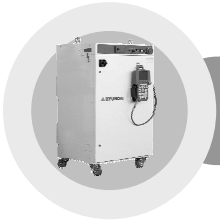
WARNING

THE INSTALLATION SHALL BE MADE BY QUALIFIED INSTALLATION PERSONNEL AND SHOULD CONFORM TO ALL NATIONAL AND LOCAL CODES

Hyundai Robot

Hi4aAW071001FMEN3



Hi4a Controller Function Manual

Arc Welding

HYUNDAI
HEAVY INDUSTRIES CO.,LTD.

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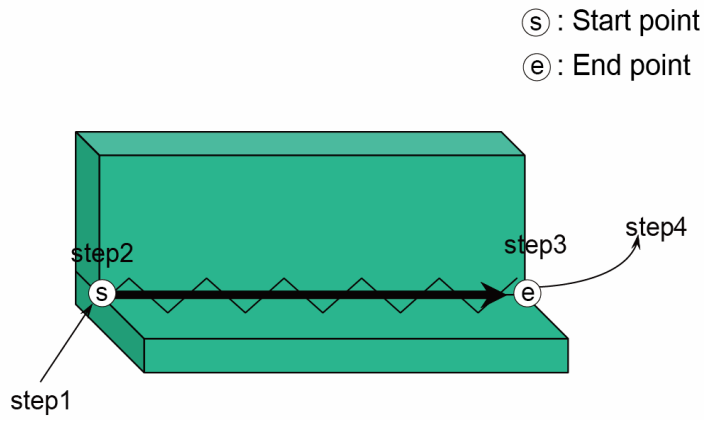
1

Basics of Arc Welding

1.1. Introduction

This teaches the welding process as shown below.



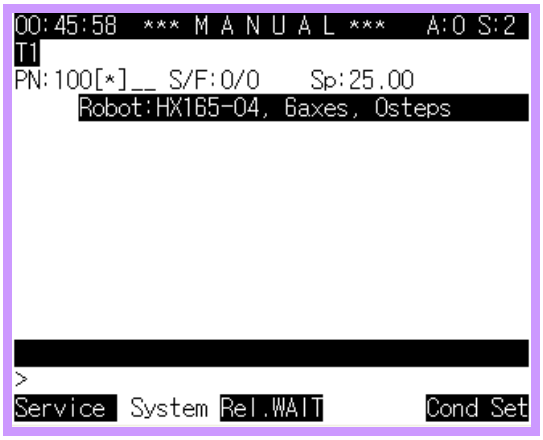
(1) Turn on the power.
Turn on the front side power switch of the controller.

(2) Switch to manual mode.
Select with OP panel switch of the controller.

(3) Select the program.
Press the [Program] in teach pendant and designate the program number. (ex. 100)

(4) Press the motor ON (operation ready ON) button.
Press the motor ON button.

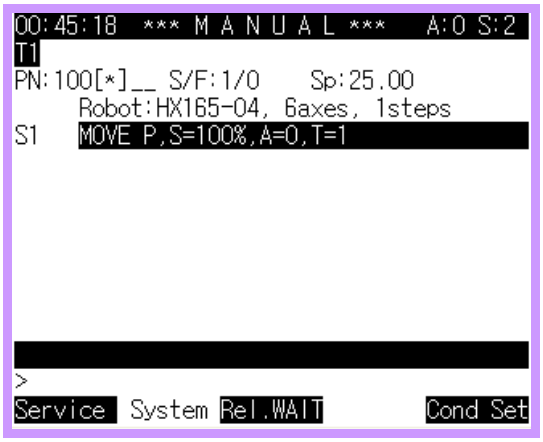
If you have followed so far the teach pendant screen should look like the following.



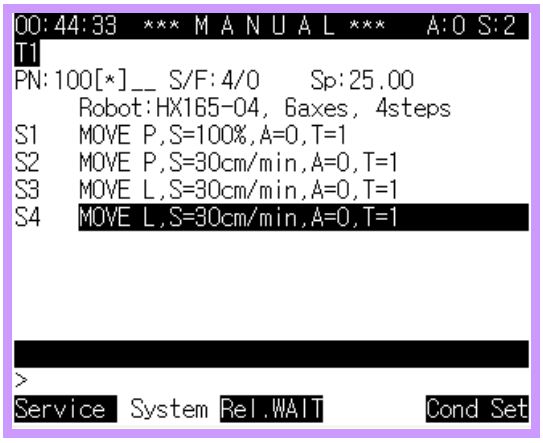
(5) Move to step 1 using the axis operation key.

(6) Designate wanted interpolation, speed, accuracy and tool number.
Use [INTP] key for interpolation and [Speed∧] key or [Speed∨] key for speed.
Use the [ACC] key for accuracy.
For the tool number, enter the tool number after R29. (If currently installed tool number is 1, press in the order of [RESET(R)] [2][9] [SET] [1] [SET]).
After this, you can press the [SET] key to edit the data.

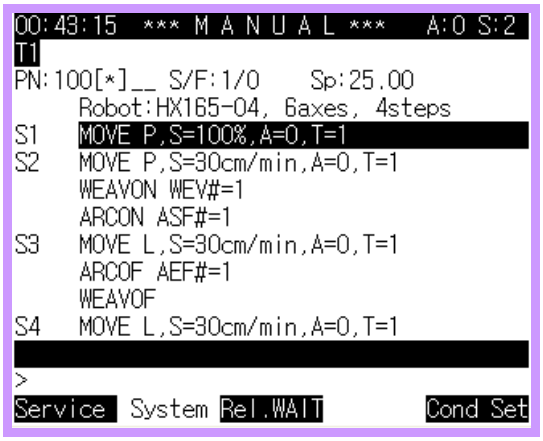
(7) Press the [REC] key.



(8) Repeat (5) ~ (7) for steps 2~4.



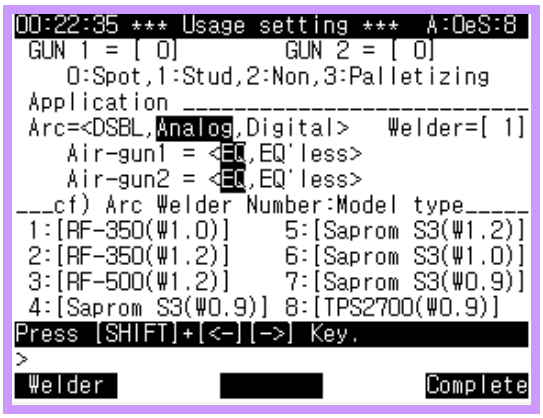
(9) Because the welding section is in between step 2 and step 3, move the cursor to step 2.
Press the WEAVON key ([SHIFT]+[5]). Enter the pattern number and press the [SET] key twice.
Press the [ARCON] key. Enter the pattern number and press the [SET] key twice.
Press the [ARCOF] key. Enter the pattern number and press the [SET] key twice.
Press the [WEAVOF] key and enter the WEAVOF command.
Insert the [END] command and use the [END] key.



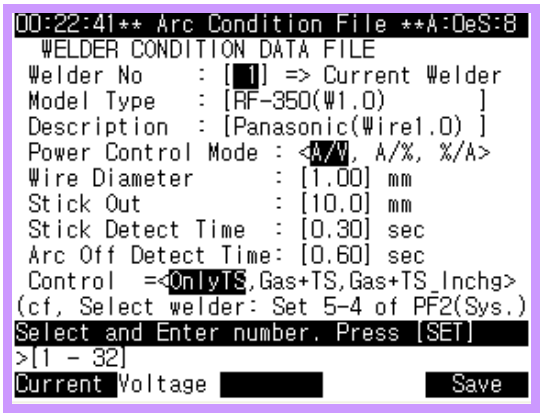
1.2. Arc Function Setting

There are cases when the arc function is not activated depending on the robot type. In this case, set the arc function as follows.

Select 『[PF2]: System』 → 『5: Initialize』 → 『4: Setting usage of the robot』 from manual setting screen and you will set the screen to set various conditions to better utilize the arc welding.



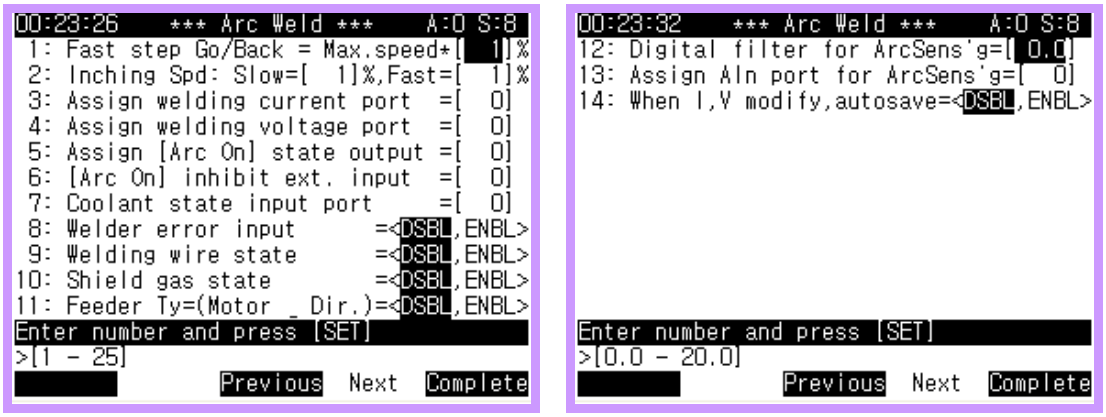
Above screen is when arc function is enabled. To use the arc function, you must set the arc item to Enable. The following screen is the screen you can see when you press 『[PF1]: Welder』 from the previous screen.



For details on setting the condition file, please refer to “Chapter 15. Welder characteristics file”.

1.3. Application condition setting for arc welding

Select 『[PF2]: System』 → 『4: Application parameter』 → 『2: Arc』 from manual setting screen and you will see the following screen where you can set various conditions for arc welding.



Item No.	Description
1	[1 ~ 25]: Fast step Go/Back setting sets the speed for high speed movement function. In other words, it sets the moving speed when pressing [SHIFT] + [step forward], [step backward]. (Refer to high speed movement function)
2	[0 ~ 50], [50 ~ 100]: Inching speed setting is the wire feeding speed during wire inching and retracting when using [Inching], [Retract] key. Wire speed is set in a current value and it sets the low and high feeding speed (operation when pressing the key for more than 3 seconds) (Refer to inching and retract function)
3~7	Assign the port number for various signals used for arc welding. In other words, it sets the DI and AO number.
8	Decide whether to use the signal input for error status.
9	Decide whether to use the signal input for wire status.
10	Decide whether to use the signal input for gas pressure status.
11	Decide whether to use the inching signal output function. Set to Enable for applicable welder.
12	If the robot stops during the welding process, turn off the arc and set the post flow time of the gas.
13	Assign the input port for voltage of the welding current sensor to use the arc sensing function.
14	Decide whether to automatically save the value when the current and voltage are changed during playback.

2 Command Insert

2.1. ARCON

ARCON command starts the arc welding of the controller. This command can be inserted in 3 ways.

- ARCON
  This starts the welding process without additional arc start condition setting.

- ARCON ASF#=1
  This starts the welding process according to the setting in arc start condition file.

- ARCON C=200,V=20,T=2,RETRY
  This starts the welding process according to the entered value after the command.

2.2. ARCOF

ARCOF command ends the arc welding process. This command can be inserted in 3 ways.

- ARCOF
  This ends the welding process without additional welding ending condition setting.

- ARCOF AEF#=1
  This ends the welding process according to the setting in arc end condition file.

- ARCOF C=200,V=20,T=2,ANTSTK
  This ends the welding process according to the entered value after the command.

2.3. ARCCUR

ARCCUR command sets the output value of arc welding current to the designated value. It is inserted as follows.

- ARCCUR C=200

2.4. ARCVOL

ARCVOL command sets the output value of the arc welding voltage to the designated value. It is inserted as follows.

- ARCVOL V=20

2.5. ARCDC

ARCDC command sets the command value of arc welding current to the designated value. It is inserted as follows. (Current command value range [V]: -14.0 ~ 14.0)

- ARCDC 10

2.6. ARCDV

ARCDV command sets the command value of arc welding voltage to the designated value. It is inserted as follows. (Voltage command range [V]: -14.0 ~ 14.0)

- ARCDV 10

2.7. WEAVON

WEAVON command starts the weaving process. It is inserted as follows.

- WEAVON WEV#=1

2.8. WEAVOF

WEAVOF command stops the weaving process. It is inserted as follows.

- WEAVOF

2.9. REFP

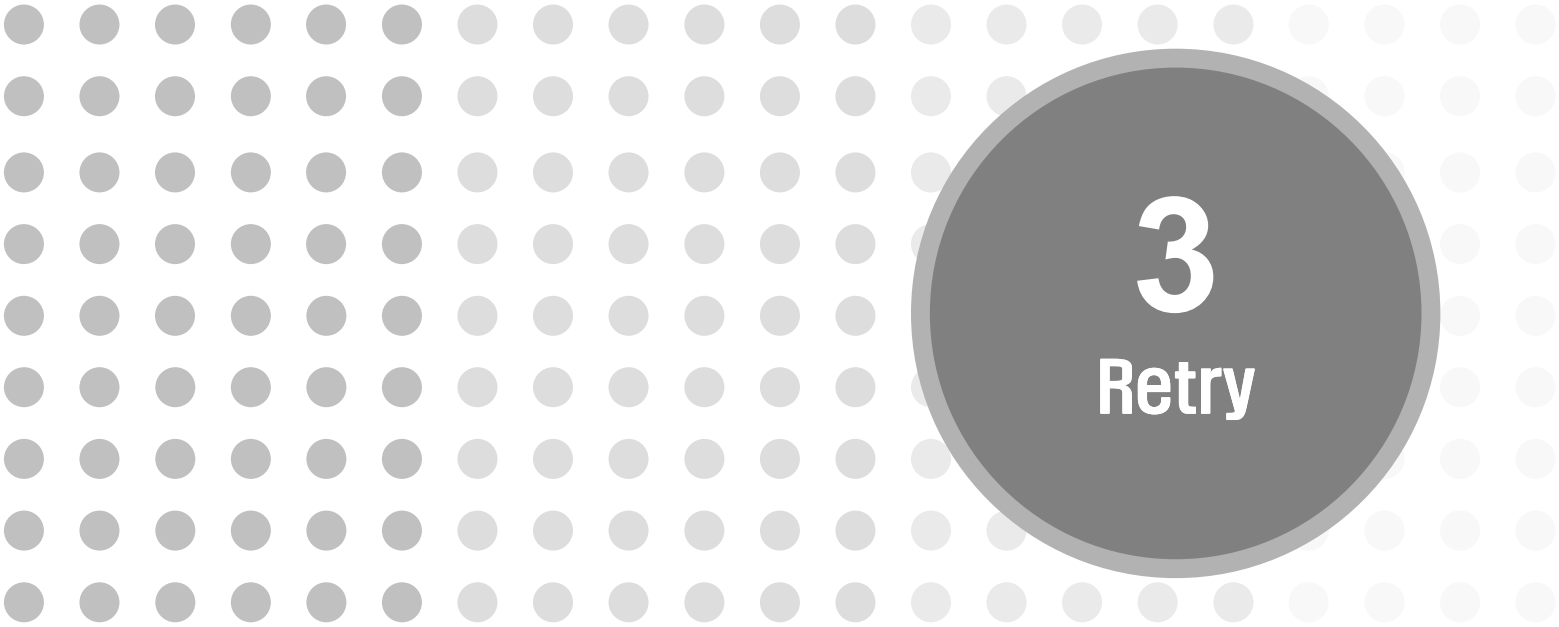
REFP command designates the reference point used in the weaving process. It is inserted as follows.

- REFP 1
  This is when the reference point is entered as hidden pose. To enter the reference point, use SHIFT (FAST) + REFP 7 to enter the command in hidden pose.

- REFP 1,P1
  The reference point is entered in applicable pose.

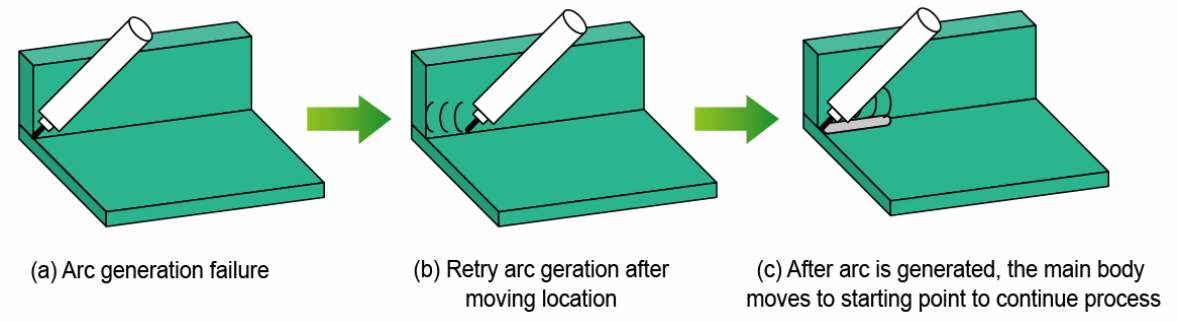
2.10. TRJLOG

This saves the moving trace of arc sensing. Please refer to the 『Arc Sensing Function Manual』 for more details.


3
Retry

3. Retry

During the arc welding, sometimes the arc is not successfully generated due to alien particles near the starting point of welding in main material. When an error occurs from arc generation failure, this enables continuous operation by automatically retrying to generate the arc with any separate processing.



(a) Arc generation failure

(b) Retry arc geration after moving location

(c) After arc is generated, the main body moves to starting point to continue process

When retry function is set, the arc generation is automatically retried in case of arc generation failure. Retry function can be done automatically according to the set condition(a).

The main body moves slightly off from the welding starting point to the set direction and retries the arc generation (b). If the arc is generated, it returns to the starting point with the arc maintain. Then it continues the welding process to the target pose.

Whether to use the retry function and the retry mode can be set in arc start condition. And number of times, current/voltage, movement etc can be set in 『RETRY』 section of arc auxiliary condition. To edit the arc start condition and Arc auxiliary condition, press the [Quick Open] key from 『ARCON』 command in the condition file.

So the Retry function generates an arc in a different pose when it is failed in the starting point and returns to the starting position to continue the welding operation. For details on the setting items, please refer to the Quick Open section of this manual.

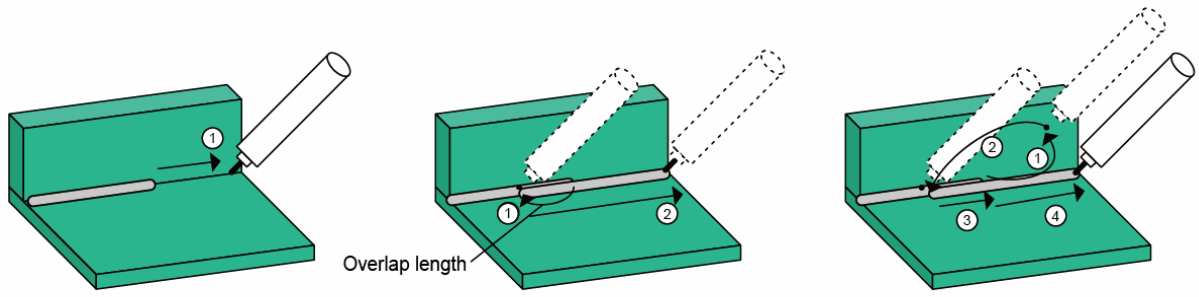
4
Restart

4. Restart

When the welding stops during an arc welding process due to arc being off, lack of wire, low pressure of gas or error with coolant status, and if the welding restarts after it was stopped, there can be a spot left unwelded. This function prevents this issue.

The setting for this function designates how the welding will restart depending on the how the welding process was stopped for example, arc being off etc. When the welding process is automatically resumed or it is restarted after a separate treatment, this function moves the torch back to a certain length along the welding line and starts the welding. Therefore it prevents any unwelded spots. Also it can create spots where welding is done more than once.

Overlap (Restart) function can be executed according to the method designated in the Arc auxiliary condition file.



(a) Ignore (b) Automatic (c) Semi automatic (manual)

The treatments for error signals for Arc Off, Gas Off, Wire Off and Coolant Error are as follows.

- Ban
  In case of Arc off, lack of wire, low gas pressure, coolant error etc., the welding and the robot stops. If you press the [START] button after resolving the issue, the robot restarts the welding from stopped pose without bead overlap.

- Conti
  It continues without stopping. In other words, it ignores the error signal and continues. This treatment method is only applicable to Arc Off.

- SemiAuto
  In case of Arc off, lack of wire, low gas pressure, coolant error etc., the welding and the robot stops. If you press the [Operate] button after resolving the issue, the robot restarts the overlap welding in the method set in “RESTART”.

- Auto
  In case of Arc off signal is received, the welder does not stop but moves over the overlap distance and restarts welding. But during the welding of the overlap zone and the arc off signal is received again, it will start welding in that position.

For details on each treatment method, please refer to the 『Quick Open』 section.

5

Auto Stick Recovery

5. Auto Stick Recovery

When the arc welding is complete, sometimes the wire sticks to the work piece. The welder temporarily increases the voltage at the end of the welding process to prevent this sticking .

After the anti-stick process, the controller operates a circuit to detect sticking. At this time, if the wire sticking is detected, an error signal is sent to the robot to stop. In this case, this function removes the sticking to enable continuous operation.

If this function is used, the welder sends a certain voltage to remove the sticking when one is detected. If the sticking is not removed after running the removal process for a number of times set, it outputs 「**Weld stick of spot gun**」 signal and stops the robot.

You can select whether to use this function in arc end condition file. Auto stick recovery conditions including voltage and number of times, can be set in the Arc auxiliary condition file.

6

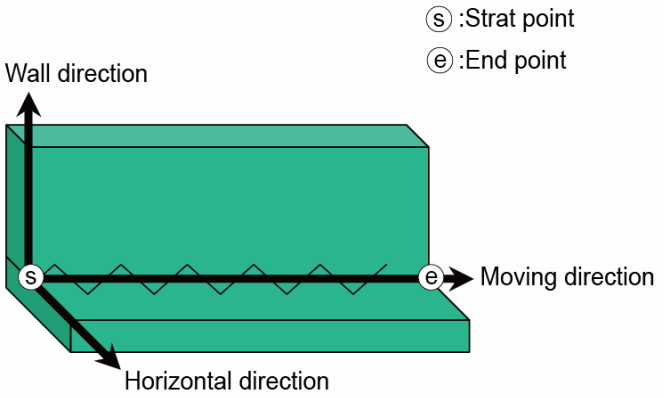
Reference Point Function

The weaving function used to widen the welding bead in arc welding, requires some factors to decide the weaving shape. In most cases, weaving condition file is enough.
But if the vertical surface of weaving is not aligned to the Z axis, if the approach point is different from the weaving direction, if the moving direction cannot be decided or if the weaving surface cannot be decided from the combination of the above reasons, a reference point is needed to decide it. The method of teaching this reference point is the reference point function.

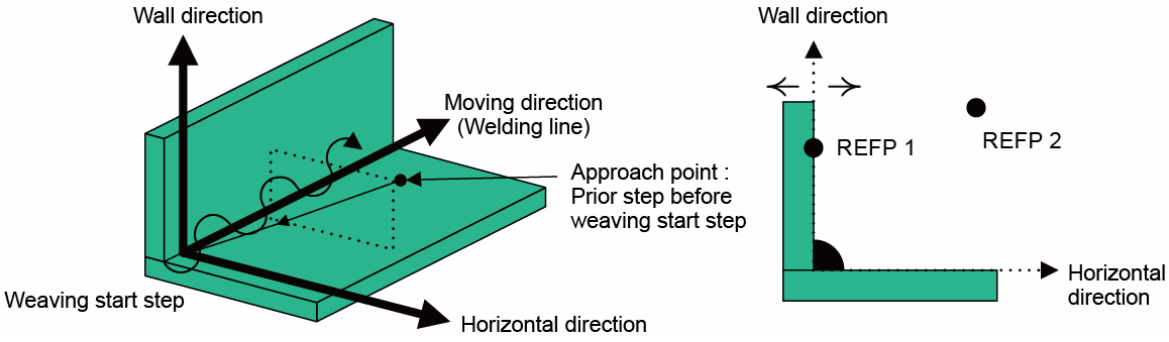
6.1. Function

Even when the work piece is set in an arbitrary shape, the weaving shape can be aligned to the work piece.

- Weaving coordinate



To execute the weaving process, basic coordinate is needed. This becomes the basis of detail weaving pattern condition. When weaving starts, this is automatically created.



Set the wall direction as reference point 1 (REFP 1). Generally it does not have to be Z axis of the robot. First set and record one point on the work piece as REFP1 ([REFP] key). Then one side is formed with welding line and reference point 1. This becomes the wall direction surface.

REFP2 is used for selecting the quadrant to execute the weaving and decides the horizontal direction.

REFP2 can be recorded as any point on the applicable quadrant. In general, the horizontal direction is selected in the direction of the approach point.

The moving direction is the direction of the weaving start point to end point.

If there is no reference point, each direction is decided based on the following standards.

① Wall direction : Z axis direction of robot coordinate
② Horizontal direction : Direction to the side from wall to approach point (Pose of step before weaving start)
③ Moving direction : Direction from weaving start point to end point

- Reference point record command
  ① REFP 1 : Reference point that decides the wall direction
  ② REFP 2 : Reference point that decides the horizontal direction
  ③ REFP 3 : Reference point that decides the moving direction
  ④ REFP 4: If it is difficult to measure the weaving pattern angle, use the REFP 4 to set this angle.

- Reference point record
  When you cannot use the above coordinate (no reference point) from the installed shape of the work piece, use the REFP 1~3 command to record the reference point.

6.2. Reference point recording method

The process of recording the reference point is as follows.

(1) Move to the pose to record the reference point using the jog key.

(2) Move the cursor to the location (generally the next step of WeavingOn command) of the step to record the reference point.

(3) Press the [REFP] key to complete the recording.

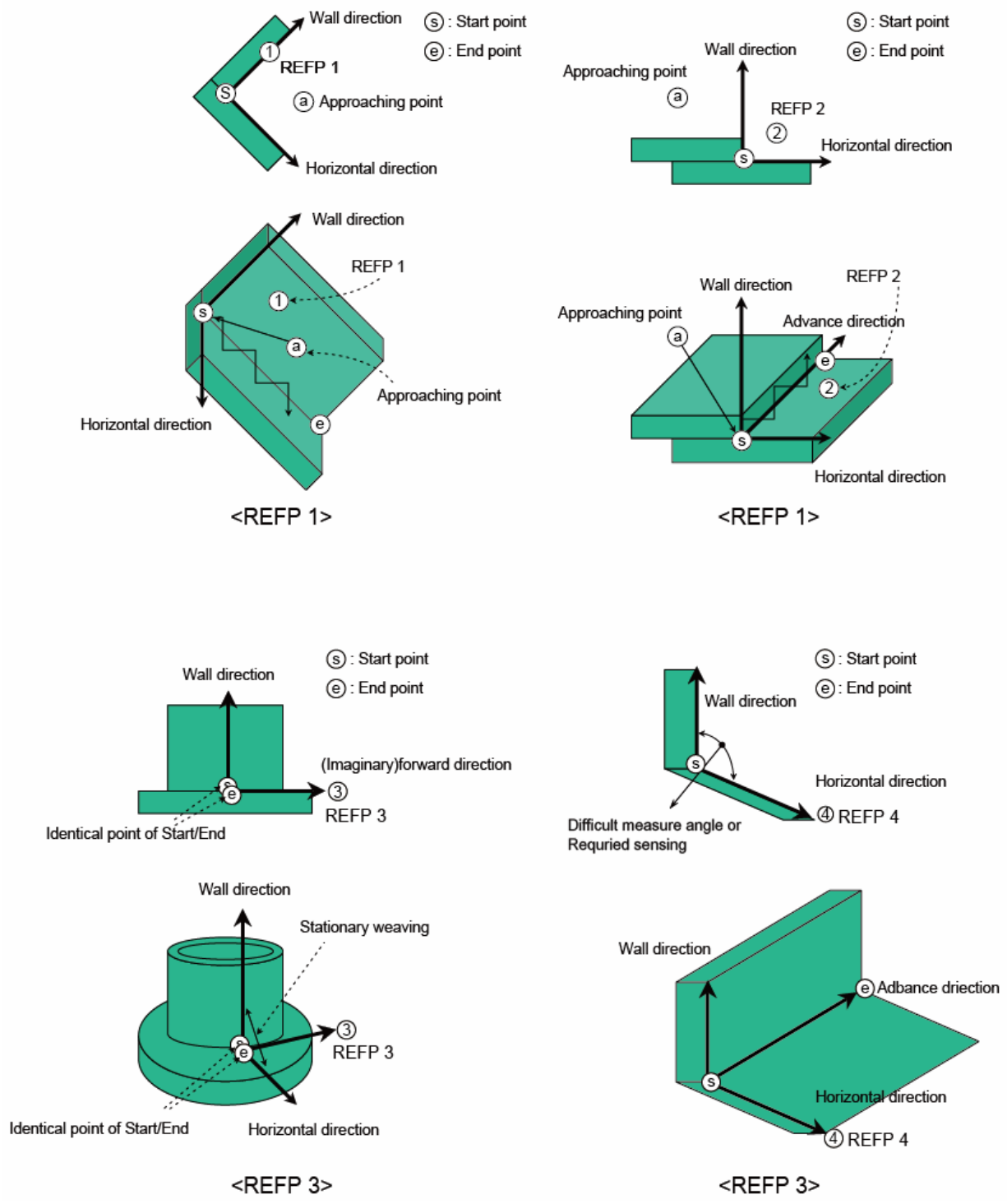
- When reference point recording is needed

  ① REFP 1: When the wall direction is different from the Z axis of robot coordinate.
  It does not matter what location on the surface that decides the wall direction. But if the distance to the welding line is too close, the process of calculating the wall direction can generate an error.

  ② REFP 2 : When the approach point is on the opposite side of weaving
  This is for setting the right or left side of the surface that decides the wall direction. It does not matter where the location is as long as it can distinguish left and right side. But if the distance to the surface of wall direction is too close, the process of calculating the horizontal direction can generate an error.

  ③ REFP 3 : When the moving direction cannot be decided like the stop weaving
  It does not matter where the location is as long as it is on the moving direction line. But if the distance to the start point (end point) is too close, the process of calculating the moving direction can generate an error.

  ④ REFP 4: When it is difficult to measure the weaving pattern angle, use the REFP 4 to designate the angle.



① REFP 1: The distance from the welding line should be at least 5mm.
② REFP 2: The distance from surface deciding the wall direction should be at least 5mm.
③ REFP 3: The distance from the start point (end point) should be at least 5mm.
④ REFP 4: When it is difficult to measure the weaving pattern angle, use REFP 4 to designate this angle.

- Movement to reference point

  Because the reference point is the pose to decide the weaving shape, generally the robot does not move to the reference point during playback. But the following process must be executed to check and change the pose of the reference point.

  ① Locate the cursor to the reference point command.
  ② Press the step forward key and move the robot to the reference point.

  ※) At this time, set the interpolation type to straight line and for moving speed, tool and ACC, use the condition recorded in weaving start point.

- Reference point pose edit

  ① Locate cursor to the reference point command.
  ② Move the reference point to the pose to change using the jog key.
  ③ Press [SHIFT] + [Pose MOD] key to change the pose of the reference point.

- Reference point command deletion

  ① Locate the cursor to the reference point command.
  ② Press the [SHIFT] + [DEL] key to delete the reference point command.

- Reference point number edit

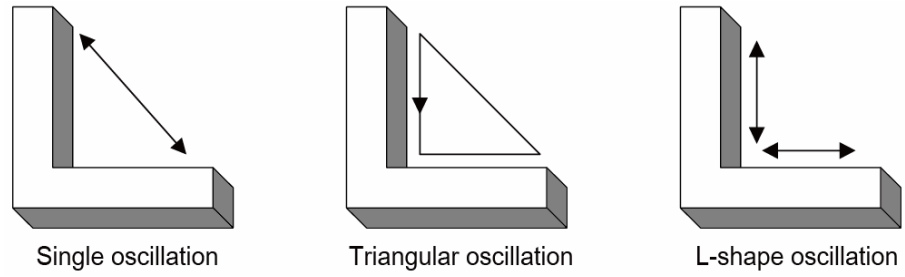
  ① Locate the cursor to the reference point command.
  ② Press the [CMD] key.
  ③ Enter the new reference point number and press the [SET] key.
  ④ Press the [SET] key one more time or press the [Pose MOD] key to change the reference point number.

7
Weaving Function

This is the function used to widen the width of the welding bead in arc welding. The details of weaving are decided by the weaving condition file and reference point. You can change set the following items from the weaving condition file.

7.1. Shape

This sets the weaving pattern shape as shown below.



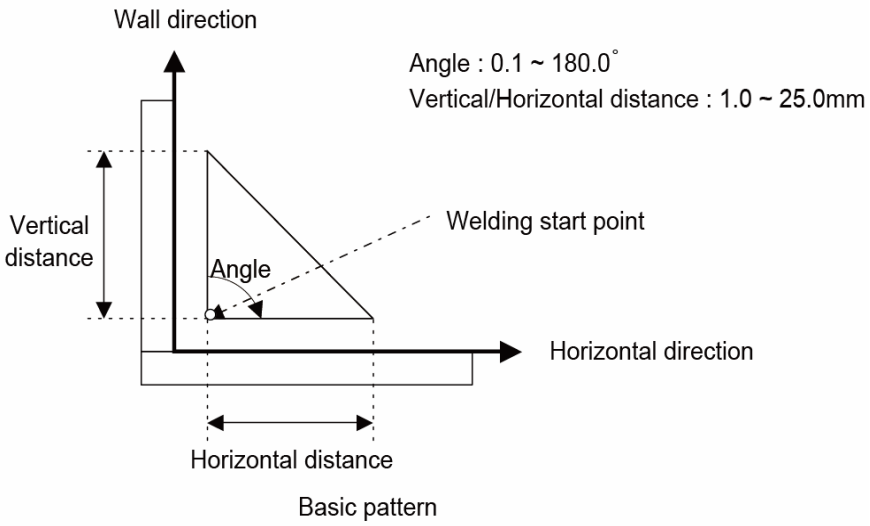
7.2. Number of frequency

If you set the value of 「Frequency」 to '0', moving time designation method is selected. Weaving frequency is set as a non-zero value.

Frequency is related to the horizontal and vertical distance. The higher the frequency the lower the range of usable amplitude and the lower the frequency, the higher the amplitude.

7.3. Basic pattern

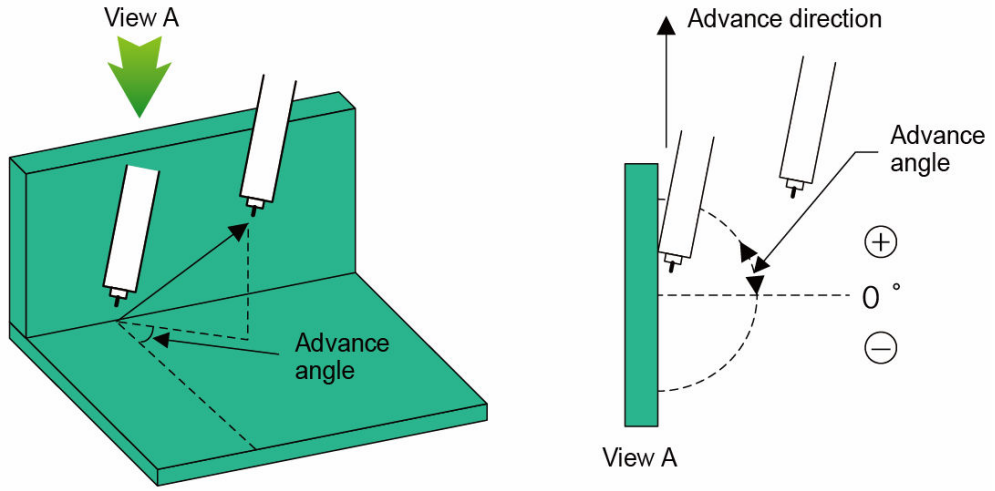
Set each element shown in the following figure.



- Vertical distance : Set the distance in wall direction (upper angle)
- Horizontal distance : Set the distance in horizontal direction (lower angle).
- Angle : Set the angle between the upper and lower side as shown in above figure.

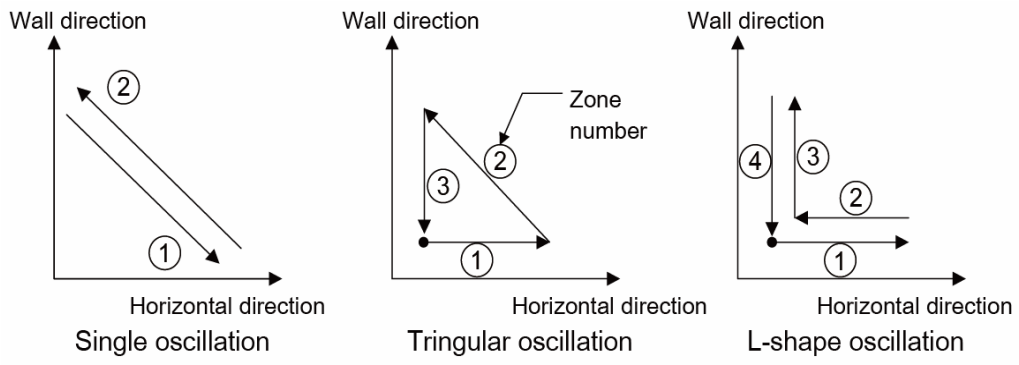
7.4. Advance angle

This is the weaving oscillation angle to the welding line and the range is -90.0 ~ 90.0 degrees.



7.5. Moving time

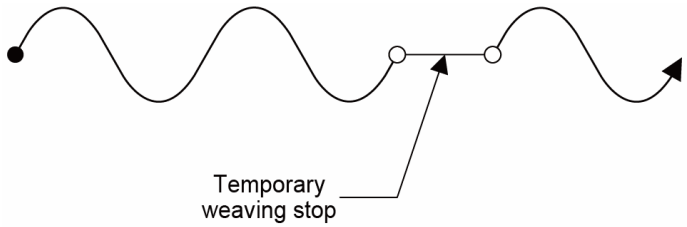
This is the item used when 「Frequency」 value is set to '0'. Individually designate the moving time by zone as shown below. The number of zones used according to the each oscillation type varies.



7.6. Timer

This is the value valid when the 「Frequency」 value is set to '0', this sets the stop time at the end point of each shape shown above.

Note) At this time, the moving trace does not stop. (Shape as shown in below Figure A.)



Shape of trace when timer is designated

8

Inching and Retract

This controls the motor of the wire feeder, which is one of the welding devices. This pulls out or rolls back in the wire.

Inching function rotates the wire feeder motor in positive direction to pull out the wire and the retract function rotates the wire feeder motor in negative direction to pull in the wire.

You can control the length of the welding wire using the inching and retract function.

8.1. Operation

(1) Inching function

- Exclusive key:
- Feeding speed: 2 stage (within 3 and after 3 seconds after pressing the key), the user can set it.

(2) Retract function

- Exclusive key:
- Feeding speed: 2 stage (within 3 and after 3 seconds after pressing the key), the user can set it.

(3) Inching speed selection

- Select 『[PF2]: System』 → 『4: Application parameter』 → 『2: Arc』 from manual setting screen.
- Set the low and high speed value in 『2: Inching Spd: Slow =[???]%, Fast =[???]%』 from arc welding setting menu.

9

Current / Voltage Up. Down Function during Welding

This function can increase/reduce the welding current or voltage.

- **Checking current/voltage value during welding**

  Press the [I,V MOD] key during welding to check the set value saved in the file.

- **Current/voltage adjusting unit during welding**

  ① Welding current adjusting unit: It increases/decreases the current by 1[A] (or 5%) when you press the button.
  ② Welding voltage adjusting unit: It increases/decreases the voltage by 0.1[V] (or 5%) when you press the button

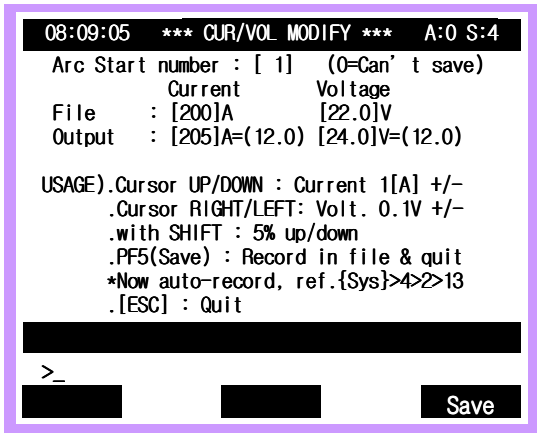
- **Saving and canceling**

  You can save to file or cancel the adjusted welding current/voltage.

  ① Save: Press the F5 "Save" key.
  ② Cancel: Press the [ESC] key.

9.1. Operation

(1) Select [SHIFT]+[8] 『I, V MOD』 from manual mode.



■ Explanation
File : It shows the set value saved in file.
Output : It displays current output value.

■ Operation
Adjust output: You can adjust the current or voltage using the [⇦][⇨][⇧][⇩] keys.
Save to file:
Press F5 key to save the output value to file and move to previous screen.
Cancel save:
Press [ESC] key to cancel the saving process to file and move to the previous screen.

(2) Current/Voltage change only applies to the arc start condition and not to the end condition. And when you directly designate the current/voltage without using the welding condition file, you can check and change but not save to file.

10

High Speed Movement Function

Because the moving speed in the welding zone is very slow during applied arc welding, you need higher speed than the teaching speed when operating a test to check the pose.
To run a test operation to check the pose, press the specific key to move the step forward/backward and the robot will move at high speed rather than the teaching speed.

■ Key for high speed movement

① This functional operation is limited to manual step forward/backward.
② When executing the high speed movement during step forward/backward operation, the『Step go/back max.speed』 of condition setting is not limited.
③ When the high speed movement status changes during operation, first stop the operation and then restart in new setting.

10.1. Operation

(1) Press the [SHIFT] key and the [Forward]/[Backward] key to ignore the teaching speed and to operate the robot at maximum speed.
At this time, the『Step go/back max.speed』 of condition setting is ignored.

(2) When there is a change in the [SHIFT] key during step forward/backward operation, immediately stop the robot and restart in the changed condition.
For example, if you press the [SHIFT] and [Forward]/[Backward] key to move in high speed and then release the [SHIFT] key during operation, the robot will stop.
When the stopping process is completed, the robot will execute step forward/backward in normal speed.

(3) High speed step forward/backward setting
Select 『[PF2]: System』 → 『4: Application parameter』 → 『2: Arc』 from manual setting screen.
Set the speed from 『1: Fast step Go/Back = Max.speed*[25]%』 of arc welding condition setting.

11

Warning Function for Multiple Recording of Same Position

When teaching the path, the process of moving the robot with jog and recording the pose is repeated. When recording the same step as the current, the controller automatically checks the step to prompts the user to check the stop so that it is not duplicated.

By preventing duplicated recording for the same step, it reduces the overall teaching work process. In other words, when you press the [REC] key, it compares the pose and condition of the stop to see if it is the same and prompts the user 『Dup-Record Warning! Record? [YES/NO]』 so that the user can choose.

If the following conditions are all satisfied, the controller judges as the same pose.

- When each item of pose is within 0.1mm
- When each item of rotation is within 0.1degree

11.1. Operation

(1) Press the [REC] key to record the current pose.

(2) It reads the recorded step to check whether it is the same step by comparing the step pose and condition.

(3) If it is the same, it prompts the user by showing 『Dup-Record Warning! Record? [YES/NO]』.

(4) Press the [SET] key to record and [R..] key to cancel.

12

Individual Output Function of Welding Current/Voltage

After individual output of welding current and voltage for arc welding, you can set to Arc On (Torch Switch).

Depending on the characteristics of the welding power source, when the receiving speed of welding current or voltage output in analog form is slow, it shifts to Arc On after a certain period of time.

12.1. Function

You can adjust the output sequence or time for individual output of welding condition (current/voltage) used in arc welding.

- Welding current output function

  ① Command Syntax: ARCCUR C=< cur.output >
  ② Current output value: Designate arithmetic formula or welding current value (0~999[A]).

- Welding voltage output function

  ① Command Syntax: ARCVOL {V=< vol.output > or VP=<Voltage ratio>}
  ② Voltage output value: Designate arithmetic formula or welding voltage value in constant value (0.0~100.0[V]).
  ③ Voltage ratio: Designate arithmetic formula or welding voltage ratio in constant value for single control (0.0~100.0[%]).

- Direct analog output function for welding current

  ① Command Syntax: ARCDC <Current command value >
  ② Current output value: Designate arithmetic formula or analog value in constant value (±14.0[V]).

- Direct analog output function for welding voltage

  ① Command Syntax: ARCDV <Voltage command value >
  ② Voltage output value: Designate arithmetic formula or analog value in constant value (±14.0[V]).

13

Coolant Monitoring Function during Welding

This function monitors the status of the coolant when using the water coolant torch, and stops and restarts the robot when there is an error. Basically the error signal comes from the external error monitoring device of the welder or controller to the general digital port.

13.1. Function

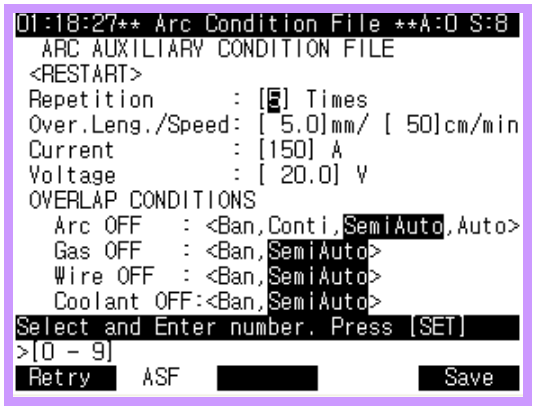
This function executes two types of setting.

- Whether to overlap when there is an error with coolant
  This decides whether to use or prohibit overlapping when restarting after an error.

- Input port assignment for coolant error signal
  This sets where to receive the error signal in digital input.
  If you do not want to use this function, set the port number to “0”.

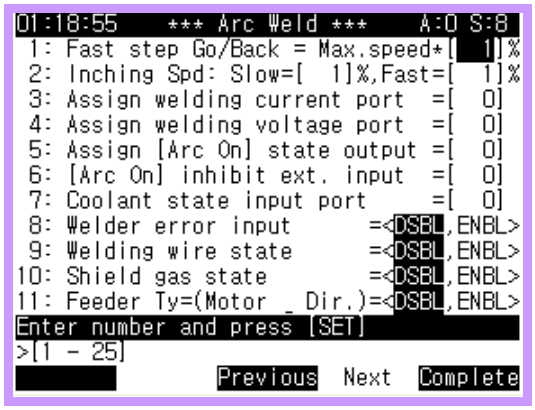
13.2. Operation

(1) To decide whether to use the overlap function for coolant error, select 『Arc Start Condition file』 → 『Arc Auxiliary Condition file』 → 『Restart』 and you will see the following screen.



You can select whether to use the overlap in 'Coolant Off' item.

(2) To designate the general port to use for error input, select 『[PF2]: System』 → 『4: Application parameter』 → 『2: Arc』. Select the menu to see the following screen.



Set the general port to use for coolant error input from 『7: Coolant state input port』. If you do not want to use this function, set it to '0'.

14

Qucik Open Function

14.1. Function summary

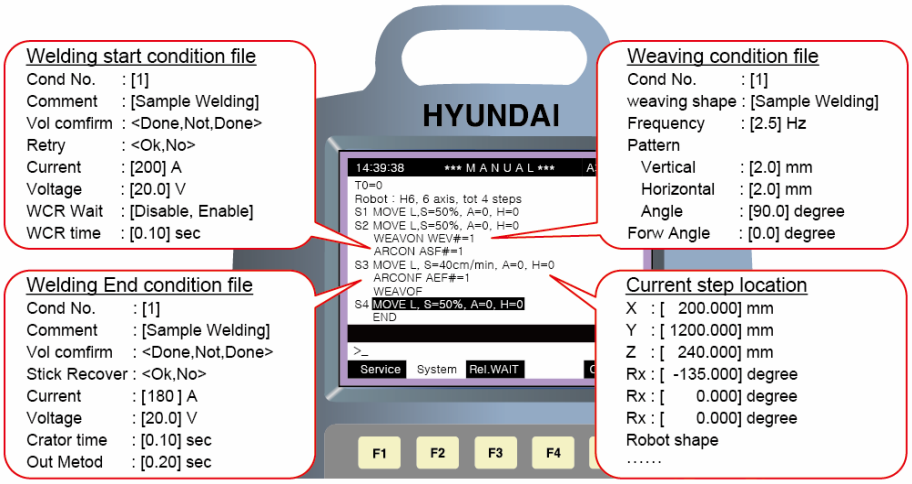
When teaching the arc welding work program, you must not only set the conditions related to the welding such as voltage, current etc. but also the detail settings exclusively for arc function such as weaving, retry/restart, welder characteristics etc. Also basically you must be able to check the step or pose of assisting point.

The conditions related to arc welding is managed in file form within the controller and this condition file requires a function easy and fast to edit.

Quick Open function enables the user to check and change the setting or pose with one key operation without complicated process.

Let's take arc start condition as an example. When the cursor is on the ARCON command which turns the Arc On, press the [Quick Open] key to see the condition number used in the current command from the arc start condition. From this screen you can check or change the details of the arc start condition and directly move to the related file when the applicable condition is linked to another file.

As shown, this function enables the user to check or change the details of a condition file or step pose related to a specific command.



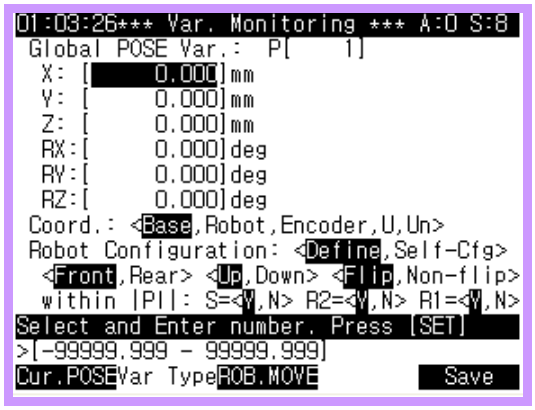
If you press the [Quick Open] key on a specific command, you can see the related file or detail content on the screen. To save and end, press the <Complete> button and to end without changing, press the [ESC].

The content appearing when you press [Quick Open] for each command is as follows.

Command	File, content	Details	Remarks
MOVE	Pose	Target pose X Y Z(mm) Rx Ry Rz(。) Robot configuration	Target pose can be edited
CALL	Called program	Show command	
JMPP			
ARCON ASF#=	Arc start condition file Arc auxiliary condition file Welder condition data file	● Arc start condition Condition no., comment, voltage confirm, retry, retry mode, current, voltage, WCR Wait, Wait Time ● Arc auxiliary condition -RETRY: Repetiion, retract time, reenter/path distance line movement, shift distance, speed, current, voltage -RESTART: Repeition, overlap length, speed, current, voltage, overlap condition setting ● Welder condition data Welder no., model type, description, power control mode, wire diameter, stick out, stick detection time, arc off detection time -Current characteristics: Polarity, reference value (V), measured value (A), adjustment - Voltage characteristics: Polarity, reference value (V), measured value (V,%), adjustment	
ARCOF AEF#=	Arc end condition file Arc auxiliary condition file Welder characteristics file	● Arc end condition file Condition no, Comment, voltage confirm, automatic stick recovery, current, voltage, Crater Time, gas postflow ● Arc auxiliary condition file Auto stick recovery disabled : Repetition, current, voltage, delay time	
WEAVON WEV#=	Weaving condition	● Weaving condition file Condition no., weaving mode, frequency, pattern, forward angle, moving time, timer	
REFP	Reference point	Reference pose. X Y Z(mm) Rx Ry Rz(。) Robot configuration	Reference pose. X Y Z(mm) Rx Ry Rz(。) Robot configuration
Inserted command	Variable check and edit	You can monitor or change the value of the applicable variable depending on the variable type of the inserted command. V%, V!, V$, P, R, LV%, LV!, LV$, LP, LR, system variable etc.	

14.2. MOVE - Step Pose Data

(1) Press the (Quick Open) key from Move command.

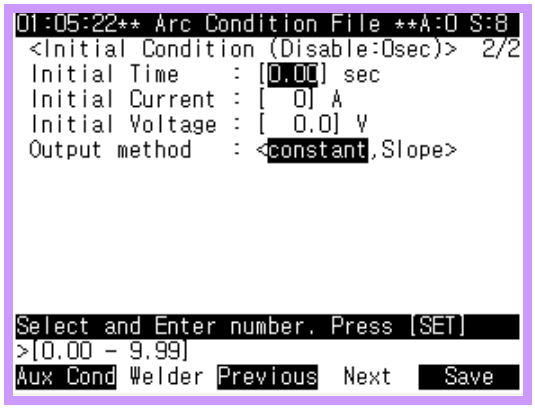


(2) It shows the pose of the applicable step.

- Use the cursor key to move and change the pose. To confirm the edit, press the [SET] key. After enter the number, press the [SET] key to save.
- When describing a pose, there are plural solutions to describe a pose depending on the robot type and characteristics. Therefore to make this description unique, there needs to be a way to designate the robot type. Please use the [SHIFT]+[←] [→] key to select one from the items in < >.
- To apply it on the program you must press the 『[PF5]: Complete』 for completing. If you press the Cancel button the content will not applied.

14.3. Arc start condition – Execute in ASF#=x

(1) When the cursor is in the command line of ARCON ASF#=, press the key to move to the following edit screen.



(2) Press [ESC] to end without saving and 『[PF5]: Save』 to end after saving.

- Cond No. : [1]
  Designate the welding condition number. (You can designate up to 32 conditions for use.)

- Comment: [Appl 1]
  Record the description related to the usage of the welding condition.

- Vol confirm: <Done, Not Done >
  This sets whether the control method for the welding power source is one source or individual and whether it has been checked.

- Retry: <OK, No>
  This decides whether to use the retry function when WCR is not entered after ARCON output.

- Retry mode: <Re-enter, Shift, Weld path >
  This is the moving direction of the torch for re-try.

  ① Re-enter
  When the arc generation fails, it moves to the prior step and retries the arc generation. This moving distance is set in 'Retract/Move along welding line' of retry setting menu in Arc auxiliary condition. The voltage/current condition for arc start condition when retrying after moving back be the set distance and then moving forward for retry, follows the arc start condition.

  ② Shift
  It shifts by the distance set in the retry condition of Arc auxiliary condition, and returns to the arc generation step. It retries the arc generation by the voltage/current set in the retry condition.

  ③ Weld Path
  It moves along the welding line by the distance set in 'Retract/Move along welding line' of retry condition of Arc auxiliary condition and retries the arc generation by the voltage/current set in the retry condition. If successful, it moves back to the welding

start point, maintain the arc, to continue welding.

- Current: [200] A (Range: 0 ~ 999)
  This is the welding current value to be used for welding power source output.

- Voltage: [24.4] V (Range: -20.0 ~ 200.0)
  This is the welding voltage value to be used for welding power source output.

- WCR wait: <Disable, Enable >
  This selects whether to wait for the WCR input or to proceed without waiting after the welding condition output.

- Wait Time : [0.10] sec (Range: 0.00 ~ 9.99)
  ① When WCR wait is “Enabled”
  The following item is shown as “Wait time”. It shows the maximum standby time for WCR input. If the signal is not received within this time, an error is sent out and retries.
  ② When WCR wait is “Disabled”
  The following item is shown as “Delay time”. It waits for as long as the set time after condition output, and then proceeds to the next step.

- Gas preflow (if GasControl) : [0.10] sec (Range: 0.0 ~ 20.0)
  This sets the time for prior exhaustion of the shield gas to protect the welding part from air before arc starts. This is applied when using the gas signal control.

- Initial Time : [0.00] sec
  This sets the time the initial condition is maintained before this condition is applied when the welding starts.

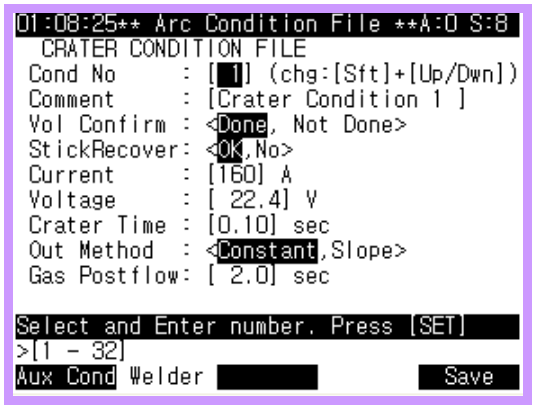
- Initial Current: [0] A
  This sets the current value applied at the beginning of welding. This value is maintained for the initial condition time.

- Initial Voltage: [0.0] V
  This sets the voltage value applied at the beginning of welding. This value is maintained for the initial condition time.

- Output method: <Constant, Slope>
  This sets the output method of current and voltage value applied to the initial condition time. If set to constant, the output stays flat for the initial condition time and after this time, changes to this condition. If set to Slope, this condition gradually increases from the initial condition for the initial condition time.

14.4. Arc end condition – Execute in AEF#=

(1) When the cursor is in the command line of ARCON AEF#=, press the key to move to the following edit screen.



(2) Press [ESC] to end without saving and 『[PF5]: Save』 to end after saving.

- Cond No : [1]
  Designate the welding condition number. (You can designate up to 32 conditions for use.)

- Comment:[Crater Condition1]
  Record the description related to the usage of the welding condition.

- Vol Confirm: <Done, Not Done>
  This sets whether the control method for the welding power source is one source or individual and whether it has been checked.

- StickRecover: <OK, No>
  This decides whether to use the automatic sticking removal function when the wire is stuck to the work piece after ARCOF output.

- Current: [160] A (Range: 0 ~ 999)
  This is the welding current value for welding power source output.

- Voltage: [22.4] V (Range: 0.0 ~ 50.0)
  This is the welding voltage value for welding power source output.

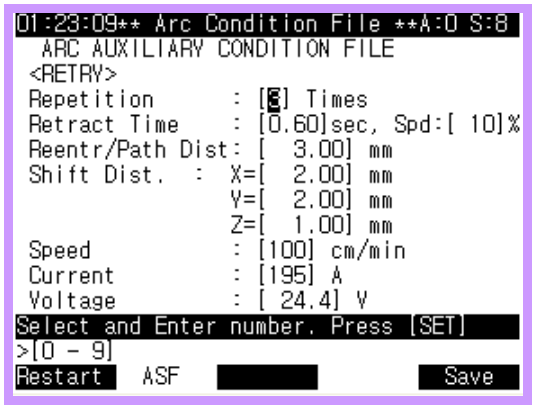
- Crater Time : [0.10] sec (Range: 0.00 ~ 9.99)
  This is the time the current and voltage of Arc end condition are maintained.

- Out method: <constant, Slope >
  This sets the output method of current and voltage value applied to the end condition time. If set to constant, the output stays constant for the end condition time and after this time, changes to this condition. If set to Slope, this condition gradually decreases the current and voltage from the end condition for the crater time.

- Gas Postflow : [2.0] sec (Range: 00.0 ~ 20.0)
  This is the time to continue gas exhaustion after Arc Off.

14.5. Arc auxiliary condition - RETRY

(1) Press the 『[PF1]: Aux Cond』 button from the arc start condition file screen to see the following menu for support condition file.



- Repetition : [1] times (Range: 1 ~ 9)
  This designates the maximum number of retries. If the arc generation fails within the designated number of times, robot returns to the zero point (Point where Arc On was tried, welding start point) and stops.

- Retract Time : [0.60] sec (Range: 0.00 ~ 9.99)
  This is the time the wire is retracted during retry. After the wire is retracted, robot moves the torch. After inching the wire, it becomes Arc On.

- Spd: [10] % (Range: 0 ~ 100)
  This is the speed for retracting the wire during retry.

- Reentr/Path Dist : [3.0] mm (Range: 0.00 ~ 99.99)
  When the operating mode is set to re-enter or move along welding line, this is the distance the torch is moved during retry. The operating mode is set in the start condition.

- Shift Dist.: X= [2.00], Y= [2.00], Z= [1.00] mm (Range: -99.9 ~ 99.9)
  If the operating mode is set to shift, this is the distance the torch moves during retry.

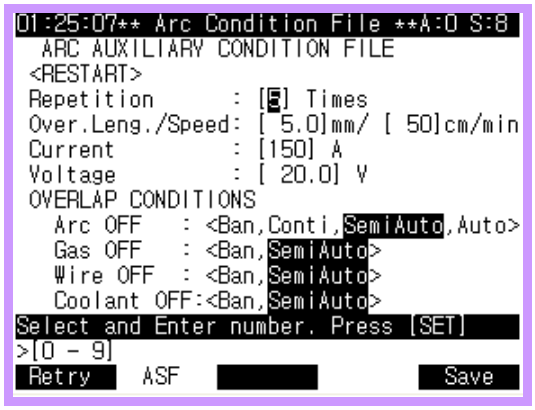
- Speed: [100]cm/min (Range: 1 ~ 999)
  This is the speed of the torch when moving or returning to the welding start point during retry.

- Current: [195] A (Range: 0 ~ 999)
  This is the welding current output value during retry. (Applied when the torch is returned to the welding start point). But when the current value is 0, it starts the current value of the arc start condition.

- Voltage: [24.4] V (Range: -20.0 ~ 200.0)
  This is the welding voltage output value during retry. (Applied when the torch is returned to the welding start point). But when the voltage value is 0, it starts the voltage value of the arc start condition.

14.6. Arc auxiliary condition - RESTART

(1) Select 『[PF1]: Restart』 form the restart screen to see the following restart setting screen.

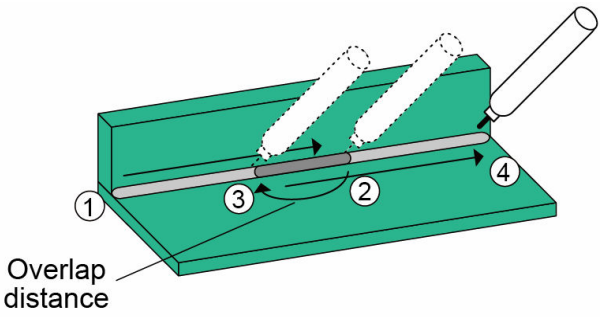


(2) After entering the numbers, press the [SET] key or select the item with [SHIFT]+[←][→].

- Repetition: [5] times (Range: 0 ~ 9)
  This designates the maximum number of restarts for same welding zone.

- Over.Leng. : [5.0] mm (Range : 0.0 ~ 99.9)
  This is the distance the welding is overlap during restart. The robot moves back as much as this distance and restarts the welding.

- Speed: [50] mm (Range : 1~999)
  This is the speed of bead overlap after moving to overlap pose. When moving as much as the overlap distance from the error, it is done in the speed 3 times faster than the designated speed, and this speed applies to the welding process for the overlap zone. After welding the overlap zone, the welding returns to its normal speed.



Speed in restart

When there is an error (②) from the welding start point (①) to welding end point (④), the welder moves in the speed 3 times faster than the designated speed over the overlap distance (③). It welds in the current and voltage set in restart up to ②, and returns to normal welding set in start condition from ② to ④. But if there is an error along the overlap zone welding (from ③ to ②), it will not overlap again and start welding from that point.

- Current: [150] A (Range : 0 ~ 999)
  This is the welding current for overlap zone. If the voltage is set to 0, it will start in the current value of arc start condition.

- Voltage: [20.0] V (Range : -20.0 ~ 200.0)
  This is the welding voltage for overlap zone. If the voltage is set to 0, it will start in the voltage value of arc start condition.

(3) Overlap condition

This set the overlap execution method in case of an error signal input of Arc Off, Gas Off, Wire Off and Coolant error signal during arc welding.

- Arc Off – Treatment for “Arc Off ”.

  ① Ban
  『E1189 Not inputs WCR at arc start.』 message is displayed and the robot stops. If you press the 『Start』 button, it will not execute the overlap welding.

  ② Conti
  『E1189 Not inputs WCR at arc start.』 message is displayed and the robot continues the operation.

  ③ SemiAuto
  『E1189 Not inputs WCR at arc start.』 message is displayed and the robot stops the operation waiting for manual operation. When you resolves the cause of the error and press the 『Start』 button, it will move from the current pose at the speed 3 times faster set in restart condition as much as the overlap distance. After reaching the restart pose, it sends out the set current and voltage to execute the welding up to the Arc Off pose at the set speed. When reaching the Arc Off pose, it sends out the current and voltage of the arc start condition and continues the normal welding process to the target point.

  ④ Auto
  『E1189 Not inputs WCR at arc start.』 message is displayed and the robot temporarily stops. It will automatically move over the overlap distance at the speed 3 times faster. After reaching the restart pose, it sends out the set current and voltage to execute the welding up to the Arc Off pose at the set speed. When reaching the Arc Off pose, it sends out the current and voltage of the arc start condition and continues the normal welding process to the target point.

- Gas Off – Treatment for “Gas condition (Yes/No)”

  ① Ban
  『E1275 An insufficiency of shield gas.』 message is displayed and the robot stops. If you press the『Start』 button to restart, it will not overlap.

  ② SemiAuto
  『E1276 A shortage of weld wire.』message is displayed and the robot stops and waits for manual operation. When you resolves the cause of the error and press the 『Start』 button, it will move from the Wire Off pose at the speed 3 times faster set in restart condition as much as the overlap distance. After reaching the restart pose,

it sends out the set current and voltage to execute the welding up to the Wire Off pose at the set speed. When reaching the Wire Off pose, it sends out the current and voltage of the arc start condition and continues the normal welding process to the target point.

※ If you set the 『10 : Shield gas state』 of 『Arc weld』 from 『[PF2]: System』 → 『4: Application parameter』 → 『2: Arc』 to “Disable”, it will ignore the signal.

■ Wire Off – Treatment for “Wire condition (Yes/No)”

① Ban
『E1276 A shortage of weld wire.』 message is displayed and the robot stops. If you press the 『Start』 button to restart, it will not overlap.

② SemiAuto
『E1276 A shortage of weld wire.』 message is displayed and the robot stops and waits for manual operation. When you resolves the cause of the error and press the 『Start』 button, it will move from the Wire Off pose at the speed 3 times faster set in restart condition as much as the overlap distance. After reaching the restart pose, it sends out the set current and voltage to execute the welding up to the Wire Off pose at the set speed. When reaching the Wire Off pose, it sends out the current and voltage of the arc start condition and continues the normal welding process to the target point.

※ If you set the 『9 : Welding wire state』 of 『Arc weld』 from 『[PF2]: System』 → 『4: Application parameter』 → 『2: Arc』 to “Disable”, it will ignore the signal.

■ Coolant Off – Treatment for “Coolant Off”

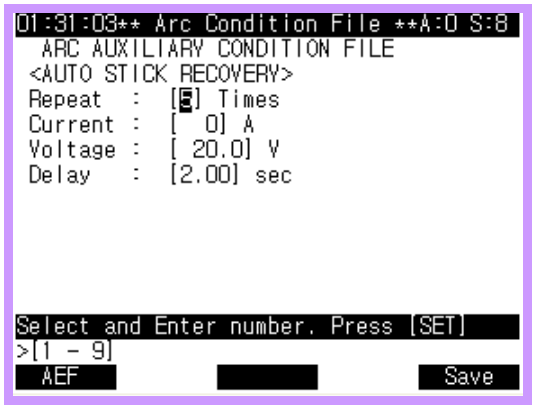
① Ban
『E1357 Detected coolant error signal.』 message is displayed and the robot stops. If you press the 『Start』 button to restart, it will not overlap.

② SemiAuto
『E1357 Detected coolant error signal.』 message is displayed and the robot stops and waits for manual operation. When you resolves the cause of the error and press the 『Start』 button, it will move from the Coolant Off pose at the speed 3 times faster set in restart condition as much as the overlap distance. After reaching the restart pose, it sends out the set current and voltage to execute the welding up to the Coolant Off pose at the set speed. When reaching the Coolant Off pose, it sends out the current and voltage of the arc start condition and continues the normal welding process to the target point.

※ If you set the 『7 : Coolant state input port』 of 『Arc weld』 from 『[PF2]: System』 → 『4: Application parameter』 → 『2: Arc』 to “0”, it will ignore the signal.

14.7. Arc auxiliary condition – Automatic stick recovery

(1) Select 『[PF1]: Aux Cond』 from arc end condition file screen and you will see the following automatic stick recovery setting screen.



(2) Move the cursor to the item to change, enter the value and press the [SET] key to make the changes. You must press the 『[PF5]: Save』 button to save the changes.

- Repeat : [5] times (Range : 1~9 times)
  Maximum number of times of welding stick recovery process

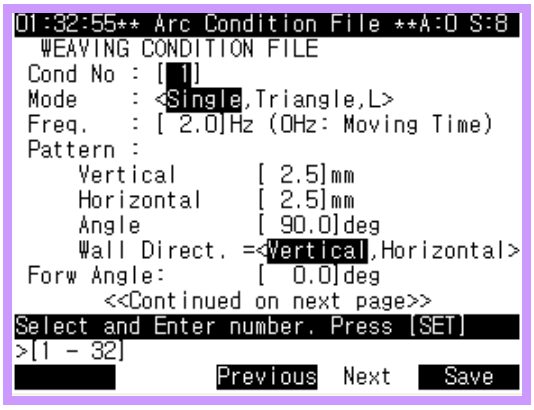
- Current : [0] A (Range : 0~999)
  Welding current output value for welding stick recovery process

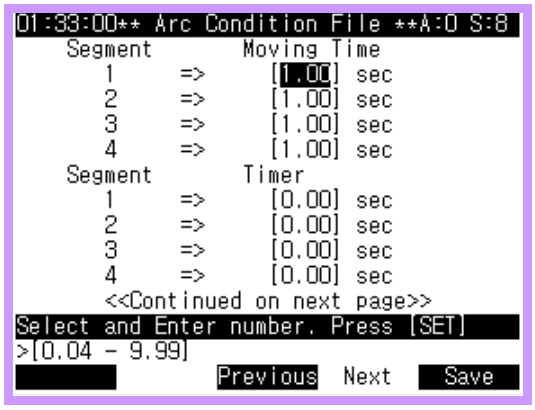
- Voltage : [20.0] V (Range : 0.0~100.0)
  Welding current output value for welding stick recovery process

- Delay : [2.00] sec (Range : 0.00~9.99)
  Output time for welding stick recovery condition.

14.8. Weaving condition file

(1) When the cursor is in the command line of WEAVON WEA#=, press the key to move to the following edit screen.





(2) Locate the cursor to the item to change and then enter the value or select the value using the [SHIFT]+ [←][→] keys. Press [ESC] to end without saving and 『[PF5]: Save』 to end after saving.

- Cond No
  This is the weaving condition number in 1 ~ 32. Directly enter the number of use the [SHIFT]+ [↑][↓] key move back and forth the numbers.

- Mode
  This designates the weaving shape. It supports the single oscillation, triangular oscillation and L-shape oscillation.

- Frequ.
  This sets the weaving frequency. Frequency range is 0.1 ~ 5.0Hz. When the frequency is set to '0', the moving time applies.

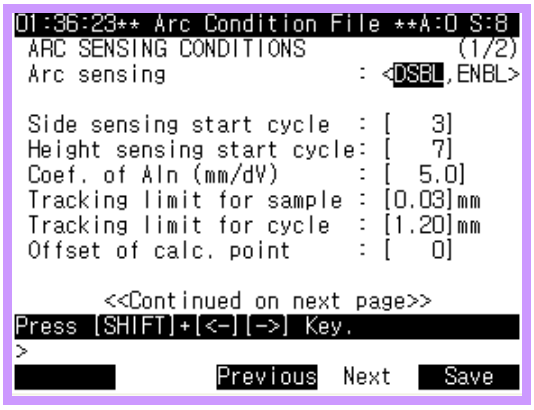
- Pattern
  Vertical : 1.0 ~ 25.0mm
  Horizontal : 1.0 ~ 25.0mm
  Angle : 0.1 ~ 180.0 degree

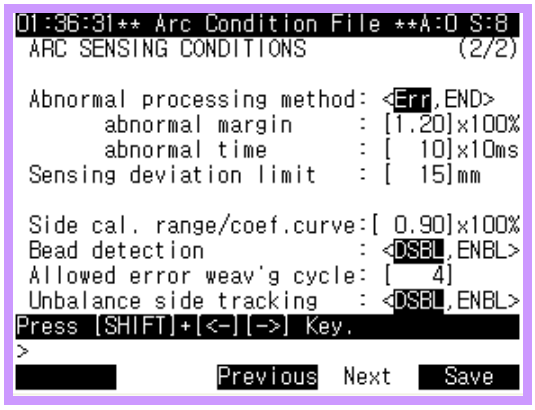
- Forw Angle : It can be set within the range of -90.0 ~ 90.0 degrees.

- Moving Time : It can be set within the range of 0.04 ~ 9.99 sec.

14.9. Arc sensing file

(1) In the next screen of the weaving file, the following arc sensing condition appears. This sets the arc sensing that can be used for weaving.





- Arc sensing: <Disable, Enable >
  This decides whether to use the arc sensing function. The default value is Disable.

※ Refer to the 『Arc Sensing Function Manual』 for more details on arc sensing function.

15

Welder Characteristics File

Arc welder (welding power source) receives the analog input and controls the welding power through welding current and voltage. But the characteristics of the gap between the analog input and the welding current/voltage differ by different products from different manufacturers. Due to this difference in gap, the current/voltage set in the controller can sometimes be different from the actual current/voltage. To remove this difference, characteristics of the welder are saved in the controller so that the set welding current/voltage can just flow out.

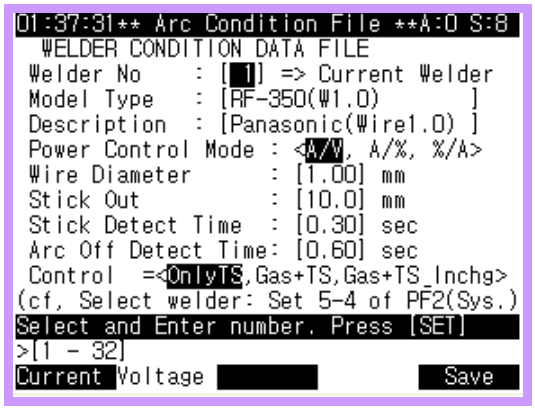
This setting enables any welder to set the welding current/voltage easily so that the welding is done in the same condition to make the process simpler.

The welder characteristics file equalizes the characteristics of the welder. For this you must measure the welding output current/voltage from the control panel and compare with the actual, and enter that data to the controller.

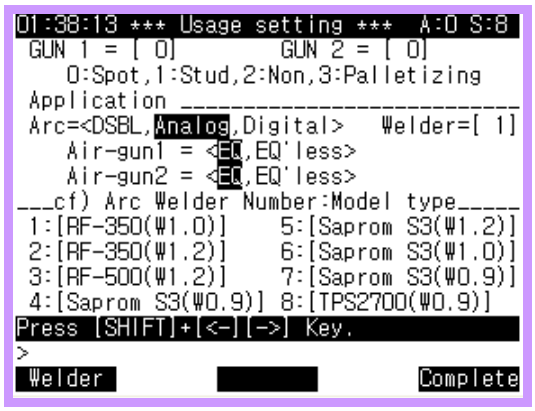
15.1. Welder condition data file edit

(1) When the cursor is in the command line of ARCON ASF#=, press the key to move to the following edit screen.

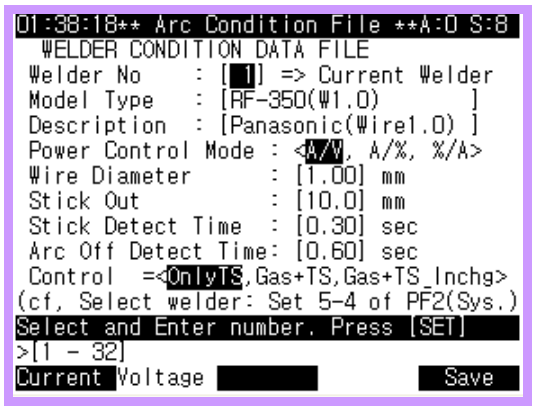
(2) Select 『[PF2]: Welder』 from the above screen and you will see the following welder characteristics setting screen. You can also select 『[PF2]: Welder』 from the Arc end condition.



(3) You can set the welder number through the welder item of menu in 『[PF2]: System』 → 『5: Initialize』 → 『4: Setting usage of the robot』.



(4) You can also enter the welder setting screen by selecting 『[PF1]: Welder』 fro m the above screen.



- Welder No.:
  This is the welder number. You can manage the characteristics of 32 welders.

- Model Type : This is the name of the welder

- Description : Short description of the welder

- Power control mode
  If you set to <(A/V)>, the welding voltage and current are individually set.
  If you set to <(A/%)>, the welding voltage is automatically set by the welding current.
  If you set to (%/A), the welding voltage port is located in front of the welding current port.

  ※ A/V : Welding current and voltage are individually controlled.
  ※ A/%
  Welding voltage is automatically set from the welding current. Externally, the voltage command is set within the range of 0.0~200.0% and the actual welding voltage change is about ±5 V.
  ※ %/A
  This is supported by WEMI of Italy and if you use this setting, the welding voltage

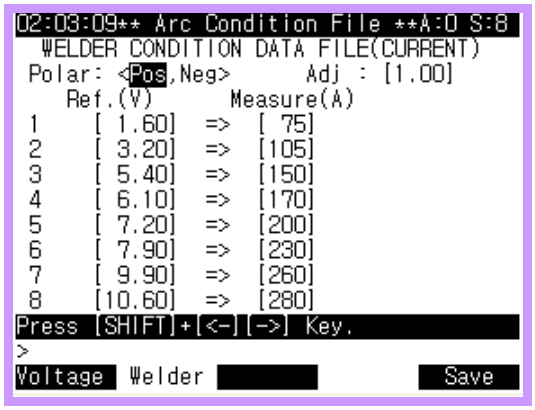
port will be located in front of the welding current port.

※ If you change the current welder and its power method in the characteristics file, the 『Voltage Confirm』 item in arc start condition and Arc end condition is set to 『Not Done』. The user must check the current and voltage, and change this item to 『Done』. If you try running the welding process in incomplete condition, you will get an error message saying 『E1280 Check VOL CONFIRM of conditions.』 and the ARCON command will not be executed.

- Wire Diameter : Diameter of the wire to be used for welding.
- Stick Out: Length of the wire projected from the torch.
- Stick Detect Time
  This is the time required between ARCOF and wire stick check. Please set this time accordingly to the model because it varies by welder model.
- ARC OFF Detect Time
  This is the time to check the WCR signal to decide whether the controller is ARC OFF. If the input WCR signal from the welder to the controller is not detected within the set time, the controller judges as ARC OFF.
- Control
  This sets the torch switch, gas, inching method. Because each welder requires a different control signal, this must be set accordingly.

15.2. Current characteristics edit

(1) Select 『[PF1]: Current』 from the characteristics file screen.



- Polar
  This is the polarity of the command value. The command is set 0~14V for positive and 0~-14V for negative.

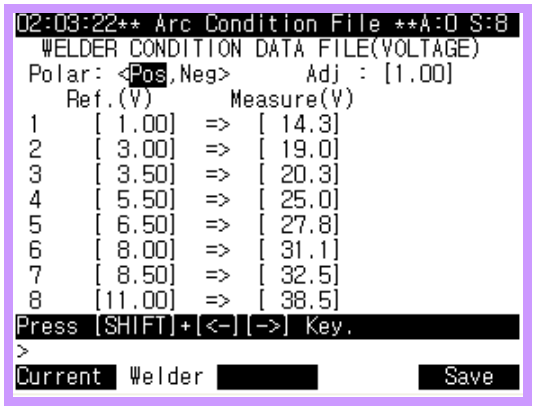
- Adj
  This is the calibrated output value of current. For example, to increase the output value, the value of 1.01~1.20 is used.

- Ref.(V)
  This is the command value of the welding current. If this voltage is entered to the welder, it outputs the current of measured value.

- Measure(A): Actual output current value from welder.

15.3. Voltage characteristics edit

(1) Select 『Voltage』 from the characteristics file screen



- Polar
  This is the polarity of the command value. The command is set 0~14V for positive and 0~-14V for negative.

- Ref.(V): This is the command value of the welding voltage. If this voltage is entered to the welder, it outputs the voltage of measured value.

- Measure (V or %): Actual output voltage value from welder.

※ You can enter up to 8 command values and measured values, which characterizes the welder. This is used to decide the command value to output a voltage designated by the user for welding. The command value calculation assumes that the command value and measured value changes in linear way.

※ When the power of the welder is in 『A/%』 method, the output voltage is optimized according to the specific current. You can adjust the output voltage in detail through % adjustment function.

16

Arc Welding Command

16.1. ARCON command

Description	This outputs welding start command.		
Syntax	ARCON ARCON ASF#=<File no.> ARCON C=<Current output value>, {V=<Voltage output value> | VP=<Voltage ratio>} [,T=<Time>] [,RETRY]		
Parameter	File no.	Arithmetic formula. Arc start condition file number.	Round up. 1~32
	Current output value	Arithmetic formula. Welding current output value. (0~500)	Unit: A round up.
	Voltage output value	Arithmetic formula. Welding voltage output value for individual power. (0~40)	Unit: V [0.0]
	Voltage ratio	Arithmetic formula. Ratio to appropriate welding voltage output value for individual power. (0~100)	Unit: % Round up
	Time	Arithmetic formula. WCR Waiting time for start condition. (0~10)	Unit: sec [0.00]
	RETRY	Retry function is used when the arc generation fails. Operating mode is 'Re-enter'.	
Example	ARCON ASF#=1 ARCON C=260, V=30, RETRY		
Remarks	The using results of the 3 syntax are as follows. 1. ARCON: Welding start according to the prior condition set with ARCCUR, ARCVOL etc. 2. ARCON <File>: Welding start according to condition set in designated condition file. 3. ARCON <Parameters>: Welding start according to condition set in parameter.		

16.2. ARCOF command

Description	This outputs the welding end command.		
Syntax	ARCOF ARCOF AEF#=<File no.> ARCOF C=<Current output value>, {V=<Voltage output value> | VP=<Voltage ratio>} [,T=<Time>] [,ANTSTK]		
Parameter	File no.	Arithmetic formula. Arc end condition file number	Round up. 1~32
	Current output value	Arithmetic formula. Welding current output value. (0~500)	Unit: A round up
	Voltage output value	Arithmetic formula. Welding voltage output value for individual power. (0~40)	Unit: V [0.0]
	Voltage ratio	Arithmetic formula. Ratio to appropriate welding voltage output value for one source power. (0~100)	Unit: % round up
	Time	Arithmetic formula. Arc end condition maintenance time. (0~10)	Unit: sec [0.00]
	ANTSTK	Use the automatic sticking recovery function.(anti stick)	
Example	ARCOF AEF#=1 ARCOF C=300, V=V10!, T=1.00, ANTSTK		
Remarks	The using results of the 3 syntax are as follows. 1. ARCOF: Welding start according to the prior condition set with ARCCUR, ARCVOL etc. 2. ARCOF <File>: Welding start according to condition set in designated condition file. 3. ARCOF <Parameters>: Welding start according to condition set in parameter.		

16.3. ARCCUR command

Description	This sets the welding current output value with the designated value.		
Syntax	ARCCUR C=<Current output value>		
Parameter	Current output value	Arithmetic formula. Welding current output value (0~500)	Unit: A round up
Example	ARCCUR C=200		

16.4. ARCVOL command

Description	This sets the welding voltage output value with the designated value.		
Syntax	ARCVOL {V=<Voltage output value> | VP=<Voltage ratio>}		
Parameter	Voltage output value	Arithmetic formula. Welding voltage output value (0~40)	Unit: V [0.0]
	Voltage ratio	Arithmetic formula. Ratio to appropriate welding voltage output value (One source power) (0~100)	Unit: % round up
Example	ARCVOL V=30		

16.5. ARCDC command

Description	This sets the welding current command value with the designated value.		
Syntax	ARCDC <Current command value >		
Parameter	Current command value	Arithmetic formula. Welding current command value	-14.0~+14.0
Example	ARCDC 12		

16.6. ARCDV command

Description	This sets the welding voltage command value with the designated value.		
Syntax	ARCDV <Voltage command value >		
Parameter	Voltage command value	Arithmetic formula. Welding voltage command value	-14.0 ~ +14.0
Example	ARCDV 2.5		

16.7. WEAVON command

Description	This starts weaving process.		
Syntax	WEAVON WEV#=<File no. >		
Parameter	File No.	Arithmetic formula. Weaving condition file no.	Round up. 1~32
Example	WEAVON WEV#=5		

16.8. WEAVOF command

Description	This stops the weaving process.
Syntax	WEAVOF
Example	WEAVOF

16.9. REFP command

Description	This sets the reference point of weaving wall point etc.		
Syntax	REFP <Reference point no. > , [<Reference point>]		
Parameter	Reference point no.	Integer without sign	1~8
	Support point	Pose formula. Not designated for hidden pose input.	
Example	REFP 1, P8 REFP 2, (-1073.33, 739.01, 258.30, 0, 76, 23)		
Remarks	REFP command is part of step like MOVE command. If you enter the REFP command using the [REFP] key from teach pendant, it becomes a hidden pose type.		

16.10. TRJLOG command

Description	This saves the moving trace of sensing.	
Syntax	TRJLOG ST=1,SC=5,LSP=0,LCV=1	
Parameter	ST=<Start /End >	1=Trace record start, 0=Trace record end
	SC=<Sampling cycle >	0 : Trace step save option 1~100 : Sampling weaving cycle
	LSP=<Record start pose parameter >	Record start pose variable no. (Max of 999)
	LCV=< LV% no. for exchanging number of records >	Designate/Check number of records, LV% variable no.
Example	LV3%=200 'Designate maximum number of storage WEAVON WEV#=1 'Weaving with the Arc sensing ARCON ASF#=1 'Start of Arc welding TRJLOG ST=1,SC=5,LSP=100,LCV=3 'Start of logging S2 MOVE L,S=40cm/min,A=0,T=0 TRJLOG ST=0 'End of logging ARCOF AEF#=1 'End of Arc welding WEAVOF 'End of the Arc sensing V5%=200-LV3% 'logging count	
Remarks	With this command, you can apply an appropriate shift to the saved POS and execute multi-pass welding. For more detail, please refer to the 『Arc sensing function manual』.	

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