




NACHI

AX CONTROLLER OPERATING MANUAL

BASIC OPERATIONS MANUAL

14th edition

	<ul style="list-style-type: none">■ Before attempting to operate the robot, please read through this operating manual carefully, and comply with all the safety-related items and instructions in the text.■ The installation, operation and maintenance of this robot should be undertaken only by those individuals who have attended one of our robot course.
	<ul style="list-style-type: none">■ This operating manual must be given without fail to the individual who will be actually operating the robot.
	<ul style="list-style-type: none">■ Please direct any queries about parts of this operating manual which may not be completely clear or any inquiries concerning the after-sale service of this robot to any of the service centers of Nachi Robotic Systems listed on the back cover.

NACHI-FUJIKOSHI CORP.

Table of Contents

Chapter 1 Introduction

1.1 Configuration of manual	1-1
1.2 How to read the instruction manual.....	1-2
1.3 Frequently used terms.....	1-4
1.4 Basic concepts applying to the robot.....	1-6
1.4.1 Robot system.....	1-6
1.4.2 Overview: from teaching to auto operation	1-7
1.4.3 Manual operation.....	1-8
1.4.4 Teaching	1-9
1.4.5 Function Command (Function).....	1-10
1.4.6 Auto operation	1-11

Chapter 2 Names and functions of the operation switches and keys

2.1 Controller	2-1
2.1.1 When the AX20 controller is used	2-1
2.1.2 When the AX21 controller is used	2-2
2.2 Operation panel (provided with AX20 controller only).....	2-3
2.3 Operation box (provided with AX21 controller only).....	2-4
2.4 Teach pendant	2-5
2.4.1 External appearance of teach pendant (AX20 Controller)	2-5
2.4.2 External appearance of teach pendant (AX21 Controller)	2-6
2.4.3 Functions of buttons and switches	2-7
2.4.4 Functions of operation keys	2-8
2.4.5 Configuration of display screen.....	2-15
2.4.6 Concerning the operation of the f keys	2-18
2.5 To input characters	2-19

Chapter 3 Turning the power on/off and manual operation

3.1 Turning the control power to ON.....	3-1
3.2 Mode selection.....	3-2
3.2.1 When the AX20 controller is used	3-2
3.2.2 When the AX21 controller is used	3-3
3.3 Turning the motor power to ON	3-4
3.4 Moving the robot manually	3-6
3.4.1 Movement Direction.....	3-6
3.4.2 Moving the robot manually	3-9
3.4.3 Switching the mechanism.....	3-10
3.5 Turning the motor power to OFF	3-11
3.6 Turning the control power to OFF.....	3-11

Chapter 4 Teaching

4.1 Teaching procedure	4-1
4.2 Preparations prior to teaching	4-2
4.2.1 Input the number of the program.....	4-2
4.2.2 Listing the programs on the display.....	4-3
4.3 Teaching.....	4-4
4.3.1 Concerning the screen displays during teaching	4-4
4.3.2 Basic teaching operations —For NACHI Nachi users —	4-5
4.3.3 Basic teaching operations —For DAIHEN Daihen users—	4-6
4.3.4 What is the interpolation type?	4-8
4.3.5 What is the accuracy level?.....	4-8
4.3.6 Continue and Pause.....	4-10
4.3.7 What is the acceleration?	4-11
4.3.8 What is smoothness?	4-12
4.3.9 Number of recordable steps	4-13
4.4 A practice teaching session —For NACHI Nachi users—	4-14
4.5 A practice teaching session —For DAIHEN Daihen users—	4-20
4.5.1 Teaching methods	4-20
4.5.2 Try teaching using normal teaching.....	4-21
4.5.3 Try teaching using easy teaching (f keys).....	4-28
4.5.4 Try teaching using easy teaching (numeric keys)	4-35
4.6 Recording function commands.....	4-39
4.6.1 Directly selecting a command with the function numbers	4-40
4.6.2 Selecting from categorized groups.....	4-40
4.6.3 Setting and recording function command parameters (conditions)	4-42
4.7 Checking what has been taught	4-43
4.8 Modifying the program.....	4-47
4.8.1 Modifying the robot position	4-47
4.8.2 Modifying movement command data —For NACHI Nachi users only—	4-48
4.8.3 Overwriting movement commands.....	4-49
4.8.4 Adding movement commands.....	4-53
4.8.5 Deleting movement and function commands	4-57
4.9 Using the screen editor function to modify commands	4-58
4.9.1 Modifying with the screen editor function	4-58
4.9.2 Batch changing the speed of MOVE command	4-61

Chapter 5 Auto operation (playback)

5.1 Before starting auto operation	5-1
5.1.1 Methods of starting automatic operation	5-1
5.1.2 Notations used for automatic operation.....	5-2
5.1.3 Playback methods (5 operation modes).....	5-2
5.1.4 Specifying the step which playback starts.....	5-3
5.1.5 Operating speed when the start step is specified	5-3
5.2 Performing automatic operation (playback) — Internal start method —	5-4
5.3 Performing automatic operation (playback) — External start method—	5-5
5.4 Performing automatic operation (playback)— Multi-station start method—	5-7
5.5 Operations in different operation modes	5-11

Chapter 6 File operations

6.1 Copying, deleting and renaming programs	6-1
6.1.1 Copying programs	6-1
6.1.2 Deleting programs	6-2
6.1.3 Renaming (renumbering) programs	6-3
6.2 Concerning the file operation menu	6-4
6.2.1 File operation menu selection and common operations	6-4
6.2.2 Types of usable storage media	6-6
6.2.3 Operable files	6-7
6.2.4 Folder structure of internal memory	6-8
6.3 Inserting the CF card	6-11
6.3.1 CF cards that can be used	6-11
6.3.2 Inserting the CF card	6-11
6.3.3 Cautions when using a CF card	6-14
6.4 Copying files	6-15
6.5 Displaying a list of the files	6-18
6.6 Deleting files	6-19
6.7 Setting protection for files	6-22
6.8 Verifying files.....	6-25
6.9 Initializing the storage media	6-27
6.10 Backing up files.....	6-28
6.11 Restoring all files from backup.....	6-32
6.12 Performing automatic backup.....	6-36

Chapter 7 Useful functions

7.1 Using short-cuts	7-1
7.2 Monitoring various information of the robot.....	7-2
7.2.1 Starting a multiple number of monitors	7-2
7.2.2 Switching and closing the monitors	7-4
7.2.3 Operating the Use Inputs and Outputs monitors	7-5
7.3 Setting the output signals ON or OFF manually	7-6
7.4 Using help for information on functions.....	7-7
7.4.1 Calling the help top page	7-7
7.4.2 Directly calling a function to be checked out	7-9
7.4.3 Searches using keywords.....	7-11
7.5 Managing programs in folders.....	7-13
7.5.1 Setting displaying the Folder list.....	7-13
7.5.2 Creating, deleting and renaming folders	7-16
7.5.3 Assign the stored folder inside programs	7-18
7.5.4 Copying and transferring programs within folders.....	7-19
7.6 Customizing the Softkey	7-20
7.6.1 Changing the Softkey Allocation	7-21
7.6.2 Changing the Maximum Number of Pages for Softkey	7-33
7.6.3 Setting the Softkey Condition Enable/Disable	7-34
7.6.4 Saving the Softkey Settings.....	7-35

7.6.5	Loading Softkey Settings from the File.....	7-37
7.7	Selecting a work program number from a list	7-38
7.7.1	Selecting a work program number from a list.....	7-38
7.7.2	Displaying programs unit by unit	7-40
7.7.3	Confirming the contents of the program	7-41
7.8	How to edit the step comment.....	7-42
7.8.1	Inputting a step comment	7-42
7.9	User error	7-44
7.9.1	Outline.....	7-44
7.9.2	Flow of operation	7-44
7.9.3	Settings.....	7-45
7.10	Display language change.....	7-48
7.10.1	Candidate language selection	7-49
7.10.2	User error file	7-50
7.10.3	I/O signal name.....	7-53
7.10.4	Software key name for interface panel	7-56

Chapter 8 Troubleshooting

8.1	To initiate emergency stop for the robot	8-1
8.2	When failure has occurred.....	8-2
8.3	Concerning the failure details.....	8-3
8.3.1	Failure category.....	8-3
8.3.2	Concerning criticality codes and failure codes.....	8-3

Chapter 9 Basic spot welding operations

9.1	Terms frequently used with spot welding.....	9-1
9.2	f key layout.....	9-2
9.3	Spot welding command	9-3
9.4	Teaching.....	9-4
9.4.1	Spot welding command recording	9-4
9.4.2	Manual pressurizing and manual welding	9-5
9.4.3	When using multiple number of welders	9-10
9.5	Sets the spot welding conditions	9-11
9.6	Setting the spot weld sequences.....	9-13
9.7	Spot welding ON/OFF.....	9-15

Chapter 10 Basic arc welding operations

10.1	Terms frequently used with arc welding	10-1
10.2	f key layout.....	10-2
10.3	Basic arc welding operations.....	10-5
10.3.1	Inching and retracting the wire	10-5
10.3.2	Switching between welding ON and OFF	10-6
10.3.3	Checking the shielding gas	10-6
10.3.4	Switching the welders.....	10-7

10.3.5 Switching between weaving ON/OFF	10-8
10.4 Teaching arc welding	10-9
10.5 Teaching of weaving	10-15
10.6 Creating condition files	10-18
10.6.1 Creating condition files	10-18
10.6.2 Copying, deleting and renaming condition files.....	10-21

NOTE

Chapter 1 Introduction

This chapter provides a guide to reading this manual, and it explains the frequently used terms and the basic concepts applying to the robot.

1.1 Configuration of manual.....	1-1
1.2 How to read the instruction manual	1-2
1.3 Frequently used terms	1-4
1.4 Basic concepts applying to the robot	1-6
1.4.1 Robot system	1-6
1.4.2 Overview: from teaching to auto operation.....	1-7
1.4.3 Manual operation	1-8
1.4.4 Teaching.....	1-9
1.4.5 Function Command (Function).....	1-10
1.4.6 Auto operation	1-11

1.1 Configuration of manual

The Basic Operations Manual describes the knowledge and operating procedures minimally required for making full use of the AX20/AX21 controller.

Read through the chapters, and master the basic operations.

■ In order to master the basic operations:

- Step 1 ... Learn the basic operations and concepts in the correct sequence.
- Step 2 ... Learn the functions which are useful to know such as how to copy and delete the programs which have been created.
- Step 3 ... Learn the basic operations which are performed for spot welding, arc welding, and other designated applications. Read the relevant chapter that corresponds to the designated application.

Step	Chapter	Details provided in the instruction manual
1	Chapter 1 Introduction	How to use this manual, frequently used terms, and concepts applying to the robot
	Chapter 2 Names and functions of the operation switches and keys	Names and functions of the operation switches, buttons and keys provided on the controller and teach pendant
	Chapter 3 Turning the power on/off and manual operation	How to turn on/off the controller's power, and manual robot operations
	Chapter 4 Teaching	Basic concepts of teaching work, and operating procedures
	Chapter 5 Auto operation	How to play back programs which have been created
2	Chapter 6 File operations	How to copy, delete, etc. programs which have been created
	Chapter 7 Useful functions	Short-cut functions, manual I/O output and other functions
	Chapter 8 Troubleshooting	Troubleshooting in robot
3	Chapter 9 Basic spot welding operations	Operations required to perform spot welding work
	Chapter 10 Basic arc welding operations	Operations required to perform arc welding work

1.2 How to read the instruction manual

How to use the instruction manual

The basic operations of the AX20/AX21 controller are described using the following formats in this manual.

The function or work to be performed is displayed here.

The description of the operation starts here.

The keys to perform the operations are listed here in the sequence of operations (indicated by the number 1, 2, etc.). "+" indicates that the keys concerned are pressed simultaneously; "→" indicates that the keys are pressed in succession one after the other.

3.3 Turning the motor power to ON

To move the robot, turn the motor power to ON. If the robot is not going to be moved, the motor power need not be turned to ON.

! DANGER Before turning the motor power to ON, be absolutely sure to check that no one is near the robot. If the robot should move without warning and come into contact or sandwich a person, death or serious injury may result.

Turning the motor power to ON (in the teach mode)

Take the following steps to turn the motor power to ON in the teach mode...

1. Check that the teach mode has been selected...

2. Press the [Motor power ON button] provided on the upper part of teach pendant...

3. Grasp the [Deadman switch]...

POINT Concerning the operation of the deadman switch...

HINT When the deadman switch cannot be operated...

The description of the functions and restrictions on operation are provided here.

As "POINT," important information which operators should know about is provided.

As "HINT," information on techniques, etc. which are useful to know is provided.

Screen displays on the teach pendant

Not all the screen displays on the teach pendant may be provided in every case. The screen displays are provided as examples. They may differ depending on the robot used.

Displays relating to descriptions of operations





Descriptions of operations are displayed as follows.

Descriptions	Details
Press [Enter].	The keys of the teach pendant are enclosed in square brackets [], and the exteriors of the actual keys are positioned on the left of the descriptions of their operations. Example: 1 Press [Enter].
Press f4 <File>.	When functions are selected using the 12 icons (f keys) indicated at both sides of the display screen, the initial assignment of the icon names and f keys is displayed inside angular brackets < >. Example: 5 Press f4 <File>. ※ In actual operations, press the f key immediate next to the icon. (In the above example, press f4.) When a teach pendant with touch panel specifications is used, touch the icons directly.
Align the cursor with "Directory."	When an item displayed on the teach pendant is to be indicated in cases, for instance, where a candidate is to be selected, the item concerned in indicated inside quotation marks (" ").

Concerning the differences in specifications and operations due to a difference in the brand

The product specifications and operations may differ due to a difference in the brand (Nachi **NACHI** , Daihen **DAIHEN**).

In this manual, these differences are indicated as follows.

External appearance	Indication used in this manual	Function
	[SPD]	<p>NACHI This is used to revise the speed of recorded movement commands.</p> <p>DAIHEN This is used to set the speed of movement commands. (The setting is reflected in the recording status.)</p> <p> This function is set by selecting [Constant Setting] - [5 Operation Constants] - [1 Operation condition] - [5 Usage of SPD key].</p>
	[ACC]	<p>NACHI This is used to revise the accuracy of a recorded movement command.</p> <p>DAIHEN This is used to set the accuracy of a movement command which is to be recorded. (What has been set is reflected in the recording status.)</p> <p> This function is set by selecting [Constant Setting] - [5 Operation Constants] - [1 Operation condition] - [6 Usage of ACC key].</p>
	[TIMER]	<p>During teaching, this short-cut records the timer command (DELAY <FN50> function command).</p>

This mark is indicated when there are differences in the specifications and functions due to a difference in the brand (Nachi or Daihen).

No mark is indicated when the specifications and functions are the same.

(Supplement)

When using a robot in a combination of “**NB/NV series manipulator + AX21 controller**”, please read the descriptions of **DAIHEN** even if the robot was purchased from **NACHI**.

1.3 Frequently used terms

Explained below, for the benefit of those individuals who will be operating the robot for the first time, are the basic terms which are frequently used in this manual.

Table 1.3.1 Frequently used terms

Terms	Explanation
Teach pendant	This is used to perform the manual robot operations, teaching, etc.
Enable switch (Deadman switch)	This is a safety device for ensuring that the robot will not operate unexpectedly due to incorrect operations, etc. The Enable switch (Deadman switch) is located on the rear panel of the teach pendant. By design, it is not possible to perform manual robot operations, check go/ back, etc. unless the Enable switch (Deadman) switch is held down. In this document, several sections describes this switch as "Deadman switch".
Teach mode	This is the mode which is mainly used for creating programs.
Playback mode	In this mode, the programs which have been created are automatically executed.
Motor Power	This denotes the status of power to the robot, that is to say, whether it is on or off. At motor power ON, power is supplied to the robot, and at motor power OFF, the robot is set to emergency stop.
Teaching	This refers to teaching the robot how to move and how to do welding work. What is taught is successively recorded in the programs.
Program	This is a file in which the robot movements, welding work and other execution procedures are recorded.
Movement Command	These commands cause the robot to move.
Function Command	These commands are used to perform auxiliary jobs during robot operations such as welding, program branching, and external I/O control.
Step	When movement or function commands are taught, their successive numbers are written in the program. These numbers are known as steps.
Accuracy	The robot reproduces the taught positions accurately but in some cases these positions need not be accurate. The "accuracy" function specifies how precisely the robot is to operate.
Coordinate System	The robot has coordinates. Normally, they are known as robot coordinates. As viewed from the front of the robot, the back and forth movement is represented by X, the left and right movement by Y and the up and down movement by Z, thus forming three orthogonal coordinates. These coordinates serve as a reference for calculating the linear interpolation, shift and other operations. In addition, there are tool coordinates which are referenced to the tool installation surface (flange surface).
Axis	The robot is controlled by a multiple number of motors. The parts controlled by these motors are called axes. A robot which is controlled by six motors is called a 6-axis robot.
AUX. axis	Axes other than those of the robot (such as positioners or sliders) are generally called auxiliary axes. An alternative term is "external axes."
Check go/check back	This function slowly runs the programs which have been created on a step by step basis, and checks the teach positions. It operates in two directions, step forward (check go) and step backward (check back).
Start	Start refers to the playback of a program which has been created.
Stop	Stop refers to stopping the robot in the start status (playback).
Emergency stop	Emergency stop refers to stopping the robot (or system) in an emergency. Generally, a multiple number of buttons for initiating emergency stop are provided in the system, and emergency stop can be applied to the system immediately by pressing one of these buttons.

Table 1.3.1 Frequently used terms

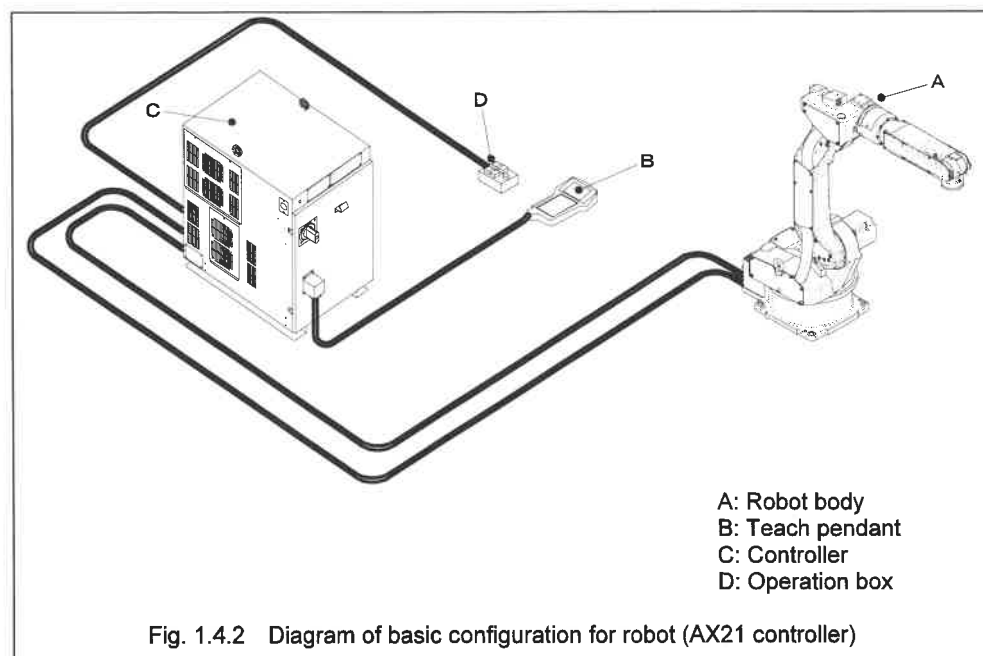
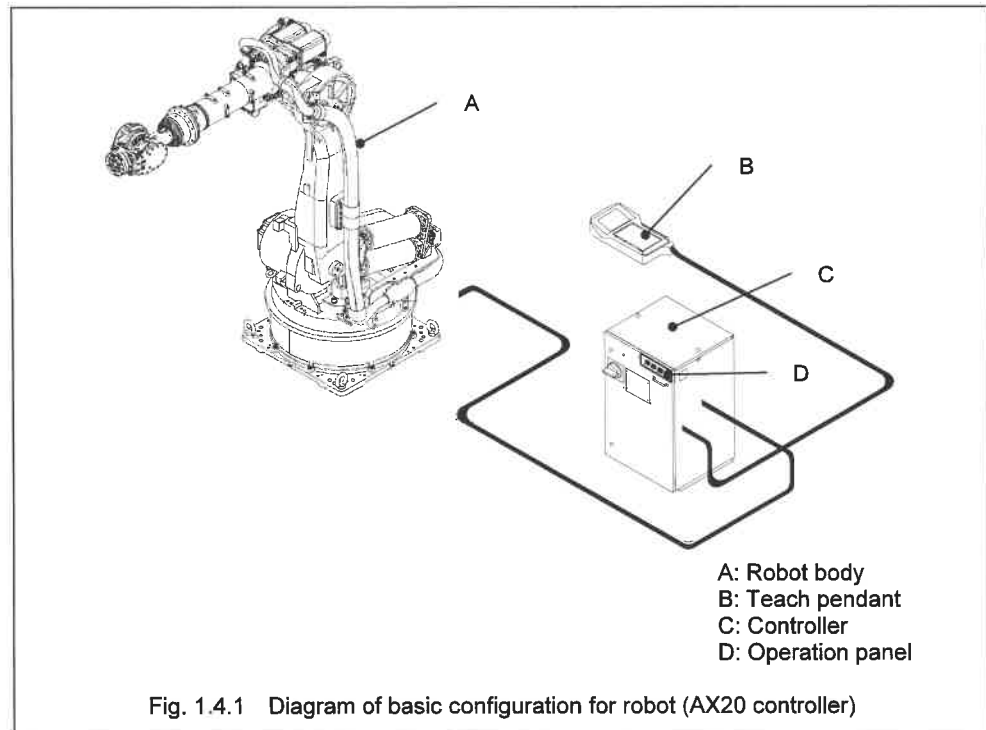
Terms	Explanation	
Error	If an error in operation or teaching or trouble in the robot itself has been detected during a teaching or playback operation, the operator is alerted to the error or trouble concerned.	If an error occurs during a playback operation, the robot is set to the stop status, and the servo power (motor power) is turned off immediately.
Alarm		If an alarm occurs during a playback operation, the robot is set to the stop status. The servo power (motor power) is not turned off. This type of trouble is less serious than an error.
Information		If information occurs, the robot remains in the start status even during a playback operation. It does not entail hazards or risks but in some cases it may potentially lead to an alarm or error in the future.
Mechanism	<p>A mechanism refers to a unit such as a "manipulator", "positioner", "servo gun" or "servo travel" device that configures a control group and cannot be broken down any further.</p> <p>A "multi-mechanism" refers to a configuration where, for instance, a servo gun has been added to a manipulator. If a multi-mechanism is to be used with manual operation, it is first necessary to declare which mechanism is to be operated.</p>	
Unit	<p>This refers to the increments in which a program is created.</p> <p>On some occasions, only one mechanism configures the unit; on other occasions, multiple mechanisms (multi-mechanism) are involved.</p> <p>Normally, only one unit is used overall. Under the multi-unit specifications (conventionally referred to by Nachi as "multi-robot" or as "multi-task" by Daihen), a multiple number of units can be operated simultaneously.</p>	

1.4 Basic concepts applying to the robot

This section describes the basic concepts applying to the robot and basic knowledge about the robot.

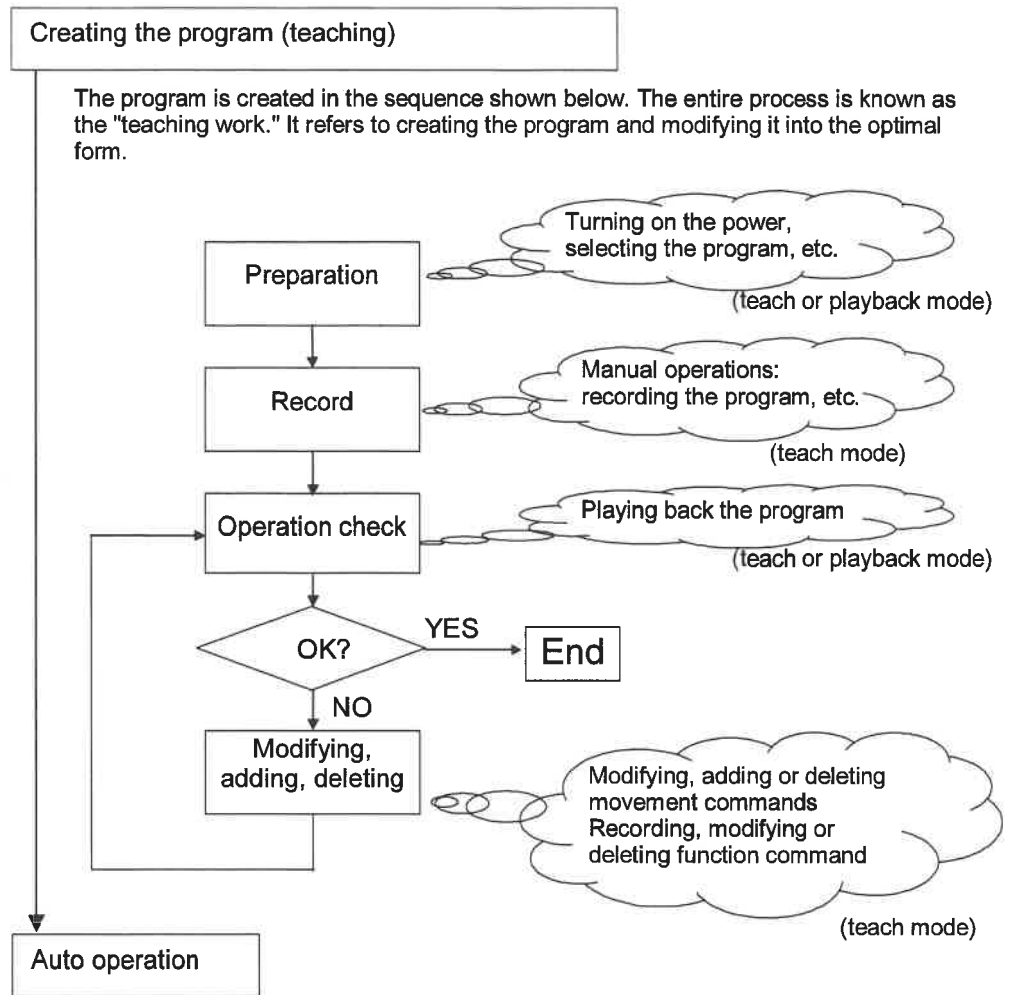
1.4.1 Robot system

A robot system normally denotes a combination of a robot, a teach pendant, and peripheral devices which are all connected to one controller.

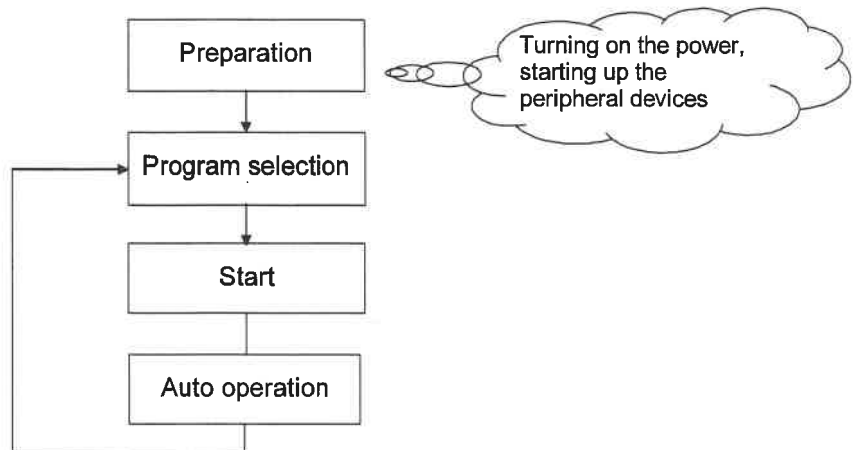


1.4.2 Overview: from teaching to auto operation

Proceed as follows to continuously operate the robot.



After the creation of the program has been completed, automatic operation is performed. When automatic operation is performed, the selected program is repeatedly played back.



1.4.3 Manual operation

"Manual operation" refers to moving the robot with the use of the teach pendant. Guide the robot to the point to be recorded by means of "manual operation".

Manual operation has a number of modes including the mode in which each axis of the "robot" is operated separately, and a mode in which the robot tip is moved in a straight line.

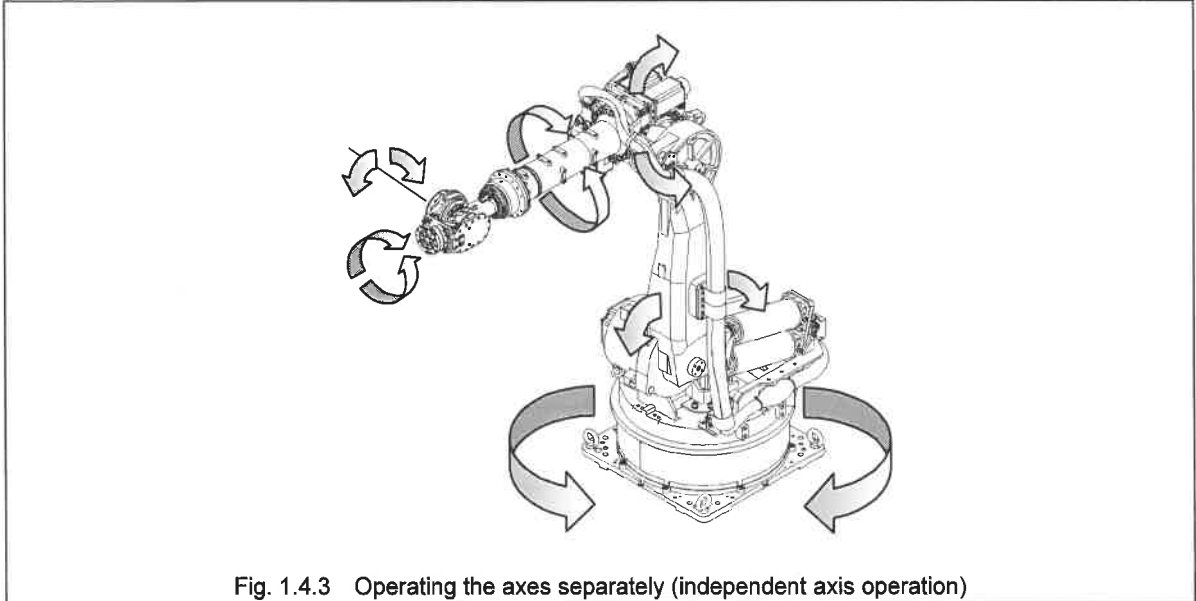


Fig. 1.4.3 Operating the axes separately (independent axis operation)

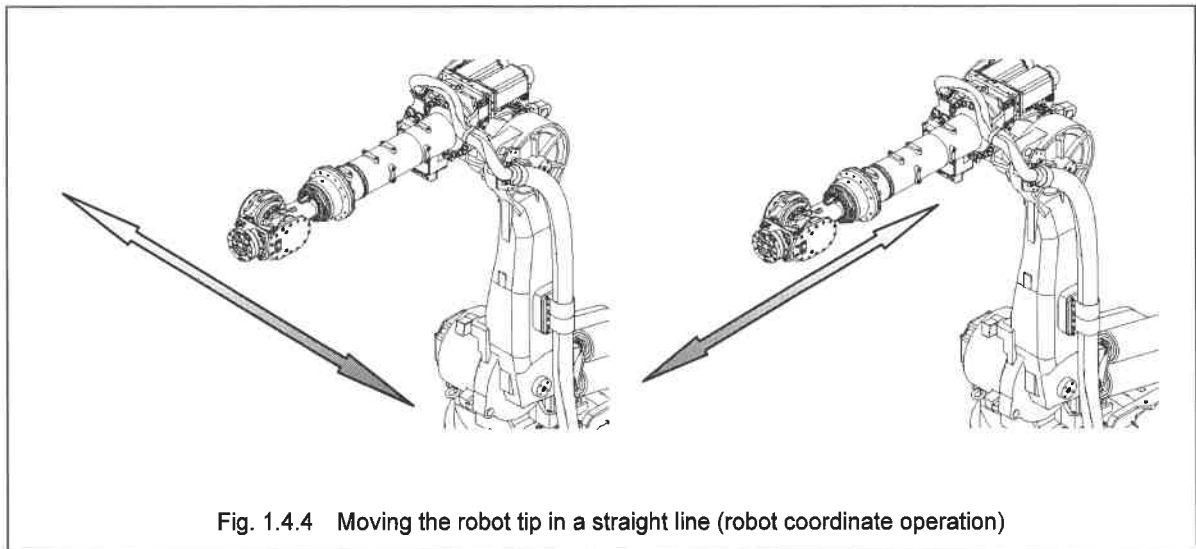
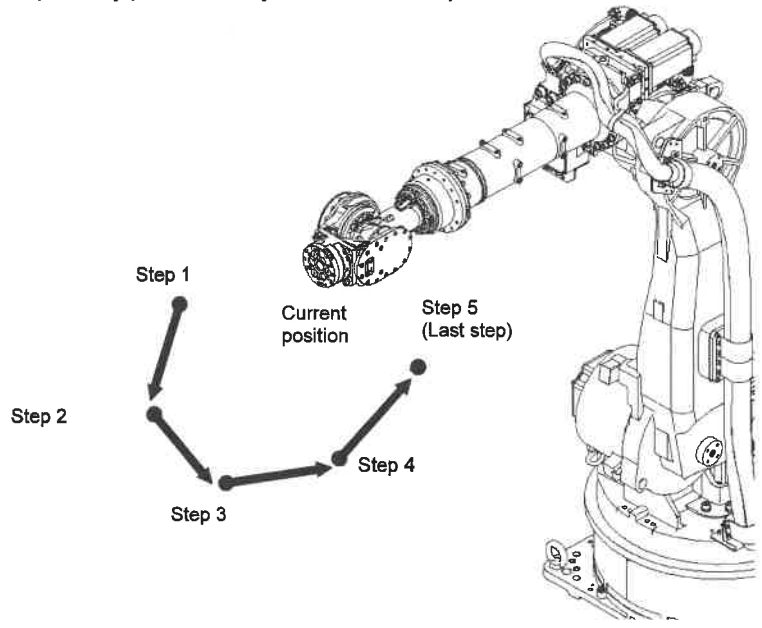


Fig. 1.4.4 Moving the robot tip in a straight line (robot coordinate operation)

1.4.4 Teaching

Teach the robot positions to which it is to be moved and the numerical sequence of these positions ahead of time.

This job is called "teaching," and it is performed in the following sequence.

1	Select the teach mode.
Teaching is performed in the teach mode.	
2	Select the program number.
Select the number of the program to be used.	
3	Successively record the operation positions to which the robot is to move and the robot's postures.
<ul style="list-style-type: none"> •Move the robot to the recorded position and posture by manual operation. •Press the record key to record the step. •Repeatedly press this key to record the steps in succession. 	
	
4	If necessary, record the function commands.
<p>Record the function commands in the appropriate steps. When the function commands are recorded, signals can be output to an external source or the robot can be placed in the standby mode, for instance.</p> <p>See 1-10 "1.4.5 Function Command (Function)".</p>	
5	Record the END command (function command END) that indicates the program end.
Record the END command (function command END) in the step that ends the movement.	
6	Check what has been taught and modify it if necessary.

This completes the sequence of the teaching session, and a program is created as a result.

The teaching system outlined above is called the "teaching playback system."

Alternative systems include the "robot language system" and "off-line teaching system."

The robot supports all of these systems but only the "teaching playback system" is explained in this instruction manual.

1.4.5 Function Command (Function)

In order to operate the hand or gun attached to the robot wrist or capture signals that check the work, function commands (functions) are recorded at the appropriate positions in the program.

Furthermore, in order to perform complicated work, other programs may be called or, depending on the status of the external signals, operation may jump to other programs. These are also recorded as function commands.

Typical function commands

The function commands are expressed using a format based on SLIM (Standard Language for Industrial Manipulators) which is a robot language.

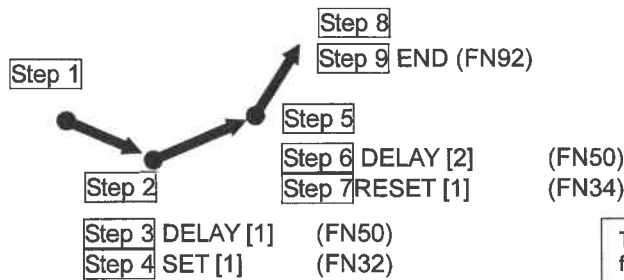
Alternatively, function commands can be specified using the "FN***" format where a 1 to 3 digit number is input into the *** part (which is called a function number).

Some typical function commands are listed below.

Table 1.4.1 Typical function commands

Function Command (SLIM)	Function number	Title	Description of function
SET	FN32	Output signal ON	The specified output signal is set to ON.
RESET	FN34	Output signal OFF	The specified output signal is set to OFF.
DELAY	FN50	Timer	Operation stands by for the specified time.
CALLP	FN80	Program call	Another program which has been specified is called.
CALLPI	FN81	Conditional program call	When the specified signal is ON, another program is called.
END	FN92	END	The execution of the program is ended.

Teaching example



The square brackets [] following an function command indicate the parameter which has been set.

In the case of the teaching example above, the robot operates in the following way.

- (1) After the robot has moved to the position in step 2
 Step 3 DELAY [1] (FN50)Operation stands by for 1 second.
 Step 4 SET [1] (FN32)Output signal "1" is set to ON.
- (2) After the robot has moved to the position in step 5
 Step 6 DELAY [2] (FN50) Operation stands by for 2 second.
 Step 7 RESET [1] (FN34)Output signal "1" is set to OFF.

1.4.6 Auto operation

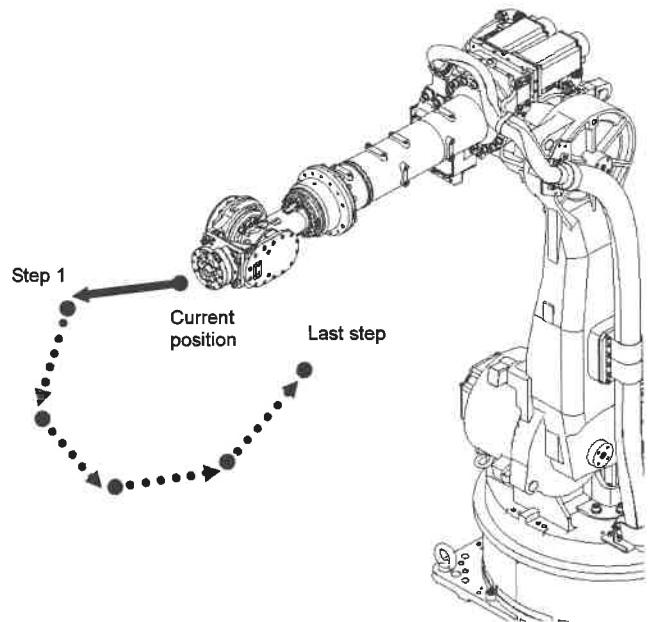
The following steps are taken to automatically run the program which has been created.

1	Select the playback mode.
---	---------------------------

One of the following playback methods may be selected.
 Step: The program is executed step by step.
 Cycle: The program is executed once from start to end.
 Continuous: The program is executed continuously.
 "Cycle" or "step" playback is selected to check what has been taught or perform a trial run for auto operation. (The program can be stopped on a step by step basis in these modes.)
 "Continuous" playback is used for actual operations.

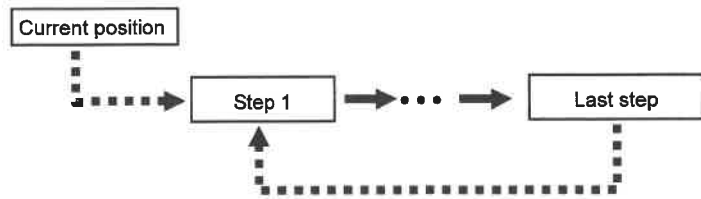
2	Proceed with playback.
---	------------------------

The robot starts to move from its current position to step 1. (It is also possible to specify the start step.)



With one-time playback (cycle), the robot moves from the current position to step 1 and subsequent steps, and its movement ends with the last step.

For the second and subsequent times: the robot moves from the step 1 and subsequent steps, and its movement ends with the last step.



End

NOTE

Chapter 2 Names and functions of the operation switches and keys

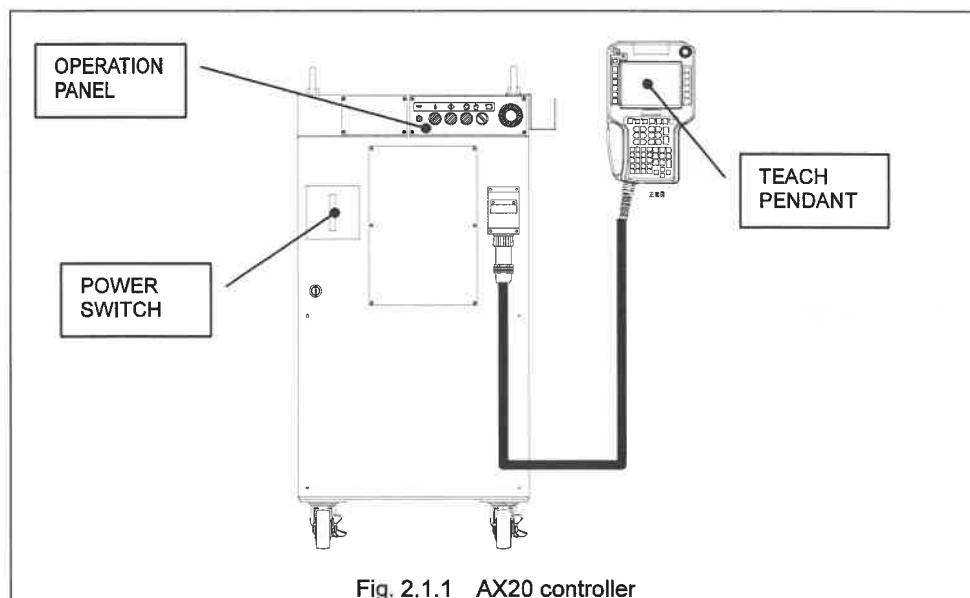
In this chapter, the functions of the operation switches and keys provided on the robot controller will be described.

2.1 Controller	2-1
2.1.1 When the AX20 controller is used	2-1
2.1.2 When the AX21 controller is used	2-2
2.2 Operation panel (provided with AX20 controller only)	2-3
2.3 Operation box (provided with AX21 controller only)	2-4
2.4 Teach pendant	2-5
2.4.1 External appearance of teach pendant (AX20 Controller)	2-5
2.4.2 External appearance of teach pendant (AX21 Controller)	2-6
2.4.3 Functions of buttons and switches	2-7
2.4.4 Functions of operation keys	2-8
2.4.5 Configuration of display screen	2-15
2.4.6 Concerning the operation of the f keys	2-18
2.5 To input characters	2-19

2.1 Controller

2.1.1 When the AX20 controller is used

The power switch and operation panel are provided on the front panel of the AX20 controller, and the teach pendant is connected here as well.



Power switch

This turns the power of the controller ON and OFF.

Teach pendant

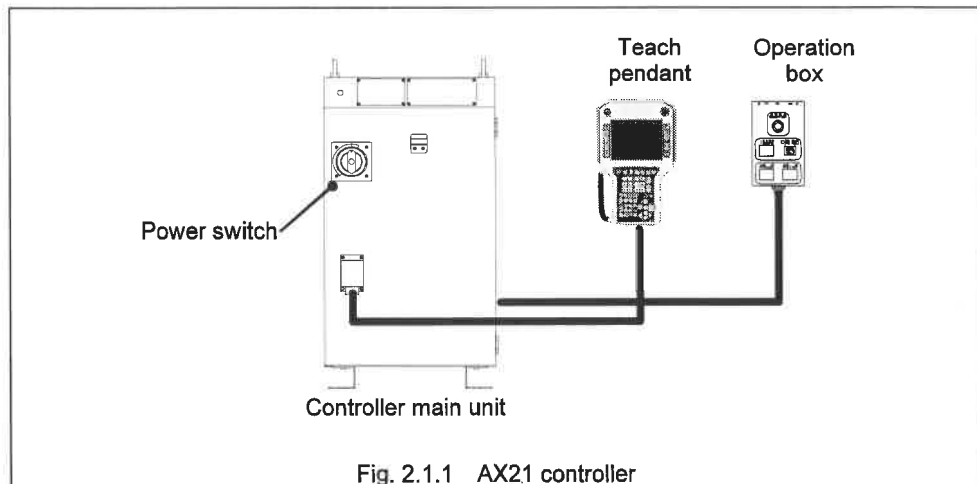
The teach pendant has the keys and buttons to perform teaching, file operation, various condition settings, etc.

Operation panel

Buttons for performing the minimally required operations such as motor power ON, starting and stopping automatic operation, emergency stop, and switching between the teach and playback modes are provided.

2.1.2 When the AX21 controller is used

The power switch is provided on the front panel of the AX21 controller. The teach pendant and operation box are connected to the side panel area of the controller.



Power switch

This turns the power of the controller ON and OFF.

Teach pendant

The teach pendant has the keys and buttons to perform teaching, file operation, various condition settings, etc.

Operation box

Buttons for performing the minimally required operations such as motor power ON, starting and stopping automatic operation, emergency stop, and switching between the teach and playback modes are provided.

2.2 Operation panel (provided with AX20 controller only)

The operation panel is provided with the minimum buttons required to exercise basic control over the robot such as motor power ON, switching between the modes, starting and stopping automatic operation, and emergency stop.

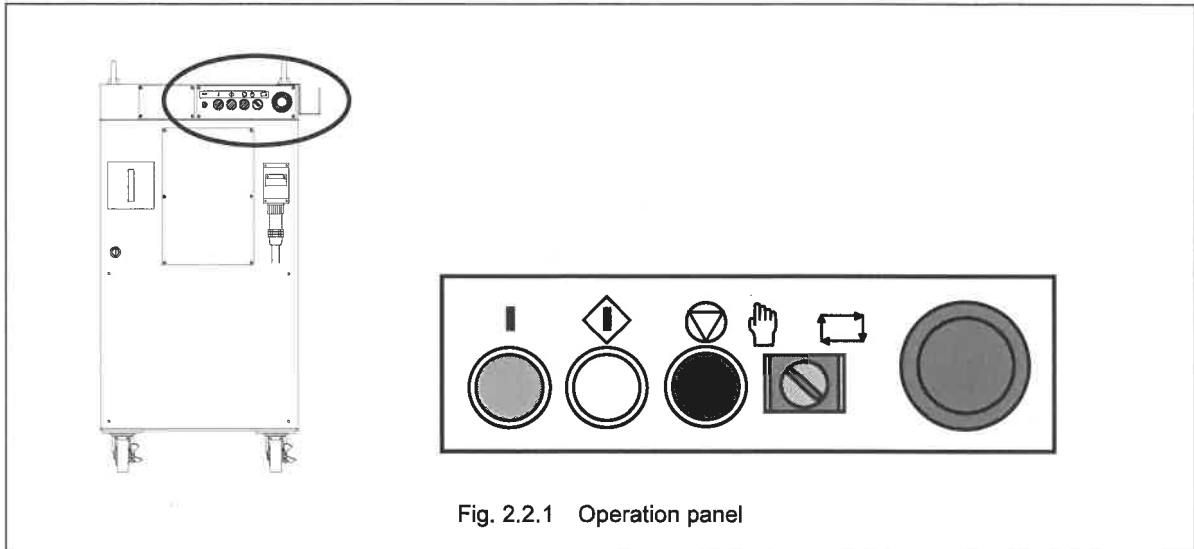


Fig. 2.2.1 Operation panel

Table 2.2.1 Functions of buttons and switches on the operation panel

Indication used in this manual		Description of function
(A)	[Motor power ON button]	This is used to set the motor power to ON. When it is set to ON, the robot is readied for operation.
(B)	[Start button]	In the playback mode, this starts the program which has been specified.
(C)	[Stop button]	In the playback mode, this stops the program which is in the start status.
(D)	[Mode selector switch]	This is used to select the mode. The teach or playback mode can be selected. This switch is used in combination with the [Teach pendant enable switch] on the teach pendant.
(E)	[Emergency stop button]	When this is pressed, the robot is set to emergency stop. Emergency stop is performed by pressing the switch on the operation panel or on the teach pendant. To release emergency stop, turn the button clockwise. (The button will then return to its original position.)

POINT

The operation panel is connected to the AX20 controller as a standard accessory. It cannot be connected to the AX21 controller.

2.3 Operation box (provided with AX21 controller only)

The operation panel is provided with the buttons minimally required to exercise basic control over the robot such as motor power ON, starting and stopping automatic operation, and emergency stop.

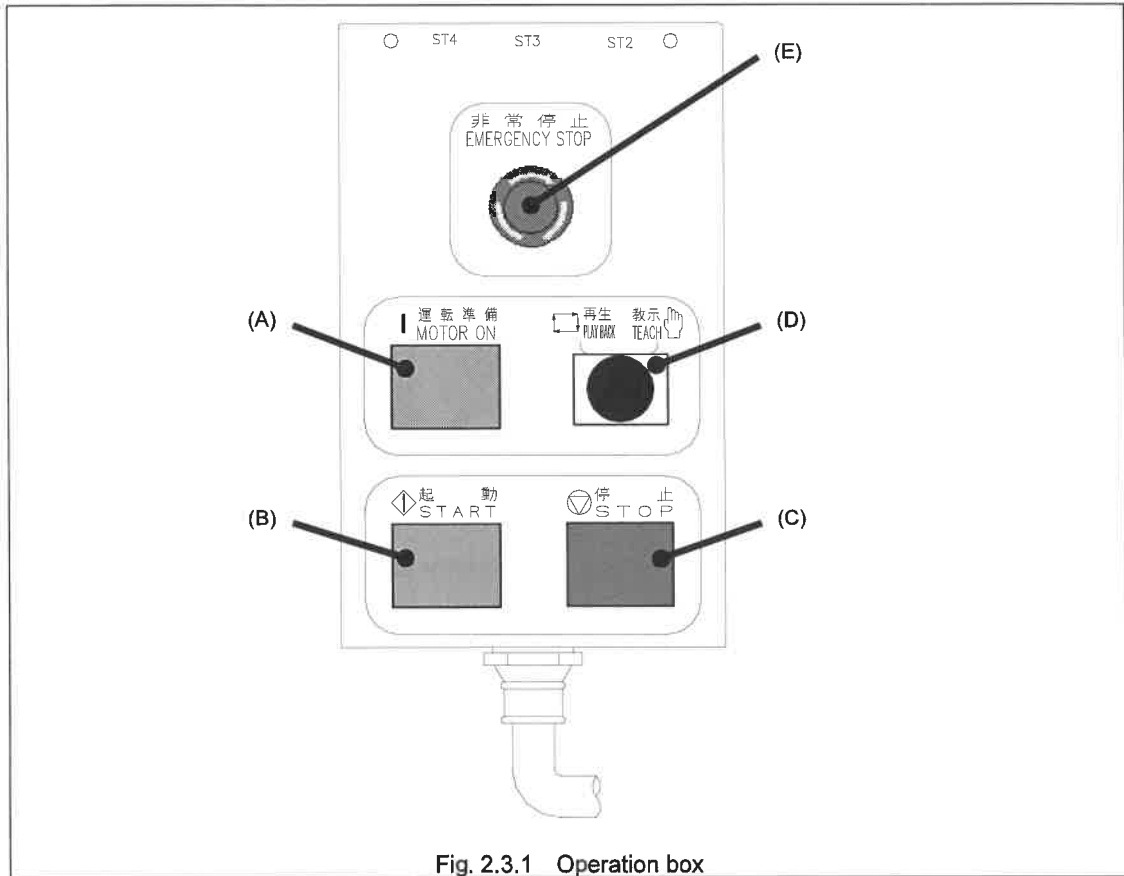


Fig. 2.3.1 Operation box

Table 2.3.1 Functions of buttons and switches on the operation box

Indication used in this manual	Description of function
(A) [Motor power ON button]	This is used to set the motor power to ON. When it is set to ON, the robot is readied for operation.
(B) [Start button]	In the playback mode, this starts the program which has been specified.
(C) [Stop button]	In the playback mode, this stops the program which is in the start status.
(D) [Mode selector switch]	This is used to select the mode. The teach or playback mode can be selected. This switch is used in combination with the [Teach pendant enable switch] on the teach pendant.
(E) [Emergency stop button]	When this is pressed, the robot is set to emergency stop. Emergency stop is performed by pressing the switch on the operation box or on the teach pendant. To release emergency stop, turn the button clockwise. (The button will then return to its original position.)

POINT

The operation box is connected to the AX21 controller as a standard accessory. It cannot be connected to the AX20 controller. It also differs from the separate operation board which is an optional accessory of the AX20 controller.

2.4 Teach pendant

2.4.1 External appearance of teach pendant (AX20 Controller)

The teach pendant is provided with the operation keys, buttons, switches, etc. for creating programs and performing various settings.

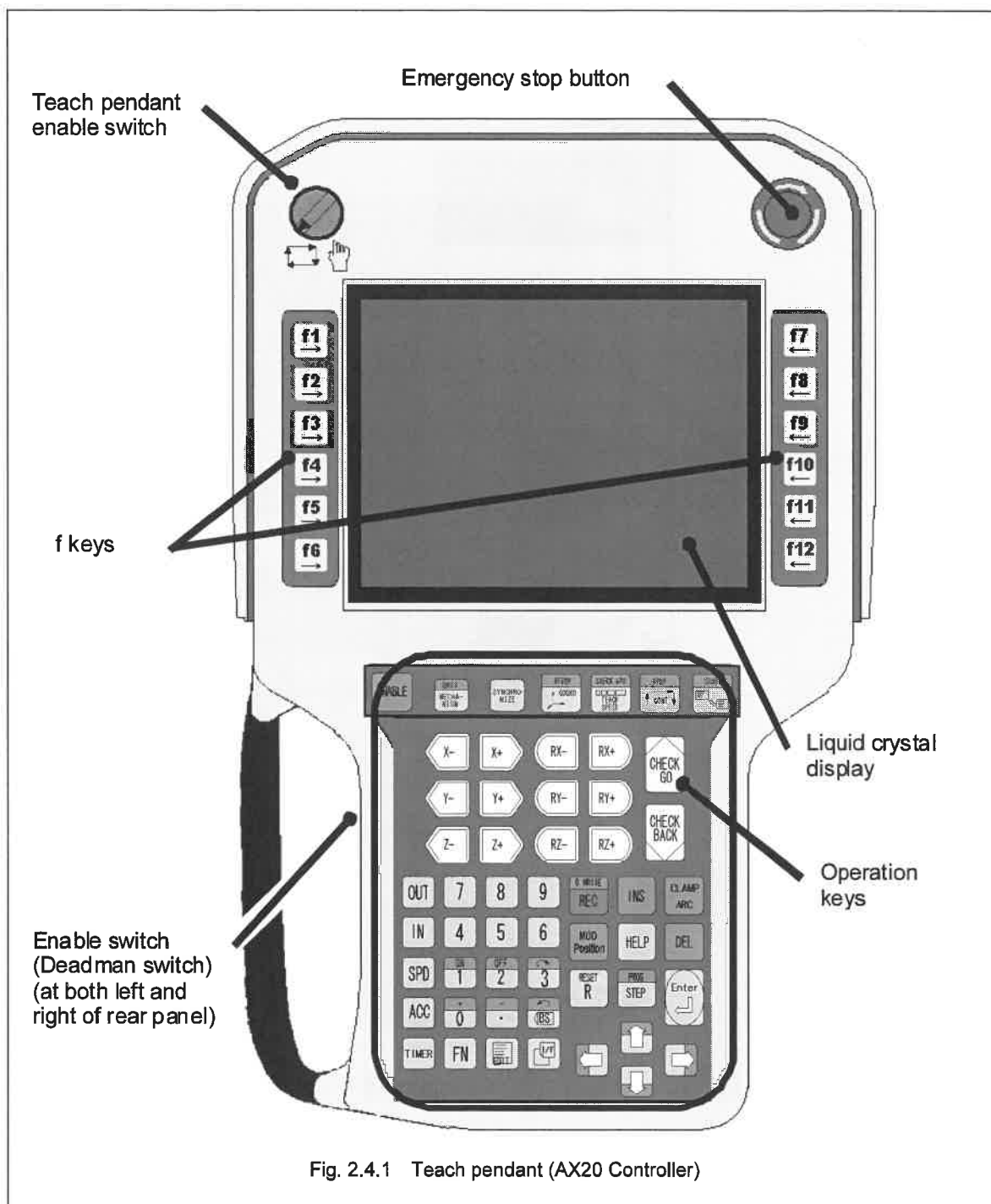


Fig. 2.4.1 Teach pendant (AX20 Controller)

2.4.2 External appearance of teach pendant (AX21 Controller)

The teach pendant is provided with the operation keys, buttons, switches, etc. for creating programs and performing various settings. Also, the numerical keys are equipped with commands such as movement commands and frequently used functional commands.

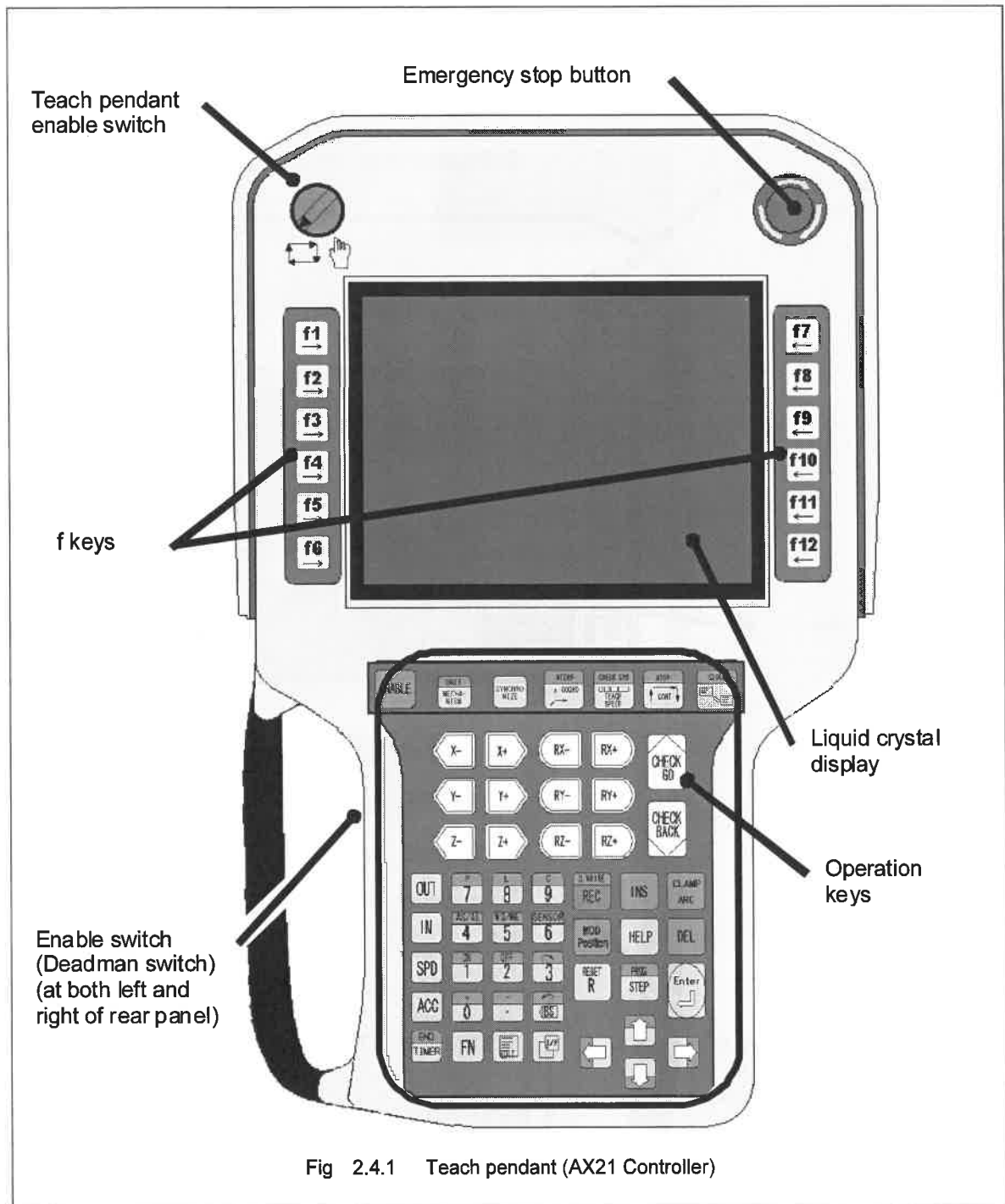
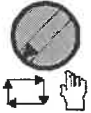

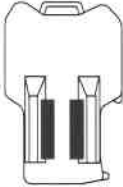


Fig 2.4.1 Teach pendant (AX21 Controller)

2.4.3 Functions of buttons and switches

The buttons and switches on the teach pendant have the following functions.

Table 2.4.1 Functions of buttons and switches

External appearance	Indication used in this manual	Function
	[Teach pendant enable switch]	<p>This is used to switch between the teach mode and the playback mode in combination with the [Mode selector switch] on the operation panel or operation box. For further details, refer to "3.2 Mode selection" in Chapter 3.</p>
	[Emergency stop button]	<p>When this is pressed, the robot is set to emergency stop. To release emergency stop, turn the button clockwise. (The button will then return to its original position.)</p>
	[Enable switch] (Deadman switch)	<p>This switch is provided on the rear panel, and it is used when the robot is to be manually operated in the teach mode. Normally, it is provided on the left side only. There may be two buttons, one at the left and the other at the right as an option.</p> <p>When the enable switch is grasped, power is supplied to the robot (the motor power is turned ON). The robot can be operated manually only while the switch is grasped.</p> <p>If an impending danger is sensed, either release the enable switch or grasp it tightly until a clicking sound is heard.</p> <p>For details on how to operate the enable switch, refer to "3.3 Turning the motor power to ON" in Chapter 3.</p>

2.4.4 Functions of operation keys

The operation keys provided on the teach pendant have the following functions.

Depending on whether a Nachi or Daihen robot has been used to date, the same operation key may have a different function. A difference in function is indicated by the **NACHI**, **DAIHEN** or display.

(There is no **NACHI** or **DAIHEN** display if the key functions in the same way for both robots.)

NACHI : This denotes a setting for users who have been using a controller available prior to the AW from Nachi.

DAIHEN : This denotes a setting for users who have been using a controller available prior to the EX from Daihen.

DAIHEN2 : This is denotes a setting for users of Daihen AX 21 products. (Including NACHI AX21)

Table 2.4.2 Functions of operation keys





External appearance	Indication used in this manual	Function
	[ENABLE]	The functions are executed by pressing this key together with other keys.
	[UNIT/MECHANISM]	<ul style="list-style-type: none"> ■ When this is pressed on its own, the mechanisms are selected. When a multiple number of mechanisms are connected to the system, the mechanism to be operated manually is selected. ■ When this is pressed together with [ENABLE], the unit is selected. When a multiple number of units are defined in the system, the unit to be operated is selected.
	[SYNCHRONIZE]	<p>This key is used by a system in which a multiple number of mechanisms are connected, and it has the following functions.</p> <ul style="list-style-type: none"> ■ When this is pressed on its own, it selects or releases coordinated manual operation. ■ When this is pressed together with [ENABLE] during teaching, it selects or releases coordinated operations. When cooperative operation is specified for a move command, "H" appears before the step number.
	[INTERP/COORD]	<ul style="list-style-type: none"> ■ When this is pressed on its own, one of the coordinates is selected. During manual operation, the coordinate system that serves as the reference for operation is selected. Each time it is pressed, the axis independent, orthogonal coordinates (or user coordinates) or tool coordinates are selected and displayed on the LCD screen. ■ When this is pressed together with [ENABLE], the interpolation type is selected. This switches the interpolation type (joint interpolation, linear interpolation or circular interpolation) of the recording status.

Table 2.4.2 Functions of operation keys





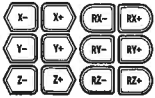
External appearance	Indication used in this manual	Function
	[CHECK SPD/TEACH SPEED]	<ul style="list-style-type: none"> ■ When this is pressed on its own, the manual speed is changed. The operating speed of the robot during manual operation is selected. Each time it is pressed, one of the 1 to 5 operating speeds is selected (the higher the number, the faster the speed). Furthermore, the following function is provided as well. NACHI The playback speed recorded in the steps is also determined by the manual speed which has been selected by this key. DAIHEN The above setting is not established. Set the playback speed when teaching the movement commands.  This function is set by selecting [Constant Setting] → [5 Operation Constants] → [4 Record speed] → [Value of recording method — Decision method]. ■ When this is pressed together with [ENABLE], the check speed is changed. The speed during a check go or check back operation is selected. Each time it is pressed, one of the 1 to 5 operating speeds is selected (the higher the number, the faster the speed).
	[STOP/CONTINUOUS]	<ul style="list-style-type: none"> ■ When this is pressed on its own, continuous or noncontinuous is selected. Continuous or non-continuous during a check go or check back operation is selected. When continuous operation is selected, the operation of the robot does not stop at each step. ■ When this is pressed together with [ENABLE], playback is stopped. The program being played back is stopped. (This has the same function as the stop button.)
	[CLOSE/SELECT SCREEN]	<ul style="list-style-type: none"> ■ When this is pressed on its own, the screen is selected or moved. If a multiple number of monitor screens are displayed, the screen targeted for operation is selected. ■ When this is pressed together with [ENABLE], the screen is closed. The selected monitor screen is closed.
	[Axis operating keys]	<ul style="list-style-type: none"> ■ When these are pressed on their own, they have no function. ■ When these are pressed together with the [Enable(Deadman) switch], the axes are operated. The robot is moved manually. If an auxiliary axis to be moved, the operation target is selected ahead of time using [UNIT/MECHANISM].

Table 2.4.2 Functions of operation keys






External appearance	Indication used in this manual	Function
	[CHECK GO] [CHECK BACK]	<ul style="list-style-type: none"> ■ When these are pressed on their own, they have no function. ■ When these are pressed together with the [Enable(Deadman) switch], the check go or check back operation is performed. Normally, the robot is stopped at each recorded position (step) but it can also be operated continuously. Use [STOP/CONTINUOUS] to select step or continuous.
	[O.WRITE / REC]	<ul style="list-style-type: none"> ■ When this is pressed on its own, the movement command is recorded. During teaching, the movement command is recorded. This can be used only when the last step in the task program has been selected. ■ When this is pressed together with [ENABLE], the movement command is overwritten. The already recorded movement command is overwritten by the current recording statuses (position, speed, interpolation type, and accuracy). However, the command can be overwritten only when changes are made to what is recorded for the movement commands. A movement command cannot be overwritten by a function command; neither can a function command be overwritten by another function command. <p>NACHI The recording position, speed and accuracy of a recorded movement command can each be revised using [MOD Position], [SPD] and [ACC], respectively.</p> <p>DATEN The recording position of a recorded movement command can be revised using [MOD Position].</p> <p> The [SPD] and [ACC] key functions are set by selecting [Constant Setting] → [5 Operation Constants] → [1 Operation condition] → [5 Usage of SPD key] or [6 Usage of ACC key].</p>
	[INS]	<ul style="list-style-type: none"> ■ When this is pressed on its own, it has no function. ■ When this is pressed together with [ENABLE], a movement command is inserted. <p>NACHI The movement command is inserted "Before" the current step.</p> <p>DATEN The movement command is inserted "After" the current step.</p> <p> "Before" can be changed to "After" or vice versa by selecting [Constant Setting] → [5 Operation Constants] → [1 Operation condition] → [7 Step insertion position].</p>

Table 2.4.2 Functions of operation keys









External appearance	Indication used in this manual	Function
	[CLAMP ARC]	<p>This key functions in a different way depending on the application concerned.</p> <p><u>When the spot welding application is used</u></p> <ul style="list-style-type: none"> ■ When this is pressed on its own, the spot welding command is set. It is used to set the spot welding commands. Each time the key is pressed, the ON or OFF is selected for the recording status. ■ When this is pressed together with [ENABLE], the spot welding gun is manually pressurized. <p><u>When the arc welding application is used</u></p> <ul style="list-style-type: none"> ■ When this is pressed on its own, commands are easily selected. Selects "easy teach mode", which allows you to select move commands, welding start/stop commands and frequently used application commands with simple operations. ■ When this is pressed together with [ENABLE], it has no function.
	[MOD Position]	<ul style="list-style-type: none"> ■ When this is pressed on its own, it has no function. ■ When this is pressed together with [ENABLE], the position is modified. The position stored in the movement command now selected is changed to the current robot position.
	[HELP]	<p>Press this for help concerning an operation or function. The built-in tutorial function (help function) is called.</p>
	[DEL]	<ul style="list-style-type: none"> ■ When this is pressed on its own, it has no function. ■ When this is pressed together with [ENABLE], a step is deleted. The step now selected (movement command or function command) is deleted.
	[RESET/R]	<p>This clears the input or returns the setting screen to its original status. It also enables R codes (short-cut codes) to be input. The function that is to be used can be called immediately by inputting an R code.</p>
	[PROG/STEP]	<ul style="list-style-type: none"> ■ When this is pressed on its own, a step is specified. This is used to call a step specified in the program. ■ When this is pressed together with [ENABLE], a program is specified. The specified program is called.
	[Enter]	<p>This enters the menu or numerical input contents.</p> <p> Determination operation of numerical input can also be performed with arrow keys by <Constant Setting> - [7F-key] - [7 Numerical input] and switching to "Cursor" under [Decision method of numerical input].</p>

Table 2.4.2 Functions of operation keys

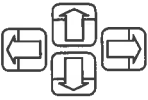







External appearance	Indication used in this manual	Function
	Arrow keys	<ul style="list-style-type: none"> ■ When these keys are pressed on their own, the cursor moves. ■ When these are pressed together with [ENABLE], the page is moved or changed. • On a screen where the settings are configured on a multiple number of pages, the page is moved. • On a program editing screen, for instance, the cursor is moved by several lines at a time. • On a service or constant setting screen, for instance, the selection items arranged horizontally (radio buttons) are selected. • On a teach or playback mode screen, the number of the current step is changed.
	[OUT]	<ul style="list-style-type: none"> ■ When this is pressed on its own, a short-cut to the SETM function command is provided. During teaching, this short-cut calls the output signal command (SETM <FN105> function command). ■ When this is pressed together with [ENABLE], the manual signals are output. The external signals are set to ON or OFF manually.
	[IN]	During teaching, this short-cut calls the input signal wait "positive logic" command (WAITI <FN525> function command).
	[SPD]	<p>NACHI This is used to revise the speed of recorded movement commands.</p> <p>DAEWEN This is used to set the speed of movement commands. (The setting is reflected in the recording status.)</p> <p> This function is set by selecting [Constant Setting] → [5 Operation Constants] → [1 Operation condition] → [5 Usage of SPD key].</p>
	[ACC]	<p>NACHI This is used to revise the accuracy of a recorded movement command.</p> <p>DAEWEN This is used to set the accuracy of a movement command which is to be recorded. (What has been set is reflected in the recording status.)</p> <p> This function is set by selecting [Constant Setting] → [5 Operation Constants] → [1 Operation condition] → [6 Usage of ACC key].</p>
	[TIMER]	During teaching, this short-cut records the timer command (DELAY <FN50> function command).

Table 2.4.2 Functions of operation keys










External appearance	Indication used in this manual	Function
	[END/TIMER]	<p> Capable of operating the following functions.</p> <ul style="list-style-type: none"> ■ When this is pressed on its own, it will lead to a short-cut to DELAY (function command) During teaching, this short-cut records the timer command (DELAY <FN50> function command) ■ When this is pressed together with [ENABLE], it will lead to a short-cut to END (function command) During teaching, this short-cut records the end command (END <FN92> function command).
	Numeric keys/ [0] to [9] / [.]	<ul style="list-style-type: none"> ■ When these are pressed on their own, numbers (0 to 9, decimal point) are input. ■ When [1] is pressed together with [ENABLE], ON is selected. On a setting screen, for instance, a check mark is placed inside the check box. ■ When [2] is pressed together with [ENABLE], OFF is selected. On a setting screen, for instance, the check mark inside the check box is removed. ■ When [3] is pressed together with [ENABLE], redo. This re-does the operation which was restored by clearing (undo) the operation immediately before. It is effective only while creating a new or editing an existing program. ■ When [0] is pressed together with [ENABLE], "+" is input. Input "+". ■ When [.] is pressed together with [ENABLE], "-" is input. Input "-".

Table 2.4.2 Functions of operation keys

External appearance	Indication used in this manual	Function
	Numeric keys/ [4] to [9]	<p>DAI-HEN 21 Capable of operating the following functions.</p> <ul style="list-style-type: none"> ■ When these are pressed on their own, numbers (4 to 9) are input. ■ When [4] is pressed together with [ENABLE], AS/AE is selected. During teaching, commands regarding arc welding will be displayed on the f key (f1 ~ f12). ■ When [5] is pressed together with [ENABLE], WS/WE is selected. During teaching, commands regarding weaving will be displayed on the f key (f1 ~ f12). ■ When [6] is pressed together with [ENABLE], SENSOR is selected. During teaching, commands regarding sensor will be displayed on the f key (f1 ~ f12). ■ When [7] is pressed together with [ENABLE], P is selected. This short-cut calls the movement command for the Joint Interpolation (JOINT). ■ When [8] is pressed together with [ENABLE], L is selected. This short-cut calls the movement command for the Line Interpolation (LIN) ■ When [9] is pressed together with [ENABLE], C is selected. This short-cut calls the movement command for the Circular Interpolation (CIR).
	[BS] (Back space)	<ul style="list-style-type: none"> ■ When this is pressed on its own, a number or character is deleted. The number or character before the cursor position is deleted. The key is also used to release a selection during file operations. ■ When this is pressed together with [ENABLE], undo the operation immediately before. The operation performed immediately before is cleared, and the status prior to the change is restored. It is effective only while creating a new or editing an existing program.
	[FN] (Function)	This is used when selecting the function commands.
	[EDIT]	<p>This opens the program editing screen.</p> <p>On the program editing screen, principally the function commands are changed, added or deleted and the parameters of movement commands are changed.</p>
	[I/F] (Interface)	When a teach pendant with touch panel specifications is used, the interface panel window is opened.
	f key	These are used to select the icons displayed at both sides of the LCD screen.

2.4.5 Configuration of display screen

Indicated on the display screens are the program and settings used for the current operation and the icons (f keys) for selecting the various functions.

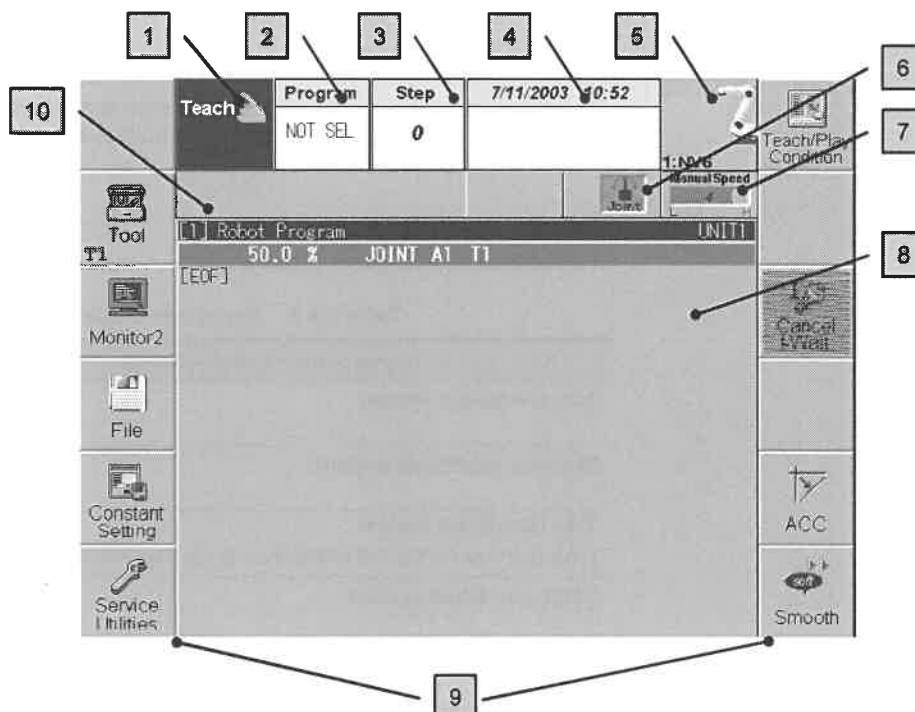


Fig. 2.4.2 Configuration of display screen (under standard specifications)

1 Mode display area

The selected mode (teach, playback or high-speed teach) is displayed here. (The highspeed teach mode is optional.)

The motor power, operation underway and emergency stopped statuses are also displayed.

Table 2.4.3 Status display









Status	Teach mode	Playback mode
Motor power OFF		
Motor power ON, servo power OFF, now saving energy (playback mode)		
Motor power ON, servo power ON		
Motors energized, check GO/BACK operation underway (teach mode), now operating (playback mode)		
Emergency stopped		

2 Program number display area

The number of the selected program is displayed.

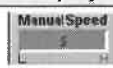
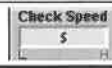
- 3 **Step number display area**
The number of the step selected in the program is displayed here.
- 4 **Date & time display area**
The current date and time are displayed here.
- 5 **Mechanism display area**
The mechanism targeted for manual operation is displayed here.
With a multi-unit specifications robot, the numbers of the units involved in the teaching are also displayed.
- 6 **Coordinate system display area**
The selected coordinate is displayed here.

Table 2.4.4 Coordinate system display

Types of coordinate systems	Display
Axis coordinate system	
Machine coordinate system	
Tool coordinate system (The number on the left of the icon is the tool number.)	
Work coordinate system	
Absolute coordinate system (world coordinate system)	
Cylindrical coordinate system	
User coordinate system (The number on the left of the icon is the coordinate number.)	
Welding line coordinate System	

- 7 **Speed display area**
The manual operation speed is displayed here. When [ENABLE] is pressed, the check speed is displayed.






















Table 2.4.5 Speed display

Speed	Display
Manual speed	
Check speed	

- 8 **Monitor display area**
The contents of the program are displayed here (in the case of the initial settings).
- 9 **f key display area**
The functions that can be selected using the f keys are displayed here. The six keys on the left correspond to f1 to f6; the six keys on the right correspond to f7 to f12.

See 2-18 "2.4.6 Concerning the operation of the f keys".
- 10 **Variable status display area**
The status displays including "input wait (I wait)" and "external start selected" appear as icons in this area. When this status ends, the icon is cleared.

Table 2.4.6 Status icon display

Status	Icon
External signal input waiting (I waiting)	
"Start selection: External" or "Program selection: Internal" now selected	
"Start selection: Internal" or "Program selection: External" now selected	
"Start selection: External" or "Program selection: External" now selected	
Software PLC now operating	
Software PLC now stopped	
Machine lock now set	
Dry run now set	
Now connected with external PC via Ethernet	
Automatic backup proceeding (The extent to which the operation has been completed is indicated as a percentage.)	
Temporarily stopped (with station startup only)	
Holding or now paused * This is displayed only when the hold signal or pause signal is input during playback.	
Mechanism now disconnected	
I/O simulation mode now selected	
J5 axis in singular point status	
Servo gun: Now writing gun search reference position	
Servo gun: Now selecting recording position check mode	
Mechanism connected Number: mechanism number - number of sub mechanism connected (The mechanism disconnection function is an option.)	
Mechanism released Number: mechanism number - number of sub mechanism connected (The mechanism disconnection function is an option.)	
Robot in the start enable area	
Now Log in (The 3 digit number signifies the user ID)	

Not all of the optional functions are listed in the above table. For details on any of the icons not described in the table, refer to the operating instructions for the optional functions concerned.

2.4.6 Concerning the operation of the f keys

A number of icons are assigned to the f key display area. The initial allocation of the icons differs according to the application such as spot welding, arc welding and so on. It is also switched in accordance with the selected mode or operating conditions.

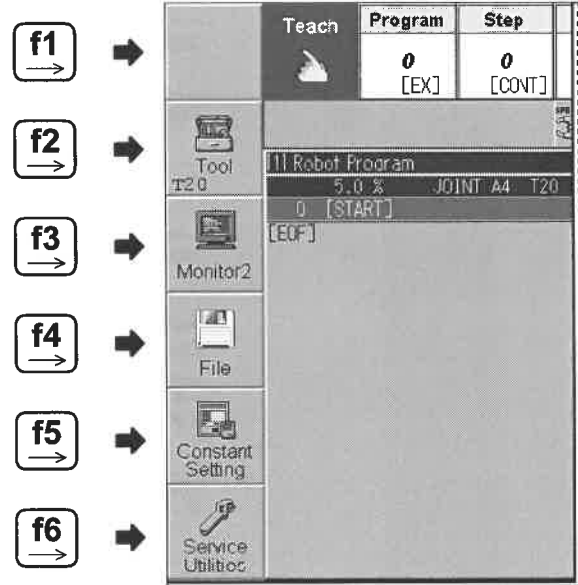


The initial allocation of the f keys differs according to the application. For details on the initial allocation, the user should refer to those sections in Chapter 9 and beyond in this instruction manual which correspond to the application that will be used.

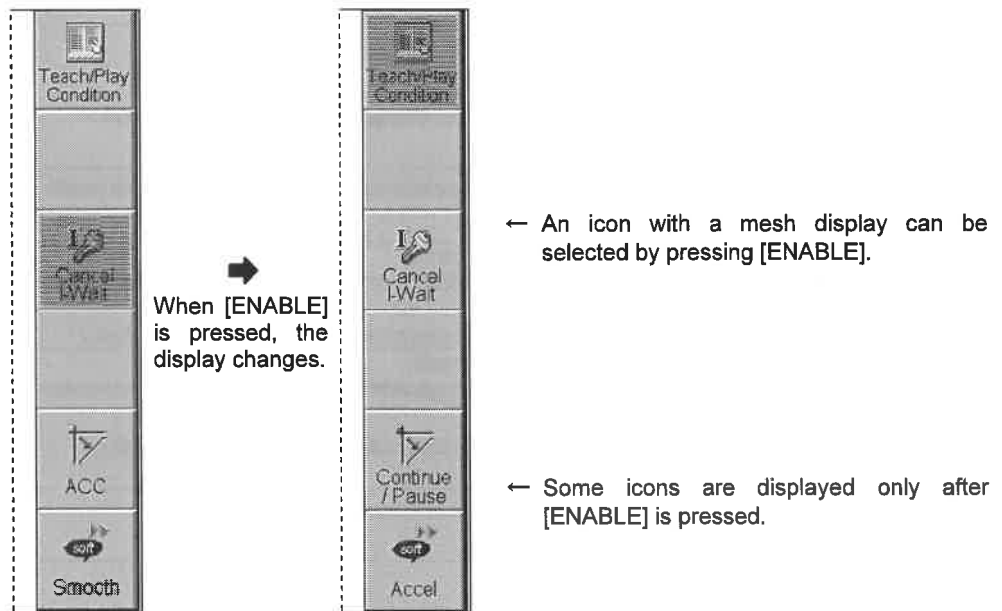
To select the function assigned to an icon, press the corresponding f1 to f12 keys at the side of the icons.

The functions are selected by pressing the [f1] to [f12] keys at the side of the icons.

For instance, when [f4] is pressed, [File operation] is selected.



Normally, a function is selected by pressing one of the f1 to f12 keys on its own. However, in some cases the key must be pressed together with [ENABLE].



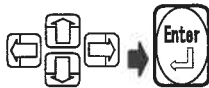
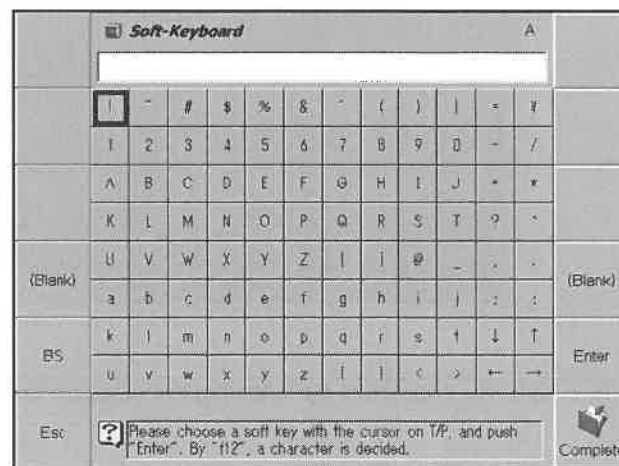
When a teach pendant with touch panel specifications is used, touch the icons directly instead of pressing [f1] to [f12].

2.5 To input characters

The method used to input characters is described here.

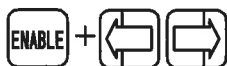
Functions of soft keyboard

- 1 When the status in which characters can be input is established, the soft keyboard starts up.



To select characters

Select the characters using the up, down, left and right keys, and press [Enter] or f11 <Enter>.



To move the cursor in the character input field

Press the left or right key while holding down [ENABLE].



To input a space

Press f4 or f10 <Blank>.



To delete a character

Move the cursor to the right of the character to be deleted, and press f5 <BS>. The character to the left of the cursor is now deleted.



- 2 To record the characters which have been input, press f12 <Complete>.
>> The characters are recorded, and operation returns to the original screen.

Chapter 3 Turning the power on/off and manual operation

This chapter describes how to turn the power on/off and how to operate the robot manually.

3.1 Turning the control power to ON	3-1
3.2 Mode selection.....	3-2
3.2.1 When the AX20 controller is used	3-2
3.2.2 When the AX21 controller is used	3-3
3.3 Turning the motor power to ON.....	3-4
3.4 Moving the robot manually.....	3-6
3.4.1 Movement Direction	3-6
3.4.2 Moving the robot manually	3-9
3.4.3 Switching the mechanism	3-10
3.5 Turning the motor power to OFF.....	3-11
3.6 Turning the control power to OFF	3-11

3.1 Turning the control power to ON

In order to use robot, first turn the controller's power (control power) to ON.

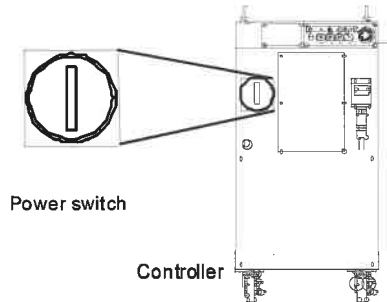


DANGER

Before turning on the control power, the controller's door must be closed without fail. Receiving an electric shocks from touching any of the power supply areas may result in death or serious injury.

Turning the control power to ON

- 1 First, check the position of the circuit breaker (power switch). (This position differs depending on the series and the specifications.)



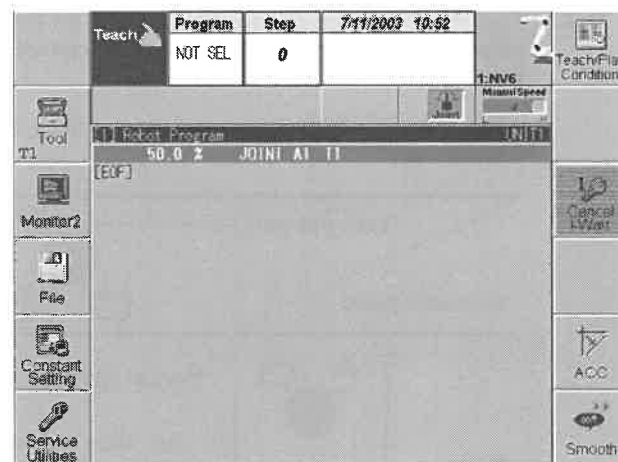
Power switch

Controller



- 2 Turn the circuit breaker to the ON position.
>> The AX20/AX21 system starts up automatically, and self-diagnosis is commenced.

- 3 If self-diagnosis is completed without any problems detected, a screen such as the one shown below is displayed on the teach pendant.



The robot is now ready to operate.

3.2 Mode selection

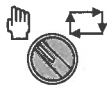
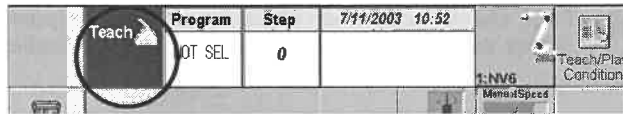
The AX20/AX21 controller features the teach mode which is mainly for creating programs and the playback mode which is for automatically running the programs.

3.2.1 When the AX20 controller is used

The mode is selected using the [Mode selector switch] on the operation panel provided on the front of the controller.

Mode selection (when the AX20 controller is used)

1 The mode can be checked on the teach pendant display.



2 To change the mode, use the [Mode selector switch] on the operation panel.

The correlation between the switch positions and the modes selected is shown below.

Mode	Switch position	Teach pendant display
Teach mode		
Playback mode		

In this status, however, the robot cannot be operated either manually or automatically. Perform the following operation to initiate operation.



3 Turn the [Teach pendant enable switch] on the teach pendant to the teach or playback position (so that the operation panel and teach pendant are both set to the same mode).

When one of the following combinations is used, the robot can be operated manually or automatically.

		Teach pendant enable switch	
Mode selector switch		Manual operation enabled * Set both switches to the teach position.	Manual operation disabled Automatic operation disabled * It is now possible to perform operations which do not involve moving the robot.
		Manual operation disabled Automatic operation disabled * It is now possible to perform operations which do not involve moving the robot.	Automatic operation enabled * Set both switches to the playback position.

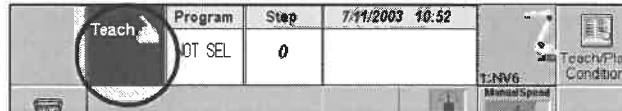
4 The following explanation concerns manual operation and teaching so keep the teach mode as the selected status.

3.2.2 When the AX21 controller is used

Use the [Mode selector switch] on the operation box to switch the mode.

Mode selection (when the AX21 controller is used)

1 The mode can be checked on the teach pendant display.



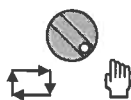
2 Turn the [Mode selector switch] on the operation box to the teach or playback position.

>> The mode is switched to the selected setting.

The correlation between the switch positions and the modes selected is shown below.

Mode	Switch position	Teach pendant display
Teach mode		
Playback mode		

In this status, however, the robot cannot be operated either manually or automatically. Perform the following operation to initiate operation.



3 Turn the [Teach pendant enable switch] on the teach pendant to the teach or playback position (so that the operation box and teach pendant are both set to the same mode).

When one of the following combinations is used, the robot can be operated manually or automatically.

Teach pendant		Teach pendant enable switch	
Mode selector switch	Operation box		
	Mode selector switch	<p>Manual operation enabled</p> <p>* Set both switches to the teach position.</p>	<p>Manual operation disabled</p> <p>Automatic operation disabled</p> <p>* It is now possible to perform operations which do not involve moving the robot.</p>
Mode selector switch	<p>Manual operation disabled</p> <p>Automatic operation disabled</p> <p>* It is now possible to perform operations which do not involve moving the robot.</p>	<p>Automatic operation enabled</p> <p>* Set both switches to the playback position.</p>	

4 The following explanation concerns manual operation or teaching so establish the manual operation enabled status before proceeding any further.

3.3 Turning the motor power to ON

To move the robot, turn the motor power to ON. If the robot is not going to be moved, the motor power need not be turned to ON.

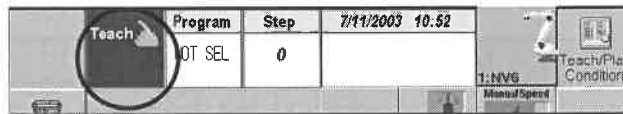


Before turning the motor power to ON, be absolutely sure to check that no one is near the robot. If the robot should move without warning and come into contact or sandwich a person, death or serious injury may result.

Turning the motor power to ON (in the teach mode)

Take the following steps to turn the motor power to ON in the teach mode.

1 Check that the teach mode has been selected.



If the teach mode has not been selected, turn the [Mode selector switch] and set it to the teach mode.

(AX20 controller)

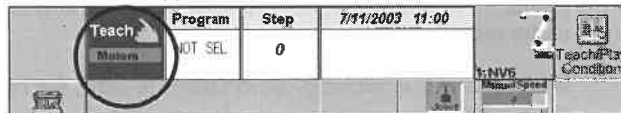


(AX21 controller)



2 Press the [Motor power ON button]. When the AX20 controller is used, the [Motor power ON button] is provided on the operation panel. When the AX21 controller is used, the [Motor power ON button] is provided on the operation box.

- >> The motor power does not come on yet. In this status, the green lamp of the [Motor power ON button] starts flashing.
- >> The indicator which indicates that the motor power is ON and the ready status is established appears in the mode display area of the teach pendant.



3 Grasp the [Enable switch(Deadman switch)].

- >> While this switch is grasped, the motor power is turned on. The green lamp of the [Motor power ON button] stops flashing and lights.
- >> The indicator which indicates motor power ON (servo ON) appears in the mode display area of the teach pendant.
The robot can now be operated by pressing the [Axis operation keys] while grasping the [Enable switch(Deadman switch)].



This completes the preparations for operating the robot.

POINT

Concerning the operation of the enable switch (Deadman switch)

- To operate the robot in the teach mode, the robot must be operated while the enable switch is grasped. (This switch is not used in the playback mode.)
- If the enable switch is released, the motor power is turned off, and the robot stops immediately. When the enable switch is grasped again, the motor power comes back on.
- Grasping the enable switch tightly until a clicking sound is heard also causes the motor power to be turned off and the robot to stop immediately.
- Two enable switches may be provided on the rear panel of the teach pendant as an option. In this case, the motor power is turned off also by grasping both of these switches simultaneously.
- When the emergency stop button has been pressed or the emergency stop command has been input from an external source during operation, the motor power can no longer be turned on or off by operating the [Enable switch]. In cases like this, perform steps 1 to 3 above.

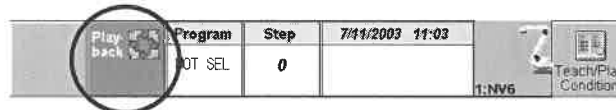
HINT

When the enable switch cannot be operated

- Has the emergency stop button on the teach pendant been pressed?
→ Turn the emergency stop button clockwise to release it.
- Has the emergency stop command been input from an external source?
→ The preparations for the peripheral devices (on the system side) have not been completed. First complete the preparations on the system side, and then release the emergency stop command.
- Are the [Teach pendant enable switch] on the teach pendant and the [Mode selector switch] on the operation panel (operation box) both at the "teach" position?
→ Set both switches to the "teach" position.

Turning on the motor power (in the playback mode)

Proceed as follows to turn on the motor power in the playback mode.

1 Check that the playback mode has been selected.

(AX20 controller)

2 Press the [Motor power ON button].

- >> The motor power is turned on, and the specified program can be played back at any time.
- >> The indicator which indicates motor power ON (servo ON) appears in the mode display area of the teach pendant.

(AX21 controller)



POINT

The enable switch need not be operated.

In the playback mode, the motor power is turned on automatically by pressing the [Motor power ON button]. Therefore, the enable switch is not used.

3.4 Moving the robot manually

In this section, the robot will actually be moved. Before proceeding, memorize to some extent how the robot moves.

3.4.1 Movement Direction

The robot is operated in accordance with the selected coordinate system. The following coordinates systems are the ones that are frequently used.

- Axis coordinate system ... Each of the robot's axes moves independently.
- Machine coordinate systemT ... The robot tip moves in a straight line. (The tip moves along the coordinates referenced to the robot.)
The direction of the axis along which the wrist moves differs depending on the type of application (such as spot welding or arc welding) used.

Movements of the robot using the axis coordinate system

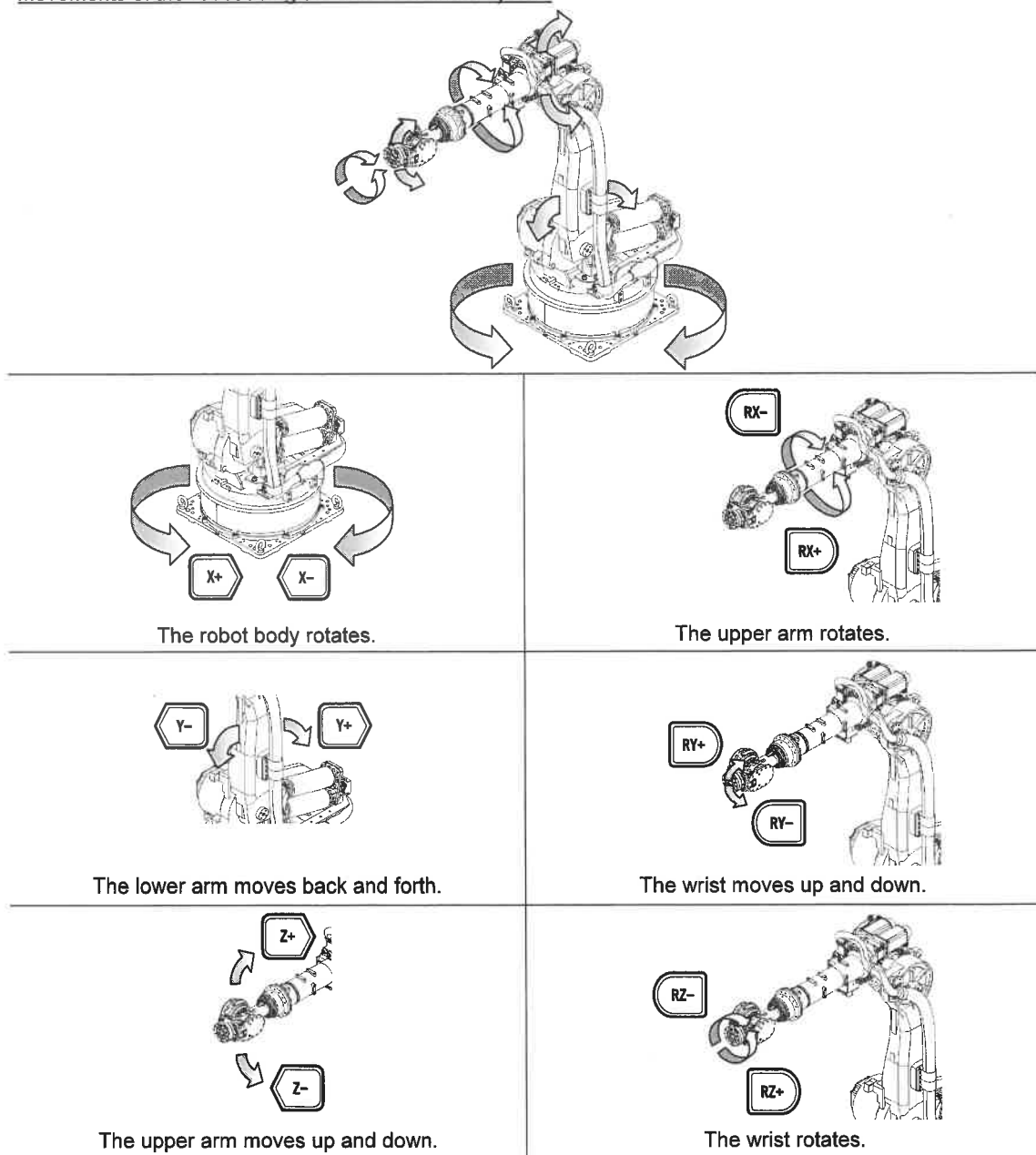


Fig. 3.4.1 Movement directions in the axis coordinate system

Movements of the robot in the machine coordinate system
(for the spot welding application)

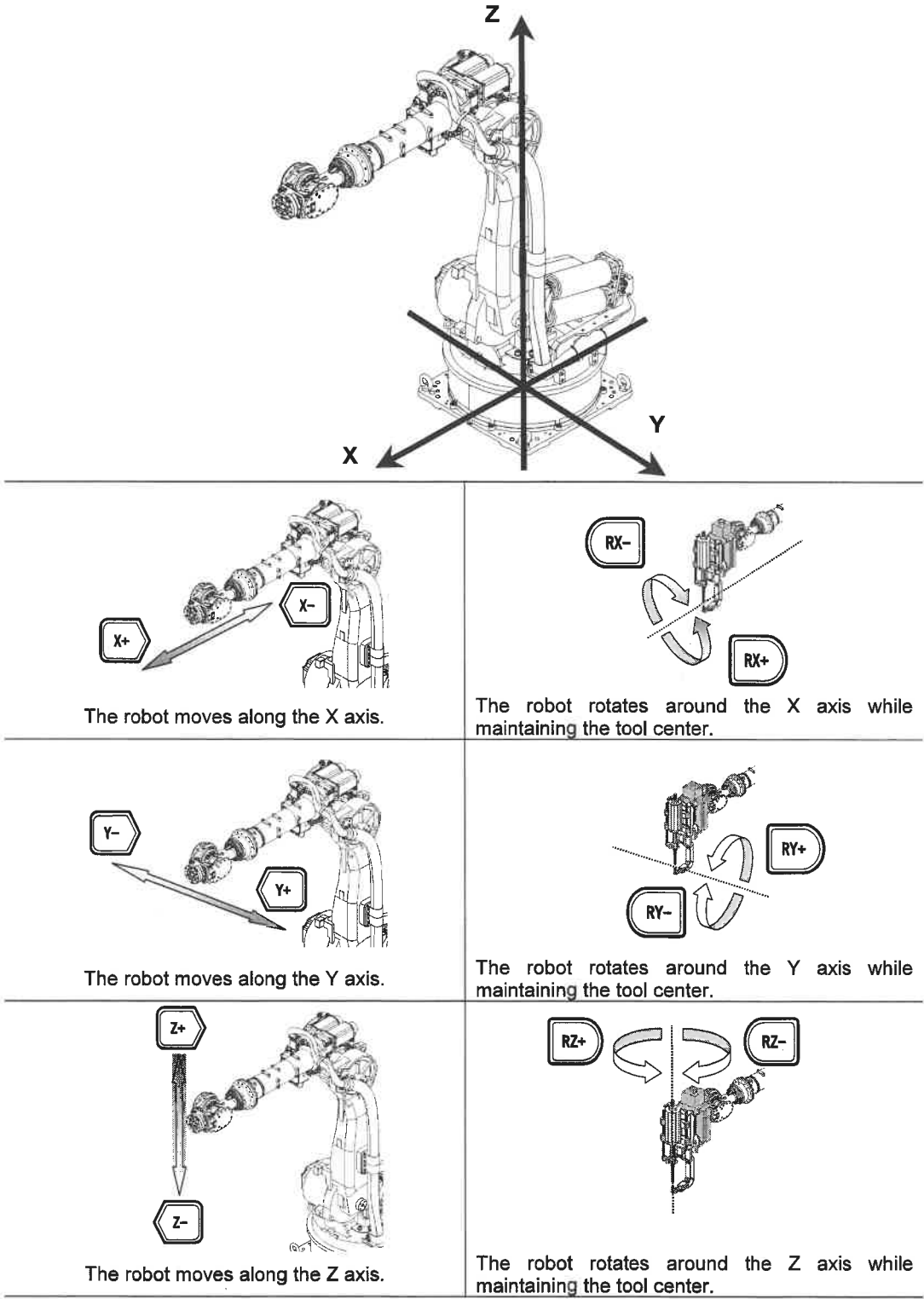
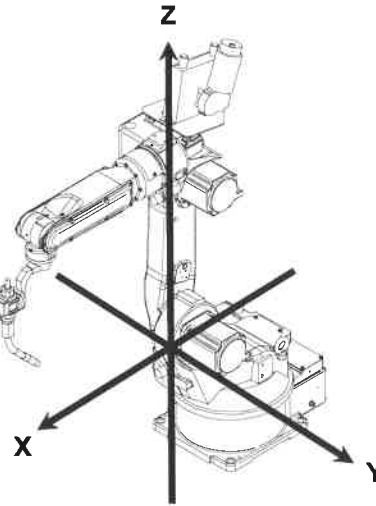


Fig. 3.4.2 Movement directions in the machine coordinate system (for the spot welding application)

Movements of the robot in the machine coordinate system
(for the arc welding application)



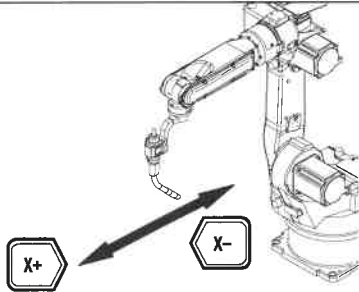
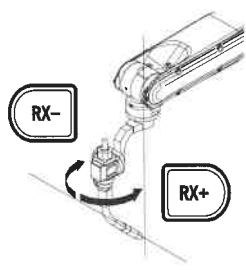
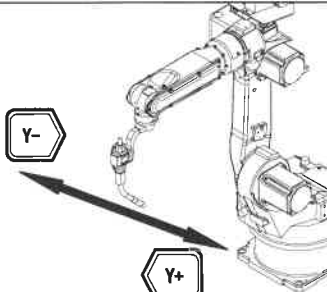
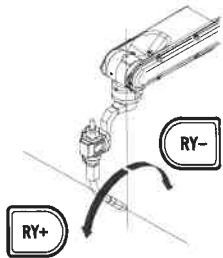
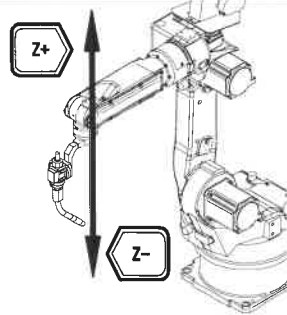
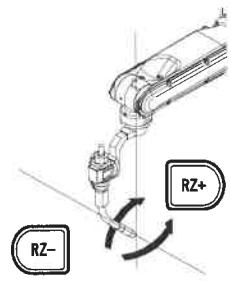
 <p>The robot moves along the X axis.</p>	 <p>The rotation of the sixth axis rotation center line centers on the Z axis while the tool tip is fixed.</p>
 <p>The robot moves along the Y axis.</p>	 <p>The rotation of the torch centers on the torch tip on the plane formed by the torch line and Z axis while the tool tip is fixed.</p>
 <p>The robot moves along the Z axis.</p>	 <p>The rotation of the torch centers on the torch line while the torch posture remains fixed and the tool tip is fixed.</p>

Fig. 3.4.3 Movement directions in the machine coordinate system (for the arc welding application)

3.4.2 Moving the robot manually

1 Check that the teach mode has been selected.

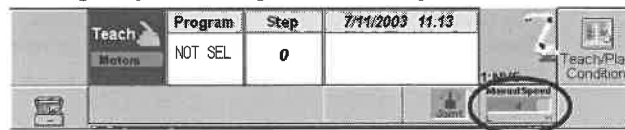


2 Press the [Motor power ON button].

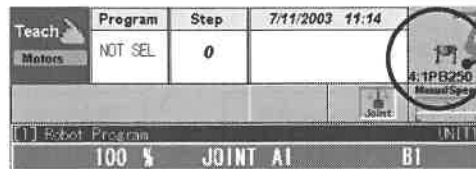
>> The preparations for moving the robot are now complete.

3 To change the speed, press [CHECK SPD/TEACH SPEED].

>> Any speed from 1 to 5 can be selected. Each time this key is pressed, the speed is changed by one setting in the following sequence: 1 → 2 ... 5 1, and so on.



4 The target mechanism for manual operation appears on the teach pendant.



The selected mechanism is displayed in colors.

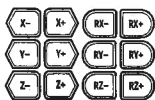
5 Grasp the [Enable switch (Deadman switch)].

>> While this switch is grasped, the motor power is turned on.



6 Press the [Axis operation keys] that corresponds to the direction in which the robot is to be moved.

>> The robot is moved in accordance with the selected coordinate system.



NACHI Notice to Nachi equipment users

Concerning the difference between the orthogonal coordinate system and the system with the AW or earlier controller by Nachi

In the AW or earlier controller, Nachi used its own coordinate system where the front as seen from the robot served as the Y direction. In the AX20/AX21 controller, the front has now been changed to serve as the X direction to follow the international standard.

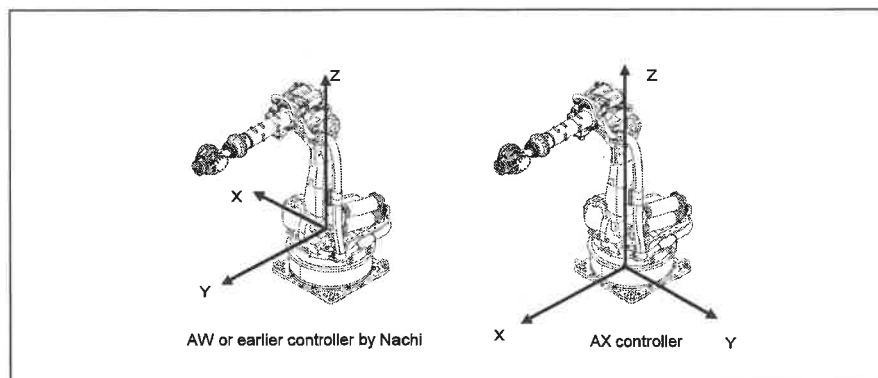
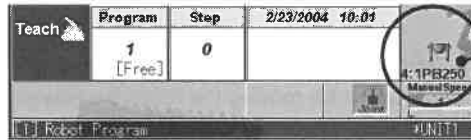


Fig. 3.4.4 Difference between the orthogonal coordinate system and the system with the AW or earlier controller by Nachi

3.4.3 Switching the mechanism

This procedure is used to select the mechanism to be manually operated when a multiple number of mechanisms have been connected. The mechanism can be selected whether the motor power is ON or OFF.

- 1 The mechanism selected for manual operation is displayed on the teach pendant.**

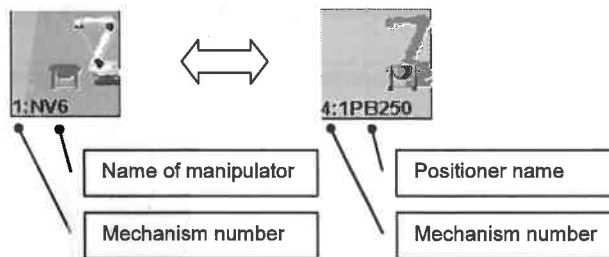


The currently selected mechanism is displayed in color.



- 2 To switch the mechanism, press [UNIT/MECHANISM].**

>> The selected mechanism changes (and the display of the teach pendant changes.) Given below is an example where a mechanism is switched in a configuration consisting of a manipulator and positioner.



- 3 After switching the mechanism, manual operation using the newly selected mechanism is possible.**

While holding the enable (deadman) switches, press the axis keys to operate the mechanism.

3.5 Turning the motor power to OFF

If some kind of danger is perceived while the robot is being operated manually in the teach mode or if work is to be suspended, release the enable switch (deadman switch) (or grasp it tightly).
When the enable switch (deadman switch) is released or grasped tightly, the motor power is turned off, and the robot stops immediately.

To turn off the motor power in the playback mode, press the emergency stop button.

Turning off the motor power

- 1 **In the teach mode, release the [Enable switch (Deadman switch)] or grasp it tightly.**
In the playback mode, press the [Emergency stop button] in the upper part of the teach pendant.
>> The motor power is now turned off.
If the robot is moving, it will stop immediately.



- 2 **The [Emergency stop button] is locked. To turn the motor power back on, the lock must be released.**
To release the lock, turn the button in the direction of the arrow.



An emergency stop button is also provided on the operation panel or operation box.
The robot is stopped by pressing any emergency stop button.

3.6 Turning the control power to OFF

To suspend the robot operation, turn off the control power.

Turning the control power to OFF

- 1 **Check that the robot has stopped.**
- 2 **Set the circuit breaker to the OFF position.**
>> The control power is now turned off.



NOTE





Chapter 4 Teaching

This chapter describes the teaching work.

4.1 Teaching procedure	4-1
4.2 Preparations prior to teaching	4-2
4.2.1 Input the number of the program	4-2
4.2.2 Listing the programs on the display	4-3
4.3 Teaching	4-4
4.3.1 Concerning the screen displays during teaching	4-4
4.3.2 Basic teaching operations —For NACHI Nachi users —	4-5
4.3.3 Basic teaching operations —For DATRIE Daihen users—	4-6
4.3.4 What is the interpolation type?	4-8
4.3.5 What is the accuracy level?	4-8
4.3.6 Continue and Pause	4-10
4.3.7 What is the acceleration?	4-11
4.3.8 What is smoothness?	4-12
4.3.9 Number of recordable steps	4-13
4.4 A practice teaching session —For NACHI Nachi users—	4-14
4.5 A practice teaching session —For DATRIE Daihen users—	4-20
4.5.1 Teaching methods	4-20
4.5.2 Try teaching using normal teaching	4-21
4.5.3 Try teaching using easy teaching (f keys)	4-28
4.5.4 Try teaching using easy teaching (numeric keys)	4-35
4.6 Recording function commands	4-39
4.6.1 Directly selecting a command with the function numbers	4-40
4.6.2 Selecting from categorized groups	4-40
4.6.3 Setting and recording function command parameters (conditions)	4-42
4.7 Checking what has been taught	4-43
4.8 Modifying the program	4-47
4.8.1 Modifying the robot position	4-47
4.8.2 Modifying movement command data —For NACHI Nachi users only —	4-48
4.8.3 Overwriting movement commands	4-49
4.8.4 Adding movement commands	4-53
4.8.5 Deleting movement and function commands	4-57
4.9 Using the screen editor function to modify commands	4-58
4.9.1 Modifying with the screen editor function	4-58
4.9.2 Batch changing the speed of MOVE command	4-61

4.1 Teaching procedure

Proceed with teaching by following the steps below.

<p>Preparations prior to teaching  Page 4-2 ~</p>	<p>1 Select the teach mode.</p>
<p>Teaching  Page 4-4 ~</p>	<p>Teaching is performed in the teach mode.</p>
<p>Checking of contents  Page 4-43 ~</p>	<p>2 Input the number of the program.</p>
<p>Modify  Page 4-47 ~</p>	<p>Input the number of the program to be created. Any number from 0 to 9999 can be input.</p>
	<p>3 Record the movement commands (positions to which the robot is to move and postures).</p> <ul style="list-style-type: none"> ▪ Move the robot to the recorded position and posture by manual operation. ▪ Press [O.WRITE/REC] to record the step (movement command). ▪ Record the steps (movement commands) in sequence by repeating this process.
	<p>4 If necessary, record the function commands.</p> <p>Record the function commands in the appropriate steps. If function commands are recorded, signals can be output to an external device or the robot can be made to stand by.</p>
	<p>5 Record the END command (function command END <FN92>) that indicates the program end.</p> <p>Record the end command (END <FN92> function command) in the step that will conclude the operation as the final step.</p>
	<p>6 Check the teaching contents.</p> <p>Move in numerical order through the recorded steps and check the recorded positions and postures.</p>
	<p>7 Revise the teaching contents if necessary</p> <p>Change the recorded points, add or delete steps, etc.</p>

4.2 Preparations prior to teaching

4.2.1 Input the number of the program

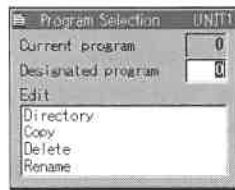
When teaching the robot new movements, provide a number to the program which will now be created. Any number from 0 to 9999 can be input.

Input the number of the program.

- 1 Select the teach mode.



- 2 While holding down [ENABLE], press [PROG/STEP].
 >> The [Program Selection] window now opens.



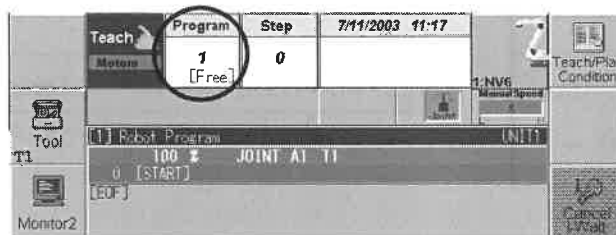
Numeric keys

- 3 Input the number of the program in the "Designated program" field, and press [Enter].

When "1" is to be specified as the program number, for instance, press the [1] numeric key.



- 4 Press [Enter].
 >> Program "1", a new program, is now opened.



At this point, the teaching can now begin.



If you do not know which numbers are not yet used

If you do not know which numbers are not yet used, check the programs already created by listing them on the display.

See page 4-3 "4.2.2 Listing the programs on the display".

4.2.2 Listing the programs on the display

A convenient way to open an already created program is to list the programs on the display and then make the selection.

Alternatively, the number of a program may be specified directly using the method described in "4.2.1 Input the number of the program".

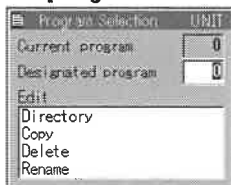
Listing the programs on the display

- 1 Select the teach mode.



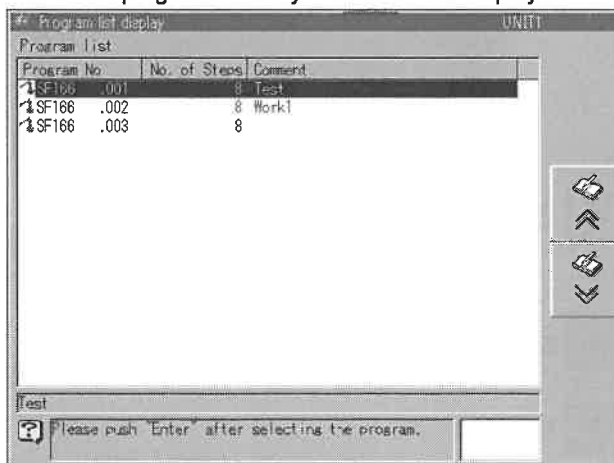
- 2 While holding down [ENABLE], press [PROG/STEP].

>> The [Program Selection] window now opens.



- 3 Align the cursor with "Directory", and press [Enter].

>> A list of the programs already created is now displayed.



- 4 Align the cursor with the program to be opened, and press [Enter].

>> The selected program is now opened.



Concerning the contents displayed when programs are listed

The contents displayed are as follows.

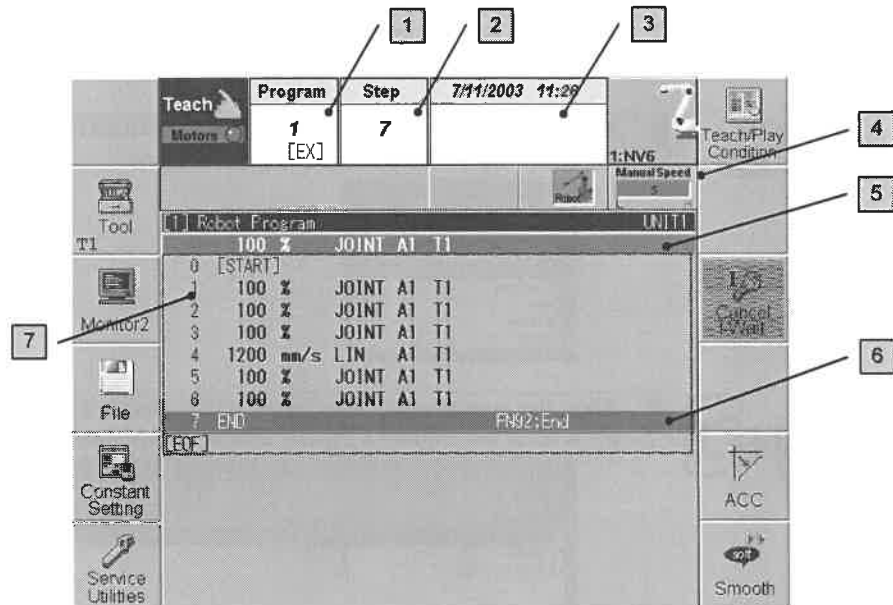
Program No.	No. of Steps	Comment
1SF166 .001	8	Test
1SF166 .002	8	Work1
1SF166 .003	8	

- 1: The program filenames are displayed in this column. The filenames are indicated using the "robot name.xxxx" format. "xxx" denotes the number of the program.
- 2: The number of recorded steps is displayed in this column.
- 3: If comments have been registered, they are displayed in this column.

4.3 Teaching

4.3.1 Concerning the screen displays during teaching

Various information is displayed on the screen during teaching as shown below. Before proceeding with teaching, remember this information as background knowledge.



1 Program No.

The number of the currently selected program is displayed. If not even one step has been recorded, "Free" is displayed; if one or more steps have been recorded, "EX" is displayed.

2 Step No.

The number of the currently selected step is displayed.

3 Comment

The contents of the comment (REM <FN99> function command) recorded at step 1 in the program are displayed as the comment of the program itself. The maximum number of characters which can be used for the REM function command is 199. However, the comment which consists of the first 38 of these characters appears in this area.

4 Manual Speed

With robots destined for Nachi users, the speed which has been set here is also reflected as the speed of the movement commands. Each time [CHECK SPD/TEACH SPEED] is pressed, the speed of the recording status is switched.

5 Recording status

The currently set speed, interpolation method, etc. are displayed here. The movement commands are recorded under the conditions displayed in recording status by pressing [O.WRITE/REC].

6 Cursor

This cursor indicates operation target. It is displayed as a green bar.

7 Program contents

The recorded steps are displayed here. The step numbers are provided for both the movement commands and function commands.

4.3.2 Basic teaching operations — For NACHI Nachi users —

Teaching using the movement commands

- (1) Operate the robot manually until it reaches the position to be recorded.
- (2) Set the speed, interpolation type and other data.

Speed	...This is the speed at which the robot is to move to the recorded position. Use [CHECK SPD/TEACH SPEED] to make the selection.
Interpolation type	...This refers to the condition under which the robot is to move to the recorded position, and it is selected by [ENABLE] + [INTERP].
Accuracy	...This refers to the degree by which the path along which the tool moves as it passes through the recorded point of each step is distanced from the recorded point, thereby describing an arc on the inside of these points. Use f-key <ACC> to make the selection.
- (3) The movement command is recorded by pressing [O.WRITE/REC].

POINT

Concerning the movement command data settings

All the movement command data can be changed after teaching. Therefore, until operators become familiar with the operation of the robot, they should simply remember "how to record the robot positions".

The data is revised upon completion of the teaching session.

 See page 4-47 "4.8 Modifying the program".

Teaching using the function commands

- (1) Press [FN].
- (2) Select the function command to be recorded, and press [Enter].
- (3) Specify the parameter (condition) of the function command, and press [Enter].
When there is more than one parameter (condition), press [Enter] with each parameter.

To correct input errors

- If the wrong function or command has been selected, press [RESET/R].
- To correct a numerical value, etc. specified in a function command, press [BS].
- To delete the last operation, press [ENABLE] + [BS].

4.3.3 Basic teaching operations —For **DAIHEN** Daihen users—

Teaching using the movement commands

When Using Easy Teaching (f keys)

- (1) Operate the robot manually until it reaches the position to be recorded.
- (2) Press [CLAMP/ARC]. Frequently used commands will be displayed on the f keys (f1 to f12).
- (3) Select the type of move command from among the following.
 - Press [7] : Joint P (Joint interpolation. The same as the conventional "P".)
 - Press [8] : Line L (Linear interpolation. The same as the conventional "L".)
 - Press [9] : Circle C (Circular interpolation. The same as the conventional "C".)
- (4) Set the speed, accuracy and other data.
 - Speed ...This is the speed at which the robot is to move to the recorded position.
 - Accuracy ...This refers to the degree by which the path along which the tool moves as it passes through the recorded point of each step is distanced from the recorded point, thereby describing an arc on the inside of these points. It is the same as [Overlap ON/OFF] which was provided with Daihen's conventional robots. You can specify one of 8 accuracy levels from A1 to A8, and can also select "Overlap Enable/ Disable" as you do with the existing Daihen robot. In this case, "Enable" would be A8 and "Disable" would be A1.
- (5) The movement command is recorded by pressing f12 <Complete>.
- (6) When recording the once-recorded move commands continuously, press [O.WRITE/REC].

When Using Easy Teaching (Numeric Keys)

When teaching movement commands by easy teaching (numeric keys), you can select from 2 types of teach settings; easy teaching and detailed teaching.

Easy Teaching Setting

- (1) By manual operation, move the robot to the location desirable for recording.
- (2) Pressing [ENABLE], press the numeric key that is assigned to the interpolation type, desired to be displayed. When the numeric key is pressed, the interpolation type that is already displayed in the record status will switch to the interpolation type that has been chosen.
 - Press [7] : Joint P (Joint interpolation. The same as the conventional "P".)
 - Press [8] : Line L (Linear interpolation. The same as the conventional "L".)
 - Press [9] : Circle C (Circular interpolation. The same as the conventional "C".)
- (3) Switch each data, such as speed and accuracy, displayed in the recording status
 - Speed ...This is the speed at which the robot is to move to the recorded position. Press [SPEED] and converse
 - Accuracy ...This refers to the degree of the inner tracks the has been recorded when passing each step. This is also known as the Accuracy; therefore, press [ACC] to make your selection.
- (4) By pressing [O.WRITE/REC] the movement command will be recorded.
- (5) When recording the once-recorded move commands continuously, press [O.WRITE/REC].

Detailed Teaching Setting

- (1) By manual operation, move the robot to the location desirable for recording.
- (2) By using [ENABLE] and determining the numerical key of the desired movement command, directly select the type of movement command.
 - Press [7] : Joint P (Joint interpolation. The same as the conventional "P".)
 - Press [8] : Line L (Linear interpolation. The same as the conventional "L".)
 - Press [9] : Circle C (Circular interpolation. The same as the conventional "C".)
- (3) Set the speed and accuracy. For procedures, review "When Using Easy Teaching (f key)".
- (4) By pressing f12 <Complete> the movement command will be recorded.
- (5) When recording the once-recorded move commands continuously, press [O.WRITE/REC].

POINT

Concerning the movement command data settings

All the movement command data can be changed after teaching. Therefore, until operators become familiar with the operation of the robot, they should simply remember "how to record the robot positions".

The data is revised upon completion of the teaching session.

 Page 4-47 "4.8 Modifying the program".

Teaching using the function commands

When Using Easy Teaching (f keys)

- (1) Press [FN]. The categories of function commands (such as signal input/output or program call) will be displayed on the f keys (f1 to f12).
- (2) Select the function command group using the f keys. The function commands registered in that group will be displayed on the f keys (f1 to f12).
- (3) Press the f key for the function command you want to record.
- (4) Specify the parameter (condition) of the function command, and press [Enter].
When inputting several parameters (conditions), press [Enter] after each parameter (condition).

When Using Easy Teaching (Numeric Keys)

- (1) Pressing [ENABLE], select the numerical key with the desired function command that is frequently used.
Pressing [ENABLE], select the type of function command from the following numerical key
Press [4] : Function commands regarding [Arc Welding] will be listed for both the f key (f 1~ f 12) and commands.
Press [5] : Function commands regarding [Weaving] will be listed for both the f key (f 1~f 12) and commands.
- (2) Select the function command, desired to be recorded, from the list of commands.
- (3) Set the parameter (condition) of the function command and press [Enter].
When inputting several parameters (conditions), press [Enter] after each parameter (condition).

**When using an easy teaching (numeric keys)**

When teaching is performed with numeric keys, "The use of the hard key" needs to be set the "Enable".
Refer to "4.5.4 Try teaching using easy teaching (numeric keys)". In "Chapter 4" for the setting procedure.


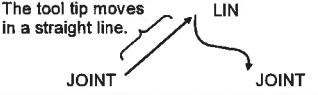
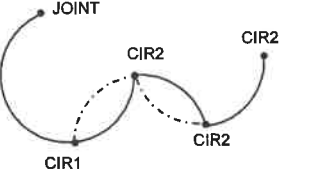
To correct input errors

- If the wrong function or command has been selected, press [RESET/R].
- To correct a numerical value, etc. specified in a function command, press [BS].
- To delete the last operation, press [ENABLE] + [BS].

4.3.4 What is the interpolation type?

How the tool tip is to be moved is determined by the interpolation type.

Table 4.3.1 Interpolation type

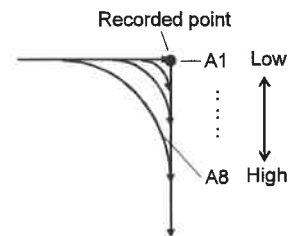
Interpolation type	Path of tool tip movement	
Joint interpolation (JOINT)	Since each axis moves independently, the path of the tool tip is not fixed.	
Line interpolation (LIN)	If the next step (target step) involves linear interpolation, the tool tip moves in a straight line that connects the steps.	
Circular interpolation (CIR)	If the target step and the step that follows involve circular interpolation, the tool tip moves along an arc.	

4.3.5 What is the accuracy level?

This refers to the degree to which the path along which the tool moves as it passes through the recorded point of each step describes an arc on the inside of the recorded point. A1 to A8 can be specified as this degree.

When A1 is specified, the tool will always pass through the recorded point. When A2 or above is specified, the time required for playback is reduced depending on how far the tool passes along an arc on the inside of the recorded points.

Select a stringent (lower) accuracy level at the welding points and a lax (higher) level in the air cutting areas. When the AX20/AX21 controller is used, the tool travels along the inside arc even when the interpolation type differs for the consecutive steps.



Control over the robot operations that involve accuracy levels differs depending on the application used.

When the spot welding application is used

When a level from A1 to A8 is specified, the inside arc amount changes step by step across a range from 0 to 500 mm.

If the accuracy level remains the same, the path of the robot is not affected even when the recording speed is changed.

Similarly, even when the playback speed changes, there is hardly any effect on the path of the robot. (The "playback speed" is the speed resulting from a change made by speed override, the low safety speed or other actual speed during playback.)

Accuracy levels when spot welding is performed

Level	Inside arc amount
A1	0 mm
A2	5 mm
A3	10 mm
A4	25 mm
A5	50 mm
A6	100 mm
A7	200 mm
A8	500 mm

When the arc welding application is used

When a level from A1 to A8 is specified, the overlap speed ratio changes step by step across a range from 0 to 100%.

Even if the accuracy level remains the same, the path of the robot is changed by the recording speed. (The higher the recording speed, the further inside the arc which is described.)

However, even when the playback speed changes, there is hardly any effect on the path of the robot. (The "playback speed" is the speed resulting from a change made by speed override, the low safety speed or other actual speed during playback.) This type of speed control is optimally suited to arc welding, and it is the same as "Overlap processing ON/OFF" which was provided with Daihen's conventional robots. "Overlap processing OFF" corresponds to A1 whereas "Overlap processing ON" corresponds to A8. (When the AX20/AX21 controller is used, this can be set more finely to one of eight levels.)

Accuracy levels when arc welding is performed

Level	Overlap speed ratio
A1	0 %
A2	5 %
A3	10 %
A4	15 %
A5	25 %
A6	50 %
A7	75 %
A8	100 %

(NOTE) In case of a manipulator of which the number of axes is seven or more, the default control setting is "**Overlap speed ratio**". Do not change this default setting.

4.3.6 Continue and Pause

The accuracy level described in the previous section can be divided into two types of control methods, "continue" and "pause."

With the "continue" method, the robot tool passes smoothly along the inside of the tool path with no reduction in its speed. ("Continue" is described in "4.3.5 What is the accuracy level?")

Since this control method generates the path in such a way that the tool moves along the inside of the path formed by the recorded points, it is used for those areas where the tool does not make contact with the work but moves from one point to the next through the air.

With the "pause" method, which is also referred to as "in-position check," each time the command position inside the robot reaches a step, the actual robot arrival is awaited before advancing to the next step.

This method is used at steps such as spot welding which require a high level of positioning accuracy.

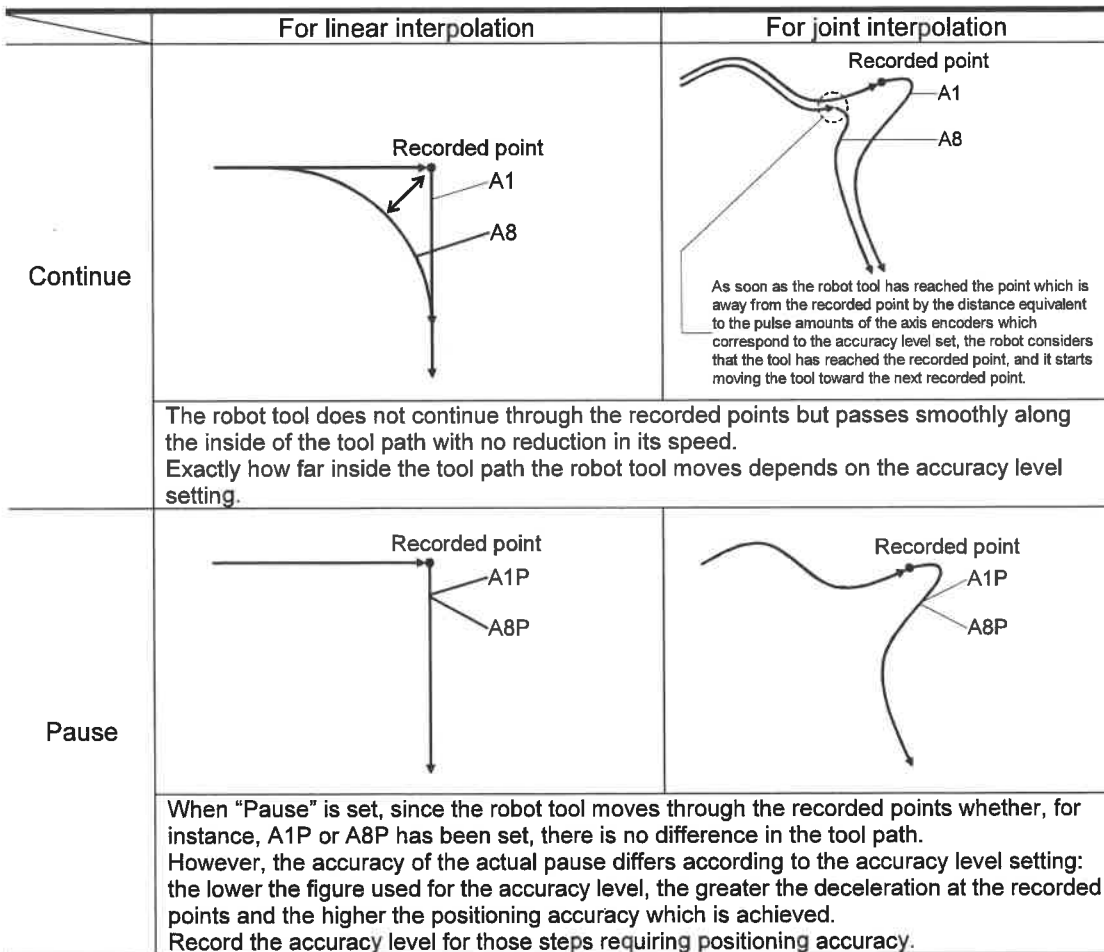
To select continue or pause, open the screen editing screen, and select "0" or "1" at the position shown in the figure below. When "1" is selected, "P" appears following accuracy levels "A1-A8." This indicates that pause has now been set.

"Continue/pause" indicated here (without "P": pass; with "P": pause).

4	1200 mm/s	LIN	A1 T1
5	600 mm/s	LIN	A1P T1
6	400 mm/s	LIN	A1 T1

Fig. 4.3.1 Example of steps displayed with "pause"

An alternative way to set continue or pause as the recording status is to use the [Continue/Pause] key.



4.3.7 What is the acceleration?

The "acceleration" is a function which adjusts the smoothness by adjusting the acceleration of the robot operation. When vibration arises due to a factor such as the rigidity of the tool or work, the robot can be moved gently by using the function in the movement command concerned. As a result, the amount of vibration is reduced. Unlike the "accuracy level" which expresses the positioning roughness when the tool passes through the recorded points, "acceleration" functions even when there is one movement command.

"Acceleration" can be specified for each movement command, and one of four different settings (0, 1, 2 or 3) can be selected. At an acceleration setting of 0 (D0), the robot accelerates or decelerates at its maximum capacity, and the higher the setting used, the more smoothly (that is to say, the lower the acceleration) the robot moves. (Factory setting)

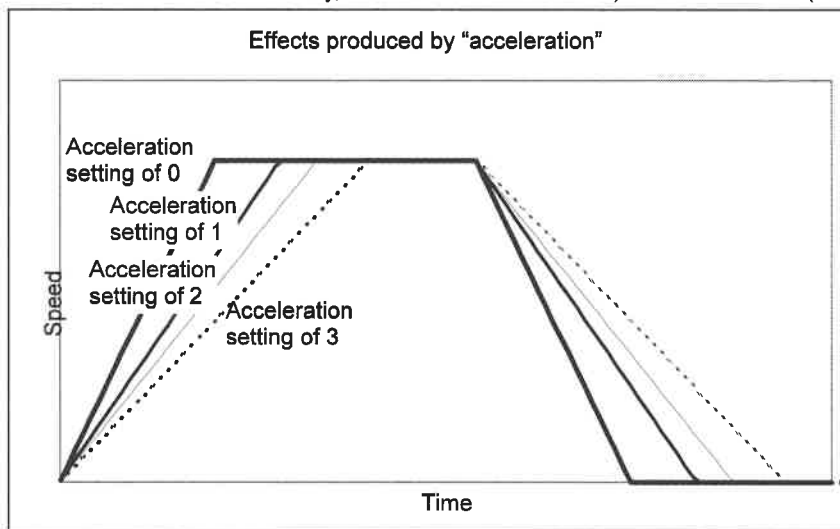


Fig. 4.3.2 "Acceleration"

Open the screen editing window, and set a level from 0 to 3 at the position shown in the figure below.

A number appears after "D." The display is cleared only when 0 has been set.

This is the "acceleration" setting.

56	1200	mm/s	LIN	A1	T1	
57	600	mm/s	LIN	A2	T1	DIS3
58	400	mm/s	LIN	A1P	T1	

Fig. 4.3.3 Example of "acceleration" step display

Furthermore, if the "Accel" F key is used, the acceleration can be set in the recording status.



IMPORTANT

When "acceleration" is set, it always takes longer for the robot to move. Since this will adversely affect the cycle (tact) time, do not record the function in movement commands unnecessarily.



IMPORTANT

Both "acceleration" and "smoothness" may be recorded at the same time. Both will function simultaneously.



IMPORTANT

This function corresponds to the M233 acceleration switching function of Nachi's conventional controllers (AW controllers).

4.3.8 What is smoothness?

“Smoothness” is a function that adjusts the smoothness by changing the acceleration speed of the robot axes. When vibration arises due to a factor such as the rigidity of the tool or work, the robot can be moved gently by using the function in the movement command concerned. As a result, the amount of vibration is reduced. Unlike the “accuracy level” which expresses the positioning roughness when the tool passes through the recorded points, “smoothness” functions even when there is one movement command.

“Smoothness” can be specified for each movement command, and one of four different settings (0, 1, 2 or 3) can be selected. At a smoothness setting of 0 (S0), the robot accelerates or decelerates at its maximum capacity, and the higher the setting used, the more smoothly (that is to say, the lower the acceleration speed) the robot moves. (Factory setting)

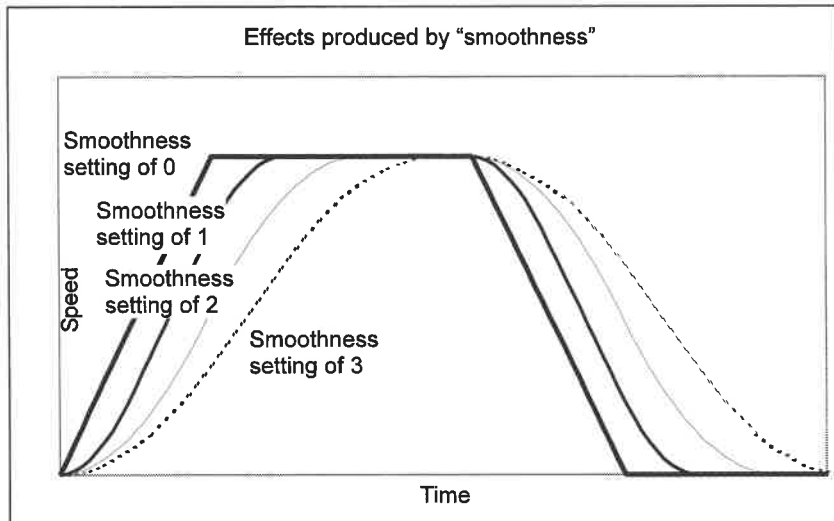


Fig. 4.3.4 “Smoothness”

Open the screen editing window, and set a level from 0 to 3 at the position shown in the figure below.

A number appears after “S.” The display is cleared only when 0 has been set.

This is the “smoothness” setting.

56	1200 mm/s	LIN	A1	T1	
57	600 mm/s	LIN	A2	T1	D1S3
58	400 mm/s	LIN	A1P	T1	

Fig. 4.3.5 Example of “smoothness” step display

Furthermore, if the “Smooth” F key is used, the smoothness can be set in the recording status.



IMPORTANT

When “smoothness” is set, it always takes longer for the robot to move. Since this will adversely affect the cycle (tact) time, do not record the function in movement commands unnecessarily.

IMPORTANT

Both “acceleration” and “smoothness” may be recorded at the same time. Both will function simultaneously.

4.3.9 Number of recordable steps

The maximum number of steps which can be recorded in a task program is 300. When this limit of 300 steps is to be exceeded, it is a good idea when preparing the task program concerned to divide it into a multiple number of separate task programs, and then call the separate sub task programs from the main task program using a command such as the program call command (FN80).

By dividing up task programs, the same task programs can be re-used, thereby facilitating management and maintenance.

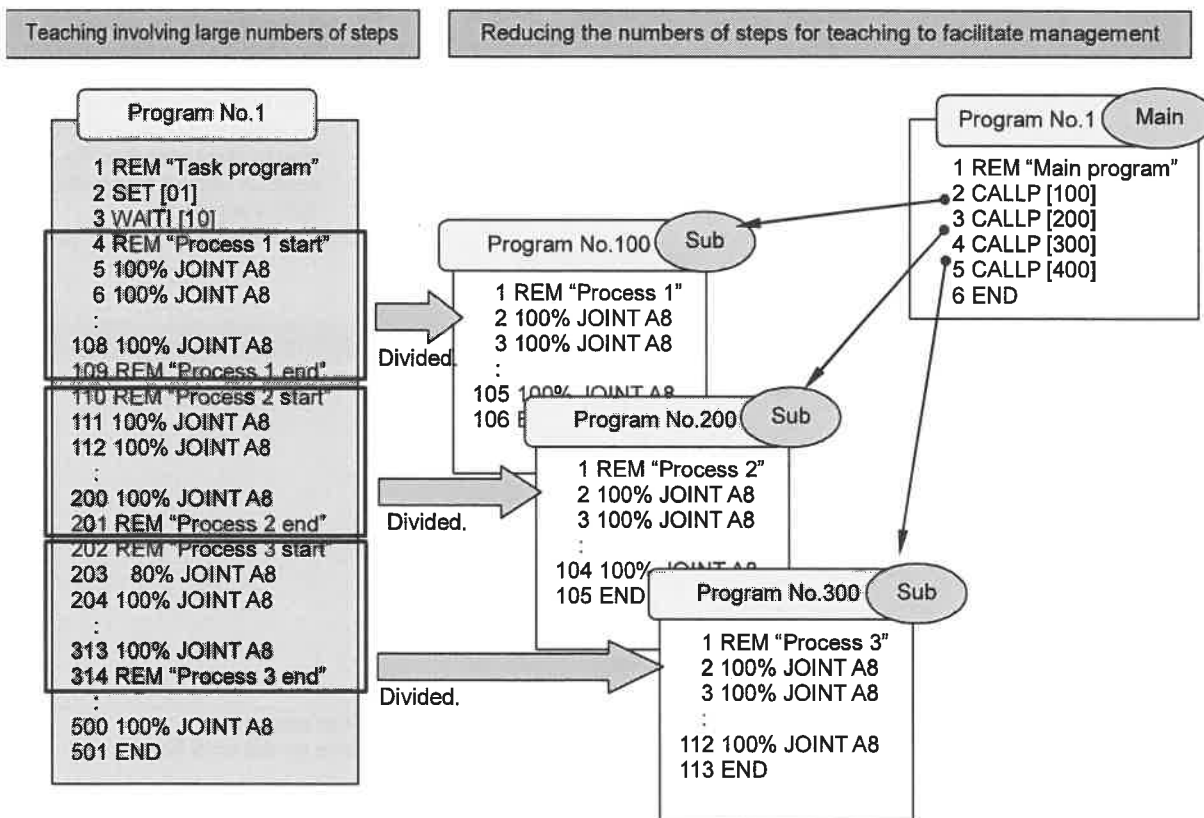


Fig. 4.3.6 Example of teaching with reduced numbers of steps



IMPORTANT

If the "A2150: Program is too large" error message appears during teaching or screen editing, it means that the number of steps stored in a task program is too high. (At present, this error occurs when the file size of 64KB is exceeded.)
In a case like this, divide the task program in the manner shown in the example above.

When dividing an existing task program, press the [PROG./STEP] key, select "Copy," and copy the steps into a new task program. (Step copy function)
The step copy function can also be selected by selecting <Service utilities> - [9 Program Conversion] - [2 Step copy].



IMPORTANT

The "A3084: Media device is full" error message sometimes appears during teaching, screen editing, file editing or a file operation. This error is caused by insufficient memory as defined in the cases described below.

- There is not enough space or no space at all in the internal memory device to record new data.
- There is not enough space in the internal memory to edit or operate the specified file.

In such a case, make more space in the internal memory by, for instance, deleting files which are no longer required or by saving files which have not been used recently onto a CF card and then deleting them from the internal memory.

4.4 A practice teaching session —For NACHI Nachi users—

Upon completion of the preparations, try a practice session in teaching.
In this section, the program shown below will be created.

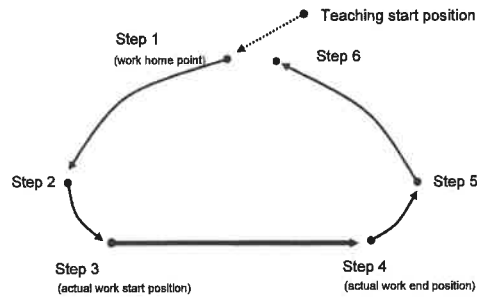


Fig. 4.4.1 Teaching example

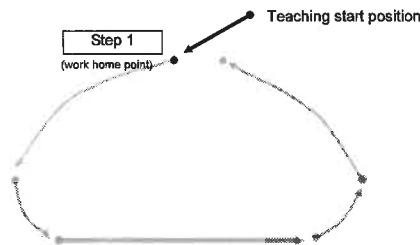
Teaching

As shown in the figure on the left, move the robot from step 1 to step 5, and record the positions. Superimpose the recording position for step 6 at the same position as step 1.

This is done in order to ensure that the robot operation will move directly from step 5 to the step 1 position without being interrupted during playback.

Recording step 1 (work home point)

Record step 1 as the work home point.



- 1 Use the [Axis operation keys] to move the robot to step 1.
As step 1, set the robot to the position which will serve as the work home point.

- 2 In the recording status, movement commands have already been selected.

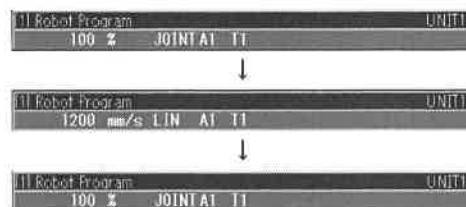


From this state, specify the method, the speed and the accuracy level of the movement up to step 1.
For step 1, try setting "joint interpolation" for the movement method, "100%" for the speed and "1" for the accuracy level.



- 3 While holding down [ENABLE], press [INTERP/COORD], and set the interpolation specification of the recording status to "JOINT."

>> Each time this is pressed, the interpolation type of the recording status is switched in the following sequence: "JOINT" □ "LIN" □ "JOINT", etc.)





- 4** Press [CHECK SPD/TEACH SPEED], and set the manual speed to “5.” (The speed of the recording status changes in tandem with the manual speed. When “5” is selected as the speed setting, “100%” is displayed.)

```

Robot Program                               UNIT1
100 % JOINT A1 T1
0 [START]
[EOF]
    
```



- 5** To specify the accuracy level, press <ACC>.
 >> Each time it is pressed, the accuracy changes in sequence by one level from A1 to A8.

```

Robot Program                               UNIT1
100 % JOINT A1 T1
0 [START]
[EOF]
    
```



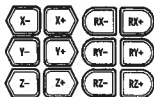
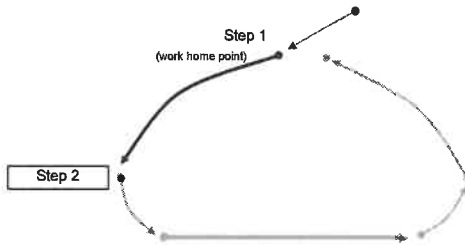
- 6** Press [O.WRITE/REC].
 >> Step 1 is now recorded.

```

Robot Program                               UNIT1
100 % JOINT A1 T1
0 [START]
1 100 % JOINT A1 T1
[EOF]
    
```

Recording step 2 (just before the actual work start position)

Record step 2 near the actual work start position. The actual work start position denotes the position where the actual welding or other work will be performed.



- 1** Use the [Axis operation keys] to move the robot to step 2.
 As step 2, set the robot to just before the start position of the work. In terms of the posture, set the robot to the posture which is close to the one in which the robot will actually perform the work in step 3.

- 2** Set the movement method and speed up to step 2.
 In the same way as for step 1, try setting “joint interpolation” for the movement method and “100%” for the speed.



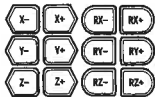
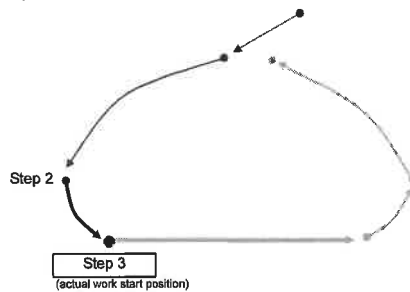
The movement command stored last is left for the recording status. To use the previous condition as is, press [O.WRITE/REC] without changing the value.
 >> Step 2 is now recorded.

```

Robot Program                               UNIT1
100 % JOINT A1 T1
0 [START]
1 100 % JOINT A1 T1
2 100 % JOINT A1 T1
[EOF]
    
```

Recording step 3 (actual work start position)

Record the position where the actual welding or other work is to start as step 3.

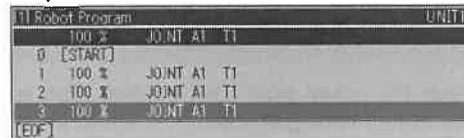


- 1 Use the [Axis operation keys] to move the robot to step 3.
Since step 3 is the position where the actual welding and other work are to start, manually operate the robot until its posture is optimal for the work to be performed.

- 2 Set the movement method and speed up to step 3.

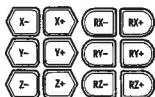
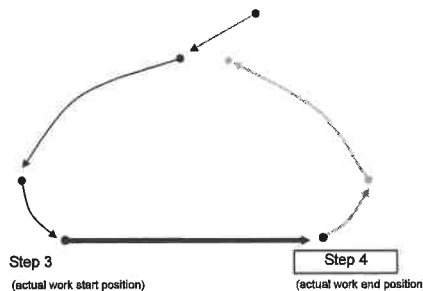


- 3 Press [O.WRITE/REC].
>> Step 3 is now recorded.



Recording step 4 (actual work end position)

Record the position where the actual welding or other work is to end as step 4.



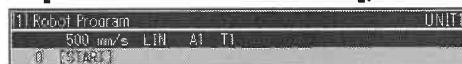
- 1 Use the [Axis operation keys] to move the robot to step 4.
The movements of the robot by manual operations up to step 4 need not be in a straight line. A detour may be taken but operate the robot manually in such a way that it does not make contact with the work piece.

- 2 Set the movement method and speed up to step 4.
Set the movement method to "interpolation ON (linear)" and the speed to "500 mm/s."

Press [INTERP/COORD] while holding down [ENABLE] to select linear interpolation as the interpolation for the recording status. ("LIN" is displayed as the recording status.)



Press [CHECK SPD/TEACH SPEED], and set the speed to "500 mm/s."



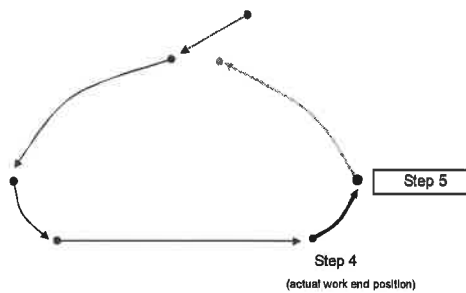


3 Press [O.WRITE/REC].
 >> Step 4 is now recorded.

Robot Program				UNIT
0	500 mm/s	LIN	A1	T1
1	[START]			
2	100 %	JOINT	A1	T1
3	100 %	JOINT	A1	T1
4	500 mm/s	LIN	A1	T1
[EOF]				

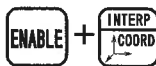
Recording step 5 (position away from the work piece)

Record the position away from the work piece as step 5.



1 Use the [Axis operation keys] to move the robot to step 5.
 As step 5, set the robot in the appropriate position at some distance from the work piece.

2 Set the movement method and speed up to step 5.
 For step 5, set the movement method to "joint interpolation" and the speed to "100%."



While holding down [ENABLE], press [INTERP/COORD], and set the interpolation specification of the recording status to "JOINT."



Further, press [CHECK SPD/TEACH SPEED], and set the speed to "100%."

Robot Program				UNIT
0	100 %	JOINT	A1	T1
1	[START]			

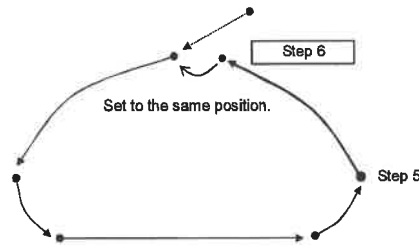


3 Press [O.WRITE/REC].
 >> Step 5 is now recorded.

Robot Program				UNIT
0	100 %	JOINT	A1	T1
1	[START]			
2	100 %	JOINT	A1	T1
3	100 %	JOINT	A1	T1
4	500 mm/s	LIN	A1	T1
5	100 %	JOINT	A1	T1
[EOF]				

Recording step 6 (same position as for step 1)

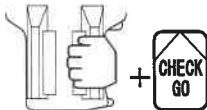
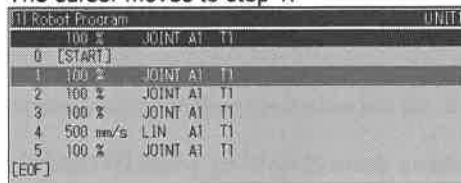
Record the same position as for step 1 as step 6.



- 1 Press **[PROG/STEP]**.
 >> The **[Step Selection]** screen now appears.



- 2 Input **"1"** in **"Designated step"**, and press **[Enter]**.
 >> The cursor moves to step 1.



- 3 While grasping the **[Deadman switch]**, press **[CHECK GO]**. (Keep pressing it until the robot stops.)
 >> The robot moves to the position recorded in step 1.

- 4 To record the position where the robot stopped (position in step 1) as step 6, call step 5.



- Press **[PROG/STEP]**.
 >> The **[Step Selection]** screen now appears.



- 5 Select **"Bottom"**, and press **[Enter]**.
 >> The cursor moves to the last step (step 5).
 This is now the state in which step 6 can be recorded.



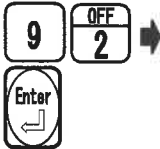
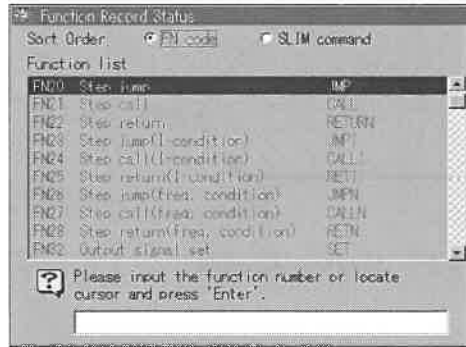
- 6 The conditions in step 5 will be used as is, so press **[O.WRITE/REC]**.
 >> Step 6 is now recorded.

Recording the end command (End function command)

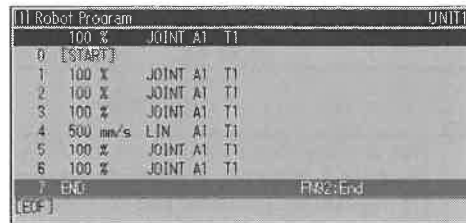
Since all the steps have now been recorded, record the end command at the end of the program. The end command can be recorded either by specifying function number FN92 or by selecting the END function command from the list of commands. (The end command must be recorded without fail.)

FN

- 1 **Press [FN].**
 >> The list of function commands is now displayed.



- 2 **Press [9] → [2] → [Enter].**
 >> The end command is now recorded.



This now completes the creation of the program. Next, check the robot operations, postures, etc.

4.5 A practice teaching session — For **DAIHEN** Daihen users —

Upon completion of the preparations, try a practice session in teaching.
In this section, the program shown below will be created.

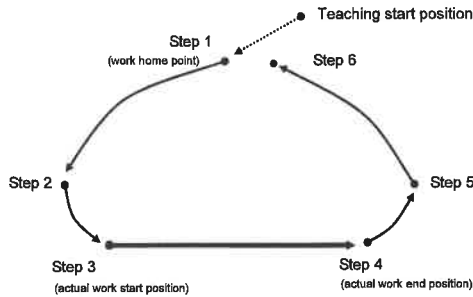


Fig. 4.5.1 Teaching example

Teaching

As shown in the figure on the left, move the robot from step 1 to step 5, and record the positions. Superimpose the recording position for step 6 at the same position as step 1. This is done in order to ensure that the robot operation will move directly from step 5 to the step 1 position without being interrupted during playback.

4.5.1 Teaching methods

The following 2 teaching methods are provided mainly for Daihen customers. Since you can use all of these 2 methods simultaneously, please use the teaching method that is easiest.

Table 4.5.1 Teaching method

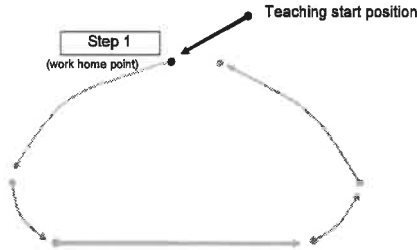
Teaching method	Description	Reference page
Normal teaching	This is a teaching method from the AX-C controller. The speed, accuracy and interpolation classification are individually specified and recorded using special keys.	Page 4-21
Easy teaching	When using easy teaching (f keys) With this method, you teach the robot in practically the same way as in the existing Daihen robot with the function keys. After selecting the move commands and frequently used function commands with the f keys, you set the necessary conditions and record it.	Page 4-28
	When using easy teaching (numeric keys) With this method, you teach the robot in practically the same way as in the existing Daihen robot with the hard keys (numeric keys). After selecting the move commands and frequently used function commands with the hard keys, you set the necessary conditions and record it.	Page 4-35

4.5.2 Try teaching using normal teaching

This section explains how to teach using the Normal Teaching method.

Recording step 1 (work home point)

Record step 1 as the work home point.



- 1 Use the [Axis operation keys] to move the robot to step 1.**
As step 1, set the robot to the position which will serve as the work home point.

- 2 In the recording status, movement commands have already been selected.**



From this state, specify the method, the speed and the accuracy level of the movement up to step 1.

For step 1, try setting “joint interpolation” for the movement method, “100%” for the speed and “1” for the accuracy level.

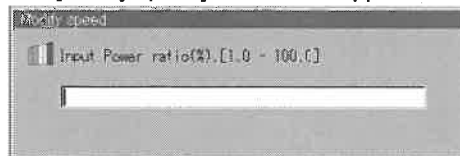


- 3 While holding down [ENABLE], press [INTERP/COORD], and set the interpolation specification of the recording status to “JOINT.”**

>> Each time this is pressed, the interpolation type of the recording status is switched in the following sequence: “JOINT” → “LIN” → “CIR” → “JOINT”, etc.)



- 4 Press [SPD].**
>> The [Modify speed] screen now appears.



100



- 5 Input “100”, and press [Enter].**
>> “100%” is displayed as the recording status.



ACC

6 To specify the accuracy level, press [ACC].

>> Each time it is pressed, the accuracy changes in sequence by one level from A1 to A8.

```
1) Robot Program UNIT1
100 % JOINT A1 T1
0 [START]
[REC]
```

O.WRITE
REC

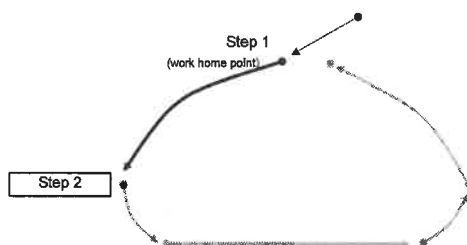
7 Press [O.WRITE/REC].

>> Step 1 is now recorded.

```
1) Robot Program UNIT1
100 % JOINT A1 T1
0 [START]
1 100 % JOINT A1 T1
[REC]
```

Recording step 2 (just before the actual work start position)

Record step 2 near the actual work start position. The actual work start position denotes the position where the actual welding or other work will be performed.



- 1 Use the [Axis operation keys] to move the robot to step 2.**
As step 2, set the robot to just before the start position of the work. In terms of the posture, set the robot to the posture which is close to the one in which the robot will actually perform the work in step 3.
- 2 Set the movement method and speed up to step 2.**
In the same way as for step 1, try setting "joint interpolation" for the movement method and "100%" for the speed.



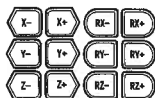
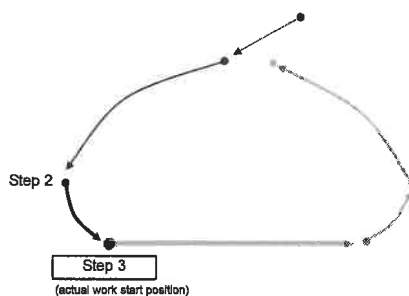
The movement command stored last is left for the recording status. To use the previous condition as is, press [O.WRITE/REC] without changing the value.

>> Step 2 is now recorded.

Robot Program		UNIT
0	100 % JOINT A1 T1	
0	[START]	
1	100 % JOINT A1 T1	
2	100 % JOINT A1 T1	
[END]		

Recording step 3 (actual work start position)

Record the position where the actual welding or other work is to start as step 3.



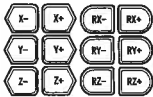
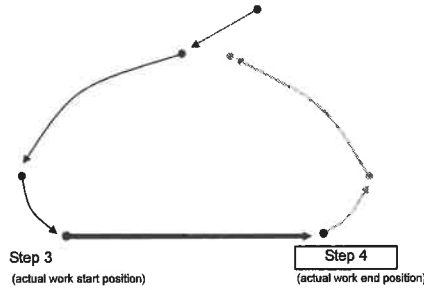
- 1 Use the [Axis operation keys] to move the robot to step 3.**
Since step 3 is the position where the actual welding and other work are to start, manually operate the robot until its posture is optimal for the work to be performed.
- 2 Set the movement method and speed up to step 3.**
- 3 Press [O.WRITE/REC].**
>> Step 3 is now recorded.



Robot Program		UNIT
0	100 % JOINT A1 T1	
0	[START]	
1	100 % JOINT A1 T1	
2	100 % JOINT A1 T1	
3	100 % JOINT A1 T1	
[END]		

Recording step 4 (actual work end position)

Record the position where the actual welding or other work is to end as step 4.



- 1 Use the [Axis operation keys] to move the robot to step 4.**
The movements of the robot by manual operations up to step 4 need not be in a straight line. A detour may be taken but operate the robot manually in such a way that it does not make contact with the work piece.



- 2 Set "linear interpolation" as the method for the movement up to step 4.**
While holding down [ENABLE], press [INTERP/COORD], and set the interpolation type of the recording status to "LIN."



- 3 Next, set the speed up to step 4.**
Press [SPD].
>> The [Modify speed] screen now appears.



200



- 4 Input "200," and press [Enter].**
>> "200 cm/m" is displayed as the recording status.

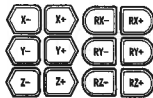
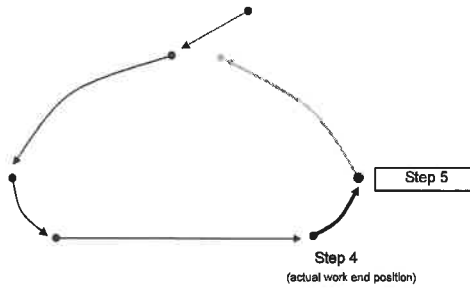


- 5 Press [O.WRITE/REC].**
>> Step 4 is now recorded.



Recording step 5 (position away from the work piece)

Record the position away from the work piece as step 5.



1 Use the [Axis operation keys] to move the robot to step 5.
As step 5, set the robot in the appropriate position at some distance from the work piece.

2 Set “joint interpolation” as the method for the movement up to step 5.
While holding down [ENABLE], press [INTERP/COORD], and set the interpolation type of the recording status to “JOINT.”

3 Next, set the speed up to step 5.
After pressing [SPD], input “100,” and press [Enter].
>> “100%” is displayed as the recording status.

```

Robot Program                               UNIT
100 % JOINT A1 T1
0 [START]
    
```

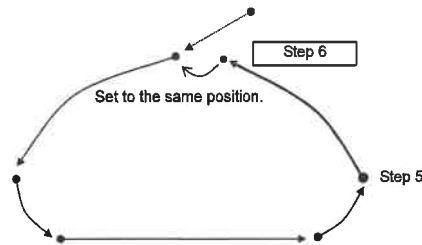
4 Press [O.WRITE/REC].
>> Step 5 is now recorded.

```

Robot Program                               UNIT
100 % JOINT A1 T1
0 [START]
1 100 % JOINT A1 T1
2 100 % JOINT A1 T1
3 100 % JOINT A1 T1
4 500 mm/s LIN A1 T1
5 100 % JOINT A1 T1
[ECF]
    
```

Recording step 6 (same position as for step 1)

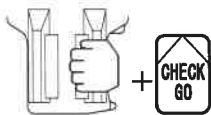
Record the same position as for step 1 as step 6.



- 1 Press **[PROG/STEP]**.
 >> The **[Step Selection]** screen now appears.



- 2 Input "1" in "Designated step", and press **[Enter]**.
 >> The cursor moves to step 1.



- 3 While grasping the **[Deadman switch]**, press **[CHECK GO]**. (Keep pressing it until the robot stops.)
 >> The robot moves to the position recorded in step 1.

- 4 To record the position where the robot stopped (position in step 1) as step 6, call step 5.



- 5 Press **[PROG/STEP]**.
 >> The **[Step Selection]** screen now appears.



- 5 Select "Bottom," and press **[Enter]**.
 >> The cursor moves to the last step (step 5).
 This is now the state in which step 6 can be recorded.



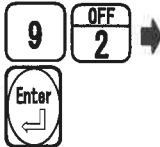
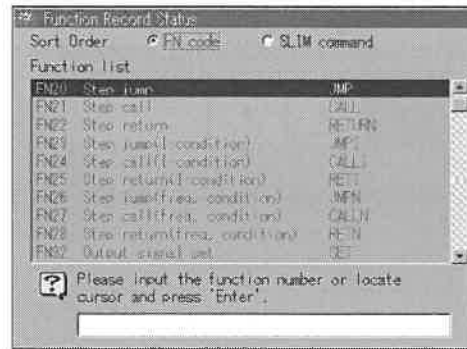
- 6 The conditions in step 5 will be used as is, so press **[O.WRITE/REC]**.
 >> Step 6 is now recorded.

Recording the end command (End function command)

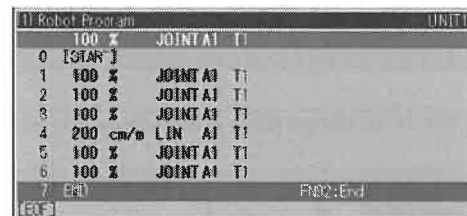
Since all the steps have now been recorded, record the end command at the end of the program. The end command can be recorded either by specifying function number FN92 or by selecting the END function command from the list of commands. (The end command must be recorded without fail.)

FN

- 1 **Press [FN].**
 >> The list of function commands is now displayed.



- 2 **Press [9] → [2] → [Enter].**
 >> The end command is now recorded.



This now completes the creation of the program. Next, check the robot operations, postures, etc.

4.5.3 Try teaching using easy teaching (f keys)

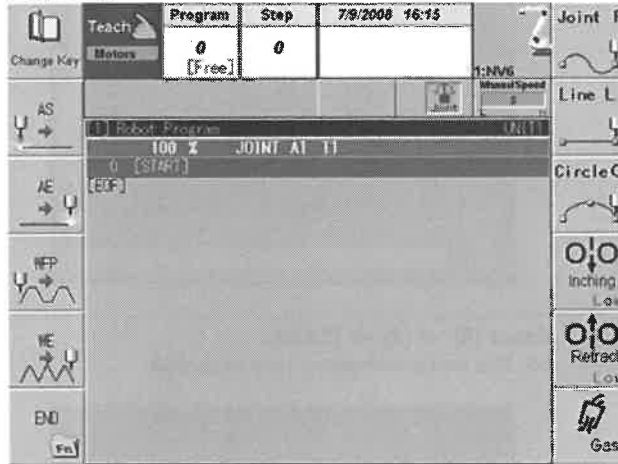
The simple operations that were well received with the conventional Daihen robot can also be used without any changes with the AX20/AX21 controller.

Input the program number and, when Teaching preparations are complete, press [CLAMP/ARC]. You can make your selection easily and just as you did in the existing robot, by using the numerical input keys to select commands such as P, L, C, AS, AE or END.

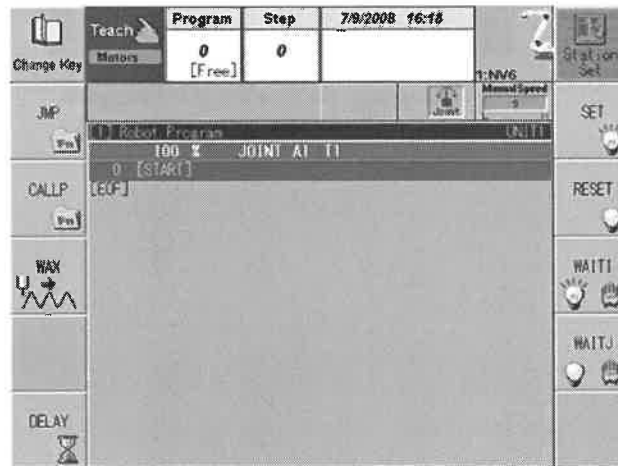
Selecting easy teach mode



- 1 Press [CLAMP/ARC].
 >> Frequently used commands will be displayed on the f keys.



- 2 Pressing the f1 <Change Key> will display the next group of commands on the f keys.



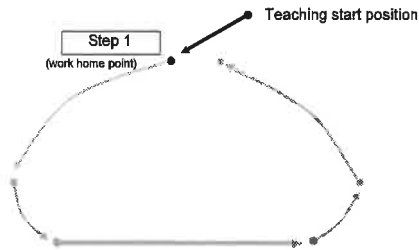
- 3 You can select a command by pressing the f key for that command.
 Now we will explain the basic teaching operations using the “easy teach mode”.



- 4 To cancel this mode, press [CLAMP/ARC] again.
 >> Return to the f key display.

Recording step 1 (work home point)

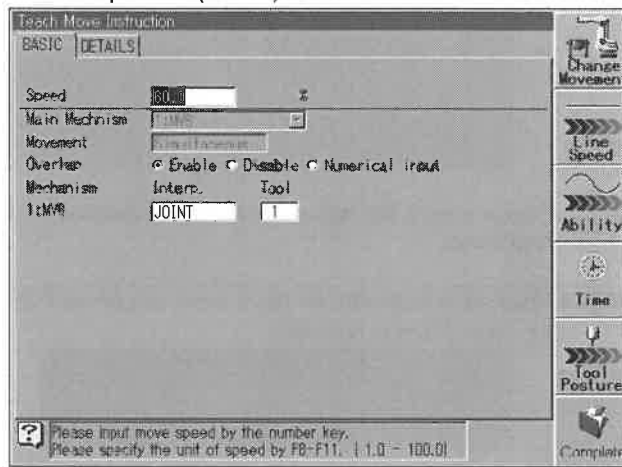
Record step 1 as the work home point.



- 1 Use the [Axis operation keys] to move the robot to step 1.
As step 1, move the robot to the position which will serve as the work home point.

- 2 "Joint Interpolation" is used for the movement up to the first step.
Press f7 <Joint P>.

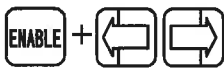
>> Joint interpolation (JOINT) is now selected.



100



- 3 Set the speed to 100%. Input "100", and press [Enter].



- 4 After aligning the cursor with "Overlap", press [LEFT/RIGHT] while holding down [ENABLE].

Select "Enable/Disable" just as you did with the existing robot. "Numerical Input" is selected when doing more detailed setting of the accuracy, but normally you can just select "Enable/Disable".

- 5 For the setup conditions, you normally only need to set the speed 3 and overlap 4, so move on to operations 6.

For a slightly more advanced level of usage, please perform operations 6, 7 and 8.

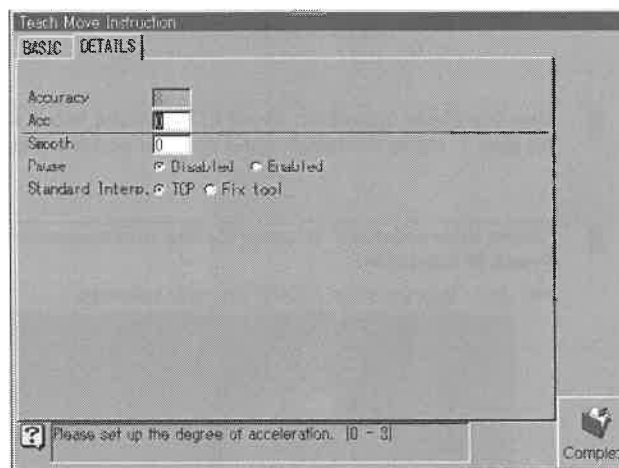
- 6 When the cursor is at "Interp.", you can switch between interpolation classifications.

This is useful when you make a mistake in the f key operations and accidentally select a command different from the one you intended to select.

- 7** **“Tool” sets the tool number.**
 Normally, there is only 1 tool (referring to a torch or hand), so you can leave this as is at “1”. If you make a mistake in specifying this, the robot’s position itself won’t change, but the control point for the tool (TCP) will be different and will therefore affect the robot interpolation accuracy at the time of playback.
 Only pay attention to this and specify the tool number when doing operations such as switching among multiple tools using tool change or such.



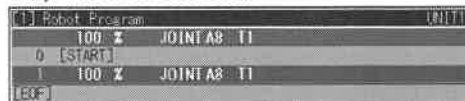
- 8** **Detailed settings such as acceleration and numerical specification of accuracy can be done with the “DETAILS” tab.**
To switch the tab, press [CLOSE/SELECT SCREEN].



Please refer to the reference manual embedded in the robot for information on these conditions.

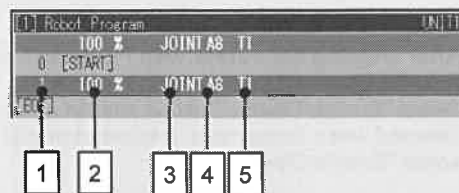


- 9** **Once all the conditions have been set, press f12 <Complete>.**
 >> Step 1 is now recorded.



After Recording Move Commands

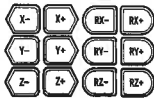
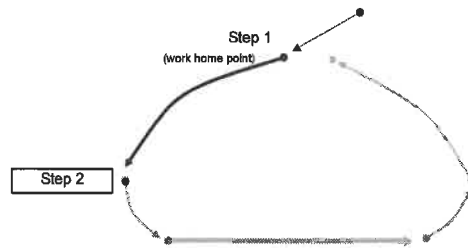
The recorded step(s) will be written to the program with step numbers appended.



- 1** : This is the number of the step. When jumping to other steps, specify the number of that step.
- 2** : This is the set speed.
- 3** : This is the interpolation type. JOINT, LIN, and CIR1/CIR2 are displayed.
- 4** : This is the accuracy. A8 for Overlap Enable and A1 for Overlap Disable. When positioning is specified, “P” is appended.
- 5** : This is the tool number.

Recording step 2 (just before the actual work start position)

Record step 2 near the actual work start position. The actual work start position denotes the position where the actual welding or other work will be performed.



- 1 Use the [Axis operation keys] to move the robot to step 2.**
As step 2, move the robot to just before the start position of the work. In terms of the posture, set the robot to the posture which is close to the one in which the robot will actually perform the work in step 3.



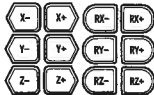
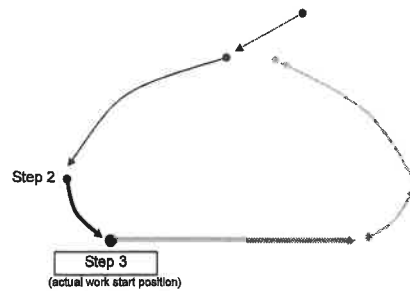
- 2 Teach step 2.**
In the same way as for step 1, try setting "joint interpolation" for the movement method and "100%" for the speed.
The move command stored last is left for the recording status. When you want to use the previous conditions as is, press [O.WRITE/REC] without changing the values.

>> Step 2 is now recorded.

[1] Robot Program				UNIT1
	100 %	JOINTAS	T1	
0	[START]			
1	100 %	JOINTAS	T1	
2	100 %	JOINTAS	T1	
[REC]				

Recording step 3 (actual work start position)

Record the position where the actual welding or other work is to start as step 3.



- 1 Use the [Axis operation keys] to move the robot to step 3.**
Since step 3 is the position where the actual welding and other work are to start, manually operate the robot until its posture is optimal for the work to be performed.

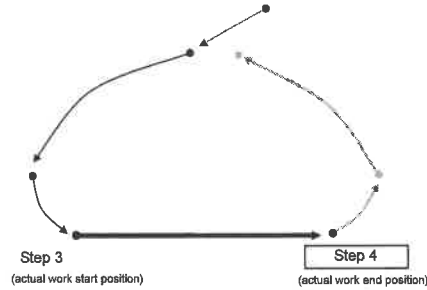


- 2 Since the previous conditions are to be used as is, press [O.WRITE/REC].**
>> Step 3 is now recorded.

[1] Robot Program				UNIT1
	100 %	JOINTAS	T1	
0	[START]			
1	100 %	JOINTAS	T1	
2	100 %	JOINTAS	T1	
3	100 %	JOINTAS	T1	
[REC]				

Recording step 4 (actual work end position)

Record the position where the actual welding or other work is to end as step 4.

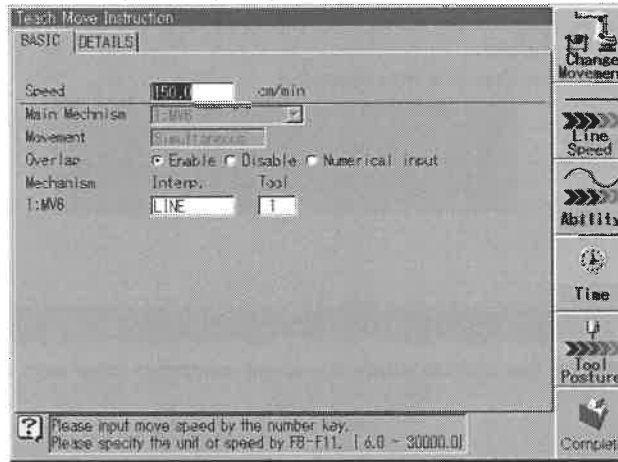


- 1 Use the [Axis operation keys] to move the robot to step 4. The movements of the robot by manual operations up to step 4 need not be in a straight line. A detour may be taken but operate the robot manually in such a way that it does not make contact with the work piece.



- 2 Linear interpolation is used for the movement up to step 4. Press f8 <Line L>.

>> Linear interpolation (LINE) is now selected.



- 3 Set the speed and whether to turn overlap on or off.



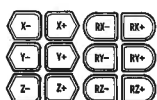
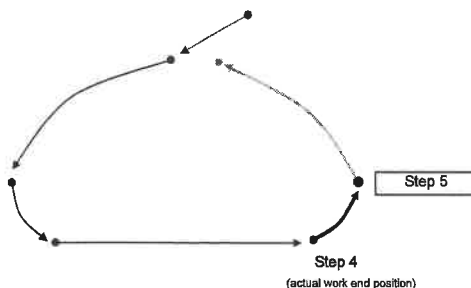
- 4 Once all the conditions have been set, press f12 <Complete>.

>> Step 4 is now recorded.



Recording step 5 (position away from the work piece)

Record the position away from the work piece as step 5.



1 Use the [Axis operation keys] to move the robot to step 5.
As step 5, set the robot in the appropriate position at some distance from the work piece.

2 "Joint Interpolation" is used for the movement up to step 5.
Press **f7** <Joint P>.
>> Joint interpolation (JOINT) is now selected.

3 Set the speed and whether to turn overlap on or off.

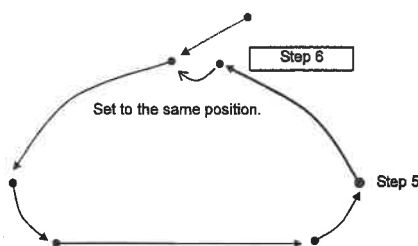


4 Once all the conditions have been set, press **f12** <Complete>.
>> Step 5 is now recorded.

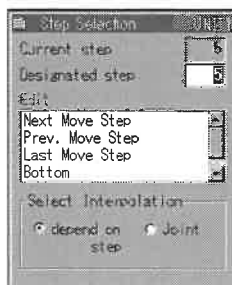
Robot Program				UNIT
0	100 X	JOINT AS	T1	
1	[START]			
2	100 X	JOINT AS	T1	
3	100 X	JOINT AS	T1	
4	200 cm/m	LTN AS	T1	
5	100 X	JOINT AS	T1	
[EOF]				

Recording step 6 (same position as for step 1)

Record the same position as for step 1 as step 6.

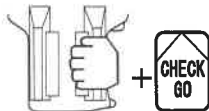


1 Press [PROG/STEP].
>> [Step Selection] screen appears.





- 2** Input "1" in "Designated step", and press [Enter].
 >> The cursor moves to step 1.



- 3** While grasping the [Deadman switch], press [CHECK GO]. (Keep pressing it until the robot stops.)
 >> The robot moves to the position recorded in step 1.

- 4** To record the position where the robot stopped (position in step 1) as step 6, designated step 5 is called.



- Press [PROG/STEP].
 >> [Step Selection] screen appears.



- 5** Select "Bottom", and press [Enter].
 >> The cursor moves to the last step (step 5).
 This is now the state in which step 6 can be recorded.



- 6** Since the conditions for step 5 are to be used as is, press [O.WRITE/REC].
 >> Step 6 is now recorded.

Recording the END command (End function command)

Since all the steps have now been recorded, record the END command at the end of the program. (The END command must be recorded without fail.)



- 1** Press f6 <END>.
 >> The END command is now recorded.



This now completes the creation of the program. Next, check the robot operations, postures, etc.



- 2** Teaching is finished, so press [CLAMP/ARC].
 >> Easy teach mode will end.

4.5.4 Try teaching using easy teaching (numeric keys)

In order operate the teaching of the operation program smoothly, teaching movement commands by using numeric keys became possible.

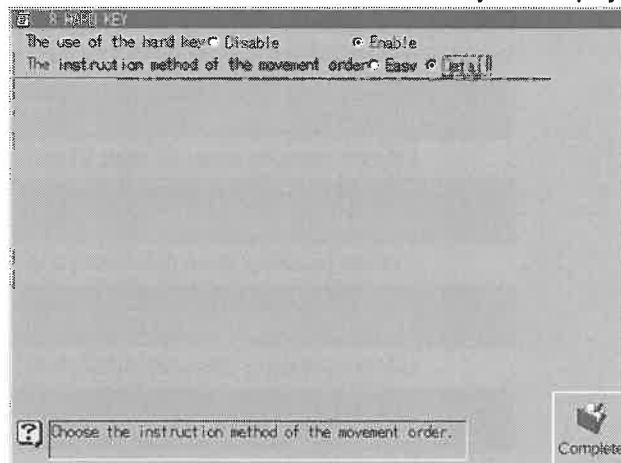
After the program number has been inputted and teaching is ready, confirm the next settings. By using the main commands to be assigned to the dedicated operation keys, teaching becomes possible with fewer operations.

Changing the use of the hard key, the operator needs to have the **Expert** or above qualification.

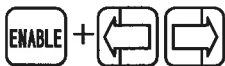
When the operator who has the qualification below **Expert** cannot change the setting but can reference the setting details.

Select the using of the hard keys

- 1 Press [Constant Setting] – [7 f-Keys] – [8 HARD KEY] .
>> The screen which is used to select for hard keys are displayed.



“The instruction method of the movement commands” is displayed when proceed “The use of the hard key” and then select “Enable”.



- 2 Align the cursor with the “The use of the hard key” or “The instruction method of the movement commands” and then press [ENABLE] and left or right cursor keys together.

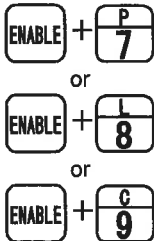
Select the “Enable” from the “The use of the hard key” and then choose any key from the “The instruction method of the movement commands”.



- 3 When all the conditions are set up, press f12<Complete>.
>> The use of the hard key is recorded.

Using the numeric key of movement commands by the setting of easy teaching

When the hard key setting is set at easy teaching, switching the interpolation type becomes possible by using keys, exclusive for this use. With the usage of the exclusive keys, the interpolation type displayed in the record status can be switched directly to the interpolation type correspondent to the exclusive keys.
 For example, for “4.5.2 Try teaching using normal teaching”, try to change the joint interpolation of step 3 (actual work start position) into the different interpolation type.



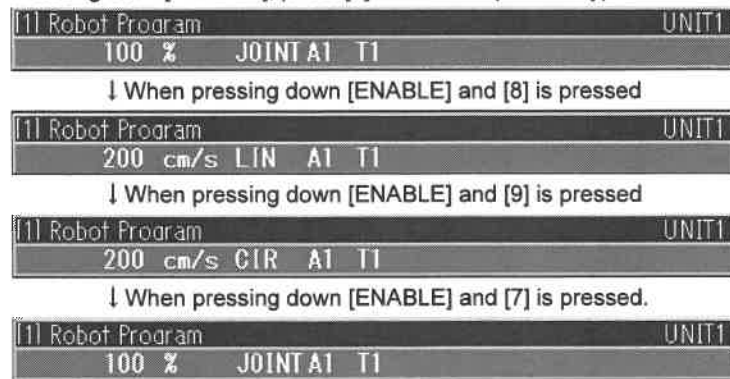
1 Pressing down [ENABLE], press the numeric key.

- >> The interpolation type which is displayed on the record status switches to the appropriate interpolation with the dedicated key.
- >> The dedicated keys have been assigned interpolation type as followings.

Pressing down [ENABLE], press [7] -> The interpolation type is switched into “JOINT”.

Pressing down [ENABLE], press [8] -> The interpolation type is switched into “LIN”.

Pressing down [ENABLE], press [9] -> The interpolation type is switched into “CIR”.

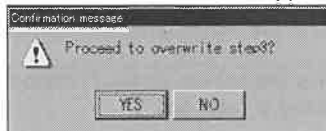


Now, try to change the joint interpolation (JOINT) into the linear interpolation (LINE). Pressing down [ENABLE], press [8] and then switch the interpolation type of record status to “LIN”.



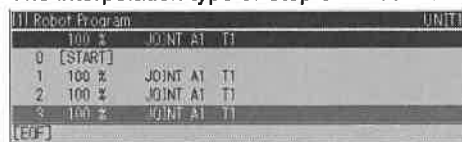
2 Pressing down [ENABLE], press [O.WRITE/REC].

- >> Confirmation screen will appear.



3 Select “YES” and press [Enter].

- >> The interpolation type of Step 3 will be modified and recorded.



Using the numeric key of movement commands by the setting of teach details

When the hard key setting is set at detailed teaching, use the numeric keys and shift to the teaching screen for movement command. There, by setting the parameter, teaching becomes possible with fewer operations.

Using “4.5.3 Try teaching using easy teaching”, the operating method with the dedicated key is described.

Using step 1 (work home point “JOINT”) teaching and step 4 (actual work end position “LIN”) teaching, try to perform the teaching.

Movements of robot and recording position comply with “4.5.3 Try teaching using easy teaching”.

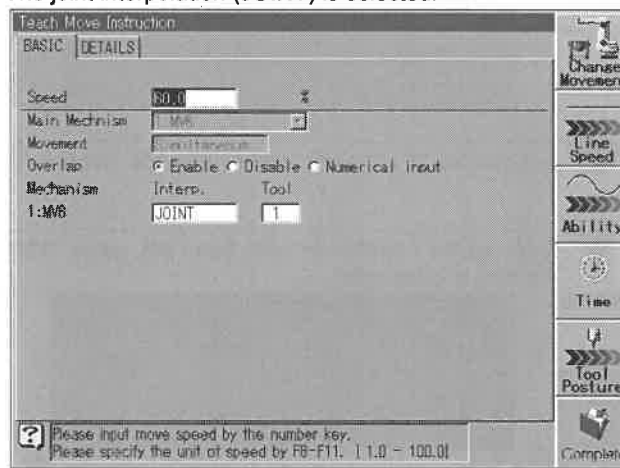
Using the dedicated key when recording step1 (work home point)



1 Movement to step 1 is set the “Joint interpolation”.

Pressing [ENABLE], press [7].

>> The joint interpolation (JOINT) is selected.



2 Set overlap to either Enable or Disable. Set the speed as well.



3 Once all the conditions have been set, press f12<Complete>.

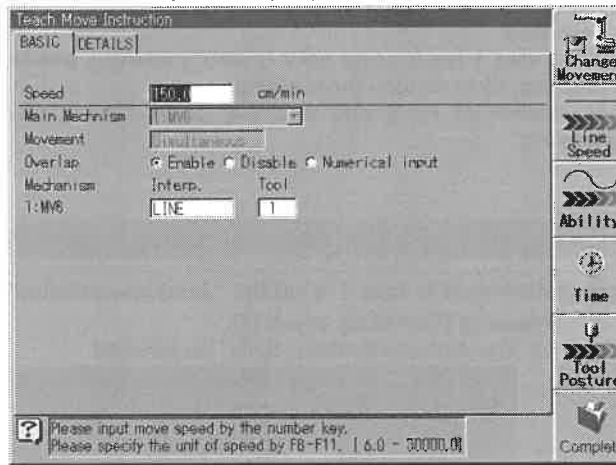
>> Step 1 is recorded.

Robot Program	UNIT
100 X JOINT A8 T1	
0 [START]	
1 100 X JOINT A8 T1	
[STOP]	

Using the numeric key when recording step 4 (actual work end position)



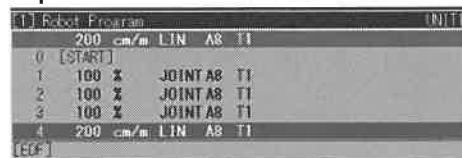
- 1** Movement step 4 is set at “Linear interpolation”. Pressing [ENABLE], press [8].
 >> The “Linear interpolation” (LIN) is selected.



- 2** Set overlap to either Enable or Disable. Set the speed as well.

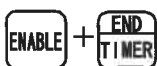


- 3** Once all the conditions have been set, press f12<Complete>.
 >> Step 4 is recorded.

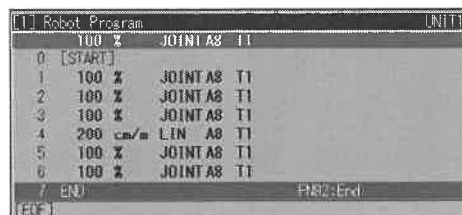


Using the End key when recording End command (function command)

The end command can be recorded with the end key. This operation can be done in either of the hard key settings; “Easy teaching” or “Detailed teaching”.



- 1** Pressing [ENABLE], press [END/Timer].
 >> End command is recorded.



4.6 Recording function commands

In order to operate the hand or gun attached to the robot wrist or capture signals that check the work, function commands (functions) are recorded at the appropriate positions in the program. Furthermore, in order to perform complicated work, other programs may be called or, depending on the status of the external signals, operation may jump to other programs. These are also recorded as function commands.

The function commands are expressed using a format based on SLIM (Standard Language for Industrial Manipulators) which is a robot language.

Alternatively, function commands can be specified using the "FN****" format where a 1- to 3-digit number is input into the "****" part (which is called a function number).

Some typical function commands are shown below.

Table 4.6.1 Typical function commands

Function Command (SLIM)	Function number	Title	Description of function
SET	FN32	Output signal ON	The specified output signal is set to ON.
RESET	FN34	Output signal OFF	The specified output signal is set to OFF.
DELAY	FN50	Timer	This causes the robot to stand by for the specified time.
CALLP	FN80	Program call	Another program which has been specified is called.
CALLPI	FN81	Conditional program call	When the specified signal is ON, another program is called.
END	FN92	END	The execution of the program is ended.
REM	FN99	Comment	This attaches a descriptive comment in the program.
WAITI	FN525	Input signal wait (positive logic)	This causes the robot to stand by until the specified signal is set to ON.
WAITJ	FN526	Input signal wait (negative logic)	This causes the robot to stand by until the specified signal is set to OFF.

4.6.1 Directly selecting a command with the function numbers

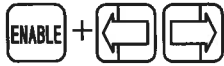
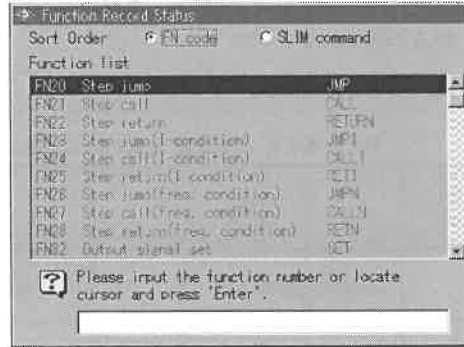
This section explains how to select function commands directly, using the function numbers.

Selecting function commands (How to directly select a command with the function numbers)

FN

1 Press **[FN]** at the position where the function command is to be recorded.

>> The list of function commands is now displayed.



2 The function commands can be rearranged in the order of function number or in alphabetical order using expressions in the SLIM format.
To select the sorting sequence, press **[left or right]** while holding down **[ENABLE]**.

3 Either select the function command from the list or input its function number, and press **[Enter]**.

4.6.2 Selecting from categorized groups

This section explains how to select function commands from categorized groups. This method is useful since it allows you to find the command you want to record from among categorized groups, even if you don't remember the function number.

To make a selection by group, it is necessary to have [Constant Setting] — [5 Operation Constants] — [1 Operation condition] — [11 Selection of a function] set to "Group". For Daihen customers, this is the initial setting for the robot.

Selecting function commands (When selecting from categorized groups)

FN

1 Press **[FN]** at the position where the function command is to be recorded.

>> The function groups will be displayed on the f keys.





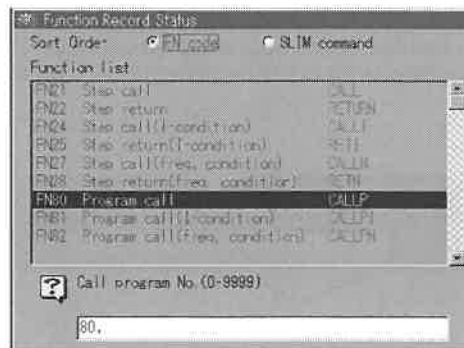
2 Selecting a program call (CALLP) is given here as an example.
Press f6 <Program/Step call>.

>> The function commands related to program calls and step calls will be displayed on the f keys. At the same time, the function commands being displayed in "Function Record Status" in the center of the screen will be narrowed down.



3 Press f9 <CALLP>.

>> The program call command is now selected.



It can also be selected using the following methods.

- Select from the list in the center of the screen using [Up/Down] [Enter].
- Input its function number, and press [Enter].

4.6.3 Setting and recording function command parameters (conditions)

This section describes how to input and record parameters (conditions) after the function commands have been selected.

Recording the output signal ON command (SET <FN32> function command) will be used here as an example.

Setting and recording function command parameters (conditions)

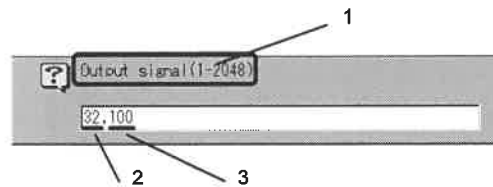
- 1 Either select the output signal ON command (SET) from the list or input its function number (FN32), and press [Enter].

>> The output signal ON command is now selected.



- 2 Input the number of the output signal using the [Number input keys].

The parameters which are to be set and their input ranges are displayed on the screen.



- 1 Name of parameter and its input range
- 2 Function number
- 3 Setting (in this case, 100 is set as the output number)



To correct input errors

To delete the wrong setting which has been input for a parameter, press [BS].



When there are 2 or more parameters

In the case of a function command with 2 or more parameters, input the first parameter, and then press [Enter]. Proceed to input the second and subsequent parameters.



- 3 Upon completion of the parameter settings, press [Enter].

>> The output signal ON command is now recorded.

4.7 Checking what has been taught

After the program has been created, be absolutely sure to check what has been taught.

This checking work is called the check operation. When the check operation is performed, the robot can be made to stop at each step so that its position and posture at each step, and the path of its movement between steps can be checked. If necessary, modifications can be made.

Use [CHECK GO] and [CHECK BACK] on the teach pendant for the check operation. "Check go" refers to moving the robot step by step starting with the lowest step number; "check back" refers to operating the robot starting with the highest step number.

The robot can also be moved through all the steps continuously.

Checking the step sequence [CHECK GO]

The operation of the program created in the previous section will be checked here. The screen that appears when teaching is completed should be the one shown below.

Robot Program				UNIT1
	100 %	JOINT A1	T1	
0	[START]			
1	100 %	JOINT A1	T1	
2	100 %	JOINT A1	T1	
3	100 %	JOINT A1	T1	
4	1200 mm/s	LIN	A1 T1	
5	100 %	JOINT A1	T1	
6	100 %	JOINT A1	T1	
7	END		PRG:End	
[EOF]				

If the created program has not been selected, select it using the method described in "4.2 Preparations prior to teaching" (Page 4-2).



- 1 Press [PROG/STEP] in order to call the step which is to be checked first.
>> The [Step Selection] screen now appears.



- 2 Input [0] in "Designated step", and press [Enter].
>> The cursor moves to step 0 ([START]).

Robot Program				UNIT1
	100 %	JOINT A1	T1	
0	[START]			
1	100 %	JOINT A1	T1	

POINT

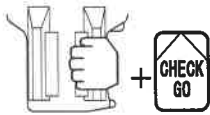
To check from the start of the program, specify "0" as the Designated step.



- 3 To specify the speed to be used during the check operation, press [CHECK SPD/TEACH SPEED] while holding down [ENABLE]. Here, select "3" to ensure safety.

>> Each time the [CHECK SPD/TEACH SPEED] key is pressed, the speed changes in sequence to the next of the 5 settings. "1" is the slowest speed, and "5" is the fastest.





4 Press [CHECK GO] while grasping the [Deadman switch].

>> While [CHECK GO] is pressed, the robot starts moving toward step 1, and when it reaches step 1, it stops.

1. Robot Program		UNIT1
100 %	JOINT A1 T2	
0 [START]		
1 100 %	JOINT A1 T1	
2 100 %	JOINT A1 T1	

When the step is reached, the display turns yellow.

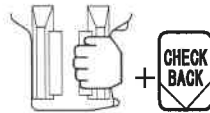
When [CHECK GO] is released while the robot is moving, the robot stops. The robot also stops when the deadman switch is released during operation. However, in this case, the servo power is turned off immediately without the acceleration or deceleration applying a heavy load to the mechanisms. Before releasing the deadman switch, try to remember to release [CHECK GO] and wait for the robot to come to a standstill.

5 To move to step 2, first release [CHECK GO] and then press it again.

Check up to the final step by repeating these operations. When the final step is reached, the robot operates again from step 1.

Checking the steps in the reverse order [CHECK BACK]

The robot can also be operated in the reverse order of the steps.



1 [Press [CHECK BACK] while grasping the [Deadman switch].

>> The robot now moves in the reverse order of the steps. When step 1 is reached by [CHECK BACK], the robot operates no further. (Check back cannot be performed to the final step.)

2 The operation method after the speed has been switched or robot has stopped at a step, etc. are the same as for check go.

The robot also stops when the deadman switch is released during operation. However, in this case, the servo power is turned off immediately without the acceleration or deceleration applying a heavy load to the mechanisms. Before releasing the deadman switch, try to remember to release [CHECK BACK] and wait for the robot to come to a standstill.

Checking the steps continuously

The robot can be operated continuously step by step by holding down [CHECK GO] or [CHECK BACK].

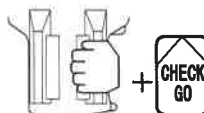
When the continuous mode is specified, the robot passes along an arc on the inside of the recorded points, reflecting the accuracy levels taught at each step.



1 Press [STOP/CONT].

>> "CONT" is displayed in the [Step number display area].

Teach	Program	Step	7/11/2003 11:34
1 [EX]	7 [CONT]		



2 Perform the check go/back operation. Hold down the [CHECK GO] or [CHECK BACK] key.

>> The robot operates continuously step by step.



3 To release the continuous mode, press [STOP/CONT] again.

Switching the continuous/step mode during check Go operation

The continuous mode can be switched to the step mode and vice versa by pressing down [ENABLE] while pressing [CHECK GO].

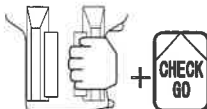
While pressing the [ENABLE], the display is shown to switch from the continuous mode to the step mode and conversely, therefore Check Go is operated following the mode which is switched.

When the continuous mode



- 1 Press the [STOP/CONT].
>> "CONT" is displayed in the [Step number display area].

Teach	Program	Step	4/23/2008 15:23
Motors	1 [EX]	7 [CONT]	



- 2 Perform the check Go operation. Press down the [CHECK GO].
>> The robot operates continuously step by step.



- 3 Pressing down the [ENABLE] while check Go operation, switching from the continuous mode into the step mode.

>> While this time, the screen switches from "CONT" into "BREAK".

While this "step" is displayed, check Go is considered as the completion when the current step has been completed as the same check Go of "BREAK" mode.

When the completion of check Go, the screen returns "CONT" from "BREAK".



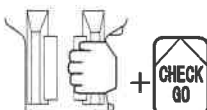
- 4 To release the step mode, release the [ENABLE].
Or release the [CHECK GO].
>> When the mode has completed to release, the screen switches "CONT" from "BREAK".

When the step mode



- 1 Press [Stop/Cont].
>> Nothing has been displayed in the [Step number display area] as "[]".

Teach	Program	Step	4/23/2008 15:23
Motors	1 [EX]	7	



- 2 Perform the check Go operation. Pressing down the [CHECK GO].
>> The robot operates step toward the next step.



- 3 Pressing down the [ENABLE] while playback, switching from the step mode into the continuous mode.

>> While this time, the screen switches from "[]" into "CONT".

While this "CONT" is displayed, check Go is considered as the completion when the final step has been completed, and the robot operates continuously step by step as the same check Go of the continuously mode.

When the completion of check Go, the screen returns "[]" from "CONT".



- 4 To release the continuous mode, release the [ENABLE].
Or release the [CHECK GO].
>> When the mode has completed to release, the screen returns "[]" from "CONT".

Jump to the Specified Step [Step Jump]

When you want to move to a specified step, press [PROG/STEP] and specify the number of the step to which you want to move.

However, when you move the robot using [CHECK GO] operation after specifying the step, always be sure to specify a move command step. You can specify an function command step and only move the cursor, but an error will occur when you do [CHECK GO].



- 1 Press [PROG/STEP].
 >> [Step Selection] screen appears.



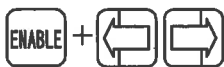
- 2 When designating the number of the step, input the number of the step in "Designated step", and press [Enter].
 >> The cursor moves to the step which has been designated.



- 3 When you move relatively from the current step, without specifying a step number, specify the jump destination in the "Edit" column.
 >> The cursor moves to the step which has been designated.

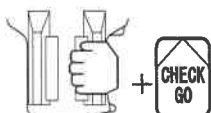
You can select from among the following items.

Movement destination	Movements of the cursor
Next Move Step	Move from the current step to the next move step (skip function command steps).
Prev. Move Step	Move from the current step to the previous move step (skip function command steps).
Last Move Step	Move to the last move step in the program.
Bottom	Move to the last step in the program.
Copy	Call the step copy function. This is the same as selecting <Service Utilities> — [9 Program Conversion] — [2 Step copy].



- 4 "Select Interpolation" specifies the operation method when moving to a step. Before inputting a step number, you can switch using [LEFT/RIGHT] while holding down [ENABLE].

Movement format	Movements of the robot
depend on step	At the time of a check operation to the specified step, operation is done according to the interpolation classification of the target step. For example, when the target step is "LIN", movement is done using linear interpolation.
Joint	At the time of check operation to the specified step, movement is done using joint interpolation.










- 5 While grasping the [Deadman switch], press [CHECK GO].
 >> The robot moves as far as the designated step.

4.8 Modifying the program

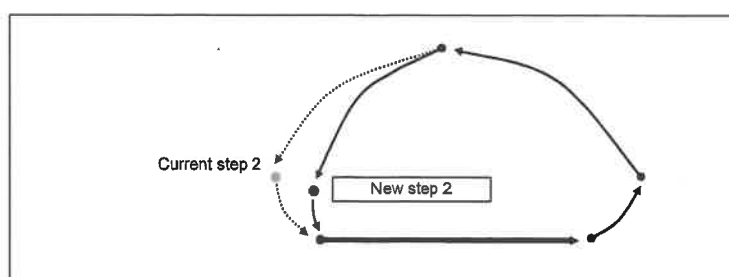
This section describes how to modify the commands which have been recorded in the program. The commands can be modified in a number of ways as follows.

Table 4.8.1 How to change the steps

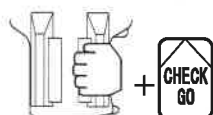
Description of modification	Operation method	Reference page	
Movement command modification	Modifying the position only	[ENABLE] + [MOD Position]	 Page 4-47
	Modifying the speed only (NACHI)	[SPD]	 Page 4-48
	Modifying the accuracy Only (NACHI)	[ACC]	
	Modifying everything together (Movement command overwriting)	[ENABLE] + [O.WRITE/REC] ※ Use this method to modify the interpolation type, tool number, etc. since they cannot be modified separately.	 Page 4-49
Adding movement commands	[ENABLE] + [INS]	 Page 4-53	
Adding function commands	This is added automatically with the same method as in new teaching. It is added at the same position as the move command.		
Deleting movement commands and function commands	[ENABLE] + [DEL]	 Page 4-57	
Using the screen editing function to modify commands	[EDIT] ※ The parameters of the function commands cannot be modified in the teach screen. Use the screen editing function to modify commands.	 Page 4-58	

4.8.1 Modifying the robot position

Try changing the position of step 2 in the program such as the following.




Modifying the robot position

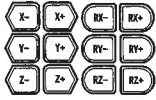


 Move the robot to step 2 using [CHECK GO] (or [CHECK BACK]).



Alternatively, the step may be called.

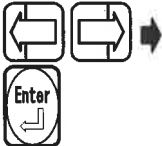
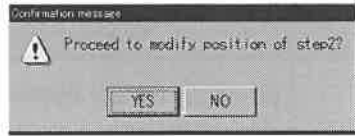
An alternative to the operation in  is to call step 2 by selecting [PROG/STEP] → [2] → [Enter]. In this case, however, what happens is that only the display moves and the robot fails to move to step 2. To move the robot, designate the step and then press [CHECK GO].



2 Use the [Axis operation keys] to operate the robot manually to set it to the position and posture to which they are to be changed.



3 Select "YES", and press [Enter].
 >> The position is now modified.



4 Select "YES", and press [Enter].
 >> The position is now modified.

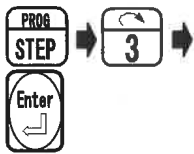
This completes the modification of the step 2 position.

4.8.2 Modifying movement command data —For NACHI Nachi users only—

The speed and accuracy recorded in a movement command can be modified separately without changing the position data of the robot. This method can be used only by Nachi users. Daihen users cannot use this method to revise data. Overwrite the movement command or use screen editing.

Modifying the speed and accuracy in step 3 is given here as an example.

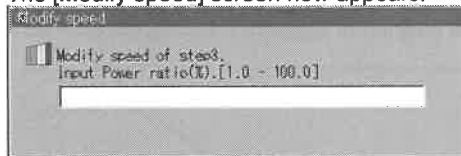
Modifying movement command data



1 Press [PROG/STEP] → [3] → [Enter].
 >> The cursor moves to step 3.



2 To change the speed, press [SPD].
 >> The [Modify speed] screen now appears.



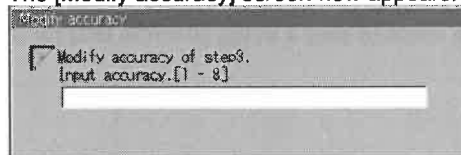
3 Use the [Number input keys] to input the value.



4 Press [Enter].
 >> The new specified speed is recorded.



5 To change the accuracy, press [ACC].
 >> The [Modify accuracy] screen now appears.



6 Press [Enter].
 >> The new specified accuracy is recorded.
 This completes the modification of the step 3 speed and accuracy.

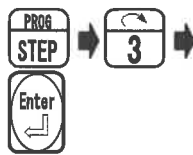
4.8.3 Overwriting movement commands

Steps can also be overwritten.

When a step has been overwritten, all the data including the position of the robot, its speed and interpolation type is modified.

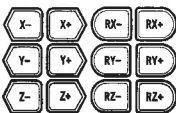
Changing joint interpolation in step 3 to linear interpolation is given here as an example.

Overwriting movement commands— For NACHI users —



1 Press [PROG/STEP] → [3] → [Enter].

>> The cursor moves to step 3.



2 To change the position, use the [Axis operation keys] to operate the robot manually.



3 While holding down [ENABLE], press [INTERP/COORD], and set the interpolation specification of the recording status to linear interpolation. ("LIN" is displayed for the recording status.)

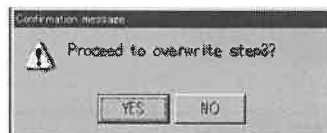


4 Press [CHECK SPD/TEACH SPEED], and set the speed to the appropriate level.



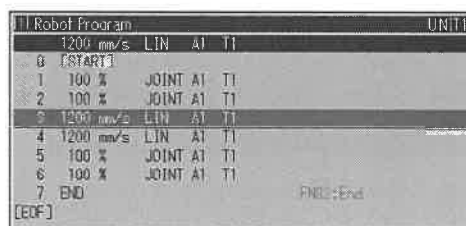
5 While holding down [ENABLE], press [O.WRITE/REC].

>> A confirmation screen now appears.



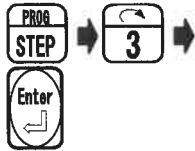
6 Select "YES", and press [Enter].

>> The step is overwritten.

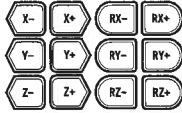


Overwriting movement commands – For **DAHEN uses –**

Changing joint interpolation in step 3 to linear interpolation is given here as an example.



- 1 Press **[PROG/STEP]** **[3]** **[Enter]**.
 >> The cursor moves to step 3.



- 2 To change the position, use the **[Axis operation keys]** to operate the robot manually.

In the case of normal teaching



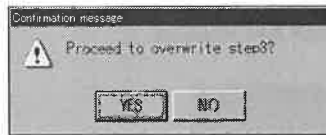
- 3 While holding down **[ENABLE]**, press **[INTERP/COORD]**, and set the interpolation specification of the recording status to linear interpolation. (“LIN” is displayed for the recording status.)



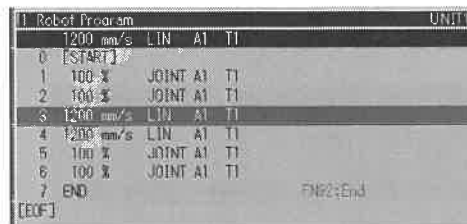
- 4 After pressing **[SPD]**, input the appropriate values.



- 5 While holding down **[ENABLE]**, press **[O.WRITE/REC]**.
 >> A confirmation screen now appears.



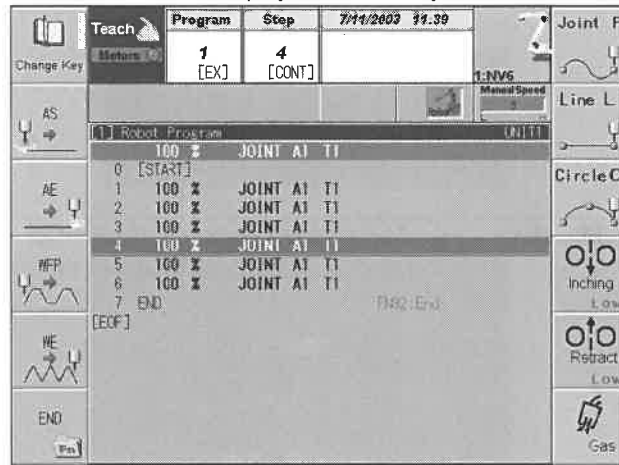
- 6 Select “**YES**”, and press **[Enter]**.
 >> The step is overwritten.



In the case of easy teaching (f key)

CLAMP
ARC

- 7 Press [CLAMP/ARC].
 >> The commands are displayed on the f keys.

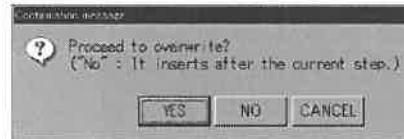


- 8 Press f8 <Line L>.
 >> Linear interpolation (LINE) is now selected.

- 9 Set the speed and whether to turn overlap on or off.



- 10 Once all the conditions have been set, press f12 <Complete>.
 >> A message confirming whether to overwrite or add will be displayed.



- 11 Select "YES", and press [Enter] to overwrite.
 >> The command is now overwritten.

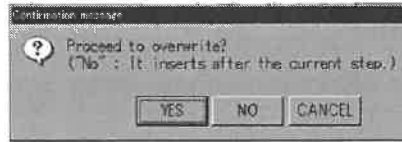
In the case of easy teaching (numeric keys)

Here, the procedures of operating the robot by detailed teaching will be explained.

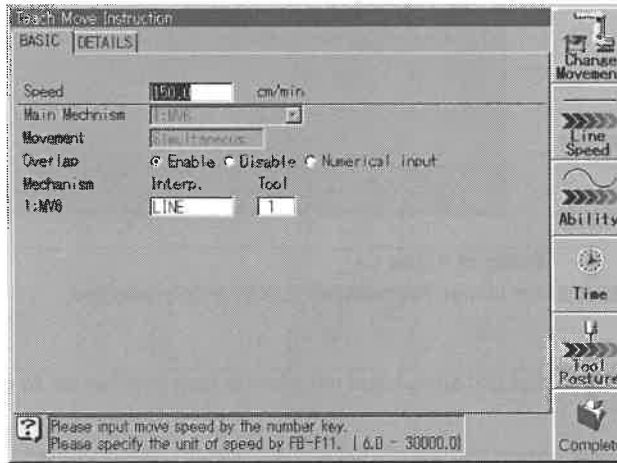


12 Holding down the [ENABLE] and press [8].

>> Confirmation message screen appears "Proceed to overwrite?"
Press "YES" to overwrite.

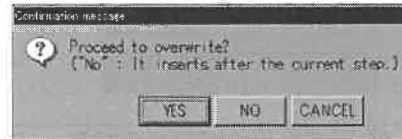


13 Set the speed and whether or not to do overlap.



14 Once all the conditions have been set, press the f12<Complete> .

>> Confirmation message screen appears "Proceed to overwrite?"

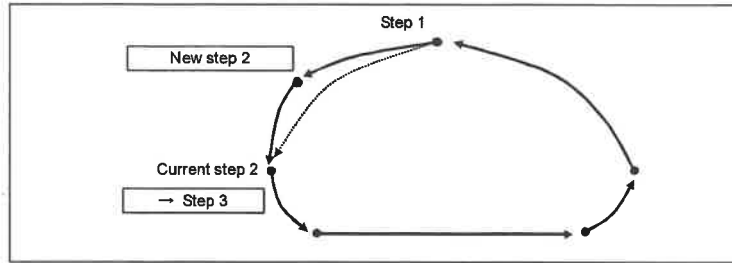


15 Select "Yes" and then press the [Enter] to overwrite.

>> The command is overwritten.

4.8.4 Adding movement commands

Using the following work program as an example, a new step will now be added between steps 1 and 2

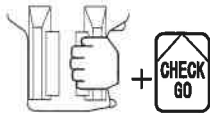


The position where the command is added differs depending on whether the user is operating a Nachi or Daihen robot. The position where the new step is added is “before the current step” for Nachi users and “after the current step” for Daihen users.

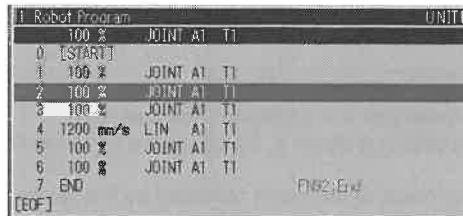


The position at which the command is added is set by [Constant Setting] — [5 Operation Constants] — [1 Operation Condition] — [7 Step insertion position], so you can change it. However, you must be **Expert** level or above to make changes.

Adding movement commands —For NACHI users—



- 1 **Move the robot to step 2 using [CHECK GO] (or [CHECK BACK]).**
To add a step, move to the step before which the new step is to be added. When the cursor is advanced in this way, the new step will be added before step 2.

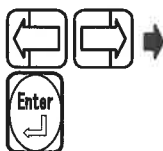


- 2 **Use the [Axis operation keys] to operate the robot manually, and set the robot to the position and posture to be added.**

- 3 **Set the speed and interpolation classification using the same method as when doing new teaching.**

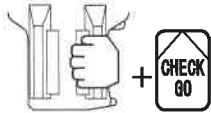


- 4 **While holding down [ENABLE], press [INS].**
>> A confirmation screen now appears.



- 5 **Select “YES”, and press [Enter].**
>> This completes the addition of the new step. All the previous steps 2, 3 and up are incremented by one to become steps 3, 4 and up. The numbers of the steps recorded as the parameters of jump/call and other function commands are automatically modified at this time.

Adding movement commands – For **DAIHEN users –**



- 1** Move the robot to step 1 using [CHECK GO] (or [CHECK BACK]).
To add a step, move to the step before which the new step is to be added.
When the cursor is advanced in this way, the new step will be added after step 1.



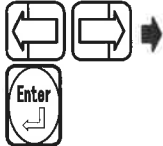
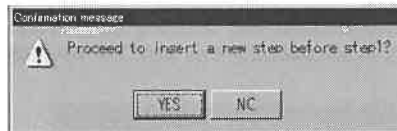
- 2** Use the [Axis operation keys] to operate the robot manually, and set the robot to the position and posture to be added.

In the case of normal teaching

- 3** Set the speed and interpolation classification using the same method as when doing new teaching.



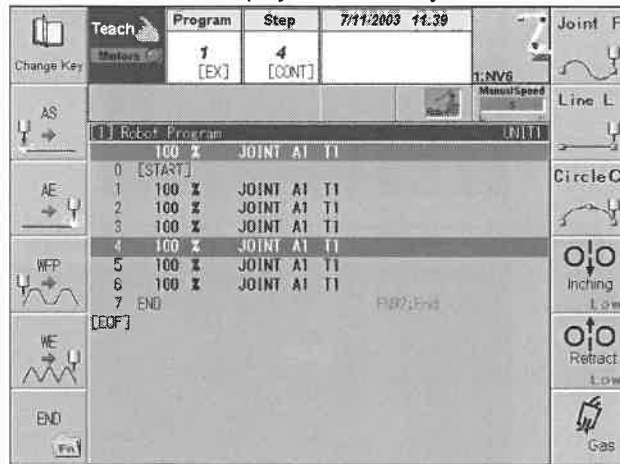
- 4** While holding down [ENABLE], press [INS].
>> A confirmation screen now appears.



- 5** Select "YES", and press [Enter].
>> This completes the addition of the new step.
All the previous steps 2, 3 and up are incremented by one to become steps 3, 4 and up.
The numbers of the steps recorded as the parameters of jump/call and other function commands are automatically modified at this time.

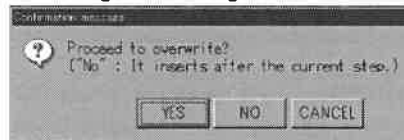
In the case of easy teaching(f keys)**CLAMP
ARC**

- 6** Press [CLAMP/ARC].
 >> The commands are displayed on the f keys.

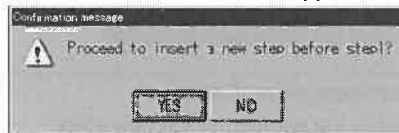


- 7** Select a command.
8 Set the speed and whether to turn overlap on or off.

- 9** Once all the conditions have been set, press f12 <Complete>.
 >> A message confirming whether to overwrite or add will be displayed.



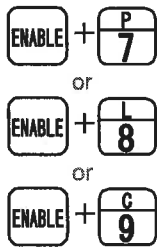
- 10** To add, select "NO" and press [Enter].
 >> A confirmation screen now appears.



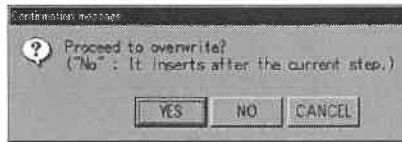
- 11** [Select "YES", and press [Enter].
 >> This completes the addition of the new step.
 All the previous steps 2, 3 and up are incremented by one to become steps 3, 4 and up.
 The numbers of the steps recorded as the parameters of jump/call and other function commands are automatically modified at this time.

In the case of easy teaching (Numeric keys)

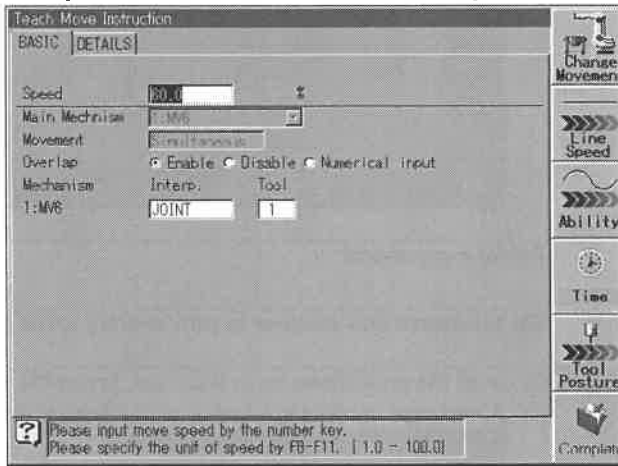
Here, the procedures of operating the robot by detailed teaching will be explained.



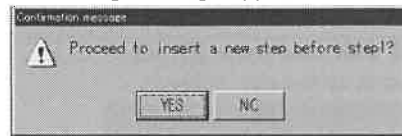
- 12** Holding down the [ENABLE] proceed [7] and [8] then [9]. Select the command.
 >> Confirmation message appears "Proceed to overwrite?"
 Select "No" to be add.



- 13** Set the speed and whether or not to do overlap.



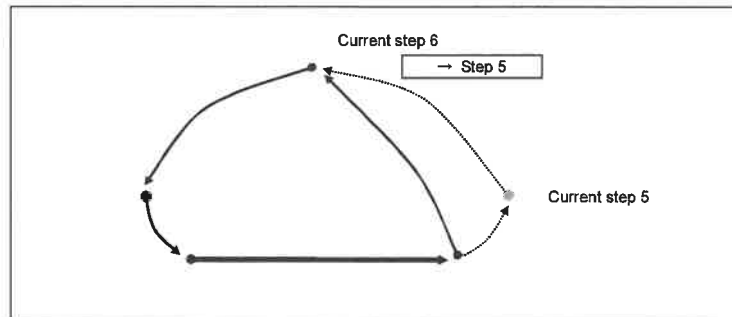
- 14** Once all the conditions have been set, press f12 <Complete>.
 >> Confirming message appears "Proceed to insert a new step before step1?".



- 15** Select "Yes" and press the [Enter].
 >> This completes the addition of the new step.
 All the previous step2, 3 and up are incremented by one to become step 3, 4 and up.
 The number of the steps recorded as the parameters of jump/call and other function commands are automatically modified at this time.

4.8.5 Deleting movement and function commands

Using the following work program as an example, step 5 will be deleted here.



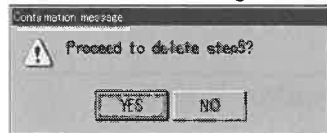
Deleting movement and function commands



- 1 Press [PROG/STEP] → [5] → [Enter].
>> The cursor moves to step 5.



- 2 While holding down [ENABLE], press [DEL].
>> A confirmation message now appears.



- 3 Select "YES", and press [Enter].
>> This completes the deletion of step 5.
The previous step 6 is decremented by one to become step 5.
The numbers of the steps recorded as the parameters of jump/call and other function commands are automatically modified at this time.

4.9 Using the screen editor function to modify commands

All the data recorded in the program can easily be modified using the screen editor function. The screen editor function can be selected not only in the teach mode but also when step playback has been selected even in the playback mode.

The operations which can be performed using the screen editor function are listed below.

Table 4.9.1 Operations which can be performed using the screen editor function

Operation	Details
Data modification	All the data (such as the speed, interpolation type and position data) recorded for movement commands can be modified. (To correct position data, you must be Expert level or above.) Further, the data recorded for function commands can also be modified.
File Copy	One line or several lines can be copied and inserted into another position.
Cut	One line or several lines can be deleted.
Paste	The copied or deleted line or lines are inserted at another position.
Function command insertion, replacement	An function command can be inserted at any position. In addition, an function command can be changed into another function command.
Function command search	Function commands can be searched.
Screen Separation	The screen can be divided into the top half and bottom half.
Batch changing of the speed	The speed of MOVE command set in two or more lines can be batch changed.

4.9.1 Modifying with the screen editor function

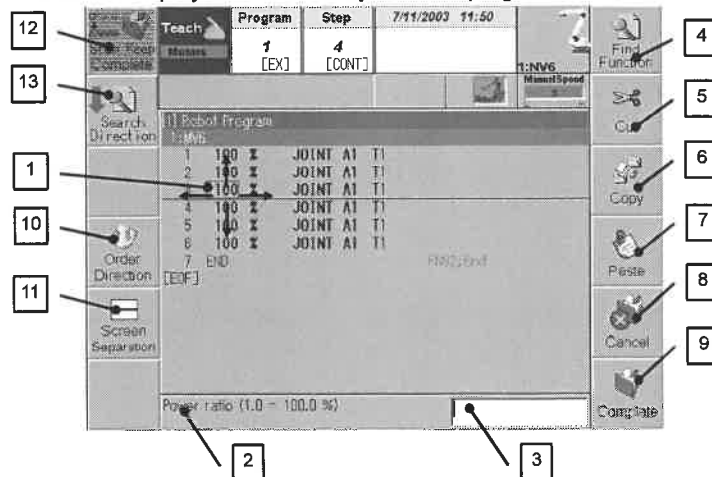
This section describes how to select and modify the screen editor function.

Selecting the screen editor function



- 1 In the teach mode or when step playback has been selected in the playback mode, press [EDIT].

>> The screen display for the currently selected program is now switched.



- 1 **Cursor**
The cursor can be moved to the data.
- 2 **Description of data**
A description of the data at the cursor position and the range of the values in which the data can be input are displayed here.
- 3 **Input field**
To change the data at the cursor position, input the new value here, and press [Enter].
- 4 **Find Function**
This is used to search the function commands.
- 5 **Cut**
This is used to cut (delete) the selected line or lines. The cut line or lines can be inserted at any position using "Paste".
- 6 **Copy**
This is used to copy the selected line or lines. The copied line or lines can be inserted at any position using "Paste".
- 7 **Paste**
This is used to insert the cut or copied line or lines at any position. They cannot be pasted to other programs.
- 8 **Cancel**
This is used to terminate program editing without reflecting the modifications made.
It is also used to cancel a cut or copy operation at any point.
[RESET/R] also has the same functions.
- 9 **Complete**
This is used to save the modification results and terminate the program editing.
- 10 **Other Direction**
This is used to select the direction during pasting.
When "reverse direction" is selected, the order of the data in the cut or copied lines is reversed, and the data is pasted in this reverse order.
- 11 **Screen Separation**
This is used to divide the screen into the top half and bottom half.
Use [CLOSE/SELECT SCREEN] to select the half of the screen where operations are to be performed.
- 12 **Step Keep**
Normally, when screen editing ends, it automatically returns to the step it was at prior to starting screen editing. If you press this key while holding down [ENABLE], it will stay at the step it was at in screen editing when it returns to the program screen (write is also done). This is useful in cases such as when you found a step in screen editing that can be an indicator for Check GO and Check BACK operations.
However, in such cases, the displayed step will differ from the actual robot step. Therefore, you need to be careful when doing Check GO and Check BACK operations after that.
- 13 **Search Direction**
Switch the search direction between up and down.

-
- 2** Move the cursor to the desired position, input the new numerical value in the “Input” field in response to the guide message displayed in the “Description of data” field, and press [Enter].
- >> The contents of the program directory now change to the new number that was input. At this time, the program contents are not rewritten.



OR



-
- 3** To reflect the changes, press f12 <Complete> or press the [EDIT] key again.
- >> The program contents are updated, the screen editor function is exited, and the original screen is restored.

To quit the function without reflecting the changes, press the [RESET/R] key.

4.9.2 Batch changing the speed of MOVE command

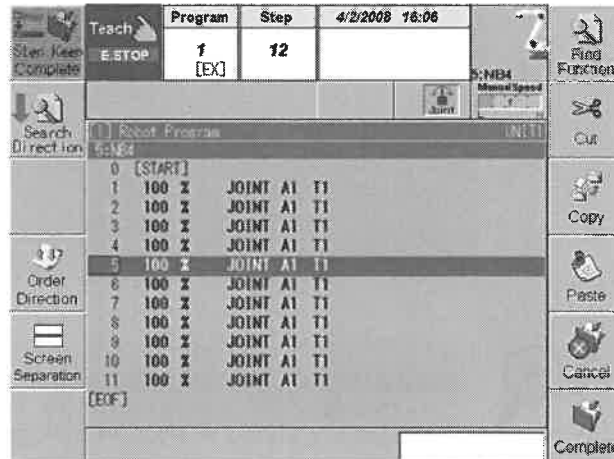
The speed of MOVE command set in two or more lines can be batch changed while performing the screen edit.

Batch changing the speed of MOVE command



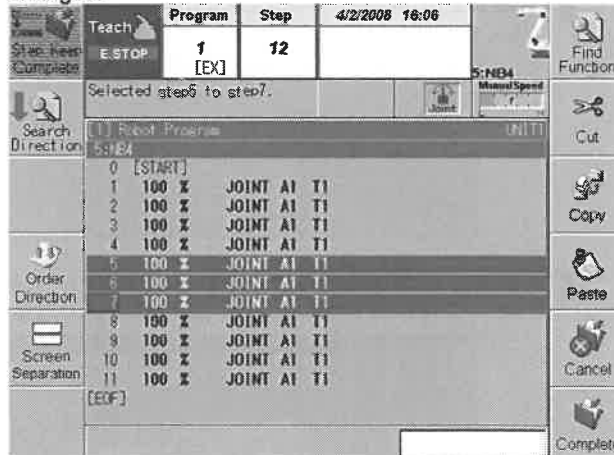
1 Press [SPD] with holding [ENABLE].

>> The currently appeared cursor is highlighted as a speed batch change start step.



2 Press [Up/Down].

>> The highlighted line(s) can be adjusted as a range of the target steps to make changes.



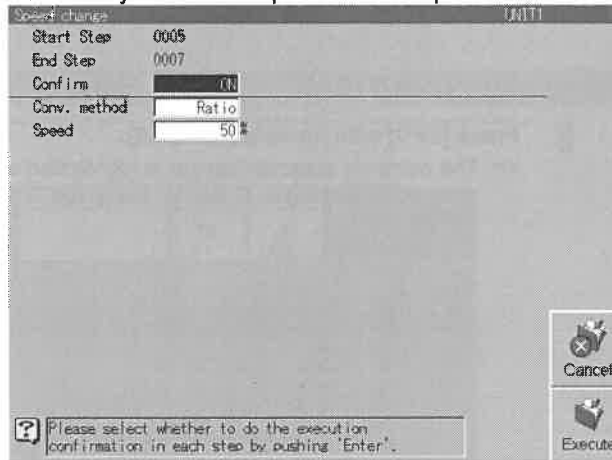
3 To cancel selecting a target step, press [Cancel] or [RESET/R] key.

>> The highlighted lines are restored.

SPD

4 Press [SPD].

>> The display changes to the "Speed change" screen. The range of speed change is indicated by the "Start Step" and "End Step".



Without the range selecting operation

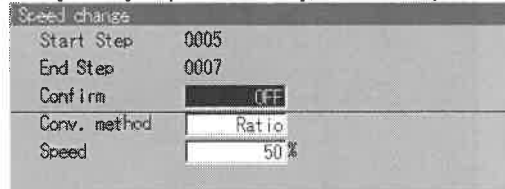
If pressing [SPD] without specifying the range for change-target steps ([ENABLE] + [SPD]), all steps are to be targeted.

5 Refer to Table 4.9.2, and set the conditions for batch changing.

Enter

6 To set "Confirm", align the cursor on it and press [Enter].

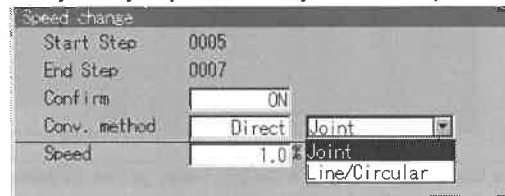
>> Every time you press this key, the status (ON/OFF) is switched.



Enter

7 To set "Conv. method", align the cursor on it and press [Enter].

>> Every time you press this key, the status (Ratio/Direct) is switched.



When switched to "Direct", the pull-down list for the interpolation type appears on the right side.

If pressing [Enter] as moving to the pull-down list, alternatives (Joint/Line/Circular) are displayed. Then, select an appropriate interpolation type with [Up/Down] key.



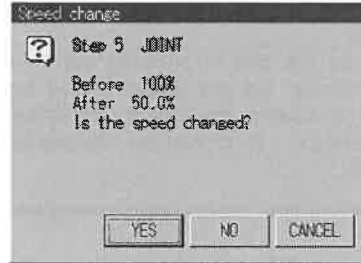
8 To set "Speed", align the cursor on it, enter the speed value, and press [Enter]



- 9 **Press f12 <Execute>.**
>> Now, the speed batch change starts.

If "Confirm" has been set to OFF, the screen-editor window is restored after executing the speed batch change.

If "Confirm" has been set to ON, on the other hand, the screen as below appears.



Button	Action
[YES]	The speed of the indicated step is changed, proceeding to "Confirm" in the next step. After changing the speed in the last step, the screen-editor window is restored.
[NO]	The speed of the indicated step is not changed, proceeding to "Confirm" in the next step. After changing the speed in the last step, the screen-editor window is restored.
[CANCEL]	The speed change is aborted for the indicated step and after, and then the speed batch change screen is restored.



- 10 **To reflect the change just made, restore the screen-editor window and press f12 <Complete> or [EDIT].**
>> Then, the program is updated, the screen editor function finishes to restore the original screen.



- 11 **If not to reflect the change, restore the screen-editor window, and press [RESET].**

Table 4.9.2 Condition settings for the speed batch changing

Condition parameter	Setting range	Meanings	Default
Confirm	ON	Pressing f12 <Execute>, the "Confirm" message appears by every step, which enables to select ON/OFF/Cancel.	ON
	OFF	All steps from the start step to the end step are batch changed without any confirming action.	
Conv. method	Ratio	Designates the ratio (%) to the current record speed for changing. (Example: To make the speed half, designate 50%.) All steps are the targets for change.	Ratio
	Direct : Joint	Designate the speed only for the step of which interpolation type is "Joint". The step of "Line/Circular" is not changed.	
	Direct : Line/Circular	Designate the speed only for the step of which interpolation type is "Line/Circular". The step of "Joint" is not changed.	

Condition parameter	Setting range	Meanings	Default
Speed	Ratio	0~200%	50%
	Direct : Joint	Use the unit in entering the value specified in "Joint Interpolation" on the record speed screen. The screen appears by proceeding to f5<Constant Setting> - [5 Operation Constants] - [4 Record Speed].	Minimum value within the available range
	Direct : Line/Circular	Use the unit in entering the value specified in "Line/Circular" on the record speed screen. The screen appears by proceeding to f5<Constant Setting> - [5 Operation Constants] - [4 Record Speed].	

**IMPORTANT**

In the step with the multi-mechanism configuration, the target step will be the one of which interpolation type agrees with that of the speed-based mechanism. And only the speed of that mechanism within the step is to be changed.

Chapter 5 Auto operation (playback)

This chapter described how to automatically run (playback) the programs that have been created.

5.1 Before starting auto operation.....	5-1
5.1.1 Methods of starting automatic operation	5-1
5.1.2 Notations used for automatic operation.....	5-2
5.1.3 Playback methods (5 operation modes).....	5-2
5.1.4 Specifying the step which playback starts.....	5-3
5.1.5 Operating speed when the start step is specified.....	5-3
5.2 Performing automatic operation (playback) — Internal start method —	5-4
5.3 Performing automatic operation (playback) —External start method—	5-5
5.4 Performing automatic operation (playback)—Multi-station start method—	5-7
5.5 Operations in different operation modes	5-11

5.1 Before starting auto operation

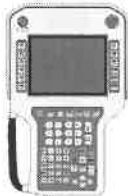
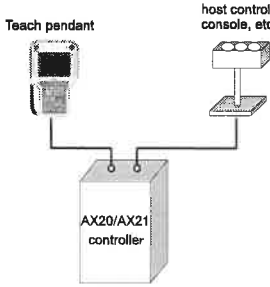
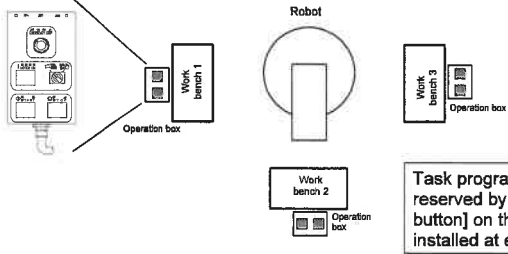
This section describes the basic knowledge required to perform auto operation.

5.1.1 Methods of starting automatic operation

Automatic operation can be started up using the following methods. Normally, the method used to start automatic operation is set prior to shipment from the factory or prior to delivery to correspond with the user's specifications.

The operation method for automatic operation differs according to the start method used. Read through the section of the following explanation that corresponds to the method used by the user to start automatic operation.

Table 5.1.1 Start method







Start method	Details
Internal start	<p>This is the method that runs the program selected by the Teach Pendant as is. Start and stop are performed using the operation panel for the AX20 controller and the operation box (Station 1) for the AX21 controller.</p> <div data-bbox="874 808 1189 1003">  <p>Run the program selected by the Teach Pendant.</p> </div>
External start	<p>The series of tasks relating to automatic operation including start, program selection and stop are input from an external device such as a host controller or control console that is readily accessible to the operator.</p> <div data-bbox="799 1106 1286 1391">  <p>The start input and program number input are initiated from the external source.</p> </div> <p>In this case, the start signal and program select signal from the external device must be set ahead of time so that they will be input to the basic input signal "external start" and "program select bits" of the AX20/AX21 controller. In addition, the signal reading method (binary, discrete or BCD) must be specified. For further details, refer to the Installation Manual part of the operating instructions.</p>
Multi-station Start	<p>This system starts and reserves the task programs by pressing the start button on the operation box or start box installed at each station. It is supported only by the AX21 controller.</p> <p>The programs to be started are allocated ahead of time for each station. (The teach pendant is used for the allocation.)</p> <div data-bbox="699 1727 1369 1980">  <p>Task programs are started or reserved by pressing the [Start button] on the operation box installed at each station.</p> </div>

5.1.2 Notations used for automatic operation

When doing automatic operation (playback) either with an internal start or station start, the [Motor power ON] button, [Start button] button and [Stop button] are used.

These buttons are on the operation panel on the front of the controller for the AX20 controller. For the AX21 controller, they are on the operation box (station 1) and startup box (stations 2 and beyond).

Table 5.1.2 Buttons needed for automatic operation (playback)

Installation location Button (Notations in this chapter)	AX20 controller	AX21 controller	
	Operation panel	Operation box (Station 1)	Start box (Station 2 onward)
[Motor power ON button]			None
[Start button]			
[Stop button]			

5.1.3 Playback methods (5 operation modes)

There are five operation modes for the playback methods. One of these modes is selected prior to playback, but the mode can also be selected during playback.

Either "Cycle" or "Continuous" is selected during actual operations. All the other modes are selected when checking what has been taught or when trying out an auto operation.

Table 5.1.3 Playback methods

Playback methods	Details
Step	<ul style="list-style-type: none"> While the [Start button] is held down, one step of the program is executed. (When it is released, the robot stops.) To advance to the next step, press the [Start button] again.
Cycle	<ul style="list-style-type: none"> When the [Start button] is pressed once, the program is executed once from start to end. When the last step is reached, the robot stops.
Cycle step by step	<ul style="list-style-type: none"> When the [Start button] is pressed, one step of the program is executed, and the robot stops. To advance to the next step, press [ENABLE] + f8 <Step by Step>. When the last step is reached, the robot stops.
Continue	<ul style="list-style-type: none"> When the [Start button] is pressed, the program is executed repeatedly.
Continuous step by step	<ul style="list-style-type: none"> When the [Start button] is pressed, one step of the program is executed, and the robot stops. To advance to the next step, press [ENABLE] + f8 <Step by Step>. When the last step is reached, operation returns to the first step, and the program is executed again.

5.1.4 Specifying the step which playback starts

Where playback is to start can be specified at any step from the teach pendant. (When the program has just been selected, the program start—namely, step 0—is automatically specified.) However, instances in which the step can be specified are the following.

Table 5.1.4 Specifying the step from which playback starts

Start method	First startup after program selection	Startup after a stop
Internal start	Step specification enabled	Step specification enabled
Ext. play start.	Step specification disabled	Step specification enabled
Multi-station start	Step specification disabled	Step specification enabled

5.1.5 Operating speed when the start step is specified

When a step other than step 0 has been selected from the teach pendant and playback has been started, the robot moves from the current position to the specified start step at the safety speed (less than 250 mm/sec.). This is a safety measure aimed at avoiding unforeseen interference and other trouble resulting from the possibility that the operator has selected an incorrect step. The safety speed restriction is canceled starting from the next step.

If the selected step (any step except step 0) is a step with a function command, the safety speed comes into effect for the step with the first subsequent movement command.

If the start of the program (that is to say, step 0) serves as the start step, the robot moves at the normal speed rather than at the safety speed.

If, for instance, step 2 is selected from the teach pendant to start the operation, the robot will move at the safety speed until step 2. From step 3 onward, it will move at the specified speed.

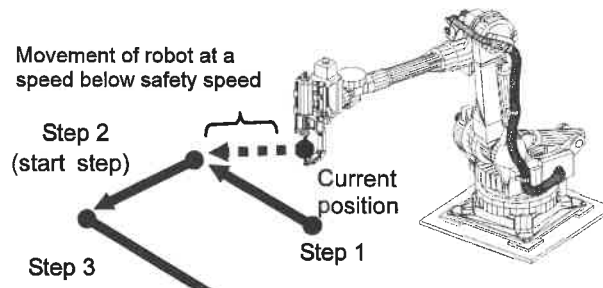


Fig. 5.1.1 Robot movements at safety speed

5.2 Performing automatic operation (playback) — Internal start method —

The playback procedure to be followed with the internal start method is described here.

Selecting the playback method

1 Establish the playback mode.



ENABLE + f4 / f5

2 Select the playback method required.
 The playback method (operation mode) can be selected by pressing the **[ENABLE]** and the **f4** key together or by pressing **[ENABLE]** and the **f5** key together (in other words, one of these two combinations of keys is pressed together).

f4	f5	Operation
 ↑ ↓ 	→ → ↑ ↓ ↑ ↓ ↑ ↓ → →	<ul style="list-style-type: none"> When f4 is set to step continuous, the mode is switched from "Cycle" → "Continue" → "Step" every time f5 is pressed. When f4 is set to single step, the mode is switched from "Cycle Step by Step" → "Continuous Step by Step" → "Step" every time f5 is pressed. When f4 is pressed while f5 is at any setting, single is switched to continuous or continuous is switched to single.

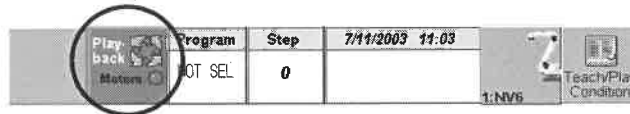
ENABLE + **PROG STEP**

3 Press [ENABLE] and [PROG/STEP] to select the program which is to be played back.

When operation is transferred to the playback mode while the task program remains selected in the teach mode, the task program concerned is played back.

4 Press the [Motor power ON] button.

>> The motor power is now turned on. The [Motor power ON] button lights.



5 Press [Start button].

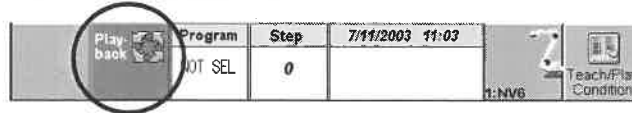
>> Automatic operation now starts in accordance with the playback method selected. For details on the movements of the robot using each playback method, the stop methods and restart methods, refer to page 5-11 "5.5 Operations in different operation modes".

5.3 Performing automatic operation (playback) – External start method –

The playback procedure to be followed with the external start method is described here.

Selecting the playback method

1 Establish the playback mode.



ENABLE + f4 / f5

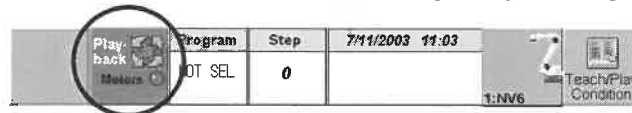
2 Select the playback method required.

The playback method (operation mode) can be selected by pressing the **[ENABLE]** and the **f4** key together or by pressing **[ENABLE]** and the **f5** key together (in other words, one of these two combinations of keys is pressed together).

f4	f5	Operation
 ↑ ↓ 	→ → ↑ ↓ ↑ ↓ ↑ ↓ → → ↑ ↓ ↑ ↓ ↑ ↓	<ul style="list-style-type: none"> When f4 is set to step continuous, the mode is switched from "Cycle" → "Continue" → "Step" every time f5 is pressed. When f4 is set to single step, the mode is switched from "Cycle Step by Step" → "Continue Step by Step" → "Step" every time f5 is pressed. When f4 is pressed while f5 is at any setting, single is switched to continuous or continuous is switched to single.

3 Input the external motor power ON signal from the external device.

>> The motor power is now turned on. The [Motor power ON] button lights.



4 Input the number of the program to be started (program selection bit) from the external device.

5 Input the external start signal from the external device.

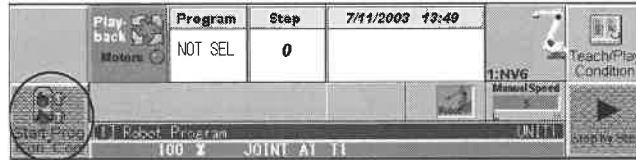
>> Automatic operation now starts in accordance with the playback method selected. For details on the movements of the robot using each playback method, the stop methods and restart methods, refer to page 5-11 "5.5 Operations in different operation modes".

Switching the start method and program selection method

If the internal start or external start method is used by the AX20/AX21 controller, the start method can be changed by a simple operation. (Internal can be changed to external and vice versa.) For instance, even when “external start” has been selected, it is possible to switch to “internal start” temporarily in order to check what has been taught.

Internal or external can be selected as the method to select the task program to be played back.

- 1 The current settings can be checked on the display of the teach pendant.

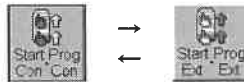


In the case of the screen shown above, internal is selected both as the start method and program select.

The allocation of the f-keys shown above differs depending on the application. If they are not displayed, check and change the settings by performing the operations described in 3.



- 2 The method can be switched between <Start Con/Prog Con> and <Start Ext/Prog Ext> by pressing f2 while holding down [ENABLE].

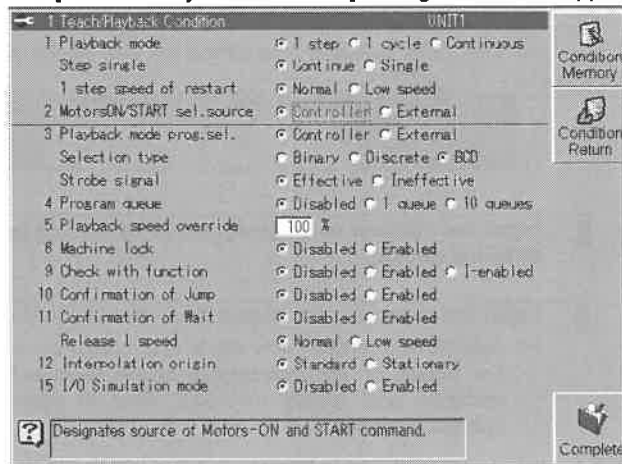


- 3 The settings can also be changed from the service menu. On the service menu, start select and program select can be changed independently.

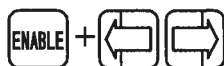


Press f6 <Service Utilities> while holding down [ENABLE], and select [1 Teach/Playback Condition].

>> The [1 Teach/Playback Condition] setting screen now appears.



- 4 Align the cursor with “2 MotorsON/START sel.source” and “3 Playback mode prog.sel.”, and set these two items.



To make changes, use [ENABLE] + [left or right].



- 5 Upon completion of the changes, press f12 <Complete>.

>> The settings are now stored in the memory, and operation returns to the original screen.

5.4 Performing automatic operation (playback)—Multi-station start method—

The playback procedure to be followed when the multi-station start method is used is described here.

Allocating the program to be started to each station

When the multi-station start method is used, the program to be started must be allocated to each station ahead of time.

The program is allocated in the teach mode.



1 Press <Station Set>.



Or select <Constant Setting> — [5 Operation Constants] — [7 Condition of Multi station starter].

>> The allocation screen now appears.
The screen below shows a case with three stations.

Station	Unit	Program	Schedule	Product
Station1	0	0	0	0
Station2	0	0	0	8
Station3	0	0	0	0

2 Input the number of the task program to be started for each station.



3 To facilitate the setting, press f9 <Program List> while the cursor is in the "Program" column.

>> A list of programs is now displayed.

Program No.	No. of Steps	Comment
UNIT1 .000	6	
UNIT1 .001	7	
UNIT1 .002	5	
UNIT1 .003	7	
UNIT1 .010	1	
UNIT1 .011	7	
UNIT1 .012	6	
UNIT1 .102	1	
UNIT1 .103	3	
UNIT1 .200	12	
UNIT1 .201	6	
UNIT1 .202	16	
UNIT1 .203	1	
UNIT1 .204	10	
UNIT1 .205	3	
UNIT1 .206	11	
UNIT1 .210	15	



4 Select the program, and press [Enter].

>> The selected program is allocated.

# 7 Condition of Multi-station starter				
	Unit	Program	Schedule	Product
Station1	1	UNIT1	0	0
Station2	0	0	0	6
Station3	0	0	0	0



5 When a program has been allocated to each of the stations, press f12 <Complete>.

>> The allocation is stored in the memory.



f9<Station Set> is displayed on "The number of station" set over 1 with proceeding <Constant Setting> and [5 Operation Constants] and then [6 Number of station]. When "The number of station" is set on 0, the f9<Station Set > is not displayed.

Starting the program

Upon completion of the allocation, start the task program.

1 Establish the playback mode.



At this time, the program which was selected in the teach mode is now deselected. (Since the selected program is not started up when doing multi-station startup, it is in an unselected state immediately after switching to playback mode.)

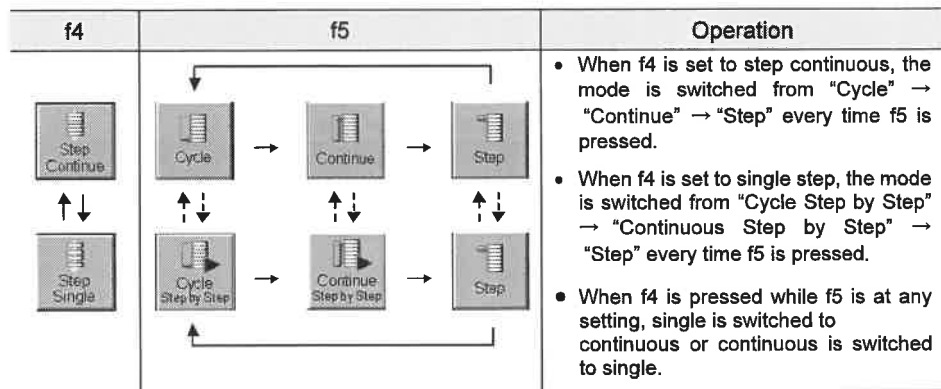
If you press the startup button for any station, the program number and program contents will be displayed for the program allocated to that station, and playback will begin.



+ f4 / f5

2 Select the playback method required.

The playback method (operation mode) can be selected by pressing the [ENABLE] and the f4 key together or by pressing [ENABLE] and the f5 key together (in other words, one of these two combinations of keys is pressed together).



3 Press the [Motor power ON button] on the operation box.

>> The motor power is now turned on. The [Motor power ON button] lights.



This now completes the preparations for auto operation.

- 4 Press the **[START]** button on the operation box installed at the station to be started.

>> Automatic operation now starts in accordance with the playback method selected. For details on the movements of the robot using each playback method, the stop methods and restart methods, refer to page 5-11 "5.5 Operations in different operation modes".

Reserving and canceling the reservation of the station to be started next

If, when a multiple number of stations are available, the **[START]** button on station (B) is pressed while station (A) has started, station (B) will be set to the reserved status. Upon completion of the station (A) playback, station (B) will start. However, a station which has already started cannot be reserved. (While station (A) has started, station (A) cannot be reserved.)

Reservations can be made for a multiple number of stations.

- 1 Press the **[START]** button on the station to be reserved.

>> The task program allocated to that station is set to the reserved status, and the **[START]** button flashes.

- 2 To cancel the reservation, press the **[START]** button on the station being reserved.

>> The reservation is now canceled.

Checking the reservations

To check the reserved stations and programs, start the "station reservation start status monitor."



- 1 Press **<Station Monitor>**.

>> The station reservation start status monitor now starts.

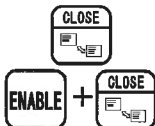
"Run" denotes now starting, "Yet" means no start, and the numbers indicate the reservation sequence.

Reserve	Station	Unit	Program	Schedule	Product
Run	3	01	UNIT1	0003	0 12
1	2	01	UNIT1	0002	0 1
Yet	1	01	UNIT1	0001	0 1

The station number is indicated here.

- 2 To exit the monitor, press **[CLOSE/SELECT SCREEN]** to set the station reservation start status monitor to active.

Then press **[CLOSE/SELECT SCREEN]** while holding down **[ENABLE]**.

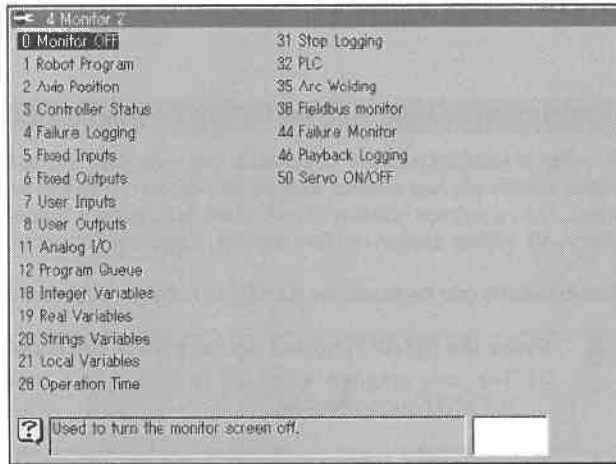


- 3 The reservations can also be checked using the following method. (This method involves allocating the station reservation start status monitor to monitor 2.)



After pressing [Service Utilities], press [4 Monitor 2].

>> A list of the monitor functions that can be displayed now appears.



- 4 Select [13 Station reservation status], and press [Enter].

>> The station reservation start status monitor now starts.

Reserve	Station	Unit	Program	Schedule	Product
Run	3	01	UNIT1	0003	0 12
1	2	01	UNIT1	0002	0 1
Yet	1	01	UNIT1	0001	0 1

5.5 Operations in different operation modes

Operations in five operation modes are described here.

The explanation given below describes the start and stop methods using the [Start button] and [Stop button]. When the external start method is used, read the following as the alternatives of the [Start button] and [Stop button].

Fig. 5.5.1 Alternatives for the [Start button] and [Stop button]

	When the external start method is used
Press the [Start button].	Input the start signal.
Press the [Stop button].	Input the stop signal.



DANGER

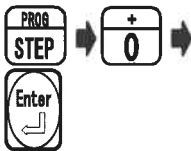
**Before initiating playback, check that no one is near the robot.
If the robot should come into contact or sandwich a person, death or serious injury may result.**

Step playback

First, to ensure safety, check the operations of the robot during step playback.



- 1 Select step playback.**



- 2 Specify the step at which playback is to start.**

To play back from the start of the program, press [PROG/STEP], [0] and then [Enter].

>> The cursor now moves to step 0.

To play back from step 2, press [PROG/STEP], [2] and then [Enter].



Concerning the designation of the step

You can specify a step prior to beginning playback when "Internal Startup Method" is employed.

When "External Startup Method" or "Multi-Station Startup Method" is used, you cannot specify a step prior to beginning playback. (Playback will always start with Step 0 for the first startup.) However, if you stop after beginning playback, you can specify a step using the method described above.

- 3 Press [Start button].**

>> While the button is held down, the robot moves from the current position to the specified step.

- 4 In the step playback mode, the robot stops at the next step.
To continue playback, press the [Start button] again.**

>> While the button is held down, the robot moves again to the next step.

Cycle playback

Next, check the operation of the robot during cycle playback.



- 1 **Select cycle playback.**

- 2 **As with step playback, specify the step at which playback is to start.**

- 3 **Press [Start button].**
 >> When the button is pressed once, the robot moves from the current position to the specified step, and operates as far as the last step. When the [Start button] is pressed again after the last step has been reached, the robot operates again from the first step.

- 4 **To stop the robot at any time, press the [Stop button].**

- 5 **To restart the robot, press the [Start button] again.**

Continuous playback

Proceed as follows to initiate continuous playback.



- 1 **Select continuous playback.**

- 2 **As with step playback, specify the step at which playback is to start.**

- 3 **Press [Start button].**
 >> When the button is pressed once, the robot moves from the current position to the specified step, and operates as far as the last step. When the last step is reached, operation proceeds again from the first step, and cycle playback is repeated.

- 4 **To stop the robot at any time, press the [Stop button].**

- 5 **To restart the robot, press the [Start button] again.**

Cycle playback (step by step)

Proceed as follows to perform cycle playback in the step by step mode.

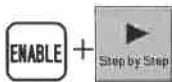


- 1 **Select cycle playback (step by step).**

- 2 **As with step playback, specify the step at which playback is to start.**

- 3 **Press [Start button].**
 >> When this button is pressed once, the robot operates from the current position to the specified step.

- 4 **To advance to the next step, press f8 <Step by Step> while holding down [ENABLE].**
 >> The robot operates as far as the next step.
 Repeat this procedure to check the operation as far as the last step.
 When the [Start button] is pressed again after the last step has been reached, the robot operates again from the first step.



Continuous playback (step by step)

Proceed as follows to perform cycle playback in the step by step mode.

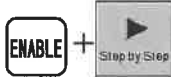


1 Select continuous playback (step by step) by following the procedure.

2 As with step playback, specify the step at which playback is to start.

3 Press [Start button].

>> When the button is pressed once, the robot operates from the current position to the specified step.



4 To advance to the next step, press f8 <Step by Step> while holding down [ENABLE].

>> The robot operates as far as the next step.
Repeat this procedure and check.

When the last step is reached, the robot operates again from the first step.

NOTE

Chapter 6 File operations

This chapter describes how to copy, delete and back up files.

6.1 Copying, deleting and renaming programs	6-1
6.1.1 Copying programs.....	6-1
6.1.2 Deleting programs.....	6-2
6.1.3 Renaming (renumbering) programs	6-3
6.2 Concerning the file operation menu	6-4
6.2.1 File operation menu selection and common operations	6-4
6.2.2 Types of usable storage media	6-6
6.2.3 Operable files.....	6-7
6.2.4 Folder structure of internal memory	6-8
6.3 Inserting the CF card	6-11
6.3.1 CF cards that can be used.....	6-11
6.3.2 Inserting the CF card	6-11
6.3.3 Cautions when using a CF card	6-14
6.4 Copying files	6-15
6.5 Displaying a list of the files	6-18
6.6 Deleting files	6-19
6.7 Setting protection for files	6-22
6.8 Verifying files.....	6-25
6.9 Initializing the storage media	6-27
6.10 Backing up files.....	6-28
6.11 Restoring all files from backup	6-32
6.12 Performing automatic backup	6-36



CAUTION

Do not turn OFF the controller power while using the file operation menu described in this chapter and while the automatic backup function is being executed. If the controller power is turned OFF while the controller is accessing the files, those files may be unexpectedly damaged and there may be some cases where the controller system cannot start up as a result.

6.1 Copying, deleting and renaming programs

This section describes the operations to copy, delete and rename programs inside the internal memory.

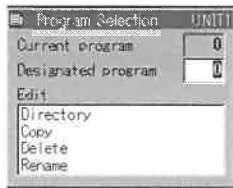
6.1.1 Copying programs

How to copy programs is described here. The operations described here enable a single program to be selected and copied. To specify a multiple number of programs and copy them, refer to page 6-15 "6.4 Copying files".

Copying programs

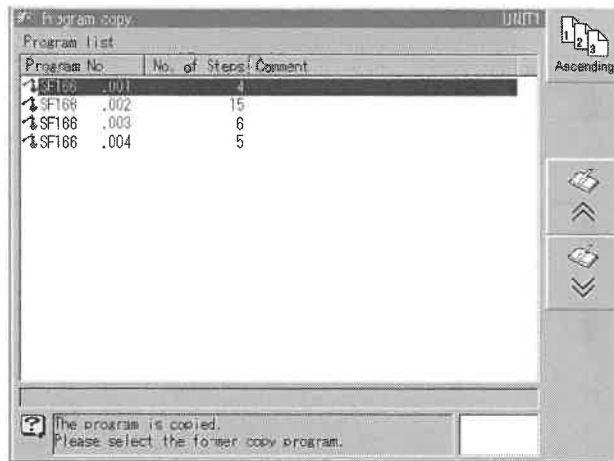


- 1 While holding down [ENABLE], press [PROG/STEP].**
>> The [Program Selection] window now opens.



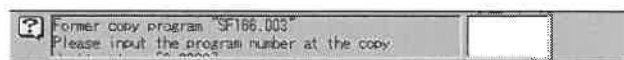
- 2 Select "Copy."**

- 3 Press [Enter].**
>> The [Program copy] screen now appears.



- 4 Select the program to be copied.**
If not all the programs can be shown on one screen, they will be displayed over a multiple number of pages. In this case, search the program targeted for the operation using f9 <^> or f10 <v>.

- 5 Press [Enter].**
>> It is now possible to input the number of the copy destination program.



Number input



- 6 Input the number of the copy destination program, and press [Enter].**
>> The program is now copied, and operation returns to the original screen.

6.1.2 Deleting programs

How to delete programs is described here. The operations described here enable a single program to be selected and deleted. To specify a multiple number of programs and delete them, refer to page 6-19 "6.6 Deleting files".

Deleting programs



- 1 While holding down [ENABLE], press [PROG/STEP].

>> The [Program Selection] window now opens.

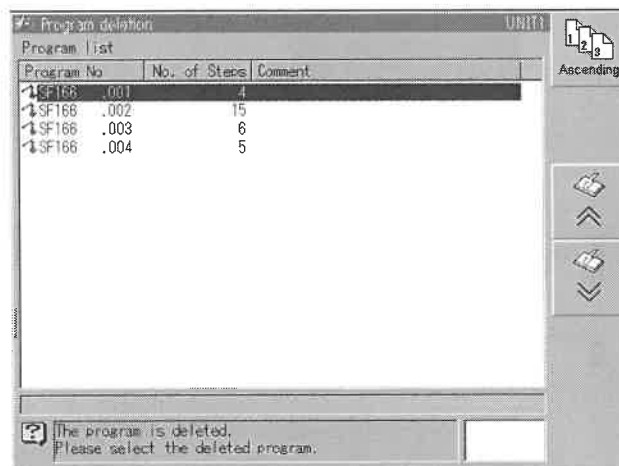


- 2 Select "Delete."



- 3 Press [Enter].

>> The [Program deletion] screen now appears.



- 4 Select the program to be deleted.

If not all the programs can be shown on one screen, search the program targeted for the operation using f9 <^> or f10 <v>.



- 5 Press [Enter].

>> A confirmation screen now appears.



- 6 Select "OK" and press [Enter].

>> The program is deleted, and operation returns to the original screen.

6.1.3 Renaming (renumbering) programs

How to rename (renumber) programs is described here.

Rename the program.



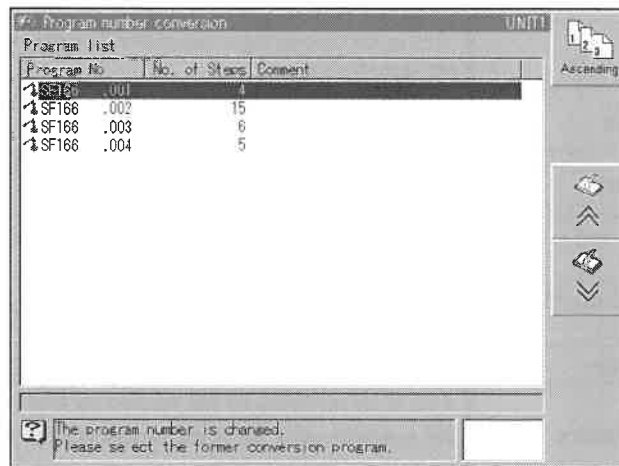
- 1 While holding down [ENABLE], press [PROG/STEP].**
>> The [Program Selection] window now opens.



- 2 Select "Rename."**



- 3 Press [Enter].**
>> The [Program number conversion] screen now appears.



- 4 Select the program to be changed.**
If not all the programs can be shown on one screen, search the program targeted for the operation using f9 <^> or f10 <v>.



- 5 Press [Enter].**
>> It is now possible to input the new program number.



- 6 Input the new program number, and press [Enter].**
>> A confirmation screen now appears.



- 7 Select "OK" and press [Enter].**
>> The program is renumbered, and operation returns to the original screen.

6.2 Concerning the file operation menu

Selecting the file operation menu enables operations for not only programs but also constant files, etc. to be performed.

This menu has the following functions which can be selected in either the teach mode or playback mode.

Table 6.2.1 Functions of file operation menu

Operation menu	Details
File Copy	This is for copying files. Files can be copied not only between internal memories but also from an internal memory to an external storage device such as a CF card (stored) or from an external storage device to an internal memory (read).
Directory	This is for displaying a list of the files stored in the internal memory or external storage device.
File Delete	This is for deleting the files stored in the internal memory or external storage device.
File Protect	This is for setting protection for the files stored in the internal memory or external storage device.
Verify	This is for verifying whether the contents match between two files or between all the files on different storage media match.
Format IC card/Floppy disk	This is for initializing a CF card or a floppy disk (optional).
File Backup	This stores all the files in an external storage device.
Backup restore	This is for restoring all the backed up files in the controller. An operator must have the qualifications class of Expert or above to use the backup restore function.
Automatic backup	This is for automatically backing up the files under the specified conditions. An operator must have the qualifications class of Expert or above to use this function.

6.2.1 File operation menu selection and common operations

This section describes how to select the file operation menu and how to perform operations after its functions have been selected.

Selecting the file operation menu



- 1 Press **f4 <File>**.
If this soft key is not provided, the menu can be opened from the service menu. In this case, select "7 File Manager" from the service menu, and press **[Enter]**.
>> The file operation menu such as the one shown below is now opened.

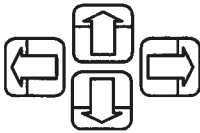
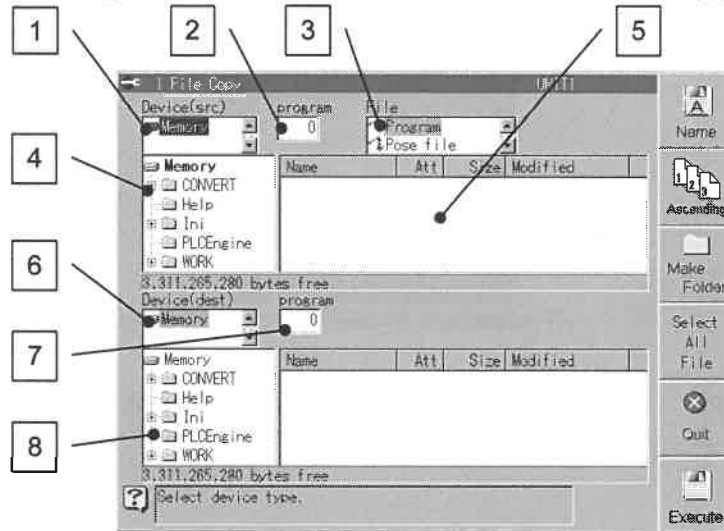


- 2 When a function is selected and **[Enter]** is pressed, the function concerned is selected.

Common operation using file operation menu

This section describes the common operations performed after the functions have been selected on the file operation menu.

1 When copy is selected, for instance, the screen shown below appears.



2 Move through fields 1 to 8, and set the items required.

To move through each field (1 to 8), use the left and right keys.
To select the items displayed in the fields, use the up and down keys.

1 Device selection field (for details, refer to page 6-6 "6.2.2 Types of usable storage media")

Select the device containing the file targeted for operation.

To copy a file, select the copy source device in field 1 and the copy destination device in field 6.

2 Program input field

To specify a program to be copied or deleted, input its number in this field (program files in ¥Work¥Program can be specified). To display a list of files and select one or more of these files, specify "PROGRAM" in field 4.

3 File type selection field (for details, refer to page 6-7 "6.2.3 Operable files")

Select the file type. Select the type here when performing file operation by type of file such as program file or constant file.

4 Folder selection field (for details, refer to page 6-8 "6.2.4 Folder structure of internal memory")

To search the file targeted for operation, specify the folder that contains the file.

5 File directory

If a folder is specified in 4, a list of files is displayed in 5. To select an individual file or files and perform file operations, select the files here.

6 Device selection field (when copying only)

Select the copy destination device.

7 Program input field (when copying only)

Input the number of the program to be copied.

8 Folder selection field (when copying only)

Specify the copy destination folder.

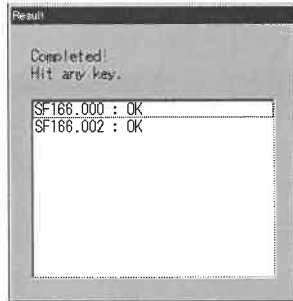


3 If a folder is specified in 4, a list of files is displayed in 5. In this case, the sequence in which the files are arranged can be switched using f7 <Name> or f8 <Ascending>.



- 4** Upon completion of the necessary settings, press f12 <Execute>.
 >> The file operation is now executed.

To stop the processing during a file operation, press f11 <Quit>.
 >> A confirmation message now appears.



Processing is aborted by pressing any key.



- 5** To exit the operation, press [RESET/R].
 >> Operation returns to the file operation menu.

6.2.2 Types of usable storage media

With the AX20/AX21 controller, data can be stored in an external storage device or, conversely, data can be read from an external storage device. To access the external storage device, specify the target device when performing the copy, delete or other operation.

The usable storage media are listed below.

Table 6.2.2 Usable storage media

External storage device (media)	Details
Card 1	This accesses the CF card which is plugged into the CF card connector of the controller. A "CF card" refers to a Compact Flash card.

Before files are stored in an external storage device, the storage media must have been initialized.

See page 6-27 "6.9 Initializing the storage media".



If the CPU board is AXCPU10-50;
 Although this board has USB port, any USB devices cannot be connected here. Do not connect any USB memory / storage devices to the USB port of the CPU board. In addition, do not connect USB keyboard, USB mouse, etc.

6.2.3 Operable files

The files that can be operated using the file operation menu are listed below.

Table 6.2.3 Operable files

File	Description of file
Program file	This kind of file contains the created programs. [Example] SH166.**** (**** denotes numbers)
Pose file	This kind of file is for the position data used in the robot language. [Example] SH166_P.**** (**** denotes numbers)
Language file	This is a program file which is described in the robot language. It is a text file. [Example] SH166_A.**** (**** denotes numbers)
Constant file	This kind of file contains the values inherent to the robots and various settings. It is an INI format text file. [Examples] MECHANISM.CON (mechanism definition file) TOOTOL01.C01 (tool constants file)
Log file	This kind of file contains the error histories, welding histories, etc. It is an INI format text file. [Example] LG-ERR001.LOG (error history file 001)
PLC program (Ladder program)	This is a PLC program (ladder program) used by the software PLC. [Example] *****.stf (***** denotes any name)
Arc welding condition files	These are the arc start/end condition files which are used with arc welding. [Example] AS###ARCW.*** (### denotes the type of welder and *** denotes number)
Weaving condition files	These are the weaving start/end condition files used when weaving with arc welding. [Examples] WFP.*** (*** denotes number) WAX.*** (*** denotes number)

6.2.4 Folder structure of internal memory

The internal memory of the AX20/AX21 controller is structured in the following way. The operator must be familiar with the folder structure when performing operations for files stored in the internal memory

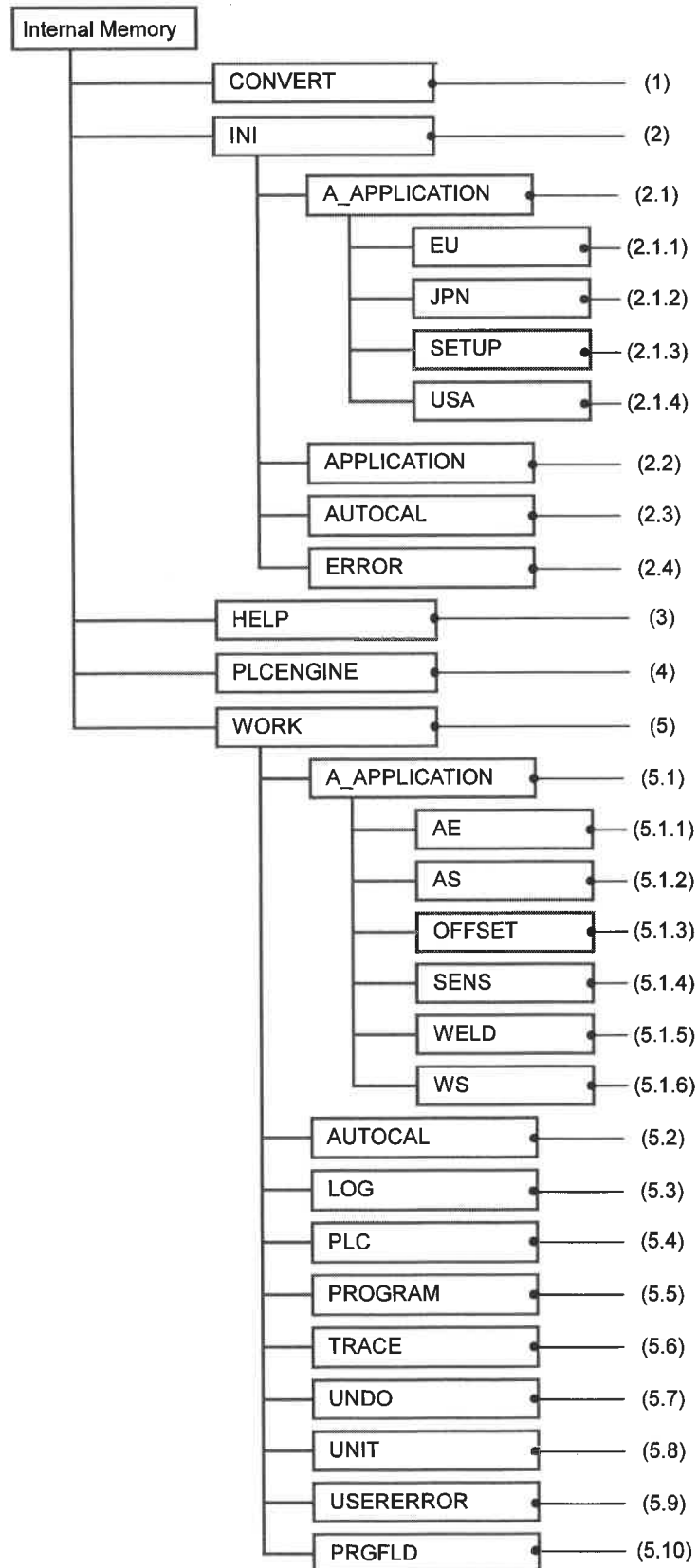


Fig. 6.2.1 Folder structure of internal memory

Table 6.2.4 Files stored in folders

No.	Folder	Files stored in folders	Filename (example) ("###" denotes numbers)
(1)	CONVERT	Folder used by conventional model format conversion function	¥AW, ¥EX
(2)	INI	Initial value files (serving as source for generating constant files when constants are to be prepared)	AC00SOFTKEY.INI, Ac01arcw.ini, etc.
(2.1)	INI¥A_APPLICATION	(Valid only for arc welding applications) Initial value files used specifically for arc welding applications (initial value data related to arc welding, initial value files for sensor applications, etc.)	AS01arcw.ini, AE01arcw.ini, etc.
(2.1.1)	INI¥A_APPLICATION¥EU	Initial value files listed below for arc welding power supply (European specifications)	
		Welding characteristics data files	\$WTBD***
(2.1.2)	INI¥A_APPLICATION¥JPN	Initial value files listed below for arc welding power supply (Japanese specifications)	
		Welding characteristics data files	\$WTBD***
(2.1.3)	INI¥A_APPLICATION¥SETUP	Control software of D series welding power supplies (Only DM-350 Japanese specifications incorporated as a standard)	mprg_dm.bin, ¥Update¥AL-111.bin
		Waveform control data files	\$WPLS***
(2.1.4)	INI¥A_APPLICATION¥USA	Initial value files listed below for arc welding power supply (U.S. specifications)	
		Welding characteristics data files	\$WTBD***
(2.2)	INI¥APPLICATION	Initial value files used specifically for arc welding applications (such as spot welding, arc welding and handling)	A_C00CTRL.INI, A_S00SIGL.INI, etc.
		Waveform control data files	\$WPLS***
(2.3)	INI¥AUTOCAL	Initial value files used by automatic calibration function (option)	nv6.kin nv6.prm, etc.
(2.4)	INI¥ERROR	Error files	Err***.ini
(3)	HELP	Help files	AX-HELP*.chm, AX-HELP*.hhc, AX-HELP*.hhk
(4)	PLCENGINE	Files related to software PLC	IsaGRAF.exe, IsalXL.dll, etc.
(5)	WORK	Constant files	C00ctrl.con, S00sigl.con, etc.
(5.1)	A_APPLICATION	(Valid only for arc welding applications) Folder for files (5.1.1 to 5.1.6) listed below	¥AE, ¥AS, ¥OFFSET, ¥SENS, ¥WELD, ¥WS
(5.1.1)	A_APPLICATION¥AE	Arc end condition files	AE##ARCW.*** ("##" denotes the type of welder)
		Arc end condition initial value files	AE##arcw1.CON ("##" denotes the type of welder)
(5.1.2)	A_APPLICATION¥AS	Arc start condition files	AS###ARCW.*** ("##" denotes the type of welder)
		Arc start condition initial value files	AS###arcw1.CON ("##" denotes the type of welder)
(5.1.3)	A_APPLICATION¥OFFSET	Files listed below used by multipass welding function (option)	
		Offset files	OFSARCW.***
		Multi offset files	MOFSARCW.***

No.	Folder	Files stored in folders	Filename (example) ("****" denotes numbers)
(5.1.4)	A_APPLICATION%SENS	Files related to sensor devices (touch sensors, arc sensors, TIG arc sensors, laser search, laser sensors)	ST01sens1.CON, ET01sens1.CON, etc.
(5.1.5)	A_APPLICATION%WELD	Welding characteristics data files	\$WTBD***
		Wire feed characteristics data files	\$WFCD***
		Waveform control data files	\$WPLS***
		Welding condition database files	WDB***
(5.1.6)	A_APPLICATION%WS	Fixed pattern weaving condition files	WFP.***
		Joint weaving condition files	WAX.***
		Taught weaving (option) condition files	WSF.***
		Fixed pattern weaving initial value files	WFP-*.CON
		Joint weaving initial value files	WAX-*.CON
		Taught weaving (option) initial value files	WSF-*.CON
(5.2)	WORK%AUTOCAL	Data files used by automatic calibration function (option)	Setup_ac.csv, etc.
(5.3)	WORK%LOG	Error log files	LG-Err***.log
		MTBF/MTTR files	Ig-MTBF_MTTR_A.bin, etc.
		Overhaul prediction files	Lg-pmd.log
		Program diagnosis files	LG-PMD0P***.LOG
		Stop log files	LG-STOP.log
(5.4)	WORK%PLC	Ladder program	*.STF
(5.5)	WORK%PROGRAM	Program files	NV6.**** , etc.
		Pause files	NV6_P.**** , etc.
		Language files	NV6_A.**** , etc.
(5.6)	WORK%TRACE	Measurement data prepared by oscilloscope function	TRACE**.CSV
(5.7)	WORK%UNDO	Undo operation history files	NV6_Undo_0.001, etc.
(5.8)	WORK%UNIT	Unit-dependent constant files	U00UNIT001.CON, etc.
(5.9)	WORK%USERERROR	User error definition file	Err7***.ini
(5.10)	WORK%PRGFLD	Program Management File	****NV6.**** etc.


Important

Some of the files listed in the above table may not be displayed depending on whether the optional functions concerned are provided and on the qualifications level of the operator.

6.3 Inserting the CF card

The AX20/AX21 controllers are equipped with a CF card connector as a standard feature. To prepare to back up the data, plug a CF card into the connector.



Backing up the data on a frequent base is advised.

If, by any chance, the data is accidentally lost by an incorrect operation, the data can be restored from the backup.

6.3.1 CF cards that can be used

You can use the following CF cards (32M, 64M type).

When using a card, please use it within the scope of the manufacturer's warranty. We cannot guarantee operation when a CF card other than those listed below is used.

Table 6.3.1 CF cards that can be used

Manufacturer	Name	Model number
Silicon Systems, Inc.	Silicon Drive CF (32M)	SSD-C32M-3562 (RoHS) Or SSD-C32M-3062



Important

Daihen users must use the CF card supplied by Daihen (model L8800U (64M) or L9742U (256M)) without fail.

6.3.2 Inserting the CF card

Before saving a file on a CF card, plug the CF card into the CF card connector inside the controller.

The location of the CF card connector differs depending on the type of controller and type of CPU board used, so refer to the instructions applicable to the controller you are using.

Inserting the CF card (when the AX20 controller is used)

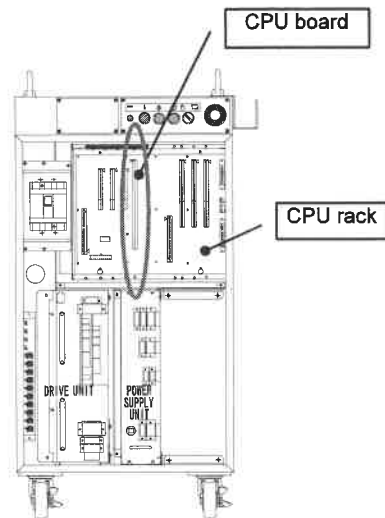


CAUTION

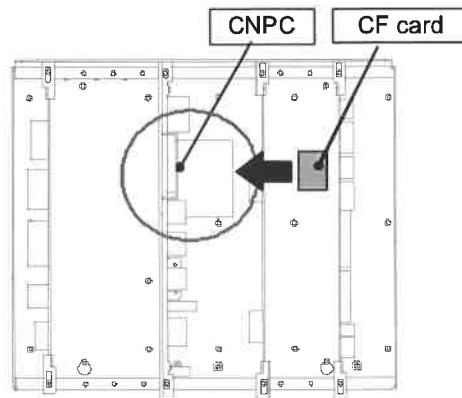
Please turn off the power to the robot control to load and unload the CF card.

If you load/unload a card with the power on, the data saved on the CF card or the card itself could be damaged.

- 1 Turn off the power of the controller, and open the door.
The CPU board is installed at the CPU rack.



- 2 Plug the CF card into the CF card connector marked "CNPC" on the CPU board.



When installing the CF card, pay attention to the direction in which it is pointing.
If the CF card is back to front and an attempt is made to forcibly insert it, the card may be damaged in the process.

- 3 Close the door of the control unit, and turn on the power.
- 4 Perform backup and other tasks.
- 5 It does not matter if the control unit is used continually while the CF card remains installed.
If the CF card is to be removed when, for instance, the control unit is not going to be used for a prolonged time; the power of the control unit must first be turned off without fail before removing the card.

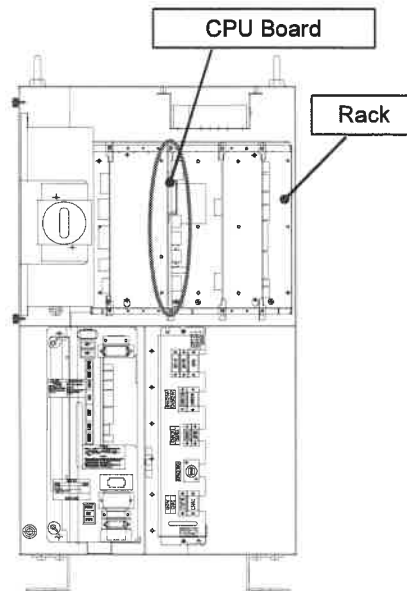
Inserting the CF card (when the AX21 controller is used)



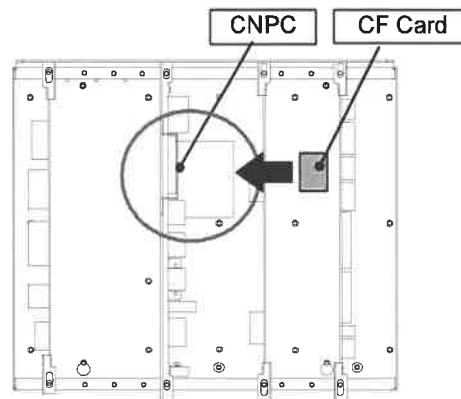
CAUTION

Please turn off the power to the robot control to load and unload the CF card.
If you load/unload a card with the power on, the data saved on the CF card or the card itself could be damaged.

- 1 Turn the power of the control unit off and open the door.
The CPU board is located within the rack.



- 2 Insert the CF card into the "CNPC" connector, located on the CPU board.



CAUTION

When installing the CF card, pay attention to the direction in which it is pointing.
If the CF card is back to front and an attempt is made to forcibly insert it, the card may be damaged in the process.

- 3 Close the door of the control unit and turn the power on.
- 4 Perform backup and other relating tasks.

- 5 Continued use of the control unit with the CF card remaining inserted is not a problem.

When removing the CF card, due to reasons such as not using the control unit for a long period of time, do not fail to turn the power of the control unit off before removing.

6.3.3 Cautions when using a CF card



WARNING

- (1) Please do not dismantle the CF card. It could ignite.
- (2) Please do not use CF cards on which a liquid such as water or chemicals has spilled.
They could cause electrical shocks or short circuits.



CAUTION

- (1) Please do not store CF cards in places where they could suffer vibration or shocks, places with a lot of dust or grit, places having high temperature/high humidity, places with direct sunlight, or places with strong electromagnetic forces. Data could be lost.
- (2) Please do not use CF cards on which a liquid such as water or chemicals has spilled.
They could cause electrical shocks or short circuits.
- (3) Please avoid use in environments with a lot of dust. The cards may not operate properly.
- (4) If you try to force the CF cards, place heavy objects on top of them, or drop them on the floor, the cards could be damaged, so please handle them with care.
- (5) A CF card is an electronic device. Please avoid using the cards where strong static electricity or electrical noise is likely to occur.
- (6) Please do not put any foreign objects into the CF card's adapter slot.
- (7) Never insert or remove a CF card when power of the controller is on. Not only may you lose data, but the CF card itself could also be damaged.

6.4 Copying files

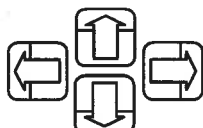
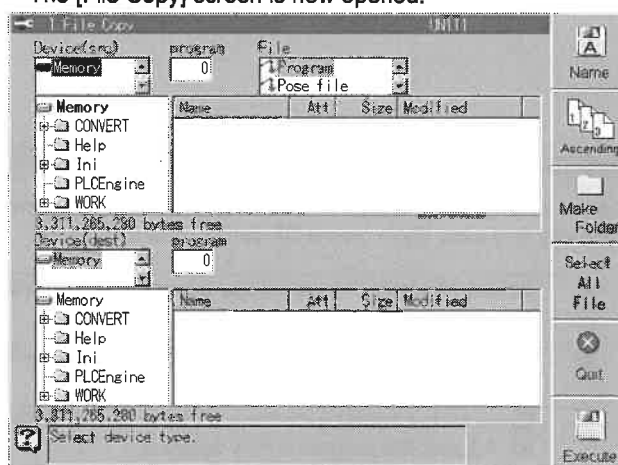
When files are copied, files with the same contents can be created in the internal memory or stored in an external storage device. The files that can be copied are listed below.

- Program file
- Pose file
- Language file
- Constant file
- Log file
- All files (all of the above files)

Opening the copy screen



- 1 Select "1 File Copy" on the file operation menu, and press [Enter].
>> The [File Copy] screen is now opened.



- 2 It is on the above screen that the files are copied.
To move through each field, use the [left or right] keys.
To select the items displayed in the fields, use the [up or down] keys.

Specify a file and copy it.

As an example, the steps taken to copy program "1" stored in the internal memory as program "10" in the internal memory will be described.

- 1 Select "Memory" in the copy source device selection field.



- 2 After moving to the program input field, input "1" and press [Enter].
>> Program "1" in "%Work%Program" is selected as what is to be copied.



When you copy a program by specifying the program number, the program copied will always be in the same folder with the original one, no matter what folder is specified or displayed. In this case, the folder is "%Work%Program". If there is no folder that has the same name, a new folder is made. Concerning the details of the file types and the folder names and their structure, refer to "6.2.4 Folder structure of internal memory".

- 3 Move to the file type selection field, and select "Program".



- 4 Move to the copy destination device selection field, and select "Memory".

- 5 Move to the program input field, and input "10".



If the program number is not specified here, the program is copied as number "0" (default setting). Be careful.

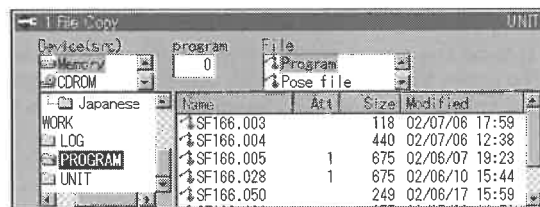
- 6 Press f12 <Execute>.
>> Copying now starts.



Specifying and copying a multiple number of files

As an example, the steps taken to select a multiple number of programs stored in the internal memory and copy them onto a CF card will be described.

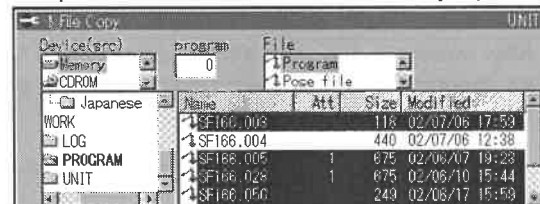
- 1 Select "Memory" in the copy source device selection field.
- 2 Move to the file type selection field, and select "Program".
- 3 Move to the folder selection field, and select "PROGRAM".
>> A list of the programs now appears.



Any settings may be used for the program input field and file type selection field. (The selection made from the file list takes precedence over the program input field and file type selection field settings.)



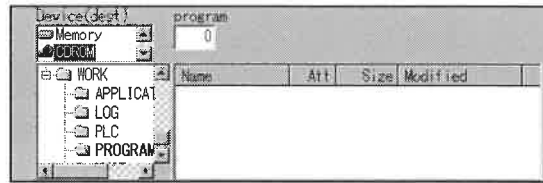
- 4 Select a file using the up or down key, and press [Enter]. The selected file is highlighted in blue.
A multiple number of files can be selected by repeating these steps.



To release the selected status, select the file to be released, and press [BS].

5 Move to the copy destination device selection field, and select "Card1".

6 Move to the folder selection field, and select the destination folder.



7 Press f12 <Execute>.
>> Copying now starts.

Copying all the files

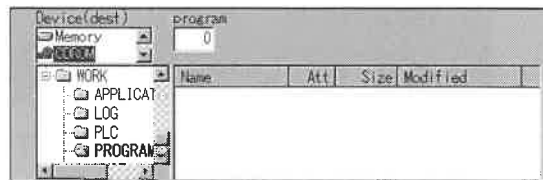
As an example, the steps taken to copy all the programs stored in the Memory onto a CF card will be described.

1 Select "Memory" in the copy source device selection field.

2 Move to the file type selection field, and select "All programs".

3 Move to the copy destination device selection field, and select "Card1".

4 Move to the folder selection field, and select the copy destination folder.



5 Press f12 <Execute>.
>> This now completes the copying.

6.5 Displaying a list of the files

When the display list function is used, what files are stored in the internal memory or external storage device can be checked.

Displaying a list of the files



- 1 Select "2 Directory" on the file operation menu, and press [Enter].

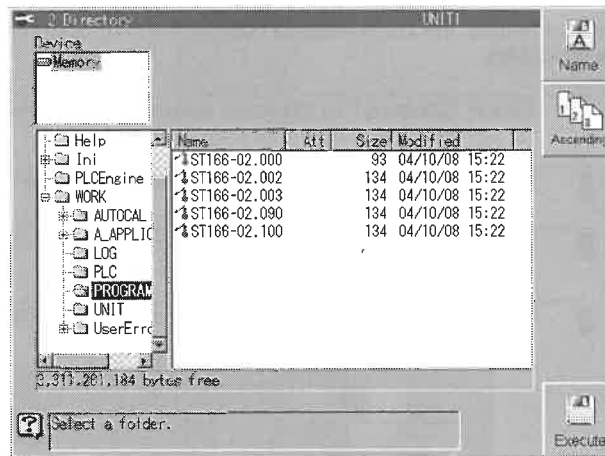
>> The [Directory] screen now appears.

- 2 In the device selection field, select the device whose files are to be listed and displayed.

- 3 In the folder selection field, select the folder whose files are to be listed and displayed.

As an example of a program, select the "PROGRAM" folder.

>> A list of the programs is displayed.



- 4 To exit the display list, press [RESET/R].

>> Operation returns to the file operation menu.

6.6 Deleting files

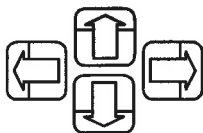
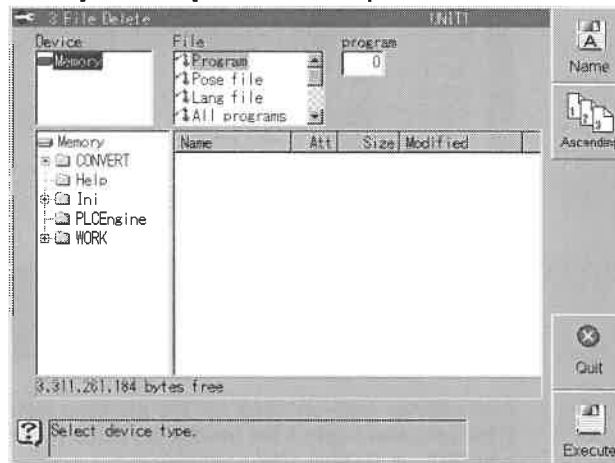
The files stored in the internal memory or external storage device can be deleted.
The files that can be deleted are as follows.

- Program files (deleted individually or altogether)
- Pose files (deleted individually or altogether)
- Language files (deleted individually or altogether)
- Log file (deleted altogether)

Opening the deletion screen



- Select "3 File delete" on the file operation menu, and press [Enter].**
>> The [File delete] screen is now opened.

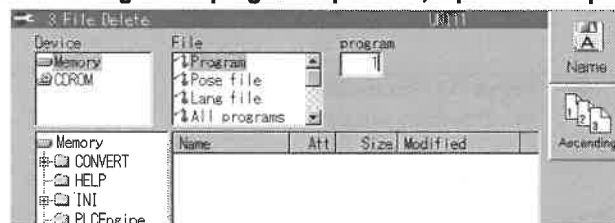


- Files are deleted on this screen.**
To move through each field, use the left and right keys.
To select the items displayed in the fields, use the up and down keys.

Specifying one file and deleting it

As an example, the steps taken to delete program "1" stored in the Memory will be described.

- In the device selection field, select "Memory".**
- Move to the file type selection field, and select "Program".**
- After moving to the program input field, input "1" and press [Enter].**

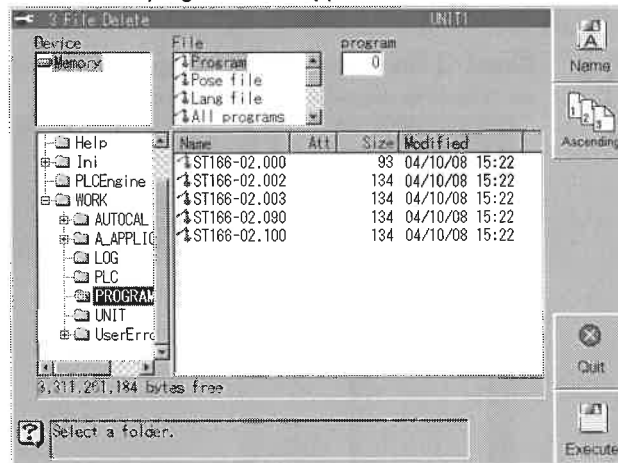


- Press f12 <Execute>.**
>> This completes the file deletion.

Specifying a multiple number of files and deleting them

As an example, the steps taken to select a multiple number of programs stored in the internal memory and delete them will be described.

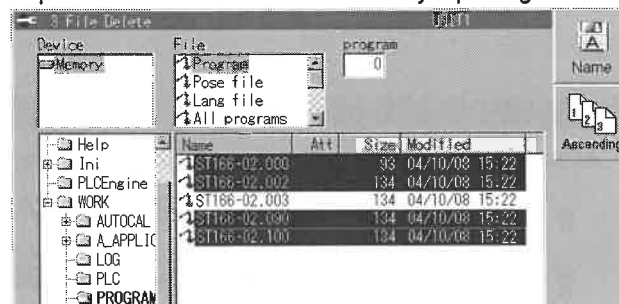
- 1 In the device selection field, select "Memory".
- 2 Move to the file type selection field, and select "Program".
- 3 Move to the folder selection field, and select "PROGRAM".
>> A list of the programs now appears.



Any settings may be used for the program input field and file type selection field. (The selection made from the file list takes precedence over the program input field and file type selection field settings.)



- 4 Select a file using the up or down key, and press [Enter]. The selected file is highlighted in blue.
A multiple number of files can be selected by repeating these steps.



To release the selected status, select the file to be released, and press [BS].



- 5 Press f12 <Execute>.
>> This completes the file deletion.

Deleting all the files

As an example, the steps taken to delete all the programs stored on a CF card will be described.

- 1 In the device selection field, select "Card1".

2 Move to the file type selection field, and select "All programs".



3 Press f12 <Execute>.
>> This completes the file deletion.

6.7 Setting protection for files

Protection settings are used for files in order to prohibit them from being changed or deleted. There are three types of protection: complete protection, partial protection and playback protection. When these settings are used, files can no longer be deleted or changed, as shown below.

Table 6.7.1 Protection types and functions

	All protect	Partial protect	Playback protect
	(Either complete or partial protection only can be selected.)		
Display mark (highlighting in red)	☐	☐	☐
Modification of position data	x	⊙	⊙
Modification of all other data		x	⊙
File Delete		x	⊙
Playback or step go from step 0, CHECK GO		⊙	x
Playback or step go from a step specified after step 1, CHECK GO		⊙	⊙

⊙ : Possible x : Cannot be performed (= protected)

- When opening a program for which protection has been set, the protection status is displayed.

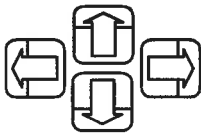
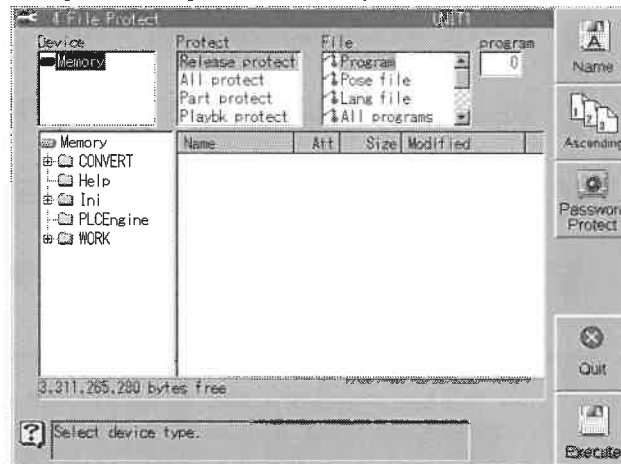


- Complete protection (or partial protection) and playback protection can be used simultaneously. (With a combination of "O" and "x", "x" takes precedence.) In this case, The display mark that indicates the protection status of the file is a combination of the two display marks.
- For constant files, partial protection has the same significance as complete protection. Playback protection cannot be set for these files.
- When files are copied, the protection information is also copied.

Opening the protection setting screen



- 1 **Select "4 File Protect" on the file operation menu, and press [Enter].**
 >> The [File Protect] screen is now opened.



- 2 **The protection is set on this screen.**
 To move through each field, use the left and right keys.
 To select the items displayed in the fields, use the up and down keys.

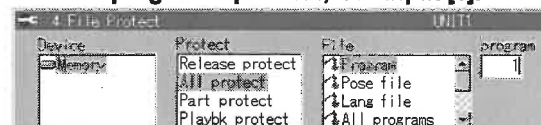
Select a file, and set the type of protection for it.

As an example, the steps taken to set "All protect" for program "1" stored in the internal memory will be described.

- 1 **In the device selection field, select "Memory".**
- 2 **Move to the protection type field, and select "All protect".**
- 3 **Move to the file type selection field, and select "Program".**



- 4 **Move to the program input field, and input [1].**



- 5 **Press f12 <Execute>.**
 >> The protection setting is now completed.

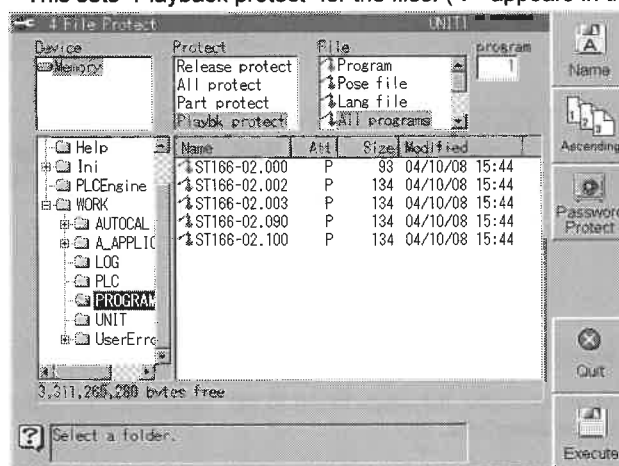
Setting protection for all files

As an example, the steps taken to set "All protect" and "Playback protect" for all the programs stored in the internal memory will be described.

- 1 In the device selection field, select "Memory".
- 2 Move to the protection type field, and select "Playback protect".
- 3 Move to the file type selection field, and select "All programs".
- 4 Move to the folder selection field, and select "PROGRAM".
>> A list of the programs now appears.



- 5 Press f12 <Execute>.
>> This sets "Playback protect" for the files. ("P" appears in the attribute field.)

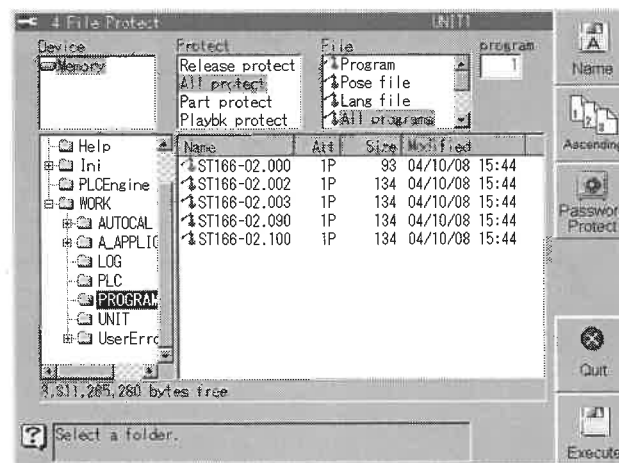


"P" appears in the attribute field.

- 6 Move to the protection type field, and select "All protect".



- 7 Press f12 <Execute>.
>> This sets "All protect" for the files. ("1P" appears in the attribute field.)



"1P" appears in the attribute field.

6.8 Verifying files

This is for verifying whether the contents match between two files or between all the files on different storage media match.

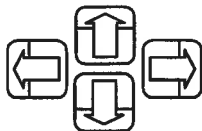
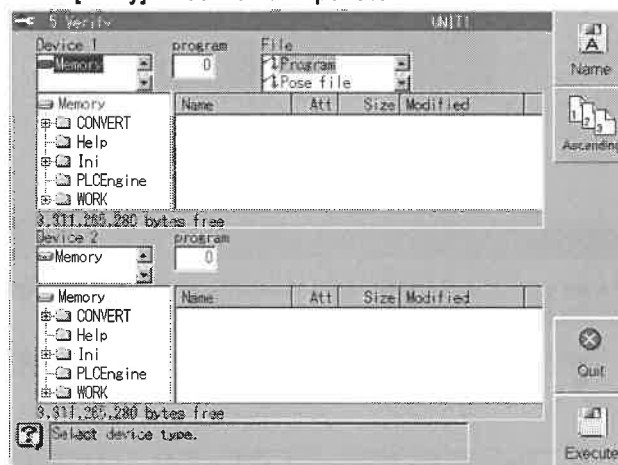
The files which can be verified are as shown below.

- Program file
- Pose file
- Language file
- Constant file
- Log file
- All files (all of the above files)

Opening the verify screen



- 1 Select "5 Verify" on the file operation menu, and press [Enter].
>> The [Verify] screen is now opened.



- 2 Files are verified on this screen.
To move through each field, use the left and right keys.
To select the items displayed in the fields, use the up and down keys.

Specifying a file and verifying it

As an example, the steps taken to verify programs "1" and "2" stored in the Memory will be described.

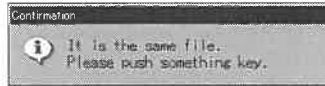
- 1 In the device 1 selection field, select "Memory".
- 2 Move to the program input field, and input [1].
- 3 Move to the file type selection field, and select "Program".
- 4 Move to the device 2 selection field, and set "Memory".
- 5 Move to the program input field, and input [2].



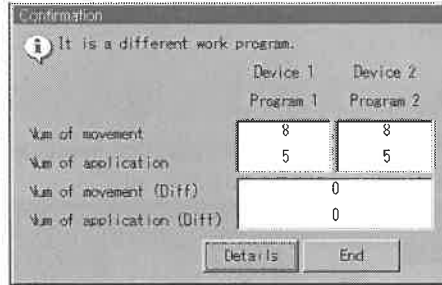


- 6 Press f12 <Execute>.
>> Verifying now starts.

If the contents of the two files are identical, the screen such as the one shown below appears.



If the contents of the two files are different, the screen such as the one shown below appears.



Verifying all files

As an example, the steps taken to verify whether all the files stored in the internal memory match all the files stored on the CF card will be described.

- 1 In the device 1 selection field, select "Memory".
- 2 Move to the file type selection field, and select "All files".
- 3 Move to the device 2 selection field, and select "Card1".



- 4 Press f12 <Execute>.
>> Verifying now starts.

6.9 Initializing the storage media

Before storing data on an external storage device, the storage media - either a CF card or floppy disk - must be initialized.

A storage media must be initialized only when it is used by the AX20/AX21 controller for the first time. (Once a media has been initialized, no further initializing is required.)

A media is also initialized when all the data stored on it is to be deleted.



CAUTION

Care is required with initializing since once a storage media has been initialized, all of the data stored on it will be deleted.



CAUTION

The CF card to be used must be initialized using the AX20/AX21 controller. When using an external device like PC to initialize the CF card, please initialize the card using "FAT16" format.

Initializing the storage media



1 Select "6. Format IC card/Floppy disk" on the file operation menu, and press [Enter].

>> The [Format IC card/Floppy disk] screen now appears.



2 In the device selection field, select the storage media to be initialized.



3 Press f12 <Execute>.

>> Initializing now starts.

6.10 Backing up files

All the files stored in the internal memory can be backed up and saved.

Unlike copying files when files are backed up, each individual file need not be selected, and the registry information required by the system is copied along with the files. The option protection information and other valuable parameters are stored in the registry, and they are not copied by following the steps in the sections on "copying all the files specified" described up to the previous section.

Either the internal memory or external storage device may be used as the storage media.

Backup does not include copying the system (operating system and the software itself).



The name of the backup folder is given automatically using the following format.

NRA2001-2003-11-06-0932

Date

Time

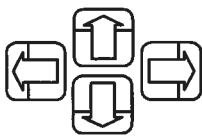
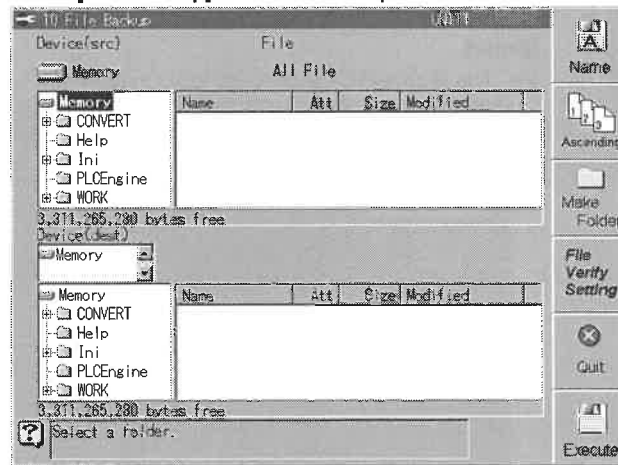
Opening the backup screen



1

Select "10 File Backup" on the file operation menu, and press [Enter].

>> The [File Backup] screen is now opened.



2

Files are backed up on this screen.

To move through each field, use the left and right keys.

To select the items displayed in the fields, use the up and down keys.

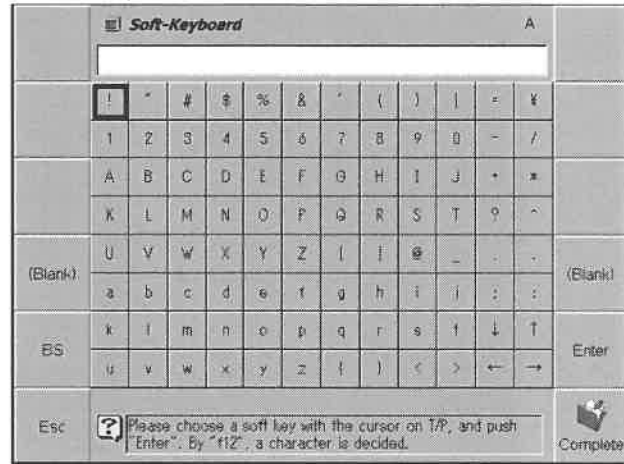
Creating folders in the storage media

To back up and store the files of a multiple number of robots in a single storage media, create folders under the kind of names that will enable the robots to be identified.



1 Press f9 <Make Folder>.

>> The soft keyboard now starts up.



2 Input the folder name.



3 Press f12 <Complete>.

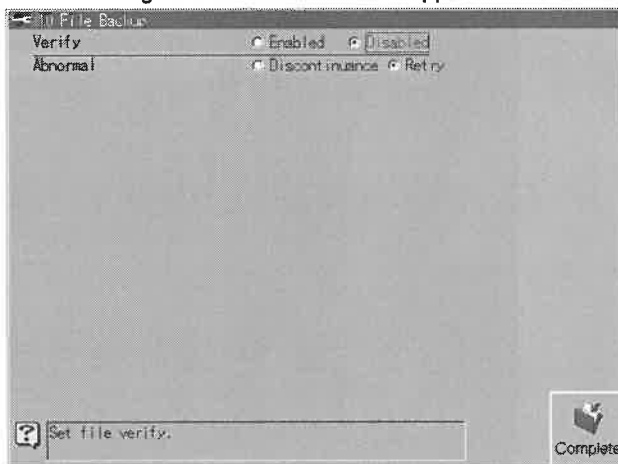
>> A folder is now created in the storage media.

Setting the file verification

For this setting, operator class **Expert** or above is required.

File
Verify
Setting

- 1 Press f-key <File Verify Setting>.
>> The setting screen shown as below appears.



- 2 Set the each setting.
- 3 After completion of the all settings, press f-key <Complete>
>> File verification will be done using the settings on this screen when executing backup process.

Complete

Table 6.10.1 File Verify Settings for Backup

Parameter	Default setting	Input range	Description
Verify	Disabled	Enabled / Disabled	Set the file verification Enabled/Disabled when executing the backup.
Abnormal	Retry	Discontinance / Retry	Select the proces to be executed when an error occurs while the file verification.

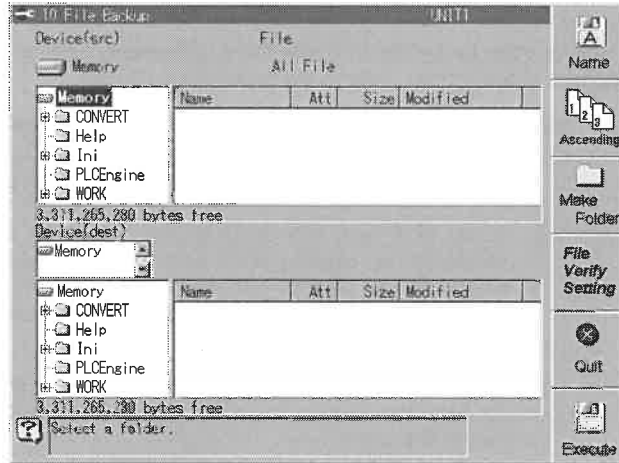
(Supplement) This item is supported on the AX system software version AXV07.8 or after.

Backing up the folders

- 1 In the device selection field, select "Card1" for instance.



- 2 Move to the folder selection field, select the backup destination folder, and press [Enter].



- 3 Press f12 <Execute>.
 - >> Backup now starts.

6.11 Restoring all files from backup

The steps taken to restore all the files using the stored backup data in order to restore normal operation after trouble has occurred or on other such occasions will be described.

When restoration has been performed, all the files including the constant files, program files and history files (all the files in 6.2.4 Folder structure of internal memory) inside the internal memory are destroyed and replaced with the backup data files.

Restoration should be done by an operator with the qualifications class of **Expert** or above. For details on how to switch the operator qualifications, refer to the Installation Manual.



CAUTION

- 1) Do not execute backup restoration so lightly except when upgrading accompanied with replacement of the system CF or restoring after a trouble occurred.
- 2) At the shutdown after backup restoration and at the power restoration, the status restoration processing of the auto resume function (restoration of the manual status, playback and others) cannot be executed. This is one of the safety measures against the mismatch in the system configuration before and after the restoration operation.
- 3) Follow the directions described in the instruction manual for the endless rotation function to execute the backup restoration operation when the endless rotation function is used.

AX20 Controller

- 4) In the backup restoration operation, the registry data (important parameters such as the optional protect information) required for the system are also restored in addition to the files. (☞ See the page 6-28 "6.10 Backing up files".)

Therefore, execute the procedures described in the page 6-15 "6.4 Copying files" to restore the file only.

- 5) If the AX software version is AXV06.36 or after, the system memory protection function should be set to "Disabled" to restore the backup files. For details, refer to "AX20 CONTROLLER MAINTENANCE MANUAL".

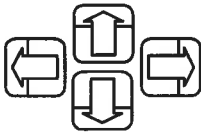
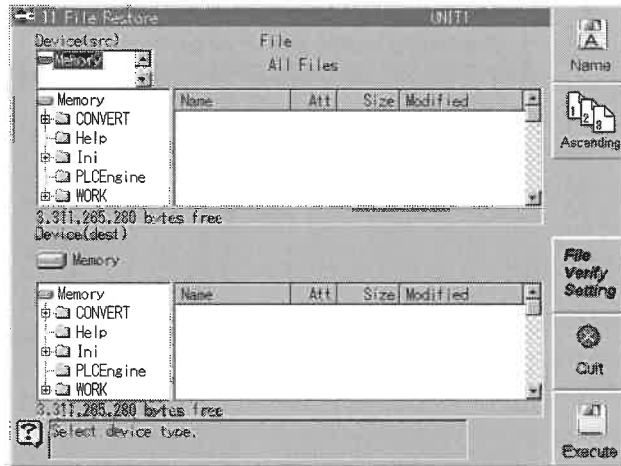
AX21 Controller

- 6) Unless the CPU board has not been changed, by using the backup restoration operation, operation programs and any other files can be restored from the time it had been backed up.
- 7) Restoring files requires a lot of time until completion. Therefore, when only restoring files, refer to the page 6-15 "6.4 Copying files".

Opening the File Restore screen



- 1 **Select "11 File Restore" on the file operation menu, and press [Enter].**
 >> The [File Restore] screen now appears.



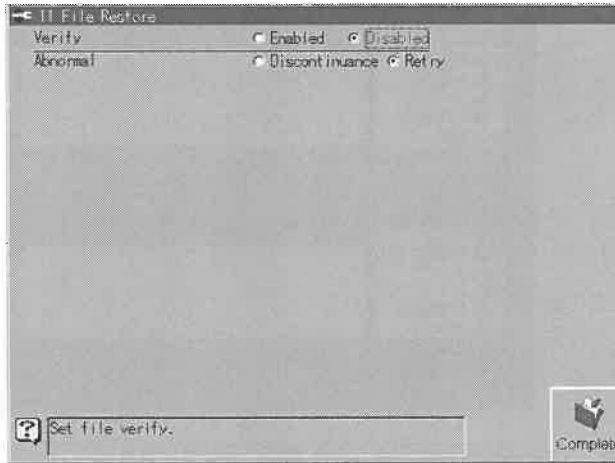
- 2 **To move through each field, use the left and right keys.**
To select the items displayed in the fields, use the up and down keys.

Setting the file verification

For this setting, operator class **Expert** or above is required.

File
Verify
Setting

- 1 **Press f-key <File Verify Setting>.**
>> The setting screen shown as below appears.



- 2 **Set the each setting.**
- 3 **After completion of the all settings, press f-key <Complete>**
>> File verification will be done using the settings on this screen when executing restoring process.

Complete

Table 6.11.1 File Verify Settings for File Restore

Parameter	Default setting	Input range	Description
Verify	Disabled	Enabled / Disabled	Set the file verification Enabled/Disabled when executing the file restore.
Abnormal	Retry	Discontinuation / Retry	Select the process to be executed when an error occurs while the file verification.

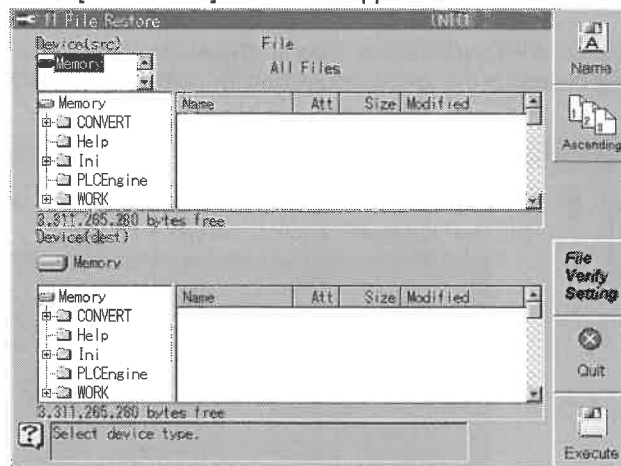
(Supplement) This item is supported on the AX system software version AXV07.8 or after.

Restoring all files from the backup

- 1 **Stop the robot, and set the motor power to OFF.**
Backup data cannot be restored while the robot is operating.
Before proceeding, the robot must be stopped and the motor power set to OFF.



- 2 **Select "11 File Restore" on the file operation menu, and press [Enter].**
>> The [File Restore] screen now appears.



- 3 **If the backup device is a CF card, for instance, select "Card1" in the device selection field.**



- 4 **Move to the folder selection field, select the folder containing the backup data to be restored, and press [Enter].**



Important

The folder in which the backup data is stored must have "read-only" attributes. (Backup folders are automatically given "read-only" attributes when data is backed up manually or automatically.)
When a CF card is accessed by the PC or other device and the attributes of a backup folder are changed to an attribute other than "read-only," the folder concerned will not be recognized as the backup source folder, and so it cannot be selected.



- 5 **Press f12 <Execute>.**
>> Backup restoration now starts.

6.12 Performing automatic backup

This function is used to back up all the files contained in the NRA2001\WORK folder at the predetermined time, day of the week and date in order to store a history of the robot's operation statuses at regular intervals. These files can also be automatically backed up when the power is turned on or when the mode is switched. By utilizing this function, the robot's operation statuses can be accurately grasped so that restoration can be initiated promptly when trouble has occurred, for example.

An operator must have the qualifications class of **Expert** or above to use this function. For the switching method of the operator qualifications, refer to the "INSTALLATION MANUAL".

Automatic backup procedure



- 1 Select "12 Automatic Backup" on the file operation menu, and press [Enter].
>> The "Automatic Backup" screen is opened.

- 2 Set the conditions listed on Table 6.12.1 below.
- 3 Upon completion of all the settings, press f12 <Execute>.
>> Automatic backup starts when the set conditions are met.



Table 6.12.1 Automatic backup settings

Parameter	Initial setting	Input range	Description of function
Dev.	Card1	Card1/Memory	This is for selecting the media that is stored backup files.
Max. backup number	0	0 to 10	This is for setting the maximum number of backup folders. Up to 10 folders can be created. Folders are given names as follows on the basis of their dates and times. (Folder name) NRA2001-2003-09-26-1834 If automatic backup is performed when the maximum number of backup folders already exists, the backup folders will be deleted one by one starting with the oldest one.
Verify	Enable	Enable/Disable	This is for setting file verification when backup files are created.
Abnormal	Discontinuanace	Discontinuanace/Retry	This is for selecting the processing to be performed when trouble has occurred during file verification.
Power on	Disable	Enable/Disable	This is for setting whether automatic backup is to be performed when the control power is turned on.
Mode change	Disable	Enable/Disable	This is for setting whether automatic backup is to be performed when the mode has been switched (from teaching to playback or vice versa).

Parameter	Initial setting	Input range	Description of function
Frequency	Disable	Disable/ Every day/ Every week/ Every month	This is for setting the automatic backup frequency.
Day	Sunday	Monday - Sunday	This is for setting the day of the week on which the data is to be backed up when "Every week" has been selected as the backup frequency.
Date	1	1 to 31	This is for setting the day of the month on which the data is to be backed up when "Every month" has been selected as the backup frequency. If 29, 30 or 31 has been set as the day of the month but the day concerned does not exist, backup will be performed at the end of the month.
Time	00:00	00:00 to 24:00	This is for setting the time at which the data is to be backed up when "Every month," "Every week" or "Every day" has been selected as the backup frequency. Automatic backup is not performed when 00:00 has been set as the time. To start backup at 00:00 AM, set "24:00."

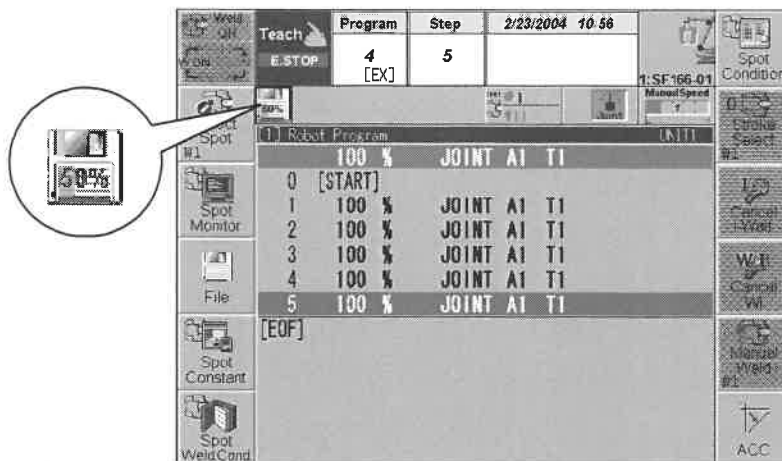


If the "Dev." is set to "Host 1" or "Host 2", the backup folder is generated on the FTP server that is set in the FTP client function. In this case, the backup folder is generated on the initial folder that is set in the FTP client function. For the details of the FTP client function, refer to the instruction manual of "Ethernet function".

Displays during automatic backup

Automatic backup is commenced when the backup execution conditions which were set on the "Automatic backup" menu are met.

When automatic backup commences, an icon appears in the message field on the status window. The progress made during automatic backup is indicated as a percentage. Upon completion of the automatic backup, the icon vanishes.



Important

If the destination device is set to "Host 1" or "Host 2", the attribute of the backup folder that will be created on the FTP server is "Read Only". And, the attribute of the initial folder on the FTP server is "Read Only"; the backup folder cannot be created. Therefore, remove the "Read Only" attribute from the initial folder on the FTP server in advance.

NOTE

Chapter 7 Useful functions

Some useful functions which are frequently used are described in this section.

7.1	Using short-cuts	7-1
7.2	Monitoring various information of the robot	7-2
7.2.1	Starting a multiple number of monitors	7-2
7.2.2	Switching and closing the monitors.....	7-4
7.2.3	Operating the Use Inputs and Outputs monitors.....	7-5
7.3	Setting the output signals ON or OFF manually	7-6
7.4	Using help for information on functions	7-7
7.4.1	Calling the help top page	7-7
7.4.2	Directly calling a function to be checked out.....	7-9
7.4.3	Searches using keywords.....	7-11
7.5	Managing programs in folders.....	7-13
7.5.1	Setting displaying the Folder list	7-13
7.5.2	Creating, deleting and renaming folders	7-16
7.5.3	Assign the stored folder inside programs.....	7-18
7.5.4	Copying and transferring programs within folders	7-19
7.6	Customizing the Softkey.....	7-20
7.6.1	Changing the Softkey Allocation	7-21
7.6.2	Changing the Maximum Number of Pages for Softkey	7-33
7.6.3	Setting the Softkey Condition Enable/Disable.....	7-34
7.6.4	Saving the Softkey Settings	7-35
7.6.5	Loading Softkey Settings from the File	7-37
7.7	Selecting a work program number from a list	7-38
7.7.1	Selecting a work program number from a list	7-38
7.7.2	Displaying programs unit by unit.....	7-40
7.7.3	Confirming the contents of the program.....	7-41
7.8	How to edit the step comment.....	7-42
7.8.1	Inputting a step comment	7-42
7.9	User error	7-44
7.9.1	Outline	7-44
7.9.2	Flow of operation	7-44
7.9.3	Settings.....	7-45
7.10	Display language change	7-48
7.10.1	Candidate language selection	7-49
7.10.2	User error file	7-50
7.10.3	I/O signal name	7-53
7.10.4	Software key name for interface panel.....	7-56

7.1 Using short-cuts

The AX20/AX21 controller comes with a short-cut function for selecting functions quickly.

Normally, even with operations where one menu is opened from another, a target operation can be quickly accessed simply by inputting a short-cut code (a number with up to 3 digits). It is a good idea to commit frequently used short-cut codes to memory.

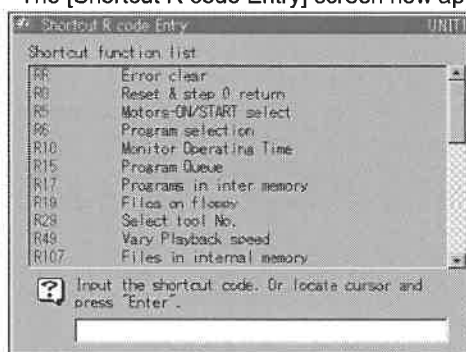
The same short-cut codes used by Nachi's conventional controllers can be used with the AX20/AX21 controller.

For details on the short-cut codes that can be used, refer to the Help function contained in the robot.

Using short-cuts



- 1 On the teach or playback mode top screen, press the [RESET/R] key.
>> The [Shortcut R code Entry] screen now appears.

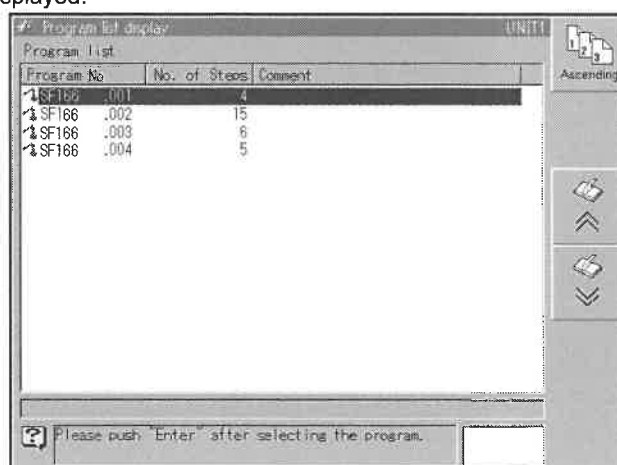


- 2 If the number of the target function is not known, press the [up or down] key.
>> The list of codes in the center of the screen is scrolled, and the usable short-cut codes (R codes) are displayed.



- 3 Align the cursor with the desired short-cut code, and press the [Enter] key.
If the number is already known, input the code number directly into the edit box at the bottom of the screen, and press the [Enter] key.

- 4 This completes the selection procedure.
The short-cut which has been input is now executed.
If, for instance, R17 (display program file list) has been input, a list of the programs of the current unit picked out from among the files stored in the internal memory is displayed.

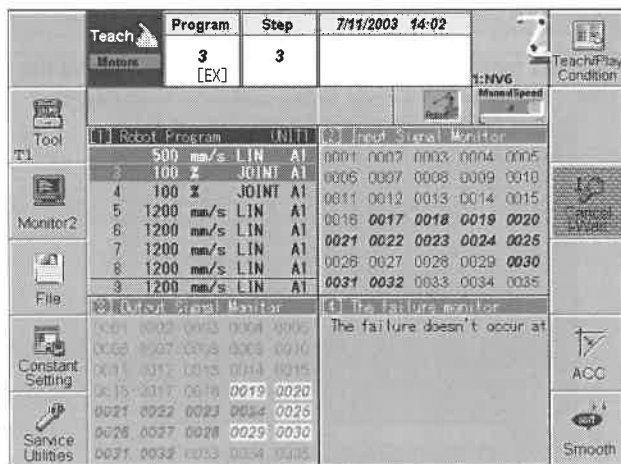


7.2 Monitoring various information of the robot

With the AX20/AX21 controller, various information of the robot can be monitored and displayed on the teach pendant.

Monitors 1 to 4 (maximum of 4) can be started and their information can be displayed simultaneously on the teach pendant. The program display screen is one of these monitors, and this is set at the factory as monitor 1. The monitor updating cycle is 100 [ms].

The next screen shows an example where all four monitors were started simultaneously. The programs are monitored on monitor 1, the general-purpose input signals on monitor 2, the general-purpose output signals on monitor 3, and trouble on monitor 4.



7.2.1 Starting a multiple number of monitors

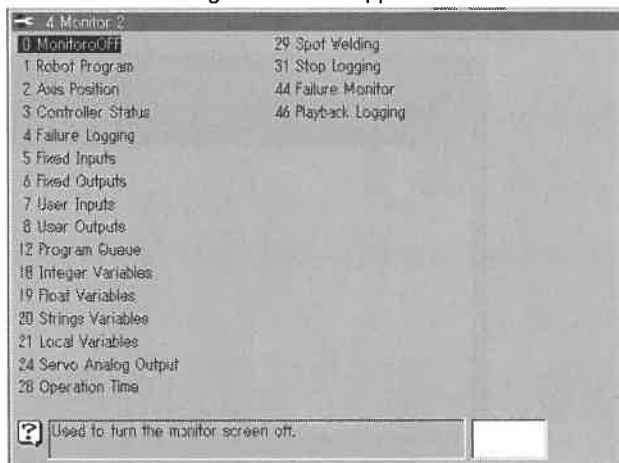
As an example, the steps taken to allocate the display of the general-purpose input signals to monitor 2 and the display of the general-purpose output signals to monitor 3 will be described.

Starting a multiple number of monitors



- The signals can easily be displayed on monitor 2 by operating an f key. Press **<Monitor 2>**.

>> The monitor 2 setting screen now appears.

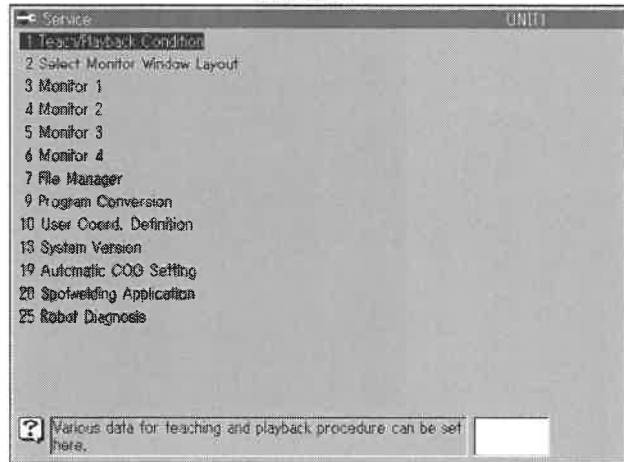




2 Align the cursor with “7 User Inputs”, and press [Enter].
 >> Monitor 2 now starts.



3 Monitor 3 is set from the service menu. Press <Service Utilities>.
 (All four monitors 1 to 4 can be set from the service menu.)
 >> The service screen now appears.



4 Select “5 Monitor 3”, and press [Enter].
 >> The monitor 3 setting screen now appears.



5 Align the cursor with “8 User Outputs”, and press [Enter].
 >> Monitor 3 now starts.



7.2.2 Switching and closing the monitors

Any one of a multiple number of monitors started can be selected to be operated or closed.

Switching and closing the monitors



- 1 To select a monitor to be operated from among a multiple number of monitors, press [CLOSE/SELECT SCREEN].

>> Each time [CLOSE/SELECT SCREEN] is pressed; the monitor which can be operated is switched.

The monitor which can be operated has a deep blue title bar.

The monitors which cannot be operated have gray title bars.

In the case of the screen shown below, monitor 1 can be operated.

When blue:
The monitor can be operated.

Monitor	Speed	Mode	Axis	Condition
1	500 mm/s	LIN	A1	T1
2	100 mm/s	JOINT	A1	T1
4	100 mm/s	JOINT	A1	T1
5	1200 mm/s	LIN	A1	T1
6	1200 mm/s	LIN	A1	T1
7	1200 mm/s	LIN	A1	T1
8	1200 mm/s	LIN	A1	T1
9	1200 mm/s	LIN	A1	T1

When gray:
The monitor cannot be operated.
(The information is updated.)



- 2 To close a monitor, select the monitor to be closed, and while holding down [ENABLE], press [CLOSE/SELECT SCREEN].

>> The monitor now selected is closed.

7.2.3 Operating the Use Inputs and Outputs monitors

When a general-purpose input or output monitor is started, the ON/OFF statuses of the general-purpose signal attributes can be viewed.

Using the general-purpose output monitor as an example, how to read the information and perform the operations on the monitor screen will be described below.

Operating the User Inputs and Outputs monitors



1 By performing the steps on page 7-2, select "8 User Outputs".

>> The statuses of general-purpose output signals 0001 to 2048 are now displayed.

Cursor

A yellow background signifies "ON" whereas a gray background signifies "OFF".

[2] Output Signal Monitor									
0001	0002	0003	0004	0005	0006	0007	0008	0009	0010
0011	0012	0013	0014	0015	0016	0017	0018	0019	0020
0021	0022	0023	0024	0025	0026	0027	0028	0029	0030
<i>0031</i>	<i>0032</i>	Emergency stopped			0036	0037	0038	0039	0040
0041	0042	0043	0044	0045	0046	0047	0048	0049	0050
0051	0052	0053	0054	0055	0056	0057	0058	0059	0060
0061	0062	0063	0064	0065	0066	0067	0068	0069	0070

The bold and italic numbers signify the robot status signals. The other numbers signify the general-purpose signals.

When the cursor is aligned here, a description of the signal is displayed.

2 There is a limit on the number of signals which can be displayed on one screen. To view the statuses of other signals, move the cursor using the up and down keys.

When the up or down key is pressed while holding down [ENABLE], one page of information can be scrolled on the screen.



3 Output signals can be turned on and off manually with the general-purpose output monitor. (You cannot turn input signals on and off with the general-purpose input monitor.)



To set the signal to ON, press [1] while holding down [ENABLE] (or press [Enter]).

>> The specified signal is now set to ON.



To set the signal to OFF, press [2] while holding down [ENABLE].

>> The specified signal is now set to OFF.

7.3 Setting the output signals ON or OFF manually

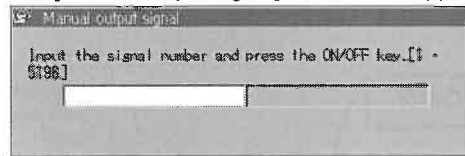
The output signals can be set to ON or OFF manually. (Each signal to be set to ON or OFF is specified using an output signal number.)

This function can be used in the teach mode or playback mode (step by step).

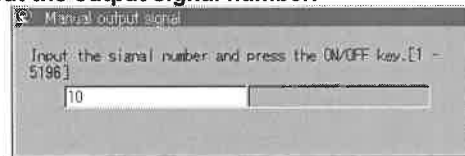
Setting the output signals to ON or OFF manually



- 1 While holding down [ENABLE], press [OUT].**
>> The [Manual output signal] screen now appears.



- 2 Input the output signal number.**



or



- 3 To set the signal to ON, press [1] while holding down [ENABLE] (or press [Enter]).**

>> The specified signal is now set to ON.



To set the signal to OFF, press [2] while holding down [ENABLE].

>> The specified signal is now set to OFF.

7.4 Using help for information on functions

The AX20/AX21 controller comes with a help function (built-in tutorial function). For information on functions, press the [HELP] key. The help function can be called not only during teaching but also during playback.

7.4.1 Calling the help top page

The best way to browse carefully through the help information from the beginning is to call the top page.

In order to call the top page, make sure that none of the functions has been selected, and press the [HELP] key.

Calling the help top page

HELP

- 1 While making sure that none of the functions has been selected, press the [HELP] key.

>> The help top page now appears.

This is the table of contents for help

- Select the desired item using the [Up/Down] key, and press [Enter].
- The information for the selected item appears in the window on the right.
- If the table of contents is partially covered by the window and cannot be read, press the [Left/Right] key.

The current mode, program number and step number are displayed here.

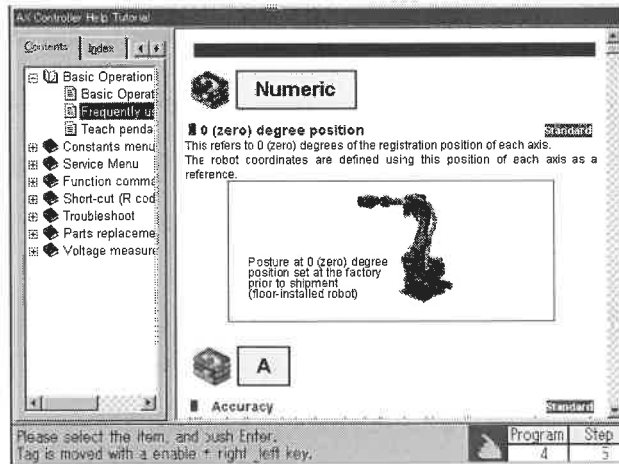
This is the help text.

- Once the item in the table of contents has been selected, press [CLOSE/Select screen] to set the window to active.
- The window can be scrolled up or down using the [Up/Down] key.
- Pages can be scrolled backward or forward using [ENABLE] and the [Up/Down] key.



2 Select the item to be viewed using the [Up/Down] key, and press [Enter].

>> The selected item now appears on the right.
For instance, select "Frequently used terms" under Basic Operations Manual to obtain the following.



3 To manipulate the window showing the text information, press [CLOSE/Select screen].

>> The text window is set to active.
To return to the table of contents window, press [CLOSE/Select screen] again



OR



4 To scroll up or down, press [Up/Down].

The text can be scrolled quickly by press [Up/Down] together with [ENABLE].



OR



5 To close help, either press [RESET/R] or press [ENABLE] and [CLOSE/Select screen].

7.4.2 Directly calling a function to be checked out

For information on the constants menu, service menu, function commands or shortcuts, select the menu, and then press the [HELP] key. The help text concerned is displayed straight away.

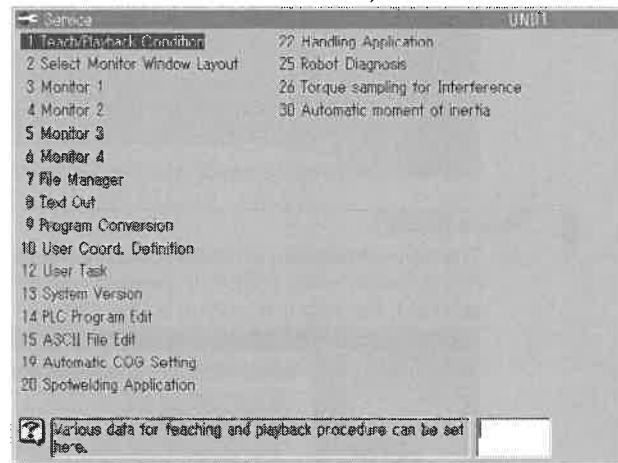
Directly calling a function to be checked out

1 Align the cursor bar with the menu.



When the constants menu or service menu has been selected

Align the cursor bar with the menu to be checked out. (The screen shown appears when the service menu is selected.)



When a function command has been selected

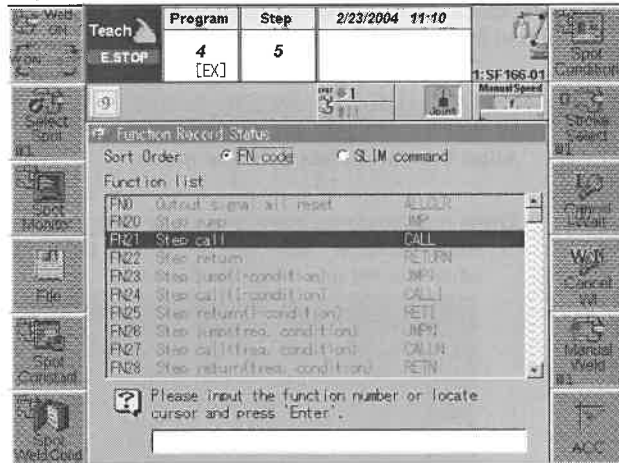
First press [FN] on the top screen of the teach/playback mode, and then align the cursor bar with the function command which is to be checked out.





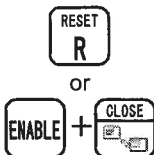
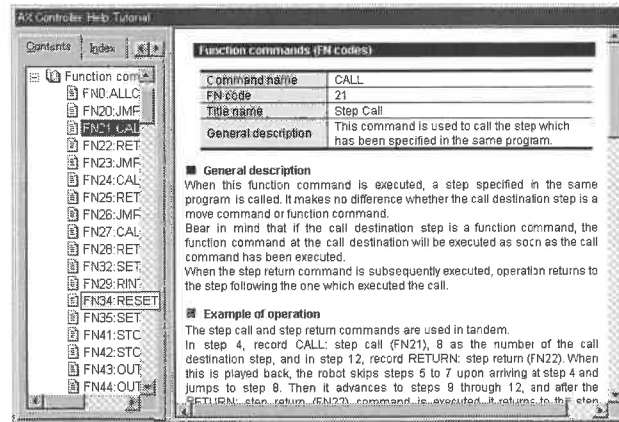
When a shortcut has been selected

First press [RESET/R] on the top screen of the teach/playback mode, and then align the cursor bar with the function command which is to be checked out.



2 Press [HELP].

>> The help information on the selected menu item appears on the right. For instance, when [HELP] is pressed with the "FN21: Step call" function command selected, the help information on the step call command (FN21) is displayed.



3 To close help, either press [RESET/R] or press [ENABLE] and [CLOSE/Select screen].

7.4.3 Searches using keywords

Help information can also be searched using the index prepared in advance or any keyword.

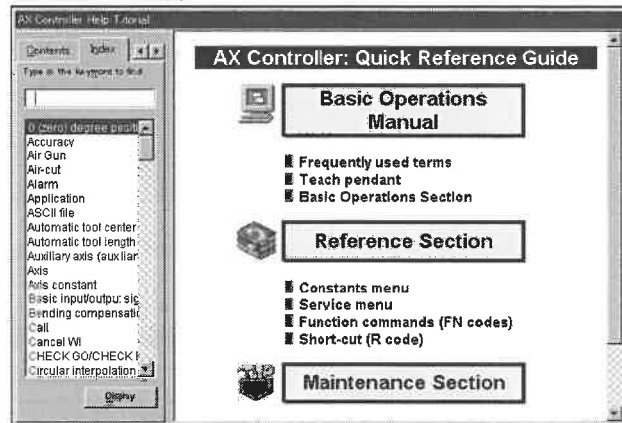
Searching using a keyword



- 1 Press [HELP].**
>> This calls help.



- 2 While holding down [ENABLE], press [Right], and select the "Index" tab.**
>> The index tab appears.



- 3 The index tab has the same function as an "Index" at the end of an instruction manual.**

Select the term using [Up/Down], and press [Enter].

>> The help information contained the selected word now appears

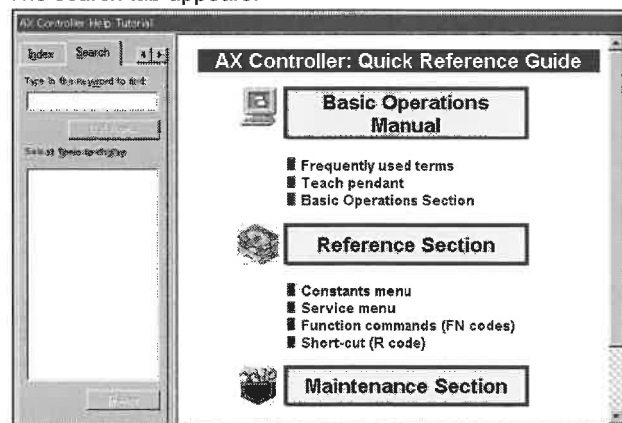
When inputting a keyword (term) to initiate a search, press [EDIT] in the "Type in the keyword to find:" field. A soft keyboard appears so that the desired keyword can now be input using its keys.

If, however, the input keyword is not included in the index, the search will not be successful. Searches can be conducted only using the keywords which have been registered in the index.

Take the following steps to search for all the help information using a particular keyword.



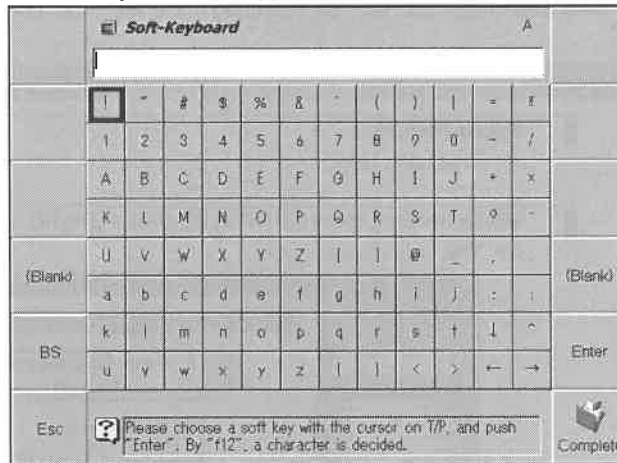
- 4 While holding down [ENABLE], press [Right], and select the "Search" tab.**
>> The search tab appears.





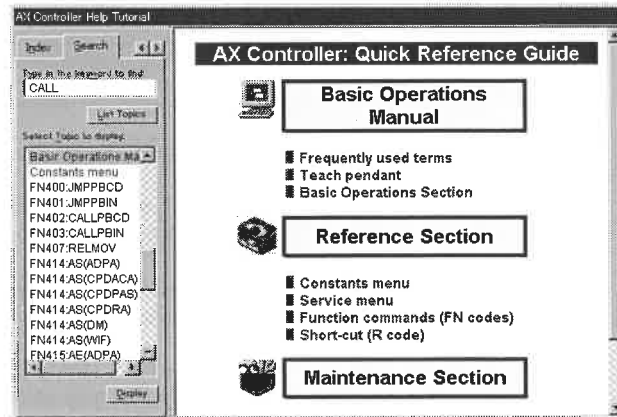
5 Align the cursor with the “Type in the keyword to find:” field, and press [EDIT].

>> The soft keyboard now appears.



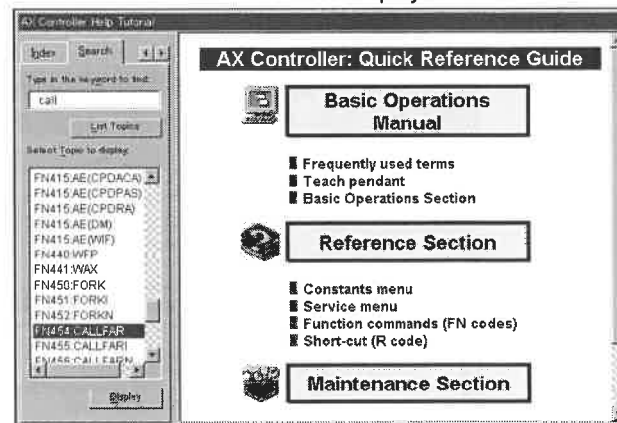
6 Use the keys on the soft keyboard to input the desired keyword, and press f12 <Complete>.

>> The help topics containing the keyword are now displayed.



7 While holding down [ENABLE], press [Up/Down], and move to the “Select Topic to display:” field.

>> Check that the blue cursor bar is displayed.



8 Select the help topic to be displayed using [Up/Down], and press [Enter].

>> The help is now displayed.

7.5 Managing programs in folders

The AX20/AX21 robot controller comes with a function for managing programs in folder. When there are many programs, you can create folders according to use and store organized related programs in folder, which is useful to find out the programs easily. The programs which are stored in folders can perform playback operation and teach modification.

(Supplement)

In case of AX20, this function is supported in AXV08.02 or after.



Important

When managing the programs in folders, there are constraints as following.

- The folders which can manage programs, which is a hierarchical folder of less than (5.5) that is in PROGRAM folder of a memory (fig 6.2.2).
- The programs cannot be stored overlapping a program number in these folders.
- The programs stored in except these folders cannot be performed playback operation and teach modification.

7.5.1 Setting displaying the Folder list

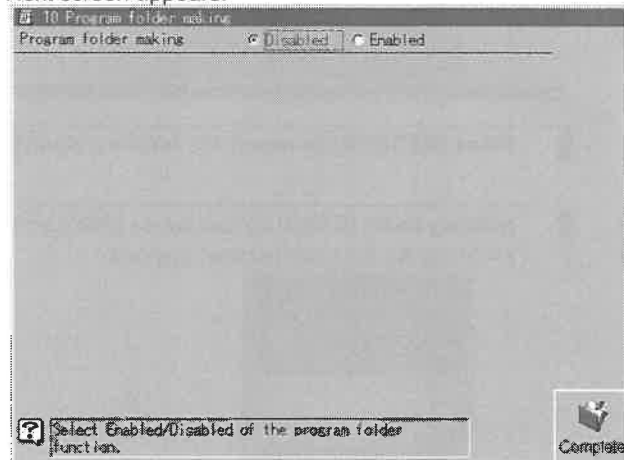
To manage the programs in folders are necessary setting as follows. This setting should be done by an operator with the qualifications class of **Expert** or above.

Setting displaying the Folder list



- 1 Press f5<Constant setting>. Select [5 Operation Constants] - [10 Program folder making] in the constant menu.

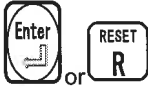
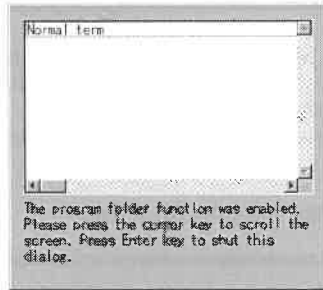
>> Next screen appears.



- 2 Align the cursor with "Program folder making" and holding down [ENABLE] and press [→] to switch into "Enabled".



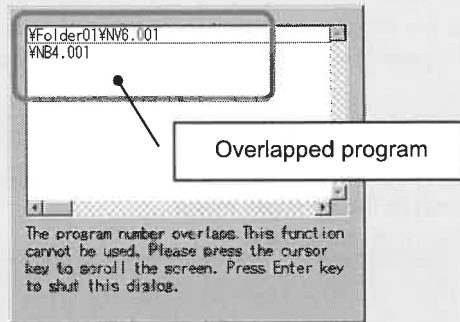
- 3 After switching "Enabled", press f12<Complete>.
 - >> The screen which is noticed the setting completion appears.



Press [Enter] or [RESET/R] to be completed the screen



When the program number overlaps, next screen is displayed as following. Then the "Program folder making" cannot be used. In this case, the overlapped programs are displayed. Therefore delete these any of programs or change the program number.



- 4 Press [RESET/R] to return the former screen 1.



- 5 Holding down [ENABLE] and press [PROG/STEP].
 - >> [Program Selection] screen appears.

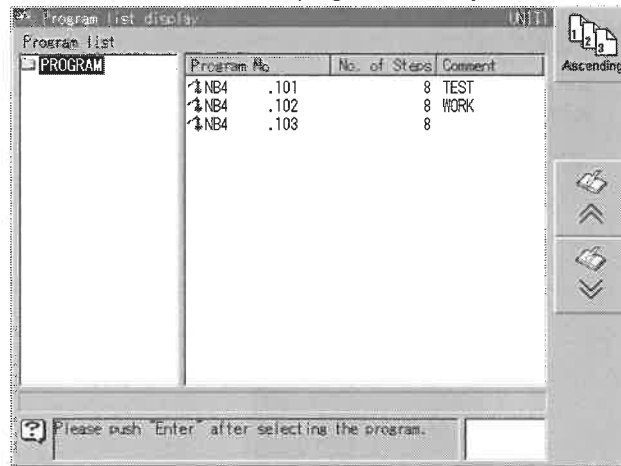


- 6 Holding down [ENABLE] and press [←].
 - >> "Folder list" switches into "Display".



7 When displaying a list of the folders align the cursor with "Directory" and press [Enter].

>> The programs which have done to create are displayed.
You can confirm the stored programs in every folder.



7.5.2 Creating, deleting and renaming folders

You can create the folders to be stored the programs, delete and rename the folders.

Creating folders

As an example, the procedures of creating a new folder below the PROGRAM folder are as follows.



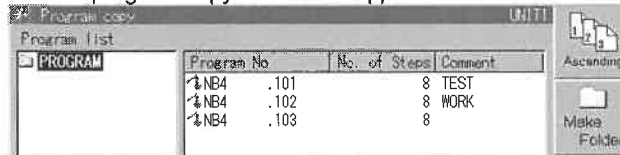
1 Holding down [ENABLE], press [PROG/STEP].

>> The program selection screen will open.



2 Align the cursor to "Copy" and press [Enter].

>> The program copy screen will appear.



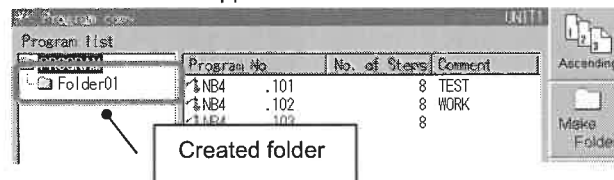
3 After the PROGRAM folder has been selected, press f8 <Make Folder>.

>> The soft keyboard appears and entering characters will become possible.

4 By using the soft keyboard, name the folder and press f12 <Complete>.

In this section, the created folder has been named "Folder01".

>> The new folder will appear below the PROGRAM folder.



Refer to Chapter 2 "2.5 To input characters" for the procedures of entering characters.

Renaming folders

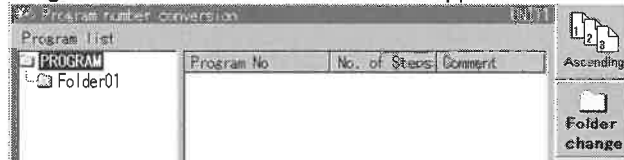
As an example, the procedures of renaming a new folder below the PROGRAM folder are as follows.



- 1 Holding down [ENABLE], press [PROG/STEP].**
>> [Program Selection] screen appears.



- 2 Align cursor to "Rename" and press [Enter].**
>> "Program number conversion" screen will appear.

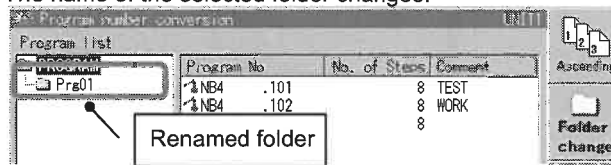


- 3 After selecting the folder that is to be changed, press f8<Folder change>.**
In this section, the selected folder is "Folder01".
>> The soft keyboard appears and entering characters will become possible.



- 4 Using the soft keyboard, enter the name of the folder that is to be changed and press f12<Complete>.**

In this section, the name entered for the folder is "Folder01".
>> The name of the selected folder changes.



Refer to Chapter 2 "2.5 To input characters" for the procedures of entering characters.

Deleting folders

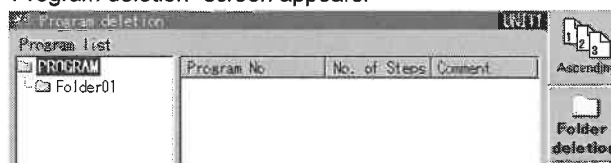
As an example, the procedures of deleting the folder listed below the PROGRAM folder will be described.



- 1 Holding down [ENABLE], press [PROG/STEP].**
>> "Program selection" screen appears.



- 2 Align cursor to "Delete" and press [Enter].**
>> "Program deletion" screen appears.



- 3 After selecting the folder that is to be deleted, press f8<Folder deletion>.**
In this section, the selected folder is "Folder01".
>> Confirmation screen appears.



- 4 Select "OK" and press [Enter].**
>> The selected folder and the programs stored inside it will be deleted.

7.5.3 Assign the stored folder inside programs

When a newly teaching, the stored folder inside programs that will be created is assigned

Assign the stored folder inside programs

1 Select the Teach mode.



2 Holding down [ENABLE], press [PROG/STEP].

>> "Program selection screen" appears.

Input a newly number



3 Input the newly program number into "Designated program", and press [Enter].

>> "Folder list display" appears.



Input an existing number



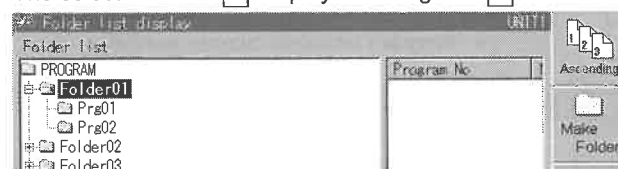
When inputting an existing number and press [Enter], the assigned program is opened directly. "Folder list display" does not appear.



4 When displaying an underneath folder, select **+** folder and press [Enter].

>> The underneath folder which is selected in folder is developed.

The selected folder **+** display is turning into **-**.



5 When an underneath folder makes no display, select **-** folder and press [Enter].

>> The underneath folder which is selected is stored.

The selected folder **-** display is turning into **+**.



6 After select the stored folder, press f12<Execute>.

>> The program is created on the selected folder.



When you do not know an empty number.

When you do not know an empty number, once try to switch the Folder list display "Hide" on the program selection screen.

After switching, check the programs already created by listing them on the display.

Refer to Chapter 4 "4.2.2 Listing the programs on the display."

7.5.4 Copying and transferring programs within folders

The programs can be copied and transferred into other folders. These functions are useful when organizing the programs in the stored folders.

Copying and transferring programs within folders

The copied programs can be copied the selected programs into the assigned folders. Also the transferred programs can be transferred into the assigned folders with the same procedure as copying. How to transfer the programs are described here.



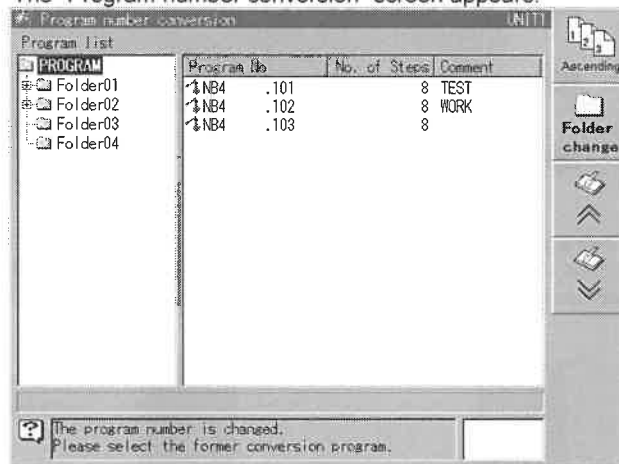
1 Holding down [ENABLE] and press [PROG/STEP].

>> The "program number conversion" screen appears.



2 Align the cursor with "Rename" and press [Enter].

>> The "Program number conversion" screen appears.



3 When displaying an underneath folder, select $\boxed{+}$ folder and press [Enter].

>> The underneath folder which is selected in folder is developed.
The selected folder $\boxed{+}$ display is turning into $\boxed{-}$.



4 When an underneath folder makes no display, select $\boxed{-}$ folder and press [Enter].

>> The underneath folder which is selected is stored.
The selected folder $\boxed{-}$ display is turning into $\boxed{+}$.

5 Select the transferred source folder is selected.

>> The selected folder is highlighted in blue.

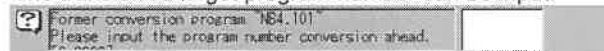
6 The transferred target program is selected.

>> The selected folder is highlighted in blue.



7 Press [Enter].

>> The transferred target program number can be input.



8 The transferred target folder can be selected.

>> The selected folder is highlighted in blue.

Input number

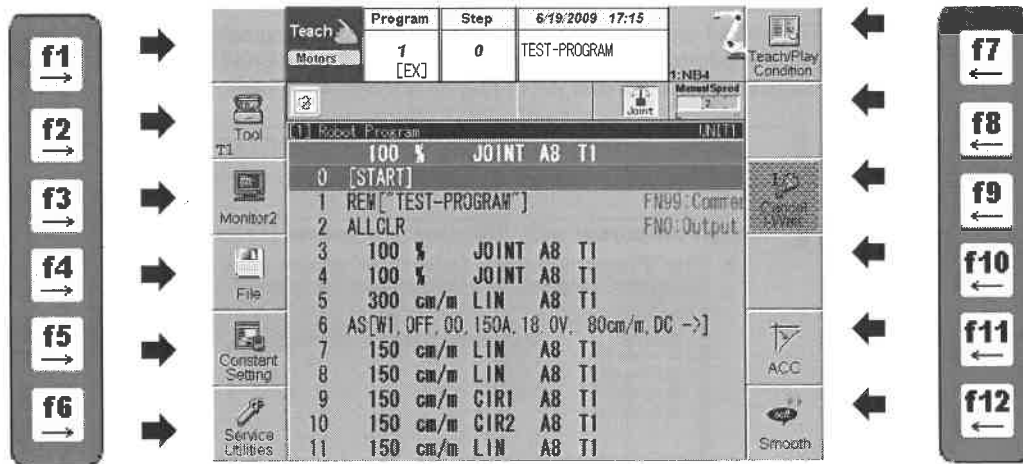


9 Input the transferred target program number and press [Enter].

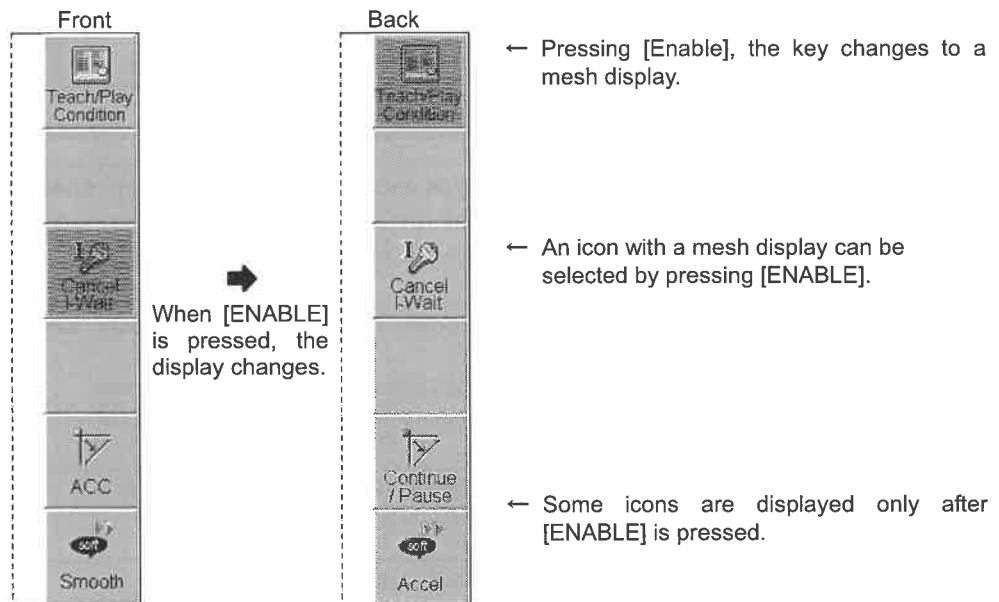
>> The programs are transferred and then put back the original screen.

7.6 Customizing the Softkey

Teach pendant is provided with 12 f-keys (f1 to f12) on its both sides of the screen. As various functions can be allocated for these f-keys, we call each of them a softkey. It is available to set up the softkey respectively for Teach mode and Playback mode. Usually, the most suitable function for each application is allocated by default.



There are two ways for the softkey allocation both on the front and the back, which the front allows to operate only by the softkey while the back, using both [Enable] key and f-key by pressing at the same time. However, you will sometimes find it only allowed on the back depending on the function of that key.



Also, it is available to set [Disable] on the softkey operation to make it disable the "Back" allocation.

7.6.3 Setting the Softkey Condition Enable/Disable



Types of softkey

Two types are available; Function and Operation switch.

Function	Functions such as various settings, R-code, Function commands are allocated.
Operation switch	This key allows to display and operate the lamp, switches, and status of signals.

7.6.1 Changing the Softkey Allocation

For the softkey setting, select the icon from the list for each corresponding function, and allocate it for each softkey.

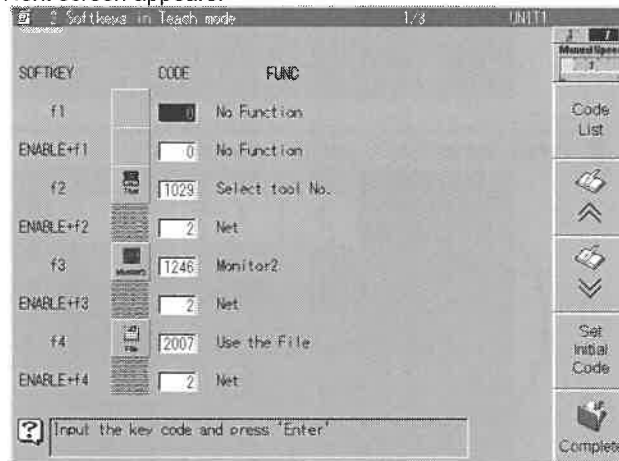
Changing the Function key



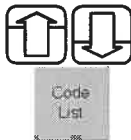
- 1 Press **f5**<Constant setting> and select **[7. T/P key]**.
Choose either **[2. Softkeys in Teach mode]** or **[3. Softkeys in Playback mode]** depending on the mode to set up the softkey.

* Currently, **[4. Softkeys in High Speed Teach mode]** is not available.

>> Next screen appears.

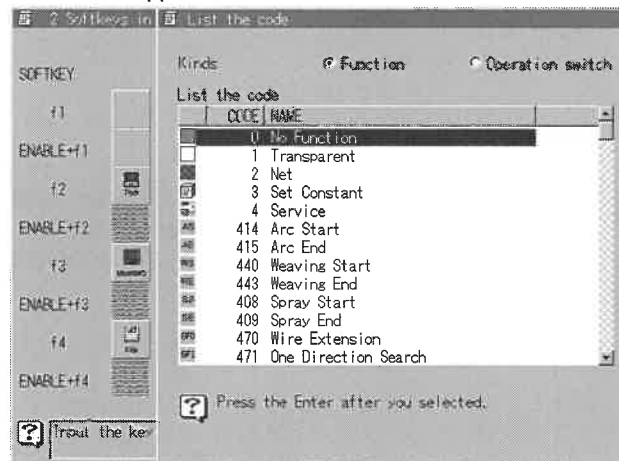


If you already know the code number of function, enter the number directly in the code field.



- 2 If you are not sure about the code number, select the softkey to be set using **[UP/DOWN]** key, and press **f8**<Code List>.

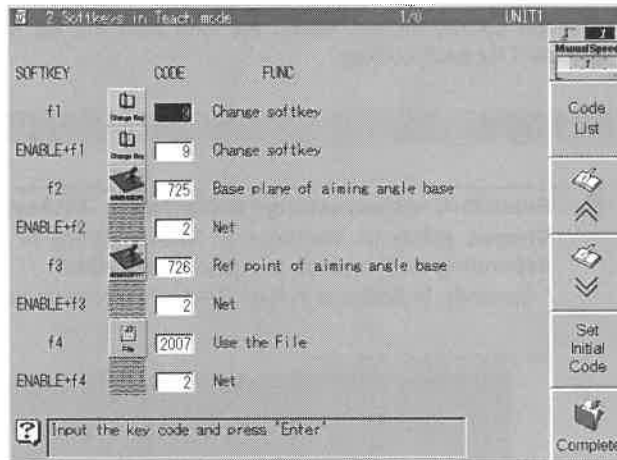
>> Next screen appears.



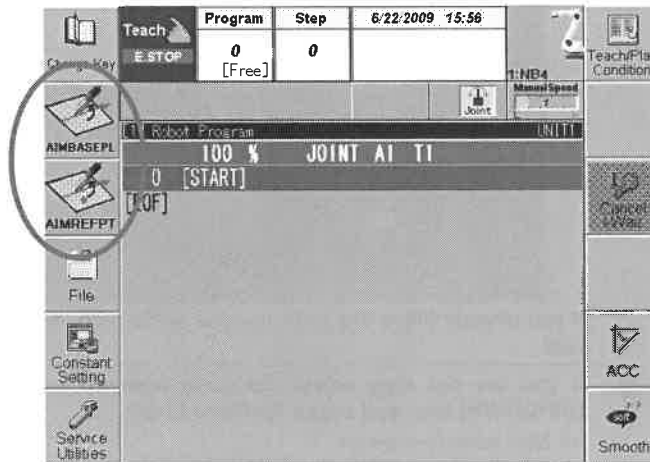
Select the function by **[UP/DOWN]** key, and confirm by pressing **[Enter]** key.



- 3 On completion of the code setting, press f12<Complete>.
 - » Then, the softkey setting is saved.





- 4 Now, the softkey is set as shown below.



Setting the operation switch is also available in the same way.
 Setting the Operation switch

Table 7.6.1 List of softkey functions

Code	Function Name	Icon	Teach	Play back	Code	Function Name	Icon	Teach	Play back
0	No Function		○	○	490	Start Laser Sensor Tracking		○	○
1	Transparent		○	○	491	End Point Detecting		○	○
2	Net		○	○	492	End Laser Sensor Tracking		○	○
3	Set Constant		⊙	○	495	Groove point Detecting		○	○
4	Service		⊙	⊙	725	Base plane of aiming angle base		○	○
408	Spray Start		○	○	726	Ref point of aiming angle base		○	○
409	Spray End		○	○	1005	Select Starting		○	○
414	Arc Start		○	○	1006	Select Program		○	○
415	Arc End		○	○	1029	Select tool No.		○	○
440	Weave Start		○	○	1245	Monitor1		○	○
443	Weave End		○	○	1246	Monitor2		○	○
470	Wire Extension		○	○	1247	Monitor3		○	○
471	One Direction Search		○	○	1248	Monitor4		○	○
473	Deviation call		○	○	1288	Wrist posture limit		○	○
474	Dev Composition		○	○	1295	Connect Mec		△	×
479	Gap file generation		○	○	1296	Change Mec		△	×
480	One Direction search (Laser)		○	○	1315	Select Spot		○	○
483	Groove Detection Search		○	○	1320	Step Go/Back		○	○
487	Laser Sensor ON		○	○	1334	Record the spot		○	○
488	Laser Sensor OFF		○	○	1400	Oscillo Scope		○	○
489	Start point Detecting		○	○	1503	Log In		○	○

Code	Function Name	Icon	Teach	Play back	Code	Function Name	Icon	Teach	Play back
2000	Drive Mode		<input type="radio"/>	<input type="radio"/>	2069	Step by Step		<input type="radio"/>	<input type="radio"/>
2001	Cancel I-Wait		<input type="checkbox"/>	<input type="checkbox"/>	2070	Arc Weld ON		<input type="radio"/>	<input type="radio"/>
2002	Cancel WI		<input type="checkbox"/>	<input type="checkbox"/>	2071	Weaving ON		<input type="radio"/>	<input type="radio"/>
2003	High Override		<input type="radio"/>	<input type="checkbox"/>	2072	External Signal ON		<input type="radio"/>	<input type="radio"/>
2004	Select Step By Step		<input type="radio"/>	<input type="radio"/>	2073	Sensor ON		<input type="radio"/>	<input type="radio"/>
2007	Use the file		<input type="radio"/>	<input type="radio"/>	2080	Change Stroke		<input type="radio"/>	<input type="radio"/>
2011	Accuracy		<input type="radio"/>	<input type="radio"/>	2081	Spot Condition		<input type="radio"/>	<input type="radio"/>
2012	Continue/pause select		<input type="radio"/>	<input type="radio"/>	2082	Spot Constant		<input type="radio"/>	<input checked="" type="radio"/>
2013	Accel		<input type="radio"/>	<input type="radio"/>	2084	Manual Pressur		<input type="radio"/>	<input type="radio"/>
2014	Smooth		<input type="radio"/>	<input type="radio"/>	2085	Status Monitor		<input type="radio"/>	<input type="radio"/>
2015	Speed Mechanism Change		<input type="radio"/>	<input type="radio"/>	2086	Spot Weld. Cond.		<input type="radio"/>	<input type="radio"/>
2016	Conveyor status ON/OFF		<input type="radio"/>	<input type="radio"/>	2087	Station Monitor		<input type="radio"/>	<input type="radio"/>
2017	Conveyor mode change		<input type="radio"/>	<input type="radio"/>	2088	Manual welding		<input type="radio"/>	<input type="radio"/>
2018	Fine motion select		<input type="radio"/>	<input type="radio"/>	2089	Panel rigid type select		<input type="radio"/>	<input type="radio"/>
2053	Weld ON/OFF		<input type="radio"/>	<input type="radio"/>	2090	Change Stroke 1		<input type="radio"/>	<input type="radio"/>
2054	Spot Monitor		<input type="radio"/>	<input type="radio"/>	2091	Change Stroke 2		<input type="radio"/>	<input type="radio"/>
2058	Gun Status		<input type="radio"/>	<input type="radio"/>	2092	Change Stroke 3		<input type="radio"/>	<input type="radio"/>
2064	Station start setting		<input type="radio"/>	<input type="radio"/>	2093	Change Stroke 4		<input type="radio"/>	<input type="radio"/>
2065	Ret Condition		<input type="radio"/>	<input type="radio"/>	2094	Change Stroke 5		<input type="radio"/>	<input type="radio"/>
2066	Play condition		<input type="radio"/>	<input type="radio"/>	2095	Change Stroke 6		<input type="radio"/>	<input type="radio"/>
2067	Select Stroke		<input type="radio"/>	<input type="radio"/>	2096	Manual Pressure 1		<input type="radio"/>	<input type="radio"/>
2068	Select starting and program		<input type="radio"/>	<input type="radio"/>	2097	Manual Pressure 2		<input type="radio"/>	<input type="radio"/>

Code	Function Name	Icon	Teach	Play back	Code	Function Name	Icon	Teach	Play back
2098	Manual Pressure 3		○	○	2160	Seam manu. rotation		△	△
2099	Manual Pressure 4		○	○	2161	Seam manu. rot. sel.		○	○
2100	Manual Pressure 5		○	○	2162	Seam manu. rot. Dir.		○	○
2101	Manual Pressure 6		○	○	2163	Seam manu. weld		△	△
2102	Manual welding 1		○	○	2200	Select arc welder		○	○
2103	Manual welding 2		○	○	2201	Select Manipulator		○	○
2104	Manual welding 3		○	○	2202	Inching (Low speed)		○	○
2105	Manual welding 4		○	○	2203	Retract (Low speed)		○	○
2106	Manual welding 5		○	○	2204	Inching (High speed)		○	○
2107	Manual welding 6		○	○	2205	Retract (High speed)		○	○
2108	Manual Cond Out 1		○	○	2206	Check gas		○	○
2109	Manual Cond Out 2		○	○	2207	Arc Constant		○	○
2110	Manual Cond Out 3		○	○	2208	Arc Condition		○	○
2111	Manual Cond Out 4		○	○	2209	Arc Monitor		○	○
2112	Manual Cond Out 5		○	○	2210	AS Monitor		○	○
2113	Manual Cond Out 6		○	○	2211	Restart method in Play mode		○	○
2114	Stop Playback		○	○	2212	Recover to stopped position		○	○
2115	Weld schedule		○	○	2213	Recover pos. after step set		○	○
2116	Adjust position		○	○	2214	Select sensor		○	○
2120	Manual Speed INC.		○	○	2215	Trial Operation		○	○
2121	Manual Speed DEC.		○	○	2216	Manual Laser		○	○
2150	Vision mode switch		○	○	2217	Check Welding		○	×

Code	Function Name	Icon	Teach	Play back	Code	Function Name	Icon	Teach	Play back
2218	SF2/ZF2 Check-Go		○	×	2401	Sealing flow		△	△
2219	Robot RS ON/OFF		○	○	2402	Sealing reload		△	△
2220	APCS Adjust		○	○	2500	Int. play start		×	△
2221	MOVEX Record (Robot language)		○	○	2510	XYZ shift		○	○
2222	Pilot arc ON/OFF		○	○	2511	Wrist Rotate Change		○	○
2223	Purge ON/OFF		○	○	2520	User Help		○	○
2224	ZF1/ZF2 Distance Data		○	○	2525	Test tracking ON		○	○
2225	ZG1 Groove Data		○	○	2529	FLEX hand Clamp		△	△
2253	Manual Grip		△	×	2530	FLEX hand Clamp1		△	△
2300	Select thermal spraying		○	○	2531	FLEX hand Clamp2		△	△
2301	Thermal spraying Constant		○	○	2532	FLEX hand Clamp state		○	○
2302	Thermal spraying Constant		○	○	2533	FLEX hand Clamp state 1		○	○
2303	Thermal spraying Monitor		○	○	2534	FLEX hand Clamp state 2		○	○
2304	Thermal spraying ON/OFF		○	○	2535	FLEX hand Clamp Side		○	○
2305	Stopping release		○	○	2536	FLEX hand Hand select		○	○
2400	Sealing condition		○	○					

- : Setting available
 ◎ : Setting required
 × : Setting unavailable
 △ : Necessary to press [Enable]. (When the [Enable] is set ON.)



Important

About the function marked "◎"

Be sure to set up the function marked "◎". Otherwise, the softkey setting cannot be completed.



Important

About the function marked "△"

When [Enable] is set, it is not available to allocate the function (△) to "Front" to avoid wrong operation.

To allocate the function (△) when [Disable] is set, the operator qualification of **EXPERT** or higher is required.

For details of the softkey condition setting Enable/Disable, see the "7.6.3 Setting the Softkey Condition Enable/Disable".

Setting the Operation switch

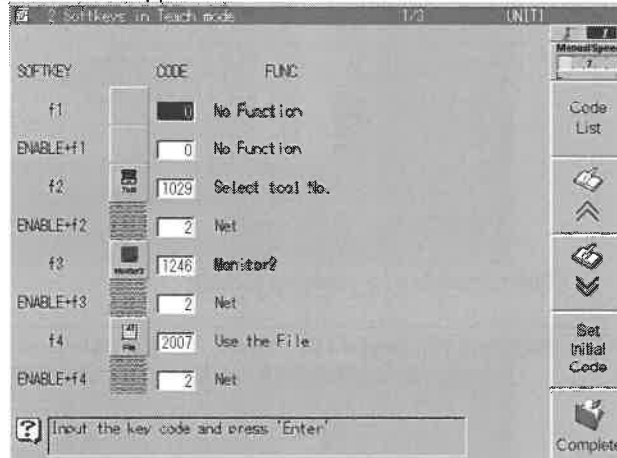
There are various types of operation switch, which allows to set the color, signal, indicated messages, etc.



1 Press f5<Constant setting> and select [7. T/P key].

Choose either [2. Softkeys in Teach mode] or [3. Softkeys in Playback mode] depending on the mode to set up the softkey..

>> Next screen appears.



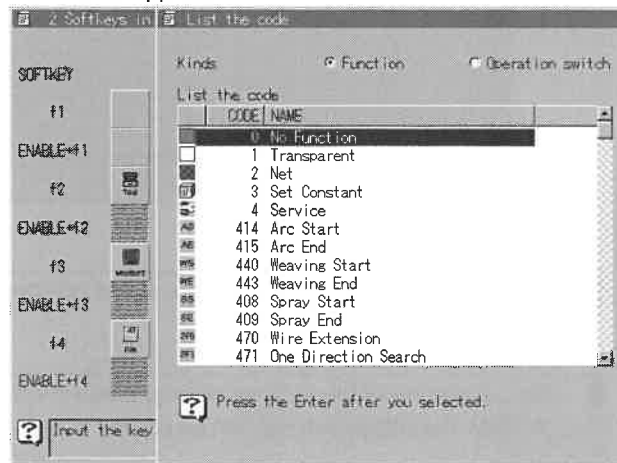
If you already know the code number, enter the number directly in the code field.

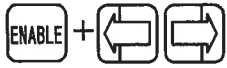


Code List

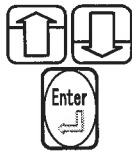
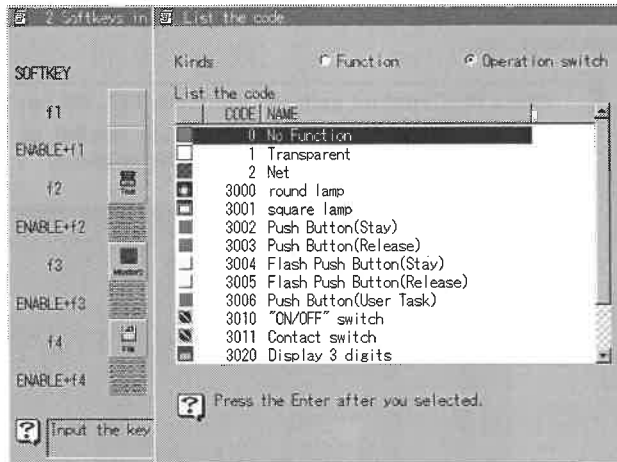
2 If you are not sure about the code number, select the softkey to set using [UP/DOWN] key, and press f8<Code List>.

>> Next screen appears.

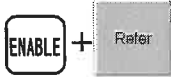




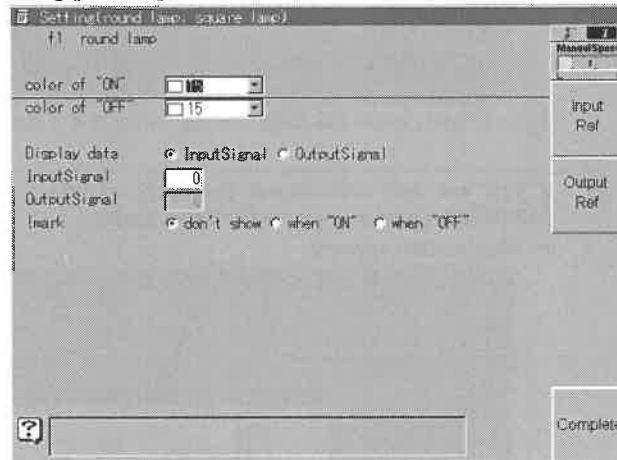
3 Select the desired Operation switch by pressing [Enable] + arrow key.
 >> Next screen appears.



Then, confirm it by pressing [Enter].



4 Pressing [Enable] + f10<Refer>, set the details of each operation switch.



Now, each detail can be set.
















5 On completion of the detail setting, press f12<Complete>.



6 On completion of the softkey setting, press f12<Complete>.

>> Now, the softkey settings can be saved.

Table 7.6.2 List of softkey operation switches

Code	Operation switch Name	Icon	Teach	Play back	Code	Operation switch Name	Icon	Teach	Play back
3000	Round lamp		○	○	3011	Contact switch		○	○
3001	Square lamp		○	○	3020	Display 3 digits		○	○
3002	Push button (Stay)		○	○	3021	Display 6 digits		○	○
3003	Push button (Release)		○	○	3030	Input 3 digits		○	○
3004	Flash Push Button (Stay)		○	○	3031	Input 6 Digits		○	○
3005	Flash Push Button (Release)		○	○					
3006	Push Button (User task)		○	○					
3010	ON/OFF switch		○	○					

○ : Setting available

◎ : Setting required

× : Setting unavailable

△ : Necessary to press [Enable]. (When the [Enable] is set ON.)

Round/ Square Lamp

Indicates the status of input or output signal

Item	Contents
Color of ON	Lamp color when the signal is ON.
Color of OFF	Lamp color when the signal is OFF.
Display data	Selection of input /output signal
Input Signal	Input signal No. to indicate
Output Signal	Output signal No. to indicate
! mark	Timing to indicate the mark "!"

Push Button

Outputs the preset signal

Item	Contents
Color of ON	Lamp color when the signal is ON.
Color of OFF	Lamp color when the signal is OFF.
Output Sig.	Signal No. to be output when the button pressed
! mark	Timing to indicate the mark "!"

Flash Push Button

Outputs not only the status of input or output signal but also the preset signal

Item	Contents
Color of ON	Lamp color when the signal is ON.
Color of OFF	Lamp color when the signal is OFF.
Display data	Selection of input/output signal
Input Signal	Input signal No. to indicate
Output Signal	Output signal No. to indicate
Output Sig.	Signal No. to be output when the button pressed
Operation method	Choice of operation whether the [Enable] key needs to be pressed together
! mark	Timing to indicate the mark “!”
Disabled operate	Setting whether to disable the operation according to the status of common switch
Touch Panel key	Setting whether to disable the button operation on the touch panel

Push Button (User task)

Executes the user tasks

Item	Contents
Color of ON	Lamp color when the signal is ON.
Color of OFF	Lamp color when the signal is OFF.
User Task Prog. No.	Signal No. to be output when the button pressed
! mark	Timing to indicate the mark “!”

ON/OFF switch

Switches the output signal ON/OFF

Item	Contents
Base color	Color of switch base
Lever Color	Color of switch lever
The place of ON	Setting the position to place “ON” whether on the right or the left side of the switch
Output Sig.	Output signal number
Operation method	Choice of operation whether the [Enable] key needs to be pressed together when changing the status
Disabled operate	Setting whether to disable the operation according to the status of common switch

Contact switch

Switches ON/OFF of two output signals

Item	Contents
Base color	Color of switch base
Lever Color	Color of switch lever
Output Signal1	Output signal No. of the output signal 1
Output Signal2	Output signal No. of the output signal 2
Operation method	Choice of operation whether the [Enable] key needs to be pressed together when changing the status
Disabled operate	Setting whether to disable the operation according to the status of common switch

Display 3 digit

Indicates the input/output signal and the variable integer by 3 digits

Item	Contents
Base color	Color of display base
Display data	Choosing the data to display out of the following. - Input Signal - Output Signal - Variable Integer
Method of read	Choosing the data format to read out of the following. - Binary - BCD
Input Signal	Setting the input signal to indicate by 12bit. The data format is as preset by "Method of read".
Output Signal	Setting the output signal to indicate by 12bit. The data format is as preset by "Method of read".
Variable integer	Setting the variable integer No. to indicate.

Input 3 digit

Inputs the output signal and the variable integer by 3 digits

Item	Contents
Base Color	Color of display base
Method of Output	Choosing the data format to read out of the following. - Binary - BCD
Output Sig	Setting the output signal to indicate by 12bit. The data format is as preset by "Method of read".
Disabled operate	Setting the variable integer No. to indicate.

Restoring the softkey to the default



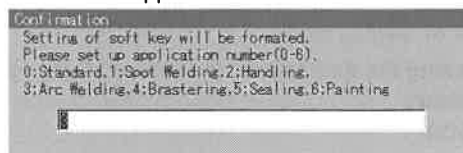
- 1 Press f5<Constant setting> and select [7. T/P key].
Choose either [2. Softkeys in Teach mode] or [3. Softkeys in Playback mode] depending on the mode of softkey to set up.

>> Next screen appears.



- 2 Press f11<Set initial Code>.

>> Next screen appears.



Enter the number corresponding to the application currently in use, and press [Enter].

- 0: Standard (The case of the application is not 1 to 6)
- 1: Spot welding
- 2: Handling
- 3: Arc welding
- 4: Thermal spraying
- 5: Sealing
- 6: Painting

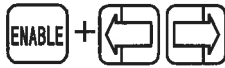


- 3 The default of softkey corresponding to the application chosen is now set. Then, press f12<Complete>.

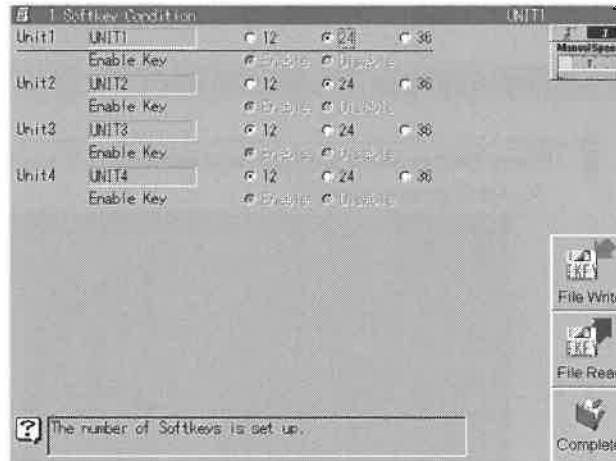
7.6.2 Changing the Maximum Number of Pages for Softkey

The softkey setting allows the maximum of 3 pages. Applying 3 pages (36), it is available to set up the maximum of 72 (sum of the front and back) softkeys.

Changing the maximum number of pages for softkey



- 1 Press **f5**<Constant setting> and select **[7 T/P key] - [1 Softkey Condition]**
 >> Next screen appears.



- 12: 1 Page (f1 to f12, [Enable]+f1 to [Enable]+f12)
- 24: 2 Pages (f1 to f24, [Enable]+f1 to [Enable]+f24)
- 36: 3 Pages (f1 to f36, [Enable]+f1 to [Enable]+f36)

When there are 2 or more units, please set up by each unit.



- 2 On completion of setting, press **f12**<Complete> to save the settings.



When setting 2 or more pages, the function key f1, f13, and f25 are automatically set out for the page shift. In this case, therefore, the number of softkeys you are able to freely use is $11 + 11 = 22$.



Important

To reduce the number of pages, make sure that the function marked "⊙" (setting required) can be still set up in that condition.
 If not, you cannot reduce the number of pages.

7.6.3 Setting the Softkey Condition Enable/Disable

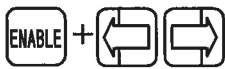
Setting the softkey condition [Disable], it allows the maximum number of softkeys in 1 page from f1 ~ f12 only.



Use this function when you are going to set only a few softkeys or you are to reduce the [Enable] key operation.

For this operation, the operator qualification of **EXPERT** or higher is required.

Setting the softkey condition Enable/Disable



- 1 Press f5<Constant setting> and select [7 T/P key] – [1 Softkey Condition]
>> Next screen appears.



Default is set at [Enable].

When there are 2 or more units, please set up by each unit.



- 2 On completion of setting, press f12<Complete> to save the settings.



Important

Be sure to set the function marked “⊙” (setting required) to “Front” before disabling the softkey condition. Otherwise, the [Disable] is invalid.



Important

If you have changed the softkey condition from [Disable] to [Enable], no confirmation message is given about the softkey that requires [Enable] pressed. In other words, the softkey requiring the [Enable] remains allocated to “Front”.

This may cause a wrong operation. Please give your full attention.

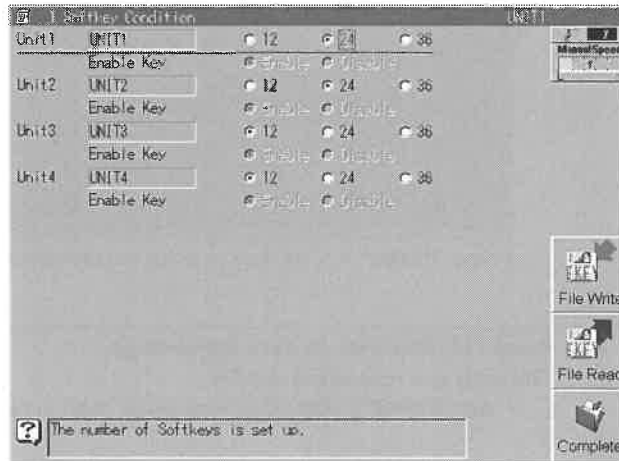
7.6.4 Saving the Softkey Settings

The softkey settings can be saved in the external memory.

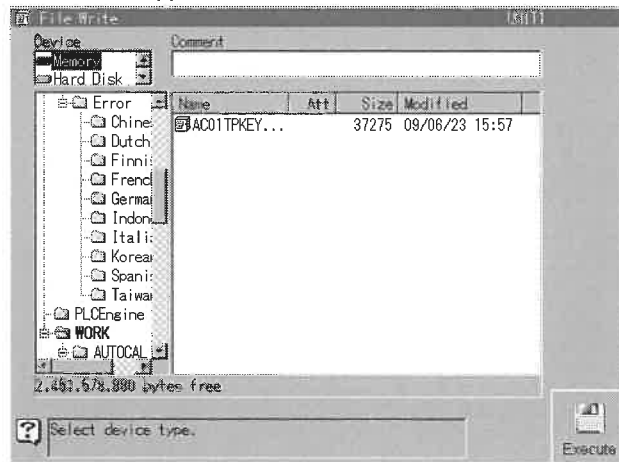
Saving the softkey settings



- 1 Press **f5**<Constant setting> and select **[7 T/P key] – [1 Softkey Condition]**
>> Next screen appears.



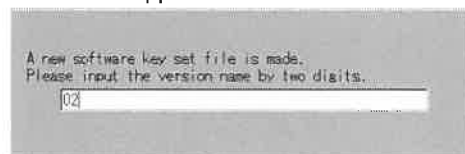
- 2 Press **f10**<File Write>.
>> Next screen appears.



Select Device, and folder.



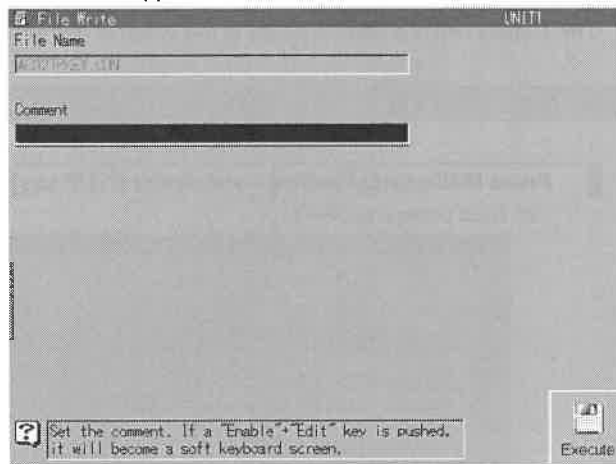
- 3 Press **F12**<Execute>.
>> Next screen appears.



Enter a 2-digit number.



- 4** Press [Enter] key.
 >> Next screen appears.



Press "Enable" + "Edit" key to enter the comment.



- 5** Press f12<Execute> to save the settings.
 This setting is now saved in a file :
ACXXTPKEY.CON (XX: Version No. fixed in saving)

7.6.5 Loading Softkey Settings from the File

You are able to load the softkey settings from the file.

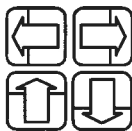
Loading the softkey settings



- 1 Press f5<Constant setting> and select [7 T/P key] – [1 Softkey Condition]
>> Next screen appears.



- 2 Press f11<File Read>.
>> Next screen appears.



Choose a desired file, and press f12<Execute>.



Important

If the setting of softkey condition Enable/Disable differs in AX21 and the softkey setting file, it is not available to read the setup file.

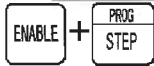
To read the file in such a condition, the operator qualification of **EXPERT** or higher is required.

7.7 Selecting a work program number from a list

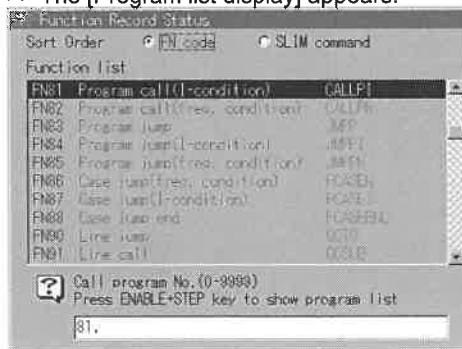
When recording functions, it is possible to select a work-program number from a work-program list. Not only in function recording screen but also in screen editor, Constant setting menu, or Service Utilities menu, it is possible to select a work-program number in the same way. And, when selecting a work-program number, it is possible to display the list unit by unit, or to confirm the details of the program's content.

7.7.1 Selecting a work program number from a list

Function recording

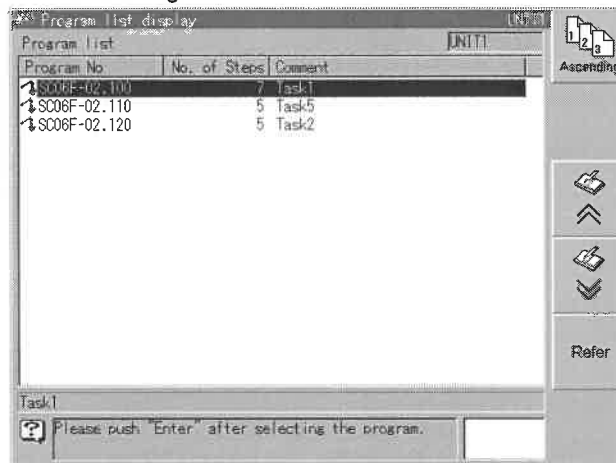


- 1 When entering a work-program number in function entering status screen, press [PROG/STEP] with pressing [ENABLE].
>> The [Program list display] appears.



- 2 Select a work program from the list and press [Enter].
>> The number of the work-program that is selected is displayed on the Function Record Status screen.

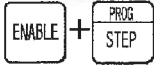
If the function's parameter is only program number, the step is immediately recorded without returning to the Function Record Status screen.



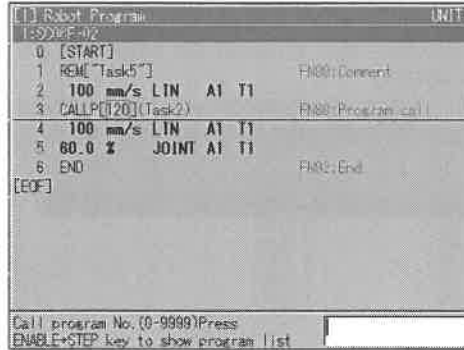
IMPORTANT

When entering the "Program list display" screen from CALL/JUMP related functions, only work-programs for the current UNIT are displayed. When entering the screen from FORK/CALLFAR related functions, work-programs for UNITS except current UNIT are displayed.

Screen editor



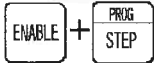
- In the screen editor, select a program number and press [PROG/STEP] with pressing [ENABLE].
 >> The [Program list display] appears.



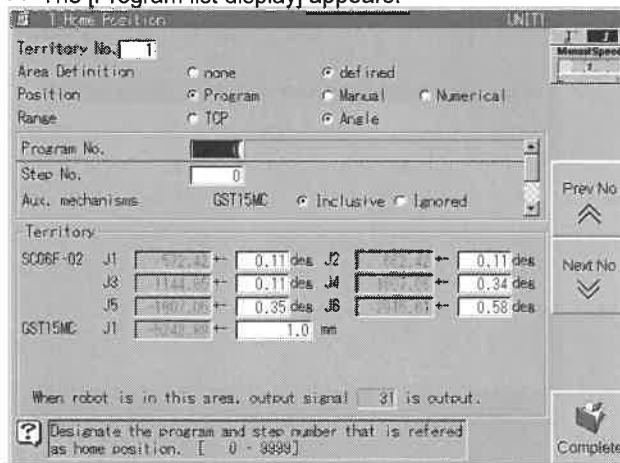
IMPORTANT

When entering the "Program list display" screen from CALL/JUMP related functions, only work-programs for the current UNIT are displayed. When entering the screen from FORK/CALLFAR related functions, work-programs for UNITS except current UNIT are displayed.

Constant setting / Service utilities



- In the Constant Setting screen or the Service Utilities screen, select an edit box for inputting a program number and then press [PROG/STEP] with pressing [ENABLE].
 >> The [Program list display] appears.



Monitor



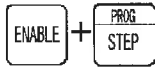
- Open a monitor window in which a work-program number can be set and press [EDIT].
 >>The monitor is changed to an edit mode.



Select an edit box for setting a work-program number and press [PROG/STEP] with pressing [ENABLE].
 >> The [Program list display] appears.

7.7.2 Displaying programs unit by unit

In case of a multi-unit specification, it is possible to display only the work programs for a specific unit.

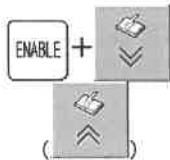
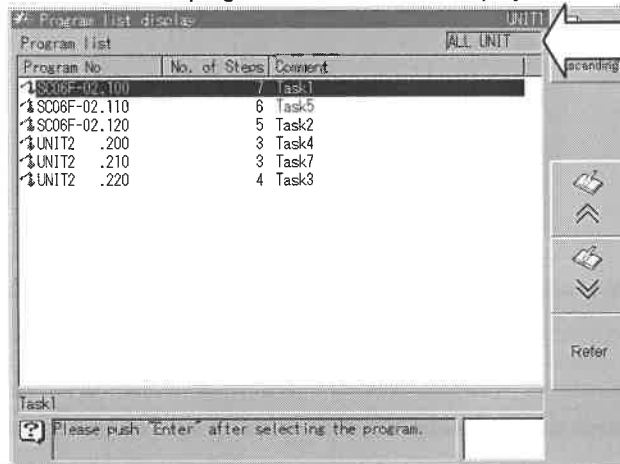


- 1 Press [PROG/STEP] with pressing [ENABLE].

>>A program list screen is displayed.

The name of the UNIT of which the programs are listed is displayed on the upper right-hand position.

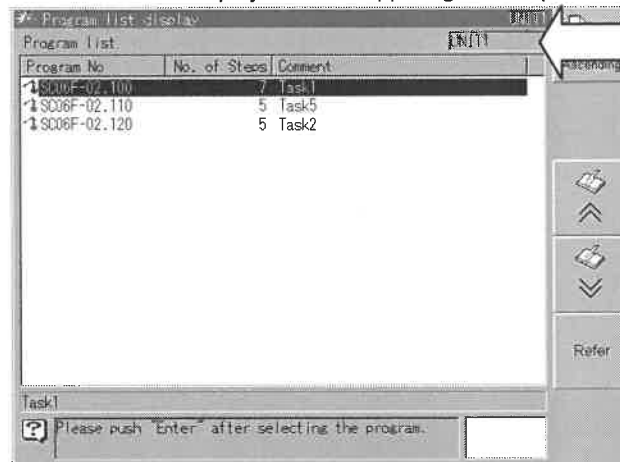
"ALL UNIT" : The programs for all units are displayed.



- 2 Press <f10 next unit> with pressing [ENABLE]

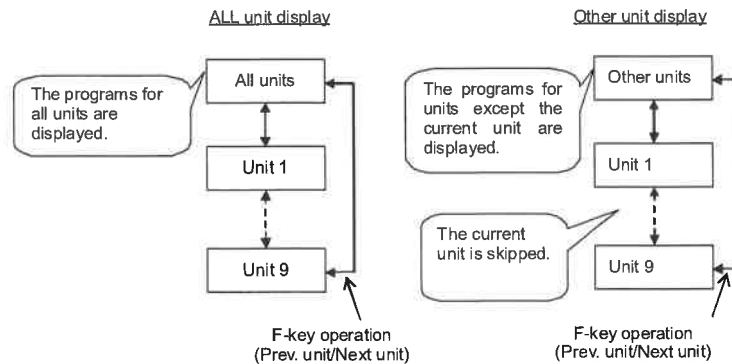
>>The programs only for UNIT1 are displayed.

The unit name is displayed on the upper right-hand position.



The unit number for displaying program list is switched like the picture shown as below using [Prev unit]/[Next unit] keys. "Other unit display" style is applied for several specific functions (e.g. CALLFAR etc.) that call programs of other unit.

And, units that do not exist are skipped.



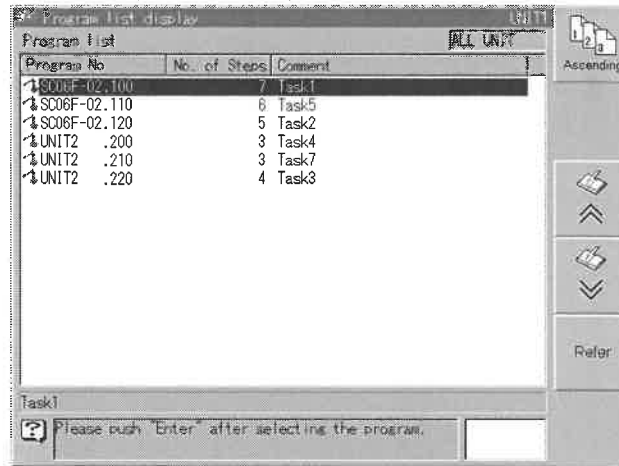
7.7.3 Confirming the contents of the program

It is possible to confirm the outline of the work program while displaying the program list.
If "Record of pose" is enabled, it is also possible to confirm the contents of the pose files.



1 Press [PROG/STEP] with pressing [ENABLE].

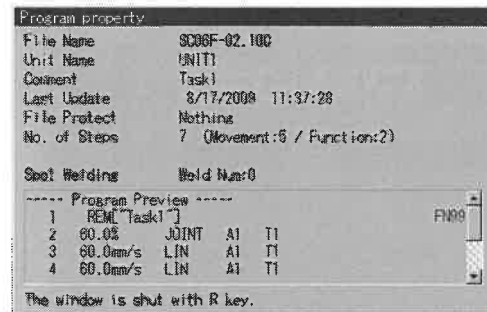
>> The [Program list display] appears.



2 Select a program and press <F11 Refer>.

>> "Program property" window is displayed.

If [R RESET] is pressed, this window will be closed.



The items to be displayed in this window are shown as below.

Item	Description
File Name	Name of the program file
Unit Name	Name of the unit
Comment	Comment recorded in the step 1
Last update	Last updated date of the program
File Protect	Protect status (All / Part / Playback / Nothing)
No. of Steps	Total number of steps in the program
Movement (Note 1)	Number of the movement command
Function (Note 1)	Number of the application command (function)
Application data (Note 1)	Application specific data is displayed. (For example, the number of welding commands are displayed in case of spot welding application) Some application types do not display any data.
Program Preview	Content of the program is displayed. (Up to 16 steps at maximum) Press up/down cursor keys to scroll up/down.

(Note 1) If "13 Record of pose" in [Teach/Playback condition] screen is enabled, these items are not displayed.

7.8 How to edit the step comment

It is possible to attach a comment for every step in a work program. This comment is called as a “Step comment”. By attaching step comments, it becomes easier to understand the meaning of each step.

7.8.1 Inputting a step comment

Step comment can be added / edited in the screen editor.



- 1 **Select (Activate) a program monitor screen and press [EDIT].**
 >> Screen editor is displayed.

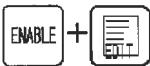
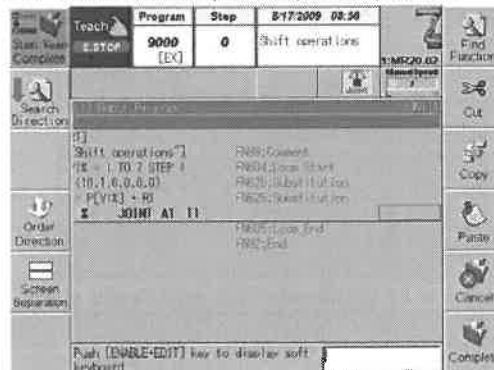


For details of the basic operation in the screen editor, refer to “Chapter 4 Teaching”.

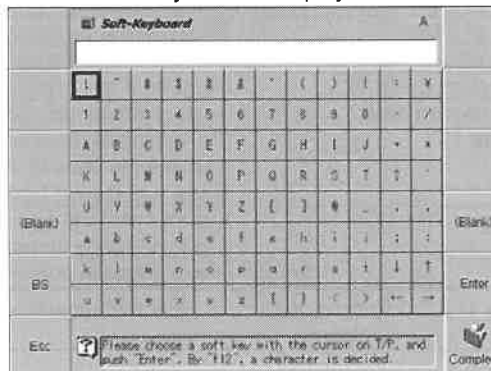


- 2 **Place the cursor to the step in which the step comment is to be added and press right cursor key.**

>>Place the cursor (red box) to the position that is shown in the following picture.



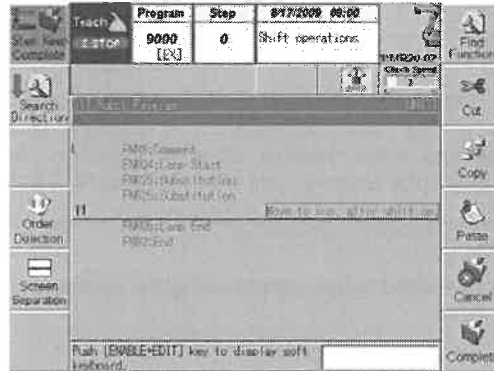
- 3 **Press [EDIT] key with pressing [ENABLE] key.**
 >>A software keyboard is displayed.





- 4 Input the step comment using the software keyboard and then press [F12 Complete] key.

>> The step comment is displayed at the cursor position.



- 5 Press [Complete] key to save the step comment to the work program.

In a case that a step comment is already set in the step, the editing procedure is the same.



CAUTION

"Step comment" is available in system software version AXV08.08 or after.



CAUTION

The maximum number of recordable steps for a program in which step comments are recorded is smaller than a program that does not have step comments. Because the step comments require larger data area. Therefore, if you try to add step comment to a program that has many steps, an error of "A2150:Program is too large." may be displayed in some cases.

In a case like that, make the number of the steps in a program less than 300 by dividing the program using program call function etc. (Refer to [4.3.9 Number of recordable steps].)

The maximum number of recordable steps in a program varies from the length of the step comments etc. in the program.

7.9 User error

7.9.1 Outline

"User error function" is to display errors occurred in peripheral equipment on the robot controller using general-purpose input signal of the robot controller. It is possible to freely customize error messages, countermeasures, error kinds and robot motions at error detection. By using this function it becomes unnecessary to provide various peripheral equipment with error display function, thus enabling cost reduction.

7.9.2 Flow of operation

General flow of operation is described below prior to using the User error function.

Creating [User error file]

Create "User error file" with your PC.

↓

Copying "User error file" into the controller

Copy the file into the controller's internal memory using CF card etc.



Before operation, set the operator class to **Expert** or greater.

For operators having the operator class "**Expert**", specify an internal memory, and then copy the [User error file].

For operators having the operator class "**Specialist**", specify each language folder following the "User Error" folder of the internal memory, and then copy the [User error file].

For folder structure, refer to information in "7.10 Display language change".

↓

Power on again for the controller

The controller reads User error file and then set data turns valid.

↓

Confirmation of User error file

Confirm what was set on User error setting screen. In addition, confirm that, by entering input signal, error is displayed and processed as designated.



CAUTION

Please be sure to confirm motions after editing User error data. If the robot and the controller are used without confirmation, peripheral devices etc. may be damaged by incorrect motion etc.

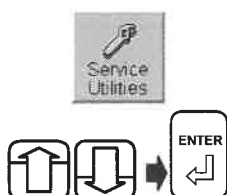
7.9.3 Settings

It is necessary for use of User error function to make setting of data of input signal numbers, error kinds, messages etc. In case of Japanese and English, these data are stored in "User error file" (ERR****.INI). (**** shows the error No. from 7001 to 7099). Since these files are written in plain text format, they can be edited easily with your PC.



To edit the [User error file] in any language other than Japanese or English using your personal computer, refer to in information in "7.10 Display language change".

Operating procedures



1 Open [Service Utilities] [25 Robot diagnosis] [6 User error] menu.

>> The setting screen shown below appears.

2 Set the respective items.

Table 7.9.1 Setting items of User error

Item	Contents
Failure code	Set the User error code No. This error code is displayed with the error message. (Range : 7001 - 7099)
Input Signal	This sets input signal. This signal, with ON-I-Sig. input, turns to User error. (Range : 0 - 2048)
Failure type	Select the failure type (Error / Alarm / Information). For more details, please refer to Chapter 8.
Failure message	Set the content for [Failure message] of error message.
Failure content	Set the content for [Failure content] of error message.
Measures	Set the content for [Measures] of error message.



To input the message, start up a software keyboard by pressing [ENABLE] + [EDIT] keys at the same time.
For more details, please refer to [2.5 To enter characters].

**IMPORTANT**

Even if the settings of the "Input Signal" and "Failure type" parameters are made in any language, these settings will be saved in the "Err****.ini file".

To edit the [User error file] using your personal computer, describe the settings of the "Input Signal" and "Failure type" parameters in the "Err****.ini" file. Unless the normal setting of the "Err****.ini" file is made, the normal function of "User error File" will be disabled in any language.

**POINT**

To make setting of user error in each language, use the shortcut command (R348) to set to the preset language. The settings of the "Failure message", "Failure content", and "Measures" parameters will be automatically saved in the "User error file" in a language currently displayed.

*The settings of the "Input Signal" and "Failure type" parameters are saved in the "Err****.ini file".



3 If the settings are finished, press the f-key <Complete>.

>>The settings are saved into the internal memory.

The functions of the f-key are shown as below.

Table 7.9.2 Functions of the f-key

Item	Contents
Refer	This is used for checking whether or not signal number, which is set with [Input signal], is already assigned through input signal assignment. With this key pressed, the [Setting of I signal] screen is displayed. Press [R / RESET] key to return to User error screen.
Copy	Copy the setting of the current User error to another number. Enter the destination number.
Page up / down keys.	Page up / down keys.
Delete	Delete (initialize) the contents of the current User error on the screen.
Complete	Save the settings into the internal memory.

An example of the User error file is shown as below.

Table 7.9.3 Sample file

```

; Copyright(c) 2001 NACHI-Fujikoshi corporation. All Rights Reserved.
;-----
[GENERAL]
; 0;Error, 1;Alarm, 2;Information
; 処置の重要度 (教示,再生)
DISPOSAL = 1, 1

; 出力信号の重要度 (教示,再生)
OUTPUT = 2, 2

; 0=ログを取らない/1=ログをとる (教示,再生)
LOGGER = 1,1

; 大括り分類コード
CLASSIFICATION = 9

; 保全支援の処理 (1=あり、0:なし)
DETAIL_TROUBLESHOOT = 0

; 0=リセットキーで異常解除できる/1=リセットキーでは異常解除できない
RESET_TYPE = 0

; 入力信号
INPUT_SIGNAL=584

[JAPANESE]
;異常メッセージ (症状)
PHENOMENON = 溶接完了信号がOFFになりません
;異常の内容 (検出理由)
EXPLANATION = 溶接完了信号がOFFになりません
;対策方法 (概略)
BRIEF_TROUBLESHOOT = 溶接機からの溶接完了信号が入りっぱなしです。溶接機をチェックしてください。
;異常解除の方法
HOW_TO_RESET = 溶接機をチェックしてください。

[ENGLISH]
PHENOMENON = Weld completion signal is not turned off
EXPLANATION = Weld completion signal is not turned off
BRIEF_TROUBLESHOOT = Check the welder unit.
HOW_TO_RESET = Check the welder unit.

```



Messages in Japanese and English can be defined in the format shown above. However, for the procedure for defining in other languages, refer to information in "Chapter 7 Display language change".

7.10 Display language change

This controller can change the display language by shortcut command (R348).

POINT

It is possible to change the display language by R348 also for the names / messages listed below by preparing display data in advance.

- Failure message / Failure content / Measures for the User error
- I/O signal names
- Soft key names of the interface panel

POINT

To display the following folders in the internal memory, the operator class must be changed to **Specialist** or higher.

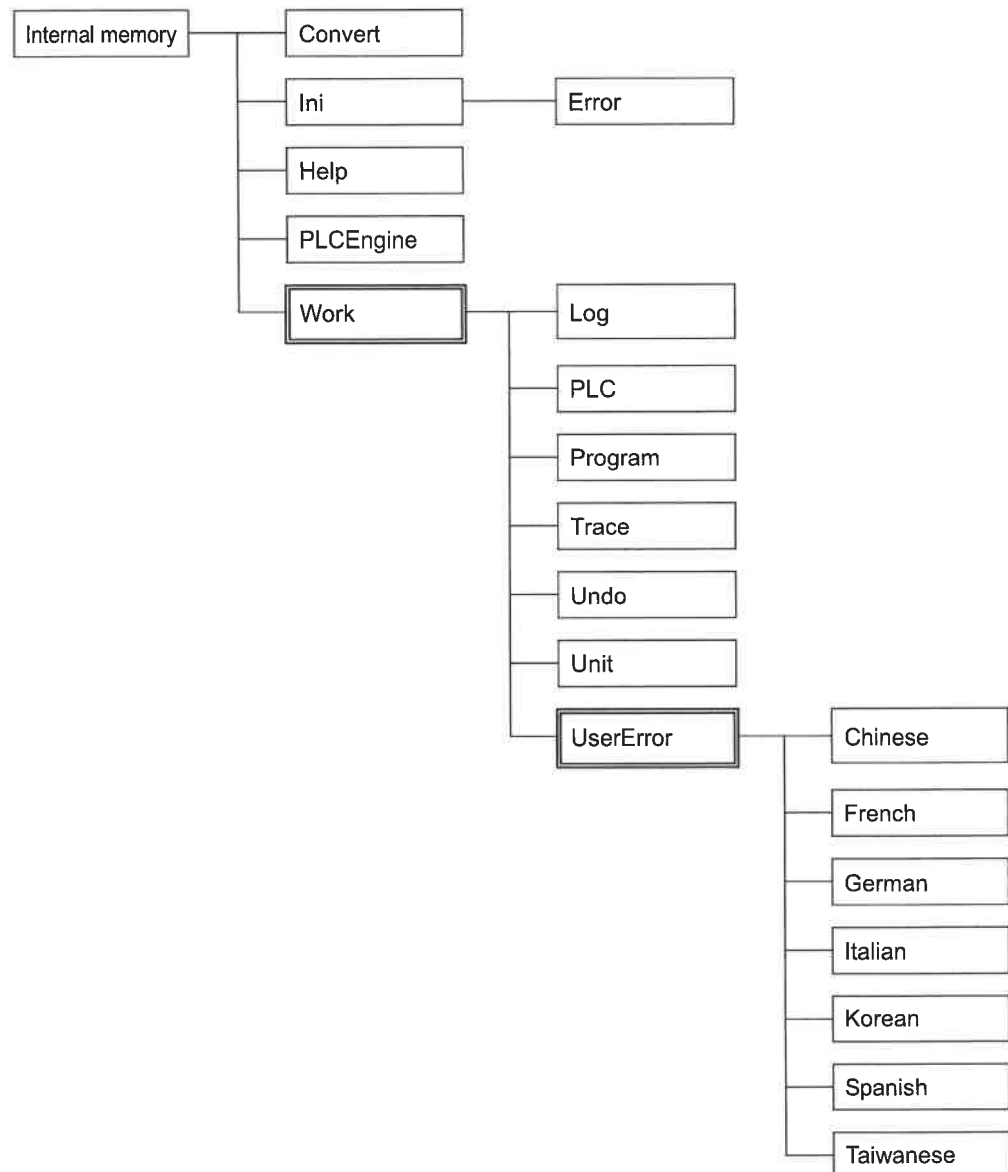


Fig. 7.10.1 Folder structure of the internal memory

7.10.1 Candidate language selection

This controller can select a language to display at the time when this controller starts up and also a language to change using the R348 command out of languages installed on the system.

This Section describes the selection of candidate language for this controller.



To select candidate language, set the operator class to **Specialist** or higher.

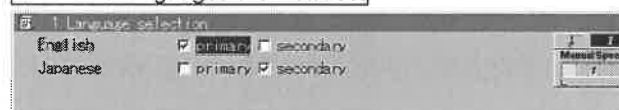
Selecting procedure



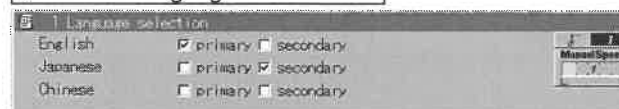
1 Open [Constant Setting] [2 Screen Constants] [1 Language Selection] screen.

>>The Setting screen shown below will be displayed.

When two languages are installed:



When three languages are installed:



2 Make setting of each parameter.

Table 7.10.1 Parameters to be set for candidate language selection

Parameter	Description
Primary language	Used to select a language to display at the time when power supply turns ON.
Secondary language	Used to select the second language to change using the shortcut command (R348).



3 Upon completion of selection, press the f-key <Complete>.

>>The setting will be saved in the internal memory.

7.10.2 User error file

When selecting a language other than Japanese and English as a display language, it is necessary to create [user error files] for the display language and store those files into each language's folder in advance.

Concerning the file name and the section name, refer to the table shown below.

If the [User error file] does not exist for the display language, English message is loaded and displayed instead.



IMPORTANT

To create [User error files] in any language other than Japanese and English, [User error files] in each language and the [User error files] of Err7001.ini to Err7099.ini corresponding to the relevant failure code are required.

Only the [User error file] in any language other than Japanese and English is not enough to properly operate the User error function.

For procedure for creating the User error files Err7001.ini to Err7099.ini, refer to information in [7.9 User error].



POINT

To display the [User error file], set the operator class to **Expert** or higher.

Table 7.10.2 File name and the section name of the User error

Language	File name	Section name
Japanese (*)	Err7001.ini to Err7099.ini	[JAPANESE]
English	Err7001.ini to Err7099.ini	[ENGLISH]
German	Erg7001.ini to Erg7099.ini	[DISP_MESSAGE]
French	Erf7001.ini to Erf7099.ini	[DISP_MESSAGE]
Korean	Erk7001.ini to Erk7099.ini	[DISP_MESSAGE]
Italian	Eri7001.ini to Eri7099.ini	[DISP_MESSAGE]
Spanish	Ers7001.ini to Ers7099.ini	[DISP_MESSAGE]
Chinese	Erc7001.ini to Erc7099.ini	[DISP_MESSAGE]
Taiwanese	Ert7001.ini to Ert7099.ini	[DISP_MESSAGE]

* The contents of Japanese ([JAPANESE]) and English ([ENGLISH]) are registered in the same INI file.



The structure of the [User error file] (Japanese, English)
 File name : Err7001.ini to Err7099.ini
 For the details of [User error file] for Japanese and English, see [7.9 User error].



The structure of the [User error file] (Except for Japanese and English)
 An example of the File name : Erf7001.ini (in case of French)

◇ An example of the [User error file]

```
[DISP_MESSAGE]
PHENOMENON = Le signal d'accomplissement de soudure n'est pas arrêté.
EXPLANATION = Le signal d'accomplissement de soudure n'est pas arrêté. Vérifiez
l'unité de soudeuse.
BRIEF_TROUBLESHOOT = Veuillez effectuer l'"échec-remise".
HOW_TO_RESET = Remise des erreurs.
```

◇ Display example

6 Définition des erreurs utilis.

Code échec: 7001

Input Signal: 101

Type d'échec: Erreur Alarme Informations

Message échec: Le signal d'accomplissement de soudure n'est pas arrêté.

Contenu échec: Le signal d'accomplissement de soudure n'est pas arrêté. Vérifiez l'unité de soudeuse.

Mesures: Veuillez effectuer l'"échec-remise".

Entrer le code échec édité. [7001 - 7099]

How to make the display data

The following section describes the procedure for making data.

Copy the [User error files] (Err7001.ini to Err7099.ini) from the internal memory to the PC.



Make [User error file] for the display language.

First, open a file "Err70**.ini" by a text editor and replace the item of "PHENOMENON", "EXPLANATION", "BREIF_*TROUBLESHOOT", and "HOW_TO_RESET" in [JAPANESE] or [ENGLISH] section to the desired display language.

At this time, use [DISP_MESSAGE] for the section name for the display language.

And, delete the other sections ([GENERAL], [JAPANESE], and [ENGLISH]) except for [DISP_MESSAGE]. Then, copy the file to the respective folder with the designated file name.

For file names of [User error file] for display language and fonts used by this controller, refer to information in Table 7.10.3

Table 7.10.3 File names and fonts of [User error file]

Language	File name	Font
Germany	Erg70**.ini	FixedSys
French	Erf70**.ini	FixedSys
Korean	Erk70**.ini	GulimChe
Italian	Eri70**.ini	FixedSys
Spanish	Ers70**.ini	FixedSys
Chinese	Erc70**.ini	MS Song
Taiwanese	Ert70**.ini	MingLiU



Copy the [User error files] for the display language from the PC to the internal memory of this controller.



For operators having the operator class **"Expert"**, specify an internal memory, and then copy the [User error file].

For operators having the operator class **"Specialist"** or higher, specify a folder for each language (Internal memory → Work folder → UserError folder → Each language folder), and then copy the [User error file].



Change the display language using R348.

Error message, Error contents, and Measure are loaded for the display language.

7.10.3 I/O signal name

The names of the general I/O signals can be defined by customers. To define the names, open the setting screens under [Constant Setting] [6 Signals] [2 Input Signal Assignment] / [3 Output Signal Assignment] and then press the f-key <Refer>. By this operation, edit / register screen for I/O signal names can be displayed.

To switch the display language, it is necessary to create an [I/O signal name file] for the display language in advance and save the file into "Work" folder.

If general I/O signals registered with the file created are already assigned, these assigned signals will be prioritized.

For the file names and the section names, refer to the table shown below.

If the [I/O signal name files] do not exist, the contents are read from the constant file and displayed.

Table 7.10.4 File name and section name for the [I/O signal name file]

Language	File name	Section name
Japanese	JAPANESE.NAM	[SIG_NAME]
English	ENGLISH.NAM	[SIG_NAME]
German	German.NAM	[SIG_NAME]
French	French.NAM	[SIG_NAME]
Korean	Korean.NAM	[SIG_NAME]
Italian	Italian.NAM	[SIG_NAME]
Spanish	Spanish.NAM	[SIG_NAME]
Chinese	Chinese.NAM	[SIG_NAME]
Taiwanese	Taiwanese.NAM	[SIG_NAME]



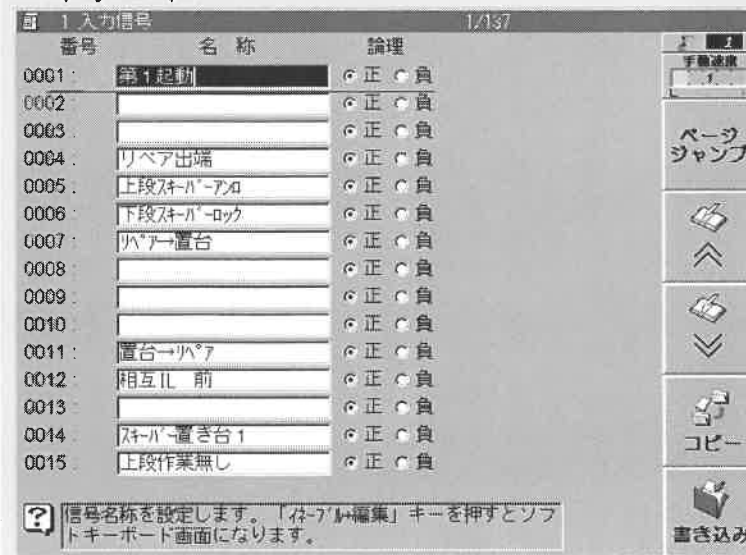
The structure of the I/O signal name file (Japanese, English)

File name : JAPANESE.NAM

◇ An example of I/O signal name file

```
[SIG_NAME]
IN1-16=第1起動,,リペア出端,上段スキハ^-アo,下段スキハ^-ロック,リハ^アo置台,,,,置台→リハ^アo,,,,,
IN17-32=下段スキハ^-セット,積込側進入OK,卸し側進入OK,,,置台スキハ^-セット,,,,,,スキハ^-置き台8,,
IN33-48=スキハ^-置台 NO6,スキハ^-置台 NO7,スキハ^-置台 NO8,スキハ^-置台 NO1,スキハ^-置台 NO2,,,,,
IN49-64=チャック端,アoチャック端,,,,,
IN65-80=,
:
IN1969-1984=,
IN1985-2000=,
IN2001-2016=,
IN2017-2032=,
IN2033-2048=,
OUT1-16=待機中出力,作業完了,,リハ^アo干渉外,相互IL 左,相互IL 右,,,,,リハ^アo戻指令,,,,置台積込み完了
OUT17-32=,,,,,下段ロック指令,上段アoロック指令,,上段積込完了,,相互IL 左前上下,相互IL 右前上下
OUT33-48=,
OUT49-64=チャック指令,アoチャック指令,,,,,
OUT65-80=,
:
OUT1969-1984=,
OUT1985-2000=,
OUT2001-2016=,
OUT2017-2032=,
OUT2033-2048=,
```

◇ Display example



How to make the display data

The following section describes the procedure for making data.

Copy the "S00SIGL.CON" file from the internal memory to the PC.

↓

Create the [I/O signal name file] for the display language.

First, open "S00SIGL.CON" file and delete sections except for I/O signal name ([SIG_NAME]).

Then replace the contents in the section [SIG_NAME] for the display language and save the modified file into "Work" folder with the designated names.

At this time, it is not necessary to change the name of section [SIG_NAME].

Table 7.10.5 lists the file names of [I/O signal name file] for display language and fonts used by this controller.

Table 7.10.5 File names and fonts of [I/O signal name file]

Language	File name	Font
Japanese	JAPANESE.NAM	FixedSys
English	ENGLISH.NAM	FixedSys
Germany	German.NAM	FixedSys
French	French.NAM	FixedSys
Korean	Korean.NAM	GulimChe
Italian	Italian.NAM	FixedSys
Spanish	Spanish.NAM	FixedSys
Chinese	Chinese.NAM	MS Song
Taiwanese	Taiwanese.NAM	MingLiU

↓

Copy the [I/O signal name file] for the display language from the PC to the internal memory.

↓

Change the display language using R348.

The I/O signal names are loaded for the display language.

7.10.4 Software key name for interface panel

Interface panel is a screen which displays the input signals as indicate lamp or push button with a lamp, or displays the status of the output signals as images of selector switches, push buttons etc.

It is also possible to edit / regist the soft key names for the interface panel in the [ConstantSetting] [22 I/F Panel on Touch Screen] [2 Interface Panel Design] screen.

To switch the display language, it is necessary to create a [soft key name file of the interface panel] for the display language in advance and save the file into "Work" folder.

For the file names, section names, and key names, refer to the table shown below.

If the [soft key name file of the interface panel] for the display language does not exist, the contents are read from the constant file and displayed.

Table 7.10.6 File name / Section name / Key name for the interface panel soft keys

Language	File name	Section name	Key name
Japanese	JAPANESE.IFP	[TOUCHINI]	P*__NAME
English	ENGLISH.IFP	[TOUCHINI]	P*__NAME
German	German.IFP	[TOUCHINI]	P*__NAME
French	French.IFP	[TOUCHINI]	P*__NAME
Korean	Korean.IFP	[TOUCHINI]	P*__NAME
Italian	Italian.IFP	[TOUCHINI]	P*__NAME
Spanish	Spanish.IFP	[TOUCHINI]	P*__NAME
Chinese	Chinese.IFP	[TOUCHINI]	P*__NAME
Taiwanese	Taiwanese.IFP	[TOUCHINI]	P*__NAME

POINT

The structure of the [soft key name file for the interface panel]

File name : ENGLISH.IFP

◇ An example of [soft key name file for the interface panel]

```
[TOUCHINI]
P1_1A_NAME="  AUTO  "
P1_1B_NAME="  AUTO  ¥r RUNNING  "
P1_1C_NAME="  HOME  ¥r POSITION  "
P1_1D_NAME="OPERATION ¥r COMPLETE  "
P1_1E_NAME=" TEACHING  "
P1_1F_NAME=" HOME POS.¥r LS FAULT  "
P1_1G_NAME="PLANT AIR ¥r  LOW  "
P1_1H_NAME="Operation¥rDis  Ena"
P1_2A_NAME="  LINE  ¥r  CODE  "
P1_2B_NAME="EMERGENCY ¥r  STOP  "
P1_2C_NAME="MATE-HAND ¥r  NO.  "
P1_2D_NAME=" ¥rMATE-HAND ¥r  FAULT  "
P1_2E_NAME="  HOLD  "
P1_2F_NAME="CYCLE TIME¥r EXCEEDED  "
P1_2G_NAME=" ¥rDISPLAY IN¥rNEXT PAGE  "
:
P8_4A_NAME="CLAMP BY-PASS"
P8_4C_NAME="UNCLAMP BY-PASS"
P8_4E_NAME="WORK1 CONF BY-PASS"
P8_4G_NAME="WORK2 CONF BY-PASS"
```

◇ Display example

The screenshot shows the '2 Interface Panel Design' software interface. It features a table with columns for SOFTKEY, CODE, FUNC, and Name. The table lists configurations for softkeys P1-1A through P1-1H. To the right of the table is a vertical list of actions: Most Speed, Code List, Refer, Interface Panel, Import, Set Initial Code, and Complete. At the bottom, there is a text input field with a question mark icon and the instruction 'Input the key code and press 'Enter''.

SOFTKEY	CODE	FUNC	Name
p1-1A	3000	round lamp	AUTO
p1-1B	3000	round lamp	AUTO ¥r RUNNING
p1-1C	3000	round lamp	HOME ¥r POSITIO
p1-1D	3000	round lamp	OPERATION ¥r COMPLET
p1-1E	3000	round lamp	TEACHING
p1-1F	3000	round lamp	HOME POS.¥r LS FAUL
p1-1G	3000	round lamp	PLANT AIR ¥r LOW
p1-1H	3010	"ON/OFF" switch	Operation¥rDis

How to make the display data

The following section describes the procedure for making data.

Export "AC**IFP.CON (** : 01 to 99)" file.

Export "AC**IFP.CON" file in the [Constant] [31 I/F Panel on Touch Screen] [2 Interface Panel Design] screen.

↓

Create the [soft key name file of the interface panel] for the display language

First, open "AC**IFP.CON" file and delete sections except for soft key names of the interface panel (P* **NAME="" in the [TOUCHINI] section).

Then replace the contents in the soft key names of the interface panel (P* **NAME="" in the [TOUCHINI] section) for the display language and save the modified file into "Work" folder with the designated names.

At this time, it is not necessary to change the name of section [TOUCHINI].

The following table lists the file names of [soft key name file of interface panel] for display language and fonts used by the AX controller.

Table 7.10.7 File names and fonts of [soft key name file of interface panel]

Language	File name	Font
Japanese	JAPANESE.IFP	FixedSys
English	ENGLISH.IFP	FixedSys
Germany	German.IFP	FixedSys
French	French.IFP	FixedSys
Korean	Korean.IFP	GulimChe
Italian	Italian.IFP	FixedSys
Spanish	Spanish.IFP	FixedSys
Chinese	Chinese.IFP	MS Song
Taiwanese	Taiwanese.IFP	MingLiU

↓

Copy the [soft key name file of the interface panel] for the display language from the PC to the internal memory.

↓

Change the display language using R348.

The soft key names of the interface panel for the display language are loaded.

Chapter 8 Troubleshooting

This chapter describes the action to be taken to deal with trouble which has occurred in the robot.

8.1 To initiate emergency stop for the robot	8-1
8.2 When failure has occurred	8-2
8.3 Concerning the failure details	8-3
8.3.1 Failure category	8-3
8.3.2 Concerning criticality codes and failure codes	8-3

8.1 To initiate emergency stop for the robot

Press the emergency stop button if the wrong program has been started or the robot has moved in an unintended direction. When the emergency stop button is pressed, the robot stops immediately. To release emergency stop, turn the button clockwise. (The button will then return to its original position.)

The emergency stop button is provided at the following locations.

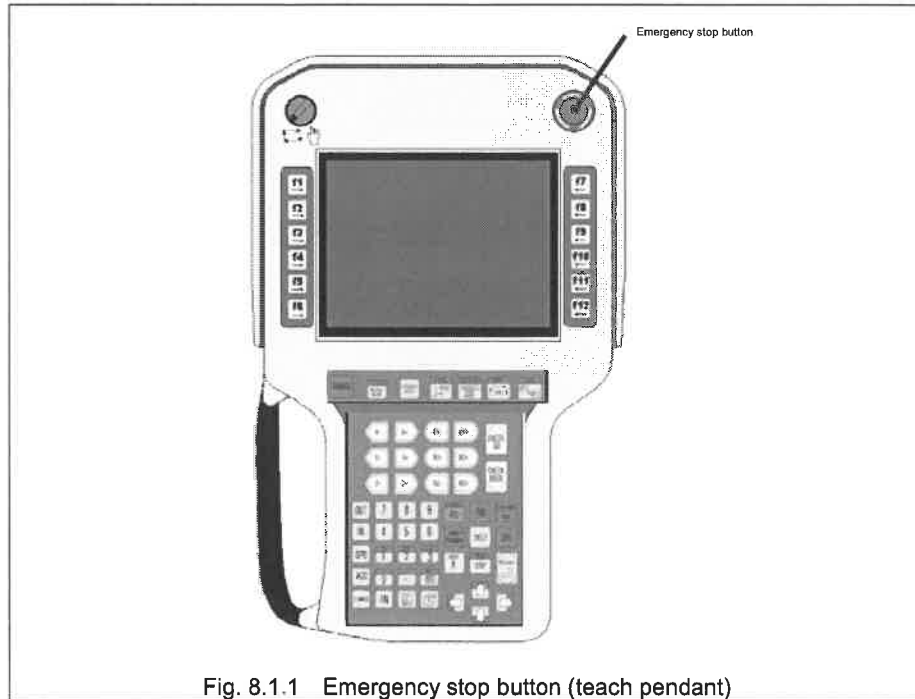


Fig. 8.1.1 Emergency stop button (teach pendant)

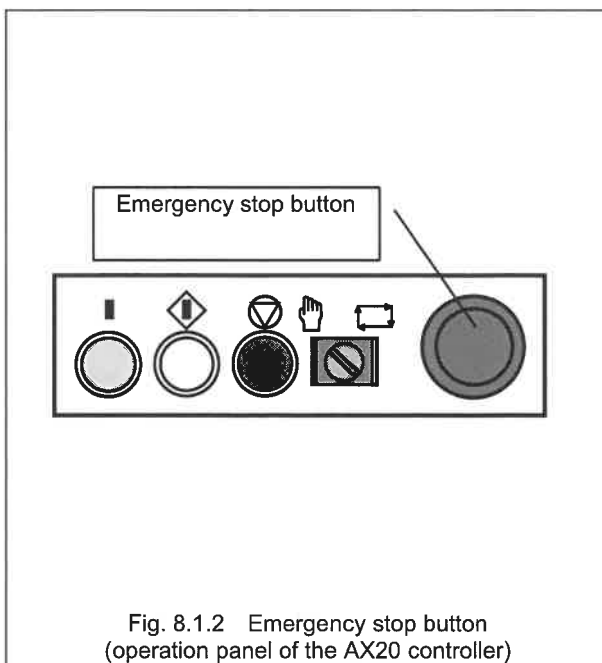


Fig. 8.1.2 Emergency stop button (operation panel of the AX20 controller)

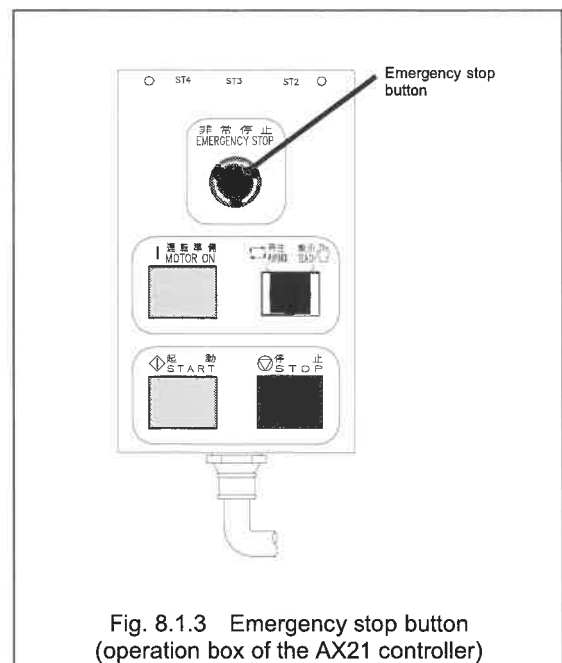
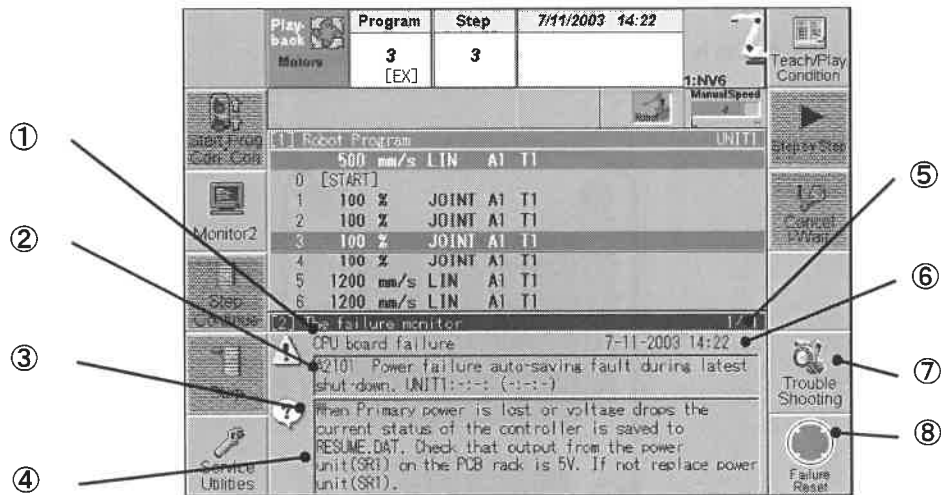


Fig. 8.1.3 Emergency stop button (operation box of the AX21 controller)

8.2 When failure has occurred

When failure has occurred in the robot, the failure monitor starts, and the details of the failure (name of its category, date/ time of its occurrence, description and remedial action) are displayed on the teach pendant.



①	Failure category	The name of the failure category appears here.
②	Failure code and cause	The failure code and cause appear here. The failure code is expressed in alphanumeric. In the example of the screen shown above, "A2101" is the failure code.
③	Details and remedial action	The details of the failure and the remedial action to be taken appear here. Use the remedial action displayed here as a reference, and eliminate the cause of the failure.
④	Release method	The method used to release the failure display appears here. When all the contents of ③ and ④ do not appear in the display area, scroll the screen using [up or down].
⑤	Number of failure incidents	The figure on the right indicates the number of failure incidents which have occurred simultaneously. Only one failure incident is displayed on the screen at one time. To view other types of trouble, press [ENABLE] and [up or down].
⑥	Date/time of occurrence	The date and time of the failure occurrence appear here.
⑦	f11 <Trouble Shooting>	When major trouble requiring parts inspection or replacement has occurred, <Trouble Shooting> is displayed here. (It is not displayed for all types of trouble.) When this key is pressed, the inspection procedure, replacement procedure, etc. is displayed. (Visual maintenance function)
⑧	f12 <Failure Reset>	Press this to release the failure display. The failure display can also be released by pressing [RESET/R] twice.

8.3 Concerning the failure details

8.3.1 Failure category

The failure categories which are displayed at ① on the previous page are established to enable where the failure has occurred to be pinpointed to some extent.

Table 8.3.1 Failure category

Failure category	Main failure
Emergency stop failure	Emergency stop triggered by input from overrun, shock sensor, etc.
Control sequence failure	Failure detected by monitoring of control systems such as magnet switches and circuit protectors, etc.
CPU board failure	Watchdog timer detection or other CPU board-related failure occurrence
Servo failure	Failure detected by servo driver
Amplifier unit failure	Failure detected by amplifier unit
Encoder failure	Encoder-related failure
Teach pendant failure	Failure detected by teach pendant
PLC failure	Failure detected by PLC
User failure	Failure defined by the operator
Operation failure	Failure caused by failure in operation made by operator
Spot welding failure	Failure inherent to "spot welding function" (but not included above)
Arc welding failure	Failure inherent to "arc welding function" (but not included above)

8.3.2 Concerning criticality codes and failure codes

The failure codes displayed at ② on the previous page are expressed using the following format.

[Example] Control sequence failure code E1103

E	1	1	0	3
(A)				(B)

(A) Criticality codes

The failure detected by the robot is classified into three types by their level of criticality.

Table 8.3.2 Criticality codes

Type of failure	Details
E (errors)	Failure caused by parts failure or internal data failure which prohibits continued operation until the cause of the failure is eliminated, and failure which may potentially injure the operator or damage the robot system if operation is continued are classified as errors.
A (alarms)	Failure which may lead to an error at a future point in time, failure which must be remedied now or failure requiring simple operations, checks and/or remedial action before robot operation or movements are continued even though it may not potentially injure the operator or damage the robot system are classified as alarms.
I (Information)	Failure requiring that the operator and ambient devices be informed of the occurrence of irregularities even though they will not interfere with continued robot operations or movements is classified as information. Information may sometimes be conveyed not when failure has occurred but when the robot is operating normally.

(B) Failure codes

These are 4-digit numbers used to identify failure.

NOTE

Chapter 9 Basic spot welding operations

This chapter describes the basic spot welding operations for operators who will be using the robot for the spot welding application.

9.1 Terms frequently used with spot welding	9-1
9.2 f key layout.....	9-2
9.3 Spot welding command.....	9-3
9.4 Teaching	9-4
9.4.1 Spot welding command recording	9-4
9.4.2 Manual pressurizing and manual welding	9-5
9.4.3 When using multiple number of welders	9-10
9.5 Sets the spot welding conditions.....	9-11
9.6 Setting the spot weld sequences	9-13
9.7 Spot welding ON/OFF	9-15

9.1 Terms frequently used with spot welding

The basic terms frequently used in connection with spot welding in this manual are defined below for the benefit of first-time operators of the robot.

Table 9.1.1 Terms frequently used with spot welding


































Terms	Explanation
Spot welding controller	This is the controller that controls the spot welding directly. A controller made by a specialist manufacturer must be provided in addition to the robot controller. It may also be referred to simply as the welder or timer contactor.
Spot welding tool	This is a tool which comes into contact with the work piece and supplies the power. It is also called the "gun".
Air gun	This refers to the kind of gun which is driven pneumatically.
Servo gun	This refers to the kind of gun which is powered by a servo drive. It utilizes the servo control of the robot controller. With the robot controller, the gun is treated as a mechanism as is the case with a positioner or travel device, and highly accurate position control is exercised in coordination with the manipulator.
Welding conditions	This is a general term used to refer to the data such as the welding current and welding force that determine the welding conditions. The conditions are edited using the teach pendant. A total of 255 items of the welding conditions data can be registered per welder.
Weld sequence	This is a general term used to refer to the data items that define the I/O sequences between the robot controller and welder (timer contactor). The conditions are edited using the teach pendant. A total of 64 items of the weld sequence data can be registered per welder.
Tip consumption amount compensation	This is a technical term used with servo guns. As welding is performed over and over again, the electrodes gradually start to wear down, and their length shortens. An equalizing function is not generally provided with servo guns. For this reason, when the electrodes start to wear down, the fixed side electrode is no longer pressed against the work, resulting in a deficient welding force on the fixed side and extra stress on the work, resulting also in a deterioration of the simultaneous arrival of the top and bottom electrodes and an increase in the cycle time. Therefore, in order to maintain the correct welding position, a "wear amount compensation function" is provided to shift the welding target point at the fixed and moving sides by the distance equivalent to the wear amount.
Gun search	This is a technical term used with servo guns. In order for the wear amount to be compensated, this amount has to be detected. A predetermined operation pattern is played back for this, and the wear amount is calculated on the basis of the position of the gun at this time. This action is known as the "gun search", and three different detection methods are provided.
Bending compensation	This is a technical term used with servo guns. The gun arm bends as the welding force is increased. It may bend not only in the welding force direction (Z direction) but also on the plane (XY direction) perpendicular to the welding force direction depending on the shape of the gun arm. This function compensates for bending to achieve the proper welding position by measuring these characteristics in advance.

9.2 f key layout

The initial settings of the f keys displayed along both edges of the LCD screen when the robot is to be used for the spot welding application are shown below.

The f keys are arranged in a layout which is optimally suited to the settings of the specific application such as spot welding or arc welding. Since initial settings are performed at the factory to suit the application for which the particular type of robot is normally used, the user does not normally need to re-arrange the f keys.

Table 9.2.1 Initial layout of f keys for spot welding

Teach mode			Playback mode		
	When pressed on its own	When pressed together with [ENABLE]		When pressed on its own	When pressed together with [ENABLE]
f1	No function	 Switches between weld ON, weld OFF and squeezing off.	f7	 Sets the teach or playback conditions exclusively for spot welding.	 Sets the teach or playback conditions.
f2	 Selects spot welder	No function	f8	 Selects the stroke.	 Switches the stroke.
f3	 Spot welding monitor	 Sets monitor 2.	f9	No function	 Forcibly initiates I release.
f4	 File Manager	No function	f10	No function	 Forcibly initiates WI release.
f5	 Sets the spot constant.	 Sets the constant.	f11	No function	 Initiates manual spot welding.
f6	 Sets the spot welding conditions.	 Calls the service menu.	f12	 Sets the accuracy.	 Performs the smooth setting.
f1	No function	 Switches between weld ON, weld OFF and squeezing off.	f7	 Sets the teach or playback conditions.	 Sets the teach or playback conditions.
f2	No function	 Simultaneously switches the start select and program select.	f8	No function	 Step feed
f3	 Spot welding monitor	 Sets monitor 2.	f9	No function	 Forcibly initiates I release.
f4	No function	 Step continuous	f10	No function	 Forcibly initiates WI release.
f5	No function	 Switches between cycle, continuous and step.	f11	No function	 Speed override (up in 10% increments)
f6	 Sets the spot welding conditions.	 Calls the service menu.	f12	No function	 Speed override (down in 10% increments)

9.3 Spot welding command

Depending on the drive system of the welding gun used, spot welding is classified into two kinds: "air gun" and "servo gun". The air welding gun is driven pneumatically where as the servo welding gun is driven by servo control.

This section describes the basic operation methods common to both air guns and servo guns.

The data required in order to perform spot welding fall into two main categories: the welding conditions such as the welding current and welding force that determine the conditions of the welding itself, and the weld sequences that define the I/O sequences between the robot controller and welding controller (timer contactor). With the AX20/AX21 controller, each set of data is stored in a separate file, namely, "the welding condition file" or "weld sequence file". An "indirect reference format", in which only the numbers of the sets of data stored in these files from the programs are referenced, is used.

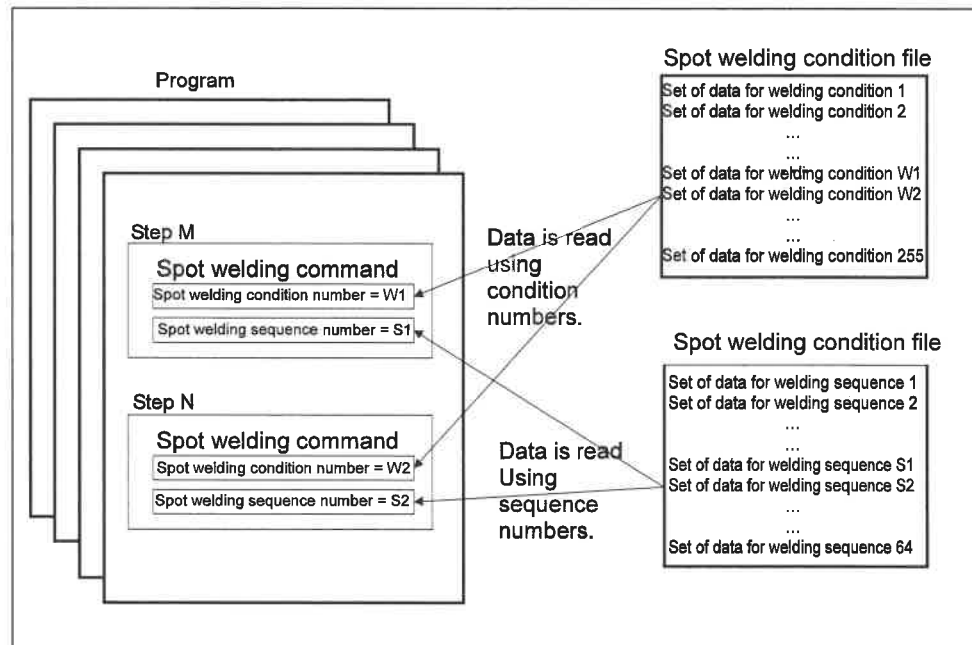


Fig. 9.3.1 Indirectly referenced spot welding data

The "welding condition files" and "weld sequence files" are completely separate from the programs. Data such as the welding current and welding force is not directly written in the program. If the same conditions or sequences are to be used, they can be called from a multiple number of programs and/or steps for use over and over again.

This comes in handy if, for instance, the welding conditions for "3-layer overlap spoting" are used, and if they can be given numbers for the same set of data and referenced using these numbers in each step. In this way, all the welding conditions for 3-layer overlap spoting can be changed at once simply by changing the set of welding conditions data for 3-layer overlap spoting.

9.4 Teaching

9.4.1 Spot welding command recording

The spot welding command is an function command. As with the timer commands or input/output commands, it can be recorded using the [FN] key.

Mnemonic	Number	Command
SPOT	FN119	Spot weld (Common to both the air gun and servo gun)
Parameter		
	Data	Description, setting range
Parameter No.1	Welder number	This parameter specifies the number of the first welder for which the welding control signal is output. (1 to 6)
Parameter No.2	Welding condition number	This parameter specifies the number of the welding condition that determines the welding force and welding condition signal. (1 to 255)
Parameter No.3	Weld sequence number	This parameter specifies the number of the welding sequence that determines the timings at which the squeezing signal, weld command signal and stroke signal are to be output, etc. (1 to 64)
Parameter No.4	Welding point number	Use this parameter when controlling the welding points. The welding point numbers are output when welding trouble has occurred to enable the hitting points to be specified. Set this to "0" when the welding point numbers are not going to be used. (0 to 16000)

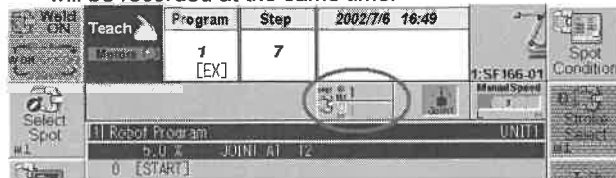
Nevertheless, insofar as only the spot welding function is concerned, automatic recording of the spot welding function at the same time as the movement commands are recorded is enabled in order to improve the operational ease. Simply by moving the robot to the hitting point position and pressing the [O.WRITE/REC] key, the two steps of recording the position concerned (movement command) and recording the spot welding (function command) can be performed at the same time. The procedure is described below. (To present the simplest scenario, the procedure is described using only one welder.)

>> A description of the basic operations for the teaching work will be omitted here: instead, the description starts from the recording of the spotting points.

- 1 Move the robot to the spotting position.**
Contact the settled-side electrode of servo gun with the workpiece, manually pressurize it (by pressing [ENABLE] + [CLAMP ARC] keys at the same time) and grasp the workpiece with the servo gun.



- 2 Press the [CLAMP/ARC] key on the teach pendant once.**
>> The letters "REC" and a red circle appear in the application area (in the section enclosed by the red frame immediately below the comment in the figure below) on the status window.
When a movement command is now recorded, the FN119 spot welding function will be recorded at the same time.





3 Press the [O.WRITE/REC] key.

- >> When a movement command is now recorded, the FN119 spot welding function will be recorded at the same time. In the example given on this page, a movement command is recorded in step 3 and the spot welding command is recorded in step 4.

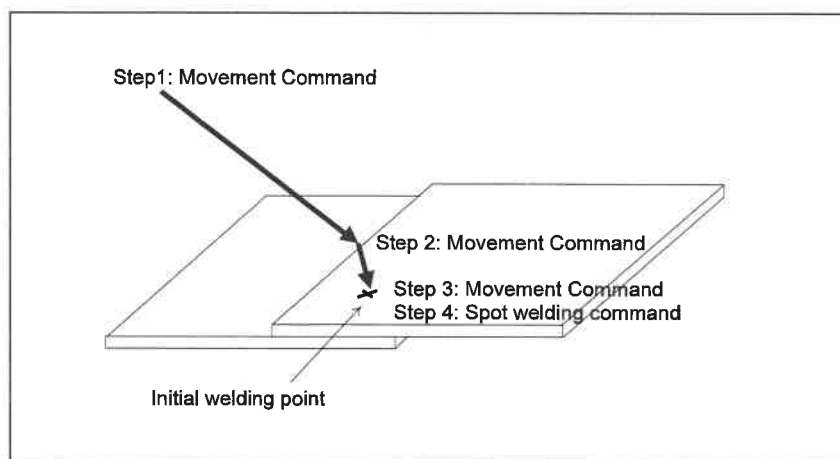
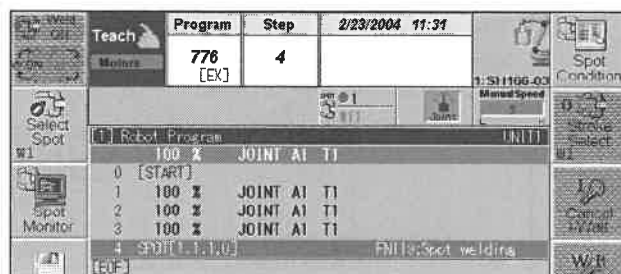


Fig. 9.4.1 Teaching the spot welding commands

- >> The contents of the parameters when the spot welding command has been recorded can be decided upon exactly as desired. For further details, refer to “9.5 Sets the spot welding conditions” and “9.6 Setting the spot weld sequences”.
- >> For details on how to edit the welding conditions and weld sequences which are referenced, refer to “9.5 Sets the spot welding conditions” and “9.6 Setting the spot weld sequences”. These descriptions will be skipped here.



4 Press the [CLAMP/ARC] key again to prepare for the recording of the next step.

- >> The red circle in the application area are cleared. From now on, the spot welding command will not be recorded simultaneously even when a movement command is recorded. When a hitting point is reached again, repeat the same operations starting with step 2.

Concerning the [CLAMP/ARC] key

This hard key on the teach pendant is used only with welder 1.

When more than one welder is used, its operation is performed by the f key for the second and subsequent welders.

For further details, refer to “9.4.3 When using multiple number of welders”.

9.4.2 Manual pressurizing and manual welding

The welding operation can be performed manually when the spotting positions or welding quality is to be checked. The operation differs slightly depending on whether the air gun or servo gun is used.



DANGER

When proceeding with manual operation, keep away from the spot welding gun. If a dry run is to be performed, be absolutely sure to turn off the power (weld OFF) before proceeding so that the welding current will not flow even when a manual welding operation is performed by mistake. If a person should be sandwiched or receive an electric shock, death or serious injury may result.

Manual pressurizing (without welding)

- 1 Select the teach mode.
- 2 Move the robot to the pressurizing position.
When using the air gun



- 3 Press the [ENABLE] and [CLAMP/ARC] keys together.
>> The welding force control signal and pressurizing signal are output. →The gun performs the pressurizing operation. The power-on signal is not output. →The welding current does not flow.0

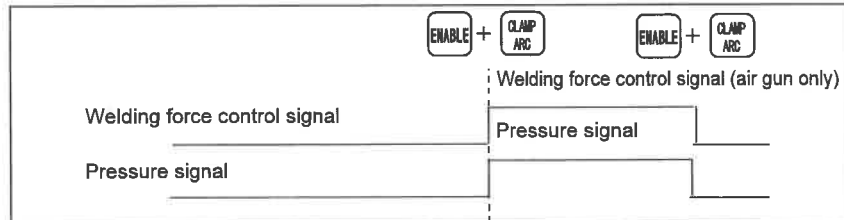
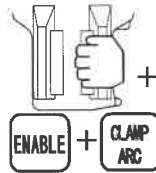


Fig. 9.4.2 Air gun manual pressurizing

Actually, the welding force control signal which was set in the “welding conditions applying for manual welding” is output. The welding force signal is output in accordance with the ON or OFF setting for the pressurizing signal output which was set in the “weld sequences applying for manual welding”.



- 4 Press the [ENABLE] and [CLAMP/ARC] keys together once more.
>> The welding force control signal and pressurizing signal are now turned off. →The gun is released.
When using the servo gun



- 3 While grasping the Enable switch (Deadman switch), press the [ENABLE] and [CLAMP/ARC] keys together.
>> The gun axis moves to the “pressurizing stroke” position which is a condition among the spot constants/servo gun conditions, and it stops there for the time being. (The fixed electrode on the robot body does not move.)

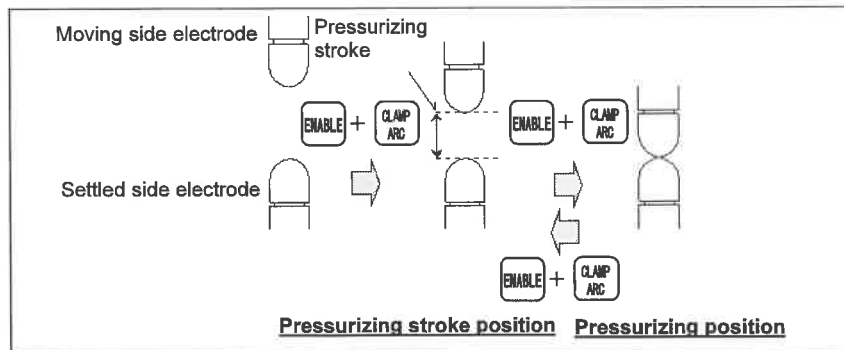
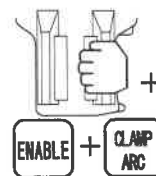


Fig. 9.4.3 Servo gun manual pressurizing

If the [CLAMP/ARC] key or Enable switch (Deadman switch) is released during the pressurizing operation, the operation is suspended immediately.



- 4 Once more, while grasping the Enable switch(Deadman switch), press the [ENABLE] and [CLAMP/ARC] keys together.
>> The gun axis moves to the pressurizing position. (The fixed electrode on the robot body does not move.)
The welding force complies with the setting for the welding conditions which were set in the “welding numbers applying for manual welding”.
- 5 From this point, whenever the [ENABLE] and [CLAMP/ARC] keys are pressed together, the movement of the pressurizing stroke position and pressurizing position will alternate.

Welding manually

- 1 Select the teach mode.
- 2 Move the robot to the position where manual welding is performed.

When using the air gun

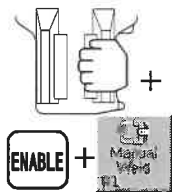


- 3 Press the [ENABLE] and [Manual Weld] keys together.
 - >> Following exactly the same procedure as for playback. Proceed with spot welding using the welding conditions which were set in the "welding conditions applying for manual welding" and the weld sequences which were set in the "weld sequences applying for manual welding".



- 4 The gun will not be released unless the welding completion signal (WI) is input from the welding controller. If the welding controller is being adjusted, the gun can be forcibly released by pressing the [ENABLE] and [Cancel WI] keys together.

When using the servo gun



- 3 While grasping the Enable switch (Deadman switch), press the [ENABLE] and [Manual Weld] keys together.
 - >> The robot moves to the pressurizing stroke position, and stops there for the time being.

- 4 Once more, while grasping the Enable switch (Deadman switch), press the [ENABLE] and [Manual Weld] keys together.
 - >> Following exactly the same procedure as for playback. Proceed with spot welding using the welding conditions which were set in the "welding conditions applying for manual welding" and the weld sequences which were set in the "weld sequences applying for manual welding". Unlike manual pressurizing, the fixed electrode on the robot body also moves. (Equalizing operation)

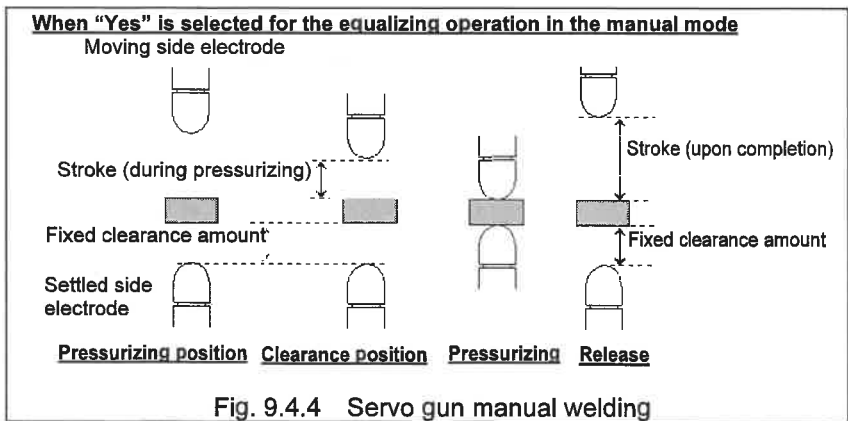


Fig. 9.4.4 Servo gun manual welding



- 5 The gun will not be released unless the welding completion signal (WI) is input from the welding controller. If the welding controller is being adjusted, the gun can be forcibly released by pressing the [ENABLE] and [Cancel WI] keys together.
- 6 From this point, whenever the [ENABLE] and [Manual Weld] keys are pressed together, the welding operation from the pressurizing stroke position will be repeated.
 - The pressurizing stroke clearance position is the distance between the tip and work piece immediately prior to pressurizing when the spot welding command (SPOT: FN119) is played back.
 - It is set in the constants/spot welding application/servo gun conditions.

Switching the stroke manually

“Stroke switching” refers to changing the release amount of the spot welding gun.

In the case of an air gun, this amount can be switched to one of two levels (fully open = wide release; semi open = narrow release) by turning the “fully open signal” or “semi-open signal” to ON or OFF. Connect either the “fully open signal” or “semi-open signal” or both signals to an air gun that supports stroke switching.

In the case of a servo gun, the gun axis is servo-controlled and so can be stopped at any position. However, out of consideration for ease of teaching, by design it is possible to release the gun by a single-touch action to one of four stroke settings.

- 1 Select the teach mode.
- 2 Move the robot to the pressurizing position.

When using the air gun



- 3 Press the [ENABLE] and [Stroke Change] keys together.
>> The semi-open signal is set to OFF, and the fully open signal is set to ON.

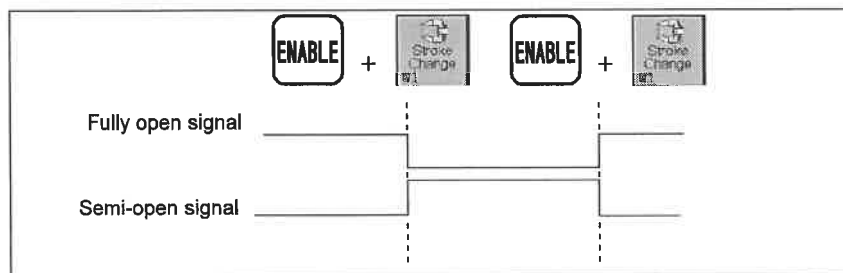


Fig. 9.4.5 Air gun manual stroke switching

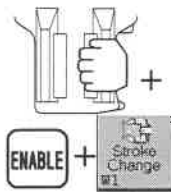


- 4 Once more, press the [ENABLE] and [Stroke Change] keys together.
>> Conversely, the semi-open signal is set to ON, and the fully open signal is set to OFF.
In this way, the semi-open signal and fully open signal are repeatedly set to ON or OFF alternately.

When using the servo gun



- 3 First, press the [Stroke Select] key, and select the desired setting from among the four stroke settings.
>> The number at the top left of the [Stroke Select] key is switched in the following sequence: 0 → 1 → 2 → 3.
Under the initial setting, the lower the number, the wider the release amount. Shown below is the correlation between the displayed number and the setting menu used for the spot constants/servo gun conditions.
0: Major release end default value
1: Stroke 1
2: Stroke 2
3: Stroke 3
4: Stroke



4

While grasping the Enable switch (Deadman switch), press the [ENABLE] and [Stroke Change] keys together.

>> The gun axis moves to the position of the stroke which was set on the previous page.

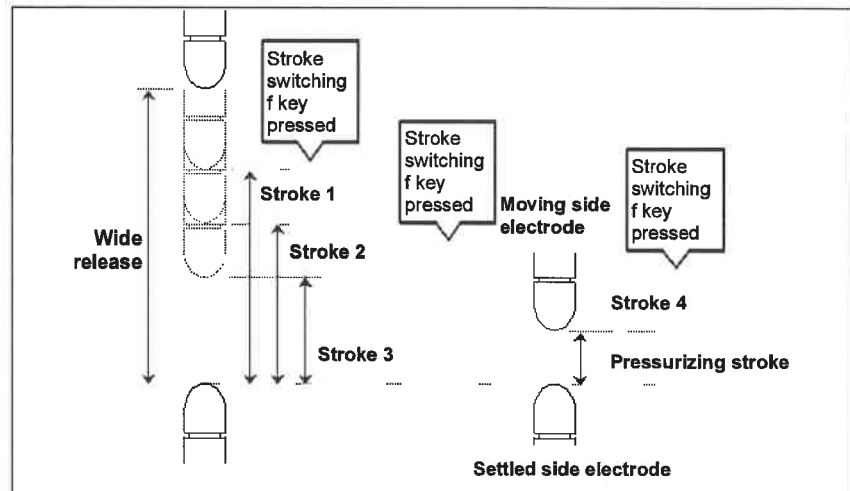


Fig. 9.4.6 Servo gun manual stroke switching

9.4.3 When using multiple number of welders

When a multiple number of welders (welding controllers) are used, the user must first declare which welders are the target of the operations.

This operation method is described below.

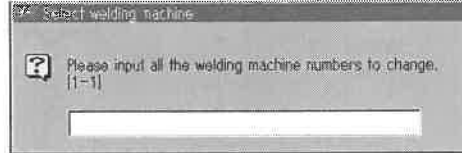
The operation procedure below shows how the [Select Spot] f key is used. If the [Select Spot] f key is not displayed, it can be allocated using [Constants] - [7 T/P keys] - [2 Soft key layout].

The same operation can be performed using the R315 shortcut.



1 In the teach or playback mode, press the [Select Spot] f key.

>> A screen such as the one shown below now appears. Now input all the numbers of the welders that will be the target of the operations performed from this point.



If, for instance, the operations are to apply to both welders 1 and 2, either 12 or 21 may be input. Input the welder numbers so that they are enumerated.

Here, only the numbers for the welders registered ahead of time can be input.

>> The numbers of the welders targeted for the current operation are displayed in the application area on the status window. They are indicated by the bold numbers on the top row.

In the example below, welders 1, 2, 3 and 4 are targeted.



>> From this point, the manual welding and spot welding commands are recorded for the welders targeted for operation.

9.5 Sets the spot welding conditions

The spot welding conditions refer to the groups of data that determine the welding current, welding force and other conditions of the spot welding itself. The spot welding conditions are completely separate from the programs, and they are stored on a one-file-per-welder basis. A file can contain groups of up to 255 conditions. During playback, the AX20/AX21 controller outputs the numbers of the welding conditions written among these conditions to the welding controller.

The actual welding current and schedule must be taught ahead of time on the welding controller side.

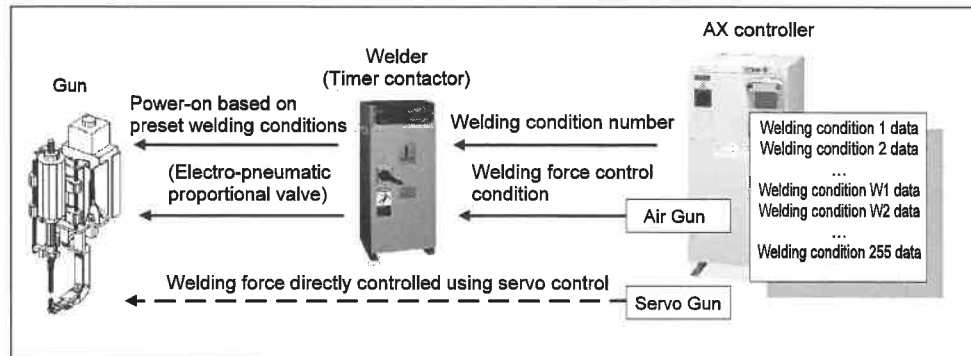


Fig. 9.5.1 Spot welding condition

As is shown in the figure above, how the control is exercised differs depending on the drive system used for the spot welding gun: this means that the setting screen for the spot welding conditions differs slightly depending on whether air guns or servo guns are used. The spot welding condition files are separate from the program files so it is possible to revise the contents of the welding conditions even during the playback operations of the robot. How to edit spot welding conditions is described below.

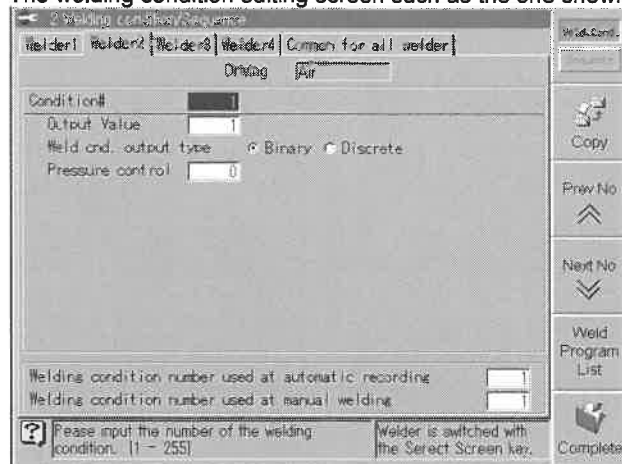
This manual does not provide a detailed description of the significance of each parameter. For a detailed description, refer to "APPLICATION MANUAL: SPOT WELDING".

When using the air gun

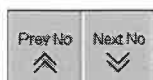


- 1 In the teach or playback mode, press the f6 [Spot Weld. Cond.] key. Alternatively, select [Service Utilities] followed by [20 Spot welding application] and [2 Welding condition/Sequence].

>> The welding condition editing screen such as the one shown below now appears.



- 2 If a multiple number of welders are being used, press the [CLOSE/SELECT SCREEN] key. Each time this key is pressed, the tab provided for each welder is switched. The "Common for all welder" tab has the welding conditions used in common for all the welders.



- 3 A total of 255 conditions can be stored. Align the cursor with "Condition#", input the number of the condition and press [Enter] or press the [Prev No] or [Next No] f key to select the desired welding condition number.

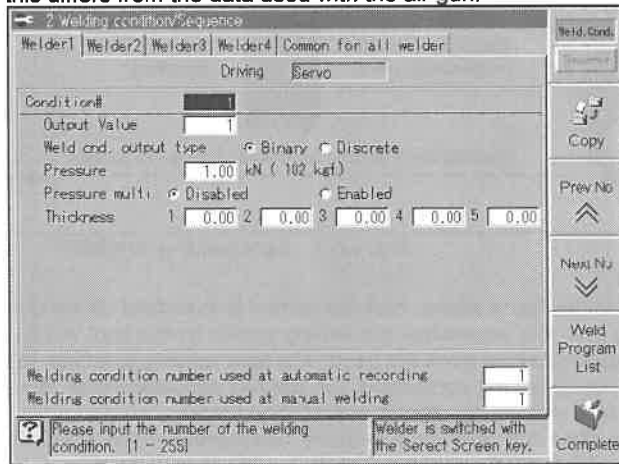
- 4 **Set the data.**
 >> This manual does not provide a detailed description of the significance of each parameter.



- 5 **Upon completion of the settings, press the [Complete] f key.**
The settings are written in the spot welding condition file.
 >> If the playback operation is underway, the changes in the settings are reflected immediately.

When using the servo gun

- 1 >> The editing screen changes to a configuration resembling the one shown below. With a servo gun, the welding force is controlled directly so that the setting data for this differs from the data used with the air gun.



- >> Otherwise, there are no differences from when air guns are used. This manual does not provide a detailed description of the significance of each parameter.

9.6 Setting the spot weld sequences

A spot welding sequence refers to the data which defines the I/O sequences, etc. between the robot controller and welder. The spot welding sequences are completely separate from the programs, and they are stored on a one file per welder basis. A file can contain up to 64 sequences per welder. During playback, the AX20/AX21 controller controls the welding flow in accordance with these sequences.

The spot welding sequences do not determine the sequences of the welding itself such as its power-on cycle and cooling cycle. The sequences of the welding itself must be taught ahead of time at the welder side.

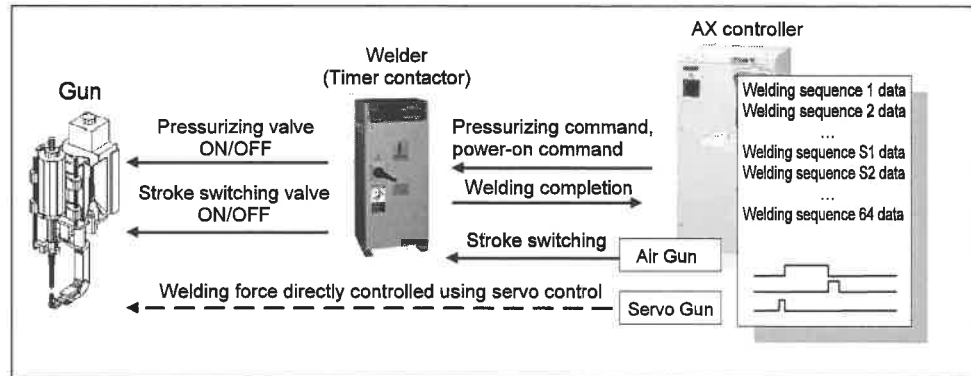


Fig. 9.6.1 Spot Weld Sequence

Depending on the drive system used for the spot welding gun, the setting screen for the spot weld sequences differs slightly. The spot weld sequence files are separate from the program files so it is possible to revise sequences even during the playback operations of the robot. How to edit spot weld sequences is described below.

This manual does not provide a detailed description of the significance of each parameter. For a detailed description, refer to "Application Manual: Spot Welding".

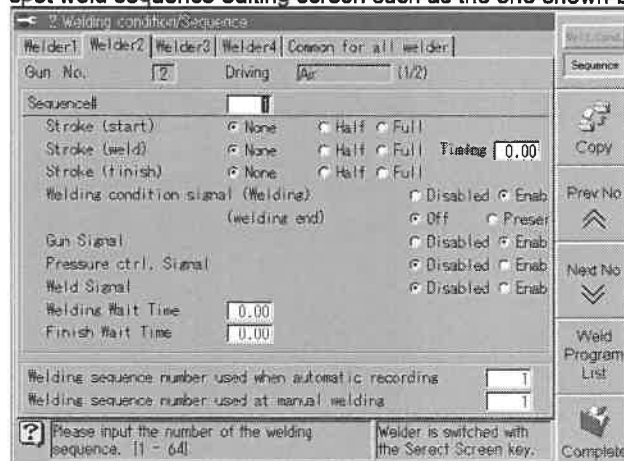
When using the air gun



- In the teach or playback mode, press the [Spot Weld. Cond.] f key. Alternatively, select [Service Utilities] followed by [20 Spot welding application] and [2 Welding condition/Sequence].**
>> The spot welding condition editing screen mentioned before now appears.

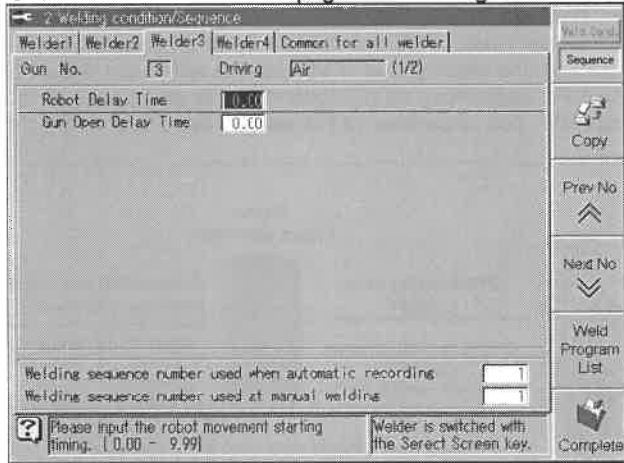


- Press the [Weld. Cond./Sequence] f key.**
>> The spot welding condition editing screen and spot weld sequence editing screen can now be selected alternately. When this key is set to "Sequence", the spot weld sequence editing screen such as the one shown below appears.





- All the weld sequence settings may not always fit onto one page of the screen.**
The screen page displayed can be switched using the [ENABLE] and [Prev No] or [Next No] keys.
 >> Shown below is the second page of the setting screen when air guns are used.



- If a multiple number of welders are being used, press the [CLOSE/SELECT SCREEN] key.**
Each time this key is pressed, the tab provided for each welder is switched.
The "Common for all welder" tab has the sequences used in common for all the welders.



- A total of 64 sequences per welder can be stored. Align the cursor with "Weld sequence number", input the number of the condition and press [Enter] or press the [Prev No] or [Next No] key to select the desired weld sequence number.**

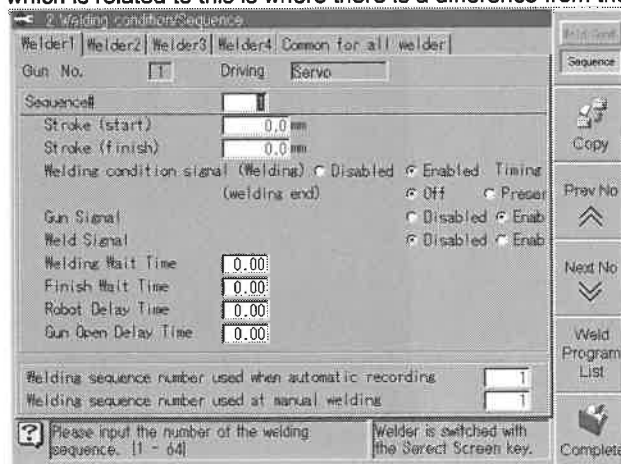
- Set the stroke and other data.**
 >> This manual does not provide a detailed description of the significance of each parameter or timing charts, etc.



- Upon completion of the settings, press the [Complete] key on each page.**
The settings are written into the spot weld sequence file.
 >> If the playback operation is underway, the changes in the settings are reflected immediately.

When using the servo gun

- >> The editing screen changes to a configuration resembling the one shown below. With the servo gun, any setting can be selected for the stroke. The data set which is related to this is where there is a difference from the air gun data.

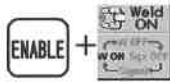


- >> Otherwise, there are no differences from when air guns are used. This manual does not provide a detailed description of the significance of each parameter.

9.7 Spot welding ON/OFF

In cases where, for instance, the spotting positions are to be checked, a setting must be performed to temporarily halt the welding. This is generally referred to as "weld ON/OFF", and it can easily be set and checked from the teach pendant.

Either the teach or playback mode may be established.



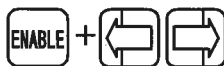
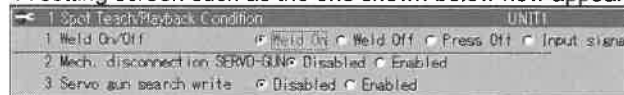
- In the teach or playback mode, press the [Weld ON/OFF] f key. Each time it is pressed, one of the four statuses in the table below is selected in turn.**

Display	Status	Details
	Weld ON	Welding is implemented in accordance with the settings of the weld sequences specified by the spot welding command (FN119).
	Weld OFF	Weld command signal is not output. At all other times, welding is implemented in accordance with the weld sequences.
	Squeezing OFF	The squeezing signal and weld command signal are not output. Neither is the WI wait processing performed. At all other times, welding is implemented in accordance with the weld sequences. The welding counter does not count up.
	Input signal	Weld ON, weld OFF or squeezing OFF is determined in accordance with the "weld ON" and "squeezing OFF" statuses of the input signal.

The f keys also serve to provide displays so that the current status can be ascertained at a glance.

- This now completes the settings.**
- The same selections as above can be accomplished by selecting [Service Utilities] followed by [20 Spot welding application] and [1 Spot Teach/Playback Condition]. The same result is achieved whichever settings are used.**

>> A setting screen such as the one shown below now appears.



- Press the [ENABLE] and [left or right] cursor keys to select the settings of the radio buttons (the horizontal rows of selector buttons).**



- Press the [Complete] f key.**



Important

To use the input signals "Weld ON" and "Weld OFF," determine the status of "Weld ON/OFF" at least 100msec before running the work program.

Even if the status of "Weld ON/OFF" is changed when running the program, such change may not be immediately incorporated in the program.

NOTE

Chapter10 Basic arc welding operations

This chapter describes the basic arc welding operations for operators who will be using the robot for the arc welding application. Read through the chapter, acquire the knowledge that is minimally required for arc welding, and master the basic operating procedures.

For details of other functions relating to arc welding, reference should be made to the Application Manual (Arc Welding).

10.1 Terms frequently used with arc welding	10-1
10.2 f key layout	10-2
10.3 Basic arc welding operations	10-5
10.3.1 Inching and retracting the wire	10-5
10.3.2 Switching between welding ON and OFF	10-6
10.3.3 Checking the shielding gas	10-6
10.3.4 Switching the welders	10-7
10.3.5 Switching between weaving ON/OFF	10-8
10.4 Teaching arc welding	10-9
10.5 Teaching of weaving	10-15
10.6 Creating condition files	10-18
10.6.1 Creating condition files	10-18
10.6.2 Copying, deleting and renaming condition files	10-21

10.1 Terms frequently used with arc welding

For the benefit of operators who will be using the robot for the first time, this section explains the basic terms relating to arc welding which come up frequently in this manual.

Table 10.1.1 Terms frequently used with arc welding























Terms	Explanation
Arc welding power supply	This is the controller that directly controls arc welding itself. It may simply be referred to as the welding power supply or welder. In the case of the AX20/AX21 controller, it enables the DAIHEN robot dedicated welding power supply or semi-automatic welding power supply as well as the welding power supplies made by other companies to be connected and controlled.
Robot dedicated welding power supply	This is a welding power supply that contains the functions for interfacing with the robot. Types include the CPDPAS-501 and CPDACA-201.
Welding interface	This is required to connect the semi-automatic welding power supply, that does not contain the functions for interfacing with the robot, to the robot.
Arc start	This refers to generating the arc in order to commence welding.
Arc start failure	This denotes that the generation of the arc failed at the point when welding was to have commenced. It has many and varied causes: for instance, "out of wire", "wire jam", "wire misfeed", "wire penetration", "welder WCR failure" or "trouble in power supplied to tip" may be to blame for the failure.
Arc run-out	This denotes that the arc has run out even though there is no arc stop command from the robot during welding. It has many and varied causes: for instance, "out of wire", "wire jam", "wire misfeed", "wire penetration", "welder WCR failure" or "trouble in power supplied to tip" may be to blame for the failure.
Pre-flow	This refers to the blowing out of the shielding gas from the nozzle a number of seconds before the welding arc is to be generated.
Arc voltage (welding voltage)	This refers to the voltage between both ends of the arc. When the arc voltage is raised, the disadvantage is that some defects may occur: for instance, the arc may increase in length or the beads may increase in width or there may be a tendency for overlapping or blow-holes to form. On the other hand, raising the arc voltage minimizes spatter.
Welding current	This is the current that is supplied in order to provide the heat required for the welding. When the welding current is raised, the penetration is deepened. In the case of thin sheets, holes may form or burst. Further, the amount of wire that melts increases, thereby extending the leg length.
Welding speed	This refers to the speed at which the weld beads are placed. It is normally expressed as the bead length per minute (cm/min.). When the speed is raised, the heat input per unit length decreases so that a number of defects may occur: for instance, the beads may become thinner, the penetration may become too shallow, there may be the tendency for undercutting or the gas shielding may be impaired. On the other hand, when the speed is lowered, overlapping may tend to occur.
Welding condition	These are the conditions for performing the welding, and they refer to a group of data consisting of the welding current, welding voltage, welding speed, etc.
Welding ON/OFF	This refers to switching between welding ON and welding OFF.
Crater	This refers to the indentations that form at the trailing end of the beads.
Crater treatment	This refers to the treatment where the arc is continuously generated for the prescribed period of time so that the craters will be filled in under the conditions which are below the regular welding conditions.
Deposition	This refers to the fact that the tip of the melted wire has adhered to the base metal upon completion of the welding. It is avoided by retracting the wire or conducting burnback processing upon completion of the welding.
Anti-sticking	This refers to a way in which deposition is prevented. Normally, upon completion of the welding, a no-load voltage (burnback voltage) is applied to the wire while the wire feed is shut down. If the wire touches the base metal, a current flows, and the resulting heat causes the wire to flare up, thereby enabling deposition to be prevented.
WCR	This is an abbreviation for welding current relay which is used as the name of the signal that indicates the welding current ON/OFF status.

10.2 f key layout

When the robot is used for the arc welding application, the initial settings of the f keys that appear at both sides of the LCD screen are as shown below.

The f keys are arranged in a layout which is optimally suited to the settings of the specific application such as spot welding or arc welding. Since initial settings are performed at the factory to suit the application for which the particular type of robot is normally used, the user does not normally need to re-arrange the f keys.

Table 10.2.1 Initial layout of f keys for arc welding (teach mode)

■ Teach mode (page 1: when the keys are simply pressed)					■ Teach mode (page 1: when the keys are pressed together with [ENABLE])						
f1		key switching	Arc start command selection		f7	f1		f key switching	Arc end command selection		f7
f2		Welding ON/OFF	Weaving start command selection		f8	f2		Welder select	Weaving end command selection		f8
f3		Weaving ON/OFF	Allocates station startup		f9	f3		Weaving ON/OFF target robot switching	Forcibly initiates I release. (Input wait release)		f9
f4		File operations	Wire inching (low-speed)		f10	f4		No function	Wire inching (high-speed)		f10
f5		Arc constant setting	Wire retract (low-speed)		f11	f5		Sets the constant.	Wire retract (high-speed)		f11
f6		Arc welding Condition setting	Gas check		f12	f6		Service menu	No function		f12



























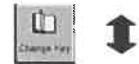
■ Teach mode (page 2: when the keys are simply pressed)					■ Teach mode (page 2: when the keys are pressed together with [ENABLE])						
f1		f key switching	Sets the teach or playback conditions		f7	f1		f key switching	No function		f7
f2		Sensor ON/OFF	Manual speed Switching (speed up)		f8	f2		No function	No function		f8
f3		Input/output ON/OFF	Manual speed switching (speed down)		f9	f3		No function	No function		f9
f4		Sets monitor 2	No function		f10	f4		No function	No function		f10
f5		Tool switching	Sets the accuracy.		f11	f5		No function	Pass/positioning setting		f11
f6		Step Clear/Change Specified Return	Performs the Smooth setting.		f12	f6		Automatic operation pause status release (only during station startup)	Acceleration setting		f12







Table 10.2.2 Initial layout of f keys for arc welding (playback mode)



■ Playback mode (page 1: when the keys are simply pressed)				
f1		f key switching	Arc welding Condition setting	f7
f2		Welding ON/OFF	No function	f8
f3		Weaving ON/OFF	No function	f9
f4		Arc monitor	Wire inching (low-speed)	f10
f5		No function	Wire retract (low-speed)	f11
f6		Stop	Gas check	f12

■ Playback mode (page 1: when the keys are pressed together with [ENABLE])				
f1		f key switching	Service Menu	f7
f2		Welder select	Step feed	f8
f3		Weaving ON/OFF target robot switching	Forcibly initiates I release. (Input wait release)	f9
f4		Step continuous	No function	f10
f5		Switches between cycle, Continuous and step.	Speed override (10% up)	f11
f6		Stop	Speed override (10% down)	f12

ENABLE



■ Playback mode (page 2: when the keys are simply pressed)				
f1		f key switching	Sets the teach or playback conditions.	f7
f2		Sensor ON/OFF	No function	f8
f3		Step Clear/ Change Specified Return	No function	f9
f4		Changing the method for returning to the stopped position for normal startup	No function	f10
f5		Changing the method for starting up after a step set.	No function	f11
f6		Stop	No function	f12

■ Playback mode (page 2: when the keys are pressed together with [ENABLE])				
f1		f key switching	No function	f7
f2		No function	No function	f8
f3		No function	No function	f9
f4		No function	Wire inching (high-speed)	f10
f5		No function	Wire retract (high-speed)	f11
f6		Stop	Simultaneously switches the start select and program select or station monitor	f12

ENABLE

Table 10.2.3 Initial layout of f keys for arc welding (when the CLAMP/ATRC key has been pressed)

Key	Icon	Function	Icon	Key
f1		f key switching	Move command (JOINT)	f7
f2		Weld start command(AS)	Move command (LINE)	f8
f3		Weld end command (AE)	Move command (CIRCLE)	f9
f4		Fixed pattern Weaving start Command (WFP)	Wire inching (low-speed)	f10
f5		Weaving end Command (WE)	Wire retract (low-speed)	f11
f6		END instruction	Gas check	f12

→

f1		f key switching	Start allocation	f7
f2		Step jump command(JMP)	SET command	f8
f3		Program call command (CALLP)	RESET command	f9
f4		Joint weaving Start command (WAX)	ON wait command (WAITI)	f10
f5		No function	OFF wait command (WAITJ)	f11
f6		Timer command (DELAY)	No function	f12

10.3 Basic arc welding operations

This section describes the basic operating procedures relating to arc welding such as wire inching and retract and switching between welding ON and OFF.

10.3.1 Inching and retracting the wire

Inching refers to the action that extends the welding wire from the tip; conversely, retracting refers to the action that draws the wire back into the tip. In the motor power status, it does not matter if these functions are OFF. (There is no need to grasp the deadman switch.) The wire can be inched or retracted in the teach mode or playback mode unless the robot is operating.

Inching and retracting the wire



- 1 To inch the wire, press f10 <Inching>.
>> The wire is now extended slowly from the tip.



- 2 To retract the wire, press f11 <Retract>.
>> The wire is now drawn back slowly into the tip.



- 3 To inch the wire at high speed, press f10 <Inching> while holding down [ENABLE].
>> The wire is now extended rapidly from the tip.



- 4 To retract the wire at high speed, press f11 <Retract> while holding down [ENABLE].
>> The wire is now drawn back rapidly into the tip.



To change the inching/retract operation patterns

You can select from among "Normal", "Limit" and "Hold" for the inching or retract movement pattern with <Arc Constant> — [3 Constant of weld] — [Inching/Retract Key operation].

- The initial setting is "Normal", whereby inching/retract is done only while the key is being pressed.
- When this is set to "Limit", inching/retract will halt after the set time has elapsed, even if the key continues to be pressed. When you release the key during the set time period, inching/retract will halt immediately.
- When this is set to "Hold", pressing the key once will cause inching/retract to be done for the set time period. Inching/retract will continue even if you release the key during the set time period. Using this setting will allow you to always do inching/retract for a fixed length. (However, there will be slight variations.) When using the "Hold" setting, please adjust the time to the desired length.

10.3.2 Switching between welding ON and OFF

Prior to shipment from the factory, this setting is at ON so that welding will be executed without fail. To disable welding temporarily, switch "welding ON/OFF" to "OFF". Use the f keys for the switching operations. Switching is possible at any time regardless of whether the teach or playback mode is established. (Switching is also possible during the playback of welding sections.)

Switching between welding ON and OFF



1 Press f2 <Weld ON/OFF>.

>> Each time this key is pressed, the welding ON/OFF status is switched as follows.

Display	Status	Details
	Weld ON	Welding is performed during automatic operation.
	Weld OFF	Welding is not performed during automatic operation.
	The input signal is complied with.	Welding ON/OFF is determined by the "welding ON / OFF" signal which is input from the external source. The f key display changes in accordance with the status of the "welding ON/OFF" signal.

2 Press the key until the desired status is established.

>> The robot proceeds with the welding in accordance with the welding ON/OFF setting status.

10.3.3 Checking the shielding gas

Whether the shielding gas used for welding is being output properly can be checked using the teach pendant. One of the f keys is used to perform the operations.

Checking the shielding gas

When a multiple number of welders are used, select the one for which this operation is to be performed before proceeding with the gas check.



1 Press f12 <Gas>.

>> The shielding gas is output while the key is pressed.

2 To stop the shielding gas, release f12 <Gas>.



Leave the welder's gas check switch at OFF.

To check the gas from the teach pendant, the gas check switch provided on the welder must be left at OFF without fail. If it is at the ON position, the gas cannot be checked from the robot.



To change the shielding gas output patterns

For the shielding gas, you can select from among "Normal", "Limit" and "Hold" with <Arc Constant> — [3 Constant of weld] — [Gas check operation]. The initial setting is "Normal", whereby gas is output only while the key is being pressed. When this is set to "Limit", gas will halt after the set time has elapsed, even if the key continues to be pressed. When you release the key during the set time period, gas will halt immediately. When this is set to "Hold", pressing the key once will cause gas to be output for the set time period. Output will continue even if you release the key during the set time period.

10.3.4 Switching the welders

Since a multiple number of welders can be connected to the AX20/AX21 controller, the target welder must be specified before inching or retracting the wire or switching between welding ON and OFF, for instance. (This switching operation need not be performed when only one welder is used.)

Switching the welders

- 1 To switch the welders, use <Select Arc>. This is possible both in the teach mode and playback mode.



"W1" appears at the bottom left of the f key. This denotes that "welder 1" is the target of operation. When "welder 2" is selected, "W2" appears. When the control power is turned on, "welder 1 (W1)" is always selected.



- 2 If, when two welders have been connected for example, f2 <Select Arc> is pressed, the target of operation is switched to "welder 2". (The display changes to "W2".)



- 3 When f2 <Select Arc> is pressed again, the next welder is selected.
 - >> If two welders are connected, the target of operation returns to "welder 1". (The display changes to "W1".)

10.3.5 Switching between weaving ON/OFF

Switching between weaving ON and OFF is performed to disable weaving temporarily such as when the weld lines are to be checked.

Switching is possible at any time regardless of whether the teach or playback mode is established. (Switching is also possible during the playback of weaving sections.)

If a multiple number of robots have been connected under the multi-unit specifications, the robot targeted for weaving ON/OFF switching must be selected first.

Switching between weaving ON/OFF



1 If a multiple number of robots have been connected under the multi-unit specifications, press f3 <Select Robot> while holding down [ENABLE] to select the target robot first.

If the multi-unit specifications do not apply (if only one robot is being used), this operation need not be performed.



"MP1" appears at the bottom left of the f key. This indicates that "manipulator 1" has been selected as the target of operation. "MP2" appears if "manipulator 2" has been selected. When the control power is turned on, "manipulator 1 (MP1)" is always selected.



2 Press f3 <Weaving ON/OFF>.

>> Each time the key is pressed, the weaving ON/OFF status is switched as shown below.

Display	Status	Details
	Weaving ON	Weaving is performed.
	Weaving OFF	No weaving is performed.
	The input signal is complied with.	Weaving ON/OFF is determined by the "weaving ON" signal which is input from the external source. The f key display changes in accordance with the status of the "weaving ON" signal.

3 Press the key until the desired status is established.

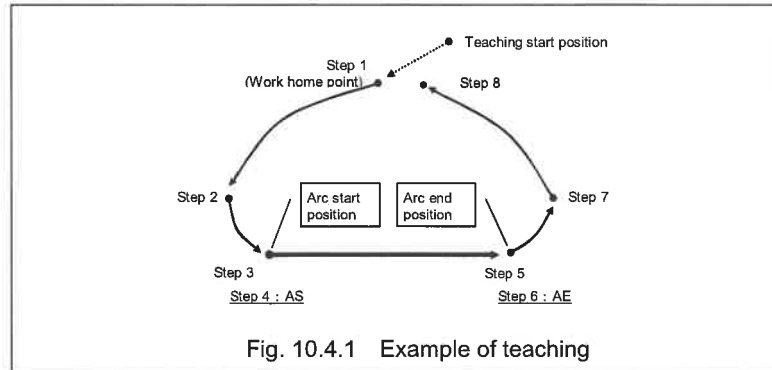
>> The robot proceeds with the weaving in accordance with the weaving ON/ OFF setting status.

10.4 Teaching arc welding

Let's now try teaching some actual welding steps.

This will not be difficult. The only steps that must be taken are to record AS at the position where welding is to start and AE where it is to end.

Using the following work program as an example, the welding steps will now be taught. However, details on recording the movement commands and other basic teaching operations will be omitted here.



POINT

When using an easy teaching (numeric keys)

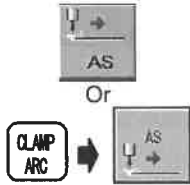
When teaching is performed with numeric keys, "The use of the hard key" needs to be set the "Enable".

Refer to "4.5.4 Try teaching using Easy teaching (numeric keys)". In "Chapter 4" for the setting procedure.

Teaching the arc welding start command

- Record this command up to the arc start position (step 3).

Robot Program			UNIT
0	[START]		
1	100 %	JOINT A1 T1	
2	100 %	JOINT A1 T1	
3	100 %	JOINT A1 T1	

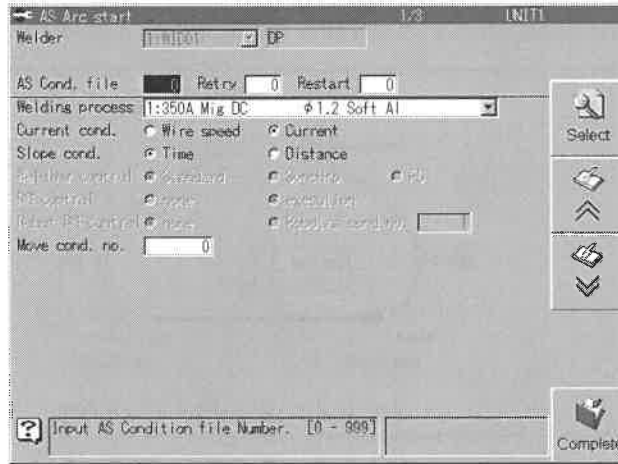


2 When the Normal teaching or the Easy teaching (f key) is performed.

Press f7 <AS>.

Alternatively, press the f2 <AS> after pressing [CLAMP/ARC].

>> The screen for setting the arc welding start conditions now appears. The method used to specify the conditions is described here using a case where the CPDPAS-501 is being operated as an example. The same operations are performed even when other welders are used.



When the Easy teaching (numeric keys) is performed.



While pressing [ENABLE], press [4].

>> The function lists which are set "Arc welding" in the function group are displayed. The Arc welding start command is selected now.



Align the cursor with the "Arc start" (AS) and then press the [Enter]. The screen for setting the arc welding start conditions now appears.



Concerning the method used to select the arc welding start command

The arc welding start command is FN414.

It can also be selected by [FN] □ "414" → [Enter].

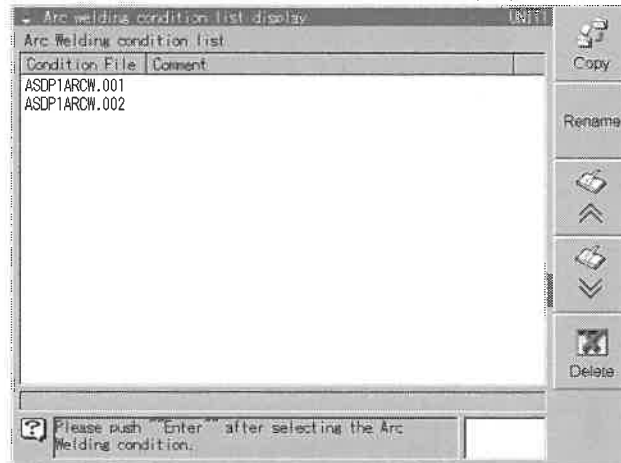
- 3 When "0" is specified as the "AS Cond. file", the conditions can be specified by number. In this case, proceed from step 5.
- 4 To specify a condition using a file, either input the file number directly or select the file from the list of files.



When selecting from the file list

To select a file from the list of files, press f8 <Select>.

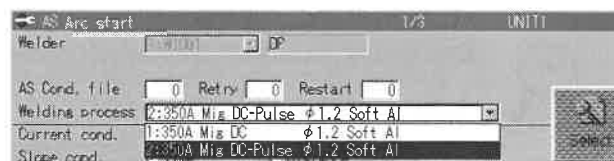
>> The arc start condition files which have been prepared are displayed.



Select a file using the [up or down] key, and press [Enter].

>> The designated arc start condition file is called.

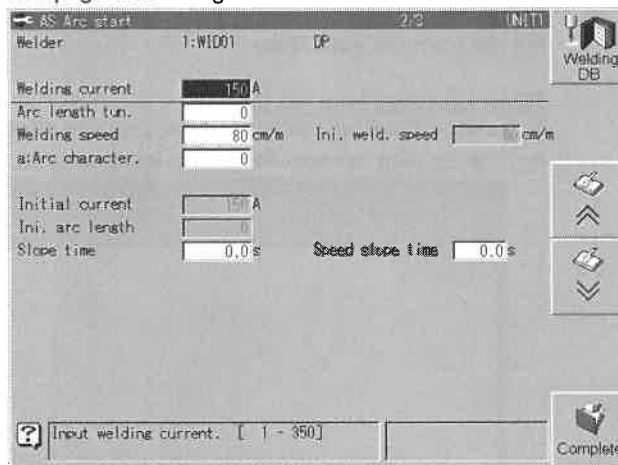
- 5 Specify the number of the arc retry file in the "Retry cond. no.". If "0" is specified, the standard arc retry is executed when arc start has failed. Leave "0" as is if you are not used to operating the robot. When executing arc retry defined by the user, specify an arc retry file which has already been created.
- 6 Specify the number of the arc retry file in the "Restart. no.". When specifying the created arc retry file, the arc restart is performed when lucking of arc as failure. Leave "0" as is if you are not used to operating the robot.
- 7 Align the cursor with "Welding process" and "Current cond.", press [Enter], and select the desired conditions from among the selection items displayed.



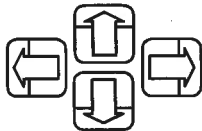


8 The remaining welding conditions are set on the second and subsequent pages. Press [Scroll page].

>> The page now changes.



Depending on the welder used, there may be no conditions to set on the second and subsequent pages. In a case like this, perform step **11**.



9 Move the cursor using the [Up], [Down], [Left] and [Right] keys, and input the "Welding curr.", "Welding speed" and "Arc length tuning".

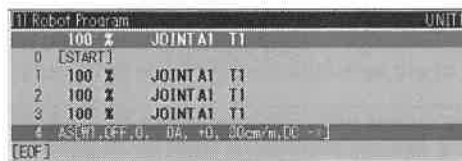


10 If there are a third page and subsequent pages, press [Scroll page] to display the screen, and then input the conditions by following the same procedure as described up until this point.



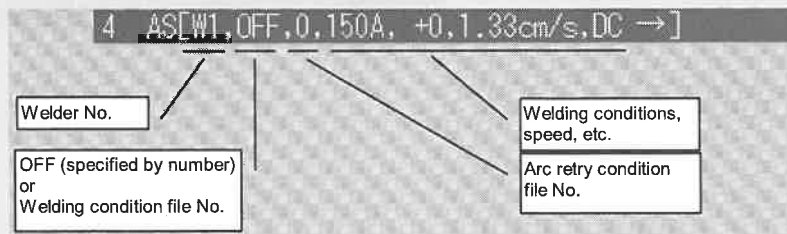
11 Once all the conditions have been set, press f12 <Complete>.

>> The arc welding start command (AS) is recorded as step 4.



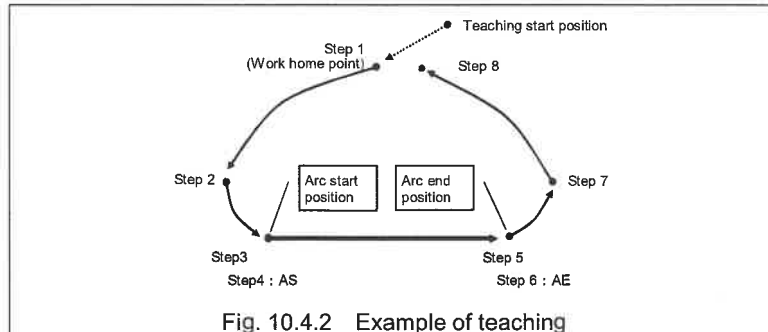
Concerning the step displays after recording

Outlined below is the significance of the step displays after the arc welding start command has been recorded.



Teaching the arc welding end command

Try recording the arc welding end command (AE) at the arc end position.



1 Record the arc end position (step 5).

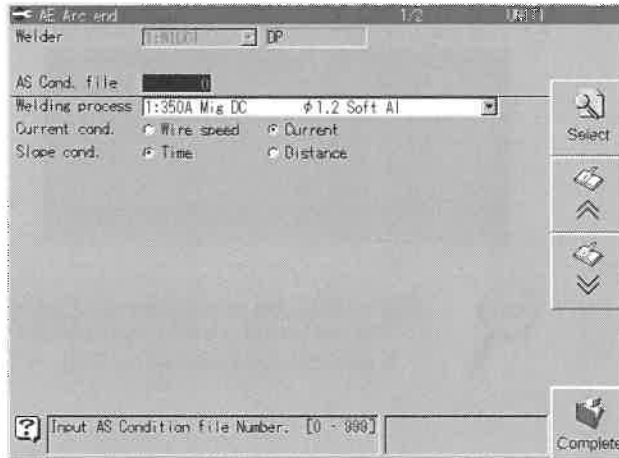
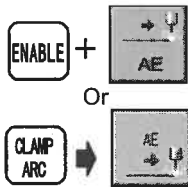
```

T1 Robot Program
100 % JOINT A1 T1
0 [START]
1 100 % JOINT A1 T1
2 100 % JOINT A1 T1
3 100 % JOINT A1 T1
4 AS[WT,OFF,0, 0A, +0, 80cm/m,DC ->]
5 100 % JOINT A1 T1
[EOF]
    
```

2 When the Normal teaching or the Easy teaching (f key) is performed.

While pressing [ENABLE], press f7 <AE>.
Alternatively, press the f3 <AE> after pressing [CLAMP/ARC].

>> The screen for setting the arc welding end conditions now appears.





When the Easy teaching (numeric keys) is performed.

Or while pressing [ENABLE], press [4].

>> The function lists which are set “Arc welding” in the function group are displayed. The arc welding end command is selected now.



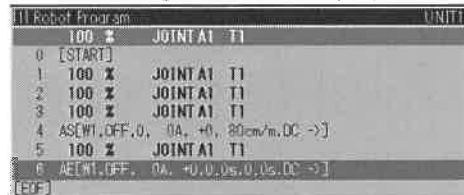
Align the cursor with the “Arc end” (AE) and then press the [Enter]. The screen for setting the arc welding end conditions now appears.

- 3 **Set the conditions by performing the same steps as for the arc welding start command (AS).**



- 4 **Once all the conditions have been set, press f12 <Complete>.**

>> The arc welding end command (AE) is recorded as step 6.



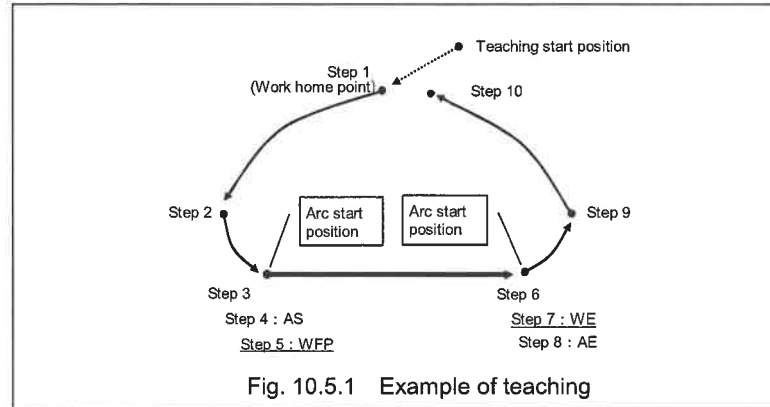
Concerning the method used to select the arc welding end command
 The arc welding end command is FN415.
 It can also be selected by [FN] → “415” → [Enter].

10.5 Teaching of weaving

Weaving is used when there are gaps in the work piece or the leg length is to be shortened.

Using the following work program as an example, this section describes how to teach fixed pattern weaving (WFP).

However, details on recording the movement commands and other basic teaching operations will be omitted here.



POINT

When using an easy teaching (numeric keys)

When teaching is performed with numeric keys, "The use of the hard key" needs to be set the "Enable".

Refer to "4.5.4 Try teaching using Easy teaching (numeric keys)". In "Chapter 4" for the setting procedure.

Teaching the weaving start command

1 Record the command up to step 4.

```

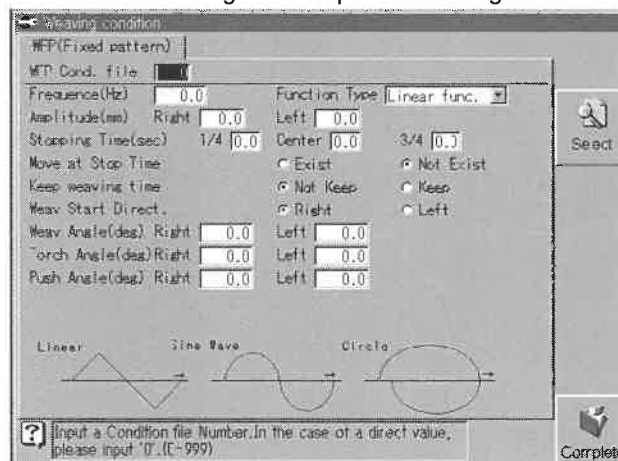
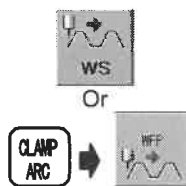
Robot Program UNIT1
100 % JOINT AI T1
0 [START]
1 100 % JOINT AI T1
2 100 % JOINT AI T1
3 100 % JOINT AI T1
4 ASEW,OFF,0, 0, +0.10cm/LS ->
[EOF]

```

2 When the Normal teaching or the Easy teaching (f key) is performed.

Press f8 <WS>. Alternatively, press the f4 <WFP> after pressing [CLAMP/ARC].

>> The screen for setting the fixed pattern weaving conditions now appears.





When the Easy teaching (numeric keys) is performed.

While pressing [ENABLE], press [5].

>> The function lists which are set "weaving" in the function group are displayed. The fixed pattern weaving command is selected now.



Align the cursor with the "fixed pattern weaving" (WFP) and then press the [Enter]. The screen for setting the fixed pattern weaving conditions now appears.



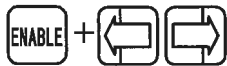
Concerning the method used to select the weaving start command

The fixed pattern weaving start command is FN440.

It can also be selected by [FN] → "440" → [Enter].

3 Move the cursor using [Up], [Down], [Left] and [Right], and set the weaving conditions.

The method used to specify the conditions using a file is the same as for the arc start and arc end commands



The "Move at Stop Time" and "Weave Start Direct." conditions are switched by pressing [left or right] while holding down [ENABLE].



4 Once all the conditions have been set, press f12 <Complete>.

>> The fixed pattern weaving start command (WFP) is recorded as step 5.

Teaching the weaving end command

1 Record the command up to step 6.

```

Robot Program
UNIT
199 cm/m LIN A1 T1
0 [START]
1 100 % JOINTA1 T1
2 100 % JOINTA1 T1
3 100 % JOINTA1 T1
4 AS[W1,OFF,0, 0A, +0, 18cm/m,DC ->]
5 WPE[OFF, 0,0Hz ->] FN[443] Pattern Weav
6 199 cm/m LIN A1 T1
[END]

```

2 When the Normal teaching or the Easy teaching (f key) is performed.

While pressing [ENABLE], press f8 <WE>.

Alternatively, press the f5 <WE> after pressing [CLAMP/ARC].

>> The weaving end command (WE) is recorded as step 7.

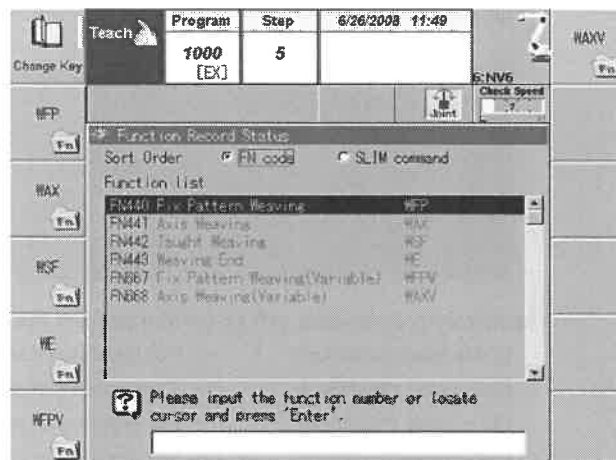


Or

**When the Easy teaching (numeric keys) is performed.**

While pressing [ENABLE], press [5].

>> The function lists which are set "weaving" in the function group are displayed. The weaving end command is selected now.



Align the cursor with the "weaving end" (WE) and then press the [Enter].The weaving end command setting screen (WE) is displayed.

**Concerning the method used to select the weaving end command**

The weaving end command is FN443.

It can also be selected by [FN] → "443" → [Enter].

10.6 Creating condition files

The method used to specify files as welding conditions or weaving conditions is useful because it cuts the time required for teaching and revisions and it facilitates the management of the conditions.

For instance, it yields the following advantages when the same welding conditions are used in more than one place.

- At the teaching stage, only the file number need be specified as the welding conditions.
- When revising the welding conditions, only the specified file need be revised. (There is no need to revise each of the conditions in each welding section in the work program.)

A comment for easy identification can be attached to the condition files.

10.6.1 Creating condition files

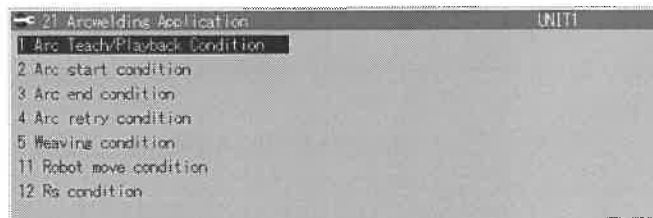
Let's now try to create an actual condition file.

Creating condition files



1 Press f6 <Arc Condition>.

>> The screen for setting the arc welding application now appears. This screen is the same one that appears when [Service Utilities] — [21 Arcwelding application] have been selected.



The following operations can be performed from this menu.

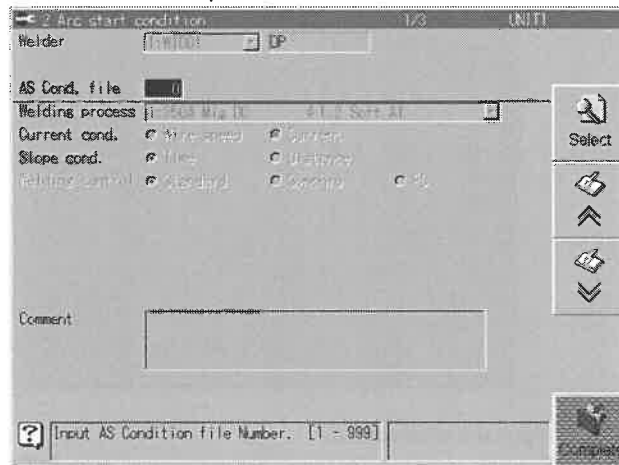
- | | |
|---------------------------|---|
| [2 Arc start condition] | ... For creating or revising arc start condition files. |
| [3 Arc end condition] | ... For creating or revising arc start condition files. |
| [4 Arc retry condition] | ... For creating or revising arc retry condition files. |
| [5 Weaving condition] | ... For creating or revising weaving condition files. |
| [11 Robot move condition] | ... or creating or revising robot move condition files. |
| [12 Rs condition] | ... or creating or revising RS condition files. |



- 2 For instance, to create an arc start condition file, select [2 Arc start condition], and press [Enter].

>> The screen for creating the arc start condition file now appears.

The screen shown below is the setting screen that appears when the DP-350 is used. Depending on the type of welder, the display screen may differ from the one shown below, but operation is the same.



- 3 Input a file number from 1 to 999 in the "AS Cond. file" field, and press [Enter].

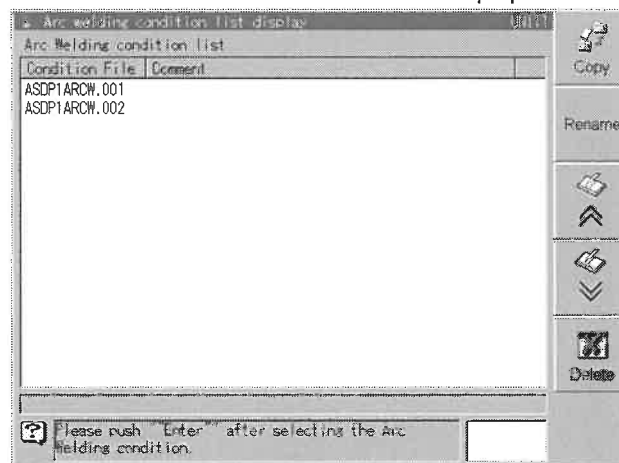
>> When a new file is created, the initial conditions are displayed.

When an existing file number has been input, the contents of the file concerned are displayed.

When selecting an existing file from the file list

To select a file from the list of files, press f8 <Select>.

>> The arc start condition files which have been prepared are displayed.

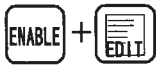


- 4 Select a file using the [up or down] key, and press [Enter].

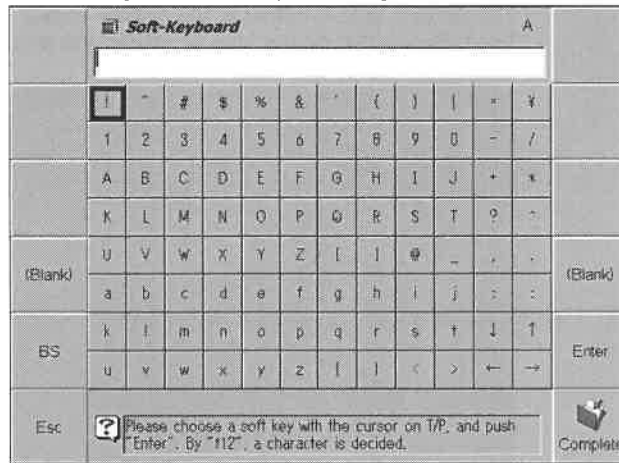
>> The designated arc start condition file is called.

- 4 Select "Welding process" or "Current cond." by performing the same operations as the ones at the teaching stage.

Depending on the type of welder used, these conditions are not displayed. (The conditions need not be set if they are not displayed.)



- 5 **Move the cursor to the "Comment" field. A comment can be attached.**
 To attach a comment, press [EDIT] while holding down [ENABLE].
 >> The soft keyboard starts up, enabling characters to be input.



- 6 **Input the characters.**
 For details on how to input the characters, refer to Chapter 2 "2.5 To input characters".
- 7 **Set the remaining conditions using the same method as the one used at the teaching stage.**



- 8 **Upon completion, press f12 <Complete>.**
 The revised conditions are reflected in the file concerned. If a new file is to be created, the new file is created and stored in the internal memory.

10.6.2 Copying, deleting and renaming condition files

This section describes the methods used to copy and delete condition files which have been created.



Files can be copied and deleted using the file operation menu as well.

Although files can be copied and deleted using the file operation menu as well, the operator must be aware of the folder structure of the internal memory and know which files are stored in which folders when the file operation menu is used.

It is easier to copy or delete condition files by following the procedure below.

Copying, deleting and renaming condition files



1 Press f6 <Arc Condition>.

>> The screen for setting the arc welding application now appears.



2 Select the type of file to be copied or deleted, and press [Enter].

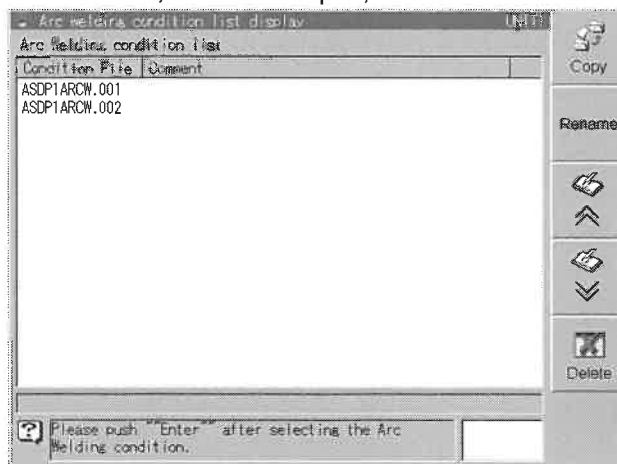
For instance, to copy or delete an arc start condition file, select [2 Arc start condition].

>> The screen for creating the selected file now appears.



3 Press f8 <Select>.

>> The arc start condition files which have been prepared are displayed. On this screen, files can be copied, deleted and renamed.



4 To copy a file:

- (1) Press f7 <Copy> →
- (2) select the copy source condition file and press [Enter] →
- (3) input the number of the copy destination file, and press [Enter].



5 To delete a file:

- (1) Press f11 <Delete> →
- (2) select the condition file to be deleted, and press [Enter].



6 To rename a file:

- (1) Press f8 <Rename> →
- (2) input the new number of the file, and press [Enter].



7 Upon completion of the operation, exit by pressing [RESET/R].

NOTE

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