FANUC Robot series

R-30*i*B/R-30*i*B Mate/R-30*i*B Plus CONTROLLER

Arc Welding Function

OPERATOR'S MANUAL

B-83284EN-3/04

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• Original Instructions

Thank you very much for purchasing FANUC Robot.
Before using the Robot, be sure to read the "FANUC Robot SAFETY HANDBOOK (B-80687EN)" and understand the content.

- No part of this manual may be reproduced in any form.
- The appearance and specifications of this product are subject to change without notice.

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In this manual, we endeavor to include all pertinent matters. There are, however, a very large number of operations that must not or cannot be performed, and if the manual contained them all, it would be enormous in volume. It is, therefore, requested to assume that any operations that are not explicitly described as being possible are "not possible".

SAFETY PRECAUTIONS

This chapter describes the precautions which must be followed to ensure the safe use of the robot.
Before using the robot, be sure to read this chapter thoroughly.

For detailed functions of the robot operation, read the relevant operator's manual to understand fully its specification.
For the safety of the operator and the system, follow all safety precautions when operating a robot and its peripheral equipment installed in a work cell.
In addition, refer to the “FANUC Robot SAFETY HANDBOOK (**B-80687EN)**”.

1 DEFINITION OF USER

The user can be defined as follows.

Operator:
- Turns ON/OFF power to the robot
- Starts the robot program from the operator’s panel

Programmer:
- Operates the robot
- Teaches the robot inside the safety fence

Maintenance engineer:
- Operates the robot
- Teaches the robot inside the safety fence
- Performs maintenance (repair, adjustment, replacement)

- Operator is not allowed to work in the safety fence.
- Programmers and maintenance engineers are allowed to work in the safety fence. The work inside the safety fence includes lifting, setting, teaching, adjustment, maintenance, etc.
- To work inside the safety fence, the person must receive a professional training for the robot.

During the operation, programming, and maintenance of your robotic system, the programmer, operator, and maintenance engineer should take additional care of their safety by wearing the following safety items.

- Adequate clothes for the operation
- Safety shoes
- A helmet

2 DEFINITION OF SAFETY NOTATIONS

To ensure the safety of users and prevent damage to the machine, this manual indicates each precaution on safety with "**WARNING**" or "**CAUTION**" according to its severity. Supplementary information is indicated by "**NOTE**". Read the contents of each "**WARNING**", "**CAUTION**" and "**NOTE**" before using the robot.

Symbol	Definitions
⚠**WARNING**	Used if hazard resulting in the death or serious injury of the user will be expected to occur if he or she fails to follow the approved procedure.
⚠**CAUTION**	Used if a hazard resulting in the minor or moderate injury of the user, or equipment damage may be expected to occur if he or she fails to follow the approved procedure.
NOTE	Used if a supplementary explanation not related to any of WARNING and CAUTION is to be indicated.

- Check this manual thoroughly, and keep it handy for the future reference.

3 SAFETY OF THE USER

User safety is the primary safety consideration. Because it is very dangerous to enter the operating space of the robot during automatic operation, adequate safety precautions must be observed.
The following lists the general safety precautions. Careful consideration must be made to ensure user safety.

(1) Have the robot system users attend the training courses held by FANUC.

FANUC provides various training courses. Contact our sales office for details.

(2) Even when the robot is stationary, it is possible that the robot is still in a ready to move state, and is waiting for a signal. In this state, the robot is regarded as still in motion. To ensure user safety, provide the system with an alarm to indicate visually or aurally that the robot is in motion.
(3) Install a safety fence with a gate so that no user can enter the work area without passing through the gate. Install an interlocking device, a safety plug, and so forth in the safety gate so that the robot is stopped as the safety gate is opened.

The controller is designed to receive this interlocking signal of the door switch. When the gate is opened and this signal received, the controller stops the robot (Please refer to "STOP TYPE OF ROBOT" in "SAFETY PRECAUTIONS" for detail of stop type). For connection, see Fig. 3 (b).

(4) Provide the peripheral equipment with appropriate earth (Class A, Class B, Class C, and Class D).
(5) Try to install the peripheral equipment outside the robot operating space.
(6) Draw an outline on the floor, clearly indicating the range of the robot operating space, including the tools such as a hand.
(7) Install a mat switch or photoelectric switch on the floor with an interlock to a visual or aural alarm that stops the robot when a user enters the work area.
(8) If necessary, install a safety lock so that no one except the user in charge can turn on the power of the robot.

The circuit breaker installed in the controller is designed to disable anyone from turning it on when it is locked with a padlock.

(9) When adjusting each peripheral equipment independently, be sure to turn off the power of the robot.
(10) Operators should be ungloved while manipulating the operator panel or teach pendant. Operation with gloved fingers could cause an operation error.
(11) Programs, system variables, and other information can be saved on memory card or USB memories. Be sure to save the data periodically in case the data is lost in an accident. (refer to Controller OPERATOR'S MANUAL.)
(12) The robot should be transported and installed by accurately following the procedures recommended by FANUC. Wrong transportation or installation may cause the robot to fall, resulting in severe injury to workers.
(13) In the first operation of the robot after installation, the operation should be restricted to low speeds. Then, the speed should be gradually increased to check the operation of the robot.
(14) Before the robot is started, it should be checked that no one is inside the safety fence. At the same time, a check must be made to ensure that there is no risk of hazardous situations. If detected, such a situation should be eliminated before the operation.
(15) When the robot is used, the following precautions should be taken. Otherwise, the robot and peripheral equipment can be adversely affected, or workers can be severely injured.
- Avoid using the robot in a flammable environment.
- Avoid using the robot in an explosive environment.
- Avoid using the robot in an environment full of radiation.
- Avoid using the robot under water or at high humidity.
- Avoid using the robot to carry a person or animal.
- Avoid using the robot as a stepladder. (Never climb up on or hang from the robot.)
- Outdoor

(16) When connecting the peripheral equipment related to stop (safety fence etc.) and each signal (external emergency, fence etc.) of robot, be sure to confirm the stop movement and do not take the wrong connection.
(17) When preparing footstep, please consider security for installation and maintenance work in high place according to Fig. 3 (c). Please consider footstep and safety belt mounting position.

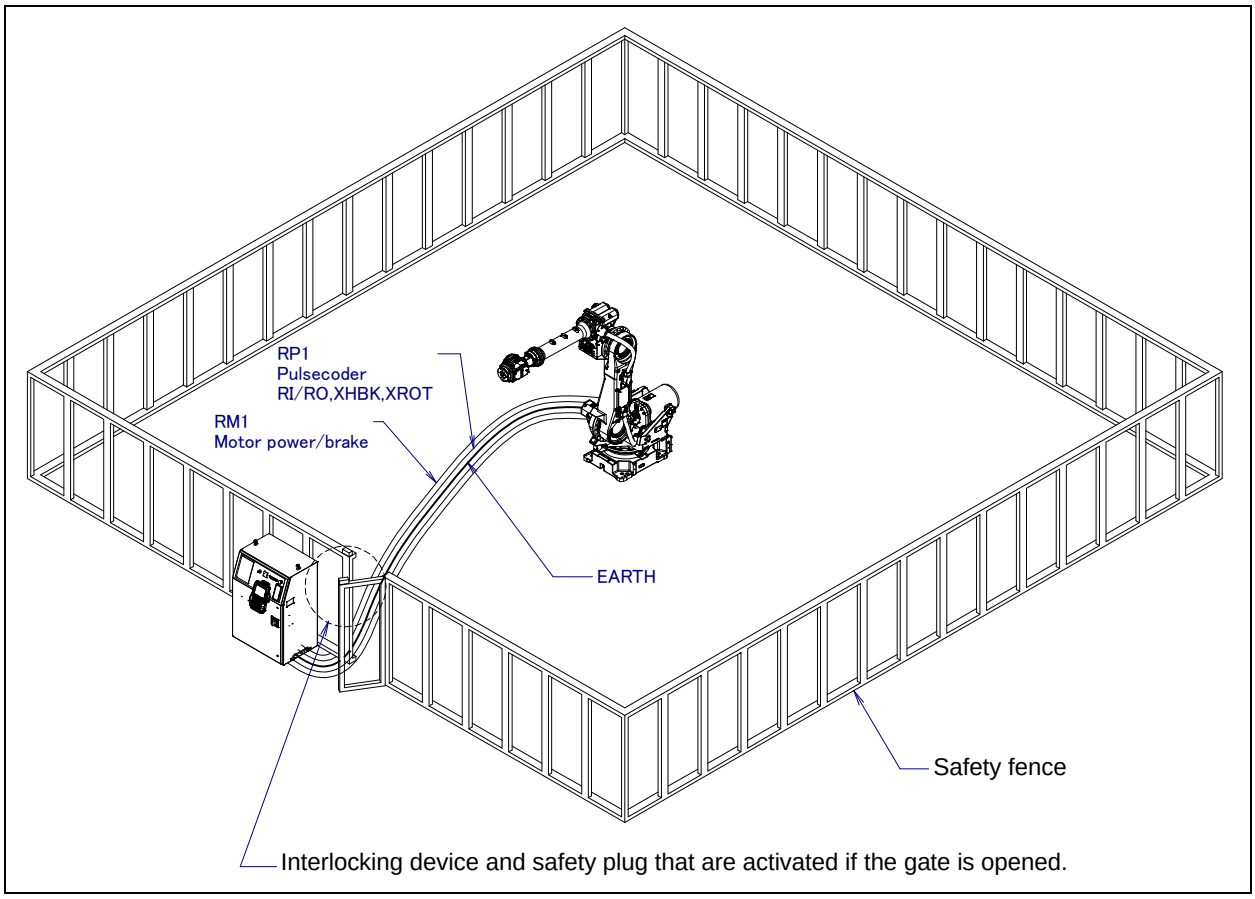

Fig. 3 (a) Safety fence and safety gate

⚠WARNING
When you close a fence, please confirm that there is not a person from all directions of the robot.

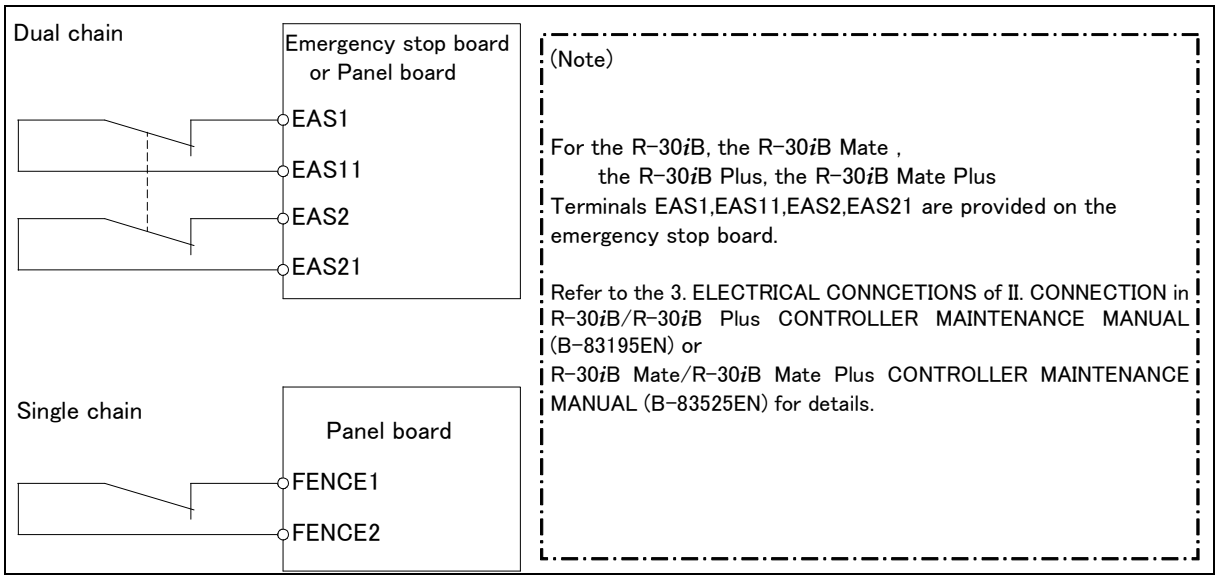

Fig. 3 (b) Connection diagram for the signal of safety fence

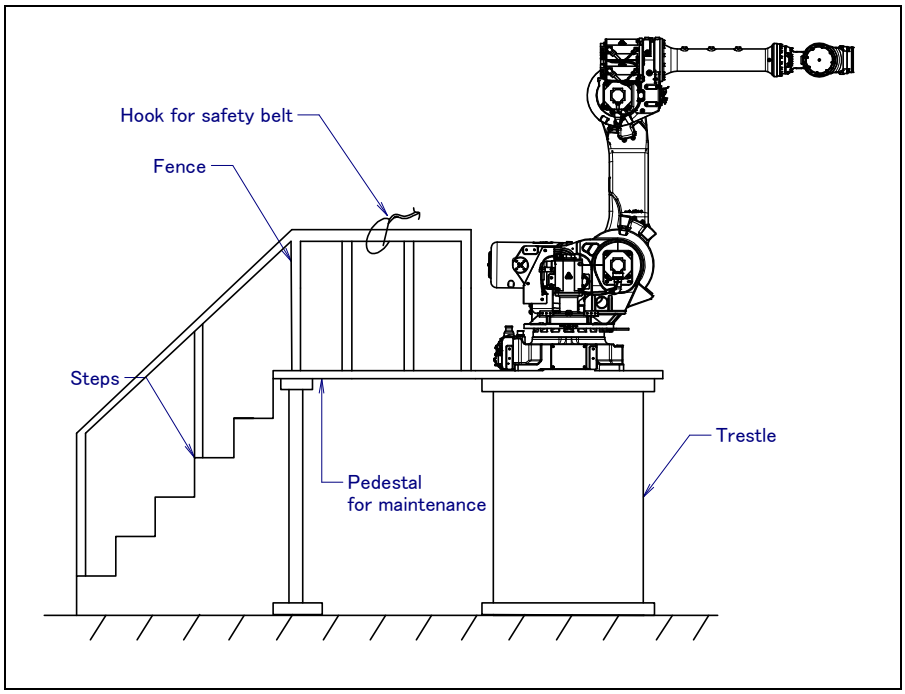

Fig. 3 (c) Pedestal for maintenance

3.1 SAFETY OF THE OPERATOR

An operator refers to a person who turns on and off the robot system and starts a robot program from, for example, the operator panel during daily operation.
Operators cannot work inside of the safety fence.

(1) If the robot does not need to be operated, turn off the robot controller power or press the EMERGENCY STOP button during working.
(2) Operate the robot system outside the operating space of the robot.
(3) Install a safety fence or safety door to avoid the accidental entry of a person other than an operator in charge or keep operator out from the hazardous place.
(4) Install one or more necessary quantity of EMERGENCY STOP button(s) within the operator's reach in appropriate location(s) based on the system layout.

The robot controller is designed to be connected to an external EMERGENCY STOP button. With this connection, the controller stops the robot operation (Please refer to "STOP TYPE OF ROBOT" in "SAFETY PRECAUTIONS" for detail of stop type) when the external EMERGENCY STOP button is pressed. See the diagram below for connection.

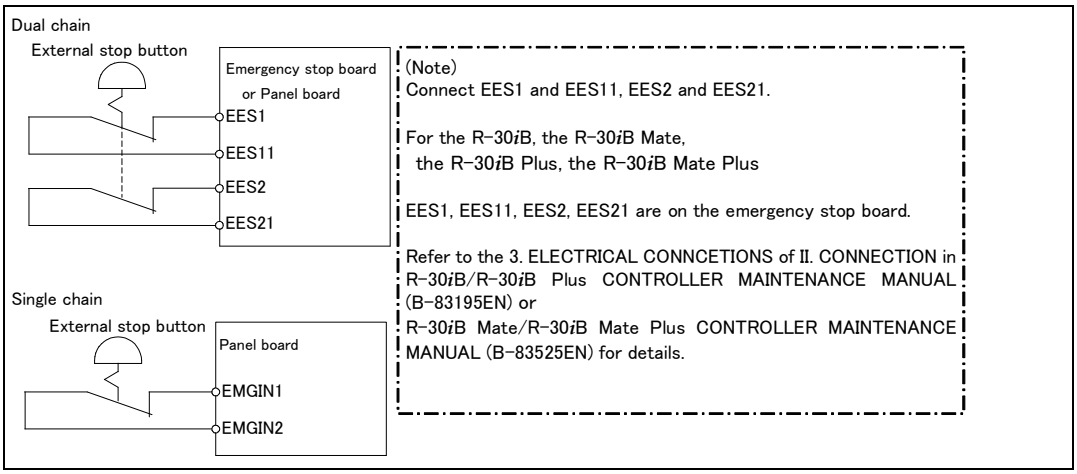

Fig. 3.1 Connection diagram for external emergency stop button

3.2 SAFETY OF THE PROGRAMMER

While teaching the robot, the operator may need to enter the robot operation area. The programmer must ensure the safety especially.

(1) Unless it is specifically necessary to enter the robot operating space, carry out all tasks outside the operating space.
(2) Before teaching the robot, check that the robot and its peripheral equipment are all in the normal operating condition.
(3) If it is inevitable to enter the robot operating space to teach the robot, check the locations, settings, and other conditions of the safety devices (such as the EMERGENCY STOP button, the DEADMAN switch on the teach pendant) before entering the area.
(4) The programmer must be extremely careful not to let anyone else enter the robot operating space.
(5) Programming should be done outside the area of the safety fence as far as possible. If programming needs to be done inside the safety fence, the programmer should take the following precautions:
   - Before entering the area of the safety fence, ensure that there is no risk of dangerous situations in the area.
   - Be prepared to press the emergency stop button whenever necessary.
   - Robot motions should be made at low speeds.
   - Before starting programming, check the whole robot system status to ensure that no remote instruction to the peripheral equipment or motion would be dangerous to the user.

Our operator panel is provided with an emergency stop button and a key switch (mode switch) for selecting the automatic operation (AUTO) and the teach modes (T1 and T2). Before entering the inside of the safety fence for the purpose of teaching, set the switch to a teach mode, remove the key from the mode switch to prevent other people from changing the operation mode carelessly, then open the safety gate. If the safety gate is opened with the automatic operation set, the robot stops (Please refer to "STOP TYPE OF ROBOT" in "SAFETY PRECAUTIONS" for detail of stop type). After the switch is set to a teach mode, the safety gate is disabled. The programmer should understand that the safety gate is disabled and is responsible for keeping other people from entering the inside of the safety fence.

Our teach pendant is provided with a DEADMAN switch as well as an emergency stop button. These button and switch function as follows:

(1) Emergency stop button: Causes the stop of the robot (Please refer to "STOP TYPE OF ROBOT" in "SAFETY PRECAUTIONS" for detail of stop type) when pressed.

(2) DEADMAN switch: Functions differently depending on the teach pendant enable/disable switch setting status.

(a) Enable: Servo power is turned off when the operator releases the DEADMAN switch or when the operator presses the switch strongly.

(b) Disable: The DEADMAN switch is disabled.

(Note) The DEADMAN switch is provided to stop the robot when the operator releases the teach pendant or presses the pendant strongly in case of emergency. The R-30*i*B/R-30*i*B Mate/R-30*i*B Plus/R-30*i*B Mate Plus employs a 3-position DEADMAN switch, which allows the robot to operate when the 3-position DEADMAN switch is pressed to its intermediate point. When the operator releases the DEADMAN switch or presses the switch strongly, the robot stops immediately.

The operator's intention of starting teaching is determined by the controller through the dual operation of setting the teach pendant enable/disable switch to the enable position and pressing the DEADMAN switch. The operator should make sure that the robot could operate in such conditions and be responsible in carrying out tasks safely.

Based on the risk assessment by FANUC, number of operation of DEADMAN SW should not exceed about 10000 times per year.

The teach pendant, operator panel, and peripheral equipment interface send each robot start signal. However the validity of each signal changes as follows depending on the mode switch and the DEADMAN switch of the operator panel, the teach pendant enable switch and the remote condition on the software.

Mode	Teach pendant enable switch	Software remote condition	Teach pendant	Operator panel	Peripheral equipment
AUTO mode	On	Local	Not allowed	Not allowed	Not allowed
		Remote	Not allowed	Not allowed	Not allowed
	Off	Local	Not allowed	Allowed to start	Not allowed
		Remote	Not allowed	Not allowed	Allowed to start
T1, T2 mode	On	Local	Allowed to start	Not allowed	Not allowed
		Remote	Allowed to start	Not allowed	Not allowed
	Off	Local	Not allowed	Not allowed	Not allowed
		Remote	Not allowed	Not allowed	Not allowed

T1,T2 mode: DEADMAN switch is effective.

(6) To start the system using the operator box or operator panel, make certain that nobody is the robot operating space area and that there are no abnormalities in the robot operating space.

(7) When a program is completed, be sure to carry out a test operation according to the following procedure.

(a) Run the program for at least one operation cycle in the single step mode at low speed.

(b) Run the program for at least one operation cycle in continuous operation at low speed.

(c) Run the program for one operation cycle in continuous operation at the intermediate speed and check that no abnormalities occur due to a delay in timing.

(d) Run the program for one operation cycle in continuous operation at the normal operating speed and check that the system operates automatically without trouble.

(e) After checking the completeness of the program through the test operation above, execute it in the automatic operation.

(8) While operating the system in the automatic operation, the programmer should leave the safety fence.

3.3 SAFETY OF THE MAINTENANCE ENGINEER

For the safety of maintenance engineer personnel, pay utmost attention to the following.

(1) During operation, never enter the robot operating space.
(2) A hazardous situation may arise when the robot or the system, are kept with their power-on during maintenance operations. Therefore, for any maintenance operation, the robot and the system should be put into the power-off state. If necessary, a lock should be in place in order to prevent any other person from turning on the robot and/or the system. In case maintenance needs to be executed in the power-on state, the emergency stop button must be pressed as far as possible.
(3) If it becomes necessary to enter the robot operating space while the power is on, press the emergency stop button on the operator box or operator panel, or the teach pendant before entering the range. The maintenance worker must indicate that maintenance work is in progress and be careful not to allow other people to operate the robot carelessly.
(4) When entering the area enclosed by the safety fence, the worker must check the whole robot system in order to make sure no dangerous situations exist. In case the worker needs to enter the safety area whilst a dangerous situation exists, extreme care must be taken, and whole robot system status must be carefully monitored.
(5) Before the maintenance of the pneumatic system is started, the supply pressure should be shut off and the pressure in the piping should be reduced to zero.
(6) Before the start of maintenance work, check that the robot and its peripheral equipment are all in the normal operating condition.
(7) Do not operate the robot in the automatic operation while anybody is in the robot operating space.
(8) When you maintain the robot alongside a wall or instrument, or when multiple users are working nearby, make certain that their escape path is not obstructed.
(9) When a tool is mounted on the robot, or when any movable device other than the robot is installed, such as belt conveyor, pay careful attention to its motion.
(10) If necessary, have a user who is familiar with the robot system stand beside the operator panel and observe the work being performed. If any danger arises, the user should be ready to press the EMERGENCY STOP button at any time.
(11) When replacing a part, please contact your local FANUC representative. If a wrong procedure is followed, an accident may occur, causing damage to the robot and injury to the user.
(12) When replacing or reinstalling components, take care to prevent foreign material from entering the system.
(13) When handling each unit or printed circuit board in the controller during inspection, turn off the circuit breaker to protect against electric shock.
If there are two cabinets, turn off the both circuit breaker.
(14) A part should be replaced with a part recommended by FANUC. If other parts are used, malfunction or damage would occur. Especially, a fuse that is not recommended by FANUC should not be used. Such a fuse may cause a fire.
(15) When restarting the robot system after completing maintenance work, make sure in advance that there is no person in the operating space and that the robot and the peripheral equipment are not abnormal.
(16) When a motor or brake is removed, the robot arm should be supported with a crane or other equipment beforehand so that the arm would not fall during the removal.
(17) Whenever grease is spilled on the floor, it should be removed as quickly as possible to prevent dangerous falls.
(18) The following parts are heated. If a maintenance user needs to touch such a part in the heated state, the user should wear heat-resistant gloves or use other protective tools.
- Servo motor
- Inside the controller
- Reducer
- Gearbox

- Wrist unit

(19) Maintenance should be done under suitable light. Care must be taken that the light would not cause any danger.

(20) When a motor, reducer, or other heavy load is handled, a crane or other equipment should be used to protect maintenance workers from excessive load. Otherwise, the maintenance workers would be severely injured.

(21) The robot should not be stepped on or climbed up during maintenance. If it is attempted, the robot would be adversely affected. In addition, a misstep can cause injury to the worker.

(22) When performing maintenance work in high place, secure a footstep and wear safety belt.

(23) After the maintenance is completed, spilled oil or water and metal chips should be removed from the floor around the robot and within the safety fence.

(24) When a part is replaced, all bolts and other related components should put back into their original places. A careful check must be given to ensure that no components are missing or left not mounted.

(25) In case robot motion is required during maintenance, the following precautions should be taken :

- Foresee an escape route. And during the maintenance motion itself, monitor continuously the whole robot system so that your escape route will not become blocked by the robot, or by peripheral equipment.
- Always pay attention to potentially dangerous situations, and be prepared to press the emergency stop button whenever necessary.

(26) The robot should be periodically inspected. (Refer to the robot mechanical manual and controller maintenance manual.) A failure to do the periodical inspection can adversely affect the performance or service life of the robot and may cause an accident

(27) After a part is replaced, a test execution should be given for the robot according to a predetermined method. (See TESTING section of “Controller operator’s manual”.) During the test execution, the maintenance worker should work outside the safety fence.

4 SAFETY OF THE TOOLS AND PERIPHERAL EQUIPMENT

4.1 PRECAUTIONS IN PROGRAMMING

(1) Use a limit switch or other sensor to detect a dangerous condition and, if necessary, design the program to stop the robot when the sensor signal is received.

(2) Design the program to stop the robot when an abnormality occurs in any other robots or peripheral equipment, even though the robot itself is normal.

(3) For a system in which the robot and its peripheral equipment are in synchronous motion, particular care must be taken in programming so that they do not interfere with each other.

(4) Provide a suitable interface between the robot and its peripheral equipment so that the robot can detect the states of all devices in the system and can be stopped according to the states.

4.2 PRECAUTIONS FOR MECHANISM

(1) Keep the component cells of the robot system clean, operate the robot where insulated from the influence of oil, water, and dust.

(2) Don’t use unconfirmed liquid for cutting fluid and cleaning fluid.

(3) Adopt limit switches or mechanical stoppers to limit the robot motion, and avoid the robot from collisions against peripheral equipment or tools.

(4) Observe the following precautions about the mechanical unit cables. Failure to follow precautions may cause problems.

- Use mechanical unit cable that have required user interface.

- Do not add user cable or hose to inside of the mechanical unit.
- Please do not obstruct the movement of the mechanical unit when cables are added to outside of mechanical unit.
- In the case of the model that a cable is exposed, please do not perform remodeling (Adding a protective cover and fix an outside cable more) obstructing the behavior of the outcrop of the cable.
- When installing user peripheral equipment on the robot mechanical unit, please pay attention that the device does not interfere with the robot itself.

(5) The frequent power-off stop for the robot during operation causes the trouble of the robot. Please avoid the system construction that power-off stop would be operated routinely. (Refer to bad case example.) Please perform power-off stop after reducing the speed of the robot and stopping it by hold stop or cycle stop when it is not urgent. (Please refer to "STOP TYPE OF ROBOT" in "SAFETY PRECAUTIONS" for detail of stop type.)
(Bad case example)

- Whenever poor product is generated, a line stops by emergency stop and power-off of the robot is incurred.
- When alteration is necessary, safety switch is operated by opening safety fence and power-off stop is incurred for the robot during operation.
- An operator pushes the emergency stop button frequently, and a line stops.
- An area sensor or a mat switch connected to safety signal operates routinely and power-off stop is incurred for the robot.
- Power-off stop is regularly incurred due to an inappropriate setting for Dual Check Safety (DCS).

(6) Power-off stop of Robot is executed when collision detection alarm (SRVO-050) etc. occurs. Please try to avoid unnecessary power-off stops. It may cause the trouble of the robot, too. So remove the causes of the alarm.

5 SAFETY OF THE ROBOT MECHANICAL UNIT

5.1 PRECAUTIONS IN OPERATION

(1) When operating the robot in the jog mode, set it at an appropriate speed so that the operator can manage the robot in any eventuality.
(2) Before pressing the jog key, be sure you know in advance what motion the robot will perform in the jog mode.

5.2 PRECAUTIONS IN PROGRAMMING

(1) When the operating spaces of robots overlap, make certain that the motions of the robots do not interfere with each other.
(2) Be sure to specify the predetermined work origin in a motion program for the robot and program the motion so that it starts from the origin and terminates at the origin. Make it possible for the operator to easily distinguish at a glance that the robot motion has terminated.

5.3 PRECAUTIONS FOR MECHANISMS

(1) Keep the robot operation area clean, and operate the robot in an environment free of grease, water, and dust.

5.4 PROCEDURE TO MOVE ARM WITHOUT DRIVE POWER IN EMERGENCY OR ABNORMAL SITUATIONS

For emergency or abnormal situations (e.g. persons trapped in or pinched by the robot), brake release unit can be used to move the robot axes without drive power.
Please refer to controller maintenance manual and mechanical unit operator's manual for using method of brake release unit and method of supporting robot.

6 SAFETY OF THE END EFFECTOR

6.1 PRECAUTIONS IN PROGRAMMING

(1) To control the pneumatic, hydraulic and electric actuators, carefully consider the necessary time delay after issuing each control command up to actual motion and ensure safe control.
(2) Provide the end effector with a limit switch, and control the robot system by monitoring the state of the end effector.

7 STOP TYPE OF ROBOT

The following three robot stop types exist:

Power-Off stop (Category 0 following IEC 60204-1)

Servo power is turned off and the robot stops immediately. Servo power is turned off when the robot is moving, and the path of the deceleration is uncontrolled.
The following processing is performed at Power-Off stop.
- An alarm is generated and servo power is turned off. The robot operation is stopped immediately.
- Execution of the program is paused.

Frequent Power-Off stop of the robot during operation can cause failures of the robot.
Avoid system designs that require routine or frequent Power-Off stop conditions.

Controlled stop (Category 1 following IEC 60204-1)

The robot is decelerated until it stops, and servo power is turned off.
The following processing is performed at Controlled stop.
- The alarm "SRVO-199 Controlled stop" occurs along with a decelerated stop. Execution of the program is paused.
- After the decelerated stop, an alarm is generated and servo power is turned off.

Hold (Category 2 following IEC 60204-1)

The robot is decelerated until it stops, and servo power remains on.
The following processing is performed at Hold.
- The robot operation is decelerated until it stops. Execution of the program is paused.

> ⚠ **WARNING**
> The stopping distance and stopping time of Controlled stop are longer than the stopping distance and stopping time of Power-Off stop. A risk assessment for the whole robot system, which takes into consideration the increased stopping distance and stopping time, is necessary when Controlled stop is used.

When the emergency stop button is pressed or the FENCE is open, the stop type of robot is Power-Off stop or Controlled stop. The configuration of stop type for each situation is called “stop pattern”. The stop patterns differ according to the controller type or option configuration.

There are the following 3 stop patterns.

Stop pattern	Mode	Emergency stop button	External Emergency stop	FENCE open	SVOFF input	Servo disconnect
A	AUTO	P-Stop	P-Stop	C-Stop	C-Stop	P-Stop
	T1	P-Stop	P-Stop	-	C-Stop	P-Stop
	T2	P-Stop	P-Stop	-	C-Stop	P-Stop
B	AUTO	P-Stop	P-Stop	P-Stop	P-Stop	P-Stop
	T1	P-Stop	P-Stop	-	P-Stop	P-Stop
	T2	P-Stop	P-Stop	-	P-Stop	P-Stop
C	AUTO	C-Stop	C-Stop	C-Stop	C-Stop	C-Stop
	T1	P-Stop	P-Stop	-	C-Stop	P-Stop
	T2	P-Stop	P-Stop	-	C-Stop	P-Stop

P-Stop: Power-Off stop
C-Stop: Controlled stop
-: Disable

The following table indicates the stop pattern according to the controller type or option configuration.

Option	R-30*i*B/R-30*i*B Mate R-30*i*B Plus/R-30*i*B Mate Plus
Standard	A (*)
Controlled stop by E-Stop (A05B-2600-J570)	C (*)

(*) R-30*i*B / R-30*i*B Mate/R-30*i*B Plus/R-30*i*B Mate Plus do not have servo disconnect. R-30*i*B Mate/R-30*i*B Mate Plus do not have SVOFF input.

The stop pattern of the controller is displayed in "Stop pattern" line in software version screen. Please refer to "Software version" in operator's manual of controller for the detail of software version screen.

"Controlled stop by E-Stop" option

When "Controlled stop by E-Stop" (A05B-2600-J570) option is specified, the stop type of the following alarms is Controlled stop in AUTO mode. In T1 or T2 mode, the stop type is Power-Off stop.

Alarm	Condition
SRVO-001 Operator panel E-stop	Operator's panel E-stop is pressed.
SRVO-002 Teach pendant E-stop	Teach pendant emergency stop is pressed.
SRVO-007 External emergency stops	External emergency stop input (EES1-EES11, EES2-EES21) is open.
SRVO-408 DCS SSO Ext Emergency Stop	In DCS Safe I/O connect function, SSO[3] is OFF.
SRVO-409 DCS SSO Servo Disconnect	In DCS Safe I/O connect function, SSO[4] is OFF.

Controlled stop is different from Power-Off stop as follows:

- In Controlled stop, the robot is stopped on the program path. This function is effective for a system where the robot can interfere with peripheral equipment or other devices if it deviates from the program path.
- Controlled stop has less physical impact than Power-Off stop. This function is effective for systems where the physical impact on tools is required to be reduced.
- The stopping distance and stopping time of Controlled stop is longer than the stopping distance and stopping time of Power-Off stop. Refer to the operator's manual of a particular robot model for the data of stopping distance and stopping time.

When this option is loaded, this function cannot be disabled.

The stop type of DCS Position and Speed Check functions is not affected by the loading of this option. The stop type set on the DCS screen is used.

> ⚠ **WARNING**
> The stopping distance and stopping time of Controlled stop is longer than the stopping distance and stopping time of Power-Off stop. A risk assessment for the whole robot system, which takes into consideration the stopping distance and stopping time increased in AUTO mode on the above alarms, is necessary when this option is loaded.

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ADDITIONAL INFORMATION

1 PREFACE

This chapter explains the manual plan.

Contents of this chapter

1.1 MANUAL PLAN

1.1 MANUAL PLAN

About this manual

This manual describes how to operate the FANUC Robot installed ArcTool function, an all-purpose compact robot. It is controlled by the FANUC R-30*i*B/R-30*i*B Mate/R-30*i*B Plus controller (called the robot controller hereinafter) containing the FANUC Robot software.

This manual describes the software of ArcTool. Each chapter describes one software option. Please select and refer to the chapters describing your required function.

Chapters	Descriptions
1. Preface	About this manual
2 Overview	Main feature of ArcTool
3 Setup	Setup procedure ArcTool
4 Instruction	Instructions for ArcTool
5 Manual Operation and Program Execution	Manual operation and test cycle for ArcTool
6 Status	Welding status check procedure for ArcTool
7. I/O	Weld input/output signal for ArcTool
8 Weaving Function	How to use weaving function
9 ArcTool Ramping	How to use ramping function
10 Heatwave Sync	How to use heat wave sync function
11 Arc Easy Teaching Function	How to use arc easy teaching function
12 Arc Easy Smart Quick Recovery Function	How to use arc easy smart quick recovery function
13 Torch Maintenance Station	How to use torch maintenance station
14 Arc Welding Override Control Function	How to use arc welding override control function
15 Path Jog	How to use PATH jog function
16 Arc Chart	How to use arc chart
17 On The Fly	How to use on the fly for arc welding
18 Arc Welding Analogue Meter Displaying Function	How to use arc welding analogue meter function
19 Arc Abnormal Monitor Function	How to use arc abnormal monitor function
20 TAST Tracking Function	How to use TAST tracking function
21 Root Pass Memorization and Multi-Pass	How to use Root Pass Memorization and Multi pass
22 Process Logger	How to use Process Logger function
23 Automatic Voltage Control Tracking	How to use automatic voltage control tracking
24 Arc Start Height Adjust Function	How to use arc start height adjust function
25 Multi Equipment Control Function	How to use multi equipment control function
26 Weld Controller Program Selection Function	How to use weld controller program selection function
27 Torch Angle	How to use torch angle
28 Used Wire Estimation	How to used wire estimation
29 Weld Procedure Process Limit	
Appendix For ArcTool	Details for back up data and configurations for General Purpose

Related manuals

The following manuals are available:

Robot controller	Arc Welding Function OPERATOR'S MANUAL B-83284EN-3 (This manual)	Intended readers: Operators responsible for designing, introducing, operating, and adjusting the robot system at the work site. Topics: Description of the setting and operation for arc welding Use: Guide to teaching, introducing, and adjusting the robot at the work site, and application designing.
	OPERATOR'S MANUAL (Basic Operation) B-83284EN	Intended readers: Operators responsible for designing, introducing, operating, and adjusting the robot system at the work site. Topics: Functions, operations and the procedure for operating the robot. Programming procedure, interface and alarm. Use: Guide to teaching, introducing, and adjusting the robot at the work site, and application designing.
	OPERATOR'S MANUAL (Alarm Code List) B-83284EN-1	Topics: Error code listings, causes, and remedies. Use: Installing and activating the system, connecting the mechanical unit to the peripheral device and maintenance the robot.
	Optional Function OPERATOR'S MANUAL B-83284EN-2	Intended readers: Operators responsible for designing, introducing, operating, and adjusting the robot system at the work site. Topics: Description of the software optional functions for arc welding. Use: Guide to teaching, introducing, and adjusting the robot at the work site, and application designing.
	Spot Welding Function OPERATOR'S MANUAL B-83284EN-4	Intended readers: Operators responsible for designing, introducing, operating, and adjusting the robot system at the work site. Topics: Description of the setting and operation for spot welding application software. Use: Guide to teaching, introducing, and adjusting the robot at the work site, and application designing.
	Dispense Function OPERATOR'S MANUAL B-83284EN-5	Intended readers: Operators responsible for designing, introducing, operating, and adjusting the robot system at the work site. Topics: Description of the setting and operation for dispense application software. Use: Guide to teaching, introducing, and adjusting the robot at the work site, and application designing.
	MAINTENANCE MANUAL B-83195EN (for R-30*i*B, R-30*i*B Plus), B-83525EN (for R-30*i*B Mate)	Topics: Installing and activating the system, connecting the mechanical unit to the peripheral device and maintenance the robot.

Mechanical unit	OPERATOR'S MANUAL	Topics: Installing and activating the robot, connecting the mechanical unit to the controller, maintaining the robot. Use: Guide to installation, activation, connection, and maintenance.

2 OVERVIEW

ArcTool is package software for arc welding robot system. This application supports not only basic operations described in OPERATOR'S MANUAL (Basic Operation) (B-83284EN) but variable operation suitable for arc welding. For basic setting and operation apart from arc welding, please refer to OPERATOR'S MANUAL (Basic Operation) (B-83284EN) .

This chapter shows inherent settings and operations when ArcTool is installed.

- 2.1 Keys on Teach Pendant
- 2.2 Status Window
- 2.3 Screen Menu and Function Menu
- 2.4 Icon Menu

For arc welding setup, I/O, program and test cycle et.al, please refer to chapter 3 and later in this manual.

2.1 KEYS ON TEACH PENDANT

Fig 2.1 shows the layout of keys on Teach Pendant for ArcTool.

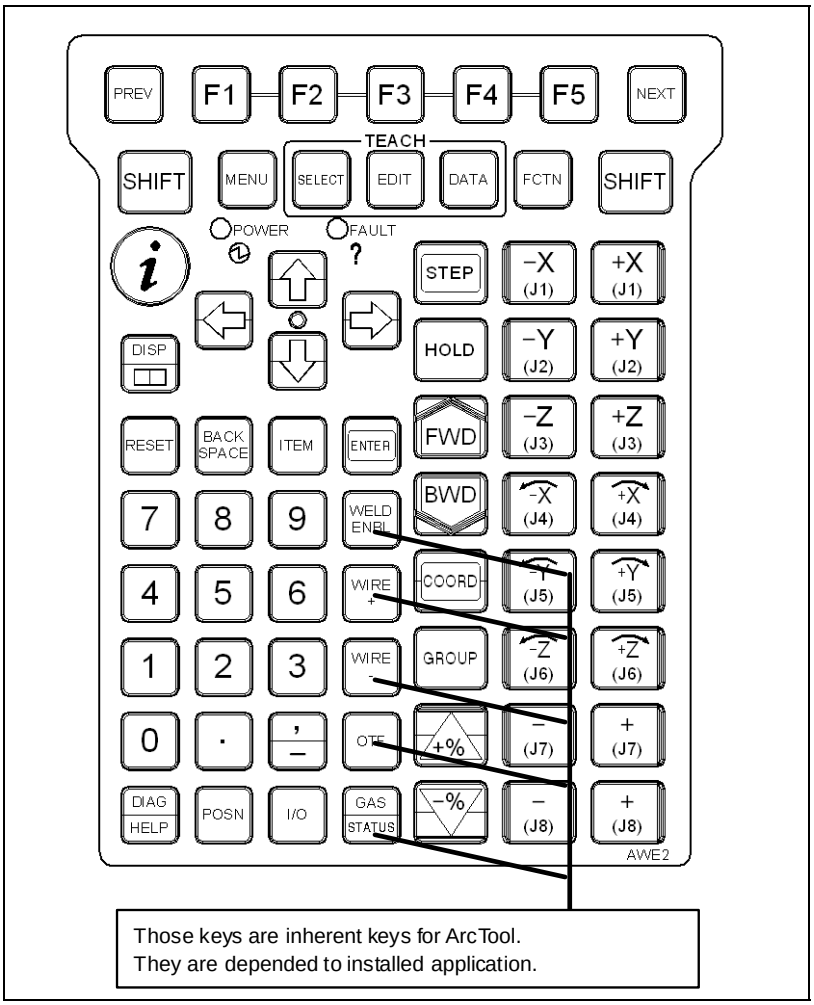


Fig. 2.1 Keys on teach pendant for Arc Tool

Table 2.1 shows the description of Inherent keys for ArcTool.

Table 2.1 Inherent keys for ArcTool

Items	Descriptions
WELD ENBL	Toggle arc welding enabled/disabled. For more details, please refer to chapter 5
WIRE +	Forward inching of weld wire by manual. For more details, please refer to chapter 5
WIRE -	Backward inching of weld wire by manual. For more details, please refer to chapter 5
OTF	Display the screen of On the fly function. For more details, please refer to chapter 17.
GAS STATUS	When pressed only it, arc welding status screen is displayed, For more details, please refer to chapter 6 When pressed in with SHIFT key, gas purge process performs For more details, please refer to chapter 5

2.2 STATUS WINDOW

The upper screen on teach pendant screen is called at status window. It shows 8 status icons, alarm and override value. Fig. 2.2 shows status window for ArcTool.

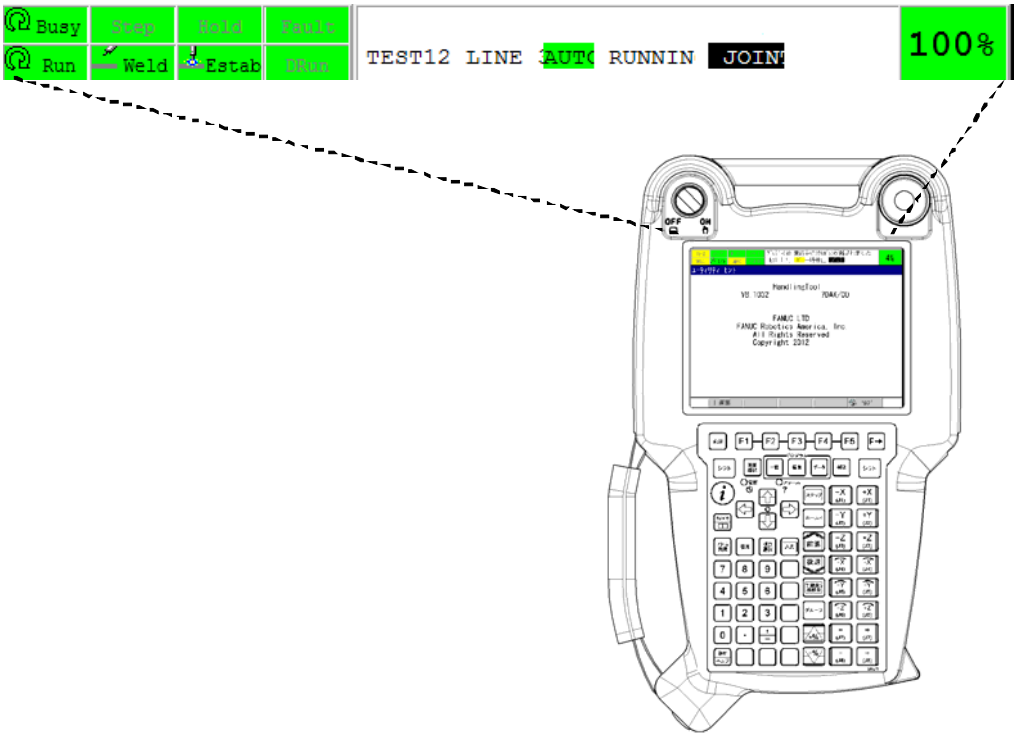


Fig. 2.2 Status window for ArcTool

When ArcTool software is installed, the status icons shown at Table 2.2 are appeared on status window. For the other icons, alarm and override value, please refer to OPERATOR'S MANUAL (Basic operation) (B-83284EN).
The icon that has graphical image means ON, otherwise, it means OFF.

Table 2.2 Status icons for ArcTool

Status Icons (Upper means ON, Lower means OFF.)	Descriptions
Dry run	Show enabled/disabled dry run mode. If it is enabled, welding doesn't perform. For more details, please refer to chapter 5.
Weld	Show enabled/disabled arc welding. For more details, please refer to chapter 5.
Arc	Show status of arc generation.

2.3 SCREEN MENU AND FUNCTION MENU

The operation on teach pendant is used with each menu and contents. Screen / Function menu is displayed by pressed [MENU]/[FCTN] key. Fig. 2.3 (a) shows screen menu for ArcTool, Fig.2.3 (b) shows function menu for ArcTool and Fig. 2.3 (c) shows quick menu for ArcTool.

Screen Menu

Screen menu is used for selecting screen. The contents on screen menus are shown below. By pressed [MENU] key, the menu is displayed.

```
              MENU 1
1 UTILITES
2 TEST CYCLE
3 MANUAL FCTN
4 ALARM
5 I/O
6 SETUP
7 FILE
8
9 USER
0 --  NEXT --
```

```
              MENU 2
1 SELECT
2 EDIT
3 DATA
4 STATUS
5 4D GRAPHICS
6 SYSTEM
7 USER2
8 BROWSER
9
0 -- NEXT --
```

Fig. 2.3 (a) Screen menu.

Table 2.3 (a) shows the contents on quick menu related ArcTool. For others, please refer to OPERATOR'S MANUAL (Basic Operation) (B-83284EN) .

Table 2.3 (a) Contents on screen menu

Items	Descriptions
TEST CYCLE	Show arc weld enabled/disabled setup screen and arc welding test cycle screen. For more details, please refer to chapter 5.
ALRAM	Display alarm screen
I/O	Display Cell interface screen, weld input / output screen and weld external output screen. For more details, please refer to chapter 7.
SETUP	Display arc weld system setup screen and arc weld equipment setup screen. For more details, please refer to chapter 3.
DATA	Display arc weld procedure screen. For more details, please refer to chapter 3.
STATUS	Display arc welding status screen. For more details, please refer to chapter 6.

Function Menus

Fig. 2.3 (b) shows the contents on Function menu. To display them, press FCTN key on teach pendant.

```
        FUNCTION 1
1 ABORT(ALL)
2 Disable FWD/BWD
3
4
5
6
7 RELEASE WAIT
8
9
0 --  NEXT --
```

Page 1

```
        FUNCTION 2
1 QUICK/FULL MENU
2 SAVE
3 PRINT SCREEN
4 PRINT
5
6 UNSIM ALL I/O
7
8 CYCLE POWER
9 ENABLE HMI MENUS
0 --  NEXT --
```

Page2

```
        FUNCTION 3
1 REFRESH PANE
2
3
4
5
6
7 Diagnostic log
8 Del Diag Log
9
0 --  NEXT --
```

Page 3

Fig. 2.3 (b) Function menu

Quick menu

When quick menu is selected by “QUICK/FULL MENU” in function menu, the number of contents on screen menu is reduced. Fig. 2.3 (c) shows quick menu for ArcTool.

```
          QUICK 1
1 ALARM
2 UTILITY
3 TEST CYCLE
4 DATA
5 MANUAL FCTNS
6 I/O
7 STATUS
8
9 USER
0 --  NEXT --
```

```
          QUICK 2
1
2
3 SETUP
4
5 4D GRAPHICS
6
7 USER 2
8 BROWSER
9
0 --  NEXT --
```

Fig. 2.3 (c) Quick menu

Table 2.3 (b) shows the contents on quick menu related ArcTool. For others, please refer to OPERATOR’S MANUAL (Basic Operation) (B-83284EN) .

Table 2.3 (b) Contents on quick menu.

Items	Descriptions
ALARM	Display alarm screen
TEST CYCLE	Show arc weld enabled/disabled setup screen and arc welding test cycle screen. For more details, please refer to chapter 5.
STATUS	Show arc welding status screen. For more details, please refer to chapter 6.

2.4 ICON MENU

Icon menu is displayed at bottom of screen during screen menu, window menu or function menu is displayed. By pressing an icon on it, change window and setup arc weld test cycle quickly. For details of procedure for icon menu, please refer to Section 11.2.2 in OPERATOR’S MANUAL (Basic Operation) (B-83284EN) .

Menu Favorites

Menu Favorites is appears during screen menu is displayed. By pressing an icon, the corresponding screen is displayed. When ArcTool software has been installed, the icons corresponding to high-frequency screen has been registered.

Default menu favorites for ArcTool

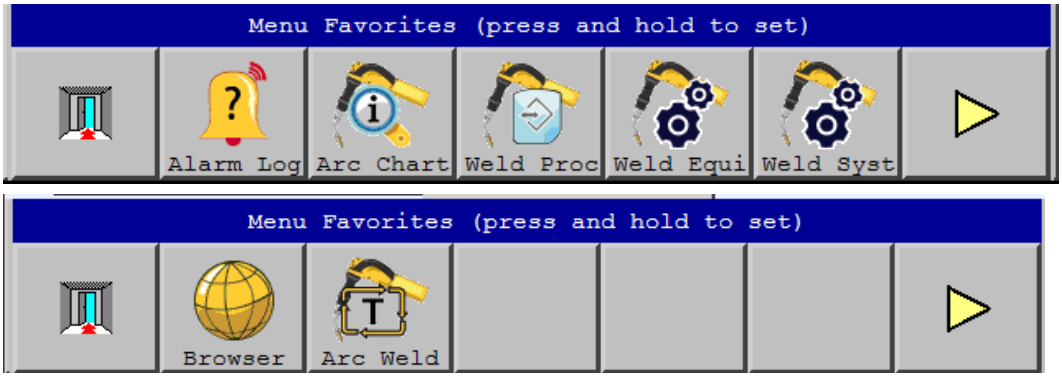


Fig. 2.4 Default menu favorites for ArcTool

Table 2.4 shows the descriptions of menu favorites.

Table 2.4 Icons on menu favorites

Items	Description
	Show ALARM screen.
	Show arc chart screen. For more details, please refer to chapter 16.
	Show arc weld procedure screen. For more details, please refer to chapter 3
	Show arc weld equipment screen. For more details, please refer to chapter 3
	Show arc weld system screen. For more details, please refer to chapter 3
	Show Internet screen.
	Show arc weld enable/disable set screen. For more details, please refer to chapter 5

3 SETUP

3.1 OVERVIEW

ArcTool has four configurations types with respect to each scope of application.

- ArcTool setup
- Arc weld system setup
- Arc weld equipment setup
- Arc weld procedure setup

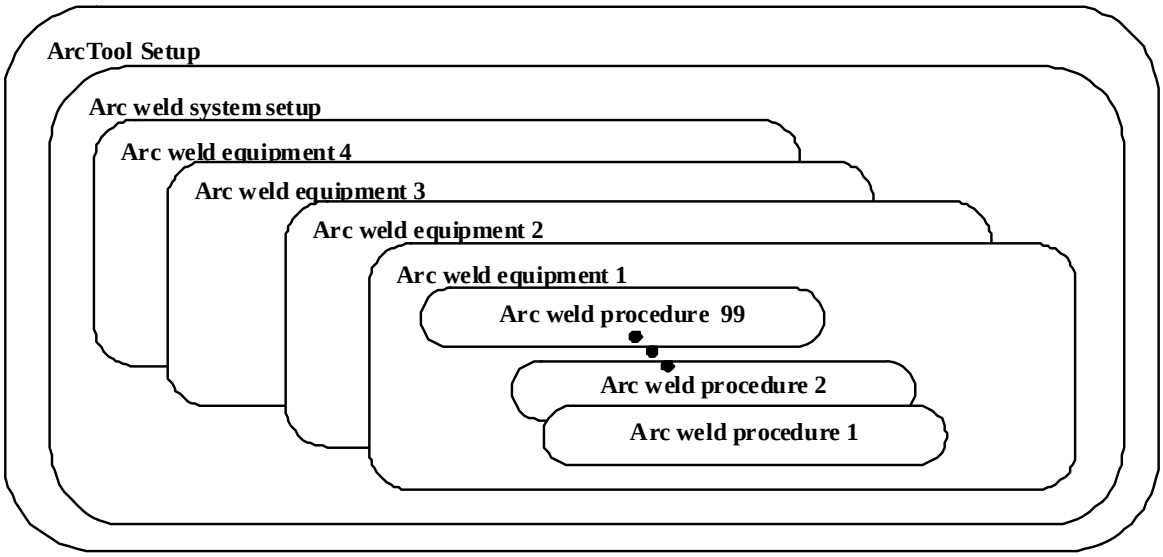


Fig. 3.1 (a) Illustration of the coverage of each ArcTool settings

ArcTool Setup (Section 3.2)

ArcTool setup is the fundamental settings for arc welding robot system like the number of weld equipment et.al.. It can set only on controlled start and need to set up at the starting up of the system.
When the configurations are changed after the starting up, it would be necessary to re-setup arc welding system and more.

Arc Weld System Setup (Section 3.3)

Arc weld system setup is the overall settings for arc welding robot system. It includes basic features configuration, Enabled/Disabled monitoring function and return to path et.al..

Arc Weld Equipment Setup (Section 3.4)

Arc weld equipment setup is settings of weld equipment connecting to arc welding robot system. If a robot system has multiple weld equipment, it is enabled to set different configuration with respect to each of weld equipment. This includes detailed configurations enabled at arc weld system setup like arc loss time and setup of devices connected to the weld equipment like wire inching speed.

Arc Weld Procedure Setup (Section 3.5)

Arc Weld Procedure is settings of commands to weld equipment and other peripheral devices while welding. Every weld equipments can have several arc weld procedures (Maximum is 20). It is possible to prepare the different welding setting in each arc weld procedures. Arc weld procedure can use the number from 1 to 99.

This includes weld schedules; command value of welding voltages and current et.al, settings of external peripheral devices; gas pre-flow time et.al. and settings of several features to each welding.

Arc welding sequence shows the timings of instructions that ArcTool software instructs robots, welding equipment, remote controllers and other peripheral devices. Since, it depends to configurations of arc welding system, users can customize arc welding sequence as you like.

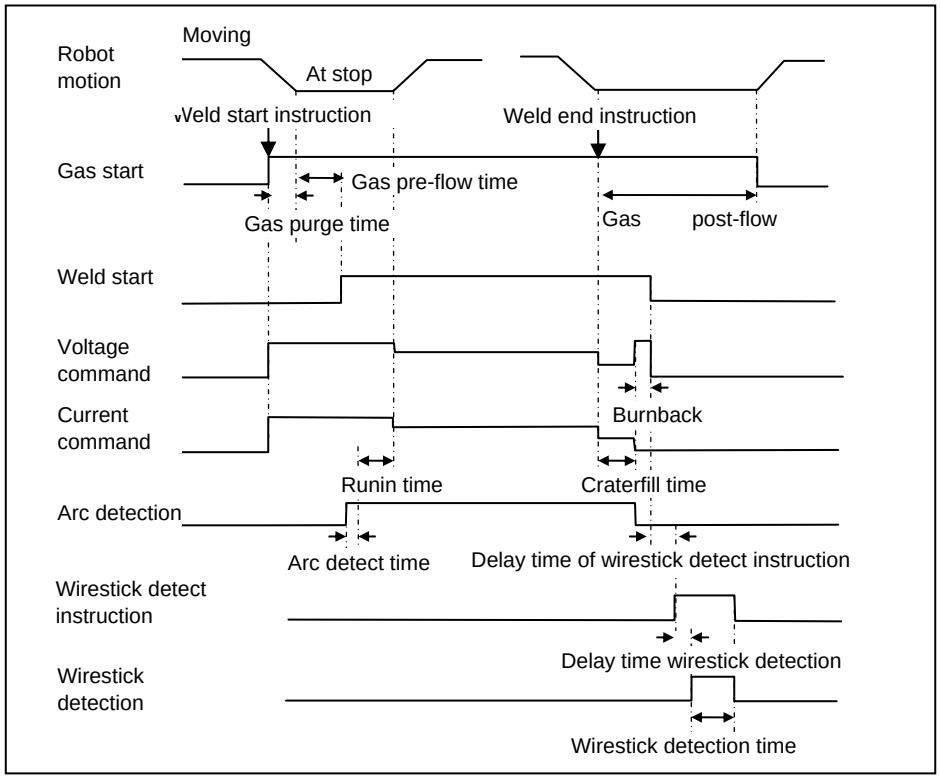


Fig. 3.1 (b) Arc welding sequence with motion instruction

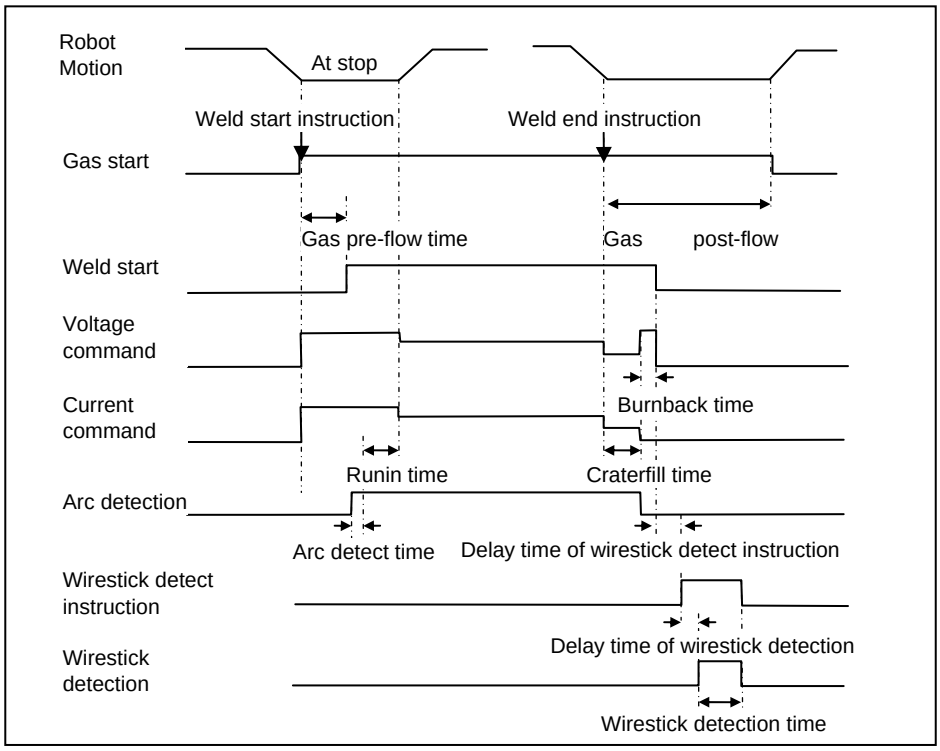


Fig. 3.1 (c) Arc welding sequence without motion instruction

3.2 ARC TOOL SETUP

Operators set the initial configurations for weld system in ArcTool SetUp screen. The configurations of weld equipment in this screen must be setup at the starting up of the system.

- Weld Equipment
  Load configuration data of the using weld equipment. It provides several configurations; I/Os, command format et.al.. They are assigned automatically by selecting. Operators can execute welding soon after controller starts.
- Speed units for arc welding
  Select the speed unit of wire and robot, and, by selecting a country, the units will be changed to the standard units of the country.
- Other configurations
  Change the number of weld equipment. This configuration becomes available when multi equipment option has been installed.

Table 3.2 Setup items on ArcTool setup screen

Items	Descriptions	Note
Robot No.	Show and set the robot serial number.	
Robot group	This item only appears on R-30iB Plus Controller. Show and set the robot group number for the current equipment number. This item becomes available only when Multi equipment option (A05B-XXXX-J617) is installed.	
Welding Setup	Show and set your country. When it has been changed, wire and weld speed units are changed to the standard units for the new country.	*1
Wire speed units	Show and set the unit of wire feed/inching speed.	*1
Weld speed units	Show and set the unit of welding speed instruction.	*1
Weld Speed	Operation speed when a welding speed instruction is executed under some of the following conditions. - Single step mode - Without welding. - Backward motion	
Manufacturer	Select manufacturer of weld equipment.	
Model	Select model of the weld equipment. Selectable models depend on the manufacturer.	
Multi-Process	Enabled/Disabled multi-process function. Basically do not change this item manually.	*2
Weld ID	Enabled/Disabled Weld ID function. When it is Enabled, “WID:” item is displayed at the end of Arc Weld End instruction. Then you can specify Weld ID, and this will help the search of weld sections. When Process Logger funciton (A05B-XXXX-R758) is ordered, this item becomes always Enabled and the cursor cannot move on this item. About the teaching method of Weld ID, please refer to Subsection 4.1.4.	
Number of weld schedules	Not used.	*2
Number of weld equipment	Show and set the number of weld equipments that connected to the controller. This item becomes available only when Multi equipment option (A05B-XXXX-J617) is installed. For more details, please refer to Chapter 25.	*2

NOTE
If some configurations marked *1 have been changed, each speed value can be converted to new speed unit automatically. For more details, refer to Procedure 3-3.
If some configuration s marked *2 have been changed, they require controlled start again. Please cycle power during controlled start. If operators perform cold start without cycle power, the change isn't applied to the system.

Procedure 3-1 Display ArcTool Setup Screen

Step

1 Perform controlled start, the following screen appears.

```
ArcTool Setup
                                        1/11
     1 Robot No.:                  M99999
       Robot group:1[                   M-10iA]
     2 Welding Setup:              Japan
     3   Wire speed units:         cm/min
     4   Weld speed units:         cm/min
     5   Weld speed:               100

     6 Manufacturer:               General Purpose
     7 Model:                      MIG(Volts, Amps)

     8 Multi-process:              Disabled
     9 Weld ID:                    Disabled
    10 Number of weld schedules:32
    11 Number of weld equipment:1

   [ TYPE ]          Check          Help
```

Fig. 3.2 ArcTool Setup screen

If other screen is displayed while controlled start, ArcTool setup screen is displayed again by the following steps.

1 Press [MENU] key.
2 Select "1. ArcTool SetUp". ArcTool Setup screen is displayed.

Procedure 3-2 Configuration of weld equipment

Step

1 Press F4"CHOICE" key with the cursor on "6 Manufacturer" and select the manufacturer of the connecting weld equipment from the displaying list as following.

```
                    1
1 General Purpose
2 Lincoln Electric
3
4
5
6
7
8
```

2 Press F4"CHOICE" key with the cursor on "7 Model" and select the model of the connecting weld equipment from the displaying list. The contents of the list depend to manufacturer of weld equipment. For example, the list of "Lincoln electric" is shown as the following.

```
                    1
1 PowerWave+ArcLnk
2 PowerWave+ENet
3 PowerWave 450
4 STT
5
6
7
8
```

3 If the setup of weld equipment configurations has been finished, press FCTN key and select “1. START(COLD)”.

4 If there is no configuration data for the connecting weld equipment, select “General Purpose” as manufacturer. The following list will be displayed as the list of “Model”, please select the model suitable for welding control mode of the connecting weld equipment.

```
                    1
1 MIG (Volts, WFS)
2 MIG (Volts, Amps)
3 TIG (Amps)
4 TIG (Amps, WFS)
5
6
7
8
```

Procedure 3-3 Change the unit of speed

Step

1 Press F4”CHOICE” key with the cursor on “2 Welding Setup”, select the country in the displayed country list.
When “Japan” is selected, both “Wire speed units” and “Weld speed units” become “cm/min”. When “USA” is selected, they become “IPM”.

```
              1
1 USA
2 Japan
3 Custom
4 Australia
5 China
6 Europe
7
8
```

2 If “Wire Speed Units” has been changed, the following message appears.

```
New Wire speed units require
converting the inch speed, the
strike speed and speed in
programs and schedules

Convert the wire speed?
     [YES]      NO
```

When “YES” is selected, the following wire speed configurations are converted according to the new speed units. (When “NO” is selected, they are not converted.)

- Wire inching speed (in arc weld equipment setup)
- Remote wire inching speed (in arc weld equipment setup)
- Wire feed speed (at Arc instruction and in arc weld procedure setup)
- Maximum value of wire speed command (in weld output setup)
- Maximum value of wire speed command (in weld output setup)

3 If weld speed unit has been changed, the following message appears.

```
New weld speed units require
converting the default weld
speed and the weld speed in all
the weld schedules.

Convert the weld speeds
      [YES]     NO
```

When “YES” is selected, the following wire speed configurations are converted according to the new speed units. (When “NO” is selected, they are not converted.)

- Weld speed (in ArcTool setup and arc weld procedure)
- Default speed (in arc weld system setup)

4 If you would like to change each unit without changing country, press F4”CHOICE” key with the cursor on Wire speed units/ Weld speed units. Select new unit in the displayed list as followings. After selecting new units, same message at 2 or 3 will appears, please select “YES” or “NO”.

```
        1
1 mm/sec
2 cm/min
3 IPM
4 m/min
5
6
7
8
```

NOTE
If you use Lincoln weld equipment model, Strike wire feed speed on Weld Procedures screen is also converted.

3.3 ARC WELD SYSTEM SETUP

Arc weld system setup is the overall settings for arc welding robot system. They are setup at Arc Weld System Setup screen. The configurations apply to every weld equipments and procedures.

Arc weld system setup includes the following configurations.

- Monitoring function
- Weld restart function
- Scratch start function
- Repeat touch retry function
- Weld speed function
- Other functions

Procedure 3-4 Setup arc weld system

Step

1 Press [MENU] key and display the screen menu.
2 Select “6. Setup”.
3 Press F1[Type] and display the screen menu.
4 Select “1. Weld System”.

```
SETUP Weld System
                                        1/22
      NAME                            VALUE
  Monitoring Functions
    1 Arc loss:                       ENABLED
    2 Gas shortage:                   DISABLED
    3 Wire shortage:                  DISABLED
    4 Wire stick:                     ENABLED
    5 Power supply failure:           ENABLED
    6 Coolant shortage:               DISABLED
  Weld Restart Function
    7 Return to path:                 ENABLED
    8 Overlap distance:               0      mm
    9 Return to path speed:           200mm/sec
  Scratch Start Function
   10 Scratch start:                  ENABLED
   11 Distance:                       7      mm
   12 Return to start speed:          50 mm/sec
   13 Retry count:                    1
  Repeat Touch Retry Function
   14 Repeat Touch Retry:             ENABLED
   15 Retry count:                    2
  Weld Speed Function
   16 Default speed:                  125 cm/min
  Other Functions
   17 On-The-Fly:                     ENABLED
   18 Weld from teach pendant:        ENABLED
   19 Remote gas purge:               DISABLED
   20 Remote wire inch:               DISABLED
   21 Gas purge key:                  ENABLED
   22 Gas purge time:                 5     sec

  [ TYPE ]                            ENABLED  DISABLED
```

Fig. 3.3 (a) Weld system setup screen

5 To set configurations, move the cursor you would like to change and input the number of press function key; ENABLED/DISABLED.

Monitoring Function

Monitoring function checks weld equipment or other external devices status. This content includes the following configurations.

Table 3.3 (a) Configurations of monitoring function in arc weld system setup

Items	Descriptions
Arc loss	Set enabled/disabled arc loss detection function. When arc detection signal has been off for a given length of time defined as “Arc loss detection time”, if the function is enabled, a weld alarm occurs.
Gas shortage	Set enabled/disabled gas shortage detection function. In the case of this function is enabled, when gas start signal become on, check gas fault signal after a certain period of time defined as “Gas detection time”, if the signal is on, the function causes a weld alarm.
Wire shortage	Set enabled/disabled wire shortage detection function. In the case of this function is enabled, check wire fault signal while welding. If the signal is on, the function causes a weld alarm.
Wire stick	Set enabled/disabled wirestick detection function. In the case of this function is enabled, set wirestick detect instruction (WST, internal signal) to on at weld ending. The device judges whether wirestick occurs or not according to voltage difference between wirestick detection signals. If current status is considered as wirestick, wirestick reset function works automatically if enabled, or it causes a weld alarm occurs. If the function is disabled, wirestick reset function also becomes disabled.

Items	Descriptions
Power supply failure	Set enabled/disabled power supply failure detection function. If this function is enabled, when power fault signal becomes on while welding, the function causes a weld alarm.
Coolant shortage	Set enabled/disabled coolant shortage detection function. If this function is enabled, when water fault signal becomes on while welding, the function causes a weld alarm.

Weld Restart Function

Weld restart function is a function setup the robot at restart the weld program while welding. This content has the following configurations.

Table 3.3 (b) The configurations of weld restart function in arc weld system setup

Items	Descriptions
Return to path (Original path resume function)	Set enabled/disabled return-to-path function (Original path resume function). In the case of the function is enabled, when a robot has been paused while welding by hold request or alarm occurrence et.al., and restart is required, the robot moves to the point of break and start welding again.
Overlap distance	When restart is required, robot goes back the distance specified by the item from the point of break and start welding again. This process prevents to break weld beads. The maximum retracing distance is limited to within the previous thought point. Overlap distance works at hold timing only with arc welding. And, it works with linear motion only (it does not work with circular motion / circle arc motion).
Return to path speed	Specify the robot speed goes back to resume point.

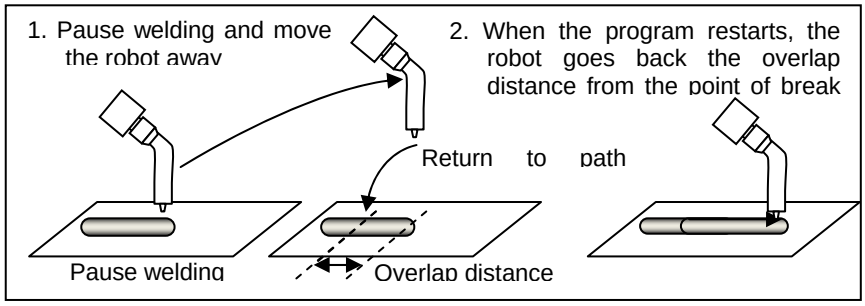


Fig. 3.3 (b) Weld restart function

Scratch Start Function

When arc is not generated at weld start instruction, scratch start function is performed as shown in the following figure. Weld start retry is performed at the position different from the weld start position. When arc generates during this process, the top of wire immediately returns to welding starting position and the welding program is continued.

Table 3.3 (c) Configurations of scratch start function in arc weld system setup

Items	Descriptions
Scratch start	Set enabled/disabled scratch start function.
Distance	This is the maximum distance that robot moves during scratch motion. The robot returns to the weld start position after forwarding this distance. When the arc does not generate during this motion, alarm is generated. This distance of scratch motion does not exceed the next taught position in TP program. When this value is too long, the area of heat insertion becomes large. So please set this value to short as much as possible.

Items	Descriptions
Return to start speed	This is the returning speed from the arc generating position during scratch motion. When this value is too slow, some holes are generated at work since heat gain increases by the arc output during returning motion. So please set this value to high as much as possible. However, robot cannot reach this speed when the posture of robot rapidly changes in the motion like a circular motion (For example, when the posture of robot rapidly changes, the scratch return speed may become 30 mm/sec even if the command is 100 mm/sec).
Retry	The numbers of maximum retry count of scratch start process.

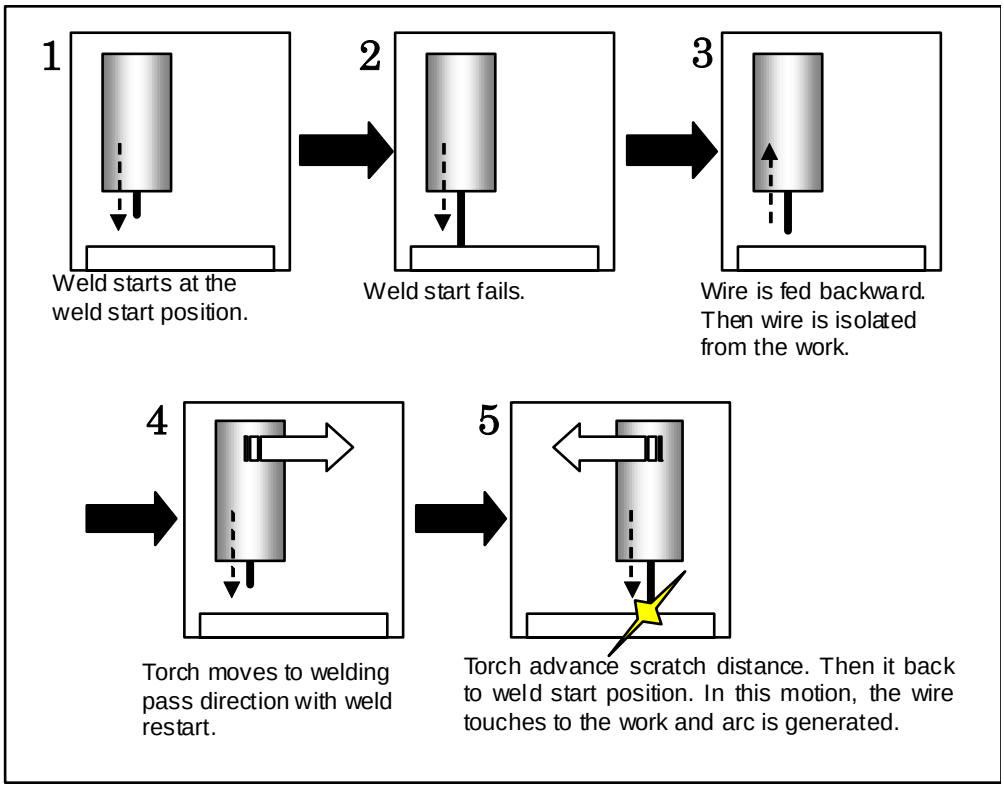


Fig. 3.3 (c) Scratch start function

⚠ **CAUTION**

- If arc weld equipment other than Lincoln manufacturer is used and ServoTorch is not used, it is necessary to perform some setup for using this function effectively. For more detail, please refer to “Adjustment of wire rewind time before scratch start running” in Subsection A.2.3.
- When scratch start function executes with higher arc start schedule to thin work, it may occur penetration at the start point, since the heat input becomes too huge. In the situation like this, please set “Distance” to 2mm and “Return to start speed” to 100mm/sec.
- Scratch start function doesn’t work if COORD instruction isn’t applied to the motion instruction that approach to arc start position at coordinated weld system.
- If scratch start function works with circular or A motion, the return motion to arc start position becomes linear. Since, it is possible that the torch interferes with the works, please do not set long scratch distance with their motion.
- If program has paused while scratch motion, the robot goes back to the point of break at scratch start motion just after restart, it isn’t arc start position.

⚠ **CAUTION**

- Even if motion instruction has Arc Weld Start instruction as additional motion instruction and position is taught with position register, scratch start works. However, scratch start does not work when the next position is taught with position register. This can be avoided by using LOCK PREG instruction.
- If OFFSET instruction or TOOL OFFSET instruction is added to the motion instruction which is located just after Arc Weld Start instruction, scratch start does not work normally. If you would like to use scratch start on the program which has OFFSET instruction or TOOL OFFSET instruction, please execute LOCK PREG instruction before Arc Weld Start instruction.

Repeat Touch Retry Function

When arc is not generated at weld start instruction, Repeat Touch Retry Function retries weld start at the same position (taught weld start position in TP program) as shown in the following figure. If arc is not generated after this motion, Scratch Start function of previous Section works.

Table 3.3 (d) Configurations of repeat touch retry function in arc weld system setup

Items	Descriptions
Arc retry	Set enabled/disabled repeat touch retry function
Retry	The numbers of maximum retry count of repeat touch retry function

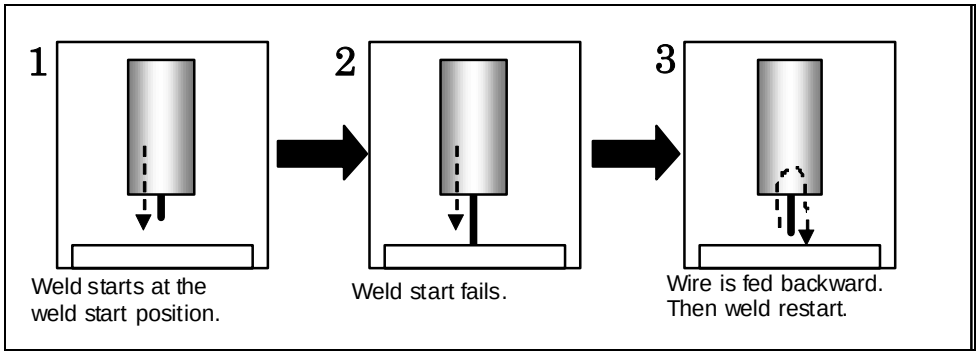


Fig. 3.3 (d) Repeat Touch Retry function

Weld speed function

Weld speed function has the following configuration. Regarding to weld speed function, please refer to Section 4.2.

Table 3.3 (e) Configuration of weld speed function in arc weld system setup

Item	Description
Default speed	Operation speed when a welding speed instruction is executed under some of the following conditions. This contents sets up same contents on ArcTool Setup screen - Single step mode - Without welding. - Backward motion

Other functions

Arc weld system setup has configurations of enabled/disabled of the following functions.

Table 3.3 (f) Configurations of several function for arc weld system setup

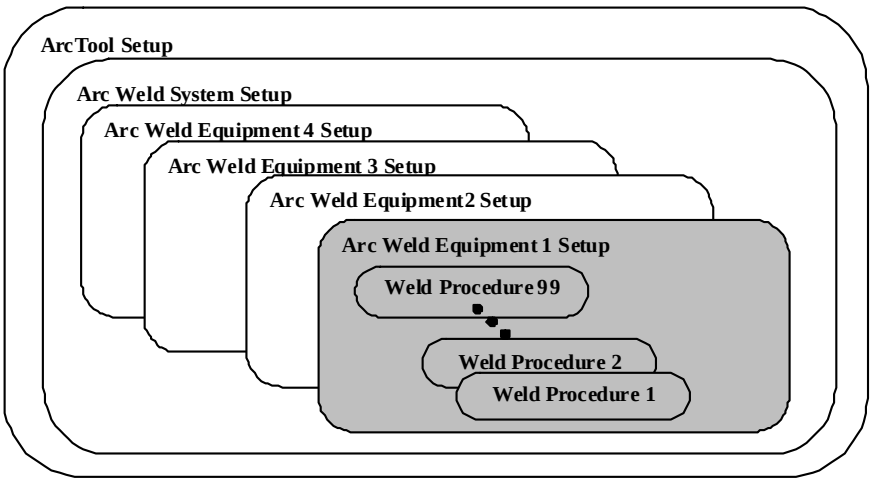
Items	Descriptions
On-the-fly	Set enabled/disabled On-the-fly function
Weld from teach pendant	Set enabled/disabled welding from teach pendant. If this function is enabled, arc welding executes actually by executing program from teach pendant. If you would like to check only welding path, please set the function to disabled to prevent the accidental welding.
Remote gas purge	Set enabled/disabled remote gas purge function. If this function is enabled, “remote gas purge” signal appears on weld input signals screen. By assigned the signal, it supports to change gas on/off from “remote gas purge” signal.
Remote wire inch	Set enabled/disabled remote wire inching function. If this function is enabled, “remote inch fwd” and “remote inch bwd” signals appear on weld input signals screen. It is possible to control wire inching by on/off the signals
Gas purge key	Set enabled/disabled gas purge key function. If operators will use gas/status key for other purpose by MACRO instruction. Set disabled it. About details of gas purge function, please refer to Section 5.2.
Gas purge time	When gas start signal becomes on by gas purge function, the gas flow stops automatically after the elapse of a period defined at the item. By pressing STATUS key with shift key again, gas flow stops immediately.

⚠ CAUTION

At system variable $AWSEMGOFF.$NOFLTR_OFF is TRUE, for safety’s sake, an arc generation will stop when robot has stopped for a time specified at system variable $AWSEMGOFF.$CHK_TIME and more. If the process time of runin, burnback craterfill et.al, becomes longer than $AWSEMGOFF.$CHK_TIME, please set up $AWSEMGOFF.$CHK_TIME again and repower the controller.

3.4 ARC WELD EQUIPMENT SETUP

Arc weld equipment setup is settings of weld equipment connecting to arc welding robot system. The configurations is set up on arc weld equipment setup screen.
The configuration in the setup is applied to selected weld equipment and every weld procedures corresponding to the selected weld equipment and doesn’t apply other weld equipment.



Arc weld equipment setup includes the following configurations.

- Common configurations for selected weld equipment
- Arc weld sequence of selected weld equipment

Procedure 3-5 Setup arc weld equipment

Step

1 Press [MENU] key.
2 Select “6 Setup”.
3 Press F1[TYPE].
4 Select “2 Weld Equip”.
5 To set configurations, move the cursor you would like to change and input the number of press function key; ENABLED/DISABLED.

```
SETUP Weld Equip
                                        1/8
   Welder: General Purpose MIG(Volts, Amps)
      Process:                      MIG
       Process control:             VLT+AMP
   Feeder: General Purpose
     1 WIRE+ WIRE- speed:           80 cm/min
     2 High WIRE+ speed:            500cm/min
     3 Remote wire inch speed:      80 cm/min
     4 Feed forward/backward:       ENABLED
   Timing
     5 Arc start error time:        1.40  sec
     6 Arc detect time:             0.005 sec
     7 Arc loss error time:         0.25  sec
     8 Gas detect time:             0.05  sec

   [ TYPE ]
```

Fig. 3.4 (a) Arc weld equipment setup screen

> **NOTE**
> The contents on the screen depend to manufacturer and model of weld equipment.
> The above screen is corresponding to
> “ Manufacturer” is “General Purpose”
> “Model” is “MIG (Volts, Amps)

Table 3.4 The configurations of arc weld equipment setup

Items	Descriptions
Welder	Show the model and manufacturer of selected weld equipment.
Process	Show the type of welding method. • MIG=CO2-MAG welding • TIG=TIG welding
Process control	Show control method of power supply. • VLT+WFS=Control with [Voltage, Wire feed speed] • VLT+AMP=Control with [Voltage, Current] • AMPS=Control with [Current]’ • AMP+WFS=Control with [Current, Wire feed speed] This item appears only when “manufacturer” is “General Purpose” on ArcTool Setup
WIRE+ WIRE– speed	Speed of manual wire feed by pressing WIRE+ or WIRE– key. The unit is defined as “Wire speed unit” at ArcTool Setup.
High WIRE+ speed	When WIRE+ key has been pressed with shift key for 2s or more, the wire feed speed changes to the speed specified the contents automatically. When WIRE– key or WIRE+ key without shift key is pressed, the wire feed speed never changes.

Items	Descriptions
Remote wire inch speed	Speed of manual wire feed by remote inch fwd and remote inch bwd signals. The unit is defined as “Wire speed unit” at ArcTool Setup. This configuration appears only when remote wire inching function is enabled.
Feed forward/backward	Set enabled/disabled wire feed speed output function while welding. If this function is enabled, “Feed forward” and “Feed backward” appear at weld output signals screen. This item is not displayed on R-30iB Plus controller.
Arc start error time(sec)	The maximum waiting time between arc start signal to on and an arc has been generated certainly. If an arc had been not generated in the time, repeat touch retry function and/or scratch start function executes if enabled, even if an arc has been generated yet, a weld alarm occurs.
Arc detect time (sec)	If an arc has been detected on continuously more than the time, the robot controller treats it as an arc has been generated certainly. The time must be shorter than arc start error time.
Arc loss error time(sec)	Delay time from arc detect signal becomes off while welding to a weld alarm occurs. If arc detect signal becomes never on in the time, a weld alarm occurs,
Gas detect time(sec)	Delay time from gas start signal becomes on to check the gas fault signal. If gas fault signal is on at the timing, a weld alarm occurs. If gas shortage detection function is disabled, this time is invalid. The time must be shorter than gas pre-flow time.

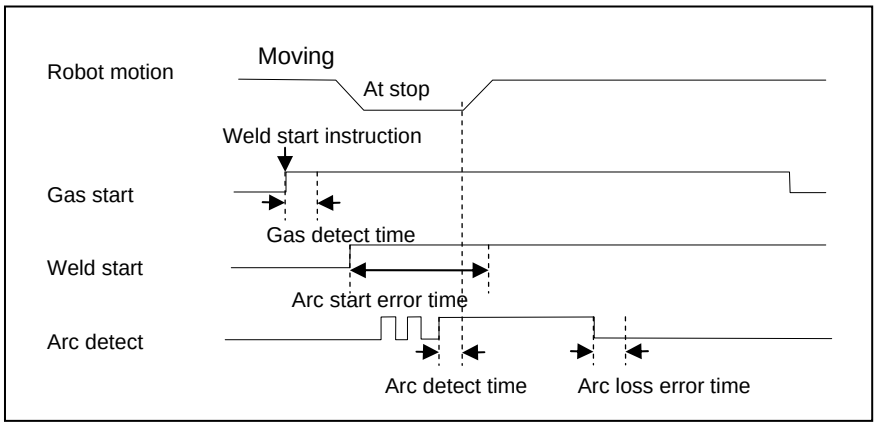


Fig. 3.4 (b) Several detection time

⚠ CAUTION

At welding with low-current, a lot of arc failed may occur just after Weld start. It prevents the problem to set arc detect time to longer.
However, longer arc detect time increases cycle time and may cause penetration at the start point. Please pay attention it when you adjust the parameter.

⚠ CAUTION

If arc loss occurs in short range; tack weld et.al., it may not pause by a weld alarm caused by arc loss detection function. This problem occurs by the balance of welding time and arc loss error time.

3.5 ARC WELD PROCEDURE

3.5.1 Overview of Weld Procedure

Arc weld procedure manages weld schedules and runin schedule, etc. By assigning weld procedure number and weld schedule number in an arc instruction, ArcTool software welds based on the specified condition. Weld procedure setup is applied to specified weld procedure only.

NOTE

- It is possible to create the weld procedure per weld equipment. Weld procedure can use the number from 1 to 99.
- However, the maximum number of weld procedure that can be created is 20 per weld equipment.
- The maximum number of weld schedule that can be created is 32 per weld procedure.
- However, in the standard setting, the total number of weld schedules that are defined by all weld procedures in per weld equipment can not be prepared over 100. Please refer to Procedure 3-9 if you would like to change the limitation of this number.

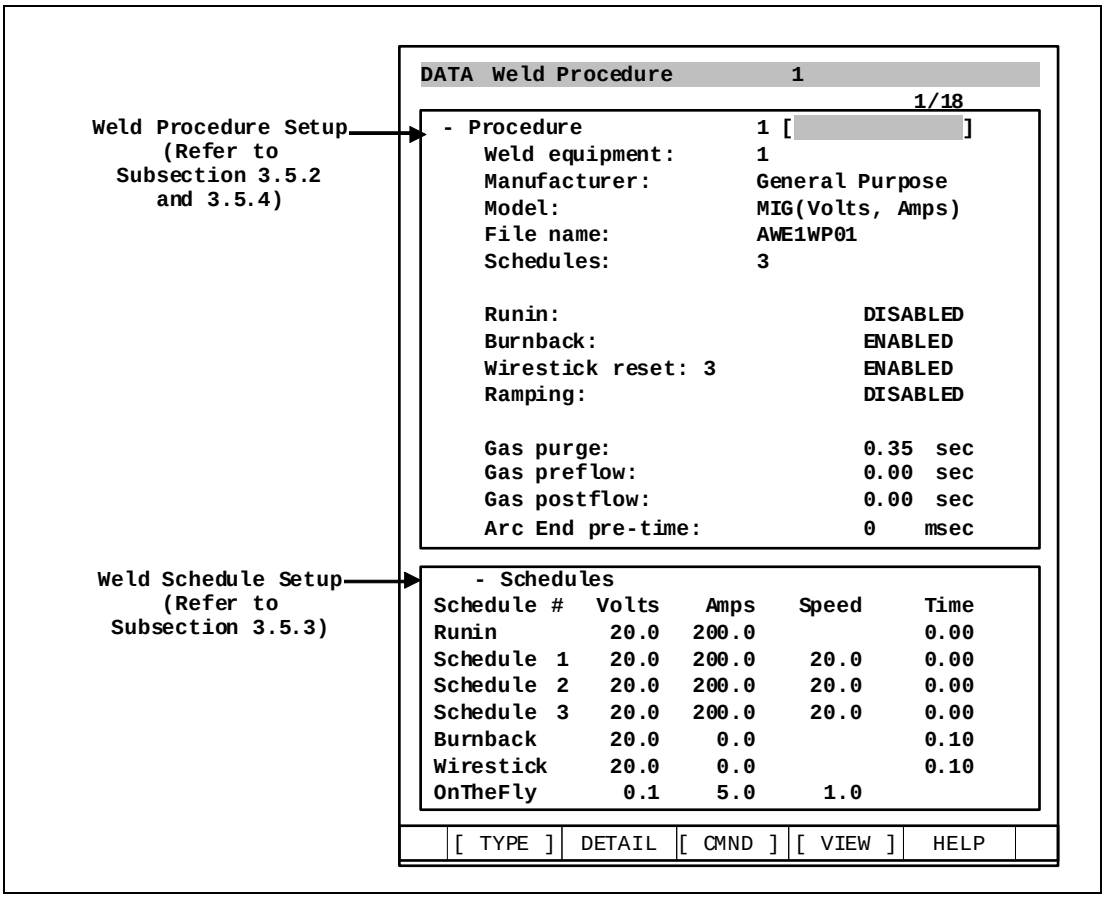


Fig. 3.5.1 Arc weld procedure screen

Procedure 3-6 Creation of arc weld procedure

There are three methods to create new weld procedure.

Step (No weld procedure exists)

1 Press [MENU] key.
2 Select “3. DATA”.
3 Press F1[TYPE] key.
4 Select “Weld Procedure”.
5 In case of “Create a weld procedure?” is displayed, ArcTool has no weld procedure. If you request creation, press F4 “YES”. When F5 “No” is pressed, the screen shows the previous screen again.

Step (Weld procedure exists and Creating new weld procedure)

1 Press [MENU] key.
2 Select “3. DATA”.
3 Press F1[TYPE] key.
4 Select “Weld Procedure”.
5 Press F3[CMND] key.
6 Select “Create WP”.

Step (Weld procedure exists and Creating new weld procedure by copy)

1 Press [MENU] key.
2 Select “3. DATA”.
3 Press F1[TYPE] key.
4 Select “Weld Procedure”.
5 Move the cursor to existing weld procedure. It becomes data of the copy origin.
6 Press F3[CMND].
7 Select “Copy WP”.

3.5.2 Arc Weld Procedure Setup

“Procedure” has the following configurations. The procedure configurations apply only to the weld schedule included in same arc weld procedure.

Table 3.5.2 Configurations of weld procedure setup in arc weld procedure

Items	Descriptions
Weld equipment	Show Equipment number to that current procedure belongs
Manufacturer	Show manufacturer of the weld equipment
Model	Show model of the weld equipment.
File name	Show KAREL file name that the weld procedure configuration is restored.
Schedules (1~32, Default:3)	Set the number of weld schedules in the weld procedure.
Runin	Set enabled/disabled Runin process. For more details, please refer to Subsection 3.5.6.
Burnback	Set enabled/disabled Burnback process. For more details, please refer to Subsection 3.5.6.
Wirestick resets	Set enabled/disabled and retry count of automatic wirestick reset function. For more details, please refer to Subsection 3.5.6. Wirestick detection function must be enabled to use the function.
Ramping	Set enabled/disabled ramping process.
Gas purge(sec)	Gas flowing starts before the specified time from the robot arrives to weld start position. Arc instruction without motion instruction, the time is invalid.
Gas preflow(sec)	Gas flowing time between the robot arrives to weld start point and actual welding starts. If gas detection time has been setup, please set it longer than gas detection time.

Items	Descriptions
Gas postflow(sec)	Gas flows continually until the specified time has passed from the welding has been finished.
Arc End pre-time(sec)	When the same length of time (unit is msec) with Craterfill time is input, robot can perform Craterfill during the robot motion. It is available when Weld End instruction of additional motion instruction is used. Do not input the longer time than Craterfill time. Otherwise, the weld will be finished before the robot reaches to the arc end point.

3.5.3 Arc Weld Schedule Setup

Weld schedules setup has the following configurations.

Table 3.5.3 (a) Simple configurations of weld schedules setup

Items	Descriptions
Voltage	Set voltage command to power supply unit(V).
Current Wire feed speed	Set current command to power supply unit(A). Set wire feed speed command to wire feed unit(IPM, cm/min, mm/sec).
Speed	Set the robot speed when weld speed instruction is used. When the instruction is used between a weld start instruction and a weld end instruction, the robot moves the specified speed. The unit of the speed is defined as “Weld speed unit” at ArcTool Setup.
Delay time(sec)	Processing time of craterfill process executed at weld end instruction. For weld start instruction, it is invalid. Please refer to Fig. 4.1.2(a), (b).

Table 3.5.3 (b) Detailed configurations of weld schedules setup

Items	Descriptions
Feedback voltage	Show the actual voltage output from power supply unit while welding.(V)
Feedback current	Show the actual current output from power supply unit while welding. (A)

Procedure 3-7 Setup the number of weld schedule

Step

1 Press [MENU] key.
2 Select”3. DATA”.
3 Press F1[TYPE].
4 Select “1 Weld Procedure”.
5 Move cursor to the character “+” on the head of “Procedure” and press ENTER key.
6 Move cursor to “Schedules” and input the number of weld schedules.
7 A acknowledgement message to apply new number in earnest will be displayed, if you would like to apply it, press F4 “YES”, if you would like to cancel it, press F5 “NO”.

> ⚠ **CAUTION**
> If the number of weld schedules is decreased, the conditions of obsolete schedules are deleted. For example, if the number has been changed 4 to 3 and 3 to 4, the conditions of weld schedule 4 is initialized.

Procedure 3-8 Setup arc weld schedule

Step

1 Press [MENU] key.
2 Select”3. DATA”.
3 Press F1[TYPE].
4 Select “1 Weld Procedure”.
5 Move cursor on “Schedules” and press ENTER key.

```
DATA Weld Procedure              1
                                              1/10
 + Procedure                 1 [                ]
    -  Schedules
 Schedule #   Volts    Amps    Speed     Time
 Runin         20.0   200.0              0.00
 Schedule  1   20.0   200.0     20.0     0.00
 Schedule  2   20.0   200.0     20.0     0.00
 Schedule  3   20.0   200.0     20.0     0.00
 Burnback      20.0     0.0              0.10
 Wirestick     20.0     0.0              0.10
 OnTheFly       0.1     5.0      1.0

   [ TYPE ]  DETAIL  [CMND]  [VIEW]   HELP
```

On the screen, the maximum and minimum value of selected command are shown the bottom of screen. Each command can be setup between the corresponding maximum and minimum values.

6 Press F2”DETAIL”.

```
DATA Weld Procedure                 1
                                              1/6
 1 Weld Procedure     1[                        ]

 2 Weld Schedule      1[Weld Schedule          ]
 3 Voltage:                          20.00  Volts
 4 Current:                          200.0  Amps
 5 Travel speed:                      20.0  cm/min
 6 Delay time:                        0.00  sec
   Feedback Voltage                    0.0  Volts
   Feedback Current                    0.0  Amps

   [ TYPE ]  SCHEDULE  ADVISE
```

The displayed items changes according to the model of weld equipment or the number of analog I/O signal. If you would like to back default screen, press PREV key.

7 About inputting the weld schedule comment,
   a Move the cursor to weld schedule comment line and press ENTER key.
   b Select “Upper Case” or “Lower Case”, “Punctuation”, “Options” from the displayed menu.
   c Input the character arbitrarily.
   d Press ENTER key after inputting the comments.

8 Move cursor you would like to change and enter a value.

9 If you would like to setup other weld schedule, press F2”SCHEDULE” key and enter the weld schedule number. The detailed screen of the weld schedules appears.

NOTE
The configurations depend on weld equipment mode, the number of I/O and label of I/O.

NOTE
As shown in above Procedure step 7, it is possible to input the comments arbitrarily in each weld schedules. On the other hand, it is possible to switch the language in the SETUP General screen if option dictionary is ordered. For example, user inputs Japanese comments in weld schedule 1. Please note that the Japanese comments is misconverted if the language is changed to other language. If misconversion is generated, it is necessary to clear the comments. Besides, if new weld procedure is created after changing language, there is no misconversion at the weld schedule comment in the created weld procedure.

Procedure 3-9 Change limitation for total number of weld schedules that are defined by all weld procedures in per weld equipment

Condition

- In the standard setting, the number of total weld schedule defined in all weld procedure per one weld equipment can not be set over 100. Please execute this procedure only when you would like to change the limitation for this number.
- Before changing limitation for this number by this procedure, please confirm whether there are some unnecessary weld procedures. Also, please confirm whether the number of weld schedules in each weld procedure is excessive. If there are unnecessary weld procedures or excessive weld schedules, FANUC recommends removing unnecessary weld procedures or excessive weld schedules at first.

Step

1 Perform a controlled start.
2 Press MENU key and select [Variables], and then SYSTEM Variables screen is displayed.
3 Move the cursor to [$AWSCFG] and press ENTER key.
4 Move the cursor to [$WP_MAX_SCH]. This value defines the total number of weld schedules that are defined by all weld procedures in per weld equipment.
5 Please change this value to the one required but as small as possible.
6 Press FCTN key and select [START (COLD)], and then Cold start is performed.

3.5.4 Weld Procedure Setup Guide Function

This function automatically calculate/setup the recommended weld schedule (command amps, command volts, weld speed) by some easy setting only shown in the following graphical screen. Adjusting weld schedule becomes easy because operators know the basis weld schedule.

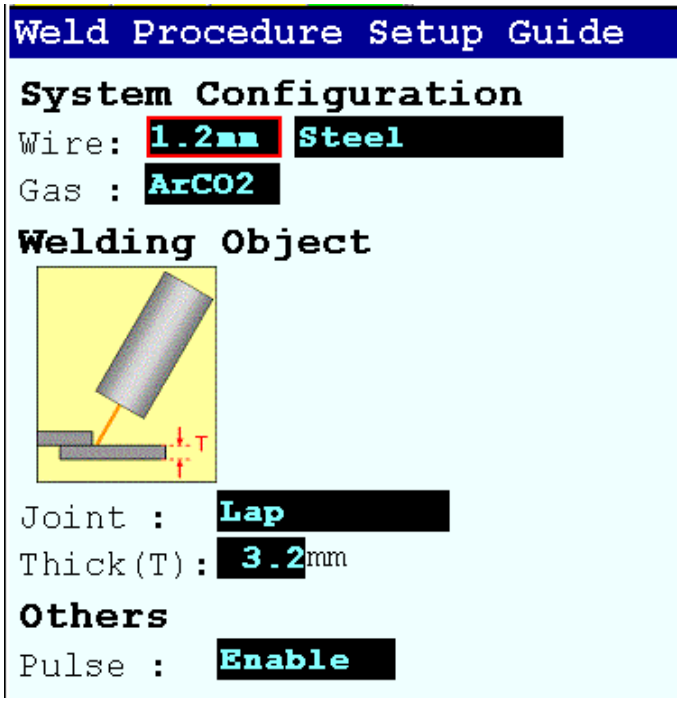


Fig. 3.5.4 Weld Procedure Setup Guide screen

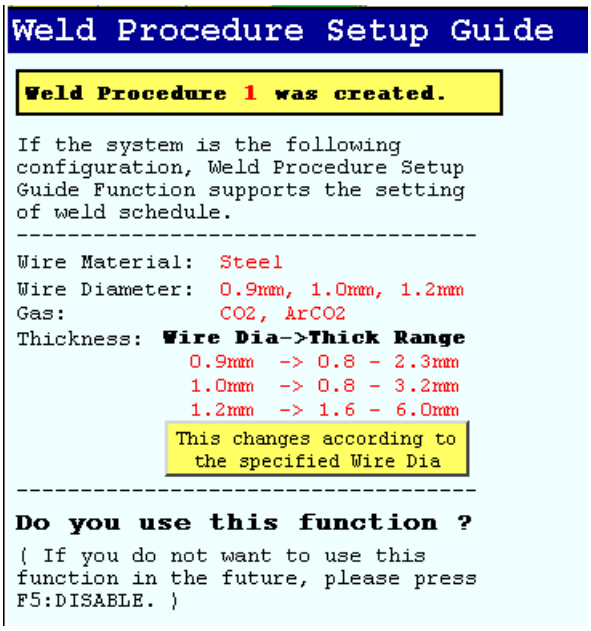
> ⚠ **WARNING**
> This function does not always provide the best weld schedule corresponding to various weld equipment manufacturer / model. Also, this function does not guarantee the welding quality. There is a possibility that a lot of spatter generates or correct welding does not be performed. Please take care enough during welding.

Procedure 3-10 shows the method of using this function.

Procedure 3-10 Setup Weld Procedure Setup Guide

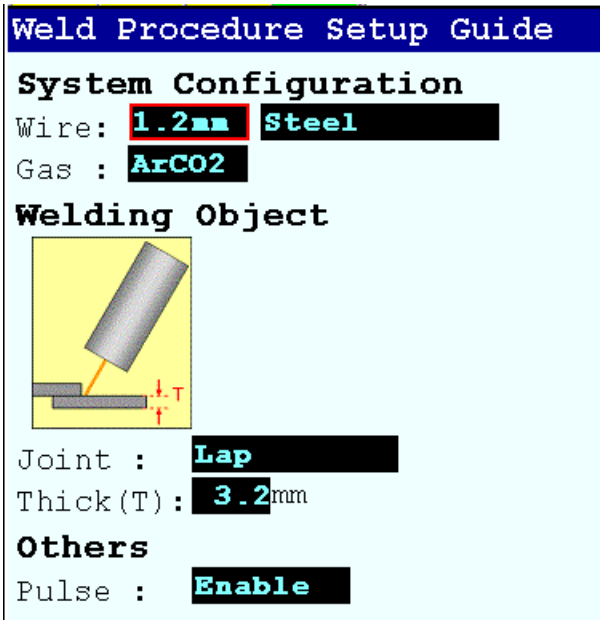
Step

1 Create new weld procedure referring the Procedure 3-6. This function can be used for new created weld procedure. After creating the new weld procedure, following introduction screen is displayed (In the following sample screen, weld procedure 1 is newly created).
However, if this function is disabled, following introduction screen is not displayed and recommended weld schedule is not set (Weld procedure creation is performed). About switching enable/disable of this function, please refer to Procedure 3-11.



2 As shown in above screen, please confirm whether this function supports your welding configuration or not. If this function supports your welding configuration, press F3[YES]. If this function does not support your welding configuration, this function can not be used. Press F4[NO]. Display is returned to DATA Weld Procedure screen (Though the new weld procedure is created, any recommended weld schedule is not set). If F5[DISABLE] is pressed, display is returned to DATA Weld Procedure screen as much as pressing F4[NO]. At the same time, this function is changed to disable. About the behavior of function disable, please refer to the step 1.

3 Following screen is displayed. Please setup according to your welding configuration. All setting items are selection form.

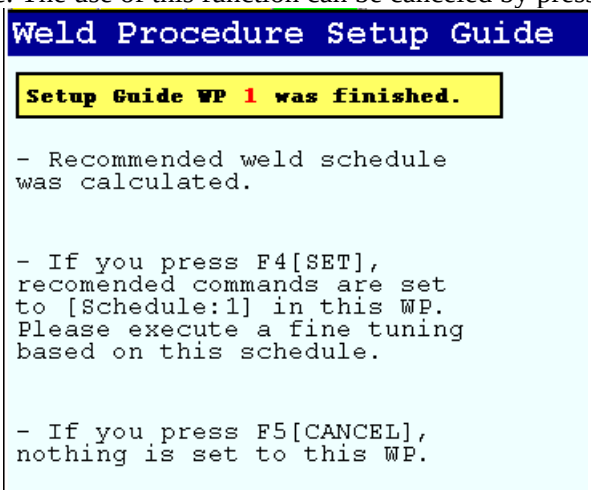


NOTE

- The available input range of “Thick(T)” changes according to the setting of wire diameter and material.
- The figure in this screen changes according to the setting of “Joint”. If there is no desired joint, please select the nearest one.
- “Pulse” can not be set to enable according to your welding configuration and the setting of this screen. In that case, “Pulse” is automatically returns to disable even if you change it to enable.

4 When F5[FINISH] is pressed, this function starts calculating the recommended weld schedule. The use of this function can be canceled by pressing F2[CANCEL].

5 Following screen is displayed.
When F4[SET] is pressed, recommended weld schedule is set to the weld schedule number 1 in the created weld procedure. The use of this function can be canceled by pressing F5[CANCEL].



6 Display is returned to DATA Weld Procedure screen. Please confirm that recommended weld schedule is set to schedule 1 in the created weld procedure. Following is sample screen in the Lincoln welding configuration.

```
DATA Weld Procedure    1
                                                  1/9
 + Procedure                    1 [              ]
  + Mode                       18 [RapidArc ArMix]
    -  Schedules
 Schedule #    Amps   Volts    Speed      Time
 Schedule 1   190.0    23.5    100.0      0.00
 Schedule 2     0.0     0.0      0.0      0.00
 Schedule 3     0.0     0.0      0.0      0.00
 Burnback     130.0    20.0               0.03
 Wirestick    200.0    20.0               0.10
 OnTheFly       0.1     0.1      1.0
 [ TYPE ] DETAIL [CMND] [VIEW] HELP
```

In the case of Lincoln configuration, recommended weld mode number is also set.

7 Please create the arc welding TP program. In this program, please teach the weld start instruction that specifies created weld procedure number and weld schedule number. Please confirm the welding quality. If necessary, please perform fine tuning.

Procedure 3-11 Switch Enable/Disable of Weld Procedure Setup Guide Function

Step

1 Press [MENU] key.
2 Select “3. DATA”.
3 Press F1[TYPE] key.
4 Select “Weld Procedure”.
5 Press F4[VIEW] and select [Guide ON/OFF].
When this function is changed to disable, the message of “WP Setup Guide Function is disabled.” is displayed at prompt line.
When this function is changed to enable, the message of “When [Create WP] WP Setup Guide starts.” is displayed at prompt line.

3.5.5 Arc Weld Advise Function

Arc weld advise function provides standard weld schedule based on “Joint type”, “Thickness”, “Wire diameter” and “Stick out”. This function works only when welding process is controlled by voltage and current and manufacturer isn’t Lincoln.
Since users cannot divide the base conditions (“Joint type”, “Thickness”, “Wire diameter” and “Stick out”) in to little pieces, please select similar condition in the list of base conditions.
This function cannot be used on R-30*i*B Plus controller.

> ⚠ **WARNING**
> Since this function provides only standard schedules, many sputter may be caused. Please pay attention for welding.

Procedure 3-12 shows the method of displaying arc advice screen and setup it.

Procedure 3-12 Arc Weld Advise Function

Step

1 Execute Step 1 - 6 in Procedure 3-8 and select to display weld schedule detailed setup screen.
2 Press F3 “Advise”, the following screen appears.

```
DATA Weld Advise
                                        1/25

     1 Butt    : T=0.8 W=0.8 S=10 CO2=15
     2 Butt    : T=1.0 W=0.8 S=10 CO2=15
     3 Butt    : T=1.2 W=0.9 S=10 CO2=15
     4 Butt    : T=1.6 W=1.2 S=10 CO2=15
     5 Butt    : T=2.0 W=1.2 S=15 CO2=15
     6 Butt    : T=3.2 W=1.2 S=15 CO2=20
     7 Butt    : T=4.5 W=1.2 S=15 CO2=20
     8 Fillet  : T=0.8 W=0.8 S=10 CO2=15
     9 Fillet  : T=1.0 W=0.8 S=10 CO2=15

   [ TYPE ] | DETAIL | SELECT |        | HELP |
```

3 Move cursor to a schedule the and press F2 “Detail” key, the following detailed screen is displayed.

```
DATA Weld Advise
                                        1/5

     1 Butt   : T=0.8 W=0.8 S=10 CO2=15

     2 Command voltage:        17.0    Volts
     3 Command current:        80.0    Amps
     4 Command wire feed:          0    cm/min
     5 Travel speed:          80.0   cm/min

   [ TYPE ] | LIST | SELECT |        | HELP |
```

4 By pressed F3 “Select”, the weld conditions provided by arc weld advise function is applied to actual welding schedules.

5 By pressed F5 “HELP”, the description of symbols and words in arc weld advise screen is shown.

```
DATA Weld Advise
     HELP     Arrows to scroll, PREV to exit


     [ Description of Joint type ]
       Butt    : Sequare-butt joint
       Fillet  : Fillet joint
       Lap     : Lap fillet joint
       C-Joint : Corner joint

     [ Description of sign ]
       T   : Thickness(mm)
       W   : Wire diameter(mm)
       S   : Stick out(mm))

   |        |        |        |        |        |
```

3.5.6 Arc Weld Process Setup

Arc weld process setup includes runin process schedule, burnback process schedule and automatic wirestick reset process schedule and increase-decrease amount of On-the-Fly function.

Runin process

Runin process provides a good start of weld by instructing different commands from weld schedule condition to power supply unit at weld start. To use the function, set it enabled at weld procedure setup.

Procedure 3-13 Setup Runin process

Step

1 Press [DATA] key.

2 Press F1[TYPE] and select “1 Weld Procedure”.

3 Move cursor on “Procedure” and press ENTER key.
4 Move cursor on “Runin” and press F4 “ENABLED” key.
5 Move cursor on “Schedule” and press ENTER key.
6 If Runin process is enabled, the schedule appears at first line of weld schedules list.

```
DATA Weld Procedure                    1
                                                 1/10
 + Procedure                  1 [                 ]
    -  Schedules
 Schedule #   Volts    Amps    Speed      Time
 Runin         20.0   200.0               0.00
 Schedule  1   20.0   200.0     20.0      0.00

   [ TYPE ]  DETAIL  [CMND]  [VIEW]  HELP
```

Table 3.5.6 (a) Configurations of Runin process

Items	Descriptions
Runin Voltage	Set voltage command to power supply unit at Runin process(V)
Runin Current	Set current command to power supply unit at Runin process (A)
Time(sec)	Processing time of Runin process executed at weld end instruction. For weld start

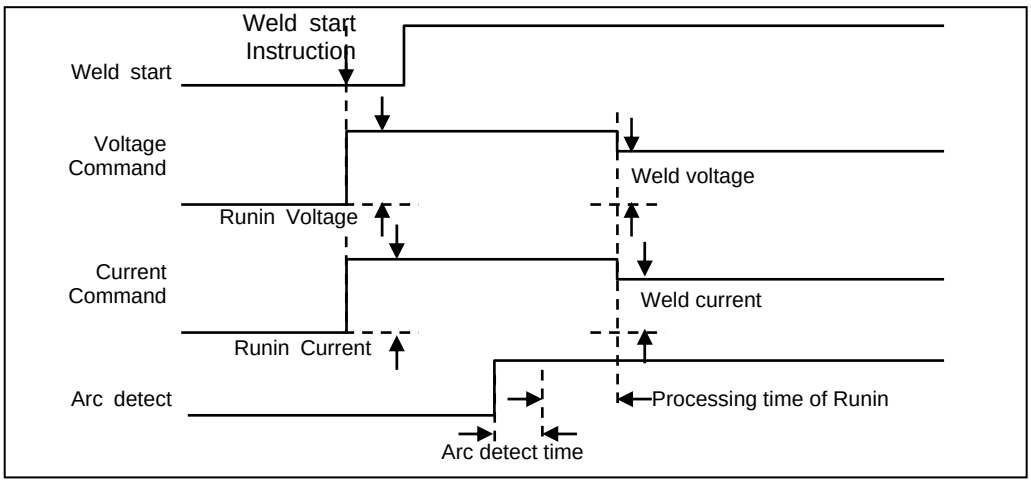


Fig. 3.5.6 (a) Runin process

Craterfill Process

Craterfill process keeps off generating crater hole by decreasing voltage and current command at arc weld ending. The weld schedule assigned at weld end instruction is used as craterfill process schedule.

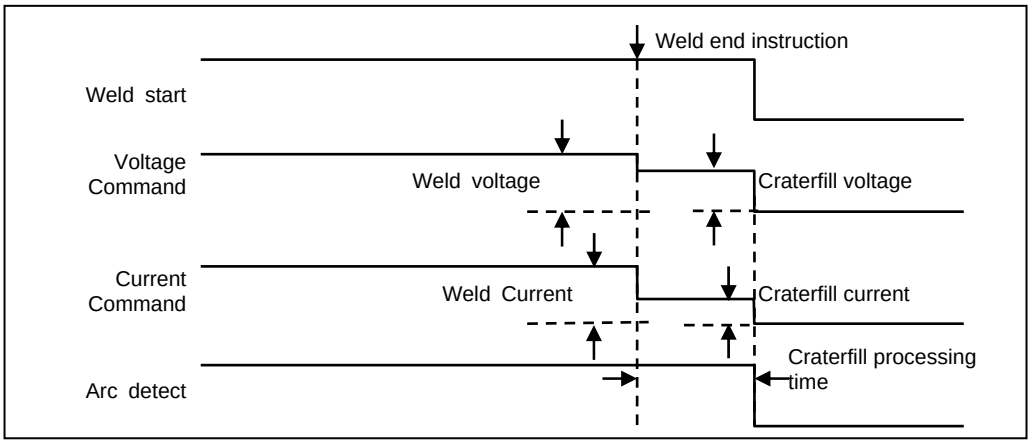


Fig. 3.5.6 (b) Craterfill process

Burnback Process

Burnback process keep off wire deposits a work by applying voltage during a specified time after wire feed ending. To use the function, set it enabled at weld procedure setup.

Procedure 3-14 Setup burnback process

Step

1 Press [DATA] key.
2 Press F1[TYPE] and select “1 Weld Procedure”.
3 Move cursor on “Procedure” and press ENTER key.
4 Move cursor on “Burnback” and press F4 “ENABLED” key.
5 Move cursor on “Schedule” and press ENTER key.
6 If Burnback process is enabled, the schedule appears at next of the last weld schedules.

```
DATA Weld Procedure                    1
                                                 1/10
 + Procedure                    1 [                ]
    -  Schedules
 Schedule #   Volts    Amps    Speed     Time
 …
 Schedule 3    20.0   200.0     20.0     0.00
 Burnback      20.0     0.0              0.10
 Wirestick     20.0     0.0              0.10
 OnTheFly       0.1     5.0      1.0
 [ TYPE ]  DETAIL  [CMND]  [VIEW]  HELP
```

Table 3.5.6 (b) Configurations of Burnback process

Items	Descriptions
Burnback Voltage	Set voltage command to power supply unit at Burnback process(V)
Burnback Current	Not used
Time(sec)	Processing time of burnback process executed at finished wire feed.

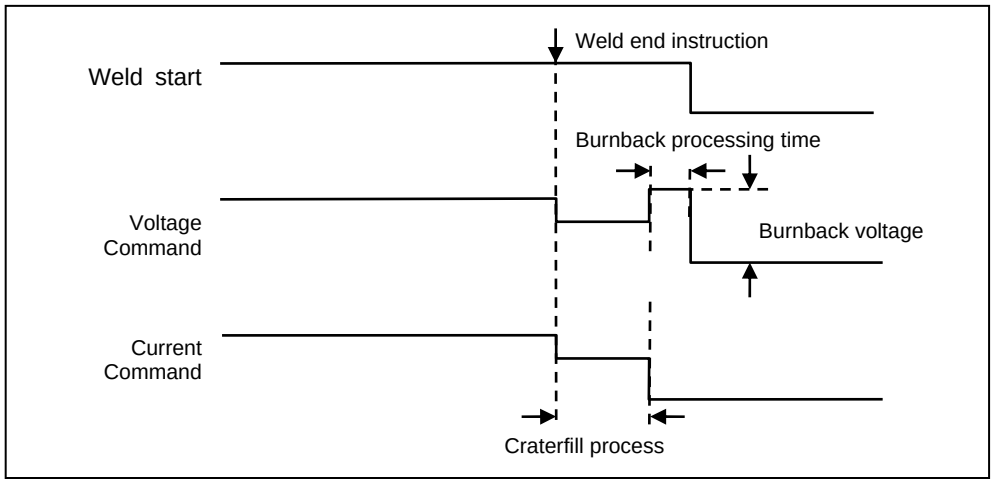


Fig. 3.5.6 (c) Burnback process

When control method of power supply uses wire feed speed as command, wire retract process has been supported if “Feed forward/backward” is enabled. In that case, the screen displayed at Step 6 of Procedure 3-14 is changed as following.

```
DATA Weld Procedure                    1
                                                 1/10
 + Procedure                  1 [                ]
    -  Schedules
 Schedule #   Volts     WFS    Speed     Time
 …
 Schedule 3    20.0   200.0     20.0     0.00
 Burnback      20.0     0.0              0.10
 Wirestick     20.0     0.0              0.10
 OnTheFly       0.1     5.0      1.0
 [ TYPE ]  DETAIL  [CMND]  [VIEW]  HELP
```

Table 3.5.6 (c) Configurations of Burnback process

Items	Descriptions
Burnback Voltage	Set voltage command to power supply unit at Burnback process.(V)
Burnback Wire feed speed	Set wire retract speed by the command is set to negative value.(IPM, cm/min, mm/sec)
Time(sec)	Processing time of burnback process executed at finished wire feed.

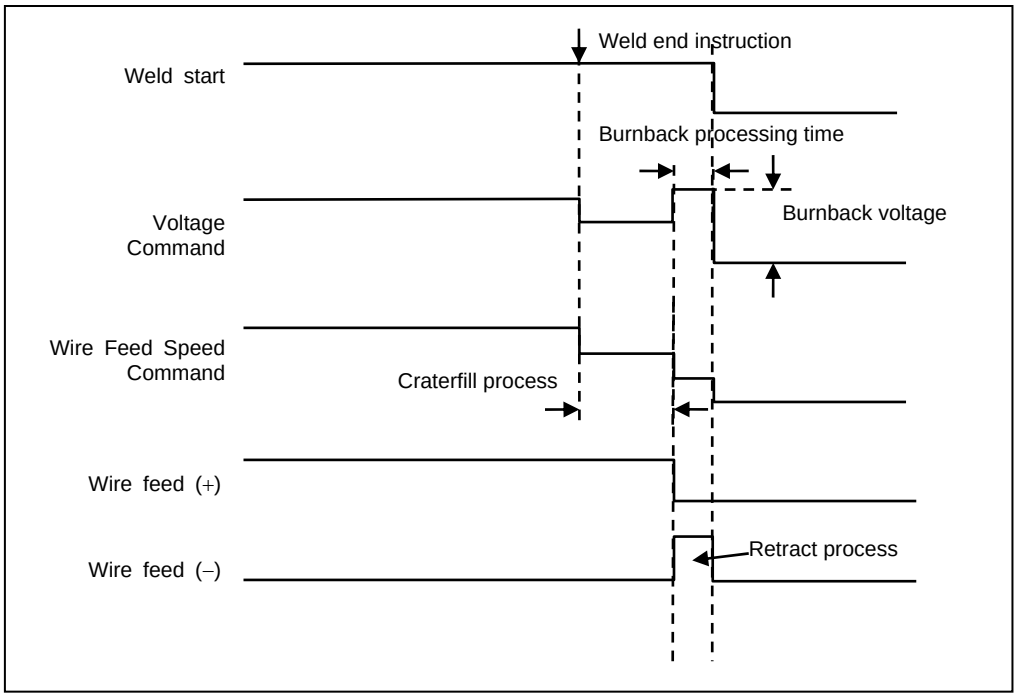


Fig. 3.5.6 (d) Wire retract process

Wirestick Reset

Automatic wirestick reset process burns out wire deposited a work by applying voltage a few time. To use the function, set wirestick monitoring function enabled at arc weld system setup and “wirestick reset” enabled at weld procedure setup.

Procedure 3-15 Setup wirestick reset process

Step

1 Press [DATA] key.
2 Press F1[TYPE] and select “1 Weld Procedure”.
3 Move cursor on “Procedure” and press ENTER key.
4 Move cursor on “Wirestick” and press F4 “ENABLED” key.
5 Move cursor on the number of “Wirestick” line and input the number of wirestick reset tries.
6 Move cursor on “Schedule” and press ENTER key.

7 If Wirestick reset process is enabled, the schedule appears at below of the last weld schedules.

```
DATA Weld Procedure                    1
                                                 1/10
 + Procedure                    1 [                ]
    -  Schedules
 Schedule #   Volts    Amps    Speed     Time
 …
 Schedule  3    20.0   200.0     20.0     0.00
 Wirestick      20.0     0.0              0.10
 OnTheFly        0.1     5.0      1.0
   [ TYPE ]  DETAIL  [CMND]  [VIEW]  HELP
```

Table 3.5.6 (d) Configurations of wire stick reset process

Items	Descriptions
Wirestick reset Voltage	Set voltage command to power supply unit at wirestick reset process(V).
Wirestick reset Current	Not used.
Time(sec)	Processing time of wirestick process executed at welding has been finished.

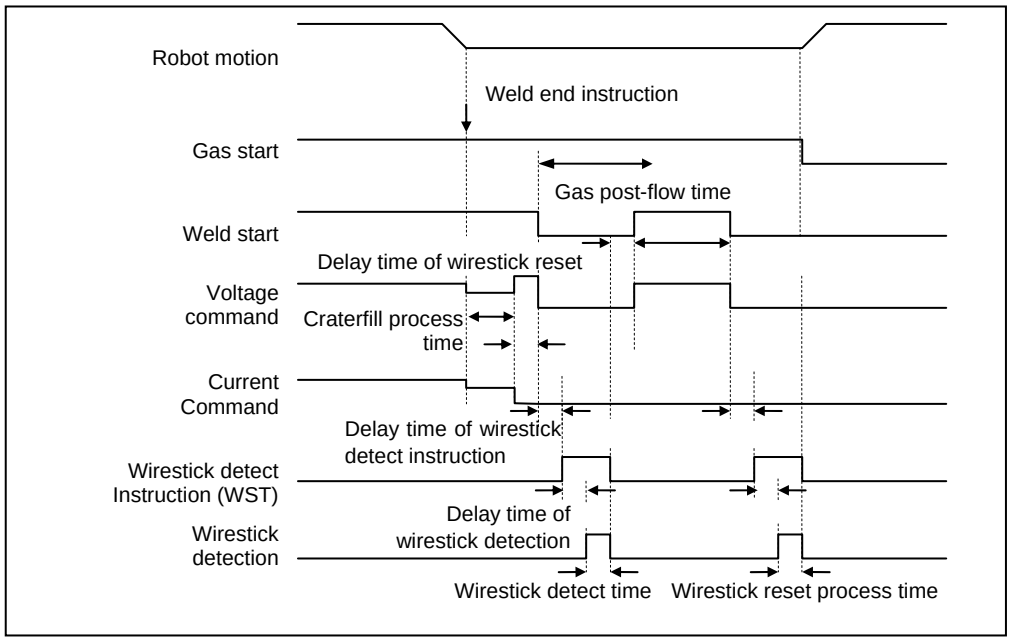


Fig. 3.5.6 (e) Automatic wirestick reset process

On-the-Fly Function

On-the-Fly function provides a fine adjustment of weld voltage, current and welding speed with function key while welding. The configurations specify the increase-decrease value by pressing function key at once.

Procedure 3-16 Setup On-the-Fly function

Step

1 Press [DATA] key.
2 Press F1[TYPE] and select “1 Weld Procedure”.
3 Move cursor on “Schedule” and press ENTER key.
4 The On-the-Fly configurations appear at the last weld schedules list.

```
DATA Weld Procedure                    1
                                                  1/10
 + Procedure                  1 [                 ]
    -  Schedules
 Schedule #   Volts    Amps    Speed     Time
 …
 Schedule  3    20.0   200.0     20.0     0.00
 Wirestick      20.0     0.0              0.10
 OnTheFly        0.1     5.0      1.0
 [ TYPE ]  DETAIL  [CMND]  [VIEW]  HELP
```

Table 3.5.6 (e) The configurations of On-The-Fly

Items	Descriptions
Voltage	Set increase-decrease voltage by single function key press on On-the-Fly screen(V)
Current	Set increase-decrease current by single function key press on On-the-Fly screen(A)
Speed	Set increase-decrease robot speed by single function key press on On-the-Fly screen (cm/min). This value must be between 1.0cm/min to 10.0cm/min. If the value is more than 10.0, it treats as 10.0cm/min. If “Weld Speed Unit” at ArcTool Setup isn’t cm/min, the increase-decrease value becomes 5 % of original welding speed.

3.5.7 Function Key Features for Weld Procedure

Weld procedure main screen

```
DATA WELD PROCEDURE
                                                  1/30
  - Procedure                  1 [                 ]
     Weld equipment:           1
     Manufacturer:             General Purpose
     Model:                    MIG(Volts, Amps)

     On the Fly          0.1      5.0      0.1
[TYPE]  DETAIL  [CMND]  [VIEW]  HELP
```

Table 3.5.7 (a) Features of function keys on weld procedure main screen

Items	Descriptions
Detail	When the cursor exists on tree-view character (“+”/”–”), expand/collapse the tree-view structure. When the cursor exists on a weld schedule, display detailed screen of the weld schedule.
Cmnd	Show the edit menu of weld procedure.
View	Show the display menu of weld procedure.

F3 key

```
CMND          1
1 Select WP
2 Create WP
3 Copy WP
3 Search
4 Copy Sch
5 Clear Sch
6 Delete WP
```

F4 key

```
VIEW          1
1 One/Many
2 Jump
3 Guide ON/OFF
3 Collapse
```

Table 3.5.7 (b) Features of menu in function key

Items	Descriptions
Select WP	Select Weld procedure data. By this instruction, several weld setup screens; weld I/O et.al, change to the selected weld procedure configurations.
Create WP	Create a new weld procedure data. It is possible to create any weld procedure number from 1 to 99 arbitrarily. It is impossible to create the weld procedure number that already exists. Single weld equipment can have up to 20 weld procedures.
Copy WP	Create a new weld procedure data based on the weld procedure on the cursor exists. If the new weld procedure number has been used, the creation is interrupted. Single weld equipment can have up to 20 weld procedures.
Search	Search the weld mode satisfied several conditions. To use it, weld equipment must support it.
Copy Sch	Copy the weld schedule on the cursor exists to specified weld schedules. The destination must exist in same weld procedure.
Clear Sch	Clear configurations of the weld schedule on the cursor exist.
Delete WP	Delete the weld procedure on the cursor exist.
One/Many	Select the number of displayed weld procedure on a window. “Many”: Show every weld procedure on a screen. Move cursor or use “Jump” function to show other weld procedure. “One”: Show a weld procedure on a screen. Users “Jump” function to show other weld procedure.
Jump	If the display type is “One”, Show the specified weld procedure data. If the display type is “Many”, Move cursor to the specified weld procedure data.
Guide ON/OFF	Switch enable/disable of weld procedure setup guide function (Please refer to Section 3.5.4).
Collapse	Collapse every expanded tree-view.

Weld procedure detailed screen for selected weld schedule

```
DATA Weld Procedure
                                                  1/6
 1 Weld Procedure     1[                          ]
 2 Weld Schedule      1[Schedule 1                ]
 3 Voltage:                            20.00  Volts
 4 Current:                            200.0  Amps
 5 Travel Speed:                        20.0  cm/min
 6 Delay time:                          0.00  sec
   Feedback Voltage                      0.0  Volts
   Feedback Current                      0.0  Amps

   [ TYPE ] SCHEDULE ADVISE
```

Table 3.5.7 (c) Features of function key

Items	Descriptions
SCHEDULE	Display specified weld schedule data

4 INSTRUCTIONS

This chapter shows arc instructions and weld speed instructions dedicated to Arc Tool Software.

4.1 ARC WELD INSTRUCTIONS

Arc weld instructions demonstrate how, where and when to execute arc welding. The domain between arc weld start instruction and arc weld end instruction becomes welding domain.

- Arc weld start instruction: Demonstrating start position/timing/procedure of arc welding.
- Arc weld end instruction: Demonstrating end position/timing/procedure of arc welding.

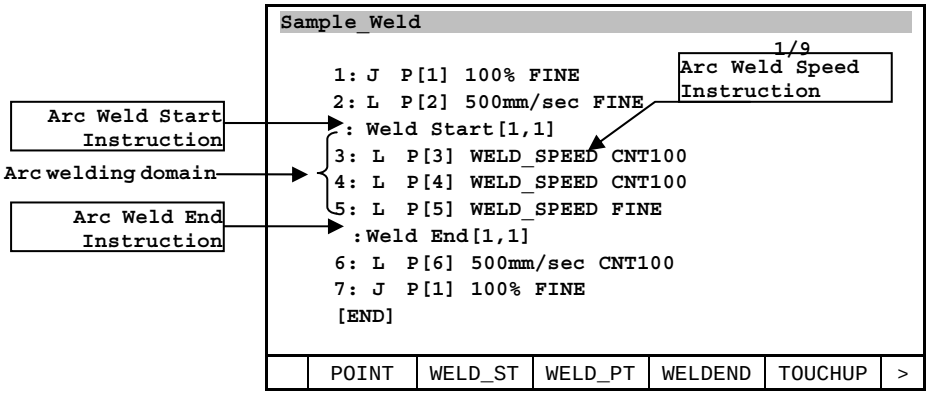


Fig. 4.1 Execute arc welding with arc weld start/end instruction

4.1.1 Arc Weld Start Instruction

Arc weld start instructions request to start arc welding or change the welding condition. ArcTool software has two formats of instructions.

- Weld Start [WP, i] : Use arc weld schedule defined at arc weld procedure.
- Weld Start [WP, V, A,…] : Use several conditions specified in TP program directly.

Weld Start [WP, i]

Weld Start [WP, i] instruction executes welding based on an arc weld schedule defined at an arc weld procedure.

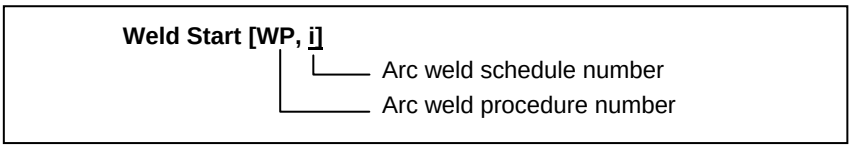
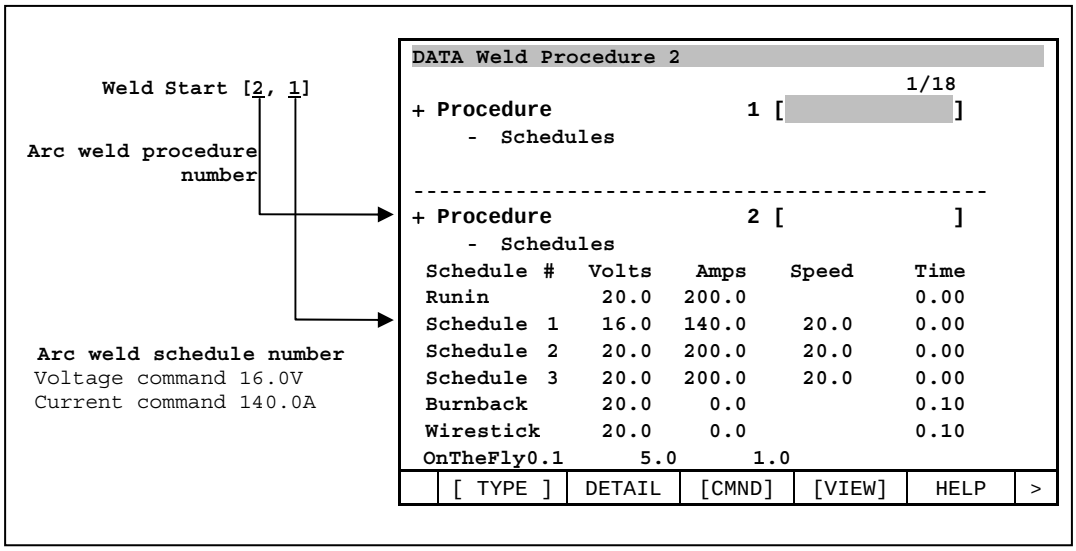


Fig. 4.1.1 (a) Arc weld start instruction at arc weld schedule format



⚠ CAUTION

Delay time is invalid at arc weld start instruction normally. However, it effects to welding condition when ArcTool ramping function or arc wait start function is enabled. Please set the time to 0.0 when it is not necessary.

Weld Start [WP, V, A,…]

Weld Start [WP, V, A,…] instruction executes welding based on the specified welding condition; voltage, current and/or wire feed speed et.al. directly.

The type and number of the conditions depends installed option, connecting weld equipment and the configurations of weld I/O.

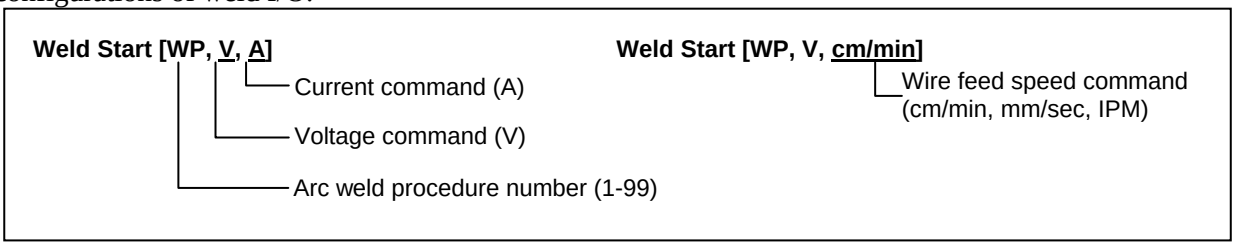


Fig. 4.1.1 (b) Arc weld start instruction at direct format

4.1.2 Arc Weld End Instruction

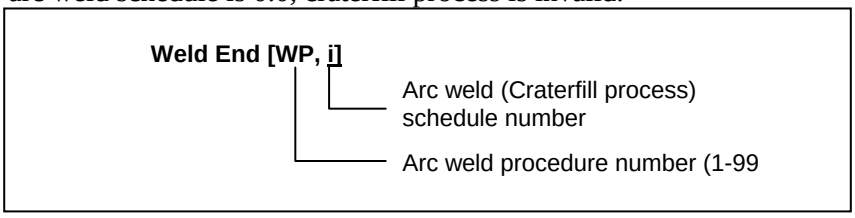
Arc weld end instructions request to finish arc welding.

- Weld End [WP, i] : Use arc weld schedule defined at arc weld procedure.
- Weld End [WP, V, A,…] : Use several conditions specified in TP program directly.

Weld End [WP, i]

Weld End [WP, i] instruction requests to execute craterfill process based on the specified arc weld schedule defined at the arc weld procedure and finish arc welding.

Craterfill process keeps off crater hole at weld ending by decreasing welding voltage and current. If the delay time of the arc weld schedule is 0.0, craterfill process is invalid.



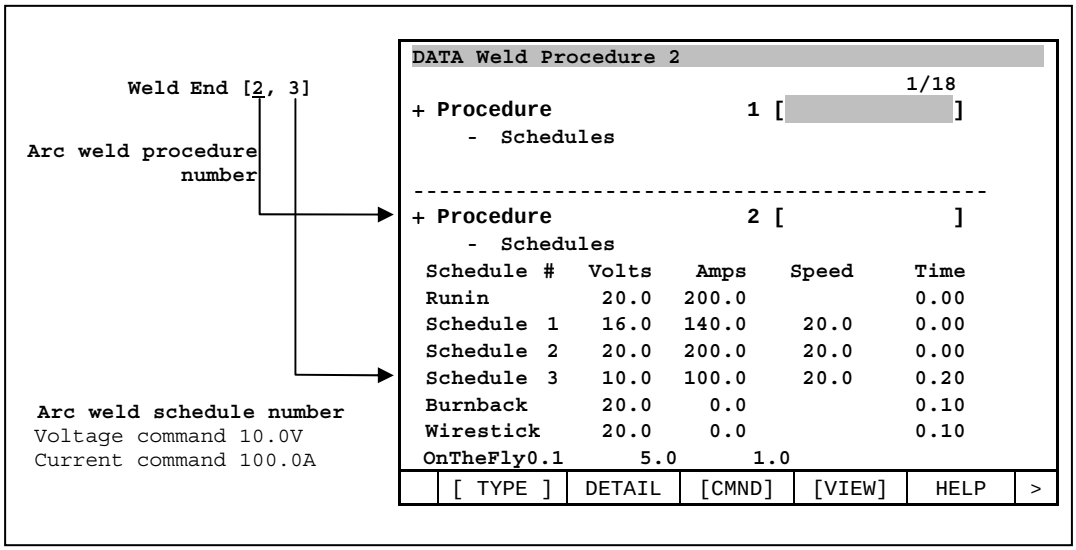


Fig. 4.1.2 (a) Arc weld end instruction at arc weld schedule format

Weld End [WP, V, A, sec]

Weld End [WP, V, A, sec] instruction requests to execute craterfill process based on the specified conditions on the TP program directly and finish arc welding.

The type and number of the conditions depends installed option, connecting weld equipment and the configurations of weld I/O.

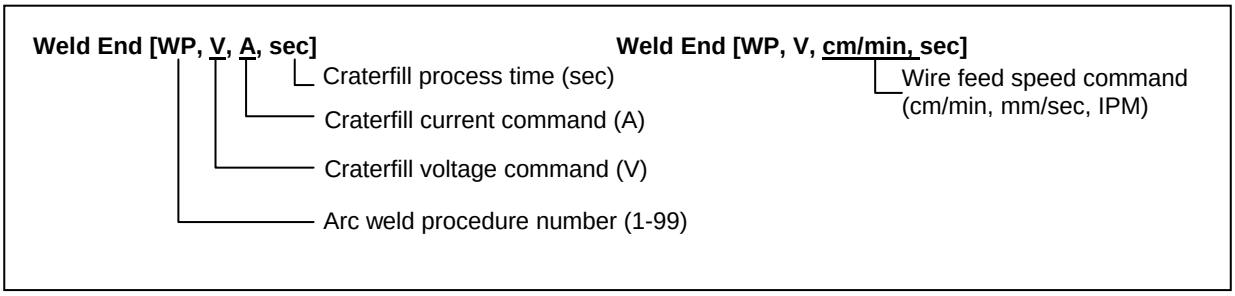


Fig. 4.1.2(b) Arc weld end instruction at direct format

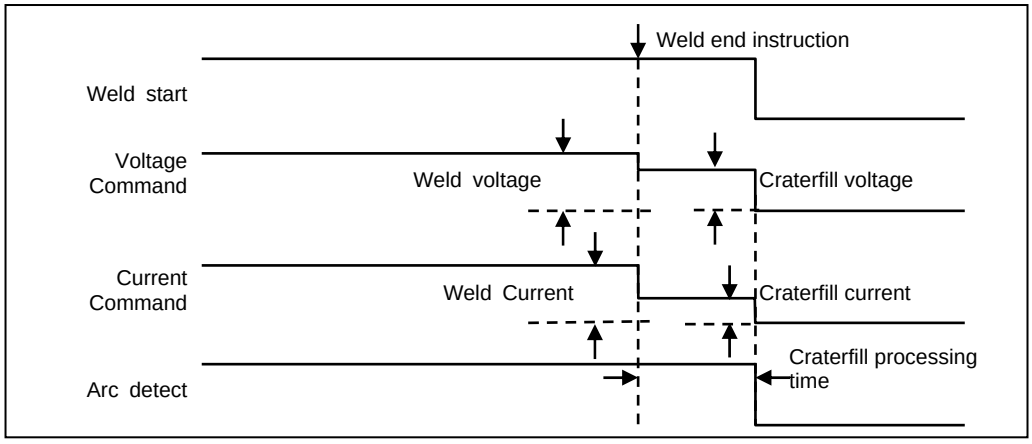


Fig. 4.1.2 (c) Sequence of craterfill process

4.1.3 Teaching Arc Instructions

Arc instructions have two type teaching ways as followings. Arc welding sequence depends on the type. Please refer to Subsection 3.1.2

- Additional motion instruction type
- Single instruction type

Additional Motion Instruction Type

This type is taught by using standard arc instruction (F2”WELD_ST”key and F4”WELDEND” key) (Refer to Step 1-4 in Procedure 4-1.)

- F2”WELD_ST”: Show additional motion instruction type standard arc instructions that include arc start instruction as following.

```
                    Weld Start def menu 1
1 J P[] 40% FINE Weld Start[1,1]
2 J P[] 100% FINE Weld Start[1,1]
3 L P[] 250cm/min FINE Weld Start[1,1]
4 L P[] 100.0inch/min FINE Weld Start[1,1]
```

Fig. 4.1.3 (a) Menu of default weld start instruction

- F4”WELDEND”: Show additional motion instruction type standard arc instructions that include arc end instruction as following.

```
                      Weld End def menu 1
1 L P[] WELD_SPEED FINE Weld End[1,1]
2 L P[] 50cm/min FINE Weld End[1,1]
3 L P[] 20.0inch/min FINE Weld End[1,1]
4 L P[] 8mm/sec FINE Weld End[1,1]
```

Fig. 4.1.3 (b) Menu of default weld end instruction

Moreover, teach as additional motion instruction to an existing motion instruction. (Refer to Step 6-7 in Procedure 4-1.)

> ⚠ **CAUTION**
> When an arc weld instruction is taught with offset instruction, tool compensation and/or coordinated motion instruction, the arc weld instruction must be after them.
> Correct: L P[1] 250cm/min FINE Offset Weld Start[1,1]
> Failure : L P[1] 250cm/min FINE Weld Start[1,1] Offset

Single Instruction Type

Teach as single instruction. Please refer to Procedure 4-2.

Please satisfy the followings when you teach arc weld instruction.

- Use FINE as terminal type for the approach motion to weld start position.
- Don’t use joint motion for welding motion and approach motion to weld end position.
- Use CNT as terminal type for welding motion to welding relay point.
- Use FINE as terminal type for the approach motion to weld end position.
- Use suitable torch angle for the welding.
- Use suitable weld condition.

Procedure 4-1 Teach as Additional motion instruction type

Condition

- Program edit screen has been displayed
- Teach pendant is enabled

Step (In the case of arc weld start instruction)

1 Press F2“WELD_ST” key. The following list appears.

```
                    Weld Start def menu 1
1 J P[] 40% FINE Weld Start[1,1]
2 J P[] 100% FINE Weld Start[1,1]
3 L P[] 250cm/min FINE Weld Start[1,1]
4 L P[] 100.0inch/min FINE Weld Start[1,1]
```

2 Select the most similar motion instruction you would like to teach in 1-4. The instruction is added to the program.

```
Sample1
                                        1/2
      1: L P[] 250cm/min FINE
        :  Weld Start[1,1]
    [END]

   | POINT | WELD_ST | WELD | WELDEND | TOUCHUP | >
```

3 Change the robot speed, the arc weld procedure and the arc weld schedule number.

4 If you would like to use register as the arc weld procedure number and/or arc weld schedule number, Move cursor on the condition and press F1“REGISTER”, the condition changed to register format and enter the register number you would like to use.

5 If you would like to specify each condition on TP program directly, move cursor on the weld procedure number or weld schedule and press F3”VALUE”, the arc weld start instruction changes to direct format.

```
Sample1
                                        1/2
      1: L P[] 250cm/min FINE
        :  Weld Start[1,1]
    [END]

   | REGISTER |  | VALUE | [CHOICE] |  |
```

6 If you would like to use normal arc weld schedule format(initial format) from register format or direct format, move cursor on the condition and press F2”SCHED”, the instruction change to the format.

```
Sample1
                                        1/2
      1: L P[] 250cm/min FINE
        :  Weld Start[0, 0.00Volts,0.0Amps]
    [END]

   | REGISTER | SCHED |  | [CHOICE] |  |
```

7 When additional motion instruction is taught without standard arc instruction, move cursor the end of motion instruction you would like to append and press F4 [CHOICE], the following menu will appear and select “Weld Start []”

```
  Motion modify 1
1 No option
2 Weld Start[]
3 Weld End[]
4 ACC
5 Skip, LBLB
6 BREAK
7 Offset/Frames
8 --Next page--
```

Fig. 4.1.3 (c) Menu of motion appending instructions

8 Select welding condition with steps 3, 4, 5, and 6.
9 Arc weld end instruction also can be appended as the same procedure of arc weld start instruction.

Procedure 4-2 Teach as single type arc instruction

Condition

- Program edit screen has been displayed
- Teach pendant is enabled

Step (In the case of arc weld start instruction)

1 Move the cursor on the "[END]" or line number of the program and press NEXT key and F1 [INST] key. The following menu will appear.

```
  Instruction 1
1 Arc
2 Register
3 I/O
4 IF/SELECT
5 WAIT
6 JMP/LBL
7 CALL
8 --next page--
```

Fig. 4.1.3 (d) Menu of single instructions

2 Select "Arc" the following menu appears.

```
          Arc 1
1 Weld Start[]
2 Weld End[]
3
4
5
6
7
8
```

3 Select "Weld Start []". Specify the welding condition. Please refer to Step 3-6 of Procedure 4-2
4 Arc weld end instruction also can be taught as the same procedure of arc weld start instruction.

Change the welding condition while welding

Arc weld start instruction provides to change welding condition while welding by taught the instruction arc welding domain (between arc weld start instructions – arc weld end instruction).

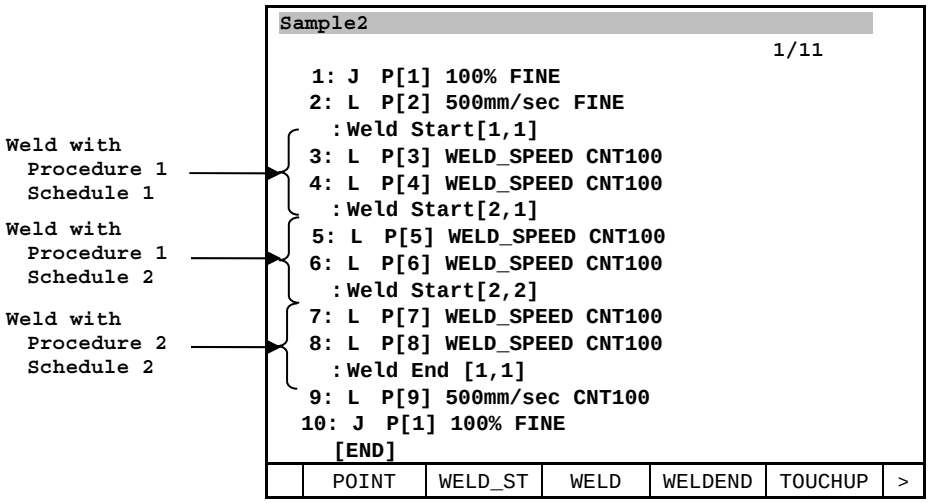
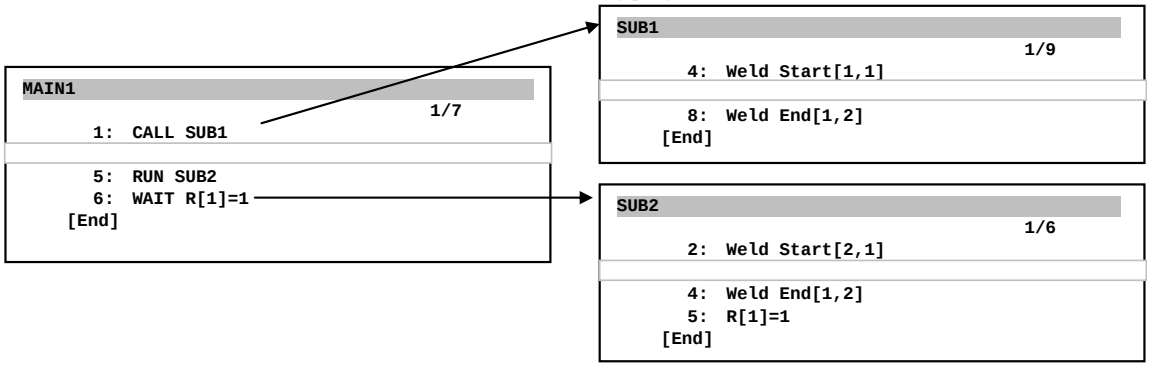


Fig. 4.1.3 (e) The arc schedule applied ranges

⚠CAUTION

As the following figure, if a program executes a sub program that includes arc instructions by RUN instruction (refer to Section 4.15 or Section 9.13 in OPERATOR'S MANUAL (Basic Operation) (B-83284EN)) after executing the other sub program that includes arc instructions by CALL instruction (refer to Subsection 4.7.3 in OPERATOR'S MANUAL (Basic Operation) (B-83284EN)), the program which has Weld Start/End instructions cannot be executed by multi task. In this case, the sub program stops and ARC-034 alarm occurs.

Cannot execute the following program.



At above case, use CALL instruction only for the program which has Weld Start/End instructions, or use RUN instruction for multi task execution.

4.1.4 Teaching Weld ID

When Weld ID is Enabled, Weld ID is added to the last index of Weld End instruction with "WID:" string. It is possible to input arbitrary Weld ID number on "WID" index.
Followings are examples of Weld End instruction which includes Weld ID.

Weld End [WP, i, WID:xx]
└ Weld ID number(0 to 32627)

Weld End [WP, V, A, … , sec, WID:xx]
└ Weld ID number(0 to 32627)

Example
```
1:Weld End [1, 3, WID:10]
2:Weld End [1, 195.0A, 20.00V, 0.50sec, WID:1211]
```

NOTE

It is not allowed to use same Weld ID number in one program. When the same ID number is input in Weld End Instruction, "ARC-139 Weld ID i is already used" message is posted and the ID number is returned to original value automatically.

4.1.5 Related View for Weld Procedure

When indirect arc weld instructions (those specifies the weld procedure number and weld schedule number) are taught, user can confirm the weld procedure and weld schedule information those are specified by arc weld instructions at the current cursor position in the program edit screen by displaying the related view screen.

Procedure 4-3 Display the related view screen for weld procedure

Condition

- Program edit screen has been displayed.
- Teach pendant is enabled.

Step

1 For example, the program named A_TEST is displayed as shown in following screen.

```
A_TEST
                                        1/7
      1: J P[1] 100% FINE
      2: L P[2] 100mm/sec FINE
         Weld Start[1,1]
      3: L P[3] 200cm/min CNT100
         Weld Start[1,2]
      4: L P[4] 200cm/min FINE
         Weld End[1,3]
      5: L P[5] 100mm/sec CNT100
      6: J P[1] 100% FINE

  | POINT | WELD_ST | WELD | WELDEND | TOUCHUP | >
    [INST]                              [EDCMD]
```

2 Please press the FCTN key with holding the *i* key. Following menu is displayed. Please select the [Weld Procedure] from the Related Views menu.

```
      DISPLAY  1
1 Related Views
```

```
  Related Views 1
1 4D Edit Node Map
2 Weld Procedure
```

3 As shown following screen, three screens are displayed. When the cursor position is in arc weld instructions in the left side screen (program edit screen), the weld procedure and the weld schedule information those are specified by arc weld instructions at the current cursor position are displayed at right side screens.

Upper right side screen : Weld procedure information specified by the arc weld instructions
Lower right side screen : Weld schedule information specified by the arc weld instructions

```
A_TEST                                   i
                                        2/7
    1:J  P[1] 100% FINE
    2:L  P[2] 100mm/sec FINE
     :  Weld Start E1[1,1]
    3:L  P[3] 200cm/min CNT100
     :  Weld Start E1[1,2]
    4:L  P[4] 200cm/min FINE
     :  Weld End E1[1,3]
    5:L  P[5] 100mm/sec CNT100
    6:J  P[1] 100% FINE
[End]

Enter schedule number.
```

```
DATA Weld Procedure  1                  1/9
  + Procedure        1 [                 ]
    + Mode          18 [                 ]
    - Schedules

  Schedule    Volts    Amps  Speed  Time
  Schedule  1   21.0  201.0  101.0  0.00
  Schedule  2   22.0  202.0  102.0  0.00
  Schedule  3   23.0  203.0  103.0  0.00
  Burnback     130.0   16.0         0.03
```

```
DATA Weld Procedure                     3/7
  2 Weld Schedule    1 [Schedule         ]
  3 Voltage                 21.00 Volts
  4 Current                201.0 Amps
  5 Wave Control            0.00 Wave
  6 Travel speed           101.0 cm/min
  7 Delay Time              0.00 sec
    Feedback Current         0.0 Amps
    Feedback Voltage         0.0 Volts
```

```
| REGISTER |  | VALUE | [CHOICE] |
```

> ⚠ **CAUTION**
> When the displaying is switched to the another screen as much as one in three screens during displaying the related view screen, the weld procedure and the weld schedule information those are specified by arc weld instructions at the current cursor position are not updated at right side screens. In such case, please execute the above-mentioned procedure again.

4.2 WELD SPEED INSTRUCTION

Weld speed instruction can be set a weld speed (refer to Subsection 3.5.3) on arc weld schedule. Therefore, weld schedule can manage voltage command, current command and robot speed command collectively and it is not necessary to change speed each time the welding motion has been taught.

```
Sample 1
                                        1/2
      1: L P[1] 250cm/min FINE
         Weld Start[0,0.00Volts, 0.0Amps]
    [END]
|  |  REGISTER | WELD | [CHOICE] |  | > |
```

↓

```
Sample 1
                                        1/2
      1: L P[1] WELD_SPEED FINE
         Weld Start[0,0.00Volts, 0.0Amps]
    [END]

|  |  REGISTER | WELD | [CHOICE] |  | > |
```

When “WELD_SPEED” instruction is taught, the robot moves the speed defined at arc weld schedule. Additionally, the unit of weld speed instruction can be set on ArcTool Setup screen (refer to Section 3.2). Under the following conditions, robot moves with the speed set on ArcTool Setup screen or Weld System Setup screen, not with the speed on arc weld schedule.

- Single step mode
- When motion instruction that has weld speed instruction is executed without the execution of Weld Start instruction
- Backward motion

Program sample:

```
12: L P[10] 500mm/sec FINE Weld Start[1,1]
13: L P[11] WELD_SPEED CNT100
14: L P[12] WELD_SPEED CNT100
15: L P[13] WELD_SPEED FINE Weld End[1,1]
```

The robot speed at line 13, 14 and 15 becomes Weld speed defined at schedule 1 of procedure 1.

Even if the robot speed has been changed by On The Fly function (refer to chapter 17) at line 2 on the following program, the robot speed at line 3 becomes old value before adjustment.

```
1: L P[1] 500mm/sec FINE Weld Start[1,1]
2: L P[2] WELD_SPEED CNT100
3: L P[3] WELD_SPEED CNT100
```

⚠WARNING
When weld speed instruction is used, operator cannot confirm the actual robot speed command as register format speed. Therefore, a robot may move as unexpected speed if a wrong value is set. Please check that the defined weld speed at weld schedule is appropriate before starting the program.

⚠WARNING
At the following situations, the speed defined at arc weld system setup or ArcTool setup is used as robot speed. Please take care to run the program.
- Single step mode
- When motion instruction that has weld speed instruction is executed without the execution of Weld Start instruction
- Backward motion

⚠WARNING
When you change the weld speed on Weld System Setup screen, Please execute cycle power. Otherwise, a robot may move as unexpected speed.

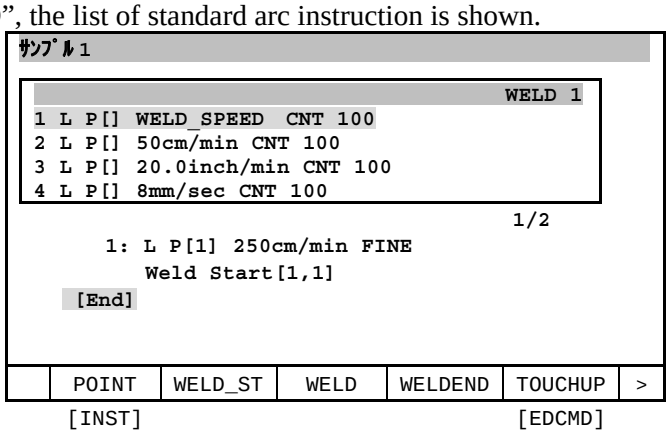
4.2.1 Teach WELD SPEED Instruction

WELD SPEED instruction can be taught by F3 “WELD” and a existing speed of motion can be changed to WELD SPEED instruction.

Procedure 4-4 Teach weld speed instruction

Condition
- Program edit screen has been displayed.
- Teach pendant is enabled.

Step
1 Press F3”WELD”, the list of standard arc instruction is shown.



2 Select a motion instruction which includes WELD_SPEED instruction. The instruction is added to the TP program.

```
ｻﾝﾌﾟﾙ1
                                        1/3
      1: L P[1] 250cm/min FINE
         Weld Start[1,1]
      2: L P[2] WELD_SPEED CNT100
    [END]

   | POINT | WELD_ST | WELD | WELDEND | TOUCHUP | >
    [INST]                              [EDCMD]
```

3 To change exiting motion instruction to WELD_SPEED instruction, Move cursor speed command of motion you would like to change it to weld speed command and press F3 “WELD” key or speed command of motion you would like to change it to weld speed command.

```
Sample1
                                        1/2
      1: L P[1] 250cm/min FINE
         Weld Start[1,1]
      2: L P[2] 50cm/min CNT 100
    [END]

   |        | REGISTER | WELD | [CHOICE] |        | >
```

```
Sample1
                                        1/2
      1: L P[1] 250cm/min FINE
         Weld Start[1,1]
      2: L P[2] WELD_SPEED CNT100
    [END]

   |        | REGISTER | WELD | [CHOICE] |        | >
```

Users can customize the standard arc instruction.

Procedure 4-5 Customize the standard instruction

Condition

- Program edit screen has been displayed
- Teach pendant is enabled

Step (In the case of arc weld start instruction)

1 Press F2 “WELD_ST”key.

2 Press F2 “ED_DEF” key, the following edit screen appears.

```
Start default
                                        1/4
      1: J P[] 40% FINE
         Weld Start[1,1]
      2: J P[] 100% FINE
         Weld Start[1,1]
      3: L P[] 250cm/min FINE
         Weld Start[1,1]
      4: L P[] 100.0inch/min
         Weld Start[1,1]

   |        |        |        |        | DONE | >
```

3 Edit each instruction (motion type, robot speed, terminal type and additional instructions et.al.).

4 If the edit has been finished, press F5 “DONE” key.

5 MANUAL OPERATION AND PROGRAM EXECUTION

This chapter shows how to control arc weld system and execute arc welding program.

5.1 MOVING THE ROBOT BY JOG FEED

The robot moves by jog feed when the jog keys on the teach pendant are pressed. The robot must be moved to a target position when motion instructions are specified in the program. About the detailed explanation for moving the robot by jog feed, please refer to Subsection 5.2.3 in OPERATOR'S MANUAL (Basic Operation) (B-83284EN).
However, in the ArcTool, feed rate override is changed by the override key operation as shown in Table 5.1.

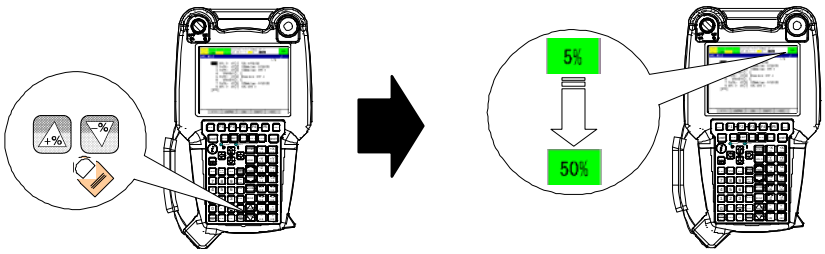


Fig. 5.1 Setup of Override

Table 5.1 Feed rate override for ArcTool

Override key	VFINE → FINE → 1% → 5% → 100% In 1% increments In 5% increments
Shift key + Override key	VFINE → FINE → 5% → 25% → 50% → 100%

In ArcTool, [Shift key + Override key] operation is enabled as the standard setting.

5.2 WIRE FORWARD/BACKWARD INCHING

Manual Wire Inching

Manual wire forward/backward inching can be achieved without program execution. The process is executed with key pressing or weld output signal as the following procedure.

Procedure 5-1 Manual wire forward/backward inching

Condition

- Every weld configuration has been setup correctly.
- Teach pendant is enabled.

Step

1 Press and hold down the deadman swtich, then turn on the teach pendant enable switch.
2 By pressing WIRE+key, wire forward inching starts. Wire is feeding forward while the key is pressing. The wire feeding speed is defined at "WIRE+ WIRE– speed" on arc weld equipment setup.
3 By pressing WIRE– key, wire backward inching start. Wire is feeding backward while the key is pressing. The wire feeding speed is defined at "WIRE+ WIRE– speed" on arc weld equipment setup.

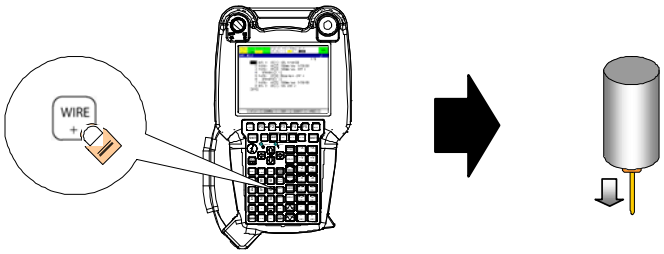


Fig. 5.2 Manual Wire Inching

4 When WIRE+ key has been pressed with shift key for 2sec or more, the wire feed speed automatically changes to higher speed defined as “HIGH WIRE+ speed” at arc weld equipment setup.

5 If “Inch forward”/“Inch backward” at Weld input are assigned correctly, operators can control the wire feeding from weld input.
Until “Inch forward” is on, the controller requests feeding wire forward with “WIRE+ WIRE– speed”, Otherwise, until “Inch backward” is on, the controller requests feeding wire backward with “WIRE+ WIRE– speed”. The speed is never changed to “HIGH WIRE+ speed”.

NOTE
Since 7DC2 (V8.20) series software, it is possible to perform the manual wire inching with AUTO mode and Teach Pendant disable.

NOTE
It is possible to change the wire forward/backward feeding speed at the setting item of [WIRE+ WIRE- speed] (this specifies the speed in Step 2, 3, 5) and [High WIRE+ speed] (this specifies the speed in Step 4) in SETUP Weld Equipment screen.

Remote Wire Inching

Remote wire inching function is the function to execute the wire inching (forward / backward) by the external input signal. When you use this function, wire inching can be executed without teach pendant.

Remote wire inching speed and manual wire inching (using teach pendant) speed can be independently set. If you would like to use this function, please execute the following setting procedure.

Procedure 5-2 Setup Remote Wire Inching Function

Step

1 Press [MENU] key and select “6. SETUP”. and press F1[TYPE] key and select “Weld System”, Weld System Setup screen is displayed. Move a cursor to the bottom and then the following screen will be displayed.

```
SETUP Weld System                                  .
                                        20/22
   Weld Speed Function
    16 Default speed:                   100 cm/min
   Other Functions
    17 On-The-Fly:                      ENABLED
    18 Weld from teach pendant:         ENABLED
    19 Remote gas purge:                DISABLED
    20 Remote wire inch:                DISABLED
    21 Gas purge key:                   ENABLED
    22 Gas purge time:                  5     sec

   [ TYPE ]                             ENABLED  DISABLED
```

2 Move cursor on “Remote wire inching”, when it needs to be enabled, press F4 “ENABLED” .
3 Next, assign the input signal. Press [MENU] key and select “5 I/O” and Press F1[TYPE] key and select “Weld”. Either Weld Input screen or Weld Output screen is displayed.
4 When Weld Output screen is displayed, press F3[IN/OUT] and change to Weld Input screen.

```
I/O Weld Input                                  .
                                        11/16

   4 [Arc detect      ] DI[   1] U  OFF
   5 [Gas fault       ] DI[   3] U  OFF
   6 [Wire fault      ] DI[   4] U  OFF
   7 [Water fault     ] DI[   5] U  OFF
   8 [Power fault     ] DI[   6] U  OFF
   9 [Wirestick       ] DI[   7] U  OFF

  10 [Arc enable      ]   [****] *  ***
  11 [Remote inch fwd ]   [****] *  ***
  12 [Remote inch bwd ]   [****] *  ***

   [TYPE]  HELP  IN/OUT  ON  OFF  >
```

5 “Remote inch fwd” and “Remote inch bwd” signals will be appeared at the bottom of Weld Input screen only when remote gas purge function is enabled at step 2 in the procedure.
6 Move cursor on “Remote inch fwd” and press NEXT key and F3 “Config”, the following screen is displayed.

```
I/O Weld Input                                  .
                                          1/2
     WELD SIGNAL        TYPE  #
   1 [Remote inch fwd]   ** [***]

   2 Polarity: NORMAL

   [TYPE]  MONITOR  VERIFY  [CHOICE]  HELP  >
```

7 Select signal type and number.
8 Press F3 “VERIFY” after press F2 “MONITOR” to check selected signal whether exists or not.
9 Assign “Remote inc bwd” with same steps (Refer to step.6 to 8)
10 Cycle power the controller. Selected signals are allocated after cycle power.
11 At last, setup remote wire feed speed. Press [MENU] key and select “6. Setup” and press F1[TYPE] key and select “Weld Equip”. Weld Equipment Setup screen is displayed.

```
SETUP Weld Equip                                .
                                          4/9
    Model:Lincoln Electric PowerWave+Enet

       Feeder         Gear
     1 AutoDrive 4R100 Std Spd (17T)

     2 WIRE+ WIRE- speed:          80 cm/min
     3 High WIRE+ speed:           500cm/min
     4 Remote wire inch speed:     80 cm/min
     5 Feed forward/backward:      ENABLED

   [TYPE]                                HELP
```

12 “Remote wire inch speed” will be appeared below on “High Wire+ speed” only when remote wire inching function is enabled in step 2. Input the speed of remote wire inching.
13 When “Remote inch fwd” signal becomes ON, wire feeding to forward, on the other hand, “Remote inch bwd” signal becomes ON, wire feeding to backward.

Wire Clamp Function

If a welding torch has a wire clamp mechanism, the wire clamp mechanism is automatically controlled by this function when following operations are performed.

- Manual wire inching
- Remote wire inching (only the software since V8.30P/21)
- Wire inching by torch mate function (only the software since V8.30P/21)

The outline of this function is shown below.

- When the above-mentioned operations are started, wire clamping automatically becomes OFF. After that, wire inching starts.
- When the above-mentioned operations are ended, wire inching stops. After that, wire clamping automatically becomes ON.
- If welding program is executed with wire clamping ON, wire clamping automatically becomes OFF when weld start instruction is executed.
- Wire clamping does not become ON when welding program ends.
- Wire clamping becomes OFF at power ON.
- RO[1] (Robot Output I/O) is used as a clamp signal for controlling wire clamping ON/OFF in the standard setting. If necessary, it is possible to use I/O other than RO[1]. Please refer to Procedure 5-3.
- Enable / Disable of this function can be set to each weld equipments. If you want to use this function with a certain weld equipment excluding EQ1(the first weld equipment), please refer to Procedure 5-3 for setting the clamp signal.
- It is possible to operate the wire clamping ON/OFF by manual. Please operate the clamp signal directly.
- Wire clamp mechanism is operated by air. Supply 0.15 – 0.49MPa air to the air inlet of the robot J1 base back side.

It is necessary to perform the following procedure before using this function.

Procedure 5-3 Setup Wire Clamp Function

Step

1 Press [MENU] key and select “SYSTEM”.
2 Press F1[TYPE] and select “Variables”. SYSTEM Variables screen is displayed.
3 Move the cursor to $AWECUSTOM and press ENTER key.
4 Move the cursor to weld equipment number that controls the wire clamp mechanism and press ENTER key.
5 Move the cursor to $WIRE_CLAMP and press ENTER key.
6 Move the cursor to $ENABLE and press F4[TRUE] key. Confirm that the value is changed to TRUE.
7 Though RO[1] is used as clamp signal in standard setting, this is defined at $SIGNAL. The port type is set at $PORT_TYPE (Normally, it is not necessary to change this from 9 that means “RO”), and the port number is set at $PORT_NUM. Besides, following setting is normally performed in the case of multi equipment configuration.

Equipment Number	1	2	3	4
$PORT_TYPE	9 (= RO)	9 (= RO)	9 (= RO)	9 (= RO)
$PORT_NUM	1	9	17	25

8 Cycle power.

NOTE
- Do not execute wire clamp when wire is not inserted. I causes damage of parts.
- When this function is changed to disable from the state of clamping ON, clamp signal keeps leaving ON. Please turn it OFF by manual operation.

5.3 GAS PURGE

Manual Gas Purge

Manual gas purge function provides to flow gas without welding. It becomes easier to check the flow rate.

Procedure 5-4 Manual Gas Purge

Condition

- Every weld configuration has been setup correctly.
- Teach pendant is enabled.
- “Gas purge key” at Arc Weld System Setup is enabled.

Step

1 Press GAS/STATUS key with SHIFT key.

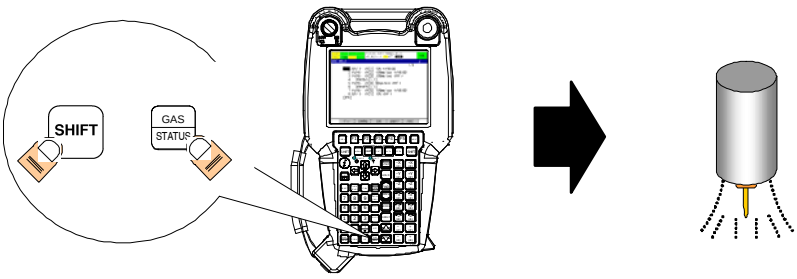


Fig. 5.3 Gas Check by Gas Purge Key Operation

2 There are 2 methods to stop the gas.
a. Press GAS/STATUS key with SHIFT key during the gas flowing.
b. Wait for “Gas purge time” at Arc Weld System Setup has been passed.

NOTE
Since 7DC2 (V8.20) series software, it is possible to perform the manual gas purge with AUTO mode and Teach Pendant disable.

Remote Gas Purge

Remote gas purge function is the function to execute the gas purge by the external input signal. When you use this function, gas check can be executed without teach pendant.

If you would like to use this function, please execute the following setting procedure.

Procedure 5-5 Setup Remote Gas Purge Function

Step

1 Press [MENU] key and select “6. Setup”. and press F1[TYPE] key and select “Weld System”, Weld System Setup screen is displayed. Move a cursor to the bottom and then the following screen will be displayed.

```
SETUP Weld System                                  .
                                        19/22
   Weld Speed Function
    16 Default speed:                    125 cm/min
   Other Functions
    17 On-The-Fly:                       ENABLED
    18 Weld from teach pendant:          ENABLED
    19 Remote gas purge:                 DISABLED
    20 Remote wire inch:                 DISABLED
    21 Gas purge key:                    ENABLED
    22 Gas purge time:                   5     sec

 [ TYPE ]                    ENABLED  DISABLED
```

2 Move cursor on “Remote gas purge”, when it needs to be enabled, press F4 “ENABLED” when it needs to be disabled press F5 “DISABLED”.

3 Next, assign the input signal. Press [MENU] key and select “5 I/O” and Press F1[TYPE] key and select “Weld”. Either Weld Input screen or Weld Output screen is displayed.

4 When Weld Output screen is displayed, press F3[IN/OUT] and change to Weld Input screen.

```
I/O Weld Input                                     .
                                        11/15

    4 [Arc detect     ] DI[   1] U  OFF
    5 [Gas fault      ] DI[   3] U  OFF
    6 [Wire fault     ] DI[   4] U  OFF
    7 [Water fault    ] DI[   5] U  OFF
    8 [Power fault    ] DI[   6] U  OFF
    9 [Wirestick      ] DI[   7] U  OFF

   10 [Arc enable     ] **[****] *  ***
   11 [Remote gas purge] **[****] *  ***

 [TYPE]   HELP   IN/OUT   ON   OFF   >
```

5 “Remote gas purge” signal will be appeared at the bottom of Weld Input screen only when remote gas purge function is enabled at step 2 in the procedure

6 Move cursor on “Remote gas purge” and press NEXT key and F3 “Config”, the following screen is displayed.

```
I/O Weld Input                                     .
                                         1/2
      WELD SIGNAL        TYPE  #
    1 [Remote gas purge]   ** [***]

    2 Polarity: NORMAL

 [TYPE]   MONITOR   VERIFY   [CHOICE]   HELP   >
```

7 Select signal type and number.

8 Press F3 “VERIFY” after press F2 “MONITOR” to check selected signal whether exists or not.

9 Cycle power the controller. After reboot it, selected signal is assigned as remote gas purge output signal.

10 When a signal is input through the signal assigned as remote gas purge signal (remote gas purge input signal becomes ON), robot request gas output signal and gas purge will be operated.

5.4 WELD ENABLE/DISABLE STATUS

Switching Weld Enable/Disable Status

In ArcTool, operators can switch Weld Enable/Disable mode. Arc welding is performed by the execution of Weld Start instruction with Weld Enable status. On the other hand, arc welding is not performed by the execution of Weld Start instruction with Weld Disable status.
However, arc welding is not performed with one of following situations even with Weld Enable status.

- Single Step Mode
- Group Motion (refer to Section 5.5) is disabled
- Dryrun (refer to Section 5.5) is enabled

The switching of Weld Enable/Disable status can be done by WELD ENBL key on Teach Pendant. It is also possible to switch it on Test Cycle screen.
The weld enable status can be changed even if welding is performing (Dynamic arc ON/OFF). If weld enable changes to enabled from disabled while welding, the arc generation stops and robot moves without welding and vice versa.

Procedure 5-6 Change Weld Enable status from key

Condition

- Every weld configuration has been setup correctly.

Step

1 Press WELD ENBL key with shift key then toggle the weld enable status. If the weld enable status becomes enabled, LED of weld enabled light up(green)).
2 When press WELD ENBL again, the LED becomes light out(yellow)

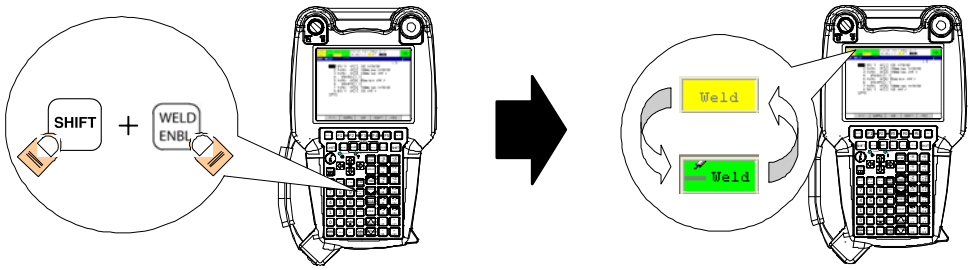


Fig. 5.4 Switching Operation of Weld Enabled/Disabled by WELD ENBL Key

Procedure 5-7 Change Weld Enable status from TP screen

Condition

- Every weld configuration has been setup correctly.

Step

1 Press [MENU] key.
2 Select “2. TEST CYCLE”.
3 Press F1[TYPE] and select “Arc Weld”, then the following screen appears.

```
TEST CYCLE Arc
                                        1/1
    1 Equipment1 ARC enable:        TRUE

  [ TYPE ]                                TOGGLE
```

4 Press F5 “TOGGLE” then toggle the weld enable status.

Switching Weld Enable/Disable Status by External Signal

When Remote Status (refer to Subsection 3.8 in OPERATOR’S MANUAL (Basic Operation) (B-83284EN)) is satisfied, you can switch Weld Enable/Disable status by external signal. Please refer to Procedure 5-8.

Procedure 5-8 Change Weld Enable status from Weld I/O

Condition

- Every weld configuration has been setup correctly.

Step

1 Press [MENU] key and select “5 I/O” and Press F1[TYPE] key and select “Weld”. Either Weld Input screen or Weld Output screen is displayed.

2 If Weld Output screen is displayed, press F3[IN/OUT] and change to Weld Input screen.

```
I/O Weld Input                                  .
                                   11/15

   4 [Arc detect     ] DI[   1] U  OFF
   5 [Gas fault      ] DI[   3] U  OFF
   6 [Wire fault     ] DI[   4] U  OFF
   7 [Water fault    ] DI[   5] U  OFF
   8 [Power fault    ] DI[   6] U  OFF
   9 [Wirestick      ] DI[   7] U  OFF

  10 [Arc enable     ] **[****] *  ***
  11 [Remote gas purge] **[****] *  ***

 [TYPE]  HELP  IN/OUT  ON  OFF  >
```

3 Move cursor on “Arc enable” and press NEXT key and F3 “Config”, the following screen is displayed.

```
I/O Weld Input                                  .
                                       1/2
     WELD SIGNAL        TYPE  #
   1 [Arc enable      ]   ** [***]

   2 Polarity: NORMAL

 [TYPE]  MONITOR  VERIFY  [CHOICE]  HELP  >
```

4 Select signal type and number.

5 Press F3 “VERIFY” after press F2 “MONITOR” to check selected signal whether exists or not.

6 Cycle power the controller. After reboot it, selected signal is assigned.

7 When Arc Enable signal is input with satisfying Remote Status (Arc Enable input signal becomes ON), the mode becomes Weld Enable Status. On the other hand, Arc Enable input signal becomes OFF, the mode becomes Weld Disable Status.

5.5 TEST CYCLE

Test cycle is used for conforming of robot before actual production. The configurations are specified at Test cycle setup screen.

Procedure 5-9 Setup test cycle

Step

1 Press [MENU] key.
2 Select “2 TEST CYCLE”, the following screen will appear.

```
TEST CYCLE Setup
                                        1/8
    Group 1(         M-10iA)
      1 Group Motion:            ENABLE
      2 Dry run:                 OFF
      3   Cart. dry run speed:   300  mm/sec
      4   Joint dry run speed:    25  %
      5   Jog dry rum speed:     100  %
      6 Digital/Analog I/O:      ENABLE
      7 Step statement type:     TP & MOTION
      8 Step path node:          OFF

   [ TYPE ]  GROUP        DISABLE  ENABLE
```

3 Setup each configuration.
4 For other group, press F2 “Group” key and enter the group number.

Table 5.5 The configurations of test cycle setup

Items	Descriptions
Group motion	Specify the enabled/disabled of robot motion. “DISABLE”: Ignore every robot instruction and arc instructions, so the robot never moves and welds.(Machine lock state) “ENABLE”: Robot moves and welds according to each instruction.
Dry run	If it is enabled, robot moves with the speed defined as dry run speed and any arc instruction is ignored
Cart. dry run speed	Robot moves the specified speed at linear and circular motion in TP programs when dry run is enabled. The unit of the speed is mm/sec. Please note move path be possibly different as same as the case program speed is changed.
Joint dry run speed	Robot moves the specified speed at Joint motion in TP programs when dry run is enabled. Please note move path be possibly different as same as the case program speed is changed.
Jog dry run speed	Robot moves with slower speed at Jog when dry run is enabled and Jog dry run speed is under 100%.
Digital/Analog I/O	Specify digital/analog input/output signals ENABLED or DISABLED while test cycle.
Step statement type	Specify how to execute a program on single step mode. STATEMENT : Pause at each instruction. MOTION : Pause at each motion instruction. ROUTINE : Pause at each instruction except programs which execute by CALL Instruction. TP&Motion : Not pause at every KAREL instruction except motion instruction
Step path node	If this status is “ON”, the robot paused after each “MOVE_ALONG” instruction execution.

5.6 EXECUTION OF ARC WELDING PROGRAM

Test cycle is used for conforming of robot before actual production. The configurations are specified at Test cycle setup screen.
For executing arc welding, the program must be executed with Weld Enabled status, 100% override and continuous operation. Please refer to the following Procedure 5-10.

Procedure 5-10 Execution of Weld Program

Condition

- Arc weld instruction is taught in a program.
- T1 or T2 mode is set.

Step

1 Press and hold down the deadman swtich, then turn on the teach pendant enable switch.
2 Press the STEP key to disable the step mode. When the step mode is disabled, the STEP LED on the teach pendant is lit green (Check that the STEP LED lights green).
3 Set Weld Enabled status. Press WELD ENBL key and set “Weld” software LED on Teach Pendant to green status.

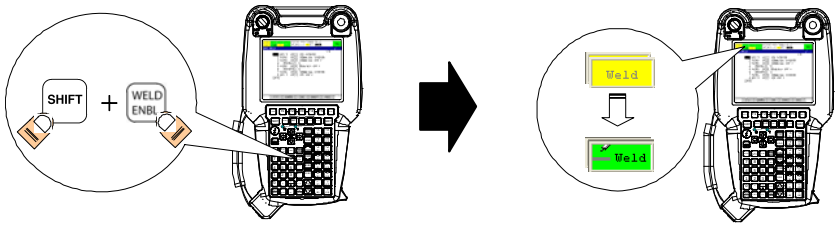


Fig. 5.6 (a) Switch to Weld Enabled

4 Set 100% override by override key.

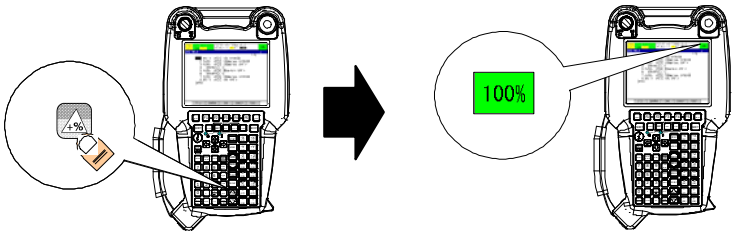


Fig. 5.6 (b) Set 100% Override

5 Move the cursor on the top of line 1 and then perform the program execution.

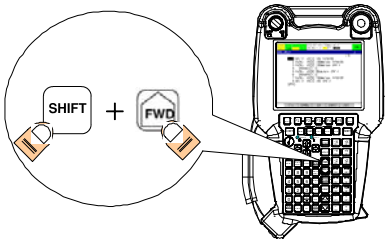


Fig. 5.6 (c) Continuous Operation of Weld Program

6 Arc welding is performed when the motion instruction that is put between Weld Start and Weld End instructions is executed.

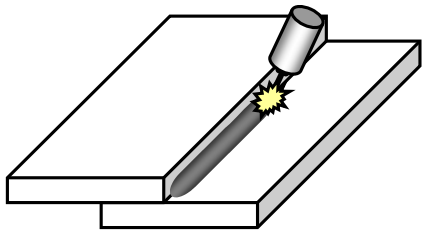


Fig. 5.6 (d) Execution of Arc Welding

NOTE
If Weld Start instruction is executed without 100% override, “ARC-033 Override must be 100% to weld” alarm is posted and the program pauses. In this case, please change override to 100% and then perform program execution again.

NOTE
If arc is not generated at Weld Start position, “ARC-013 Arc Start failed” alarm is posted and the program pauses. Then, please investigate the cause of arc failure referring to Chapter 7 “Trouble Shooting”.

Detailed Pause/Resume Specifications of Arc Welding Program

- When program execution is paused by alarms, etc. during arc welding, arc welding is stopped. When program is resumed, arc welding is also resumed. At resume timing, Restart Function, Arc Retry Function and Scratch Start Function will be applied according to the situation (refer to Section 3.3).
- After the power of a robot controller is turned off during arc welding, arc welding is resumed at program resume timing after cycle power of robot controller if Hot Start is enabled. At resume timing, Restart Function, Arc Retry Function and Scratch Start Function will be applied according to the situation (refer to Section 3.3).
- If Backward Execution of program is done after the pause of arc welding, arc welding is not performed at program resume timing. If you would like to restart arc welding after Backward execution, it is required to resume the program after returning to the motion instruction before Weld Start instruction by further Backward Execution.
- If cursor is moved to other line on the program during the pause of arc welding and then program is restarted, arc welding is not performed as long as Weld Start is not executed again.
- Single Step Mode becomes enabled during arc welding, arc welding is stopped at the finish timing of the current motion instruction, and robot is also stopped. After the program resume, arc welding is not performed as long as Weld Start is not executed again.

5.7 WELD SIMULATION MODE

Weld simulation mode is one of the program execution methods to estimate cycle time of the weld program without actual welding. This function can be used since 7DC2 series software.
Previously, running a program with weld disabled is only method to estimate cycle time without actual weding, however, since, this method ignores wait time for arc detection et.al. and process time like craterfill process et.al, the estimated cycle time always is shorter than actual cycle time.
On the other hand, at Weld simulation mode programs are executed same as actual weld exclude arc detection process, so Weld simulation mode provides more accurate cycle time.

NOTE
- Arc detect time at Weld simulation mode is defined in system variable $AWEPCR[i]. $AS_DELAY(unit : ms).
- When weld simulation mode is enabled, all weld I/O becomes Simulated status.

Procedure 5-11 Activate Weld Simulation Mode

Step

1 Perform controlled start.
2 Press [MENU] key and select “4. Variables”.
3 Move cursor on system variable $AWSCFG and press enter key.
4 Mover cursor on variable $TST_CYC_SIM in $AWSCFG and press F4 “TRUE”.
5 Perform cold start.

Procedure 5-12 Enable Weld Simulation Mode

Step

1 Press [MENU] key.
2 Select “2.TEST CYCLE”
3 Press F1[TYPE] and select “Arc Weld”. The following screen will appear.

```
TEST CYCLE
                                        1/2
    1 Equipment 1 ARC enable:       TRUE
    2 Equipment 1 Simulation:       FALSE

 [TYPE]                                TOGGLE
```

4 Move cursor on “Simulation” and press F5 “TOGGLE” then Weld simulation mode becomes enabled/disabled.

6 STATUS

This chapter shows Arc Welding Status Screen that present current state of arc welding.

6.1 ARC WELDING STATUS

Arc welding status shows the current welding status.

Procedure 6-1 Display arc welding status screen

Step

1 Press [MENU] key.
2 Select “6. Status”.
3 Press F1 [TYPE] key.
4 Select “Weld”.

or

1 Press STATUS key.
2 Press F1 [TYPE] key.
3 Select “1. Weld”.

```
STATUS Weld

            COMMAND            FEEDBACK
          20.0  Volts        20.0  Volts
         210.0  Amps        210.0  Amps
                            500.0  cm/min



     Arc enable:  ON    PROCESS SELECT: 1
     Arc detect:  OFF   [               ]
     Arc on time:          0: 0: 0: H:M:S

   [TYPE]  RESET
```

Fig. 6.1 Arc welding status screen

Table 6.1 The contents on arc welding status screen

Items	Descriptions
Command	Show command values requested to weld equipment; voltages, Current et.al.. The type and number of signals is depended on model of weld equipment and the number of analog signals.
Feedback	Show feedback values send from weld equipment.
Arc enable	Show enabled/disabled arc welding. If it is enabled, arc welding doesn’t execute at arc weld instructions.
Arc detect	Show the weld equipments detects arc or not.
Arc on time	Show total welding time. By press F2”RESET”, clear the time.

7 I/O

This chapter shows weld I/O; input/output signals specified ArcTool.

7.1 WELD I/O

Weld I/O screen supports the following operations.

- Check the status of weld input and output signals.
- Set simulating input/Forcible output signals.
- Change the types and port numbers of weld I/O.
- Assign new weld I/O signals (Weld enable signal, remote gas purge signal et.al.)

In the case of the controller connects weld equipment through Process I/O board, since, the assignation to types and index of weld I/O is usually unnecessary, because the weld I/O is mapped automatically at weld equipment setup on ArcTool setup screen.

⚠CAUTION

If a controller connects a weld equipment ArcTool doesn't provide the model through digital I/O board like DeviceNet and Profibus et.al., please go through the following procedures.

1. Set $AWEPRR.$VENDOR_ID to 108 manually. If the setting is incorrect, "ARC-045 Weld EQ is OFFLINE" alarm will occur.
2. Set required weld I/O manually refer to Procedure 12-11. If the settings are incorrect, "ARC-040 EQi Missing I/O" alarm will occur.

Procedure 7-1 Setup Weld I/O

Step

1 Press [MENU] key.
2 Select “5. I/O”.
3 Press F1 [TYPE] key.
4 Select “1. Weld”. Weld I/O screen is displayed.

```
I/O Weld In
                                                    1/15
        WELD SIGNAL            TYPE   # SIM  STATUS
   1 [Voltage            ]   AI[   1]  U     0.0
   2 [Current            ]   AI[   2]  U     0.0

   3 [                   ]   WI[   1]  U     OFF
   4 [Arc detect         ]   WI[   2]  U     OFF
   5 [Gas fault          ]   WI[   3]  U     OFF
   6 [Wire fault         ]   WI[   4]  U     OFF
   7 [Water fault        ]   WI[   5]  U     OFF
   8 [Power fault        ]   WI[   6]  U     OFF
   9 [                   ]   WI[   7]  U     OFF
  10 [                   ]   WI[   8]  U     OFF

  11 [Wirestick          ]   WS[   1]  U     OFF

  12 [Arc enable         ]      [***]  *     ***
  13 [Remote gas purge   ]      [***]  *     ***
  14 [Remote inch fwd    ]      [***]  *     ***
  15 [Remote inch bwd    ]      [***]  *     ***

|  | [TYPE] | HELP | IN/OUT |  |  | > |
|---|---|---|---|---|---|---|
|  | [TYPE] | HELP | CONFIG |  |  |  |
```

Fig. 7.1 (a) Weld Input signals screen

5 To change weld output signals screen from weld input signals screen, press F3 “IN/OUT”.

```
I/O Weld Out
                                                    1/14
        WELD SIGNAL            TYPE   #  SIM  STATUS
   1 [Voltage            ]   AO[   1]  U     0.0
   2 [Current            ]   AO[   2]  U     0.0
   3 [Wire inch          ]   AO[   2]  U     0.0

   4 [Weld Start         ]   WO[   1]  U     OFF
   5 [Gas Start          ]   WO[   2]  U     OFF
   6 [                   ]   WO[   3]  U     OFF
   7 [Inch forward       ]   WO[   4]  U     OFF
   8 [Inch backward      ]   WO[   5]  U     OFF
   9 [Wire stick alarm   ]   WO[   6]  U     OFF
  10 [Feed forward       ]   WO[   7]  U     OFF
  11 [Feed backward      ]   WO[   8]  U     OFF

  12 [Proc select1       ]      [***]  *     ***
  13 [Proc select2       ]      [***]  *     ***
  14 [Proc select3       ]      [***]  *     ***

|  | [TYPE] | HELP | IN/OUT |  |  | > |
|---|---|---|---|---|---|---|
|  | [TYPE] | HELP | CONFIG |  |  |  |
```

Fig. 7.1 (b) Weld output signals screen

6 Forcible output/simulated input is executed by pressing function key with the cursor on “ON” or “OFF”.

⚠WARNING
Robot controller controls external devices by I/O. There might be certain bad influence to the system safety by forcible output/simulated input. Please do not perform forcible output/simulated input until confirming the usage of I/O.

NOTE
The part of displaying analog signal in the above screen changes according to the number of analog I/O signal.

NOTE
Forcible output/simulated input cannot be performed at the item of no line number.

Table 7.1 shows the descriptions of weld I/O contents.

Table 7.1 Weld I/O contents

Items	Descriptions	
Weld signal	Name of weld I/O signal.	
Type	Signal type of the weld I/O signal.	
	Input signals AI: Analog Input signals DI: Digital Input signals WI: Weld Input signals GI: Group Input signals RI: Robot Input signals WS: Wire Stick detection signal	**Output signals** AO: Analog Output signals DO: Digital Output signals WO: Weld Output signals RO: Robot Output signals
#	Port number of Weld I/O signal.	
Sim	The flag of simulated signal. S : The signal is Simulated. Output or input doesn't follow physical output/input signal. U : The signal is Unsimulated. Output or inputs follows physical output/input signal. In this status, operator cannot change the status of input. Otherwise can change the status of output.	
Status	Show current status of weld I/O signals. If the signal is unsimulated, it follows physical output/input status.	

7.1.1 Welding Input Signals

Weld input signals are supplied from to connecting weld equipment or other external devices.

Table 7.1.1 Weld input signals

Items	Descriptions
Voltage	Feedback of welding voltage from weld power supply unit.
Current	Feedback of welding current from weld power supply unit.
Arc detect	When an arc is generated and welding is in progress correctly, the signal become on. If it becomes off while welding, arc generation is fault and cannot progress the weld. If arc loss detection function is enabled, a weld alarm occurs, the robot stop immediately and the program is paused.
Gas fault	When a gas shortage occurs, the signal becomes on. If gas shortage detection function is enabled, a weld alarm occurs. Usually, the signal connects to the gas output switch.
Wire fault	When a wire shortage or some troubles occur in the wire feed unit while welding, the signal becomes on. If wire shortage detection function is enabled, a weld alarm occurs.

Items	Descriptions
Water fault	When some troubles occur in cooling unit or water circulation hose while welding, the signal becomes on. If coolant shortage detection function is enabled, a weld alarm occurs.
Power fault	When some troubles occur in weld power supply unit while welding, the signal becomes on. If power supply failure detection function is enabled, a weld alarm occurs.
Wirestick	Wirestick is detected by reading voltage across weld detection circuit while welding. If the voltage difference is less than a certain level, it is treated as wire stick and the signal becomes on.
Arc enable	Control welding enabled/disabled from a peripheral unit. This signal works only when remote mode (when the remote switch on the operator's panel is set to on). If port number of the signal is 0, the signal is invalid. If *SFSPD or ENBL signal becomes off with the signal is valid, the welding becomes disabled.
Remote gas purge	Control gas purge process from a peripheral unit. When the signal is on, gas purge process runs. The signal appears only when "Remote gas purge" on arc weld system setup is enabled and assigned to the peripheral unit.
Remote inch fwd	Control wire feeding from a peripheral unit. When the signal is on, wire feeds forward. The signal appears only when "Remote wire inch" on arc weld system setup is enabled and assigned to the peripheral unit.
Remote inch bwd	Control wire feeding from a peripheral unit. When the signal is on, wire feeds backward. The signal appears only when "Remote wire inch" on arc weld system setup is enabled and assigned to the peripheral unit.

7.1.2 Welding Output Signals

Weld output signals are supplied to the connecting weld equipment or other external devices.

Table 7.1.2 Weld output signals

Items	Descriptions
Voltage command	Instruction of welding voltage to weld power supply unit. Actual voltage of analog output depends on scaling factor of it.
Current command/ Wire feed speed command	Instruction of welding current to weld power supply unit. Actual voltage of analog output depends on scaling factor of it. Instruction of welding voltage to wire feed unit connected to weld power supply unit. Actual voltage of analog output depends on scaling factor of it.
Wire inch	Instruction of wire forward/backward speed to wire feed unit when "Inch forward"/"Inch backward" signal is on. Actual voltage of analog output depends on scaling factor of it.
Weld start	Request signal of arc generating to weld power supply unit.
Gas start	Request signal to flow welding gas.
Inch forward	Manual wire forward command from teach pendant to wire feed unit.
Inch backward	Manual wire backward command from teach pendant to wire feed unit.
Feed forward	Wire forward command while welding. The signal appears only when "Feed forward/backward" is enabled at arc weld equipment setup.
Feed backward	Wire backward command while welding. The signal appears only when "Feed forward/backward" is enabled at arc weld equipment setup.
Prog select 1-3	Those signals appear only when weld controller program selection function is enabled. For more details, please refer to Chapter 26.

Procedure 7-2 Changing a welding signal type and number

Step

1 On the welding input or output signal screen, move the cursor to a digital signal to be modified. For example, move the cursor to the Arc enable signal on the welding input screen.

2 After pressing [NEXT] key, press the F3 [CONFIG] key. The screen shown below appears.

```
I/O Weld In
                                                  1/14
        WELD SIGNAL      TYPE  #
   1 [Arc enable       ]   [****]

   2 Polarity: NORMAL

   [TYPE]  MONITOR  VERIFY  [SELECT]  HELP  >
```

3 To change the signal type:
- Move the cursor to the signal type field.
- Press the F4 [CHOICE] key.
- Choose a desired signal type from WI, DI, and RI, then press the ENTER key.

4 To change the signal number:
- Move the cursor to the signal number field.
- Enter a desired number.

5 To change the polarity type:
- Move the cursor to the polarity type field.
- Press the F4 [INVERSE] or F5 [NORMAL].

6 By pressing the F3 [VERIFY] key, whether assigned signal type and number actually exist can be checked.

7 Pressing the F2 [MONITOR] key returns the screen display to the welding I/O monitor screen.

7.2 WELD EXTERNAL OUTPUT

The function provides to output several weld signals to external devices (PLC, etc.). Signals and explanations for weld are described on Table 7.2 and setup procedure is described on Procedure 7-3.

Procedure 7-3 Setup Weld External Output function

Step

1 Press [MENU] key.
2 Select “5. I/O”.
3 Press F1 [TYPE].
4 Select “3. Weld Ext DO”, the following screen appears.

```
WELD EXTERNAL OUTPUT
                                                  1/8
      SIGNAL              INPUT        OUTPUT
   1  Arc enable        ********      DO[   0]
   2  AS failed         ********      DO[   0]
   3  Arc loss          ********      DO[   0]
   4  Power fault       WI[   6]      DO[   0]
   5  Gas fault         WI[   3]      DO[   0]
   6  Wire fault        WI[   4]      DO[   0]
   7  Water fault       WI[   5]      DO[   0]
   8  Touch detect      WS[   1]      DO[   0]

   [TYPE]                                HELP
```

5 Assign correspond digital output to each weld external signal.
If the port number is 0, the signal is invalid.
If the port has been used as weld external signal, message “This NO. is already used as Weld Output” is displayed and back to previous value.
If the port is invalid, message “Port assignment is invalid” is displayed and back to previous value.

> ⚠ **CAUTION**
> Since port assignation to weld external output applies without repower the controller, the signal may become on suddenly. Please take care to setup it.

Table 7.2 Signals of Weld external output function

Items	Descriptions
Arc enable	Corresponding to weld enable/disabled of the selecting weld equipment.
Weld simulated	Corresponding to weld simulation mode enable/disabled of the selecting weld equipment. Regarding to weld simulation mode, please refer to Section 5.7.
AS failed	This signal becomes on when arc start fails. At the same time, “ARC-013 Arc start fails” alarm occurs. When the alarm is reset, the signal also becomes off.
Arc loss	This signal becomes on when an arc has lost while welding. At the same time, “ARC-018 Lost arc” alarm occurs. When the alarm is reset, the signal also becomes off.
Power fault	When some troubles occur in weld power supply while welding, the signal becomes on. Since the signal is corresponding to “Power fault” of weld input, if the input isn’t assigned, the output signal becomes invalid.
Gas fault	When a gas shortage occurs, the signal becomes on. Since the signal is corresponding to “Gas fault” of weld input, if the input isn’t assigned, the output signal becomes invalid.
Wire fault	When a wire shortage occurs or some troubles occur in the wire feed unit while welding, the signal becomes on. Since the signal is corresponding to “Wire fault” of weld input, if the input isn’t assigned, the output signal becomes invalid.
Water fault	When some troubles occur in cooling unit or water circulation hose while welding, the signal becomes on. Since the signal is corresponding to “Water fault” of weld input, if the input isn’t assigned, the output signal becomes invalid.
Touch detect	When wire touches or deposits work, the signal becomes on. Since the signal is corresponding to “Wirestick” of weld input, if the input isn’t assigned, the output signal becomes invalid.

8 WEAVING FUNCTION

8.1 OVERVIEW

Weaving means swinging the welding torch right and left periodically at a certain angle relative to the welding direction, thus increasing the width of a bead to increase the strength of welding. Additionally, if TAST tracking (refer to Chapter 20) is used during welding, the welding with weaving motion is necessary.
In this chapter, following descriptions are shown. You can execute weaving motion by referring to two sections, Weaving Instruction and Weaving Schedule. If you need more detailed weaving setup, please refer to other sections.

- Weaving Instruction
- Weaving Setup
- Weaving Schedules
- Multi Group Weaving
- Wrist Axes Weaving
- Customized Weaving

This function is an ArcTool standard function.

8.2 WEAVING INSTRUCTION

The weaving instructions direct the robot to perform weaving.

Weaving motion is done at the execution timing of motion instructions between Weave Start and Weave End instructions. Once weaving motion is started by Weave Start instruction, weaving motion is continued up to the execution of Weave End instruction.

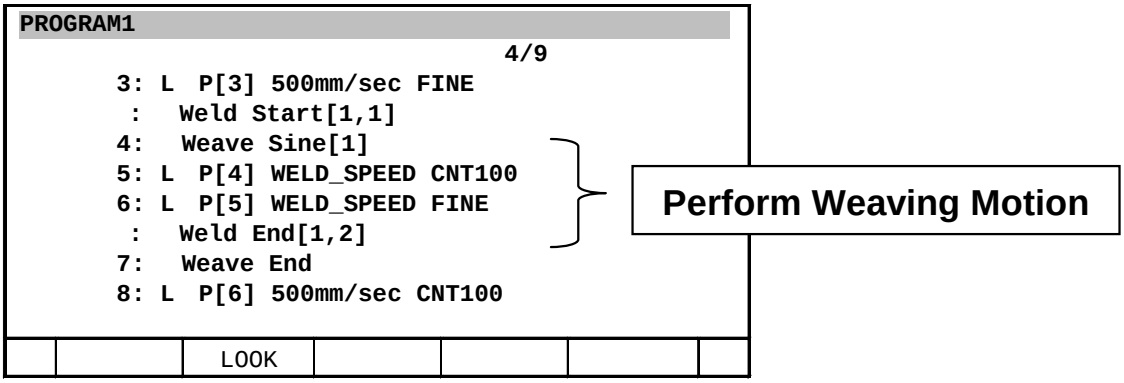


Fig. 8.2 (a) Example of weaving program

The weaving instructions include:

-Weave (pattern) [i] instruction
-Weave (pattern) [Hz, mm, sec, sec] instruction
-Weave End instruction
-Weave End [i] instruction

To teach the weaving instructions to the robot, click F1 [INST] to display the related submenu, then select [Weave] from the submenu.

```
      Instruction 2
1 Miscellaneous
2 Weave
3 Skip
4 Payload
5 Track/Offset
6 Offset/Frames
7 Multiple control
8 --next page--
```

Weave Pattern

The weaving instructions specify the following weaving patterns:

- **Weave Sine**
  This is a standard weave pattern for arc welding. It can be used with TAST and Root Pass Memorization/Multi Pass function.

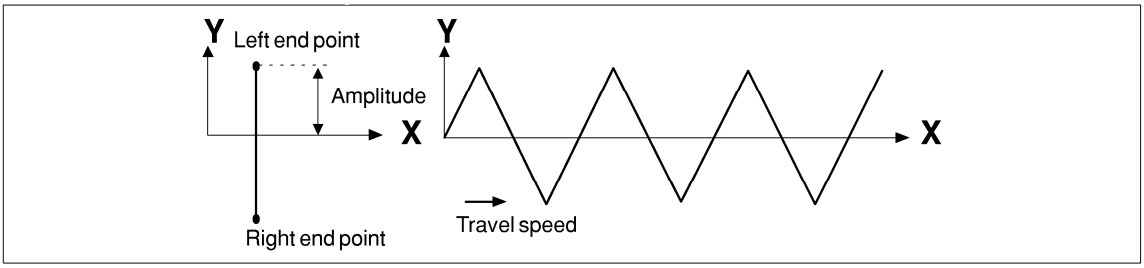


Fig. 8.2 (b) Weave sine/Weave Sine2 pattern

- **Weave Sine 2**
  The motion is similar to Weave Sine. Motion control process for Weave Sine2 is different from Weave sine for achieving high frequency (generally more than 5Hz) weave motion. Normally, please use this pattern with Wrist Axis Weaving function.

- **Weave Circle**
  Weaving motion is done with describing circle. Mainly, this pattern is used for lap joint or large gap welding.

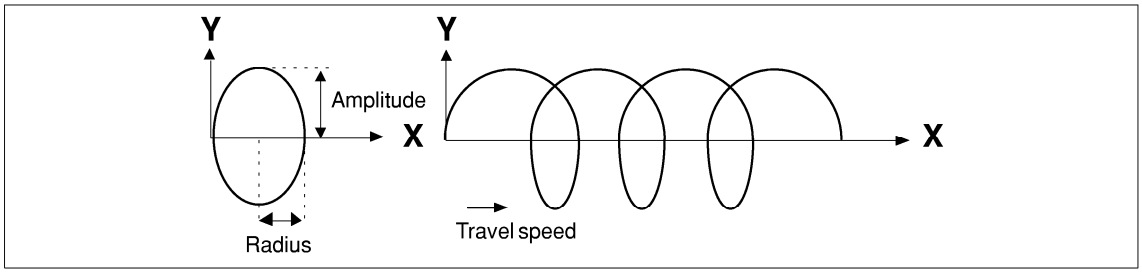


Fig. 8.2 (c) Weave Circle pattern

- **Weave Figure 8**
  Weaving motion is done with describing figure 8. Mainly, this pattern is used for heavy welding, hard facing and cladding, poor part tolerances, large gap conditions, etc.

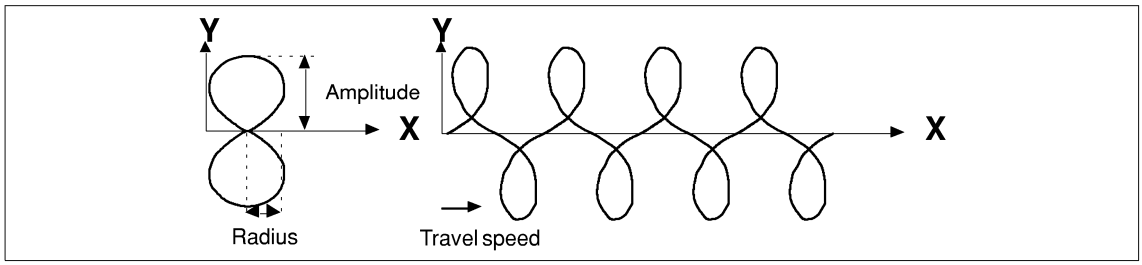


Fig. 8.2 (d) Weave Figure 8 pattern

- **Weave L**
  This pattern is mainly used for fillet joint and V-groove joint. Weave azimuth or weave plane should be adjusted to match the weld joint orientation before using it.

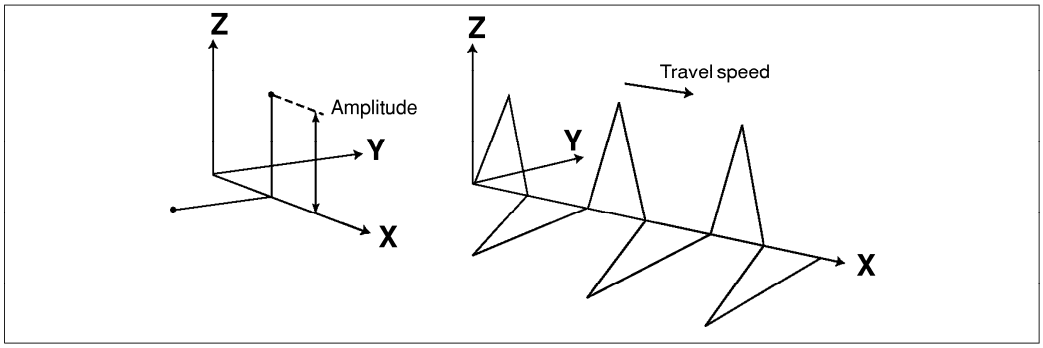


Fig. 8.2 (e) Weave L pattern

> **NOTE**
> The following restrictions are placed except weave sine pattern
> -"Cenerrise" is disabled.
> -It is impossible to use TAST, AVC, and RPM&Mpass.

> **NOTE**
> The following restrictions are placed on weave L.
> -It is impossible to use soft float, space check, and continuous turn.

Weave (pattern) [i]

The Weave (pattern) [i] instruction starts weaving according to a weaving schedule and pattern specified beforehand. Please refer to Section 8.4 for weave schedule.

Weave (pattern) [i]

Weaving pattern — Weaving schedule number

Example
```
1: Weave Sine[1]
2: Weave Circle[11]
3: Weave Figure 8[ R[31] ]
```

Weave (pattern) [4]

Weaving schedule
Frequency 1.5Hz
Amplitude 1.0mm
Right dwell 0.150sec
Left dwell 0.150sec

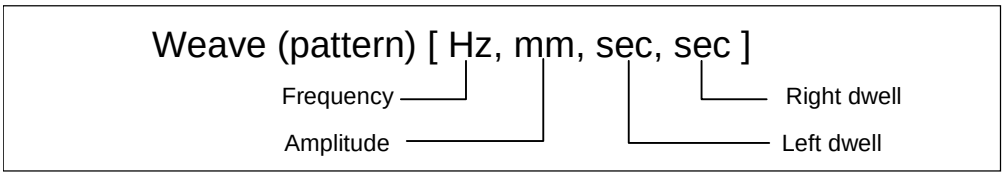
Weaving schedule list screen

```
DATA Weave Sched
                                    1/10
      FREQ(Hz) AMP(mm) R_DW(sec) L_DW(sec)
    1   1.0    4.0      .100      .100
    2   2.0    3.0      .100      .100
    3   1.3    1.5      .100      .100
    4   1.5    1.0      .150      .150
```

Fig. 8.2 (f) Weaving start instruction (Indirect)

Weave (pattern) [Hz, mm, sec, sec]

The Weave (pattern) [Hz, mm, sec, sec] instruction starts weaving by directly specifying weaving conditions such as a frequency, amplitude, dwell time at the left end, and dwell time at the right end. Please refer to Section 8.4 for each weave parameters.



Example `1: Weave Sine [1.0Hz, 4.0mm, 0.1sec, 0.1sec]`

Fig. 8.2 (g) Weaving start instruction (condition description)

> **NOTE**
> Left and Right dwell are ignored on Figure 8 and Circle patterns.

Weave End

The Weave End instruction ends all weaving in progress.

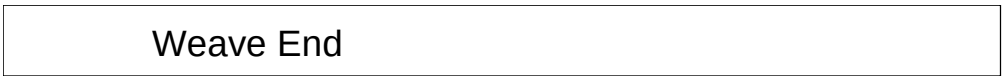


Fig. 8.2 (h) Weaving end instruction

Weave End [i]

The Weave End [i] instruction is used when the number of motion groups in a program is more than 2 and when there are multiple weave (pattern) [i] instructions in the program. This instruction stops only the weaving motion of a motion group specified by specified weave schedule. About more detail, please refer to Section 8.5 Multi Group Weaving.

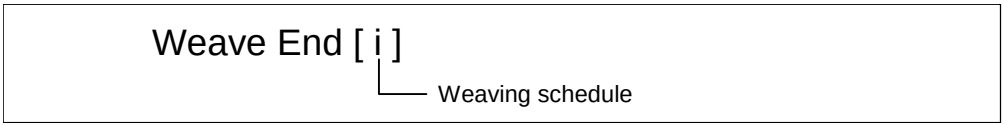


Fig. 8.2 (i) Weaving end [i] instruction

Procedure 8-1 Teaching of the weaving instruction

Step

1 Move the cursor to END.
2 Press F1 (INST). A list of control instructions is displayed.

```
      Instruction 1
1 Arc
2 Registers
3 I/O
4 IF/SELECT
5 WAIT
6 JMP/LBL
7 CALL
8 --next page--
```

3 Select Weave on the next page.

```
      Instruction 2
1 Miscellaneous
2 Weave
3 Skip
4 Payload
5 Track/Offset
6 Offset/Frames
7 Multiple control
8 --next page--
```

4 List of Weave instructions is displayed. Select the instruction whose weave pattern is that you would like to use.

```
                Weave  1
1 Weave Sine[ ]
2 Weave Figure 8[
3 Weave Circle[ ]
4 Weave End
5 Weave Sine 2[ ]
6 Weave L[ ]
7 Weave End[ ]
8
```

5 Selected instruction is added to TP program. Enter Weave Schedule number into [ ].

```
PROGRAM1
                                        4/5
     3: L  P[3] 500mm/sec FINE
       :   Weld Start[1,1]
     4:    Weave Sine[...]
    [End]

    Enter schedule number.
| | REGISTER | | VALUE | CHOICE | | |
```

```
PROGRAM1
                                        5/5
     3: L  P[3] 500mm/sec FINE
       :   Weld Start[1,1]
     4:    Weave Sine[1]
    [End]
| | [INST] | | | | [EDCMD] | |
```

6 Press F1 (REGISTER) for register-based indirect specification and enter register number into [ ].

```
PROGRAM1
                                        4/5
     3: L  P[3] 500mm/sec FINE
       :   Weld Start[1,1]
     4:    Weave Sine[R[...]]
    [End]

    Enter register number.
| | | SCHED | VALUE | CHOICE | | |
```

```
PROGRAM1
                                        5/5
     3: L  P[3] 500mm/sec FINE
       :   Weld Start[1,1]
     4:    Weave Sine[R[1]]
    [End]
| | [INST] | | | | [EDCMD] | |
```

7 Press F3(VALUE) to directly enter values for weaving conditions.

```
PROGRAM1
                                        4/5
     3: L  P[3] 500mm/sec FINE
       :   Weld Start[1,1]
     4:    Weave Sine[...,...,0.0s,0.0s]
    [End]

    Enter frequency (Hz).
| | REGISTER | SCHED | | CHOICE | | |
```

```
PROGRAM1
                                        5/5
     3: L  P[3] 500mm/sec FINE
       :   Weld Start[1,1]
     4:    Weave Sine[1.0Hz,4.0mm,0.100s,
       :   0.100s]
   [End]

   [INST]                                [EDCMD]
```

8 After teaching the motion instruction for weaving motion, repeat Step 1-3 and then select and teach select Weave End instruction on Step 4.

Detailed Specifications of Weaving Instruction

- Weaving can be performed regardless of the existence of arc instructions or arc enabled/disabled status.
- When weaving instruction is taught with arc welding instruction, both order of “Arc welding instruction – Weaving instruction” or “Weaving instruction – Arc welding instruction” are allowed.
- Weaving motion is performed at step execution.
- Weaving motion is not performed at backward motion. Additionally, weaving motion is not performed when forward motion is done again after weaving motion – pause – backward motion.
- Weaving motion is not performed during dry run.

8.3 WEAVING SETUP

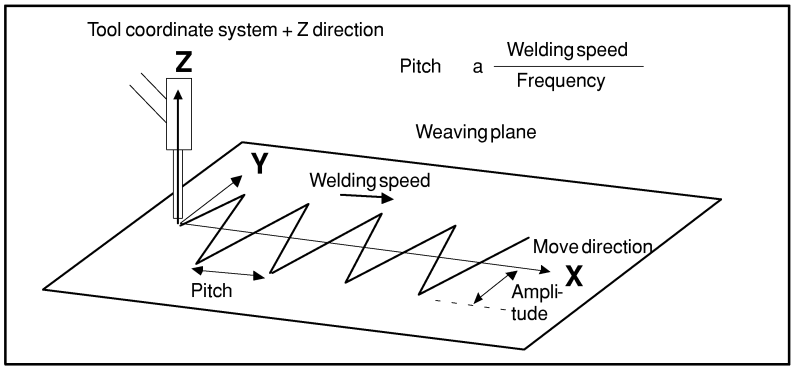
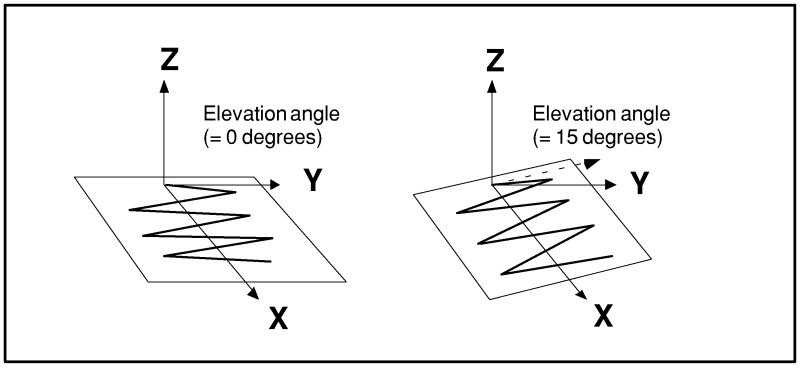
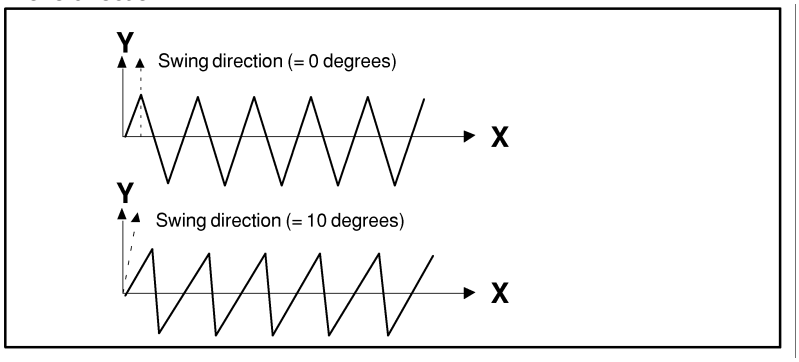
A setting for weaving can be made with [6 SETUP-Weave] on the weaving setting screen. The setup (except Azimuth - Radius) is reflected to all weaving motion. Basically, general weaving motion will not need a parameter change from default value in this screen.

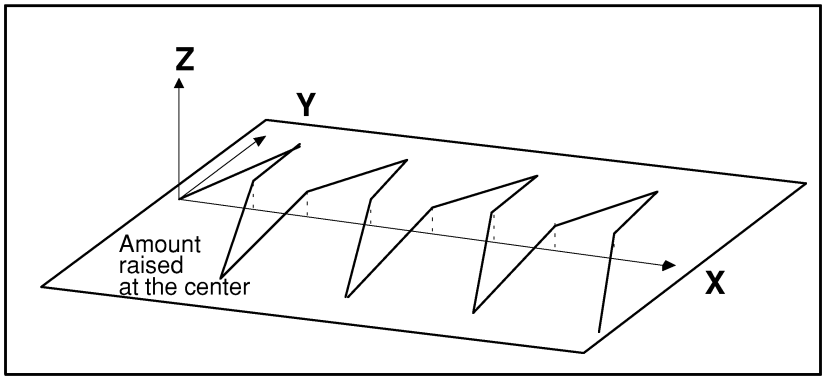
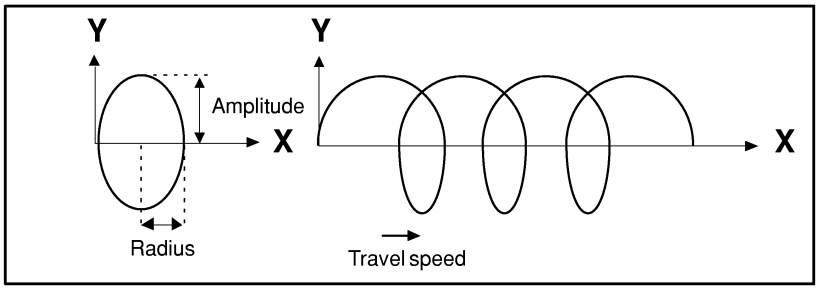
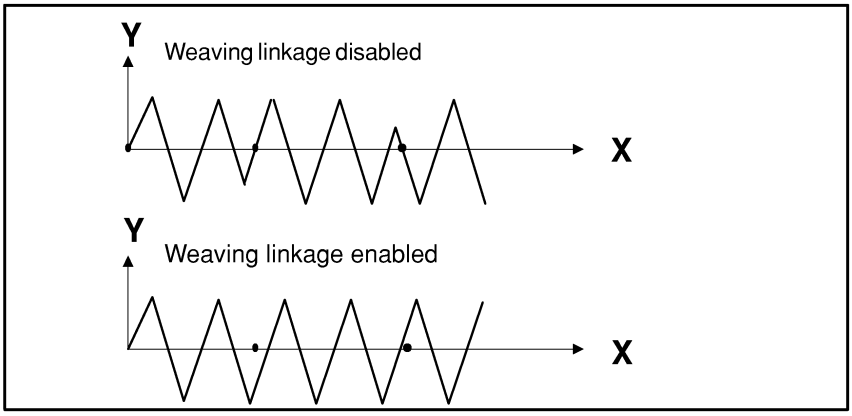
Weaving Setup Screen

```
SETUP Weave
                                        1/12
          NAME                VALUE
      1 Weave Enable Groups[1,*,*,*,*,*,*,*]
      2 Dwell delay type:        Move
      3 Frame type:             Tool&Path
      4 Elevation:              0     deg
      5 Azimuth:                0     deg
      6 Center rise:            0.0    mm
      7 Radius:                 0.0    mm
      8 Blend weave end:         YES
      9 Robot Group:            1
     10   Peak output port DO:0
     11   Peak output pulse:  .10    sec
     12   Peak output shift:  .08    sec

   [TYPE]                                HELP
```

Table 8.3 Setting for weaving

SETTING ITEM	DESCRIPTION
Weave Enable Groups	This item specifies a motion group for which weaving is enabled. Set 1 for the part corresponding to a motion group for which weaving is enabled. You can set 1 only to Robot Group (You cannot set 1 to positioner group or external axis group). About more detail, please refer to Section 8.5 Multi Group Weaving.

SETTING ITEM	DESCRIPTION
Dwell delay type	This item is used to specify whether to stop the robot completely or stop sideway movements only at both end points during weaving. The dwell time during which the robot stops at end points is determined by the values set in R_DW and L_DW (refer to Section 8.4 Weave Schedule). -**Stop:** Completely stops the robot at both weaving end points. -**Move:** Stops only sideway movements at both weaving end points.
Frame type	This item is used to select a frame for weaving plane determination. -**Tool & Path:** Formed by the Z direction of the tool frame and move direction. -**Tool:** Tool frame.  **Fig. 8.3 (a) Weaving Frame**
Elevation	This item specifies the inclination of the weaving plane relative to the weaving frame (in degrees). If this value is positive, the angle becomes clockwise at move direction. If this value is negative, the angle becomes counterclockwise at move direction.  **Fig. 8.3 (b) Elevation**
Azimuth	This item specifies the inclination of weaving swing direction on the weaving plane (in degrees). If this value is positive, the right edge inclines at move direction. If this value is negative, the left edge inclines at move direction. When you set 90deg or -90deg to azimuth, the direction of weaving motion becomes parallel to move direction.  **Fig. 8.3 (c) Azimuth**

SETTING ITEM	DESCRIPTION
Center rise	This item specifies the amount the torch is raised at the center of weaving (in mm). When multi pass welding is performed, this item is set to avoid the height of the previous bead(s). Only when Weave Pattern in Weave Start instruction is Weave Sine or Weave Cust (refer to Section 8.7), this item is applied.  **Fig. 8.3 (d) Center rise**
Radius	This item specifies the amplitude relative to the welding direction (in mm). Only when Weave Pattern in Weave Start instruction is Weave Circle or Weave Figure 8, this item is applied.  **Fig. 8.3 (e) Radius**
Blend weave end	This item specifies whether to ignore the taught points of the move instruction to continue weaving. -**NO**: Moves to taught points at all times. -**YES:** Does not follow taught points but links an end point of weaving with a start point of weaving.  **Fig. 8.3 (f) Blend weave end**
Robot group	This item allows you to select the robot group whose peak output parameters can be displayed and configured.
Peak output port DO	This item specifies the signal number of an DO signal output at a weaving end point. When the torch reaches an end point during weaving, a specified output DO signal is output.
Peak output pulse	This item specifies the output pulse width of the end point output DO signal (Unit: sec).
Peak output shift	This item specifies the time delay in output of the end point output DO signal (Unit: sec).

⚠CAUTION
If “Stop” is set as “Dwell delay type”, heat input at weave edge becomes large during welding and burn through may be generated on some thickness works. When “Stop” is used, please take care the adjustment of right/left dwell time.

⚠CAUTION
If the weaving motion sentence uses register as command speed or position register, blend weave end process is not executed, because program pre-process is disabled.
If you would like to use both blend weave end and register as command speed, it is possible by setting system variable $RGSPD_PREXE to TRUE. Then, please execute “$RGSPD_PREXE = 1” by parameter instruction for temporarily enabling program pre-process before starting weaving (After weaving, returning to original setup is recommended).
If you would like to use both blend weave end and position register, it is possible by using Position Register Look-ahead Execution Function. Then, please execute LOCK PREG instruction before starting weaving.
Please refer to Subsection 4.3.3 “Feed Rate” of OPERATOR’S MANUAL (Basic Operation) (B-83284EN) for more details of $RGSPD_PREXE, and Section 9.4 “POSITION REGISTER LOOK-AHEAD EXECUTION FUNCTION” of the same manual (B-83284EN) for more details of Position Register Look-ahead Execution Function.

⚠CAUTION
“Elevation”, “Azimuth”, “Center rise” and “Radius” on weaving setup screen are used only for Weave (pattern) [Hz, mm, sec, sec] instruction (refer to Section 8.2). Please note that “Elevation”, “Azimuth”, “Center rise” and “Radius” on Weave schedule screen are used when Weave (pattern) [i] instruction is used.

Procedure 8-2 Setting for weaving

Step

1 Press [MENU] key to display the screen menu.
2 Select 6 SETUP.
3 Press F1 (TYPE) to display the screen switch menu.
4 Select Weave.

```
SETUP Weave
                                        1/12
        NAME                VALUE
    1 Weave Enable Groups[1,*,*,*,*,*,*,*]
    2 Dwell delay type:        Move
    3 Frame type:             Tool&Path
    4 Elevation:              0     deg
    5 Azimuth:                0     deg
    6 Center rise:             0.0   mm
    7 Radius:                 0.0   mm
    8 Blend weave end:         YES
    9 Robot Group:             1
   10   Peak output port DO:0
   11   Peak output pulse:  .10   sec
   12   Peak output shift:  .08   sec

     [TYPE]                              HELP
```

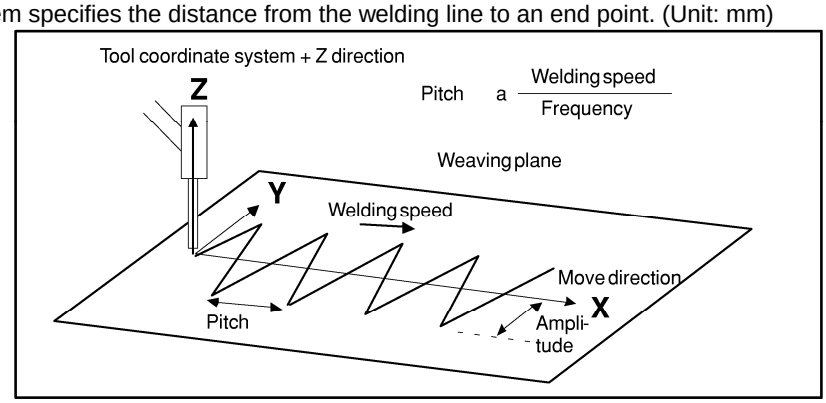
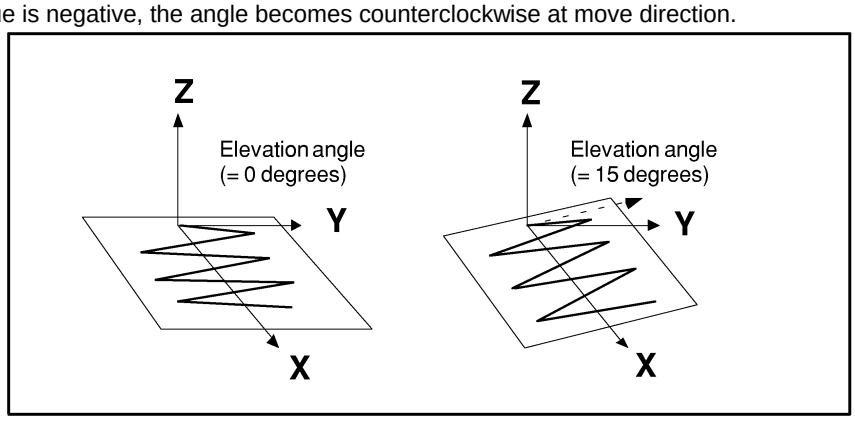
5 When setting an item, move the cursor to the setting field, then
  a Press F4 (CHOICE), then select a desired menu.
  b Enter a desired value or select an F key menu item.

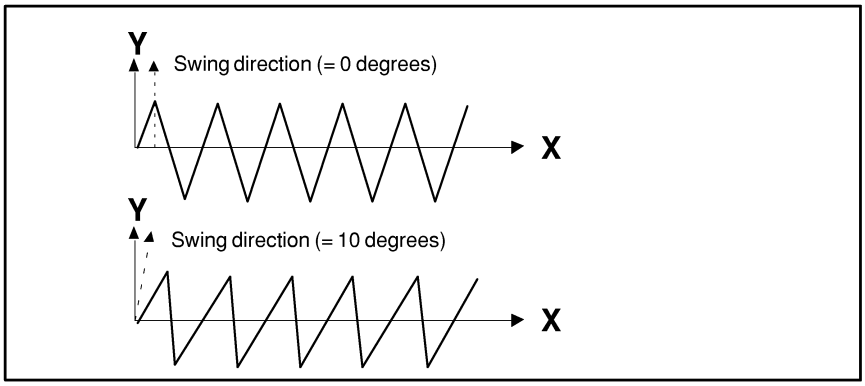
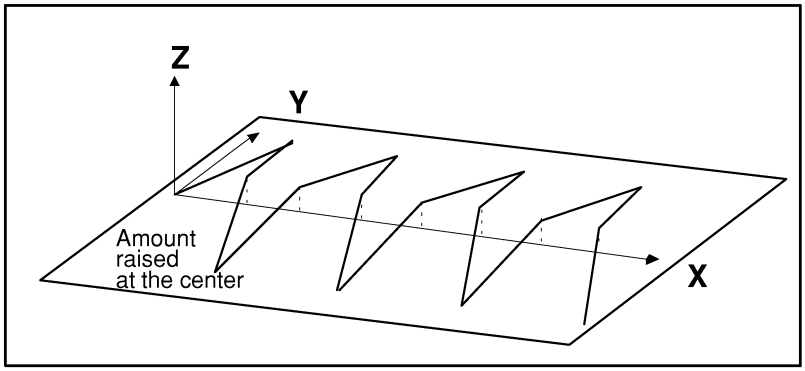
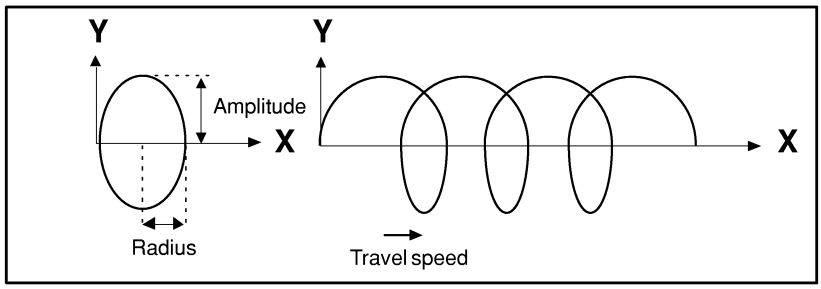
8.4 WEAVE SCHEDULE

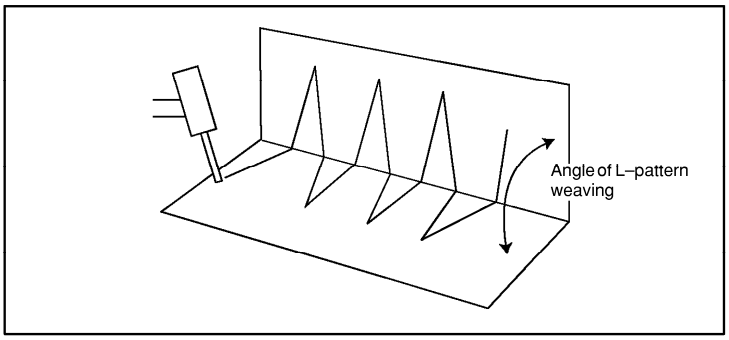
A weave schedule defines a pattern of weaving performed during welding. A weaving instruction is executed by specifying a weave schedule number in the program.

A weave schedule is defined with [DATA - Weave Sched] on the weave schedule screen. You can use 10 weave schedules as default. Please refer to Procedure 8-3. It is possible to increase the number of weave schedules up to 98. Please refer to Procedure 8-4.

Table 8.4 Weave schedule setting

SETTING ITEM	DESCRIPTION
Frequency	This item specifies the number of weaving cycles per second. (Unit: Hz)
Amplitude	This item specifies the distance from the welding line to an end point. (Unit: mm)  **Fig. 8.4 (a) Weave schedule**
Right dwell	This item specifies a dwell time at the right end points of weaving. When Move is specified for dwell at end points, the robot moves in the welding direction. (Unit: sec)
Left dwell	This item specifies a dwell time at the left end points of weaving. When Move is specified for dwell at end points, the robot moves in the welding direction. (Unit: sec)
Elevation	This item specifies the inclination of the weaving plane relative to the weaving frame (in degrees). If this value is positive, the angle becomes clockwise at move direction. If this value is negative, the angle becomes counterclockwise at move direction.  **Fig. 8.4 (b) Elevation**

SETTING ITEM	DESCRIPTION
Azimuth	This item specifies the inclination of weaving swing direction on the weaving plane (in degrees). If this value is positive, the right edge inclines at move direction. If this value is negative, the left edge inclines at move direction. When you set 90deg or -90deg to azimuth, the direction of weaving motion becomes parallel to move direction.  **Fig. 8.4 (c) Azimuth**
Center rise	This item specifies the amount the torch is raised at the center of weaving (in mm). When multi pass welding is performed, this item is set to avoid the height of the previous bead(s). Only when Weave Pattern in Weave Start instruction is Weave Sine or Weave Cust (refer to Section 8.7), this item is applied.  **Fig. 8.4 (d) Center rise**
Radius	This item specifies the amplitude relative to the welding direction (in mm). Only when Weave Pattern in Weave Start instruction is Weave Circle or Weave Figure 8, this item is applied.  **Fig. 8.4 (e) Radius**

SETTING ITEM	DESCRIPTION
L pattern angle	This item specifies the angle made by the left weaving plane and right weaving plane. 0 to 360 (degrees) Only when Weave Pattern in Weave Start instruction is Weave L, this item is applied.  **Fig. 8.4 (f) L-pattern angle**
Robot group mask	This item enables weaving on multi-group system in this weave schedule. Set 1 for the part corresponding to a motion group for which weaving is enabled on this schedule. If there is no group enabled in this item, the system will check ”Weave Enable Groups” on weaving setup screen and turn on weave for their groups. If there is only one group in this system, no changes are required. About more detail, please refer to Section 8.5 Multi Group Weaving.

⚠CAUTION

Available frequency and amplitude are changed from robot model and robot posture at weaving motion. Normally, if you use more than 5Hz frequency, please use Wrist Axis Weaving function (refer to Section 8.6).
When the time of right/left dwell is shorter, sometimes weaving motion cannot reaches specified amplitude.
“Elevation”, “Azimuth”, “Center rise” and “Radius” on weave schedule screen are used only for Weave (pattern) [i] instruction (refer to Section 8.2). Please note that “Elevation”, “Azimuth”, “Center rise” and “Radius” on Weaving Setup screen are used when Weave (pattern) [Hz, mm, sec, sec] instruction is used.

Procedure 8-3 Weave schedule setting

Step

1 Press [MENU] key to display the screen menu.
2 Select 3 DATA.
3 Press F1 (TYPE).
4 Select Weave Sched.

Weave schedule list screen

```
DATA Weave Sched
                                          1/10
        FREQ(Hz) AMP(mm) R_DW(sec) L_DW(sec)
     1   1.0    4.0      .100      .100
     2   1.0    4.0      .100      .100
     3   1.0    4.0      .100      .100
     4   1.0    4.0      .100      .100
     5   1.0    4.0      .100      .100
     6   1.0    4.0      .100      .100
     7   1.0    4.0      .100      .100
     8   1.0    4.0      .100      .100
     9   1.0    4.0      .100      .100
    10   1.0    4.0      .100      .100

   [TYPE]  DETAIL                    HELP
           COPY    CLEAR                    >
```

5 When copying a set schedule, move the cursor to the schedule number to be copied, press F2 (COPY) on the next page, then enter a copy destination schedule number.
6 When deleting a set schedule, move the cursor to the schedule number to be deleted, then press F3 (CLEAR) on the next page.
7 For detail setting, press F2 (DETAIL).

Weave schedule detail screen

```
DATA Weave Sched
                                        1/10
        Weave Schedule: 1

      1 Frequency:         1.0       Hz
      2 Amplitude:         4.0       mm
      3 Right dwell:       .100      sec
      4 Left dwell:        .100      sec
      5 L pattern angle:    90.0      deg
      6 Elevation:         0         deg
      7 Azimuth:           0         deg
      8 Center rise:        0.0       mm
      9 Radius:            0.0       mm
     10 Robot Group Mask: [*,*,*,*,*,*,*,*]

  [TYPE]  SCHEDULE                    HELP
                COPY     CLEAR                  >
```

To return to the list screen, press the return key.
8 To set an item, move the cursor to the setting field, then enter a desired value.
9 To switch to another weave schedule detail screen, press F2 (SCHEDULE), then enter the desired schedule number. The weave schedule detail screen of the specified number is displayed.

Procedure 8-4 Change the number of weave schedules

Step

1 Perform Controlled Start.
2 Press the MENU key and then select “4.VARIABLES”.
3 Move the cursor to “$WVCFG” and press ENTER key.
4 Move the cursor to “$MAX_NUM_SCH”.
5 Input the new number of the schedule (maximum: 98) and press ENTER key.

```
SYSTEM Variables
    $WVCFG                          24/29
     15 $GDO_PULSE     [8] of REAL
     16 $GDO_SHIFT     [8] of REAL
     17 $GDO_TYPE      [8] of INTEGER
     18 $WEAVE_TSK     [8] of INTEGER
     19 $WV_TSK_GP     [8] of INTEGER
     20 $SUPPORT_CF    TRUE
     21 $CNVT_DONE     TRUE
     22 $RAMP_ENB      FALSE
     23 $RAMP_GRP      [8] of WV_RAMP_T
     24 $MAX_NUM_SCH   10
     25 $ACCTIME1_GP   [8] of INTEGER

  [TYPE]
```

6 After the change is completed, press FCTN key and select “1 Cold Start”
7 The number of weave schedules becomes specified number.

8.5 MULTI GROUP WEAVING

Weave instructions support a program execution for multi group. Two types of weaving setups for multi group are prepared, one is “Weave Enable Groups” on Weaving Setup screen and another is “Robot Group Mask” on Weave Schedule screen.
“Weave Enable Groups” on Weaving Setup screen is reflected to all weaving instructions, so robot groups which have the plan to use weaving should be set enabled to “Weave Enable Groups”. As default, all robot groups become enabled on this setup, so if you want to set disabled to robot group which never have the plan to use weaving, please refer to Procedure 8-5.
On the other hand, “Robot Group Mask” on Weave Schedule can apply weaving motion only to specific groups under each situation. As default, all robot groups become “*”. In this situation, all robot groups which are set by “Weave Enable Groups” perform weaving motion. If you want to perform weaving motion only to specific groups within “Weave Enable Groups”, please refer to Procedure 8-6.

Procedure 8-5 Change of Weave Enable Groups

Step

1 Press [MENU] key and then select 6. SETUP.
2 Press F1(TYPE) and then select Weave. Following screen is displayed.

```
SETUP Weave
                                        1/12
        NAME                  VALUE
     1 Weave Enable Groups[1,1,*,*,*,*,*,*]
     2 Dwell delay type:        Move
     3 Frame type:             Tool&Path
     4 Elevation:              0     deg
     5 Azimuth:                0     deg
     6 Center rise:            0.0    mm
     7 Radius:                 0.0    mm
     8 Blend weave end:         YES
     9 Robot Group:            1
    10   Peak output port DO:0
    11   Peak output pulse:  .10    sec
    12   Peak output shift:  .08    sec

   [TYPE]                                HELP
```

3 Move the cursor on the position for the group which you want to change on “Weave Enable Groups”.
4 When F4 “1” is pressed, weaving for the group becomes enabled. When F5 “*” is pressed, weaving for the group becomes is never performed.
5 Perform cycle power after change.

Procedure 8-6 Change of Robot Group Mask

Step

1 Press [MENU] key and then select 3. DATA.
2 Press F1(TYPE) and then select Weave Sched. Weave Schedule List screen is displayed.
3 Move the cursor on the weave schedule you want to change and then press F2 DETAIL. Following screen is displayed.

```
SETUP Weave
                                          10/10
        Weave Schedule: 1

       1 Frequency:         1.0       Hz
       2 Amplitude:         4.0       mm
       3 Right dwell:       .100      sec
       4 Left dwell:        .100      sec
       5 L pattern angle:    90.0      deg
       6 Elevation:         0         deg
       7 Azimuth:           0         deg
       8 Center rise:        0.0      mm
       9 Radius:            0.0       mm
      10 Robot Group Mask: [*,*,*,*,*,*,*]

 [TYPE]  SCHEDULE          1      *
```

4 Move the cursor on the position for the group which you want to change on “Robot Group Mask”.
5 When F4 “1” is pressed, weaving for the group becomes enabled. When F5 “*” is pressed, weaving for the group becomes is never performed.

8.6 WRIST AXIS WEAVING

This function is an option. (A05B-XXXX-R627)

The combination of Wrist axis weaving and sine2 pattern weaving is can provide greater weaving frequency more than 5Hz. The performance of wrist axis weaving depends on proper torch and configuration settings. The weave plane that is generated when using wrist axis weaving is limited because the weaving motion is generated only in axes 4 and 5. As such some arm configurations will result in weave azimuth and elevation angles that are unusable for welding.
To use wrist axis weaving, you must
- Enable wrist axis weaving.
- Set the tolerance angle.

You do this by setting wrist axis weaving system variables.

Enabling Wrist Axis Weaving $WVWRIST.$WRIST_ENB
- **$WVWRIST.$WRIST_ENB** enables wrist axis weaving. The default value is FALSE. Set this to TRUE to enable wrist axis weaving.

Setting the Tolerance Angle $WVWRIST.$RUN_ANG$WVWRIST.$TOL_ANG
- **$WVWRIST.$RUN_ANG** returns the actual angle between the TOOL Z-X plane and the TOOL Z-PATH during execution, as shown in Fig. 8.6. This variable is updated dynamically.
  - The best weave pattern occurs when $RUN_ANG is less than 10°.
  - Decreasing $RUN_ANG can be achieved by reteaching path points by moving to the existing points, and then rotating about TOOL Z to change the wrist orientation.

- **$WVWRIST.$TOL_ANG** allows you to specify the upper limit for $RUN_ANG. The default value is 10°. When $RUN_ANG reaches its limit value, the robot will stop executing and display the error message, "WEAV-017 run_ang exceeds tol_ang."

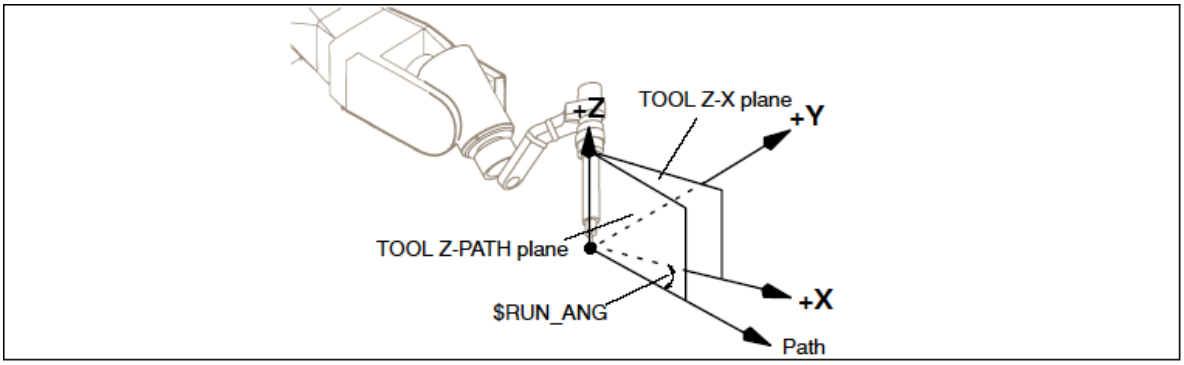


Fig. 8.6 $RUN_ANG

Using Wrist Axis Weaving

The highest weaving frequency (generally more than 5Hz) can be achieved by using a Sine2[] weaving pattern.

Wrist axis weaving supports all weaving functions except

- Wrist weaving does not support coordinated motion.
- Wrist weaving does not support the center rise function.
- Wrist axis weaving is not supported on DualARM systems.
- Wrist axis weaving is not supported on Universal Sensor Interface function.

8.7 CUSTOMIZED WEAVING

Customized weaving uses weaving patterns defined by the user.

This function is an option. (A05B-XXXX-J722)

Customized Weaving Instruction

The customized weaving instruction allows the robot to weave using patterns defined by user.

Once started by the customized weaving start instruction, weaving continues until the weaving end instruction is executed.

Customized weaving uses the following six instructions.

- Weave Cust1[i]
- Weave Cust1[Hz, mm, sec, sec]
- Weave Cust2[i]
- Weave Cust2[Hz, mm, sec, sec]
- Weave Cust3[i]
- Weave Cust3[Hz, mm, sec, sec]

To teach weaving instructions in a TP program, press F1 [INST] to display the available set of instructions, then select [Weave] from the submenu.

```
            Weave 2
1 Weave Cust1[ ]
2 Weave Cust2[ ]
3 Weave Cust3[ ]
4
5
6
7
8 --next page--
```

NOTE

The following restrictions are placed on Customized Weaving Pattern.

- "L pattern angle" and "Radius" are disabled.
- It is impossible to use TAST, AVC, RPM & Mpass.
- Peak output port DO is not output even when this is assigned.

Weaving Pattern Setting

Up to 3 customized weaving pattern can be defined. Each pattern can have a name. (Refer to "Weaving Pattern Setting by KAREL" which is mentioned later when you want to set 4 or more weaving pattern.) Their weaving patterns can be used by teaching Weave Cust1, Weave Cust2, and Weave Cust3 instructions. Weave Cust1, Weave Cust2 are triangle type and Weave Cust3 is sine type by default.

The weaving pattern setting has some limitations. The followings explain the setting method and the limitations.

- Up to ten phases.
- The value of X, Y, and Z is component of the unit vector. To set the weaving pattern of Fig. 8.7(a), 8.7(b), you should set the component of X, Y, and Z as shown in Fig. 8.7(c).
- Y component of all the unit vectors is multiplied by amplitude, and Z component of all the unit vectors is multiplied by center rise. Basically, use Z component at the position of Y=0.
- The total of the component of all the unit vectors at the weaving cycle should be 0 (but except start phase). When the end point of the weaving cycle is origin, the total of the component of all the unit vectors at the weaving cycle becomes 0.
- Dwell time can be set up to two per one pattern, and can be set to the all phase. Dwell time of two(R_Dwell and L_Dwell) per one phase cannot be set. Weaving stops during the set dwell time at the position in which the check box was turned on. When R_Dwell is set, turn on the check box of R_Dwell, and when L_Dwell is set, turn on the check box of L_Dwell. Refer to Fig. 8.7(c).
- Input the total number of phases of weaving cycle to "Total of phases". Refer to Fig. 8.7(c).
- When the end point of the weaving cycle is not the origin, the start phase must be used. When start phase is set, turn on the check box of Start phase. Refer to Fig. 8.7(d), 8.7(e).
- Push "Confirm" button of the screen of Weave Cust Setup when you want to confirm the weaving pattern. Refer to Fig. 8.7(c), 8.7(e).

NOTE

If you do not set the weaving pattern to match the following conditions, you will see the error screen then you have to re-set them again.

- Dwell time cannot be set up to more than two per one pattern.
- Dwell time of two(R_Dwell and L_Dwell) per one phase cannot be set.
- The total of the component of all the unit vectors should be 0.

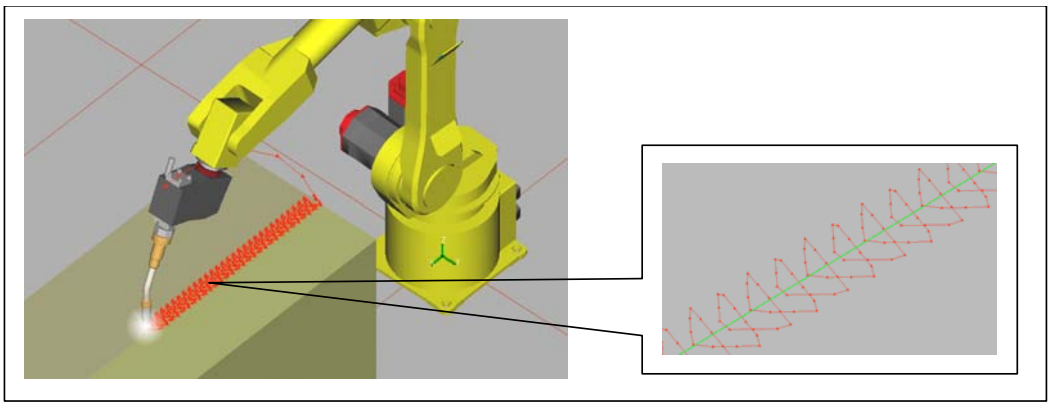


Fig. 8.7 (a) Example of triangle weaving

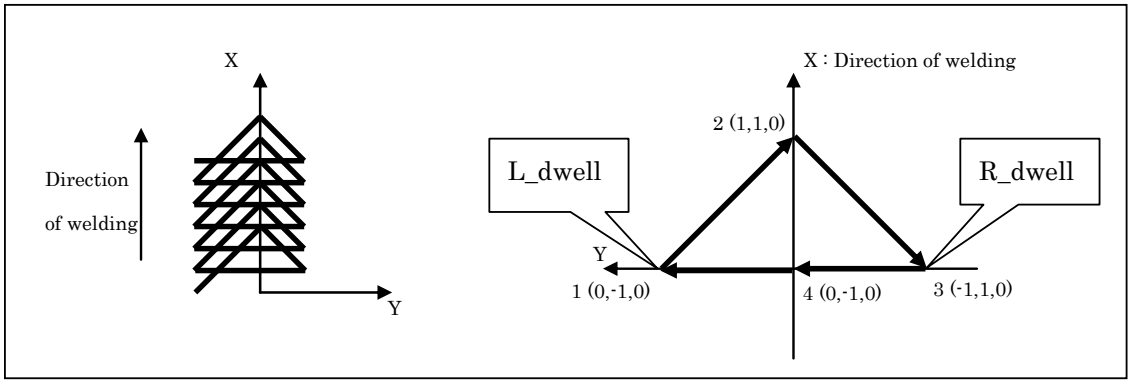


Fig. 8.7 (b) Triangle weaving

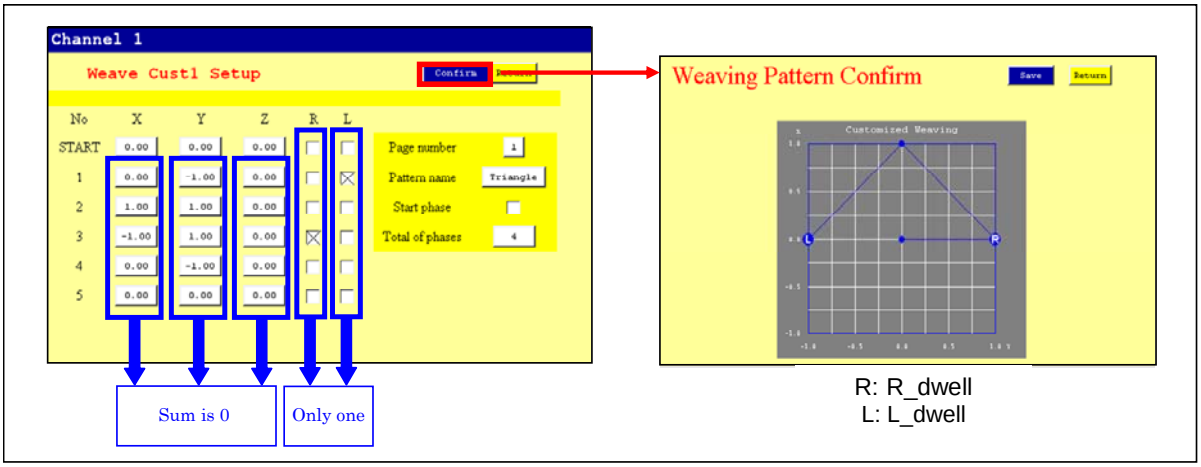


Fig. 8.7 (c) Weaving pattern setup and confirmation of triangle

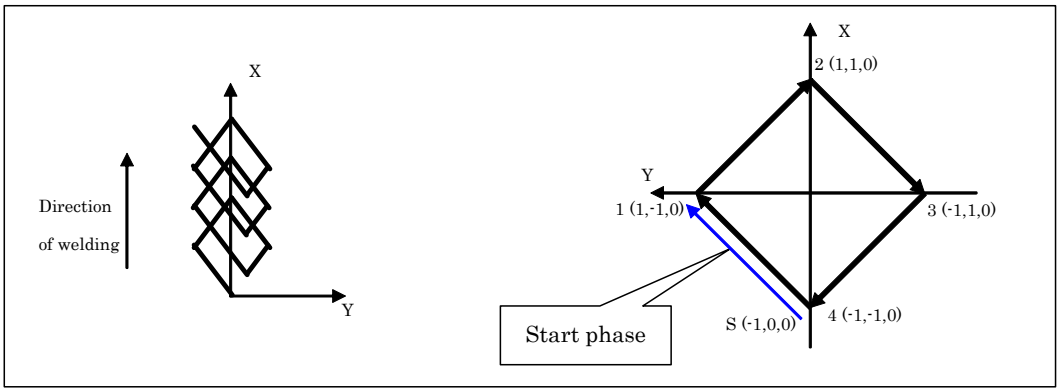


Fig. 8.7 (d) Diamond weaving

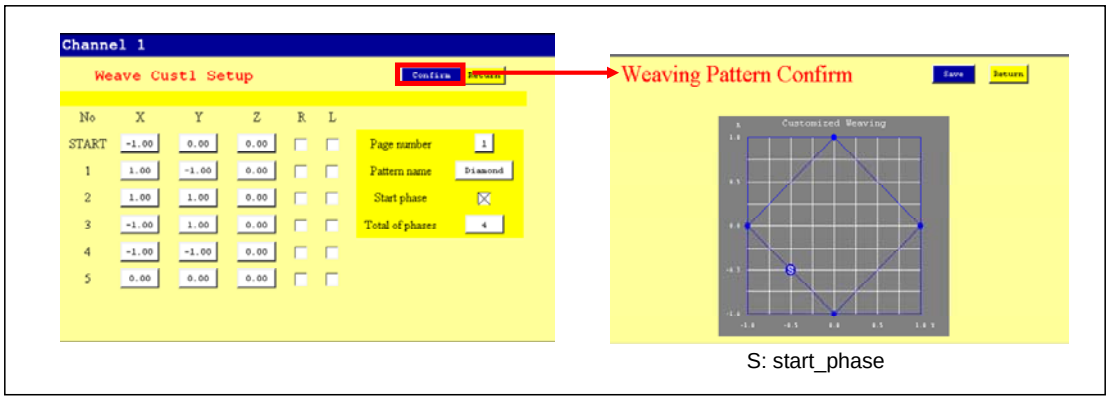
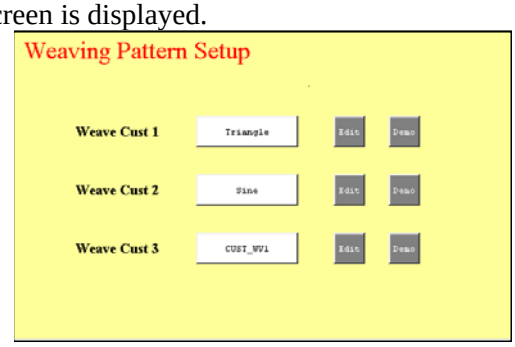


Fig. 8.7 (e) Weaving pattern setup and confirmation of diamond

Procedure 8-7 Weaving pattern setting

Step

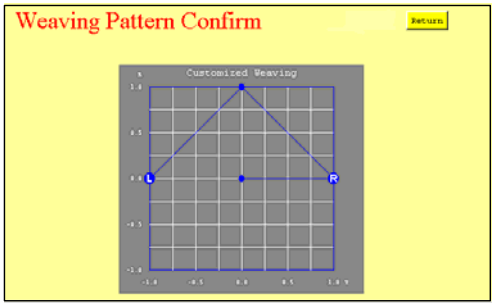
1 To display weaving pattern setup press [MENU] key, select 6(SETUP), and select WEAVE CUST. Weaving Pattern Setup screen is displayed.



2 Press the Edit button of the weaving pattern you want to set up. Press the Demo button when if want to see the weaving pattern which have already been set.

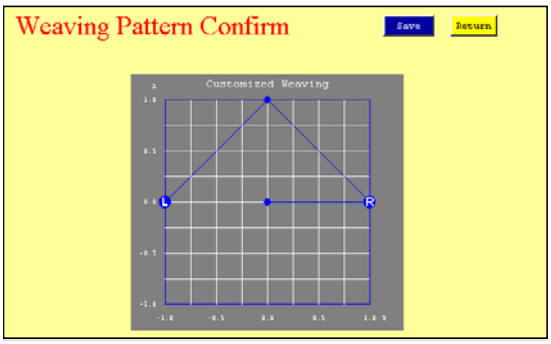
Edit

Demo

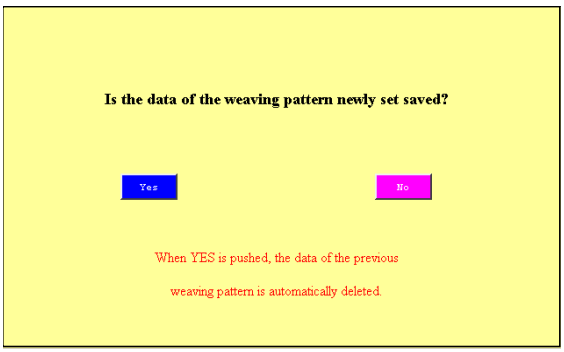


3 Input 2 to page number of Weave Cust1 Setup when you want to use six phases or more.

4 Press “Confirm” button of the screen of Weave Cust Setup. The following weaving pattern confirms screen can be displayed.



5 Press the Save button when you want to save the set weaving pattern. The following screen is displayed. When Yes button is pressed, the data of the previous weaving pattern is automatically deleted.



Weaving Pattern Setting by KAREL

The weaving pattern can be defined by inputting directly the data of the weaving pattern to the KAREL variables. There are ten KAREL programs cust_wv*.pc (* is 1 to 10.). cust_wv*.pc set the sine type as default. If TP program calls cust_wv*.pc before executing the weaving instruction, then you can use the weaving pattern data set by KAREL. At this time, the weaving instruction executed after cust_wv*.pc must be Weave Cust3. Cust_wv*.pc called in the TP program overwrites the data of Weave Cust3 instruction. When the "Demo" button of the Weave Cust3 in Weaving Pattern Setup screen is pressed, the weaving pattern you defined is displayed.

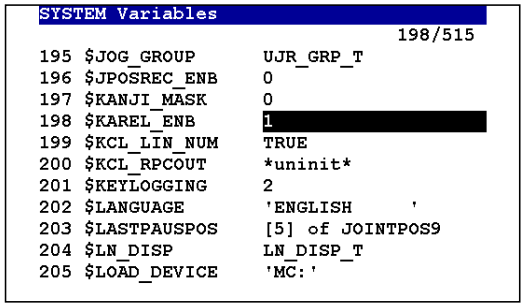
The following parameters are set, and the weaving pattern is made.

- PAT_NAME : Name of the weaving pattern
- USE_START : Start phase (True: enable, False: disable)
- S_VECTOR_X,Y,Z : Component of start phase's unit vector xyz.
- S_SWELL_R,L : Start phase dwell time (True: enable False: disable)
- NUM_PHASE : Total number of phases
- VECTOR*_X,Y,Z : Component of unit vector* xyz (* is 1 to 10.)
- DWELL*_R,L : Dwell time (True: enable False: disable)

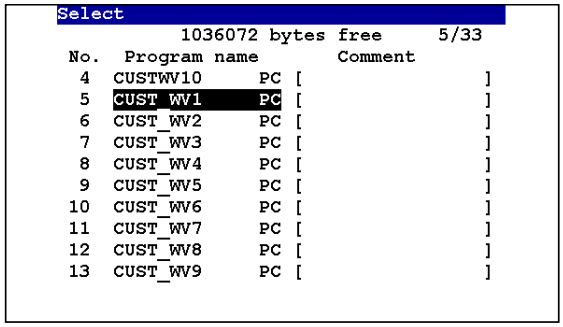
Procedure 8-8 Weaving pattern setting by KAREL

Step

1 Change the system variable $KAREL_ENB from 0 to 1 to enable the KAREL variables setup.
Go to SYSTEM Variables menu.
[MENU] → SYSTEM → F1 [TYPE] → Variables
Change the system variable $KAREL_ENB from 0 to 1.



2 Press SELECT key and then Program Select screen is displayed. Press F1(TYPE) and select KAREL Progs. Then move the cursor on cust_wv*.pc which you want to set and press ENTER key.



3 Go to KAREL variables screen.
[MENU] → DATA → F1 [TYPE] → KAREL Vars → [Enter]
Set the KAREL variables.

```
DATA KAREL Vars
CUSTWV1                                  1/60
  1 PAT_NAME          'CUST_WV1'
  2 USE_START         FALSE
  3 S_VECTOR_X        0.000
  4 S_VECTOR_Y        0.000
  5 S_VECTOR_Z        0.000
  6 S_DWELL_R         FALSE
  7 S_DWELL_L         FALSE
  8 NUM_PHASE         4
  9 VECTOR1_X         0.000
 10 VECTOR1_Y         -1.000
 11 VECTOR1_Z         0.000
```

KAREL program cust_wv1.pc of Fig. 8.7(f) is an example of setting weaving pattern of Fig. 8.7(a) and Fig. 8.7(b) using the KAREL variables.

cust_wv1.pc

```
PAT_NAME                    'Triangle'
USE_START                     FALSE
S_VECTOR_X                      0
S_VECTOR_Y                      0
S_VECTOR_Z                      0
S_DWELL_R                     FALSE
R_DWELL_L                     FALSE
NUM_PHASE                       4
VECTOR1_X                       0
VECTOR1_Y                      -1
VECTOR1_Z                       0
DWELL1_R                      TRUE
DWELL1_L                      TRUE
VECTOR2_X                       1
VECTOR2_Y                       1
VECTOR2_Z                       0
DWELL2_R                      FALSE
DWELL2_L                      FALSE
VECTOR3_X                      -1
VECTOR3_Y                       1
VECTOR3_Z                       0
DWELL3_R                      TRUE
DWELL3_L                      TRUE
```

```
VECTOR4_X                       0
VECTOR4_Y                      -1
VECTOR4_Z                       0
DWELL4_R                      FALSE
DWELL4_L                      FALSE
VECTOR5_X                       0
VECTOR5_Y                       0
VECTOR5_Z                       0
DWELL5_R                      FALSE
DWELL5_L                      FALSE
VECTOR6_X                       0
VECTOR6_Y                       0
VECTOR6_Z                       0
DWELL6_R                      FALSE
DWELL6_L                      FALSE
………………………….
………………………….
VECTOR10_x                      0
VECTOR10_y                      0
VECTOR10_z                      0
DWELL10_R                     FALSE
DWELL10_L                     FALSE
```

Fig. 8.7 (f) KAREL variables setting screen

⚠CAUTION

There are the following limitations when setting the weaving pattern by KAREL. When Weave Cust3 instruction is executed by the TP program and the following limitations are not fulfilled, the robot ABORT.

- Do not set 1 to the Karel variable “NUM_PHASE”.
- Do not set 0 to all Karel variable “VECTOR*_X,Y,Z”. (*=1 to Num_phase)

Procedure 8-9 Weaving pattern change by KAREL

Step

1 Following TP program is done by user.

```
PROGRAM2
                                        3/8
     1: J  P[1] 30% CNT100
     2: L  P[2] 500mm/sec FINE
       :   Weld Start[1,1]
     3:   Weave Cust3[1]
     4: L  P[3] 30cm/min FINE
       :   Weld End[1,1]
     5:    Weave End
     6: L  P[4] 500mm/sec CNT100
     7: J  P[1] 30% CNT100
   [End]

   | REGISTER |        | VALUE | CHOICE |        |
```

2 KAREL program cust_wv*.pc is called before WEAVE CUST3[1] execution.
Move the cursor to END. → Press the F1 (INST) key. Then, the control instruction menu is displayed. → Select CALL. → Select CALL program. → Press the F3 (KAREL) key. Then, the KAREL program list is displayed. Select cust_wv*.pc.

```
PROGRAM2
                                        3/9
     1: J  P[1] 30% CNT100
     2: L  P[2] 500mm/sec FINE
       :   Weld Start[1,1]
     3:   CALL CUST_WV1
     4:   Weave Cust3[1]
     5: L  P[3] 30cm/min FINE
       :   Weld End[1,1]
     6:    Weave End
     7: L  P[4] 500mm/sec CNT100
     8: J  P[1] 30% CNT100
   [End]

   |        |        |        | CHOICE |        |
```

⚠CAUTION
- It is necessary to call cust_wv*.pc before WEAVE CUST3 execution.
- The data of cust_wv*.pc is reflected only in WEAVE CUST3 instruction.

9 ARCTOOL RAMPING

9.1 OVERVIEW

ArcTool Ramping function gradually increases/decreases the parameters in a program at a specified rate. This function includes the following three functions.

- Weld Parameter Ramping
- Speed Ramping
- Weave Ramping

This function is an ArcTool standard function, and this is enabled by default.

9.2 WELD PARAMETER RAMPING

The weld parameter ramping allows you to gradually increase or decrease a welding parameter (Voltage, Current, etc) in specified section. It is possible to increase / decrease a welding parameter smoothly.
As this weld parameter ramping, there are following modes.

- Time Ramping
- Position Ramping
- Hold Ramping

Additionally, you can increase or decrease multiple commands simultaneously. Please refer to following figure that shows the overview of weld parameter ramping, weld parameter command is shown in Fig. 9.2 (a) if the setting is in the following TP program and weld procedure.

```
MAIN1
                                    1/6
 1: J P[1] 50% FINE
 2: L P[2] 100mm/sec FINE
  :  Weld Start[1,1]
 3: L P[3] WELD_SPEED CNT100
 :  Weld Start[1,2]
 4: L P[4] WELD_SPEED FINE
 :  Weld End[1,3]
 5: J P[1] 100% FINE
 [END]
   [INST]                    [EDCMD  >
```

```
DATA  Weld Procedure  1
                                    1/10
 + Procedure              1 [            ]
   -  Schedules
 Schedule #  Volts   Amps   Speed   Time  Ramp
 Runin        25.0   200.0          1.00
 Schedule 1   30.0   260.0  100.0   2.00  Time
 Schedule 2   20.0   140.0   70.0   0.00  Posn
 Schedule 3   17.0   100.0    0.0   1.00  Time
 Burnback     20.0     0.0          0.10
 Wirestick    20.0     0.0          0.10
 OnTheFly      0.1     5.0    1.0
   [TYPE]  DETAIL  [CMND]  [VIEW]  HELP
```

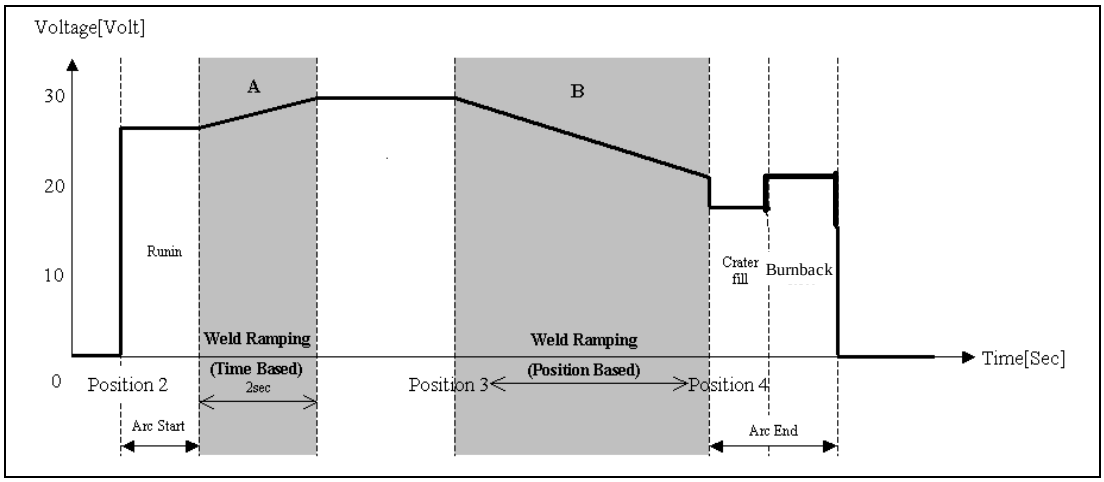


Fig. 9.2 (a) Sample program of weld parameter ramping

Time Ramping

In Time Ramping, you specify the ramping time(sec) in weld schedules. The command values increase or decrease from the previous command(this is weld parameter commands before changing) to current command (this is weld parameter commands after changing) during the delay time set into weld start instruction (Please refer to “A” in the Fig. 9.2 (a)).

Position Ramping

In Position Ramping, the command values increase or decrease from the previous command(this is weld parameter commands before changing) to current command(this is weld parameter commands after changing) till reaching the next taught position after the weld start instruction(Please refer to “B” in the Fig. 9.2 (a)).

Hold Ramping

Hold Ramping is basically the same as Time Ramping(That is, the command values increase or decrease from the previous command to current command during the delay time set into weld start instruction). Please refer to following figure about the difference. Hold Ramping is used in the case of first weld start instruction only.

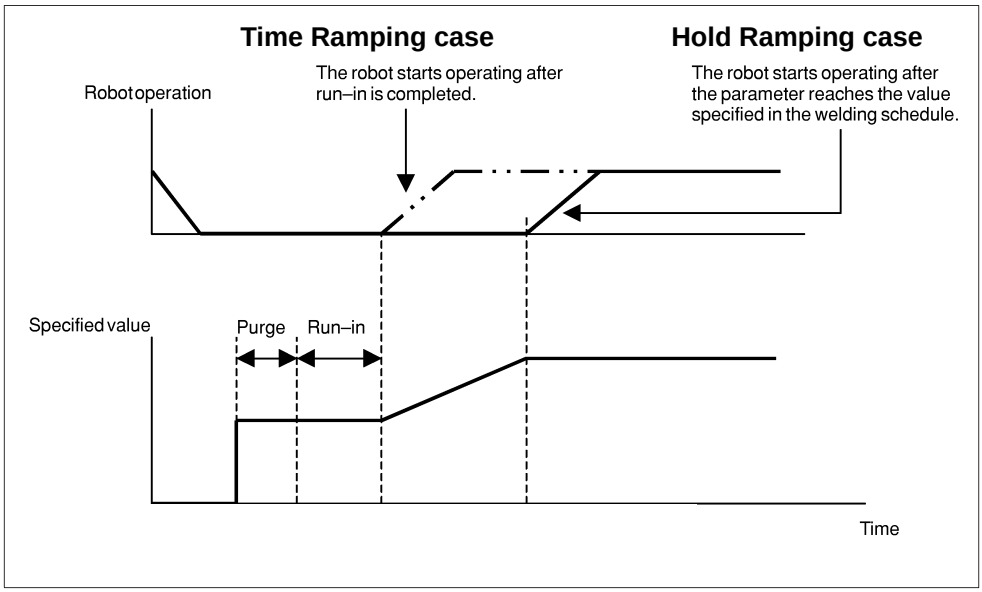


Fig. 9.2 (b) Robot operation at the beginning of welding

Ramping At the first Weld Start(use “Time” or “Hold” ramping)

In the first weld start instruction (not for changing weld schedules), the ramping is decided whether it is executed or not by the setting of runin enable/disable.

If Runin is enabled and the ramping is set to “Time” or “Hold” in the weld schedule that is used by the first weld start instruction, arc welding starts with runin schedule that is set in specified weld procedure number. After runin finishes, command values gradually increase or decrease to the weld schedule that is taught by the first weld start instruction.

If runin is disabled, arc welding starts with weld schedule that is taught by the first weld start instruction. So the ramping is not executed at the first weld start.

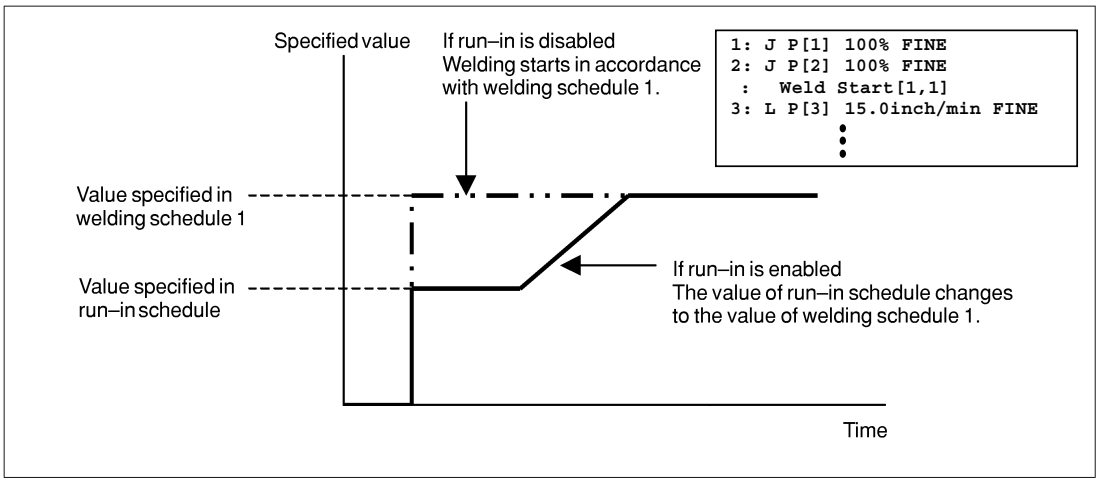


Fig. 9.2 (c) Ramping at the first weld start

Ramping At the Weld End(use “Time” ramping)

In the crater fill of weld end instruction, it is possible to setup the ramping whether it is executed or not. If the ramping is set to “Time” in the weld schedule that is used by the weld end instruction, command values gradually increase or decrease to the weld schedule(crater fill schedule) that is taught by weld end instruction.

Weld Parameter Ramping is not performed during wire stick reset.

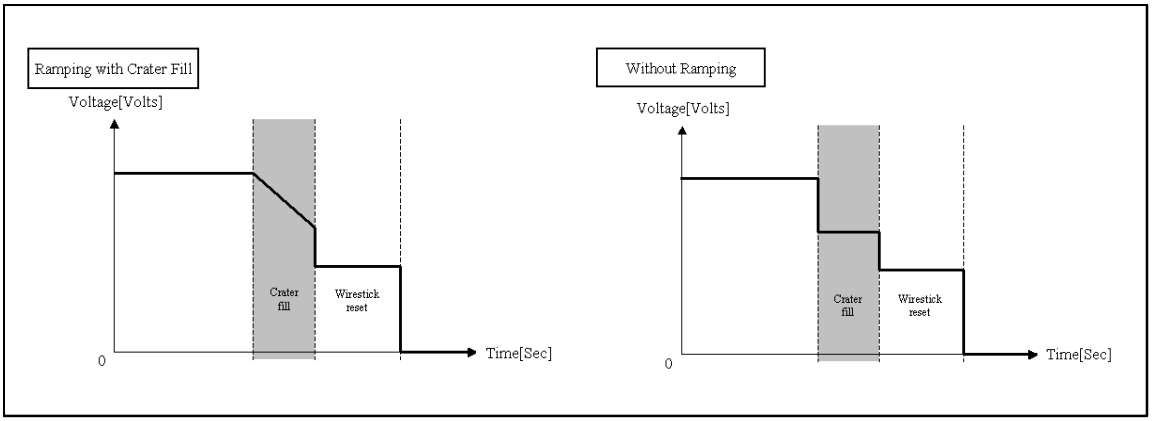


Fig. 9.2 (d) Ramping at the crater fill

How to Teach Weld Parameter Ramping

How to teach weld parameter ramping is different by the format of arc weld instruction. Please refer to Procedure 9-1 for arc weld schedule format, and refer to Procedure 9-2 for direct format.

> **NOTE**
> Weld parameter ramping with direct format is supported only by R-30iB Plus controller.

Procedure 9-1 How to teach weld parameter ramping (Schedule format)

Step

1 Press [MENU] key.
2 Select the [DATA].
3 Press F1[TYPE].
4 Select the [Weld Procedure].

5 Move the cursor to [Procedure] and press the ENTER key. Move the cursor to [Ramping] and change it to ENABLED.

```
DATA  Weld Procedure  1
                                        1/14
  - Procedure          1[              ]
     Weld equipment:  1
     Manufacturer:     General Purpose
     Model:            MIG(Volts, Amps)
     File name:        AWE1WP01
     Schedules:        3

     Runin:                 DISABLED
     Burnback:              ENABLED
     Wirestick resets:   3   ENABLED
     Ramping:               DISABLED

     Gas purge:              0.35  sec
     Gas preflow:            0.00  sec
     Gas postflow:           0.00  sec

   [ TYPE ]  DETAIL  [CMND]  [VIEW]  HELP
```

If the setting item of [Ramping] is not displayed, please repower after changing following system variables to TRUE.

- **$AWERAMP[i].$RAMP_ENABLE (“i” is the equipment number)**

Enable or disable of Weld Parameter Ramping.

- **$AWERAMP[i].$RAMP_TO_POS**

Enable or disable of Position ramping.

NOTE

1 If $RAMP_ENABLE is FALSE, Weld Parameter ramping does not work even if $RAMP_TO_POS is TRUE. If you change those system variables, please repower the robot controller.

2 Speed Ramping is always TRUE regardless of these system variables.

6 Move the cursor to [Schedules] and press ENTER key. Following screen is displayed.

```
DATA  Weld Procedure  1
                                        1/10
 + Procedure            1  [              ]
   -  Schedules

 Schedule #  Volts   Amps   Speed   Time  Ramp
 Runin        25.0   200.0          1.00
 Schedule 1   30.0   260.0  100.0   2.00  None
 Schedule 2   20.0   140.0   70.0   0.00  None
 Schedule 3   17.0   100.0    0.0   1.00  None
 Burnback     20.0     0.0          0.10
 Wirestick    20.0     0.0          0.10
 OnTheFly      0.1     5.0    1.0

   [ TYPE ]  DETAIL  [CMND]  [VIEW]  HELP
```

7 When you move the cursor to “Ramp” of weld schedule number that is used by weld start instruction and press the F4[CHOICE], following menu is displayed. Please select the desired mode. If “Time” or “Hold” are selected, please set the ramping time(This setting can be also executed in the weld schedule detailed screen).

```
      1
1 None
2 Posn
3 Time
4 Hold
5
6
7
8
```

8 Teach the weld start instruction in the program edit screen and specify the weld schedule number that is set to weld parameter ramping.

Procedure 9-2 How to teach weld parameter ramping (Direct format)

Step

1 Set system variable $AWSPCR.$AS_TIM_ENAB to TRUE on system variable screen and execute cycle power.
2 Teach arc weld instruction of direct format on program edit screen.
3 “0.0s” is added to the end of arc weld instruction. Please input the ramping time here. In the following program, the command values change from weld schedule of the arc start instruction on line 3 (140Amps, 16.0Volts) to the instruction on line 5 (160Amps, 17.5Volts) within two seconds after arriving at position 3.

```
MAIN1
                                        1/6
 1: J P[1] 50% FINE
 2: L P[2] 100mm/sec FINE
 3:   Weld Start[1,140.0Amps, 16.00Volts,
 :   0.00, 0.0s]
 4: L P[3] WELD_SPEED CNT100
 5:   Weld Start[1,160.0Amps, 17.50Volts,
 :   0.00, 2.0s]
 [END]

   [INST                [EDCM   >
```

4 Above procedure is for time ramping. If you want to achieve position ramping, please check that the system variable $AWERAMP[i].$RMP_TO_POS is TRUE first. If this is FALSE, please change it to TRUE.
5 Input “99.0” to time delay item on arc weld instruction. By this setting, ramping type becomes position ramping for the arc weld instruction.
6 If you want to use hold ramping type, set the system variable $AWERAMP[i].$RAMP_HOLD to TRUE and then specify the wait time to the arc weld start instruction which is executed first (this instruction is not for weld schedule change).

Ramping starts before previous Ramping finishes

If Time Ramping is used, there is a possibility that the next weld start instruction is executed while the command values gradually increase or decrease (before arriving at the weld schedule of weld start instruction that is performed now). In this case, current ramping is interrupted. For the next motion, command values will change depending on the following cases.

- Weld parameter ramping is specified in the next weld start instruction
  The command value is changed to the value which is specified on previous weld start instruction, and then the command value is gradually changed to the value of the next weld start instruction.

- Weld parameter ramping is not specified in the next weld start instruction
  The command value is immediately changed to the value of the next weld start instruction.

A user can create the program using this characteristic. To avoid the interruption of ramping, please allow sufficient time before the next motion instruction, or use the position ramping. Or please use the wait instruction.

> ⚠**CAUTION**
> This function is not performed during gas purge, runin, burnback, or wire stick reset. This function cannot use with direct format arc weld instructions.

9.3 SPEED RAMPING

In the Speed Ramping, it is possible to increase or decrease the robot motion speed gradually while the robot moves from the starting position to the destination position.

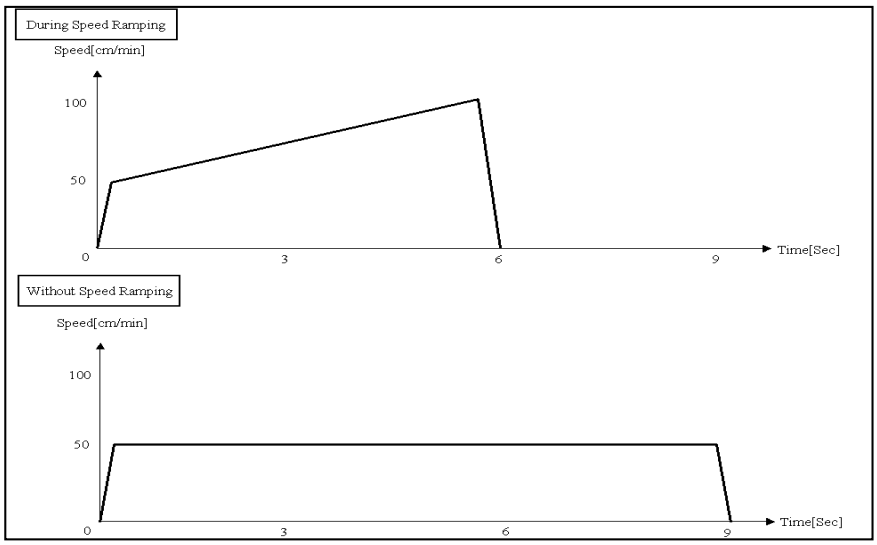


Fig. 9.3 Speed ramping

> **NOTE**
> This function does not support A motion instruction.

Procedure 9-3 How to teach speed ramping

Step

1 Teach motion instruction in program edit screen. Please enter the Ramping start speed to motion speed.

```
MAIN1
                                        1/3
     1: J P[1] 100% FINE
     2: L P[2] 250cm/min FINE
   [END]

   [INST]                          [EDCMD]  >
```

2 Move the cursor to the last blank of motion instruction.
3 Press F4[CHOICE] and select [RampTo] from the menu.

```
 Motion Modify  3
1 Offset/Frames
2 PSPD
3 Offset,PR[]
4 Incremental
5 RampTo
6 RampTo R[]
7 Tool_Offset
8 –next page--
```

4 [RampTo (…)] is added to motion instruction. Input the speed value you want to reach finally (destination speed). The speed unit of RampTo becomes the same as the speed unit of the motion instruction.

```
MAIN1
                                        2/3
      1: J P[1] 100% FINE
      2: L P[2] 250cm/min FINE
        :  RampTo (…)
    [END]

     ENTER Pamp Speed.

   [INST]                          [EDCMD]  >
```

Detailed Specification of Speed Ramping

- Speed Ramping can be also used with WELD_SPEED instruction or register (specifying indirect value).
- If the motion distance is shorter than the time to complete the motion to accelerate/decelerate to the specified speed, the controller will post an alarm and Speed Ramping will not executed.
- Speed Ramping can be used with mm/sec, cm/min and inch/min. If sec, msec, deg/sec are used as the speed unit, the controller will post an alarm and Speed Ramping will not executed.
- When the motion is orientation dominated, the controller will post an alarm and Speed Ramping will not executed.
- Speed Ramping is not executed during the backward execution.
- Speed Ramping is not executed during the dry run mode.

9.4 WEAVE RAMPING

Weave Ramping can change the following parameters gradually during weaving.

- Frequency (Freq)
- Amplitude (Ampl)

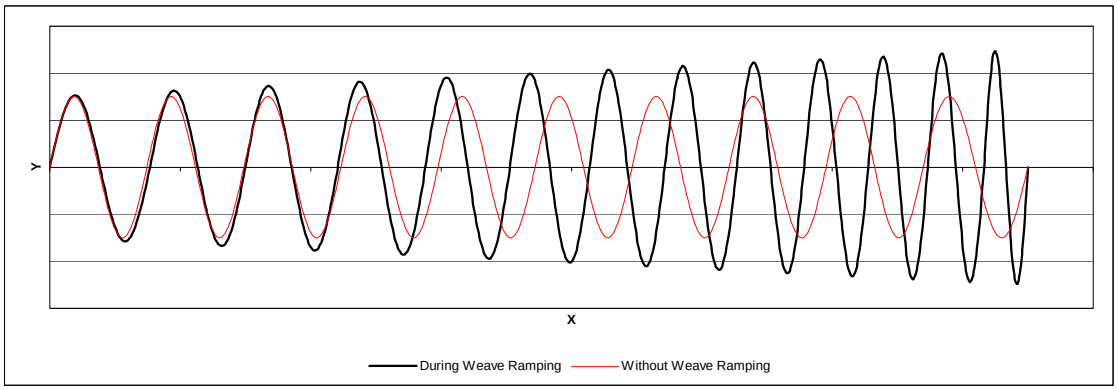


Fig. 9.4 Weave ramping

Procedure 9-4 How to teach weave ramping

Step

1 Change system variable $WVCFG.$RAMP_ENB to TRUE. Weave Ramping becomes enabled.
2 Create the weaving program in program edit screen(Refer to Chapter 8).

```
MAIN1
                                        1/5
      2: L P[1] 250cm/min FINE
       :  Weld Start[1,1]
      3:  Weave Sine[1]
      4: L P[2] 8mm/sec FINE
    [END]

  POINT | WELD_ST | WELD_PT | WELDEND | TOUCHUP | >
```

3 Move the cursor to the end of the motion instruction that placed between Weave Start - Weave End.
4 Press F4[CHOICE] and select `[WV[ ] ] in the menu.`

```
 Motion Modify  4
1 Skip,LBL,PR
2 TIME AFTER
3 DISTANCE BEFORE
4 COORD
5 COORD[LDR]
6 WV[]
7 PTH
8 –next page--
```

5 [WV[…]] is added to the end of the motion instruction. Enter the number of the weaving schedule that has the destination frequency or amplitude.

```
MAIN1
                                        4/5
      2: L P[1] 250cm/min FINE
       :  Weld Start[1,1]
      3:  Weave Sine[1]
      4: L P[2] 8mm/sec FINE WV[…]
    [END]

     Enter schedule number.
  REGISTER |  |  | CHOICE |  | >
```

Detailed Specification of Weave Ramping

- Weave Ramping is not executed during backward execution.
- Weave Ramping only partially supports TAST(Through Arc Seam Tracking). It supports amplitude ramping, but does not support ramping of the weave frequency.

9.5 RESUMING AFTER A FAULT

Resume the Weld Parameter Ramping after a Fault

If runin is enabled, welding is resumed with runin schedule after the program is paused by a fault during weld parameter ramping. At the resuming, either weld parameter ramping with robot motion or weld parameter ramping without robot motion is decided based on the ramping mode (“Time” or “Hold” that is set in weld schedule) that is used at resuming.
Following system variables decides the welding commands at the resuming. If it is FALSE, the welding resumes with runin schedule. If it is TRUE, the welding resumes with commands that is the ramping value at the program paused timing. This setting is respectively prepared for Time ramping and Position ramping.

- $AWERAMP[i].$TIM_RMP_RSM
  This variable decides resuming method for Time ramping. If TRUE, Time ramping resumes at paused values. If FALSE, Time ramping resumes from the runin schedule.
- $AWERAMP[i].$POS_RMP_RSM
  This variable decides resuming method for Position ramping. If TRUE, Position ramping resumes at paused values. If FALSE, Position ramping resumes from the runin schedule.

Resume Speed Ramping after a Fault

If program is paused and resumed during Speed ramping, resuming method is different depending on Original Path Resume is enable or disable (Refer to Section 3.3).

- Original Path Resume is enabled
  When the robot is moved from the paused position during pausing, the robot moves back to the paused point. After returning to the paused position, The Speed ramping resumes from the speed of Weld Restart function to the desired speed.
- Original Path Resume is disabled
  The robot moves from the current position to the destination position with the speed before paused and the Speed ramping resumes from the paused speed to desired speed.

Resume Weave Ramping after a Fault

After the motion is resumed, the weave will resume its frequency and amplitude before the fault, and complete the motion with the desired weave frequency and amplitude.

9.6 USING OTHER FUNCTIONS

Using On The Fly Function

On The Fly function (Refer to Chapter 17) is temporarily disabled during a ramping. When parameters are ramped, On The Fly screen will show the command values changing (But cannot check the Speed ramping). If you use the increment or decrement function keys, a warning message will be displayed.

Using Through-Arc Seam Tracking (TAST)

Through-Arc Seam Tracking (Refer to Chapter 20) will not function properly if you program a weld parameter ramping during tracking. Please do not execute the weld parameter ramping during tracking.

10 HEAT WAVE SYNC

10.1 OVERVIEW

HeatWave Sync is a function that controls the amount of heat input by changing the welding commands periodically during welding. This function has two method, one is a method that changes the welding commands with synchronizing the weaving motion (Weave Sync HeatWave), other is a method that changes the welding commands with arbitrary pulse frequency and pulse duty (Pulse HeatWave).

This function is an option (A05B-XXXX-R799). When the TIG Arc Weld Package option (A05B-XXXX-J582) is ordered (but not ordering A05B-XXXX-R551), it is supported to use the pulse HeatWave only.

Weave Sync HeatWave

This mode provides a welding method that controls welding commands with synchronizing the weaving motion, it is possible to control each welding commands arbitrary based on the weaving center/left/right position. Therefore, it is possible to control the amount of heat input by adjusting the weaving frequency. This method can improve weld process tolerance for joint point variation. It is possible to weld the object that combines the different thickness because the shape of welding bead can be finely controlled.

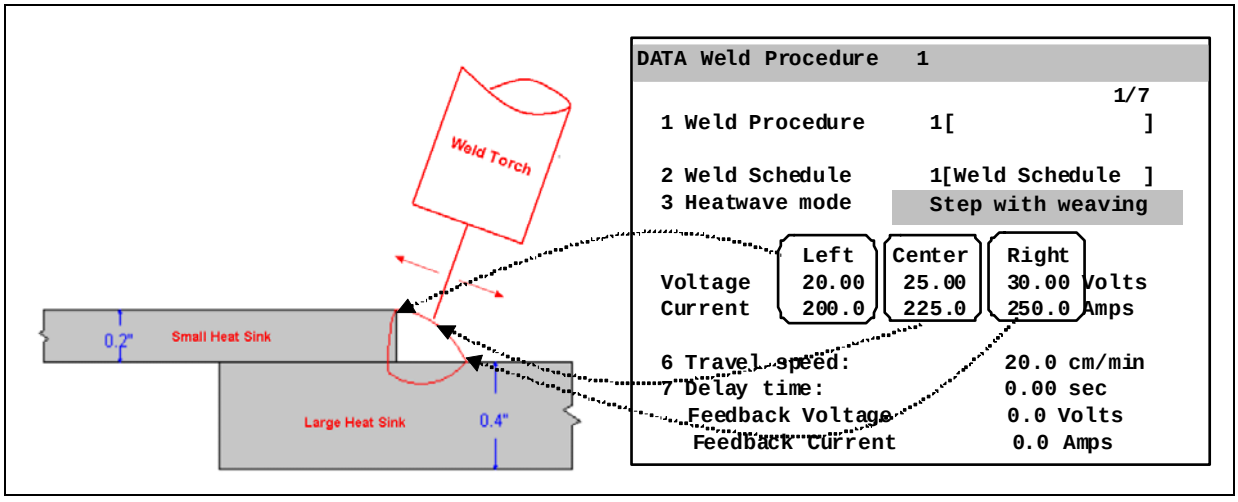


Fig. 10.1 (a) Weave Sync HeatWave

Pulse HeatWave (Low-Frequency Pulse welding)

This mode provides a low-frequency pulse welding method that controls welding commands with arbitrary pulse frequency and pulse duty, the peak commands (higher weld schedule) and the base commands (lower weld schedule) are periodically changed with arbitrary pulse frequency (0.1–10Hz) and pulse duty by a robot side. It is possible to apply the low-frequency pulse welding regardless of the kind of weld equipments / weld processes because the pulse waveform of weld commands is arbitrarily controlled by a robot side.

By applying this mode to aluminum MIG pulse welding, it is possible to combine the high-frequency (decided by weld equipment side) and low-frequency (decided by robot side) in the pulse welding, so heat input is reduced even in pulse welding, and this welding can prevent burn-through. Additionally, high quality bead like TIG welding is formed by aluminum MIG welding.

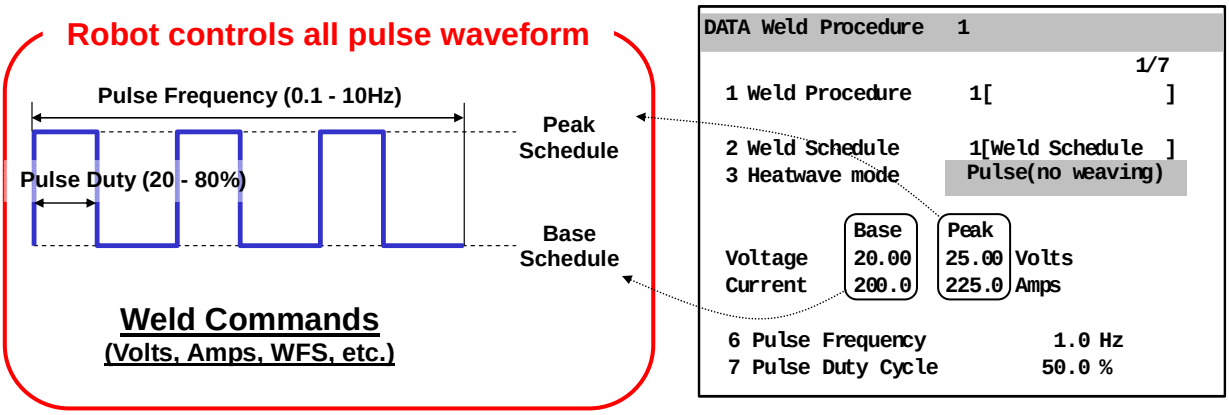


Fig. 10.1 (b) Pulse HeatWave

10.2 WEAVE SYNC HEATWAVE

In the Weave Sync HeatWave, user sets each weld schedules for weaving center/left/right positions. On the other hand, it is possible to change each weld schedule gradually during the weaving motion by automatic using of ramping function (refer to Chapter 9), welding commands gradually changes in the motion between the center position and left/right position.

There are two modes in the Weave Sync HeatWave.

Step with weaving

The weld command is changed by step when the weaving motion reaches to the endpoint (left and right). The center weld schedule is outputted during the weaving motion other than the endpoint motion. The left weld schedule is outputted during the weaving left endpoint motion only. The right weld schedule is outputted during the weaving right endpoint motion only. In this mode, user normally sets each left and right dwell in the weaving schedule.

Ramp with weaving

The weld command is gradually changed by ramping in the weaving motion between the center position and the endpoint (left and right) position.
The center weld schedule is outputted at the weaving center motion. In the weaving motion from the center position to left (or right) position, the weaving motion is executed with ramping from the center weld schedule to the left (or right) weld schedule. In the weaving motion from the left (or right) position to the center position, the weaving motion is also executed with ramping from the left (or right) weld schedule to the center weld schedule. When user sets each left and right dwell in the weaving schedule, each endpoint weld schedule is outputted at the weaving end point motion.

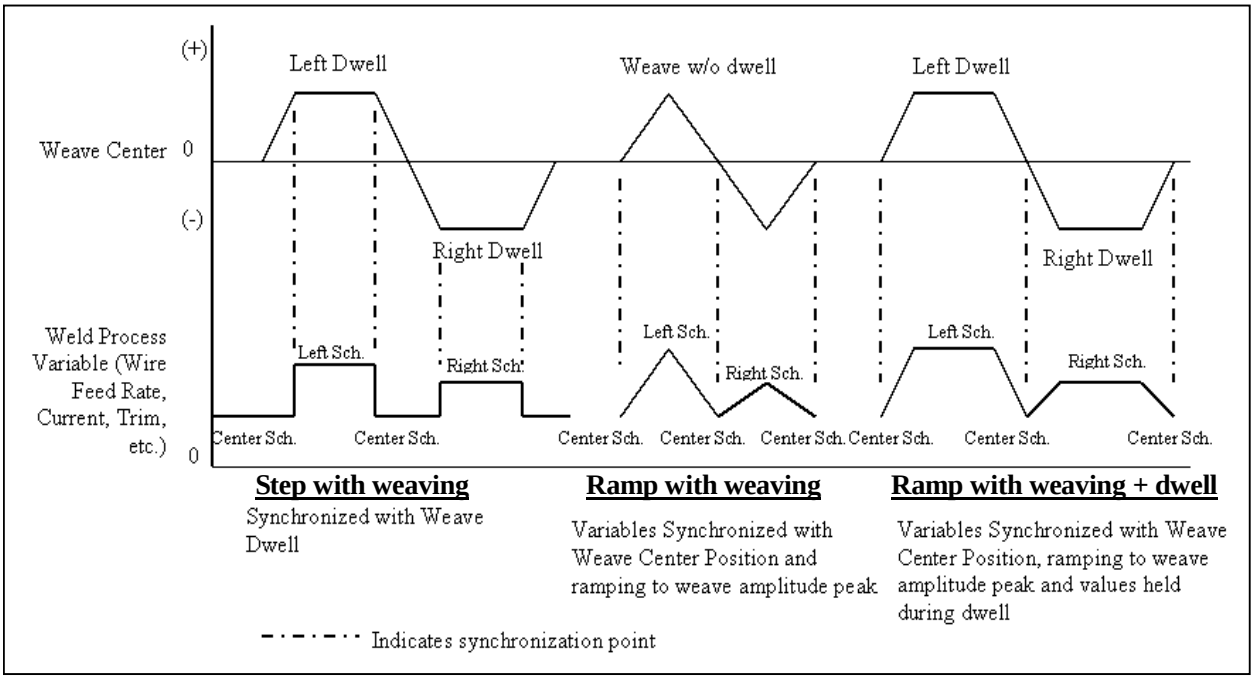


Fig. 10.2 Step with weaving mode and ramp with weaving mode

How to use the Weave Sync HeatWave

The following procedure explains how to use the Wave Sync HeatWave.

Procedure 10-1 How to use the Weave Sync HeatWave

Condition

- HeatWave Sync option is ordered.

Step

1 Press the [MENU] key and select [DATA]. Or press DATA key.
2 Press F1[TYPE].
3 Select [Weld Procedure].
4 Move the cursor to [Procedure] that you use and press ENTER key. Following screen is displayed.

```
DATA  Weld Procedure  5
                                  1/14
  - Procedure          5[              ]
     Weld equipment:  1
     Manufacturer:     General Purpose
     Model:           MIG(Volts, Amps)
     File name:       AWE1WP05
     Schedules:       3

     Runin:                   DISABLED
     Burnback:                 ENABLED
     Wirestick resets:   3     ENABLED
     Ramping:                 DISABLED
     Heatwave:                 DISABLED

     Gas purge:                0.35  sec
     Gas preflow:              0.00  sec
     Gas postflow:             0.00  sec

   [ TYPE ]  DETAIL  [CMND]  [VIEW]  HELP
```

5 Move the cursor to [Heatwave] and press F4[ENABLED]. If the HeatWave Sync option is ordered but the setting item of [Heatwave] is not displayed, please execute the Procedure 10-3.

6 Move the cursor to [Schedules] and press ENTER key.

```
DATA  Weld Procedure  5
                                                  1/9
 + Procedure                  5 [                 ]
   -  Schedules

 Schedule #  Volts   Amps   Speed   Time
 Schedule 1   20.0   200.0   20.0   0.00
 Schedule 2   20.0   200.0   20.0   0.00
 Schedule 3   20.0   200.0   20.0   0.00
 Burnback     20.0     0.0          0.10
 Wirestick    20.0     0.0          0.10
 OnTheFly      0.1     5.0    1.0

 [ TYPE ] | DETAIL | [CMND] | [VIEW] | HELP
```

7 Move the cursor to the weld schedule that you use in HeatWave and press F2[DETAIL].

```
DATA  Weld Procedure
                                                  1/7
 1 Weld Procedure     5[                           ]

 2 Weld Schedule      3[Weld Schedule              ]
 3 Heatwave mode      None
 4 Voltage:                              20.00  Volts
 5 Current:                              200.0  Amps
 6 Travel speed:                          20.0  cm/min
 7 Delay time:                            0.00  sec
   Feedback Voltage                        0.0  Volts
   Feedback Current                        0.0  Amps

 [ TYPE ] | SCHEDULE | ADVISE | [CHOICE] | HELP
```

8 Move the cursor to [Heatwave mode] and press F4[CHOICE], select [Step with weaving] or [Ramp with weaving]. Left and Right, Center weld schedules are displayed.

```
DATA  Weld Procedure
                                                  1/7
 1 Weld Procedure     5[                           ]

 2 Weld Schedule      3[Weld Schedule              ]
 3 Heatwave mode      Step with weaving

                 Left   Center   Right
 Voltage        20.00   25.00   30.00  Volts
 Current        200.0   225.0   250.0  Amps

 6 Travel speed:                         20.0  cm/min
 7 Delay time:                           0.00  sec
   Feedback Voltage                       0.0  Volts
   Feedback Current                       0.0  Amps

 [ TYPE ] | SCHEDULE | ADVISE | [CHOICE] | HELP
```

9 Input each weld schedules.

10 Next, create the TP program that executes the Weave Sync HeatWave. Teach the weld start instruction that specifies the HeatWave weld schedule number, and teach the weave instruction.

```
MAIN1
                                                  1/6
     2:L P[1] 100mm/sec FINE
      :  Weld Start [5,3]
     3:  Weave Sine[1]
     4:L P[2] 100cm/min FINE
      :  Weld End [5,2]
     5:  Weave End
    [END]

   [INST]                                    [EDCMD]  >
```

> ⚠ **CAUTION**
> There is a case that the welding commands is not changed correctly after Dynamic Arc ON/OFF(Refer to Section 5.4) is performed during the Weave Sync HeatWave. Do not perform the Dynamic Arc ON/OFF during the Weave Sync HeatWave.

Detailed specifications and limitations of Weave Sync HeatWave

- Weave Sync HeatWave does not support the weld start instruction of direct type. If direct type weld start instruction is executed, Weave Sync HeatWave is never executed and standard weld start is executed.
- Weave Sync HeatWave can work only when Weave Pattern is Weave Sine. When other Weave Pattern is used, Weave Sync HeatWave does not work.
- If the weld start instruction specifies the weld schedule number that is set to Weave Sync HeatWave(Step with weaving mode or Ramp with weaving mode) but there is not weave instruction, standard weld start is executed. In this case, left and right weld schedule is never outputted.
- Weave Sync HeatWave does not support On The Fly function. Do not use On The Fly function during Weave Sync HeatWave.
- Weave Sync HeatWave does not support Arc End pre-time. During Weave Sync HeatWave, Arc End pre-time is ignored and normal craterfill is performed.
- There is a case that the program is paused and welding is interrupted by alarms “ARC-057 Cannot ramp t1 = xx > t2 = xx” and “ARC-133 Adjusted time_factor xx to xx” when the ramp with weaving mode is used. At that alarm timing, the parameter to decide the timing of switching commands by ramping ($AWERAMP[i].$TIME_FACTOR) is automatically adjusted. Therefore, it is possible to restart the program after alarm reset. Additionally, those alarms never generated after the parameter within a proper value.

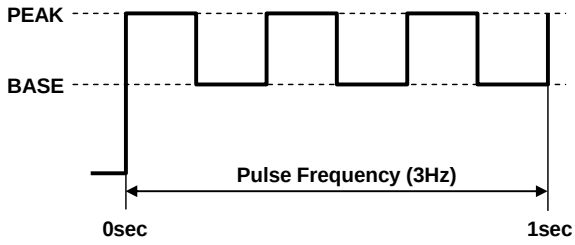
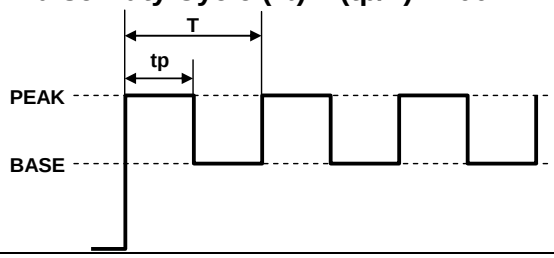
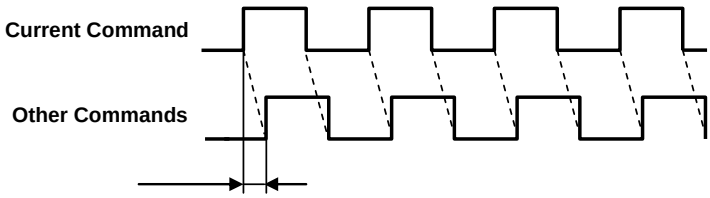
10.3 PULSE HEATWAVE

In the Pulse HeatWave, weld commands is periodically changed to peak schedule or base schedule. It is necessary to setup the peak and base weld schedule. Moreover, it is necessary to setup the pulse frequency and pulse duty though the change timing of weld schedule synchronizes the weaving motion in Weave Sync HeatWave.

Condition of Pulse HeatWave

The following table explains the setting item of Pulse HeatWave.

Table 10.3 Condition of pulse HeatWave

SETTING ITEM	DESCRIPTION
Pulse Frequency	This item is the iterative frequencies for the combination of base and peak commands at per 1 second. Allowable Pulse Frequency range is 0.1Hz – 10Hz. (Default is 1Hz) 
Pulse Duty Cycle	This is the ratio concerning to the “Peak width” and “Total width of Base and Peak” in the waveform of Pulse Frequency. This is calculated by the following expression. Allowable Pulse Duty Cycle range is 20% - 80%. (Default is 50%) **Pulse Duty Cycle (%) = (tp/T) * 100** 
Phase Shift	This specifies the amount of phase shift concerning to the current command (Basis of command parameter) and the other commands. This can adjust the switching timing of Base/Peak Schedules. Allowable Phase Adjustment range is -180deg - +180deg.  **Phase Adjustment (deg)** **NOTE** When the Pulse HeatWave is used in the TIG welding with Wire Feed Speed/Current command control, the basis of command parameter for Phase Shift is Wire Feed Speed command.

How to use the Pulse HeatWave

The following procedure explains how to use the Pulse HeatWave.

Procedure 10-2 How to use the Pulse HeatWave

Condition

- HeatWave Sync option or TIG Arc Weld Package option is ordered.

Step

1 Press [MENU] key and select [DATA]. Or press DATA key.
2 Press F1[TYPE].
3 Select [Weld Procedure].

4 Move the cursor to [Procedure] that you use and press ENTER key. Following screen is displayed.

```
DATA  Weld Procedure  4
                                  1/14
 - Procedure          4[              ]
    Weld equipment:  1
    Manufacturer:     General Purpose
    Model:           MIG(Volts, Amps)
    File name:       AWE1WP04
    Schedules:       3

    Runin:                   DISABLED
    Burnback:                ENABLED
    Wirestick resets:   3    ENABLED
    Ramping:                 DISABLED
    Heatwave:                DISABLED

    Gas purge:               0.35  sec
    Gas preflow:             0.00  sec
    Gas postflow:            0.00  sec

  [ TYPE ] | DETAIL | [CMND] | [VIEW] | HELP
```

5 Move the cursor to [Heatwave] and press F4[ENABLED]. If the HeatWave Sync option is ordered but the setting item of [Heatwave] is not displayed, please execute the Procedure 10-3.

6 Move the cursor to [Schedules] and press ENTER key.

```
DATA  Weld Procedure  4
                                          1/9
 + Procedure                  4 [             ]
   -  Schedules

 Schedule #  Volts   Amps   Speed   Time
 Schedule 1   20.0   200.0   20.0   0.00
 Schedule 2   20.0   200.0   20.0   0.00
 Schedule 3   20.0   200.0   20.0   0.00
 Burnback      20.0    0.0          0.10
 Wirestick     20.0    0.0          0.10
 OnTheFly       0.1    5.0    1.0

  [ TYPE ] | DETAIL | [CMND] | [VIEW] | HELP
```

7 Move the cursor to the weld schedule that you use in HeatWave and press F2[DETAIL].

```
DATA  Weld Procedure
                                          1/7
 1 Weld Procedure     4[                     ]

 2 Weld Schedule      1[Weld Schedule        ]
 3 Heatwave mode      None
 4 Voltage:                          20.00  Volts
 5 Current:                          200.0  Amps
 6 Travel speed:                      20.0  cm/min
 7 Delay time:                        0.00  sec
   Feedback Voltage                    0.0  Volts
   Feedback Current                    0.0  Amps

  [ TYPE ] | SCHEDULE | ADVISE | [CHOICE] | HELP
```

8 Move the cursor to [Heatwave mode] and press F4[CHOICE], select [Pulse(no weaving)]. Base and Peak weld schedules are displayed. And, [Pulse Frequency] and [Pulse Duty Cycle] are also displayed. By the way, Step with weaving mode and Ramp with weaving mode can not be selected when TIG Arc Weld Package option is ordered but HeatWave Sync option is not ordered.

```
DATA  Weld Procedure
                                                  1/9
 1 Weld Procedure     4[                            ]

 2 Weld Schedule      1[Weld Schedule               ]
 3 Heatwave mode      Pulse(no weaving)

                Base   Peak
 Voltage       20.00   25.00  Volts
 Current       200.0   225.0  Amps

 6 Pulse Frequency            1.0 Hz
 7 Pulse Duty Cycle          50.0 %

 8 Travel speed              20.0  cm/min
 9 Delay time                 0.00 sec
   Feedback Voltage            0.0 Volts
   Feedback Current            0.0 Amps

 [ TYPE ] SCHEDULE ADVISE [CHOICE] HELP
```

9 Input each weld schedules.

10 Input [Pulse Frequency] and [Pulse Duty Cycle].

11 If you want to set the [Phase Shift], please display the weld schedule detailed screen again after changing the system variable of $AWEPLS[i].$PHSFT_ENB (i : weld equipment number) to TRUE. [Phase Shift] is displayed under [Pulse Duty Cycle].

12 Next, create the TP program that executes the Pulse HeatWave.

```
MAIN1
                                                  1/4
     2:L P[1] 100mm/sec FINE
      :  Weld Start [4,1]
     3:L P[2] 100cm/min FINE
      :  Weld End [4,2]
    [END]

 [INST]                                  [EDCMD] >
```

13 It is possible to execute the Pulse HeatWave during crater fill by specifying the weld schedule number (that is set to [Pulse(no weaving)] mode) in weld end instruction.

> ⚠ **CAUTION**
> Pulse HeatWave does not support the weld start/end instruction of direct type. If direct type weld start/end instruction is executed, Pulse HeatWave is never executed and standard weld start/end is executed.

> ⚠ **CAUTION**
> There is a case that the program is paused and welding is interrupted by alarms “ARC-136 Cannot pulse t1 = xx > t2 = xx” and “ARC-133 Adjusted time_factor xx to xx” when the pulse(no weaving) mode is used. At that alarm timing, the parameter to decide the timing of switching commands periodically ($AWERAMP[i].$TIME_FACTOR) is automatically adjusted. Therefore, it is possible to restart the program after alarm reset. Additionally, those alarms never generated after the parameter within a proper value.

> ⚠ **CAUTION**
> There is a case that the welding commands is not changed correctly after Dynamic Arc ON/OFF(Refer to Section 5.4) is performed during the Pulse HeatWave. Do not perform the Dynamic Arc ON/OFF during the Pulse HeatWave.

> **NOTE**
> When the pulse frequency is set to high value, there is a case that the pulse frequency and the pulse duty cycle are clamped. In that case, “ARC-137 Clamp pulse, xx.x Hz, xx.x %” is posted and those clamped values are displayed.

Detailed Sequence

- Basis of command parameter always starts at peak wchedule. At the timing of weld schedule change or pause/resume during weld, the weld starts at peak schedule regardless of pulse state of peak/base just before.
- Pulse HeatWave is never executed during Runin.
- It is possible to change from pulse HeatWave welding to pulse-less welding by weld start instruction for weld schedule change. Additionally, the opposite is also possible.
- Normally, higher value is set to peak schedule and lower value is set to base schedule. It is also possible to set higher value to base schedule and set lower value to peak schedule.

Use Together with ArcTool Ramping Function

The Pulse HeatWave can be used with ramping function.
Please setup the weld parameter ramping(Enable the ramping function, set delay time for time ramping, etc.) concerning to the weld schedule number that is set to Pulse HeatWave mode. About the details of ramping function, please refer to Chapter 9.

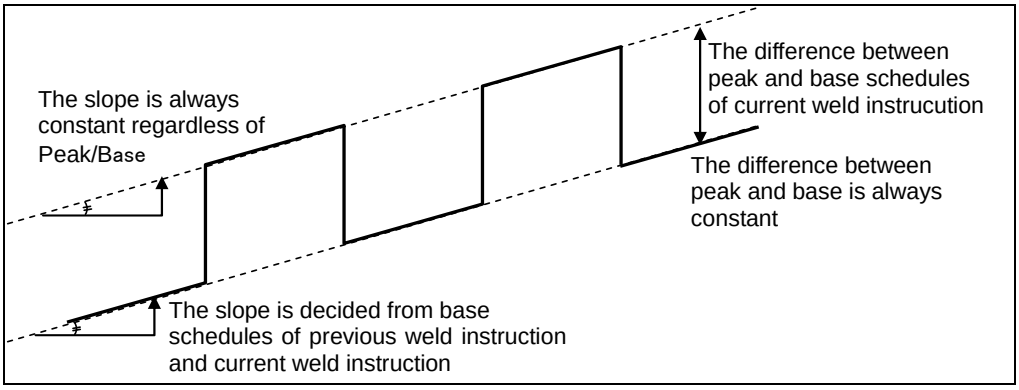


Fig. 10.3 Use together with ArcTool ramping function

If the Pulse HeatWave is combined to weld parameter ramping, the slope of the weld commands becomes always constant regardless of peak/base. The slope is decided from the difference between the previous base weld schedule and the current base weld schedule(those are specified by the weld start instruction), and from the delay time of current weld start instruction. Additionally, the difference between the peak and the base during weld parameter ramping is decided by the current weld start instruction, and the value is always kept constant.

The followings are all supported with the Pulse HeatWave.

- Weld Parameter Ramping at the weld start timing
- Weld Parameter Ramping at weld end timing
- Program resume in the case of Weld Parameter Ramping (2 methods)

- Hold ramping mode(Robot waits at weld start position until Weld Parameter Ramping is completed)

10.4 INITIAL SETTING OF HEATWAVE SYNC

When the [Heatwave] item is not displayed in Procedure tree view in DATA Weld Procedure screen(even if HeatWave Sync option is ordered), please execute the following procedure.

Procedure 10-3 Initial Setting of HeatWave Sync

Condition

- Even if the HeatWave Sync option is ordered, [heatwave] item is not displayed in the above-mentioned Step 5 of Procedure 10-1 or 10-2.

Step

1 Execute the Controlled Start. ArcTool Setup screen is displayed.
2 Change system variable $AWSCFG.$WEAVE_SYNC to TRUE in system variable screen. HeatWave Sync function becomes enabled.
3 Turn off the power supply of robot controller and then turn it on again, wait for ArcTool Setup screen is displayed.
4 Change system variable $AWERAMP[i].$RAMP_ENABLE to TRUE(i : weld equipment number) in system variable screen. ArcTool ramping function becomes enabled at the specified weld equipment number. Please set the system variable to TRUE in all weld equipments where you will use HeatWave Sync.
5 Press FTCN key and select [START (COLD)]. Cold Start is executed.
6 Execute the Procedure 10-1 or 10-2 again.

10.5 APPLICATION OF PULSE HEATWAVE FOR TIG FILLER WELDING

In the TIG filler welding using filler wire, outputting higher current and feeding wire into arc are executed during the peak schedule, and outputting lower current and feeding wire slowly(or feeding stop) into arc are executed during the base schedule, this is the general method (Refer to Fig. 10.5). In that welding with TIG welding robot(ServoTorch controls the feeding of filler wire), it is necessary to synchronize the wire feeding(that is controlled by ServoTorch) and current control(that is controlled by weld equipment).
By using Pulse HeatWave with TIG filler welding, it is possible to execute the Pulse HeatWave that the change timing of wire feed speed synchronizes to the change timing of base/peak current.

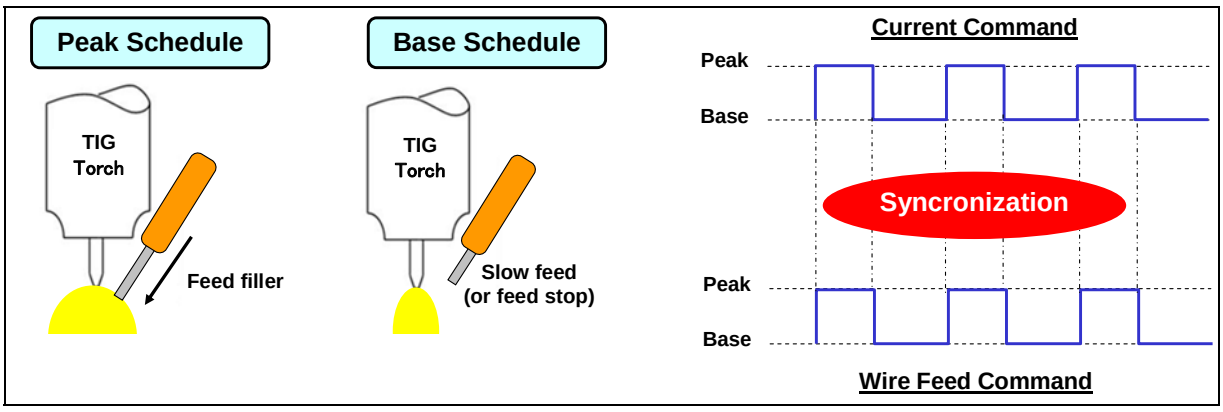


Fig. 10.5 Application of Pulse HeatWave for TIG filler welding

11 ARC EASY TEACHING FUNCTION

11.1 OVERVIEW

This function includes following two functions that reduces the burden of teaching arc welding program.

- Torch Posture Conversion Function
- Torch Posture Adjustment Function

This function is an option (A05B-XXXX-J623).

As the preparation before using this function, it is necessary to set the tool frame as shown below figure. And, please refer to following table about key words that is used for explaining this function.

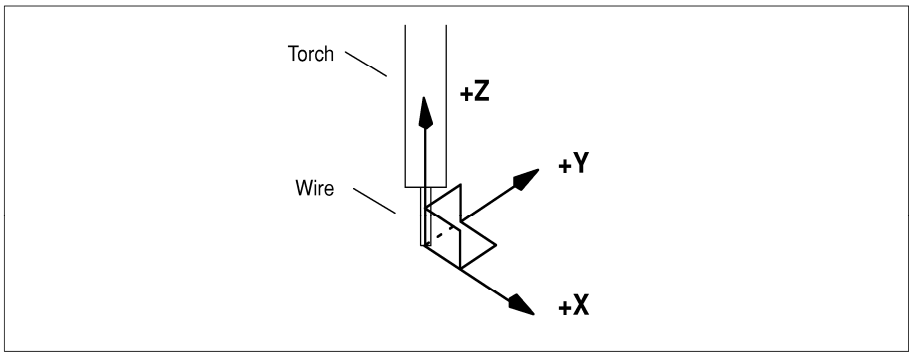
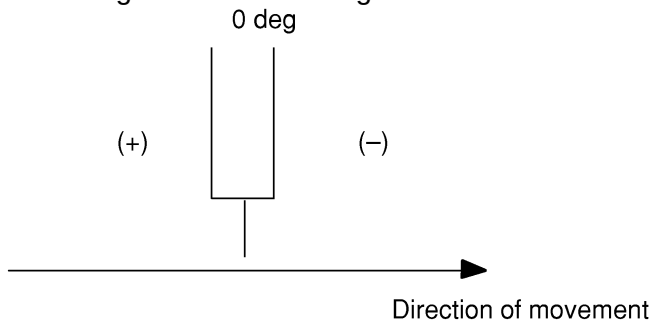


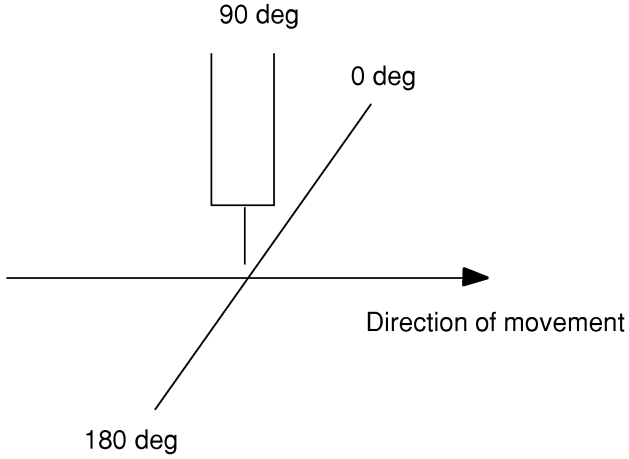
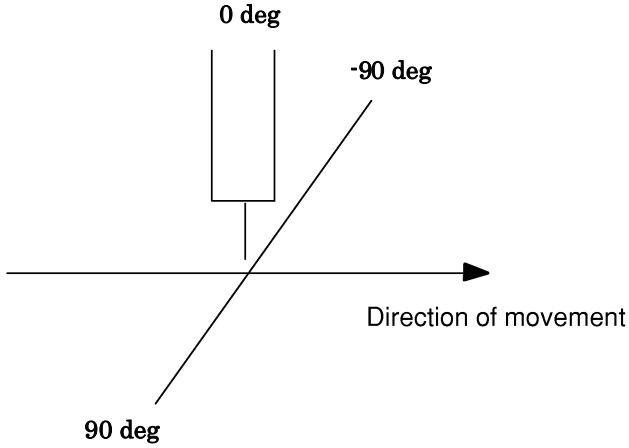
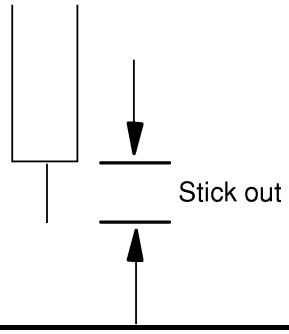
Fig. 11.1 Tool frame setup

NOTE

1. The tool frame must be set so that the Z (+) direction corresponds to the torch direction.
2. Though there is basically no problem that the torch is in any posture during teaching the torch posture, the recommended torch posture is that the torch can easily aim the welding path.
3. The TCP accuracy largely depends on the conversion accuracy of this function. All settings must be made to maximize the TCP accuracy.

Table 11.1 Words for arc easy teaching function

WORD	DESCRIPTION
Travel angle	This indicates the angle between a path direction vector and a Z-vector of the tool frame. When the angle of both vectors is 90 degrees, the travel angle is defined to 0 degrees. The travel angle is negative when the angle of both vectors is less than 90 degrees. The travel angle is positive when the angle of both vectors is greater than 90 degrees. 

WORD	DESCRIPTION
Work angle	This indicates the angle between the Z-vector of the tool frame and the reference plane. • About the work angle for Torch Posture Conversion Function, please refer to the following figure.  • About the work angle for Torch Posture Adjustment Function, please refer to the following figure. 
Spin angle	This indicates the angle of rotation around the Z-axis of the tool frame.
Stick out	This indicates the amount of length that the wire protrudes from the contact tip. 

11.2 TORCH POSTURE CONVERSION FUNCTION

This function is that the torch posture is converted by using the specified travel angle and work angle on the specified reference plane. The quality of arc welding depends on the torch posture so the travel angle and work angle must be taught correctly. The operator can teach a position without any considering the torch posture. After that, the torch posture can be arbitrarily converted by this function so the burden of teaching arc welding program is reduced.

⚠WARNING
Interference with the workpiece is not considered when calculating the torch posture. Some combinations of work angle, travel angle, and reference plane may result in the converted torch posture interfering with the workpiece. Therefore, extreme care should be applied when executing the program. For example, override should be minimized and step execution should be selected.

⚠WARNING
Conversion at a corner may suddenly change the torch posture. Therefore, extreme care should be applied when executing the program to check the results of conversion. For example, override should be minimized and step execution should be selected. If the posture seems to change too suddenly, the number of additional points and the pitch of the additional points specified for the corner smoothing function should be increased.

⚠WARNING
An incorrectly specified conversion range may result in an unexpected torch posture. User should be careful to specify the conversion range correctly. Therefore, extreme care should be applied when executing the program to check the results of conversion. For example, override should be minimized and step execution should be selected.

NOTE
This function does not support A motion instruction.

11.2.1 Reference Plane Setting

The reference plane is used to calculate a work angle. There are following methods to set the reference plane.

- Horizontal plane
  The X-Y plane of the robot world frame is set as the reference plane.
- Three-point teaching
  A plane determined by three points is set as the reference plane. There are following methods to set the three points.
  - Using positions specified in the program to be converted
  - Using positions held in the position registers
  - By recording positions

NOTE
If a plane cannot be determined by the three points, such as when the three positions are on a single line, conversion cannot be successfully executed.

- Torch posture
  A point is stored, and a plane perpendicular to the torch at that point is set as the reference plane.

11.2.2 Details of Torch Posture Conversion Function

This function includes the following two function.

- Corner smoothing function
- Absolute adjustment function

Corner Smoothing Function

This function adds additional points near a specified point so that the torch traverses the joints of specified paths while changing its posture smoothly. The number of additional points and the distance between those additional points (pitch) can be set as necessary.

(Rules governing conversion)

- The motion speed at an additional point is the same as that specified in the motion instruction for the corresponding corner.
- After conversion, CNT100 is selected as the positioning method at the corresponding corner.
- When motion instructions includes an additional statement, the statement will remain only in the corner motion instruction after conversion. Whenever possible, therefore, perform conversion before adding an additional statement.
- For the motion instruction for an additional point, “Additional pnt” is displayed in the comment field of the position data. For an additional point of a circular corner, “Circle ADD_pnt” is displayed.

This function cannot be used under the following conditions.

- When the conversion range only contains up to two motion instructions.
- When the conversion range contains a motion instruction that uses a position register.
- When the conversion range contains an incremental instruction.
- When the conversion range contains a palletizing instruction.
- When the target robot is independent axis.

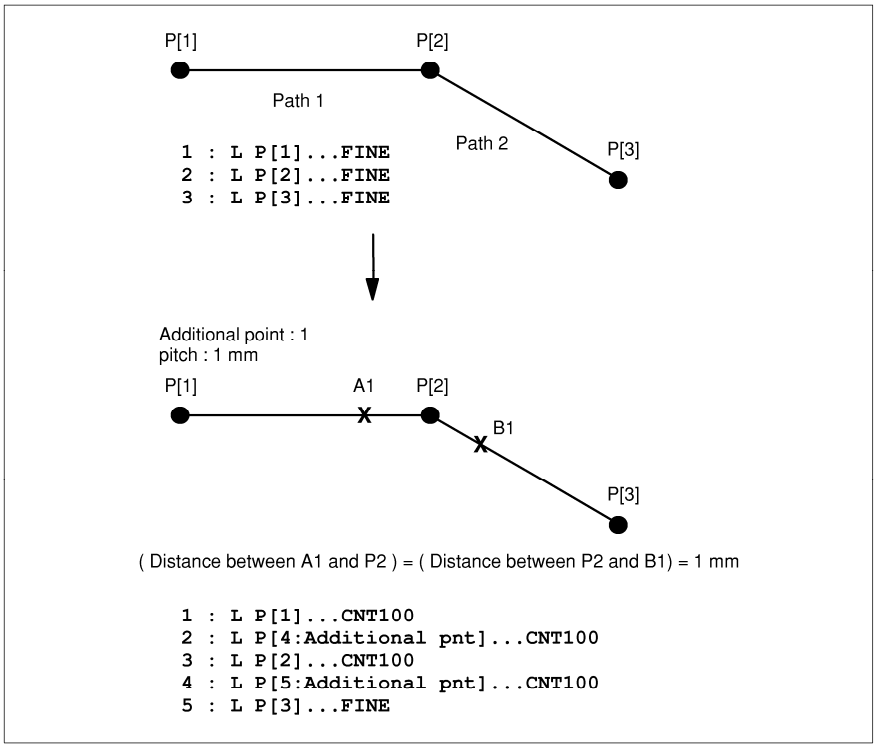


Fig. 11.2.2 Corner smoothing function

The torch posture at A1 is determined from the work angle and travel angle at P1, and half the difference between the spin angles at P2 and P1. (The spin angle is the angle of rotation around the Z-axis of the tool frame.)

The torch posture at B1 is determined from the work angle and travel angle at P2 half the difference between the spin angles at P2 and P3.

The torch posture at P2 is determined from half the difference between the work angles at A1 and B1, half the difference between the travel angles at A1 and B1, and the spin angle at P2.

After this conversion, the torch moves along path 1, maintaining a constant work angle and travel angle. The spin angle varies, but the variation does not affect the welding. When the torch moves to welding path 2, its posture is changed quickly.

NOTE
The corner smoothing function is not required when a path consists of two half-circle arcs, or of straight line and an arc having tangents to match at the joint.

If a program includes a circular motion instruction, the program is converted as shown below:

```
from
   1 : L P[1]...FINE
   2 : C P[2]
         P[3]...FINE
   3 : L P[4]...FINE

to
   1 : L P[1]...FINE
   2 : C P[2]
         P[5:Circle Add_pnt]...CNT100
   3 : L P[3]...CNT100
   4 : L P[6:Additional pnt]...CNT100
   5 : L P[4]...FINE
```

NOTE
To delete the additional point motion instructions from a program, the following must be set for the conversion.
- Corner smoothing function : TRUE
- Number of add.points : 0
- Absolute adjustment : FALSE

NOTE
When Corner smoothing function is TRUE and Absolute adjustment is FALSE, only additional points are added, and the posture is not adjusted on the additional points.

Absolute Adjustment Function

This function changes the specified position data to the specified travel angle and work angle according to the reference plane and path direction data (obtained from the teaching data for two points). (ABSOLUTE is set as Adjustment type on the setting screen.) For an explanation of setting the reference plane, see the description given later.

Apart from the directly specified travel angle and work angle, the travel angle and work angle at the beginning of the conversion range can be applied to the modification of all position data within the specified range. To do this, MATCH_1 must be specified for Adjustment type on the setting screen. About details of this, see the description given later.

Table 11.2.2 (a) Torch posture conversion setup item description

ITEM	DESCRIPTION
Group	This indicates the motion group to be converted. To change the indicated group, press the F7[GROUP] key. At the prompt, enter the desired group number.
Original Program	Enter the name of the program to be converted. If this screen is displayed when nothing is specified for this item, the current program is automatically selected.
Range	Specify [WHOLE] or [PART] as the conversion range. When [PART] is selected, the start and end lines must be specified.
Start line	Specify the start line of the conversion range.
End line	Specify the end line of the conversion range.
Create / Replace	Select whether the original program is to be overwritten with the converted data [REPLACE] or whether a new program is to be created for the converted data [CREATE].
New Program	When selecting [CREATE] for the above item, enter the name of the program to be created.
Insert line	When inserting converted data into an existing program, specify the number of the line from which the data will be inserted.
Corner smoothing	Enable [ENABLE] or disable [DISABLE] the corner smoothing function.
Number of add. points	Set the number of additional points for corner smoothing. When the number increases, the wrist rotation speed decreases at corner.
Pitch length	Set the distance between additional points for corner smoothing. When the distance increases, the wrist rotation speed decreases at corner.
Absolute adjustment	Enable [ENABLE] or disable [DISABLE] the absolute adjustment.
Adjustment type	Select how the torch angles (travel angle and work angle) are specified in absolute adjustment. - ABSOLUTE : Torch angles are specified directly. - MATCH_1 : Torch angles are specified by the torch angles at the beginning of the conversion range.
Travel angle	Specify a travel angle directly. Only when Adjustment type is ABSOLUTE.
Work angle	Specify a work angle directly. Only when Adjustment type is ABSOLUTE.

Table 11.2.2 (b) Torch posture conversion function keys description

ITEM	DESCRIPTION
F2 [PLANE]	Displays the reference plane screen (See the next table).
F3 [EXECUTE]	Executes the absolute adjustment and corner smoothing.
F6 [CLEAR]	Initializes the original program name, start line, end line, new program, insert line, motion group number, and cursor line. When the original program name is erased by this function key operation in the state of selecting a program, the selected program is set to original program immediately.
F7 [GROUP]	Specifies the motion group to be converted.

Table 11.2.2 (c) Reference plane screen setup item description

ITEM	DESCRIPTION
Reference Plane Teach	Specifies a reference plane format. There are following format. - HORIZON: The X-Y plane of the robot world frame is used as the reference plane. - 3 POINTS: A plane determined by three specified points is used as the reference plane. There are following methods to specify 3 points. • Positions specified in the original program are used. • Positions held in position registers are used. • New positions are stored. If no plane is determined by the three specified points, such as when all the points fall on a single line, an alarm prompt message is output to indicate that the attempted conversion is impossible. - ADJUST: A single point is stored and a plane perpendicular to the torch at that point is used as the reference plane.
P1, P2, P3	When [3POINTS] is selected as the reference plane teach, this item is displayed. Indicates whether the three points necessary to determine a reference plane have been stored. If they are not currently stored, the field appears blank. If they have already been stored, [Recorded] is displayed.
Adjust Posture	When [ADJUST] is selected as the reference plane teach, this item is displayed. Indicates whether the torch posture for determining a reference plane has been specified. If the posture is not currently stored, the field appears blank. If the posture has already been stored, [Recorded] is displayed.

Table 11.2.2 (d) Reference plane screen function keys description

ITEM	DESCRIPTION
F2 [CLEAR]	Erases the reference plane data.
F3 [REFER]	After pressing this key, select whether the position data provided by the original program, or that in the position registers, is to be used. - F4 [P [ ]]: Position data provided by original program. - F5 [PR [ ]]: Position register. Then, enter the position register number of position data. This key is valid only for the second, third, or fourth line.
F4 [CHOICE]	Selects a reference plane format from the options indicated above.
F5 [RECORD]	This key is used to store the position data which determines a reference plane through position teaching.

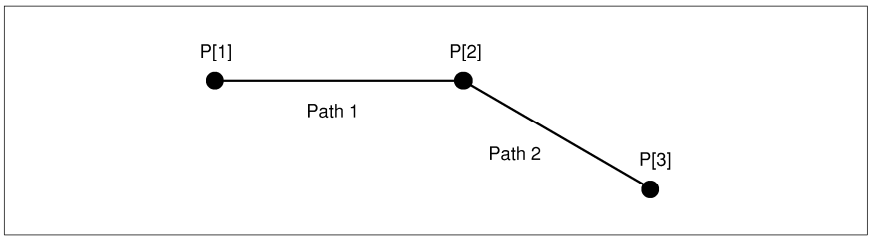
Procedure 11-1 Setting the Torch Posture Conversion Function (Corner smoothing, Absolute adjustment)

Condition

The Z(+) axis direction of tool frame is set to the torch direction(Refer to Section 11.1).

Step

1 Specify corner points only when a weld path program is generated. The torch posture need not be considered in this programming. However, please take care not to involve the cable so the recommended torch posture is that the torch can easily aim the welding path.



2 Press [MENU] key and select the [UTILITIES].

3 Press F1[TYPE] and select the [Posture convert]. Following screen is displayed.

```
POSTURE CONVERSION
                                        1/14
  Program:
  Group :[1]
      Original Program:
    1 [ MAIN                              ]
    2   Range:                      PART
    3   Start line:                    5
    4   End   line:                   10
    5 Create/Replace:              CREATE
      New Program:
    6 [ MAIN1                             ]
    7   Insert line: (not used)  ****
  Corner smoothing function
    8 Corner smoothing:            ENABLE
    9 Number of add. Points:       1
   10 Pitch length:                3.00mm
  Absolute adjustment function
   11 Absolute adjustment:         ENABLE
   12 Adjustment type:             ABSOLUT
   13 Travel angle:               10.00deg
   14 Work angle:                 45.00deg

   [ TYPE ]  PLANE  EXECUTE                 >
```

4 Press F4[PLANE] and set the reference plane. If it has already set, it is not necessary to set it. When the PREV key is pressed, the displaying returns from reference plane setup screen to posture conversion setup screen.

```
POSTURE CONVERSION
                                         1/1
  Reference plane
  Group :[1]
    1 Reference Plane Teach:   HORIZON

   [ TYPE ]                   [CHOICE]
```

5 Set the original program name, conversion range, and the contents of the conversion are to be overwritten or created.

6 In the case of setup the corner smoothing, select TRUE for the corner smoothing function. Enter the desired values to set the number of add-points and the pitch length.

7 In the case of setup the absolute adjustment, select TRUE for the absolute adjustment function. Then, specify the torch posture angles (travel angle and work angle) either by directly entering the values or by reflecting the torch posture at the beginning of the conversion range.

8 Press F3[EXECUTE], then press F4[YES]. When the conversion has been completed, the message of "The conversion was completed." is displayed at the prompt line.

11.3 TORCH POSTURE ADJUSTMENT FUNCTION

The quality of arc welding depends on the torch posture so the travel angle and work angle must be taught correctly. So there is a case that it is necessary to adjust the torch angle(travel angle, work angle, stick out) when the quality of arc welding is not good after teaching the program. The torch angle of entire welding path can be adjusted by using this function so the burden of teaching arc welding program is reduced. This function is different from the torch posture conversion function. That means, this function does not require specifying the reference plane so this function can be used more easily.

⚠WARNING
Interference with the workpiece is not considered when calculating the torch posture. Some combinations of work angle, travel angle may result in the adjusted torch posture interfering with the workpiece. Therefore, extreme care should be applied when executing the program. For example, override should be minimized and step execution should be selected.

⚠WARNING
Adjustment at a corner may suddenly change the torch posture. Therefore, extreme care should be applied when executing the program to check the results of adjustment. For example, override should be minimized and step execution should be selected.

⚠WARNING
An incorrectly specified adjustment range may result in an unexpected torch posture. User should be careful to specify the adjustment range correctly. Therefore, extreme care should be applied when executing the program to check the results of adjustment. For example, override should be minimized and step execution should be selected.

NOTE
This function does not support A motion instruction.

Table 11.3 (a) Torch posture adjustment setup item description

ITEM	DESCRIPTION
Group	This indicates the motion group to be adjusted. To change the indicated group, press the F7[GROUP] key. At the prompt, enter the desired group number.
Original Program	Enter the name of the program to be adjusted. If this screen is displayed when nothing is specified for this item, the current program is automatically selected.
Range	Specify [WHOLE] or [PART] as the adjustment range. When [PART] is selected, the start and end lines must be specified.
Start line	Specify the start line of the adjustment range.
End line	Specify the end line of the adjustment range.
Stick out	Set the amount of stick out.
Travel angle	Set the amount of travel angle.
Work angle	Set the amount of work angle.

Table 11.3 (b) Torch posture adjustment function keys description

ITEM	DESCRIPTION
F2 [REVERSE]	Execute the torch posture adjustment to subtract the specified amount of change.
F3 [EXECUTE]	Execute the torch posture adjustment to add the specified amount of change.
F6 [CLEAR]	Initialize the original program name, start line, end line, motion group number, and cursor line. When the original program name is erased by this function key operation in the state of selecting a program, the selected program is set to original program immediately.
F7 [GROUP]	Specifies the motion group to be adjusted.

Procedure 11-2 Setting the Torch Posture Adjustment Function

Condition

- The Z(+) axis direction of tool frame is set to the torch direction(Refer to Section 11.1).
- This function cannot be used under the following conditions.
  - The adjustment range does not contain two or more motion instructions.
  - The adjustment range contains a motion instruction that uses a position register.
  - The adjustment range contains an incremental instruction.
  - The adjustment range contains a palletizing instruction.
  - The target robot is independent axis.

Step

1 Press [MENU] key and select the [UTILITIES].

2 Press F1[TYPE] and select the [Path adjust]. Following screen is displayed.

```
POSTURE PATH ADJUST
                                        1/7
  Program:
  Group :[1]
      Original Program:
    1 [ MAIN                              ]
    2   Range:                        PART
    3   Start line:                     5
    4   End   line:                    10
  Adjustment values
    5 Stick out:                    0.00mm
    6 Travel angle:                0.00deg
    7 Work angle:                  0.00deg

|  | [ TYPE ] | REVERSE | EXECUTE |  |  | > |
```

3 Set the original program name, adjustment range, the amount of adjustment values.

4 Press F3[EXECUTE], then press F4[YES]. When the adjustment has been completed, the message of "The conversion was completed." is displayed at the prompt line.

12 ARC EASY SMART QUICK RECOVERY FUNCTION

12.1 OVERVIEW

The arc easy smart quick recovery function consists of a torch guard function and Torch Mate function.

This function is an option (A05B-XXXX-J681).

Torch Guard Function

- The torch guard function immediately stops the robot with an alarm when a collision is detected. At this time, this function decelerates the robot to reduce damage to the robot. This function has greater detection sensitivity than the ordinary basic collision detection function. Therefore, this function detects a collision more quickly to reduce damage to the torch and robot remarkably. This function eliminates the need for a shock sensor that has been traditionally used for torch collision detection.
- It is not necessary to adjust the detection sensitivity. The detection sensitivity is adjusted on each robot beforehand.
- This function can be enabled or disabled by a instruction in TP program.
- The detection sensitivity automatically increases during teaching to protect against damage, especially due to a robot collision that tends to occur by mishandling in teaching.

Torch Mate Function

- This function can automatically correct a slippage of TCP in a short time.

12.2 TORCH GUARD FUNCTION

12.2.1 Overview

1 This function is enabled when the power is turned on.

2 Please set the payload information and the robot arm load information. (Refer to Subsection 12.2.2)
This function uses payload information and the robot arm load information to detect a collision, so those information need to be set. Please set the weight of a payload, payload center, and weight on the robot arm payload correctly. If the payload inertia (figure) is large, inertia setting around the payload center may be additionally required. For example, there is a case that the detection error occurs in only setting of the payload weight and the payload center position if the figure of torch is large. In such case, please execute an inertia setting. Before operating the robot, please select the payload number that is set. (Refer to Subsection 12.2.2)

3 If the large force is anticipated beforehand during the program execution in your application, please disable this detection during its execution by program instruction. (Refer to Subsection 12.2.3)

4 During teaching, the detection sensitivity automatically increases.

12.2.2 Motion Performance Screen

Procedure 12-1 Setting of Motion Performance for Torch Guard Function

Step

1 Press [MENU] key and select [SYSTEM].
2 Press F1[TYPE] and select the [Motion]. Following screen is displayed.

```
MOTION PERFORMANCE
                                        1/10
      Group1
    No.   PAYLOAD[kg]          Comment
     1          0.00    [                  ]
     2          0.00    [                  ]
     3          0.00    [                  ]
     4          0.00    [                  ]
     5          0.00    [                  ]
     6          0.00    [                  ]
     7          0.00    [                  ]
     8          0.00    [                  ]
     9          0.00    [                  ]
    10          0.00    [                  ]

  [ TYPE ] GROUP DETAIL ARMLOAD SETIND >
```

3 Payload information items of No.1-No.10 can be set. Move the cursor to the line of a desired number, then press F3[DETAIL] to display the payload setting screen.

```
MOTION/PAYLOAD SET
                                         1/8
      Group1
  1 Schedule No[   1]:[******************]
  2 PAYLOAD            [kg]            0.00
  3 PAYLOAD CENTER X   [cm]             0.00
  4 PAYLOAD CENTER Y   [cm]             0.00
  5 PAYLOAD CENTER Z   [cm]             0.00
  6 PAYLOAD INERTIA X  [kgfcms^2]       0.00
  7 PAYLOAD INERTIA Y  [kgfcms^2]       0.00
  8 PAYLOAD INERTIA Z  [kgfcms^2]       0.00

  [ TYPE ] GROUP NUMBER DEFAULT HELP
```

4 Set the weight of a payload, payload center position, and inertia.
The X, Y, and Z directions indicated on the payload setting screen correspond to the directions of the standard tool coordinate system (when no special tool coordinate system is set).
When desired values are entered, the confirmation message "Path and Cycle time will change. Set it?" appears. Press F4 [YES] or F5 [NO].
5 By pressing F3[NUMBER], the user can switch to the payload setting screen for another condition number. By pressing F2[GROUP], the user can switch to the setting screen for another group (in the case of a multi-group system).
6 Press the PREV key to return to the list screen. Press F5[SETIND], then enter a desired payload setting condition number.
7 Press F4[ARMLOAD] on the list screen, then displays the arm load setting screen.

```
MOTION/ARMLOAD SET
                                         1/2
      Group1
  1 ARM LOAD AXIS #1  [kg]              0.00
  2 ARM LOAD AXIS #3  [kg]              0.00

  [ TYPE ] GROUP        DEFAULT HELP
```

8 Set the weight of the payload on the J1 axis and the weight of the payload on the J3 axis. When the values are entered, the confirmation message "Path and Cycle time will change. Set it?" appears. Press F4[YES] or F5[NO]. After setting the weight of arm payload, turn the power off then back on for the setting to become effective.

12.2.3 Program Instruction

COL DETECT ON/OFF

These instructions can disable and enable collision detection during program execution.

Example)
10: J P[1] 100% FINE
11: COL DETECT OFF
12: L P[2] 2000mm/sec CNT100
13: L P[3] 2000mm/sec CNT100
14: L P[4] 2000mm/sec CNT100
15: COL DETECT ON
16: J P[5] 50% FINE

In this program, collision detection is disabled on lines from 12 to 14.

Collision detection is usually enabled.
When a program is terminated or temporarily stopped, collision detection is automatically enabled.

12.2.4 Notes

- A collision detection may be wrongly occurred in the cases listed below.
  - When the setting of payload information or arm payload information is incorrect
  - Rough operation using ACC Override
  - Rough operation such as turnaround using CNT motion
  - Operation such as Linear operation near a singular point where an axis turns at high speed
  - When the power supply voltage is too low
  - When the weight of payload or inertia exceeds the upper limit of the robot

  If a collision is wrongly detected by above-mentioned causes, first, please try to correct those causes. In an unavoidable case, the termination of robot operation with an alarm may be prevented by enclosing only a part of incorrect collision detection with a pair of COL DETECT OFF/ON instructions.

- In the cases below, collision detection is disabled.
  - When Soft Float is enabled
  - When brake control is exercised (at brake lock time)

- Axis drops after the collision detection.
  - To reduce excess force to the robot due to collision, the collision detection function disables position control for 200 ms after collision. For this reason, the axis may drop slightly after collision detection.

12.2.5 Related Alarms

- SRVO-050 SERVO Collision Detection alarm (G:iA:j)
  This alarm is posted when a collision is detected. The robot stops with this alarm. If there is a cause described in Subsection 12.2.4, a nonexistent collision might be wrongly detected. In such case, take the action described in Subsection 12.2.4.

- SRVO-053 WARN Disturbance excess (G:iA:j)
  This alarm warns the operator that an estimated disturbance value is close to the level for posting the Collision Detect alarm due to collision detection. The robot does not stop. If there is no problem, this message might be ignored. If there is a cause described in Subsection 12.2.4, the output of this alarm is suppressed by taking the described action.

12.3 TORCH MATE FUNCTION

A welding robot system is taught so that the wire tip travels along a welding line. If welding is performed for a long time, however, the wire tip position (TCP, Tool Center Point) might be shifted due to the wearing of the contact chip. The tool center point might also be shifted due to interference with the torch fixture caused by contact chip or torch replacement or an operation error.
If the tool center point is shifted, precise welding becomes impossible. In this case, the tool center point needs to be set again, or re-teaching is required in a worst case, thus production stops for a long time.

Torch Mate function can correct a shift of the tool center point of the welding torch automatically in a short time. With this function, production stop time can be reduced, and stable welding quality can be achieved. Four robots system can use this function simultaneously.

To use Torch Mate function, follow the setup procedure given below. Carry out this setup for each robot that uses Torch Mate function.

1 Set a torch recovery fixture.
2 Set the wire tip position as TCP.
3 Set the data of Torch Mate function for the specified TCP (if necessary).
4 Calibrate Torch Mate function for the specified TCP.

Upon completion of the above procedure, the tool center point can be corrected with the torch recovery function at any time. Torch Mate function can be used just by executing the program prepared for correction. The program can be called from a production program (automatic correction), or can be selected and executed by the user (manual correction).

Torch Mate function corrects a shift of the tool center point by touching the wire to the torch recovery fixture. This means Torch Mate function cannot correct a shift of the attitude of the torch. When a shift of the torch attitude is very small, welding is little affected. When a shift of the torch attitude is large, however, the quality of welding is much affected, and the robot and torch can interfere with the fixture even if a shift of the tool center point is corrected. When a shift of the torch attitude is large, return the welding torch manually to near the place where the torch was first installed. Then, correct the tool center point precisely with Torch Mate function.

⚠CAUTION
Torch Mate function adjusts the top of the wire by changing the tool frame data. Therefore when the teaching path is near the boundary of motion possible range, if the compensated program is executed, the alarm of "Not reachable" and "Singularity point" may occur. In this case, touchup the teaching point.

> ⚠**CAUTION**
> If Tool Frame Number adjusted by Torch Mate function is monitored by DCS Tool Frame Function in Dual Check Safety Function, “TMAT-018 DCS tool frame is not allowed” message is posted and Torch Mate is not performed. Do not monitor Tool Frame Number for Torch Mate function by DCS Tool Frame Function.

12.3.1 Before Using This Function

Before using the Torch Mate function, check the following items.

- Torch Mate function corrects a shift of the tool center point by using a stick detection circuit. So, if a stick detection circuit is not provided, set a mechanism such as a touch sensor (mechanism that applies a voltage between two points, and enters a signal for detecting a short circuit between the two points) between the wire and torch recovery fixture. The stick detection circuit uses a low voltage. So, if a sufficient voltage is not applied, provide a similar mechanism.
- Torch Mate function cannot correct a shift of the torch posture. When a shift of the torch posture is very small, welding is little affected. When a shift of the torch posture is large, however, return the welding torch manually to near the place where the torch was first installed. Then, correct the tool center point precisely with Torch Mate function.
- A system equipped with Torch Mate function has a torch recovery macro. The position registers set on the torch recovery setup screen, which will be described later, are used for the torch recovery function.
- On the clock screen, check that the date and time are set correctly with the clock function. Time data is used on the correction data history screen for displaying the history of correction. The clock screen can be displayed using the procedure below:
  [MENU] key → [SYSTEM] → F1[TYPE] → [CLOCK]
- When attaching a torch to the robot flange, do not perform the work desultorily, but set some reference so that when the torch is replaced, the tool center point can come at approximately the previous position. If the tool center point is shifted from the previous position after torch replacement, or the posture of a new torch is much shifted from the previous posture, automatic correction using the torch recovery function is impossible.

> ⚠**CAUTION**
> Please check there is no surges on insulation cylinder, chip, and torch body of the torch before the Torch Mate teaching.

> ⚠**CAUTION**
> Please perform the following setting for Torch Mate (fixture installation, TCP setting, calibration) before creating the TP program. If those settings are not performed, it is necessary to teach programming again in the worst case. Moreover, it is necessary to teach programming again if this function is added to the system later and the TCP setting is not performed correctly.

12.3.2 Torch Recovery Fixture Installation

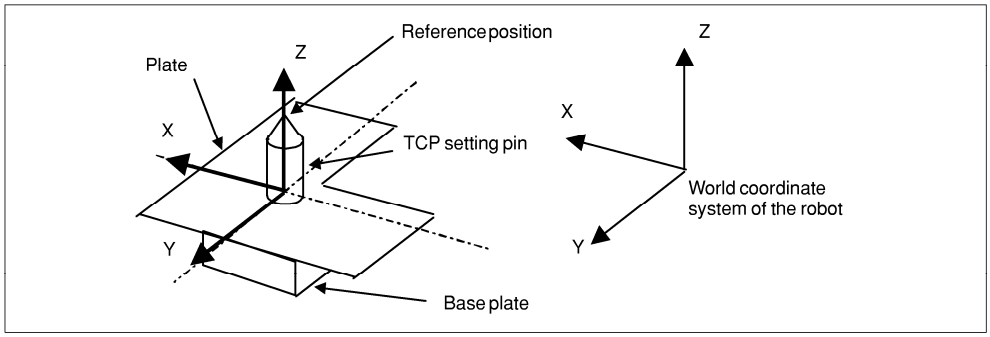
Install a fixture for Torch Mate function according to the procedure below.

Procedure 12-2 Torch Recovery Fixture Installation

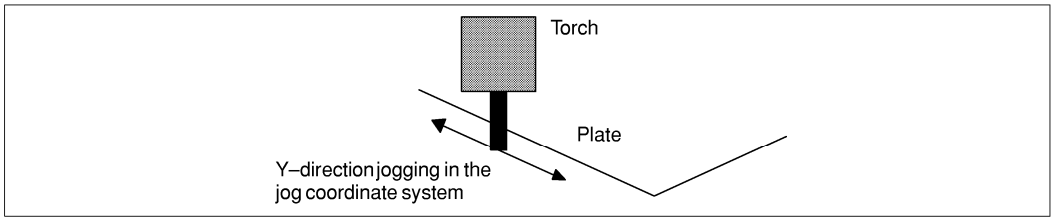
Step

1 Install the torch recovery fixture at the position that allows the robot to operate freely, then secure it firmly.

2 Connect the torch recovery fixture (base block) to the base metal electrode (electrode (usually minus electrode) with the polarity opposite to the wire electrode) of the welding power supply via a wire.
3 Loosen the screws on the fixture, make an adjustment so that the sides of the square plate are aligned with the world coordinate system of the robot as shown below.



4 Adjust the plate position so that the wire travels along the side of the plate by Y-direction jogging (in the Y direction of the world coordinate system) in the jog coordinate system as shown below.



5 After tightening the screws, check the plate installation precision by performing jogging again.
6 Bring the wire into contact with the plate by jogging. Using a continuity tester in this state, check that the wire and plate are electrically continuous.

> ⚠ **CAUTION**
> Install the torch recovery fixture insulated from peripherals to prevent bypass weld current during arc welding.

> ⚠ **CAUTION**
> The torch recovery fixture must be installed according to a world coordinate system of a robot. If an installation of the robot is upside-down mount type, an installation of the torch recovery fixture must be upside-down mount type, too.

12.3.3 TCP Setting

Set the top of wire position as TCP. About the details of TCP setting, refer to Subsection 3.9.1 in the OPERATOR'S MANUAL (Basic Operation) (B-83284EN). Here, an example of TCP setting using the torch recovery fixture is described.
When teaching the origin of a coordinate system with the six -point setting method, use the following posture by using the coordinate system origin of the torch recovery fixture.

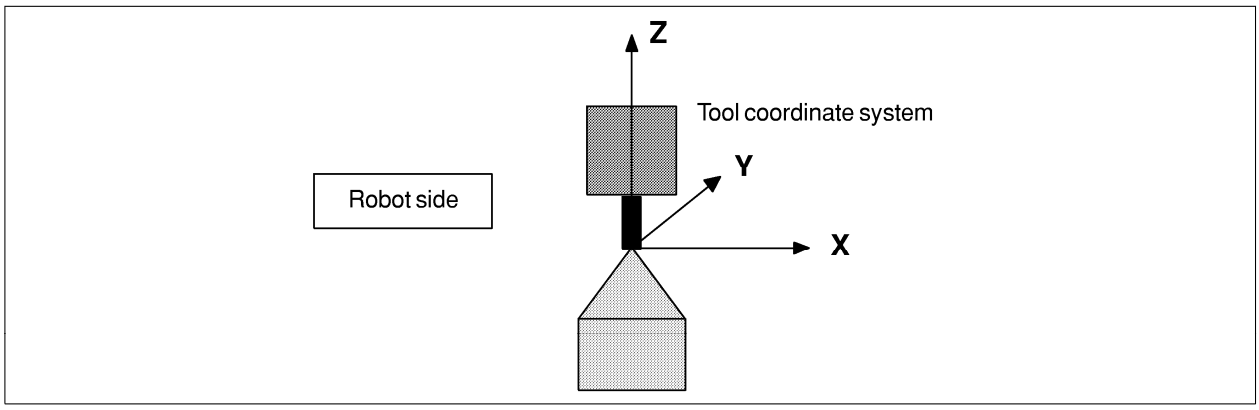


Fig. 12.3.3 (a) TCP Setting 1

In the six-point setting method, three reference points are taught by changing the posture. At this time, use the procedure below.
Teach the first point with the posture above figure.
When teaching the second point, move the sixth axis by an angle from 90 degrees to less than 360 degrees by axial jogging from the first point, then match the tool center point with the tip of the fixture.
When teaching the third point, move the fourth axis and fifth axis by an angle less than 90 degrees from the second point by axial jogging, then match the tool center point with the tip of the fixture.
Ensure that the three points are directed roughly as shown below.

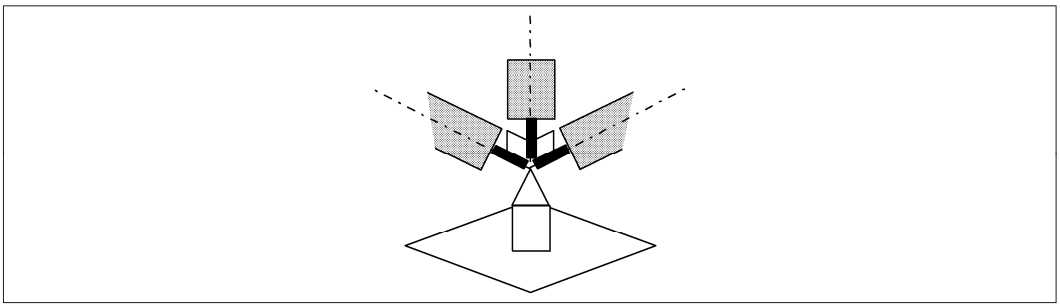
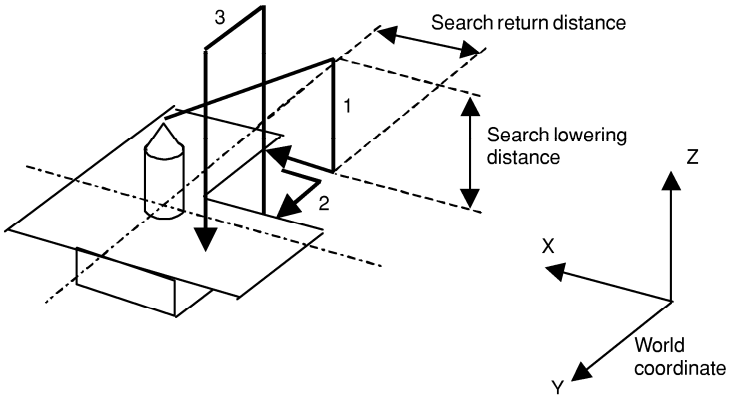


Fig. 12.3.3 (b) TCP Setting 2

12.3.4 Setting of Torch Mate Function and Calibration

After TCP setting, Torch Mate function needs to be calibrated for each TCP of robot. If there are two or more robots, please note that this calibration is required by each robot's TCP. The first tool center point is stored by this calibration.
Once this calibration is performed, it is not necessary to calibrate again. When the torch is replaced, re-calibration is not required if the tool center point and torch posture before replacement are about the same as those after replacement. If the tool center point and torch posture after replacement much differ from those before replacement, however, perform re-calibration or reinstall the torch manually to minimize the shift.

The overview of torch mate motion and the setting items for this function are explained below.



Search operation (After arrow 1 operation, arrow 2 operation is performed. Then, if Z compensation is enabled, arrow 3 operation is performed.)

Fig. 12.3.4 Overview of torch mate motion

Table 12.3.4 Description for torch mate setting screen

SETTING ITEM	DESCRIPTION
Tool number	Indicates the number of the tool coordinate system for which the currently displayed settings are made. To display the settings of another tool coordinate system, type the number of the desired tool coordinate system in this field. All settings in torch mate setting screen are stored for each tool number. Therefore, please set tool number first. After that, please set another setting items. If two or more tool frames are used, it is necessary to perform calibration for each tool frame number.
Group Number	Display motion group which perform mastering.
Weld equipment number	Specify welding equipment which is used by mastering.
Mastering status	• UNINIT Mastering is not executed yet. • X/Y Mastering for X, Y directions have already finished. • X/Y/Z Mastering for X, Y, Z directions have already finished.
Input signal	Specify the signal type and number of a digital signal (contact confirmation signal) that is turned on when the wire contacts the torch recovery fixture plate. The user can choose from the following options. • DI : General purpose digital input signal • WI : Welding digital input signal • RI : Robot digital input signal • WSI : Stick detection circuit input signal
Output signal	Though the voltage is applied to recognize that the wire contacted to the torch recovery plate fixture, specify the signal type and number of a signal output for this purpose. The user can choose from the following options. • DO : General purpose digital output signal • WO : Welding digital output signal • RO : Robot digital output signal • WSO : Stick detection circuit output signal

SETTING ITEM	DESCRIPTION
X Y offset limit	Set a maximum offset value of X and Y direction that allows correction by the Torch Mate function. If an offset value greater than this value, torch recovery operation is stopped, and the message of “Offset is out of range” is displayed.
Z compensation	Set whether the tool center point compensation in the Z direction is executed or not. By default, this is disabled.
Z offset limit	Set a maximum offset value of Z direction that allows correction by the Torch Mate function. If an offset value greater than this value, torch recovery operation is stopped, and the message of “Offset is out of range” is displayed.
Search speed	When the tool center point is corrected, search operation is performed in the X and Y directions (or in three directions when Z compensation is enabled). Specify an approach speed used for such search operation. When a lower search speed is set, a higher precision in correction results.
Search start	Specify a return distance used for tool center point correction.
Search start Z	Specify a lowering distance used for tool center point correction.
Reference position	This item is used to record a reference position for calibration. Whether a reference position is recorded is indicated.
Wire advance time	Before the start of search operation, the wire can be fed for a short time to allow the wire to contact the plate easily. Specify such a feed time.
Wire retract time	After the end of search operation, the wire can be rewound for a short time. Specify such a rewind time. This item is used if the wire has been fed as described above.
Wire speed	Specify a wire speed used for wire feed and rewind operations above. The unit selected in the item of wire feed speed units on the welding equipment setting screen is used.
Starting PR[] number	In the Torch Mate function, two position registers are used to indicate the TCP before correction and TCP after correction. Specify the numbers of such position registers. For example, [1] is set, the TCP before correction is set in position register 1, and the TCP after correction is set in position register 2. If this position register number is already used, change the value as required. Note that these data items are indicated only, and changing the value of this item has no effect on torch recovery operation.

SETTING ITEM	DESCRIPTION
Error recovery method	During torch recovery motion, if the following situation occurs, chose the method of recovery. - The wire doesn't connect with the plate - The wire connects with the plate before torch recovery motion - The detected compensation value is over the allowable limit The following selections are provided. For more detail, please refer to Subsection 12.3.6. - PROMPT Display the WARNING alarm according each alarm reason and the confirmation screen is displayed and the robot controller waits for the input by the operation. - REDO Display the WARNING alarm according each alarm reason and the fault signal is also turned on. Then the program is paused. When the program is restarted after resetting the alarm, the torch recovery motion is performed without displaying the confirmation screen. - SKIP Display the WARNING alarm according each alarm reason and the fault signal is also turned on. Then the program is paused. When the program is restarted after resetting the alarm, the torch recovery motion is skipped without displaying the confirmation screen. - ABORT Display the WARNING alarm according each alarm reason and the fault signal is also turned on. Then the program is paused. When the program is restarted after resetting the alarm, the program is aborted without displaying the confirmation screen.
Error output signal	During torch recovery motion, when the following situation occurs, the specified digital output signal is turned on. - When the wire doesn't connect with the plate - When the wire connects with the plate before torch recovery motion - When the detected compensation value is over the allowable limit This signal is turned off at the following timing. - "PROMPT" is selected in Error recovery method : When the confirmation screen is disappeared("REDO" or "SKIP" or "ABORT" is selected in confirmation screen). - "REDO", "SKIP", "ABORT" is selected in Error recovery mothod: When the program is restarted or aborted. - F3[ADVWIRE] is pressed : Pressing the F3 key feeds the wire for a set wire advance time at a set wire speed. - F4[RETWIRE] is pressed : Pressing the F4 key rewinds the wire for a set wire retract time at a set wire speed.

SETTING ITEM	DESCRIPTION
Touchup Monitor	Touchup Monitor can display the alarm of [Run TorchMate before edit] and the message of [TorchMate adjustment is recommended before editing any program positions.]. After passing the time which is set in this item, if the user try to edit the program which use the same tool frame number as [Tool number] of the item 1 in this screen, the alarm is occurred and message is displayed. The message vanishes if enter key is pushed. If the time is set to 0.0 (standard), Touchup Monitor becomes disabled. After changing the time, the user must perform mastering or correct wire tip position.
Collision Monitor	When this item is enabled, the alarm of [Collision! Run TorchMate] and the message of [A collision or hand broken alarm has just occurred. TorchMate Adjustment is recommended at this time.] can be displayed if the following collision alarm is occurred during teaching or welding. - SRVO-006 Hand broken - SRVO-050 CLALM alarm (G : i Axis : j) - SRVO-102 Hand broken (Robot : i) - SSPC-202 Collision Detected (G : i) - SSPC-211 Collision Detected (G : i) - SRVO-023 Stop error excess (Group : i Axis : j) - SRVO-024 Move error excess(Group : i Axis : j) The message vanishes if enter key is pushed. If the item is set to FALSE (standard), Collision Monitor becomes disabled.

⚠CAUTION

In the case of [Z compensation] is enabled, it is necessary to use the mechanism that prevents from withdrawing the wire when the searching of Z direction is executed.

⚠CAUTION

In the setting of [X Y offset limit] and [Z offset limit], set a value as small as possible. A greater offset value means a greater torch bend or shift. If a correction is made in such a case, the robot or torch may interfere with the fixture in the program. Set minimum offset values. If an alarm is issued to report that an offset limit is exceeded, correct the torch manually to satisfy the offset limit. Then, perform torch recovery operation according to the procedure for recovery from alarms.

For the X and Y directions, set about 15 mm when using a straight torch, or set about 10 mm when using a curved torch. For the Z direction, set about 5 mm.

NOTE

In the setting of [Input signal] and [Output signal], please set the same signal type. For example, you should set DO at Output signal if you set DI at Input signal.

If two welders are used with two-unit control system and WSI/WSO is selected, set WSI[1]/WSO[1] for the first unit and WSI[9]/WSO[9] for the second unit. However, please refer to Subsection 5.3.8 in ROBOWELD *i*C series operator's manual(B-83374EN) in the case of ROBOWELD *i*C series.

Procedure 12-3 Setting of Torch Mate Function

Step

1 Press [MENU] key and select the [SETUP].

2 Press F1[TYPE] and select the [TorchMate]. Following screen is displayed.

```
SETUP TorchMate
                                        1/19
Schedule Status
   1 Tool number:                 1
     Group number:                1
   2 Weld equipment number:       1
     Mastering status:            UNINIT

 Search Settings
   3 Input signal:                DI[1 ]
   4 Output signal:               DO[1 ]
   5 X Y offset limit:             20  mm
   6 Z compensation:             DISABLED
   7 Z offset limit:                5  mm
   8 Search speed:                15  mm/sec
   9 Search start:                25  mm
  10 Search start Z:              36  mm
  11 Reference position:          UNINIT

 Wirefeed Settings
  12 Wire advance time:           .150 sec
  13 Wire retract time:           .150 sec
  14 Wire speed:                  250 cm/min

 Recovery and Monitor Settings
  15 Starting PR[] number:         1
  16 Error recovery method:        PROMPT
  17 Error output signal:          DO[0 ]
  18 Touchup Monitor:              0.000 Hrs.
  19 Collision Monitor:            DISABLED

  [ TYPE ] | MASTER | ADVWIRE | RETWIRE | HELP
```

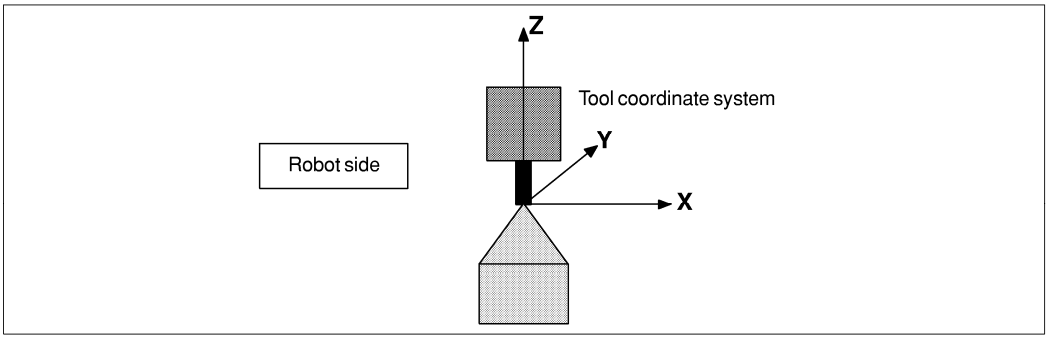
⚠CAUTION
Be sure to display this setting screen at least once. By displaying this screen, the standard value is set for each data item.

3 At this stage, the screen shows the settings of the tool coordinate system (TCP) having the number displayed in item 1 of [Tool number] on the screen, and the motion group currently subjected to jog feed. The sample screen shown above displays the settings of tool coordinate system 1 and motion group 1.
Change the motion group number and tool coordinate system number as desired. The changing method of motion group is selecting [CHANGE GROUP] after pressing FCTN key. The changing method of tool coordinate system is inputting the desired number in the item 1 of [Tool number].

⚠CAUTION
Changing the motion group changes the motion group subjected to job feed. When performing jog feed after this operation, check the selected motion group in advance.

⚠CAUTION
All settings in torch mate setting screen are stored for each tool number. Therefore, please set tool number first. After that, please set another setting items. If two or more tool frames are used, it is necessary to perform calibration for each tool frame number.

4 By jogging the robot, move the tool center point (TCP) to the reference position (central pin tip) of the torch recovery fixture. At this time, ensure that the torch assumes the posture shown below with respect to the reference position of the torch recovery fixture.



5 Move the cursor to the [Reference position] item. Then, press the F4 [RECORD] key together with the shift key to record the reference position. The indication item changes from [UNINIT] to [RECORDED].
6 Set other items if required.
7 Set an override of 100%.

⚠WARNING
The next step starts robot operation to perform torch recovery calibration. Please note it.

⚠WARNING
Pressing the forced termination key in the FCTN menu during torch recovery operation (calibration operation, correction operation) stops the robot.
However, the signal output to apply a voltage for search continues to be output. So, do not touch the wire and electrode(This output is stopped when robot operation is temporarily stopped).
If the robot is temporarily stopped or forcibly terminated while the wire is being fed, the wire continues to be fed. If the robot is temporarily stopped or forcibly terminated while the wire is being rewound, the wire continues to be rewound. Never temporarily stop and forcibly terminate the robot during torch recovery operation.

8 Press the F2[MASTER] key together with the shift key. The robot starts calibration operation. Search operation is first performed in the X direction of the world coordinate system, then in the Y direction. When Z compensation is enabled, search operation in the Z direction is then performed. Upon completion of calibration, store the calibration information internally. This calibration information is used for TCP correction operation.

> ⚠**CAUTION**
> If an attempt to do any of the following is made on this setup screen while a TP program is running or being halted, an alarm of “TMAT-014 Abort program using G:#” (# is a group number) is posted:
> teaching a reference position, movement to a reference position, or calibration in a motion group which is the same as the motion group used for the TP program. The processing is not performed. If this alarm occurs, end the TP program, then carry out the operation again.

12.3.5 Execution of Correction with Torch Mate Function

After completion of [12.3.2 Torch Recovery Fixture Installation], [12.3.3 TCP Setting], and [12.3.4 Setting of Torch Mate Function and Calibration], a tool center point shift can be corrected manually or automatically (by calling the torch recovery program from a user program) at any time with Torch Mate function. To execute Torch Mate function, a torch recovery program or torch recovery macro is used. These programs and macros are provided for use with each motion group. When the function is executed, the program or macro corresponding to the motion group is used.
The following table lists the programs and macros provided for the motion groups.

Table 12.3.5 Correspondence motion group and torch recovery program/macro

Motion group	Program	Macro
Group 1	TM_ADJST	TorchMate Adjust
Group 2	TM_ADJ2	TMate Adjust GP2
Group 3	TM_ADJ3	TMate Adjust GP3
Group 4	TM_ADJ4	TMate Adjust GP4
Group 5	TM_ADJ5	TMate Adjust GP5

In the case of correction by manual, please refer to Procedure 12-4. In the case of correction by automatic (by calling the torch recovery program from a user program), please refer to Procedure 12-5.

Procedure 12-4 TCP Correction by Manual

Step

1. On the program select screen, select the torch recovery program corresponding to the motion group that executes a correction.
2. Set the tool coordinate system of the motion group that executes a correction to the tool coordinate system that executes a correction.
3. When the torch recovery program is executed, the motion to the torch recovery fixture starts, then the correction operation starts. If there is an obstacle between the current robot position and the torch recovery fixture, the robot interferes with the obstacle. Before executing the torch recovery program, jog the robot to such a position that there will be no obstacle between the robot and the torch recovery fixture.
4. Disable the teach pendant, then press the start button on the operator's panel or enter the external start signal. The correction operation is executed on the basis of the setting of the currently selected tool coordinate system.

Procedure 12-5 TCP Correction by Automatic

Step

1. Teach a program with using the tool coordinate system that a calibration is performed. Alternatively, check that the program that has already been taught is based on the tool coordinate system.

2 Modify the program so that the torch recovery program or macro is called for the motion group to which correction operation is carried out. For example, add some lines to the production program (refer to following program modification) if you want to execute the correction operation for motion group 1 once in every ten times execution of production program by torch mate function.

```
MAIN1

 20:J P[10:HOME] 100% FINE
 21:  R[10] = R[10] + 1
 22:  IF R[10] = 10, JMP LBL[1]
 23:  JMP LBL[2]
 24:  LBL[1]
 25:J P[11:Approach position] 100% FINE
 26:  CALL TM_ADJST  or  TorchMate Adjust
 27:  R[10] = 0
 28:  LBL[2]
[END]

   [INST]                    [EDCMD]  >
```

Added

NOTE) In above program, [TorchMate Adjust] means a macro instruction

3 Disable the teach pendant, then press the start button on the operator's panel or enter the external start signal. The correction operation is executed on the basis of the setting of the currently selected tool coordinate system.

12.3.6 Recovery from Alarms

When following situations are occurred during Torch Mate correction, the confirmation screen is displayed.

- The wire does not connect with the torch recovery plate
- The wire connects with the torch recovery plate before torch recovery motion
- The detected compensation value is over the allowable limit

The following screen shows the confirmation screen for motion group 1.

```
RECOVERY Menu1

     Error Recovery Menu G:1

   1 Redo TorchRecovery Adjustment
   2 Skip TorchRecovery Adjustment
   3 Abort Program

                    ADVWIRE  RETWIRE   HELP
```

On this recovery screen, select redo or skip, abort of torch recovery execution.

NOTE

1. This recovery screen is designed on the assumption of AUTO mode execution. It is impossible to operate this screen when the execution is in T1 or T2 mode.
2. In a Multi Group control system, the correction operations of the two robots can be simultaneously executed by the multi-task function or some other function. If an alarm is issued during the torch recovery of one robot while the RECOVERY screen is being displayed for the other robot, the RECOVERY screen for the alarm appears after the processing on the screen displayed earlier is completed.

In the case of redo, please refer to following procedure.

Procedure 12-6 Redo Operation of Torch Recovery motion

Step

1 When this recovery screen is displayed, an alarm has been posted during torch recovery operation. From an alarm message, determine the cause of posted alarm. For details of the alarms, see the Subsection 12.3.7.
2 Correct the cause of the alarm. Perform recovery, for example, repair the voltage detection circuit (stick detection circuit, usually) used at wire contact time, correct manually the torch bent too much, etc. To correct the cause of the alarm, the robot can be moved slightly away from the torch recovery fixture by jogging. However, move the robot to a place that prevents the robot from interfering with the fixture and so on when performing the torch recovery operation again.
3 Cut the wire to an appropriate length.
4 Press the start button on the operator's panel or enter the external start signal to reexecute the program.
5 Move the cursor to [Redo TorchRecovery Adjustment], then press the ENTER key. The robot starts search operation.

To skip torch recovery operation, move the cursor to [Skip TorchRecovery Adjustment], then press the ENTER key. The program that is calling the program for torch recovery operation is not terminated, but the preceding torch recovery correction operation only is canceled. At this time, TCP is not updated.
To terminate the program, move the cursor to [Abort Program], then press the ENTER key. The program that is calling the program for torch recovery operation is terminated.

12.3.7 Torch Recovery Alarms

There is a possibility that following alarms are posted during torch recovery operation.

- Standard search alarms
  The standard search alarms includes alarms described below.

TMAT-000 Offset is out of range

Cause: The upper offset limit was exceeded as the results of tool center point correction based on torch recovery operation.
Remedy: Manually correct the torch so that the tool center point shift is within the maximum offset limit. Then, perform torch recovery operation again on the RECOVERY screen.

TMAT-001 Sensor is ON before search

Cause: Before search operation is started, the contact confirmation signal (search signal) to be applied when the plate is contacted is already ON.
Remedy: Check the contact confirmation signal and its connection path. After confirmation of the signal, perform torch recovery operation again on the RECOVERY screen.

TMAT-002 Sensor failed during search

Cause: Search operation was performed, but the wire did not contact the plate.
Remedy:
1 Make the wire long when it is short.
2 If the torch bends too much, correct the torch manually so that the wire can contact the plate in correction operation.
3 Check that the contact confirmation signal is inputted when the wire contacts the plate.

12.3.8 Displaying and Saving Correction History Data

Each time the torch recovery program or macro is executed to carry out a torch recovery correction operation, an offset value is reflected in TCP. The offset value is calculated on the basis of the TCP internally saved in the torch recovery calibration.

Up to 100 offset values, each obtained in each correction operation, are internally recorded as correction history data together with dates. This history can be viewed, and can be saved in ASCII format to the external storage device.
This correction history can be used to manage a tool center point shift.

Correction history data can be displayed on the teach pendant according to the procedure below.

Procedure 12-7 Displaying and Saving Correction History Data

Step

1 Press [MENU] key and select the [DATA].
2 Press F1 [TYPE] and select the [TorchMate]. The following screen is displayed. In the screen shown below, motion group numbers are displayed in the G column, and tool coordinate system numbers are displayed in the T column.

```
DATA TorchMate
                                          1/100
     Date   Time  G  T     X      Y     Z
  1  1-10  04:37  1  1   3.10  .60   0.00
  2  1-10  04:36  1  1  -1.10  .09   0.00
  3


 98  1-9   04:10  1  1  -.10  -.09  -1.10
 99  1-9   04:09  1  1   Mastered X Y Z
100
   [ TYPE ]        SAVE          HELP
```

* "Mastered X Y" means that the calibration has been performed in the XY direction.
* "Mastered X Y Z" means that the calibration has been performed in the XYZ direction.

3 Check that the currently selected storage device is connected. The currently selected device can be checked by pressing [MENU] key and then selecting [FILE].
To save the data on a Memory Card, insert the card into the PCMCIA slot in the front operation panel.
4 If necessary, format the corresponding storage device, then press F3[SAVE].
5 Upon completion of saving of the data, the message "Data file copied successfully" is displayed.
6 An ASCII format file named TMDATA.DT is created on the selected device. If a file with the same name already exists on the device, the file is overwritten.

12.3.9 Torch Recovery Unit

The figure of a typical torch recovery unit is shown in Fig.12.3.9 (a). When this figure is used, the standard settings can be used without modification. Low voltage is used for the stick detection circuit. So use a material that is sufficiently conductive for parts of torch recovery unit.
If a unit can satisfy the specifications below, it is not necessary to prepare the same unit described in following figure.

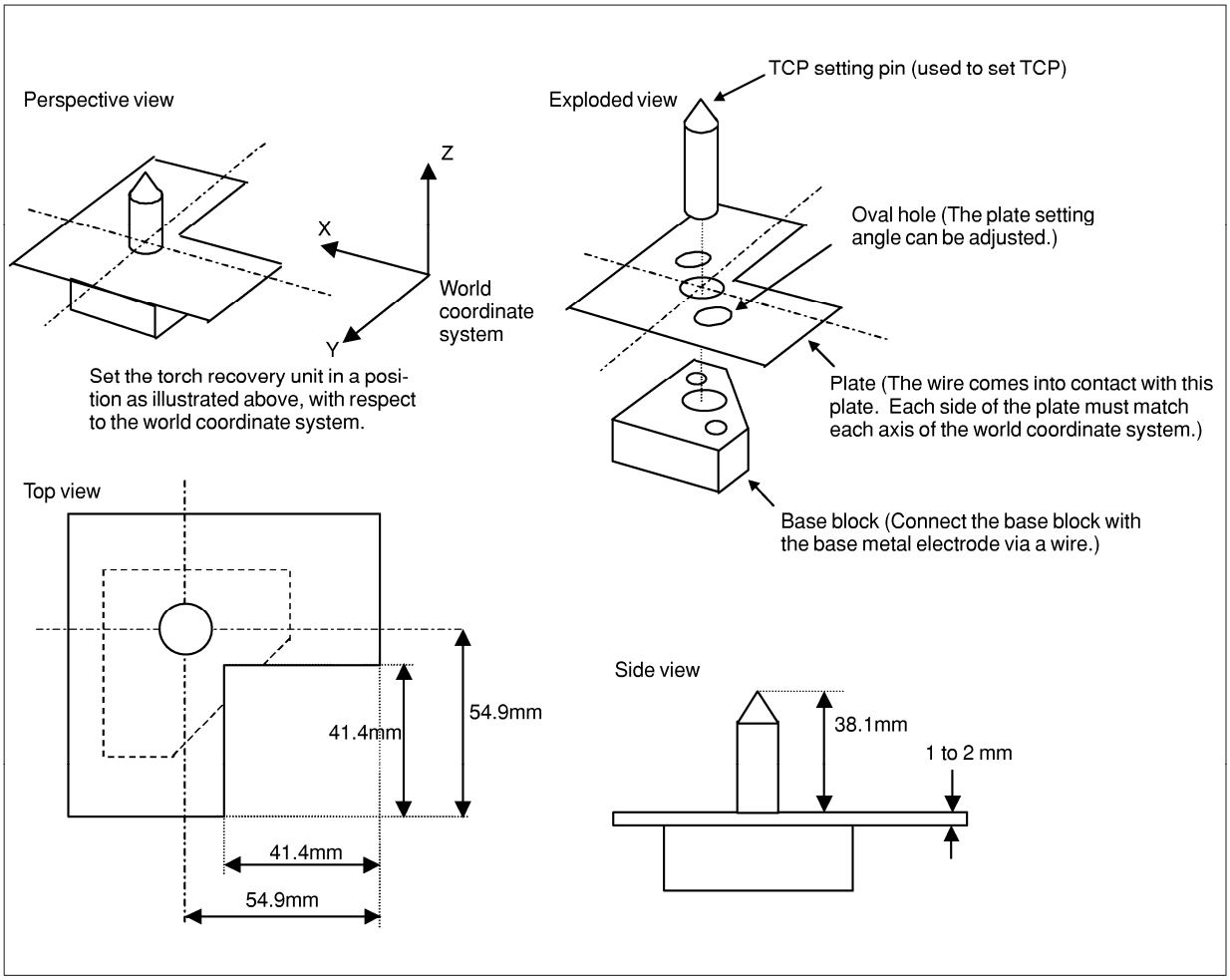


Fig. 12.3.9 (a) Torch recovery unit 1

The following Fig.12.3.9 (b) shows high-speed torch recovery unit (A05B-1221-J056) that FANUC releases.

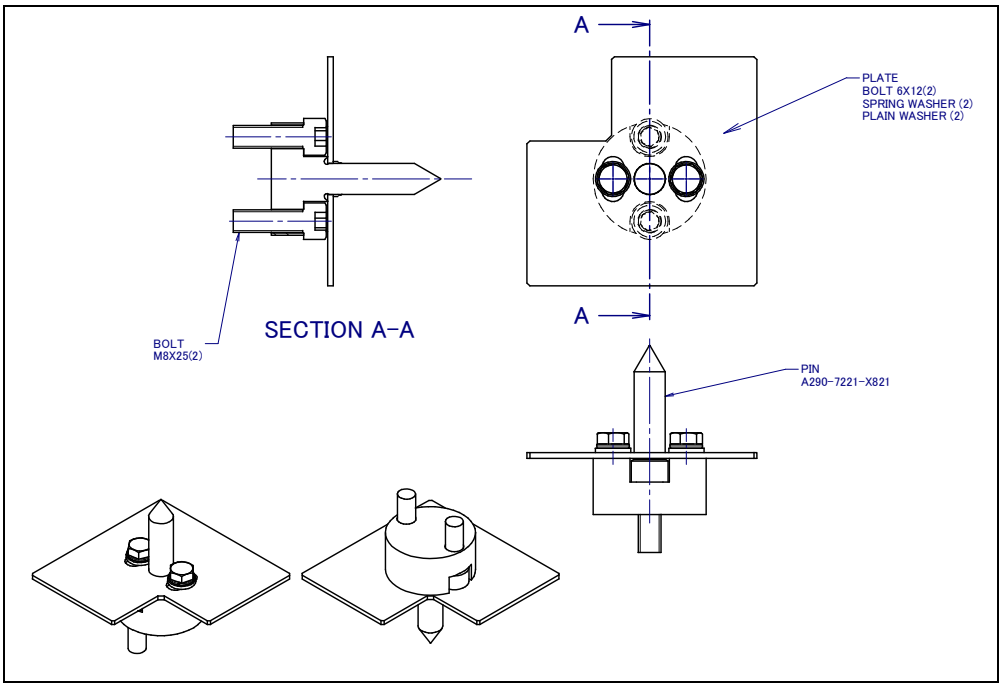


Fig. 12.3.9 (b) Torch recovery unit 2

The following Fig.12.3.9 (c) shows torch recovery unit (A05B-1210-J056) that FANUC releases.

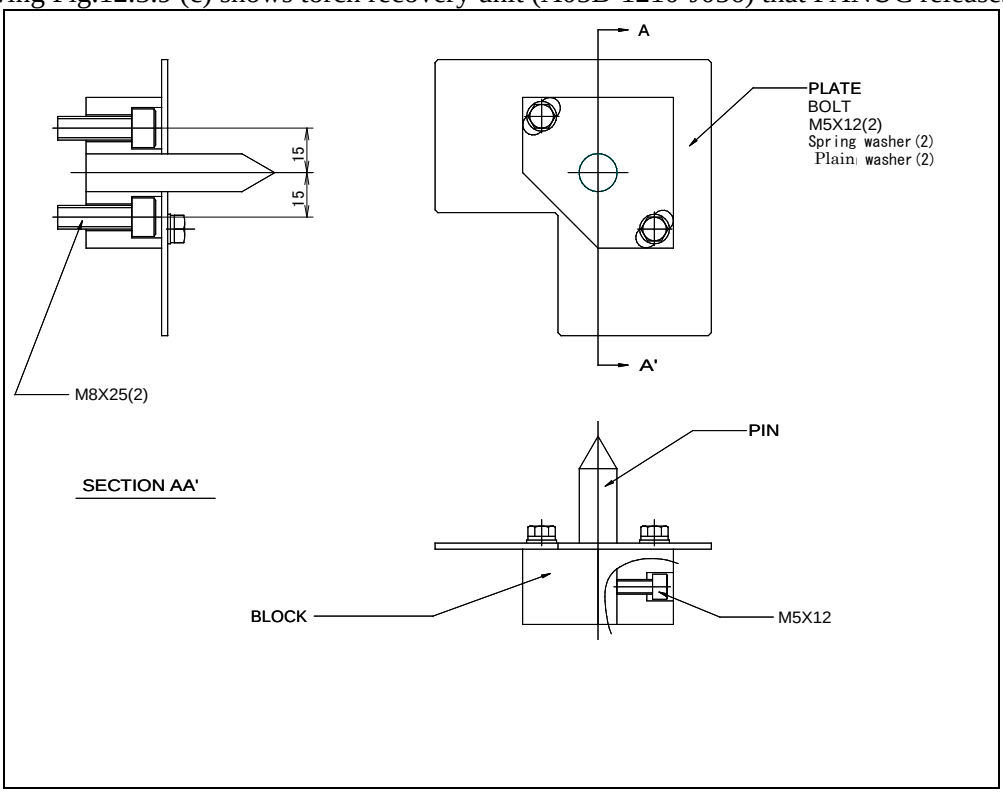


Fig. 12.3.9 (c) Torch recovery unit 3

12.3.10 Backup Data

When the data is backed up on the file screen, the data of the Torch Mate function is saved in the device under the following file names. These files are saved in the device when the all of above backup or application backup is performed.

- Setting data : main_tcp.vr
- Correction history data : offsetdt.vr

13 TORCH MAINTENANCE STATION

Outline

Torch maintenance station can perform automatic contact tip changing, nozzle cleaning using robot motion without any external power. Torch maintenance station can stock three new tips and allows non-stop running till 24 hours (Replacing a tip every 8 hours × 3 times).

This function is an option (A05B-XXXX-J564).

Torch maintenance station is composed of the following equipments.
- Tip changer fixture (A05B-XXXX-J059)
- Nozzle cleaner fixture (A05B-XXXX-J060)

Preparations

It is necessary to prepare following equipments by customer.
- Wire cutting device
  This device must have a capacity to cut the welding wire that is used in your application.
  This device must be able to control by the Digital Output signal on Robot controller.
  To drive this device, it is necessary to prepare the layout and solenoid valve, air compressor, etc.
- Mounting base
  Mounting base must have a capacity for tip changer and nozzle cleaner, wire cutting device.
  Mounting base must be horizontal.
- Box for wire scrap(recommendation)
  It is recommended to prepare a box to collect wire scrap.

13.1 INSTALLATION

- Please install the tip changer and the nozzle cleaner parallel to the ground to avoid the influence of gravity.
- Please install the fixtures to avoid influence of vibration.
- When deciding the fixtures position, distance between tip changer and nozzle cleaner (refer to Fig.13.1 (a)) must be minimum 220 mm and must remain free(refer to Fig.13.1 (b)).
- Please not to install any fixtures at slash area in Fig.13.1 (b). The interference area of robot arm becomes large corresponding to the torch posture at using the tip changer or nozzle cleaner fixture.
- Please install the fixtures within robot motion range (refer to Fig.13.1 (c)).
- Please refer to Fig.13.1 (d) and Fig.13.1 (e) about the mounting base that installs the tip changer, nozzle cleaner, and wire cutting device.

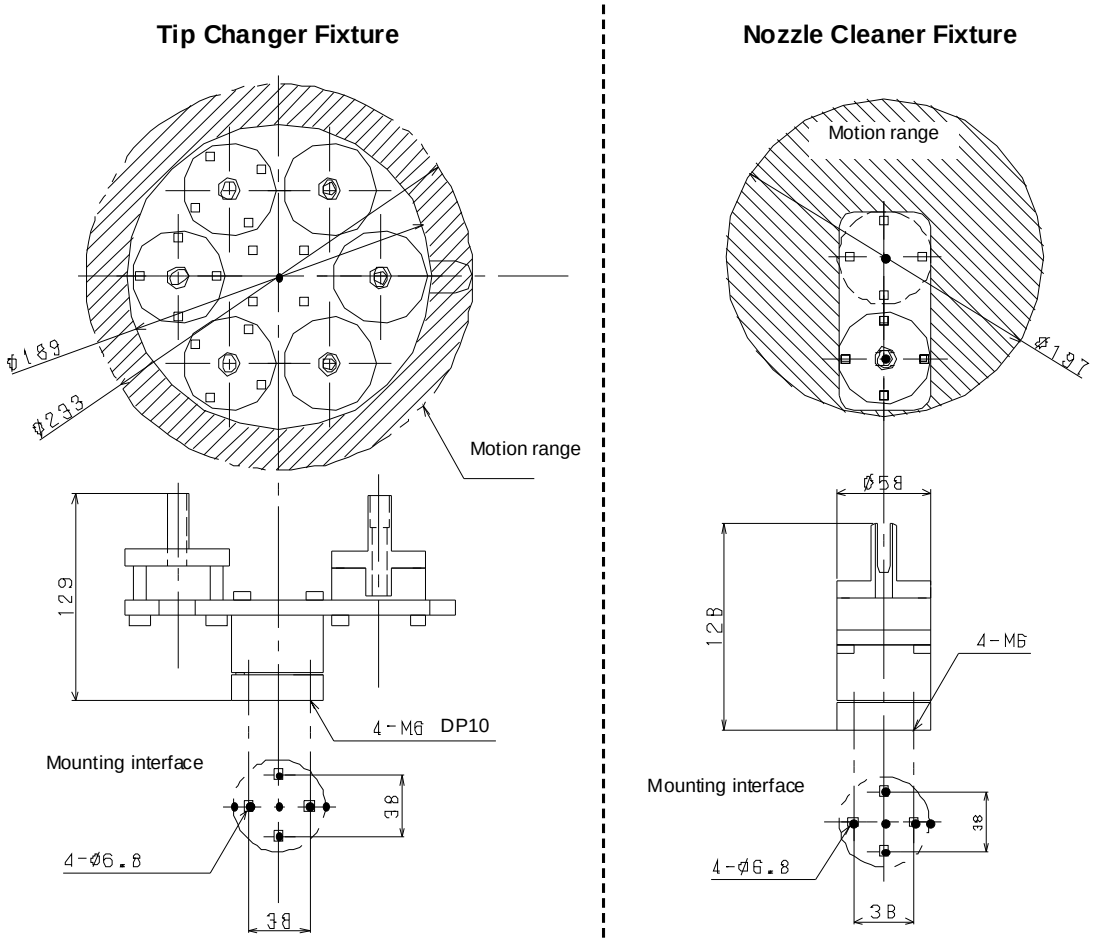


Fig. 13.1 (a) Outer dimensions of the tip changer fixture and nozzle cleaner fixture

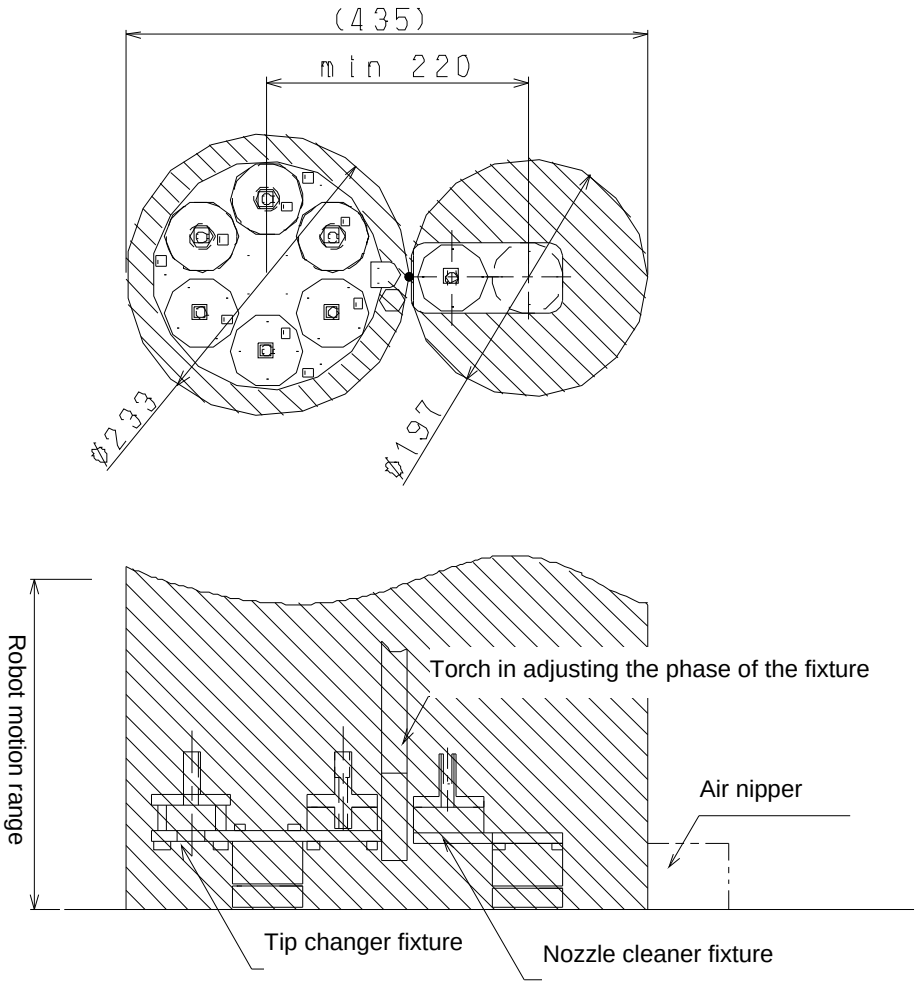


Fig. 13.1 (b) Installation of the torch maintenance station

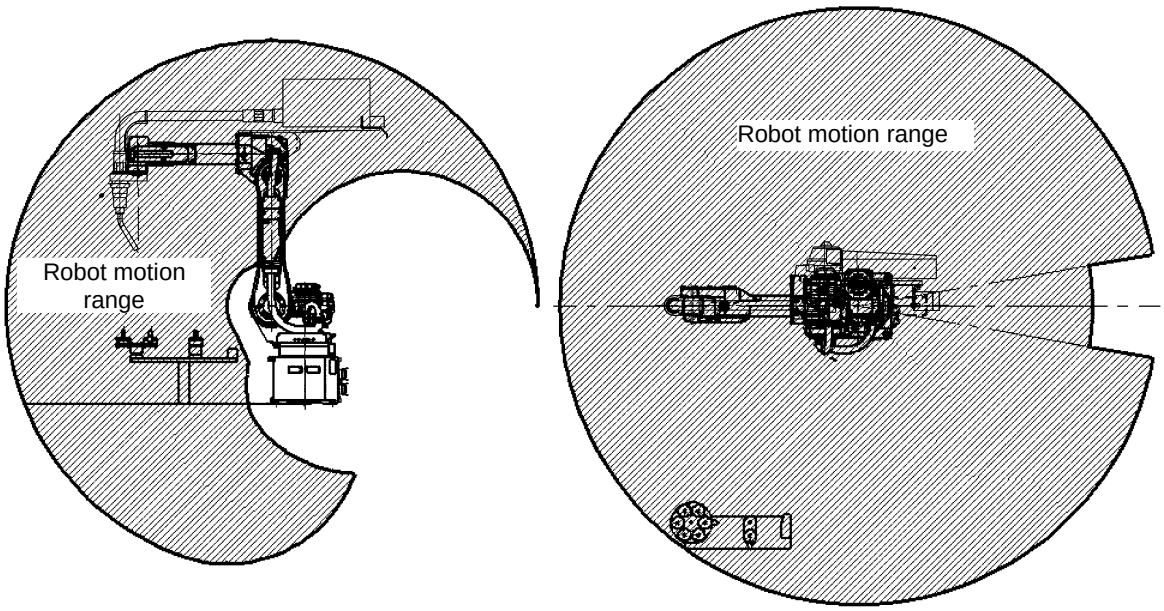


Fig. 13.1 (c) Example of installation of torch maintenance station

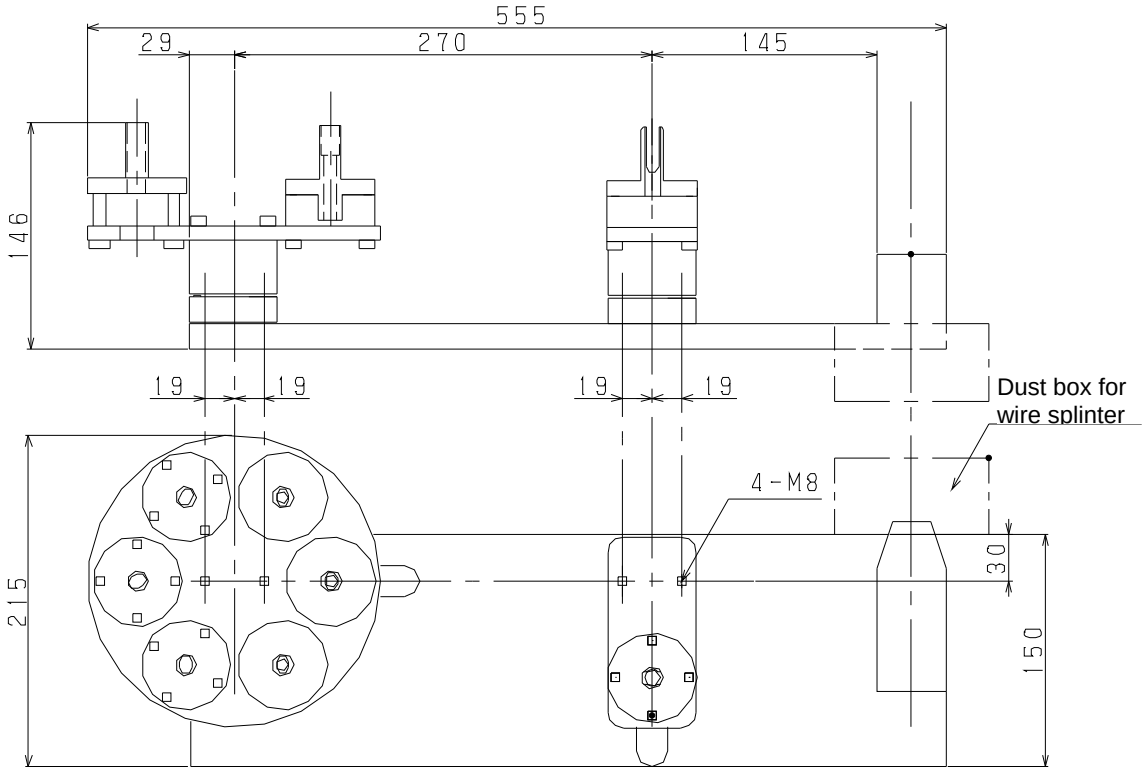


Fig. 13.1 (d) Example of mounting the fixtures on the mounting base 1

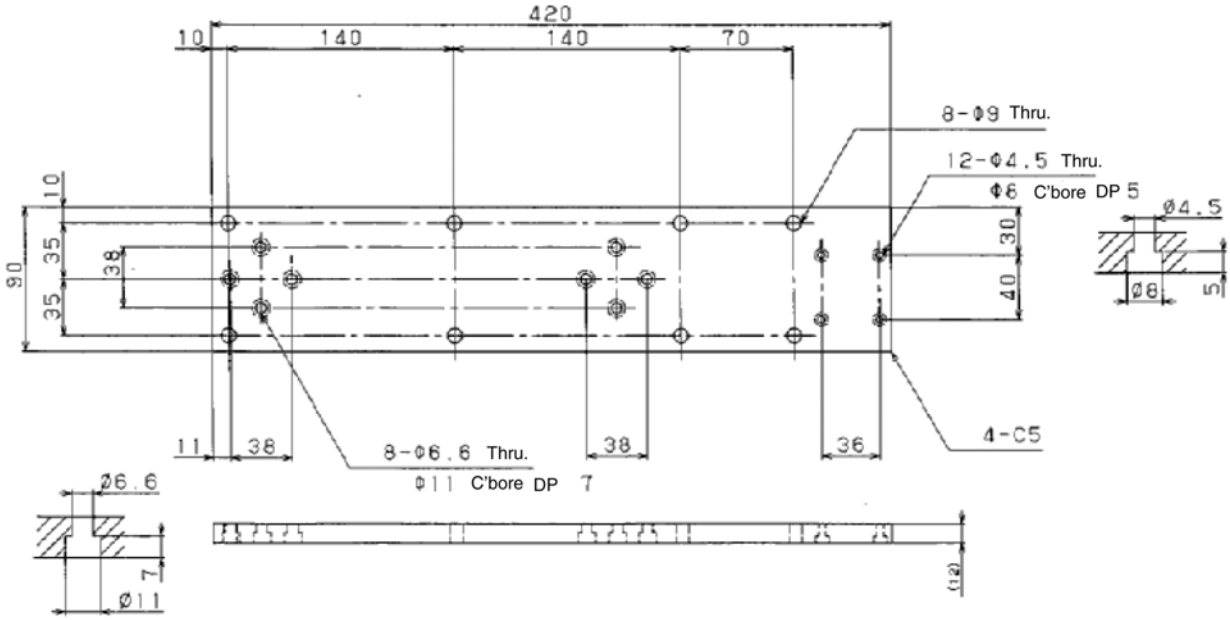


Fig. 13.1 (e) Example of mounting the fixtures on the mounting base 2 (Compact type)

13.2 PREPARATION

Setting of TCP

Set up the Tool Frame so that the TCP position is at the tip of the welding wire.
Please refer to setting a tool coordinate system about the setting of TCP.

13.3 TOUCHUP (TIP CHANGER)

Setting of Insertion Depth for 3 Points Teaching

Mark the tip according to the figure below. Recommended value is 28mm.

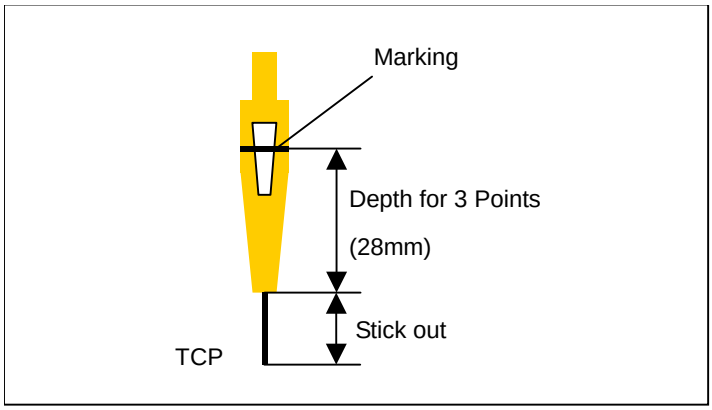


Fig. 13.3 (a) Marking of tip

Touchup

Execute the touch-up according to the following procedures.

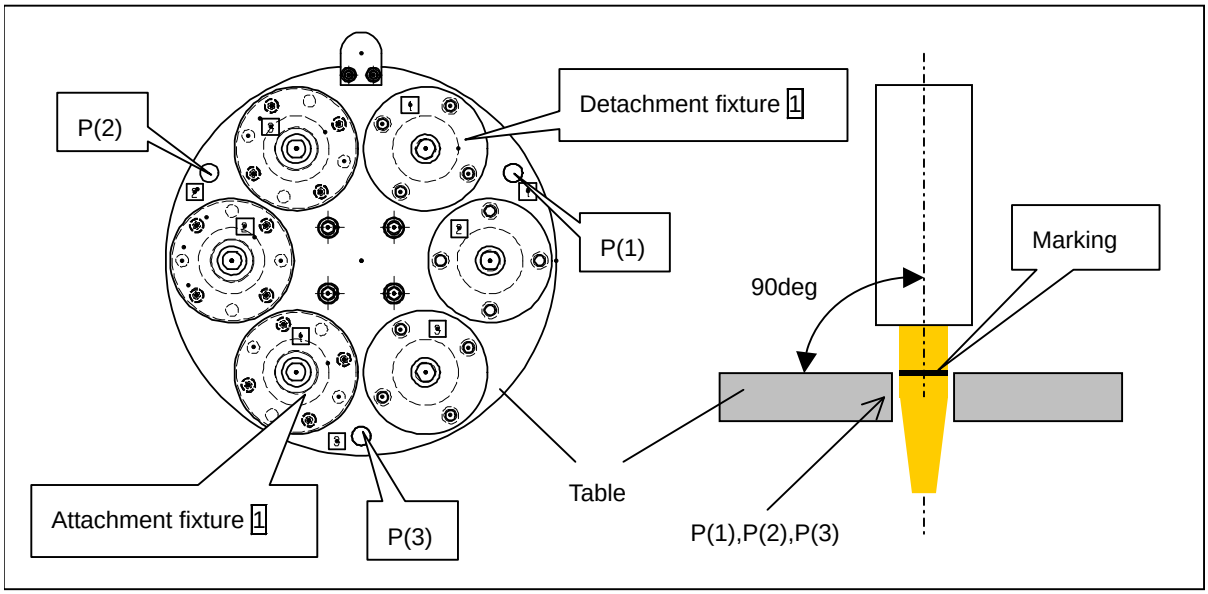
Procedure 13-1 Touchup to the Tip changer fixture

Step

1 Touchup is done in a position where the table is locked. (Table is locked every 60 degrees.)

2 Insert the tip vertically in the teaching hole (P(1), P(2), P(3)) on the table till the mark on the tip, and touch up the position P[1], P[2] and P[3] in the program "TORGRP1" (Following table shows program names for each motion group in multi robot system). By this touch up positions, the tip changer motion program is automatically created.

Group No.	1	2	3	4	5
Program name	TORGRP1	TORGRP2	TORGRP3	TORGRP4	TORGRP5



```
TORGRP1
                                        1/9
  1:  !PROGRAM for 3 POINTS TEACHING
  2:  JMP LBL[1]
  3:J P[1:Point 1] 1% FINE
  4:  JMP LBL[1]
  5:J P[2:Point 2] 1% FINE
  6:  JMP LBL[1]
  7:J P[3:Point 3] 1% FINE
  8:  LBL[1]
 [END]

    [INST]                    [EDCMD]  >
```

⚠CAUTION
- Tip exchange is always executed at the attachment fixture [1] position, detachment fixture [1] position during the touch up.
- Approach with the nozzle to position the table. Please set the start point not to interfere with other equipments etc. You can change the approach length on the setting screen.

⚠CAUTION
- Teaching is performed with the nozzle detached.
- Teach the torch posture vertically for the table.
- Keep the torch posture constant during the 3-points teaching.
- Do not rotate the table while teaching.
- Do not change the program name.

⚠CAUTION
- Teach the 3-points using the same Tool frame number.
- Teach the 3-points after you selected the user frame 0.
- Associate correctly the position numbers P[xx] of the 3 points according to the corresponding positions on the fixture, otherwise it may generate wrong coordinate system and unexpected operation may occur.
- If you use extended axis, do not move it during the 3 points teaching. That is, teach the 3-points without moving the extended axis.

Parameter Setting

Please refer to following table, and please set the torch maintenance according to the following procedure.

Table 13.3 Description for torch maintenance setting screen

SETTING ITEM	DESCRIPTION
Calculate	After setting other items in this screen, move the cursor to this item, and press the F4[Calc] when you want to convert the position data of auto program. The positions of programs TORCHDO1, TSETPOS1, TDETACH1, TATTACH1 are calculated(in case of motion group 1). In the case of motion group 2, the positions of the programs that the last numerical value of each program name is “2” are calculated. [INCOMPLETE] changes to [COMPLETE] when the calculation is completed.
Stick out	Wire length from the contact tip of the torch barrel to the tip of the welding wire.

SETTING ITEM	DESCRIPTION
Approach height	Specify the approach height at teaching of the table. The approach height is the distance from the tip body to the table. For more detail, please refer to Fig.13.3(b).
Approach length	Specify the length for the tangent direction from the approach start position to the approach position at teaching of the table. For more detail, please refer to Fig.13.3(c).
Depth for 3 Points	Specify the depth from the contact tip to marking.
Mounting adjustment	It is possible to execute the fine adjustment for the tip mounting.
Removal adjustment	It is possible to execute the fine adjustment for the tip removal.

⚠CAUTION

- Never changes the program name, positions number, and the positions data of TORCHDO1-5, TSETPOS1-5, TDETACH1-5, TATTACH1-5.
- Press the F4[Calc] again when you change settings of tip exchange.

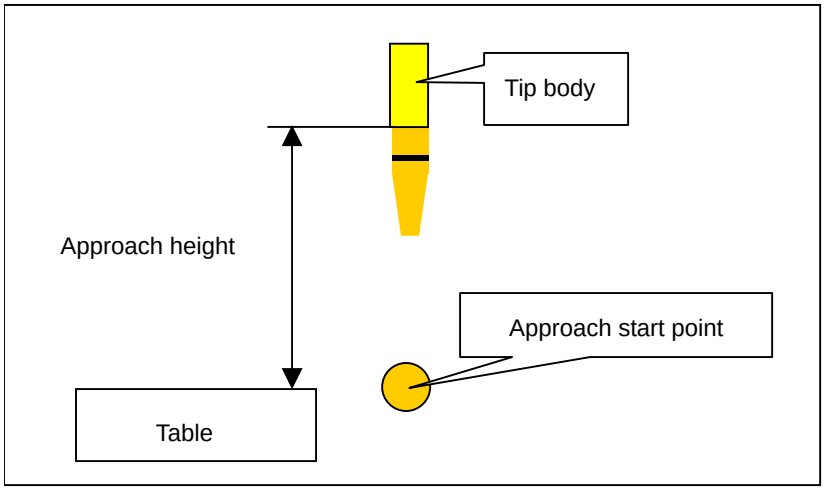


Fig. 13.3 (b) Approach height

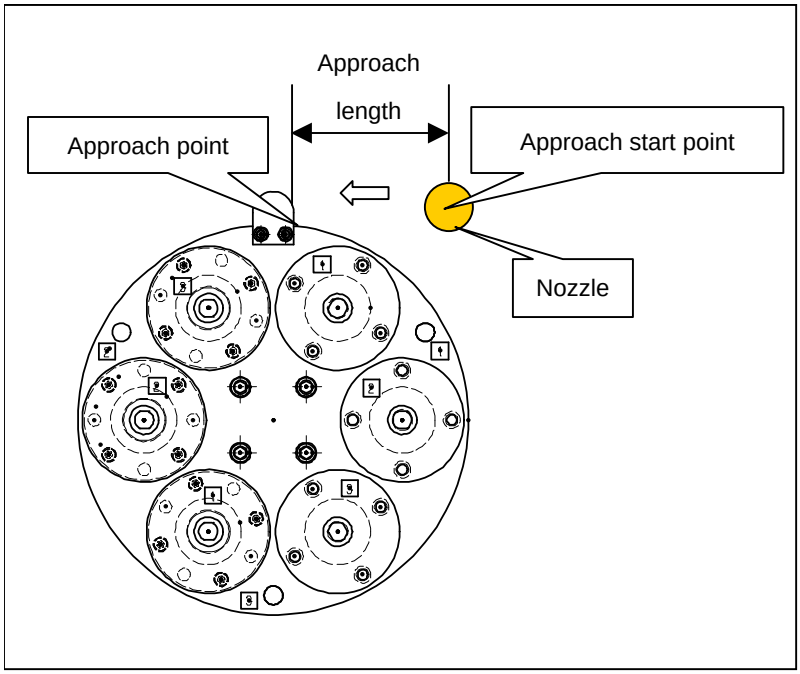


Fig. 13.3 (c) Approach length

Procedure 13-2 Setting of Torch Maintenance

Step

1 Press [MENU] key to display the setting menu.
2 Select [SETUP].
3 Press F1[TYPE] to display the select menu.
4 Select [TorchMainte]. Torch Maintenance Station Setup screen is displayed. Following sample screen shows the setting for motion group 1. If you want to change the group number, press F2[Group] then input Group number.

```
Torch Maintenance Station Setup
                                        1/7
  Group No.                    :1
1 Calculate                    :INCOMPLETE

  <Setup Parameters>
2 Stick out                    :15.0[mm]
3 Approach height              :150.0[mm]
4 Approach length              :100.0[mm]
5 Depth for 3 Points           :28.0[mm]
6 Mounting adjustment          :5.0[mm]
7 Removal adjustment           :5.0[mm]

  [ TYPE ]  Group        Calc   HELP
```

5 Set parameters other than [Calculate].
6 Move the cursor to [Calculate] and press the F4[Calc]. The positions of the programs TORCHDO1 and TSETPOS1, TDETACH1, TATTACH1 are calculated(in the case of motion group 1). In the case of motion group 2, the positions of the programs that the last numerical value of each program name is “2” are calculated.
7 [INCOMPLETE] changes to [COMPLETE] after the calculating.

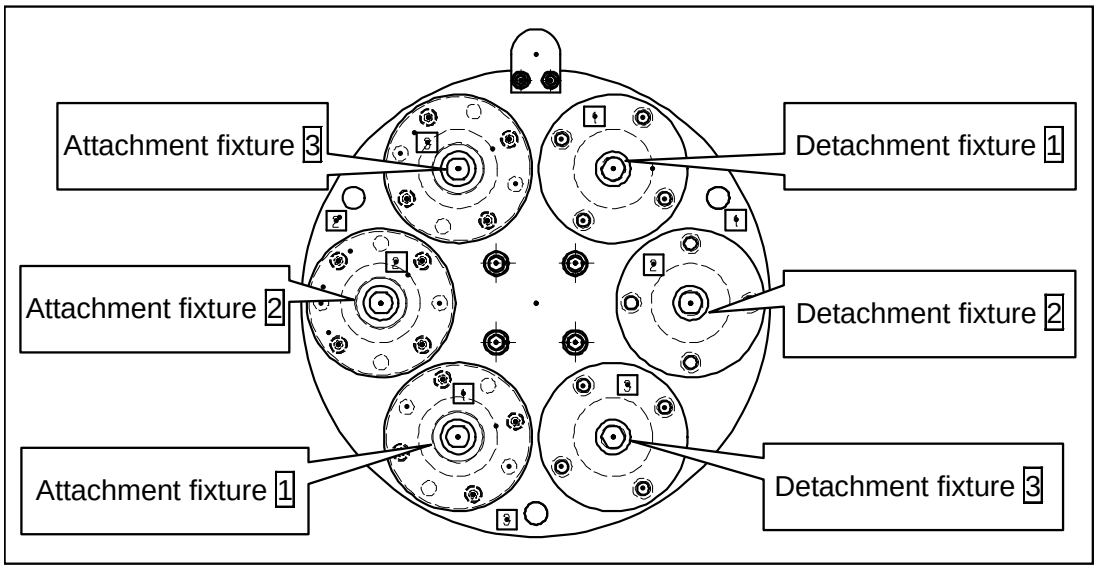
13.4 EXECUTION OF AUTO PROGRAM FOR TIP EXCHANGE

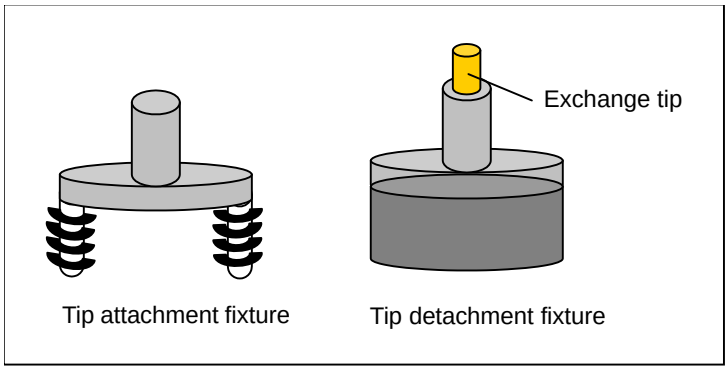
Please execute the auto program for tip exchange with the following procedure.

Procedure 13-3 Execution of Auto Program for Tip Exchange

Step

1 Insert the exchange tips into the tip attachment fixtures 1-3.



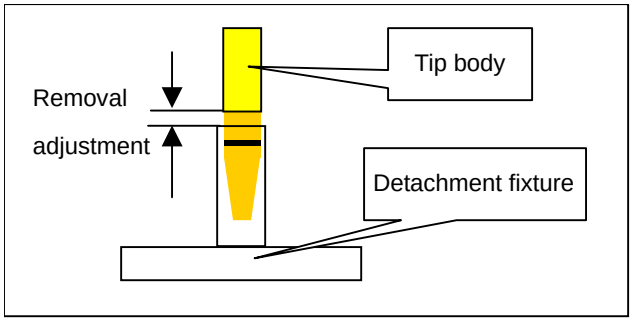


2 Execute the program TORCHDO1.
TORCHDO1 is executed only if target robot is motion group 1. When you use other motion group, execute TORCHDOx (x : motion group number 1-5) accordingly.

⚠CAUTION
- When you perform a wrong setting, the robot might operate in an unexpected direction. For example, if you make a mistake on the relation between the fixture location and 3 points teaching by teaching the opposite way, the robot may collide with the fixture.
  Execute the trial run at slow speed.
- Do not output the wire during trials.

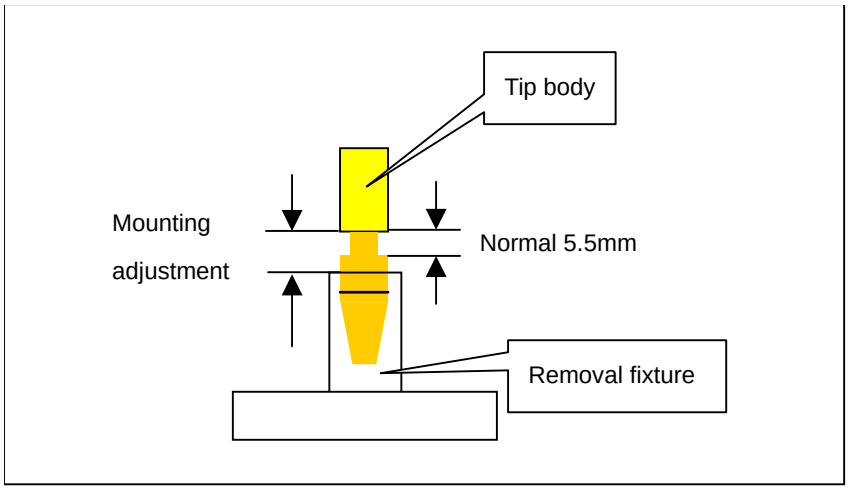
3 The torch moves to the approach point after moving to the above the center of the table. The table is rotated. Please execute with the nozzle installed.

4 Detach the Tip. When the Tip adapts to the fixture, it is normal that the spring of the fixture is slightly pushed. If adjustment is necessary, change [Removal adjustment] on Torch Maintenance Station Setup screen, and then executes the calculation again.



NOTE) It is impossible to expect the phase of tip.
When the phase is shifted, it is adjusted by pressing the spring.

5 Mount the tip. Adjust the [Mounting adjustment] on Torch Maintenance Station Setup screen so that the interval becomes about 5.5mm between the tip body and the top of the fixture.



NOTE

If you try to execute TORCHDOx (x：Group number 1-5) one more time after finishing the exchange in the fixture Number 3, an alarm is generated and you cannot exchange the tip. In this state, the register [50] value becomes 4. Inform user (using DO signal, user alarm…) to remove the used tips and to install new tips when register[50] becomes 4 by improving the TORCHDOx. In addition, please set the register[50] to 1 when you completed the replacement. If you use group number 1, modify the program of TORCHDO1. If you use group number 2-5, change the register value according to the table below.

Group No.	1	2	3	4	5
Program name	TORCHDO1	TORCHDO2	TORCHDO3	TORCHDO4	TORCHDO5
Register	R[50]	R[70]	R[90]	R[110]	R[130]

13.5 TOUCHUP (NOZZLE CLEANER)

Setting of Insertion Depth for 3 Points Teaching

Prepare the tip as described in Section 13.3. (Recommended value is 28.0mm)

Touchup

Perform the touchup according to the following procedure.

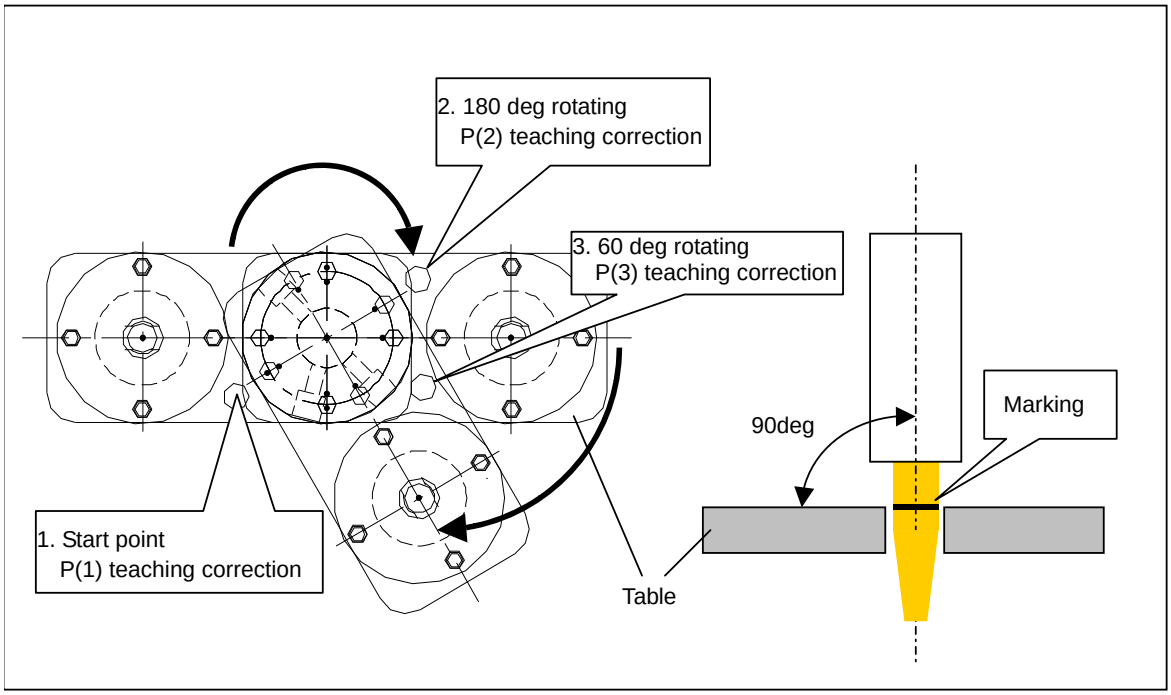
Procedure 13-4 Touchup to the Nozzle Cleaner

Step

1 Execute the touchup at a position where the table is locked. (Table is locked every 60 degrees.)

2 Insert the marked tip vertically in the teaching hole on the table. Touchup the P[1] position in program ”TOCLGRP1” (According to the following table, each programs are prepared for multi robot system). By this touchup, the tip cleaner motion program is automatically created.

Group No.	1	2	3	4	5
Program name	TOCLGRP1	TOCLGRP2	TOCLGRP3	TOCLGRP4	TOCLGRP5




```
TOCLGRP1
                                        1/8
  1:  JMP LBL[1]
  2:J P[1] 1% FINE
  3:  JMP LBL[1]
  4:J P[2] 1% FINE
  5:  JMP LBL[1]
  6:J P[3] 1% FINE
  7:  LBL[1]
 [END]

   [INST]                          [EDCMD]  >
```

⚠CAUTION
- Cleaning is always executed at first table position used for touch up.
- Execute the approach motion using the nozzle to position the table. Please set the start point not to interfere with other equipments. You can change approach length on the setting screen.

⚠CAUTION
- Touch up is executed with the nozzle detached.
- Teach the torch posture vertically according to the table.
- Keep the torch posture constant during 3-points teaching.
- Do not change the program name.

⚠CAUTION
- Teach the 3-points using the same Tool frame.
- Teach the 3-points after you selected the user frame 0.
- Associate correctly the position number P[xx] of the 3 points according to the corresponding positions on the fixture, otherwise it may generate wrong coordinate system and unexpected operation may occur.
- If you use extended axis, do not move it during the 3 points teaching. That is, teach the 3-points without moving the extended axis.

3 Turn the table 180 degree and insert the tip into the hole then touch up the position P[2].
4 Turn the table 60 degree and insert the tip into the hole then touchup the position P[3].

Parameter Setting

Please refer to following table, and please set the torch clean according to the following procedure.

Table 13.5 Description for torch clean setting screen

SETTING ITEM	DESCRIPTION
Calculate	After setting other items in this screen, move the cursor to this item, and press the F4[Calc] when you want to convert the position data of auto program. The positions of programs TOCLEAN1 is calculated(in case of motion group 1). In the case of motion group 2, the positions of the programs that the last numerical value of program name is “2” are calculated. [INCOMPLETE] changes to [COMPLETE] when the calculation is completed.
Stick out	Wire length from the contact tip of the torch barrel to the tip of the welding wire.
Approach height	Specify the approach height at teaching of the table. The approach height is the distance from the tip body to the table. For more detail, please refer to Fig.13.5(a).
Approach length	Specify the length for the tangent direction from the approach start position to the approach position at teaching of the table. For more detail, please refer to Fig.13.5(b).
Depth for 3 Points	Specify the depth from the contact tip to marking.
Torch approach	Adjust the height of torch approach. For more detail, please refer to Fig.13.5(c).
Rotation adjustment	Adjustment the height(depth) for inserting to the tip cleaner.

⚠CAUTION
- Never changes the program name, the position numbers and the position data of TOCLEAN1-5, TOCLGRP1-5.
- After changing parameter in the torch clean setup screen, please execute F4[Calc] again.

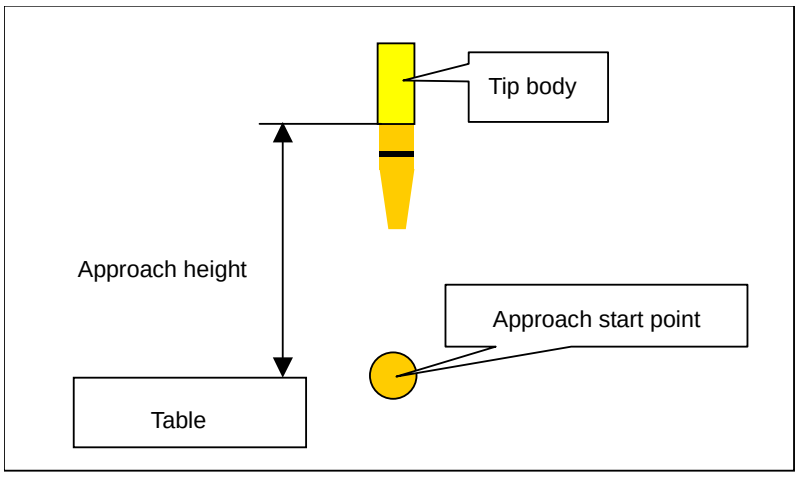


Fig. 13.5 (a) Approach height

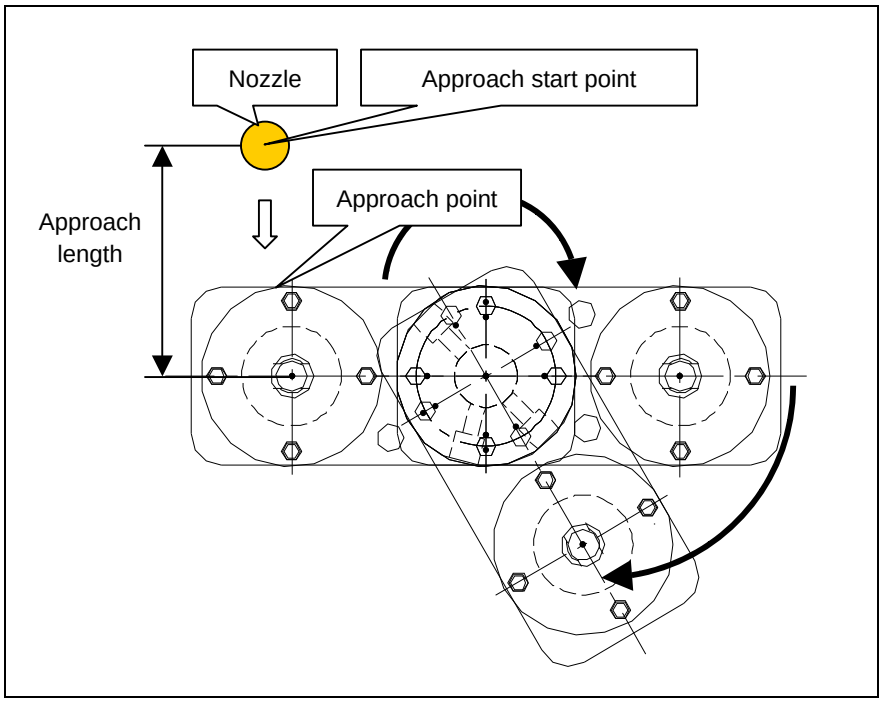


Fig. 13.5 (b) Approach length

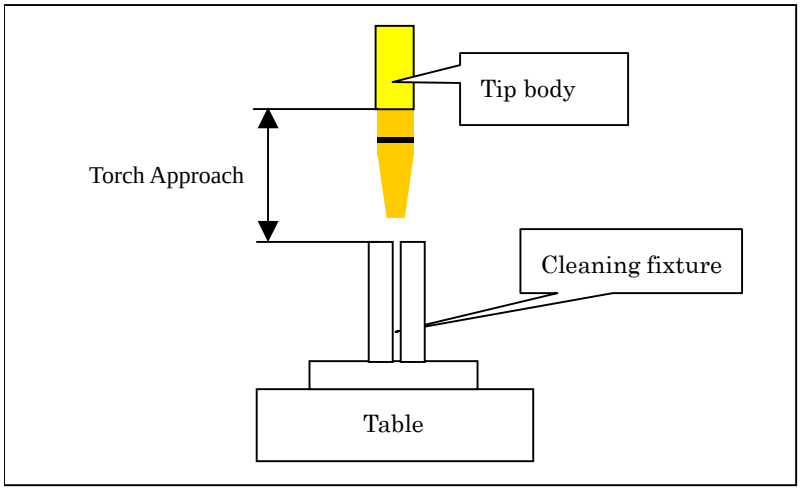


Fig. 13.5 (c) Torch approach

Procedure 13-5 Setting of Torch Clean

Step

1 Press [MENU] key to display the setting menu.
2 Select [SETUP].
3 Press F1[TYPE] to display the select menu.
4 Select the [TorchClean]. Torch Clean Setup screen is displayed. Following sample screen shows the setting for motion group 1. If you want to change the group number, press F2[Group] then input Group number.

```
Torch Clean Setup
                                        1/7
    Group No.                   :1
  1 Calculate                   :INCOMPLETE

    <Setup Parameters>
  2 Stick out                   :15.0[mm]
  3 Approach height             :150.0[mm]
  4 Approach length             :100.0[mm]
  5 Depth for 3 Points          :28.0[mm]
  6 Torch approach              :30.0[mm]
  7 Rotation adjustment         :3.0[mm]

    [ TYPE ]  Group          Calc   HELP
```

5 Set parameters other than [Calculate].

6 Move the cursor to [Calculate] and press the F4[Calc]. The positions of the programs TOCLEAN1 is calculated(in the case of motion group 1). In the case of motion group 2, the position of the program that the last numerical value of program name is “2” are calculated.

7 [INCOMPLETE] changes to [COMPLETE] after the calculating.

13.6 EXECUTION OF AUTO PROGRAM FOR NOZZLE CLEANING

Please execute the program for nozzle cleaning by following procedure.

Procedure 13-6 Execution of Auto Program for Nozzle Cleaning

Step

1 Execute the program TOCLEAN1.
This operation is executed only if target robot is motion group 1. When you use other motion group, execute TOCLEAN x (x：motion group number 1-5) corresponding to the motion group.

> ⚠**CAUTION**
> - When you perform wrong settings, the robot might operate in an unexpected direction. For example, if you make a mistake on the relation between the fixture location and 3 points teaching by teaching the opposite way, the robot may collide with the fixture.
> Execute the trial run at slow speed.
> - Do not output the wire during trials.

2 The torch moves to the approach point after moving to the above the center of the table. The table is rotated. Please execute with the nozzle installed.

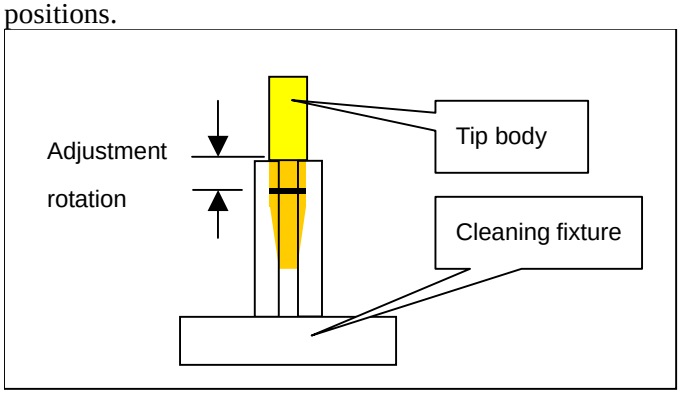
> **NOTE**
> While cleaning the nozzle, approach motion is not indispensable. When it is not necessary, delete below a part of program. (Recommended)

```
TOCLEAN1
                                                  1/34
  1:  IF R[62]<>1,JMP LBL[2]
  2:  UTOOL_NUM = R[63]
  3:  UFRAME_NUM = R[64]
  4:  R[61] = R[60]
  5:J P[1] 10% CNT100
  6:J P[2] 5% CNT100
  7:L P[3] 100mm/sec CNT100
  8:L P[4] 100cm/min CNT100
  9:C P[5]
   :   P[6] 100mm/sec CNT100
 10:C P[7]
   :   P[8] 100mm/sec CNT100
 11:C P[9]
   :   P[10] 200cm/min FINE
 12:  WAIT  1.00(sec)
 13:L P[11] 100mm/sec CNT100
 14:L P[1] 100mm/sec CNT100
 15:L P[19] 100mm/sec CNT100
 16:L P[12] 200cm/min CNT100
 17:L P[13] 100cm/min FINE
 18:  WAIT  .50(sec)
 19:  LBL[1]
   [INST]                          [EDCMD]  >
```

In the case that the positioning operation is not necessary Delete L6-L14.

When you use other motion group, please refer to TOCLEANx (x : group number 1-5) corresponding to the group.

3 Nozzle cleaning is executed without the nozzle. The tip body must be in contact with the top of the cleaning fixture. If not, please adjust the [Rotation adjustment] in the Torch Clean Setup screen and calculate again the positions.



13.7 ROTATION DIRECTION FOR NOZZLE CLEANING OPERATION

Nozzle cleaning operation is a counterclockwise rotation (view from top position). If you want to make the nozzle cleaning operation clockwise, execute the following procedure.

Procedure 13-7 Change the Rotation Direction for Nozzle Cleaning Operation

Step

1 Change the main program of the torch cleaning TOCLEAN1.TP to another name (backup program).
2 By copying the template program TOC_RR1.TP that is the main program of the torch cleaning for clockwise rotation, and create TOCLEAN1.TP.
3 Calculate the position according to the above-mentioned procedure.

If you want to change back to counterclockwise rotation, rename the “backup program” to TOCLEAN1.TP or copy the template program TOC_LR1.TP, and create TOCLEAN1.TP.

Clockwise (TOC_RR1.TP) and counterclockwise (TOC_LR1.TP) rotation template program are prepared only for motion group 1.

13.8 REGISTER

While using this function, the following registers are used.
Normally, do not change those values.

Motion group 1

R[50:Change chip No]=2	Next tip changer number
R[51:Att Rev]=7	Turn Number for attachement
R[52:Det Rev]=7	Turn number for Detachment
R[53:Buffer]=0	
R[54:Buffer2]=-1	
R[55:TpRunFlag]=1	
R[56:Tool Frame No]=1	
R[57:User Frame No]=0	
R[60:Rev for Clean]=7	Turn Number for cleaning
R[61:Buffer]=7	
R[62:TpRunFlag]=1	
R[63:Tool Frame No]=1	
R[64:User Frame No]=0	

Motion group 2

R[70:Change chip No]=2
R[71:Att Rev]=7
R[72:Det Rev]=7
R[73:Buffer]=0
R[74:Buffer2]=-1
R[75:TpRunFlag]=1
R[76:Tool Frame No]=1
R[77:User Frame No]=0
R[80:Rev for Clean]=7
R[81:Buffer]=7
R[82:TpRunFlag]=1
R[83:Tool Frame No]=1
R[84:User Frame No]=0

Motion group 3

R[90:Change chip No]=2
R[91:Att Rev]=7
R[92:Det Rev]=7
R[93:Buffer]=0
R[94:Buffer2]=-1
R[95:TpRunFlag]=1
R[96:Tool Frame No]=1
R[97:User Frame No]=0
R[100:Rev for Clean]=7
R[101:Buffer]=7
R[102:TpRunFlag]=1
R[103:Tool Frame No]=1
R[104:User Frame No]=0

Motion group 4

```
R[ 110:Change chip No ]=2
R[ 111:Att Rev        ]=7
R[ 112:Det Rev        ]=7
R[ 113:Buffer         ]=0
R[ 114:Buffer2        ]=-1
R[ 115:TpRunFlag      ]=1
R[ 116:Tool Frame No  ]=1
R[ 117:User Frame No  ]=0
R[ 120:Rev for Clean  ]=7
R[ 121:Buffer         ]=7
R[ 122:TpRunFlag      ]=1
R[ 123:Tool Frame No  ]=1
R[ 124:User Frame No  ]=0
```

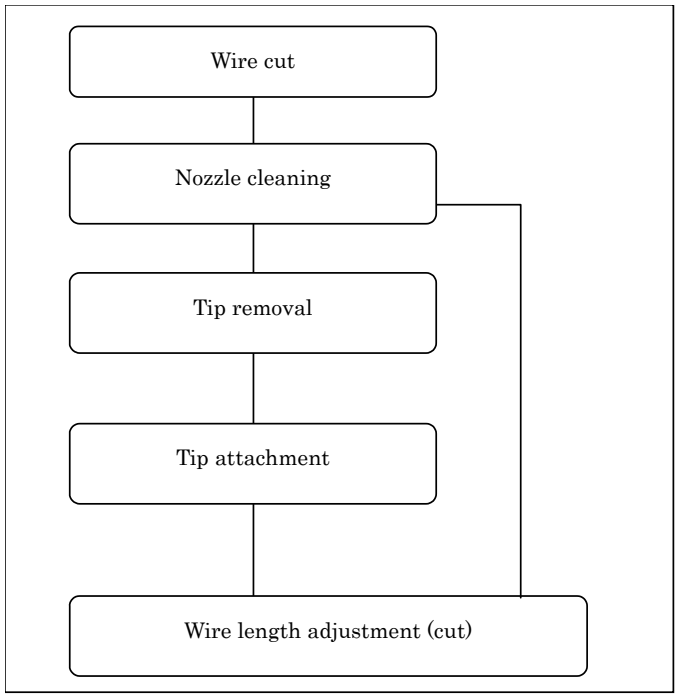
Motion group 5

```
R[ 130:Change chip No ]=2
R[ 131:Att Rev        ]=7
R[ 132:Det Rev        ]=7
R[ 133:Buffer         ]=0
R[ 134:Buffer2        ]=-1
R[ 135:TpRunFlag      ]=1
R[ 136:Tool Frame No  ]=1
R[ 137:User Frame No  ]=0
R[ 140:Rev for Clean  ]=7
R[ 141:Buffer         ]=7
R[ 142:TpRunFlag      ]=1
R[ 143:Tool Frame No  ]=1
R[ 144:User Frame No  ]=0
```

13.9 CREATING A TORCH MAINTENANCE PROGRAM

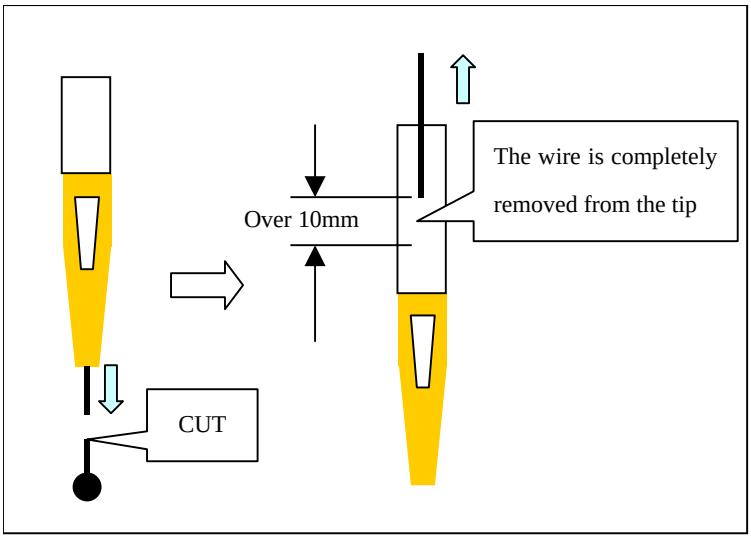
The entire flow (Tip Exchange)

Use the following flow chart.



Wire cut:

1 Push out the wire about 10mm and cut the wire using the Wire cutting device (not included in the maintenance station).
2 Pull the wire inside the tip completely.



SAMPLE PROGRAM

```
CUTWIRE1

  1:  WO[42:Wire inching+] = PULSE,1.0sec
  2:L P[2] 600mm/sec FINE
  3:L P[3] 200mm/sec CNT100
  4:L P[1] 100mm/sec FINE
  5:  DO[1:Wire cut] = ON
  6:  WAIT  1.50(sec)
  7:  DO[1:Wire cut] = OFF
  8:L P[2] 200mm/sec CNT100
  9:  WDO[43:Wire inching-] = PULSE,3.0sec
[END]

 [INST]                    [EDCMD]  >
```

Time adjustment is necessary
Approach for wire cut
Cutting position
Time adjustment is necessary

Nozzle cleaning

Execute program [TOCLEAN1] created by the torch maintenance station auto adjustment function.

Tip Exchange

Execute program [TORCHDO1] made by the torch maintenance station function.
When this program performed the tip exchange three times, R[50: Change tip No] becomes 4. Inform user (using DO signal, user alarm…) to remove the used tips and to install new tips. In addition, please set the R[50] to 1 when you completed the replacement.

Length adjustment of the wire (cut)

Execute Wire inching+ to push out the wire, and cut it using wire cutting device.

SAMPLE PROGRAM

```
CUTWIRE2

  1:  WO[42:Wire inching+] = PULSE,2.0sec   Time adjustment is necessary
  2:L P[2] 600mm/sec FINE
  3:L P[3] 200mm/sec CNT100   Approach for wire cut
  4:L P[1] 100mm/sec FINE   Cutting position
  5:  DO[1:Wire cut] = ON
  6:  WAIT  1.50(sec)
  7:  DO[1:Wire cut] = OFF
  8:L P[2] 200mm/sec CNT100
 [END]

    [INST]                    [EDCMD]  >
```

13.10 FOR THE DOUBLE TORCH (TANDEM)

Be sure to achieve the following requirements when you use the torch maintenance function with double torch.

- One torch maintenance station corresponds to one robot.
- Use the TCP No.1 in the executed program even when you use two or more TCP.
- After setting TCP of the torch to UTOOL No.1, touchup the 3 positions in the program.
- Execute the tip exchange with copied program.

Tip Exchange (The First Torch)

1 Touchup
  1.1 Set TCP of the first torch to No.1.
  1.2 Adjust the touchup setting (tip changer fixture) and execute a trial run.

2 Copy / Change program
  2.1 Copy the following generated programs using arbitrary program name.

> ⚠ **CAUTION**
> Do not change the original program name otherwise you cannot execute the program generation anymore.

(exchange program)		copy and rename the programs
(example)		
TORCHDO1	→	TORCHDOA
TSETPOS1	→	TSETPOSA
TDETACH1	→	TDETACHA
TATTACH1	→	TATTACHA

  2.2 Change the programs names in TORCHDOA so the call instructions fit the new program names.

```
TORCHDOA
                                        1/17
  1:   IF R[55]<>1,JMP LBL[3]
  2:   IF R[50]>=4,JMP LBL[2]
  3:   UTOOL_NUM = R[56]
  4:   UFRAME_NUM = R[57]
  5:   CALL TSETPOS1          Change to TSETPOSA
  6:   CALL TDETACH1          Change to TDETACHA
  7:   CALL TATTACH1          Change to TATTACHA
  8:   R[50] = R[50] + 1
  9:   JMP LBL[1]
 10:   LBL[2]
 11:   R[50] = 4
 12:   UALM[1]
 13:   JMP LBL[1]
 14:   LBL[3]
 15:   UALM[2]
 16:   LBL[1]

    [INST]                          [EDCMD]  >
```

3 Execute TORCHDOA. The first torch tip exchange starts.

Nozzle Cleaning (The First Torch)

1 Touchup
   1.1 Set TCP of the first torch to No.1.
   1.2 Adjust the touchup setting (nozzle cleaning fixture) and execute a trial run.
2 Copy program
   2.1 Copy the following generated program using arbitrary program name.

> ⚠**CAUTION**
> Do not change the original program name otherwise you can not execute the program generation anymore.

(exchange program) (example)		copy and rename the programs
TOCLEAN1	→	TOCLEANA

3 Execute TOCLEANA. The first torch cleaning starts.

Tip Exchange (The Second Torch)

1 Touchup
   1.1 Mount the second torch and set TCP to No.1.
   1.2 Adjust the touchup setting (tip changer fixture) and execute a trial run.
2 Copy / Change program
   2.1 Copy the following generated programs using arbitrary program name. However, do not use the program name that is used in the case of the first torch.

> ⚠**CAUTION**
> Do not change the original program name.

(exchange program) (example)		copy and rename the programs
TORCHDO1	→	TORCHDOB
TSETPOS1	→	TSETPOSB
TDETACH1	→	TDETACHB
TATTACH1	→	TATTACHB

2.2 Change the programs names in TORCHDOB so the call instructions fit the new program names.

```
TORCHDOB
                                        1/17
  1:  IF R[55]<>1,JMP LBL[3]
  2:  IF R[50]>=4,JMP LBL[2]
  3:  UTOOL_NUM = R[56]
  4:  UFRAME_NUM = R[57]
  5:  CALL TSETPOS1          Change to TSETPOSB
  6:  CALL TDETACH1          Change to TDETACHB
  7:  CALL TATTACH1          Change to TATTACHB
  8:  R[50] = R[50] + 1
  9:  JMP LBL[1]
 10:  LBL[2]
 11:  R[50] = 4
 12:  UALM[1]
 13:  JMP LBL[1]
 14:  LBL[3]
 15:  UALM[2]
 16:  LBL[1]

     [INST]                          [EDCMD]  >
```

3 Execute TORCHDOB. The second torch tip exchange starts.

Nozzle Cleaning (The Second Torch)

1 Touchup
   1.1 Set the TCP of the second torch to No.1.
   1.2 Adjust the touchup setting (nozzle cleaning fixture) and execute a trial run.
2 Copy / Change program
   2.1 Copy the following generated program using arbitrary program name.

> ⚠ **CAUTION**
> Do not change the original program name.

(exchange program) (example)		copy and rename the programs
TOCLEAN1	→	TOCLEANB

3 Execute TOCLEANB. The second torch cleaning starts.

> ⚠ **CAUTION**
> The above program works when target robot is motion group 1. If you use other motion group, use the program and the register corresponding to the selected motion group.

14 ARC WELDING OVERRIDE CONTROL FUNCTION

14.1 OVERVIEW

Arc Welding Override Control Function change the override value to 100% automatically between Arc Weld Start and Arc Weld End instructions in T1 Mode.
When the override value is automatically changed, the changed override value is displayed on Teach Pendant (Refer to Fig. 14.1).

This function is an option. (A05B-XXXX-J880)

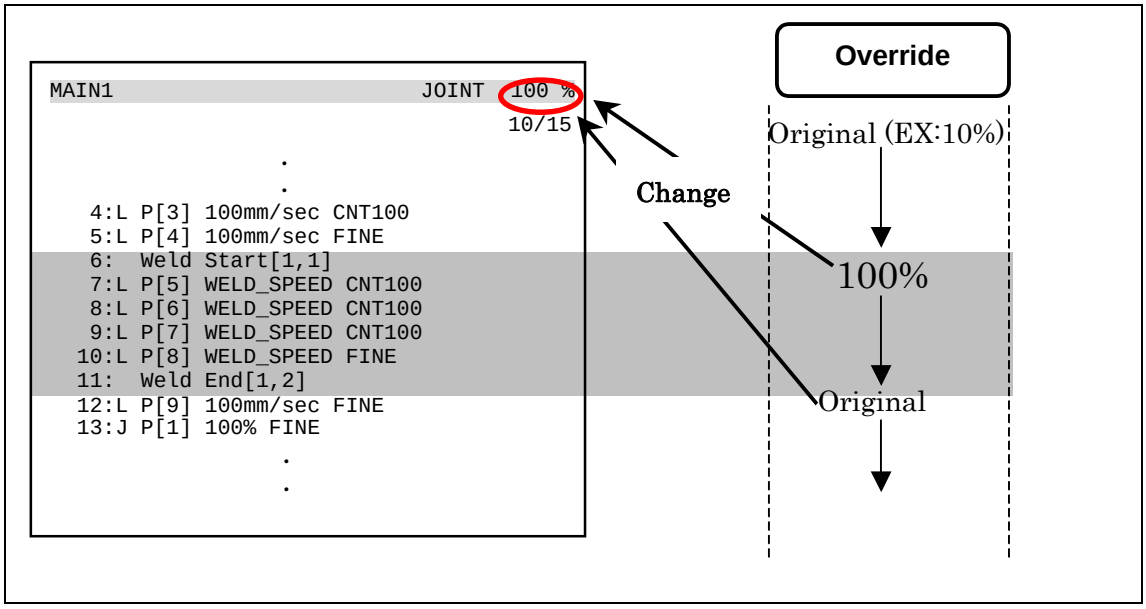


Fig. 14.1 Overview of arc welding override control function

14.2 ENABLING OR DISABLING THE FUNCTION

When this option is installed, the system variable "$AWOVRCTL" is installed in the controller.
When the system variable "$AWOVRCTL $OVRCTL_ENB" is TRUE, this function is enabled and the override is automatically changed (default value is TRUE).
If you want to disable this function, set the system variable to FALSE.

> ⚠ **CAUTION**
> Never change the system variable except $AWOVRCTL $OVRCTL_ENB. The timing of the override changing may become unexpected.

14.3 EXECUTION OF PROGRAM

This function is executed between Arc Weld Start and Arc Weld End instructions. You make the Arc Welding program and execute the program in T1 Mode. The override value is automatically changed and the motion speed of the robot is also changed (Refer to Fig. 14.3).
When Arc End instruction is executed, the override value automatically returns to the original value.

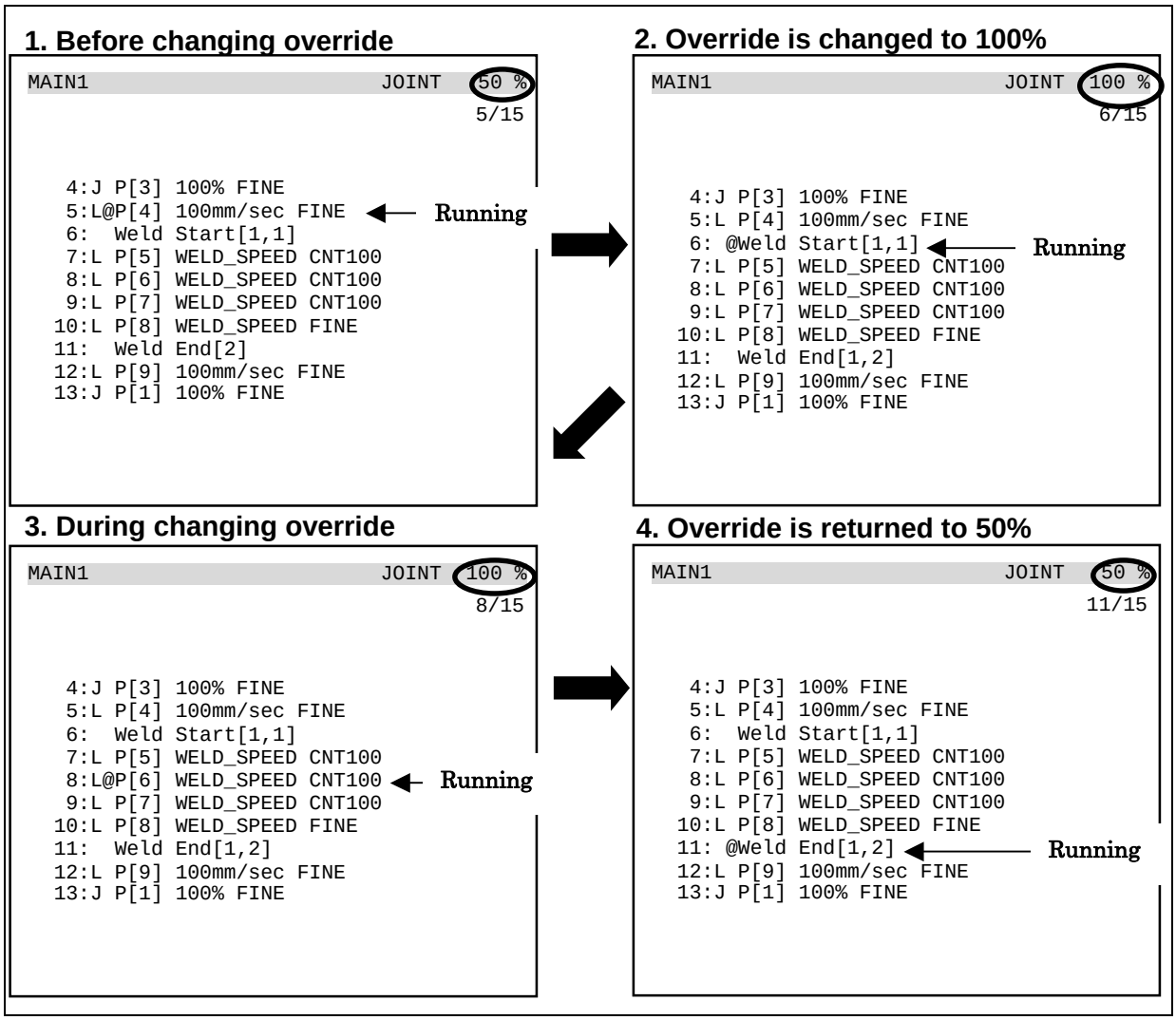


Fig. 14.3 Example of the arc welding program with arc welding override control

NOTE

This function can be used in only T1 Mode. If you select T2 Mode or AUTO Mode and Arc Weld Start instruction is executed when the override value is less than 100%, the alarm “ARC-033 Override must be 100% to Weld” is occurred and the program is stopped.

NOTE

If the override value is limited less than 100% by $SCR.$RUNOVLIM or $SCR.$SFRUNOVLIM, the alarm “ARC-033 Override must be 100% to Weld” is occurred and the program is stopped during executing Weld Start.
(The limitation of $SCR.$SFRUNOVLIM is enabled only when SFSPD signal is OFF.)

14.4 DETAILED SPECIFICATION

Timing of the Override Changing

The override is automatically changed to 100% when

- Arc Weld Start instruction is executed.
- Program is resumed between Arc Weld Start and Arc Weld End instructions (after Arc Weld Start instruction is executed and program is paused).

The override is automatically returned to the original value when the override value is changed automatically to 100% and

- Arc Weld End instruction is executed.
- Program becomes paused, aborted or finished between Arc Weld Start and Arc Weld End instructions.

If the controller is shutdown during controlling the override value, the override value becomes the following status when power on.

- If Hot Start is executed (“Use HOT START “ = TRUE), the overrirde is returned to the original value.
- If Cold Start is executed (“Use HOT START” = FALSE), the override is initialized to 10% (initial value of T1 mode).

The relationship between this function and some functions for arc welding is the followings.

- If Scratch Start is executed in Arc Weld Start or resume, the override is changed just before Scratch Start is started.
- If Original Path Resume is executed during using this function, resume motion is executed with the original override value. After Original Path Resume is finished, the override value is automatically set to 100%.

Supported Function/Status

This function supports the following status.

-Arc Enable
-Arc Disable
-Robot lock

This function supports the following functions.

-Multi Group function
-Multi Task
-Arc Multi equipment function
-Coordinated Motion function
-Hot Start

NOTE

This function is enabled in both Arc Enable and Arc Disable. Therefore, the override is not changed when Dynamic Arc ON/OFF (Refer to Section 5.3) is performed.

Limitation

This function does not support the following status.

-T2 Mode
-AUTO Mode
-Single Step Mode
-Backward Motion
-Dry Run Mode

If the following operation is executed when this function is running, this function becomes disabled.
-Move program cursor during pausing a program
-Manual change of the override during override control

NOTE
1. If you change override value from 100% to lower value manually when this function is running, and if the program is paused before Weld End, this function becomes enabled again and the override value is automatically set to 100% when you resume the program.
2. If you change the override value from 100% to lower value manually when this function is running, and if the override value is returned to 100% manually again before Weld End, pause or abort, this function becomes enabled again and the override value returns to the original value when Weld End is executed or the program is paused or aborted.

Using Arc Multi Equipment

If you use this function with Arc Multi Equipment function (Refer to Chapter 25), the override value is changed to 100% when Arc Weld Start instruction to any one of the equipments is executed. The override value is not returned to the original value until Arc Weld End instructions to all equipments are executed (Refer to Fig. 14.4 (a)).

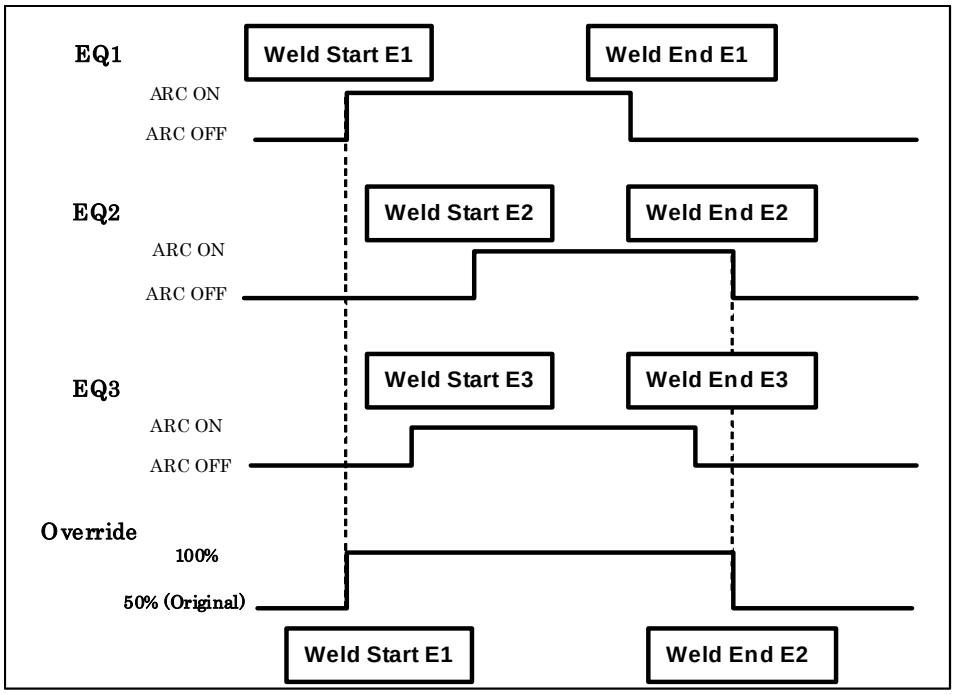


Fig. 14.4 (a) Example of this function using arc multi equipment

Using Multi Group/ Multi Task

In Multi Group, Multi Task configuration, the override value is applied to all groups and all tasks.
Please refer to Fig. 14.4 (b). In this case, the speed of Handling Robot is changed in the timing which Arc Weld Start instruction is executed by Arc Welding Robot. When Arc Weld End instruction is executed by Arc Welding Robot, the speed of Handling Robot is changed.

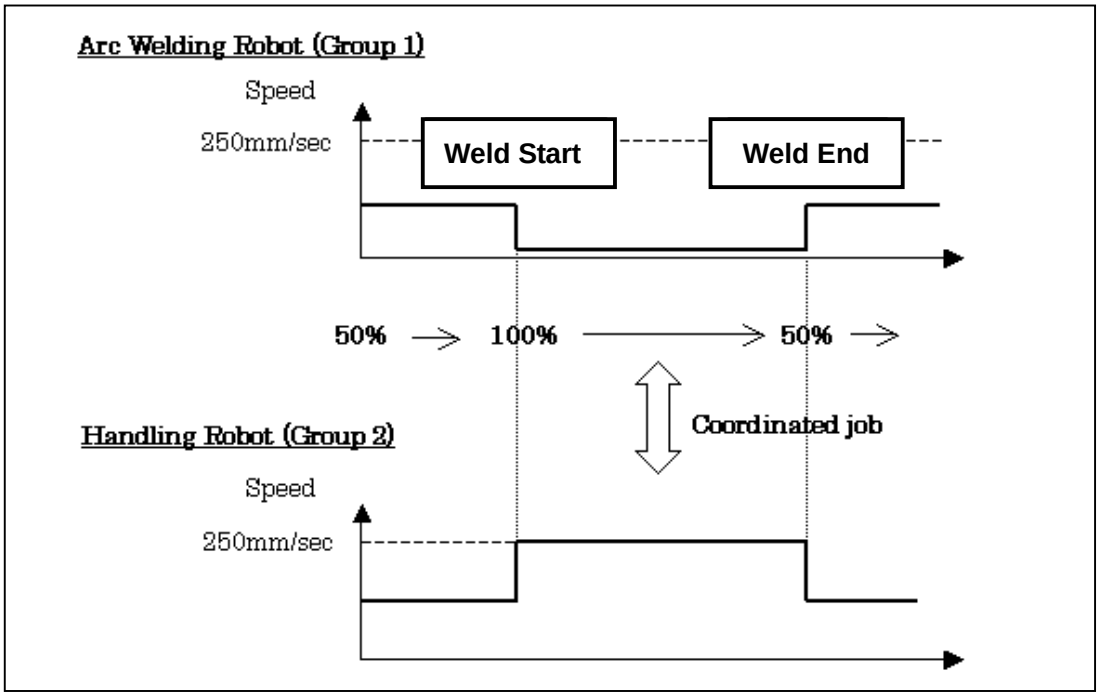


Fig. 14.4 (b) Example of this function using multi group, multi task

NOTE

The speed of these groups are limited by 250mm/sec. This is the same case for Coordinated Motion Control.

15 PATH JOG

15.1 OVERVIEW

PATH Jog function generates a special coordinated system called PATH frame based on taught trace and jogs the robot on the frame.

This function is a standard function for ArcTool.

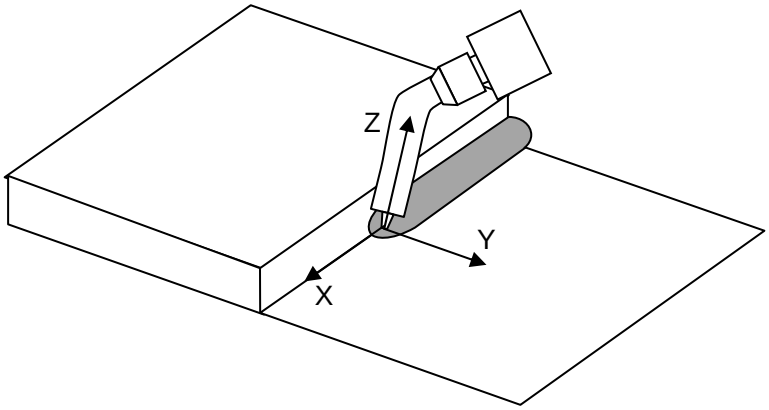


Fig. 15.1 (a) PATH Jog and PATH frame

The PATH Jog function can be used after set manual-feed coordinate system (jog type) to PATH. Manual-feed coordinate system can be changed by press [COORD] key on the teach pendant (For selecting manual-feed coordinate system, see Subsection 5.2.3 of OPERATOR'S MANUAL (Basic Operation) (B-83284EN)).

The function has the following features.

- PATH Jog function provides the adjustment of taught trace easier, since PATH frame is generated based on the direction of taught trace(X-axis), Z-axis of TOOL frame(Z-axis) and orthogonal direction to X and Z-axis(Y-axis).
- If PATH jog function used after Hot Start is executed, the robot moves based on PATH frame before power off the controller.

Procedure 15-1 Select PATH jog function

Step

1 Press COORD key until PATH is displayed on top-right of screen.

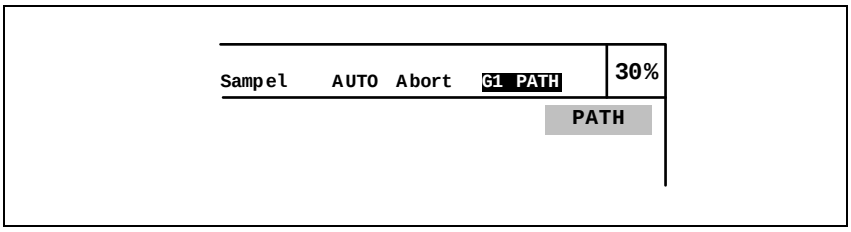


Fig. 15.1 (b) At PATH jog function is selected

⚠CAUTION

- Since, PATH frame is dynamical coordinates based on taught trace direction, the robot moves other jog method. Please take more care than the other jog method.
- Please check the selecting group number before using PATH jog function when the robot controller has multiple groups or sub groups.

NOTE

- If no PATH jog frame exists by several reasons; no moving distance, jogging on PATH jog frame is failure and an alarm occurs.
- Since PATH jog frame is generated based on taught trace, the jogging on PATH jog frame is enabled only when a program has been paused.
  If operator jogs the robot on PATH jog frame even if the program is aborted, the jogging is failure and an alarm occurs.
- PATH jog function doesn't support wrist switch function and remote TCP function
- If taught trace and Z-axis of the tool frame are same direction, jogging on PATH jog frame is failure and an alarm occurs.
- PATH jog frame cannot be generated while joint motion.
- PATH jog frame reset when the controller is repowered while backward program.
- PATH jog frame cannot be generated while coordinated motion.
- When PATH jog function is used soon after restart the controller, it uses PATH frame before power off the controller.

15.2 FEATURES FOR EACH MOTION TYPE

15.2.1 Joint Motion

PATH jog function doesn't support joint motion. When PATH jog function is used with joint motion, "Jog-020 Cannot PATH JOG now" occurs.

15.2.2 Linear Motion

The following linear motion program is running.

```
1: L P[1] 50cm/min    FINE
2: L P[2] 50cm/min    FINE
3: L P[3] 50cm/min    FINE
```

When the program stops at position A between P[1] and P[2], the PATH jog frame becomes in Fig. 15.2.2 (a).

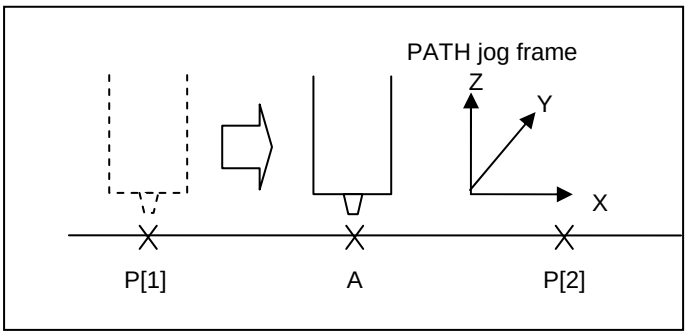


Fig. 15.2.2 (a) PATH jog frame in linear motion

When the program stops at P[2] while it runs forward, the PATH jog frame become inFig.15.2.2 (b).

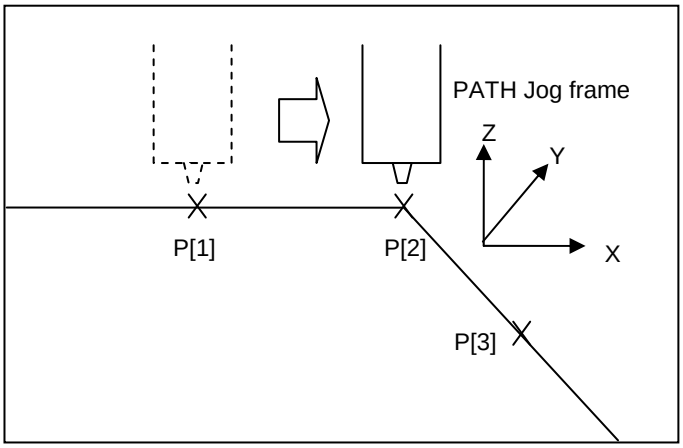


Fig. 15.2.2 (b) PATH jog frame on paused at P[2] when program running to forward

When the program stops on P[2] while it runs backward the PATH jog frame become inFig.15.2.2(c).

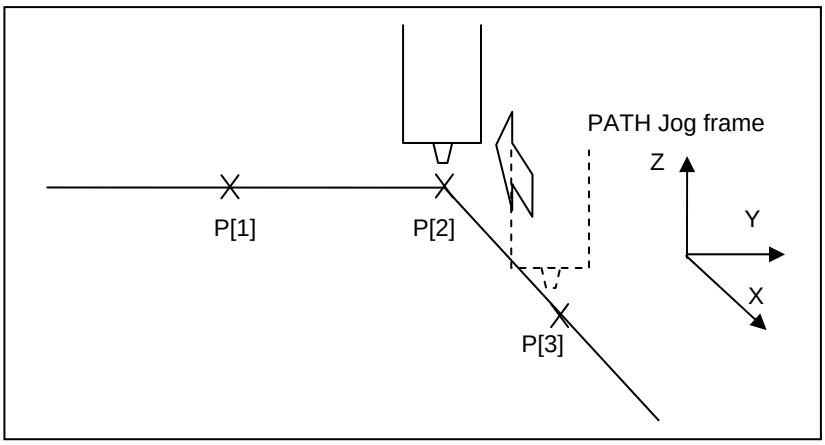


Fig. 15.2.2 (c) PATH jog frame on paused at P[2] when program running to backward

15.2.3 Circular Motion

When the robot is jogged on PATH jog frame while circular motion,
Jogging with X-axis: Move along to the arc of the circular motion.
Jogging with Y-axis: Move along to a linear that links the center of the circular for the motion to current robot position.

The following circular motion program is running.
1:L P[1] 50cm/min FINE
2:C P[2] 50cm/min
P[3] FINE

The program stops at position A in Fig.15.2.3, the PATH jog frame becomes the left illustration of the figure
If the robot is jogged to X-axis with PATH jog frame, the robot moves along to the arc of the circular motion and the PATH jog frame is update. When the robot arrived at position B with jogging, the PATH jog frame becomes the right illustration of the figure.

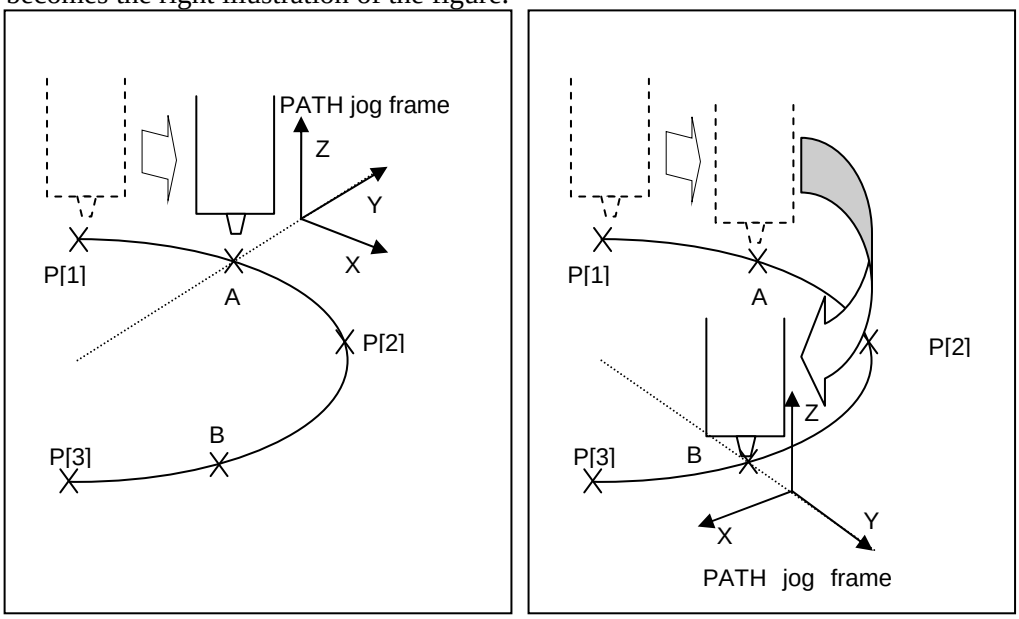


Fig. 15.2.3 PATH jog frame in circular motion

15.3 ALARM CODES

JOG-020PAUSE "Cannot PATH JOG now"
[Cause] The creation of PATH jog frame has been fault by several reason; use Joint motion et.al..
[Remedy] Use other jog method.

JOG-021PAUSE "Multi key is pressed"
[Cause] PATH jog function doesn't support multiple jog keys inputs.
[Remedy] Use only one jog key at same time.

16 ARC CHART

16.1 OVERVIEW

Arc Chart function shows the graphs of the time chart of values at analog I/O value for weld (Voltage, Current, etc.). This function makes check status easier.
Horizontal axis is the time axis; vertical axis represents the value of the values at analog I/O value for weld. Graphs are drawn during welding automatically.

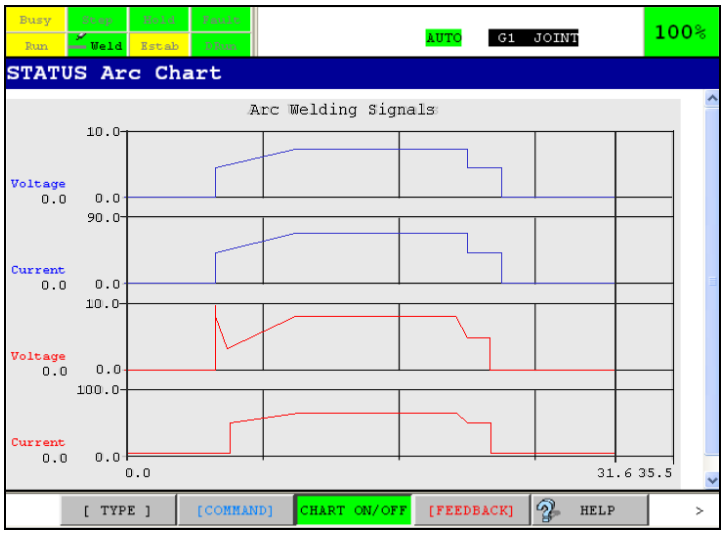


Fig. 16.1 Arc chart screen

Operator can change the screen settings using the function keys.

Table16.1 Function keys on arc chart screen

Items	Descriptions
F2 : COMMAND	This key can add or remove the graph of command value. If you want to remove displayed graph of a specified command value, select [Remove:@@] (@@ is a name of analog output signal) If you add the graph which is not displayed in this screen, select [Add:@@].
F3 : CHART ON/OFF	Change the setting of enable/disable of Arc Chart function. When this key is green, Arc Chart is enabled. When this key is red, Arc Chart is disabled and no graphs are drawn during arc welding.
F4 : FEEDBACK	This key can add or remove the graph of feedback value. If you want to remove displayed graph of the feedback value, select [Remove:@@]. If you add a graph that is not displayed in the screen, select [Add:@@].
F7 : TIME	This key is used to adjust the time axis scale of the graph.
F8 : TICKS	This key is used to adjust the number of vertical tick marks on the chart. It is possible to set it between 1-20.

NOTE
- This function cannot keep graphs.
- If screen is changed to other one, graphs are cleared.
- If you change TIME or TICKS after making graphs, graphs are cleared.

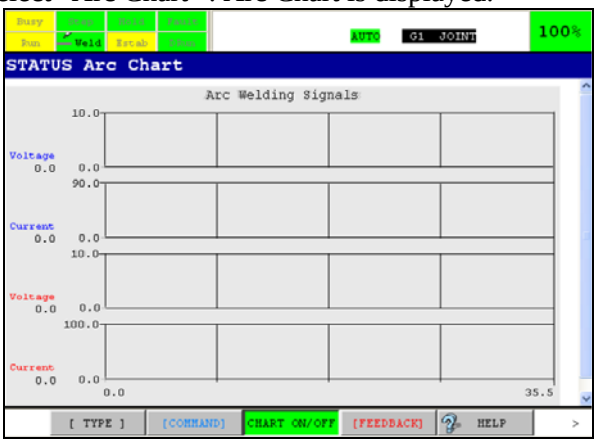
16.2 ARC CHART SCREEN

Procedure 16-1 Check Weld Status by Arc Chart

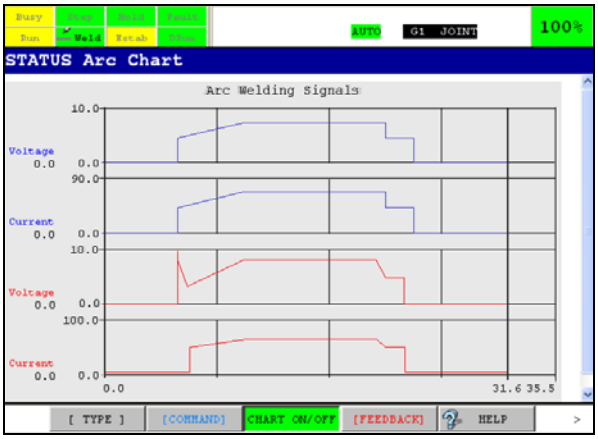
Step

1 Press [MENU] key and select “4 Status”.

2 Press F1[TYPE] and select “Arc Chart “. Arc Chart is displayed.



3 Execute TP Program with welding. The time chart graphs of command and feedback values between Arc Start and Arc End instruction are automatically traced. The actual output value is displayed by the numerical values under the output signal name of each graph.



4 When arc welding is finished, trace ends and vertical line is automatically drawn at finishing time. If welding is executed again, trace starts at time where the welding ended before.

5 The scale of the vertical axis changes automatically according to the maximum output value.

17 ON THE FLY

17.1 OVERVIEW

On The Fly function enables you to adjust command values of the weld schedule (or the weaving schedule) in real time during executing program. Additionally, it is also possible to save the adjustment data of the weld schedule (or weaving schedule).
Following data can be adjusted.

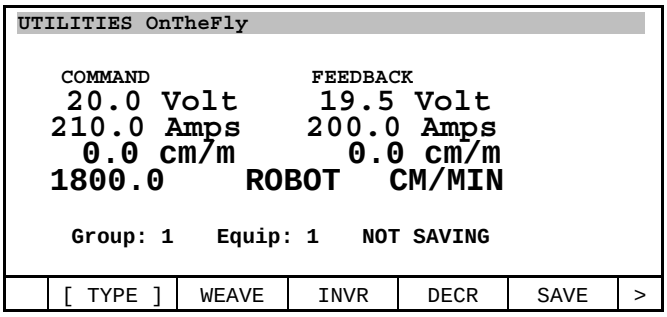
- Weld schedule data
  - Voltage
  - Current
  - Wire feed speed
  - Welding speed
- Weaving schedule data
  - Amplitude
  - Frequency
  - Right dwell（R dwell）
  - Left dwell（L dwell）

This function is ArcTool standard function.

17.2 ON THE FLY FOR WELDING

In On The Fly for Welding, the welding schedule of the arc welding is changed little by little by executing arc welding program with displaying the On The Fly screen. Weld schedule data can be adjusted by using F3[INCR] and F4[DECR]. Amount of adjustment by one operation (pressing F3 or F4) is decided in OnTheFly schedule(please refer to OnTheFly described in the Subsection 3.5.5).

To use On The Fly function for Welding, user must set [On-The-Fly] in Arc Weld System setup screen to [ENABLED] (please refer to Other Functions described in the Section 3.3).



Procedure 17-1 OnTheFly for Welding

Condition

- [On-The-Fly] in weld system setup screen is enabled.
- During execution of a program.
- During arc welding.

Step

1 Press [MENU] key.
2 Select the [UTILITIES].
3 Press F1[TYPE] and select the [OnTheFly]. OnTheFly screen is displayed.

```
UTILITIES OnTheFly

   COMMAND              FEEDBACK
   20.0 Volt            19.5 Volt
  210.0 Amps           200.0 Amps
    0.0 cm/m             0.0 cm/m
  1800.0     ROBOT   CM/MIN

    Group: 1    Equip: 1    NOT SAVING

|  | [ TYPE ] | WEAVE | INVR | DECR | SAVE | > |
```

4 If you want to overwrite the adjustment results to the weld schedule, press F5[SAVE] and change to saving mode.
5 Move the cursor to the command value that you want to adjust and press F3[INCR] or F4[DECR]. The command value is changed according to the keys.
6 If needed, please change increase and decrease rate by changing the OnTheFly schedule in the weld procedure (Refer to Subsection 3.5.5).

NOTE
It is impossible to adjust the welding speed if the unit is not cm/min or mm/sec, IPM.

Table 17.2 (a) Items in OnTheFly screen for welding

Item	Explanation
COMMAND	This shows command values during arc welding. User can adjust these values by F3 [INCR] and F4[DECR]. This contains the following items. - Command voltage (Volt) - Command current (Amps) - Command wire feed speed（cm/m） - Welding speed (ROBOT cm/min) NOTE : Units of wire feed speed and welding speed are changed by the setting of speed unit in Arc Tool Setup (Refer to Procedure 3-3).
FEEDBACK	This shows feedback values during arc welding. This values changes according to the changes of command values. This contains the following items. - Feedback voltage (Volt) - Feedback current (Amps)
Group	This displays the motion group number for adjusting welding speed. A user can change F7[Group].
Equip	This displays the equipment number for adjusting weld schedule (excepting the weld speed). When multi equipment is installed, a user can change this item by changing the equipment number for displaying (Refer to Procedure 25-2).

Item	Explanation
SAVING / NOT SAVING	This indicates whether adjustment value is saved or not. A user can change by F5 key. When this state is [SAVING], adjustment command value is saved to the weld schedule. The save timing and place is different between weld speed and other weld schedules. - Weld speed This value is saved when each motion line is finished. If the speed is specified in the motion line, the value after adjustment is overwritten. If weld speed instruction (Refer to Section 4.2) is used, adjustment value is overwritten in the weld schedule. - Weld schedule (excepting the weld speed) Those values are saved at the weld end. If user teaches Weld Start instruction by specifying schedule number, the adjustment values are overwritten in the weld schedule. If user teaches Weld Start instruction by specifying welding commands directly, the adjustment value is overwritten in specified Weld Start instruction. When this state is [NOT SAVING], adjustment values are not saved.

Table 17.2 (b) Function keys of OnTheFly screen for welding

Function key	Explanation
F2 : WEAVE	The screen moves to OnTheFly screen for Weaving.
F3 : INCR F4 : DECR	Those keys changes the command value by using the rate that is set in “OnTheFly” of weld procedure screen. For more detail, please refer to Subsection 3.5.5.
F5 : SAVE (or NO SAVE)	This key is used for changing [SAVING] / [NOT SAVING].
F7 : GROUP	This key is used to change motion group for adjusting weld speed.

17.3 ON THE FLY FOR WEAVING

In On The Fly for Weaving, the weaving schedule is changed little by little by executing weaving program with displaying the On The Fly screen for Weaving. Weaving schedule can be adjusted by using F3[INCR] and F4[DECR].

To use On The Fly function for Weaving, user must set system variable “$WV_OTF_GP[i]. $OTF_ENABLE” (i means Group number) to TRUE in System Variables screen.
For Example, if you use On The Fly for Weaving in both Motion Group 1 and 2, you must set WV_OTF_GP[1].$OTF_ENABLE and $WV_OTF_GP[2].$OTF_ENABLE to TRUE.

```
UTILITIES OnTheFly

   COMMAND            FEEDBACK
    4.00 Ampl          4.00 mm
    4.00 Freq          1.00 Hz
    0.10 Ldwl          0.10 Sec
    0.10 Rdwl          0.10 sec

    Group: 1   Equip: 1   NOT SAVING

|  [ TYPE ] | WELD | INVR | DECR | SAVE | >
```

Procedure 17-2 On the fly for weaving

Condition

- WV_OTF_GP[i].$OTF_ENABLE is TRUE.
- During weaving.

Step

1 Display the On The Fly screen for Welding. (Refer to Procedure 17-1, Step 1 to 3)
2 Press F2[WEAVE]. On The Fly screen for Weaving is displayed.

```
UTILITIES OnTheFly

   COMMAND              FEEDBACK
   4.00 Ampl            4.00 mm
   4.00 Freq            1.00 Hz
   0.10 Ldwl            0.10 Sec
   0.10 Rdwl            0.10 sec

    Group: 1   Equip: 1   NOT SAVING

|  | [ TYPE ] | WELD | INVR | DECR | SAVE | > |
```

3 If you want to overwrite the adjustment results to the program, press F5[SAVE] and change to saving mode.

4 Move the cursor to the command value that you want to adjust and press F3[INCR] or F4[DECR]. The command value is changed according to the keys.

NOTE

1 In On The Fly function for Weaving, the value is not increased or decreased momentarily at the time of pressing F3 / F4 keys. The value increases and decreases at the next weave cycle.

2 Please change Weave Ramping function (Refer to Section 9.4) to disabled when On The Fly for Weaving is executed.

Table 17.3 (a) Items in On The Fly screen for weaving

Item	Explanation
COMMAND	This shows command values during weaving. User can adjust these values by F3[INCR] and F4[DECR]. This contains the following items. - Amplitude (Ampl) - Frequency (Freq) - Right dwell (Rdwl) - Left dwell (Ldwl)
FEEDBACK	This shows feedback values during weaving. This values change according to the changes of command values. These items are the same as COMMAND.
Group	This displays the motion group number for adjusting weaving schedules. User can change by pressing the F7[Group].
Equip	This is irrelevant in On The Fly screen for Weaving.
SAVING / NOT SAVING	This indicates whether adjustment value is saved or not. User can change by pressing F5 key. When this state is [SAVING], adjustment command value is saved to the weaving schedule. Saving is executed when pressing F3 / F4 keys . When this state is [NOT SAVING], adjustment values are not saved. NOTE : In On The Fly for Weaving, adjustment value cannot be saved to Weaving instruction when direct values are specified.

Table 17.3 (b) Function keys of On The Fly screen for weaving

Function key	Explanation
F2 : WELD	The screen moves to On The Fly screen for Welding.
F3 : INCR F4 : DECR	Those keys increases or decreases the weaving command value. The rate is decided in each parameters as follows. - Amplitude : 0.5 mm - Frequency : 0.5 Hz - Right dwell : 0.1 Sec - Left dwell : 0.1 Sec
F5 : SAVE (or NO SAVE)	This key is used for changing [SAVING] / [NOT SAVING].
F7 : GROUP	This key is used to change motion group for adjusting weaving schedules.

18 ARC WELDING ANALOGUE METER DISPLAYING FUNCTION

18.1 OVERVIEW

Arc welding analogue meter function is the graphical user interface of displaying welding command/feedback voltage and current.

The UIF displays not only the contents on arc welding status screen but also the following contents.

- Voltmeter and ammeter
- Average of welding voltage, current and wire feed speed per a welding
- The name of running TP program
- The line number of the latest arc start instruction in running TP program
- Currently using weld mode
- Weld distance and welding speed
- Arc on time per a welding

This function is an option (A05B-XXXX-J599).

18.2 ARC WELDING ANALOGUE METER FUNCTION

Procedure 18-1 Display Arc Welding Analogue Meter

Step

1 Press [MENU] key and select “4 Status”.
2 Press F1 [TYPE] and select “Anlg Meter”. Arc welding analogue meter screen is displayed.

If R651 option is ordered, the shortcut to Arc Welding Analogue Meter screen is registered to “Menu Favorites”. In this case, you can also display Arc Welding Analogue Meter screen only by the following step.

Procedure 18-2 Display Arc Welding Analogue Meter

Step

1 Press [MENU] key and Press F2 key.

> **NOTE**
> Arc Welding Analogue Meter screen can be always displayed when backlight automatic blanking function of *i*Pendant (Refer to “Backlight automatic blanking” in Subsection 2.3.1 in OPERATOR’S MANUAL (Basic Operation) (B-83284EN)) is set to DISABLED. Backlight automatic blanking function can be set to DISABLED by changing the system variable $UI_CONFIG.$BLNK_ENABLE to FALSE and executing Cycle Power of controller.

18.3 EXPLANATION OF ARC WELDING ANALOGUE METER SCREEN

18.3.1 Overview

Arc welding analogue meter function has two screens.

- **Main screen**
  Two analogue meters and averages of outputs are displayed.
- **Detailed screen**
  Two analogue meters and various information, currently-running TP program, weld distance et al. are displayed.

Procedure 18-3 Switch between main screen and detailed screen

Condition

- Arc welding analogue meter screen has been displayed.

Step

1 Press F3 [SCRN] key.
2 The menu is displayed. To display main screen, select “1 Main”, otherwise, to display detailed screen, select “2. Details”.

```
SCRN        1
1 Main
2 Details
```

18.3.2 Main Screen

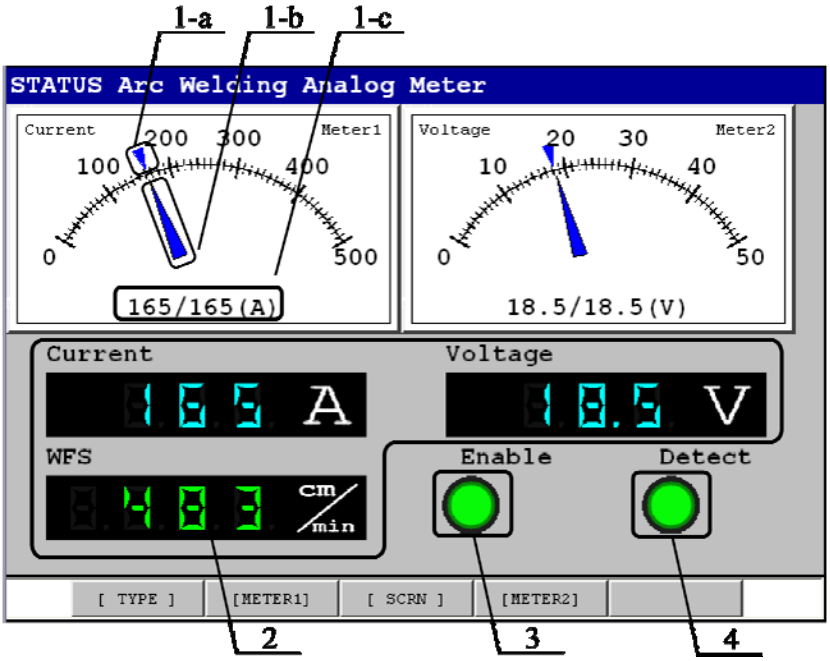


Fig. 18.3.2 Main screen of arc welding analogue meter function

Table 18.3.2 Description of content on arc welding analogue meter main screen

Items	Descriptions	
1. Analogue Meter	In default, left side is ammeter, right side is voltmeters. The maximum value of each meter is referred to selected weld process. If the selected weld process doesn't have each limit, the following value is selected. The maximum value of voltmeter : 60 V The maximum value of ammeter : 400 A The maximum value of wire feed speed meter : 1200 IPM	
	a. Command needle	During a weld: Points at the command value of voltage, current or wire feed speed. When a weld schedule does not include command of it, the needle is not displayed. Otherwise: Not displayed
	b. Feedback needle	During a weld: Points at the actual welding voltage, current or wire feed speed Otherwise: Points at the average of actual welding voltage, current or wire feed speed at the latest welding
	c. Digital representation	Display feedback value and command value as digital representation. During a weld: Display feedback value and command value as digital representation. Left side of "/" is feedback value, right side is command value. When a weld schedule does not include command of it, the only feedback value is displayed at corresponding digital representation Otherwise: Display the average of actual welding voltage or wire feed speed at the latest welding
2 Average	The averages of voltage, current and wire feed speed are displayed as digital format.	
3 Arc welding	If arc welding is enabled, this lamp is green; otherwise, this lamp is yellow.	
4 Arc detect	If the controller detects arc, this lamp is green, otherwise, this lamp is yellow.	

18.3.3 Detailed Screen

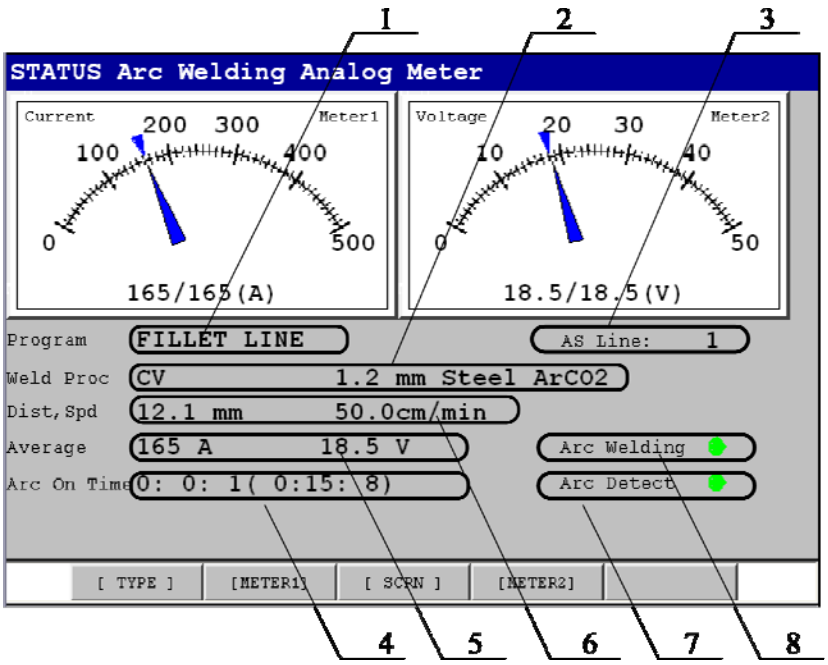


Fig. 18.3.3 Detailed screen of arc welding analogue meter function

Table 18.3.3 Description of content on arc welding analogue meter detailed screen

Items	Descriptions
1 TP program name	Display the name of currently-running TP program. When any TP program is not operating, display the name of the most recently run TP program
2 The line number of arc start instruction	Display the line number of most recently operated arc start instruction in the currently-running TP program.
3 Weld Process	Display the information of currently-using weld process. When a Lincoln weld equipment, the following information is displayed, Weld mode name - The diameter of using wire - The material of using wire - The names of using gases When non-Lincoln weld equipment is used and multi process is enabled, the following information is displayed. The description of weld mode. When multi process is disabled, this content is blank. This content is updated only during a weld. When a user opens arc welding analogue meter screen while an arc welding is not running, this content is blank.
4 Arc on time	**During a weld:** Display the elapsed time from arc start instruction of the currently running arc welding and the total arc on time. Total arc on time is shown in parentheses **Otherwise:** Display welding time of most recent arc welding and total arc on time.
5 Average	**During a weld:** Display averages of feedback values. This average is calculated from the most recent arc start instruction. The first 0.5 sec feedback values are not included to each average calculation. **Otherwise:** Display the averages of the most recent arc welding.
6 Distance and welding speed	**During a weld:** Display the welded distance from the arc start position and current welding speed. **Otherwise:** Display the welded distance of the most recent arc welding.
7 Arc detect	If the controller detects arc, this lamp is green, otherwise, this lamp is yellow.
8 Arc welding	If arc welding is enabled, this lamp is green; otherwise, this lamp is yellow.

NOTE
"During a weld" described in the above explanation is not included runin, crater process and burnback.

There are two analogue meters on arc welding analogue meter screen. It is able to change the displayed data on each analogue meter.

Procedure 18-4 Change a displayed data on each analogue meter

Condition

- Arc welding analogue meter screen has been displayed.

Step

1 Press F2 [Meter1] or F4 [Meter2] key. The meter number is displayed at the upper right on each analogue meter.
2 The following menu is displayed. Select the data you want to display.

```
Meter1          1
1 Current
2 Voltage
3.Wire Feed
```

18.4 COOPERATION WITH ARC ABNORMAL MONITOR FUNCTION

18.4.1 Overview

Arc welding analogue meter function has cooperation features with arc abnormal monitor function. If arc abnormal monitor function is enabled, the following features are run.

- Displaying the threshold of warning and stop limit defined by arc abnormal monitor.
- Changing the color of needle and digital representation on analogue meter the alarm arc abnormal monitor function provides.

Refer to Chapter 19 about setup methods of arc abnormal monitor.

Condition

Arc abnormal monitor function is enabled and the configuration is correct.

Step

The configuration of arc abnormal monitor function is reflected on arc welding analogue meter function automatically.

18.4.2 Additional Contents on Arc Welding Analogue Meter screen

In this section, additional contents when arc abnormal monitor function is enabled are explained. Regarding the arc welding analogue meter contents displayed regardless of arc abnormal monitor, please refer to the above section “Explanation of arc welding analogue meter screen”.

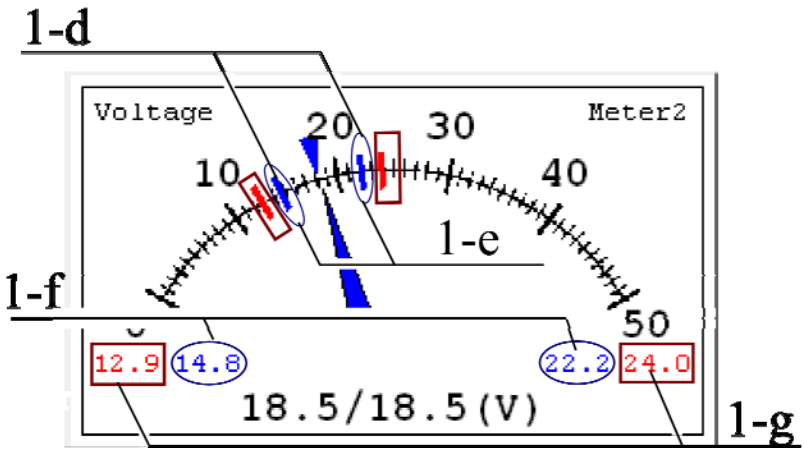


Fig. 18.4.2 Additional contents by arc abnormal monitor function

Table 18.4.2 Description of additional contents by arc abnormal monitor function is enabled

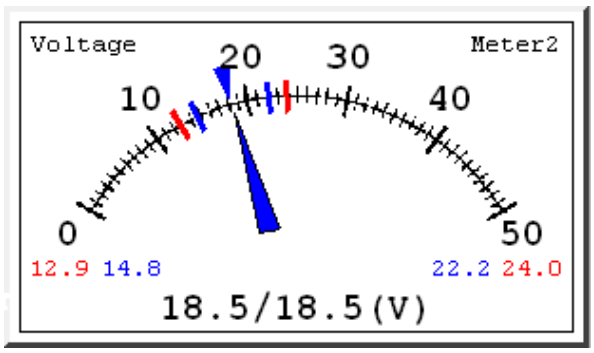
Items	Descriptions
1-d Warning limit	The markers represent the threshold values of warning limit. **During a weld:** Mark the upper/lower threshold value of warning limit with blue line. **Otherwise:** Display at 0 point on each meter.
1-e Stop limit	The markers represent the threshold values of stop limit. **During a weld:** Mark the upper/lower threshold value of stop limit with red line. **Otherwise:** Display at 0 point on each meter.

Items	Descriptions
1-f Warning limit (digital)	The threshold values of warning limit. **During a weld:** Displayed. **Otherwise:** Not displayed.
1-g Stop limit (digital)	The threshold values of stop limit. **During a weld:** Displayed. **Otherwise:** Not displayed.

Arc abnormal monitor function executes the monitoring of actual voltage and current and announce the alarms when actual voltage and/or exceeds specified limits. The needle and digital representation on each analogue meter is changed in response to the severity of the alarms.

Normal status

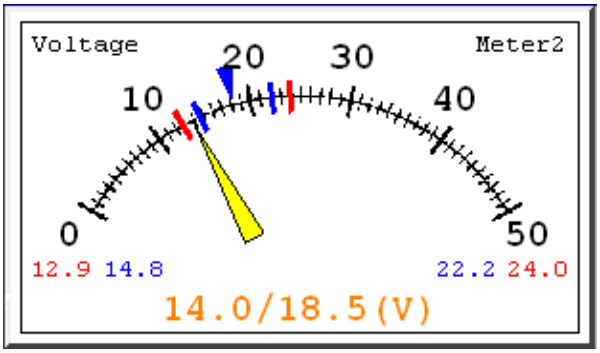
The color of feedback needle is blue and the color of digital representation on the analogue meter is black.



When main screen is displayed, the following digital value is also blue.

Warning status

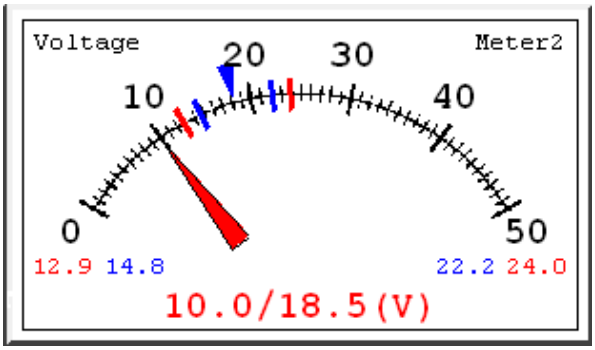
When “ARC-096 Feedback exceeds WARN limit (Program name, Line number)” is caused, the color of corresponding feedback needle and digital representation becomes yellow. Even if the feedback value returns inside the warning limit, the color is not changed.



When main screen is displayed, the following digital value also becomes yellow.

Stop status

When “ARC-095 Feedback exceeds STOP limit (Program name, Line number)” is caused, the color of corresponding feedback needle and digital representation becomes red. Even if the feedback value returns inside the stop limit, the color is not changed.



When main screen is displayed, the following digital value also becomes red.

19 ARC ABNORMAL MONITOR FUNCTION

19.1 OUTLINE OF ARC ABNORMAL MONITOR

Normally, when some bad conditions occur during arc welding, an operator needs to stand near the system, needs to check the weld conditions by an analog meter etc. ,and needs to chase the root cause.
Arc Abnormal Monitor Function monitors the actual current and voltage during arc welding, and it can inform the operator that some bad weldings occurred quickly by some alarms and output signals when these values exceed the thresholds (it is possible to stop the running program by alarms). This function makes the root cause analysis of the bad welding easier.
Additionally, Arc Weld Log function is included in Arc Abnormal Monitor Function. The function can save the actual current and voltage in output device for each weld bead, and it can also display graphs such as Fig. 19.1 (b) on Teach Pendant.

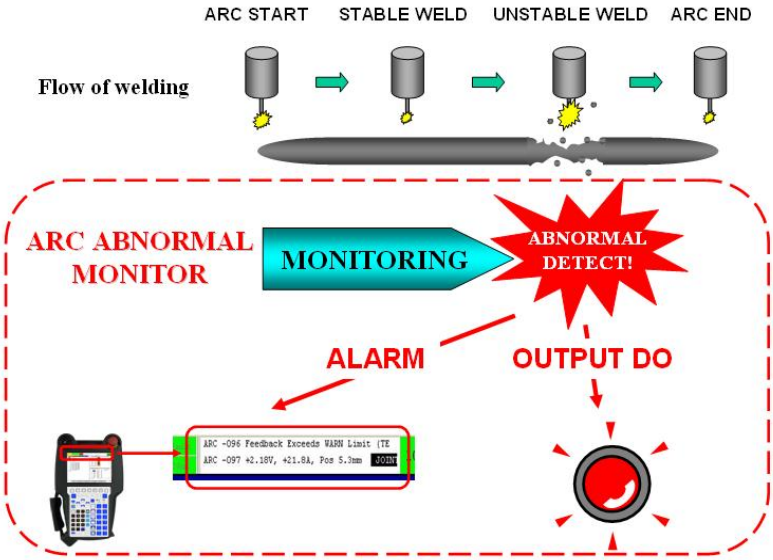


Fig. 19.1 (a) Outline of arc abnormal monitor

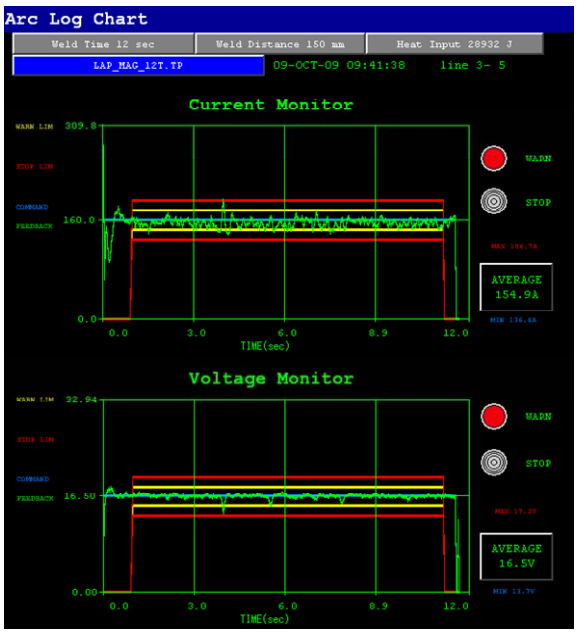


Fig. 19.1 (b) Arc weld log – chart function

The function provides the following merits.

- **Prevent the spill of bad-welding works**
  The function allows to find bad-welding works and prevent the spill of the work toward down streams.
- **Easy root cause analysis**
  It is easy to find the part of bad-welding. This leads the speedy discussion of the countermeasure.
- **Prediction of the timing for chip change and nozzle cleaning**
  The wastage of a chip and the adherence of many spatters to a nozzle leads the unstable welding. As a result, actual current and voltage become unstable. Arc Abnormal Monitor allows to predict the timing for chip change and nozzle cleaning by detecting the unstable state.
- **Displacement of analog meters**
  This function can be used instead of analog ammeter and voltmeter which are conventionally used for checking actual current and voltage.

This function is an option. (A05B-XXXX-J987)

> ⚠ **CAUTION**
> This function can be used only on the arc welding robot whose controller receive signal inputs of voltage and current feedbacks and can display actual voltage and current (EX: ROBOWELD*i*C series).

19.2 CHARACTERISTICS OF ARC ABNORMAL MONITOR

Automatic Monitoring during Arc Welding Section

This function executes the monitoring of actual current and voltage automatically between Weld Start – Weld End instructions if an operator completes to input the tolerance level (threshold) as the difference of command and actual current/voltage. Therefore, the operator can remove the troublesome teaching time of trigger instruction for monitor start/end, and there are no leaks of monitoring by forgetting the teaching.

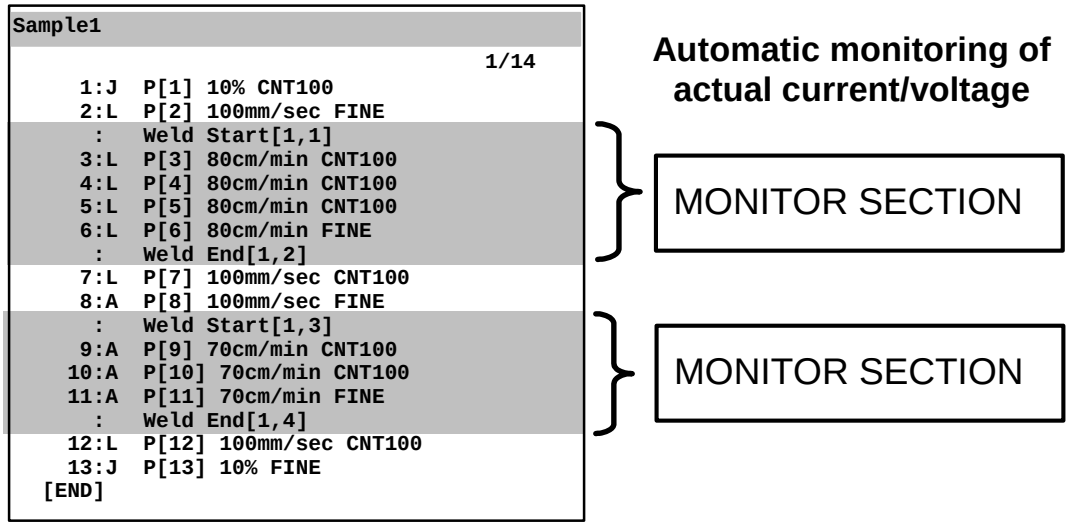


Fig. 19.2 (a) Automatic monitoring of arc welding section

WARN Limit and STOP Limit

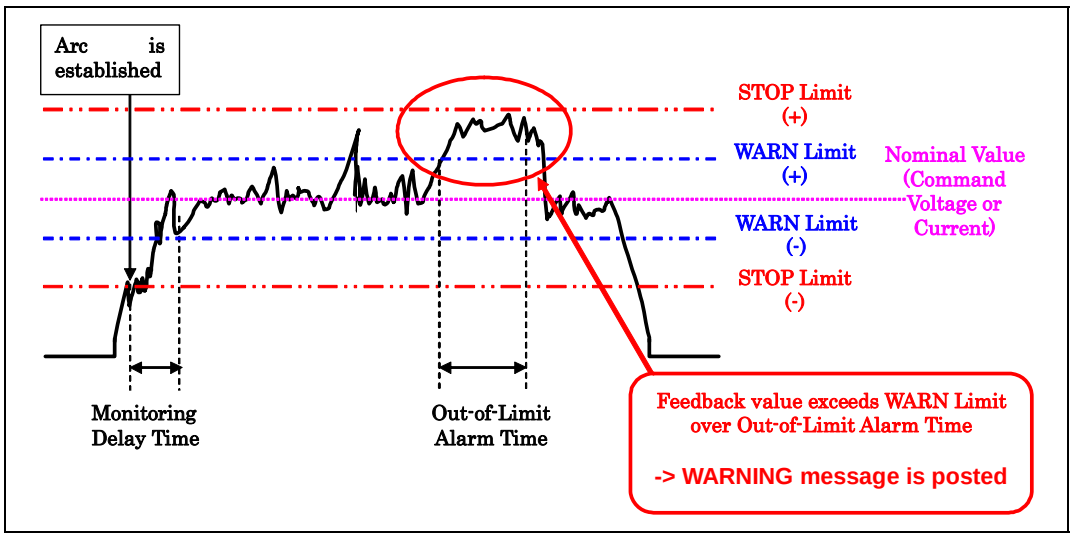


Fig. 19.2 (b) Details of abnormal monitor

Arc Abnormal Monitor is monitoring actual current and voltage during arc welding on real time, and it is checking whether these values exceed threshold. **For this function, the user can specify "WARN limit" and "STOP limit" as the range of threshold.** Basically, these ranges are specified as differences based on command current and voltage (Please refer to the item "Monitoring Method" in Subsection 19.3.2).

- **WARN limit**
  If the judgment "actual current or voltage had exceeded WARN limit" is done, the warning message "ARC-096 Feedback exceeds WARN limit (Prog Name, Line Number)" is displayed. It never stop the running program. It is possible to output DO simultaneously.
  It is suitable for predicting the timing of a weld chip change and of a nozzle cleaning by setting threshold stricter than STOP limit. If over-limit occurs at the particular position frequently, the confirmation and modification of the teaching position is recommended.
- **STOP limit**
  If the judgment "actual current or voltage had exceeded STOP limit" is done, the warning message "ARC-095 Feedback exceeds STOP limit (Prog Name, Line Number)" is displayed. Additionally, it stops the running program at the timing which is set by "STOP Timing" (say later). It is possible to output DO simultaneously. It is recommended to prepare against an accidental scene by setting threshold wider than WARN limit.

> ⚠ **CAUTION**
> This function is developed for the system that is welding by current and voltage commands. In the system using wire feed speed or "Trim" commands, you can set only one WARN limit and one STOP limit on all of programs. Please refer to the explanation "ABS (V, A)" in "Monitoring Method".

> ⚠ **CAUTION**
> If the stick out is not set properly, there is a possibility that differences between command and actual current (voltage) becomes large. Please set the stick out correctly. (In ROBOWELD*i*C series, proper stick outs are prepared for each weld mode. Please confirm these.)

Abnormality Judgement Method

This function has two methods of abnormality judgement by "Out-of-limit Time" and "Out-of-limit Count".

- **Out-of-limit Time**

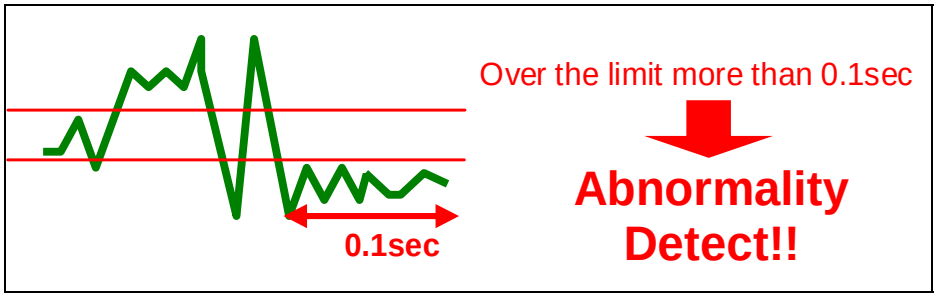


Fig. 19.2 (c) Example of abnormality judgement by out-of-limit time

"Out-of-limit Time" judges the abnormality when the feedback value exceeds the limit more than specified seconds. If the feedback value does not exceed more than specified seconds continuously, the judgement result does not become "Abnormal". The above example figure indicates that "Out-of-limit Time" is set to 0.1sec and that the judgement result becomes "Abnormal" when the feedback value is continuously exceeding the limit more than 0.1sec. On the other hand, if the feedback value returns even once within the limit (or exceeds the inverse side of the limit) before 0.1sec has passed, the judgement does not become "Abnormal". Additionally, the next time, the 0.1sec will be counted again.
It is specified by "Out-of-limit Time" item in "WARN limit" or "STOP limit". This method will be appropriate under the tendency which feedback voltage and current are stable and do not oscillate.

- **Out-of-limit Count**

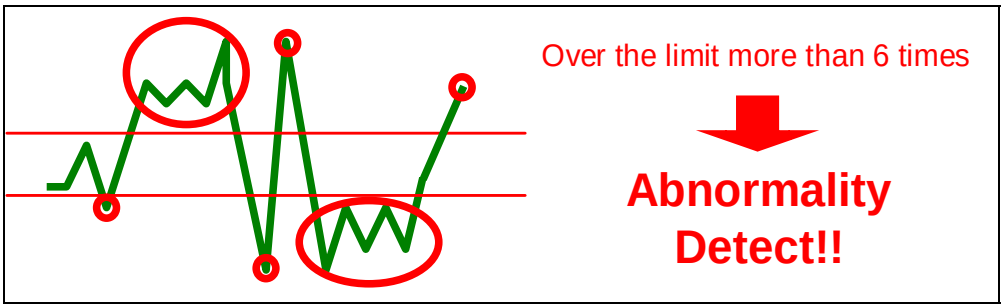


Fig. 19.2 (d) Example of abnormality judgement by out-of-limit count

"Out-of-limit Count" judges the abnormality when the feedback value exceeds the limit more than specified times during specified seconds. Even if the value exceeds the limit of one side continuously, the judgement becomes "1 count". For example, if "6 counts during 10sec" is specified and the exceeded counts become 6 counts like the above figure, the judgement result becomes "Abnormal" for the first time. (Each of 2nd count and 5th count is regarded to "1 count" because both cases exceeded the limit of one side continuously.)
It is specified by "Out-of-limit Count" item in "WARN limit" or "STOP limit". This method will be appropriate under the tendency which feedback voltage and current are not stable and largely oscillate.

WARNING Message during Over-limit

For example, when a feedback exceeds WARN limit, two messages like Fig. 19.2 (e) are displayed. When limit is STOP limit, "ARC-096" is changed to "ARC-095" and "WARN" is changed to "STOP".

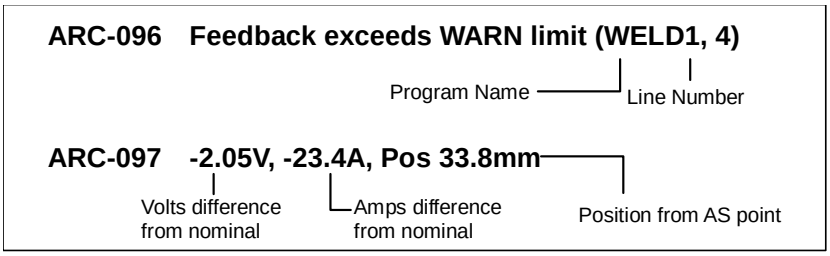


Fig. 19.2 (e) Message for over WARN limit

It is possible to specify the over-limit position on a program by referring ARC-096. Additionally, ARC-097 has momentary information obtained at the timing which is judged as over-limit.

> **NOTE**
> When “Monitoring Method” is “ABS(V,A)”, The difference displayed on ARC-097 becomes the one between intermediate value of thresholds and actual value.

Monitoring Start/End Timing

Arc Abnormal Monitor can ignore the interval from arc detect to the feedback-stable timing by setting “Monitoring Delay Time”. Conversely, if you want to monitor the unstable status just after weld start, please set shorter (or zero) as Monitoring Delay Time. About more detail, please refer to Fig. 19.2(b) or the item “Monitoring Delay Time” in Section 19.3.

> **NOTE**
> The monitoring is not executed during Runin, Resume and Scratch Start. The monitoring starts after finishing these processes. Additionally, The monitoring stops just before Craterfill of Arc End. The monitoring is not executed during Craterfill, Burnback and Wire Stick Detect/Reset.

STOP Timing

If actual current or voltage exceeds STOP limit, you can select the timing for stopping the running program by “STOP Timing”. You can select from 3 types. “IMMEDIATELY” stops the running program just after over limit. “AFTER 1BEAD” stops the running program after the weld for its section is finished. “ABORT PROG” do not stop the running program and it only warns with a message. About more detail, please refer to “STOP Timing” item in Subsection 19.3.1.

19.3 SETUP FOR ARC ABNORMAL MONITOR

The common setup for Arc Abnormal Monitor is performed on Arc Abnormal Monitor Setup screen. The Arc Abnormal Monitor setup for each Weld Procedure is performed on Weld Procedure screen.

19.3.1 Common Setup for Arc Abnormal Monitor

Refer to Procedure 19-1 to perform common setup for Arc Abnormal Monitor.

Procedure 19-1 Display Arc Abnormal Monitor Setup Screen

Step

1 Press [MENU] key and select “6 SETUP”.
2 Press F1[TYPE] and select “Arc Monitor”. The following screen is displayed.

```
SETUP Arc Abnormal Monitor
                                        1/7
   Arc Abnormal Monitor Setup
     1 Arc Abnormal Monitor:        DISABLED

   WARN Limit
     2 WARN Output Signal:           DO[   0]
   STOP Limit
     3 STOP Output Signal:          DO[   0]
     4 STOP Timing:               AFTER 1BEAD

   Arc Weld Log Setup
     5 Arc Weld Log:                ENABLED
     6 Log Mode:                    NONE
     7 Serial No. Register:    R    [    0]

   [TYPE]                          ENABLED  DIABLED
```

Table 19.3.1 Common setup for arc abnormal monitor

SETTING ITEM	DESCRIPTION
Arc Abnormal Monitor	This item specifies the enabled/disabled of Arc Abnormal Monitor. When it is ENABLED, the item of “Arc Abnormal Monitor” is displayed on Weld Procedure screen and you can specify the thresholds of Arc Abnormal Monitor for each Weld Procedure. When it is DISABLED, the item of “Arc Abnormal Monitor” is not displayed on Weld Procedure screen and the monitorings for actual current and voltage are not performed.
WARN Output Signal	In the moment which the monitoring function judges that the actual voltage or current exceeds WARN limit, DO which is specified by this item becomes ON with ARC-096. If a reset key is pressed, DO becomes OFF. If “0” or nonexistent DO number is specified, DO is not output.
STOP Output Signal	In the moment which the monitoring function judges that the actual voltage or current exceeds Stop limit, DO which is specified by this item becomes ON with ARC-095. If a reset key is pressed, DO becomes OFF. If “0” or nonexistent DO number is specified, DO is not output.
Alarm Timing	There are 3 types of the timing for stopping the running program after out-of-limit. **IMMEDIATELY** The running program is stopped immediately in the moment that the monitoring function judges the actual voltage or current exceeds STOP limit. (In detail, ARC- 095 is posted with STOP.L severity.) Please select this type if you want to stop the program immediately just after any accidents. **AFTER 1BEAD** “ARC-098 STOP after 1bead EQi (i is an equipment number)” is posted and the running program is stopped when the weld for the current weld bead is completed (or when the running program is stopped by any other reason) after judging out- of-limit. Please select this type if you want to complete the weld for the current weld bead even after judgeing out-of-limit. **ABORT PROG** “ARC-099 Some Bead Exceeds STOP Limit EQi” is posted and it tells the operator the existence of some weld accident which occurred during the production when the program execution status becomes "ABORT" after judging out-of-limit. When the program is stopped by some other reasons, there is no action. Select this type if you want not to interrupt the production even when some weld accidents occur.

19.3.2 Individual Setup for Arc Abnormal Monitor

Refer to Procedure 19-2 to perform individual setup for Arc Abnormal Monitor.

Procedure 19-2 Individual Setup of Arc Abnormal Monitor

Condition

- “Arc Abnormal Monitor” item in Arc Abnormal Monitor (Common) Setup screen is ENABLED.

Step

1 Press [MENU] key and select “3 DATA”.
2 Press F1[TYPE] and select “Weld Procedures”.
3 Move the cursor on “Procedure” to which you want to set Arc Abnormal Monitor, and press ENTER key. The following screen is displayed.

```
DATA Weld Procedure          1
                                        7/13
  - Procedure              1 [             ]
     Weld equipment:       1
     Manufacturer:         General Purpose
     Model:                MIG(Volts, Amps)
     File name:            AWE1WP01
     Schedules:            3

     Runin:                          DISABLED
     Burnback:                       ENABLED
     Wirestick reset: 3              ENABLED
     Ramping:                        DISABLED
     Arc Abnormal Monitor:           DISABLED

     Gas purge:                      0.35  sec
     Gas preflow:                    0.00  sec
     Gas postflow:                   0.00  sec
     Arc End pre-time:               0    msec

   [TYPE]                    ENABLED  DIABLED
```

4 If you want to set Arc Abnormal Monitor on this weld procedure, move the cursor on Arc Abnormal Monitor item on above screen and press F4(ENABLED). If you want to set on this weld procedure, press F5(DISABLED).
When ENABLED, weld procedure screen becomes like the following.

```
DATA Weld Procedure          1
                                        7/13
  - Procedure              1 [             ]
                        .
                        .
                        .
     Ramping:                        DISABLED
     Arc Abnormal Monitor:           ENABLED
                                    <*DETAIL*>
                        .
                        .
                        .
```

5 When you set the each parameters of Arc Abnormal Monitor function, move the cursor on <*DETAIL*> and then press ENTER key.

```
DATA Weld Procedure          1
                                          1/16
 - Procedure            1 [                ]
   Method:
     Monitoring Method:       DIFF(%)
     Monitoring Delay Time:    0.00 sec
     Craterfill Monitor:     ENABLED

   Judgement Condition
     Out-of-limit Alarm Time
       WARN Time:               0.00 sec
       STOP Time:               0.00 sec
     Out-of-limit Alarm Count
       WARN Cnt:         0 cnt / 1.0 sec
       STOP Cnt:         0 cnt / 1.0 sec

   Limit:
     Welding WARN V:    - 0.0 %  + 0.0 %
                 A:    - 0.0 %  + 0.0 %
     Welding STOP V:    - 0.0 %  + 0.0 %
                 A:    - 0.0 %  + 0.0 %

     Crater  WARN V:    - 0.0 %  + 0.0 %
                 A:    - 0.0 %  + 0.0 %
     Crater  STOP V:    - 0.0 %  + 0.0 %
                 A:    - 0.0 %  + 0.0 %

   [TYPE]
```

6 Set each items by referring to Table 19.3.2.

Table 19.3.2 Individual setup of arc abnormal monitor in weld procedure screen

SETTING ITEM	DESCRIPTION
Monitoring Method	This item specifies the method of limit range by thresholds. There are 3 methods. • **DIFF(%)** Set the range of thresholds against the command values relatively by using +/- percentages of current and voltage. For example, when the command current is 200A and the WARN limit is from -10% to +10%, the actual current within +/-10% range of command current is treated as the range. Therefore, 180A -220A becomes the WARN limit for the current. • **DIFF(V,A)** Set the range of thresholds against the command values relatively by using +/- current and voltage values. For example, when the command current is 200A and WARN limit is from -10A to +10A, 190A-210A becomes WARN limit for the current. • **ABS(V,A)** Set the range of thresholds by absolute values of current and voltage. For example, the WARN limit for the current is specified as 190A – 210A. This cannot allow the set for each weld section, so it is needed to set rough values for all weld sections. On the other hand, you can also use it for the system that has Wire Feed Speed command or “Trim” command (without voltage/current command).
Monitoring Delay Time	This specifies the delay time from an arc detect timing to the monitoring start timing of actual current and voltage. By this delay time, you can ignore the unstable state of actual current and voltage around arc start. Conversely, if you want to monitor the unstable state around arc start, please set the values shorter (or zero).
Craterfill Monitor	If you also want to monitor during Craterfill, please set this item to ENABLED. When this becomes ENABLED, “Crater WARN V”, “Crater WARN A”, “Crater STOP V” and “Crater STOP A” for Craterfill Monitor are newly added to the setup screen. About how to use of Craterfill Monitor, please refer to “Craterfill Monitor” in this section.
Out-of-limit Alarm Time WARN Time	If the time has passed since actual current or voltage becomes out of range of WARN limit, ARC-096 and WARN Output Signal are output. If the time is set to “0”, The abnormal detection by Out-of-limit Time for WARN Limit becomes disabled.

SETTING ITEM	DESCRIPTION
Out-of-limit Alarm Time STOP Time	If the Time has passed since actual current or voltage becomes out of range of STOP limit, ARC-095 and STOP Output Signal are output. If the time is set to “0”, The abnormal detection by Out-of-limit Time for STOP Limit becomes disabled.
Out-of-limit Alarm Count WARN Cnt	If the out-of-range counts of WARN limit exceed the specified count during the specified seconds, ARC-096 and WARN Output Signal are output. If the count is set to “0”, The abnormal detection by Out-of-limit Count for WARN Limit becomes disabled.
Out-of-limit Alarm Count STOP Cnt	If the out-of-range counts of STOP limit exceed the specified count during the specified seconds, ARC-096 and STOP Output Signal are output. If the count is set to “0”, The abnormal detection by Out-of-limit Count for STOP Limit becomes disabled.
Welding WARN	This specifies the WARN limit range during welding. Please set the values based on Monitoring Method. “V” is voltage and “A” is current. If feedback value exceeds the WARN limit, “ARC-096 Feedback exceeds WARN limit (Program Name, Line Number)” is posted. If “0.0” is input in + or - side, the WARN Limit of this item becomes disabled.
Welding STOP	This specifies the STOP limit range during welding. Please set the values based on Monitoring Method. “V” is voltage and “A” is current. If an feedback value exceeds the STOP limit, “ARC-095 Feedback exceeds STOP limit (Program Name, Line Number)” is posted. Additionally, the running program is stopped at the “STOP timing”. If “0.0” is input in + or - side, the STOP Limit of this item becomes disabled.
Crater WARN	This specifies the WARN limit range during Craterfill. Please set the values based on Monitoring Method. “V” is voltage and “A” is current. If feedback value exceeds the WARN limit, “ARC-096 Feedback exceeds WARN limit (Program Name, Line Number)” is posted. If “0.0” is input in + or - side, the WARN Limit of this item becomes disabled. This item is displayed only when “Craterfill Monitor” is ENABLED.
Crater STOP	This specifies the STOP limit range during Craterfill. Please set the values based on Monitoring Method. “V” is voltage and “A” is current. If an feedback value exceeds the STOP limit, “ARC-095 Feedback exceeds STOP limit (Program Name, Line Number)” is posted. Additionally, the running program is stopped at the “STOP timing”. If “0.0” is input in + or - side, the STOP Limit of this item becomes disabled. This item is displayed only when “Craterfill Monitor” is ENABLED.

⚠ **CAUTION**

If “Monitoring Method” is changed after inputting values to WARN and STOP Limits, previous values remain on these items. After changing “Monitoring Method”, please confirm that values on WARN and STOP Limits are proper.

NOTE

When arc schedule is changed by the execution of Arc Start instruction during arc welding, WARN and STOP limits for new arc schedule are re-calculated automatically if “Monitoring Method” is “DIFF(%)” or “DIFF(V,A)”.

NOTE

The monitoring is done after program stop/resume during arc welding.

19.3.3 Notifications for Monitoring

Monitoring with ArcTool Ramping

During ArcTool Ramping, monitoring function of feedback voltage and current becomes disabled temporarily. After the increment/decrement of weld parameters is completed, monitoring function becomes enabled.

Monitoring with HeatWave

Arc Abnormal Monitor function can monitor actual current/voltage during HeatWave Sync (Refer to Chapter 10). There is no need for performing monitoring during HeatWave. If normal setup for Arc Abnormal Monitor is done by Procedure 19-1 and 19-2, the monitoring is performed during HeatWave.
The upper limit of threshold during HeatWave is calculated by dealing the highest command value during HeatWave as a nominal value. On the other hand, the lower limit of threshold is calculated by dealing the lowest command value during HeatWave as a nominal value.

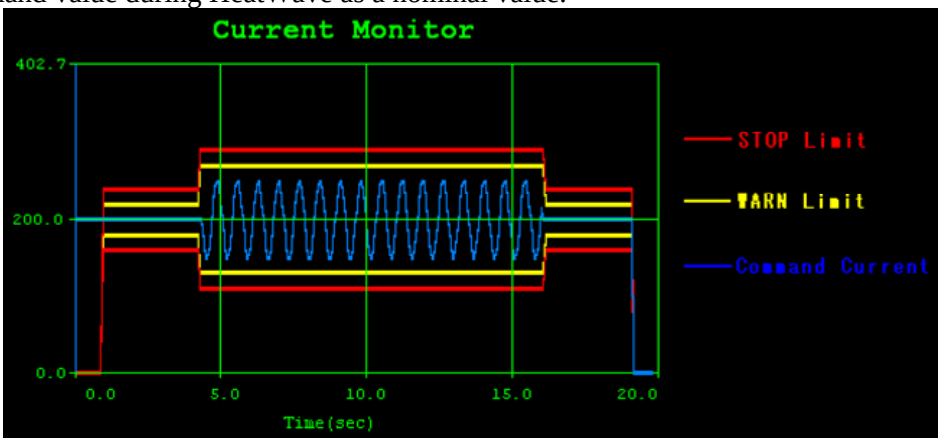


Fig. 19.3.3 Monitoring during HeatWave

> **NOTE**
> Voltage and current on ARC-097 posted during HeatWave become different values from center value of command voltage / current during HeatWave.

19.4 ARC WELD LOG FUNCTION

Arc Weld Log Function automatically save the actual current/voltage data between Weld Start – Weld End instructions (only when Arc Enable) to Memory Card as files. The information of command current/voltage are also saved simultaneously. Additionally, threshold values of WARN and STOP limit are also saved when Arc Abnormal Monitor works.

19.4.1 Setup of Arc Weld Log Function

The setup of Enabled/Disable of Arc Weld Log Function and the condition of the log save timing (Log Mode) are performed on Arc Abnormal Monitor Setup Screen. Please refer to Procedure 19-3.

Procedure 19-3 Setup of Arc Weld Log

Step

1 Press [MENU] key and select “6 SETUP”.
2 Press F1[TYPE] and select “Arc Monitor”. Arc Abnormal Monitor Setup Screen is displayed.
3 Move the cursor to the lower. The following 2 items for Arc Weld Log are displayed.

```
SETUP Arc Abnormal Monitor
                                        1/7
   Arc Abnormal Monitor Setup
     1 Arc Abnormal Monitor:        DISABLED

   WARN Limit
     2 WARN Output Signal:           DO[   0]
   STOP Limit
     3 STOP Output Signal:          DO[   0]
     4 STOP Timing:               AFTER 1BEAD

   Arc Weld Log Setup
     5 Arc Weld Log:                ENABLED
     6 Log Mode:                    NONE
     7 Serial No. Register:     R    [    0]

[TYPE]                    ENABLED  DIABLED
```

Table 19.4.1 Setting for arc abnormal monitor

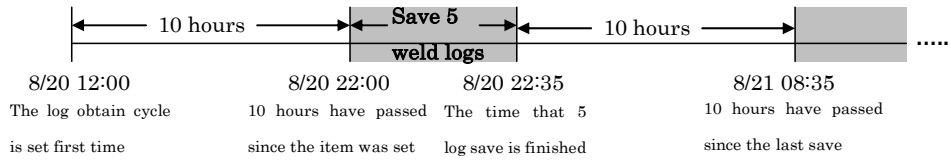
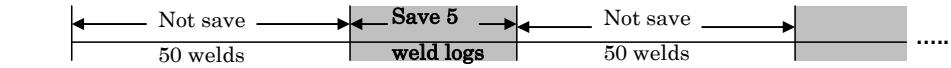
SETTING ITEM	DESCRIPTION
Arc Weld Log	This item specifies the enabled/disabled of Arc Weld Log Function (Default: ENABLED). When it is ENABLED, actual current and voltage between Weld Start and Weld End instructions are automatically saved on Memory Card when the condition of Log Mode is achieved. Additionally, Arc New Log (5 items) are automatically saved on temporary memory on Robot Controller regardless of Log Mode. Save is performed just after Weld End. If you change the setup, please perform Cycle Power.
Log Mode	This item specifies the condition for saving the log to Memory Card (Default: NONE). • **ABNORMAL** The log data is saved to Memory Card when the arc weld is paused, or when actual current or voltage exceed WARN or STOP limits of Arc Abnormal Monitor. • **ALL** All of Arc Weld Log during arc welding is saved to Memory Card. • **NONE** Arc Weld Log during arc welding is not saved to Memory Card. But you can see newest 5 Arc Weld Log on “DATA Arc New Log” Screen (Refer to 19-6). • **CUSTOM** You can set detailed log timings. In detail, please refer to “Custom Log Mode” on this section.
Serial No. Register	The contents in the register (or string register) specified by this item are saved in Arc Weld Log. If register (or string register) is updated in TP program for each weld section, you can store the characteristic serial number to each Arc Weld Log.

19.4.2 Custom Log Mode

If you want to set the log save timing to memory card more depth, you can use “CUSTOM” Log Mode. If at least one condition is accomplished, the arc weld log is saved.
The explanation of each item is shown on Table 19.4.2, setup procedure is shown Procedure 19-4.

Table 19.4.2 Setting for custom log mode

SETTING ITEM	DESCRIPTION
Abnormal Log	You can select whether log is saved to memory card or not when the program is paused or aborted during welding, or when the feedback exceeds WARN or STOP limit which are set by Arc Abnormal Monitor. If the item is ENABLED and the condition is accomplished, the log is saved.

SETTING ITEM	DESCRIPTION
Log Get Cycle	The specified number (“Data” which is an item under Log Get Cycle) of logs are saved on regular intervals (EVERY … HOURS) or regular number of welds (EVERY … WELDS). After specified number of saves are done, the count of Log Get Cycle are started. In detail, please refer to the following figure. If “0” is set on the item, the condition becomes DISABLED. **EX1: Log Get Cycle: EVERY 10 HOURS** **Data: 5 WELDS**  **EX2: Log Get Cycle: EVERY 50 WELDS** **Data: 5 WELDS** 
Data	After Log Get Cycle is passed, the specified number of logs on this item are saved.
Log Get Signal	Logs are always saved when the digital input signal which is specified by this item is ON. The status check of the digital input signal is performed at Arc Weld End timing. If this is “DI[0]”, this condition becomes DISABLED.
Log Get Register	If the value of the register which is specified by this item is 1 or more, log is saved. If the save is done, the value decreases by 1. You can achieve specified number of times of save if you input the desired number in the register.

Procedure 19-4 Setup of Custom Log Mode

Step

1 Set “Arc Welding Log” to ENABLED and “Log Mode” to “CUSTOM” by referring to Procedure 19-3. 5 items are newly added under “Log Mode” item.

```
SETUP Arc Abnormal Monitor
                                        1/7
   Arc Abnormal Monitor Setup
     1 Arc Abnormal Monitor:        DISABLED

   WARN Limit
     2 WARN Output Signal:           DO[   0]
   STOP Limit
     3 STOP Output Signal:           DO[   0]
     4 STOP Timing:               AFTER 1BEAD

   Arc Weld Log Setup
     5 Arc Weld Log:                ENABLED
     6 Log Mode:                    CUSTOM
     7   Abnormal Log:              ENABLED
     8   Log Get Cycle:    EVERY     0 HOURS
     9             Data:             1 WELDS
    10   Log Get Signal:             DI[   0]
    11   Log Get Register:        R    [  0]
    12 Serial No. Register:       R    [  0]

   [TYPE]                    ENABLED  DIABLED
```

2 Set each parameter in Table 19.4.2. About “Log Get Cycle”, you can move the cursor on “HOURS” and can select “WELDS” by pressing F4[SELECT].

19.4.3 Notifications for Log Save

- If Arc Weld Log is Enabled, do not pull out/insert Memory Card during arc welding or after few seconds of Weld End because log data is saved.
- Normally, the period of data save is every 16msec (But it becomes 12msec if 1ITP is 12msec). The period can become longer by changing system variable $AWEAMON.$SAVE_INTVAL manually. For example, when $SAVE_INTVAL is changed from 1 to 3, the period is changed from 16msec to 48msec (3 times value). When the welding time is long, please change this period as required.
- There is a case that log data cannot be obtained when the welding time is long (about over 5 minutes). Then, please increase the value of above system variable.
- Waveforms of feedback voltage and current become totally vibrational or smooth by the difference of weld equipment model and weld processes (CO2, MIG, MAG, Pulse ON/OFF, etc.). If you want to see smoother waveform of feedback voltage and current, you can store the averaged data by changing $AWEAMON.$AVRG_INTVAL. For example, if the value is set to 5, the stored data becomes the averaged data of 5 data which are obtained every 16msec. However, the stored values are averaged when $AVRG_INTVAL is increased, then the response of waveform delays. Additionally, monitoring values are also averaged when $AVRG_INTVAL is changed. Therefore, you should re-adjust the threshold of Arc Abnormal Monitor.
- Use the Memory Card whose capacity is more than 512MB. The remained capacity is gradually decreased by the save of Arc Weld Log. Therefore, please move older Arc Weld Log files per month and keep the sufficient remains on Memory Card.
- Arc Weld Log data are saved on “ALOG” folder that is automatically created on Memory Card. Do not edit/change files and folders in ALOG folder. Do not delete files in the folder except removing the old log data.
- If Memory Card is changed to the one which does not have “ALOG” folder, log data are not saved until the execution of Cycle Power of robot controller.
- If the empty space on Memory Card becomes small, the oldest log data are automatically deleted and empty space is increased, and then new log data is saved. If enough space for new log is not obtained after deleting oldest 20 files, the new log is not saved. Then, please obtain the empty space on Memory Card manually.

19.4.4 Arc Hist Log Screen

You can see log data on Memory Card on Teach Pendant by displaying Arc Hist Log Screen. Latest 200 logs can be checked on the screen. Procedure 19-5 shows the display method of Arc Hist Log Screen.

Procedure 19-5 Display of Arc Hist Log Screen

Step

1 Press [MENU] key, select “0 NEXT” and select “3 DATA” (or press DATA key).

2 Press F1[TYPE] key and select “Arc Hist Log”. The following screen is displayed. The newest information is displayed on the top of the screen.

Arc weld history log screen

```
DATA Arc Weld Log (Hist)
                                                  1/200
        DATE      TIME   PROGRAM       LINE
   1 23-MAR-09 11:04:08 TEST2     11    14
   2 19-MAR-09 17:26:24 TEST1     11    15
   3 19-MAR-09 17:23:11 TEST1     11    15
   4 15-MAR-09 20:08:34 WELDA01   22    27
   5 12-MAR-09 18:33:22 ARC0312    1     5
   6 06-MAR-09 15:22:55 WELD_B02  12    15
   7 06-MAR-09 14:22:28 WELD_B02  12    15

   [TYPE]  TIMCHART  DSTCHART          HELP
```

19.4.5 Arc New Log Screen

Regardless of Log Mode, newest 5 logs information are displayed on the screen. Since the data are located on the temporary memory on Robot Controller, the information is cleared if the power of Robot Controller becomes OFF. please use this screen when the Log Mode is ”ABNORMAL” or “NONE” and when the log data which you want to see is not saved on Memory Card.

Procedure 19-6 Display of Arc New Log Screen

Step

1 Press [MENU] key, select “0 NEXT” and select “3 DATA” (or press DATA key).

2 Press F1[TYPE] key and select “Arc New Log”. The following screen is displayed. The newest information is displayed on the top of the screen.

Arc weld New log screen

```
DATA Arc Weld Log (Hist)
                                          1/200
        DATE      TIME   PROGRAM       LINE
   1 23-MAR-09 11:04:08 TEST2     11    14
   2 19-MAR-09 17:26:24 TEST1     11    15
   3 19-MAR-09 17:23:11 TEST1     11    15
   4 15-MAR-09 20:08:34 WELDA01   22    27
   5 12-MAR-09 18:33:22 ARC0312    1     5

   [TYPE]  TIMCHART  DSTCHART          HELP
```

19.4.6 Arc Log Chart Screen

You can see actual current/voltage during welding by graphs. The screen is called from Arc Hist Log Screen or Arc New Log Screen. Command current/voltage are also displayed in graphs. Thresholds are also displayed when Arc Abnormal Monitor works. Additionally, you can check average values, weld distance, and so on.

You can display both time-based graphs and distance-based graphs as lateral axis.

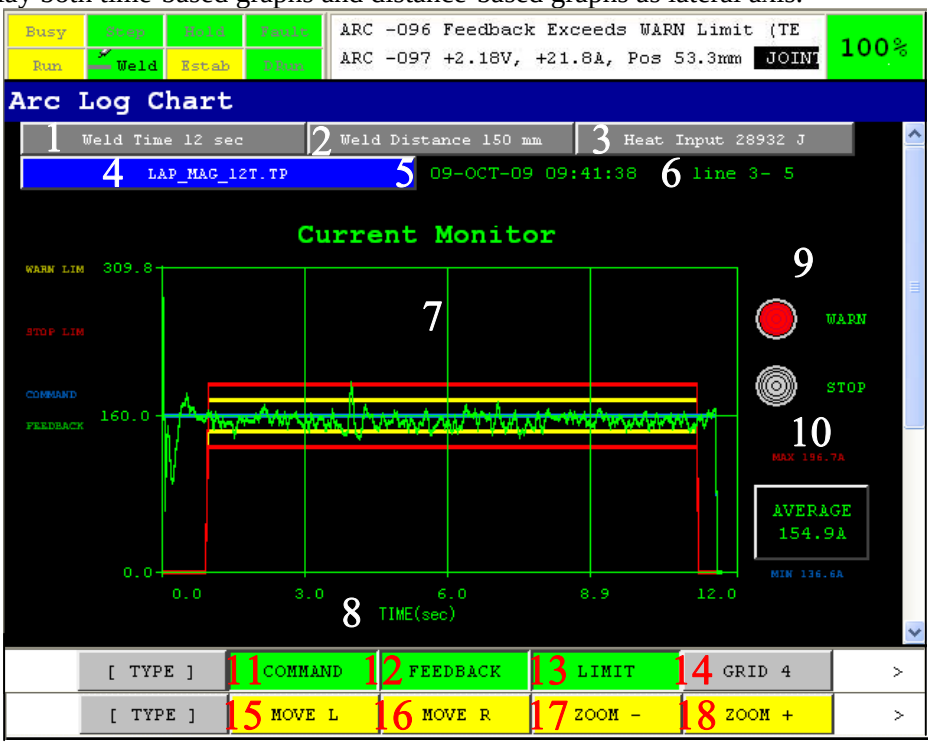


Fig. 19.4.6 Arc log chart screen

Table 19.4.6 Displayed Items on arc log chart screen

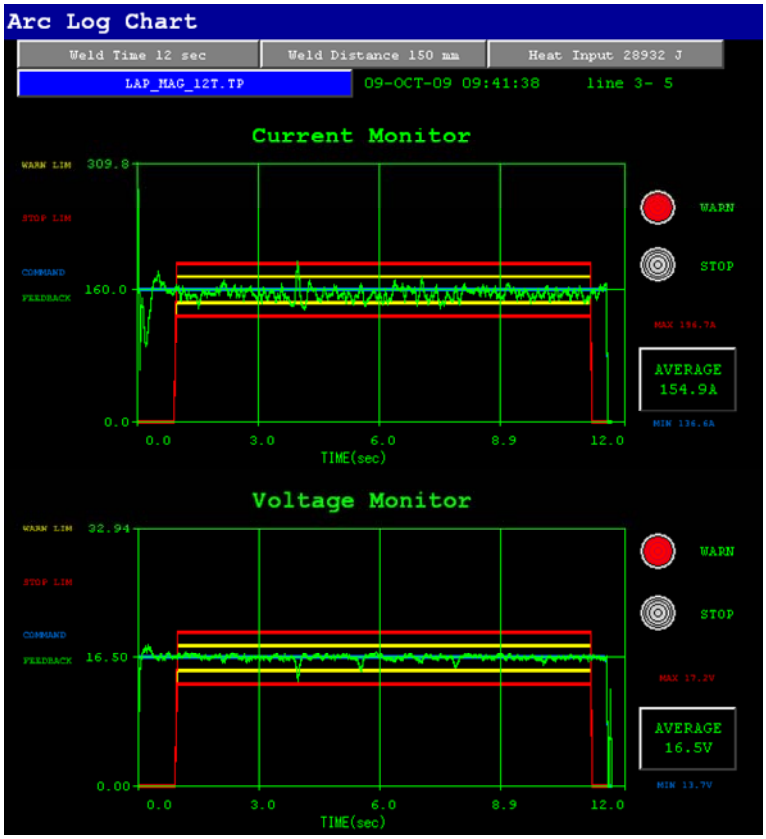
SETTING ITEM	DESCRIPTION
1. Weld Time	Weld time between Arc Weld and Weld End are displayed (The unit is sec). If the program is paused during welding, the number becomes the weld time between Weld Start and weld pause timing.
2. Weld Distance	Weld distance between Weld Start and Weld End are displayed (The unit is mm). If the program is paused during welding, the number becomes the weld distance between Weld Start and weld pause timing.
3. Heat Input	Heat Input between Weld Start and Weld End are displayed (The unit is J). If the program is paused during welding, the number becomes the heat input between Weld Start and weld pause timing.
4. Program Name	The name of the program which performs this welding is displayed.
5. Date / Time	The date and the time at the timing of Arc Start for this welding is displayed.
6. Line Number	The line numbers of Weld Start position and Weld End position are displayed. If the weld program is paused, line number for Weld End becomes 0. Additionally, in resume case, line number for Weld Start becomes the line of Weld Start instruction and not become resumed line.
7. Current Monitor / Voltage Monitor	Transitions of Feedback current (or voltage), commands, WARN limit and STOP limit are plotted on graphs. • Green: Feedback current / voltage • Blue: Command current / voltage • Yellow: WARN limit • Red: STOP limit You can change ON / OFF of each graph by function keys 11 – 14.
8. Time / Distance	If graphs are time-based, lateral axes of Current Monitor and Voltage Monitor becomes “Time”. If distance-based, they becomes “Distance”.
9. WARN/STOP Lump	If feedback exceeds WARN limit during welding, WARN lump lights with red. If feedback exceeds STOP limit, STOP lump lights with red. These lumps are prepared for both Current Monitor and Voltage Monitor, and the judgement is independent. (For example, when the current feedback exceeds WARN limit and the voltage feedback does not exceed WARN limit, WARN lump only for Current Monitor lights.)
10. Average / Max / Min	Average value is calculated from the range between 0.5 sec has passed since arc has been started – Just before Weld End (Just before Craterfill). Maximum and minimum value are found in the same range.
11. Command	You can switch “Display” or “Not Display” of command graphs. Command graphs are displayed when the key is green and not displayed when the key is yellow.
12. Feedback	You can switch “Display” or “Not Display” of feedback graphs. Feedback graphs are displayed when the key is green and not displayed when the key is yellow.
13. Limit	You can switch “Display” or “Not Display” of WARN and STOP limit graphs. WARN and STOP limit graphs are displayed when the key is green and not displayed when the key is yellow.
14. Grid	You can specify the number of division of graphs (Max: 20). When the number is 1 – 5, the value is displayed under the grid line. If the number is more than 6, the value is not displayed.
15. Move L	Move graphs to lateral – direction. Cannot move to under 0.
16. Move R	Move graphs to lateral + direction.
17. Zoom -	Zoom out graphs. Center point of the current graph becomes reference point.
18. Zoom +	Zoom in graphs. Center point of the current graph becomes reference point.

Procedure 19-7 Display of Arc Log Chart Screen

Step

1 Display Arc Hist Log Screen or Arc New Log Screen (Refer to Procedure 19-5 or 19-6).

2 Move the cursor on the information which you can see more detail and press “F2 TIMCHART” key. Arc Log Chart Screen for the log is displayed by time-based. If you want to display distance-based log chart, press “F3 DSTCHART” key.



3 "Current Monitor" is displayed upper side, and "Voltage Monitor" is displayed lower side. If you want to see Voltage Monitor, press SHIFT key and "↓" key simultaneously, and then the screen scrolls.
You can change display/non-display of "COMMAND", "FEEDBACK" and "LIMIT" graphs.

4 When "F->" key is pressed, the displays for function keys are changed to "MOVE L", "MOVE R", "ZOOM -" and "ZOOM +". Then you can perform "MOVE" and "ZOOM" of charts.

NOTE
Arc Log Chart Screen display graphs after loading data in the file. Therefore, some seconds – more than 10seconds are required until displaying all graphs.

19.5 DETAILS OF LOG DATA FILES

19.5.1 Configuration of ALOG Folder

If memory card is slotted to the robot controller whose Arc Weld Log function has already became ENALED, "ALOG" folder is automatically made just under the disk drive (made on the root directory).
If log file save to the memory card is performed, related folders and files are automatically made in ALOG folder. About the configuration of ALOG folder, please refer to Fig. 19.5.1.

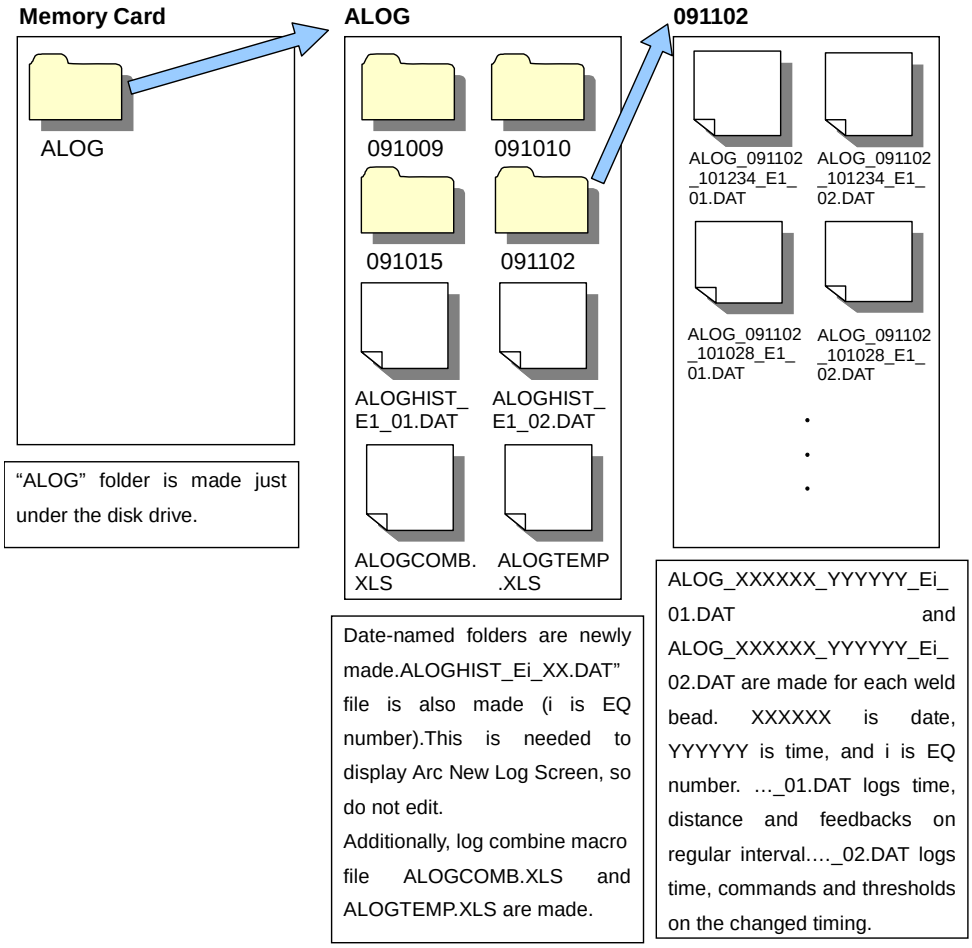


Fig. 19.5.1 Configuration of ALOG Folder

NOTE

When the large number of log files are made in one folder, The writing speed of log file becomes slower. Therefore, when the number of log files in one folder exceeds 400, "DateName_01" (EX: 091009_01) is newly made and old log files are moved to this folder. New log files are stored to "DateName" (EX: 091009) folder. If the number of log files in one folder continuously exceeds 400 again and again, "DateName_02", "DateName_03" folders are automatically made and old log files are moved to these folders.

19.5.2 Data in Arc Weld Log Files

In two arc weld logs per one weld section of Date Name folder, following data are saved.

ALOG_XXXXXX_YYYYYY_Ei_01.DAT

Normally, following data are logged every 16msec (If Multi-Group, every 12msec).

- **Time** --- Time (msec)
- **Dist** --- Distance (mm)
- **FbkV** --- Feedback voltage (V)
- **FbkA** --- Feedback Current (A)

```
Time Dist FbkV FbkA
16    0.0 18.4   4.0
32    0.0 18.3   4.0
48    0.0 18.3   2.6
64    0.0 18.4   4.0
80    0.0 18.3   4.0
96    0.0 18.3   2.6
112    0.0 18.3   2.6
128    0.0 18.4   4.0
272    0.0 18.4   1.9
288    0.0 18.4   4.0
304    0.0 18.4   4.0
            .
            .
            .
```

Fig. 19.5.2 (a) Data of ALOG_XXXXXX_YYYYYY_Ei_01.DAT

ALOG_XXXXXX_YYYYYY_Ei_02.DAT

Following data are logged at the timing when one of data (except Time) are changed.

- **Time** --- Time (msec)
- **CmdV** --- Command Voltage (V)
- **CmdA** --- Command Current (A)
- **WminV** --- Lower threshold for WARN Voltage (V)
- **WmaxV** --- Upper threshold for WARN Voltage (V)
- **WminA** --- Lower threshold for WARN Current (A)
- **WmaxA** --- Upper threshold for WARN Current (A)
- **SminV** --- Lower threshold for STOP Voltage (V)
- **SmaxV** --- Upper threshold for STOP Voltage (V)
- **SminA** --- Lower threshold for STOP Current (A)
- **SmaxA** --- Upper threshold for STOP Current (A)

Additionally, following data are logged at the end of the file.

- **warn_vlt** --- 1: Exceed WARN voltage limit. 0: Not exceed
- **stop_vlt** --- 1: Exceed STOP voltage limit. 0: Not exceed
- **warn_amp** --- 1: Exceed WARN current limit. 0: Not exceed
- **stop_amp** --- 1: Exceed STOP current limit. 0: Not exceed
- **AvrgEndTime** --- The time when Arc End is started. Later data do not use average calculation.
- **Resume** --- 1: Arc welding is resumed 0: Not resume
- **Stop/Abort** --- 1: Program is paused or aborted during welding. 0: Not pause/abort.
- **ProgramName** --- Program Name
- **AS** --- Arc Start Line Number
- **AE** --- Arc End Line Number
- **WeldTime** --- Weld Time (sec)
- **WeldDist** --- Weld Distance (mm)
- **WeldHeat** --- Heat Input (J)
- **F_Number** --- F Number of robot
- **SerialNo**. --- Serial Number
- **WeldID**. --- Weld ID
-

```
Time CmdV CmdA WminV WmaxV WminA WmaxA SminV SmaxV SminA SmaxA
16 20.0 200.0  0.0  0.0   0.0   0.0  0.0  0.0   0.0   0.0
976 20.0 200.0 18.0 22.0 180.0 220.0 16.0 24.0 160.0 240.0
10032  0.0   0.0  0.0  0.0   0.0   0.0  0.0  0.0   0.0   0.0
warn_vlt stop_vlt warn_amp stop_amp
1 0 1 1
AvrgEndTime
10032
Resume  Stop/Abort
0 0
ProgramName  AS  AE  WeldTime  WeldDist  WeldHeat
TEST 2 5 7  148.8 171171
F_Number
MA99999
SerialNo.
WELD091009_TEST_1201_0154
WeldID
1201
```

Fig. 19.5.2 (b) Data of ALOG_XXXXXX_YYYYYY_Ei_02.DAT

Data in Arc Weld Log file are separated by space. Therefore, you can open the file by Excel application on PC. If you open the file on Excel, set file type to “All file” and then select the file. After that, please check “Separated data by comma or tab” and “Space” on “Text File Wizard”. Then data are separated by each cell. (This operation will be changed by setup environment or version of PC or Excel)

19.5.3 Data Combine Macro for Arc Weld Log

Log data are saved separately into 2 log files (refer to Data in Arc Weld Log Files). Therefore, if you want to confirm these data by some graphs on Excel like Arc Log Chart screen, the work to combine data in 2 files into 1 Excel sheet is needed.

Arc Abnormal Monitor Function supports Excel macro files (ALOGCOMB.XLS and ALOGTEMP.XLS) : they can combine data in 2 files into 1 Excel sheet. You can achieve data combination for all log files by using the Excel macro.

Excel macro files “ALOGCOMB.XLS” and “ALOGTEMP.XLS” are copied automatically at the power-on timing of the robot controller if they do not exist in ALOG folder on the memory card.

Procedure are described on Procedure 19-8.

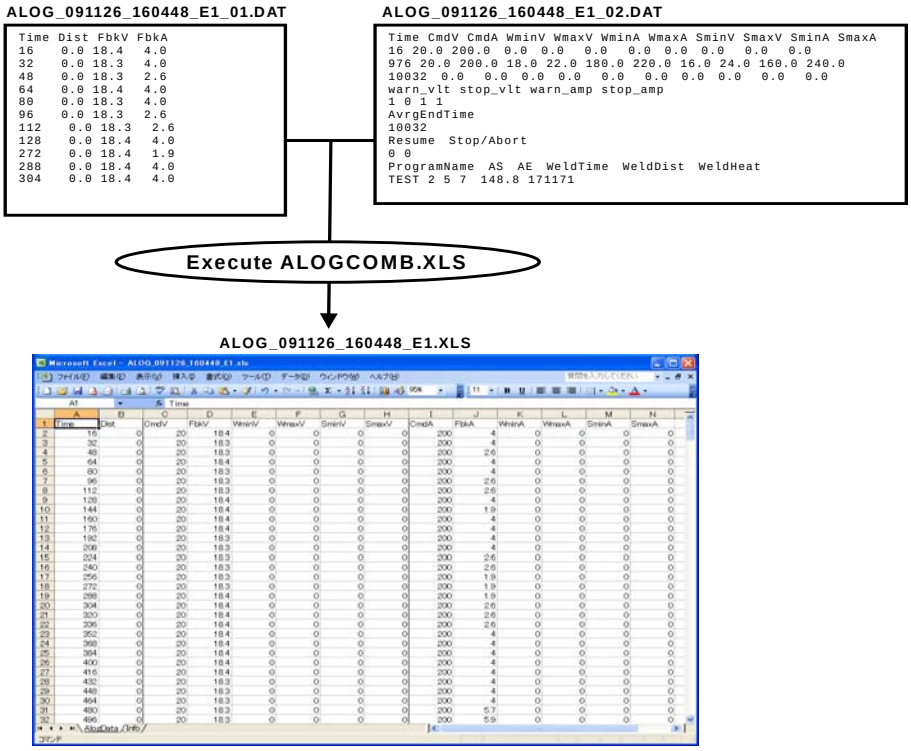


Fig. 19.5.3 Execution result of data combine macro of arc weld logs

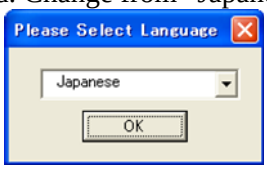
Procedure 19-8 Combine Log Data by Data Combine Macro of Arc Weld Logs

Condition

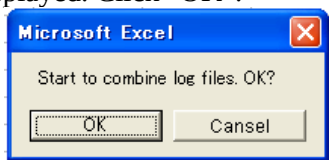
- Microsoft Excel has already been installed on your PC and macro execution is permitted.

Step

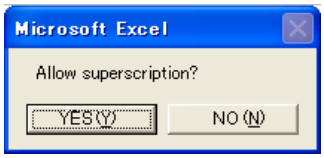
1 Insert the memory card which has Arc Weld Log Data (ALOG folder) into the PC.
2 Open ALOG folder which has log data.
3 Click and execute ALOGCOMB.XLS.
4 In some OS versions and settings, the window of a security warning is displayed. Please set the macro to enable.
5 Language select window is displayed. Change from “Japanese” to “English” and then click “OK”.



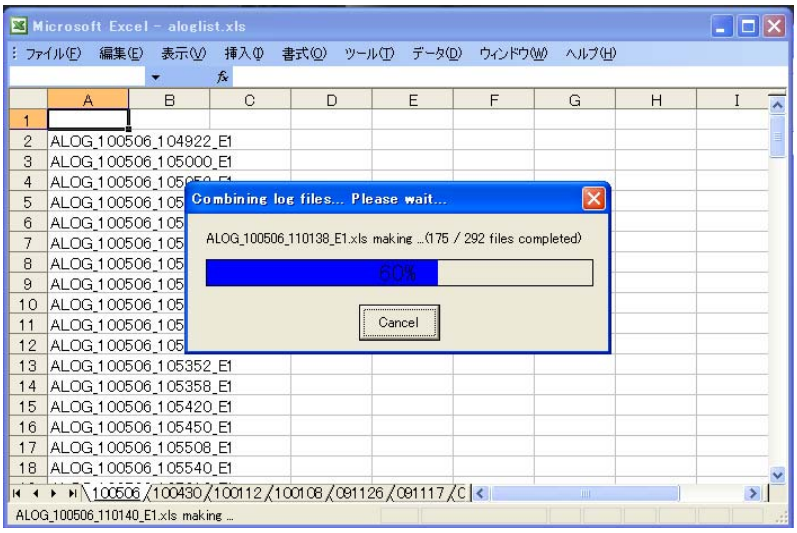
6 Next, the following window is displayed. Click “OK”.



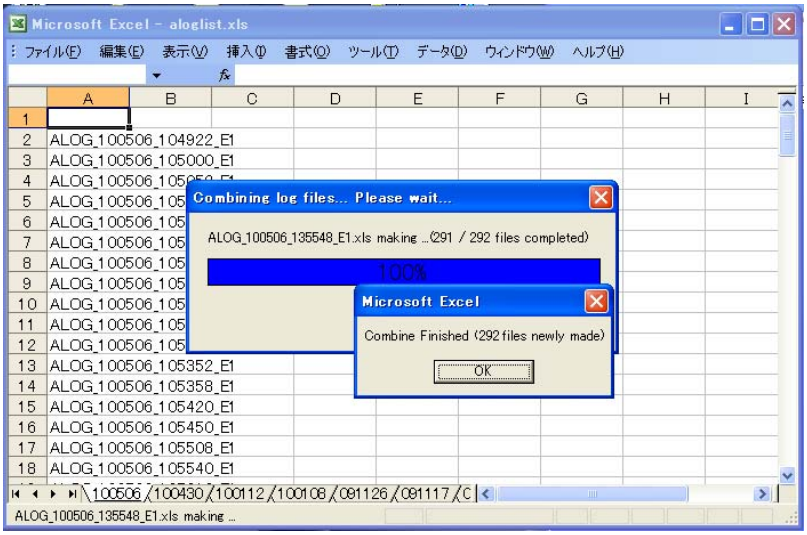
7 You can decide to permit “file superscription” or not. If the execution is first time or if you want to retry log combination for all of files, please select “YES”. If you do not want to execute log combination for performed files, please select “NO”.



8 After a while, progress status bar for the combination is displayed. Please wait for a while without PC operations.



9 When the combination for all of files are finished, the message “Combine finished” is displayed. Click “OK” and finish Excel application.



10 Combined Excel files have been made in date-named folder under ALOG folder.

NOTE

For speed up of macro execution, it is recommended to execute ALOGCOMB.XLS in ALOG folder of the hard disk after copying ALOG folder of the memory card to the hard disk of PC.

NOTE

The correct execution of this Excel macro file has been confirmed in following environments. There is a possibility that this will not work correctly in other environments.

- Microsoft Windows 2000, Windows XP, Windows 7
- Microsoft Excel 2000, Excel 2003, Excel 2007

19.5.4 Data Display on ROBOGUIDE

You can see Arc Log Chart Screen of each weld result on ROBOGUIDE by copying ALOG folder to “MC” folder on work cell of ROBOGUIDE.

Procedure 19-9 Display Arc Log Chart Screen on ROBOGUIDE

Condition

- The work cell which orders Arc Abnormal Monitor (J987) on ROBOGUIDE has already made and it has been opened on ROBOGUIDE.
- You have the memory card which saves log data that you can check on ROBOGUIDE.

Step

1 Click “Tool” on tool bar of ROBOGUIDE and then select “Explorer XXXX folder” (XXXX is work cell name). The folder of current work cell is opened.
2 Select “Robot_1” -> “MC” in the folder. “MC” folder of the Robot 1 on work cell is opened.
3 Slot the memory card to PC and copy ALOG folder in “MC” folder.
4 Display Teach Pendant on ROBOGUIDE.
5 Click “iP” button on the upper right of Teach Pendant. Then Teach Pendant is changed to Pendant Mode.
6 Display Arc Log Chart Screen on Teach Pendant of ROBOGUIDE by referring to Procedure 19-5 and 19-7.

19.5.5 Transmission of Log Files by FTP

You can copy arc weld log files on memory card slotted on robot controller to PC by FTP communication. Procedure 19-10 shows the example of obtain method by using Command Prompt of Windows.

Procedure 19-10 Copy of Arc Weld Log Files to PC

Condition

- The setup of TCP/IP on the robot has completed and IP address is assigned to the robot. (If this has not completed, please refer to Ethernet function manual and perform the setup.)
- Both PC and robot exist on the same network which they can communicate mutually.

Step

1 Execute “Command Prompt” on PC. (EX: “Start Menu” -> “Programs” ->”Accessory” -> “Command Prompt”)

2 Input following commands on Command Prompt. (Bold characters are actual commands.)

C:¥> ***cd xxxxx¥xxx***

Change directory to save folder for logs on PC. (We recommend that the folders are prepared and managed on each robot and each date.)

C:¥xxxxx¥xxx> ***ftp xxx.xxx.xxx.xxx***

Input robot IP address to xxx.xxx.xxx.xxx.

Connected to xxx.xxx.xxx.xxx
220 R-30iB FTP server ready. [ArcTool V8.20/Pxx]
User (xxx.xxx.xxx.xxx(none)) :

Need not to input. Press Enter key.

230 User logged in [NORM].
ftp> ***asc***

Perform transmission with ASCII mode.

200 Type set to A
ftp> ***prompt***

The confirmation of copy for each file is not performed during “mget” and copy work is simplified.

Interactive mode Off .
ftp> ***cd MC:***

Set the device to MC.

250 CWD command successful.
ftp> ***cd ALOG***

Change directory to ALOG folder.

250 CWD command successful.
ftp> ***cd xxxxxx***

Specify the date name on xxxxxx. (EX: 091016)

ftp> ***mget *.****

Copy all of files in the current folder.

200 Type set to A
200 PORT command successful.
150 ASCII data connection.
226 ASCII Transfer complete.
ftp: xxxxxx bytes received in x.xxSeconds xxx.xxKbytes/sec.
.
.
.
200 PORT command successful.
150 ASCII data connection.

226 ASCII Transfer complete.
ftp: xxxxxx bytes received in x.xxSeconds xxx.xxKbytes/sec.
ftp> **bye**
Release the FTP connection to robot.

NOTE
There is a case that displayed contents on Step 2 are changed by setup environments on PC or robot controller.

NOTE
If you cannot know the information of folders and files in the current file, please confirm by “dir” command.

NOTE
Above-mentioned procedure only explains the copy for Arc Weld Log files. About more detailed operation of FTP, please refer to Ethernet function manual (B-82974EN).

NOTE
You can also copy log files by other FTP client software.

20 TAST TRACKING FUNCTION

20.1 OVERVIEW

Through-Arc Seam Tracking (TAST) function can control robot for keeping constant current value between the wire and the work. Therefore, even if the work is set to slightly different position, or if the work has slight different size or heat distortion, the robot can correct the proper welding path automatically and can perform appropriate welding.

TAST allows the robot to track a weld seam both vertically, in the distance between the torch and workpiece, and laterally, across the seam by monitoring changes in the weld current (by Weave Sine). TAST can be used in linear path and circular path.

The tracking performance of TAST is largely affected by construction environment and welding status. Under most proper situation for TAST, you can see sufficient tracking performance only by the weld execution of tracking instructions (refer to Section 20.4) with default setup. If tracking performance is not good, it is necessary to review weld construction environment by referring to Section 20.2 and 20.3. If you cannot obtain the good tracking performance after that (or it is difficult to change weld construction environment), it is necessary to adjust TAST schedules by referring to Section 20.6 and 20.7.

This function is an option. (A05B-XXXX-J511)

⚠CAUTION
This function does not support A motion instruction.

NOTE
1 The six point method for setting the tool frame must be used for proper tracking. When jogging in tool, coordinate z+ should move along the nozzle of the torch and away from the work.
2 This function can be used only when the user can get the stable feedback current value.
3 Please set “Return to path” in Arc Welding System Setup screen to ENABLED (refer to Section 3.3).

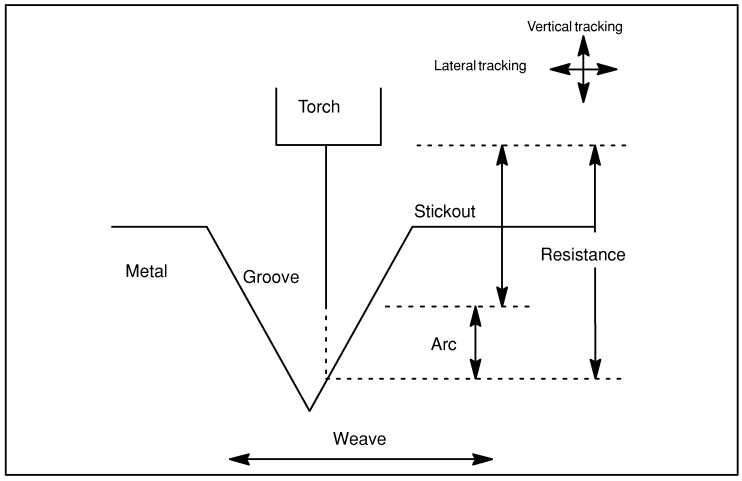


Fig. 20.1 (a) Thru-arc seam tracking

Weave Plane (XY-plane) Lateral Tracking

When weaving, the current varies as the torch moves back and forth across the seam like Fig. 20.1 (a). The side walls of the seam have a higher current value than the center of the seam because of a decrease in weld wire resistance. This decrease in resistance is due to shorter wire stick out.
The current feedback follows cyclic pattern generated by changes in the wire stick out. See Fig. 20.1 (b).
When the welding path is on the center (the center of weaving motion is just on the center of V-groove), the current forms of right and left side are the same as follows.

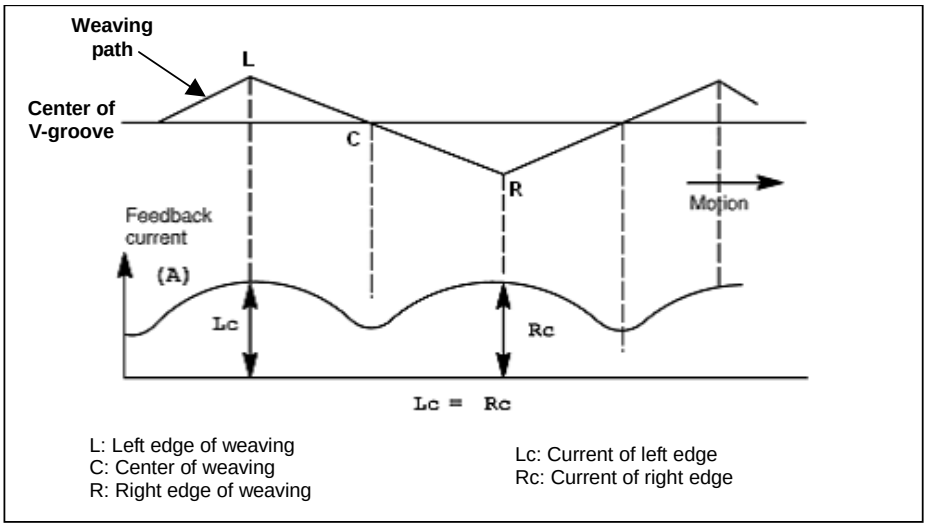


Fig. 20.1 (b) Current feedback pattern of centered weld

If the weld becomes off-center, the pattern becomes offset and distorted. See Fig. 20.1 (c).

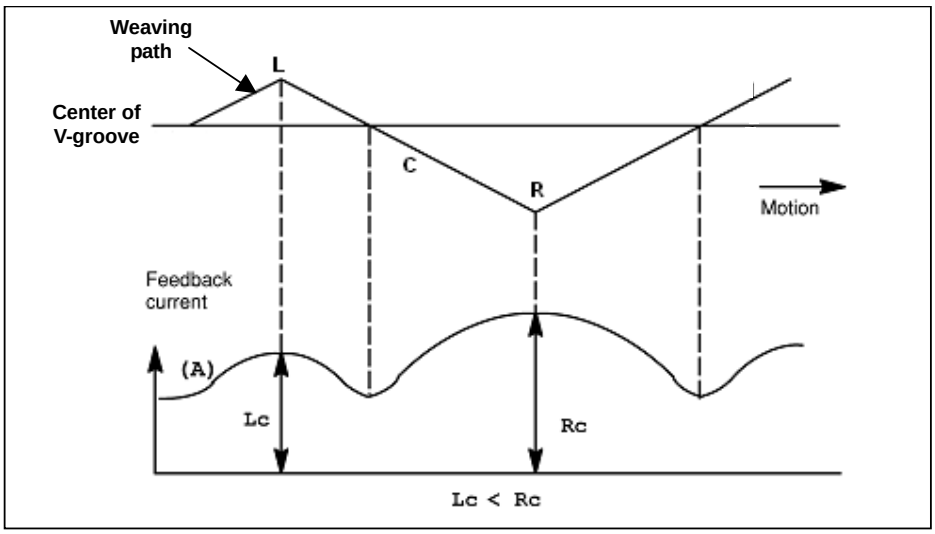


Fig. 20.1 (c) Current feedback pattern of weld shifted to the right

TAST samples the current feedback and calculates the area under the curve for each side of the weld. If the area under the left side is greater than that of the right, the robot path is corrected toward the right, and vice versa. These weld path corrections occur after each weave cycle.

Vertical Plane (Z-plane) Tracking

The weld can distort either downward, away from the torch or upward, toward the torch. TAST tracks the current at the center of the weld so the robot path can be offset to compensate for this distortion. See Fig. 20.1 (d).
TAST performs sampling of the current for correcting vertical direction in the timing of “1” in Fig. 20.1 (d).

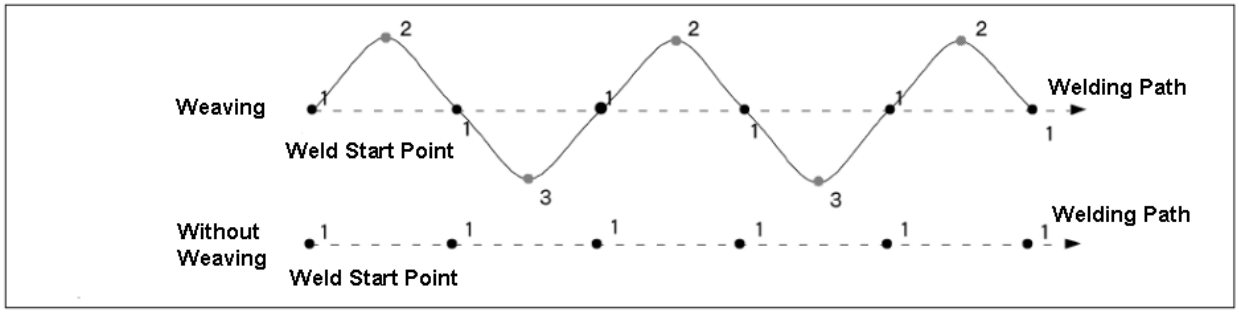


Fig. 20.1 (d) Sampling of the current

When TAST vertically tracks a weld, it compares the current at the weave center to a reference current reading. TAST samples the current after a predetermined number of weave cycles at the beginning of the weld, and uses the recorded value as the reference, or a weld current value can be entered.

If the weld seam is offset downward, away from the weld torch, the current at the center of the weave decreases due to the lengthening of the wire stick out. A path offset will be issued to move the welding torch closer to the seam.
If the weld seam is offset upward, toward the torch, the current increases because the wire stick out is shortened, causing less resistance. The offset then corrects the robot path by moving it farther away from the seam.
The reference current can be set to a constant value when tracking vertically. Refer to the definition of V_Master Current Constant in Table 20.5 (b).

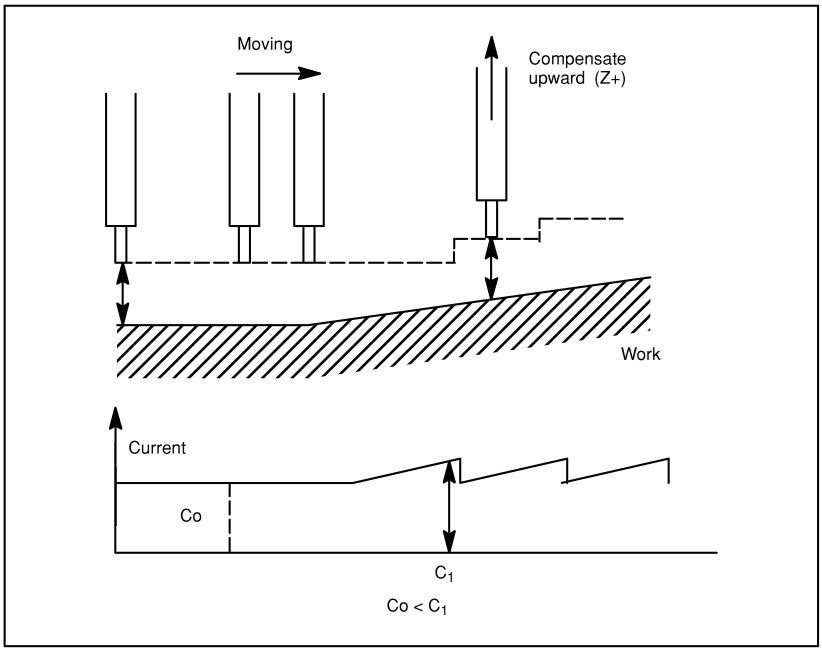


Fig. 20.1 (e) TAST vertical tracking

20.2 FACTORS THAT AFFECT TAST TRACKING

TAST performance can be affected by a number of factors. For most applications, after parameters are set, in-process adjustments are not required.
Factors that can affect TAST are:

- Changes in welding wire type (such as steel and stainless steel)
- Changes in welding wire diameter
- Wire stickout

- Torch posture
- Changes in weaving conditions (frequency, amplitude, dwell time)
- Changes in arc welding schedules (voltage, current, weld speed)
- Changes in welding arc location in respect to the weld puddle
- Gas composition
- Transfer type or arc transfer mechanism such as spray, short circuiting, pulsed spray, or globular
- Joint type of work
- Material surface condition
- Extreme changes in workplace temperature

When one of above factors is changed, readjustment of TAST may be required. The use of the TAST might become impossible according to the situation. Therefore, please take care when you change the above-mentioned factor.

20.3 TAST APPLICATION GUIDELINES

This Section includes application guidelines. These are guidelines only. In some cases, welds that are outside of these guidelines can be tracked successfully.

- The material thickness should be greater than 3 mm.
- Only Sine type weaving can be used for TAST.
- V-grooves should have a consistent included angle of 90 degrees or less.
- Fillet joints can have a maximum included angle of 90 degrees and must have at least 5 mm leg length.
- Outside corner and lap joint fillets must use a weave width of 2 mm less than the base metal thickness.
- A weld current of at least 270 A is recommended. If the weld current is lower than 270 A, the feedback current becomes unstable, which makes tracking difficult.
- The minimum weave width must be three times the diameter of the electrode or greater.
- The torch must be positioned close to the center of the weld seam at the start of the weld; Touch Sensing (refer to Chapter 39 of Optional Function OPERATOR’S MANUAL (B-83284EN-2)) might be necessary.
- Tack weld, leg size, should be less than or equal to one-half the weld size, if possible, and concave in profile.
- The actual weld seam should deviate less than 10 degrees rotation from the taught weld seam even if the feedback of current is stable. If the feedback of current is unstable, the actual weld seam should deviate less than 10 degrees rotation.
- Fit up of the joint (gap) must be within normal (blind) welding robot tolerances. Ideally, gaps should be consistent along the weld path
- Base metal must be ferrous or have a resistance greater than mild steel.

Optimum TAST performance (.045, solid wire) occurs with the following weave and shielding gas combinations. About the Setup for Weaving, Weave Setup screen has more information. Make the following changes:

- Set amplitude to 1.8 mm or greater.
- Set frequency to 4.0 Hz or less.
- Set dwell time to 0.05 sec or greater.

Additionally, you should use appropriate weaving schedule and arc weld schedule for stable welding.

20.4 TRACK INSTRUCTIONS

Track instructions specifies sensing using TAST function.

Track instructions for TAST are divided into two types:
- Track TAST[i] instruction
- Track End instruction

Track TAST[i]

The Track TAST[i] instruction starts sensing using an arc sensor according to a TAST condition specified beforehand.

Track TAST [i]

TAST schedule number

Example
```
1: Track TAST [2]
2: Track TAST[ R[5] ]
```

Track TAST [3] TAST schedule

TAST schedule
V Gain 22.5
L Gain 28
V Cur 270.0A
V Bias 4.0 %
L Bias -2.0 %

```
DATA TAST Sched
                                        1/20
        V-Gain-L   V_Cur(A)  V-Bias(%)-L
  1  20.0   15.0    0.0    0.0       0.0
  2  20.0   15.0    0.0    0.0       0.0
  3  22.5   28.0  270.0    4.0      -2.0
  4  20.0   15.0    0.0    0.0       0.0
```

Fig. 20.4 (a) Track TAST[i] instruction

Track End

The Track End instruction ends sensing using TAST.

Track End

Example
```
1: Track End
```

Fig. 20.4 (b) Track end instruction

Procedure 20-1 Teaching of Track instructions

Condition

- Program edit screen has been displayed
- Teach pendant is enabled

Step

1 Press NEXT key and then press F1[INST]. Following list of instructions is displayed.

```
      Instruction 2
1 Miscellaneous
2 Weave
3 Skip
4 Payload
5 Track/Offset
6 Offset/Frames
7 Multiple control
8 --next page--
```

2 Select Track/Offset. Following list of Track/Offset instructions is displayed. If you want to teach Track TAST instruction, please select Track.

```
     Track/Offset 1
1 Track
2 Track End
3 MP Offset
4 MP Offset End
5 Track RPM
6 Track End[]
7
8
```

3 Enter TAST schedule number to [] on the instruction.
4 If you want to teach Track End instruction, please select Track End on Step 2.

Sample Program of TAST

Fig.20.4(c) is the sample program which using Track instructions.

```
TAST1
                                        5/10
     1: J  P[1] 30% CNT100
     2: L  P[2] 500mm/sec CNT100
     3: L  P[3] 100mm/sec FINE
       :   Weld Start[1,1]
     4:    Weave Sine[1]
     5:    Track TAST[1]
     6: L  P[4] 30cm/min FINE
     7:    Weld End[1,2]
     8:    Track End
     9: L  P[5] 500mm/sec FINE
   [End]
```

Fig. 20.4 (c) Sample program of TAST

Detailed Specifications of Track Instructions

- There is no limitation about the order of Weld instruction, Weaving instruction and Track instruction.
- Teach Track TAST instruction at the start point of arc welding.
- The tracking by TAST is performed only with Weld Enabled (refer to Section 5.3). The tracking is never performed when Track TAST instruction is executed with Weld Disabled.
- If the travel time of taught points during execution of Track instruction is shorter than the 1 weaving cycle (or sampling time), the tracking by TAST is not performed.

⚠CAUTION
If you use the on-the-fly function or ArcTool Ramping function to change welding schedules, welding speed and weaving schedules during TAST execution, TAST performance will be affected and the result cannot be expected.

⚠CAUTION
Single Step testing turns off tracking by TAST and welding. Do not use single step testing during tracking because it will cancel tracking and welding on the next motion instruction.

> ⚠**CAUTION**
> If robot controller is turned off during tracking by TAST, tracking cannot be resumed correctly even with Hot Start after cycle power.

20.5 TAST SCHEDULE SETUP

A TAST schedule allows you to set how TAST will function.
There are two screens associated with TAST: the list screen and the detail screen.

The list screen allows you to view limited information for all TAST schedules. The detail screen allows you to view the complete information for a single TAST schedule.
You can change the total number of TAST schedules up to 98. Please refer to Procedure 20-4.

Table 20.5 (a) TAST schedule list screen

CONDITION	DESCRIPTION
V-Gain-L	This item displays and allows you to change the vertical and lateral gain independently. About more detail, please refer to DETAIL screen.
V_Cur(A)	This item displays and allows you to change the vertical current reference value. About more detail, please refer to DETAIL screen.
V-Bias(%)-L	This item displays and allows you to change the vertical and lateral bias independently. About more detail, please refer to DETAIL screen.

Table 20.5 (b) TAST schedule detail screen

CONDITION	DESCRIPTION
TAST Schedule:[n]	This item indicates the schedule whose information is currently being displayed and allows you to change to a different schedule by F2 (SCHEDULE) key.
TAST schedule: [ ]	This item allows you to enter a comment for this schedule.
V_compensation enable default: TRUE	This item allows you to enable or disable TAST tracking in the vertical direction (z plane).
L_compensation enable default: TRUE	This item allows you to enable or disable TAST tracking in the lateral direction (xy-plane).
V_master current type (feedback/constant) default: FEEDBK	This item allows you to specify the weld current that TAST uses to compare the tracking data. **-FEEDBK:** The actual weld controller feedback current at the center of the weave is obtained as reference current for V compensation before the sensing. The feedback current is obtained the time that is set by “V_master sampling count (feedback)”, and the average is set as reference current. The obtained cycle becomes weaving cycle with weaving motion. On the other hand, the cycle becomes “Sampling timing (no WV)” without weaving motion. -**CONST:** The value of the V_master current constant in the TAST Schedule becomes the reference current for V compensation. When the difference between command value and feedback value is large, please use this type. About more detail, please refer to “Reference Current Adjustment for V Compensation” in Section 20.6.
Sampling timing (no WV) default: 0.5 sec	This item allows you to set the length of time in seconds that the arc welding system will sample the current feedback. This is used for tracking without weaving motion only.
Comp frame (no WV) default: TOOL	This item allows you to specify the frame, either Tool or User, which will be used as the reference frame when tracking vertically without weaving. You can select TOOL or USER. On the other hand, If weaving motion is done with tracking, the value of frame type on the SETUP Weave screen (Section 8.3 Weaving Setup) determines the reference frame.

CONDITION	DESCRIPTION
V_compensation gain (sensitivity) default: 20.0	This item allows you to specify the gain for vertical tracking. If this value becomes large, the compensation also becomes large with the same current value. If this value becomes too large, the compensation becomes large by slight current change. Therefore, the weld seam will snake easily. This item is also displayed on list screen.
V_dead band default: 0 mm	This item allows you to specify an amount of data, in millimeters, which TAST will ignore before generating an offset. If the V_dead band value is set to 0.5 mm, TAST will not generate an offset until the required offset exceeds 0.5 mm. V_dead band is used for arc welding systems that have unstable feedback conditions.
V_bias rate (up +) default: 0 %	This item allows you to set the percentage that the offset will compensate closer to or further away from the workpiece. This value should be used when compensation becomes always large or small from desired value. If this value is set to a negative percentage, the offset will be towards the workpiece. If this value is set to a positive percentage, the offset will be away from the workpiece. This item is also displayed on list screen.
V_tracking limit default: 600.0 mm	This item allows you to set the limit of the length that TAST will compensate vertically. If the compensation extends beyond this length, vertical compensations is clumped by this value. If this value is set to 0, vertical tracking becomes disabled.
V_tracking limit per cycle default: 1.0 mm	This item allows you to specify the limit of the length that TAST will compensate vertically per cycle. Even when the compensation per cycle exceeds this value, the compensation is clumped by this value. Please adjust this value when the vertical compensation is not sufficient.
V_compensation start count default: 5	This item allows you to specify the cycle number for TAST to start tracking the weld vertically. This allows time for the arc to stabilize prior to tracking. If the value is set to less than 3, the value is ignored and the system starts to track on the third cycle. Normally, you should set the value more than the total value of “V_master sampling start count” and “V_master sampling count”. If the total value is larger than this value, the total value is used.
V_master sampling start count (feedback) default: 4	This item allows you to specify at which cycle TAST will start collecting the reference sample. The feedback current values becore this start count are ignored. This allows the arc enough time to stabilize before recording the sample data. This is only used then “V_master current type” is FEEDBK.
V_master sampling count (feedback) default: 1	This item allows you to specify the number of cycles for which the arc welding system will collect the reference weld current sample for vertical tracking, and then collected values are averaged as reference value. This is only used then “V_master current type” is FEEDBK.
V_master current constant data (constant) default: 0	This item allows you to specify a constant weld current value which is used as the reference weld current sample. When V_master current type is specified as CONST, then TAST will use this value for vertical tracking. When V_master current type is specified as FEEDBK, averaged current value by sampling is automatically set on this item. This item is also displayed on list screen. About more detail, please refer to “Reference Current Adjustment for V Compensation” in Section 20.6.
L_compensation gain (sensitivity) default: 15.0	This item allows you to specify the gain for lateral tracking. If this value becomes large, the compensation also becomes large with the same current value. If this value becomes too large, the compensation becomes large by slight current change. Therefore, the weld seam will snakes easily. This item is also displayed on list screen.
L_dead band default: 0 mm	This item allows you to specify an amount of data, in millimeters, which TAST will ignore before generating an offset. If the L_dead band value is set to 0.5 mm, TAST will not generate an offset until the required offset exceeds 0.5 mm. L_dead band is used for arc welding systems that have unstable feedback conditions.

CONDITION	DESCRIPTION
L_bias rate (right +) default: 0 %	This item allows you to set the percentage that the offset will compensate towards the left or right side. If this value is set to a negative percentage, the offset will be towards the left side of the weld when looking in the direction of travel. This value should be used when compensation becomes always large or small from desired value. If this value is set to a positive percentage, the offset will be towards the right side of the weld. Left and right directions are relative to robot tip travel direction. This item is also displayed on list screen.
L_tracking limit default: 600.0 mm	This item allows you to set the limit of the length that TAST will compensate laterally. If the compensation extends beyond this length, lateral compensations are clumped by this value. If this value is set to 0, lateral tracking becomes disabled.
L_tracking limit per cycle default: 0.4 mm	This item allows you to specify the limit of the length that TAST will compensate laterally per weave cycle. Even when the compensation per cycle exceeds this value, the compensation is clumped by this value. Please adjust this value when the lateral compensation is not sufficient.
L_compensation start count default: 5	This item allows you to specify the weave cycle number for TAST to start tracking the weld laterally. This allows time for the arc to stabilize prior to tracking. If the value is set to less than 3, the value is ignored and the system starts to track on the third cycle.
Robot group mask	This item allows you to specify the motion group that is actually doing the welding. If you do not have multiple motion groups, do not change default state. If you perform TAST in multiple motion groups, please set “1” only to the group which perform tracking by this TAST schedule.
Adjust delay time	This item is the value that strongly relates to acceleration/deceleration of the robot and communication delay with weld equipment. This proper value is changed by system configuration. Normally the proper value is automatically set as default. Re-adjustment may be required when motion setup for robot is changed or when weld equipment model is changed. You will be able to re-adjust the value automatically with some Lincoln weld equipment models (Refer to Procedure 20-3).
Adaptive Gain Control	TAST checks the direction of vertical or lateral calculated compensation value (up/down or right/left) for each cycle. If the check determines the compensation value uses the same direction multiple times, then this indicates the offset is still smaller than the actual value. Adaptive gain allows you to set a value that is multiplied times the gain value. The applied offset is larger than normal and the torch can return to the weld center faster.
V_AG_correction count (0: disable) default: 0 cyc	This item allows you to specify the weave cycle in which the adaptive gain control begins checking the vertical compensation direction. The vertical adaptive gain function is effective if the calculated compensation values tend to be biased one way, either up or down. If the V_AG correction count is set to 0, it is disabled. The vertical adaptive gain function is enabled when the V_AG correction count is set to 2 or higher.
L_AG_correction count (0: disable) default: 0 cyc	This item allows you to specify the weave cycle in which the adaptive gain control begins checking the lateral compensation direction. The lateral adaptive gain function is effective if the calculated compensation values tend to be biased to one side, either left or right. If the L_AG correction count is set to 0, it is automatically disabled. The lateral adaptive gain function is enabled when the L_AG correction count is set to 2 or higher.
V_AG_correction band default: 4.0	This item allows you to specify the amount of data to which the lateral adaptive gain function compares the calculated lateral compensation. If the value is set to a small amount, the adaptive gain is disabled until the required offset exceeds the set value. A value of over 6.0 is required when using a small circular weld or when the weld is not stable.

CONDITION	DESCRIPTION
L_AG_correction band default: 4.0	This item allows you to specify the amount of data to which the lateral adaptive gain function compares the calculated lateral compensation. If the value is set to a small amount, the adaptive gain is disabled until the required offset exceeds the set value. Value of over 6.0 is required when using small circular weld / when the weld is not stable.
V_AG_multiplier default: 1.5	This item specifies the multiplier for vertical adaptive gain.
L_AG_multiplier default: 1.5	This item specifies the multiplier when lateral adaptive gain.
TAST Equip Mask	This item allows you to specify the equipment number that is actually doing the welding. If you do not have multiple equipments, do not change default state. If you perform TAST in multiple equipments system, please set “1” only to the equipment which perform tracking by this TAST schedule.

Procedure 20-2 Setting up TAST Schedule

Step

1 Press [MENU] key and then select [3. DATA], or press DATA key.
2 Press F1, [TYPE]. Following menu is displayed.

```
                Type  1
1 Weld Procedure
2 Registers
3 Position Reg
4 String Reg
5 Track Sched
6 KAREL Vars
7 KAREL Posns
8 -- NEXT --
```

3 Select Track Sched. You will see a screen similar to the following.

TAST schedule list screen

```
DATA TAST Sched
                                        1/20
          V-Gain-L   V_Cur(A)  V-Bias(%)-L
     1  20.0   15.0    0.0    0.0      0.0
     2  20.0   15.0    0.0    0.0      0.0
     3  20.0   15.0    0.0    0.0      0.0
     4  20.0   15.0    0.0    0.0      0.0
     5  20.0   15.0    0.0    0.0      0.0
     6  20.0   15.0    0.0    0.0      0.0
     7  20.0   15.0    0.0    0.0      0.0
     8  20.0   15.0    0.0    0.0      0.0
     9  20.0   15.0    0.0    0.0      0.0
    10  20.0   15.0    0.0    0.0      0.0

 [TYPE]  DETAIL                    HELP  >
         COPY    CLEAR                   >
```

4 To set an item, move the cursor to the setting field, then enter a desired value.
5 When copying a set schedule, move the cursor to the schedule number to be copied, press F2 (COPY) on the next page, then enter a copy destination schedule number.
6 When deleting a set schedule, move the cursor to the schedule number to be deleted, then press F3 (CLEAR) on the next page.
7 Press F2, DETAIL. You will see a screen similar to the following.

TAST schedule detail screen

```
DATA TAST Sched
                                        1/30
      TAST Schedule: [ 1]

      1 TAST Schedule: [     Schedule 1 ]
      2 V_compensation enable:     TRUE
      3 L_compensation enable:     TRUE
      4 V_master current type:     FEEDBK
        (feedback/constant)
      5 Sampling timing (no WV):    .50   sec
      6 Comp frame (no WV):        TOOL
      7 V_compensation gain:        20.0
        (sensitivity)
      8 V_dead band:               0.0   mm
      9 V_bias rate (up+):         0.0   %
     10 V_tracking limit:          600.0  mm
     11 V_tracking limit per cycle:.4    mm
     12 V_compensation start count:5    cyc
     13 V_master sampling start:   4    cyc
        count (feedback)
     14 V_master sampling count:   1    cyc
        (feedback)
     15 V_master current constant: 0.0   A
        data (constant)
     16 L_compensation gain:       15.0
        (sensitivity)
     17 L_dead band:              0.0   mm
     18 L_bias rate (right+):     0.0   %
     19 L_tracking limit:         600.0  mm
     20 L_tracking limit per cycle:.4    mm
     21 L_compensation start count:5    cyc
     22 Robot Group Mask: [1,*,*,*,*,*,*,*]
     23 Adjust delay time:        .094  sec
        -- Adaptive gain control --
     24 V_AG_correction count:    0    cyc
        (0:disable)
     25 L_AG_correction count:    0    cyc
        (0:disable)
     26 V_AG_correction band:     4.0
     27 L_AG_correction band:     4.0
     28 V_AG_multiplier:          1.5
     29 L_AG_multiplier:          1.5
     30 TAST Equip Mask:  [1,*,*,*,*,*,*,*]

   [TYPE]  SCHEDULE                    HELP  >
                COPY     CLEAR                >
```

8 To add a comment:
   a Move the cursor to the to the comment line and press ENTER.
   b Select a method of naming the comment.
   c Press the appropriate function keys to add the comment.
   d When you are finished, press ENTER.
9 To set items except comment, move the cursor to the setting field, then enter a desired value or press function keys for select.
10 To return TAST schedule list screen, press PREV key.

Procedure 20-3 Recalculate Adjust Delay Time

Step

1 Display TAST schedule detail screen by referring to Procedure 20-2.
2 Move the cursor on “Adjust Delay Time”.
3 Press F3(RECALC). If the system configuration allows recalculation, “Delay time is recalculated, 0.xxx sec.” Message is displayed and the value is updated.

Procedure 20-4 Change the total number of TAST schedule

Step

1 Perform Controlled Start.
2 Press [MENU] key and select[4 System Variables]. System Variables screen is displayed.
3 Move the cursor on “$TAST_SCH” and press ENTER key.
4 Next, move the cursor on “$MAX_NUM_SCH”.
5 Input the number which you want to set and press ENTER key (Max: 98).
6 Press FCTN key and select [1 Cold Start].
7 The total number of TAST schedule is changed.

20.6 TAST DIAGNOSIS FUNCTION

The TAST function, which requires adjustments with considering various factors as described in Section 20.2, is one of the most difficult functions to operate and adjust. The TAST diagnosis function helps you adjust the TAST function more easily. The function displays various types of information obtained during tracking on the teach pendant to support the user to adjust the weld construction environment. The following main items are displayed on TAST diagnosis function screens:

- Calculated lateral and vertical compensation values for each weave cycle and total lateral and vertical compensation values during tracking
- Current waveform for each weave cycle and average current waveform for all weave cycles
- Average weld current values in the left, center, and right areas of weaving

NOTE
The TAST diagnosis function is available only with the R-30iB Plus controller.

20.6.1 Displaying the TAST Diagnosis Screen

This subsection describes how to display the TAST diagnosis screen.

Procedure 20-5 Displaying the TAST diagnosis screen

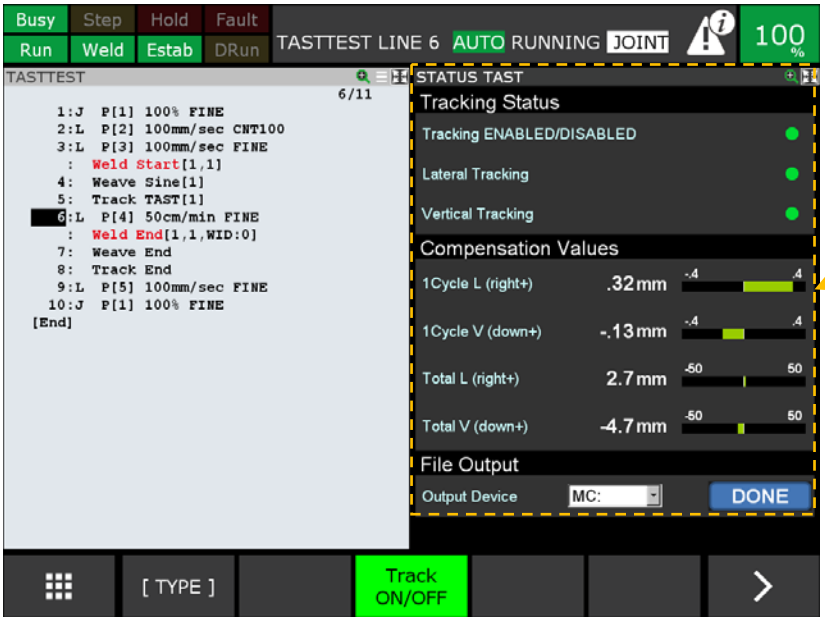
Step

1 Press the [MENU] key and select [4. STATUS].
2 Press the F1 key and select [TAST].

20.6.2 Screen Description

There are the following two types of screens as the TAST diagnosis screen:

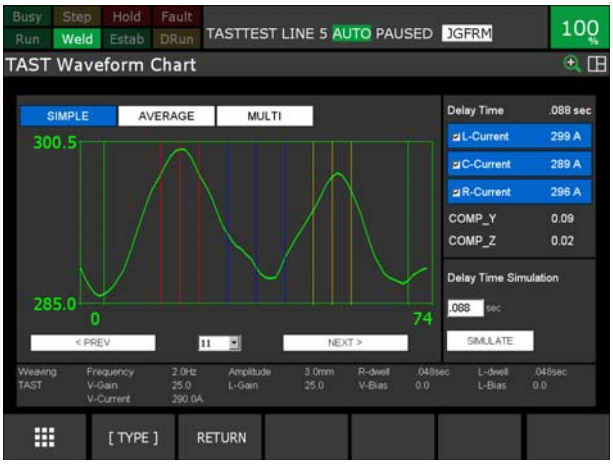
- TAST status screen
  This screen displays calculated lateral and vertical compensation values for each weave cycle and total lateral and vertical compensation values during tracking in real time. Each compensation value is indicated with a numeric value and with the relevant position on the meter bar. You can check the TAST tracking status in real time.



Displays each compensation value during tracking in real time.

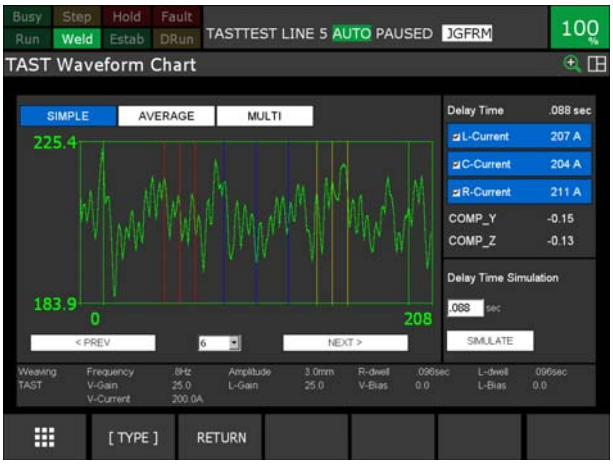
Fig. 20.6.2(a) TAST status screen

- TAST waveform chart screen
  This screen displays the current waveform for each weave cycle, average current waveform for all weave cycles, average weld current values in the left, center, and right areas of weaving, and other various types of information in addition to each compensation value. For example, you can check a current waveform to see whether the current weld construction environment is appropriate for TAST.



Waveform showing two clear peaks

→ Appropriate construction environment



Disturbed current waveform
→ Inappropriate construction environment, which requires adjustment

Fig. 20.6.2(b) TAST waveform chart screen

Procedure 20-6 Switching between the TAST status screen and TAST waveform chart screen

Condition

- Tracking has been executed.

Step

1 When the TAST status screen is displayed, press F8 (WAVEFORM). When the TAST waveform chart screen is displayed, press the F2 (RETURN) or PREV key.

NOTE

- Before the execution of tracking or during tracking, the TAST waveform chart screen is not displayed.
- Immediately after the execution of a TAST program with Weld Disabled, the TAST waveform chart screen is not displayed.

20.6.3 TAST Status Screen

The TAST status screen displays calculated lateral and vertical compensation values for each weave cycle and total lateral and vertical compensation values during tracking.

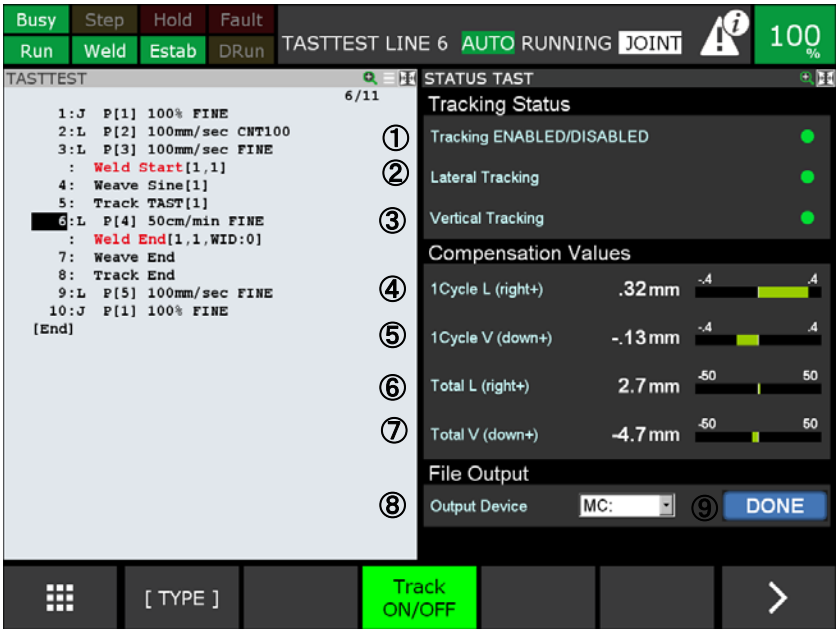


Fig. 20.6.3(a) TAST status screen

Table 20.6.3(a) Items in the TAST status screen

ITEM	DESCRIPTION
① Tracking ENABLED/DISABLED	When tracking is enabled, a green indicator is displayed. When it is disabled, a red indicator is displayed. You can specify whether to enable or disable tracking by pressing F3 (Track ON/OFF). When tracking is disabled, tracking by TAST is not performed.
② Lateral Tracking	When TAST tracking in the lateral direction is performed, a green indicator is displayed. When tracking is disabled or L_compensation enable in the TAST schedule is set to FALSE, the indicator is not lit.
③ Vertical Tracking	When TAST tracking in the vertical direction is performed, a green indicator is displayed. When tracking is disabled or V_compensation enable in the TAST schedule is set to FALSE, the indicator is not lit.
④ 1Cycle L (right+)	This item indicates the calculated lateral compensation value for each weave cycle with a numeric value and with the relevant position on the meter bar. The meter range is determined according to the setting of L_tracking limit per cycle in the TAST schedule. When the calculated compensation value is within the range, the meter indicator is displayed in green. When the value is beyond the range, the meter overflows and the meter bar is displayed in red. The display of this item is updated even when tracking is disabled. In this case, tracking by TAST is not actually performed.

ITEM	DESCRIPTION
⑤ 1Cycle V (down+)	This item indicates the calculated vertical compensation value for each weave cycle with a numeric value and with the relevant position on the meter bar. The meter range is determined according to the setting of V_tracking limit per cycle in the TAST schedule. When the calculated compensation value is within the range, the meter indicator is displayed in green. When the value is beyond the range, the meter overflows and the meter bar is displayed in red. The display of this item is updated even when tracking is disabled. In this case, tracking by TAST is not actually performed.
⑥ Total L (right+)	This item indicates the total lateral compensation value from the start of tracking with a numeric value and with the relevant position on the meter bar. The meter range is determined according to the setting of L_tracking limit in the TAST schedule. When the total compensation value is within the range, the meter indicator is displayed in green. When the value is beyond the range, the meter overflows and the meter bar is displayed in red. When tracking is disabled, the display is not updated.
⑦ Total V (down+)	This item indicates the total vertical compensation value from the start of tracking with a numeric value and with the relevant position on the meter bar. The meter range is determined according to the setting of V_tracking limit in the TAST schedule. When the total compensation value is within the range, the meter indicator is displayed in green. When the value is beyond the range, the meter overflows and the meter bar is displayed in red. When tracking is disabled, the display is not updated.
⑧ Output Device	This item indicates the device to which to output a tracking log file.
⑨ DONE	This item allows you to output tracking log file DATA.txt to the specified device. Select "MC:", "UT1:", or "UD1:" as the output device. When there is no log data before the execution of tracking or tracking is being performed, clicking the DONE button causes an alarm to be displayed. In this case, no log file is output.

NOTE

When a screen for the TAST diagnosis function is displayed or when another screen is displayed from a screen for the TAST diagnosis function, tracking is automatically enabled. For this reason, if you want to disable tracking, disable tracking in the TAST status screen every time. In the AUTO mode, tracking is always enabled.

Details of the Log File

In log file DATA.txt created by clicking the DONE button shown in Fig. 20.6.3(a), the following data items are recorded in respective sections.

Compensation values and average weld current in each area of weaving for each weave cycle

```
CYC#  COMP_Y  COMP_Z  L_EDGE   C_EDGE   R_EDGE
  1    .21   -2.34   317.76   300.20   311.43
  2    .22   -2.21   318.08   296.23   311.46
  3    .10   -2.21   311.52   296.34   308.48
  4   -.11   -2.15   306.16   294.39   309.63
  5    .00   -1.99   306.66   289.56   306.57
```

Fig. 20.6.3(b) Log file data 1

Table 20.6.3(b) Log file data items 1

ITEM	DESCRIPTION
CYC#	Weave cycle number
COMP_Y	Lateral compensation value for each weave cycle
COMP_Z	Vertical compensation value for each weave cycle
L_EDGE	Average weld current in each area of weaving for each weave cycle
C_EDGE	Average weld current in each area of weaving for each weave cycle
R_EDGE	Average weld current in each area of weaving for each weave cycle

TICK count and feedback current value at each sampling point

```
SAMP#   TICK#   FBK CURRENT
   1       11    304.2000
   2 10448292    303.0000
   3 10448296    301.5000
   4 10448300    301.4000
   5 10448304    300.7000
```

Fig. 20.6.3(c) Log file data 2

Table 20.6.3(c) Log file data items 2

ITEM	DESCRIPTION
SAMP#	Sampling point number
TICK#	TICK count (1 TICK = 4 ms) at each sampling point. "11" indicates the start point of each weave cycle.
FBK CURRENT	Feedback current at each sampling point

Important parameters related to TAST

```
Freq
  1.5
Ampl
  3.0
R-dwell
  .096
L-dwell
  .096
V-Gain
 25.0
L-Gain
 25.0
V-Bias
  0.0
L-Bias
  0.0
M-Curr
  230.0
delay_time
 .094
trk_disable
 0
sch_no
 1
```

Fig. 20.6.3(d) Log file data 3

Table 20.6.3(d) Log file data items 3

ITEM	DESCRIPTION
Freq	Frequency set in the weaving schedule
Ampl	Amplitude set in the weaving schedule
R-dwell	Right timer value set in the weaving schedule

ITEM	DESCRIPTION
L-dwell	Left timer value set in the weaving schedule
V-Gain	Value set for V_compensation gain (sensitivity) in the TAST schedule
L-Gain	Value set for L_compensation gain (sensitivity) in the TAST schedule
V-Bias	Value set for V_bias rate (up+) in the TAST schedule
L-Bias	Value set for L_bias rate (right+) in the TAST schedule
M-Curr	Value set for V_master current constant data in the TAST schedule
delay_time	Value set for Adjust delay time in the TAST schedule
trk_disable	1 when tracking is disabled or 0 when it is enabled
sch_no	Number of the TAST schedule used for tracking

20.6.4 TAST Waveform Chart Screen

The TAST waveform chart screen displays the current waveform for each weave cycle, average current waveform for all weave cycles, average weld current values in the left, center, and right areas of weaving, and other various types of information in addition to each compensation value.

There are the following five modes available for the TAST waveform chart screen:

- Single cycle display mode
- Delay time simulation mode
- Average display mode
- Multi-cycle display mode
- Simultaneous single cycle display mode

Single Cycle Display Mode

In the single cycle display mode, the current waveform for the specified weave cycle is displayed.

Fig. 20.6.4(a) Single cycle display mode screen

Table 20.6.4(a) Items in the single cycle display mode screen

ITEM	DESCRIPTION
① Mode switch buttons	These buttons allow you to switch the relevant modes. • SIMPLE: Single cycle display mode • AVERAGE: Average display mode • MULTI: Multi-cycle display mode

ITEM	DESCRIPTION
② Data scale	This item shows the maximum and minimum values displayed in the chart screen. These values are automatically calculated based on the feedback current values for the currently selected weave cycle and cannot be changed.
③ Current waveform chart	This item shows the current waveform for the currently selected weave cycle.
④ Area lines	These items indicate current value areas used for tracking. Red, blue, and yellow lines indicate the left, center, and right areas of weaving, respectively.
⑤ Area center lines	These items indicate the center of each area indicated by area lines. When each peak of the current waveform is at an area center line, an appropriate value is set for Adjust delay time and the robot is correctly synchronous with the feedback current. When a peak is not at any area center line, an inappropriate value is set for Adjust delay time and the robot is not synchronous with the feedback current. In this case, sufficient tracking performance may not be obtained. Set an appropriate value for Adjust delay time in the delay time simulation mode described below.
⑥ Display cycle change	This item allows you to change the weave cycle for which to display the current waveform. • List box: Allows you to select a weave cycle for which to display the current waveform from the list in it: • < PREV: Allows you to select the weave cycle previous to the currently selected weave cycle. When 1 is selected, this button is disabled. • NEXT >: Allows you to select the weave cycle next to the currently selected weave cycle. When the weave cycle with the maximum number is selected, this button is disabled.
⑦ Delay Time	This item shows the current robot adjustment delay time.
⑧ Average weld current	This item shows the average weld current values in the left, center, and right areas of weaving. When a check box is unchecked, the corresponding area lines and area center line are hidden. When the check box is checked, they are displayed again.
⑨ Compensation values	These items indicate the lateral and vertical compensation values for the currently displayed weave cycle.
⑩ Delay Time Simulation	This item shows the adjustment delay time used in the delay time simulation mode. Enter an adjustment delay time you want to use for simulation.
⑪ SIMULATE	This item allows you to move to the delay time simulation mode. In the delay time simulation mode, the current waveform is simulated with the adjustment delay time set for Delay Time Simulation. For details, see "Delay Time Simulation Mode" described later.
⑫ Parameters	Some important parameters in the TAST schedule are displayed. For each parameter, see Table 20.6.4(b).

Table 20.6.4(b) Parameters displayed in the single cycle display mode screen

ITEM	DESCRIPTION
Frequency	Frequency set in the weaving schedule
Amplitude	Amplitude set in the weaving schedule
R-dwell	Right timer value set in the weaving schedule
L-dwell	Left timer value set in the weaving schedule
V-Gain	Value set for V_compensation gain (sensitivity) in the TAST schedule
L-Gain	Value set for L_compensation gain (sensitivity) in the TAST schedule
V-Bias	Value set for V_bias rate (up+) in the TAST schedule
L-Bias	Value set for L_bias rate (right+) in the TAST schedule
V-Current	Value set for V_master current constant data in the TAST schedule

Delay Time Simulation Mode

In the delay time simulation mode, you can adjust the adjustment delay time. The basic configuration of the relevant screen is the same as in the single cycle display mode. Clicking the SIMULATE button in the single cycle display mode screen changes to this mode.

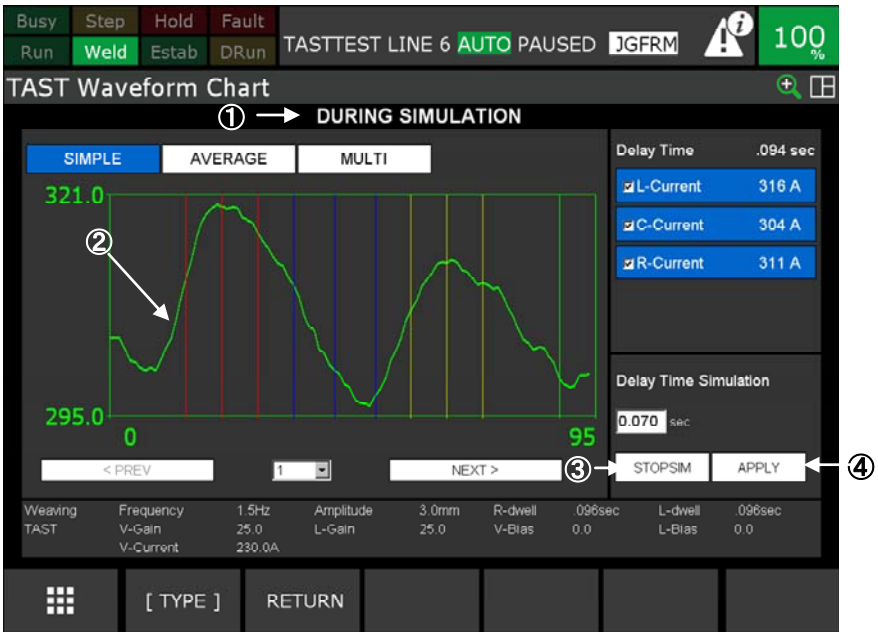


Fig. 20.6.4(b) Delay time simulation mode screen

Table 20.6.4(c) Items in the delay time simulation mode screen

ITEM	DESCRIPTION
① Status display	This item shows "DURING SIMULATION" in the delay time simulation mode.
② Current waveform chart	This item shows the current waveform and average current value in each weaving area again based on the specified adjustment delay time.
③ STOPSIM	This item allows you to quit the simulation mode and move to the single cycle display mode. The current waveform and average current value in each weaving area return to the state before simulation.
④ APPLY	This item allows you to apply the delay time used for simulation to Adjust delay time in the TAST schedule.

NOTE

The delay time used for simulation is applied only for Adjust delay time in the TAST schedule used for tracking. The value for Adjust delay time in another TAST schedule is not changed.

Average Display Mode

In the average display mode, the average current waveform for all weave cycles is displayed. The basic configuration of the relevant screen is the same as in the single cycle display mode. You can perform delay time simulation for the current waveform displayed in this mode to obtain the result of more stable delay time adjustment.

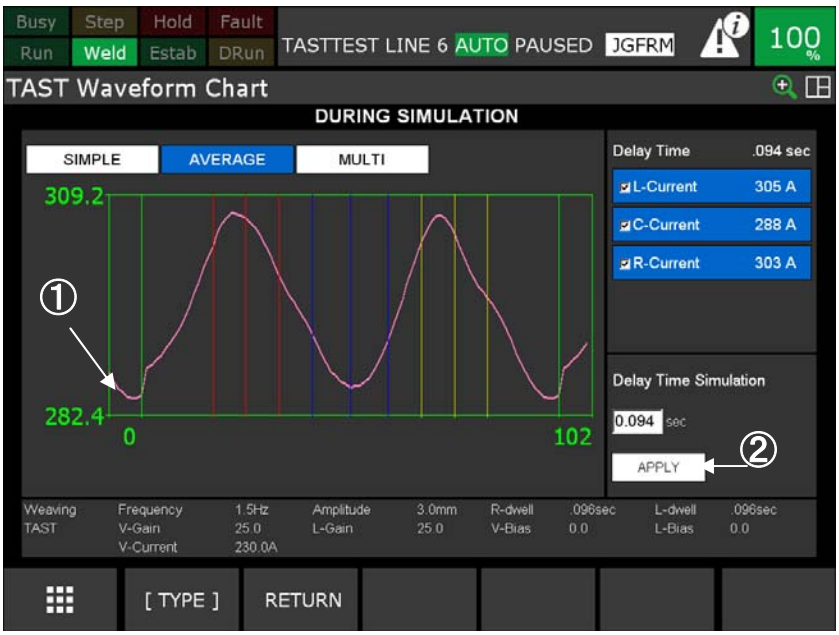


Fig. 20.6.4(c) Average display mode screen

Table 20.6.4(d) Items in the average display mode screen

ITEM	DESCRIPTION
① Current waveform chart	This item shows the feedback current average value for all weave cycles.
② APPLY	This item allows you to apply the delay time used for simulation to Adjust delay time in the TAST schedule.

Multi-Cycle Display Mode

In the multi-cycle display mode, a current waveform for multiple consecutive weave cycles is displayed in one screen.

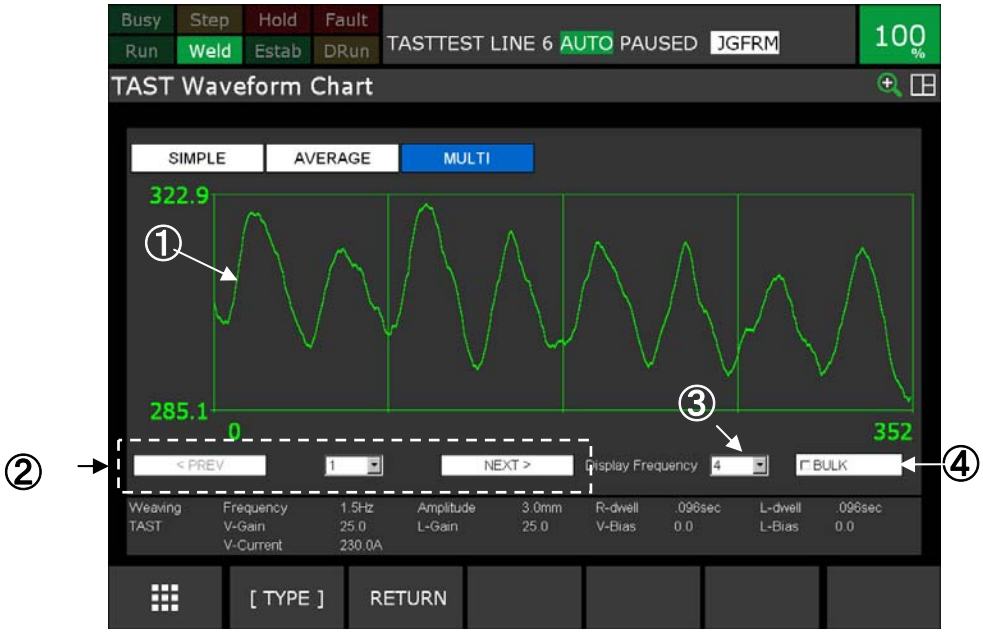


Fig. 20.6.4(d) Multi-cycle display mode screen

Table 20.6.4(e) Items in the multi-cycle display mode screen

ITEM	DESCRIPTION
① Current waveform chart	This item shows the current waveform for the specified number of frequencies from the display start cycle.
② Display start cycle	This item allows you to change the weave cycle from which to start displaying the current waveform. • List box: Allows you to select a weave cycle from which to display the current waveform from the list in it. • < PREV: Allows you to select the weave cycle previous to the currently selected weave cycle. When 1 is selected, this button is disabled. • NEXT >: Allows you to select the weave cycle next to the currently selected weave cycle. When the weave cycle with the maximum number is selected, this button is disabled.
③ Display Frequency	This item allows you to select the number of frequencies for which to display the current waveform. The current waveform for the specified number of frequencies from the cycle specified for the display start cycle is displayed.
④ BULK	When this check box is checked, the screen for the simultaneous single cycle display mode is displayed. The screen displays the current waveforms for the specified number of frequencies from the specified display start cycle within the single cycle range at a time. For details, see "Simultaneous Single Cycle Display Mode" described later.

NOTE

A current waveform can be displayed for up to eight cycles in the multi-cycle display mode.

Simultaneous Single Cycle Display Mode

In the simultaneous single cycle display mode, current waveforms overlaid within the single cycle range are displayed for multiple consecutive weave cycles. The basic configuration of the relevant screen is the same as in the multi-cycle display mode. Checking BULK in the multi-cycle display mode screen changes to this mode. Unchecking BULK changes to the multi-cycle display mode.

Fig. 20.6.4(e) Simultaneous single cycle display mode screen

Table 20.6.4(f) Items in the simultaneous single cycle display mode screen

ITEM	DESCRIPTION
① Current waveforms	Current waveforms overlaid within the single cycle range are displayed for the number of frequencies from the start weave cycle.

NOTE

Current waveforms can be displayed for up to eight cycles in the simultaneous single cycle display mode.

20.6.5 Changing the TAST Waveform Chart Screen Mode

As described in Subsection 20.6.4, there are five modes available for the TAST waveform chart screen. To change the mode, select the relevant button in the screen. Fig. 20.6.5 shows the transition of mode screens according to the selected buttons. For details of the modes and buttons, see the description of each mode in Subsection 20.6.4.

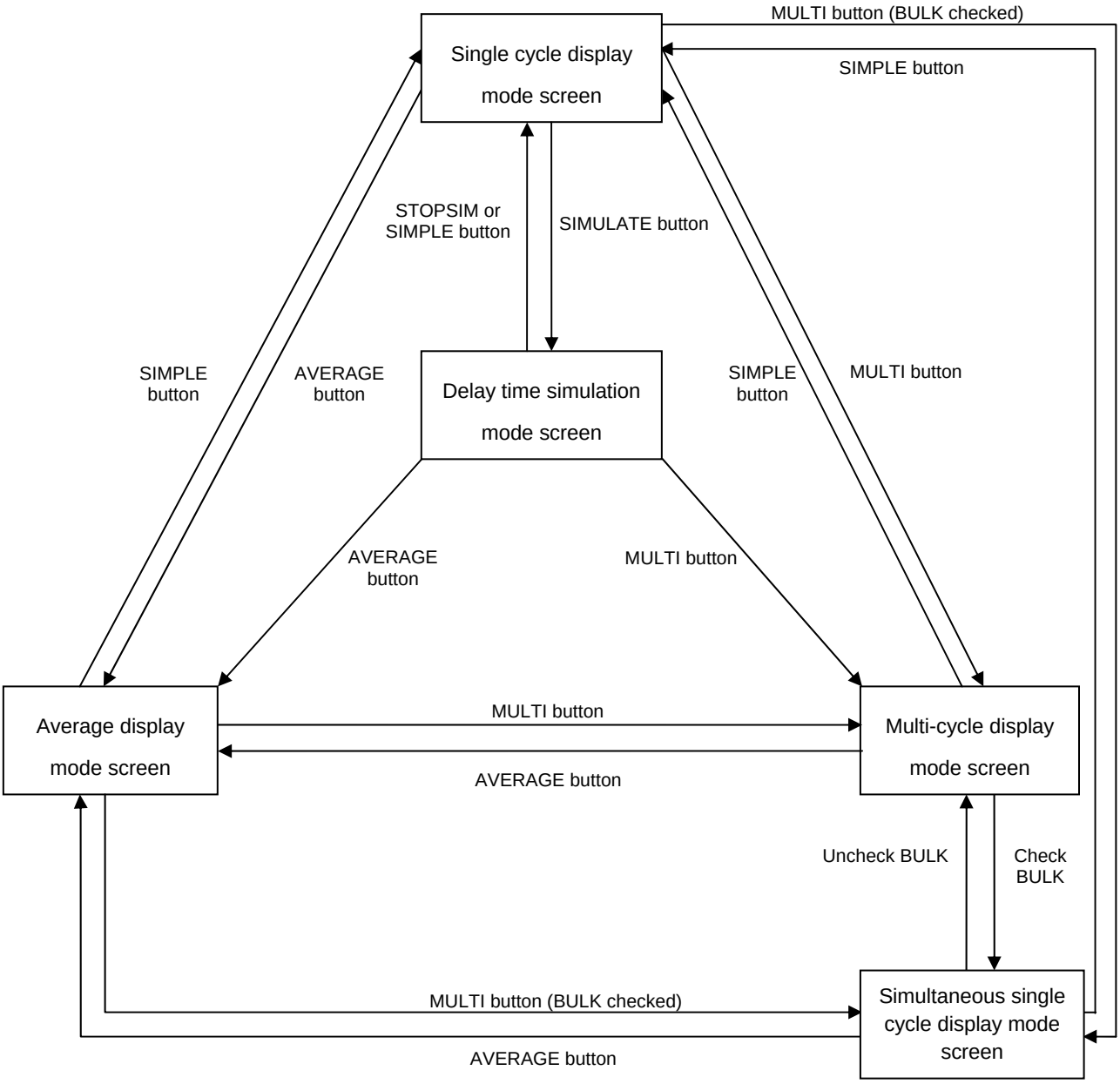


Fig. 20.6.5 Transition of mode screens

20.6.6 Using the TAST Diagnosis Function

This subsection gives a recommended example of a TAST adjustment procedure using the TAST diagnosis function.

Procedure 20-7 Adjusting TAST using the TAST diagnosis function

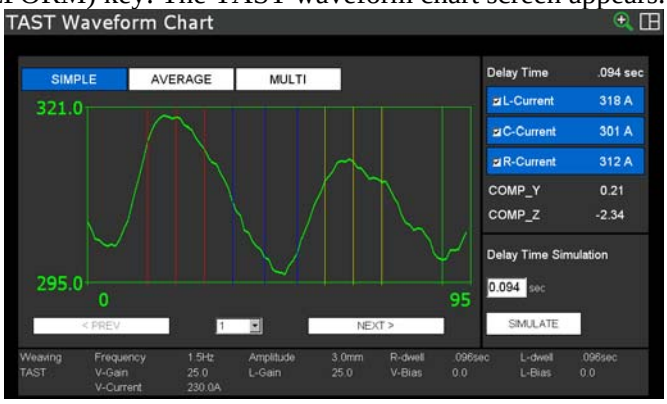
Step

1 Prepare a test workpiece for adjustment. Its fillet or V-groove joint should be similar to that of the actual workpiece and the weld length should be 200 to 300 mm.

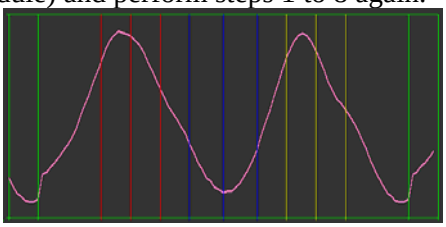
2 Create a program which performs tracking by TAST for the test workpiece. For the program, specify the same values as or values similar to those for the actual workpiece in the arc welding and weaving schedules.

3 Display the TAST status screen as described in Procedure 20-5.

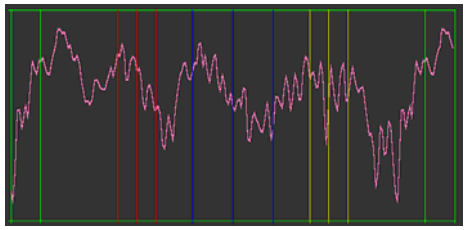
4 Press the F3 (Track ON/OFF) key in the TAST status screen to disable tracking.
5 Execute the program with Weld Enabled.
6 Press the F8 (WAVEFORM) key. The TAST waveform chart screen appears.



7 Click the AVERAGE button in the screen to change to the average display mode.
8 Check the displayed waveform. When the waveform shows two clear peaks as shown in the left figure below, the feedback current value is stable and tracking by TAST can be performed. Proceed to step 9. When the waveform is disturbed as shown in the right figure below or it shows three or more peaks, review the construction conditions (including the weld mode, welding schedule, and weaving schedule) and perform steps 1 to 8 again.

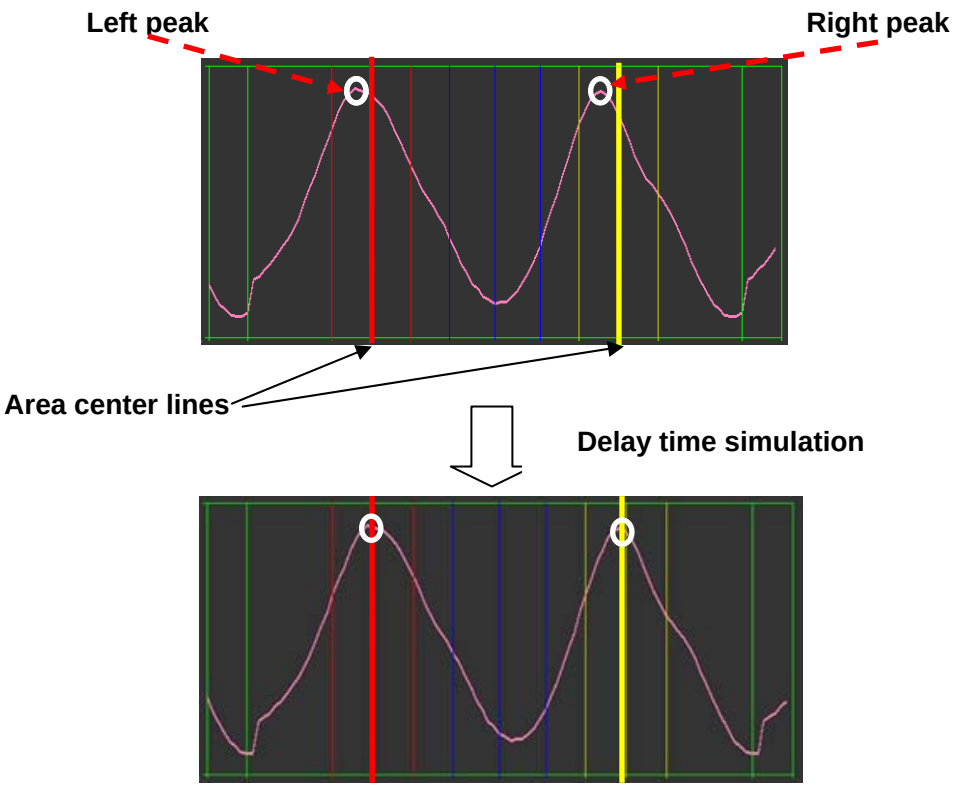


Tracking is enabled.



Waveform must be improved.

9 Adjust the robot adjust delay time. Update the time for Delay Time Simulation to the position at which the left peak is closest to the red area center line and the right peak is closest to the yellow area center line. It is recommended that you update the current value in units of 0.008.



10 When you finish adjustment, click the APPLY button. The robot adjust delay time in the used TAST schedule is updated to the value after adjustment.

11 Then, check the tracking performance of TAST after adjustment. Place the test workpiece (with the same shape in step 1) so that the arc welding end position is shifted to left from the taught point in the program by a few mm. If it is difficult to shift the test workpiece, shift the arc welding end position in the program and teach the position again. Execute the program with Tracking ENABLED and Weld Enabled.

12 Check the result of tracking after welding. When welding is not fully traced, perform adjustment as described in Sections 20.3, 20.7, and 20.8.

13 In step 11, place the test workpiece so that the arc welding end position is shifted to right by a few mm this time and execute the program again. If it is difficult to shift the test workpiece, shift the arc welding end position in the program and teach the position again. Then, check the tracking result. When welding is not fully traced, perform adjustment as described in Sections 20.3, 20.7, and 20.8.

20.7 ADJUSTMENT TECHNIQUES OF TAST

TAST tracking function is affected by various factors described in Section 20.2. Therefore, the only adjustment of TAST schedule is not sufficient for good tracking. In this section, adjustment techniques of TAST are widely described.

Gain Adjustment of TAST

Gain value adjustment might be necessary if TAST performance is poor. The TAST GAIN parameter adjusts the seam tracking sensitivity.

Then, you should make the test program for confirming TAST tracking performance, and execute test program with arc welding. In this test, tracking performance should be confirmed with changing both “V compensation gain” and “L compensation gain”.

If the lateral gain is too high, the path correction for each weave cycle will be too large, causing the weld bead to "snake" back and forth across the weld joint in a sinusoidal pattern. If the lateral gain is too low, the tracking correction to the taught path will be insufficient to match the part deviation. You should

TAST performance becomes best when gain is slightly smaller than high response value. Therefore, it is recommended that the value is adjusted from “snake” status to “snake” reduction status.

Procedure 20-8 describes the basic adjustment procedure.

Procedure 20-8 Gain Adjustment of TAST

Step

1 Create the test program for TAST by referring to Fig. 20.4(c) and then execute it. Then, place the workpiece with 1 – 2 degrees rotation (the center of the rotation should be TAST start point) and you will be able to check the tracking performance of TAST.

2 Check the following:
- No snaking
  Vertical and Lateral gain values should be increased (about 10 - 20) by the same amount. Try welding again until snaking is found.
  Then, adjust the gain for placing the weld seem on weld joint.
- Snaking
  The gain values should be decreased in small increments (2.0 or 3.0) until snaking stops.

3 If you cannot see the good tracking performance by gain adjustment, please refer to Section 20.7 Trouble shouting.

Master Current Adjustment for Vertical Tracking

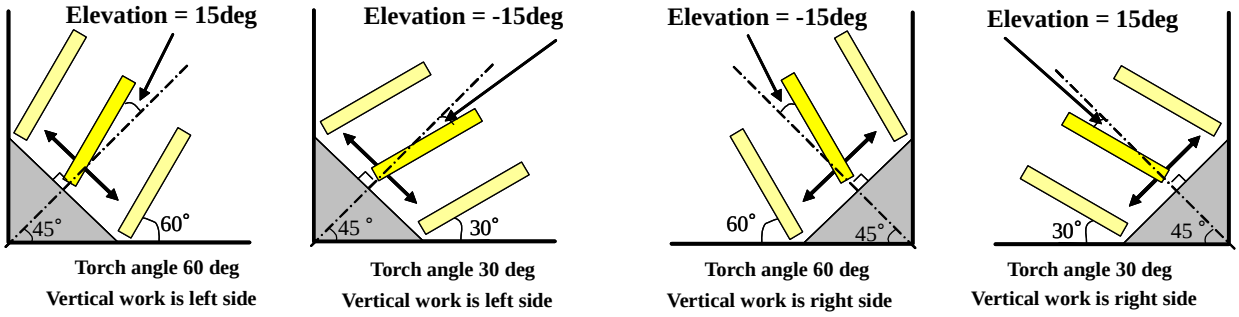
You can specify the setup method of master current for vertical tracking by “V_master current type” in TAST schedule. Master current data will decide the wire stickout during TAST.
When “V_master current type” is “CONST”, the value on “V_master current constant data” is always used. You can always weld with the same stickout when you use the same combination of weld schedule and TAST schedule, and stable result will be obtained. On the other hand, you must prepare the other V_master current constant data for other weld sections that have other weld schedule. Feedback current may not be the same value with command current, please confirm the correct value and then input the value to V_master current constant data.
When “V_master current type” is “FEEDBK”, current value at the weld start point is always obtained at each weld, and this value will be used as V_master current constant data. The master current value at each weld will have some unevenness about few Amps. Therefore, the wire stickout will vary by the unevenness.
If you perform TAST once with “FEEDBK” as V_master current type, the obtained value by “FEEDBK” is stored to V_master current constant data automatically. After that, it is possible to switch “CONST” and use this value which obtained with “FEEDBACK”.

> ⚠ **CAUTION**
> The master current value will be changed because the sampling position is changed if there is a large difference between teaching path around weld start position and actual weld seam with “FEEDBK” type. As a result, the wire stickout during tracking is also changed and it will lead poor weld quality and poor tracking result. In this case, please use “CONST” type as “V_master current type”.

TAST Adjustment for Horizontal Fillet Welding

If TAST which has both lateral and vertical tracking is used for horizontal fillet welding (joint angle is 90 deg), there is a case that torch angle is set larger than 45 deg and the aim is slightly shifted toward the surface of lateral work. When TAST is used with normal weaving schedule in this situation, weld bead may be shifted to lateral work and the equal leg length may not be achieved.

In this case, if swing angle of the weaving becomes near 45 degree though torch angle is not changed, tracking result will also become near the equal leg length. You can adjust swing angle of the weaving by “Elevation”.
If you have used indirect weaving instruction with Track TAST instruction, adjust “Elevation” in Weaving Schedule Detail screen by Procedure 8-3. On the other hand, If you have used direct weaving instruction with Track TAST instruction, adjust “Elevation” in Weave Setup screen by Procedure 8-2. About the input value, please refer to Fig. 20.6(a).



All welding directions are toward the depth

Fig. 20.7 (a) Setup sample of elevation for horizontal fillet welding

If you cannot obtain the good result by above setup, please adjust “L bias rate (right+)” in TAST schedule by 1% interval.

Carry On Offset

The Carry On Offset function allows the robot to move to a taught position with the last TAST offset and then start to execute TAST with welding, again. These functions are useful to move the robot around a clamp while the last offset value is maintained.

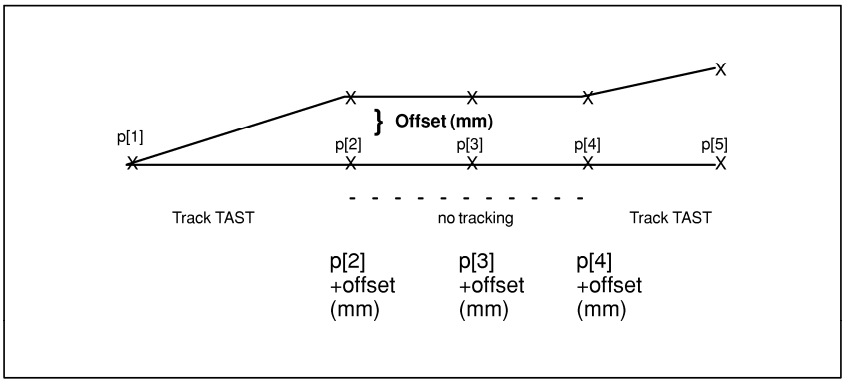


Fig. 20.7 (b) Carry on offset function example

Followings are the method to achieve Carry On Offset function.
- Prepare TAST schedule for Carry On Offset purpose (Schedule number is not limited)
- Select another TAST schedule which is prepared above just before no tracking section.
- Linear motion is required on non-tracking path.

Program example for Carry On Offset function is shown to Fig. 20.7(c). Procedure 20-9 shows the method to create TAST schedule for Carry On Offset.

```
TAST2
                                        16/16
     3: L  P[3] 500mm/sec FINE
      :   Weld Start[1,1]
     4:    Weave Sine[1]
     5:    Track TAST[1]
     6: L  P[4] 30cm/min FINE
     7:    Weld End[1,2]
     8:    Track TAST[5]      <---- Change to other TAST schedule number
     9: L  P[5] 100mm/sec CNT100 <- Motion type is Linear
    10: L  P[6] 100mm/sec FINE   <- Motion type is Linear
      :   Weld Start[1,1]
    11:    Weave Sine[1]
    12:    Track TAST[1]      <---- Return to original TAST schedule number
    13: L  P[7] 30cm/min FINE
      :   Weld End[1,2]
    14:    Weave End
    15:    Track End
   [End]
```

No Offsets

Fig. 20.7 (c) Carry on offset example program

Procedure 20-9 Create TAST Schedule for Carry On Offset Function

Step

1 Display TAST schedule list screen (refer to Step 1-4 of Procedure 20-2).

2 Move the cursor to TAST schedule used for TAST (in Fig. 20.6(c), the number is 1) , and copy the schedule to unused number (in Fig. 20.6(c), the number is 5). About Copy operation, please refer to Step6 of Procedure 20-2.

3 Move the custor to TAST schedule number which is copied on Step2 and then press F2(DETAIL). TAST schedule detail screen is displayed. Set 0.0 mm toV_Tracking limit per cycle and set 0.0 mm to L_Tracking limit per cycle.

NOTE

All other parameters except “V_Tracking limit per cycle” and “L_Tracking limit per cycle” should be the same values between two TAST schedules.

20.8 TAST TROUBLESHOOTING

This troubleshooting information is provided as an aid to solve poor robot tracking performance.
There are several reasons that might lead to poor tracking performance. They are as follows:

- No compensation with high Vertical or Lateral gain setting
- Poor welding or workpiece conditions.
- The robot wanders away from the path and does not return to the center
- Weld path is shifted
- Slow response
- Snaking
- Weld path has changed on specific position
- Significant changes in joint gap
- Extreme changes in workpiece temperature.

1. No Compensation with High Vertical or Lateral Gain Setting
   If the welding path does not receive compensation with high gain values, then a gain value of 95 (V-gain) and a 90 (L-gain) should be tried. Use the following procedure to resolve no compensation.
   a Set the value of V_master comp type to FEEDBK on the DATA/TAST/DETAIL screen.
   b Execute TAST with arc welding and check the value of V_cur on the DATA/TAST screen. Proper value of V_cur is from 150 Amps to the maximum current capacity of the welding wire.

c If the feedback current value is almost zero, check the hardware connection from the welding machine to the controller. If the feedback current value is small, check the setting of the analog input (Feedback current is normally analog port 2). Additionally, check whether the value is near the command current value or not.

d If the value is appropriate, check the setting data of TAST parameters compared with the value on the "TAST Parameter List." Check the following data:
- V_tracking limit
- V_tracking limit per cycle
- L_tracking limit
- L_tracking limit per cycle

2. TAST Schedule

If the TAST schedule data seems to be correct, use the following procedure to execute TAST.

a Set a large weave amplitude, such as 3.0 mm or greater.

b Set a large weave center rise value, such as 2.0 mm center rise (refer to Section 8.3 Weaving Setup and Section 8.4 Weaving Schedule).

c Test run the program. If the result is not improved, check the following items:
- Check Gas composition.
- Adjust the weld schedule for achieving low spatter and stable arc.
- Execute the program without arc welding and check whether the robot has any vibration during weaving. If heavy vibration is visible, slightly adjust the value of the elevation angle and the azimuth angle to decrease the vibration when weaving. Adjust in increments of 2 - 5 degrees.

3 Robot Wanders from Path

Use the following procedure to correct the path set if the robot wanders from the correct path set.

a Increase the V and L gain values and then execute TAST again.

b If you see snaking, then decrease the gain values in small increments until the snaking stops.

c If tracking performance is not improved, memorize the current “adjust delay time” on TAST schedule first and then adjust the value in increments/decrements of 0.008sec.

4 Weld Path Is Shifted

If the weld path is shifted, use the following procedure.

a Adjust gain values properly

b Set proper torch angle. If the torch angle is shifted, it causes weld path shifting

c If no adjustment of torch position can be made, the bias values should be adjusted. Refer to Table 20.5(a) and (b).

5 Slow Response

a Review and/or adjust gain values

b Check following TAST schedule parameters.
- V_tracking limit
- V_tracking limit per cycle
- L_tracking limit
- L_tracking limit per cycle

Increase value of V_tracking limit per cycle and L_tracking limit per cycle, because the required compensation may be larger than those values.

c Also check to see whether the values of V_dead band and L_dead band are zero or small values (0.1 mm). If too large, the tracking correction will occur only for large offsets.

6 Weld Path Is Snaking

If the weld path is snaking, decrease the value of both L-gain and V-gain, in small increments until snaking stops.

7 Weld Path Has Changed at a Specific Position

a Check wire flip at the problem point by executing the program with weld OFF and observe the wire closely. The weld system may have weld wire delivery problems, such as torch liner or contact tip wear.
b Check to see whether the welding schedule changes at the position.
c Check to see whether the torch is touching the workpiece.

8 Significant Changes in Joint Gap
If the joint gap changes significantly, TAST performance might be affected. To avoid this problem, you should:
a Maintain a constant joint gap as much as possible.
b Use as large a work angle as possible.
c Apply different TAST schedules for different joint gaps.

9 Extreme Changes in Workpiece Temperature
If the workpiece temperature varies to an extreme degree, TAST performance may be affected. To avoid this problem, you should:
a Reduce variations in workpiece temperature whenever possible
b Apply different TAST schedules for areas of the workpiece with extreme temperature differences.

20.9 STATIONARY WELDING WITH TAST

During stationary welding with robot, the arc welding robot is taught stationary at the same position, and only the positioner loaded with the part is rotated / translated. In conjunction with coordinated motion, the arc welding robot(s) as the follower group(s) can be single arm or multi arm, the positioner as the leader can be a simple headstock or another robot arm with full kinematics. When TAST is used with Stationary Welding, robot never moves to weld direction and this will have only oscillation by weaving and tracking compensation by TAST.

Stationary Welding has the following merits.

- Simple to teach the program execution.
- Arc Welding Robot maintains the torch relative to the gravity.
- Supports multiple process robots.
- Supports coordinated motion.
- Support not only TAST but also Multi-Pass / RPM.

Followings are the sample of Stationary Welding with 3 groups system.

- Group 1: Arc Welding Robot 1 (Follower group 1, Weld EQ1)
- Group 2: Arc Welding Robot 2 (Follower group 2, Weld EQ 2)
- Group 3: Positioner (Leader group)
- Create the program that specifies above 3 motion groups in program header.
- Group 1 and Group 2 are taught stationary at the same position.
- Group 3 continues rotating the part during stationary welding.
- The part loaded on the positioner can be a pipe, tank or vessel.

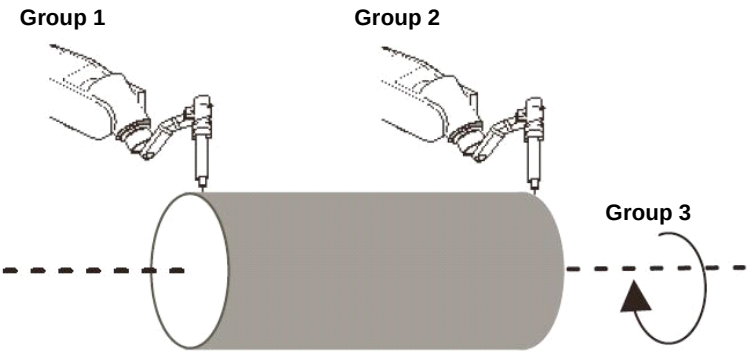


Fig. 20.9 (a) Stationary welding with 3 motion groups

Motion Group[1,1,1,*,*,*,*]

```
TAST3
                                        13/13
     3: L  P[3] 500mm/sec FINE
      :   Weld Start E1[1,1,E2]
     4:   Weld Start E2[1,1,E1]
     5:   Weave Sine[1]
     6:   Track TAST[1]
     7: C  P[4]
      :    P[5] 30cm/min CNT100 COORD
     8: C  P[6]
      :    P[7] 30cm/min FINE COORD
      :   Weld End E1[1,2]
     9:   Weld End E2[1,2]
    10:   Weave End
    11:   Track End
    12: L  P[8] 500mm/sec FINE
   [END]
```

```
DATA TAST Schedule
                                        1/30
   TAST Schedule: [ 1]

    1 TAST Schedule: [    Schedule 1 ]
                     .
                     .
                     .
   22 Robot Group Mask: [1,1,*,*,*,*,*,*]
                     .
                     .
                     .
   30 TAST Equip Mas:   [1,1,*,*,*,*,*,*]

 [TYPE] SCHEDULE                    HELP >
```

Fig. 20.9 (b) TAST program example of stationary welding

> **NOTE**
> It is available to prepare each weave schedule and TAST schedule individually for Group 1 and Group 2. In this case, 2 weaving instructions and 2 TAST instructions are needed. Additionally, appropriate group setup for each weave schedule and appropriate group/equipment setups for each TAST schedule are required.

Limitations of Stationary Welding

Stationary Welding with TAST has the following limitations.

- It supports coordinated stationary welding with TAST only, non-coordinated stationary welding with TAST is not supported.
- Stationary welding for single motion group with one robot and the part loaded on an external rotary device is not supported.
- Teach circular relative motion for the follower robot if the follower robot if the leader positioner has rotary axis type.
- Teach linear relative motion for the follower robot if the leader positioner has linear axis type.
- During stationary welding, the follower robot is taught stationary at the same position while the leader positioner is taught at different positions.

21 ROOT PASS MEMORIZATION AND MULTI-PASS

21.1 OVERVIEW

For heavy welding applications, multi-pass welding which welds the same weld pass repeatedly is generally used to increase the weld size. Root Pass Memorization and Multi-Pass (RPM/MP) function decreases the burden of the teaching operation of multi-pass welding.

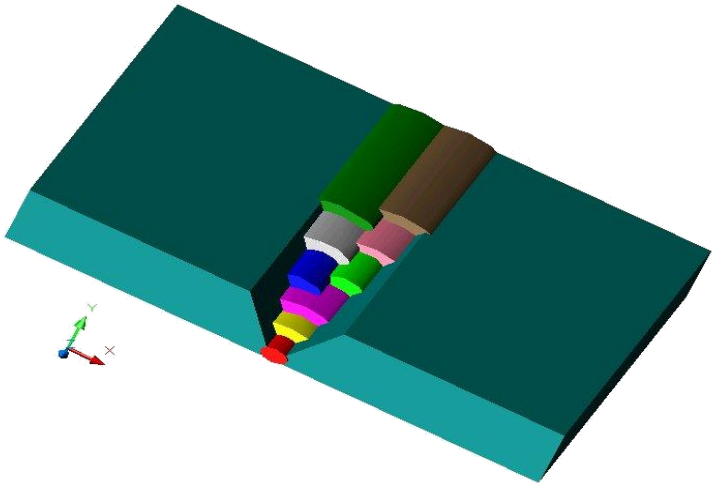


Fig. 21.1 Multi-Pass Welding

RPM/MP function is roughly divided to the following 2 functions.

- **Root Pass Memorization**
  This function stores the tracking compensation data by tracking sensor (TAST etc.) to Root Pass Memorization (RPM) data memory. RPM data memory can be applied to 2nd or later welding.

- **Weld Pass Offset Function**
  This function offsets 2nd or later welding totally by the data of position register. This offset approach is special for multi-pass.

By the combination of two functions, it is possible to gradually offset the weld pass which is stored by 1st pass tracking and to weld multi layers repeatedly. As a result, it is not necessary that the user uses tracking sensor to all weld path. Additionally, you can simplify the teaching of multi-pass welding.

This function uses two instructions to achieve above 2 functions.

- **Track RPM instruction**
- **MP Offset instruction**

This function is an option (A05B-XXXX-J532).

NOTE
This function does not support A motion instruction.

21.2 ROOT PASS MEMORIZATION

Root Pass Memorization (RPM) is the process of recording position offset information at specified intervals during the first welding pass. Root pass memorization is achieved by Track RPM instruction. See Fig. 21.2.

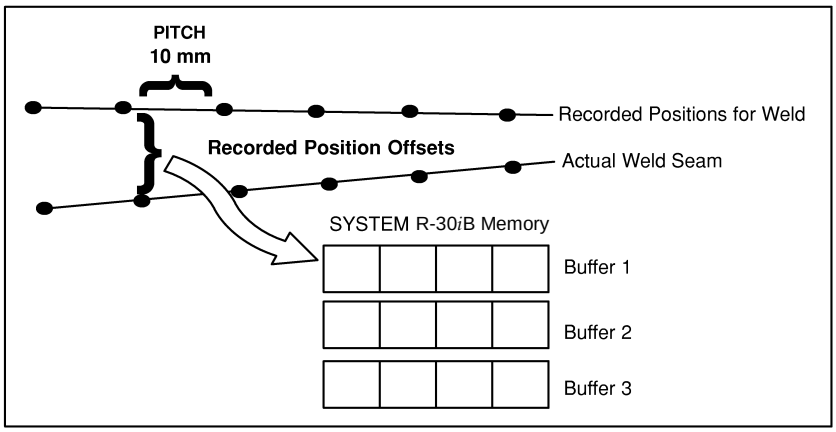


Fig. 21.2 Root pass memorization

RPM data is the difference between the robot positions taught during programming and the positions obtained by tracking sensor. Tracking sensors include Thru-Arc Seam Tracking (TAST), Automatic Voltage Control (AVC), and others.

For recording RPM data, Track RPM instructions are used. Track RPM instructions have two instructions. First instruction is the sampling start instruction of RPM data and second is end instruction.

- **Track (sensor) RPM[ ]**
- **Track End**

Track (sensor) RPM[ ]

Track RPM instruction records the position offset information to a buffer data area called “RPM data”. Recording of RPM data starts when motion instruction is executed after the execution of this instruction.

By default, there are ten buffers available. This means that up to 10 weld paths can be tracked and recorded. The information that RPM records is specific to the program in which RPM is used, but more than one weld path can be recorded in a single program.

Track End

The instruction finishes the process of Track RPM instruction.

Procedure 21-1 Teaching of Track RPM instructions

Condition

- Program edit screen has been displayed
- Teach pendant is enabled

Step

1 Press [NEXT] key and then press F1[INST]. Following list of instructions is displayed.

```
      Instruction 2
1 Miscellaneous
2 Weave
3 Skip
4 Payload
5 Track/Offset
6 Offset/Frames
7 Multiple control
8 --next page--
```

2 Select Track/Offset. Following list of Track/Offset instructions is displayed. If you want to teach Track RPM instruction, please select Track RPM.

```
      Track/Offset 1
1 Track
2 Track End
3 MP Offset
4 MP Offset End
5 Track RPM
6 Track End[]
7
8
```

3 Enter TAST schedule number to first [] on the instruction. Then, enter RPM data number to second [] on the instruction.
4 If you want to teach Track End instruction, please select Track End on Step 2.

⚠CAUTION
1 RPM data can be used only in the program and positions in which RPM data is recorded. The MP OFFSET sections and the TRACK {sensor} RPM sections must reside in the same program.
2 The RPM data cannot be used in a subprogram and then called to a main program for use with multi-pass.
3 Recorded positions and position registers are affected by UFRAME, and UFRAME has an affect during playback. If you change UFRAME, any recorded positions and position registers will also change.

21.3 MULTI-PASS

The multi-pass instruction in the ArcTool software provides an easy method of programming multi-pass welding. Multi-Pass welding is repeatedly welding the same seam. Multi-Pass welding is useful in applications where large welds are required. The large welds are created by layering and offsetting smaller welds. Fig. 21.3 (a) shows a simple multi-pass weld.

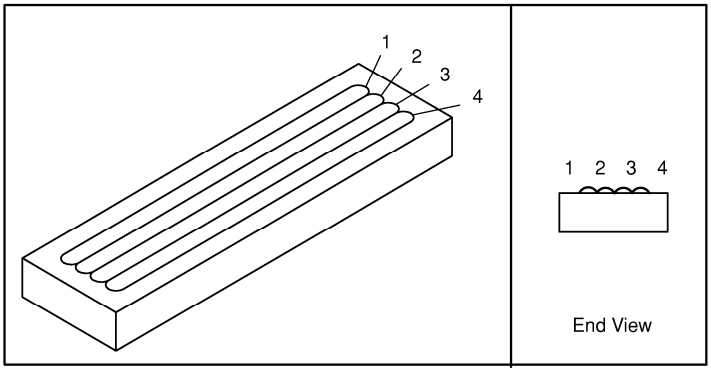


Fig. 21.3 (a) Simple multi-pass weld overlay

Different weld and weave schedules can be used between passes. Multi-Pass can be used with and without weaving.

MP Offset instructions

Multipass consists of two programming instructions:

- **MP Offset PR[...] RPM[...]**
- **MP Offset End**

> **NOTE**
> Weld Start instruction of direct format and the offset condition instruction is not supported between MP Offset PR and MP Offset End instructions.

MP Offset PR[...] RPM[...]

In MP Offset PR[..] RPM[…] instruction,

- **PR[…]**
- **RPM[…]**

are specified for offsetting entire weld passes.

The position register, PR[...], allows you to the offset the entire weld and change the tool orientation. The position register is normally set up prior to running the weld program and modified by your program to change the offset values.

> **NOTE**
> If the position register is set to all zeros, the weld will not be offset. However, the root pass memorization information will still be used.

Table 21.3 and Fig. 21.3(b) explain how to change the position register that affects the weld. All offsets are relative to the tool and path.

About the offset application examples by position register, please refer to Section 21.5.

Table 21.3 Offset directions by each element of position register

PR Element	Offset Direction
X	The position register X element elongates or shortens the weld. A positive X value adds to the weld length on both ends of the weld. A negative X value shortens both ends of the weld.
Y	The position register Y element offsets the weld laterally. When facing the end of the weld, positive Y is to the left side of the weld, and negative Y is to the right side of the weld. The lateral movement will be perpendicular to the tool.
Z	The position register Z element elevates the weld. In many cases, this direction will be the same as z-axis of tool frame. Even if torch has travel angle, the movement of the torch will be perpendicular to the weld path. Positive Z is to up direction and negative Z is down direction.
W	The position register W element changes the tool orientation by rotating about X. X is the weld path. This changes the torches work angle.
P	The position register P element changes the tool orientation by rotating about Y. Y is perpendicular to the torch. This changes the torches travel angle relative to the weld path.
R	The position register R element has no effect on the weld.

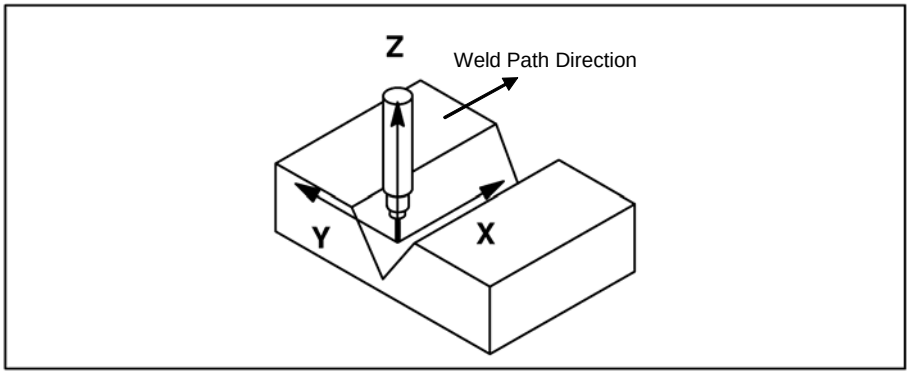


Fig. 21.3 (b) Coordinates for MP offset

RPM[...] allows you to specify the RPM data number which obtained by Track RPM instruction.

Track RPM instruction records the tracking compensation data on the first welding pass as RPM data. A tracking sensor provides RPM data. Multi-Pass uses this RPM data on subsequent passes of a multi-pass weld for offsetting entire taught path.

> ⚠**CAUTION**
> The offset process by position register doesn't execute the following situations.
> - Single step
> - BWD execution
> - Dry run

> **NOTE**
> If you do not want to use any RPM data when multi-pass welding, set the RPM data number to 99. This will allow the MP Offset instruction to ignore RPM data.

MP Offset End

MP Offset End stops the use of the MP Offset instruction within the program.

Procedure 21-2 Teaching of MP Offset instructions

Condition

- Program edit screen has been displayed
- Teach pendant is enabled

Step

1 Press [NEXT] key and then press F1[INST]. Following list of instructions is displayed.

```
      Instruction 2
1 Miscellaneous
2 Weave
3 Skip
4 Payload
5 Track/Offset
6 Offset/Frames
7 Multiple control
8 --next page--
```

2 Select Track/Offset. Following list of Track/Offset instructions is displayed. If you want to teach MP Offset instruction, please select MP Offset.

```
     Track/Offset 1
1 Track
2 Track End
3 MP Offset
4 MP Offset End
5 Track RPM
6 Track End[]
7
8
```

3 Enter position register number which is used for offsetting entire taught weld path. Additionally, enter RPM data number to [] just after RPM. If you do not use RPM data, enter 99 to [] just after RPM.

4 If you want to teach MP Offset End instruction, please select MP Offset End on Step 2.

21.4 PROGRAMMING RPM

In this section, program examples that use Track RPM instruction and MP Offset instruction are described. Fig. 21.4(a) and Fig. 21.4(b) are standard program examples for multi-pass welding which use Track RPM instruction and MP Offset instruction. Fig. 21.4(c) is the program example that only has MP Offset instruction without Track RPM instruction. Fig. 21.4(d) is the program example for 3 passes welding of V-groove without torch posture change.

When you create multi-pass weld program, same program structure and same position number are required for using RPM data obtained by Track RPM instruction on MP Offset instruction. In this situation, it is efficient to copy and past program lines for 1st pass as the program of 2nd or later passes. Procedure 21-3 explains the procedure of effective creation of multi-pass weld program with referring to Fig. 21.4(a)

```
MULTI-PASS_1
                                        23/23
     1:J  P[1] 30% FINE
     2:L  P[2] 100mm/sec FINE
      :  Weld Start[1,1]
     3:  Weave Sine[1]
     4:  Track TAST[1] RPM[1]
     5:L  P[3] 40cm/min CNT100
     6:L  P[4] 40cm/min CNT100
     7:C  P[5]
      :   P[6] 40cm/min CNT100
     8:L  P[7] 40cm/min CNT100
     9:L  P[8] 40cm/min FINE
      :  Weld End[1,2]
    10:  Weave End
    11:  Track End
    12:J  P[9] 30% FINE
    13:  MP Offset PR[1] RPM[1]
    14:L  P[2] 100mm/sec FINE
      :  Weld Start[1,3]
    15:  Weave Sine[2]
    16:L  P[3] 40cm/min CNT100
    17:L  P[4] 40cm/min CNT100
    18:C  P[5]
      :   P[6] 40cm/min CNT100
    19:L  P[7] 40cm/min CNT100
    20:L  P[8] 40cm/min FINE
      :  Weld End[1,4]
    21:  Weave End
    22:  MP Offset End
```

Record taught path by position between [2] - [8] during TAST to RPM data 1

Replay RPM data 1

Fig. 21.4 (a) Multi-Pass program example 1

```
MULTI-PASS_2
                                        28/28
     1:  !Multi-pass with RPM
     2:J  P[1:Safe Position] 30% FINE
     3:L  P[2] 100mm/sec FINE
      :  Weld Start[1,1]
     4:  Weave Sine[1]
     5:  Track TAST[1] RPM[1]
     6:L  P[3] 40cm/min CNT100
     7:C  P[4]
      :   P[5] 40cm/min CNT100
     8:L  P[6] 40cm/min FINE
      :  Weld End[1,6]
     9:  Weave End
    10:  Track End
    11:  R[1]=0
    12:J  P[1:Safe Position] 30% FINE
    13:  MP Offset PR[1] RPM[1]
    14:  JMP LBL[2]
    15:  LBL[1]
    16:  MP Offset PR[2] RPM[1]
    17:  LBL[2]
    18:L  P[2] 100mm/sec FINE
      :  Weld Start[1,2]
    19:  Weave Sine[2]
    20:L  P[3] 40cm/min CNT100
    21:C  P[4]
      :   P[5] 40cm/min CNT100
    22:L  P[6] 40cm/min FINE
      :  Weld End[1,6]
    23:  Weave End
    24:  MP Offset End
    25:J  P[1:Safe Position] 30% FINE
    26:  R[1]=R[1]+1
    27:  IF R[1]=1,JMP LBL[1]
```

First Pass
Record RPM data by TAST

Multipas instructions for second and third passes
Change PR number for offset

Second Pass, Third Pass
Same position numbers of first pass are used

Pass count calculation

Fig. 21.4 (b) Multi-Pass program example 2

```
MULTI-PASS 3
                                        24/24
     1:  !MULTI-PASS WITHOUT RPM
     2:J  P[1:Safe Position] 30% FINE
     3:L  P[2] 100mm/sec FINE
      :  Weld Start[1,1]
     4:  Weave Sine[1]
     5:L  P[3] 40cm/min CNT100
     6:C  P[4]
      :   P[5] 40cm/min CNT100
     7:L  P[6] 40cm/min FINE
      :  Weld End[1,6]
     8:  Weave ENd
     9:J  P[1:Safe Position] 30% FINE
    10:  MP Offset PR[1] RPM[99]
    11:L  P[2] 100mm/sec FINE
      :  Weld Start[1,2]
    12:L  P[3] 40cm/min CNT100
    13:C  P[4]
      :   P[5] 40cm/min CNT100
    14:L  P[6] 40cm/min FINE
      :  Weld End[1,6]
    15:  MP Offset End
    16:J  P[1:Safe Position] 30% FINE
    17:  MP Offset PR[2] RPM[99]
    18:L  P[2] 100mm/sec FINE
      :  Weld Start[1,3]
    19:L  P[3] 40cm/min CNT100
    20:C  P[4]
      :   P[5] 40cm/min CNT100
    21:L  P[6] 40cm/min FINE
      :  Weld End[1,6]
    22:  MP Offset End
    23:J  P[1:Safe Position] 30% FINE
```

First Pass
Weaving welding
(Without TAST)

Second Pass
Without weaving
Change weld schedule
Only MP Offset by PR
(Use PR[1])

Third Pass
Without weaving
Change weld schedule
Only MP Offset by PR
(Use PR[2])

Fig. 21.4 (c) Multi-Pass program example without RPM

```
MULTI-PASS_4
                                        27/27
     1:  !V GROOVE MULTIPASS WITH RPM
     2:J  P[1:Safe Position] 30% FINE
     3:L  P[2] 100mm/sec FINE
      :  Weld Start[1,1]
     4:  Weave Sine[1]
     5:  Track TAST[1] RPM[1]
     6:L  P[3] 40cm/min CNT100
     7:C  P[4]
      :   P[5] 40cm/min CNT100
     8:L  P[6] 40cm/min FINE
      :  Weld End[1,6]
     9:  Weave End
    10:  Track ENd
    11:  R[1]=0
    12:J  P[1:Safe Position] 30% FINE
    13:  LBL[1]
    14:  MP Offset PR[1] RPM[1]
    15:L  P[2] 100mm/sec FINE
      :  Weld Start[1,2]
    16:  Weave Sine[2]
    17:L  P[3] 40cm/min CNT100
    18:C  P[4]
      :   P[5] 40cm/min CNT100
    19:L  P[6] 40cm/min FINE
      :  Weld End[1,6]
    20:  Weave End
    21:  MP Offset End
    22:J  P[1:Safe Position] 30% FINE
    23:  R[1]=R[1]+1
    24:  PR[1,2]=-5
    25:  IF R[1]=1,JMP LBL[1]
    26:  PR[1,2]=5
```

First Pass
Record RPM data by TAST

Safe Position before starting second pass

Second Pass, Third Pass
Same PR number with First Pass

Set offset for Third Pass

Return offset for Second Pass

Fig. 21.4 (d) Multi-Pass program example for three passes v-groove welding

Procedure 21-3 Create RPM/MP Program

Step

1 By referring to Procedure 21-1, create the record program of first pass by Track RPM instruction..

```
MULTI-PASS_1
                                        12/12
     1:J  P[1] 30% FINE
     2:L  P[2] 100mm/sec FINE
      :  Weld Start[1,1]
     3:  Weave Sine[1]
     4:  Track TAST[1] RPM[1]
     5:L  P[3] 40cm/min CNT100
     6:L  P[4] 40cm/min CNT100
     7:C  P[5]
      :   P[6] 40cm/min CNT100
     8:L  P[7] 40cm/min CNT100
     9:L  P[8] 40cm/min FINE
      :  Weld End[1,2]
    10:  Weave End
    11:  Track End
```

2 Teach Safe Position on Line 12.
3 Teach MP Offset instruction on Line 13.
4 Press NEXT key and then press F5 (EDCMD) key. Then select Copy.
5 Move the cursor on Line 2 and then press F2 (COPY) key. Then move the cursor on Line 10 and press F2 (COPY) again.
6 Move the cursor on after Line 14 and press F5 (PASTE) key.
7 “Paste before this line?” is displayed. Press F3 (POSID). The program that has the same position number as first pass is copied.

```
MULTI-PASS_1
                                        23/23
     8:L  P[7] 40cm/min CNT100
     9:L  P[8] 40cm/min FINE
      :  Weld End[1,2]
    10:  Weave End
    11:  Track End
    12:J  P[9] 30% FINE
    13:  MP Offset PR[1] RPM[1]
    14:L  P[2] 100mm/sec FINE
      :  Weld Start[1,3]
    15:  Weave Sine[2]
    16:  Track TAST[1] RPM[1]
    17:L  P[3] 40cm/min CNT100
    18:L  P[4] 40cm/min CNT100
    19:C  P[5]
      :   P[6] 40cm/min CNT100
    20:L  P[7] 40cm/min CNT100
    21:L  P[8] 40cm/min FINE
      :  Weld End[1,4]
    22:  Weave End
```

8 Move the cursor on Track RPM instruction of Line 16. Press F5 (EDCMD) key and then select Delete. After “Delete line(s)?” is displayed, select F4 (YES) and delete Track RPM instruction.
9 Move the cursor under Weave End instruction, and then teach MP Offset End instruction.
10 If needed, change weld schedule number and weave schedule number.

NOTE
This procedure is one sample insistently. If you can create the program like above program sample finally, you do not need to follow this procedure.

Reciprocating Multi-Pass

This function supports reciprocating multi-pass: that is, 2nd or later welding of reverse direction from 1st pass can be achieved. For achieving the welding of reverse direction, a reverse teaching of motion instructions from 1st pass is required. Then, the order of position numbers should also be reversed. RPM data recorded by 1st pass is properly applied to reverse passes.

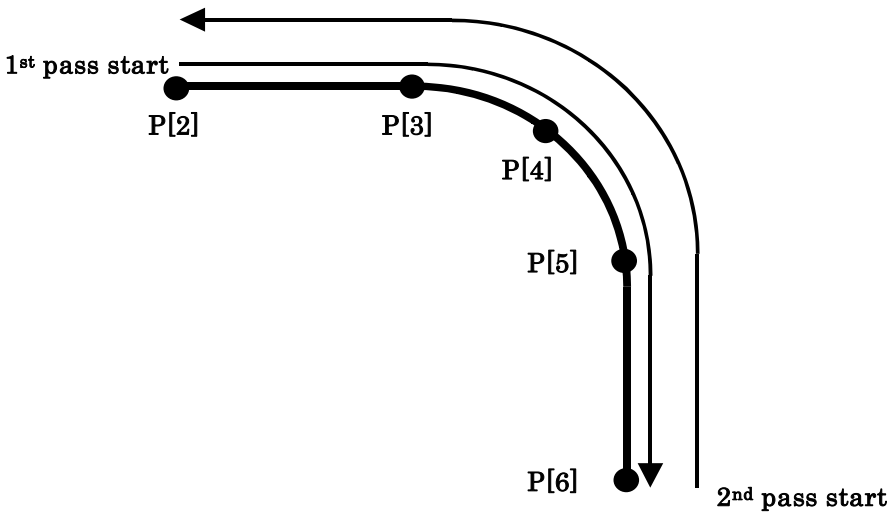


Fig. 21.4 (e) Reciprocating Multi-Pass

```
MULTI-PASS_RECIPRO
                                        21/22
     1:  !Reciprocating Multi-pass
     2:J  P[1:Safe Position] 30% FINE
     3:L  P[2] 100mm/sec FINE
      :  Weld Start[1,1]
     4:  Weave Sine[1]
     5:  Track TAST[1] RPM[1]
     6:L  P[3] 40cm/min CNT100
     7:C  P[4]
      :   P[5] 40cm/min CNT100
     8:L  P[6] 40cm/min FINE
      :  Weld End[1,6]
     9:  Weave End
    10:  Track End
    11:
    12:J  P[7:Safe Position B] 30% FINE
    13:  MP Offset PR[2] RPM[1]
    14:L  P[6] 100mm/sec FINE
      :  Weld Start[1,2]
    15:  Weave Sine[2]
    16:L  P[5] 40cm/min CNT100
    17:C  P[4]
      :   P[3] 40cm/min CNT100
    18:L  P[2] 40cm/min FINE
      :  Weld End[1,6]
    19:  Weave End
    20:  MP Offset End
    21:J  P[1:Safe Position] 30% FINE
```

First Pass
Welded by the order of P[2] -> P[6]

Second Pass
Motion direction is reversed from 1st pass
Welded by the order of P[6] -> P[2]

Fig. 21.4 (f) Program Example of Reciprocating Multi-Pass

> **NOTE**
> Even when reciprocating multi-pass is done, applied direction of PR offset is based on the direction of each pass section. For example, if 3rd pass is reverse direction from 2nd pass, PR offset for 2nd pass is based on the direction of 2nd pass and PR offset for 3rd pass is based on the direction of 3rd pass.

21.5 APPLICATIONS OF PR OFFSET

These offsets are applied to the weld path through the use of a position register on MP Offset instruction. The following multi-pass weld path changes are available:

- Vertical and lateral path shifts
- Torch angle changes
- Lengthen or shorten weld path
- Corners

Vertical and Lateral Path Shifts

Path shifts permit layering individual welds to form a pattern. Each pass can be offset laterally, using the position register Y value, and vertically, using the position register Z element value. See Figure Fig. 21.5 (a).

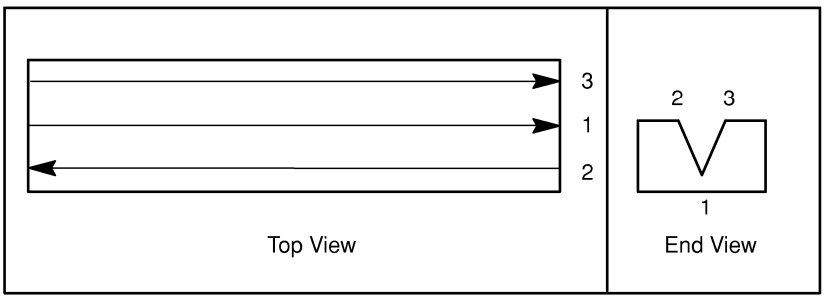


Fig. 21.5 (a) Multi-Pass weld 3 pass v-groove

Torch Angle Changes

The lateral and vertical offsets of each pass also can be accompanied by welding torch orientation changes. The W value in the position register is used to change the torch work angle. The P value in the position register is used to change to torch travel angle. See Fig. 21.5(b).

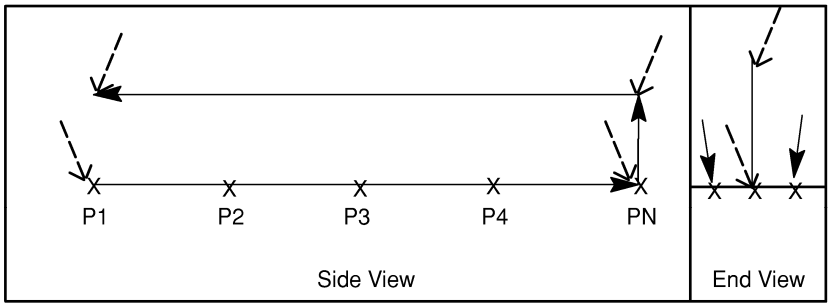


Fig. 21.5 (b) Multi-Pass weld with torch posture changes

Lengthen or Shorten Weld Path

To offset the start/stop location of the weld, the X value in the position register is used.
A positive value increases the length of the weld at the start and stop. A negative value shortens the weld at the start and stop. See Fig. 21.5(c).
The X value can be changed during welding to allow one end of the weld path to be shortened and the other end to be shortened or lengthened. This is done by adding another MP Offset instruction in the weld path. Only the X value in the new position register should be changed. All other values from the starting position register should be used.

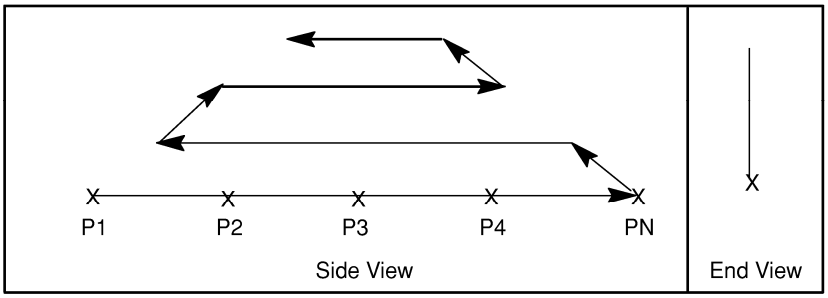


Fig. 21.5 (c) Multi-Pass weld with offsetting start/end positions

Corners

If any two path segments differ at all in direction, they form a corner of varying degree. The transition around the corner must be smooth to avoid loosing the arc. Record enough positions to gradually change the orientation over an appropriate distance before and after the corner. Positions that are recorded too close together and include large angle changes can produce unexpected torch motion or an error message. If this occurs, try recording the positions further apart.
Fig. 21.5(d) shows an outside corner of 90 degrees.

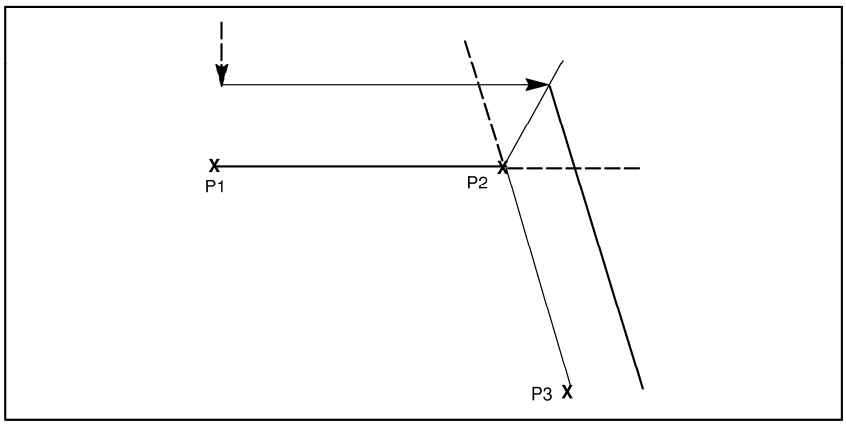


Fig. 21.5 (d) Multi-Pass corners

Multipass can offset rounded corners also.
See Fig. 21.5(e). The position register Y element controls the offset value for rounded corners.

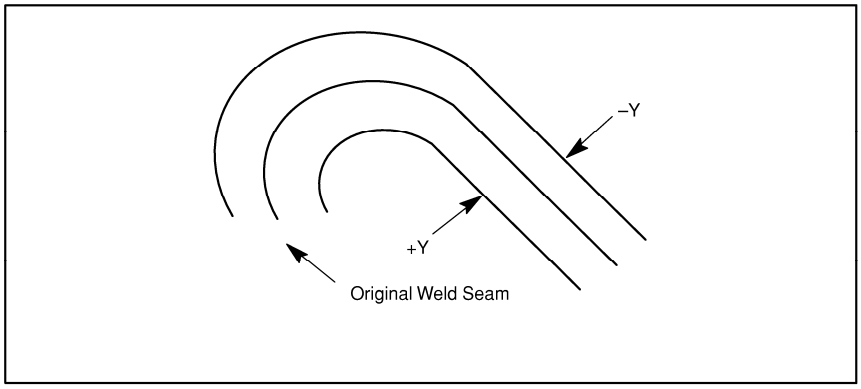


Fig. 21.5 (e) Rounded multi-pass corners

Corners with Logic Statements

If you insert logic statements, or change any values, such as position registers or frames, between robot positions, the multipass instruction stops blending, or looking ahead. This means the weld will not be following the same offset values for any positions that occur after the logic statement or change. See Fig. 21.5 (f).

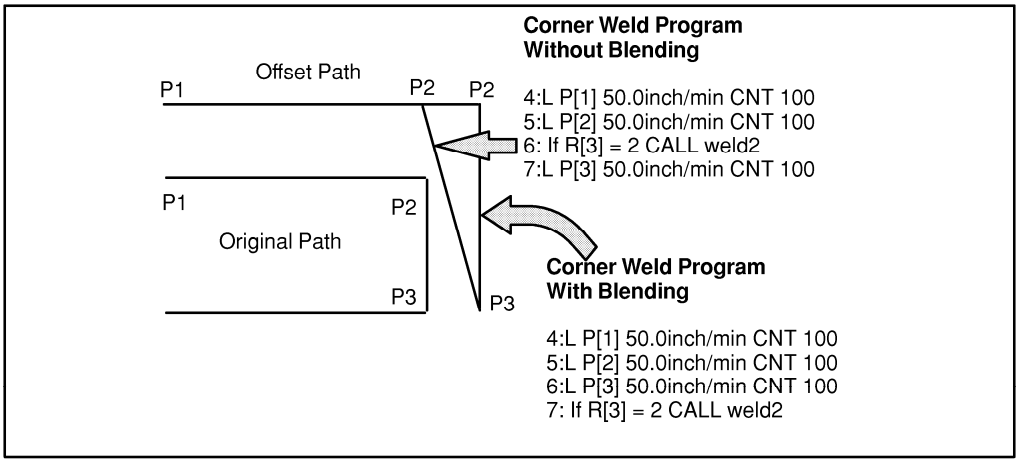


Fig. 21.5 (f) Multipass corners when logic statements appear between recorded positions

21.6 SETTING RPM SYSTEM VARIABLE

Ordinarily, modifying RPM system variables is not required. However, your site and specific type of welding might require some modifications to the $RPM_PG system variable. For more information about viewing and changing system variables, refer to Table 21.6 contains a description of RPM system variables that you might modify.
About the program example that has changing of these system variables, please refer to Fig. 21.6.

```
MULTI-PASS_1
                                        1/25

     1:  $RPM_PG.$PITCH_MODE=1
     2:  $RPM_PG.$PITCH=120
     3:J  P[1] 30% FINE
     4:L  P[2] 100mm/sec FINE
      :  Weld Start[1,1]
     5:  Weave Sine[1]
     6:  Track TAST[1] RPM[1]
     7:L  P[3] 40cm/min CNT100
     8:L  P[4] 40cm/min CNT100
     9:C  P[5]
      :   P[6] 40cm/min CNT100
    10:L  P[7] 40cm/min CNT100
    11:L  P[8] 40cm/min FINE
      :  Weld End[1,2]
    12:  Weave End
    13:  Track End
    14:J  P[9] 30% FINE
    15:  MP Offset PR[1] RPM[1]
    16:L  P[2] 100mm/sec FINE
      :  Weld Start[1,1]
    17:  Weave Sine[1]
    18:  Track TAST[1] RPM[1]
    19:L  P[3] 40cm/min CNT100
    20:L  P[4] 40cm/min CNT100
    21:C  P[5]
      :   P[6] 40cm/min CNT100
    22:L  P[7] 40cm/min CNT100
    23:L  P[8] 40cm/min FINE
      :  Weld End[1,2]
    24:  Weave End
```

Fig. 21.6 Program example with changing $PITCH and $PITCH_MODE

Table 21.6 RPM system variables

SYSTEM VARIABLE	DESCRIPTION
$RPM_PG.$PITCH default : 10 mm	This item allows you to specify the distance between the recording of position offset information. In other words, $PITCH specifies how often RPM will actually record the information that the sensor is supplying. This distance can be in time, milliseconds, or in linear distance, millimeters, depending upon the setting of $PITCH_MODE. When using milliseconds, the time between recording must be greater than 100 ms or an error will occur. When pitch mode is distance, the program speed has to be adjusted so that the time between the two records is greater than 100 ms. $PITCH can be changed in your program by using the PARAMETER NAME instruction.
$RPM_PG.$PITCH_MODE default: 0	This item allows you to specify whether the measurement used between recorded position offset information will be based in time, milliseconds, or in linear distance, millimeters. $PITCH controls the actual length between recordings. If $PITCH_MODE is set to 0, linear distance is used. If $PITCH_MODE is set to 1, time is used. $PITCH_MODE can be changed in your program by using the PARAMETER NAME instruction.

21.7 VERTICAL TRACKING DURING MP OFFSET

This function supports the additional vertical tracking by TAST during RPM replay by MP Offset instruction. By this support, it is possible to track the workpiece that has the heat distortion after 1st pass welding.
If you would like to add vertical tracking during MP Offset, please add Track instructions between MP Offset instructions.

```
MULTI-PASS_TRACKING
                                        26/27

    14:J  P[9] 30% FINE
    15:  MP Offset PR[1] RPM[1]
    16:L  P[2] 100mm/sec FINE
      :  Weld Start[1,1]
    17:  Track TAST[2]
    18:  Weave Sine[2]
    19:L  P[3] 40cm/min CNT100
    20:L  P[4] 40cm/min CNT100
    21:C  P[5]
      :    P[6] 40cm/min CNT100
    22:L  P[7] 40cm/min CNT100
    23:L  P[8] 40cm/min FINE
      :  Weld End[1,2]
    24:  Track End
    25:  Weave End
    26:  MP Offset End
```

Vertical tracking by TAST is also applied with the offset by RPM data

Fig. 21.7 (a) Program Example of Vertical Tracking during MP Offset

Actual path with vertical tracking during MP Offset is the sum of Nominal path, MP Offset, interpolated RPM offset and vertical track offset.

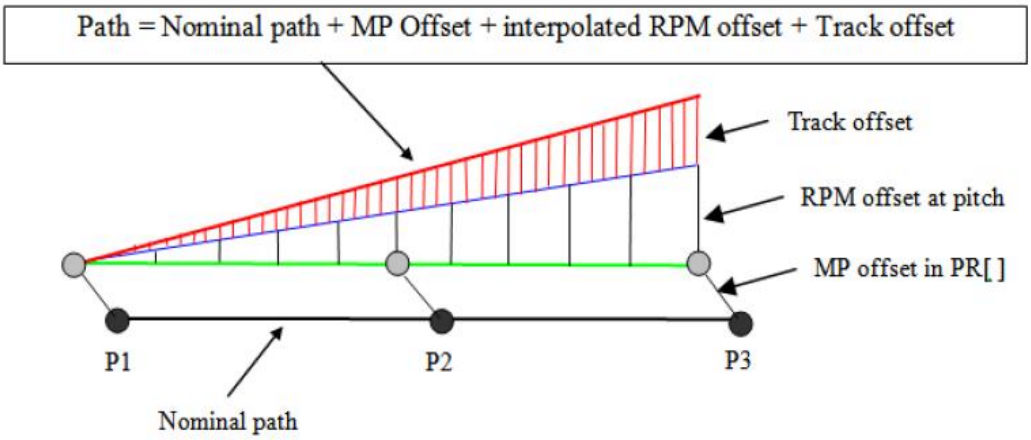


Fig. 21.7 (b) Vertical Tracking during MP Offset

Notifications of Vertical Tracking during MP Offset

- Different TAST schedule can be selected between 1st pass and later passes.
- During MP Offset, lateral tracking is ignored even when this is enabled in TAST schedule, and only vertical tracking works.
- Please teach Track TAST instruction at the timings of Weld Start and Weld End (refer to Fig. 21.7 (a)). Do not teach the instruction during welding or before MP Offset Start instruction.

21.8 COORDINATED MOTION WITH RPM/MP

It is possible to use RPM/MP function with coordinated motion. During coordinated motion, all of RPM/MP functions can be used. RPM data is stored based on coordinated frame, not on world frame.

Please note followings during coordinated motion with RPM/MP.

- It is required to add COORD instruction to all motion instructions between Track RPM Start and End instructions.
- It is required to add COORD instruction to all motion instructions between MP Offset Start and End instructions.

Fig. 21.8 (a) is a program example of coordinated motion between robot and 2 axes positioner with RPM/MP. Additionally, Fig. 21.8 (b) is a motion example of this program.

```
MULTI-PASS_COORD
                                        21/22
     1:  !Multipass & Coordinated Motion
     2:J  P[1:Safe Position] 30% FINE
     3:L  P[2] 100mm/sec FINE
      :  Weld Start[1,1]
     4:  Weave Sine[1]
     5:  Track TAST[1] RPM[1]
     6:L  P[3] 40cm/min CNT100 COORD
     7:C  P[4]
      :   P[5] 40cm/min CNT100 COORD
     8:L  P[6] 40cm/min FINE COORD
      :  Weld End[1,6]
     9:  Weave End
    10:  Track End
    11:
    12:J  P[1:Safe Position] 30% FINE
    13:  MP Offset PR[1] RPM[1]
    14:L  P[2] 100mm/sec FINE COORD
      :  Weld Start[1,2]
    15:  Weave Sine[2]
    16:L  P[3] 40cm/min CNT100 COORD
    17:C  P[4]
      :   P[5] 40cm/min CNT100 COORD
    18:L  P[6] 40cm/min FINE COORD
      :  Weld End[1,6]
    19:  Weave End
    20:  MP Offset End
    21:J  P[1:Safe Position] 30% FINE
```

First Pass
Add COORD instruction to all motion instruction between Track RPM instructions.

Second Pass
Add COORD instruction to all motion instruction between MP Offset instructions.

Fig. 21.8 (a) Program Example of Coordinated Motion with RPM/MP

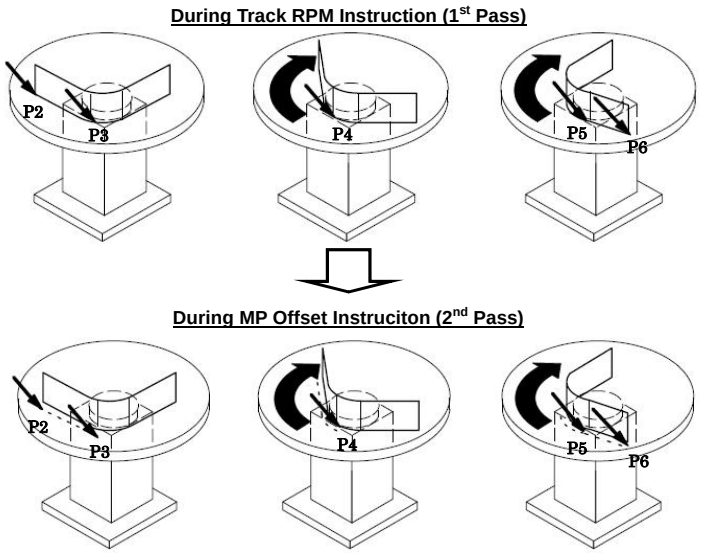


Fig. 21.8 (b) Motion Example of Coordinated Motion with RPM/MP

21.9 MULTI-PASS POSITIONER OFFSET FUNCTION

For heavy welding, generally welding with perpendicular torch posture is preferable because a large molten weld pool becomes flat by exploiting the effects of gravity and this improves the weld quality. For achieving this on 2nd or later passes, the angle of workpiece should be adjusted during keeping the torch posture perpendicular. By using Multi-Pass Positioner Offset Function, it is possible not only to offset weld pass by robot, but also to offset each joint of positioner that mounts a workpiece, and this leads the flat weld on 2nd or later passes.
Following example achieves flat weld on all passes of multi-pass weld: root position of Vgroove is welded as 1st pass, and 2nd and 3rd passes are welded with a perpendicular torch and a tilted workpiece by 2 axes positioner.

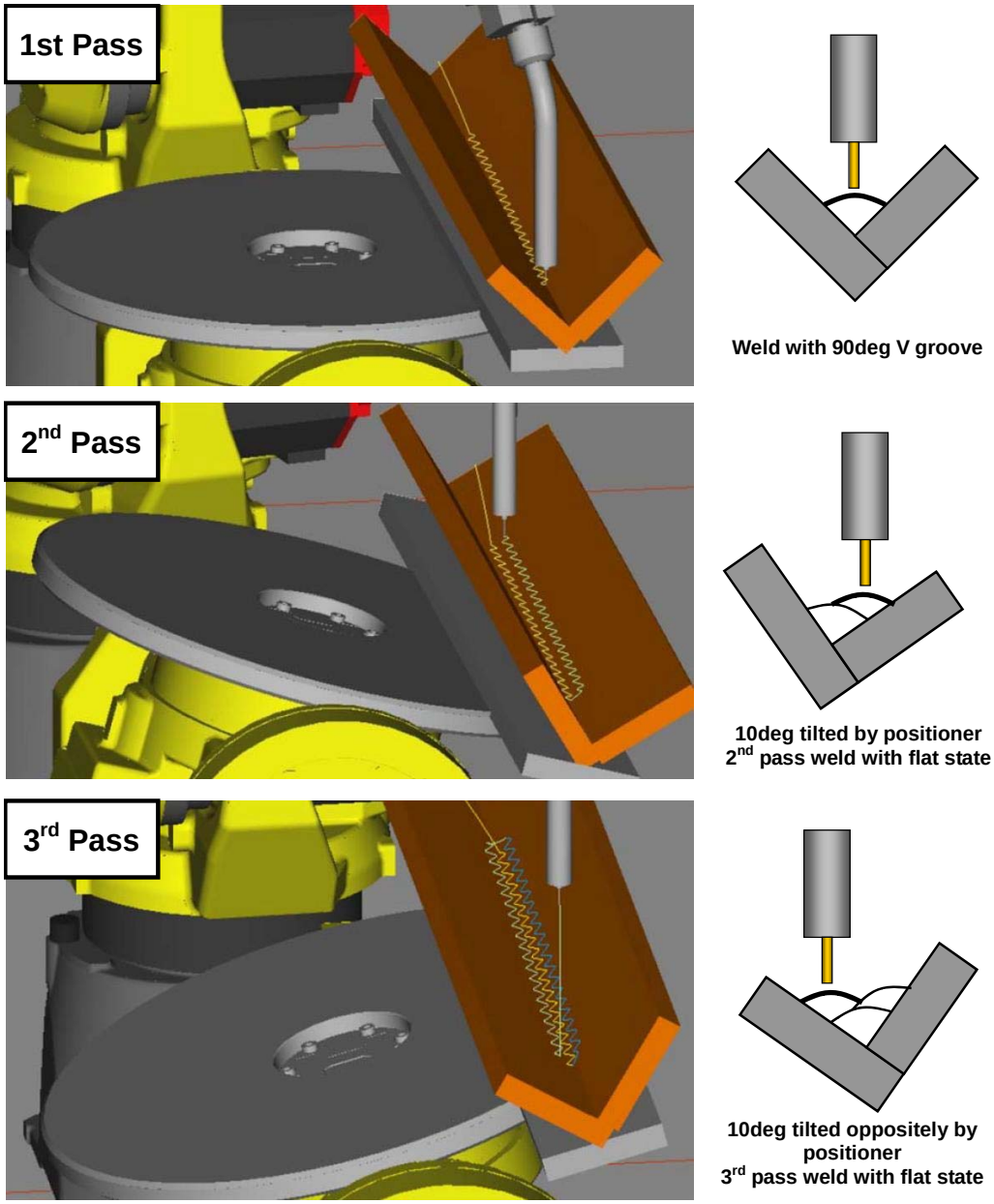


Fig. 21.9 (a) Motion Example of Multi-Pass Positioner Offset

Default setup of Multi-Pass Positioner Offset Function is disabled. Setup of enabling this function can be achieved by changing system variables. Please refer to Procedure 21-4.

Procedure 21-4 Setup of Enabling Multi-Pass Positioner Offset

Step

1 Press [MENU] key and select “6 SYSTEM” from the menu. Press F1 [TYPE] and select “Variables”. List screen of system variable is displayed.

2 Move the cursor on the line of “$MA_PSOFS” and press ENTER key.

```
SYSTEM VARIABLES
    $MA_PSOFS                          1/5
      1 $PSOFS_ENBL     FALSE
      2 $PSOFS_GMSK     0
      3 $PSOFS_ON       FALSE
      4 $PSOFS_GRP      [4] of GRP_OFS_T
      5 $DBG            0

   [ TYPE ]                    TRUE    FALSE
```

3 Move the cursor on the line of “PSOFS_ENBL” and press F4[TRUE].

4 Move the cursor on the line of “PSOFS_GMSK”. This value is bit mask style, so it is required to change the input value by group number of positioner that is used for Multi-Pass Positioner Offset Function. Enter a value referring to the following table.

Group No.	2	3	4	5	6	7	8
Input Value	2	4	8	16	32	64	128

If you would like to use 2 or more positioners for this function, you should enter sum of above values. If you would like to use group 3 and 4 for positioner offset, please enter “12” (4 + 8 = 12).

5 Perform cycle power of robot controller.

Program Example of Multi-Pass Positioner Offset

Fig. 21.9 (b) is the program example of Multi-Pass Positioner Offset Function and it also includes the setup status of position registers for MP Offset function.

```
MULTI-PASS_POSITIONER
                                    27/28
     1:  !Multipass Positioner Offset
     2:J  P[1:Safe Position] 30% FINE
     3:L  P[2] 100mm/sec FINE
      :  Weld Start[1,1]
     4:  Weave Sine[1]
     5:  Track TAST[1] RPM[1]
     6:L  P[3] 40cm/min FINE COORD
      :  Weld End[1,6]
     7:  Weave End
     8:  Track End
     9: J  P[4:Safe Position B] 30% FINE
    10:
    11:  !2nd pass Reciprocating
    12:  MP Offset PR[1] RPM[1]
    13:L  P[3] 100mm/sec FINE COORD
      :  Weld Start[1,2]
    14:  Weave Sine[2]
    15:L  P[2] 40cm/min FINE COORD
      :  Weld End[1,6]
    16:  Weave End
    17:  MP Offset End
    18:J  P[1:Safe Position] 30% FINE
    19:
    20:  !3nd pass
    21:  MP Offset PR[2] RPM[1]
    22:L  P[2] 100mm/sec FINE COORD
      :  Weld Start[1,2]
    23:  Weave Sine[2]
    24:L  P[3] 40cm/min FINE COORD
      :  Weld End[1,6]
    25:  Weave End
    26:  MP Offset End
    27:J  P[1:Safe Position] 30% FINE
```

Group Mask [1,*,1,*,*,*,*,*]

```
PR[1] GP1UF:F  UT:F  CONF:NUT 000
X      0.000   mm  W      0.000  deg
Y    -10.000   mm  P      0.000  deg
Z      8.000   mm  R      0.000  deg

PR[1] GP3UF:F  UT:F
X     10.000   deg
Y      0.000   deg
```

```
PR[2] GP1UF:F  UT:F  CONF:NUT 000
X      0.000   mm  W      0.000  deg
Y    -10.000   mm  P      0.000  deg
Z      8.000   mm  R      0.000  deg

PR[2] GP3UF:F  UT:F
X    -10.000   deg
Y      0.000   deg
```

Fig. 21.9 (b) Program Example of Multi-Pass Positioner Offset

22 PROCESS LOGGER

22.1 OVERVIEW

22.1.1 Description of Process Logger

Process Logger function records welding status information automatically. The recorded welding information is managed by unique ID consisted by program name and PROCESS ID. User can check them not only on teach pendant but on PC connected to the robot controller through network.
The followings are the representative features of Process Logger function.

- Confirm the recorded welding information on teach pendant.
- Derive and show some statistical data of the recorded welding information.
- Search the recorded welding information which satisfies several conditions; for example, some welding errors occurred, etc.
- Confirm the recorded welding information on Web browser connected to the controller through Ethernet network.
- Download the recorded welding information with FTP.

NOTE
This function is an option(A05B-XXXX-R758).

22.1.2 Inherent Features for ArcTool

At ArcTool, Weld ID is corresponding to Process ID. Weld ID is a parameter of Weld End[] instructions. The teaching method of Weld ID, please refer to Subsection 4.1.4.
If Process Logger function is ordered, Weld ID function becomes enabled automatically.

NOTE
If Weld ID function is disabled, Process Logger function also becomes disabled.

The following data is recorded in ArcTool.

Table 22.1.2 Welding Information recorded for ArcTool

Items	Descriptions
Executed time	Date of the Arc welding is executed.
Fault	Occurred alarm codes or counts. The count of alarm occurrence is 1: Record as alarm code ex. ARC-123. The count of alarm occurrence is more than 1: Record the count of alarm.
Bookmark	This is not used.
Weld time	The time of welding process execution.
Weld distance	Welded length.
Weld heat	The amount of heat applied during welding.
Wire length	Used wire length at welding.
Current	Average of actual welding current.
Voltage	Average of actual welding voltage
Wire feed speed	Average of actual wire feed speed.
Travel speed	Average of robot speed during welding.
Arc detect time	The time to detect arc generation.
Start faults	The count of errors occurred at weld start process.
Start retries	The count of retries to start weld.

Items	Descriptions
End faults	The count of errors occurred at weld end process.
Wiresticks	The count of wirestick
Disabled	Welding status. 0: Welding is disabled. 1: Welding is enabled.
Aborted	Have program is aborted during welding. 0: No 1: Yes

NOTE
If program running during weld is disabled, every data expect for “Disabled” is recorded as 0.

22.2 RECORDING WELDING INFORMATION

Process Logger function record each welding information automatically, however, by limitation of memory size et.al., it cannot record it inexhaustibly. Please confirm the following limitation and specification.

- The maximum keeping number of welding information stored in the controller is 50 for each welding point. If a welding point has been welded more than 50, Process Logger function deletes older information to make room for the new one.
- The statistical information; minimum, maximum and average value of each welding status is derived on the every welding information that Process Logger function records until now.
- The number of recordable welding point is depended on the equipped DRAM and FROM memory size.
- Process Logger records welding information at the welding has finished.
- The first time a program is executed, the data is not saved until the program ends. So if power was cycled before the program was completed the first time, then the data would be lost. Once the program ends the first time, then the data will be saved. All subsequent executions will always be saved.

22.3 PROCESS LOGGER USER INTERFACE

Process Logger function provides the following user interface to confirm welding information on teach pendant.

- Process Data screen
- Related view for Process Logger function.
- Process Report screen

22.3.1 Process Data Screen

Process Data screen shows any welding information that Process Logger records.

Procedure 22-1 Display Process Data screen

Step

1 Show Menu by pressed MENU key.
2 Select "Next”.
3 Select “Status”.

4 Show Menu by pressed F1[TYPE] key.
5 Select “Process Data”, then the following screen appears.
If you would like to confirm the below:
- Previous weld position: Press F2”PRV_PRC”
- Next weld position: Press F3”NXT_PRC”
- Older information: Press F4”PRV_HST”
- Newer information: Press F5”NXT_HST”

Process Data screen

```
Process Data
     Program:ARCLINE1
     Process ID: 1          [           ]
     Record : 9            Total : 210
     Touchup:               1-APR-12 16:01
     Execute:               3-APR-12 17:25

     Fault:                 None
      Bookmark:              None
     Weld time:             00:02:30.244 H:M:S
     Weld distance:          125cm
     Weld heat:             253896 J
     …
  [TYPE] PRV_PRC NXT_PRC PRV_HST NXT_HST
```

Table 22.3.1 Contents on Process Data screen

Items	Descriptions
Program	Program name executed the currently-shown welding information.
Process ID	Process ID corresponding to currently-shown welding information. At ArcTool, Weld ID is used.
Records	Record Index of currently-shown welding information.
Total	Total number of welding to current Process ID.
Touch up date	Touch up date of the weld.
Executed	Executed date the currently-shown welding information

22.3.2 Related View for Process Logger

Related View for Process Logger also shows any welding information same as the above Process Data screen. In addition, it is available to select welding position on TP program by Related View function and to confirm the temporal behavior of welding information by chart function.

Procedure 22-2 Display Related View for Process Logger

Step

1 Show Menu by pressed [MENU] key.
2 Select “Next”.
3 Select “SELECT”.
4 Select TP program you would like to confirm welding information and show edit screen.
5 Press FCTN key with *i* key, then the following menu appears.

```
   Related View 1
1 Node Map
2 Weld Procedure
3 Process Data
```

6 Select “Process Data” then the following screen is displayed.
If you would like to confirm the below:
- Older information: Press F4”PRV_HST”
- Newer information: Press F5”NXT_HST”

- Other welding position: Move cursor to the ARC instruction you want in edit screen on top-left window.

Related View for Process Logger

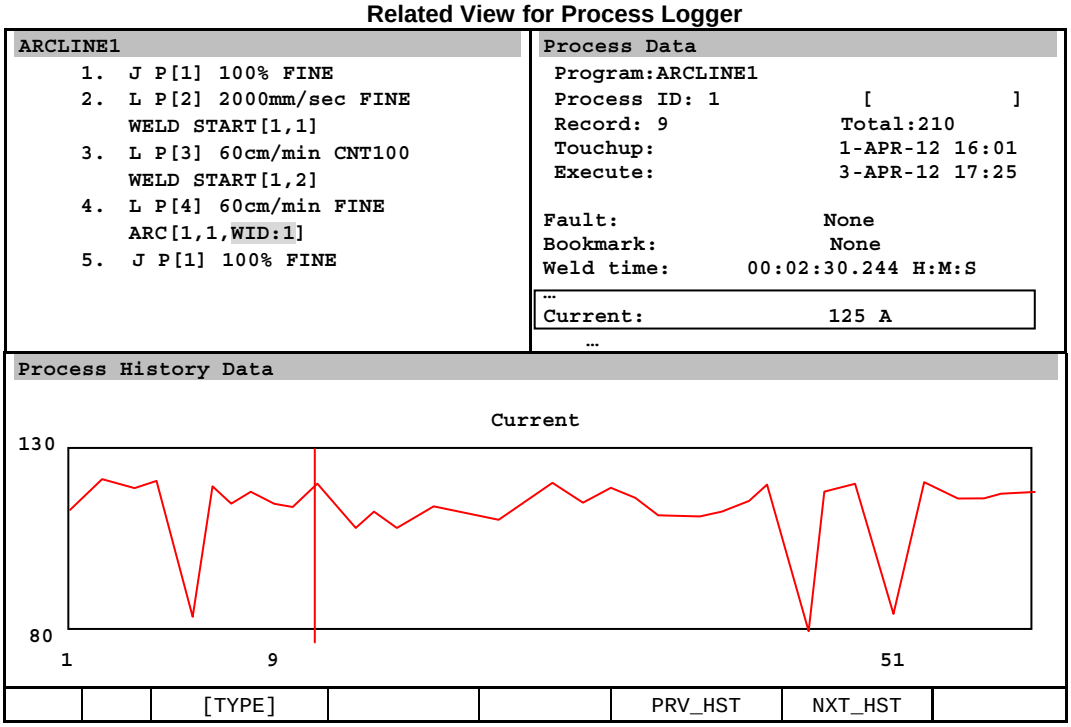


Table 22.3.2 Display contents on Related View for Process Data

Items	Descriptions
Program	Program name executed the currently-shown welding information
Process ID	Process ID corresponding to currently-shown welding information. At Arc welding, Weld ID is used.
Records	Record Index of currently-shown welding information
Total	Total number of welding to current Process ID.
Touch up date	Touch up date of the weld
Executed	Executed date the currently-shown welding information
Process History Data	Show time series graph selected welding information in Process Data screen on top –right screen. The red polygonal line along to transverse axis is the welding information selecting at Process Data screen. The red straight line along to vertical axis is executed time of currently-shown welding information.

22.3.3 Process Report Screen

Process Report screen extracts and displays some welding information that satisfies several conditions from among every welding information Process Logger records. For example, by using some error occurs or weld time is too short as extracting condition, you will find poor welding points quickly.
The statistical information; maximum, minimum and average value of welding information also is displayed.

Procedure 22-3 Display Process Report screen

Step

1 Show Menu by pressed [MENU] key.
2 Select “Next”.
3 Select “Status”.
4 Show Menu by pressed F1[TYPE] key.
5 Select “Process Report”, then the following screen appears.

Process Report search condition screen

```
Process Report
     Application: Arc Weld
     Report Type: USER DEFINED
     Filter name:
     Filters
      1:Exec_time
        Start date: 01/APR/12 TIME:12:00:00
        End date  : 02/APR/12 TIME:12:00:00
      2:Current            <   100.0
      3:None               =   0.00
      4:None               =   0.00
      5:None               =   0.00

     Outputs
      1:MIN   Current
      2:AVG   Current
      3:MAX   Current
```

	[TYPE]		EXEC	[CHOICE]	CLEAR	
	CLR_DAT			[CHOICE]		

Table 22.3.3 Display and configuration contents on Process Report search condition screen

Items	Descriptions
Application	Application type; Arc Weld et.al.
Report Type	Set search type. At “USER DEFINED”, You can set up search and output conditions circumstantially. Arc weld application provides the following presets of search conditions. “RP1:ALL ARCS”: Show every welding information “RP2:ARCS WITH FAULTS”: Show welding information some alarms occur.
Filter name	Name of search conditions This content is displayed only when report type is ”USER DEFINED”.
Filters	Search conditions. At search result screen, the welding information which satisfies any filter condition expect “None” The maximum number of condition is 5. This content is displayed only when report type is ”USER DEFINED”.
Outputs	Select some welding information shown statistical data on search result screen. User can select 3 type statistical information; maximum, minimum and average value. The statistical data is derived by the search result. This content is displayed only when report type is ”USER DEFINED”.

NOTE
Only 1st filter supports “execute time”.

Procedure 22-4 Search welding information

Condition

- Process Report screen is displayed.

Step

1 Select “Application” and “Report type”
   a: “USER DEFINED” requires to configure filter conditions and outputs. At least, a filter must be configured.
   b: “RP1: ALL WELDS” and “RP2: WELDS WITH FAULTS” have no configuration.
2 Press F3”EXEC” then start searching and displayed search result as following.
   If you would like to the search result, press F4”SAVE”, then, the search result is saved as “PATREPORT.HTM” to the default device with HTML format.

Process Report search result screen

```
PAT Report
F Number : XXXXXX
VERSION  : ArcTool
$VERSION : 7DC1P/01
DATE     : 3-APR-12 12:00

Arc Weld filtered report.

ARCLINE 1
   Process ID = 1, Hist Index = 1  Current = 98.0
   Process ID = 1, Hist Index = 8  Current = 90.0
   Process ID = 1, Hist Index = 34 Current = 83.3
      Global STAT for Process ID:1 after 210 execution
      Current      :MIN:83.30, MAX:125.00, AVG:120.00

   Process ID = 2, Hist Index = 34  Current = 73.3
      Global STAT for Process ID:2 after 210 execution
      Current      :MIN:73.30, MAX:128.00, AVG:121.00

ARCLINE 2
   Process ID = 4, Hist Index = 4  Current = 85.0
   Process ID = 4, Hist Index = 5  Current = 93.0
      Global STAT for Process ID:4 after 210 execution
      Current     :MIN:85.00, MAX:122.00, AVG:119.00

6 histories's with matching parameters found.
  Min  Current         = 73.3
  Max  Current         = 128.0.
  Avg  Current         = 120.0
```

		BACK		SAVE		

22.4 PROCESS LOGGER ON PC VIA ETHERNET NETWORK

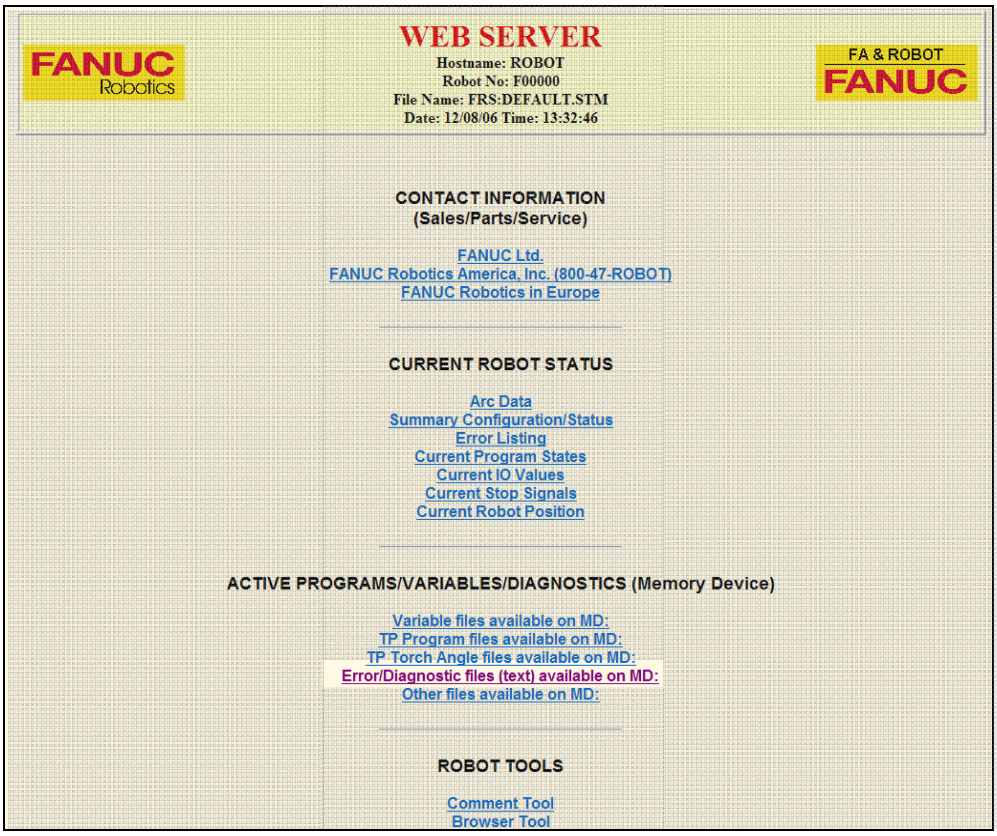
If a PC connects to a robot controller through Ethernet network, it's available to confirm welding information of Process Logger function on the PC. Process Logger function supports the following 2 procedures.

- Confirm the welding information on Web browser
- Access the welding information via FTP.

Procedure 22-5 Confirm the welding information on Web browser

Step

1 With Web browser on PC connected to a robot controller, bring up the robot home page, then the following page will appear.



2 Select “Error/Diagnostic files (text) available on MD:”

3 The list of error and diagnostic files appears. The welding information recorded by Process Logger function for Arc welding is saved in “PRCAWSUM.DG”. When it is selected, the welding information is displayed as the following type.

FANUC Robotics

WEB SERVER

Hostname: ROBOT
Robot No: F00000
File Name: /MD/PRCAWSUM.DG
Date: 12/08/03 Time: 10:09:38

FA & ROBOT FANUC

```
F Number: F00000
VERSION : ArcTool
$VERSION: V8.1056        7/6/2012
DATE:     03-AUG-12 10:09:38

ARC Weld Process Summary File
```

HIST_IDX	PROGRAM	PROCESS_ID	TOUCHUP_TIME	EXEC_TIME	Faults	****	Weld time (H:M:S)	Weld distance (cm)	Weld heat (J)	Wire length (cm)	Current (A)	Voltage (V)	Wire feed speed (cm/sec)	Tr sp (
1	TEST12	30	12-JUL-12 12:11:18	12-JUL-12 12:11:08	Weld AO scaling limit used (% s^4,%d^5)	00-0-80 00:00:00	00:00:10.350	33.6	0.0	0.0	0.0	0.0	0.0	19
2	TEST12	30	12-JUL-12 12:11:18	12-JUL-12 20:20:26	Weld AO scaling limit used (% s^4,%d^5)	00-0-80 00:00:00	00:00:09.758	33.6	0.0	0.0	0.0	0.0	0.0	20
3	TEST12	30	12-JUL-12 12:11:18	13-JUL-12 11:10:38	Weld AO scaling limit used (% s^4,%d^5)	00-0-80 00:00:00	00:00:10.294	33.6	0.0	0.0	0.0	0.0	0.0	19
4	TEST12	30	12-JUL-12 12:11:18	17-JUL-12 10:10:36	Weld AO scaling limit used (% s^4,%d^5)	00-0-80 00:00:00	00:00:00.695	1.0	0.0	0.0	0.0	0.0	0.0	86

Procedure 22-6 Accessing welding information via FTP

Condition

- The setup of TCP/IP on the robot has completed and IP address is assigned to the robot. (If this has not completed, please refer to Ethernet function manual and perform the setup.)
- Both PC and robot exist on the same network which they can communicate mutually.

Step

1 Execute “Command Prompt” on PC. (EX: “Start Menu” -> “Programs” ->”Accessory” -> “Command Prompt”)

2 Input following commands on Command Prompt. (Bold characters are actual commands.)

C:¥> ***cd xxxxx¥xxx***

Change directory to save folder for logs on PC. (We recommend that the folders are prepared and managed on each robot and each date.)

C:¥xxxxx¥xxx> ***ftp xxx.xxx.xxx.xxx***

Input robot IP address to xxx.xxx.xxx.xxx.

Connected to xxx.xxx.xxx.xxx

220 R-30iB FTP server ready. [ArcTool V8.20/Pxx]

User (xxx.xxx.xxx.xxx(none)) :

Need not to input. Press Enter key.

230 User logged in [NORM].

ftp> ***asc***

Perform transmission with ASCII mode.

200 Type set to A

ftp> ***prompt***

The confirmation of copy for each file is not performed during “mget” and copy work is simplified.

Interactive mode Off .

ftp> ***cd MD:***

Set the device to MD.

ftp> ***mget prcawsum.csv***

Copy prcawsum.csv in the current folder.

200 PORT command successful.

150 ASCII data connection.

226 ASCII Transfer complete.

ftp: xxxxxx bytes received in x.xxSeconds xxx.xxKbytes/sec.

ftp> **bye**

Release the FTP connection to robot.

NOTE

- ”PRCAWSUM.CSV”, welding information is saved, is also obtained at performing a “backup all” from the File menu.
- There is a case that displayed contents on Step 2 are changed by setup environments on PC or robot controller.
- If you cannot know the information of folders and files in the current file, please confirm by “dir” command.
- Above-mentioned procedure only explains the copy for PRCAWSUM.CSV. About more detailed operation of FTP, please refer to Ethernet function manual.
- You can also copy log files by other FTP client software.

22.5 PROCESS MONITOR

Process Monitor function detects abnormal welding by comparing with specified thresholds at recording weld information. The values of thresholds is specified it directly or allowable ratio of statistical information of past recorded weld information.
Alarm severity can be set each recorded item. For example, abnormality of heat input will dictate only weld quality, so the severity of it to WARN, on the other hand, since abnormality of weld disable will not weld at all, the severity of the alarm is PAUSE.

ArcTool provides similar function; Arc Abnormal Monitor function. The combination of Arc Abnormal Monitor function that analyzes weld status in a welding and Process Monitor that analyze weld information in a weld cycle provides most efficient monitoring feature.

NOTE
Process Monitor function is supported since 7DC2 software version and later.

22.5.1 Process Monitor Setup Screen

Enabled/Disabled of monitoring and threshold values is specified on Process Monitor setup screen.

Procedure 22-7 Process Monitor setup screen

Step

1 Press [MENU] key.
2 Select “SETUP”.
3 Press F1[TYPE].
4 Select “Process Monitor” then the following screen will be appeared.

Process Monitor setup screen

```
PROC LOG MON
     Application:  ARC Weld
     Fault Output:   DO[0]
     Warning Output: DO[0]
     Alarm Reset Input: DI[0]

#   Item        Act    ULim     LLim   TYPE  Sev
1 Weld time       N    100.0    65.0    DIR   W
2 Heat input      Y    0.8      10.0     %    W
3 Weld distance   N    10.0     10.0     %    W
4 Current         N    10.0     10.0     %    W
5 Voltage         N    10.0     10.0     %    W

    [TYPE]
```

Table 22.5.1(a) Process Monitor setup screen

Items	Descriptions
Application	Monitoring target application.
Fault Output	When a value of item that error severity is “WARN” exceed upper/lower limit, the DO specified the content becomes ON.
Warning Output	When a value of item that error severity is “FAULT” exceed upper/lower limit, the DO specified the content becomes ON.
Alarm Reset Input	DOs specified “Fault Output” and “Warning Output” become OFF
Item	Recorded item name.
Act	Enabled/Disabled monitoring feature for the item.
ULim	Specify upper limit. unit of the limit depends on “TYPE”
LLim	Specify lower limit. unit of the limit depends on “TYPE”

Items	Descriptions
Type Sev	Specify the unit of threshold value and error severity. The unit of threshold. “TOL”(TOLerance): The ULim and LLim value become percentage values around a reference value. “DIR”(DIRect): The ULim and LLim value become threshold values directly. Error severity. “W: Warning” Severity of alarm emergency becomes WARN, so, a robot continues processes after the emergency. “F: Fault” Severity of alarm emergency becomes PAUSE, so, a robot stops processes after the emergency.

Procedure 22-8 Enable monitoring with direct type

Step

1 Display Process Monitor setup screen.
2 Move cursor on the item you would like to monitor.
3 Move cursor on “ULim” and input upper limit value in “ULim”.
4 Move cursor on “LLim” and input lower limit value.
5 Move cursor on “TYPE” and select “DIR”. Set error severity to “W:Warning” or “F:Fault”.
6 Move cursor on “Act” and press F4 “Y”.

Procedure 22-9 Enable monitoring with tolerance type

Step

1 Display Process Monitor setup screen.
2 Move cursor on the item you would like to monitor.
3 Move cursor on “ULim” and input upper limit value in “ULim”.
4 Move cursor on “LLim” and input lower limit value.
5 Move cursor on “TYPE” and select “DIR”. Set error severity to “W:Warning” or “F:Fault”.
6 Move cursor on “Act” and press F4 “Y” and then the following details setup screen will appear.

Process Monitor detailed setup screen

```
PROC LOG MON DET

 Tol. Avg type: Running Average

   [TYPE]  APPLY          [CHOICE]
```

7 Move cursor on “Tol. Avg type” and press F4 [CHOICE] then the following menu will appear.
8 Select average type for tolerance, for the details of each type, please see table. 11.5.2.

```
1 Running Average
2 Learn X-->STOP Learning
3 Learn X-->Cont. Learning
```

9 When “Learn X -->STOP Learning” or “Learn X-->Cont. Learning” is selected, it requires to input the number of sample corresponding to “X” in each type. Input the number of it.

```
PROC LOG MON DET

 Tol. Avg type: Learn X-->STOP Learning
 Number of lern cycles:    20

|  | [TYPE] | APPLY |  | [CHOICE] |  |  |
```

10 After every setup has done, press F2 “APPLY”, the monitoring feature becomes to enable.

Table 22.5.1 (b) Process Monitor detailed setup screen

Items	Descriptions
Tol. Avg type	“Running Average” Use average of all recorded data as the reference value. **The average is updated by executing processes.** “Learn X --> STOP Learning” User average for the next X cycles values as the reference value. **The average isn’t updated after the X cycle.** “Learn X -->Cont. Learning” User average for the recorded values of the next X cycles and after values as the reference value. **The average is updated after the X cycle.**
Number of Learn	The content appears only when “Learn X-->STOP Learning” or “Learn X-->Cont. Learning” is selected as “Tol. Avg type”. Specify the minimal number of cycles to calculate the reference value(corresponding to “X” in each type).

Procedure 22-10 Change reference value type

Step

1 Display Process Monitor setup screen.
2 Move cursor on the item you would like to change the reference value.
3 Mover cursor on “Act” and press F4 “Y” then Process Monitor detailed setup screen will appear.
4 Change reference value type with step 7 to 9 in Procedure 11-10.
5 After every setup has done, press F2 “APPLY”, the new reference value becomes to enable.

NOTE
- Since the reference value derived at each weld point, the reference value depend on weld point.
- Until F2 “APPLY” is pressed, the monitoring feature doesn’t become to enable.
- When “Learn X-->STOP Learning” or “Learn X-->Cont. Learning” is selected as “Tol. Avg type”, the motoring feature is disabled until the X specified as “Number of Learn” cycles have executed.

22.5.2 User interfaces with Process Monitor

On Process Data screen, the item of monitoring target displays with red character.

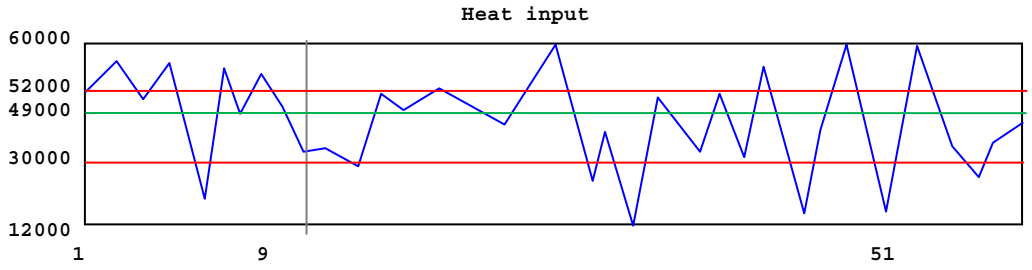
Process Data screen when “Heat input” monitoring is enabled

```
Process Data
     Prog.:WELD1
     Process ID: 1                [           ]
     Record: 9                    Total:210
     Touchup:                     12- 4- 1 16:01
     Execute:                     12- 4- 3 17:25

     Fault:                       None
      Bookmark:                   None
     Weld time:                   00:00:12.151 H:M:S
     Weld distance:               10.5cm
     Heat input:                  34320 J
     …
  [TYPE] | PRV_PRC | NXT_PRC | PRV_HST | NXT_HST
```

Related view of Process Logger, the item of monitoring target displays with red character on Process Data screen at right-top window same as above. The contents on PROCESS HISTORY DATA screen at bottom depend on Process Monitoring setup.
When monitoring feature is enabled, the reference value appears with green charactera and line on the chart and upper and lower limit appear with red characters and lines.

Related View of Process Logger (Monitoring is enabled)

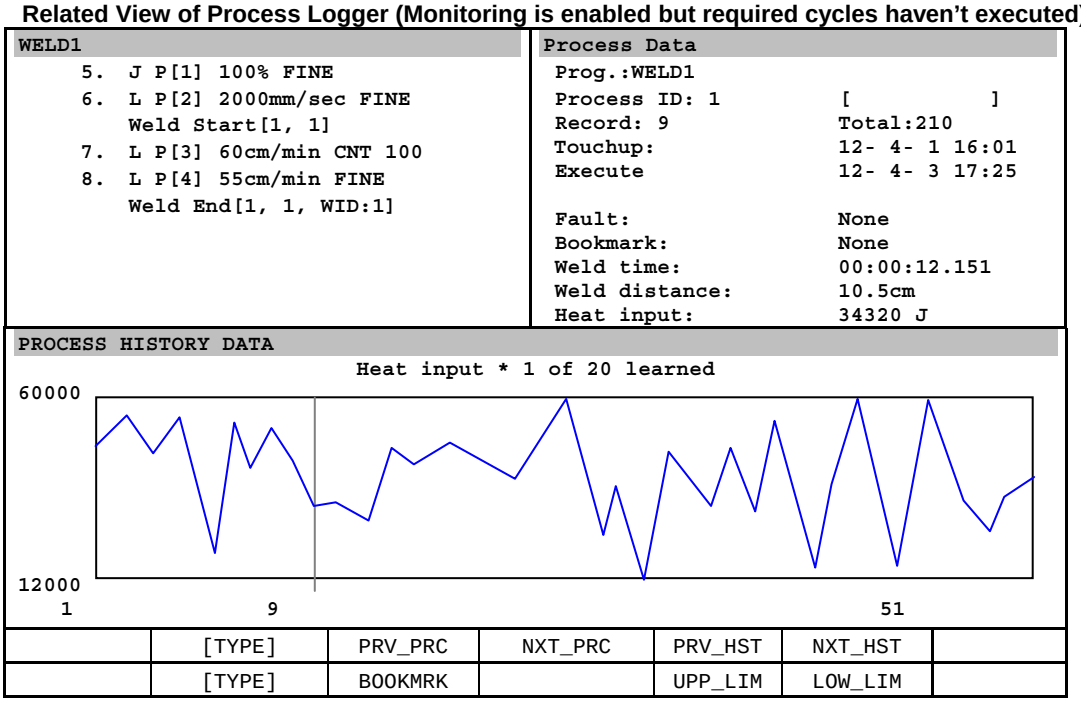
```
WELD1
     1.  J P[1] 100% FINE
     2.  L P[2] 2000mm/sec FINE
         Weld Start[1, 1]
     3.  L P[3] 60cm/min CNT 100
     4.  L P[4] 55cm/min FINE
         Weld End[1, 1, WID:1]

Process Data
 Prog.:WELD1
 Process ID: 1          [           ]
 Record: 9              Total:210
 Touchup:               12- 4- 1 16:01
 Execute                12- 4- 3 17:25

 Fault:                 None
 Bookmark:              None
 Weld time:             00:00:12.151
 Weld distance:         10.5cm
 Heat input:            34320 J

PROCESS HISTORY DATA
```




```
[TYPE] | PRV_PRC | NXT_PRC | PRV_HST | NXT_HST
[TYPE] | BOOKMRK |         | UPP_LIM | LOW_LIM
```

When “Learn X-->STOP Leaning” or “Learn X-->Cont. Leaning” is selected, the monitoring features is disabled until X specified at “The number of Learn” on Process Monitor detailed setup screen cycles have executed. In this case, the number of required and current executed cycles appears with item name on PROCESS HISTORY DATA screen as below.

Related View of Process Logger (Monitoring is enabled but required cycles haven't executed)



Thresholds of monitoring feature can be changed on PROCESS HISTORY DATA in Related View of Process Logger

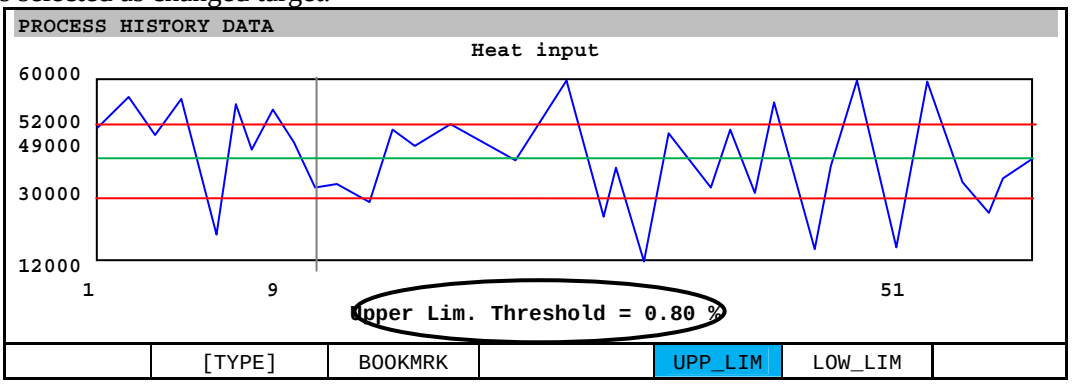
Procedure 22-11 Change thresholds on Related View of Process Logger

Step

1 Display Related View of Process Logger.
2 Press DISP key until PROCESS HISTORY DATA is selected.
3 Press [NEXT] key. The following function key will appear.

	[TYPE]	BOOKMRK		UPP_LIM	LOW_LIM	

4 When you would like to change the upper limit, press F4 "UPP_LIM", you would like to change the lower limit, press F5 " LOW_LIM".
5 The background of pressed item becomes blue and the current setting appears of the bottom of PROCESS HISTORY DATA screen. The following example is corresponding to when Upper limit is selected as changed target.

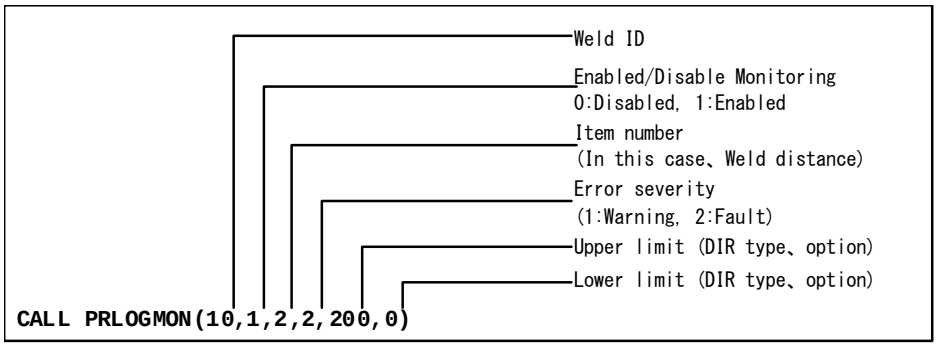


6 The threshold value increases/decreases by pressing UP/DOWN key. When the type is "TOL", it increases/decreases 1, otherwise, it increases/decreases the 1% value of average.
7 After the change, press same function key again, back to step 4. status.

NOTE
When “Learn X-->STOP Leaning” or “Learn X-->Cont. Leaning” is selected and required cycles haven’t done, since the monitoring feature is still disabled, it isn’t prohibited to change the threshold values from Related View of Process Logger.

22.5.3 Adjustment of Process Monitor Settings from TP Program

Process Monitor feature provides a macro to adjust Process Monitor settings from TP program. The format of the macro is below.



Procedure 22-12 Adjust Process Monitor settings from TP program

Step

1 Open the TP program you would like to adjust Process Monitor settings.
2 Move cursor to a previous line from the weld point you would like to adjust.
3 Press [NEXT] key.
4 Press F1[INST] key.
5 Select “CALL”.
6 Select “CALL program”.
7 Select “PROGMONOVER” in the list.
8 Press F4[CHOICE] and input new settings.

NOTE
- It isn’t prohibited to change the type of threshold; TOL or DIR from the macro.
- The macro must execute in the same TP program with the weld point you would like to change Process Monitoring settings.
- The macro must execute before the weld point you would like to change Process Monitoring settings.

22.6 4D PROCESS LOGGER

22.6.1 Overview

4D Process Logger feature provides a new 4D screen to confirm recorded data and process executed position of current selecting TP program on teach pendant screen graphically.

The principal features of this function are as follows.
- Show process executed points as map pins on 4D graphics screen.
- Show recorded data on pop-up text.
- Record Filtering.
- Calculate statistical information.
- Display record as time-series chart format.

NOTE
- This function can be used since 7DC2 version (V8.20) software.
- This function requires 4D Graphics function (A05B-XXXX-R764).
- This function recommends to use touch panel type *i*Pendant.

22.6.2 Home Screen

Procedure 22-13 Show home screen of 4D Process Logger

Step

1 Press [MENU] key.
2 Select “4D GRAPHICS”.
3 Press F1[TYPE] key.
4 Select “4D Process Logger”. The following screen is appeared.

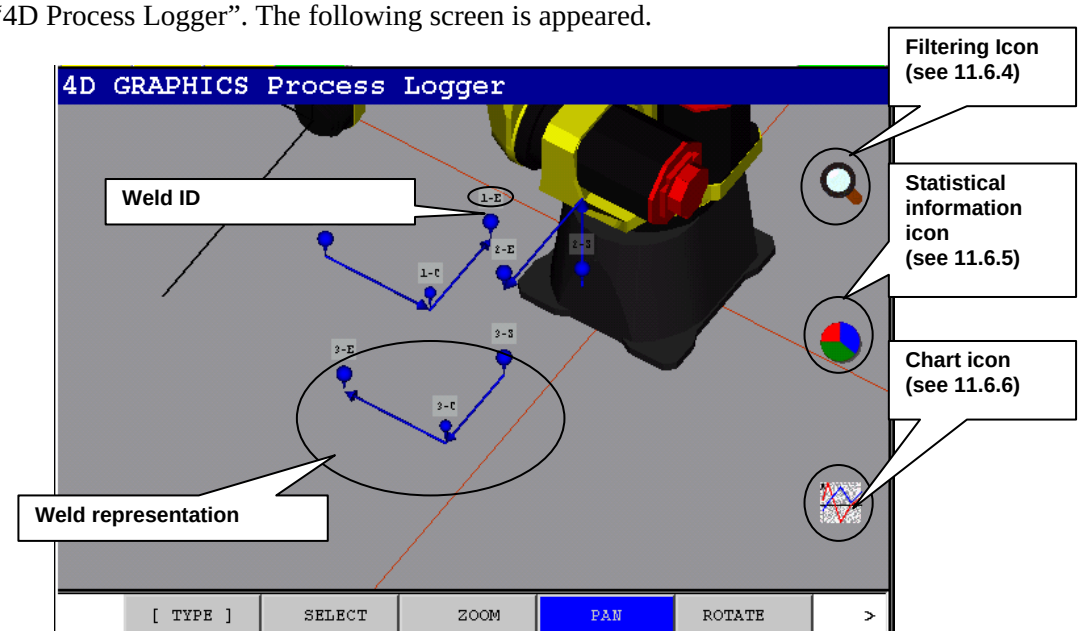


Fig. 22.6.2 Descriptions items on home screen of 4D Process Logger

22.6.3 Fundamental Features

Process representation

At ArcTool, positions executing Weld Start/Weld End instruction are represented as several map pins and arrows of welding path and the process ID is displayed above of the map pin with several suffixes.

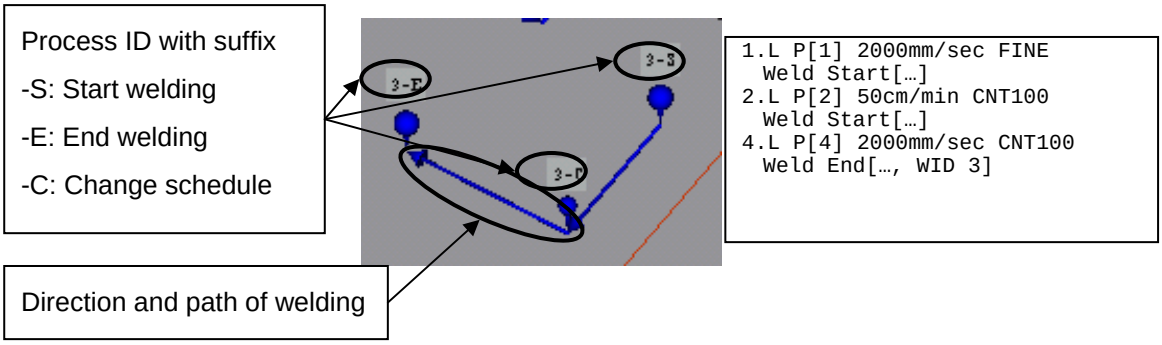
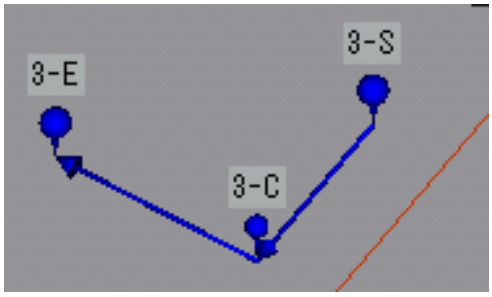
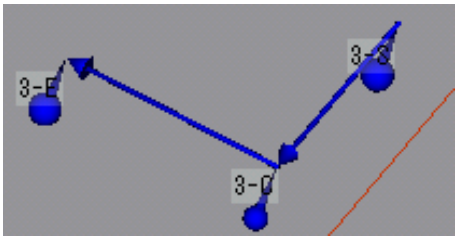


Fig. 22.6.3 (a) Weld representation

User can change the direction of map pin between two different frames; WORLD frame and USER TOOL frame.



WORLD



USER TOOL

Fig. 22.6.3(b) Two different map pin direction)

Procedure 22-14 Change map pin direction

Step

1 Display home screen of 4D Process Logger.
2 Press F2 “SELECT”.
3 Press [NEXT] key
4 Press F3 key then the frame of map pin .

Select process and popup

4D Process Logger provides to show recorded weld information on pop-up window. It requires selecting a Process you would like to confirm it. When a process is selected, the color of the process representation is changed to light green from blue and popup that shows latest history data appears near the process representation.
There are two ways to select a process; using a touch panel feature or key

Procedure 22-15 Select a process on 4D Process Logger with touch

Condition

- *i*Pendant has touch panel.
- Home screen of 4D Process Logger has been displayed.

Step

1 Press F2 “SELECT”.
2 Touch a map pin that represents the process you would like to select.
3 If something other than process representations is selected, the selected process becomes unselected.

Procedure 22-16 Select Process on 4D Process Logger with key

Condition

- Home screen of 4D Process Logger has been displayed.

Step

1 Press F2 “SELECT”.
2 Press UP key then a process that has the lowest process ID is selected when any process isn’t selected.
3 Press UP key when you would like to select next process.
4 Press DOWN key when you would like to select previous process.

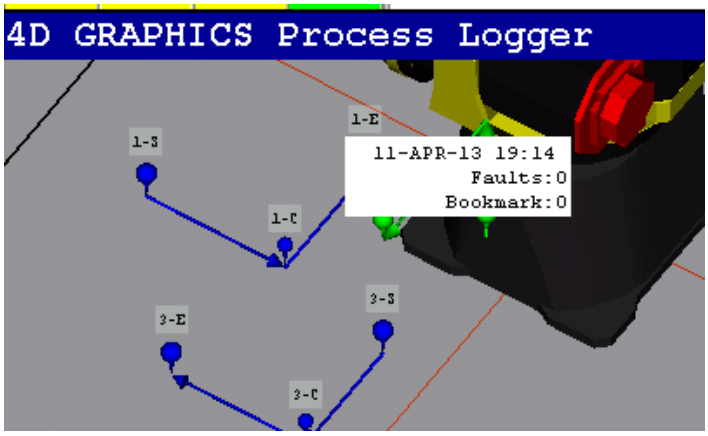


Fig. 22.6.3 (c) Pop-up on 4D Process Logger

Procedure 22-17 Change displayed record in the process

Condition

- A process has been selected and popup has been appeared.

Step

1 Press F2 “SELECT”.
2 Press LEFT key then older history is displayed.
3 Press RIGHT key then later history is displayed.

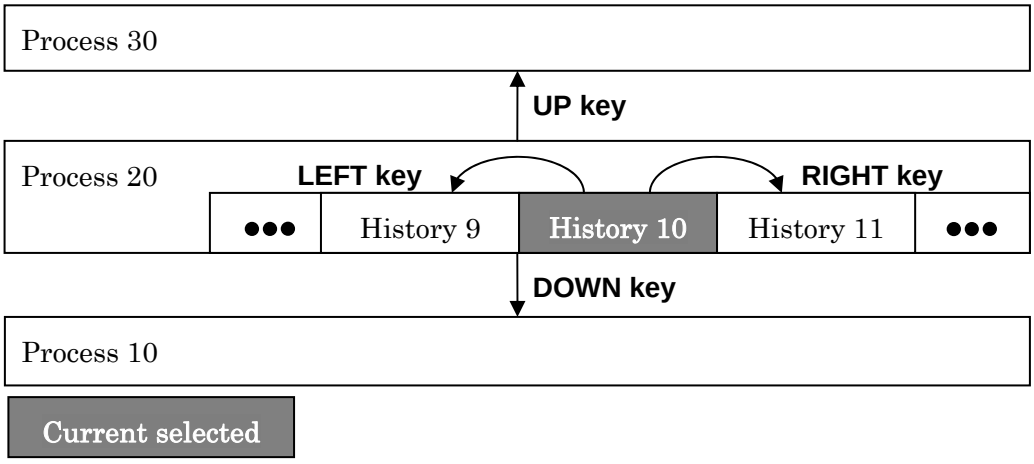


Fig. 22.6.3 (d) Key features to select process and history

22.6.4 Filtering

Filtering feature extracts processes that satisfy specified filtering conditions. When a process that have no records satisfy the filtering conditions, the process representation becomes invisible on 4D Process Logger screen and cannot select from touch, UP, DOWN key.

Procedure 22-18 Show and setup filtering condition setup dialog with touch

Condition

- *i*Pendant has touch panel.

Step

1 Press F2 “SELECT”.

2 Touch the following filtering icon.

Fig. 22.6.4 (a) Filtering icon

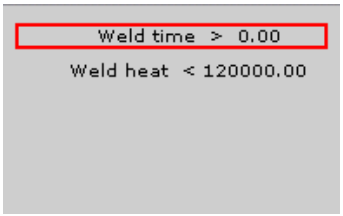


Fig. 22.6.4 (b) List of filtering condition

3 Fig. 11.6.4.(c) or (d) will appear.
4 To change a target;
a. Touch the target item text box.
b. Item list box is appeared.
c. Select the item you would like to set to target from the list.
5 To change a comparison operator;
a. Touch comparison operator text box.
b. Operator list box is appeared.
c. Select the comparison operator from the list.
6 To change a threshold value;
a. Touch threshold text box.
b. Input new threshold value.
7 After every filtering condition has been setup, press OK button, new filtering conditions are applied.
8 If you would like to back to previous filtering conditions, press Cancel button, the new filtering conditions are ignored and back to previous filtering conditions.
9 If you would like to reset every filtering condition, press Erase button, the every filtering condition is initialized.

Procedure 22-19 Show and setup filtering condition setup dialog with key

Condition

- No dialog is displayed.

Step

1 Press F2 “SELECT”.
2 Press [NEXT] key.
3 Press F4 key once.
4 The following dialog is appeared.
5 To change a target;
a. Move cursor on the target item text box and press ENTER key.
b. Item list box is appeared.
c. Select the item you would like to set to target from the list.
6 To change a comparison operator…
a. Move cursor on the comparison operator text box and press ENTER key.
b. Operator list box is appeared.
c. Select the comparison operator from the list.
7 To change a threshold value;
a. Move cursor on the threshold text box and press ENTER key.
b. Input new threshold value.
8 After every filtering condition has been setup, move cursor on OK button and press ENTER key.

9 If you would like to back to previous filtering conditions, move cursor on Cancel button and press ENTER key. The new filtering conditions are ignored and back to previous filtering conditions.

10 If you would like to reset every filtering condition, move cursor on Erase button and press ENTER key. The every filtering condition is initialized.

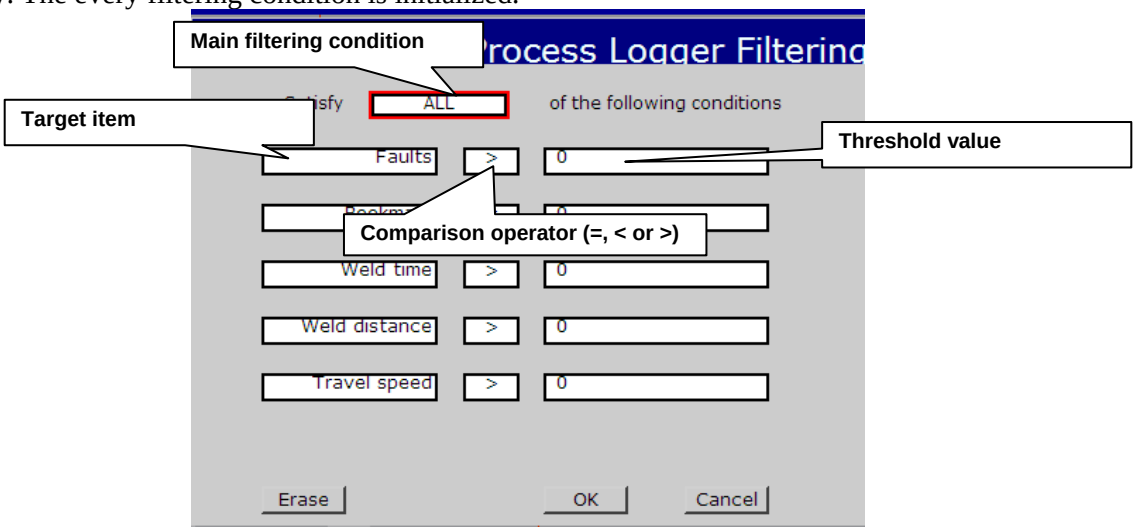


Fig. 22.6.4 (c) Filtering condition setup dialog(Normal)

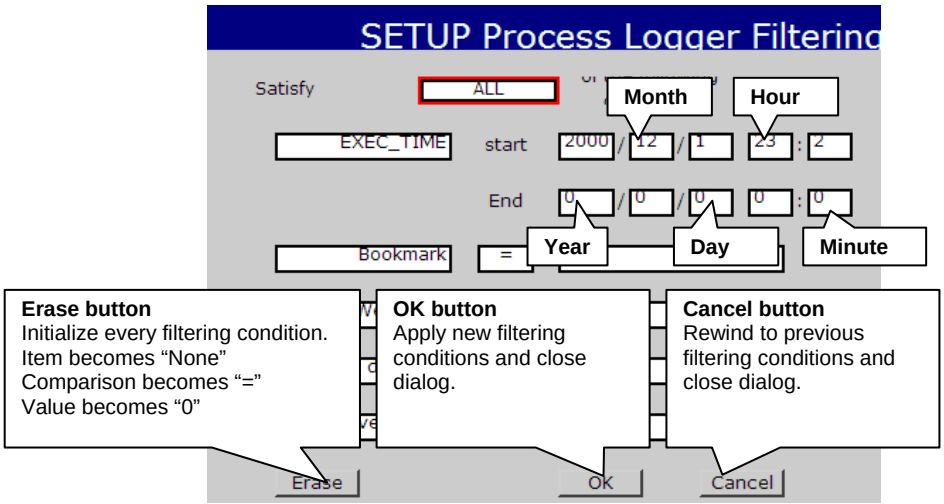


Fig. 22.6.4 (d) Filtering condition setup dialog(1st item is executed time)

There are 2 main filtering method.
"SOME": Processes that satisfy any of the filtering conditions appear on 4D Process Logger screen.
"ALL ": Processes that satisfy all of the filtering conditions appear on 4D Process Logger screen.

DATA	Conditions	Decision	
		All	Some
Fault is 2 Bookmark is 1 Weld time is 40	Fault > 0 Bookmark = 1 Weld time > 100	**Not satisfy** (Since, weld time doesn't satisfy the condition 3)	**Satisfy** (Since, Fault satisfies the condition 1)

Fig. 22.6.4 (e) Illustration of filtering condition

When filtering is applied, sub window that shows filtering condition is appeared on the right-top of screen and record data of the target item of the filtering is appeared on pop-up text.

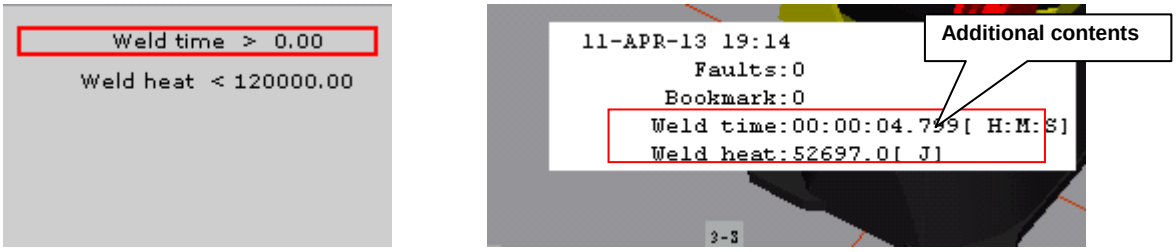


Fig. 22.6.4 (f) Sub window and additional information on popup

When a filtering is applied, the data that doesn't satisfy the filtering condition isn't appeared on pop-up screen. Therefore, UP/DOWN/LEFT/RIGHT key features differ slightly when filtering isn't applied.
For example, in the following situations,

- Process 10 has some satisfying records.
- Process 20 has some satisfying records and current selected process.
  - 9th record satisfies the condition.
  - 10th record satisfies the conditions and current selected history.
  - 11th record doesn't satisfy the conditions.
  - 12th record satisfies the conditions
- Process 30 doesn't have any records that satisfy the conditions.
- Process 40 has some satisfying records

Each key operation becomes as the followings.

UP key :	Move to Process 40 by skip Process 30.
DOWN key:	Move to Process 10.
LEFT key:	Move to 9th record in Process 20
RIGHT key:	Move to 12th record in Process 20 by skip Process 30.

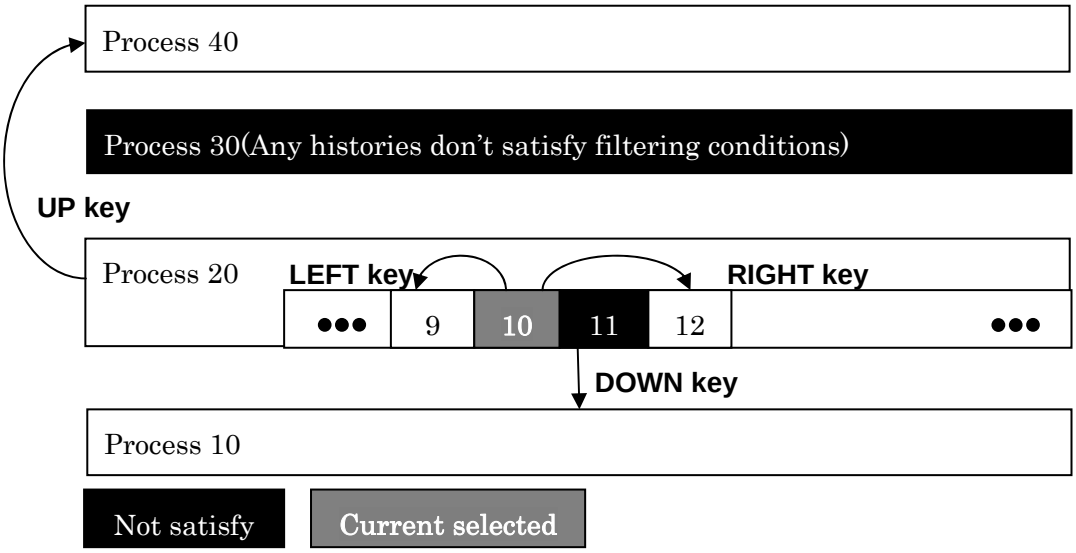


Fig. 22.6.4 (g) Key features to select process and history with filtering

22.6.5 Statistical Information

Statistical information feature shows fundamental statistical information; minimum, maximum and average of selected items at sub window on 4D Process Logger screen.

Procedure 22-20 Show and setup statistical information dialog with touch

Condition

- *i*Pendant has touch panel.

Step

1 Press F2 “SELECT”.
2 Touch the following statistical information icon. When statistical information has been displayed, touch the list of statistical information textbox.

Fig. 22.6.5 (a) Statistical information icon

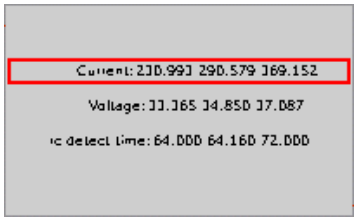


Fig. 22.6.5 (b) List of statistical information

3 Fig. 11.6.5 (c) will appear.
4 To change a target;
a. Touch the target item text box.
b. Item list box is appeared.
c. Select the item you would like to set to target from the list.
5 After every target has been setup, press OK button.
6 If you would like to back to previous filtering conditions, press Cancel button, the new filtering conditions are ignored and back to previous filtering conditions.
7 If you would like to reset every filtering condition, press Erase button, the every filtering condition is initialized.

Procedure 22-21 Show and setup statistical information dialog with key

Condition

- No dialog is displayed.

Step

1 Press F2 “SELECT”.
2 Press [NEXT] key.
3 Press F4 key twice.
4 Fig. 11.6.5.(c) will appear.
5 To change a target;
a. Move cursor on the target item text box and press ENTER key.
b. Item list box is appeared.
c. Select the item you would like to set to target from the list.
6 After every target has been setup, move cursor on OK button and press ENTER key.
7 If you would like to back to previous filtering conditions, move cursor on Cancel button and press ENTER key. The new filtering conditions are ignored and back to previous filtering conditions.
8 If you would like to reset every filtering condition, move cursor on Erase button and press ENTER key. The every filtering condition is initialized.

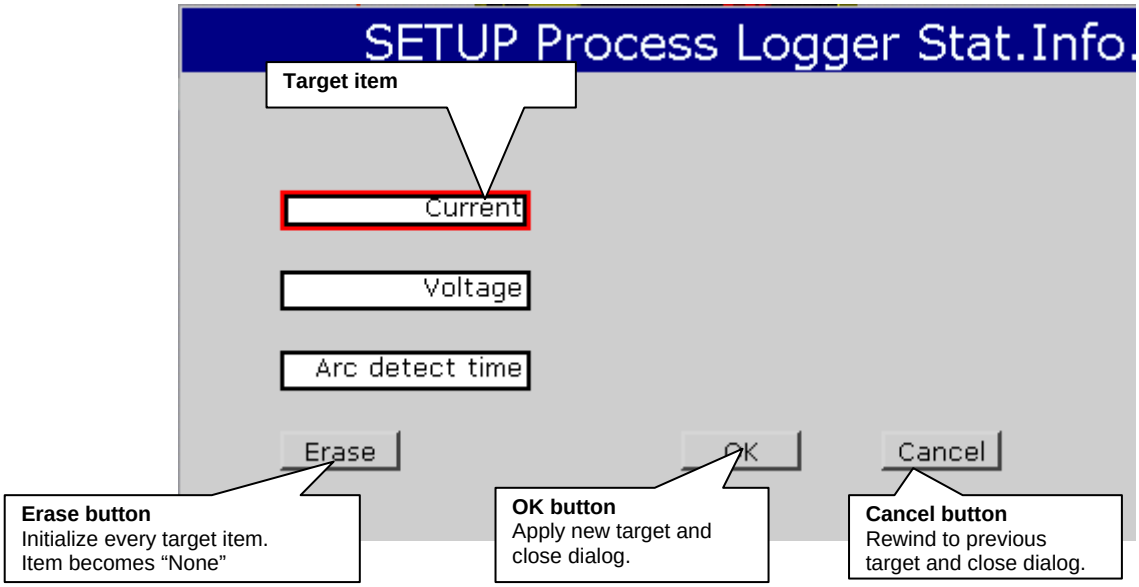


Fig. 22.6.5 (c) Statistical information setup dialog

When statistical information is setup, the following sub window is appeared at right-middle of 4D Process Logger screen. This sub window shows statistical information of current selecting process.

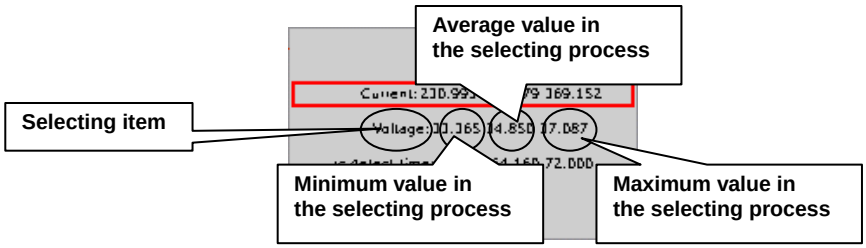


Fig. 22.6.5 (d) Sub window for statistical information

22.6.6 Chart

Chart feature show time-series behavior of each target item in a process.

Procedure 22-22 Show and setup chart dialog with touch

Condition

- *i*Pendant has touch panel.

Step

1 Press F2 "SELECT".

2 Touch the following statistical chart icon.

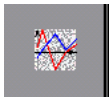


Fig. 22.6.6 (a) Chart icon

3 Fig. 22.6.6 (b) will appear.

4 To change the selecting process;
a. Press ">" button on the top of dialog to forward the process.
b. Press "<" button on the top of dialog to backward the process.
The selecting process ID is displayed at the text box between the buttons.

5 To change a target;
a. Touch the target item text box.
b. Item list box is appeared.
c. Select the item you would like to set to target from the list.

6 To change the executed date of record…
a. Press “>” button on the bottom of dialog to forward executed date.
b. Press “<” button on the bottom of dialog to backward executed date.
The selecting executed date is displayed at the text box between the buttons.
When executed date is changed, the record data displayed at below of each record item text box is also changed.

Procedure 22-23 Show and setup chart dialog with touch

Condition

- No dialog is displayed.

Step

1 Press F2 “SELECT”.
2 Press [NEXT] key.
3 Press F9 key three times.
4 The following dialog is appeared.
5 To change the selecting process…
a. Move cursor on “>” button on the top of dialog and press ENTER key to forward the process.
b. Move cursor on “<” button on the top of dialog and press ENTER key to backward the process.
The selecting process ID is displayed at the text box between the buttons.
6 To change a target…
a. Move cursor on the target item text box and press ENTER key.
b. Item list box is appeared.
c. Select the item you would like to set to target from the list.
7 To change the executed date of record…
a. Move cursor on “>” button on the bottom of dialog and press ENTER key to forward executed date.
b. Move cursor on “<” button on the bottom of dialog and press ENTER key to backward executed date.
The selecting executed date is displayed at the text box between the buttons.
When executed date is changed, the record data displayed at below of each record item text box is also changed.

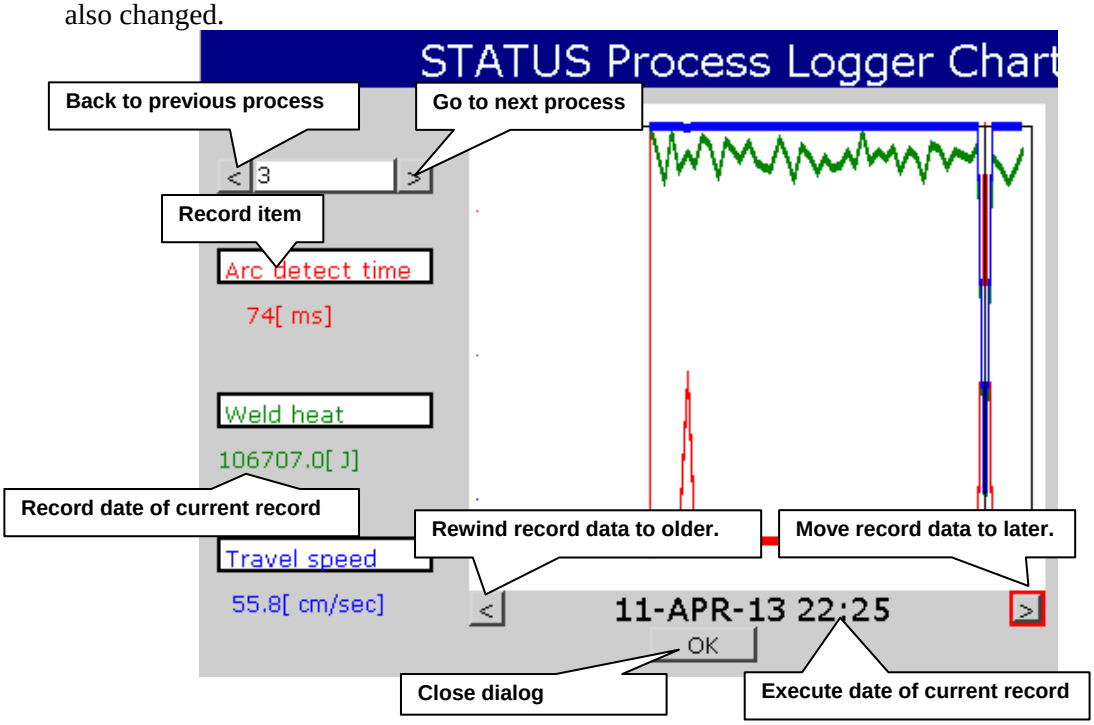


Fig. 22.6.6 (b) Chart dialog on 4D Process Logger screen

23 AUTOMATIC VOLTAGE CONTROL TRACKING

23.1 OUTLINE

In many gas tungsten arc welding (TIG) applications, the weld joint location varies to a degree that weld quality is not acceptable. Typically, these applications cannot be welded satisfactorily by a robot without some means of adaptive control.

Inconsistent forming, castings, tolerance stack-up, distortion and fixture are just some of the common causes of repeatability problems. Sensors adapt the path of the robot to the weld seam to ensure consistent weld quality.
Automatic Voltage Control (AVC) is used in constant current welding processes. In these processes, the voltage varies as a function of the distance between the electrode and the weld puddle.
AVC can be used on linear or circular paths.
Basic functionality of the software is almost the same as TAST tracking function (refer to Chapter 20), and there are many common points except using current feedback for tracking. The explanations in this chapter are only limited to vertical tracking. If some lacks are found, please refer to Chapter 20.

This function is an option (A05B-XXXX-J526). This function is also included in TIG Arc Welding Package (A05B-XXXX-J582).

NOTE
This function does not support A motion instruction.

NOTE
1 The six point method for setting the tool frame must be used for proper tracking. When jogging in tool, coordinate z+ should move along the nozzle of the torch and away from the work.
2 This function can be used only when the user can get the stable feedback voltage value.
3 Please set “Return to path” in Arc Welding System Setup screen to ENABLED (refer to Section 3.3).

23.2 AVC TRACKING

AVC allows the robot to track a weld seam by monitoring changes in the weld voltage both vertically and across the seam. The information provided by AVC enables the system to adjust the robot path to keep the weld aligned with the joint.

Vertical Plane (Z-Plane) Tracking

The weld can distort either downward away from the torch or upward toward the torch. AVC tracks the voltage during the weld so the robot path can be offset to compensate for distortion or inconsistent parts. See Fig. 23.2.

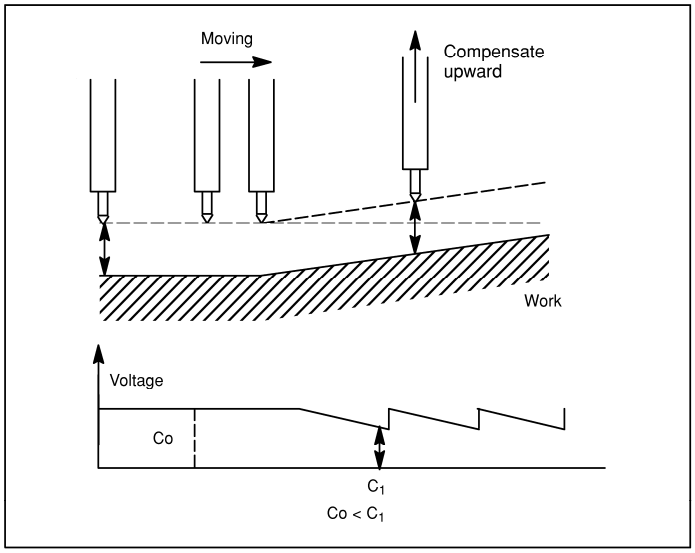


Fig. 23.2 AVC vertical tracking

When AVC vertically tracks a weld, it compares the voltage to a reference voltage setting.
If the weld seam is offset downward away from the weld torch, the voltage of the arc increases due to resistance caused by a lengthening of the arc length. A path offset will be issued to move the welding torch closer to the seam.
If the weld seam is offset upward toward the torch, the voltage decreases because the arc length is shortened, causing less resistance. The offset then corrects the robot path by moving it farther away from the seam.

The reference voltage can be set to a constant value when tracking vertically. Refer to “Master Voltage Adjustment for Vertical Tracking” in Section 23.6.

23.3 FACTORS THAT AFFECT AVC TRACKING

AVC performance can be affected by a number of factors. For most applications, however, after parameters are set, in-process adjustments are not required.

Factors that can affect AVC are:
- Changes in welding electrode type or diameter
- Extreme changes in weld size
- Changes in the welding arc location in respect to the weld puddle
- Gas composition
- Changes in weaving condition (frequency, dwell time)
- Material surface condition

> ⚠ **CAUTION**
> If you use the On-The-Fly function to change welding conditions or welding speed during AVC execution, AVC performance is affected.

23.4 AVC HARDWARE REQUIREMENTS

The welding power source (interface) must provide analog feedback signals that correspond to the voltage at the weld.
Additional filtering can be required if a pulsed power supply is used.
Pulsing above 60 Hz will not cause problems.

23.5 AVC INSTRUCTIONS

The instructions execute sensing process with AVC function.

AVC instruction has following instructions.

- Track AVC[i] instruction
- Track End instruction

Track AVC [i]

Start sensing process based on the selected AVC schedule.

```
Track AVC [ i ]
              └── AVC schedule number
```

Example
```
1: Track AVC[2]
2: Track AVC[ R[5] ]
```

Track AVC[3]

AVC schedule

AVC schedule	
V Gain	22.5
L Gain	15
V Volt	12.0V
V Bias	4.0 %
L Bias	0.0 %

```
DATA AVC Sched
                                        1/20
        V-Gain-L  V_Volt(V) V-Bias(%)-L
  1  20.0   15.0    0.0    0.0       0.0
  2  20.0   15.0    0.0    0.0       0.0
  3  22.5   28.0   12.0    4.0       0.0
  4  20.0   15.0    0.0    0.0       0.0
```

Fig. 23.5 (a) Track AVC[i] instruction

Track End

Stop sensing process.

```
Track End
```

Example
```
1: Track End
```

Fig. 23.5 (b) Track end instruction

Procedure 23-1 Teaching of Track instructions

Condition

- Program edit screen has been displayed
- Teach pendant is enabled

Step

1 Press NEXT key and then press F1[INST]. Following list of instructions is displayed.

```
      Instruction 2
1 Miscellaneous
2 Weave
3 Skip
4 Payload
5 Track/Offset
6 Offset/Frames
7 Multiple control
8 --next page--
```

2 Select Track/Offset. Following list of Track/Offset instructions is displayed. If you want to teach Track AVC instruction, please select Track.

```
     Track/Offset 1
1 Track
2 Track End
3 MP Offset
4 MP Offset End
5 Track RPM
6 Track End[]
7
8
```

3 Enter AVC schedule number to [] on the instruction.
4 If you want to teach Track End instruction, please select Track End on Step 2.

Sample Program of AVC

Fig. 23.5 (c) is the sample program which using Track instructions.

```
AVC1
                                        5/10
     1: J  P[1] 30% CNT100
     2: L  P[2] 500mm/sec CNT100
     3: L  P[3] 100mm/sec FINE
       :   Weld Start[1,1]
     4:    Weave Sine[1]
     5:    Track AVC[1]
     6: L  P[4] 30cm/min FINE
     7:    Weld End[1,2]
     8:    Track End
     9: L  P[5] 500mm/sec FINE
   [End]
```

Fig. 23.5 (c) Sample program of AVC

Detailed Specifications of Track Instructions

- There is no limitation about the order of Weld instruction, Weaving and Track instruction.
- Teach Track AVC instruction at the start point of arc welding.
- The tracking by AVC is performed only with Weld Enabled (refer to Section 5.3). The tracking is never performed when Track AVC instruction is executed with Weld Disabled.

> ⚠ **CAUTION**
> If you use the on-the-fly function or ArcTool Ramping function to change welding schedules, welding speed and weaving schedules during AVC execution, AVC performance will be affected and the result cannot be expected.

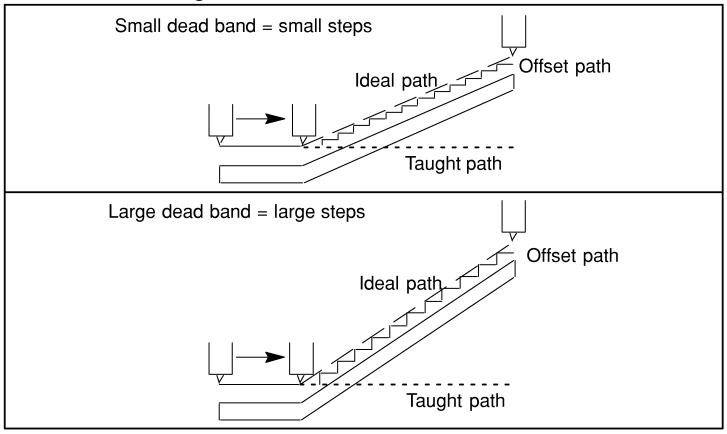
23.6 AVC SCHEDULE SETUP

An AVC schedule allows you to set how AVC will function. There are two screens associated with AVC: the SCHEDULE screen and the DETAIL screen. The schedule screen allows you to view limited information for all AVC schedules. The detail screen allows you to view the complete information for a single AVC schedule.
Table 23.6 (a) lists and describes each condition on the AVC schedule screen.
Table 23.6 (b) lists and describes each condition on the AVC detail screen.

Table 23.6 (a) AVC setup condition schedule screen

CONDITION	DESCRIPTION
V-Gain-L	This item displays and allows you to change the vertical and lateral gain.
V_Volt(V)	This item displays and allows you to change the vertical voltage.
V-Bias(%)-L	This item displays and allows you to change the vertical and lateral bias.

Table 23.6 (b) AVC setup conditions

CONDITION	DESCRIPTION
AVC Schedule:[n]	This item indicates the schedule whose information is currently being displayed and allows you to change to a different schedule.
AVC schedule [ ]	This item allows you to enter a comment for this schedule.
V_compensation enable default: TRUE	This item allows you to enable or disable AVC tracking in the vertical direction (z plane). If both L_compensation enable and V_compensation enable are disabled, AVC is non-functional. -**TRUE** indicates that AVC tracking in the vertical direction is enabled. -**FALSE** indicates that AVC tracking in the vertical direction is disabled.
L_compensation enable	This item is not used.
V_master voltage type (feedback/constant) default: FEEDBACK:	This item allows you to specify whether the arc welding system uses the actual weld controller feedback for the reference sample or uses value of V_master voltage constant as the reference sample. The reference sample is the value to which the arc welding compares the tracking data. -**FEEDBACK** indicates that the actual weld controller feedback will be used for the reference sample. **-CONSTANT** indicates that the value of the V_master voltage constant will be used for the reference sample.
Sampling timing (no WV) default: 0.5 sec	This item allows you to set the length of time that the arc welding system will sample the voltage feedback. This is used for tracking without weaving only.
Comp frame (no WV) default: TOOL	This item allows you to specify the frame, either Tool or User, which will be used as the reference frame when tracking without weaving. This frame must be accurately defined for AVC to function correctly. **-TOOL** indicates that the tool frame will be used as the reference frame when tracking. **-USER** indicates that the user frame will be used as the reference frame when tracking.
V_compensation gain (sensitivity) default: 20.0	This item allows you to specify the conversion scale the arc welding system uses to convert the incoming voltage to millimeters per 10 volts and add to the compensation data when tracking vertically.
V_dead band default: 0 mm	This item allows you to specify an amount of data, in millimeters, which the arc welding system will ignore before generating an offset. If the V_dead band value is set to 0.5mm, the software will not generate an offset until the required offset exceeds 0.5mm. V_dead band is used for arc welding systems that have unstable feedback conditions. See Fig. 23.6.  **Fig. 23.6 V_dead band**

CONDITION	DESCRIPTION
V_bias rate (up+) default: 0 %	This item allows you to set the percentage that the offset will compensate towards the top or bottom of a weld. Gravity can cause the downhill side of a weld to enlarge and degrade tracking. If this value is set to a negative percentage, the bias will reduce the arc length. If this value is set to a positive percentage, the bias will increase the arc length.
V_tracking limit default: 600.0 mm	This item sets the length, in millimeters, that arc welding system will track the weld vertically. If this value is set to 0, vertical tracking is disabled. If the weld extends beyond this length, vertical tracking is disabled.
V_tracking limit per cycle default: 0.4 mm	This item allows you to specify the length, in millimeters, the arc welding system will track the weld per cycle. If the tracking compensation for vertical direction is not enough, increase the value.
V_compensation start count default: 5	This item allows you to specify the cycle when the arc welding system will start to track the weld vertically. This allows time for the arc to stabilize prior to tracking. If the value is set to less than 4, the value is ignored and the system starts to track on the third cycle.
V_master sampling start count (feedback) default: 4	This item allows you to specify at which cycle the arc welding system will start collecting the reference sample. This allows the arc enough time to stabilize before recording the sample data.
V_master sampling count (feedback) default: 1	This item allows you to specify the number of cycles for which the arc welding system will collect the reference sample.
V_master voltage constant data (constant) default: 0.0 V	This item allows you to specify a constant value used as the reference sample instead of using feedback from the system. When V_master voltage type is specified as the reference sample, the arc welding system sets the reference voltage automatically.
L_compensation gain	This item is not used.
L_dead band	This item is not used.
L_bias rate (right +)	This item is not used.
L_tracking limit	This item is not used.
L_tracking limit per cycle	This item is not used.
L_compensation start count	This item is not used.
Robot group mask	This item allows you to specify the motion group that is actually doing the welding. If you do not have multiple motion groups, do not change default state. If you use AVC tracking on multi group system, please set “1” on the group which is compensated by AVC.
Adjust delay time	This item is not used.
Adaptive Gain Control	AVC checks the direction of vertical or lateral calculated compensation values (up/down or right/left) for each cycle. If the check determines the compensation value uses the same direction multiple times, then this indicates the offset is still smaller than the actual value. Adaptive gain allows you to set a value that is multiplied times the gain value. The applied offset is larger than normal and the torch can return to the weld center quickly. Over the weld center, the gain value is set to normal.
V_AG_correction count (0: disable) default: 0 cyc	This item allows you to specify the cycle in which the adaptive gain control begins checking the compensation direction. The vertical adaptive gain function is effective if the calculated compensation values are found to be slanted to one side (up/down). If the V_AG correction count is set to 0, it is automatically disabled. The vertical adaptive gain function is enabled when the V_AG correction count is set to 2.
L_AG_correction count	This item is not used.
V_AG_correction band default: 4.0	This item allows you to specify the amount of data to which the lateral adaptive gain function compares the calculated compensation. If the value is set to a small amount, the adaptive gain is disabled until the required offset exceeds the set value.A value of over 6.0 is required when using a small circular weld or when the weld is not stable.
L_AG_correction band	This item is not used.

CONDITION	DESCRIPTION
V_AG_multiplier default: 1.5	This item allows you to specify the multiplier when vertical adaptive gain is enabled.
L_AG_multiplier	This item is not used.
AVC Equip Mask	This item specifies the welding equipment number used for the AVC. If you do not have multiple equipment system, do not change default state. If you use AVC tracking on multi equipment system, please set “1” on the equipment which is used by AVC.

Procedure 23-2 Setting Up AVC Schedule

Step

1 Press [MENU] key. Then, press DATA.
2 Press F1, [TYPE]. Following menu is displayed.

```
                Type  1
1 Weld Procedure
2 Registers
3 Position Reg
4 String Reg
5 Track Sched
6 KAREL Vars
7 KAREL Posns
8 -- NEXT --
```

3 Select Track Sched. You will see a screen similar to the following.

AVC schedule list screen

```
DATA AVC Sched
                                        1/20
          V-Gain-L  V_Volt(V)  V-Bias(%)-L
      1  20.0   15.0    0.0    0.0      0.0
      2  20.0   15.0    0.0    0.0      0.0
      3  20.0   15.0    0.0    0.0      0.0
      4  20.0   15.0    0.0    0.0      0.0
      5  20.0   15.0    0.0    0.0      0.0
      6  20.0   15.0    0.0    0.0      0.0
      7  20.0   15.0    0.0    0.0      0.0
      8  20.0   15.0    0.0    0.0      0.0
      9  20.0   15.0    0.0    0.0      0.0

   [TYPE]  DETAIL                    HELP  >
                COPY    CLEAR                >
```

4 To set an item, move the cursor to the setting field, then enter a desired value.
5 When copying a set schedule, move the cursor to the schedule number to be copied, press F2 (COPY) on the next page, then enter a copy destination schedule number.
6 When deleting a set schedule, move the cursor to the schedule number to be deleted, then press F3 (CLEAR) on the next page.
7 Press F2, DETAIL. You will see a screen similar to the following.

AVC schedule detail screen

```
DATA AVC Sched
                                        1/30
      AVC Schedule: [ 1]

      1 AVC Schedule: [    Schedule 1 ]
      2 V_compensation enable:     TRUE
      3 L_compensation enable:     FALSE
      4 V_master voltage type:     FEEDBK
        (feedback/constant)
      5 Sampling timing (no WV):   .50   sec
      6 Comp frame (no WV):        TOOL
      7 V_compensation gain:       20.0
        (sensitivity)
      8 V_dead band:               0.0   mm
      9 V_bias rate (up+):         0.0   %
     10 V_tracking limit:          600.0  mm
     11 V_tracking limit per cycle:.4     mm
     12 V_compensation start count:5    cyc
     13 V_master sampling start:   4    cyc
        count (feedback)
     14 V_master sampling count:   1    cyc
        (feedback)
     15 V_master voltage constant: 0.0   V
        data (constant)
                        .
                        .
                        .
 [TYPE] SCHEDULE                    HELP  >
        COPY    CLEAR                      >
```

8 To add a comment:
   a Move the cursor to the to the comment line and press ENTER.
   b Select a method of naming the comment.
   c Press the appropriate function keys to add the comment.
   d When you are finished, press ENTER.
9 To set items except comment, move the cursor to the setting field, then enter a desired value or press function keys for select.
10 To return AVC schedule list screen, press PREV key.

Master Voltage Adjustment for Vertical Tracking

You can specify the setup method of master current for vertical tracking by “V_master voltage type” in AVC schedule. Master current data will decide the arc length during AVC.

When “V_master voltage type” is “CONST”, the value on “V_master voltage constant data” is always used. You can always weld with the same arc length when you use the same combination of weld schedule and AVC schedule, and stable result will be obtained. On the other hand, you must prepare the other V_master voltage constant data for other weld sections that have other weld schedule. Feedback voltage may not be the same value with command voltage, please confirm the correct value and then input the value to V_master voltage constant data.

When “V_master voltage type” is “FEEDBK”, voltage value at the weld start point is always obtained at each weld, and this value will be used as V_master voltage constant data. The master voltage value at each weld will have some unevenness about few Volts. Therefore, the arc length will vary by the unevenness.

If you perform AVC once with “FEEDBK” as V_master voltage type, the obtained value by “FEEDBK” is stored to V_master voltage constant data automatically. After that, it is possible to switch “CONST” and use this value which obtained with “FEEDBACK”.

23.7 USE TOGETHER WITH PULSE HEATWAVE

Since 7DC2 (V8.20) version software, it becomes possible to use AVC with Pulse HeatWave.
Software can automatically judge weather AVC is used with Pulse HeatWave, and tracking is performed based on the feedback voltage during peak output (Refer to Fig. 23.7).
Regarding to Pulse HeatWave, please refer to Section 10.3 and Section 10.5.

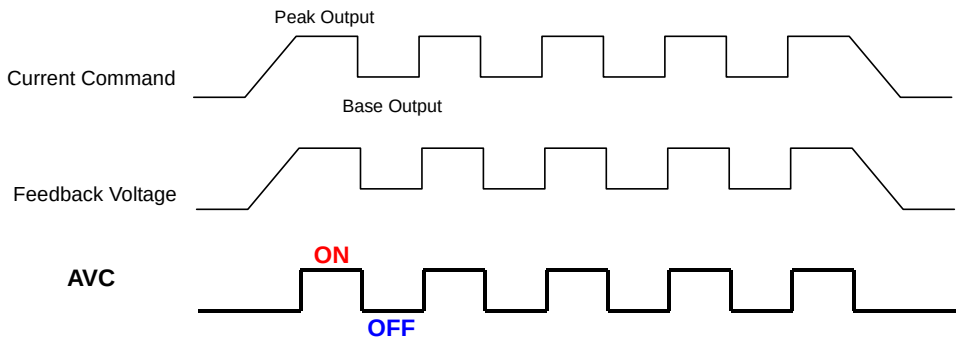


Fig. 23.7 Use AVC with Pulse HeatWave

When you use AVC with Pulse HeatWave, following setup is recommended.

- Set “V_master voltage type” to “FEEDBK” and input average of voltage during peak output as “V_master voltage constant”.
- Set shorter time (about 0.03 sec) as “Sampling timing (no WV)”.
- Set higher compensation gain (about 90) than normal AVC.
- Set 3Hz or smaller frequency for Pulse HeatWave.

24 ARC START HEIGHT ADJUST FUNCTION

24.1 OUTLINE OF ARC START HEIGHT ADJUST FUNCTION

Generally at the Arc Start timing of TIG welding, arc start often fails if the distance between workpiece and tungsten electrode is not appropriate. Additionally, if the electrode touches the surface of the workpiece and then High-frequency start for TIG welding is done, there is a case that the electrode sticks the work. Therefore, the distance between workpiece and electrode at the arc start timing is very important. However, it is difficult to keep the same distance at every time by an exhausted electrode and individual difference and installation error of a workpiece.
Arc Start Height Adjust Function detects the position of the work surface by a sensor such as stick detection circuit and then raise-up the electrode by specified height just before arc start (refer to Fig. 24.1(a)). This function can keep the constant distance between electrode and workpiece at every arc start timing, and it achieves a stable and non-failure arc start. It is possible to perform Arc Start Height Adjust Function after setting on the setup screen and teaching the macro instruction (refer to Fig. 24.1(b)).

This function is included in TIG Arc Welding Package (A05B-XXXX-J582).

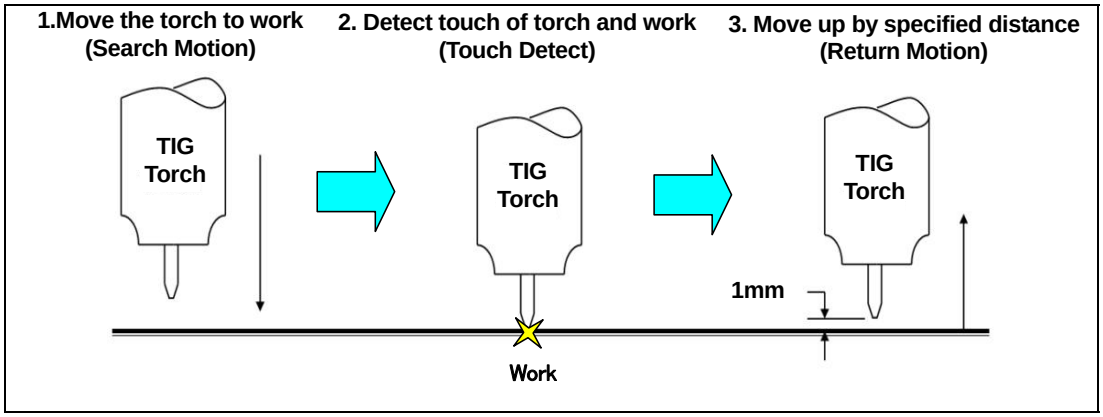


Fig. 24.1 (a) Outline of arc start height adjust function

```
Sample1
                                        3/11
      1: J  P[1] 30% CNT100
      2: L  P[2] 100mm/sec FINE
      3:   Adjust Start Height
      4:   Weld Start[1,1]
      5: L  P[3] 60cm/min CNT100
      6: L  P[4] 60cm/min CNT100
      7: L  P[5] 60cm/min FINE
      8:   Weld End[1,2]
      9: L  P[6] 100mm/sec CNT100
     10: J  P[1] 100% FINE
    [END]
```

Fig. 24.1 (b) Program sample of arc start height adjust function

⚠ CAUTION

- This function is designed by the assumption that this is executed just before Weld Start. Therefore, do not execute Arc Start Height Adjust except just before Arc Weld Start instruction.
- Arc Weld Start instruction after Arc Start Height Adjust should be “Single Instruction”, and you cannot use additional-motion Arc Weld Start Instruction.

Before Use

Please confirm followings before using of Arc Start Height Adjust Function.

- This function adjusts the height by detecting the touch between the top of electrode and the workpiece with Wirestick Detection Circuit. If Wirestick Detection Circuit is not provided, prepare the mechanism such as a touch sensor (mechanism that applies a voltage between two points, and enters a signal for detecting a short circuit between two points) between the electrode and the workpiece. Generally Wirestick Detection Circuit uses a low voltage. Therefore, if a sufficient voltage is not applied, please provide a similar mechanism.
- The macro for height adjust is prepared beforehand in Arc Start Height Adjust system. Additionally, position registers set in Arc Start Height Adjust Setup screen are used for exclusive use.

> ⚠ **CAUTION**
> Do not forget the TCP setup before using this function.

24.2 SETUP OF ARC START HEIGHT ADJUST FUNCTION

About the setup of Arc Start Height Adjust Function, please refer to following Procedure 24-1.

Procedure 24-1 Setup of Arc Start Height Adjust

Step

1 Press [MENU] key and select “6 SETUP”.

2 Press F1[TYPE] and select “Weld Equip”. Weld Equipment Setup screen is displayed.

Weld equipment setup screen

```
SETUP Weld Equip
                                        4/8
     1 WIRE+ WIRE- speed:          80 cm/min
     2 High WIRE+ speed:           500cm/min
     3 Feed forward/backward:      DISABLED
     4 Start Height Adjust:        <*DETAIL*>

   Timing
     5 Arc Start error time:       1.40  sec
     6 Arc detect time:            0.005 sec
     7 Arc loss error time:        0.25  sec
     8 Gas detect time:            0.05

   [TYPE]
```

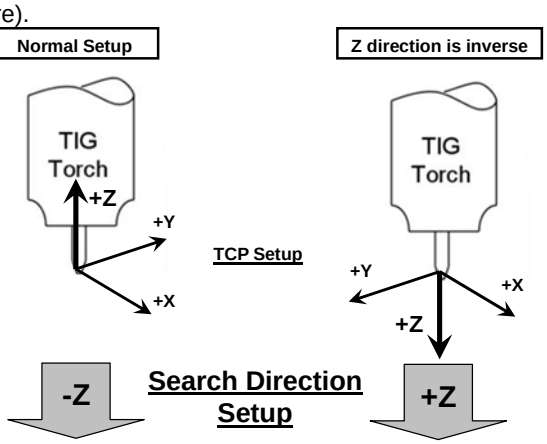
3 Move the cursor on <*DETAIL*> of “Start Height Adjust” line and then press ENTER key. Arc Start Height Adjust Setup screen is displayed.

Arc start height adjust setup screen

```
SETUP Start Height Adjust
                                        1/12
     1 Robot Group:                1
     2 Touch Command Signal:       DO[  1]
     3 Touch Detect Signal:        DI[  1]
     4 Start Height:               1.00 mm
     5 Speed to Start Position:    100  mm/sec
     6 Search Direction:           -Z
     7 Search Speed:                 5  mm/sec
     8 Search Max Distance:        10.00  mm
     9 Skip with Weld Disabled:    TRUE
    10 Contact Before Search:      STOP
    11 PR No. for Work Detect:     PR[ 80]
    12 PR No. for Start Pos:       PR[ 81]

   [TYPE]  RETURN                  HELP
```

4 Set the proper signal to “Touch Command Signal” and “Touch Detect Signal”. (In ROBOWELD*i*C series, this operation is not required because they are assigned automatically.)
5 Refer to Table 24.2 and set “Start Height”, “Search Speed” etc.

Table 24.2 Setting for arc start height adjust

SETTING ITEM	DESCRIPTION
Robot Group	In the multi-robot system, specify the robot group number that the weld equipment is connected to. You cannot specify the group number except for robot (EX: Positioner etc.) If the system is single robot system (not multi-robot system), do not change the number from 1. If multi-equipment system is used, please refer to Section 24.5 Teaching of Arc Start Height Adjust in Multi-Equipment System.
Touch Command Signal	This signal becomes ON automatically during search motion of Arc Start Height Adjust. Specify the port type and the port number. If invalid signal (bodiless signal) is assigned and Arc Start Height Adjust is performed, “ARC-303 Invalid I/O assignment” alarm is posted and the program is paused. In ROBOWELD*i*C series, this signal is automatically assigned to the proper signal, so user should not change the assignment.
Touch Detect Signal	This specifies the signal for detecting the touch to the workpiece during Arc Start Height Adjust. Specify the port type and the port number. If invalid signal (bodiless signal) is assigned and Arc Start Height Adjust is performed, “ARC-303 Invalid I/O assignment” alarm is posted and the program is paused. In ROBOWELD*i*C series, this signal is automatically assigned to the proper signal, so user should not change the assignment.
Start Height	This specifies the distance between the workpiece and the electrode (the raise-up distance after touch detection) at the Arc Start timing. At the Arc Start Height Adjust motion, electrode is raised-up from the workpiece after detecting the touch, and the distance from the work surface to the top of the electrode becomes the Start Height.
Speed to Start Position	This specifies the moving speed during raise-up of the electrode from the work surface to Arc Start position.
Search Direction	This specifies the search direction during the search motion to the work surface. If TCP (Tool Coordinate Point setup) has already been set properly for Arc Welding Robot (refer to the lower left figure), do not change the item form “-Z”. Change the item to “+Z” only if TCP is set inverse direction from the standard (refer to the lower right figure). 
Search Speed	This specifies the moving speed during the search of work surface. If the speed is slower, the detection accuracy of the work surface position becomes higher.
Search Max Distance	If the work is not detected (Touch Detect Signal never becomes ON) after moving the Search Max Distance during search motion, “ARC-308 Contact is not detected” alarm is posted and the program is paused.

SETTING ITEM	DESCRIPTION
Skip with Weld Disabled	If this item is set to “TRUE” and Arc Start Height Adjust is performed with Weld Disabled, “ARC-306 Start Height Adjust is ignored” Warning Message is posted, the macro instruction “Adjust Start Height” is ignored and auto adjustment is never performed. On the other hand, If this item is set to “FALSE”, Arc Start Height Adjust is performed even with Weld Disabled.
Contact Before Search	This specifies the reaction when the electrode has already touched to the work surface at the search start timing. • **STOP** “ARC-307 Contact before search” is posted with STOP.L alarm severity, and the program is paused. • **WARN** Search motion is immediately finished and the motion to Arc Start position is started. Then, “ARC-307 Contact before search” is posted with WARN alarm severity.
PR No. for Work Detect	The specified PR No. is used temporarily for saving the position of work detection in Arc Start Height Adjust motion. Change the default PR No. and specify other PR No. only when the PR No. is used for other function or other purpose.
PR No. for Start Pos	The specified PR No. is used temporarily for executing the raise-up motion of the electrode from the work surface. Change the default PR No. and specify other PR No. only when the PR No. is used for other function or other purpose.

⚠ **CAUTION**

- If “Touch Command Signal” or “Touch Detect Signal” is assigned with improper state and Arc Start Height Adjust is performed, the electrode continues to move to the workpiece after touching the workpiece, because the touch is never detected. As a result, it is a possibility to damage the electrode.
- If Search Speed is higher, the electrode clash to the workpiece and it is a possibility to damage the electrode, or the electrode does not reach to the specified Start Height. Therefore, please set the speed as slower as possible. (About 5mm/sec is recommended.)
- Values in PR No. for Work Detect is automatically overwritten at every height adjust motion. Therefore, do not use this PR No. for other function or other purpose.
- Values in PR No. for Start Pos is automatically overwritten at every height adjust motion. Therefore, do not use this PR No. for other function or other purpose.

24.3 TEACHING OF ARC START HEIGHT ADJUST

Arc Start Height Adjust is achieved by adding the following macro instruction just before Arc Weld Start instruction. Please refer to Procedure 24-2.

Adjust Start Height

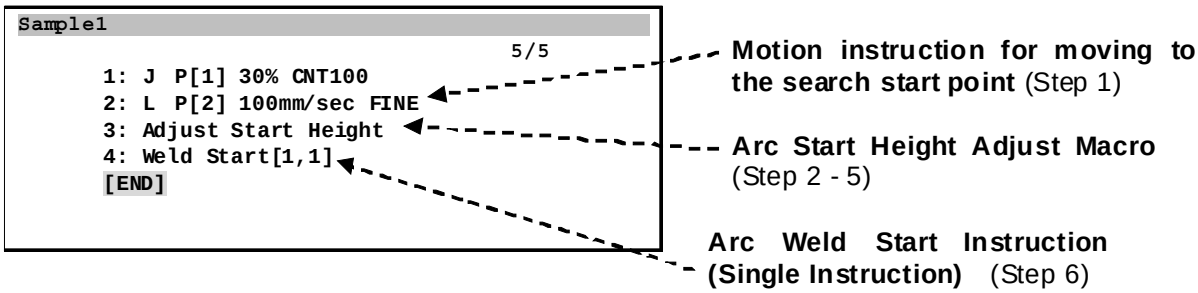
Procedure 24-2 Teaching of Arc Start Height Adjust Macro

Condition

- The group number specified in “Robot Group” item on Arc Start Height Adjust Setup screen is set on the Group Mask in Program Detail.
- Program Edit screen is displayed.
- Teach Pendant is ON.

Step

1 Move the robot to the start position of Arc Start Height Adjust motion and teach the motion instruction. Set “FINE” as positioning path mode. The position becomes the start position of the search motion.
2 Next, add “Adjust Start Height” macro instruction. Then, move the cursor to the next line.
3 Press “F->” key and then press “F1 INST”key. The list of instruction is displayed.
4 Select “MACRO” from the list. Then, possible macro instruction list is displayed.
5 Select “Adjust Start Height” macro from the list. “Adjust Start Height” macro is taught on the program.
6 Add Single Arc Weld Start instruction to the next line.



7 Make an arc welding program as usual.

⚠ CAUTION

- This function is designed by the assumption that this is executed just before Weld Start. Therefore, do not execute Arc Start Height Adjust except just before Arc Weld Start instruction.
- Arc Weld Start instruction after Arc Start Height Adjust should be “Single Instruction”, and you cannot use additional-motion Arc Weld Start Instruction.
- Do not use “CNT” and must use “FINE” in the motion instruction just before “Start Height Adjust” instruction.
- Search motion is performed to the “-Z” direction (or “+Z direction”) of selected Tool Coordinate Number during Arc Start Height Adjust. You must select the Tool Coordinate Number for the target torch.

NOTE

- Cannot perform program execution when “Start Height Adjust” is taught between “A P” motion instructions.
- When the robot moves over the distance specified by “Max Search Distance” and touch is never detected, “ARC-308 Contact is not detected” is posted and the program is paused. On the other hand, touch is detected before search start, “ARC-307 Contact before search” is posted (At this time, if “Contact before search” item is “STOP”, the program is paused.). Therefore, it is recommended that search start position is not too close, and not too far.

24.4 OTHERS

- When program is resumed during arc welding, Arc Start Height Adjust is not performed.
- Arc Start Height Adjust is never performed during Step execution, Dry Run and Backward Motion. Then, “ARC-306 Start Height Adjust is ignored” warning message is posted.
- (Only ROBOWELD*i*C series) If the weld equipment is not turned on or if the connection to the weld equipment is not established (“ARC-045 Weld EQ is OFFLINE” is posted), Arc Start Height Adjust is never performed. Then, “ARC-306 Start Height Adjust is ignored” warning message is posted.
- The motion speed during Arc Start Height Adjust depends on the override value.
- 10 seconds has passed since Arc Start Height Adjust is started and this is not completed, “ARC-310 Too long adjust motion time” alarm is posted and program is paused.
- When program is paused during Arc Start Height Adjust motion, the robot returns to the search start point (position of the previous motion instruction) at the resume timing and then restart the search motion. The speed of the return motion becomes “Return to path speed” for “Weld Restart Function” (Weld System Setup screen).
- If the robot group number in “Robot Group” item of Arc Start Height Adjust Setup screen is not set on the Group Mask of Program Detail and if Arc Start Height Adjust is performed, “ARC-302 Invalid robot group number” is posted and program is paused.

24.5 TEACHING OF ARC START HEIGHT ADJUST WITH MULTI-EQUIPMENT

In this section, the execution method of Arc Start Height Adjust under Multi-Equipment environment is explained. If only one (single) weld equipment is used in this robot system, this explanation is never required.

Execution with Multi-Equipment

Following 4 macro instructions (instead of conventional “Adjust Start Height” instruction) are automatically prepared under Multi-Equipment environment.

Adjust Start Height 1
Adjust Start Height 2
Adjust Start Height 3
Adjust Start Height 4

Values attached at the last of instructions (1 - 4) are “ID Number” of macro instructions. The teaching method of instructions is changed by a configuration of the program. Additionally, Arc Start Height Adjust Setup screen is prepared for each weld equipment number. In this screen, you should specify a proper robot group number for each weld equipment.

Execute for Single Robot under Multi-Equipment Environment

Under multi-equipment environment, if Arc Start Height Adjust is performed only for single arc welding robot, ID Number in the macro instruction is used as “Equipment Number”.
For example, in the system which has 2 arc welding robots such as Fig. 24.5 (a), if Arc Start Height Adjust is performed only for the arc welding robot (Group 2) which is connected to Weld Equipment 2, “Adjust Start Height 2” should be taught in the program. In the case, “2” should be set as “Robot Group” item in Arc Start Height Adjust Setup screen for Weld Equipment 2.

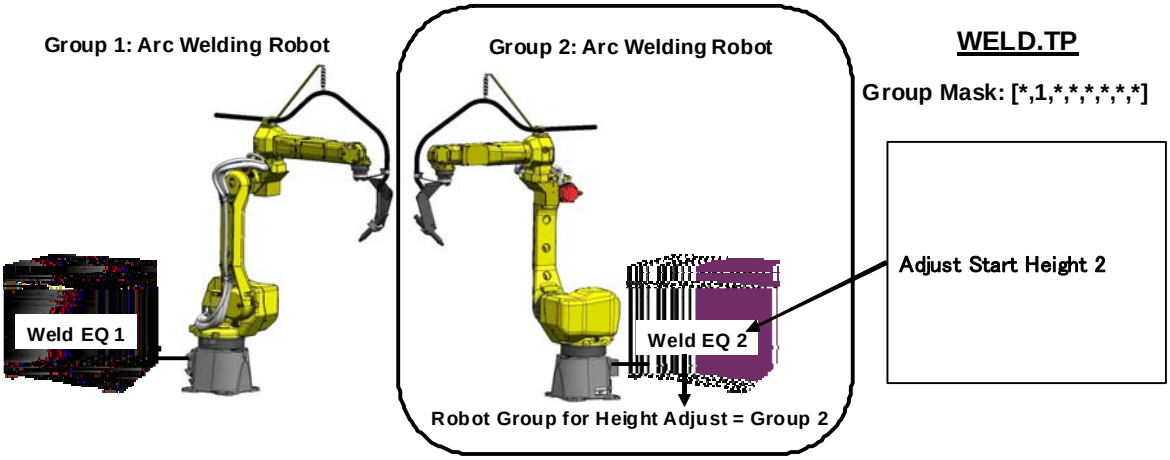


Fig. 24.5 (a) Execute height adjust for single robot under multi-equipment environment

Execute for Multi Robots by Multi Programs (Multi Task)

Such as Fig. 24.5 (b), ID Number in macro instruction is dealt with "Weld EQ Number" when Arc Start Height Adjust for multiple arc welding robots is performed simultaneously by "MULTIPLE" programs (Arc Start Height Adjust for multiple robots is performed by Multi Task). A child program for Group 1 has "Adjust Start Height 1" macro and for Group 2 has "Adjust Start Height 2" macro. Additionally, "1" is set as "Robot Group" in setup screen for Weld EQ 1 and "2" is set as "Robot Group" in setup screen for Weld EQ 2.

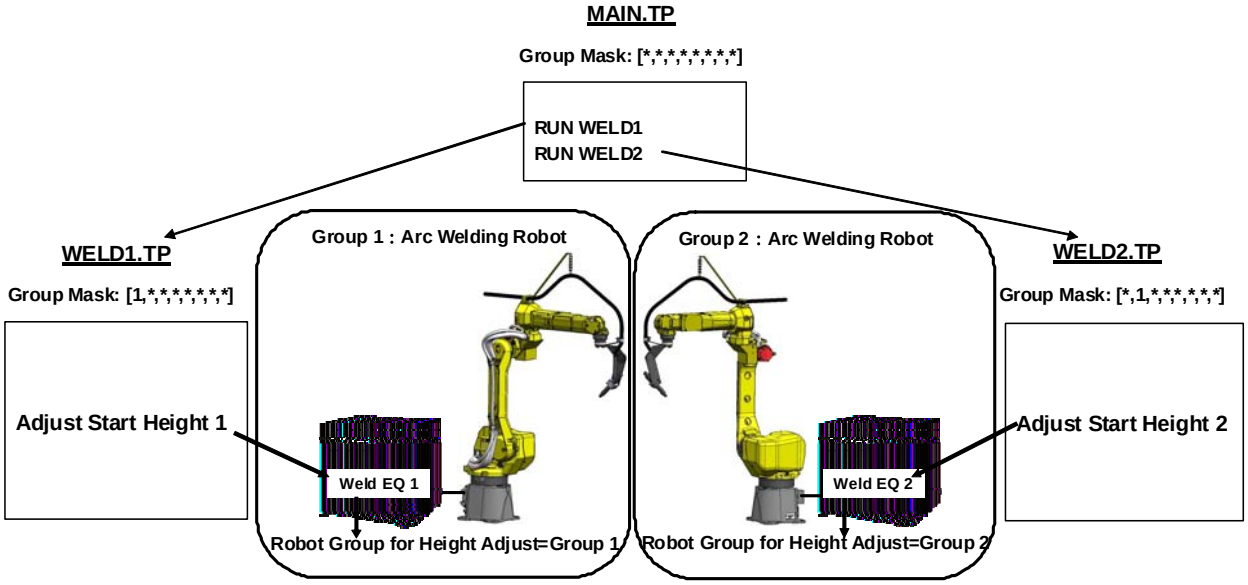


Fig. 24.5 (b) Execute height adjust for multi robot simultaneously by multi task

Execute for Multi Robots by One Program (Single Task)

Such as Fig. 24.5 (c), ID Number in macro instruction is not dealt with Weld EQ Number when Arc Start Height Adjust for multiple arc welding robots is performed simultaneously by "ONE" program (That is, Arc Start Height Adjust for multiple robots is performed by Single Task). In this case, it is needed to add arguments to macro instruction, and arguments means "Weld EQ Number".

If you want to perform Arc Start Height Adjust simultaneously for both Weld Equipment 1 and 2, "1" and "2" should be added as arguments. Additionally, a child program for Group 1 has "Adjust Start Height 1" macro and for Group 2 has "Adjust Start Height 2" macro. Additionally, "1" is set as "Robot Group" in setup screen for Weld EQ 1 and "2" is set as "Robot Group" in setup screen for Weld EQ 2.

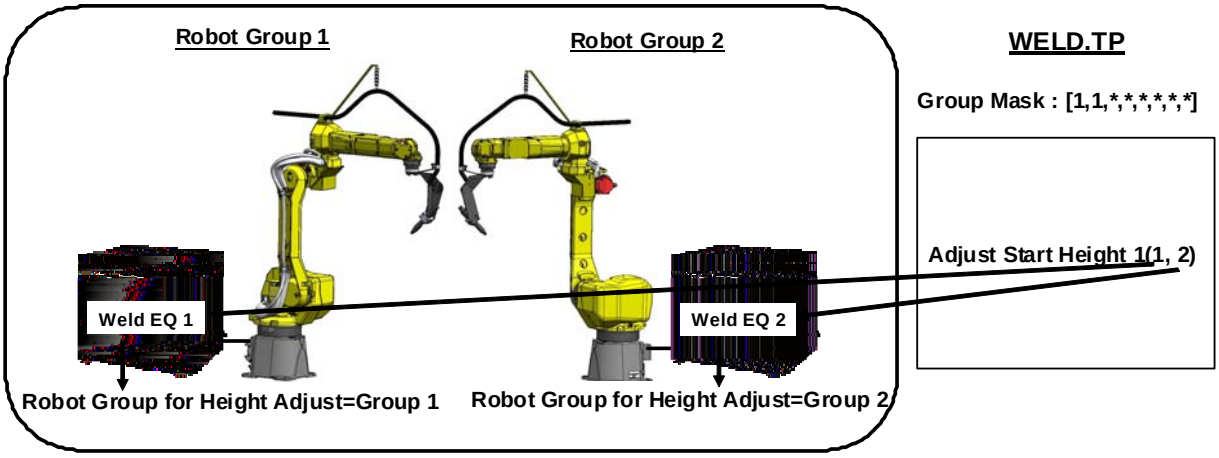


Fig. 24.5 (c) Execute height adjust for multi robot simultaneously by single task

> ⚠ **CAUTION**
> Do not execute the macro instruction of the same ID Number simultaneously in each program by multi task. If you want to use the instruction by multi task, use the macro instruction of the different ID Number in each program.

25 MULTI EQUIPMENT CONTROL FUNCTION

25.1 OVERVIEW

Multi Equipment Control Function enables one robot controller to control two or more welding equipments, and it can control up to 4 equipments. By this function and Multi Group Function, one robot controller can control two or more robots and two or more weld equipments.

There are following two concrete configurations using this function.

- Tandem welding (One robot has two or more welding torch)
- Multi Arm welding (Two or more robots respectively has one welding torch)

The process of weld start is different according to above-mentioned configuration. In the tandem welding, arc start of precedence welding wire (lead arc) is performed. After that, robot starts the welding motion. Thereafter, arc start of subordination welding wire (second arc) is performed. On the other hand, in the multi arm welding, there is a case that the synchronization of arc start by two or more welding power supplies is needed. For example, it is required when two arc welding robots performs welding the object on the rotating positioner. The positioner must start rotating after the arcs are generated in both robots. If the positioner starts moving when arc is established by one robot and the other fails it, the welding fails. Because the welding quality decreases by changing the relative/absolute angle between the torch and the object.

Those two weld start processes are defined by the setting of Weld Start Synchronization for Multi Equipment (For more detail, please refer to Section 25.6 and 25.7).

This function is an option. (A05B-XXXX-J617)

25.2 MULTI EQUIPMENT SETUP

Executing the following procedures is required for each welding equipment to control two or more welding equipments with one robot controller.

1	Setting the number of weld equipments	(Procedure 25-1)
2	Select Manufacturer and Model of the weld equipment	(Procedure 3-1 and 3-2)
3	Detail setup of the weld equipment	(Procedure 3-5)
4	Weld I/O Setup	(Procedure 7-1, 7-2)
5	Weld Procedure Setup	(Refer to Section 3.5)

Firstly, set the number of weld equipments to be used. By this operation, it is possible to use the multi equipment control.

Next, execute above-mentioned step 2-5. In the setting of step 2-5, there are setting screens that are prepared for each weld equipment. For example, parameters can be set for E1 and E2 (E1: weld equipment No.1, E2: weld equipment No.2) respectively in each Arc weld equipment setup screen. It is necessary to setup corresponding to each weld equipment.
In setting of step 2-5, it is required to select the screen corresponding to the equipment. How to change screen is indicated in Procedure 25-2.

Please refer to each Section and Procedure for the setting of each screen.

NOTE
Arc welding system setup screen (Refer to Section 3.3) is the same for all weld equipments, and these items in this screen are reflected for all weld equipments.

Procedure 25-1 Setting of the number of the weld equipments

Step

1 Execute Controlled Start. ArcTool Setup screen is displayed.
2 If Multi Equipment Control function is installed, user can move the cursor on item [Number of weld equipment] and enter the number of weld equipment (Max number is 4).

```
ArcTool Setup
                                    1/10

   5 Weld speed:              100

   6 Manufacturer:     General Purpose
   7 Model:            MIG (Volts, Amps)

  Press FCTN then START (COLD) when done.

   8 Multi-process:         ENABLED
   9 Weld ID:               DISABLED
  10 Number of weld schedules:   32
     Number of weld equipment:    4

   [ TYPE ]          CHECK          HELP
```

3 Please power off and on. By this operation, Controlled Start is automatically executed. After finishing Controlled Start, the number of the weld equipment is increased and user can set the new weld equipments.

NOTE
If you execute Cold Start without power off/on in Step 3, the change in the number of welding equipment is not reflected.

Procedure 25-2 How to change each weld equipment screen

This procedure is the example of ArcTool Setup screen.

Condition

- [Number of weld equipment] in Arc Tool Setup screen is more than one.

Step

1 E i (i is an equipment number) is displayed in the upper right on the screen. This shows the current equipment number of setup screen. Please press [DISP] key with holding SHIFT key. Window display menu is displayed.

```
ArcTool Setup                                E1
                                            1/10
  1 FNumber:              F000000

  2 Welding setup:          Japan
  3   Wire speed units:    cm/min
  4   Weld speed units:    cm/min
  5   Weld speed:          100

  6 Manufacturer:      General Purpose
  7 Model:            MIG (Volts, Amps)

     [ TYPE ]          CHECK          HELP
```

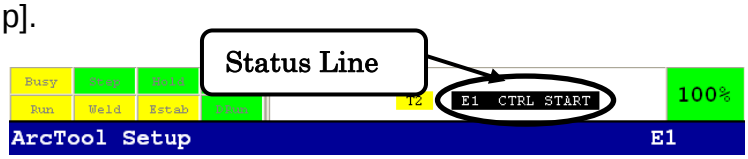
```
          DISPLAY  1
1 Single
2 Double
3 Triple
4 Status/Single
5 Single Wide
6 Double Horizontal
7 Triple Horizontal
8 Help/Diagnostics
9 Display Equip
0 - NEXT --
```

2 Select the [Display Equip]. If the number of the weld equipment is 2, the equipment number is alternatively displayed E1-> E2 ->E1. According to this operation, the contents of ArcTool setup screen is changed. If you use more than 2 equipments, equipment number of E1 – E@ is displayed after moving the cursor on [Display Equip], please select the desired equipment number.

3 When two or more screens are displayed, the equipment number is displayed in each screen. Therefore, for example, a user can open the Arc weld equipment screen of E1 in first screen and the Arc weld equipment screen of E2 in the second screen.

NOTE :About Wire Inching

E@ is also displayed on Status Line. This indicates the active equipment (for Wire Inching), and this is not changed by [Display Equip] in window display menu. To change the equipment for wire inching, press FCTN key and select the [Change Equip].



25.3 WELD ENABLE/DISABLE IN MULTI EQUIPMENT CONTROL

If you press SHIFT key and USER1 key at the same time, Weld Enable/Disable is changed. (Refer to Procedure 5-3). In Multi Equipment Control case, if this operation is executed, weld Enable/Disable of all equipments is changed at once.
Switching weld enable/disable each weld equipment individually can be done in Test Cycle Weld screen which is displayed by pressing USER1 key (or [MENU] key -> [Test Cycle] -> [Arc Weld]).

```
TEST CYCLE Arc
                                    1/2

  1 Equipment 1 ARC enable:     FALSE
  2 Equipment 2 ARC enable:     FALSE

    [ TYPE ]                                TOGGLE
```

Weld enable/disable of the weld equipment is changed by pressing F5[TOGGLE].
A user can check weld enable/disable on the above screen. Additionally, the Status LED of Teach Pendant indicates if one of the equipment has weld enable. However, this LED indicates at least one equipment enable. For more detail, please refer to following table.

EQ1	Disable	Enable	Disable	Enable
EQ2	Disable	Disable	Enable	Enable
LED	OFF	ON	ON	ON

The ARC ESTAB LED is also similar to the table. The LED of ARC ESTAB LED indicates at least one equipment is currently welding.

25.4 CREATE THE PROGRAM IN MULTI EQUIPMENT CONTROL

In the case of multi equipments, it is necessary to specify the equipment number that you want to use in the program detailed screen.

When you use Multi equipments, the equipment number is added to Weld Start and Weld End instructions (See the following figure). In this arc instruction, Weld Start and Weld End instructions are executed only for the weld equipment corresponding to the equipment number.

Weld Start instruction	:	Weld Start E1[ ]
Weld End instruction	:	Weld End E1[ ]

Procedure 25-3 Creating the multi equipment program

Condition

- [Number of weld equipment] in Arc Tool Setup screen is more than two.
- Setup for each equipment (weld equipment setup, weld I/O, etc.) has already finished in all equipments.

Step

1 Display Program detail screen.

2 Press F3[NEXT] at the program detail screen. The following screen is displayed. Leave this item “TRUE”.

```
Appl process
                                        1/1

 1 ARC Weld                        TRUE

| | END | PREV | NEXT | TRUE | FALSE | |
```

3 Press the F3[NEXT]. The following screen is displayed. This screen specifies the equipment number used by this program.

```
Appl process
                                        1/1
 ARC Welding Application DATA

 1 Equipment Number          [1,*,*,*,*]

| | END | PREV | NEXT | 1 | * | |
```

To specify the first equipment : [1,*,*,*,*]
To specify the second equipment : [*,1,*,*,*]
To specify both equipments : [1,1,*,*,*]

4 Press F1[END]. Program detail screen is finished.
5 The following is an example to teach a single Arc instruction. Please display the arc instruction menu. (Refer to Procedure 4-2) You can select Weld Start or Weld End instruction whose equipment number is set in step 3.

```
            Arc  1
1 Weld Start E1[]
2 Weld Start E2[]
3 Weld End E1[]
4 Weld End E2[]
5
6
7
8
```

Fig. 25.4 The case of [1,1,*,*,*]

NOTE

You cannot call the program of different weld equipment number as sub program. You must execute this program in other task.
For Example, the following two programs.

- MAIN001 (Eq number : [1,*,*,*,*])
- SUB001 (Eq number : [*,1,*,*,*])

In this case, SUB001 cannot be called as sub program in MAIN001.

NOTE

When main program (includes called program from it) executes some arc instructions for a certain weld equipment, it is impossible to execute any arc instructions for the same weld equipment in child program that is executed as a multi task. In this case, an alarm “ARC-034 Task does not control welding” will be posted.

25.5 MOTION GROUP COUPLING

When one robot controller controls two arc welding robots, generally the first group robot uses the first weld equipment, and the second group robot uses the second weld equipment.
In that case, it is possible to save labor for switching the equipment number if the selecting equipment number is changed corresponding to the selecting motion group.

The following procedure enables to assign the weld equipment automatically according to the current selected group.

Procedure 25-4 Setting of the Motion Group Coupling

Condition

- [Number of weld equipment] in Arc Tool Setup screen is more than two
- The motion group is set to more than two by Multi Group function.

Step

1 Press [MENU] key and select the [SYSTEM].
2 Press F1[TYPE] and select the [Coupling]. The following screen is displayed.

```
System Coupling
 ARC Welding                          1/6
 Group/Equipment Coupling:          FALSE
  1 Group1          Equipment[1,*,*,*,*]
  2 Group2          Equipment[*,1,*,*,*]
  3 Group3          Equipment[*,*,1,*,*]
  4 Group4          Equipment[*,*,*,1,*]
  5 Group5          Equipment[*,*,*,*,1]
  6 Group6          Equipment[*,*,*,*,*]

   [ TYPE ]  TRUE  FALSE
```

3 Move the cursor to [Group/Equipment Coupling] and press F4[TRUE]. Coupling function becomes effective.
4 If you want to change the coupling between a group and a equipment, move the cursor to the item of each group and press [1] on the place which corresponds to the equipment number.
5 Press FCTN key and select [Change Group]. By changing motion group, the equipment number is changed simultaneously, too.
6 Another method to change the motion group, press the SHIFT key and COORD key at the same time. Following menu is displayed. Move the cursor to [Group] and input the number of targeted group.

```
Tool (.=)   1
Jog         0
User        0
Group       1
```

25.6 SETTING OF WELD START SYNCHRONIZATION FOR MULTI EQUIPMENT

This function provides the synchronization of Weld Start timing on two or more weld equipment.
To use this function, it is necessary to setup the synchronization data for each weld equipment that is an argument of Weld Start instruction.
The setting method and creating the program is described below.

Procedure 25-5 Setting of Synchronized Weld Start, Creating the Program

This procedure is a setup example of Synchronized Weld Start between Equipment 1 and Equipment 2.

Condition

- [Number of weld equipment] in Arc Tool Setup screen is more than two.
- Setup of each equipment (weld equipment setup, weld I/O, etc.) was completed.

Step

1 If Arc Multi Equipment function is ordered, synchronization data [E0] is added to the end of the weld parameter values of Weld Start instruction.

```
MAIN1
                                        1/3
     1: L P[1] 8mm/sec FINE
     2:   Weld Start E1[0,0.0Volts,0.0Amps,E0]
   [END]

 POINT | WELD_ST | WELD_PT | WELDEND | TOUCHUP | >
```

2 Move the cursor to [E0] and input synchronization data. Please enter [E2] to Weld Start instruction of EQ1 and [E1] to Weld Start instruction of EQ2.

```
MAIN1
                                        1/4
 1: L P[1] 8mm/sec FINE
 2:   Weld Start E1[1,10.0Volts,50.0Amps,E2]
 3:   Weld Start E2[1,10.0Volts,50.0Amps,E1]
   [END]

 POINT | WELD_ST | WELD_PT | WELDEND | TOUCHUP | >
```

NOTE

1 The setting of synchronization data is disregarded in Weld End instruction.
2 If the synchronization data is set in Weld Start instruction for one of the equipment, an alarm is occurred.
3 If you do not use Weld Start synchronization (in the case of tandem welding or multi arm welding that perform the respective weld start by multi task), please set [E0] in the synchronization data.

25.7 EXAMPLES OF WELD START SYNCHRONIZATION FOR MULTI EQUIPMENT

In the case of tandem welding (one robot has two or more welding torch), it is not necessary to synchronize the weld start. Please refer to the following sample program.

MAIN1.TP

Motion Mask : [1,*,*,*,*]
Equipment Number : [1,1,*,*,*]

```
MAIN1
                                        1/7
 1: L P[1] 250cm/min FINE
 2:   Weld Start E1[1,1,E0]
 3:   Weld Start E2[1,1,E0]
 4: L P[2] 50cm/min FINE
 5:   Weld End E1[1,2]
 6:   Weld End E2[1,2]
 7: J P[1] 100% FINE
[END]

 POINT | WELD_ST | WELD_PT | WELDEND | TOUCHUP | >
```

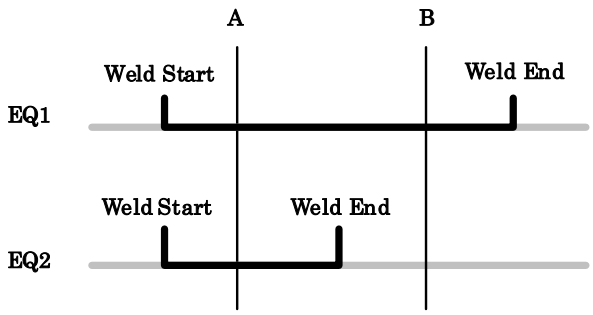
In the case of multi arm welding (Two or more robots respectively has one welding torch), please refer to the following sample program if it is necessary to synchronize the weld start.

MAIN2.TP
Motion Mask : [1,1,*,*,*]
Equipment Number : [1,1,*,*,*]

```
MAIN1
                                        1/7
 1: L P[1] 250cm/min FINE
 2:   Weld Start E1[1,1,E2]
 3:   Weld Start E2[1,1,E1]
 4: L P[2] 50cm/min FINE
 5:   Weld End E1[1,2]
 6:   Weld End E2[1,2]
 7: J P[1] 100% FINE
[END]
| POINT | WELD_ST | WELD_PT | WELDEND | TOUCHUP | >
```

25.8 SPECIFICATION AND LIMITATION OF WELD START SYNCHRONIZATION FOR MULTI EQUIPMENT

- Please teach Weld Start instructions for synchronization in one program. (If you teach Weld Start Synchronization in multi Task program, an alarm occurs during Weld Start.) In general, you should continuously teach Weld Start instructions for synchronization. Do not add motion instruction between Weld Start instructions.
- In the case of arc synchronization, if an arc is generated in one equipment and is not generated in the other equipment, the equipment waits the other equipment while generating arc. In this case, if runin is enabled, runin schedule is used in the equipment generating arc. Therefore, please set lower values to runin schedule. It prevents that the bead size at arc start point becomes big and the welding object is melted (the hole opened).
- In the case of Weld Start Synchronization, repeat touch retry and scratch start are automatically disabled. Because it prevents that welding object is melted (the hole opened) by the generating arc if certain weld equipment successfully generates the arc and the other equipment executes the repeat touch retry or scratch start after failing the weld start. However, it is possible to execute the repeat touch retry and scratch start at Weld Start Synchronization by the setting of system variable "$AWSPCR.$SYNC_RETRY = TRUE".
- About the arc detection time (Refer to Section 3.4), please set the same time for both weld equipment.
- Weld Start Synchronization is resumed when the program execution is resumed after pausing the execution during the welding. Weld Start Synchronization is not executed when the program execution is resumed after finishing the welding by one of the weld equipment.
  For example, both arc welding of Equipment 1 and 2 starts at the same time and the arc welding of Equipment 2 finished earlier than the arc welding of Equipment 1.



The program is paused at the timing A then when the program is restarted, the synchronization between Weld Start for Eq1 and Eq2 is performed.
The program is paused at the timing B then when the program is restarted, the synchronization is not performed because the arc welding of Eq2 has already done. The arc welding of EQ1 is restarted.

- If robot is not on the resuming point when starting resume, Original Path Resume is executed. In two robots case, synchronization is not executed until that both robots return on the resuming points. After finishing Original Path Resume, Weld Start Synchronization is executed.
- If arc welding schedule is changed in one equipment during synchronizing, Weld Start Synchronization is not executed.
- If WELD SPEED instruction is used after weld start synchronization, a weld speed which is specified by last Weld Start instruction is applied.

26 WELD CONTROLLER PROGRAM SELECTION FUNCTION

26.1 OVERVIEW

Some weld controllers contains programs (mode setting, sequence setting, database, etc.), which can be switched by a digital signal input. Additionally, some weld controllers allows programs to be switched during welding. (The function of the weld controller program depends on the weld controller.)
The weld controller program selection function is used to switch an internal program of the weld controller from the robot controller.

The overview of this function is as follows.

- The weld controller program selection function is enabled or disabled by setting of system variable.
- Three digital output signals are assigned as program select output signals. These three digital output signals give the weld controller a direction for specifying the weld controller program.
- Eight different weld controller programs can be selected by using the program select output signals. On the DATA Weld Procedure screen, a weld controller program can be specified (A weld controller program can be specified in each weld procedures). When a weld controller program is selected on the screen, the program select output signals are set accordingly.

This function is an ArcTool standard function.

26.2 ENABLING OR DISABLING THE FUNCTION

The weld controller program selection function is enabled or disabled by setting the system variable $AWEPCR.$PRG_SEL_ENA.

$AWEPCR.$PRG_SEL_ENA = TRUE: Enabled
=FALSE: Disabled

26.3 ASSIGNING OF PROGRAM SELECT OUTPUT SIGNALS

To use the weld controller program select function, three digital output signals must be assigned as program select output signals. A weld controller program is selected in accordance with the combination of the on/off statuses of the three digital output signals. Following table shows the relationship between the eight weld controller programs and combinations of the on/off statuses of the digital output signals.

Table 26.3 Weld controller program numbers

Weld controller program number	Combination of program select output signals		
	Signal 1	Signal 2	Signal 3
1	ON	OFF	OFF
2	OFF	ON	OFF
3	ON	ON	OFF
4	OFF	OFF	ON
5	ON	OFF	ON
6	OFF	ON	ON
7	ON	ON	ON
8	OFF	OFF	OFF

Following figure shows an example of selecting a weld controller program by the program select output signals.

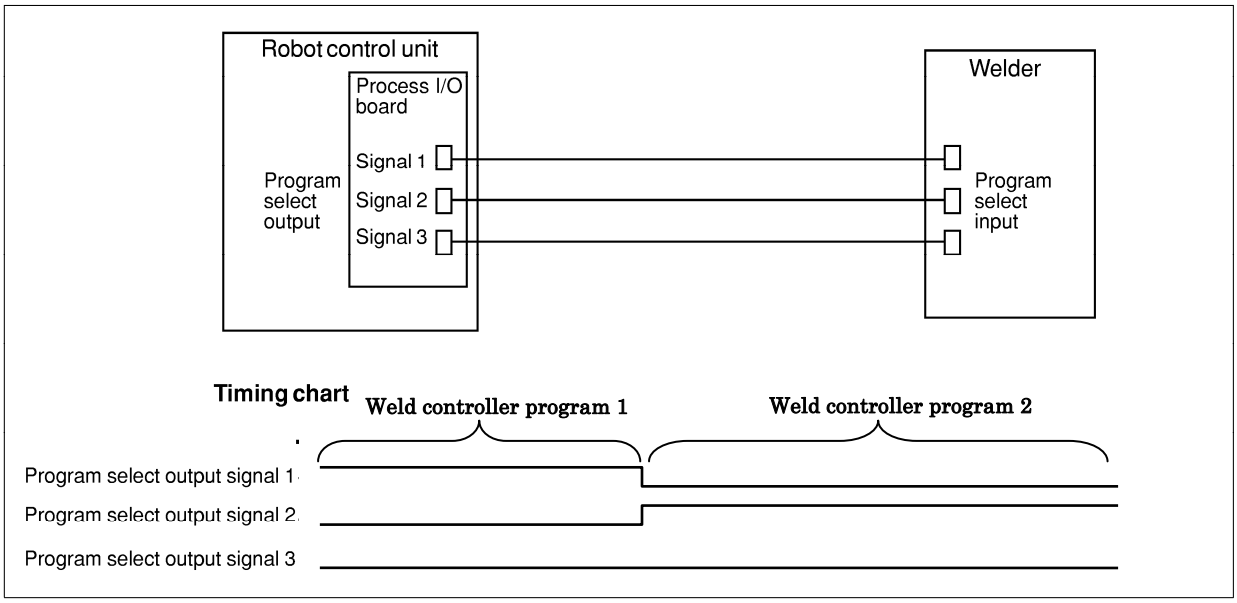


Fig. 26.3 Example of selecting a weld controller program

Any types of available digital output signals can be assigned as program select output signals.

Procedure 26-1 Assigning weld controller program select output signals

Condition

- Weld controller program selection function is enabled ($AWEPCR.$PRG_SEL_ENB = TRUE).

Step

1 Press [MENU] key.
2 Select [I/O].
3 Press F1[TYPE], then select [Weld].
4 Press F3[IN/OUT] to switch the screen to the welding output signal screen.
5 Following screen is displayed. Move the cursor to the line of the program select output signal to be assigned.

```
I/O Weld Out
                                                12/14
          WELD SIGNAL        TYPE   #  SIM  STATUS

    4 [Weld Start         ]   WO[   1]  U     OFF
    5 [Gas Start          ]   WO[   2]  U     OFF
    6 [                  ]   WO[   3]  U     OFF
    7 [Inch forward       ]   WO[   4]  U     OFF
    8 [Inch backward      ]   WO[   5]  U     OFF
    9 [Wire stick alarm   ]   WO[   6]  U     OFF
   10 [                   ]   WO[   8]  U     OFF
   11 [                   ]   WO[   8]  U     OFF

   12 [Proc select 1      ]      [***]  *     ***
   13 [Proc select 2      ]      [***]  *     ***
   14 [Proc select 3      ]      [***]  *     ***

 [TYPE]  HELP  IN/OUT                        >
 [TYPE]  HELP  CONFIG                        >
```

6 Press the F8[CONFIG]. Following screen is displayed.

```
I/O Weld Out
                                                  1/2
        WELD SIGNAL        TYPE  #
  1 [Proc select 1       ]   **  [***]

  2 Polarity: NORMAL

   [TYPE]  MONITOR  VERIFY  [CHOICE]  HELP
```

7 Move the cursor to the signal type field, then select a signal type.
8 Move the cursor to the signal number field, then select a signal number.
9 Press the PREV key or F2[MONITOR]. The digital output signal is assigned. When the digital output signal is assigned, the screen appears as shown below.

```
I/O Weld Out
                                                 12/14
         WELD SIGNAL       TYPE   #  SIM  STATUS

    4 [Weld Start         ]   WO[   1]  U    OFF
    5 [Gas Start          ]   WO[   2]  U    OFF
    6 [                  ]   WO[   3]  U    OFF
    7 [Inch forward       ]   WO[   4]  U    OFF
    8 [Inch backward      ]   WO[   5]  U    OFF
    9 [Wire stick alarm   ]   WO[   6]  U    OFF
   10 [                   ]   WO[   8]  U    OFF
   11 [                   ]   WO[   8]  U    OFF

   12 [Proc select 1      ]   DO[  10]  U    OFF

   13 [Proc select 2      ]      [***]  *    ***
   14 [Proc select 3      ]      [***]  *    ***
   [TYPE]  HELP  IN/OUT                      >
   [TYPE]  HELP  CONFIG                      >
```

10 Repeat steps 5 to 9 to assign the remaining two program select output signals.

26.4 SELECTING A WELD CONTROLLER PROGRAM

Weld controller programs can be set in each weld procedure. Weld controller programs are set in the DATA Weld Procedure screen.

Procedure 26-2 Selecting a weld Controller Program

Condition

- Three program select output signals have already been assigned.

Step

1 Press [MENU] key, then select the [DATA].
2 Press F1[TYPE], then select [Weld Procedure]. Following screen is displayed.

```
DATA Weld Procedure     1
                                          2/3
  + Procedure              1 [              ]
    Process select         1 [              ]
    + Schedules
   [ TYPE ]  DETAIL  [CMND]  [VIEW]  HELP
```

3 Move the cursor to [Process select] in the desired weld procedure, then input the weld controller program number.

27 TORCH ANGLE

27.1 OVERVIEW

The posture of torch; especially, work angle and travel angle are the important parameter for welding quality. Previously, the values of work angle and travel angle are estimated manually.
This function provides very accurate the values of work angle and travel angle automatically by defined reference posture of touch and also have graphical user interface to display the values, user can confirm them on teach pendant.

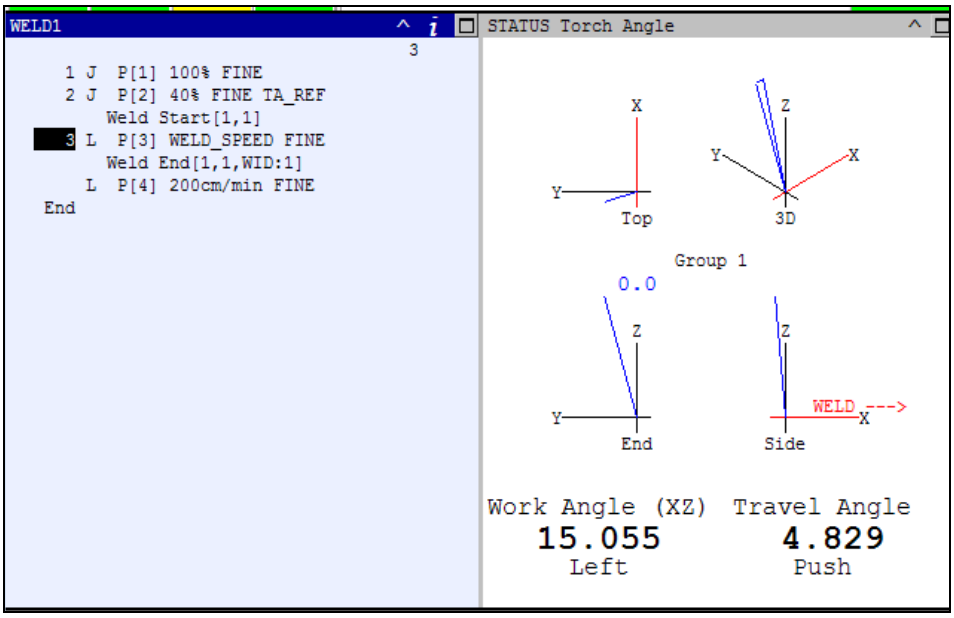


Fig. 27.1 Torch Angle Function

Features

- Show work and travel angle value in real time.
- Show work and travel angle by two and three dimension expression on teach pendant.

> **NOTE**
> This function is an option (A06B-XXXX-R734).

27.2 EXPLANATION OF FEATURES

Torch angle function calculates work angle and travel angle based on a standard posture of torch recorded in the program or in position register called ‘Reference Posture’.

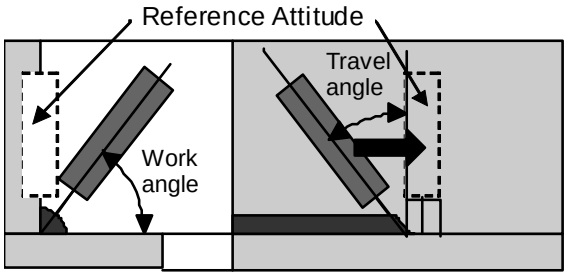


Fig. 27.2 Definition of work angle and travel angle

27.2.1 Reference Posture

Reference Posture is assigned by TA_REF instruction. Two types of TA_REF instructions exists: one is record Reference Posture in the program, another is use the position register as Reference Posture.

Procedure 27-1 Record Reference Posture in TP Program

Condition

- User tool frame has already been setup.

Step

1 Display Edit screen.
2 Move the cursor to the tail of a motion instruction you would like to use Torch Angel function.
3 Press F4 and select “TA_REF”.
4 The message “Align torch with ref axis and record” is appeared.
5 Move the robot to a point has enough space to change the robot posture unrestrictedly.
6 Adjust the robot posture to become perpendicular to the plane of work.
7 Press F3 “Record” with Shift key. Reference Posture is recorded.
8 If you would like to confirm Reference Posture, move the cursor to the TA_REF and press F2 “MOVE_TO” with Shift key. Robot moves recorded Reference Posture.

Procedure 27-2 Record Reference Posture in Position Register

Condition

- User tool frame has already been setup.

Step

1 Display position register screen.
2 Move the robot to a point has enough space to change the robot posture unrestrictedly.
3 Adjust the robot posture to become perpendicular to the plane of work.
4 Record the position to a position register.
5 Open Edit screen.
6 Move the cursor to the tail of a motion instruction you would like to use Torch Angel function.
7 Press F4 and select “TA_REF []”.
8 The message “Enter PR number” is appeared and then input the index number of the position register used at Step 4.

NOTE

1 If there is unrecorded TA_REF instruction or the position register used at TA_REF [] instruction is not touchup, alarm INTP-201 occurs.
2 If TA_REF [] instruction is used, the user frame and user tool frame of position register must be same as the program.
3 TA_REF instruction must be before weld start/end instruction.
Correct: J P[1] 40% FINE TA_REF Weld Start[1,1]
Fault: J P[1] 40% FINE Weld Start[1,1] TA_REF
4 When torch angle function is used while coordinated motion, only TA_REF [] instruction is supported coordinated motion.
5 When coordinated motion becomes enabled in a program, user must teach TA_REF [] at the motion that start coordinated motion. For example,
1: L P[1] 300cm/min FINE
2: L P[1] 300cm/min FINE TA_REF PR[1] COORD Weld Start[1,1]
6 TA_REF instruction cannot be appended to Circular-Arc motion.

27.3 TORCH ANGLE DISPLAYING FUNCTION

The calculated value of torch angle is confirmed at Torch Angle screen.

Procedure 27-3 Displaying Torch Angle screen

Step

1 Press [MENU] key and select “4. STATUS”.
2 Press F1 [TYPE] and select “Torch Angle”.

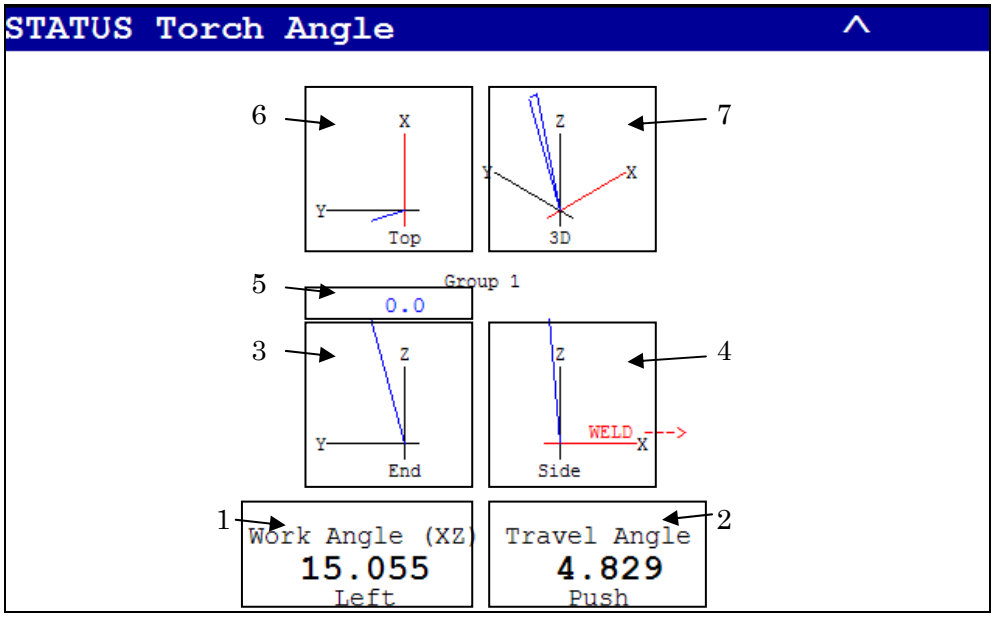


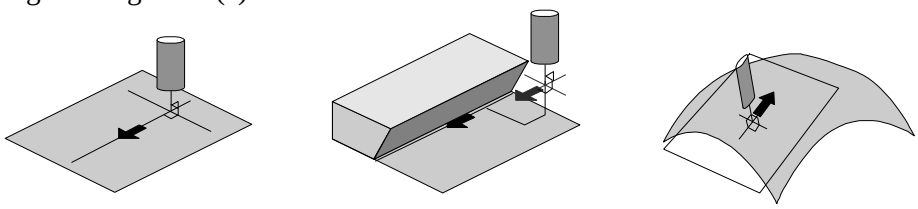
Fig. 27.3 Torch Angle screen

Table 27.3 Descriptions of contents on Torch Angle screen

Items	Descriptions
1 Work angle	Show work angle. (??) shows the origin plane of work angle.
2 Travel angle	Show push/drag angle.
3 Expression of work angle	Show work angle in the welding direction view as an image.
4 Expression of travel angle	Show travel angle in the perpendicular of weld direction view as an image. The red line and arrow shows welding direction.
5 Origin plane of work angle	Show origin plane of work angle.
6 Expression of torch angle above the work	Show travel angle in the perpendicular of weld direction point as an image. The red line and arrow shows welding direction.
7 Three-dimensional expression	Show torch angle as three-dimensional expression

27.4 NOTES FOR REFERENCE POSTURE

In many cases, Reference Posture is defined as perpendicular to the plane of work like left figure of Fig. 27.4 (a).When Reference Posture is not perpendicular to the plane, calculated value of work angle and travel angle includes the difference between optimum Reference Posture and actual Reference Posture.
When robot cannot move to the posture you would like to define as Reference Posture by interference from work and/or jig, the touchup of Reference Posture can be executed away from the work has enough space to move the robot. In this case, Reference Posture is defined as perpendicular to the plane of work like center figure of Fig. 27.4 (a).
When work surface is curved, Reference Posture is defined as perpendicular to the tangential plane of the point like the right of Fig. 27.4 (a).



Fig, 27.4 (a) Example of Reference Posture

Case: NOT Need re-touchup of Reference Posture

Even if work position was moved and weld path has been changed, it isn't need to re-touchup Reference Posture when the each following condition is satisfied.

- The posture of work hasn't changed.
- The change of posture of work has rotated center around Reference Posture.

Case: Need re-touchup of Reference Posture

In the following case, re-touchup of Reference Posture will need. If it is not executed, inaccurate torch angle will be derived.

- The perpendicular direction to work is changed.
- The z axis of Reference Posture is parallel with welding direction.
- Start or end coordinated motion.

In the case of single weld process, if the torch posture changes suddenly, recommend to re-touchup Reference Posture at the point.

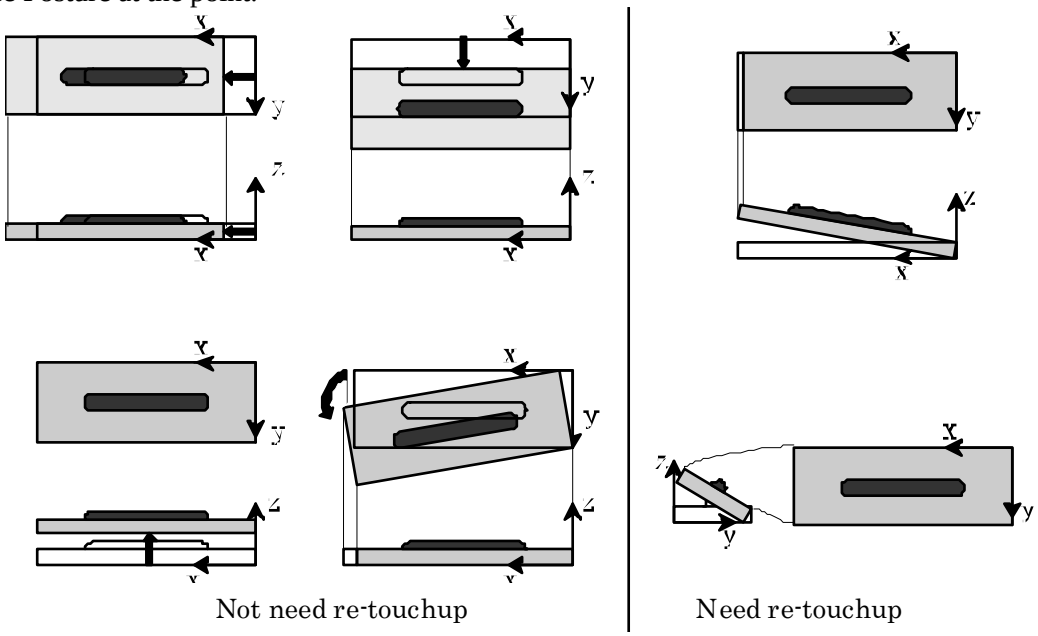


Fig. 27.4 (b) The moves and posture changes not need re-touch and The moves and posture changes need re-touchup

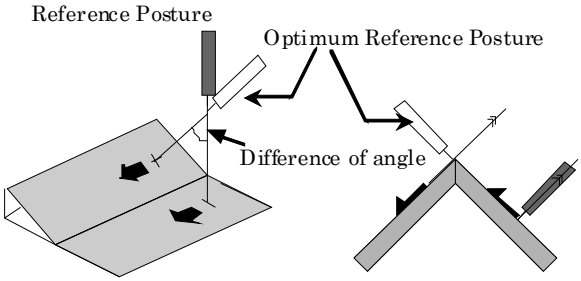


Fig. 27.4 (c) Case of re-touchup of Reference Posture

28 USED WIRE ESTIMATION

28.1 OVERVIEW

Used wire estimation function derives the weight of used wire during welding continually and the remnant of the wire. This function also has alarm occurrence when the remnant is less than a threshold value, the supplementation of wire becomes rising efficiency.

NOTE
This function requires wire feed speed signal assigned to analog or group input.
Refer to appendix A.2.2.2 about he setup of the assignation.

28.2 WIRE INFORMATION SCREEN

Wire information screen shows the remnant of wire and setup the material of wire etc.

Procedure 28-1 Display wire information screen

Step

1 Show menu by pressed MENU key.
2 Select “Next”.
3 Select “Status”.
4 Show Menu by pressed F1[TYPE].
5 Select “Wire”, then the following screen is appeared.

Wire information screen

```
STATUS Wire

     Current weight:          30.0 kg
  1  Warning weight:           5.0 kg
  2  Initial weight:          50.0 kg

  3  Warning signal:      DO[  1] S OFF

  4  Wire Diameter:            1.200mm
  5  Wire Material:            Steel
  6  Wire Density:             7.850 g/cm3
     …
[TYPE] RESET kg/lb HELP
```

Table 28.2 The descriptions of the contents on wire information screen

Items	Description
Current weight	The remnant of wire.
Warning weight	Specify weight of warning. When current weight is less than the value, An alarm occurs and the output specified at “Warning signal” becomes ON.
Initial weight	Specify the unused weight.
Warning signal	Specify the output that becomes ON when current weight is less than warning weight. Support DO and RO.
Wire diameter	Specify the diameter of using wire.
Wire material	Specify the material of using wire. If steel, stainless or aluminum is used, select the material in the list. The following “Wire density” becomes the standard density of the material automatically. Otherwise, select “User defined” in the list and set wire density manually.
Wire density	Specify the density of wire.

Procedure 28-2 Setup Wire information

Step

1 Select the units of weigh ant length by pressed F3 “kg/lb”. The following two types are supported.
- Weight : kg, Length : cm
- Weight : lb, Length : in

2 Move cursor to “Initial weight” and input the wire weight at unused.
3 Move cursor to “Wire diameter” and input the diameter of using wire.
4 Move cursor to “Wire material” and press F4[CHOICE], the following menu appears.
Select the material of the wire in the menu, if there is no material in the menu, select “User defined”.

```
                    1
1 User defined
2 Steel
3 Stainless
4 Alum 4043
5 Alum 5356
```

5 If “User defined” is selected at step 4, the value of “Wire density” is initialized, specify the density of wire. Otherwise, the standard value of density of the selected material is setup automatically.
6 After any configurations have been setup, press F2 “RESET”.

If you would like to observe the used wire estimation, please perform the following procedure.

Procedure 28-3 Setup observation of used wire estimation

Step

1 Move cursor to “Warning weight” and input the wire weight that is threshold.
2 Move cursor to “Warning signal” and specify the port type and port number.
3 When the current wire weight falls below the warning weight and warning signal becomes ON, press F2 “RESET” after replenishing the wire. Then, warning signal becomes OFF.

NOTE
If the current wire weight falls below the warning wire weight, warning wire weight cannot be changed.

29 WELD PROCEDURE PROCESS LIMIT

29.1 OVERVIEW

Weld procedure process limit is management function of setting change operation related to weld procedure corresponding to the password levels (Install, Setup, Program, Operator) that are set by password function. This function prevents the situation that a wrong setting is performed before one is aware. About the password function, please refer to Section 9.10 in OPERATOR'S MANUAL (Basic Operation) (B-83284EN). In the case of high level user "Install" or "Setup", there is no limitation in the operation of setting change concerning to weld procedure. On the other hand, there is a prescribed limitation in the case of low level user "Program" or "Operator". Though the low level user can perform the fine-tuning of weld parameters only, the high level user can restore the changing by low level user.

This is an optional function (A05B-XXXX-J745). The password function (A05B-XXXX-J541) is also required to use this function.

NOTE

If this function is ordered, this function enables by default. When this function is ordered and enable, please note that the maximum number of weld schedule becomes 16 per one weld procedure (It is usually 32). Please set system variable of $AWSCFG.$PROC_LIMIT to FALSE to disable this function after controlled start. After that, please perform cold start.

29.2 PREPARATION

As a necessary preparation before using this function, it is necessary to set the password function. Please perform the Procedure 29-1. If the password function is already set, it is not necessary to perform this procedure.

Procedure 29-1 Setting of Password Function

Step

1 Press the MENU key.
2 Select "SETUP".
3 Press F1[TYPE].
4 Select "Passwords". The password setup screen will be displayed.
5 Setup the user of password level "Install". For more detail about this step, please refer to Section 9.11 in OPERATOR'S MANUAL (Basic Operation) (B-83284EN).
6 If necessary, setup users of password level other than "Install".

29.3 OPERATION OF WELD PROCEDURE SCREEN

The operativeness in the weld procedure screen is changed according to the password level (The operativeness in other than weld procedure screen is decided by password function, not weld procedure process limit function).

Install : All settings can be arbitrarily changed.
Setup : All settings can be arbitrarily changed.
Program : Only fine-tuning of weld parameters can be performed.
Operator : Only fine-tuning of weld parameters can be performed.

The following procedure 29-2 explains the detailed usage and the feature of weld procedure process limit function.

Procedure 29-2 Setting of Password Function

Condition

- The setting of password function (Procedure 29-1) is finished

Step

1 Press the DATA key.
2 Press F1[TYPE].
3 Select “Weld Procedure”. Weld Procedure DATA screen will be displayed. There are two kinds of screens (List, Detail) in Weld Procedure DATA screen as shown bellow.

Weld Procedure List screen

```
DATA  Weld Procedure  1
                                          1/10
 + Procedure                1 [                ]

    - Schedules
 Schdule  #   Volts    Amps    Speed     Time
 Schdule  1    20.0   200.0     20.0     0.00
 Schdule  2    20.0   200.0     20.0     0.00
 Schdule  3    20.0   200.0     20.0     0.00
 Burnback      20.0     0.0              0.10
 Wirestick     20.0     0.0              0.10
 OnTheFly       0.1     5.0      1.0
 Adjust +       0.0     0.0      0.0     0.00
 Adjust -       0.0     0.0      0.0     0.00
   [ TYPE ] | DETAIL | [ CMND] | [ VIEW ] | HELP
```

Weld schedule detailed screen

```
DATA  Weld Procedure
                                          1/6
 1 Weld Procedure     1[                        ]
 2 Weld Schedule      1[Schedule                ]
 3 Voltage:                            20.00  Volts
 4 Current:                            200.0  Amps
 5 Travel speed:                        20.0  cm/min
 6 Delay time:                          0.00  sec
   Feedback Voltage                      0.0  Volts
   Feedback Current                      0.0  Amps
   [ TYPE ] | SCHEDULE | ADVICE | INCR | DECR | >
```

In the case of high level user (Install, Setup), all setting items can be arbitrarily changed. For example, weld schedule is changed while examining whether the runin or ramping are used or not in the start-up first stage of the welding system. An important setting that influences such a welding quality can be changed by the high level user only. Welding system is protected from the setting change by the low level user (Program, Operator). Please change the weld schedule at the high level user. In the following steps, the weld schedule decided by the high level user is called “fiducial schedule”.

4 Please set the “Adjust +” and “Adjust -” schedules that are displayed in the weld procedure list screen. Those settings can be performed by the high level user only.
For example, it is assumed that the following setting is performed.

Weld Schedule 1	: 20.0V,	200.0A,	100cm/min,	1.00sec
Weld Schedule 2	: 30.0V,	300.0A,	200cm/min,	0.00sec
Adjust +	: 1.0V,	10.0A,	20cmmin,	0.10sec
Adjust -	: 0.5V,	5.0A,	10cm/min,	0.05sec

Though the low level user can not change almost settings, only fine-tuning of weld parameters can be performed. Fine-tuning of weld parameters means that the range from “Adjust -” to “Adjust +” that centers on the command value of each “fiducial schedule” (this is the weld schedule decided by the high level user). Therefore, the adjustable range of weld schedule 1 and 2 by the low level user is shown below in the above-mentioned example case.

Adjustable range of weld schedule 1	
Voltage	: 19.5 to 21.0 V
Current	: 195.0 to 210.0 A
Travel speed	: 90 to 120 cm/min
Delay time	: 0.95 to 1.10 sec

Adjustable range of weld schedule 2	
Voltage	: 29.5 to 31.0 V
Current	: 295.0 to 310.0 A
Travel speed	: 190 to 220 cm/min
Delay time	: 0.0 to 0.10 sec

NOTE

- ArcTool software decides the adjustable lowest/highest value according to each weld commands (voltage, current, wave control, etc.) beforehand. Both the range and the range from “Adjust -” to “Adjust +” that centers on the command value of each “fiducial schedule” are checked by ArcTool, the range in narrower one is applied.
- When the setting of “Adjust +” and “Adjust -” is 0.0 (= initial value), the fine-tuning of each parameters by the low level user can not be performed.

Normally, the welding system is operated with the “Operator” password level when the system is set up to the stage of the production operation. Because the system is protected by the wrong setting change, so the safety is high in the operation of the system. However, there are often case that the fine-tuning of weld schedule is performed for a better welding quality even if the system is set up to the stage of the production operation. It is bad operability to switch the password level to high in each time, so the fine-tuning of weld schedule can be performed by the low level user within only the prescribed range set by the high level user.

5 The fine-tuning of weld schedule by the low level user is performed in the weld schedule detailed screen. Please use F2[DETAIL] key in the switching from weld procedure screen to the weld schedule detailed screen. Each parameters can be adjusted by moving the cursor to the desired parameter and press F4[INCR] or F5[DECR] key with holding shift key. As shown in following screen, parameters that are adjusted by low level user are highlighted. The highlight display continues as long as the following step 6 is not performed.

```
DATA  Weld Procedure
                                                  1/6
 1 Weld Procedure      1[                          ]
 2 Weld Schedule       1[Schedule                  ]
 3 Voltage:                              20.50  Volts
 4 Current:                              200.0  Amps
 5 Travel speed:                          50.0  cm/min
 6 Delay time:                            0.00  sec
   Feedback Voltage                        0.0  Volts
   Feedback Current                        0.0  Amps

   [ TYPE ] | SCHEDULE | ADVICE | INCR | DECR | >
```

SHIFT key + F4 [INCR] :
This operation increases the parameter of the current cursor position a little.
The amount of increase is fixed according to each parameter.

SHIFT key + F5 [DECR] :
This operation decreases the parameter of the current cursor position a little.
The amount of decrease is fixed according to each parameter.

NOTE

- When the setting of “Adjust +” and “Adjust -” is 0.0 (= initial value), the fine-tuning of each parameters by the low level user can not be performed.
- All schedules of heat wave sync function (left, center, right, base, peak, weld speed, delay time) can not be adjusted at all by the low level user.

6 When the high level user displays the screen at step 5, following screen is displayed. When the cursor is moved to the highlighted line, prompt line that means the area of screen bottom displays the [Original value:] and F4 key becomes [ACCEPT] and F5 key becomes [REJECT].

```
DATA  Weld Procedure
                                                  1/6
 1 Weld Procedure      1[                          ]
 2 Weld Schedule       1[Schedule                  ]
 3 Voltage:                              20.50  Volts
 4 Current:                              200.0  Amps
 5 Travel speed:                          50.0  cm/min
 6 Delay time:                            0.00  sec
   Feedback Voltage                        0.0  Volts
   Feedback Current                        0.0  Amps

Original value: 20.000
   [ TYPE ] |  |  | ACCEPT | REJECT |
```

Original value :
This displays the command value before the changing by low level user (this means "fiducial schedule").

F4 [ACCEPT] :
This key operation accepts the changing by low level user. New command value becomes the "fiducial schedule".

F5 [REJECT] :
This key operation rejects the changing by low level user. New command value disappears and returns to original value (= fiducial schedule).

When F4 [ACCEPT] or F5[REJECT] operations are performed, the highlight displaying disappears because those operations means that the high level user finishes confirming the changing by low level user.

29.4 PASSWORD LOG

When the password function is ordered, password log can be performed. Password log is a function to leave the operation log when various operations are performed. For more detail, please refer to Subsection 9.10.7 in OPERATOR'S MANUAL (Basic Operation) (B-83284EN).
The almost setting change operation concerning to the weld procedure is logged. When the weld procedure process limit function is ordered, the operation concerning to "Adjust +" and "Adjust -" described at step 4 in Procedure 29-2 is also logged. Moreover, the operation concerning to F4[ACCEPT] and F5[REJECT] described at step 6 is also logged.

Procedure 29-3 Confirm Password Log for Weld Procedure

Condition

- Password log events is set to ENABLE
- Full menus is displayed

Step

1 Press the MENU key.
2 Select "ALARM".
3 Press F1[TYPE] and select "Password Log". The password Log screen will be displayed.

```
Password Log
                                                    1/10
  1 PWD -089 Edit E1 WP 1 Weld Sch 1 Voltage
    PWD -030 (16.50 to 17.00) Volts

  2 PWD -089 Edit E1 WP 1 Weld Sch 1 Current
    PWD -030 (100.0 to 110.0) Amps

  3 PWD -034 Login (user name) INSTALL from Teach Pendant
    14- 6-23   09:13

   [ TYPE ]  [ VIEW ]          CLEAR    DETAIL
```

4 Move the cursor to the specified log and press F5[DETAIL] key to display the specified log for more detail.

APPENDIX

A APPENDIX FOR ARC TOOL

A.1 BACKUP DATA

Table A.1 Backup files related to ArcTool

Items	Descriptions
.TP (is any string)	TP program files.
AWSETUP.SV	Configuration data for ArcTool, arc welding system and equipments.
AWE**x**WP**yy**.VR	Weld procedure data. **x**:Weld equipment number. **yy**: Weld Procedure number.
WVSCHED.SV	Scheduled data for weaving.
WVSETUP.SV	Configuration data for weaving.

A.2 CONFIGURATION FOR GENERAL PURPOSE

A.2.1 Overview

ArcTool software provides configuration data for various weld system and equipments. However, it cannot support provide it for every weld system and equipments. If you use weld equipments ArcTool doesn't provides it, please setup the configuration refer to description of this section.

A.2.2 I/O

A.2.2.1 Digital I/O

Procedure A-1 Assign Signal type and number to weld I/O

Step

1 Move the cursor on the signal you would like to setup on weld input or weld output screen.
In this description, "Arc enable" on weld input screen is used.

2 Press NEXT key. Press F3 "Config" key, the following screen is appeared.

```
I/O Weld In
                                                1/2
      WELD SIGNAL        TYPE  #
   1 [ Arc enable       ]   ** [***]

   2 Polarity: NORMAL

   [TYPE]  MONITOR  VERIFY  [CHOICE]  HELP
```

Fig.A.2.2.1 Configuration screen for digital type weld I/O

3 Change signal type.
- Move the cursor on "TYPE".
- Press F4 [CHOICE] key.
- Select the new signal type in WI、DI、RI on the displayed menu and press ENTER key.

4 Change signal number
- Move the cursor on "#".

- Enter a new signal number.

5 Change polarity
- Move the cursor on “Polarity”.
- Select polarity by press F5 “NORMAL” key and F4 “INVERSE” key.

6 To check signal assignation correctly, press F3 “Verify” key.

7 To previous weld I/O list screen, press F2 “MONITOR” key.

A.2.2.2 Analog I/O

- Setup the number of analog type weld I/O
- Setup the range of command and feedback for analog type weld I/O.

Setup the number of analog type weld I/O

Setup the number of analog type weld I/O to be suitable for thee connecting weld equipment.

Procedure A-2 Setup the number of analog type weld I/O

Step

1 Perform controlled start.

2 Press enter key and select “4. VARIABLES”.

3 Change the value of following system variables to be suitable for the connecting weld equipment

$AWECFG.$NUM_AO : The number of analog type weld output.

$AWECFG.$NUM_AI : The number of analog type weld input.

4 Setup configurations each analog signal. Each signal is corresponding to the following system variable.

Analog input for weld	Analog output for weld
$AWEPRR.$VOLTAGE_FBK	$AWEPRR.$VOLTAGE_CMD
$AWEPRR.$CURRENT_FBK	$AWEPRR.$WFS_CMD
$AWEPRR.$WFS_FBK	$AWEPRR.$CURRENT_CMD
$AWEPRR.$FBK4	$AWEPRR.$PK_CURR_CMD
$AWEPRR.$FBK5	$AWEPRR.$FREQ_CMD
$AWEPRR.$FBK6	$AWEPRR.$PULSE_CMD

The system variable has the following configurations.

$PORT_NUM : The analog I/O port number corresponding to the command/feedback.

$WELD_SIGNAL : Select weld I/O signal type in the following.
If it is entered 1-6 the signal name($name) and unit($unit) entered corresponding name and unit automatically.
1: Voltage
2: Wire feed speed
3: Current
4: Wire inching speed
5: Non unit signal
6: Frequency
0: Otherwise

$NAME : Signal name (12 characters)

$UNIT : Unit of signal (6 characters)

5 Press FCTN key and select cold start.

6 After cold start performed, please setup the range of command and feedback for analog type weld I/O.

The following figure; Fig. A.2.2(a),(b) shows the setup sample for MIG(Volts,Amps).

Example1 :
AO[1] is used as Base current (B-Amp),
AO[2] is used as Peak current (C-Amp

```
$AWECFG.$NUM_AO   = 2
AO[1]
  $AWEPRR.$ VOLTAGE_CMD $ PORT_NUM        = 1
  $AWEPRR.$ VOLTAGE_CMD $ WELD_SIGNAL     = 0
  $AWEPRR.$ VOLTAGE_CMD $NAME             = BaseAmp
  $AWEPRR.$ VOLTAGE_CMD $UNIT             = B-AMP
AO[2]
  $AWEPRR.$ WFS_CMD $ PORT_NUM        = 2
  $AWEPRR.$ WFS_CMD $ WELD_SIGNAL     = 0
  $AWEPRR.$ WFS_CMD $NAME             = PeakAmp
  $AWEPRR.$ WFS_CMD $UNIT             = C-AMP
```

```
I/O Weld Out
                                          1/14
      WELD SIGNAL        TYPE   #  SIM  STATUS
  1 [Base Amp          ]  AO[   1]  U    0.0
  2 [Peak Anp          ]  AO[   2]  U    0.0
```

Fig. A.2.2.2 (a) Setup and weld I/O screen sample(Change weld signal type)

Example 2 :
Add Frequency to AO[3]

```
$AWECFG.$NUM_AO                          = 4
AO[3](Frequency)
  $AWEPRR.$CURR_CMD$ PORT_NUM            = 3
  $AWEPRR.$CURR_CMD$ WELD_SIGNAL         = 6
AO[2](Wire inching)
  $AWEPRR.$PK_CURR_CMD$ PORT_NUM         = 2
  $AWEPRR.$PK_CURR_CMD$ WELD_SIGNAL      = 4
```

```
I/O Weld Out
                                          1/14
      WELD SIGNAL        TYPE   #  SIM  STATUS
  1 [Voltage           ]  AO[   1]  U    0.0
  2 [Current           ]  AO[   2]  U    0.0
  3 [Frequency         ]  AO[   3]  U    0.0
  4 [Wire Inch         ]  AO[   2]  U    0.0
```

Fig. A.2.2.2 (b) Setup and weld I/O screen sample(Add weld signal)

NOTE

- The enabled/disabled of configurations in $AWEPRR is depended to the number of analog type weld I/O. For example, if $AWECFG.$NUM_AO is 4, the configuration from $VOLTAGE_CMD to $PK_CURR_CMD are applied. The configurations in $FREQ_CMD and $PULSE_CMD are never applied to actual analog type weld I/O.
- If a signal is added and “Wire Inch” has been assigned, move the configuration of wire inching signal to last effective weld output system variable. (Set the ort number to be same as “Current”)
  For example the number of weld output is five, the configuration for wire inching is setup in $AWEPRR.$REQ_CMD

NOTE
- Don’t set the number of AI/AO to zero. If the connecting weld equipment doesn’t use AI, keep the default number of AI.

Setup the range of command and feedback for analog type weld I/O

Setup the range of command and feedback by assign the correspondence between analog I/O value (reference value) and actual output value (command value) for the connecting weld equipment.

Input

Reference: Feedback signal value received the controller from weld equipment.
Command: Actual output value of weld equipment as weld corresponding to above.

Output

Reference: Command signal value sent from the controller to weld equipment.
Command: Actual output value of weld equipment as weld corresponding to above.

Procedure A-3 Setup the range of command and feedback for analog type weld I/O

Step

1 Move cursor on the analog I/O in weld I/O screen. In this case, AI[1] is used.
2 Press NEXT key. PressF3 “CONFIG”. The following screen is appeared.

```
I/O Weld In
                                                  1/4
   1 AI[   1]^
      (Volts)|
             |                          *
   2  10.000 + -----------------*
             |              *     |
   3   0.000 + ------*            |
            *       |            |
   4        +-------+----------+-------->
                  0.000     50.000
                  Voltage(Volts)

   [TYPE]  MONITOR  VERIFY          HELP
```

3 Move cursor on reference value (vertical axis) or command value (transverse axis) you would like to change and enter the value.
The following configurations are allowed to modify.
- Minimum of reference value (bottom of vertical axis)
- Maximum of reference value (top of vertical axis)
- Minimum of command value (left of transverse axis)
- Maximum of command value (right of transverse axis)

4 To check signal assignation correctly, press F3 “Verify” key.
5 To previous weld I/O list screen, press F2 “MONITOR” key.

A.2.3 Other Configurations

Adjustment of wire rewind time before scratch start running

This content shows the procedure for adjustment wire rewind time to run scratch start correctly. If scratch distance and/or robot backward speed has been changed, adjust the time again.

NOTE
If ServoTorch is equipped and used, it isn’t necessary this adjustment.

1 Edit the welding program as above on condition that...
- Schedule: any weld schedule, since, arc isn't generated for the adjustment.
- Eject length: Same length as actual production.
- Robot speed: The maximum welding speed used in actual production.

2 Check the value of $AWSCUSTOM.$AW_CUSTOM[1] If the value is odd, set the value subtracted 1. However, since it is necessary to put it the previous value, please take down the original value.

3 Press [MENU] key and select "I/O".

4 Press F1 [TYPE] key and select "Weld".

5 Press F3 "IN/OUT" and change the display to Weld Output screen.

6 Set "weld start" signal to simulated and OFF.

7 Press WELD ENBL key with SHIFT key and set weld to enabled.

8 Run the TP program created at Step.1. Do not look at around the arc start position directly for the case that arc is generated, Please confirm the wire inching forward/backward is running without arc generation.

9 If wire becomes bent, cut the part of bent after inching wire for several time.

10 Run the TP program created at Step.1. The robot will run as follows
a. Move to welding start position.
b. Arc generation has been failed.
c. Wire is rewound.
d. Start scratch start motion.
e. An alarm occurs after finishing scratch start motion.
Above d., confirm the tip of wire contacts to work.
The ideal motion of wire and robot are following.
a-1 The tip of wire has been contacted while scratch start motion that returns to weld start position.
b-2 Return to start position whit scratching work by the tip of wire.

If the wire and robot don't move as the ideal motion shown above, change the value of $AWEPRCR[eq].$BEFEED_TIME (eq is the equipment number) until the actual motion becomes same as the ideal motion. The value is corresponding to the time of wire rewind before start scratch start motion (unit:s).

11 Change the robot speed in the TP program to the minimum of welding speed used in actual production and repeat do Step.9 and Step.10.

12 Cancel "weld start" signal to simulate.

13 Put the value of $AWSCUSTOM.$AW_CUSTOM[1] the original value.

ADDITIONAL INFORMATION

Addition for
FANUC Robot series R-30*i*B/ R-30*i*B Plus CONTROLLER
Arc Welding Function OPERATOR'S MANUAL

1.Type of applied technical documents

Name	FANUC Robot series R-30*i*B/ R-30*i*B Plus CONTROLLER Arc Welding Function OPERATOR'S MANUAL
Spec.No./Ed.	B-83284EN-3/04

2.Summary of Change

Group	Name/Outline	New, Add, Correct, Delete	Applicable Date
Basic			
Optional Function	Description for Arc Welding Override Control Function is revised.	Add, Correct	Immediately
Unit			
Maintenance Parts			
Notice			
Correction			
Another			

01	19.05.31	Utsumi	Initial release				
Ed.	Date	Design	Description				
Date	2019/05/31	Desig.	Utsumi	Check		Apprv.	

Title	Addition for FANUC Robot series R-30iB/ R-30iB Plus CONTROLLER Arc Welding Function OPERATOR'S MANUAL		
Draw No.	B-83284JA-3/04-05		
FANUC CORPORATION		Sheet	1/8

Chapter 14 “ARC WELDING OVERRIDE CONTROL FUNCTION” is revised as following.

14 ARC WELDING OVERRIDE CONTROL FUNCTION

14.1 OVERVIEW

Added

Arc Welding Override Control Function change the override value to 100% automatically between Arc Weld Start and Arc Weld End instructions in T1 Mode and AUTO Mode.
When the override value is automatically changed, the changed override value is displayed on Teach Pendant (Refer to Fig. 14.1).

This function is an option. (A05B-XXXX-J880)

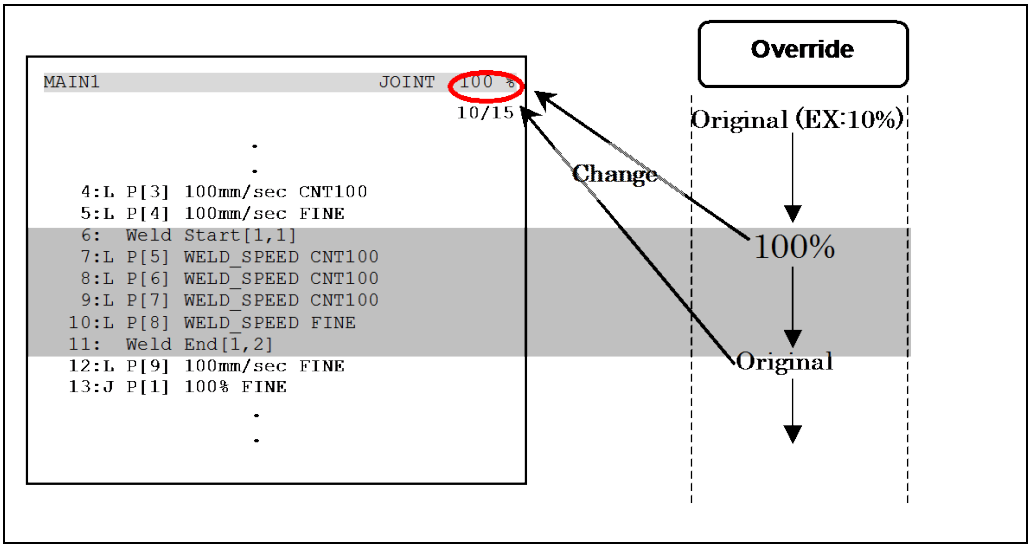


Fig. 14.1 Overview of arc welding override control function

14.2 SETUP

Modified

Modified

When this option is installed, the system variable “$AWOVRCTL” is installed in the controller.
This function must be set up system variables below.

When using in T1 Mode:
Set $AWOVRCTL $T1_ENB to TRUE (default value is TRUE).
When using in AUTO Mode:
Set $AWOVRCTL $AUTO_ENB to TRUE (default value is FALSE).
To disable this function:
Set $AWOVRCTL $OVRCTL_ENB to TRUE (default value is FALSE). When this system variable is FALSE, override value is not automatically changed even if $ AWOVRCTL $ T1_ENB or $ AWOVRCTL $ AUTO_ENB is TRUE.

⚠CAUTION

When the system variable $ AWORRCTL $ AUTO_ENB is TRUE, if the fast teaching speed is incorrectly taught between an arc start command and an arc end command, the robot operates at an unexpectedly high speed even while confirming program execution with low override..

⚠CAUTION

Never change the system variable except $AWOVRCTL $OVRCTL_ENB, $AWOVRCTL $T1_ENB and $AWOVRCTL $AUTO_ENB. The timing of the override changing may become unexpected.

Added

NOTE

Override can not be changed automatically when AUTO mode is selected in versions released before software version 7DF1/14 or 7DC3/50.
The system variable $ AWOVRCTL $ OVRCTL_ENB can be set in versions released before software version 7DF1/14 or 7DC3/50. When this system variable is TRUE, override is automatically changed when T1 mode is selected (standard value: TRUE).

14.3 EXECUTION OF PROGRAM

Added

This function is executed between Arc Weld Start and Arc Weld End instructions. You make the Arc Welding program and execute the program in T1 Mode or AUTO Mode. The override value is automatically changed and the motion speed of the robot is also changed (Refer to Fig. 14.3).
When Arc End instruction is executed, the override value automatically returns to the original value.

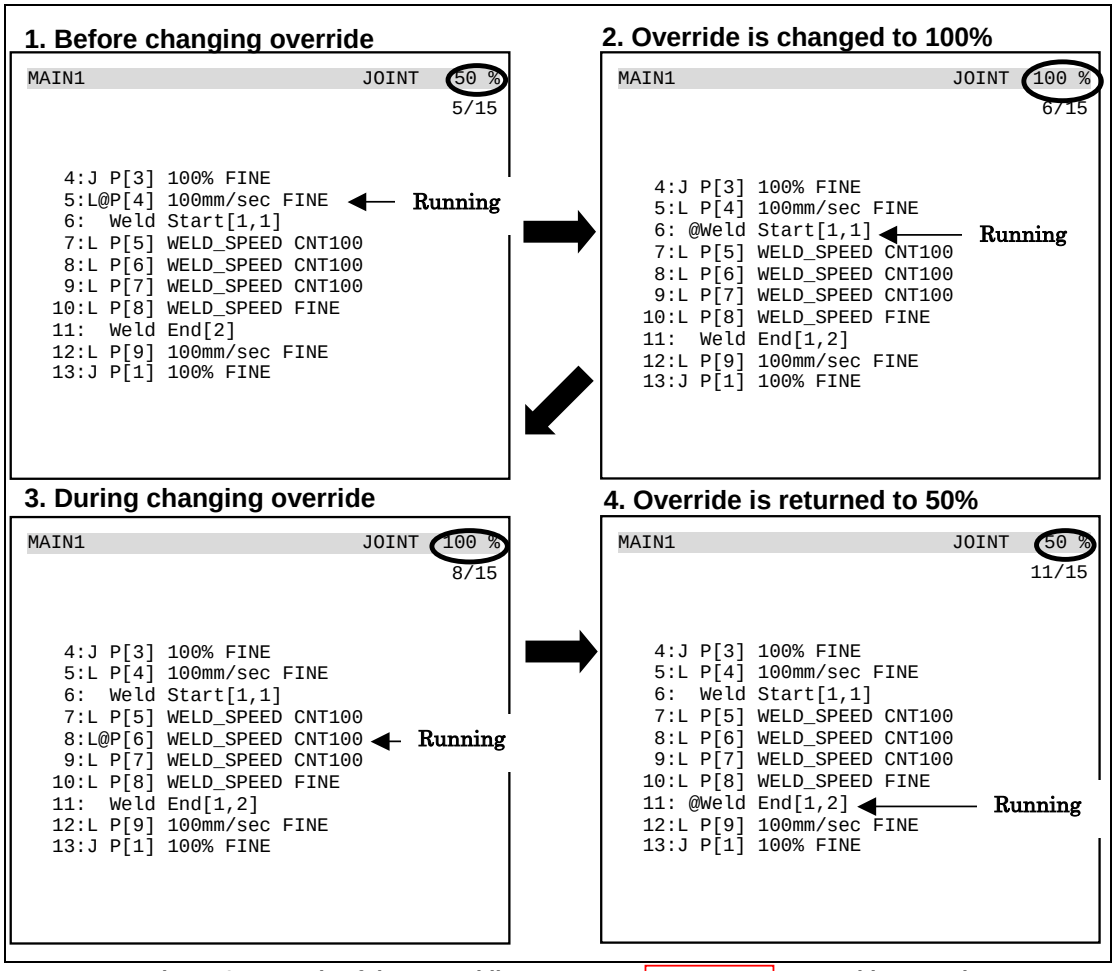


Fig. 14.3 Example of the arc welding program w ng override control

Modified

NOTE

This function can be used in T1 Mode or AUTO Mode. If you select T2 Mode and Arc Weld Start instruction is executed when the override value is less than 100%, the alarm “ARC-033 Override must be 100% to Weld” is occurred and the program is stopped.

NOTE

If the override value is limited less than 100% by $SCR.$RUNOVLIM or $SCR.$SFRUNOVLIM, the alarm “ARC-033 Override must be 100% to Weld” is occurred and the program is stopped during executing Weld Start.
(The limitation of $SCR.$SFRUNOVLIM is enabled only when SFSPD signal is OFF.)

14.4 DETAILED SPECIFICATION

Timing of the Override Changing

The override is automatically changed to 100% when

- Arc Weld Start instruction is executed.
- Program is resumed between Arc Weld Start and Arc Weld End instructions (after Arc Weld Start instruction is executed and program is paused).

The override is automatically returned to the original value when the override value is changed automatically to 100% and

- Arc Weld End instruction is executed.
- Program becomes paused, aborted or finished between Arc Weld Start and Arc Weld End instructions.

If the controller is shutdown during controlling the override value, the override value becomes the following status when power on.

- If Hot Start is executed (“Use HOT START “ = TRUE), the overrirde is returned to the original value.
- If Cold Start is executed (“Use HOT START” = FALSE), the override is initialized to 10% (initial value of T1 mode).

The relationship between this function and some functions for arc welding is the followings.

- If Scratch Start is executed in Arc Weld Start or resume, the override is changed just before Scratch Start is started.
- If Original Path Resume is executed during using this function, resume motion is executed with the original override value. After Original Path Resume is finished, the override value is automatically set to 100%.

Supported Function/Status

This function supports the following status.

-Arc Enable
-Arc Disable
-Robot lock

This function supports the following functions.

-Multi Group function
-Multi Task
-Arc Multi equipment function
-Coordinated Motion function
-Hot Start

NOTE

This function is enabled in both Arc Enable and Arc Disable. Therefore, the override is not changed when Dynamic Arc ON/OFF (Refer to Section 5.3) is performed.

Limitation

This function does not support the following status.

-T2 Mode
-Single Step Mode
-Backward Motion
-Dry Run Mode

Modified

If the following operation is executed when this function is running, this function becomes disabled.

-Move program cursor during pausing a program

-Manual change of the override during override control

NOTE

1. If you change override value from 100% to lower value manually when this function is running, and if the program is paused before Weld End, this function becomes enabled again and the override value is automatically set to 100% when you resume the program.
2. If you change the override value from 100% to lower value manually when this function is running, and if the override value is returned to 100% manually again before Weld End, pause or abort, this function becomes enabled again and the override value returns to the original value when Weld End is executed or the program is paused or aborted.

Using Arc Multi Equipment

If you use this function with Arc Multi Equipment function (Refer to Chapter 25), the override value is changed to 100% when Arc Weld Start instruction to any one of the equipments is executed. The override value is not returned to the original value until Arc Weld End instructions to all equipments are executed (Refer to Fig. 14.4 (a)).

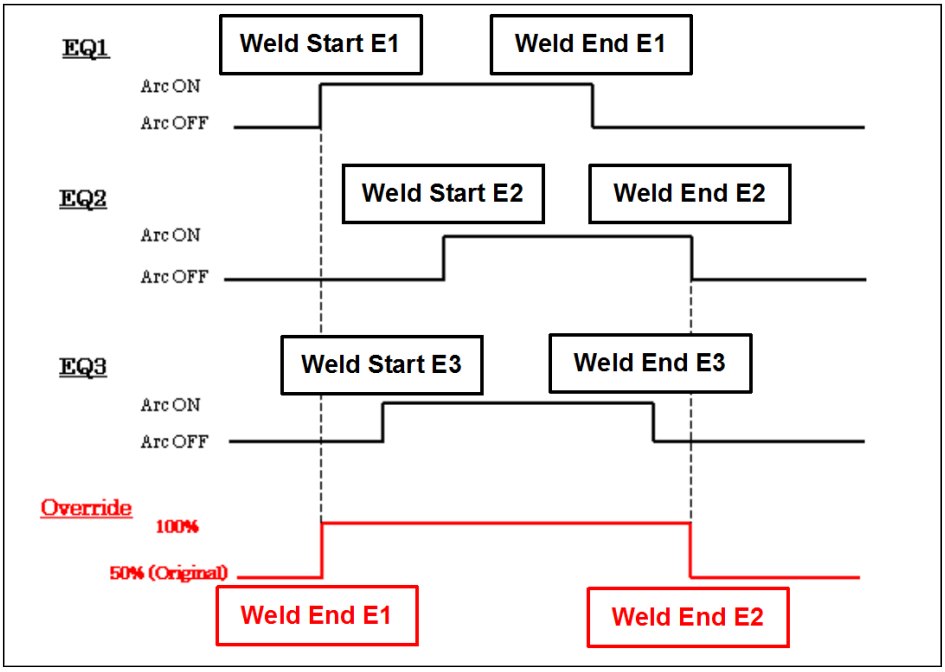


Fig. 14.4 (a) Example of this function using arc multi equipment

Using Multi Group/ Multi Task

In Multi Group, Multi Task configuration, the override value is applied to all groups and all tasks.

Please refer to Fig. 14.4 (b). In this case, the speed of Handling Robot is changed in the timing which Arc Weld Start instruction is executed by Arc Welding Robot. When Arc Weld End instruction is executed by Arc Welding Robot, the speed of Handling Robot is changed.

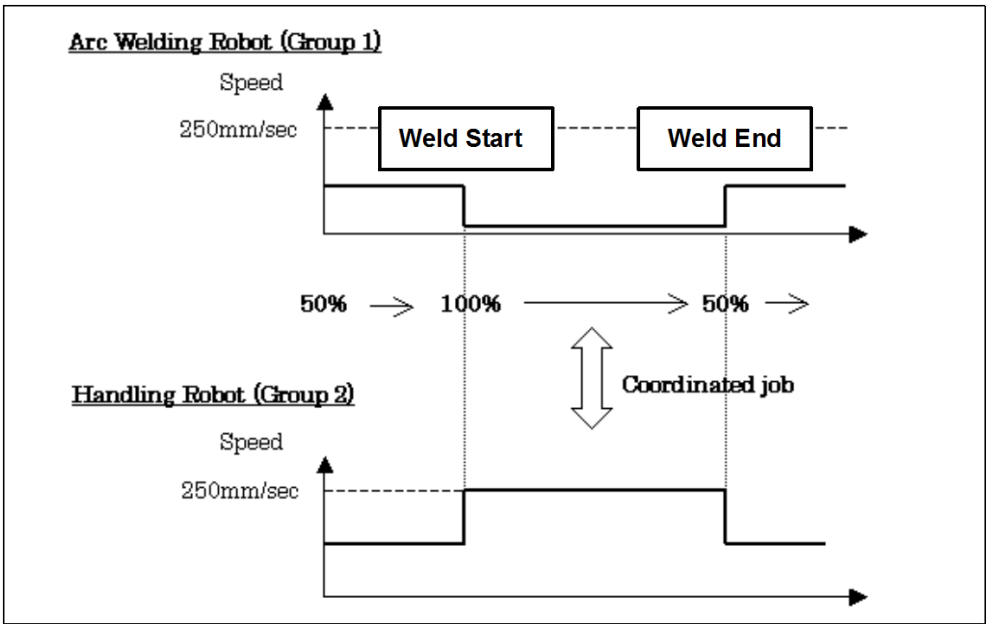


Fig. 14.4 (b) Example of this function using multi group, multi task

NOTE

The speed of these groups are limited by 250mm/sec in T1 Mode. This is the same case for Coordinated Motion Control.

Added

01	19.05.31	Utsumi	Initial release				
Ed.	Date	Design	Description				
Date	2019/05/31	Desig.	Utsumi	Check		Apprv.	

Title	Addition for FANUC Robot series R-30iB/ R-30iB Plus CONTROLLER Arc Welding Function OPERATOR'S MANUAL
Draw No.	B-83284JA-3/04-05
FANUC CORPORATION	Sheet 8/8

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REVISION RECORD

Edition	Date	Contents
04	Feb., 2017	• Applied to R-30*i*B Plus. • Add a description of [TAST DIAGNOSIS FUNCTION] to Section 20.6. • Add Chapter 29 [WELD PROCEDURE PROCESS LIMIT]. • Add a description of [Wire Clamp Function] to Section 5.2. • Some errors in writing have been corrected.
03	Jul., 2013	• Applied to series 7DC2 (V8.20P). • Applied to R-30*i*B Mate. • Some errors in writing have been corrected.
02	Aug, 2012	• Add Subsection 4.1.4 [Related View for Weld Procedure]. • Add Section 5.1 [MOVING THE ROBOT BY JOG FEED]. • Move Chapter 22 [TOUCH SENSING] to R-30*i*B CONTROLLER Optional Function OPERATOR'S MANUAL. • Add Chapter 22 [PROCESS LOGGER]. • Add Chapter 27 [TORCH ANGLE]. • Add Chapter 28 [USED WIRE ESTIMATION].
01	July, 2012	

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