HD HYUNDAI
ROBOTICS
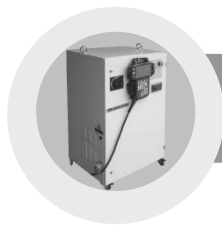
WARNING

INSTALLATION SHOULD ONLY BE PERFORMED BY QUALIFIED INSTALLATION PERSONNEL AND MUST CONFORM TO ALL NATIONAL AND LOCAL CODES

Hyundai Robot

Hi5a Controller Function Manual

Spot welding

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Introduction

This manual provides explanation based on the following systems below. If individual systems on sites are different, the site workers are required to follow the manual to meet their requirements.

Specifications of the system used in this manual

Robot-gun (Welding gun change):
Servo-gun (G1), Servo-gun (G2), EQless-gun (G3), Eq-gun (G4)

Stationary-gun: Servo-gun (G5), Servo-gun (G6), EQless-gun (G7)

(1) Servo-gun
This gun carries out squeeze and opening operation by delivering the turning force of the servo motor to the ball screw to operate GUN TIP, and is used by setting it as an additional axis of the robot. The robot will carry out the equalization process during welding operation.

(2) Eq-gun
A spot-gun that carries out squeeze and opening operation by air pressure, the Eq-gun controls welding operation with welding condition and welding (applied current) output signal, and mechanically carries out the equalization process at the time of welding operation.

(3) EQless-gun
A spot-gun that carries out squeeze and opening operation by air pressure, the EQless-gun controls welding operation with welding condition and welding (applied current) output signal. As this gun does not have a cylinder that will carry out equalization at the time of welding operation, the robot will carry out the equalization process.

Required manuals

- Hi5a controller operation manual
- Hi5a additional axis function manual

1.1. Main specifications

Item	Specifications
Spot welding setting file	ROBOT.SWD
Maximum number of welders	4
Number of multi-gun simultaneous welds (the same gun type)	4
Number of welding gun changes	16
Welding condition number	1 ~ 1024
Output data due to welding condition	1 ~ 1024
Welding sequence number	1 ~ 63 (64 is only for tip dressing)
Location change(Servo gun)	SPOT command step – Location of consumption automatic compensation Other steps – Locations where consumption is not considered
Air gun opening and closing	Assign X1~X4 as an option of MOVE command
Gun Number correspond Tool Number test	Robot-gun will be tested; Stationary-gun will not be tested
Welding condition signal output	Output by synchronizing when welding execution signal is output Welding condition signal cannot be output separately.

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1.2. The sequence of operation
1.2.1. Operation sequence by using the servo gun autosetting

Initialize system	Execute system initialization (『[F2]: System』 → 『5: Initialize』 → 『1: System format』) * Refer to Hi5a controller operation manual

▼

Select robot type	Select robot type and register number of additional axis (『[F2]: System』 → 『5: Initialize』 → 『2: Robot type selection』) * Refer to Hi5a controller operation manual

▼

Additional axis parameter setting	Register the additional (servo gun) axis information. (『[F2]: System』 → 『5: Initialize』 → 『5: Additional axis parameter setting』) * Refer to the Hi5a Additional Axis Function Manual. - AMP specification = SAZ-2 - Motor specification = 2.0 kW – TSM1008N8220E735 - Acceleration time = 50 ms (Recommended)

▼

Re-insert power	

▼

Setting usage	Set welding usage, initialize input/output signal and user key assignment (『[F2]: System』 → 『5: Initialize』 → 『3: Usage setting』) * Refer to Hi5a controller operation manual

▼

Re-insert power	

▼

Servo gun autosetting	Progress the standard procedure of the servo gun setting. (『[F2]: System』 → 『4: Application parameter』 → 『1: Spot welding』 → 『8: Servo gun autosetting』) * Refer to Chapter 3 Servo gun initial setting.

▼

Preparation of the program	Prepare the spot-welding operation program. * Spot welding by using the **SPOT** command * Tip dressing by using the **SPOT** command * Measure the tip consumption by using the GUNSEA command.

▼

Automatic operation	

1.2.2. Operation sequence by using the servo gun manual setting

Initialize system

Execute system initialization
(『[F2]: System』 → 『5: Initialize』 → 『1: System format』)
* Refer to Hi5a controller operation manual

▼

Select robot type

Select robot type and register number of additional axis
(『[F2]: System』 → 『5: Initialize』 → 『2: Robot type selection』)
* Refer to Hi5a controller operation manual

▼

Setting additional axis constant

Register additional (Servo-gun) axis information
(『[F2]: System』 → 『5: Initialize』 → 『5: Additional axis parameter』
* Refer to Hi5a additional axis function manual
 - AMP specification = SAZ-2
 - Motor specification = 2.0KW‐TMS1008N8230E735
 - Acceleration time = 50ms(Recommended)

▼

Re-insert power

▼

Setting usage

Set welding usage, initialize input/output signal and user key assignmen
(『[F2]: System』 → 『5: Initialize』 → 『3: Usage setting』)
* Refer to Hi5a controller operation manual

▼

Re-insert power

▼

Encoder offset setting

Register the origin of encoder
(『[F2]: System』 → 『3: Robot parameter』 → 『4: Encoder offset』)
* Refer to Hi5a controller operation manual
* A location of servo gun being completely opened mechanically

▼

Axis origin setting

Setting axis constant
(『[F2]: System』 → 『3: Robot parameter』 → 『2: Axis origin』)
* Refer to Hi5a controller operation manual
* A location of new tips of servo gun contracting each other

▼

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Setting Tool No. gun type corresponding to spot-gun

Setting Too; No., gun type corresponding to gun No.
(『[F2]: System』 → 『4: Application parameter』 → 『1: Spot welding』 → 『1: Set tool number and gun-type』)

▼

Re-insert power

▼

Setting tool data

Robot-gun : Use load estimation function
(『[F2]: System』 → 『6: Auto calibration』 → 『4: Load estimation function』)
Stationary gun : Register user's coordinate system
(『[F2]: System』 → 『2: Control parameter』 → 『7: Coordinate registration』 → 『1: User coordinate』)
* Refer to Hi5a controller operation manual

▼

Setting spot welding parameter

Setting various parameters for spot welding
(『[F2]: System』 → 『4: Application parameter』 → 『1: Spot welding』)
『2: Environment setting』
『3: Welding gun parameter』
『4: Welding data (Dnd, Seq)』
『5: Input signal setting』
『6: Output signal setting』
『7: Servo gun squeeze force automatic tuning』

▼

Measure wear loss of tip

Execute gun search

▼

Prepare program

Prepare spot-welding operation program
* Spot welding by using SPOT command
* Tip dressing by using SPOT command
* Measure the tip consumption by using GUNSEA command

▼

Automatic operation

1.3. Terms according to movements between servo-gun electrodes

Moving tip				
Fixed tip				PANEL

Soft Limit (Minimum) Encoder offset reference point	Large stroke	Small stroke	CLEARANCE
Maximum range of operation	Users set the range. Smaller than the soft limit (min.) and larger than the small stroke	Users set the range. Smaller than the large stroke limit (min.) and larger than the clearance	Distance to be wider automatically after the squeeze starts or progresses.

Moving tip		Position where the new tip touches slightly
Fixed tip		

Welding point Record location	Axis origin	Soft Limit (Maximum)
State in which the fixed/moving tip contacts the panel	A new tip is mounted and the distance between the two tips is 0.	Minimum operation ranges after the two tips are removed.

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2

Servo gun
initial setting

2.1. Servo gun initial setting procedure

This function is related to spot and other applications for which a servo gun is used. If you are using a different kind of gun (air gun) instead of the servo gun, refer to "Setting of tool number and gun type corresponding to the gun number" and "Tool angle/distance setting" in this chapter as well as "Relevant functions" in the next chapter.

The servo gun initial setting is a compulsory step to create a state in which spot welding can be performed using a servo gun. After completing the initial setting procedure, you can do the following.

- Operating the servo gun moving tip
- Squeezing with the designated squeeze force
- Inputting/outputting signals for spot welding

After completing the initial setting procedure, set the relevant functions and spot welding parameters (welding conditions, sequence, etc.), and carry out work teaching according to the purpose of use.

Through the "Servo gun autosetting function" (『[F2]: System』 → 『4: Application parameter』 → 『1: Spot welding』 → 『8: Servo gun autosetting』), the company provides the settings for spot welding, servo gun operation environment, and relevant procedures.
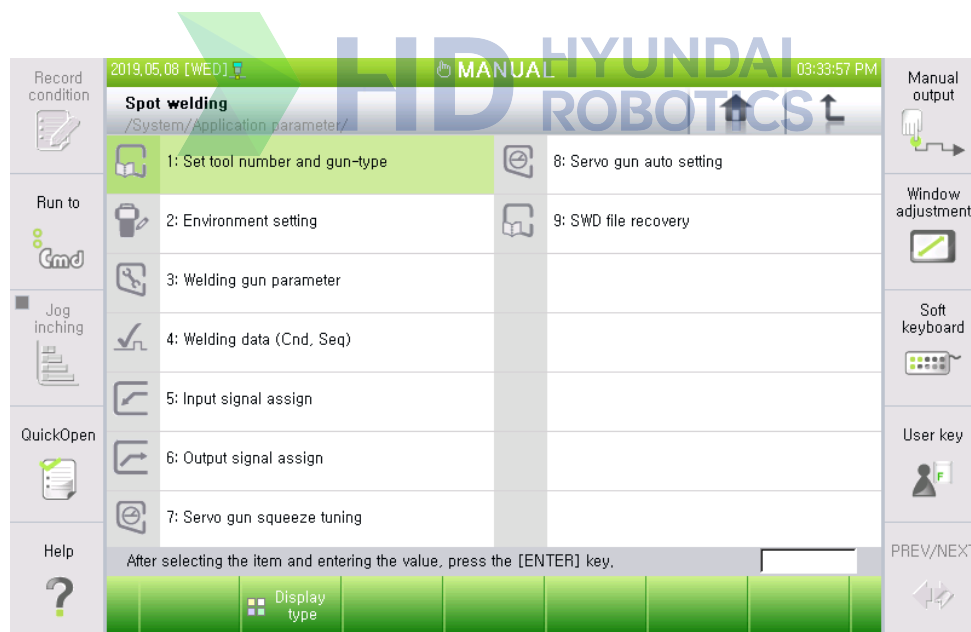
Figure 2.1 Screen for entering the "Servo gun autosetting" menu

Caution: This menu can be entered only when the currently selected gun number is for a servo gun ("Additional axis parameter setting," "Load estimation," "Tool data input," and "Tool number and gun type corresponding to the gun number" are compulsory items that must be set before the servo gun autosetting process.)
If you will use multiple guns, proceed with individual settings while changing the gun number.

The initial setting for the servo gun and spot welding is divided into five steps as follows. The progress status of each step will be indicated for monitoring.
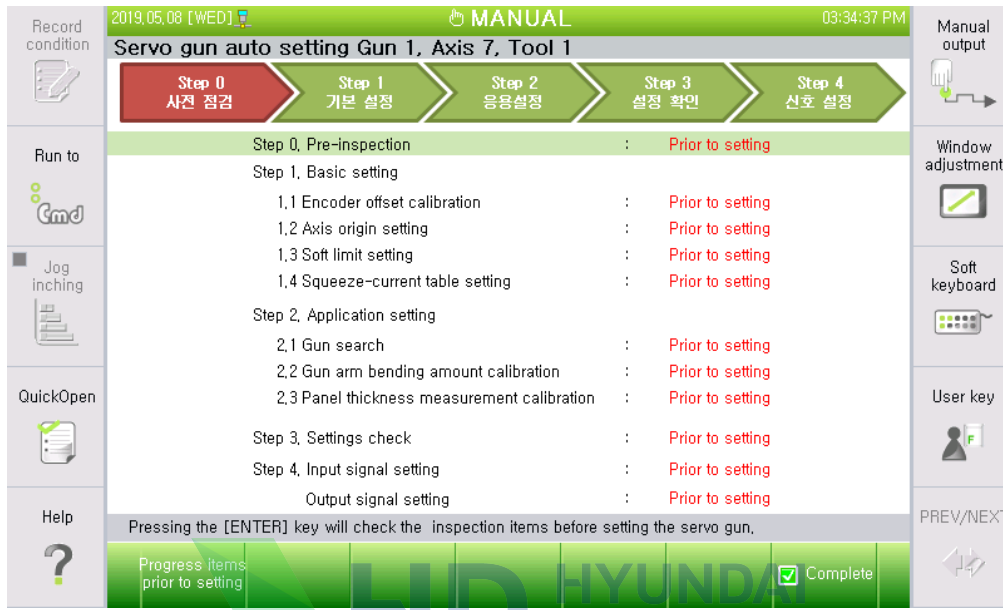

Figure 2.2 Standard procedure for servo gun initial setting

The standard procedure for servo gun initial setting is as follows.

(1) Precheck: Check the compulsory preset items to set the servo gun operation environment.
   − Additional axis parameter
   − Setting of the tool number corresponding to the gun number
   − Tool data (including load estimation) setting
   − Servo gun parameter setting
(2) Basic setting: Setting of the servo gun operation environment
   − Encoder offset compensation
   − Axis origin setting
   − Soft limit setting
   − Squeeze force – current table setting
(3) Application setting: Setting for the application functions that use the servo gun
   − Gun search
   − Gun arm bending compensation
   − Panel thickness measurement compensation
(4) Confirmation of the setting: Process to confirm the present setting
Input/Output signal setting: Assignment of input and output signals for spot application

The screen for the servo gun initial setting standard procedure not only shows the indication process and completion status but also makes it possible to progress related items or move to a screen that can progress related items.

In other words, the initial setting related to the servo gun can all be completed in the screen above without moving to related menus. There are two ways to progress in the initial setting.

(1) Move to the relevant procedure using the cursor, and press 『[Enter]』 .
(2) Press 『[F1]: Progressing the items not set』 to allow the initial setting to be automatically progressed.

The 『[F1]: Progressing the items not set』 key will enable you to check all procedures to find any procedure that has not been progressed and then allow it to be automatically progressed. When it comes to the initial setting, after pressing the 『[F1]: Progressing the items not set』 key, you can complete the setting by simply progressing the items according to the guide.

2.1.1. Set Tool No. and Gun-type

Set the tool number and the gun type that corresponds to the spot-gun number. This provides support for setting various welding guns in a way that they can be used for individual welders and tool numbers. As welding methods vary according to the gun type, the tool number and the gun type should be set correctly.
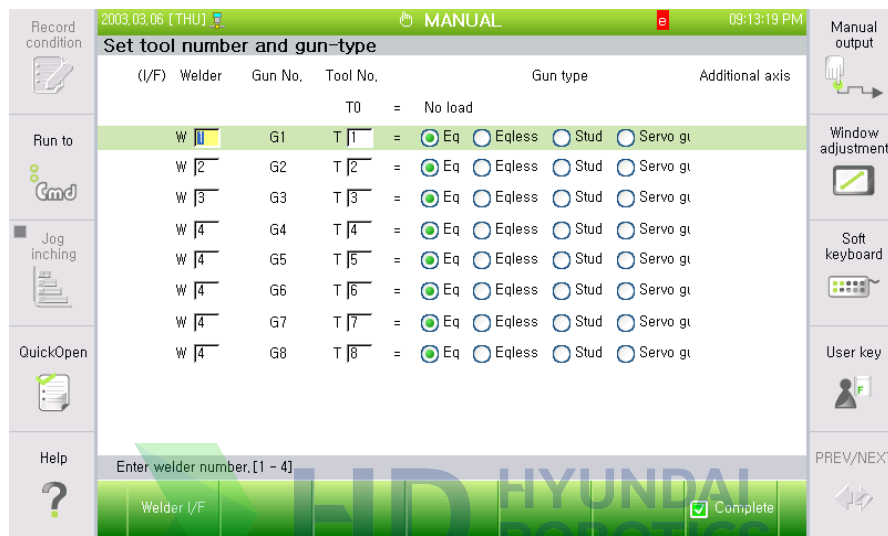
The "Welder" section is for designating the welder connected to the relevant gun number. When the relevant gun performs welding, signals will be inputted and outputted through the ports that match the relevant welder setting. Multiple guns can be shared and used through the servo tool change function.

A "tool" is an object that is to be combined with the R1 axis front end of the robot, and the robot must know the tool's information. "Tool No." means the tool number to be matched with the relevant gun number. In the tool number, the load estimation and tool data should already be inputted. In general, each gun is different in type, so choose a unique tool number for each gun number. As the "G5"–"G7" stationary-type guns will not be combined with the R1 axis front end, they can be arbitrarily set. Please note that playback will be impossible, when the work teaching is performed, if the gun number of the "Spot" command and the tool number of the "Move" command, which are to be used for welding, do not match.

In the "Gun type" section, select a relevant one from the four gun types. If the type is a servo gun, input the information of the additional axis assigned to the gun together. When it comes to the information, it is required to note that when using the servo tool change function, the same additional axis may be assigned to multiple guns.

In the figure above, "G1"–"G4" guns need to be set in a way that you can use the servo tool change function by enabling the four welding guns to use the same welder (W1). As the "G5"–"G7" guns will be set as stationary types, they are independent of the tool number of the robot. Furthermore, there will be no problem even when an arbitrary tool number "4" is set for them.

(Cautions for setting Stud-gun) Set the gun type as "Stud" only if the tool attached on the robot R1 axis is Stud-gun. It should be selected as "Eq" if spot welding is being executed with a stationary stud-gun.

Set a gun type corresponding to the gun number as in the screen above, according to the system specifications discussed in this manual.

◆ 【References】 ◆

● If no gun number that corresponds to the tool number is set, the specific tool number will be used for other purpose.

● When setting the gun type as servo-gun, the additional axis number corresponding to the gun number will be matched in the following way.

Gun number	Gun usage	Additional axis number
G1, G2	Welding gun change, including servo-gun	Additional axis 1
G5	Stationary Servo-gun 1	Additional axis 2
G6	Stationary Servo-gun 2	Additional axis 3

2.1.2. Tool angle/distance setting

In carrying out spot welding, the equalizing motion (the fixed tip goes through the clearance position to contact the panel) is needed. For this operation, it is necessary to set the tool coordinate. The +Z axis should be set accurately in the direction from the fixed tip to the moving tip. (Refer to the Hi5a controller operation manual)
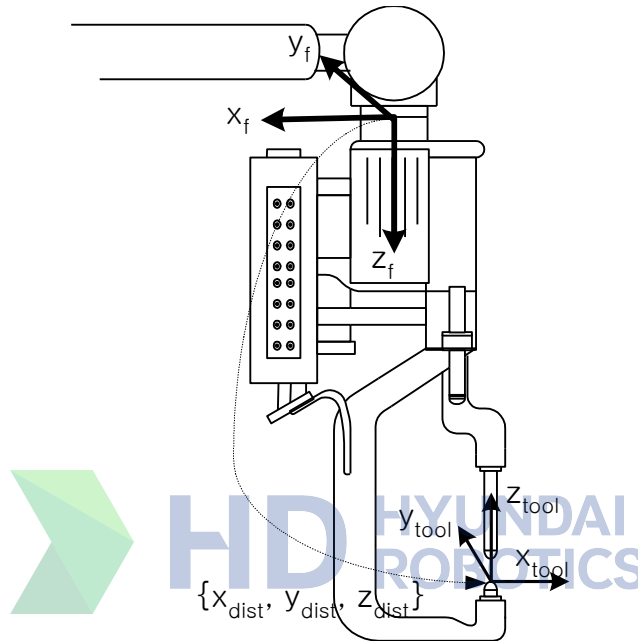
Figure 2.3 Setting tool length and angle of welding gun

- Tool length
  Input the distance from the center of robot R1 axis flange to the tool nose (the top of fixed tip) for tool length, assuming that a new electrode with no wear is attached. To set the tool length, set the coordinate direction of the reference tool coordinate in the (+) direction and input the measured length values of X, Y, and Z or use the auto calibration function.

- Tool angle
  Input rotation angles of 3 directions (Rx, Ry, Rz) based on the flange coordinate system, or use the 'Angle calibration' function. Set the tool angle in the manner that the direction of the fixed tip to the top will be +Z. This can be confirmed by placing [coordinate system] of teach pendant on 『Tool』 and pressing the jog key [up] to see if it is the same as Z+ direction (Direction of fixed tip squeeze).
  Set the tool angle as {0deg, 180deg, 0deg} if the tool state matches the picture above.

2.2. Step 0. Pre-check

Pre-check must be performed for servo gun initial setting in advance. The following settings must be completed before entering this menu.

- Additional axis parameter
  - Input the motor and amp specifications of the servo gun that you want to use for the designated additional axis.
- The soft limit can be arbitrarily set because it changes during the initial setting procedure.
  - Designate the servo gun and gun number that you want to currently set.
- Tool data setting
  - Input the load estimation, tool angle/length, etc.
- Servo gun parameter setting
  - Set necessary items such as the command value offset, squeeze force tolerance, etc.

The pre-check step makes it possible to see whether the pre-settings are complete. Considering that you can still move to the screen where you can perform related settings when they are not performed in advance, the relevant setting must be completed before you progress the servo gun initial setting.
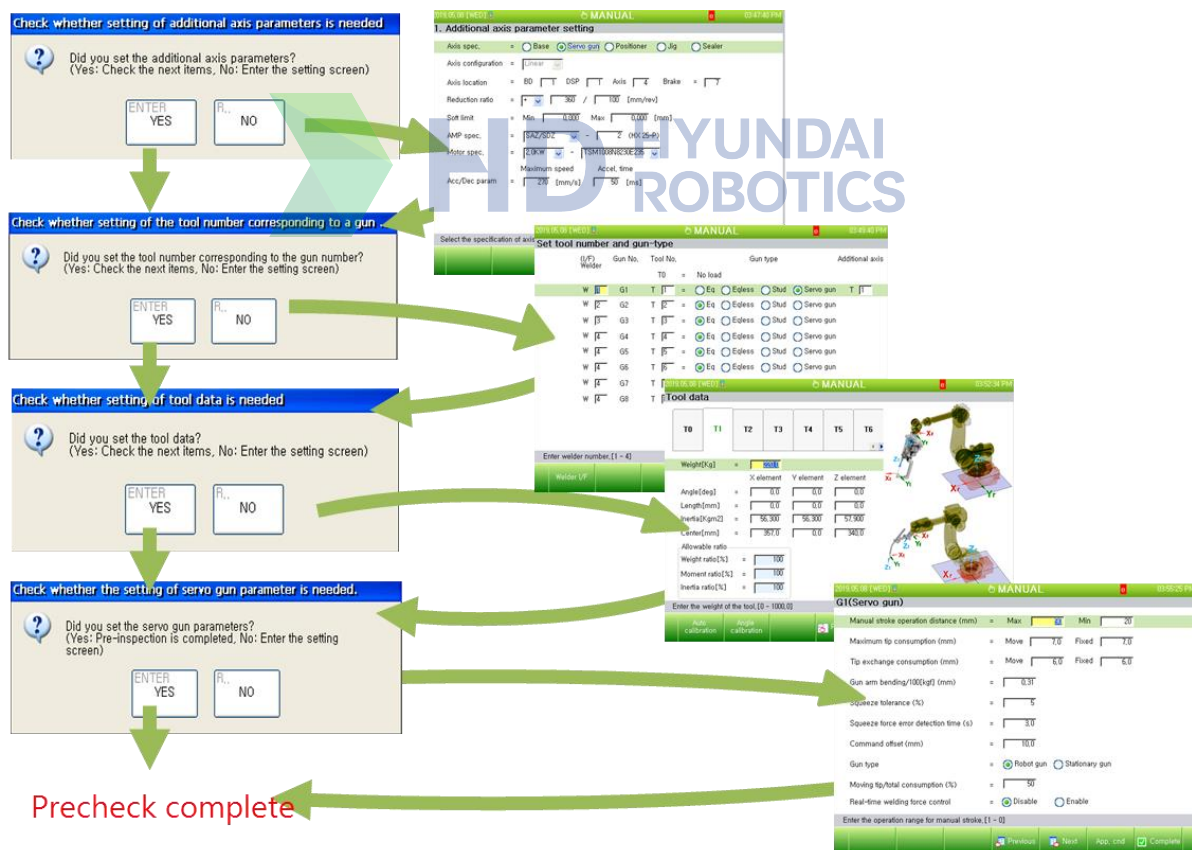
Figure 2.4 Procedures for progressing the precheck

Caution) When setting is complete in the "Additional axis parameter setting" screen, request a reboot after the completion of the pre-check. After rebooting, enter the "Servo gun autosetting" screen again, and continue setting.

2.3. Step 1. Basic setting

After the pre-check is complete, you can carry out basic setting. Basic setting is a compulsory setting process to set the reference location of the moving tip of the servo gun, move it to the desired location, and apply the desired squeeze force.

Basic setting consists of four items as shown in the figure below.
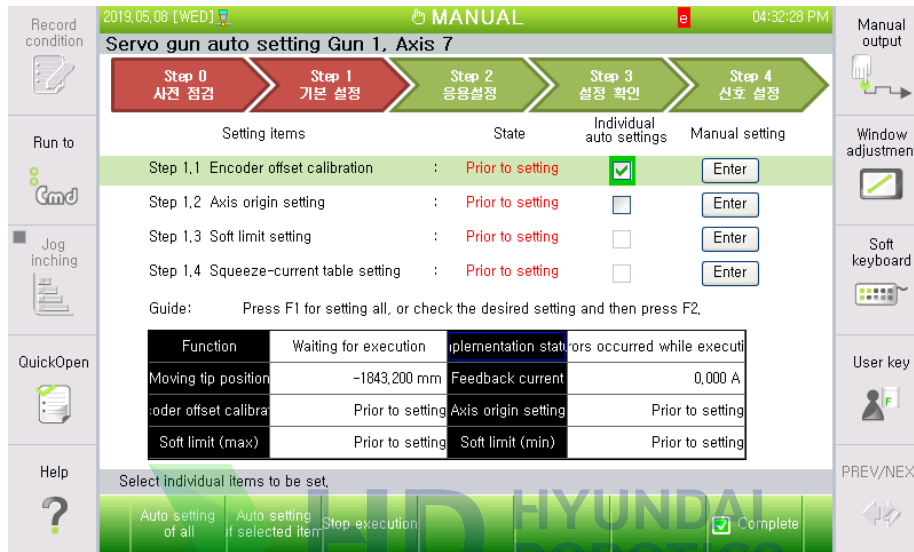
(1) Encoder offset compensation
- Normally, the encoder origin should be set where the same location can be mechanically matched when the encoder data is changed following the replacement of the servo gun motor for example. In the case of the servo gun, the setting should be performed while the moving tip is mechanically at the maximum open location.
- For manual setting, refer to "Encoder offset compensation" in "Manual setting."

(2) Axis origin setting
- Normally, the servo gun axis origin should be set, while a new tip is attached to both the moving and fixed electrodes, at the location where the two tips touch each other. As most of the operation of the servo gun is performed based on the axis origin, it is very important to set it.
- For manual setting, refer to "Axis origin setting" in "Manual setting."

(3) Soft limit setting
- Normally, the servo gun soft limit should be set to "Minimum" while the moving tip is opened at the maximum level, and at the same time, it should be set to "Maximum" at the closest location in which all tips are removed.
- For manual setting, refer to "Soft limit setting" in "Manual setting."

(4) Squeeze force – current table setting
- To squeeze the various servo guns installed on the robot with the desired squeeze force, it is necessary to make the current applied to the servo gun correspond to the generated squeeze force. For this, we provide a servo gun squeeze force – current table, and it is necessary to tune the table to the servo gun.
- To use this function, five representative values should be selected from the squeeze force range that will be used. The tuning of the servo gun squeeze force – current table is a process of finding the current table that matches with the five representative values of

squeeze force. This table can be changed according to the posture of the servo gun. Therefore, it is necessary to carry out tuning both for the case in which the moving tip is in the direction of gravity and for the case in which it is in the opposite direction of gravity. That way, squeeze can be carried out with high accuracy with the servo gun at various postures.

- For more details, refer to the "Servo gun squeeze force – current table tuning" section.

The basic setting can be carried out both in the autosetting and manual setting modes.

(1) Autosetting: The servo gun will automatically move to the designated location and perform the designated setting.
- Items for autosetting
  - Encoder offset compensation
  - Axis origin setting
  - Soft limit setting
- The squeeze force – current table setting cannot be automatically carried out because it requires user intervention such as the installation of squeeze force gauge.
(2) Manual setting: The user performs the operation to move the servo gun to the designated location and performs the function designated in the specific setting screen.

2.3.1. Autosetting

Press 『[F1]: All autosetting』 to progress autosetting in the "basic setting" of the servo gun. The following conditions must be satisfied because the moving tip of the servo gun will automatically move in the "All autosetting" mode.

- Attachment of a new tip to the moving and fixed electrodes
- No presence of workers near the servo gun
- No workpiece between the moving and fixed tips
- Manual mode
- Motor on
- Prohibition of the maximum opening of the moving tip (certain clearance from the maximum opening locations)

In the "All autosetting" mode, the following procedures must be automatically performed.

(1) Encoder offset compensation
- Moving the moving tip to the maximum open location
- Executing encoder offset compensation after stopping at the maximum open location
(2) Axis origin setting
- Squeezing the servo gun three times and opening it two times
- Moving to the location where the two tips meet after squeezing three times
- User's confirmation of the relevant location
- Executing the axis origin setting
(3) Soft limit setting
- Automatically performing the setting after axis origin setting
(4) Squeeze force – current table setting
- Automatically moving to the menu for the setting

In the autosetting of the servo gun basic setting, the "encoder offset compensation" location and "axis origin compensation" location are automatically recognized, allowing the "encoder offset compensation," "axis origin compensation," and "soft limit setting" to be progressed. In the autosetting of the basic setting, the "squeeze force – current table setting" does not automatically proceed. Please refer to the chapter for "Servo gun squeeze force – current table tuning" to proceed with the setting.

In the "all autosetting" mode, after movement to the axis origin location is performed, the user is required to confirm the location as shown below. At this time, check the location of the moving tip and return current (less than 1 A). If the tips are at a location where they touch each other slightly, press "Yes" to continue the setting. If the return current is high or the moving and fixed tips are not in contact with each other, use the jog key to fine-tune, and then press "Yes." If you do not want autosetting, press "No" to end it.
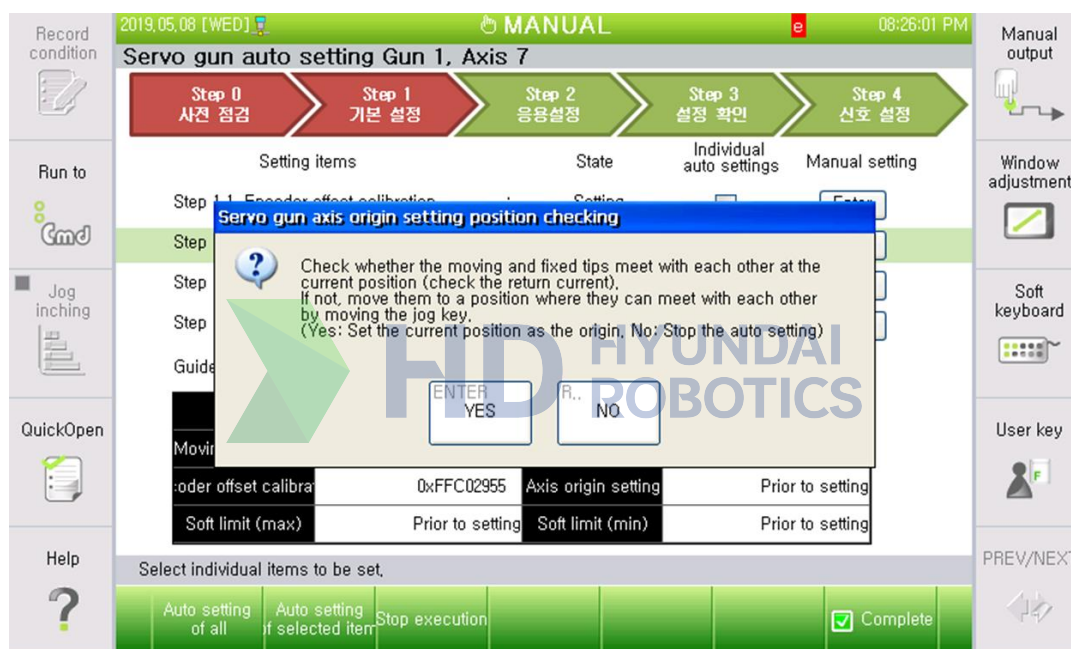
Figure 2.5 User's confirmation of the axis origin location

Caution) If there is a nonmetal stopper, such as a bumper hanging at the servo gun maximum open location, it will make it difficult to estimate the maximum open location. It is recommended to remove it before carrying out setting.

The configuration and functions of the servo gun basic setting screen are as follows.
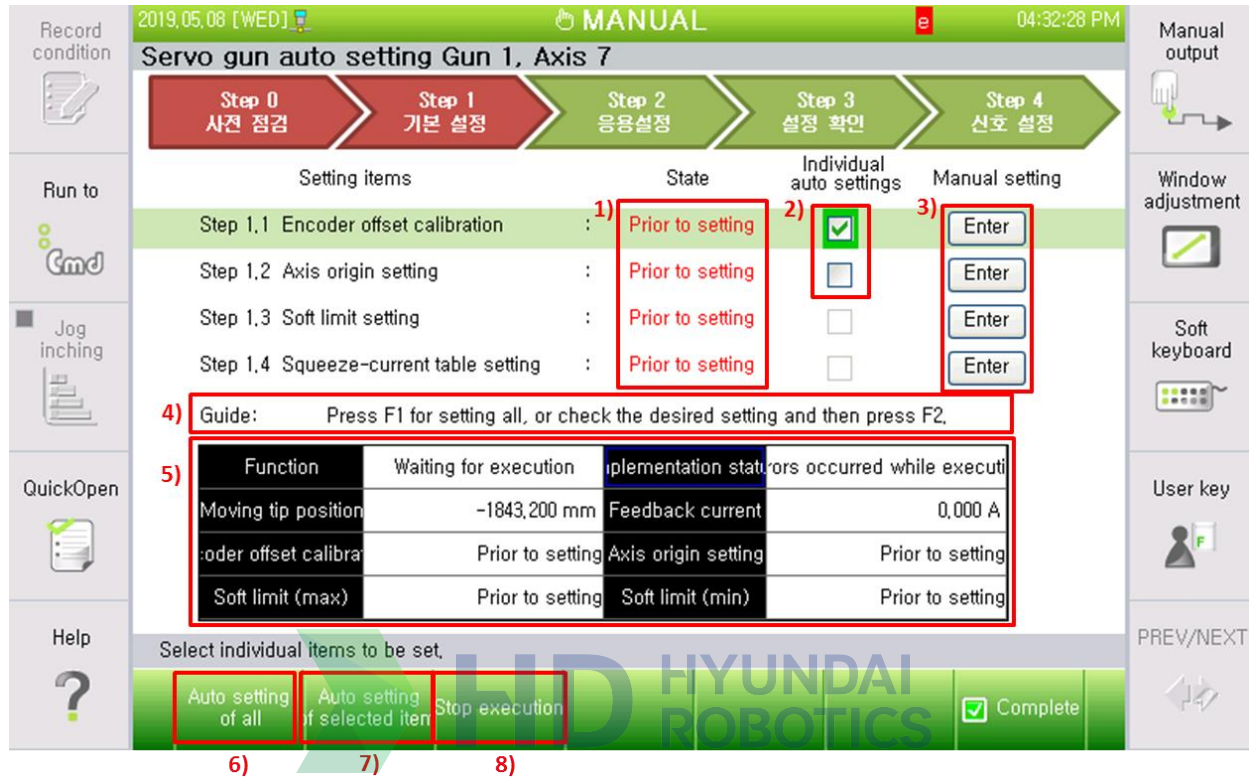
1) Status: Presents the state of the servo gun (Not set, Completed, or Changed)
2) Individual autosetting: Supports the automatic setting of the checked items only, not all. If you press "[F2]: Autosetting of selected items," only the checked items would be automatically progressed.
3) Manual setting: Moves to the screen to set each relevant item
   - Encoder offset compensation
     Automatically moves to the 『[F2]: System』 → 『3: Robot parameter』 → 『4: Encoder offset』 screen.
   - Axis origin setting
     Automatically moves to the 『[F2]: System』 → 『3: Robot parameter』 → 『2: Axis origin』 screen.
   - Soft limit setting
     Automatically moves to the 『[F2]: System』 → 『3: Robot parameter』 → 『3: Soft limit』 screen.
   - Squeeze force – current table setting
     Automatically moves to the 『[F2]: System』 → 『4: Application parameter』 → 『1: Spot welding』 → 『7: Servo gun squeeze force tuning』 screen.
4) Guide: Indicates the present setting status or the cause of error and action plan
5) Monitoring: Displays the current setting status, servo gun location, return current and set values, etc.
6) All autosetting: Commands to execute all autosetting
7) Autosetting of selected items: Performs the autosetting of the items designated for individual autosetting
8) Execution on hold: Stops the setting in progress

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2.3.2. Manual setting

The procedure for manually progressing the servo gun basic setting is as follows.

    1) Servo gun encoder offset setting
    2) Servo gun axis origin setting
    3) Servo gun soft limit setting

2.3.2.1. Servo gun encoder offset setting

Normally, the encoder origin should be set where the same location can be mechanically matched when the encoder data is changed following the replacement of the servo gun motor for example. In the case of the servo gun, the setting should be performed while the moving tip is mechanically at the maximum open location.

The encoder compensation procedure of the servo gun axis is as follows.

(1) After manually releasing the servo gun axis brake, open the moving tip at the maximum level.

Maximum open position
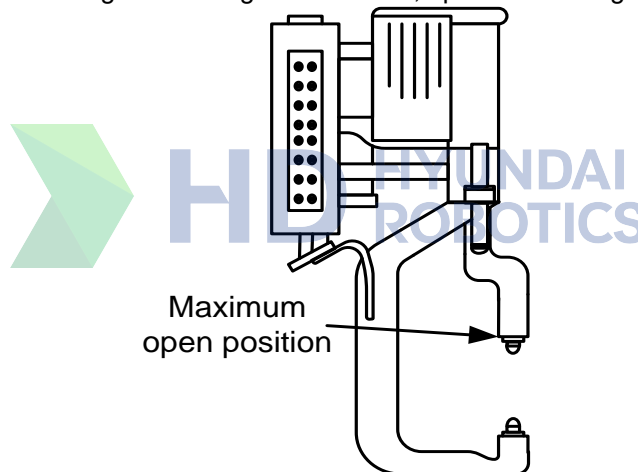
(2) Press the "Manual setting" button of the "Encoder offset compensation" menu in the basic setting screen of the "Servo gun autosetting" menu (as shown below), or select, by using the cursor, the relevant servo gun axis in 『[F2]: System』 → 『3: Robot parameter』 → 『4: Encoder offset』 , and then, press the 『[F1]: Apply』 button. When the present encoder value is "00400000," press the 『[F7]: Complete』 button.

2.3.2.2. Servo gun axis origin

Normally, the servo gun axis origin should be set, while a new tip is attached to both the moving and fixed electrodes, at the location where the two tips meet each other. As most of the operation of the servo gun is performed based on the axis origin, it is very important to set it.

The procedure to set the servo gun axis origin is as follows.

(1) Manually operate the servo gun axis to place it into the state shown below.

Slightly touched position with new tip
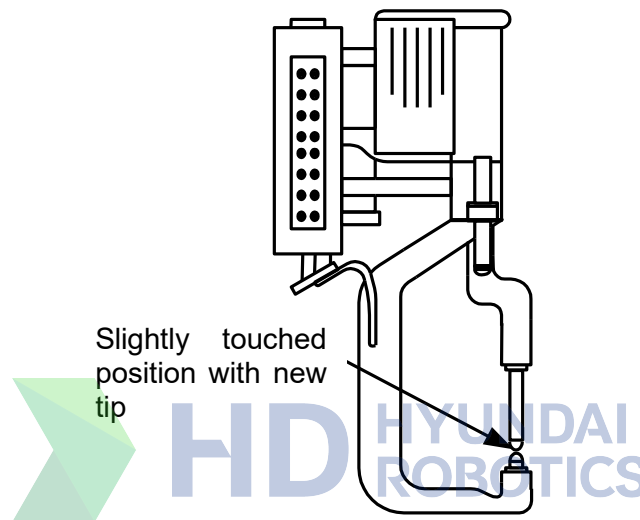
(2) Press the "Manual setting" button of the "Axis origin setting" menu in the basic setting screen of the "Servo gun autosetting" menu (as shown below), or select, by using the cursor, the relevant servo gun axis in 『[F2]: System』 → 『3: Robot parameter』 → 『4: Axis origin』 , and then, press the 『[F1]: Apply』 button. When the present axis location is displayed as 0.0 mm, press the 『[F7]: Complete』 button.

2.3.2.3. Servo gun soft limit

Normally, the servo gun soft limit should be set to "Minimum" while the moving tip is opened at the maximum level, while it should be set to "Maximum" at the closest location where all tips are removed.

The procedure to set the servo gun axis soft limit is as follows.

(1) Manually operate the servo gun to place it into the state shown below.

Maximum open position where brake is released

Maximum approach position after removal of moving / fixed electrode tip
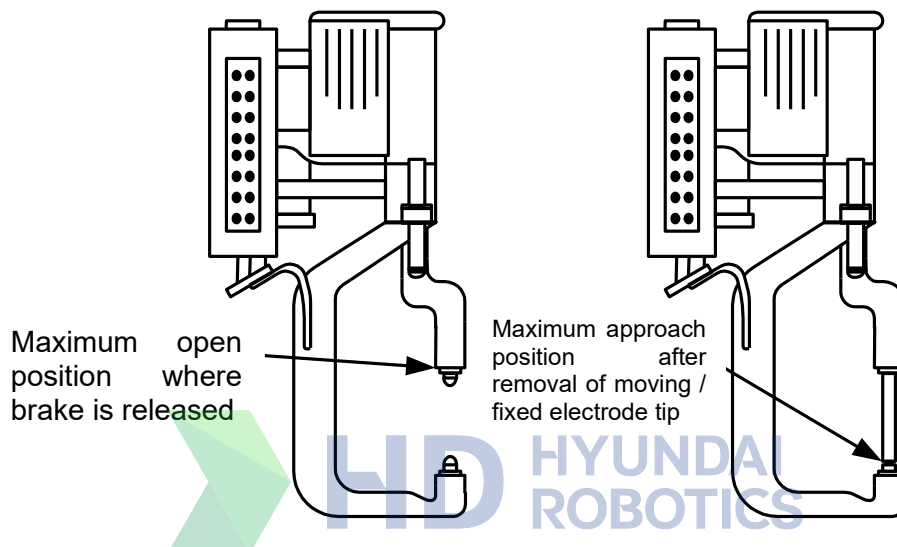
(2) Press the "Manual setting" button of the "Soft limit setting" menu in the basic setting screen of the "Servo gun autosetting" menu (as shown below), or select, by using the cursor, the relevant servo gun axis in 『[F2]: System』 → 『3: Robot parameter』 → 『3: Soft limit』 , and then, press the 『[F1]: Apply』 button. When the state is normally displayed, press the [F7]: Complete』 button.

2.3.3. Servo gun squeeze force – current table tuning

To squeeze the various servo guns installed on the robot with the desired squeeze force, it is necessary to make the current applied to the servo gun correspond to the generated squeeze force. For this, we provide a servo gun squeeze force – current table, and it is necessary to tune it to the servo gun. The level of tuning accuracy determines the accuracy of the servo gun squeeze force. Therefore, the relevant setting must be carried out prior to the use of the servo gun.

To use this function, five representative values should be selected from the squeeze force range that will be used. The tuning of the servo gun squeeze force – current table is a process of finding the current table that matches with the five representative values of squeeze force. This table can be changed according to the posture of the servo gun. Therefore, it is necessary to carry out tuning for the case in which the moving tip is in the direction of gravity and for the case in which it is in the opposite direction of gravity. That way, squeeze can be carried out with high accuracy with the servo gun at various postures.

We provide two different modes for servo gun squeeze force – current table tuning.

- Automode tuning
  This is for automatically tuning the table using the squeeze force data sent from the communicable squeeze force gauge designated by the company.

- Manual mode tuning
  It is possible to carry out tuning regardless of whether or not there is a communicable squeeze force gauge. The user can tune the table by directly inputting the measured squeeze force.

2.3.3.1. Autotuning mode

This function is used to automatically set the servo gun squeeze force – current table. For this, it should be possible to transfer data between the squeeze force gauge and the robot controller. The user must inquire whether the squeeze force gauge that he/she wants to use is supported.
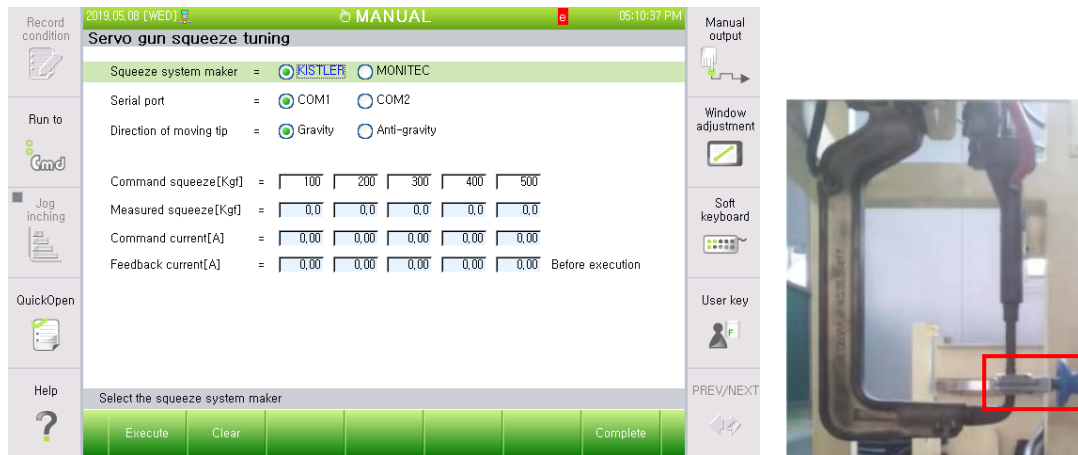
Before using the function, place the squeeze force gauge on the upper part of the fixed tip, and operate the moving tip for them to touch the squeeze force gauge. After that, go to the servo gun squeeze force – current table autotuning setting screen, and press the [F1: Execute] button to progress tuning. Considering that the moving tip moves repeatedly during autotuning, it is necessary to carry out the process in the motor-on state in the manual mode (Stop at motor off). Press the [F2: Clear] button to forcibly end the tuning while it is in progress. After the tuning is completed, apply individual squeeze forces for testing. If the accuracy is abnormal, repeat the process.

The setting items are described below.

- Squeeze force gauge manufacturer
  Select the squeeze force gauge that is used.

- Serial port
  Select the number of connected serial ports.

- Direction of the moving tip
  Select whether the moving tip moves in the direction of gravity or the opposite direction of gravity.

- Command the squeeze force
  Set the desired squeeze force range table in five steps.

2.3.3.2. Manual tuning mode

The manual tuning mode is a function that is used to manually set the servo gun squeeze force – current table. If the squeeze force, which is measured after the servo gun squeeze is performed, is directly inputted by the user utilizing the teaching pendant, the optimal command current will be calculated. This process needs to be repeated to increase accuracy. The accuracy can be checked by the degree of convergence as well as through the squeeze test.

In automode tuning, a communication link must be established between the squeeze force gauge and the robot controller. However, in case of the manual mode, it can be used regardless of whether or not there is a communication with the squeeze force gauge because the measured squeeze force will be inputted.

The recommended procedure for setting the servo gun squeeze force – current table in the manual mode is as follows.

1. Set the direction of the moving tip to be tuned (the direction of gravity or the opposite direction of gravity).
2. Move the moving tip, by pressing Shift + F3 or using the servo gun axis jog, to the location where it touches the squeeze force gauge, and then measure the thickness of the squeeze force gauge (distance between the tips).
3. Input the measured thickness into the squeeze force gauge section on the upper side of the screen.
4. Input the representative value of the squeeze force that needs to be set into the "Set squeeze force" section.
5. Perform servo gun squeeze by applying the desired squeeze force from the set squeeze force section. (In the figure below, squeeze is performed by applying 100 kgf that has the current green focus. For the svgun person, press ([Ctrl] + [F3] or [Shift] + [F3]).
6. Input the squeeze force measured by the squeeze force gauge into the "Measured squeeze force" section.
7. Repeat steps 3–6 for all set squeeze forces.
8. After inputting is complete, press [F4: Command current calculation] to calculate the command current that matches with the set squeeze force.
9. Check the degree of convergence, and carry out the squeeze test. If the command current needs to be repeatedly calculated, redo steps 3–8.
10. If there is a need to calculate the command current for a specific squeeze force, input the measured squeeze force and then execute by pressing [F5: Individual calculation of command current].
11. Press [F6: Save] to save the present setting. After that, change the direction of the moving tip and then repeat steps 1–8.

Press [Shift] + [F3] or [Ctrl] + [F3] to perform servo gun squeeze. It is recommended to use [Ctrl] + [F3] because it performs control in the same way as in the automatic mode.

The figure below shows the screen after the "command current calculation" is performed twice. If the degree of convergence is sufficiently low, carry out squeezing by applying the set squeeze force, and then, check the difference from the measured squeeze force to decide whether to continue.

For command current calculation, more than one measured squeeze force should be inputted. If the initial command current exceeds the range where the servo gun can perform squeezing, it is possible to set the initial value by performing "command current calculation" after inputting only one to two measured squeeze forces. However, if the command current calculation is performed without inputting all measured squeeze forces, the overall accuracy will be lowered. Considering that, it is recommended to perform "command current calculation" after inputting all measured squeeze forces, except for the case of resetting the initial command current.

The setting items are described below.

- **Direction of the moving tip**
  This is the direction of the moving tip of the servo gun that is currently being tuned. It is required to set it in the direction of gravity and the opposite direction of gravity once for each direction, respectively.

- **Set squeeze force**
  This is the representative value of the squeeze force to be used. The command current corresponding to the set squeeze force will be found through the tuning process.

- **Measured squeeze force**
  This is the squeeze force measured when squeezing is performed using the present command current. The user should directly input it by using the squeeze force gauge.

- **Command current**
  The command current corresponds to the present set squeeze force. It can be renewed through calculation.

- **Degree of convergence**
  This is the amount of variation in the command current calculated against the previous command current after current calculation. The lower the value, the higher the accuracy of the squeeze force tuning.

- **Tolerance of the set squeeze force**
  This is the tolerance of the squeeze force among servo gun parameters. It can be used to check the present status after the squeeze test.

- **Distance between the tips**
  It is possible to monitor the distance between the tips of the servo gun. (The squeeze and open status can be monitored.)

- **Number of repeated calculations**
  This is the number of times the command current is renewed by pressing the "Command current calculation" button up to now. If the degree of convergence does not decrease after several repetitions, use "Individual calculation of command current" or check the status of the squeeze force and servo gun.

- **Measured current**
  This is the currently measured current. When squeezing is performed, it will be monitored in a way that the current can get close to the command current.

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Caution) [Ctrl] + [F3] is for one-time execution up until squeezing is complete, making it impossible to release the button and stop the process. Therefore, to stop squeezing, release the enable switch or press the emergency stop button. Furthermore, if the squeeze force gauge thickness is different from the actual value, the squeeze force may change in the automatic mode. Considering it, input the accurate value.

In the present screen, F1, F2, and F3 can be used to set and operate the servo gun. The setting and operation are as follows.

- [Shift] + [F1]: Servo gun at large stroke (Open with the indicated open distance.)

- [Shift] + [F2]: Servo gun at small stroke (Open with the indicated open distance.)

- [Shift] + [F3]: Servo gun squeeze (Squeeze with the squeeze force currently marked with the cursor.)

- [Ctrl] + [F1]: Setting of the large stroke distance for the servo gun

- [Ctrl] + [F2]: Setting of the small stroke distance for the servo gun

- [Ctrl] + [F3]: Servo gun squeeze (Squeeze with the squeeze force currently marked with the cursor [same control method as the automode].)

2.4. Step 2. Application setting

Once basic setting is complete, application setting can be performed. Application setting can be performed after the "squeeze force – current table tuning" process. In the application setting, the gun search reference location is determined, the servo gun arm bending at the time of squeeze is estimated, and the compensation procedure for accurately measuring the panel thickness is performed.

Application setting consists of the following three items.
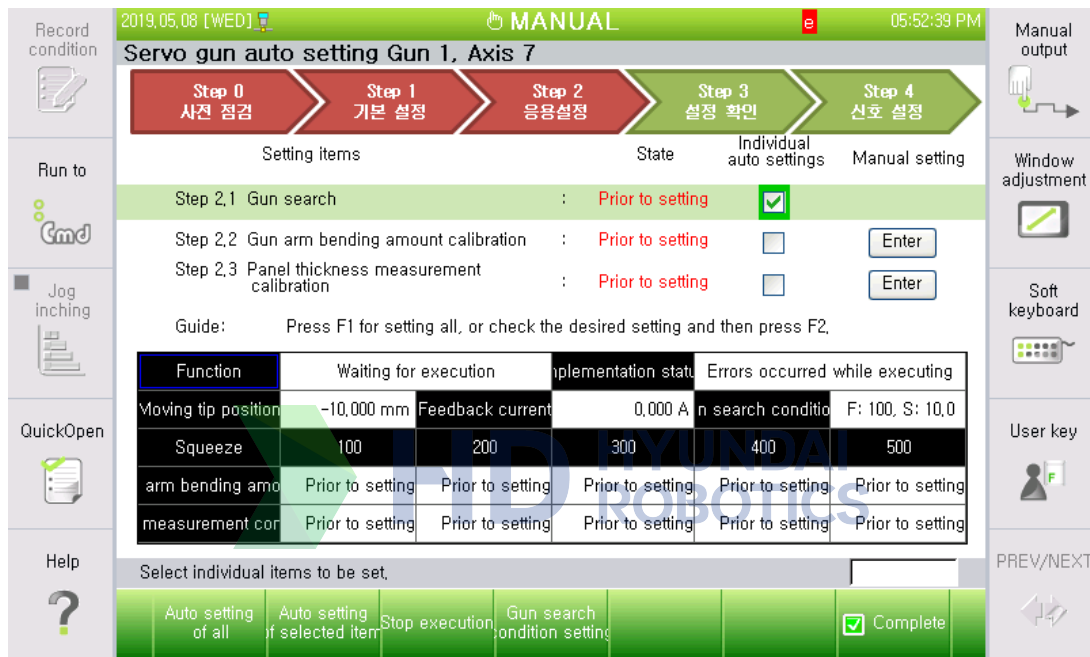
(1) Gun search
   - Set the reference location for measuring the tip consumption, and check the consumption once.
   - For manual setting, refer to the "Gun search" chapter.
(2) Gun arm bending compensation
   - The gun arm bending compensation needs to be set in a way to compensate the degree at which the gun arm is bent when servo gun squeeze is performed. It is required to set the bending according to the squeeze force set in the squeeze force – current table.
   - For manual setting, press the manual setting button in the figure above, or select the gun number you want to set in 『[F2]: System』 → 『4: Application parameter』 → 『1: Spot welding』 → 『3: Welding gun parameter』, and then, press 『[F6]: Application condition』 for entry.
(3) Panel thickness measurement compensation
   - The panel thickness measurement compensation is a setting to improve the precision of the panel thickness measured with the ThickCheck command.
   - For manual setting, press the manual setting button in the figure above, or select the gun number you want to set in 『[F2]: System』 → 『4: Application parameter』 → 『1: Spot welding』 → 『3: Welding gun parameter』, and then, press 『[F6]: Application condition』 for entry.

The "Gun search" setting in the application setting is compulsory. If "Gun search" is not set, it is impossible to execute and teach spot welding–related commands (e.g., SPOT GN = 1,...).

On the other hand, the "Gun arm bending compensation" and "Panel thickness measurement compensation" are independent of the execution and teaching of spot welding–related commands but are necessary settings for accurate operation and panel thickness measurement.

The basic setting can be carried out both in the autosetting and manual setting modes.

(1) Autosetting
  – The servo gun automatically moves and executes "Gun search," "Gun arm bending compensation," and "Panel thickness measurement compensation." All items in the application setting can be automatically set.
(2) Manual setting
  – The user performs "Gun search" and inputs the values for "Gun arm bending compensation" and "Panel thickness measurement compensation."

2.4.1. Autosetting

Press "[F1]: All autosetting" to progress the autosetting for the application setting of the servo gun. In the "All autosetting" mode, the moving tip of the servo gun will automatically move. In addition, the following conditions must be satisfied because the setting value is affected by the squeeze force.

- Attachment of a new tip to the moving and fixed electrodes
- No presence of workers near the servo gun
- No workpiece between the moving and fixed tips
- Manual mode
- Motor on
- Completion of the basic setting (Step 1) of the servo gun

In the "All autosetting" mode, the following procedures will be automatically performed.

(1) Gun search
   − Executes gun search while squeezing the servo gun two times
   − First time: "Gun search reference location record" enabled
   − Second time: "Gun search reference location record" disabled
(2) Gun arm bending compensation
   − Compensate the bending while squeezing the servo gun five times
(3) Panel thickness measurement compensation
   − Compensate the bending while squeezing the servo gun five times

Caution: If you proceed with "Autosetting," you can only perform gun search.
1. If gun searches other than gun search 1 needs to be used, refer to the "Gun Search" chapter of "Work teaching."

In the "All autosetting" mode, the "Gun arm bending compensation" and "Panel thickness measurement compensation" will be performed, and at the same time, the servo gun squeeze will be performed only five times.

To execute "Gun search," you should designate the squeeze force and gun search speed. If you press [F4]: Gun search condition setting』 in the previous "Application setting" screen, you can set the squeeze force and moving speed that can be used for the Gun search shown below.
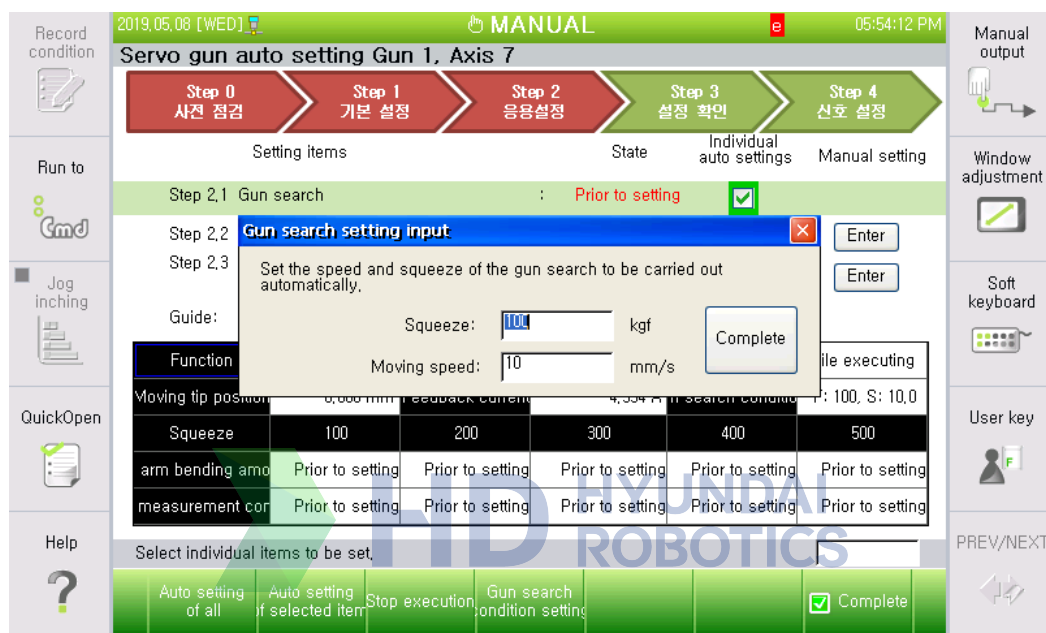
Caution) As far as "gun arm bending compensation" and "panel thickness measurement compensation" are concerned, it is recommended to use the automatic setting because it is difficult to perform measurement and manually fill the values.

The "Gun arm bending compensation" value is the one to be used in place of the "Gun arm bending / 100 kgf [mm]" among servo gun parameters. If the "Gun arm bending compensation" setting is performed, the "Gun arm bending / 100 kgf [mm]," which is set in advance, will not be used. On the contrary, if the "Gun arm bending compensation" is not set, the "Gun arm bending / 100 kgf [mm]" will be used.

The configuration and functions of the servo gun application setting screen are as follows.
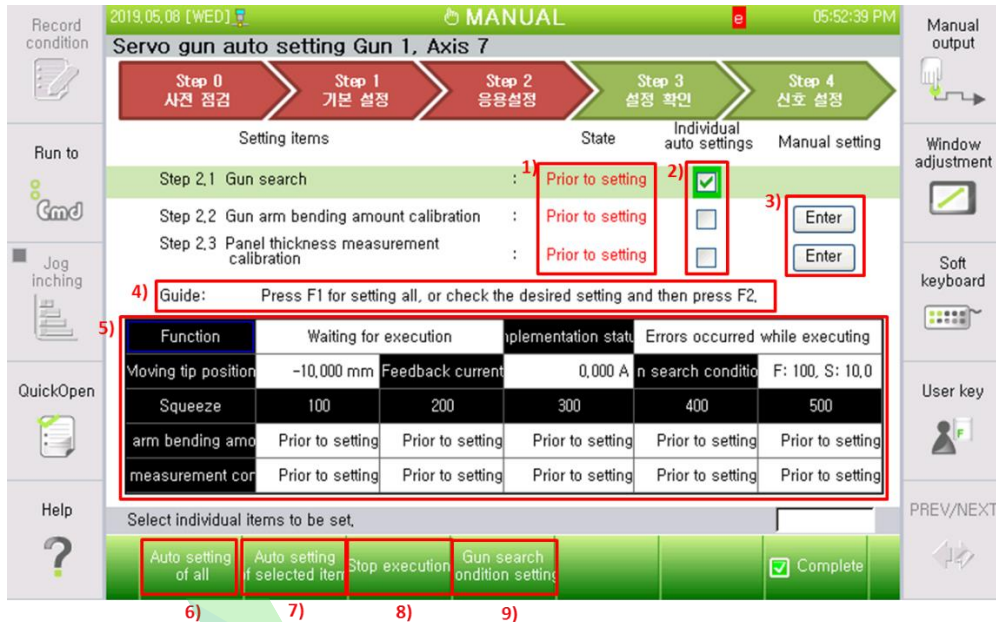
1) Status: Presents the state of the servo gun (Not set, Completed, or Changed)
2) Individual autosetting: Supports the automatic setting of only the checked items, not all. If you press 『[F2]: Autosetting of selected items』, only the checked items will be automatically progressed.
3) Manual setting: Moves to the screen to set each relevant item
    –   Gun arm bending compensation
        Automatically moves to the 『[F2]: System』 → 『4: Application parameter』 → 『1: Spot welding』 → 『3: Welding gun parameter』 screen
    –   Panel thickness measurement compensation
        Automatically moves to the 『[F2]: System』 → 『4: Application parameter』 → 『1: Spot welding』 → 『3: Welding gun parameter』 screen
4) Guide: Indicates the present setting status or the cause of the error and action plan
5) Monitoring: Displays the present setting status, servo gun location, return current and set values, etc.
6) All autosetting: Commands to execute all autosetting
7) Autosetting of selected items: Performs autosetting of the items designated for individual autosetting
8) Execution on hold: Stops the setting in progress
9) Gun search condition setting: Sets the speed and squeeze for gun search

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2.5. Step 3. Confirmation of setting

When application setting is complete, the "Confirmation of setting" procedure allows the user to check the contents of the settings. The confirmation of setting can only be performed when basic setting and application setting are complete.

As shown below, when "Step 1. Precheck," "Step 2. Basic setting," and "Step 3. Application setting" are complete, the user can progress the confirmation of setting by pressing 『[F1]: Progressing the items not set』 or place the focus on "Step 3. Confirmation of the setting" and press "Enter." Then, the confirmation of setting will be progressed.
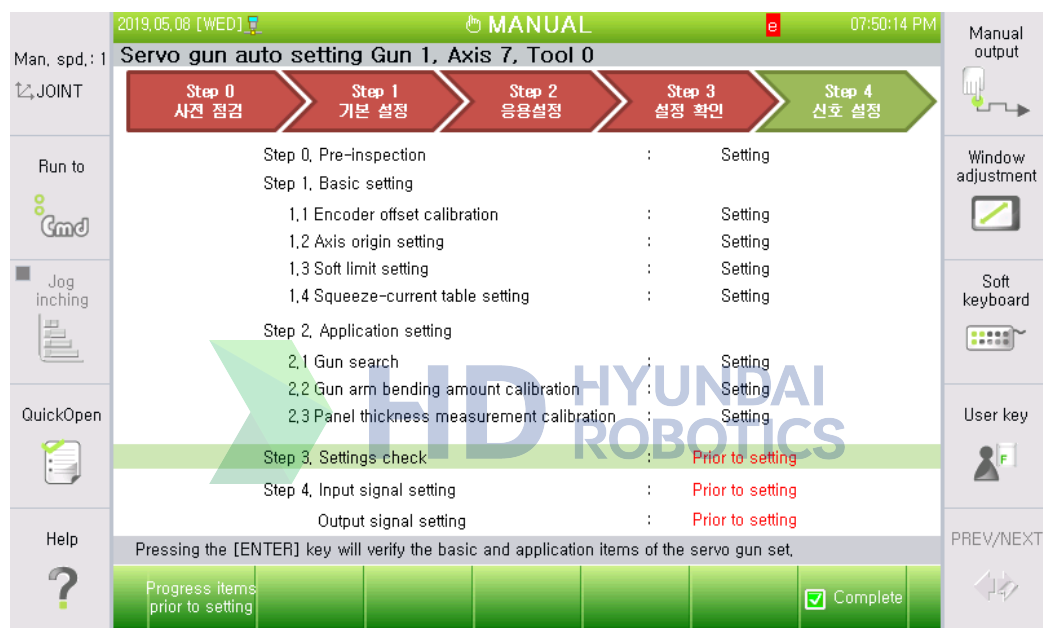
As the confirmation of setting will be progressed by moving the servo gun, the preconditions must be satisfied as follows.
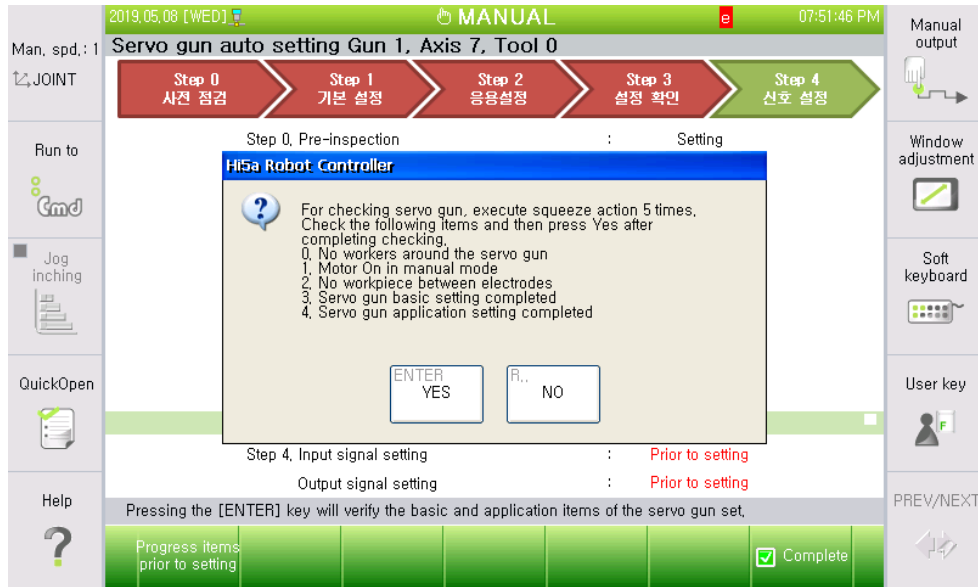
- − Attachment of a tip in the same condition as the one used for the setting (When tip dressing is performed after a new tip is attached, it is impossible to correctly check it.)
- − No presence of workers near the servo gun
- − No workpiece between the moving and fixed tips
- − Manual mode
- − Motor on
- − Completion of the basic setting of the servo gun
- − Completion of the application setting of the servo gun

If the conditions above are satisfied and the confirmation of setting is progressed, it is now possible to move to the "Application setting" screen to monitor relevant status such as the servo gun movement status, etc.

When "Confirmation of setting" is complete, the error estimated during verification is displayed as shown below. As the displayed value is an error, if it comes close to 0, the setting can be considered as normal. If the error is greater than 0, you should perform the setting process again or check for any change with the servo gun and in the surrounding environment.

If you are satisfied with the results of the confirmation of setting, press "Yes" to end the "Confirmation of setting" procedure. If you are not satisfied, press "No" to reset or check for any change with the servo gun and in the surrounding environment.

2.6. Step 4. Signal setting

If "Step 3. Confirmation of setting" is complete, it is possible to move and normally squeeze the servo gun. However, for spot welding, you should set the input and output signals of the spot welder and others. In "Signal setting," set the input and output signals related to spot welding.

When you press [Enter] after moving the cursor to "Step 4. Input signal setting" or "Step 4. Output signal setting" as shown below, or press 『[F1]: Progressing the items not set』 after previous items are complete, you can enter the screen where you can set relevant items.
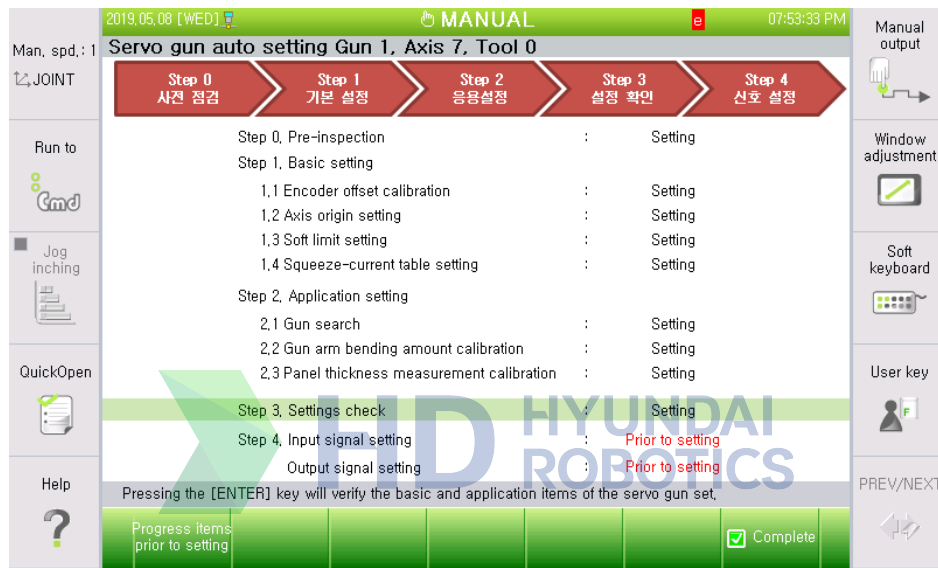
(1) Input signal setting
   - Refer to the "Input signal assignment" chapter in "Spot welding parameters."
(2) Output signal setting
   - Refer to the "Output signal assignment" chapter in "Spot welding parameters."

References) The top of the "Servo gun autosetting" screen shows the present progress. A red color background means a completed state, and a green background means a not-set state. In addition, the rightmost part (the step adjacent to the green background) of the red background means the step to be progressed now. If any of the sub-settings is not performed, the relevant step is recognized to be in the not-set state.
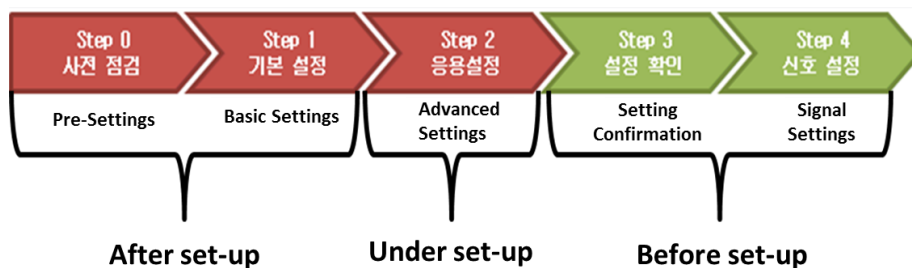
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3

Relevant functions

3.1. Monitoring

This function enables the user to monitor the various present data and setting states used in spot welding. The monitoring screen related to spot welding is shown below.
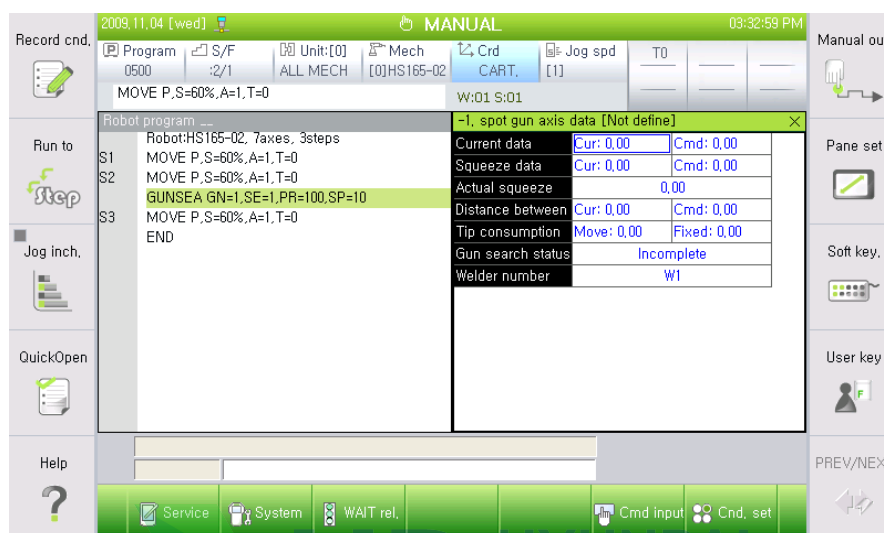
- – Spot gun axis data
- – Spot welding input/output signals
- – Spot welding operation information

3.1.1. Spot-gun axis data

This displays the real time data related to the currently selected spot gun. In addition, the gun type for the gun number can be confirmed from the title bar.
(『[F1]: Service』 → 『1: Monitoring』 → 『4: Spot welding data』 → 『1: Spot gun axis data』)

- Current data (Servo-gun)
  Displays the feedback current that flows through the servo gun axis and Cmd displays the command current for the current limit

- Squeeze data (Servo gun)
  Converts the command current and feedback current into squeeze force by using the 'welding gun parameter squeeze force – current table' and display the converted data. Cmd shows the command squeeze force and Cur shows the feedback squeeze force.

- Actual squeeze (Servo-gun)
  Displays average squeeze force from the point of squeeze alignment to the point of opening (Kgf)

- Distance between tips (Servo-gun)
  Displays the distance (mm) between tips from the axis origin (mm).

- Tip consumption (Servo-gun, EQless-gun)
  Displays consumption detected by gun search (mm) (For EQless-gun, only the fixed side tip consumption is managed)

- Gun search status (Servo-gun, EQless-gun)
  Displays whether the gun search is executed.

- Welder number
  Displays the welder number for the currently selected gun number

- SvClamp(Servo-gun)
  Displays the state of the clamping operation of the currently selected gun's clamping.

3.1.2. Input and output signal

This can be used conveniently because the state of the assigned input and output signals related to the spot welding are sorted out and monitored.
(『[F1]: Service』 → 『1: Monitoring』 → 『4: Spot welding data』 → 『2: Spot welding input/output signal』)
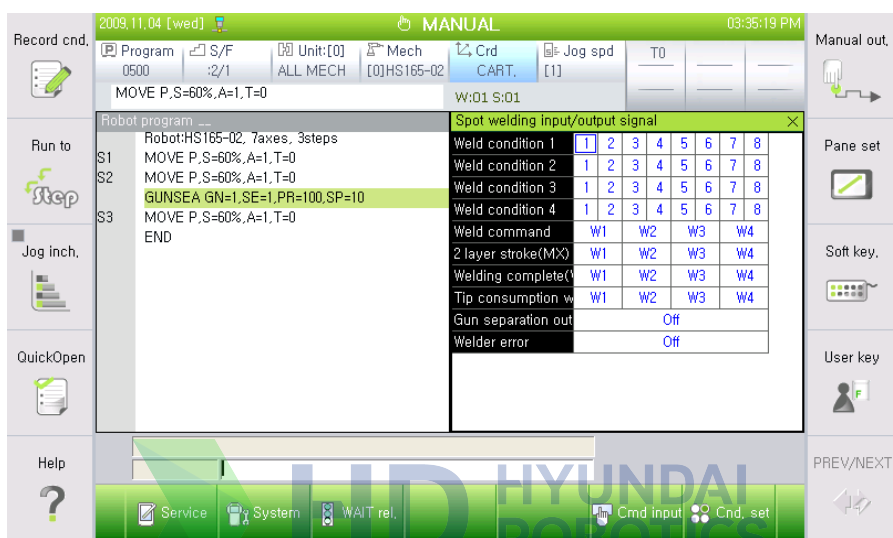
3.1.3. Spot welding operating information

Welding time and the number of welds for the welder currently in use can be confirmed. This displays the 3 items from the controller initialization up to the present status (total), the current cycle in execution (recent), and from the power input to up to present (cumulative),
(『[F1]: Service』 → 『1: Monitoring』 → 『4: Spot welding data』 → 『3: Spot welding operating information』)
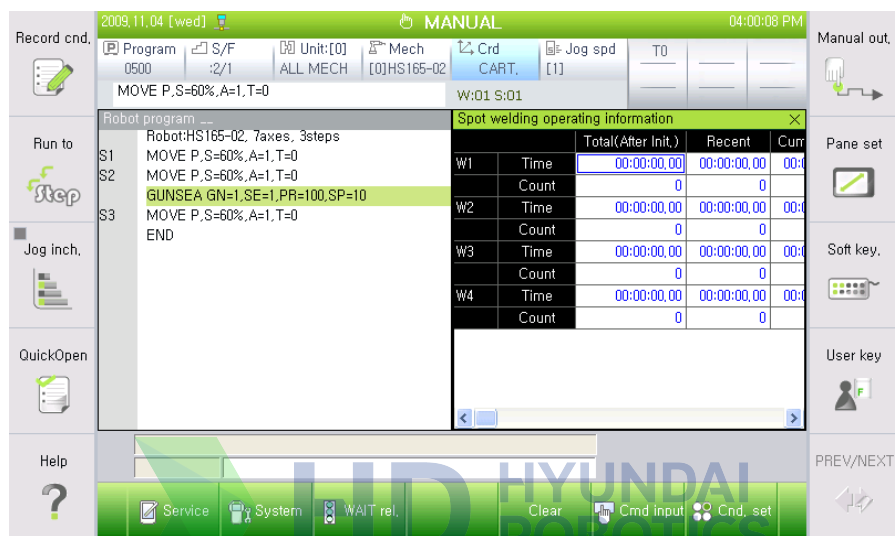
■ **Spot welding operating information clear**

When spot welding operating information window is activated, the 『[F5]: Clear』 button will be displayed. When this button is pressed, the operating information clear dialog box will be displayed, as shown in the following screen. Click the button of the item to be cleared to clear its information.
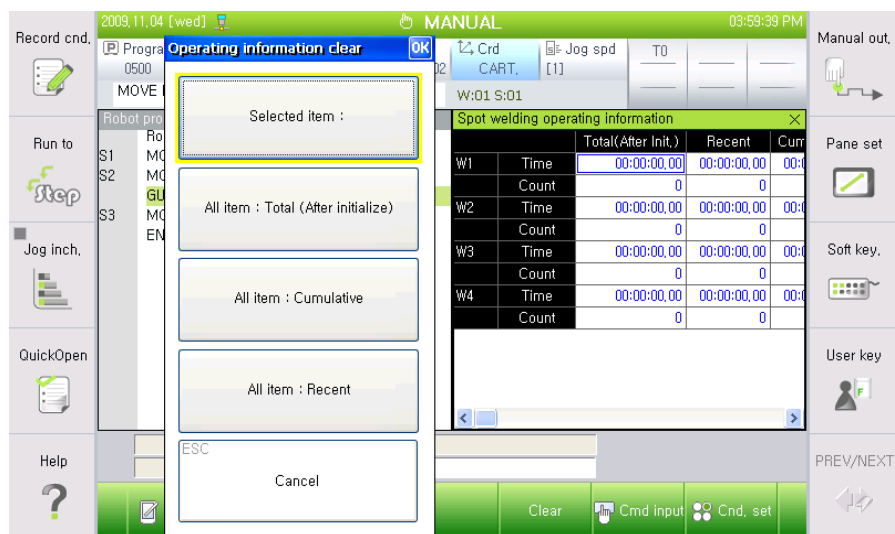
3.1.4. Status flag

Various statuses related to spot welding will be displayed, as shown in the following screen.
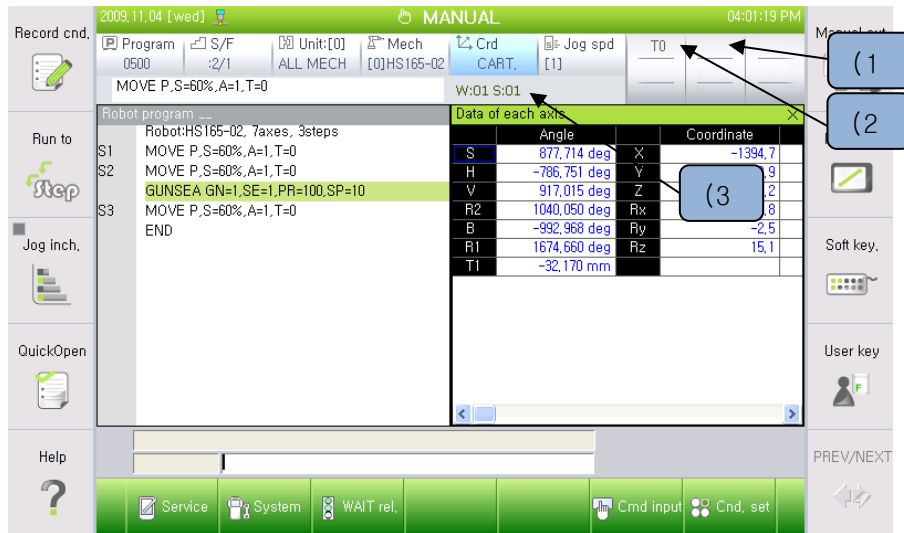
■ (1) Gun number
The relevant item displays the currently selected gun number, multi-gun number and the state of the servo gun detachment state (🔒). For example, if it is displayed like 🔒G5,6, it means that the stationary gun #5 and #6 are selected to carry out the welding at the same time. In addition, when the lock icon is displayed, it means that the servo gun is disconnected.

■ (2) Tool number
This displays the tool number which corresponds to the gun number currently selected. This indicates that when the gun number is changed, the tool number will be changed automatically to the tool number set from 『[F2]: System』 → 『4: Application parameter』 → 『1: Spot welding』 → 『1: Tool No. corresponding to Gun No., and gun-type set』.

■ (3) Welding condition, welding sequence (panel thickness)
This displays the currently selected welding condition number and welding sequence number. It displays the thickness of the currently set panel. The information should be set correctly because the servo gun axis position will be created automatically based on the panel thickness when the servo gun welding step is recorded. It is also possible to carry out recording manually through R220. When the welding step is to be recorded after [Manual squeeze], the setting will take place automatically by taking into consideration the current gun position.

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3.2. Servo-gun simple maintenance

After the servo-gun is repaired because of failure, support will be provided in a way that makes it possible to carry out a series of settings to conveniently restart through one window. Press the [CTRL]+[GUN] keys, and the dialogue box will come up to carry out simple maintenance.
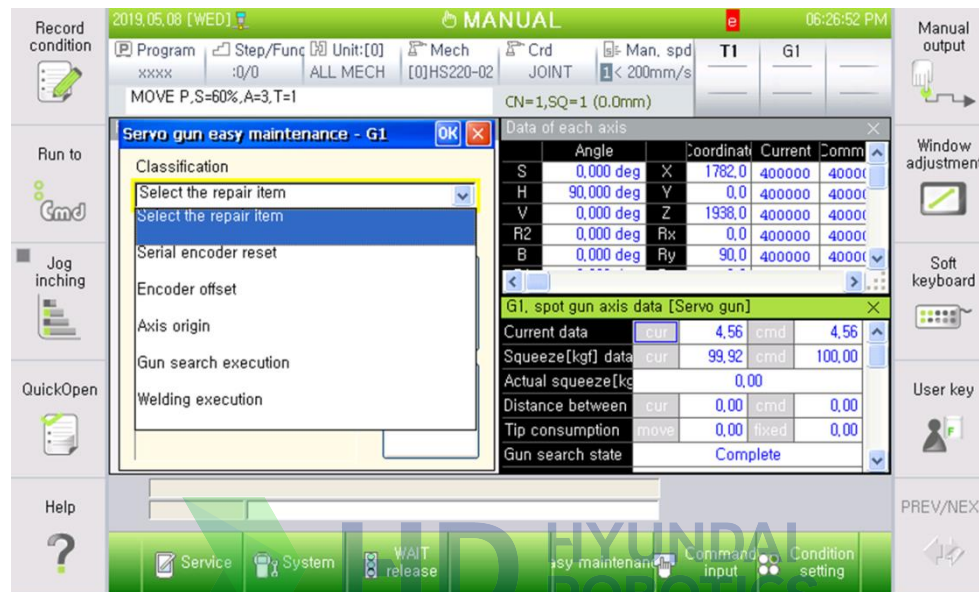
■ Serial encoder reset
Carries out "Encoder reset" or "Error removal" for the serial encoder attached to the servo gun motor. The power must be supplied again to allow the changed setting to be applied. After "Encoder reset" is executed, the encoder information will be initialized. That is why the encoder offset setting, the axis origin setting, and the gun search reference position record shall be carried out again.

■ Encoder offset
Sets the encoder origin of the servo gun. The encoder origin of the servo gun axis needs to be set by releasing the brake manually and by bringing the moving tip at the large stroke position.

■ Axis origin
Sets the axis origin of the servo gun axis. The axis origin of the servo gun axis needs to be set at the position while the tips meet each other after a new tip without wear is installed.

■ Gun search execution
Carries out the GUNSEA command while the servo gun axis runs only at the current position.

■ Welding execution
Carries out the SPOT command while the servo gun axis runs only at the current position.

3.3. User key

This part describes the user key related to spot welding. Please refer to the operating manual for the Hi5a controller for the method of registering and using the user key.
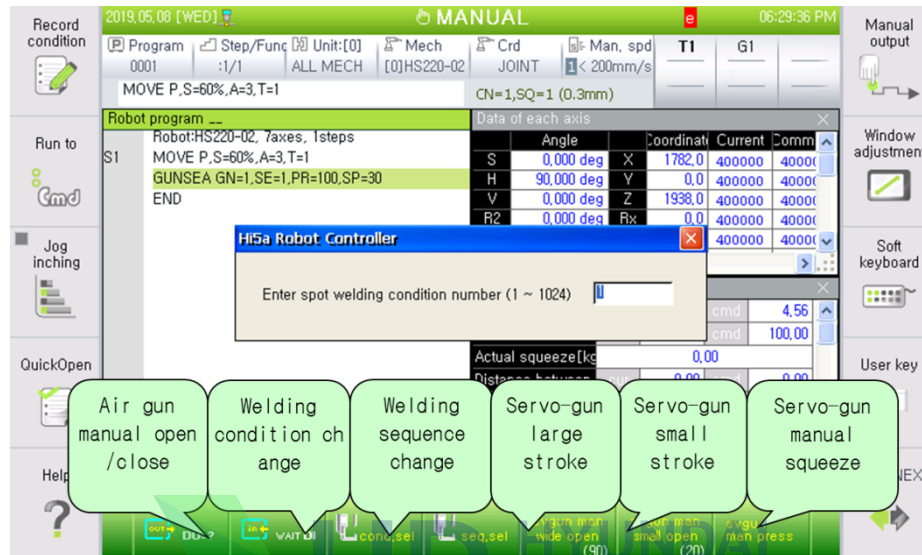
- Air gun manual open and close
  This enables the manual opening and closing of the air gun by displaying the MX signal.

- Welding condition change
  This enables manual changing of the currently selected welding condition number.

- Welding sequence change
  This enables manual changing of the currently selected welding sequence number.

- Servo-gun large stroke
  This manually moves the servo gun to the large stroke position

- Servo-gun manual open and close
  This manually moves the servo gun to the small stroke position

- Servo-gun manual squeeze
  This enables manual squeeze of servo-gun.

3.4. Manually opening and closing the welding gun, and manual squeeze

The procedure for manually opening and closing the welding gun and performing manual squeeze is as follows.
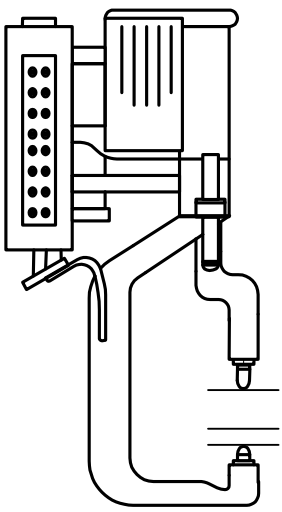
(1) Confirm the manual mode. Make preparations for operating the servo-gun axis if the servo-gun is used.

(2) Select the gun number for manual open and close or squeeze. The gun number is selected as follows:

Single-gun	For welding gun change	R358 (Welding gun connection/disconnection)
	Not for welding gun change	R210 (Welding gun selection)
Multi-gun		R214 (Simultaneous welding gun selection)

(3) Confirm if the following [user] key is registered.

Servo-gun			Air gun	
large stroke	Small stroke	Manual squeeze	Manual open and close	Manual squeeze
svgun man wide open (90)	svgun man small open (20)	svgun man press	MX	[GUN] key (Provided in key pad)

(4) By pressing "[SHIFT] and [user]" key together, the movement described below will be carried out. If multi-gun is selected, all guns will be operated in a uniform manner.

Servo-gun	Air gun	
	Manual open and close	Manual squeeze
Large stroke ← Small stroke ← Manual squeeze	Opening and closing air gun (X1 ~ X4) Output assigned signal	Executing welding process (W1 ~W4) Output assigned signal Welding condition (W1~W4) Output assigned signal

If using the servo-gun, the gun will display the following characteristics at the time of manual open/close and squeeze operation.

- If this stops automatically with the large stroke position, the small stroke position and the squeeze force set value are reached.

- The moving speed is 『2: Step fwd/bwd max. speed』 of 『[F7]: Condition setting』.

- Set the appropriate squeeze force, as the operation will not be successful if the set squeeze force is too small. (R211: Squeeze force setting)

- When using multi-gun mode with different moving distances for the two guns, the gun that arrives first will be stopped, and the other gun will be stopped after moving the remaining distance.
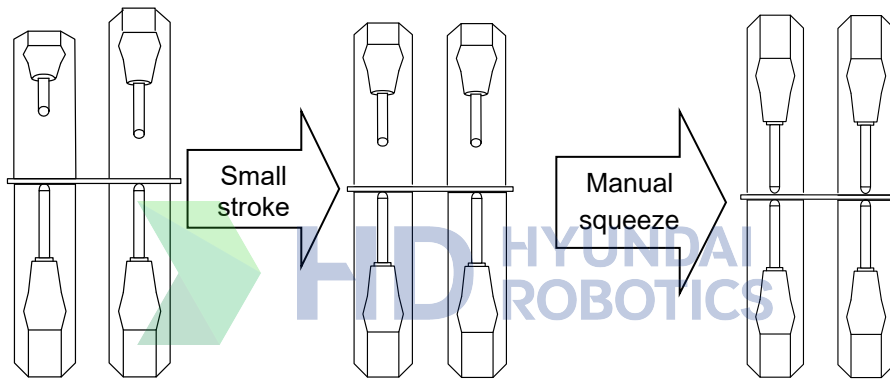
4
Work teaching

4.1. Gun search

The gun search function is the function to measure the tip consumption. It should be used when the tip electrode needs to be measured again after grinding the tip with a tip dressing or replacing a new tip.
If gun type is servo-gun or EQless-gun, the squeeze location will be corrected to the extent of consumption automatically when executing SPOT command. Consumption should be strictly managed, as the accuracy of this consumption measurement affects welding quality.

The types of gun search and simple features provided by our company are as follows.

- GUNSEA
  This is a servo gun search function and is executed by squeezing once.
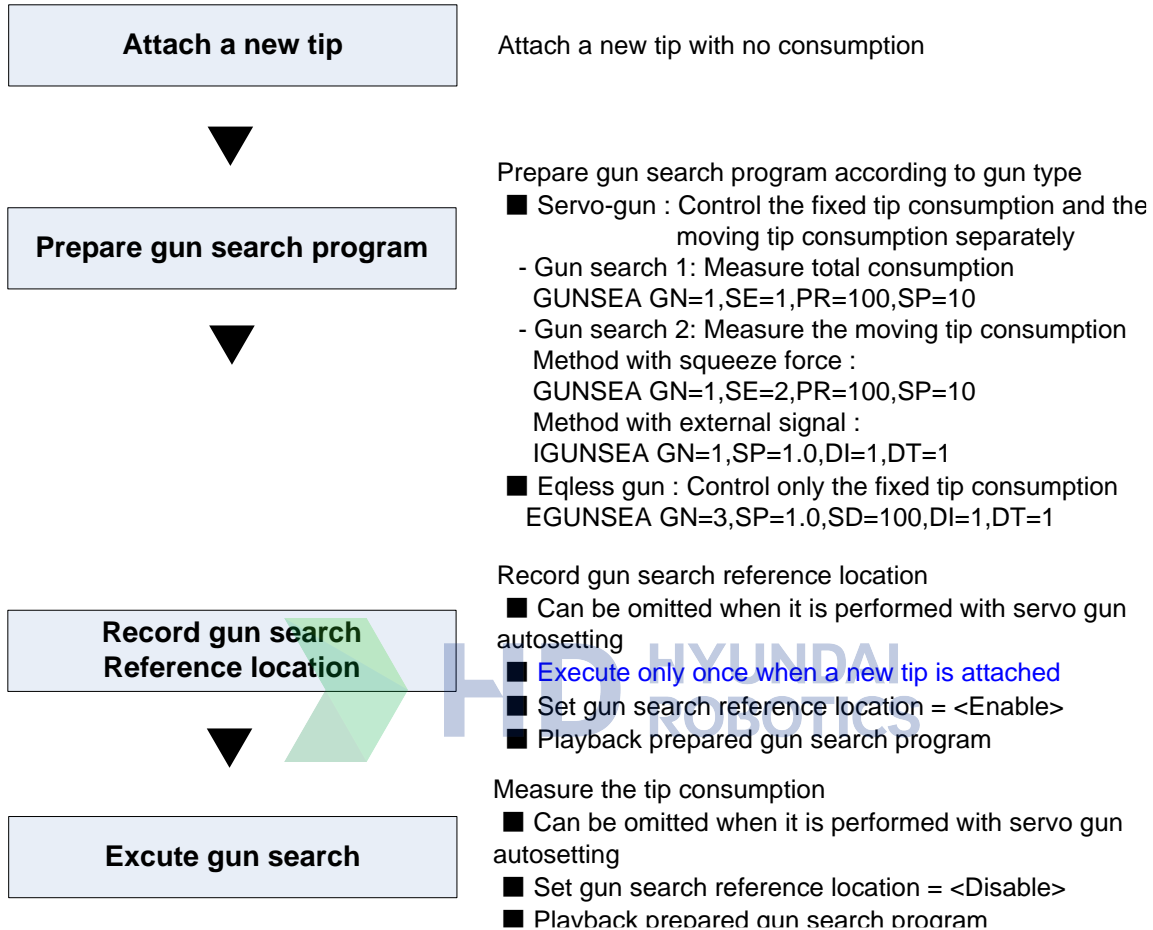 The total consumption of the moving and fixed tips is measured and distributed at a designated ratio.
  This can be used when the consumption ratios of the moving and fixed tips are the same or fixed.

- GUNSEA2
  This is a servo gun search function, and is executed by squeezing and moving once, respectively.
  The total consumption of the moving and fixed tips is measured (by squeezing once). After that, the consumption of the moving tip will be measured separately (by moving once).
  This can be used when the consumption ratios of the moving and fixed tips are not fixed.

- IGUNSEA
  This is the same servo gun search method as GUNSEA2, and is executed by squeezing and moving once, respectively. However, a sensor will be used to measure the consumption of the moving tip.
  The total consumption of the moving and fixed tips is measured (by squeezing once). After that, the consumption of the moving tip will be separately measured (by moving once).
  This can be used when the consumption ratios of the moving and fixed tips are not fixed.

- EGUNSEA
  This is a gun search function for an EQless gun. This function measures the consumption by receiving a signal from a sensor in the same way as in IGUNSEA.

The gun search status can be checked in the 『1: Spot gun axis data』 monitoring section.

4.1.1. Sequence of execution

Attach a new tip	Attach a new tip with no consumption

▼

Prepare gun search program	Prepare gun search program according to gun type
	■ Servo-gun : Control the fixed tip consumption and the moving tip consumption separately
	  - Gun search 1: Measure total consumption
	    GUNSEA GN=1,SE=1,PR=100,SP=10
	  - Gun search 2: Measure the moving tip consumption
	    Method with squeeze force :
	    GUNSEA GN=1,SE=2,PR=100,SP=10
	    Method with external signal :
	    IGUNSEA GN=1,SP=1.0,DI=1,DT=1
	■ Eqless gun : Control only the fixed tip consumption
	    EGUNSEA GN=3,SP=1.0,SD=100,DI=1,DT=1

▼

Record gun search Reference location	Record gun search reference location ■ Can be omitted when it is performed with servo gun autosetting ■ Execute only once when a new tip is attached ■ Set gun search reference location = <Enable> ■ Playback prepared gun search program

▼

Excute gun search	Measure the tip consumption ■ Can be omitted when it is performed with servo gun autosetting ■ Set gun search reference location = <Disable> ■ Playback prepared gun search program

HD **HYUNDAI ROBOTICS**

4.1.2. Commands related to Gun Search

(1) GUNSEA

Used for executing gun search 1 or gun search 2 based on squeeze force, when the gun type is servo-gun

GUNSEA GN=\<Gun Number\>,SE=\<Search Number\>,PR=\<Squeeze force\>, SP=\<Search speed\>,MG=\<Multi-gun Number\>,MP=\<Multi-gun squeeze force \>	
Item	**Description**
Gun Number	Assign the gun number to be searched
Search Number	Assign the gun search 1 operation or gun search 2 operation
Squeeze force	Assign the squeeze force to detect squeeze alignment
Search speed	Assign the operating speed of gun axis during search operation. Search speed is set based on safe speed, and the recommended speed is 10mm/s.
Multi-gun Number	Assign the multi-gun number in order to execute gun search on multiple servo-guns at the same time
Multi-gun squeeze force	Assign the multi-gun squeeze force when a separate squeeze force must be applied to each gun, in order to execute Gun Search on multiple servo-guns at the same time. If nothing is assigned, the squeeze force of a basic-gun will be applied.

Example of usage)
When executing gun search 1 with servo-gun 5 and 6 simultaneously, with 100 and 200kgf of squeeze force, respectively
=> GUNSEA GN=5,SE=1,PR=100,MG=6,MP=200

(2) IGUNSEA

Used for executing gun search 2 based on input signal when the gun type is servo-gun.

IGUNSEA GN=<Gun Number>,SP=<Search speed>,DI=<Input signal>

Item	Description
Gun Number	Assign the gun number to be searched
Search speed	Assign the operating speed of gun axis during search operation. Search speed is set based on safe speed, and the recommended speed is 10mm/s.
Input signal	Assign the connected input signal number for phototube output

(3) EGUNSEA

Used when gun type is EQless-gun.

| EGUNSEA GN=<Gun Number>,SP=<Search speed>,SD=<search distance>,
DI=<Input signal> |
|---|

Item	Description
Gun Number	Assign the gun number to be searched
Search speed	Assign the operating speed of gun axis during search operation. Search speed is set based on safe speed, and the recommended speed is 10mm/s.
Search distance	Assign the operating distance of gun axis during search operation.
Input signal	Assign the connected input signal number for phototube output

4.1.3. Gun search ref. pose record

Tip consumption will be measured based on a new tip with no consumption. The procedure to register the reference location on a new tip must be executed at least once in the early stage, and this is called Gun Search reference location record.

Gun search reference location should be recorded at least once before executing Gun Search.

After attaching a new tip, the Gun Search reference location will be recorded according to the following procedure.
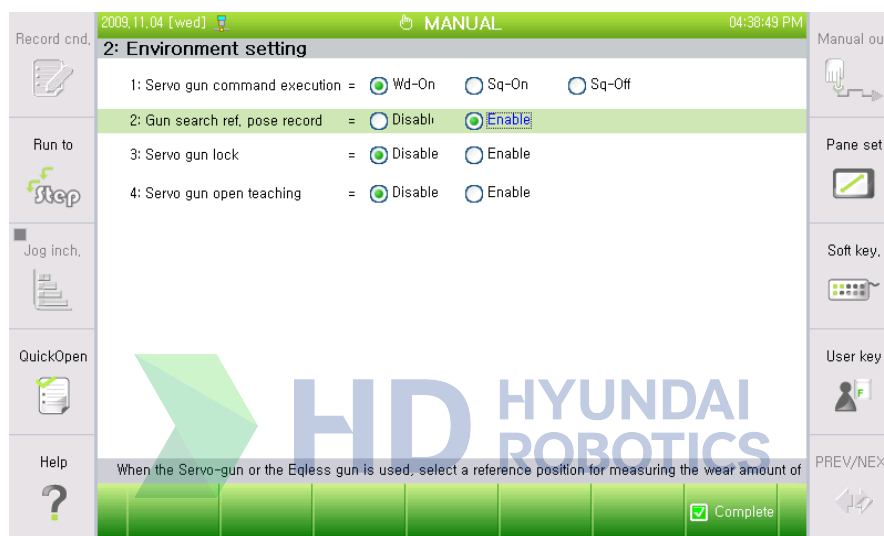
(1) Set up 『2: Gun search ref. pose record』 as <Enable>.

(2) Execute the prepared gun search program. In the 『1: Spot gun axis data 』 monitoring screen, the gun search state will be initialized as "incomplete".

(3) Set 『2: Gun search ref. pose record』 as <Disable>. The amount of change in comparison with the reference location will be calculated as consumption using the Gun Search program.

4.1.4. Gun search movement by gun type

4.1.4.1. Servo-gun

The gun search function of servo-gun is initially set to reflect the share of the contribution of fixed tip and moving tip to the total tip consumption by 50% each. Therefore, the consumption can be calculated by using gun search 1 only. Refer to gun search 2 descriptions for calculating consumption of fixed tip and moving tip.

If the value of 『moving tip consumption/total consumption(%)』 is "0", it is necessary to operate gun search 2; if the set value is not "0", total consumption owing to gun search 1 operation will be divided according to the set ratio.

(1) Gun search1

This measures the total tip consumption by squeezing the fixed tip with the moving tip.

```
S1    MOVE P,S=60%,A=1,T=1    'Move to the location of gun search 1 operation
      GUNSEA GN=1,SE=1,PR=100,SP=10    'Gun search 1 operation
      END
```
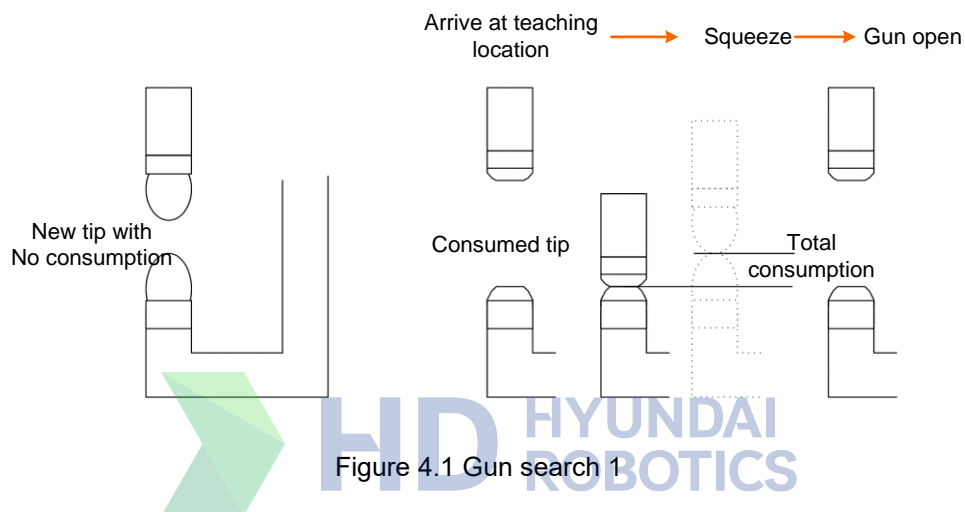

Figure 4.1 Gun search 1

① Move to the record location of step.

② Squeeze the fixed tip using the moving tip until the setting of squeeze force is achieved.

③ Measure total tip consumption, and execute opening when squeeze alignment is detected.
Previous tip consumption = Squeeze alignment detecting location - Gun search 1 reference location

④ Open up the record location of step.

⑤ Spilt total consumption measured in the ratio of moving tip and fixed tip as shown in the picture below, when operating Gun Search 1 only. (Default is 50:50)
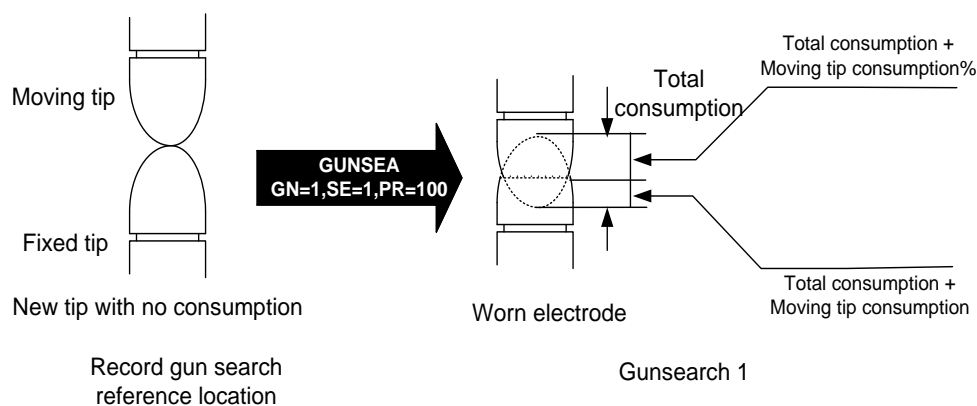

Figure 4.2 Calculation of consumption using only Gun Search 1

(2) Gun search 2

This measures the moving tip consumption. It can be measured using a method based on squeeze force, or a method based on an external signal.

● Method based on squeeze force

Squeeze the calibration jig using the moving tip, and measure the moving tip consumption.

```
S1     MOVE P,S=60%,A=1,T=1    'Move to the location of gun search 1 operation
         GUNSEA GN=1,SE=1,PR=100,SP=10    'Gun search 1 operation
S2     MOVE P,S=60%,A=1,T=1    'Move to the location of gun search 1 operation
         GUNSEA GN=1,SE=2,PR=100,SP=10    'Gun search 2 operation
         END
```
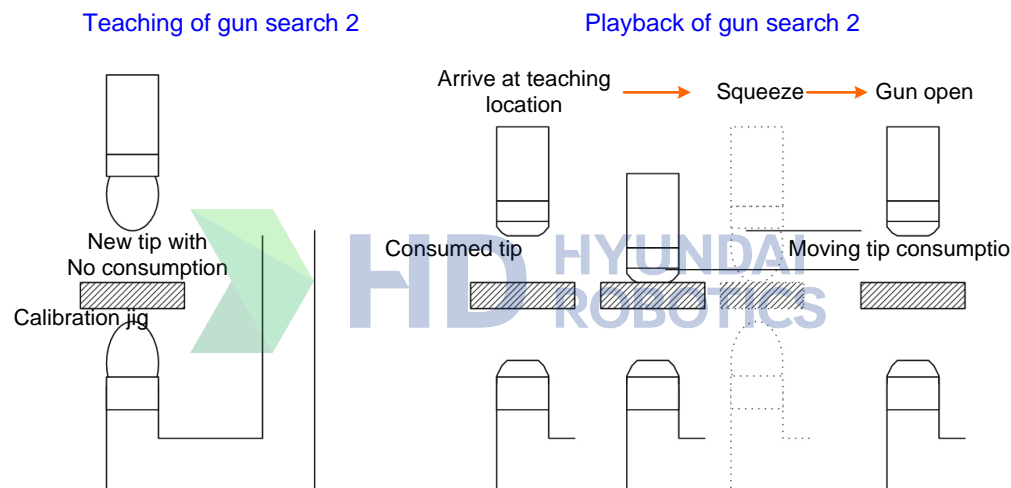

Figure 4.3 Gun search 2 based on squeeze force

① Move to the record location of step.

② Squeeze the search calibration jig using a moving tip until squeeze force is set.

③ Measure the moving tip consumption, and execute opening operation when squeeze alignment is detected.
Moving tip consumption = Squeeze alignment detecting location – Reference location of Gun Search 2 based on squeeze force
Fixed tip consumption = Total consumption detected by Gun Search1 - consumption of moving tip

④ When opening is complete, the consumption of the moving tip and the fixed tip will be updated.

● Method based on an external signal

Measure the moving tip consumption of by moving the moving tip to a location where a sensor is placed, and detecting the sensor input.

```
S1    MOVE P,S=60%,A=1,T=1   'Move to the location of gun search 1 operation
         GUNSEA GN=1,SE=1,PR=100,SP=10    'Gun search 1 operation
S2    MOVE P,S=60%,A=1,T=1 'Move to the location of gun search 2 operation
         IGUNSEA GN=1,SP=10.0,DI=1 'Gun search 2 operation
         END
```
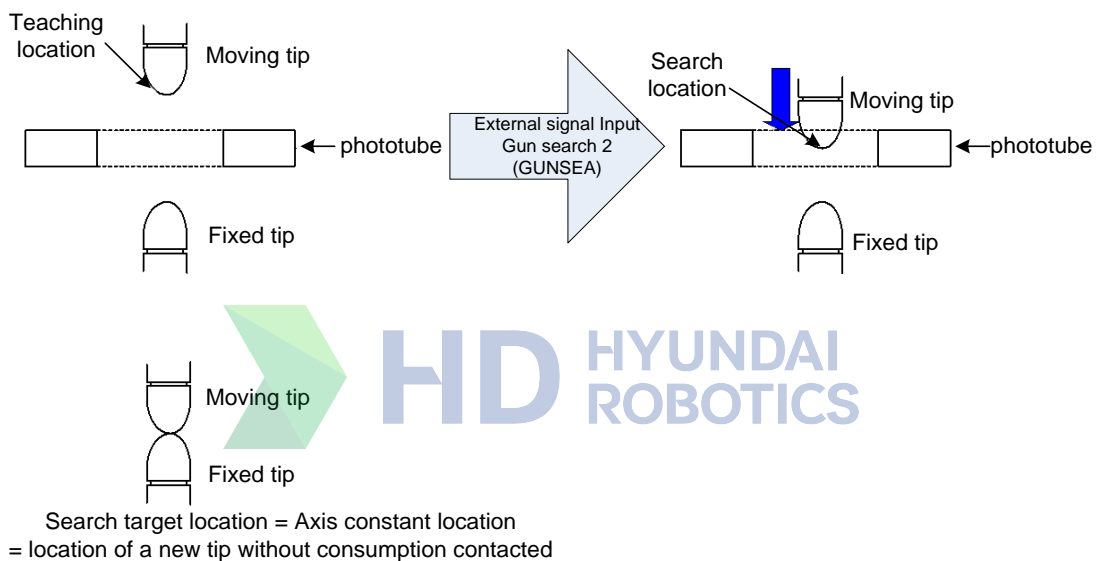

Figure 4.4 External signal input Gun Search2

① Move to the record location of step.

② The moving tip will approach in search speed to switch the phototube contact signal.

③ Measure the moving tip consumption, and execute opening when a signal is detected in the phototube.
Moving tip consumption = External signal detecting location – Reference location of Gun Search 2 based on external signal input
Fixed tip consumption = Total consumption detected by Gun Search 1 - Moving tip consumption

④ When opening is complete, the consumption of the moving tip and the fixed tip will be updated.

4.1.4.2. EQless-gun

EQless-gun only controls the fixed tip consumption, so the Gun Search function measures the fixed tip consumption.

```
S1    MOVE P,S=60%,A=1,T=1   'Move to the location of gun search operation
       EGUNSEA GN=3,SP=10.0,,SD=100,DI=1   'Gun search operation
       END
```
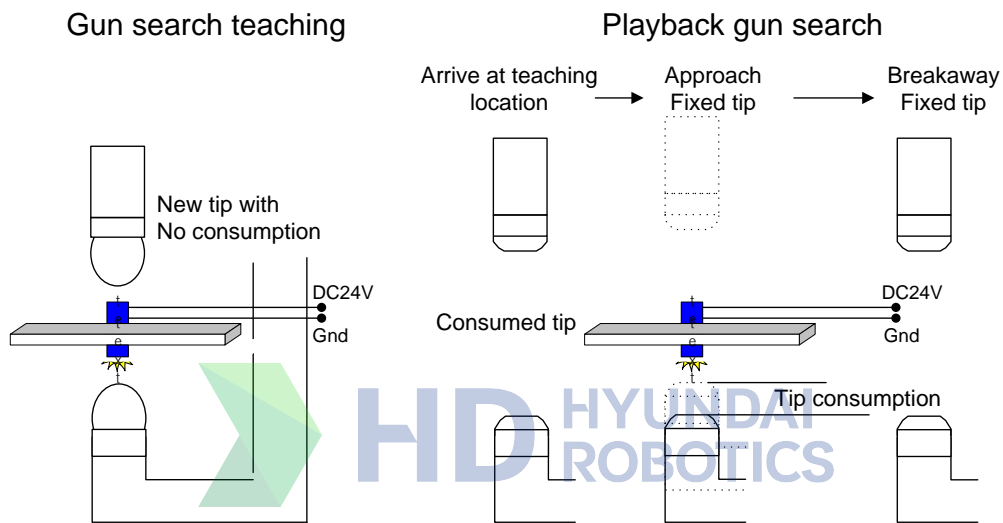

Figure 4.5 EQless-Gun Search

(1) Move to the record location of step.

(2) Fixed tip will approach in search speed to switch the phototube contact signal.

(3) Measure the fixed tip consumption and execute opening when a signal is detected in phototube
     Fixed tip consumption = Sensor detecting location – Record location of Gun search

(4) When opening is complete, consumption of the fixed tip will be updated.

4.2. Spot welding

Spot welding will be carried out by the welder when the fixed tip and moving tip are squeezed by applying the welding current.

4.2.1. SPOT command

Execute the spot welding step again in the event that the operation is stopped and executed again while spot welding is not yet completed.

[GUN] LED is illuminated when recording a step using the [Record] key, and SPOT command will be recorded together with MOVE command. (One-touch recording)

To set the panel thickness when the welding step is recorded, it is necessary to bring the fixed tip into contact with the panels through the jog operation. Then, while squeezing the panel manually, it is needed to record the SPOT command through one-touch recording method to set the panel thickness. After the panel thickness is set, it is necessary to bring the fixed tip into contact with the panel through the jog operation. After that, without manual squeeze, it is necessary to record the SPOT command through one-touch record method, the recording will take place by taking into consideration the panel thickness and the corrected position based on the tip consumption.

When the gun type is servo gun, if the SPOT command exists when carrying out [Position correction], the relevant position will be corrected by taking into consideration the tip consumption.

SPOT GN=<Gun Number>,CN=<Condition Number>,SQ=<Sequence Number>,

MG=<Multi-gun Number>,MC=<Multi-gun condition Number>,MS=<Multi-gun sequence>

Item	Description
Gun Number	Designate the welding gun number
Condition Number	Designate the welding condition
Sequence Number	Designate the welding sequence
Multi-gun Number	Designate the multiple gun numbers when carrying out welding with multiple guns at the same time.
Multi-Gun Condition Number	To be designated because the welding condition varies depending on the guns when carrying out welding with multiple guns at the same time. If not designated, the welding condition of the basic gun will be applied.
Multi-Gun Sequence Number	To be designated because the welding sequence varies depending on guns when carrying out welding with multiple guns at the same time. If not designated, the welding sequence of the basic gun will be applied.

Example of usage)
If carrying out spot welding by using servo-guns 5 and 6 simultaneously with 7 and 8 for each welding condition, and 9 and 10 for each welding sequence.
=> SPOT GN=5,CN=7,SQ=9,MG=6,MC=8,MS=10

4.2.2. Welding sequence by gun type

The controller carries out the welding operation by executing SPOT command to the program. The playback of the spot welding function varies by gun type, as follows.

4.2.2.1. Servo-gun

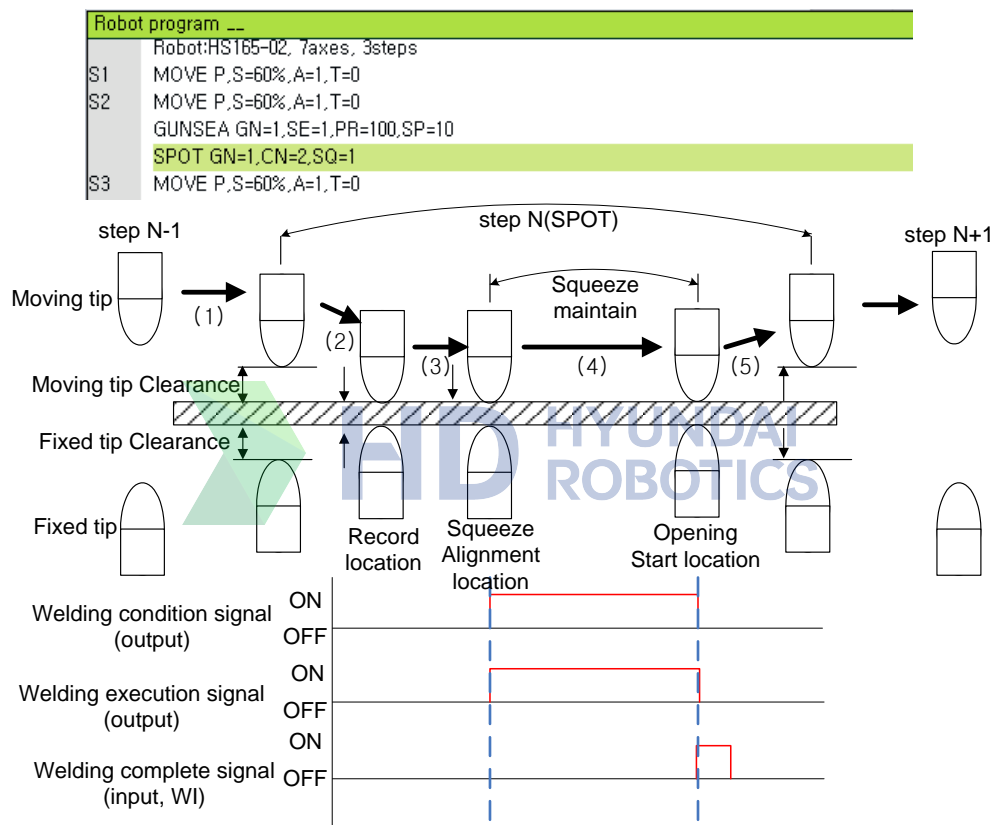If the gun type is servo-gun, the playback of spot welding function will be carried out as shown below.

Figure 4.6 Playback of servo-gun spot welding

(1) In the N-1 step position, the moving tip and the fixed tip will move to the position where they are distant as much as the "moving tip clearance" and the "fixed tip clearance" individually.

(2) The fixed tip moves to the record location of the step through the robot equalizing operation, and the moving tip moves to the record location of the step by shifting to compensate for consumption.

(3) The moving tip carries out squeeze at the set squeeze force. When the squeeze alignment is achieved, the welding execution signal will be output together with the welding condition signal at that location.

(4) When the welding complete signal (WI) is received, both the moving tip and the fixed tip will be opened sufficiently for clearance.

(5) Continue to the next step.

4.2.2.2. EQless-gun

If the gun type is EQless-gun, the playback of spot welding function will be carried out as shown in the picture below.
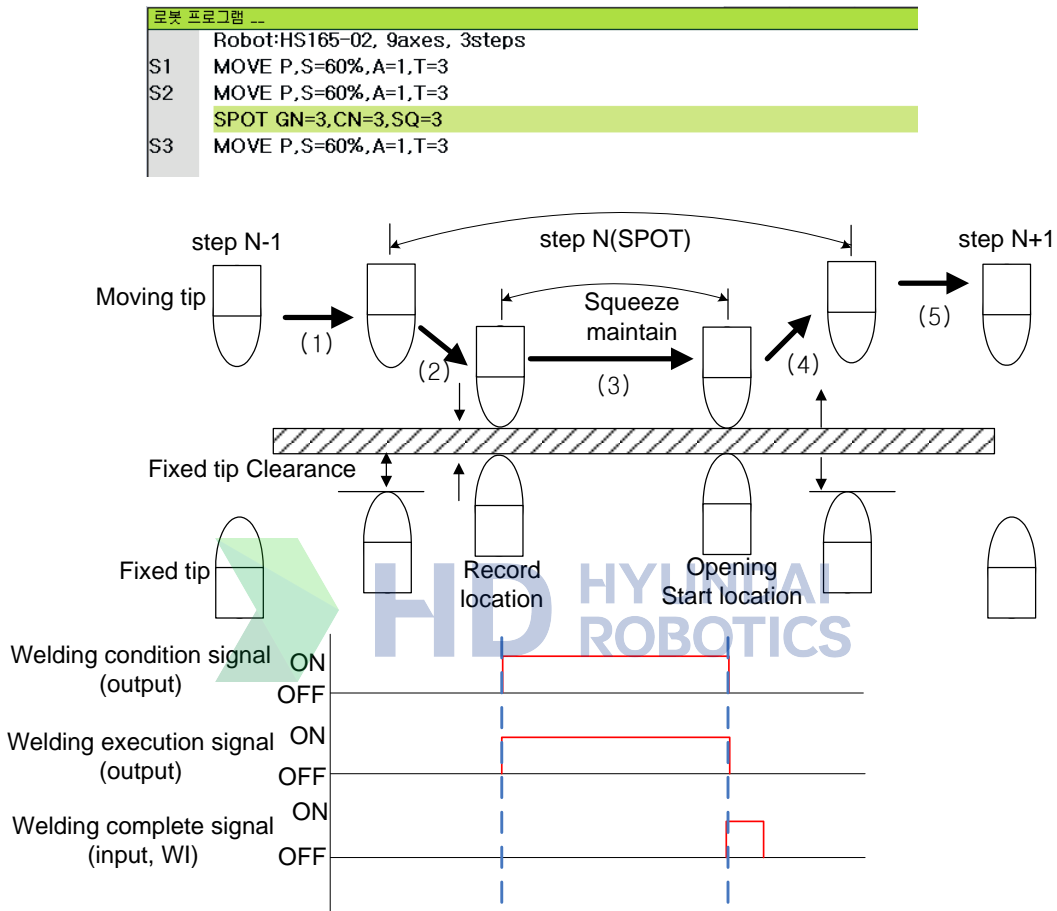


```
로봇 프로그램 __
        Robot:HS165-02, 9axes, 3steps
S1      MOVE P,S=60%,A=1,T=3
S2      MOVE P,S=60%,A=1,T=3
        SPOT GN=3,CN=3,SQ=3
S3      MOVE P,S=60%,A=1,T=3
```

Figure 4.7 Playback of EQless-gun spot welding

(1) From N-1 step location, the fixed tip moves to a location at a distance of 'fixed tip clearance' from the record location.

(2) The fixed tip moves to the record location of the step through the robot equalizing operation, and the moving tip squeezes the panel using air pressure.

(3) When the squeeze alignment is achieved, the welding execution signal will be output together with the welding condition signal at that location.

(4) When the welding complete signal (WI) is received, the fixed tip moves to a location from the record location that is equal to the fixed tip clearance, and the moving tip moves to a location where air pressure is not supplied.

(5) Continue to the next step.

4.2.2.3. Eq-gun

If the gun type is Eq-gun, the playback of spot welding function will be carried out as shown in the picture below.
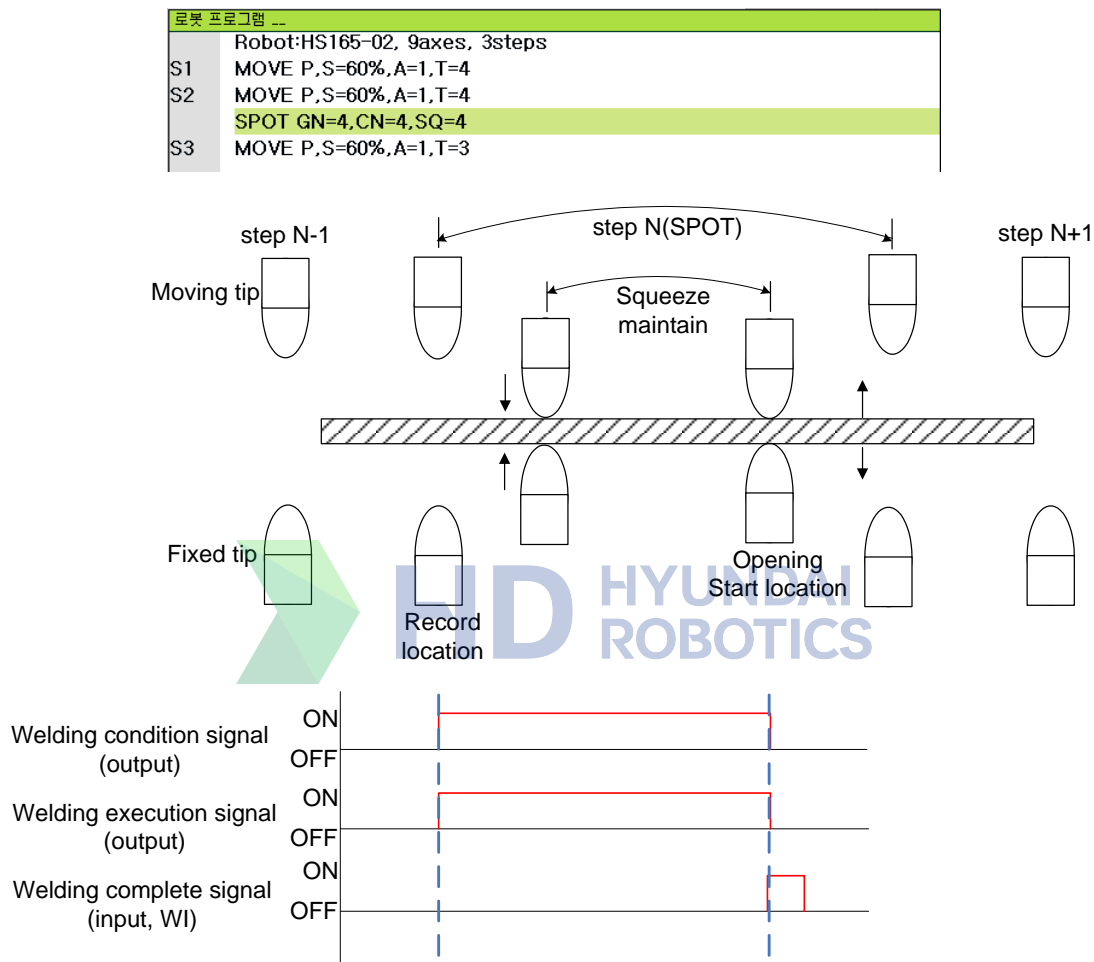


```
로봇 프로그램 __
        Robot:HS165-02, 9axes, 3steps
S1      MOVE P,S=60%,A=1,T=4
S2      MOVE P,S=60%,A=1,T=4
        SPOT GN=4,CN=4,SQ=4
S3      MOVE P,S=60%,A=1,T=3
```

Figure 4.8 Playback of Eq-gun spot welding

(1) Move from N-1 step location to the record location of the step.

(2) Output the welding execution signal together with the welding condition signal. Squeeze the panel with equalizing equipment if the fixed tip is used and with air pressure if the moving tip is used.

(3) When the welding complete signal (WI) is received, the fixed tip will move to a location where equalizing equipment is not operated, and the moving tip will move to a location where air pressure is not supplied.

(4) Continue to the next step.

4.3. Servo-gun tip dressing

4.3.1. Condition setting

Tip dressing condition setting of servo-gun is executed by selecting 『[F2]: System』 → 『4: Application parameter』 → 『1: Spot welding』 → 『4: Welding data (Cnd, Seq)』 → 『4: Servo gun tip dressing condition』. Please refer to the corresponding menu.

4.3.2. Operation type

To execute tip dressing operation by using the servo-gun tip dressing condition, the welding sequence number of SPOT command should be assigned to 64, as shown below.
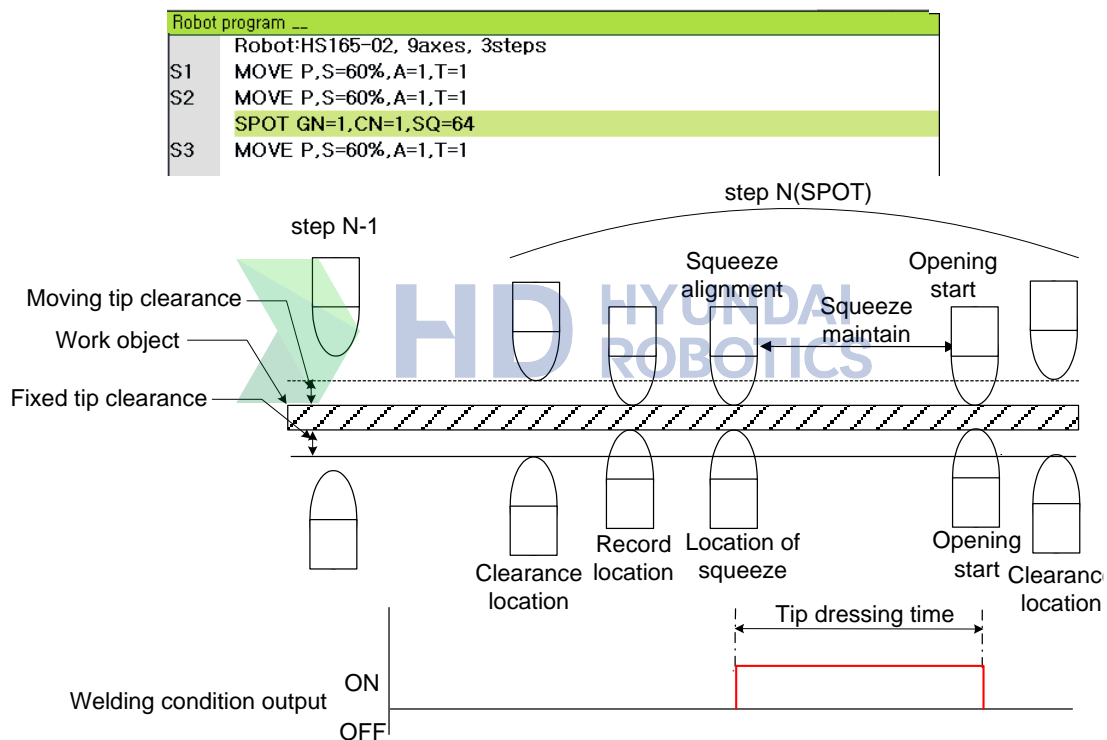
(1) From the N-1 step location, the moving tip moves to location that is at a distance equal to the moving tip clearance from the record location, and the fixed tip moves to location that is at a distance equal to the fixed tip clearance from the record location.

(2) Move to the record location of step.

(3) The moving tip carries out squeeze with the squeeze force registered on the welding condition. When the squeeze alignment is achieved, the welding condition signal will be displayed at that location. At this time, the output of the welding execution signal together will be determined according to the "Welding signal output" from the tip dressing condition.

(4) After the time to register tip dressing has passed, both the moving tip and fixed tip will be opened sufficiently for clearance.

(5) Continue to the next step.

4.4. Servo-gun opening location record

Recording spot welding step of the servo-gun will be carried out through the following steps.

    (1) Confirm one-touch recording status ([GUN] key LED lighting).
    (2) Contact the fixed tip of servo-gun to the workpiece.
    (3) Operate the manual squeeze to squeeze the moving tip into the workpiece.
    (4) Record SPOT command together with step by pressing [REC] Key. → Automatic registration of the panel thickness
    (5) Disconnect the moving tip from the workpiece through the manual open and close operation.
    (6) Move to the next location.

By recording the servo-gun opening location, steps (3) and (5) above can be omitted, and significant teaching time can be saved. To carry out this procedure, the controller should know the panel thickness to be welded.
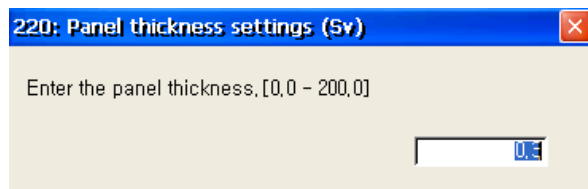
4.4.1. Registering the panel thickness

The panel thickness should be registered, because servo-gun opening location record calculates the location of the moving tip based on the designated panel thickness.

There are two ways of registering the panel thickness. The users can register the thickness manually or the thickness can be registered automatically while the panel is squeezed.

4.4.1.1. Manual registration method

Enter the panel thickness by executing "R220 Panel thickness setting (Sv)"

4.4.1.2. Auto registration method

While the [GUN] led is turned on, squeeze manually and press the [Record] key to allow the panel thickness to be registered automatically.

4.4.2. Teaching method

(1) Execute teaching when the moving tip is opened and the fixed tip is attached to the panel after the panel thickness is registered.

1st	2nd	3rd	4th
Registering the panel thickness	➔		Teaching servo-gun opening

Operating type for equal panel thickness
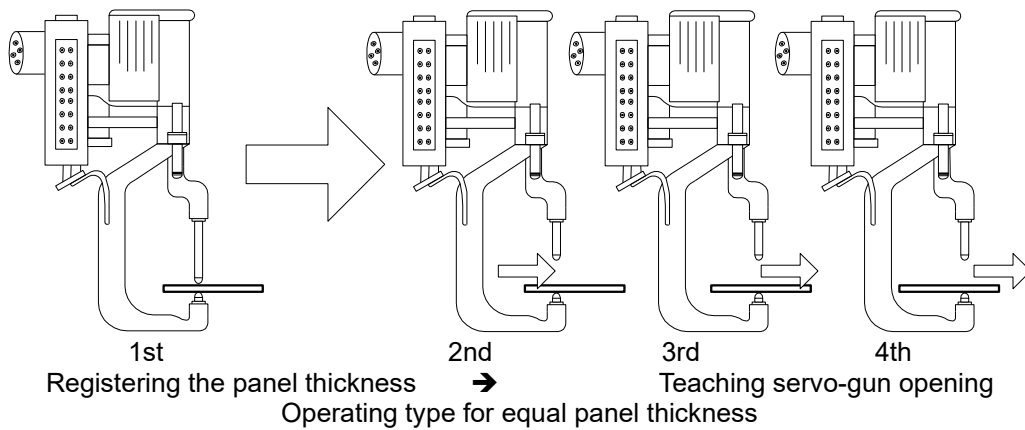
(2) When the panel thickness is changed, it is necessary to register the panel thickness again and carry out teaching.

4.5. Welding gun change

The welding gun change function is used to connect and disconnect the robot R1 axis and the welding gun when two or more guns are to be combined with the robot R1 axis.

Caution) Considering that this function is mostly the same as the servo tool change function, which is easier to set, it is recommended to use this function instead of the servo tool change function. Note that the servo tool change function and welding gun change function cannot be used together.

4.5.1. Environment setting

Proceed in the following order to set the environment for welding gun change.

    A.   Welding gun change count setting
    B.   Tool number and gun type corresponding to the gun number
    C.   Servo tool parameter setting

4.5.1.1. Welding gun change count setting

Designate the count of guns to be used for welding gun change in 『[F2]: System』 → 『5: Initialize』 → 『3: Usage setting』. At this time, all the guns targeted for the change will be initialized as the robot guns.
(e.g., If a gun is mounted on the robot R1 axis and three more guns will be used for the change, four guns are to be set.)

The welding gun change function makes it possible to change up to 16 guns for 1 additional axis. However, the count of gun changes that can be set will be reduced if a servo gun is used for other additional axes.
(e.g., If 5 additional axes are currently set and 3 of them are set for servo gun, then only up to 14 (16 - [3-1] = 14) can be set.)
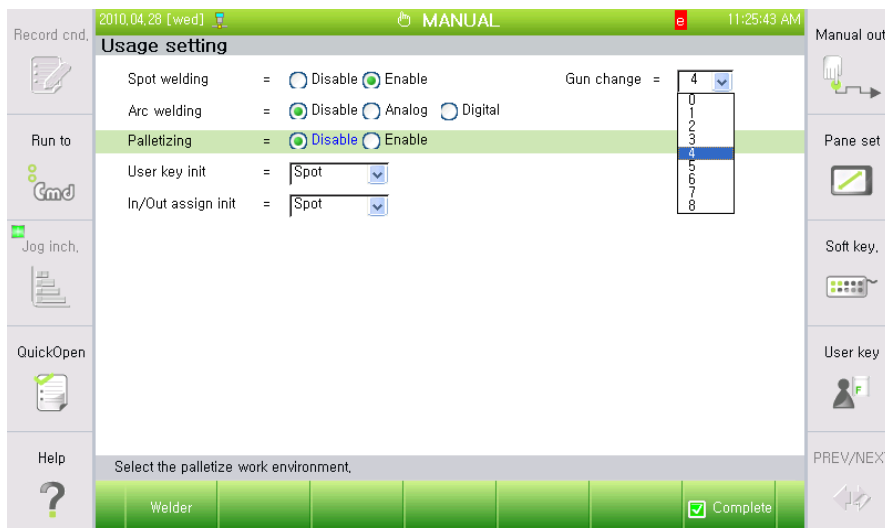
4.5.1.2. Tool number and gun type corresponding to the gun number

Designate the gun type and tool number for welding gun change in 『[F2]: System』 → 『4: Application parameter』 → 『1: Spot welding』 → 『1: Setting of tool number and gun type corresponding to the gun number』. The welding gun change function supports not only the change between servo guns but also that with air guns.
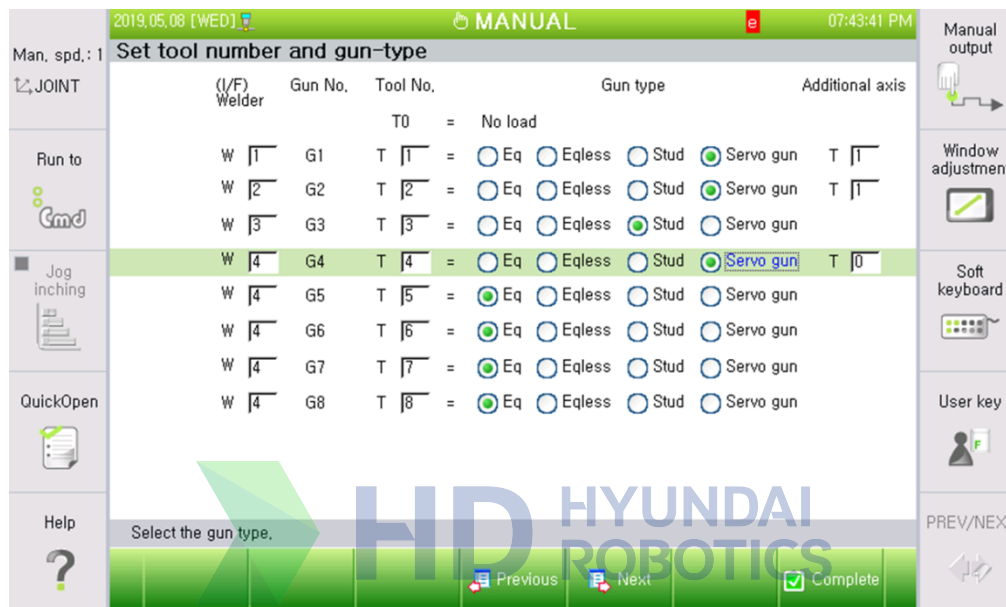
The figure above shows an example of setting, following four welding gun changes after registering them.

- Gun 1: Welder 1, Tool number 1, Servo gun, Additional axis T1 → Servo tool parameter setting required
- Gun 2: Welder 1, Tool number 2, Servo gun, Additional axis T1 → Servo tool parameter setting required
- Gun3: Welder 1, Tool number 3, Stud gun, No additional axis assigned
- Gun 4: Welder 1, Tool number. 4, Servo gun, Additional axis T1 → Servo tool parameter setting required

When it comes to guns that are targeted for welding gun change and are also set for servo gun, it is required to set servo tool parameters for them as in the following chapter.

Caution) All welding guns targeted for welding gun change must use the same welder.
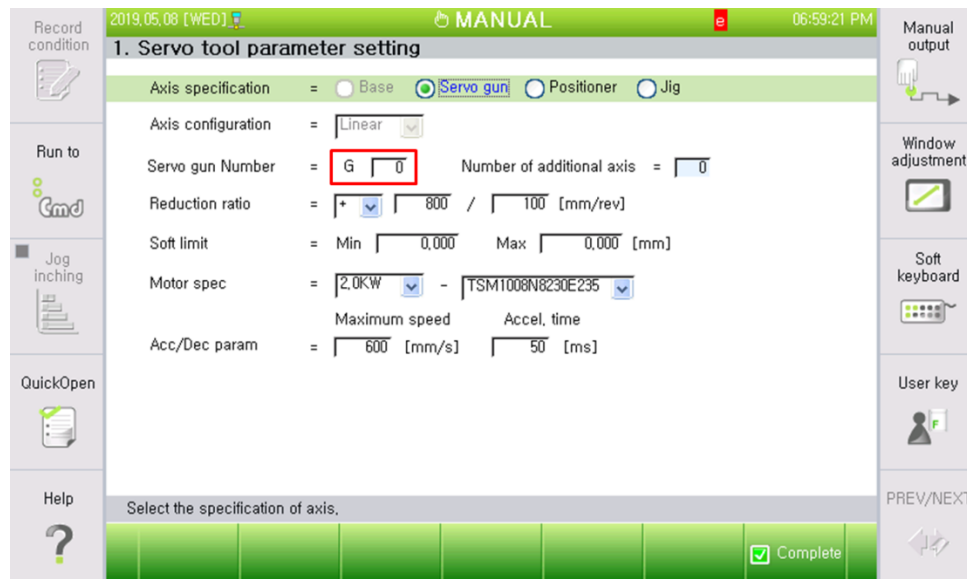
4.5.1.3. Servo tool parameter setting

Designate the gun type and tool number targeted for welding gun change in 『[F2]: System』 → 『4: Application parameter』 → 『11: Servo tool change』 → 『2: Servo tool parameter setting』.
If a servo gun is targeted for the welding gun change, it is required to set the parameters of the servo gun to be used because the currently set parameters of the additional axis and the parameters of the servo gun to be used may be different. The parameters to be set should use the same setting items as the parameters of the additional axis because they replace the present values of the additional axis when different welding guns are used by applying the welding gun change function as shown below.
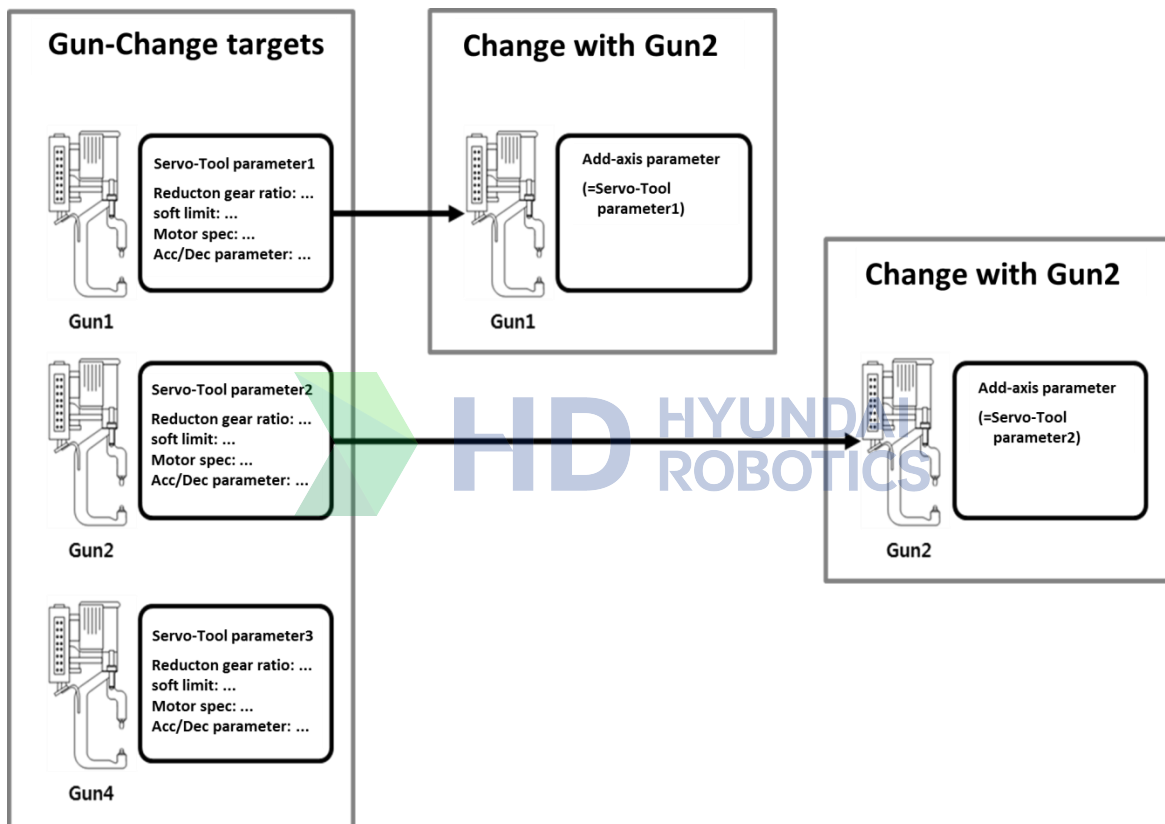
The setting items of the servo tool parameters are mostly the same as those of the additional axis parameters. The difference is that it is required to assign a servo gun number corresponding to the relevant parameters (red box below).

If a number except for 0 is assigned to the relevant servo gun, the [F5: Next] button will be activated as shown below to allow the user to set the next parameters of the servo tool. If there is no more servo tool parameter to be set, set the relevant gun number to 0.
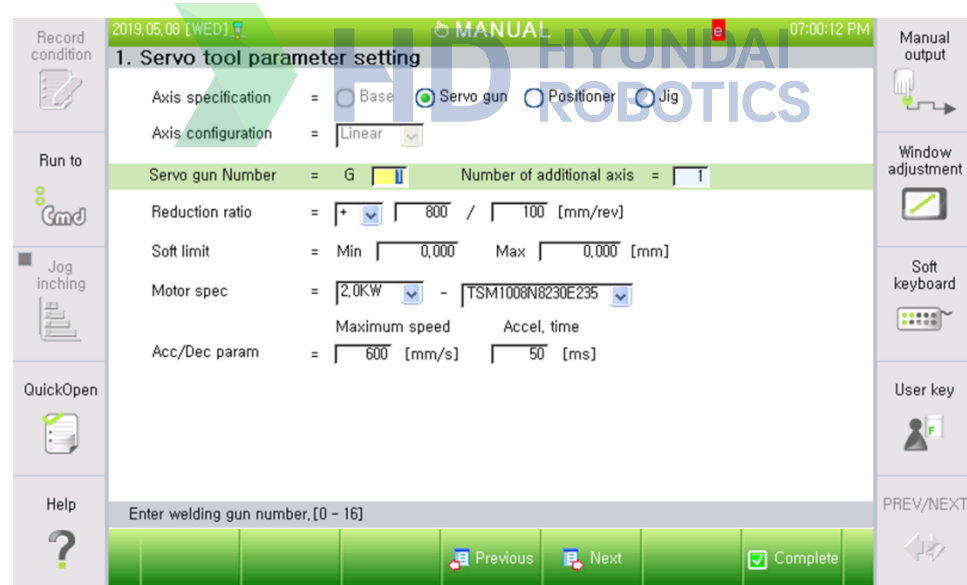
4.5.2. Connection/disconnection command

In the welding gun change environment, welding gun connection / disconnection is executed in one of two ways; by R code or by the execution of a work program. When connecting the welding guns, the gun number and the tool number will be changed automatically according to the set value, and when separating the welding guns, the gun number and the tool number will be changed automatically.

(1) R358
    Welding gun change by R code; used in motor ON state of manual mode (Enable switch ON)

Control	Parameter	#1	#2
R358,#1,#2	Meaning	connection / disconnection	Gun Number
	Set value	Connection = 1, Disconnection = 0	Welding Gun Number to be changed
	Example of usage	R358,1,2 (Connect Gun Number 2)	
		R358,0 (Separate the gun)	

(2) GUNCHNG
    A function of welding gun change by execution of a work program

GUNCHNG ON/OFF/Fixed,GN=<Gun No.>,DI<Connection Complete Condition>,WT=<Connection Complete Waiting Time>			
ON/OFF/Fixed	ON	Welding gun connected	
	OFF	Welding gun disconnected	
	Fixed	Welding gun connected (electric/mechanical connection not necessary)	Motor and encoder information sustained (Refer to 2.16.)
Gun number	1–16	Number of the welding gun to connect	Parameter to be ignored when GUNCHNG OFF
Connection complete condition	Conditional expression	Conditions for the completion of mechanical connection	
Connection complete waiting time <0–5.0> (s)		Connection complete signal input waiting time (If the parameter is absent or 0, the waiting time is infinite, and if it is not completed within the relevant time, an error occurs.)	

The connection will be processed completely when the mechanical connection and the internal processing in the robot controller are finished. The connection completion waiting time is the time for waiting for the two processes above to be completed.

4.5.3. Connection/disconnection timing
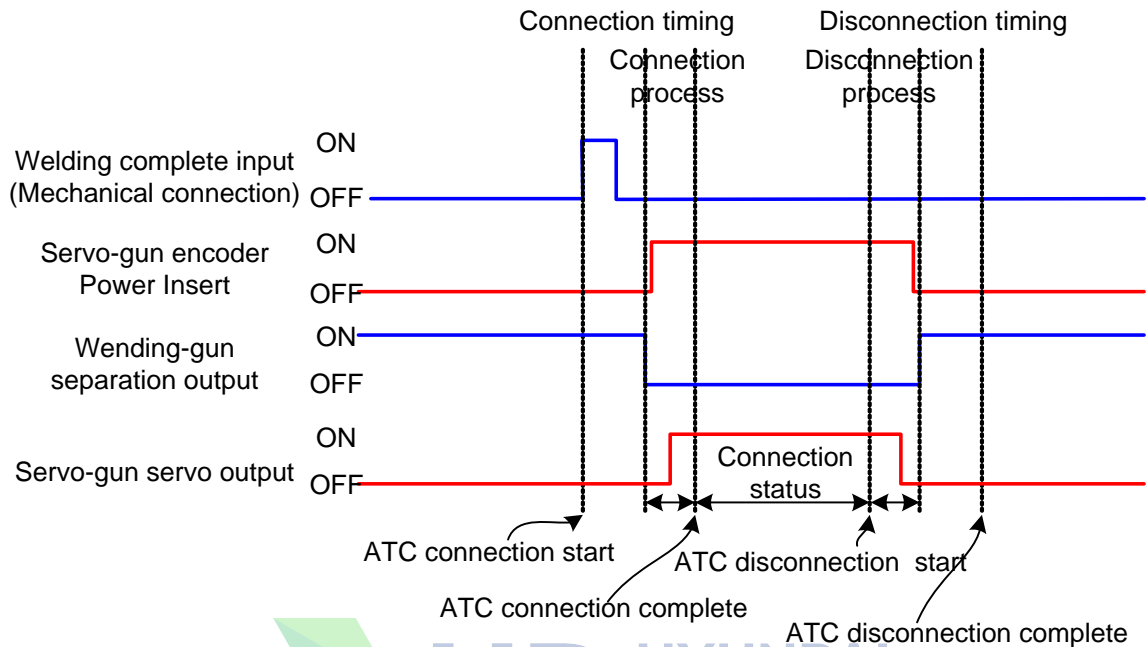
■ Connection
While the connection command (GUNGHNG ON) is being executed, if the robot and the welding gun come into contact mechanically, the connection completion signal will be inputted and the connection will be processed internally by the controller. If the gun type is servo-gun, encoder power input and motor ON operation will be added for driving the servo-gun axis.

■ Disconnection
Disconnection command (GUNCHNG OFF) executes the disconnection process in a sequence that runs counter to connection.

4.5.4. Sample program

	Disconnection/connection program	Meaning of command	Note		Direction of signal	
Step B	....	(Location of welding gun disconnection)		ROBOT		ATC
	GUNCHNG OFF	Execute welding gun disconnection				
		Output welding gun disconnection	Private output		→	
	DO11=1	Output ATC cam open			→	
	WAIT DI11	Confirm ATC cam open complete	Confirm the signal		←	
	MOVE L, ...	I				
	MOVE L, ...	Move robot				
	MOVE L, ...	I				
Step K		(Location of welding gun connection)				
	WAIT DI12	Confirm connection possibility	Confirm the signal		←	
	DO11=0	Output ATC cam close			→	
	GUNCHNG N,GN=1,DI1	Input mechanical connection complete			←	
		Process connection of welding gun	GUNCHNG			
		I				
	MOVE L, ...	Move robot				

4.5.5. Servo gun control for the variation of the fixed tip location

Changing the entire servo gun requires additional facilities (ATC, gun stand, etc.). However, if the user runs the system in a way that the moving tip is fixed and the fixed tip is changed, additional facilities will not be needed, and the time for the change can be saved as well. To support this, it is necessary to manage the consumption and the soft limit as much as the count of fixed tips, making it necessary to operate similarly to the welding gun change (servo tool change) function. Therefore, learn the welding gun change (servo tool change) function first before using this function.

This function differs from the servo gun change function in that mechanical and electrical connection and disconnection will not take place, and the motor and encoder information is always the same, so the information will not be not updated.

Sample Program		Meaning of the Command
Step B	....	(Move fixed tip 1.)
	GUNCHNG Fixed,GN=1	Handle the change with fixed tip 1.
Step	MOVE L, ...	I
	SPOT GN=1	Execute welding with gun number 1.
	...	I
Step K	....	(Move fixed tip 2.)
	GUNCHNG Fixed,GN=2	Handle the change with fixed tip 2.
Step	MOVE L, ...	
	SPOT GN=2	Execute welding with gun number 2.

4.6. Multi-gun simultaneous welding

In normal spot welding operation, one welding operation is carried out by one welding gun. In multi-gun simultaneous welding, one welding operation is carried out by multiple welding guns.

For this, all the type of the guns (Servo gun, Egless gun, Eq gun, and Stud gun) should be the same.

4.6.1. Manual selection of multiple guns

Multiple guns can be assigned manually by R214.
The procedure of selecting G5 (master) and G6 (slave), which are stationary servo-guns, as multiple guns while G3 (EQless-gun) is connected as a robot-gun is as follows.

(1) Select [R] + [210] and #5 to select G5.

(2) Select [R] + [214] and #6 to add welding guns simultaneously.

(3) The state of the selected guns will be displayed on the status flag.

◆ 【Reference】 ◆

[R] + [210] master gun number change

(1) Single gun environment → [R]+[210]+[3] → Single gun environment (Ex.: G1→ G3)
(2) Multi-gun environment → [R]+[210]+[1] → Single gun environment (Ex.: G1,3→ G1)

[R] + [214] Multi-gun selection

(1) When selecting a number differently from the set one.
A. Single gun environment → [R]+[214]+[3] → Multi-gun environment (Ex.: G1→ G1,3)
B. Multi-gun environment → [R]+[214]+[2] → Multi-gun environment (Ex.: G1,3→ G1,3,2)

(2) When selecting the same number as set
A. Multi-gun environment → [R]+[214]+[3] → Multi-gun environment (Ex.: G1,3,2→ G1,2)
B. Multi-gun environment → [R]+[214]+[2] → Single gun environment (Ex.: G1,2→ G1)
C. Master gun number should not be changed.

4.6.2. Supported functions

Functions provided for simultaneous welding with multiple guns are as follows.

    (1)   Manual open and close
    (2)   Manual squeeze
    (3)   SPOT command
    (4)   GUNSEA command

4.7. Panel thickness abnormality detection during the servo gun welding

This detects any problem in line with parts or any missing material by measuring the panel thickness when carrying out the servo gun welding. As shown below, it can be carried out simply by adding the "ThickCheck" command. When there is any problem with the panel thickness will be decided by checking whether the measured value is within the normal range.

S18 MOVE L,S=60%,A=0,T=1

    ThickCheck MEA=LV1!,REF=4.1,TOL=1.0

    SPOT GN=1,CN=3,SQ=1

- ■ MEA
  Designates the variable for storing the panel thickness measured by squeezing the servo gun.

- ■ REF
  Designates the normal panel thickness.

- ■ TOL
  Designate the allowable deviation.

- ■ Branch line(optional)
  Designates the handling method when a problem is detected with the panel thickness. If a branch line is not recorded, "E1492 Measured panel thickness is out of the normal range", causing the robot to stop, and the output signal set in "Panel thickness abnormal" will be turned on. If a branch line is recorded, "E0152 Measured panel thickness is out of the normal range", will be generated and jumping to a branch line will take place while the robot continue to work". In this case, output signals set in "Panel thickness abnormal" will be turned on only for 200ms.

Caution) For accurate measurement of the panel, the following actions should be taken first.
- i. Gun search (precise management of the moving and fixed tips)
- ii. Gun arm bending setting (setting of the gun arm bending per squeeze force)
- iii. Panel thickness setting (setting of the panel thickness per squeeze force)

4.8. Workpiece handling based on servo gun

This is for transporting small workpieces by using the servo gun, not using a separate hanger.

It can carry out the operations of holding the workpiece and opening the clamp by using the SvClamp command. The servo gun will not open if it is "on".

Sample program		Command description	Remarks
STEP B	....	(Position of holding the workpiece)	
	SvClamp ON	Holding the workpiece using a servo gun	
STEP	MOVE L, ...	I	
STEP	MOVE L, ...	Robot moves	
STEP	MOVE L, ...	I	
STEP K		(Position of releasing the workpiece)	
	SvClamp OFF	Workpiece released	
	MOVE L, ...	Robot moves	

4.9. Spot welding point calculation

The following system variable saves the count of times that WI was inputted during the execution of the spot welding command.

_SpotRunNo[Welding machine number]

Item	Content
Welder number (1–4]	Designates the welder number (up to four welders in total)

The variable above will be initialized to 0 when a new job program is executed after one cycle of the job program is completed or when [R] + [Enter] is pressed to move to the first line of the job program.

```
Usage example 1)
    V1%=_SpotRunNo[1]          The count of WIs inputted through welder no. 1 up to now will be
    saved in V1%.

Usage example 2)
    IF 10<>_SpotRunNo[1]       "If the count of WIs inputted through welder no. 1 up to now is not
     10"
    PRINT #0,"Welding count("; _SpotRunNo[1];") error !!" "Error message print"
    STOP                                                          "Stop"
    ENDIF
    END
```

Caution) The SPOT command executed in the subtask is not calculated.

4.10. Consumption setting

The following system variable is used to set the total consumption of the gun or save the total consumption measured through gun search.

_TIPWEAR[Gun number]

Item	Content
Gun number (1–16)	Designates the welding gun number (up to 16 guns in total)

When the consumption is arbitrarily set by using the variable above, the total consumption will be applied to the moving or fixed tips based on the consumption ratio set for the moving tip. This value will remain until gun search is performed.

Usage example 1)
    V1!=_TIPWEAR[1]   The consumption of gun no. 1 measured through gun search will
    be saved in V1!.

Usage example 2)
    _TIPWEAR[2]=V1!   The total consumption of gun no. 1 will be saved in V1!.

Caution: This is only applicable for the servo gun and EQless gun. In the case of the EQless gun, the total consumption is the same as that of the fixed tip.

4.11. SWD file recovery function

The settings related to spot application are saved in the controller's (ROBOT.SWD) file. When copying the (ROBOT.SWD) file to share welding conditions and sequences with other robots, not only welding conditions and sequences but also other settings will be changed, possibly causing problems such as change of the gun search reference location, gun search status, or squeeze force; etc.
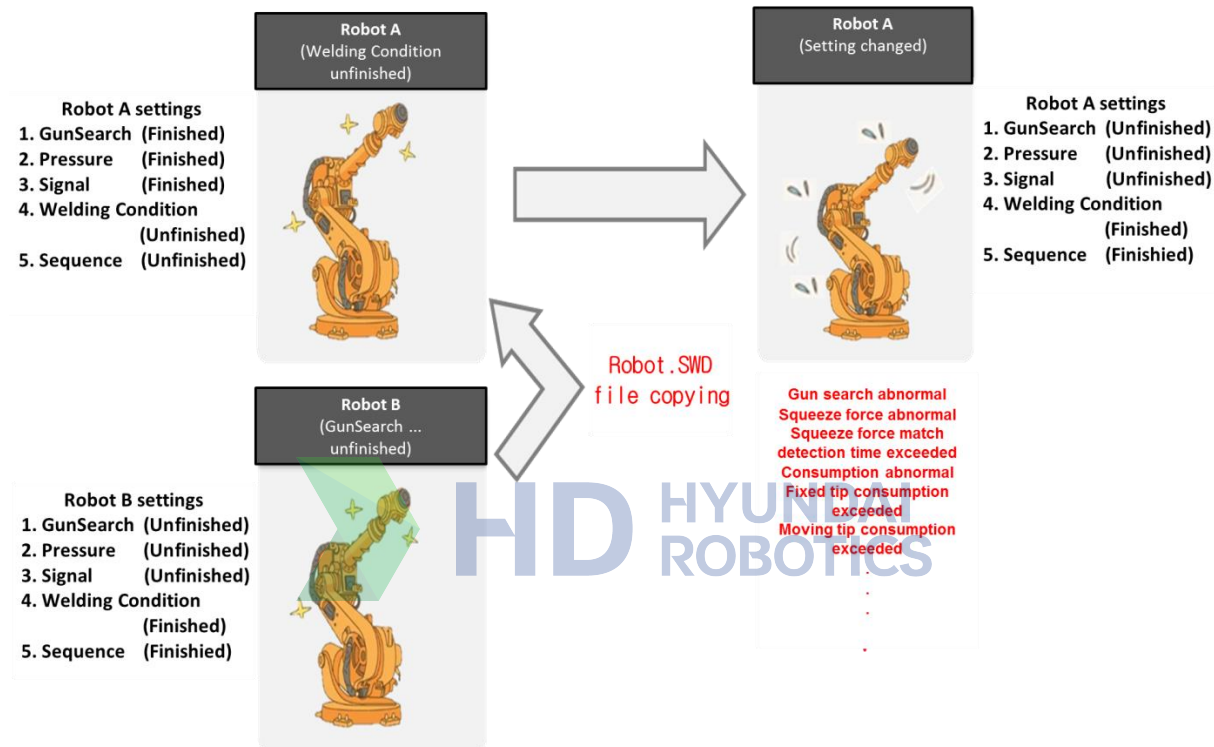
To prevent the problems above, warnings will be generated when the SPOT and GUNSEA commands are executed if copying of the (ROBOT.SWD) file causes any change of the main parameters such as the gun search reference location, squeeze force – current table, etc.

Caution: If the user copies a file to recover the controller initialization settings, it is required to set an exception to the test above. The test will not be performed if the user disables the change test when copying the SWD file by entering 『[F2]: System』 → 『4: Application parameter』 → 『1: Spot welding』 → 『2: Usage environment setting』 .

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The SWD file recovery function allows the user to initially perform recovery only once when the main parameters are changed due to the copying of the ROBOT.SWD file.

This function can be executed by entering 『[F2]: System』 → 『4: Application parameter』 → 『1: Spot welding』 → 『9: SWD file recovery』 .
At this time, if the parameters of the currently selected gun number are changed, the SWD file recovery process will proceed. The point of time for which the recovery will be performed is the time just before the file was changed due to copying. Please note that recovery may be impossible if the data of the previous state is lost due to the repetition of recovery.
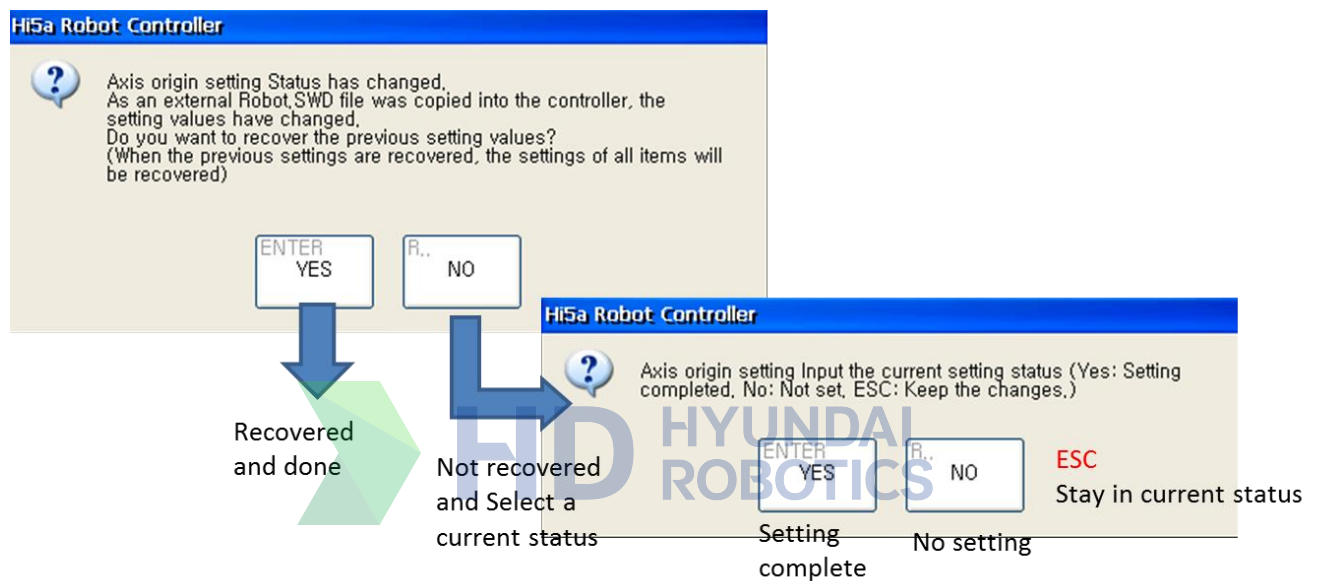
This function can be executed using R code. Execution with R code requires permission from the engineer or above.

■ [R]+[367]: Recovers the designated settings of all guns
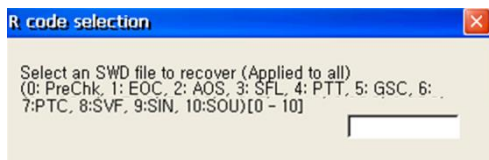
■ [R]+[366]: Only the warning output can be removed without changing or recovering the setting status of the designated gun. After inputting the desired number, input the desired setting and the desired status in order.
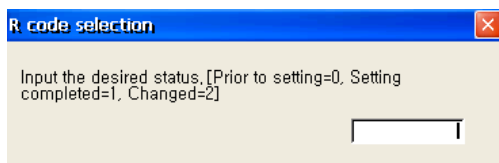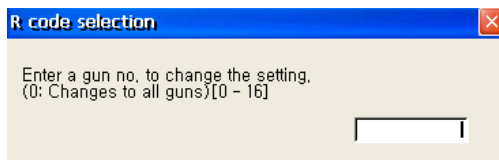
■ Setting number
0 PreChk: Precheck
1 EOC: Encoder offset setting
2 AOS: Axis origin setting
3 SFL: Soft limit setting
4 PTT: Squeeze force – current table tuning
5 GSC: Gun search
6 GBC: Gun arm bending setting
7 PTC: Panel thickness compensation
8 SVF: Servo gun setting confirmation
9 SIN: Input signal setting
10 SOU: Output signal setting

5
Spot welding parameter

5.1. Environment setting

The spot welding environment should be set in the manner that the system will carry out appropriate operations according to actual circumstances.
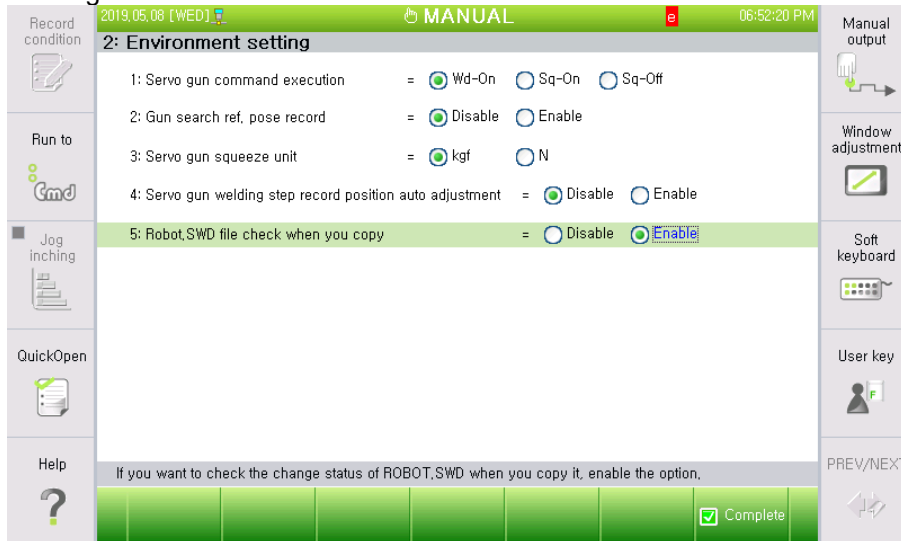
(1) Servo-gun SPOT command execution type

If the gun type is servo-gun, the execution of squeeze and the output of the welding signal can be prohibited when executing SPOT command, regardless of welding sequence setting. Therefore, this function can be useful for confirming the teaching location. The sequence of spot welding will be executed according to the following setting conditions.

Output type	Description
Wd-On	Execute all welding sequences assigned to the spot welding function. clearance location → squeeze → squeeze alignment test → Welding signal output → welding complete wait → clearance location
Sq-On	Execute the welding sequence except for the welding related signals. clearance location → squeeze → squeeze alignment test → clearance location
Sq-Off	Squeeze operation, applied current signal output, WI wait will not be carried out. Clearance location.

(2) Gun search reference location record

If using a gun type (Servo-gun, EQless-gun) for which the controller manages tip consumption, a reference location for calculating consumption should be determined, and actual consumption will be calculated based on this location.

- Disable:
  Actual consumption will be calculated based on the determined the reference location.
- Enable:
  The reference location for calculating consumption will be determined, and can be executed just one time in the beginning stage when a new tip is attached.

(1) Servo gun squeeze force unit
Select the squeeze force unit for controlling servo guns.

(2) Servo gun welding step record position auto adjustment
Select whether to adjust the servo gun position of the MOVE command recorded by taking into consideration the panel thickness, measured while squeezing when executing the SPOT command. This function can be used very usefully because after the teaching is completed or if the servo gun has deformation, it is possible to set the state as "Enable" and allow the work program to automatically play back once, allowing the position record to be adjusted in the optimal condition.

(3) Change test when copying the SWD file
After copying the SWD file, it is prohibited to use it for other controllers. However, it is possible to make an exception to recover the previous setting after initializing the controller. If the change test is disabled, the change test will not be performed even when the SWD file is copied. This setting will be applied only once, so the status will automatically change to "Enable" when rebooting takes place after the SWD file is copied.
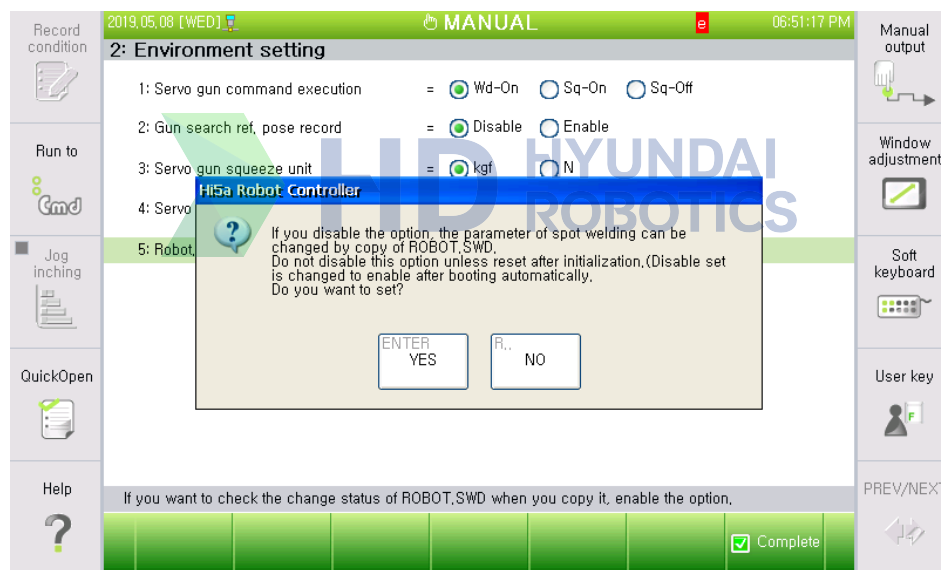
5.2. Welding gun parameter

If the gun type is servo-gun or EQless-gun, the individual parameter for each gun can be set.
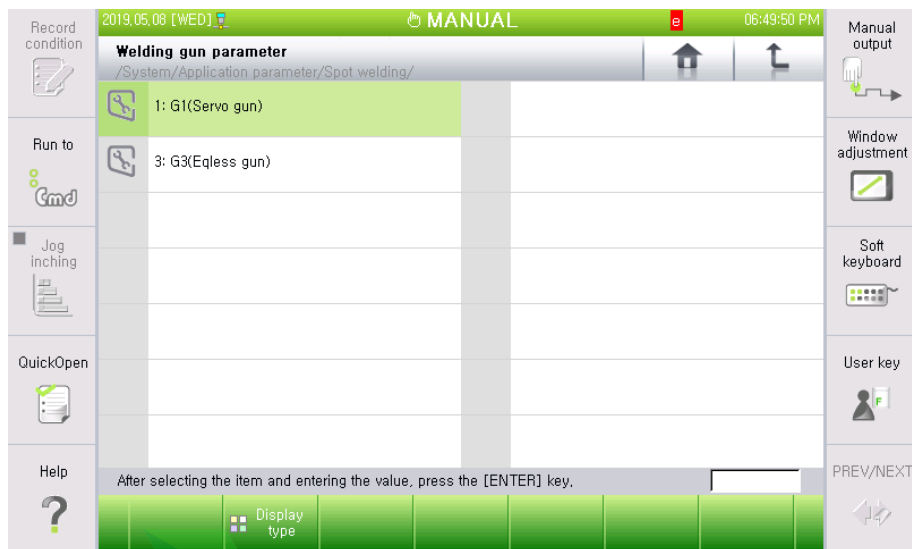
5.2.1. Servo-gun

If the gun type is a servo gun, a screen to set the servo gun-related parameters will show up on the screen.

5.2.1.1. Servo gun basic setting

(1) Manual open operation distance (mm)
Designate the target position for the servo gun large and small stroke operations by using the user key

(2) Maximum tip consumption (mm)
If the consumption of the mobile or fixed tips, when detected through the gun search, exceeds the set value, an error will be generated and operation will stop.

(3) Tip consumption exchange (mm)

When the consumption of the moving tip or fixed tip detected by gun search exceeds the set value, the tip consumption warning signal will be displayed together with a warning message notifying the user of the need for tip replacement. If this is set as 0.0mm, error detection will not be carried out.

(4) Gun arm bending/100Kgf(mm)
Set gun arm bending due to squeeze force in the bending amount over 100Kgf. When it comes to the position of the fixed tip when the spot welding is carried out, the gun arm bending will be calculated not only from this set value but also the command squeeze force. Then, squeezing will take place after they are corrected as necessary.
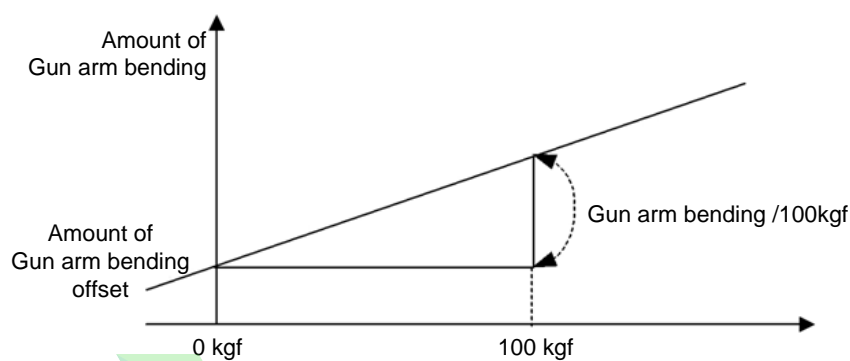
Figure 5.1 Gun arm bending/100Kgf

(5) Squeeze force match rate (%)
Compare actual squeeze force and command squeeze force when executing squeeze alignment detection, and consider squeeze alignment to have been achieved if squeeze force reaches the designated squeeze force match rate. If this is set as "0", 『W0110 Set under the condition of no squeeze detection』 will be outputted, not allowing the squeeze alignment detection to take place.

(6) Squeeze force error detection time (s)
Set the time from the squeeze start to the squeeze alignment. Within that time, if the squeeze alignment takes place, the welding signal will be outputted immediately. If there is no squeeze alignment within the time, 『E1314 Squeeze alignment detection time exceeded.』 will be outputted and the operation will stop. If this is set as "0.0", the squeeze alignment detection will be in the wait mode continuously.

(7) Command offset (mm)
Squeeze force should be generated by the servo gun when the SPOT command is executed. For this, there will be a command for the moving tip to move to the squeeze position.
The squeeze position means a position created by adding the 'command offset' to the record position'.

(8) Gun type
Select the type of servo gun that is selected (robot gun or stationary gun). When a stationary servo gun is used, it is required to set the user coordinate number in which the coordinate of the stationary gun is set in advance (robot coordinate if the value is 0). Set the user coordinate so that the moving direction of the fixed tip can match the Z (+) direction.
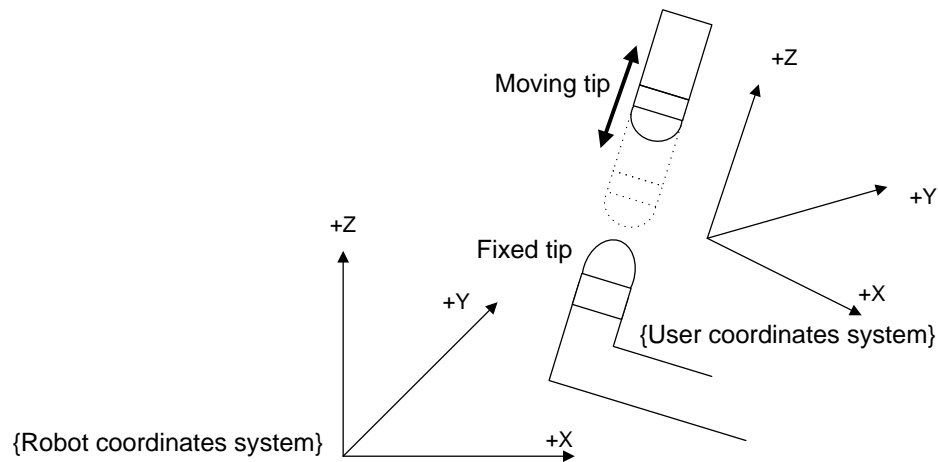
Figure 5.2 Coordinate system of stationary-gun

(9) Moving tip/total consumption (%)
To measure the consumption of a servo-gun, there is a method that uses gun search 1 only and a method that uses both gun search 1 and gun search 2.
If set to 0, consumption will be calculated using both gun search 1 and gun search 2. If set to a value other than 0, the total consumption measured using gun search 1 will be distributed between the mobile tip consumption and the fixed tip consumption based on the set ratio (%)

(10) Real-time squeeze force control
Set whether to use the real-time squeeze force control function. This function controls the actual squeeze force measured by the squeeze force gauge in a way that allows it to reach the set squeeze force. When the function is enabled, the 『F1: Signal』 key will be activated to set the parameters.

(11) Squeeze - Current table setting
    The squeeze force table can be prepared with the range that the user wants in 5 steps, by measuring squeeze force with a force gauge. If the squeeze force is set by differentiating between direction of gravity and the opposite direction of gravity, the squeeze force will be corrected according to the gun operation direction.
    This squeeze force-current table sets the current values for squeeze forces at 5 levels. This table sets squeeze force-current value to increase as each level is increased. The upper limit value and the lower limit value of squeeze force input on this table will be used as the limit of squeeze force for playback or manual operation.
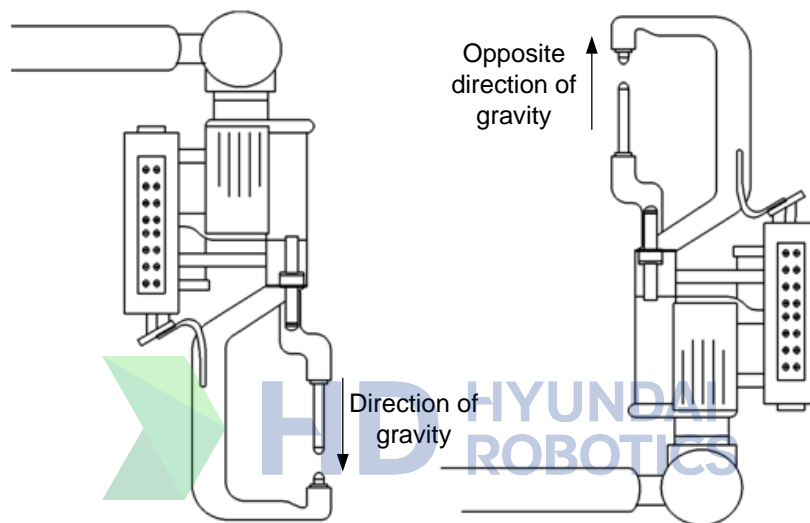
Figure 5.3 Direction of gravity, opposite direction of gravity

5.2.1.1.1. Real-time squeeze force control

Real-time squeeze force control is a function that improves the accuracy of the servo gun squeeze force by utilizing data, which is measured by the squeeze force gauge, for the purpose of controlling it. To perform real-time squeeze force control, the squeeze force gauge should communicate with the robot controller, and it is required to set the communication specification in the following menu.
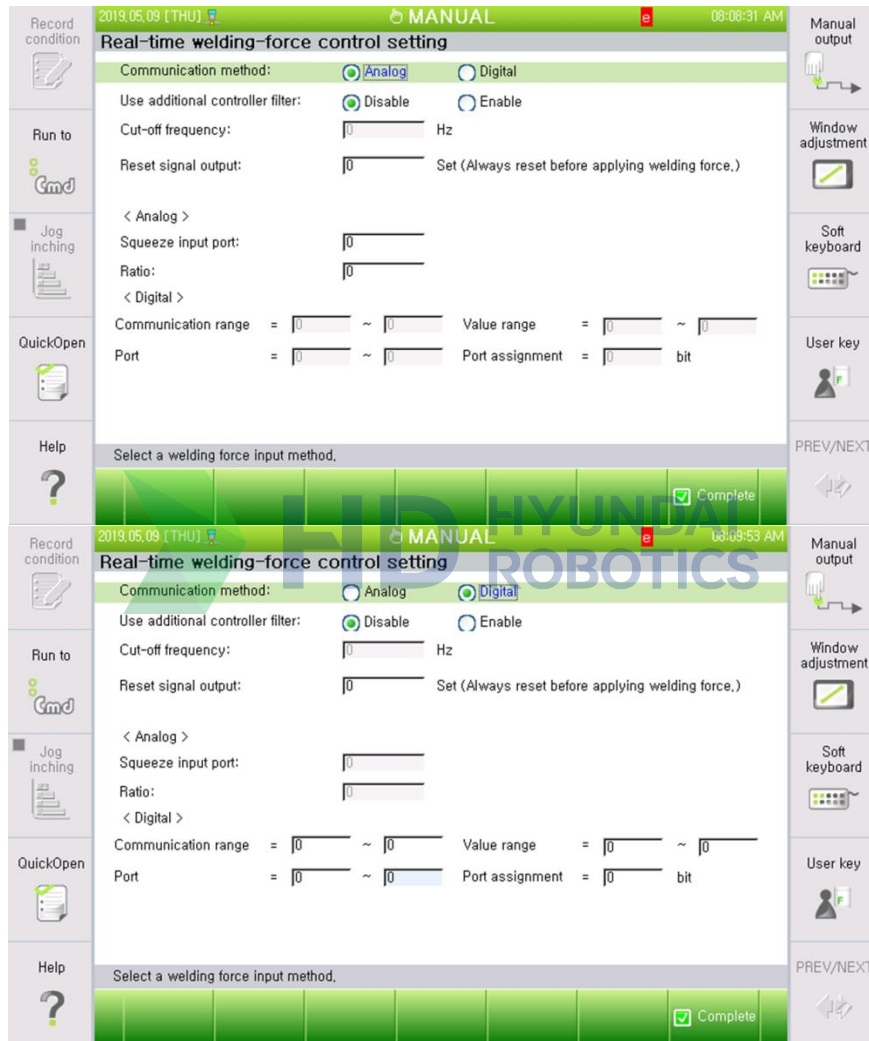
(1) Communication method
Set the communication method: analog or digital. The digital method is recommended for fast and reliable control.

(2) Use of an additional controller filter
This will be utilized to use an additional filter for the controller.

(3) Cut-off frequency
This will be activated when the user enables the use of an additional controller filter. Set the size of the filter required for control.

(4) Reset signal output
The signal to be outputted to reset the squeeze force gauge will be assigned. When the signal

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is assigned, the signal will be outputted whenever the servo gun squeeze is performed.

(5) <Analog>
This will be activated when the analog communication method is selected.
- i. Squeeze force input port: The number of the signal assigned for input
- ii. Magnification: The magnification of the analog input value

(6) <Digital>
This will be activated when the digital communication method is selected.
- iii. Communication range: The minimum to maximum range of the assigned signal
- iv. Value range: The minimum and maximum values of the assigned signal
- v. Port: The number of the signal assigned for input
- vi. Port assignment: The count of bits assigned to the signal

5.2.1.2. Servo gun application setting
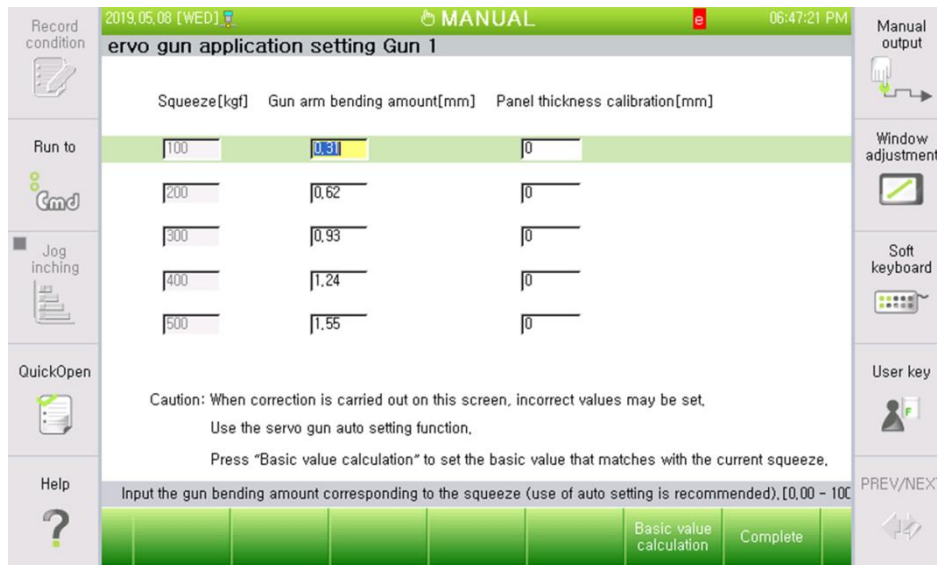
(1) Gun arm bending (mm)
   Set the gun arm bending for the squeeze force set on the left. As it is difficult to perform measurement and manually input the values, it is recommended to use the servo gun autosetting function. If you press "[F6] Basic value calculation," the basic value of 0.31 mm per 100 kgf will be set.

(2) Panel thickness compensation (mm)
   Set the panel thickness compensation for the squeeze force set on the left. As it is difficult to perform measurement and manually input the values, it is recommended to use the servo gun autosetting function.

Caution) As far as the "gun arm bending compensation" and "panel thickness measurement compensation" are concerned, it is recommended to use the automatic setting because it is difficult to perform measurement and manually input the values.
The "gun arm bending compensation value" is a value used instead of the "gun arm bending / 100 kgf [mm]" among servo gun parameters. If the "gun arm bending compensation" is set, the "gun arm bending / 100 kgf [mm]" that is set will not be used. On the contrary, if the "gun arm bending compensation" is not set, the "gun arm bending / 100 kgf [mm]" will be used.

5.2.2. EQless-gun

The gun type of G3 and G7 is the "Eqless" gun, and the screen used to set the EQless-gun parameters is displayed below:
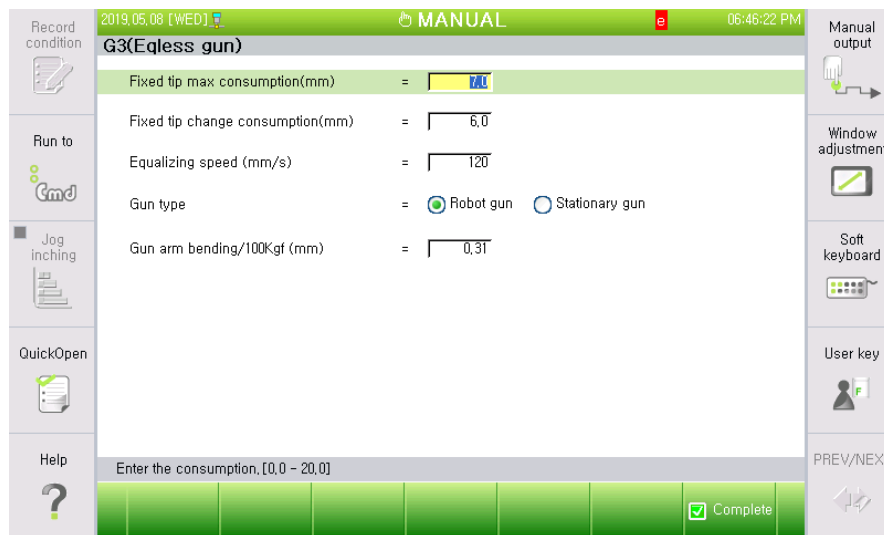
(1) Fixed tip max consumption(mm)
An error will occur when the consumption measured by EGUNSEA exceeds this set value.

(2) Fixed tip change consumption(mm)
A warning will be displayed when the consumption measured by EGUNSEA exceeds this set value.

(3) Equalizing speed (mm/s)
Set the Equalizing speed of robot.

(4) Gun type
Choose either 'robot-gun' or 'stationary-gun' as the gun type of the selected EQless-gun. Refer to 『2.3.1 Servo-gun parameter』.

(5) Gun arm bending/100Kgf(mm)
Set the gun arm bending from the squeeze force as the bending from 100Kgf. When it comes to the position of the fixed tip when carrying out spot welding, the gun arm bending is to be calculated by taking into consideration this set value and the command squeeze force. After that, the calculated value will be corrected and the squeeze will take place accordingly.

5.3. Welding data (Cnd, Seq)

The setting of various parameters related to spot welding will be executed from this screen to carry out the appropriate operations according to the work environment.

5.3.1. Common data

Setting data that is commonly applied regardless of spot welding sequence will be executed from this screen.
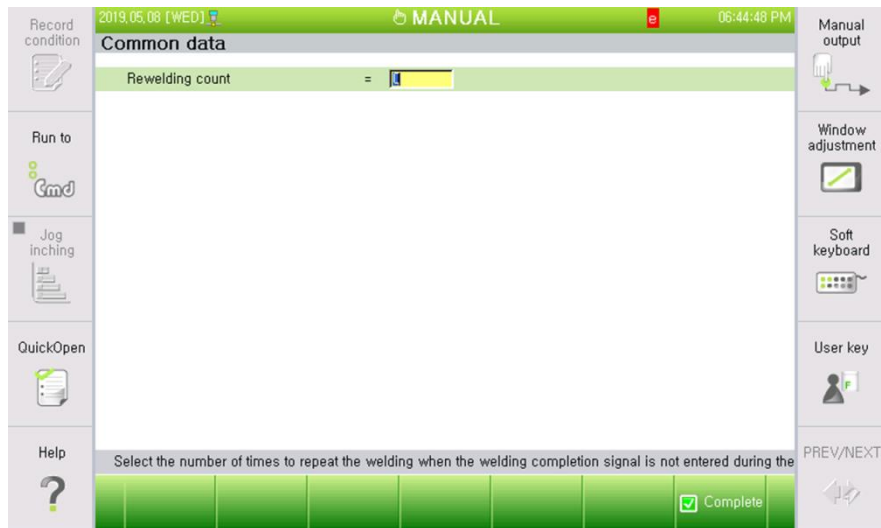
(1) Rewelding count
Re-welding should be executed in the event that WI is not received after the set welding complete (WI) wait time. The count of rewelding can be set up to 3 times. When WI is not generated even after welding is retried according to the rewelding count, an error will be generated

5.3.2. Welding condition

Setting conditions related to spot welding will be executed from this screen to carry out welding operation according the work environment.
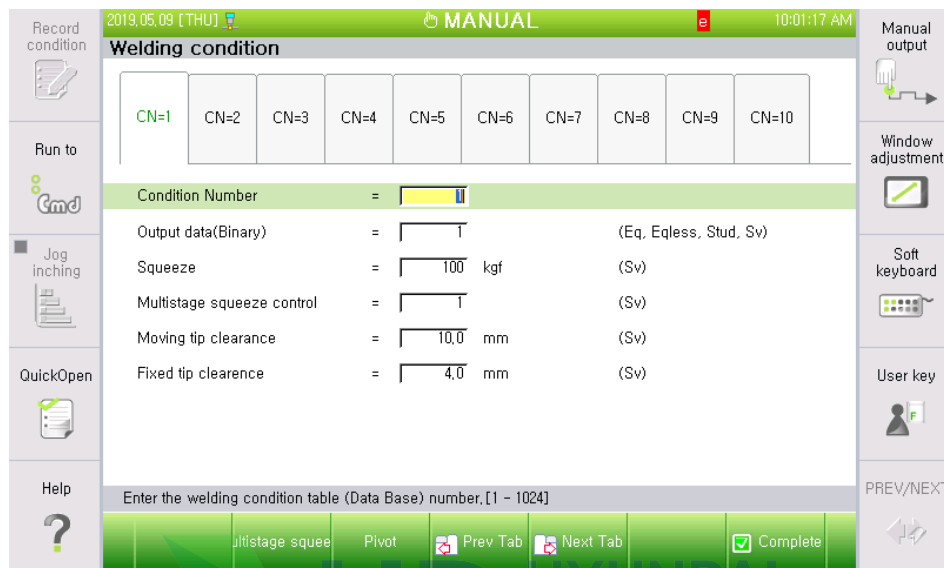
(1) Condition Number
This selects the welding conditions quickly

(2) Output data(Binary)
This sets the data to be displayed to the welder for Welding Condition Number when a SPOT command is executed.

(3) Initial squeeze force
This sets the squeeze force to be applied to the panel when the SPOT command is executed. It is used as the initial squeeze force when setting the multistep squeeze control.

(4) Multistep squeeze and auxiliary conditions
This sets the numbers of the auxiliary conditions for managing the multistep pressure control and pivot setting. If the user inputs a number, 『F1: Multistep squeeze force』 and 『F2: Pivot』 will be activated, allowing the user to enter the menu.

(3) Moving tip clearance
This sets the open position of the mobile tip before and after executing the SPOT command.

(4) Fixed tip clearance
This sets the open position of the fixed tip before and after executing the SPOT command.

5.3.2.1. Multistep squeeze and auxiliary conditions
5.3.2.1.1. Multistep squeeze control

This function is to change the squeeze force being applied to the servo gun spot welding. There are two ways to change the squeeze force. The first one is by generating a predefined profile, and the second one is by changing it by inputting a signal.

(1) Condition number
This displays the condition number for the multistep squeeze and auxiliary conditions.

(2) Initial squeeze force
This displays the initial squeeze force set in the welding condition.

(3) Squeeze force change
Select the method to change the squeeze force. Profile generation is a method in which the point of time and the duration of time for change are designated, and the squeeze force is changed at the relevant time. Signal input is a method in which the squeeze force is changed when a signal is inputted from an external device.

(4) Handling when the status changes
If the status changes while in the multistep squeeze process or the waiting process, it will be decided whether to proceed after stopping the multistep squeeze process or to proceed after completing the multistep process.

(5) <Profile generation>
This will be activated when the profile generation method is selected as the means of changing the squeeze force.
    vii.   The point of time for change: Divide the spot steps into [Initial squeeze force reached] → [Welding execution output] → [Welding complete input], and designate the point of time to start the multi-squeeze process.
    viii.   Duration of time for change: Once the point of time for change is reached, the squeeze force will be changed after the duration of time for change.
    ix.   Squeeze force: Squeeze force targeted after the change

(6) <Signal input>


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This will be activated when the signal input method is selected as the means of changing the squeeze force. It is required to input the necessary information to communicate with external devices.

x.   Communication range: The minimum to maximum range of the assigned signal

xi.   Value range: The minimum and maximum values of the assigned signal

xii.   Squeeze force port: The number of the signal assigned for input

xiii.   Port assignment: The count of bits assigned to the signal

xiv.   Change request: Input the signal port for the change request.

xv.   Delay time: Input the delay time, if necessary, after inputting the request.

xvi.   Squeeze force: Squeeze force for the change request. It can be designated or inputted as a signal. The squeeze force received through a signal input will be ignored when the squeeze force is designated.

5.3.2.1.2. Gun movement while squeezing (pivot)

This function is used to move the gun during the squeeze process in the servo gun spot welding. The robot will move the designated distance in the designated direction at the designated speed at the set point of time for movement. With this function, the robot moves based on the tool coordinate, so the servo gun tool data, consumption, gun arm bending, teaching posture, and robot calibration may affect the performance. To effectively apply the function, the factors above should be continuously managed.
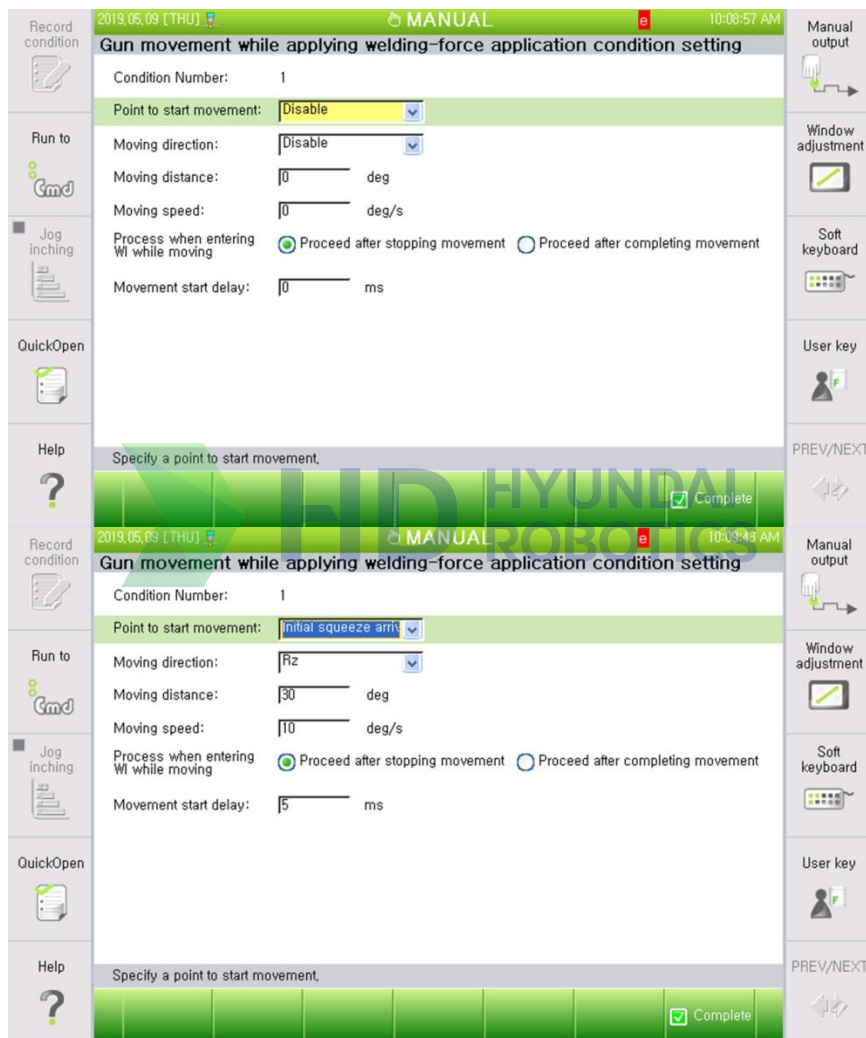
(1) Condition number
This displays the condition number for the multistep squeeze and auxiliary conditions.

(2) Point of time for movement
This divides the spot process into [Initial squeeze force reached] → [Welding execution output] → [Welding complete input] and designates the time to start the movement.

(3) Movement direction
This selects the direction in which the gun moves based on the tool coordinate system.

(4) Movement distance [deg]
This sets the distance of the movement.

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(5) Movement speed [deg/s]
This sets the speed of the movement.

(6) Handling when there is WI input during the movement
If the "Welding complete" status occurs while the robot is moving, it will be decided whether to stop moving or proceed to the next step after completing the movement.

(7) Movement start delay time
When the point of time for movement is reached, the robot will start to move after waiting for the delay time.

5.3.3. Welding sequence

The setting of various sequences related to spot welding will be executed from this screen to determine robot operation according to the work environment.

(1) Number
This selects the desired welding sequence quickly.

(2) Welding signal output delay time (GWT)
For a Servo-gun, this is the wait time until welding signal will be displayed after squeeze alignment is achieved.
For a air gun, this is the wait time until welding signal will be displayed after the execution of SPOT command.

(3) Welding signal pulse output (0=Level)
This is an item for displaying welding signal for a fixed time only. When this value is set to "0", the signal will be displayed continuously until the welding complete (WI) signal is received.

(4) Welding completion(WI) wait time
This is wait time until the welding complete (WI) signal is received. When this value is set to "0", the system will wait continuously until the welding complete (WI) signal is received.

(5) Robot wait time after welding completion (RWT)
This is the wait time for stick detection after the welding complete (WI) signal is received. If this is set to "0.0", stick detection will not be carried out. It is recommended to use the value over "0.3 sec (300msec)" if the stick detection signal is used. However, if this value is too large, the welding time will be extended and cycle time will be increased.

(6) Brake wait time (BWT)
This input wait time until brake will be operated when executing spot welding using Stud-gun as a robot-gun.

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(7) Brake slip detection range (mm)
This sets the range of detecting the remaining distance of each robot axis when executing spot welding by using Stud-gun as a robot-gun.

(8) Brake slip detection count
This displays a warning in the event that the number of detected brake leave exceeds the set value when executing spot welding by using Stud-gun as a robot-gun.

5.3.4. Servo-gun tip dressing conditions

The setting of various tip dressing conditions will be executed from this screen for executing tip dressing to servo-gun.
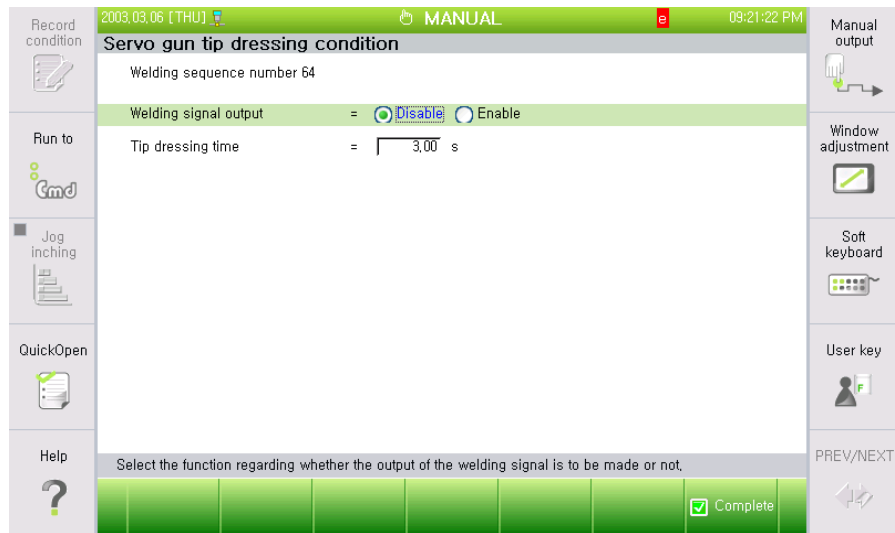
(1) Welding signal output
This selects whether to output the welding signal for tip dressing operation.

(2) Tip dressing time
This sets the time for tip dressing. Tip dressing will be carried out equally by using SPOT command. However, the welding sequence number will be set as "64".

5.4. Input signal assign

Input signal assign related to spot welding will be executed from this screen, so that the controller can monitor the signal status and carry out the necessary processes.
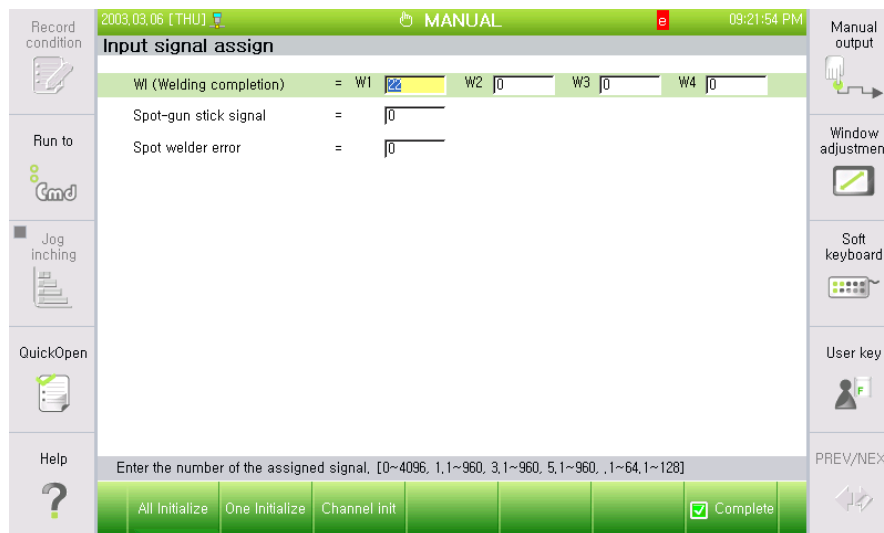
(1) WI (welding complete)
When spot welding is carried out, the controller can execute the welding complete process only if the welding complete signal has been received.

(2) A signal in the process of spot gun fusion
This is used for processing a stick signal when the signal is received.

(3) Spot welder error
This is used to stop the robot operation when a welder error signal is received

5.5. Output signal assign

Output signal assign related to spot welding will be executed from this screen so that the signal status will be delivered to outside

(1) Welding execution
This is used to output welding commands to the welder when the SPOT command is executed.

(2) Air gun opening/closing
This is used to control air gun opening/closing.

(3) Welding condition
This is used to assign the number of the signal that will generate the output data relevant to the welding condition when executing the SPOT command.

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(4) Servo gun squeezing
This is the signal that will be turned on when squeeze is carried out by the SPOT command, and turned off when the opening process is initiated.

(5) Welding Gun Searching
This is the signal that will be turned on when gun search is carried out by the GUNSEA, IGUNSEA, or EGUNSEA command, and turned off when the opening process is initiated.

(6) Tip consumption warning
This is used to cut a signal when the consumption detected by gun search exceeds the tip exchange consumption.

(7) SVG welding output (Wd-On)
This is used to display a signal when "Servo-gun spot welding output type" is set as Wd-On in the spot-gun common parameter setting menu.

(8) Welding gun disconnection
This is used to externally generate an output in which the welding gun is disconnected.

(9) Spot welder error
This is used to display spot welder errors when they are received.

(10) Spot gun sticking warning
This is used to display spot-gun stick when it occurs.

(11) Abnormal panel thickness
When there is a problem with the panel thickness when executing the servo gun welding, this is used to externally generate an output.

6

Frequently Asked Questions

■   How will the servo-gun axis move if the shift function is used?
All functions (offline, online, search, palletize) for shift will be only applied to the robot axis, and the servo-gun axis will move to the record location.

■ What will happen to the servo-gun axis at the time of coordinate conversion?
Only movement elements for the robot will be converted, and the servo-gun axis will not be converted.

■ If operating the relative program call function, how the system will be operated?
Shifting will be carried out by applying only the relative location for the robot.

■ What will happen to the servo-gun axis at the time of mirror image conversion?
At the time of mirror image conversion, only the additional axis with a "base" for axis specification and "direct-acting" for axis structure will be applied. All other cases are not applicable. Therefore, the Servo-gun axis will not be converted.

■ I would like to change the currently selected gun number
The currently selected gun number can be changed by "R210: Spot-Gun Number select". If the gun type you desire to change is robot-gun, the tool number will be changed at the time when the gun number is changed by referring to Tool No. corresponding to Gun No. While in the multi-gun setting, if the gun number is changed using R210, the environment will change to the selected single gun environment.

■ I'm trying to execute manual squeeze simultaneously by selecting multi-gun. How can I select multi-gun?
Multi-gun can be selected only for guns with same gun type. It can be changed by "R214: simultaneous welding gun select". To deselect specific guns after selecting multi-gun, it is needed to enter the specific gun numbers using R214. However, it is impossible to deselect the first gun number (master gun).

■ I want to change squeeze force at the time of servo-gun manual squeeze.
If the gun type of the selected gun is servo-gun, it can be changed by "R211: Servo-gun squeeze force setting".

■ I want to change the moving tip consumption for servo-gun at my discretion.
If the gun type of the selected gun is servo-gun, it can be changed by "R212: Servo-gun moving tip consumption preset". When executing gun search, this value will be updated again automatically.

■ I want to change the fixed tip consumption for servo-gun at my discretion.
If the gun type of the selected gun is servo-gun, it can be changed by "R212: Servo-gun fixed tip consumption preset". When executing gun search, this value will be updated again automatically

■ I want to change the fixed tip consumption for the EQless-gun at my own discretion.
If the gun type of the selected gun is EQless-gun, it can be changed by "R220: EQless-gun fixed tip consumption preset". When executing gun search, this value will be updated again automatically.

■ The robot is currently working automatically, and I want to change the squeeze force of the welding condition. How can I do it?
Even if the robot is currently working automatically, the squeeze force of the welding condition can be changed by using "R215: Spot welding condition squeeze force setting".

■ Can I manually change the currently selected welding condition number and welding sequence number?
Welding condition can be changed by pressing the [cond.sel] user key, and welding sequence can be changed by pressing the [seq.sel] user key.

■ Is there any short-cut key for entering the 『[F2]: System』 → 『4: Application parameter』 → 『1: Spot welding』 menu?
You can open that menu quickly by placing the cursor on commands (SPOT, GUNSEA, IGUNSEA, EGUNSEA) related to spot welding at the manual mode initialize side, and clicking [QuickOpen]

■ How can I change the panel thickness manually?
As long as the selected gun type is servo gun, you can change it using "R220: Panel thickness setting (Sv)"

■ How can I change the overall recording locations of the spot welding steps to the normal values ?
In 『[F2]: System』 → 『4: Application parameter』 → 『1: Spot welding』 → 『2: Environment settings』, you can do this simply by setting the "servo gun welding step recording location auto adjustment" as <Enable>. Then, play back the work program.

■ Is it possible to detect whether a welding point has been missed?
First, initialize the welding execution count in the work program start section and then carry out welding normally. Then, the welding count will increase. When the work is completed, compare the number of points and the count of the executed welding. To achieve this, you just need to carry out the programming as shown below.

```
. IF 5<>_SpotRunNo[1] THEN
. PRINT #0,"용접 회수(";_SpotRunNo[1];") 오류 !!"
. STOP
  ENDIF
```

■ While the robot is in the process of handling, is it possible to shorten the work time while independently carrying out the tip dressing and gun search for the stationary servo gun ?
It is possible simply by using the multitasking function. Refer to the multitasking function manual provided separately.

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7
Errors and warnings

7.1. Error message

Code	E0007　Stick detection
Details	Stick signal is detected in completion of the welding sequence.
Measure	- Check the stick detection signal. - Remove the stick.

Code	E0154　Maximum tip consumption exceeded
Details	Total tip consumption detected by gun search has exceeded the maximum tip consumption (moving + fixed) set by the welding gun parameter.
Measure	- Check the maximum tip consumption at the welding gun parameter. - Replace the tip.

Code	E0155　Maximum moving tip consumption exceeded
Details	Total moving tip consumption detected by gun search has exceeded the maximum tip consumption (moving) set by the welding gun parameter.
Measure	- Check the maximum tip consumption (mobile) at the welding gun parameter. - Replace the tip.

Code	E0156　Maximum fixed tip consumption exceeded
Details	Total fixed tip consumption detected by gun search has exceeded the maximum tip consumption (fixed) set by the welding gun parameter.
Measure	- Check the maximum tip consumption (fixed) at the welding gun parameter. - Replace the tip.

Code	E0171　Gun open time (5 seconds) exceeded
Details	Open time has exceeded 5 seconds after squeeze of spot welding and gun-search function.
Measure	- Check if the gun has been stuck to the object, or if interference to the gun has occurred. - Check the stick and interference on the moving side gun.

Code	E1036　Electricity connection wait time exceeded
Details	Welding complete (WI) signal is not received within the wait time defined in the welding sequence menu while servo-gun welding is being executed.
Measure	Check the circuit diagram of the welding complete (WI) signal and relevant peripheral equipment.

Code	E1038　Position in which tip consumption cannot be calibrated
Details	Robot is not positioned to correct tip consumption when the location will be recorded by correcting the tip consumption.
Measure	Arrange the robot position so as not to leave the range of robot operation for correcting detected consumption.

Code	E1281 Welder error signal is entered
Details	This occurs when a welder error signal is detected during welding operation.
Measure	1) Check the welding power device.

Code	E1306 Gun search reference location not recorded
Details	This error occurs when playback of gun search function or spot welding function is initiated without recording the Gun Search reference location.
Measure	Attach new electrodes and record Gun Search reference location.

Code	E1307 Gun search is not completed normally
Details	This error occurs when playback of spot welding function is executed without termination of Gun Search normally or Gun Search 2 is executed without execution of Gun Search 1.
Measure	Detect the tip consumption first by executing gun searches 1 and 2, and start the work.

Code	E1308 Problems in specifying tool numbers for steps.
Details	The tool number was not selected correctly for the servo gun number when the step was executed with the spot welding function and Gun Search function.
Measure	Check the tool number corresponding to the gun number and the gun type for their set states to ensure that the gun number of the function can match the tool number of the step.

Code	E1310 Set squeeze force exceeded current limit range
Details	This error occurs when the current limit calculated from command squeeze force exceeds the current limit (IP) of servo amp.
Measure	Reduce the squeeze force, or increase the capacity of the servo-gun drive motor.

Code	E1311 Set squeeze force exceeded overload detection level
Details	This error occurs when the command squeeze force exceeds the overload detection level.
Measure	Reduce squeeze force in anticipation of an overload error.

Code	E1312 Gun squeeze target location calculation result area deviation
Details	This error occurs when robot was out of the designated workspace as a result of the calculation of squeeze position (Object position) of servo gun.
Measure	Change the robot pose, and record the position.

Code	E1313 Set squeeze force range exceeded
Details	This error occurs when the squeeze force set on the welding condition exceeds the range of the squeeze force set on the squeeze force table of the welding gun parameter.
Measure	Reduce the set squeeze force.

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Code	E1314 Squeeze force alignment detection time exceeded
Details	This error occurs when the squeeze alignment is not achieved within the squeeze force error detection time of the welding gun parameter after moving tip begins squeezing on the record location.
Measure	Check the command offset. Check the squeeze force error detection time. Check the squeeze force match rate.

Code	E1320 Sensor is not operating during gun search
Details	This error occurs when the sensor does not work although the robot approaches the targeted position during the wear quantity detection work in gun searching functions of servo gun and Eqless gun.
Measure	1) Check the sensor work when electrodes approach the sensor. 2) Check the connection of the connectors. 3) Check the type of sensor contact.

Code	E1326 Gun search 2 environment is inappropriate
Details	This error will occur when Gun Search 2 is executed when the environment is set to measure consumption of the gun using Gun Search 1.
Measure	Set the environment for correcting consumption of gun using Gun Search 1, 2.

7.2. Warning messages

Code	W0109 Brake slip (Set value exceeded)
Details	Brake slip measured at the time of stud welding exceeded the brake slip detection range set in the welding sequence.
Measure	Check set brake slip detection range, and change the setting to a higher value if required.

Code	W0105 Total tip exceeds consumption for exchange.
Details	This occurs when total moving tip consumption detected by the gun search exceeds the tip exchange consumption (moving + fixed) set in the welding gun parameter.
Measure	Check the set maximum tip consumption. Confirm that the reference location for Gun Search has been registered normally. Replace the tip.

Code	W0106 Moving tip exceeds consumption for exchange
Details	This occurs when total moving tip consumption detected by gun search exceeds the tip exchange consumption (moving) set in the welding gun parameter.
Measure	Check set tip exchange consumption (moving). Confirm that the reference location for Gun Search has been registered normally. Replace the tip.

Code	W0107 Fixed tip exceeds consumption for exchange
Details	This occurs when total fixed tip consumption detected by gun search exceeds the tip exchange consumption (fixed) set in the welding gun parameter.
Measure	Check set tip exchange consumption (fixed). Confirm that the reference location for gun search has been registered normally. Replace the tip.

Code	W0108 Actual squeeze force during jog operation exceeded the set value
Details	This occurs when actual squeeze force value exceeds the set value during manual axis squeezing. Operate the servo-gun axis to the opposite direction.
Measure	Confirm that the squeeze force value of the axis you intend to operate has been sufficiently set. Contact the servo-gun manufacturer, as a mechanical problem with the servo-gun is likely.

Code	W0109 Unselected servo gun cannot be operated manually
Details	The servo gun you intend to operate is different from the selected servo gun number.
Measure	Servo gun should be operated by manual jog after being selected. Select the servo gun you intend to operate with the R210 code before operating.

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