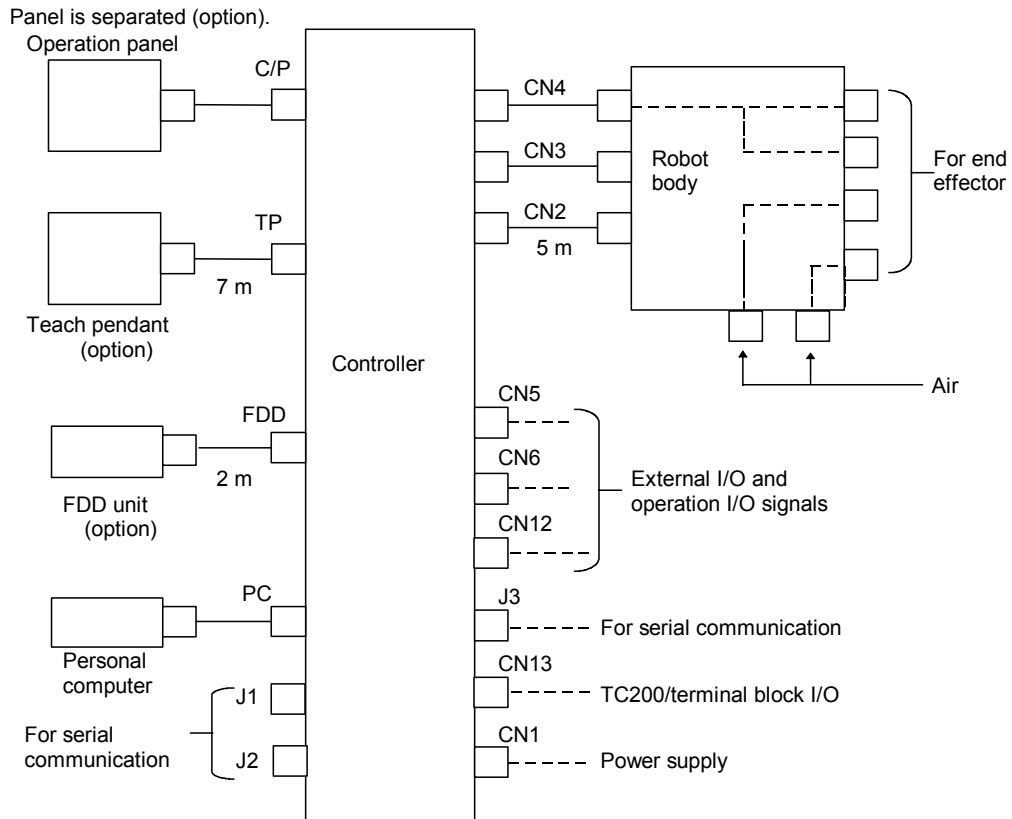
T: Rotation or direct advance of the 5th axis (in degrees or mm)



Note) A plural number of work coordinate system and tool coordinate system can be set.

### 1.3 External Input/Output Signals

#### a) External interface



**Note:** Cables for connecting the operating panel, teaching pendant, FDD unit, and robot to the controller can be extended up to 30 m long at the maximum.

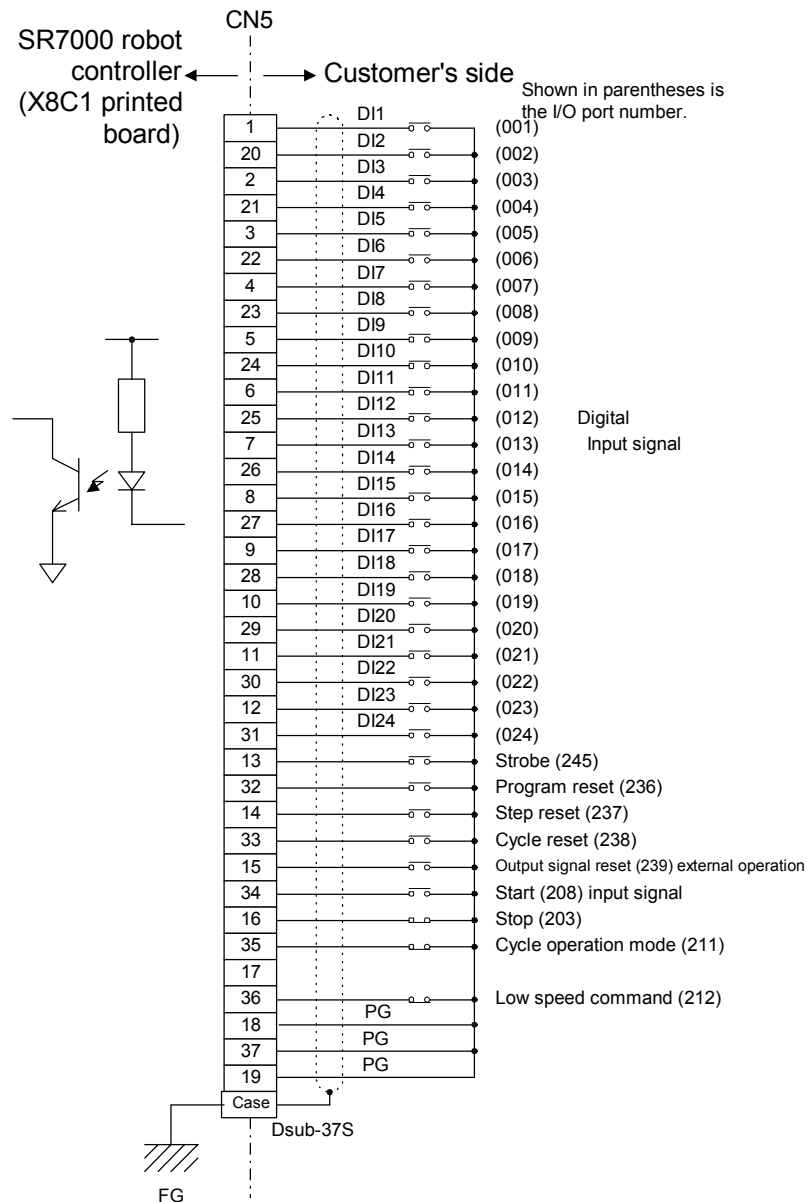
- CN1: Power supply
- CN2: Power cable for the main body of the robot
- CN3: Robot body encoder wire
- CN4: Robot body sensor signal, hand control signal
- CN5: External operation input signal
- CN6: External operation output signal
- C/P: Signal wire for the operating panel (used to draw out the operating panel)
- TP: Serial port for the teaching pendant
- J1 to J3: Serial ports for users
- CN12: External input output signals
- CN13: RS485 port for connecting TC200/terminal board I/O

a) Input output signals

1) External operation input signal (CN5)

External operation input signals are those to control the start and stop of the robot controller SR7000 from external equipment such as a sequencer.

- "Stop," "Cycle operation mode," and "Low speed command" are b contact point input. If this signal is not used, connect CN5-16, CN5-35, CN5-36 to either of CN5-18, CN5-19 or CN5-37.



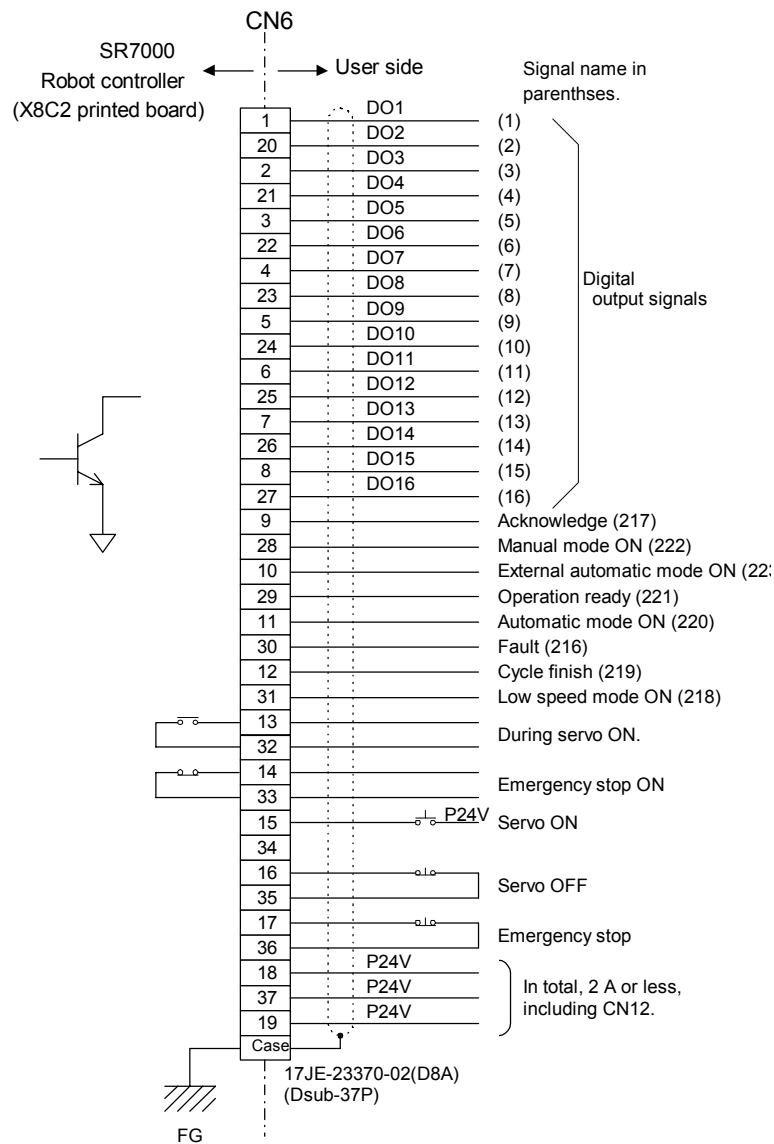
Connection of external input signal wire



2) External operation output signal (CN6)

External operation output signals are those which output operating conditions of the robot controller SR7000.

- When input signals such as "servo off" and "emergency stop" are open, "servo on" is not feasible.
- User output is open collector output of capacity of DC 24 V, 100 mA.
- Output signals "servo on" and "emergency stop" are 2 output non voltage output.
- Use the 24 V power supply at a total capacity of 2 A or less including CN12.

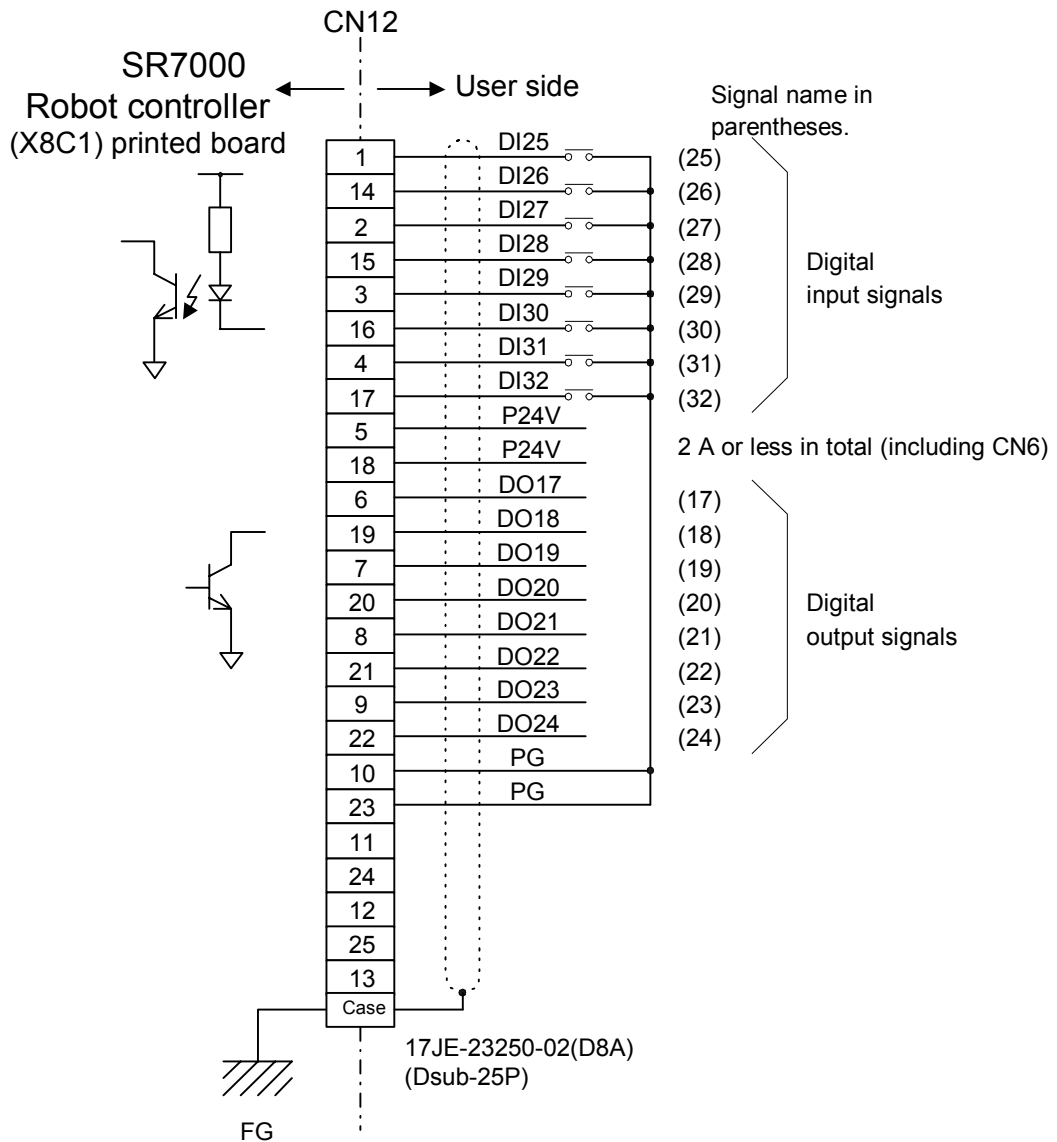


Connection of external output signal wire

3) External output signals (CN12)

External input output signals are those which input and output the operating condition of the robot controller SR7000.

- User output is open collector output with a capacity of DC 24 V, 100 mA.
- Use the 24 V power supply at 2A or less including CN6.



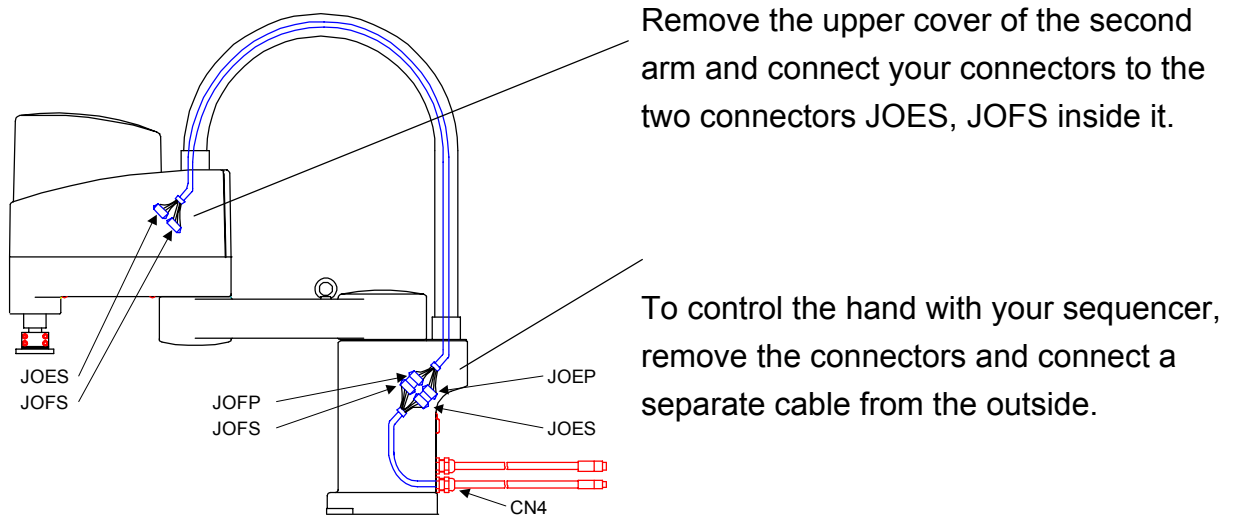
Connection of external I/O signal wire

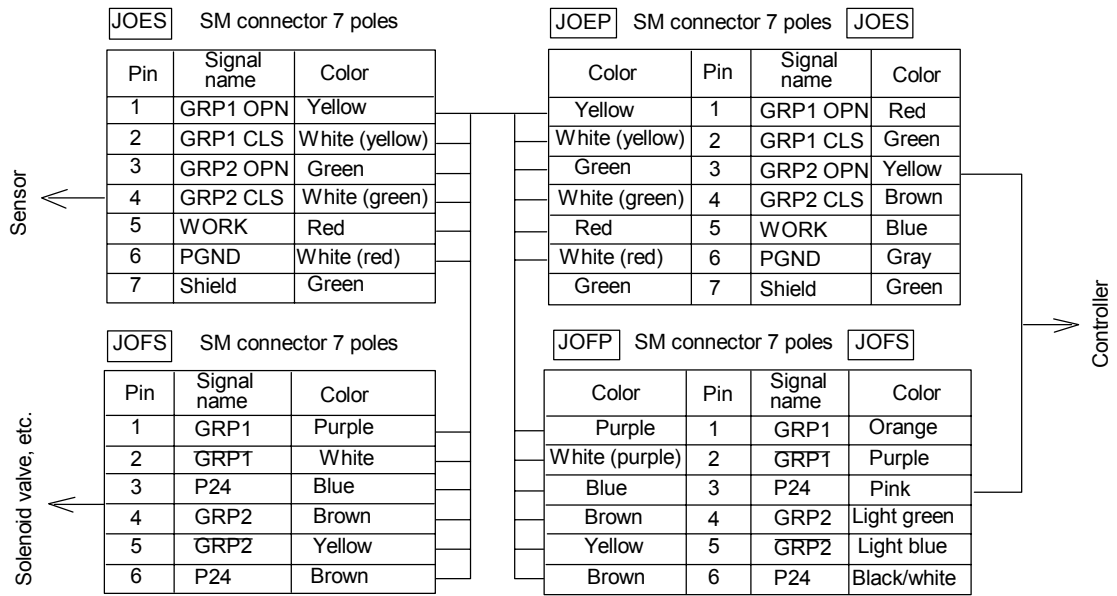
4) Auxiliary input and output signals

DC 24 V wires, including five for input signals from sensors and 4 for control output signals to electromagnetic valves, are routed to the second arm of the robot, and allow the opening and closing of the hand and the monitoring of on/off of sensors.

- Output is open collector output and has a capacity of DC24V, 1 A.
- Signal numbers of auxiliary input signals are as given below.

Input: Signal number	220 ... GRP1 OPN	Output: Signal number	214 ... GRP1
	219 ... GRP1 CLS		213 ... $\overline{\text{GRP1}}$
	218 ... GRP2 OPN		212 ... GRP2
	217 ... GRP2 CLS		211 ... $\overline{\text{GRP2}}$
	216 ... WORK		



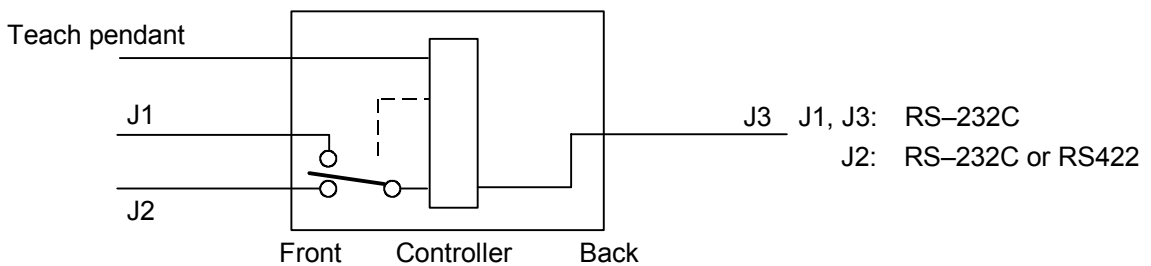


- Connector type
- JOES** ---- SMP-07V-BC (J.S.T Corporation)
  - JOEP** ---- SMR-07V-B (J.S.T Corporation)      Provided by the customer.
  - JOFS** ---- SMR-06V-BC (J.S.T Corporation)
  - JOFP** ---- SMR-06V-B (J.S.T Corporation)      Provided by the customer.

5) Serial communication

The SR7000 controller is furnished with hardware and software for communication with external equipment as standard components.

- Port: there are four ports including one exclusively used for the teaching pendant.  
 J1 and J2 are switchable. Switching is made by operation mode or robot language instructions.  
 Equipment to be connected to J1 to J3 is registered in the system configuration file.



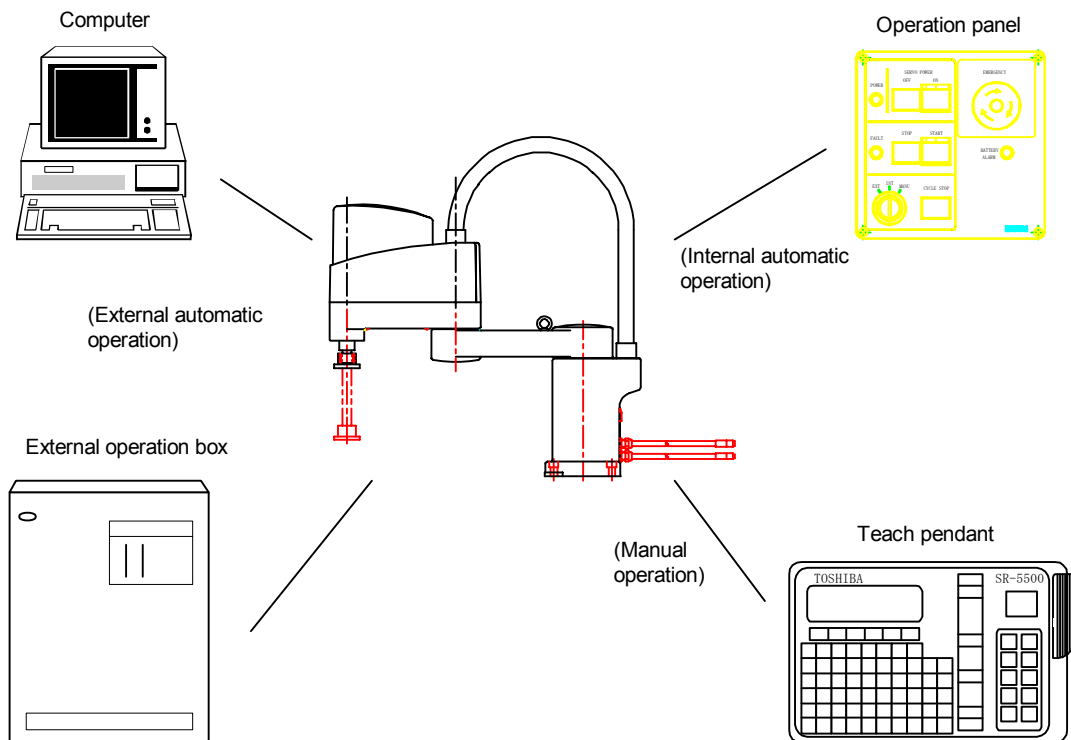
## 1.4 Mode System

Operation modes include the following.

Master mode: Switching is made by the key switch on the operating panel.

Sub mode: Switching is made by specifying the teaching pendant or system configuration file.

Master mode	Sub mode	Description
External automatic	Communication mode	Operation of the robot by serial communication.
	I/O mode	Operation of the robot by external operation signals.
Internal automatic		Operation of the robot from the controller operating panel.
Manual	Test run	Running the program at lower speed.
	Edit	Editing of programs, teaching of positions, editing of data.
	File manipulation	Saving, reading and copying of files.
		Teaching of joint limits, setting of coordinates.



## 1.5 File

### a) File names

File: Unit of storage for a program, etc.

A maximum of 248 program files used by a user can be stored.

However, memory is limited. 3,000 program steps and 150 points of position data are a rule of thumb for measuring the size of a file.

File name: “\$\$\$\$\$\$\$\$.\$\$\$”

Extensions (omission is allowed.)

Up to three alphanumerics

File name

Up to eight alphanumerics (headed by an English letter)

Drive name: Suffixed to a file name and specifies the location of the file.

"A": FDD (floppy disk)

"R": RAM drive (controller memory)

If the drive name is omitted, it is regarded as a file in the RAM drive.

Floppy disks must be 3.5-inch 2HD. For the SR-5500, 2DD type is used.

### b) Types of files

1) Program file “\$\$\$\$\$\$\$\$.\$\$\$”

File storing robot language programs and position data

2) Batch file “\$\$\$\$\$\$\$\$.BAT”

File to run multiple commands together

Operations which are performed frequently are registered in the batch file and run.

To run a batch file, enter the file name of the batch file as a command.

(entering the extension "BAT" is not needed)

Example: "FLOAD.BAT"

LOAD PROG1 LOAD PROG2 LOAD PROG3 LOAD PROG4	→ When FLOAD is run, PROG1 to PROG4 are read out to the RAM drive.
--	--

- 3) System configuration file "CONSTRC.SYS."  
File storing an optional configuration of the robot, equipment connected to the serial port, settings of signals used for selecting files by external signals.  
(When necessary, users may change the content. After change, save the change in a floppy disk).
- 4) Automatic execution file "AUTOSTR.BAT"  
Batch file which is run automatically when the power is turned on (when necessary, users may change the content. Store it on a floppy disk after change)
- 5) System parameter file "SYSTEM.PAR"  
File storing control parameters of the robot
- 6) User parameter file "USER.PAR"  
File storing the home position and soft limits of the robot.  
When these settings are changed, the content of the file is changed automatically. (After changed, save the change on a floppy disk)
- 7) System file "SVPMTX.SYS", "MCPMTX.SYS"  
File storing a system to operate the robot.  
It is stored only on a system disk. (LOAD, SAVE, COPY commands can not be used.)
- 8) Message file "ALARM.MES"  
Error messages to be display on the teaching pendant are stored in the file.  
They are read out only by the COPY command.
- 9) External selection file "EXTRNSEL.SYS"  
File to be selected by external signals are stored in the file.
- 10) Library file "SCOL.LIB"  
Some instruction words of the robot language are stored in the file.  
Sub programs created in the library file can be run in all files.

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