ADVANCED WELDING &
ROBOTIC SYSTEMS

ADVANCED PROGRAMMING

DAIHEN Inc.

Almega FD series

INSTRUCTION MANUAL

BASIC OPERATIONS MANUAL

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	This is a safety device for ensuring that the robot will not operate unexpectedly due to incorrect operations. The Enable switch is located on the rear panel of the teach pendant. Manual robot operations and check go/back operations are only permitted when the Enable switch is held down.
Teach mode	This mode is mainly used for creating programs.
Playback mode	This mode is used to automatically execute the created programs.
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 operations such as manual operations or shift operations etc. 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 created programs on a step by step basis to check 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.
Automatic operation / Playback	Both “automatic operation” and “playback” mean the playback of a program in the playback mode.
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

<table>
<tr><th>Terms</th><th colspan="2">Explanation</th></tr>
<tr><td>Error</td><td rowspan="3">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.</td><td>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.</td></tr>
<tr><td>Alarm</td><td>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.</td></tr>
<tr><td>Information</td><td>If information occurs, the robot remains in the start status even during a playback operation. It includes alarms or errors that have the potential to develop in the future.</td></tr>
<tr><td>Mechanism</td><td colspan="2">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.
A “multi-mechanism” refers to a configuration where, for instance, a servo gun has been added to a manipulator. For the multi-mechanism, it is necessary to select which mechanism will be manually operated.</td></tr>
<tr><td>Unit</td><td colspan="2">This refers to the increments in which a program is created.
On some occasions, only one mechanism configures the unit; on other occasions, multiple mechanisms (multi-mechanism) are involved.
When the “Multi-unit” option is set, multiple units can be operated at the same time. In other cases, only 1 unit is used overall, so there is no need to be concerned with the unit.</td></tr>
</table>

Basic concepts applying to the robot

This section describes an overview of operations that you should know before reading chapter 2 and subsequent chapters.

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.

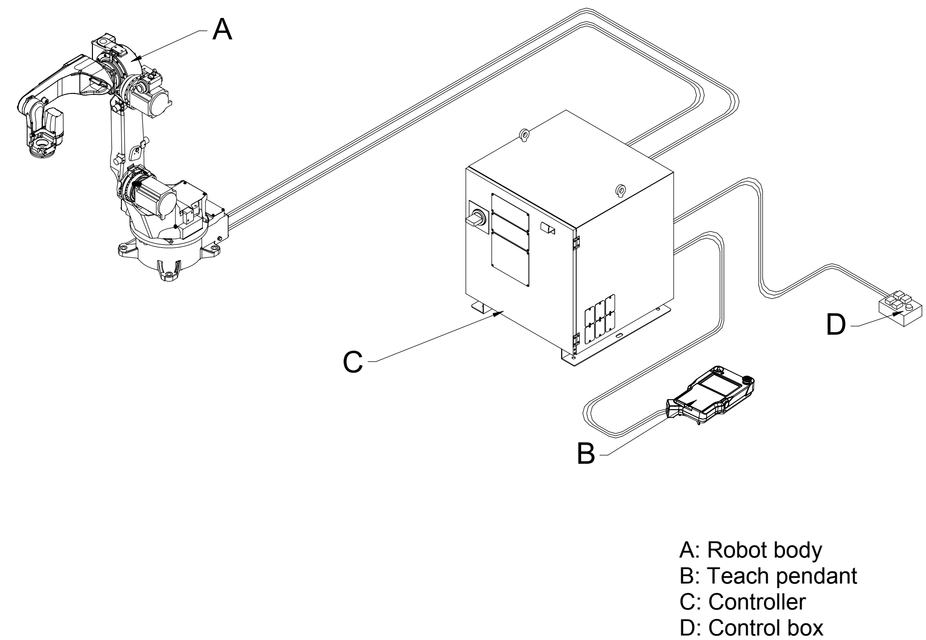


Fig. 1.4.1 Diagram of basic configuration for robot (When the control box is connected)

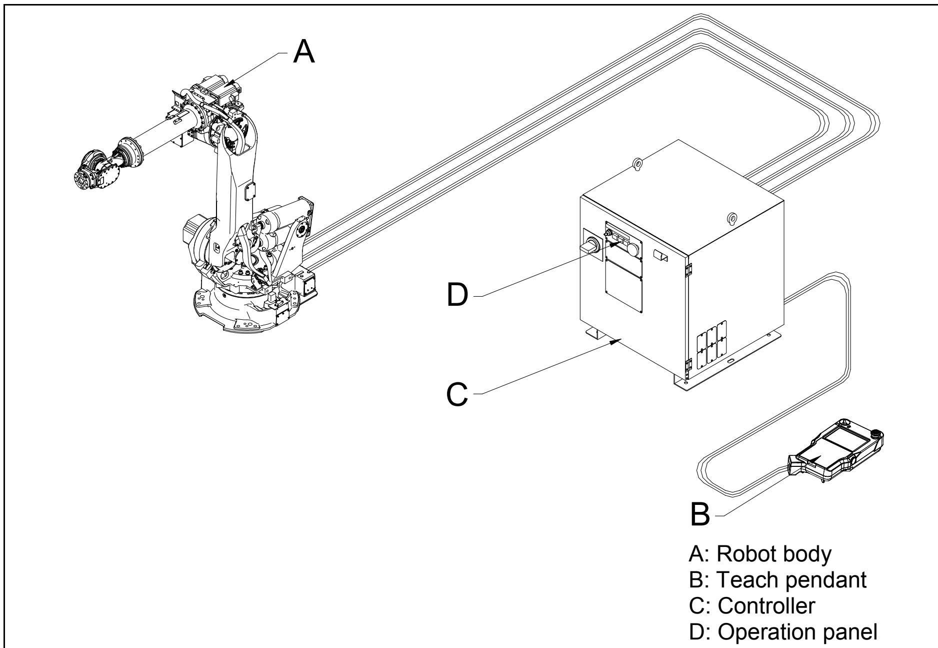


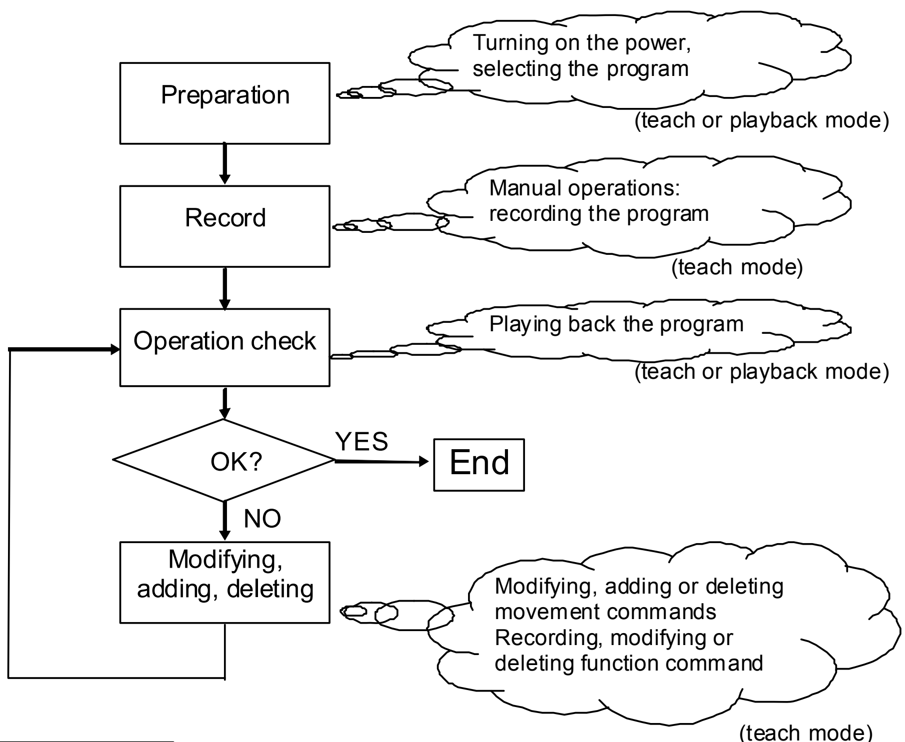
Fig. 1.4.2 Diagram of basic configuration for robot (When the operating panel is equipped)

Overview: from teaching to auto operation

Proceed as follows to continuously operate the robot.

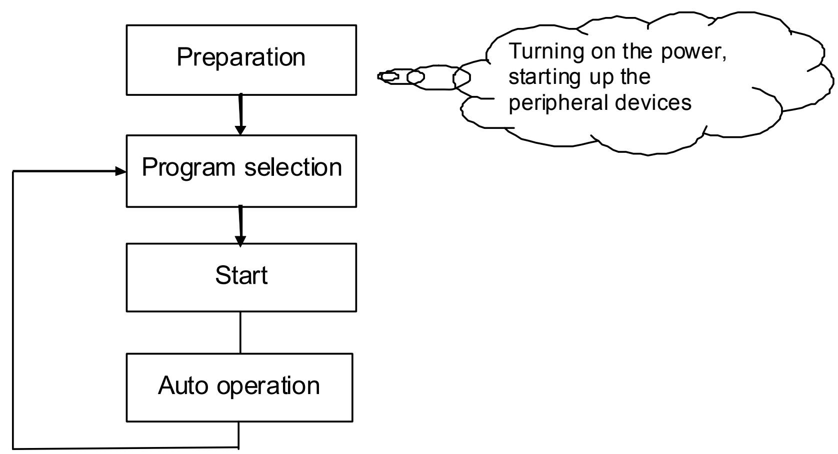
Creating the program (teaching)

The program is created in the sequence shown below. The entire process is known as the "teaching work." It refers to creating the program and modifying it into the optimal form.



Auto operation

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.



Manual operation

"Manual operation" refers to moving the robot with the use of the teach pendant. Move the robot to the position recorded using the "manual operation".

For manual operation, there is a mode in which each axis of the "robot" is operated separately, and the mode in which the robot tip is moved in a straight line.

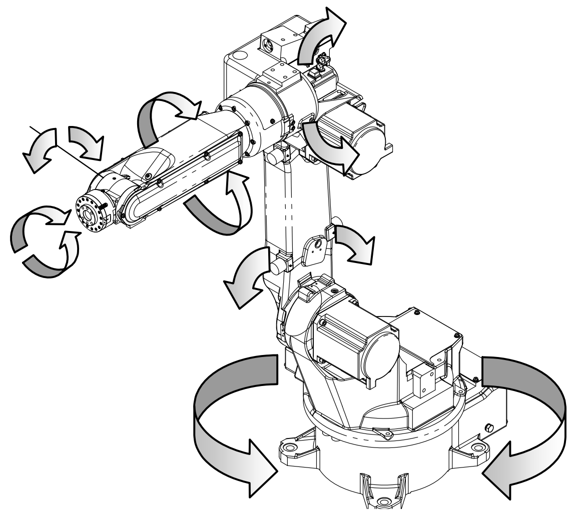


Fig. 1.4.3 Operating the axes separately (independent axis operation)

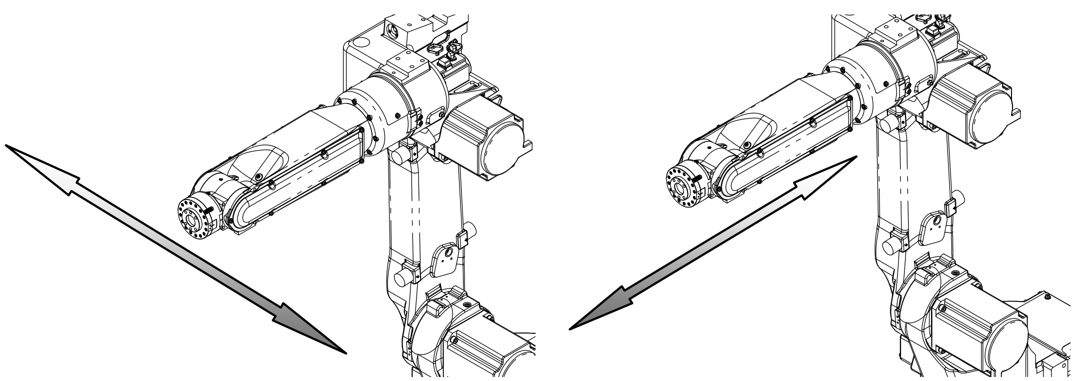


Fig. 1.4.4 Moving the robot tip in a straight line (robot coordinate operation)

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.

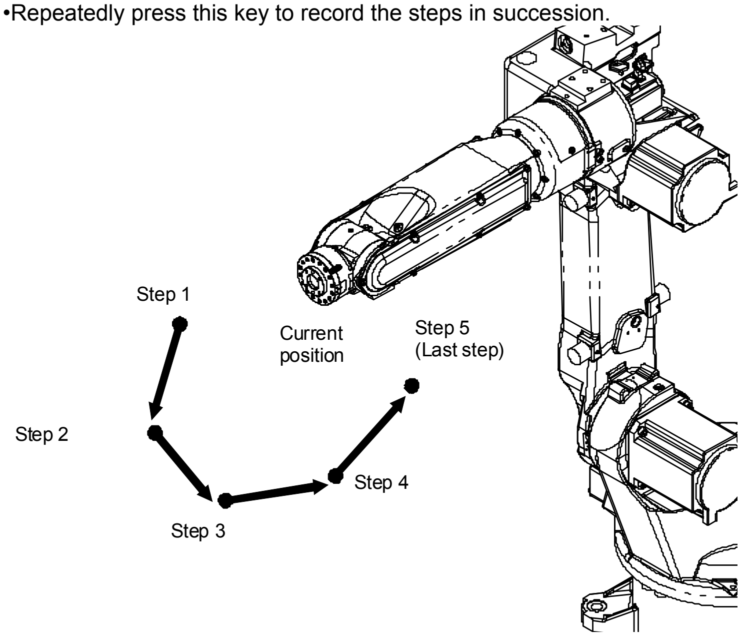
Teaching is performed in the teach mode.

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.

•Move the robot to the recorded position and posture using manual operation.
•Press [O.WRITE/REC] key to record the step.
•Repeatedly press this key to record the steps in succession.



4	If necessary, record the function commands.

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.

See 1-10 ”1.4.5 Function Command (Function)”.

5	Record the end command (function command END) that indicates the end of operation.

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.

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

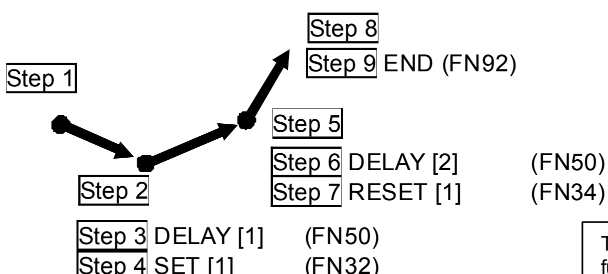
The function commands are expressed using a format based on SLIM (Standard Language for Industrial Manipulators) that is a robot language.
Alternatively, function commands can be specified using the “FN***” format where a 1 to 3 digit number is input into the *** part (which is called a function number).

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.

Auto operation

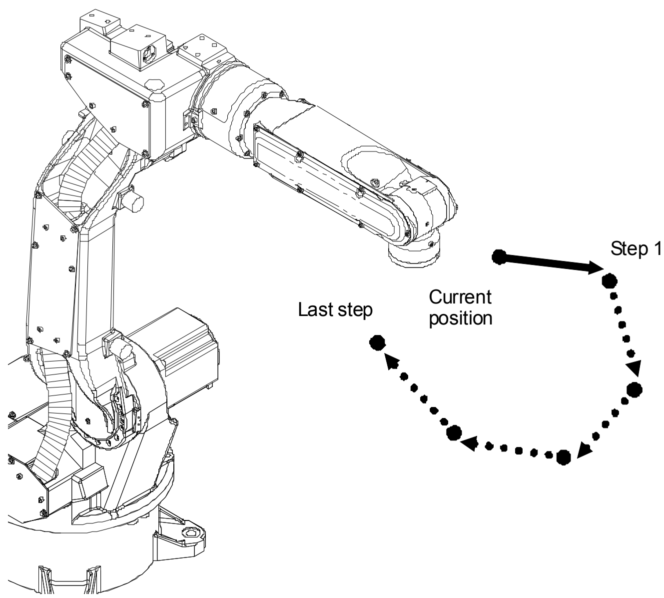
The following steps are taken to automatically run the program which has been created.

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.

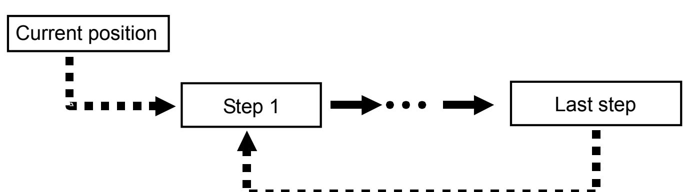
2	Proceed with playback.

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

Controller

When the operation box is connected

The circuit breaker is provided on the front side of the FD11 controller, and the teach pendent and operation box are connected here as well.

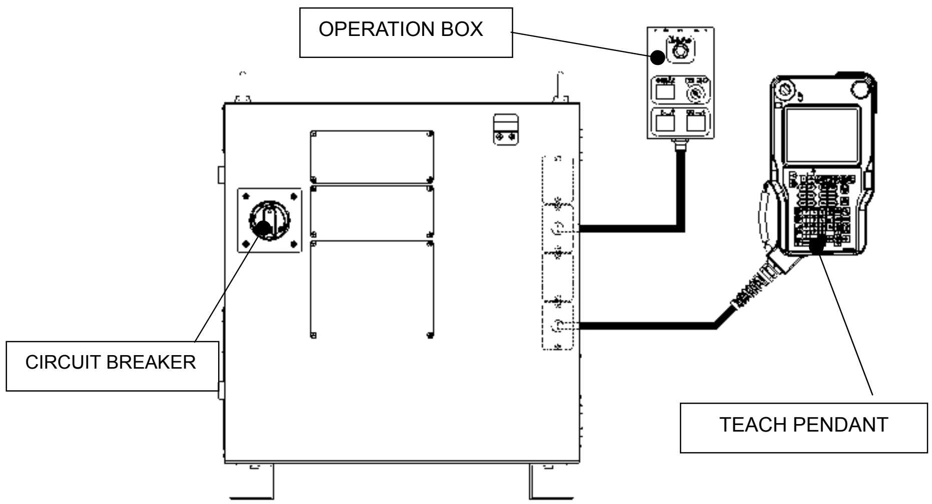


Fig. 2.1.1 FD11 Controller (OPERATION Box Specifications)

<u>Circuit breaker</u>

This turns the power of the controller ON and OFF.

<u>Teach pendant</u>

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

<u>Operation Box</u>

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

operation box

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

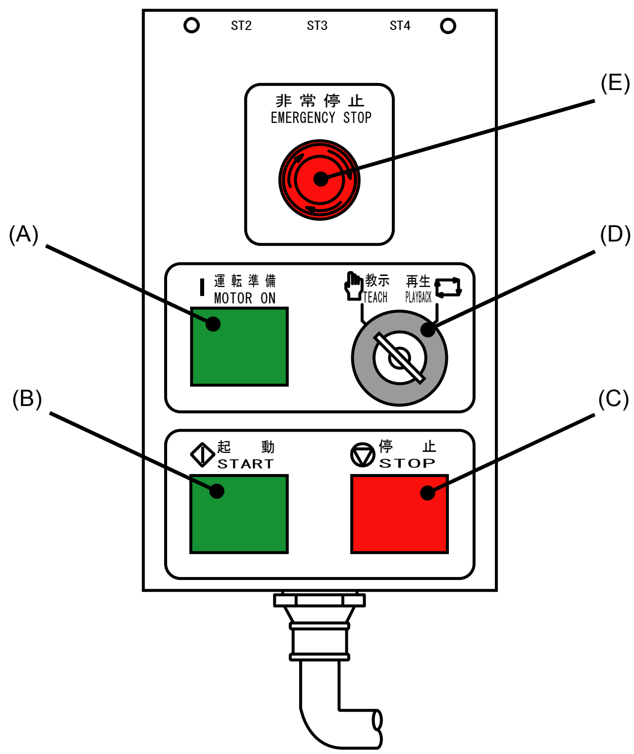


Fig. 2.2.1 Operation box

Table 2.2.1 Functions of buttons and switches on the operation box

Indication used in this manual		Description of function
(A)	[MOTOR 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 SELECT 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 pendent “TP selector switch.”
(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 control box or on the teach pendant. To release emergency stop, turn the button clockwise. (The button will then return to its original position.)

POINT

When a control box is connected, an operation panel cannot be installed.

Teach pendant

External appearance of teach pendant

The teach pendent is provided with operation keys, buttons, switches and jog dials etc. for creating programs and performing various settings.
You can allocate move commands to number keys [7~9] by pressing the [ENABLE] key at the same time as a number key [7~9], and allocate often used function commands (function groups) by pressing the [ENABLE] key and a number key [4~6]. Functions can also be allocated to the [JOG DIAL] .

CAUTION

Be sure to follow the cautions below for the USB port (see fig. 2.4.2).

- Only connect USB memory while operating files.
- When file operations have finished, always remove the USB memory and close the USB cap.
- Continuing use with the USB memory connected, or failing to close the USB cap may hinder the dust protection, waterproofing, and anti-spatter properties, which may lead to failure.
- The USB cap is a consumable part. If the USB cap becomes loose, or is damaged or lost, quickly replace it with a new one. In the time until a new one is procured, use tape etc. to block up the USB port.

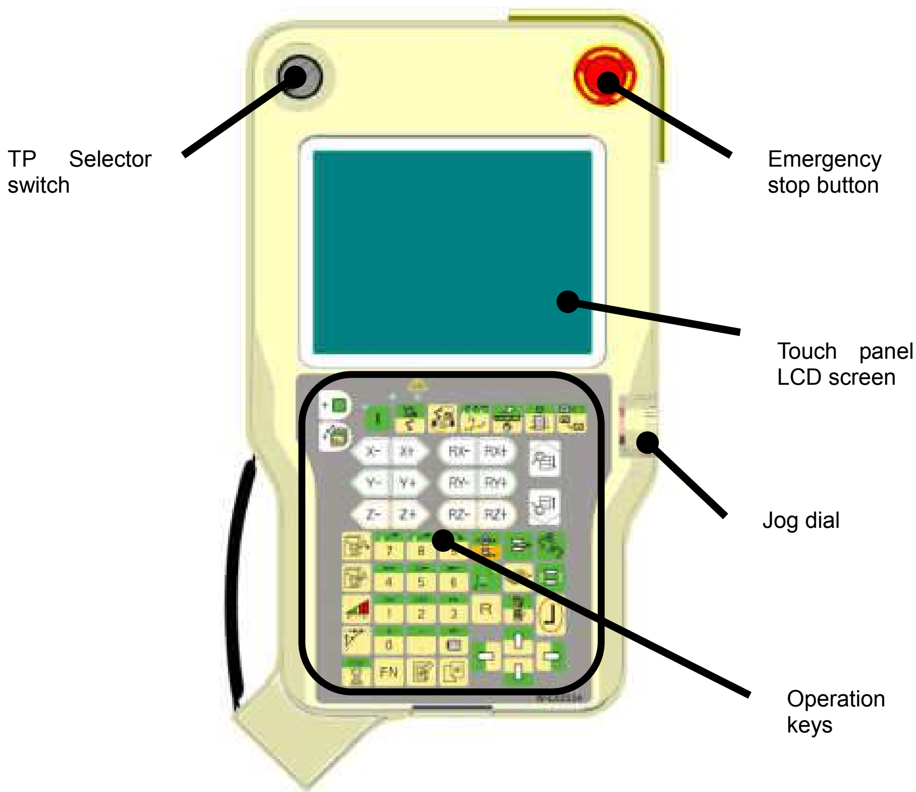


Fig. 2.4.1 Teach pendant (Front)

INFO.

The design of the operation keys shown in Fig. 2.4.1 may be slightly different to those on the actual teach pendant.

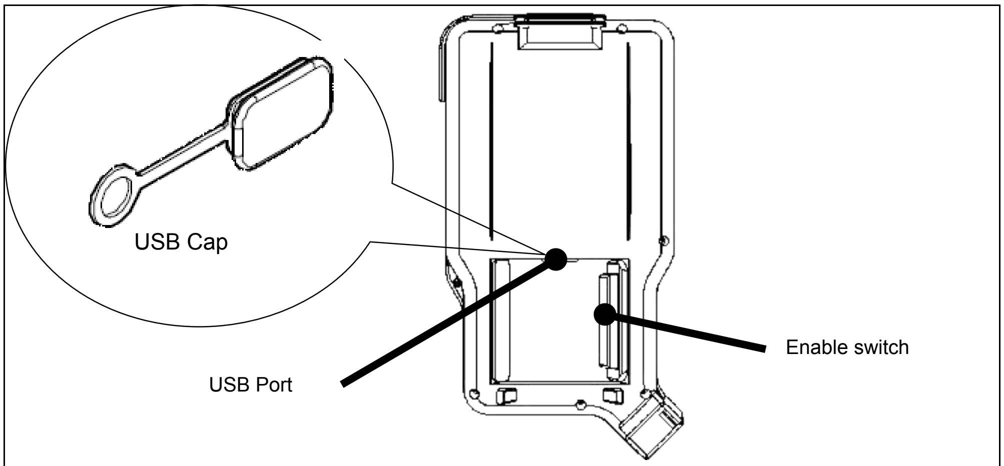


Fig. 2.4.2 Teach pendant (rear)

LED Functions

LEDs are arranged above each teach pendent operation key, and operate as shown below.

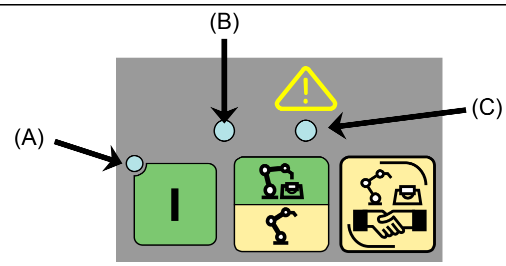


Fig. 2.4.3 Teach pendent LED

Table 2.4.1 LED Functions

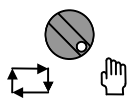
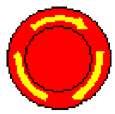
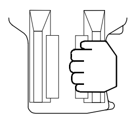
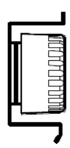
	LED Color	Functions
(A)	Green	Flashes during preparation of motor power ON, and lights when motor power is ON (servo ON). It is the same as the green “Motor power ON button” lamp on the operation panel and control box.
(B)	Orange	Flashes after the power to the controller is switched on, and lights when the teach pendent system starts. At all other times it remains lit.
(C)	Red	Lights when a hardware malfunction occurs in the teach pendent. Normally this remains off.

Directly after power to the controller is switched on, all of the LEDs light for approximately 0.5 seconds to check they are operating normally, and then switch off. After this, they operate as shown in Table 2.4.1.

Functions of buttons and switches

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

Table 2.4.2 Functions of buttons and switches

External appearance	Indication used in this manual	Function
	[TP SELECTOR SWITCH]	This is used to switch between the teach mode and the playback mode in combination with the [MODE SELECT SWITCH] on the operation panel or control box. For further details, refer to “3.2 Mode selection” in Chapter 3.
	[EMERGENCY STOP BUTTON]	When this is pressed, the robot is set to emergency stop. To release emergency stop, turn the button in the direction of the arrow. (The button will then return to its original position.)
	[Enable switch]	Used to manually operate the robot in 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. When the enable switch is grasped, power is supplied to the robot (Motor power ON (servo ON)). The robot can be operated manually only while the switch is grasped. If an impending danger is sensed, either release the enable switch or grasp it tightly until a clicking sound is heard. The robot is set to emergency stop. For details on how to operate the enable switch, refer to “3.3 Turning the motor power to ON” in Chapter 3.
	[JOG DIAL]	The [JOG DIAL] has two operations, a longitudinal dial rotation operation and a latitudinal push button operation. The dial rotation operations move the cursor and scrolls through screens, and the push button operation selects items and enters inputs. Also, a wide range of operations such as frequently used key operations can be allocated to the dial rotation operation and push button operation. For details, see “2.4.8 [JOG DIAL].”

Functions of operation keys

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

Table 2.4.3 Functions of operation keys

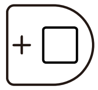
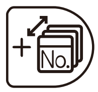
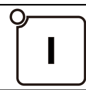
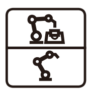
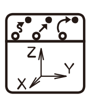
External appearance	Indication used in this manual	Function
	[ENABLE]	The functions are executed by pressing this key together with other keys. Also, various functions can be executed by rotating or pushing the [JOG DIAL] while holding down this key.
	[SHIFT]	The functions are executed by pressing this key together with other keys. Also, various functions can be executed by rotating or pushing the [JOG DIAL] while holding down this key.
	[MOTOR POWER ON]	The motor power is set to ON by pressing this key together with the [ENABLE] key.
	[UNIT/MECHANISM]	PRESSED ON ITS OWN **MECHANISM SELECTION** When a multiple number of mechanisms are connected to the system, the mechanism to be operated manually is selected. WITH [ENABLE] **UNIT SELECTION** When a multiple number of units are defined in the system, the unit to be operated is selected.
	[SYNCHRONIZE]	This key is used by a system in which a multiple number of mechanisms are connected, and it has the following functions. PRESSED ON ITS OWN **SYNCHRO MOTION ON/OFF** It selects or releases synchronized (cooperative) manual operation. WITH [ENABLE] **SYNCHRO MOTION ON/OFF** When synchronized (cooperative) operation is specified for a move command, "H" appears before the step number.
	[INTERP/COORD]	PRESSED ON ITS OWN **COORDINATE SYSTEM SELECTION** 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. WITH [ENABLE] **INTERPOLATION TYPE SELECTION** This switches the interpolation type (joint interpolation, linear interpolation or circular interpolation) of the recording status.

Table 2.4.3 Functions of operation keys

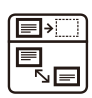
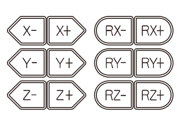
External appearance	Indication used in this manual	Function
	[CHECK SPD/TEACH SPEED]	PRESSED ON ITS OWN **MANUAL SPEED CHANGE** The operating speed of the robot during manual operation is selected. Each time it is pressed, one of the 1 to 5 operating speeds is selected (the higher the number, the faster the speed). Furthermore, the following function is provided as well. <<Operating mode S>> The playback speed recorded in the steps is also determined by the manual speed which has been selected by this key. INFO. This function is set by selecting [Constant Setting] → [5 Operation Constants] → [4 Record speed] → [Value of recording method — Decision method]. WITH [ENABLE] **CHECK SPEED CHANGE** 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]	PRESSED ON ITS OWN **CONTINUOUS / NON-CONTINUOUS** 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. WITH [ENABLE] **PLAYBACK STOP** The program being played back is stopped. (This has the same function as the stop button.)
	[CLOSE/SELECT SCREEN]	PRESSED ON ITS OWN If a multiple number of monitor screens are displayed, the screen targeted for operation is selected. WITH [ENABLE] The selected monitor screen is closed.
	[Axis operating keys]	PRESSED ON ITS OWN No function WITH [ENABLE SWITCH] **AXIS OPERATION** The robot is moved manually. If an auxiliary axis to be moved, the operation target is selected ahead of time using [UNIT/MECHANISM].

Table 2.4.3 Functions of operation keys

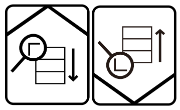
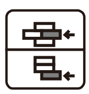
External appearance	Indication used in this manual	Function
	[CHECK GO] [CHECK BACK]	PRESSED ON ITS OWN No function WITH [ENABLE SWITCH] **CHECK GO / BACK** When these are pressed together with the [ENABLE SWITCH], the check go or check back operation is performed. Normally, the robot is stopped at each recorded position (step). It is also possible to move the robot continuously. Use [STOP/CONTINUOUS] to select step or continuous.
	[O.WRITE / REC]	PRESSED ON ITS OWN **RECORDING A MOVEMENT COMMAND** During teaching, the movement command is recorded. This can be used only when the last step in the task program has been selected. WITH [ENABLE] **OVERWRITING THE MOVEMENT COMMAND** 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. <<Operating mode A>> The recording position of a recorded movement command can be revised using [MOD Position]. <<Operating mode S>> The recording position, speed and accuracy of a recorded movement command can each be revised using [MOD Position], [SPEED] and [ACC], respectively. INFO. The [SPEED] 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].

Table 2.4.3 Functions of operation keys

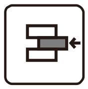
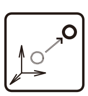
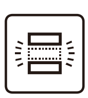
External appearance	Indication used in this manual	Function
	[INS]	PRESSED ON ITS OWN No function WITH [ENABLE] **INSERTION OF A MOVEMENT COMMAND** <<Operating mode A>> The movement command is inserted “After” the current step. <<Operating mode S>> The movement command is inserted “Before” the current step. INFO. “Before” can be changed to “After” or vice versa by selecting [Constant Setting] → [5 Operation Constants] →[1 Operation condition] →[7 Step insertion position].
	[CLAMP ARC]	This key functions in a different way depending on the application concerned. When the arc welding application is used PRESSED ON ITS OWN **EASY SELECTION OF A COMMAND** Frequently used function commands such as the movement command, welding start and stop commands and weaving commands are displayed in the f key, and can be input. WITH [ENABLE] No function When the spot welding application is used PRESSED ON ITS OWN **SPOT WELDING COMMAND** It is used to set the spot welding command. Each time the key is pressed, the ON or OFF is selected for the recording status. WITH [ENABLE] **MANUAL PRESS** The spot welding gun is manually pressurized. Other functions can also be allocated. For details, see “4.13 Clamp/Arc Key Settings” in the “SETUP” of the instruction manual.
	[MOD Position]	PRESSED ON ITS OWN No function WITH [ENABLE] **STEP POSITION MODIFICATION** The position stored in the movement command now selected is changed to the current robot position.
	[HELP]	Press this for help concerning an operation or function. The built-in tutorial function (help function) is called.
	[DEL]	PRESSED ON ITS OWN No function WITH [ENABLE] **STEP DELETION** The step now selected (movement command or function command) is deleted.
R	[RESET/R]	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.

Table 2.4.3 Functions of operation keys

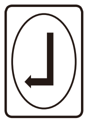
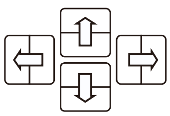
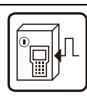
External appearance	Indication used in this manual	Function
	[PROG/STEP]	PRESSED ON ITS OWN **STEP SELECTION** This is used to call a step specified in the program. WITH [ENABLE] **PROGRAM SELECTION** The specified program is called.
	[Enter]	This enters the menu or numerical input contents. INFO. Determination operation of numerical input can also be performed with arrow keys by <Constant Setting> - [7F-key] – [7 Numerical input] and switching to “Cursol” under [Decision method of numerical input].
	Cursor keys	PRESSED ON ITS OWN **CURSOR MOVEMENT** When these keys are pressed on their own, the cursor moves. WITH [ENABLE] **PAGE UP/DOWN , SETTING MODIFICATION** • On a screen where the settings are configured on a multiple number of pages, the page is moved. • Lines are moved in units of multiple lines in the work program editing screen etc. • 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]	PRESSED ON ITS OWN **SHORTCUT FOR SETM function** During teaching, this short-cut calls the output signal command (SETM <FN105> function command). WITH [ENABLE] **MANUAL SIGNAL 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]	<<Operating mode A>> This is used to set the speed of movement commands. (The setting is reflected in the recording status.) <<Operating mode S>> This is used to revise the speed of recorded movement commands. INFO. This function is set by selecting [Constant Setting] →[5 Operation Constants] → [1 Operation condition] →[5 Usage of SPD key].

Table 2.4.3 Functions of operation keys

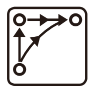
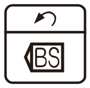
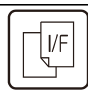
External appearance	Indication used in this manual	Function
	[ACC]	<<Operating mode A>> This is used to set the accuracy of a movement command which is to be recorded. (What has been set is reflected in the recording status.) <<Operating mode S>> This is used to revise the accuracy of a recorded movement command. INFO. This function is set by selecting [Constant Setting] →[5 Operation Constants] → [1 Operation condition] →[6 Usage of ACC key].
	[END／TIMER]	PRESSED ON ITS OWN **SHORTCUT FOR DELAY function** During teaching, this short-cut records the timer command (DELAY <FN50> function command) WITH [ENABLE] **SHORTCUT FOR END function** During teaching, this short-cut records the end command (END <FN92> function command).

Table 2.4.3 Functions of operation keys

External appearance	Indication used in this manual	Function
	Numeric keys/ [0] to [9] / [.]	PRESSED ON ITS OWN **Numerical input** Numbers (0 to 9, decimal point) are input. WITH [ENABLE] **JOINT INTERPOLATION (with [7])** A shortcut for a "JOINT" move command WITH [ENABLE] **LINEAR INTERPOLATION (with [8])** A shortcut for a "LIN" move command WITH [ENABLE] **CIRCULAR INTERPOLATION (with [9])** A shortcut for a "CIR" move command
		<u>For arc welding uses</u> WITH [ENABLE] **APPLICATION FUNCTION 1 (with [4])** During teaching, commands for arc welding are displayed on the f keys (f1~f12). WITH [ENABLE] **APPLICATION FUNCTION 2 (with [5])** During teaching, commands for weaving are displayed on the f keys (f1~f12). WITH [ENABLE] **APPLICATION FUNCTION 3 (with [6])** During teaching, commands for sensors are displayed on the f keys (f1~f12).
		<u>For uses other than arc welding</u> WITH [ENABLE] **APPLICATION FUNCTION 1 (with [4])** **APPLICATION FUNCTION 2 (with [5])** **APPLICATION FUNCTION 3 (with [6])** Application functions 1~3 can be allocated to the desired functions. For details, see “7.7 Customizing Hard Keys”.
		WITH [ENABLE] **"ON" (with [1])** On a setting screen, for instance, a check mark is placed inside the check box. WITH [ENABLE] **"OFF" (with [2])** On a setting screen, for instance, the check mark inside the check box is removed. WITH [ENABLE] **"REDO" (with [3])** 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. WITH [ENABLE] **"+" (with [0])** “+” is input. WITH [ENABLE] **"-" (with [.])** “-” is input.

Table 2.4.3 Functions of operation keys

External appearance	Indication used in this manual	Function
	[BS]	PRESSED ON ITS OWN **Deletion of a number or character** The number or character before the cursor position is deleted. The key is also used to release a selection during file operations. WITH [ENABLE] **UNDO** 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]	Opens the program editing screen. In the program editing screen, mainly function commands are changed, added or deleted, and the parameters of move commands are changed.
	[I/F] (Interface)	Opens the interface panel window.

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.

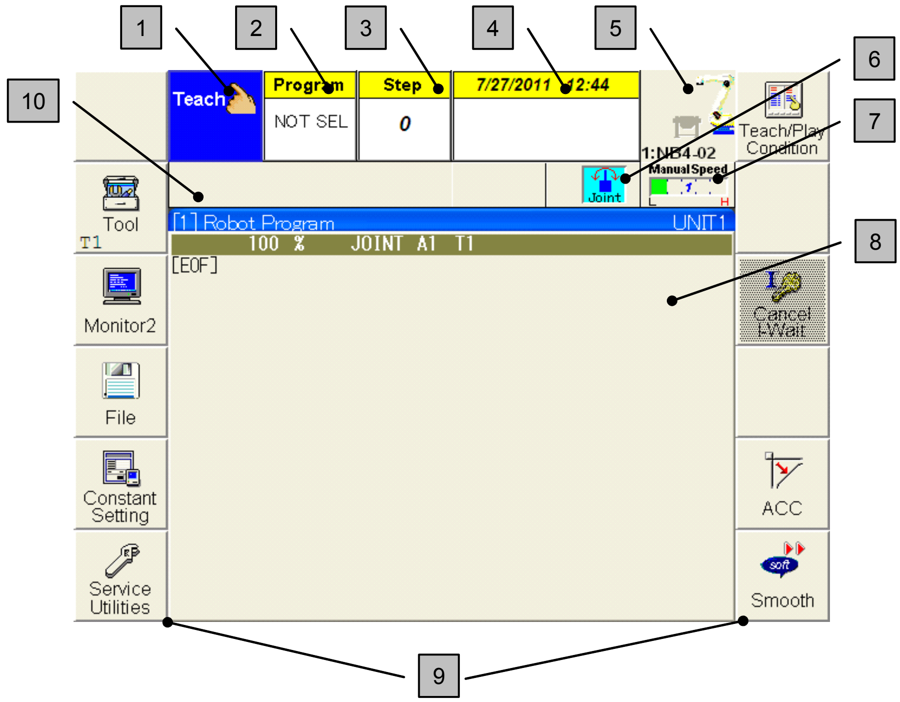
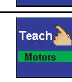
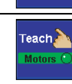


Fig. 2.4.4 Configuration of display screen

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 2.4.4 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.

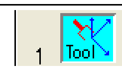
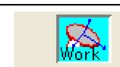
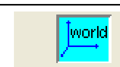
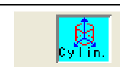
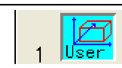
5 Mechanism display area

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.

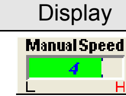
Table 2.4.5 Coordinate system display

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 2.4.6 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

By touching a display area, called f key, selectable functions are displayed. The six keys on the left correspond to f1 to f6; the six keys on the right correspond to f7 to f12.
See 2-19 “2.4.6 Concerning the operation of the f keys”.

10 Variable status display area

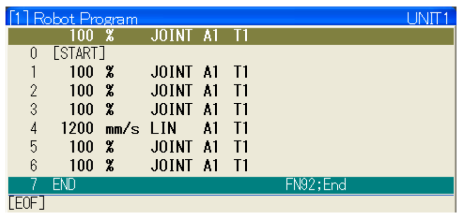
Various status displays such as “Input wait (I wait)” and “External start selected” appear as the icons shown in Table 2.4.7 in this area. When this status ends, the icon is cleared.

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]

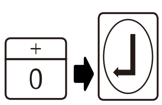
The operation of the program created in the previous section will be checked here.
The screen that appears when teaching is completed should be the one shown below.



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

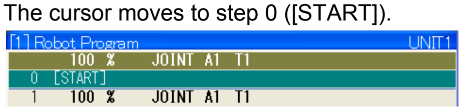
1 Press [PROG/STEP] in order to call the step which is to be checked first.

\>> The [Step Selection] screen now appears.



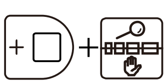
2 Input [0] in "Designated step", and press [Enter].

\>> The cursor moves to step 0 ([START]).



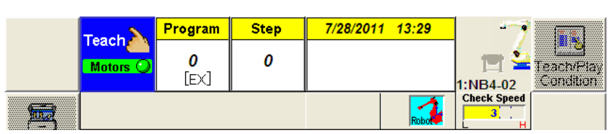
POINT

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

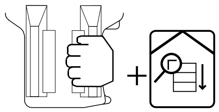


3 To specify the speed to be used during the check operation, press [CHECK SPD/TEACH SPEED] while holding down [ENABLE]. Here, select "3" to ensure safety.

\>> 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.

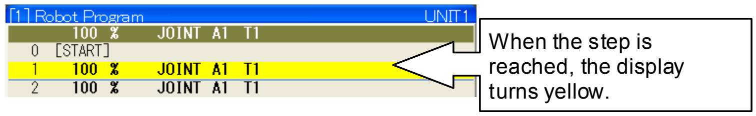


> **INFO.** The check operation speed can be changed by grasping the [ENABLE SWITCH], and rotating the [JOG DIAL] while holding down [Enable].



4 Press [CHECK GO] while grasping the [ENABLE SWITCH].

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



When [CHECK GO] is released while the robot is moving, the robot stops.

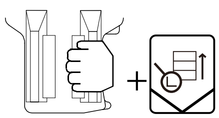
The robot also stops when the enable switch is released during operation. However, in this case, the servo power is turned off immediately without the acceleration or deceleration applying a heavy load to the mechanisms. Before releasing the enable switch, try to remember to release [CHECK GO] and wait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

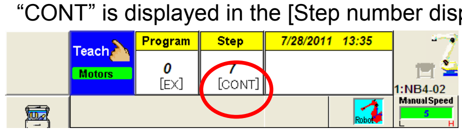
2 The operation method after the speed has been switched or robot has stopped at a step, etc. are the same as for Check Go.
The robot also stops when the enable switch is released during operation. However, in this case, the servo power is turned off immediately without the acceleration or deceleration applying a heavy load to the mechanisms. Before releasing the enable switch, try to remember to release [CHECK BACK] and wait for the robot to come to a standstill.

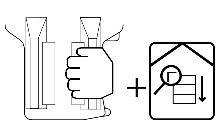
Checking the steps continuously

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].

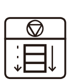
>> "CONT" is displayed in the [Step number display area].





**2 Perform the Check Go/Check 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.

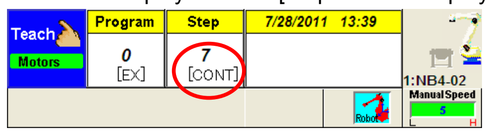
Switching the continuous/step mode during Check Go operation

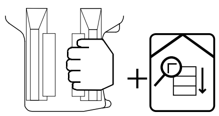
The continuous mode can be switched to the step mode and vice versa by pressing down [Shift] while pressing [CHECK GO].
While pressing the [Shift], the display is shown to switch from the continuous mode to the step mode and conversely, therefore Check Go is operated following the mode which is switched.

When the continuous mode

1 **Press the [STOP/CONT].**

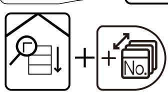
>> “CONT” is displayed in the [Step number display area].





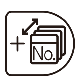
2 **Perform the Check Go operation. Press down the [CHECK GO].**

>> The robot operates continuously step by step.



3 **Pressing down the [Shift] while Check Go operation, switching from the continuous mode into the step mode.**

>> During this time, the display changes from "[CONT]" to “[step].”
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 Check Go is completed, the display returns from “[step]” to “[CONT].”



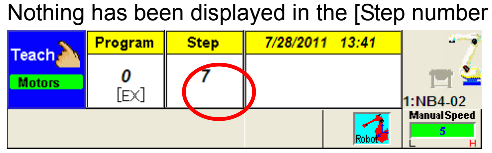
4 **To release the step mode, release the [Shift].**
Or release the [CHECK GO].

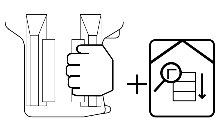
>> When the mode release is completed, the display returns from “[step]” to “[CONT].”

When the step mode

1 **Press [Stop/Cont].**

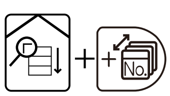
>> Nothing has been displayed in the [Step number display area].





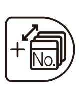
2 **Perform the Check Go operation. Pressing down the [CHECK GO].**

>> The robot operates step toward the next step.



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

>> During this time, the display changes from “ ” (no display) to "[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 Check Go is completed, the display returns from “[CONT]” to “ ” (no display).



4 **To release the continuous mode, release the [Shift].**
Or release the [CHECK GO].

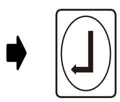
>> When the mode release is completed, the display returns from “[CONT]” to “ ” (no display).

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].

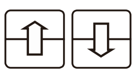
1 **Press [PROG/STEP].**

>> [Step Selection] screen appears.

Number 

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.

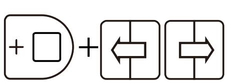


3 **When you move relatively from the current step, without specifying a step number, specify the jump destination in the "Edit" column.**

>> The cursor moves to the step which has been designated.

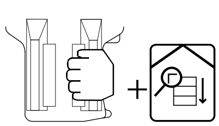
You can select from among the following items.

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 [ENABLE SWITCH], press [CHECK GO].**

>> The robot moves as far as the designated step.

Almega FD series

INSTRUCTION MANUAL

UTILIZING SHORT-CUTS

Using short-cuts

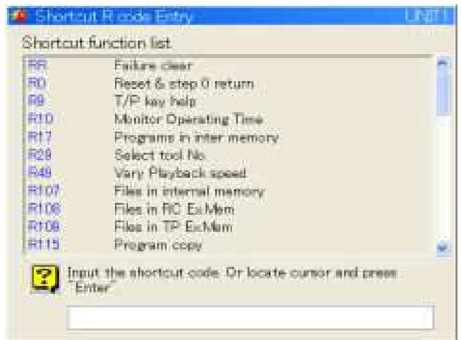
The controller comes with a short-cut function for selecting functions quickly.
Normally, even with operations where one menu is opened from another, a target operation can be quickly accessed simply by inputting a short-cut code (a number with up to 3 digits). It is a good idea to learn frequently used short-cut codes to memory.

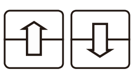
For details on the short-cut codes that can be used, refer to the Help function contained in the robot controller.

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.



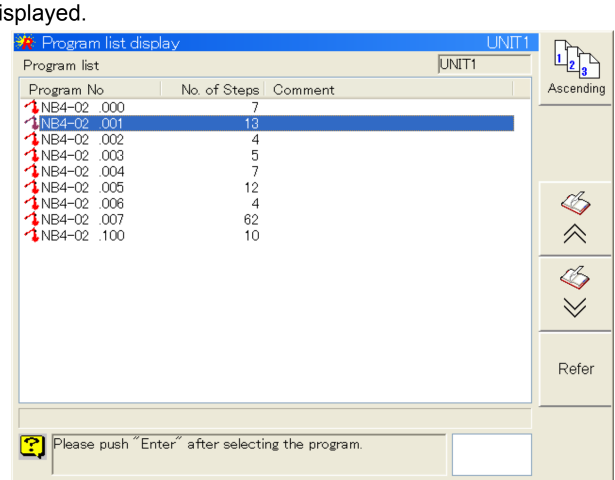


2 If the number of the target function is not known, press the [up or down] key.

>> 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.

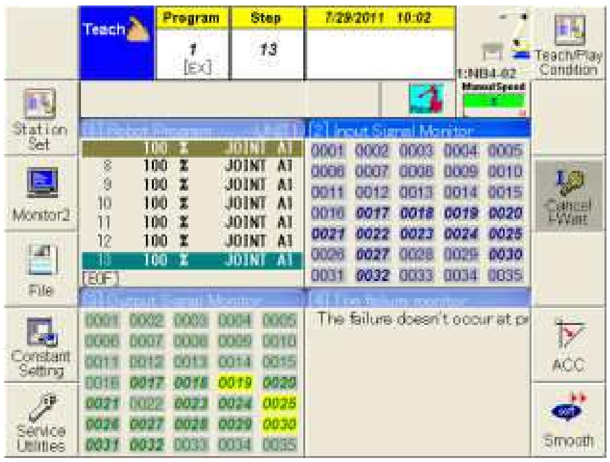


Monitoring various information of the robot

With this controller, various information from 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 approximately 100 [msec].

The next screen shows an example where all four monitors were started simultaneously. Programs are monitored on monitor 1, general-purpose input signals are monitored on monitor 2, general-purpose output signals are monitored on monitor 3, and errors are monitored on monitor 4.

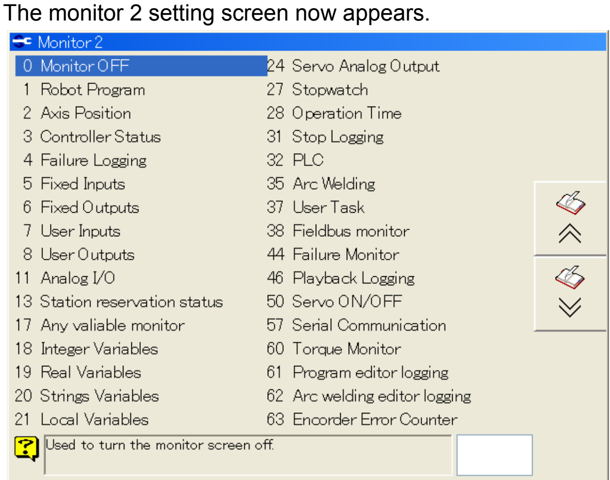


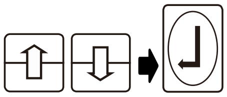
Starting a multiple number of monitors

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

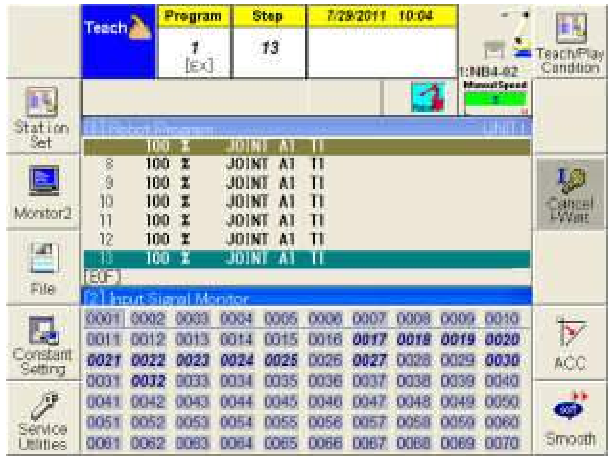
1 The signals can easily be displayed on monitor 2 by operating an f key.
Press <Monitor 2>.
>> The monitor 2 setting screen now appears.





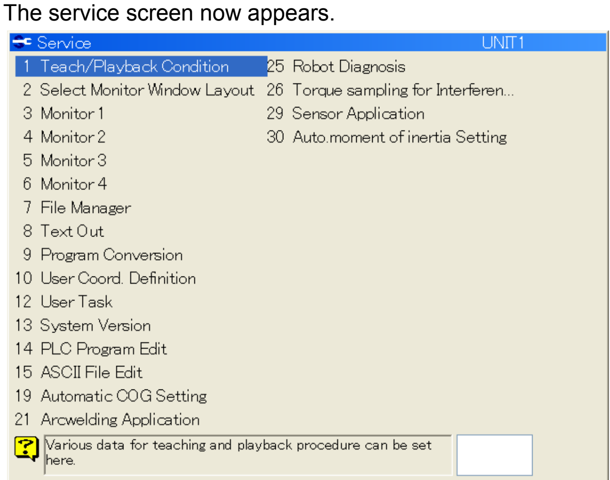
2 **Align the cursor with “7 User Inputs”, and press [Enter].**

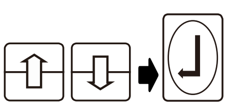
>> Monitor 2 now starts.



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.)**

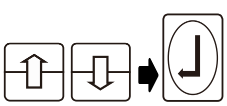
>> The service screen now appears.





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.

Switching and closing the monitors

Any one of a multiple number of monitors started can be selected to be operated or closed.

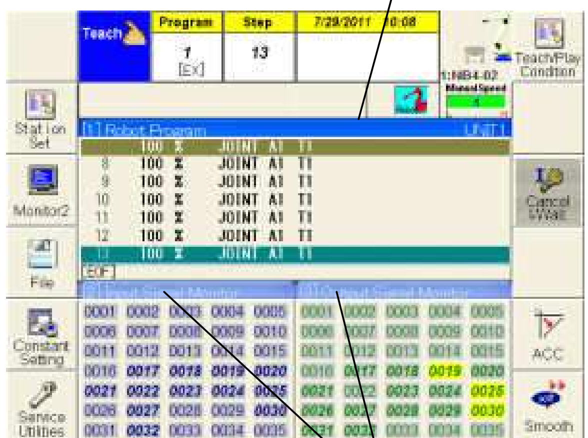
Switching and closing the monitors

1 **To select a monitor to be operated from among a multiple number of monitors, press [CLOSE/SELECT SCREEN].**

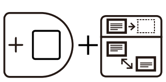
>> Each time [CLOSE/SELECT SCREEN] is pressed; the monitor which can be operated is switched.
The monitor which can be operated has a deep blue title bar.
Monitors that cannot be operated have light blue title bars.

In the case of the screen shown below, monitor 1 can be operated.

When deep blue:
The monitor can be operated.



When light blue:
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].**

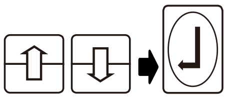
>> The monitor now selected is closed.

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.

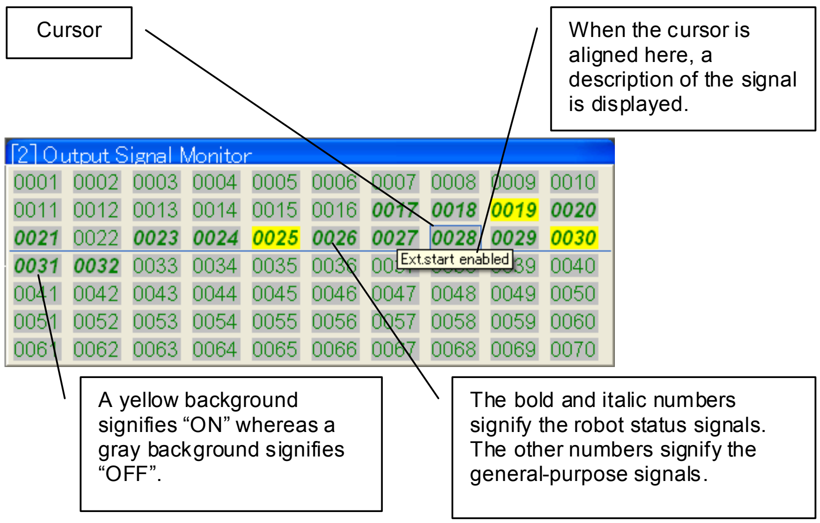
Using the general-purpose output monitor as an example, how to read the information and perform the operations on the monitor screen will be described below.

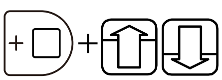
Operating the User Inputs and Outputs monitors



1 **By performing the steps on page 7-2, select "8 User Outputs".**

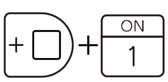
>> The statuses of general-purpose output signals 0001 to 2048 are now displayed.





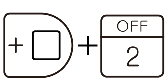
2 **There is a limit on the number of signals which can be displayed on one screen. To view the statuses of other signals, move the cursor using the up and down keys.**
When the up or down key is pressed while holding down [ENABLE], one page of information can be scrolled on the screen.

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 generalpurpose 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.



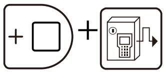
To set the signal to OFF, press [2] while holding down [ENABLE].

>> The specified signal is now set to OFF.

Setting the output signals ON or OFF manually

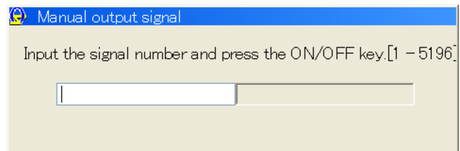
The output signals can be set to ON or OFF manually. (Each signal to be set to ON or OFF is specified using an output signal number.)
This function can be used in the teach mode or playback mode (step by step).

Setting the output signals to ON or OFF manually

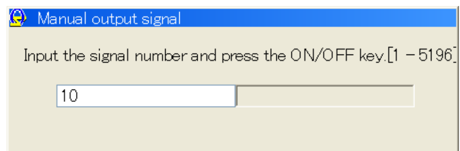


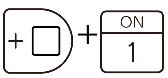
1 **While holding down [ENABLE], press [OUT].**

>> The [Manual output signal] screen now appears.



2 **Input the output signal number.**

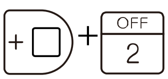




or

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.

Using help for information on functions

This controller comes with a help function (built-in tutorial function).

For information on functions to be known or to be checked out, press [HELP]. The help function can be called not only during teaching but also during playback.

Calling the help top page

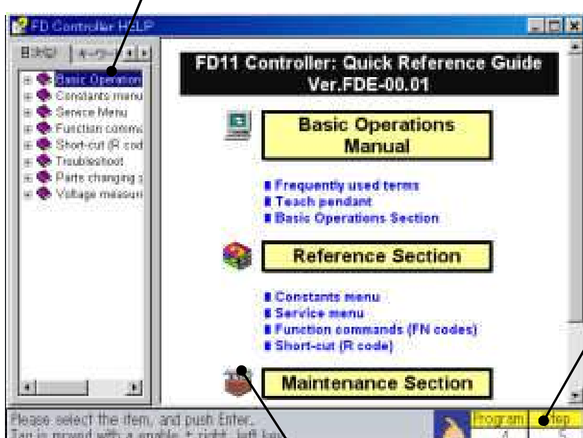
The best way to browse carefully through the help information from the beginning is to call the top page.
In order to call the top page, make sure that none of the functions has been selected, and press the [HELP] key.

Calling the help top page

1 While making sure that none of the functions has been selected, press the [HELP] key.

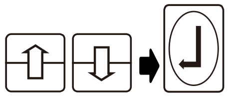
>> The help top page now appears.

This is the table of contents for help
- Select the desired item using [Up/Down], and press [Enter].
- The information for the selected item appears in the window on the right.
- If the contents window is partially covered, press [Left/Right].



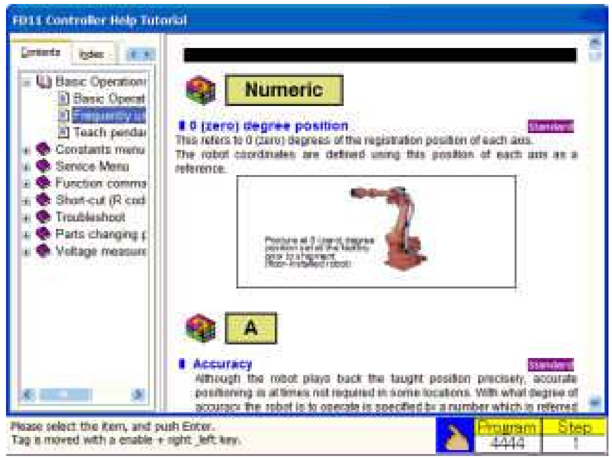
The current mode, program number and step number are displayed here.

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 using [Up/Down].
- Pages can be scrolled using [ENABLE] and [Up/Down].



2 Select the item to be viewed using the [Up/Down] key, and press [Enter].

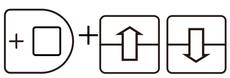
\>> The selected item now appears on the right.
For instance, select “Frequently used terms” under Basic Operations Manual to obtain the following.



3 To manipulate the window showing the text information, press [CLOSE/ Select screen].

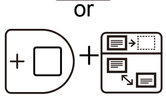
\>> The text window is set to active.
To return to the table of contents window, press [CLOSE/Select screen] again

or



4 To scroll up or down, press [Up/Down].
The text can be scrolled quickly by press [Up/Down] together with [ENABLE].

or



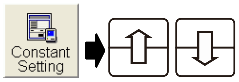
5 To close help, either press [RESET/R] or press [ENABLE] and [CLOSE/Select screen].

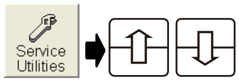
Directly calling a function to be checked out

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

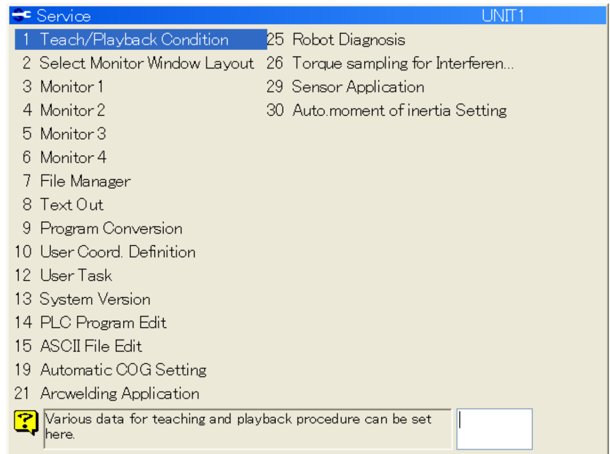
1 Align the cursor bar with the menu.

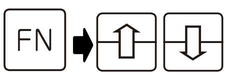




When the constants menu or service menu has been selected

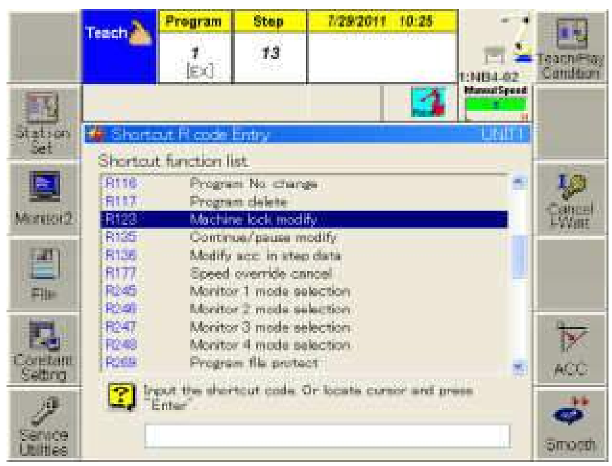
Align the cursor bar with the menu to be checked out. (The screen shown appears when the service menu is selected.)

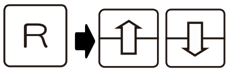




When a function command has been selected

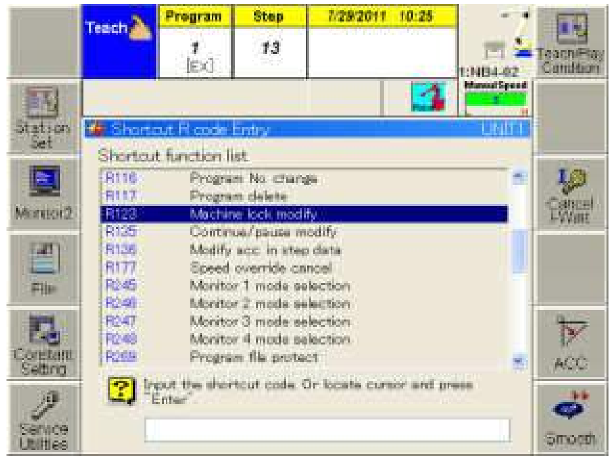
First press [FN] on the top screen of the teach/playback mode, and then align the cursor bar with the function command which is to be checked out.





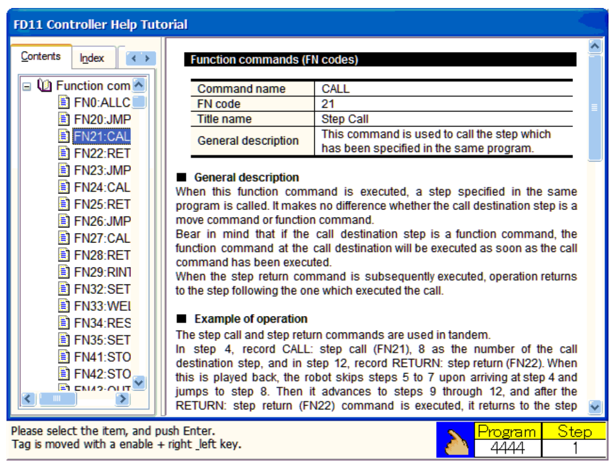
When a shortcut has been selected

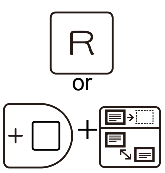
First press [RESET/R] on the top screen of the teach/playback mode, and then align the cursor bar with the function command which is to be checked out.



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].**

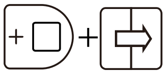
Searches using keywords

Help information can also be searched using the index prepared in advance or any keyword.

Searching using a keyword

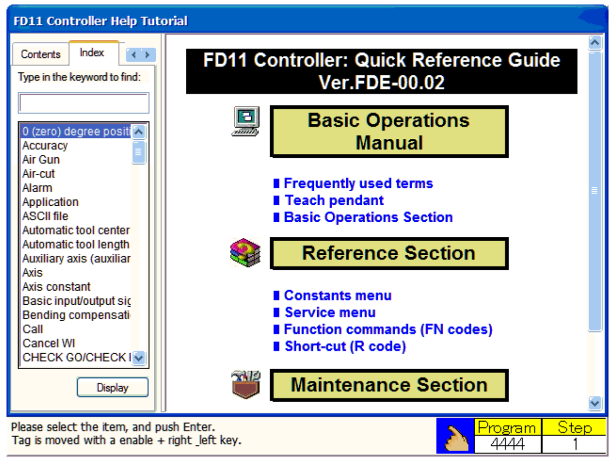
1 **Press [HELP].**

>> This calls help.



2 **While holding down [ENABLE], press [Right], and select the "Index" tab.**

>> The index tab appears.

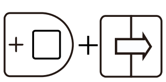


3 **In the Index tab, select the term using [Up/Down] and press [Enter].**

>> The help information contained the selected word now appears

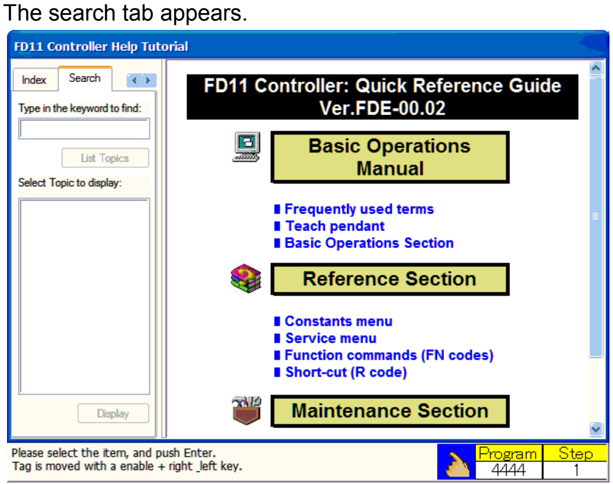
When inputting a keyword (term) to initiate a search, press [EDIT] in the "Type in the keyword to find:" field. A soft keyboard appears so that the desired keyword can now be input using its keys.
If, however, the input keyword is not included in the index, the search will not be successful. Searches 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.



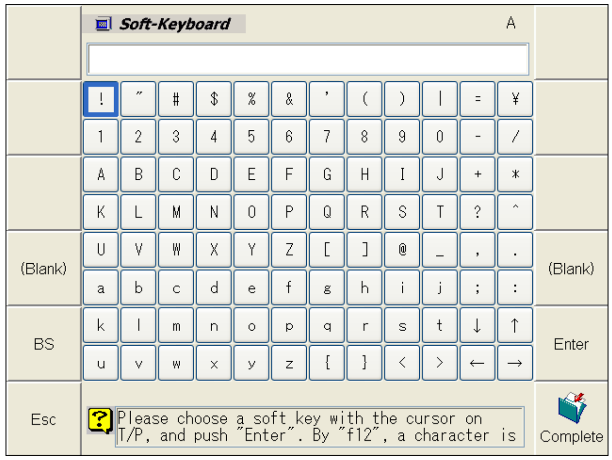
4 **While holding down [ENABLE], press [Right], and select the "Search" tab.**

>> The search tab appears.



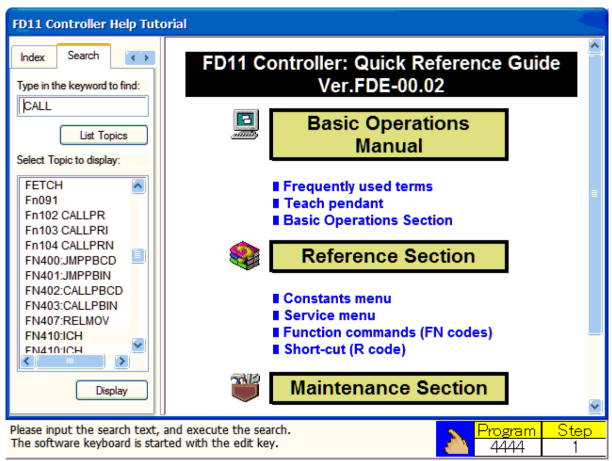
5 Align the cursor with the “Type in the keyword to find:” field, and press [EDIT].

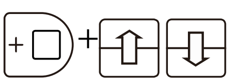
\>> The soft keyboard now appears.



6 Use the keys on the soft keyboard to input the desired keyword, and press f12 <Complete>.

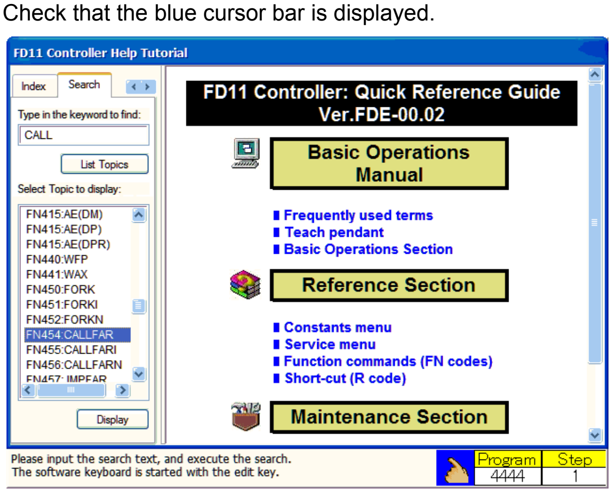
\>> The help topics containing the keyword are now displayed.

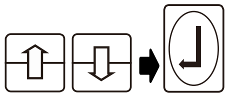




7 While holding down [ENABLE], press [Up/Down], and move to the “Select Topic to display:” field.

\>> 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.

Displaying T/P Key Help

The name, position, and design of each operating key on the monitor screen can be checked. By displaying "68 T/P Key Help" on the monitor screen, the content can be checked when using either the teach mode or playback mode.

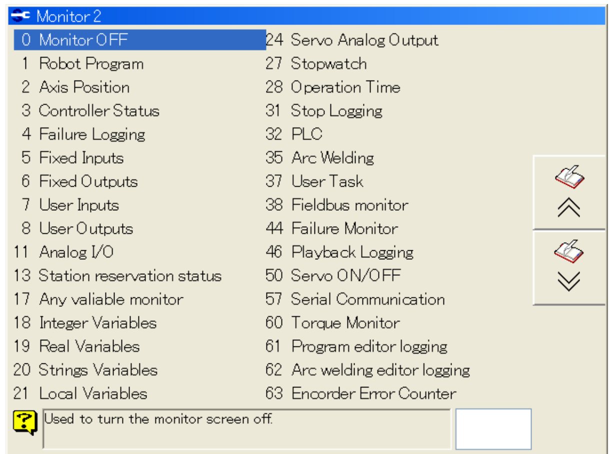
Displaying the T/P Key Help

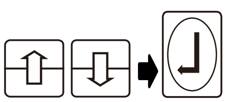
Display the T/P key help on the monitor screen.

Selecting from the monitor menu

1 **Press <Monitor 2>**

>> A list of monitor functions that can be displayed is shown.





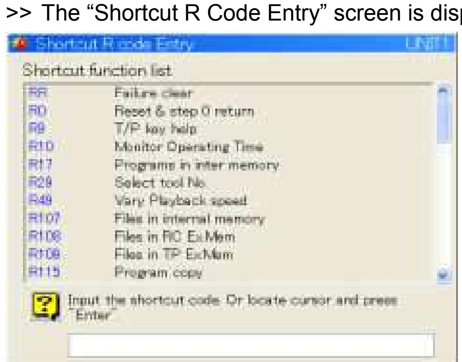
2 **Select “68 T/P Key help,” and press [Enter]. Alternatively, enter the numbers [6] [8] directly into the edit box at the bottom, and press [Enter].**

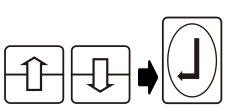
>> The T/P key help is displayed on the monitor screen.

Selecting from the shortcut function

1 **Press the [RESET/R] key in the top screen of Teach/Playback mode.**

>> The “Shortcut R Code Entry” screen is displayed.





2 **Select "T/P Key help” with the [Up/Down] keys, and press the [Enter] key. Alternatively, enter the number [9] directly into the edit box at the bottom, and press the [Enter] key.**

Operating T/P Key Help

This section explains the operations of the T/P key help. The structure of the T/P key help screen is as shown below. Here, T/P key help is displayed in monitor 2.

1 Operation key list

Displays a list of operation keys. Selected operation keys are reverse highlighted in blue.

2 Operation key arrangement

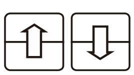
Displays the arrangement of the operation keys. Selected operation keys are encircled by a blue line.

3 Key names

Displays the key name of the operation key selected in the operation key list or operation key arrangement.

Searching for the operation key position and design from the name

Perform the following operations to search for the position and design of an operation key from the name of the operation key.

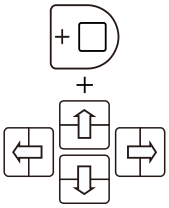


1 Press the [Up/Down] key, and select the name of the operation key that you want to search for from the "Operation Key List" on the left side of the monitor. Alternatively, touch the key name in the "Operation Key List."

>> The selected operation key is displayed in the "Operation Key Arrangement" on the right of the monitor with a blue border.

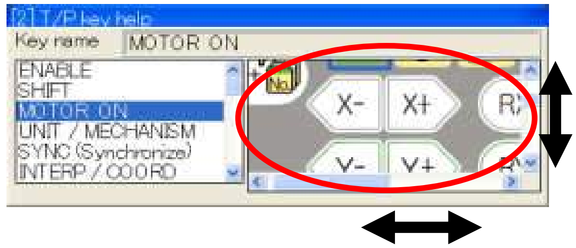
Searching for the operation key name from the position or design

Select the key name from the operation key arrangement.



1 **Use [ENABLE] + cursor keys to scroll up, down, left, and right the "Operation Key Arrangement" on the right side of the monitor screen, and display the operation key that you want to research.**

>> The "Operation Key Arrangement" is scrolled up, down, left and right.



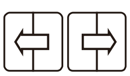
Use [ENABLE] + [Up/Down] to scroll vertically, and [ENABLE] + [Left/Right] to scroll horizontally.

2 **Touch the operation key that you want to research from the "Operation Key Arrangement" on the right side of the monitor screen.**

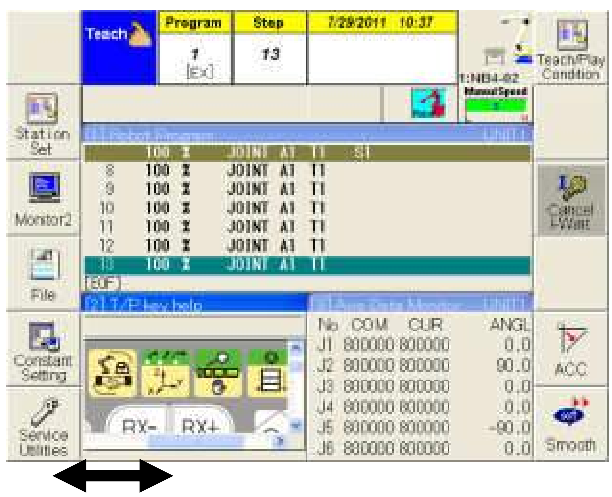
>> The name of the touched operation key is displayed in "Key Name" at the top of the monitor screen.
Also, the same name also becomes selected in the "Operation Key List" on the left of the monitor screen.

Moving the display area

When multiple monitors are running, part of the T/P key help screen may be hidden. In this situation, the following operations can be used to display the hidden parts of the display area.



1 **Press the [Left/Right] keys to scroll the T/P key help screen itself horizontally.**



For example, if the "Operation Key Arrangement" is hidden press [Right], or if the "Operation Key List" is hidden press [Left] to scroll the monitor screen itself.

If this operation is performed when no parts are hidden, the screen does not scroll.

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.

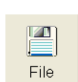
Table 6.2.1 Functions of file operation menu

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 using a USB memory (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 the USB memory. Initialization can only be executed by "RC External Storage."
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.

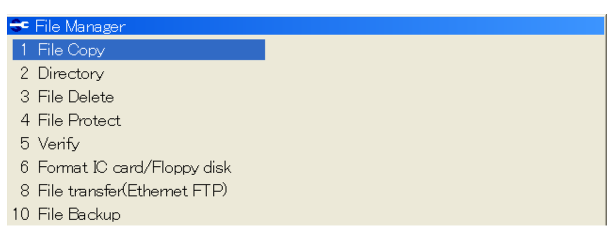
File operation menu selection and common operations

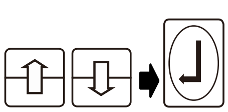
This section describes how to select the file operation menu and how to perform operations after its functions have been selected.

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.



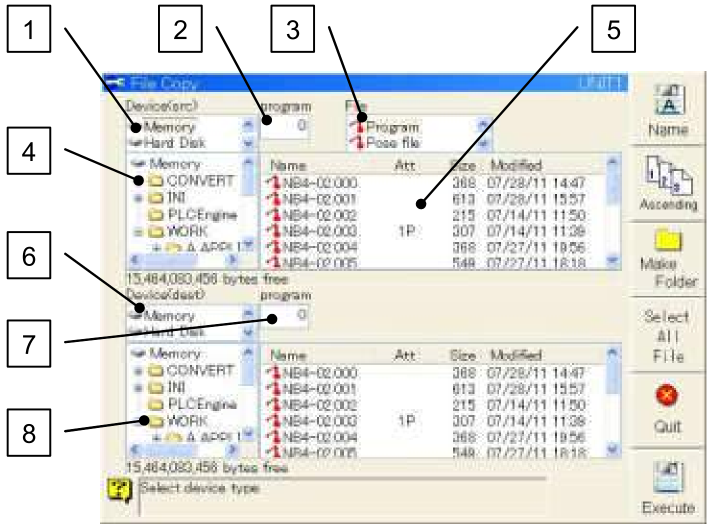


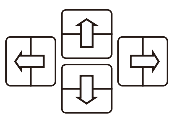
2 When a function is selected and [Enter] is pressed, the function concerned is selected.

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 older selection field (for details, refer to page 6 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)

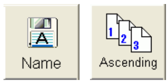
Select the copy destination device.

7 Program input field (when copying only)

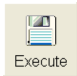
Input the number of the program to be copied.

8 Folder selection field (when copying only)

Specify the copy destination folder.

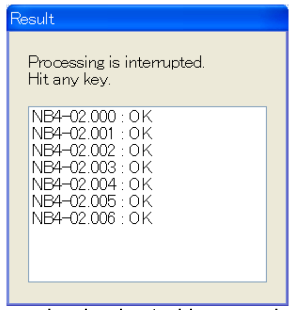


3 If a folder is specified in 4, a list of files is displayed in 5. In this case, the sequence in which the files are arranged can be switched using f7 <Name> or f8 <Ascending>.



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.

Types of usable storage media

This controller is equipped with a USB port for external storage devices, and USB memory can be used as storage media. Data can be stored in an external storage device, or conversely, data can be read from an external storage device.
USB ports for external storage devices are equipped to both the controller and the teach pendent. To access the external storage device, it is necessary to select the target beforehand.
See table 6.2.2.

Table 6.2.2 Usable storage media

External storage device (media)	Details
RC External memory 1	This accesses the USB memory connected to the USB port on the controller.
TP External memory	This accesses the USB memory connected to the USB port on the teach pendant.

Before files are stored in an external storage device, the storage media must have been initialized.
See page 6-27 “6.9 Initializing the USB memory ”.

CAUTION

Do not connect any other type of USB device other than USB memory to the USB port.

IMPORTANT

There are two RC external memory USB ports. Do not use them at the same time.

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 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)

Folder structure of internal memory

The internal memory of the 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

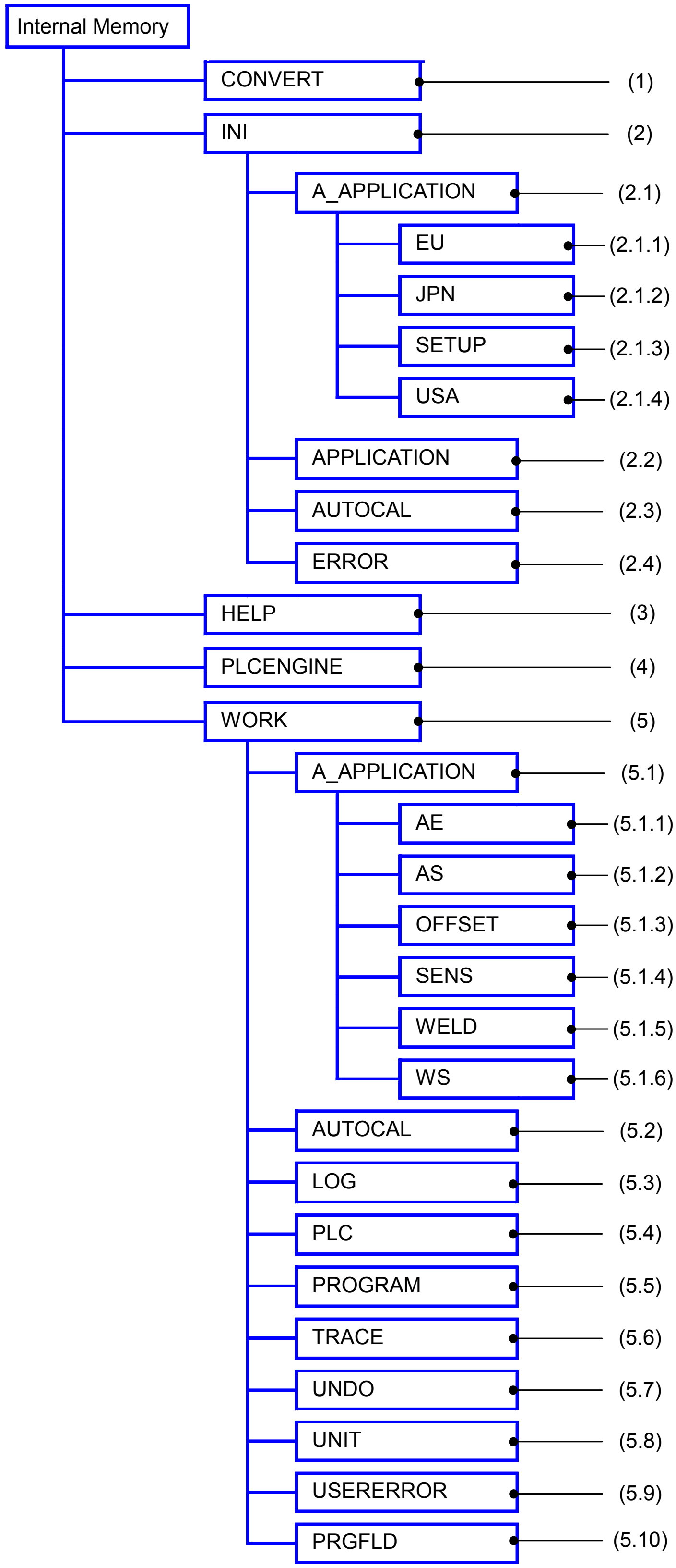


Fig. 6.2.1 Folder structure of internal memory

Inserting the USB Memory

This controller is equipped with USB ports as a standard feature.
To prepare to back up the data, plug a USB memory into the USB port.

POINT

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.

CAUTION

Do not connect any other type of USB device other than USB memory to the USB port.

Types of USB memory that can be used

For details on the types of USB memory that can be used and for precautions for use, see the "Controller Maintenance" section of the instruction manual.

Inserting the USB Memory

To save files onto the USB memory, plug the USB memory into the USB port of the controller or teach pendant in advance.
If there are two storage devices available which USB memories are inserted into, it is advisable to use them as shown in table 6.3.1 below.

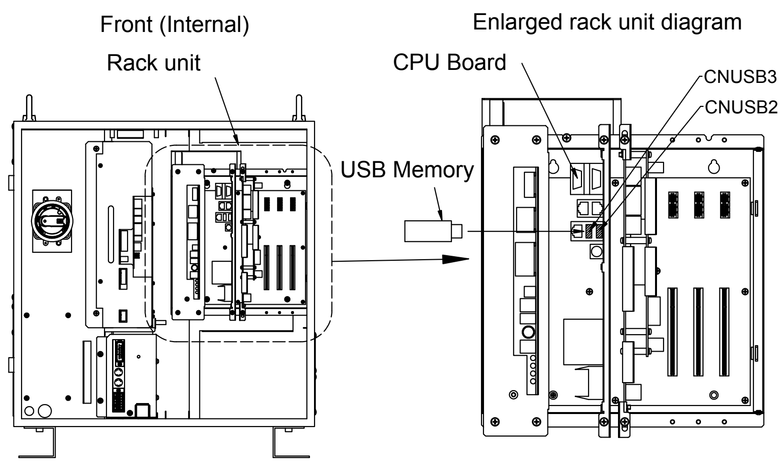
Table 6.3.1 USB memory uses

External Storage Device (Media)	Use
RC External memory 1	Suitable for transferring large files, such as for backup etc. Use this when the USB memory is always connected for automatic backup.
TP External memory	Suitable for transferring small files, such as for copying files etc.

Inserting USB memory into the robot controller (RC External Memory)

> **WARNING**
>
> Only insert and remove the USB memory when the robot controller power is switched off.
> Inserting or removing the USB memory when the power is on may corrupt the data saved on the USB memory.

1 **Turn off the power of the robot controller, and open the door.**
Insert the USB memory into "CNUSB2" or "CNUSB3" on the CPU board.
The CPU board is installed in the rack unit.
Insert the USB memory in the correct orientation. It cannot be inserted in the wrong orientation.



> **IMPORTANT**
>
> There are 2 USB ports in the CPU board. The USB memory will work irrespective of which USB port it is connected to. However, do not connect 2 USB memories at the same time.

2 **Close the door of the controller, and turn the power on.**

3 **Perform backup and other tasks.**

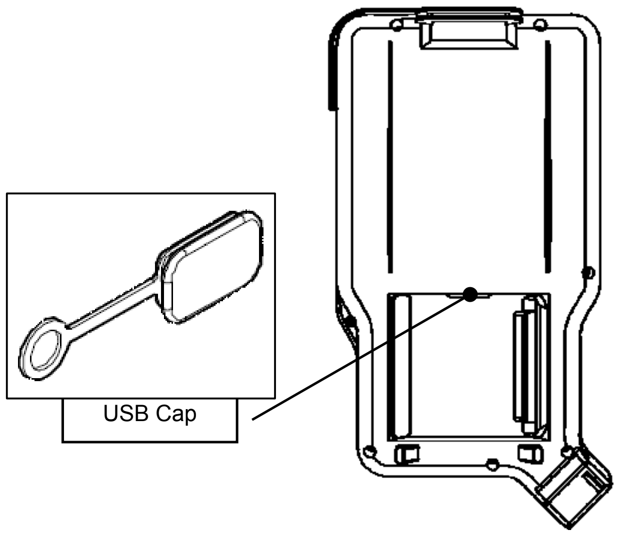
4 **The USB memory can be used continually when connected.**
Before removing the USB memory, always be sure to turn off the controller power.

Inserting USB memory into the teach pendant (TP External Memory)

IMPORTANT

During LED of the USB memory has been flashing, please don't remove the USB memory from the USB port. Data may break.

1 **Remove the USB cap from the back of the teach pendant.**



2 **Insert the USB memory.**

>> Insert the USB memory in the correct orientation. It cannot be inserted in the wrong orientation.

3 **Perform file copying and other tasks.**

4 **When the tasks are complete, remove the USB memory.**
When the USB memory is removed, firmly close the USB cap on the back of the teach pendant.

CAUTION

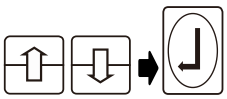
Only connect USB memory to the USB port when operating files. When the TP external storage memory is not being used, always close the USB cap on the back of the teach pendant.
Leaving the USB cap open for long periods may hinder the dust protection and waterproofing properties, which may lead to failure.

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.

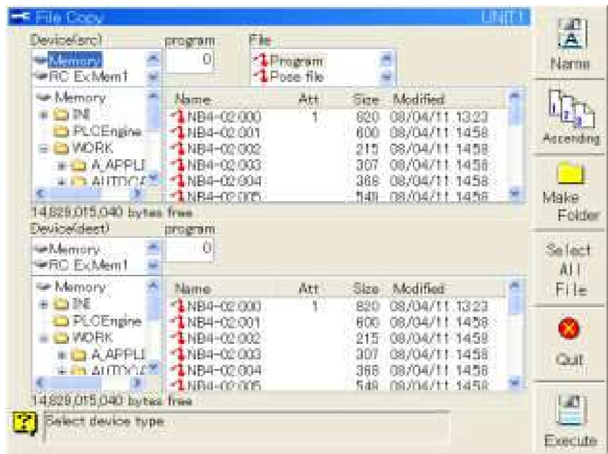
- Program file
- Pose file
- Language file
- Constant file
- Log file
- All files (all of the above files)

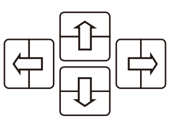
Opening the copy screen



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.

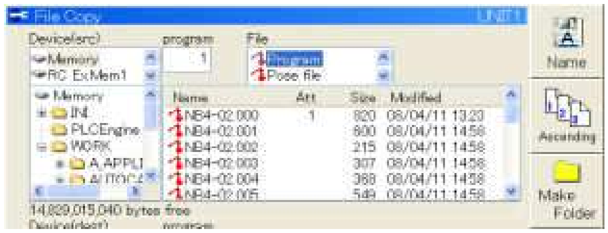
1 **Select "Memory" in the copy source device selection field.**

2 **After moving to the program input field, input "1" and press [Enter].**

>> The program "1" in "¥WORK¥PROGRAM″ is selected for copying.

When you copy a program by specifying the program number, the program copied will always be in a folder with the same name as the original folder, 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".

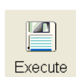
3 Move to the file type selection field, and select “Program”.



4 Move to the copy destination device selection field, and select “Memory”.

5 Move to the program input field, and input “10”.

If the initial value for the copy location program number is not changed, the program is copied as number 0. Be careful.



6 Press f12 <Execute>.
>> Copying now starts.

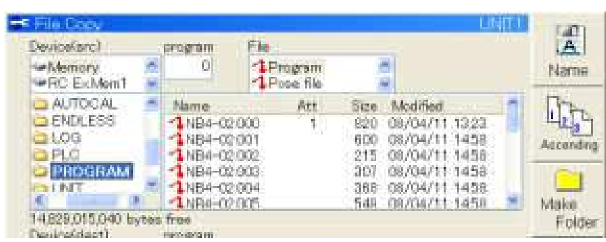
Specifying and copying a multiple number of files

As an example, the steps taken to select a multiple number of programs stored in the internal memory and copy them onto a USB memory stick will be described.

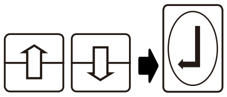
1 Select “Memory” in the copy source device selection field.

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.

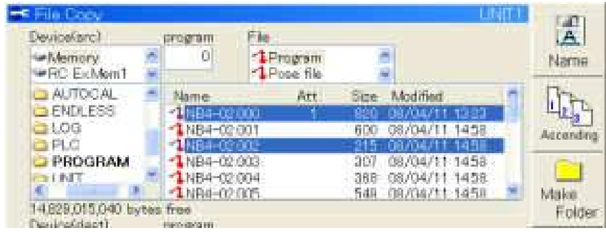


Any settings may be used for the program input field and file type selection field. (The selection made from the file list takes precedence over the program input field and file type selection field settings.)



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 “RC ExMem1.”

6 Move to the folder selection field, and select the destination folder.

7 Press f12 <Execute>.

>> Copying now starts.

Copying all the files

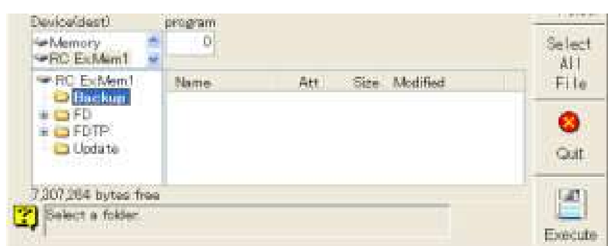
As an example, the steps taken to copy all the programs stored in the Memory onto a USB memory stick will be described.

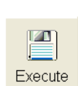
1 Select “Memory” in the copy source device selection field.

2 Move to the file type selection field, and select “All programs”.

3 Move to the copy destination device selection field, and select “RC ExMem1.”

4 Move to the folder selection field, and select the copy destination folder.





5 Press f12 <Execute>.

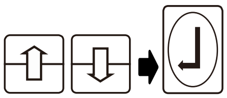
>> This now completes the copying.

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.

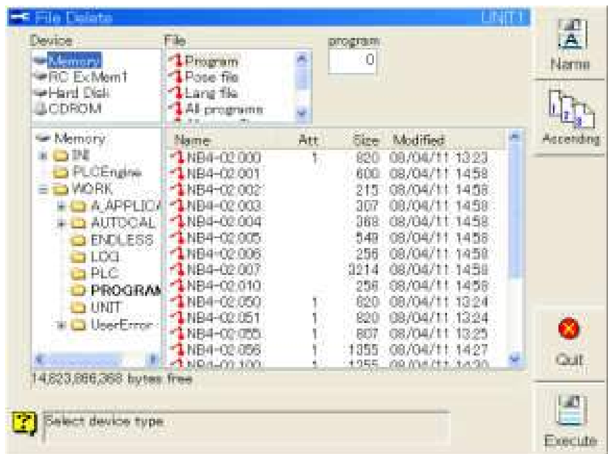
- Program files (deleted individually or altogether)
- Pose files (deleted individually or altogether)
- Language files (deleted individually or altogether)
- Log file (deleted altogether)

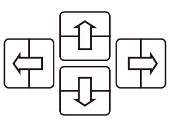
Opening the deletion screen



1 Select “3 File delete” on the file operation menu, and press [Enter].

>> The [File delete] screen is now opened.





2 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.

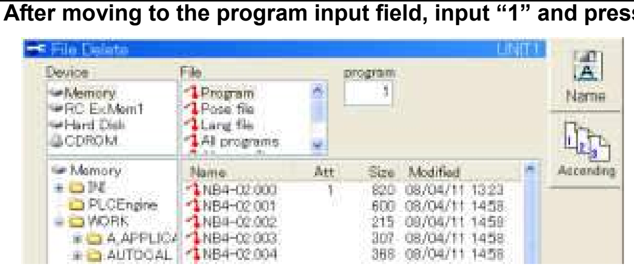
Specifying one file and deleting it

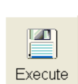
As an example, the steps taken to delete program “1” stored in the Memory will be described.

1 In the device selection field, select “Memory”.

2 Move to the file type selection field, and select “Program”.

3 After moving to the program input field, input “1” and press [Enter].





4 Press f12 <Execute>.

>> This completes the file deletion.

Specifying a multiple number of files and deleting them

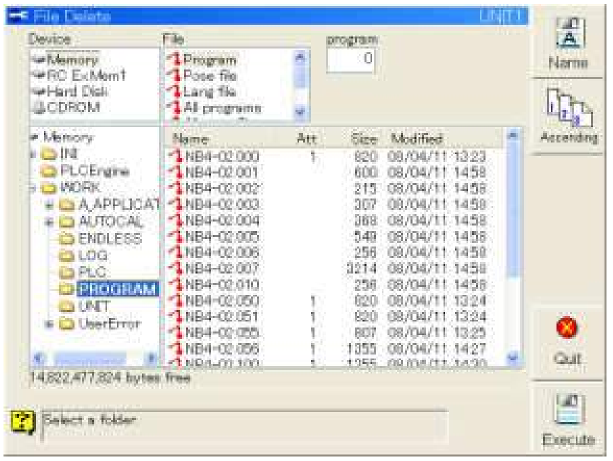
As an example, the steps taken to select a multiple number of programs stored in the internal memory and delete them will be described.

1 In the device selection field, select "Memory".

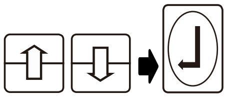
2 Move to the file type selection field, and select "Program".

3 Move to the folder selection field, and select "PROGRAM".

>> A list of the programs now appears.

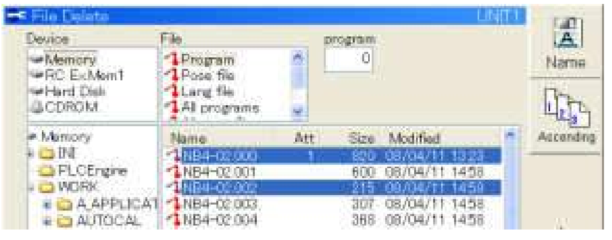


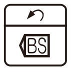
Any settings may be used for the program input field and file type selection field. (The selection made from the file list takes precedence over the program input field and file type selection field settings.)



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.

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.

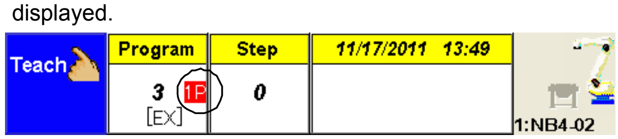
Table 6.7.1 Protection types and functions

	All protect	Partial protect	Playback protect
	(Either complete or partial protection only can be selected.)		
Display mark (highlighting in red)	1	2	P
Modification of position data	×	◎	◎
Modification of all other data	×		◎
File Delete	×		◎
Playback or step go from step 0, CHECK GO	◎		×
Playback, check go after step 1	◎		◎

◎ : Possible

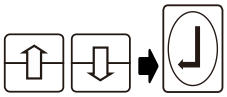
× : Cannot be performed (= protected)

- When opening a program for which protection has been set, the protection status is displayed.



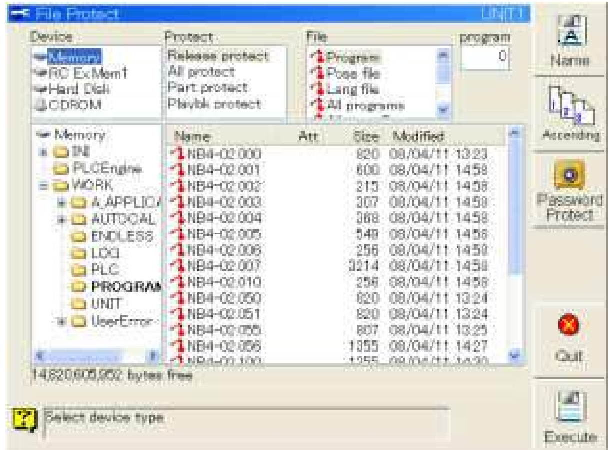
- Complete protection (or partial protection) and playback protection can be used simultaneously.(With a combination of “O” and “×”, “×” takes precedence.)
  In this case, The display mark that indicates the protection status of the file is a combination of the two display marks.
- For constant files, 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.

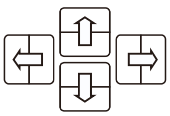
Opening the protection setting screen



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.

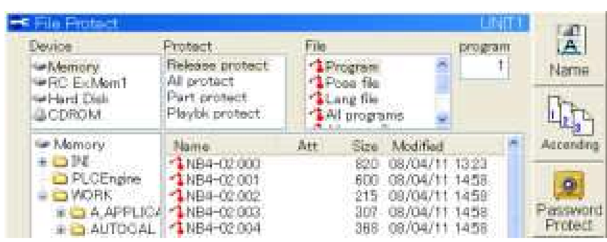
As an example, the steps taken to set "All protect" for program "1" stored in the internal memory will be described.

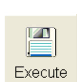
1 **In the device selection field, select "Memory".**

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.

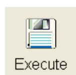
1 **In the device selection field, select “Memory”.**

2 **Move to the protection type field, and select “Playback protect”.**

3 **Move to the file type selection field, and select “All programs”.**

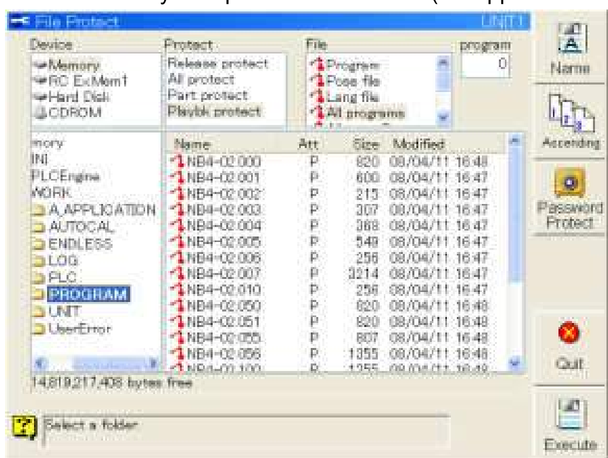
4 **Move to the folder selection field, and select “PROGRAM”.**

>> A list of the programs now appears.



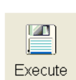
5 **Press f12 <Execute>.**

>> This sets “Playback protect” for the files. (“P” appears in the attribute field.)



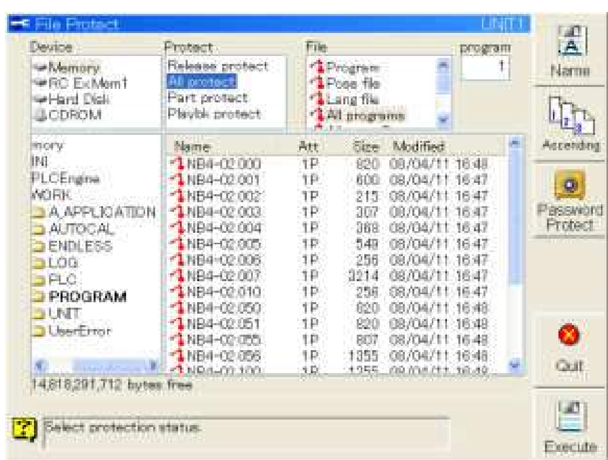
“P” appears in the attribute field.

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.

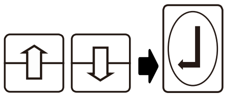
Initializing the USB memory

To save data onto an external storage device, the USB memory needs to be initialized in advance.
Initialization is only required the first time the USB memory is connected to the controller. (If initialization is done once, these steps are no longer required).
Also, initialization is performed to erase all of the contents of the media.

IMPORTANT

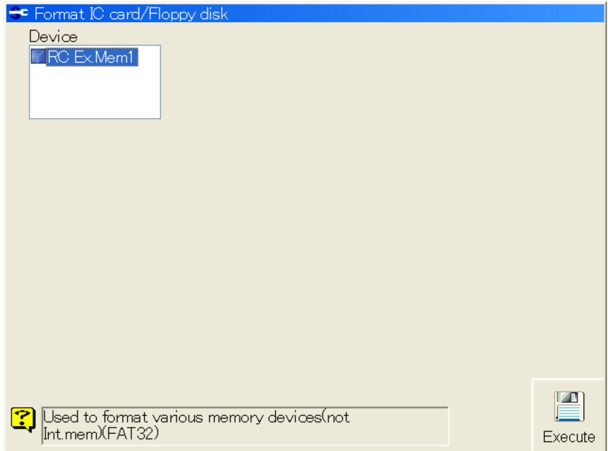
- **When the USB memory is initialized, all of the data stored on it is deleted. Be careful when initializing the memory.**
- **Connect the USB memory to be used to the CPU board in this controller to initialize it.** When initializing USB memories using an external device such as a personal computer, initialize it to “FAT32” format.
- **Do not remove the USB memory, and switch off the power while the USB memory is initialized.**

Initializing the USB Memory



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 USB memory to be initialized.**

3 **Press f12 <Execute>.**

>> Initializing now starts.

Backing up files

All the files stored in the internal memory can be backed up and saved.
Differences with file copying are as follows.

- There is no need to select which files to copy.
- Important parameters such as option protection information that is not copied when “Specify and copy all files” is used are also copied.

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).

INFO.

The name of the backup folder is given automatically using the following format.

NRA2011-2011-11-06-0932

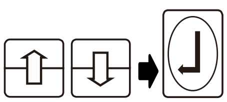
Date Time

POINT

The external storage device is recommended for the backup destination device.

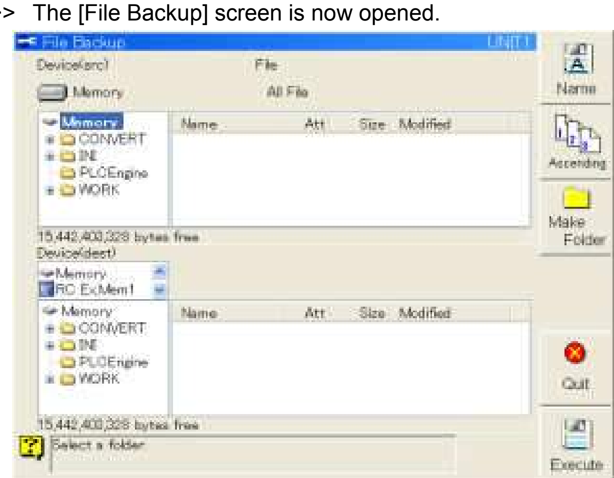
If the backup destination to the internal memory, please make sure you have enough free space in internal memory
(Only as a guide. requires at free space of 10MB after the backup).

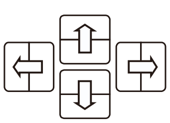
Opening the backup screen



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>, and input the folder name.

The soft keyboard starts up. Input the folder name.

For details on how to input text, see “2.5 To input characters”.

2 Press f12 <Complete>.

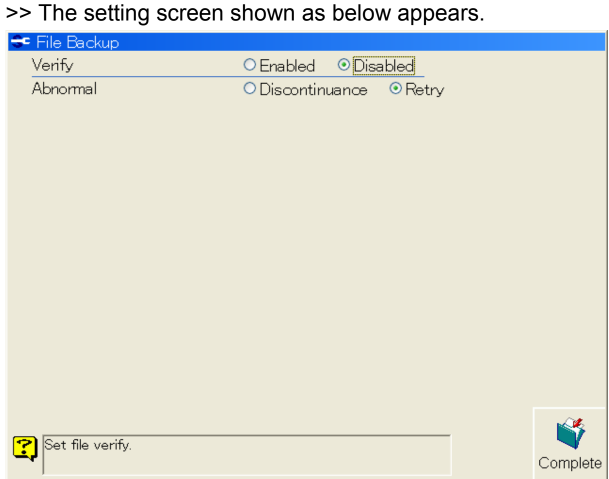
>> A folder is now created in the storage media.

Setting the file verification

For this setting, it is necessary to switch operator class to *EXPERT* or above.

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 f12 <Complete>

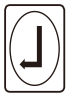
>> File verification will be done using the settings on this screen when executing backup process.

Table 6.10.1 File Verify Settings for Backup

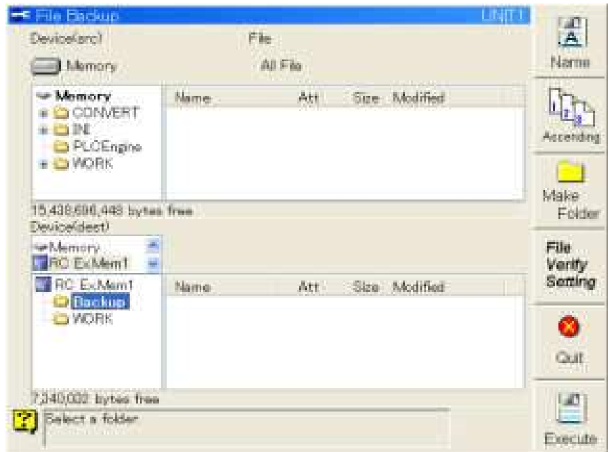
Parameter	Default setting	Input range	Description
Verify	Disabled	Enabled / Disabled	Set the file verification Enabled/Disabled when executing the backup.
Abnormal	Retry	Discontinuance / Retry	Select the procces to be executed when an error occurs while the file verification.

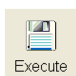
Backing up the folders

1 **In the device selection field, select "RC ExMem1" for instance.**



2 **Move to the folder selection field, select the backup destination folder, and press [Enter].**





3 **Press f12 <Execute>.**

>> Backup now starts.

Restoring all files from backup

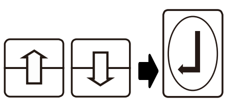
The steps taken to restore all the files using the stored backup data in order to restore normal operation after trouble has occurred or on other such occasions will be described.
When restoration has been performed, all the files including the constant files, program files and history files (all the 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 switching operator qualifications, see the instruction manual "SETUP MANUAL".

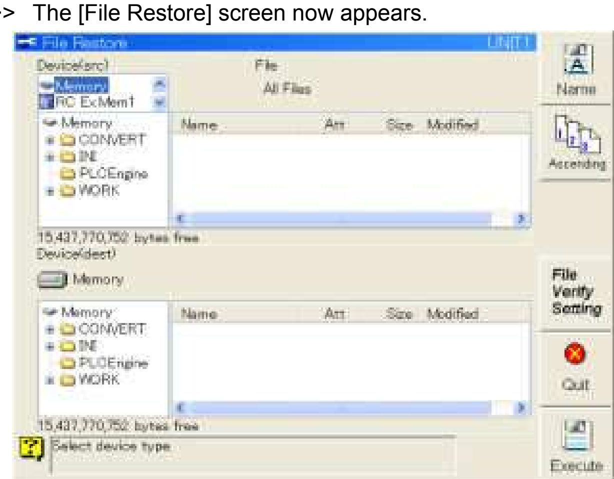
CAUTION

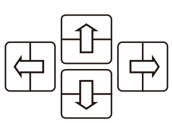
1) Do not execute backup restoration so lightly except when upgrading accompanied with replacement of the system CF or restoring after a trouble occurred.
2) At the shutdown after backup restoration and at the power restoration, the status restoration processing of the auto resume function (restoration 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.
4) When restoring the backup, it is necessary to change the settings of the system memory maintenance function. For details, see the “Controller Maintenance” section of the instruction manual.

Opening the File Restore screen



1 **Select “11 File Restore” on the file operation menu, and press [Enter].**
\>> The [File Restore] screen now appears.





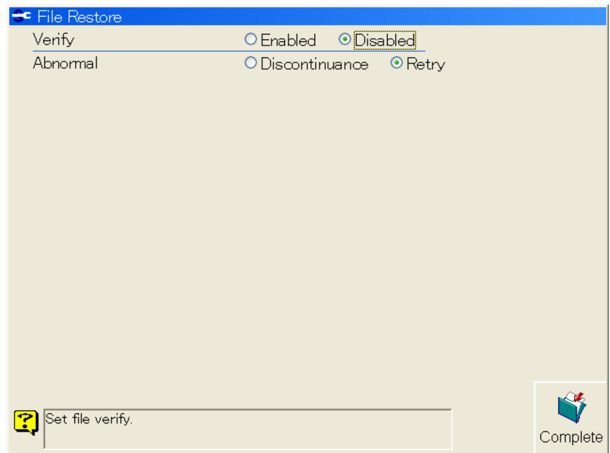
2 **To move through each field, use the [Left/Right] keys.**
To select the items displayed in the fields, use the [Up/Down] keys.

Setting the file verification

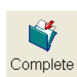
For this setting, it is necessary to switch to operator class *EXPERT* or above.

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 f12 <Complete>.**

>> File verification will be done using the settings on this screen when executing restoring process.

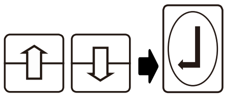
Table 6.11.1 File Verify Settings for File Restore

Parameter	Default setting	Input range	Description
Verify	Disabled	Enabled / Disabled	Set the file verification Enabled/Disabled when executing the file restore.
Abnormal	Retry	Discontinuance / Retry	Select the process to be executed when an error occurs while the file verification.

Restoring all files from the backup

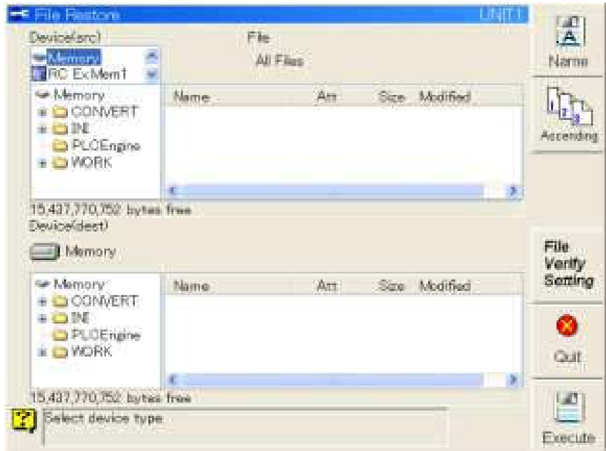
1 Stop the robot, and set the motor power to OFF.

Backup data cannot be restored while the robot is operating.
Before proceeding, the robot must be stopped and the motor power set to OFF.



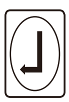
2 Select “11 File Restore” on the file operation menu, and press [Enter].

>> The [File Restore] screen now appears.



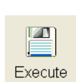
3 In the device (source) selection field, select the device on which the backup data to be restored is saved.

For example, if backup data is saved to the USB memory and the USB memory is inserted in the controller, select “RC ExMem1.”



4 Move to the folder selection field, select the folder containing the backup data to be restored, and press [Enter].

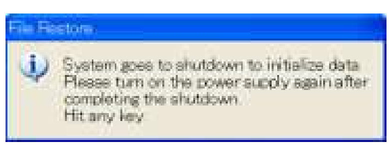
The folder in which the backup data is stored must have “read-only” attributes. (Backup folders are automatically given “read-only” attributes when data is backed up manually or automatically.)
If the USB memory is accessed by a PC or other devices and the attributes of the backup folder are changed to an attribute other than “read-only,” the folder cannot be selected because it is not recognized as a backup source folder.



5 Press f12 <Execute>.

>> Backup restoration now starts.

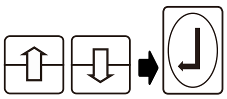
6 The following message is displayed. Press a key to shutdown.
Do not switch off the power during shutdown.



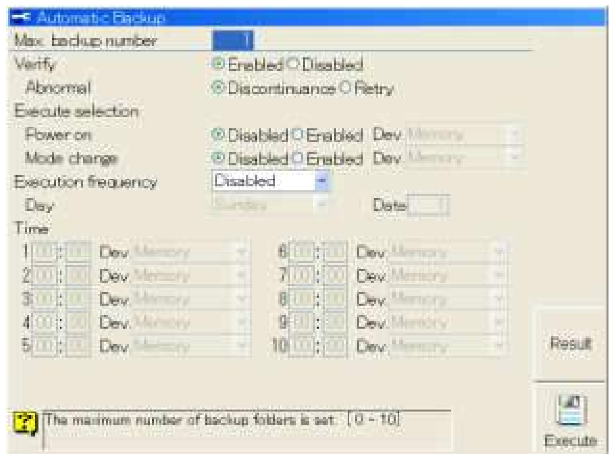
Performing automatic backup

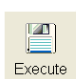
This function is used to back up all the files contained in the NRA2011¥WORK folder at the predetermined time, day of the week and date in order to store a history of the robot's operation statuses at regular intervals. These files can also be automatically backed up when the power is turned on or when 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 details on switching operator qualifications, see the instruction manual "SETUP 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**, and 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.	Internal memory	Internal memory/ RC External memory 1/ Host 1/ Host 2	This is for selecting the media that is stored backup files. "TP external memory" cannot be used in automatic backup.
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) NRA2011-2011-09-26-1834 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	Discontinuance	Discontinuance/ 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.

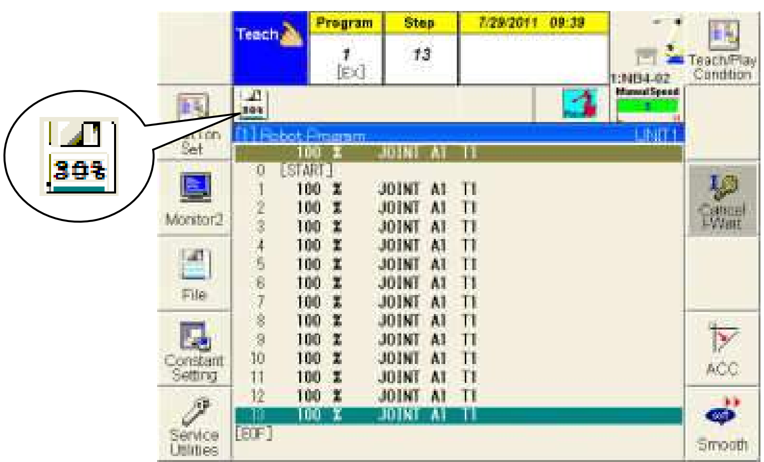
Parameter	Initial setting	Input range	Description of function
Mode change	Disable	Enable/Disable	This is for setting whether automatic backup is to be performed when the mode has been switched (from teaching to playback or vice versa).
Frequency	Disable	Disable/ Every day/ Every week/ Every month	This 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.”

INFO.

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 in 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 is started, an icon is displayed in the variable status display area.
The progress made during automatic backup is indicated as a percentage.
Upon completion of the automatic backup, the icon vanishes.

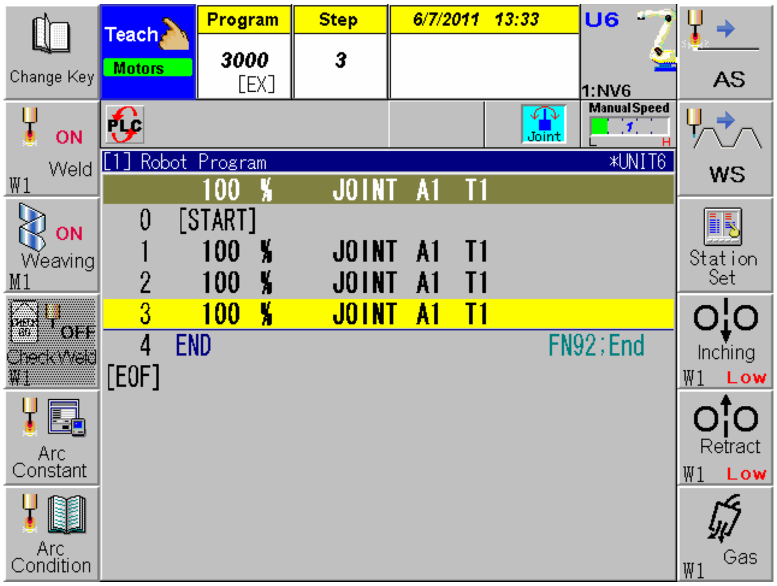


IMPORTANT

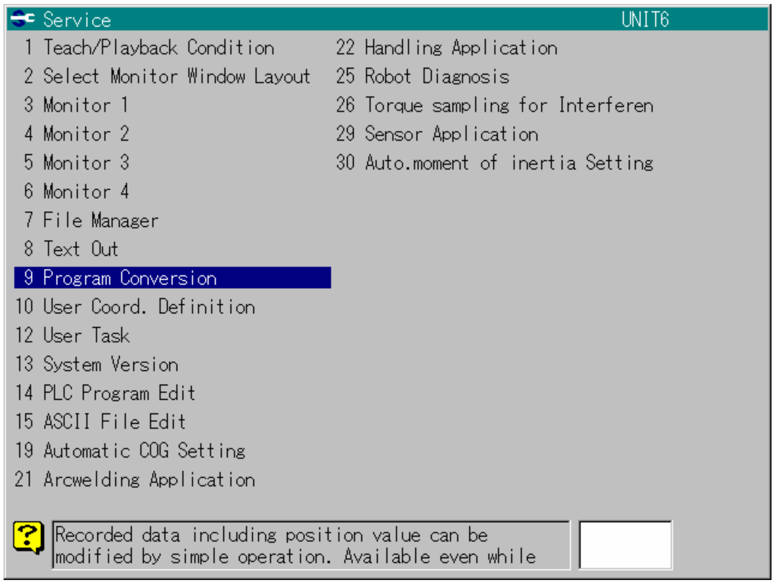
If the destination device is set to "Host 1" or "Host 2", the attribute of the backup folder that will be created on the FTP server is "Read Only". And, the attribute of the initial folder on the FTP server is "Read Only"; the backup folder cannot be created. Therefore, remove the "Read Only" attribute from the initial folder on the FTP server in advance.

Program Conversion AXC to AII

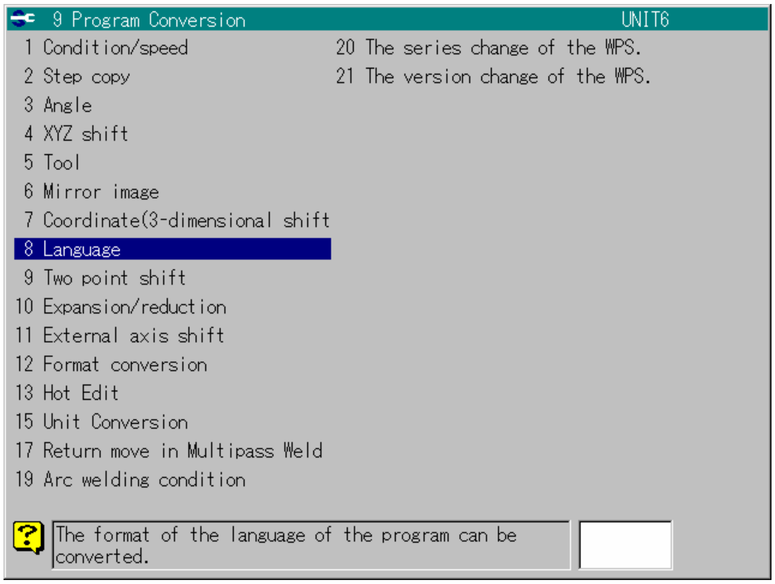
1. In AX controller select what unit you will be converting



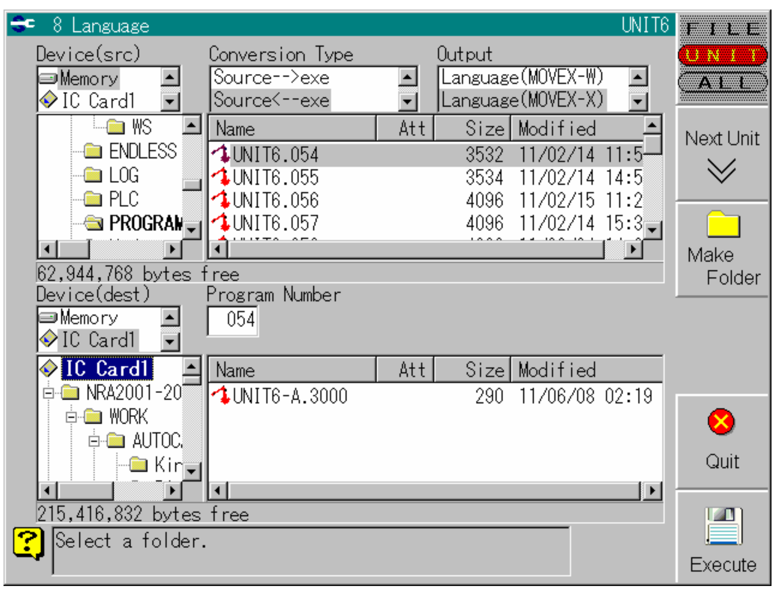
2. Press enable and Service utilities, then select Program conversion



3. Select Language

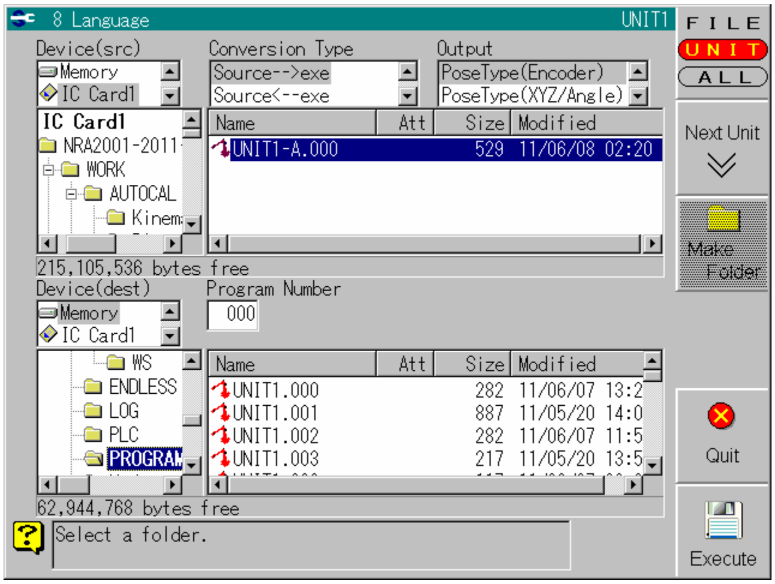


4. Select SRC "Memory", Conversion Type "Source{--exe", Output "Language (MOVEX-X), select what program you wish to convert/copy, select (dest) "IC Card", then press execute.



5. Move CF card to AII controller and do steps 1-3 then step 6.

6. To copy to the AII controller select Src “IC card”, Conversion Type “Source--}exe”, Output “PoseType(Encoder)”, select what program you wish to load, select dest “Memory”, then press Execute.



- Please note that only the unit you are in on your TP screen will appear for conversion selection so when doing multiple units copy all of like units then move to the next unit.
- You must copy the programs from the AX control using steps 1-4, you cannot use a backup or standard program copy.

OTC DAIHEN Corporation

Almega FD series

INSTRUCTION MANUAL

APPLICATION MANUAL

ARC WELDING

ARC WELDING

Connect digital welding power supplies

WARNING

Electric shock may cause serious injury or death.
Wiring work should be done after turning off the primary power supply and circuit breaker on the robot controller and welding power supply.

This section describes the connection procedures to perform the arc welding by combining a robot and a digital welding power supply.

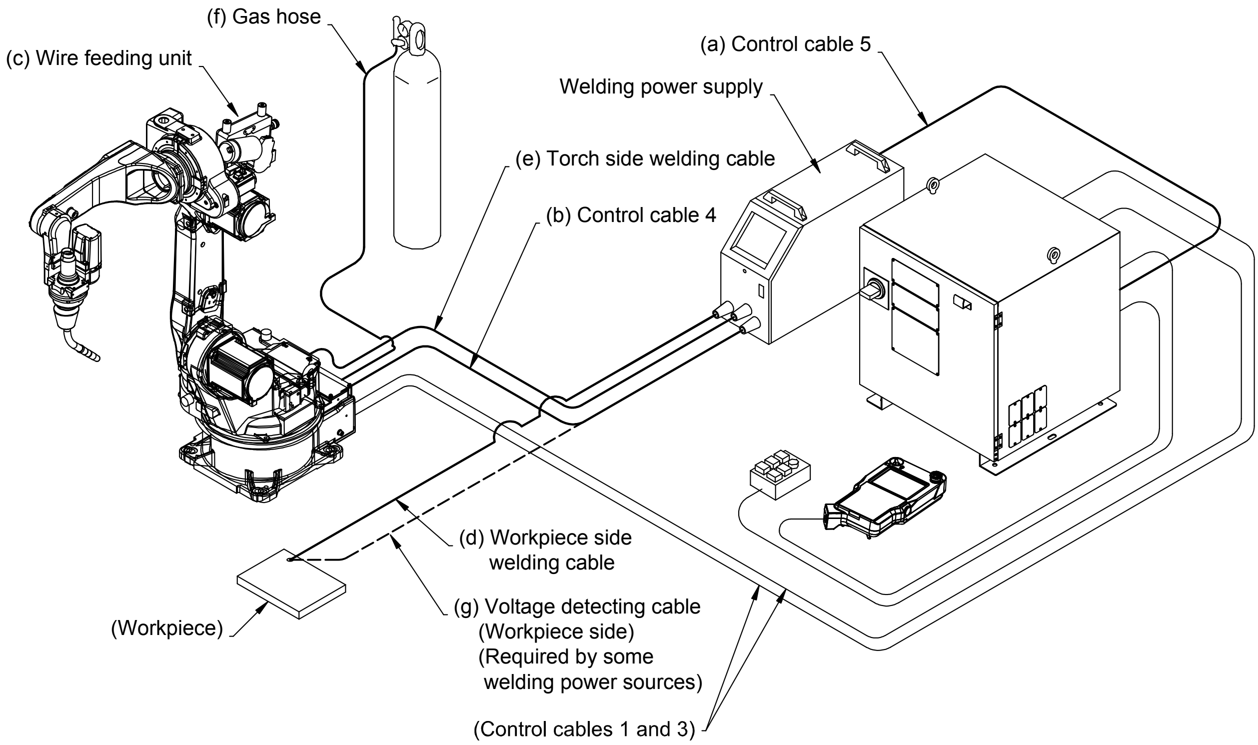


Fig. 1.2.1 Connect a digital welding power supply

Do the connecting work, referring to Table 1.2.1 on the following page.

Registering the welding power supply

This section describes the procedure for setting the welding power supply which is to be used. The welding power supply which is to be actually connected must be registered without fail.

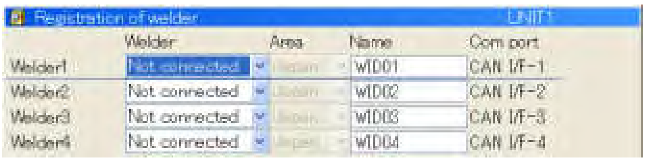
The registered welding power supply can be given any name (composed of up to 10 halfsize characters or 5 full-size characters).
The name given here is displayed at times when, for instance, teaching is performed or the welding constants are set. Especially when a number of welding power supplies are to be connected, giving each one a different name makes it easier to identify for which welding power supply the operation or settings is to be performed, thereby preventing errors in operation or mistakes in settings.

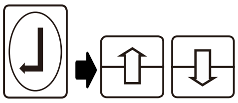
Registering the welding power supply

Before proceeding, switch the operator qualification level to ***EXPERT*** or above.

1 **In teach mode, select f5 <Arc Constant> - [1 Registration of welder].**

>> The registration of welder screen appears.





2 **When only one welder is to be used, proceed with the registration for the “Welder 1” line.**

When [Enter] is pressed, the selection choices appear. Select the welder using [up] or [down].

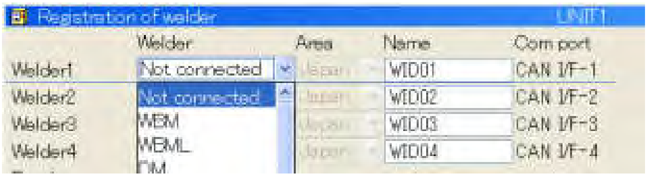
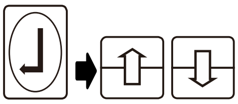


Table 2.3.1 Selection Choice List

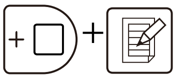
Welding power unit used	Welding power supply	Region
Welbee Inverter M350L (Japan specifications)	WBML	Japan
Welbee Inverter M350L (CCC specifications)		
Welbee Inverter M350L（Asia specifications）		
Welbee Inverter M350 (Japan specifications）	WBM	Japan
Welbee Inverter M350（Asia specifications）		
Welbee Inverter M500 (Japan specifications）	WBM	Japan
DM350 (Japan specifications)	DM	Japan
DM350 (U.S. specifications)	DM	U.S.
DM350 (Europe specifications)	DM	Europe
DM350 (Asia specifications)	DM	Japan
DM500 (Japan specifications)	DM	Japan
DM500 (U.S. specifications)	DM	U.S.
DM500 (Asia specifications)	DM	Japan
DP350 (Japan specifications)	DP	Japan
DP350 (Taiwan specifications)	DP	Japan
DP400 (U.S. specifications)	DP	U.S.

Table 2.3.1 Selection Choice List

Welding power unit used	Welding power supply	Region
DP400 (Europe specifications)	DP	Europe
DP400 (CCC specifications)	DP	Europe
DP500 (Japan specifications)	DP	Japan
DP500 (U.S. specifications)	DP	U.S.
DP500 (Europe specifications)	DP	Europe
DP500 (Taiwan specifications)	DP	Japan
DP400R (Japan specifications)	DPR	Japan
DP400R (U.S. specifications)	DPR	U.S.
DP400R (CCC specifications)	DPR	Japan
DA300P (Japan specifications)	DA	Japan
DA300P (Europe specifications)	DA	Europe
DR350 (Japan specifications)	DR	Japan
DR350 (Taiwan specifications)	DR	Japan
DL350 (Japan specifications)	DL	Japan
DL350 (U.S. specifications)	DL	U.S.
DW300+(PLUS) (Japan specifications)	DW	Japan
DW300+(PLUS) (U.S. specifications)	DW	U.S.
DW300+(PLUS) (Europe specifications)	DW	Europe
DM-350(S-2) (Japan specifications)	DM(S-2)	Japan
Digital inverter DL-350(S-2) (Japan specifications)	DL(S-2)	Japan
Welding interface (Standard)	WIF	—
Welding interface (4-channel specifications)	WIF(4ch)	—
Welder connected by input/output signals	WPS(I/O)	—



3 **When [Enter] is pressed after moving to "Area," a list of options appears. Select the area which matches the welder using [up] and [down].**



4 **To give a name to a welder, first move to "Name," and then press [EDIT] while holding down [ENABLE].**

>> The soft keyboard now starts up.

5 **Input the desired name, and exit the soft keyboard.**

6 **When a multiple number of welding power supplies are to be connected, follow the same steps to register "Welder2" and so on.**

7 **When the settings are completed, press f12 <Complete>.**

>> This completes the registration of the welder or welders.

IMPORTANT

When the welder has been re-registered, the welding characteristic data may be initialized.
Back up this data before re-registering the welding power supply.

POINT

When two or more welding power supplies are connected, continuously register in order starting from "Welder1".

Settings relating to how to operate the welding power supply

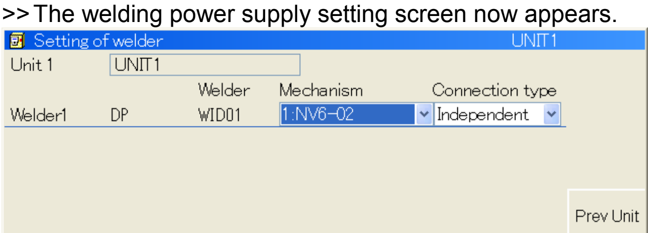
Set the robot to which the welding power supply is to be connected and the connection type.
When a robot system with the multi-unit specifications is to be used, these settings must be performed for each unit.

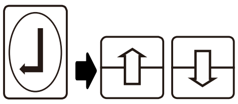
Settings relating to how to operate the welding power supply

Before proceeding, switch the operator qualification level to ***EXPERT*** or above.

1 In teach mode, select f5 <Arc Constant> - [2 Setting of welder].

>> The welding power supply setting screen now appears.

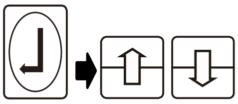




2 In the "Mechanism" field, set the robot to which the welding power supply is to be connected.
When [Enter] is pressed, the selection choices appear. Select one of them.

Table 2.4.1 Mechanism Selection Choice

Selection choice	Description
Manipulator Name (Example: NV6-02)	Manipulator connected to the user's robot system. If a multiple number of manipulators are connected, select one of them.
Not used	This is selected when the welding power supply is not going to be used.
Stationary	This is selected in the case of special usage where, rather than connecting the welding power supply to the manipulator, the torch is permanently installed in a fixed position, for example.



3 In the "Connection type" field, set the connection type of the welding power supply.
When [Enter] is pressed, the selection choices appear. Select one of them.

Table 2.4.2 Connection Type Selection Choices

Selection choice	Description
Independent	This is selected when none of the applications below apply.
TwinTorch1	This is set when two welding power supplies are connected to one manipulator and twin-torch welding is performed. Up to two sets of twin torches can be connected to the system: the first one is set as "TwinTorch1" and the second as "TwinTorch2."
TwinTorch2	
Tandem 1	This is set to use the tandem GMA welding function. Up to two sets of tandem GMA welding power supplies can be connected to the system: the first one is set as "Tandem 1" and the second as "Tandem 2."
Tandem 2	
ToolChange	This is set when the tool changer at the end of the manipulator is to be used to replace two or more welding power supplies in the same unit with a single welding power supply which is then to be connected to the manipulator.

4 For multi-unit specification robot systems, press <f10 <Next unit> to set the second and subsequent units.

5 When the settings are completed, press f12 <Complete>.

>> This completes the registration of the welder or welders.

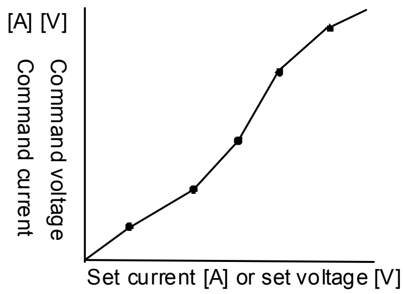
Registering the welding characteristic data and wire feed characteristic data

What is the welding characteristic data?

In order to proceed with arc welding using the robot, the welding characteristic data must be registered ahead of time.

The welding characteristic data defines the welding process, wire material, wire diameter, gas type and the correspondence table (welding characteristic curve) for welding current/voltage setting value (value taught to the task program) and command values (actual values instructed to the welding power supply that correspond to the setting values).Depending on the operating environment such as the wire extension length or welding power supply secondary cable length, if the setting value and actual welding power supply output do not match, the welding characteristic data can be corrected.

Robot Dedicated Welding Power Supply



Each point is connected with a straight line to give an approximation of a welding characteristic curve. The set values and the command values are determined by the proportionality between each pair of points.

Fig. 2.5 1 Welding characteristic curve

What is the wire feed characteristic data?

When the robot dedicated welding power supply is used, the wire feed characteristic data must be registered alongside the welding characteristic data. (It need not be registered with a welding power supply which does not use a robot dedicated welding power supply.)

Wire characteristic data defies the maximum rated feed speed for the wire feeder and type of wire feeder. The robot dedicated welding power supply controls the wire feeder based on this data.

Performing the registration operation

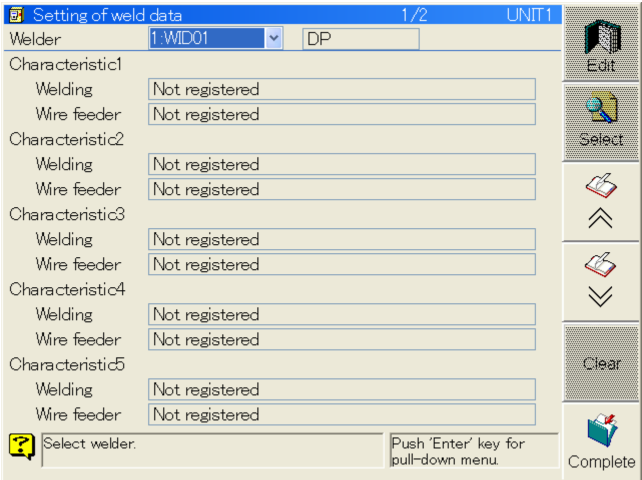
The welding characteristic data and wire feed characteristic data of the robot dedicated welding power supplies are contained inside the robot as standard data. This means that if the applicable data suited to the welding power supply to be used and the environment (wire diameter, wire material, shielding gas, etc.) is registered, the welding can be performed immediately.
If the robot does not contain this information as standard data, operators must first prepare the characteristic data (user characteristic data) themselves (Page 2-41 “2.7 Preparing the user characteristic data”) and then register it by performing the following steps.

Registering the welding characteristic data and wire feed characteristic data

Before proceeding, switch the operator qualification level to ***EXPERT*** or above.

1 In teach mode, select f5 <Arc Constant> - [4 Setting of weld data].

>> The screen for setting the characteristic data now appears.



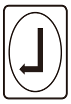
The DP-350 is shown as the example given on the screen shown above, and up to 10 sets of characteristic data (characteristic 1 to 10) can be registered (The display screen and maximum number of registrations differ depending on the type of welding power supply connected.).

Table 2.5.1 Characteristic Data Registration Quantity

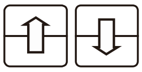
Model	Format	Maximum number of registrations	
		Welding characteristic	Wire characteristics
Welbee Inverter M350L	WB-M350L	10	10
Welbee Inverter M350/500	WB-M350/500	10	10
DM-350/500	DM-350/-500	2	2
DM-350(S-2)	DM-350(S-2)	2	2
DP350/400/500	DP-350/400/500	10	10
DP400R	DP-400R	10	10
DA-300	DA-300	0 (unnecessary)	1
DR-350	DR-350	10	10
DW300+(PLUS)	DW-300	10	10
DL350	DL-350	10	10
DL350(S-2)	DL-350(S-2)	10	10
Semi-automatic welder other than the above (When equipped with a welding interface)	―――	1	0

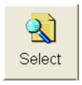
To weld while switching among multiple welding methods,

The multiple sets of welding characteristic data which have been registered are displayed as the welding methods, one of which can be selected when the arc welding start command (AS) and arc welding end command (AE) are set.
Therefore, when welding while switching among multiple welding methods, register the welding characteristic data that corresponds to all of the welding modes here.



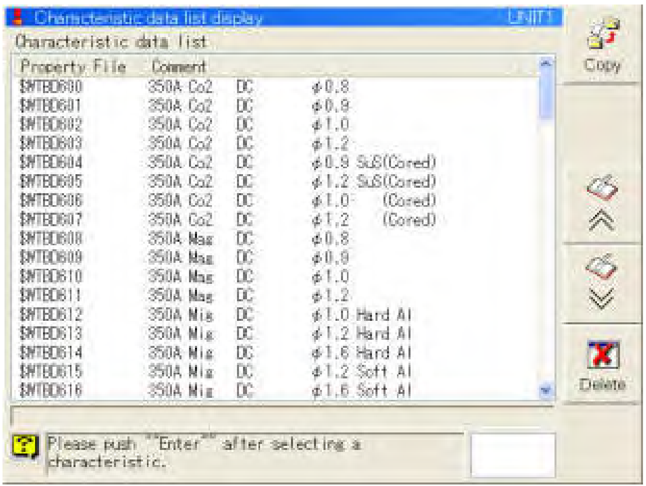
2 **When a multiple number of welding power supplies have been registered by the operations on page 2-3 “2.3 Registering the welding power supply”, press [Enter] in the “welder” field, and select the welding power supply which is the target of the settings.**
This operation need not be performed when only one welding power supply has been registered.



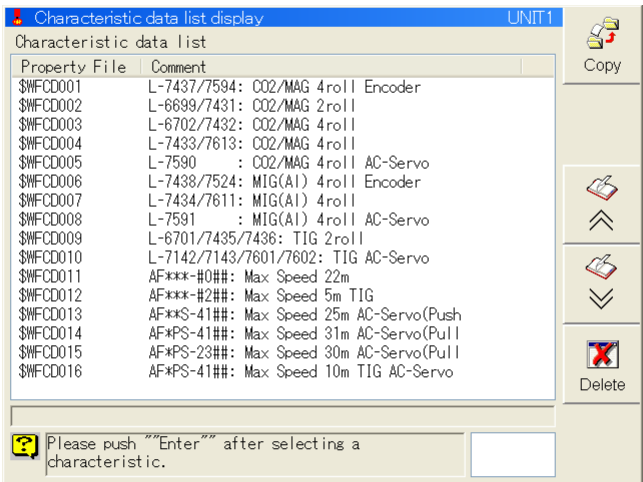


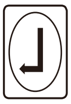
3 **Use [Up] and [Down] to the target section, and press f8 <Select>.**
>> A list of the characteristic data now appears.

[Welding characteristic data display]



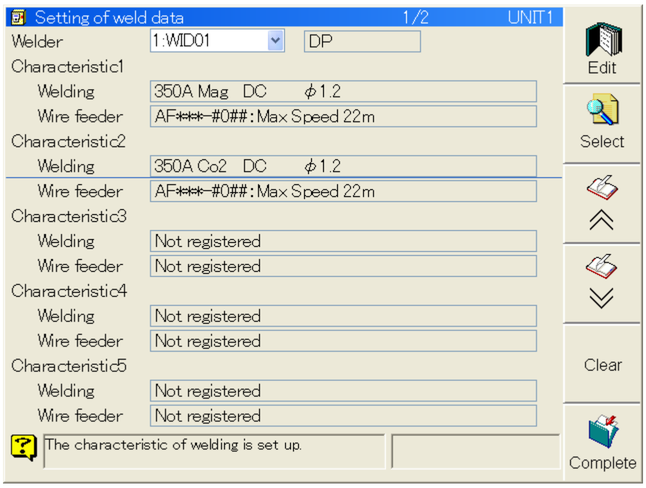
[Wire feed characteristic data display]





4 **While reading the comments, select the desired characteristic data, and press [Enter].**

>> The characteristic data is now selected. Repeat these steps for as many times as necessary.



5 **Lastly, press the f12 <Complete>.**

>> This completes the registration of the characteristic data.

IMPORTANT

When registering multiple sets of characteristic data, register the sets starting from characteristic data 1.

Standard internal wire feed characteristic data

The robot contains the following wire feed characteristic data serving as the standard welding characteristic data for using the wire feeder.

Table 2.5.29 Standard internal wire feed characteristic data

Wire feed characteristic data number	Wire feeder model	Welding application, description	Comment
$WFCD001	L-7437 L-7594	Steel type (CO2, MAG) 4-roll with encoder, 18 m	L-7437/7594： CO2/MAG 4 roll Encoder
$WFCD002	L-6699 L-7431	Steel type (CO2, MAG) 2-roll, 15m	L-6699/7431： CO2/MAG 2roll
$WFCD003	L-6702 L-7432	Steel type (CO2, MAG) 4-roll, 15m	L-6702/7432：CO2/MAG 4 roll
$WFCD004	L-7433 L-7613	Steel type (CO2, MAG) 4-roll, 18m	L-7433/7613：CO2/MAG 4 roll
$WFCD005	L-7590	Steel type (CO2, MAG) 4-roll, 32m	L-7590： CO2/MAG 4 roll AC-Servo
$WFCD006	L-7438 L-7524	Aluminum type (MIG) 4-roll with encoder, 18 m	L-7438/7524： MIG(Al) 4 roll Encoder
$WFCD007	L-7434 L-7611	Aluminum type (MIG) 4-roll, 18m	L-7434/7611： MIG(Al) 4 roll
$WFCD008	L-7591	Aluminum type (MIG) 4-roll, 32m	L-7591： MIG(Al) 4 roll AC-Servo
$WFCD009	L-6701 L-7435 L-7436	Steel, aluminum type (TIG) 2-roll, 3 m	L-6701/7435/7436： TIG 2 roll
$WFCD010	L-7142 L-7143 L-7601 L-7602	Steel, aluminum type (TIG) 4-roll AC servo, 15 m	L-7142/7143/7601/7602： TIG AC-Servo
$WFCD011	AF***-****	Wire feeder for D-series / Welbee Inverter series of welding power supplies Rated feed speed 22 m specifications	AF***-#0##: Max Speed 22m
$WFCD012	AF***-****	Wire feeder for D-series of welding power supplies TIG specifications Rated feed speed, TIG specifications	AF***-#2##: Max Speed 5m TIG
$WFCD013	AF***-****	Wire feeder for D-series of welding power supplies, AC servo Rated feed speed 25m (push)	AF**S-41##: Max Speed 25mAC-Servo(Push)
$WFCD014	AF***-****	Wire feeder for D-series of welding power supplies, AC servo Rated feed speed 31m (pull)	AF*PS-41##: Max Speed 31mAC-Servo(Pull)
$WFCD015	AF***-****	Wire feeder for D-series / Welbee Inverter series of welding power supplies, AC servo Rated feed speed 30m (pull)	AF*PS-23##: Max Speed 30mAC-Servo(Pull)

When the welding mode or voltage adjustment method was changed

When the following changes are made in the welding characteristic data, either correct the arc start command, arc end command, and welding condition file recorded for the completed task programs, or delete all of these and redo teaching. However, it is not necessary to correct the arc start command, arc end command and welding condition files for welding characteristic data that has not been used yet.

- When registered welding characteristic data is changed to welding characteristic data for a different welding mode
  (Example) "DC" is registered in the welding characteristic data for characteristic 1, and this is changed to the "DC pulse" welding characteristic data.
- When the voltage adjustment method in the welding characteristic data is changed
- When the welding mode in the user characteristic data is changed

If these steps are not taken, the robot may stop abnormally or the welding quality may deteriorate significantly.

When the welding power supply type had been changed

When the type of welding power supply is changed during operation, perform the following actions (1), (2) and (3) in order.
If these steps are not taken, the robot may stop abnormally or the welding quality may deteriorate significantly.

(1) Refer to "Chapter 8 Useful Functions", and check that the welding power supply supports "File conversion required by the change of welding power supply". This function can be used to convert program files, welding characteristic data files, and welding condition files. Also, the steps after (2) are not required.

(2) If step (1) is not performed, the welding characteristic data of the current welding power supply is re-registered.

(3) The new data will be added and the arc start command and arc end command stored in the already prepared task program will be deleted.

Revising the welding characteristic data

The welding characteristic data is revised in the following situations.

- When the setting values taught by the welding conditions in the task program and actual output values are different

  The welding conditions are affected by a number of factors including the length of the secondary side cable and length of the protruding wire. As a result, there may be slight discrepancies between the settings which were established at the teaching stage and what is actually output. In this type of situation, adjustments are performed by correcting the welding characteristic data.

- To adjust the “automatic voltage adjustment function”:

  The voltage of the “automatic voltage adjustment function” (where the voltage that has been aligned with the current is automatically displayed when the arc start command is taught) while the individual adjustment welding power supply is being used is calculated on the basis of the welding characteristic data. When this voltage is to be changed, adjustment is made by revising the welding characteristic data.

- When switching the voltage adjustment method

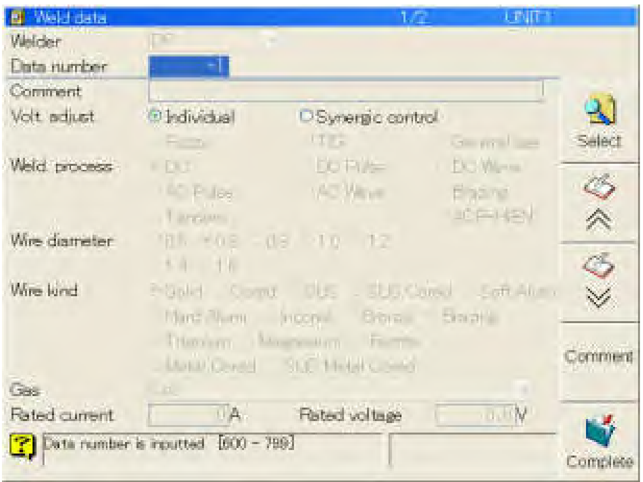
  There are two types of voltage adjustment method, namely "individual control" and "synergetic control", and they can be switched by revising the welding characteristic data.
  When the voltage adjustment method has been switched, the already taught arc start and arc end commands cannot be used. See "2.5.7 When the welding mode or voltage adjustment method was changed" and perform the correct steps.

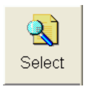
Revising the welding characteristic data

Before proceeding, switch the operator qualification level to ***EXPERT*** or above.

1 In teach mode, select f5 <Arc Constant> - [5 Weld data].

>> The characteristic data preparation screen now appears.

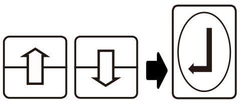




2 Place the cursor in the "Data number" field, and press f8 <Select>.

>> A table of the welding characteristic data now appears.

If the number of the data to be revised (the “***” part of $WTBD***) is already known, this number may also be input directly.



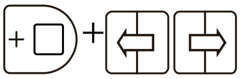
3 Align the cursor with the welding characteristic data to be revised using [up or down], and press [Enter].

>> The data stored in the selected welding characteristic data is called.

The screen shown above contains both data that can and cannot be revised. Any attempt to change data cannot be revised, these changes will not be accepted.

4 To edit the comment, align the cursor with the "Comment" field, and press f11 <Comment>.

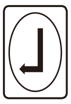
>> The comment can now be revised.
The soft keyboard starts up when [ENABLE] and [EDIT] are pressed together so make the changes to the characters.



5 For revising the data that can be changed.
Use [ENABLE] + [left or right] to revise the data.

6 To revise the welding characteristics, press f10 <Scroll page>.

>> The welding characteristic editing screen now appears.



7 Move the cursor to each point, and then input the value and press [Enter].

8 Lastly, press the f12<Complete>.

>> This completes the revision of the characteristic data.

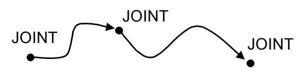
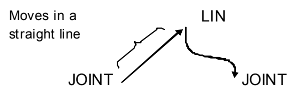
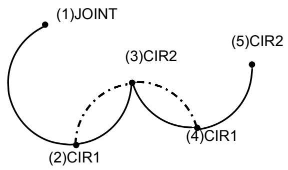
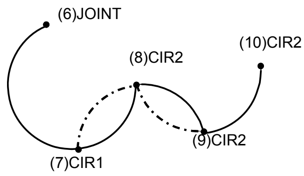
Teaching using the movement commands

Details on recording movement commands are described in "Teaching" in chapter 4 of the Basic Operation manual.
This section provides additional information that is required for arc welding.

Interpolation type

The operation methods used as far as the specified position and posture are called interpolation types, namely, joint interpolation, linear interpolation and circular interpolation. Select an interpolation type when recording a movement command.

Table 3.2.1 Interpolation type

Interpolation type	Path of tool nose movement		
Joint interpolation (JOINT)	General description	If the target step involves joint interpolation, the robot moves to the target step in such a way that the movement amount between each joint is at the minimum. The path of the tool tip is not controlled.	
	Application	Joint interpolation is recorded at a location where there is no need to weld. For instance, this location may be the section that the robot approaches the welding start point, or the section between the robot completed welding and return to the home point.	
	Speed	Specify the ratio (0 to 100%) to the maximum speed.	
Linear interpolation (LIN)	General description	If the target step involves linear interpolation, the tool tip moves in a straight line that connects the steps.	
	Application	Record it at the location where welding along a straight line is required.	
	Speed	Specify the movement speed (1 to 9999 cm/min.)	
Circular interpolation (CIR)	General description	If the target step involves circular interpolation, the tool tip moves along an arc.The CIR1 and CIR2 arcs are different. CIR1 An arc that connects the 3 points of the "current step", "target step" and "step after the target step". In the figure on the right, if the current step is (3) and the target step is (4), it is the arc that connects (3)-(4)-(5). CIR2 An arc that connects the 3 points of the "step before the current position step", "current position step" and "target step". In the figure on the right, if the current step is (8) and the target step is (9), it is the arc that connects (7)-(8)-(9).	 
	Application	Record this at a position where circular welding is required.	
	Speed	Specify the movement speed (1 to 9999 cm/min.) as the speed.	

POINT

Record a movement command in a welding section with a linear interpolation or circular interpolation

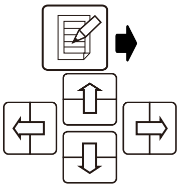
Record a movement command in a welding section with a linear interpolation (LIN) or circular interpolation (CIR1, CIR2).
During automatic operation (playback), the movement speed of the robot in the welding section is not the speed specified with the movement command, but rather the welding speed specified with the arc start command. However, when the movement command is a joint interpolation (JOINT), the robot operates with the speed specified with the movement command.

INFO.

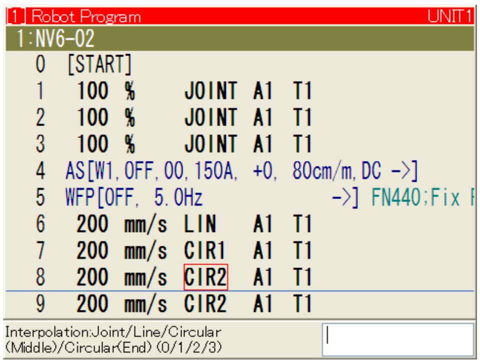
When recording a circular interpolation (CIR) movement command, CIR1 or CIR2 is recorded automatically according to the previous movement command. If the previous movement command is CIR1, the interpolation type of the recorded movement command is CIR2. In other cases, it is CIR1.

Revising the interpolation type of recorded movement commands

The interpolation type of a movement command that has already been recorded can be changed. When circular interpolation is set as the interpolation type of the movement command, CIR2 can be revised to CIR1.



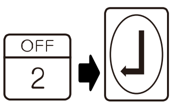
1 As an example, the procedure for changing CIR2 to CIR1 is described below. Select the screen editing function, and move the cursor to the interpolation type (CIR2 here) of the movement command to be revised.



The interpolation type identifiers and input values are as follows.

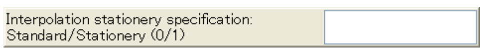
Table 3.2.2 Interpolation type

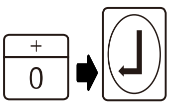
Step identifier	Guide message identifier	Input value
JOINT	OFF	0
LIN	Linear	1
CIR1	Circular (Middle)	2
CIR2	Circular (End)	3



2 Input the value in response the guide message that appears at the bottom of the screen.
Since circular (Middle) is displayed for CIR1, input “2” and press [Enter].

>> CIR2 is changed to CIR1, and the status in which the interpolation stationery specification is to be input is established.





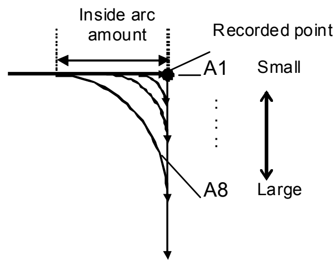
3 Input “0” that signifies the standard, and press [Enter].

>> CIR2 has now been changed to CIR1.

Stationary “1” is selected only when the torch has been defined as a “stationary tool”. Since a “stationary tool” is one which is used for special applications, standard “0” is set normally.
This is the same as when revising to linear interpolation (LIN).

Accuracy

This refers to the degree by which the path along which the tool tip travels 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 specified with a level from A1 to A8. When A1 is specified, the tool tip will pass through the recorded point. When A2 or above is specified, the playback time is reduced depending on how far the tool tip passes along an arc on the inside of the recorded points. Set a strict level (low) at welding points and a light level (high) at air cut portions.
This controller describes an inside arc even for successive steps whose interpolation types are different.



The operation control of robots related to the accuracy level differs depending on the application that is used.

When A1 to A8 is specified, the speed lapping ratio is set that varies in steps in a range of 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.)
Even when the playback speed is changed, the inside arc path is calculated so it will not affect the path. However, the actual inside arc amount may vary due to machine deflection or delays in servo control.
“When the playback speed is changed” is the speed change when using the speed override or low safety speed functions.

Accuracy level

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

INFO.

"Accuracy" is equivalent to "Overlap" of the DAIHEN robots in the EX-C series and earlier. "With overlap" can be used as A8 and "Without overlap" can be used as A1.

When preparing arc welding programs, the key points for setting accuracy are as follows.

- Increase the level for air cut portions where there is no fear of running into peripheral jigs.
- When moving in small areas where the robot could run into peripheral jigs, or in cases such as moving the torch to the torch cleaner, lower the level.
- When there are multiple straight line or circular arc steps in a welding section, increase the accuracy level at those points. This is because decreasing the level causes the speed to be reduced at each step, so it affects the welding quality. If the accuracy level is raised, then the robot will move smoothly without reducing speed at each step, so there is no affect on welding quality.

POINT

If the higher positioning accuracy at the recorded point is needed, use “A1P” (‘P’ means “Pause”).

Torch posture during welding

To obtain good welding results, teaching must be performed not only with the welding conditions to be set, but also with the appropriate torch posture and target position.

Torch angle

The torch angle is the angle between the vertical plate and welding torch. The torch angle and the target position in the case of horizontal fillet welds are classified into the following two kinds depending on the difference in their leg length.To obtain beads with equal leg lengths at high current, set the torch angle and tool center point as shown on the right in the figure below.

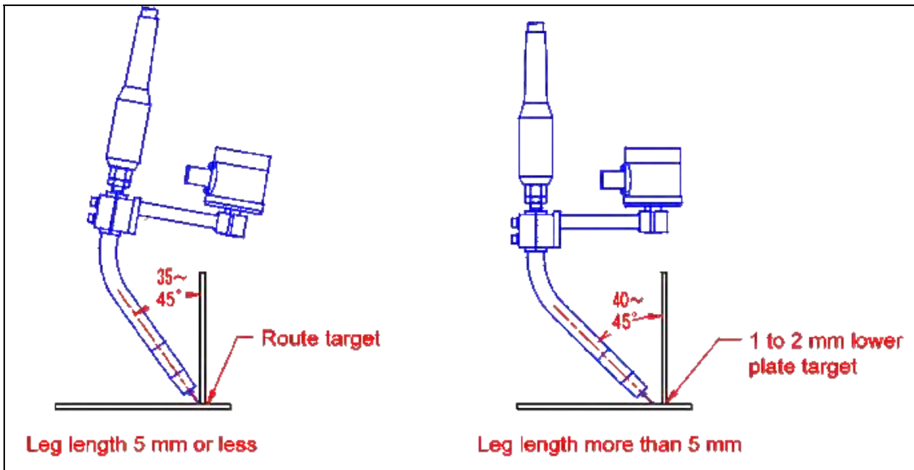


Fig. 3.2.1 Torch angle

Push and drag angles

Welding when the torch tilts in the opposite direction to the forward direction of welding is known as the push method, and the torch angle in this situation is known as the push angle. Conversely, welding when the torch tilts in the same direction as the welding direction is known as the drag method, and the angle in this situation is known as the drag angle.

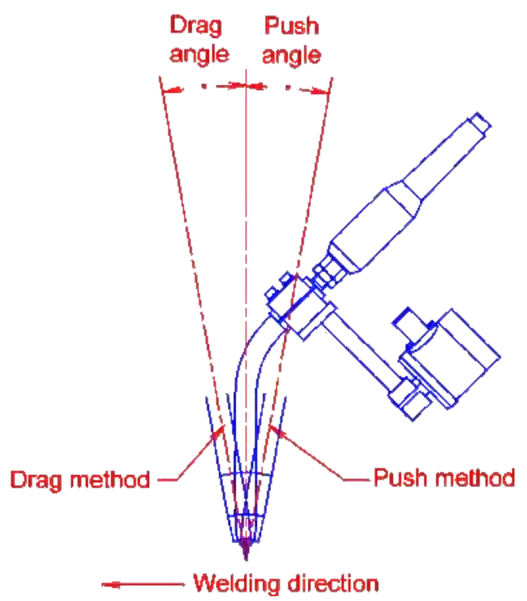


Fig. 3.2.2 Push and drag angles

Wire extension length

The wire extension length is the length from the contact tip to the tip of the welding wire. Although it differs depending on the level of the welding current which is set and the diameter of welding wire which is used, adjust it to 15 mm as a rough guide.

Teaching arc welding start/end commands

This section describes the arc welding commands and the conditions set with these commands.
For details on the teaching and operation methods for arc welding, refer to "Chapter 9 Basic arc welding operations" in the Basic Operation manual.
The following arc welding start and end commands are provided.

Table 3.3.1 Arc welding start/end command list

Command			Description
Name	SLIM identifier	FN code	
Arc welding start commands	AS	FN414	This command starts the arc welding. Even if the welding condition is changed during welding, this command is recorded in the changed position. The condition described in "3.3.1 Arc welding start conditions" is set for this command.
	ASV	FN665	In the same way as the AS command, this command starts the arc welding or changes the conditions during welding. The arc welding start condition is set by this command using the method described in "3.3.9 Designating a variable for the condition file number".
Arc welding end commands	AE	FN415	This command ends the arc welding. The condition described in "3.3.2 Arc welding end conditions" is set for this command.
	AEV	FN666	In the same way as the AE command, this command ends the arc welding. The arc welding end condition is set by this command using the method described in "3.3.9 Designating a variable for the condition file number".

POINT

About the arc welding start/end (variable) (ASV/AEV)

ASV and AEV are mainly used when changing the welding conditions with an external signal or for complex teaching using robot language.
When performing other types of welding, use AS and AE.

POINT

Changing conditions in a welding section

Even while in a welding section, if you record the arc welding start command (AS<FN414> or ASV<FN665>) in the position where you want to change the welding condition, the condition will be changed during welding.

Arc welding start conditions

The arc welding start conditions specified with the arc start command include special setting items provided for individual welding power supply models, and setting items common to multiple models.
This section describes typical setting items common to multiple models. For details on items special to individual welding power supply models, see the chapters shown in Table 3.3.2.

Table 3.3.2 Locations of detailed descriptions of welding conditions

Welding power supply used	Description location
Welbee Inverter series welding power supply	Chapter 4
D-series welding power supply	Chapter 5
All other welding power supplies (such as welding power supply interface)	Chapter 6

Table 3.3.3 Arc start control conditions

Setting item	Description
Welder	This is used to specify the target welding power supply when multiple welding power supplies are connected. This need not be set if only one welding power supply is to be used.
AS Cond. file	This is used to specify the welding condition file number to use in the arc start command. Condition file ID 0 : The welding conditions are set directly with the arc start command. A welding condition file is not used. Condition file ID 1 to 999 : The welding condition file of the specified number is used. ☞ ”3.3.3 How to set the arc welding conditions”
Retry No.	This is used to set the retry operations if an arc is not generated at the start of welding. Retry No. 0 : The standard internal arc retry operation is performed. Retry No. 1 to 99 : The arc retry operation is performed using the retry condition file of the specified number. ☞ “3.3.6 Arc retry”
Restart No.	This is used to set the restart (retry) operation if arc outage occurs during welding. Restart No. 0 : A restart operation is not performed. Restart No. 1 to 99 : The arc restart operation is performed using the retry condition file of the specified number. ☞ “3.3.7 Arc restart”
Welding process	This is used to select the welding method to use. The welding methods registered as welding characteristic data are displayed as selection choices.
Welding speed	This is the movement speed of the torch in the welding section.
Current cond.	This is used to select whether to specify the welding conditions with current or the wire feed speed.
Slope cond.	This is used to select the setting method for the slope control performed at the start of welding. Select whether to specify the slope control range with time (time specification) or distance (distance specification). ☞ “3.3.5 Slope control”
Welding control	Normally, fixed to "Standard". This condition can be set when optional software such as "Synchro MIG" is installed.
RS control	This is used to set the operation method for RS control. This condition can be set when the "RS control" optional software is installed and the "RS control" welding constant is set to "Enabled". OFF : RS control is not performed. ON : RS control is performed using the wire feeder.
RS No.	This is used to specify the condition file number for RS control. RS No. 0 : The standard internal RS condition is used. RS No. 1 to 999 : The RS condition file of the specified number is used.
Robot RS control	This is used to set the operation method for robot RS control. This condition can be set when the "Robot RS control" optional software is installed and the "Robot RS control" welding constant is set to "Enabled". OFF : RS control is not performed. Robot RS No. : RS control is performed with the robot using the robot RS condition file of the specified number. It is necessary to create the robot RS condition file in advance.
Robot RS cond. no.	This is used to set the robot RS condition file number to use in robot RS control.
Move cond. no.	This is used to specify the robot move condition at the start of welding and in the welding section with a file number. Details about the robot move condition number are described in "Chapter 7 Arc welding-related settings". Normally, “0” is set.

Table 3.3.3 Arc start control conditions

Setting item	Description
Gas flow control setting	This condition can be set when the "Gas flow control unit" of arc constant is set to "ON". For details, see the separate instruction manual for option [Gas saver GFC]. Disabled : The gas flow rate that is set in the welding characteristic data or welding constant is used. Enabled : The gas flow rate is set in the arc start condition.

Table 3.3.4 Arc start conditions

Item name	Setting range	Unit
Welding current (when current is the current condition)	1 to rating	A
Wire speed (when wire speed is the current condition)	1 to rating	cm/min.
Welding voltage (with separate adjustments)	0.1 to rating	V
Arc length tun. (with individual adjustment)	-100 ～ 100	—
Welding speed	1 ～ 999	cm/min.
Arc character.	-100 ～ 100	—
Gas flow rate *1	See below *1	L/min.
Slow down	100 to rating	cm/min.
Slope time (when time is the slope condition)	0.0 ～ 9.9	sec.
Slope distance (when distance is the slope condition)	0 ～ 99	mm
Initial current (when current is the current condition)	1 to rating	A
Ini. wire speed (when wire feed speed is the current condition)	1 to rating	cm/min.
Initial voltage (with individual control)	0.1 to rating	V
Initial arc length fine adjustment (with synergetic control)	-100～100	—

*1: For details on the gas flow rate and the input range for the gas flow rate, see the separate instruction manual for option [Gas saver GFC].

Arc welding end conditions

The arc welding end conditions specified with the arc end command include special setting items provided for individual welding power supply models, and setting items common to multiple models.
This section describes setting items common to multiple models. For details on items special to individual welding power supply models, see the chapters shown in Table 3.3.2.

Table 3.3.5 Arc end control conditions

Item name	Setting range
Welder	This is used to specify the target welding power supply when multiple welding power supplies are connected. This need not be set if only one welding power supply is to be used.
AS Cond. file	This is used to specify the welding condition file number to use in the arc end command. Welding condition file No. 0 : The welding conditions are set directly with the arc end command. A welding condition file is not used. Welding condition file No. 1 to 999 : The welding condition file of the specified number is used. “3.3.3 How to set the arc welding conditions”
Welding process	This is used to set which welding method to use for welding. The items displayed here are the welding methods registered as welding characteristic data.
Current cond.	This is used to select whether to specify the welding conditions with current or the wire feed speed.
Slope cond.	This is used to select the setting method for the slope control performed at the end of welding. Select whether to specify the slope control range with time (time specification) or distance (distance specification). “3.3.5 Slope control”

Table 3.3.6 Arc end conditions

Item name	Setting range	Unit
Welding current (when current is the current condition)	1 to rating	A
Wire speed (when wire speed is the current condition)	1 to rating	cm/min.
Welding voltage (with individual control)	0.1 to rating	V
Arc length tun. (with synergetic control)	−100 ～ +100	—
Crater time	0.0 ～ 9.9	sec.
Post-flow time	0.0 ～ 9.9	sec.
Arc characteristics	-100 ～ +100	—
Slope time (when time is the slope condition)	0.0～9.9	sec.
Slope distance (when distance is the slope condition)	0～99	mm
Robot stop time	0.0～9.9	sec.

How to set the arc welding conditions

The arc start commands and arc end commands have the following three methods available for setting the welding conditions.

<u>Method by which the welding conditions are specified directly using numerical values</u>

In this method, numerical values for the welding conditions are input directly into the arc start command and arc end command. In this case, specify "0" in "Condition file ID". This setting method is known as "direct input".
This can only be used in arc start command (AS <FN414>) and arc end command (AE <FN415>).

<u>Method by which the number of the file storing the welding conditions is specified directly</u>

In this method, the welding conditions are stored in a file in advance, and the number of this file is input directly into the arc start command and arc end command. In this case, specify the number of the condition file to be used in "AS Cond. file ". This setting method is known as "file designation".

<u>Method by which the number of the file storing the welding conditions is specified with a variable</u>

In this method, the welding conditions are stored in a file in advance, and the number of the condition file to use is input indirectly by using a variable in the arc start command and arc end command. This setting method is known as "variable designation".
This can only be used in arc start command (ASV <FN665>) and arc end command (AEV <FN666>).

“3.3.9 Designating a variable for the condition file number”

Table 3.3.7 Arc welding start/end commands and welding condition setting methods

Command			Welding condition setting methods		
Name	SLIM identifier	FN code	Direct input	File designation	Variable designation
Arc welding start commands	AS	FN414	○	○	×
	ASV	FN665	×	○	○
Arc welding end commands	AE	FN415	○	○	×
	AEV	FN666	×	○	○

○ Can be used
× Cannot be used

INFO.

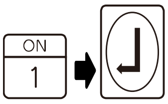
When welding multiple locations with the same welding conditions, it is useful to specify the welding conditions with a file number. By revising the contents of a welding condition file, you can change the welding conditions of all the arc start commands and arc end commands that specify this file number.

Creating new condition files and revising existing ones during teaching

When a number other than “0” is input in the “AS cond. file” field during arc welding command teaching, the conditions stored in the corresponding condition file that has already been created are called. If the number input corresponds to a file which has not yet been created, the initial conditions are called.
The condition file can be created or edited with f6<Arc Condition>, as described in "Chapter 9 Basic arc welding operations" in the Basic Operation manual. However, the called conditions can be immediately revised. When the revisions are made and then written, 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.

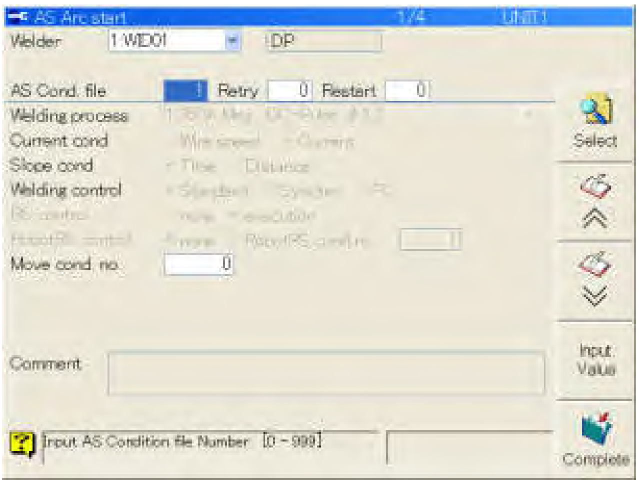
This operation is common to commands that specify conditions with a file, such as the arc start command, arc end command and weaving start command.

This section describes the method used to call and revise condition file “1” during teaching, using the arc start command (AS) as an example. (The same description applies when a new condition file “1” is created.)



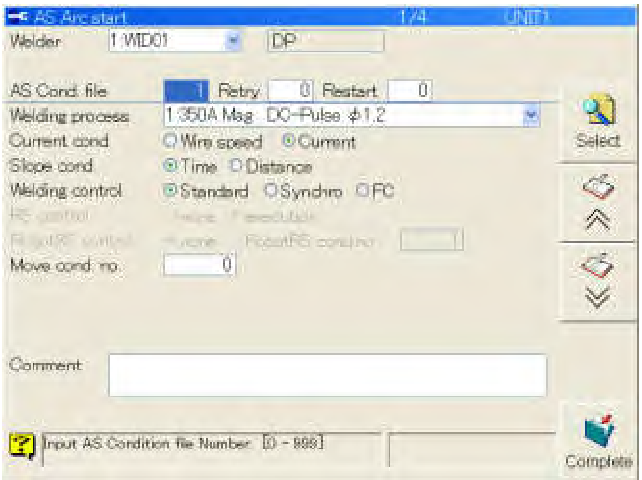
1 Input “1” in the “AS Cond. file” field, and press [Enter].

>> The conditions stored in condition file “1” are called. (If a new file is created, the initial conditions are called.) At the same time, the f key for [Input Value] is displayed in f11.



2 To revise the conditions, press f11 <Input Value>.

>> The status in which the conditions can be revised is now established.



3 Revise the conditions, and after finishing 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.

Arc welding condition guide function

The welding condition guide function uses the welding condition database to automatically set welding conditions suitable for the joint.
The welding conditions can be set automatically using the welding condition guide function if the welding condition database for the welding power supply and wire diameters being used is installed in the controller.
The welding condition guide function has the welding condition database shown in Table 3.3.8 loaded internally as standard. If any of Table 3.3.8 applies as the operating environment, the welding condition guide function can be used straight away.
If they do not apply, creating a new welding condition database will enable the welding condition guide function to be used. For details on creating a welding condition database, refer to “Chapter 7 Arc welding-related settings”.

Table 3.3.8 Standard internal welding condition database

<table>
<tr><th rowspan="2">Welding power units</th><th rowspan="2">Welding method</th><th rowspan="2">Gas</th><th colspan="2">Wire</th><th rowspan="2">Joint shape</th></tr>
<tr><th>Material</th><th>Diameter</th></tr>
<tr><td rowspan="18">Welbee Inverter series /D-series welding power supply</td><td>DC</td><td>CO_2</td><td>Solid mild steel</td><td rowspan="10">Φ0.8
Φ0.9
Φ1.0
Φ1.2</td><td rowspan="18">Horizontal fillet weld
Lap fillet weld</td></tr>
<tr><td>DC</td><td rowspan="3">MAG (80%Ar, 20%CO_2)</td><td rowspan="3">Solid mild steel</td></tr>
<tr><td>DC pulsed</td></tr>
<tr><td>DC wave pulsed</td></tr>
<tr><td>DC</td><td rowspan="3">MIG (98%Ar, 2%O_2)</td><td rowspan="3">Stainless steel solid</td></tr>
<tr><td>DC pulsed</td></tr>
<tr><td>DC wave pulsed</td></tr>
<tr><td>DC</td><td rowspan="3">MAG (90%Ar, 10%CO_2)</td><td rowspan="3">Ferrite*1</td></tr>
<tr><td>DC pulsed</td></tr>
<tr><td>DC wave pulsed</td></tr>
<tr><td>DC</td><td>CO_2</td><td>Mild steel cored</td><td>Φ1.0
Φ1.2</td></tr>
<tr><td>DC</td><td>CO_2</td><td>Stainless steel cored</td><td>Φ0.9
Φ1.2</td></tr>
<tr><td>DC</td><td rowspan="3">MIG (100%Ar)</td><td rowspan="3">Soft aluminum</td><td rowspan="3">Φ1.2
Φ1.6</td></tr>
<tr><td>DC pulsed</td></tr>
<tr><td>DC wave pulsed</td></tr>
<tr><td>DC</td><td rowspan="3">MIG (100%Ar)</td><td rowspan="3">Hard aluminum</td><td rowspan="3">Φ1.0
Φ1.2
Φ1.6</td></tr>
<tr><td>DC pulsed</td></tr>
<tr><td>DC wave pulsed</td></tr>
</table>

*1 A “Ferrite” indicates a ferritic stainless steel solid wire.

IMPORTANT

In some cases, it is not possible to use the above standard internal welding condition database as is.
The standard internal welding condition database in Table 3.3.8 contains values obtained under the test environment inherent to the manufacturer. Depending on the user’s operating environment, it may not be possible to use these values as is. In a case like this, revise the data in the welding condition database before operation.

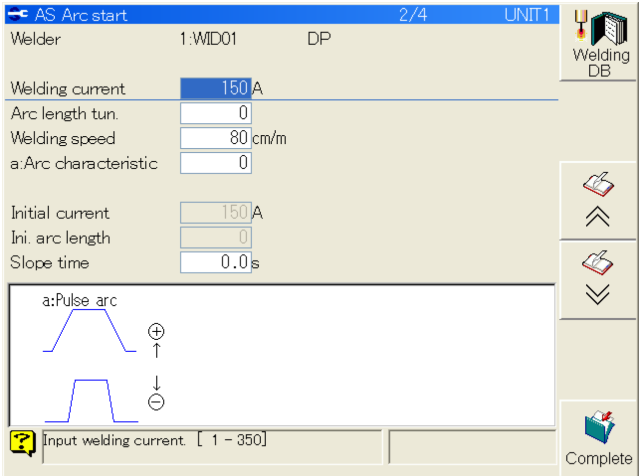
INFO.

When using WB-M350L/WB-M350/WB-M500 with characteristic data where the application in "Table 2.5.2.", “Table2.5.3.” and “Table2.5.4.” is "automatic machine", use a welding condition database.

Setting the conditions using the welding condition guide function

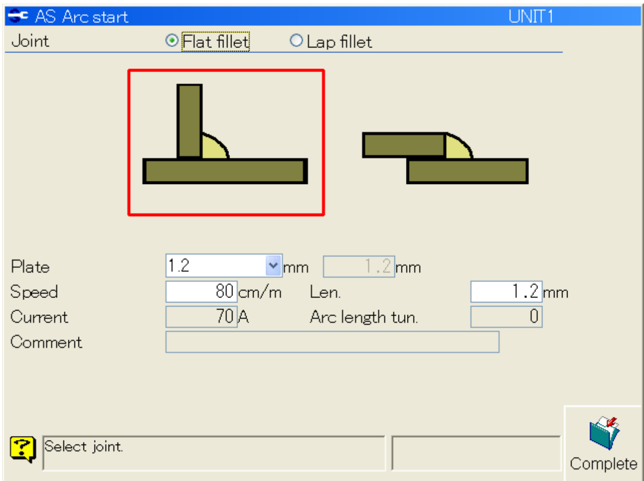
1 **Open the welding conditions editing screen.**

>> If a welding power supply is registered that can use the welding condition guide function, f7 <Welding DB> appears on the pages with welding current items.
The following screen shows the display for the DP-350.



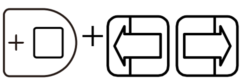
2 **Press f7 <Welding DB>.**

>> The following screen now appears.



If the following message is displayed, it means that there is no built-in welding condition database that corresponds to the welding method (welding characteristics data) to be used. If the welding condition guide function is to be used, it is necessary to create the welding condition database.

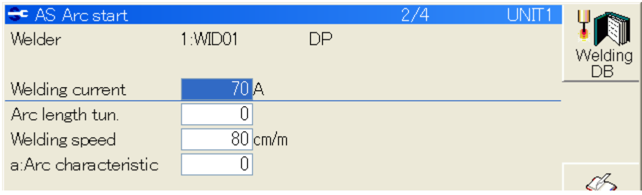
3 **Move the cursor to “Plate,” and then press [Enter] to specify the plate thickness of the workpiece.**



4 **Move the cursor to “Joint,” and then select the type of joint using [ENABLE] + [LEFT/RIGHT].**

5 **To change the calculated welding speed or leg length, input the desired value.**

6 **Press f12 <Complete>.**
>> The welding conditions are input automatically.



Slope control of arc welding conditions

Slope control changes the conditions (welding current, welding voltage) in a sloping form (gradually), instead of immediately changing welding conditions to the specified values. Slope control reduces abnormalities such as spatter and welding defects when starting welding or changing conditions. Slope control can be used at the start of welding, when changing conditions, and at the end of welding.

Slope control at the start of welding

As shown in the figure below, slope control is performed from the set initial welding conditions to the regular welding conditions.
You can specify the section in which to perform slope control using either distance or time.

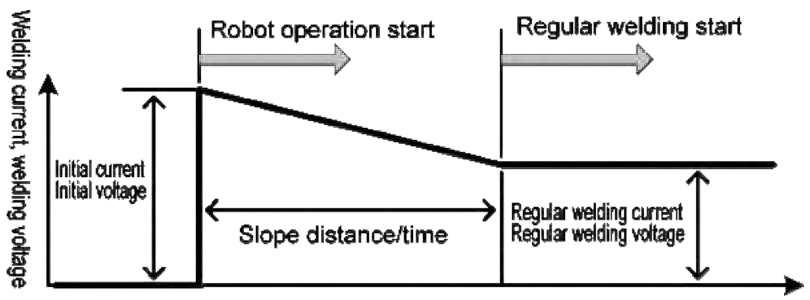


Fig. 3.3.1 Slope control sequence at the start of welding

Slope control when changing conditions

When changing conditions, slope control is performed from the conditions before the change to the conditions after the change.
The current and voltage are changed gradually from the conditions before the change to the conditions after the change. The initial current and initial voltage settings are not used when changing the conditions.

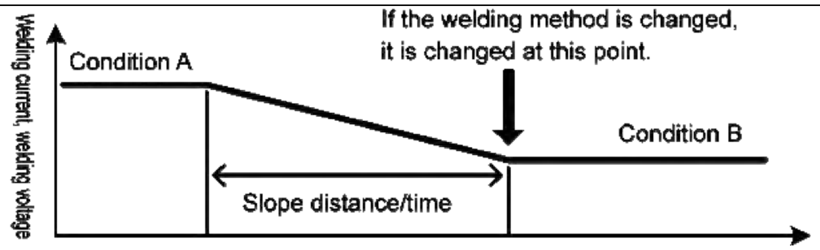


Fig. 3.3.2 Slope control sequence when changing conditions

POINT

If a welding command is executed again during slope control

If the arc end command is taught immediately after starting to weld, or welding conditions are changed at a short distance, the arc start command or end command will be executed during slope control. If this happens, slope control stops at the moment that the command is executed.

Slope control at the end of welding

At the end of welding, slope control is performed from the regular welding conditions to the crater conditions.
As shown in the figure below, slope control is performed of the welding current and welding voltage for the "Slope distance or time" + "Robot stop time".

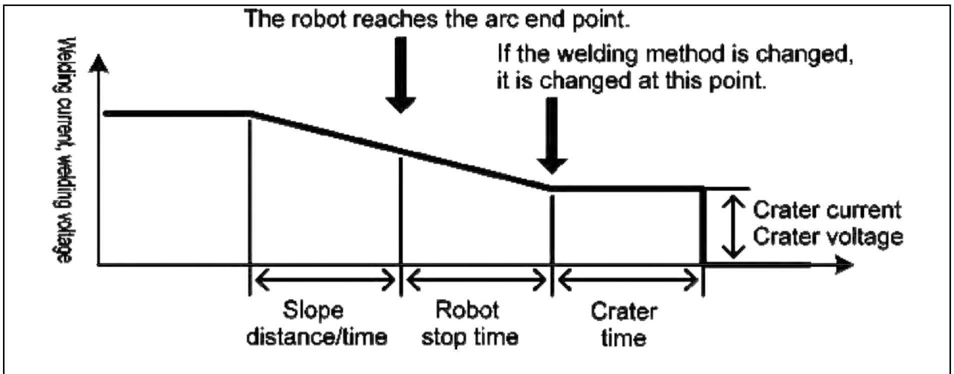


Fig. 3.3.3 Slope control sequence at the end of welding

POINT

Before performing the slope process, be sure to set the crater conditions

At the end of welding, slope control is performed from the regular welding conditions to the crater conditions. This means that even if the crater treatment is not required, the crater conditions (crater current, crater voltage) must be input in order to perform slope control.

About restrictions to the slope process at the end of welding

If the robot reaches the arc end point during slope control, the slope control stops and the crater treatment is entered.
This is because, although the maximum input value for the slope time (or distance) is 9.9 sec. (or 99 mm), during robot control, the movement time (or distance) from the step before the welding end to the welding end step is recognized as the maximum slope time (or distance).

Arc retry

Arc retry is an operation that tries arc start again after arc start fails. The following two methods are available for arc retry.

Table 3.3.9 Arc retry methods

Type	Specification method	Description
Standard internal	Specify 0 in the "Retry No." of the arc start command.	The retry operation available internally as standard is performed.
User defined	Specify the retry condition file number (1 to 99) in the "Retry No." of the arc start command.	If arc start fails, you can perform various retry methods, such as changing the arc start position or changing the retry operation with each retry. The retry method is defined in the retry condition file (RETRYARCW file).

This section describes the standard internal arc retry. For details on the user defined arc retries, refer to “7.4 Defining arc start” in “Chapter 7 Arc welding-related settings”.

In the standard internal arc retry operation, the robot initiates wire retract and slowdown at the corresponding position (arc start point). "Slowdown" is feeding the wire at a lower speed than the feed speed during welding while applying the voltage for generating the arc. If the arc is not generated even after repeating this operation the number of times set with the welding constant, the robot stops because of an arc start failure.
The welding constants related to the standard internal arc retry when using a robot-dedicated welding power supply are shown in the table below.

Table 3.3.10 Arc welding constants related to standard internal arc retry (robot-dedicated welding power supply)

Constant name	Setting range	Default	Significance
Arc start failure detection time	0.0 ～ 9.9	1.3 sec.	This is used to set the time taken to determine that arc start has failed. The wire is slowed down from the start of the arc start process to the specified time. If arc start fails to be performed in the specified time, the arc retry process is performed.
Arc start retry number	0 ～ 9	3 times	This sets how many retries are to be initiated if arc start was not successful.
Wire retract time	0.00 ～ 0.99	0.5 sec.	This sets the wire retract time. This parameter is used to make the adjustment if the wire has been retracted too far or too little.

POINT

Adjust the retract amount during arc retry using the arc welding constants
The retract amount during arc retry varies slightly depending on factors such as the feeder used and the feed path length. If the retract amount during arc retry is not appropriate for the inching amount at arc start, adjust the value of the welding constant [Wire retract time], for instance.

Arc retry does not work with scratch starts
The arc retry function does not work when scratch start has been set.

No need to create retry condition file 0
When “0” is specified as the number of the retry condition file, the standard internal arc retry is initiated. This means that there is no need to create a retry condition file with the number “0.”

Arc restart

Arc restart is the operation that retries arc start to restart welding after an arc outage has occurred during welding for some reason or other. Using this function prevents the robot from being stopped by an arc outage.
For the welding restart method of the arc restart operation, the same definition and same conditions as user defined arc retry conditions are used. Also, the three specification methods shown in the table below are available for arc restart.

Table 3.3.11 Arc restart specification methods

Setting type	Specification method	Description
Not used	Specify 0 in the "Restart No." of the arc start command, and specify 0 in the "Arc restart number for arc outage" of the welding constant.	A restart operation is not performed.
For individual welding sections	Specify the retry condition file number (1 to 99) in the "Restart No." of the arc start command.	Restart operations are performed with the specified restart conditions for each individual welding section. This has priority over the “For all welding sections” setting.
For all welding sections	Specify the retry condition file number (1 to 99) in the "Arc restart number for arc outage" welding constant.	A common restart operation is performed for all welding sections.

For details on arc restart, refer to “7.5 Specifying arc restart” in “Chapter 7 Arc welding-related settings”.

Robot movement condition file

These conditions are provided for optimizing the robot movement to suit the arc welding conditions. The parameters shown in Table 3.3.12 can be specified as the parameters of the AS commands.
For details, refer to “7.5 Robot movement condition file” in “Chapter 7 Arc welding-related settings”.

Table 3.3.12 Type of robot movement condition

Motion condition	Description
Chasing Level (0 to 3)	This parameter is used to enhance the ability of the robot to track commands values.
Smooth Level (0 to 3)	This parameter is used to make the robot operations smoother.
Accel Level (0 to 3)	This parameter is used to make the robot operation speeds smoother.
Smooth Level before AS (0 to 3)	This parameter is used to reduce the vibrations of the robot at arc start.

Teaching the weaving command

Weaving is used when there are gaps in the work piece or the leg length is to be shortened. Details on the teaching and operation methods for weaving are described in "Chapter 9 Basic arc welding operations" in the Basic Operation manual. This section describes the weaving commands and the conditions set with these commands.

To set up the robot for weaving, record the weaving start command where weaving is to start and the weaving end command where it is to end. The following weaving start and end commands are available.

Table 3.4.1 Weaving command list

Command			Description
Name	SLIM identifier	FN code	
Fixed pattern weaving start command	WFP	FN440	This is the command for weaving using the NV6 and other 6-axis robots. Weaving can be performed to match the groove shape by specifying the inclination angles, crosswise angles and other conditions.
Fixed pattern weaving start command (variable)	WFPV	FN667	This is the fixed pattern weaving start command. The weaving condition can be specified by a weaving condition file. There are alternatives whether to specify the condition file number directly by a number or to specify by a variable.
Joint weaving start command	WAX	FN441	This performs weaving using the simple harmonic motion of the axes.
Joint weaving start command (variable)	WAXV	FN668	This is the joint weaving start command. The weaving condition can be specified by a weaving condition file. There are alternatives whether to specify the condition file number directly by a number or to specify by a variable.
Taught weaving start command	WSF	FN442	This is the command for starting the weaving using the pattern which was taught in advance in accordance with the groove shape. However, taught weaving is an option and, as such, it is not described in this chapter. Refer to the separate instruction manual for option "Taught Weaving."
Weaving end command	WE	FN443	This is the command for ending the weaving.

POINT

Changing the conditions in a weaving section

To change the conditions during weaving, record a weaving start command of the same type again in the position where you want to change the conditions. If the weaving command is of the same type, the phase direction is continued even if a condition is changed. (It is not continued if the weaving command is of a different type.)

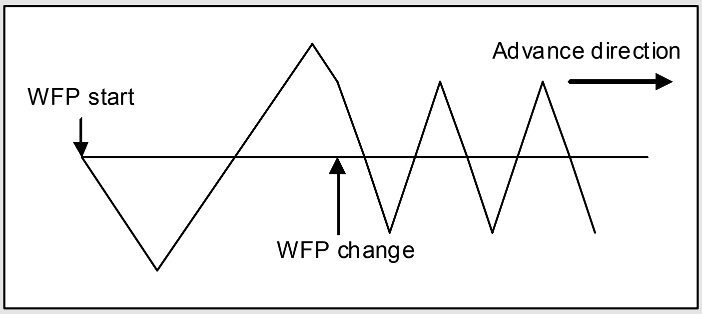


Fig. 3.4.1 Continuation of phase when conditions are changed

Fixed pattern weaving

This command is used to start weaving using a predetermined pattern in accordance with the specified amplitude and frequency.
The following conditions are set.

Table 3.4.2 Fixed pattern weaving conditions

Item	Setting range	Default	Unit
Frequency	0.0 ～ 20.0	5.0	Hz
Function type	Linear function / Sine wave / Circle	Linear function	―
Amplitude (right amplitude, left amplitude) * When the linear function or trigonometric function has been set as the operation pattern	0.0 ～ 50.0	1.0	mm
Radius (right radius, left radius) * When the arc has been set as the operation pattern	0.0 ～ 50.0	1.0	mm
Stopping time (center, 1/4 period, 3/4 period)	0.0 ～ 9.9	0.0	sec.
Move at stop time	ON / OFF	ON	―
Keep weaving time	Yes / no	No	―
Weaving start direction	Right / Left	Right	―
Weaving Angle (right angle of inclination, left angle of inclination)	-180 ～ 180	0.0	deg
Torch Angle (right angle of inclination, left angle of inclination)	-180 ～ 180	0.0	deg
Push Angle (right crosswise angle, left crosswise angle) * When the linear function or trigonometric function has been set as the operation pattern	-180 ～ 180	0.0	deg
Circle ratio (front roundness ratio, back roundness ratio) * When the arc has been set as the operation pattern	1 ～ 100	100	%

Frequency

This is the weaving frequency (number of waveforms per second).

Function type

One of the following can be selected as the weaving operation pattern (waveform).

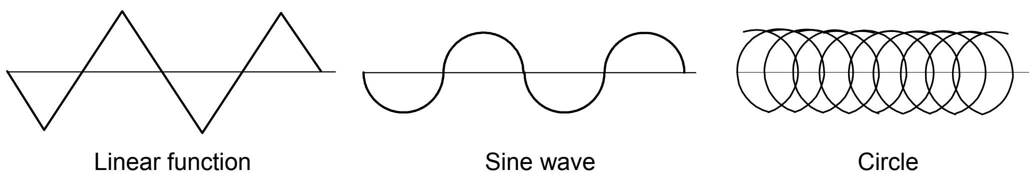
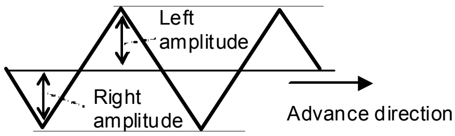


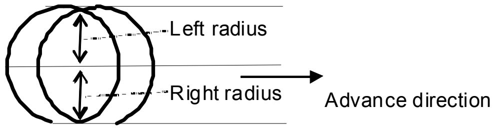
Fig. 3.4.2 Weaving operation patterns

Amplitude and radius

This condition is for setting the weaving amplitude when the linear function or trigonometric function has been set as the operation pattern. Both the left and right amplitudes relative to the advance direction can be set.
The radius from the center of the circle is set when the circle has been set as the operation pattern. Both the left and right radius relative to the advance direction can be set.



When the linear function or trigonometric function is set



When the circle is set

Fig. 3.4.3 Amplitude

Stopping time

The center stop time, 1/4 period stop time and 3/4 period stop time are set.

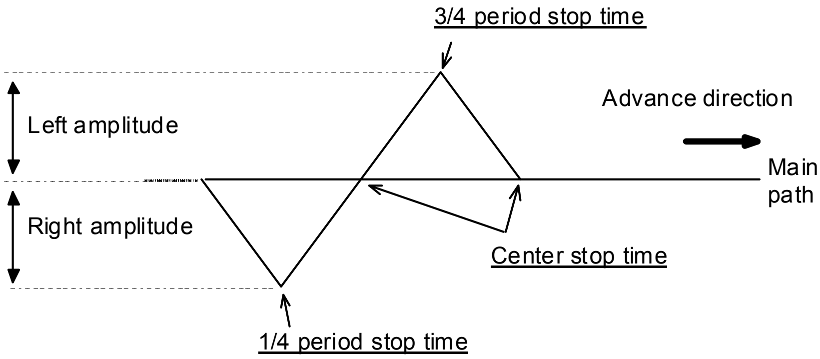
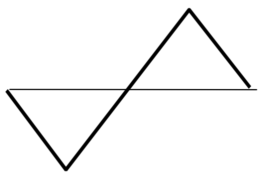


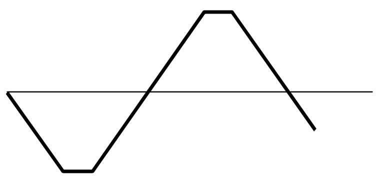
Fig. 3.4.4 Stopping time

Move at stop time

This condition is for selecting whether the robot is to move forward in the advance direction or stop during the weaving stop time when weaving stop time has been set. The default setting is “ON”.



When the advance at stop time has been set to "Not Exist"



When the advance at stop time has been set to "Exist"

Fig. 3.4.5 Forward movement during stop time

Keep weaving time

The condition is for setting whether the actual welding time is to be maintained even when the weaving stop time has been set.
If the weaving stop time is not set, the condition will not have any function.

IMPORTANT

- Setting the Keep weaving time to 'Keep', the movement speed of the robot becomes larger than the welding speed taught in advance according to the setting of the weaving stop time.
- When setting the weaving ON/OFF to 'OFF', the weaving control is not executed, however the movement speed of the robot is the same as the case with the weaving set to 'ON'.

Weaving start direction

This condition is for setting whether the weaving is to start on the right or left relative to the advance direction. Right is the default setting, and weaving starts from the right side relative to the advance direction.

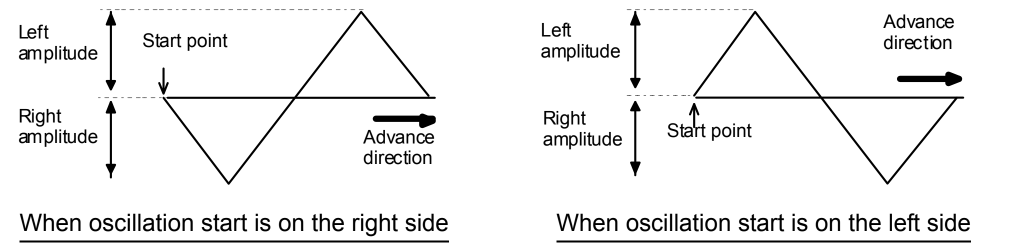


Fig. 3.4.6 Phase when started (oscillation start direction of weaving)

Weaving angle

This condition is for setting angle of the weaving from the main path. It can be set for both the left and right amplitude. The initial value is 0 degrees, and the weaving plane is perpendicular to the torch.

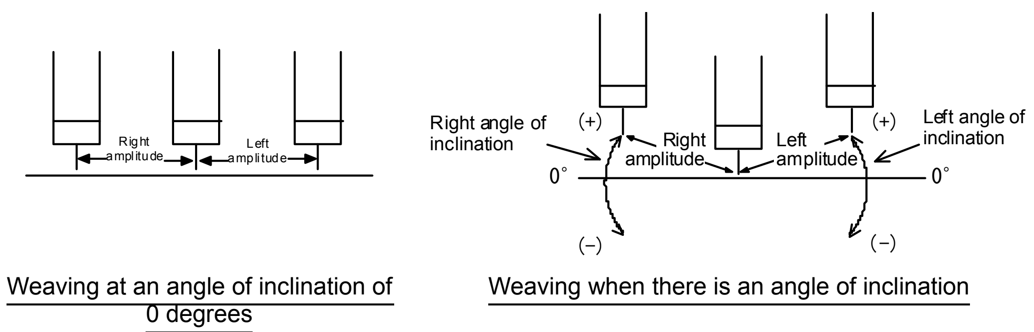


Fig. 3.4.7 Weaving angle

Torch angle

When the angle of inclination of the torch is set, this condition makes it possible to determine the welding posture in respect of the work piece surface at the weaving end point.

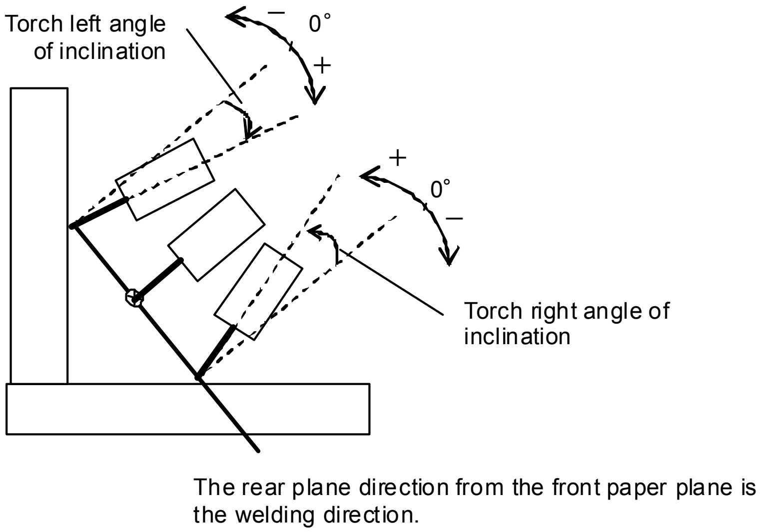


Fig. 3.4.8 Torch angle

Crosswise angle

When the crosswise angle is set, this enables a change into a waveform such as the one shown in the figure below.
However, when the crosswise angle is set, the amplitude is tilted in the advance direction and is thus shortened. If, for instance, the angle is set to −45 degrees, the amplitude will be about 70% of what it would be if the angle were 0 degrees.

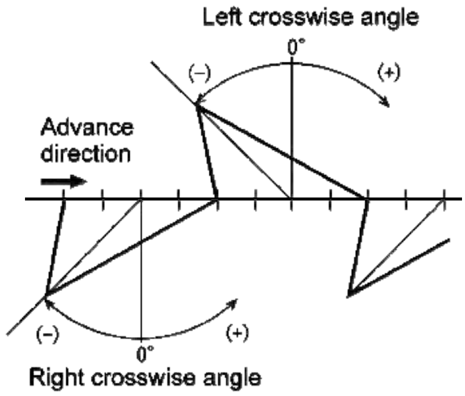


Fig. 3.4.9 Crosswise angle

Circle center ratio

The roundness ratio is set when arc has been set as the operation pattern. This ratio is for determining the percentage of the advance direction components to be reflected in the arc radius (for determining to what extent the arc is to be distorted).

The circle will be completely round if, for instance, it is assumed that the circle in Fig. 3.4.10 has:
• A left radius and right radius of the same length
• A front roundness and back roundness of 100%
(Perfect circles are formed in cases where weaving is performed immediately. Normally, they are not formed since the speed component of the advance direction is added.)

The center circle ratio is what determines the extent to which the arcs are to be distorted in the advance direction.
The circle shown in Fig. 3.4.11 will be formed if 50% is set as the front roundness ratio and 75% as the back roundness ratio.

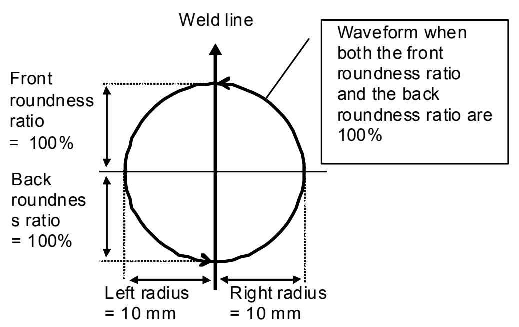


Fig. 3.4.10 When the front roundness ratio and back roundness ratio are 100%

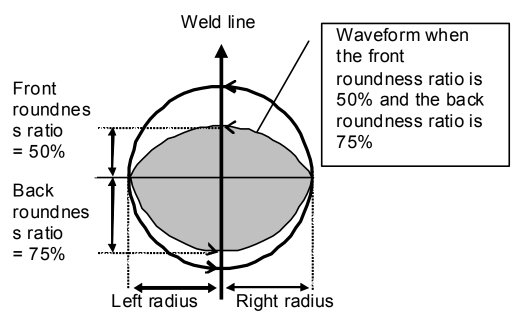


Fig. 3.4.11 When the front roundness ratio is 50% and the back roundness ratio is 75%

Joint weaving

This command is used to start weaving using the simple harmonic motion of the axes.
The following conditions are set.

Table 3.4.3 Joint weaving conditions

Item	Setting range	Unit
Frequency	0.0 ～ 20.0	Hz
Stopping time (center, 1/4 period, 3/4 period)	0.0 ～ 9.9	sec.
Move at stop time	ON/OFF	—
Keep weaving time	Yes/no	—
Axis number	1 ～ 6	—
Amplitude (right amplitude, left amplitude)	0.0 ～ 9.99°	deg

Axis number

This condition specifies the number of the axis which will be used to conduct the weaving.

Other items

Refer to "3.4.1 Fixed pattern weaving".

Weaving end command

This command is used to end the weaving while it is being executed.
Operation returns to the main path if it is midway through a weaving waveform.

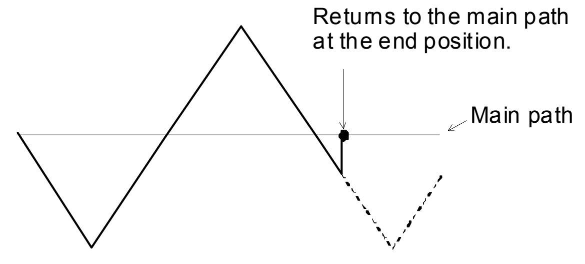


Fig. 3.4.12 Weaving end

How to set the weaving conditions

With the weaving start command, “the conditions under which weaving is to be performed in the section concerned” are set. These conditions are known as the weaving conditions.
The following methods of setting the weaving conditions are provided.

<u>Method by which the weaving conditions are specified directly using numerical values</u>

In this method, numerical values for the weaving conditions are input directly into the weaving start command. In this case, specify "0" in "Weaving condition file ID". This setting method is known as "direct input".

<u>Method by which a file specifying the weaving conditions is created beforehand and its number is specified</u>

In this method, the weaving conditions are stored in a file in advance, and the number of this file is input directly into the weaving start command. In this case, specify the number of this file in "Condition file ID". This setting method is known as "file designation".

<u>Method by which the number of the file specifying the weaving conditions is specified with a variable</u>

In this method, the weaving conditions are stored in a file in advance, and the number is specified indirectly by using a variable as the number of this file in the weaving start command. This setting method is known as "variable designation".
This can only be used for fixed pattern weaving start command (WFPV<FN667>) and the joint weaving start command (WAXV<FN668>).

Table 3.4.4 Weaving start commands and weaving condition setting methods

Command			How to set the weaving conditions		
Name	SLIM identifier	FN code	Direct input	File designation	Variable designation
Fixed pattern weaving	WFP	FN440	○	○	×
	WFPV	FN667	×	○	○
Joint weaving	WAX	FN441	○	○	×
	WAXV	FN668	×	○	○
Taught weaving*1	WSF	FN442	*1	*1	*1

○ Can be used
× Cannot be used
∗1 Refer to the separate instruction manual for option “Taught Weaving.”

INFO.

- When welding multiple locations with the same weaving conditions, it is useful to specify the weaving conditions with a file number. By revising the contents of a weaving condition file, you can change the weaving conditions of all the weaving start commands that specify this file number.
- In the same way as arc welding commands, you can create new condition files and revise existing ones during the teaching of a weaving start command. For details, refer to "3.3.1 Arc welding start conditions" in "Chapter 3 Preparing arc welding programs".

Teaching other arc welding commands

In addition to the arc start command and arc end command, the following arc welding commands are also available.

Table 3.5.1 Arc welding start/end command list

Command			Description
Name	SLIM identifier	FN code	
Inching command	ICH	FN410	This is used to inch (forward feed) the welding wire. "3.5.1 Inching command/retract command"
Retract command	RTC	FN411	This is used to retract (reverse feed) the welding wire. "3.5.1 Inching command/retract command"
Gas ON command	GS	FN412	This is used to discharge the shielding gas. "3.5.2 Gas ON command/gas OFF command"
Gas OFF command	GE	FN413	This is used to stop the discharging of the shielding gas. "3.5.2 Gas ON command/gas OFF command"

Inching command/retract command

The inching command (ICH command) and retract command (RTC command) are used for inching and retracting the wire during automatic operation.
The following conditions are set for both these commands.

Table 3.5.2 Setting conditions for the inching and retract commands

Condition to set	Setting range	Unit
Time	0.0 ～ 9.9	sec.
Wire feed speed	1 ～ 9999	cm/min.

POINT

<u>About the inching and retract amounts</u>

The inching and retract amounts are determined by the relationship between the time and speed described above.

<u>A robot does not stop while executing inching or retract.</u>

The movement of the robot does not stop while an inching or retract command is being executed.
Also, if an arc start command is taught immediately after an inching or retract command is executed, the welding starts after the inching or retract is completed.

<u>Sometimes inching or retract may not be executed</u>

In the following cases, inching and retract commands are not executed.

- When welding ON/OFF is set to OFF
- When in a welding section *1
- When operation was temporarily stopped and restarted while inching or retract was being executed

*1: The retract command for the filler wire in DA-300P is executed even when in the welding section.

Gas ON command/gas OFF command

Gas ON command

The gas can be output by recording the gas ON command (GS command). This is useful for situations such as when you want to start the welding gas pre-flow at a time of your own choosing. If automatic operation is temporarily stopped while gas is being output due to the gas ON command, the gas output is stopped, but when the operation is restarted, the gas output is also executed again.

Gas OFF command

The gas can be stopped by recording the gas OFF command (GE command). This is useful for situations such as when you want to stop the gas output with the gas ON command, or when you want to stop the welding gas post-flow at a time of your own choosing.

POINT

Sometimes gas output may not be executed

In the following cases, gas output is not executed.

- When welding ON/OFF is set to OFF
- When in a welding section

Continuing the gas output even after an END command

To continue the gas output even after an END command, in [Arc constant] - [3 Constant of Weld], set [Stop welder at END] to "OFF".
At this time, you can use the operations described in Table 3.5.3 to continue the gas output even after the END command.

Table 3.5.3 Gas output after END command

Setti method	Description
Arc end command (AE command)	Stops the gas output after the execution of the post-flow of the arc end command. It continues until the time specified in [Arc constant] - [3 Constant of Weld] - [Gas off delay time]. The gas output is not stopped with the END command.
Gas ON command (GS command)	The gas output is not stopped automatically. The gas output continues until the following. • Gas OFF command (GE command) • AS command is executed • Emergency stop

Useful function commands

This section gives a simple description of the function commands in Table 3.6.1, which are useful when preparing arc welding programs. For details on function commands not described in this section, refer to the internal help of the robot controller.

Table 3.6.1 Useful function commands

Classification	Name	Identifying abbreviation	Function number	Function	Reference page
Comment	Comment	REM	FN99	This attaches a comment inside a program.	3-30
Timer	Timer	DELAY	FN50	Operation stands by for the specified time.	3-30
External input/ output	Output signal ON	SET	FN32	The specified output signal is set to ON.	3-32
	Output signal OFF	RESET	FN34	This sets the specified output signal to OFF.	3-32
	Output signal ON/OFF	SETM	FN105	This sets the specified output signal to ON or OFF.	3-33
	Output signal (pulsed, with delay)	SETMD	FN35	This sets the specified output signal to ON for a specific period of time only. The delay time can also be specified.	3-33
	All output signals clear	ALLCLR	FN0	This sets all the output signals to OFF.	3-34
	Input signal wait (positive logic)	WAITI	FN525	This waits for the specified input signal to be set to ON.	3-34
	Input signal wait (negative logic)	WAITJ	FN526	This waits for the specified input signal to be set to OFF.	3-35
Program branch inside program	Step jump	JMP	FN20	This jumps to the specified step.	3-36
	Step jump (conditional)	JMPI	FN23	This jumps to the specified step if the input signal is ON.	3-37
	Step jump (with count condition)	JMPN	FN26	This jumps to the specified step after the command has been executed for the specified count.	3-38
Program call	Program call	CALLP	FN80	This calls other programs.	3-39
	Program call (conditional)	CALLPI	FN81	This calls the specified program if the input signal is ON.	3-40
	Program call (with count condition)	CALLPN	FN82	This calls the specified program after the command has been executed for the specified count.	3-41

IMPORTANT

Including the above function commands, all the function commands relevant to I/O signals cannot use the signals allocated to the dedicated I/O signals.
If the signals allocated to the dedicated I/O signals are to be placed as the condition for the branch command or signal wait command, it lapses into the conditional failures without exception.

Comment - [REM<FN99>] -

Function This command is used to write a comment inside the program.

Alphanumerics, symbols, hiragana, katakana and kanji can be input using the software keyboard. (Hiragana, katakana and kanji can be input only when the Japanese language specifications are provided.)
Up to 199 half-size (or 99 full-size) characters can be input.

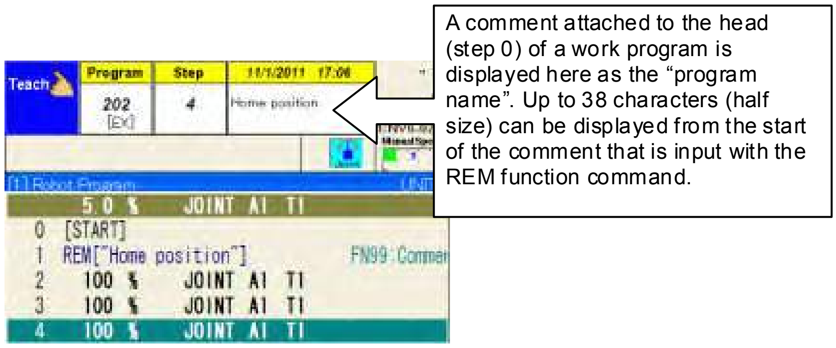
Selection method [FN] → [9] [9] → [Enter]

Parameters Any character string (with up to 199 half-size or 99 full-size characters)

Point

(1) A comment written at the head (step 1) of a task program is treated specially as the "program name", and it appears on the program list display using short-cut R17 or status window at the top of the screen.

[Example] Comment displayed on status window



(2) Comments may be recorded at any position in task programs. In addition, any number of comments may be recorded.

Timer - [DELAY<FN50>] -

Function Operation stands by immediately for the time specified by the robot. During standby, the robot remains stationary at the position recorded immediately before the timer command.

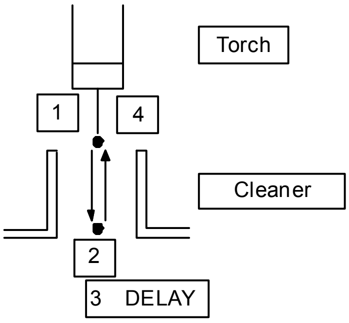
Selection method [FN] → [5] [0] → [Enter]

Parameters Standby time (0 to 60 sec.)

Point The timer command can be used in the following ways.

Torch cleaning

When the torch is to be cleaned, teach this command so that the robot will stand by for the time required by cleaning after the torch has moved by linear interpolation as far as the inside of the cleaner.

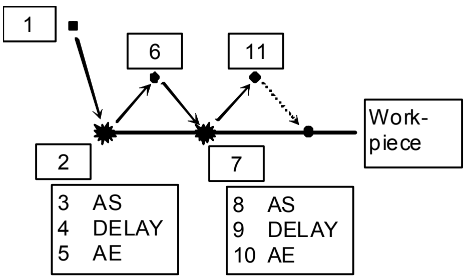



```
1    100 %      JOINT  A1  T1
2   60.0 mm/s   LIN    A1  T1
3  DELAY[2]                     FN50:Timer
4   60.0 mm/s   LIN    A1  T1
5    100 %      JOINT  A1  T1
```

Fig. 3.6.1 Example of teaching the timer command for torch cleaning

Tack welding

When tack welding is to be performed, teach the timer command so that it is sandwiched between the arc start and arc end commands.




```
1    100 %      JOINT  A1  T1
2    100 %      JOINT  A1  T1
3  AS[W1,OFF,00,150A, +0, 80cm/m,DC ->]
4  DELAY[1]                        FN50:Timer
5  AE[W1,OFF,150A, +0,0.0s,0.0s,DC ->]
6    100 %      JOINT  A1  T1
7    100 %      JOINT  A1  T1
8  AS[W1,OFF,00,150A, +0, 80cm/m,DC ->]
9  DELAY[1]                        FN50:Timer
10 AE[W1,OFF,150A, +0,0.0s,0.0s,DC ->]
11   100 %      JOINT  A1  T1
```

Fig. 3.6.2 Example of teaching the timer command for tack welding

Weaving during timer time

If there are places where deep penetration is desired while thick sheets are being welded, teach the timer command so that welding is executed immediately while weaving is conducted for the specified time. In this case, the following must be taught to determine the operation direction of the weaving.

```
2   200 mm/s  LIN    A1  T1
3  AS[W1,OFF,00,150A, +0, 80cm/m,DC ->]
4  WFP[OFF, 5.0Hz              ->] FN440:Fix
5  DELAY[3]                        FN50:Timer
6  WE                              FN443:Weav
7  AE[W1,OFF,150A, +0,0.0s,0.0s,DC ->]
8   100 %      JOINT  A1  T1
9   100 %      JOINT  A1  T1
```

To determine the weaving direction, teach the movement command (linear interpolation) for the direction to the welding location. It doesn't matter if the distance is short.

Fig. 3.6.3 Example of teaching the timer command during weaving within timer time

Output signal ON - [SET<FN32>] -

Function

This command is used to set any one of the general-purpose output signals (O1 to O2048) to ON.

However, it cannot be used to set a status signal (a gun signal, starting signal or other signal whose application has been pre-allocated) to ON.

Selection method

[FN] → [3] [2] → [Enter]

* The command can be selected by a single action if the [Output] key on the teach pendant is used.

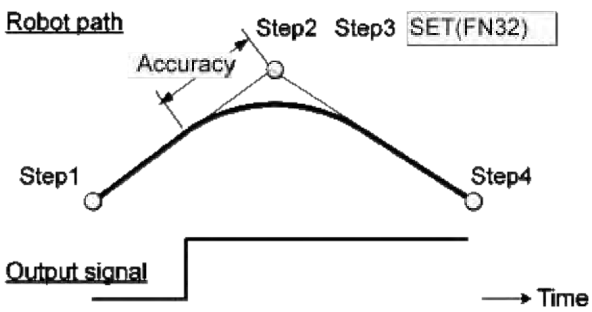
Parameters

Output signal number (1 to 2048)

Point

As in steps 2 and 3 in the figure below, the signal is output as soon as the inside arc is started if the accuracy level (inside arc) has been specified using a movement command immediately before this function command.

If the timing at which the signal is to be output must be exactly at the position (step 2), where the movement command is recorded, the command must be taught in such a way that the accuracy level is set to A1 or positioning is to be performed so that the tool will not describe an inside arc.



Output signal OFF - [RESET<FN34>] -

Function

This command is used to set any one of the general-purpose output signals (O1 to O2048) to OFF.

However, it cannot be used to set a status signal (a gun signal, starting signal or other signal whose application has been pre-allocated) to OFF.

Selection method

[FN] → [3] [4] → [Enter]

Parameters

Output signal number (1 to 2048)

Point

Same as for output signal ON (SET <FN32>).

Output signal ON/OFF - [SETM<FN105>] -

Function

This command is used to set any one of the general-purpose output signals (O1 to O2048) to ON and OFF.

However, it cannot be used to set a status signal (a gun signal, starting signal or other signal whose application has been pre-allocated) to ON.

Selection method

[FN] → [1] [0] [5] → [Enter]

Parameters

(1) Output signal number (1 to 2048)
(2) ON/OFF (1/0)

Point

Same as for output signal ON (SET <FN32>).

Output signal ON/OFF (pulsed, with delay) - [SETMD<FN35>] -

Function

This command is used to set any one of the general-purpose output signals (O1 to O2048) to ON or OFF. It can also specify a pulsed output, advance output or delayed output.

However, it cannot be used to set a status signal (a gun signal, starting signal or other signal whose application has been pre-allocated) to ON and OFF

Selection method

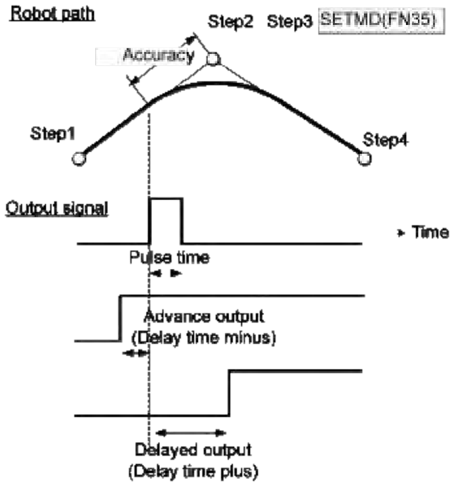
[FN] → [3] [5] → [Enter]

Parameters

(1) Output signal number (1 to 2048)
(2) ON/OFF (1/0)
(3) Delay time (–10.0 to 10.0 [sec.])
If "0.0" is specified as the time, the command is executed at the timing which coincides with the recorded position. If a minus value is specified, the command is output ahead of the original execution timing by the amount equivalent to the delay time setting. Conversely, if a plus value is specified, it is output after the timing by the amount equivalent to the delay time setting.
(4) Pulse time (0.0 to 10.0 [sec.])
This is set when the output signal is to be output as a pulse signal. It is used to specify the width of the pulse signal. When "0.0" is specified as the time, a level signal is output.

Point

When advance output or delayed output has been specified, it can be output astride the immediately preceding movement command (step 1 in the figure below) or immediately subsequent movement command (step 4 in the figure below).



All output signals clear - [ALLCLR<FN0>] -

Function

This command is used to set all the general-purpose output signals (O1 to O2048) to OFF.

However, it cannot be used to set a status signal (a gun signal, starting signal or other signal whose application has been pre-allocated) to OFF.

Whether it has been allocated to a status signal can be ascertained on the monitor screen. Signals whose numbers are in bold italics are status signals, and so the command sets all other signals to OFF.

Selection method

[FN] → [0] → [Enter]

Parameters

OFF

Point

Same as for output signal ON (SET <FN32>).

Input signal wait (positive logic) - [WAITI<FN525>] -

Function

This command is used to cause the robot to stand by until one of the specified general-purpose input signals is set to ON.

It is not possible to wait for a status signal (a signal such as the welding finish signal and start signal whose application has already been assigned). Whether it has been allocated to a status signal can be ascertained on the monitor screen. Signals whose numbers are displayed in the bold italics are status signals so any of the other signals can be awaited.

Selection method

[FN] → [5] [2] [5] → [Enter]

* The command can be selected by a single action if the [Input] key on the teach pendant is used.

Parameters

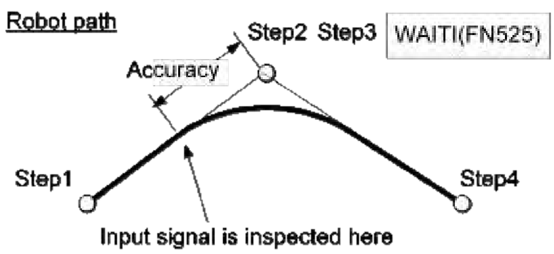
Input signal number (1 to 2048)

Point

When the inside arc has been set by the movement command immediately before this function command, the input of the signal is checked at the timing at which the inside arc is started.

If the signal has been input, the robot describes the inside arc straight away with no deceleration.

If the signal has not been input, the robot moves to the position where the movement command is recorded, and then the signal input is checked.



Input signal wait (negative logic) - [WAITJ<FN526>] -

Function	This command is used to cause the robot to stand by until one of the specified general-purpose input signals is set to OFF. It is not possible to wait for a status signal (a signal such as the welding finish signal and start signal whose application has already been assigned).
Selection method	[FN] → [5] [2] [5] → [Enter]
Parameters	Input signal number (1 to 2048)
Point	Same as for input signal wait (positive logic).

Step jump - [JMP<FN20>] -

Function

This command is used to jump unconditionally to a step which has been specified in the same program.
It makes no difference whether the jump destination step is a movement command or function command. However, bear in mind that if the jump destination step is a function command, the function command at the jump destination will be executed as soon as the step jump command is executed.
Use JMPI <FN23> to jump in accordance with the input signal status, and use JMPN <FN26> to jump after the command has been executed for the specified count.

Selection method

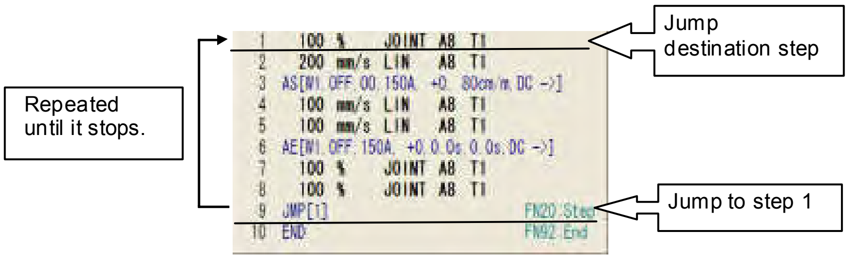
[FN] → [2] [0] → [Enter]

Parameters

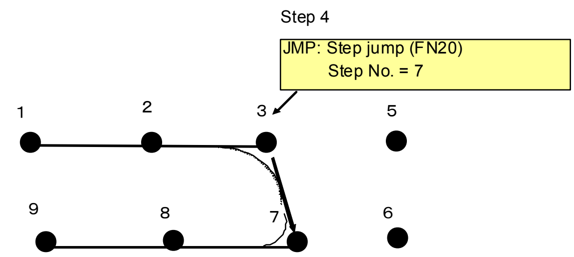
Step number (1 to 9999)

Point

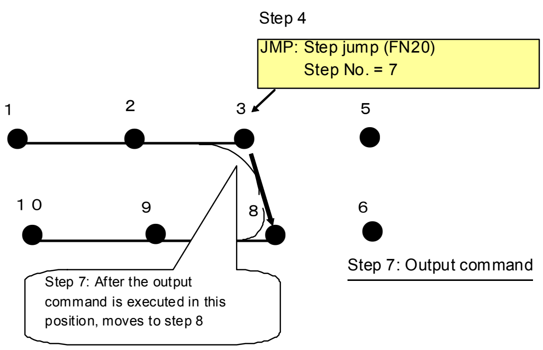
(1) Teach as follows when a program is to be repeatedly played back using the step jump command.



(2) When the step jump command is taught midway through a program as below, the subsequent steps will not be executed. In the case of the figure below, steps 5 and 6 will not be executed.



(3) If the jump destination step is a function command, the function command at the jump destination will be executed as soon as the step jump command is executed.



(4) Even when the jump destination step has shifted because a command was added or deleted, the jump destination step number specified by the step jump command will be followed. (If the jump destination step prior to a revision was 2 but it then became 1 due to a deletion, the number of the jump destination step number will change from 2 to 1.)

Step jump (conditional) - [JMPI<FN23>] -

Function

This command is used to jump to a step which was specified in the same program in accordance with the input signal status.
If the specified input signal is ON, the robot jumps; conversely, if it is OFF, the robot does not jump, and it passes the command.
It makes no difference whether the jump destination step is a movement command or function command. However, bear in mind that if the jump destination step is a function command, the function command at the jump destination will be executed as soon as the step jump command is executed.

Selection method

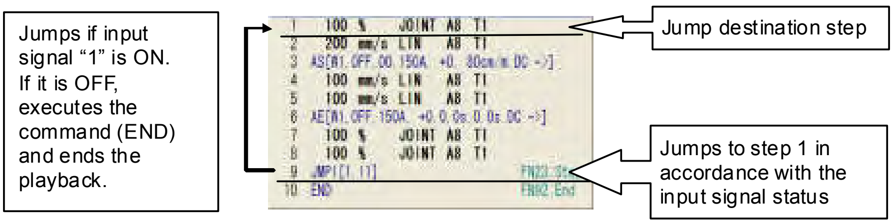
[FN] → [2] [3] → [Enter]

Parameters

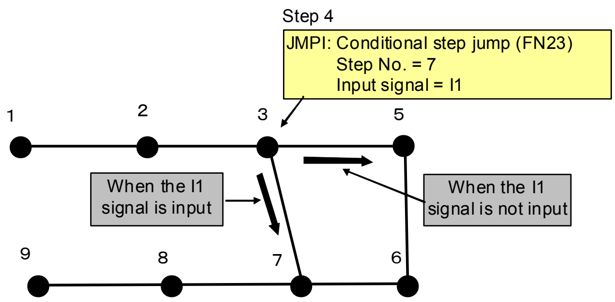
(1) Step number (1 to 9999)
(2) Input signal number (1 to 2048)

Point

(1) Teach as follows when a program is to be repeatedly played back using the step jump command. In the example given below, the robot jumps if input signal “1” is ON; if it is OFF, it ends the playback.



(2) In the example shown in the figure below, if input signal “1” has been input, the robot jumps to step 7; if it has not been input, it advances to step 5.



If the accuracy level (inside arc) has been specified by a movement command immediately before this function command, the input of the signal is checked at the timing at which the inside arc is started.
If the signal has been input, the robot describes the inside arc straight away with no deceleration.
If the signal has not been input, the robot moves to the position where the movement command is recorded, and then the signal input is checked.

(3) Even when the jump destination step has shifted because a command was added or deleted, the jump destination step number specified by the step jump command will be followed. (If the jump destination step prior to a revision was 2 but it then became 1 due to a deletion, the number of the jump destination step number will change from 2 to 1.)

Step jump (with count condition) - [JMPN<FN26>] -

Function

This command is used to jump to the step specified in the same program in accordance with the pass count.

The robot passes for the specified count, and the jump is executed the next time (specified count + 1). (For instance, if the specified count is “2”, the robot passes twice and on the third occasion the jump is executed.)

It makes no difference whether the jump destination step is a movement command or function command. However, bear in mind that if the jump destination step is a function command, the function command at the jump destination will be executed as soon as the step jump command is executed.

Selection method

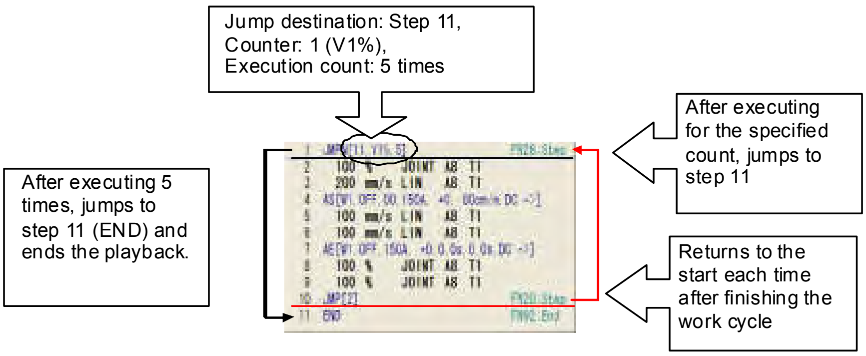
[FN] → [2] [6] → [Enter]

Parameters

(1) Step number (1 to 9999)
(2) Variable number (1 to 200)
(3) Frequency (0 to 10000)

Point

(1) Teach as follows if a program is to be repeated five times using the step jump command and then its playback is to be ended.



(2) If the accuracy level (inside arc) has been specified by a movement command immediately before this function command, the robot jumps at the timing at which the inside arc is started.

(3) Even when the jump destination step has shifted because a command was added or deleted, the jump destination step number specified by the step jump command will be followed. (If the jump destination step prior to a revision was 2 but it then became 1 due to a deletion, the number of the jump destination step number will change from 2 to 1.)

Program call - [CALLP<FN80>] -

Function

This command is used to call the specified program unconditionally.
When the playback of the program at the call destination finishes (when the END command is executed), operation returns to the step following the call command in the call source program.

Use CALLPI <FN81> to call in accordance with the input signal status, and use CALLPN <FN82> to call after the command has been executed for the specified count.

Selection method

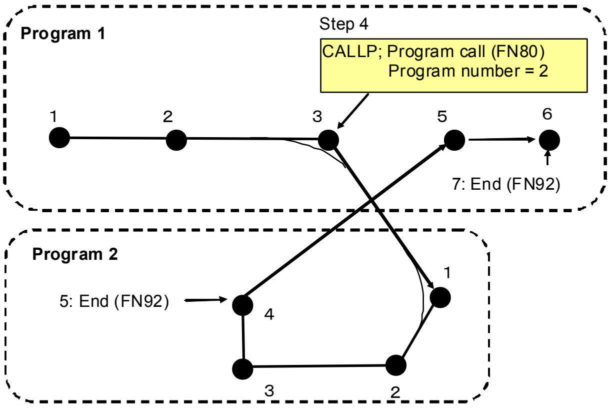
[FN] → [8] [0] → [Enter]

Parameters

Program number (1 to 9999)

Point

(1) The following operations are performed when another program is called midway through a program.



(2) The program call can be executed again in the call destination program. Up to 8 layers of calls can be executed. If calls exceeding 8 layers are executed, the “A2138 Wrong call command setting” alarm is detected during playback, and the robot stops.

Program call (conditional) - [CALLPI<FN81>] -

Function

This command is used to call the specified program in accordance with the input signal status.
If the specified input signal is ON, the program is called; conversely, if it is OFF, the program is not called, and the robot passes.
When the playback of the program at the call destination finishes (when the END command is executed), operation returns to the step following the call command in the call source program.

Selection method

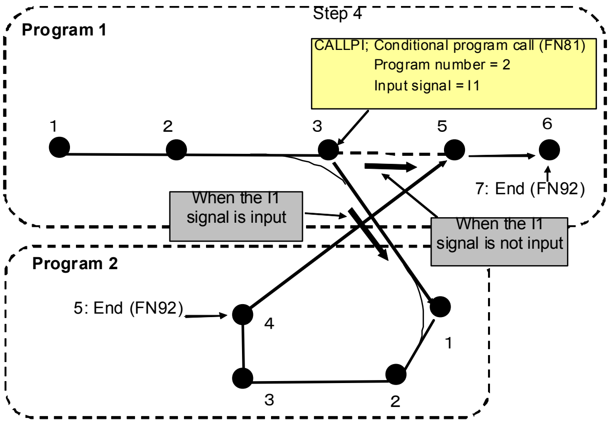
[FN] → [8] [1] → [Enter]

Parameters

(1) Program number (1 to 9999)
(2) Input signal number (1 to 2048)

Point

(1) The following operations are performed when another program is called conditionally midway through a program.



If the accuracy level (inside arc) has been specified by a movement command immediately before this function command, the input of the signal is checked at the timing at which the inside arc is started.
If the signal has been input, the robot describes the inside arc straight away with no deceleration.
If the signal has not been input, the robot moves to the position where the movement command is recorded, and then the signal input is checked.

(2) The program call can be executed again in the call destination program. Up to 8 layers of calls can be executed. If calls exceeding 8 layers are executed, the “A2138 Wrong call command setting” alarm is detected during playback, and the robot stops.

Program call (with count condition) - [CALLPN<FN82>] -

Function

This command is used to call a program in accordance with the pass count.
The robot passes for the specified count, and the call is executed the next time (specified count + 1). (For instance, if the specified count is “2”, the robot passes twice and on the third occasion the call is executed.)

When the playback of the program at the call destination finishes (when the END command is executed), operation returns to the step following the call command in the call source program.

Selection method

[FN] → [8] [2] → [Enter]

Parameters

(1) Program number (1 to 9999)
(2) Variable number (1 to 200)
(3) Frequency (0 to 10000)

Point

If the accuracy level (inside arc) has been specified by a movement command immediately before this function command, the program is called at the timing at which the inside arc is started.

Operations during check GO or BACK

This section describes the items required in the check operations of task programs that perform arc welding.
After the task program has been created, check what has been taught with a check operation (check GO/BACK).
For detail on operating check GO/BACK , refer to the “Chapter 4 Teaching” in the “BASIC OPERATION MANUAL”.
During the check operations for task programs that perform arc welding, also check the following.

- Target position check
  Check whether what has been taught ensures that the wire tip will move along the weld line. If it is off the weld line, revise the already recorded positions and/or add new ones.
- Torch posture check
  Check for problems in the torch posture, push angle, drag angle, etc. If necessary, correct the robot’s posture at the recorded positions.
- Weaving check
  First, set weaving ON/OFF to OFF, and check whether what has been taught ensures that the wire tip will move along the center of the groove.
  Now set weaving ON/OFF to ON, and check whether the weaving follows the shape of the groove. If necessary, revise the amplitude and other conditions.

Operations in the arc welding section

In the check operation, the robot does not perform arc welding regardless of the following setting statuses. In the same way, the output and stopping of the shielding gas with the function commands and the inching and retract of the welding wire are not performed either.

- [Service] - [1 Teach/Playback Condition] -[9 Function playback during checking]
- Welding ON/OFF

Also, the movement speed in the welding section during the check operation is the check speed, and not the welding speed specified in the arc start command.

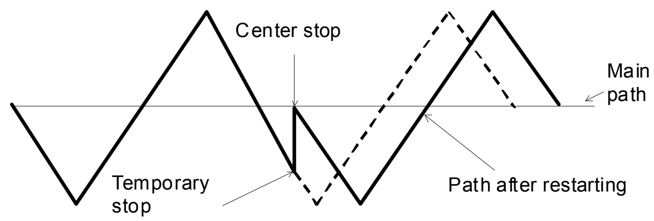
INFO.

Arc welding can also be performed in the check operation.
For details, see "8.3 Welding during check operations (check welding)" in "Chapter 8 Useful functions".

Weaving operation

The robot performs the following operations when check GO or BACK is initiated for the weaving section.

Table 3.7.1 Operation when check GO or BACK is initiated

Description	Robot operation
When check GO is initiated	Weaving is performed in the weaving section. However, weaving is not performed if weaving ON/OFF is set to OFF.
When check BACK is initiated	Weaving is not performed even in the weaving section.
If operation has been temporarily stopped during check GO	The robot returns to the main path and stops. When check GO is then resumed, weaving starts from current position.  “Center stop” refers to returning to the main path (or to the path when no weaving is performed).

Operations in automatic operation (playback)

This section describes the items required for checking the robot operations and welding results in automatic operation.

Temporary stopping and restarting operations during arc welding

If operation has been temporarily stopped and restarted during welding, the robot operates as follows.

(1) When operation was temporarily stopped and restarted during pre-flow

Temporary stop	The pre-flow is suspended, and the robot stops.
Restart	The pre-flow time which elapsed up until the operation was temporarily stopped is canceled, and pre-flow is performed from the start.

(2) When operation was temporarily stopped and restarted during welding

Temporary stop	Welding is stopped immediately and post-flow is performed. The crater treatment is not executed.
Restart	Welding is started under the welding conditions which were established prior to the temporary stop.

(3) When operation was temporarily stopped and restarted during crater treatment

Temporary stop	The crater treatment is stopped immediately and post-flow is performed.
Restart	The crater time which elapsed up until the operation was temporarily stopped is canceled, and the crater treatment is performed from the start.

(4) When operation was temporarily stopped and restarted during inching or retract

Temporary stop	The inching or retract is suspended immediately.
Restart	Operation is restarted with the command of the current step without inching or retract.

(5) When operation was temporarily stopped and restarted during arc retry

Temporary stop	Arc retry is suspended immediately.
Restart	The robot returns to the arc retry start point (original arc start point), and regular arc start is initiated. If no arc was generated at this time, arc retry is initiated again.

(6) When operation was temporarily stopped and restarted during arc restart

Temporary stop	Arc restart is suspended immediately.
Restart	The robot returns to the arc restart start point (arc outage detection point), and regular arc start is initiated. If an arc was not generated at this time, arc restart is not initiated. (However, arc retry is initiated if the arc retry setting is valid.)

(7) When operation was temporarily stopped and restarted during on-line changes

Temporary stop	Welding is stopped immediately and post-flow is performed. The crater treatment is not executed. Whatever has been changed so far is not stored in the memory.
Restart	Operation is restarted under the welding conditions existing prior to the changes.

Temporary stopping and restarting operations during weaving

If operation has been temporarily stopped and restarted during weaving, the robot operates as follows.

Temporary stop	The torch tip returns to the main path, and the robot stops.
Restart	The robot returns to the weaving path where it stopped, and the weaving waveform is continued. However, the weaving waveform is not continued if lap start or a mode change was initiated after the robot stopped.

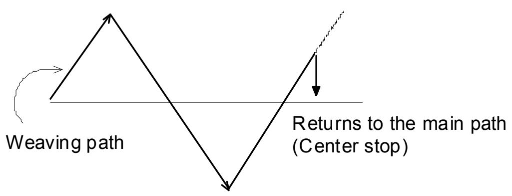


Fig. 3.8.1 Temporary stop during weaving

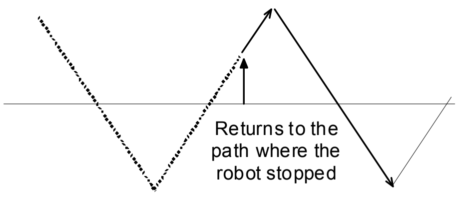
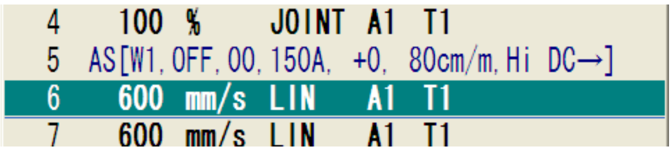


Fig. 3.8.2 Weaving during restart

Various restart methods

This section uses the following terms in its descriptions.

Table 3.8.1 Terminology in this section

Term	Description
Stopped position	The position where the robot stopped temporarily during automatic operation.
Current position	The current position of the robot. In most cases, the current position and the stopped position are the same position. However, if the teaching mode is selected after temporarily stopping and the robot is moved with a manual operation, the current position and the stopped position will be different.
Recorded position	This is the position recorded in the movement command step of the task program.
Lapped position	This is the position after returning a fixed distance from the position where the robot stopped temporarily.
Current step	As shown below, this is the step indicated by the green band in the task program. 

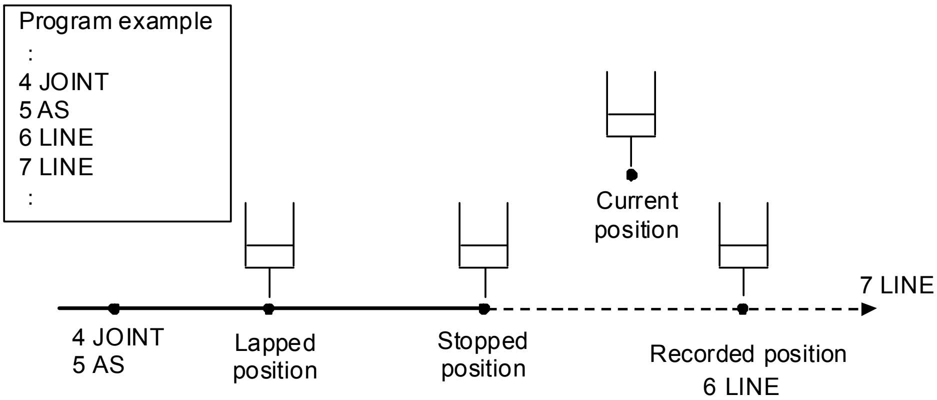
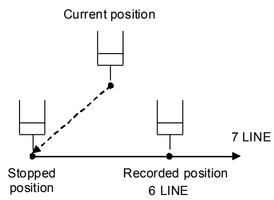
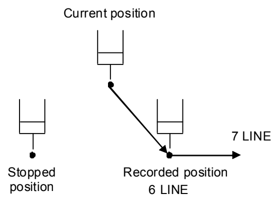
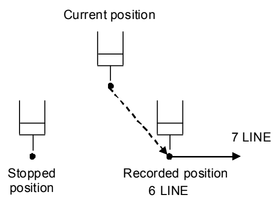
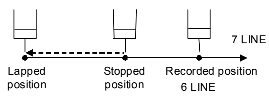


Fig. 3.8.3 Relationship between the position of each term

The methods in Table 3.8.2 are available for restarting automatic operation after it has been temporarily stopped.

Table 3.8.2 Restarting methods

	Restarting method	Description
(1)	Returning the program to non-selected status before restarting	This can be set only in the case of multi-station startup. Each time the mode is changed from the teach mode to the playback mode, the program enters the non-selected status. When restarting, the program corresponding to the multi-station start button is started up from the beginning. "3.8.4 Restart settings"
(2)	Restarting from the stopped position 	The robot is returned to the stopped position before restarting automatic operation. Example: A temporary stop is performed during automatic operation, and the robot is moved with a manual operation in teach mode. The position to which the robot was moved is the current position. When restarting, the robot returns from the current position to the stopped position before welding restarts. "3.8.5 Restarting after returning to the position at which the robot stopped"
(3)	Restarting from the current position 	The automatic operation restarts from the current position. Example: A temporary stop is performed during automatic operation, and the robot is moved with a manual operation in teach mode. The position to which the robot was moved is the current position. When restarting, the welding restarts from the current position. "3.8.6 Restarting from a position after manual operation" "3.8.8 Restarting operation after changing the current step"
(4)	Restarting from the recorded position 	The robot moves with a joint interpolation operation to the recorded position before automatic operation restarts. Example: A temporary stop is performed during automatic operation, and the current step is moved from the step when the robot was stopped to another step. When restarting, the robot moves with joint interpolation to the recorded position of the current step and the automatic operation restarts. "3.8.8 Restarting operation after changing the current step"
(5)	Restarting welding from the lapped position 	This function is enabled only when a temporary stop is performed during welding. When restarting, the robot reverses from the stopped position to the lapped position before welding restarts. "3.8.7 Restarting after reversing a fixed distance "

Selectable restarting methods and settings from the current status

Check the restarting methods and settings that are selectable from the current status by following the flowchart in Fig. 3.8.4 and checking the corresponding item from (A) to (C) in Table 3.8.3.

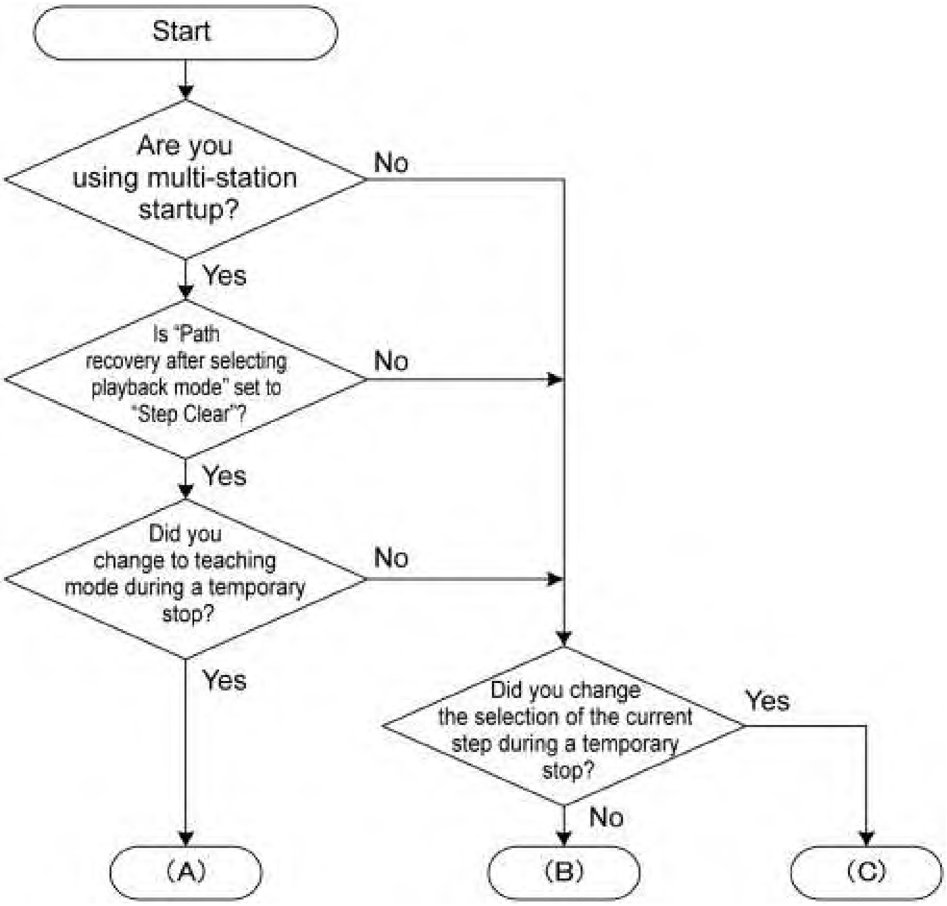


Fig. 3.8.4 Restarting method flowchart

Table 3.8.3 Restarting methods

Flowchart	Restarting method	f keys on 2nd page of playback mode		
		f3 <Restart method in Play Mode>	f4 <Recover to stopped position>	f5 <Recover pos. after step set>
(A)	(1) Returning the program to a non-selected status when playback mode is selected	<Step Clear>	*	*
(B)	(2) Restarting from the stopped position	<Specified>	<Stopped position>	*
	(3) Restarting from the current position	<Specified>	<Current position>	*
	(5) Restarting welding from the lapped position	<Specified>	<Lapped position>	*
(C)	(3) Restarting from the current position	<Specified>	*	<Current position>
	(4) Restarting from the recorded position	<Specified>	*	<Recorded position>

*: Will not affect the restarting method no matter what is set.

Restart settings

After a stop, you need to set the restart method using the f keys or service utilities menu in order to restart the robot with the methods described in Table 3.8.2. If the functions in Table 3.8.4 are not allocated to the f keys, refer to "Chapter 7 Useful functions" in the Basic Operation manual and allocate the functions.

This section explains the operations involved in setting the restart method, and is based on a condition where the initial allocations have not been changed. Also, the f keys in the operation descriptions are explained with their positions on the screen.

Table 3.8.4 Function names and commands

Function	Code	Initial allocation	Position on screen
Restart method in Play Mode	2211	f18	f6 (teach mode 2nd page)
		f15	f3 (playback mode 2nd page)
Recover to stopped position	2212	f16	f4 (playback mode 2nd page)
Recover pos. after step set	2213	f17	f5 (playback mode 2nd page)

Setting the path recovery method

1 In the teach mode, press f1 <Change Key>.

2 Press f6 <Step Clear>.

>> The [f6] display changes to <Specified>.

For internal start and external start

For internal start and external start, this operation is not needed because the setting is always <Specified>.

Table 3.8.5 Setting the path recovery method

f3	Significance of the displays
	<Step Clear> is set. This setting can be selected only in the case of multi-station startup. For internal start and external start, it is fixed to <Specified>. If <Step Clear> is set, when the mode is changed from the teach mode to the playback mode, the program will be a non-selected. To set the restart method, press f3 and change to <Specified>.
	<Specified> is set. With this setting, restarting is performed according to the restart method set with f4 <Recover to stopped position> or f5 <Recover pos. after step set>.

POINT

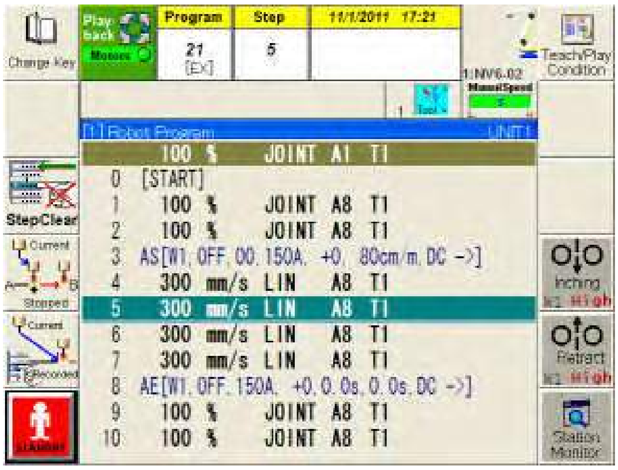
For multi-station startup, in the default setting, < Restart method in Play Mode > is set to <Step Clear>.

Setting the restart method

Change the operator qualification to ***EXPERT*** or higher in advance.

1 In the playback mode, press f1 <Change Key>.

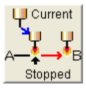
>> The f keys used to determine the restart method are displayed in [f3] to [f5].



2 Check f3 < Restart method in Play Mode >.

>> If <Step Clear> is set, press f3 to set <Specified>.

> **POINT**
>
> In playback mode, <Specified> cannot be changed to <Step Clear>. To return to <Step Clear>, select the theach mode, and change with an f3<Restart method in Play Mode> key operation or select "Step Clear" in [Service] - [Teach/Playback Condition] - [19 Restart method in Play Mode].

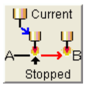
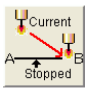
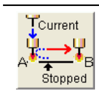


3 Press f4 < Recover to stopped position >.

>> Every time you press f4, the setting will switch in order among the following 3 states.

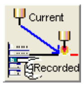
Select the recovery position if the current step will not be changed. The recovery position is for determining “where the robot should return to before resuming operations” when restarting the robot.

Table 3.8.6 Stopped position recovery in playback mode

f4	Significance of the displays
	<Stopped Position> is set. In this setting, the robot returns from the current position to the stopped position with joint interpolation before restarting. Select this setting to restart the robot after you have moved the robot in teach mode from the position at which it stopped to a safe place and want to return it to the position at which it stopped before restarting it. Example: If the robot was stopped in the welding section and is then restarted, it restarts welding from the stopped position. “3.8.5 Restarting after returning to the position at which the robot stopped”
	<Current position> is set. In this setting, the robot restarts from the current position, going towards the step that was the target when the robot stopped. Example: If the robot was stopped in the welding section and is then restarted, it restarts welding from the current position. “3.8.6 Restarting from a position after manual operation”
	<Lapped welding> is set. This setting is enabled only in the welding section. Example: If the robot was stopped in the welding section and is then restarted, the robot reverses a fixed distance before restarting welding from the lapped position. “3.8.7 Restarting after reversing a fixed distance ”

POINT

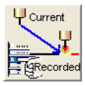
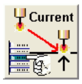
- The default setting is <Stopped position>.
- If the display does not change even after pressing f4, change [Teach/Playback Condition] - [20 Recover to stopped position] to "Enabled".



4 Pres f5 <Recover pos. after step set>.

>> Every time you press f5, the setting will switch in order among the following 2 states.
Select the recovery position for when the current step is different from the step at the time of the temporary stop.

Table 3.8.7 Start position after step setting

f5	Significance of the displays
	<Recorded position> is set. In this setting, the robot returns to the recorded position of the current step with joint interpolation before restarting. Example: If the robot was stopped in the welding section and is then restarted, it moves to the recorded position of the current step before restarting welding. "3.8.8 Restarting operation after changing the current step"
	<Current position> is set. In this setting, the robot restarts from the current position according to the interpolation type of the current step. Example: If the robot was stopped in the welding section and is then restarted, it restarts welding from the current position. "3.8.8 Restarting operation after changing the current step"

POINT

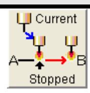
- f4 <Recover to stopped position> and f5 <Recover pos. after step set> are different functions. The f5 setting does not affect the f4 setting (and vice versa).
  "Restarting if the current step will not be changed" is set with f4, and
  "Restarting if the current step is changed" is set with f5.
- The following operations correspond to the operations when the "current step is changed".
  - Press [PROG/STEP] and select the step.
  - Play back the steps using check GO and check BACK.
  - Select the step using [ENABLE] + [up or down].
  - Select the step using [ENABLE] + [Jog Dial].
- If the display does not change even after pressing f5, change [Teach/Playback Condition] - [20 Recover to stopped position] to "Enabled".

5 This now completes the settings.

Restarting after returning to the position at which the robot stopped

This section describes the operation for returning the robot automatically to the stopped position after a manual operation, and then restarting automatic operation.
This section is based on "3.8.4 Restart settings" with the settings shown in Table 3.8.8.

Table 3.8.8 Restarting after returning to the position at which the robot stopped

f3	f4
Restart method in Play Mode	Recover to stopped position
 <Specified>	 <Stopped position>

In this setting, after the robot is operated manually, the robot will return to the position at which it stopped using joint interpolation and then resume operations. If the stopped position is within the welding section, the robot will begin welding after it returns to that position.
This is useful, for example, when moving the robot to a safe place to replace a chip or cut wires after a welding failure has occurred.

POINT

- In the default settings, the robot moves to the stopped position with joint interpolation. At this time, the movement speed is 60%.
  The interpolation classification and movement speed can be changed with "Position Resume at Restart" in [Constant Settings] — [Machine Constants] - [10 Position Resume Setting].
- If an operation is performed to change the current step before the operation is restarted, the function in this section cannot be used. Restart the operation using the method in "3.8.8 Restarting operation after changing the current step".

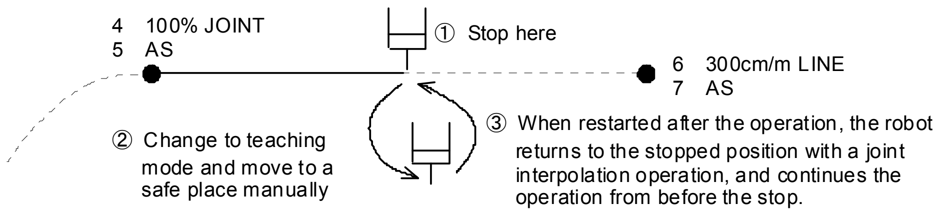
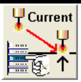


Fig. 3.8.5 Restarting after returning to the position at which the robot stopped

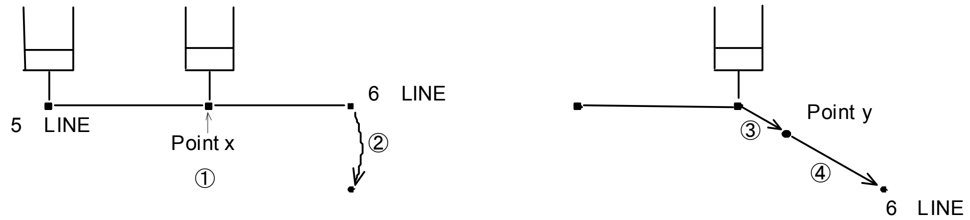
Restarting from a position after manual operation

This section describes the operation for restarting automatic operation from a position after a manual operation (current position).
This section is based on "3.8.4 Restart settings" with the settings shown in Table 3.8.9.

Table 3.8.9 Restarting from a position after manual operation

f3	f4
Restart method in Play Mode	Recover to stopped position
 <Specified>	 <Current position>

In this setting, when you restart the robot, it operates according to the interpolation classification and speed of the current step (safety speed restrictions do not apply for this restart method).



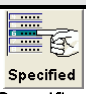
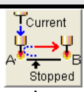
① During automatic operation, the shock sensor is triggered at point x.
② After clearing the shock sensor, change to Teach mode and correct the position in Step 6.
③ Do Check GO operation up to point y, near point x, and end teaching corrections.
④ When you change to Playback Mode and startup the robot, resume operations from point y.

Fig. 3.8.6 Restarting from a position after manual operation/from a revised position (current position)

Restarting after reversing a fixed distance (lap welding function)

This function used to be known as the lap welding function (lap start). The robot reverses a fixed distance on the weld line and restarts from the lapped position. This is useful if a welding failure such as arc outage occurs.
This section is based on "3.8.4 Restart settings" with the settings shown in Table 3.8.10.

Table 3.8.10 Restarting from a position after manual operation

f3	f4
Restart method in Play Mode	Recover to stopped position
 <Specified>	 <Lapped position>

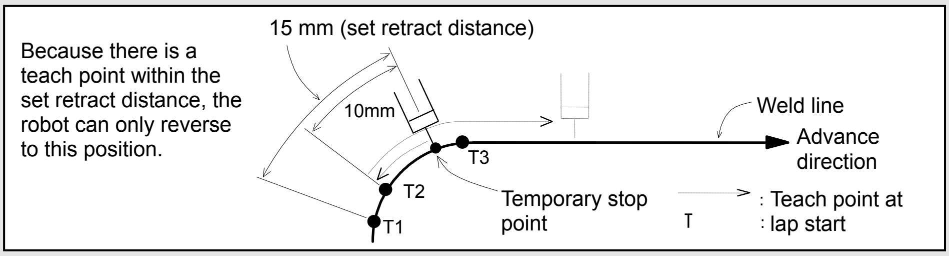
To use this function, set the welding constants in Table 3.8.11.

Table 3.8.11 Welding constants

Item name	Setting range	Default
Restart retract distance	0 to 99 [mm]	0

IMPORTANT

- Reversal beyond the current step cannot be implemented. In following case, even when the retract distance is set to 15 mm, the robot reverses by 10 mm only.



- The lap welding function works only when the stop timing is inside a welding section regardless of the welding ON/OFF status. The lap welding function does not work, even if it has been set, when the stop timing is outside a welding section.

- When the robot is stopped again during lap welding (from the lapped position to the stopped position), the start position of lap welding serves as the first lapped position.

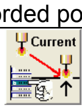
- The lap welding function does not work, even if it has been set, in an arc sensor copy section (between ST and ET).

- The lap welding function does not work, even when it has been set, in a laser sensor copy section (between ZT and ZN and ZE or between ZT and ZE).

Restarting operation after changing the current step

This section describes the method for “operating after changing the current step”.
This section is based on "3.8.4 Restart settings" with the settings shown in Table 3.8.12.

Table 3.8.12 Restarting after changing the current step

f3	f5	
Restart method in Play Mode	Recover pos. after step set	
 <Specified>	(a)	 <Recorded position>
	(b)	 <Current position>

POINT

Restarting from the recorded position

In the default settings, the robot moves to the stopped position with joint interpolation. At this time, the movement speed is 60%.

The interpolation classification and movement speed can be changed with " Position Resume at Restart " in [Constant Settings] — [Machine Constants] - [10 Position Resume Setting].

There are 2 ways of doing this method.

(a) Restart operations after moving the robot from the current position to the changed current step using joint interpolation.
This operation is the same as "3.8.5 Restarting after returning to the position at which the robot stopped".
(b) Immediately restart operations from the current position towards the changed current step.
This operation is the same as "3.8.6 Restarting from a position after manual operation".

The current step can be changed in both the teach and playback modes.

Robot movement condition file

The robot movement conditions are provided for optimally tailoring the robot operations to suit the arc welding conditions. See the parameters shown in Table 7.6.1.
For how to set the robot movement conditions in the arc welding condition, refer to "Chapter 3 Preparation of Arc Welding Programs and Automatic Operation".

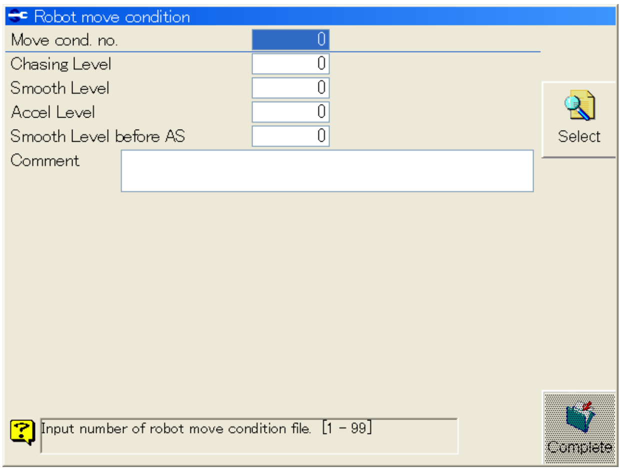
Table 7.6.1 Type of robot movement condition

Motion condition	Description/Explanation
Chasing Level (0 to 3)	This parameter is used to enhance the ability of the robot to track commands values.
Smooth Level (0 to 3)	This parameter is used to make the robot operations smoother.
Accel Level (0 to 3)	This parameter is used to make the robot operation speeds smoother.
Smooth Level before AS (0 to 3)	This parameter is used to reduce the vibrations of the robot at arc start.

Creating the robot movement condition files

Creating the robot movement condition files

1 **Select f6 <Retry condition file> - [11 Robot move condition].**
>> The robot movement condition screen appears.



2 **Set the condition file ID and parameters and press f12 <Complete>.**
>> The robot movement condition file of the specified ID is created.

It is possible to edit the robot movement conditions in the arc welding start condition editing screen. Select "Move cond. no." in the arc welding start conditions and press [Enable] + f8 <Edit>.

Parameters of robot movement condition

This section explains each parameter in detail.

Chasing level

When level 1 or above is recorded, the accuracy of the robot path within the welding section is improved.
It can be used effectively when the target position of the wire tip is inadvertently changed with welding performed while the torch posture changes significantly.

INFO.

The higher the level, the greater the improvement in the path accuracy but the longer the operating time.

IMPORTANT

- Do not change the level for arc start command (AS command) changing the conditions. The robot may slow down its speed depending on the recorded robot movement conditions.
- With check go, the robot operates at a path accuracy commensurate with the tracking level. With check back, however, it operates using a tracking level of zero.
- When level 1 or above is recorded, the corner areas may become more rounded.
- When level 1 or above is recorded, the smoothness level and acceleration/deceleration level cannot be specified.
- When level 1 or above is recorded, the smoothness and acceleration specifications recorded in each step within the welding section are rendered invalid.

Smooth level

When level 1 or above is recorded, the path accuracy when the robot starts off and when it stops is improved.
Smoothness is a function for adjusting the smoothness by changing the jerk of each of the robot's axes. This parameter is used to specify the smoothness of all the steps within the welding section together. It is used effectively if the target position of the wire tip is inadvertently changed when high-speed welding starts off.

INFO.

If the level is increased, the path accuracy at start-off is improved, but the operation time is increased.

IMPORTANT

- Do not change the level for arc start command (AS command) changing the conditions. The robot may slow down its speed depending on the recorded robot movement conditions.
- When level 1 or above is recorded, the corner areas may become more rounded.
- When level 1 or above is recorded, the smoothness specification recorded in each step within the welding section are rendered invalid.

Accel level

When level 1 or above is recorded, the path accuracy when the robot starts off and when it stops is improved.
Acceleration is a function for adjusting the smoothness by adjusting the acceleration of the robot operation. This parameter is used to specify the acceleration of all the movement commands within the welding section together. It is used effectively if the target position of the wire tip is inadvertently changed when high-speed welding starts off.

INFO.

If the level is increased, the path accuracy at start-off is improved, but the operation time is increased.

IMPORTANT

- Do not change the level for arc start command (AS command) changing the conditions. The robot may slow down its speed depending on the recorded robot movement conditions.
- When level 1 or above is recorded, the corner areas may become more rounded.
- When level 1 or above is recorded, the “acceleration” specification recorded in each step within the welding section are rendered invalid.

Smooth Level before AS

This parameter is used to reduce the vibration in the positioning operation immediately before arc start command (AS command).
It is used effectively when the robot approaches the arc start point in an extended forward-tilting posture and there is significant vibration when it stops.

INFO.

As the level is increased, the vibration during arc start can be reduced, but the operation time is increased.

Monitoring the welding conditions (Arc Monitor)

Arc Monitor is a function to monitor the teaching conditions of the arc welding start command and the actual welding conditions that are being output (such as current and voltage). Arc Monitor has the functions shown in Table 8.1.1.

Fig 8.1.1 Arc Monitor screens

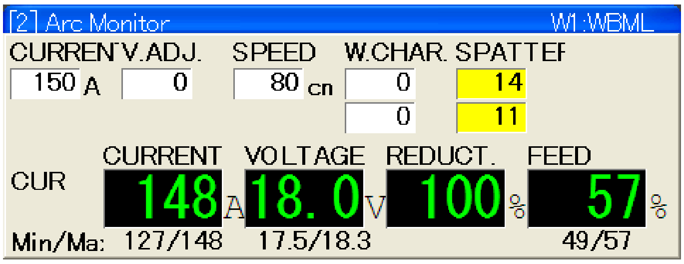


Table 8.1.1 Arc Monitor functions

Function	Description/Explanation
Arc Monitor	It can monitor actual welding conditions and teaching conditions in real time. "8.1.3 Arc Monitor"
Arc Monitor customizing	Monitoring items for the actual welding conditions can be changed. "8.1.4 Arc Monitor customizing"
The online modification function	Welding and weaving conditions can be modified in real time during welding. "8.1.5 The online modification function"
Feeder I/F adjustment function	0 adjustment of Feeder I/F can be performed. "8.1.6 0 adjustment of Feeder I/F"

Actual welding conditions that can be monitored

The actual welding conditions that can be monitored by Arc Monitor (hereafter referred to as 'monitoring items') depend on the welding power supply. The monitoring items for each welding power supply are shown in Table 8.1.2.

Table 8.1.2 Actual welding conditions that can be monitored

<table>
<tr><th>Welding power supply</th><th>Welding method</th><th>Current</th><th>Voltage</th><th>EN ratio</th><th>Reduction rate</th><th>Feed load ∗</th><th>Feed speed ∗</th></tr>
<tr><td>WB-M350L</td><td>All</td><td>●</td><td>●</td><td>－</td><td>●</td><td>●</td><td>○</td></tr>
<tr><td>WB-M350/500</td><td>All</td><td>●</td><td>●</td><td>－</td><td>－</td><td>●</td><td>○</td></tr>
<tr><td>DM-350/500
DM-350(S-2)</td><td>All</td><td>●</td><td>●</td><td>－</td><td>－</td><td>●</td><td>－</td></tr>
<tr><td>DP-350/400/500
DP-400R</td><td>All</td><td>●</td><td>●</td><td>－</td><td>－</td><td>●</td><td>－</td></tr>
<tr><td>DA-300P</td><td>All</td><td>●</td><td>●</td><td>－</td><td>－</td><td>●</td><td>－</td></tr>
<tr><td>DR-350</td><td>All</td><td>●</td><td>●</td><td>－</td><td>－</td><td>●</td><td>－</td></tr>
<tr><td>DL-350
DL-350(S-2)</td><td>All</td><td>●</td><td>●</td><td>－</td><td>●</td><td>●</td><td>－</td></tr>
<tr><td rowspan="4">DW-300+ (Plus)</td><td>AC pulsed</td><td rowspan="2">●</td><td rowspan="2">●</td><td rowspan="2">●</td><td rowspan="2">－</td><td rowspan="2">●</td><td rowspan="2">－</td></tr>
<tr><td>AC wave pulsed</td></tr>
<tr><td>DC pulsed</td><td rowspan="2">●</td><td rowspan="2">●</td><td rowspan="2">－</td><td rowspan="2">－</td><td rowspan="2">●</td><td rowspan="2">－</td></tr>
<tr><td>DC wave pulsed</td></tr>
</table>

● : Monitoring possible (Initial value for the Arc Monitor customizing)
○ : Monitoring possible (Necessary to set the Arc Monitor customizing))
－ : Monitoring impossible
∗ : Handling monitoring outside the welding section.

If the AC Servo wire feeder controller is used, the following combinations make "Feed Load" monitoring possible.

- AC Servo type wire feeder controller L21588
- Robot I/F L21030C

However, when the Welbee Inverter series and DP-400R welding power supply are used, regardless of the above combinations, it is possible to monitor "Feed Load".

The current value is also displayed when the current condition type is wire feed speed

The actual current value is always displayed on the monitor, even if the current condition types in the welding conditions are specified by wire feed speed.

The voltage value is displayed when synergetic control is the voltage adjustment method.

The actual voltage value is always displayed on the monitor when the welding method is under synergetic control.

What is the feed load?

The feed load shows the load current as a percentage of the wire feeder's rated current. With normal wire feed, it ranges from around 40% to 60%.

What is the reduction rate?

The reduction rate indicates the necking detection status in the form of a percentage. It ranges from 90 % to 100% when necking is detected properly. For details, refer to "Chapter 4 Welding Conditions for Welbee Inverter Series Welding power supplies" or "Chapter 5 Welding Conditions for D Series Welding power supplies".

Optional monitoring conditions that can be added

In addition to the items in Table 8.1.2, it may be possible to add monitoring items depending on optional functions. Please refer to the relevant instruction manuals for details.

About the section to monitor the actual welding conditions:

- The actual welding conditions are monitored in the section between the AS command and the AE command.
- The feed load and feed speed can also be monitored at times other than during welding. For details, see “7.1.4 Monitoring Other Than During Welding”.

Actual welding conditions cannot be monitored for some welding power supplies

Actual welding conditions are not displayed in the case of welding interface or WPS (I/O). Only teaching conditions are displayed.

Settings relating to Arc Monitor

The settings relating to Arc Monitor can be set with <Arc Constant> - [3 Constant of weld]. Please refer to "7.1 Setting the welding constants" in "Chapter 7 Arc welding-related settings" with regard to the constants.

Table 8.1.3 Constants settings relating to Arc Monitor

Constant name	
Arc monitor sampling cycle*	Welding voltage failure limit (Rate) *
Arc monitor sample data num	Welding voltage failure time*
Arc Monitor display cycle*	Wire feed load fail action
Arc Monitor display type*	Wire feed load fail rate
Arc Monitor output cycle type*	Welding wire feed speed failure time*
Welding curr./volt. fail. act.	Disregard time of Arc start*
Welding current failure limit type*	Disregard time of Arc change*
Welding current failure limit (inc.)	Feeder I/F*
Welding current failure limit (Rate) *	Feeder I/F Adj.*
Welding current failure time*	Arc monitor customizing
Welding voltage failure limit type*	Gas flow control unit
Welding voltage failure limit (inc.)	

*: Change not available in DM series.

Table 8.1.4 Constants settings related to Arc Monitor (Welbee inverter series welding power supply only)

Constant name	
Abnormal speed of wire judgment	Detection time at abnormal speed
Abnormal speed of wire(inc.)	Action at abnormal speed of wire
Abnormal speed of wire(Rate)	

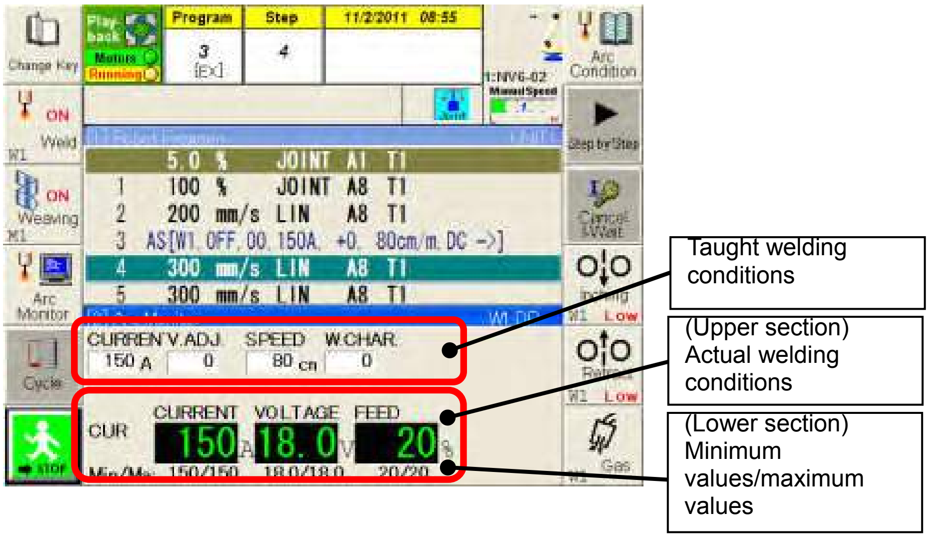
Arc Monitor

This chapter explains the basic operations of Arc Monitor

Starting up Arc Monitor

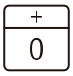
1 Press f4 <Arc Monitor> in playback mode.

>> "Arc Monitor" starts up in monitor 2.
The following information appears if welding is in progress.

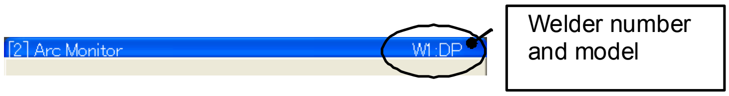


2 Do one of the following operations to switch which welding power supply is shown on the monitor. These operations are only available when multiple welding power supplies are connected.

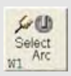
- **Press the number key corresponding to the W.P.S No. of the monitoring target. For instance, to monitor welding power supply 2, press the number key [2].**



- **Press the number key "0".**
  Every time you press the key, the W.P.S No. switches in turn.
  The welder being shown on the monitor will be displayed in the title bar.



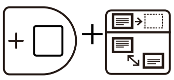
It cannot be changed using the f keys



The <Select arc welder> f keys are used to change the welding power supply that is to be operated manually. They cannot be used to change the welding power supply that is to be monitored.

How to switch weaving conditions

Weaving conditions and tracking conditions are switched to mechanism conditions for the currently selected welding power supply.



3 To close Arc Monitor, press [ENABLE] + [CLOSE/SELECT SCREEN].

>> Arc Monitor now closes.

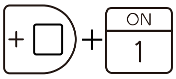
4 **Press [CLOSE/SELECT SCREEN] when Arc Monitor has not been selected for an active monitor.**

>> Each time [CLOSE/SELECT SCREEN] is pressed, the active monitor is switched through.
The monitor which can be operated has a deep blue title bar.
The monitors which cannot be operated have gray title bars.

POINT

Depending on the monitor layout, not all the items may be displayed on the screen. In that case, you can view all the items by scrolling up and down the screen using the cursor keys.

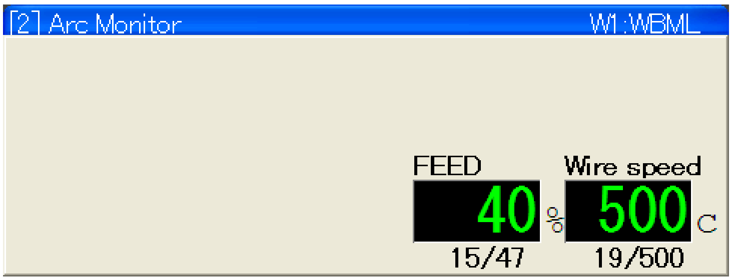
Displaying Arc Monitor outside the welding sections



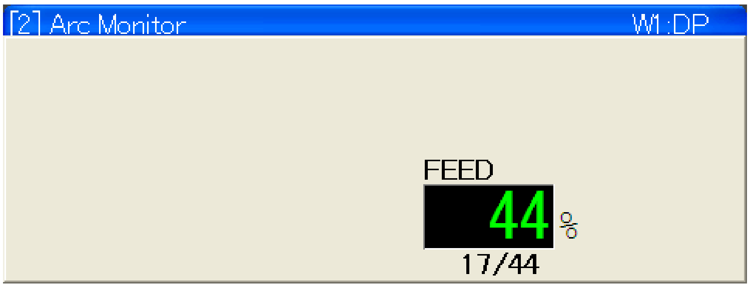
1 **Press [ENABLE] + [1] in Arc Monitor.**

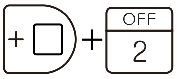
>> The monitoring items are displayed.

When the Welbee Inverter series welding power supply is used



When the D series welding power supply is used





2 **Press [ENABLE] + [2] for non-display of feed load.**

INFO.

- Select <Service Utilities> - [4 Monitor 2] - [35 Arc welding] to display Arc Monitor in teach mode.
- It will not be on monitors outside the welding section after the welding has been completed, and will always be in non-display status.

Arc Monitor customizing

It is possible to change the Table8.1.5 items by using the Arc Monitor customizing function.

Table8.1.5 Arc Monitor customizing settings

<table>
<tr><th>Item name</th><th>Description/Explanation</th><th>Setting range</th><th>Default</th></tr>
<tr><td>Arc Monitor Display items</td><td>Set any monitoring items. Monitoring items can be set at the top/bottom of Sequences 1 to 4.</td><td>See Table 8.1.2</td><td>See Table 8.1.2</td></tr>
<tr><td>Arc Monitor Display item size</td><td>The size of the monitoring items can be set from "Large" to "Small".<table><tr><th>Item</th><th>Size</th><th>Max./Min. display</th></tr><tr><td>Large</td><td>Default</td><td>ON</td></tr><tr><td>Small</td><td>Half the size of "Large"</td><td>OFF</td></tr></table></td><td>Large/Small</td><td>Large</td></tr>
<tr><td>Weaving conditions display</td><td>The display of weaving conditions can be changed between ON/OFF in Arc Monitor. Weaving conditions must be set as ON in order to change them online.</td><td>Enable / Disable</td><td>Enable</td></tr>
<tr><td>Tracking conditions display</td><td>The display of tracking conditions can be changed between ON/OFF in Arc Monitor.
Tracking conditions must be set as ON in order to change them online.</td><td>Enable / Disable</td><td>Enable</td></tr>
</table>

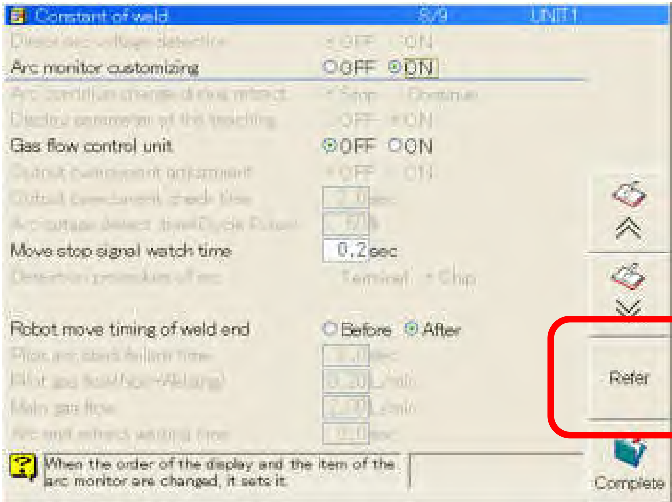
INFO.

By changing the "Arc Monitor display items", it is possible to display the Welbee Inverter series wire feed speed or additional optional monitoring items.

Changing the monitoring item

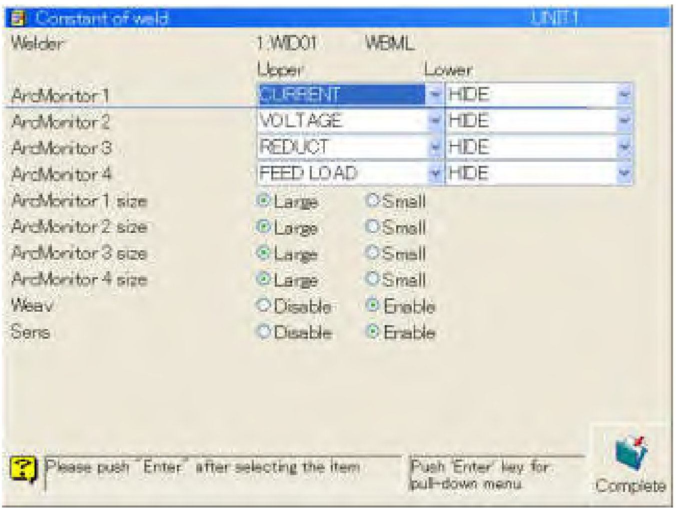
1 **Select f5 <Arc Constant> - [3 Constant of weld] in teach mode, and then select "ON" in [Arc Monitor customizing].**

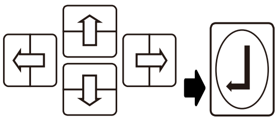
>> f11 <Refer> is displayed.



2 **Press f11 <Refer>.**

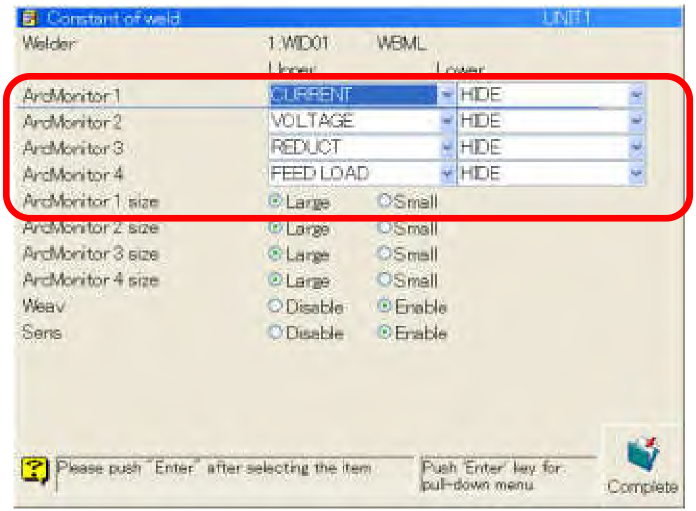
>> The setting screen for arc monitor customizing appears.





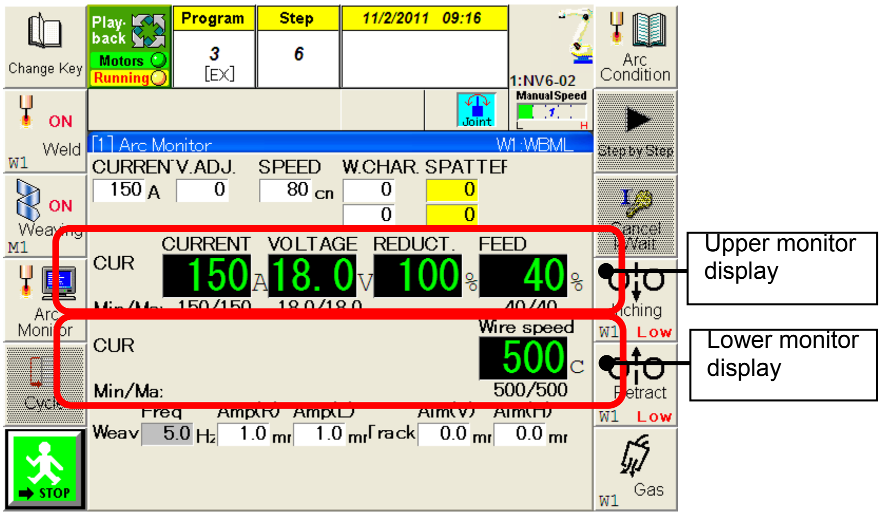
3 **Set monitoring items.**

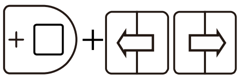
>>Set monitoring items and the size of monitoring item by row. Press the [Enter] key and the selectable items are displayed. Please refer to Table 8.1.2 for the selectable items.



Allocation sample of monitoring item

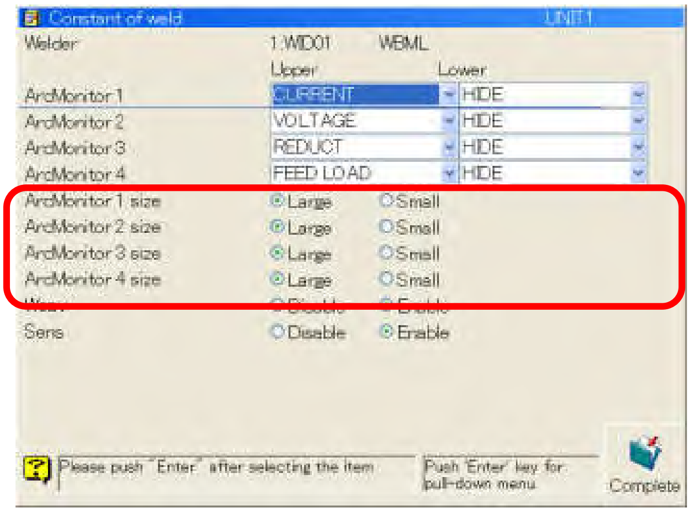
The arc monitor display item 1, 2, 3, and 4 respectively corresponds to each column from the left. A maximum of 2 lines x 4 columns can be displayed.



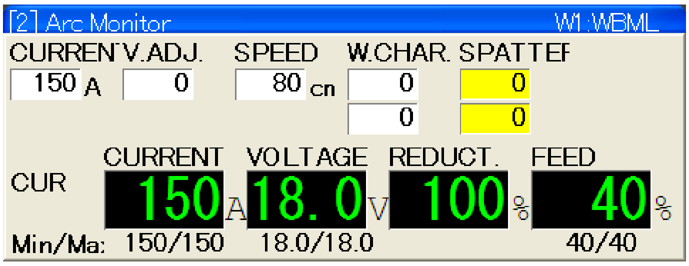


4 **Specify the size of the monitoring item.**

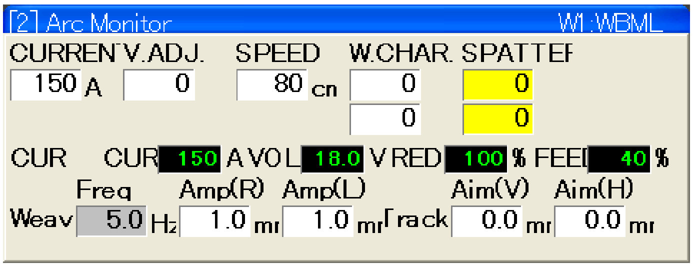
>> Specify the size of the monitoring item. Press [ENABLE] + [LEFT/RIGHT] to switch between Large/Small.



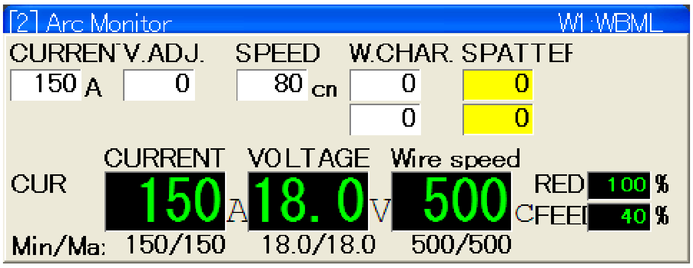
Example of "Large" display



Example of "Small" display



Example of "Large" and "Small" combination display

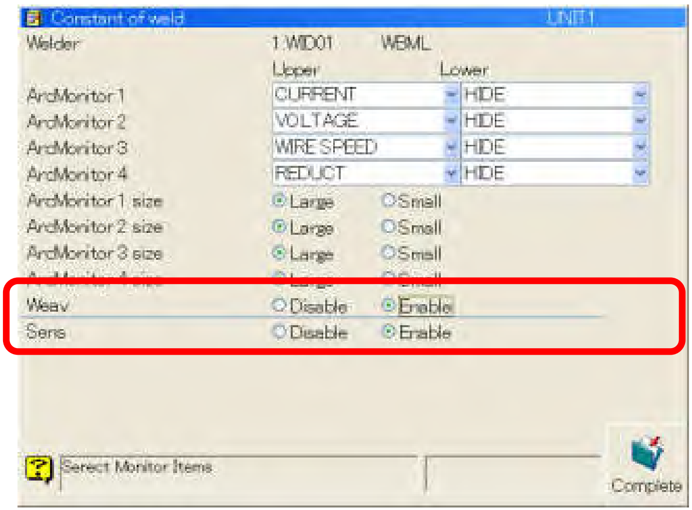


INFO.

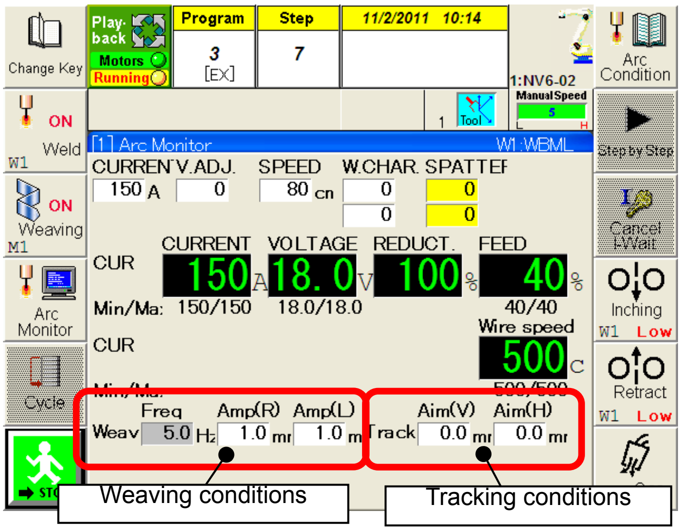
Indication of "Min/Max" appears when the display size is "Large".

5 **Set the weaving conditions and tracking conditions.**

>> Press [ENABLE] + [LEFT/RIGHT] to switch the weaving conditions and tracking conditions Enable/Disable.



The weaving conditions and tracking conditions are displayed as below. Tracking conditions appear only when the type of sensor is “Arc sensor”, “TIG-AVC” and “Manual-Tracking”.



The weaving condition items to be displayed are as shown below depending on the weaving command.

Table 8.1.6 Weaving condition display items

Weaving command	Frequency	Right amplitude	Left amplitude
WFP(Fixed pattern)	●	●	●
WAX(Axis)	●	●	●
WSF(Taught)	—	—	—

(●: Displayed —: Not displayed)

The tracking condition items to be displayed are as shown below depending on the type of sensor.

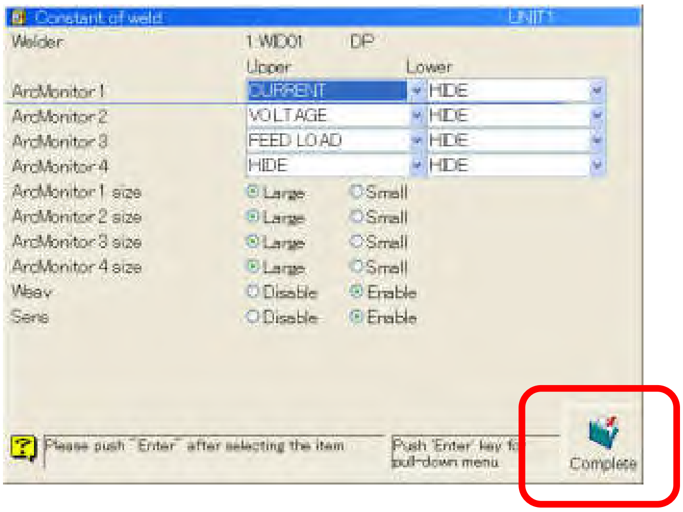
Table 8.1.7 Tracking condition display items

Type of sensor	Offset Up/Down	Offset Left/Right	Tracking Up/Down	Tracking Left/Right
Arc sensor	●	●	—	—
TIG-AVC	●	—	—	●
Manual-Tracking	—	—	●	●

(●: Displayed —: Not displayed)

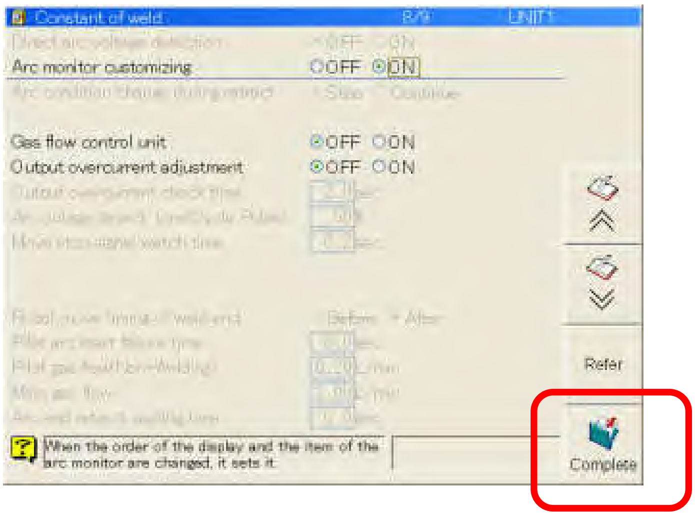
6 **Press f12 <Complete>.**

>> The setting for Arc Monitor customizing is stored.



7 **Press f12 <Complete> again.**

>> The setting for Arc Monitor customizing is stored as “ON”.

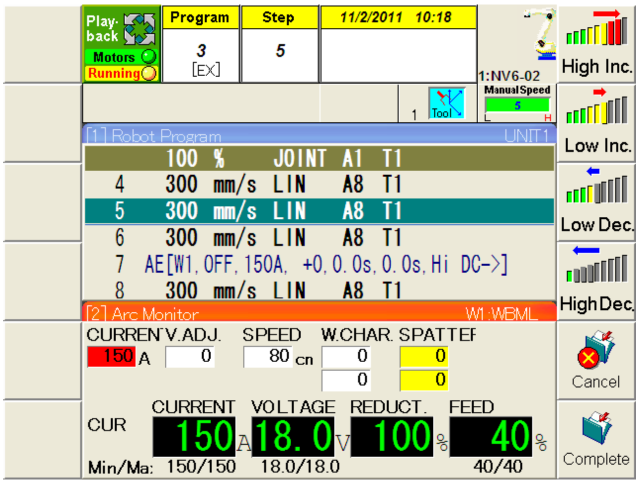
Performing online modifications

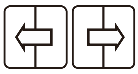
1 **Press f4 <Arc Monitor> in playback mode during welding.**

>> "Arc Monitor" starts up in Monitor 2.

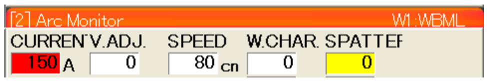
2 **Activate Arc Monitor, and press [EDIT].**

>> During welding, it will switch to the screen editor (It won't switch if it is not during welding).
At this time, online modification is available.

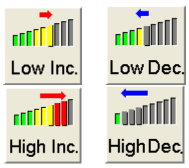




3 **Align the cursor with the condition to be changed.**

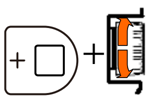


4 **The condition to be modified can be changed by operations 5~7 below.**



5 **Modify the welding conditions/weaving conditions.**

>> To increase/decrease at low speed, press f8 <Low Inc.> or f9 <Low Dec.>.
To increase/decrease at high speed, press f8 <High Inc.> or f9 <High Dec.>.

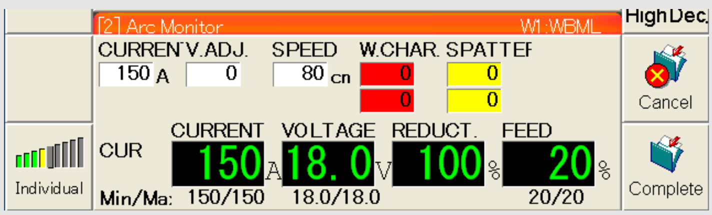


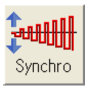
Alternatively, modify by turning the jog dial while holding down [ENABLE].

POINT

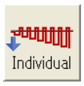
Simultaneous modification for the arc characteristics

In using WB-M350L or WB-M350/500, it is available to execute online modification to change the "Arc char.1 (Short)" and "Arc char.2 (Arc)" at the same time. For the setting of "Simultaneous" and " Individual", use the f6 key.



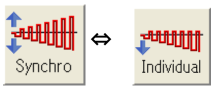


Or



6 **Switch the weaving condition to be modified.**

>> Modification method can be switched by using f6 <Synchro> or <Individual>.

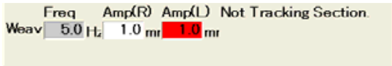


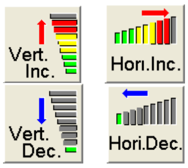
<Synchro>

Right and Left amplitude is modified in synchro.

<Individual>

Right and Left amplitude is modified individually.





7 **Modify the tracking conditions.**

>> To make adjustments in the vertical direction, press f2 <Vert. Inc.> or f3 <Vert. Dec.>. To make adjustments in the horizontal direction, press f8 <Hori. Inc.> or f9 <Hori. Dec.>.

POINT

Online modification order

The order of modification at low speed is the minimum unit of the target x 1. In the case of high-speed modification, the default setting is the minimum unit x 5. The order of modification done at high speed can be altered with the setting in Table 8.1.11.

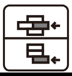
Table 8.1.11 High-speed modification order settings

Item name	Setting points
Welding conditions	<Arc Constant> - "Online modification cycle" in [3 Constant of weld].
Weaving amplitude	<Arc Constant> - "Modification order" in [12 Weaving Condi ion].
Manual tracking input	<Service Utilities> - [29 Sensor application] - "Adjust pitch" in [11 Online Correct. of Seam Track.].

8 **At this point the conditions have only been temporarily modified.**
The changes are not reflected in the task program (or in each condition file).

To save the modifications, perform the following operations.

Table8.1.12 Save operations

Operation		Description/Explanation
	Press f12 <Complete>	The welding conditions after making changes are saved. The online modification is finished.
	Press [EDIT]	
	Press [WRITE/REC]	The modified welding conditions are saved. The online modification is continued.

They are automatically saved when the following commands are executed. The timing is different for the automatic storing of welding and weaving conditions.

Table8.1.13 Automatic storage timing

Command	Description/Explanation
Arc start command (AS command)	The modifications are saved when the welding conditions are modified by arc start command.
Arc end command (AE command)	The modifications to the welding conditions are saved when the welding section currently being run is finished by arc end command.
Weaving start command (WFP/WAX command)	The modifications are saved when the weaving conditions are modified by weaving start command.
Weaving end command (WE command)	The modifications to the weaving conditions are saved when the weaving section currently being run is finished by weaving end command.

POINT

To disable automatic storage of online modifications

If you do not wish to automatically store the online modifications, you can disable automatic storage with the items in Table 8.1.14.

Table 8.1.14 Automatic storage settings

Item name	Setting points
Wel ing conditions	<Arc Constant> - [3 Constant of weld]. Set "Auto. storing for online mod." to "OFF".
Weaving conditions	To enable/disable automatic storage, <Arc Constant> - [12 Weaving operation condition settings]. Set "Auto. storing for online mod." to "OFF".

or R

9 **Press f11 <Cancel> or [RESET/R] if the changes are not to be saved.**
>>This will exit online modification without saving the changed welding conditions.

Welding during check operations (check welding)

The check welding function runs arc welding executed step by step when the Check Go operation is performed for arc welding sections in teach mode. (Arc welding is not executed with check back operations.) For further information about check operations, please refer to both "Chapter 4 Teaching" in the “BASIC OPERATIONS MANUAL”, and to "Chapter 3 Preparation and Automatic Operation of Arc Welding Programs" in this manual.
By using this function, arc welding can be done without performing automatic operations. This simplifies operations such as setting conditions, performing tack welding and reworking sections where the welding is incomplete.

IMPORTANT

- This function cannot be used for a tandem pulse GMA robot system.
- This function does not support the multi-pass welding system.

Preparing for check welding (allocation in f key)

Check welding is enabled or disabled using an f key. If it is set to ON, welding is performed during Check Go. No welding is done if it is set to OFF.
However, the f key used to set Check Welding to ON or OFF is not allocated as an initial setting when the system is shipped. To use the Check Welding function, refer to "Chapter 7 Useful Function" in the “BASIC OPERATIONS MANUAL”, and allocate the function in Table 8.3.1.

Table 8.3.1Function name and code

Function	Code
Check Welding ON/OFF setting	2217

IMPORTANT

Please do not allocate the "Check welding ON/OFF" f key to the following locations.

- f1, f13, f25 (keys allocated to <soft key selection>)
- [ENABLE] + f1 to f36

Switching check welding between ON and OFF

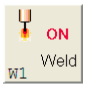
Check Welding can be switched ON/OFF using the <Check Weld> assigned to an f key.
The current status can be checked by the <Check Weld> f key display. A beep is sounded while Check Welding is ON.

Table8.3.2 Check welding setting statuses

Setting status	Description
	Check welding is OFF. No welding is executed even when the Check Go operation is performed for the welding section.
	Check welding is ON. While check welding is ON, a continuous beep is sounded to remind the operator to proceed with caution. Welding is executed when the Check Go operation is performed for the welding section in this status. The setting is automatically set to OFF when any of the following operations has been performed. • When an operation for selecting a welding power supply has been performed • When an operation for changing a mode has been performed • When f1 <Switch keys> has been pressed • When any one of the menus has been displayed by operating an f key • When [ENABLE] has been pressed • When [RESET/R] has been pressed
 (Shaded)	Check Welding cannot be enabled (one of the following statuses applies). ・The operator has the qualifications level of *USER* or *BEGINNER*. ・"Function playback during check" in <Service Utilities> - [1 Teach/Playback condition] hasn't been set as "All". ・The teach mode is not the currently established mode. ・Arc welding is not the currently selected application. ・The welding power supply has not been registered. ・The current unit is the control unit (when the multi-unit specifications apply). ・The welding power supply currently selected is not registered to the current unit.

Switching check welding between ON and OFF

Set the operator qualifications level to *EXPERT* or above beforehand.



1 **Set <Welding ON/OFF> to ON.**

2 **Press <Check Weld>.**

>> The f key displays changes, and a continuous beep is sounded.

3 **Welding is now performed in the welding sections if the Check Go operation is performed in this status.**

IMPORTANT

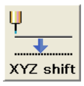
> The welding ON/OFF status always takes precedence.
> The status must be "Welding ON" for the check welding function to be performed.

Executing the collective shift of a welding section

The collective shift of a welding section is performed by the following operation.

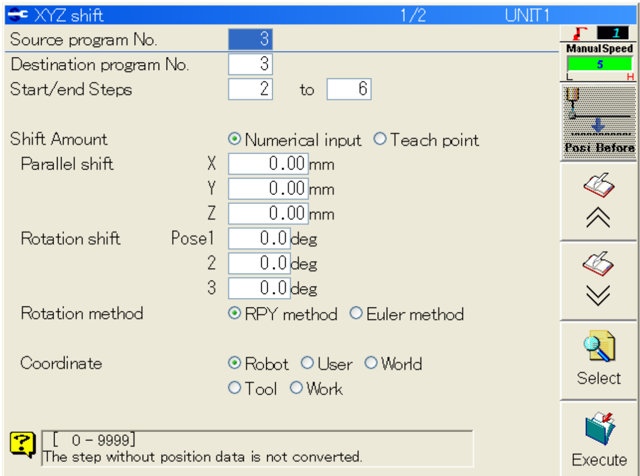
Performing the collective shift of a welding section

1 **Select the program to shift, and perform the check operation to get the welding section to shift.**



2 **Press <XYZ shift>.**

>>The following screen will be displayed. At that time, the "Source program No." and "Start/end Steps" of the currently selected welding section will automatically be entered.



POINT

Welding section is automatically set to shift object step

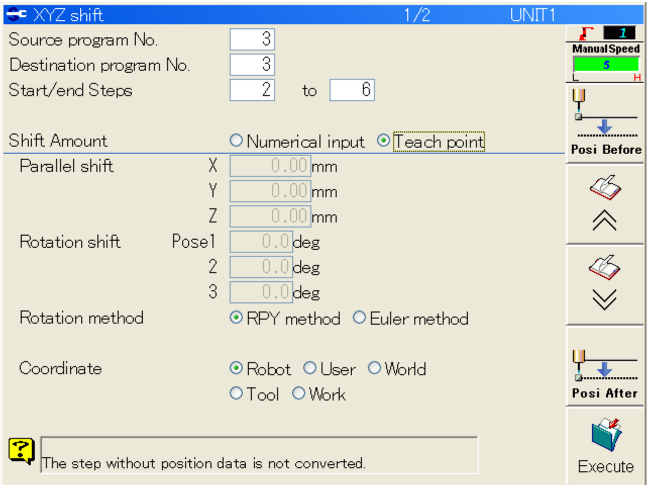
If the parallel shift function is selected when the current step is in the welding section, the default value of the shift condition's shift start/end step is the arc start point/arc end point step.
However, if the current step is outside the welding section, the default value of the shift condition's shift start/end step is the first/last step of the program.

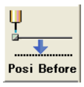
3 **When the amount of shift is specified by "numerical value input".**

Each amount of shift is entered as a numerical value.

When the amount of shift is specified by "storage location value".

The amount of shift is set by operations 4~6 below.

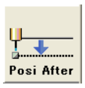




4 **Press f8 <Pre-conversion reference>.**

>> The current position is set as the pre-conversion reference.

5 **The robot is moved for the amount of the shift from the location in 4 by a manual operation.**



6 **Press f11 <Post-conversion reference>.**

>>The amount of movement from 4 to 6 is set as the amount of shift.

IMPORTANT

f11 <Select> is displayed instead of f11 <Post-conversion reference>

While "origin program" or "destination program" is selected, f11 <Post-conversion reference> becomes f11 <Select>. If you set the amount of shift with the "storage location value", please do so with items that exclude these selected.

Shift amount input range

If the amount of movement in 5 exceeds the shift amount input range, the upper and lower limits of the amount of shift are set.
The input range of the shift amount can be changed by <Constant Setting> - [3 Machine constants] - [6 Shift Amount Limit].

7 **Press f12 <Execute>.**

>>Parallel shift will be executed.

Displaying the torch angles

This section explains the function to display torch angles on the axis monitor (hereafter referred to as the torch angle display function).
Monitoring the torch angles with this function makes it possible to teach while checking the push/drag angles with respect to the welding direction (torch advance direction), which serves as a welding condition, and while checking the work angles.

The torch angle is displayed based on the following coordinate system.

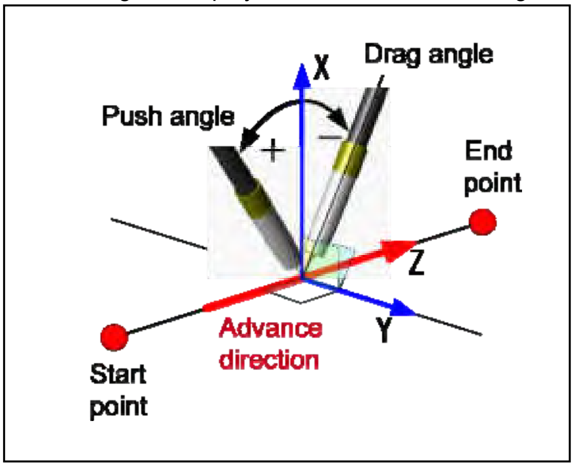


Fig. 8.8.1　Push/drag angle

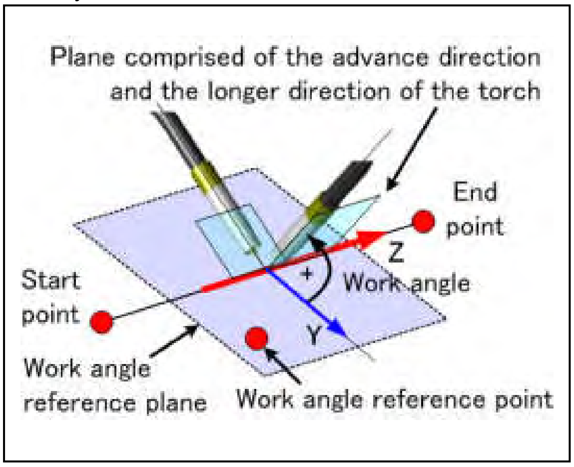


Fig. 8.8.2　Work angle

The “reference plane” must be set so that the work angle is 0 degrees. The “reference plane” is set in the torch angle display by setting the “Base coord of work ang” and the “Base plane of work ang”. For example, the XY plane of the machine coordinate system can be set as the “reference plane” by setting the “Base coord of work ang” as the machine coordinate system and the “Base plane of work ang” as the XY plane.

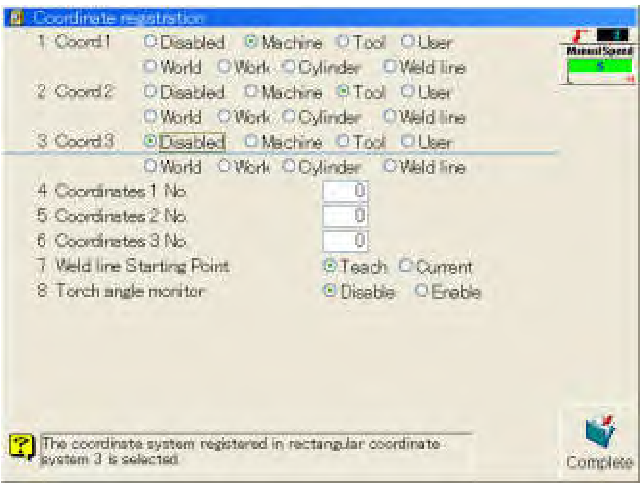
Setting the torch angle display

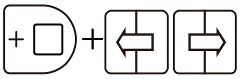
To enable the torch angle display, switch the function to enabled using the constant setting.
For this procedure, the operator must be qualified as *EXPERT* or above.

Setting the torch angle display to enabled

1 **In teach mode, press <Constant Setting> - [5 Operation Constants] - [5 Coordinate registration].**

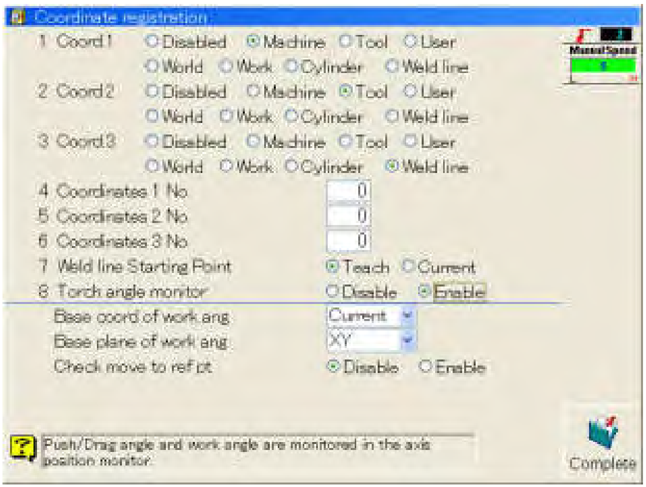
>> The setting screen on which to register the orthogonal coordinate system is displayed.

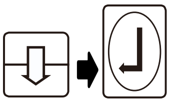




2 **Bring the cursor to "8 Torch angle monitor", press [ENABLE] + [Right] and select "Enable".**

>> The setting items for the torch angle display are now displayed.



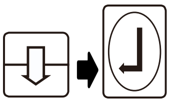


3 **Select "Base coord of work ang" and press [ENTER].**

>> The coordinate system is selected from the following items.

Table 8.8.1 Work angle reference coordinate system

Item name	Description		
Current	During a manual operation	The selected manual operation coordinate system becomes the "Base coord of work ang".	
	During an automatic operation	Simultaneous (without H)	The machine coordinate system becomes the "Base coord of work ang".
		Cooperative (with H)	The work coordinate system becomes the "Base coord of work ang".
Machine	The selected coordinate system becomes the "Base coord of work ang".		
User			
Absolute			
Work			



4 **Select "Base plane of work ang" and press [ENTER].**

>> The reference plane is selected from the following items.

Table 8.8.2 Work angle reference plane

Item name	Description
XY	The coordinate system plane selected in the "Base coord of work ang" becomes the "Base plane of work ang".
YZ	
ZX	

5 **Press f12 <Complete>.**

>> The torch angle display is now enabled, and the work angle reference plane is set.

Axis monitor display

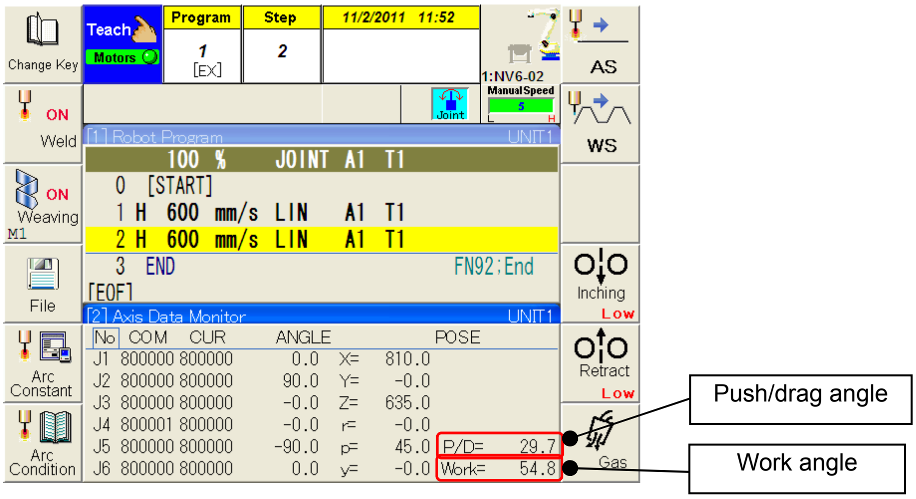
Displaying the axis monitor

Service Utilities

1 **Press <Service Utilities> - [Monitors 1 to 4] - [2 Axis Position].**

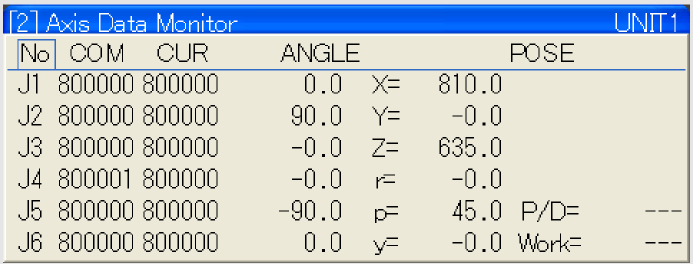
>> The axis monitor starts up, and the torch angles are displayed.

When the torch angle display is enabled



IMPORTANT

(1) Under the following conditions, the torch angles are not displayed, and "---" will appear instead.
- When the program has not been selected
- When the positions defining the direction of movement are the same points



(2) The direction of movement is defined using the teach point positions. It is not affected by compensation provided by the sensor commands or shift commands.

No. 1L22150D-E-1

OTC DAIHEN Corporation

Almega FD series

INSTRUCTION MANUAL

MULTI-UNIT

	■ Read and follow these instructions and all safety blocks carefully. ■ Have only trained and qualified persons install, operate, or service this unit.
	■ Give this manual to the operator.
	■ For help, call your distributor.

DAIHEN Corporation

Introduction

What the multi-unit function does

The multi-unit function divides up all the mechanisms connected to a control unit into a number of groups called "units" and controls the robot on a unit-by-unit basis.
The units are preset prior to shipment from the factory or prior to delivery in accordance with what the user has specified.

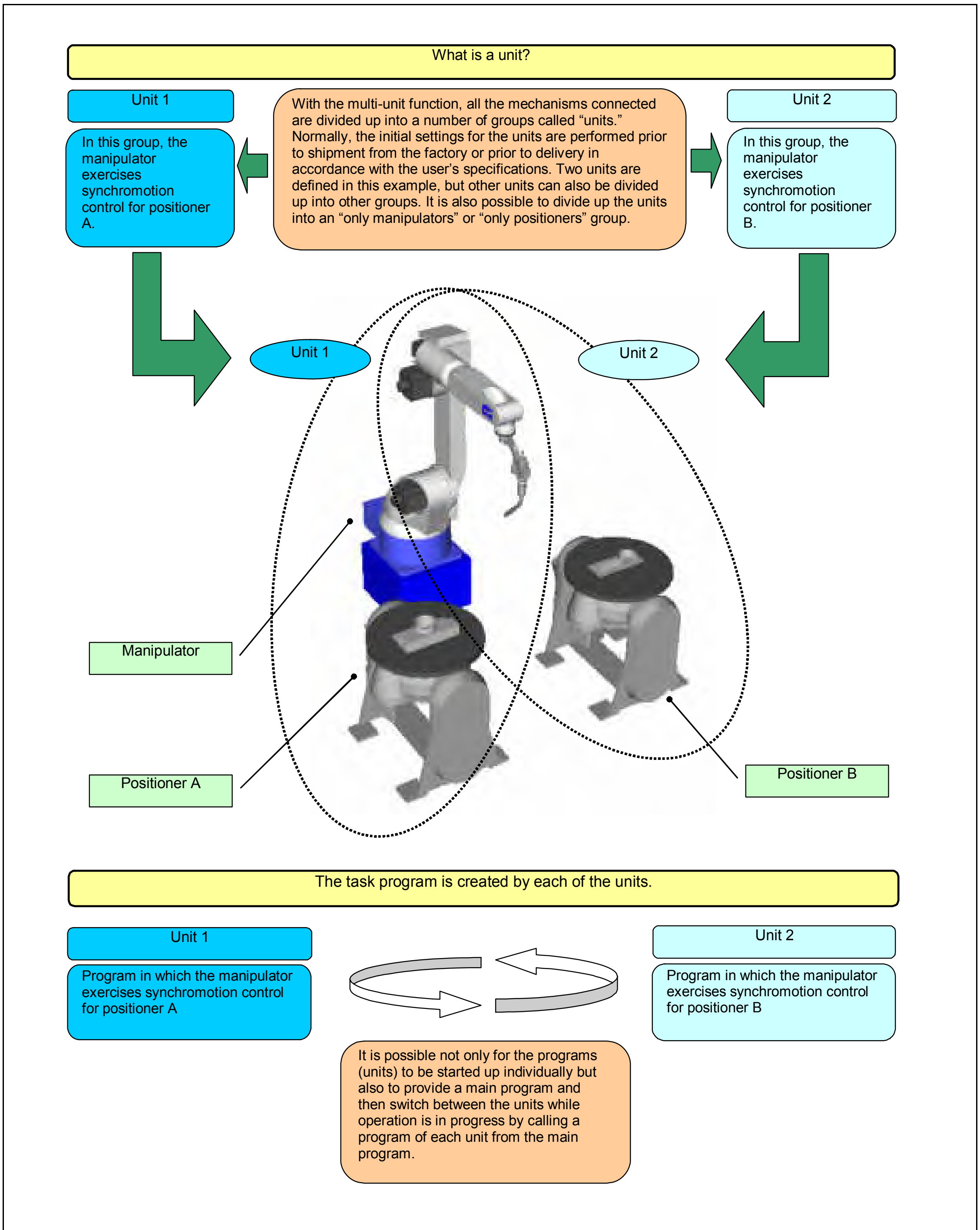


Fig. 1.1.1 Thinking behind the multi-unit (with multi-cooperation robots)

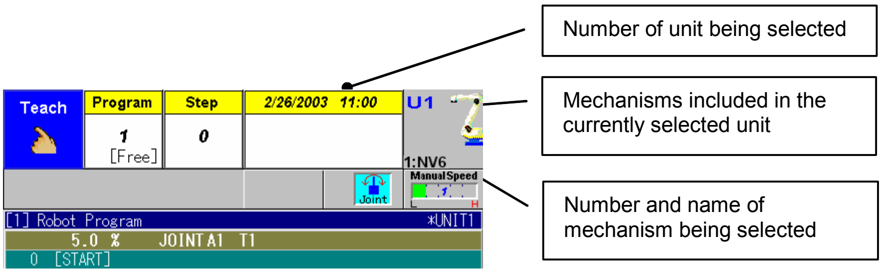
Basic Operations

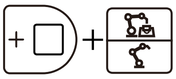
Switching between units

Before proceeding with teaching or manual operation, the units to be operated must first be selected. Motor power may be either on or off.

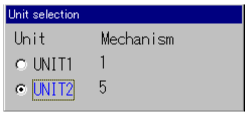
Switching between units

1 The currently selected unit and the mechanism defined for it are displayed on the teach pendant.
Confirm the current unit selection by checking the display of the teach pendant.

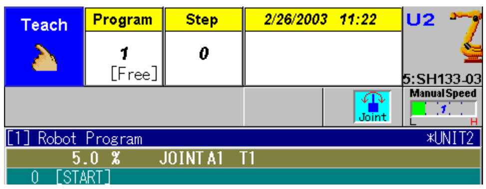




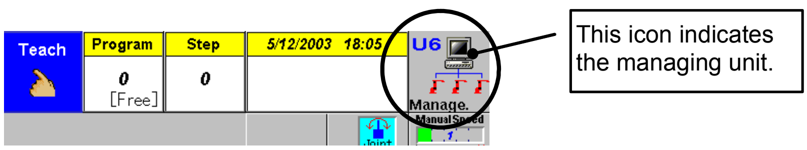
2 **Press [UNIT/MECHANISM] while holding down [ENABLE].**
>>The unit selection screen is displayed while [ENABLE] is held down.



3 **The units are switched in sequence by pressing [UNIT/MECHANISM] while [ENABLE] is held down so switch to the desired unit.**



4 **When the managing unit has been defined, it is selected by performing the same operations.**
The managing unit can be distinguished by the icon displayed below.
(Shown below is an example that the managing unit has been defined for the unit 4.)



Switching between mechanisms

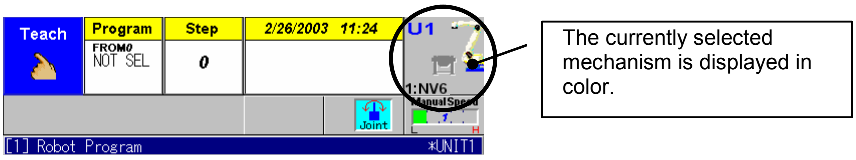
If a multiple number of mechanisms are connected to the units, select the mechanism to be manually operated.
Motor power may be either on or off.

POINT

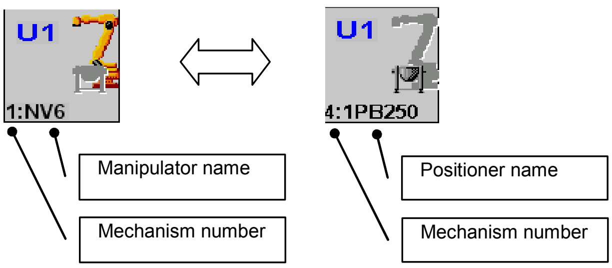
When selecting the mechanism to be manually operated, be absolutely sure to switch to the unit which belongs to the mechanism in question. Mechanisms which are not defined for the units cannot be operated manually.
For instance, it is assumed that the current unit is unit 1 and that NV6 is the only mechanism defined. In this case, mechanisms other than NV6 cannot be operated manually while unit 1 is selected.
In addition, when the managing unit has been defined, any mechanism cannot be operated manually since the managing unit does not have mechanisms.

Switching between mechanisms

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



2 To switch the mechanism, press [UNIT/MECHANISM].
>>The selected mechanism changes (and the display of the teach pendant changes).
An example of switching in a unit comprising a manipulator and a positioner is shown below.



3 After switching the mechanism, manual operation using the newly selected mechanism is possible.
While holding the deadman switches, press the axis keys to operate the mechanism.

Preparing the program s for each unit

In the case of a multi-unit function robot, the task program is created for each unit. (The teaching is targeted at the currently selected units.) For instance, when number “100” for a new program is specified while “UNIT1” is selected, program “100” will be created as belonging to “UNIT1.”
When a prepared program is opened, operation is automatically switched to the unit to which that program belongs.
For instance, if a program belonging to unit 1 is opened while unit 2 is selected, operation is automatically switched to unit 1.

After a program has been prepared, the filename is as follows.

<u>Filename of task program</u>

Program name. ****

Program name: Prior to delivery, the system was set up using names which will easily identify programs.

For instance, when the system was set up with “UNIT1” as the unit name and “NV6” as the program name, then if new program number “100” is specified while “UNIT1” is selected, the program will be stored inside the internal memory under the name of “NV6.100.”

****: This denotes the program number.

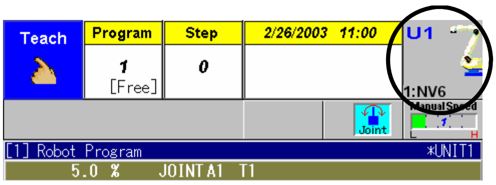
Program numbers range from 0 to 9999, and they are used in common by all the defined units.

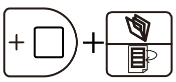
POINT

The filename (UNIT1.001, etc.) of a program appears on the teach pendant when a list of the programs is displayed or when file copy or other operations are performed.
In the case of a multi-unit function robot, there will be one program name for each unit. Therefore, unless the operator knows under what names the prepared programs have been stored, there may be some confusion when a list of the programs is displayed or when file operations are performed. The operator must remember the filenames correctly by preparing programs on a test basis immediately after the robot is delivered or by taking some other such step.

Preparing the programs for each unit

1 **Switch to the unit targeted for teaching by performing the operations described on Page 3-1 "3.1 Switching between units".**



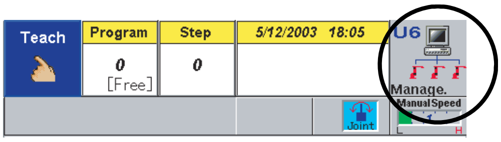


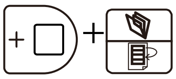
2 **Press [PROG/STEP] while holding down [ENABLE], and input the program number.**
>>A new program is now prepared.

3 **No further special steps need to be taken. Proceed with teaching as usual.**

Preparing the managing program using the managing unit

1 **Switch to the managing unit by performing the operations described on Page 3-1 "3.1 Switching between units".**





2 **Press [PROG/STEP] while holding down [ENABLE], and input the program number.**
>>A new program is now prepared.

3 **The “managing unit” refers to a special unit which has no defined mechanism and welder, and which exists solely to start the other units, call the programs, and control the input/output signals.**

Therefore, the following restrictions apply compared to other units.

- Manual operation of mechanisms is not possible. (However, the inching/retract and gas check operations for welders are possible.)
- Teaching of movement commands is not possible.
- Teaching of function commands regarding welding and sensors is not possible.
- Teaching of function commands controlling movement of mechanisms is not possible.

Copying programs between units

Copying files using shortcut R115 (program copy) or by selecting [1 File Copy] from <File> is limited to copying between identical units.

When copying programs prepared with one unit to another unit, follow the steps for “Copying programs between units” in order to reduce the number of teaching steps. (The operator must have the qualifications level of *EXPERT* or above.)

However, programs can be copied only when the number of axes and configuration are exactly the same. One example is copying a program prepared with unit 1 which is a separate NV6 unit to unit 2 which is another separate NV6 unit. Programs cannot be copied if the units have a different number of axes or if the type and number of their mechanism differ even though they have the same number of axes.

(1) Examples where programs can be copied
If the copy source and copy destination units have exactly the same number of axes and configuration, programs can be copied between these units.
However, if the configuration includes a multiple number of mechanisms, the numerical sequence of the mechanisms must be the same for both the copy source and copy destination units.

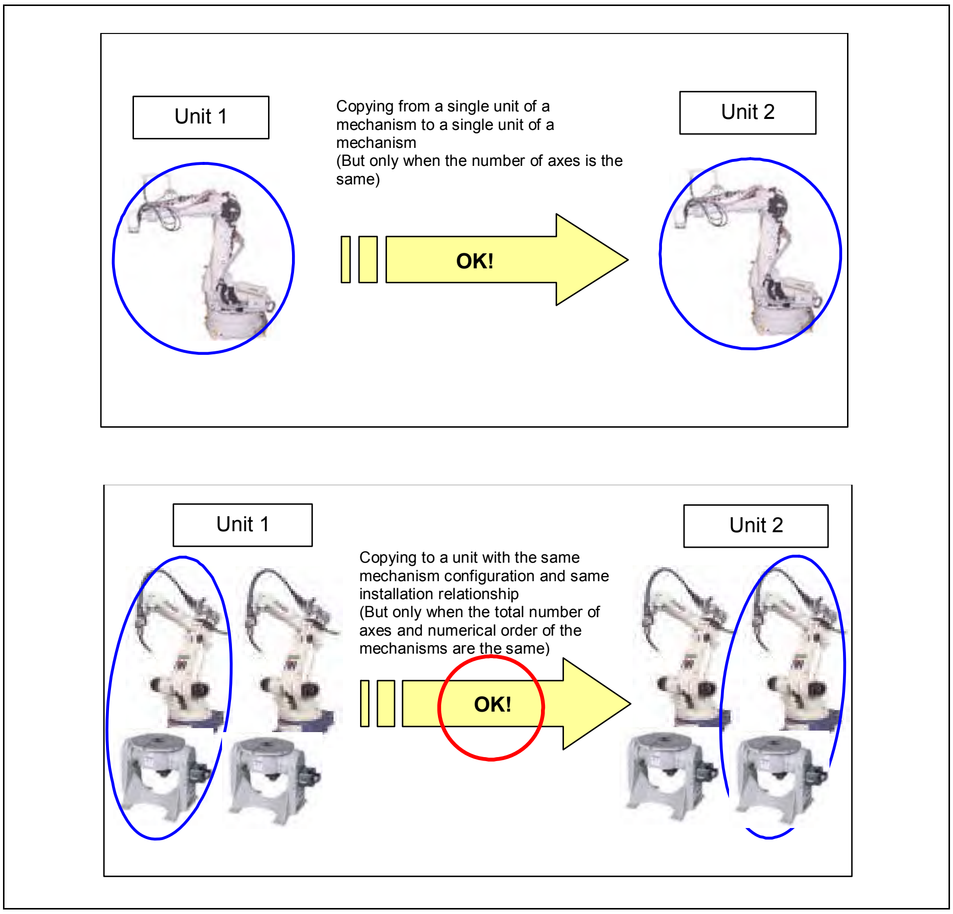


Fig. 3.4.1 Example where programs can be copied

(2) Examples where programs can be copied but changes must be made

When, as shown below, units such as ones capable of switching positioners A and B which are subject to cooperative control have been defined, programs can be copied between the unit. However, major changes must be made to the positions.

For instance, the program for unit 1 below contains the jobs recorded for the work installed on positioner A. If this program is copied into unit 2, the recorded positions for positioner A will be transferred as is in the copied program: in other words, these positions will not serve as the recorded positions for positioner B. Therefore, after a program has been copied, the positions in all the steps must be changed (or shift operation performed) so that the jobs will be done for the work installed on positioner B.

Please see Angle Shift or Mirror Shift for possible shift operations.

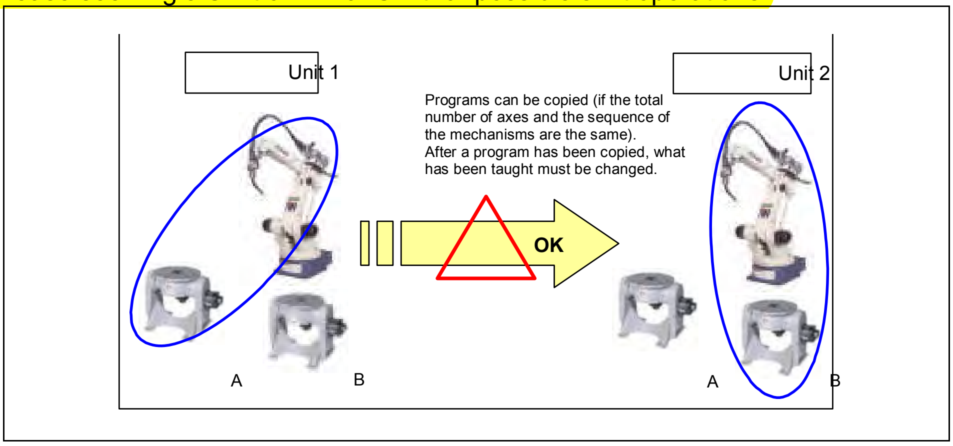


Fig. 3.4.2 Example where major changes must be made to a program

(3) Examples where programs cannot be copied

When the copy source and copy destination units have a different number of axes or configuration, programs cannot be copied between these units.

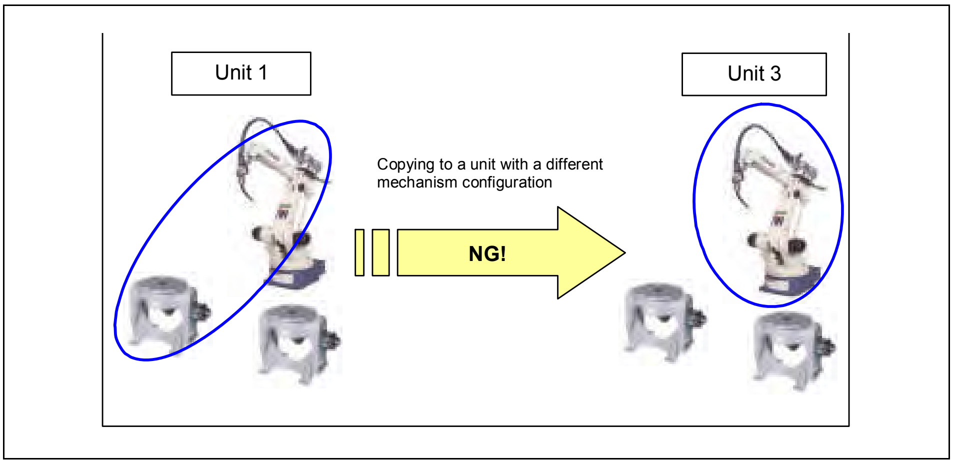
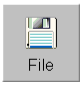


Fig. 3.4.3 Examples where programs cannot be copied between units

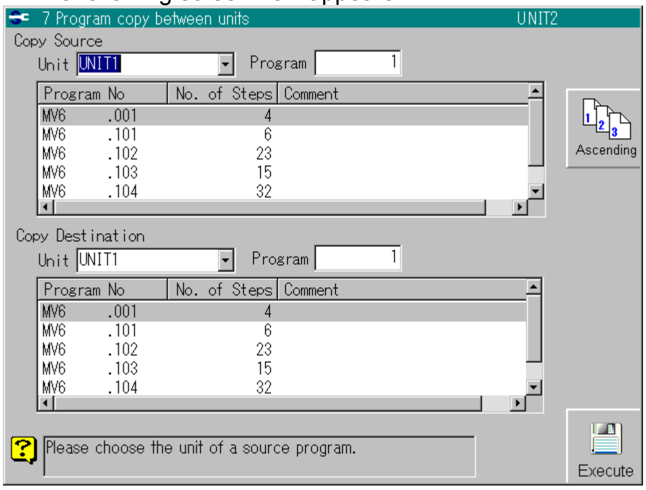
Important

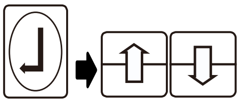
Even when programs are copied between units, the function commands are not converted.
In other words, if information relating to the units has been recorded in the parameters of the function commands, that information will not be converted.
After copying the programs, the function commands must be changed.
An instance will now be considered where welder 1 is defined as unit 1 and welder 2 as unit 2 and where the arc start command (AS) has been recorded in the program for each of these units.
Since, in a case like this, the function command will not be converted even when the unit 1 program is copied into unit 2, the arc start command (AS) in the copied program will be the command for welder 1. Consequently, this command must be changed after copying the program.

Copying programs between units



1 **After pressing <File>, select [7 Program copy between units].**
Alternatively, select <Service Utilities> – [7 File] – [7 Program copy between units].
>>The following screen now appears.



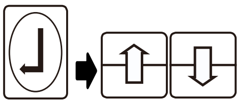


2 **Select the copy source unit. Press [Enter] in the "Unit" field, and select the unit using the [UP/DOWN] key.**
>>The program belonging to the selected unit is displayed.

At the same time, if the unit to serve as the copy destination is present, this unit can be selected in the combo box.

If the unit to serve as the copy destination is not present, only the same unit as the copy source is displayed. In this case, the same operation as simple program copying is performed.

3 **Specify the copy source program.**
Input the number of the copy source program in the "Program" field or press [Enter] on the program list to select it. By pressing [Enter] on other programs on the list one after another, a multiple number of programs can be selected.



4 **Select the copy destination unit.**

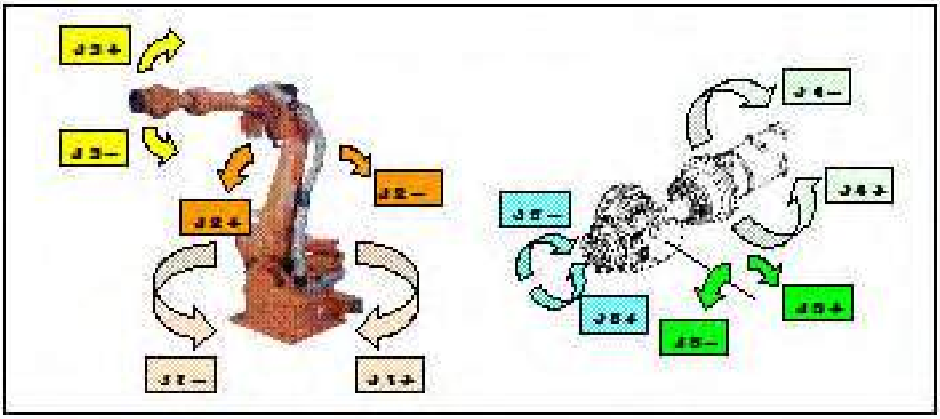
5 **Input the number of the copy destination program.**

6 **Press f12 <Execute>.**
>>The programs are now copied from one unit to another.

Service Menu

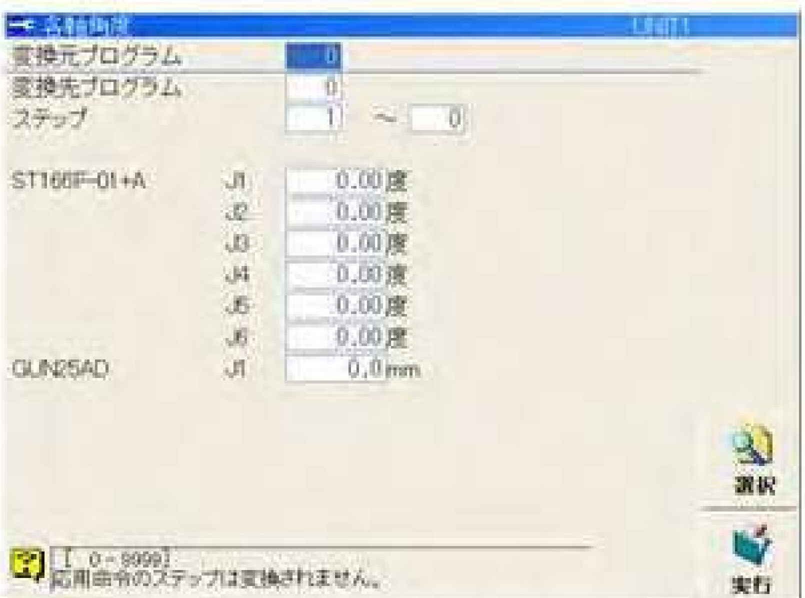
■ Program conversion / Angle

Starting from any step and extending as far as any step in any already created task program, any axis angle can added or subtracted. Its unit is "degree" or "mm or inch" depending upon axis type. +/- direction is same as manual operating direction.



CAUTION

After changes have been made to a task program, the operation check must be performed at the low speed without fail. Changes in operation may cause the robot to interfere with the peripheral devices.

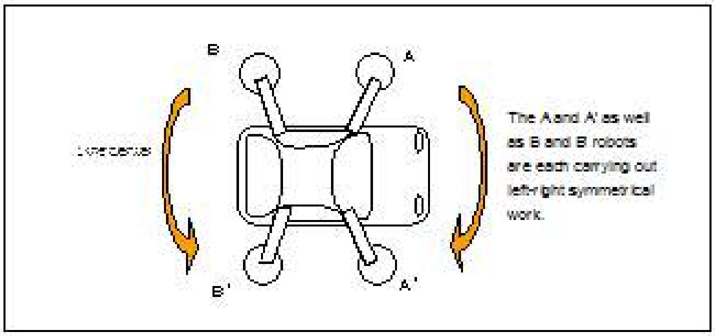


Steps with function commands are not changed by this conversion.

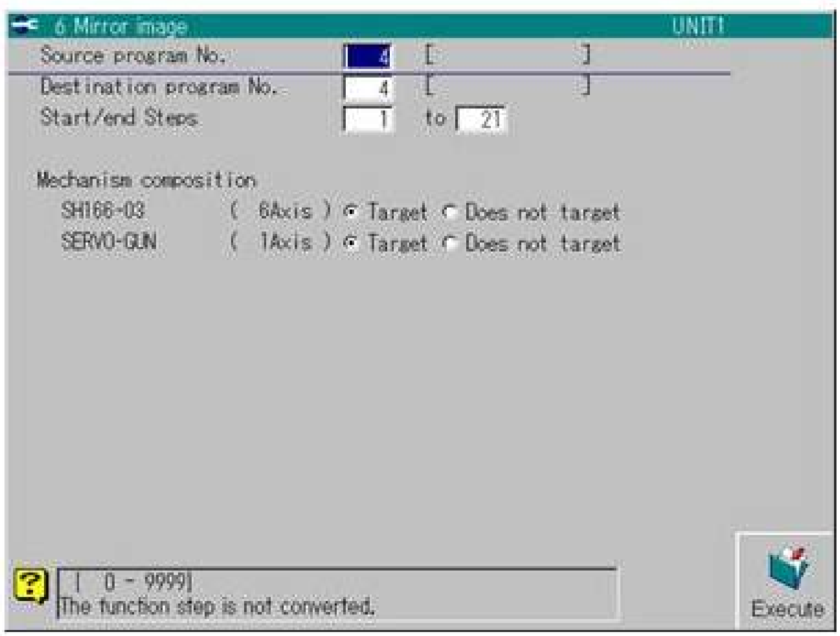
Service Menu

■ Program conversion/Mirror image

Starting from any step and extending as far as any step in any already created task program, a left-right symmetrical task program can be created as referenced to the 0-degree position of the swivel axis (J1 axis). If left-right symmetrical work is to be done as with the welding of automobile bodies, for example, use of this function reduces the time taken for the teaching work.



⚠CAUTION	**After changes have been made to a task program, the operation check must be performed at the low speed without fail. Changes in operation may cause the robot to interfere with the peripheral devices.**



Steps with function commands are not changed by this conversion.
An even more accurate mirror image is achieved by setting the 0-degree position of the J1 axis perpendicularly to the center of the line and setting the 0-degree positions of the J4 and J6 axes accurately.

Locking the unit to be displayed on the program monitor

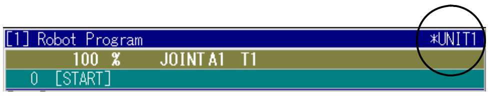
It is possible to lock the program monitor to display the data of only the specified unit.
With the initial settings, the program monitor displays the data on the “current unit.” The “current unit” refers to the unit now selected. When steps are taken to switch to another unit, this setting ensures that details of the programs previously selected by the current unit will be displayed.

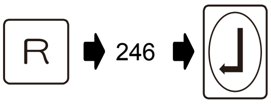
In the case of a robot with the multi-unit function, in order to enable a multiple number of units to be started simultaneously, the operator may want to check which step of the program is being executed by the current unit especially during automatic operation and at other such times. At times like this, the program monitor is set to display the data of the specified unit.

Recording, adding, overwriting and deleting instructions, specifying steps and performing other such teach operations are performed only for the current unit. For all other units (the monitor is set up to display only the specified unit), modifications can be made after starting up the screen editor. (Editing tasks with the exception of modifying the position data can be performed.)

Locking the unit to be displayed on the program monitor

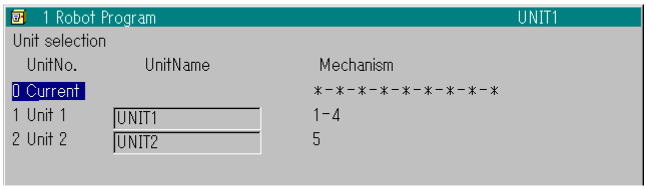
1 If the unit now selected is unit 1, the “*” and “UNIT1” characters are displayed at the top right of the program monitor screen. “*” indicates that the setting to display the current unit is established.

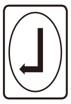




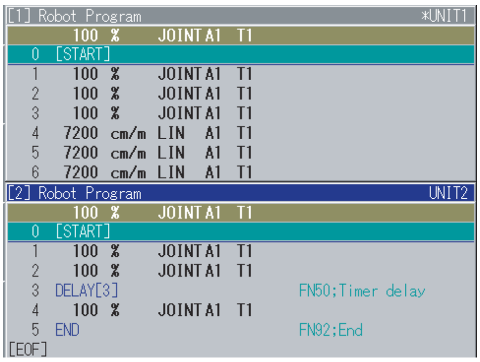
2 **As an example, the method used to switch the teach pendant display to two screens by having the display of unit 2 fixed on monitor 2 will be described.**
After pressing [RESET/R], input “246”, and press [Enter].
(The same can be achieved by selecting [4 Monitor 2] from [Service Utilities].)

3 **Select [1 Robot program], and press [Enter].**
>>The program monitor setting screen now appears.





4 **Use the [UP/DOWN] key to select “Unit 2,” and press [Enter].**
>>The unit 2 program appears on monitor 2.



5 **The teach operations are performed for the programs of unit 1 which is the current unit.**
Modifications cannot be made even when the active window has been switched to monitor 2.
However, after the active window has been switched, modifications can be made if the screen editor has been started up. (Editing tasks with the exception of modifying the position data can be performed.)

Function Command

FORK <FN450> ーUnit external startー

Outline

This command starts the task programs in the other units.

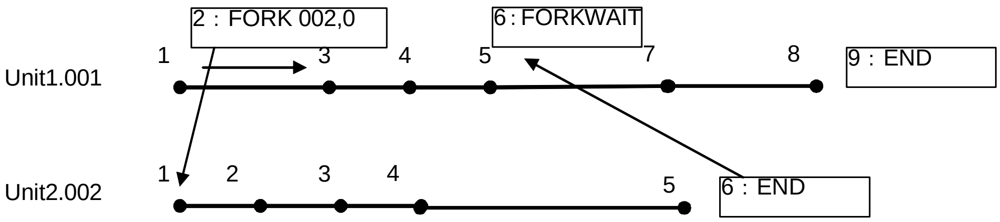
Example of operation

The specified task program is started up alongside the task program now being played back.
When the FORK command has been taught, teach the FORKWAIT command, which is for awaiting the completion of the FORK command, at the appropriate position whenever this is possible.
The FORK and FORKWAIT commands do not always need to be taught as a pair, but it is safer to do so in order to avoid contention for resources and duplicated execution of the FORK command.

```
Unit1.001
001 100% JOINT
002 FORK [002,0]
003 600cm/m LIN
004 600cm/m LIN
005 600cm/m LIN
006 FORKWAIT
007 100% JOINT
008 100% JOINT
009 END
```

```
Unit2.002
001 100% JOINT
002 600cm/m LIN
003 600cm/m LIN
004 600cm/m LIN
005 600cm/m LIN
006 END
```

: The shaded areas indicate operations performed in parallel.



■ Parameter

Parameter	Data	Details	Setting range
First parameter	Number of task program	This is used to specify the number of the program to be started.	1 to 9999
Second parameter	Resource contention wait time	In a case where the mechanism used inside the program to be started may be played back by another unit, this parameter is used to specify in seconds how long to wait for that mechanism to be released. If the mechanism is released within the specified time, the specified program starts. If it is not released, an error results.	∞ (-1)、 0 to 100

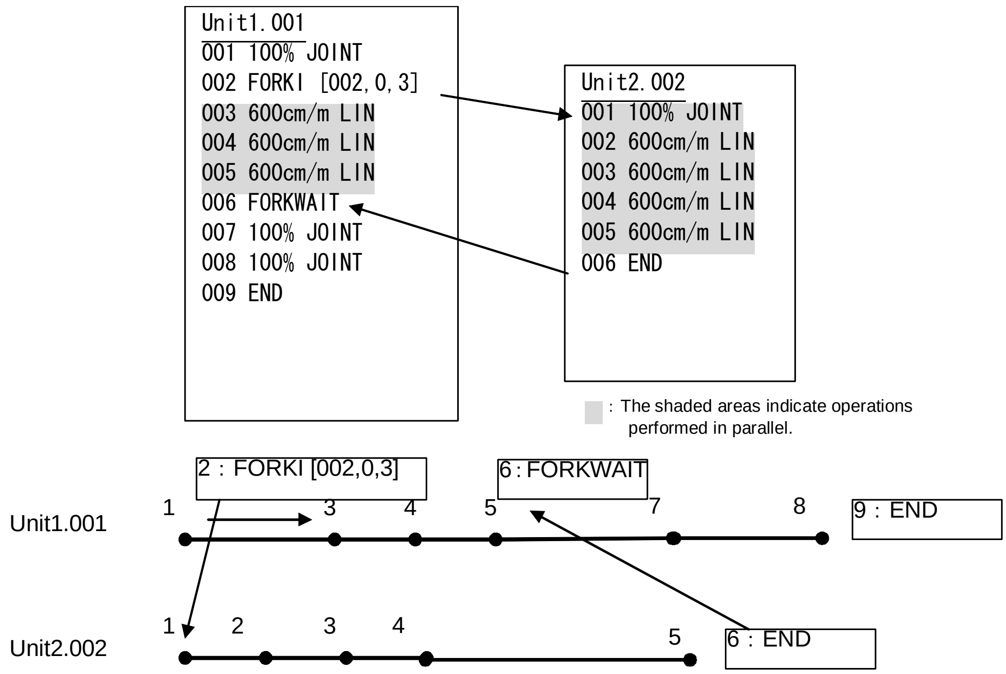
FORKI <FN451> －Unit external start (with input condition)－

Outline

This command enables a task program of another unit to be started up when its signal is input. If its signal is not input, the task program is not started up.

Example of operation

The specified task program is started up alongside the task program now being played back.
When the FORKI command has been taught, teach the FORKWAIT command, which is for awaiting the completion of the FORKI command, at the appropriate position whenever this is possible.
The FORKI and FORKWAIT commands do not always need to be taught as a pair, but it is safer to do so in order to avoid contention for resources and duplicated execution of the FORKI command.



Parameter

Parameter	Data	Details	Setting range
First parameter	Number of task program	This is used to specify the number of the program to be started.	1 to 9999
Second parameter	Resource contention wait time	In a case where the mechanism used inside the program to be started may be played back by another unit, this parameter is used to specify in seconds how long to wait for that mechanism to be released. If the mechanism is released within the specified time, the specified program starts. If it is not released, an error results.	∞ (-1) 、0 to 100
Third parameter	Number of input signal	This is used to specify the number of the input signal which decides whether the program is to be started up.	1 to 2048、5001 to 5064

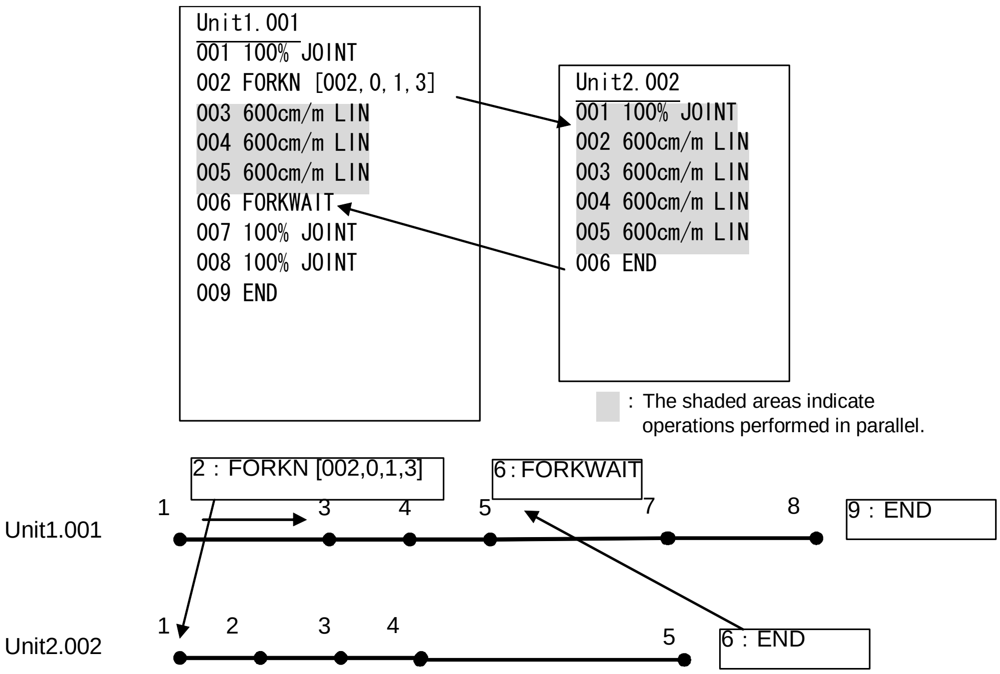
FORKN <FN452> －Unit external start (with count condition)－

Outline

This command enables a task program of another unit to be started up when the counter exceeds the specified value. If the counter shows a figure below the specified value, the task program is not started up.

Example of operation

The specified task program is started up alongside the task program now being played back.
When the FORKN command has been taught, teach the FORKWAIT command, which is for awaiting the completion of the FORKN command, at the appropriate position whenever this is possible.
The FORKN and FORKWAIT commands do not always need to be taught as a pair, but it is safer to do so in order to avoid contention for resources and duplicated execution of the FORKN command.



■ Parameter

Parameter	Data	Details	Setting range
First parameter	Number of task program	This is used to specify the number of the program to be started.	1 to 9999
Second parameter	Resource contention wait time	In a case where the mechanism used inside the program to be started may be played back by another unit, this parameter is used to specify in seconds how long to wait for that mechanism to be released. If the mechanism is released within the specified time, the specified program starts. If it is not released, an error results.	∞、0 to 100
Third parameter	Register number	This is used to specify the number of the count register.	0 to 100
Fourth parameter	Count	This is used to specify the number of times (count) for comparing the specified value with the counter value.	0 to 10000

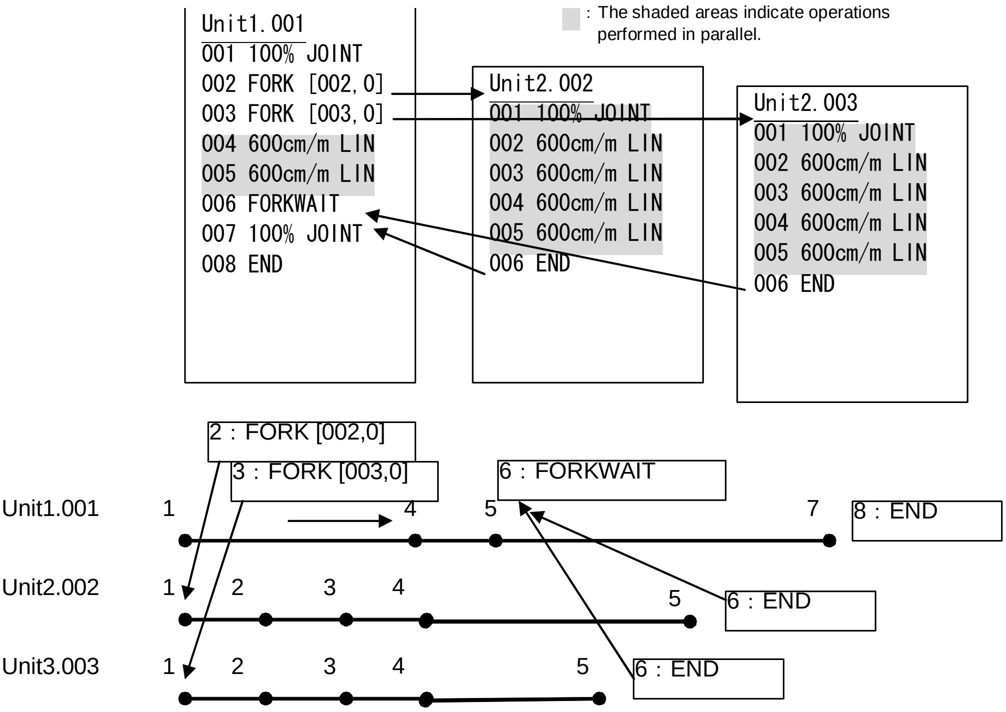
FORKWAIT <FN453> －Fork completion wait－

Outline

This command leads the robot to await the completion of the task program of the other unit which was started up by the FORK, FORKI or FORKN command.

Example of operation

When the task program specified by the FORK, FORKI or FORKN command has started up, the completion of all the programs being started is awaited.



CALLFAR <FN454> －Unit external call－

Outline

This command calls a task program of another unit.
When it is called, the execution of the existing program is suspended, and it is not resumed until the execution of the called program is completed.
Another unit external call cannot be executed by the call destination program. However, programs can be called inside the unit using the CALLP or other such commands in the call destination program (up to 8 levels).

■ Parameter

Parameter	Data	Details	Setting range
First parameter	Number of task program	This is used to specify the number of the program to be called.	1 to 9999
Second parameter	Resource contention wait time	In a case where the mechanism used inside the program to be called may be played back up by another unit, this parameter is used to specify in seconds how long to wait for that mechanism to be released. If the mechanism is released within the specified time, the specified program is called. If it is not released, an error results.	∞ (-1)、 0 to 100

CALLFARI <FN455> ーUnit external call(with input condition)ー

Outline

This command calls a task program of another unit when its signal is input.
When it is called, the execution of the existing program is suspended, and it is not resumed until the execution of the called program is completed.
Another unit external call cannot be executed by the call destination program. However, programs can be called inside the unit using the CALLP or other such commands in the call destination program (up to 8 levels).

■ Parameter

Parameter	Data	Details	Setting range
First parameter	Number of task program	This is used to specify the number of the program to be called.	1 to 9999
Second parameter	Resource contention wait time	In a case where the mechanism used inside the program to be called may be played back up by another unit, this parameter is used to specify in seconds how long to wait for that mechanism to be released. If the mechanism is released within the specified time, the specified program is called. If it is not released, an error results.	∞ (-1)、 0 to 100
Third parameter	Number of input signal	This is used to specify the number of the input signal which determines whether the program is to be called.	1 to 2048、 5001 to 5064

CALLFARN <FN456> －Unit external call (with count condition)－

Outline

This command calls a task program of another unit when the counter shows a figure above the specified value. If the counter shows a figure below the specified value, the task program is not started up.
When it is called, the execution of the existing program is suspended, and it is not resumed until the execution of the called program is completed.
Another unit external call cannot be executed by the call destination program. However, programs can be called inside the unit using the CALLP or other such commands in the call destination program (up to 8 levels).

■ Parameter

Parameter	Data	Details	Setting range
First parameter	Number of task program	This is used to specify the number of the program to be called.	1 to 9999
Second parameter	Resource contention wait time	In a case where the mechanism used inside the program to be called may be played back up by another unit, this parameter is used to specify in seconds how long to wait for that mechanism to be released. If the mechanism is released within the specified time, the specified program is called. If it is not released, an error results.	∞(-1)、 0 to 100
Third parameter	Register number	This is used to specify the number of the count register.	0 to 100
Fourth parameter	Count	This is used to specify the number of times (count) for comparing the specified value with the counter value.	0 to 10000

Start status displays and start release

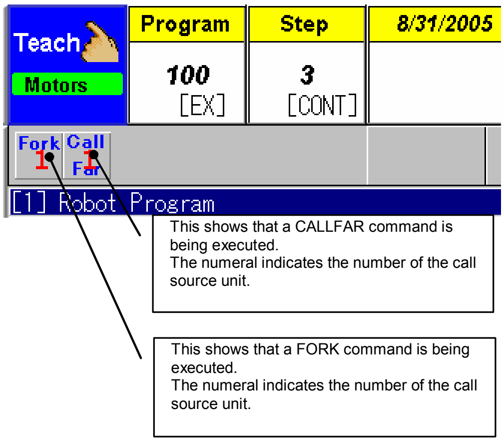
Checking the start status of programs

If programs have been started in parallel using the program start commands (FORK, FORKI or FORKN) and unit external call commands (CALLFAR, CALLFARI and CALL FARN) described in Chapter 4, it is possible to check (1) which unit is the start source (call source) and (2) which unit is now running by monitoring the display on the teach pendant.

(1) is displayed in the status area of the teach pendant.
When Multi Task Monitor is started, both statuses (1) and (2) can be checked.

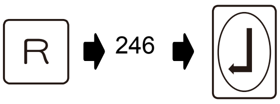
Checking the start status of programs

1 **If one of the units has been started by a FORK or CALLFAR command, the following icons will appear on the teach pendant.**



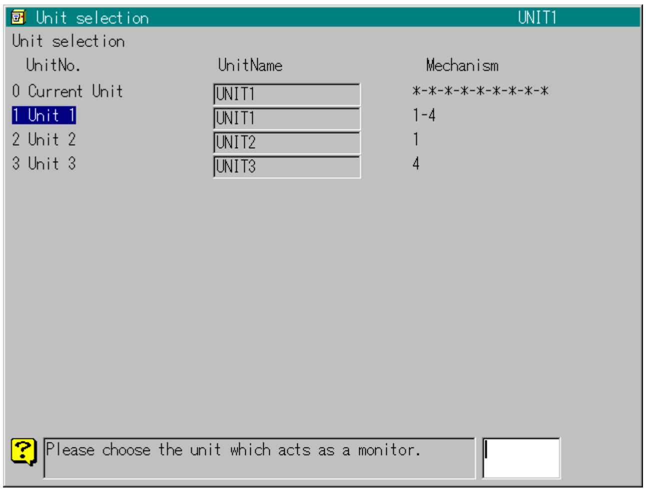
This display remains on the teach pendant even when the playback is stopped or when operation has been transferred to the teach mode.

2 **An alternative method is to start the Multi Task Monitor.**
As an example, the method used to switch the teach pendant display to two screens by having the display of unit 2 fixed on monitor 2 will be described.

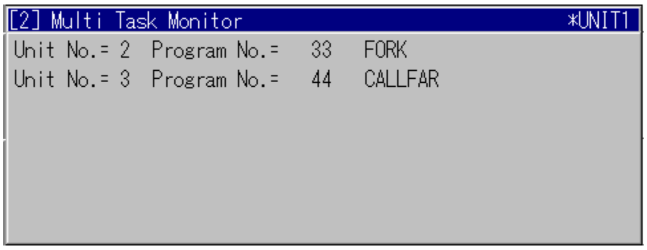


After pressing [Reset/R], input “246,” and press [Enter].
(The same result is obtained also by selecting [4 Monitor 2] from <Service Utilities>.)

3 **Select [51 Multi Task], and press [Enter].**
>>The unit selection screen now appears.



4 **Select the unit to be monitored.**
It is a good idea to select the unit whose icon is displayed on screen 1.
>>The start statuses of the units are now displayed.

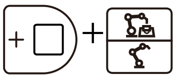


Releasing the start statuses of the programs

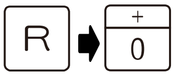
Once playback has stopped, the program may be played back again from its start. Perform the following steps in a situation like this.

Releasing the start statuses the programs

When releasing all the starts using a FORK or CALLFAR command

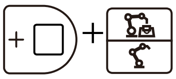


1 **Perform the unit switching operation to switch to the "call source unit."**
The call source unit is displayed on the operation 1 screen on page 5-4.

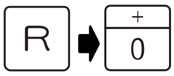


2 **Press [RESET/R], [0] and [Enter] in this sequence.**
(Execute shortcut R0 which executes reset and return to step 0.)
>>The start statuses of all the programs executed by the FORK or CALLFAR command are released (all multi-task starts are released).
At the same time, the start status icons are cleared.
The fact that the programs have not yet been started is also shown on the multi-task monitor.

When playing back only the FORK or CALLFAR destination program from the start while the start statuses remain unchanged



1 **Perform the unit switching operation to switch to the "called unit."**



2 **Press [RESET/R], [0] and [Enter] in this sequence.**
(Execute shortcut R0 which resets the step counter.)
>>The step of the selected unit is reset to "0." (The start status established by the FORK or CALLFAR command remains unchanged so the program is executed from the start when it is started next.)

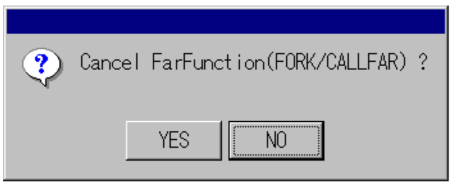
Concerning automatic release of the start status

If either of the following steps is taken in the stopped status after another program has started up from the parent program (control program) serving as the start source, the start status will be released.

(A)When the number of a step in the parent program (control program) serving as the start source has been changed
(B)When an attempt has been made to open a program which is different from the parent program (control program) serving as the start source

A confirmation message giving the option of either proceeding with the release or canceling it now appears.

1 **When either of the above steps is taken, the following message appears.**



2 **If YES is selected, the operation during which the attempt was made to release the start continues.**
If NO is selected, the operation is canceled, and the display returns to the original screen.

For operators using the multi-cooperation

What is multi-cooperation?

The multi-cooperation enables playback to be performed while the positioners serving as the target of cooperative control are switched.
If, for instance, a system consists of a manipulator and positioners A and B, cooperative control can be exercised on some occasions for the manipulator and positioner A and on other occasions for the manipulator and positioner B.

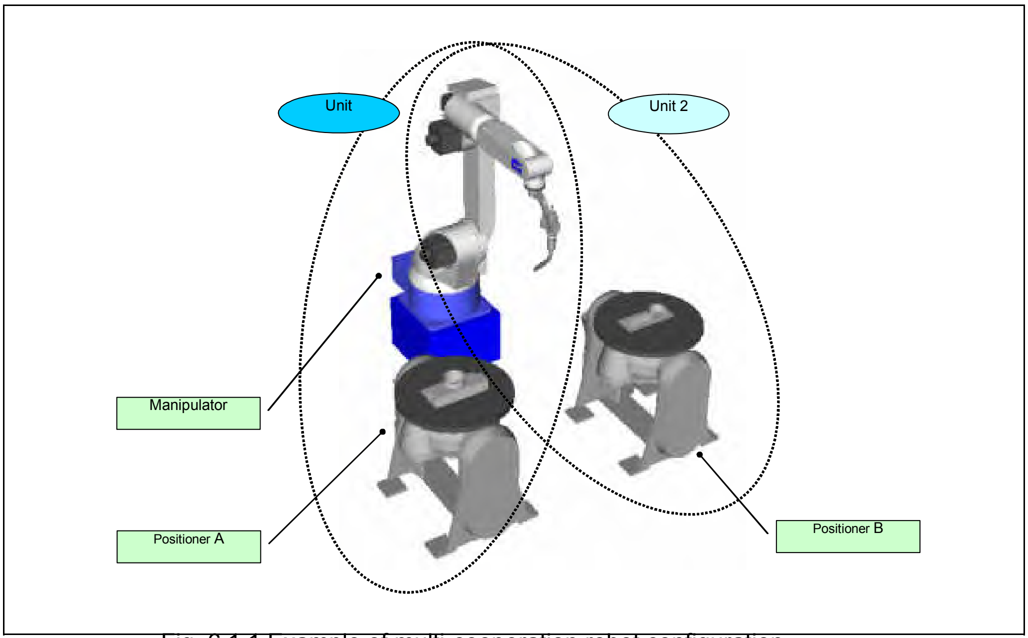


Fig. 6.1.1 Example of multi-cooperation robot configuration

Key points for teaching

With multi-cooperation robots, the simplest procedure is to prepare the main program with one of the units and then teach so that the programs of the units will be called by this main program.

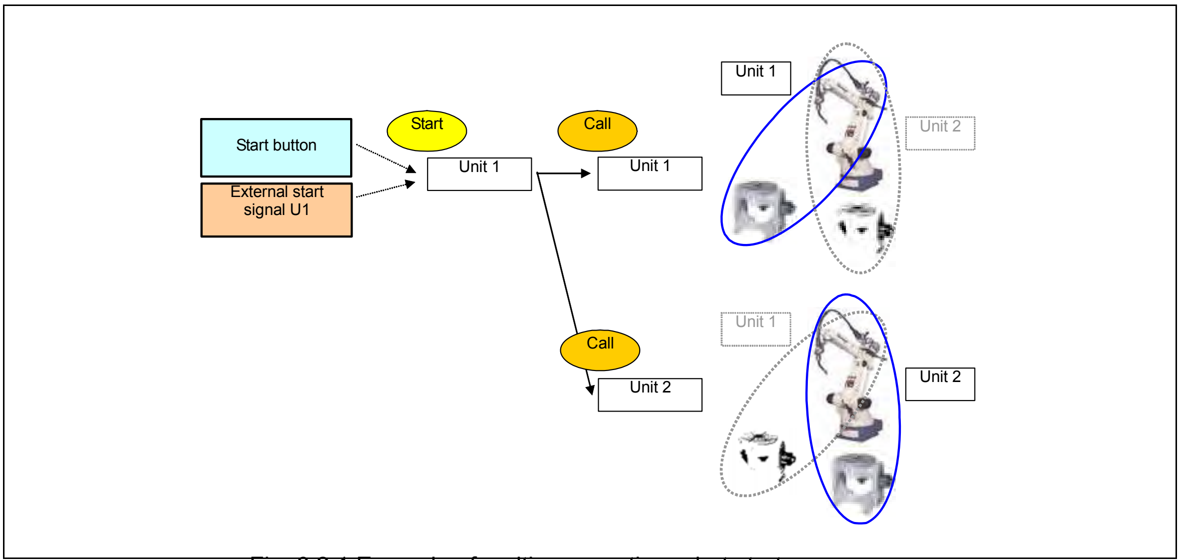
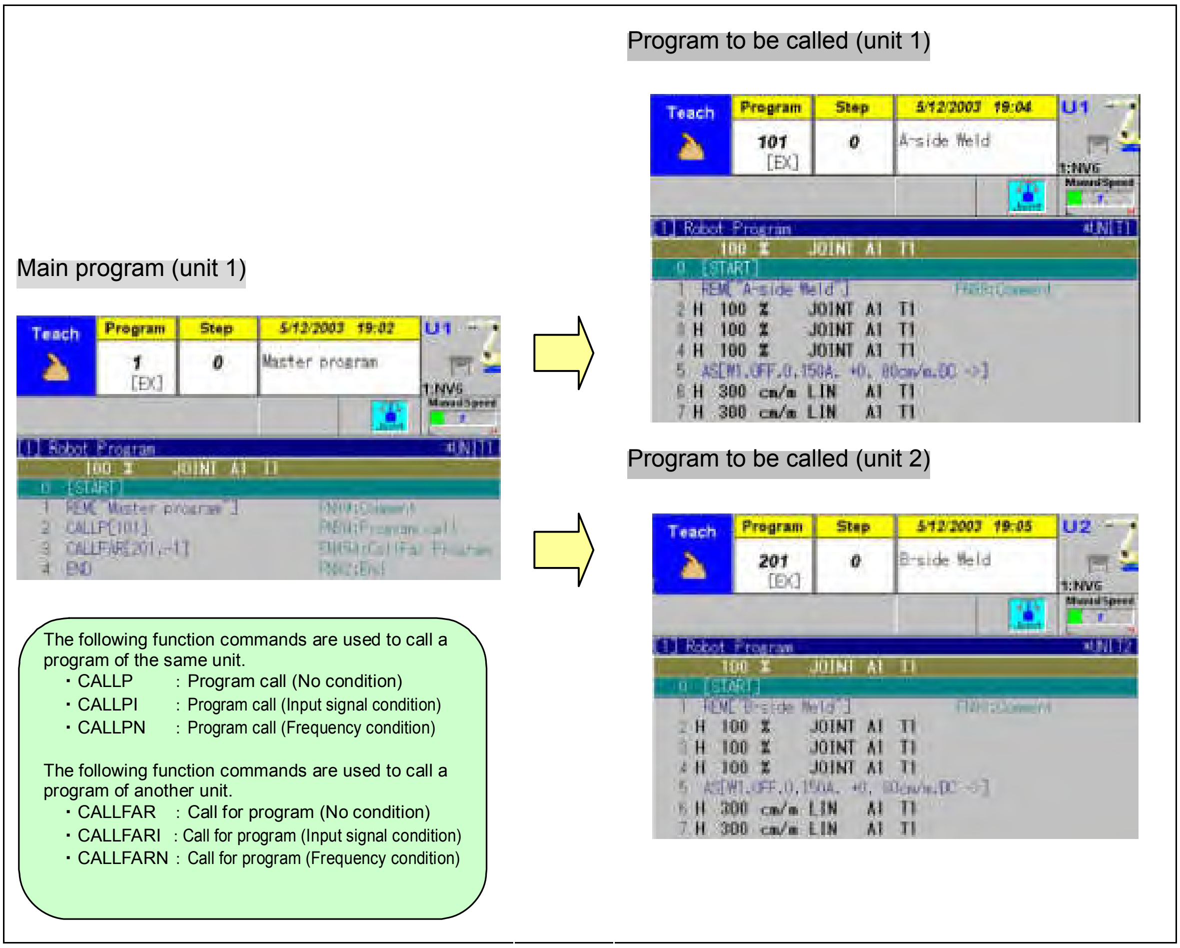


Fig. 6.2.1 Example of multi-cooperation robot startup

In the case of the diagram above, a main program prepared with unit 1 is started up, and then programs of unit 1 and unit 2 are called.



For operators using the multi task

What is multi task?

For robots with the multi-unit function, a multiple number of units can be started up in parallel from the managing unit. The “managing unit” refers to a special unit which has no defined mechanism, and which exists solely to start the other units, call the programs, and control the input/output signals. It is defined prior to shipment from the factory or prior to delivery in accordance with the user’s specifications.

By using the multi-tasks in conjunction with multi-cooperation robots, it is possible to switch dynamically between the parallel or separate tasks and the cooperative tasks, as shown below.

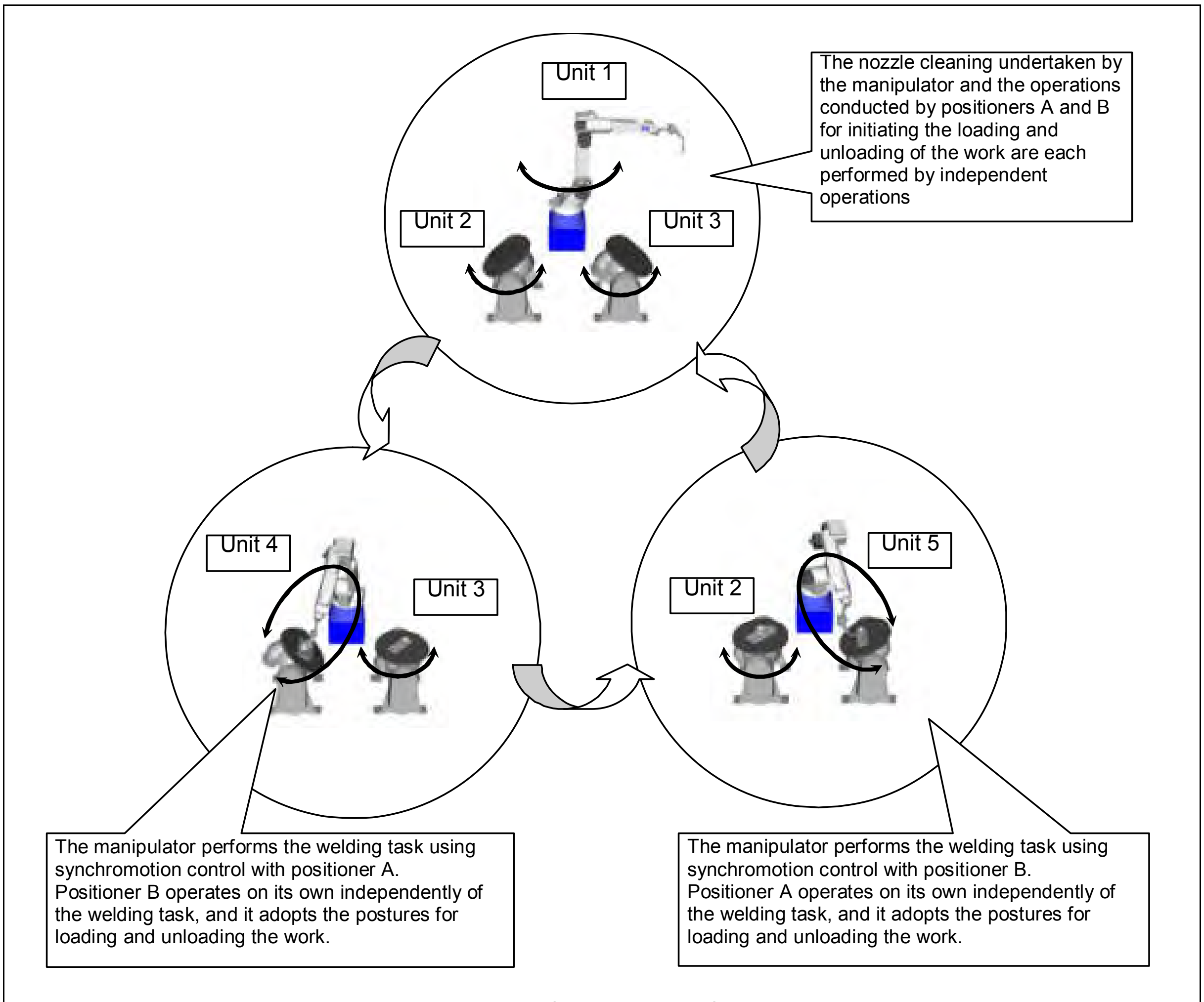


Fig. 7.1.1 Example of multi-task configuration

Key points for teaching

To facilitate the multi task, prepare the managing program using the managing unit, and teach in such a way that the units will be started up from the managing program.

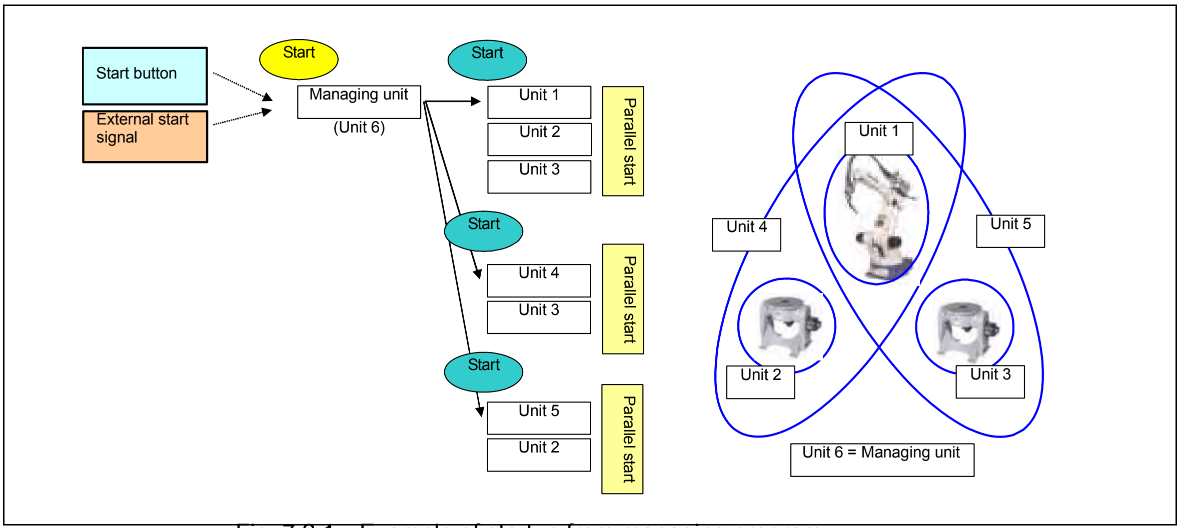


Fig. 7.2.1 Example of startup from managing program

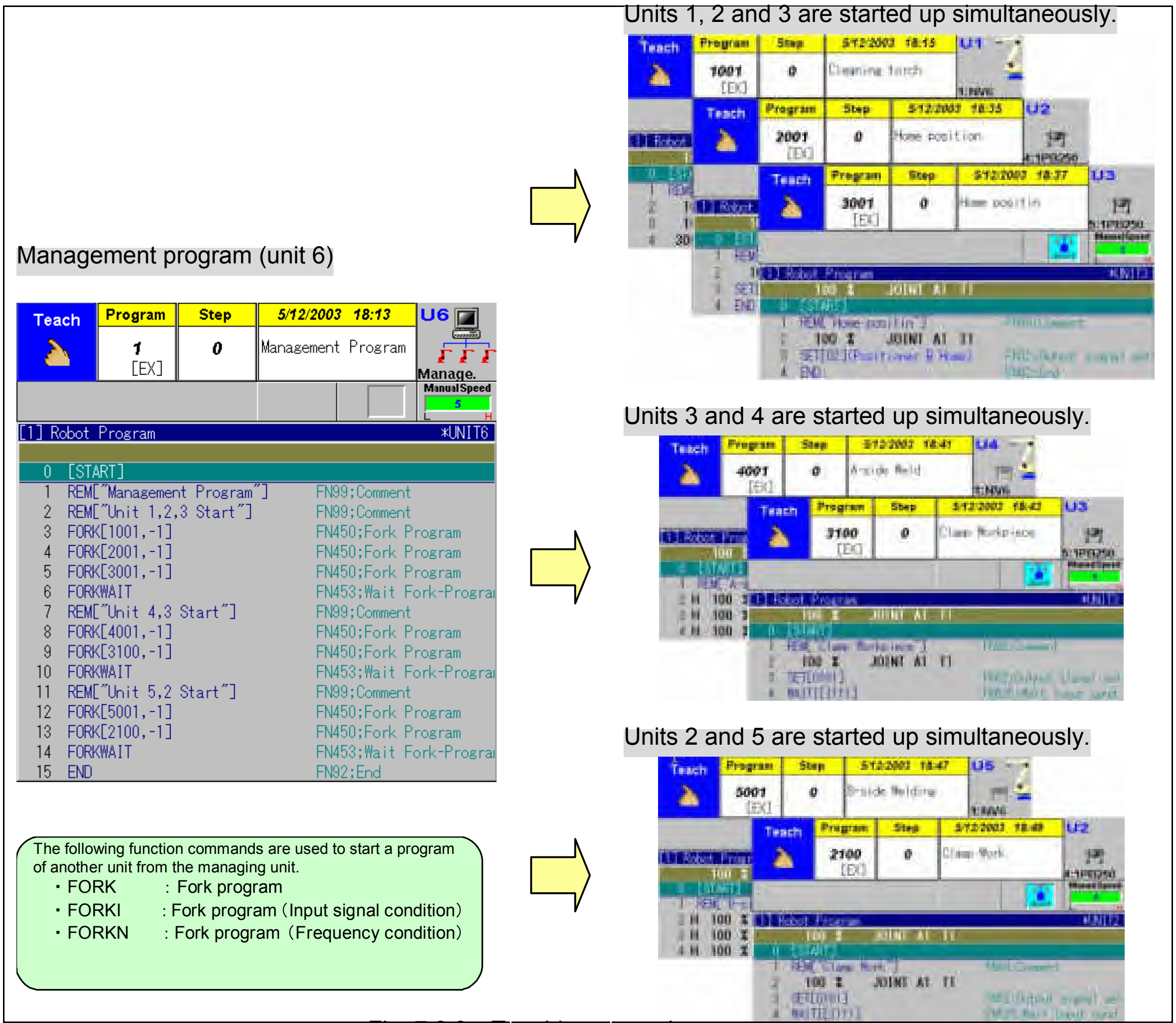


Fig. 7.2.2 Teaching example

No. 1L22150C-E-1

Almega FD series

INSTRUCTION MANUAL

SYNCHROMOTION SIMULTANEOUS CONTROL

	■ Read and follow these instructions and all safety blocks carefully. ■ Have only trained and qualified persons install, operate, or service this unit.
	■ Give this manual to the operator.
	■ For help, call your distributor.

SYNCHROMOTION SIMULTANEOUS CONTROL

DAIHEN Corporation

Control processes

This controller is equipped with the functions outlined below. They allow the controller to control multiple mechanisms connected with it simultaneously, thereby permitting the robot system to operate more efficiently overall and producing high-quality welding results. Each of your robots is configured for one of the following control processes. They are also optimally configured and fine tuned for their specific applications and modes of use.

- Simultaneous Control
- Synchromotion control (cooperative control)
- Multi-unit control

Multi-mechanism

Single unit

Simultaneous control | **Cooperative control**

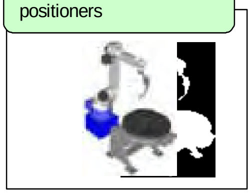
Multiple mechanisms start out simultaneously toward their target step and reach it simultaneously

Control of the position, posture, and speed of tools relative to the ground

Control of the position, posture, and speed of tools relative to the work

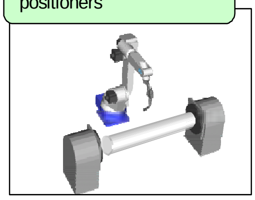
Cooperative control and simultaneous control setup example

Cooperative control of positioners

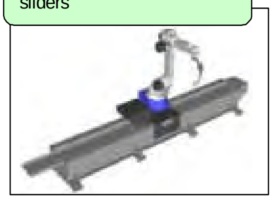


Cooperative control of positioners and sliders

Simultaneous control of positioners



Simultaneous control of sliders



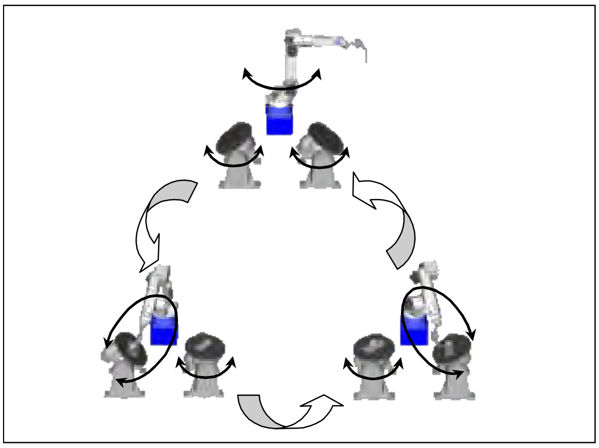
Multi unit

Cooperative control, simultaneous control, or single mechanism control for individual units

At some times, multiple units start operating in parallel and each works independently (multi task)

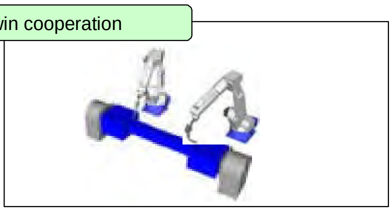
Cooperative operation at some times
Dynamic switching of targets of cooperative control (multi-cooperation)
Manipulator grips work (jig-less cooperation)
Two manipulators weld simultaneously (twin cooperation)
Multiple manipulators work in cooperation (collaboration)

Example of switching between independent, parallel operation and cooperative operation

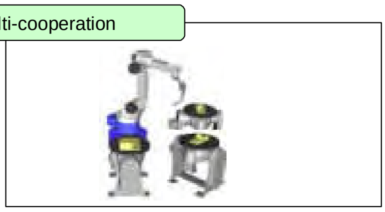


Examples of the application of cooperative control

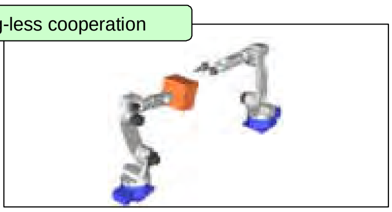
Twin cooperation



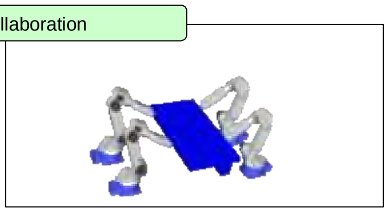
Multi-cooperation



Jig-less cooperation



Collaboration



Synchromotion control

Synchromotion control is a control process in which multiple mechanisms (manipulators, auxiliary axes, etc.) operate simultaneously and the position, posture, and speed of the tools is controlled relative to the work. It is also sometimes referred to as cooperative control.
For example, in an arc welding system configured as shown below, the manipulator could maintain at all times the optimal torch posture and speed, relative to the work mounted on the positioner.

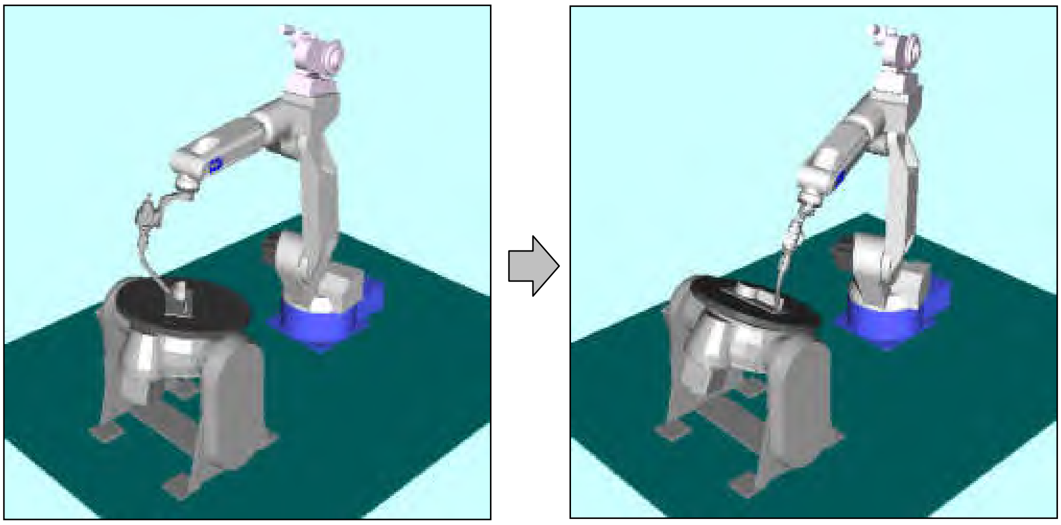


Fig. 1.3.1 Arc welding using synchromotion control

Simultaneous control

Simultaneous control is a control process in which multiple mechanisms (manipulators, auxiliary axes, etc.) operate simultaneously.
Multiple mechanisms begin to move toward their target step at the same time and they stop moving at the same time. Cooperative control allows control over position, posture, and speed relative to the work. Simultaneous control permits control the position, posture, and speed of tools relative to the ground.
Simultaneous control is sufficient for applications such as the following.

- Cases where it is possible for the manipulators to maintain an optimal posture at all times relative to the work mounted on the positioner
- Controlling sliders on which manipulators are conveyed

Multi-unit control

The multi-unit control divides up all the mechanisms connected to a control unit into a number of groups called “units” and controls the robot on a unit-by-unit basis.
The units are preset prior to shipment from the factory or prior to delivery in accordance with what the user has specified.

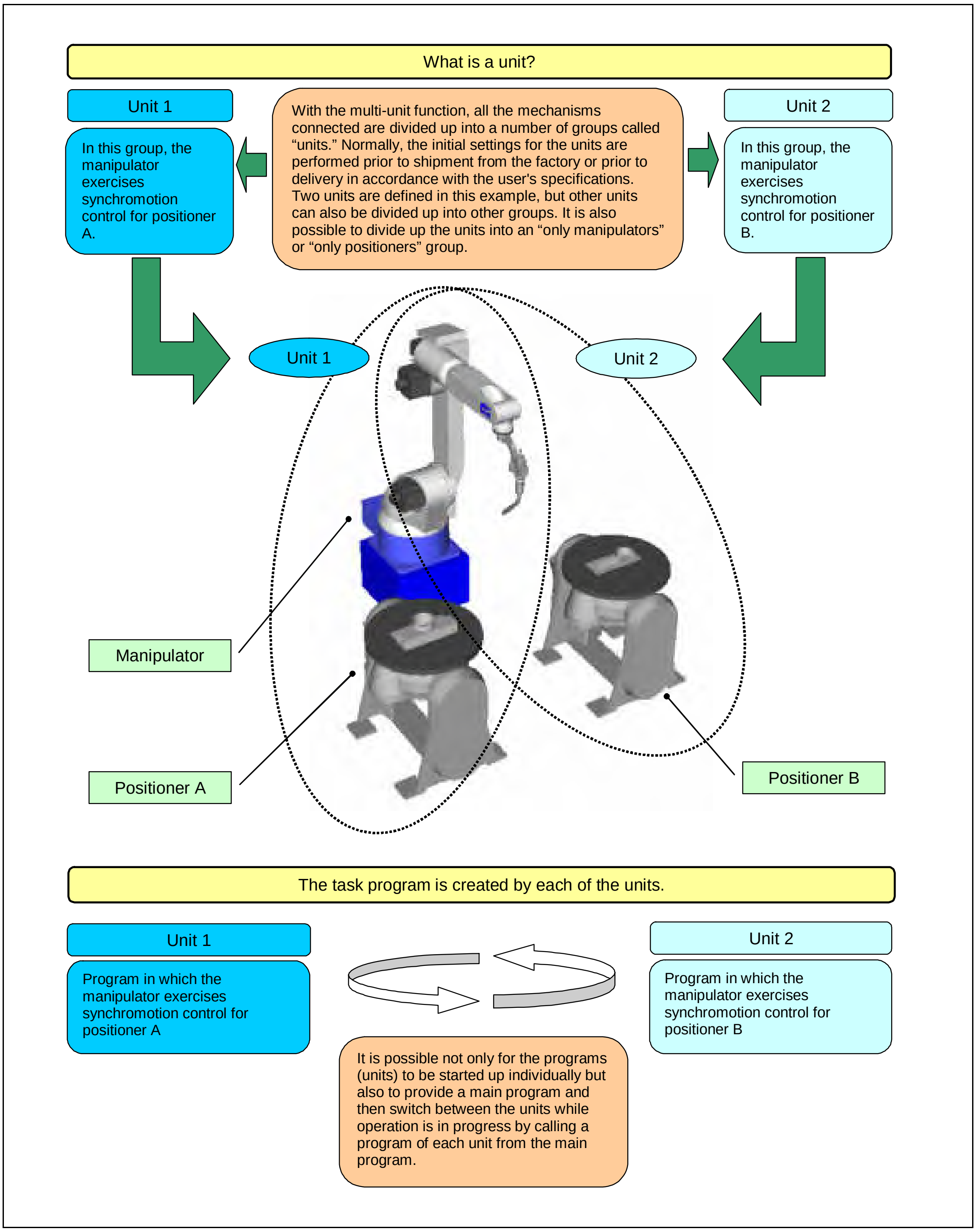


Fig. 1.3.2 Thinking behind the multi-unit (with multi-cooperation robots)

This figure shows a simple outline the concept of the multi-unit. Note that it is only one example.
By using a multi-unit, you can operate the robots more flexibly and efficiently.
For details, see the instruction manual “Multi-unit”.

Before performing teaching or manual operation

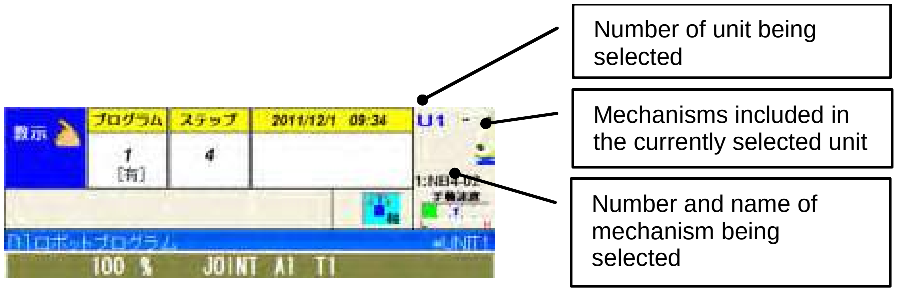
If multiple mechanisms are connected to the system, it is necessary to switch among units or mechanisms when performing teaching or manual operation.

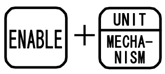
Switching between units

If the system has multiple units defined (multi-unit specification), it is necessary to first select the unit to be the target for teaching or manual operation. Motor power may be either on or off.
This operation is unnecessary if multiple units are not defined. (No switching takes place even if the unit switching operation is performed.)

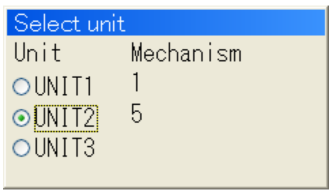
Switching between units

1 **The currently selected unit and the mechanism defined for it are displayed on the teach pendant.**
Confirm the current unit selection by checking the display of the teach pendant.

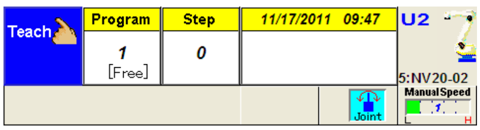




2 **While holding down [ENABLE], press [UNIT/MECHANISM].**
>> The unit selection screen is displayed while [ENABLE] is held down.



3 **The units are switched in sequence by pressing [UNIT/MECHANISM] while [ENABLE] is held down so switch to the desired unit.**



Switching between mechanisms

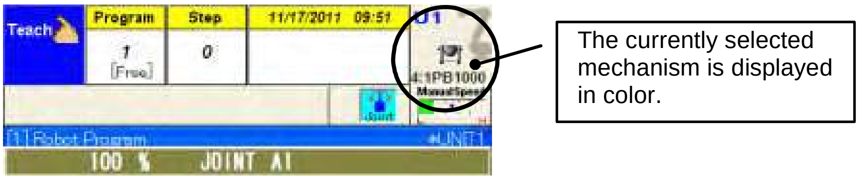
After switching the unit, select the mechanism to be used for manual operation. Motor power may be either on or off.

POINT

When selecting the mechanism to be manually operated, be absolutely sure to switch to the unit to which the mechanism in question belongs. Mechanisms which are not defined for the units cannot be operated manually.
For instance, it is assumed that the current unit is unit 1 and that NV6 is the only mechanism defined. In this case, mechanisms other than NV6 cannot be operated manually while unit 1 is selected.
In addition, when the managing unit has been defined, any mechanism cannot be operated manually since the managing unit does not have mechanisms.

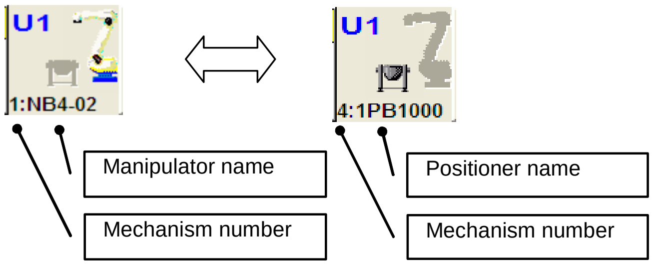
Switching between mechanisms

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



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

>>The selected mechanism changes (and the display of the teach pendant changes).
An example of switching in a unit comprising a manipulator and a positioner is shown below.



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

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

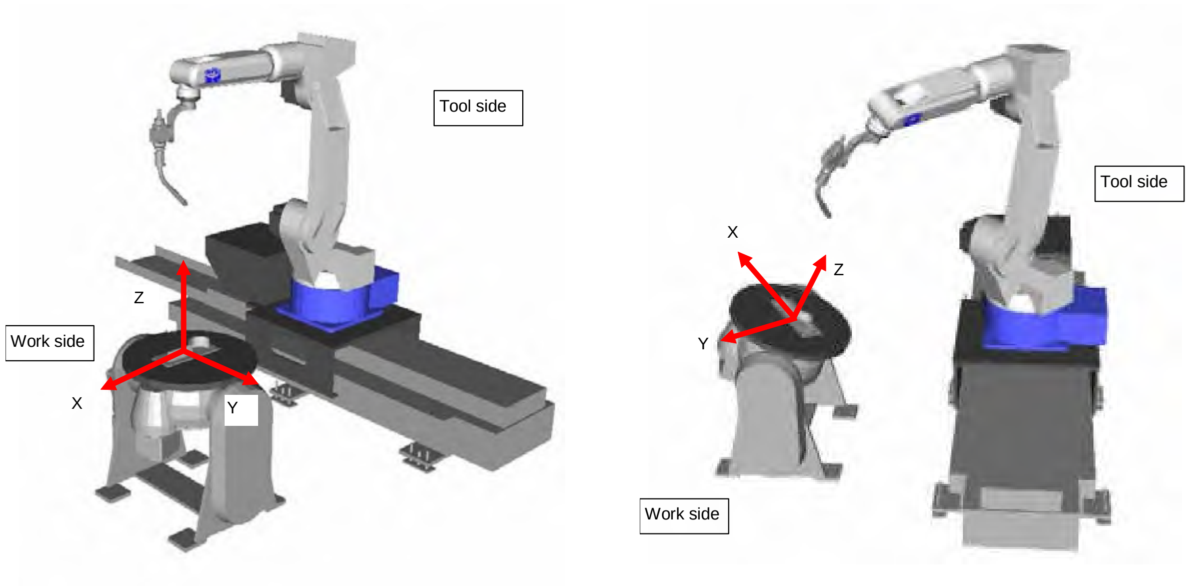
Coordinates

The coordinates used for manual operation of a manipulator are generally axis coordinates and robot coordinates (machine coordinates).
If the unit supports cooperative control, manual operation using “work coordinates” is also possible.
In addition, if multiple mechanisms are connected to the system, “world coordinates (absolute coordinates)” that are unique to the system as a whole may be selected.

- Axis coordinates
- Decalt coordinate system
  - Robot coordinates (machine coordinates)
  - Tool coordinates
  - Work coordinates
  - World coordinates (absolute coordinates)

Work coordinates

Work coordinates can be selected for units supporting cooperative control. One example would be a case in which cooperative control is used for a manipulator and an auxiliary axis (such as a positioner). Work coordinates cannot be selected for simultaneous control of the manipulator and auxiliary axis, or for the unit with the single manipulator or single auxiliary axis.
Work coordinates have a starting point and axis directions fixed at the mechanism on the work side (such as a positioner). If the mechanism on the work side moves, the starting point and axis directions of the work coordinates move with it.



Work coordinates for starting point at positioner　　Work coordinates after movement of positioner

Fig. 2.2.1　Work coordinates

As shown in the illustration at right above, moving the mechanism on the work side causes the work coordinates to move to match.
When performing manual operation in a case such as this, with work coordinates selected, the manipulator must follow the work coordinates (X, Y, and Z directions) after they have moved. It is quite useful when performing teaching for cooperative operation.
The rotation of the wrist axis performs the same action as the robot coordinates (machine coordinates), relative to the work coordinates after they have moved.

World coordinates (absolute coordinates)

World coordinates are fixed at a specified position. Unlike tool coordinates or work coordinates, the starting point and axis directions of world coordinates do not change to match the posture of individual mechanisms.
If, for example, multiple manipulators are connected, world coordinates can be used for tasks such as having all the manipulators move in the same direction.

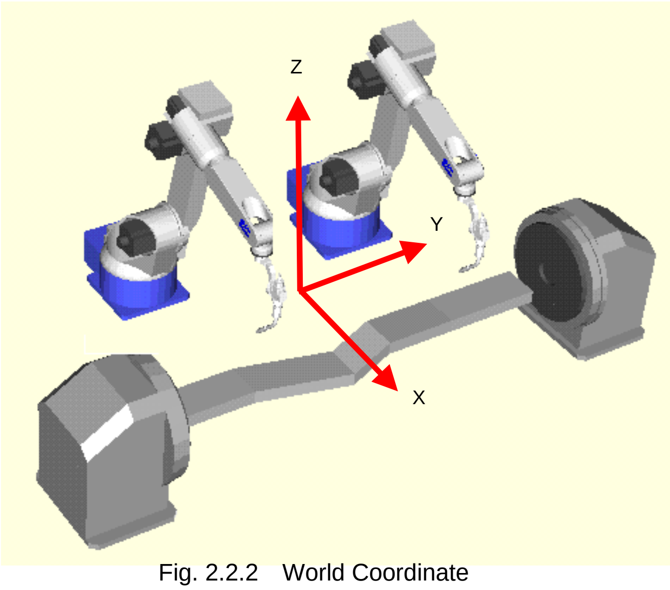


Fig. 2.2.2 World Coordinate

In a typical system, the starting point and axis directions of the world coordinates are the same as those of the machine coordinates for the first manipulator. In cases where multiple robots are operating on a production line, the world coordinates can be set to a specified position with absolute coordinates, as per the customer's specifications.

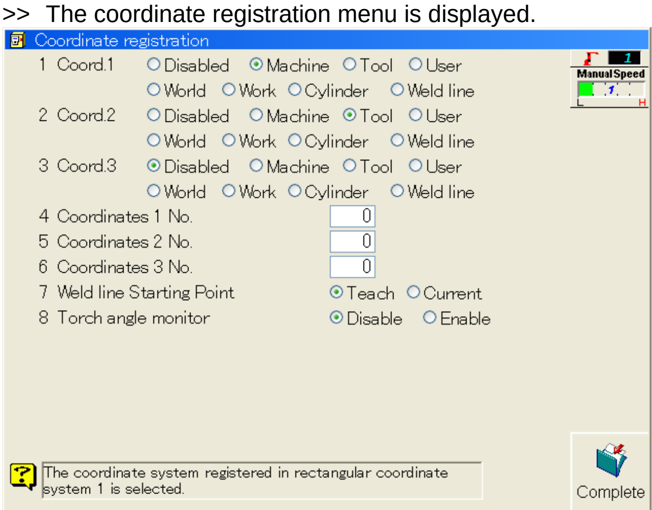
Registering coordinates

Under the default factory settings, each time the [INTERP/COORD] key is pressed, the setting changes in the following sequence: “axis coordinates” → “robot coordinates” → “tool coordinates”.
This is the case because under the factory settings robot coordinates (machine coordinates) and tool coordinates are registered as rectangular coordinates to be used. (Axis coordinates can be selected even if they have not been registered.)
This controller allows a maximum of three sets of rectangular coordinates to be registered.
In order to use work coordinates or world coordinates for manual operation, the desired coordinates must first be registered using the following procedure.
Note, however, that an operator qualification of **Expert** or above is necessary in order to register coordinates.

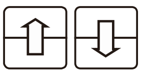
Registering coordinates

1 **After pressing <Constant Setting>, select [5 Operation Constants] — [5 Coordinate registration].**

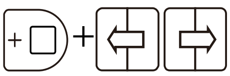
>> The coordinate registration menu is displayed.



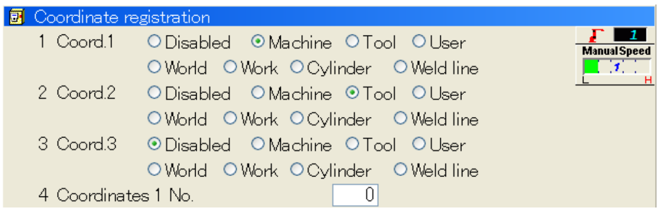
Under the default factory settings, “robot coordinates (machine coordinates)” is set as coordinate set 1 and “tool coordinates” is set as coordinate set 2.



2 **The example below shows the procedure for registering work coordinates as coordinate set 3.**
Use [Up] or [Down] key to move the cursor to “Coord.3”.



3 **While holding down [ENABLE], press [Left] or [Right] to select “Work”.**



4 **Press f12 <Complete>.**

>> The new settings are saved to memory and the previous menu is redisplayed.

Cooperative manual operation

Cooperative manual operation is a function that causes the additional mechanisms to move to match if one among two or more mechanisms that have been defined in the unit as enabled for cooperative control is moved using manual operation. This function is used when teaching movement commands for cooperative operation and when making position or posture corrections.

If a manipulator and positioner are under cooperative control
When the positioner is moved, the manipulator moves so as to maintain the same position and posture relative to the work mounted on the positioner. When the manipulator is moved it operates independently; the positioner does not move.

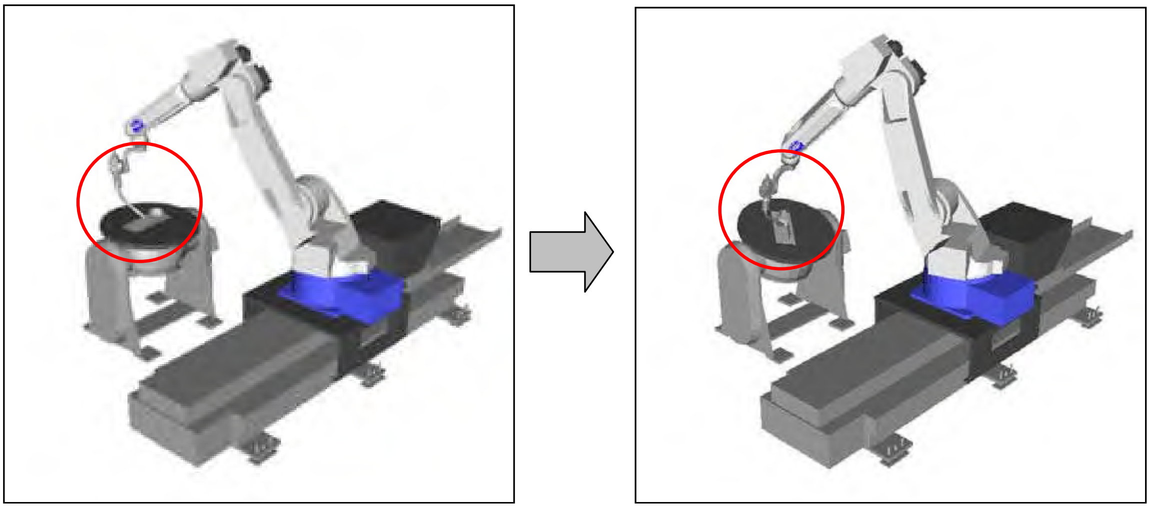


Fig 2.3.1 Cooperative manual operation when positioner is moved

If a manipulator and slider are under cooperative control
When the slider is moved, the manipulator moves so as to keep the tip of the tool at the same spot. When the manipulator is moved it operates independently; the slider does not move.

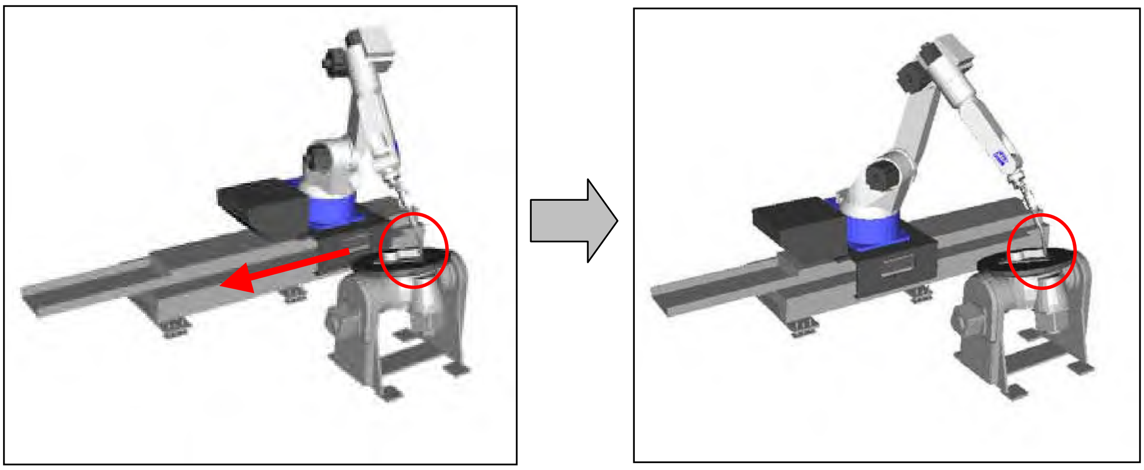


Fig 2.3.2 Cooperative manual operation when slider is moved

If two manipulators are under cooperative control

When one of the manipulators is moved the other manipulator moves to match.
For example, moving a manipulator holding the work causes the manipulator holding the tool to move so as to maintain the relative positions and postures of the tool and the work. The same thing happens in the reverse case.
Either axis coordinates or rectangular coordinates may be used to perform manual operations.

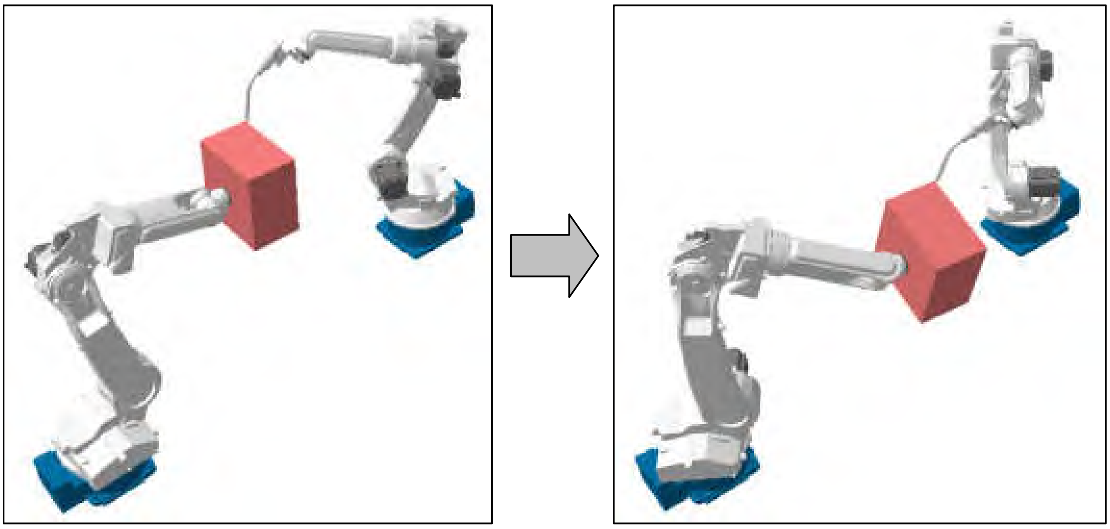


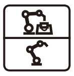
Fig 2.3.3 Cooperative manual operation by two manipulators

Performing cooperative manual operation

Cooperative manual operation is not possible under all circumstances.
In order for it to be possible, the following conditions must all be met.

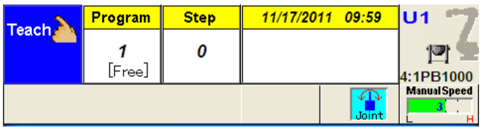
- The unit on which cooperative manual operation is to be performed must be selected.
- The unit’s manipulator and auxiliary axis (positioner or slider) must be enabled for cooperative control, or two of the unit’s manipulators must be enabled for cooperative control.
- In the case of a manipulator and auxiliary axis, the auxiliary axis must be the target for manual operation.
  (In the case of two manipulators, either may be the target for manual operation.)

1 In this example a manipulator and auxiliary axis are under cooperative control.
Confirm that a unit for which cooperative control is enabled has been selected.



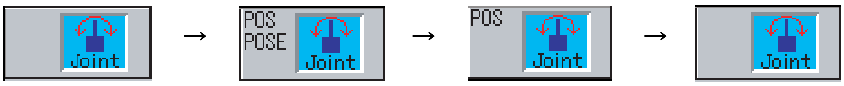
2 **Press [UNIT/MECHANISM] to select the auxiliary axis as the target for manual operation.**

>> When the auxiliary axis is selected the coordinate set switches automatically to “axis coordinates”.



3 **Press [SYNCHRONIZE] at the position where you wish to perform cooperative manual operation.**

>> The display changes each time [SYNCHRONIZE] is pressed, as shown below.

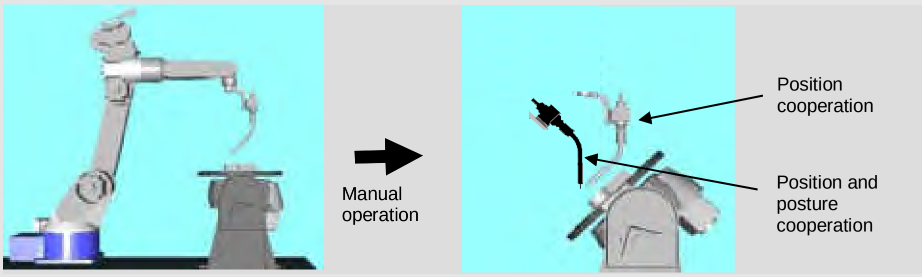


Cooperative manual operation is possible if “POS/POSE” or “POS” is displayed.
If neither of these is displayed the system operates in the normal way (each axis operating independently).

POINT

There are two ways to perform cooperative manual operation. Select the one that is most appropriate for the teaching position or the work configuration.

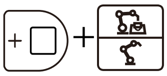
- Position and posture cooperation — The relative positions and posture of the tool and work are maintained.
- Position cooperation — Only the relative positions of the tool and work are maintained.



Teaching with cooperative control and simultaneous control

Even if the unit has multiple mechanisms defined, the series of operations involved in teaching—moving the mechanism and recording its position—is the same as when working with a unit with only a single manipulator.
The difference is that recording a movement command causes the position of all of the mechanisms to be recorded at once. (It is not possible to record the position of only one particular mechanism.)
For units with cooperative control enabled, you can specify whether or not to use cooperative control when recording movement commands. If no specification is made simultaneous control is used automatically.
In addition, if multiple mechanisms with different speed standard are defined, you can specify which speed standard will be used.

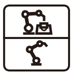
Recording movement commands



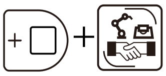
1 **For a multi-unit specification system, hold down [ENABLE] and then press [UNIT/MECHANISM] to select the unit to be the target for teaching.**

This step is unnecessary if there is only one unit.

2 **Hold down [ENABLE] and then press [PROG/STEP] to input the number of the program to be created.**

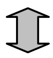
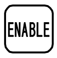


3 **Using [UNIT/MECHANISM] to switch among the mechanisms as necessary, use manual operation to move all of the mechanisms to the position to be recorded.**



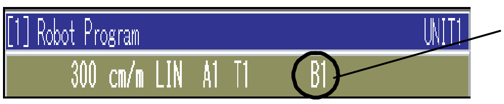
4 **To have the mechanisms move from the preceding position to the present position under cooperative control, hold down [ENABLE] and then press [SYNCHRONIZE].**

>> The indication “H” appears as the recording status.
This indication means that the mechanisms will move to that position under cooperative control.

 Use  and  to toggle between cooperative control (“H” displayed) and simultaneous control (“H” not displayed).

If the “H” indication does not appear even when [SYNCHRONIZE] is pressed while holding down [ENABLE], cooperative control is not possible for the current unit.

5 **The next step, 6, is where the speed will be set. Before that, however, it is necessary to specify for which mechanism teaching of the speed will be performed.**
This mechanism is called the speed standard mechanism. Switching among the mechanisms is accomplished using the <Change Speed Standard Mechanism> f key.



The number (B*) of the mechanism to be used as the speed standard is displayed here.
Depending on the system settings, there may be nothing displayed in some cases. (There is no need to make a setting if there is no display.)

However, in most cases there is no need to be aware of the speed standard mechanism.
This step is therefore unnecessary and we can continue with step 6.

HINT

What is the speed standard mechanism?

The speed standard mechanism is the mechanism that sets the standard for cases where multiple mechanisms move at the same time. During playback the other mechanisms move at the same speed as the speed standard mechanism.
For example, if the unit comprises a manipulator and an auxiliary axis (such as a positioner) and the manipulator is set as the speed standard, the procedure described in step 6 below is used to teach the operating speed of the manipulator. During playback the positioner moves in synchronization with the movement speed of the manipulator. It also begins and ends movements at the same time as the manipulator.
Conversely, if the positioner is the speed standard, the step below will teach the operating speed for the positioner. During playback the manipulator moves in synchronization with the movement speed of the positioner. It also begins and ends movements at the same time as the positioner.

Based on the above, we can see that it is best to be aware of the speed standard mechanism in cases such as the following.

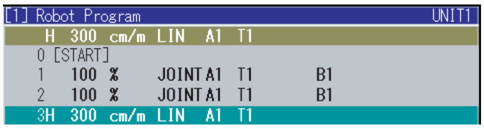
<u>When performing linear or circular interpolation when the manipulator and positioner are under simultaneous control ("H" not displayed)</u>
If the position is rotated without moving the manipulator much in order to perform arc welding, or the like, teaching is easier if one is aware of the speed of the positioner. In a case such as this the positioner should probably be selected as the speed standard mechanism.

<u>When performing straight line or arc interpolation when two or more manipulators are under cooperative control ("H" displayed)</u>
If two or more manipulators are under cooperative control, it is probably best to select the speed standard mechanism based on which of the manipulators is doing the majority of the movement.

6 **Set the necessary parameters, such as interpolation type, speed, and accuracy.**

7 **Press [O.WRITE/REC] to record the settings.**

>> When step is recorded while the "H" indication is displayed, movement commands corresponding to cooperative control are recorded. ("H" is displayed after the step No.)



If the "H" indication is not displayed when the settings are recorded, the result is simultaneous control.

Operation during playback is as described below, depending on whether or not the "H" indication is displayed and the interpolation type setting.

Interpolation type	"H" indication	Operation during playback
Joint interpolation (JOINT)	"H" displayed	All of the mechanisms in the unit move from the preceding recorded position to the present position using joint interpolation.
	"H" not displayed	Same as when "H" is displayed. In other words, the same movements take place regardless of whether or not the "H" indication is displayed when joint interpolation is used.
Linear interpolation (LIN) or Circular interpolation (CIR)	"H" displayed	All of the mechanisms in the unit move from the preceding recorded position to the present position simultaneously. The manipulators move on the work coordinates using linear or circular interpolation, so the position, posture, and speed are maintained relative to the work.
	"H" not displayed	All of the mechanisms in the unit move from the preceding recorded position to the present position simultaneously. The manipulators move using linear or circular interpolation, but they move independently and without regard to the work coordinates; position, posture, and speed are not maintained relative to the work.

Twin cooperation

This function enables multiple manipulators to perform cooperative control of one work item.
Specifically, this function could be employed to have two manipulators perform arc welding on both ends of a long piece of work held by a double support positioner at the same time. This enables two different points to be welded simultaneously, thus enabling the work efficiency to be improved.

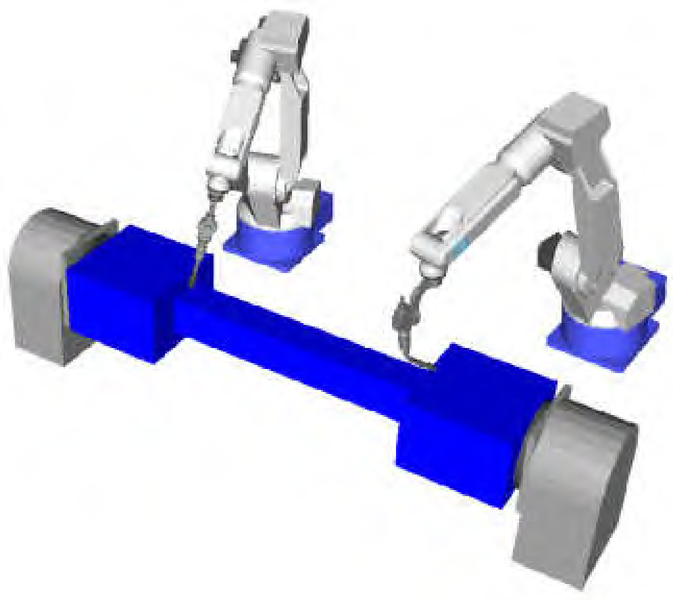


Fig. 3.1.1 Example of twin cooperation configuration

IMPORTANT

- Multiple manipulators cannot execute search operation commands simultaneously when a touch sensor or laser search is being used during twin cooperation. Each manipulator executes a search operation command one at a time in the taught sequence.
  Search operation commands refer to the following.
  Touch sensor:
  Wire length detection (SF0), unidirectional search (SF1), pattern search (SF2)
  Laser search:
  Unidirectional search (ZF1), pattern search (ZF2), acquisition of beveling data (ZG1)
- Twin cooperation drift acquisition (SF3) can be performed by means of a cooperative operation by multiple manipulators.
- For the method of teaching using a touch sensor or a laser search, refer to “Touch sensor” or “Laser search” in the instruction manual.
- An arc sensor or laser sensor cannot be used in twin cooperation.
- An arc retry function cannot be used on the user settings in twin cooperation.
- A check welding which is enabled cannot be set simultaneously as multiple welders in twin cooperation.
- An on-line change cannot be used simultaneously as multiple welders in twin cooperation.

Preparations for using twin cooperation

In order to perform twin cooperation, it is necessary to set up the welder and also set up the input and output signals exclusive to arc welding.

Setup relating to welder

Perform the setup relating to the welder. For this procedure, an operator qualification of ***Expert*** or above is necessary.

When the robot and welder have been purchased at the same time, the setup is normally done prior to shipment, and so it need not be done by the user.
The setup must be done if operators aim to do the setup themselves or if the welder is to be changed after the robot was delivered. For further details, refer to the “Application Manual (Arc Welding)”.
Here, a description of the points to note concerning setup for twin cooperation operation is given.

Settings relating to how to operate the welder

Set the robot to which the welder is to be connected and the connection type.
When a robot system with the multi-unit specifications is to be used, these settings must be performed for each unit.

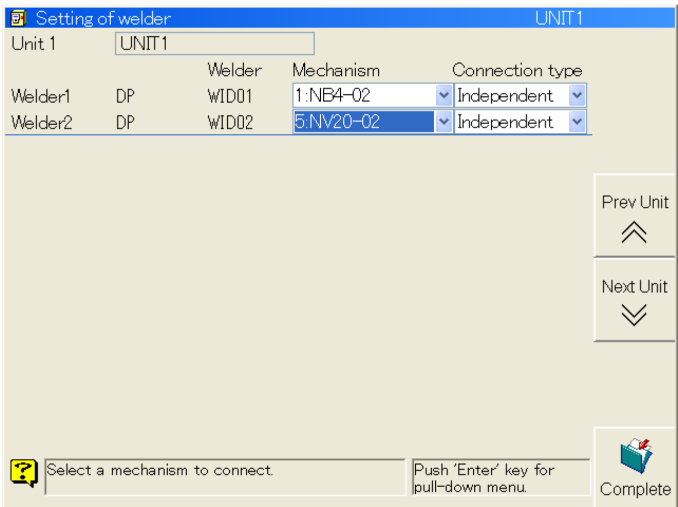
POINT

- Multiple welders connected to the unit are used for twin cooperation.

The following is an example of setup for the case where twin cooperation is performed by assigning a welder to each of the two manipulators in unit 1.

1 **In the teach mode, press f5 <Arc Constant>, and then select [2 Setting of welder].**

>> The welder setting screen is displayed.



Set Welder 1 as “Mechanism 1”, and Welder 2 as “Mechanism 5”, in the “Mechanism” box.
Set “Independent” for both “Welder 1” and “Welder 2” in the “Connection type” box.

Section welding OFF【W1 to W4】

Initial allocation No.	0
Meaning of the signal	The operation is underway in the “Section welding OFF” status.
Operation when turned ON	When a welding trouble (arc outage or arc start failure) occurred while section OFF was set as the operation that takes place after an arc start failure or an arc outage, by the **Abnorm. sect. OFF** input signal (page 3-5).
Operation when turned OFF	• All the action for the welding section concerned is completed. or • When the section weld OFF status was canceled by the **Section weld OFF status cancel** input signal (page 3-5)
Remarks	
Operator qualifications	*User* or above

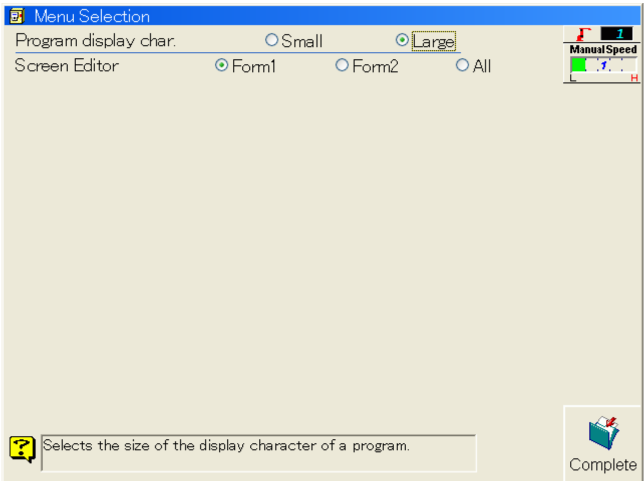
Setup for the screen edit display mode

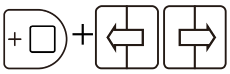
Under the twin cooperation system, it is available to use two or more manipulators at the same time and individually teach a different interpolation type to each manipulator. Therefore, it is necessary to set to the mode in advance, allowing to edit the command by each manipulator on screen editing.

Changing the screen edit display mode

1 **Press f5 <Constant Setting> in the Teach mode, select [2 Screen Constants] - [4 Menu Selection].**

≫ Next screen appears.





2 **In the “Screen Editor”, select [Form2] or [All].**

3 **Lastly, press f12<Complete>.**

≫ Thus, the screen edit display mode has been changed.

HINT

Concerning the screen edit display mode

The screen edit display mode has 2 kinds of screen by each mechanism.

-Standard screen : Displaying the data such as the interpolation type, Speed, Accuracy, etc…

-Second screen : Displaying the joint angle or coordinate value of each axis.

The details for the screen edit display mode are as follows.

From1	Mechanism1 Mechanism2~	: Standard screen + Second screen : Second screen
Form2	All mechanism	: Standard screen only
All	All mechanism	: Standard screen + second screen

For the unit where two or more manipulators are set, it is necessary to set the interpolation type by each manipulator. Please select [Form2] or [All].

Switching over the welders and mechanisms to be operated

The twin cooperative system consists of multiple mechanisms. Multiple welders are connected to the system. For this reason, it is necessary to specify the welder to be operated when welding is to be performed manually for inching or retracting the wire, for example.
Also, it is necessary to specify which mechanisms are to be turned ON/OFF when turning weaving ON/OFF.

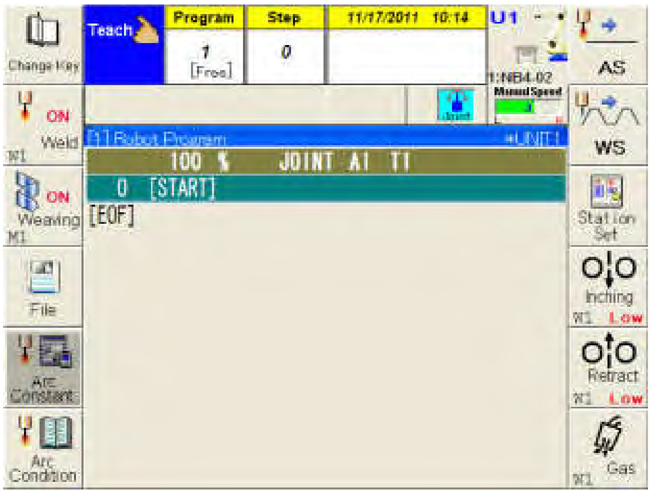
Switching over the welder to be operated

It is necessary to select the welder to be operated when performing one of the following operations.

- Wire inching/retraction
- Gas check

Switching over the welder to be operated manually.

1 **Teach mode f key**



>> It is possible to judge which of the welders has been selected for operation by observing the “W1” indication at bottom left of f10 <Inching>, f11 <Retract> and f12 <Gas>.
This is an example in which welder 1 has been selected for operation.

2 **While pressing [ENABLE], press f2 <Select Arc>.**

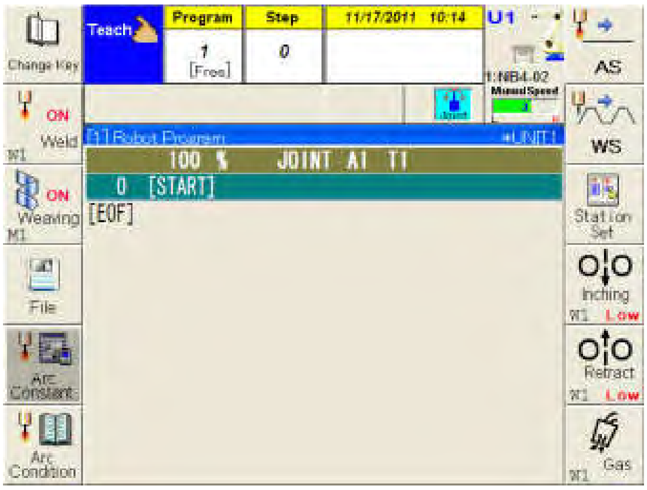
>> The number of the welder selected for operation that is displayed at bottom left of f10 <Inching>, f11 <Retract> and f12 <Gas> changes over to the number of the next welder registered in the system.

3 **It is possible to inch the welder selected for operation at low speed, by pressing f10 <Inching>.**
To inch the welder at high speed, press f10 <Inching> while pressing [ENABLE].
It is possible to retract the welder selected for operation at low speed, by pressing f11 <Retract>.
To retract the welder at high speed, press f11 <Retract> while pressing [ENABLE].
It is possible to perform a gas check of the welder selected for operation, by pressing f12 <Gas>.

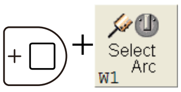
Switchover between welding ON/OFF consists of individual switchover in which a single welder is switched ON/OFF, and ganged switchover in which all welders registered in the system are switched ON/OFF together.

Switching each welder ON/OFF individually

1 Teach mode f key



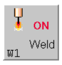
>> Confirm that the welder number of the selected welder (“W1” in this case) is displayed at bottom left of f2 <Weld ON/OFF>. In this status, it is possible to turn each welder ON/OFF individually.



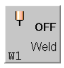
2 While pressing [ENABLE], press f2 <Select Arc>.

>> The number indicating the welder selected for operation displayed at bottom left of f2 <Weld ON/OFF> switches over to the number of the next welder registered in the system.

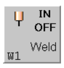
3 It is possible to change the ON/OFF status of the welder selected for operation, by pressing f2 <Weld ON/OFF>.



Indicates that the welder selected for operation is ON.



Indicates that the welder selected for operation is OFF.

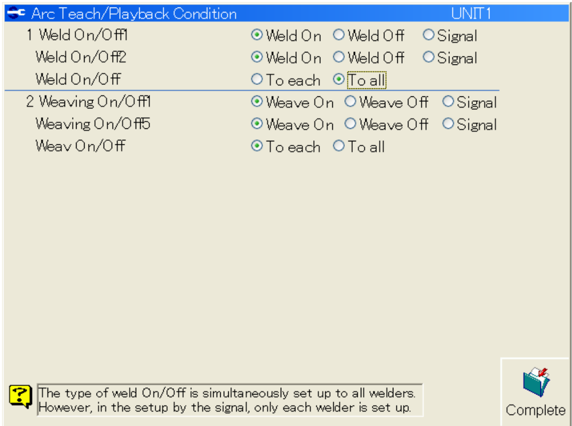


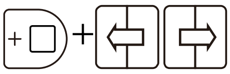
Indicates that the welding ON/OFF status of the welder selected for operation switches over according to the status of the “Weld ON/OFF” input signal.
In this example, the “Weld ON/OFF” input signal is OFF, and welding is OFF.

Switching over all welders ON/OFF together

1 **Press f6 <Arc Condition> in the teach mode, then select [1. Arc Teach/Playback Condition].**

>> The arc teach and playback condition setting screen is displayed.





2 **Move the cursor to “Weld On/Off”, then switch the radio buttons (horizontal row of selector buttons) to “To all” using the [ENABLE] + [Left/right cursor] keys.**

3 **Upon completion of the settings, press f12 <Complete>.**
The settings are saved in the file, and so their statuses are retained even when the power is turned off.

4 **When the display returns to the top screen of the teach mode, “To all” appears at bottom left of f2 <Weld ON/OFF>.**

It is possible to change the welding ON/OFF status of all welders registered in the system, by pressing f2 <Weld ON/OFF>.

Indicates that all welders are ON.

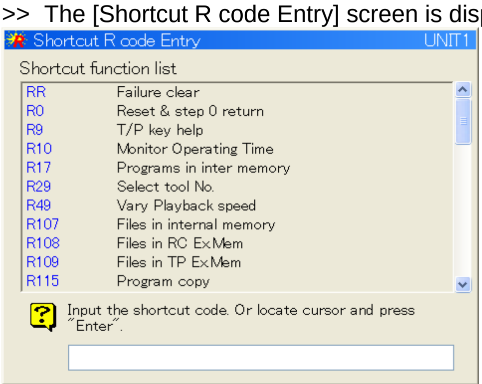
Indicates that all welders are OFF.

Indicates that the welding ON/OFF status of all welders switches over according to the status of the “Weld ON/OFF” input signal.
The ON/OFF status of each welder differs according to the status of each “Weld ON/OFF” input signal.
The ON/OFF status displayed at f2 <Weld ON/OFF> indicates the status of the welder selected by f2 <Select Arc> which is displayed when [ENABLE] is pressed.

Method of easily switching between “To each” and “To all”

5 **On the teach or playback mode top screen, press the [RESET/R] key.**

>> The [Shortcut R code Entry] screen is displayed.



6 **Press the [Up/Down] key to move the cursor to [R380: Change the arc welder selection], or enter “380” in the edit box directly below and press the [Enter] key.**

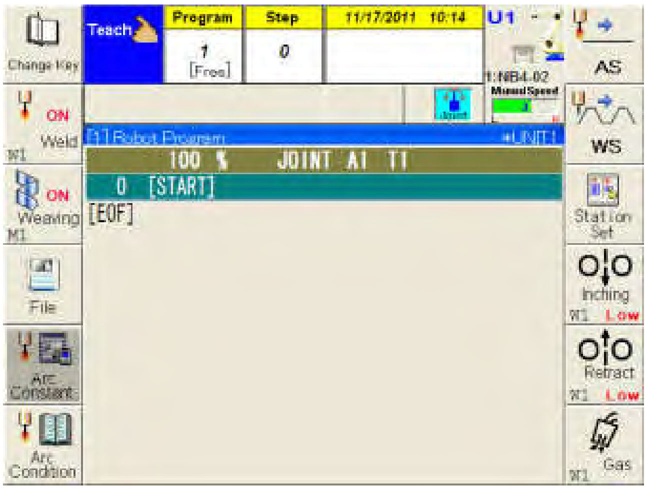
>> The display switches between “To each” and “To all” of Weld On/Off.

Switching over mechanism selected for a weaving ON/OFF operation

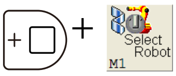
There are two types of switchover between weaving ON/OFF: Individual switchover of weaving ON/OFF of one mechanism, and ganged switchover of weaving ON/OFF of all mechanisms (manipulators or module robots) registered in the system that can perform weaving.

Individual switchover of weaving ON/OFF

1 Teach mode f key



>> Confirm that the applicable mechanism number ("M1" in this case) is diaplayed at bottom left of f3 <Weaving ON/OFF>. It is possible to perform individual weaving ON/OFF in this status.



2 While pressing [ENABLE], press f3 <Select Robot>.

>> The number indicating the mechanism selected for operation displayed at bottom left of f3 <Weaving ON/OFF> switches over to the number of the next welder mechanism (manipulator or module robot) registered in the system that can perform weaving.

3 It is possible to change the weaving ON/OFF status of the mechanism selected for operation, by pressing f3 <Weaving ON/OFF>.

Indicates that the mechanism selected for operation is in a weaving ON status.

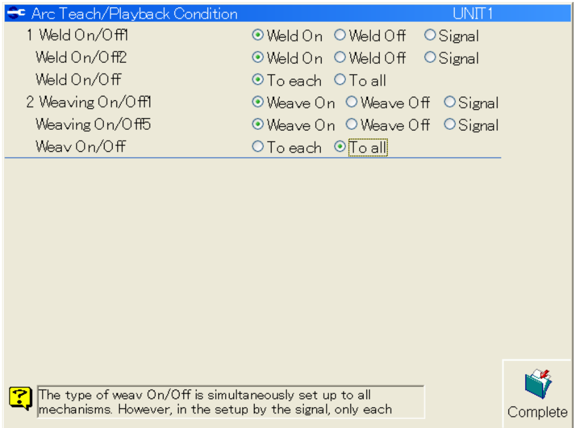
Indicates that the mechanism selected for operation is in a weaving OFF status.

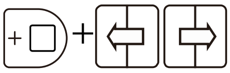
Indicates that the weaving ON/OFF status of the mechanism selected for operation is switched over according to the status of the "Weaving ON/OFF" input signal. In this example, the "Weaving ON/OFF" input signal is OFF, and weaving is OFF.

Switching over all weaving ON/OFF together

1 **Press f6 <Arc Condition> in the teach mode, then select [1. Arc Teach/Playback Condition].**

>> The arc teach and playback condition setting screen is displayed.





2 **Move the cursor to “Weav On/Off”, then set the radio buttons (horizontal row of selector buttons) to “To all” using the [ENABLE] + [Left/right cursor] keys.**

3 **Upon completion of the settings, press f12 <Complete>.**
The settings are saved in the file, and so their statuses are retained even when the power is turned off.

4 **When the display returns to the top screen of the teach mode, “To all” appears at bottom left of f3 <Weaving ON/OFF>.**
It is possible to change the weaving ON/OFF status of all mechanisms registered in the system that can perform weaving, by pressing f3 <Weaving ON/ OFF>.

Indicates that all mechanisms that can perform weaving are in a weaving ON status.

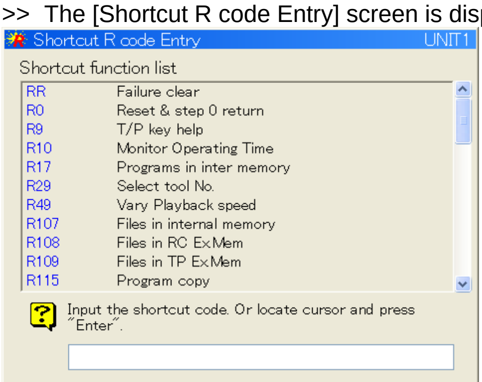
Indicates that all mechanisms that can perform weaving are in a weaving OFF status.

Indicates that all mechanisms that can perform weaving are switched over between “Weaving ON and OFF” by the “Weaving ON/OFF” input signal.
The ON/OFF status of each mechanism differs according to the status of each “Weaving ON/OFF” input signal.
The ON/OFF status indicated by f3 <Weaving ON/OFF> indicates the status of the mechanism selected by f3 <Select Robot> which appears when [ENABLE] is pressed.

Method of easily switching between “To each” and “To all”

5 **On the teach or playback mode top screen, press the [RESET/R] key.**

>> The [Shortcut R code Entry] screen is displayed.



6 **Press the [Up/Down] key to move the cursor to [R381: Change the weaving mecha. selection], or enter “381” in the edit box directly below and press the [Enter] key.**

>> The display switches between “To each” and “To all” of Weav On/Off.

Teaching of twin cooperation

The twin cooperative system consists of multiple mechanisms. Multiple welders are connected to the system. For teaching the MOVE commands, it is necessary to set the interpolation type by manipulator. For details, see the instruction manual “Basic Operation”.
And, it is necessary to specify the object of teaching when teaching welding commands and weaving commands. (For example, in the case of a welding start command, specify which welder a command is intended for during teaching.)
For details of the method of teaching welding commands, refer to the “Application Manual (Arc Welding)” in the instruction manual.

Teaching the MOVE Command

In the twin cooperation, the interpolation action is performed by two manipulators. It is available to set up the interpolation (Positioning, Linear interpolation, Circular interpolation) by each manipulator. When the manipulator 1 is in the linear interpolation, the manipulator 2 could be in the circular interpolation for example.
However a motion speed follows the standard mechanism, be sure to give attention to the interpolation motion of the mechanism other than the standard one.

IMPORTANT

Concerning the motion speed

A motion speed of the standard mechanism is a taught speed. Meanwhile, a motion speed of the mechanism other than the standard one is calculated on the basis of the time of motion of standard mechanism by each sequence.
If the amount of motion is extremely large comparing with one of the standard mechanism, the manipulator may operate at unexpected high speed.

The explanation is given below with the twin cooperation unit including all the following mechanisms.

Mechanism 1 : Manipulator
Mechanism 4 : Positioner
Mechanism 5 : Manipulator

Teaching the MOVE command (Normal)

1 **Move the positioner to the teaching position.**
Switch the mechanism to Mechanism4. (The interpolation type of positioner is fixed at JOINT.)
Move the positioner by manual operation to the teaching point.

2 **Move the manipulator of Mechanism1 to the teaching position.**
Switch the mechanism to Mechanism1, and select a desired interpolation type.
Move the manipulator by manual operation to the teaching point.

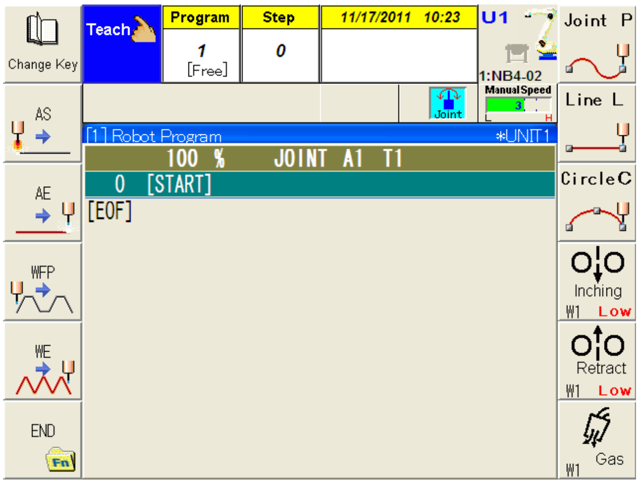
3 **Move the manipulator of Mechanism5 to the teaching position.**
Switch the mechanism to Mechanism5, and select a desired interpolation type.
Move the manipulator by manual operation to the teaching point.

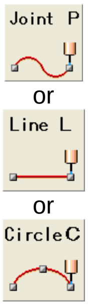
4 **Set up the speed, accuracy, acceleration, and smoothness, and press <Record>.**

Teaching the MOVE command (Simple teaching)

1 Press [CLAMP/ARC] key.

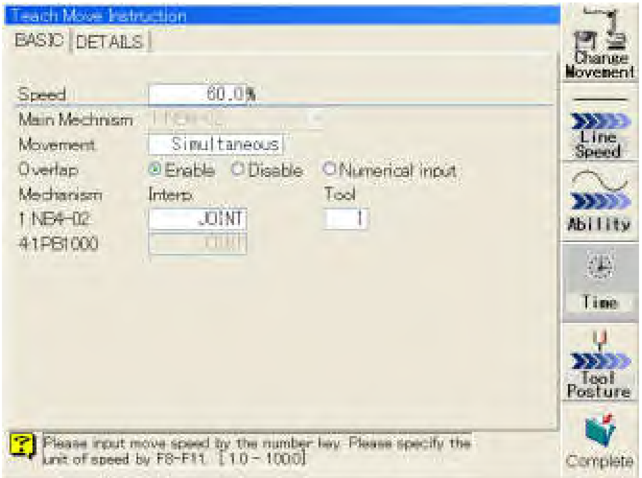
≫ The commands frequently used for f key are now displayed.





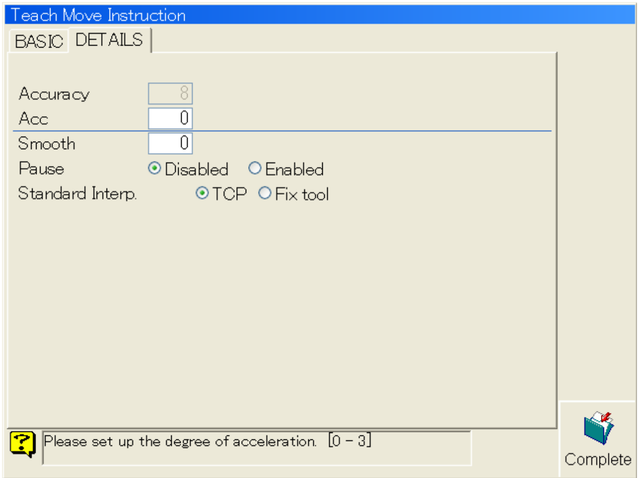
2 Move all the mechanisms to the teaching point, and select either [f7 Joint P], [f8 Line L], or [f9 Circle C] depending on the interpolation type.

≫ Then, the next screen appears.



Item		Detail
Speed		Sets up the motion speed of main mechanism. Mechanisms other than the main mechanism operate at a speed consistent with the time of operation of main mechanism in each step. The speed can be set either by the Line Speed (cm/min), Ability (%), or Time (sec).
Main Mechanism		This is the mechanism to be a standard for speed.
Movement		Simultaneous/Synchronize
Overlap		Enable/Disable or Numerical input
Mechanism	Interp.	The interpolation type (JOINT, LINE, CIRCLE) can be set for each mechanism. The auxiliary axis such as positioner and slider is fixed at "JOINT".
	Tool	The tool number can be set for each mechanism. This is available only for manipulator.

3 **For detailed settings such as the specified value of accuracy and the acceleration, use the "DETAILS" tab.**
To switch the tab, press [CLOSE/Move screen].



4 **On completion of setting all the conditions, press f12<Complete>.**

IMPORTANT

When teaching the MOVE command in the twin cooperation, be sure to confirm the interpolation type in all mechanisms. Even if changing the interpolation type in Mechanism1 for example, that of the other mechanisms remains the same.

HINT

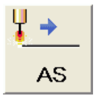
The interpolation type in each mechanism can be changed on the screen edit mode for the teaching data already created or the wrong sequence.
However, it is necessary to set the screen edit display mode to "Form2" or "All" in advance.

3.2.3 Setup for the screen edit display mode

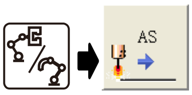
Specifying the object welder of a welding command

This section describes the method of specifying the welder to be made the object of welding commands during teaching of welding start and welding end commands.
The description given here is based on the welding start command as an example. It is possible to specify a welder as the object of a welding end command, using the same method.

Specifying a welder when teaching welding commands

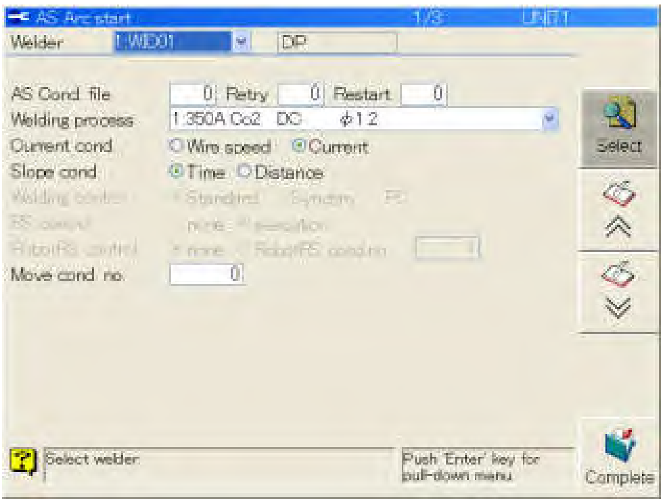


or



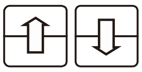
1 **Press f7 <AS>.**
Alternatively, after pressing [CLAMP/ARC], press f2 <AS>.

>> The screen for setting the arc welding start conditions is displayed.



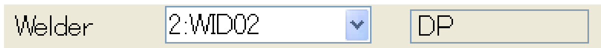
2 **Press [Enter] in the “Welder” box.**

>> A list of welders connected to the unit currently being taught is displayed.



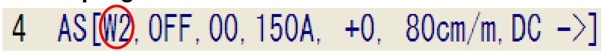
3 **Press the [Up/Down] key to select a welder, and then press the [Enter] key.**

>> The “Welder” box display switches over.



The welder that is the object of the welding start command has now been specified.
Enter the parameters of the welding start command, and press f12 <Complete> to end teaching.

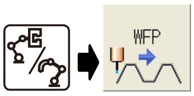
4 **“W2” and the object welder are displayed alongside the welding start command on the program monitor.**



Specifying the mechanism that is the object of a weaving start command

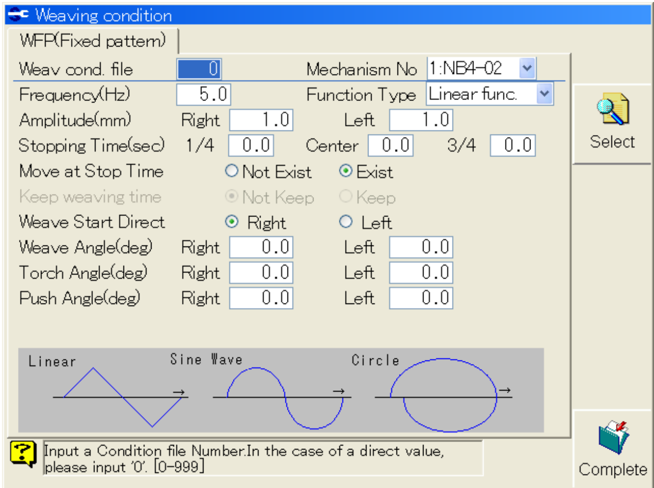
This section describes the method of specifying the mechanism to be the object of weaving during teaching of a weaving start command.
Here, the description is given based on fixed pattern weaving as an example. It is also possible to use the same method to specify a mechanism as the object of another weaving start command.

Specifying a mechanism when teaching a weaving start command

or


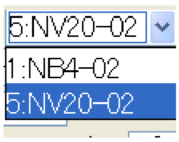
1 **Press f8 <WS>.**
Alternatively, after pressing [CLAMP/ARC], press f4 <WFP>.

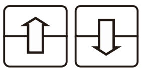
\>> The screen for setting the fixed pattern weaving conditions is displayed.



2 **Press [Enter] in the "Mechanism No." box.**

\>> A list of mechanisms contained in the unit currently being taught that can perform weaving is displayed.



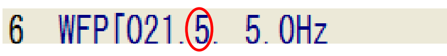


3 **Press the [Up/Down] key to select a mechanism, and then press the [Enter] key.**

\>> The display in the "Mechanism No." box switches over.

The mechanism that is the object of the weaving start command has now been specified.
Enter the parameters of the weaving start command, then press f12 <Complete> to end teaching.

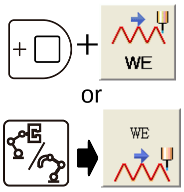
4 **"5" and the object mechanism are displayed alongside the weaving start command on the program monitor.**



Specifying the mechanism that is the object of a weaving end command

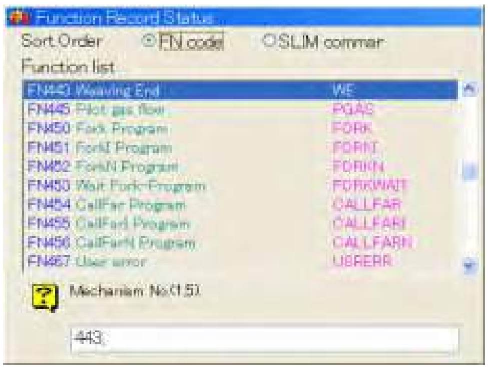
This section describes the method of specifying the mechanism to be the object of weaving during teaching of a weaving end command.

Specifying a mechanism when teaching a weaving end command



1 **While pressing [ENABLE], press f8 <WE>.**
Alternatively, after pressing [CLAMP/ARC], press f5 <WE>.

>> The functions are displayed, and the mechanism ID can now be input by [FN443 Weaving end].



2 **Enter the mechanism ID and press the [Enter] key.**

>> The mechanism that is the object of the weaving end command has now been specified, thus ending teaching of the weaving end command.

3 **“5” and the object mechanism are displayed alongside the weaving end command on the program monitor.**

Automatic operation of the twin cooperative system

The twin cooperative system permits simultaneous welding of multiple points (multi-pass welding) using multiple welders.
Automatic operation of arc welding is programmed to stop the motion of the robot during normal welding start/end in order to prevent an arc start failure or the formation of craters. However, during multi-pass welding, trouble will occur if the motion of the robot stops while an arc is generated by one welder. For this reason, a special function is provided for multi-path welding.
For a general description of automatic operation, refer to “Basic Operation” in the instruction manual.

Welding start

It is possible to select the method of welding start processing when a welding start command is issued to multiple welders simultaneously.

- Scratch start
  Even if an arc is not generated, the system deems that the welding start command has been executed.
  If all of the welders have scratch-started, the robot will start even if an arc is not generated. It is possible to make a setting that prevents the robot on which arcing started normally from stopping in the event of an abnormality, such as an arc start failure, in one welder.
- Normal arc start
  The system confirms that an arc has been generated, and deems that the welding start command has been executed.
  The system confirms that an arc has been generated, and the robot starts operating. Used for tack welding, and similar cases.
- Twin arc start (Arc start → Scratch start)
  Initially, the system performs normal arc start processing, and then waits until an arc is generated. It deems that a welding start command has been executed when an arc has been generated by another welder, even if an arc has not been emitted from the selected welder.

For a description of welding start processing when the welding section has shifted, refer to **“3.5.3 Processing by the welder and robot in the welding section”**.

Select the welding start method

To start welding using scratch starting, turn ON the “**Scratch start** signal” (page 3-4).

To start welding using a twin arc start, turn ON the “**WCR input twin AS** signal” (page 3-5).

To start welding using a normal arc start, turn OFF both of the above signals.

IMPORTANT

- To select the welding start method, set “Scratch start” to “OFF” according to “Setting various constants related to arc welding” in “3.2.1 Setup relating to welder”. When “Scratch start” is set to “ON”, welding always starts by scratch starting.
- To start welding using a twin arc start, turn ON the “**WCR input twin AS** signal” for all of the welders that are to be started by twin arc start. If even one welder is OFF, the robot will not start to operate until the system has confirmed that the arc has been generated.
- When both the “**Scratch start** signal” and the “**WCR input twin AS** signal” are turned ON, the “**Scratch start** signal” has priority.

Welding end

When multiple welders execute welding end commands simultaneously, the welding end processing stops the motion of the robot in the conventional way, and processing of craters and after-flow takes place according to the teaching conditions of the welding end command.

For a description of welding end processing when the welding section has shifted, see **"3.5.3 Processing by the welder and robot in the welding section"**.

Processing by the welder and robot in the welding section

For multi-path welding, it is possible to teach welding command to each welder, so it is also possible to shift the welding section. There are several points that differ from the standard specifications in order to ensure that welding work is not impeded when the welding section has shifted.

	100% JOINT A8 T1	Welder 1	Welder 2
1	AS [W1, OFF, 00, 150 A, 18.0 V, 60 cm/m, →]	Welding start	
	200 cm/m LIN A8 T1	↓	
2	AS [W2, OFF, 00, 150 A, 18.0 V, 60 cm/m →]	↓	Welding start
	200 cm/m LIN A8 T1	↓	↓
3	AE [W2, OFF, M, 150 A, 18.0 V, 0.5 s, 0.5 s, →]	↓	Welding end
	200 cm/m LIN A8 T1	↓	
4	AE [W1, OFF, M, 150 A, 18.0 V, 0.5 s, 0.5 s, →]	Welding end	
	100% JOINT A8 T1		

(1) Welding start when all of the welders are in non-welding sections

AS command processing (when scratch start was enabled)

Preflow
Robot motion stop
Arc start processing
Robot motion start

(2) Welding start when another welder is in the welding section

AS command processing (when scratch start was enabled)

Preflow
Arc start processing
(The motion of the robot does not stop.)

(3) Welding end when another welder is in the welding section

AE command processing

Anti-stick processing
Welding check processing
Postflow
(The motion of the robot does not stop.)

(4) Welding end when another welder is already in a non-welding section

AE command processing

Robot motion stop
Crater processing
Anti-stick processing
Welding check processing
Postflow
Robot motion start

Speed of motion in the welding section

A movement command in the welding section causes the robot to move, not at the speed taught by the movement command, but at the welding speed taught by the welding start command. The robot moves at the welding speed determined by the welding start command that was taught immediately prior to the movement command.

	Non-welding section	Speed of motion under the MOVE command
	100% JOINT A8 T1	Moves at the taught speed
1	AS [W1, OFF, 00, 120 A, 18.0 V, 50 cm/m, →]	Welder 1 Welding start
	200 cm/m LIN A8 T1	Moves at the welding speed of 1.
2	AS [W1, OFF, 00, 150 A, 18.0 V, 60 cm/m, →]	Welder 1 Change of condition
	200 cm/m LIN A8 T1	Moves at the welding speed of 2.
3	AS [W2, OFF, 00, 140 A, 18.0 V, 70 cm/m →]	Welder 2 Welding start
	200 cm/m LIN A8 T1	Moves at the welding speed of 3.
4	AS [W1, OFF, 00, 150 A, 18.0 V, 70 cm/m →]	Welder 1 Change of condition
5	AS [W2, OFF, 00, 150 A, 18.0 V, 60 cm/m, →]	Welder 2 Change of condition
	200 cm/m LIN A8 T1	Moves at the welding speed of 5.
	AE [W2, OFF, M, 150 A, 18.0 V, 0.5 s, 0.5 s, →]	Welder 2 Welding end
	200 cm/m LIN A8 T1	Moves at the welding speed of 5.
	AE [W1, OFF, M, 150 A, 18.0 V, 0.5 s, 0.5 s, →]	Welder 1 Welding end
	100% JOINT A8 T1	Moves at the taught speed

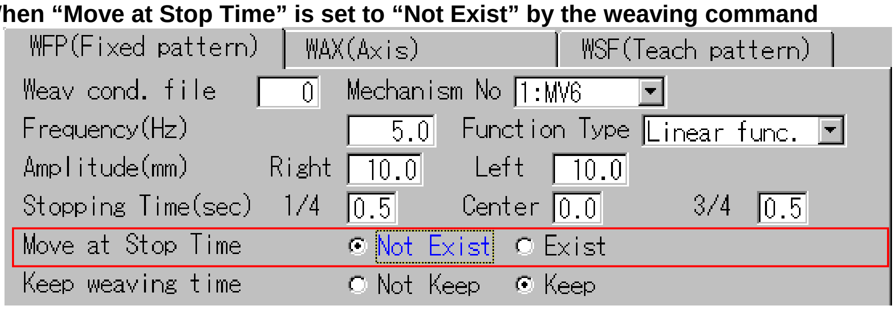
POINT

- The movement command in the welding section causes the robot to move at the welding speed determined by the welding start command taught immediately prior to the movement command, regardless of the mechanism that is connected to the welder.
- In the above example, welder 1 is still in the welding section when welding of the welding section in which welder 2 is located has ended. The movement command at this time causes the robot to move, not at the welding speed determined by the welding start command of welder 1, but at the welding speed determined by the welding start command of welder 2. This is because the welding start command taught immediately prior to the movement command is the welding start command (5) of welder 2.

Multi weaving

The following precautions must be observed when weaving simultaneously using multiple mechanisms.

When “Move at Stop Time” is set to “Not Exist” by the weaving command



To set “Move at Stop Time” to “Not Exist”, it is necessary to set the parameters so that multiple weaving mechanisms stop simultaneously and also remain stopped for an equal length of time. Concretely, perform teaching as indicated below.

- Make the value of “Frequency” the same for all mechanisms.
- Make the parts (1/4, center, 3/4) for setting “Stopping Time” the same for all mechanisms.
- Make “Stopping Time” the same for all mechanisms.
- Make the setting for “Keep weaving time” the same for all mechanisms.

If these conditions are mismatched, preventing weaving from being performed, an abnormality (“E4102 It is weaving condition disagreement.”) will occur.

Pause and restart

If the restart variation is set so that “after welding is paused, the robot returns exactly a fixed distance, and then restarts welding” (“lap start” of the conventional Daihen model), when the robot restarts after pausing during operation, it first returns exactly the specified distance with respect to the weld line, and then restarts welding. In this case, the distance through which the robot returns is set by the welding constant setting for each welder. It is the longest distance among the settings of the welders in the welding section.

POINT

The welding constant setting that “causes the welder that was paused during welding to return exactly a fixed distance, and then resume operation” is “the method of reversing when restarting” and also the “Reversing distance during restarting”/“Correction time during restarting”.

No. 1L22150F-E-1

Almega FD series

INSTRUCTION MANUAL

EXTERNAL AXIS SHIFT

	■ Read and follow these instructions and all safety blocks carefully. ■ Have only trained and qualified persons install, operate, or service this unit.
	■ Give this manual to the operator.
	■ For help, call your distributor.

DAIHEN Corporation

1. What is external axis shift function

In a system where a slider or positioner is connected to the manipulator, the positions of the slider, positioner or servo gun may be shifted (moved) in the task program. This function is called "external axis shift." This function can shift these positions either using cooperative control or simultaneous control as the control system.
This function can shift the positions in any task program which has already been prepared. (A program can be shifted itself or stored under a different number.)
It is also possible to shift any ranges in the task programs by specifying the step numbers.

1.1 Specifying the shift amount

With external axis shift, the shift amount is determined by manually operating the external axis as far as the position where the shift is to be made. The shift amount cannot be specified using numerical values. (Positions can be shifted by inputting numerical values by selecting <Service Utilities> – [9 Program Conversion] – [3 Angle].)

1.2 Example of shifting a slider

When the position of a slider is to be shifted, what has been taught can be moved as is in the motion direction of the slider.

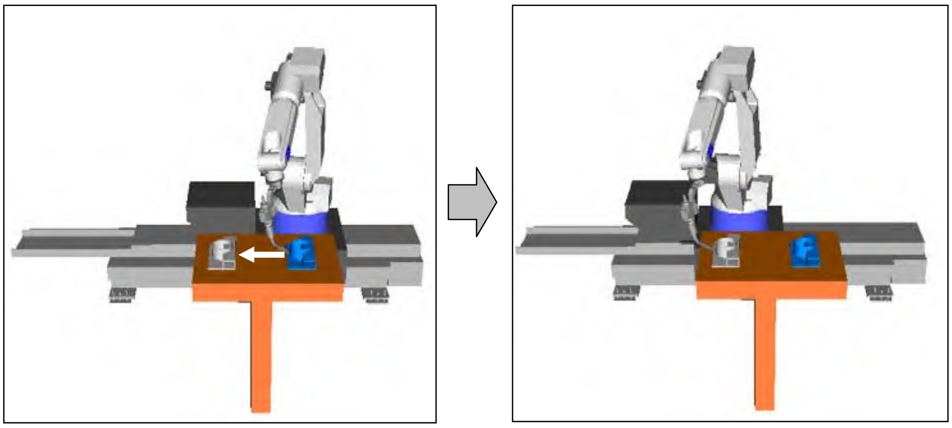


Fig. 1.1 Example where the taught position of a slider has been shifted

1.3 Example of shifting a positioner

When the position of a positioner is to be shifted, what has been taught can be moved as is in the rotational direction of the positioner.

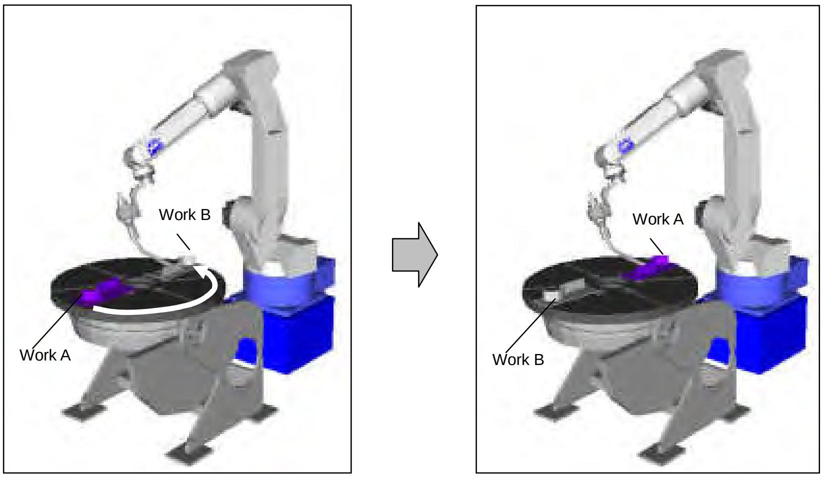


Fig. 1.2 Example where the taught position of a positioner has been shifted

2. External axis shift operations

External axis shift is implemented by selecting <Service Utilities> - [9 Program Conversion] - [11 External Axis Shift].

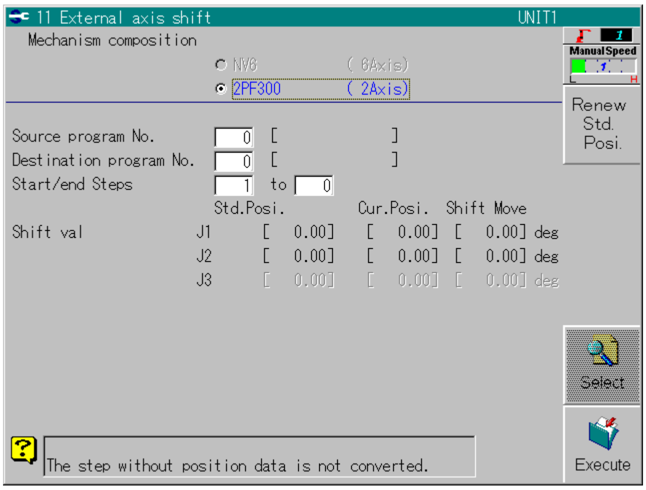
The shift amount is specified by manually operating the mechanism. The simplest method is first to move to the standard position (any step with a movement instruction) by initiating a check operation and then to move the mechanism to the position to which the mechanism is to be shifted. The movement amount resulting from the manual operation is set as the shift amount.

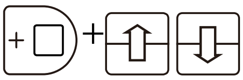
Implementing external axis shift

1 **External axis shift is accompanied by manual operations so the teach mode is selected.**
(It cannot be implemented in the playback mode.)

2 **Open the program in which the shifts are to be made, and advance to the shift standard position (any step with a movement instruction) by initiating a check operation.**

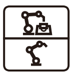
3 **After pressing <Service Utilities>, select [9 Program Conversion] – [11 External Axis Shift].**
>>The screen shown below appears.





4 **If there is a multiple number of external axes, select the mechanism to be shifted using [ENABLE] and [UP/DOWN].**

5 **Input the "Source program No.," "Destination program No." and "Start/end Steps."**



6 **Since the shift amount is specified by performing manual operations, switch the target of the manual operations to the mechanism to be shifted.**

7 **If the operator neglected to specify the shift standard position in step 2 or if the standard position is to be changed, press f8 <Renew Std. Posi.>. The current mechanism position is set as the standard position.**
Normally, the position that applies when external axis shift is selected is automatically set as the standard position.

8 **Manually operate the mechanism as far as the position resulting from the shift.**

9 **Press f12 <Execute>.**
>>External axis shift is executed. Open the program which reflects the shift, conduct a check operation, and check the position and posture.

No. 1L22150G-E-1

Almega FD series

INSTRUCTION MANUAL

POSITIONER ENDLESS ROTATION FUNCTION

POSITIONER ENDLESS
ROTATION FUNCTION

	■ Read and follow these instructions and all safety blocks carefully. ■ Have only trained and qualified persons install, operate, or service this unit.
	■ Give this manual to the operator.
	■ For help, call your distributor.

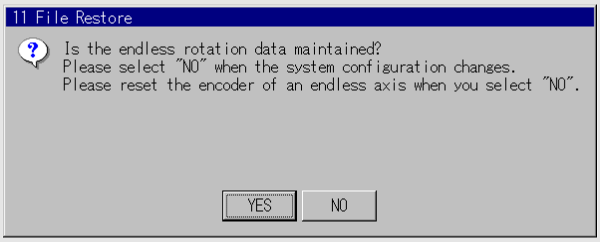
DAIHEN Corporation

1. Endless rotation function

When the positioner is rotated one turn, it returns to the original position. However, because the amount of rotation is stored, there is a difference between the positional data before and after rotation.
Therefore, during continuous Automatic operation, the positioner must be rotated one turn in the reverse direction to return to the start position whenever the Program is started.
The Endless Rotation function lets a positioner rotate in the shortest direction. In other words, useless rotation from the end position to the start position can be excluded. Therefore, the positioner always rotates in the shortest direction, resulting in the improvement of cycle time.

CAUTION

- When the power failure detection function is invalidated, the endless rotation function cannot be used.
- When you execute the restoration operation of the backup, or the copy operation of the constant file, the following pop-up window opens, asking whether to maintain the endless rotation data.



Select “No” if the system configuration before and after the restoration (copy) is different. Then, reset the encoder of the endless axis and execute the encoder compensation.

See page3 ”2.3 Encoder reset of endless axis”

2. Setup

The following setup work is necessary to use the endless rotation function.

2.1 Setting up the optional software

The endless rotation function is an optional software. The optional software was already set up at the shipment from the factory or installation stage so no further steps need to be taken by the user.

2.2 Enabling Endless Rotation function

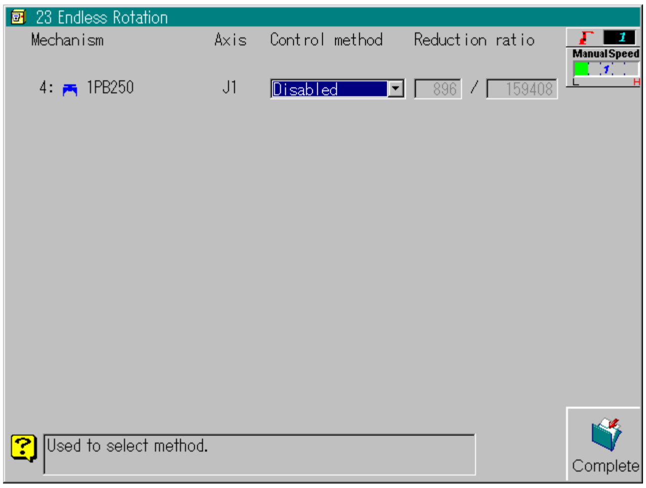
After setting the optional software, set the control method and the reduction ratio of target positioner for the endless control.

Note that *Specialist* or higher operator qualification is required for this work.

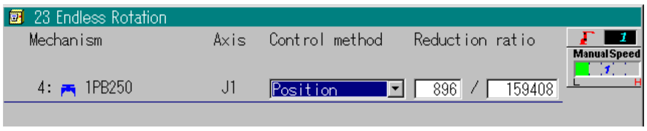
How to enable the endless rotation function

1 **Press <Constant Setting> key and select [3 Machine Constants] - [23 Endless Axis Information].**

≫ The target axis information for the endless control appears. (The screen below shows the case when the 1-axis positioner 1PB250 is in connection.)



2 **Select the target axis for the endless control and move to the “Control method”. Press [Enter] key and select “Position”.**



3 **Move to “Reduction ratio” and set the reduction ratio of endless axis.**
Input a numerator and a denominator, respectively by an integral number, of the total reduction ratio from the motor axis to the mechanism axis.

IMPORTANT

- Now that checking the specifications of reduction device, exactly input a numerator and a denominator of the total reduction ratio with an integral number, respectively.
- If the setting of total reduction ratio disagrees with the specifications of reduction device, the position deviation occurs.

4 **Lastly, press f12 <Complete> key.**

2.3 Encoder reset of endless axis

After resetting the encoder of endless axis, be sure to compensate the encoder of endless axis in the standard posture. (Perform the encoder compensation according to the position record.)

If inputting the encoder compensation at shipment by numerical values or not compensating the encoder, positional deviation may occur in the endless axis.

With the endless axis, the motor angle in the standard posture does not always come to the same position. therefore, positional deviation may occur if just using the encoder compensation value at shipment.

3. Teaching and playback

3.1 Teaching

How to teach the endless axis is the same as that for the regular axis. However, the endless axis always rotates in the direction, taking a shorter distance from the current position to the destination. Considering this feature, it is recommended to teach the amount of rotation smaller than ±180 [deg].

Even if teaching it larger than ±180 [deg], the endless axis rotates in the direction of shorter distance.

3.2 Motion during check go/back or automatic operation

During Check operation or Automatic operation, any endless axis always rotates in the direction of less than 180 [deg]. For example, if rotated 200 [deg] and taught at that position, the endless axis or axes will rotate 160 [deg] in the reverse direction during Check operation or Automatic operation.

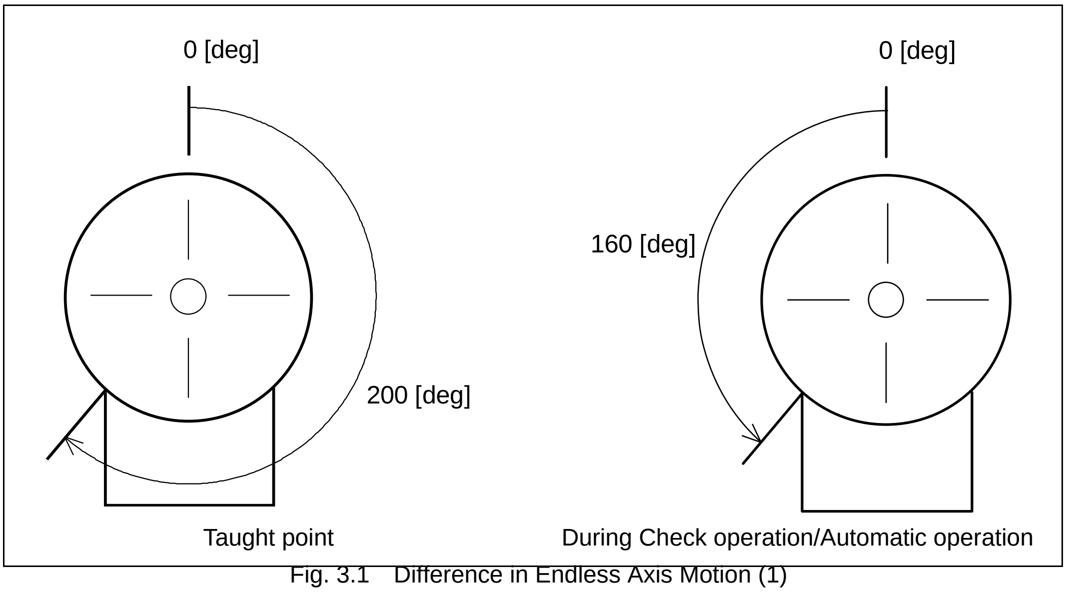


Fig. 3.1 Difference in Endless Axis Motion (1)

If rotated 400 [deg] and taught at that position, the endless axis or axes will rotate only 40 [deg].

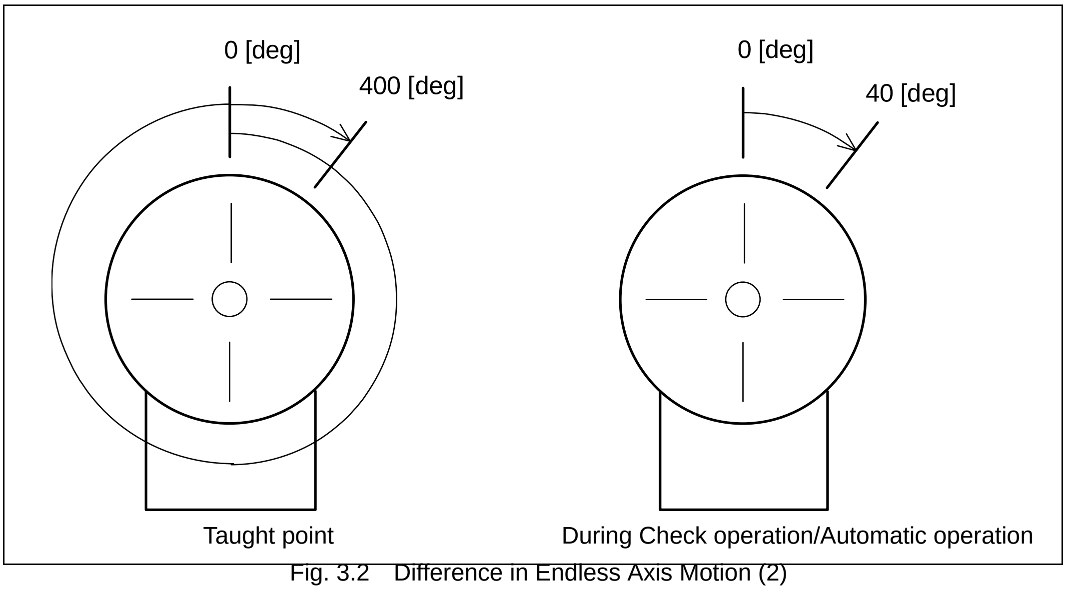


Fig. 3.2 Difference in Endless Axis Motion (2)

3.3 Modification of positioner rotation angle on screen edit

Press [EDIT] key on Teach pendant to start the screen edit function and modify the task programs currently displayed.

Also, the record position of the endless axis can be modified in the same way as the regular axis using the screen edit function. However, note that it must be within the range of ±180 [deg], otherwise the position cannot be recorded.

MACHINE
ADJUSTMENT
PROCEDURE

Machine Adjustment Procedure

The machine adjustments using the AX21 control unit (ABSO settings, mastering, etc.) are performed in the sequence below.
Before the machine adjustments can be undertaken, the settings set forth in "Chapter 1 System Installation and Memory Formatting" must have already been performed.

Encoder reset and encoder correction

Page 3-2 3.2 Performing Encoder Reset and Encoder Correction

"Encoder correction" is the same as what was previously called the "ABSO setting," and it refers to the task that determines the home positions of the axes.

In this way, the "encoder correction values" are obtained.

Discrete mastering

Page 3-6 3.3 Performing Discrete Mastering

Since an adequate interpolation accuracy is not achieved with the encoder correction alone, it is calibrated by the "mastering."

Upon completion of the mastering, the "encoder correction values" are adjusted further. The "post-mastering encoder correction values" may be thought of as identical to what has been called the "main unit adjustment amounts" in the past.

Tool-related settings

Page 3-9 3.4 Setting Tool Constants

The "tool length" and "tool angle" are input. These settings are the identical to what has been conventionally referred to as the "tool parameters".

Since the tool parameters are already known for a DAIHEN standard torch, all that needs to be done is input their values.

The tool parameters for hands or spot guns, etc. are not known. They are set using the automatic setting function.

V series -AP type manipulators are not available for mounting the torch gauge. Fine-adjust the “tool length” according to the actual torch tip position using the “Tool length automatic setting function”. If changing the tool shape, retain the task program that contains the previous tool tip position before change so that the tool length can be easily adjusted with the two-point tool length setting function.

Installation posture settings

Page 3-31 3.5 Setting the Installation Posture

If a discrete manipulator is mounted on the wall or ceiling or if an external axis is provided, the installation posture is set in order to determine in what kind of position and posture the manipulator or external axis is installed.

In the case of a cooperative system, the values obtained as a result of the cross mastering are input here.

Incidentally, no settings are required if a discrete manipulator is mounted on the floor.

Cross mastering

Page 3-34 3.6 Performing Cross Mastering

Cross mastering is performed in order to obtain the necessary cooperative accuracy.

The values obtained as a result of the cross mastering are input as the "installation posture of the external axis."

There are both ”former system” and ”new system” for the cross mastering. This instruction manual describes ”former system”.

For details of “new system”, see the instruction manual ”Cross mastering (No.1L9341L-J)”.

Performing Encoder Reset and Encoder Correction

Encoder reset and encoder correction (previously referred to as the ABSO setting) are performed in order to adjust the home positions of the robot's axes.
These tasks must be carried out when the robot is shipped from the factory and whenever a motor is replaced (including when a mechanism main unit is replaced).
Upon completion of the encoder correction, the basic posture check program is prepared. This program corresponds to the conventional P999 or P9999. Prepare the program using the same number of 9999 for the AX21 control unit as well.

CAUTION

In some robots and servo guns that apply the servo motors, encoder reset cannot be executed on Teach pendant. With these models, special operation is required to execute encoder reset.
For the details on how to execute encoder reset, refer to each instruction manual.

< Relevant models >
・Servo guns driven by Panasonic MS152Q2D and MS252Q2D

Moving to the basic posture and selecting the menu items

1 Select the teach mode.

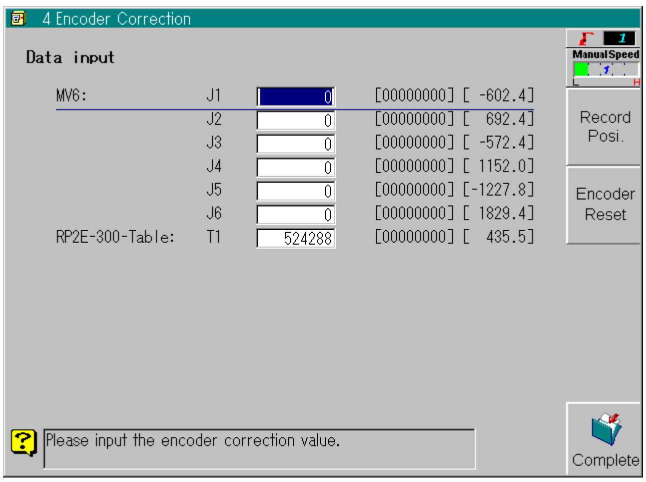
2 Turn on the servo power supply.

3 Perform manual operations in such a way that all the robot's axes are aligned with the mark-off lines on the castings.

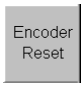
*** The encoder reset and encoder correction positions are not index mark positions. (Index marks have been discontinued with the AX control unit.)**
If an index mark is adhered at the home position of an axis, peel it off (and adhere it elsewhere) to reveal the mark-off lines underneath, and then proceed with the manual operations.

4 Press <Constant Setting>, and select [3 Machine Constants] and [4 Encoder Correction].

≫ This has the effect of selecting the encoder correction & reset screen.
Now proceed with the encoder reset and encoder correction operations. (These are described on the next and subsequent pages.)
The screen that appears when the menu is selected is the screen on which the encoder correction is performed. The encoder correction or encoder reset operation is selected on this screen.

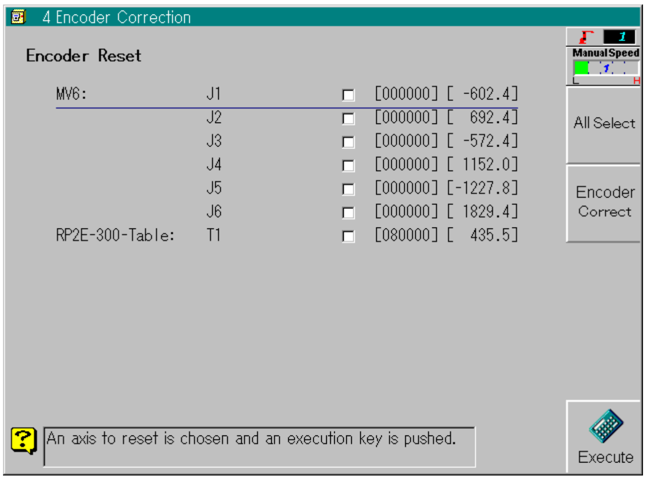


Resetting the encoder



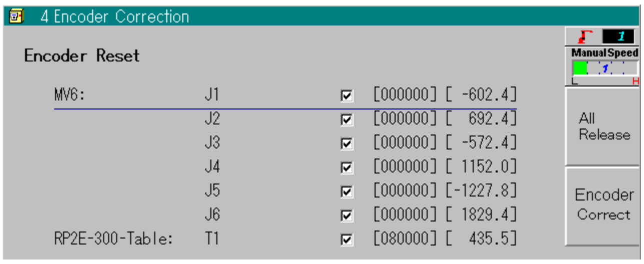
1 **To reset the encoder, press f9 <Encoder Reset>.**

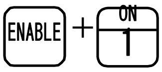
≫ The encoder reset screen is selected.



2 **To reset all the axes at once, press f8 <All Select>.**

≫ All the axes are selected, and check marks appear for them.
The selected status can be released by pressing f8 <All Release>.





3 **To reset a specific axis only for replacing a motor, for instance, select the axis, and press [ENABLE] + [1].**

≫ A check mark appears for the selected axis.

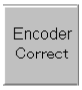
To release the selected axis, press [ENABLE] + [2].

4 **When the axis to be reset is selected, press f12 <Execute>.**
If the robot axes are not equipped with a brake, press f12 <Execute> while keeping the servo power on. (If all the axes of the robot are equipped with a brake, this operation may be performed with the servo power off.)

(Action to be taken soon after the motor replacement)

5 **After resetting the encoder, move the robot so that its margin becomes 50.**
At this time, the robot is not supposed to pass through “00”. Aligning the margin at 50, line it up with the triangular mark.

Correcting the encoder



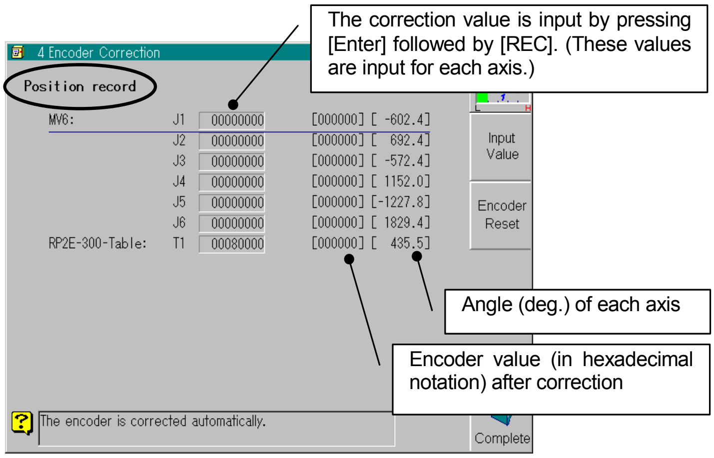
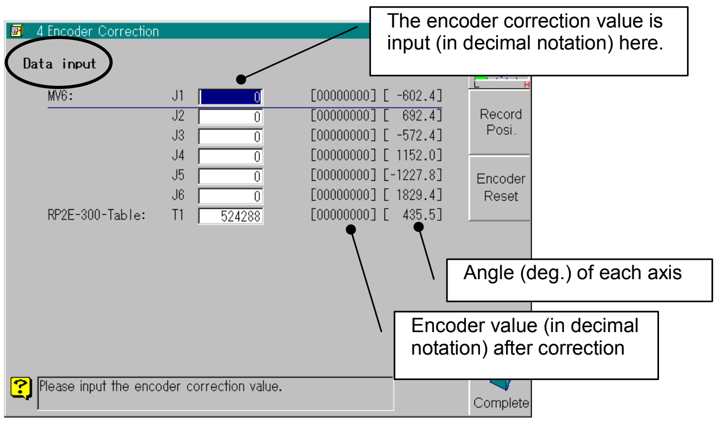
1 **Upon completion of the encoder resetting, proceed with the encoder correction.**

Press f9 <Encoder Correct>.

≫ The screen which appeared immediately after [3 Machine Constants] and [4 Encoder Correction] were selected is restored.

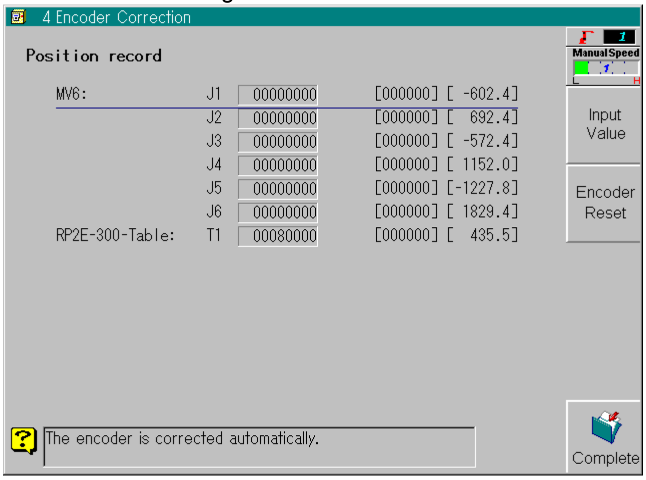
2 **Either "Data Input" or "Position Record" can be used as the method for encoder correction.**

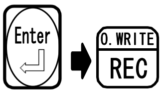
"Position Record" is normally used.

Compensation method	Details
Position Record	Select this method at a production process or when a motor or mechanism is to be replaced. Be absolutely sure to perform the operations with the robot placed in a posture where the mark-off lines are aligned. 
Data Input	Use this method when the encoder correction values are already known. An "encoder correction value which is already known" is a post-mastering encoder correction value which is provided inside the control unit when the robot is shipped from the factory. It corresponds to what was referred to as the "manipulator adjustment value" in the past. Therefore, the times when the encoder correction values are input after shipment are as follows: • When the encoder battery has been replaced • After the memory has been formatted When these values are input, it is acceptable for the robot to be in any position and any posture. 

3 The "Position Record" method is described here.
Press f8 <Record Position>.

≫ The screen now changes.





4 Align the cursor with the axis whose encoder is to be corrected, and press [Enter] followed by [REC].
If the robot axes are not equipped with a brake, press [REC] while keeping the servo power on. (If all the axes of the robot are equipped with a brake, this operation may be performed with the servo power off.)

* Encoder correction cannot be implemented for all the axes together so repeat these operations for each axis in turn.

5 At this stage, the encoder correction values are still not saved in the memory.
To save them, first turn the motor power OFF (by pressing emergency stop).
Then press f12 <Complete>.

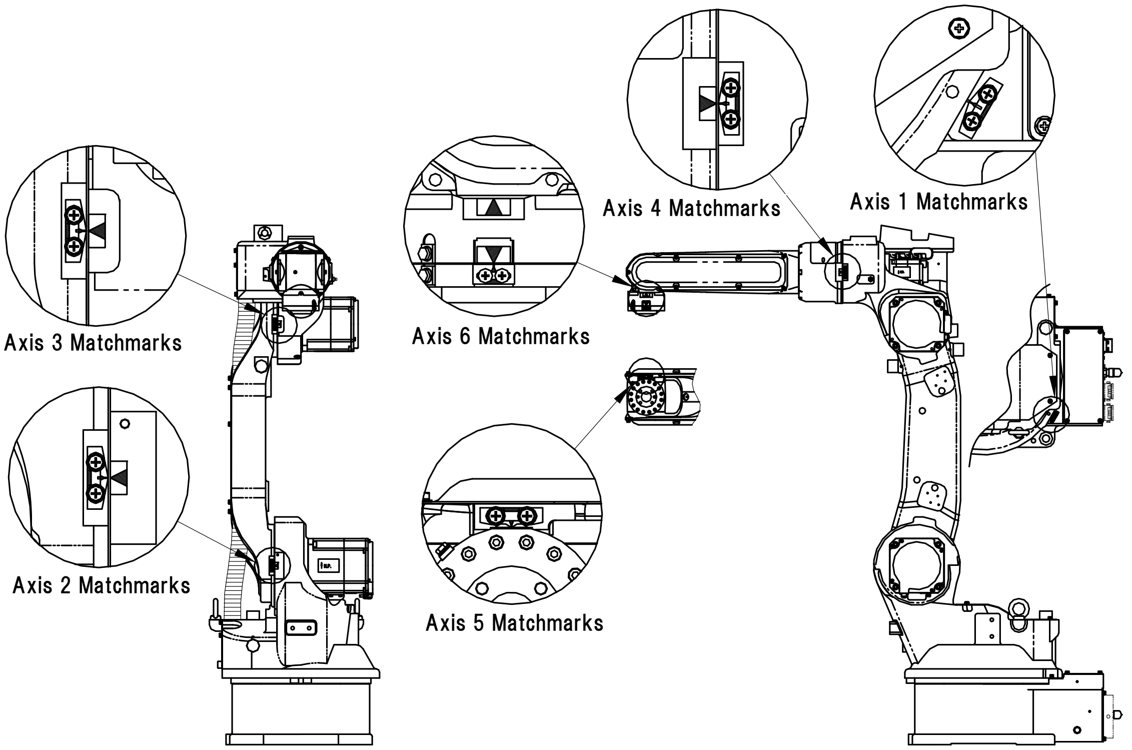
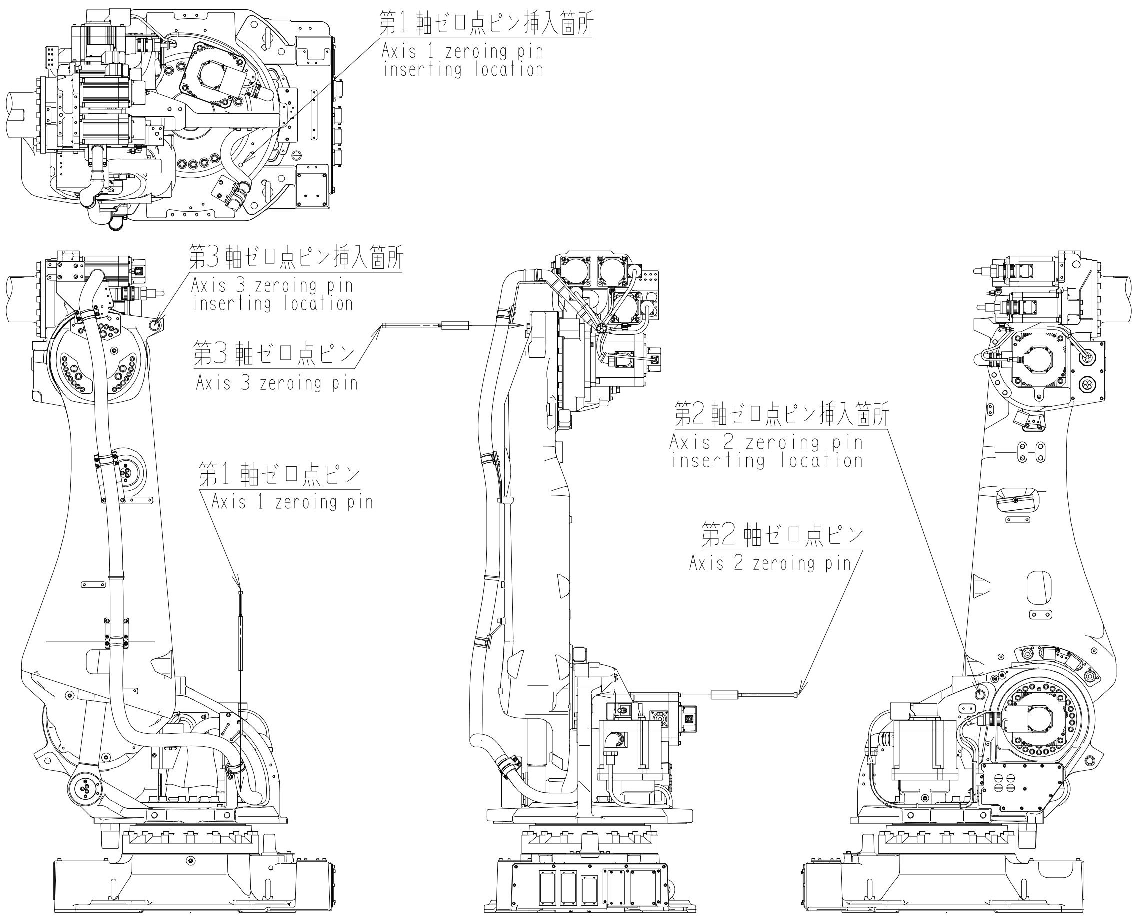


Fig. 4.3.5 Origin Adjusting Match-mark Positions (NV6/NV6L/NV20)



A Pose to insert the zeroing pin (J1,J2 and J3 axis of SRA166-01)

Performing Discrete Mastering

Mastering is performed to achieve the interpolation accuracy.
There are two kinds of mastering: discrete mastering which achieves the accuracy for the manipulator unit, and cross mastering which achieves the accuracy when cooperative control is performed. Discrete mastering is described here. For a description of cross mastering, refer to page 3-34 3.6 Performing Cross Mastering.

The AX21 control unit provides a choice between two ways of achieving discrete accuracy. One of these ways must be used without fail. When the "tool length and axis constant adjustments" are performed on an already mastered robot, the positions in the programs already prepared will be offset. The reverse is also true.

Table 3.3.1 Method used to achieve discrete accuracy

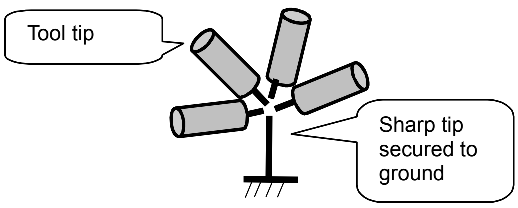
Method used to achieve discrete accuracy	Details
Mastering	This method is the same as conventional mastering. Use this method with a DAIHEN manipulator.
Tool length and axis constant adjustments	This is the adjustment method used by NACHI in the past. Use this method with a NACHI manipulator. It is usually helpful to use it when the tool parameters are not known (when a hand or spot gun has been attached). When it is used, the settings of the tool parameters and discrete mastering can be completed altogether. When using this method to perform the adjustments, follow the steps outlined on page 3-16 3.4.2 Setting tool length of unkown tool. As the setting type, select "Tool length & axis constant."

Performing discrete mastering

1 Perform the steps listed below.

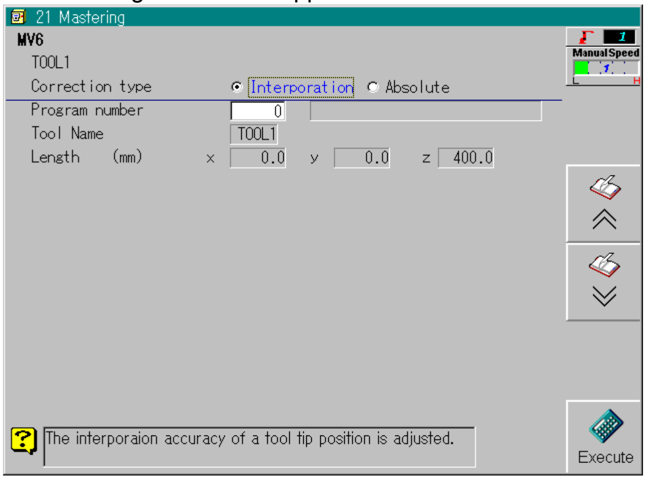
■ In the case of production processes
① Attach the mastering gauge to the robot.
② Input the tool parameters (see 3.4 Setting Tool Constants in page 3-9 of the mastering gauge in "Tool 1" by following the steps on page 3-9 3.4 Setting Tool Constants.
③ Copy the mastering program, which was prepared in advance for production processes, into the AX21 control unit. Use [File] - [Copy] to copy the program from the CF card into ¥Work¥Program.
④ Open the mastering program and perform CHECK/GO.
⑤ Position the mastering stand in such a way that its tip is aligned with the torch tip position in the first step.
⑥ Perform CHECK/GO at the next step. If the torch tip is offset from the tip of the mastering stand, correct the teaching (position correction) so that the two tips are aligned.
⑦ Perform step ⑥ at all the steps in which the linear interpolation instruction (LIN) was taught.

■ When a motor or other part has been replaced after shipment
① Attach the tip gauge.
② Create a new mastering program.
Teach at least 20 or so steps for various angles for one fixed point (at any position) inside the operating range of the robot.



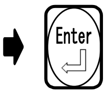
2 Press <Constant Setting>, and select [3 Machine Constants] and [21 Mastering].

≫ The following screen now appears.



3 Select the number of the tool to be adjusted using f10 <Next>.
This is "Tool 1" in almost all cases.

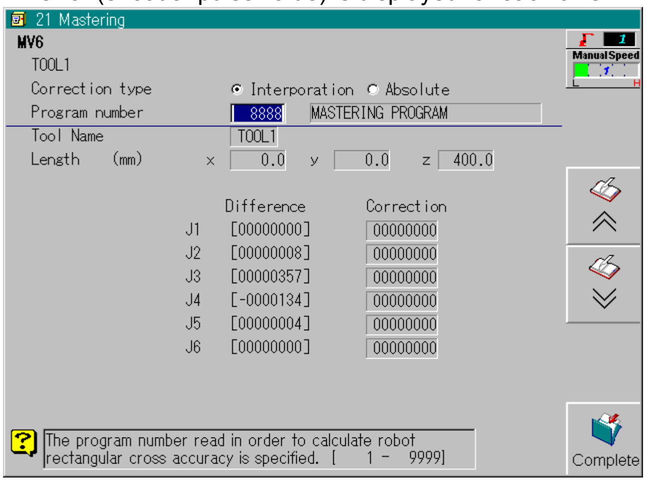
4 Align the cursor with "Correction type," and select "Interpolation."
"Absolute" is selected when the absolute accuracy is to be corrected. However, a special jig is required for this, and it is a task which is carried out only by the Quality Management Section at the request of the user. Normally, do not select it.
It is usually sufficient to select only "Interpolation." (Conventional mastering also involved the correction of only the interpolation accuracy.)

Number 

5 Align the cursor with "Program Number," input the number of the mastering program, and press [Enter].

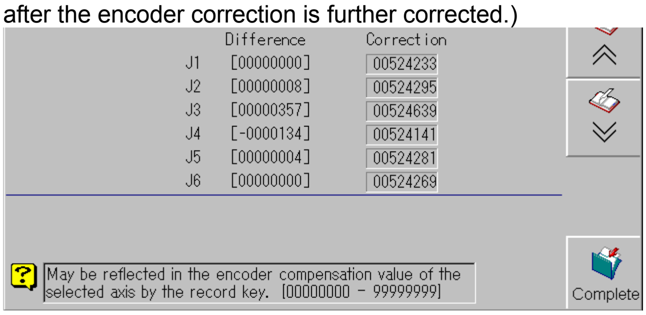
6 Press f12 <Execute>.

≫ An error (encoder pulse value) is displayed for each axis.



7 Select the axis for which the calculation result is to be reflected, and press [REC].

≫ The result is reflected in the encoder correction value. (The correction value obtained after the encoder correction is further corrected.)



8 The post-mastering encoder correction values correspond to the "main unit adjustment amounts" used in the past.

Save these values as the data for the production processes.

9 At this stage, the encoder correction values are still not saved in the memory.
To save the data, press f12 <Complete>.

Setting Tool Constants

The “tool constants” refer to a set of parameters including the length, angle, center of gravity, weight and moment of inertia of the installed tool. These parameters are extremely important for ensuring precise linear operations and appropriate acceleration/deceleration control. Before moving the robot, read carefully through the instructions in this section and take the steps described without fail. Tool constants for up to 32 tools can be stored in the AX21 controller’s memory. If an application involves the use of a multiple number of tools, perform the settings for all the tools concerned.

CAUTION

Continued use under the wrong settings for the center of gravity, weight and tool’s moment of inertia may fatally damage the machine. Perform the settings set forth in this section without fail.
The settings must be performed even for small and/or lightweight tools. The theory “The greater embraces the less” does not apply.

CAUTION

When using the welding torch, be sure to use the values of tool length, angle, center of gravity, and moment of inertia described in the page 3-10 3.4.1 Tool constants of DAIHEN arc welding torch. Use of the automatic setting function of the tool center of gravity and moment of inertia may occasionally bring inaccurate values depending on the arrangement of conduit or cables. And then, this will cause improper acceleration/deceleration control of the robot.

CAUTION

The new software shock sensor function requires the accurate tool setting data (Weight, Center of gravity). Inaccurate setting of these values may cause misdetection on the interference.

Table 3.4.1 Tool Constants

Tool Constants	Explanation	Usage
Tool Name	A name can be set for each of the tools. A tool name may consist of not more than 16 alphanumerics and symbols.(Japanese characters cannot be used.)	If tool names are provided when a multiple number of torches are selected by a tool changer, etc. for use, it will be easier to identify the tools.
Length	This constant is the length up to the tool tip in the TCP coordinate system (X, Y and Z components of the tool tip). It is absolutely necessary in order to ensure precise linear movements. When the **tool length automatic setting function** is used, the tool length can be ascertained automatically using the already created program. With the tool shape changed, use the **two-point tool length setting function** so that the tool length after its shape’s change can be easily calculated.	• The "tool length" and "tool angle" together correspond to what used to be referred to as the "tool parameters" with DAIHEN's conventional models. • When the DAIHEN standard welding torch is to be used, input the values which match the torch to be used. • Use the "simple setting function" to perform the

Angle	This constant is for setting the inclination of the tool tip in the TCP coordinate system using the X, Y and Z axis rotation components. It proves useful since, when teaching, the tool can be operated manually in the direction in which it is pointing. When the **tool angle simple setting function** is used, the tool angle can be set easily.	settings when using a tool such as a hand or spot gun for which the parameters are not known. • With the V series -AP type manipulators, use the “Tool length automatic setting function” to fine-tune the tool length.
C of G	This constant is for setting the tool's center of gravity position in the TCP coordinate system and its weight. It is required in order to ensure appropriate acceleration/deceleration control. The constant is set using the **tool center of gravity (COG) and weight automatic setting function**. (The weight of a tool cannot be input manually.)	• These constants correspond to the "transfer conditions for optimum acceleration/ deceleration control" with DAIHEN's conventional models. • When using a welding torch or other such tool, input the values which match the torch to be used. • Use the "simple setting function" to adjust to the optimum values when using a tool such as a hand or spot gun for which the parameters are not known.
Inertia	This constant is for setting the moment of inertia around the center of gravity in the TCP coordinate system using the X, Y and Z components. It must be set if the moment of inertia has exceeded the allowable value. When the **tool moment of inertia simple setting function** is used, the moment of inertia can be set easily by designating the tool shape.	
Max. radius	This constant is the max. radius of the tool. It is used to check the territory, etc.	Set this parameter when setting the interference area.

Tool constants of DAIHEN arc welding torch

When an arc welding torch made by DAIHEN is used, use the following tool constant values.
The values “Moment of inertia” and ”Max. rotation diameter” are negligible for the welding torch. They should be set to ”0.0”.

CAUTION

To use the welding torch, be sure to apply the values introduced below for the tool length, angle, tool center of gravity and moment of inertia. Especially about the center of gravity and moment of inertia, follow the table below.

CO_2/MAG Torch

Table 3.4.2 Daihen arc welding torch tool constant(New torch)

For N series V type	Length			Angle			Center of gravity			Weight	Moment of inertia			Radius	Referential drawing
	X [mm]	Y [mm]	Z [mm]	Rx [deg]	Ry [deg]	Rz [deg]	Gx [mm]	Gy [mm]	Gz [mm]	Mass [kg]	Ix kgm^2	Iy kgm^2	Iz kgm^2	r mm	
RT3500S	140.0	0.0	385.0	180.0	0.0	0.0	118.0	0.0	127.0	2.1	0.050	0.090	0.030	0.0	Fig. 3.4.1
RT5000S									128.0	2.2					
RTW5000S							119.0		129.0	2.3	0.060		0.040		
RZ3500S							118.0		126.0	2.2					
RT3500H	0.0	0.0	400.0	180.0	-45.0	0.0	107.0	0.0	140.0	2.3	0.070	0.100	0.030		Fig. 3.4.2
RT5000H									142.0						
RTW5000H										2.4	0.080	0.110			
RZ3500H							111.0		141.0	2.3	0.070				
RT3500L	0.0	0.0	400.0	180.0	-45.0	0.0	119.0	0.0	148.0	2.4	0.080	0.120	0.040		Fig. 3.4.3
RT5000L									149.0						
RTW5000L							121.0		146.0	2.6		0.130	0.050		
RZ3500L							126.0		142.0	2.5					

For N series B type	Length			Angle			Center of gravity			Weight	Moment of inertia			Radius	Referential drawing
	X [mm]	Y [mm]	Z [mm]	Rx [deg]	Ry [deg]	Rz [deg]	Gx [mm]	Gy [mm]	Gz [mm]	Mass [kg]	Ix kgm^2	Iy kgm^2	Iz Kgm^2	r mm	
RT3500H	-135.5	0.0	310.0	180.0	-45.0	0.0	-10.0	0.0	74.0	1.9	0.030	0.030	0.0	0.0	Fig. 3.4.4
RT5000H							-11.0		76.0	2.0					
RTW5000H			320.0				-12.0		85.0	2.1	0.040	0.040			Fig. 3.4.5
RZ3500H	-140.5		315.0						79.0	2.0	0.030				Fig. 3.4.6
RT3500L	-90.5	0.0	310.0	180.0	-31.0	0.0	-5.0	0.0	69.0	1.9	0.030	0.030	0.0	0.0	Fig. 3.4.7
RT5000L							-6.0		70.0						
RTW5000L			330.0						82.0	2.0	0.040	0.040			Fig. 3.4.8
RZ3500L	-95.5						-7.0		78.0		0.030	0.030			Fig. 3.4.9

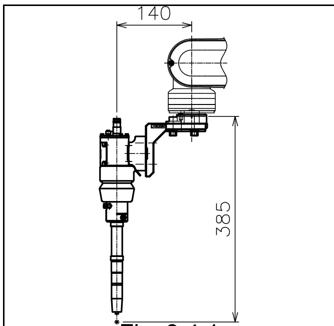


Fig. 3.4.1

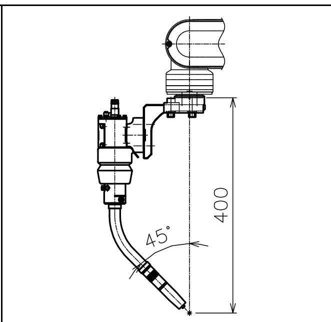


Fig. 3.4.2

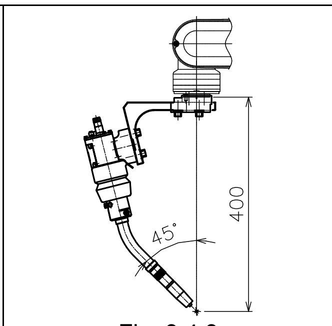


Fig. 3.4.3

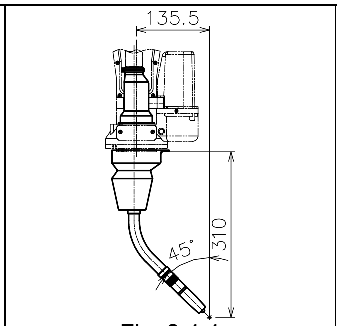


Fig. 3.4.4

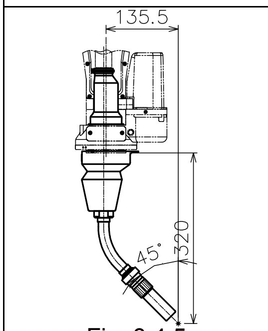


Fig. 3.4.5

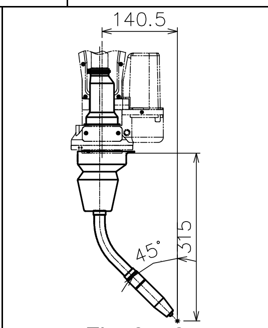


Fig. 3.4.6

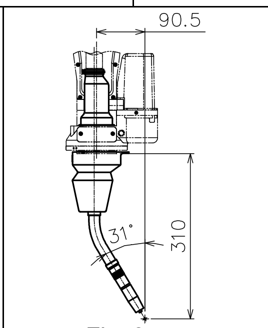


Fig. 3.4.7

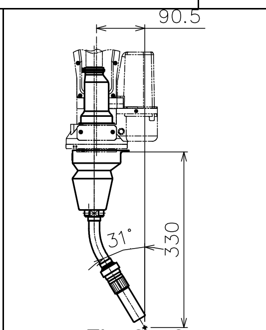


Fig. 3.4.8

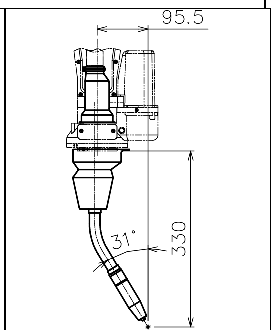


Fig. 3.4.9

CO_2/MIG/MAG Torch(Past Torch)

Table 3.4.3 Daihen arc welding torch tool constant (Past Torch)

For V series	Length			Angle			Center of gravity			Weight	Moment of inertia			Radius	Referential drawing
	X [mm]	Y [mm]	Z [mm]	Rx [deg]	Ry [deg]	Rz [deg]	Gx [mm]	Gy [mm]	Gz [mm]	Mass [kg]	Ix kgm^2	Iy kgm^2	Iz kgm^2	r mm	
MTXC-3531	0.0	0.0	400.0	180.0	-45.0	0.0	109.0	0.0	123.0	2.0	0.0	0.0	0.0	0.0	Fig 3.4.1
MTXCB-3531										2.1					
MTXCB-5031										2.3					
MTXC-5031										2.1					
MTXCW-5031										2.2					
MTXCA-2531										2.1					
MTXCAW-5031										2.2					
MTX-3531	140.0	0.0	385.0	180.0	0.0	0.0	116.0	0.0	107.0	1.9					Fig 3.4.2
MTXB-3531										2.0					
MTX-5031										2.0					
MTXB-5031										2.2					
MTXW-5031										2.1					
MTXA-2531										2.0					
MTXAW-5031										2.1					
MTX-3531	0.0	0.0	350.0	180.0	-45.0	0.0	143.0	0.0	195.0	1.9					Fig 3.4.3
MTXB-3531										2.0					
MTX-5031										2.0					
MTXB-5031										2.2					
MTXW-5031										2.2					
MTXA-2531										1.9					
MTXAW-5031										2.2					

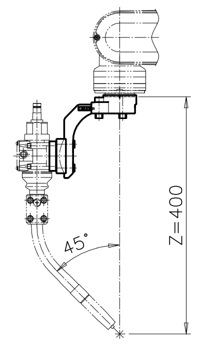


Fig 3.4.1

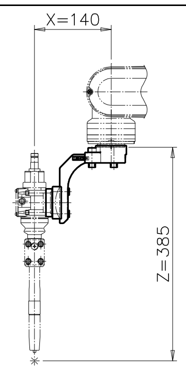


Fig 3.4.2

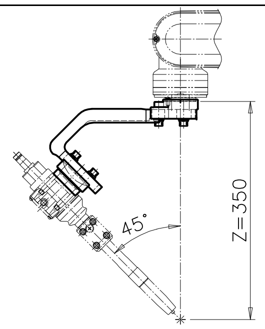


Fig 3.4.3

TIG Torch

Table 3.4.4 Daihen arc welding torch tool constant (TIG Torch)

For V series	Length			Angle			Center of gravity			Weight	Moment of inertia			Radius	Referential drawing
	X [mm]	Y [mm]	Z [mm]	Rx [deg]	Ry [deg]	Rz [deg]	Gx [mm]	Gy [mm]	Gz [mm]	Mass [kg]	Ix kgm^2	Iy kgm^2	Iz kgm^2	r mm	
MWXC-2001	0.0	0.0	360.0	180.0	-45.0	0.0	90.0	0.0	151.0	2.2	0.0	0.0	0.0	0.0	Fig 3.4.4
MWXC-3501							90.0	0.0	148.0	2.1					
MWX-2001	170.0	0.0	385.0	180.0	0.0	0.0	114.0	0.0	148.0	2.2					Fig 3.4.5
MWX-3501							111.0	0.0	146.0	2.1					

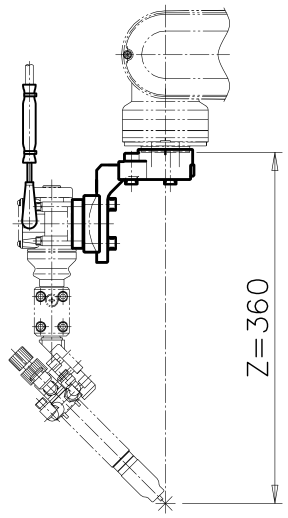


Fig 3.4.4

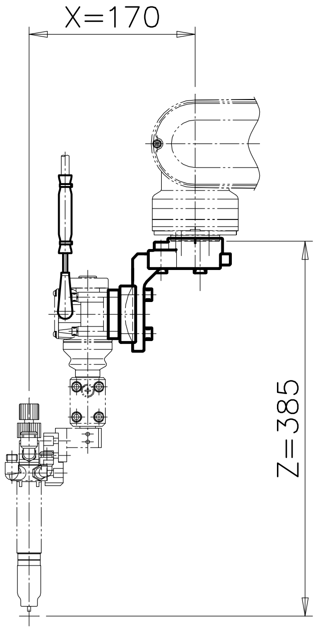


Fig 3.4.5

Pull type servo torch (4 roll specifications) CO_2/MIG/MAG

Table 3.4.5 Tool constants of DAIHEN pull type servo torch (4 roll specifications)

For V series	Length			Angle			Center of gravity			Weight	Moment of inertia			Radius	Referential drawing
	X [mm]	Y [mm]	Z [mm]	Rx [deg]	Ry [deg]	Rz [deg]	Gx [mm]	Gy [mm]	Gz [mm]	Mass [kg]	Ix kgm^2	Iy kgm^2	Iz kgm^2	r mm	
MTXC-3534P	0.0	0.0	445.0	180.0	-45.0	0.0	107.0	0.0	212.0	5.4	0.0	0.0	0.0	0.0	Fig 3.4.6
MTXCB-3534P										5.5					
MTXC-5034P										5.4					
MTXCW-5034P	0.0	0.0	465.0							5.6					Fig 3.4.7
MTXCA-2534P										5.6					Fig 3.4.8
MTXCAW-5034P										5.7					Fig 3.4.9

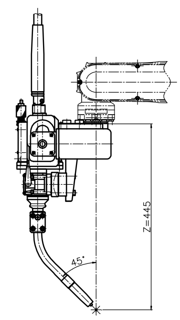


Fig 3.4.6

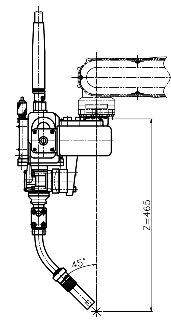


Fig 3.4.7

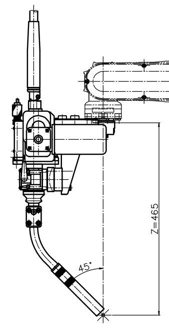


Fig 3.4.8

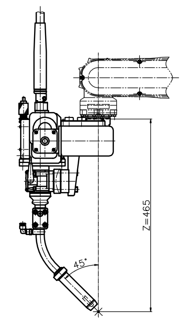


Fig 3.4.9

Pull type servo torch (2 roll specifications) Aluminum MIG

Table 3.4.6 Tool constants of DAIHEN pull type servo torch (2 roll specifications)

For N series V type	Length			Angle			Center of gravity			Weight	Moment of inertia			Radius	Referential drawing
	X [mm]	Y [mm]	Z [mm]	Rx [deg]	Ry [deg]	Rz [deg]	Gx [mm]	Gy [mm]	Gz [mm]	Mass [kg]	Ix kgm^2	Iy kgm^2	Iz kgm^2	r mm	
MTXC-3541PS	0.0	0.0	375.0	180.0	-45.0	0.0	110.0	0.0	80.0	3.3	0.0	0.0	0.0	0.0	Fig.3.4.10
MTXCA-3041PS															
MTXCW-5041PS	0.0	0.0	385.0							3.4					Fig.3.4.11
MTXCAW-4041PS										3.3					
For N series B type	**Length**			**Angle**			**Center of gravity**			**Weight**	**Moment of inertia**			**Radius**	**Referential drawing**
	X [mm]	Y [mm]	Z [mm]	Rx [deg]	Ry [deg]	Rz [deg]	Gx [mm]	Gy [mm]	Gz [mm]	Mass [kg]	Ix kgm^2	Iy kgm^2	Iz kgm^2	r mm	
MTXC-3541PS	-137.0	0.0	440	180.0	-45.0	0.0	-11.0	0.0	150.0	3.2	0.0	0.0	0.0	0.0	Fig.3.4.12
MTXCA-3041PS															
MTXCW-5041PS	-127.0	0.0	460.0							3.3					Fig.3.4.13
MTXCAW-4041PS	-123.0	0.0	455.0							3.2					Fig.3.4.14

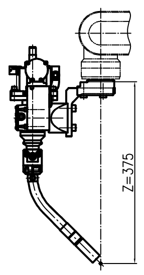


Fig.3.4.10

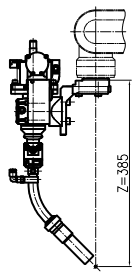


Fig.3.4.11

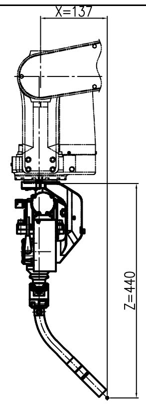


Fig.3.4.12

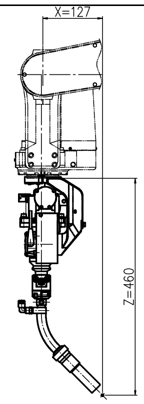


Fig.3.4.13

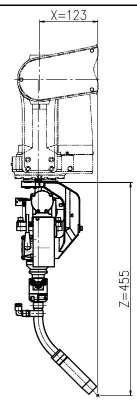


Fig.3.4.14

Mastering Gauge

CAUTION

The mastering adapter (No.Y2861X08) is necessary to mount the mastering gauge of V/B common type (No. Y1886W70) to the B series manipulator.

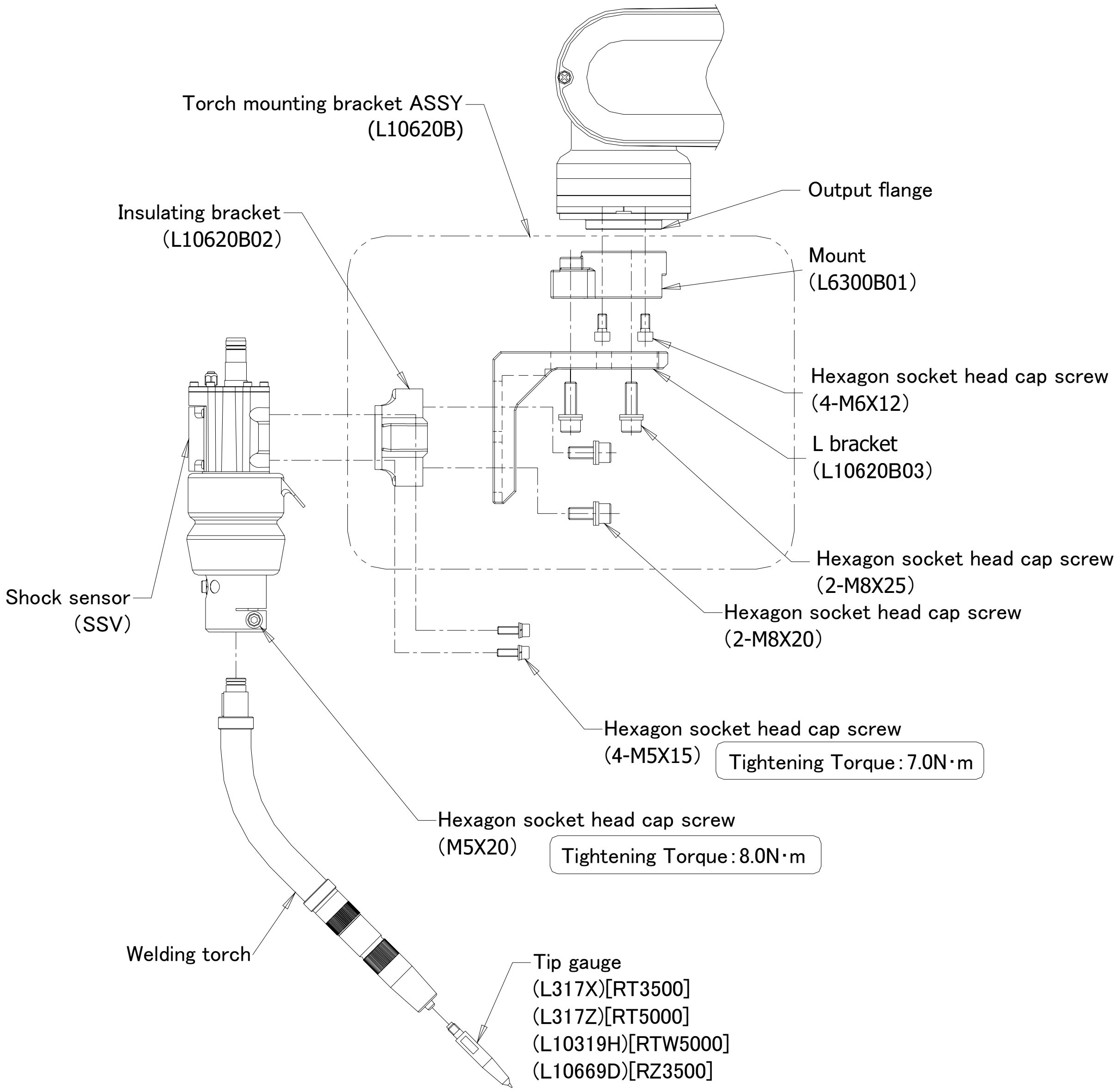
Table 3.4.7 Tool constants of DAIHEN's Mastering Gauge

Mastering Gauge	Length			Angle			C of G			Weight	Inertia			Radius
V/B common type Y1886W70 For V series	-350.0	0.0	150.0	0.0	0.0	0.0								
V/B common type Y1886W70 For B series	-350.0	0.0	165.0	0.0	0.0	0.0								
For B series Y3087S11A	-135.0	0.0	310.0	0.0	0.0	0.0								
For H03/S03	-200.0	0.0	122.0	0.0	0.0	0.0								
For G series (MTX-3531)	0.0	-285.0	29.5	-90.0	0.0	0.0								

3. Installing and Adjusting Procedure of Welding Torch

3.1 Mounting of Welding Torch on AII-V6 Type Manipulator

3.1.1 Mounting of shock sensor and mounting bracket



(Note: Purchase the torch mounting bracket ASSY separately.)

Fig. 3.1 Mounting of torch and shock sensor (for 45° curved / straight torch)

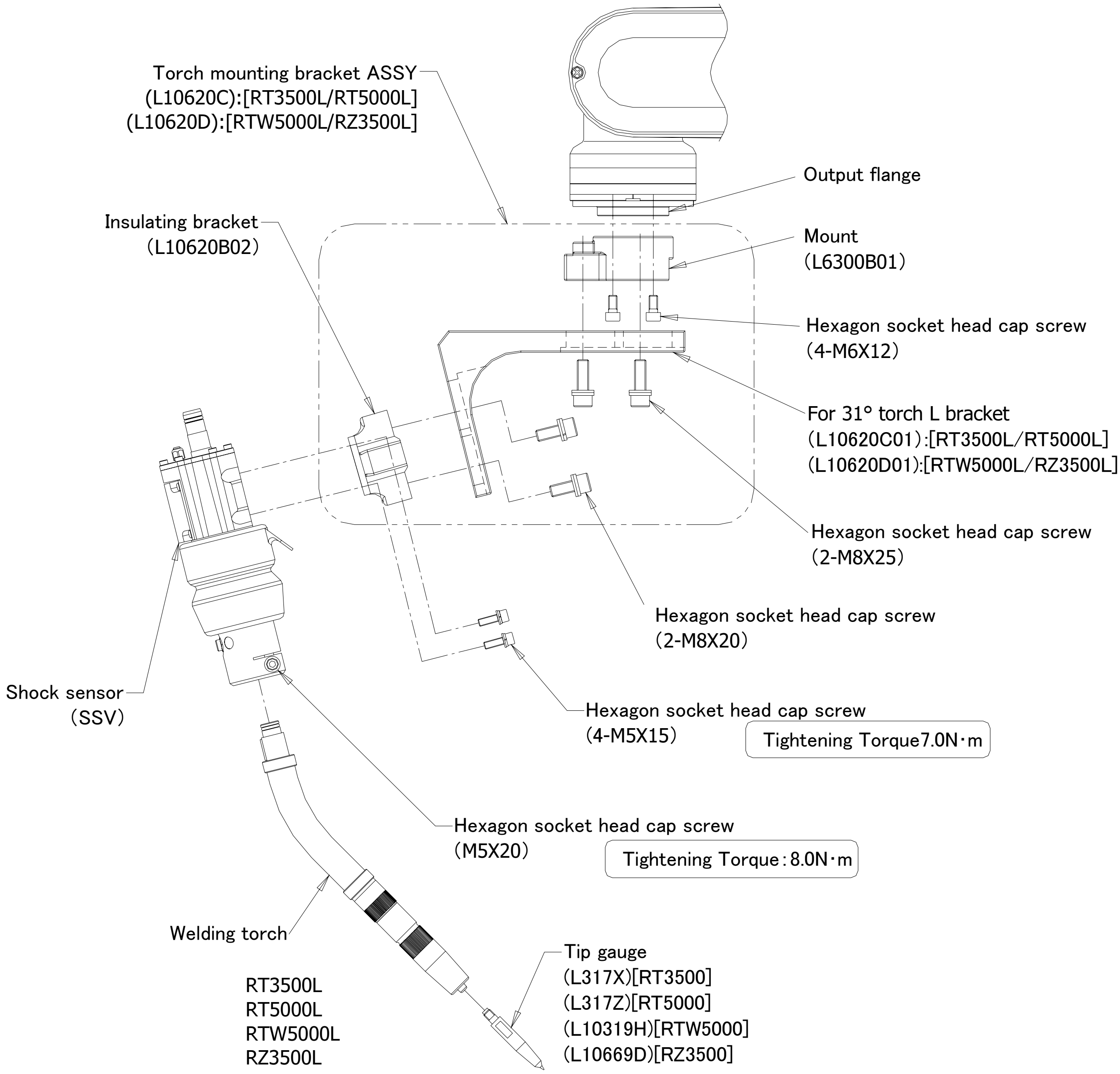
(1) Assemble the mount (L6300B01) onto the output flange of manipulator using 4 pieces of hexagon socket head cap screws (M6×12).

(2) Mount the L-bracket (L10620B03) to the mount that has assembled in the procedure (1) with 2 pieces of hexagon socket head cap screws (M8×25).

(3) Mount the insulating bracket (L10620B02) to the L-bracket that has mounted in the procedure (2) with 2 pieces of hexagon socket head cap screws (M8×20).

(4) Mount the shock sensor onto the insulating bracket with 4 pieces of hexagon socket head cap screws (M5×15).

(5) Loosen the hexagon socket head cap screw (M5×20) of shock sensor to insert the torch. Fix it by tightening the screw.



(Note: Purchase the torch mounting bracket ASSY separately.)

Fig. 3.2 Mounting of torch and shock sensor (for 31° curved torch)

(1) Assemble the mount (L6300B01) onto the output flange of manipulator using 4 pieces of hexagon socket head cap screws (M6×12).

(2) Mount the L-bracket (L10620B01 or L10620D01) to the mount that has assembled in the procedure (1) with 2 pieces of hexagon socket head cap screws (M8×25).

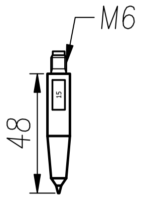
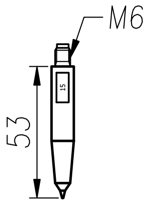
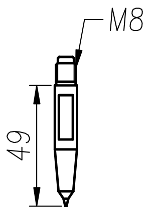
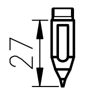
    Choose an L bracket according to the type of the welding torch. (For detail, refer to Fig. 3.2)

(3) Mount the insulating bracket (L10620B02) to the L-bracket that has mounted in the procedure (2) with 2 pieces of hexagon socket head cap screws (M8×20).

(4) Mount the shock sensor onto the insulating bracket with 4 pieces of hexagon socket head cap screws (M5×15).

(5) Loosen the hexagon socket head cap screw (M5×20) of shock sensor to insert the torch. Fix it by tightening the screw.

3.1.2 Mounting the torch gauge

L317X 350A トーチ用 for 350A torch	L317Z 500A 空冷トーチ用 for 500A torch	L10319H 500A 水冷トーチ用 for 500A torch	L10669D RZ トーチ用 for RZ torch
ｴｸｽﾃﾝｼｮﾝ Extension 15mm	ｴｸｽﾃﾝｼｮﾝ Extension 20mm	ｴｸｽﾃﾝｼｮﾝ Extension 20mm	ｴｸｽﾃﾝｼｮﾝ Extension 15mm
			
RT3500S RT3500H RT3500L	RT5000S RT5000H RT5000L	RTW5000S RTW5000H RTW5000L	RZ3500S RZ3500H RZ3500L

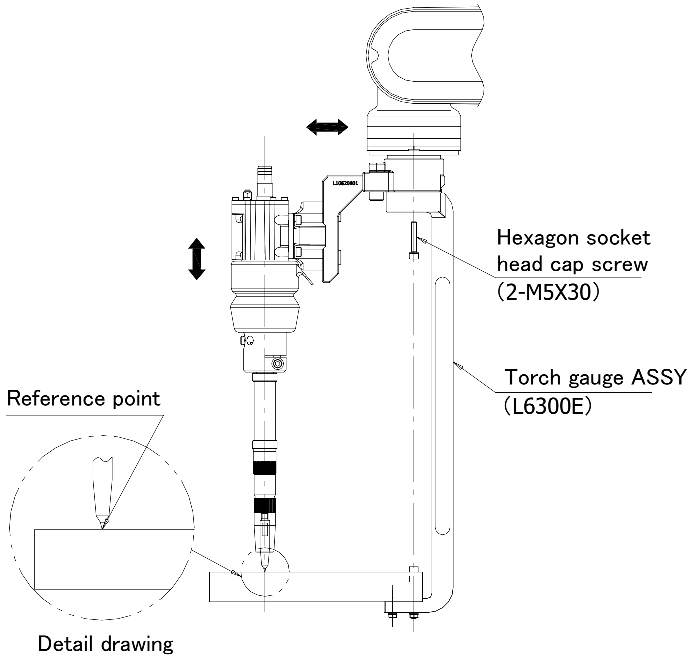


Fig. 3.3 Mounting the torch gauge (for straight torch)

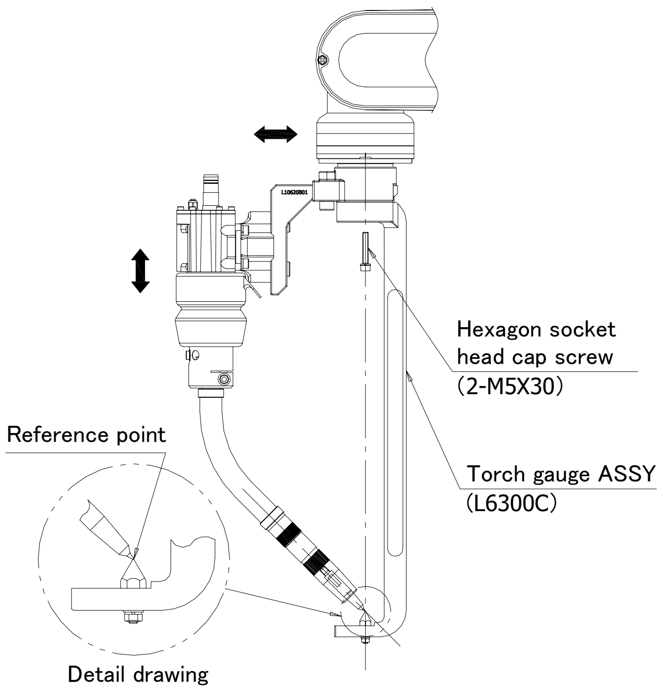


Fig. 3.4 Mounting the torch gauge (for 45° curved torch)

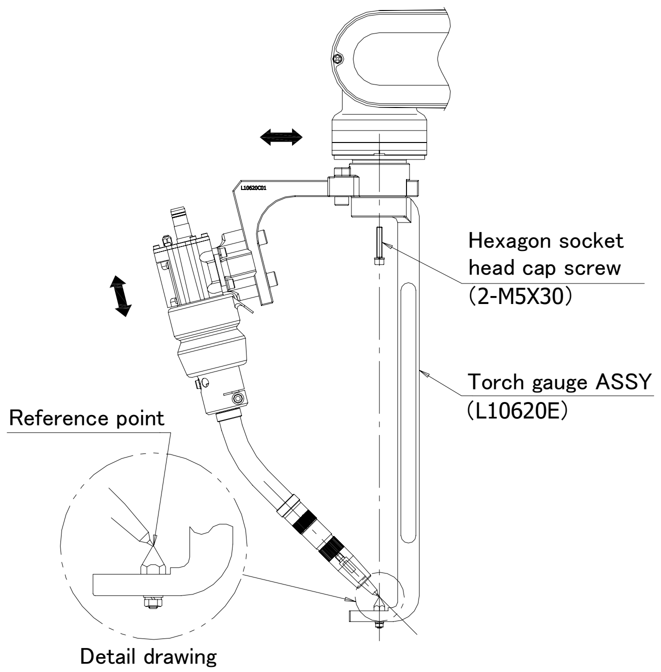


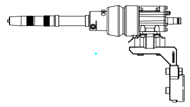
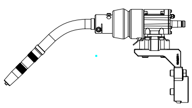
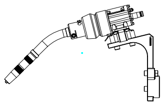
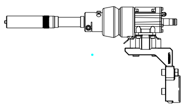
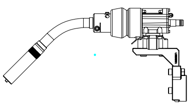
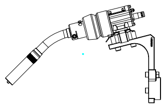
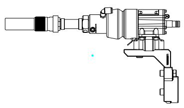
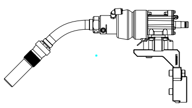
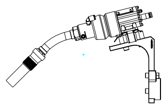
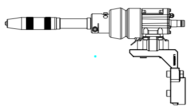
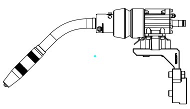
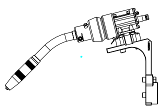
Fig. 3.5 Mounting the torch gauge (for 31° curved torch)

(Note: Purchase the torch gauge ASSY separately.)

(1) As for the RT series dismount the nozzle and the contact tip from the torch. As for the RZ series dismount the nozzle and the tip holder from the torch.
(2) Mount the tip gauge firmly to the torch. (The gauge is an attached component of the torch mount.)
(3) Mount the torch gauge ASSY with 2 pieces of hexagon socket head cap screws (M5x30). (The screws are attached components of the torch gauge Assy.)
(4) Make sure that the reference point of torch gauge matches with the tip gauge end. If not, make adjustments for the reference point to align with it.

In addition, about each part to use at the time of torch installation to the V6 type manipulator, confirm it in Table 3.1.

Table 3.1 Type of Torch mounting bracket ASSY / Torch gauge ASSY / Tip gauge

Torch model	Torch mounting bracket ASSY	Torch gauge ASSY	Tip gauge
RT3500S 	L10620B	L6300E	L317X
RT3500H 		L6300C	
RT3500L 	L10620C	L10620E	
RT5000S 	L10620B	L6300E	L317Z
RT5000H 		L6300C	
RT5000L 	L10620C	L10620E	
RTW5000S 	L10620B	L6300E	L10319H
RTW5000H 		L6300C	
RTW5000L 	L10620D	L10620E	
RZ3500S 	L10620B	L6300E	L10669D
RZ3500H 		L6300C	
RZ3500L 	L10620D	L10620E	

3.1.3 Adjusting procedure of the torch

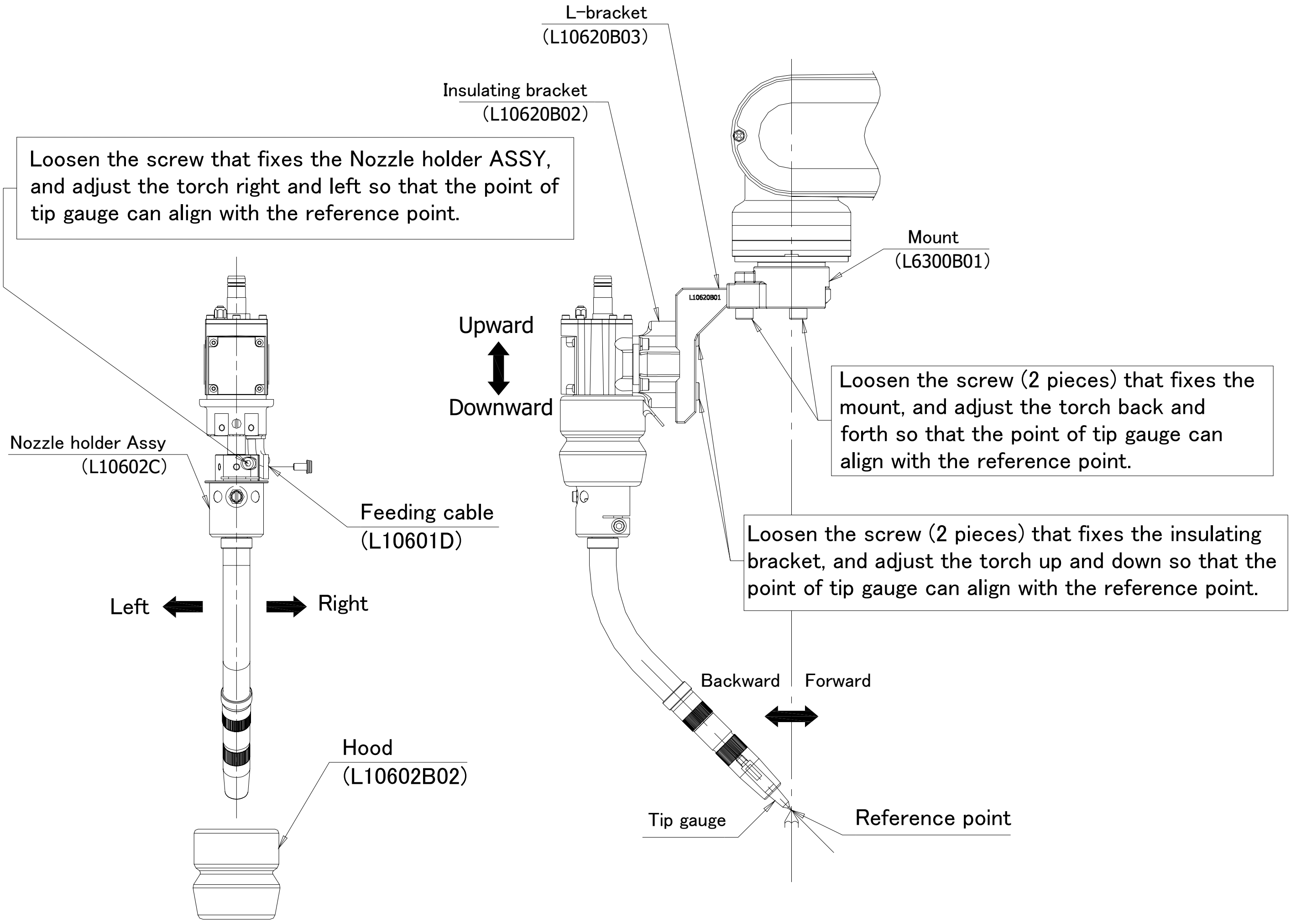


Fig. 3.6 Adjusting procedure of the torch

(1) If the tip gauge end slips out of the reference point of torch gauge in the upward or downward direction, loosen the 2 pieces of hexagon socket head cap screws (M8×20) that fix the insulating bracket (L10620B02) onto the L-bracket (L10620B03). Correct the position, moving the insulating bracket upward or downward, and then fix it firmly by tightening the screws.

(2) If the tip gauge end slips out of the reference point of torch gauge in the frontward or rearward direction, loosen the 2 hexagon socket head cap screws (M8×25) that fix the mount (L6300B01) onto the L-bracket (L10620B03). Correct the position, moving the mount frontward or rearward, and then fix it firmly by tightening the screws.

(3) If the tip gauge point is out of alignment in the horizontal direction to the reference point of the touch gauge, make alignment adjustment following the procedure shown below.
    1. Dismount the hood (L10602B02).
    2. Disconnect the power cable (L10601D) from the nozzle holder assembly (L10602C), unfasten the hexagon socket head cap screws (M5×20) that fix the nozzle holder to rotate it to the direction of misalignment (or to the left or right), and then make adjustment.
    3. Securely fix the nozzle holder and power supply cable, and then mount the hood.

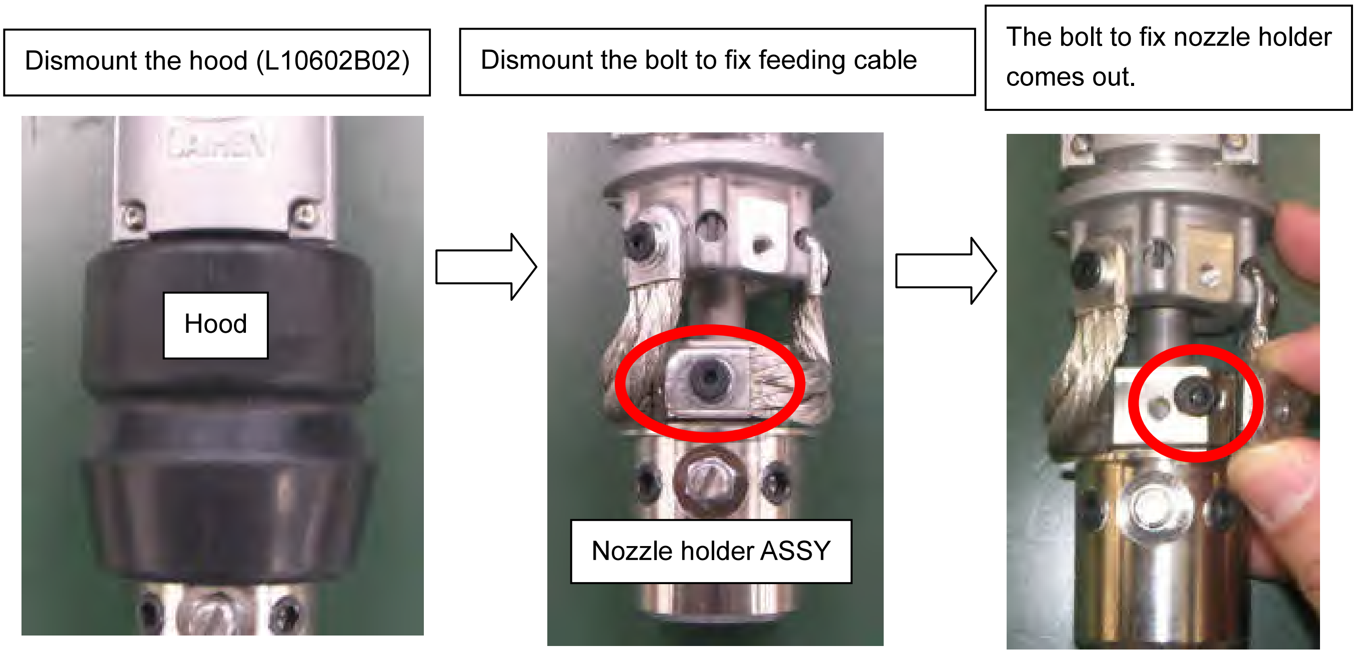


Fig. 3.7 Right and left direction adjusting procedure of the torch

(4) In case that the torch tip is not correctly positioned even after making adjustments as shown in (1) - (3), it is possible that there is a distortion in the L-bracket or the nozzle assembly. Follow the procedures (1) - (3) once again, and if it remains uncorrected, please contact to your nearest sales distributor of our company.
(5) Dismount the torch gauge when the adjusting procedure of torch is finished. Note that you need to create the origin position checking program before removing the tip gauge and mounting the nozzle and the contact tip onto the torch.

3.2 Mounting of Welding Torch on AII-B4 Type Manipulator

3.2.1 Mounting of curved torch

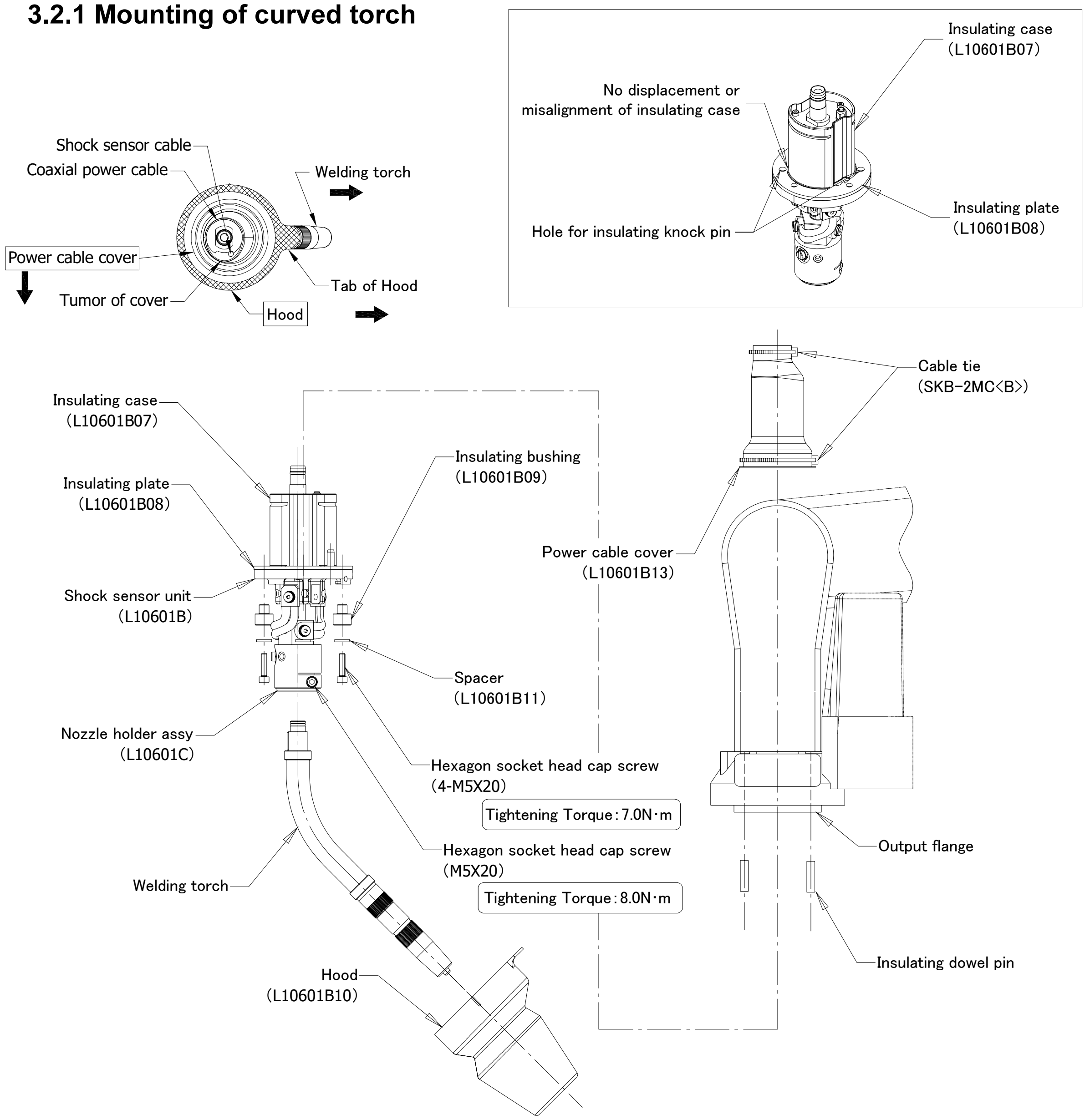


Fig. 3.8 Mounting of torch and shock sensor

(1) Drive the two insulating dowel pins onto the output flange of manipulator from underneath. (The pins are attached to the shock sensor unit (L10601B).)
(2) Make sure that the insulating case (L10601B07) and the insulating plate（L10601B08）are fixed properly.
(3) Insert the shock sensor unit into the output flange of manipulator from underneath. Position correctly the holes for insulating dowel pin of shock sensor to the insulating dowel pins.
(4) Mount the insulating bushing (L10601B09) and the spacer (L10601B11) onto the shock sensor unit from underneath, using 4 pieces of hexagon socket head cap screws （M5×20）. (The screws are attached to the shock sensor unit.)
(5) Unfasten the hexagon socket head bolt (M5×20) that fixes the shock sensor, and then insert and fix the welding torch.
(6) Attach the power cable cover (L10601B13) from above, and the hood (L10601B10) from underneath. (Refer to the top view in fig.3.8 for the installation direction.)
To fix the power cable cover, use the cable ties that come with the shock sensor. (Fix the cover at the top and bottom.)

3.2.2 Reference point teaching procedure (Creation of home position confirmation program)

(1) On the RT series, dismount the nozzle and the contact tip from the torch. On the RZ series, dismount the nozzle and the tip holder from the torch.

(2) Secure the tip gauge to the torch.

(3) To set a reference point, prepare a sharp-pointed object fixed to the ground (e.g. tip gauge) (hereinafter referred to as the “reference gauge”).

(4) Align the point of the tip gauge on tip of the reference gauge, and then teach such point as the reference point 2 (point teaching). Use this reference point 2 to confirm the mechanical deviation of the torch.

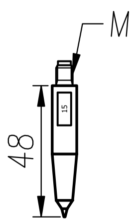
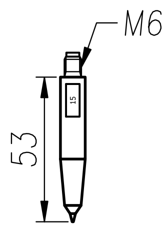
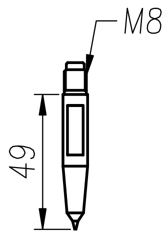
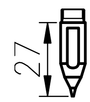
L317X for 350A torch	L317Z for 500A torch	L10319H for 500A torch	L10669D for RZ torch
Extension 15mm	Extension 20mm	Extension 20mm	Extension 15mm
			
RT3500S RT3500H RT3500L	RT5000S RT5000H RT5000L	RTW5000S RTW5000H RTW5000L	RZ3500S RZ3500H RZ3500L

Fig.3.9 Tip gauge

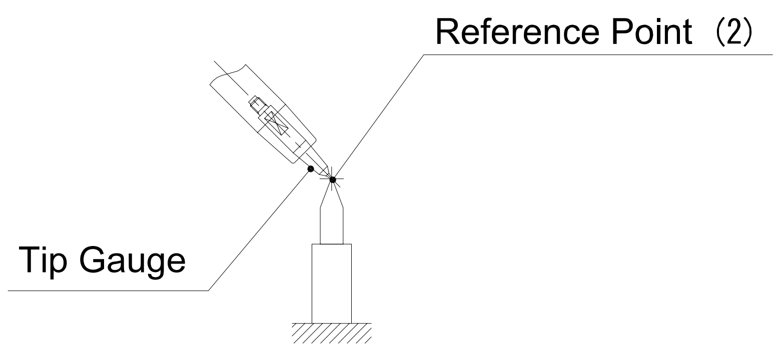


Fig.3.10 Teaching of reference point

3.2.3 Mounting of gauge ASSY (option)

(1) Dismount the nozzle and the contact tip from the torch to the RT series. Dismount the nozzle and the tip holder from the torch to the RZ series.
(2) Secure the tip gauge (L317X, L317Z, L10319H or L10669D01) to the torch.
(3) Dismount the hood from the shock sensor. Mount the gauge ASSY (L10618B) with the two hexagon socket head cap bolts (M5×16) that comes with the gauge ASSY.
(4) To set a reference point, prepare a sharp-pointed object fixed to the ground (e.g. tip gauge (L317X)) (hereinafter referred to as the “reference gauge”).

Note) This gauge is designed to confirm the current position of the robot. (Unlike the conventional torch gauges, it is not designed to make measurement of positional accuracy of the torch.) For the adjustment procedure, refer to information in Section 3.2.4.

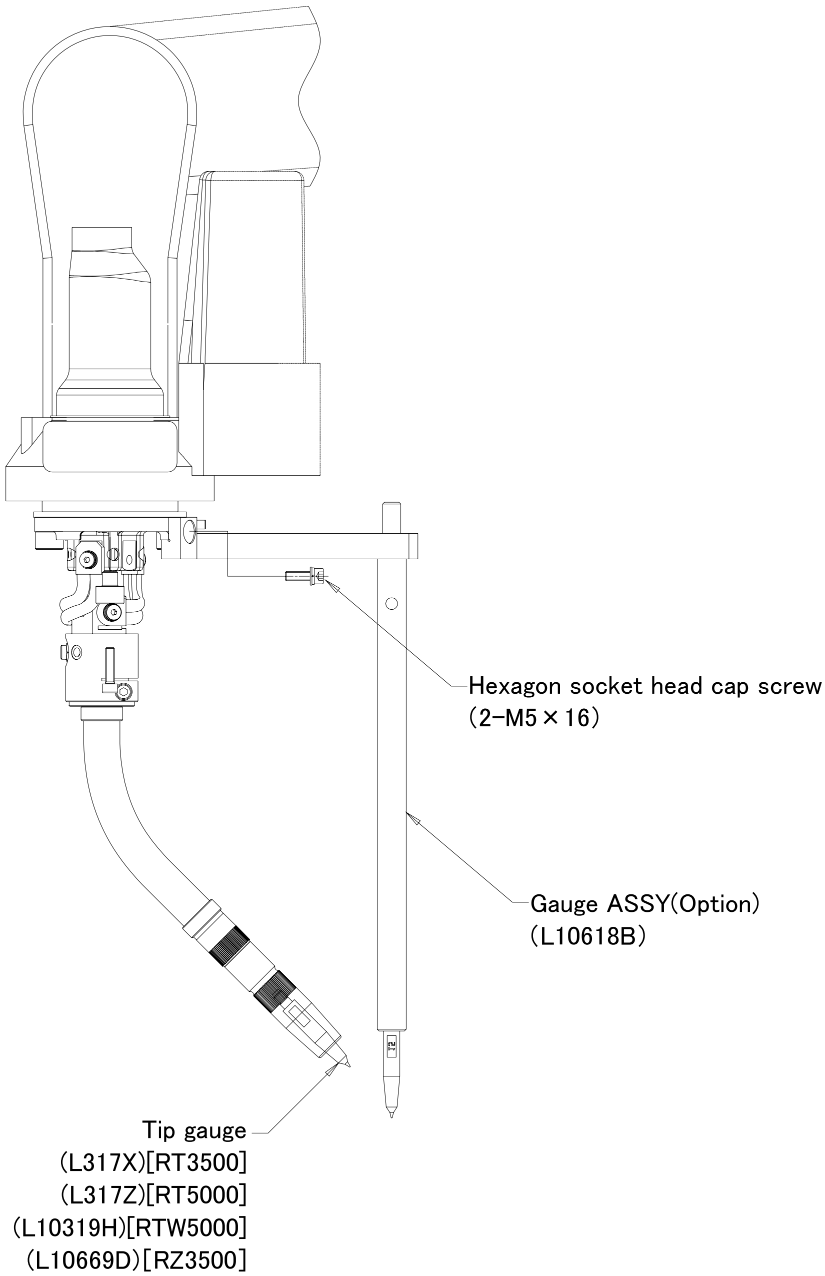


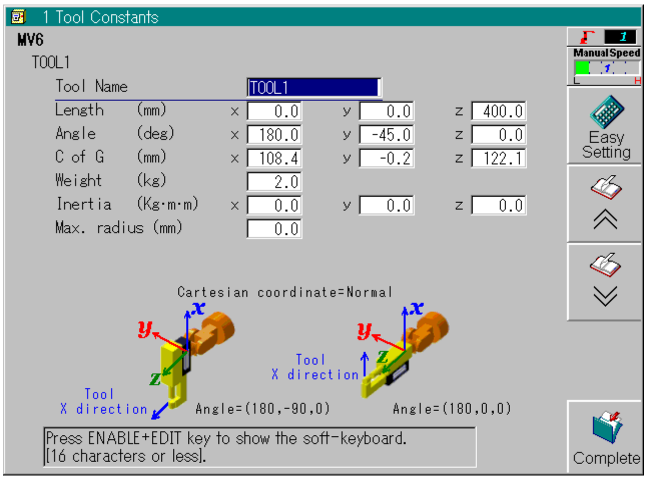
Fig.3.11 Mounting of gauge ASSY

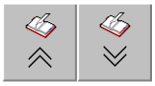
Setting Tool Constants

1 **Select the teach mode.**

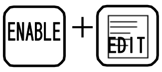
2 **Select <Constants>, and select [3 Machine constants] -> [1 Tool constants].**

>>The tool constant input screen resembling the one shown below now appears.



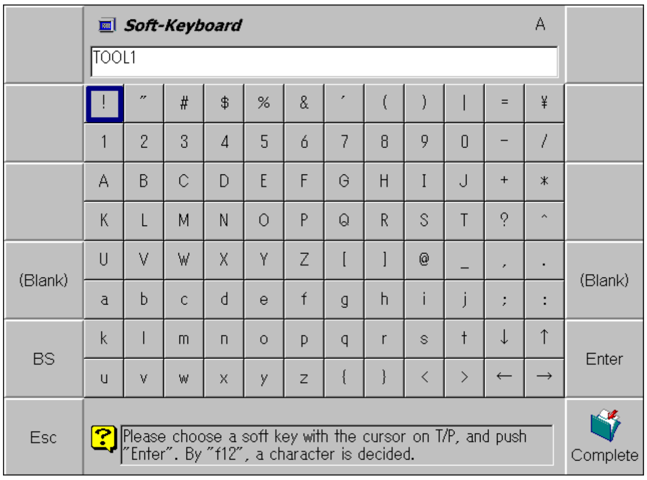


3 **To change the tool number, press the page up or down key.**



4 **Following the common operating procedure outlined above: Align the cursor with the tool name field, and press [ENABLE] + [EDIT].**

>>The character input screen (Soft Keyboard) shown below now appears. Input a tool name consisting of up to 16 characters using alphanumerics and symbols.



With an application which involves the use of a multiple number of tools, the parameters become more comprehensible if the welding gun or torch name and model, for instance, are registered here first.

It is not required to set the tool name. The initial setting may be used as is. (Initial setting: TOOL∗ where "∗" is the tool number)

The tool name does not appear on the programs display screen.

5 **Upon completion of the character input, press f12 <Complete>.**

>>Operation returns to the above tool constant setting screen.

6 **Enter the tool constants of a welding torch or a mastering gauge.**

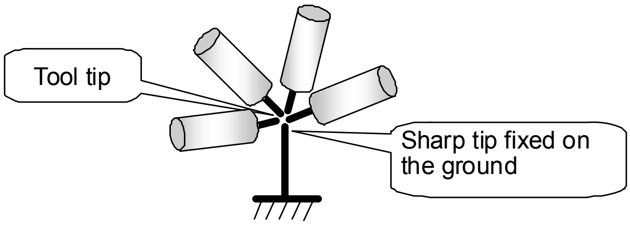
7 **Upon completion of the settings, press f12 <Complete>. The settings are now saved in the constant file.**

>>Operation returns to the machine constant menu screen.

Setting the tool length automatically

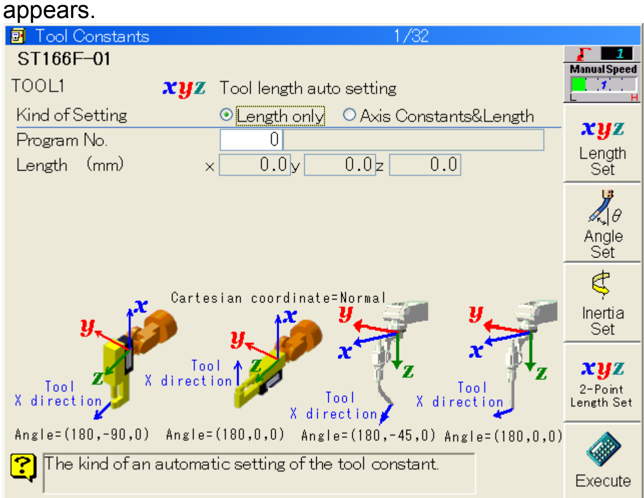
Although one program for calculating the tool length must be taught, the tool length can then be set automatically simply by taking this preparatory step.
It does not matter whether the tool angle has already been set or not.

1 **First, the programs for setting the tool length automatically must be taught. Teach the kind of programs where the tip of the installed tool (install a tool with a sharp tip here as well) is aimed in a number of different postures at a sharp tip which has been secured to the ground. The required number of steps is at least 10.**

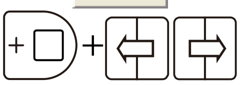


Ensure that the posture of the robot varies significantly with each of the steps, and that its aim is as accurate as possible. This holds the key for ensuring a high accuracy.
Record all the steps with linear interpolation ON. (Although it has nothing to do with calculating the tool length, this comes in handy when checking the results in 7.)

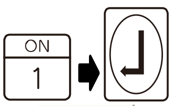
2 **On the tool constant setting screen for the desired tool number, press the <Easy Setting> key.**
>>The tool length automatic setting screen such as the one shown below now appears.



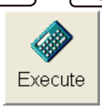
3 **If any other screen has appeared, press the <Length Set> key.**



4 **Select the setting type. Select "Axis Constants & Length" or "Length only" using the [ENABLE] and [Left/right cursor] keys.**
Normally, "Length only" is selected.
Select "Axis Constants & Length" only when more accurate length setting is required.
In this case, the axis constants of J2, J3, J4 and J5 axes are corrected automatically.
(The axis constants of all the other axes remain unaffected.)
(The axis to be compensated differs depending on the mechanism type.)

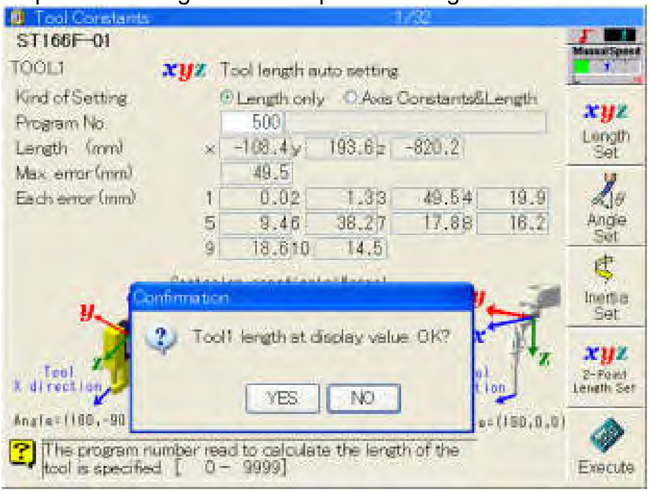


5 **Align the cursor with the program No., input the program No. (such as 1) that was created previously in 1, and press the [Enter] key.**



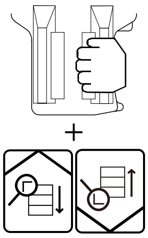
6 **Press the <Execute> key.**

7 **The tool length is calculated, and the results appear as follows a few moments later.**
>>The maximum error expresses the accuracy of the tool length which has been calculated. The lower the value here, the higher the resulting accuracy of the tool length which has been calculated.
The errors at each step up to a maximum of 10 steps are displayed simultaneously. If the results in 9 below are not satisfactory, simply proceed to modify the position in sequence starting with the step with the highest value.

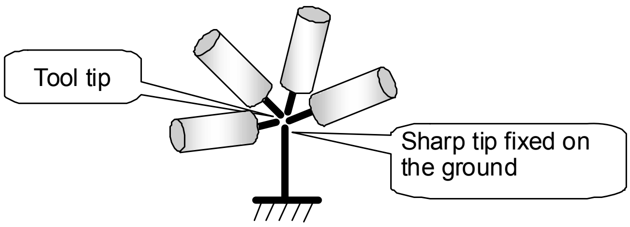


If satisfactory results have been obtained, select [Yes] on the pop-up window, and press [Enter] key.
>>At this stage, only the display is updated, and the data is not yet stored in the constant file.

8 **Upon completion of the settings, press the <Complete> key. The settings are now saved in the constant file.**
>>Operation returns to the machine constant menu screen.



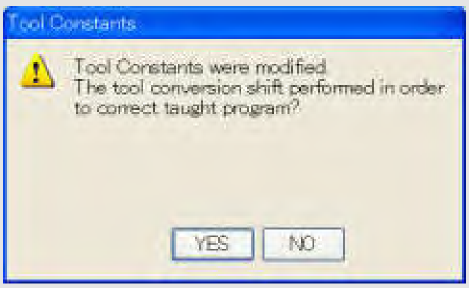
9 **Upon completion of the settings, check them.**
Exit the constant menu and try check go/back of program taught in 1.



If, unlike the movements which resulted when the program was first taught, the tool tip hardly moves at all from the sharp tip secured to the ground even during operations between the steps, then the tool length has been set successfully.

CAUTION

When pressing <Complete> key, following message will appear. If programs are already taught and these are not to be modified, please select [NO].

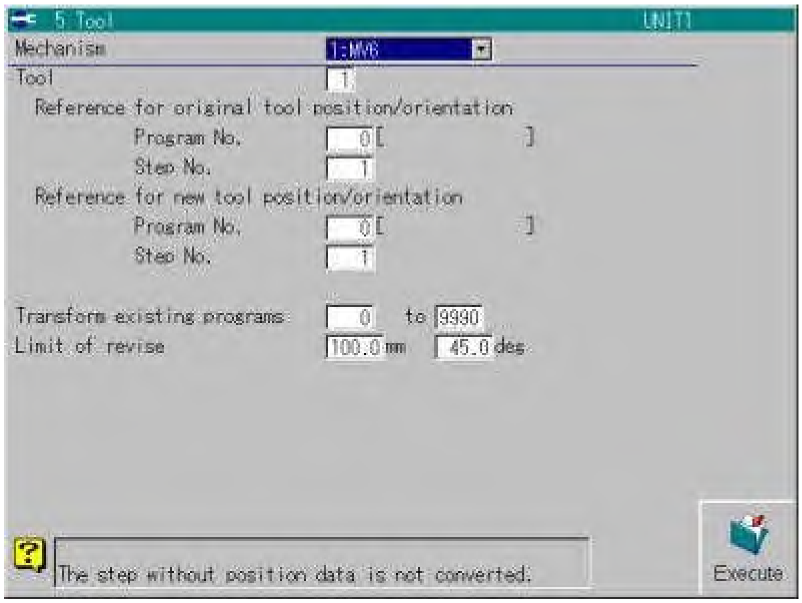


Service Utilities menu

■Transform existing program/Tool transform

This function enables already prepared task programs to be easily converted so that, even when a tool (such as a gun, hand or torch) has been deformed, the tool center point position and target angle will remain unchanged from their statuses prior to the deformation.A multiple number of programs can be converted at one time (the steps to be converted cannot be specified). Steps with function commands are not changed by this conversion.

However, the reference point program taught by the tool prior to its deformation is required in order to use this function. Immediately after the robot is delivered, create the reference point program in which are recorded the steps where the tool center point position and target angle are clearly defined.
The program specified for a reference point before and after conversion is not converted.



●**Display and setting items**

Item name	Initial value	Setting range
Mechanism	The manipulator that becomes an object from all manipulators registered to the system is selected.	
Tool	The tool number to be converted is specified.	1 to 32
Reference for original tool position / orientation Program No.	This is for specifying the number of the program in which the pre-conversion reference points have been taught.	0 to 9999
Reference for original tool position / orientation Step No.	This is for specifying the number of the step in which are stored the reference points of the program in which the pre-conversion reference points have been taught.	1 to 9999
Reference for new tool position / orientation Program No.	This is for specifying the number of the program in which the destination reference points have been taught.	0 to 9999
Reference for new tool position / orientation Step No.	This is for specifying the number of the step in which are stored the reference points of the program in which the post-conversion reference points have been taught.	1 to 9999
Transform existing programs	Specify the program number to be shifted.	0 to 9999
Limit of revise	This is for setting a value close to the	1 to 999 mm

	deformation amount of the tool as the compensation amount limit width.It prevents errors from being made in conversion by extremely large amounts due to an erroneous wrong program number, etc.	1 to 180 deg.

CAUTION	**After changes have been made to a program, the operation check must be performed at the low speed without fail.Changes in operation may cause the robot to interfere with the peripheral devices.**

No. 1L22151L-E-1

Almega FD series

INSTRUCTION MANUAL

CROSS MASTERING

	■ Read and follow these instructions and all safety blocks carefully. ■ Have only trained and qualified persons install, operate, or service this unit.
	■ Give this manual to the operator.
	■ For help, call your distributor.

CROSS MASTERING

DAIHEN Corporation

1. What the mastering among mechanisms is

In order to execute cooperative motions at a high level of accuracy in a synchromotion system, there must be a precise match between the correlation of the actual positions of the mechanisms that configure the system and the settings which are contained inside the controller. However, the installation of the mechanisms is a job which is done on-site, and it is extremely difficult to install the mechanisms very precisely.
As a result, it is necessary to match the parameters inside the controller with the actually installed mechanisms. This job is referred to as "mastering among mechanisms".
Using the task program, this function compensates the parameters by calculating the positions between the mechanisms and the torsion information.

In order to use this function, the operator must have the qualifications level of ***EXPERT*** or above.

2. Prior to starting the mastering among mechanisms

2.1 The accuracy of a single robot

The TCP calibration must be conducted in advance for each single robot in order to use the function of the mastering among mechanisms, because the installation information among the mechanisms is to be calculated automatically, based on the position information given in the task program for mastering.

POINT

*1 Confirm that the accuracy of each robot is within a 3mm diameter sphere in terms of TCP before teaching the task program for the mastering among mechanisms.
→Make the "Tool length auto setting" as necessary.

*2 Be sure to record, in the task program for mastering among mechanisms, the number of the tool with which the accuracy of a single robot has been adjusted to be within 3mm in diameter.

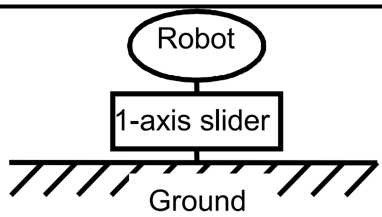
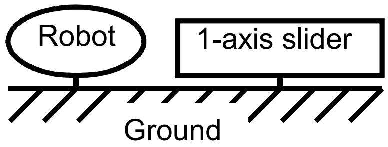
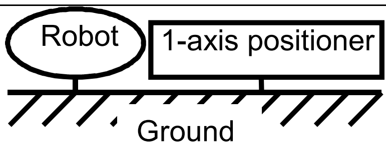
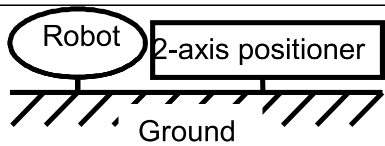
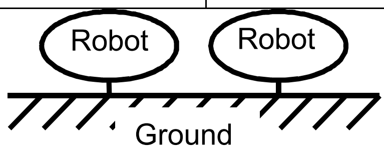
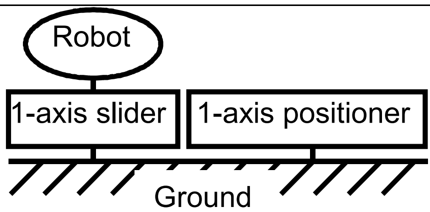
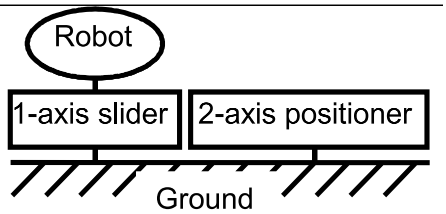
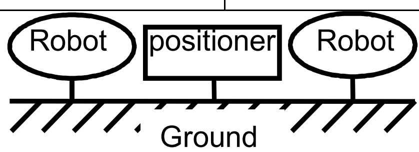
2.2 Mechanism configuration

The function of the mastering among mechanisms can be utilized in the certain mechanism configurations described in Table 2.1. As for other mechanism configurations, the mechanism installation posture must be calculated manually and then entered from Teach Pendant.

POINT

Regarding the case of a mechanism installation upon other mechanism, the function of the mastering among mechanisms can be used only for the installation relation of "the ground →one-axis slider→robot". For other installation relations, the installation posture must be calculated manually.

Table 2.1 Mechanism configurations that enable the function of the mastering among mechanisms

<table>
<tr><th>Mechanism configuration</th><th colspan="2">Image of installation relation among mechanisms</th></tr>
<tr><td>Robot＋One axis slider</td><td>
</td><td>
</td></tr>
<tr><td>Robot＋Positioner (*1)</td><td>
</td><td>
</td></tr>
<tr><td>Robot＋Robot</td><td colspan="2">
</td></tr>
<tr><td>Robot ＋ One axis slider ＋ Positioner (*1)</td><td>
</td><td>
</td></tr>
<tr><td>Robot＋Robot＋Positioner (*1)</td><td colspan="2">
</td></tr>
</table>

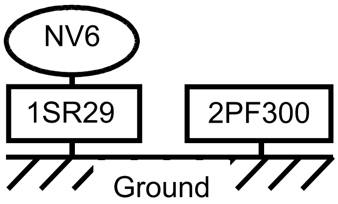
(*1) The function of the mastering among mechanisms is available for 1-axis positioner (Table type or Tilted type) and 2-axis positioner (Tilted axis＋Table axis).

2.3 Installation relation among mechanisms

When conducting the mastering, the current installation place of each mechanism must be set up in advance. Confirm the setting details of <Constant > - [12 Format and configuration] - [9 Mechanism relation].

The following Fig. 2.1 shows the settings of the installation relation in a system composed of three mechanisms: a robot (installed on a one-axis slider), a 1-axis slider (installed on the ground) and a 2-axis positioner (installed on the ground).

Composition of mechanism installations	Settings of installation relation among mechanisms



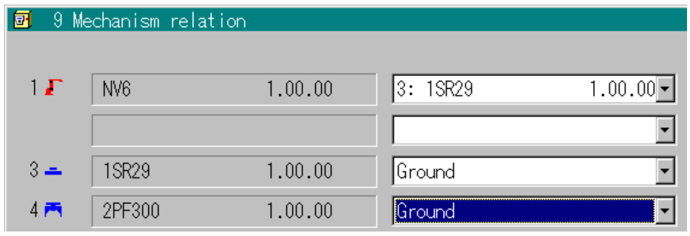


Fig. 2.1 Installation relation among mechanisms

2.4 Notes for a system composed of three or more mechanisms

In the function of the mastering among mechanisms, the installation posture of one mechanism is set up through one operation. Therefore, a system composed of three or more mechanisms requires multiple operations of the mastering among mechanisms, according to each type of combination of mechanisms that are under synchronous control.

POINT

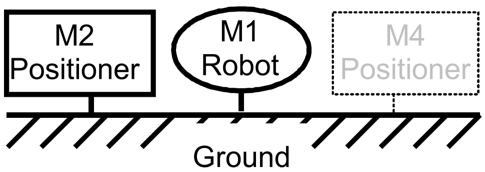
Be sure to teach the task program for the mastering among mechanisms for a unit that includes a robot whose mechanism number is the smallest and a mechanism on which the installation posture needs to be set up.

To conduct the mastering among mechanisms for a system with two positioners

For a system that has two positioners, conduct twice the operation of the mastering between mechanisms in order to set up the installation posture of each positioner. When two sliders are installed instead of two positioners, conduct twice the mastering between mechanisms as well in order to set up the installation postures of both the sliders.

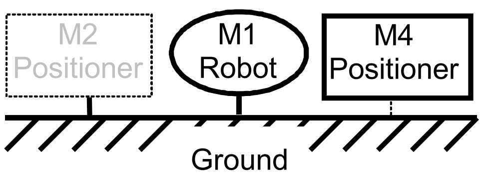
1 Mastering between M1 Robot and M2 Positioner

Create the task program for the mastering among mechanisms for the unit including M1 and M2. Conduct the mastering between the two mechanisms, using the created task program, and the installation posture of M2 will be set up.



2 Mastering between M1 Robot and M4 Positioner

Create the task program for the mastering among mechanisms for the unit including M1 and M4. Conduct the mastering between the two mechanisms, using the created task program, and the installation posture of M4 will be set up.



To conduct the mastering among mechanisms for a system with a robot installed upon a slider.

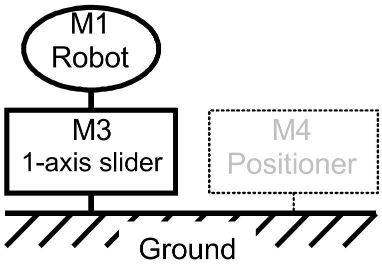
First, conduct the mastering between a robot and a 1-axis slider in order to set up the installation posture of the robot. Then, conduct the mastering between the robot and the positioner in order to set up the installation posture of the positioner.

POINT

Be sure to firstly conduct the mastering among for the robot and the slider for a system where a robot has been installed upon a slider.

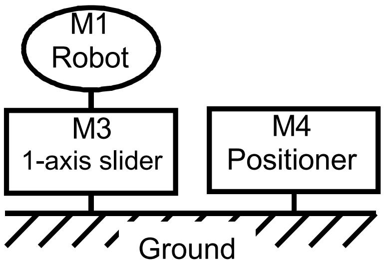
1 Mastering between M1 Robot and M3 1-axis slider

Create the task program for the mastering among mechanisms for the unit including M1 and M3. Conduct the mastering between the two mechanisms, using the created task program, and the installation posture of M3 will be set up.



2 Mastering between M1 Robot and M4 Positioner

Create the task program for the mastering among mechanisms for the unit including M1, M3 and M4. Conduct the mastering among the three mechanisms, using the created task program, and the installation posture of M4 will be set up.

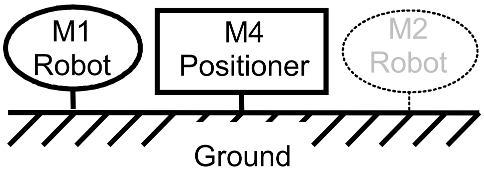


To conduct the mastering among mechanisms for a twin synchronization system

First, conduct the mastering between the robot and the positioner in order to set up the installation posture of the positioner. Then, conduct the mastering between the two robots in order to set up the installation posture of M2 Robot.

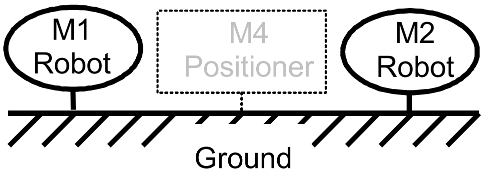
1 Mastering between M1 Robot and M4 Positioner

Create the task program for the mastering among mechanisms for the unit including M1 and M4. Conduct the mastering between the two mechanisms, using the created task program, and the installation posture of M4 will be set up.



2 Mastering between M1 Robot and M2 Robot

Create the task program for the mastering among mechanisms for the unit including M1 and M2. Conduct the mastering between the two mechanisms, using the created task program, and the installation posture of M2 will be set up.



3. Preparing the task program

The mastering among mechanisms first prepares the task program used for the mastering among mechanisms, and it calculates the mechanism installation information using this task program.

POINT

In the case of a robot with the multi unit specifications, the task program for the mastering among mechanisms is prepared by the units that exercise cooperative motion control. (Teaching is not required with units which do not exercise cooperative motion control or units of discrete mechanisms.)

3.1 Preparing the task program for a table-type 1-axis positioner

1 **Provide a point serving as a reference on the surface of the positioner's face plate.(This point will henceforth be referred to as the "fixed point".)**
Ensure that the fixed point remains fixed and motionless on the face plate of the positioner even when the positioner is moved.

2 **Select an appropriate task program number, and display the screen on which the task programs are prepared.**

3 **Align the robot TCP with the fixed point, and store the position in the memory.** (Point A) *
It does not matter whether the format is joint, linear or circular for the teach points which are recorded from this time on. Neither do the speed and accuracy level matter.

4 **Move the positioner so that its angle differs from the angle obtained in step 3, align the robot TCP with the fixed point, and store the position in the memory.** (Point B) *
Move the positioner counterclockwise as seen facing the face plate through at least 90 degrees.

5 **Move the positioner so that its angle differs from the angles obtained in step 3 and 4, align the robot TCP with the fixed point, and store the position in the memory.** (Point C) *
Move the positioner counterclockwise as seen facing the face plate through at least 90 degrees.

This now completes the preparation of the task program.

* Concerning the sequence for preparing the teach points

- When the teach points are to be prepared, proceed in the counterclockwise direction as seen facing the face plate of the positioner. (Sequence as shown in figure below: [1st point: A] → [2nd point: B] → [3rd point: C])
- Three teach points must be provided without fail. An error results if not enough teach points are provided. If there are too many teach points, an error does not result, and the three teach points starting with the step having the lowest number are used for the calculation.

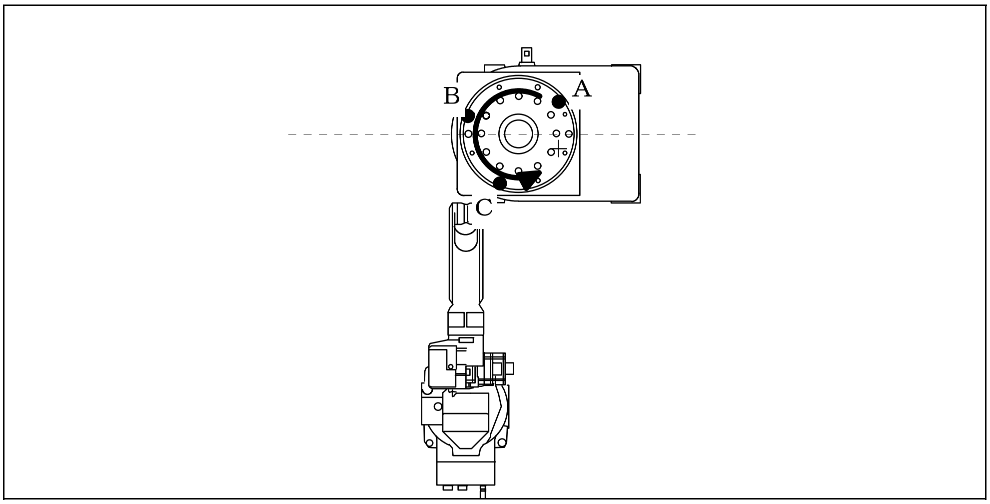


Fig 3.1 Position (table-type 1-axis positioner) recorded in task program for mastering among mechanisms

3.2 Preparing the task program for a tilted 1-axis positioner

1 **Provide a point serving as a reference on the surface of the positioner's face plate. (This point will henceforth be referred to as the "fixed point".)**
Ensure that this point remains fixed and motionless on the face plate of the positioner even when the positioner is moved.

2 **Select an appropriate task program number, and display the screen on which the task programs are prepared.**

3 **Align the robot TCP with the fixed point, and store the position in the memory.** (Point A) *
It does not matter whether the format is joint, linear or circular for the teach points which are recorded from this time on. Neither do the speed and accuracy level matter.

4 **Move the positioner so that its angle differs from the angle obtained in step 3, align the robot TCP with the fixed point, and store the position in the memory.** (Point B) *
Move the positioner counterclockwise as seen facing the face plate through at least 90 degrees.

5 **Move the positioner so that its angle differs from the angles obtained in steps 3 and 4, align the robot TCP with the fixed point, and store the position in the memory.**(Point C) *
Move the positioner counterclockwise as seen facing the face plate through at least 90 degrees.

This now completes the preparation of the task program.

* Concerning the sequence for preparing the teach points

- Prepare the teach points by proceeding in the counterclockwise direction as seen facing the face plate of the positioner.
(Sequence as shown in figure below: [1st point: A] → [2nd point: B] → [3rd point: C])
- Three teach points must be provided without fail. An error results if not enough teach points are provided. If there are too many teach points, an error does not result, and the three teach points starting with the step having the lowest number are used for the calculation.

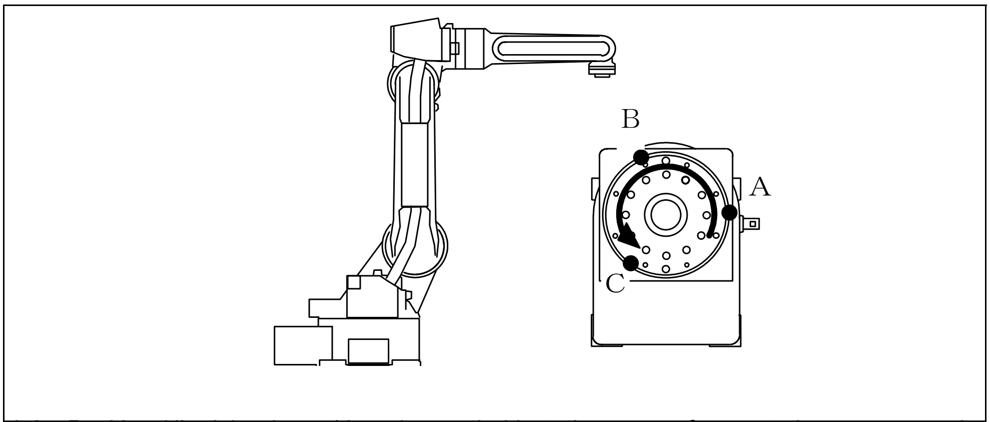


Fig 3.2 Position (tilted 1-axis positioner) recorded in task program for mastering among mechanisms

3.3 Preparing the task program for a 2-axis positioner

1 **Provide a point serving as a reference on the surface of the positioner's face plate. (This point will henceforth be referred to as the "fixed point".)**
Ensure that this point remains fixed and motionless on the face plate of the positioner even when the positioner is moved.

2 **Select an appropriate task program number, and display the screen on which the task programs are prepared.**

3 **Set J2 (table axis) to 0.0 deg. *3**

4 **Align the robot TCP with the fixed point, and store the position in the memory.** (Point A) *1
It does not matter whether the format is joint, linear or circular for the teach points which are recorded from this time on. Neither do the speed and accuracy level matter.

5 **Move positioner J1 (tilted axis) so that its angle differs from the angle obtained in step 4, align the robot TCP with the fixed point, and store the position in the memory.** (Point B) *1
Move the positioner away from the robot by at least 30 degrees.

6 **Move positioner J1 (tilted axis) so that its angle differs from the angles obtained in steps 4 and 5, align the robot TCP with the fixed point, and store the position in the memory.** (Point C) *1
Move the positioner away from the robot by at least 30 degrees.

7 **Set J1 (tilted axis) to 0.0 deg. *3**

8 **Align the robot TCP with the fixed point, and store the position in the memory.** (Point D) *2

9 **Move the positioner so that its angle differs from the angle obtained in step 8, align the robot TCP with the fixed point, and store the position in the memory.** (Point E) *2
Move the positioner counterclockwise as seen facing the face plate through at least 90 degrees.

10 **Move the positioner so that its angle differs from the angles obtained in steps 8 and 9, align the robot TCP with the fixed point, and store the position in the memory.** (Point F) *2
Move the positioner counterclockwise as seen facing the face plate through at least 90 degrees.

This now completes the preparation of the task program.

*1 Concerning the sequence for preparing the teach points for J1 (tilted axis)

- Prepare the teach points in sequence in the direction away from the robot. (Sequence as shown in figure below: [1st point: A] → [2nd point: B] → [3rd point: C])

*2 Concerning the sequence for preparing the teach points for J2 (table axis)

- Prepare the teach points in sequence in the counterclockwise direction as seen facing the face plate of the positioner. (Sequence as shown in figure below: [1st point: D] → [2nd point: E] → [3rd point: F])

*3 When the joint angle is to be set to 0.0, use the home stop function. In the case of a 2-axis positioner, teach a total of six points.

- If points A to F have not been recorded in the sequence described above, the calculation will not be performed properly.

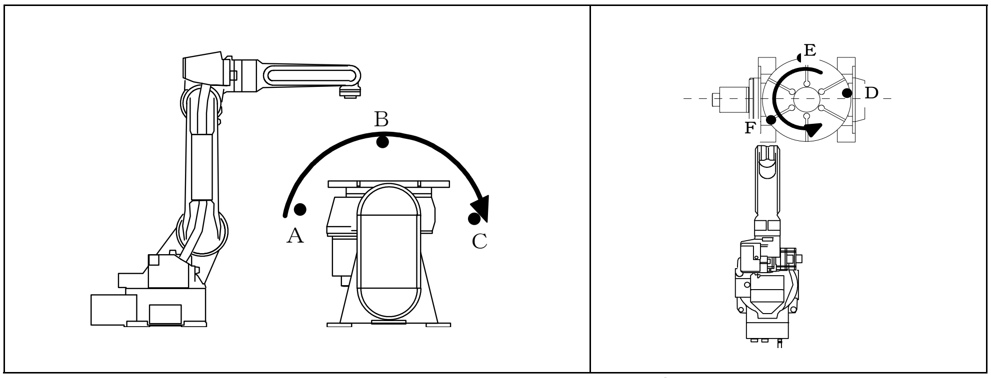


Fig 3.3 Position (2-axis positioner) recorded in task program for mastering among mechanisms

3.4 Preparing the task program for a slider

1 **Provide a fixed point which will serve as the reference on the ground. (Select a fixed point which will remain motionless even when the slider moves.)**

2 **Select an appropriate task program number, and display the screen on which the task programs are prepared.**

3 **Align the robot TCP with the fixed point, and store the position in the memory.** (Point A) *

4 **Move the slider, set it to a position (angle) which differs from the position obtained in step 3, align the robot TCP with the fixed point, and store the position in the memory.** (Point B) *
Now move the slider in the "+" direction, and teach.

This now completes the preparation of the task program.

* Concerning the sequence for preparing the teach points
- Move the slider in the "+" direction, and teach the teach points.
- Two teach points must be provided without fail.
  An error results if not enough teach points are provided.
  If there are too many teach points, an error does not result, and the two teach points starting with the step having the lowest number are used for the calculation.

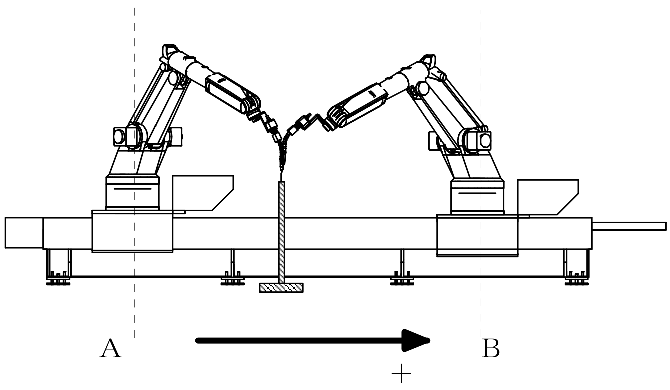


Fig 3.4 Position (slider) recorded in task program for mastering among mechanisms

3.5 Preparing the task program for two robots

1 **Provide a point that will serve as the reference (hereafter referred to as the "reference point") for the tool TCP of each of the two robots.**
Adjust the discrete accuracy of the robots to less than 3 mm diameter sphere at each reference point.
(Use the numbers of the tools at the teaching stage for which the above accuracy has been confirmed.)

2 **Select an appropriate task program number, and display the screen on which the task programs are prepared.**

3 **At the appropriate position, align the reference points of the two robots, and record the positions.** (Point A) *

4 **Move the robots to positions which differ from the ones in step 3, align the reference points of the two robots, and record the positions.** (Point B) *
Now increase the movement amount as much as possible.

5 **Move the robots to positions which differ from the ones in steps 3 and 4, align the reference points of the two robots, and record the positions.** (Point C) *
Now increase the movement amount as much as possible.

This now completes the preparation of the task program.

* Precautions when preparing the teach points

- Ensure that points A, B and C do not form a straight line.
- Prepare points A, B and C in such a way that they will be on a surface which is horizontal to the ground. (This may be done by sight.)
- Prepare the teach points in such a way that the area of the triangle formed with points A, B and C is as great as possible. The greater the area of the triangle formed with the three points, the better the accuracy between the mechanisms.

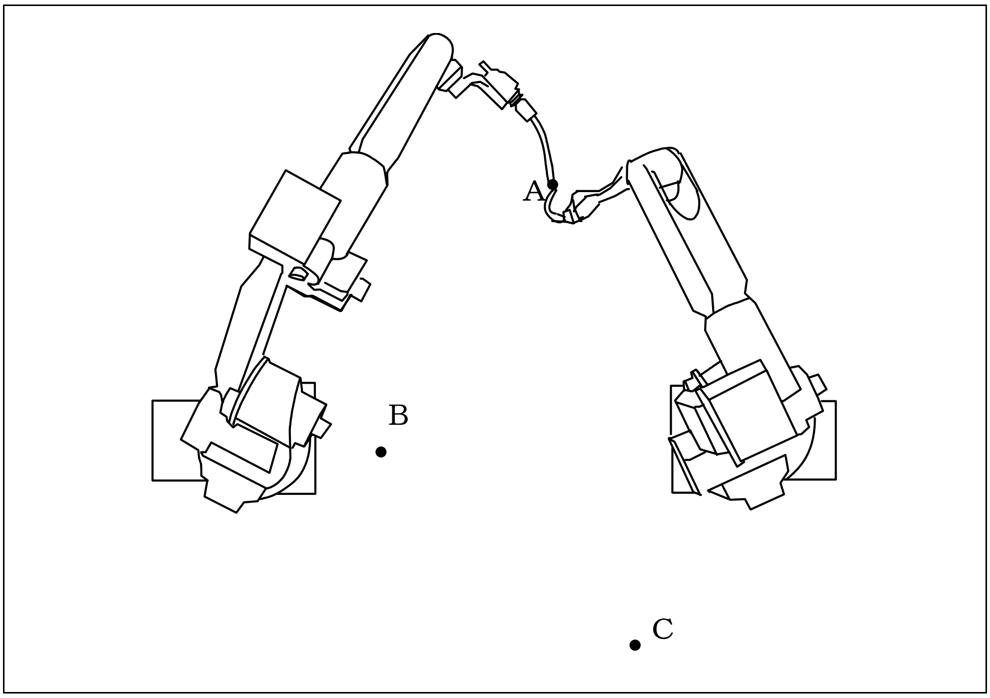


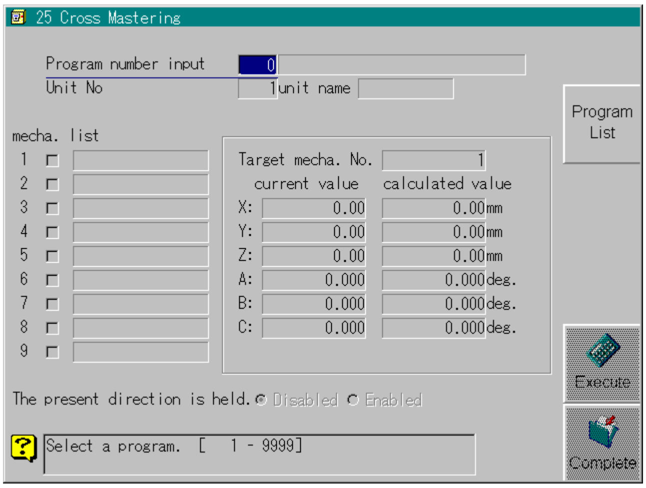
Fig 3.5 Positions (of the 2 robots) recorded in task program for mastering among mechanisms

4. Performing mastering among mechanism

Using the task programs created by following the procedure in "3. Preparing the task program," the information on the installation between the mechanisms is calculated.
Before proceeding with mastering among mechanisms, check whether the discrete accuracy of each of the mechanisms has been obtained.

Performing mastering among mechanism

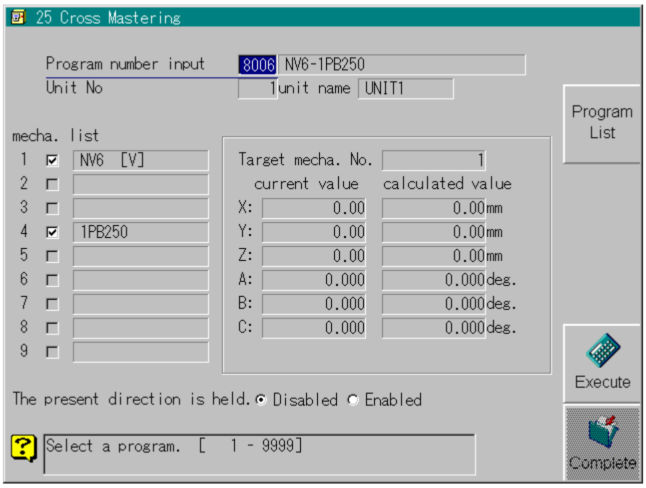
1 **Select <Constant Setting> – [3 Machine Constants] – [25 Cross Mastering].**
>>The following screen now appears.



2 **Input the program number.**
If the program number is already known, input it using the number keys.

If the program number is not known, press f8 <Program List> to display a list of the programs, and then select the desired program.

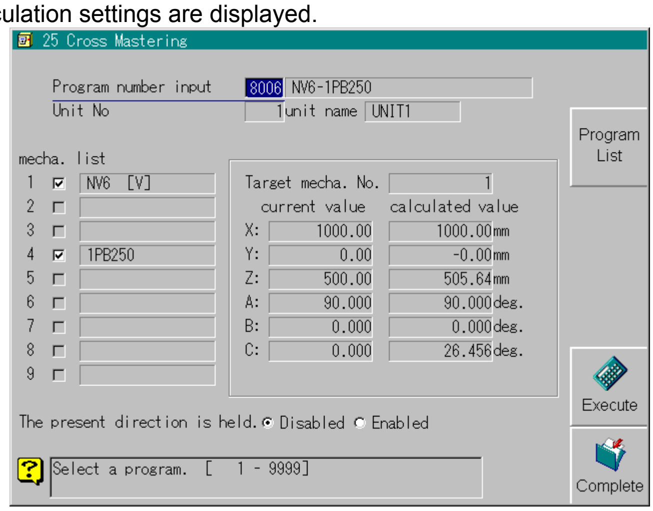
When the program is selected, the program comment, unit number, unit name and list of mechanisms are displayed.



If there is a multiple number of mechanisms such as a robot, positioner and slider units, select the mechanisms targeted for mastering among mechanisms. The robot and only one mechanism can be selected as the mechanisms.

3 **Press f11 <Execute>.**

>>Based on the teach points recorded in the designated program, the mastering among mechanisms is automatically executed, and the pre-calculation settings and post-calculation settings are displayed.



The values thus obtained are the positions and poses of the mechanisms as expressed in terms of the worked coordinates.

4 **To save the post-calculation settings, press f12 <Complete>.**

>>The settings are now saved in the constant file.

5 **The values obtained by the mastering among mechanisms are stored in the robot as the data which is set in "Installation Angle".**

To check the installation poses, select <Constant Setting> – [12 Format and Configuration] - [5 Installation Angle]. In order to do this, the operator must have the qualifications level of ***EXPERT*** or above.

Adjustment between mechanism	Installation angle
X	X coordinates of the installation position
Y	Y coordinates of the installation position
Z	Z coordinates of the installation position
A	X axis rotation
B	Y axis rotation
C	Z axis rotation

POINT

<u>Settings regarding “The present direction is hold.”</u>

Normally, select “Disabled”.

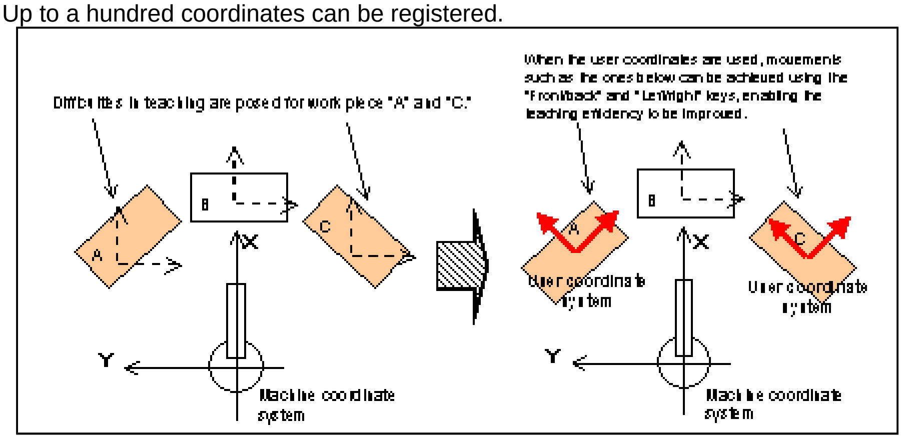
However, under all of the following conditions, select “Enabled”.

- The mastering object, between machines, is robot + positioner.
- It is a re-adjusting operation for the mastering between machines which improves the synchro motion’s accuracy of robot + positioner.
- The interchangeability of the task program’s position data is necessary after the re-adjustment operation of the mastering, and when the task program, taught before re-adjustment, exists.

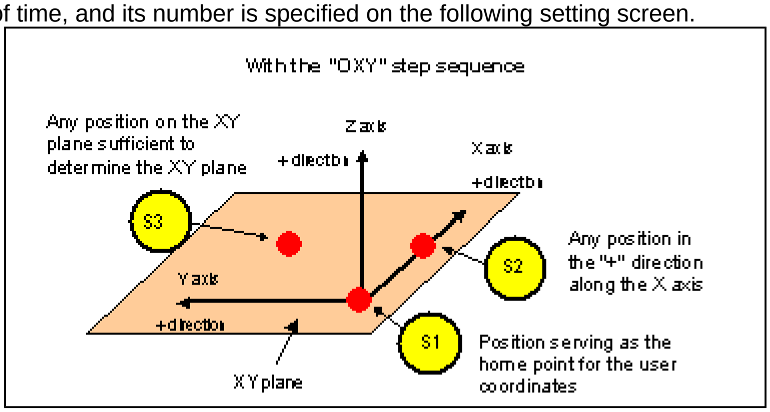
■ User coordinate

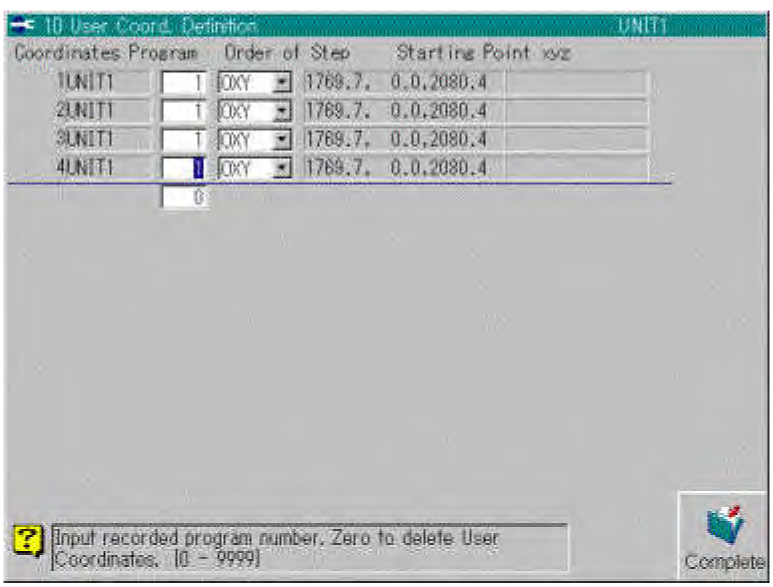
Teaching is facilitated by setting the original coordinate system for the jigs, the work pieces, etc. installed around the robot.

Up to a hundred coordinates can be registered.



User coordinates can be specified in a program in which 3-point positions have been recorded. The program is created ahead of time, and its number is specified on the following setting screen.

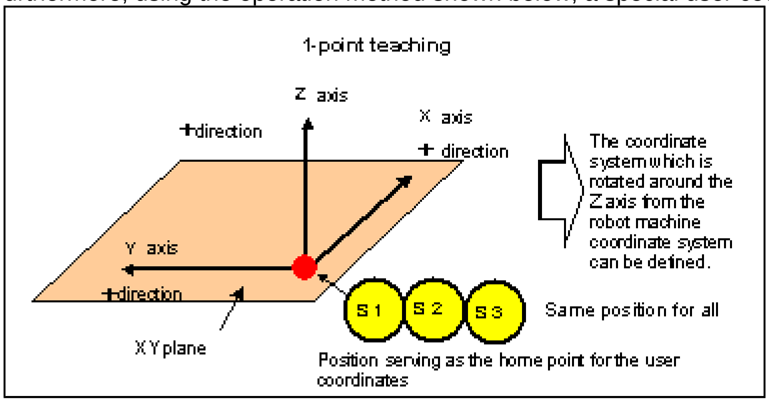


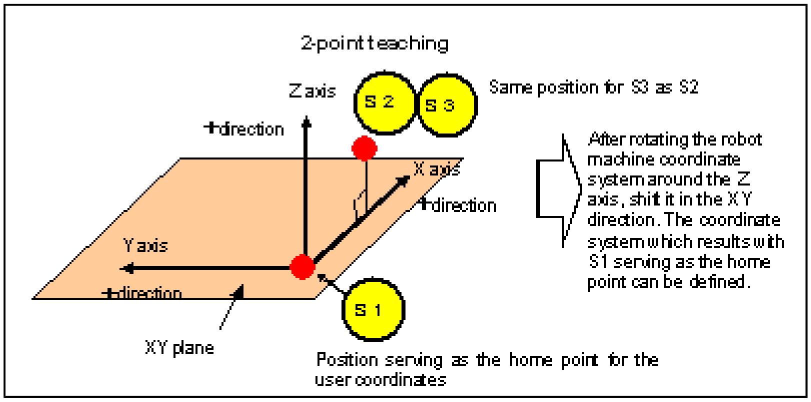


Menu	Explanation
Program	User coordinates are specified in a program in which 3-point positions have been recorded. The number of the already taught program is input

	here.
Order of Step	The method used to specify the above 3 points may differ depending on the shape of the peripheral device. One of the following three variations is specified. OXY: S1 = starting point, S2 = X direction, S3 = Y direction OZX: S1 = starting point, S2 = Z direction, S3 = X direction OYX: S1 = starting point, S2 = Y direction, S3 = X direction

Furthermore, using the operation method shown below, a special user coordinate system can be defined.





The user coordinates are also used to register the settled installation tool tip location for stationary tool interpolation as well. In this case, only the home point of the user coordinates is referenced.


FD-B4S
FD-B4S

Home position registration

When a multiple number of robots are to be started up together from the host controller unless start is instructed after it has been verified that the robots are at their prescribed positions (home positions), they may, in a worst case scenario, interfere with one another.
To solve this problem, whether the robots are at their prescribed positions can be verified by means of an output signal by registering the home positions of the robots.
In checking the home positions, the positions of each robot axis are directly monitored so that the operator can know for sure that a robot is at its home position by the output signal.

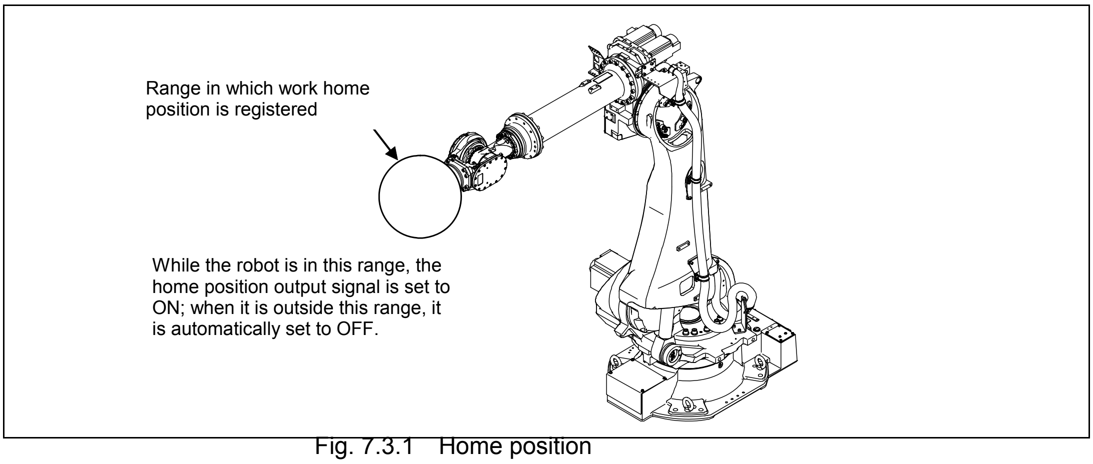


Fig. 7.3.1 Home position

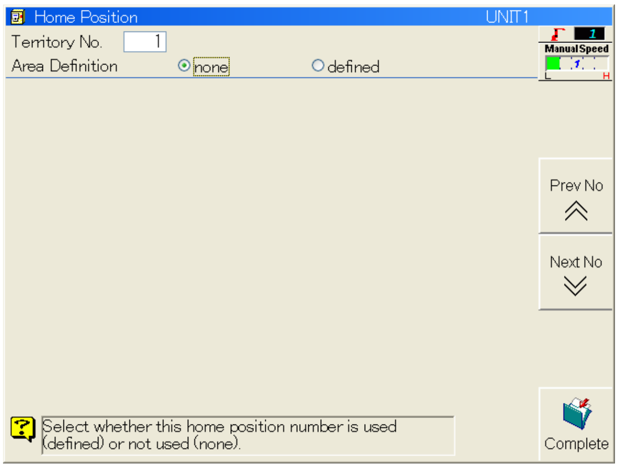
Up to 32 home positions can be registered per unit (the unit in which the task program is configured).
Some methods are provided for registering. First, the usual registration method is described.

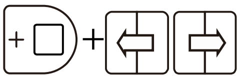
Home position registration by referencing the program

1 **First, teach the position that is to serve as the home position using the robot. Select any program, and record the actual position as a step. Any interpolation type, speed or tool number is acceptable.**
>>Normally, this step should be the first step (move command) in the program which is to be started from the work home position. Any program and any step with any number will do. Make a note of them.

2 **Select the teach mode.**

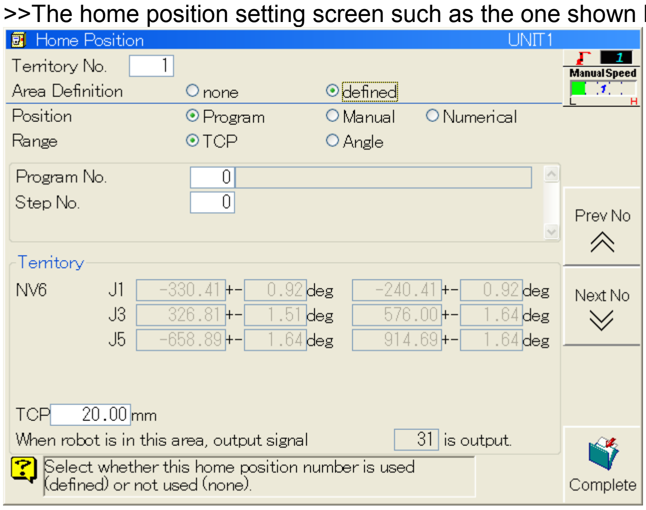
3 **Select <Constant Setting> - [9 Territory Definition] - [1 Home Position].**
>>A screen such as the one shown below now appears.



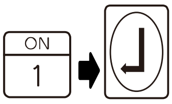


4 **Align the cursor with "Area Definition," and press[ENABLE] and left or right cursor keys together to set the radio button to "Defined."**

>>The home position setting screen such as the one shown below now appears.

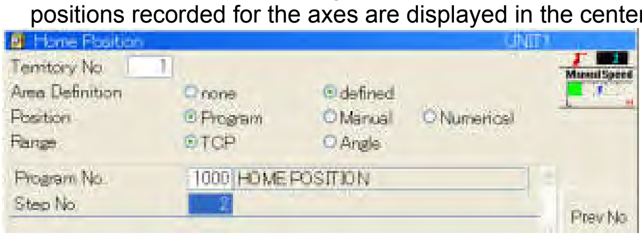


5 **Leave the "Position" setting as "Program" and the "Range" setting as "TCP."**



6 **Align the cursor with "Program No.," input the number of the program prepared in 1, and press [Enter] key.**
In the same way, align the cursor with "Step No.," input the step number, and press [Enter] key. A step No. indicating a move command—not a comment or other function command—must be input without fail.

>>The data recorded in the program and step which were input is now called, and the positions recorded for the axes are displayed in the center.



7 **Align the cursor with "TCP," input the home position range here, and press [Enter] key. The diameter of a spherical shape that can be visualized is input here. The home position signal is output when the tool tip is inside this spherical shape.**
Normally, about 20 mm is recommended.

>>The size of the spherical shape is broken down into the angles of the axes, and a range is now displayed at the positions recorded for the axes in the center.

8 **Press the <Complete> f key.**
This now completes the settings.

If the position of the program and step which were input in 6 has been modified or if interim steps have been deleted or inserted at any point after this, the setting for the step number of the home position will be automatically updated in tandem with this change.
By having the step in the registered program serve as the first step in the program which is started, no further attention need be paid to the home position registration even when the position in that step has been modified by teaching after home position registration.
(However, in the event that the registered step itself has been deleted, the home position registration will be deleted in tandem with this deletion.)

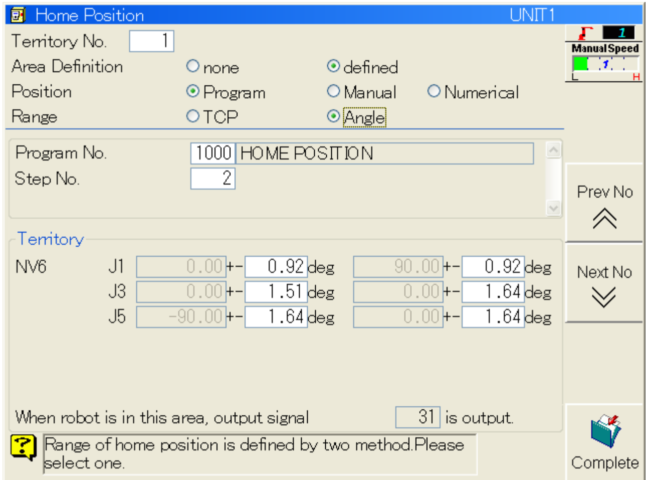
Registering a multiple number of work home positions

9 **A multiple number of home positions can be recorded. (Up to 32 positions per unit) To switch the screen, press [Prev No] or [Next No] key.**
Alternatively, align the cursor with the "Territory No." in the edit box, input the home position number directly, and press [Enter] key.

Basic output signal is allocated to only "Territory No.1" when shipped. To use No.2 and up, basic output signals must be allocated for each of it.
Output signal number currently assigned is displayed at the bottom of the screen.

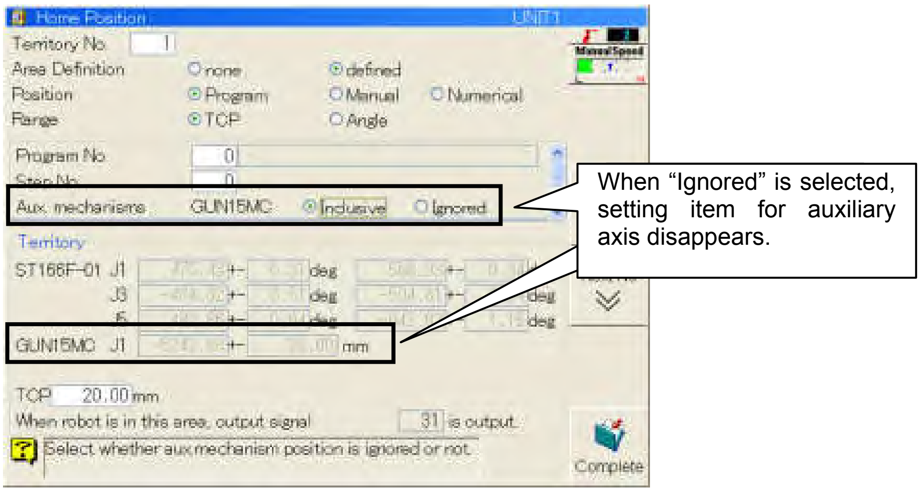
Specifying the range on an axis by axis basis

10 **The range of the home position can be specified directly for each of the axes. Set "Range" to "Angle" rather than to "TCP."**
>>The range input field changes as shown below. Input the range directly in degrees into the range field of each axis (the edit box on the right of + –).



When auxiliary mechanisms are present

11 **If an auxiliary mechanism such as servo gun or travel unit is being used, "Aux. mechanisms," which is a new item, is displayed. Depending on the characteristics of the mechanism concerned, the home position may or may not be monitored.**
Select one or the other. In the case of a servo gun, select "Ignored."



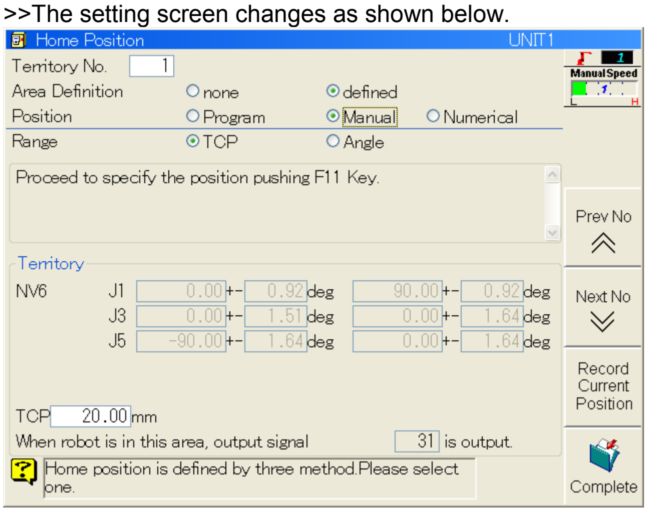
Home position registration by manual recording

This method is used to record the home position directly without referencing the program. Operate the robot to set it.

The home position registration is not changed in tandem with any modifications made by teaching, and the absolute position is now registered. Unlike the program reference system, a programs need not be provided ahead of time.

Only the differences from the program reference system will be described below.

1 **Set "Position" to "Manual."**
>>The setting screen changes as shown below.



2 **Turn on the motor power (servo power), and move the robot by manual operations to the position which is to serve as the home position.**
Once the position has been determined, release the enable switch.
(Alternatively, turn off the motor power.)

3 **Press the <Current Record Posi.> f key.**
>>The current position is read from the robot encoder, and the position data of each axis is displayed in the center.

4 **Set the "TCP" in the same way as with referencing the program. (The next steps are the same.)**

Home position registration by numeric input

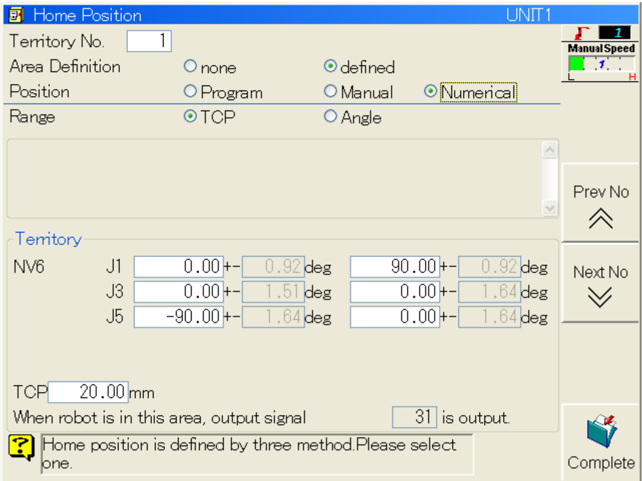
This method is used to record the home position directly without referencing the program. Key in the position data directly from the teach pendant.

The home position registration is not changed in tandem with any modifications made by teaching, and the absolute position is now registered. Unlike the program reference system, a programs need not be provided ahead of time.

Only the differences from the program reference system will be described below.

1 **Set "Position" to "Numerical."**

>>The setting screen changes as shown below.



2 **Move the cursor to the "Territory" field, input the position of each of the axes directly in degrees, and press the [Enter] key.**

>>It is possible to input positions that significantly exceed the software limits (operating ranges) of the axes. Some axes which have been excluded from being the target of inspection for their home positions can be supported by setting a high value.

The same result can be achieved by proceeding as follows: after "Position" has been set to "Program," the program and step have been specified and the position data has been read, switch the "Position" setting to "Numerical," and modify the position of each axis.

3 **Set the "TCP" in the same way as with referencing the program. (The next steps are the same.)**

OTC DAIHEN Corporation

Almega FD series

INSTRUCTION MANUAL

Software PLC,I/O

	■ Read and follow these instructions and all safety blocks carefully. ■ Have only trained and qualified persons install, operate, or service this unit.
	■ Give this manual to the operator.
	■ For help, call your distributor.

DAIHEN Corporation

General description of the software PLC

The PLC (Programmable Logic Controller) is a device that controls various devices by incorporating input signals and previously created programs to switch contacts within output circuits ON/OFF.
The software PLC is software incorporated into the robot controller that has all of the functions of the PLC, and can be programmed using the teach pendant. In this way, the need to provide a special external PLC is obviated, thereby helping to reduce costs.

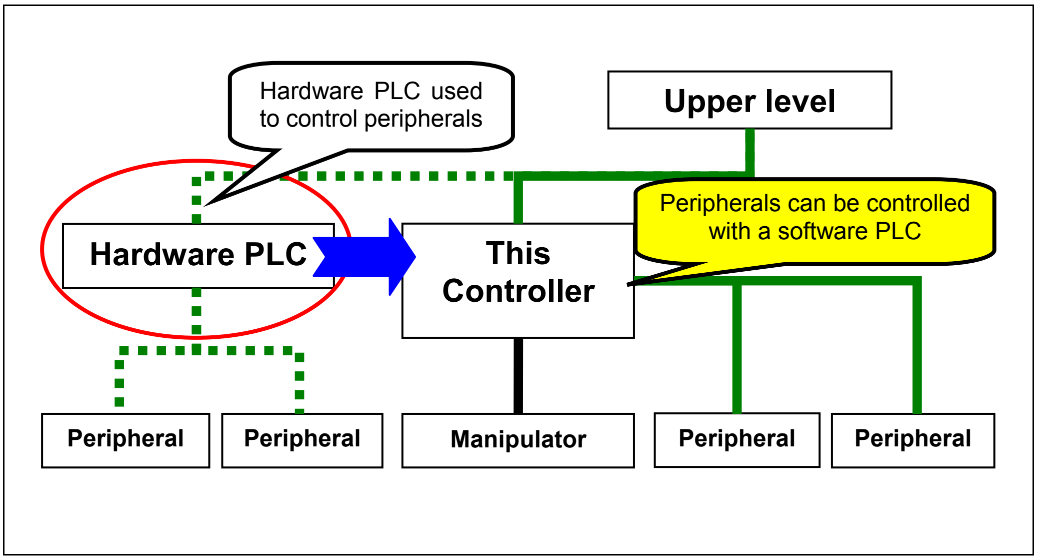


Fig. 1.1.1 Utilizing the software PLC

As in Fig. 1.1.2, the software PLC occupies a position between the inside and outside of the robot controller. The physical signals to and from the devices outside the controller connected by the parallel I/O, field buses, etc. are connected to the logical signals through the PLC programs.

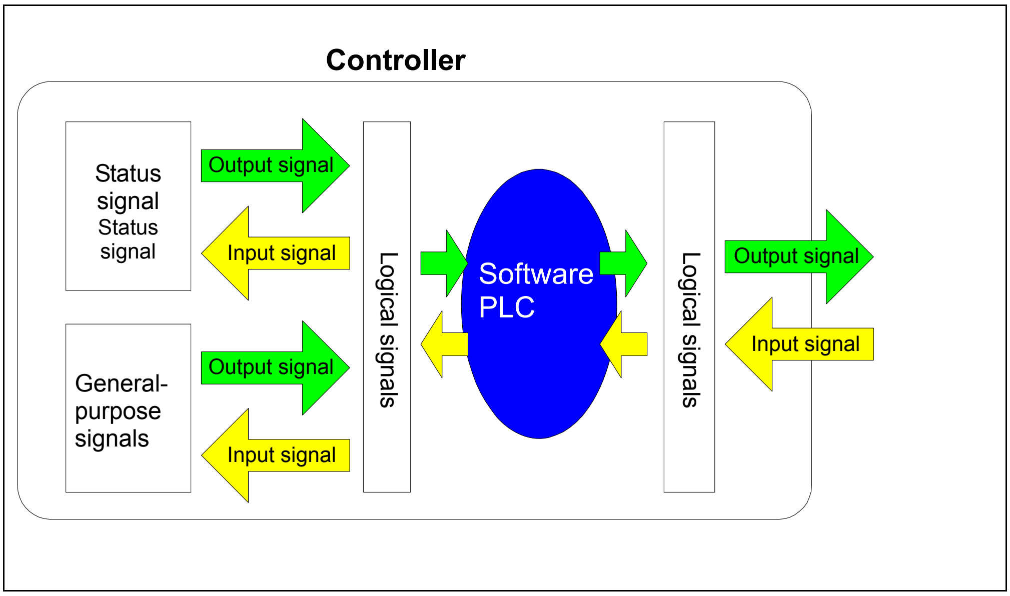
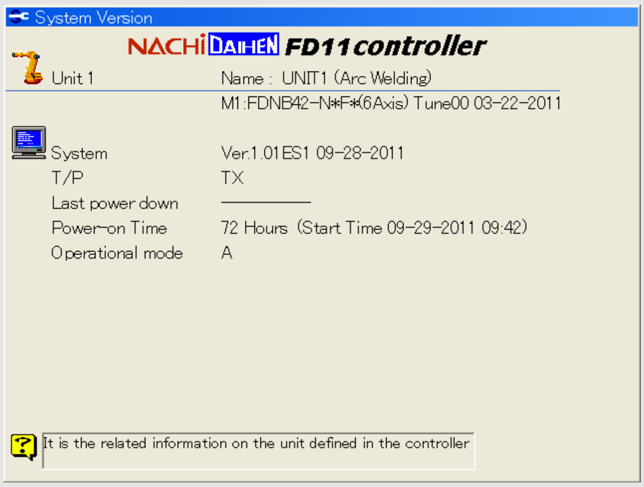


Fig. 1.1.2 Flow of input/output signals through software PLC

POINT

Software PLC Factory Settings

The factory settings for the software PLC differ depending on the operation mode.
The current operating mode can be checked on the system environment screen displayed with shortcut code "286". For details, see “Basic Operations Chapter 1 Introduction” in the Instruction Manual.



Irrespective of the operation mode, both cases are directly connected with logical signals and physical signals.

Operation mode A:	Shipped in the <startup> state using the software PLC. Logical and physical signals are connected directly by the PLC program "Default.stf" installed in the factory.
Operation mode S:	Shipped in the disconnected state, not using the software PLC. In the disconnected state, logical and physical signals are directly connected.

PLC programs are scanned normally irrespective of the work program. Use of the software PLC can be switched on and off in <Constant settings> - [1 Control Environment] – [4 Built-in PLC].

Input/output relays

The input/output relays and internal relays are described here. Relays are called “variables” as far as the software PLC is concerned. The ON/OFF coil contacts and those with integer data are all treated equally.

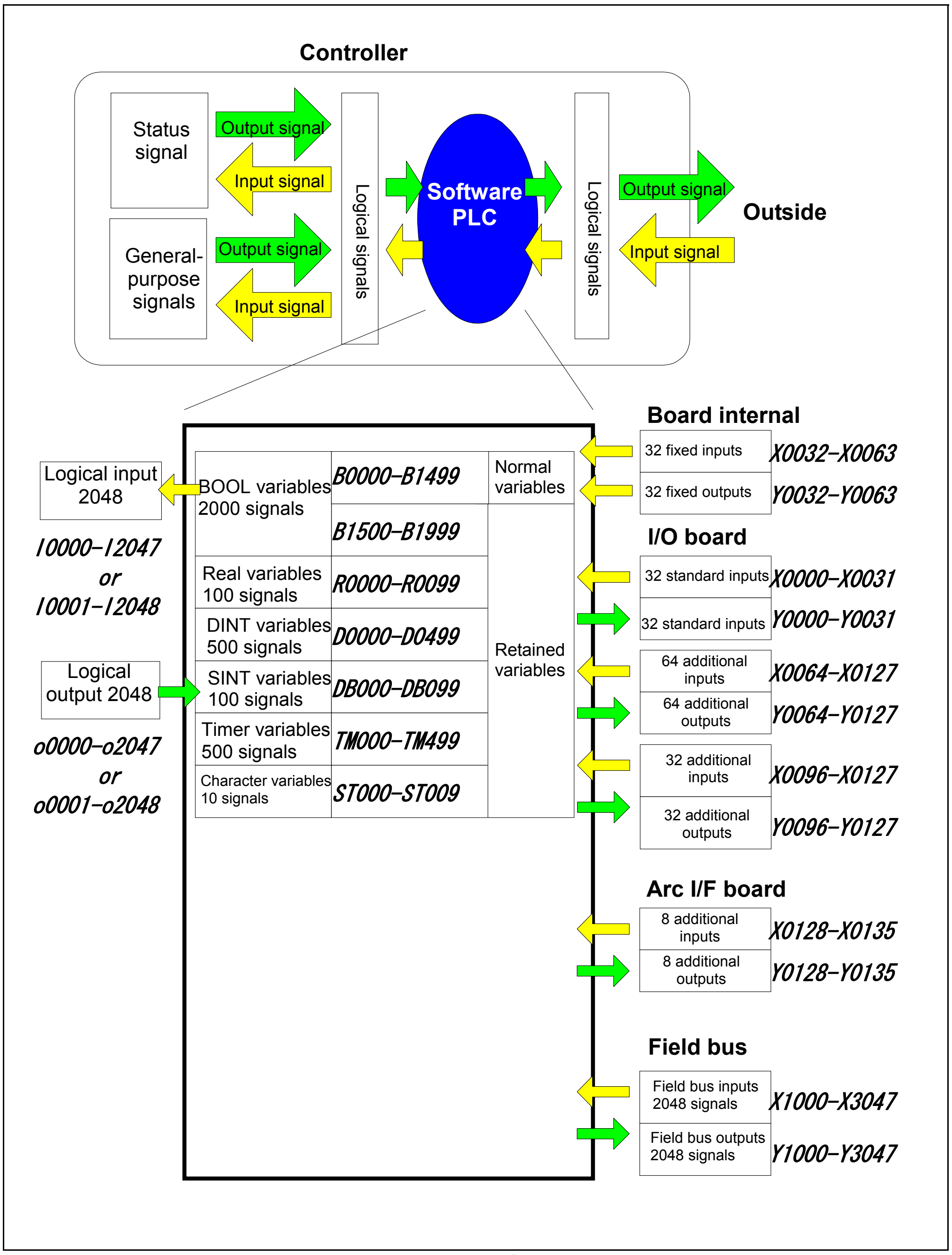


Fig. 1.2.1 Input/output relays & internal relays

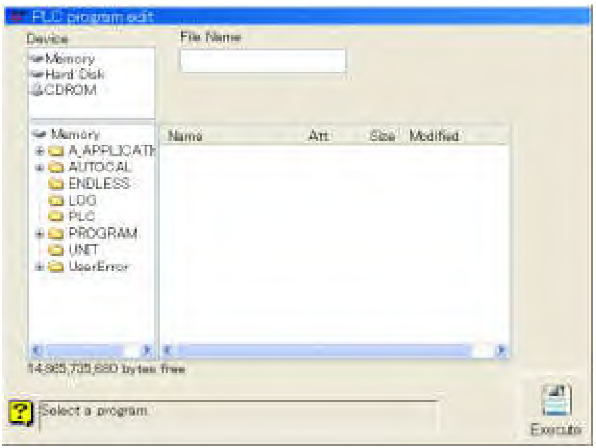
Creating programs

Starting the ladder editor

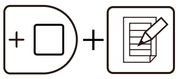
Use the ladder editor to create new PLC programs or editing programs which have already been taught. The ladder (LD language) displays appear on the teach pendant, enabling direct editing. Either the teach or playback mode may be established.
Any number of PLC programs can be recorded in the memory in the form of display image files.

1 **Select <Service Utilities> - [14 PLC Program Edit], and select [1 PLC program edit] from the menu items displayed.**

>> A list of the ladder programs (display image files) is now displayed as follows.
Depending on the factory settings, Default.stf may be incorporated. For details, see “Chapter 1 Overview”.



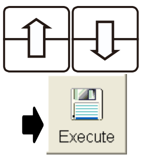
A new ladder programs can be edited regardless of whether the scanning of a ladder program is in progress.
The programs listed here on the display are display image files which have been recorded in the memory, and they are not the files which are actually being scanned by the run time engine.



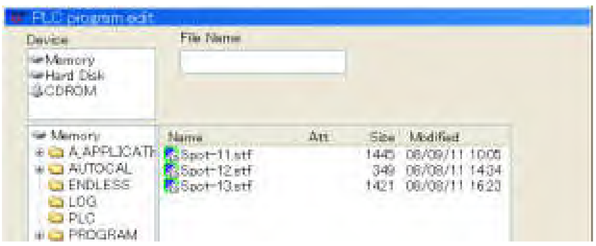
2 **The first step which must be taken when a new program is created is to decide on the filename of the ladder program.**
Align the cursor with the filename field, and press [ENABLE] + [EDIT].

>> The soft keyboard screen is now displayed so register the filename using this keyboard.
Hiragana, Katakana and Kanji can be used as well as alphanumerics for the file name.

After inputting the filename, press f12 [Complete]. →4

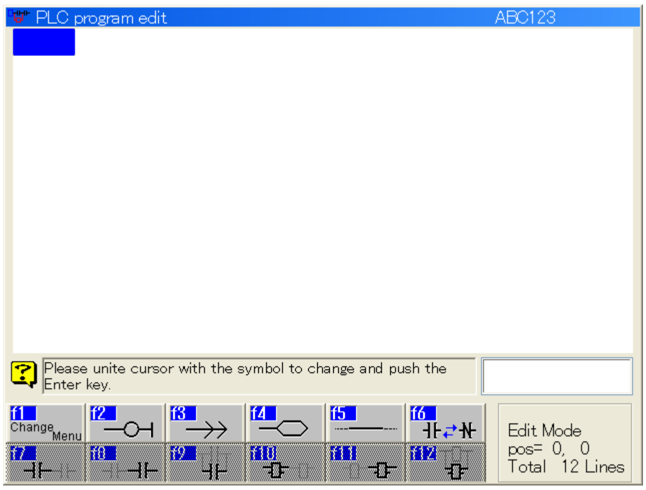


3 **If the ladder programs have already been recorded, use the up or down cursor key to select the file to be edited, and press f12 [Execute].**



Ladder programs (display image files) have the "stf" extension. A list of all the stf files already stored in the memory now appears on the display.

4 **When the file to be edited is entered, the ladder editor starts up, and a ladder-editing screen such as the one shown below appears.**

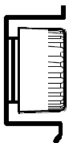


When a ladder program (display image file) already stored in the memory has been selected, the head of this program is displayed.

The "Insert" status is always established for ladder editing. No data is overwritten.

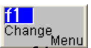
[Up/Down]

Or

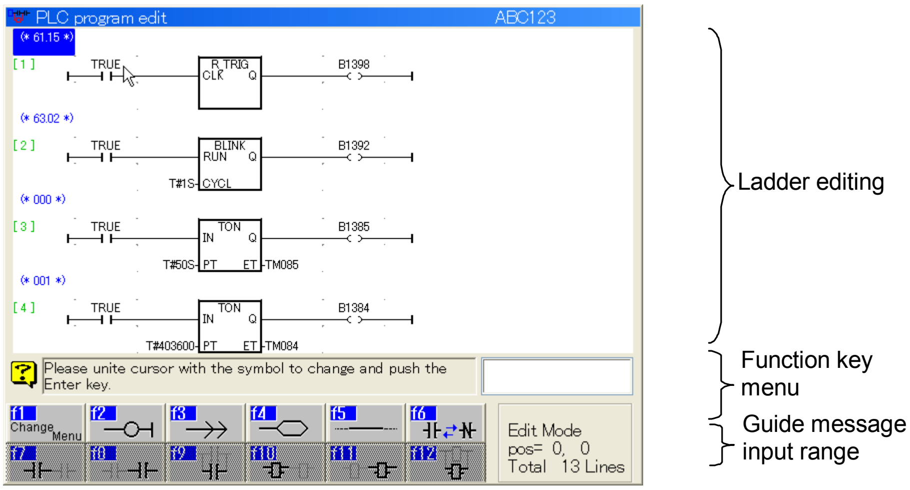


[Jog Dial]

Scrolling upward and downward can be done using.



There are f keys for two screens: select the applicable menu items using f1 <Change Menu> to switch between the two screens, and edit the ladder program.



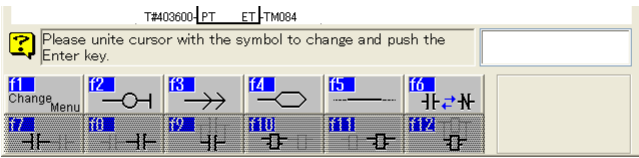
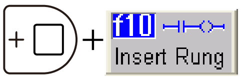


Fig. 2.1.1 Ladder program editing screen

Inputting a new rung

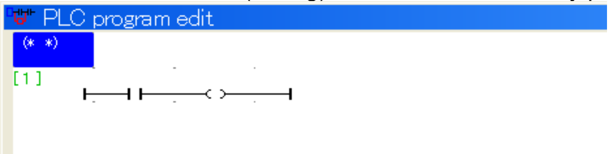
The "rung" is a closed circuit. Input a new rung according to the procedure shown below.



1 **Select the f keys with f1 <Operation Menu>, and then press [Enable] + f10 <Insert Rung> in a blank area.**

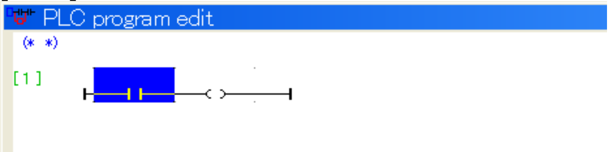
>> A new closed circuit (1 rung) is inserted and displayed as shown below.

The closed circuit (1 rung) can be also inserted by pressing [Enable] + [Enter].

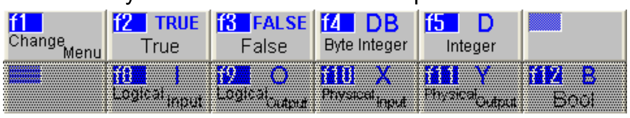


The area with a blue background represents the cursor position (area subject to editing).
A rung comment (i.e., a comment describable in units of closed circuits) is displayed inside (* *), while the rung number (i.e., the serial closed circuit number starting from "1") is displayed inside [ ].

2 **To input the contact number, put the cursor on the contact, and then press [Enter].**

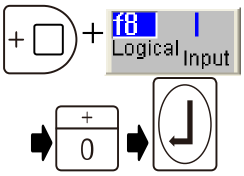


>> The f keys are now switched to the parameter selection menu as shown below.



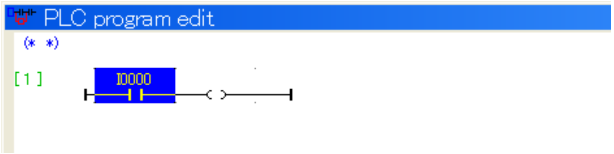
1st Page	
Function Name	Input example/Description
f1<Variable switch>	Switches parameter candidates.
f2<TRUE>	Insertion of TRUE constant (always ON)
f3<FALSE>	Insertion of FALSE constant (always OFF)
f4<SINT variable>	E.g: DB123 Specify the bit number as the relay number + "." + bit number 0~7.
f5<DINT variable>	E.g: D1234 Specify the bit number as the relay number + "." + bit number 0~31.
f6	
f7	
f8<Logic input>	E.g: I1234
f9<Logic output>	E.g: O1234
f10<Physical input>	E.g: X1234
f11<Physical output>	E.g: Y1234
f12<BOOL variable>	E.g: B1234

2nd Page	
Function Name	Input example/Description
f1<Variable switch>	Switches parameter candidates.
f8<String variable>	E.g: ST123
f9<Time variable>	E.g:TM123
f10<Real variable>	E.g: R1234



3 **To input the logical input I0000, press [Enable] + f8 <Logical Input>, and then [0] [Enter].**

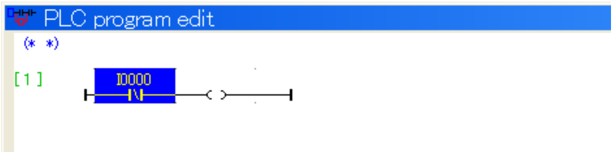
>> "I0000" is displayed above the contact symbol.



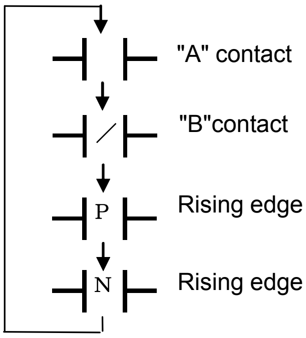
The f keys return to the original menu placement..

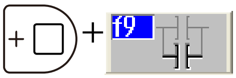
4 **Now try to change the contact type. Press f6 <Switch type> once.**

>>The contact type is changed to the "B".



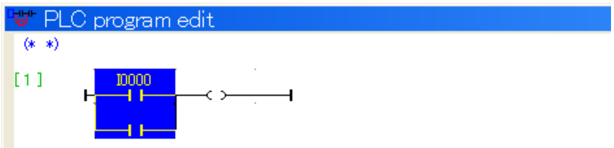
Every time f6 [Switch type] is pressed, the contact type is changed as shown below.



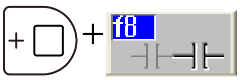


5 **Now try to insert the OR circuit. Press [Enable] + f9 <Insert OR>.**

>> The symbol is inserted as shown below.

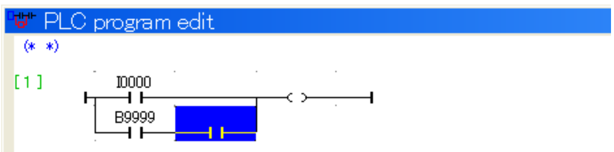


Input the contract number that was inserted according to the same procedure as those in the Steps 2 to 3.

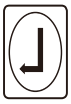


6 **Now try to insert the relay contact to the right.**
Press [Enable] + f8 <Insert a relay to the right of the cursor>.

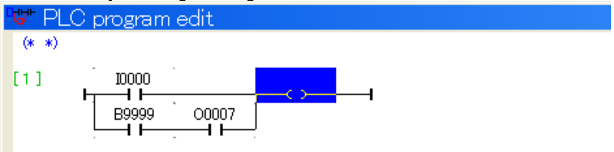
>> The symbol is inserted as shown below.



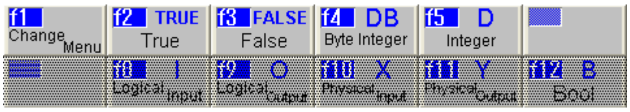
Input the contract number that was inserted according to the same procedure as those in the Steps 2 to 3.

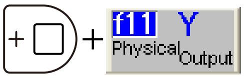


7 **Then, input the coil number.**
As in the case of inputting the contact number, put the cursor on the coil, and then press [Enter].

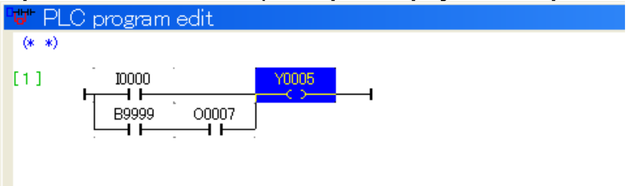


>> The f keys are switched to the Parameter Selection screen as shown below.

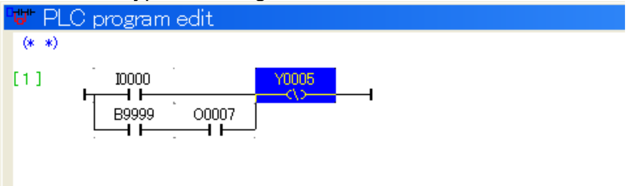




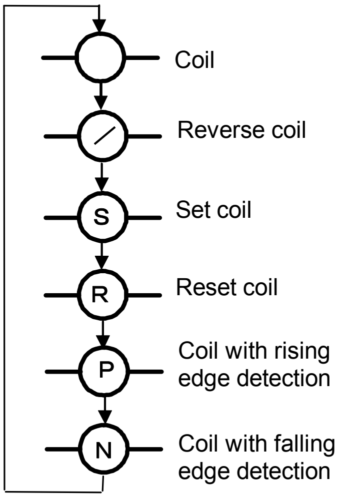
8 **According to the same procedure as that for inputting the contact number, input the coil number. (Example for physical output Y0005)**

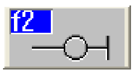


9 **Now try to change the coil type. Press f6 <Switch type> once.**
>> The coil type is changed to the reverse coil as shown below.

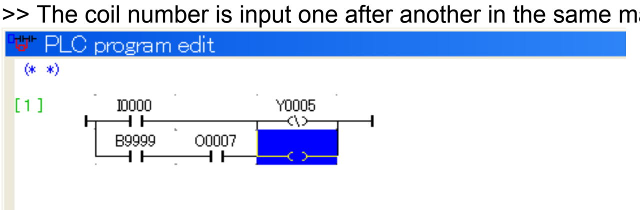


Every time f6 <Switch type> is pressed, the coil type is changed as shown below.





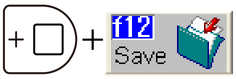
10 **To output multiple coils, put the cursor on the coils respectively, and then press f2 <Coil>.**
>> The coil number is input one after another in the same manner.



Saving program in editing process

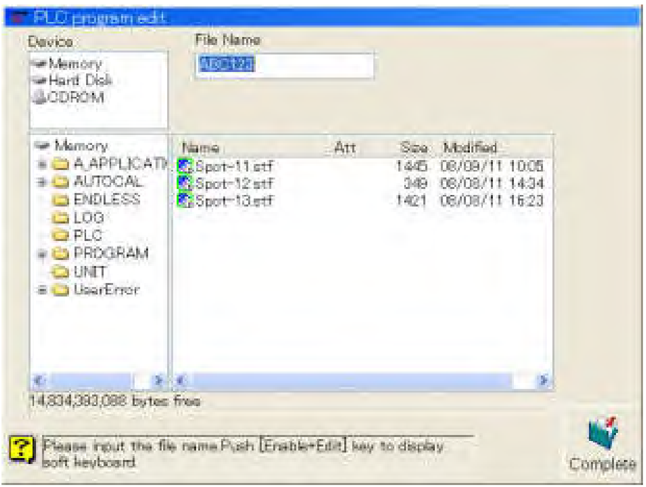
Save the finished PLC program in the memory in the form of display image.

Compiling and download of the created PLC program can also be done from the ladder editor. Operations are the same as “3.2 From compile to download”.



1 **Press [Enable] + f12 <Save>, wherever the cursor is positioned.**

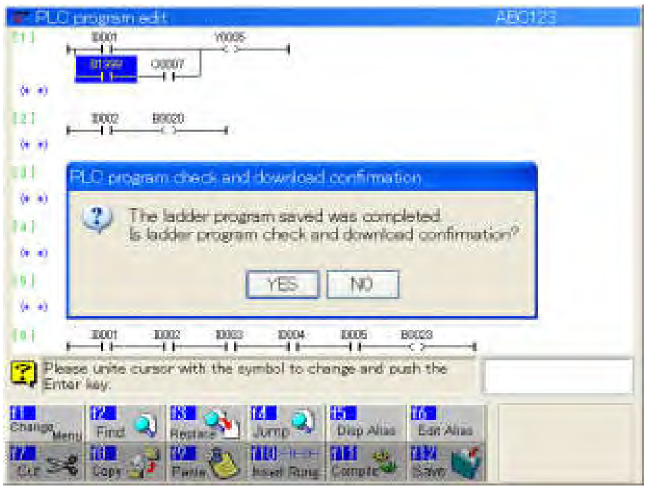
\>> The ladder program (display image file) on display is saved in the memory.

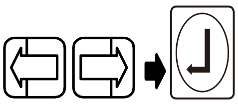


Make sure the display image file with a name that was specified before the editing was initiated is still on the List.

2 **Press f12 <Complete>.**

\>>The following pop-up message is displayed.





3 **To continue editing without checking and transferring the program, use [Right/Left] to select [NO], and then press [Enter].**

Selecting [YES] makes it possible to check and transfer the program.

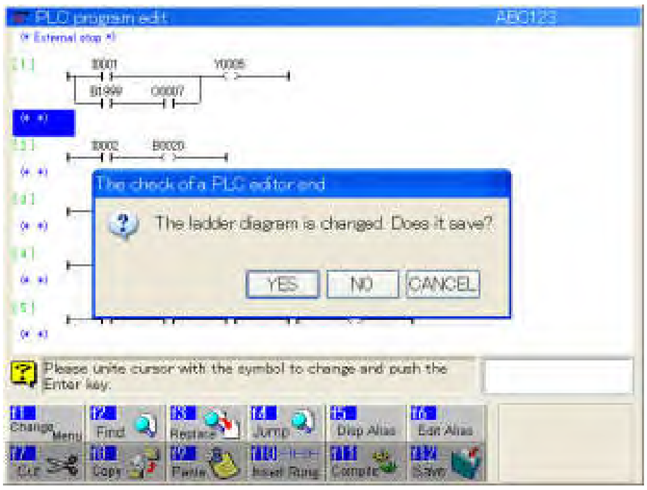
For details on program checking and transfer, see Chapter 3 “Program Check”.

Exiting editor

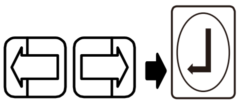
Exit the ladder editor.

1 **Press [Reset/R] at any cursor position.**

>> If the ladder program has been changed, the message shown below is displayed.



If the ladder program has not been changed, the editor is exited without displaying the message.



2 **To exit the editor without saving the ladder program, use [Right/Left] to select [NO], and then press [Enter].**

Selecting [YES] makes it possible to save the ladder program in the editing process sand then exit the editor.

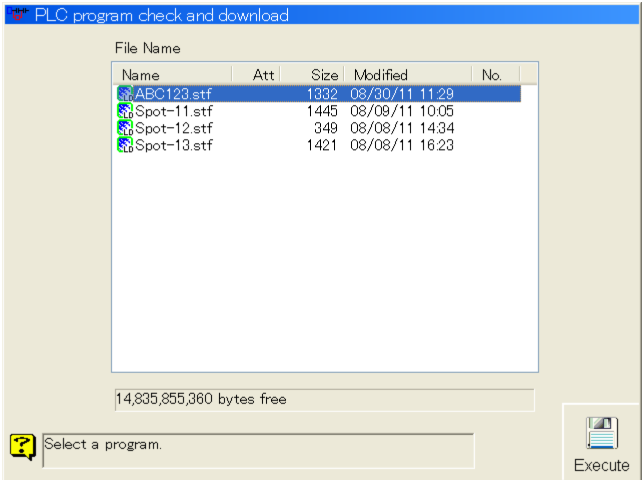
Selecting [Cancel] does not exit the editor.

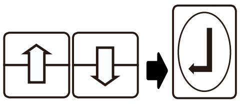
From compiling to downloading

This section describes the operations involved in selecting ladder programs (display image files) stored in the internal memory, compiling them while specifying the running sequence, and downloading.

1 **Select <Service Utilities> - [14 PLC Program Edit], and select [3 PLC program check] from the menu items displayed.**

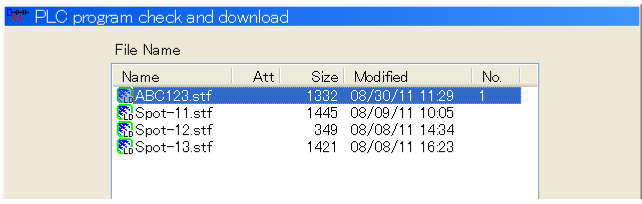
>> A list of the ladder programs (display image files) is now displayed as follows.

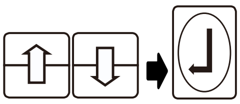




2 **Select the ladder program to be compiled using [Up/Down], and press [Enter].**

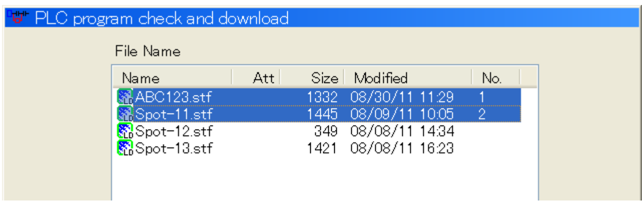
>> The selected ladder program is highlighted in blue, and the figure "1" appears on its right. This indicates that when a multiple number of ladder programs are to be linked together and run, this file is the ladder program which will be run first.



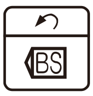


3 **Select the next ladder program to be compiled using [Up/Down], and press [Enter].**

>> The selected ladder program is highlighted in blue, and the figure "2" appears on its right. This indicates that when a multiple number of ladder programs are to be linked together and run, this file is the ladder program which will be run second.



In this way, the ladder programs are selected in the sequence in which they will be run.
If only one executable file is sufficient, select just the one file.

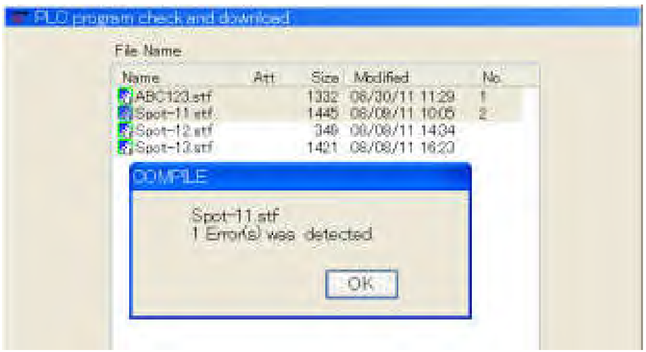


4 **If a mistake was made in specifying the execution sequence, move the cursor to the ladder program concerned, and press [BS].**

>>The display of the ladder program number in the execution sequence is now cleared.

5 After all the ladder programs have been selected, press f12 <Execute>.

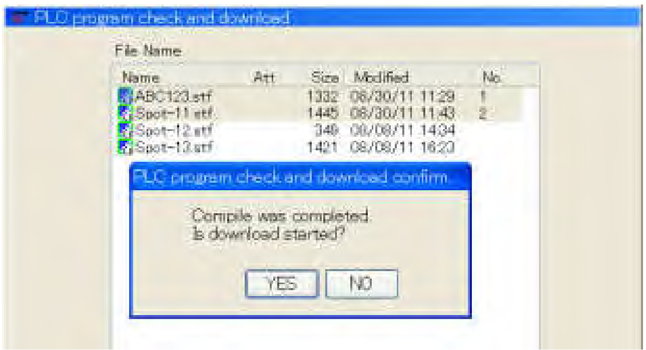
>>The programs are compiled in sequence starting with execution sequence number 1. Upon completion of the compiling, the results are displayed as shown below.

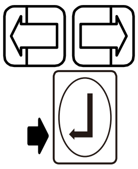


In the example given here, file ABC456.stf is error-free but one compilation error was found in file ABC123.stf.

6 If one or more compilation errors have been found, use [Reset/R] to exit the program check menu.
Start the ladder editor using [1 PLC program edit], resume compiling, pinpoint the error locations and make corrections.

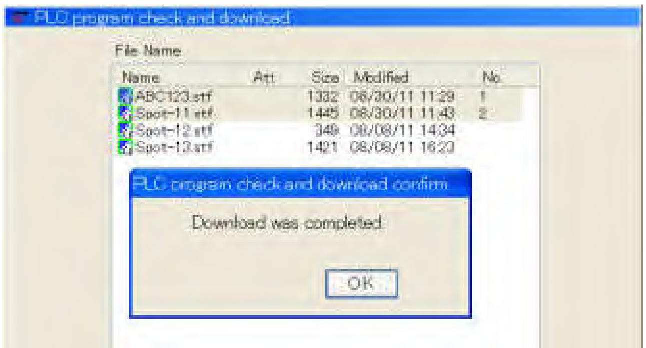
7 If there are no compilation errors, the message shown below appears.





8 Select "Yes" using [Right/Left], and press [Enter].

>> The multiple number of ladder programs which have been compiled are linked together into a single program and downloaded to the run time engine. When the file downloading is completed properly, the message shown below appears.



The program has now been transferred to the run time engine.
If the PLC (run time engine) is already started, it stops scanning temporarily, and after the program has been downloaded, resumes scanning.

9 Exit the menu using [Reset/R].

>> If PLC (run time engine) is not started, set it to start using the procedure in “3.3 Program start, stop, and disconnect”.

Program start, stop and disconnect

This section describes the procedures for starting and stopping the scanning of the ladder program downloaded from the run time engine. This operation is done from the constant menu.
Normally, if the PLC status setting is set to “Running”, it need not be changed later. Scanning is started by turning on the power of the controller.
Furthermore, it is possible for the software PLC not to be used (=disconnected) temporarily depending on the connection status of the peripheral devices etc.

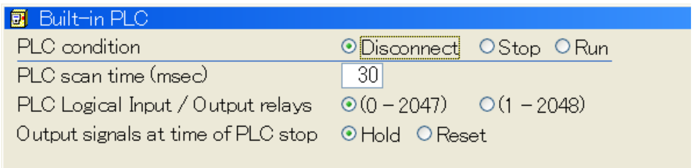
The PLC status setting has the following three status settings.

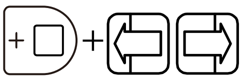
Table 3.3.1 Program start, stop and disconnect

Setting choice	Explanation
Isolation	The built-in PLC is not used. In other words, the logical inputs/outputs and physical inputs/outputs are connected on a one-on-one basis in this status. The PLC (run time engine) does not scan the downloaded programs.
Stop	The built-in PLC is used. However, since the PLC (run time engine) does not scan downloaded programs, no further changes occur in the physical I/O statuses.
Start	The built-in PLC is used. The PLC (run time engine) scans the downloaded programs. <Start> is not established automatically even when the downloading is initiated in the program check. The status must be changed to <Start> without fail using this menu.

1 **In the teach mode, select f 5 <Constant Setting> - [1 Control Constants], and select [6 Built-in PLC] from the menu items displayed.**

>> The setting menu related to the built-in PLC now appears as shown below.





2 **Select “Disconnect/Stop/Run” by pressing [ENABLE] + [Right/Left] together.**

3 **Press f12 [Complete].**

>> Operation is immediately transferred to the “Disconnect/Stop/Run” control status.

If the PLC status setting is changed to "Running", the PLC program input/output signal status also changes accordingly. It is extremely dangerous to perform this operation while work piece is gripped or while there is interference with any of the peripheral devices. Take sufficient care when performing this operation.

Ladder monitor

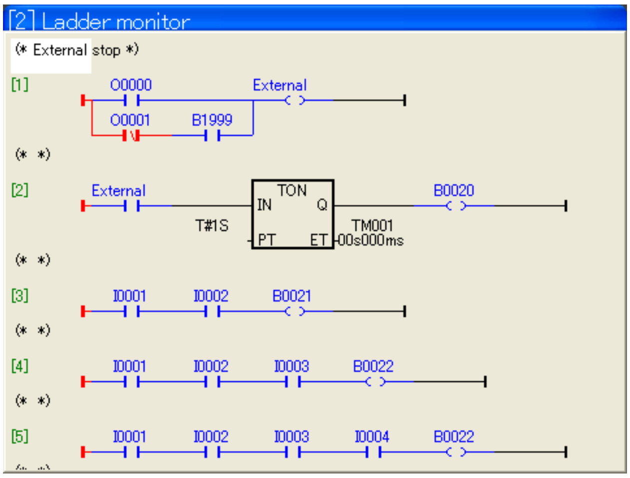
The program now being run by the PLC can be monitored on the display in the ladder display status.

Displaying the ladder monitor

1 **Select [3 Ladder monitor] from the monitor menu items.**

>> The monitor screen such as the one shown below appears. (The figure below shows the whole screen display.)

The program now being run by the PLC is displayed from its start.
The area with the white background is the cursor position. Move across the display using [Cursor keys].

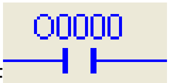


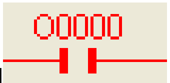
<u>Linking and executing multiple programs</u>

1 program (display image file; *.stf) can be displayed for 1 ladder monitor. If multiple programs are being linked and executed, a dialog box for selecting the program for monitor display appears. Select the programs to be displayed.**
Up to 4 monitors can be displayed (opened) simultaneously. To monitor multiple programs at the same time, display the ladder monitor in a different monitor window, and select a different program in that window.

The contact and coil ON/OFF, timer and other current values are displayed as shown below.

When the A (normally open) contact is set to the ON status, a red display in bold lines appears.

OFF 

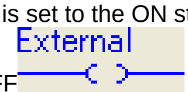
ON 

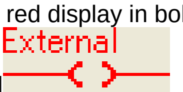
When the B (normally open) contact is set to the OFF status, a red display in bold lines appears.

OFF 

ON 

When the coil is set to the ON status, a red display in bold lines appears.

OFF 

ON 

Logical input/output relays

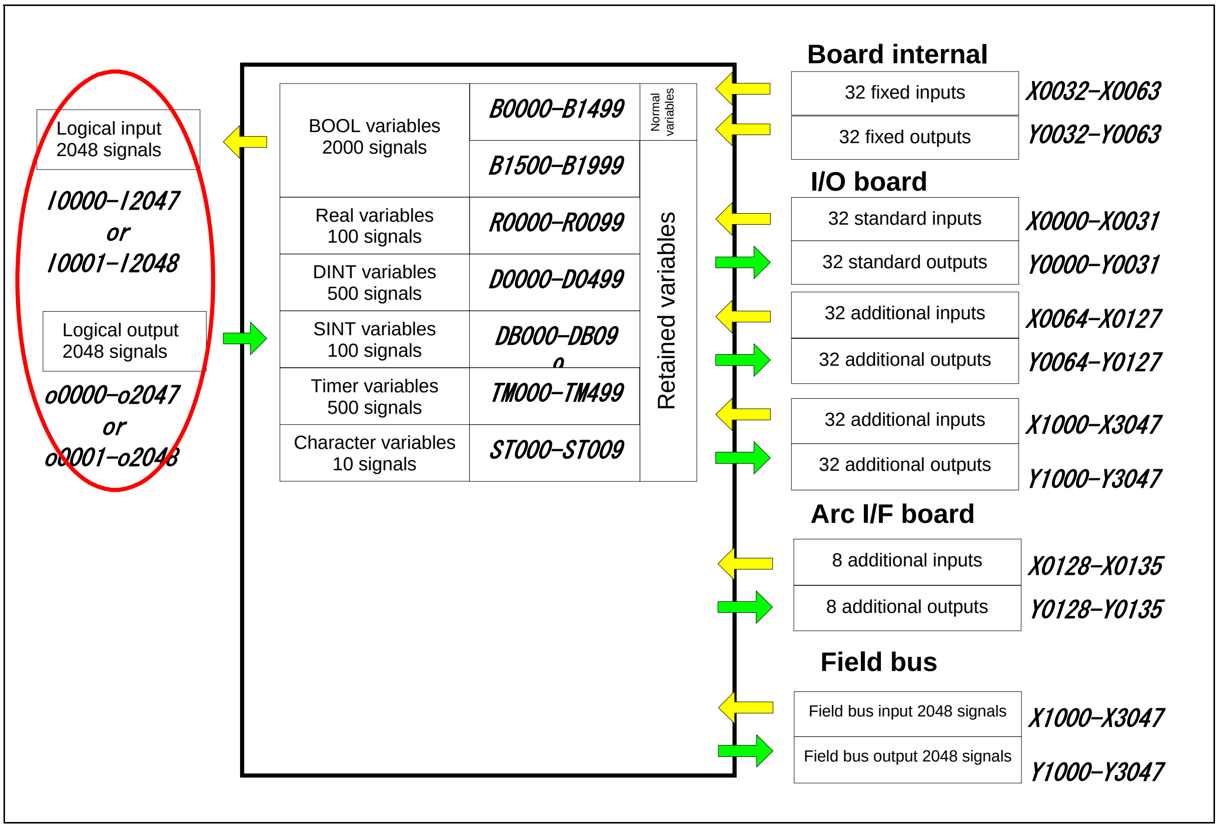


Fig. 6.1.1 Logical input/output relays

The logical input/output signals are the input/output signals of this controller as seen from the software PLC. The logical input/output relays are identified using a code starting with I (input) or O (output) so that their identification is consistent with the input/output signals which are actually recorded in the programs.

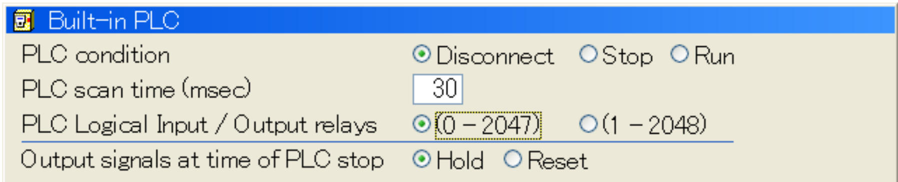
Relay numbers

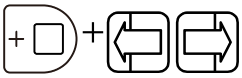
This function enables the settings of logical input/output relay numbers with the Constant menu.
Select the numbers from the two types listed in Table 6.1.1. The factory setting is made to the range of "0 to 2047".

Table 6.1.1 Logical input and output

Selection range	Description
0 - 2047	Used to make settings of relay numbers in the range of 0 to 2047. Signal numbers are assigned in the range of 1 to 2048. Consequently, "Logical input relay number = Logical input signal number - 1" "Logical output relay number = Logical output signal number - 1"
1 - 2048	Used to make settings of relay numbers in the range of 1 to 2048, like the signal numbers. "Logical input relay number = Logical input signal number" "Logical output relay number = Logical output signal number"

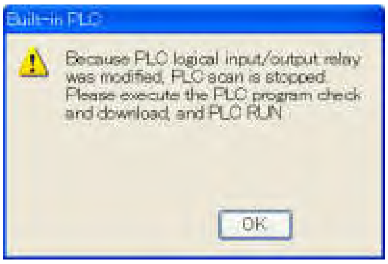
1 **While in teach mode, select f5 <Constant Setting> - [1 Control Constants] and [4 Built-in PLC] from the menu on display.**
>> The setting menu related to the built-in PLC is as shown below. Move the cursor to the PLC logical input/output.





2 **Press [Enable] + [Right/Left] at a time to select either 0-2047 or 1-2048.**

3 **Press f12 <Complete>.**
>> If the PLC status is set to "Start", the message shown below is displayed.



Pressing [Enter] exits the Setting screen. At this time, the PLC status is set to "Stop".
Be sure to execute checking according to information in Chapter 3 "Program check".

Physical input/output relays

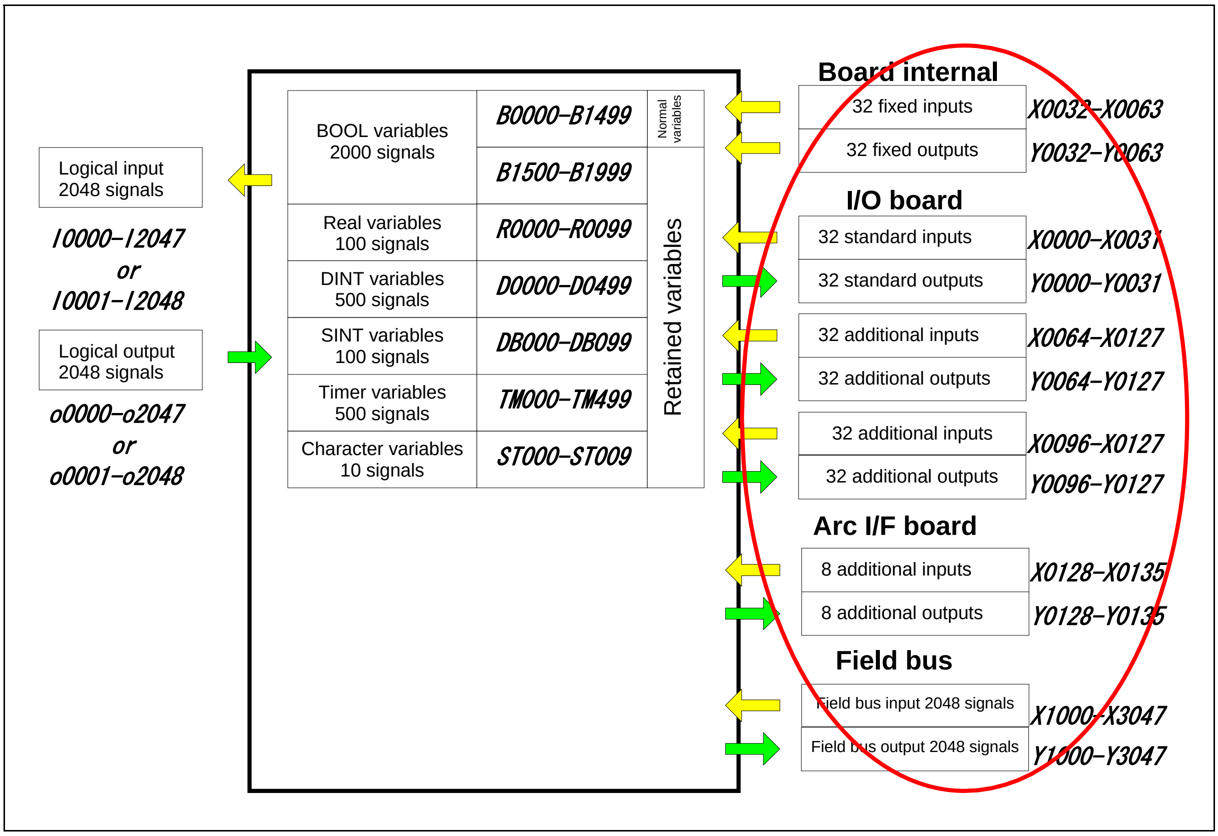


Fig. 6.2.1 Physical input/output relays

Fixed input/output

These are the servo ON/OFF and other input/output signals which are used to control the operations inside the controller.
The fixed input/output signals can only be referenced by the software PLC. An error results during compiling if a program calling for signals to be output to the settled input/output signals is created.

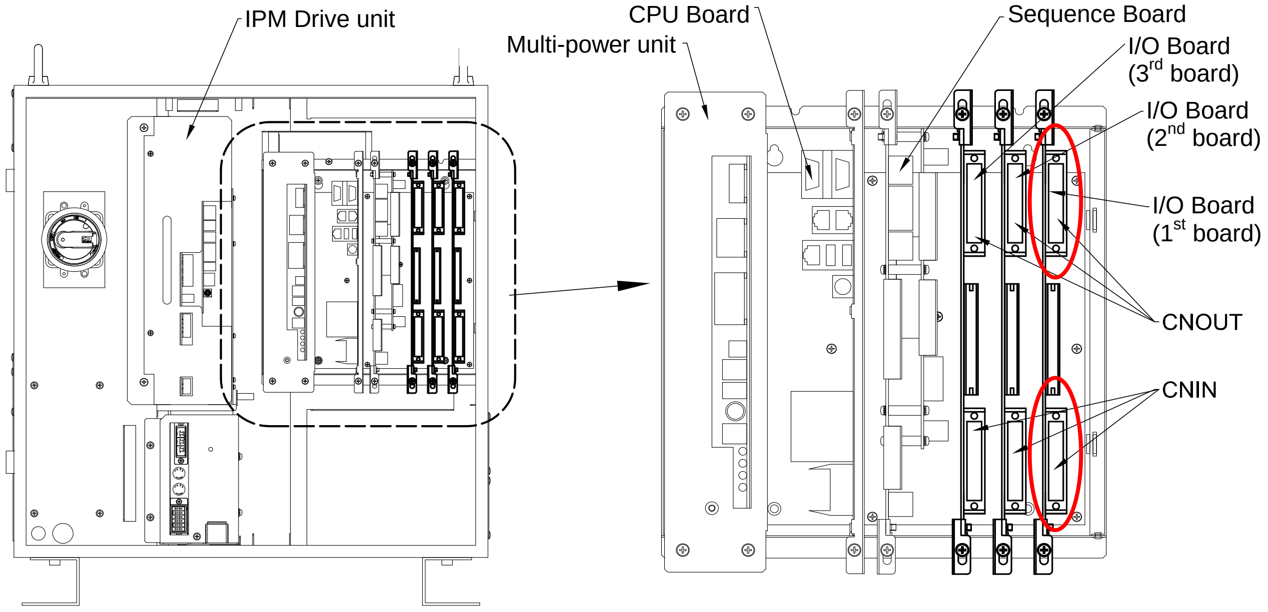
Table 6.2.1 List of settled input/output relay numbers

	Settled input signal name	Relay number		Settled output signal name	Relay number
0	Motors-ON	***X0032***	0	Motors-ON lamp	***Y0032***
1	G-STOP	***X0033***	1	Motors-ON request	***Y0033***
2	Start 1	***X0034***	2	Start lamp 1	***Y0034***
3	Start 2	***X0035***	3	Start lamp 2	***Y0035***
4	Start 3	***X0036***	4	Start lamp 3	***Y0036***
5	Start 4	***X0037***	5	Start lamp 4	***Y0037***
6	Stop	***X0038***	6	Stop lamp	***Y0038***
7	Playback mode	***X0039***	7	TP enable release	***Y0039***
8	Mat switch	***X0040***	8	Motors-ON enable	***Y0040***
9	—	***X0041***	9	Magnet-ON enable	***Y0041***
10	High-speed Teach	***X0042***	10	Internal/External	***Y0042***
11	P1 correct	***X0043***	11	WPS E-STOP ctrl	***Y0043***
12	Ext Emergency stop	***X0044***	12	CPU failure	***Y0044***
13	Emergency stop	***X0045***	13	TP mode	***Y0045***
14	Safety plug	***X0046***	14	Ext motors-ON	***Y0046***
15	Confirm motors-ON	***X0047***	15	Motors-ON lamp	***Y0047***
16	TP Emergency stop	***X0048***	—	—	—
17	Teach mode	***X0049***	—	—	—
18	—	***X0050***	—	—	—

19	TP enable SW	***X0051***	—	—	—
20	—	***X0052***	—	—	—
21	CR ON	***X0053***	—	—	—
22	Servo-ON	***X0054***	—	—	—
23	Servo enable	***X0055***	—	—	—
24	—	***X0056***	—	—	—
25	—	***X0057***	—	—	—
26	—	***X0058***	—	—	—
27	Magnet-ON	***X0059***	—	—	—
28	—	***X0060***	—	—	—
29	Weld detection	***X0061***	—	—	—
30	Inconsistency	***X0062***	—	—	—
31	—	***X0063***	—	—	—
32	Inconsist(GSTOP)	—	—	—	—
33	Inconsist(mode)	—	—	—	—
34	Inconsist(MAT-SW)	—	—	—	—
35	Inconsist(HI-SP)	—	—	—	—
36	Inconsist(Ext ES)	—	—	—	—
37	Inconsist(E.S.)	—	—	—	—
38	Inconsist(S.plug)	—	—	—	—
39	Inconsist(TP-ES)	—	—	—	—
40	Inconsist(ENB-SW)	—	—	—	—
41	Inconsist(CRON)	—	—	—	—
42	—	—	—	—	—
43	—	—	—	—	—
44	—	—	—	—	—
45	—	—	—	—	—
46	—	—	—	—	—
47	—	—	—	—	—

Standard inputs/outputs

These are the input/output signals for the CNIN (input) and CNOUT (output) connectors of the I/O PCB provided as an optional accessory.



<Front view (internal)>

<Rack unit magnified view>

Fig. 6.2.2 Positions of standard input/output signal connectors

Signal specifications of Optional Physical I/O board

This section explains the physical I/O signal specifications for the Arc I/F board, Relay Unit + I/O board, and I/O board. Refer to Table 3.9.1, and refer to the correct explanation for your board.

Table 3.9.1 Reference Explanations for Each Board

Board name	Reference			
	Common items		Individual	
Arc I/F board	This page	Refer to the section 3.9.1.	page 3-48	Refer to the section 3.9.2.
Relay unit + I/O board	This page	Refer to the section 3.9.1.	page 3-53	Refer to the section 3.9.3.
I/O board	This page	Refer to the section 3.9.1.	page 3-59	Refer to the section 3.9.4.

Common items

DC24V supplying procedure

The capacity for the DC24V that can be supplied by the internal DC24V is 0.8A.
If the input/output current for the used external device exceeds this value, you need to prepare an external DC24V power supply.
In case of supplying the internal DC24V to the external device, the Relay Unit cannot be combined due to the capacity limitation of the internal DC24V.

Electrical specifications of physical input

Table 3.9.2 shows the power specifications for 1 input signal point. This is the same for all boards.

Table 3.9.2 Electrical specifications of physical input

Items	Specifications
Input impedance	Approx. 3 kΩ
Input voltage	DC+24 V ±10 %
Input current	8 mA (typ.)

Table 3.9.3 and Fig. 3.9.1 show the input load (customer prepared) specifications.

Table 3.9.3 Specifications of the load for input circuit (prepared by customer)

Input load (Customer prepared)	Specifications	Remarks
Relay contact	Minimum applicable load should be DC24V, 5 mA	The input signals needs to be closed for 150ms or longer.
Open collector device	Leakage current should be 1 mA or less.	

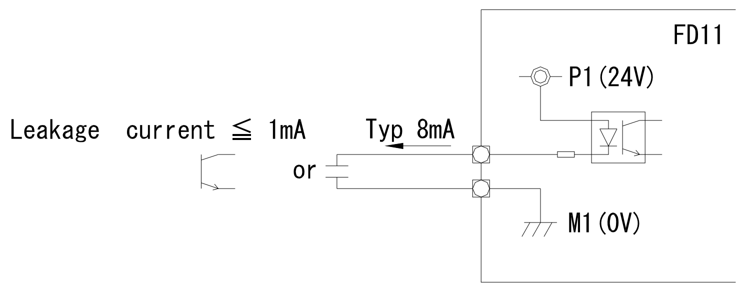


Fig. 3.9.1 Specifications of the load for input circuit (prepared by customer)

A transistor (PNP) type can be selected for the relay unit.
page 3-57, Refer to “Fig. 3.9.8 Signal connection with external jigs”.

Electrical specifications of physical output

Table 3.9.4 and Table 3.9.5 show the power specifications for 1 output signal point for each board.

Prepare the output load that conforms to the used physical output signal.

Electrical specifications of physical output (Arc I/F board, Relay unit + I/O board)

Table 3.9.4 Electrical specifications of physical output (Arc I/F board, Relay unit + I/O board)

Items	Specifications
Output method	Relay contact
Rated voltage	AC 100 V or DC 30 V
Rated current	1A
Minimum applicable load	DC24V 5mA
Electrical expected life	Min. 10^5 (1A,100 V AC, 1A,30 V DC, resistive load, at 20 times/min.)

CAUTION

- Be absolutely sure to use a surge killer for the load.
- Since the value of minimum applicable load depends on the switching frequency, environment conditions, and expected reliable level, be sure to check with the actual load condition before operation.
- Electrical expected value is a reference value in case of using under the conditions described in parentheses. The value depends on the environmental conditions.

Electrical specifications of physical output (I/O board)

Table 3.9.5 Electrical specifications of physical output (I/O board)

Items	Specifications
Rated voltage	DC+24 V ±3 V
Rated current	0.1 A

CAUTION

- Be absolutely sure to use a surge killer for the load.
- Do not use power with the wrong polarity.

I/O signal specifications of Arc I/F board

3.9.2.1 I/O signal specifications of Arc I/F board

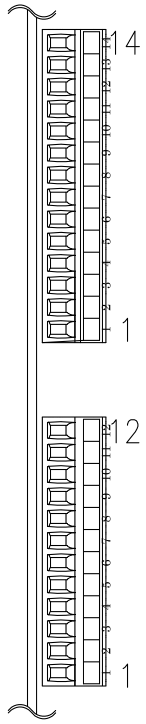
Table 3.9.6 and Table 3.9.7 show the input signal specifications and output signal specifications for the Arc I/F board terminal block.

Table 3.9.6 Input terminal block TBIN of Arc I/F board

Pin No.	Signal name	Signal (I*)	Descriptions
14	M1	Internal 0V	Internal power source 0V (to drive relays)
13	M1	Internal 0V	Internal power source 0V
12	P1	Internal 24V	Internal power source DC24V (to drive relays)
11	P1	Internal 24V	Internal power source DC24V
10	INCOM102	COMMON	Common for IN101～IN104
9	IN104	I104	General input signals
8	IN103	I103	
7	IN102	I102	
6	IN101	I101	
5	INCOM101	COMMON	Common for IN97～IN100
4	IN100	I100	General input signals
3	IN99	I99	
2	IN98	I98	
1	IN97	I97	

Table 3.9.7 Output terminal block TBOUT of Arc I/F board

Pin No.	Signal name	Signal (O*)	Descriptions
12	OUTCOM102	COMMON	Common for OUT101～OUT104
11	OUT104	O104	General output signals
10	OUT103	O103	
9	OUT102	O102	
8	OUT101	O101	
7	OUTCOM101	COMMON	Common for OUT97～OUT100
6	OUT100	O100	General output signals
5	OUT99	O99	
4	OUT98	O98	
3	OUT97	O97	
2	HP-	HP-	Warning lamp signal -
1	HP+	HP+	Warning lamp signal +



Terminal blocks TBIN / TBOUT

I/O signal specifications of Relay unit with I/O board

I/O signal specifications of relay unit

This section shows the input signal specifications and output signal specifications for the relay unit terminal blocks.
References for the explanations of each terminal block are shown in Table 3.9.8.

Table 3.9.8 Relay Unit Terminal Block Input Signal Specifications and Output Signal Specifications (Factory Settings)

I/O type	Terminal block No.	Reference	
Input	Terminal block TBIN1	page 3-54	Refer to Table 3.9.9.
	Terminal block TBIN2	page 3-54	Refer to Table 3.9.10.
Output	Terminal block TBOUT1	page 3-55	Refer to Table 3.9.11.
	Terminal blockTBIOUT2	page 3-55	Refer to Table 3.9.12.

For general signals, logical signals used as status signals can be assigned freely.
Table 3.9.9 to Table 3.9.12 show the factory setting assignments.
For details on the assignment method, see “4.6 Signal attribute settings”.

INFO.

Initial settings of signal allocations depend on the application type.

Table 3.9.9 List of input signals(TBIN1)

Terminal block pin No.	Signal name	Signal (I*)	Pin description
1	IN1	I1	General-purpose input signals
2	IN2	I2	General-purpose input signals
3	IN3	I3	General-purpose input signals
4	IN4	I4	General-purpose input signals
5	IN COM1	COMMON	Common for pins 1 to 4 (IN1～IN4)
6	IN5	I5	General-purpose input signals
7	IN6	I6	General-purpose input signals
8	IN7	I7	General-purpose input signals
9	IN8	I8	General-purpose input signals
10	IN COM2	COMMON	Common for pins 6 to 9 (IN5～IN8)
11	IN9	I9	General-purpose input signals
12	IN10	I10	General-purpose input signals
13	IN11	I11	General-purpose input signals
14	IN12	I12	General-purpose input signals
15	IN COM3	COMMON	Common for pins 11 to 14 (IN9～IN12)
16	IN13	I13	General-purpose input signals
17	IN14	I14	General-purpose input signals
18	IN15	I15	General-purpose input signals
19	IN16	I16	General-purpose input signals
20	IN COM4	COMMON	Common for pins 16 to 19 (IN13～IN16)
21	24V	Internal 24V	24V internal power supply
22	EX 24VA	Input 24V	External power supply input (24V)
23	EX 24VB	Output 24V	External power supply output (24V)

Table 3.9.10 List of input signals（TBIN2）

Terminal block pin No.	Signal name	Signal (I*)	Pin description
1	EX 0VB	Output 0V	External power supply output (0V)
2	EX 0VA	Input 0V	External power supply input (0V)
3	0V	Internal 0V	0V internal power supply
4	IN17	I17	Program selection bit 1
5	IN18	I18	Program selection bit 2
6	IN19	I19	Program selection bit 3
7	IN20	I20	Program selection bit 4
8	IN COM5	COMMON	Common for pins 4 to 8 (IN21～IN24)
9	IN21	I21	Program selection bit 5
10	IN22	I22	Program selection bit 6
11	IN23	I23	Program selection bit 7
12	IN24	I24	Program selection bit 8
13	IN COM6	COMMON	Common for pins 9 to 12 (IN21～IN24)
14	IN25	I25	Program strobe U1
15	IN26	I26	General-purpose input signals
16	IN27	I27	General-purpose input signals
17	IN28	I28	Welding ON/OFF
18	IN COM7	COMMON	Common for pins 14 to 17 (IN25～IN28)
19	IN29	I29	General-purpose input signals
20	IN30	I30	Ext. play start.
21	IN31	I31	External stop (keep an input signal supplied here when this pin is not used.)
22	IN32	I32	External motor power OFF
23	IN COM8	COMMON	Common for pins 19 to 22 (IN29～IN32)

Table 3.9.11 List of output signals (TBOUT1)

Terminal block pin No.	Signal name	Signal (O*)	Pin description
1	OUT1	O1	General-purpose output signals
2	OUT2	O2	General-purpose output signals
3	OUT3	O3	General-purpose output signals
4	OUT4	O4	General-purpose output signals
5	OUT COM1	COMMON	Common for pins 1 to 4 (OUT1～OUT4)
6	OUT5	O5	General-purpose output signals
7	OUT6	O6	General-purpose output signals
8	OUT7	O7	General-purpose output signals
9	OUT8	O8	General-purpose output signals
10	OUT COM2	COMMON	Common for pins 6 to 9 (OUT5～OUT8)
11	OUT9	O9	General-purpose output signals
12	OUT10	O10	General-purpose output signals
13	OUT11	O11	General-purpose output signals
14	OUT12	O12	General-purpose output signals
15	OUT COM3	COMMON	Common for pins 11 to 14 (OUT9～OUT12)
16	OUT13	O13	General-purpose output signals
17	OUT14	O14	General-purpose output signals
18	OUT15	O15	General-purpose output signals
19	OUT16	O16	General-purpose output signals
20	OUT COM4	COMMON	Common for pins 16 to 19 (OUT13～OUT16)

Table 3.9.12 List of output signals(TBOUT2)

Terminal block pin No.	Signal name	Signal (O*)	Pin description
1	OUT17	O17	Wire stick check
2	OUT18	O18	Weld failure
3	OUT19	O19	Unit READY U1
4	OUT20	O20	Program end U1
5	OUT COM5	COMMON	Common for pins 4 to 8 (OUT17～OUT20)
6	OUT21	O21	Error U1
7	OUT22	O22	Interlock alarm U1
8	OUT23	O23	Alarm U1
9	OUT24	O24	Emergency stopped
10	OUT COM6	COMMON	Common for pins 9 to 12 (OUT21～OUT24)
11	OUT25	O25	In teach mode
12	OUT26	O26	Robot running U1
13	OUT27	O27	Ext. prg. sel enable
14	OUT28	O28	Ext. start enable
15	OUT COM7	COMMON	Common for pins 14 to 17 (OUT25～OUT28)
16	OUT29	O29	Motors energized
17	OUT30	O30	Status output 1
18	OUT31	O31	Work home position 1 U1
19	OUT32	O32	Information U1
20	OUT COM8	COMMON	Common for pins 19 to 22 (OUT29～OUT32)

Connections to Relay Unit Input Signals

For details on the electrical specifications for the input signals, see “section 3.9.1.2 Electrical specifications of physical input” on page 3-46.

A connection example to relay unit input signals is shown below.
Both type of NPN and PNP power suppies can be selected by switchig CNSW.

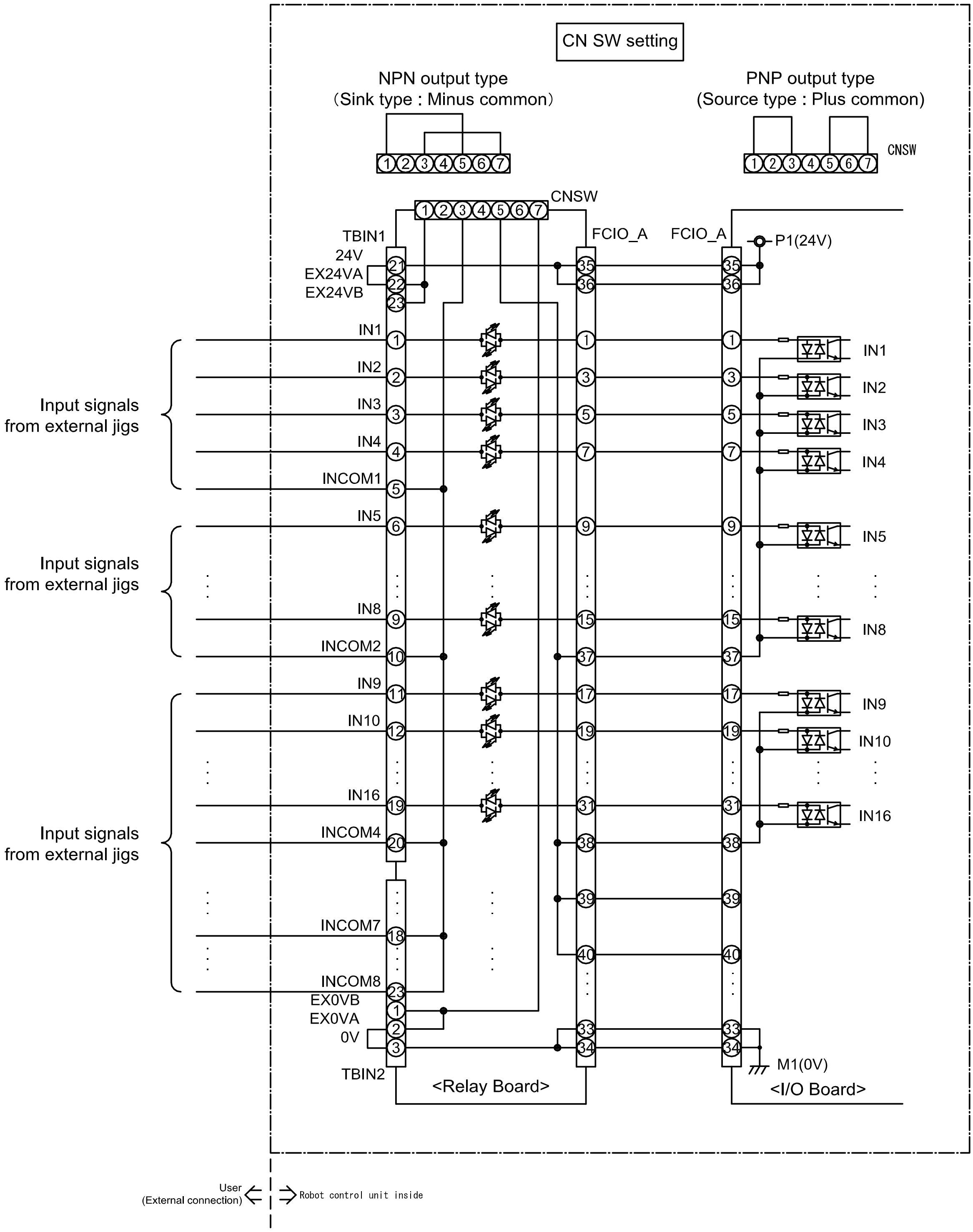
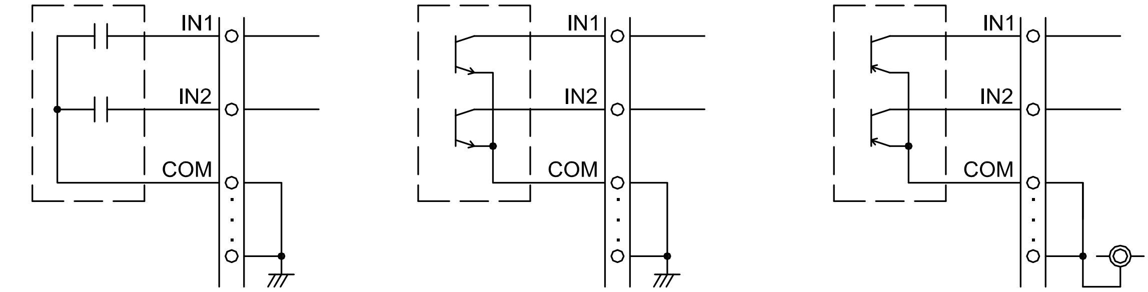


Fig. 3.9.7 Input circuit of relay unit

Signal connection with external jigs

To input the relay unit, connect the output of relay dry contact or transistor as the diagram below.



Connection of relay dry contact

Connection of transistor output (NPN). (Sink type (-) Common)

Transistor (PNP) Output connections (Sink type：(+) common)

Fig. 3.9.8 Signal connection with external jigs

Procedure to supply DC 24 V by external power source

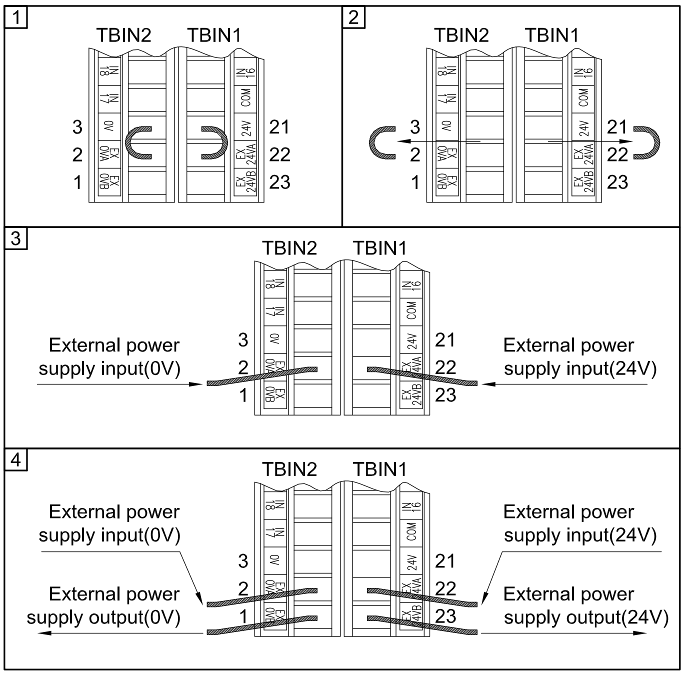


Fig. 3.9.9 Procedure to supply DC 24 V by external power source

1 Check that shorting cables are connected to TBIN1 and TBIN2.

2 Disconnect the two TBIN1 and TBIN2 shorting cables.

3 Connect the external power supply input (24 V) and (0 V) pins to the pins shown in 3.

4 When a multiple number of relay units are used or 24 V is to be supplied elsewhere, connect the 24 V output pin to the pin shown in 4.