HYUNDAI ROBOTICS

WARNING

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

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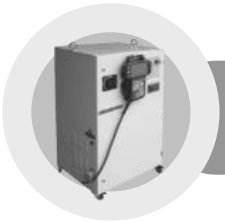
Hi5aAW230424FMEN7



Hi5a Controller Function Manual

Arc welding

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Manual configuration

This manual consists of 8 chapters and appendices.

Chapter 1: Explanation of the settings, basic teaching methods, and convenience functions that are necessary when using the arc welding robot for the first time.

Chapter 2: Introduction of various commands related to arc welding, including simple setting methods. This chapter will provide an overview of the basic functions provided by the arc welding robot.

Chapter 3: Introduction of the “Quick Open” function that is needed for setting details related to some commands introduced in Chapter 2. This chapter describes the editing process of the arc welding conditions and the commands for the application functions, which must be set to use the arc welding robot.

Chapter 4: Introduction of the methods in setting the arc welders. This chapter outlines the methods for selecting welders and also the items that need to be selected for individual welders.

Chapter 5: Descriptions of the editing processes of the arc welding conditions. This chapter introduces the methods for setting the current, voltage, welding mode, and gas pre- and post-flow. Considering that the welding conditions may vary depending on individual welders, users may choose to follow the contents regarding the welder that they want to use.

Chapter 6: Detailed explanation of the weaving function and the relevant settings. Users may skip this chapter if the weaving operation will not be used.

Chapter 7: Introduction of functions that utilize data that the arc welder sends during welding. This chapter introduces the methods to carry out real-time monitoring of data sent by the welder and methods to save the data into files. In addition, this chapter also explains the data visualization functions that output the stored data into graphs. The functions for converting the welding quality into numeric data are also explained.

Chapter 8: Introduction of the arc application functions, which provide useful functionality under special conditions. This chapter provides a simple introduction of the functions that can be applied when there are problems with the welding operation caused by uneven welding path and errors in the position of the welding work piece.

Appendices describe the usage of the PC-based arc welding data check program provided by the company. Descriptions on the file backup process of stored data and their simple and convenient verification are given.

Users are required to read Chapters 1 – 5 when using the arc welding robot for the first time and selectively read Chapters 6 – 8 regarding necessary functions.

For users who have read previous manuals, it is recommended that they read the newly added sections, including “1.3 Arc welding convenient function”, “4.5 Arc welder general interface”, “7 Arc welding data monitoring”, and “8 Arc welding application function”.

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1

Basic information of arc welding

1.1. Introduction

Teach the arc welding work as the following picture.

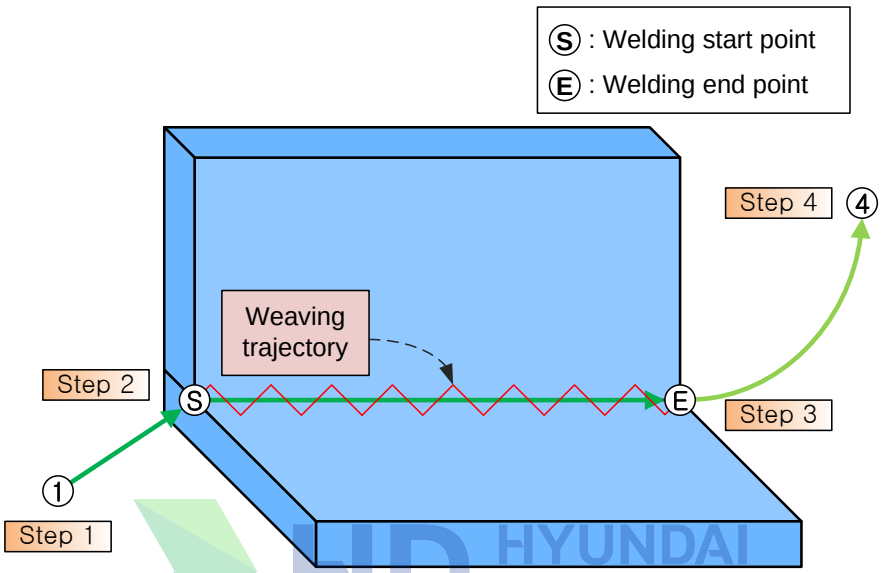

Figure 1.1 Basic arc welding teaching

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

(2) Select a manual mode from [Mode] switch of teach pendant.

(3) Click [Program] on the teach pendant and enter the program number.

(4) At this stage, the teach pendant will display the following screen.

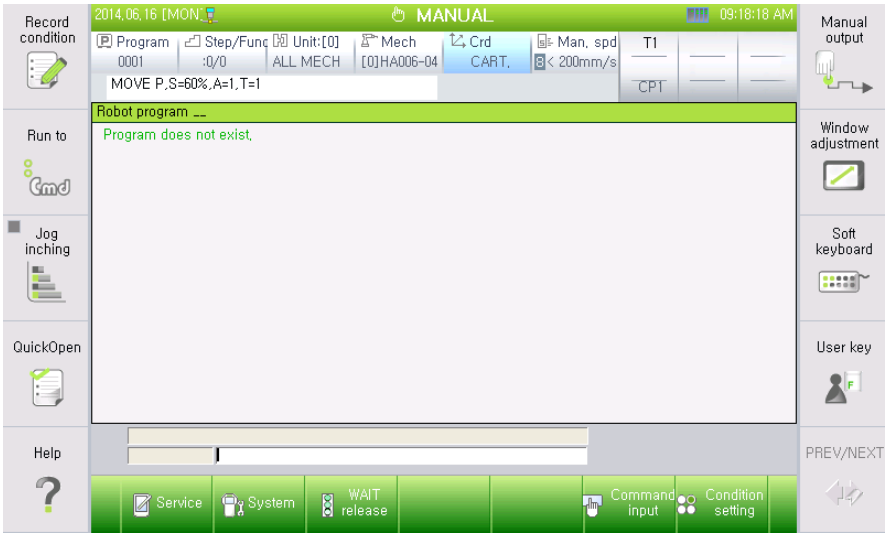

Figure 1.2 New program number selected

(5) Click [Motor On] on the teach pendant to supply power to the robot motor.

(6) Use the axis control button to move the robot torch to Step 1 position.

(7) Click [Record condition] key and select the interpolation type, speed, accuracy and the tool number that you want to use.

① Use the arrow keys to move to the target item and then set the value and press the [ENTER] key to save the setting.

② Press [Tool] key and enter the tool number you want for setting the tool number. (Select [Tool] key by pressing [SHIFT]+[Coordinate] key.)

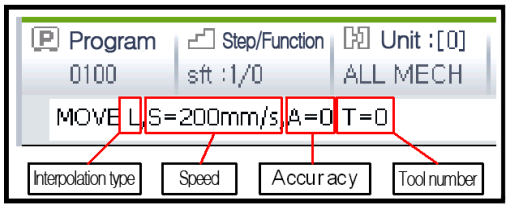

Figure 1.3 Contents of the record condition displayed

When the [Record condition] key is pressed, the set conditions will be recorded as shown below.

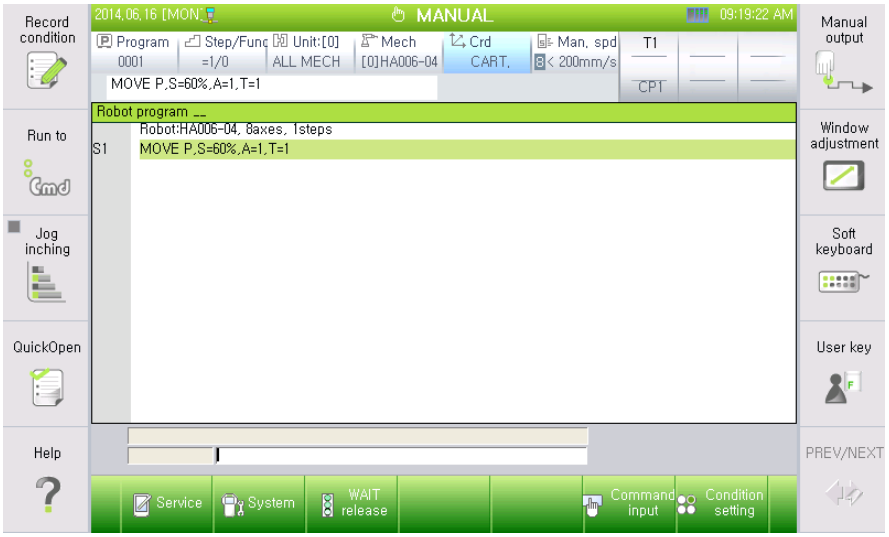

Figure 1.4 Step recording screen (1)

(8) Repeat (5) ~ (7) process for Step 2~4.

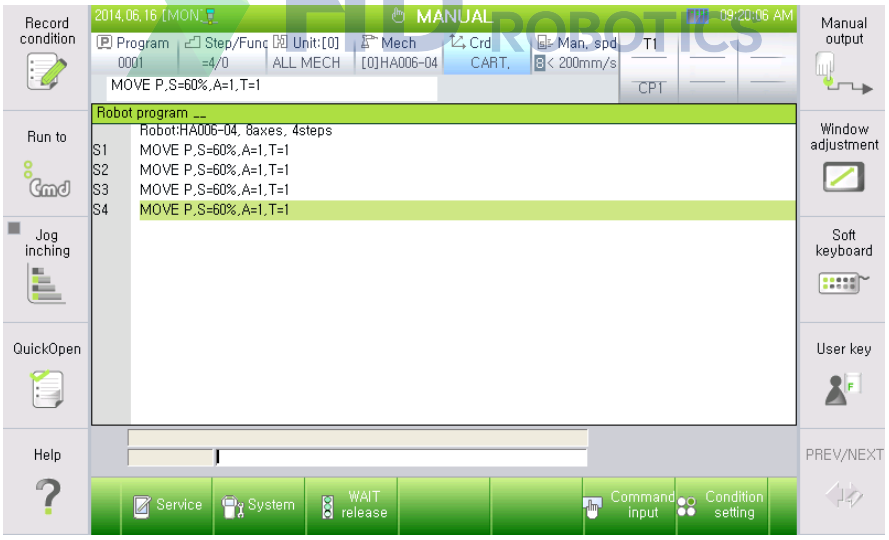

Figure 1.5 Step recording screen (2)

(9) Move the cursor to Step 2 since welding sections are between Step 2 ~ Step 3.

① Click [User key] to display the registered user key at the bottom of the screen.
② Click [WEAVON] key ([F4] by default) when using weaving. Input the pattern number and click [ENTER].
③ Click [ARCON] key in the same way. Enter the pattern number and press the [ENTER] key. (Refer to [Chapter 5. Arc welding condition editing] to learn more about how to set arc welding conditions.)

(10) Bring the cursor to Step 3 in which the arc welding ends.

① Click [User key] again to display the registered user key at the bottom of the screen and click [ARCOF] key to enter the command.
② Click [WEAVOF] key in the same way to enter WEAVOF command.

(11) Adjust the speed in Step 3 to the desired welding speed. (Ex. 12mm/s)

(12) Finally, enter the END command that will terminate the program.
Click 『[F6]: Command input』 → 『[F2]: Flow control』 → 『[F7]: END』 to enter the END command.

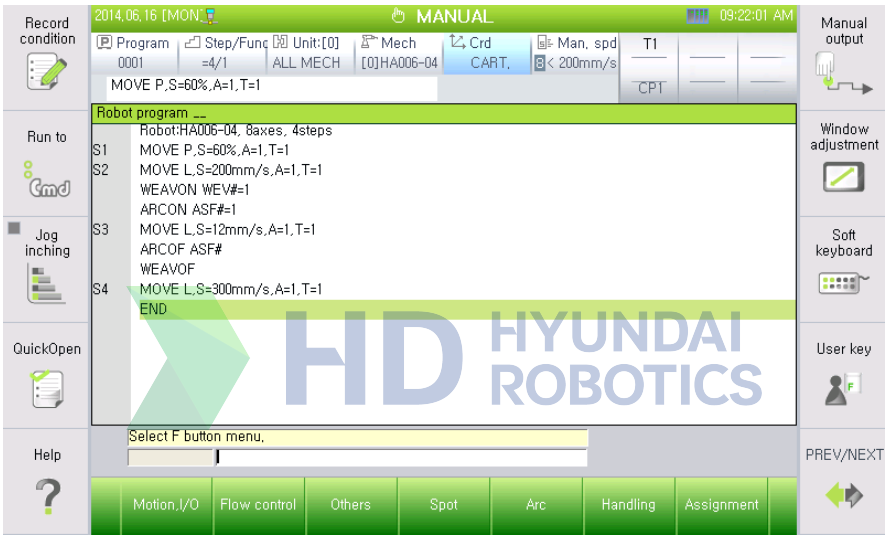

Figure 1.6 Teaching complete

1.2. Arc welding function setting

1.2.1. Usage setting

(1) The arc welding function may not be activated in some robot types. In such cases, set the arc welding function according to the following process. (Engineering authority is required for setting the arc welding function)

(2) Pressing 『[F2]: System』 → 『5: Initialize』 → 『3: Usage Setting』 in manual mode will bring up a dialogue box will come up to allow the user to set the usage of the robot, the welder to be used, the user key and the assignment of input and output signals, as shown in [Figure 1-7].

(3) The arc welding is divided into “Aanalog” and “Digital” modes depending on method of interface that is used.

(4) [Figure 1.7] shows an example of a Panasonic welder that is set for arc welding.
On this screen, pushing 『[F1]: Welder』 will allow the user to enter a dialogue box for setting the conditions of a welder that the user wants to use.

(5) Refer to Chapter 4. Arc welder setting for more detailed configuration of the welder characteristics file.

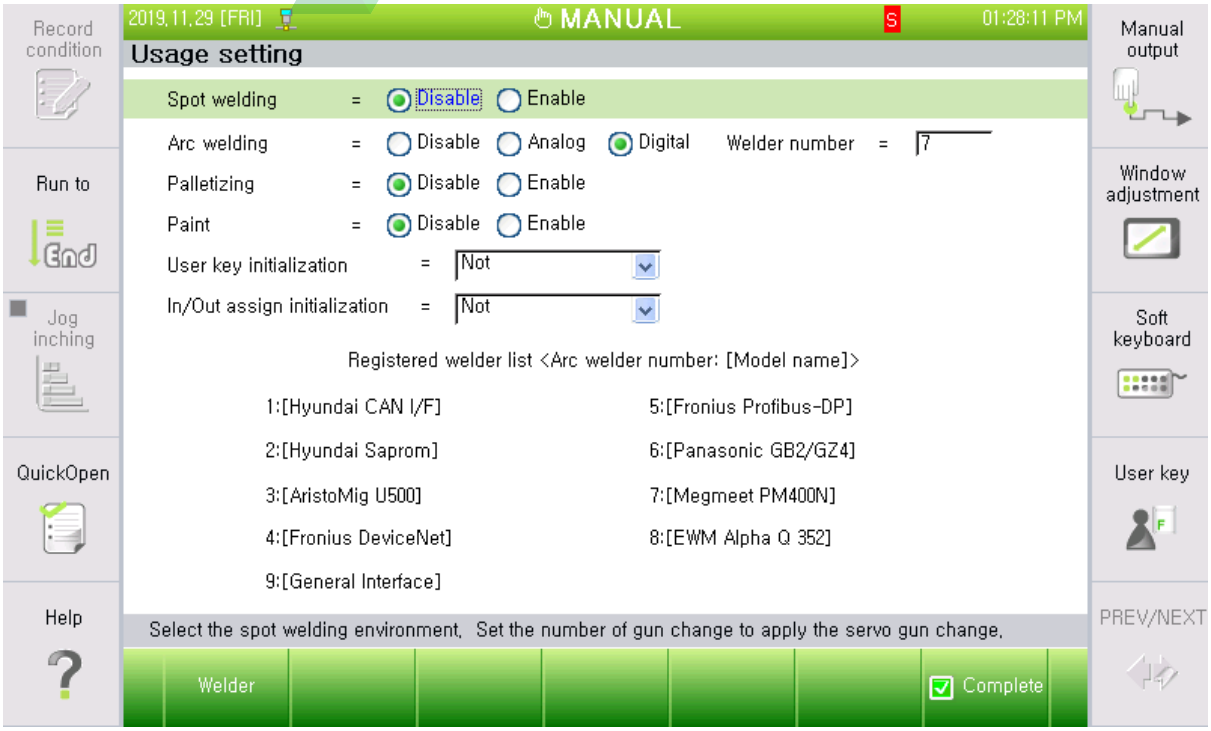

Figure 1.7 Usage setting dialog box

1.2.2. Setting various arc welding signals and functions

In manual mode screen, pressing 『[F2]: System』 → 『4:Application Parameter』 → 『2: Arc Welding』 will bring up a screen for setting various conditions for applying arc-welding as shown in the following screen.

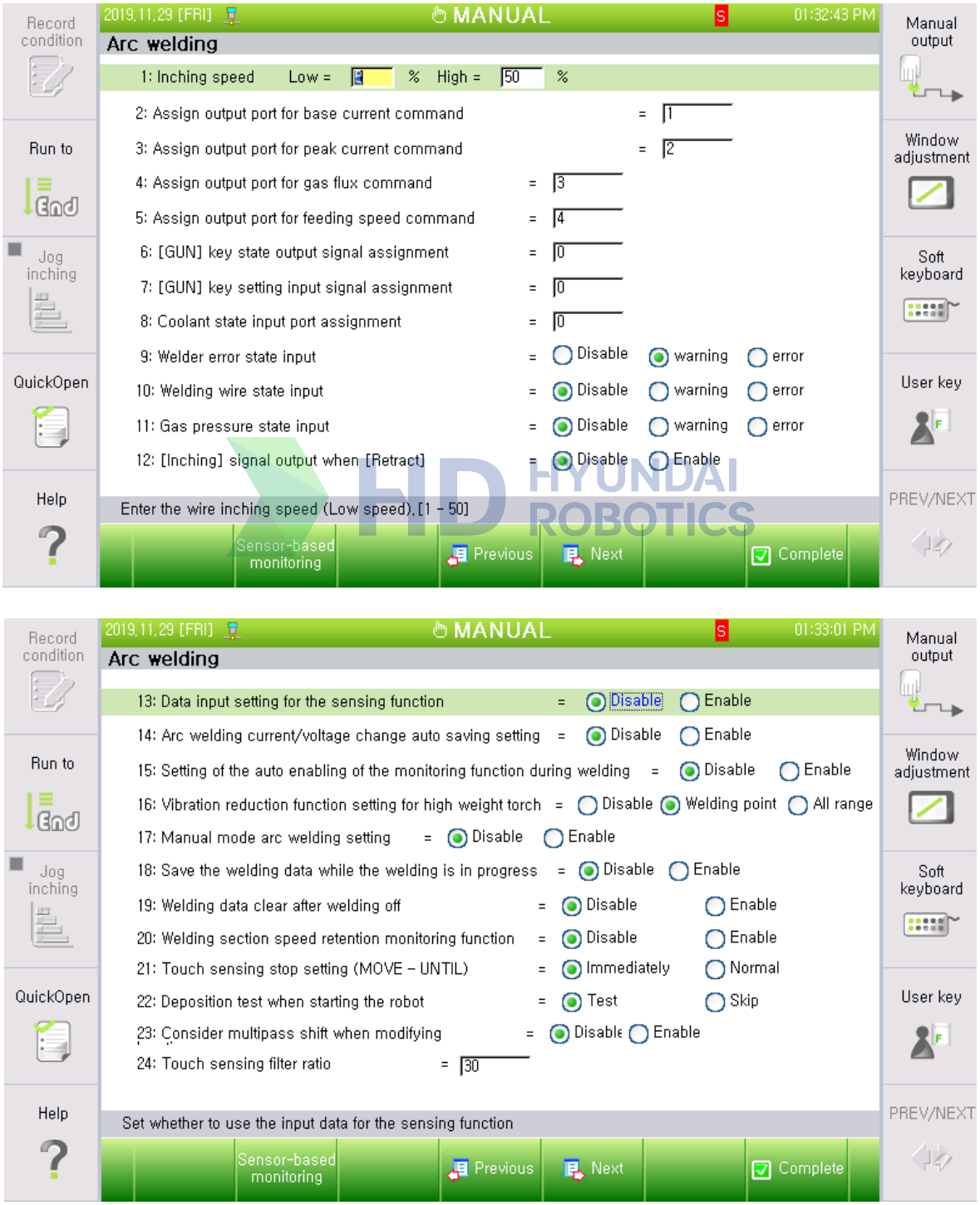

Figure 1.8 Arc welding application condition dialog box

Details for each item are as follows.

(1) Inching speed setting: Low speed [1~50] % and high speed [10~100]%
The “Inching speed” setting is for the wire feeding speed for the wire inching and retraction operations that can be carried out by using the [SHIFT]+[2] keys (for inching) or the [SHIFT]+[3] keys (for retraction). When the key combinations are pressed for longer than 3 seconds, this function allows the user to set the feeding speed for the high and low speed operations

(2) Out port assignment for welding current command: [1 ~ 32]
Sets the analog output port no. for generating the arc welding current reference voltage. This can be used when the method of interface is analog.

(3) Out port assignment for welding voltage command: [1 ~ 32]
Sets the analog output port no. for generating the arc welding voltage reference voltage. This can be used when the method of interface is analog.

(4) Preliminary 1 output port assignment for arc welding: [1 ~ 32]
Sets the analog output port no. for generating the reference voltage on the reserve arc welding output port No.1. This can be used when the method of interface is analog.

(5) Preliminary 2 output port assignment for arc welding: [1 ~ 32]
Sets the analog output port no. for generating the reference voltage on the reserve arc welding output port No.2. This can be used when the method of interface is analog.

(6) [GUN] key state output signal assignment: [Assignment of normal output signal]
For setting the signal for producing the current state of the [GUN] key of the teaching pendant.

(7) [GUN] key state input signal assignment: [Assignment of normal input signal]
This is used for assigning the input signals that allow the on/off mode setting of the [GUN] key from outside. When a signal is assigned, it is impossible to change the arc welding on/off mode by pressing the [GUN] key of the teach pendant. This function prevents accidental activation of the [GUN] key, which may cause the welding operation to stop within the welding section (While the [GUN] key’s LED is turned off, if the robot is in playback mode, the operation will continue in the “Dry Run” mode with the welding not being performed within the arc welding section). When the assigned signal is inputted, the [GUN] key’s LED will be turned off, and, if the robot is in playback mode, the operation will continue in the “Dry Run” state.

(8) Coolant state input port assignment: [Assignment of normal input signal]
For setting a signal for receiving the information about the problem with the coolant circulation if a water-cooling type arc welding torch is to be used.

(9) Welder error status input: [Disable, Positive, Negative]
For setting the use of and a logic for a signal for receiving the information about errors with the welder.

(10) Welding wire state input: [Disable, Positive, Negative]
For setting the use of and a logic for a signal for receiving the information about the state of

the welding wire.

(11) Gas pressure state input: [Disable, Positive, Negative]
For setting the use of and a logic for a signal for receiving the information about the state with the gas pressure.

(12) [Inching] signal output when [Retract]: [Disable, Enable]
For deciding whether to use a function that will produce the [Inching] signal together during the [Retract] operation. The function needs to be set be valid only when using a welder that requires the relevant function.

(13) Sensing function data input setting: [Disable, Enable]
This is used for setting the option to use the input data for the sensing function of the arc welding. The sensing function includes arc sensing and height sensing. When these options are set as “Enable,” it is possible to enter the “sensing function data input setting dialog” window by pressing the F1 key and selecting the relevant sensing data. Refer to [1.2.2.1 Sensing function data input setting] dialog window.

(14) Automatic saving when changing I and V: [Disable, Enable]
Determines whether to auto-save the value when changing the current and voltage in the 'Change arc welding current/voltage' box. Refer to "1.3.3 Changing current/voltage during welding" for further details.

(15) Automatic activation of monitoring during the welding: [Disable, Enable]
When the arc welding starts, the arc welding monitoring automatically sets the usage of the function displayed on the screen.

(16) Heavy arc torch vibration reduction function setting: [Disable, Welding point, All sections]
This is used for setting the method of reducing the vibration that could be caused by using a heavy arc torch. This can help reduce the vibration that could be generated when using heavy torches, such as water-cooling torches or push-pull torches. When the function is set as “Welding Point,” it is possible to significantly reduce the vibration at the entry section of the welding point without a significant change in the robot operation speed. If it is set as “All sections,” an arc torch filter will be reflected, and there will be almost no vibration throughout all sections. However, the robot operation speed will be decreased.

(17) Using Arc welding in manual mode: [Disable, Enable]
For setting whether to perform welding through forward steps. While the function is set to be valid and the execution unit is set to be ‘End’, if the welder moves to the arc welding range through forward steps, it will be possible to perform welding. Refer to [1.3.4. Manual mode arc welding] for more details.

(18) Saving the welding data during welding [Disable, Enable]
When the function is set as “Enable”, the welding data will be automatically saved in the teach pendant during the arc welding operation. Refer to **[7.3. Arc welding data management function]** for more details.

(19) Clearing the welding data when welding ends: [Disable, Enable]

It is required to set“Enable” if the items below need to be handled before moving the robot when the welding section ends.
The items below will be cleared when the Fronius welder is used.

- Welder mode
- Welding power
- Welding voltage compensation
- Dynamics compensation
- Wire burnback
- Welder program / job number

(20) Welding section speed that sustains the monitoring function [Disable, Enable]
This function monitors whether the robot moves at a slower speed than the taught speed in the welding section. When this function is enabled, a warning occurs when the robot moves at a speed lower than 95% of the taught speed.

(21) Touch sensing of the stop setting (MOVE - UNTIL) [Immediate, Normal]
Sets whether to immediately or normally stop if the UNTIL condition is satisfied, while the UNTIL option is in the MOVE statement; select “Immediate Stop” if the accuracy should be high and “Normal Stop” if the vibration should be low.

(22) Deposition inspection when starting the robot: [Inspect, Skip]
Sets to perform the wire deposition inspection when the robot starts the cycle for the first time; when an inspection is performed, the robot will move after carrying out an inspection for about 0.2 s initially.

(23) Consider the multipass shift when modifying the position: [Disable, Enable]
Sets to consider the current multipass shift when calculating the modified position in the case that the position of a step is modified in the multipass section; when this function is enabled, the position modification will be executed considering the applied multipass shift.

(24) Touch sensing filter ratio: [10–90]
For the touch sensing operation, a smaller filter than the one originally used for the robot will be used. This function is to set the filter ratio that will be decreased. If the value is too large, the error will be large, and if it is small, noise and vibration will occur with the robot during the touch sensing operation. It is required to set a small value within the range where there is no problem when touching is performed.

1.2.2.1. Sensing function data input setting

While the “Sensing function data input setting” is set as “Enable,” if the 『F1: Data input setting』 is pressed, a screen will be displayed for setting the input signals for the arc welding sensing functions as shown below.

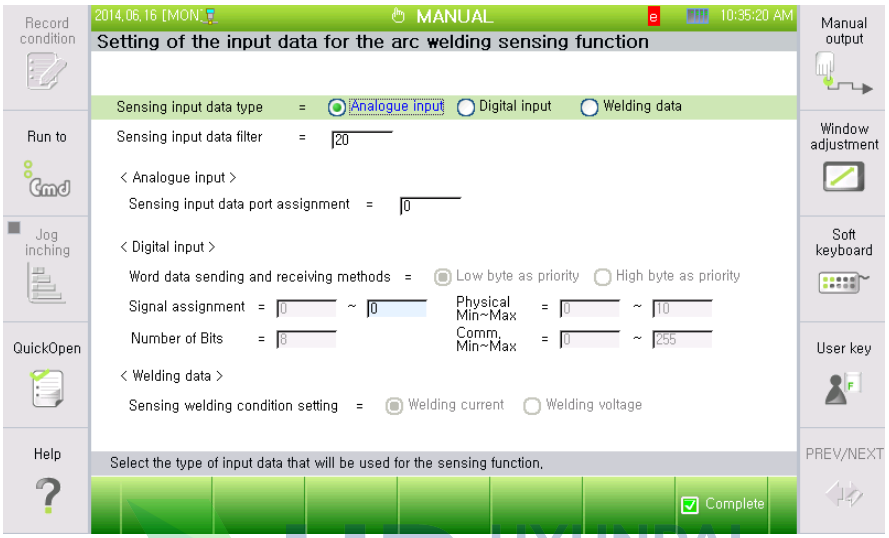

Figure 1.9 Arc welding sensing function input data setting dialog box

The descriptions of individual settings are as shown below.

(1) Sensing input data type: [Analog input, Digital input, Welder data]
This is used for setting the type of the input data that can be used for the sensing function.
Analog input: Needs to be selected when using the voltage that is inputted through the board (BD584) for the arc welding.
Digital input: To be selected if the input value of the Fieldbus module is received and used; depending on the welder, this can also be used when other values than the current and voltage are provided.
Welder data: Needs to be selected when using the current and voltage values transmitted through the welder.

(2) Sensor data filtering: [Filter not applied, Partial filtering, and Maximum filtering]
This is for setting the filter value to perform filtering when sensing input data has severe noise.
Filter not applied: The input data for which the filter is applied at the minimum level will be used as it is.
Partial filtering: The filter is applied partially, removing the noise partially and causing slight data delay.
Maximum filtering: The filter is applied at the maximum level, removing the noise as much as possible and causing data delay at the highest level.

(3) Sensing input data port assignment: [1 ~ 32]
This is activated when using “Analog Input.”. This is for setting the port that will receive the input of the analog voltage detected by the sensor.

(4) Word data sending and receiving method: [Low order byte transmission first, High order byte transmission first]
This is for setting whether to assign low-order bytes first or high-order bytes first for the signals when receiving 16-byte data.
Low-order byte first: High-order bytes are assigned for high-number signals (Little endian).
High-order byte first: High-order bytes are assigned for low-number signals (Big endian).

(5) Module resolution: [0.0 ~ 1000.0]
If a module that receives an analog input and converts it to a digital signal is to be used, it is required to input the resolution of the module. If a value other than 0 is set, the input data will be directly converted using the resolution instead of the"Minimum to maximum (Module input / output)" set in the [Current sensor data].

(6) Assigned bit rate: [Input signal port]
This is for setting the input port to receive the sensing data. If the port number at which data starts and the assigned bit count is set, then the data endpoint port will be automatically set.

(7) Min ~ Max: [Module input]
This is for setting the range of data to be inputted into the module that converts external input signals to digital signals.

(8) Min ~ Max: [Module output]
This is for setting the output range of the digital signal value converted from external signals.

1.2.3. Crash sensor signal setting

The arc welding robot system uses a crash sensor to prevent deformation on the torch. The crash sensors uses negative logic so disconnected sensor cable can be detected immediately.

Here is the setting dialog. System → 1: User Interface → 6: Crash Sensor

The following are the setting items of the crash sensor:

- Sensor processing: Emergency stop, stop
  Emergency stop: The robot turns off the motor and stops for emergency when the crash sensor signal is input.
  Stop: The robot keeps the motor on and stops when the crash sensor signal is input.

- Signal logic: Set the input logic of crash sensor signal.
  Positive logic: The input signal is off with no sensor connected. Set it with the arc welding robot system when the crash sensor supports positive logic only or it is not connected.
  Negative logic: The input signal is on with no sensor connected. If the sensor wire is disconnected, the crash sensor signal input is processed.

※ Other items
If the crash sensor is set with the input signal setting item of system, the system input is checked first and then the crash sensor signal input through the welding machine communication is ignored.

1.3. Arc welding convenient functions

1.3.1. Gas check, Wire inching and retraction

These functions control the motor of the wire feeder and shield gas valve among Arc welding device.

The gas check function is to output the shield gas.
The wire inching function is to feed the wire to the front of the torch.
The wire retract function is to rewind the wire.

The gas check function can be used to confirm the current shield gas flow rate.
The inching and retracting functions can be used to adjust the length of the wire that comes out of the welding torch.

The operation method is as below.

(1) Gas check function
  ① Shortcut key: [Shift]+[1]
  ② Dedicated key: “Inching” located in the middle of the user keys
  ③ Inching speed: Low speed is set when the key is pressed for less than 3 seconds and high speed is set when pressed for 3 seconds or longer.

(2) Inching function
  ④ Shortcut key: [Shift]+[2]
  ⑤ Dedicated key: “Inching” located in the middle of the user keys
  ⑥ Inching speed: Low speed is set when the key is pressed for less than 3 seconds and high speed is set when pressed for 3 seconds or longer.

(3) Retraction function
  ① Shortcut key: [Shift]+[3]
  ② Dedicated key: “Retract” located in the middle of the user keys
  ③ Retract speed: Low speed is set when the key is pressed for less than 3 seconds and high speed is set when pressed for 3 seconds or longer.

(4) Inching speed setting
  ① In the manual setting screen, select 『[F2]: System』 → 『4: Application Parameter』 → 『2: Arc Welding』.
  ② In the arc welding setting menu, set the desired low and high speed values in 『1: Inching speed: Low speed=[---]%, High speed=[---]%』. The individual speeds will be shown in the rate compared with the maximum inching speed.
  ③ The change in the inching speed may not be reflected depending on the model of welder.

1.3.2. High-speed movement

While the program and the arc welder is in playback mode, the robot moves very slowly in the welding section, which may cause problems when performing a pilot operation to identify the working position of the robot. In order to resolve the problem, this function allows the robot to move at higher speeds than the recorded speed in the welding section.

This function is allowed only during the step forward and backward operation in manual mode.

When the high speed movement function is applied, the robot movement speed is not limited by 『Max. speed in the step forward/backward operation』. In addition, it is possible to set and unset functions in the welding section regardless of whether the high speed movement function is applied or not. (Ex.: It is possible to set the high-speed movement function in the middle of the function being applied in the welding section.

The operation method is as below.

(1) Manual maximum speed step forward/backward
   ① Shortcut key: [Shift]+[FWD]/[BWD]
   ② Moving speed: Manual max. speed

(2) [SHIFT] key change handling in moving at high speed
   ① High-speed movement [SHIFT] key release: The robot stops and moves in the step forward/backward motion at the teaching speed.
   ② Entered by using the [SHIFT] key during step forward/backward at the teaching speed: Move at the maximum manual speed after the robot stops.

1.3.3. Changing current/voltage change welding

While carrying out teaching for the arc welding operation, this function can be used to change the current/voltage in the middle of welding to find a proper level of current/voltage.

This function allows the change in current/voltage in real time while in welding operation to find the optimal condition, and also allows the saving of confirmed conditions as the actual welding conditions.

The details of the function and the setting method are as below.

(1) Entering the change arc welding current/voltage dialog box
- ① Carry out the arc welding in auto mode.
- ② Indicate the user key at the bottom by using the [User Key] key
- ③ Enter the [F7: change I, V in arc welding] key in case of arc welding shortcut key
- ④ Entering the dialog box is complete

(2) Current and voltage adjustment unit during welding, and the adjustment key
- ① Cursors Up/Down: Welding current goes up/down by 1[A]
- ② [SHIFT] + Cursor Up/Down: Welding current goes up/down by 5[A]
- ③ Right/Left Cursors: Welding voltage goes up/down by 0.1[A]
- ④ [SHIFT] + Cursor Right/Left: Welding voltage goes up/down by 0.5[A]

(3) Welding speed and weaving parameter adjustment key
- ① Speed HI/LOW: Increases/decreases the welding speed by 0.1[cm/min]
- ② [SHIFT] + Speed HI/LOW: Increases/decreases the welding speed by 0.5[A] [cm/min]
- ③ F1/F2: Increases/decreases the weaving width (left) by 0.1[mm]
- ④ [SHIFT] + F1/F2: Increases/decreases the weaving width (left) by 0.5[mm]
- ⑤ F3/F4: Increases/decreases the weaving width (right) by 0.1[mm]
- ⑥ [SHIFT] + F3/F4: Increases/decreases the weaving width (right) 0.5[mm]
- ⑦ F5/F6: Increases/decreases the weaving frequency by 0.1[Hz]
- ⑧ [SHIFT] + F5/F6: Increases/decreases the weaving frequency by 0.5[Hz]

(4) Current/voltage change auto saving setting
- ① Entering 『[F2: System]』 → 『4: Application parameter』 → 『2: Arc welding』
- ② 14: Arc welding current/voltage change auto saving setting as Enable, Disable
- ③ Disable: Users save by using the [F7: Record] key. The changed content will be deleted when entering by using the [ESC] key.
- ④ Enable: The changed content will be saved in the welding condition immediately when the user changes the value.

1.3.3.1. Operation

Press the [F7: change I, V in arc welding] key while performing arc welding in auto mode.

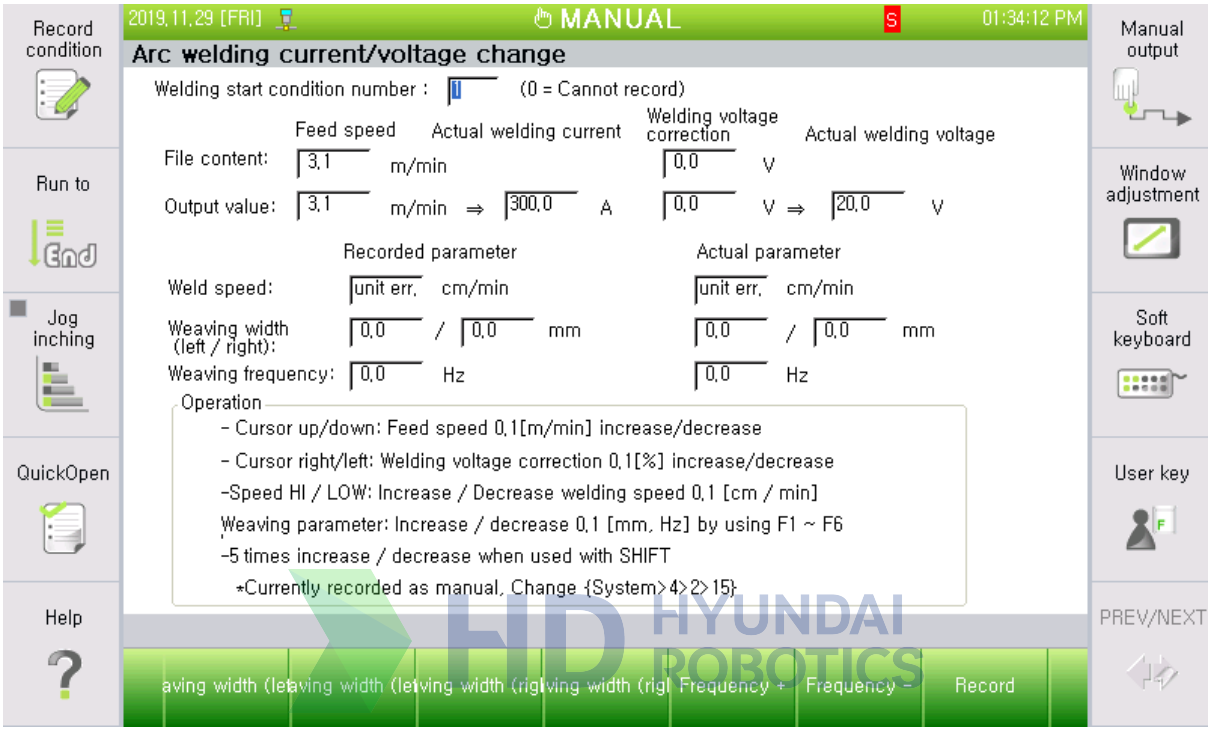

Figure 1.10 Arc welding current/voltage change dialog box(EWM)

The figure above shows a dialog box that will be displayed when EWM welder is used. The form of the dialog box can be differently displayed depending on the welder. The individual options of the dialog box are as below.

(1) Feed speed
  ① File content: Displays the feed speed of the welding condition that is currently being used.
  ② Output value: Displays the feed speed that the controller outputs to the welder currently

(2) Actual welding current
  ① Output value: Displays the output welding current that is being transmitted from the digital welder to the controller.

(3) Welding voltage offset
  ① File content: Displays the relevant welding voltage compensation of the welding condition currently being used
  ② Output value: Displays the welding voltage compensation that the controller currently outputs to the welder

(4) Actual welding current
  ① Output value: Displays the output welding voltage that is being transmitted from the digital welder to the controller.

(5) Recorded parameters
① Displays the recorded parameter of the work program that the robot is currently performing; the values will not be changed, even when the keys are operated.

(6) Actual parameters
① Displays the speed and weaving parameters with which the robot actually performs; the values can be changed by operating the keys.

Reference

- The change in the current/voltage will be saved in the welding start condition and not in the end condition.
- Of the ARCON command type commands, the commands for which separate current and voltage values are designated, changes will be saved in the welding condition.

Ex.) ARCON C=200,V=20,ASF#=1 〈- The changed current and voltage values will be saved in #1 of the welding start condition.

1.3.4. Manual mode arc welding

Generally, the arc welding can be carried out only when the robot is operated automatically or remotely. This function allows the robot to perform arc welding in manual mode. Under various conditions, it may provide ease of operation in repetitive welding works by setting the welding conditions.

The following settings should be in place to apply manual mode arc welding.

1. 『[F2]: System』 → 『4: Application parameter』 → 『2: Arc welding』 → 『12: Manual mode arc welding setting』 → Enable
2. 『Execution unit』 → End (2nd menu on the left of the basic screen of the teach pendant)
3. Execute ARCON by applying the step forward motion (When the welding stops because the step forward operation discontinued in the middle of welding before ARCOFF, if the step forward motion needs to be performed again, the robot will move to the next teaching point without performing welding because ARCON will not be executed)

1.3.5. Heavy arc torch vibration reduction

This function is used for reducing the vibration that may occur when using heavy torches (water-cooling or push-pull torches) for small robots. In order to reduce vibration, 2 methods are provided, each of which have advantages and disadvantages as shown below. It is recommended to apply each method for each condition by taking into consideration their advantages and disadvantages.

1. Welding point: Moderate reduction of vibration. There will be almost no impact on the robot operation time.
2. All sections: Significant reduction of vibration. The robot operation time will be increased.

This function can be set as below.

1. 『[F2]: System』 → 『4: Application parameter』 → 『2: Arc welding』 → 『16: Heavy torch vibration reduction function setting』 → Select one of “Disable,” “Welding point,” or “All sections.”

1.3.6. Arc welding signal test

The arc welding signal test function is used for testing the input and output states of the main signals and carrying out manual stick recovery. This function can be used to check any abnormality of welders or communication equipment because it determines whether a specific signal is working or not.

In order to use this function, enter the " ARC Signal (SIO, AIO) Test" screen by pressing the [Shift] + [Help] keys on the basic screen of the teach pendant. Function operation can be tested by setting High/Low for the targeted signals in 〈Output Signal〉 of the "Analog Board #1" screen. In 〈Input Signal〉, operation-specific input signals can be tested.

In addition, it is possible to carry out manual command for stick recovery by pressing [F1: Stick recovery].

Figure 1.11 Arc welding current/voltage change dialog box

1.3.7. Arc welding operation information

This function is used for checking, through a monitoring window, the information related to the operation of the arc welding. Using this function will allow the checking and monitoring of the following items.

(1) This function allows the verification of accumulated welding time and the welding time for the final cycle.

(2) Entering the welding tip usage time menu allows the continuous monitoring of usage time. When the remaining time of the tip usage time is less than 10%, a warning will be generated. Exceeding the set using time will generate another warning.

(3) This function allows the verification of the number of automatic retrials performed and the number of automatic stick recoveries performed when starting the welding work.

(4) This function allows the verification of the number of overlaps by the types of causes that are performed when the robot stops in the middle of welding.

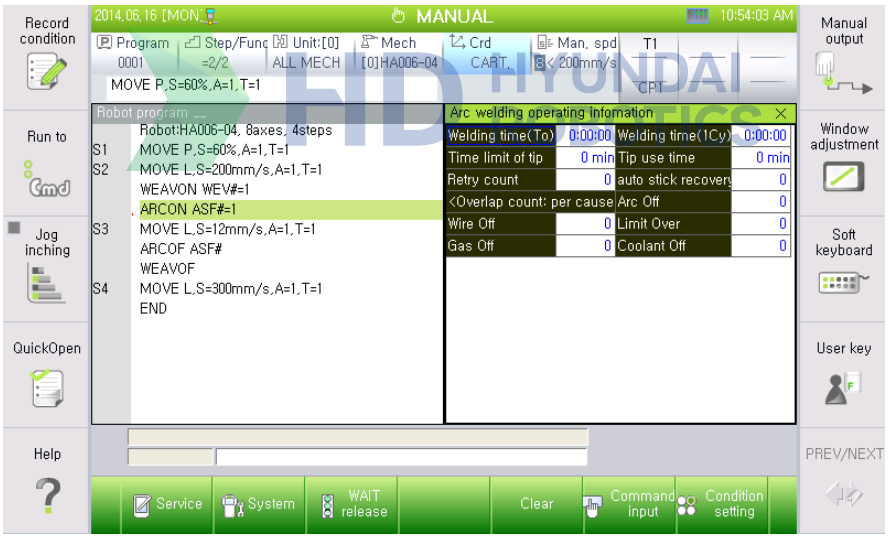

Figure 1.12 Arc welding operation information monitoring window

The operation method is as below.

(1) The user can operate the arc welding operation information monitoring window by selecting [F1]: Service』 → 『1: Monitoring』 → 『13: Arc welding operation information』 . In addition, it is possible to select it after pressing the [Window adjustment] button in the split monitoring window.

(2) Method of applying the tip usage time limit
① This is to be used when replacing the torch tip.
② Move the cursor onto “limit” or the relevant numeric information cell.
③ Press the [ENTER] key.
④ Enter the desired tip usage time limit value.
⑤ Move the cursor onto the title of “Tip usage time limit” or the relevant numeric information cell.
⑥ Pressing the [ENTER] key will bring up the “Operation information clear window.”
⑦ Press the selected item to clear the tip usage time.

(3) Results of applying the tip usage time limit
① When the tip usage time reaches 90% of the time limit, a warning will be given as “W149: the remaining time of the arc welding tip usage time limit is less than 10%.”
② When the tip usage time limit is exceeded, an instant warning will be given as “W150: the arc welding tip usage time limit is exceeded.”
③ When the tip usage time is exceeded, a replacement of the welding tip is needed. Then, go through the procedure (2) shown above again.

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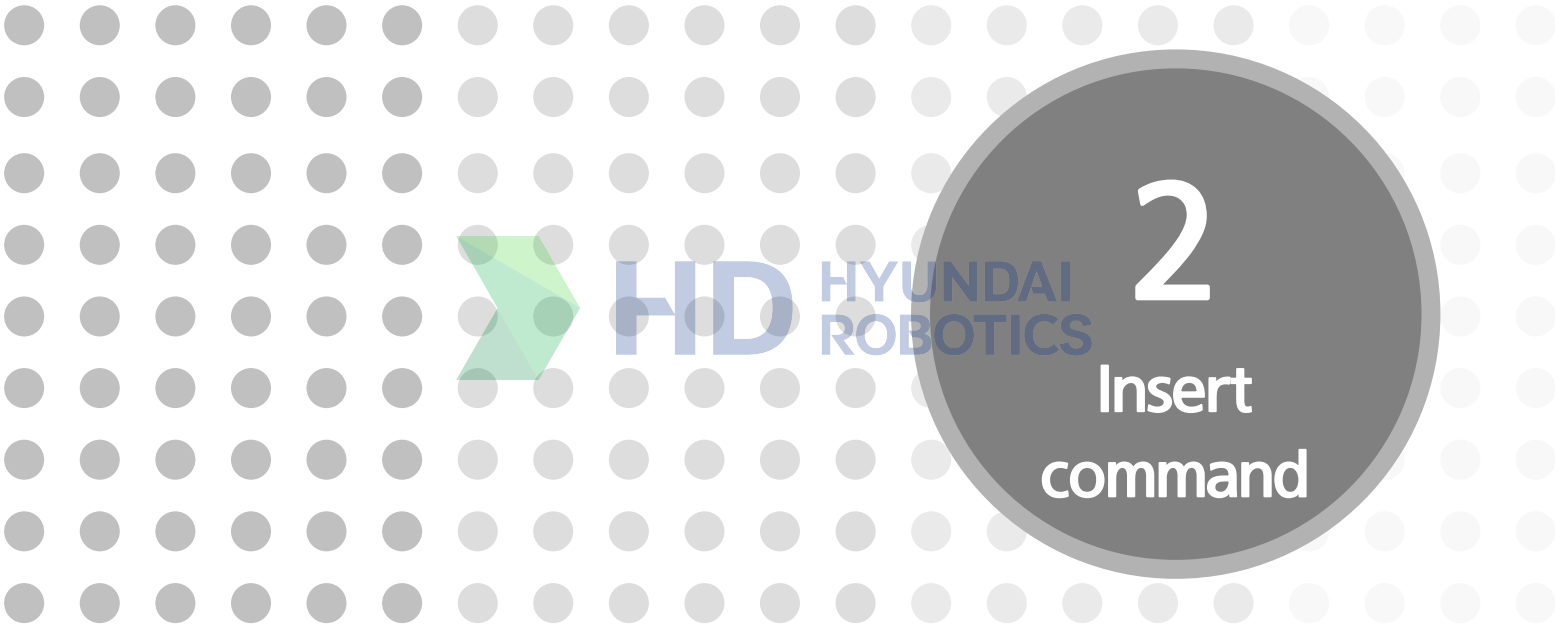
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2
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command

2.1. ARCON

Description	ARCON command starts the arc welding and can be used in 4 forms. However, it will be impossible to use commands that are not supported by the set welder.		
Grammar	• ARCON • ARCON ASF#=〈Arc welding condition no.〉 • ARCON C=〈Current〉,V(VP)=〈Voltage〉,ASF#=〈Arc welding condition no.〉 • ARCON ASF#=〈Arc welding condition no.〉,JOB#=〈Welder job no.〉 → Only for a welder that supports the job mode		
Parameter	Arc welding condition no.	Welding condition no. used for arc welding start and main condition	Rounded-up. 1~32
	Current	Output current for arc welding	0~500 A
	Voltage(V) Voltage(VP)	Actual output voltage upon arc welding Offset voltage of synergic voltage upon arc welding	-20 ~ 40 V -200 ~ 200 V(%)
	Welder job no.	Job no. to use among job no. saved in welder	1~999
Example of usage	• ARCON: Starts welding based on previous welding conditions or conditions set according to commands such as ARCCUR, ARCVOL • ARCON ASF#=1: Starts welding with the designated welding start condition • ARCON C=200,V=22,ASF#=1: Starts welding by applying input values for current and voltage, and using welding start condition no. for other welding conditions • ARCON ASF#=1, JOB#=5: Applies the job mode for welding and uses job no. 5. Starts welding based on welding start condition no. for other welding conditions • ARCON ASF#=1,REF#=7: Performs welding based on the designated #1 welding start condition and performs quantification of the welding results by using the reference file #1.		
Detailed Explanation	• [Chapter 5 Arc welding condition editing]		

Reference

- In order to use a digital welder, it is needed to set the 'Arc welding' item as 'digital' at 『[F2]: System』 → 『5: Initialize』 → 『3: Usage Setting』
- Some welder models have the function of internally saving jobs by presetting various welding

settings. In such cases, it is possible to use the 4th criterion.

2.2. ARCOF

Description	ARCOF command ends the arc welding and can be used in 4 forms. However, it is impossible to use commands that are not supported by the set welders.		
Grammar	• ARCOF • ARCOF ASF# • ARCOF AEF#=〈Arc weld end condition number〉 →Only for analogue arc welding • ARCOF C=〈Current output〉,V(VP)=〈Voltage output〉 , AEF#=〈Arc weld end condition number 〉 → Only for analogue arc welding		
Parameter	Arc end condition number	Welding condition number which is used on arc welding end	1~32
	Current output	Output current on arc welding end	0 ~ 500A
	Voltage output (V) Voltage output (VP)	Output voltage for individual setting arc welding end. Output voltage for unified setting arc welding end	0.0~40.0 V -20~200 (%)
Example of usage	• ARCOF: Ends arc welding without special ending process. • ARCOF ASF#: Ends welding according to details set by ARCON in case of digital setting. Condition setting can be approached only from ARCON. • ARCOF AEF#=1: Ends welding according to the condition on the condition file. • ARCOF C=200,V=22, AEF#=1: Ends welding according to input value for current and voltage and the value on the assigned condition file for other welding conditions.		
Detailed Explanation	• [Chapter 5 Arc welding condition editing]		

Reference

- To use the digital welder, set 'arc welding' of 『[F2]: System』 → 『5: Initialize』 → 『3: Usage Setting』 as digital.

2.3. WEAVCmd

Description	WEAVCmd command sets the individual items of the weaving condition externally. With the command, it is possible to set weaving conditions over the weaving condition count limit (32).
Grammar	WEAVON WEV#=〈Weaving condition number〉 ← Loads weaving condition. WEAVCmd.Freq=5 ← Sets an item among weaving conditions to be changed.
Example of usage	• WEAVON WEV#=1 ← Loads weaving condition No. 1. • WEAVCmd.Freq=5 ← Change only frequency among weaving conditions to 5Hz. • WEAVCmd.FwdAngle=10 ← Change 10° of proceeding angle among weaving condition • MOVE L,S=100cm/min,A=0,T=0 ← The robot moves while operating according to the weaving condition shown above
Detailed Explanation	• [Chapter 6 Weaving function]

Reference

- Some commands in the WEAVCmd assignment statement are not reflected when change occurs during the weaving operation. For a list of commands that make it possible to change during the weaving operation, refer to “Chapter 6 Weaving.”

2.4. WEAVOF

Description	WEAVOF command ends the weaving operation.
Grammar	• WEAVOF
Example of usage	• WEAVOF
Detailed Explanation	• [Chapter 6 Weaving function]

2.5. REFP

Description	REFP command is used for entering the necessary reference point for the weaving motion. Insert reference points such as weaving wall or approach direction.		
Grammar	REFP 〈Reference point number〉,〈Pose (number)〉 REFP 〈Reference point number〉		
Parameter	Reference point number	The number to set the type of reference point.	1~4
	Pose number	Inserts pose of reference point. Except, it is omitted in case it is inserted as hidden pose.	
Example of usage	• REFP 1,P1 ← Designate the wall direction of weaving by using P1 • REFP 1 ← Designate the wall direction of weaving by using the hidden pose. • REFP 2, (-1073.33, 739.01, 258.30, 0, 76, 23) ← Designate the position of the weaving surface		
Detailed Explanation	• [Chapter 6 Weaving function]		

Reference

- Alike the MOVE grammar, the REFP grammar falls under the step.
- Becomes a hidden pose type when entering the REFP command using the 〈REFP〉 key of the user keys.
- It is possible to move to the teaching position by executing the step advance after setting the execute unit as Cmd, Step.

2.6. ARCCUR

Description	The ARCCUR grammar sets a designated value for the welding current output.		
Grammar	• ARCCUR C=〈Current〉		
Parameter	Current	The current output value for the main arc welding work.	0~500 A
Example of usage	• ARCCUR C=200		

2.7. ARCVOL

Description	The ARCVOL grammar sets a designated value for the welding voltage output. The value to be designated will vary depending on the type of welder.		
Grammar	• ARCVOL V(VP)=〈Voltage〉		
Parameter	Voltage (V) Voltage (VP)	The voltage output value for the main welding work Synergic voltage % when carrying out the arc welding. However, in case of GB2, GZ4 and GE2, the offset voltage value of the synergic voltage.	0.0 ~ 40.0 V -200 ~ 200 V(%)
Example of usage	• ARCVOL V=20 • ARCVOL VP=100 ←Synergic voltage value 100% • ARCVOL VP=2 ← Reference synergic voltage, and the offset voltage +2V (In case of GB2, GZ4 and GE2)		

2.8. ARCDC

Description	ARCDC command sets the analog voltage that is outputted to the welder to set the welding current. This can be used only when using an analog welder.		
Grammar	• ARCDC 〈 Voltage value 〉		
Parameter	Voltage value	Analog voltage to be outputted for setting the welding current	-14.0 ~ 14.0 V

Example of usage	• ARCDC 10

2.9. ARCDV

Description	ARCDV command sets the analog voltage that is outputted to the welder to set the welding voltage. This can be used only when using an analog welder.		
Grammar	• ARCDV 〈 Voltage value 〉		
Parameter	Voltage value	Analog voltage to be outputted for setting the welding voltage	-14.0 ~ 14.0 V
Example of usage	• ARCDV 10		

2.10. LVSON

Description	LVSON command starts the LVS welding path tracking function.		
Grammar	• LVSON COND#=〈Condition number〉, OPT=〈Option〉,SN=〈Seam number〉		
Parameter	LVS condition number	LVS condition number to be used for executing the LVS function	1 ~ 32
	Option	SEAM: Seam finding TRK: Tracking EPS: End point prioritized search	
	SN	Seam no.: The no. to be sent to the LVS controller. LVS transmits the seam point information of the relevant seam no. to the controller.	
Example of usage	• LVSON COND#=1, OPT=SEAMF, SN=10 The seam finding function will be performed with condition no. 1 and seam no. 10. • LVSON COND#=1, OPT=SEAMF, SN=10 LVS welding line tracking will start with condition no. 1 and seam no. 10.		
Detailed Explanation	• Please contact manufacturer to use this as an option.		

2.11. TRJLOG

Description	TRJLOG command saves the trajectory tracked by the arc sensing.		
Grammar	• TRJLOG ST=〈Start/End〉,SC=〈Sampling cycle〉,LSP=〈Recording start pose number〉, LCV=〈Recorded pose count saving variable number〉		
Parameter Description Grammar	Start/end	1: Starts trajectory saving 0: Ends trajectory saving	0, 1
	Sampling cycle	Designates the weaving cycle for sampling. It is the via point in case of “0”	0 ~ 100
	Recording start pose number	Pose parameter for starting the trajectory saving	1 ~ 999
	Recorded pose count saving variable number	LV% variable for storing the maximum number of the pose variables that are to be saved. The initial value of the variable is the maximum number of the variables that can be saved. It can be decreased by 1.	1 ~ 50
Parameter	• TRJLOG ST=1,SC=5,LSP=100,LCV=10 ← Start the trajectory saving, Saves the trajectory in sequence beginning with P100 for every 5 weaving cycles. LV10% is the maximum number of the variables that can be saved. The LV1% value will be decreased by 1.		
Detailed Explanation	• Refer to the “arc sensing function manual” for more details. • The arc sensing function is optional.		

2.12. ATDC

Description	ATDC command executes the automatic tool data calibration function.		
Grammar	• ATDC T=〈Tool number〉,OrgP=〈Original pose〉,NewP=〈Current pose〉		
Parameter	Tool number	Tool number which will execute automatic tool data calibration function	0~15
	Original pose	Originally saved pose	
	Current pose	Current modified pose	
Example of usage	• ATDC T=1,OrgP=P1,NewP=P2		

Detailed Explanation	• Please contact manufacturer to use this as an option.

2.13. WEAVON

Description	WEAVON is a command to start the weaving motion.		
Grammar	• WEAVON WEV#=〈Weaving condition number〉		
Parameter	Weaving condition number	Weaving condition number when performing the weaving motion.	1~32
Example of usage	• WEAVON WEV#=1		
Detailed Explanation	• [Chapter 6 Weaving function]		

2.14. CalTVSft

Description	CalTVSft is a command to obtain the shift value which can stand a tool on two pose variables inserted.		
Grammar	• CalTVSft 〈Pose 1〉,〈Pose 2〉,〈Shift variable〉		
Parameter	Pose 1	Pose 1 obtained by sensing	
	Pose 2	Pose 2 obtained by sensing	
	Shift variable	Shift variable to stand a tool obtained by two pose values straight.	
Example of usage	• CalTVSft LP1,LP2,LR1		

2.15. ARCRSV1

Description	ARCRSV1 command outputs the preliminary analog signal 1. This command can be used only when the +2 channel is set for the addition of analog signals when using an analog welder.		
Grammar	• ARCRSV1 RSV1=〈Preliminary 1 analog output〉		
Parameter	Preliminary 1 analog output	The preliminary analog signal value to be outputted	-200 ~ 1000 V
Example of usage	• ARCRSV1 RSV1=100 ← Executes an analog output corresponding to 100. This value will be outputted as the BD584 analog voltage by the “preliminary analog output 1” table.		

2.16. ARCRSV2

Description	ARCRSV2 command outputs the preliminary analog signal 2. This command can be used only when the +2 channel is set for the addition of analog signals when using an analog welder.		
Grammar	• ARCRSV2 RSV1=〈 Preliminary 2 analog output 〉		
Parameter	Preliminary 2 analog output	The preliminary analog signal value to be outputted	-200 ~ 1000 V
Example of usage	• ARCRSV2 RSV2=100 ← Executes an analog output corresponding to 100. This value will be outputted as the BD584 analog voltage by the “preliminary analog output 2” table.		

2.17. HSensON

Description	HSensON command starts height sensing (AVC, arc length control). Refer to “Height sensing” for more details.		
Grammar	• HSensON AVC#=〈Height sensing condition number〉		
Parameter	Height sensing condition number	Condition number to be used for executing height sensing	0 ~ 8
Example of usage	• HSensON AVC#=1 ← Starts height sensing with the height sensing condition #1		

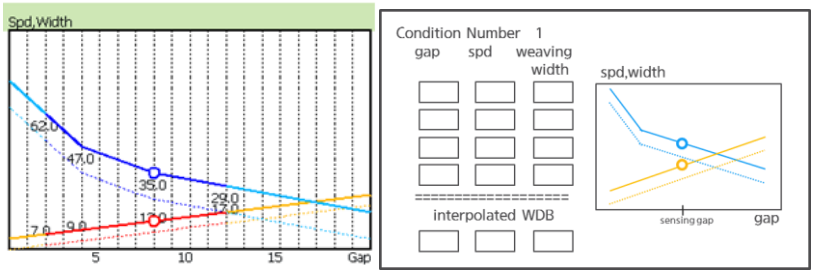
Detailed Explanation	• [8.2 Height sensing function]

2.18. HSensOFF

Description	HSensOFF command ends height sensing (AVC, arc length control)
Grammar	• HSensOFF
Example of usage	• HSensOFF ← Ends the execution of height sensing
Detailed Explanation	• [8.2 Height sensing function]

2.19. ARC_COND

<table>
<tr><td>Description</td><td colspan="3">The ARC_COND statement is a command to set the current, voltage, speed, weaving width, and weaving frequency for arc welding. The user can also change the condition, linearly ranging from the current ARC_COND condition to the next ARC_COND condition. In other words, the interpolation conditions will be applied in consideration of the left direction distance / right direction distance (gap), and the welding speed and weaving width will be automatically calculated based on the gap.
The parameters to be set by this command can be individually designated and set by reading the desired welding condition database and designating the WDB number.</td></tr>
<tr><td>Grammar</td><td colspan="3">• ARC_COND 〈Welding condition change method〉, 〈Welding speed〉, 〈Left direction distance〉, 〈Right direction distance〉, 〈Weaving frequency〉, 〈Current〉, 〈Voltage〉
• ARC_COND 〈Welding condition change method〉, WDB#=〈Welding condition database〉</td></tr>
<tr><td rowspan="8">Parameter</td><td>Welding condition change method</td><td>Work program number where the station calibration is being taught</td><td>1 ~ 9999</td></tr>
<tr><td>Welding speed</td><td>Designates the robot movement speed in the welding section; The speed in the MOVE statement ignored</td><td>0.6~1000 cm/min</td></tr>
<tr><td>Left direction distance / right direction distance</td><td>Sets the amplitude of the left/right direction for the weaving operation</td><td>0.0~50.0 mm</td></tr>
<tr><td>Weaving frequency</td><td>Sets the weaving frequency</td><td>0.0~10.0 Hz</td></tr>
<tr><td>Current</td><td>Sets the welding current for the welding section</td><td>1~1000 A(%, m/min)</td></tr>
<tr><td>Voltage</td><td>Sets the welding voltage (compensation) for the welding section</td><td>-200~200 V(%)</td></tr>
<tr><td>Welding condition database</td><td>Sets the welding condition database number to be used in the welding section</td><td>1~1000</td></tr>
<tr><td>Example of usage</td><td colspan="3">• ARC_COND L, 30, 4, 4, 3, 400, 28
• ARC_COND L, WDB#=1
• Interpolation condition editing window</td></tr>
</table>



If four points are set as the interpolation conditions as above, it will be possible to change the weaving width and welding speed by performing linear interpolating variably according to the sensed gap, instead of the set left and right weaving widths. In the figure, the circles represent the welding speed and width interpolated for the reference conditions expressed in dotted lines with regard to the current gap.

2.20. MULTIPASS

<table>
<tr><td>Description</td><td colspan="3">It is a multipass command to reproduce the path of arc sensing. With this command, the user can reproduce the path as much shift as desired in the original arc welding path.</td></tr>
<tr><td>Grammar</td><td colspan="3">• SAVE, TrjNo=〈Multipass trajectory number〉, SampDist=〈Trajectory store cycle distance〉
• MULTIPASS LOAD, TrjNo=〈 Multipass trajectory number 〉, Side=〈Left/right shift distance〉, Updown=〈Up/down shift distance〉, Reverse=〈Multipass playback direction〉, TAS=〈Torch front/rear direction angle shift〉, WAS=〈 Torch left/right direction angle shift〉
• MULTIPASS OFF</td></tr>
<tr><td rowspan="8">Parameter</td><td>Multipass trajectory number</td><td>Multipass trajectory number to store/load</td><td>1 ~ 50</td></tr>
<tr><td>Trajectory store cycle distance</td><td>Sampling distance to store the multipass trajectory</td><td>5 ~ 100 mm</td></tr>
<tr><td>Left/right shift distance</td><td>Distance to be shifted in the left/right direction from the original arc sensing trajectory in the multipass reproduction</td><td>-20 ~ 20 mm</td></tr>
<tr><td>Up/downshift distance</td><td>Distance to be shifted in the up/down direction from the original arc sensing trajectory in the multipass reproduction</td><td>-20 ~ 20 mm</td></tr>
<tr><td>Multipass playback direction</td><td>Sets whether to playback from the opposite direction of the original arc sensing trajectory in the multipass reproduction</td><td>0: 정방향
1: 역방향</td></tr>
<tr><td>Torch front/rear direction angle shift</td><td>Shift angle at which the torch is tilted in the front/rear direction in multipass reproduction</td><td>-20 ~ 20 deg</td></tr>
<tr><td>Torch left/right direction angle shift</td><td>Shift angle at which the torch is tilted in the left/right direction in multipass reproduction</td><td>-20 ~ 20 deg</td></tr>
<tr><td>Example of usage</td><td colspan="3">WEAVON WEV#=1
MULTPASS SAVE,TrjNo=1,SampDist=10 〈- Store in Trajectory 1 at an interval of 10 mm
ARCON ASF#=1
S10 MOVE L, R2,S=LV1!cm/min,A=3,T=1
S11 MOVE L, R2,S=LV1!cm/min,A=3,T=1
ARCOF
WEAVOF
MULTPASS OFF
S12 MOVE L, S=50%,A=3,T=1</td></tr>
</table>

	S13 MOVE L, S=50%,A=3,T=1 S14 MOVE L, S=50%,A=3,T=1 MULTPASS LOAD,TrjNo=1,Side=3,Updown=3,Reverse=0,TAS=0,WAS=0 〈- Shifts 3 mm to the right and 3 mm upward by reading the trajectory #1. There is no angle shift in the right direction. S15 MOVE L, R2, S=50%, A=0,T=1 **〈- Step to move while shifting to the multipass start position** WEAVON WEV#=11 ARCON ASF#=1 S16 MOVE L,R2,S=LV1!cm/min,A=3,T=1 S17 MOVE L,R2,S=LV1!cm/min,A=3,T=1 ARCOF WEAVOF MULTPASS OFF

2.21. PosiCal

Description	PosiCal command calibrates a station designated by an inputted program number. This is used together with the servo axis change function. This allows the calibration of the changed servo axis positioner even during robot operation.		
Grammar	• PosiCal Prog=〈Program number〉,Station=〈Station number〉		
Parameter	Program number	The number of the work program for which the station calibration teaching is performed.	1 ~ 9999
	Station number	Number of the station that needs to be calibrated	S0, S1, S2, S3, All
Example of usage	PosiCal Prog=9997,Station=2 ← Calibrates Station #2 of the work program of 9997.JOB .		

2.22. TOUCHSEN

<table>
<tr><td>Description</td><td colspan="3">The TOUCHSEN statement is a command for performing touch sensing. It is possible to set the sensing type and sending a condition through a quick open window. Such information will be stored in ROBOT.TSC. When the movement to the position for touch sensing is performed, and the TOUCHSEN statement is executed, touch sensing will be performed automatically according to the sensing type and condition at the relevant position.</td></tr>
<tr><td>Grammar</td><td colspan="3">• TOUCHSEN TSC#=〈Condition number〉, 〈Direction 1〉, 〈 Direction 2〉, 〈Direction 3 or Amount to lift〉, 〈Pose to store〉, 〈Butt gap variable〉
• TOUCHSEN TSC#=〈Condition number〉, 〈Direction 1〉, 〈 Direction 2〉, 〈Direction 3〉, 〈Sensing angle〉, 〈PAR number〉, 〈Butt gap variable〉</td></tr>
<tr><td rowspan="7">Parameter</td><td>Condition number</td><td>Touch sensing condition number</td><td>1 ~ 8</td></tr>
<tr><td>Direction 1–3</td><td>Touch sensing direction
(Orthogonal, pose, tool and tool projection)

In the direction 3 parameter, the amount to lift, following the lower part sensing, needs to be designated in the case of VGroove and butt types.

The direction to be supported varies depending on the sensing type.</td><td>+X, -X
+Y, -Y,
+Z, -Z,
+TX, -TX,
+TY, -TY,
+TZ, -TZ,
TF, TD, TL, TR
P1~P9999</td></tr>
<tr><td>Pose to store</td><td>Designates the pose number</td><td>P1~P9999</td></tr>
<tr><td>Butt gap variable</td><td>Variable to store the gap measured in the case of the butt and VGroove types</td><td>V 변수</td></tr>
<tr><td>Sensing angle</td><td>An axis for the base, tool, and tool projection coordinates. It rotates in all sensing directions.</td><td>Y30, Y-30
X30, X-30
TL30, TL-30
TY30, TY-30</td></tr>
<tr><td>PAR number</td><td>A number is for the pose and shift and is to be used when utilizing the master mode. In the master mode, the sensing value will be stored in the pose of the relevant number. In the execution mode, the shift value will be stored in the shift of the relevant number.</td><td>PAR=1~9999</td></tr>
</table>

Example of usage	• TOUCHSEN TSC#=2, +TX, +TZ, 3, P10, V1! #2 condition, tool coordinate direction and ascending 3 mm after bottom sensing • TOUCHSEN TSC#=1, TF, TD, 0, P10, 0 #1 condition, tool projection direction and two-point touching • TOUCHSEN TSC#=1, +X, -Y, -Z, P10, 0 #1 condition, base coordinate direction and three-point touching

2.23. STITCH

Description	The STITCH statement is a command for performing STITCH welding. Pressing the [QuickOpen] key on top of the STITCH command will allow you to enter the Edit screen. The information for editing the STITCH conditions will be saved in ROBOT.STC. Move the robot to the position where stitch welding is to be performed. The stitch welding function will be applied when welding starts at the position if you execute the STITCH command on top of the ARCON command. The STITCH function will operate up to the end point of welding or the point where the STITCH OFF command is executed.		
Grammar	• STITCH ON,CON#=〈Condition number〉 • STITCH OFF		
Parameter	Condition number	STITCH Condition number	1 ~ 20
Example of usage	• STITCH ON,CON#=2 STITCH condition 2 executed • STITCH OFF STITCH function ended		
Detailed Explanation	• [8.7 STITCH function]		

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Quick open function

3.1. Overview

When teaching of an arc welding operation program needs to be performed, not only the welding related conditions, such as voltage and current, but also details of the arc welding functions such as weaving and retry/overlap and characteristics of the welder, should be set. Additionally, not only in the arc welding, but also in general cases that would used a robot, it may be required, in some cases, to check the information (such as coordinates and pose) of the position not only of the steps set through teaching, but also of the auxiliary points. The arc welding condition and the position information of the steps and auxiliary points are managed inside the controller in the form of a file, meaning that it would not be easy to edit them. That is why a function to help edit those files easily and fast is provided.

Quick Open is a function that will make it possible to set the arc welding conditions or check and edit the information of the steps and auxiliary points by using a key once without going through inconvenient operation.

Here, we take the case of editing the welding start condition, as an example. While the cursor is on the ARCON command that is for the Arc On function, if the user presses the [Quick Open] key, the screen will display the content that matches with the number of the condition, among those for starting welding, that is being used by the current command. On this screen, it is possible to check or change the details of the welding start condition. It is also possible to shift to other condition files that are related to the relevant condition file.

As explained above, this function will make it possible to check and change, easily and fast, relevant details of a condition file or a step position in relation to a specific command.

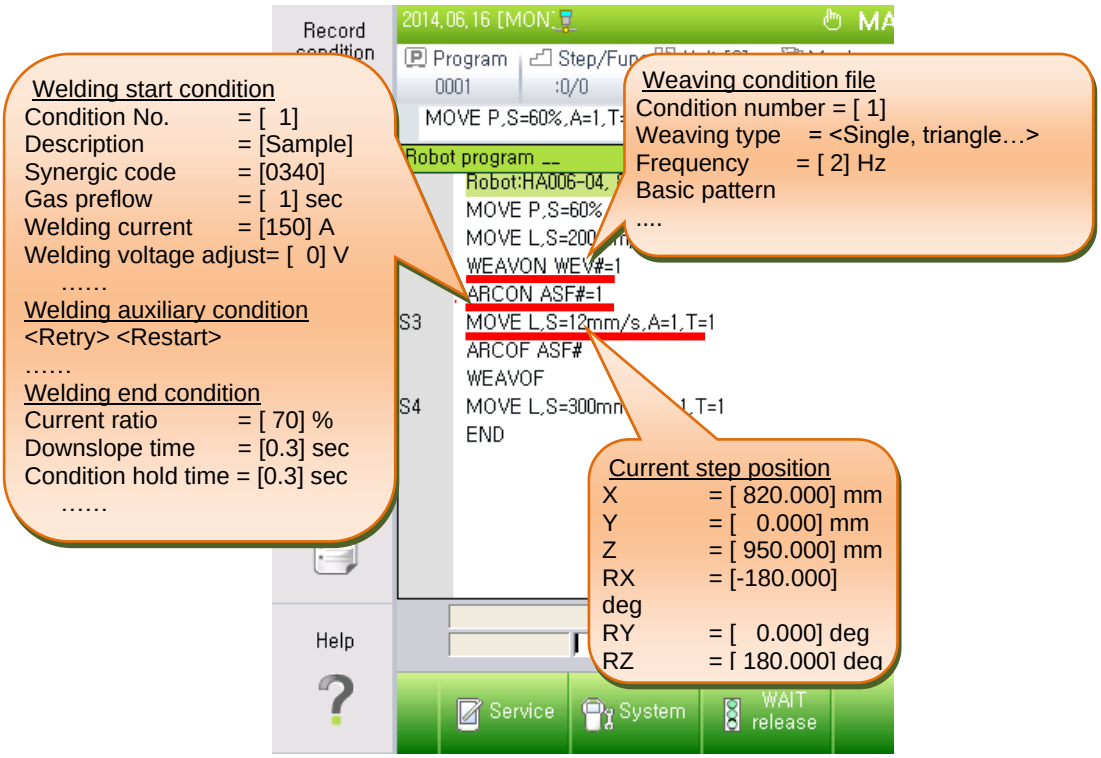

Figure 3.1 Quick open in the robot program

Clicking the [Quick Open] key in certain commands displays relevant files or details on the screen. After saving the changed content in a file, if it is required to end the process, the 〈Complete〉 key needs to be pressed. If required to end without saving, the 〈ESC〉 key needs to be pressed.

3.2. Details

The content displayed when pressing [Quick Open] in each command is as follows.

<table>
<tr><th>Command</th><th>File, content</th><th>Details</th><th>Note</th></tr>
<tr><td>MOVE</td><td>Pose</td><td>Current position and command values.
X Y Z(mm) Rx Ry Rz(deg)
Robot configuration</td><td>Can correct the command values</td></tr>
<tr><td>CALL</td><td rowspan="2">Program to be called</td><td rowspan="2">Shift to the program that is targeted for calling</td><td>Can move to the previously called position through [Step] + “Entering -1”</td></tr>
<tr><td>JMPP</td><td></td></tr>
<tr><td>Assignment statement</td><td>Confirm and change variable</td><td colspan="2">Monitor and change relevant variables depending on their types Including V%, V!, V$, P, R, LV%, LV!, LV$, LP, LR, and system variables</td></tr>
<tr><td rowspan="2">ARCON</td><td>Digital welders
Arc welding condition

Type of use:
ARCON ASF#=XX
ARCON C=XX,V=XX,ASF#
ARCON ASF#=XX,JOB#=X
ARCON ASF#=XX,REF#=X</td><td colspan="2"><u>Welding initiation condition</u>
Condition number, Description, Synergic code, Gas preflow, Current/feed speed, Welding voltage (correction) /Arc length, WCR wait time, Robot delay time, …
<u>Welding auxiliary condition</u>
- Retry: Count, Retry condition, Operation mode, Speed, Retract time, Retract speed, Reentr./Path Dist., Shift Distance
- Restart: Count, Restart condition, Overlap length, Moving speed, Welding speed
<u>Welding end condition</u>
Current ratio, Downslope time, Condition hold time, Gas preflow, …
<u>Welding auxiliary condition (Enter the end condition)</u>
- Auto Stick Recovery: Count, Stick recovery condition, Stick recovery time</td></tr>
<tr><td>Analog welders:
Arc welding start condition
Arc welding auxiliary

Type of use:
ARCON ASF#=XX
ARCON C=XX,V=XX,ASF#</td><td colspan="2"><u>Welding initiation condition</u>
Condition number, Description, Output current, Output voltage, WCR wait, Robot delay, Gas preflow, Initial condition time, ……
<u>Welding auxiliary condition</u>
- Retry: Count, Retract time, Retract speed, Retract/ Welding path moving, Shift amount, Speed, Current, and Voltage
- Restart: Frequency, Overlap amount, Moving speed, Welding speed, Current, and Voltage</td></tr>
</table>

Command	File, content	Details	Note
'ARCOF	Analog welders: Arc welding end condition	Welding end condition Condition number, Voltage check, Output current, Output voltage, Down slope, Condition hold time, and Gas postflow	
	Analog welders: Arc welding auxiliary condition	Welding auxiliary condition (Entering the end condition) Auto stick recovery: Counter, Current, Voltage, Delay time	
WEAVON	Weaving condition check and change	Condition number, Weaving type, Frequency, Basic pattern, Forward angle, Boundary limit, Moving time, Timer	
REFP	Reference point check and change	Current Pose and command. X Y Z(mm) Rx Ry Rz(deg) Robot configuration	The command can be modified Same as the "Pose" screen
LVSON	LVS condition check and change	Function setting: Condition number, Joint form, Operation mode, Start point detection, Cross-section point detection, and Sensing offset Tracking condition: Roll tracking, Pitch tracking, Yaw tracking, Start point position correction …… Gap adaptive welding condition: Prepare the condition table	Optional functions
HSensOn	Height sensing condition check and change	Condition number, Input data type for height sensing, Reference data setting method ……	
ARC_COND	Welding condition database	For confirming and editing the database that consists of the welding speed, current, voltage, weaving width, and weaving frequency	
TOUCHSEN	Touch sending functions setting	For setting the sensing type, search distance, retraction distance, error compensation amount, point of time for sensing, and the pose calculation	

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Arc Welder Setting

4.1. Arc welder setting

This function for editing the characteristics of welders allows the use of various welders together with the arc welding robot. The following describes steps to access the welder setting screen.

First of all, when a welder needs to be used, the user can set it through the 'Welder Number' item by selecting the 『[F2]: System』 → 『5: Initialize』 → 『3: Usage Setting』. When the user selects 『[F1]: Welder』, then the screen for editing the conditions of the relevant welder will be displayed.

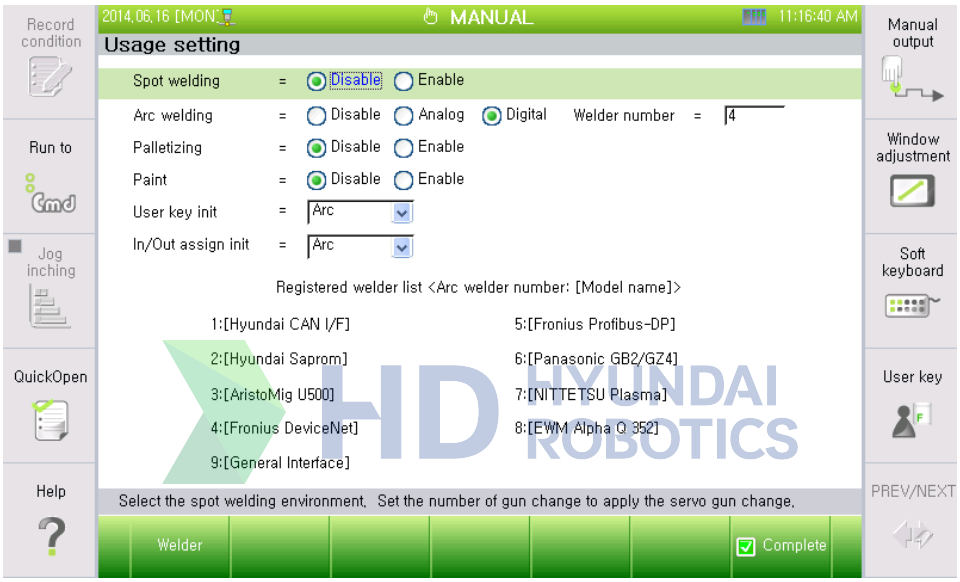


Figure 4.1 Usage setting dialog box

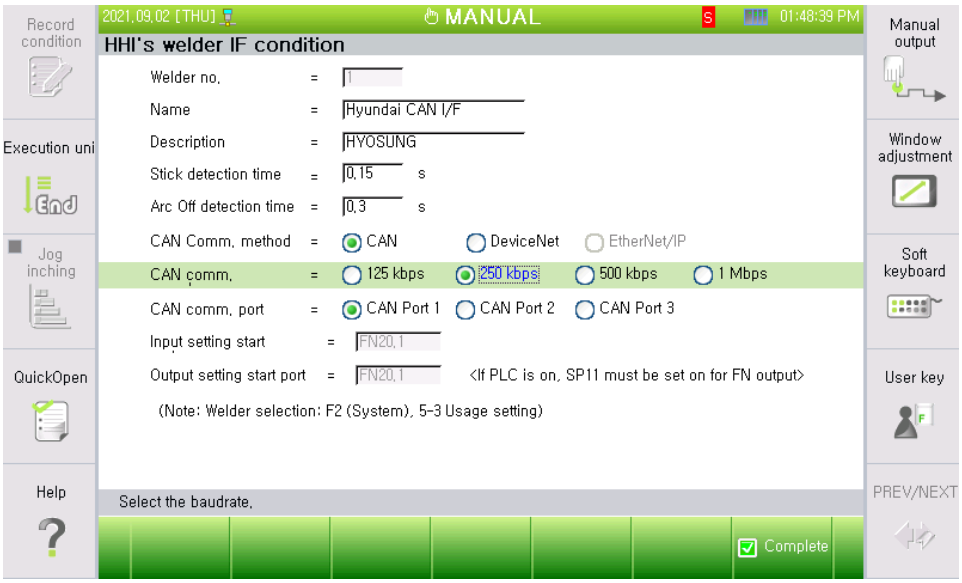


Figure 4.2 Welder setting dialog box (when BD574+CAN communication is used)

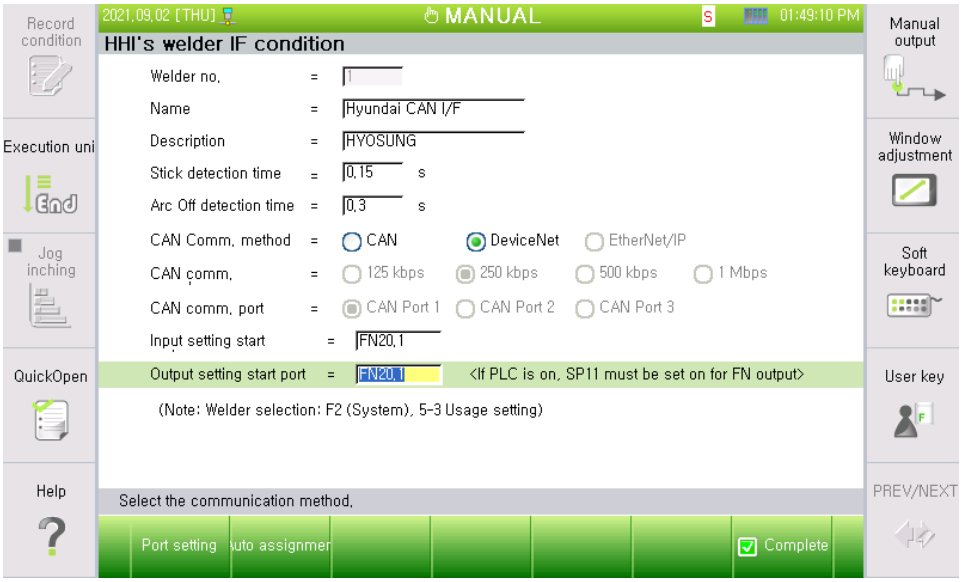


Figure 4.3 Welder setting dialog box (when BD574+DeviceNet communication is used)

As individual welder condition screens provide editing functions relevant to specific welders, the editing items will vary depending on welders. The following items are the common items that can be edited on the condition screens of welders.

The items that can be edited commonly are as shown below.

(1) Number
Display current setting welding number. Through the relevant item, the currently selected welder and its number can be checked. Changing the information is possible only through the 'usage setting' screen.

(2) Model type
Record the model name of welder. Basically, the model name of welder supported by our company is written.

(3) Description
Record the welder description. Basically, the name of welder maker is written.

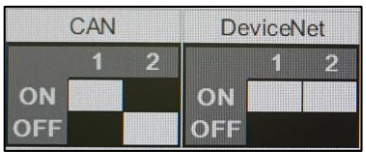
(4) Stick detection time: [0.2] sec (Range: 0.1 ~ 10.0)
Once welding is completed, wire stick will be inspected during the set time.

(5) ARC OFF detection time: [0.6] sec (Range: 0.0 ~ 10.0)
Set the reference time for the arc off that could occur in the middle of arc welding. If the arc stays turned off for longer than a specific duration, the state will be recognized as arc off. If the value is small, arc ignition failure would occur frequently. However, if the set value is too large, the time duration in which robot movement and wire inching continue even after the arc is off will increase, causing the robot movement distance and the wire projection length to increase.

4.2. HRWI characteristic file editing

(1) Communication method
It sets the method to communicate with the Hyosung welder.
The Hyosung welder supports CAN communication, while DeviceNet communication can be used depending on the site situation.
After removing the welder cover, you can set the welder communication through the dip switch on the main board.
The following shows how you can set the communication in the Zi-sol model.

- Turn off the welder, and then change the setting of dip switch no. 1 (SW1). After that, turn on the power.
- The part marked in light color in the figure below is the protruding part of the dip switch.



(2) CAN communication speed: {125kbps, 250kbps, 500kbps, 1Mbps}
Set the communication speed of a welder. It is required to check the communication speed that is supported by the welder.
For Hyosung welder, the communication speed should be set to 250 kbps.

(3) CAN communication port: {CAN port 1, CAN port 2, CAN port 3}
This sets the CAN port used for communicating with the welder. As one of the 4 CAN ports has been already used basically, one of the remaining 3 ports needs to be designated for the use.
CAN port 1: When BD5B2 or the DeviceNet connector on the controller door is used
CAN port 2: When the BD574 DeviceNet connector is used
CAN port 3: Smaller connector in the case of using the BD574 two-port model

(4) Input setting start port
The set port will be used as a reference port that will become the starting point among the input ports during the automatic assignment.

(5) Output setting start port
The set port will be used as a reference port that will become the starting point among the output ports during the automatic assignment.

(6) Port setting
When using the DeviceNet interface, if you press the [F1: Port Setting] key, you can enter the dialog box to set the input/output signal port.

(7) Automatic assignment
When using the DeviceNet interface, if you press the [F2: Auto Assignment] key, the input/output signals will be automatically assigned based on the input and output setting start ports set above. After that, you will be automatically allowed to enter the port setting dialog box.

(8) Port setting dialog box

If you press the “port setting” or “auto assignment” button, you can enter the input or output port setting dialog box, as shown below.

If ports will not be used, set them to “0,” allowing the internal processes associated with those signals to be skipped. It is recommended to use the set values for individual ports.

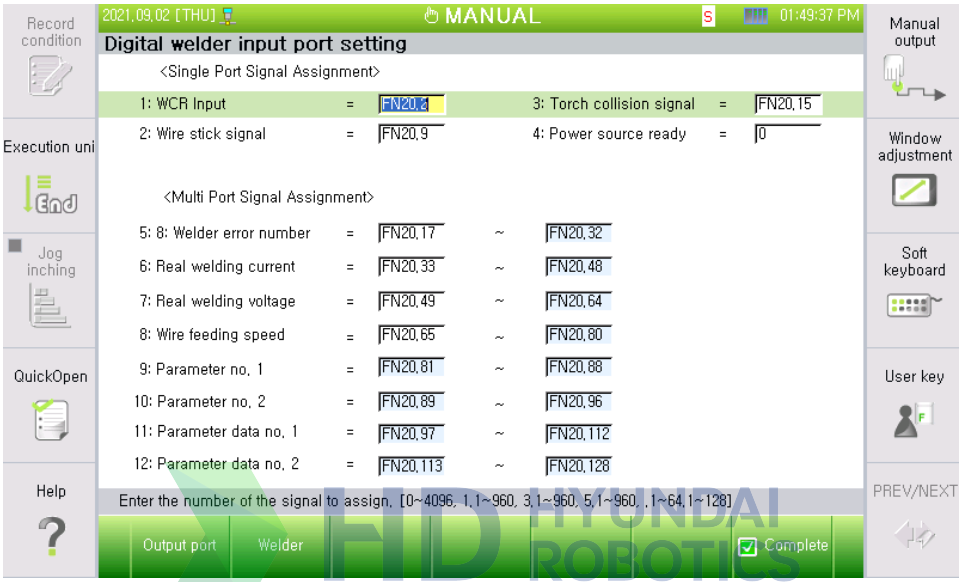


Figure 4.4 Welder input port setting dialog box (when Hyosung welder is used)

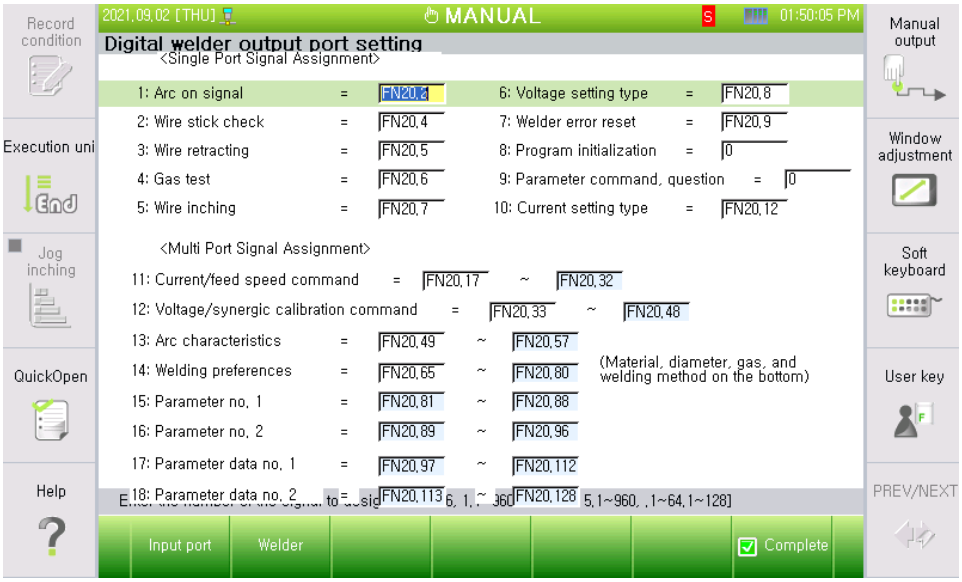


Figure 4.5 Welder output port setting dialog box (when Hyosung welder is used)

4.3. Panasonic welder characteristic file editing

(1) Max welding current: [350]A (0 ~ 999)
Set the maximum welding current for a welder.

(2) Welding communication port: {Serial port #1(CNSIO), Serial port #2(OPSIO)}
This sets the serial port used for communicating with the welder.

(3) Welder models in details: {YD-350GB2, YD-350GZ4, YD-350GE2}
Set the model of a welder that will be used.

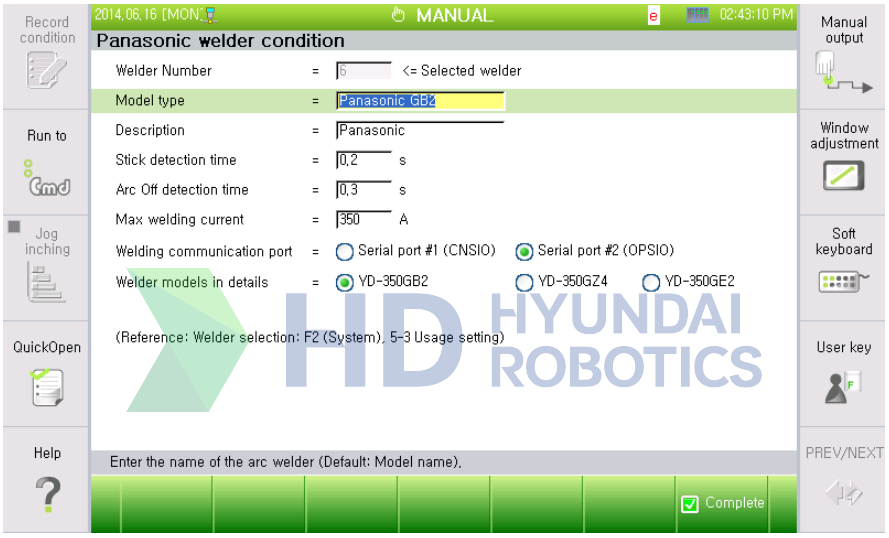


Figure 4.6 Panasonic welder condition setting

4.4. ESAB/Fronius/EWM welder characteristic file editing

(1) QuickStop: {Used, No Used}
This function sets whether to use the QuickStop function when ending in the middle of arc welding. When the QuickStop function is set as “Used,” the welding will end in mid-operation without handling craters. Support will vary depending on welders (ESAB is supported, but Fronius and EWM are not supported)

(2) Input set start port
If a port is set for this function, it will be used as a reference port that will be an input start port when auto assignment takes place.

(3) Output set start port
If a port is set for this function, it will be used as a reference port that will be an output start port when auto assignment takes place.

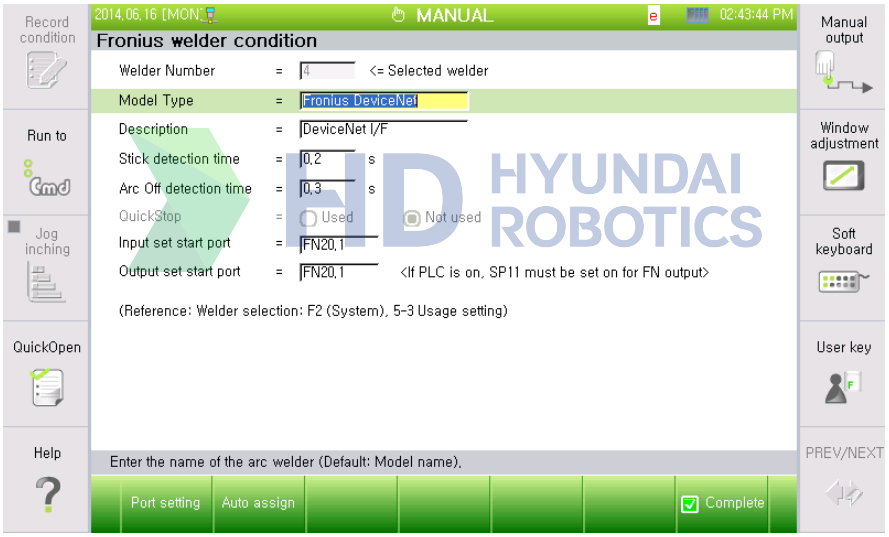


Figure 4.7 Fronius welder condition setting

4.5. Megmeet welder property file editing

(1) QuickStop: {Use, No use}
This function sets whether to use the QuickStop function when ending in the middle of arc welding. When the QuickStop function is set as “Use,” the welding will end in the middle of the welding process without handling craters. Support will vary depending on welders (to be supported in the case of ESAB and Froniu while not in EWM).

(2) Input setting start port
If a port is set for this function, the port will be used as the reference port that will be the input start port when an auto-assignment takes place.

(3) Output setting start port
The port set for this function will be used as the reference port that will be the output start port when an auto-assignment takes place.

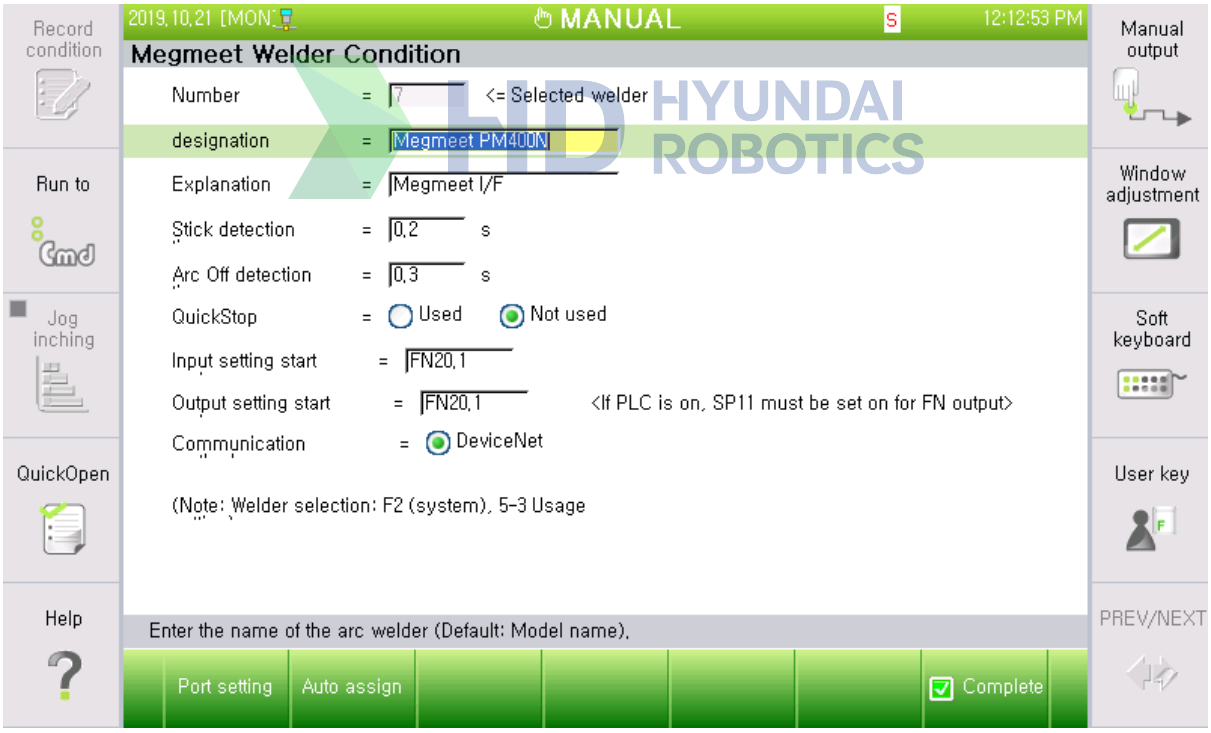


Figure 4.8 Megmeet welder condition setting

4.6. Arc welder general interface

The manufacturer provides users with the “arc welder general interface function” to allow for the usage of various welders. The function supports direct user settings when using arc welders that are based on the DeviceNet interface. By entering detailed welder information into the UI (User Interface), various welders may be used. The function can be used by setting “#9 (General interface)” for the digital arc welders. If necessary, you many request and receive a copy of the **“Arc welder general interface training material”** from the manufacturer. Refer to **“Arc welder general interface training material”** for more detailed information about the function.

The following list shows the welders that are supported through the arc welder general interface.

1. Kemppi welders
2. Selco welders
3. Cebora welders
4. Fronius TIG welders
5. Currently reviewing the support for many other welders

Please, contact the manufacturer if you want to use other types of welders that are not officially supported at present.

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Arc welding condition editing

5.1. Arc welding condition configuration

It is necessary to set the welder and the welding condition in order to perform arc welding using the welders provided by the manufacturer. When needed to apply special functions such as weaving and arc sensing, in addition to basic arc welding, their relevant function details need to be set. The company provides the welder characteristic file editing function (Refer to Chapter 4. Arc welder setting), the arc welding application function editing (Refer to 1.2.2. Setting various arc welding signals and functions) and the arc welding condition editing function, in order to help users carry out welding by using various welders as desired in diverse working environments.

The arc welding condition is configures as follows.

- Arc welding start condition:
  Editing of the welding start condition setting and also of the main conditional welding setting.
  - Arc welding start auxiliary condition: Editing of the retry and restart functions

- Arc welding end condition: Editing of the setting when welding ends
  - Arc welding end auxiliary condition: Editing of the Auto Stick Recovery function

5.2. Arc welding time chart

This is the digital arc welding time chart. Refer to the dialog box description per each command for each condition setting.

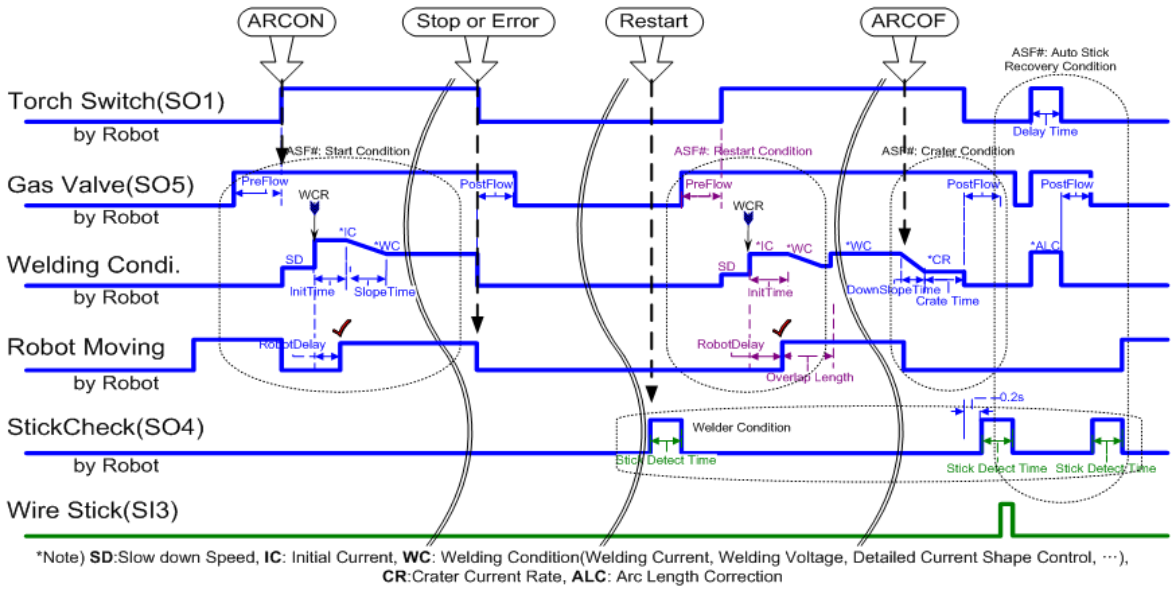

Figure 5.1 Digital arc welding time chart

5.3. Welding start condition – Execute it by using [Quick Open] at ASF#=x

While the arc welding setting is digital, and there is the cursor on the ARCON ASF#= command line, if the [Quick Open] key is pressed, the welding start condition editing screen will be displayed as shown below.

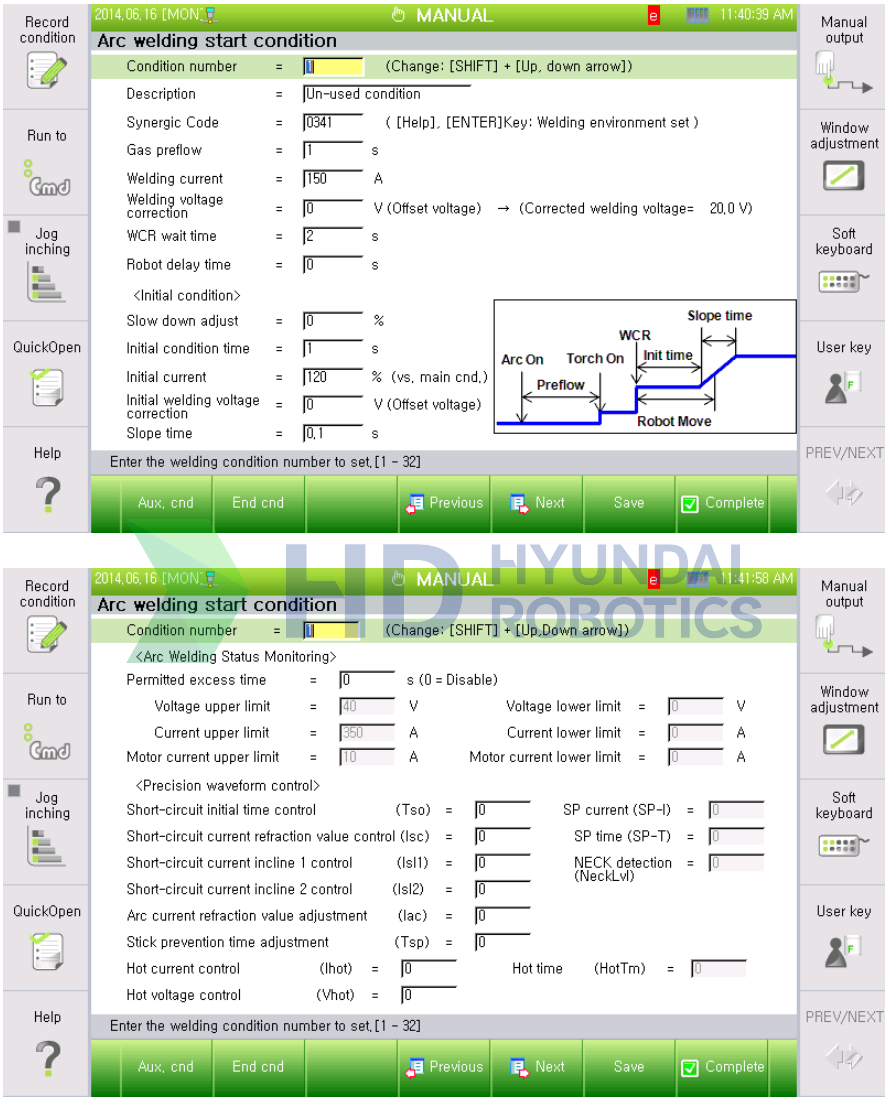

Figure 5.2 Welding start condition dialogue box (Example of GB2 digital welder)

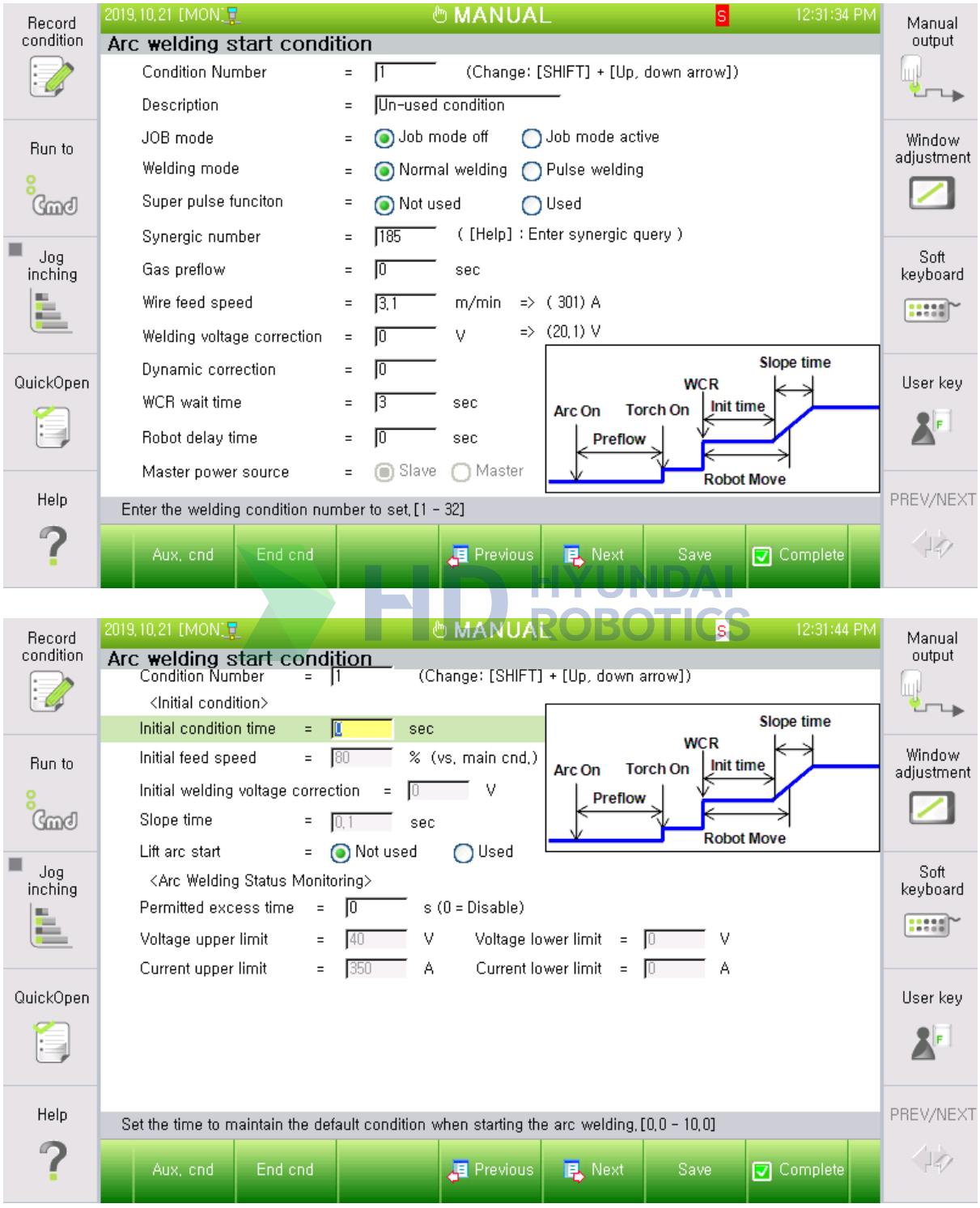

Figure 5.3 EWM welder's welding start condition dialog box

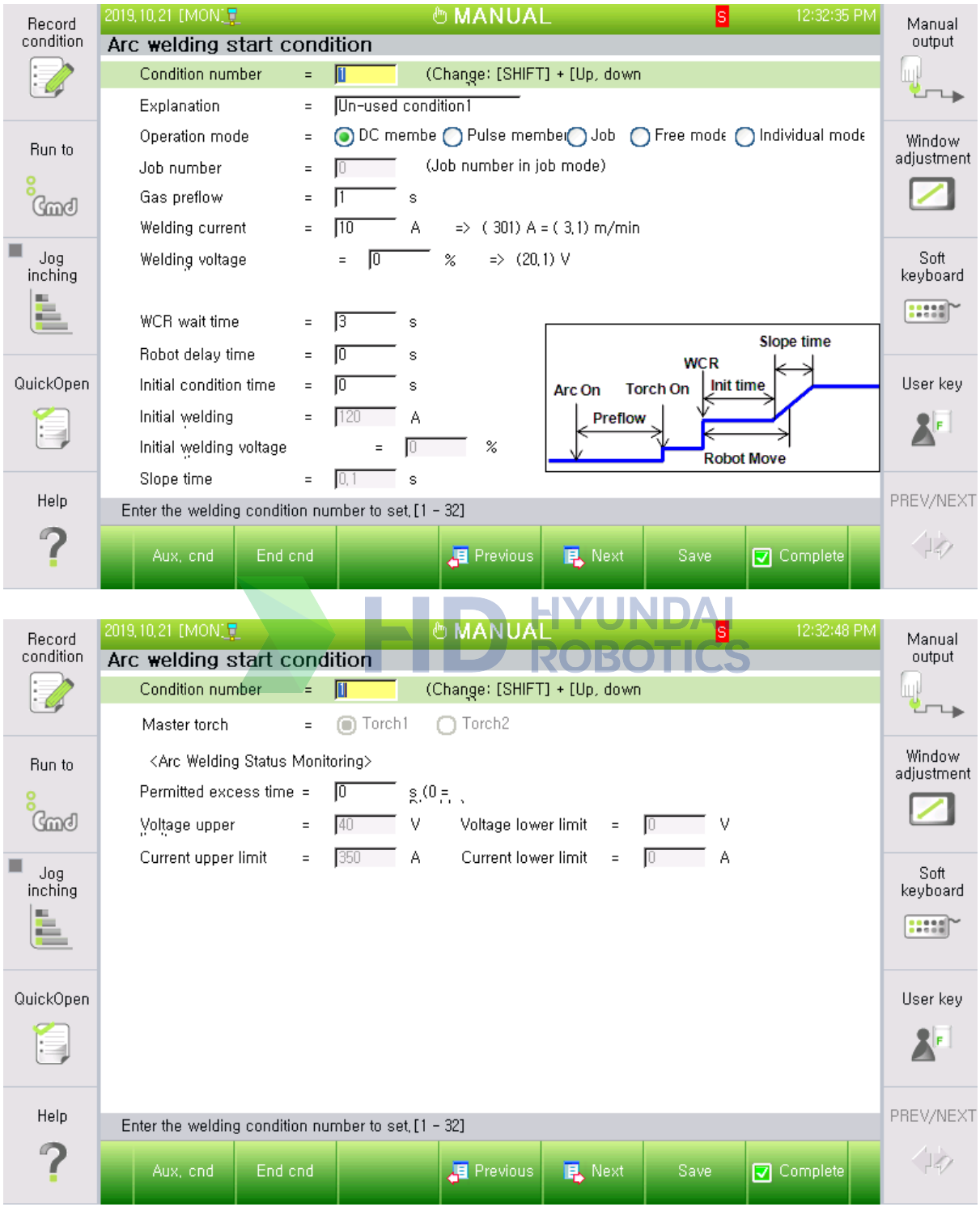

Figure 5.4 Megmeet welder's welding start condition dialog box

After the conditions are edited, if the [ESC] key is pressed, the dialogue box will close without saving the edited condition. If the [F7: Complete] key is pressed, the edited content will be saved and the dialogue box will close.

The following information is about the items that are to be applied commonly for welders. Refer to [Chapter 4. Arc welder setting] for the items that can be set specifically for individual welders.

The contents of the common items may vary in their model type, units and range. Refer to each table of individual items when it comes to the difference of welders.

(1) Condition number

	Name	Range
Common to all welders	Condition number	1 ~ 32

Designate the welding start condition number for editing. (32 conditions can be designated and used)

(2) Description

	Name
Common to all welders	Description

Record the description about the relevant welding start condition.

(3) Synergic code

	Name	Unit	Range	Default
HRWI	Synergic code	-	-	040
GB2/GZ4/GE2	Synergic code	-	-	0340/1153/0340
ESAB, Fronius MEGMEET	Not supported			
EWM	JOB Nr.(synergic)	-	-	185

Set the synergic code that needs to be sent to the welder. The code value can be set through the synergic code selection dialogue box. It is possible to enter the synergic code selection dialogue box by pressing the [Help] key, or pressing the [Enter] key when the cursor is placed on the welding environment code.

(4) Gas preflow (When controlling the gas signal)

	Name	Unit	Range	Default
Common to all welders	Gas preflow	Second	0.0 ~ 10.0	0.5

Set the time for emitting the shield gas in order to separate the welding area from the atmosphere before

starting welding.

(5) Welding current/ Welding power / Feeding speed

	Name	Unit	Range	Default
HRWI	Welding current	A	0.0 ~ 500.0	100
GB2/GZ4/GE2	Welding current	A	30.0 ~ 350.0	150
Fronius	Welding power	%	0.0 ~ 100.0	10
ESAB/EWM	Wire feeding speed	m/min	0.0 ~ 25.0	3.1
MEGMEET	Welding current	A	30 ~ 400	150

Set the value that corresponds to the welding current. This is for the current that will be used for the main conditional welding, while the current to be used for the initial condition as well as the end condition will be decided based on the ratio of this value.

(6) Welding voltage correction/ Arc length correction

	Name	Unit	Range	Default
HRWI	Welding voltage correction	%	50.0 ~ 150.0	100
GB2/GZ4/GE2 ESAB/EWM	Welding voltage correction	V	-10.0 ~ 10.0	0
Fronius	Arc length correction	%	-30.0 ~ 30.0	0
MEGMEET	Welding voltage correction	%	-30.0 ~ 30.0	0

When it comes to digital welding, the welding voltage selected due to the welding current from the synergic data will be used in many cases, the welding voltage will not be entered directly. If needed to change the welding voltage selected automatically due to the synergic data, it is required to set the offset value for the target voltage based on the relevant welding voltage.

(7) WCR wait time

	Name	Unit	Range	Default
Common to all welders	WCR wait time	Second	0.0 ~ 10.0	2

Displays the WCR input wait time. If the WCR signal is not fed within the time, retry will be performed. However, if the count of retry is 0, an error will be generated and the robot will stop. The functions related to retry, such as restart methods and retry count, can be set from the welding auxiliary condition (Refer to 5.5. Welding auxiliary condition – retry and 5.6. Welding auxiliary condition - restart).

(8) Robot delay time

	Name	Unit	Range	Default
Common to all welders	Robot delay time	Second	0.0 ~ 10.0	0

Set the wait time before the robot performs welding by following the welding path after the arc welding gets started normally. It has nothing to do with the initial condition and the robot can move while the initial condition is being processed.

(9) Initial condition time

	Name	Unit	Range
Common to all welders	Initial condition time	Second	0.0 ~ 10.0

Set the time for maintaining the initial current value when welding gets started.

(10) Initial welding current / Welding power / Feeding speed

	Name	Unit	Range	Default
HRWI GB2/GZ4/GE2 MEGMEET	Initial welding current	%	20 ~ 200	120
Fronius	Initial welding power	%	20 ~ 200	120
ESAB/EWM	Initial feeding speed	%	20 ~ 200	120

Set the output welding current during the initial condition hold time when starting arc welding. Set it based on the % against the welding current of the main condition.

(11) Initial welding voltage correction / Arc length correction

	Name	Unit	Range	Default
HRWI	Initial welding voltage correction	%	50.0 ~ 150.0	100
GB2/GZ4/GE2 ESAB/EWM	Initial welding voltage correction	V	-10.0 ~ 10.0	0
MEGMEET	Initial welding voltage correction	%	-30.0 ~ 30.0	0
Fronius	Initial arc length correction	%	-30.0 ~ 30.0	0

Set the output welding voltage during the initial condition hold time when starting arc welding. Set it based on the corrected value against the synergic voltage.

(12) Slope time

	Name	Unit	Range
Common to all welders	Slope time	Second	0.0 ~ 10.0

Set the time for processing the change of current between the initial condition and the main condition as a slope.

(13) Permitted excess time

	Name	Unit	Range	Default
Common to all welders	Permitted excess time	Second	0.0 ~ 10.0	0

Set the allowable limit exceeded time for the welding current/voltage and the feed motor current. If the welding current/voltage or the feed motor exceeds the limit for longer than this time limit, restart will be performed. However, if the count of retry is 0, an error will be generated and the robot will stop. The functions related to retry, such as restart methods and retry count, can be set from the welding auxiliary condition (Refer to 5.6 Welding auxiliary condition – restart). If the time is set as 0, the arc limit monitoring function will not be used.

(14) Voltage upper limit/voltage lower limit

	Name	Unit	Range
Common to all welders	Voltage upper limit /Voltage lower limit	V	0.0 ~ 100.0

Set the upper and lower voltage limits to be applied while carrying out welding. An error will be generated when the limit is exceeded for longer than allowable time.

(15) Current upper limit/current lower limit

	Name	Unit	Range
Common to all welders	Current upper limit/ Current lower limit	A	0 ~ 1000

Set the upper and lower current limits to be applied while carrying out welding. An error will be generated when the limit is exceeded for longer than allowable time.

(16) Motor current upper limit/Motor current lower limit

	Name	Unit	Range	Default
GB2/GZ4	Motor current upper limit/ Motor current lower limit	A	0.0 ~ 50.0	10/0
Other welders	Not supported			

Set the motor upper and lower current limits to be applied while carrying out welding. An error will be generated when the limit is exceeded for longer than allowable time.

5.3.1. Welding start condition – Exclusive setting for HRWI

(1) Welding mode selection: Normal, pulse
Set the arc welding methods.

(2) Slowdown adjustment: [100] % (Range: 0 ~ 255)
Set the offset of the basic speed with which wire is fed until the arc is generated.

(3) Inductor effect: [100] % (Range: 0 ~ 255)
Set the inductor effect.

5.3.2. Welding start condition - Exclusive setting for GB2/GZ4/GE2

(1) Slowdown adjustment: [0] % (Range: -10 ~ 10)
Set the offset of the basic speed with which wire is fed until the arc is generated.

(2) Short-circuit initial time control (Tso): [0] (Range: -3 ~ 3)
Set for inhibiting the current from increasing after the wire contacts the welding pool.
When this value gets lower, shock will decrease and spatter will increase and the arc maintainability will get degraded.
If the value gets larger, shock will increase and the arc maintainability will get enhanced.

(3) Short-circuit current refraction value control (Isc): [0] (Range: -3 ~ 3)
Set for the adjustment of the current value that connects the slope 1 and sloe.
When this value gets lower (-), spatter will decrease and the arc maintainability will get degraded and sound will get softer. If the value gets larger (+), the arc maintainability will get enhanced and spatter will increase.

(4) Short-circuit current incline 1 control (Isl1): [0] (Range: -7 ~ 7)
When this value gets lower (-), arc will get softer and spatter will decrease. If the value gets larger (+), the arc maintainability will get enhanced in high speed welding and spatter will be agglomerated as time passes by.

(5) Short-circuit current incline 2 control (Isl2): [0] (Range: -7 ~ 7)
When this value gets lower (-), spatter will decrease, and shock will increase when contacting the welding pool. If the value gets larger (+), the arc stability will get enhanced in high speed welding and more spatters will be created.

(6) Arc current refraction value adjustment (Iac): [0] (Range: -3 ~ 3)
Set the refractive current adjustment value to be applied when arc is generated. With the help of this value, amount of spatter will be inhibited at the moment when arc is generated, and the arc length at the moment when arc is generated again will be decided.

(7) Stick prevention time adjustment (Tsp): [0] (Range: -3 ~ 3)
Set the stick prevention time.

(8) Hot current control (Ihot): [0] (Range: -3 ~ 3)
Set the value of high current to be applied when welding gets started.

(9) Hot voltage control (Vhot): [0] (Range: -10 ~ 10)
Set the value of high voltage to be applied when welding gets started. It will decide the arc length.

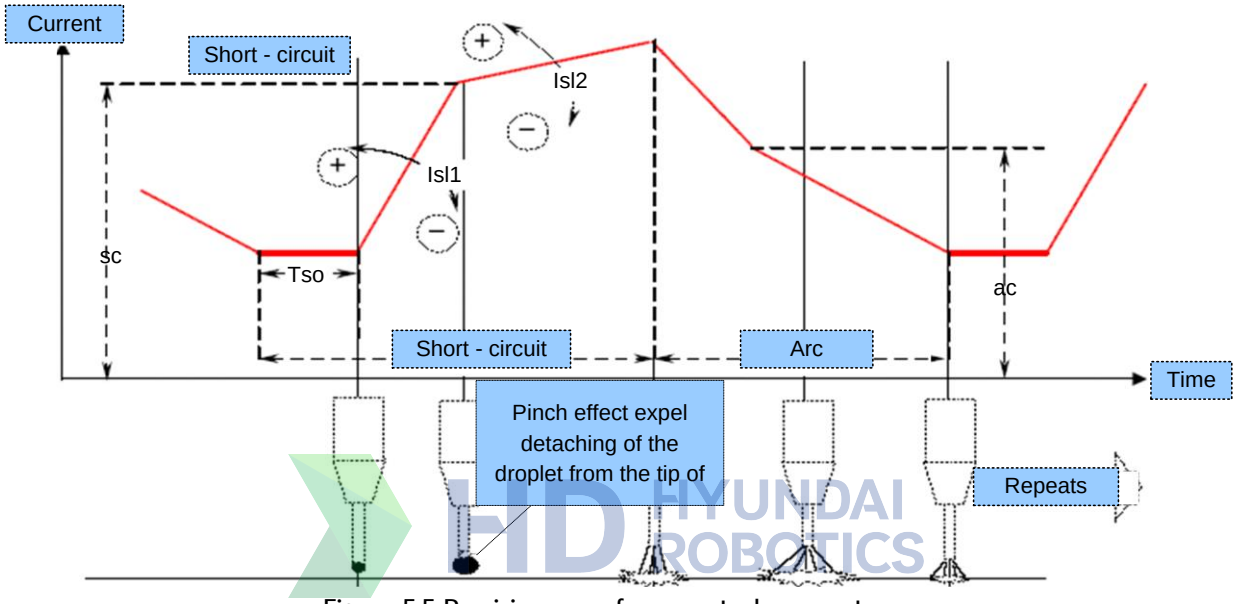

Figure 5.5 Precision waveform control parameter

5.3.3. Pulse welding condition – Exclusive setting for GE2

(1) Pulse mode
Set either to use or not use pulse welding.
(2) Pulse type : Hybrid/Soft/Hard
Set the type of pulse welding.
(3) Initial peak current
Set the peak current of the pulse welding in the initial welding condition.
(4) Initial base current
Set the base current of the pulse welding in the initial welding condition.
(5) Pulse peak current (IP)
Set the peak current of the main pulse welding.
(6) Pulse base current 1 (IB1)
Set the base current 1 of the main pulse welding.
(7) Pulse base current 2 (IB2)
Set the base current 2 of the main pulse welding.
(8) Pulse peak rising (Ipr)
Set the current rising of the pulse welding.
(9) Pulse peak falling (Ipf)
Set the current falling of the pulse welding.
(10) Pulse rising time (Tipr)
Set the current rising time of the pulse welding.
(11) Pulse peak time (Tip)
Set the peak current hold time of the pulse welding.
(12) Pulse falling time (Tipf)
Set the current falling time of the pulse welding.
(13) Pulse frequency
Set the frequency of the pulse welding.

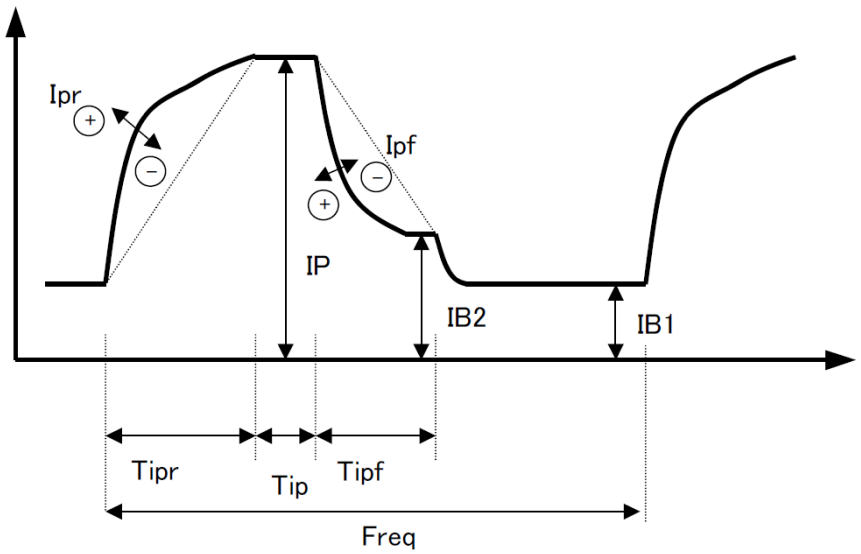

Figure 5.6 GE2 pulse wave elements

5.3.4. Welding start condition – Exclusive setting for Fronius

(1) Operation mode: Prog-Std/Prog-Pulse/CMT/JOB
Set the welding modes that are supported by the Fronius welder. Individual modes are explained below.
- Prog-Std: Use the general welding program that is saved in the welder.
- Prog-Pulse: Use the pulse welding program that is saved in the welder.
- CMT: Use the cool metal transfer function
- JOB: Use the job saved in the welder.

(2) Prog/Job number
Set one of the program number and job number that are saved in the welder.

(3) Dynamic correction: [0]% (Range: -5.0 ~ 5.0)
Set the dynamic correction value. When this value gets lower, strong and stable arc will be generated and spatter will increase. When the value gets larger, softer arc will be generated and spatter will decrease.

5.3.5. Welding start condition – Exclusive setting for ESAB

(1) Analog Active: Normal(Job Mode)/Analog Active(Feeding speed/Voltage setting reflected)
Set the welding mode that is supported by the ESAB welders. The details on individual modes are as below.
- Normal: Uses the job saved in the welder. Does not reflect the feeding speed and voltage setting.
- Analog Active: Uses the general welding program saved in the welder. Reflects the feeding speed and the voltage setting.

(2) Weld Data Number
Set the specific work data number, which will be used, of the work data numbers saved in the welders. In case of Analog Active, it is possible to perform work while changing the feeding speed and the voltage in the work data setting.

5.3.6. Welding start condition – Exclusive setting for EWM

(1) JOB mode: 〈Job mode off, Job mode active〉
Set the welding mode that is supported by the EWM AlphaQ welders. The details for individual modes are as below.
- Job mode off: Welding will be performed after reflecting the feeding speed and the voltage offset in the welder according to the synergic data.
- Job mode active: Welding will be performed by using the job data saved in the welder.

(2) Welding mode
Set either to use or not use pulse welding.

(3) Super pulse function
Set either to use or not use the super pulse (2 stage pulse) function for the pulse welding.

(4) Job Nr. (synergic)
Enter one of the synergic numbers and job numbers as needed. Pressing the [Help] key will make display a dialog box in which a job number can be set properly for the welding method, material, gas, and diameter of wire.

(5) Dynamic correction: [0] (Range: -40.0 ~ 40.0)
Set the dynamic correction value. If the value is small, a strong and stable arc will be generated and the amount of spatter will increase. When the value is large, a smooth arc will be generated and the amount of spatter will decrease

(6) Lift arc start: 〈Use, No use〉
Sets whether to use the lift arc function when starting the welding. The use of the lift arc function can reduce the occurrence of large spatters at the start of the welding.

5.3.7. welding start condition – Exclusive setting for Megmeet

(1) Operating mode: DC synergic / Pulse synergic / Job/ Free mode / Individual mode
Sets the welding mode that the Megmeet welder supports; the description for each mode is as follows.
- DC synergic: The program of the general welding, stored in the welder, is to be used.
- Pulse synergic: The program of the pulse welding, stored in the welder, is to will be used
- JOB: The job stored in the welder is to be used.
- Mode proximity control (Free): To perform storing and calling by setting parameters and options in the welder
- Individual mode: It is impossible to store and call the operating mode manually. This mode can be used when the robot transfers the current and voltage.

(2) Job number
Sets the job number that is stored in the welder and will be used.

5.4. Welding end condition

While the arc welding is set as digital, if the [F2: End cnd] key on the welding start condition dialogue box is pressed, the welding end condition editing screen will be displayed as shown below.
However, if the arc welding setting is analog, it is necessary to press the [QuickOpen] key in the "ARCOF AEF#=??" command to enter the editing screen.

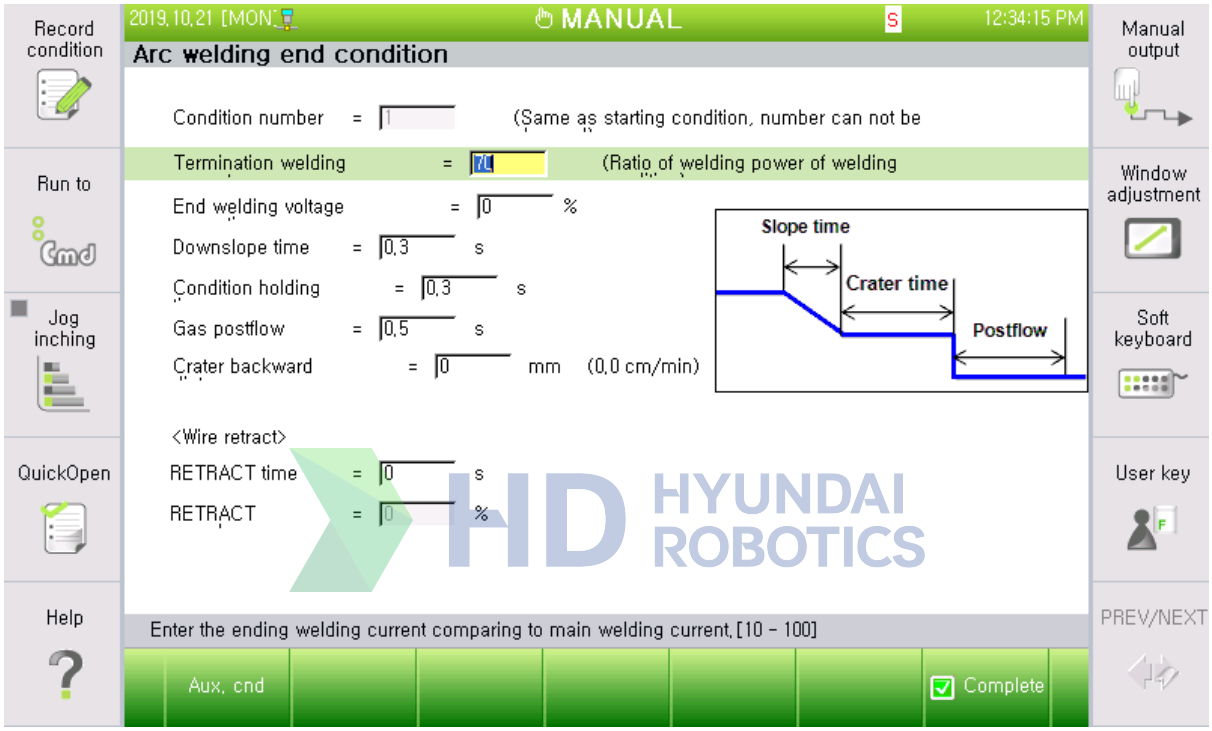

Figure 5.7 welding end condition dialog box (Example of digital EWM)

After changing an item of the welding end condition, if the [ESC] key is pressed, the screen will move to the welding start condition dialogue box without saving the changed content. If the [F7: Complete] key is pressed, the changed content will be saved and the screen will move to the welding start condition dialogue box.
The 'FTT level adjust' of the end condition can be used only for GB2/GZ4/GE2, while other items can be commonly used for welders.

The contents of individual items are as shown below.

(1) Condition number: [1] (Range: cannot change)
Display the welding start condition number. In case of the digital arc welding function, the end condition number and the start condition number are managed together as one. Accordingly, in order to change the end condition number, the start condition number needs to be changed. In the end condition screen, checking is allowed only, while changing is not.

(2) End welding current / Welding power / Feeding speed

	Name	Unit	Range	Default
HRWI GB2/GZ4/GE2 MEGMEET	End welding current	%	10 ~ 100	70
Fronius	End welding power	%	10 ~ 100	70
ESAB	End feeding speed	%	10 ~ 100	70
EWM	End feeding speed	m/min	0.0~25.0	7.0

Set the current value that will be outputted when handling craters. Set the % amount against the main condition (Welding current, welding power, and feeding speed of the start condition). However, For EWM welders, set the same 'm/min' as the mainl condition,

(3) End welding voltage correction / Arc length correction

	Name	Unit	Range	Default
HRWI	End welding voltage correction	%	50.0 ~ 150.0	100
GB2/GZ4/GE2 ESAB/EWM	End welding voltage correction	V	-10.0 ~ 10.0	0
Fronius	End arc length correction	%	-30.0 ~ 30.0	0

Set the voltage (arc length) correction value when handling craters. It is necessary to set the voltage that needs to be outputted.

(4) Down Slope time (Crate Time): [0.10] sec (Range : 0.0 ~ 10.0)
Set the time for processing the current change between the main condition and the end condition as a slope.

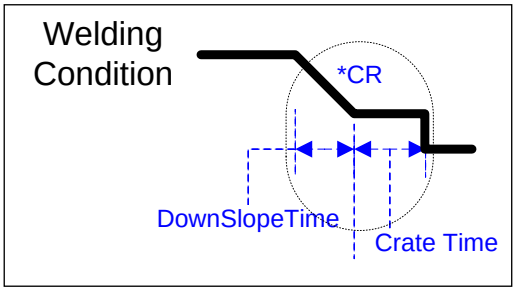

Figure 5.8 DownSlope time and crate time chart

(5) End condition time: [1] sec (Range : 0.1 ~ 10.0)
Set the time for maintaining the output value as set in the 'current ratio' item of the welding end condition.

(6) Burnback adjustment: [0] % (Range: -20 ~ 20)
Set for processing Burnback.

(7) Gas postflow: [0.10] second (Range: 0.3 ~ 10.0)
Set the time for emitting the shied gas continuously even after arc is turned off.

(8) FTT level adjustment (Can be set only for GB2/GZ4/GE2): [0] (Range: -50 ~ 50)
Set the Fine tip treatment adjustment value. Through this value, the amount of wire agglomerated at the wire tip, after welding, can be adjusted.

(9) Crater backward distance: [0] (Range: 0–100)
Sets the distance for the robot to move backward during the DownSlope time + Condition sustaining time in the middle of the crater handling process; the speed will be determined automatically based on distance and time.

(10) Retract time: [0] (Range: 0.0-10.0)
Sets the time for the robot to rewind the wire while performing the next movement after the handling of the welding end process is completed; this will be used to prevent the start of the welding while the wire is bent because of interference, or the wire is in contact when the next step starts.

(11) Retract speed: [0] (Range: 0.0-100)
Designates the wire feed speed for rewinding the wire when the welding is finished; the speed will be set as the ratio against the maximum current.

5.5. Welding auxiliary condition – retry

In some cases, the arc cannot be generated due to impurities attached near the welding start point on the base metal. When an arc cannot be ignited, the Retry function will allow a retry of arc ignition, allowing the robot to work continuously without stopping.

While the arc welding is set as digital, if the [F1: Aux. cnd] key on the welding start condition dialogue box is pressed, the welding auxiliary condition editing screen will be displayed as shown below.

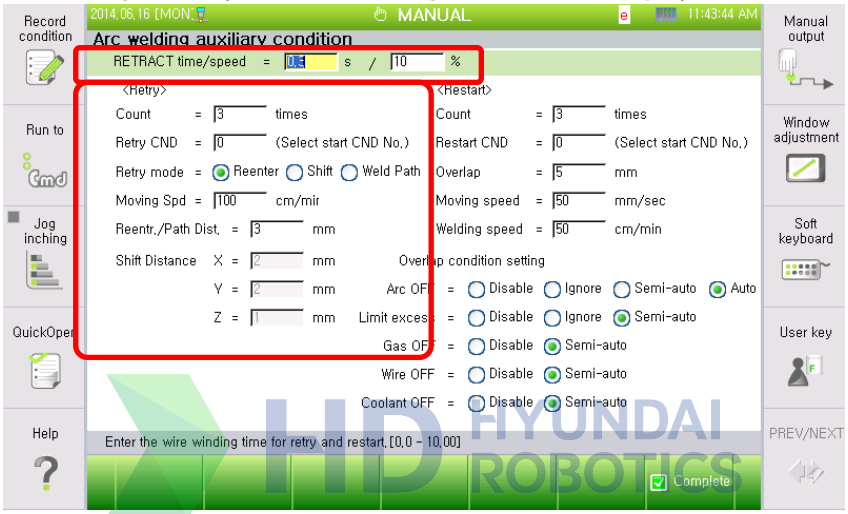

Figure 5.9 Welding auxiliary condition dialog box retry (Digital welders, Retry)

Reference

- The retry function is to be performed when trying but keeping failing to turn on the arc. The restart function is to be performed when needed to restart the arc welding after stopping in the middle of welding being performed.

The item displayed on the left side of [Figure 5.7] shows the retry condition of the welding auxiliary conditions. The contents of individual items of the retry condition are as shown below.

(1) Retraction time: [0] second(s) (Range: 0.00 ~ 10.00)
A retrial will take place when the arc is not generated after trying to feed the wire and perform welding. This may cause the wire to be fed excessively when retrying. In this case, the wire and the base metal may be in contact with each other, causing stick or moving the wire too close to the base metal in a way that can cause arc generation instability. In response to the problem, the system provides a function that creates a proper environment for welding by retracting the wire before retrying. This function is used for setting the time of wire retraction. As long as its value is not 0, the wire will be retracted and the torch will move before an arc generation attempt.

(2) Retraction speed: [10] % (Range: 0 ~ 100)
This is used for setting the speed of wire retraction when retrying. The function may not be supported on some welders. (Ex. Saprom welders)

(3) Count: [5] time (Range: 0 ~ 9)
Set the count of retries to be applied when failing to turn on the arc. If failing continuously within the set count, the robot will move back to the home position (The first arc ignition try point, welding start point) and stops there.

(4) Retry condition: [0] (Range: 0 ~ 32)
Enter the number of the welding condition to be applied when retrying to turn on the arc. Welding will be performed according to the main condition (Including current and voltage) of the welding start condition as entered for retrying. However, if the entered condition number is “0”and if the operation mode is reentry, the retried welding will be performed according to the main condition of the welding start condition that is being executed currently.

(5) Retry mode: 〈Reenter, Shift, Weld Path〉
Set the method for moving the torch for the retry. 3 setting modes are supported, and individual methods for moving the torch are as shown below depending on their settings. Refer to Figure 5.8

A. Reenter
Retry arc generation after moving back to the previous step in case arc generation is failed. Enter the moving distance to the distance during retracting/moving welding path during the retrial mode. Set the moving distance to ‘Reentr./Path Dist.’ distance in the Welding auxiliary condition retry setting menu. Follow the welding start condition for voltage and current condition since the robot will step forward again after stepping back a certain distance.

B. Shift
The robot will move set shift distance in retry condition of Welding auxiliary condition and return to the arc generation step. The shift distance can be set in the front/rear, left/right, and up/down directions based on the welding line. The welding condition for retrying is the welding start condition in the retry condition item. When an arc is generated successfully, the robot will perform welding after moving to the welding start point at the set speed.

C. Multi-direction
The first try will be made after moving along the welding line as much as the front/rear direction distance among the distances set in the “Shift movement amount” in the retry condition of the welding auxiliary condition. The second try will be performed after moving the distance that considers the distances set in the left/right and up/down directions. In the third try, the welding will be tried only after moving in the opposite direction of the left/right direction of the second try.
In the fourth to sixth tries, the same work as the works done in the first to third tries will be performed but along the distance two times longer. In the seventh to ninth tries, the same work will be performed along the distance three times longer. Welding will start according to the welding start condition of the retry condition item. When the arc generation is successful, the movement to the welding start point will take place at the set speed, while the arc is sustained, and then welding will be progressed.

(6) Moving Speed: [100]cm/min (Range : 1 ~ 999)
It is the speed of torch to move to the retry point or to return to the welding start point.

(7) Retraction movement distance.: [3] mm (Range : 0.00 ~ 99.99)
This is the distance that the torch will move when reentering if the operating mode is set as reentry. The operating mode can be designated in the starting condition.

(8) Shift movement amount: Front/rear=[2], left/right=[2], up/down=[1] mm (Range : -99.9 ~ 99.9)
This is the distance that the torch will move if the operating mode is set as shift and multi-direction.

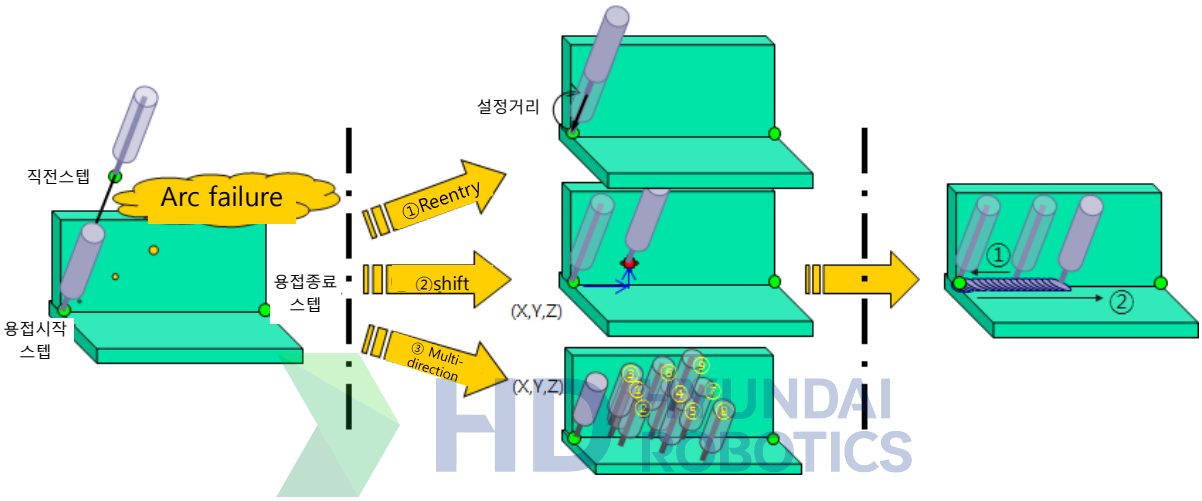

Figure 5.10 Reentry function sequence

5.6. Welding auxiliary condition – restart

While arc welding is in progress, the welding work may be stopped for several reasons, such as arc off, exceeding the welding current and voltage limits, lowering of gas pressure, shortage of wire, and coolant errors. In these cases, if welding restarts from the stopped point, there may be some sections that are not welded. The Restart function is for performing overlapped welding to make up for the sections, which may not have been welded in the process.

The restart condition setting allows a necessary restart after the welding stops in response to some specific reasons, such as arc off. When the welding restarts automatically without taking specific measures after the welding work has ceased or when the welding work restarts after removing the causes of the cessation, the robot moves backwards along the welding path for a certain distance before perfroming welding again. As a result, there will be an overlapped section near the position where the welding had stopped previously due to errors. This function prevents a section from being passed without being welded after restarting following a cessation in welding.

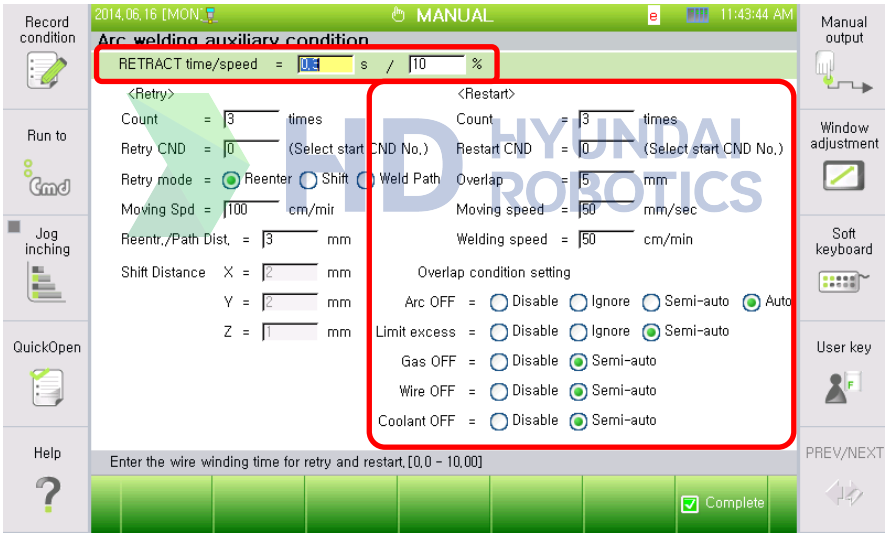

Figure 5.11 Welding auxiliary condition dialog box (Digital welder, Restart)

Wire could be stuck to the base metal when welding is completed. The automatic stick removal condition is for setting a function for allowing stick to be removed automatically.

The content per each item of the automatic stick recovery condition is as follows.

(1) Retraction time: [0] second(s) (Range: 0.00 ~ 10.00)
When the welding is restarted after being stopped, the wire may be fed excessively for many reasons. In this case, the wire and the base metal may be in contact with each other, causing stick or the wire may be too close to the base metal resulting instability of arc generation. Responding to the problem, the system provides a function that creates a proper environment for welding by retracting the wire before retrying. This function is used for setting the time for retracting the wire. As long as its value is not 0, the wire will be retracted and the torch will move before arc generation is attempted.

(2) Retraction speed: [10] % (Range: 0 ~ 100)
This is used for setting the retraction speed of the wire when restarting. The function may not be supported on some welders. (Ex. Saprom welders)

(3) Restart count: [5] time (Range : 0 ~ 9)
Designate the maximum number of times re-operating within same welding period. When this number is exceeded, “E1274 Number of times re-operating within same welding period exceeded” error will occur.

(4) Restart condition: [0] (Range : 0 ~ 32)
Enter the number of welding condition to be applied in the overlap range when restarting. When needed to restart welding by overlapping, welding will be performed in the overlapped range based on the main condition (Including current and voltage) of the welding start condition as entered for restarting. However, if the entered condition number is “0”, welding will be performed according to the main condition of the welding start conditions currently being executed in the overlapped range.

(5) Overlap: [5] mm (Range : 0.0 ~ 99.9)
It is the welding overlap distance (Overlap distance) for restarting welding. The robot will move back the overlap distance and start welding work again.

(6) Moving speed: [50] mm/second (Range: 1~999)
Set the speed at which the torch moves back to the overlap start point. It means the speed of moving in the range of ③ ~ ④ as shown in [Figure 5.10] (Refer to Figure 5.13).

(7) Welding speed: [50] cm/minute (Range: 1~999)
Set the speed at which the robot moves from the overlap start point to the end point while performing overlap. It means the speed of moving along the overlap length starting from ④ as shown in [Figure 5.13] (Refer to Figure 5.13).

When an error occurs while performing welding from the welding start point to the welding end point (⑤), if the overlap condition is semi-automatic, the user needs to identify what have caused welding to stop, and take care of the error. After the cause of the error is eliminated (②), if the user presses the [START] button (③) to restart welding, then, the robot will move to the overlap start point automatically at the speed set at [MOVING SPEED] (④). After moving to the overlap start point, the welder will move, while carrying out welding, along the overlap distance at the speed set at [WELDING SPEED] first and, after that, it will move at the normal speed while performing. However, if an error occurs while performing welding in the overlap area, the welder will restart welding at that point.

(8) Overlap condition setting
The bottom right of Figure 5.11 shows how to set the method for performing overlap if welding stops in the middle of arc welding, due to some reasons, such as arc off(Arc off), limit exceeded, gas off(lowering of gas pressure), wire off(wire shortage) and coolant off(coolant error).

A. Automatic
This setting is used to perform automatic overlap. It can be set only when the welding is

stopped by arc off. When the arc is turned off during welding, the robot will not stop. It will instead perform the overlapped welding according to the methods set in the restart options of the welding auxiliary condition before performing the main welding work. However, when the arc is turned off again while performing overlapped welding in the section, it will be restarted at the position without overlapping.

B. Semi-automatic

This setting is used to allow the user to perform the overlapped welding. When events, such as arc off, exceeding of limits, lowering of gas pressure, wire shortage, and coolant errors occur, arc welding and the robot will both come to a halt. When the cause is removed and the user presses the [Start] button, the robot will perform the overlapped welding according to the methods set in the restart options of the welding auxiliary condition before performing the main welding work.

At this point, if the user moves the robot to another position through a jog operation and presses the [Start] button, the robot will move to the overlap welding position and perform welding.

Caution

While the robot is moving, if the step forward/backward key is pressed, the restart information will be initialized, preventing overlapped welding. Movement must be performed through the jog operation.

C. Ignore

This setting is used to ignore errors. When the setting is activated, the robot will move continuously without stopping after the welding has ceased. This means that even when the arc is turned off or the limits are exceeded, the robot will ignore these events and continue. This operation can be performed only when restarting after the welding has stopped due to arc off or exceeding of limits.

D. Inhibit

This setting is used to prevent overlaps. When events, such as arc off, exceeding of limits, lowering of gas pressure, wire shortage, and coolant errors occur, arc welding and the robot will both come to a halt. When the cause is removed and the user presses the [Start] button, the robot will start and continue welding at the stopped position without performing overlapped welding.

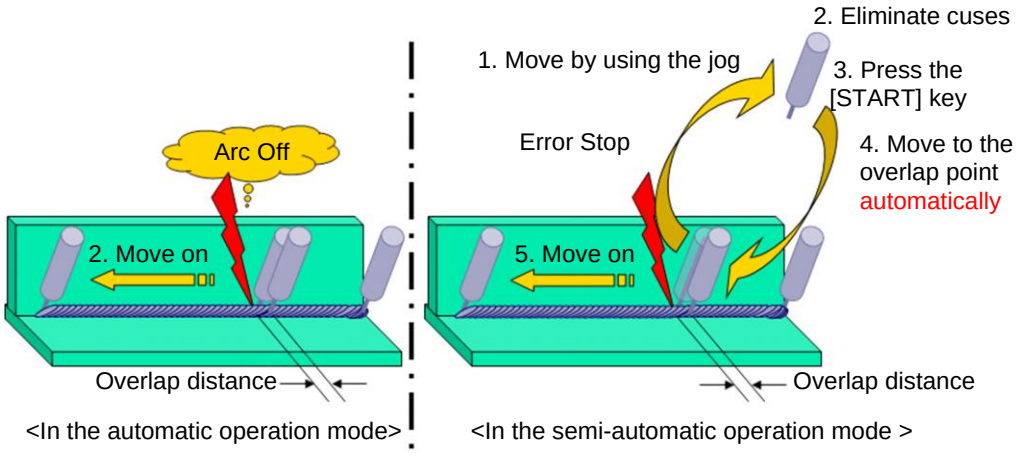

Figure 5.12 Restart operation sequence

5.7. Welding auxiliary condition – Automatic stick recovery

When arc welding finishes, wire may stick to the base metal in some cases. In order to prevent this situation, the welder will increase voltage temporarily as a prevention measure when ending the welding. In some cases, sticking occurs even after taking the stick prevention measure. For this reason, the robot controller sends the stick check signal to the welder after performing welding to check for sticking.
The auto stick recovery function is used to perform the stick recovery operation automatically when stick is detected after welding to allow the robot to continue the work without stopping. When the function is used, the stick recovery process will immediately supply a certain level of voltage when stick is detected. The auto stick recovery will be repeated according to the set count. If stick occurs even after the stick recovery process exceeds the set count, the 『Stick in progress』 signal is outputted and the robot will stop.

The following edit screen will be displayed when pressing [F1: Aux. cnd] key in 『[Welding start condition] → [F2: End cnd]』 dialog box while arc welding is set to digital.

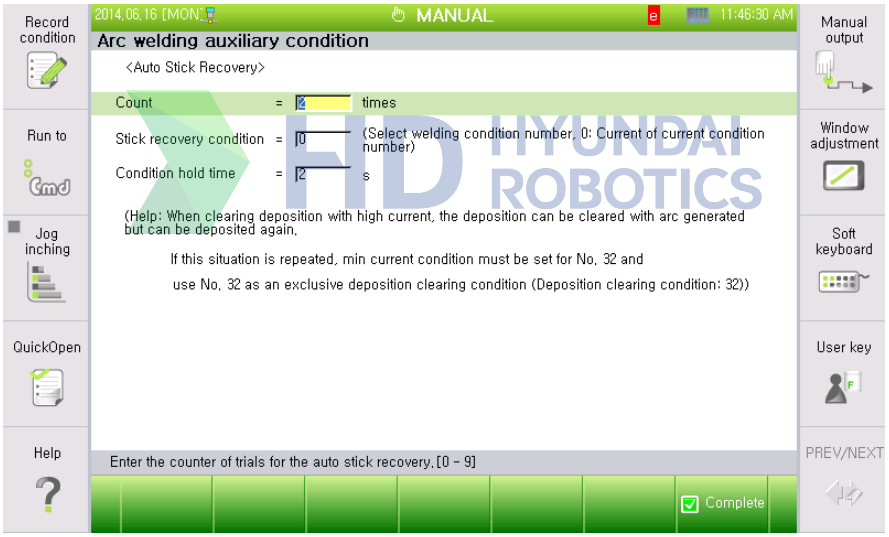

Figure 5.13 Automatic stick recovery dialog box

The content per each item of the automatic stick recovery condition is as follows.

(1) Count: [2] time (Range : 0 ~ 9 times)
It is the maximum number of times to repeat stick recovery processing. When the stick is not recovered within the set count, a stick related error (“E1262 Wire stick being detected”) will be output. As an exception, when “0” is set, the stick check will not be performed and the robot will move to the next step directly.

(2) Stick recovery condition: [0] (Range : 0 ~ 32)
This is the welding condition number used when handling the stick recovery process. When the entered condition number is “0” the stick recovery process will take place according to the the welding start condition that is being implemented.

(3) Stick recovery time: [2] sec (Range: 0.00 ~ 9.99)
This is the time during which the stick recovery condition output is maintained. If this is set too low, the stick recovery will not be implemented successfully.

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6 Weaving function

6.1. Weaving function

The weaving function is used to widen the width of the welding bead in the arc welding. The details of the weaving function are decided by the weaving condition and the reference point. In the weaving condition, the following options can be selected.

6.1.1. Weaving condition

While the cursor is placed on the WEAVON WEA#= command, if the [QuickOpen] key is pressed, the weaving condition editing screen will be displayed as shown below.

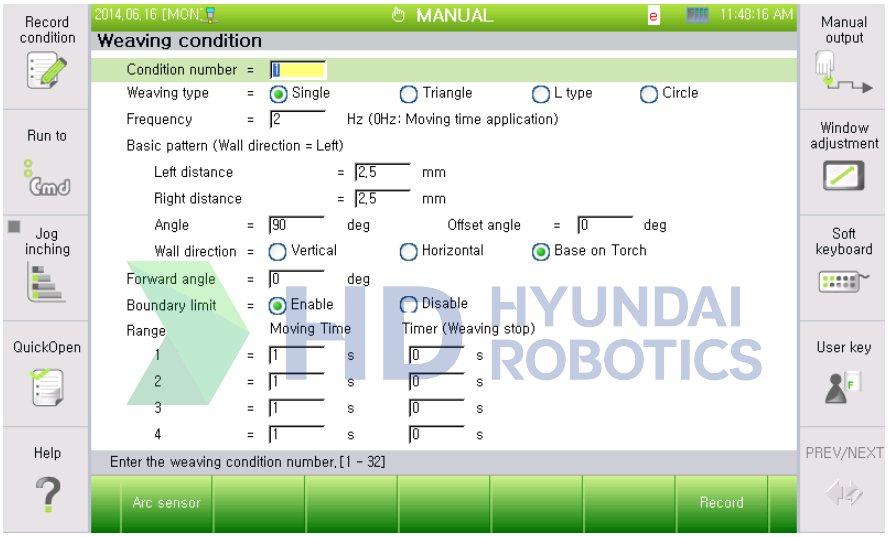


Figure 6.1 Weaving condition dialog box

The content per each item of weaving condition is as follows.

(1) Condition number: [1] (Range :1 ~ 32)
This is the number of the condition where the weaving operation setting is saved. By entering numbers or by using the [SHIFT] + [↑], [↓] keys, users can edit the relevant condition number by moving to the previous or the next condition number of the current number.

(2) Weaving type: 〈Single, Triangle, L type, Circle〉
Designate the weaving operation type. (Refer to 6.1.2 Weaving Form)

(3) Frequency: [2] Hz (Range : 0.0 ~ 10.0)
Set the weaving frequency. The range of frequency is 0.0 ~ 10.0Hz. In case the frequency is set to '0', the moving time will be applied. (Refer to 6.1.3 Frequency)

(4) Basic pattern
Set the weaving operation pattern. (Refer to 6.1.4 Basic pattern)
Left distance: [2.5] (Range: 1.0 ~ 25.0mm)
Right distance: [2.5] (Range 1.0 ~ 25.0mm)
Angle: [90] (Range: 0.1 ~ 180.0°)

Wall direction: 〈Vertical, Horizontal, Base on Torch〉
Offset angle: Designates the angle of inclination in the left and right directions from the torch position when using the reference of the torch posture

(5) Forward angle : [0] (Range: -90.0 ~ 90.0°)
It displays the weaving angle direction to the processing direction. In case this is set to 0° , proceeding direction and weaving direction will be at right angles to each other.

(6) Boundary limit: 〈Enable, Disable〉
Set whether to limit weaving trace by boundary of welding start section and end section. In case this function is set to valid, weaving trace will be limited to the welding section.

(7) Robot operation when weaving is stopped: 〈Move, Stop〉
If the timer is set in the weaving pattern, the weaving operation stops at the left and right ends of the weave. This menu sets whether the robot operation will continue to move or stop in this situation.

(8) Moving time: [1] (Range: 0.01 ~ 10.0 sec), Timer: [0] (Range: 0.00 ~ 2.00)
In case the weaving frequency is set to '0', weaving will be executed in the moving time. Set the moving time per each section and the weaving stop time between sections. (Refer to 6.1.7 Moving Time, 6.1.8 Timer)
When "Weaving frequency" is set, only the "Timer (Weaving Stop)" item can be configured.
The robot will perform the weaving operation for the time excluding the time set in "Timer (Weaving Stop)" from the total time for the set frequency, and the weaving operation will stop during the weaving stop time. The "Robot operation when weaving is stopped" setting will apply whether the robot moves while weaving is stopped.

(9) Weaving drive axis: 〈Robot, Additional Axis〉, additional axis no.: [1]
It sets whether the part to perform the weaving operation is the robot or an additional axis. If an additional axis is selected, the robot will move as recorded, while only the additional axis will move as much as the set distance and frequency to perform the weaving.
When an additional axis is selected, the additional axis designated in the "Additional axis no." item will operate to perform the weaving.

6.1.2. Weaving Form

Set the weaving pattern type as the following pictures.

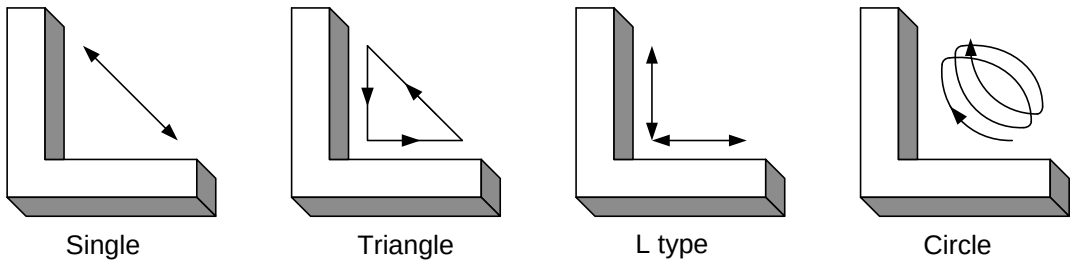


Figure 6.2 Weaving pattern type

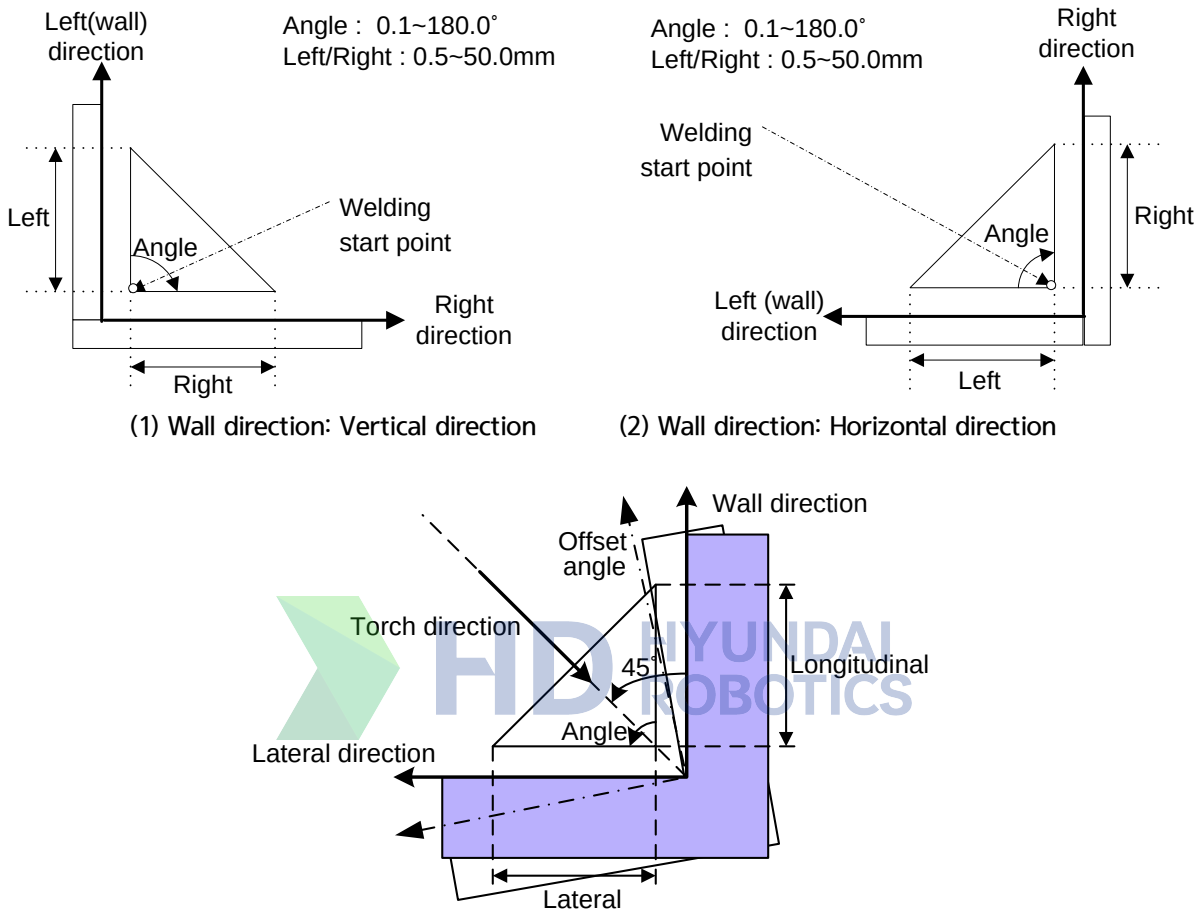
6.1.3. Frequency

「Frequency」 means the weaving repetition cycle. When 「Frequency」 is set as‘0’, the repetition cycle will be set based on ‘moving time’ not based on 「frequency」. In order to set the repetition cycle based on 「frequency」, other value, not ‘0’ should be set.

Frequency has something to do with the distances in lateral and longitudinal directions. When frequency gets larger, the distances of moving in lateral and longitudinal directions will get shorter, reducing the amplitude. On the contrary, if frequency gets smaller, the amplitude will get larger. If the weaving form is triangular wave, the sum of the time for moving in the lateral direction and the time for moving in the longitudinal direction is equal to the time for moving in the diagonal direction.

6.1.4. Basic pattern

Set each element on the following pictures.



(1) Wall direction: Vertical direction

(2) Wall direction: Horizontal direction

(3) Wall direction: torch position standard

Figure 6.3 Weaving elements according to the wall direction

(1) Left direction distance: Sets the distance of the left (wall) direction.

(2) Right direction distance: Sets the distance of the right direction.

(3) Angle:
Sets the left (wall) direction and right direction angles as shown in Figure 6.2. The angle indicates from the left (wall) direction to the right direction. But, this angle is ignored when using REFP 4.

(4) Wall direction (Refer to Figure 6.3)
For setting to decide whether the vertical direction (Figure (1), the horizontal direction (Figure (2)) or the torch position direction (Figure (3) will be used as the left (wall) direction. In general, the vertical direction is used as the left (wall) direction, while the horizontal direction is mainly used for a 180-degree weaving work that is to be performed on a flat surface. The left (wall) direction for a weaving work that will be performed based on the torch position direction will be set to be counterclockwise based on the weaving moving direction (The moving direction in Figure (3) is outward bound direction, ⊙). In case of the weaving work based on the torch position direction, it is possible to respond to all different left (wall) directions and also respond to cases in which the left (wall) direction changes in the middle of weaving.

(5) Offset angle (Refer to Figure 6.3)
If the wall direction is set based on the torch position direction, the rotating angle for the weaving surface is to be set based on the weaving moving direction (The moving direction in Figure (3) is outward bound direction, ⊙). When 0 degree is set, the angle created between the left (wall) direction and the right direction needs to be cut in half.

(6) Forward angle

This is the angle of the weaving oscillation direction relative to the welding line. The possible setting range is -90.0° ~ 90.0°.
When the angle is set to 0°, weaving will be performed at the right angle to the welding line.

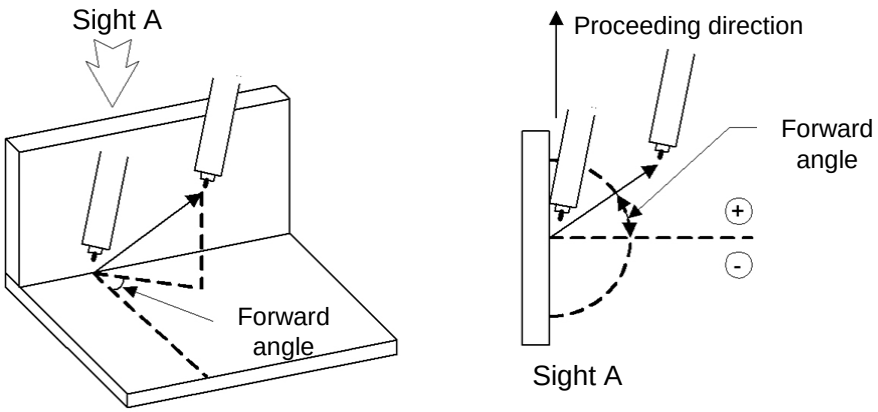
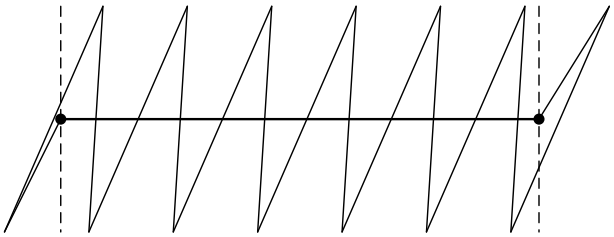


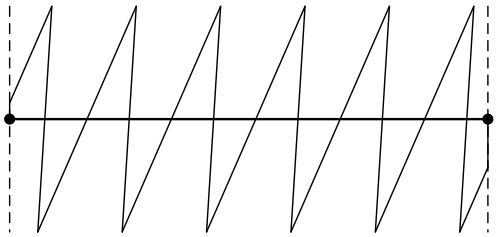
Figure 6.4 Weaving forward angle

(7) Boundary limit

In case of a weaving work whose moving angle is not 0 degree, the weaving work may step over the boundary of the weaving range at the start and end sections of it. It is required to set whether to allow weaving to take place while not crossing the range boundary by restricting the boundary of the range by setting the boundary limit.



When the boundary limit is <Disable>



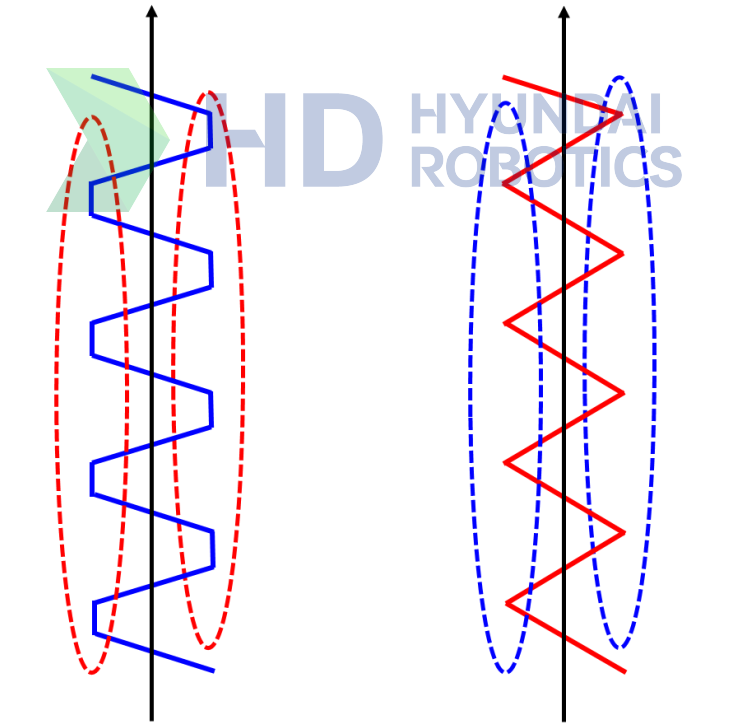
When the boundary limit is <Enable>

6.1.5. Weaving section setting

(1) Robot operation when weaving is stopped

If Timer (Weaving Stop) is set to a value other than “0” in the weaving section, the weaving pattern will stop at the end of the weaving section for that time. This menu sets whether to move the robot in this situation.

If “Move” is selected, the operation shown on the left in the figure below will be performed, and if “Stop” is chosen, the operation illustrated on the right will be performed.



Robot moves when weaving is stopped

Robot also stops when weaving is stopped

(2) Moving time

This is an item that will be used for setting the weaving repetition cycle when the 「frequency」 value is set as ‘0’. As shown below, the moving time for individual ranges can be set. The range for the weaving work will vary depending on the types of weaving. Accordingly, the time set for a range where the set weaving type is not applied will be ignored (Ex. No. 3 and 4 in case of “Single”).

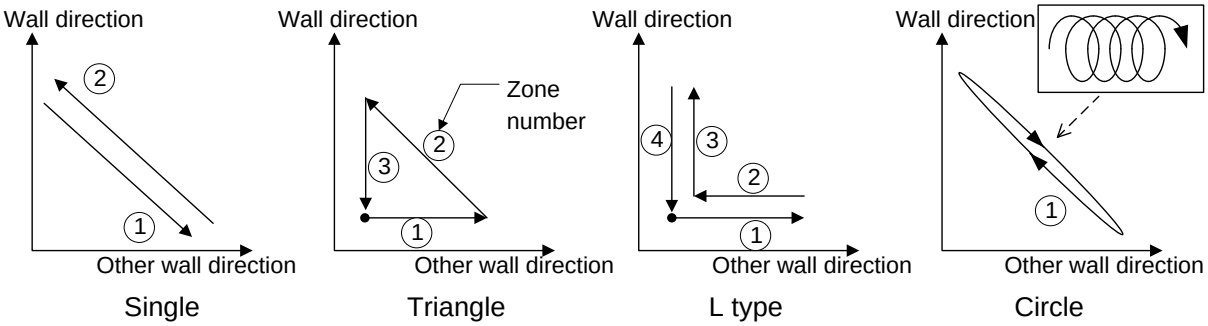


Figure 6.5 Moving section per each weaving pattern

(3) Timer
(4) It sets the weaving stop time at the end of each section, as shown in the figure below. This item also applies when the weaving frequency is set.
(5)
(6) When the weaving frequency is set, the robot's moving time during the weaving cycle will be fixed as follows.
(7)
(8) Robot moving time = (1 / weaving frequency) − total time of the timer
(9)
(10) Caution: If "Robot operation when weaving is stopped" is set to "Move," the movement trajectory does not stop.
(11) A straight line will be formed, as shown in the figure below.

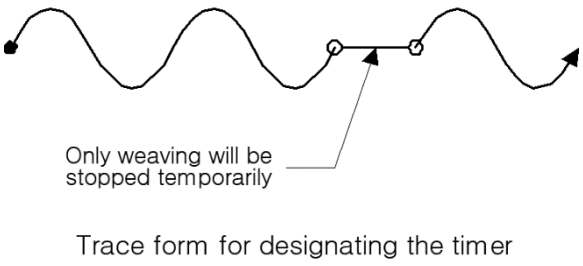


Figure 6.6 Example of trace in case timer is designated

Caution: If "Robot operation when weaving is stopped" is set to "Stop," the movement trajectory will also end. Even in this case, the robot movement speed will be the same.

6.2. Reference point function

In order to carry out weaving, it is necessary to secure weaving coordinates that will determine the position of the weaving form trajectory, as explained in **6.1 Weaving function**. The set weaving coordinates will be used to set the details of the weaving function.
When the weaving motion is started, the Z-axis of the robot coordinate will be placed in the direction of the wall. The position of the approaching pose of the welding start point and also the proceeding torch direction in the welding section are used to allow the weaving coordinates (rectangular coordinates) to be generated automatically.
However, in some cases, it would be impossible to create weaving coordinates depending on the position of the approaching pose of the welding start point, the type and position of base metals, and also when the set weaving coordinate needs to be changed (Ex.: If the angle between the wall direction and other direction is not 90 degrees).
In such cases, the reference point function can be used to generate weaving coordinates as desired in a way that can match the weaving type with the base metal.

Reference

- When setting the weaving condition as [Basic pattern] → [Wall direction] based on the “Base on Torch”, REFP commands other than REFP 3 (Reference Point 3) are not used.

6.2.1. Type of reference point

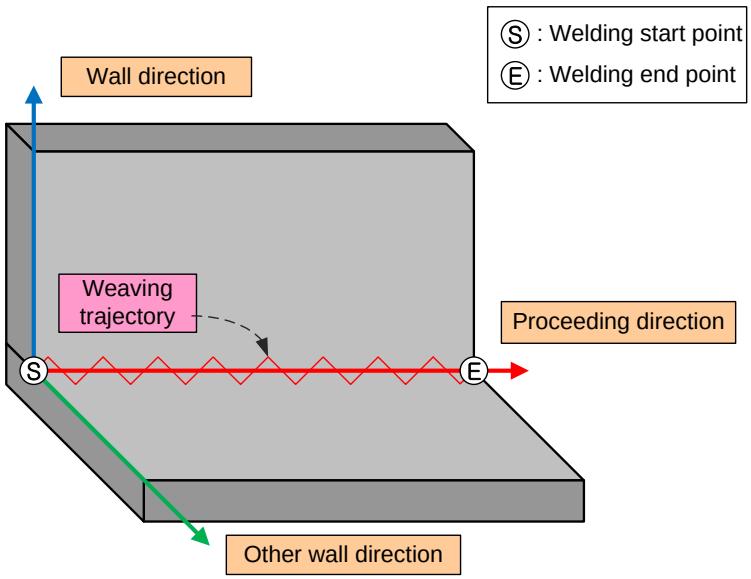


Figure 6.7 Weaving coordinate

(1) REFP 1 (Reference Point 1)
REFP 1 is a command for designating the wall direction of the weaving coordinate. When the wall direction is not designated specifically, the robot will perform the weaving work while taking the vertical direction as the wall direction. Accordingly, if the wall direction is not the vertical direction, this command should be used to designate the wall direction.
Method of use: Record a point on the wall direction surface of the workpiece as REFP 1. The wall direction surface can be determined by using the point and the welding path (linear line ⓢ ⓔ). When only the REFP 1 command is used, the other direction can be set by rotating them according to the angles of their basic patterns based on the proceeding direction of the decided wall direction.

(2) REFP 2 (Reference Point 2)
REFP 2 is a command for setting the weaving trajectory in either of the spaces of the surface, which decides the wall direction.
Method of use: Record a point in the space above the surface where the weaving will be performed as REFP 2. Figure 6.8 shows an example of a weaving coordinate that is set by recording REFP 2 in the space between the two base metals. When only the REFP 2 command is used, the other direction can be set by taking the Z-axis of the robot coordinate as the wall direction.

(3) REFP 3 (Reference Point 3)
REFP 3 is a command for designating the weaving proceeding direction for stationary weaving in which the robot stops while the positioner rotates.
Method of use: Record as REFP 3 a point on the linear line that shows the proceeding direction at the position where the robot stops. The robot will perform weaving in the vertical direction to the line that is created by the welding start point and REFP 3.

Example of use: After the teaching of REFP 3 is performed, the teaching for the welding start and end step positions need to be performed. The moving speed needs to be set by using time (Caution: An error will be generated without the weaving work being performed if REFP 3 is not designated)

(4) REFP 4 (Reference Point 4)
REFP 4 is a command for setting the angle between the wall direction and another direction. Figure 6.8 shows an example of the angle being set at 90 degrees. If the angle is designated by using the command, the value set through [Basic pattern] -> [Angle] will be ignored.

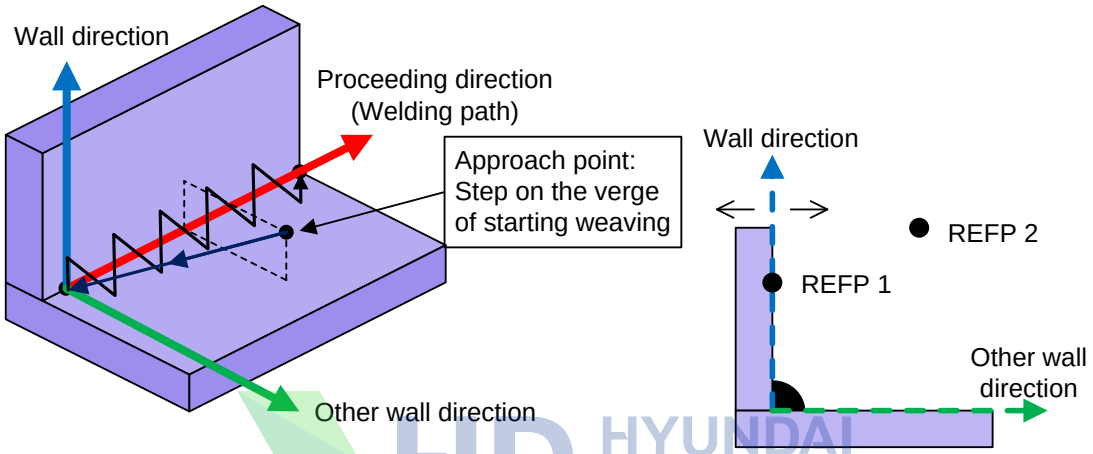


Figure 6.8 Weaving direction and reference point

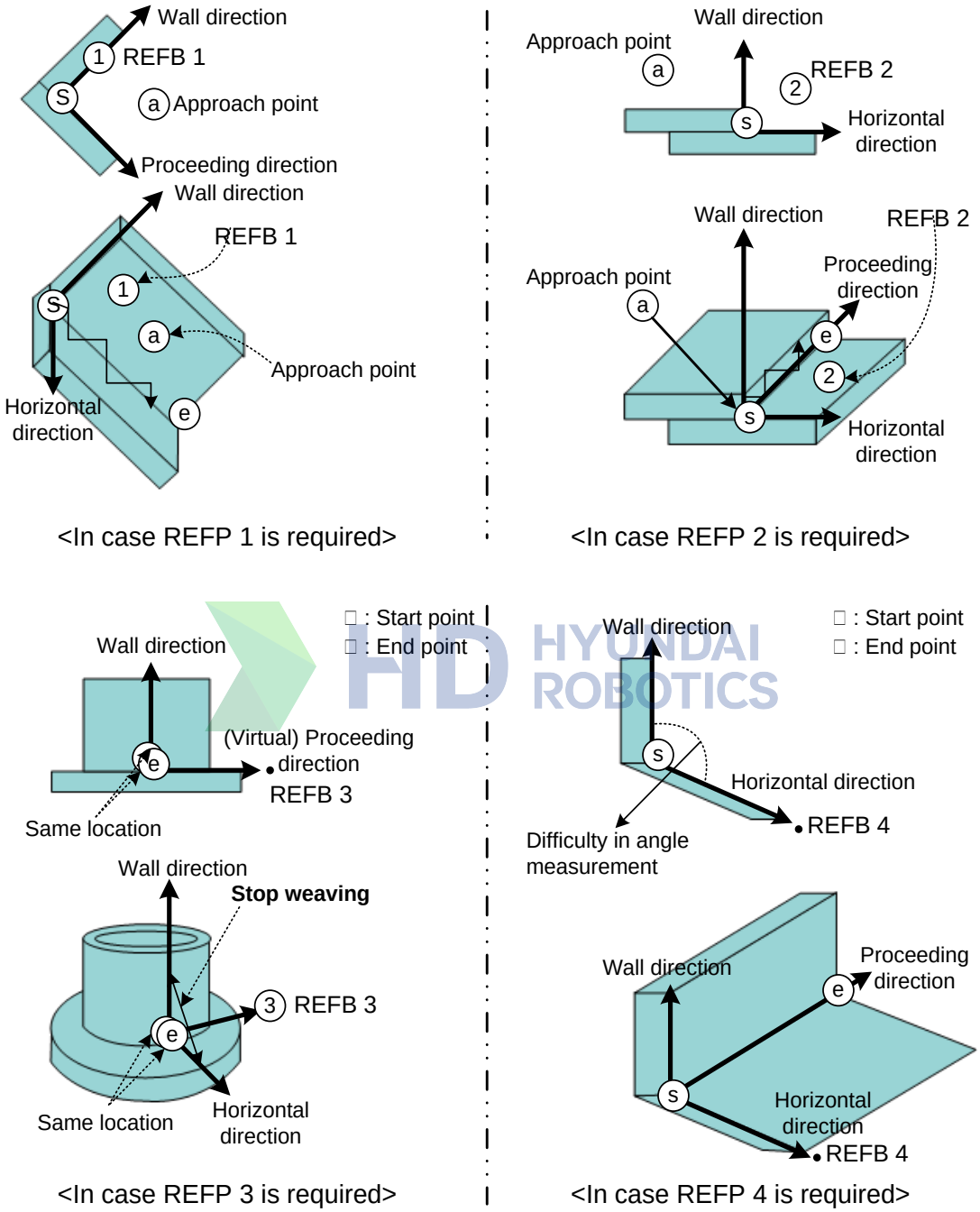


Figure 6.9 Application per each reference point type

Reference

- REFP 1: Set the distance to the welding path to at least 5mm.
- REFP 2: Set the distance to the wall direction to at least 5mm.

- REFP 3: Set the distance to the start point to at least 5mm.
- REFP 4: Designate an angle if it is difficult to measure the weaving pattern angle.

6.2.2. Reference point editing

(1) Reference point recording (hidden pose method)

① Move the reference point by using the jog key to the location for the recording.
② Move the cursor to the location (the step immediately previous to the WEAVON command in general) where the reference point is to be recorded.
③ Record the reference point (entering the pose variable) by pressing [User key] → [REFP] key.

(2) Reference point recording (pose variable entering method)

① Record the reference point command by pressing the [Command input] → [Arc] → [REFP] key.
② Enter the reference point number according to the types of reference points.
③ Enter the pose variable that will be used as the reference point location.

(3) Reference point movement

Since the reference point is a location to decide the weaving type, the robot will not move to the reference point for general playback. However, execute the following procedure for confirming and changing the reference point location.

① Place the cursor on the reference point command.
② Move to the reference point after pressing the step forward key. .

At this moment, the type of interpolation should be linear line, and the conditions, such as moving speed, tools, and AC should be used as recorded in the weaving section start step.

(4) Reference point location edit (hidden pose method)

① Place the cursor on the reference point command.
② Move to the reference point location to change using Jog key.
③ The reference point location will be changed after pressing [SHIFT] + [POSE.MOD] key.

(5) Reference point command delete

① Place the cursor on the reference point command.
② The reference point command will be deleted after pressing [SHIFT] + [DEL] key.

(6) Reference point number change

① Place the cursor on the reference point command.
② Click [ENTER] key.
③ Enter new reference point number and press the [ENTER] key.
④ Change the reference point number by pressing the [ENTER] key again.

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7

Welding data monitoring

7. Welding data monitoring

While the arc welding is being executed, it is sometimes necessary to check the instructed values for the current and voltage transmitted from the robot controller to the welder and the actual transmitted current and voltage values from the welder to the robot controller. In this process, the arc welding data monitoring function can be used to check the arc welding related data in real time while the welding work is being executed.

The manufacturer's controller provides 3 types of monitoring functions for monitoring the welding data.

1) Monitoring in detail: Can check all the available data
2) Wide screen monitoring: Can check all the available data in large characters
3) Wave monitoring: Can check the welding current/voltage waveform, and their related data

When it comes to the above 3 monitoring methods, it is possible to shift among different monitoring screens by pushing the [F5] key.

7.1. Arc welding data monitoring in real time

7.1.1. Monitoring in detail

This function is used for checking data related to arc welding. As the information may vary depending on the type of the set welders, the relevant monitoring window may also vary depending on the type of the set welders. When there is an error in the communication with the welders or the communication channel is not connected, the “Welder error code” or “Welder communication state” section will be displayed in red. For the GB2/GZ4/GE2 welders, the following data can be checked via the detailed data monitoring function.

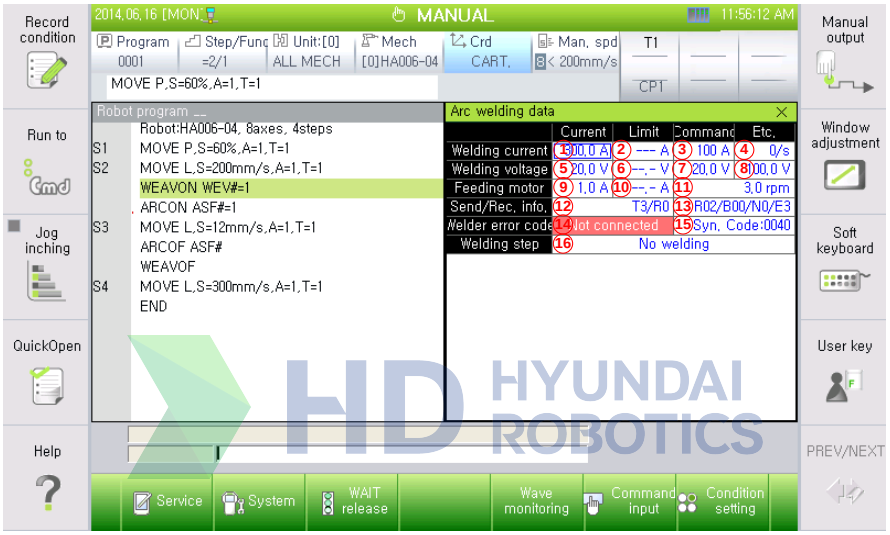

Figure 7.1 Arc welding Monitoring in detail

(1) Actual welding current outputted in the welder (A).
(2) Welding current limit. Indicate as ‘---’ in case arc limit monitoring function is not used.
(3) Command welding current outputted from the robot to the welder (A).
(4) Arc short circuiting frequency for 1 sec.
(5) Actual welding voltage (V) generated from current welder.
(6) Welding voltage limit. Indicate as '--.-' when not using the arc limit monitor function.
(7) Reference welding voltage offset value (V) generated from the robot to the welder.
(8) Offset value + synergic voltage. In other words, target output voltage (V).
(9) Current value (A) that drives the actual feeding motor.
(10) Indicated as “--.-” when the feeding motor arc limit monitoring function is not used.(A)
(11) Feeding motor rotation speed (rpm).
(12) T: command send frequency, R: command receive frequency.
(13) R: retry frequency, B: busy detection frequency, N: NG frequency, E: error frequency.
(14) Welder error code.
(15) Synergic code delivered via welder.
(16) Welding procedure

7.1.2. Wide screen monitoring

When the welding data wide-screen monitoring function is used, the teach pendant will show the welding data as shown below. With the wide-screen monitoring function, some important data of [7.1.1. Monitoring in detail] will be indicated in large fonts. The window for the function can be designed in a way that it will pop up automatically in the middle of welding. It is possible to monitor the data only when performing the welding work. Refer to '7.1.4 Operation' for details for setting the automatic window pop-up for the wide screen monitoring.

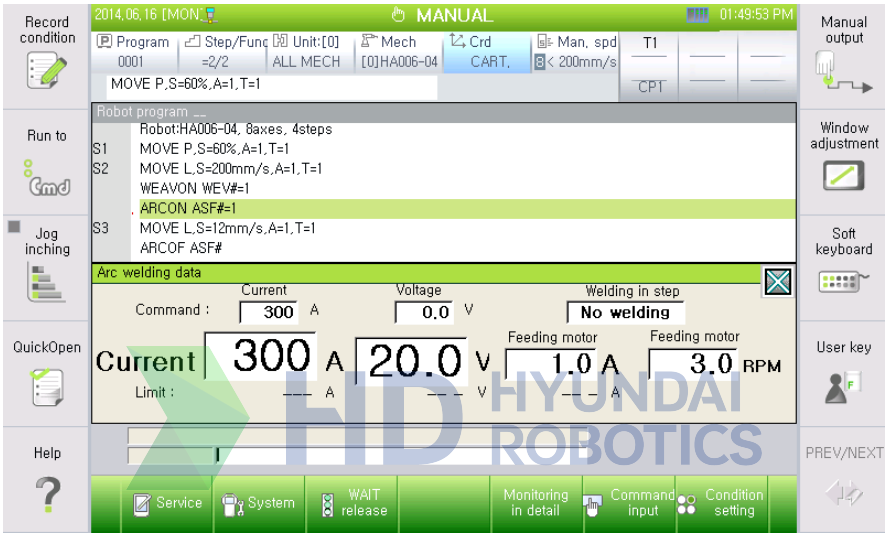

Figure 7.2 Arc welding wide screen monitoring.

7.1.3. Wave monitoring

Through the Wave monitoring, the information related to the waveform of welding data will be displayed, making it possible to grasp instant information as well as past information of welding at one glace. The function will help filter out the current and voltage supplied by the welder, and will display their waveforms. The function will also show the average of the current/voltage values calculated in one welding process (ARCON-ARCOF) and also their deviation. In addition, this function will display the upper and lower limits of the current and voltage set in the welding start condition as well as the time during which the limits are exceeded.

The waveform monitoring function makes it possible to make the waves larger and smaller and move them in the left or right direction. Moving the wave will make it possible to check the wave created up to 100 seconds earlier within the range of 0 ~ 500 A or 0 ~ 50 V. Refer to [7.14 Operation] for operation description.

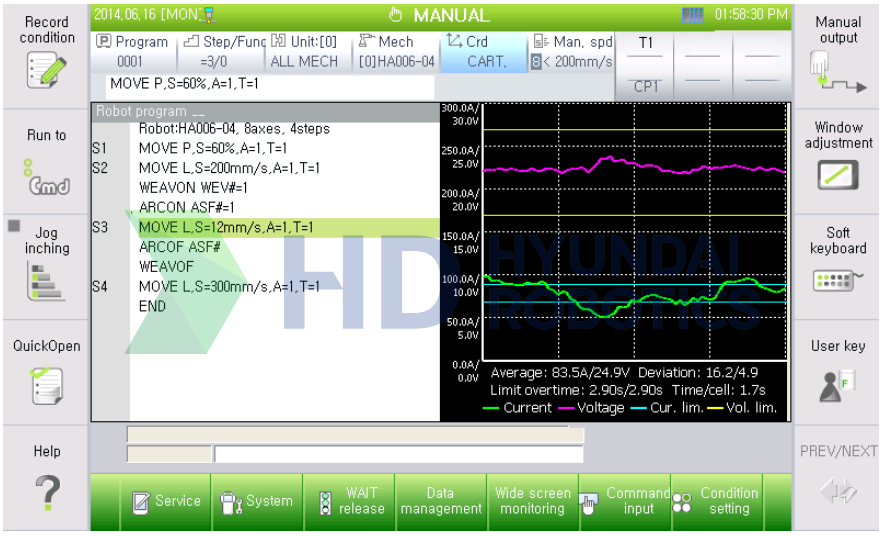

Figure 7.3 Arc waveform monitoring

(1) Average:
Averages of current values as well as voltage values. Values accumulated through one single welding process.

(2) Deviation:
Deviation in current values and voltage values. Values accumulated through one single welding process.

(3) Limit Overtime:
The time that the upper and lower limits for the current and the voltage are exceeded. Values accumulated through one single welding process

(4) Time/cell:
The graph shows the time of 1 cell. Currently, there are 4 cells, making it possible to check the results of welding performed for 10 seconds.

7.1.4. Operation

The welding data monitoring screen can be selected by accessing 『[F1]: Service』 → 『1: Monitoring』 → 『12: Digital Arc Welding Data』.

There is another way of selecting the screen. Users need to split the screen by using the [Window adjustment] key on the basic screen first before accessing 『[F1]: Content sel』 → 『12: Digital Arc Welding Data』.

When the monitoring function needs to be run, the 'Monitoring in detail' function will be executed basically. It is possible to shift among the monitoring functions by using the [F5] key. The shifting will repeat in the order of 'Monitoring in detail' →'Wave monitoring'→ 'Wide screen monitoring' →' Monitoring in detail'….

In order to use the automatic pop-up for the 'wide screen monitoring' function, it is needed to access 『[F2: System]』 → 『4: Application Parameters』 → 『2: Arc Welding』 → 『16: Automatic activation of monitoring during the welding』 and set it as "Enable"

The upsizing function in the welding wave monitoring function makes it possible to move the waves to examine the past (left) and future (right) as well as the high current/voltage (up) and low current/voltage (down) and compare with the current state. In order to move in a desired direction, touch the wave monitoring screen to activate it, and then press the [Up/Down/Left/Right] cursor. Then, the graphs will move. If it is necessary to move farther in the past (left) or future (right) direction, you can move at a scope 10 times wider.

Press [SHIFT] + [UP] to look at waves in detail and press [SHIFT] + [DOWN] to look at waves in an overall pattern. In order to look at the current data in the while examining at the past data, press [ENTER] to go back to the current screen

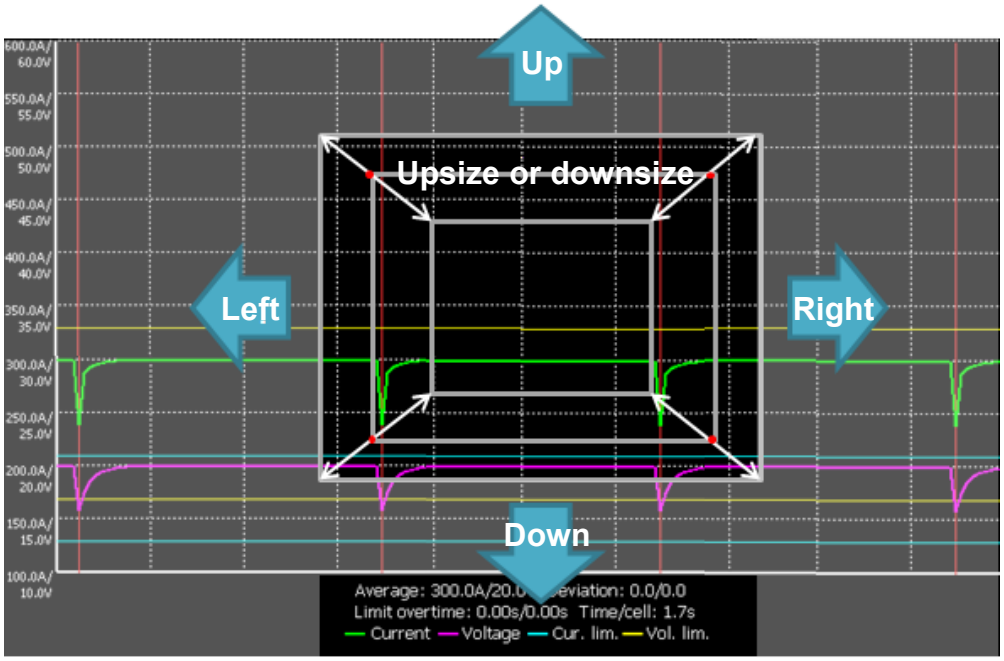

Figure 7.4 Arc welding waveform monitoring upsizing function

7.2. Arc welding data autosaving

This function is used to automatically save the arc welding data in text files. It is a useful function to manage the history of the arc welding works and relevant past data. In order to activate the function, it is necessary to set "Enable" in 『[F2: System]』 → 『4: Application parameter』 → 『2: Arc welding』 → 『18: Saving welding data during the welding』

The data related to the current/voltage sent from the welder and additional data, including welding start time, end time, and condition along with statistical data, such as average, deviation, and quantitative data will be saved automatically. The process starting from the generation of the ARCON command to the stage of arc off will be considered as one cycle of welding. In each cycle, data will be saved in the following format. The saved statistical data will correspond to each welding cycle. The types of data are as shown below.

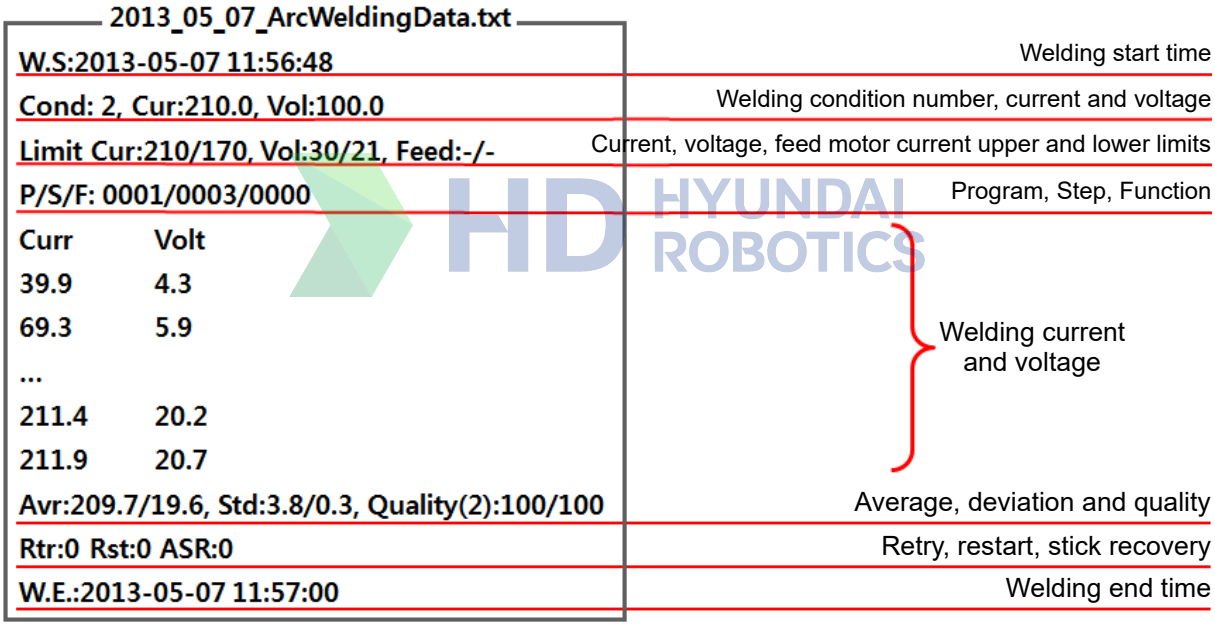

Figure 7.5 Saved arc welding data

One single text file containing the data will be saved into a specific folder in the teach pendant every day (ResidentFlash₩bin₩ArcWeldingData). The file name will be **yyyy_mm_dd.ArcWeldingData.txt**. If the file name is changed, it could be impossible to use the welding data check program that is provided by the manufacturer. It is recommended to maintain the basic name of the file.

Considering that there is a limit to the memory of the teach pendant, files will be deleted, starting with the oldest, automatically when there is not enough free memory left in the teach pendant. In addition, if there are some files that are old, they will be deleted automatically. Thus, it is recommended to make backup files periodically if it is necessary to keep the history of the arc welding works.

The stored welding data will exist in text form, making it difficult to locate and understand the desired data at first sight. In order to overcome such inconvenience, the manufacturer provides the following two methods to help users to easily find the desired welding data and understand the located data at first sight.

1. PC-based arc welding check program
2. Arc welding data management function (for teach pendants, refer to **7.3 Arc welding data management function**)

The PC-based arc welding data check program makes it possible for the user to check the backup files easily through a PC or a laptop computer. Users can search desired welding data by using the search parameters, such as welding time, welding condition, program and steps after selecting the desired welding file. In addition, the searched welding data will be visualized in graphs, allowing the users to check them intuitively. The welding data will also be compared with visual tools, making it possible to make a comparison with the past data.

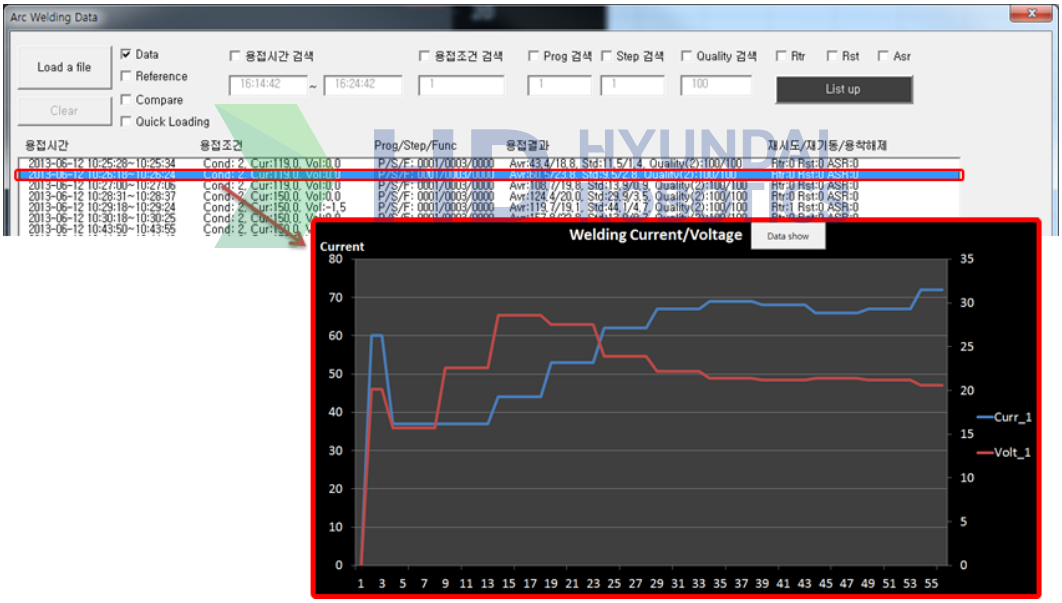

Figure 7.6 PC-based arc welding data check program

In order to use the program, the manufacturer should be contacted. Refer to the last appendix of the manual for the method regarding the use of the PC-based arc welding data check program.

7.3. Arc welding data management function

This function allows for the loading of stored arc welding data files into the teach pendant and also provides data search and display functionality in visual tools. In addition, this function provides support in setting the reference data that will be used in [7.4 Arc welding data quantification function]. In order to use this function, there should be at least one stored welding data file in the teach pendant.
It is necessary to set the monitoring window as the arc welding wave monitoring window, and then press the [F5: Data management] in manual mode to bring up the arc welding data management dialog box.

Figure 7.7 Arc welding data management function entering screen

The arc welding data management dialog box is configured as below. The “A” section determines the type of file that will be loaded and also shows the list of files. The “B” section is used for entering the parameters that are needed to search the welding data. The “C” section is used to save the reference file that will be used for the arc welding quantification function. The “D” section displays the description of the current mode of the setting. The “E” section displays the list of welding data stored in the loaded file.

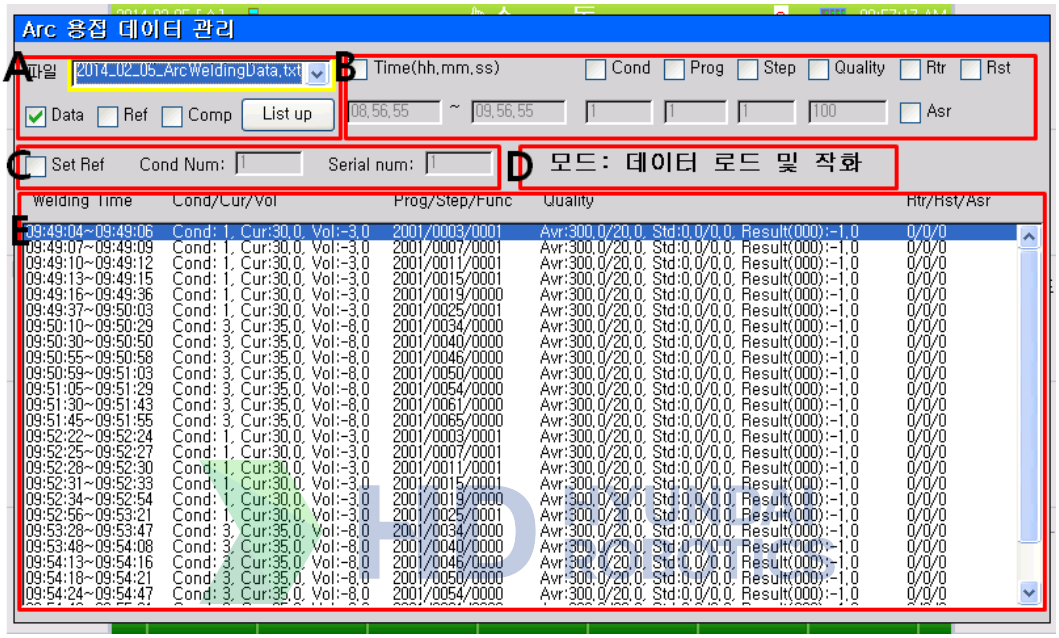

Figure 7.8 Arc welding data management function entering screen

7.3.1. File loading and comparison function setting (“A” on the screen)

There are two main types of files that can be loaded by the arc welding data management function. The files of the first type are the automatically stored arc welding data. In order to load these files, it is necessary to check “Data” of the “A” section. The files of the second type are the reference files that are set for the quantification of the arc welding results. In order to load these files, it is necessary to check “Ref” of the “A” section. When it is checked, the list of the files stored in the specific folder in the teach pendant will be loaded and displayed on “File” of “A” section. Select the desired data from “File” of the “A” section and press the “List up” button. The welding data stored in the relevant file will be displayed on the “E” section.

7.3.2. Search condition setting (“B” on the screen)

In the “B” section, it is possible to set conditions that makes it possible to load data that satisfy specific conditions when loading the welding data stored in files by pressing the “List up” button. In order to use specific conditions, it is necessary to activate the relevant conditions by selecting their checkboxes. In “Cond,” it is possible to designate a welding condition number in order to load only some of the specific data of welding works performed using specific welding condition numbers. In “Prog” and “Step”, it is possible to designate the loading of data from welding works performed in some specific programs and steps. In “Quality”, it is possible to load some specific welding results that are lower than the designated value when the arc welding results are stored by using the quantification function. In “Rtr”, “Ret”, and “Asr”, it is possible to load only the result data of welding works for which retry, restart, and stick recovery were performed. If multiple conditions are set at the same time, only the data that meet all of the conditions will be loaded.

7.3.3. Reference file designation (“C” on the screen)

The “C” section is for designating reference files that are to be used for the quantification of welding results. In order to designate the desired welding data as the reference file, it is necessary to select “Set Ref” in “C” and then designate the condition number that needs to be used as well as the serial number. Then, it is necessary to enter by pressing the [ENTER] key after focusing on the desired data. The file will be saved in the form of RF_xx_yyy.txt. (xx for condition number and yyy for serial number)

7.3.4. Current mode indication (“D” on the screen)

The “D” section shows the current mode. The arc welding data management function can be operated in two modes. One is “Data load and drawing” and the other is “Reference data setting.” In the “Data load and drawing” mode, if the data in “E” are selected, graphs will be shown on the wave monitoring screen, and in the “Reference data setting” mode, the selected data will be saved as the reference file.

7.3.5. Welding data list (“E” on the screen)

The “C” section shows the list of stored welding data. The list displays additional information, such as the data that will be used for searching, the condition, the current and the voltage as well as the average current and voltage. It will also indicate the state of the relevant data. Up to 100 welding data will be displayed on the screen. The welding data to be omitted in “E” can be checked by using the search condition of “B.”

7.3.6. Welding data comparison

The arc welding data wave monitoring function can be used to compare two different welding data. Select “Comp” in the “A” section and select one of the welding data in the “E” section, the welding data currently displayed in the wave monitoring screen and the currently selected welding data will be displayed in comparison.

In order to compare two past data, not including the current data, it is necessary to deselect “Comp” in the “Data load and drawing” mode. Instead, select and visualize the targeted data in the wave monitoring screen, and then select “Comp” and then select another desired past data in order to make a comparison on them. It is also possible to compare reference files and other welding data.

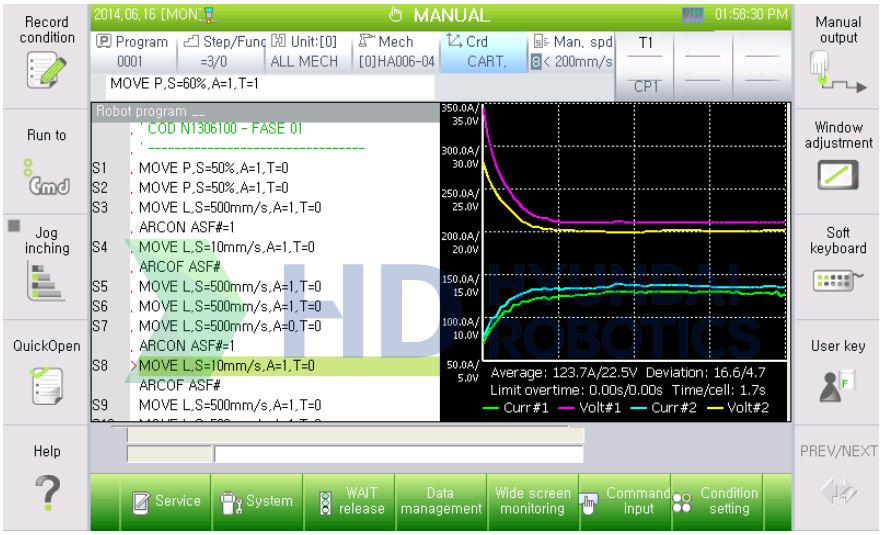

Figure 7.9 Arc welding data comparison function

7.4. Arc welding result quantification function

The manufacturer provides the arc welding result quantification function to evaluate the quality of the arc welding works in a quantitative manner. This function converts the welding results into numeric measurement ranging from 0 to 100 by using the existing welding data, and stores the data in the relevant stored file. In order to use the function, users should get assistance from engineers. It is necessary to contact the company for help.

7.5. Sensor-based arc welding data monitoring function

This function enables different monitoring functions by sending data from power and voltage sensors to controllers. In general, a welding machine that is connected through digital communication sends welding current and voltage to controllers, whereas the one that is connected through analog communication doesn't send the welding data. For some digital welding machines, the sent data are way distorted (different from the original one) and its sending cycle is slow, making it unsuitable for functions. This is the sensor-based arc welding data monitoring function to measure limited welding machine data with sensor to use it.

The following is the list of current arc welding robot monitoring functions:

(1) Real-time monitoring (detailed information, waveform, and large screen)
(2) Arc welding data storage function
(3) Arc welding data management function
(4) Arc welding result quantification function
(5) HRMS arc welding data monitoring function

If a welding machine doesn't provide the robot controller with welding data, all of the functions will not be available. In addition, if data are distorted, incorrect data will be used for management, so the sensor-based arc welding data monitoring will be useful for the following:

(1) A welding machine that doesn't provide robot controllers with welding data
(2) A welding machine that has serious welding data distortion
(3) A welding machine that has very slow sending cycle

Note

If this function is used, only data from the sensor are used instead of those from the welding machine.

To use this function, connecting the sensors to measure current and voltage during welding is required, and communication device to send measured welding data to controllers. Both digital and analog communication types are available and either of them can be selected according to field conditions. Here is the system structure by communication type.

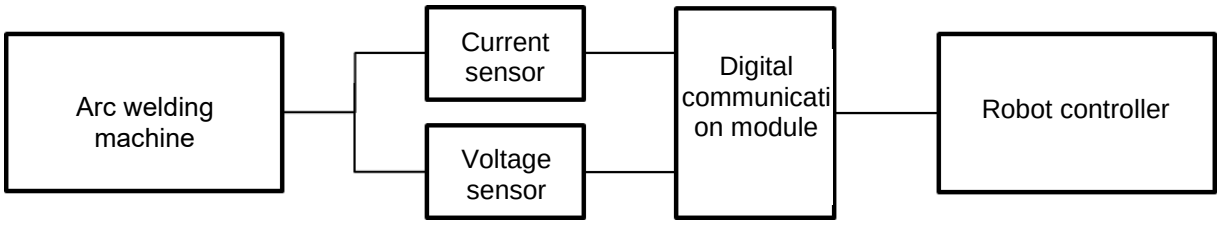

Figure 7.10 Structure drawing of sensor-based arc welding data monitoring (digital communication)

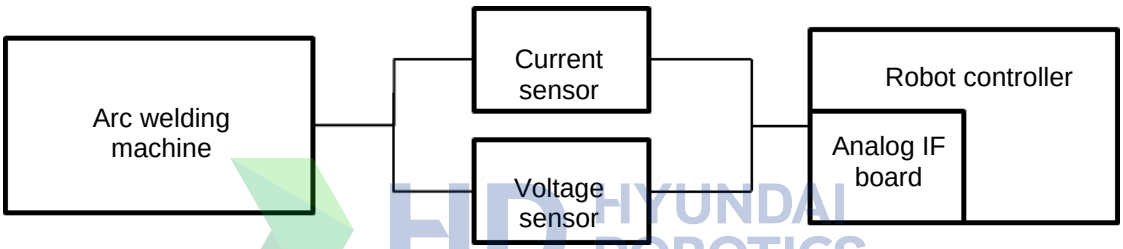

Figure 7.11 Structure drawing of sensor-based arc welding data monitoring (analog communication)

Go to 『[F2: System]』 → 『4: Application Parameter』 → 『2: Arc Welding』 → 『[F2: Sensor-based Monitoring]』 to set this function.

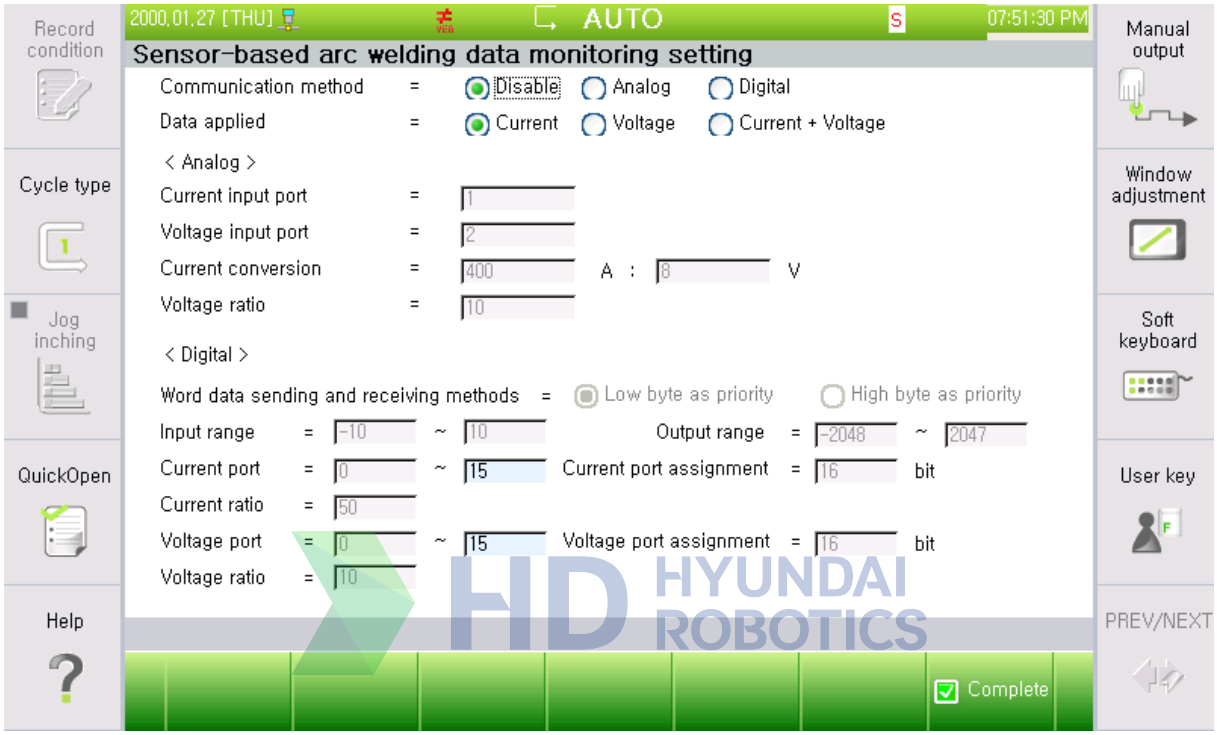

Figure 7.12 Sensor-based arc welding data monitoring (settings screen)

(1) Communication type: Communication-type setting to receive data from current and voltage sensors
(2) Data to apply: Data to apply this function. (Sensor data are used instead of welding machine data for this function.)
(3) 〈Analog〉
    A. Current input port: The output of the current sensor is connected.
    B. Voltage input port: The output of the voltage sensor is connected.
    C. Current conversion: The ratio between a value from the sensor and the actual current, frequently found in sensor specifications
    D. Voltage multiplying factor: The ratio between a value from the sensor and the actual voltage
(4) 〈Digital〉
    A. Word data communication type: There is a difference between sending lower and upper bytes when communicating Word data according to communication. DeviceNet uses the lower byte preferred type in general.
    B. Input range: In communication module specifications, set the range of the input values from sensors to communication modules.
    C. Output range: In communication module specifications, set the range of the input values to convert and output.

D. Current port: Port to receive the output of the current sensor
E. Current port assignment: Number of ports to receive
F. Current multiplying factor ratio between a value from the sensor and the actual current
G. Voltage port: Port to receive the output of the voltage sensor
H. Voltage port assignment: Number of ports to receive
I. Voltage multiplying factor: Ratio between a value from the sensor and the actual voltage

Our high-voltage touch sensing unit includes current and voltage sensors, so this function can be connected just by adding a communication module. Welding current and voltage will be available by connecting output values with the communication module and enabling the sensor-based arc welding data monitoring function.

The following are examples of connection and settings when using the high-voltage touch sensing unit. (It depends on the specifications of high-voltage touch sensing unit and communication module.)

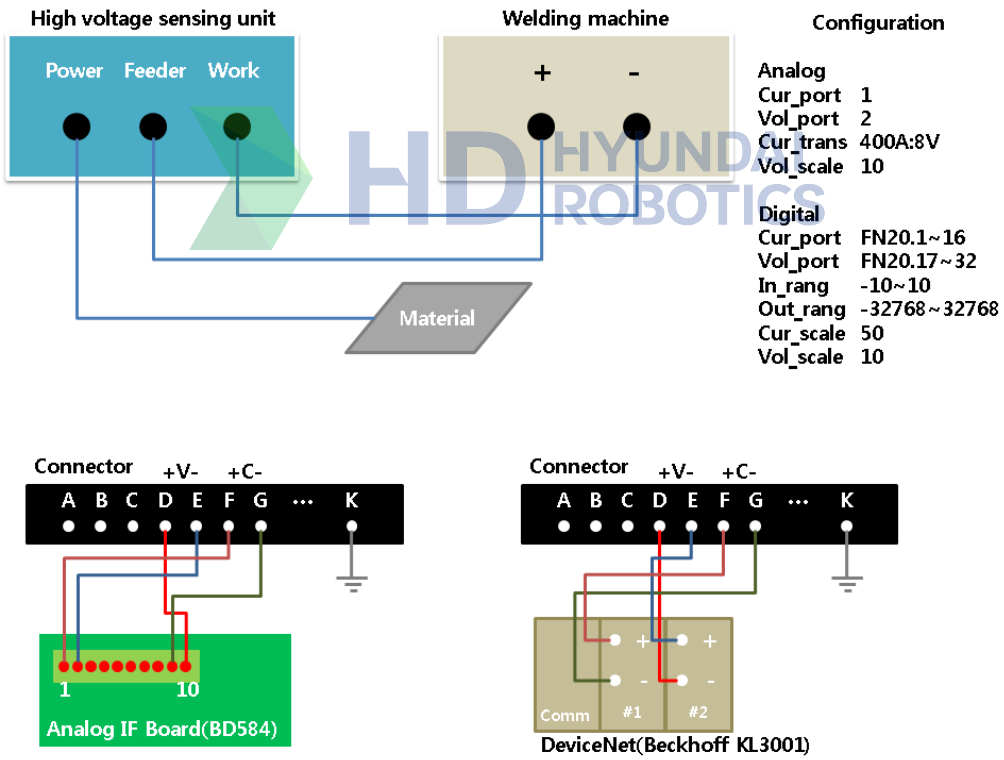

Figure 7.13 High-voltage touch sensing unit and sensor-based arc welding data monitoring

HD
HYUNDAI
ROBOTICS

8

Arc welding application function

8. Arc welding application function

The manufacturer provides various application functions to improve the quality and stability of the arc welding works. In this chapter, relevant functions will be introduced simply. There are separate manuals for individual functions. Refer to the functional manuals for more details and their application.

8.1. Arc sensing function

This function is used for tracking the welding path and can be thus used when the weaving function needs to be used for perform arc welding on thick materials. When the function is used, the welding work can be performed accurately along the welding path even when there is an error in the welding path caused by tolerance in the workpiece or even when there is deformation on the workpiece.

When the welding work is defective because of the uneven position of the workpiece, the touch sensing function can be used to accurately find the welding position and track the welding path, which will ensure defect-free quality of welding.

In order to use this function, the weaving function must be used and the data input setting for the sensing function should be set as “Enable.” Refer to [1.3 Arc welding application condition setting] for more details about the data input setting.

8.1.1. Arc sensing condition

On the second screen of the weaving file condition editing screen, the arc sensing condition will be displayed as below. This is for adjusting the setting of the arc sensing that can be used during the weaving operation.

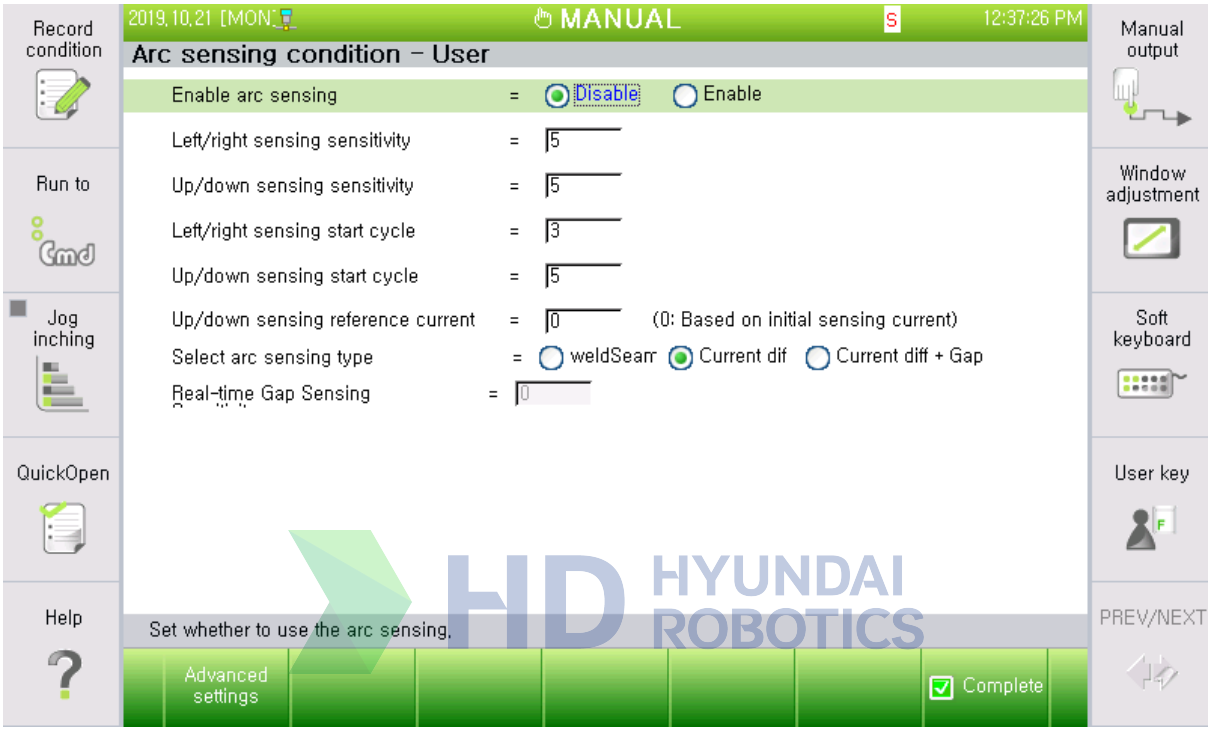

Figure 8.1 Arc sensing condition – User dialog box

The setting and operation methods for individual options are as below.

(1) Arc sensing function activation: 〈Disable, Enable〉
Sets whether to use the arc sensing function

(2) Left/right sensing sensitivity: [0–10]
Sets the sensing sensitivity in the left and right directions on the weaving surface

(3) Up/down sensing sensitivity: [0–10]
Sets the sensing sensitivity in the upward and downward directions on the weaving surface

(4) Left and right direction sensing start cycle: [0 ~ 9]
Set the cycle for starting the sensing in the left and right directions on the weaving surface

(5) Up/down sensing start cycle: [Left/right start cycle+1 to 10]
Sets the cycle of starting the up/down sensing on the weaving surface

(6) Up/down sensing reference current: [0–3,000]
Sets the reference current when performing the up and down sensing; this setting adjusts the

torch height; if it is set to 0, the average value of the initial section current will be the reference. When it is set to 0, torch collisions could occur because of the inaccurately high initial current if there is a tack welding area.

(7) Arc sensing type selection: 〈Welding line, current difference, current difference + Gap〉
Selects the welding line follow-up method; the welding line mode is to be selected if the accurate right angle fillet welding and asymmetric sensing will be used. In the general symmetric arc sensing, the current difference mode will be used. The current difference + gap mode will be used if the width needs to be adjusted automatically in the middle of welding.

(8) Real-time gap sensing sensitivity: [0–10]
Sets the width variation sensitivity for using the current difference + gap method; it is required to set an appropriate value according to the level of the bead quality and width variation

If you press F1 in the Arc Sensing Condition - User dialog box, the following Arc Sensing Condition - Engineer dialog box appears. This dialog box can only be edited by the engineer.

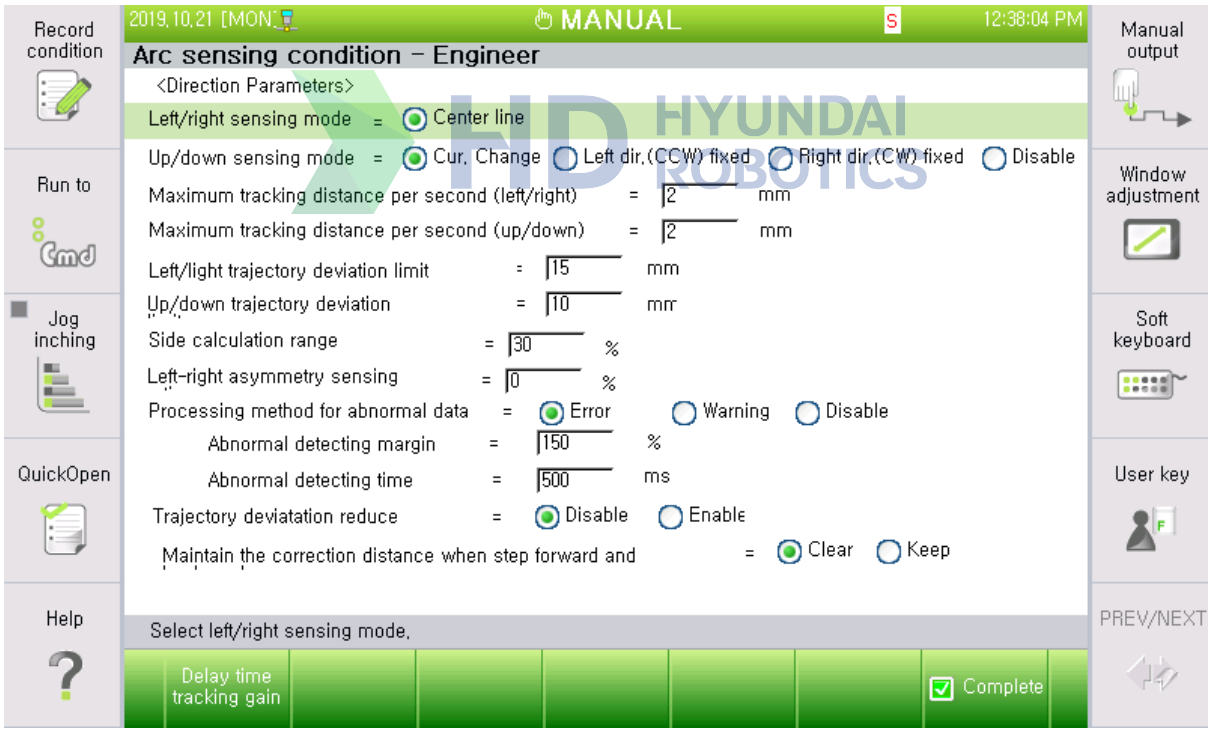

Figure 8.2 Arch sensing condition - Engineer dialog box

The setting and operation method for each item is as follows.

(1) Up/down sensing mode: 〈Current variation, Wall direction (CCW) fixing, Non-wall direction (CW) fixing, Disable〉
Sets the method to perform the up/down sending
- Current variation: Performs height sensing by taking the sensing initial reference data

average as the reference

- Wall direction (CCW) fixing, Non-wall direction (CW) fixing: When looking in the direction of the torch moving forward, and if one side is fixed and the deformation occurs only on the other side, then the height sensing will be performed according to the movement amount based on the relationship between the left/right compensation amount and fixed surface.
- Disable: To be selected only when performing only the left/right sensing for the flat arc sensing in which the up/down sensing is not required or cannot be performed

(2) Maximum compensation distance per second (Left/right, Up/down): [0.1–20.0] mm

Sets the maximum distance that can be followed up for 1 s; if you set the value as 10 in the user dialog box, a follow-up will be performed by considering the maximum compensation distance set here.

(3) Left/right and Up/down sensing trajectory deviation limit: [0 ~ 200]

Sets the arc sensing follow-up distance limit value in the left/right and up/down directions; if a follow-up is performed, exceeding the limit distance set by arc sensing, the operation will stop because of an error.

(4) Left/right asymmetric sensing ratio: [-40 to 40] %

Sets the asymmetric sensing ratio to perform sensing by considering the difference, if any, in the width of the beads

(5) Abnormal data handling method: 〈Error, Warning, and Disable〉

This is a method to handle a case in which the normal current range, calculated based on the "abnormality determination margin," is exceeded for a duration longer than the "abnormality determination time."

Error: The robot displays an error and stops.
Warning: The robot displays a warning and continues working.
Disable: The robot continues to work.

(6) Abnormality determination margin: [100–200] %

Sets a range to determine abnormality by using the five previous units of data

(7) Abnormality determination time: [10–1000] ms

Sets the time to allow the current input that exceeds the abnormality determination margin; if the margin exceeded beyond this time, the robot will operate according to the relevant handling method.

(8) Trajectory deviation decrease: 〈Disable, Enable〉

Sets whether to ignore the compensation amount of the relevant count when the sensing data is abnormal; if this option is "Enable," and if the data has severe noise, the previous compensation amount will be sustained.

(9) Sustaining the compensation distance for the step forward/backward: 〈Clear, Sustain〉

Sets whether to sustain the compensation amount when making the robot step forward or backward in the arc sensing or in the multipass operation section; when it is set as Clear, the arc sensing compensation amount will be cleared when the robot steps backward.

When you press F1 in the Arc Sensing Condition - Engineer dialog box, the Data Delay and Follow-up Factor Table dialog box will be displayed as below. The contents of this dialog require our engineering.

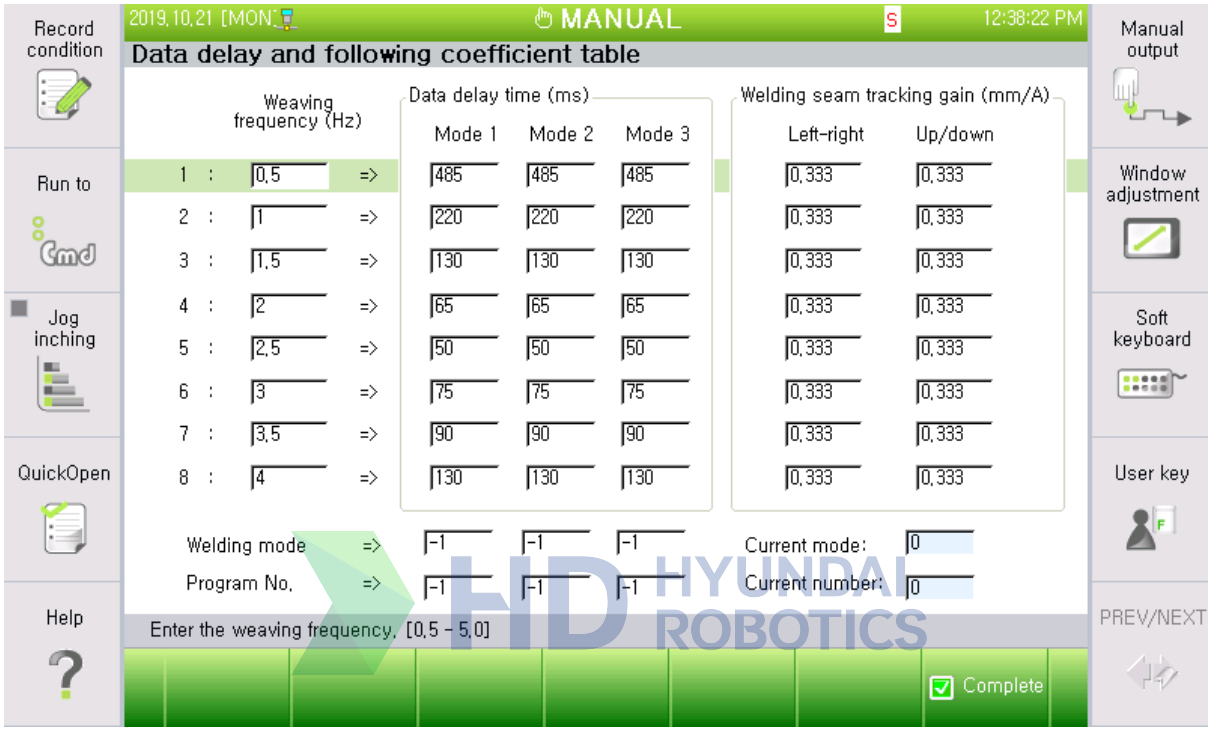

Figure 8.3 Arch sensing condition - Engineer dialog box

Please refer to the 'Arc sensing function manual' for details of Arc sensing

8.2 Touch sensing function

Touch sensing is a function used to detect the position of the workpiece and the start point or welding end point.

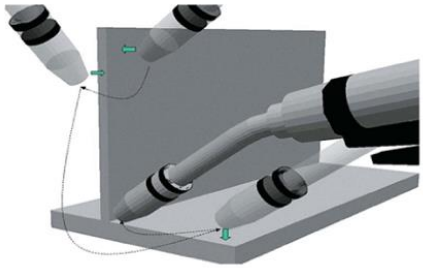

Figure 8.4 Example of Touch Sensing

The workpiece is not always in a fixed position because of the error in the jig or positioner and the variation in the gaps of workpieces. Considering this, touch sensing can be used to detect the welding start point and welding end point to carry out welding.
Alternatively, if the reference position is recorded through touch sensing, it will be possible to calculate how much shift is made from the reference position when the workpiece enters. A function that automatically calculates and compensates these shifts can also be used.
In touching sensing, eight types in total (Fillet, VGroove, Butt, LRCen, AP Fillet1, AP Fillet 2, DetectGroove, and Wall) will be supported, as shown in Figure 8.12.

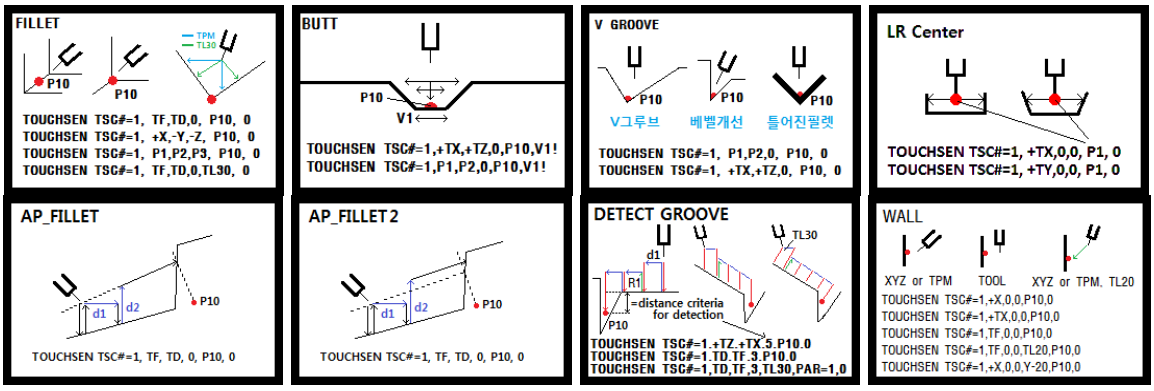

Figure 8.5 Touch Sensing Type

There are eight conditions in total for touch sensing. If you press Quick Open in the command, the edit screen will appear, as shown in Figure 8.13. The edited contents related to the search speed, retraction speed, search distance, progress distance, error compensation amount, touch method, etc. will be stored in the ROBOT.TSC file.

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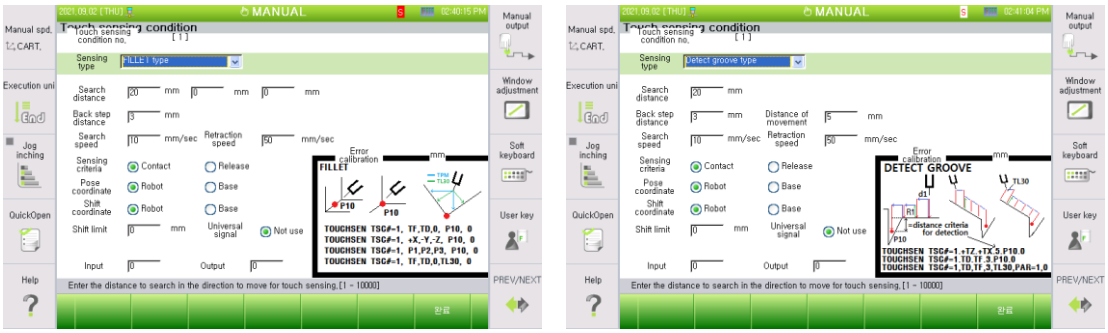


Figure 8.6 Touch Sensing Condition Edit Screen

The touch sensing command can be recorded by inputting “command input” – “Arc” – “TOUCHEN” on the TP screen. The command can be configured as follows.

TOUCHSEN TSC#= Condition number, Search direction 1, Search direction 2, Search direction 3, Calculated pose, Butt gap variable
TOUCHSEN TSC#= Condition number, Search direction 1, Search direction 2, Search direction 3, Angle of search direction, Calculated pose, Butt gap variable
TOUCHSEN TSC#= Condition number, Search direction 1, Search direction 2, Search direction 3, Angle of search direction, PAR=Pose shift number, Butt gap variable

TOUCHSEN TSC#1, +TX, +TZ, 3, P10, V1!
TSC#1 : Touch sensing option number (index number corresponding to the conditions of the ROBOT.TSC file)
+TX, +TZ : Search direction parameters (orthogonal, pose, tool coordinate and, tool projection can be inputted)
3 : Amount to lift after touching the bottom (mm) (Butt, VGroove), Detection reference distance (DetectGroove).
P10 : Pose variable to store the pose calculated through sensing
V1! : Variable to store the gap of the workpiece for the butt operation (rounded to the first decimal place)
QuickOpen key : Search speed, retraction speed, search distance, progress distance, error compensation amount, and touch type (upon contact or upon contact release) can be designated.

The sensing direction can be designated as follows according to the workpiece type.

Fillet : Base coordinate direction, Pose direction, Tool projection direction, +TZ direction
Butt : Pose direction, Tool direction
V Groove : Pose direction, Tool direction
LRCen : Tool direction
AP_Fillet : Tool projection direction
DetectGroove: Tool direction, Tool projection direction
Wall : Orthogonal direction, Tool direction, Tool projection direction

Type	Maximum number of search directions	*Orthogonal X, Y, and Z shall be supported for all types*	Tool coordinate	Tool projection coordinate	Pose	Other input parameters
Fillet	3	O	O (1 touch point)	O	O	Retraction distance

Butt	2	X	O	X	O	Error compensation amount
VGroove	2	X	O	X	O	
LRCen	1	O	O	X	X	
AP_Fillet	2	X	X	O	X	Progress distance 1 and 2
AP_Fillet2	2	X	X	O	X	Progress distance 1 and 2
DetectGroove	2	X	O	O	X	Progress distance 1, Retraction distance 1

The following is an example based on the assumption that the workpiece type is designated as a fillet for the first condition for touch sensing, but for the second condition, and V groove for the third condition (the conditions set by the user with Quick Open in the command).

TOUCHSEN TSC#=1, TF, TD, 0, P10, 0 #1 condition, Tool projection direction, Two-point touch
TOUCHSEN TSC#=1, +X, -Y, -Z, P10, 0 #1 condition, Base coordinate direction, Three-point touch
TOUCHSEN TSC#=1, P1, P2, 0, P10, 0 #1 condition, Pose direction, Two-point touch
TOUCHSEN TSC#=1, +TZ, 0, 0, P10, 0 #1 condition, +TZ direction, One-point touch
TOUCHSEN TSC#=2, +TX, +TZ, 3, P10, V1! #2 condition, Tool coordinate direction, Ascending 3 mm after touching the bottom
TOUCHSEN TSC#=2, P1, P2, 2, P10, V1! #2 condition, Pose direction, Ascending 2 mm after touching the bottom
TOUCHSEN TSC#=3, -TY, +TZ, 3, P10, 0 #3 condition, Tool coordinate direction
TOUCHSEN TSC#=3, P1, P2, 3, P10, 0 #3 condition, Pose direction

The touch sensing methods (workpiece types) to be provided are as follows.

[1] Fillet type

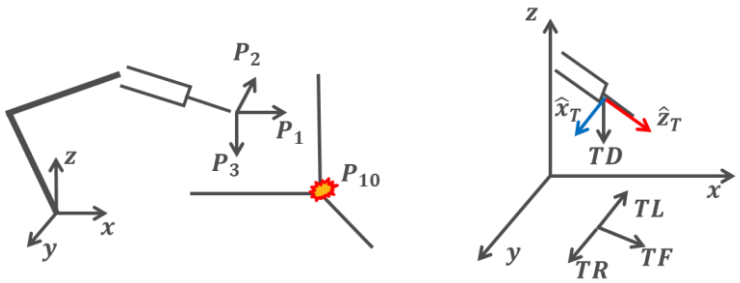


Figure 8.7 Example of Touch Sensing – Fillet Type

TOUCHSEN TSC#=1,P1,P2,P3,P10, 0
TOUCHSEN TSC#=1,+X,-Y,-Z,P10, 0
TOUCHSEN TSC#=1,TF,TD,0,P10 0
TOUCHSEN TSC#=1,+TZ,0,0,P10 0

• Tool projection method: A method of determining the forward, left, right, and down directions by projecting the Z-axis of the tool coordinate system onto the base XYZ plane. The combination of TF

(forward), TD (down), TL (left), and TR (right) is used. TL is TF*RotZ(90) direction, and TR is TF*RotZ(-90) direction.
• If there are too many welding points, making it difficult to manage pose variables, the tool projection method (TPM) can be used
• In the case of a twisted fillet in which the workpiece has a rotation amount (RX, RY, and RZ), the angle designation option can be used to change the search direction.
• For one-point sensing, only one search direction will be designated, and for the two-point sensing, two search directions can be designated, sequentially.

[2] V Groove type

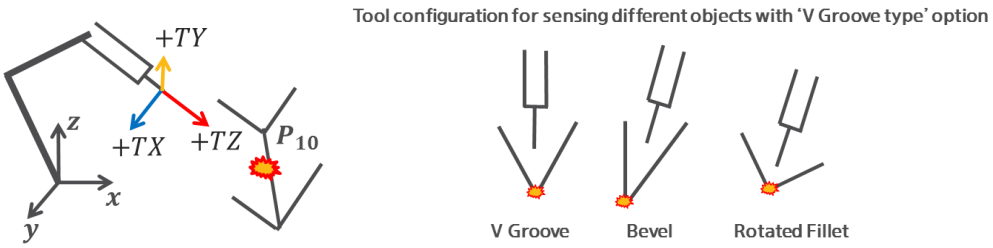


Figure 8.8 Example of Touch Sensing - V Groove Type

V Groove type can be used for V Groove sensing. However, the position and direction of the tool should be positioned on a bisector, similarly shown in the figure.

TOUCHSEN TSC#=3, -TY, +TZ, 3, P10, 0 #3 condition, Tool coordinate direction
TOUCHSEN TSC#=3, P1, P2, 5, P10, 0 #3 condition, Pose direction

• It will provide stability to have at least an ascending amount of 3 mm for sensing.

[3] BUTT type

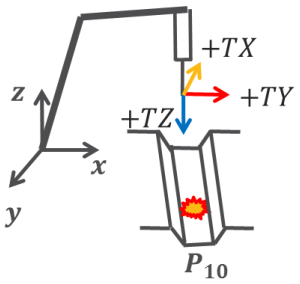


Figure 8.9 Example of Touch Sensing – Butt type

TOUCHSEN TSC#=2, +TX, +TZ, 3, P10, V1! #2 condition, Tool coordinate direction, Ascending 3 mm after touching the bottom
TOUCHSEN TSC#=2, P1, P2, 5, P10, V1! #2 condition, Pose direction, Ascending 5 mm after touching the bottom

• For the BUTT type, it is important to position the tool perpendicular to the bottom surface, as shown in the figure.
• It will provide stability to have at least an ascending amount of 3 mm after the bottom sensing is performed for sensing.
•Depending on the ascending amount, the size of the butt gap may change. In this case, it is required to input the error compensation amount in Quick Open in the command, making it possible to calculate the butt gap by subtracting the error compensation amount.

Touch sensing will progress according to the following sequence.

For the Fillet type, the welding start point will be calculated by repeating the process of “Forward → Return” in the orthogonal, pose, tool projection, and tool coordinate directions, depending on the four options. In the case of the Butt or V Groove type, sensing will be progressed as follows. (Upper left and right sensing → Bottom sensing → Ascending → Lower left and right sensing)

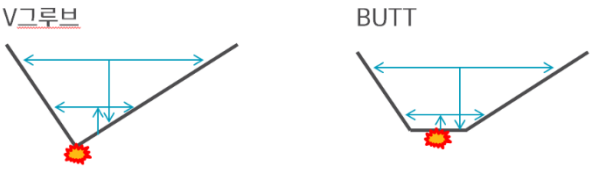


Figure 8.10 Touch Sending Sequence – Butt Type

For V Groove and Butt types, the point lowered in the workpiece direction from the lower left and right sensing midpoint will be the pose. In the case of DetectGroove type, the process of “Lower sensing → Ascending as much as the ascending amount → Forward” will be repeated. If the point is lowered than the detection reference designated by the user, the descending operation will stop in the middle of the lower sensing process.

Pressing Quick Open in the touch sensing command will make it possible to edit the touch sensing conditions for the relevant condition number TSC#.
• Search distance: This refers to the distances in the search direction. If a workpiece is not detected when it reaches the distance, an error will occur.

• Search speed and retraction speed: The speed for searching or retracting can be designated.
• Error compensation amount: This will be used for compensating the butt gap.
• Retraction distance: In the case of the Fillet type, this refers to the distance to retract after sensing and the distance to lift after touching the bottom in case of the DetectGroove type.
• Point of time for sensing: Supports the “Upon contact” and “Upon contact release” modes. In general, the sensing in “Upon contact” mode is much used and has nearly no error. Only in a case, that sensing shall be performed, considering slight errors because of wire bending during the sensing process, the method of sensing during the retraction will be used.

The angle designation option makes it possible to designate the angle of the search direction. The angle designation option will be supported for the Fillet and DetectGroove types. The angle designation option makes it possible to rotate all the movement trajectories in the sensing sequence on one of the TL axis and base X, Y, and Z axes.
Figure 8.18 shows an example of rotation on the Y-axis or TL axis for the Fillet or DetectGroove type workpiece.

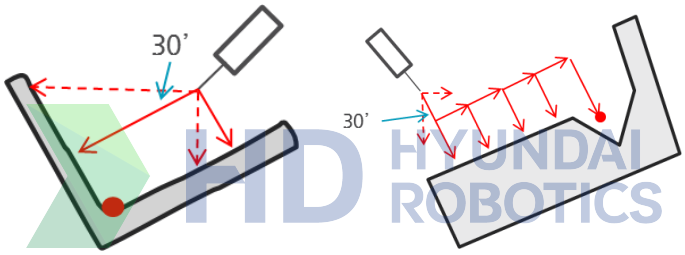


Figure 8.11 Example of Touch Sensing – Angle Setting

TOUCHSEN TSC#=1, +X, -Z, 0, Y30, P100, %V1!
TOUCHSEN TSC#=1, +X, -Z, 0, TL30, P100, %V1!
TOUCHSEN TSC#=2, TD, TF, 5, Y30, P100, %V1! ‘DetectGroove
TOUCHSEN TSC#=2, TD, TF, 5, TL30, P100, %V1!‘DetectGroove

The workpiece type and the angle rotation axis to be designated according to the coordinate designated for the sensing direction designated in the command are as follows.

Type	Coordinate designated for the sensing direction	Axis designated for angle
Fillet	All coordinates	Orthogonal X, Y, and Z axes. TL axis
Detect Groove	Tool	Impossible
	Tool projection	Orthogonal X, Y and Z axes. TL axis

The following description shows how to use touch sensing that interworks with the Master/Execution mode.
In Master mode, the sensing pose will be stored in the pose number that corresponds to the PAR number. In the Execution mode, the current sensing pose will be compared with the sensing pose calculated in the Master mode to calculate the shift amount, which will be recorded into the shift variable, corresponding

to the PAR number.

TOUCHSEN TSC#=1, +X, -Z, 0, X0, PAR=10, %V1!

PAR stands for Pose and Shift and is used to assign the number for the shift variable. In the command shown above, the sensing pose will be stored in the P10 pose variable in the Master mode, and when sensing occurs in the Execution mode, the shift amount in comparison with the Master mode will be automatically calculated and stored in RO.

8.3. Height sensing function

This function can be used in tasks, such as TIG welding, in which the tool of a root is required to keep a certain distance from the workpiece. For TIG welding, because the height is proportionate to the arc length, the function is called AVC (Arc Voltage Control). The distance from the workpiece can be controlled by the sensors' analog voltage input as well as the arc length correction parameter and welding current or voltage value that will be detected at the welder.

In order to use this function, the data input setting for the sensing function should be set as "Enable." Refer to **1.2.2.1. Sensing function data input setting** for more details about the data input setting.

After the input data setting for the sensing function is completed, it is possible to use the height sensing function by going through the procedure shown below.

(1) Command input

Use the HSensON command to start the height sensing. In later stages of the command, the condition number needs to be entered. There are 8 height sensing conditions in total.
Use the HSensOFF command to end the height sensing. The end command does not require any special arguments.

The following information shows an example of the work program in which the height sensing command is entered.

```
S1   MOVE L,S=100%,A=1,T=0
S2   MOVE L,S=20%,A=1,T=0
S3   MOVE L,S=100mm/s,A=1,T=0
     HSensON AVC#=1          ←    Height sensing start
     ARCON ASF#=2            ←    Arc welding start
S4   MOVE L,S=10mm/s,A=1,T=0
     ARCOF ASF#         ←    Arc welding end
     HSensOFF           ←    Height sensing end
S5   MOVE L,S=20%,A=1,T=0
     END
```

(2) Height sensing function operating sequence
Height sensing will be performed when the ARCON command is executed after the height sensing command execution.
In general, at the initial welding stage, the current and voltage are not stable. Thus, the input

data will be ignored until they are stabilized. When the input data are stabilized, the average will be calculated according to the reference data setting method. Height sensing will start immediately when the reference data are entered by the user.
The height sensing operating sequence is as shown below.

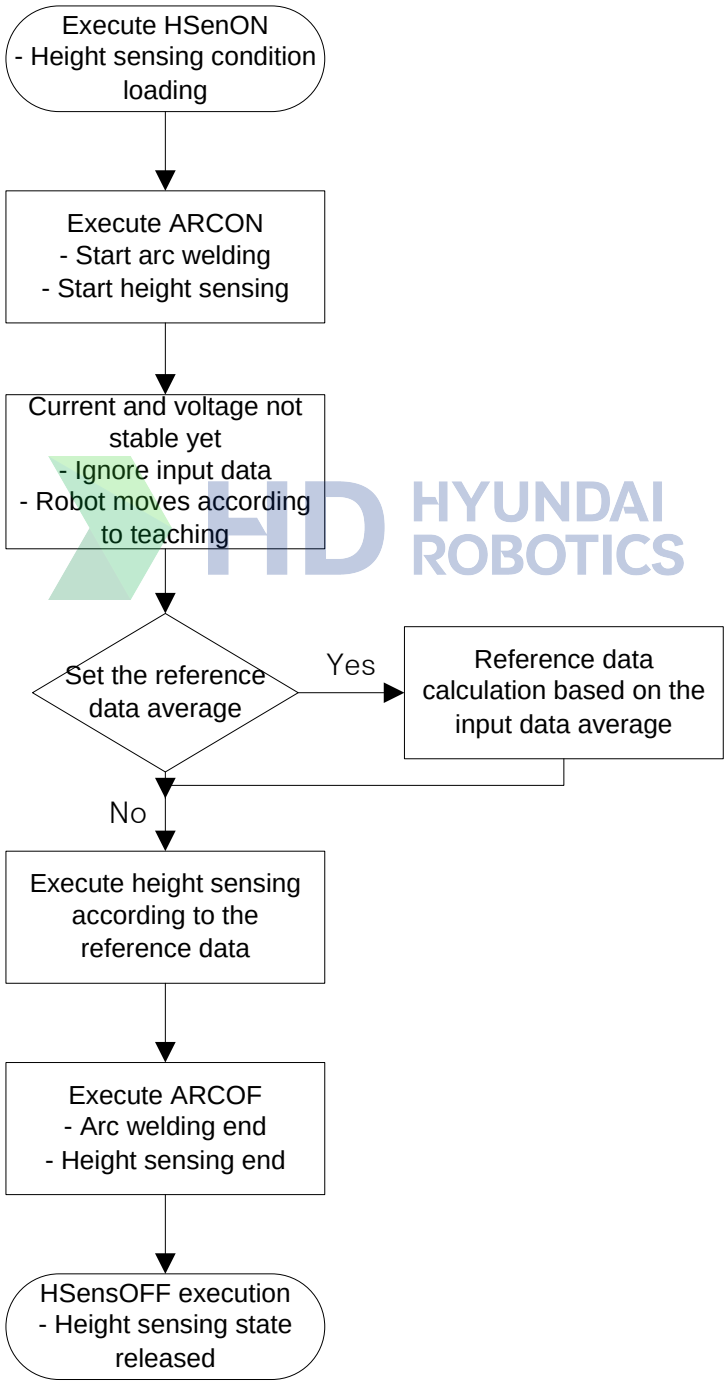


Figure 8.12 Height sensing function operating sequence

8.3.1. Height sensing condition

While in the “HSensON AVC#=??” command, press the [QuickOpen] key to enter the 『Height sensing condition』 setting screen. The condition setting screen is as shown below.

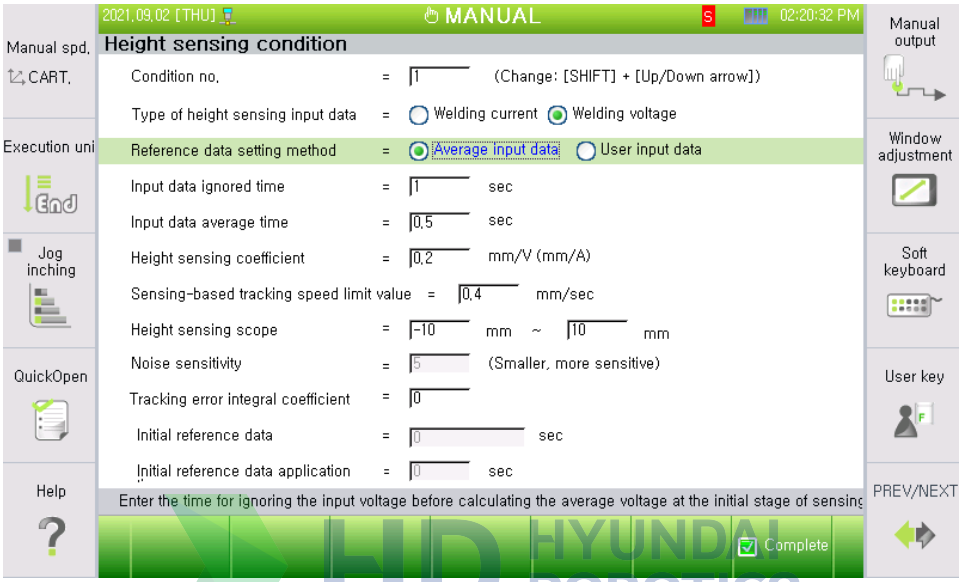


Figure 8.13 Height sensing condition dialog box (average input data)

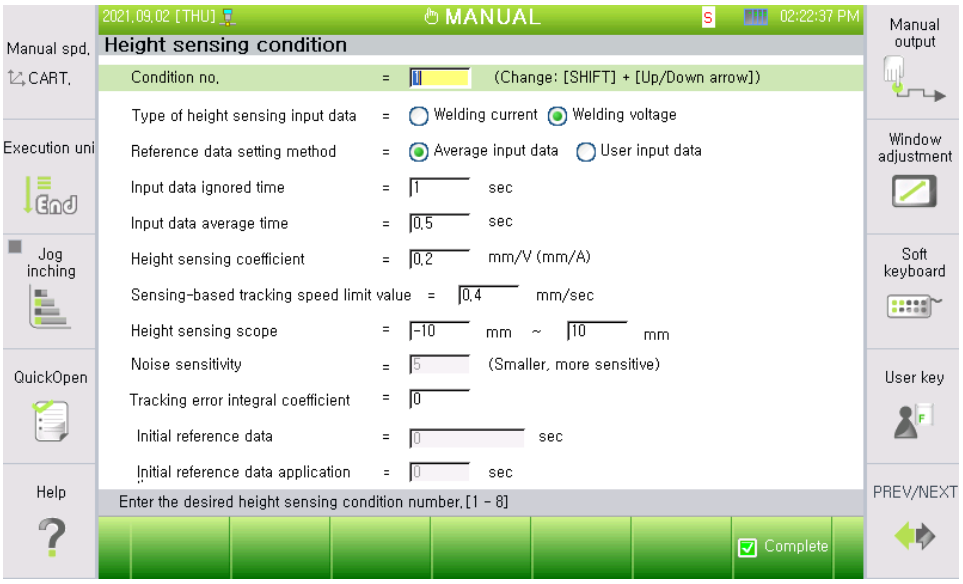


Figure 8.14 Height sensing condition dialog box (user input data)

The methods for setting and operating individual options are as below.

(1) Condition number: [1 ~ 8]
Sets the height sensing condition number.

(2) Height sensing input data type
Indicates the input data type. Welding current will be used for GMAW welding, and welding voltage will be used for TIG welding.

(3) Reference data setting method: 〈Average input data, User input data〉
Selects the reference data setting method.
- Average input data: Set based on the reference data average at the initial sensing stage.
- User input data: Users enter the reference data directly.

(4) Input data ignore time: [0.0 ~ 5.0]
This is the time during which the input data will be ignored because of the instability of the initial welding stage. After the initial welding stage, the average will be calculated and the sensing operation will start. If the “Average input data” is set as the reference data, the reference value will be calculated based on the average value during this designated period. If the “User input data” is used as the reference data, the height sensing operation will start immediately.

(5) Input data average time: [0.5 ~ 10.0]
Set the time required for calculating the average input data to compute the sensing reference data. The time will be displayed when the “Average input data” is selected in the reference data setting method. When the accurate reference height is not calculated.

(6) Reference data setting: [-500 ~ 500]
This item is for the user to input the reference value of height sensing directly. If the “User input data” is set as the reference data, this item will be displayed.

(7) Height sensing coefficient: [-100.0 ~ 100.0]
This value refers to the distance coefficient compared to the difference between input data. If this value decreases, the tracking amount in line with the input data also decreases so that tracking can be performed smoothly. If this value increases, tracking will become faster, but oscillation in upward and downward directions may occur on the trajectory.

(8) Speed limit value for tracking by sensing: [0.001–5.0]
It sets the maximum value for the tracking to be performed at 1 s. If this value decreases, the tracking will be performed smoothly, but tracking will become faster if it increases.

(9) Height sensing range: [-300.0 ~ 0.0], [0.0 ~ 200.0]
Sets the height sensing total tracking distance limit.

(10) Noise sensitivity
It sets the noise sensitivity of the input data. If this item is disabled, there will be no support for this version.

(11) Tracking error integral coefficient: [0.0–10.0]
It sets the compensation amount for the continuous error value among the tracking performance of height sensing. If a value greater than “0” is set, the tracking performance will be improved, but if the value becomes too large, oscillation on the trajectory will occur. Furthermore, it is necessary to select an appropriate value for the site by applying a minute value to begin.

(12) Initial reference data: [-500.0 – 500.0]
This item must be set if separate reference data should be applied at the initial welding stage. After the input data ignore time has passed, height sensing will be performed using this reference data for the time set in “Initially set time-based data application time.”

(13) Initial reference data application time: [0.0–10.0]
It sets the time to perform height sensing with the initial reference data. After this time has passed, height sensing will be performed based on the data inputted in the “Reference data setting” item.

8.4. Cooperation control arc function

This is the function to execute arc welding simultaneously in case more than 2 robots are in the cooperation condition using HiNet. In order to use cooperation control arc function, positioner group setting and common coordinate setting between more than 2 robots should be done first. Refer to 'Cooperation control function manual' for details of relevant cooperation control setting. This manual will explain only about how to use the cooperative controlled arc function while assuming that the cooperative control function is already set for the positioner and the common coordinates.

8.4.1. Overview

For this function, the following two settings need to be applied.

(1) Cooperation arc welding HiNet GE port setting

Set GE port to receive and send required signals during arc welding in cooperation control. 1 port for signal output and 3 ports for signal input can be set.
If 0 is set for a port, the input and output ports set for 0 will not be used.
Individual robots that will be used for the cooperative control have specific numbers (No. 1 ~ No. 4) and, depending on the numbers, different port numbers will be used for the input and output ports. The following shows the port numbers that can be used depending the robot numbers.

	Output port number	Input port number
Robot number 1	GE 1~4	GE 5~16
Robot number 2	GE 5~8	GE 1~4, GE 9~12
Robot number 3	GE 9~12	GE 1~8, GE 13~16
Robot number 4	GE 13~16	GE 1~12

※ Content per set GE bit

- Bit 0(ArcOn): To be set as '1' when the torch is on as the ARCON command is executed.
- Bit 2(WCR): To be set as '1' when there is an input of WCR of the robot as set.
- Bit 3(Retry): To be set as '1' until retry ends while the retry function is being performed..
- Bit 4(Overlap):
  To be set as '1' until overlapping ends while the restart function is being carried out.

- Bit 5(Dry Run):
  To be set as '1' in the arc simulation state in which the robot just moves without performing welding actually.

- Bit 6(ArcSt):
  To be set as '1' until the main moving operation is handled after the arc is turned on. The retry state is included.

(2) Remote WCR wait setting

For setting whether to start welding simultaneously after waiting for and receiving the Remote WCR signals sent from other robots, while the cooperative controlled arc function is being used. In case of Dry Run (Playback without welding), as the Remote WCR signal will not be sent, the cooperative controlled arc function cannot be applied. That is why is recommended to set the relevant condition as 'Disable' in case of Dry Run. When welding is carried out actually after this function is made invalid, synchronization may not work well in the welding range. Users are required to take precautions in using the system.

8.4.2. Operation

As shown below, if two robots are performing welding for one positioner at the same time, the cooperation control arc function will be used. In this situation, if the two robots do not carry out welding simultaneously, defective welding could be caused.

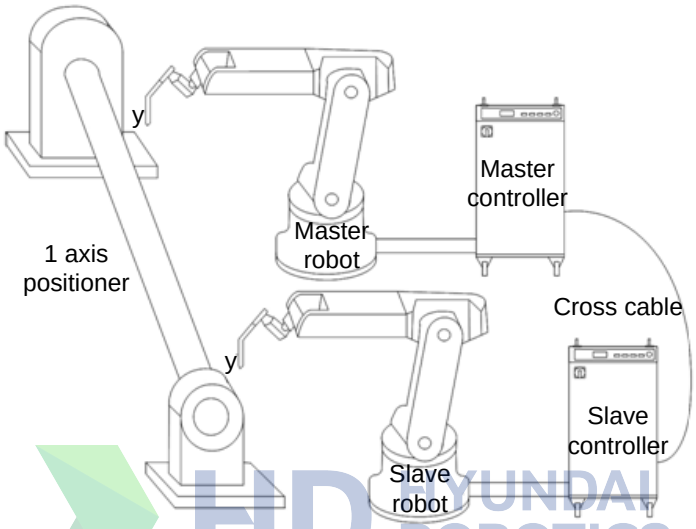


Figure 8.15 Conceptual diagram of cooperative controlled arc welding function

When the cooperation control is set, it is necessary to press the [QucikOpen] key in the “ARCON ASF#=??” command to enter the 『Welding start condition』 setting screen and then move to the next screen to bring up the additional menus as shown below. When the GB2/GZ4/GE2 welder is used, the cooperation control setting will be located on the third page of the 『Welding start condition』 setting screen.

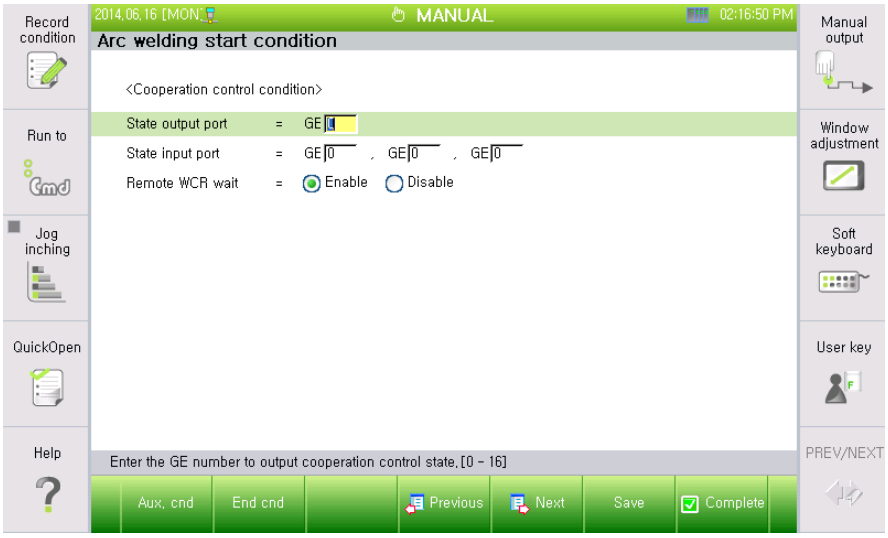


Figure 8.16 Arc welding start condition dialogue box when setting the cooperative control

Setting and operation per each item are as described below.

(1) In case the master robot number is 1 and the slave robot number is 2, the master side controller setting can be done as follows.
- State output port: GE4 (Select one among 1~4)
- State input port: GE8 (Match with slave size state output port)

(2) Slave side controller setting can be done as follows.
- State output port: GE8 (Select one among 5~8)
- State input port: GE4 (Match with master side state output port)

(3) Through the cooperative control, the two robots should be allowed to execute the ARCON command. Refer to the 'Cooperative Control Function Manual' for more details about the method.

(4) When two robots succeed the arc ignition simultaneously, two robots will move and execute arc welding simultaneously.

(5) If one robot fails the arc ignition, the other robot will stop arc and both robots will execute the retry function simultaneously. When two robots succeed the arc ignition simultaneously, two robots will move normally.

(6) If one of the two robots stops the arc welding due to stoppage or an error during the welding work, the other robot will also cease the arc welding work. When started again after the cause of the error is removed, the two robots will perform the overlap function together before enter the stage of performing the main welding work again.

(7) When only arc welding work on one side is finished normally during welding work by ARCOF, arc welding work on the other side will not be influenced by this.

8.5. LVS(Laser Vision Sensor) welding path tracking and detection function

This function will help recognize the welding path by using the LVS to detect and track the changed welding path in a given environment in order to provide stable quality in welding. LVS is installed near the torch mounted on the robot to recognize the detection target and send the relevant information to the robot. The robot moves the tool tip to the recognized location by using the received information. When the location of the welding workpiece is changed, making it impossible to perform welding at the existing teaching point, the robot will move the tool tip to the welding start point to ensure the starting of welding from the correct position.
In addition, while welding is in progress, LVS will keep recognizing the welding path and send this information to the robot, making it possible for the robot to perform accurate welding along the welding path. This function can help secure stable welding quality even when the location of the welding workpiece changes frequently or the welding path is not even.

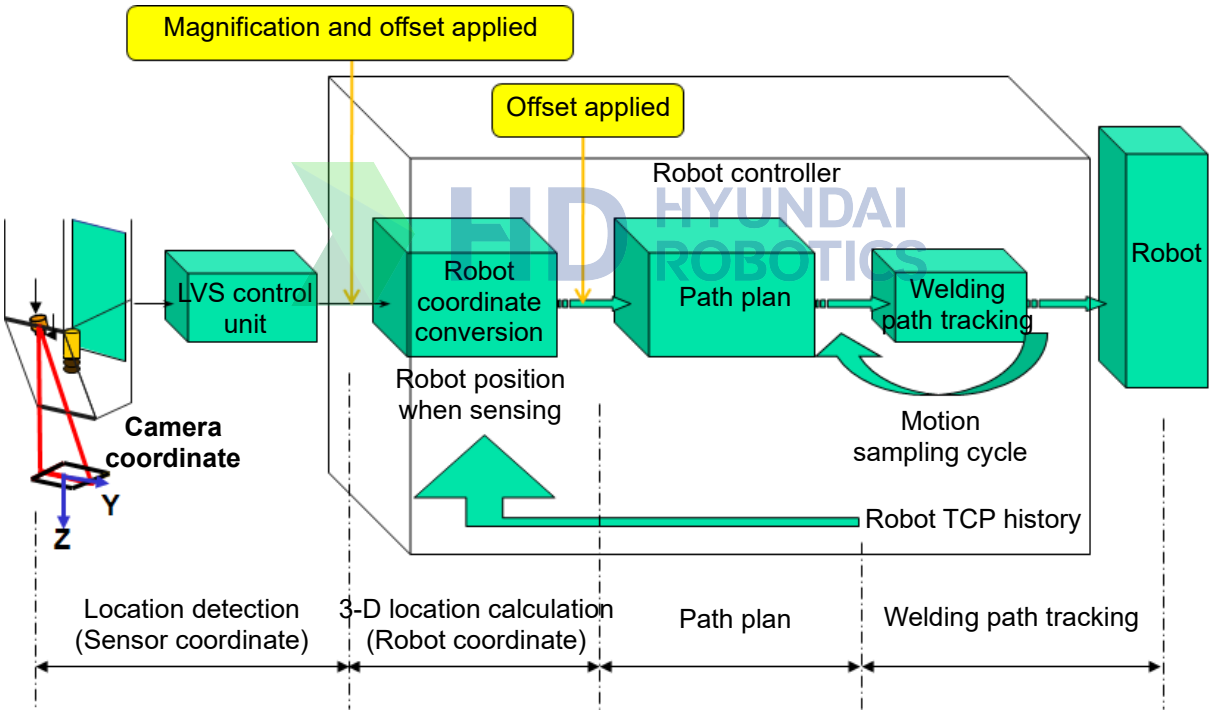


Figure 8.17 LVS welding path tracking data flow

The LVS welding path tracking and detection can be performed by using the LVSON command. For the environment setting of the function and specific details, it is necessary to refer to “LVS welding path tracking and detection function manual.” As this function requires an engineer’s assistance, it is necessary to contact the manufacturer.

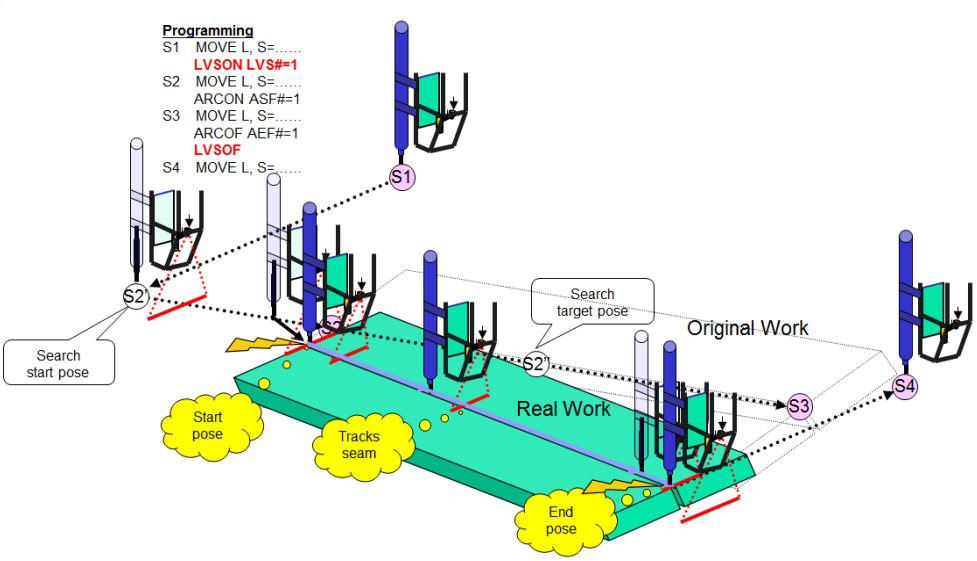


Figure 8.18 LVS welding path tracking data flow

8.6. LVS LVS-based welding condition change function

This function is used to change the welding current and voltage based on the width of the gap measured using LVS. This will optimize the welding condition based on the gap measured while tracking the welding path by LVS. If the workpiece has deformation due to heat, causing the gap to be uneven, the welding condition can be changed according to the variation of the gap to ensure stable quality in welding.

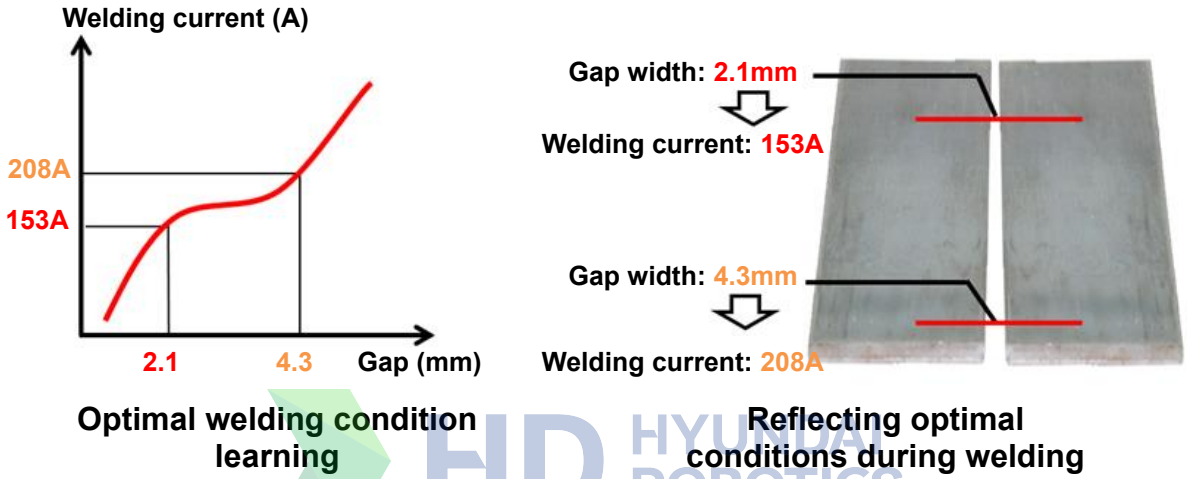


Figure 8.19 LVS-based welding condition change function

In order to seek the optimal welding condition, preset conditions will be used. Relevant user interface will be provided.

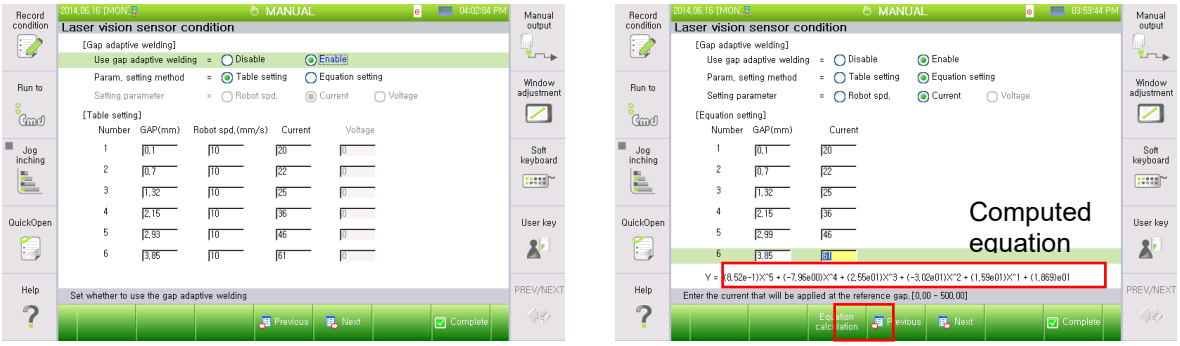


Figure 8.20 User interface for setting the optimal condition (Left: Table setting method. Right: Equation setting method

In order to set the change condition in the LVS-based welding condition change function, it is necessary to acquire preset conditions. Acquiring preset conditions means finding the welding conditions proper for the gap in the environment for which the function will be applied, ahead of applying the conditions. According to the gap, acquire the previous conditions and input into the provided user interface after performing the actual welding. When using this function, the users will be provided with the table setting method and the equation setting method. For the table setting method, 2 ~ 6 preset conditions need to be entered to change the current welding condition to a welding condition proper for the entered gap by implementing the linear interpolation between the entered preset conditions. For equation setting method, 2 ~ 6 preset conditions need to be entered to change the current welding condition to a welding condition proper for the entered gap by implementing the curved interpolation between the entered preset conditions.

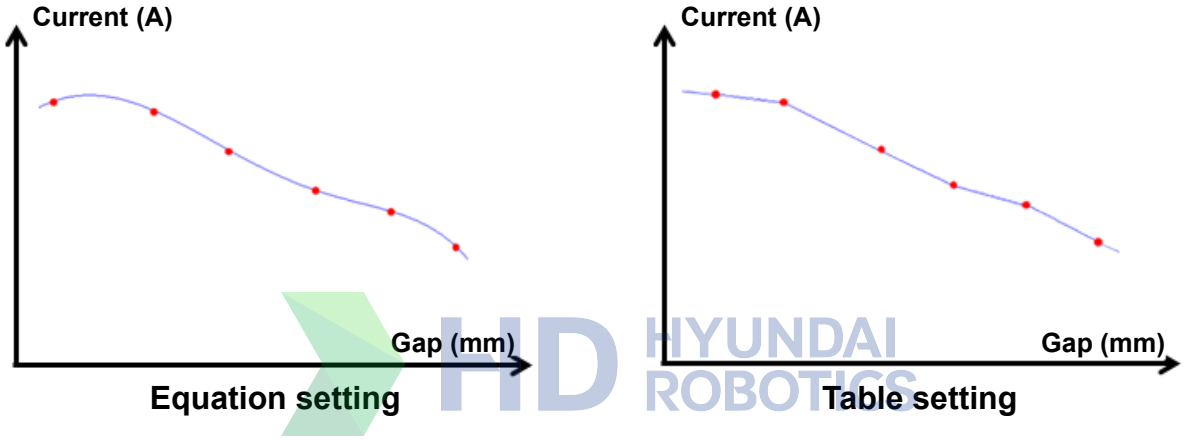


Figure 8.21 Condition change depending on the setting methods

8.7. STITCH function

8.7.1. Overview of the STITCH function

Stitch welding is a function for performing welding intermittently, like sewing. Figure 8.23 shows stitch welding in which the starting and end points are set on the specimen for the stitch welding to be performed. It will be done in a stitch pattern where welding section “a” and nonwelding section “b” are set, as shown in Figure 8.22.

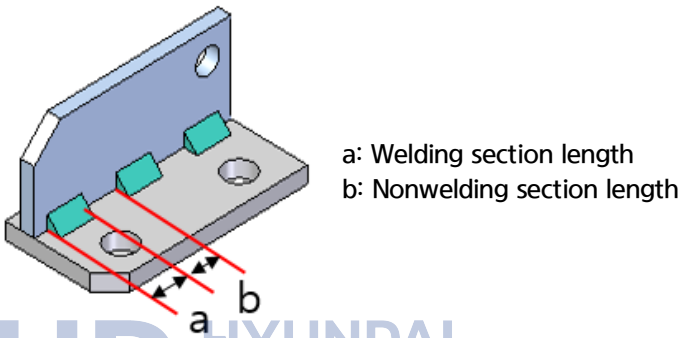


Figure 8.22 Basic parameters for the STITCH function

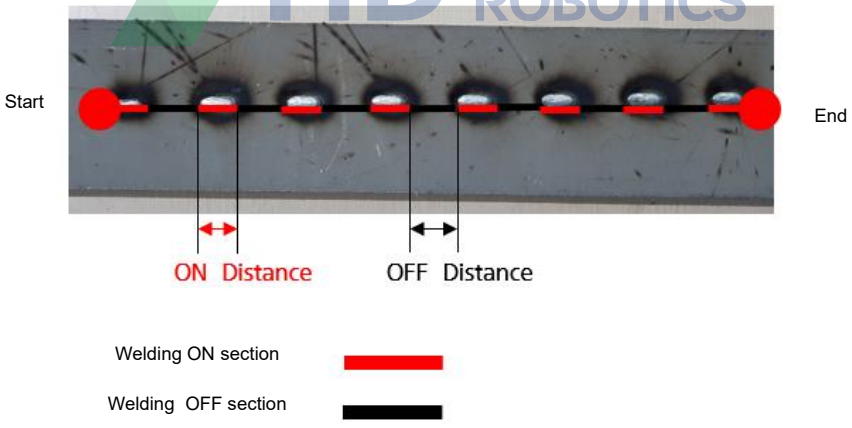


Figure 8.23 Stitch welding test specimen

Figure 8.24 presents a schematic diagram illustrating the stitch welding process. In line with the recording, the robot will move from position P [1] to P [4]. The P [2] and P [3] sections are for stitch welding, which will be performed through the “STITCH ON” and the “ARCON” command at the P [2] position. After moving to the P [3] position, the robot will execute the “STITCH OFF” and “ARCOF” commands to finish the procedure. After the work is completed, the robot will move to the next step, P [4].

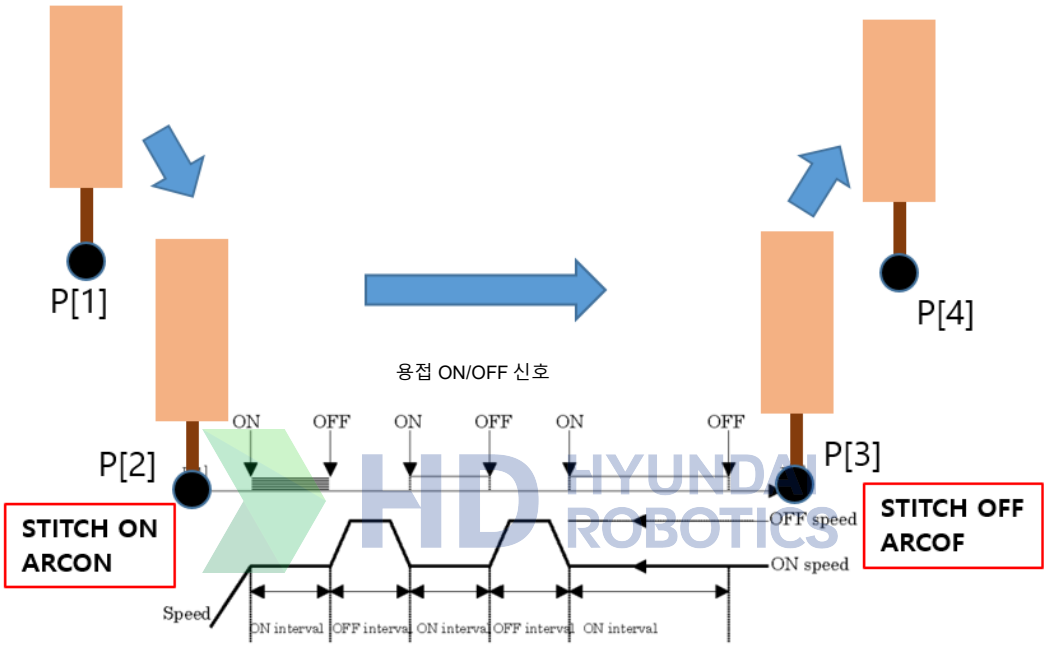


Figure 8.24 Stitch welding process

8.7.2. Creating the STITCH command

Inputting the STITCH command

1. Input the command → 2. Arc → 3. STITCH (Select “ON/OFF,” and then click the “ENTER [YES]” button.)

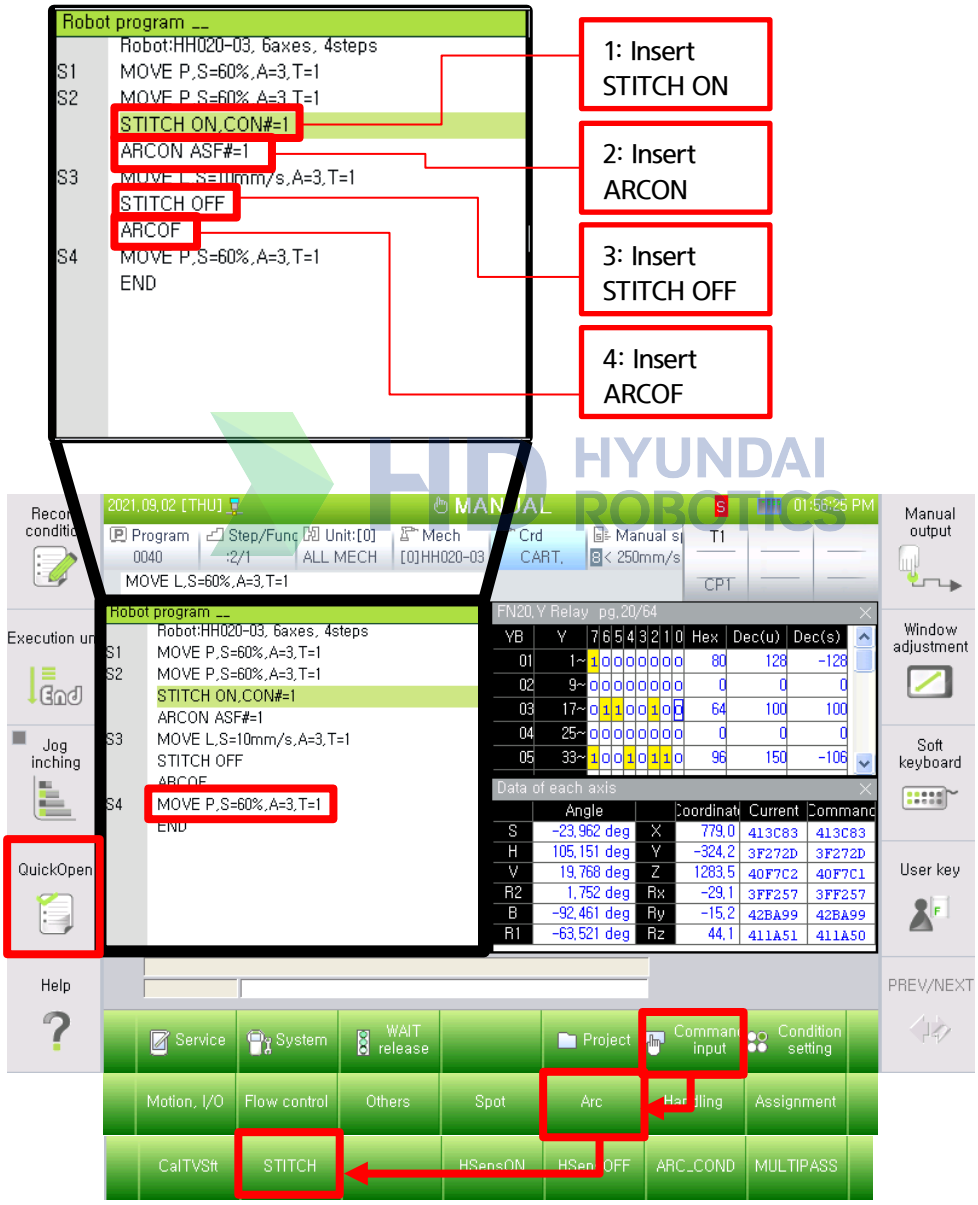


Figure 8.25 Example of creating the STITCH command

Caution

1. S3 MOVE L, S=10mm/s, A3, T1
   - ➔ L: Linear interpolation must be selected
   - ➔ 10mm/s: Welding speed, speed in ON section of stitch welding, Unit must be selected as mm/s
2. Used together with ARCON / ARCOF commands → Need to run in weld zone
3. Stitch welding is in progress, It restarts after emergency stop or playback stop, but Stitch does not restart when rebooting after power off the controller

8.7.3. Setting STITCH function parameters

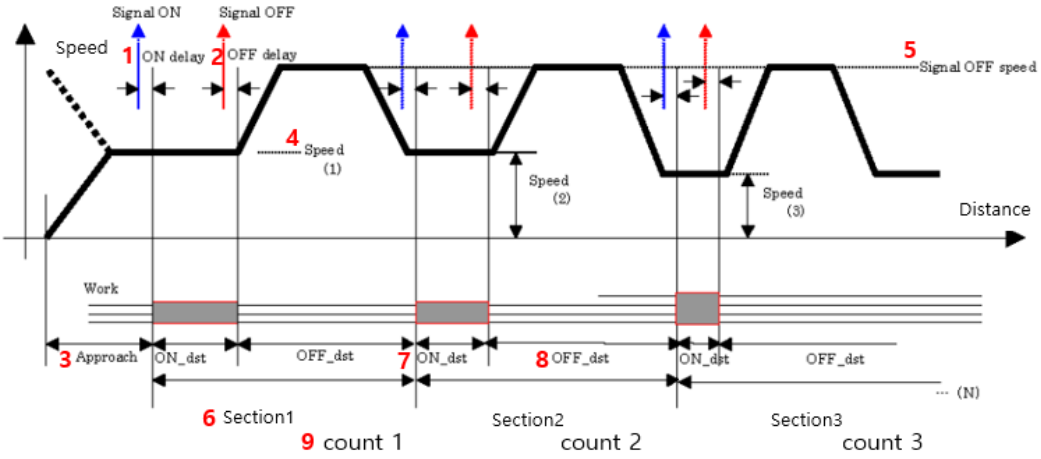


Figure 8.26 Profile in line with the stitch welding process

Figure 8.26 displays a screen you can access by pressing the “Quick Open” button in the “STITCH” command, while Figure 8.27 presents the screen where you can enter with the “Signal Port (F1)” button in Figure 8.26. Moreover, Figure 8.28 shows the screen of a job program for which the command is used. The parameters of the number marked in red in Figures 8.26–8.28 can be described below.

Condition no.: Select with the “Shift” + direction keys.
Description: Can be inputted using the soft keyboard
1. On signal delay time
→ Time for the welding signal to be turned on in advance
2. Off signal delay time
→ Time for the welding signal to be turned off in advance
3. STITCH preparation distance
→ Section length for entering the “On” section speed before stitching
4. ON speed: Welding speed at the welding section
5. OFF speed: Welding speed at the nonwelding section
6. Section: Stitch welding condition
Ex.: If the stitch welding under the section 1 condition progresses as much as the count, the stitch welding corresponding to the section 2 condition will progress.
7. ON_dst: Welding section length
8. OFF_dst: Nonwelding section distance
9. Count: Stitch welding count
Stitch Enable / Equipment Enable / Equipment Output
→ Stitch welding will progress during playback only when “1” is inputted for the three parameters.

** Only after all data are inputted in “7. ON_dst,” “8. OFF_dst,” and “9. Count” will it be possible to input the conditions for section 2.
**Inputting “1all” in “10. STITCH Enable Port,” “11. Equipment Enable Port,” and “12. Equipment Output Port” is required for stitch welding to be performed during playback. Otherwise, only the stitch operation will proceed (Welding X).
**4. ON speed: In the stitch section, the speed of the welding (ON) section should be set as the step

speed.

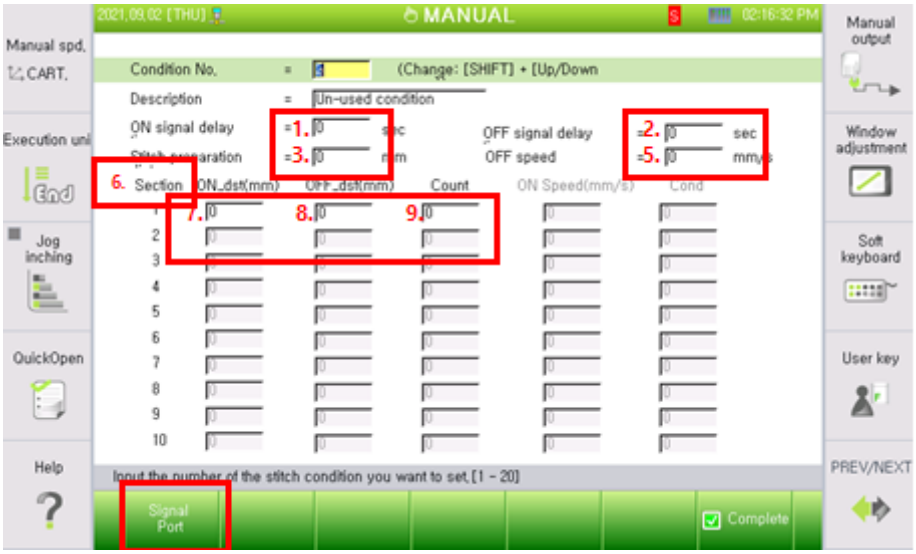


Figure 8.27 Stitch welding parameter setting no. 1

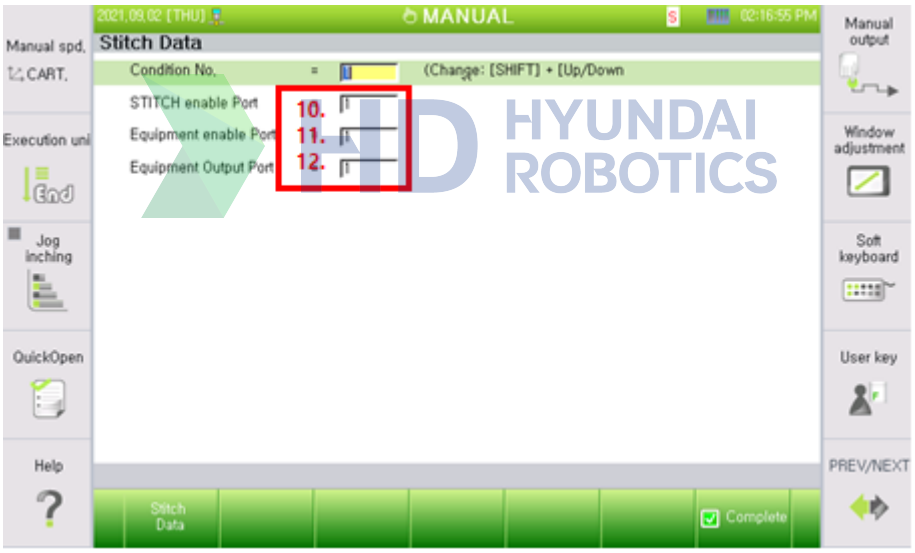


Figure 8.28 Stitch welding parameter setting no. 2

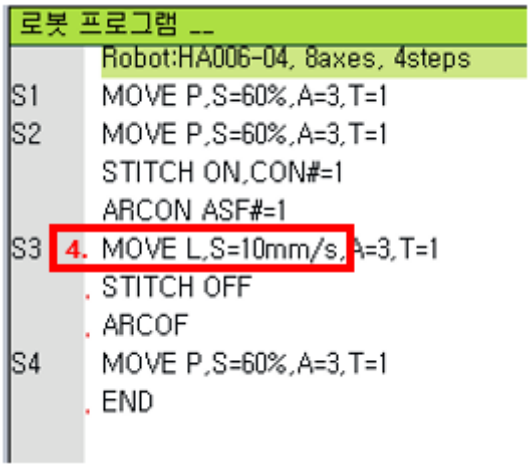


Figure 8.29 Stitch welding parameter setting no. 3

HYUNDAI ROBOTICS

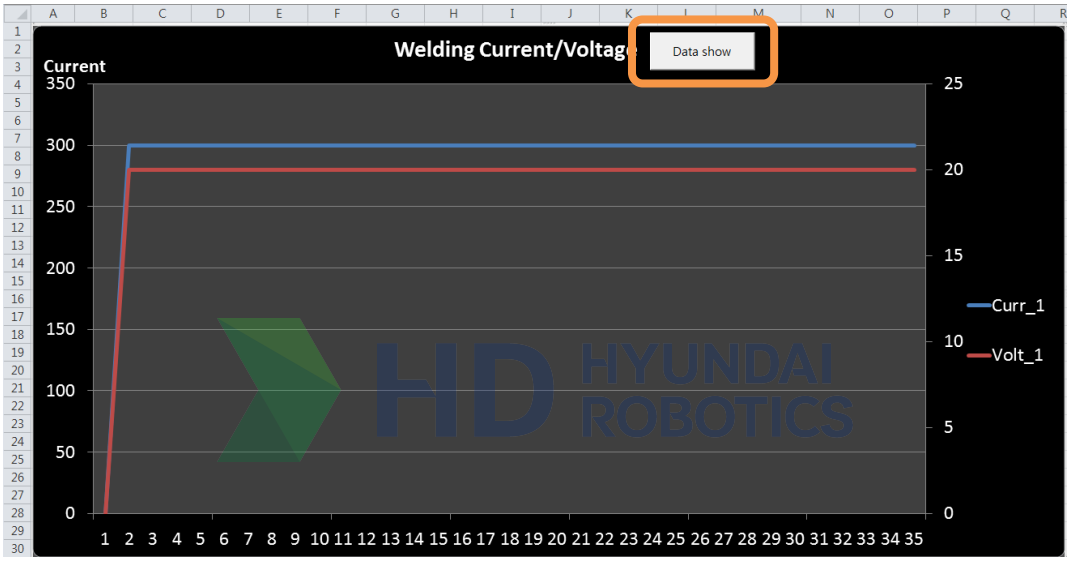
9 Appendices

9.1. How to check welding data with PC

9.1.1. Basic function

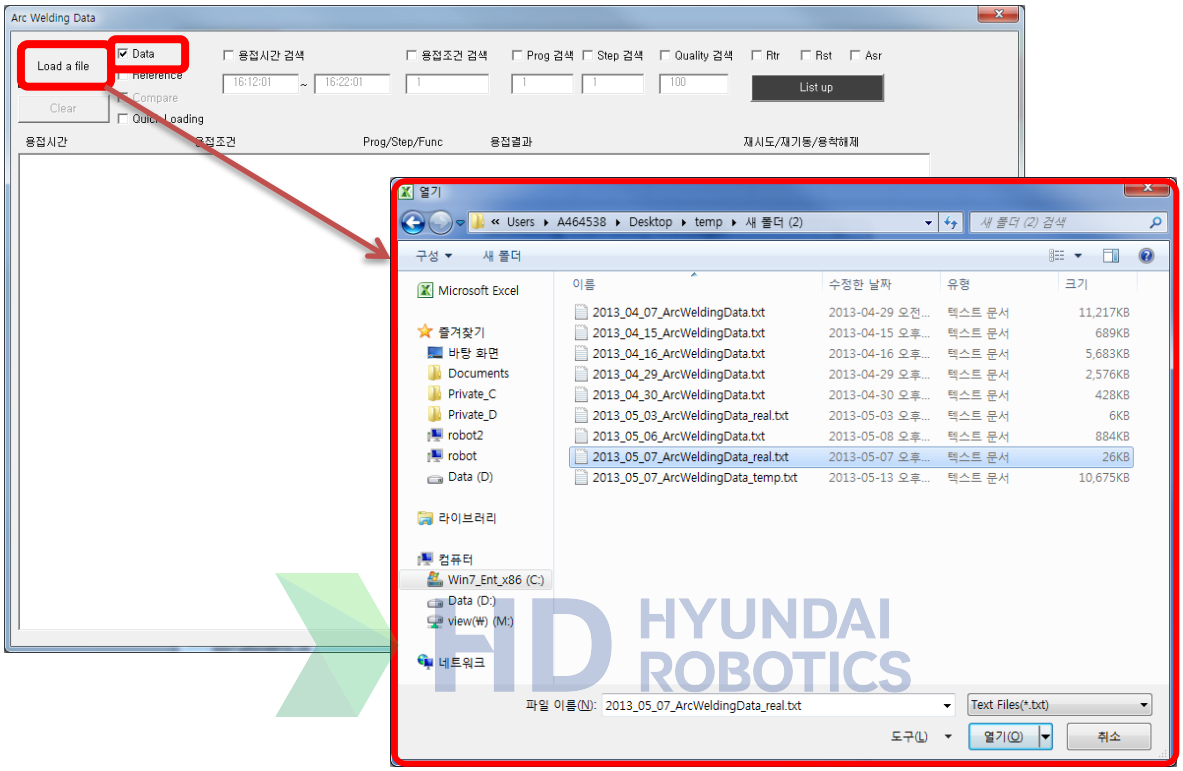
9.1.1.1. View dialog box

- Open the "xlsm" file, and then click the "Drawing Graph" button.
- The "Arc Welding Data" dialog box will then pop up.



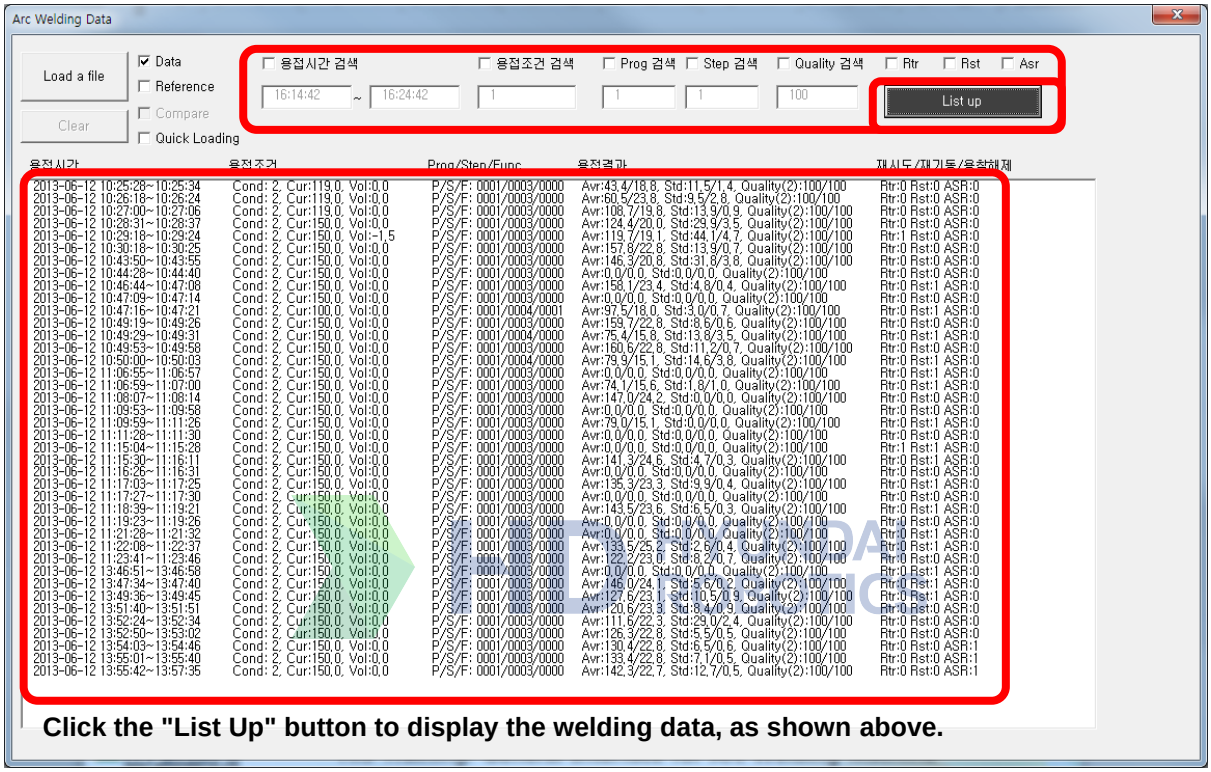
9.1.1.2. Select the arc welding data file.

- Tick "Data," and then click the "Load a File" button.
- Select the arc welding data file to check, as shown below.



9.1.1.3. Set the search conditions.

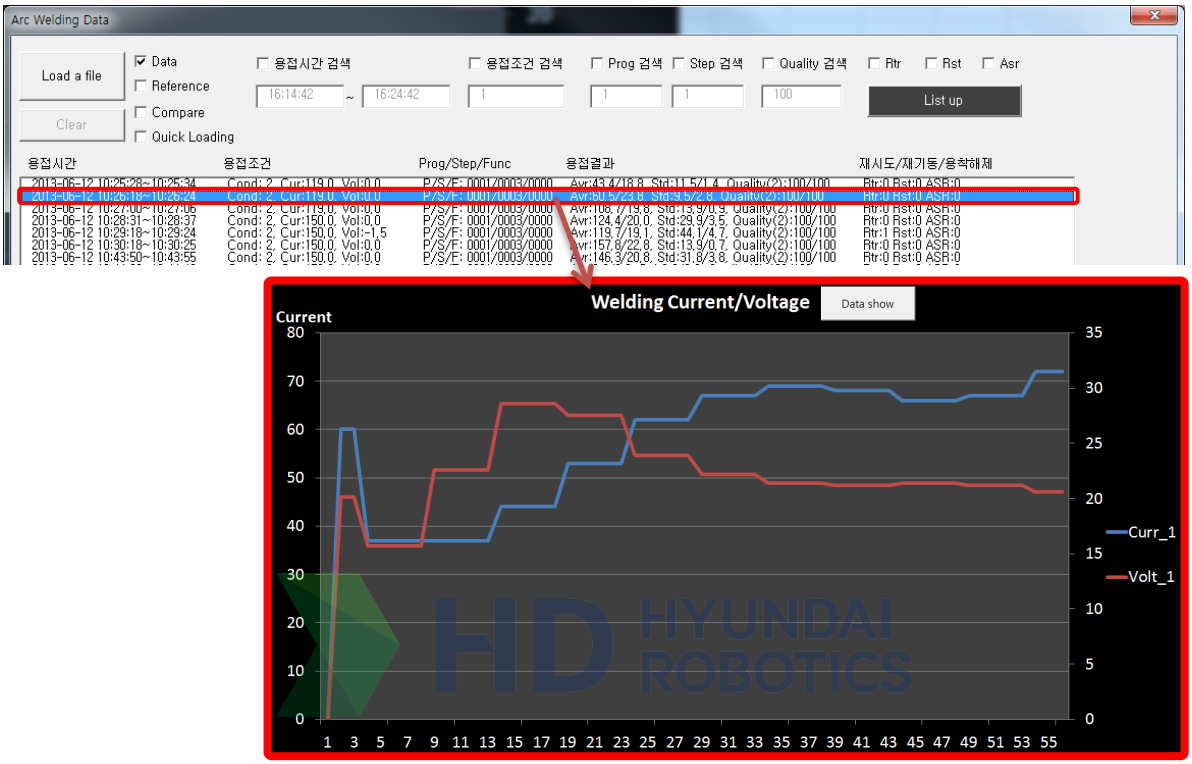
- Enter the search conditions. (Otherwise, all welding data will be loaded.)
- Press the "List Up" button to display the welding data, as shown below.



Click the "List Up" button to display the welding data, as shown above.

9.1.1.4. Select the data

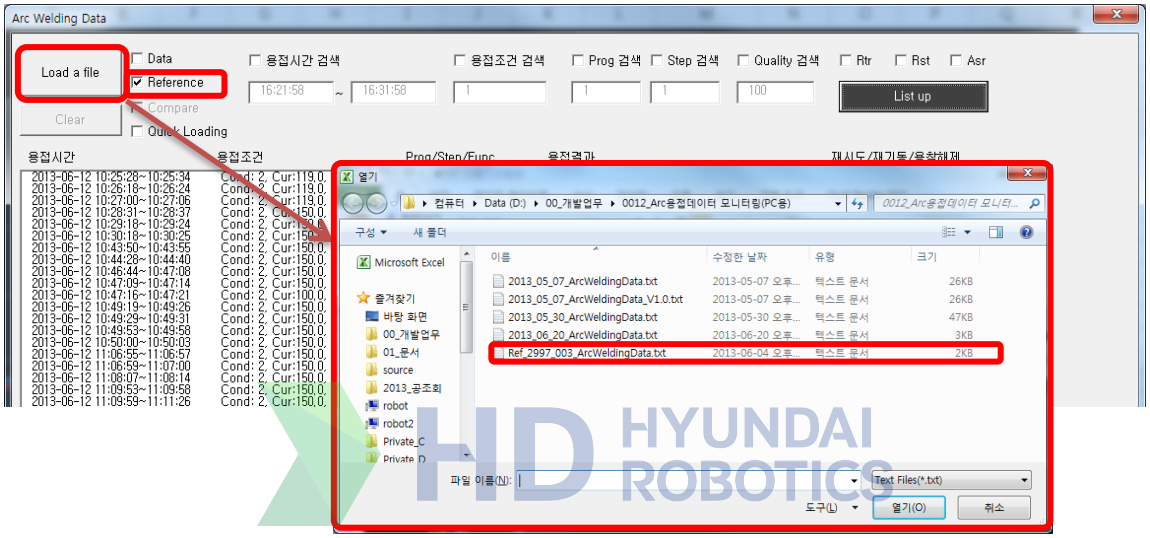
- Select one of the lists displayed.
- The welding graph is displayed on the Excel graph.



9.1.2. Reference file

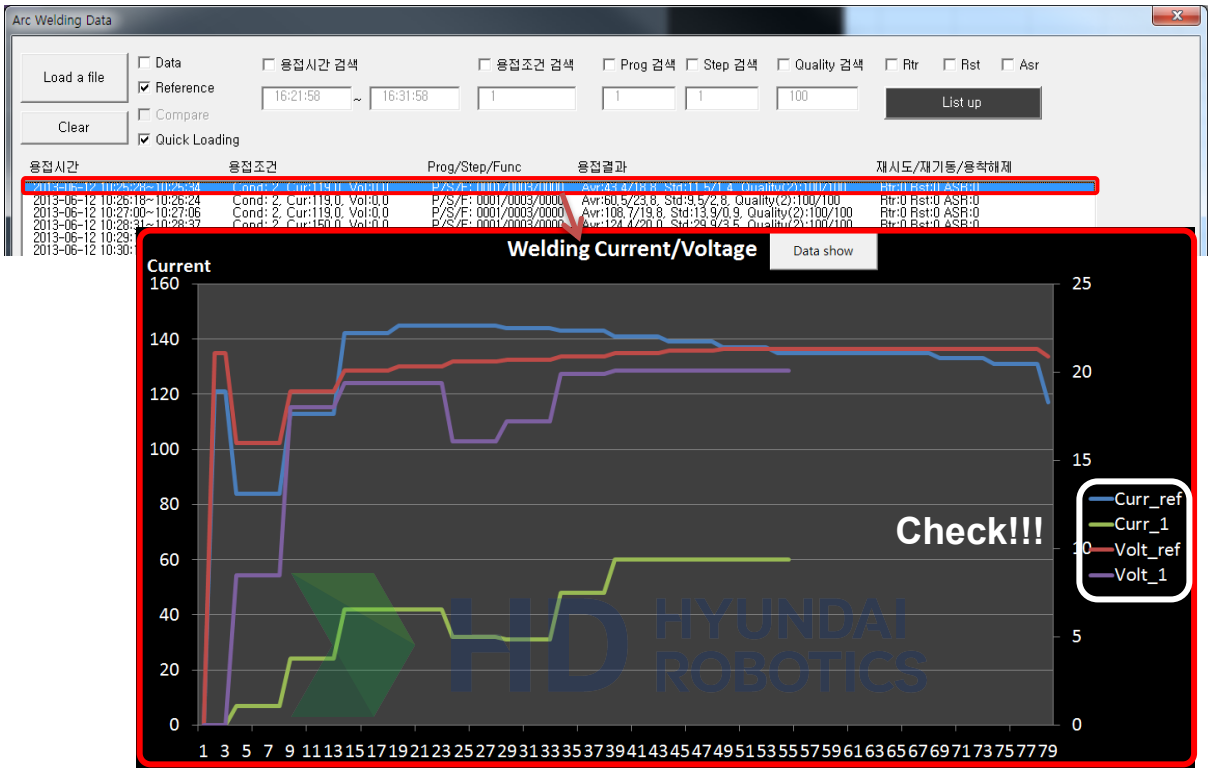
9.1.2.1. Select the reference file

- Tick "Reference," and then click the "Load a File" button.
- Select a reference file to check in the dialog box.
- A graph is then drawn for the reference file and fixed to compare with the other data.



9.1.2.2. Select the data to compare

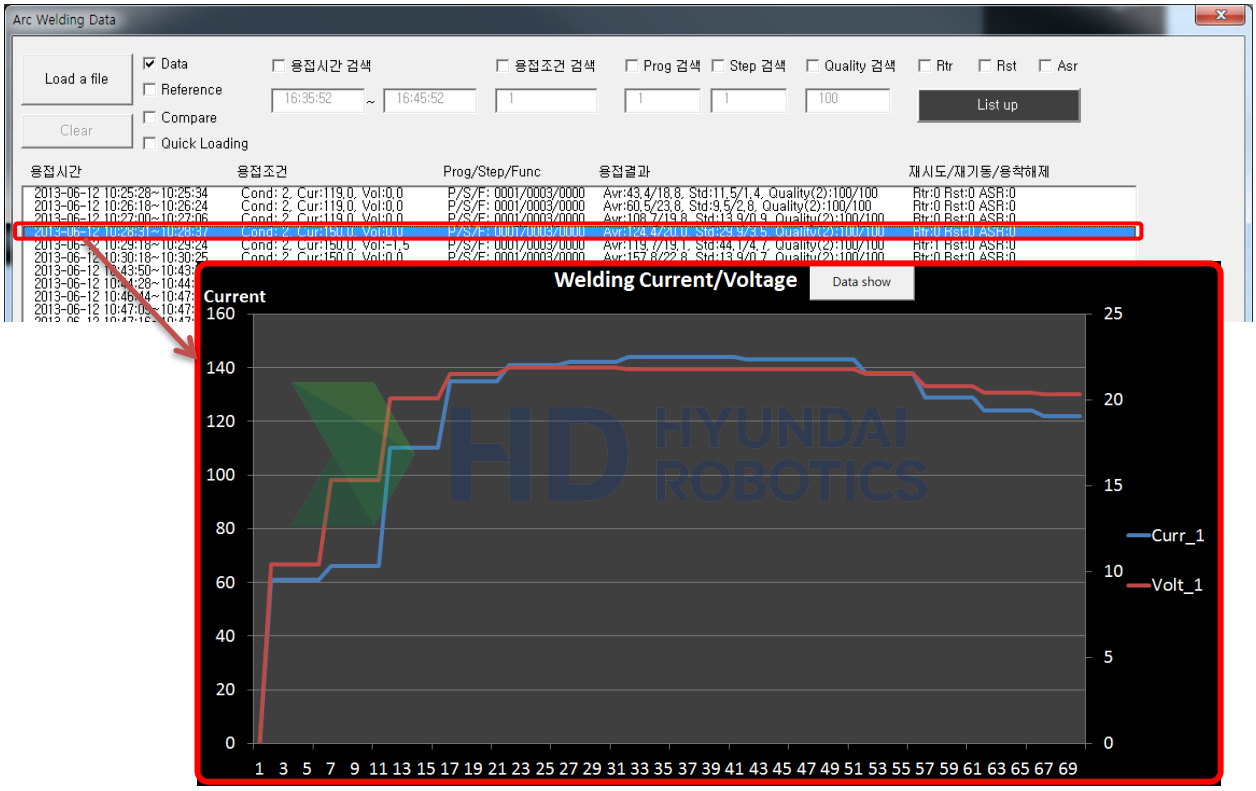
- With the reference graph fixed, select the data from the list to draw a graph so as to compare the data with the reference data.



9.1.3. Comparison

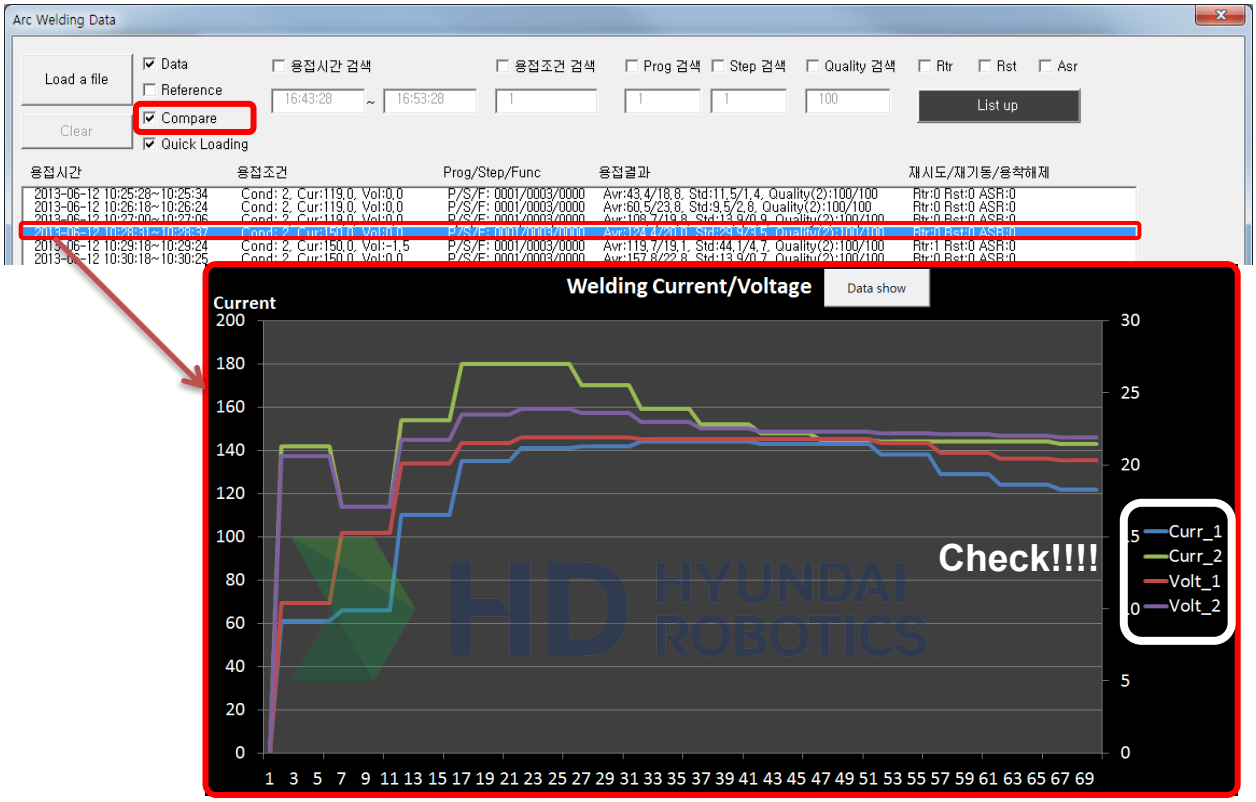
9.1.3.1. Select the first data

- To fix general data as a reference subject instead of reference data.
- It works in comparison mode until the "Clear" button is pressed.
- Select the first data to fix in the list.



9.1.3.2. Select the second data

- Tick "Compare," and then select the second data to compare.
- The comparison results of both data are then drawn on the Excel graph.



9.1.4. Other functions

- Quick loading
  - Tick "Quick loading" to load the files quickly.
  - However, the loading dialog box may show a "No Response" message. (However, it will continue loading.)
  - It is recommended only for loading large data.

- Clear
  - To initialize an Excel graph
  - The loaded data and the search conditions are maintained.
  - If a reference file is loaded and then cleared, it is not displayed.
  - If this function is used for comparison, the comparison is disabled.

- Welding search result
  - Data of a certain value or lower can be displayed among numerical welding results. However, the welding results must be saved as numerical values.

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