DAIHEN INC.

FD21 ROBOTIC PROGRAMMING 1

FD21
CONTROLLER

Arc Welding

Almega Friendly series II

INSTRUCTION MANUAL

BASIC OPERATIONS

	■ 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

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

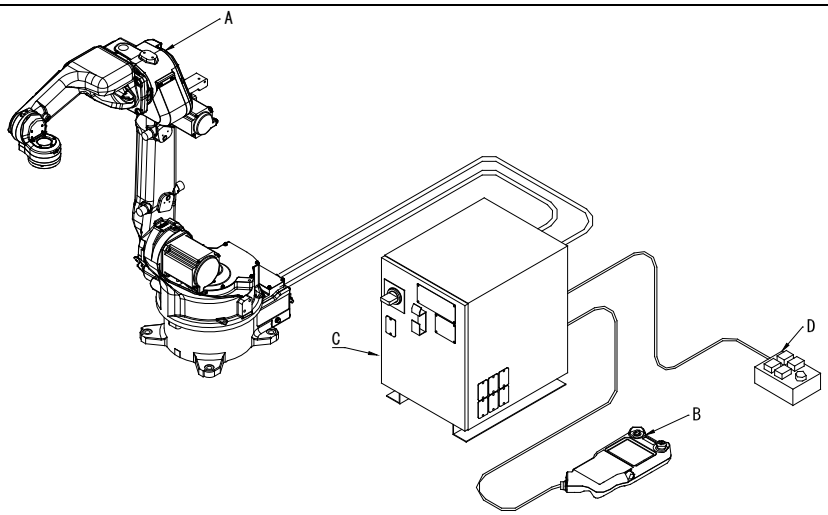
Terms	Explanation	
Error	If an error in operation or teaching or trouble in the robot itself has been detected during a teaching or playback operation, the operator is alerted to the error or trouble concerned.	If an error occurs during a playback operation, the robot is set to the stop status, and the servo power (motor power) is turned off immediately.
Alarm		If an alarm occurs during a playback operation, the robot is set to the stop status. The servo power (motor power) is not turned off. This type of trouble is less serious than an error.
Information		If information occurs, the robot remains in the start status even during a playback operation. It includes alarms or errors that have the potential to develop in the future.
Mechanism	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.	
Unit	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.	

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.

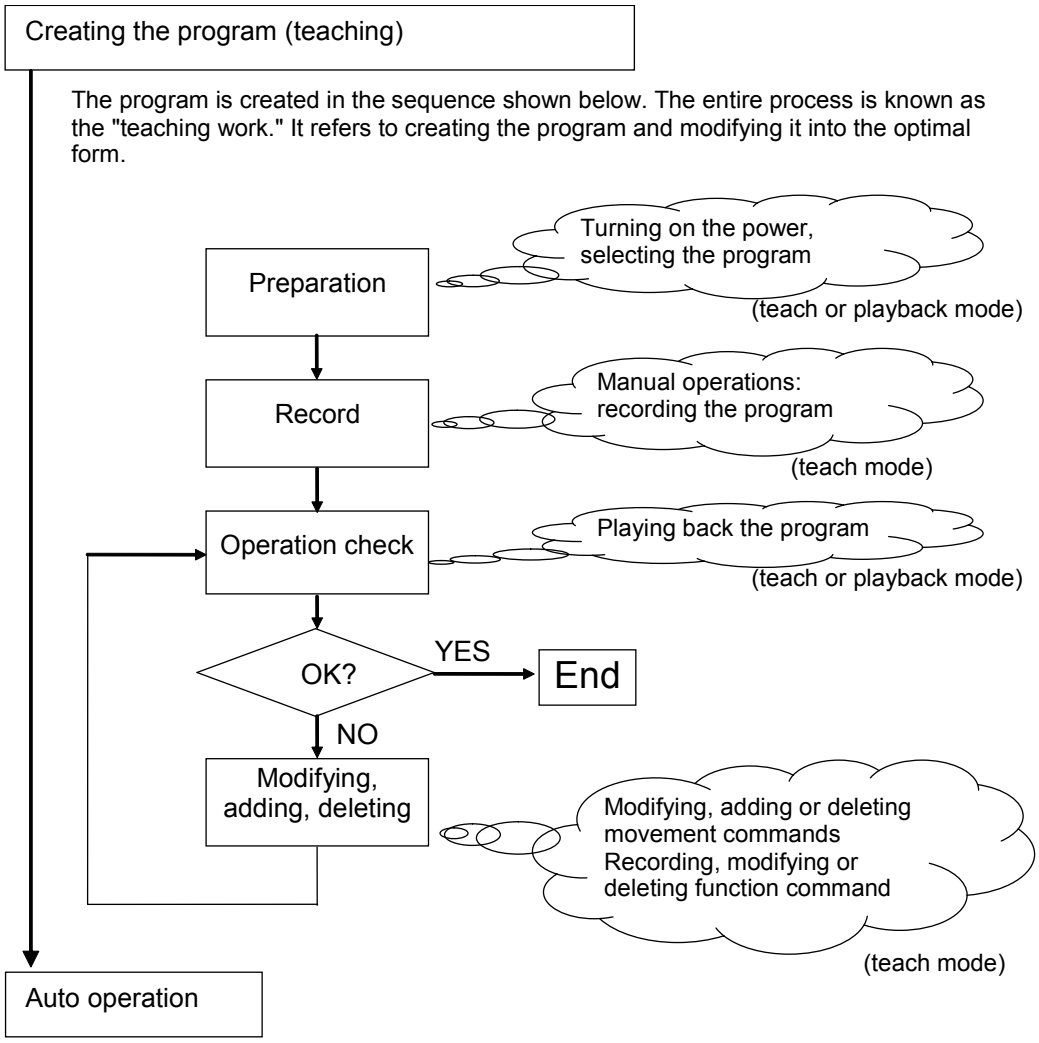


A: Robot body
B: Teach pendant
C: Controller
D: Control box

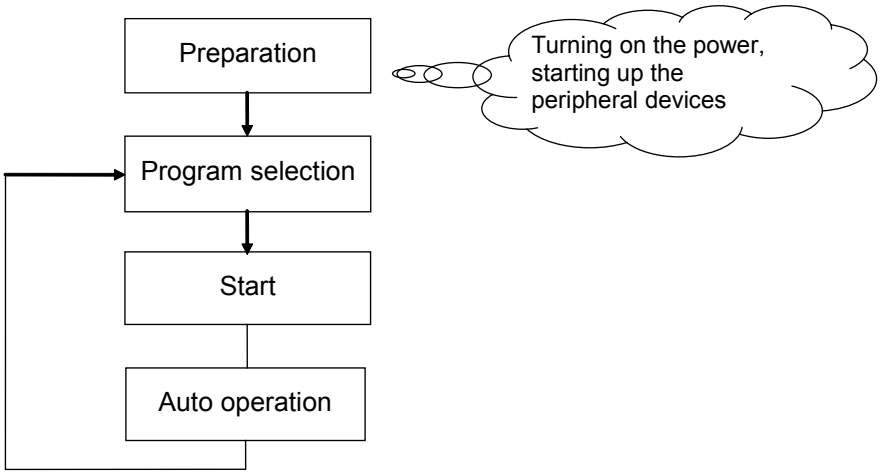
Fig. 1.4.1 Diagram of basic configuration for robot (When the control box is connected)

Overview: from teaching to auto operation

Proceed as follows to continuously operate the robot.



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



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.

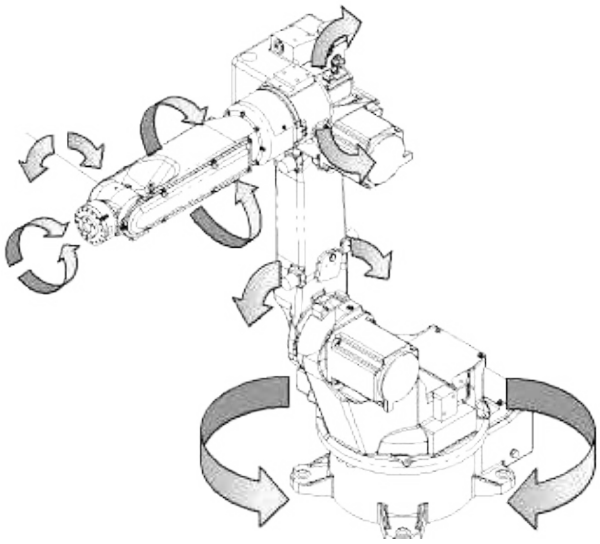


Fig. 1.4.2 Operating the axes separately (independent axis operation)

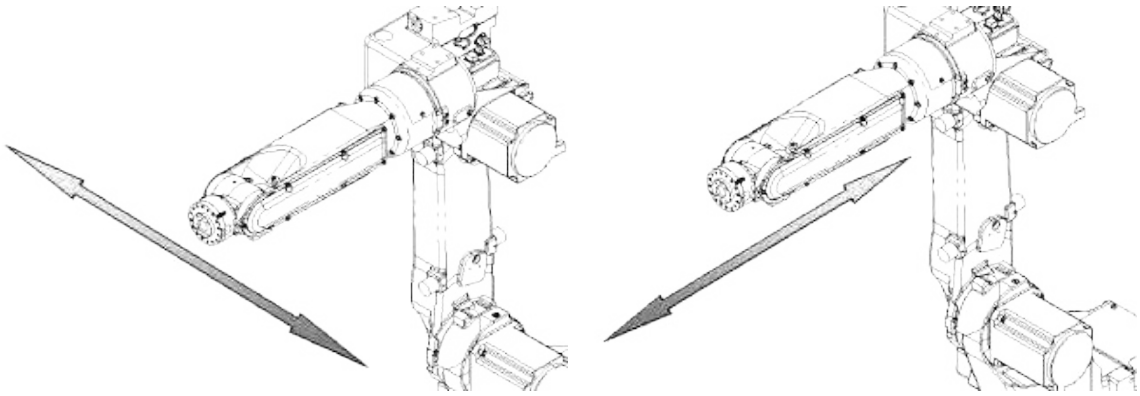


Fig. 1.4.3 Moving the robot tip in a straight line (robot coordinate operation)

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.

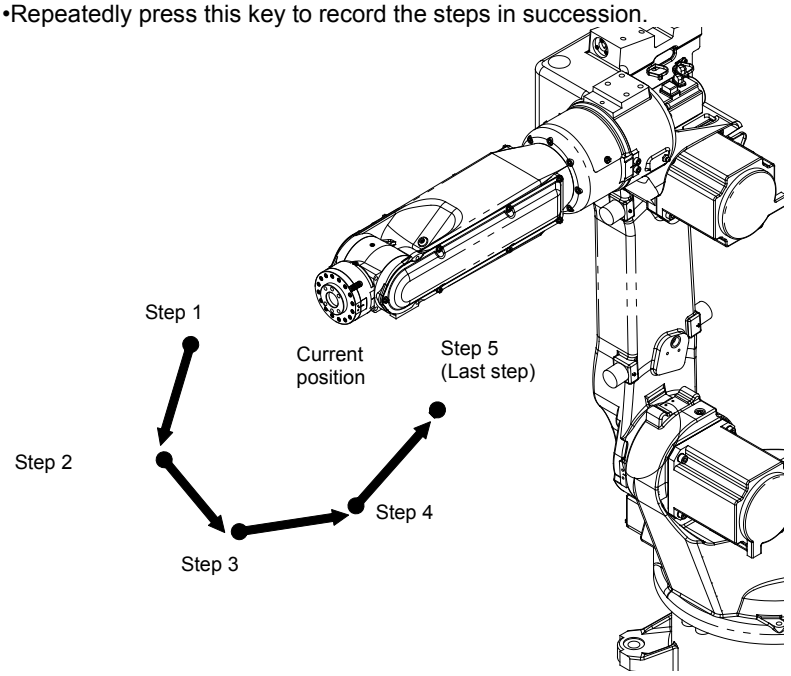
Teaching is performed in the teach mode.

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

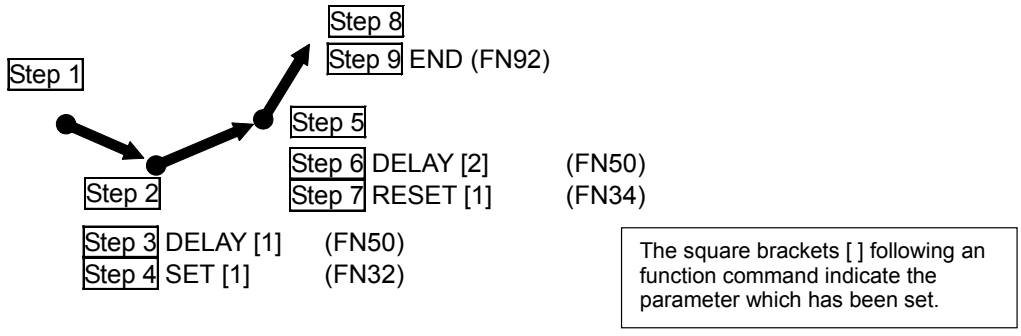
The function commands are expressed using a format based on SLIM (Standard Language for Industrial Manipulators) that is a robot language.
Alternatively, function commands can be specified using the “FN***” format where a 1 to 3 digit number is input into the *** part (which is called a function number).

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



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.

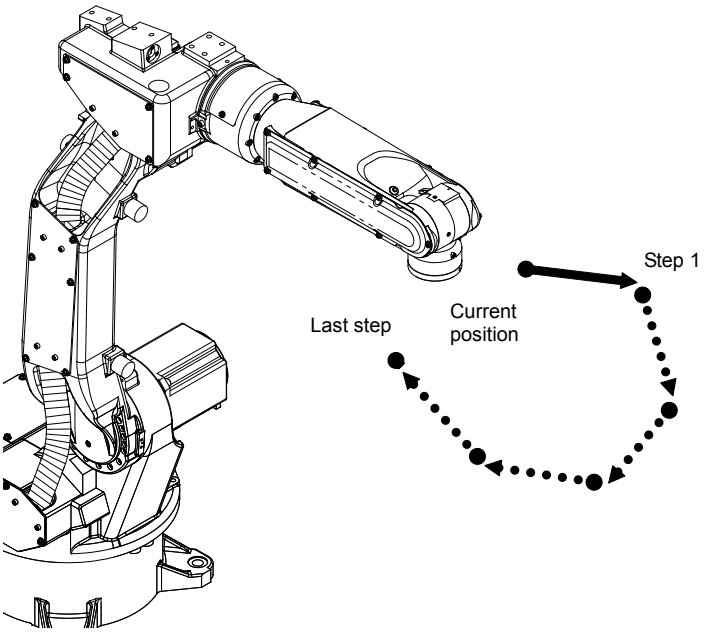
1	Select the playback mode.

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.

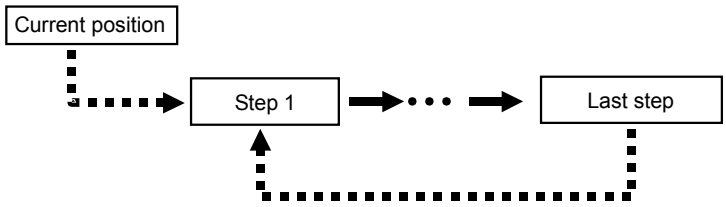
2	Proceed with playback.

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

Configuration of the controller

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

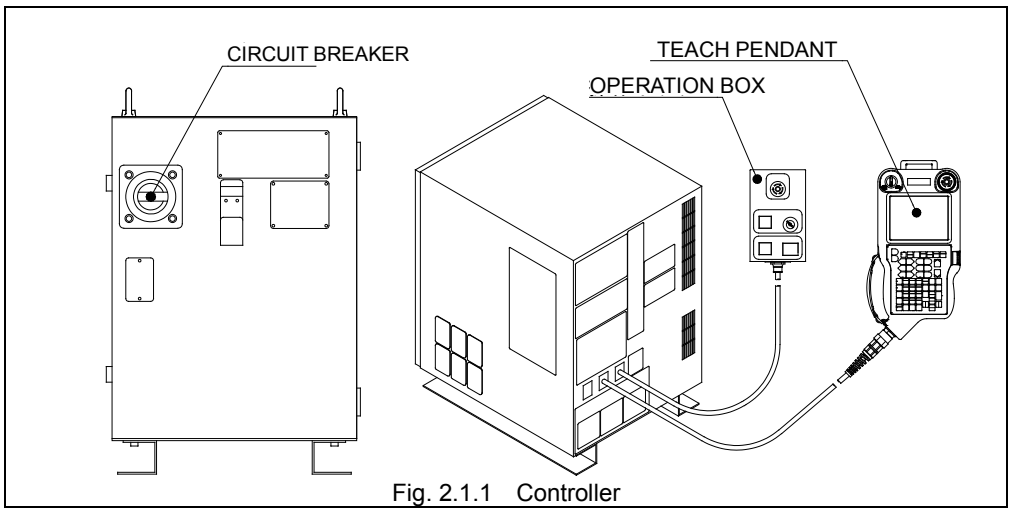


Fig. 2.1.1 Controller

Circuit breaker

This turns the power of the controller ON and OFF.

Teach pendant

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

Operation Box

Buttons for performing the 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.

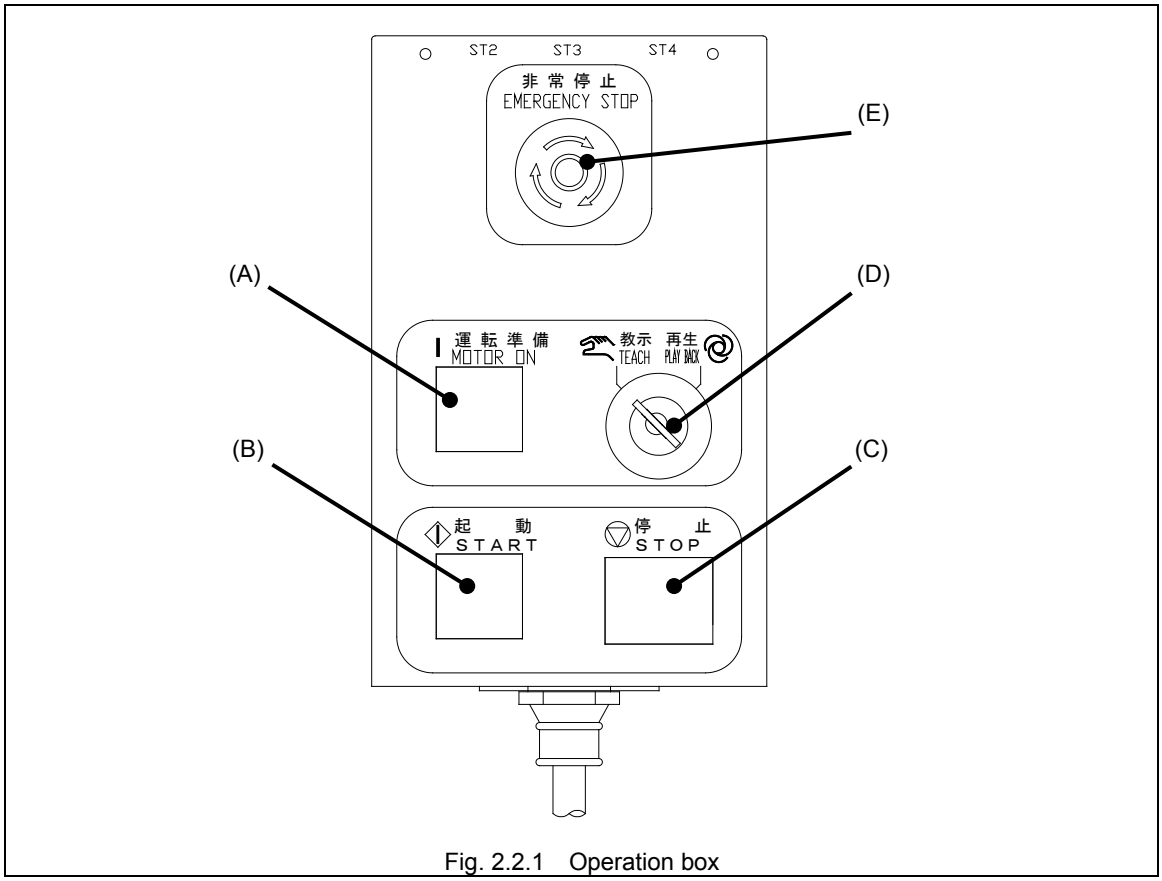


Fig. 2.2.1 Operation box

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.)

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.

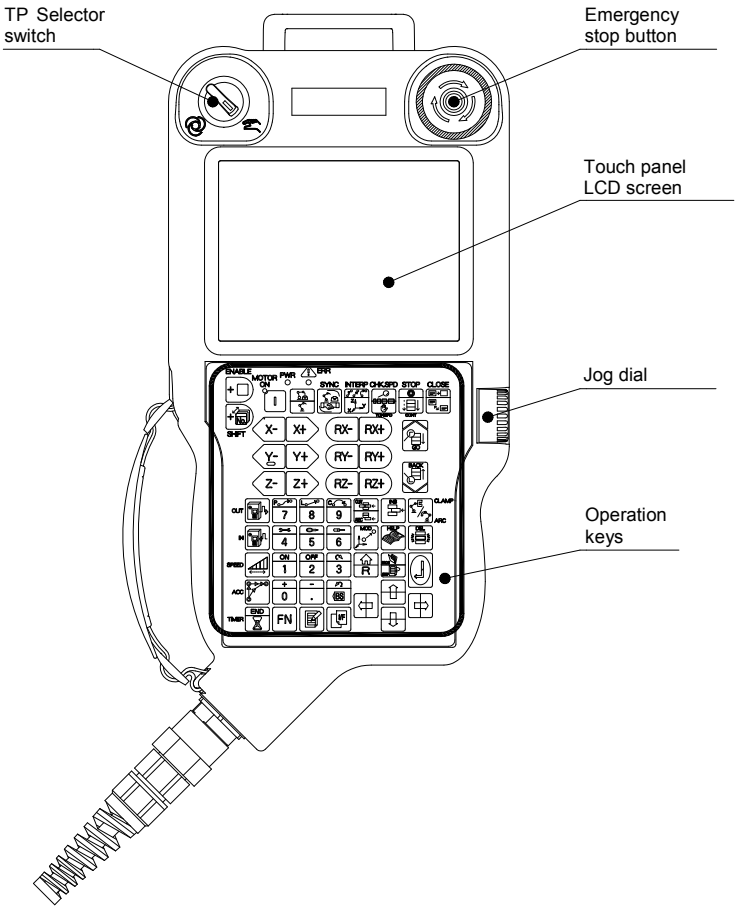


Fig. 2.3.1 Teach pendant (Front)

INFO.

The design of the operation keys shown in Fig. 2.3.1 may be slightly different to those on the actual teach pendant.

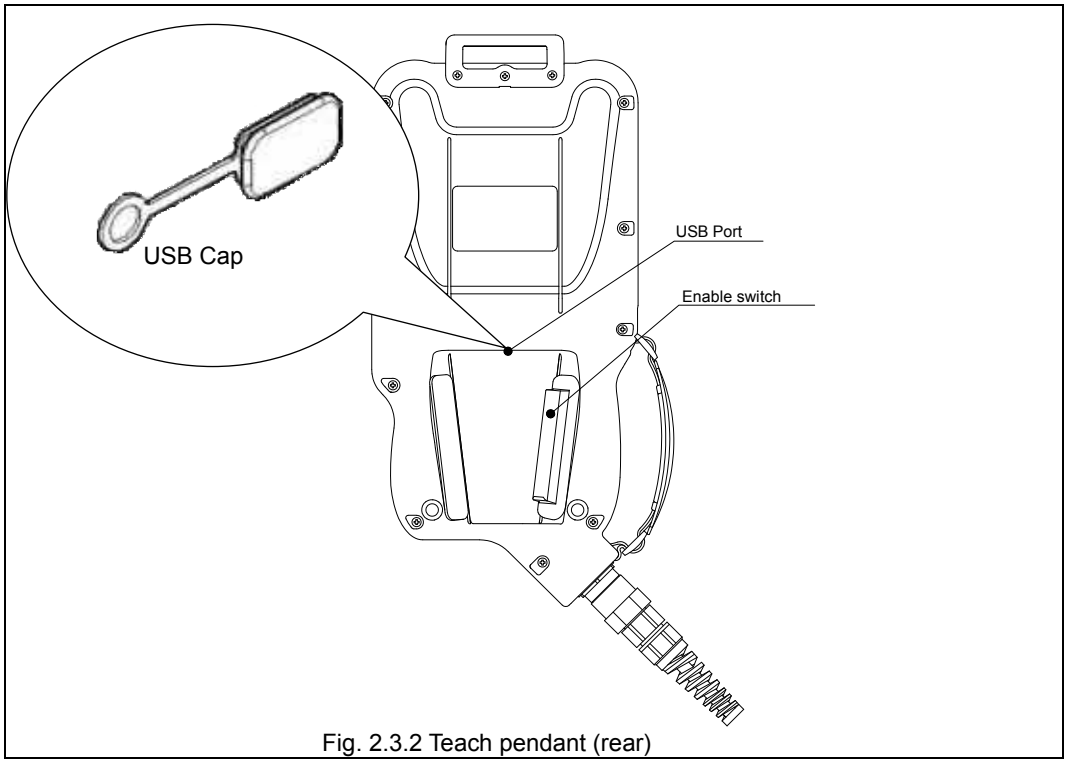


Fig. 2.3.2 Teach pendant (rear)

LED Functions

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

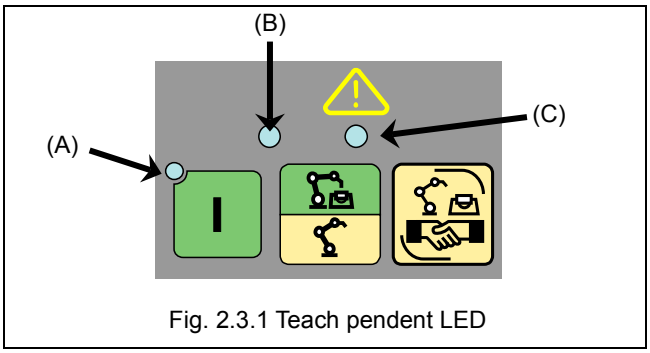


Fig. 2.3.1 Teach pendent LED

Table 2.3.1 LED Functions

	LED Color	Functions
(A)	Green	Blinks when servo is in standby and lights when motor power is ON (servo ON). It is the same as the green lamp for the [MOTOR ON BUTTON] on the operation 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.

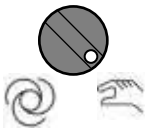
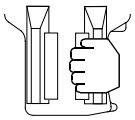
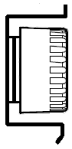
Directly after power to the controller is switched on, all of the LEDs light for approximately 0.5 seconds to check they are operating normally, and then switch off. After this, they operate as shown in Table 2.3.1.

The top of keys are convex to enable operations without looking at the keys.

Functions of buttons and switches

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

Table 2.3.2 Functions of buttons and switches

External appearance	Indication used in this manual	Function
	[TP SELECTOR SWITCH]	Switches between teach mode and playback mode in combination with the [MODE SELECT SWITCH] on the operation 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 “2.3.8 JOG DIAL.”

Functions of operation keys

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

Table 2.3.3 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.

Table 2.3.3 Functions of operation keys

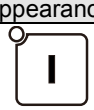
External appearance	Indication used in this manual	Function
	[MOTOR POWER ON]	The motor power is set to ON by pressing this key together with the [ENABLE] key.
	[UNIT/MECHANISM]	PRESSED ON ITS OWN **MECHANISM SELECTION** When a multiple number of mechanisms are connected to the system, the mechanism 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 2.3.3 Functions of operation keys

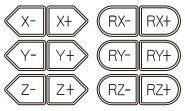
External appearance	Indication used in this manual	Function
	[CHECK SPD/TEACH SPEED]	PRESSED ON ITS OWN **MANUAL SPEED CHANGE** The operating speed of the robot during manual operation is selected. Each time it is pressed, one of the 1 to 5 operating speeds is selected (the higher the number, the faster 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. 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 2.3.3 Functions of operation keys

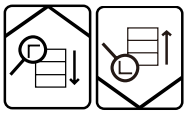
External appearance	Indication used in this manual	Function
	[CHECK GO] [CHECK BACK]	PRESSED ON ITS OWN No function WITH [ENABLE SWITCH] **CHECK GO / BACK** When these are pressed together with the [ENABLE SWITCH], the check go or check back operation is performed. Normally, the robot is stopped at each 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. 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 2.3.3 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. “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/QUICK ACCESS]	PRESSED ON ITS OWN **Help** Press this for help concerning an operation or function. The built-in tutorial function (help function) is called. WITH [ENABLE] **Quick Access** Displays the favorites screen to enable frequently used settings to be easily accessed.
	[DEL]	PRESSED ON ITS OWN No function WITH [ENABLE] **STEP DELETION** The step now selected (movement command or function command) is deleted.

Table 2.3.3 Functions of operation keys

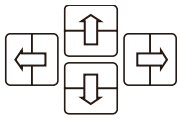
External appearance	Indication used in this manual	Function
	[R/HOME]	PRESSED ON ITS OWN **Reset/Return** This clears the input or returns the setting screen to its original status. It also enables R codes (short-cut codes) to be input. The function that is to be used can be called immediately by inputting an R code. WITH [ENABLE] **Home** Returns from the advanced settings screen to the home screen (teach or playback mode home screen).
	[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. 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).

Table 2.3.3 Functions of operation keys

External appearance	Indication used in this manual	Function
	[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. This function is set by selecting [Constant Setting] →[5 Operation Constants] → [1 Operation condition] →[5 Usage of SPD key].
	[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. 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 2.3.3 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 2.3.3 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.

2.3.5 Configuration of display screen

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

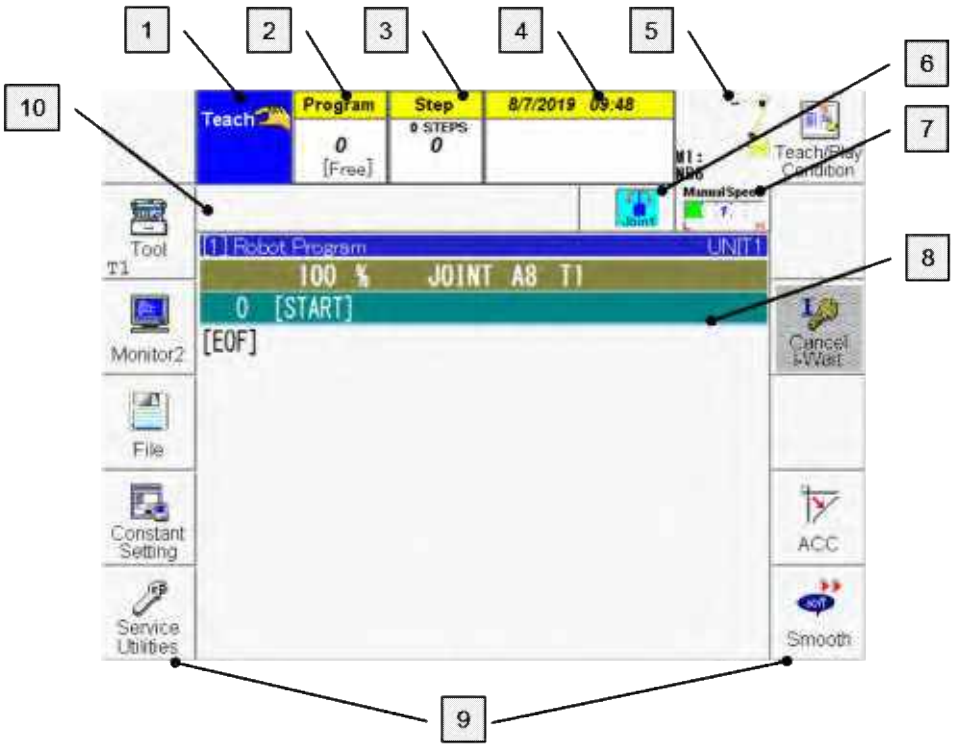


Fig. 2.3.2 Configuration of display screen

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 2.3.4 Status display

Status	Teach mode	Playback mode
Motor power OFF		
Motor power ON, servo power OFF		
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.
The total number of steps is displayed on a step number.

4 Date & time display area

The current date and time are displayed here.

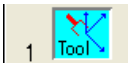
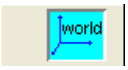
5 Mechanism display area

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.

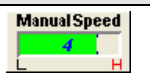
Table 2.3.5 Coordinate system display

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 2.3.6 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).

Touch the monitor display area while holding [SHIFT] to switch full screen display on and off.

9 f key display area

Selectable functions are displayed by touching the f key display area. The six keys on the left correspond to f1 to f6; the six keys on the right correspond to f7 to f12.
See 2-18 “2.3.6 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 2.3.7 in this area. When this status ends, the icon is cleared.

Table 2.3.7 Status icon display

Status	Icon
Wireless teach pendant radio field intensity	
Wireless teach pendant remaining battery	
Wireless teach pendant forbidden connection	
The axis requires overhaul within 1,000 hours of operation.	
Temporary option set (The number indicates the number of days the option will be enabled)	
External signal input waiting (waiting)	
“Start selection: External” or “Program selection: Internal” now selected	
“Start selection: Internal” or “Program selection: External” now selected	
“Start selection: External” or “Program selection: External” now selected	
Software PLC now operating	
Software PLC now stopped	
Shift operation in progress	
Search reference writing mode in operation	
Multidrive disabled	
Automatic calibration: Reference point acquisition mode	
Machine lock now set	
Dry run now set	
Robot in the start enable area	
Now connected with external PC via Ethernet	

Status	Icon
Automatic backup proceeding (The extent to which the operation has been completed is indicated as a percentage.)	
Temporarily stopped (with station startup only)	
The TCP speed is limited to low speed (250mm/sec)	
Energy-saving mode activated	
Holding or now paused * This is displayed only when the hold signal or pause signal is input during playback.	
Mechanism now disconnected	
I/O simulation mode now selected	
J5 axis in singular point status	
CallFar command executing (The number indicates the number of the unit from where the call originates)	
Fork command executing (The number indicates the number of the unit from where the call originates)	
Revise bend operation in progress	
Fieldbus disconnecting	
Now accumulating interference torque	
Interference notification disabled	
Interference area check disabled	
Welding characteristics data adjustment in progress	
User task program call in progress	
User task: User window starting up	
Switch control endless: Position control endless	

Status	Icon
Switch control endless: Speed control endless	
Seam welding: Seam welding section speed override disabled	
Servo gun gripping	
Servo gun released	
Equalize operation amount set	
Servo gun: Now writing gun search reference position	
Servo gun: Now selecting recording position check mode	
Servo gun: Pressure amount adjustment in progress	
Mechanism connected Value: Mechanism number - connected sub-mechanism number *(The mechanism disconnection function is an option.)*	
Mechanism released Value: Mechanism number - connected sub-mechanism number *(The mechanism disconnection function is an option.)*	
Robot in the start enable area	
Now Log in (The 3 digit number signifies the user ID)	

Status	Icon
Record function is allocated to the [JOG DIAL] function.	
Overwrite function is allocated to the [JOG DIAL] function.	
Position correction function is allocated to the [JOG DIAL] function.	
Interpolation classification switching function is allocated to the [JOG DIAL] function.	
Coordinate switching function is allocated to the [JOG DIAL] function.	
Insertion function is allocated to the [JOG DIAL] function.	
Tool fine adjustment function is allocated to the [JOG DIAL] function.	
Manual operation function is assigned to the jog dial, but operation via the axis operation key is enabled, so manual operation with the jog dial cannot be performed.	
G-STOP in operation	
Power control (touch) activated	
Weld wire inching/retracting function is allocated to the [JOG DIAL] function. * The color changes depending on the feed setting.	
The touch panel is locked.	

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

Concerning the operation of the f keys

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

INFO.

The initial allocation of the f keys differs according to the application. For details on the initial allocation, see the sections in chapter 8 and beyond in this instruction manual that correspond to the application that will be used.

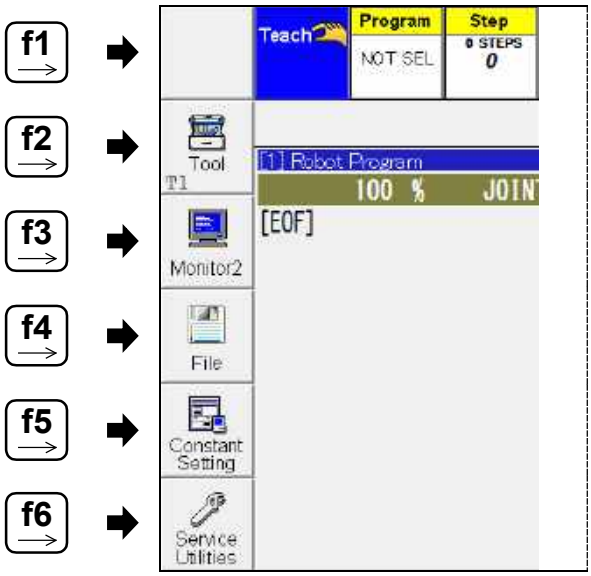
Enter the f key from the touch panel

To select the function allocated to an icon, touch the f key display area icon directly.
f1 to f6 (6 total) are assigned to the left side of the screen, and f7 to f12 (6 total) are assigned to the right side.

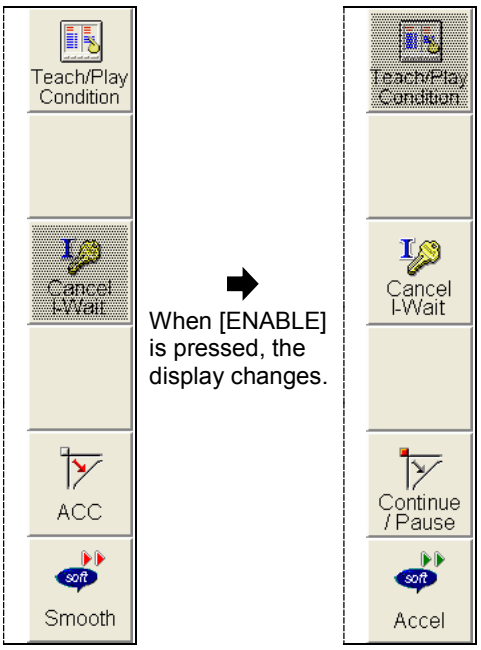
INFO.

Icons can be arranged per user preference. For details, see “7.9 Customizing the Softkey”.

Each function can be selected by touching the icon directly.



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



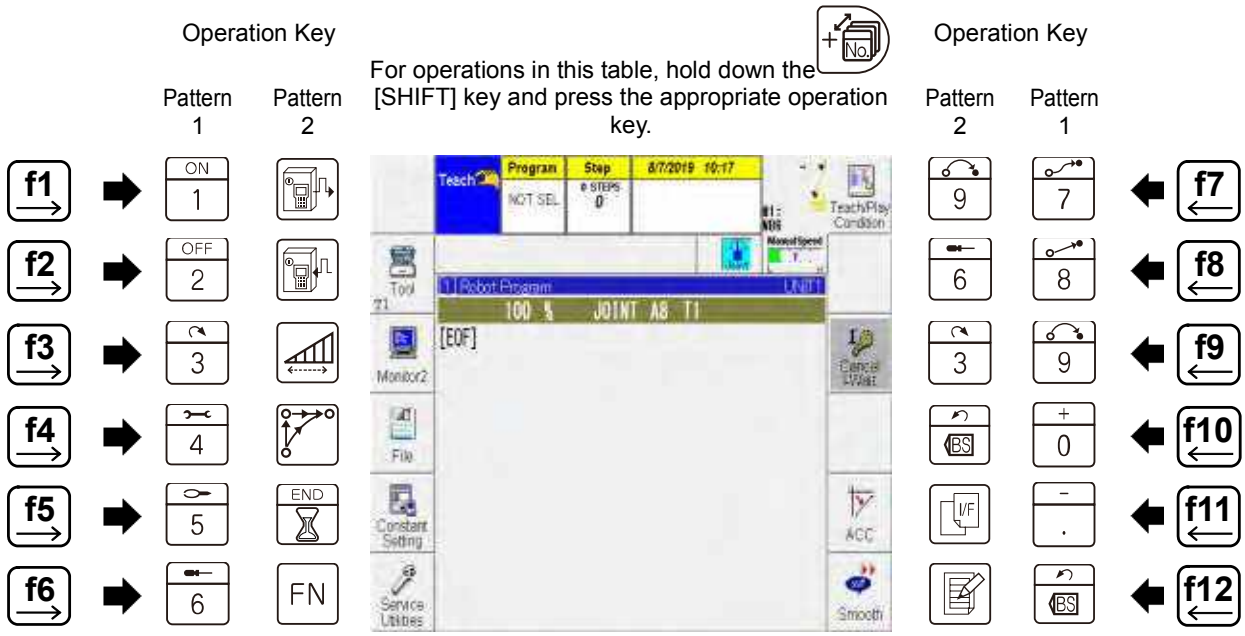
← An icon displayed with the mesh display can be selected by pressing [ENABLE].

← Some icons are only displayed when [ENABLE] is pressed.

Enter the f key from the operation key

Inputting using only the f keys, without using the touch panel (this is known as “f key substitute operation”). There are 2 types of operating method. See Table 2.3.8. In the default settings, “f Key substitute operation“ is disabled (no key input method).

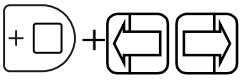
Table 2.3.8 Key allocation in f key substitute operation



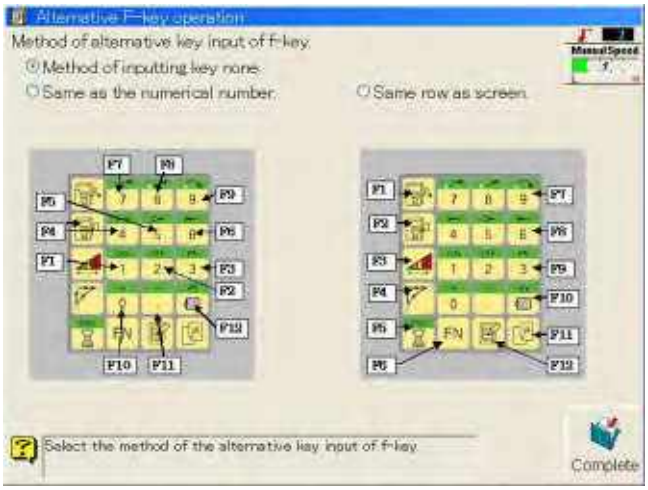
The description below shows how to enable “f key substitute operation.”

1 **Change the operator qualification to *EXPERT* or higher.**

2 **Select <Constant Setting> - [7 f-Keys] – [9 Alternative F-key operation].**



3 **Hold down [ENABLE] and press [Left/Right] to select the item.**
>> Correspondences between the f keys and operation keys for each setting are shown in Table 2.3.8.



4 **After selecting the item, press f12 <Complete>.**
>>This completes the settings.

POINT

Settings can also be changed from the shortcut R971.
For details on shortcut operations, see “Chapter 7 Useful Functions”.
Correspondence between shortcuts and constant settings when constant settings are configured are shown in Table 2.3.9.

Table 2.3.9 Correspondence with Constant Settings

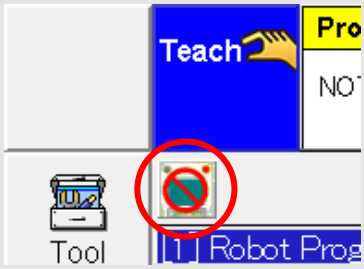
Shortcut	Constant settings
0 (None)	No key input method
1 (Pattern 1)	Same as the numerical figure
2 (Pattern 2)	Same as the screen arrangement

2.3.7 Touch Panel

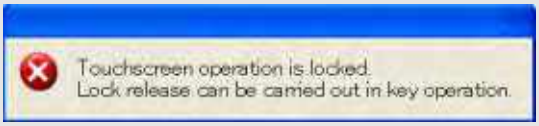
The touch panel is equipped as standard to the teach pendant, and operations such as selecting items on the screen via touch and swiping to scroll are enabled.
Touch panel operations are enabled in the factory default settings. Operations using the touch panel can be enabled or disabled by changing the setting.
The touch panel can be set to temporarily lock (be inoperable) even when enabled if the teach pendant is not operated for a set period of time. This is called the “touch panel lock” function, and prevents unwanted entries being caused by unintentional touching of the touch panel. The touch panel lock function is enabled by default.

POINT

The icon shown below is displayed in the status icon display if the touch panel is locked by the touch panel lock function.



The following message is displayed if the touch panel is touched in this case.



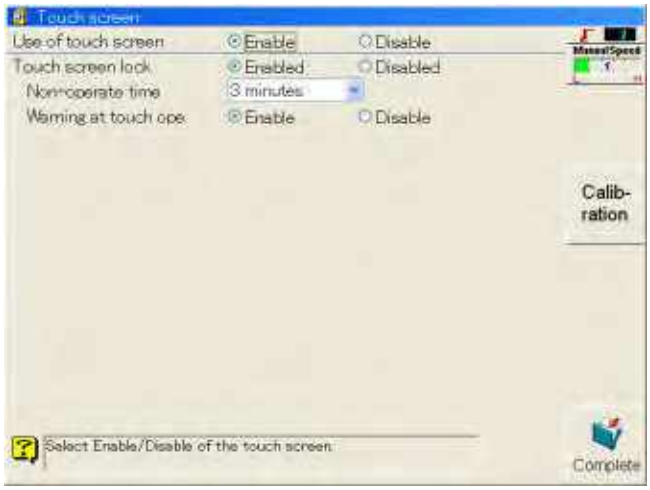
The touch panel is automatically unlocked if the operation keys or jog dial are used.

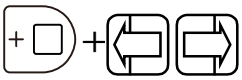
This section explains how to change the touch panel settings.

Changing the Touch Panel Settings

1 **Change the operator qualification to *EXPERT* or higher.**

2 **Select <Constant Setting> - [7 f-Keys] - [10 Touch screen].**
>>The following setting screen is displayed.





3 **Select the item using [ENABLE] + [Left/Right] to enable or disable touch panel operation.**
>> To change other settings items, use [Up/Down] to move the cursor to the item you want to change. Settings are as follows.

Item	Details
Use of touch screen	Select “Enable” to enable use of the touch panel or “Disable” to disable use.
Touch screen lock	Select “Enabled” to use the touch panel lock function or “Disabled” not to use it.
Non-operate time	Set the period of non-use after which the touch panel is locked.
Warning at touch ope.	Select “Enable” to display a message if the touch panel is touched while locked. Select “Disabled” not to display this message.

IMPORTANT

Touch panel operation cannot be disabled if the “Method of alternative key input of F-key.” in <Constant Setting> - [7 f-keys] – [9 Alternative F-key operation] is set to “Method of inputting key none.”

4 **After selecting the item, press f12 <Complete>.**
>>This completes the settings.

POINT

The touch panel can also be enabled/disabled from the shortcut R970.
For details on shortcut operations, see “Chapter 7 Useful Functions.”

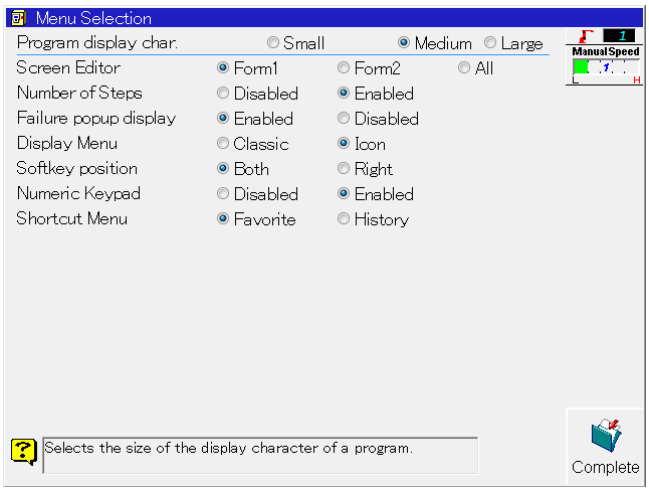
Changing the touch panel menu display

You can choose between a menu display with icons that is geared toward touch panel operations, or one with text that enables more items to be displayed on the screen.

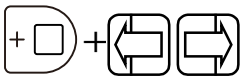
1 Change the operator qualification to ***EXPERT*** or higher.

2 Select <Constant setting> - [2 Display environment] - [4 Menu display select].

≫The following setting screen is displayed.



2 Select [Display menu] by moving the cursor up and down.



3 Select the item using [ENABLE] + [Left/Right].

Item	Details
Icon	Menu items are displayed as button icons and text.
Classic	Menu items are displayed as text only.

4 After selecting the item, press f12 <Complete>.

≫This completes the settings.

For example, the constant setting menu display screen appears as follows.

<Icon>

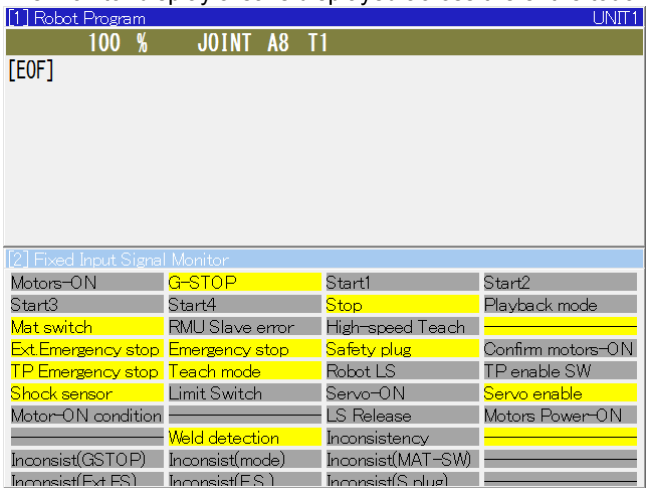
<Classic>

Displaying the monitor display area in full screen

When performing tasks such as editing programs or checking input/output status on the monitor display area, you can enter full screen display to show more items and facilitate operations.

1 Touch the monitor display area while holding [SHIFT].

≫The monitor display area is displayed across the entire touch panel.



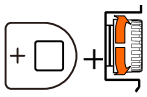
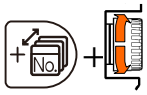
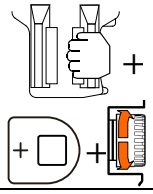
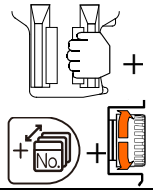
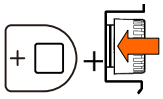
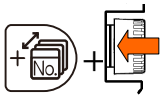
To return to the original screen display, once again touch the monitor display area while holding [SHIFT].

JOG DIAL

Jog dials, equipped as standard to teach pendants, can be rotated and pressed, and have a variety of functions.

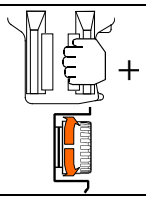
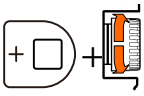
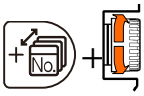
The main operations are explained in Table 2.3.10 and table Table 2.3.11.

Table 2.3.10 [JOG DIAL] Functions

Operation	When to use	Details
	When the cursor can be moved using the [Up, Down, Left, Right] keys	Moves the cursor up and down.
	When selecting the robot program monitor	Moves the current step. 1)
	When the page can be turned using f key	Turns the page.
	In arc monitor editing mode during arc welding (when changing online)	Slowly increases and decreases each weld condition value.
	When the cursor can be moved using the [Up, Down, Left, Right] keys	Moves the cursor left and right.
	When selecting the robot program monitor in teach mode	Increases or decreases the check speed.
		Increases or decreases the manual speed.
	When selecting the robot program monitor	Mechanism can be switched.
	When the [Enter] key can be used to select items.	Selects items.
	When selecting the robot program monitor	Unit can be switched.
	When f12 key can be used to enter, execute and write values	Enters, executes, and writes values.
	When the cursor can be moved using the [Up, Down, Left, Right] keys while the robot program monitor is being selected	The jog dial function allocation dialog is displayed, and the functions shown in Table 2.3.11 can be allocated to the [JOG DIAL]. (Functions that can be allocated differ for teach mode and playback mode.))

1) In order to perform this operation, [Constant Setting] - [5 Operation/Teaching Conditions] – [1 Operating conditions] – [8 Step selection with E+up/down keys] needs to be set to [ENABLE].

Table 2.3.11 Jog Dial Functions when Allocating Functions

Function Allocation Status	Operation	When to use	Details
		When selecting the robot program monitor in teach mode	Executes the record.
			Overwrites.
			Adjusts the position.
			Interpolation can be switched.
			Coordinates can be switched.
			Inserts the record.
		When selecting the robot program monitor in teach mode	Robot can be moved. 1)
		When selecting the robot program monitor	Check the operating direction of inching/retracting. 2)
			Performs inching/retracting of the arc weld wire. 2)
			Performs inching/retract of the arc weld wire. 2)

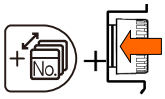
1) For details, see “3.4.3 Moving the robot with the [JOG DIAL].”

2) For details, see “Chapter 8 Basic Operations for Arc Welding.”

The only function that can be allocated in playback mode is wire inching/retracting.

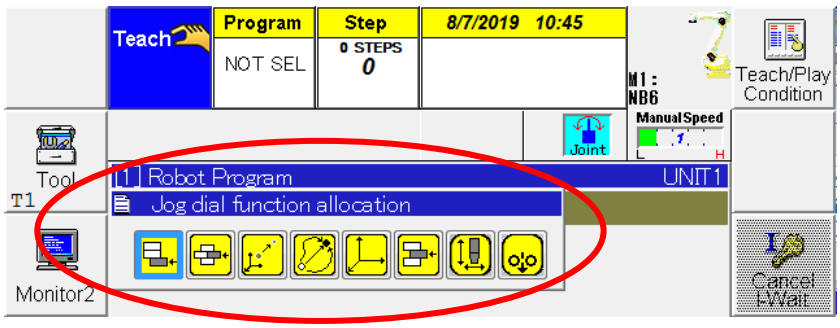
Allocating functions to [JOG DIAL] operations

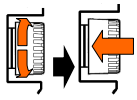
Frequently used operations such as recording or overwriting can be allocated to the [JOG DIAL] push button operation, and functions such as manual operation can be allocated to the [JOG DIAL] rotation operation.
This section explains how to allocate operations. Operations are allocated when the robot program monitor is in the selected state.



1 **When robot program monitor is selected in teach mode, hold down [Shift] and press the [JOG DIAL].**

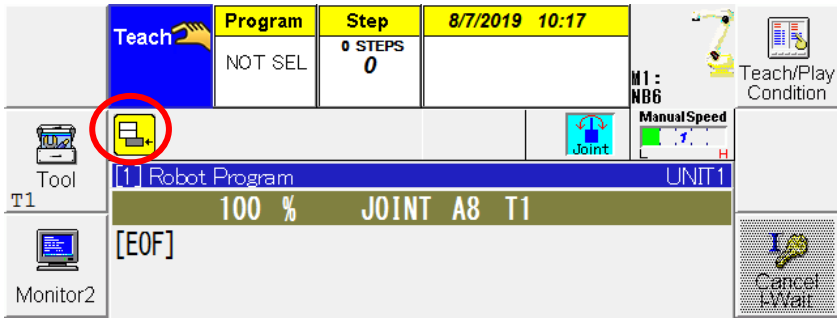
>> A [JOG DIAL] function allocation dialog such as the one shown below is displayed.





2 **Rotate the [JOG DIAL] to select the desired icon (from record/overwrite/position correction/interpolation/coordinates/insert/manual operation), and either press the push button, or touch the icon.**

>> The selected function is allocated, and the icon is displayed in the “Variable status display area.”

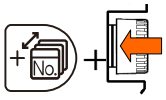


To execute allocated functions

Press the [JOG DIAL] while the robot program monitor is selected.
The same function as when the edit key is pressed during allocation is executed.

- To change the allocated function, perform the same operation.
- The allocated function can also be changed by pressing the displayed icon.
- For details on the "tool fine adjustments,” see “3.4.3 Moving the robot with the [JOG DIAL]”

Clearing the allocated function from the [JOG DIAL]



1 **With the icon of the function allocated to the [JOG DIAL] displayed in the “Variable status display area,” select the robot program monitor, and hold down [Shift] and press the [JOG DIAL].**

>> The allocated function is cleared, and the icon display disappears.

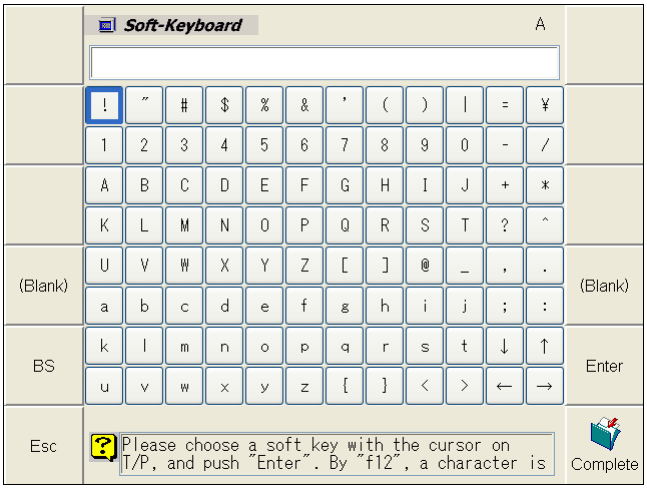
When switching modes, such as from the teach mode to playback mode, the function allocated to the [JOG DIAL] is automatically disenabled.

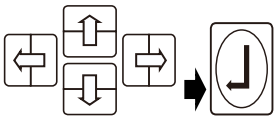
To input characters

The method used to input characters is described here.

Functions of soft keyboard

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

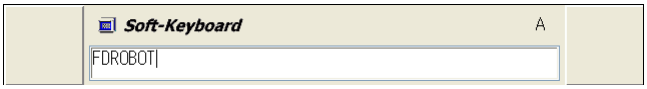


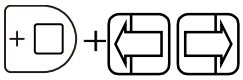


To select characters

Select characters using one of the following methods.

- Select the characters using the up, down, left and right keys, and press [Enter] or f11 <Enter>.
- Touch the characters that you want to enter on the screen.



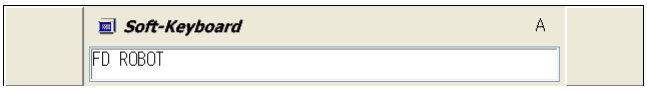


To move the cursor in the character input field

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

To input a space

Press f4 or f10 <Blank>.



To delete a character

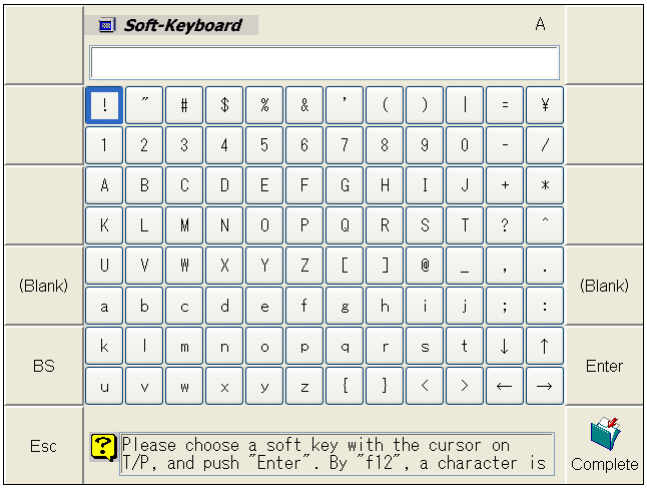
Move the cursor to the right of the character to be deleted, and press f5 <BS>.
The character to the left of the cursor is now deleted.

2 **To record the characters which have been input, press f12 <Complete>.**

>> The characters are recorded, and operation returns to the original screen.

To input letters of the alphabet or symbols

1 **Alphanumerics and half-size symbols can be input in the initial start status of the soft keyboard.**

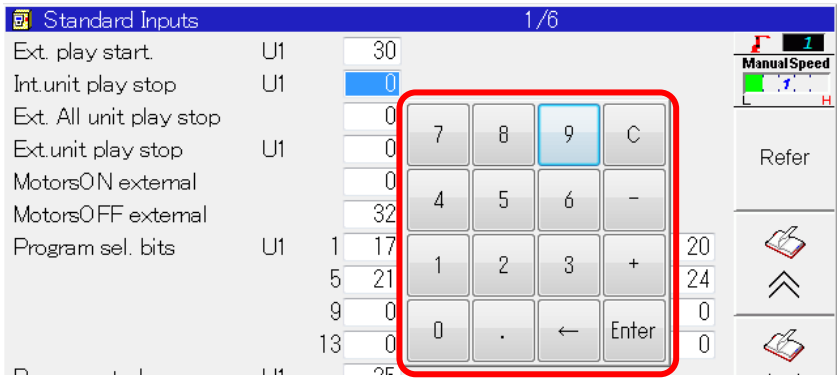


2 **Input the characters by following the steps on the previous page.**

Keypad input

In addition to the teach pendent keypad, the software keypad can also be used for numerical input.

1 **The keypad turns on when numerical input is enabled.**



<u>To select characters,</u>
Touch the screen to enter characters.

<u>To delete the last character you entered,</u>
Touch [←].

<u>To delete all characters,</u>
Touch [C].

2 **Touch [Enter] to save the characters you entered.**

≫ The characters are recorded, and operation returns to the original screen.

POINT

[Keypad display] in <Constant setting> - [2 Display setting] - [4 Menu display select] must be set to “enable” to use the keypad.

Turning the control power to ON

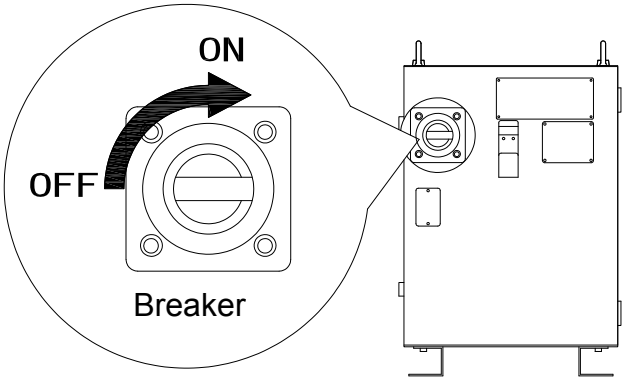
In order to use robot, first turn the controller's power (control power) to ON.

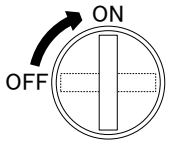
DANGER

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

Turning the control power to ON

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





2 **Turn the circuit breaker to the ON position.**

>> The system starts up automatically and the self-diagnostic starts.

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

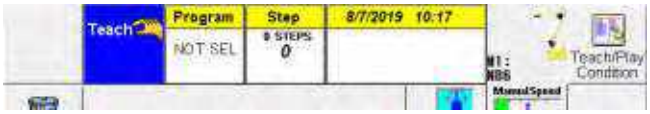
The robot is now ready to operate.

Mode selection

The controller features a teach mode that is mainly used for creating programs, and a playback mode that is for automatically running programs.
The mode is selected using the [MODE SELECT SWITCH] on the operation box.

Mode selection

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



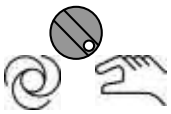
2 **Rotate the [MODE SELECT SWITCH] on the operation box to either the teach side or playback side.**

>> The mode switches to the selected mode.

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

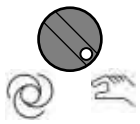
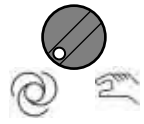
Mode	Switch position	Teach pendant display
Teach mode		
Playback mode		

In this state, the robot cannot be operated manually or automatically.
Continue with the following operations.



3 **Turn the [TP SELECTOR SWITCH] on the teach pendant to the teach or playback position (so that the operation panel and teach pendant are both set to the same mode).**

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

Mode	Operation box	[TP SELECTOR SWITCH]	Teach Pendant Display
Teach Mode			
Playback Mode			

If the operation box and [TP SELECTOR SWITCH] do not match, one of the following messages is displayed.

- "E0967 Teach pendant selector switch is set to manual."
- "A2006 Teach pendant selector switch is set to automatic."

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

Turning the motor power to ON

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

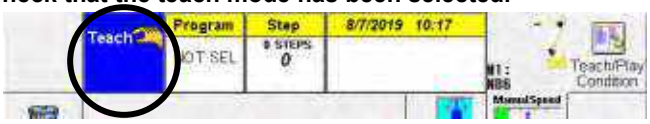
DANGER

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

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

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

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



If the teach mode has not been selected, turn the [MODE SELECT SWITCH] and set it to the teach mode.

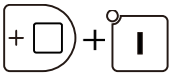
(Operation Box)

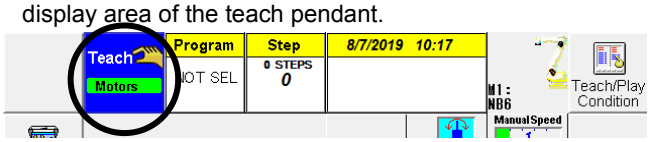
2 **Press the [MOTOR ON BUTTON] or hold down the [ENABLE] key and press the [MOTOR ON] KEY.**
The [MOTOR ON BUTTON] is provided on the operation box.
The [ENABLE] and [MOTOR ON] keys are provided on the teach pendant.

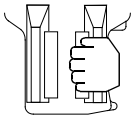
>> The green [MOTOR ON BUTTON] lamp flashes.
In this state, power is not supplied to the motor, and the robot cannot be controlled.

>> The indicator which indicates motor power ON (servo OFF) appears in the mode display area of the teach pendant.

(Teach Pendant)



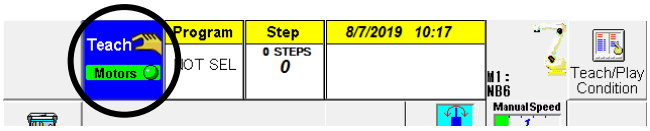




3 **Grasp the [ENABLE SWITCH].**

>> The green lamp of the [MOTOR ON BUTTON] remains lit.

>> The indicator which indicates motor power ON (servo ON) appears in the mode display area of the teach pendant.
While the [ENABLE SWITCH] is grasped, power is supplied to the motor, and the robot can be moved by pressing the [Axis operating keys].



This completes the preparations for operating the robot.

Concerning the operation of the [ENABLE SWITCH]

- To operate the robot in the teach mode, the robot must be operated while the [ENABLE SWITCH] is grasped. (This switch is not used in the playback mode.)
- If the [ENABLE SWITCH] is released, the servo is turned off, and the robot stops immediately. When the [ENABLE SWITCH] is grasped again, the servo comes back ON.
- Grasping the [ENABLE SWITCH] tightly until a clicking sound is heard also causes the servo power to be turned off and the robot to stop immediately.
- Double type [ENABLE SWITCH] may be provided on the rear panel of the teach pendant as an option. In this case, the servo power goes off when both are grasped at the same time.
- When the [EMERGENCY STOP BUTTON] has been pressed or the emergency stop command has been input from an external source during operation, the servo power can no longer be turned on or off by operating the [ENABLE SWITCH]. In cases like this, perform steps 2 to 3 above.

When the [ENABLE SWITCH] cannot be operated

- Has the [EMERGENCY STOP BUTTON] on the teach pendant been pressed?
  → Turn the [EMERGENCY STOP BUTTON] clockwise to release it.
- Has the emergency stop command been input from an external source?
  → The preparations for the peripheral devices (on the system side) have not been completed. First complete the preparations on the system side, and then release the emergency stop command.
- Are the [TP SELECTOR SWITCH] on the teach pendant and [MODE SELECT SWITCH] on the operation box both set to teach?
  → Set both switches to the “teach” position.

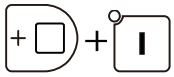
Turning on the motor power (in the playback mode)

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

1 Check that the playback mode has been selected.

(Operation Box)

(Teach Pendant)



2 Press the [MOTOR ON BUTTON] or hold down the [ENABLE] key and press the [MOTOR ON] KEY.

>> The motor power is turned on, and the specified program can be played back at any time.

>> The indicator which indicates motor power ON (servo ON) appears in the mode display area of the teach pendant.

[ENABLE SWITCH] need not be operated

In playback mode, pressing the [MOTOR ON BUTTON] turns on the motor (servo on). The [ENABLE SWITCH] is not used.

Moving the robot manually

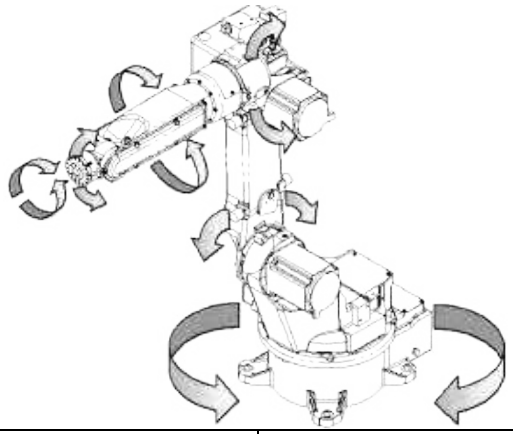
In this section, the robot will actually be moved. Before proceeding, memorize to some extent how the robot moves.

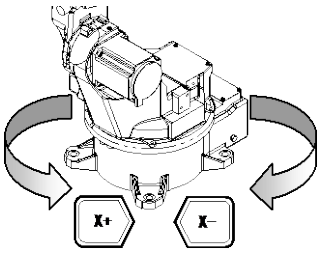
Movement Direction

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

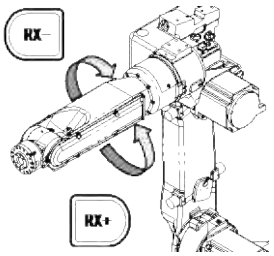
- Axis coordinate system … Each of the robot's axes moves independently.
- Robot coordinate system … The robot tip moves in a straight line. (The tip moves along the coordinates referenced to the robot.)
  The direction of the axis along which the wrist moves differs depending on the type of application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

Movements of the robot using the axis coordinate system

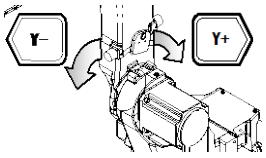




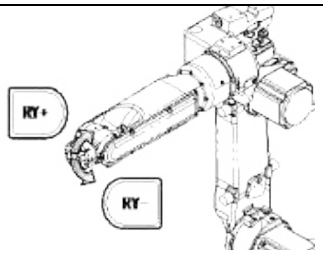
The robot body rotates.



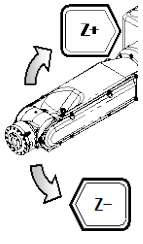
The upper arm rotates.



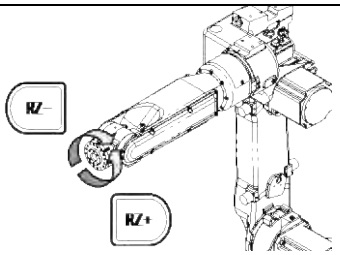
The lower arm moves back and forth.



The wrist moves up and down.



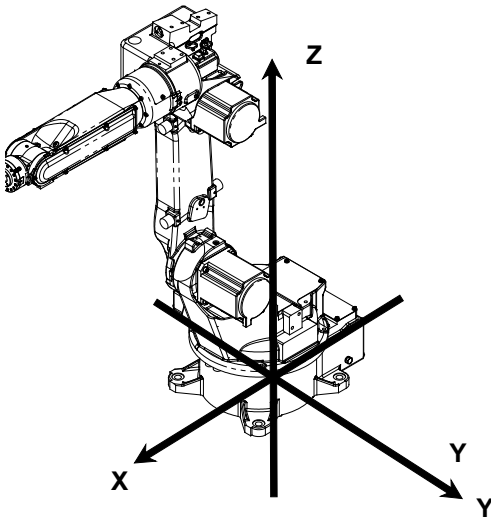
The upper arm moves up and down.

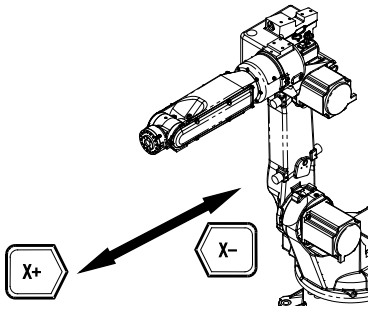


The wrist rotates.

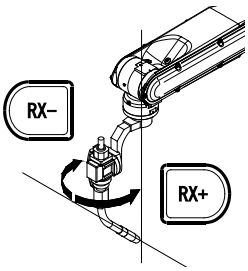
Fig. 3.4.1 Movement directions in the axis coordinate system

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

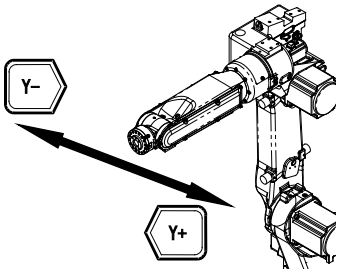




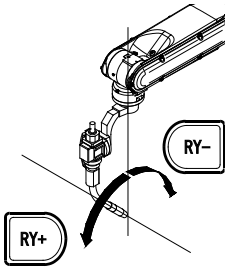
The robot moves along the X axis.



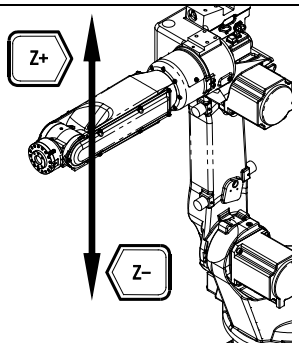
The rotation of the sixth axis rotation center line centers on the Z axis while the tool tip is fixed.



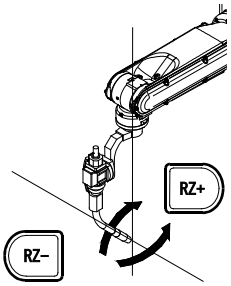
The robot moves along the Y axis.



The rotation of the torch centers on the torch tip on the plane formed by the torch line and Z axis while the tool tip is fixed.



The robot moves along the Z axis.

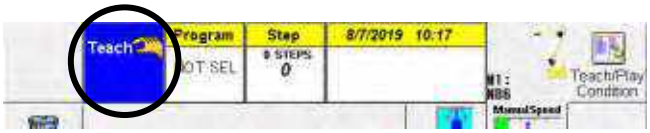


The rotation of the torch centers on the torch line while the torch posture remains fixed and the tool tip is fixed.

Fig. 3.4.2 Movement directions in the robot coordinate system (for the arc welding application)

Moving the robot manually

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

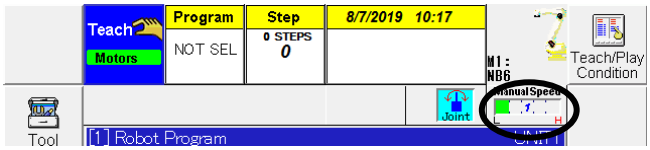


2 **Press the [MOTOR ON BUTTON] or hold down the [ENABLE] key and press the [MOTOR ON] KEY.**

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

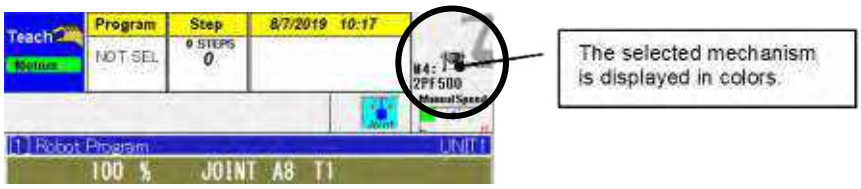
3 **To change the speed, press [CHECK SPD/TEACH SPEED].**

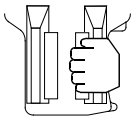
>> Any speed from 1 to 5 can be selected. Each time this key is pressed, the speed is changed by one setting in the following sequence: 1 → 2 ... → 5 → 1, and so on.



The manual speed can be changed by grasping the [ENABLE SWITCH], and rotating the [JOG DIAL] while holding down [Shift].

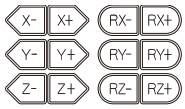
4 **The target mechanism for manual operation appears on the teach pendant.**





5 **Grasp the [ENABLE SWITCH].**

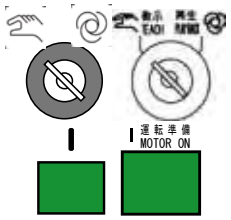
>> While this switch is grasped, the motor power is turned on.



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

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

Moving to the Mechanical reference pose and selecting the menu items



1 Select the teach mode.

2 Turn on the servo power supply.

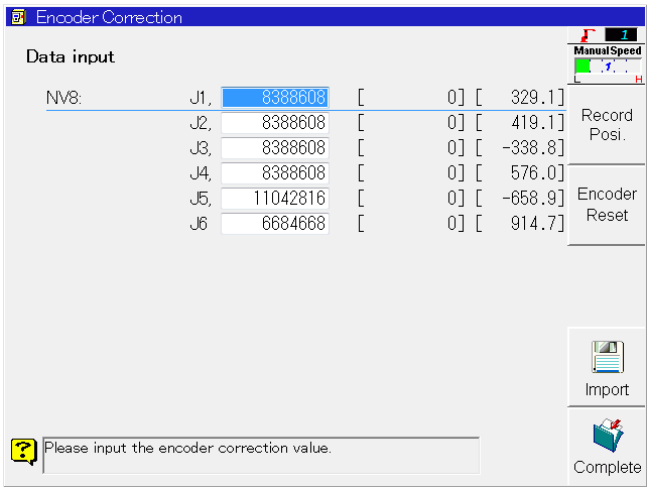
3 Perform manual operations in such a way that all the robot's axes are aligned with the reference positions.
(A robot posture in which the all axes are set to the reference positions is called "**Reference pose**")

>>For an example of a robot that uses "Origin adjusting match-mark" , refer to Fig. 4.4.3
>>For an example of a robot that uses "Zeroing pin" , refer to Fig. 4.4.5

The reference pose differs from each other. For details, refer to the instruction manual "MANIPULATOR MANUAL" of each robot.

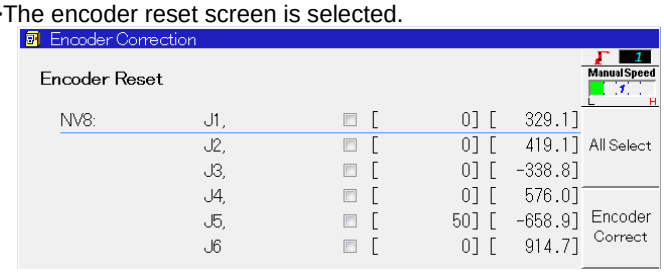
4 Open <Constant Setting> - [3 Machine Constants] - [4 Encoder Correction].

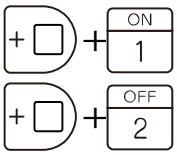
Now proceed with the encoder reset and encoder correction operations. (These are described on the next and subsequent pages.)
The screen that appears when the menu is selected is the screen on which the encoder correction is performed. The encoder correction or encoder reset operation is selected on this screen.



Encoder Reset procedure

1 To reset the encoder, press f9 <Encoder Reset>.
>>The encoder reset screen is selected.

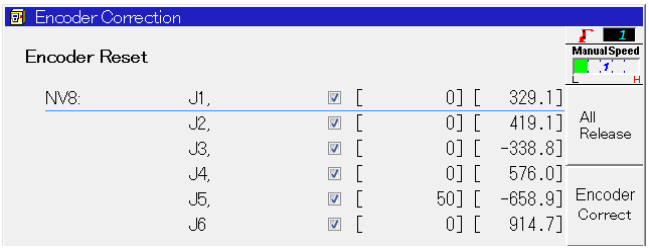




2 To reset a specific axis only for replacing a motor, for instance, select the axis, and press [ENABLE] + [1].
>>A check mark appears for the selected axis.

To release the selected axis, press [ENABLE] + [2].

3 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>.



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.)

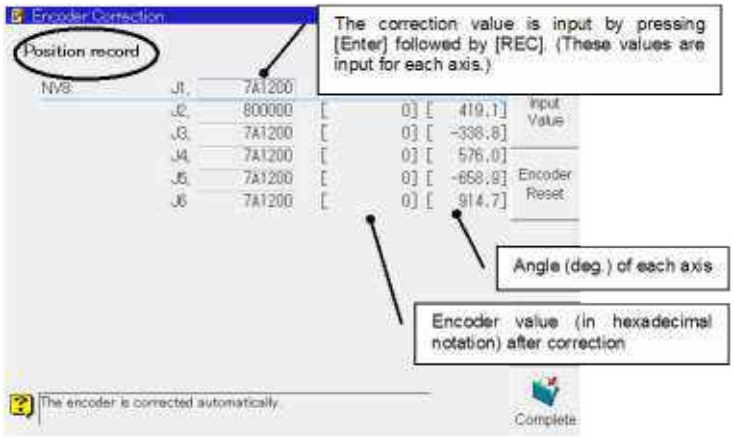
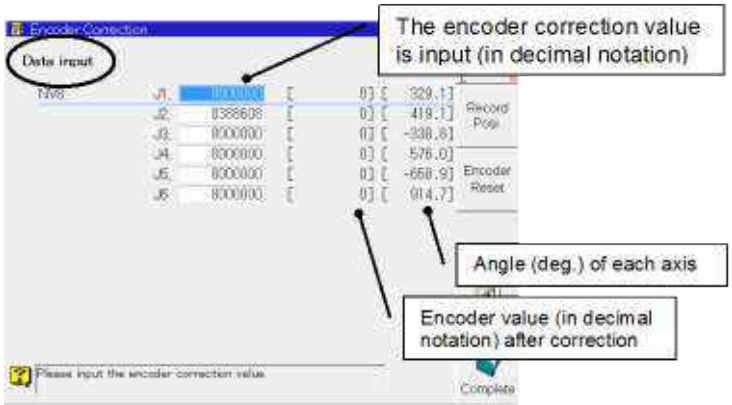
>>If the encoder reset is successfully finished, a message to show the result will appear.

Encoder Correction procedure

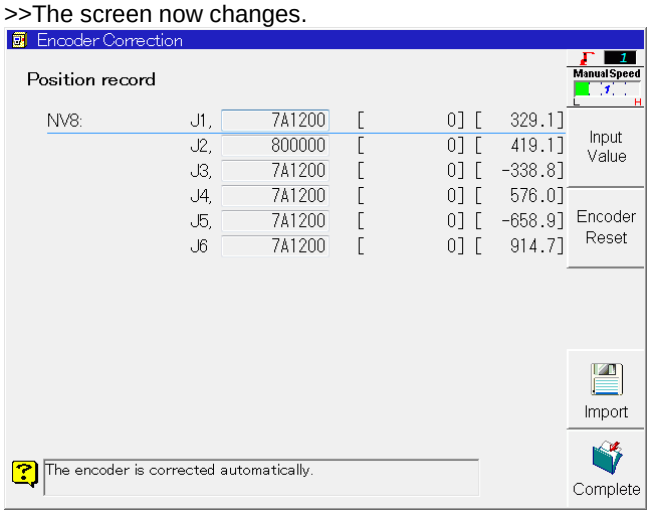
Encoder Correct

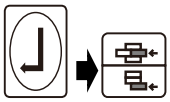
1 Upon completion of the encoder resetting, proceed with the encoder correction.
Press f9 <Encoder Correct>.
>> The screen which appeared immediately after [3 Machine Constants] [4 Encoder Correction] were selected is restored.

2 Either "Data Input" or "Position Record" can be used as the method for encoder correction.

Correction method	Details
Position Record	In this screen, the mechanical position is regarded as a reference position for the axis when [Enter] and [REC] keys are pressed and then the encoder correction value is calculated and set. 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 all axes are aligned to the "reference position". 
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 controller when the robot is shipped from the factory. Therefore, cases where this screen is used to set the values after shipment are as follows; • When the encoder battery has been replaced • After the controller's 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 After confirming that the axis is mechanically aligned to the reference position, 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 [Enter] and [REC] while keeping the servo power ON ([ENABLE SWITCH]). (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 BUTTON]).
Then press f12 <Complete>.

If "Reference position check program". is not recorded in memory, it is recommended to record this "Reference pose" (a pose in which the all axes are aligned to the reference positions) to program 9999 as a "Reference position check program". This program is convenient to check if the all axes of the robot are correctly set to the reference position respectively.

WARNING

This work includes some jobs that should be conducted with the motors ON. Consequently, be sure to conduct the work at least by a pair of two persons. One person must stay on guard to press an Emergency Stop button at any time, while the other person must promptly finish the work with thorough attention paid to the robot operating area. Furthermore, prior to starting the work, check for safe corridors. If this procedure is omitted, operator may be caught or sandwiched by the robot parts, possibly resulting in death or serious injury.

CAUTION

As for the robot using “Zeroing pin and block”, check to be sure that the zeroing pin has been removed and then operate the robot. Note that operating the robot with the zeroing pin inserted may bend the pin or deform the hole for this pin, thus disabling proper positioning of the zeroing pin.

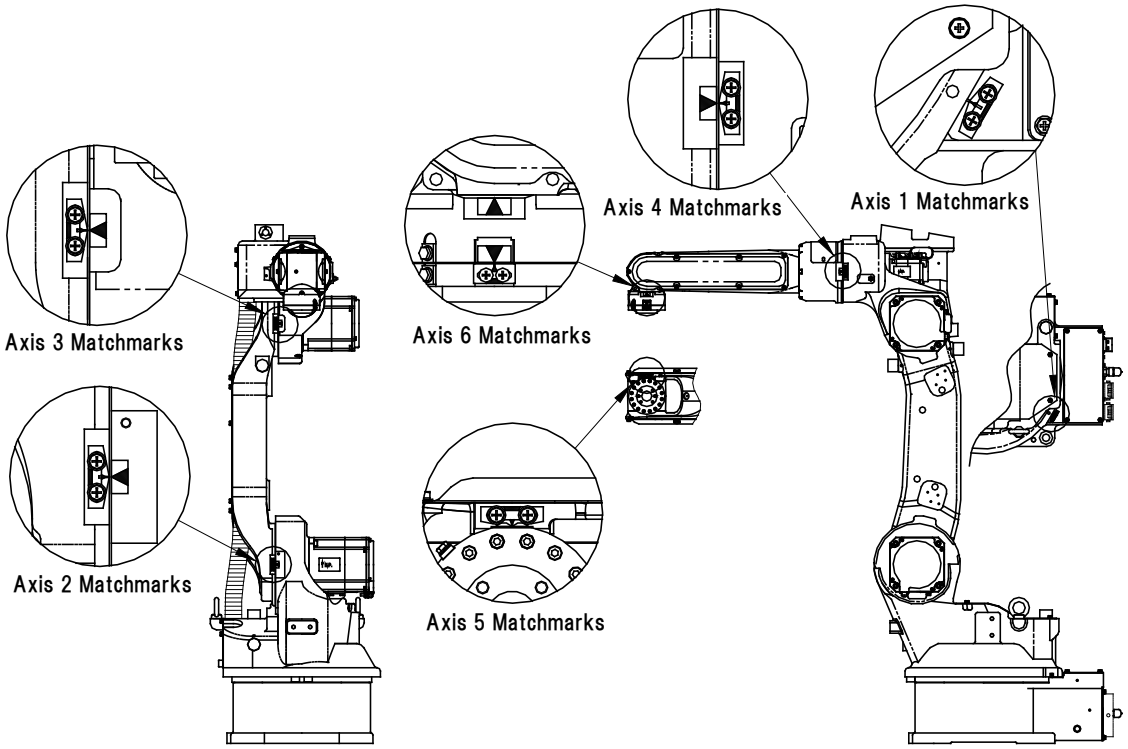


Fig. 4.4.3 Origin Adjustment Match-mark Positions (NV8/ NV8L/ NV25/ NA20)

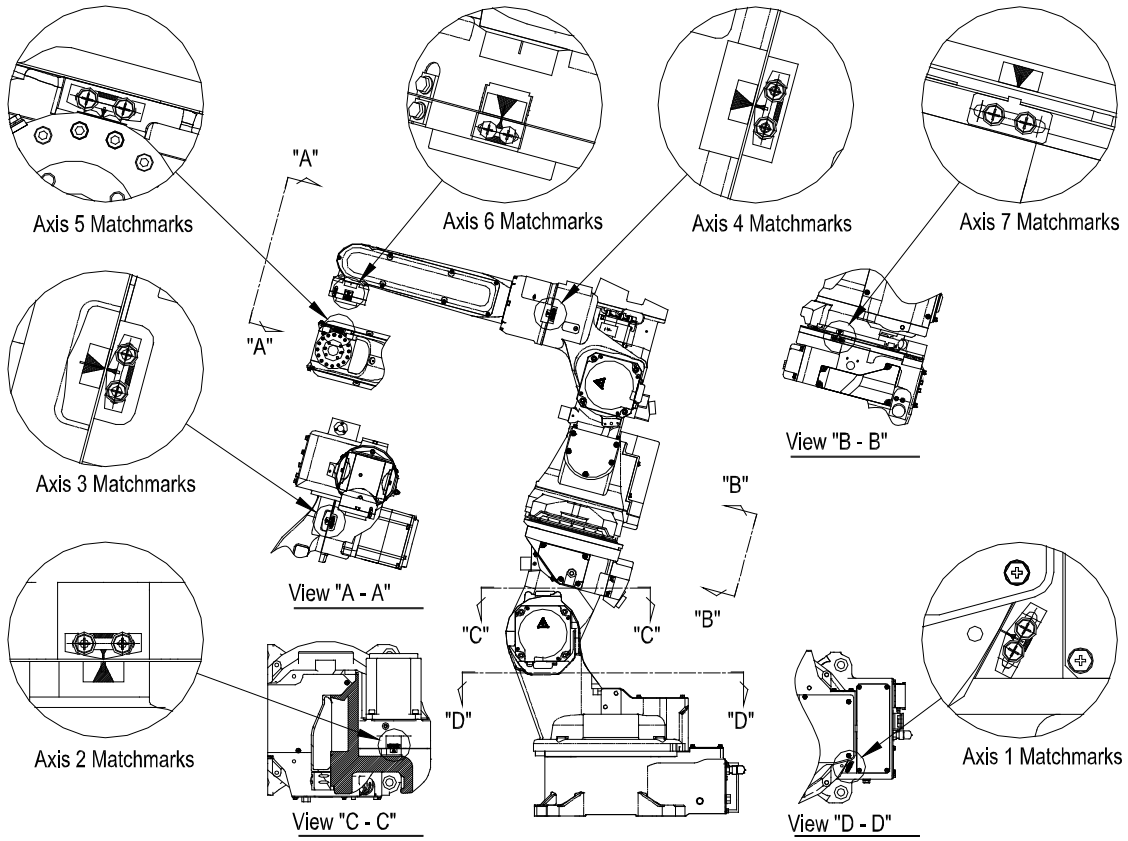


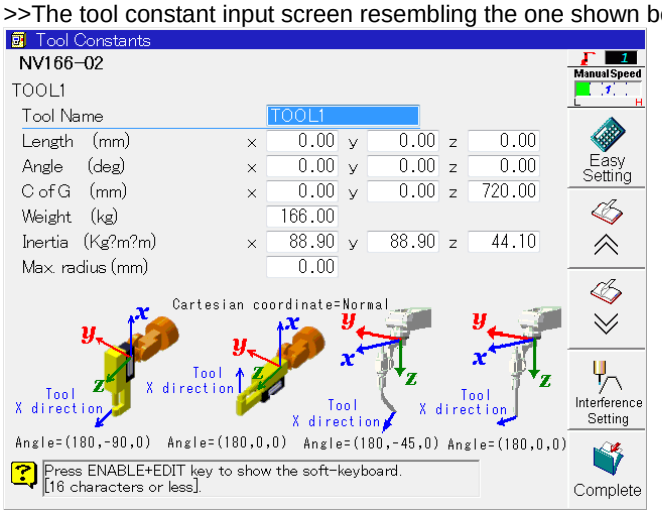
Fig. 4.4.4 Origin Adjusting Match-mark Positions (NV6S/NB4S)

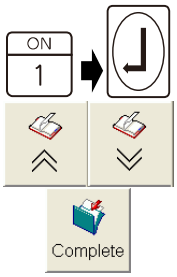
Common operating procedure for setting tool constants

(With the exception of the tool weight, all of the tool constants are set on the same screen shown below.)

1 **Select the teach mode.**

2 **Select <Constant Setting>- [3 Machine constants] - [1 Tool constants].**
>>The tool constant input screen resembling the one shown below now appears.





3 **Align the cursor with the desired position, input a number (such as 1), and then press the [Enter] key.**

4 **To change the tool number, press the page up or down key.**

5 **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.

4.6.1 Tool name

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.

A tool name may consist of not more than 16 alphanumerics and symbols.
Refer to the instruction manual "BASIC OPERATIONS MANUAL"

Tool length

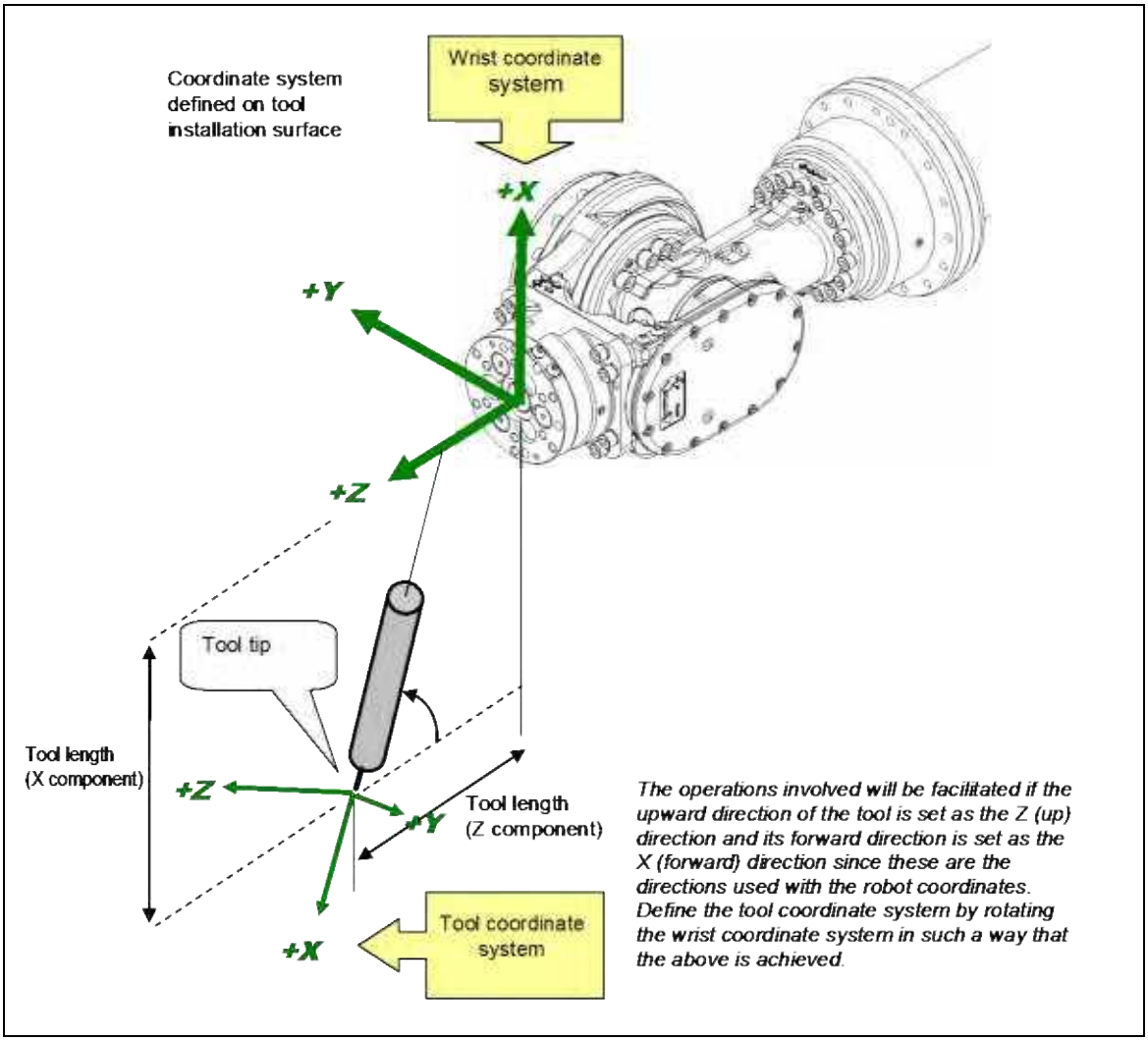


Fig. 4.6.1 Illustration of tool length and angle

The tool length is the coordinates of the X, Y and Z component of the tool tip in the wrist coordinate system. Similarly, the tool angle expresses the inclination of the tool tip in the wrist coordinate system as the angle of rotation around the X, Y and Z axes. The coordinate system defined by these parameters is called the tool coordinate.

In the wrist coordinate system, the center of the tool installation surface serves as the zero point, and the direction in which this surface is pointing serves as the Z direction as is shown above.

Measure the tool length which was measured in accordance with the definition given above, and input it.

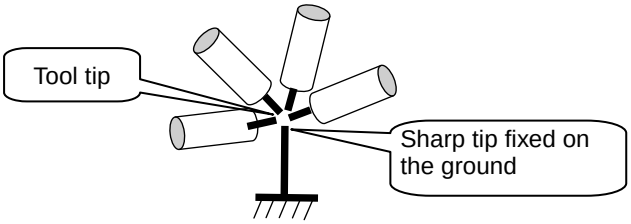
However, if the tool dimensions are not known or high-accuracy interpolation operations are required by a material handling application, use the method that automatically measures the tool length.

For the **tool length automatic setting function** described next to be used, the basic teaching and playback check jobs must be performed. Since these jobs cannot be done if the "BASIC OPERATIONS MANUAL" has not yet been read, do not set the tool length but use the initial setting as is and continue until the end of the setup is reached.
After reading the Basic Operations Manual, proceed with this setting again.

Setting the toll length automatically

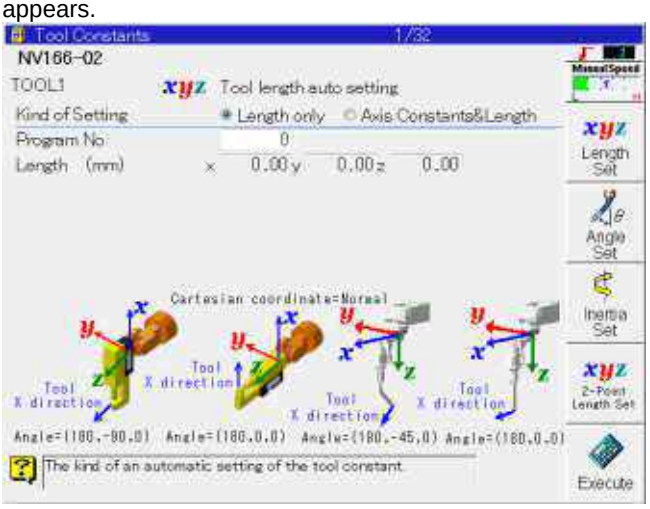
Although one program for calculating the tool length must be taught, the tool length can then be set automatically simply by taking this preparatory step.
It does not matter whether the tool angle has already been set or not.

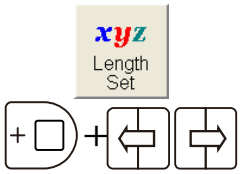
1 **First, the programs for setting the tool length automatically must be taught. Teach the kind of programs where the tip of the installed tool (install a tool with a sharp tip here as well) is aimed in a number of different postures at a sharp tip which has been secured to the ground. The required 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. (This is unrelated to tool length calculations, but is useful when checking the results in 7.)

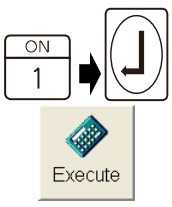
2 **On the tool constant setting screen for the desired tool number, press the <Easy Setting> key.**
>>The tool length automatic setting screen such as the one shown below now appears.





3 **If any other screen has appeared, press the <Length Set> key.**

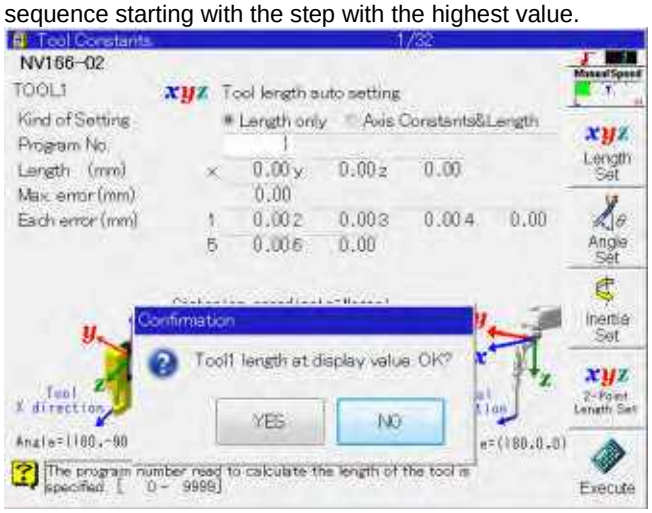
4 **Select the setting type. Select "Axis Constants & Length" or "Length only" using the [ENABLE] and [Left/right cursor] keys.**
Normally, "Length only" is selected.
Select "Axis Constants & Length" only when more accurate length setting is required.
In this case, the axis constants of J2, J3, J4 and 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.**

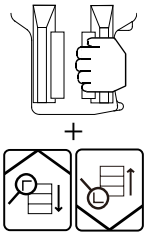
6 **Press the <Execute> key.**

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.

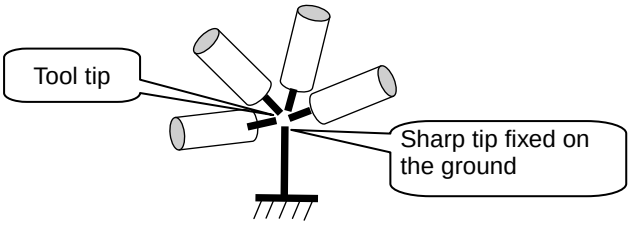


If satisfactory results have been obtained, select [Yes] on the pop-up window, and press [Enter] key.
>>At this stage, only the display is updated, and the data is not yet stored in the constant file.

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].

Tool length and angles of Daihen's arc welding torch

Tool constant of an arc welding torch differs according to a torch type or a robot type which is installed. When a representative arc welding torch made by Daihen is used, the tool constant values are shown as following.

Tool constant of an arc welding torch which is not mentioned in this instruction manual is described in the instruction manual for each arc welding torch. For further details, refer to the instruction manual for that.

CO_2/MAG Torch

Table 4.6.2 Tool constants for Daihen arc welding torch tools (RT/RZ Series)

For N series V type and A 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. 4.6.3
RT5000S									128.0	2.2			0.040		
RTW5000S							119.0		129.0	2.3	0.060				
RZ3500S							118.0		126.0	2.2					
RZ3510S									128.0	2.1	0.050		0.030		
RZW5000S							119.0		129.0	2.3	0.060		0.040		
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	0.0	Fig. 4.6.4
RT5000H									142.0						
RTW5000H										2.4	0.080	0.110			
RZ3500H							111.0		141.0	2.3	0.070				
RZ3510H							107.0		140.0			0.100			
RZW5000H							111.0		142.0	2.4	0.080	0.110			
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	0.0	Fig. 4.6.5
RT5000L									149.0						
RTW5000L							121.0		146.0	2.6		0.130	0.050		
RZ3500L							126.0		142.0	2.5					
RZ3510L							119.0		148.0	2.4		0.120	0.040		
RZW5000L							121.0		146.0	2.6		0.130	0.050		

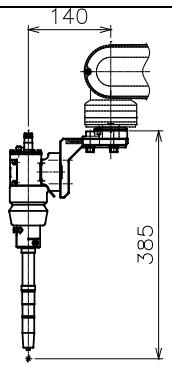


Fig. 4.6.6

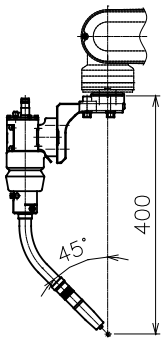


Fig. 4.6.7

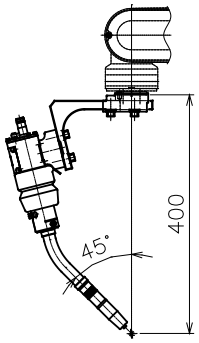


Fig. 4.6.8

Table 4.6.3 Tool constants for Daihen arc welding torch tools (RT/RZ Series)

For N series B type manipulater except NB6.	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	0.000	0.0	Fig. 4.6.9
RT5000H							-11.0		76.0	2.0					
RTW5000H			320.0				-12.0		85.0	2.1	0.040	0.040			Fig. 4.6.10
RZ3500H	-140.5		315.0						79.0	2.0	0.030				Fig. 4.6.11
RZ3510H	-135.5		310.0				-10.0		74.0	1.9		0.030			Fig. 4.6.12
RZW5000H			320.0				-12.0		85.0	2.1	0.040	0.040			Fig. 4.6.13
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	0.000	0.0	Fig. 4.6.14
RT5000L							-6.0		70.0						
RTW5000L			330.0						82.0	2.0	0.040	0.040			Fig. 4.6.15
RZ3500L	-95.5						-7.0		78.0		0.030	0.030			Fig. 4.6.16
RZ3510L	-90.5		310.0				-5.0		69.0	1.9					Fig. 4.6.17
RZW5000L			330.0				-6.0		82.0	2.0	0.040	0.040			Fig. 4.6.18

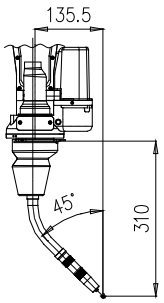


Fig. 4.6.19

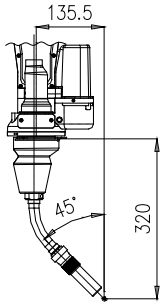


Fig. 4.6.20

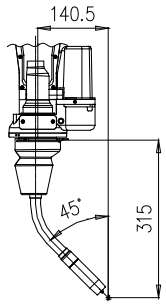


Fig. 4.6.21

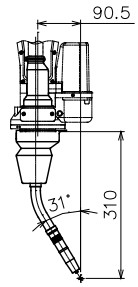


Fig. 4.6.22

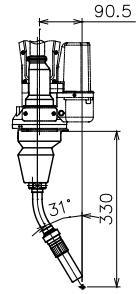


Fig. 4.6.23

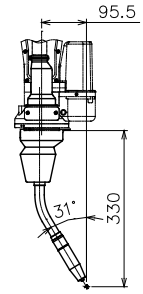


Fig. 4.6.24

Table 4.6.4 Tool constants for Daihen arc welding torch tools (RT/RZ Series)

For NB6	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	-140.0	0.0	430.0	180.0	-45.0	0.0	-15.0	0.0	176.0	2.1	0.090	0.090	0.000	0.0	Fig. 4.6.25
RT5000H							-16.0		178.0	2.2					
RTW5000H			440.0				-17.0		187.0	2.3	0.110	0.110			Fig. 4.6.26
RZ3500H	-145.0		435.0						181.0	2.2	0.090				Fig. 4.6.27
RZ3510H	-140.0		430.0				-15.0		176.0	2.1		0.090			Fig. 4.6.28
RZW5000H			440.0				-17.0		187.0	2.3	0.110	0.110			Fig. 4.6.29
RT3500L	-95.0	0.0	430.0	180.0	-31.0	0.0	-11.0	0.0	166.0	2.1	0.090	0.090	0.000	0.0	Fig. 4.6.30
RT5000L							-12.0		168.0	2.2					
RTW5000L			450.0				-13.0		177.0	2.3	0.110	0.110			Fig. 4.6.31
RZ3500L	-100.0								171.0	2.2	0.090				Fig. 4.6.32
RZ3510L	-95.0		430.0				-11.0		166.0	2.1		0.090			Fig. 4.6.33
RZW5000L			450.0				-13.0		177.0	2.3	0.110	0.110			Fig. 4.6.34

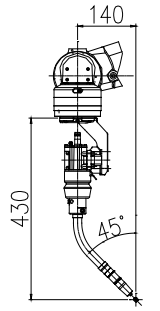


Fig. 4.6.35

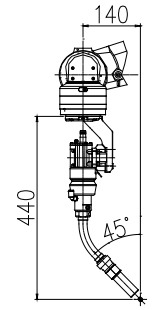


Fig. 4.6.36

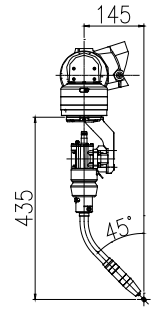


Fig. 4.6.37

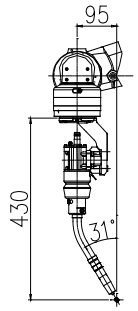


Fig. 4.6.38

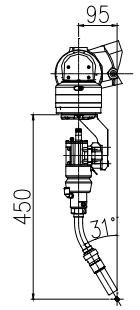


Fig. 4.6.39

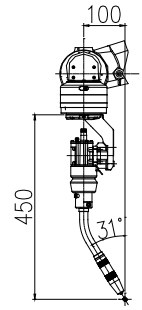


Fig. 4.6.40

CO_2/MAG/MIG torch (MTX Series)

Table 4.6.5 Tool constants for Daihen arc welding torch tools (MTX Series)

For N series V type and A 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-3531										2.0					
MTXCB-3531										2.1					
MTXCB-5031										2.3					
MTXC-5031	0.0	0.0	400.0	180.0	-45.0	0.0	109.0	0.0	123.0	2.1					Fig. 4.6.41
MTXCW-5031										2.2					
MTXCA-2531										2.1					
MTXCAW-5031										2.2					
MTX-3531										1.9					
MTXB-3531										2.0					
MTX-5031										2.0					
MTXB-5031	140.0	0.0	385.0	180.0	0.0	0.0	116.0	0.0	107.0	2.2	0.0	0.0	0.0	0.0	Fig. 4.6.42
MTXW-5031										2.1					
MTXA-2531										2.0					
MTXAW-5031										2.1					
MTX-3531										1.9					
MTXB-3531										2.0					
MTX-5031										2.0					
MTXB-5031	0.0	0.0	350.0	180.0	-45.0	0.0	143.0	0.0	195.0	2.2					Fig. 4.6.43
MTXW-5031										2.2					
MTXA-2531										1.9					
MTXAW-5031										2.2					

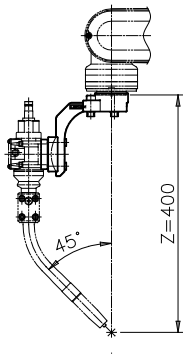


Fig. 4.6.44

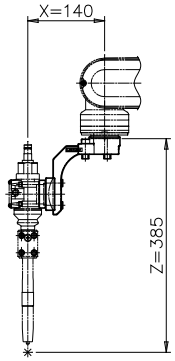


Fig. 4.6.45

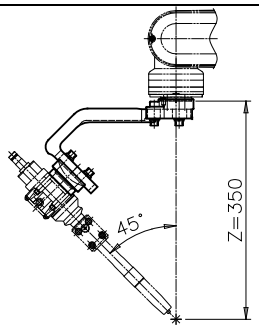


Fig. 4.6.46

TIG Torch

Table 4.6.6 Daihen arc welding torch tool constant (TIG Torch)

For N series V type and A 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	
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. 4.6.47
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. 4.6.48
MWX-3501							111.0	0.0	146.0	2.1					

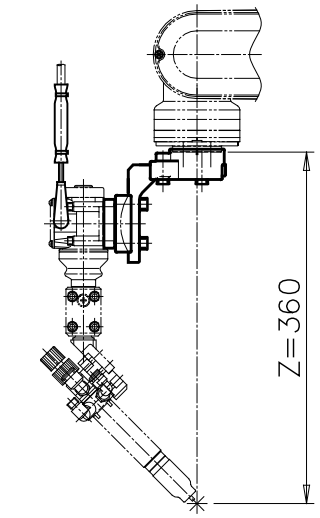


Fig. 4.6.49

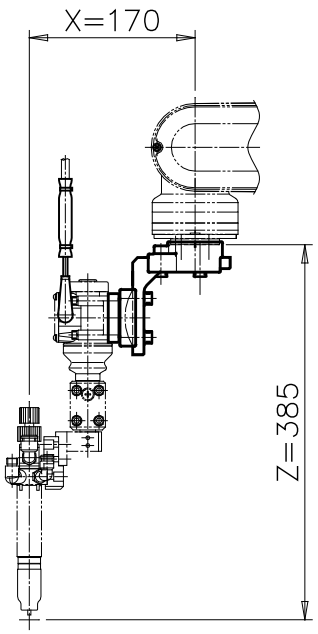


Fig. 4.6.50

Pull type servo torch (4 roll specifications) CO_2/MIG/MAG

Table 4.6.7 Tool constants of DAIHEN pull type servo torch (4 roll specifications)

For N series V type and A 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-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. 4.6.51
MTXCB-3534P										5.5					
MTXC-5034P										5.4					
MTXCW-5034P	0.0	0.0	465.0							5.6					Fig. 4.6.52
MTXCA-2534P										5.6					Fig. 4.6.53
MTXCAW-5034P										5.7					Fig. 4.6.54

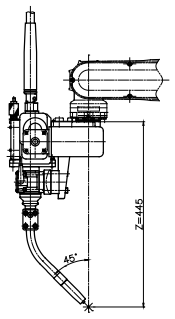


Fig. 4.6.55

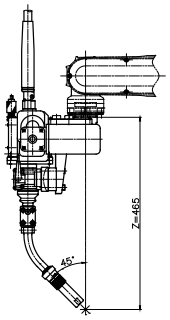


Fig. 4.6.56

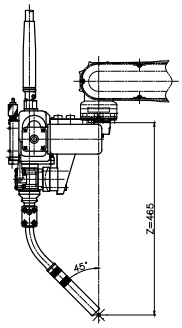


Fig. 4.6.57

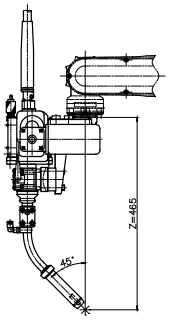


Fig. 4.6.58

Pull type servo torch (2 roll specifications) Aluminum MIG

Table 4.6.8 Tool constants of DAIHEN pull type servo torch (2 roll specifications)

For N series V type and A 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.4.6.59
MTXCA-3041PS															
MTXCW-5041PS	0.0	0.0	385.0							3.4					Fig.4.6.60
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.4.6.61
MTXCA-3041PS															
MTXCW-5041PS	-127.0	0.0	460.0							3.3					Fig.4.6.62
MTXCAW-4041PS	-123.0	0.0	455.0							3.2					Fig.4.6.63

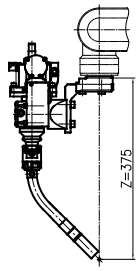


Fig.4.6.64

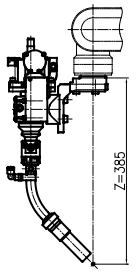


Fig.4.6.65

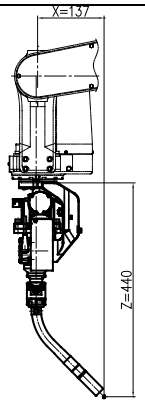


Fig.4.6.66

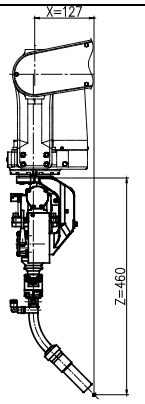


Fig.4.6.67

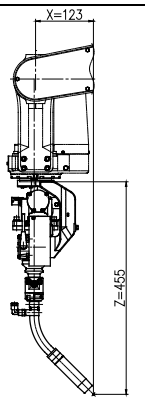
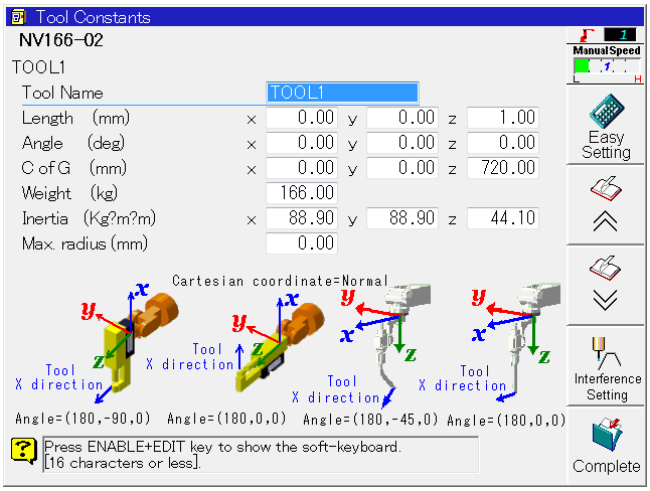


Fig.4.6.68

Tool Exchange

In the case the tool shape deforms, an already taught task program will lose compatibility. It is necessary to convert the already taught task program so that the tool tip position and the target angle should be same as those before deformation.
When the settings of the tool length and the tool angle are changed, in order to keep the compatibility of already taught task program, the following tool conversion function is prepared. Convert the program according to the following procedures.

1 **After the settings of the tool length and the tool angle, press <Complete> key. The set contents are stored into the constant file.**



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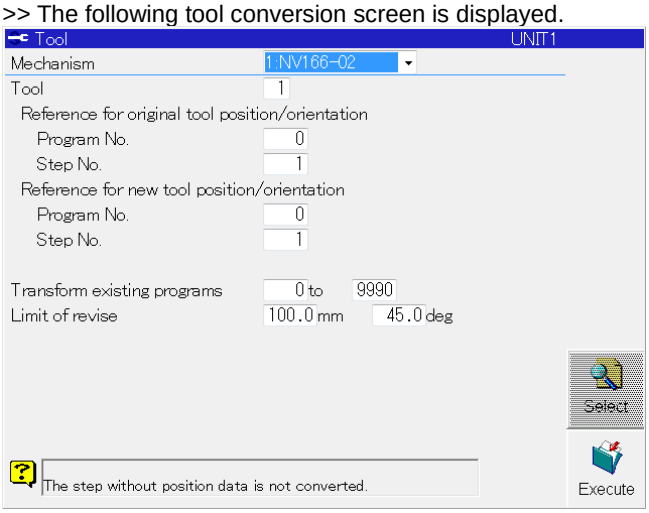
2 **When some of tool constants are changed, the following popup window is displayed.**

>> The change of tool constants can be checked by either of the following changes.

- When one of tool lengths x, y, and z has changed 0.05mm or more
- When one of tool angle length x, y, and z has changed 0.005deg or more

3 **When to convert the program, select [OK] and press [Enter] key.**

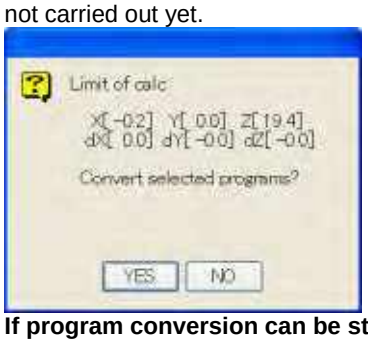
>> The following tool conversion screen is displayed.



When the 2-point tool length is set, the conducted mechanism and the tool number, and the program number and the step number showing referential points before and after conversion are succeeded to.

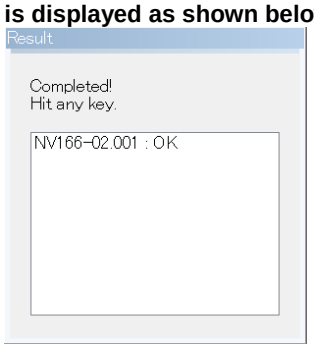
4 **Press <Execute> key.**

5 **The corrected value is calculated, and after a while, the result is displayed as shown below.**
>> At this time, only the corrected value is displayed, and the program conversion is not carried out yet.



If program conversion can be started, select [OK] and press [Enter] key.

6 **The objective programs are converted, and the result of the converted program is displayed as shown below.**



7 **After conversion of all the objective programs is completed, press [Enter] key.**
>> The screen goes back to the machine constant menu screen.

8 **After the conversion, carry out entire confirmation.**
Exit the constant menu, and run the program converted in the above 6 by check go/back in the teach mode.

The conversion is successful if the tool tip position and the target angle are same as those before deformation.

Teaching the reference points (point teaching)

Teaching the reference points before using the robot is recommended to check the accuracy if manipulator parts are replaced or in situations that decrease the accuracy of the robot, such as interference by the torch or chuck.

1 **Attach the tip gauge to the tool.**

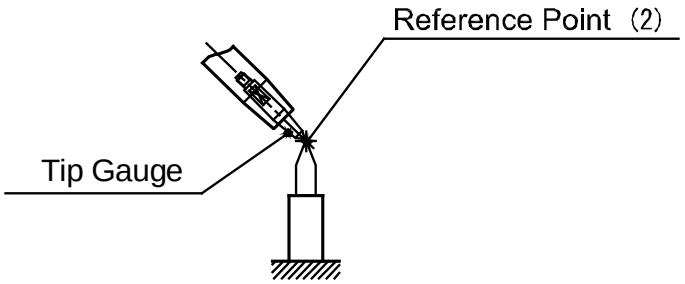
For welding robots
Remove the nozzle and tip of the welding torch and attach the tip gauge.

For handling robots
Make a tip gauge with a sharp point.
Attach the gauge to the tool and calibrate the tool to ensure the accuracy of the robot.

2 **Make a reference point.**
Prepare a sharp point secured to the ground (a tip gauge or similar pointed item) to use as a reference point.
(This will be referred to as a "reference point gauge".)

3 **Make teaching data for the reference point.**
Match the point of the tip gauge with that of the reference point gauge and perform point teaching as reference point (2).

When the 2-point tool length is set, the conducted mechanism and the tool number, and the program number and the step number showing referential points before and after conversion are succeeded to.



If there are issues such as deviation of the teaching point during playback, check the program and confirm the accuracy of the robot and torch.

IMPORTANT

B type robots do not have a torch gauge. Be sure to perform point teaching to confirm the accuracy of the torch.

POINT

An optional robot gauge is provided with B type robots to confirm the accuracy of the manipulator.
Use the robot gauge to check the mechanical deviation of robots without torches.

POINT

If there is an external axis such as a positioner or slider, create a reference point for the external axis in addition to that of the ground and perform point teaching for all reference points.

Teaching procedure

Proceed with teaching by following the steps below.

Preparations prior to teaching ☞ Page 4-2 ～	1	Select the teach mode. Teaching is performed in the teach mode.
	2	Input the number of the program. Input the number of the program to be created. Any number from 0 to 9999 can be input.
Teaching ☞ Page 4-4 ～	3	Record the movement commands (positions to which the robot is to move and postures). ・ Move the robot to the recorded position and posture by manual operation. ・ Press [O.WRITE/REC] to record the step (movement command). ・ Record the steps (movement commands) in sequence by repeating this process.
	4	If necessary, record the function commands. Record the function commands in the appropriate steps. If function commands are recorded, signals can be output to an external device or the robot can be made to stand by.
	5	Record the end command (function command END <FN92>) that shows the program end. Record the end command (END <FN92> function command) in the step that will conclude the operation as the final step.
Checking of contents ☞ Page4-33 ～	6	Check the teaching contents. Move in numerical order through the recorded steps and check the recorded positions and postures.
Modify ☞ Page 4-37 ～	7	Revise the teaching contents if necessary Change the recorded points, add or delete steps, etc.

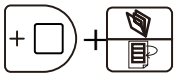
Preparations prior to teaching

Input the number of the program

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

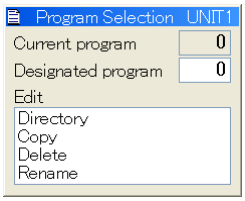
Input the number of the program.

1 **Select the teach mode.**



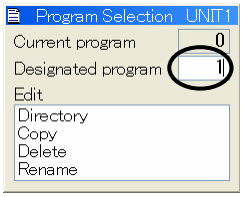
2 **While holding down [ENABLE], press [PROG/STEP].**

>> The [Program Selection] window now opens.



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

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



4 **Press [Enter].**

>> Program "1", a new program, is now opened.

At this point, the teaching can now begin.

INFO.

<u>If you do not know which numbers are not yet used</u>

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

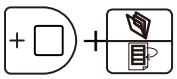
See page 4-3 "4.2.2 Listing the programs on the display".

Listing the programs on the display

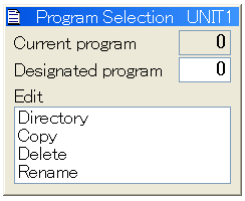
A convenient way to open an already created program is to list the programs on the display and then make the selection.
The number can also be directly specified as described in “4.2.1 Input the number of the program”.

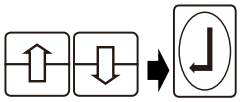
Listing the programs on the display

1 **Select the teach mode.**

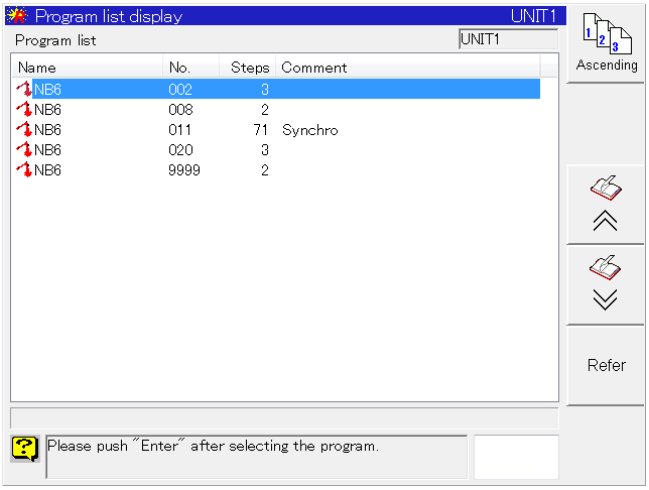


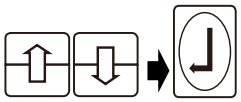
2 **While holdings down [ENABLE], press [PROG/STEP].**
>> The [Program Selection] window now opens.





3 **Align the cursor with “Directory”, and press [Enter].**
>> A list of the programs already created is now displayed.



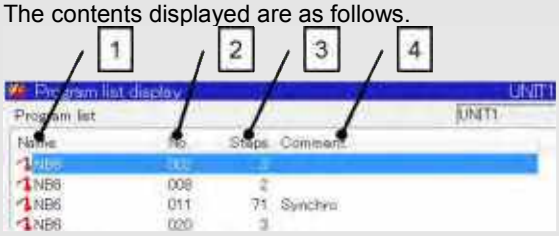


4 **Align the cursor with the program to be opened, and press [Enter].**
>> The selected program is now opened.

POINT

Concerning the contents displayed when programs are listed

The contents displayed are as follows.

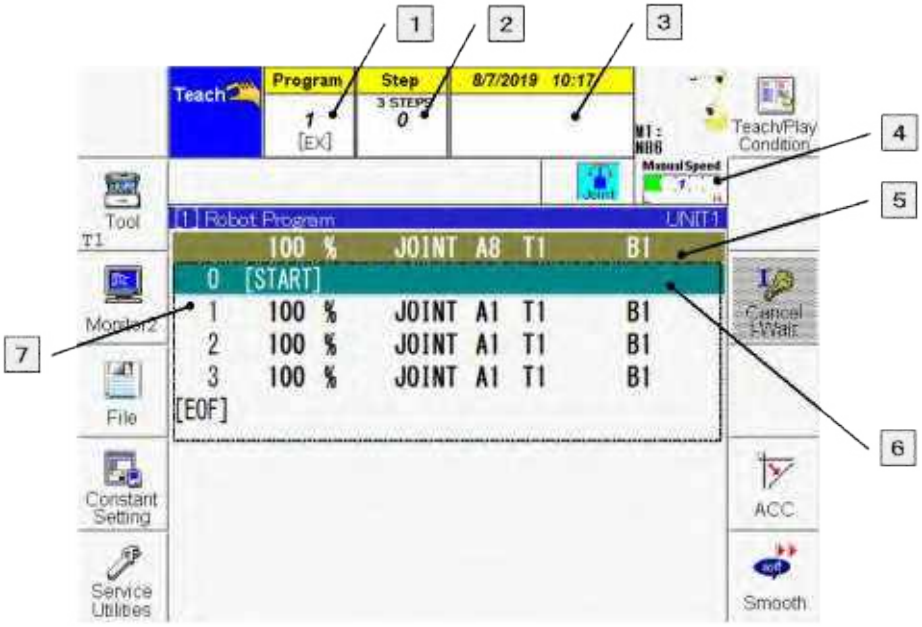


1 : The name of the robot.
2 : The program number.
3 : The number of recorded steps is displayed.
4 : Any registered comments are displayed.

Teaching

Concerning the screen displays during teaching

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



1 Program No.

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

2 Step No.

The number of the currently selected step is displayed.

3 Comment

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

4 Manual Speed

The speed set here is reflected as the movement command of the robot set in <<Operating mode S>>.
Each time [CHECK SPD/TEACH SPEED] is pressed, the speed of the recording status is switched.

5 Recording status

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

6 Cursor

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

7 Program contents

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

Basic teaching operations

There are two types of teaching, “movement command teaching” and “function command teaching.”

Teaching using the movement commands

(1) Operate the robot manually until it reaches the position to be recorded.
(2) Set the speed, interpolation type and other data.
- Speed …This is the speed at which the robot is to move to the recorded position.
- Interpolation type …Select the tracks of the operations up to the recorded position.
- Accuracy …This refers to the degree by which the path along which the tool moves as it passes through the recorded point of each step is distanced from the recorded point, thereby describing an arc on the inside of these points. This is also called accuracy.

(3) The movement command is recorded by pressing [O.WRITE/REC].

POINT

Concerning the movement command data settings

All the movement command data can be changed after teaching. Therefore, until operators become familiar with the operation of the robot, they should simply remember “how to record the robot positions”.
The data is revised upon completion of the teaching session.
See page 4-37 “4.8 Modifying the program”.

Teaching using the function commands

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

To correct input errors

- Press [R/HOME] if you accidentally select a different function or command.
- To correct a numerical value, etc. specified in an function command, press [BS].
- To delete the last operation, press [ENABLE] + [BS].

POINT

The operating method of teaching differs according to the set “Operating mode.”
There are two types of operating mode, <<Operating mode A>> and <<Operating mode S>>.
For details on the operating method, check the set operating mode, and read the appropriate section for that operating mode.

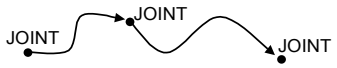
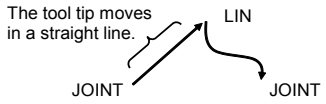
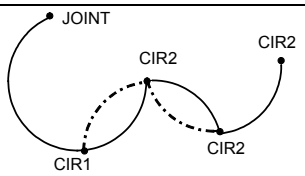
<<Operating mode A>> Page 4-12 “4.4 Try Teaching <<Operating Mode A>>”
<<Operating mode S>> Page 4-23 “4.5 A practice teaching session <<Operating mode S>>”

The set operating mode can be checked in the system environment display.
For details, see “1.2 How to read the instruction manual.”

What is the interpolation type?

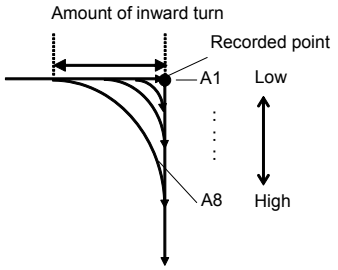
How the tool tip is to be moved is determined by the interpolation type.

Table 4.3.1 Interpolation type

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

What is the accuracy level?

This refers to the degree to which the path along which the tool moves as it passes through the recorded point of each step describes an arc on the inside of the recorded point. A1 to A8 can be specified as this degree.
When A1 is specified, the tool tip will pass through the recorded point. When A2 or above is specified, the time required for playback is reduced depending on how far the tool passes along an arc on the inside of the recorded points.
Select a stringent (lower) accuracy level at the welding points and a lax (higher) level in the air cutting areas.
This controller performs inward turn even if the interpolation classification of the linked step is different.
Control over the robot operations that involve accuracy levels differs depending on the application used.



When the arc welding application is used

When a level from A1 to A8 is specified, the overlap speed ratio changes step by step across a range from 0 to 100%.
Even if the accuracy level remains the same, the path of the robot is changed by the recording speed. (The higher the recording speed, the further inside the arc which is described.)
Even if the playback speed is changed, the inward turn tracks are calculated so as not to affect the tracks. However, the actual amount of inward turn may differ due to machine curvature or servo control delay.
Changing the playback speed means speed changes when the speed override or low safety speed functions are used.

Accuracy levels when arc welding is performed

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

When the spot welding application is used

When a level from A1 to A8 is specified, the inside arc amount changes step by step across a range from 0 to 500 mm.
If the accuracy level remains the same, the path of the robot is not affected even when the recording speed is changed.
Similarly, even when the playback speed changes, there is hardly any effect on the path of the robot. (The "playback speed" is the speed resulting from a change made by speed override, the low safety speed or other actual speed during playback.)

Accuracy levels when spot welding is performed

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

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

Continue and Pause

The accuracy level described in the previous section can be divided into two types of control methods, “continue” and “pause.”
With the “continue” method, the robot tool passes smoothly along the inside of the tool path with no reduction in its speed. (“Continue” is described in “4.3.4 What is the accuracy level?”.)
Since this control method generates the path in such a way that the tool moves along the inside of the path formed by the recorded points, it is used for those areas where the tool does not make contact with the work but moves from one point to the next through the air.

With the “pause” method, which is also referred to as “in-position check,” each time the command position inside the robot reaches a step, the actual robot arrival is awaited before advancing to the next step.
This method is used at steps such as spot welding which require a high level of positioning accuracy.

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

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

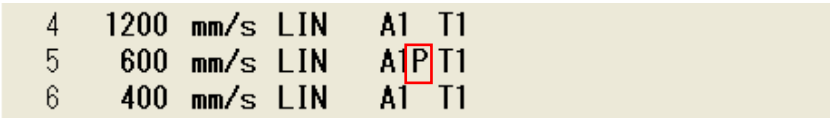
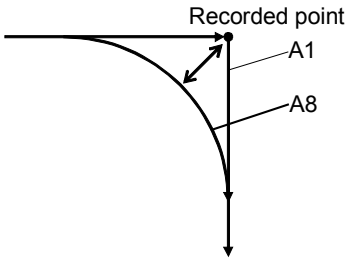
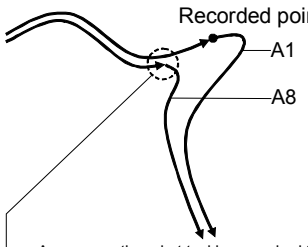
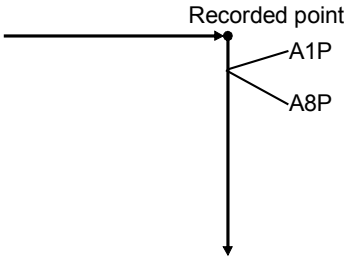
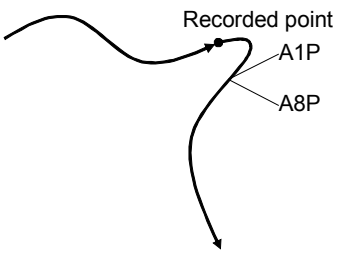


Fig. 4.3.1 Example of steps displayed with “pause”

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

<table>
<tr><th></th><th>For linear interpolation</th><th>For joint interpolation</th></tr>
<tr><td>Continue</td><td> 
</td><td> 

As soon as the robot tool has reached the point which is away from the recorded point by the distance equivalent to the pulse amounts of the axis encoders which correspond to the accuracy level set, the robot considers that the tool has reached the recorded point, and it starts moving the tool toward the next recorded point.</td></tr>
<tr><td></td><td colspan="2">The robot tool does not continue through the recorded points but passes smoothly along the inside of the tool path with no reduction in its speed.
Exactly how far inside the tool path the robot tool moves depends on the accuracy level setting.</td></tr>
<tr><td>Pause</td><td> 
</td><td> 
</td></tr>
<tr><td></td><td colspan="2">Both A1P and A8P tool tip continue through the recorded points. However, the positioning accuracy differs according to the accuracy level. The lower the figure used for the accuracy level, the greater the deceleration at the recorded points and the higher the positioning accuracy which is achieved.
Record the accuracy level for those steps requiring positioning accuracy.</td></tr>
</table>

What is the acceleration?

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

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

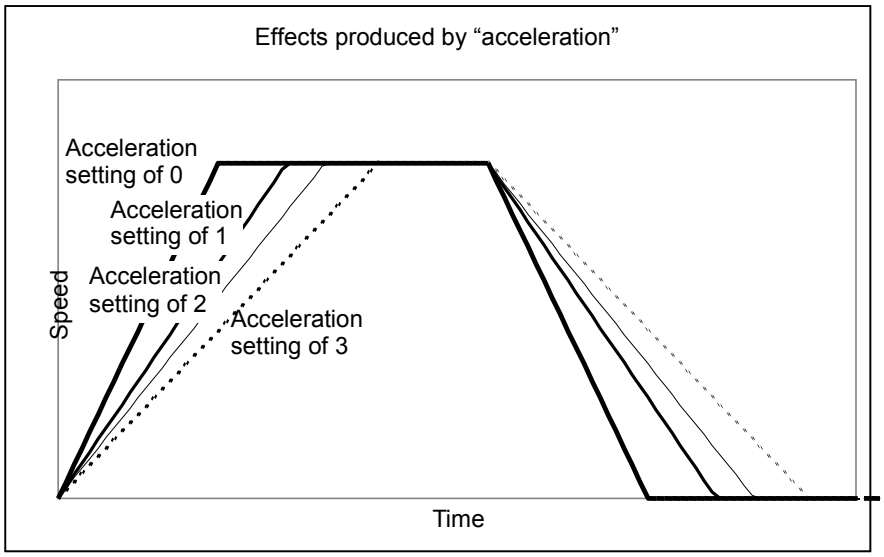


Fig. 4.3.2 “Acceleration”

Open the screen editing window, and set a level from 0 to 3 at the position shown in the figure below.
A number appears after “D.” The display is cleared only when 0 has been set.

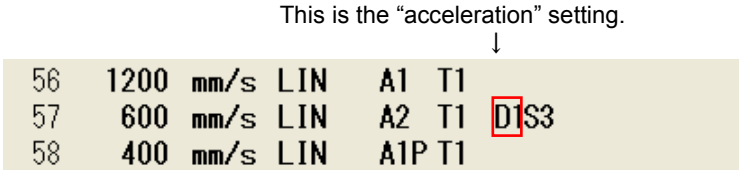


Fig. 4.3.3 Example of “acceleration” step display

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

IMPORTANT

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

IMPORTANT

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

What is smoothness?

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

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

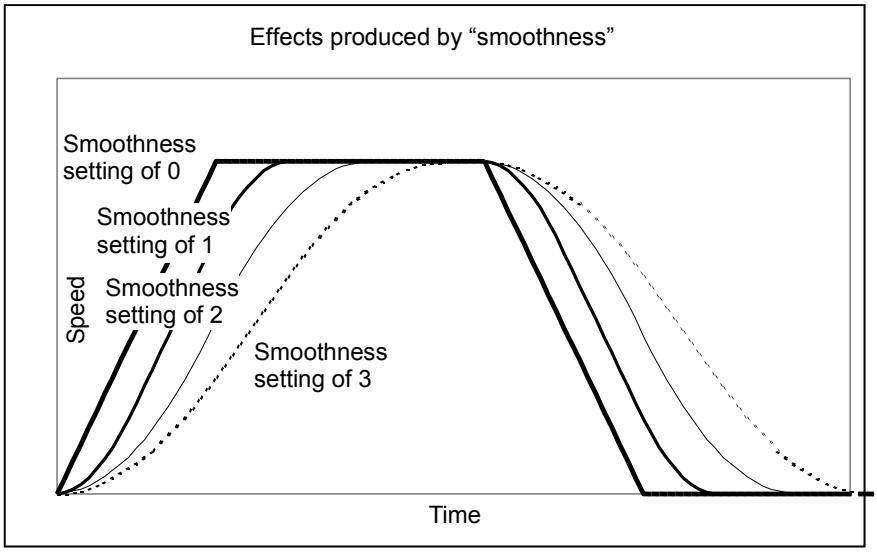


Fig. 4.3.4 “Smoothness”

Open the screen editing window, and set a level from 0 to 3 at the position shown in the figure below.
A number appears after “S.” The display is cleared only when 0 has been set.

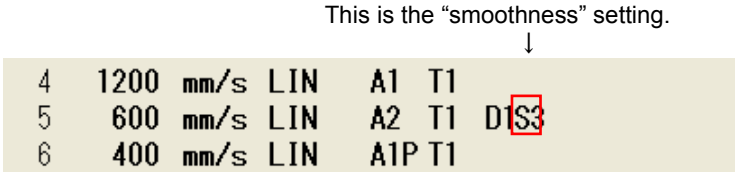


Fig. 4.3.5 Example of “smoothness” step display

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

IMPORTANT

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

IMPORTANT

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

Number of recordable steps

The maximum number of steps that can be recorded in a single program is 9999.
To exceed 9999 steps, divide the steps into multiple programs, and then call the programs divided from the parent program using the program call command (FN80).
By dividing, the programs can be reused, and management and maintenance also become easier.

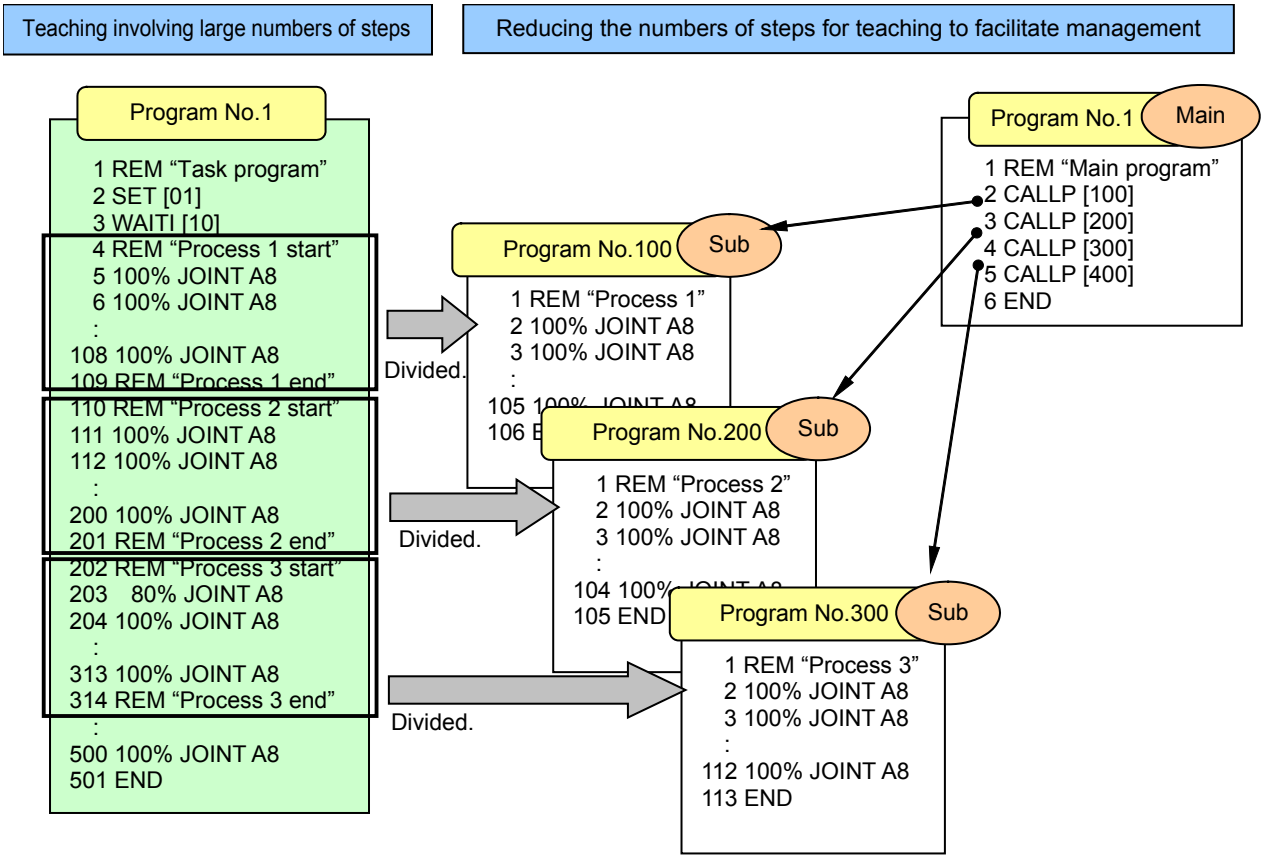


Fig. 4.3.6 Example of teaching with reduced numbers of steps

IMPORTANT

If the “A2150: Program is too large” error message appears during teaching or screen editing, it means that the number of steps stored in a task program is too high. An error will occur if the file size exceeds 16 megabytes.
In a case like this, divide the task program in the manner shown in the example above.

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

IMPORTANT

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

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

In such a case, make more space in the internal memory by “deleting unused files” or “saving files which have not been used recently onto a USB memory and deleting them.”

A practice teaching session

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

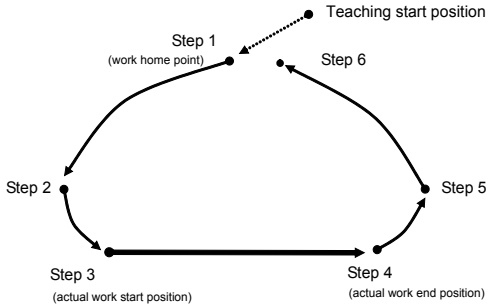
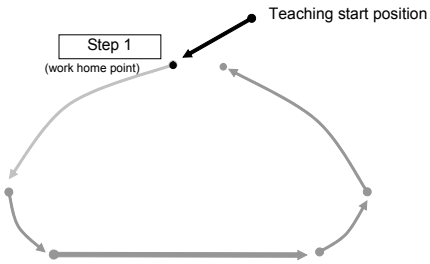


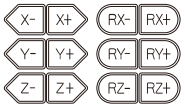
Fig. 4.5.1 Teaching example

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

Recording step 1 (work home point)

Record step 1 as the work home point.

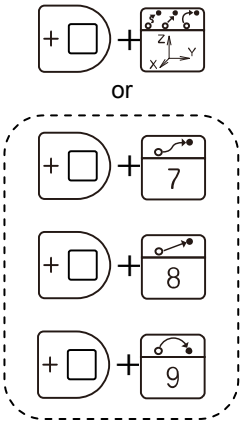




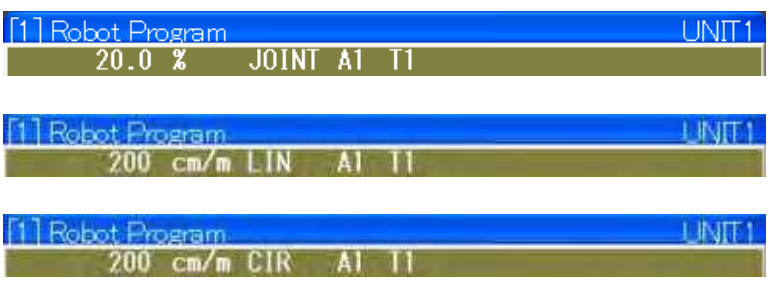
1 **Use the [Axis operation keys] to move the robot to step 1.**
As step 1, set the robot to the position which will serve as the work home point.

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

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

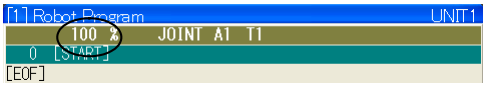


3 **While holding down [ENABLE], press [INTERP/COORD], and set the interpolation specification of the recording status to “JOINT.”**
>> Each time this is pressed, the interpolation type of the recording status is switched in the following sequence: “JOINT” → “LIN” → “JOINT”, etc.



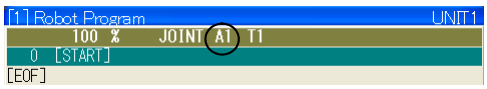
↓

4 **Press [CHECK SPD/TEACH SPEED], and set the manual speed to “5” (the recording status speed also changes along with the manual speed. When “5” is set, “100%” is displayed).**



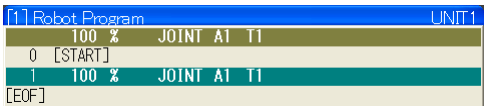
5 **To specify the accuracy level, press [ACC].**

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



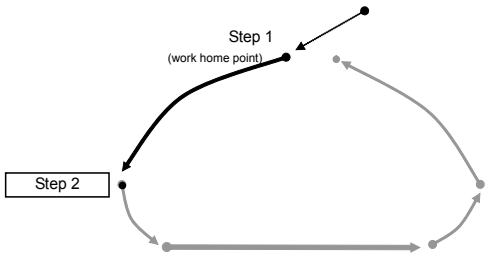
6 **Press [O.WRITE/REC].**

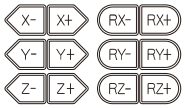
>> Step 1 is now recorded.



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

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





1 **Use the [Axis operation keys] to move the robot to step 2.**

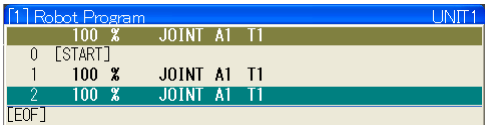
As step 2, set the robot to just before the start position of the work. In terms of the posture, set the robot to the posture which is close to the one in which the robot will actually perform the work in step 3.

2 **Set the movement method and speed up to step 2.**

In the same way as for step 1, try setting “joint interpolation” for the movement method and “100%” for the speed.

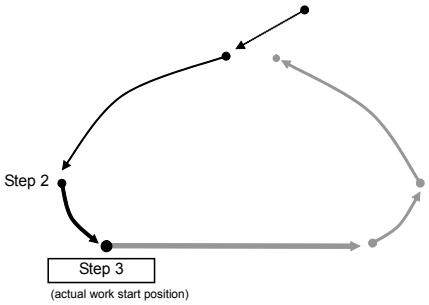
The movement command stored last is left for the recording status. To use the previous condition as is, press [O.WRITE/REC] without changing the value.

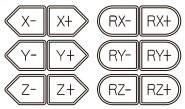
>> Step 2 is now recorded.



Recording step 3 (actual work start position)

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

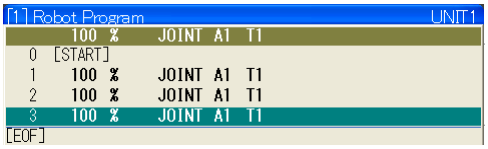




1 **Use the [Axis operation keys] to move the robot to step 3.**
Since step 3 is the position where the actual welding and other work are to start, manually operate the robot until its posture is optimal for the work to be performed.

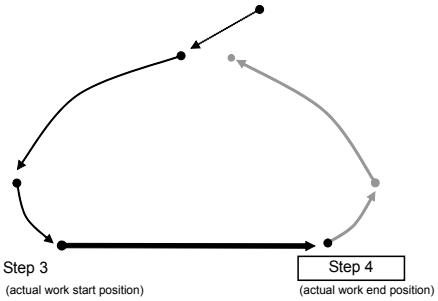
2 **Set the movement method and speed up to step 3.**

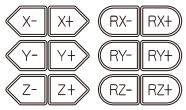
3 **Press [O.WRITE/REC].**
>> Step 3 is now recorded.



Recording step 4 (actual work end position)

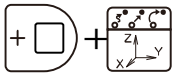
Record the position where the actual welding or other work is to end as step 4.





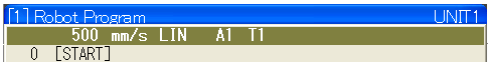
1 **Use the [Axis operation keys] to move the robot to step 4.**
The movements of the robot by manual operations up to step 4 need not be in a straight line. A detour may be taken but operate the robot manually in such a way that it does not make contact with the work piece.

2 **Set the move method and speed up to step 4.**
Set the move method to “Interpolation on (linear),” and the speed to "500mm/s.”



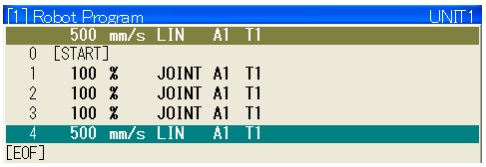
While pressing [ENABLE], press [INTERP/COORD] and set the interpolation specification for the recorded status to linear interpolation (“LIN” is displayed in the recorded status).

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



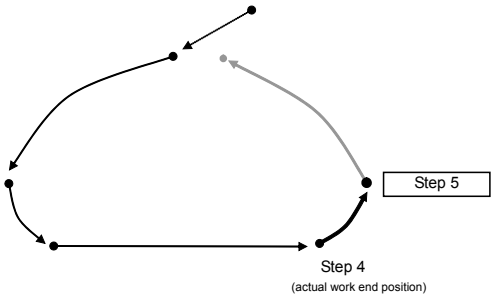
3 **Press [O.WRITE/REC].**

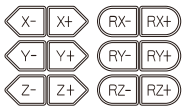
>> Step 4 is now recorded.



Recording step 5 (position away from the work piece)

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



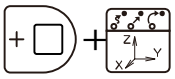


1 **Use the [Axis operation keys] to move the robot to step 5.**

As step 5, set the robot in the appropriate position at some distance from the work piece.

2 Set the move method and speed up to step 5.

Set the move method for step 5 to “Joint interpolation”, and speed to “100%.”

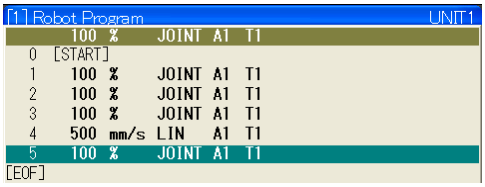


While pressing [ENABLE], press [INTERP/COORD] and set the interpolation specification for the recorded status to “JOINT.”

Also, press [CHECK SPD/TEACH SPEED], and set the speed to “100%.”

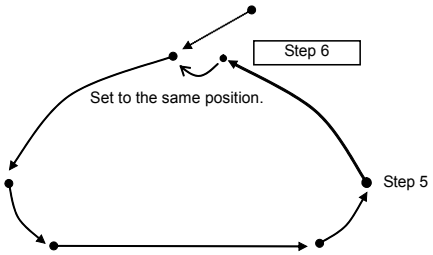
3 **Press [O.WRITE/REC].**

>> Step 5 is now recorded.

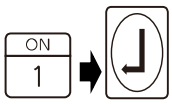


Recording step 6 (same position as for step 1)

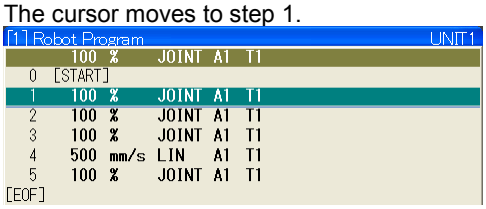
Record the same position as for step 1 as step 6.

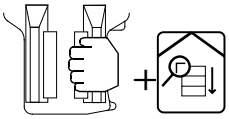


1 **Press [PROG/STEP].**
>> The [Step Selection] screen now appears.



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

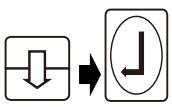




3 **While grasping the [Enable switch] press [CHECK GO]. (Keep pressing it until the robot stops.)**
>> The robot moves to the position recorded in step 1.

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

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

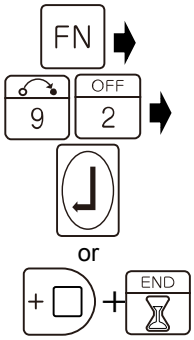


5 **Select “Bottom,” and press [Enter].**
>> The cursor moves to the last step (step 5).
This is now the state in which step 6 can be recorded.

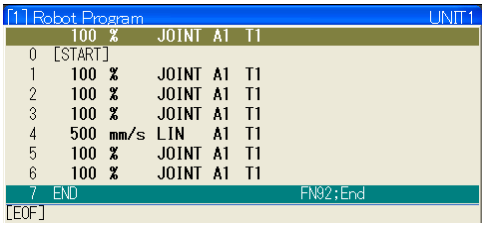
6 **The conditions in step 5 will be used as is, so press [O.WRITE/REC].**
>> Step 6 is now recorded.

Recording the end command (End function command)

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



1 **Press [FN], then press [9] → [2] → [Enter].**
Alternatively, hold [ENABLE] and press [END/TIMER].
>> The end command is now recorded.



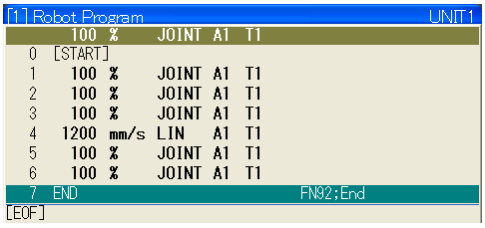
This now completes the creation of the program.
Next, check the robot operations, postures, etc.

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]

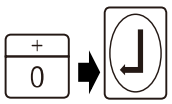
The operation of the program created in the previous section will be checked here.
The screen that appears when teaching is completed should be the one shown below.



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

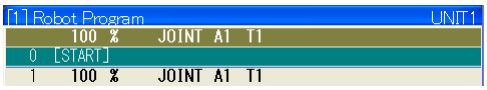
1 **Press [PROG/STEP] in order to call the step which is to be checked first.**

>> The [Step Selection] screen now appears.



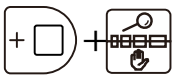
2 **Input [0] in “Designated step”, and press [Enter].**

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



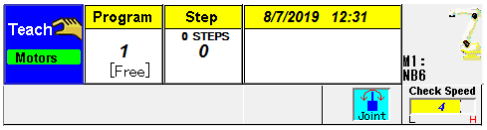
POINT

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



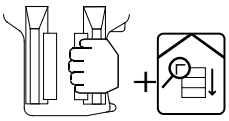
3 **To specify the speed to be used during the check operation, press [CHECK SPD/TEACH SPEED] while holding down [ENABLE]. Here, select “3” to ensure safety.**

>> 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.



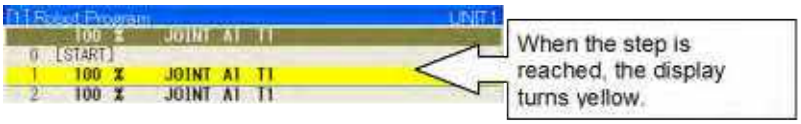
INFO.

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.

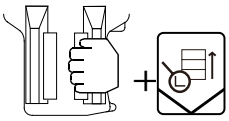
5 **To move to step 2, first release [CHECK GO] and then press it again.**

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.

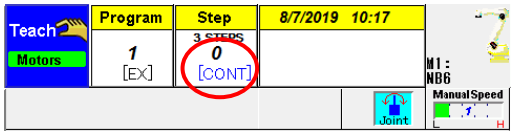
Checking the steps continuously

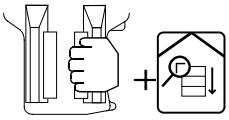
The robot can be operated continuously step by step by holding down [CHECK GO] or [CHECK BACK].

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.**

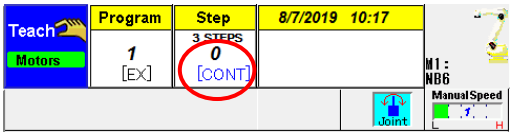
Switching the continuous/step mode during Check Go operation

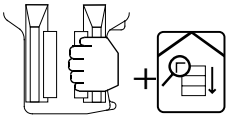
The continuous mode can be switched to the step mode and vice versa by pressing down [Shift] while pressing [CHECK GO].
While pressing the [Shift], the display is shown to switch from the continuous mode to the step mode and conversely, therefore Check Go is operated following the mode which is switched.

When the continuous mode

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

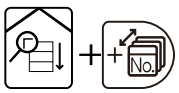
>> “CONT” is displayed in the [Step number display area].





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].”

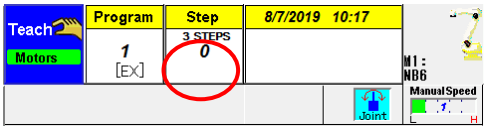
4 **To release the step mode, release the [Shift].**
Or release the [CHECK GO].

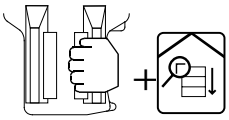
>> When the mode release is completed, the display returns from “[step]” to “[CONT].”

When the step mode

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

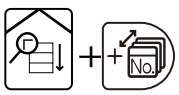
>> Nothing has been displayed in the [Step number display area].





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.

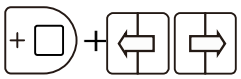
Number

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.

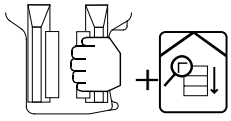
You can select from among the following items.

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.

Modifying the program

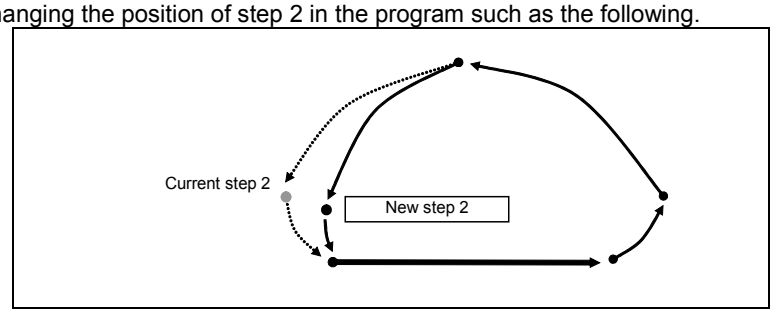
This section describes how to modify the commands which have been recorded in the program.
The commands can be modified in a number of ways as follows.

Table 4.8.1 How to change the steps

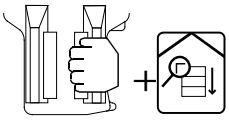
Description of modification		Operation method	Reference page
Movement command modification	Modifying the position only	[ENABLE] + [MOD Position]	Page 4-37
	Modifying the speed only <<Operating mode S>>	[SPD]	Page 4-38
	Modifying the accuracy only <<Operating mode S>>	[ACC]	
	Modifying everything together (Movement command overwriting)	[ENABLE] + [O.WRITE/REC] ※ Use this method to modify the interpolation type, tool number, etc. since they cannot be modified separately.	Page 4-39
Adding movement commands		[ENABLE] + [INS]	Page 4-42
Adding function commands		This is added automatically with the same method as in new teaching. It is added at the same position as the move command.	
Deleting movement commands and function commands		[ENABLE] + [DEL]	Page 4-45
Using the screen editing function to modify commands		[EDIT] ※ The parameters of the function commands cannot be modified in the teach screen. Use the screen editing function to modify commands.	Page 4-46

4.8.1 Modifying the robot position

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



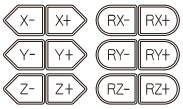
Modifying the robot position



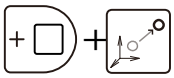
1 Move the robot to step 2 using [CHECK GO] (or [CHECK BACK]).

Alternatively, the step may be called.

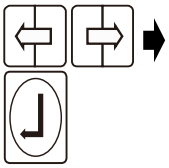
An alternative to the operation in 1 is to call step 2 by selecting [PROG/STEP] → [2] → [Enter]. In this case, however, what happens is that only the display moves and the robot fails to move to step 2. To move the robot, designate the step and then press [CHECK GO].



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



3 **Hold [ENABLE] and press [Modify position].**
>> A confirmation screen is displayed.



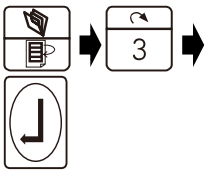
4 **Select “OK” and press [Enter].**
>> The position is now modified.

This completes the modification of the step 2 position.

4.8.2 Modifying movement command data <<Operating mode S>>

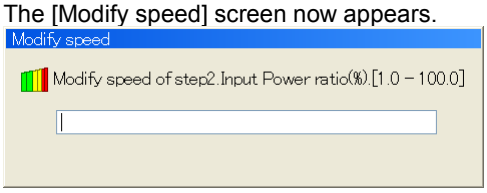
The speed and accuracy recorded in a movement command can be modified separately without changing the position data of the robot. This method can only be used when <<Operating mode S>> is set. This method cannot be used for modification when <<Operating mode A>> is set. Overwrite the linear command, or use screen editing.
Modifying the speed and accuracy in step 3 is given here as an example.

Modifying movement command data



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

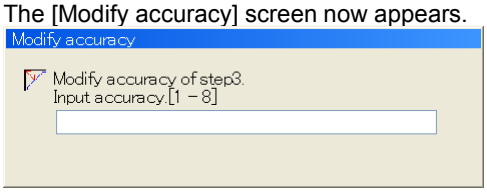
2 **To change the speed, press [SPD].**
>> The [Modify speed] screen now appears.



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

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

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

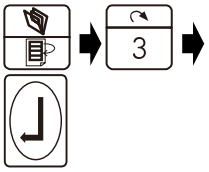


6 **Press [Enter].**
>> The new specified accuracy is recorded.
This completes the modification of the step 3 speed and accuracy.

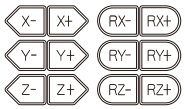
Overwriting movement commands

Steps can also be overwritten.
When a step has been overwritten, all the data including the position of the robot, its speed and interpolation type is modified.
Changing joint interpolation in step 3 to linear interpolation is given here as an example.

Overwriting movement commands <<Operating mode A>>

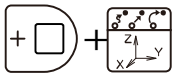


1 **Press [PROG/STEP] → [3] → [Enter].**
>> The cursor moves to step 3.



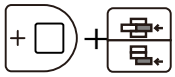
2 **To change the position, use the [Axis operation keys] to operate the robot manually.**

Modifying with the teaching method using the recorded status



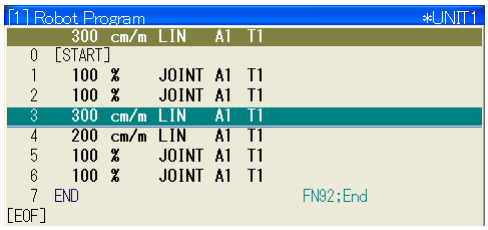
3 **While holding down [ENABLE], press [INTERP/COORD], and set the interpolation specification of the recording status to linear interpolation. (“LIN” is displayed for the recording status.)**

4 **After pressing [SPD], input a suitable value.**



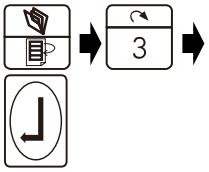
5 **While holding down [ENABLE], press [O.WRITE/REC].**
>> A confirmation screen now appears.

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



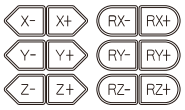
Overwriting movement commands

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

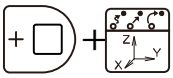


1 **Press [PROG/STEP] →□[3] →□[Enter].**

>> The cursor moves to step 3.

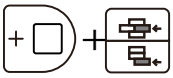


2 **To change the position, use the [Axis operation keys] to operate the robot manually.**



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

4 **Press [CHECK SPD/TEACH SPEED], and set a suitable value for the speed.**

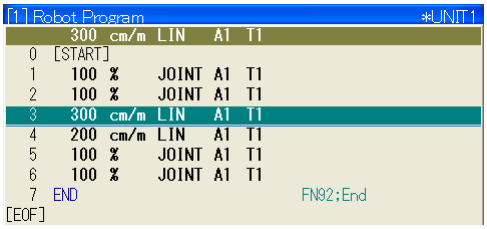


5 **While holding down [ENABLE], press [O.WRITE/REC].**

>> A confirmation screen now appears.

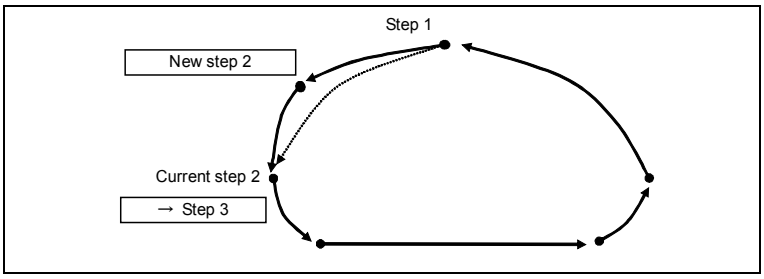
6 **Select “OK” and press [Enter].**

>> The step is overwritten.



Adding movement commands

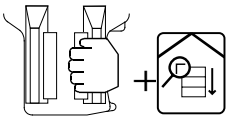
Using the following work program as an example, a new step will now be added between steps 1 and 2



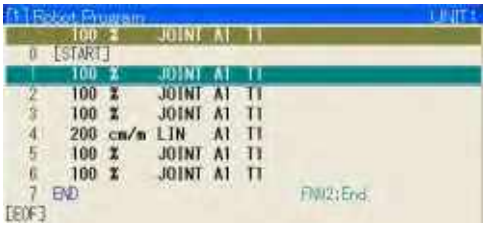
The position at which the command is added differs between <<Operating mode A>> and <<Operating mode S>>. The added position of the new step is “After the current step” for <<Operating mode A>>, and "Before the current step” for <<Operating mode S>>.

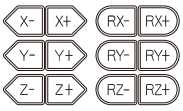
The position at which the command is added is set by [Constant Setting] — [5 Operation Constants] — [1 Operation Condition] — [7 Step insertion position], so you can change it.
However, you must be ***EXPERT*** level or above to make changes.

Adding movement commands



1 **Move the robot to step 2 using [CHECK GO] (or [CHECK BACK]).**
To add a step, move to the step before the location where you want to add the step.
Moving the cursor as shown below adds the step after the first step.

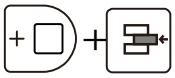




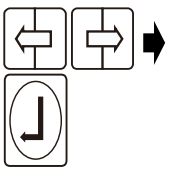
2 **Use the [Axis operation keys] to operate the robot manually, and set the robot to the position and posture to be added.**

Modifying with the teaching method using the recorded status

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

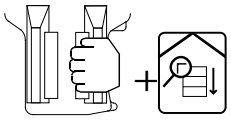


4 **While holding down [ENABLE], press [INS].**
>> A confirmation screen now appears.



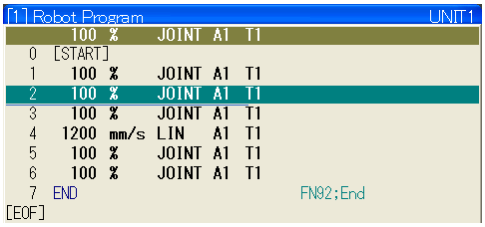
5 **Select “OK” and press [Enter].**
>> This completes the addition of the new step.
All the previous steps 2, 3 and up are incremented by one to become steps 3, 4 and up.
The numbers of the steps recorded as the parameters of jump/call and other function commands are automatically modified at this time.

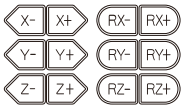
Adding movement commands



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

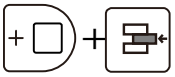
To add a step, move to the step after the location where you want to add the step.
Moving the cursor as shown below adds the step before the 2nd step.





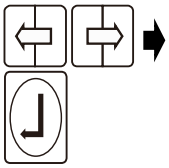
2 **Use the [Axis operation keys] to operate the robot manually, and set the robot to the position and posture to be added.**

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



4 **While holding down [ENABLE], press [INS].**

>> A confirmation screen now appears.

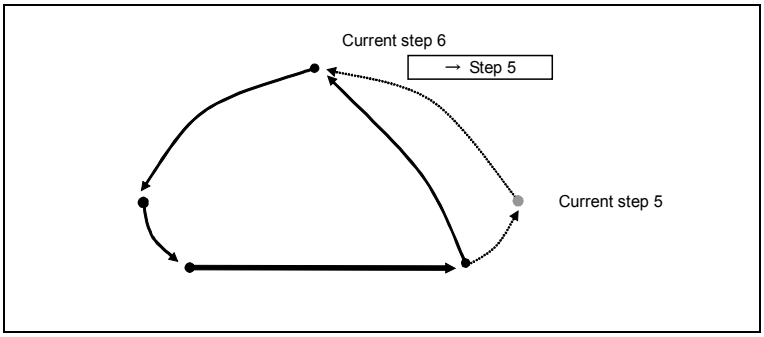


5 **Select “OK” and press [Enter].**

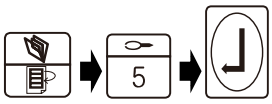
>> This completes the addition of the new step.
All the previous steps 2, 3 and up are incremented by one to become steps 3, 4 and up.
The numbers of the steps recorded as the parameters of jump/call and other function commands are automatically modified at this time.

Deleting movement and function commands

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

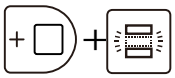


Deleting movement and function commands



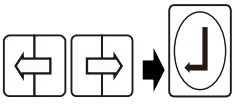
1 **Press [PROG/STEP] → [5] → [Enter].**

>> The cursor moves to step 5.



2 **While holding down [ENABLE], press [DEL].**

>> A confirmation message now appears.



3 **Select “YES” and press [Enter].**

>> This completes the deletion of step 5.
The previous step 6 is decremented by one to become step 5.
The numbers of the steps recorded as the parameters of jump/call and other function commands are automatically modified at this time.

Using the screen editor function to modify commands

All the data recorded in the program can easily be modified using the screen editor function. The screen editing function can be used in the teaching mode, and during playback in the playback mode.
The operations which can be performed using the screen editor function are listed below.

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

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

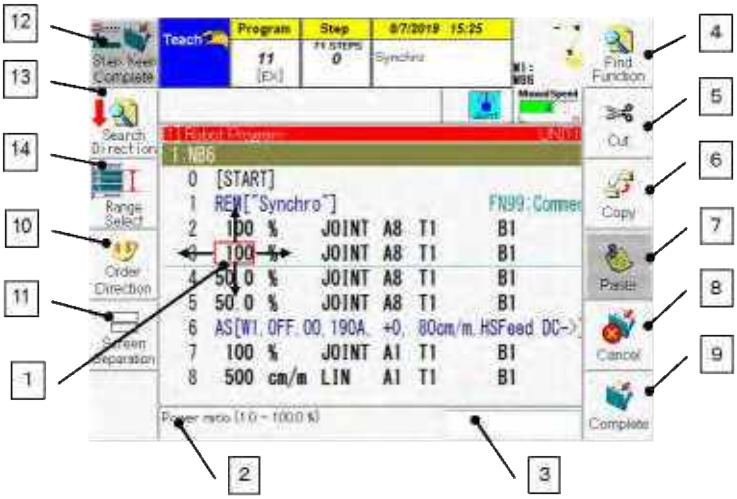
Modifying with the screen editor function

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

Selecting the screen editor function

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

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



1 Cursor

The cursor can be moved to the data.

2 Description of data

A description of the data at the cursor position and the range of the values in which the data can be input are displayed here.

3 Input field

To change the data at the cursor position, input the new value here, and press [Enter].

4 Find Function

This is used to search the function commands.

5 Cut

This is used to cut (delete) the selected line or lines. The cut line or lines can be inserted at any position using “Paste”.

6 Copy

This is used to copy the selected line or lines. The copied line or lines can be inserted at any position using “Paste”.

7 Paste

This is used to insert the cut or copied line or lines at any position.

8 Cancel

This is used to terminate program editing without reflecting the modifications made.
It is also used to cancel a cut or copy operation at any point.
[R/HOME] functions in the same way.

9 Complete

This is used to save the modification results and terminate the program editing.

10 Other Direction

This is used to select the direction during pasting.
When “reverse direction” is selected, the order of the data in the cut or copied lines is reversed, and the data is pasted in this reverse order.

11 Screen Separation

This is used to divide the screen into the top half and bottom half.
Use [CLOSE/SELECT SCREEN] to select the half of the screen where operations are to be performed.

12 Step Keep

Normally, when screen editing ends, it automatically returns to the step it was at prior to starting screen editing. If you press this key while holding down [ENABLE], it will stay at the step it was at in screen editing when it returns to the program screen (write is also done). This is useful in cases such as when you found a step in screen editing that can be an indicator for Check GO and Check BACK operations.
However, in such cases, the displayed step will differ from the actual robot step. Therefore, you need to be careful when doing Check GO and Check BACK operations after that.

13 Search Direction

Switch the search direction between up and down.

14 Range select

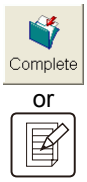
You can select multiple steps then batch change the movement command speed.

INFO.

If the number of steps does not fit on the screen, swipe the screen to scroll to the next step.

2 **Move the cursor to the desired position, input the new numerical value in the "Input" field in response to the guide message displayed in the "Description of data" field, and press [Enter].**

>> The contents of the program directory now change to the new number that was input. At this time, the program contents are not rewritten.



3 **To reflect the changes, press f12 <Complete> or press the [EDIT] key again.**

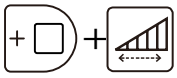
>> The program contents are updated, the screen editor function is exited, and the original screen is restored.

To end without reflecting changes, press the [R/HOME] key.

Batch changing the speed of MOVE command

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

Batch changing the speed of MOVE command

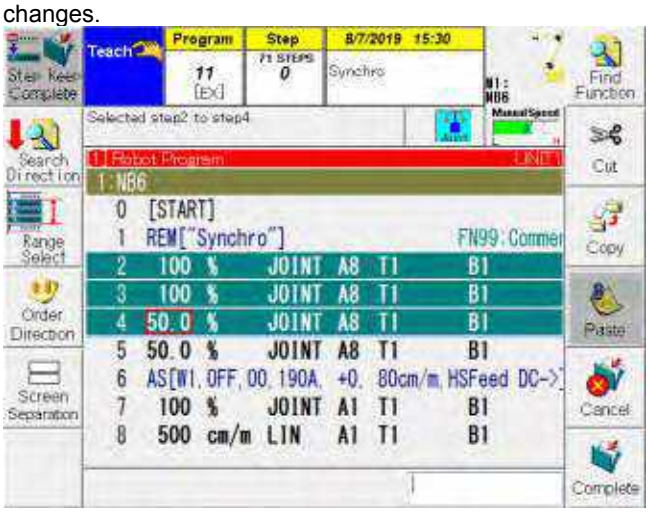


1 **Press [SPD] with holding [ENABLE].**

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

2 **Press [Up/Down].**

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



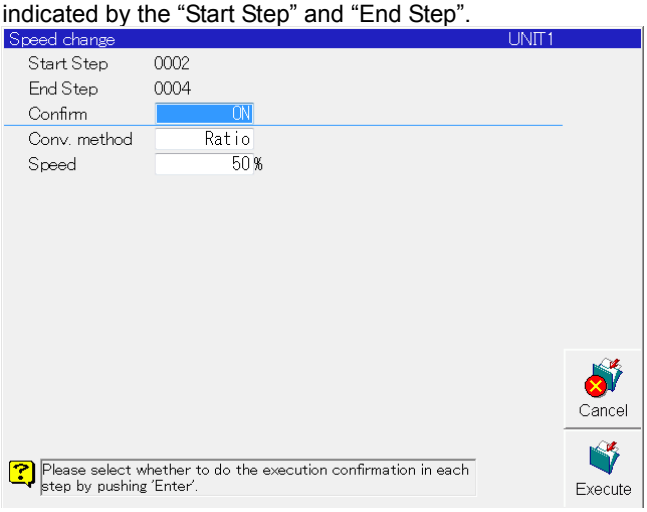
or

3 **To cancel the range selection of steps to change, press [CANCEL] or [R/HOME].**

>> The highlighted lines are restored.

4 **Press [SPD].**

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



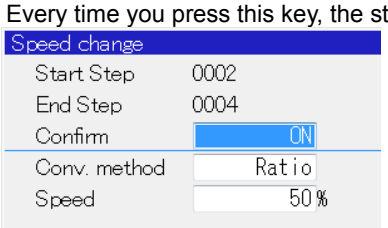
Without the range selecting operation

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

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

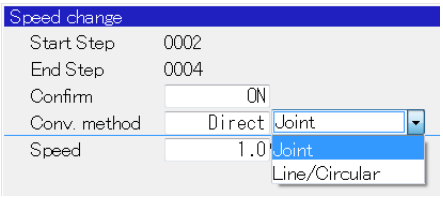
6 **To set “Confirm”, align the cursor on it and press [Enter].**

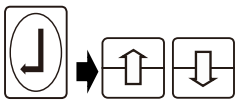
>> Every time you press this key, the status (ON/OFF) is switched.



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

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





When switched to “Direct”, the pull-down list for the interpolation type appears on the right side.
If pressing [Enter] as moving to the pull-down list, alternatives (Joint/Line/Circular) are displayed. Then, select an appropriate interpolation type with [Up/Down] key.

Entering the speed value

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

9 **Press f12 <Execute>.**

>> Now, the speed batch change starts.

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

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

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

or

10 **To reflect the change just made, restore the screen-editor window and press f12 <Complete> or [EDIT].**

>> The program details are updated, the screen editing function exits and the screen returns to the previous screen.

11 **To not reflect the change, return to the screen-editor window, then press [R/HOME].**

Table 4.9.2 Condition settings for the speed batch changing

Condition parameter	Setting range	Meanings	Default
Confirm	ON	Pressing f12 <Execute>, the “Confirm” message appears by every step, which enables to select ON/OFF/Cancel.	ON
	OFF	All steps from the start step to the end step are batch changed without any confirming action.	

Condition parameter	Setting range	Meanings	Default
Conv. method	Ratio	Designates the ratio (%) to the current record speed for changing. (Example: To make the speed half, designate 50%.) All steps are the targets for change.	Ratio
	Direct：Joint	Designate the speed only for the step of which interpolation type is “Joint”. The step of “Line/Circular” is not changed.	
	Direct：Line/Circular	Designate the speed only for the step of which interpolation type is “Line/Circular”. The step of “Joint” is not changed.	
Speed	Ratio	0～200% Note that the value after change does not exceed the upper/lower limit of the record speed.	50%
	Direct：Joint	Use the unit in entering the value specified in “Joint Interpolation” on the record speed screen. The screen appears by proceeding to f5<Constant Setting> - [5 Operation Constants] – [4 Record Speed].	Minimum value within the available range
	Direct：Line/Circular	Use the unit in entering the value specified in “Line/Circular” on the record speed screen. The screen appears by proceeding to f5<Constant Setting> - [5 Operation Constants] – [4 Record Speed].	

IMPORTANT

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

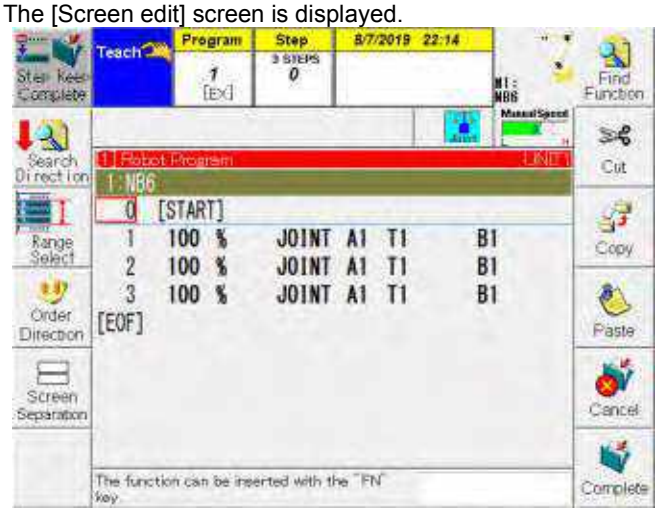
Editing Step Comments

Comments can be added to each step of the program. This comment is called a step comment. Adding step comments makes the meaning of steps easier to understand.

Inputting step comments

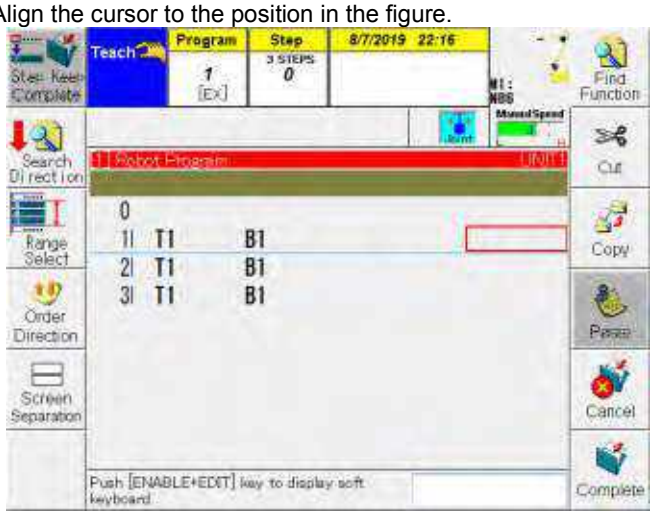
Step comments can be added and edited in the screen edit.

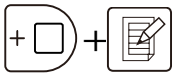
1 **Set the robot program monitor to the operable state, and press [Edit].**
>> The [Screen edit] screen is displayed.



For details of the basic operations for screen edit, see “Chapter 4 Teaching.”

2 **Align the cursor with the step you want to add a step comment to, and press [Right].**
>>Align the cursor to the position in the figure.

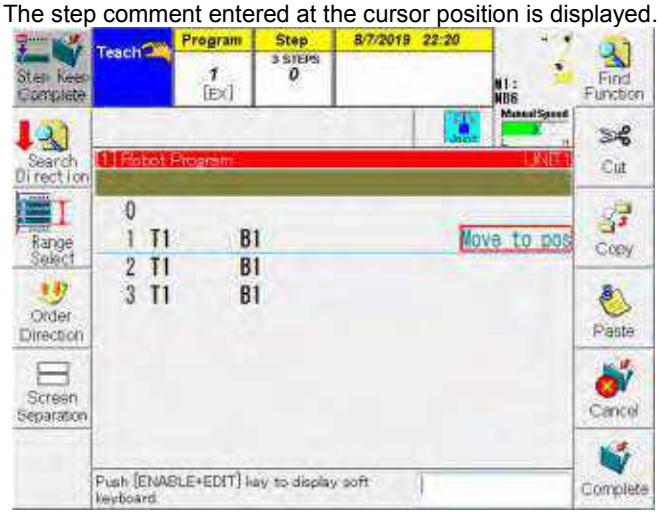




3 **Hold [ENABLE] and press [Edit].**
>>The soft keyboard is displayed.

4 **Enter the step comment using the soft keyboard, and press f12 <Complete>.**

>> The step comment entered at the cursor position is displayed.



5 **Press f12 <Complete>, and the step comment is written to the program.**

If a step comment is already input, it can be edited using the same procedure.

Programs which step comments are written to require data space enough to save them. For this reason, the number of steps that can be registered to one program is smaller compared to programs that do not have step comments. If step comments are added to a program that has many steps, “A2150: Too many steps” may be displayed. As explained in “4.3.8 Number of recordable steps,” use the program call etc. to divide the program so that the number of steps does not exceed 300 per program.

The maximum number of steps that can be assigned differs depending on the number of characters in the step comment etc.

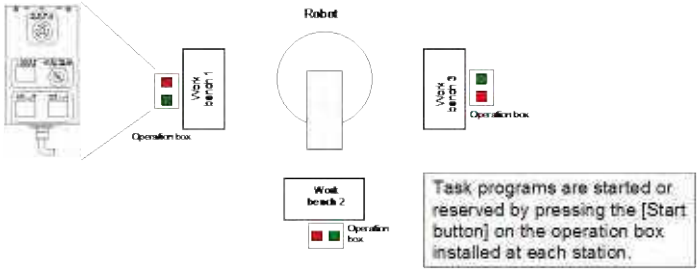
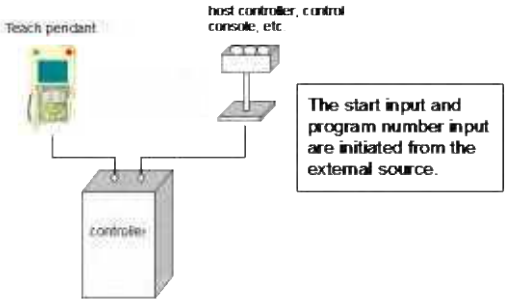
Before starting auto operation

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

Methods of starting automatic operation

There are three methods for starting operation. Table 5.1.1 indicates the starting methods. Normally, the starting method is set prior to shipment or prior to delivery according to the customer's specifications.
The operation method for automatic operation differs according to the start method used. Read through the section of the following explanation that corresponds to customer start method.

Table 5.1.1 Start method

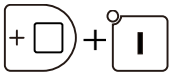
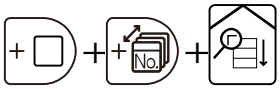
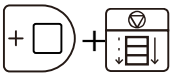
Start method	Details
Multi-station Start	This is the method that starts/reserves the program by pressing the [START BUTTON] on the start box or control box installed at each station. The programs to be started are allocated ahead of time for each station. (The teach pendant is used for the allocation.) 
Internal start	This is the method that runs the program selected by the Teach Pendant as is. Start and stop using the operation box (station 1) or the teach pendant.
External start	The series of tasks relating to automatic operation include start, program selection and stop are input from an external device such as a host controller or control console in front of the operator.  In this case, the start signal and program select signal from the external device must be set ahead of time so that they will be input to the basic input signal "external start" and "program select bits" of the controller. In addition, the signal reading method (binary, discrete or BCD) must be specified. For further details, refer to the Installation Manual part of the operating instructions.

Notations for buttons used in automatic operation

When doing automatic operation (playback) either with an internal start or station start, the [MOTOR ON BUTTON], [START BUTTON] button and [STOP BUTTON] are used.

These buttons are located on the operation box on the front of the controller (station 1), the start box (station 2 and later) and the teach pendant.

Table 5.1.2 Buttons needed for automatic operation (playback)

Installation location / Button (Notations in this chapter)	Operation Box	Start Box	Teach Pendent
[MOTOR ON BUTTON]		None	
[START BUTTON]			
[STOP BUTTON]			

POINT

In factory default settings, the [START BUTTON] on the Teach pendent is disabled.

If you start automatic operation from the Teach pendent, set the [Starting key] to "Enabled" by selecting the menu <Constant Setting>- [7 f-Keys]-[11 Starting key].

5.1.3 Playback methods (5 operation modes)

There are five operation modes for the playback methods. One of these modes is selected prior to playback, but the mode can also be selected during playback.
Either “Cycle” or “Continuous” is selected during actual operations. All the other modes are selected when checking what has been taught or when trying out an auto operation.

Table 5.1.3 Playback methods

Playback methods	Details
Step	• While the [START BUTTON] is held down, one step of the program is executed. (When it is released, the robot stops.) • To advance to the next step, press the [START BUTTON] again.
Cycle	• When the [START BUTTON] is pressed once, the program is executed once from start to end. • When the last step is reached, the robot stops.
Cycle step by step	• When the [START BUTTON] is pressed, one step of the program is executed, and the robot stops. • To advance to the next step, press [ENABLE] + f8 <Step by Step>. • When the last step is reached, the robot stops.
Continue	• When the [START BUTTON] is pressed, the program is executed repeatedly.
Continuous step by step	• When the [START BUTTON] is pressed, one step of the program is executed, and the robot stops. • To advance to the next step, press [ENABLE] + f8 <Step by Step>. • When the last step is reached, operation returns to the first step, and the program is executed again.

5.1.4 Specifying the step which playback starts

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

Table 5.1.4 Specifying the step from which playback starts

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

POINT

In case of the factory default setting, it is not possible to playback a program from a function command step. To make it possible, it is necessary to make a setting. For details, refer to "7.12 Selecting a Function Command Step and operating". And, there are some function commands that cannot be designated as a start step even if this setting is made.

5.1.5 Operating speed when the start step is specified

When a step other than step 0 has been selected from the teach pendant and playback has been started, the robot moves from the current position to the specified start step at the safety speed (less than 250 mm/sec.). This operation prevents unforeseen interference and other trouble resulting from the operator selecting the incorrect step. The safety speed restriction is canceled starting from the next step.
If the selected step (any step except 0) is a function command, the safety speed restriction comes into effect for the first operation to the movement command step. In the default settings, playback cannot be performed with a function command step selected. For details, see "7.12 Selecting a Function Command Step and Operating."
If a start step is selected for the program start (namely, step 0), the program runs at normal speed instead of safety speed.
If, for instance, step 2 is selected from the teach pendant to start the operation, the robot will move at the safety speed until step 2. From step 3 onward, it will move at the specified speed.

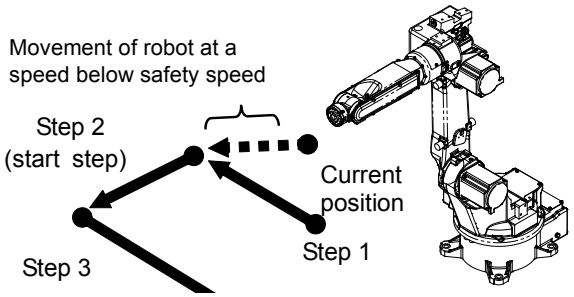


Fig. 5.1.1 Robot movements at safety speed

WARNING

If <Service Utilities> - [1 Teach/Playback Conditions] – [20 Recover to stopped position] is set to [Enabled], and [After Step Set] in the detailed conditions is set to [Current position], the robot operates at the specified speed, not the safety speed.
Restart operation after checking operation in advance using the check operation.

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

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

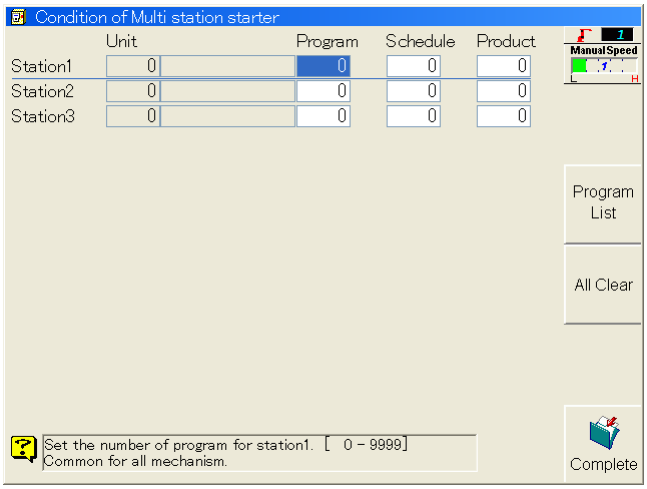
Allocating the programs to be started to stations

It is necessary to allocate the programs to be started to stations in advance for the multi-stage station method.
The program is allocated in the teach mode.

1 Press <Station Set>.

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

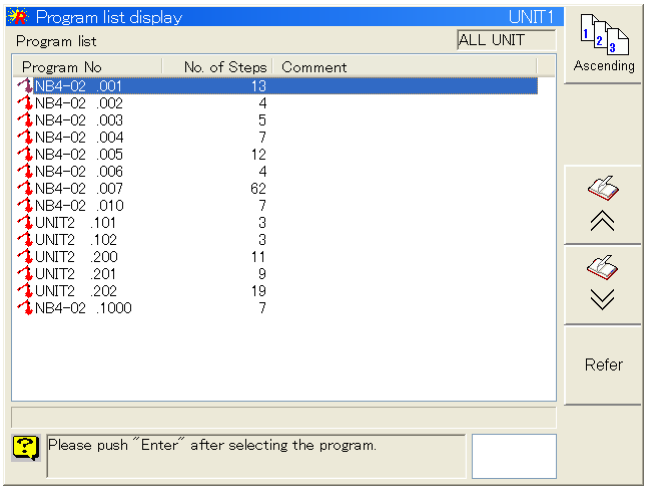
>> The allocation screen now appears.
The screen below shows a case with three stations.



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

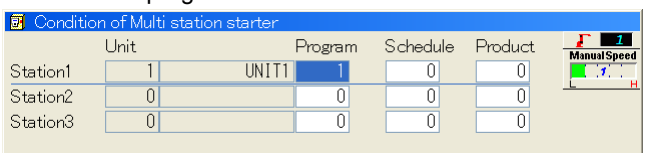
3 To facilitate the setting, press f9 <Program List> while the cursor is in the "Program" column.

>> A list of programs is now displayed.



4 **Select the program, and press [Enter].**

>> The selected program is allocated.



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

>> The allocation is stored in the memory.

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

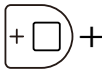
Start the program

Upon completion of the allocation, start the task program.

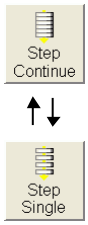
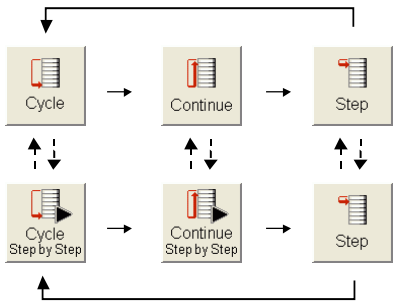
1 **Establish the playback mode.**

At this time, the program selected in the teach mode becomes deselected (as the select program is not started in multi-station startup, the program becomes deselected immediately after switching to the playback mode).

When one of the station start buttons is pressed, the program number and program details of the program allocated to that station are displayed, and playback starts.



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

f4	f5	Operation
		• When f4 is set to step continuous, the mode is switched from “Cycle” → “Continue” → “Step” every time f5 is pressed. • When f4 is set to single step, the mode is switched from “Cycle Step by Step” → “Continuous Step by Step” → “Step” every time f5 is pressed. • When f4 is pressed while f5 is at any setting, single is switched to continuous or continuous is switched to single.

3 **Press the [MOTOR ON BUTTON] on the operation box.**

>> The motor power is now turned on. The [MOTOR ON BUTTON] lights.

This now completes the preparations for auto operation.

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

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

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

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

Reservations can be made for a multiple number of stations.

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

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

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

>> The reservation is now canceled.

Operations in different operation modes

Operations in five operation modes are described here.
The explanation given below describes the start and stop methods using the [START BUTTON] and [STOP BUTTON].
When the external start method is used, read the following as the alternatives of the [START BUTTON] and [STOP BUTTON].

Fig. 5.5.1 Alternatives for the [START BUTTON] and [STOP BUTTON]

	When the external start method is used
Press the [START BUTTON].	Input the start signal.
Press the [STOP BUTTON].	Input the stop signal.

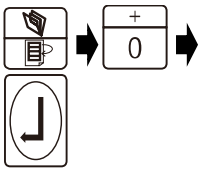
Before initiating playback, check that no one is near the robot.
If the robot should come into contact or sandwich a person, death or serious injury may result.

Step playback

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

1 Select step playback.

2 Specify the step at which playback is to start.



To play back from the start of the program, press [PROG/STEP], [0] and then [Enter].
>> The cursor now moves to step 0.

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

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

3 Press [START BUTTON].
>> While the button is held down, the robot moves from the current position to the specified step.

4 In the step playback mode, the robot stops at the next step.
To continue playback, press the [START BUTTON] again.
>> While the button is held down, the robot moves again to the next step.

Cycle playback

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

1 **Select cycle playback.**

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

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

4 **Press the [STOP BUTTON] to stop during an operation.**

5 **To restart the robot, press the [START BUTTON] again.**

Continuous playback

Proceed as follows to initiate continuous playback.

1 **Select continuous playback.**

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

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

4 **Press the [STOP BUTTON] to stop during an operation.**

5 **To restart the robot, press the [START BUTTON] again.**

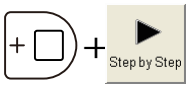
Cycle playback (step by step)

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

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

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

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



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

Continuous playback (step by step)

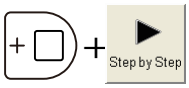
Proceed as follows to perform cycle playback in the step by step mode.

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

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

3 **Press [START BUTTON].**

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



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

>> The robot operates as far as the next step.
Repeat this procedure and check.
When the last step is reached, the robot operates again from the first step.

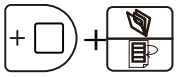
Copying, deleting and renaming programs

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

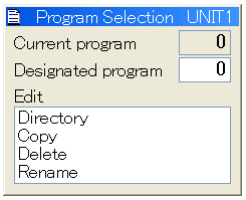
6.1.1 Copying programs

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

Copying programs

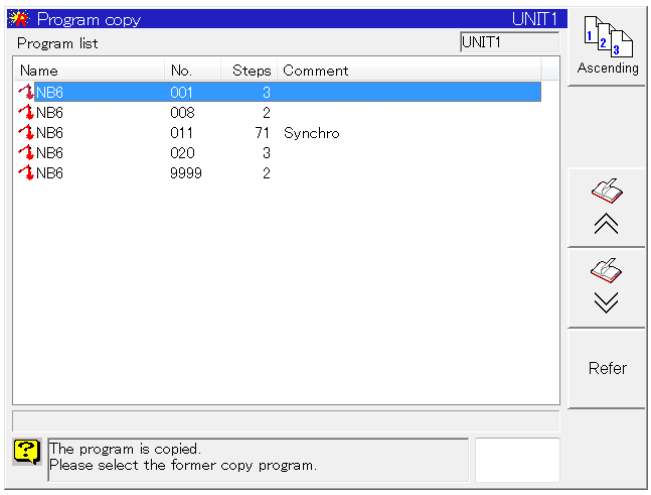


1 **While holding down [ENABLE], press [PROG/STEP].**
>> The [Program Selection] window now opens.



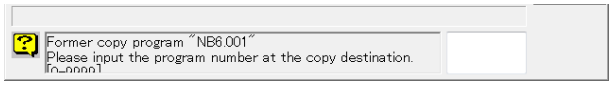
2 **Select “Copy.”**

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



4 **Select the programs to be copied.**
If the programs do not fit into 1 screen, they are displayed over multiple pages.
In this case, search the program targeted for the operation using f9 <⩓> or f10 <⩔>.

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



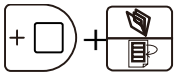
Number input

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

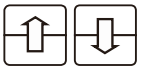
Deleting programs

How to delete programs is described here. The operations described here enable a single program to be selected and deleted. To specify a multiple number of programs and delete them, refer to page 6-20 “6.6 Deleting files”.

Deleting programs

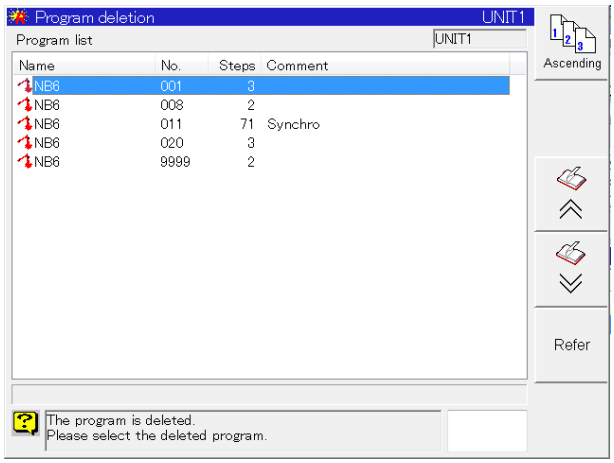


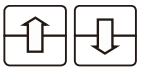
1 **While holding down [ENABLE], press [PROG/STEP].**
>> The [Program Selection] window now opens.



2 **Select “Delete.”**

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





4 **Select the program to be deleted.**
If the programs do not fit into 1 screen, they are displayed over multiple pages.
In this case, search the program targeted for the operation using f9 〈^〉 or f10 <v>.

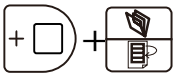
5 **Press [Enter].**
>> A confirmation screen now appears.

6 **Select “OK” and press [Enter].**
>> The program is deleted, and the operation returns to the previous screen.

Renaming (renumbering) programs

How to rename (renumber) programs is described here.

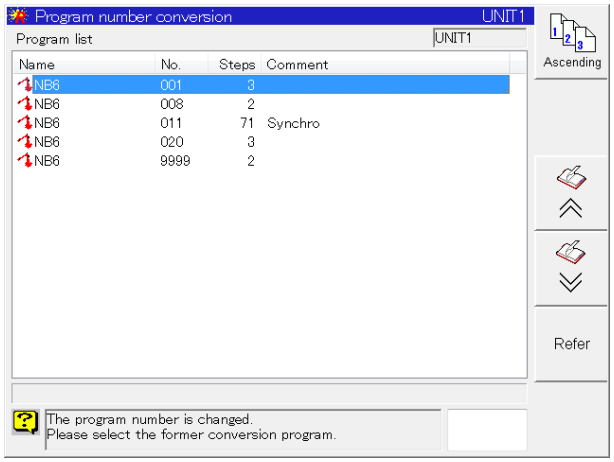
Rename the program.

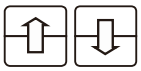


1 **While holding down [ENABLE], press [PROG/STEP].**
>> The [Program Selection] window now opens.

2 **Select “Rename.”**

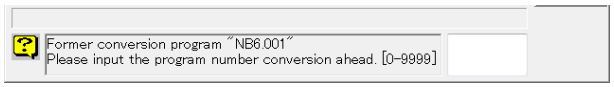
3 **Press [Enter].**
>> The [Program number conversion] screen now appears.





4 **Select the program to be changed.**
If the programs do not fit into 1 screen, they are displayed over multiple pages.
In this case, search the program targeted for the operation using f9 <⩓> or f10 <⩔>.

5 **Press [Enter].**
>> The new program number can now be input.



6 **Input the number of the program after changing, and press [Enter].**
>> A confirmation screen now appears.

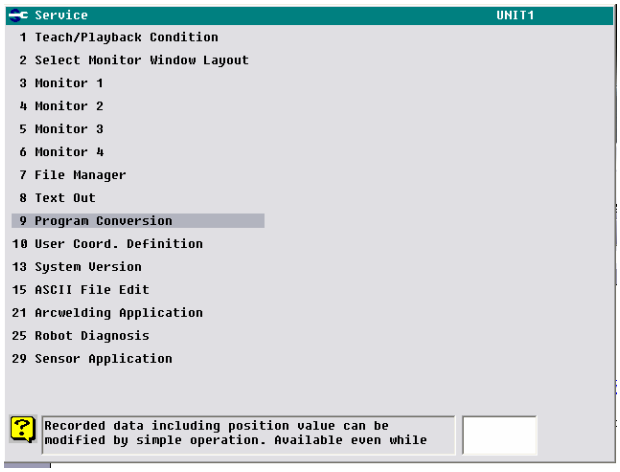
7 **Select “OK” and press [Enter].**
>> The number of the program is changed, and the operation returns to the previous screen.

SHIFTING A PROGRAM WITH THE MODEL FD SERIES CONTROLLER

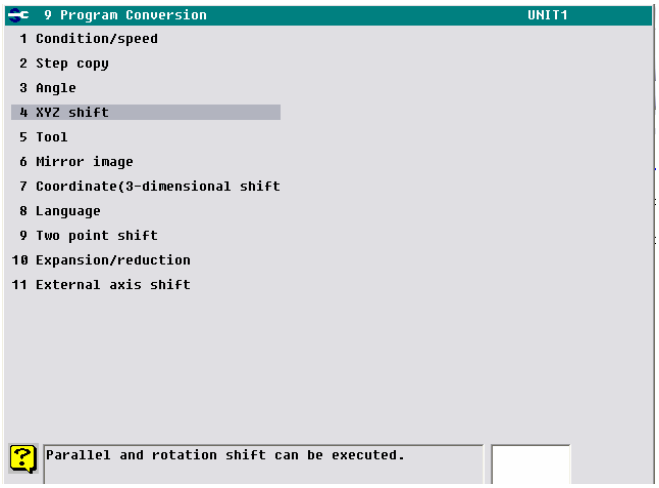
The following describes how to use the XYZ Shift function.

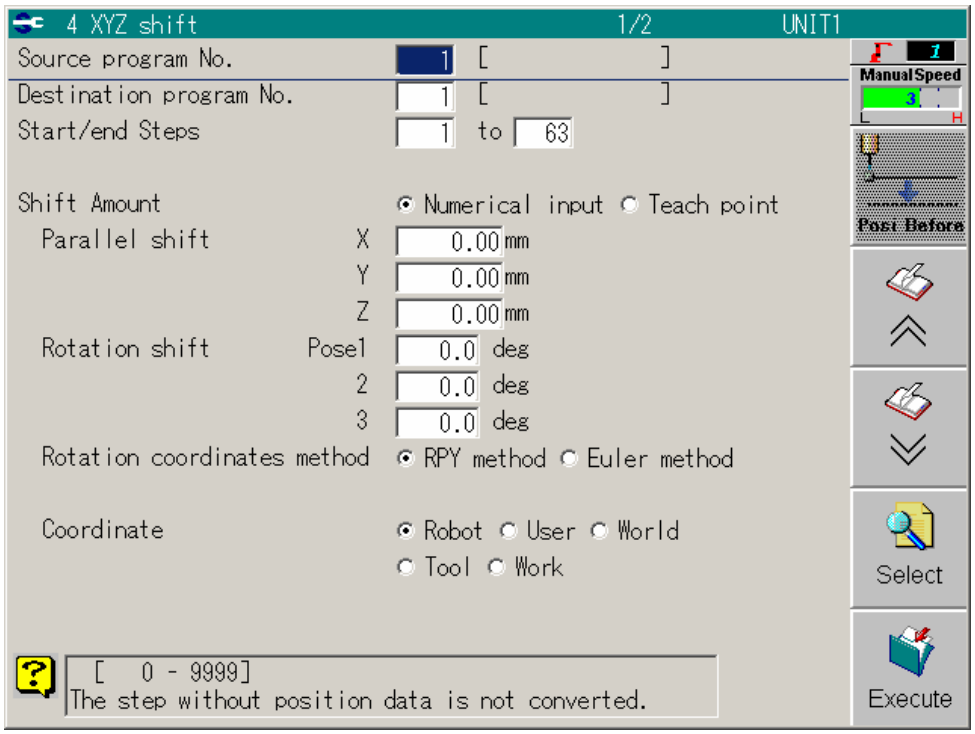
NOTICE: It is strongly recommended that you copy the target program and work off of the copied program before shifting the original.

- Press the **enable key + F6 key** (Service Utilities). You are now in the service menu.
- Move your cursor down to number 9 (Program Conversion) and press enter. **See Illustration 1:**



You are now in the Program Conversion menu. You will notice that there are a few different methods of program shifting available to you. We will use the most common which is number 4 (XYZ Shift). **See Illustration 2:**

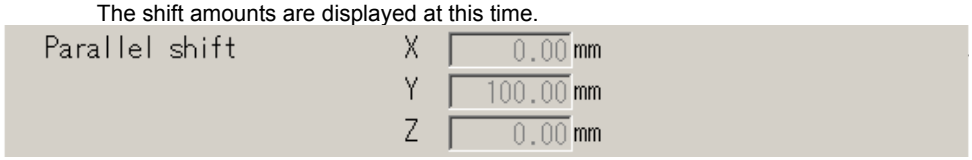




Steps with function commands are not changed by this conversion.

● Operation when specifying the shift amounts using memory positions

(1) Open the shift program, and use check GO to move to the reference position (any move command step) prior to shift conversion.
(2) Select this menu.
(3) Input the pre-conversion program number, post-conversion program number and step range.
(4) Change the target of manual operation over to the shift target mechanism.
(5) If the specification of the reference position prior to shift conversion was overlooked in step (1) or the reference position is to be changed, press f8 <Pre-conversion reference>. The current mechanism position now serves as the reference position.
Normally, the position at the time when parallel shift was selected is automatically set as the reference position.
(6) Manually operate the mechanism as far as the position after shift conversion.
(7) Press f11 <Post-conversion reference>. The current mechanism position now serves as the reference position after shift conversion.
The shift amounts are displayed at this time.



(8) Press f12 <Complete>.

Parallel shift is now executed. Open the post-shift program, run a check, and confirm the positions and poses.

CAUTION

When shift amounts are to be specified using memory positions, manual operations are involved so this operation cannot be selected in the playback mode.

Recording function commands

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

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

Some typical function commands are shown below.

Table 4.6.1 Typical function commands

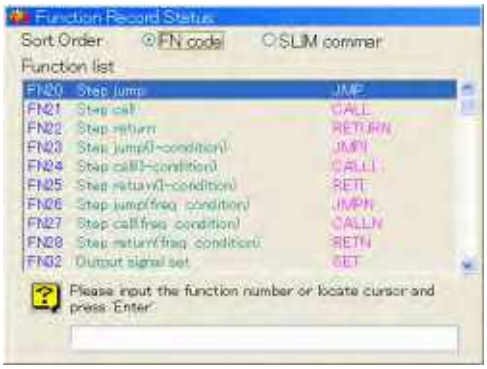
Function Command (SLIM)	Function number	Title	Description of function
SET	FN32	Output signal ON	The specified output signal is set to ON.
RESET	FN34	Output signal OFF	The specified output signal is set to OFF.
DELAY	FN50	Timer	This causes the robot to stand by for the specified time.
CALLP	FN80	Program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

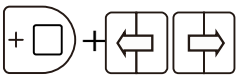
Directly selecting a command with the function numbers

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

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

1 **Press [FN] at the position where the function command is to be recorded.**
>> The list of function commands is now displayed.





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

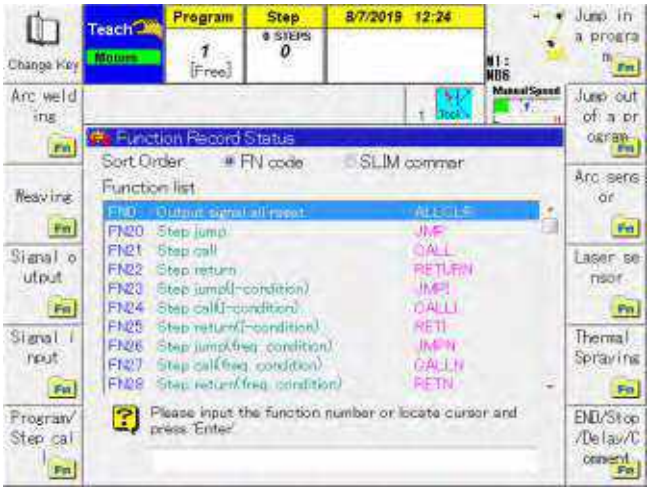
3 **Either select the function command from the list or input its function number, and press [Enter].**

Selecting from categorized groups

This section explains how to select function commands from categorized groups. This method is useful since it allows you to find the command you want to record from among categorized groups, even if you don't remember the function number.
To make a selection by group, it is necessary to have [Constant Setting] — [5 Operation Constants] — [1 Operation condition] — [11 Selection of a function] set to "Group". These settings become the default status for the robot set in <<Operating mode A>>.

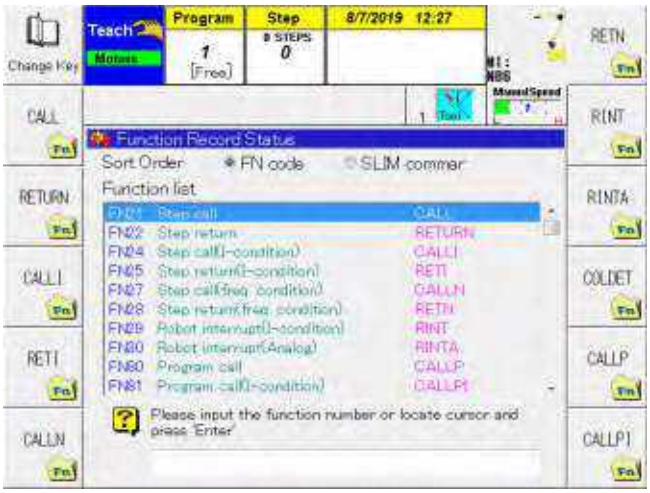
Selecting function commands (When selecting from categorized groups)

1 **Press [FN] at the position where the function command is to be recorded.**
>> The function groups will be displayed on the f keys.



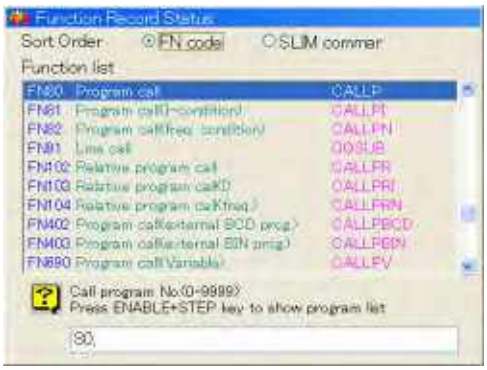
2 **Selecting a program call (CALLP) is given here as an example.**
Press f6 <Program/Step call>.

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



3 **Press f10 <CALLP>.**

>> The program call command is now selected.



It can also be selected using the following methods.

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

Setting and recording function command parameters (conditions)

This section describes how to input and record parameters (conditions) after the function commands have been selected.
Recording the output signal ON command (SET <FN32> function command) will be used here as an example.

Setting and recording function command parameters (conditions)

1 **Either select the output signal ON command (SET) from the list or input its function number (FN32), and press [Enter].**
>> The output signal ON command is now selected.

2 **Input the number of the output signal using the [Number input keys].**
The parameters which are to be set and their input ranges are displayed on the screen.

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

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

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

3 **Upon completion of the parameter settings, press [Enter].**
>> The output signal ON command is now recorded.

Function commands (FN codes)

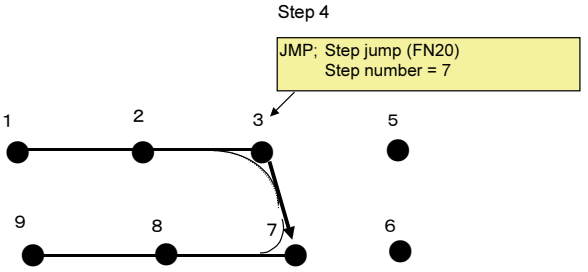
Command name	JMP
FN code	20
Title name	Step jump
General description	The robot jumps to the step specified in the same program.

■ General description

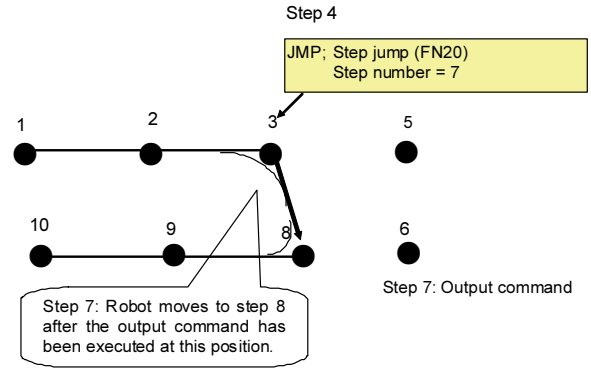
When this function command is executed, the robot is able to jump to the step specified in the same program. It makes no difference whether the jump destination step is a move command or function command.
Bear in mind that if the jump destination step is a function command, the function command at the jump destination will be executed as soon as the jump command has been executed.

■ Example of operation

In step 4, record JMP: step jump (FN20), and 7 as the number of the jump destination step. When this is played back, the robot skips steps 5 and 6 upon arriving at step 4 and jumps to step 7.



The robot is not decelerated by this command. If positioning is not specified, the command is executed at the position reached by the robot in the accuracy range of the move command immediately before.



■ Parameter

Parameter No. 1	Step No.	This specifies the number of the step serving as the robot's jump destination. (1-9999)

■ Example of screen display

JMP[35] FN20; Step jump

See
JMPI: Conditional step jump (FN23)
JMPN; Conditional step jump after specified number of passes (FN26)

Function commands (FN codes)

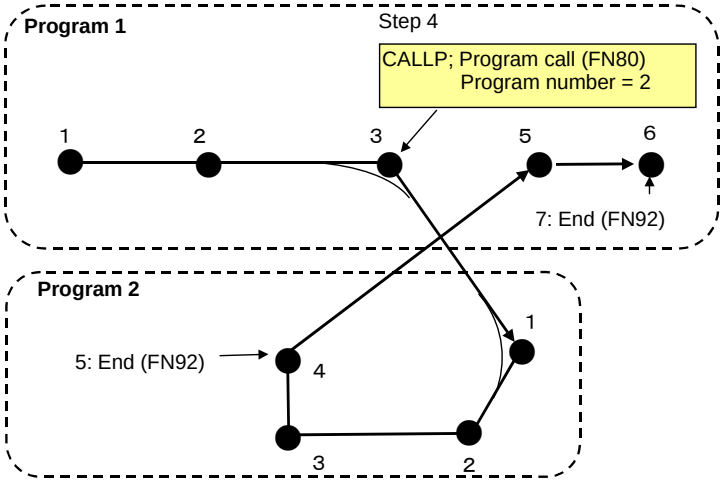
Command name	CALLP
FN code	80
Title name	Program call
General description	This command is used to call the specified program.

■ General description

When this function command is executed, the specified program is called.
Bear in mind that if a function command has been recorded in the first step in the call destination program, the function command at the jump destination will be executed as soon as the call command has been executed.
When the playback of the program at the call destination is completed (in the status established by executing the END command), the robot returns to the step following the step with the call command of the call source program.

■ Example of operation

In step 4, record CALLP: program call (FN80) and "2" as the program number. When this is played back, the robot skips steps 5 and 6 upon arriving at step 4 and jumps to the first step in program 2. When the playback of program 2 is completed (in the status established by executing the END command), the robot returns to step 5 following the step with the call command of call source program 1.



The robot is not decelerated by this command. If positioning is not specified, the command is executed at the position reached by the robot in the accuracy range of the move command immediately before.

The program call can be executed again at the call destination (during program 2 in the above figure.) 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.

■ Parameter

Parameter No. 1	Program No.	This specifies the number of the program serving as the call destination. (1-9999)

■ Example of screen display

CALLP [2] FN80; Program call

See
CALLPI: Conditional program call (FN81)
CALLPN: Conditional program call after specified number of passes (FN82)

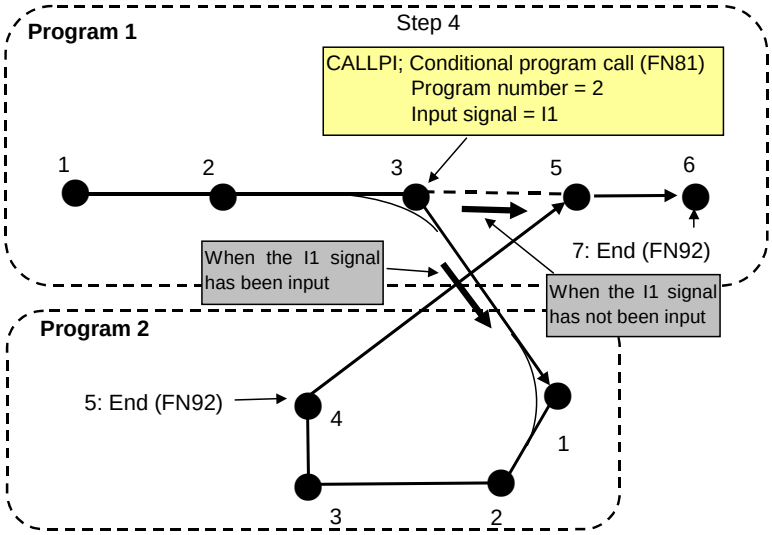
Command name	CALLPI
FN code	81
Title name	Conditional program call
General description	Using an input signal, this command is used to call the specified program.

■ General description

When this function command is executed, the specified program is called. When the specified input signal has been input, the step is called; when it has not been input, the step is not called and the robot passes the command by.
Bear in mind that if a function command has been recorded in the first step in the call destination program, the function command at the jump destination will be executed as soon as the call command has been executed.
When the playback of the program at the call destination is completed (in the status established by executing the END command), the robot returns to the step following the step with the call command of the call source program.

■ Example of operation

In step 4, record CALLPI: conditional program call (FN81), "2" as the program number, and I1 as the input signal.
When this is played back, the robot arrives at step 4, and if input signal I1 has been input, it jumps to the first step in program 2, and when the playback of program 2 is completed (the END command is executed), the robot returns to step 5 following the step with the call command of call source program 1. If the signal has not been input, the robot does not jump to program 2.



The robot is not decelerated by this command. If no positioning is specified, the input signal is inspected just before the command value reaches the accuracy range of the move command, and if it has been input, an inside arc is drawn. If the input signal has not been input, the command value heads toward the recorded point, and the input signal is inspected when the robot has reached the accuracy range.

The program call can be executed again at the call destination (during program 2 in the above figure.) 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.

■ Parameter

Parameter No. 1	Program No.	This specifies the number of the program serving as the call destination. (1-9999)
Parameter No. 2	Input signal	This records the number of the input signal which is to serve as the condition for executing the call. When number 5101 or above is specified, multiple input signals can be specified. (1-2048、5101—5196)

■ Example of screen display

```
CALLP [2,I1]      FN81; Conditional program call
```

See
CALLP: Program call (FN80)
CALLPN: Conditional program call after specified number of passes (FN82)

Function commands (FN codes)

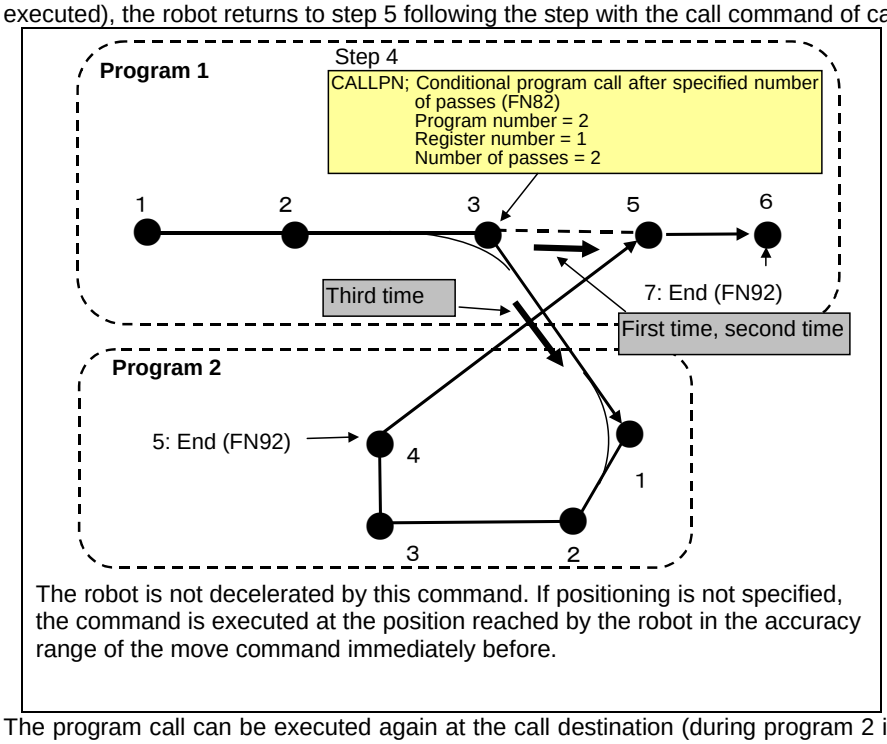
Command name	CALLPN
FN code	82
Title name	Conditional program call after specified number of passes
General description	Using a pass count (number of passes), this command is used to call the specified program.

■ General description

When this function command is executed, the specified program is called. The robot passes for the specified number of passes, and on the next time (specified number of passes +1) the call command is executed. (For instance, if "2" is specified as the number of passes, the robot passes twice, and on the third time the call command is executed.)
Bear in mind that if a function command has been recorded in the first step in the call destination program, the function command at the jump destination will be executed as soon as the call command has been executed.
When the playback of the program at the call destination is completed (in the status established by executing the END command), the robot returns to the step following the step with the call command of the call source program.

■ Example of operation

In step 4, record CALLPN: conditional program call after specified number of passes (FN82), "2" as the program number, "1" as the register number, and "2" as the number of passes.
When this is played back, the robot passes by for the first and second times, and then advances to steps 5; however, on the third time, it jumps to the first step in program 2. When the playback of program 2 is completed (the END command is executed), the robot returns to step 5 following the step with the call command of call source program 1.



The robot is not decelerated by this command. If positioning is not specified, the command is executed at the position reached by the robot in the accuracy range of the move command immediately before.

The program call can be executed again at the call destination (during program 2 in the above figure.) 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.

A global integer variable common to all units is used for the number of passes.
The current number of passes can be referenced using monitor/integer variables.

■ Parameter

Parameter No. 1	Program No.	This specifies the number of the program serving as the call destination. (1-9999)
Parameter No. 2	Register number	A "register" refers to the memory used for counting. Since an integer variable (1 to 200) is used, this parameter specifies its number. (1-200)
Parameter No. 3	Number of passes	This records the number of passes which is to serve as the condition for executing the call. The robot passes for the specified number of passes, and on the next time (specified number of passes +1) the call command is executed. (0-10000)

■ Example of screen display

```
CALLPN [2, V1%, 2]    FN82; Conditional program call after
                            specified number of passes
```

See
CALLP: Program call (FN80)
CALLPI: Conditional program call (FN81)

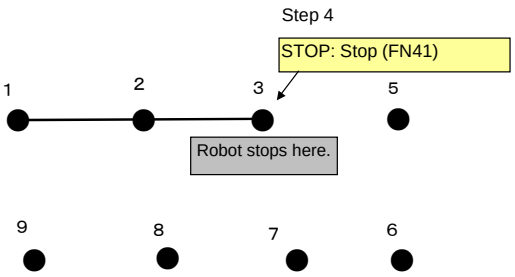
Command name	STOP
FN code	41
Title name	Stop
General description	This command is used to stop the robot.

■ General description

When this function command is executed, the robot is stopped.
The robot will not start unless the start command is input again.

■ Example of operation

In step 4, record STOP: stop (FN41).
When this is played back, the robot stops at step 4. This command does not establish the program end status (status established by executing the END: FN92 command to end the program): this means that the robot will head to step 5 without returning to the first step if it is restarted at the step 4 position. This should be borne in mind.



The robot stops after reaching the recorded point regardless of the accuracy of the move command immediately before.

■ Parameter

None

■ Example of screen display

STOP FN41; Stop

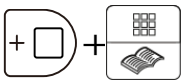
See
STOPI: Conditional stop (FN42)
END: End (FN92)

Using the quick access menu

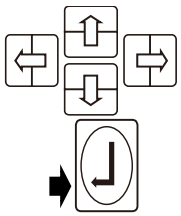
The quick access menu allows you to quickly select functions and setting items you use frequently.
Even operations normally embedded in layers of menus can be performed quickly by saving them in the quick access menu.
The “Favorites Menu” and “Used Frequently Menu” are in the quick access menu.
Up to 72 frequently used functions can be saved in advance for use in the favorites menu.
The frequently used menu contains the 9 items you use most frequently.

7.1.1 Using the favorites menu

Using the favorites menu



1 **Press [HELP/QUICK ACCESS] while pressing and holding [ENABLE].**
You can also display it by pressing f7 <Favorites> on the frequently used menu screen.
>> The [Favorites Menu] screen is displayed.



2 **Select a function you want to use, then press the [Enter] key.**
>> The settings screen for the selected function is displayed.

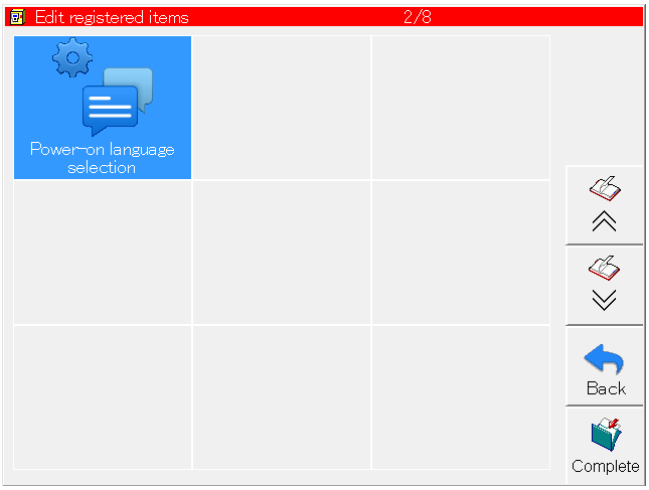
POINT

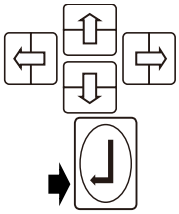
You can set whether the “Favorites Menu” or the “Frequently Used Menu” is displayed when pressing [ENABLE] and [HELP/QUICK ACCESS].

Adding favorites

1 **Press f8 <Edit> in the favorites menu screen.**

>> The [Edit Saved Items] screen is displayed.





2 **Select an empty block and press [Enter].**

>> The function selection screen is displayed.

3 **Select a function to add to your favorites.**

>> If the function can be saved, the confirmation screen is displayed.

4 **Press [OK] to save.**

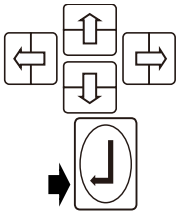
5 **Once all settings are completed, press f12 <Write>.**

>> The favorites menu is saved.

Editing favorites

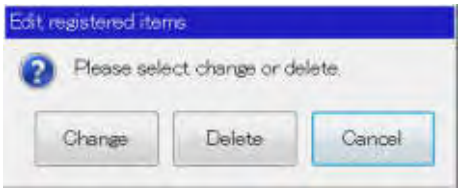
1 **Press f8 <Edit> in the favorites menu screen.**

>> The [Edit Saved Items] screen is displayed.



2 **Select saved favorites and press [ENTER].**

>> The screen for editing saved items is displayed.



Change: Replace the selected item with a different function.

Delete: Delete the selected item.

3 **Press [Change] or [Delete].**

>> If you press [Change], the function selection screen is displayed.
If you press [Delete], the selected item is deleted.

4 **Once all settings are completed, press f12 <Write>.**

>> The favorites menu is changed.

Using the frequently used menu

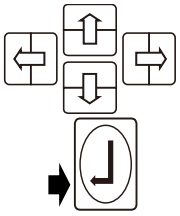
The nine functions you most frequently use are automatically displayed on the frequently used menu. This makes it easy to call up a function you use often.

Using the frequently used menu

1 **Press f7 <History> in the favorites menu screen.**

Depending on your settings, you can also display this screen by pressing [ENABLE] and [HELP/QUICK ACCESS].

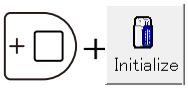
>> The [History Menu] screen is displayed.



2 **Select a function, then press the [Enter] key.**

>> The settings screen for the selected function is displayed.

Initializing the frequently used menu



1 **Press f8 <Initialize> while pressing and holding [ENABLE] on the frequently used menu.**

>> A confirmation screen is displayed.

2 **Press [OK] .**

>> Items on the frequently used menu are deleted.

Using short-cuts

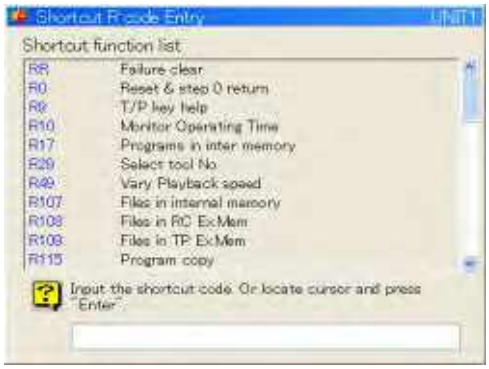
The controller comes with a short-cut function for selecting functions quickly.
Normally, even with operations where one menu is opened from another, a target operation can be quickly accessed simply by inputting a short-cut code (a number with up to 3 digits). It is a good idea to learn frequently used 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 **Press [R/HOME] on the teach or playback mode home screen.**

>> The [Shortcut R code Entry] screen now appears.

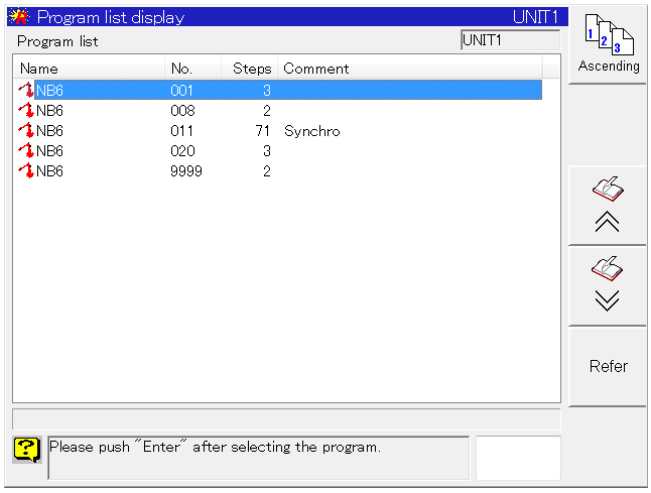


2 **If the number of the target function is not known, press the [up or down] key.**

>> 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.

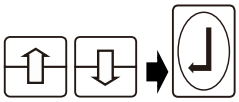
7.3.1 Starting a multiple number of monitors

As an example, the steps taken to allocate the display of the general-purpose input signals to monitor 2 and the display of the general-purpose output signals to monitor 3 will be described.

Starting a multiple number of monitors

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.

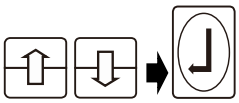


2 **Align the cursor with “7 User Inputs”, and press [Enter].**

>> Monitor 2 now starts.

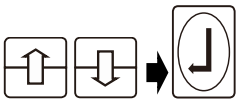
3 **Monitor 3 is set from the service menu. Press <Service Utilities>.**
(All four monitors 1 to 4 can be set from the service menu.)

>> 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

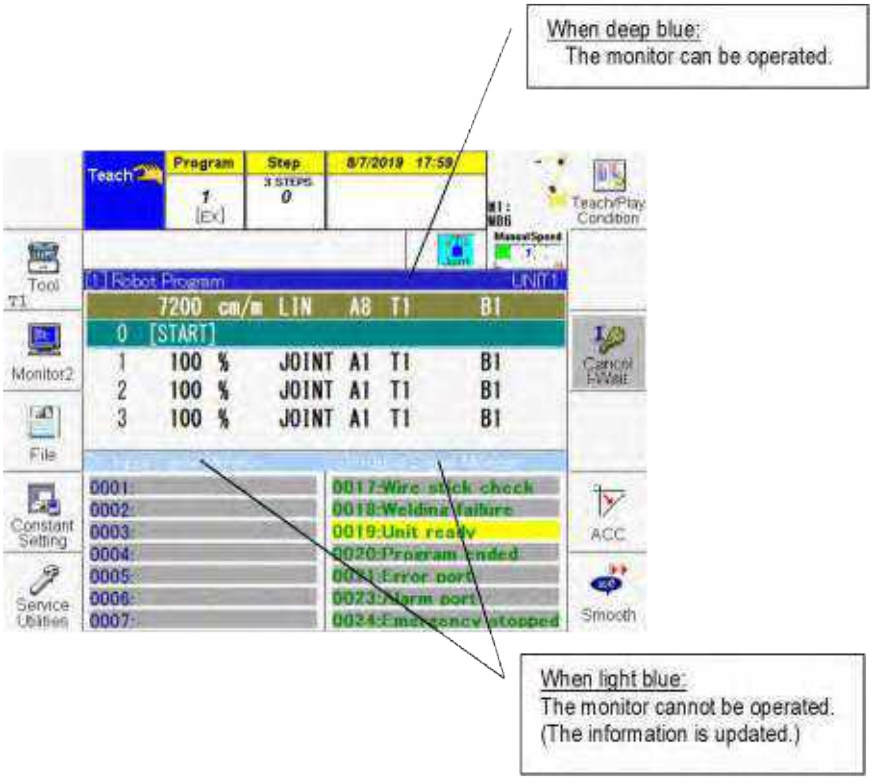
Any one of a multiple number of monitors started can be selected to be operated or closed.

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.



2 **To close a monitor, select the monitor to be closed, and while holding down [ENABLE], press [CLOSE/SELECT SCREEN].**

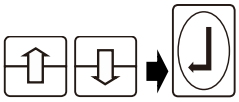
>> The monitor now selected is closed.

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.

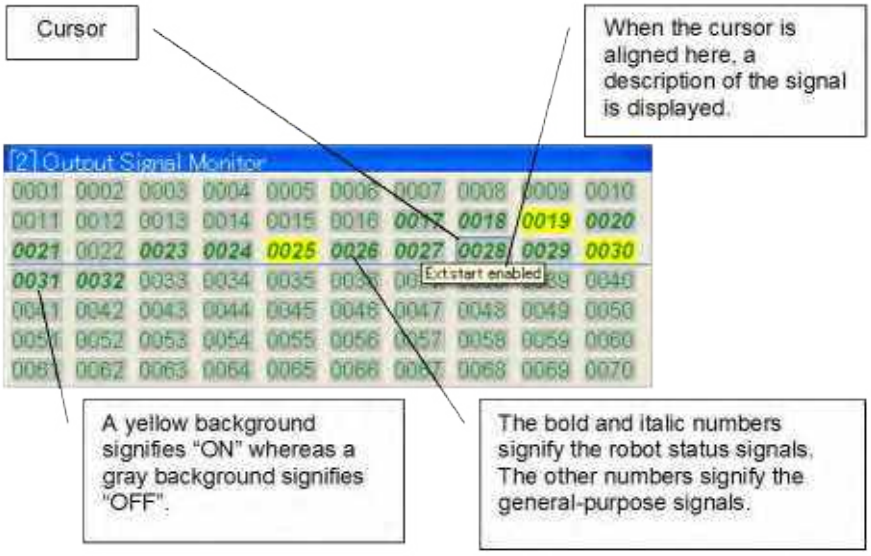
Using the general-purpose output monitor as an example, how to read the information and perform the operations on the monitor screen will be described below.

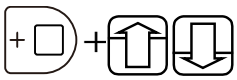
Operating the User Inputs and Outputs monitors



1 **By performing the steps on page 7-6, select “8 User Outputs”.**

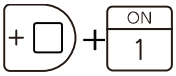
>> The statuses of general-purpose output signals 0001 to 2048 are now displayed.





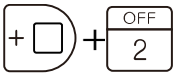
2 **There is a limit on the number of signals which can be displayed on one screen. To view the statuses of other signals, move the cursor using the up and down keys.**
When the up or down key is pressed while holding down [ENABLE], one page of information can be scrolled on the screen.

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.



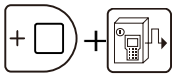
To set the signal to OFF, press [2] while holding down [ENABLE].

>> The specified signal is now set to OFF.

Setting the output signals ON or OFF manually

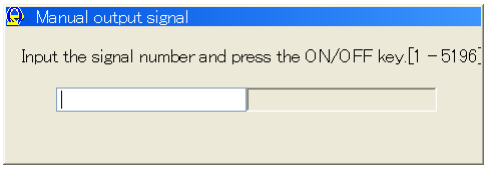
The output signals can be set to ON or OFF manually. (Each signal to be set to ON or OFF is specified using an output signal number.)
This function can be used in the teach mode or playback mode (step by step).

Setting the output signals to ON or OFF manually

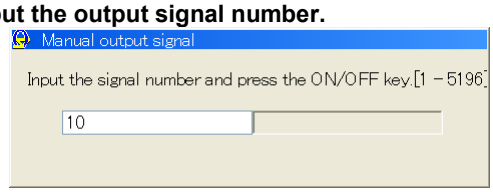


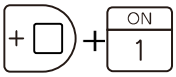
1 **While holding down [ENABLE], press [OUT].**

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



2 **Input the output signal number.**

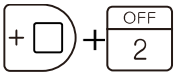




or

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.

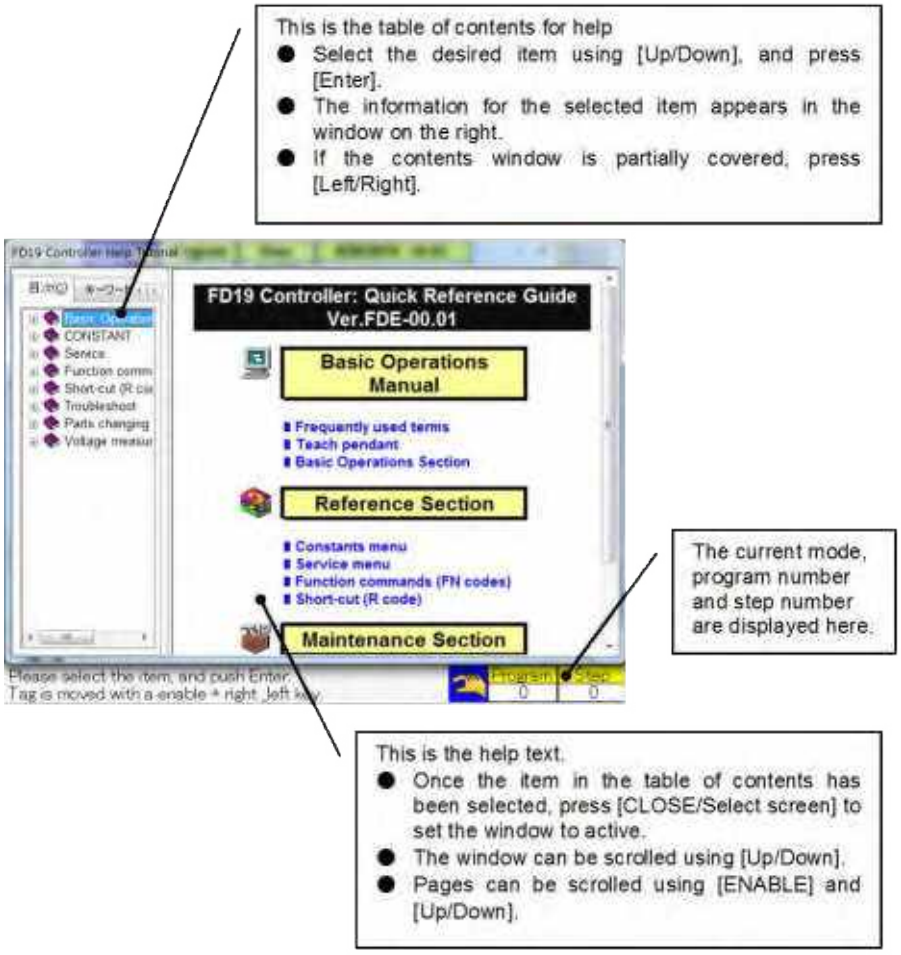
Calling the help top page

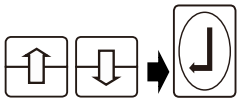
The best way to browse carefully through the help information from the beginning is to call the top page.
In order to call the top page, make sure that none of the functions has been selected, and press the [HELP] key.

Calling the help top page

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

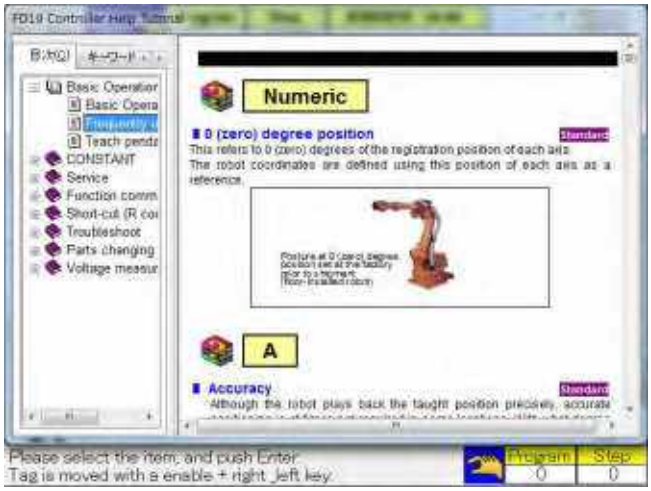
>> The help top page now appears.





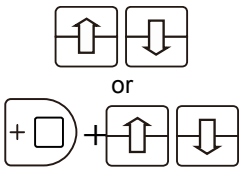
2 Select the item to be viewed using the [Up/Down] key, and press [Enter].

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

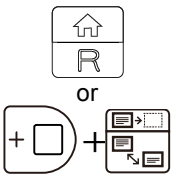


3 To manipulate the window showing the text information, press [CLOSE/ Select screen].

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



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



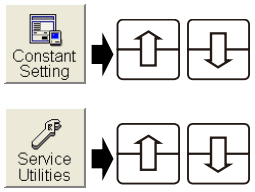
5 Press [R/HOME] or [ENABLE] and [CLOSE/SELECT SCREEN] to close help.

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.

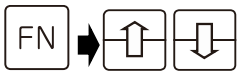
Directly calling a function to be checked out

1 Align the cursor bar with the menu.



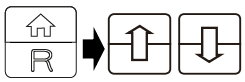
When the constants menu or service menu has been selected

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.

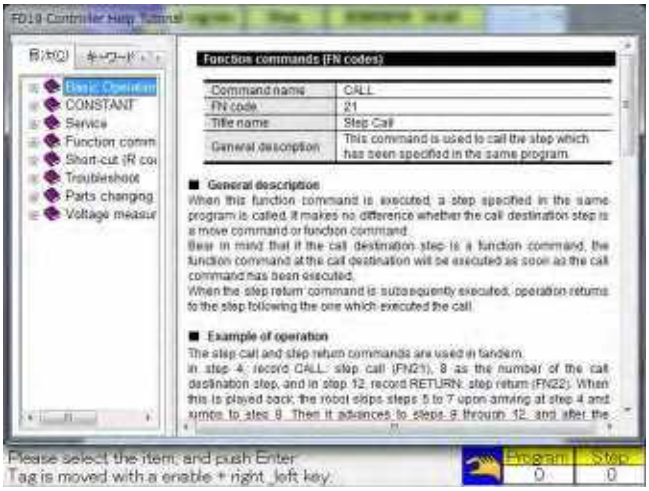


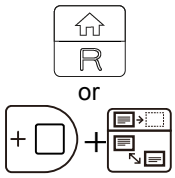
When a shortcut has been selected

Press [R/HOME] on the teach or playback mode home screen, then move the cursor bar to the function command you want to check.

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 **Press [R/HOME] or [ENABLE] and [CLOSE/SELECT SCREEN] to close help.**

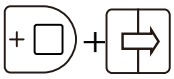
Searches using keywords

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

Searching using a keyword

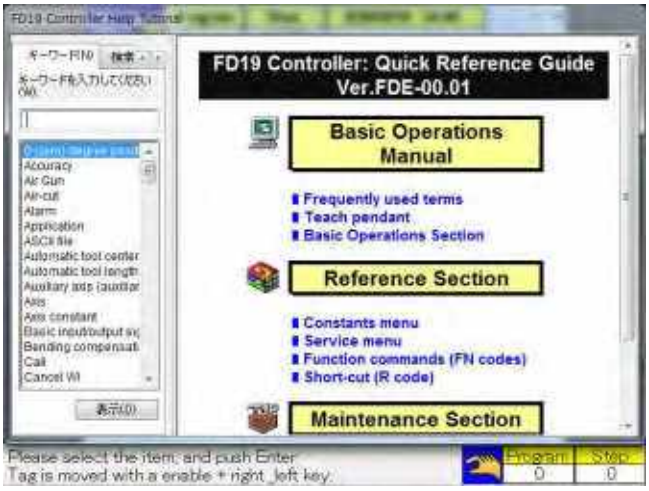
1 **Press [HELP].**

>> This calls help.



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

>> The index tab appears.

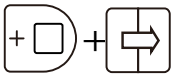


3 **In the Index tab, select the term using [Up/Down] and press [Enter].**

>> 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.

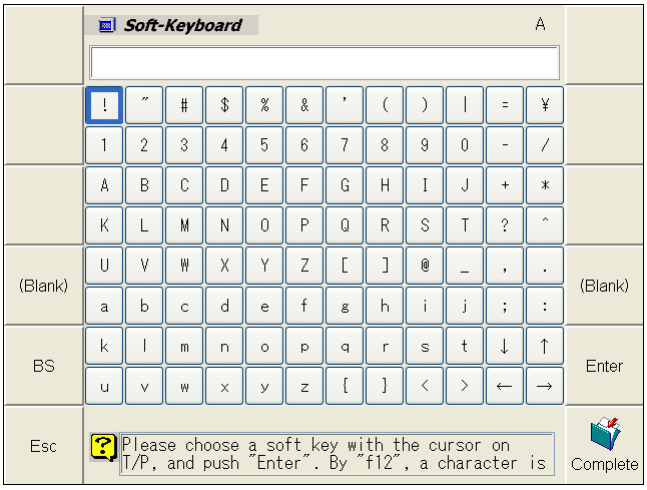


4 **While holding down [ENABLE], press [Right], and select the “Search” tab.**

>> The search tab appears.

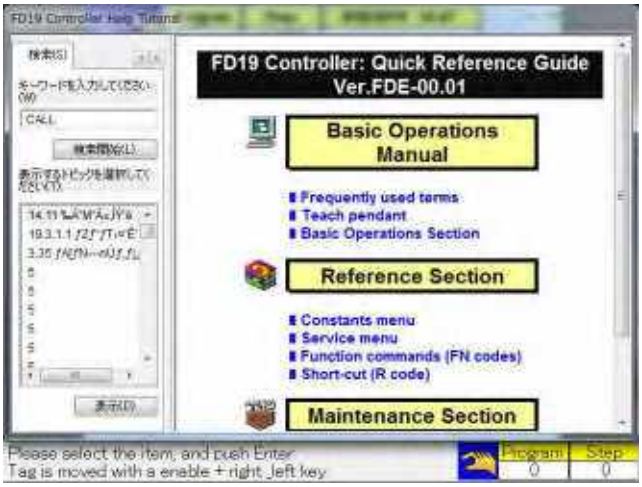
5 **Align the cursor with the “Type in the keyword to find:” field, and press [EDIT].**

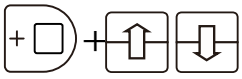
>> The soft keyboard now appears.



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

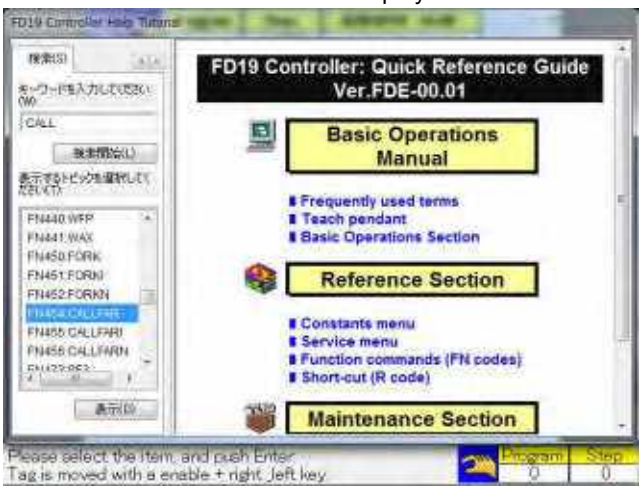
>> The help topics containing the keyword are now displayed.

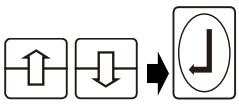




7 **While holding down [ENABLE], press [Up/Down], and move to the “Select Topic to display:” field.**

>> 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.

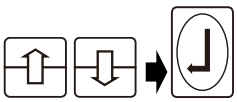
Displaying the T/P Key Help

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.



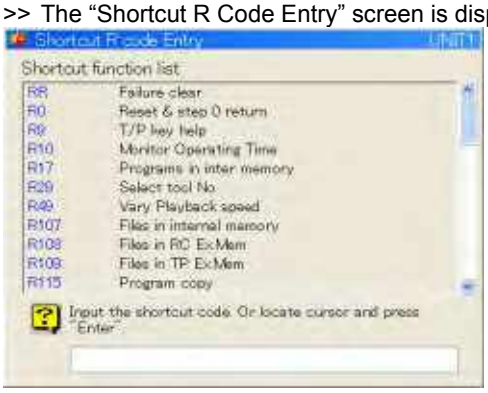
2 **Select "68 T/P Key help," and press [Enter]. Alternatively, enter the numbers [6] [8] directly into the edit box at the bottom, and press [Enter].**

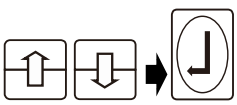
>> The T/P key help is displayed on the monitor screen.

Selecting from the shortcut function

1 **Press [R/HOME] on the teach or playback mode home screen.**

>> The "Shortcut R Code Entry" screen is displayed.

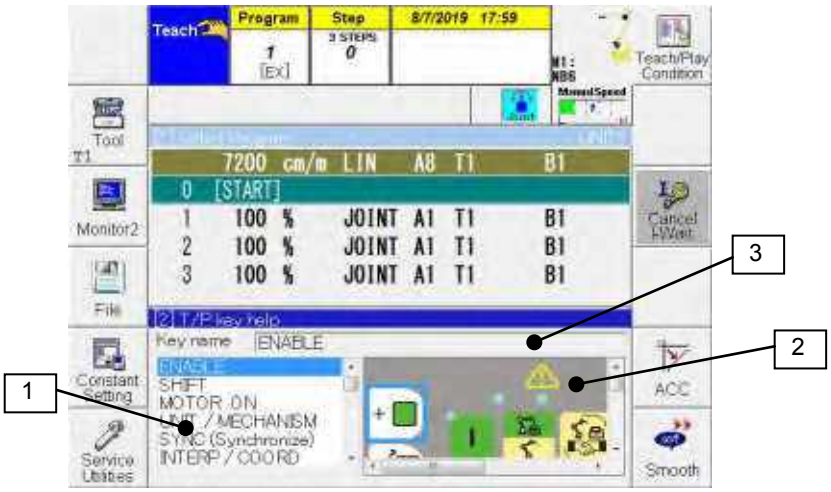




2 **Select "T/P Key help" with the [Up/Down] keys, and press the [Enter] key. Alternatively, enter the number [9] directly into the edit box at the bottom, and press the [Enter] key.**

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

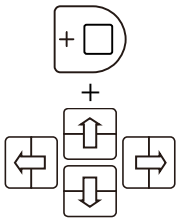
Perform the following operations to search for the position and design of an operation key from the name of the operation key.

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.

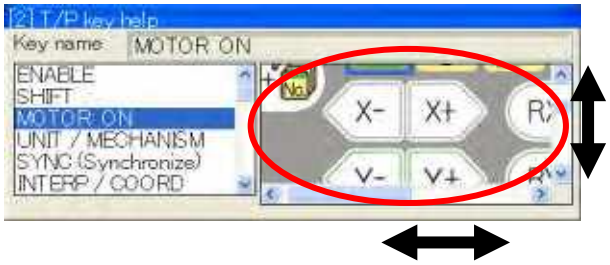
Searching for the operation key name from the position or design

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.

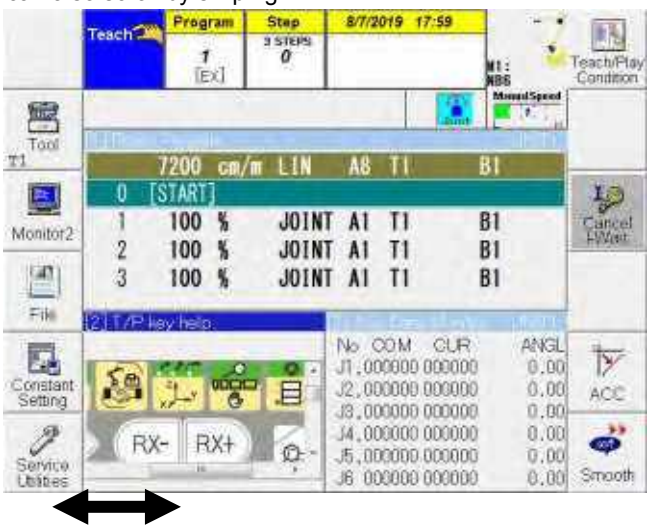
2 **Touch the operation key that you want to research from the “Operation Key Arrangement” on the right side of the monitor screen.**

>> 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.**
You can also scroll by swiping.



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.

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

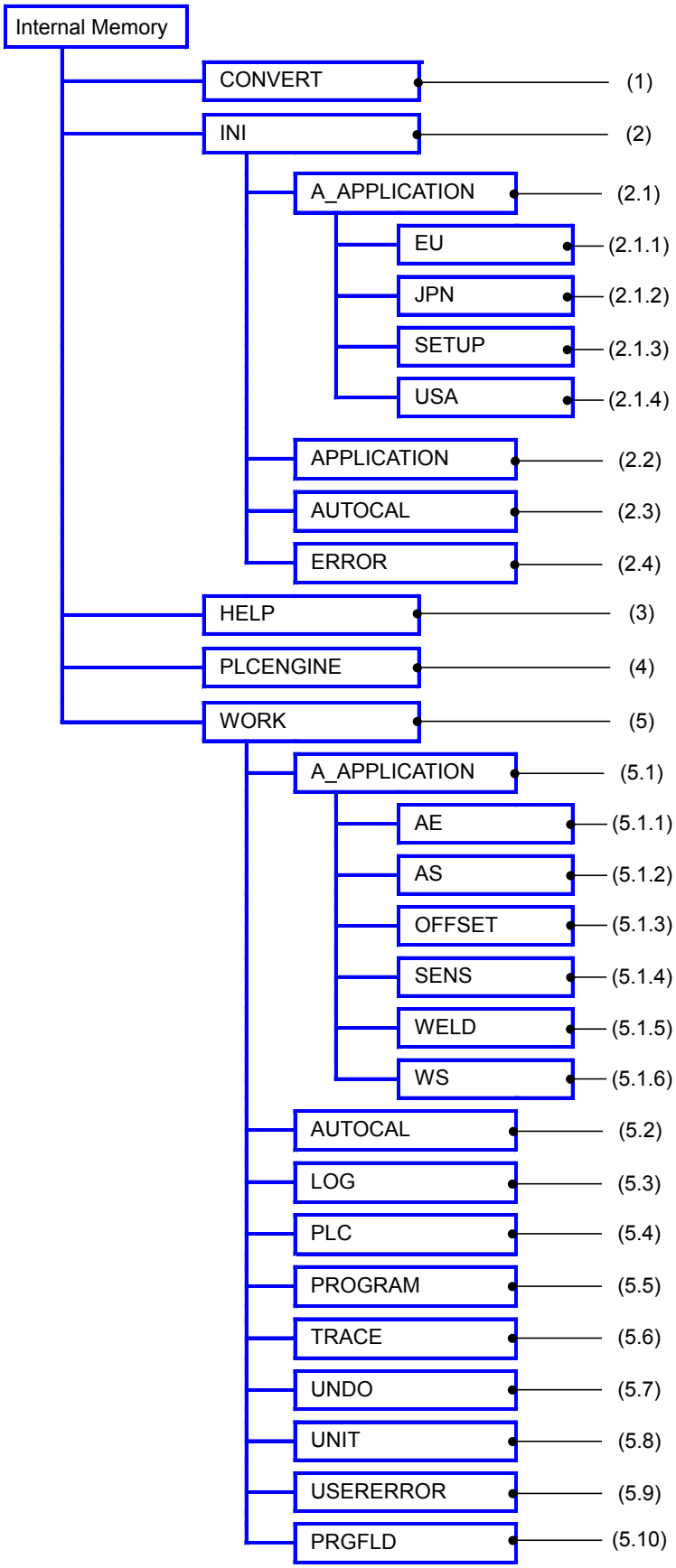


Fig. 6.2.1 Folder structure of internal memory

Table 6.2.4 Files stored in folders

No.	Folder	Files stored in folders	Filename (example) ("***" denotes numbers)
(1)	CONVERT	Folder used by conventional model format conversion function	¥AW, ¥EX
(2)	INI	Initial value files (serving as source for generating constant files when constants are to be prepared)	AC00SOFTKEY.INI, Ac01arcw.ini, etc.
(2.1)	INI¥A_APPLICATION	(Valid only for arc welding applications) Initial value files used specifically for arc welding applications (initial value data related to arc welding, initial value files for sensor applications, etc.)	AS01arcw.ini, AE01arcw.ini, etc.
(2.1.1)	INI¥A_APPLICATION¥EU	Initial value files listed below for arc welding power supply (European specifications)	
		Welding characteristics data files	$WTBD***
		Waveform control data files	$WPLS***
(2.1.2)	INI¥A_APPLICATION¥JPN	Initial value files listed below for arc welding power supply (Japanese specifications)	
		Welding characteristics data files	$WTBD***
		Waveform control data files	$WPLS***
(2.1.3)	INI¥A_APPLICATION¥SETUP	Control software of arc welding power supplies.	mprg_dm.bin, ¥Update¥AL-111.bin
(2.1.4)	INI¥A_APPLICATION¥USA	Initial value files listed below for arc welding power supply (U.S. specifications)	
		Welding characteristics data files	$WTBD***
		Waveform control data files	$WPLS***
(2.2)	INI¥APPLICATION	Initial value files used for specific applications (such as spot welding, arc welding and handling)	A_C00CTRL.INI, A_S00SIGL.INI, etc.
(2.3)	INI¥AUTOCAL	Initial value files used by automatic calibration function (option)	nv6.kin nv6.prm, etc.
(2.4)	INI¥ERROR	Error files	Err****.ini
(3)	HELP	Help files	AX-HELP*.chm, AX-HELP*.hhc, AX-HELP*.hhk
(4)	PLCENGINE	Files related to software PLC	IsaGRAF.exe, IsaIXL.dll, etc.
(5)	WORK	Constant files	C00ctrl.con, S00sigl.con, etc.
(5.1)	A_APPLICATION	(Valid only for arc welding applications) Folder for files (5.1.1 to 5.1.6) listed below	¥AE, ¥AS, ¥OFFSET, ¥SENS, ¥WELD, ¥WS
(5.1.1)	A_APPLICATION¥AE	Arc end condition files	AE##ARCW.*** ("##" denotes the type of welder)
		Arc end condition initial value files	AE##arcw1.CON ("##" denotes the type of welder)
(5.1.2)	A_APPLICATION¥AS	Arc start condition files	AS###ARCW.*** ("##" denotes the type of welder)
		Arc start condition initial value files	AS###arcw1.CON ("##" denotes the type of welder)
(5.1.3)	A_APPLICATION¥OFFSET	Files listed below used by multipass welding function (option)	
		Offset files	OFSARCW.***
		Multi offset files	MOFSARCW.***
(5.1.4)	A_APPLICATION¥SENS	Files related to sensor devices (touch sensors, arc sensors, TIG arc sensors, laser search, laser sensors)	ST01sens1.CON, ET01sens1.CON, etc.

No.	Folder	Files stored in folders	Filename (example) ("****" denotes numbers)
(5.1.5)	A_APPLICATION¥WELD	Welding characteristics data files	$WTBD***
		Wire feed characteristics data files	$WFCD***
		Waveform control data files	$WPLS***
		Welding condition database files	WDB***
(5.1.6)	A_APPLICATION¥WS	Fixed pattern weaving condition files	WFP.***
		Joint weaving condition files	WAX.***
		Taught weaving (option) condition files	WSF.***
		Fixed pattern weaving initial value files	WFP-*.CON
		Joint weaving initial value files	WAX-*.CON
		Taught weaving (option) initial value files	WSF-*.CON
(5.2)	WORK¥AUTOCAL	Data files used by automatic calibration function (option)	Setup_ac.csv, etc.
(5.3)	WORK¥LOG	Error log files	LG-Err***.log
		MTBF/MTTR files	lg-MTBF_MTTR_A.bin, etc.
		Overhaul prediction files	Lg-pmd.log
		Program diagnosis files	LG-PMD0P****.LOG
		Stop log files	LG-STOP.log
(5.4)	WORK¥PLC	Ladder program	*.STF
(5.5)	WORK¥PROGRAM	Program files	NV6.**** , etc.
		Pause files	NV6_P.**** , etc.
		Language files	NV6_A.**** , etc.
(5.6)	WORK¥TRACE	Measurement data prepared by oscilloscope function	TRACE**.CSV
(5.7)	WORK¥UNDO	Undo operation history files	NV6_Undo_0.001, etc.
(5.8)	WORK¥UNIT	Unit-dependent constant files	U00UNIT001.CON, etc.
(5.9)	WORK¥USERERROR	User error definition file	Err7***.ini
(5.10)	WORK¥PRGFLD	Program management file	****NV6.**** etc.

Some of the files listed in the above table may not be displayed depending on whether the optional functions concerned are provided and on the qualifications level of the operator.

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.

6.3.1 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.

6.3.2 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.

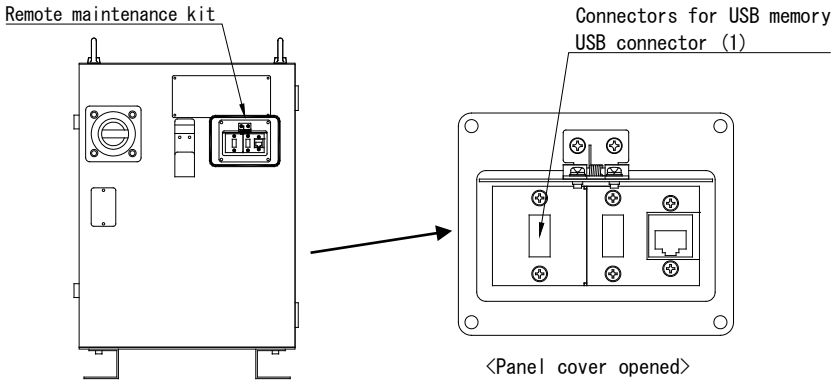
Table 6.3.1 USB memory uses

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)

＜In the case the remote maintenance kit is installed.＞

1 **Open the panel cover of remote maintenance kit.**
Insert the USB memory into "USB connector (1)" on the remote maintenance kit.
Insert the USB memory in the correct orientation. It cannot be inserted in the wrong orientation.



IMPORTANT

There are 2 USB ports in the remote maintenance kit. Please use USB connector (1). USB connector (2) is used for LTE router of remote maintenance.

2 **Perform backup and other tasks.**

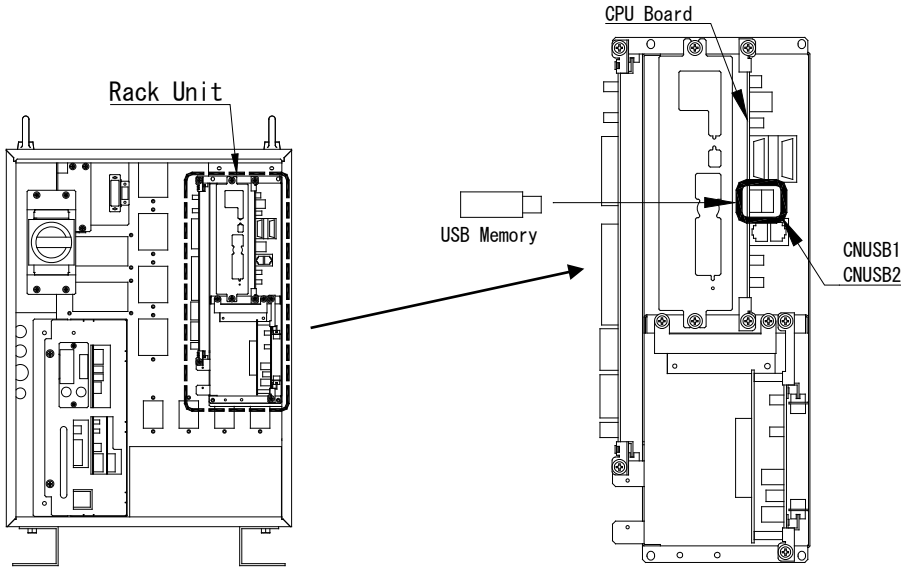
3 **The USB memory can be used continually when connected.**
When you are done, remove the USB memory.

＜In the case the remote maintenance kit is not installed.＞

WARNING

Only insert and remove the USB memory when the robot controller power is switched off.

1 **Turn off the power of the robot controller, and open the door.**
Insert the USB memory into “CNUSB1” or “CNUSB2” 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.**

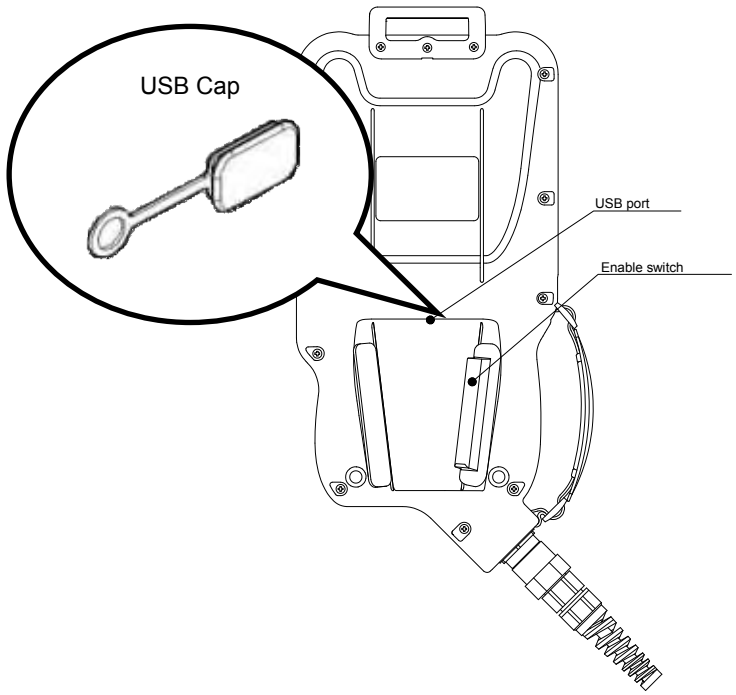
4 **The USB memory can be used continually when connected.**
Before removing the USB memory, always be sure to turn off the controller power.

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.

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

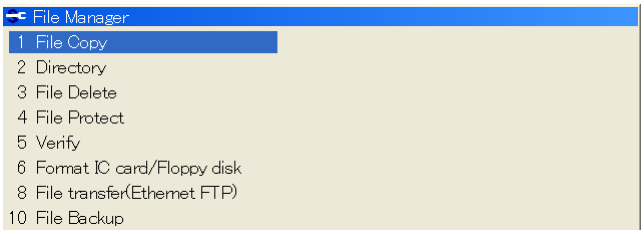
Operation menu	Details
File Copy	This is for copying files. Files can be copied not only between internal memories, but also from an internal memory to an external storage device using a USB memory (stored), or from an external storage device to an internal memory (read).
Directory	This is for displaying 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.

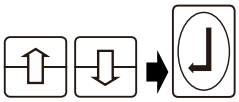
File operation menu selection and common operations

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.



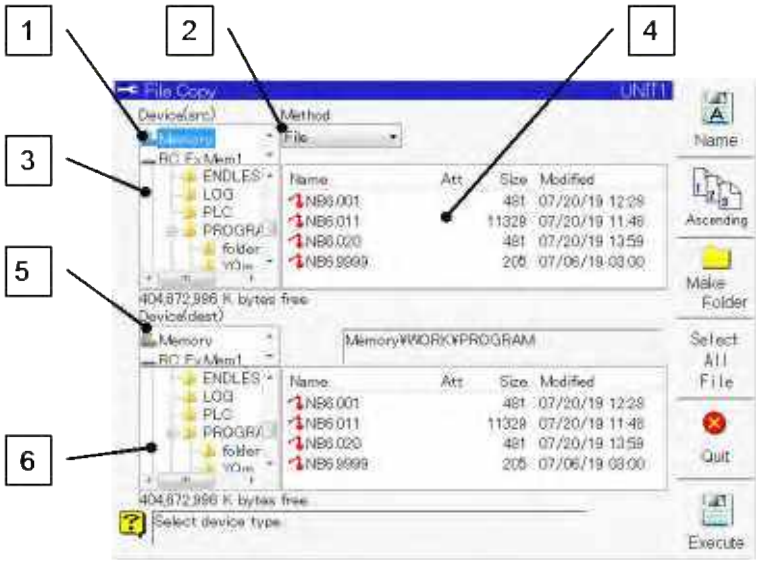


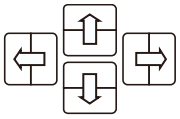
2 **When a function is selected and [Enter] is pressed, the function concerned is selected.**

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 6 and set the required items.**
Use the [Left/Right] key to move through fields 1 to 6.
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 File selection method field

Specify the selection method of the file to be operated. For operable files, refer to page (6-7 “6.2.3 Operable files”)

File select: Select by file.

Folder select: Select by folder. All files in the folder are selected for the operation.

Program number: Specify a program number to select. When copying, the program number can be changed then copied to the destination.

File type: Specify the file type to select. All files of that type are selected for the operation.

3 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.

4 File directory

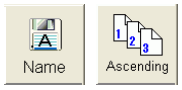
When you specify a folder in step 3, the file list is displayed. To select an individual file or files and perform file operations, select the files here.

5 Device selection field (when copying only)

Select the copy destination device.

6 Folder selection field (when copying only)

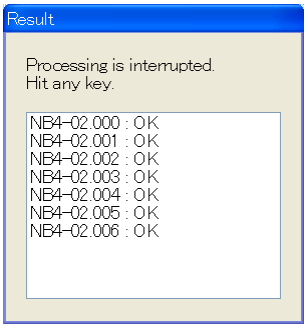
Specify the copy destination folder.



3 **When you specify a folder in step 3, a list of the files in the folder specified in 4 is displayed. 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 **Press the [R/HOME] key to end an operation.**
>> 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 6-34 “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

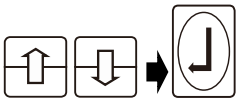
There are two RC external memory USB ports. Do not use them at the same time.

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.

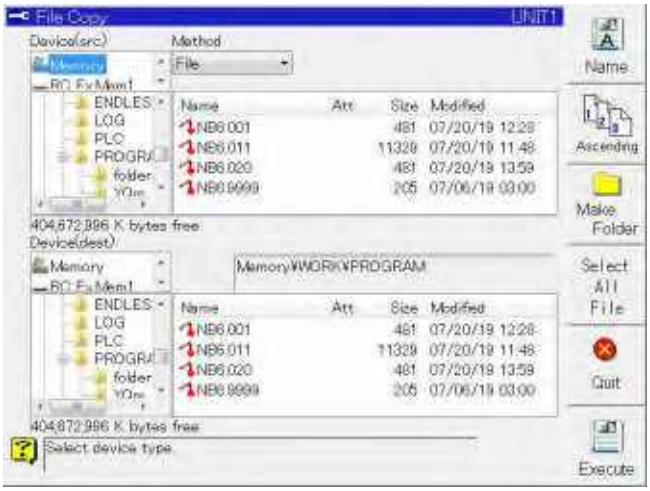
- Program file
- Pose file
- Language file
- Constant file
- Log file
- All files (all of the above files)

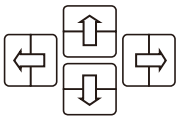
Opening the copy screen



1 **Select “1 Copy” in the file operation menu, then press the [Enter] key.**

>> 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.

Specifying a file and copying

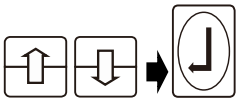
Directly specify a file and copy it. Multiple files can be copied at the same time.
As an example, the steps taken to select a multiple number of programs stored in the internal memory and copy them onto a USB memory stick will be described.

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

2 **Select “File” in the file selection method field.**

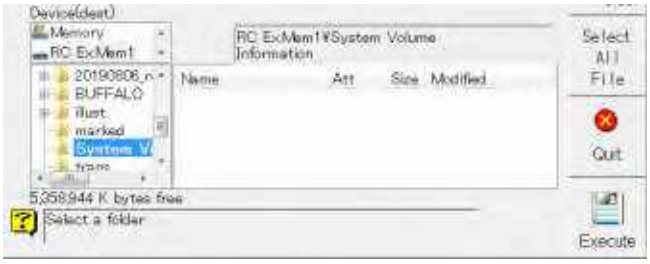
3 **Move to the folder selection field, and select “PROGRAM”.**

>> A list of the programs now appears.



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.

5 **Move to the device selection field to be copied to, select “RC ExMem1”, then select the folder you want to copy to in the folder selection field.**
≫The copy destination directory is displayed.



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

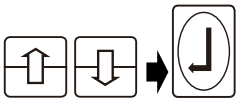
Specifying a folder and copying

Specify a folder to copy all of the files it contains.
The following example is how to copy a program folder saved on internal memory to USB memory.

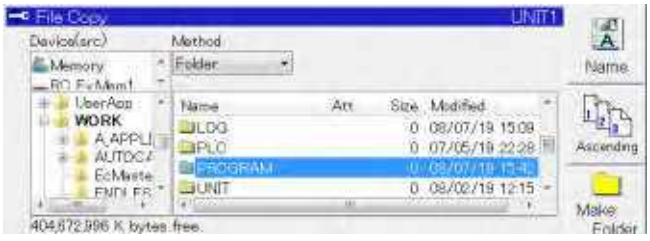
1 **Select “Memory” in the copy source device selection field.**

2 **Select “Folder” in the file selection method field.**

3 **Move to the folder selection field and select “WORK”.**
≫The list of folders in the WORK folder is displayed.
Folders in the lowest layer cannot be specified at this time.

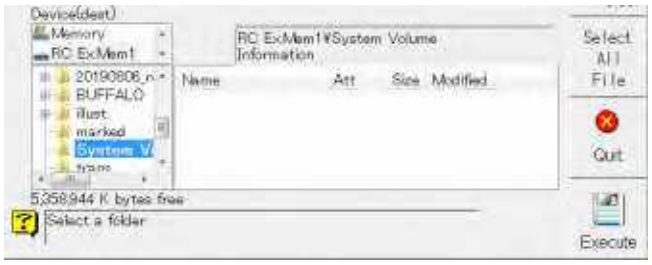


4 **Select “PROGRAM” with the [UP/DOWN] key, then press the [Enter] key.**
≫Repeat these operations to select multiple folders.



5 **Move to the device selection field to be copied to, select “RC ExMem1”, then select the folder you want to copy to in the folder selection field.**

≫The copy destination directory is displayed.



6 **Press f12 <Execute>.**

≫Copying now starts.

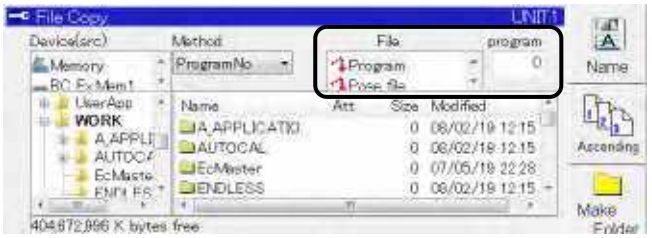
Specifying a program number and copying

Specify a program number and copy the program file.
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 **Select “ProgramNo” in the file selection method field.**

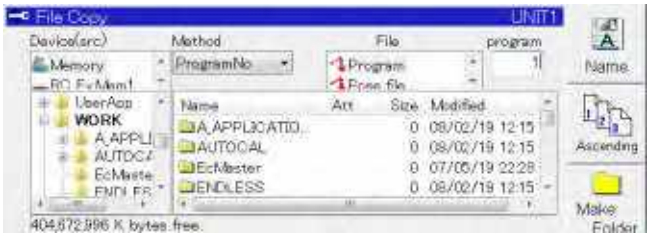
≫The file type selection field and program number field are displayed.



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

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

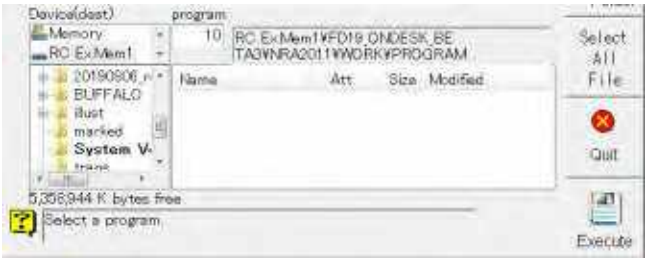
≫The program “1” in “¥WORK¥PROGRAM" is selected for copying.



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.

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

6 **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.

7 **Press f12 <Execute>.**

≫Copying now starts.

Specifying a file type and copying

Specify a file type and copy all files of that type. You can also delete all files regardless of type. 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.**

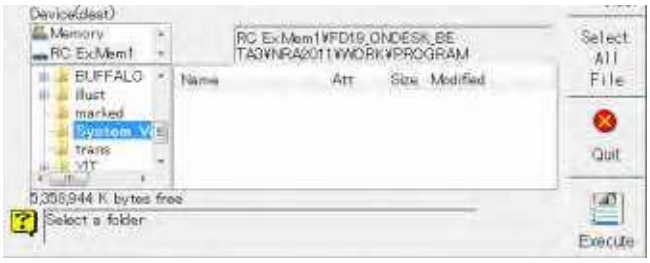
2 **Select “File Type” in the file selection method field.**

≫The file type selection field is displayed.

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

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

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



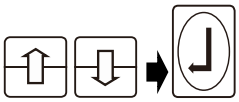
6 **Press f12 <Execute>.**

≫Copying now starts.

Displaying a list of the files

When the display list function is used, what files are stored in the internal memory or external storage device can be checked.

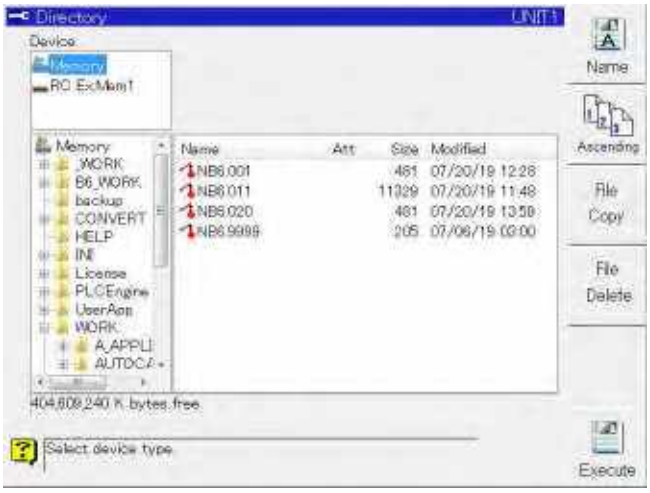
Displaying a list of the files



1 **Select “2 Directory” on the file operation menu, and press [Enter].**
>> The [Directory] screen now appears.

2 **In the device selection field, select the device whose files are to be listed and displayed.**

3 **In the folder selection field, select the folder whose files are to be listed and displayed.**
As an example of a program, select the “PROGRAM” folder.
>> A list of the programs is displayed.



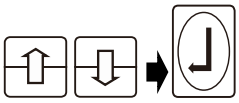
4 **To exit the list display, press the [R/HOME] key.**
>> Operation returns to the file operation menu.

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.

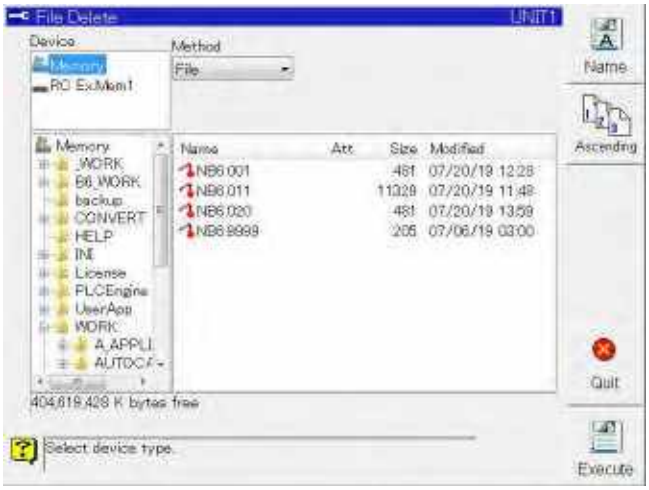
- Program files (deleted individually or altogether)
- Pose files (deleted individually or altogether)
- Language files (deleted individually or altogether)
- Log file (deleted altogether)

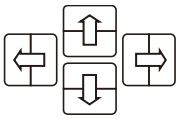
Opening the deletion screen



1 **Select “3 File Delete” in the file operation menu, then press the [Enter] key.**

>> 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 a file and deleting

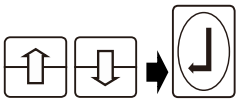
Specify a file and delete it. Multiple files can be deleted.
As an example, the steps taken to select a multiple number of programs stored in the internal memory and delete them will be described.

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

2 **Move to the file selection method field and select “File”.**

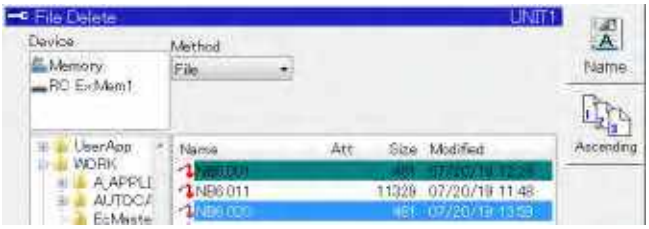
3 **Move to the folder selection field, and select “PROGRAM”.**

>> A list of the programs now appears.



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.

Specifying a folder and deleting

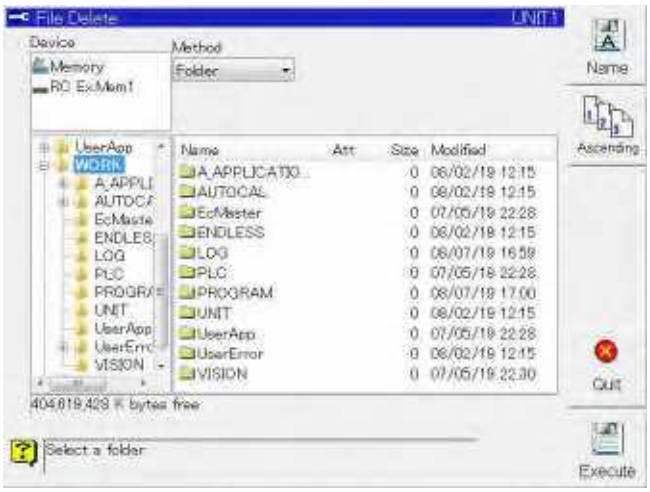
Specify a folder to delete all of the files it contains.
The following example is how to delete a program folder saved on internal memory.

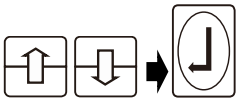
1 **In the device selection field, select “Memory”.**

2 **Move to the file selection method field and select “Folder”.**

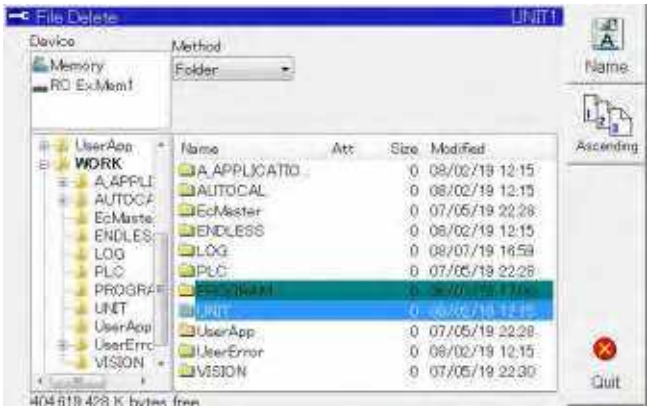
3 **Move to the folder selection field and select “WORK”.**

≫The list of folders in the WORK folder is displayed.
Folders in the lowest layer cannot be specified at this time.





4 **Select the folder with the [UP/DOWN] key, then press the [Enter] key.**
The selected folder is highlighted in blue.
Repeat these operations to select multiple folders.



To cancel a selection, select the folder to unselect and press the [BS] key.

5 **Press f12 <Execute>.**

≫This completes the file deletion.

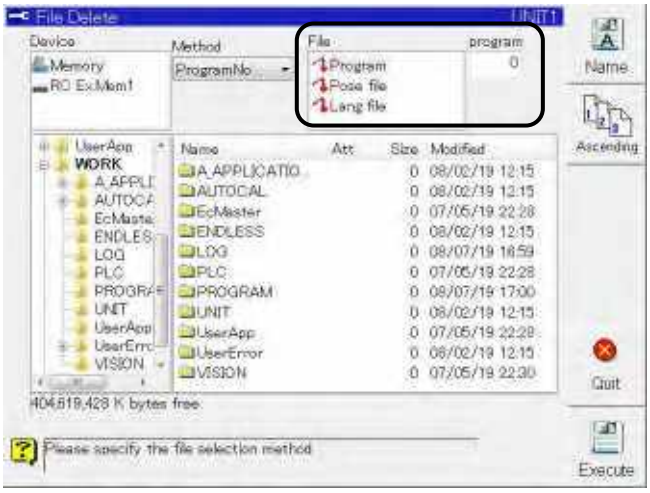
Specifying a program number and deleting

Specify a program number and delete the program file.
As an example, the steps taken to delete program “2” stored in the Memory will be described.

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

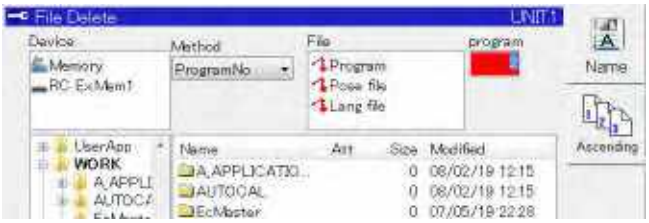
2 **Move to the file selection method field and select “ProgramNo”.**

≫The file type selection field and program number field are displayed.



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

4 **After moving to the program input field, input “2” and press [Enter].**



Execute

5 **Press f12 <Execute>.**

≫This completes the file deletion.

Specifying a file type and deleting

Specify a file type and delete all files of that type. You can also delete all operation files regardless of type.
As an example, the method for deleting all programs saved on the USB memory will be described.

1 **Select “RC ExMem1” in the device selection field.**

2 **Select “File Type” in the file selection method field.**

≫The file type selection field is displayed.

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

Execute

4 **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.

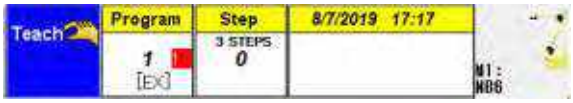
Table 6.7.1 Protection types and functions

	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

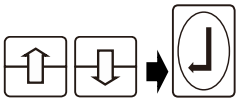
× : Cannot be performed (= protected)

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



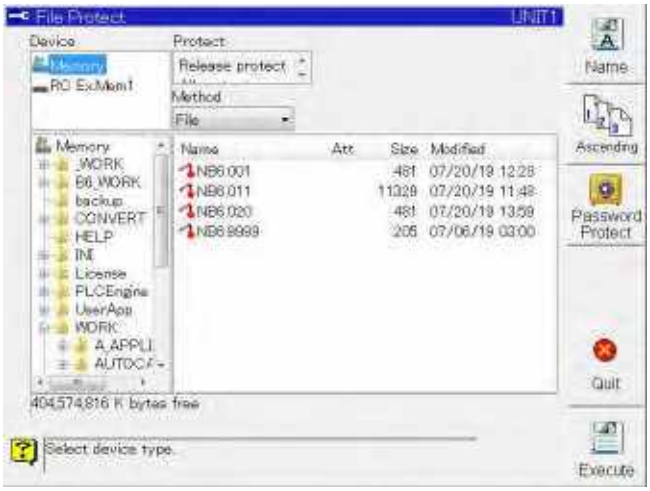
- Complete protection (or partial protection) and playback protection can be used simultaneously.(With a combination of “O” and “×”, “×” takes precedence.)
  In this case, The display mark that indicates the protection status of the file is a combination of the two display marks.
- For constant files,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

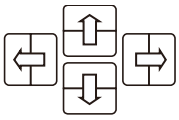
Opening the protection setting screen



1 **Select “4 File Protect” in the file operation menu, then press the [Enter] key.**

>> 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.

Specifying a file and setting protection

Specify a file and set protection. Multiple files can be protected.
As an example, the steps taken to set “All protect” for program “1” stored in the internal memory will be described.

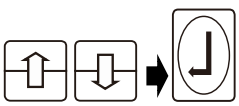
1 **In the device selection field, select “Memory”.**

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

3 **Move to the file selection method field and select “File”.**

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

≫A list of the programs now appears.



5 **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.

6 **Press f12 <Execute>.**

>> The protection setting is now completed.

Specifying a folder and setting protection

Specify a folder to protect all of the files it contains.
The following example is how to set “Protect all” for a program folder saved on internal memory.

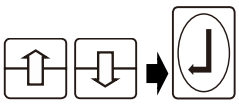
1 **In the device selection field, select “Memory”.**

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

3 **Select “Folder” in the file selection method field.**

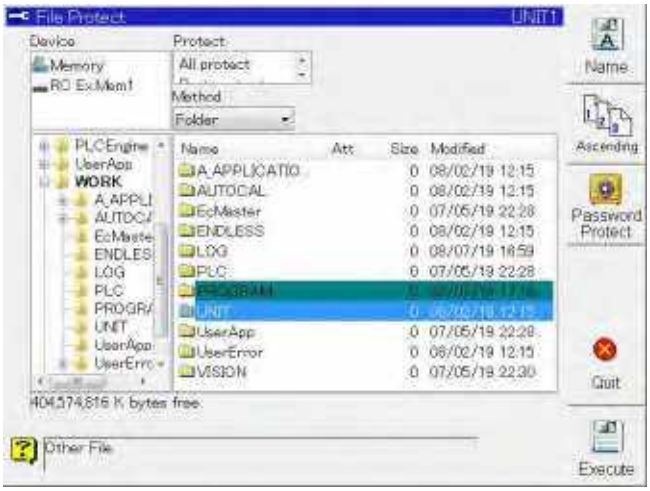
4 **Move to the folder selection field and select “WORK”.**

≫The list of folders in the WORK folder is displayed.
Folders in the lowest layer cannot be specified at this time.



5 **Select “PROGRAM” with the [UP/DOWN] key, then press the [Enter] key.**
The selected folder is highlighted in blue.

≫Repeat these operations to select multiple folders.



6 **Press f12 <Execute>.**

≫The protection setting is now completed.

Specifying a program number and setting protection

Specify a program number and protect that program file.
As an example, the steps taken to set “All protect” for program “2” 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”.**

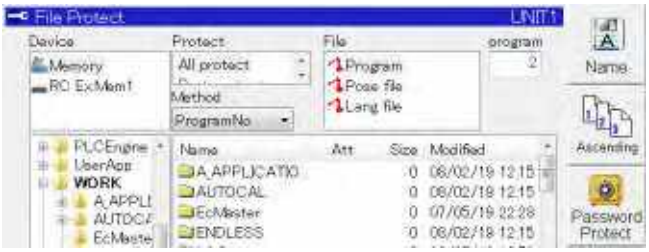
3 **Move to the file selection method field and select “ProgramNo”.**

≫The file type selection field and program number field are displayed.

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

ON
1

5 **Move to the program input field, and input [2].**



Execute

6 **Press f12 <Execute>.**

≫The protection setting is now completed.

Specifying a file type and setting protection

Specify a file type and protect all files of that type. You can also protect all operation files regardless of type.
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 selection method field and select “File Type”.**
≫The file type selection field is displayed.

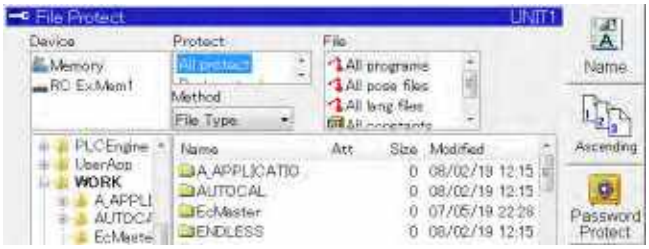
4 **Move to the file type selection field, and select “All programs”.**

5 **Press f12 <Execute>.**
≫This sets “Playback protect” for the files.

“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.



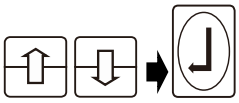
“1P ” appears in the attribute field.

Verifying files

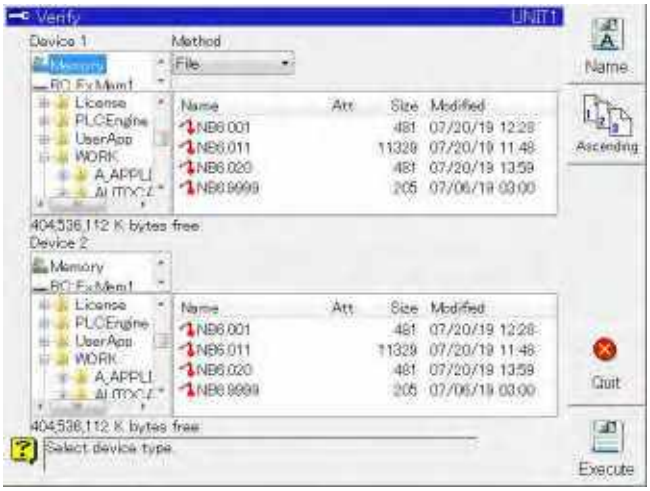
This is for verifying whether the contents match between two files or between all the files on different storage media match.
The files which can be verified are as shown below.

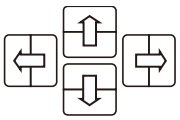
- Program file
- Pose file
- Language file
- Constant file
- Log file
- All files (all of the above files)

Opening the verify screen



1 **Select “5 Verify” in the file operation menu, then press the [Enter] key.**
>> The [Verify] screen is now opened.





2 **Files are verified on this screen.**
To move through each field, use the left and right keys.
To select the items displayed in the fields, use the up and down keys.

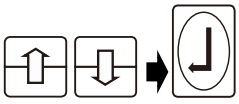
Specifying a file and verifying it

Specify a file and verify it. Multiple files can be verified.
As an example, the steps taken to verify programs “1” and “2” stored in the Memory will be described.

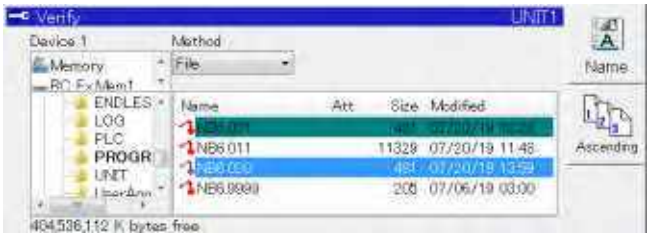
1 **In the device 1 selection field, select “Memory”.**

2 **Move to the file selection method field and select “File”.**

3 **Move to the folder selection field, and select “PROGRAM”.**
≫A list of the programs now appears.

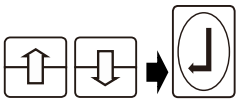


4 **Select a file using the up or down key, and press [Enter].**
The selected file is highlighted in blue.
≫A multiple number of files can be selected by repeating these steps.



5 **Select “RC ExMem1” in the device 2 selection field.**

6 **Move to the folder selection field, and select “PROGRAM”.**
≫A list of the programs now appears.

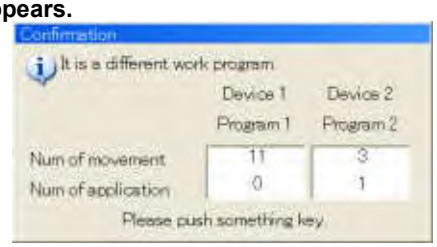


7 **Select a file using the up or down key, and press [Enter].**
The selected file is highlighted in blue.
≫A multiple number of files can be selected by repeating these steps.

8 **Press f12 <Execute>.**
≫Verifying now starts.

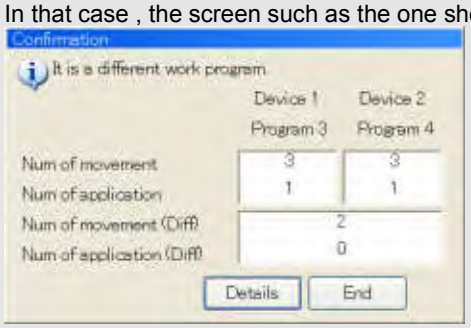
If the contents of the two files are identical, the screen such as the one shown below appears.

If the contents of the two files are different, the screen such as the one shown below appears.

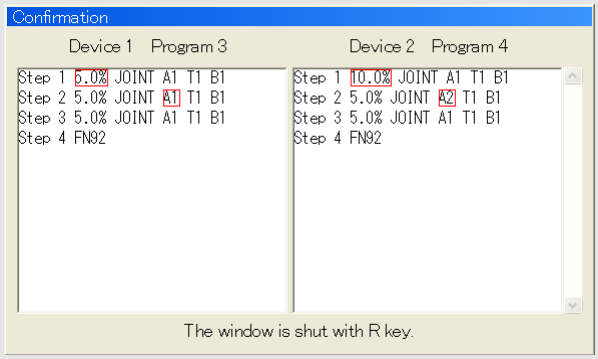


If the num of movement is same, the details can be see.

In that case , the screen such as the one shown below appears.



“Details” is selected, the different places are shown as below appears.
To close screen, select “End”.



The [R/HOME] key closes the screen.

Specifying a folder and verifying

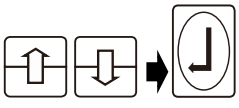
Specify a folder and verify it. You can verify all files in a folder.
The following example is how to verify a program folder saved on internal memory against those saved on USB memory.

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

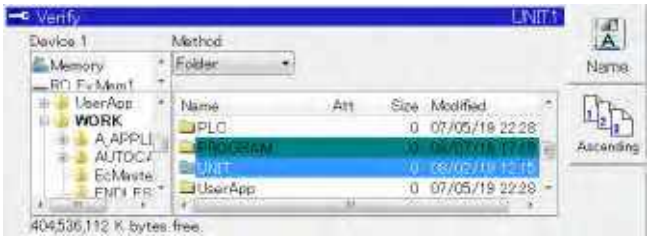
2 Move to the file selection method field and select “Folder”.

3 Move to the folder selection field and select “WORK”.

≫The folder list is displayed.

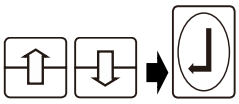


4 Select “PROGRAM” with the [UP/DOWN] key, then press the [Enter] key.



5 Select “RC ExMem1” in the device 2 selection field.

6 **Move to the folder selection field and select “WORK”.**
≫The folder list is displayed.



7 **Select “PROGRAM” with the [UP/DOWN] key, then press the [Enter] key.**

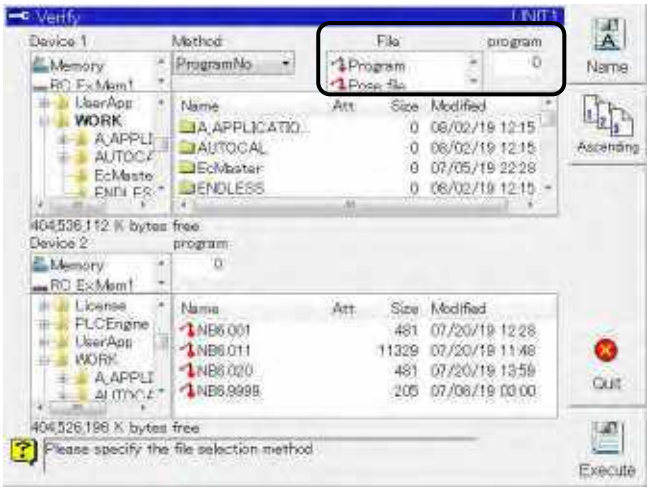
8 **Press f12 <Execute>.**
≫Verifying now starts.

Specifying a program number and verifying

As an example, the steps taken to verify programs “1” and “2” stored in the Memory will be described.

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

2 **Move to the file selection method field and select “ProgramNo”.**
≫The file type selection field and program number field are displayed.



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

4 **Move to the program input field, and input [1].**

5 **Move to the device 2 selection field, and set “Memory”.**

6 **Move to the program input field, and input [2].**

7 **Press f12 <Execute>.**
≫Verifying now starts.

Specifying a file type and verifying

Specify a file type and verify all files of that type. You can also verify all operation files regardless of type.
The following example is how to verify all programs saved on internal memory against those saved on USB memory.

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

2 **Move to the file selection method field and select “File type”.**
≫The file type selection field is displayed.

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

3 **Move to the device 2 selection field, and select “RC ExMem1.”**

4 **Press f12 <Execute>.**
≫Verifying now starts.

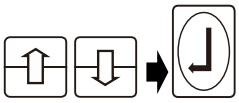
Initializing the USB memory

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 Initialize” in the file operation menu, then press the [Enter] key.**

>> 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).

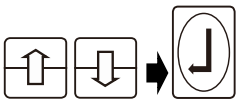
The name of the backup folder is given automatically using the following format.

NRA2011-2011-11-06-0932
Date Time

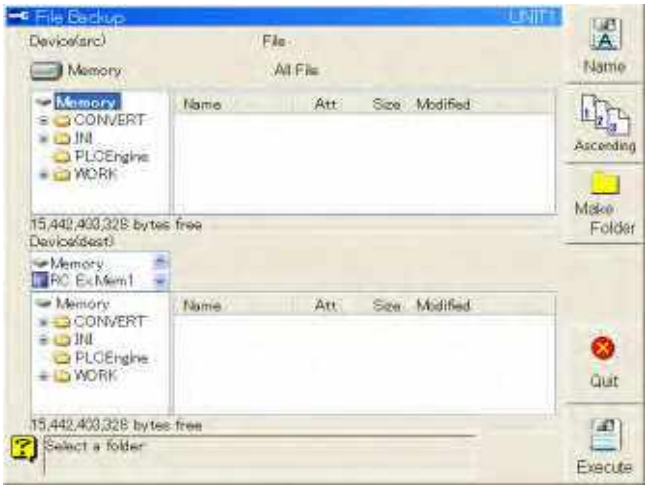
The external storage device is recommended for the backup destination device.

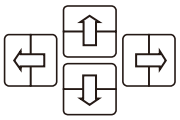
If the backup destination to the internal memory, please make sure you have enough free space in internal memory
(Only as a guide. requires at free space of 10MB after the backup).

Opening the backup screen



1 **Select “10 Backup” in the file operation menu, then press the [Enter] key.**
>> 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.

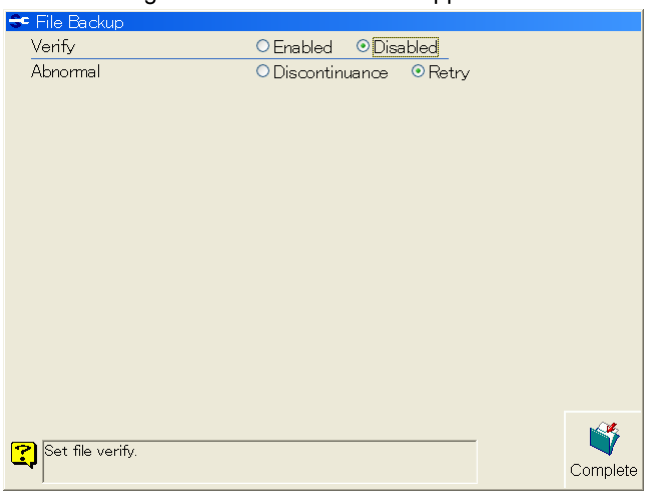
1 **Press f9 <Make Folder>, and input the folder name.**
The soft keyboard starts up. Input the folder name.
For details on how to input text, see “2.5 To input characters”.

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.

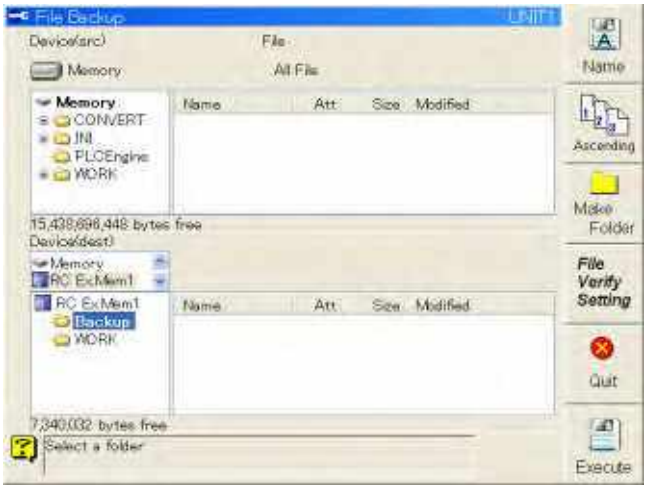
Table 6.10.1 File Verify Settings for Backup

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

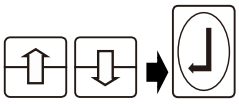
1) Do not execute backup restoration so lightly except when upgrading accompanied with replacement of the system CF or restoring after a trouble occurred.

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.

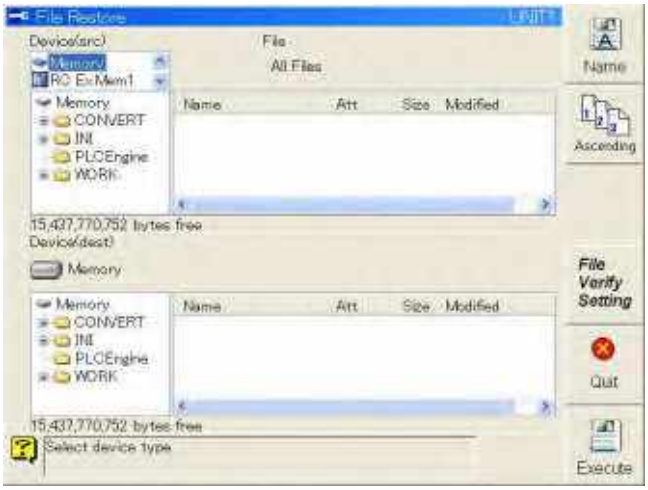
4) When restoring the backup, it is necessary to change the settings of the system memory maintenance function. For details, see the “Controller Maintenance” section of the instruction manual.

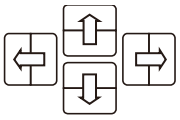
Opening the File Restore screen



1 **Select “11 Restore from backup” in the file operation menu, then press the [Enter] key.**

>> The [File Restore] screen now appears.





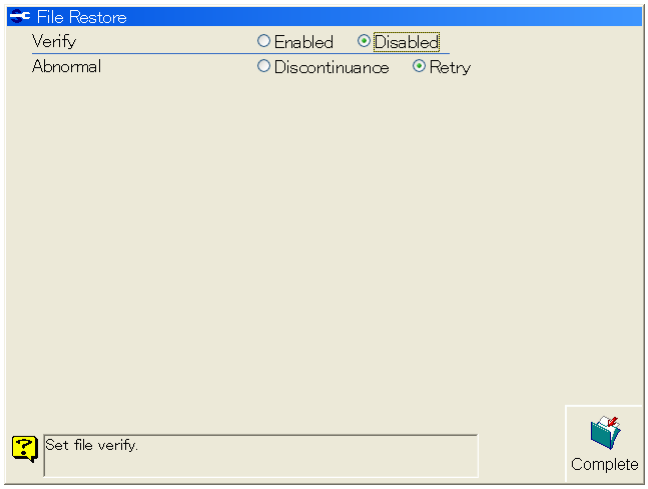
2 **To move through each field, use the [Left/Right] keys.**
To select the items displayed in the fields, use the [Up/Down] keys.

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>.**

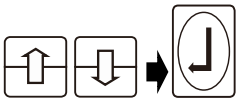
>> File verification will be done using the settings on this screen when executing restoring process.

Table 6.11.1 File Verify Settings for File Restore

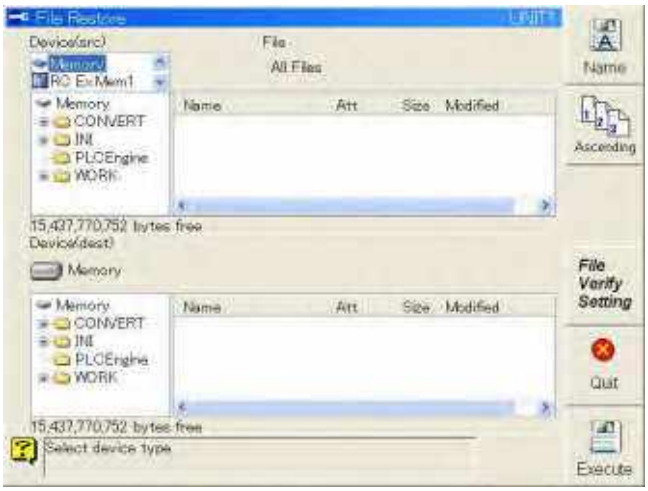
Parameter	Default setting	Input range	Description
Verify	Disabled	Enabled / Disabled	Set the file verification Enabled/Disabled when executing the file restore.
Abnormal	Retry	Discontinuance / Retry	Select the process to be executed when an error occurs while the file verification.

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 Restore from backup” in the file operation menu, then press the [Enter] key.**
>> 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.”

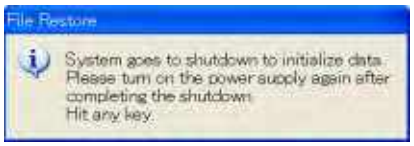
4 **Move to the folder selection field, select the folder containing the backup data to be restored, and press [Enter].**

IMPORTANT

The folder in which the backup data is stored must have “read-only” attributes. (Backup folders are automatically given “read-only” attributes when data is backed up manually or automatically.)
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.

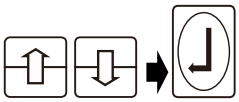
6 **The following message is displayed. Press a key to shutdown.**
Do not switch off the power during shutdown.



Performing automatic backup

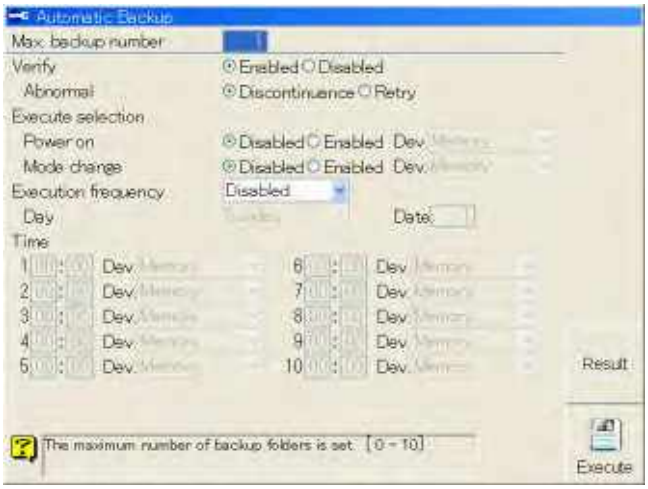
This function is used to back up all the files contained in the NRA2011¥WORK folder at the predetermined time, day of the week and date in order to store a history of the robot's operation statuses at regular intervals. These files can also be automatically backed up when the power is turned on or when 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" in the file operation menu, then press the [Enter] key.**

>> 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.

Terms frequently used with arc welding

For the benefit of operators who will be using the robot for the first time, this section explains the basic terms relating to arc welding which come up frequently in this manual.

Table 9.1.1 Terms frequently used with arc welding

Terms	Explanation
Arc welding power supply	This device directly controls arc welding. In some cases this is simply the welding power supply or welding device. For this controller, the specialized Daihen robot dedicated welding power supply or semi-automatic welding power supply can be controlled, and welding power supply for other manufacturer's devices can be connected and controlled.
Robot dedicated welding power supply	Welding power supply with an internal or internally available robot interface function. Welbee Inverter series welders or D series welders are available.
Welding interface	This is required to connect the semi-automatic welding power supply, that does not contain the functions for interfacing with the robot, to the robot.
Arc start	This refers to generating the arc in order to commence welding.
Arc start failure	This is when an arc fails to occur at the welding start point. It has many and varied causes: for instance: "bad passage of electrical current due to slag in the welding base metal," "misaligned wire aim," "out of wire," "wire jam," "wire misfeeding," or "trouble in power supplied to tip" may be to blame for the failure.
Arc run-out	This denotes that the arc has run out even though there is no arc stop command from the robot during welding. It has many and varied causes: for instance, "out of wire", "wire jam", "wire misfeed", "wire penetration" or "trouble in power supplied to tip" may be to blame for the failure.
Pre-flow	This refers to the blowing out of the shielding gas from the nozzle a number of seconds before the welding arc is to be generated.
Arc voltage (welding voltage)	This refers to the voltage between both ends of the arc. When the arc voltage is raised, the disadvantage is that some defects may occur: for instance, the arc may increase in length or the beads may increase in width or there may be a tendency for overlapping or blow-holes to form. On the other hand, raising the arc voltage minimizes spatter.
Welding current	This is the current that is supplied in order to provide the heat required for the welding. When the welding current is raised, the penetration is deepened. In the case of thin sheets, holes may form or burst. Further, the amount of wire that melts increases, thereby extending the leg length.
Welding speed	Moving speed of the welding torch. Generally shows the movement distance (cm/min) for 1 minute. When the speed is raised, the heat input per unit length decreases so that a number of defects may occur: for instance, the beads may become thinner, the penetration may become too shallow, there may be the tendency for undercutting or the gas shielding may be impaired. On the other hand, when the speed is lowered, overlapping may tend to occur.
Welding condition	These are the conditions for performing the welding, and they refer to a group of data consisting of the welding current, welding voltage, welding speed, etc.
Welding ON/OFF	This refers to switching between welding ON and welding OFF.
Crater	This refers to the indentations that form at the trailing end of the beads.
Crater treatment	This refers to the treatment where the arc is continuously generated for the prescribed period of time so that the craters will be filled in under the conditions which are below the regular welding conditions.
Deposition	This refers to the fact that the tip of the melted wire has adhered to the base metal upon completion of the welding. It is avoided by retracting the wire or conducting burnback processing upon completion of the welding.
Anti-sticking	This refers to a way in which deposition is prevented. Normally, upon completion of the welding, a no-load voltage (burnback voltage) is applied to the wire while the wire feed is shut down. If the wire touches the base metal, a current flows, and the resulting heat causes the wire to flare up, thereby enabling deposition to be prevented.
WCR	This is an abbreviation for welding current relay which is used as the name of the signal that indicates the welding current ON/OFF status.

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.

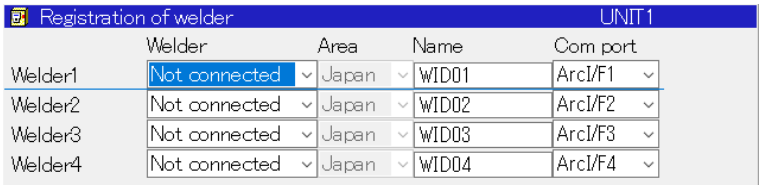
The registered welding power supply can be given any name (composed of up to 10 halfsize characters or 5 full-size characters).
The name given here is displayed at times when, for instance, teaching is performed or the welding constants are set. Especially when a number of welding power supplies are 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.

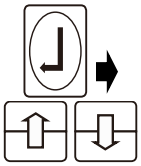
Registering the welding power supply

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 candidates appear. Select the welder using [up] or [down].

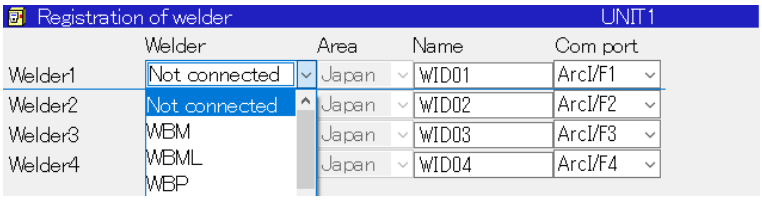


Table 2.3.1 Selection Candidates List

Welding power unit used	Welding power supply	Region
Welbee Inverter M350L (Japan specifications)	WBML	Japan
Welbee Inverter M350L (CCC specifications)	WBML	
Welbee Inverter M350L（Asia specifications）	WBML	
Welbee Inverter M350L（U.S. specifications）	WBML	U.S.
Welbee Inverter M400L (Europe specifications)	WBML	Europe
Welbee Inverter M350 (Japan specifications）	WBM	Japan
Welbee Inverter M350 (CCC specifications)	WBM	
Welbee Inverter M350（Asia specifications）	WBM	
Welbee Inverter M350（U.S. specifications）	WBM	U.S.
Welbee Inverter M400 (Europe specifications)	WBM	Europe
Welbee Inverter M500 (Japan specifications）	WBM	Japan
Welbee Inverter M500 (CCC specifications)	WBM	
Welbee Inverter M500（Asia specifications）	WBM	
Welbee Inverter M500 (U.S. specifications）	WBM	U.S.
Welbee Inverter M500 (Europe specifications)	WBM	Europe

Table 2.3.1 Selection Candidates List

Welding power unit used	Welding power supply	Region
Welbee Inverter P350 (Japan specifications)	WBP	Japan
Welbee Inverter P400 (U.S. specifications)	WBP	U.S.
Welbee Inverter P400 (Europe specifications)	WBP	Europe
Welbee Inverter P400 (CCC specifications)	WBP	ASIA
Welbee Inverter P400 (ASIA specifications)	WBP	
Welbee Inverter P350L (Japan specifications)	WBPL	Japan
Welbee Inverter P400L (CCC specifications)	WBPL	ASIA
Welbee Inverter P400L (ASIA specifications)	WBPL	
Welbee Inverter P400L (U.S. specifications)	WBPL	U.S.
Welbee Inverter P400L (Europe specifications)	WBPL	Europe
Welbee Inverter P500L (Japan specifications)	WBPL	Japan
Welbee Inverter P500L (CCC specifications)	WBPL	
Welbee Inverter P500L (ASIA specifications)	WBPL	
Welbee Inverter P500L (U.S. specifications)	WBPL	U.S.
Welbee Inverter P500L (Europe specifications)	WBPL	Europe
Welbee Inverter W350 (Japan specifications)	WBW	Japan
Welbee Inverter W400 (U.S. specifications)	WBW	U.S
Welbee Inverter W400 (Europe specifications)	WBW	Europe
Welbee Inverter W400 (CCC specifications)	WBW	ASIA
Welbee Inverter W400 (ASIA specifications)	WBW	
Welbee Inverter F300P (Japan specifications)	WBF	Japan
Welbee Inverter F300P (U.S. specifications)	WBF	
Welbee Inverter F300P (Europe specifications)	WBF	
Welbee Inverter T500P (Japan specifications)	WBT	Japan
Welbee Inverter T500P (Europe specifications)	WBT	
Welbee Inverter T500P (CCC specifications)	WBT	
Welbee Inverter T500P (ASIA specifications)	WBT	
Welbee Inverter DPS Parallel configuration (Japan specifications)	WBDPS	Japan
Welbee Inverter DPS Parallel configuration (CCC specifications)	WBDPS	
Welbee Inverter DPS Parallel configuration (ASIA specifications)	WBDPS	
Welbee Inverter DPS Parallel configuration (Europe specifications)	WBDPS	Europe
Welbee Inverter DPS Single configuration (Japan specifications)	WBDPS(SINGLE)	Japan
Welbee Inverter DPS Single configuration (CCC specifications)	WBDPS(SINGLE)	
Welbee Inverter DPS Single configuration (ASIA specifications)	WBDPS(SINGLE)	
Welbee Inverter DPS Single configuration (Europe specifications)	WBDPS(SINGLE)	Europe
Welbee Inverter A350P (Japan specifications)	WBA	Japan
Welbee Inverter A350P (Europe specifications)	WBA	
Welbee Inverter A350P (U.S. specifications)	WBA	
Welbee Inverter A350P (CCC specifications)	WBA	
Welbee Inverter A350P (ASIA specifications)	WBA	
Welbee Inverter A500P (Japan specifications)	WBA	
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.
DP400 (Europe specifications)	DP	Europe

Table 2.3.1 Selection Candidates List

Welding power unit used	Welding power supply	Region
DP400 (CCC specifications)	DP	Europe
DP500 (Japan specifications)	DP	Japan
DP500 (U.S. specifications)	DP	U.S.
DP500 (Europe specifications)	DP	Europe
DP500 (CCC specifications)	DP	Japan
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
DM-353(S-1) (Japan specifications)	DM3	Japan
DL-350(S-2) (Japan specifications)	DL(S-2)	Japan
DT300P(S-2) (Japan specifications)	DT	Japan
DT300P(S-2) (Europe specifications)	DT	Europe
DT303P(S-1) (Japan specifications)	DT3	Japan
DT315P (CCC specifications)	DT	ASIA
Welding interface (Standard)	WIF	—
Welding interface (4-channel specifications)	WIF(4ch)	—
Welder connected by input/output signals	WPS(I/O)	—
CPVE-400R(CCC specifications) *1	CPVE	Japan
CPVE-400R(S-2) (CCC specifications) *1	CPVE(S-2)	
EP-400R (CCC specifications)*1	EPR	Japan

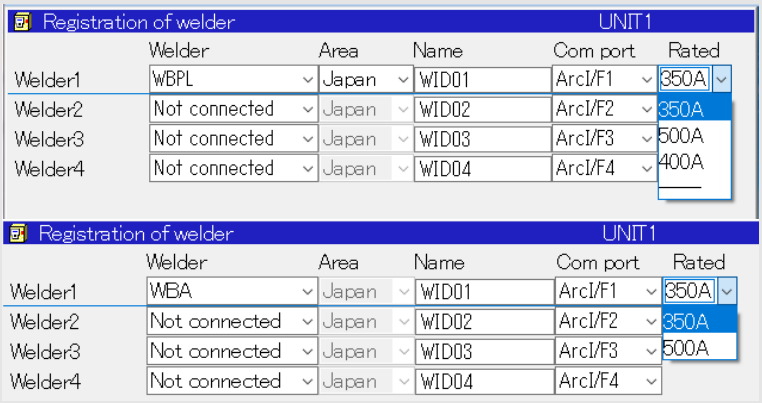
*1 The primary-side input voltage 380V, CCC, Chinese panel

IMPORTANT

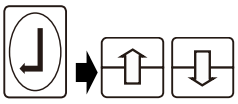
- To use Welbee Inverter M350L / M400L / P350L / P400L or Welbee Inverter P500L, it is required to prepare the optional software “Welbee-SP”.
- The welding power supply applicable to register (connect) with the CPVE series welding power supply to the same communication port at the same time is WPS (I/O) only. When using simultaneously with other series welding power supply and Welding interface, use a communication port different from CPVE.
- Welbee Inverter series welding power supply, D-series welding power supply, EP series welding power supply and Welding interface can connect at the same time.
- Same series welding power supply of different region, cannot connect at the same time.

POINT

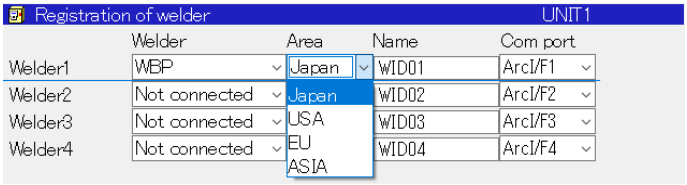
When using the Welbee Inverter P350L / P400L / P500L / A350P / A500P, in the following figure, select the “Rated” for the type of connected welding power supply.

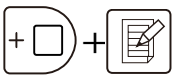


When using the Welbee Inverter P350L / P400L / P500L, in "2.5 Registering the welding characteristic data and wire feed characteristic data", the welding characteristic data for the welder set in "Rated" is displayed.
If "Rated" is not set (if "—" is set), all welding characteristic data for Welbee Inverter P350L / P400L / P500L is displayed.



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].



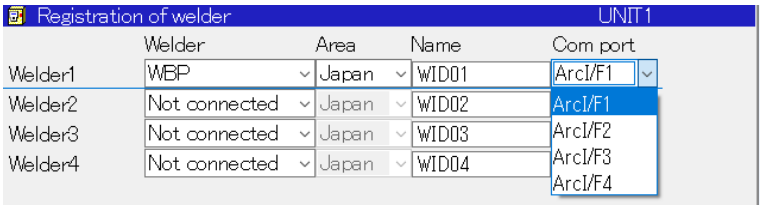


4 To give a name to a welder, first move to “Name,” and then press [EDIT] while holding down [ENABLE].

>> The soft keyboard now starts up.

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

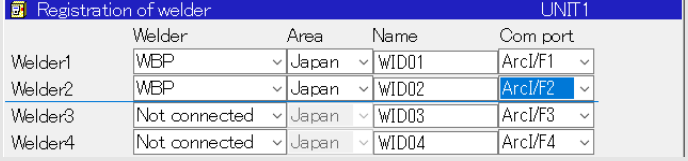
6 Set the communication port. Move to “Com port” and select the Arc I / F to which the welding power supply is connected.



POINT

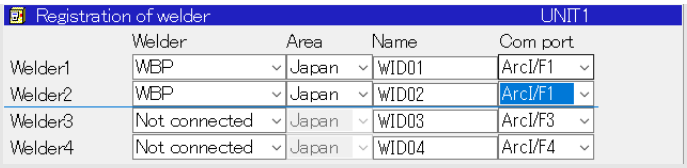
Example of communication port settings when connecting multiple welding power supplies

① Setting when using two Arc I / F to connect two welding power supplies.
Set the different communication port for Welder 1 and Welder 2.



Set the Welder ID to “1st welder” (standard setting) for both Welder1 and Welder2.※

② Setting when using two Arc I / F to connect two welding power supplies.
Set the same communication port for Welder 1 and Welder 2.



Set the Welder ID as "1st welder " for welding power supply 1 and "2nd welder " for Welder 2.※

※For the setting of the Welder ID, refer to 1.4.2.2 Setting of Welder ID

7 When a multiple number of welding power supplies are to be connected, follow the same steps to register “Welder2” and so on.

8 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. Please back up this data before re-registering the welding power supply.
- When the following welding power supply is connected, set the “Ver.2”.(Refer to Figure 2.3.1)
  - Welbee Inverter M350L(Japan specification)
  - Welbee Inverter M350(Japan / CCC / Asia specification)
  - Welbee Inverter M500(Japan / CCC / Asia specification)

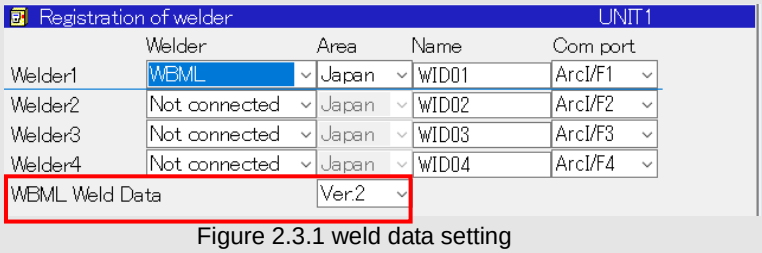


Figure 2.3.1 weld data setting

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

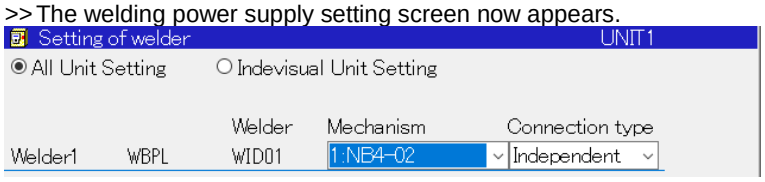
Set the robot to which the welding power supply is to be connected and the connection type.
When a robot system with the multi-unit specifications is to be used, these settings must be performed for each unit.

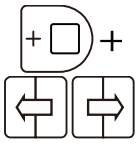
Settings relating to how to operate the welding power supply

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.

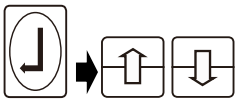




By default, the welding power supply connection is set for all units at once.
It is possible to set for each unit by changing the setting.

Table 2.4.1 Selecting the setting screen

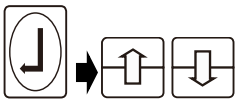
Selection candidates	Contents
All Unit Setting	Set all units at once.
Indivisual Unit Setting	Set for each unit. Set for all units.



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

Table 2.4.2 Mechanism Selection Candidates

Selection candidates	Description
Manipulator Name (Example: NV6 etc.)	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 candidates appear. Select one of them.

Table 2.4.3 Connection Type Selection Candidates

Selection candidates	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 welding function. Up to two sets of tandem 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 **When selecting "Indivisual Unit Setting" 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.

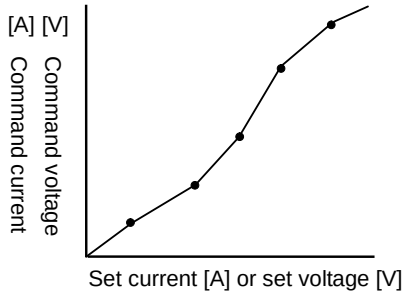
Registering the welding characteristic data and wire feed characteristic data

2.5.1 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

2.5.2 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.

2.5.3 Performing the registration operation

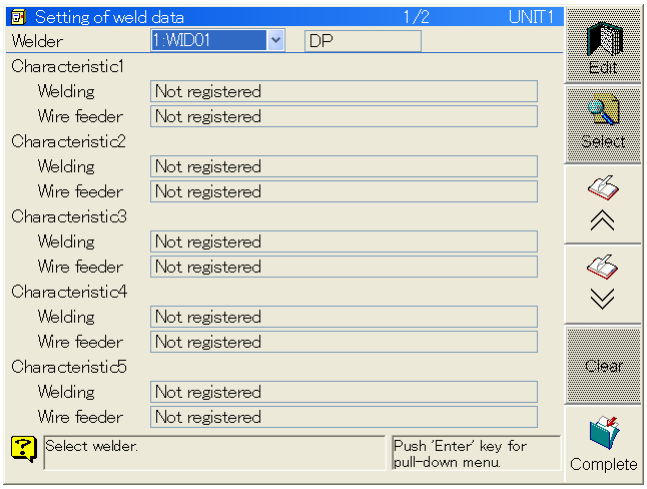
The welding characteristic data and wire feed characteristic data of the robot dedicated welding power supplies are contained inside the robot as standard data. This means that if the applicable data suited to the welding power supply to be used and the environment (wire diameter, wire material, shielding 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 2-31 “2.8 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 WB-P350 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/M400L	WB-M350L/M400L	10	10
Welbee Inverter M350/400/500	WB-M350/400/500	10	10
Welbee Inverter P350/P400	WB-P350/P400	10	10
Welbee Inverter P350L/P400L/P500L	WB-P350L/P400L/P500L	10	10
Welbee Inverter W350/W400	WB-W350/W400	10	10
Welbee Inverter F300P	WB-F300P	0(unnecessary)	1
Welbee Inverter T500P	WB-T500P	0(unnecessary)	1
Welbee Inverter DPS	WB-DPS	10	10
Welbee Inverter A350P	WB-A350P	0(unnecessary)	1
Welbee Inverter A500P	WB-A500P	0(unnecessary)	1
DM-350/500	DM-350/500	2	2
DM-350(S-2)	DM-350(S-2)	2	2
DM-353(S-1)	DM-353(S-1)	2	2
DP350/400/500	DP-350/400/500	10	10
DP400R	DP-400R	10	10
DA-300P	DA-300P	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
CPVE-400R	CPVE	2	2
CPVE-400R(S-2)	CPVE(S-2)	2	2
DT300P(S-2)	DT -300P(S-2)	0(unnecessary)	1
DT303P(S-1)	DT -303P(S-1)	0(unnecessary)	1
DT315P	DT -315P	0(unnecessary)	1
Digital Inverter EP-400R	EPR	10	10
Semi welding power supply 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.

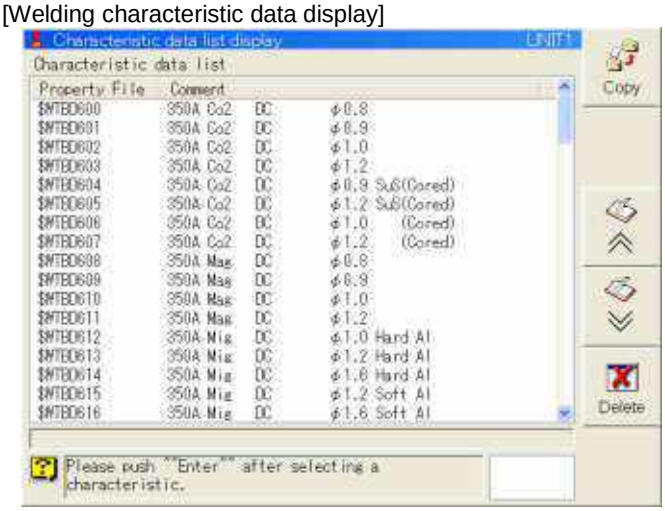
2 **When a multiple number of welding power supplies have been registered by the operations on page 2-4 "2.3** Registering the welding power supply**", press [Enter] in the "welder" field, and select the welding power supply which is the target of the settings.**

This operation need not be performed when only one welding power supply has been registered.

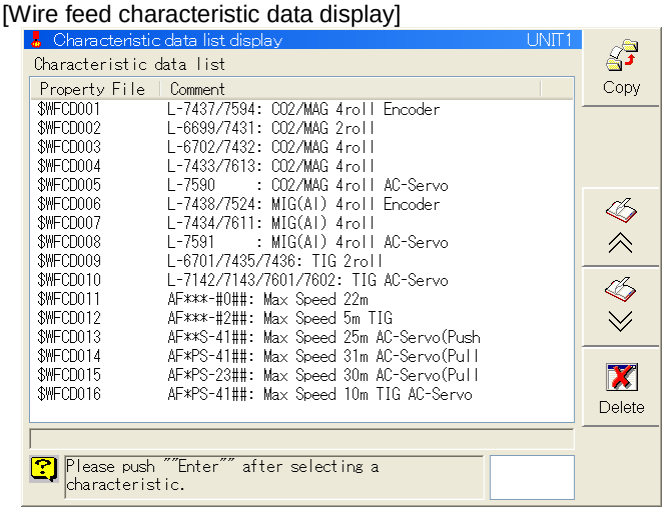
3 Use [Up] and [Down] to the target section, and press f8 <Select>.

>> A list of the characteristic data now appears.

[Welding characteristic data display]



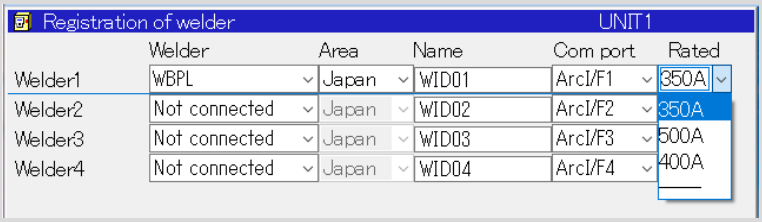
[Wire feed characteristic data display]



POINT

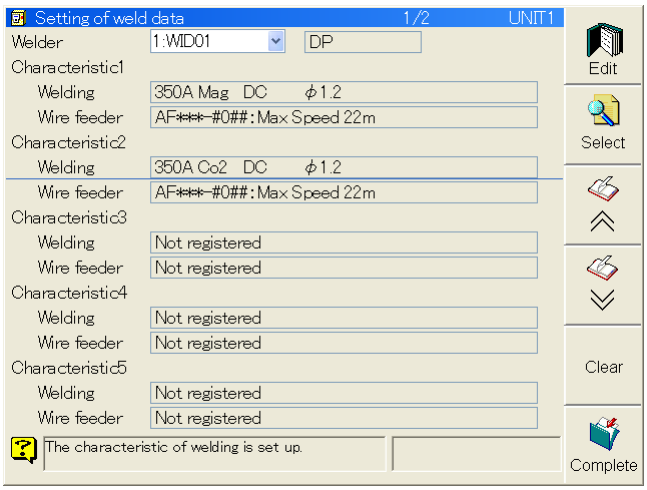
When using the Welbee Inverter P350L / P400L / P500L, the welding characteristic data for the welder set in “Rated” of "2.3 Registering the welding power supply" is displayed.

If "Rated" is not set (if "—" is set), all welding characteristic data for Welbee Inverter P350L / P400L / P500L is displayed.



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.



The robot contains the standard characteristic data for each welding power supply. For details, refer to Chapter11.

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

>> This completes the registration of the characteristic data.

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

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.

(1) 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.

(2) When the voltage adjustment method in the welding characteristic data is changed

(3) 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.

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.

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

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.

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.

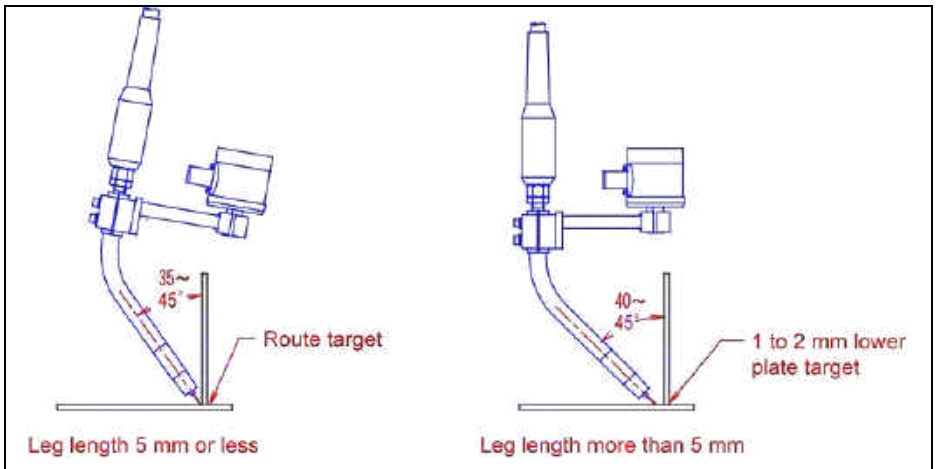


Fig. 3.2.1 Torch angle

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.

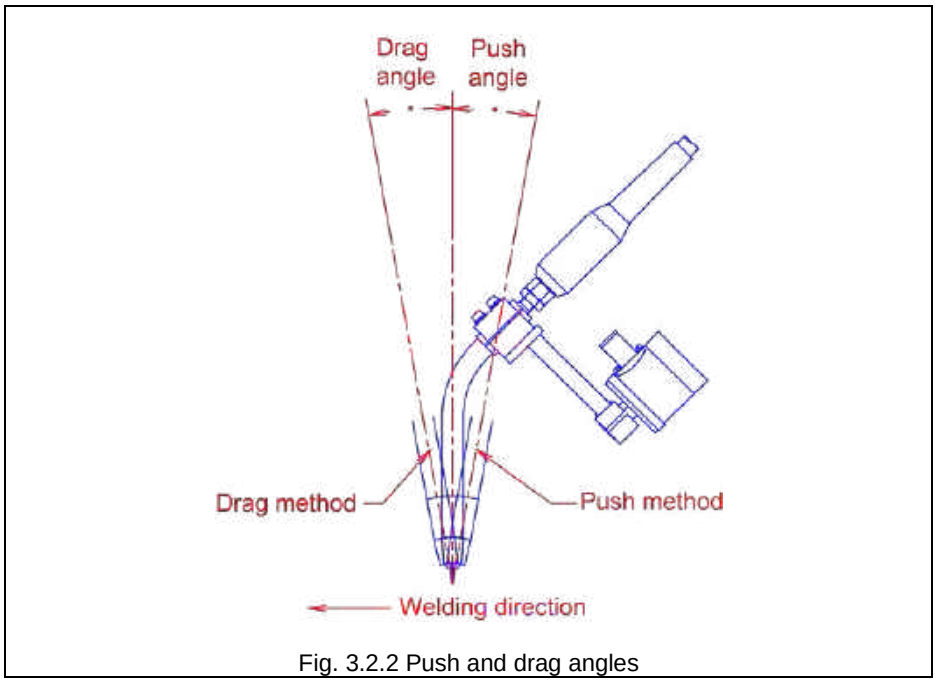


Fig. 3.2.2 Push and drag angles

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 candidates.
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.

Method by which the welding conditions are specified directly using numerical values

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>).

Method by which the number of the file storing the welding conditions is specified directly

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".

Method by which the number of the file storing the welding conditions is specified with a variable

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

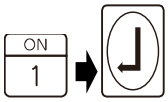
When welding multiple locations with the same welding conditions, it is useful to specify the welding conditions with a file number. By revising the contents of a welding condition file, you can change the welding conditions of all the arc start commands and arc end commands that specify this file number.

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.

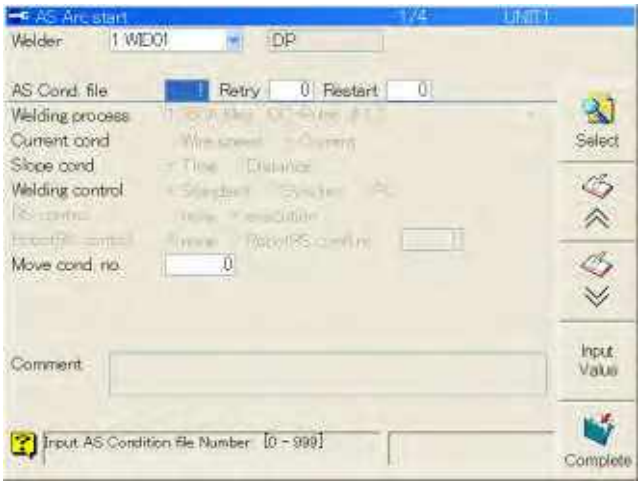
This operation is common to commands that specify conditions with a file, such as the arc start command, arc end command and weaving start command.

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.)



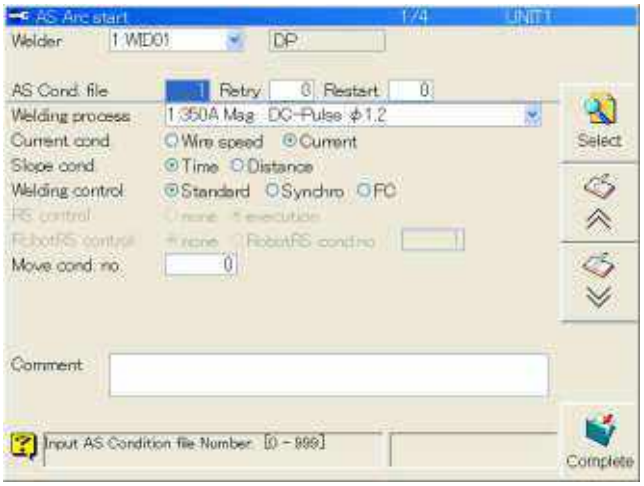
1 **Input “1” in the “AS Cond. file” field, and press [Enter].**

>> 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

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

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

IMPORTANT

The standard built-in database may be unusable in certain situations.
The Table 3.3.8 welding conditions in the standard built in database are generated from values obtained from our testing environment. They may therefore be unusable in your usage environment. In such situations, adjust the values in the welding conditions environment according to your usage environment.

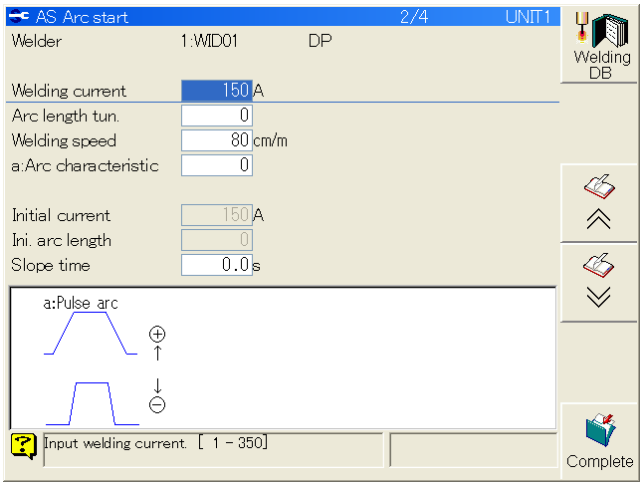
INFO.

When using Welbee Inverter series (the WB-F300P, and TIG welding power supply are excluded) with characteristic data where the application from "Table 2.5.2." to “Table 2.5.17.” is "automatic machine", use a welding condition database.

Setting the conditions using the welding condition guide function

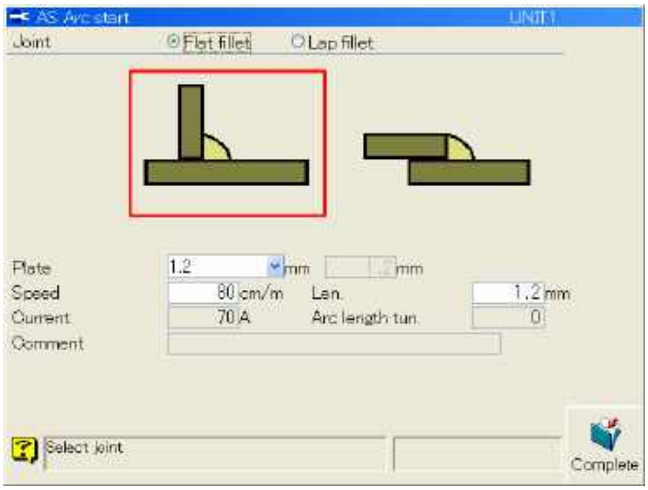
1 **Open the welding conditions editing screen.**

>> 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.



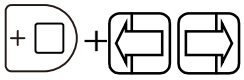
2 **Press f7 <Welding DB>.**

>> 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.**

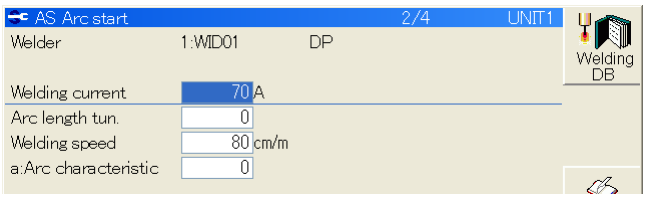


4 **Move the cursor to “Joint,” and then select the type of joint using [ENABLE] + [LEFT/RIGHT].**

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.

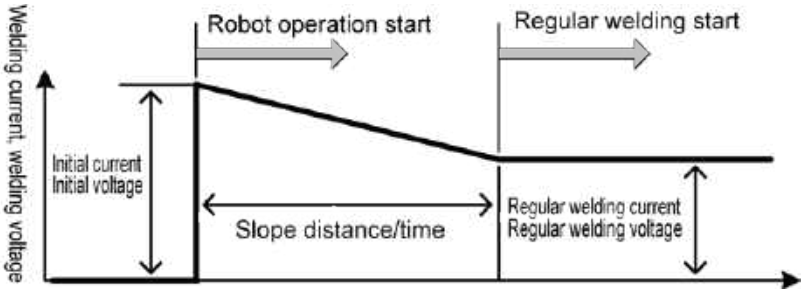


Fig. 3.3.1 Slope control sequence at the start of welding

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.

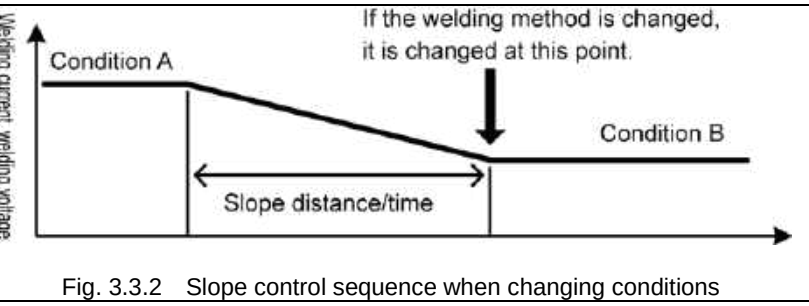


Fig. 3.3.2 Slope control sequence when changing conditions

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".

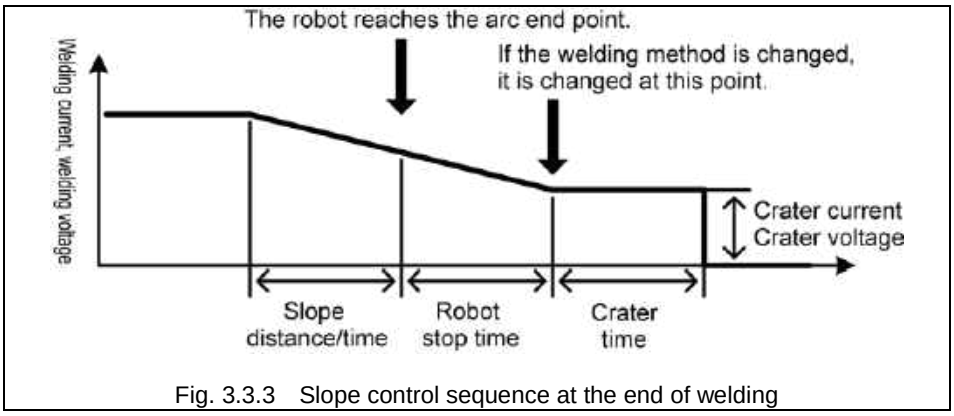


Fig. 3.3.3 Slope control sequence at the end of welding

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.

f key layout

When the robot is used for the arc welding application, the initial settings of the f keys that appear at both sides of the LCD screen are as shown below.
The f keys are arranged in a layout which is optimally suited to the settings of the specific application such as spot welding or arc welding. Since initial settings are performed at the factory to suit the application for which the particular type of robot is normally used, the customer does not normally need to re-arrange the f keys.

Table 9.2.1 Initial layout of f keys for arc welding (teach mode)

■Teach mode (page 1: when the keys are simply pressed)

f1	key switching	Arc start command selection	f7
f2	Welding ON/ OFF	Weaving start command selection	f8
f3	Weaving ON/ OFF	Allocates station startup	f9
f4	File operations	Wire inching (low-speed)	f10
f5	Arc constant setting	Wire retract (low-speed)	f11
f6	Arc welding Condition setting	Gas check	f12

■Teach mode (page 1: when the keys are pressed together with [ENABLE])

f1	f key switching	Arc end command selection	f7
f2	Welder select	Weaving end command selection	f8
f3	Weaving ON/ OFF target robot switching	Forcibly initiates I release. (Input wait release)	f9
f4	No function	Wire inching (high-speed)	f10
f5	Sets the constant.	Wire retract (high-speed)	f11
f6	Service menu	No function	f12

■Teach mode (page 2: when the keys are simply pressed)

f1	f key switching	Sets the teach or playback conditions	f7
f2	Sensor ON/ OFF	Manual speed Switching (speed up)	f8
f3	Input/output ON/OFF	Manual speed switching (speed down)	f9
f4	Sets monitor 2	No function	f10
f5	Tool switching	Sets the accuracy.	f11
f6	Step Clear/ Change Specified Return	Performs the Smooth setting.	f12

■Teach mode (page 2: when the keys are pressed together with [ENABLE])

f1	f key switching	No function	f7
f2	No function	No function	f8
f3	No function	No function	f9
f4	No function	No function	f10
f5	No function	Pass/ positioning setting	f11
f6	Automatic operation pause status release (only during station startup)	Acceleration setting	f12

Table 9.2.2 Initial layout of f keys for arc welding (playback mode)

■ Playback mode (page 1: when the keys are simply pressed)				
f1	f key switching	Arc welding Condition setting		f7
f2	Welding ON/ OFF	No function		f8
f3	Weaving ON/ OFF	No function		f9
f4	Arc monitor	Wire inching (low-speed)		f10
f5	No function	Wire retract (low-speed)		f11
f6	Stop	Gas check		f12

■ Playback mode (page 1: when the keys are pressed together with [ENABLE])				
f1	f key switching	Service Menu		f7
f2	Welder select	Step feed		f8
f3	Weaving ON/OFF target robot switching	Forcibly initiates I release. (Input wait release)		f9
f4	Step continuous	No function		f10
f5	Switches between cycle, Continuous and step.	Speed override (10% up)		f11
f6	Stop	Speed override (10% down)		f12

■ Playback mode (page 2: when the keys are simply pressed)				
f1	f key switching	Sets the teach or playback conditions.		f7
f2	Sensor ON/ OFF	No function		f8
f3	Step Clear/ Change Specified Return	No function		f9
f4	Changing the method for returning to the stopped position for normal startup	No function		f10
f5	Changing the method for starting up after a step set.	No function		f11
f6	Stop	No function		f12

■ Playback mode (page 2: when the keys are pressed together with [ENABLE])				
f1	f key switching	No function		f7
f2	No function	No function		f8
f3	No function	No function		f9
f4	No function	Wire inching (high-speed)		f10
f5	No function	Wire retract (high-speed)		f11
f6	Stop	Simultaneously switches the start select and program select or station monitor		f12

Table 9.2.3 Initial layout of f keys for arc welding (when the CLAMP/ATRC key has been pressed)

f1	f key switching	Move command (JOINT)		f7
f2	Weld start command(AS)	Move command (LINE)		f8
f3	Weld end command (AE)	Move command (CIRCLE)		f9
f4	Fixed pattern Weaving start Command (WFP)	Wire inching (low-speed)		f10
f5	Weaving end Command (WE)	Wire retract (low-speed)		f11
f6	END instruction	Gas check		f12

f1	f key switching	Start allocation		f7
f2	Step jump command(JMP)	SET command		f8
f3	Program call command (CALLP)	RESET command		f9
f4	Joint weaving Start command (WAX)	ON wait command (WAITI)		f10
f5	No function	OFF wait command (WAITJ)		f11
f6	Timer command (DELAY)	No function		f12

Basic arc welding operations

This section describes the basic operating procedures relating to arc welding such as wire inching and retract and switching between welding ON and OFF.

Inching and retracting the wire

Inching refers to the action that extends the welding wire from the tip; conversely, retracting refers to the action that draws the wire back into the tip. In the motor power status, it does not matter if these functions are OFF. (There is no need to grasp the [Enable switch]). The wire can be inched or retracted in the teach mode or playback mode unless the robot is operating.

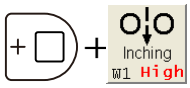
Inching and retracting the wire

1 **To inch the wire, press f10 <Inching>.**

>> The wire is now extended slowly from the tip.

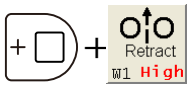
2 **To retract the wire, press f11 <Retract>.**

>> The wire is now drawn back slowly into the tip.



3 **To inch the wire at high speed, press f10 <Inching> while holding down [ENABLE].**

>> The wire is now extended rapidly from the tip.



4 **To retract the wire at high speed, press f11 <Retract> while holding down [ENABLE].**

>> The wire is now drawn back rapidly into the tip.

<u>To change the inching/retract operation patterns</u>

You can select from among “Normal”, “Limit” and “Hold” for the inching or retract movement pattern with <Arc Constant> — [3 Constant of weld] — [Inching/Retract Key operation].

- The initial setting is “Normal”, whereby inching/retract is done only while the key is being pressed.
- When this is set to “Limit”, inching/retract will halt after the set time has elapsed, even if the key continues to be pressed. When you release the key during the set time period, inching/retract will halt immediately.
- When this is set to “Hold”, pressing the key once will cause inching/retract to be done for the set time period. Inching/retract will continue even if you release the key during the set time period.
  Using this setting will allow you to always do inching/retract for a fixed length. (However, there will be slight variations.) When using the “Hold” setting, please adjust the time to the desired length.

Inching/Retracting the Wire with the [JOG DIAL]

When the “Wire inching/retracting function” is assigned to the [JOG DIAL], wire inching/ retracting can be performed using the rotate operation of the [JOG DIAL].

Operation patterns using the [JOG DIAL]

There are three operation patterns when controlling inching/retracting with the [JOG DIAL], namely “Low pitch feed,” “High pitch feed,” and “Variable speed feed.” Select one of the patterns.

When this function is assigned to the [JOG DIAL], the initially selected pattern is “Low pitch feed.”

You can confirm which pattern is selected by the icon displayed in the variable status display area.

Pattern	Display Icon	Function Overview
Low pitch feed	Yellow	When the [JOG DIAL] is rotated 1 notch, inching/retracting is performed at low pitch (approx. 1mm).
High pitch feed	Green	When the [JOG DIAL] is rotated 1 notch, inching/retracting is performed at high pitch (approx. 15mm).
Variable speed feed	20% 20% Light blue	When the [JOG DIAL] is rotated 1 notch, the inching/retracting speed increases or decreases 10%.

Adjusting the amount of wire supply

If the amount of wire supply is not at the desired length, it can be adjusted.

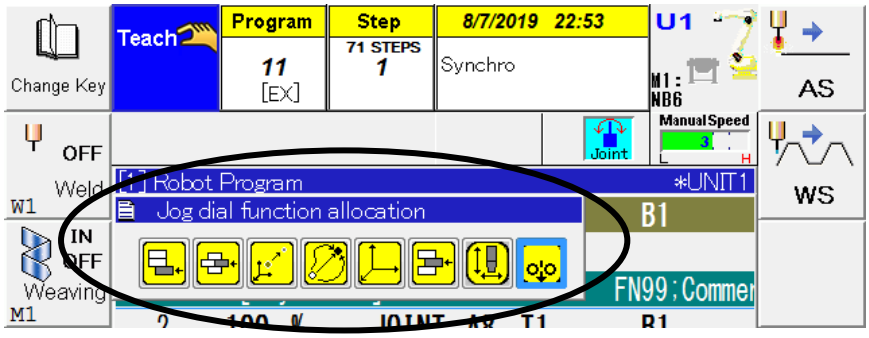
For details, see “Application section (Arc welding)” in the instruction manual.

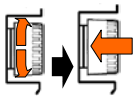
Switch the operator level to ***EXPERT*** or higher.

Assigning the wire inching/retracting function to the [JOG DIAL]

1 **Select the robot program monitor in the teach mode, hold down [Shift] and press the [JOG DIAL].**

>> A [JOG DIAL] function allocation dialog such as the one shown below is displayed.





2 **Rotate the [JOG DIAL] to select the “inching/retracting” icon, and press the [JOG DIAL]. Alternatively, touch the “inching/retracting” icon.**

>> The “Wire inching/retracting function" is allocated to the [JOG DIAL], and the icon is displayed in the “variable status display area.”

To clear the function allocation

When the icon is being displayed, hold down [Shift] and rotate the [JOG DIAL]. The function allocation is cleared and the icon display disappears.

When the mode is switched (teach -> playback, playback -> teach), the allocation is automatically cleared.

To change the function allocation

Touch the icon in the display. The [JOG DIAL] function allocation dialog is displayed, and the allocated function can be changed.

Check the wire supply direction

1 **Before performing wire supply, rotate the [JOG DIAL] and check the wire supply direction.**

>> The icon display changes according to the rotation direction of the [JOG DIAL], and the supply direction can be checked.

POINT

Wire is not supplied simply by rotating the [JOG DIAL]

If the [JOG DIAL] is rotated without pressing [ENABLE] or [Shift], wire is not supplied.

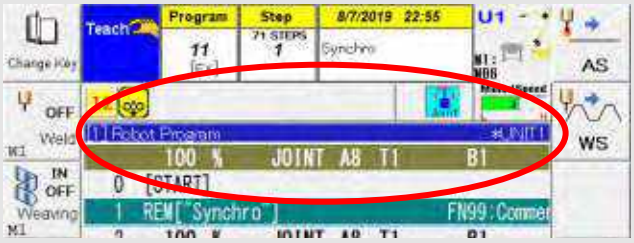
INFO.

About wire supply direction settings

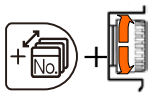
The wire supply direction can be set in <Arc constant settings>. For details, see “Application section (Arc welding)” in the instruction manual.

IMPORTANT

If the icon display does not change when the [JOG DIAL] is rotated, the robot program monitor is not selected. Wire feed cannot be performed in this state. Touch the robot program monitor area.



Performing feed at low pitch



1 **Assign the Wire inching/retracting function" to the [JOG DIAL].**

2 **Inching**

Hold [Shift], and rotate the [JOG DIAL] 1 notch in the inching direction.

>> The "Inching" icon (yellow) is displayed, approximate 1mm of wire inching is performed, and the wire feed automatically stops.

(Yellow)

Retracting

Hold [Shift], and rotate the [JOG DIAL] 1 notch in the retracting direction.

>>The "Retracting" icon (yellow) is displayed, approximate 1mm of wire retracting is performed, and the wire feed automatically stops.

(Yellow)

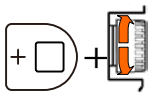
3 **Release [Shift].**

>> If wire feed is being performed, the feed stops.

POINT

- Directly after switching the wire feed direction, the stipulated length of wire may not be fed.
- Hold down [Shift] and continue to rotate the [JOG DIAL] to continuously feed the wire.

Performing feed at high pitch



1 **Assign the "Wire inching/retract function" to the [JOG DIAL].**

2 **Inching**

Hold [ENABLE], and rotate the [JOG DIAL] 1 notch in the inching direction.

>> The "Inching" icon (green) is displayed, approximate 15mm of wire inching is performed, and the wire feed automatically stops.

(Green)

Retracting

Hold [ENABLE], and rotate the [JOG DIAL] 1 notch in the retracting direction.

>> The "Retracting" icon (green) is displayed, approximate 15mm of wire retracting is performed, and the wire feed automatically stops.

(Green)

3 **Release [ENABLE].**

>> If wire feed is being performed, the feed stops.

POINT

- Directly after switching the wire feed direction, the stipulated length of wire may not be fed.
- The wire feed direction cannot be switched during feed.
  Temporarily release [ENABLE].

Performing variable speed feed

1 **Assign the “Wire inching/retracting function” to the [JOG DIAL].**

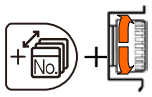
2 **Press the [JOG DIAL] to switch to “Variable speed feed.”**

>> The icon display color changes to light blue.

The “%” shown in the icon represents the current feed speed (as a percentage of the maximum feed speed).

After switching to “Variable speed feed,” the display always shows “0%.”

Each time the [JOG DIAL] is pressed, feed switches between “Variable speed feed” and “Low pitch feed.”



3 **Inching**

Hold the [Shift] key, and rotate the [JOG DIAL] 1 notch in the inching direction.

>> The wire is fed at slow speed (10%).

Retracting

Hold the [Shift] key, and rotate the [JOG DIAL] 1 notch in the retracting direction.

>> The wire is reverse fed at slow speed (10%).

POINT

The speed increases by 10% for every notch on the [JOG DIAL].
If the [JOG DIAL] is rotated in the opposite direction, the speed reduces by 10% for every notch.

4 **Release [Shift].**

>> The speed returns to “0%.”
If wire feed is being performed, the feed stops.

POINT

The feed direction cannot be switched during feed.
Temporarily release [Shift].

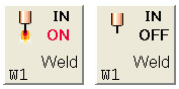
Switching between welding ON and OFF

Prior to shipment from the factory, this setting is at ON so that welding will be executed without fail. To disable welding temporarily, switch “welding ON/OFF” to “OFF”.
Use the f keys for the switching operations. Switching is possible at any time regardless of whether the teach or playback mode is established. (Switching is also possible during the playback of welding sections.)

Switching between welding ON and OFF

1 **Press f2 <Weld ON/OFF>.**

>> Each time this key is pressed, the welding ON/OFF status is switched as follows.

Display	Status	Details
	Weld ON	Welding is performed during automatic operation.
	Weld OFF	Welding is not performed during automatic operation.
	The input signal is complied with.	Welding ON/OFF is determined by the “welding ON / OFF” signal which is input from the external source. The f key display changes in accordance with the status of the “welding ON/OFF” signal.

2 **Press the key until the desired status is established.**

>> The robot proceeds with the welding in accordance with the welding ON/OFF setting status.

Checking the shielding gas

Whether the shielding gas used for welding is being output properly can be checked using the teach pendant. One of the f keys is used to perform the operations.

Checking the shielding gas

When a multiple number of welders are used, select the one for which this operation is to be performed before proceeding with the gas check.

1 **Press f12 <Gas>.**

>> The shielding gas is output while the key is pressed.

2 **To stop the shielding gas, release f12 <Gas>.**

Leave the welder’s gas check switch at OFF.

To check the gas from the teach pendant, the gas check switch provided on the welder must be left at OFF without fail.
If it is at the ON position, the gas cannot be checked from the robot.

To change the shielding gas output patterns

For the shielding gas, you can select from among “Normal”, “Limit” and “Hold” with <Arc Constant> — [3 Constant of weld] — [Gas check operation].
The initial setting is “Normal”, whereby gas is output only while the key is being pressed.
When this is set to “Limit”, gas will halt after the set time has elapsed, even if the key continues to be pressed. When you release the key during the set time period, gas will halt immediately.
When this is set to “Hold”, pressing the key once will cause gas to be output for the set time period. Output will continue even if you release the key during the set time period.

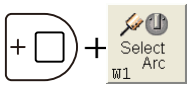
Switching the welders

Multiple welders can be connected to this controller. When two or more welders are connected to this controller, it is necessary to select the welder to be controlled in advance.

Switching the welders

1 **To switch the welders, use <Select Arc>. This is possible both in the teach mode and playback mode.**

"W1" appears at the bottom left of the f key. This denotes that "welder 1" is the target of operation. When "welder 2" is selected, "W2" appears.
When the control power is turned on, "welder 1 (W1)" is always selected.



2 **If, when two welders have been connected for example, f2 <Select Arc> is pressed, the target of operation is switched to "welder 2". (The display changes to "W2".)**

3 **When f2 <Select Arc> is pressed again, the next welder is selected.**

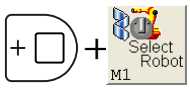
>> If two welders are connected, the target of operation returns to "welder 1". (The display changes to "W1".)

Switching between weaving ON/OFF

Switching between weaving ON and OFF is performed to disable weaving temporarily such as when the weld lines are to be checked.
Switching is possible at any time regardless of whether the teach or playback mode is established. (Switching is also possible during the playback of weaving sections.)

If a multiple number of robots have been connected under the multi-unit specifications, the robot targeted for weaving ON/OFF switching must be selected first.

Switching between weaving ON/OFF



1 **If a multiple number of robots have been connected under the multi-unit specifications, press f3 <Select Robot> while holding down [ENABLE] to select the target robot first.**
If the multi-unit specifications do not apply (if only one robot is being used), this operation need not be performed.

"M1" appears at the bottom left of the f key. This indicates that "manipulator 1" has been selected as the target of operation. "M2" appears if "manipulator 2" has been selected. When the control power is turned on, "manipulator 1 (M1)" is always selected.

2 **Press f3 <Weaving ON/OFF>.**
>> Each time the key is pressed, the weaving ON/OFF status is switched as shown below.

Display	Status	Details
	Weaving ON	Weaving is performed.
	Weaving OFF	No weaving is performed.
	The input signal is complied with.	Weaving ON/OFF is determined by the "weaving ON" signal which is input from the external source. The f key display changes in accordance with the status of the "weaving ON" signal.

3 **Press the key until the desired status is established.**
>> The robot proceeds with the weaving in accordance with the weaving ON/ OFF setting status.

Teaching arc welding

Let's now try teaching some actual welding steps.
This will not be difficult. The only steps that must be taken are to record AS at the position where welding is to start and AE where it is to end.

Using the following work program as an example, the welding steps will now be taught. However, details on recording the movement commands and other basic teaching operations will be omitted here.

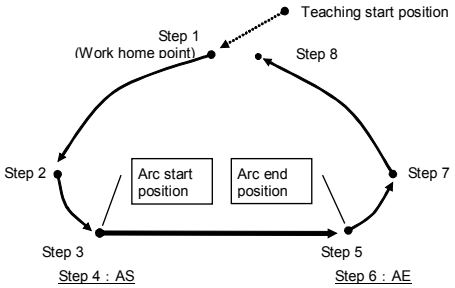


Fig. 9.4.1 Example of teaching

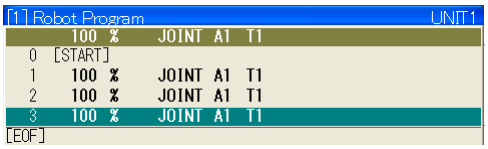
POINT

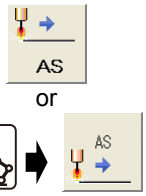
When using number keys

When teaching is performed with numeric keys, "The use of the hard key" needs to be set the "Enable".
For details on the setting procedure, see "Section 7.7 Customizing the Hard Keys" in "Chapter 7 Useful Functions."

Teaching the arc welding start command

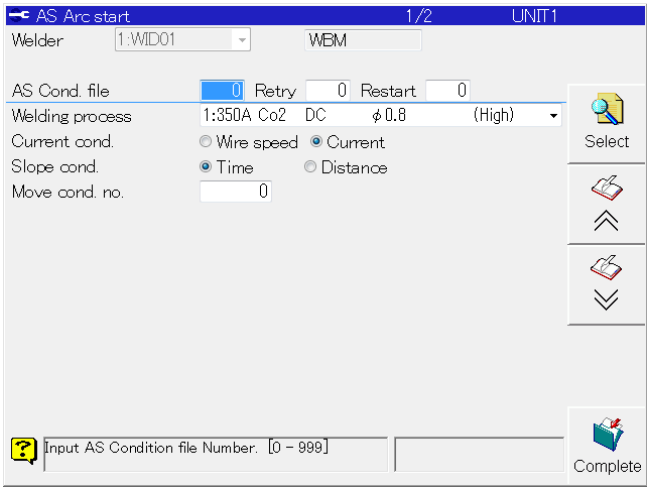
1 **Record this command up to the arc start position (step 3).**





2 **Press f7 <AS>.**
Alternatively, press the f2 <AS> after pressing [CLAMP/ARC].

>> The screen for setting the arc welding start conditions now appears. The method used to specify the conditions is described here using a case where the WB-M350L is being operated as an example. The same operations are performed even when other welders are used.



Concerning the method used to select the arc welding start command

- **The arc weld start command is FN414.**
  It can also be selected using [FN] -> ”414” -> [Enter].
- **You can also hold [ENABLE] and press [4] to call the function group, and select the arc welding start command.**

---

3 **When “0” is specified as the “AS Cond. file”, the conditions can be specified by number. In this case, proceed from step 5.**

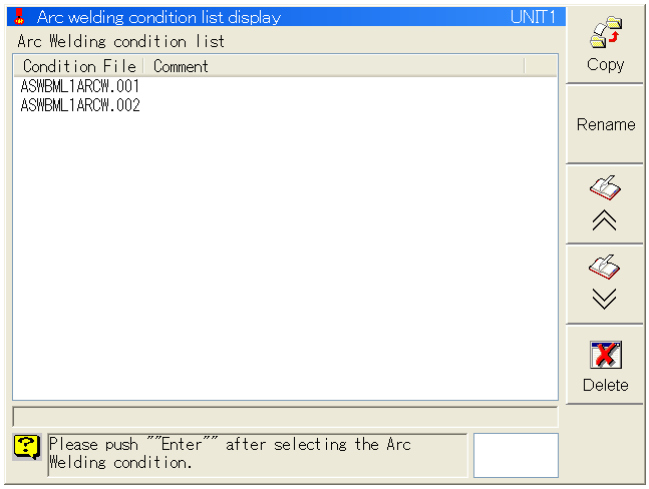
---

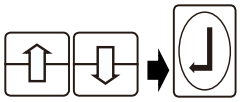
4 **To specify a condition using a file, either input the file number directly or select the file from the list of files.**

When selecting from the file list

To select a file from the list of files, press f8 <Select>.

>> The arc start condition files which have been prepared are displayed.





Select a file using the [up or down] key, and press [Enter].

>> The designated arc start condition file is called.

---

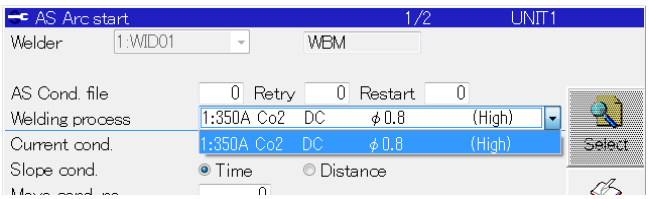
5 **Specify the number of the arc retry file in the “Retry cond. no.”.**
If “0” is specified, the standard arc retry is executed when arc start has failed.
Leave “0” as is if you are not used to operating the robot.
When executing arc retry defined by the user, specify an arc retry file which has already been created.

---

6 **Specify the number of the arc retry file in the “Restart. no.”**
When specifying the created arc retry file, the arc restart is performed when lucking of arc as failure. Leave “0” as is if you are not used to operating the robot.

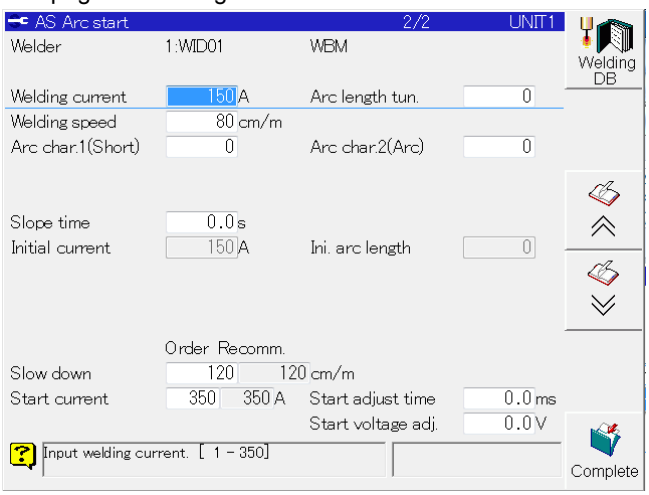
---

7 **Align the cursor with “Welding process” and “Current cond.”, press [Enter], and select the desired conditions from among the selection items displayed.**

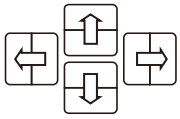


8 **The remaining welding conditions are set on the second and subsequent pages. Press [Scroll page].**

>> The page now changes.



Depending on the welder used, there may be no conditions to set on the second and subsequent pages. In a case like this, perform step **11**.

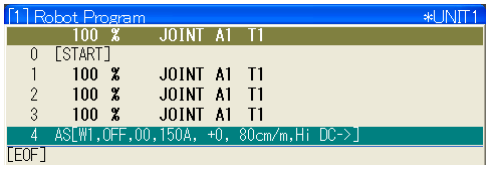


9 **Move the cursor using the [Up], [Down], [Left] and [Right] keys, and input the "Welding curr.", "Welding speed" and "Arc length tuning".**

10 **If there are a third page and subsequent pages, press [Scroll page] to display the screen, and then input the conditions by following the same procedure as described up until this point.**

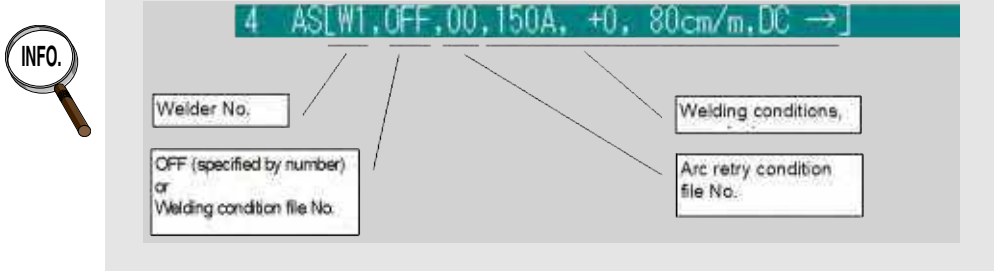
11 **Once all the conditions have been set, press f12 <Complete>.**

>> The arc welding start command (AS) is recorded as step 4.



Concerning the step displays after recording

Outlined below is the significance of the step displays after the arc welding start command has been recorded.



Teaching the arc welding end command

Try recording the arc welding end command (AE) at the arc end position.

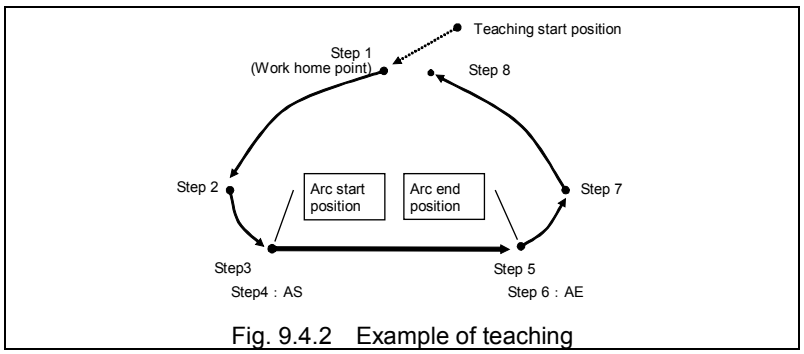
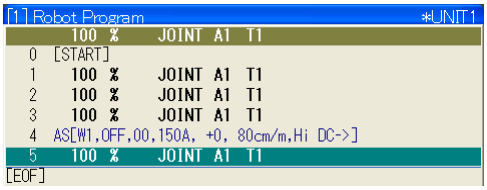
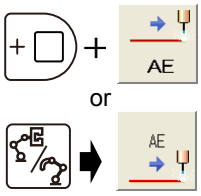


Fig. 9.4.2 Example of teaching

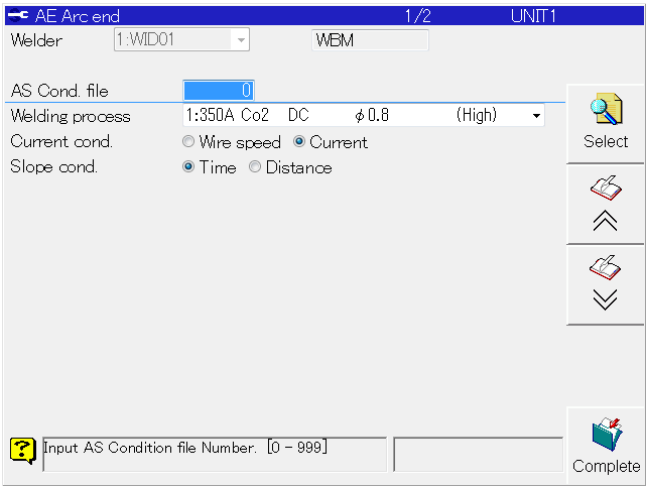
1 **Record the arc end position (step 5).**





2 **While pressing [ENABLE], press f7 <AE>.**
Alternatively, press the f3 <AE> after pressing [CLAMP/ARC].

>> The screen for setting the arc welding end conditions now appears.



Concerning the method used to select the arc welding end command

- **The arc weld end command is FN415.**
  It can also be selected using [FN] -> ”415” -> [Enter].
- **You can also hold [ENABLE] and press [4] to call the function group, and select the arc welding end command.**

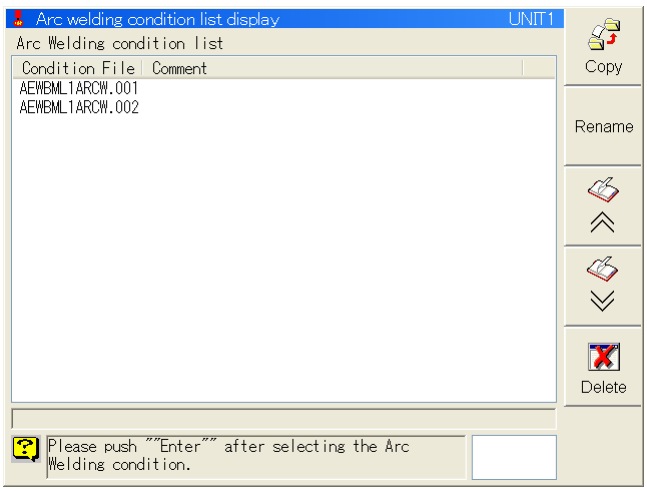
3 **When “0” is specified as the “AS Cond. File,” the conditions can be specified by number. In this case, proceed from step 5.**

4 **To specify a condition using a file, either input the file number directly or select the file from the list of files.**

When selecting from the file list

To select a file from the list of files, press f8 <Select>.

>> The arc welding condition files which have been prepared are displayed.



Use "Up/Down" to select the file, and press [Enter].

>> The specified arc welding condition file is called.

5 **Align the cursor with "Weld method," "Current conditions classification" and press [Enter], select the desired conditions from the displayed selection items.**

6 **Set the remaining weld conditions on the 2nd and subsequent pages. Press [Turn page].**

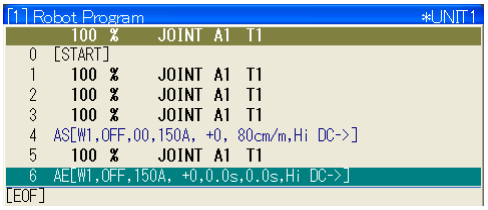
>> The page is turned.

Depending on the welder used, there may be no conditions to set on the second and subsequent pages. In a case like this, perform step .

7 **If there are setting items on the 3rd and subsequent pages, press [Scroll page] to display the screen, and then input the conditions using the same operations.**

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

>> The arc welding end command (AE) is recorded as step 6.



Teaching of weaving

Weaving is used when there are gaps in the work piece or the leg length is to be shortened.

Using the following work program as an example, this section describes how to teach fixed pattern weaving (WFP).
However, details on recording the movement commands and other basic teaching operations will be omitted here.

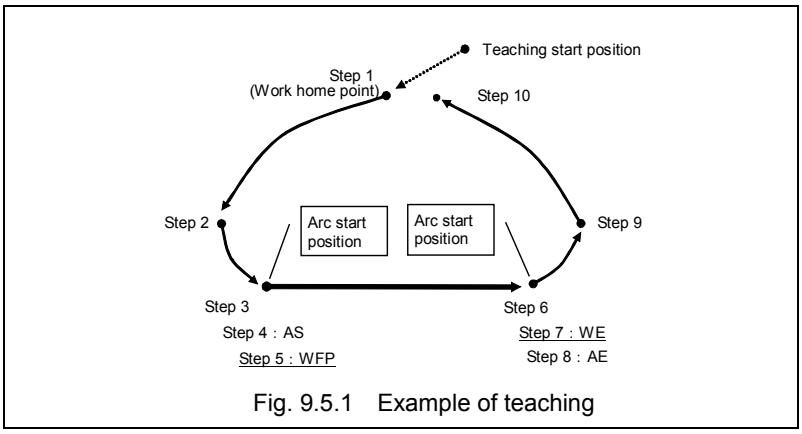


Fig. 9.5.1 Example of teaching

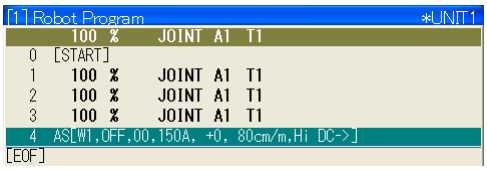
POINT

When using number keys

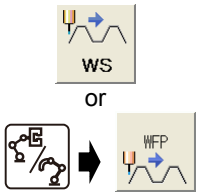
When performing teaching using the number keys, it is necessary to set the use hard key settings to “On.”
For details on the setting procedure, see “Section 7.7 Customizing the Hard Keys” in “Chapter 7 Useful functions.”

Teaching the weaving start command

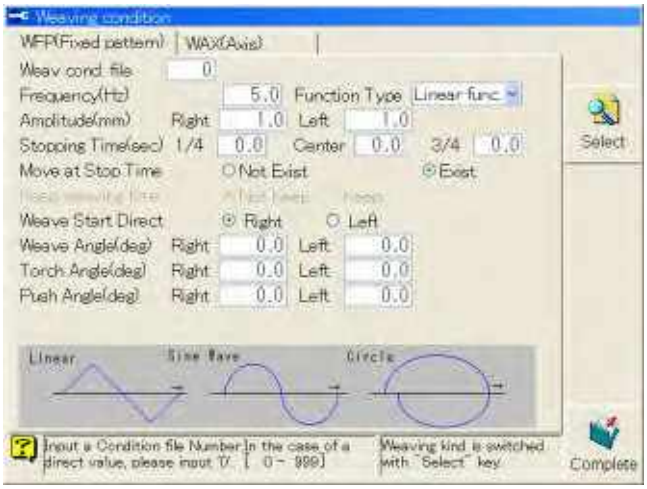
1 **Record the command up to step 4.**



2 **Press f8 <WS>.Alternatively, press the f4 <WFP> after pressing [CLAMP/ARC].**



>> The screen for setting the fixed pattern weaving conditions now appears.

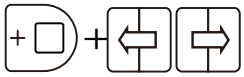


Concerning the method used to select the weaving start command

- **The weaving start command is FN440.**
  It can also be selected using [FN] -> ”440” -> [Enter].
- **You can also hold [ENABLE] and press [4] to call the function group, and select the weaving start command.**

3 **Move the cursor using [Up], [Down], [Left] and [Right], and set the weaving conditions.**

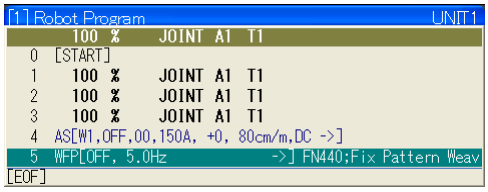
The method used to specify the conditions using a file is the same as for the arc start and arc end commands



The “Move at Stop Time” and “Weave Start Direct.” conditions are switched by pressing [left or right] while holding down [ENABLE].

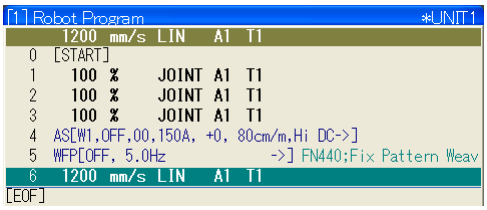
4 **Once all the conditions have been set, press f12 <Complete>.**

>> The fixed pattern weaving start command (WFP) is recorded as step 5.

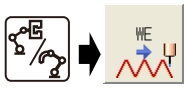


Teaching the weaving end command

1 **Record the command up to step 6.**

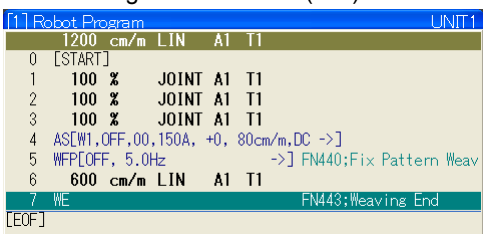


or



2 **While pressing [ENABLE], press f8 <WE>.**
Alternatively, press the f5 <WE> after pressing [CLAMP/ARC].

>> The weaving end command (WE) is recorded as step 7.



Concerning the method used to select the weaving end command

- **The weaving end command is FN443.**
  It can also be selected using [FN] -> ”443” -> [Enter].
- **You can also hold [ENABLE] and press [4] to call the function group, and select the weaving end command.**

Creating condition files

The method used to specify files as welding conditions or weaving conditions is useful because it cuts the time required for teaching and revisions and it facilitates the management of the conditions.

For instance, it yields the following advantages when the same welding conditions are used in more than one place.

- At the teaching stage, only the file number need be specified as the welding conditions.
- When revising the welding conditions, only the specified file need be revised. (There is no need to revise each of the conditions in each welding section in the work program.)

A comment for easy identification can be attached to the condition files.

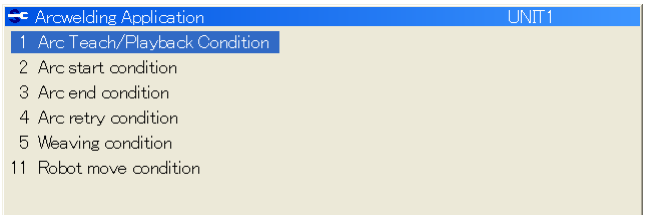
Creating condition files

Let's now try to create an actual condition file.

Creating condition files

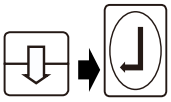
1 Press f6 <Arc Condition>.

>> The screen for setting the arc welding application now appears.
This screen is the same one that appears when <Service Utilities> — [21 Arcwelding application] have been selected.



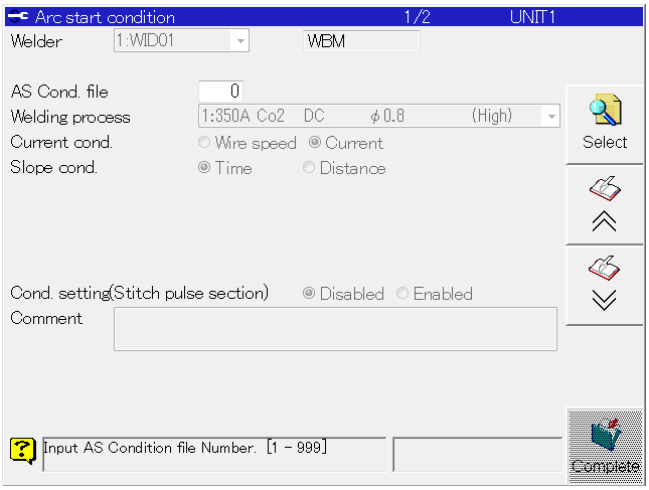
The following operations can be performed from this menu.

[2 Arc start condition] ⋯ For creating or revising arc start condition files.
[3 Arc end condition] ⋯ For creating or revising arc end condition files.
[4Arc retry condition] ⋯ For creating or revising arc retry condition files.
[5 Weaving condition] ⋯ For creating or revising weaving condition files.
[11 Robot move condition] ⋯ or creating or revising robot move condition files.
[12 Rs condition] ⋯ or creating or revising RS condition files.



2 For instance, to create an arc start condition file, select [2 Arc start condition], and press [Enter].

>> The screen for creating the arc start condition file now appears.
The screen shown below is the setting screen that appears when the DP-350 is used. Depending on the type of welder, the display screen may differ from the one shown below, but operation is the same.



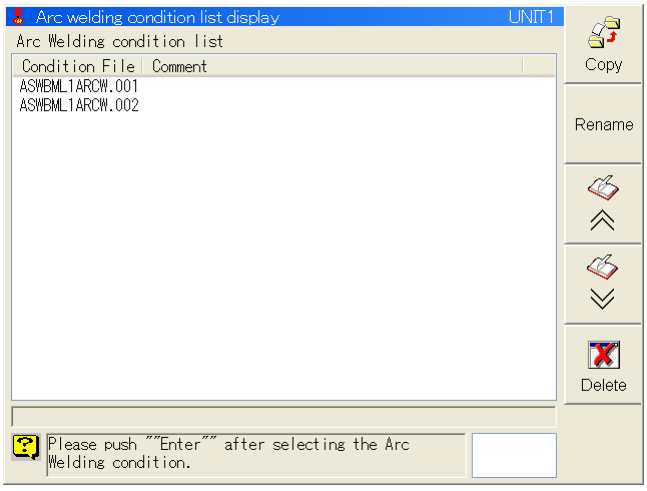
3 Input a file number from 1 to 999 in the "AS Cond. file" field, and press [Enter].

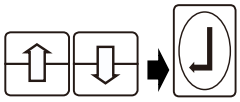
>> When a new file is created, the initial conditions are displayed.
When an existing file number has been input, the contents of the file concerned are displayed.

<u>When selecting an existing file from the file list</u>

To select a file from the list of files, press f8 <Select>.

>> The arc start condition files which have been prepared are displayed.



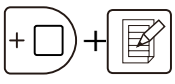


Select a file using the [up or down] key, and press [Enter].

>> The designated arc start condition file is called.

4 Select "Welding process" or "Current cond." by performing the same operations as the ones at the teaching stage.

Depending on the type of welder used, these conditions are not displayed.
(The conditions need not be set if they are not displayed.)



5 Move the cursor to the "Comment" field. A comment can be attached.

To attach a comment, press [EDIT] while holding down [ENABLE].

For details on how to input characters, see "2.5 To input characters" in Chapter 2.

6 Set the remaining conditions using the same method as the one used at the teaching stage.

7 **Upon completion, press f12 <Complete>.**

The revised conditions are reflected in the file concerned. If a new file is to be created, the new file is created and stored in the internal memory.

Copying, deleting and renaming condition files

This section describes the methods used to copy and delete condition files which have been created.

Files can be copied and deleted using the file operation menu as well.

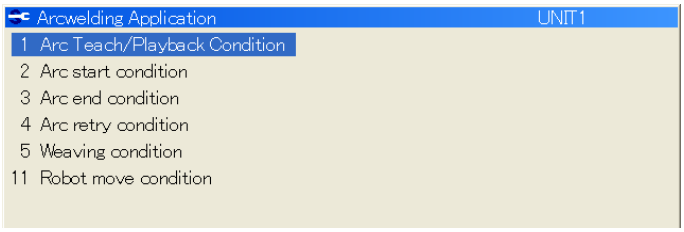
Although files can be copied and deleted using the file operation menu as well, the operator must be aware of the folder structure of the internal memory and know which files are stored in which folders when the file operation menu is used.

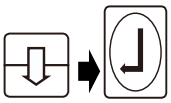
It is easier to copy or delete condition files by following the procedure below.

Copying, deleting and renaming condition files

1 **Press f6 <Arc Condition>.**

>> The screen for setting the arc welding application now appears.





2 **Select the type of file to be copied or deleted, and press [Enter].**

For instance, to copy or delete an arc start condition file, select [2 Arc start condition].

>> The screen for creating the selected file now appears.

3 **Press f8 <Select>.**

>> The arc start condition files which have been prepared are displayed.
On this screen, files can be copied, deleted and renamed.

4 **To copy a file:**

(1) Press f7 <Copy>
(2) Select the copy source condition file and press [Enter]
(3) Input the number of the copy destination file, and press [Enter].

5 **To delete a file:**

(1) Press f11 <Delete>
(2) Select the condition file to deleted, and press [Enter].

6 **To rename a file:**

(1) Press f8 <Rename>
(2) Input the new number of the file, and press [Enter].

7 **Close with [R/HOME] once operations are finished.**

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.)

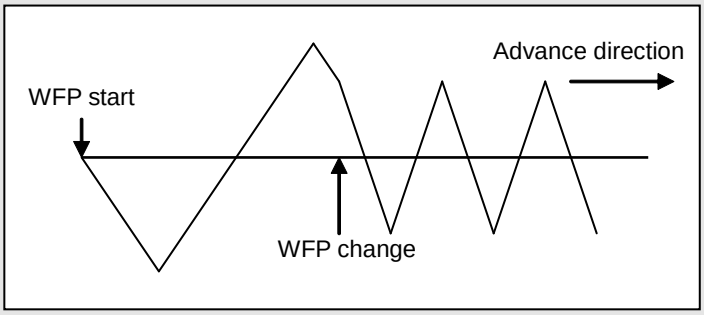


Fig. 3.4.1 Continuation of phase when conditions are changed

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).

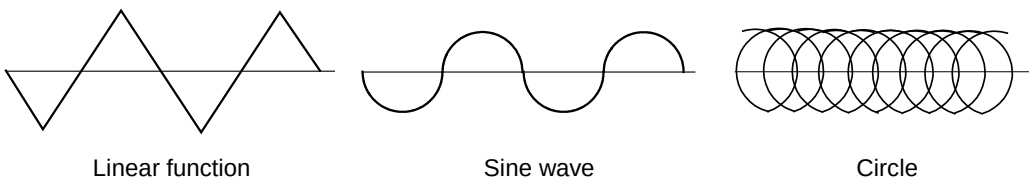
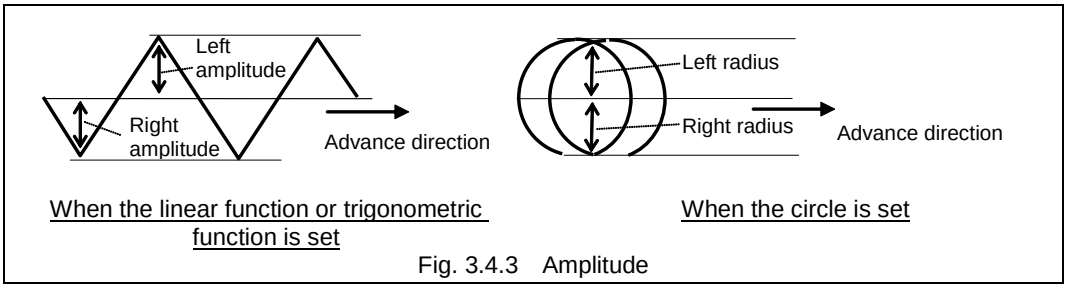


Fig. 3.4.2 Weaving operation patterns

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.

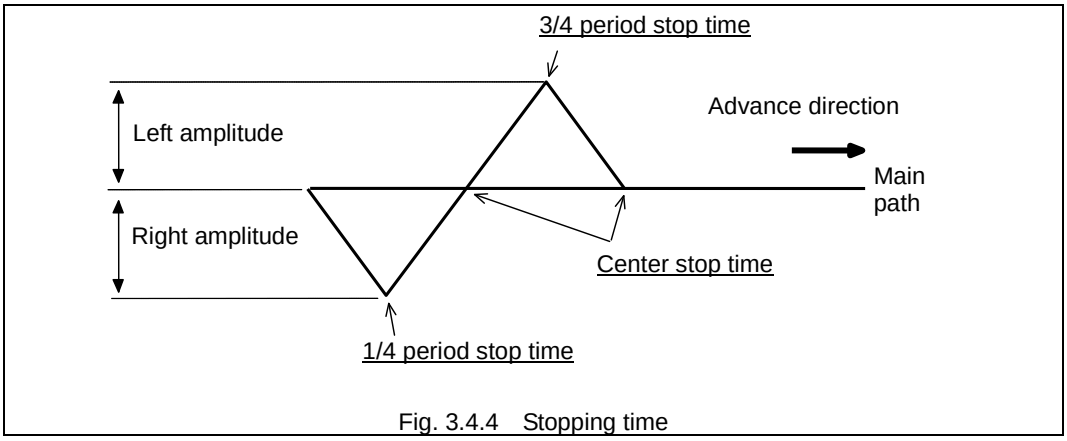
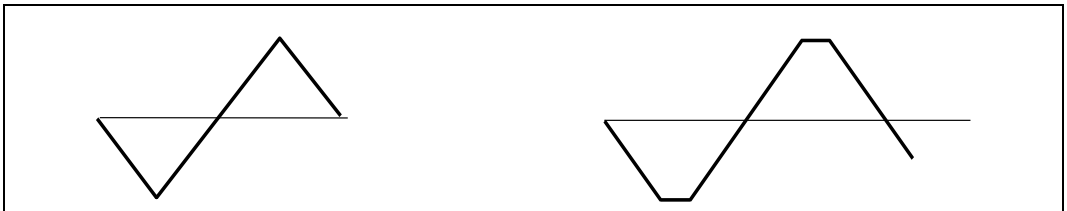


Fig. 3.4.4 Stopping time

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

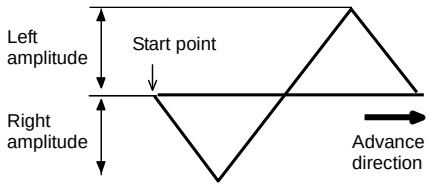
The condition is for setting whether the actual welding time is to be maintained even when the weaving stop time has been set.
If the weaving stop time is not set, the condition will not have any function.

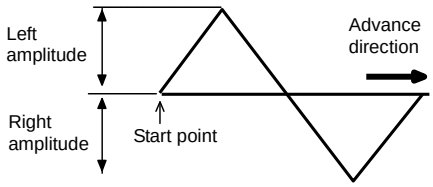
IMPORTANT

- 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.





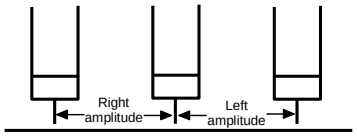
When oscillation start is on the right side

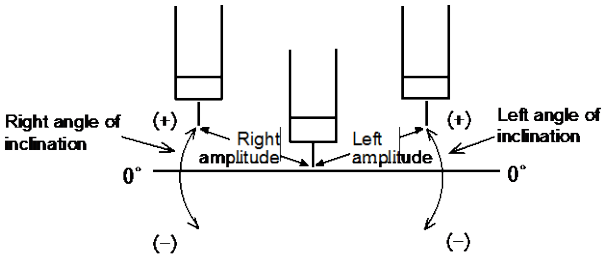
When oscillation start is on the left side

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.





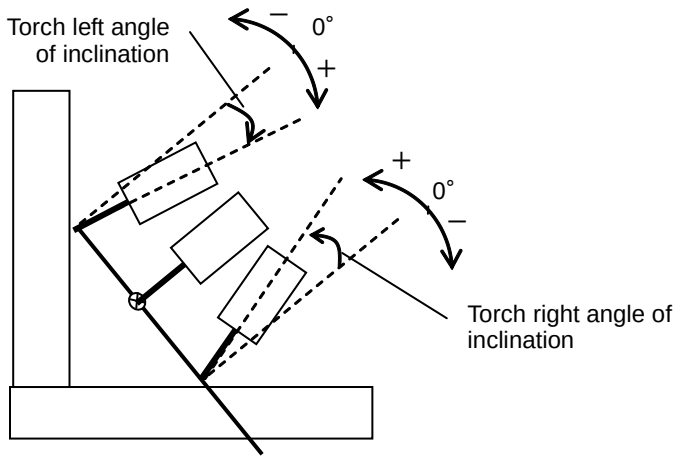
Weaving at an angle of inclination of 0 degrees

Weaving when there is an angle of inclination

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.



The rear plane direction from the front paper plane is the welding direction.

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.

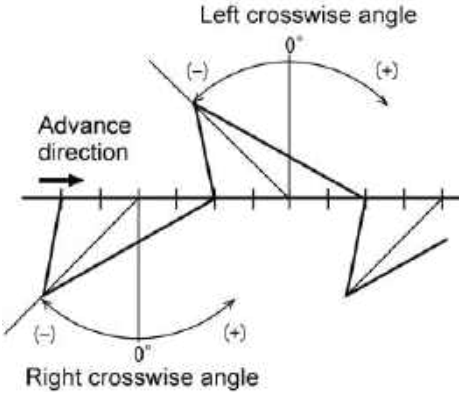


Fig. 3.4.9 Crosswise angle

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.

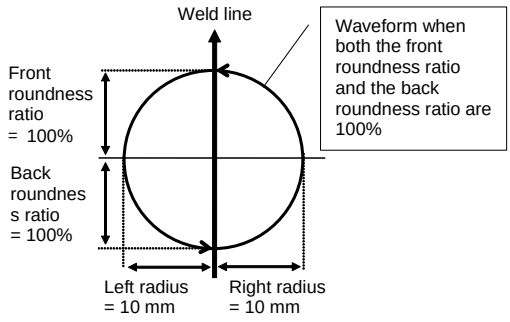


Fig. 3.4.10 When the front roundness ratio and back roundness ratio are 100%

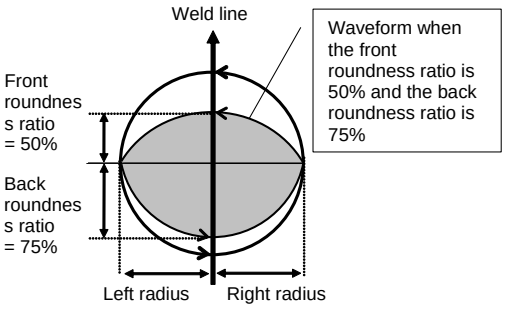


Fig. 3.4.11 When the front roundness ratio is 50% and the back roundness ratio is 75%

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.

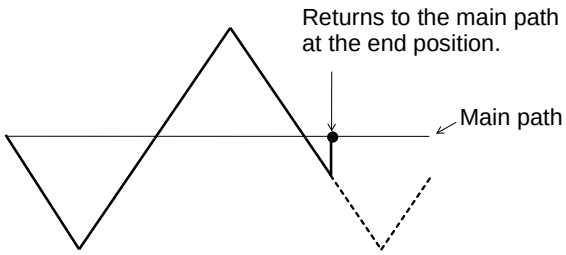


Fig. 3.4.12 Weaving end

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.

Method by which the weaving conditions are specified directly using numerical values

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".

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

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".

Method by which the number of the file specifying the weaving conditions is specified with a variable

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.”

- 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".

Function commands (FN codes)

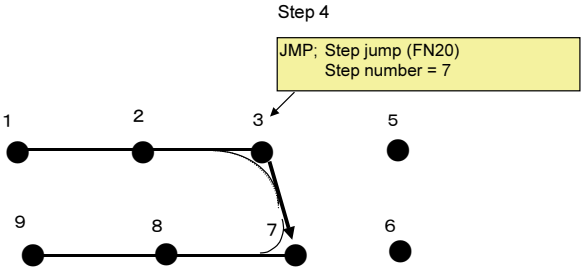
Command name	JMP
FN code	20
Title name	Step jump
General description	The robot jumps to the step specified in the same program.

■ General description

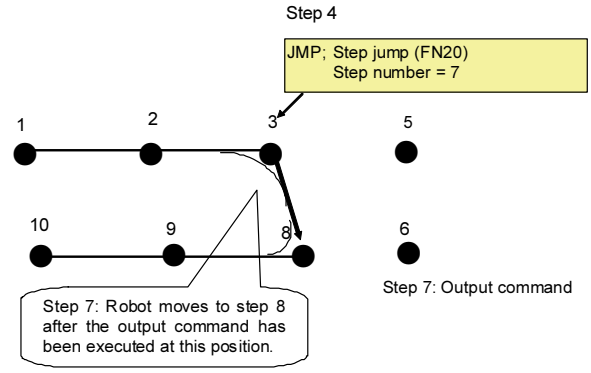
When this function command is executed, the robot is able to jump to the step specified in the same program. It makes no difference whether the jump destination step is a move command or function command.
Bear in mind that if the jump destination step is a function command, the function command at the jump destination will be executed as soon as the jump command has been executed.

■ Example of operation

In step 4, record JMP: step jump (FN20), and 7 as the number of the jump destination step. When this is played back, the robot skips steps 5 and 6 upon arriving at step 4 and jumps to step 7.



The robot is not decelerated by this command. If positioning is not specified, the command is executed at the position reached by the robot in the accuracy range of the move command immediately before.



■ Parameter

Parameter No. 1	Step No.	This specifies the number of the step serving as the robot's jump destination. (1-9999)

■ Example of screen display

JMP[35] FN20; Step jump

See
JMPI: Conditional step jump (FN23)
JMPN; Conditional step jump after specified number of passes (FN26)

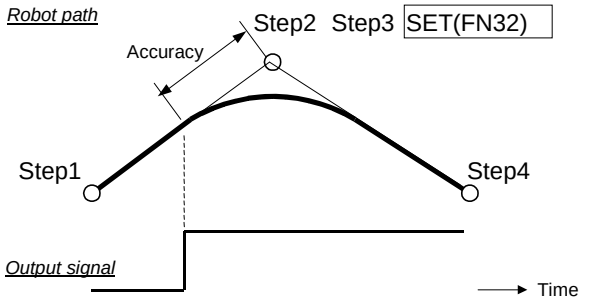
Function commands (FN codes)

Command name	SET
FN code	32
Title name	Output signal ON
General description	This command is used to set one of the general-purpose output signals to ON.

■ General description

When this function command is executed, it is possible to set any one of the general-purpose output signals (O1 to O2048) to ON. However, the command cannot set any of the status signals (signals with pre-assigned applications such as the gun signals and starting signal) to ON.
Which signals have been assigned as status signals can be identified on the monitor screen. Signals whose numbers are displayed in the bold italics are status signals so any of the other signals can be set to ON.

■ Example of operation



The robot is not decelerated by this command. If positioning is not specified, the command is executed at the position reached by the robot in the accuracy range of the move command immediately before.

■ Parameter

Parameter No. 1	Output signal number	This specifies the number of the general-purpose output signal which is to be set to ON. (1-2048)

■ Example of screen display

```
SET[O12]          FN32; Output signal ON
```

See
ALLCLR; All output signals clear (FN0)
RESET; Output signal OFF (FN34)
SETO; Consecutive output signal ON/OFF (FN100)
SETM ; Output signal ON/OFF (FN105)

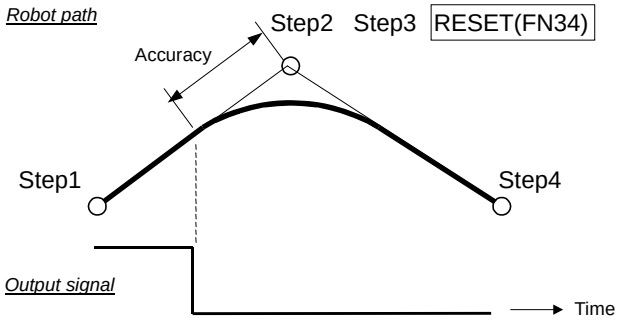
Function commands (FN codes)

Command name	RESET
FN code	34
Title name	Output signal off
General description	This command is used to set one of the general-purpose output signals to OFF.

■ General description

When this function command is executed, it is possible to set any one of the general-purpose output signals (O1 to O2048) to OFF. However, the command cannot set any of the status signals (signals with pre-assigned applications such as the gun signals and starting signal) to OFF.
Which signals have been assigned as status signals can be identified on the monitor screen. Signals whose numbers are displayed in the bold italics are status signals so any of the other signals can be set to ON.

■ Example of operation



The robot is not decelerated by this command. If positioning is not specified, the command is executed at the position reached by the robot in the accuracy range of the move command immediately before.

■ Parameter

Parameter No. 1	Output signal number	This specifies the number of the general-purpose output signal which is to be set to OFF.（1-2048）

■ Example of screen display

```
RESET [O12]          FN34; Output signal OFF
```

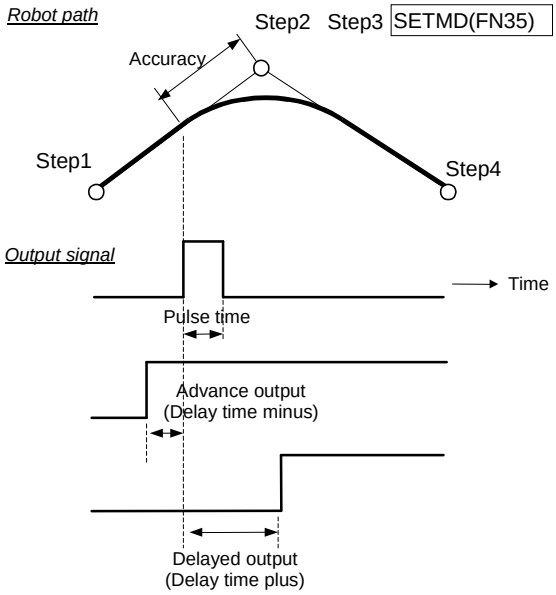
See
ALLCLR: All output signals clear (FN0)
SET; Output signal OFF (FN32)
SETO: Consecutive output signal ON/OFF (FN100)
SETM: Output signal ON/OFF (FN105)

Command name	SETMD
FN code	35
Title name	Output with pulse or delay ON/OFF
General description	This command is used to set one of the general-purpose output signals to come with a pulse or delay and to ON or OFF.

■ General description

When this function command is executed, it is possible to set any one of the general-purpose output signals (O1 to O2048) to ON or OFF. Furthermore, the command enables pulse output, advance output or delayed output to be specified.
However, the command cannot set any of the status signals (signals with pre-assigned applications such as the gun signals and starting signal) to ON or OFF. Which signals have been assigned as status signals can be identified on the monitor screen. Signals whose numbers are displayed in the bold italics are status signals so any of the other signals can be set to ON or OFF.

■ Example of operation



The robot is not decelerated by this command. If positioning is not specified, the command is executed at the position reached by the robot in the accuracy range of the move command immediately before.

If an advanced output or delayed output has been specified, the output can cover both the move command immediately before (step 1 in the above figure) and the move command immediately after (step 4 in the above figure).

■ Parameter

Parameter No. 1	Output signal number	This specifies the number of the general-purpose output signal which is to be set to ON or OFF. (1-2048)
Parameter No. 2	ON/OFF	"1" is specified for ON, and "0" for OFF. (0-1)
Parameter No. 3	Delay time	If "0.0" is specified as the time, the command is executed at the timing which coincides with the recorded point. 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. (Increment: seconds) In either case, it can be executed beyond the time lapse to the step before or after. (-10.0 – 10.0)
Parameter No. 4	Pulse time	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. (Increment: seconds) (0.0 – 10.0)

■ Example of screen display

```
SETMD [O12, 1, -5, 3]   FN35;     Output with pulse or delay ON/OFF
```

See
ALLCLR: All output signals clear (FN0)
SET: Output signal ON (FN32)
RESET: Output signal OFF (FN34)
SETO: Consecutive output signal ON/OFF (FN100)
SETM: Output signal ON/OFF (FN105)

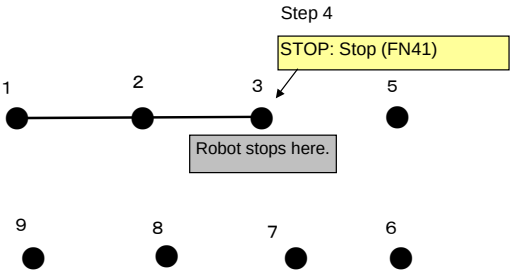
Command name	STOP
FN code	41
Title name	Stop
General description	This command is used to stop the robot.

■ General description

When this function command is executed, the robot is stopped.
The robot will not start unless the start command is input again.

■ Example of operation

In step 4, record STOP: stop (FN41).
When this is played back, the robot stops at step 4. This command does not establish the program end status (status established by executing the END: FN92 command to end the program): this means that the robot will head to step 5 without returning to the first step if it is restarted at the step 4 position. This should be borne in mind.



The robot stops after reaching the recorded point regardless of the accuracy of the move command immediately before.

■ Parameter

None

■ Example of screen display

STOP FN41; Stop

See
STOPI: Conditional stop (FN42)
END: End (FN92)

Function commands (FN codes)

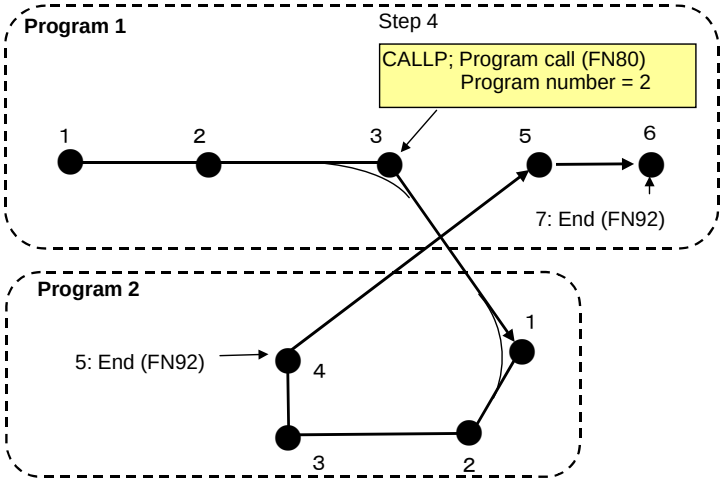
Command name	CALLP
FN code	80
Title name	Program call
General description	This command is used to call the specified program.

■ General description

When this function command is executed, the specified program is called.
Bear in mind that if a function command has been recorded in the first step in the call destination program, the function command at the jump destination will be executed as soon as the call command has been executed.
When the playback of the program at the call destination is completed (in the status established by executing the END command), the robot returns to the step following the step with the call command of the call source program.

■ Example of operation

In step 4, record CALLP: program call (FN80) and "2" as the program number. When this is played back, the robot skips steps 5 and 6 upon arriving at step 4 and jumps to the first step in program 2. When the playback of program 2 is completed (in the status established by executing the END command), the robot returns to step 5 following the step with the call command of call source program 1.



The robot is not decelerated by this command. If positioning is not specified, the command is executed at the position reached by the robot in the accuracy range of the move command immediately before.

The program call can be executed again at the call destination (during program 2 in the above figure.) 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.

■ Parameter

Parameter No. 1	Program No.	This specifies the number of the program serving as the call destination. (1-9999)

■ Example of screen display

CALLP [2] FN80; Program call

See
CALLPI: Conditional program call (FN81)
CALLPN: Conditional program call after specified number of passes (FN82)

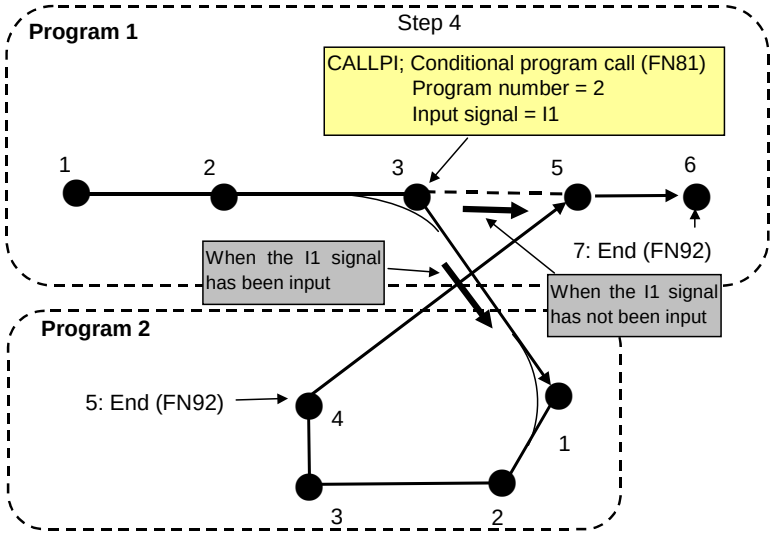
Command name	CALLPI
FN code	81
Title name	Conditional program call
General description	Using an input signal, this command is used to call the specified program.

■ General description

When this function command is executed, the specified program is called. When the specified input signal has been input, the step is called; when it has not been input, the step is not called and the robot passes the command by.
Bear in mind that if a function command has been recorded in the first step in the call destination program, the function command at the jump destination will be executed as soon as the call command has been executed.
When the playback of the program at the call destination is completed (in the status established by executing the END command), the robot returns to the step following the step with the call command of the call source program.

■ Example of operation

In step 4, record CALLPI: conditional program call (FN81), "2" as the program number, and I1 as the input signal.
When this is played back, the robot arrives at step 4, and if input signal I1 has been input, it jumps to the first step in program 2, and when the playback of program 2 is completed (the END command is executed), the robot returns to step 5 following the step with the call command of call source program 1. If the signal has not been input, the robot does not jump to program 2.



The robot is not decelerated by this command. If no positioning is specified, the input signal is inspected just before the command value reaches the accuracy range of the move command, and if it has been input, an inside arc is drawn. If the input signal has not been input, the command value heads toward the recorded point, and the input signal is inspected when the robot has reached the accuracy range.

The program call can be executed again at the call destination (during program 2 in the above figure.) 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.

■ Parameter

Parameter No. 1	Program No.	This specifies the number of the program serving as the call destination. (1-9999)
Parameter No. 2	Input signal	This records the number of the input signal which is to serve as the condition for executing the call. When number 5101 or above is specified, multiple input signals can be specified. (1-2048、5101—5196)

■ Example of screen display

```
CALLP [2,I1]      FN81; Conditional program call
```

See
CALLP: Program call (FN80)
CALLPN: Conditional program call after specified number of passes (FN82)

Function commands (FN codes)

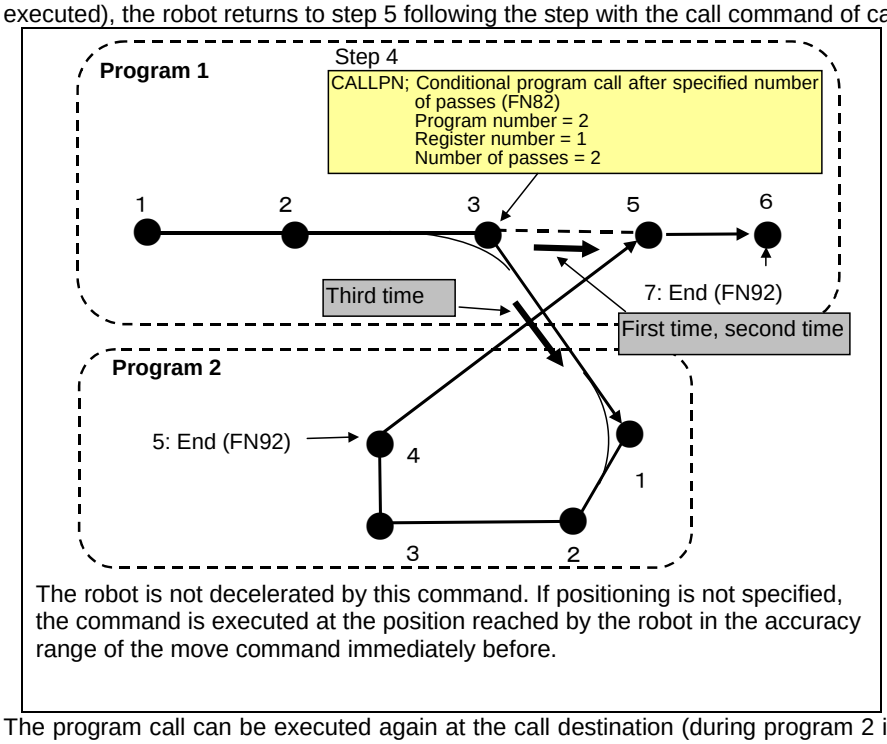
Command name	CALLPN
FN code	82
Title name	Conditional program call after specified number of passes
General description	Using a pass count (number of passes), this command is used to call the specified program.

■ General description

When this function command is executed, the specified program is called. The robot passes for the specified number of passes, and on the next time (specified number of passes +1) the call command is executed. (For instance, if "2" is specified as the number of passes, the robot passes twice, and on the third time the call command is executed.)
Bear in mind that if a function command has been recorded in the first step in the call destination program, the function command at the jump destination will be executed as soon as the call command has been executed.
When the playback of the program at the call destination is completed (in the status established by executing the END command), the robot returns to the step following the step with the call command of the call source program.

■ Example of operation

In step 4, record CALLPN: conditional program call after specified number of passes (FN82), "2" as the program number, "1" as the register number, and "2" as the number of passes.
When this is played back, the robot passes by for the first and second times, and then advances to steps 5; however, on the third time, it jumps to the first step in program 2. When the playback of program 2 is completed (the END command is executed), the robot returns to step 5 following the step with the call command of call source program 1.



The robot is not decelerated by this command. If positioning is not specified, the command is executed at the position reached by the robot in the accuracy range of the move command immediately before.

The program call can be executed again at the call destination (during program 2 in the above figure.) 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.

A global integer variable common to all units is used for the number of passes.
The current number of passes can be referenced using monitor/integer variables.

■ Parameter

Parameter No. 1	Program No.	This specifies the number of the program serving as the call destination. (1-9999)
Parameter No. 2	Register number	A "register" refers to the memory used for counting. Since an integer variable (1 to 200) is used, this parameter specifies its number. (1-200)
Parameter No. 3	Number of passes	This records the number of passes which is to serve as the condition for executing the call. The robot passes for the specified number of passes, and on the next time (specified number of passes +1) the call command is executed. (0-10000)

■ Example of screen display

```
CALLPN [2, V1%, 2]    FN82; Conditional program call after
                            specified number of passes
```

See
CALLP: Program call (FN80)
CALLPI: Conditional program call (FN81)

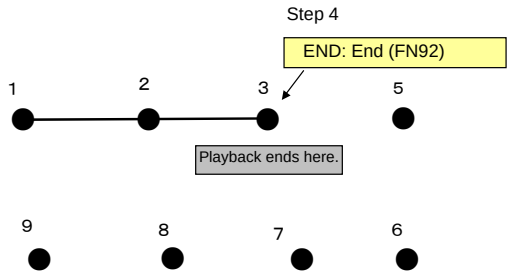
Command name	END
FN code	92
Title name	END
General description	This command is used to end program playback.

■ General description

When this function command is executed, the playback of the program is ended.
In the single cycle mode, operation stops immediately; in the continuous mode, operation returns to the start of the program and continues.
At least one END command is required in a program. This command does not signify the very end of the file so steps can still be recorded after this function. It is also permissible to record a multiple number of END commands in a program.

■ Example of operation

In step 4, record END: End (FN92).
When this is played back in the single cycle mode, the robot stops at step 4. The program end status is established, and the "program end" signal is output. If operation is now started again immediately, the robot returns to the first step.
However, if this program is the call destination program, the robot does not stop after END but returns to the call source program. The "program end" signal is not output.



After the robot reaches the recorded point, playback ends regardless of the accuracy of the move command immediately before.

■ Parameter

None

■ Example of screen display

```
END                    FN92; End
```

"Program end" basic output signal

See
STOP: Stop (FN41)

Function commands (FN codes)

Command name	REM
FN code	99
Title name	Comment
General description	This command is used to provide comments inside programs.

■ General description

This command is used to provide comments inside programs.
Using the software keyboard, alphanumerics and symbols can be input.
A comment provided in step 0 is handled specially as the "program name," and it appears on the program directory by the R17 short-cut and on the status window at the top of the screen.

Software keyboard

Entire text of comment entered using

.

■ Example of operation

The robot is not decelerated by this command.
More than one comment may be recorded in a program.

■ Parameter

Parameter No. 1	Comment	Comments consisting of up to 230 characters can be recorded.

■ Example of screen display

```
REM [“Test program”]        FN99; Comment
```

See
None

Command name	ICH
FN code	410
Title name	Inching
General description	Performs inch the wire with specified time and wire speed.

■ General description

The robot performs to inch the wire with specified time and wire speed.
Specified time and speed determines the inching value.

The robot does not stop operating while the inching or retract command is executed.
Furthermore, if the arc start command is placed immediately after an inching or retract command in the teaching, welding will be started as soon as the inching or retract operation is completed.

The inching or retract command is not executed in the following situations.

- When welding ON/OFF has been set to OFF
- During a welding section (If TIG filler wire is used by the APDA-301, the retract command can be executed. In the case of other power supplies, neither inching commands nor retract commands can be executed in the welding section.)
- If operation has been temporarily stopped and restarted during inching or retraction

■ Parameters

Conditions	Range	Unit
Time	0.0 ～ 9.9	sec
Wire speed	1 ～ 9999	cm/min

■ Example of screen display

```
ICH[W1,2.0s,  6%]        FN410:Inching
```

[ ] shows the welder number, time, and wire speed from the left.

See
RTC ; Retract (FN411)

Command name	RTC
FN code	411
Title name	Retract
General description	Performs to retract the wire with specified time and wire speed.

■ General description

The robot performs to retract the wire with specified time and wire speed.
Specified time and speed determines the retract value.

The robot does not stop operating while the inching or retract command is executed.
Furthermore, if the arc start command is placed immediately after an inching or retract command in the teaching, welding will be started as soon as the inching or retract operation is completed.

The inching or retract command is not executed in the following situations.

- When welding ON/OFF has been set to OFF
- During a welding section (If TIG filler wire is used by the APDA-301, the retract command can be executed. In the case of other power supplies, neither inching commands nor retract commands can be executed in the welding section.)
- If operation has been temporarily stopped and restarted during inching or retraction

■ Parameters

Conditions	Range	Unit
Time	0.0 ～ 9.9	sec
Wire speed	1 ～ 9999	cm/min

■ Example of screen display

```
RTC[W1,2.0s,  6%]        FN411:Retract
```

[ ] shows the welder number, time, and wire speed from the left.

See
ICH ;Inching (FN410)

Command name	GS
FN code	412
Title name	Gas ON
General description	Starts to output the shield gas.

■ General description

The robot starts to output the shield gas.

Prior to starting welding, the robot normally performs pre-flow for the duration which was set in the welding constants ("pre-flow time"). However, pre-flow can be started from any position by teaching the following commands.

The robot performs pre-flow from the position of the operation command that was taught immediately before the gas ON command (GS). When automatic operation is temporarily stopped during pre-flow initiated by the gas ON command (GS), pre-flow is suspended but it is then resumed after operation has been restarted.

■ Parameters

Parameter No.1	Welder No.	This specifies the welder number (1 to 12) to be controlled to output the shield gas.

■ Example of screen display

```
GS[W1]                    FN412:Gas ON
```

See
GE; Gas OFF(FN413)

Command name	GE
FN code	413
Title name	Gas OFF
General description	Stops the shield gas.

■ General description

The robot stops the shiled gas performed to start with Gas ON command (GS).

■ Parameters

Parameter No.1	Welder No.	This specifies the welder number (1 to 12) to be controlled to stop the shield gas.

■ Example of screen display

```
GE[W1]                          FN413:Gas OFF
```

See
GS; GasON(FN412)

Application Command (FN Code)

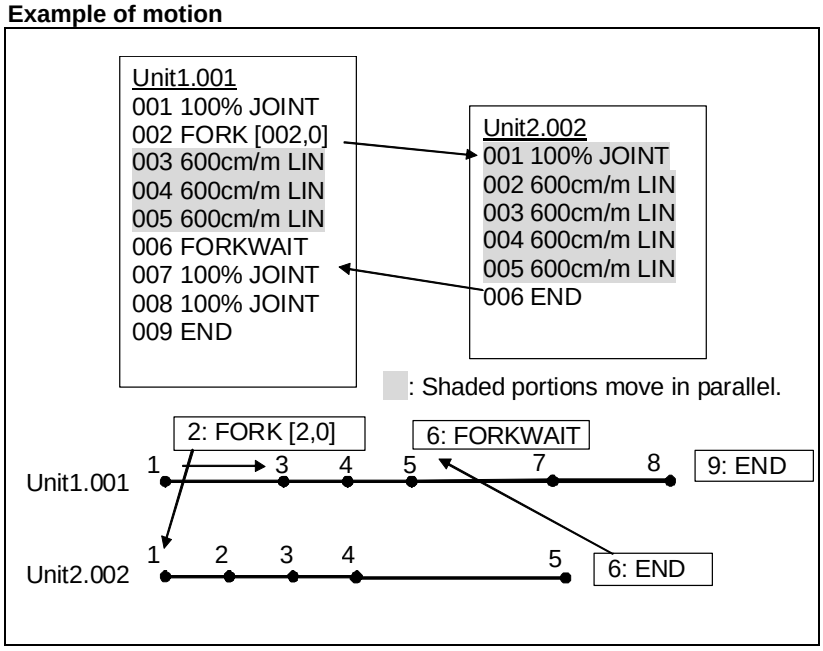
Command name	FORK
FN code	450
Title name	Start other unit
Outline	Used to start the work program of other unit.

■ Outline

This command is used to start the work program of other unit. (The command starts a specified work program in addition to a work program currently being played back.)

If the FORK command is taught, teach the FORKWAIT command that waits for the completion of the FORK command to a proper position.
Even though the FORK command and the FORKWAIT command are not necessarily taught by the set, it is recommended to teach them by the set for the safety purpose in order to avoid resource conflict or multiple execution of the FORK command.

■ Example of motion



If the FORKWAIT command is not used in the source work program of the FORK command, the source work program of the FORK command may be completed before its destination work program is completed.
In this case, the handling of the start signal for the source work program of the FORK command varies with the setting of "Service" → "1 Teach/Playback Condition" → "27 Start during FORK".

When the "Start during FORK" parameter is set to "Prohibited":
The error message "E6080: The system attempted to start a unit including a resource that is in starting mode" will be output. The system accepts no starting signal unless the FORM command is completed.

When the "Start during FORK" parameter is set to "Allowed":
The system will accept the starting signal and play back it.

■ Parameters

Parameter 1	Program No.	Used to make setting of program number to be started. (Setting range: 0 to 9999)
Parameter 2	Resource conflict waiting time	Used to make setting of a period of time waiting for a mechanism to be used in the work program that is started to be released if this mechanism is being started in a different unit, in seconds. (Setting range: ∞ (–1) or 0 to 99) If the relevant mechanism is released within the set period of time, the set program will be started. If it is not released, a fault will be output.

■ Example of screen display

FORK[1,-1]	FN450: Start other unit

Related commands
FORKI: Start other unit (Input) (FN451)
FORKN: Start other unit (Number of times) (FN452)
FORKWAIT: Fork complete waiting (FN453)

Application Command (FN Code)

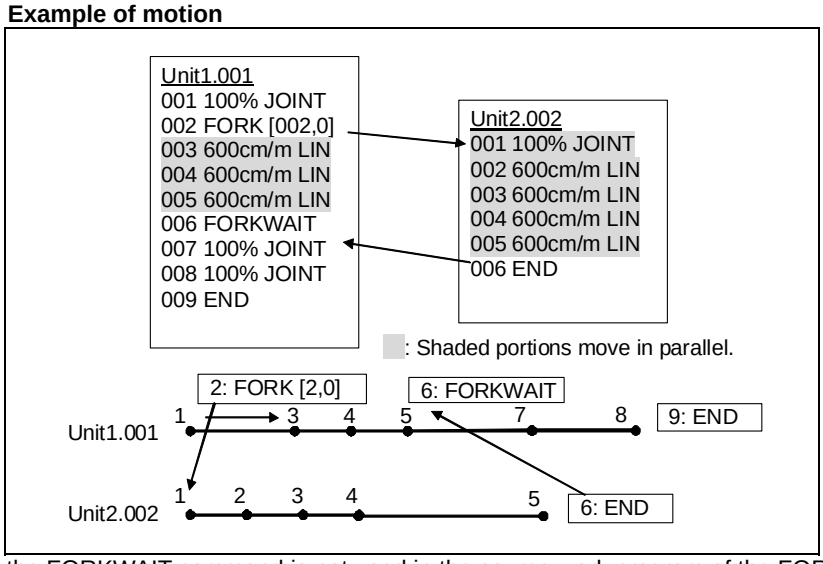
Command name	FORKI
FN code	451
Title name	Start other unit (Input)
Outline	Used to start the work program of other unit according to input signal.

■ Outline

This command is used to start the work program of other unit according to input signal. (The command starts a specified work program in addition to a work program currently being played back.)
Without input signal, the work program cannot be started.

If the FORKI command is taught, teach the FORKWAIT command that waits for the completion of the FORKI command to a proper position.
Even though the FORKI command and the FORKWAIT command are not necessarily taught by the set, it is recommended to teach them by the set for the safety purpose in order to avoid resource conflict or multiple execution of the FORKI command.

■ Example of motion



If the FORKWAIT command is not used in the source work program of the FORK command, the source work program of the FORK command may be completed before its destination work program is completed.
In this case, the handling of the start signal for the source work program of the FORK command varies with the setting of "Service" → "1 Teach/Playback Condition" → "27 Start during FORK".

When the "Start during FORK" parameter is set to "Prohibited":
The error message "E6080: The system attempted to start a unit including a resource that is in starting mode" will be output. The system accepts no starting signal unless the FORK command is completed.

When the "Start during FORK" parameter is set to "Allowed":
The system will accept the starting signal and play back it.

■ Parameters

Parameter 1	Program No.	Used to make setting of program number to be started. (Setting range: 0 to 9999)
Parameter 2	Resource conflict waiting time	Used to make setting of a period of time waiting for a mechanism to be used in the work program that is started to be released if this mechanism is being started in a different unit, in seconds. (Setting range: ∞ (–1) or 0 to 99) If the relevant mechanism is released within the set period of time, the set program will be started. If it is not released, a fault will be output.
Parameter 3	Input signal No.	Used to make setting of input signal number that determines whether or not to start the work program. (Setting range: 1 to 2048 or 5001 to 5064)

■ Example of screen display

FORKI[1,-1,I1]	FN451: Start other unit (Input)

Related commands
FORK: Start other unit (FN450)
FORKN: Start other unit (Number of times) (FN452)
FORKWAIT: Fork complete waiting (FN453)

Application Command (FN Code)

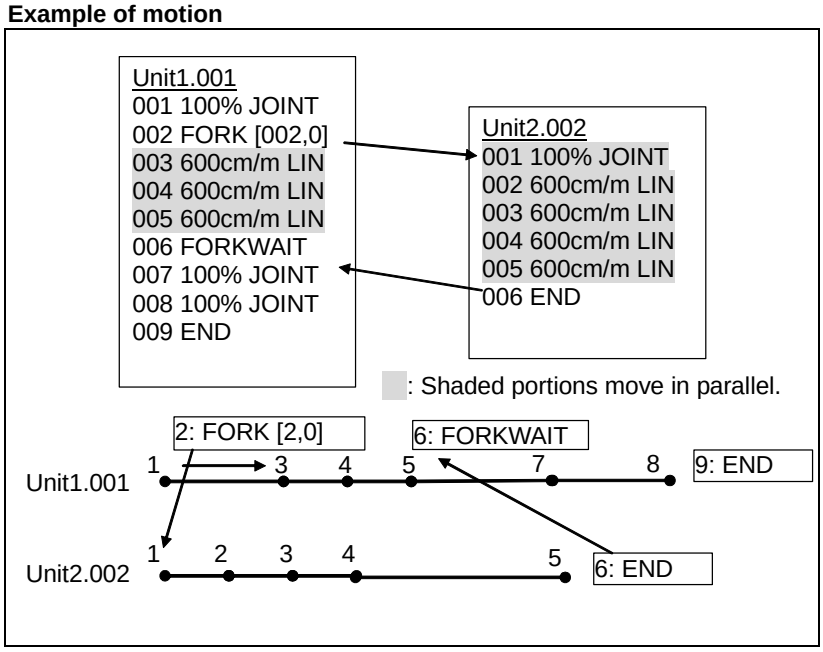
Command name	FORKN
FN code	452
Title name	Start other unit (Number of times)
Outline	Used to start the work program of other unit according to the number of pass times.

■ **Outline**

This command is used to start the work program of other unit. (The command starts a specified work program in addition to a work program currently being played back.)
This command makes the unit pass by the specified number of times and starts the work program of a different unit when the number of pass times reaches “specified number of pass times + 1”.
For example, when the “Number of times” parameter is set to “2”, the unit will pass two times, and the work program of a different unit will be started at the third pass.
When the number of pass times is less than the set value, such work program will not be started.

If the FORKN command is taught, teach the FORKWAIT command that waits for the completion of the FORKN command to a proper position.
Even though the FORKN command and the FORKWAIT command are not necessarily taught by the set, it is recommended to teach them by the set for the safety purpose in order to avoid resource conflict or multiple execution of the FORKN command.

■ **Example of motion**



If the FORKWAIT command is not used in the source work program of the FORK command, the source work program of the FORK command may be completed before its destination work program is completed.
In this case, the handling of the start signal for the source work program of the FORK command varies with the setting of “Service” → “1 Teach/Playback Condition” → “27 Start during FORK”.

When the “Start during FORK” parameter is set to “Prohibited”:
The error message “E6080: The system attempted to start a unit including a resource that is in starting mode” will be output. The system accepts no starting signal unless the FORK command is completed.

When the “Start during FORK” parameter is set to “Allowed”:
The system will accept the starting signal and play back it.

■ **Parameters**

Parameter 1	Program No.	Used to make setting of program number to be started. (Setting range: 0 to 9999)
Parameter 2	Resource conflict waiting time	Used to make setting of a period of time waiting for a mechanism to be used in the work program that is started to be released if this mechanism is being started in a different unit, in seconds. (Setting range: ∞ (−1) or 0 to 99) If the relevant mechanism is released within the set period of time, the set program will be started. If it is not released, a fault will be output.
Parameter 3	Register No.	The term “register” means a memory used to count. Since integer variables are used, this parameter makes setting of the register number. (Setting range: 1 to 200)
Parameter 4	Number of times	Used to record the number of pass times that serves as condition for executing jump. The relevant unit passes by the specified number of times and executes jump when the number of pass times reaches “specified number of pass times + 1”. (Recording range: 0 to 10000)

■ **Example of screen display**

FORKN[1,-1,V1%,5]	FN452: Start other unit (Number of times)

Related commands

FORK: Start other unit (FN450)
FORKI: Start other unit (Input) (FN451)
FORKWAIT: Fork complete waiting (FN453)

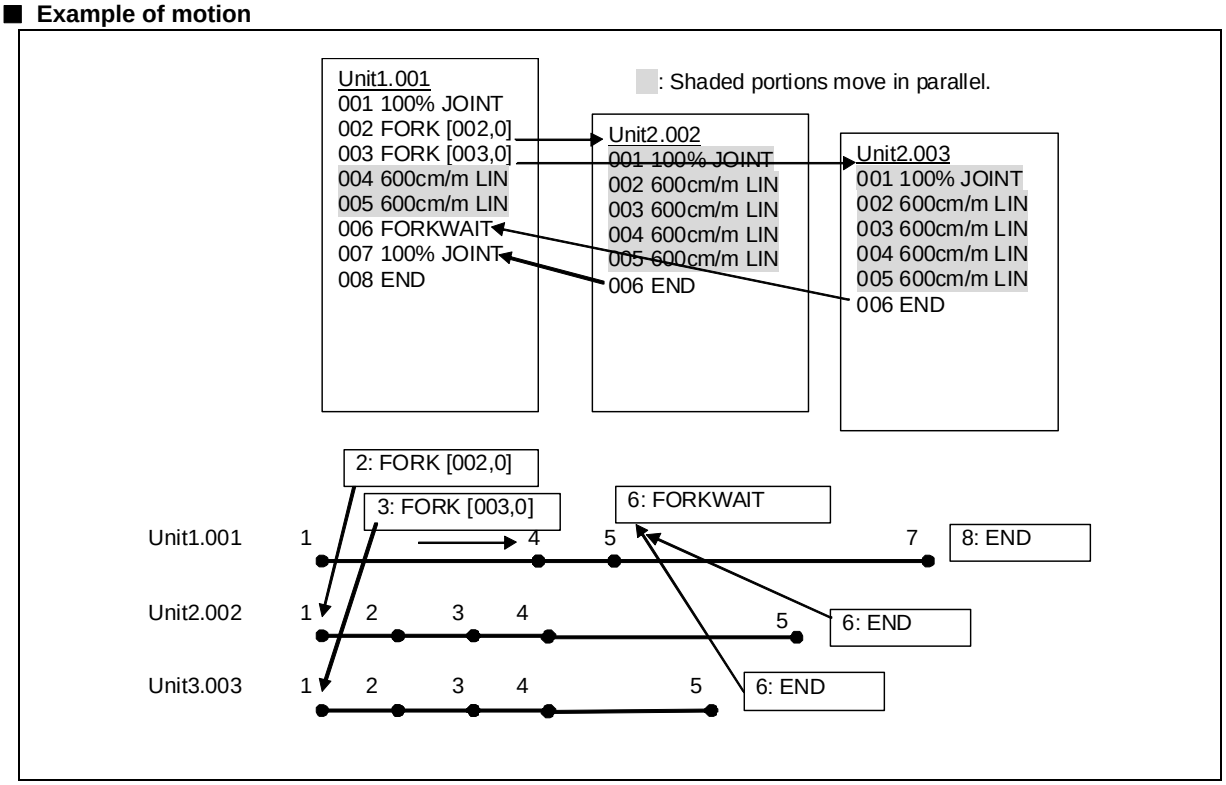
Application Command (FN Code)

Command name	FORKWAIT
FN code	453
Title name	Fork complete waiting
Outline	Used to wait for the completion of the work programs of other unit started by the FORK, FORKI and FORKN commands.

■ Outline

This command is used to wait for the completion of all programs started by the FORK, FORKI and FORKN commands.

■ Example of motion



■ Parameters

N/A

■ Example of screen display

FORKWAIT	FN453: Fork complete waiting

Related commands
FORK: Start other unit (FN450)
FORKI: Start other unit (Input) (FN451)
FORKN: Start other unit (Number of times) (FN452)

Application Command (FN Code)

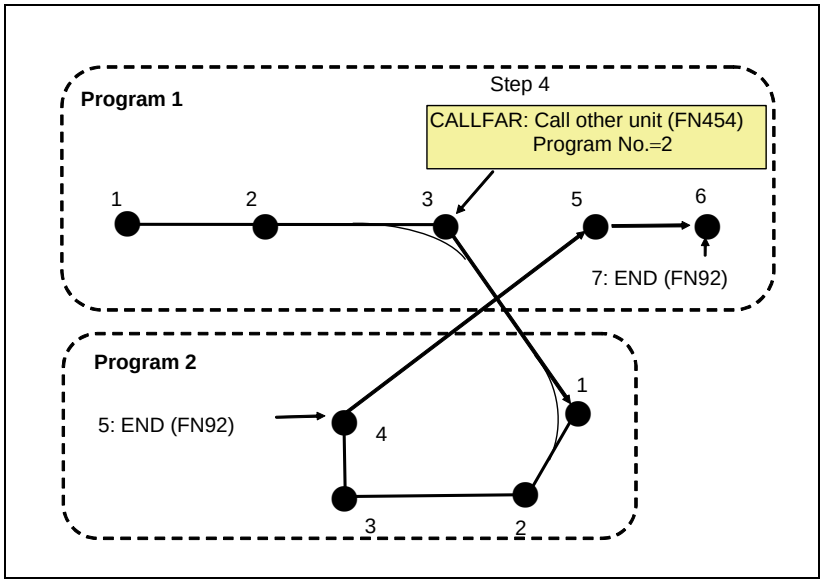
Command name	CALLFAR
FN code	454
Title name	Call other unit
Outline	Used to call the work program of other unit.

■ Outline

Using this command makes it possible to call the work program of other unit.
When the work program of other unit is called, the relevant unit will stop executing its own work program, and resume it when the execution of the program called is completed.
It is impossible to further call the program of other unit with the program of call destination.
However, it is possible to call the program within the unit using the CALLP command with the program of call destination (for a maximum of eight hierarchies).

■ Example of motion

Record “CALLFAR: Call other unit (FN454), Program No.=2” in Step 4.
When playing back this program, the robot will reach Step 4, and then skip Steps 5 and 6 to jump to the leading step of the Program 2.
When the playback of the Program 2 is completed (the END: End command is executed), the robot will return to the next step, Step 5 of call command of the call source program 1.



This command will not cause the robot to decelerate.
If no step positioning is specified, this command will be executed when the robot reaches the accuracy range of the immediately preceding movement command.

■ Parameters

Parameter 1	Program No.	Used to make setting of program number to be called. (Setting range: 0 to 9999)
Parameter 2	Resource conflict waiting time	Used to make setting of a period of time waiting for a mechanism to be used in the work program that is called to be released if this mechanism is being started in a different unit, in seconds. (Setting range: ∞ (–1) or 0 to 99) If the relevant mechanism is released within the set period of time, the set program will be called. If it is not released, a fault will be output.

■ Example of screen display

CALLFAR[1,-1]	FN454: Call other unit

Related commands
CALLFARI: Call other unit (Input) (FN455)
CALLFARN: Call other unit (Number of times) (FN456)

Application Command (FN Code)

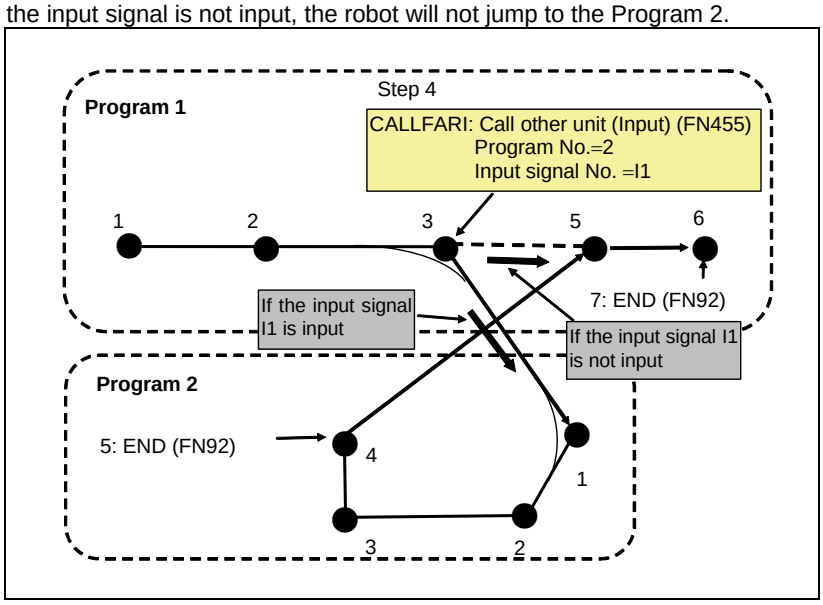
Command name	CALLFARI
FN code	455
Title name	Call other unit (Input)
Outline	Used to call the work program of other unit if input signal is input.

■ Outline

Using this command makes it possible to call the work program of other unit if input signal is input.
This command makes the unit pass by the specified number of times and calls the work program of other unit when the number of pass times reaches “specified number of pass times + 1”.
For example, when the “Number of times” parameter is set to “2”, the unit will pass two times, and the work program of other unit will be called at the third pass.
Note that, if application command is recorded in the leading step of the program of call destination program, the application command of jump destination will be executed on the spot where the call command is executed.
When the work program of other unit is called, the relevant unit will stop executing its own work program, and resume it when the execution of the program called is completed.
It is impossible to further call the program of other unit with the program of call destination.
However, it is possible to call the program within the unit using the CALLP command with the program of call destination (for a maximum of eight hierarchies).

■ Example of motion

Record “CALLFARI: Call other unit (Input) (FN455), Program No. of other unit=2, Input signal=I1)” in Step 4.
When playing back this program, the robot will reach Step 4, jump to the leading step of the Program 2 when the input signal I1 is input, and return to the next step, Step 5 of call command of the call source program 1, when the playback of the Program 2 is completed (the END: End command is executed).
If the input signal is not input, the robot will not jump to the Program 2.



This command will not cause the robot to decelerate.
If no step positioning is specified, the input signal will be inspected just before the command value reaches the accuracy range of the movement command. If the input signal is input, the robot will make an inward turn.
If the input signal is not input, the command value will move toward the recorded point. And when the robot reaches the accuracy range, the input signal will be inspected.

■ Parameters

Parameter 1	Program No.	Used to make setting of program number to be called. (Setting range: 0 to 9999)
Parameter 2	Resource conflict waiting time	Used to make setting of a period of time waiting for a mechanism to be used in the work program that is called to be released if this mechanism is being started in a different unit, in seconds. (Setting range: ∞ (–1) or 0 to 99) If the relevant mechanism is released within the set period of time, the set program will be called. If it is not released, a fault will be output.
Parameter 3	Input signal No.	Used to make setting of input signal number that determines whether or not to start the work program. (Setting range: 1 to 2048 or 5001 to 5064)

■ Example of screen display

CALLFARI[1,-1,I1]	FN455: Call other unit (Input)

Related commands
CALLFAR: Call other unit (FN454)
CALLFARN: Call other unit (Number of times) (FN456)

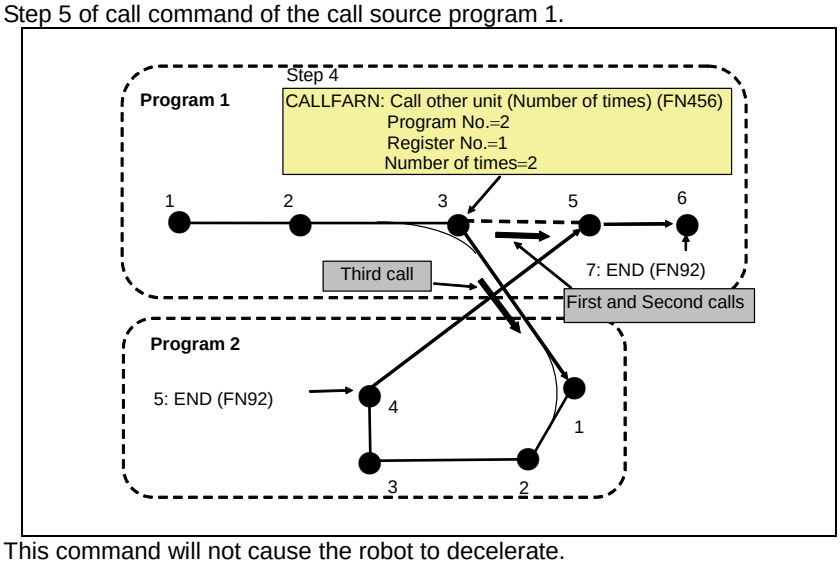
Command name	CALLFARN
FN code	456
Title name	Call other unit (Number of times)
Outline	Used to call the work program of other unit according to the number of pass times.

■ **Outline**

This command is used to call the work program of other unit.
This command makes the unit pass by the specified number of times and calls the work program of other unit when the number of pass times reaches “specified number of pass times + 1”.
For example, when the “Number of times” parameter is set to “2”, the unit will pass two times, and the work program of other unit will be called at the third pass.
Note that, if application command is recorded in the leading step of the program of call destination program, the application command of jump destination will be executed on the spot where the call command is executed.
When the work program of other unit is called, the relevant unit will stop executing its own work program, and resume it when the execution of the program called is completed.
It is impossible to further call the program of other unit with the program of call destination.
However, it is possible to call the program within the unit using the CALLP command with the program of call destination (for a maximum of eight hierarchies).

■ **Example of motion**

Record “CALLFARN: Call other unit (Number of times) (FN456), Program No. of other unit =2, Register No.=1, Number of times=2)” in Step 4.
When playing back this program, the robot will pass the first and second calls to move to the Step 5, but jump to the leading step of the Program 2 at the third call.
When the playback of the Program 2 is completed (the END: End command is executed), the robot will return to the next step, Step 5 of call command of the call source program 1.



This command will not cause the robot to decelerate.
If no step positioning is specified, this command will be executed when the robot reaches the accuracy range of the immediately preceding movement command.

■ **Parameters**

Parameter 1	Program No.	Used to make setting of program number to be called. (Setting range: 0 to 9999)
Parameter 2	Resource conflict waiting time	Used to make setting of a period of time waiting for a mechanism to be used in the work program that is called to be released if this mechanism is being started in a different unit, in seconds. (Setting range: ∞ (–1) or 0 to 99) If the relevant mechanism is released within the set period of time, the set program will be called. If it is not released, a fault will be output.
Parameter 3	Register No.	The term “register” means a memory used to count. Since integer variables are used, this parameter makes setting of the register number. (Setting range: 1 to 200)
Parameter 4	Number of times	Used to record the number of pass times that serves as condition for executing jump. The relevant unit passes by the specified number of times and executes jump when the number of pass times reaches “specified number of pass times + 1”. (Recording range: 0 to 10000)

■ **Example of screen display**

CALLFARN[1,-1,V1%,5]　　FN456: Call other unit (Number of times)

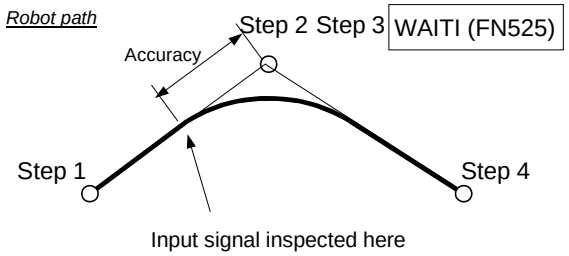
Related commands
CALLFAR: Call other unit (FN454)
CALLFARI: Call other unit (Input) (FN455)

Command name	WAITI
FN code	525
Title name	Input signal wait (positive logic)
General description	This command is used to wait for any one general-purpose input signal.

■ General description

When this function command is executed, the robot is made to stand by until the specified general-purpose input signal is input.
It can be recorded in a single action using the [IN] dedicated key on the teach pendant.
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). Which signals have been assigned as status signals can be identified 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.

■ Example of operation 1

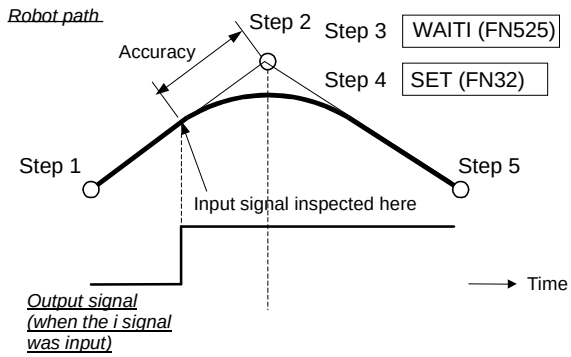


The robot is not decelerated by this command. If no positioning is specified, the input signal is inspected just before the command value reaches the accuracy range of the move command, and if it has been input, an inside arc is drawn. If the input signal has not been input, the command value heads toward the recorded point, and the input signal is inspected when the robot has reached the accuracy range.

In the case of an interlock signal requiring a stringent accuracy, either reduce the accuracy level in step 2 or record positioning "P" in step 2 in the figure above.

■ Example of operation 2

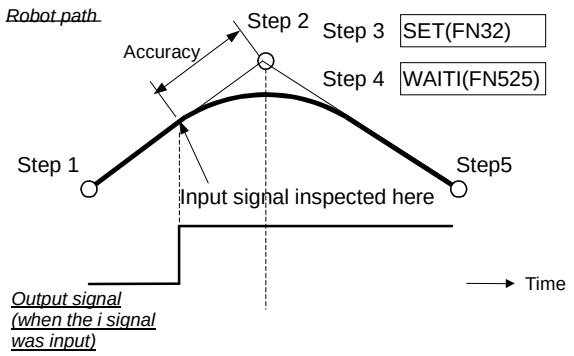
If SET (FN32) has been recorded after WAITI (FN525)



If the input signal has been input, step 4 is executed at the time when the accuracy is matched.
If it has not been input, after arriving at step 2, the input signal is checked, and after it has been input, step 4 is executed.

■ **Example of operation 3**

If SET (FN32) has been recorded before WAITI (FN525)



If the input signal has been input, step 3 is executed at the time when the accuracy is matched.
If it has not been input, step 3: SET is not executed at the above location; instead, after arriving at step 2, step 3: SET is executed. Then, the input signal is checked again, and after it has been input, the robot moves toward step 5.

■ **Parameter**

Parameter No. 1	Input signal number	This specifies the number of input signal to be awaited. When number 5101 or above is specified, multiple input signals can be awaited. (1–2048, 5101–5196)

■ **Example of screen display**

WAITI [I7] FN525; Input signal wait (positive logic)

See
WAITJ: Input signal wait (negative logic) (FN526)
WAIT: Input signal wait with timer (FN552)