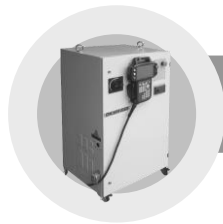**HYUNDAI**
HEAVY INDUSTRIES CO.,LTD.

WARNING

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

Hyundai Robot

Hi5SW120701FMEN2

Hi5 Controller Function Manual

Spot welding

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1
Introduction

This Hi5 spot welding function manual provides instructions on the use of the Hi5 controller based on the system described below. The user should note that systems provided in the field may be different, and therefore this manual is intended as a reference only.

<u>**Specifications of the system used in this manual**</u>

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.

<u>**Required manuals**</u>

■ Hi5 controller operation manual
■ Hi5 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	8
Welding condition number	1 ~ 64
Output data due to welding condition	1 ~ 255
Welding sequence number	1 ~ 63 (64 is only for tip dressing)
Location change	SPOT command step – Location of consumption automatic compensation Other steps – Locations where consumption is not considered
Spot welding command (SPOT)	Should be recorded as the first function of step
Commands related with Gun Search (GUNSEA, IGUNSEA, EGUNSEA)	Executed only in automatic playback.
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.

1.2. The sequence of operation

Initialize system

Execute system initialization
(『[F2]: System』 → 『5: Initialize』 → 『1: System format』)
* Refer to Hi5 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 Hi5 controller operation manual

▼

Setting additional axis constant

Register additional (Servo-gun) axis information
(『[F2]: System』 → 『5: Initialize』 → 『5: Additional axis constant』)
* Refer to Hi5 additional axis function manual
- AMP specification = SAZ-2
- Motor specification = 2.0KW‐TMS1008N8230E235
- Acceleration time = 50ms(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 Hi5 controller operation manual

▼

Re-insert power

▼

Encoder calibration

Register the origin of encoder
(『[F2]: System』 → 『3: Robot parameter』 → 『4: Encoder offset』)
* Refer to Hi5 controller operation manual
* A location of servo gun being completely opened mechanically

▼

Setting axis constant

Setting axis constant
(『[F2]: System』 → 『3: Robot parameter』 → 『2: Axis constant』)
* Refer to Hi5 controller operation manual
* A location of new tips of servo gun contracting each other

▼

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: Tool No. corresponding to Gun No., and gun-type set』)

▼

Re-insert power

▼

Setting tool data

Robot-gun : Use load estimation function
(『[F2]: System』 → 『6: Automatic constant setting』 → 『4: Load estimation function』)
Stationary gun : Register user's coordinate system
(『[F2]: System』 → 『2: Control parameter』 → 『7: Coordinate registration』 → 『1: User coordinate』)
* Refer to Hi5 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 change parameter』

▼

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 (Backward)
Reference point
of Encoder
Calibration

Maximum range of
operation

Large open

User sets the range
Smaller than
SOFR (Backward)
Lager then
Smaller open

Semiopen

User sets the range
Smaller than OPEN
Lager then
CLEARLANCE

CLEARANCE

A squeeze point
And the distance bein
Apart automatically
After squeeze

Moving tip	
Fixed tip	

Welding point
Record location

A state of
Fixed/moving tip
Being
Contacted to PANEL

Axis constant

Standard distance
Between two
Tips 0

Soft Limit (forward)

Minimum range of
operation after
separating both
electrodes

# 2
Relevant functions

2.1. Operating environment setting

2.1.1. Servo-gun encoder offset

Generally, setting the encoder origin for the servo-gun will be executed in the state in which the moving tip is opened to the greatest extent possible. This is because the location can be matched uniformly when encoder data is changed due to the replacement of the servo-gun motor.

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

(1) Release the brake of the Servo-gun axis manually, and open the moving tip as widely as possible.

Max open position
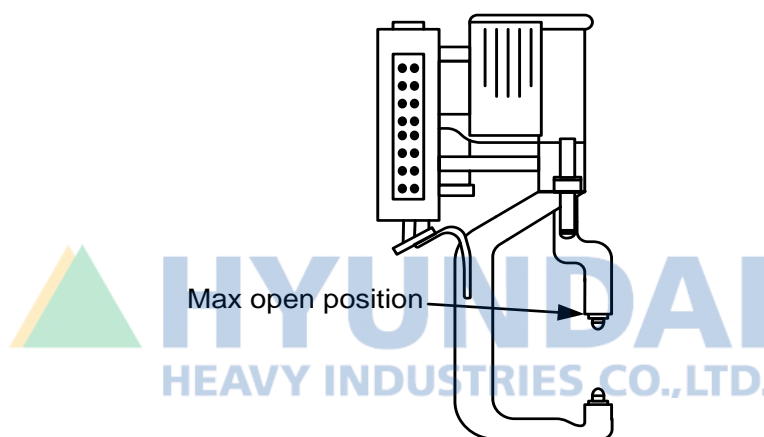
(2) Select a corresponding Servo-gun axis using 『[F2]: System』 → 『3: Robot parameter』 → 『4: Encoder offset』 , and press 『[F1]: Apply』 . Press 『[F7]: Complete』 when the value of the current encoder becomes "00400000".
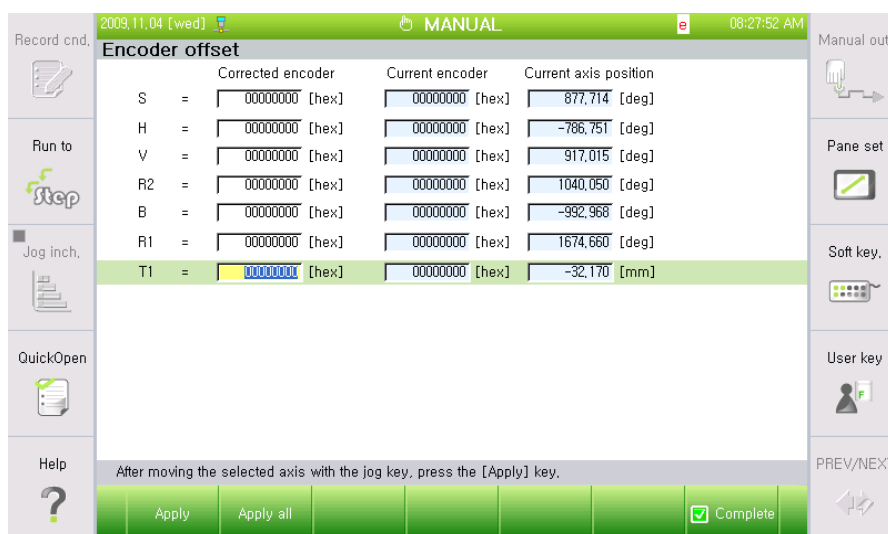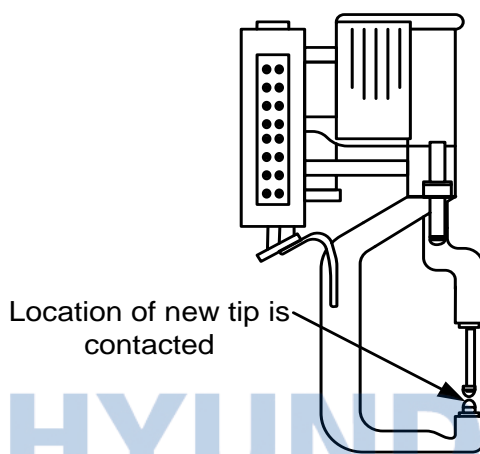
2.1.2. Axis constant of servo-gun

Usually, the axis constant of the servo-gun will be set in the contact location of the moving tip and fixed tip in the state in which a new tip is attached to both electrodes. Most servo-gun movements are carried out based on this axis constant, so the axis constant setting is very important.

The procedure for setting the axis constant of the servo-gun axis is as follows.

(1) Manually set the servo-gun axis to be in the state below.

Location of new tip is contacted

(2) Select a corresponding servo-gun axis using 『[F2]: System』 → 『3: Robot parameter』 → 『2: Axis constant』, and press 『[F1]: Apply』. Press 『[F7]: Complete』 when everything is displayed normally.
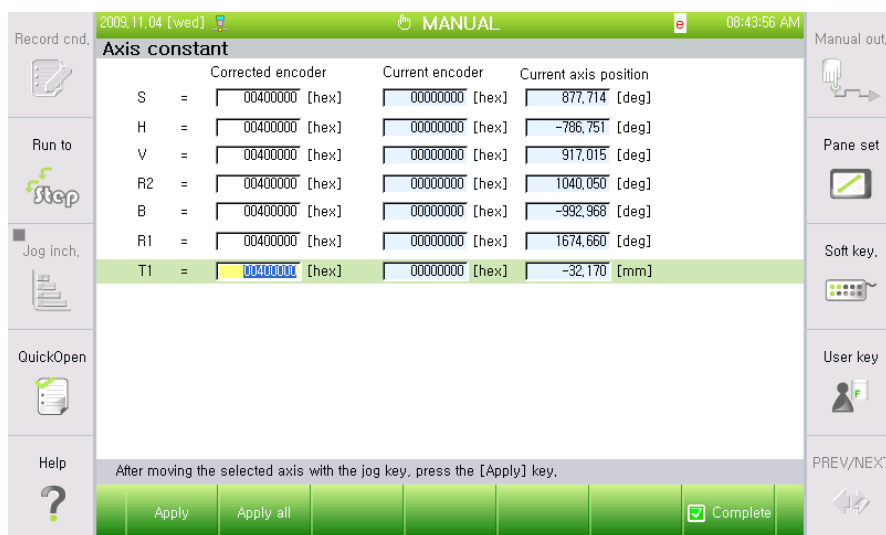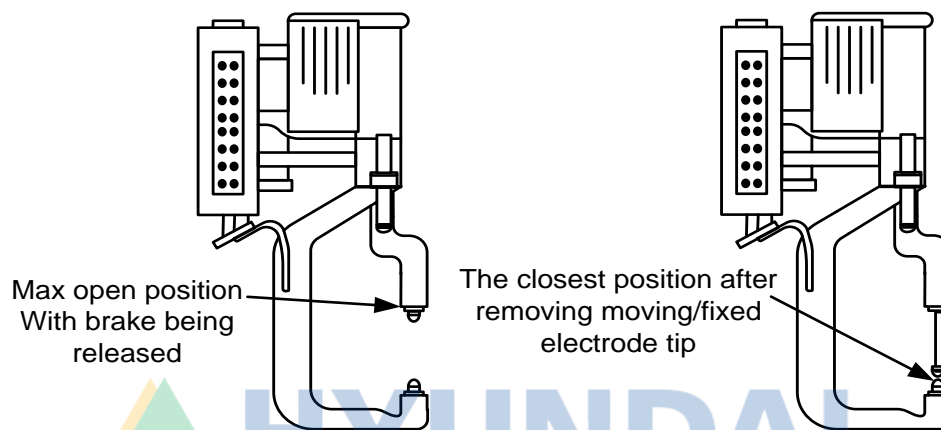
2.1.3. Soft limit of Servo-gun

Usually, the soft limit of servo-gun will be set to a minimum in the closest location, after removing as many tips as possible and opening the moving tip as widely as possible.

The procedure for setting the soft limit of the servo-gun axis is as follows.

(1) Manually set the servo-gun axis to have the following status.

Max open position
With brake being
released

The closest position after
removing moving/fixed
electrode tip

(2) Select a corresponding servo-gun axis using 『[F2]: System』 → 『3: Robot parameter』 → 『3: Soft limit』, and press 『[F1]: Apply』. Press 『[F7]: Complete』 when everything is displayed normally.
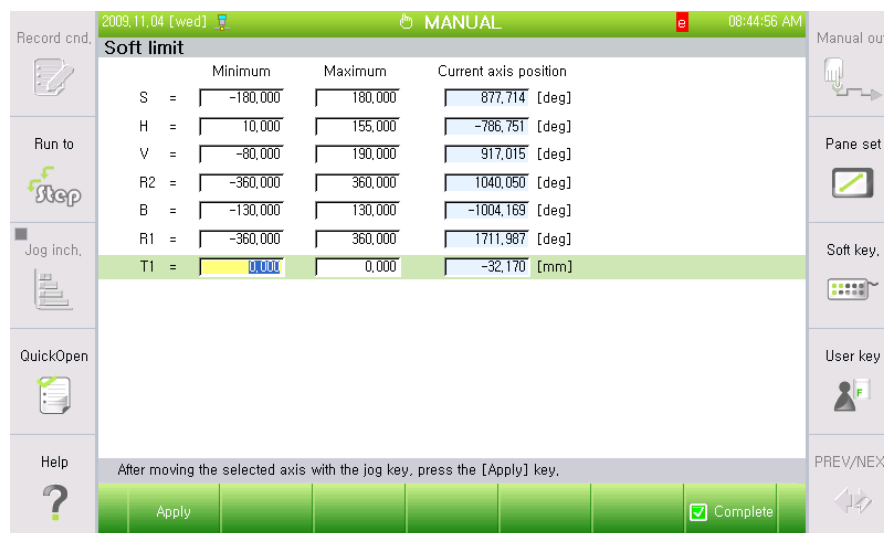
(3) Repeat processes (1) and (2).

2.1.4. Tool angle/distance setting

When executing spot welding, equalizing operation will be carried out based on the angle and distance data of the tool (welding gun) attached to the robot, so these items should be set as precisely as possible. (Refer to the Hi5 controller operation manual)
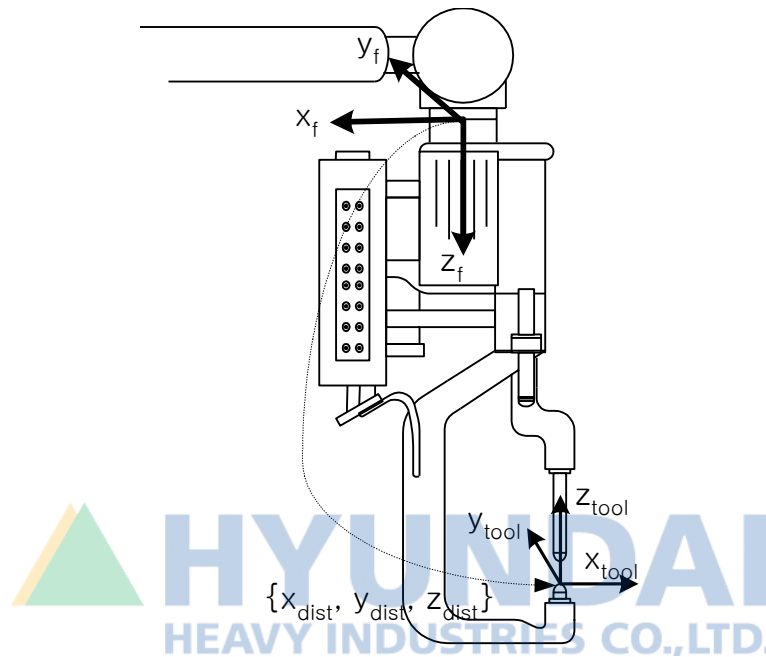

Figure 2.1 Setting tool length and angle of welding gun

■ 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. Set the coordinate direction of the tool coordinate system to be positive (+) based on the picture above, and input measured lengths X, Y and Z; or, set tool length using the automatic constant setting 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. Monitoring

This enables the user to monitor the various data and setting condition currently being used in spot welding.

2.2.1. Spot-gun axis data

The Spot-gun axis data window displays the current, squeeze force, tip consumption, gun search status and the welder number of the currently selected spot-gun in real-time. 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』)
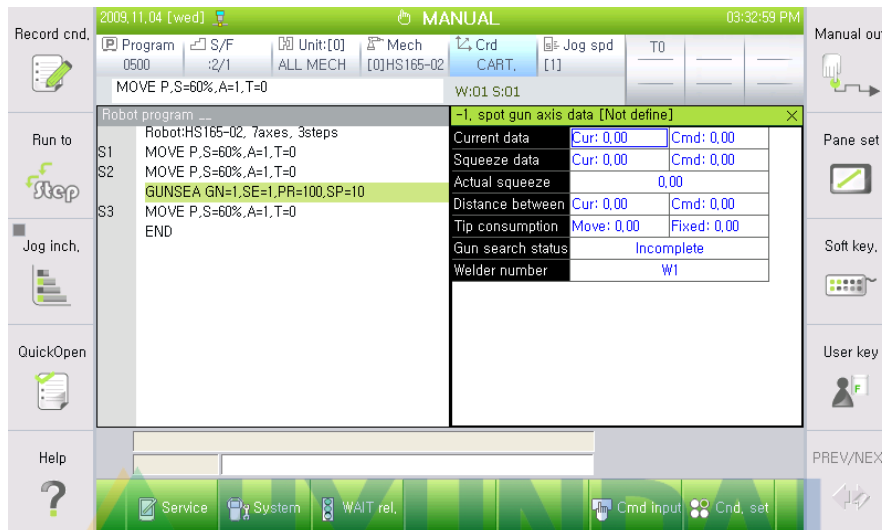
- ■ Current data (Servo-gun)
  Displays feedback current flowing on the servo-gun axis for the current value, and the current limit command current for the command value (A)

- ■ Squeeze data (Servo-gun)
  Displays the returned current converted into actual squeeze force for current value, and command current converted into squeeze force for command value from squeeze force - current table of welding gun parameter (Kgf)

- ■ 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 distances from reference location (axis constant) to the static tip and moving tip of the servo-gun axis (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)

- ■ Fixed tip monitor value (Servo-gun)
  Displays the distance from the reference location (axis constant) to the record location of Gun Search1 reference location (mm)

- ■ Gun search status (Servo-gun, EQless-gun)
  Displays the Gun Search status

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

2.2.2. Input and output signal

This is a function to monitor the input and output status of allocated signals in relation to spot welding. General-purpose input and output signals are arranged clearly at a glance, so that they can be used easily, without the need to check all numbers individually.
(『[F1]: Service』 → 『1: Monitoring』 → 『4: Spot welding data』 → 『2: Spot welding input/output signal』)
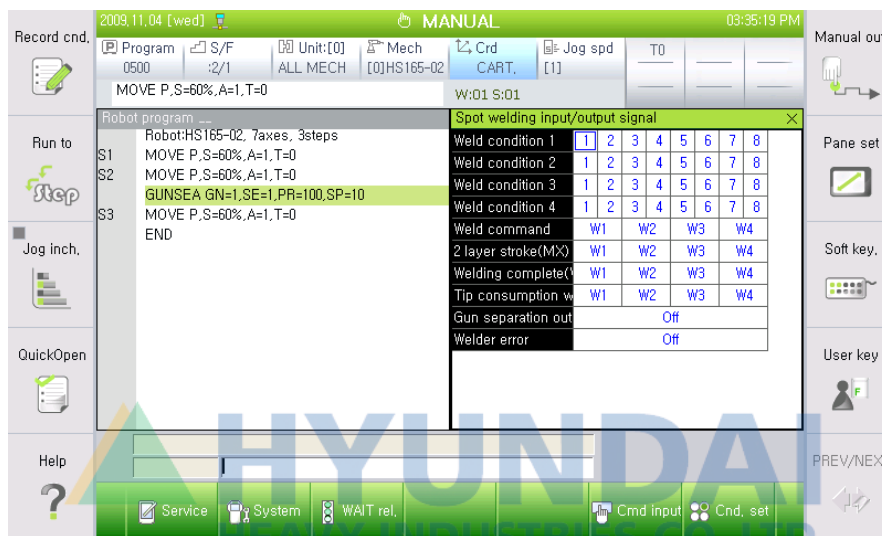
2.2.3. Spot welding operating information

Welding time and the number of welds for the welder currently in use can be confirmed. Welding time and the number of welds will be displayed in 3 timelines: from controller initialize to the present, during previous cycle operation, and from power input to the present.
(『[F1]: Service』 → 『1: Monitoring』 → 『4: Spot welding data』 → 『3: Spot welding operating information』)
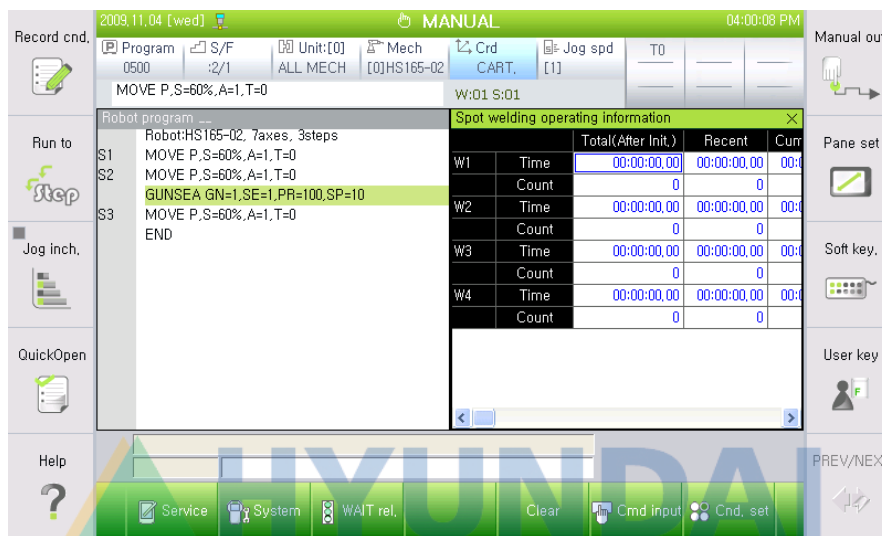

■ Spot welding operating information clear

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.

2.2.4. Status flag

Various statuses related to spot welding will be displayed, as shown in the following screen.
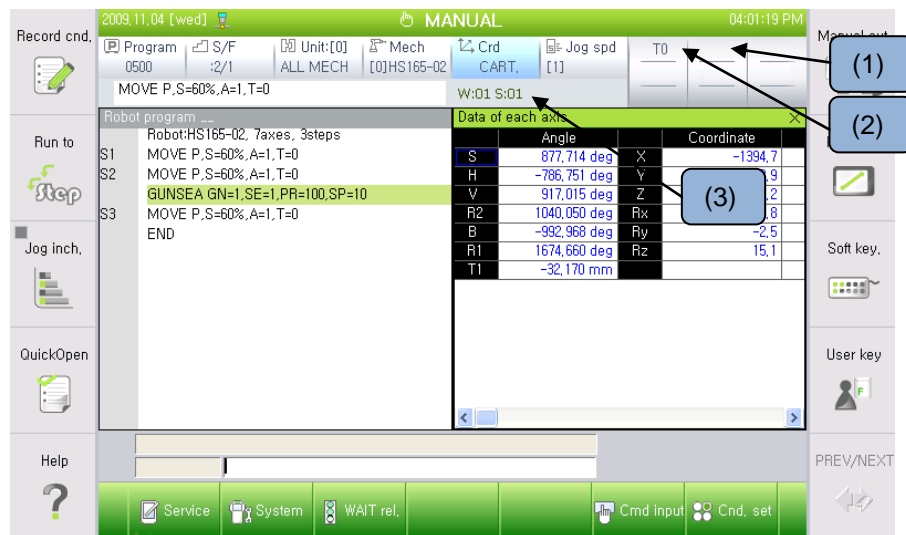
■ **Gun number**
This displays the currently selected basic gun number, multi-gun number, change gun number (:1) and servo-gun lock status (🔒). Change gun number will be displayed only when it differs from the basic gun number

For example, 🔒G5,6:1 shows that stationary gun number 5 and number 6 have been selected for simultaneous welding, and also indicates that the robot-gun selected by gun change is G1. The lock symbol indicated that "Servo gun lock" has been set to <Enable>.

■ **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』.

■ **Welding condition number and welding sequence number**
This displays the currently selected welding condition number and welding sequence number.

2.3. User key

This part describes the user key related to spot welding. Please refer to the operating manual for the Hi5 controller for the method of registering and using the user key.
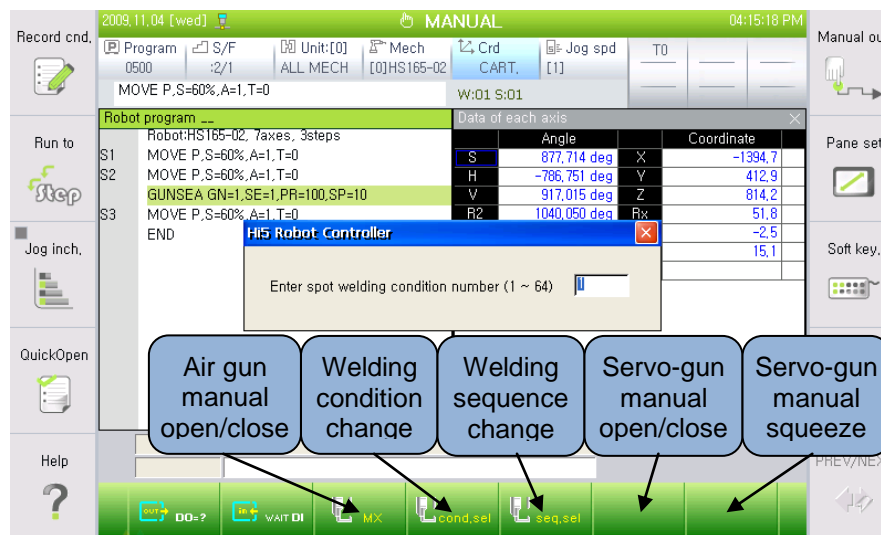
■ Air gun manual open and close
This enables the manual opening and closing of the air gun by displaying the MX signal. [2.4. Manual opening and closing welding gun and squeeze]

■ 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 manual open and close
This enables manual opening and closing of the servo-gun. [2.4. Manual opening and closing welding gun and manual squeeze]

■ Servo-gun manual squeeze
This enables manual squeeze of servo-gun. [2.4. Manual opening and closing of welding gun, and manual squeeze]

2.4. 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.
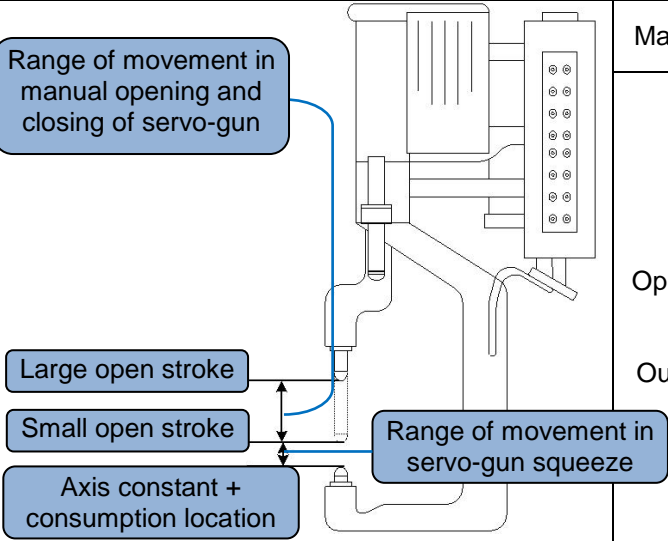
(1) Confirm the manual mode. Make preparations for operating the servo-gun axis if the servo-gun is used.

(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/separation)
	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	
Manual open and close	Manual squeeze	Manual open and close	Manual squeeze
svgun man open/close	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
Range of movement in manual opening and closing of servo-gun Large open stroke Small open stroke Axis constant + consumption location Range of movement in servo-gun 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.

● The operation will be stopped automatically at the location where large open stroke, small open stroke and squeeze force reach their set values.

● 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.
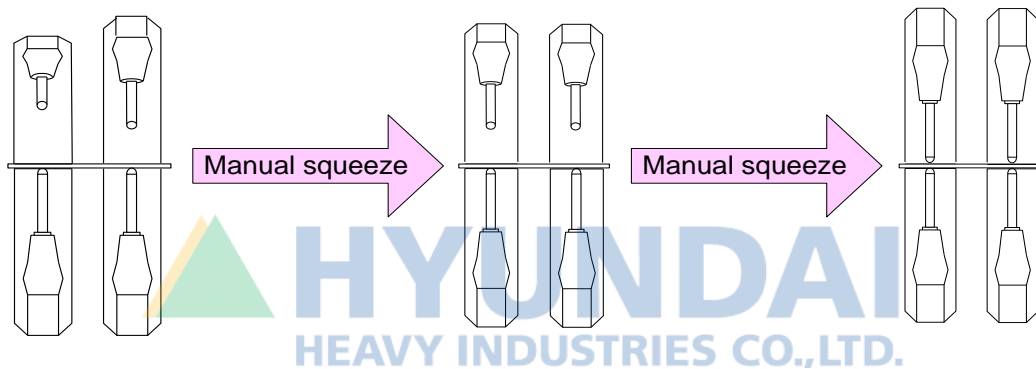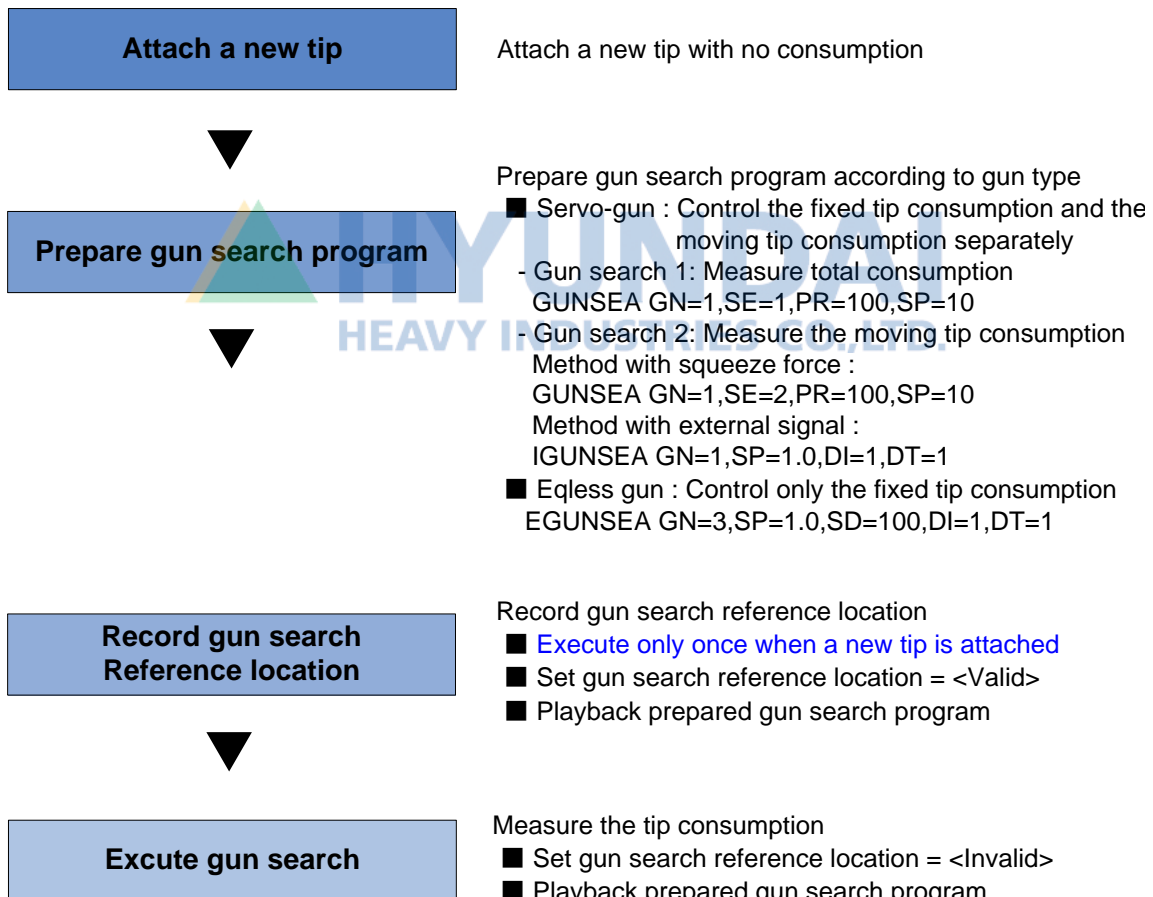
2.5. Gun search

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.

Gun search status can be confirmed from 『[F1]: Service』 → 『1: Monitoring』 → 『4: Spot welding data』 → 『1: Spot gun axis data』 .

2.5.1. 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 ■ Execute only once when a new tip is attached ■ Set gun search reference location = <Valid> ■ Playback prepared gun search program

▼

Excute gun search	Measure the tip consumption ■ Set gun search reference location = <Invalid> ■ Playback prepared gun search program

2.5.2. Commands related to Gun Search

Commands related to gun search (GUNSEA, IGUNSEA, EGUNSEA) will not be executed in manual mode by 『step forward/backward』.

Execute a gun search step again when the operation is stopped and executed again while gun search operation is incomplete.

(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

2.5.3. 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.
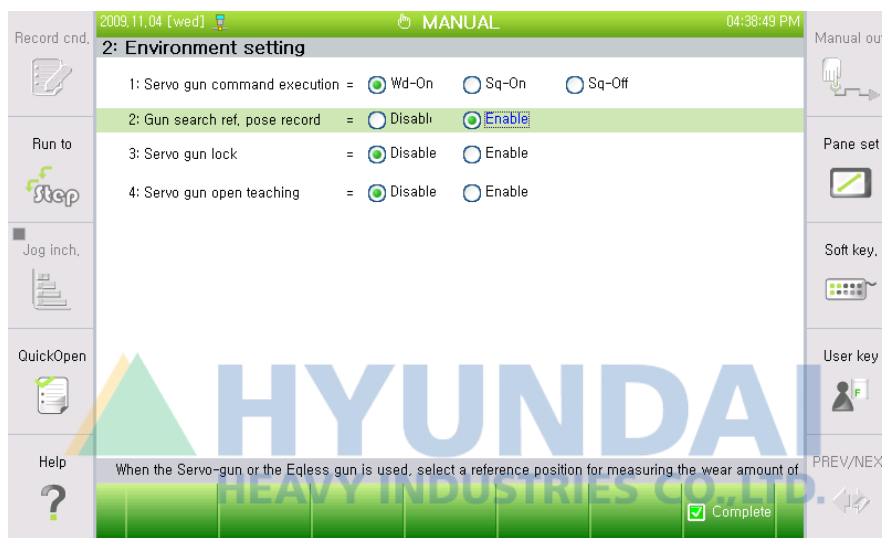
(1) Set up 『2: Gun search ref. pose record』 as <Enable>.

(2) Confirm that "SW (Search Write)" is displayed on status flag.

(3) Playback prepared Gun Search program for 1 Cycle. Gun search status will be initialized as "Incomplete" at "『[F1]: service』 → 『1: monitoring』 → 『4: Spot welding data』 → 『1: Spot gun axis data』 ".

(4) 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.

2.5.4. Gun search movement by gun type

2.5.4.1. 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.

The measuring of the moving tip consumption with gun search 2 operation will be determined according to the value of the 『moving tip consumption/total consumption(%)』 item. (Refer to 3.5.1 Servo-gun parameter)

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
```

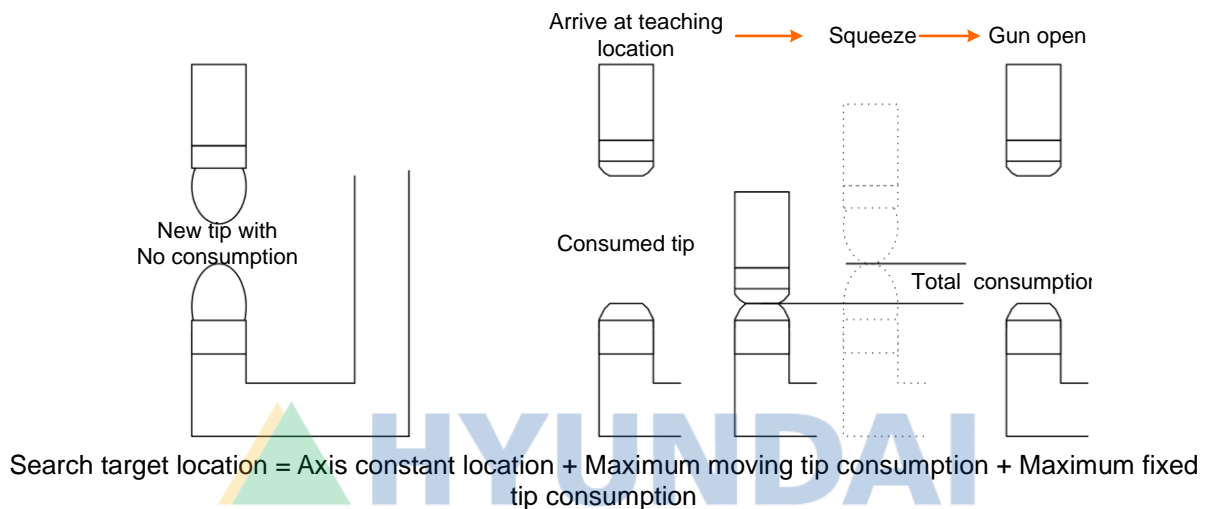Teaching of gun search 1   Playback of gun search 1

Arrive at teaching location → Squeeze → Gun open

New tip with No consumption

Consumed tip

Total consumption

Search target location = Axis constant location + Maximum moving tip consumption + Maximum fixed tip consumption

Figure 2.2 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)

Moving tip

Fixed tip

New tip with no consumption

Record gun search reference location

GUNSEA
GN=1,SE=1,PR=100

Total consumption

Total consumption + Moving tip consumption%

Total consumption + Moving tip consumption
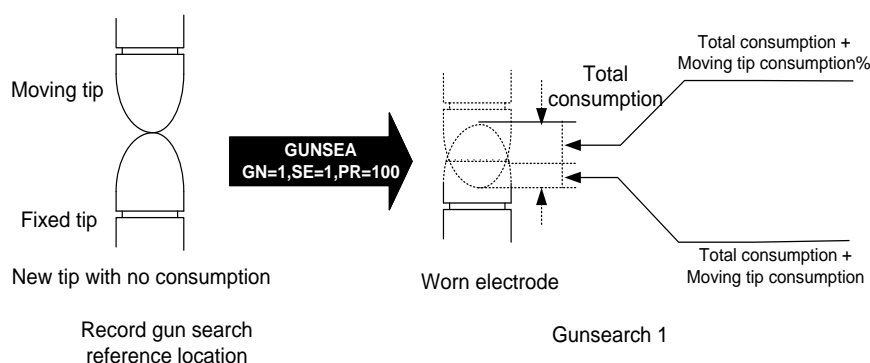
Worn electrode

Gunsearch 1

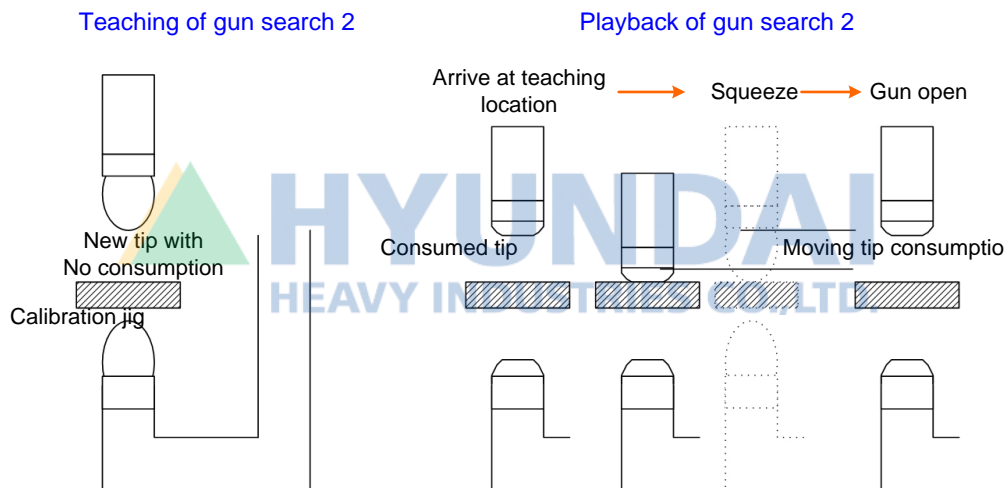Figure 2.3 Calculation of consumption using only Gun Search 1

(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
```

Teaching of gun search 2   Playback of gun search 2

Arrive at teaching location → Squeeze → Gun open

New tip with No consumption

Consumed tip

Moving tip consumptio

Calibration jig

Search target location = Axis constant location + Maximum moving tip consumption + Maximum fixed tip consumption

Figure 2.4 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
```
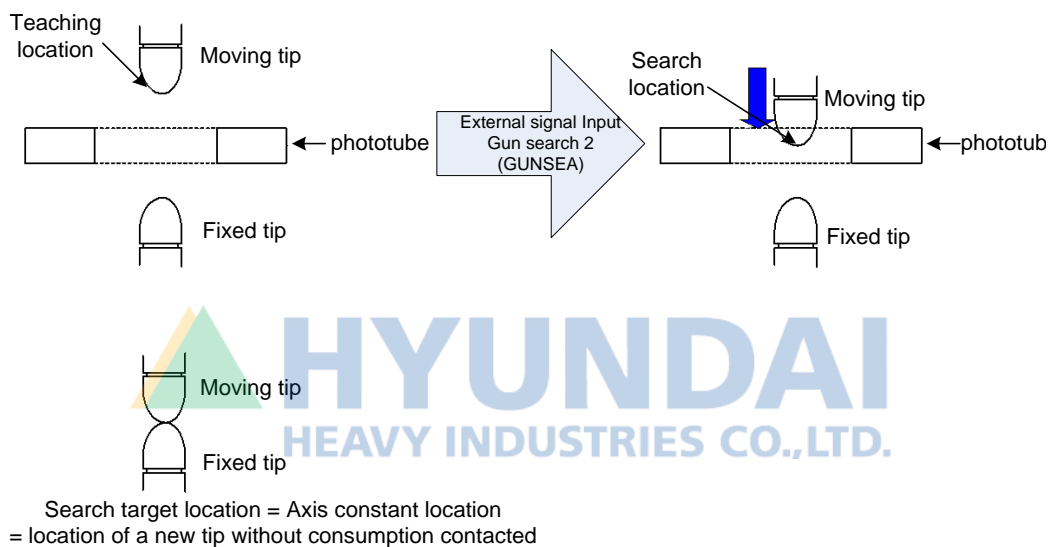

Figure 2.5 External signal input Gun Search2

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.

2.5.4.2. 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
```
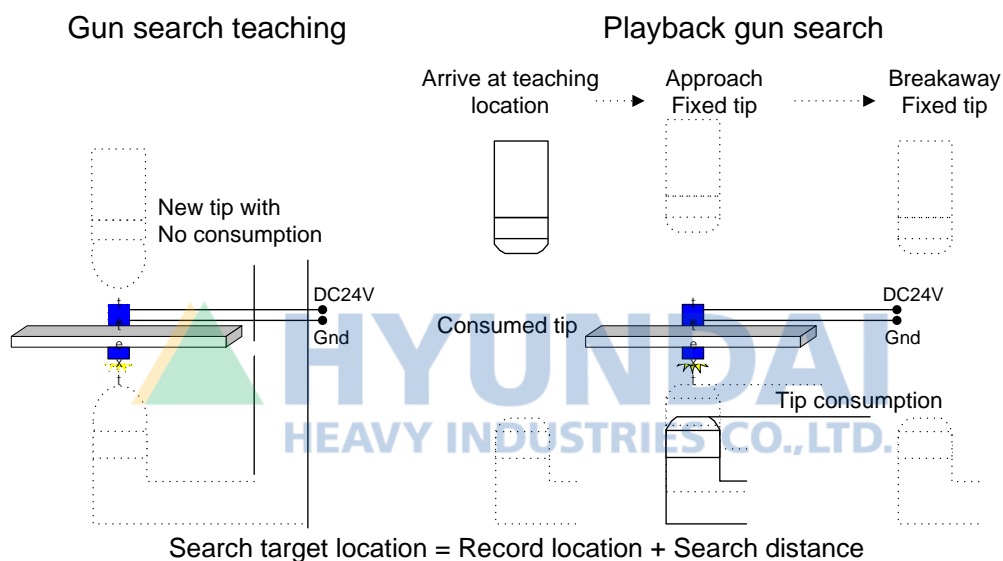
Gun search teaching   Playback gun search

Search target location = Record location + Search distance

Figure 2.6 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.

2.6. 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.

2.6.1. SPOT command

If spot welding command (SPOT) is not the first function of the spot welding step, it will not be executed, and if it is the first function, it will always be executed in manual mode, regardless of the 『 step forward/backward 』 function setting in the condition setting menu when 『 step forward/backward』 operation is executed.
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)

In one-touch recording, a location of the tip consumption calibrated will be recorded to step if the gun type is servo-gun, and if the gun type is not servo-gun, the current location will be recorded to step. Therefore, SPOT command should be input through one-touch recording when the panel is squeezed by manual squeeze operation after attaching the fixed tip to the panel by jog operation when recording the welding step.

If the gun type is servo-gun, the location will be automatically changed to a location of the tip consumption calibrated when executing [Location change] in case SPOT command is the first function of the step.

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	Assign the gun number for spot welding
Condition Number	Assign the spot welding condition
Sequence Number	Assign the spot welding sequence
Multi-gun Number	Assign the multi-gun number for carrying out spot welding by multiple guns simultaneously
Multi-Gun Condition Number	Assign multi-gun condition number in the event that a different welding condition needs to be assigned to each gun for carrying out spot welding by multiple guns simultaneously. If nothing is assigned, the welding condition of the basic-gun will be applied.
Multi-Gun Sequence Number	Assign multi-gun sequence number in the event that a different welding sequence needs to be assigned to each gun for carrying out spot welding by multiple guns simultaneously. If nothing is assigned, the welding condition 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

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2.6.2. Changing SPOT command record condition

When executing the gun number selection, multi-gun selection, welding condition change and welding sequence change, the record condition of the SPOT command will be changed automatically. The following method can be used in the event that the record conditions of the SPOT command needs to be changed manually.

(1) By pressing 『[F6]: Cmd input』 → 『[F4]: Spot』 from the manual mode initialize side, the F button will be changed as follows.

SPOT	GUNSEA	IGUNSEA	EGUNSEA	GUNCHNG			

(2) By pressing 『[SHIFT]+[SPOT]』, the contents of the record condition window will be changed as follows, so that SPOT command can be changed.
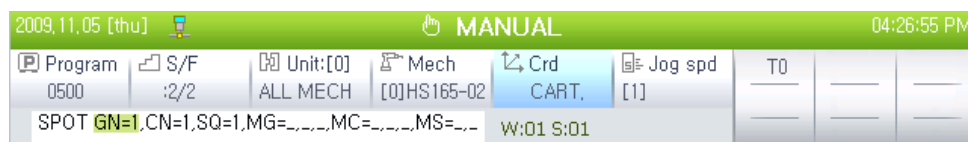
(3) Change the record condition using the same operation as is used for changing the command. The following picture shows that the welding condition number has been changed to 2.
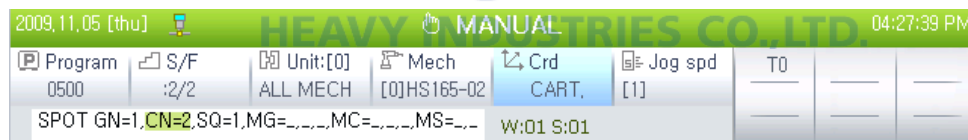
(4) When recording [SPOT] command, recording will be executed according to the changed record condition.

2.6.3. 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.

2.6.3.1. Servo-gun

If the gun type is servo-gun, the playback of spot welding function will be carried out as shown in Figure 2.7.
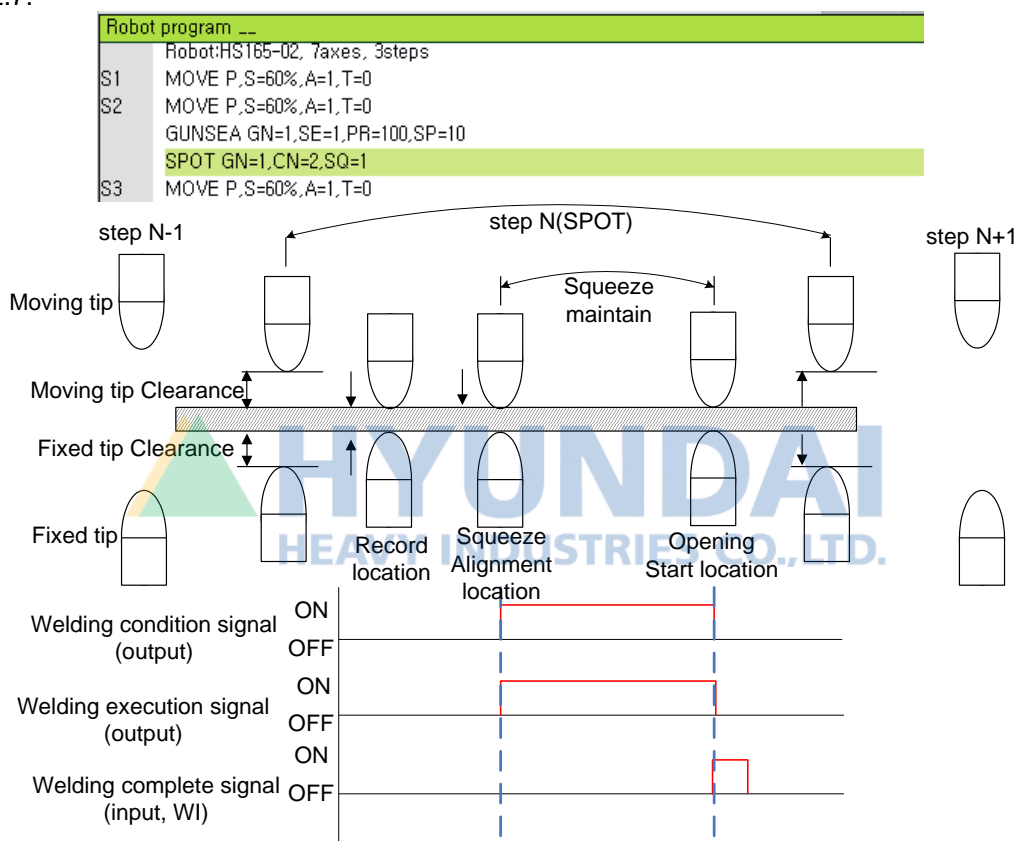

Figure 2.7 Playback of servo-gun spot welding

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

2.6.3.2. 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.
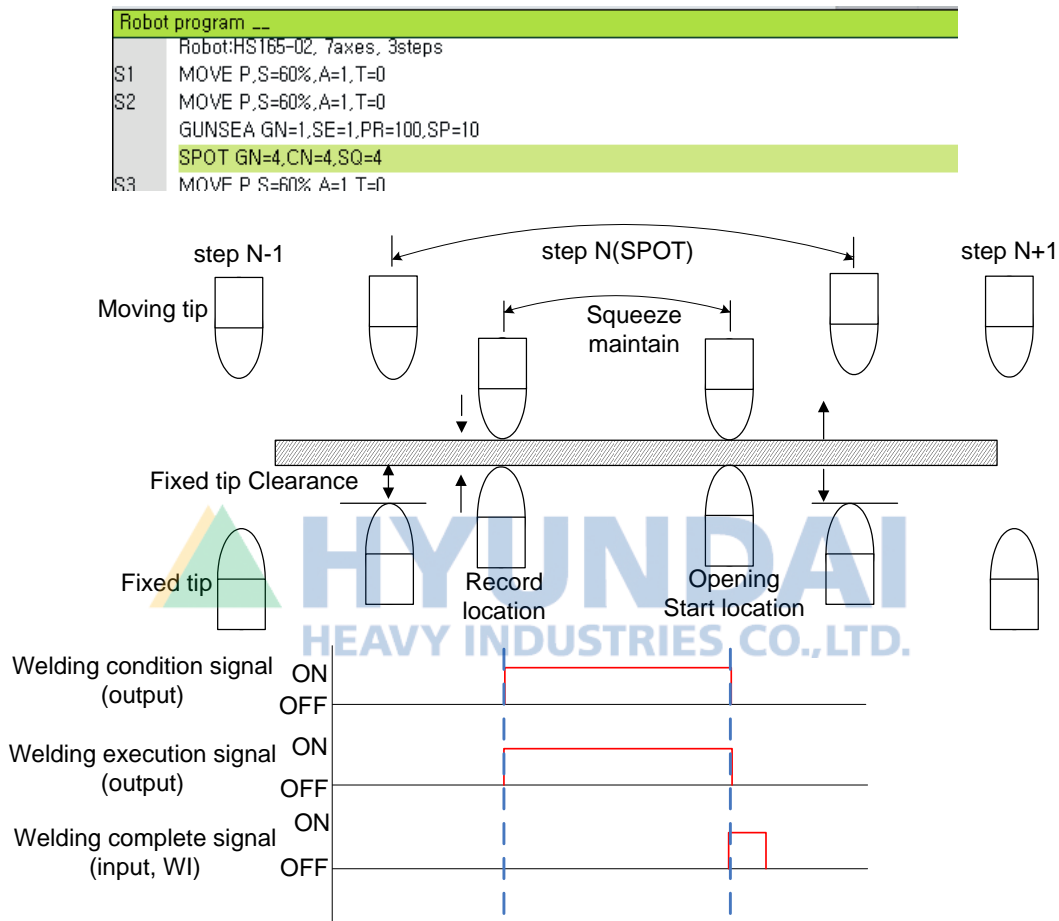

Figure 2.8 Playback of EQless-gun spot welding

(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.

2.6.3.3. 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.
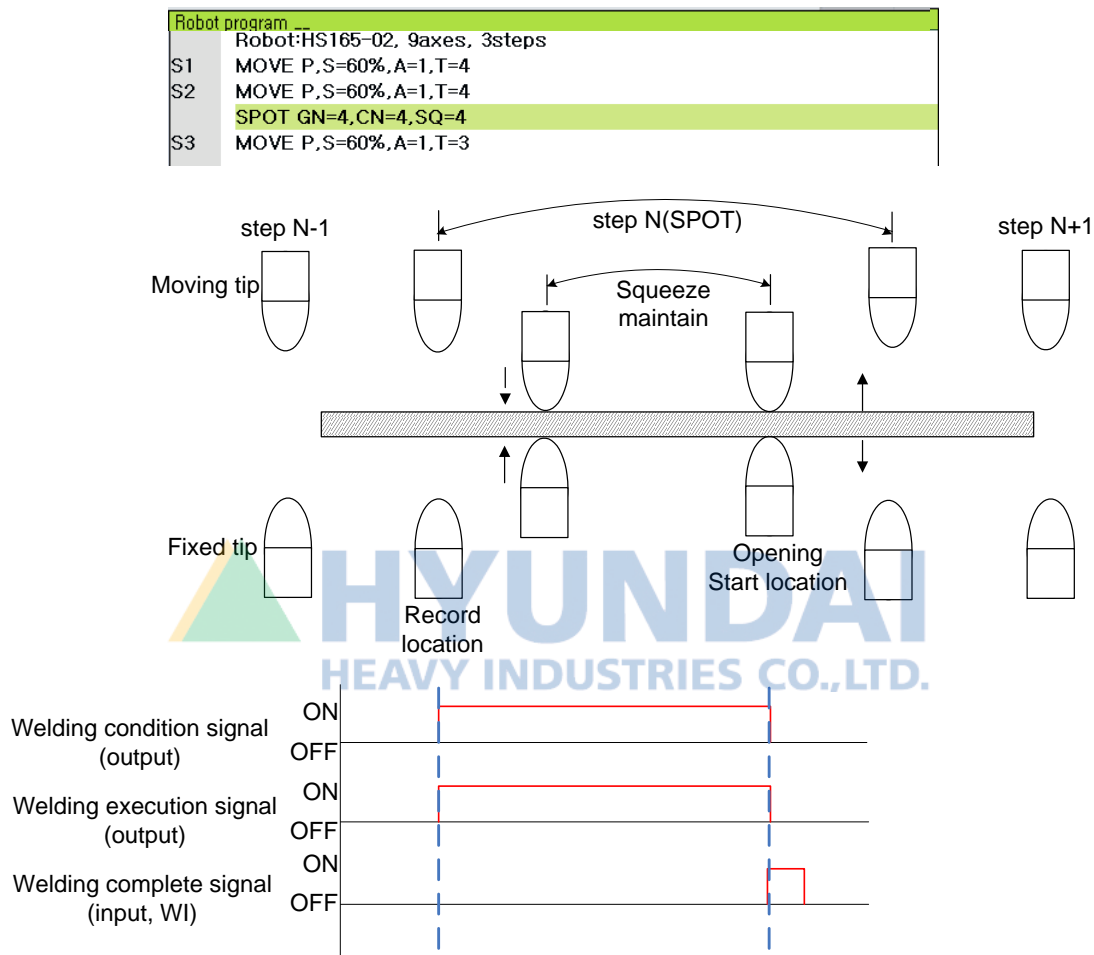

Figure 2.9 Playback of Eq-gun spot welding

(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.

2.7. Servo-gun tip dressing

2.7.1. 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.

2.7.2. 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.
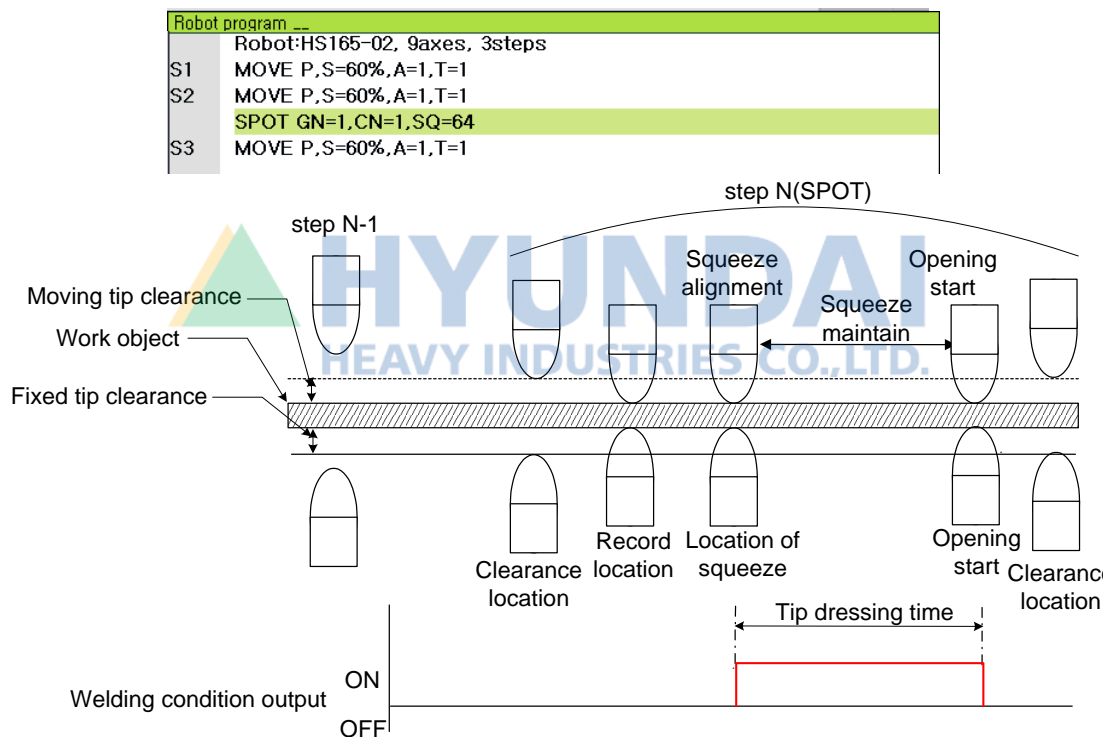
(1) From the N-1 step location, the moving tip moves to location that is at a distance equal to the moving tip clearance from the record location, and the fixed tip moves to location that is at a distance equal to the fixed tip clearance from the record location.

(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.

2.8. 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 work object.
(3) Operate the manual squeeze to squeeze the moving tip into the work object.
(4) Record SPOT command together with step by pressing [REC] Key.
(5) Separate the moving tip from the work object using manual squeeze or manual open/close.
(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.

2.8.1. Setting servo-gun opening location record to <Enable>

Select 『[F2]: System』 → 『4: Application parameter』 → 『1: Spot welding』 → 『2: Environment setting』 from the menu.
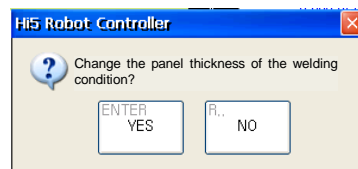
2.8.2. Registering the panel thickness

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.

You can register panel thickness by selecting 『[F2]: System』 → 『4: Application parameter』 → 『1: Spot welding』 → 『4: Welding data (Cnd, Seq)』 → 『2: welding condition』 from the menu, and the panel thickness should be input manually if it is known.

The following is the description of a method for registering the panel thickness automatically if the panel thickness is not known. The value for the panel thickness item in welding condition menu should be 0.

(1) The following message will be displayed after selecting the welding condition number, squeezing manually while "[GUN] LED" is illuminated and pressing [REC].
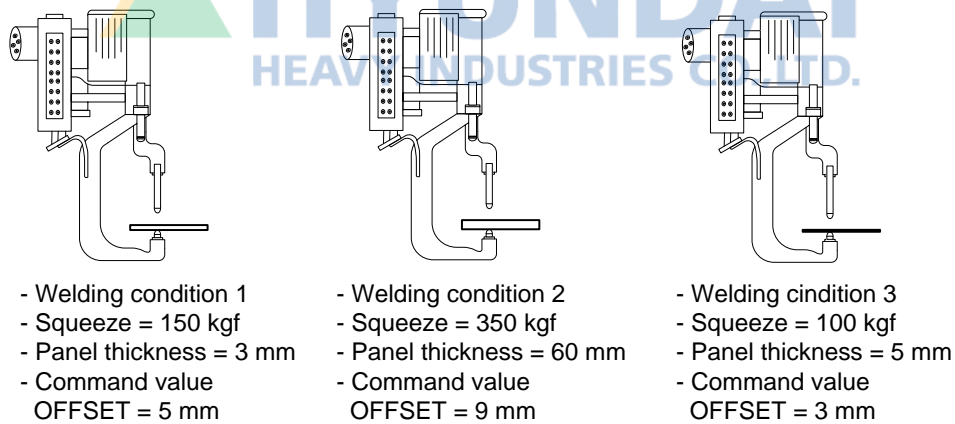

(2) Select [Yes] to register the panel thickness. After entering the corresponding welding condition menu, the changed panel thickness can be confirmed.

2.8.3. 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
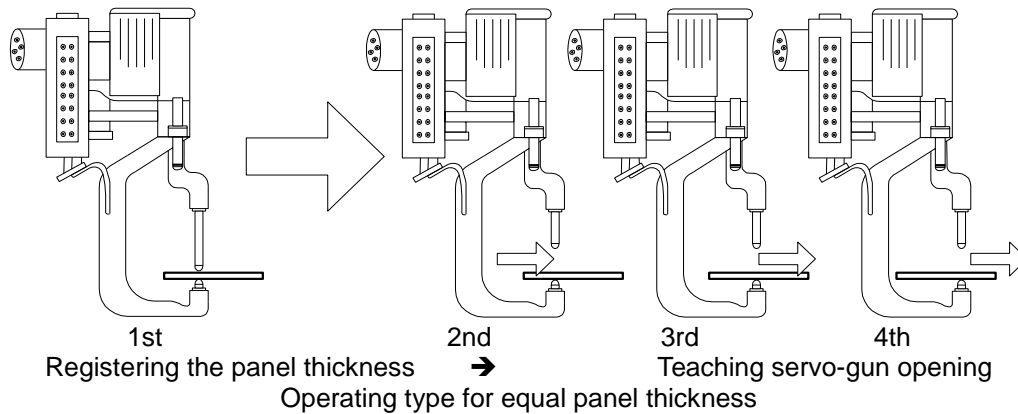
(2) Execute teaching by selecting the appropriate welding condition for the panel thickness after registering various panel thicknesses, in the event that there are numerous panel thicknesses to be welded.

- Welding condition 1	- Welding condition 2	- Welding cindition 3
- Squeeze = 150 kgf	- Squeeze = 350 kgf	- Squeeze = 100 kgf
- Panel thickness = 3 mm	- Panel thickness = 60 mm	- Panel thickness = 5 mm
- Command value OFFSET = 5 mm	- Command value OFFSET = 9 mm	- Command value OFFSET = 3 mm

(3) Execute teaching when the moving tip is opened and only the fixed tip is attached to panel by changing only the welding condition, as follows:

Select welding condition 1 ⟹ Change to welding condition 2 ⟹ Change to welding condition 3
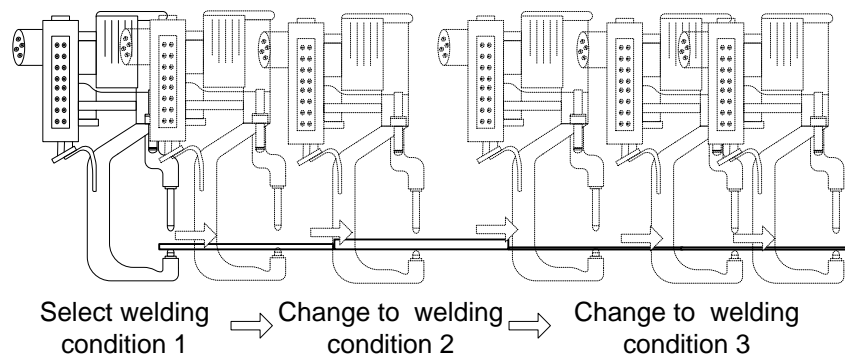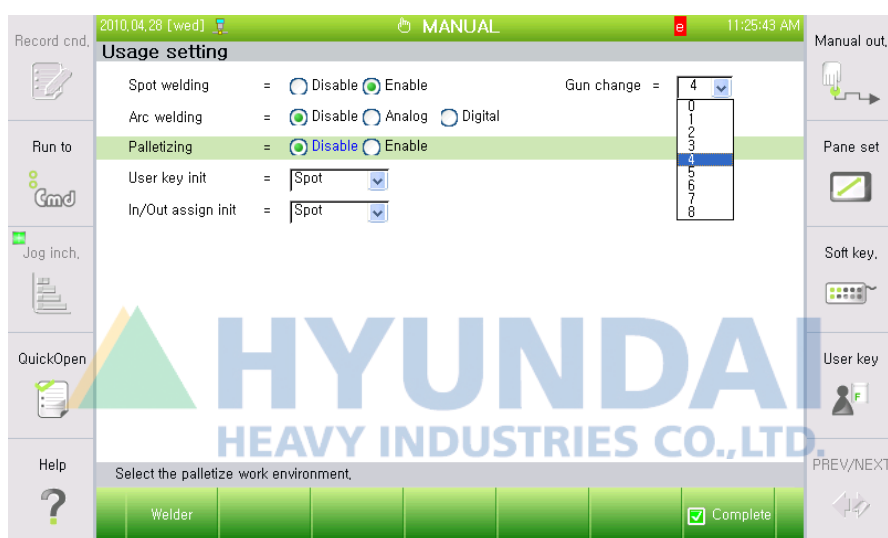
2.9. Welding gun change

If there are more than 2 guns for executing welding operation by coupling with the robot R1 axis, the operation should be carried out by changing welding guns. The method of using guns in this environment will be described below.

2.9.1. Setting environment

The number of welding gun change can be registered by selecting 『[F2]: System』 → 『5: Initialize』 → 『3: Usage setting』, and all guns for welding gun change are robot-guns. (A stationary-gun cannot be set as the gun for welding gun change)

2.9.2. Connection/separation command

In the welding gun change environment, welding gun connection / separation 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 / separation	Gun Number
	Set value	Connection = 1, Separation = 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,GN=<Gun Number>,DI=<connection complete signal>, WT=<connection complete wait time>			
ON/OFF	ON	Welding gun connection	
	OFF	Welding gun separation	
Gun Number	1~8	Number of welding gun to be connected	Parameters that will be disregarded if GUNCHNG OFF
Connection complete signal	1~4096	Input signal number for mechanical connection complete	
Connection complete wait time <0~5.0> (sec)		Input wait time of connection complete signal (Unlimited wait if no parameter or 0)	

2.9.3. Connection/separation timing
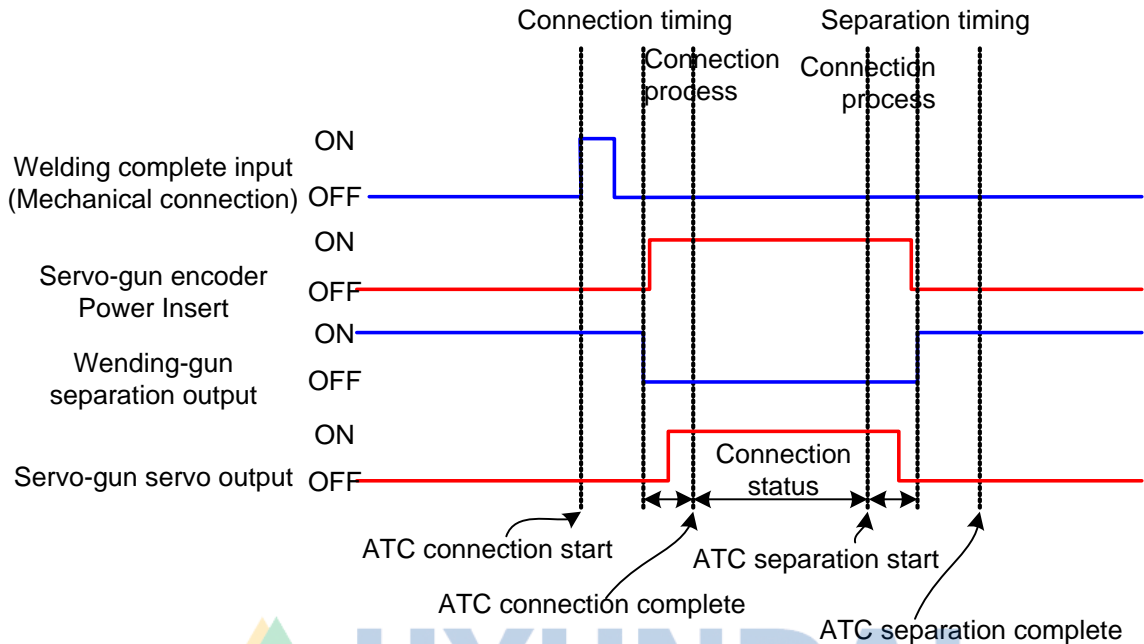
■ Connection
  When the robot and welding gun are connected mechanically while the connection command (GUNCHNG ON) is running, the connection process will be executed internally from the controller by receiving the connection complete signal. If the gun type is servo-gun, encoder power input and motor ON operation will be added for driving the servo-gun axis.

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

2.9.4. Sample program

Separation/connection program		Meaning of command	Note		Direction of signal	
Step B	....	(Location of welding gun separation)		ROBOT		ATC
	GUNCHNG OFF	Execute welding gun separation				
		Output welding gun separation	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 ON,GN=1,DI1	Input mechanical connection complete			←	
		Process connection of welding gun	GUNCHNG			
		I				
	MOVE L, ...	Move robot				

2.9.5. Servo-gun LOCK

This function is only "enable" in the servo-gun change environment.

Servo-gun Lock setting condition can be confirmed by selecting 『[F2]: System』 → 『4: Application parameter』 → 『1: Spot welding』 → 『2: Environment setting』 .

If the welding gun is separated or the air gun is connected, the setting condition is fixed to <Disable>, and the setting condition can be changed if the connected gun is servo-gun.

Since the motor of the servo-gun axis will be turned off if "Servo-gun Lock" is set to <Enable>, servo-gun axis cannot be operated. Lock (🔒) will be displayed next to the gun number on the status flag on the screen as follows.
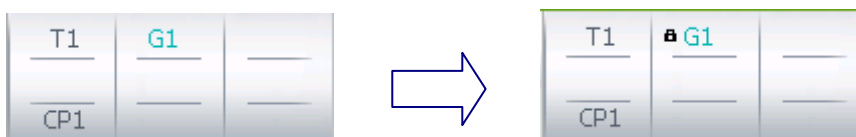
2.10. Multi-gun simultaneous welding

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.

The following conditions must be met to execute this function.

- The gun type (Servo-gun, EQless-gun, Eq-gun, and stud) of all guns should be the same.
- All guns should be stationary-guns.
  (Note: Guns set by welding gun change are all robot-guns, so these guns cannot be used for simultaneous multi-gun welding.)

2.10.1. 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 G5 by R210, 5.

(2) When pressing R214, the following screen will be displayed. Select "G6" as the simultaneous welding gun, and click [OK].
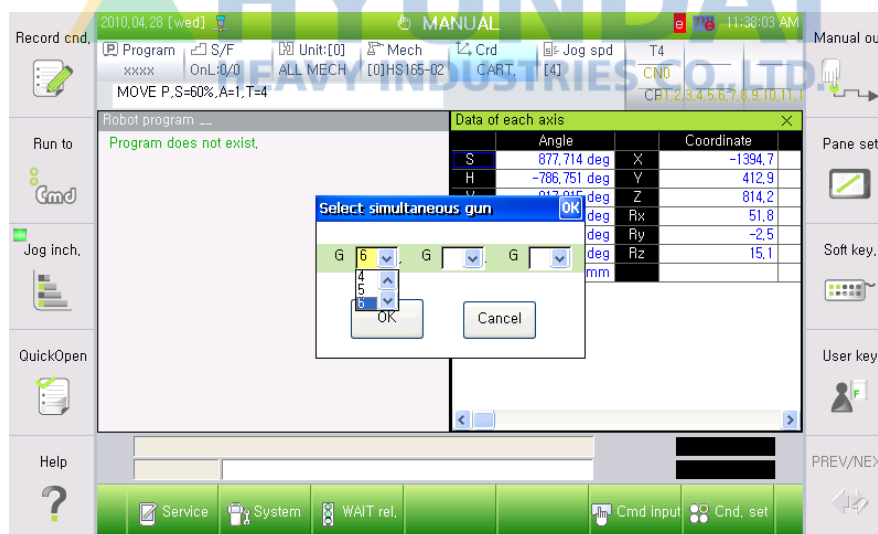
(3) The status of the selected gun will be displayed on the status flag, as follows.
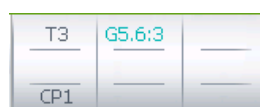
2.10.2. Supported functions

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

3
Spot welding parameter

3.1. Tool No. corresponding to Gun No., and gun-type set

Set the tool number and the gun type that corresponds to the spot-gun number. As welding methods vary according to the gun type, the tool number and the gun type should be set correctly.

(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.

As an example, in the setting shown in the screen above, G1 ~ G4 are set to use the welding gun change function, so the same welder will be used. Therefore, it should be set as one welding system (W1). If guns G5 ~ G7 are stationary guns, these gun numbers are irrelevant to the tool number assigned to the robot, so the tool number for all guns can be set as "4," which is the last tool number used for welding gun change. In addition, the welder can be set in the manner that each individual welding system (W2 ~ W4) will be assigned.

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

Tool refers to an object that will be connected with the R1 axis hem of the robot. Therefore, a separate tool number should be assigned to each welding gun change (robot-gun) without duplication, since each of these guns has a different weight and appearance. G5 ~ G7, which are stationary guns, do not connect to the R1 axis hem, so these can be set at the user's discretion. (All tool numbers are set to "4" in the screen above)

◆【References】◆

- If a tool to be used does not support spot-gun, set all other guns to the tool number assigned to the last gun, so that this tool number is used for other purposes. That is, when making the setting as shown in the screen above, there is no gun number corresponding to "T5 ~ T15", so T5 ~ T15 can be used for other purposes.

- 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

3.2. Setting the welding environment

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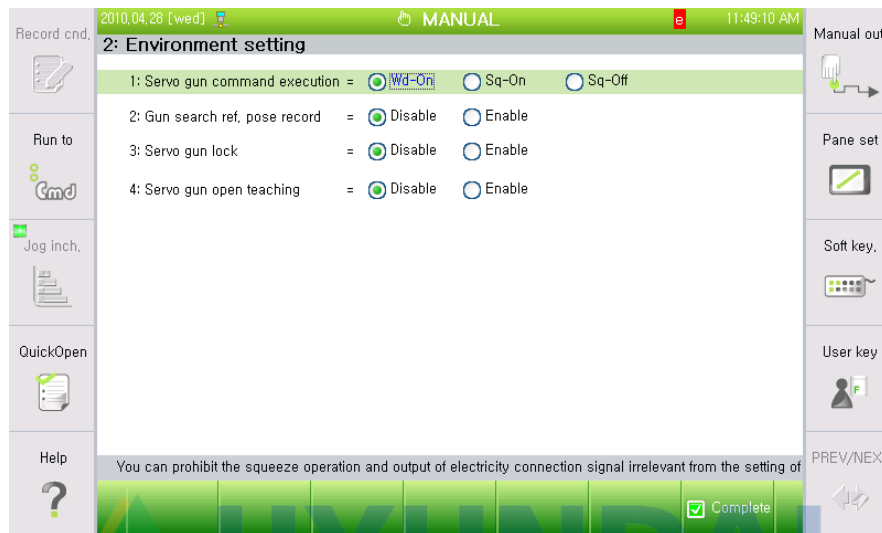
(1) Servo-gun SPOT command execution type

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 complete wait → clearance location
Sq-On	Execute all welding sequences, except for the applied current signal. Location of squeeze can be confirmed since WI wait is carried out while pressure is maintained. 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.

■ Off:

Actual consumption will be calculated based on the determined the reference location.

■ On:

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.

3-5

(3) Servo-gun Lock
This sets whether to playback the first servo-gun without moving the servo-gun.

(4) Servo-gun opening location record

■ Disable:
This is a general way of recording the welding point of servo-gun, and the current location will be recorded after executing manual squeeze.

■ Enable:
This is a way of recording the current location from the location where only the fixed tip is connected to the panel if manual squeeze is impractical, and panel thickness should be set in welding condition.

3.3. Welding gun parameter

If the gun type is servo-gun or EQless-gun, the individual parameter for each gun can be set. Since the gun type of G4 is set as "Eq-gun" in the screen below, this item will not be displayed.

3.3.1. Servo-gun

The gun types of G1, G2, G5, and G6 are servo-guns, and the screen to set the parameters related to servo-gun will appear as follows:

(1) Manual open/close Distance (mm)
This assigns a maximum (open) and minimum (close) distance between the moving tip and fixed tip for servo-gun manual opening and closing by user key and for servo-gun large open and servo-gun small open by external input signal. In addition, this distance is the same as the distance between the moving tip and fixed tip in an opened (maximum) and closed (minimum) state during manual servo-gun squeeze.

(2) Maximum tip consumption (mm)

This determines the search range when the gun search (GUNSEA) function is used. The range of gun search will be two times the maximum tip consumption (Moving + fixed). When the consumption of moving tip or fixed tip detected by gun search exceeds the set value, an error will be displayed and the welding operation will be stopped.

(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 offset (mm)

Bending of gun occurs due to squeeze force during servo-gun squeeze. Set the gun arm bending and the gun arm bending offset in order to consider the gun bending. The gun arm bending offset is theoretically the bending of the gun when the squeeze force is 0. This is a parameter for considering linearity within the range of squeeze force mainly used by the gun, even though the bending of the gun does not actually occur if there is no squeeze force on the tip.

When the playback of spot welding function is executed, squeeze should be done by calibrating the locations of the moving tip and fixed tip as much as this offset.

Amount of
Gun arm bending
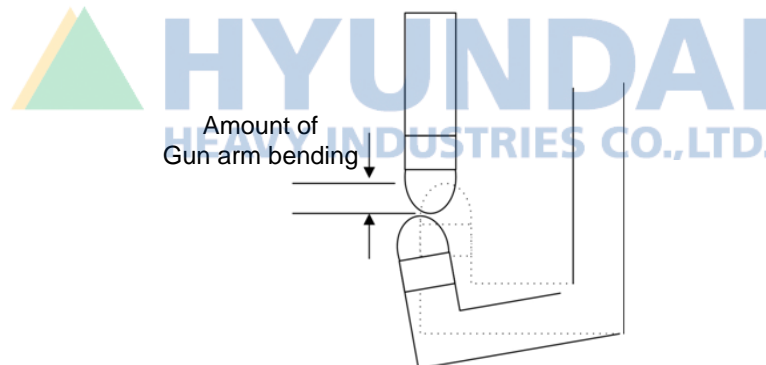
Figure 3.1 Gun arm bending

(5) Gun arm bending/100Kgf(mm)

Set gun arm bending due to squeeze force in the bending amount over 100Kgf. Squeeze the location of the fixed tip by calculating and calibrating the amount of gun arm bending from this set value and the command squeeze force. The moving tip bending does not need to be calibrated.

Amount of
Gun arm bending

Gun arm bending /100kgf

Amount of
Gun arm bending
offset

0 kgf   100 kgf

Figure 3.2 Gun arm bending/100Kgf

(6) Squeeze force match rate (%)
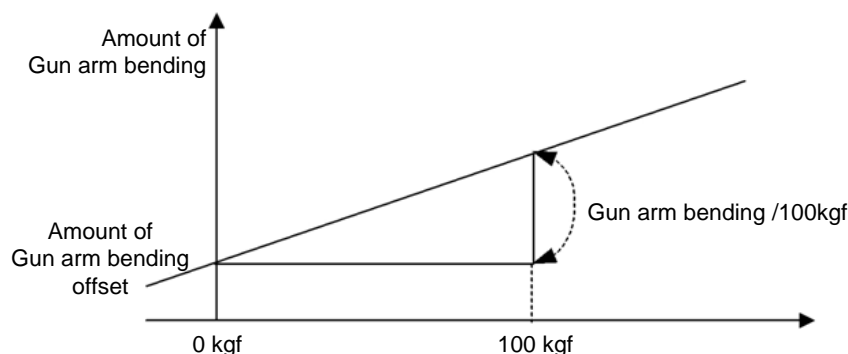Compare actual squeeze force and command squeeze force when executing squeeze alignment detection, and consider squeeze alignment to have been achieved if squeeze force reaches the designated squeeze force match rate. If this has been set to 0, the squeeze alignment detection will not be carried out.

(7) Squeeze force error detection time (s)
Set time from the beginning of squeeze to the squeeze alignment. If the squeeze alignment is achieved within this time, the applied current signal will be displayed as soon as squeeze alignment is achieved. If squeeze alignment has not been achieved within this time, the error message 『E1314 Squeeze alignment detection time exceeded.』 will be displayed, and the operation will be stopped. If squeeze force error detection time is set as 0.0 seconds, applied current signal will be displayed without detecting squeeze alignment.

(8) Command offset (mm)
Output command designating the amount of command offset distance to moving tip from the record location to the direction of squeeze in order to create squeeze force at the time of executing SPOT command.

(9) Gun type
Select whether the selected servo-gun is a 'robot-gun' or a 'stationary-gun'. Set the coordinate system of the stationary-gun to the user coordinate system number that is set in advance if the stationary servo-gun is being used. Set the user coordinate system with the direction of fixed tip in the Z (+) direction. That is, the Z (+) direction should be set in the opposite direction of the squeeze direction of the moving tip. When SPOT command is executed, consumption detected by gun search will be corrected using the user coordinate system, so the direction of the user coordinate system should be set correctly.

If the coordinate system number is "0", it will be set to the robot coordinate system.
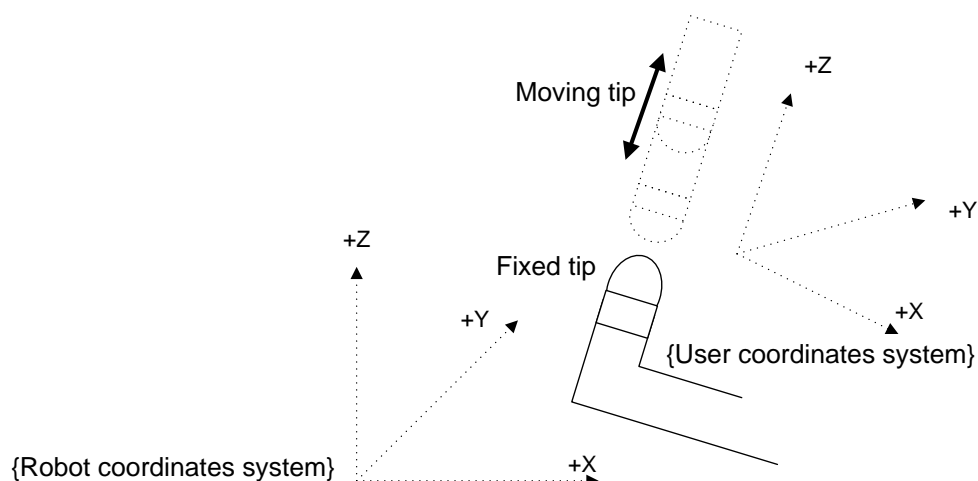
Figure 3.3 Coordinate system of stationary-gun

(10) 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 it is set to a value other than 0, the consumption will be calculated by dividing total consumption measured using gun search 1 into the moving tip consumption and fixed tip consumption in a set ratio (%).

(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.

The set value at the time of shipping the controller is prepared based on an "Obara C type" gun. As guns with the same specifications often have different properties, it should be prepared again in the event that precise tuning is desired. More precise squeeze force can be obtained from the squeeze force table if the setting is done based on the measurement under a gravity or semi-gravity state.

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.
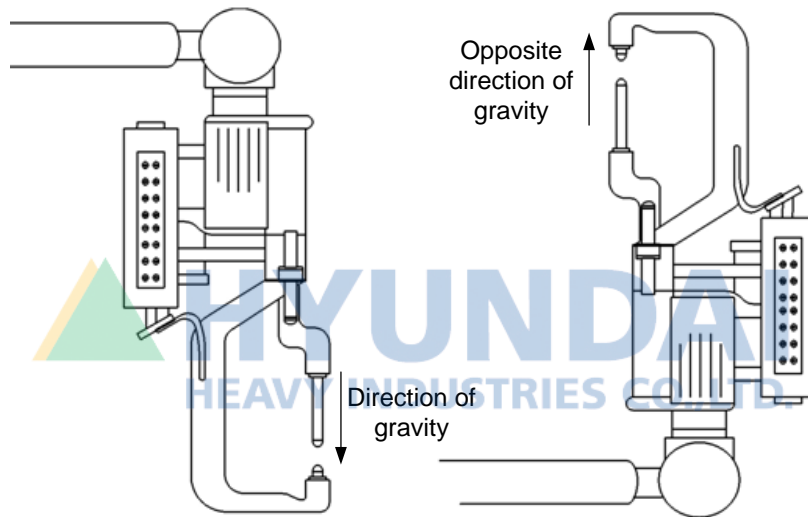
Figure 3.4 Direction of gravity, opposite direction of gravity

3.3.2. 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:
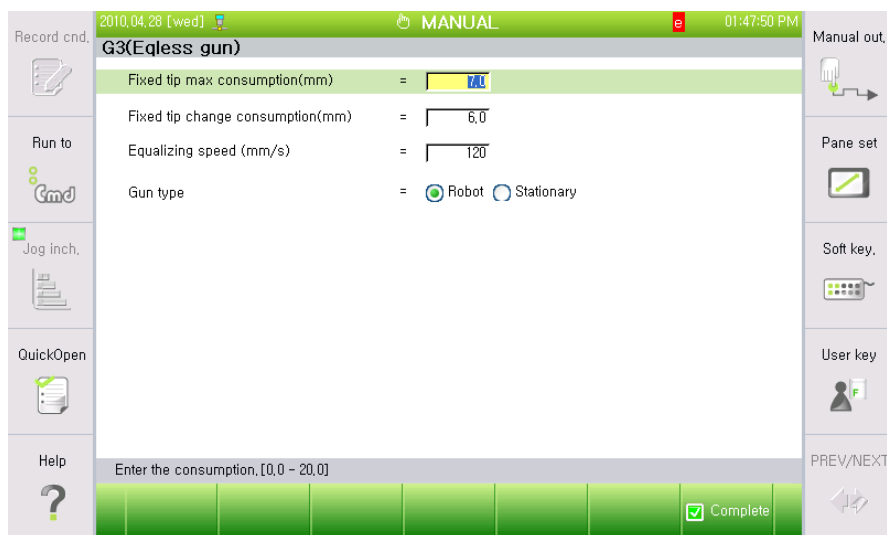
(1) Fixed tip max consumption(mm)
   An error will occur when the consumption measured by EGUNSEA exceeds this set value.

(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』 .

3.4. 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.
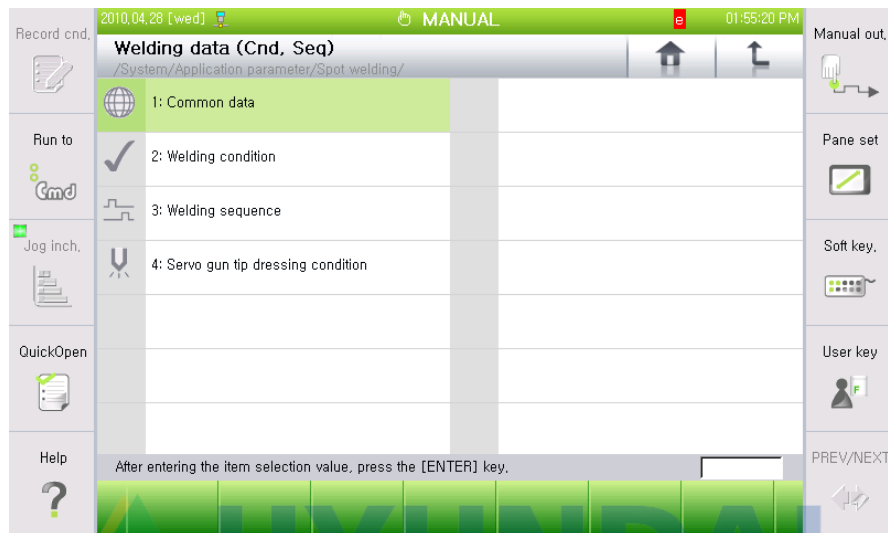
3.4.1. Common data

Setting data that is commonly applied regardless of spot welding sequence will be executed from this screen.

(1) Process when WI not entered
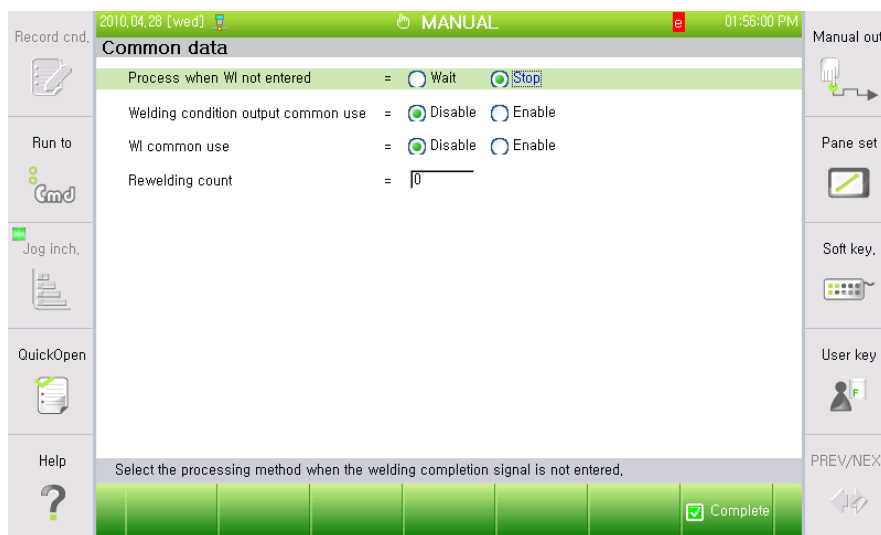This selects the process for errors that occur in the event that WI is not entered after the set welding complete (WI) wait time. Robot operation should be waited or stopped. If waited, robot operation should be waited until the welding complete signal is received.

(2) Welding condition output common use
In the event that multiple spot welders are used, the welding condition signal will generally be set separately for each welder, but if applying one common welding condition signal for multiple spot welders, this item shall be set as [Enable].

(3) WI common use
In the event that multiple spot welders are used, the WI signal will be generally set separately for each welder, but if applying one common WI signal for multiple spot welders, this item shall be set as [Enable].

(4) Rewelding count
Re-welding should be executed in the event that WI is not received after the set welding complete (WI) wait time. A maximum number of re-welds can be assigned (up to 3 times), and if WI is not received after trying as the maximum number of re-welds, an error should be issued and 'Process in the event of no WI input' should follow.

3.4.2. Welding condition

Setting conditions related to spot welding will be executed from this screen to carry out welding operation according the work environment.
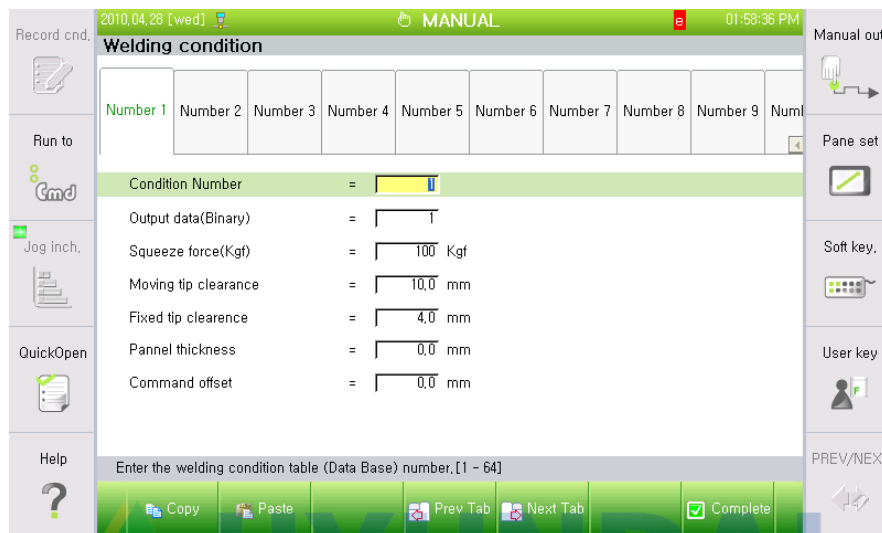
(1) Condition Number
This selects the Welding Condition Number, from Welding Condition Number 1 to Welding Condition Number 64.

(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) Squeeze force(Kgf)
In the event that the gun type for the designated Gun Number is servo-gun, this sets the squeeze force when a SPOT command is executed.

(4) Moving tip clearance
In the event that the gun type for the designated Gun Number is a servo-gun, this sets the clearance location of the moving tip when the SPOT command is executed.

(5) Fixed tip clearance
In the event that the gun type for the designated Gun Number is servo-gun, it sets the clearance location of the fixed tip when the SPOT command is executed

(6) Panel thickness
This sets the panel thickness as a required parameter in the event that the servo-gun opening location record function is used.

(7) Command offset
Refer to 『2.3.1 Servo-gun parameter』. If set as "0", the set value on servo-gun parameters will be applied, and if it is not set as "0", this set value will be applied.

3.4.3. 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
It selects the Welding Sequence Number, between Welding Sequence Number 1 and Welding Sequence Number 63.

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

(3) Welding signal pulse output (0=Level)
This is an item for displaying welding (applied current) 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 inputs wait time until brake will be operated when executing spot welding using Stud-gun as a robot-gun.

(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.

3.4.4. 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.
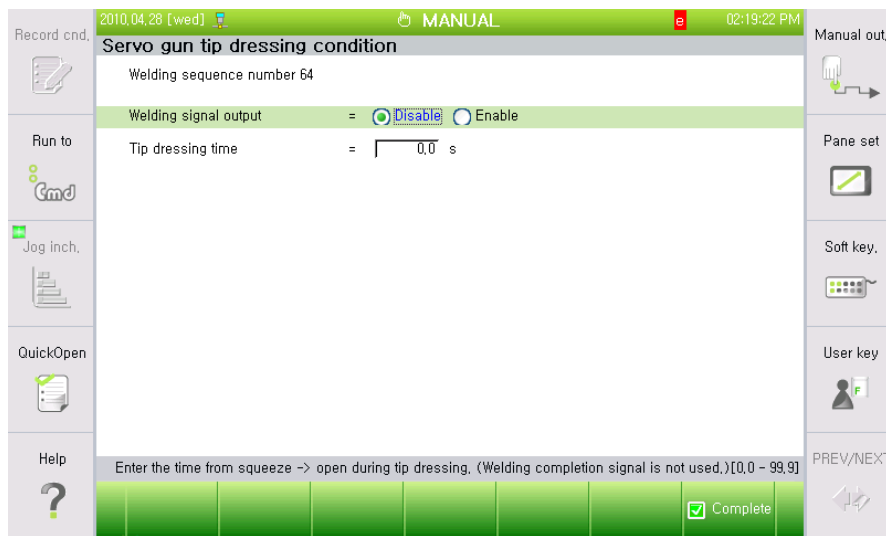
(1) Welding signal output
This selects whether to output the welding (applied current) signal for tip dressing operation.

(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".

3.5. 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.
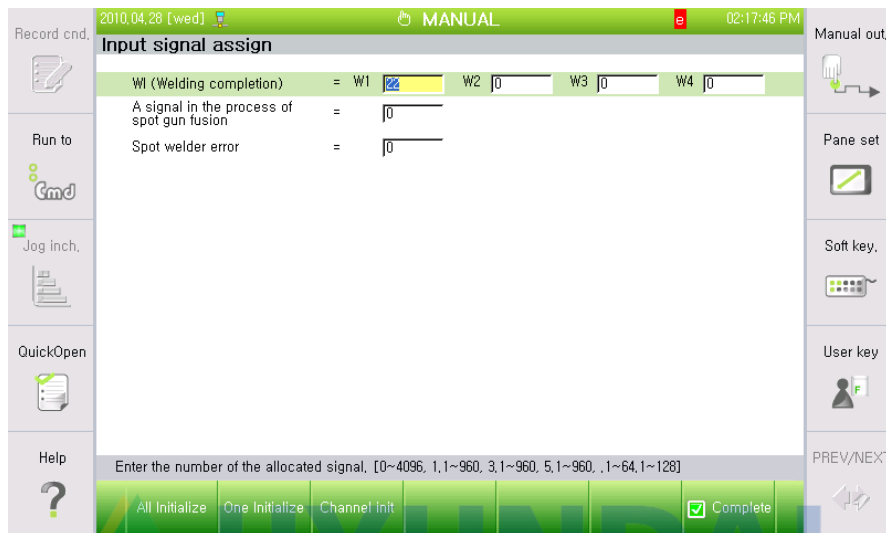
(1) WI (welding complete)
When spot welding is carried out, the controller can execute the welding complete process only if the welding complete signal has been received. Welding complete signal is processed with a total of 4 separate signals. However, if a user wants to use it commonly, 『WI common use』 should be set as <Enable> on 『[F2]: System』 → 『4: Application parameter』 → 『1: Spot welding』 → 『4: Welding data (Cnd, Seq)』 → 『1: Common data』 .

(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.

3.6. 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 assigns the signal number, which will output the welding condition when the SPOT command is executed. When assigning a welding condition signal that is up to 8 bits between B01~B08, maximum of 256 conditions can be used.
When more than 2 welding guns are used, the setting should be done to each welding line.

(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 separation
This displays that the welding gun is separated. If the gun type is servo-gun, it displays the message when all electric signals (encoder power, motor current) are turned OFF after the separation process.

(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.

3.7. Servo gun change parameter

If the type of gun you intend to change is servo-gun, the information of the gun should be registered to use the welding gun change function.
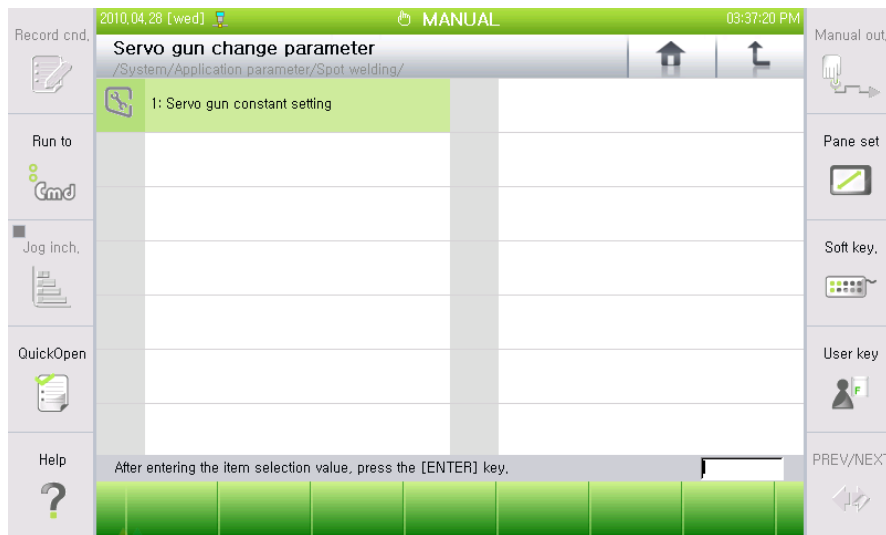
3.7.1. Servo gun constant setting

If the type of gun you intend to change is servo-gun, the setting to register the information of the gun should be done using the same method as registering an additional axis. [Please refer to the Hi5 controller additional axis function manual]

4

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.

■ 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".

■ 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".

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■ 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]

5
Errors and warnings

5.1. Error message

Code	E0007 Deposition 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	E0210 Servo gun connection initialize failure
Details	Initialization process to connect servo-gun in the GUNCHNG ON command or manual welding gun connection command has failed.
Measure	Check if the ATC connection is faulty, or if the encoder power is not supplied.

Code	E0211 Servo gun servo On time limit exceeded
Details	Servo of the servo-gun has not been turned on within the time limit.
Measure	Encoder signal is not processed correctly due to the faulty connection of ATC. Remove foreign substances from the ATC and try it again.

Code	E0212 Servo gun filter clear time exceeded.
Details	Clearance of servo-gun filter failed while trying to connect to Servo-gun axis.
Measure	Communication between the main board and the servo board is bad. Check the connection between each board and the controller, and if no problem is detected, replace boards.

Code	E0213 Servo gun servo Off time limit exceeded
Details	The servo of the servo-gun was not turned off within the time limit during the separation of the servo-gun.
Measure	Check ATC connection status. Replace the servo board.

Code	E0214 Servo gun encoder power connection failure.
Details	Failure of encoder power on has occurred while connecting servo-gun axis.
Measure	Check for any problems in the encoder power control system of the servo-gun axis.

Code	E0215 Servo gun encoder power separation failure
Details	Failure of encoder power off has occurred while disconnecting servo-gun axis.
Measure	Check any problem from the encoder power control system of servo-gun axis.

Code	E0216 Servo gun encoder data error
Details	Encoder reception result is abnormal while connecting the servo-gun axis.
Measure	Check the following items for the connected servo-gun. Confirm that the encoder battery is discharged; replacing the battery if this is the case. Reset the encoder and try again once the battery is replaced. (After resetting the encoder, encoder offset should be re-adjusted.)

Code	E0230 Encoder condition error during servo gun connection
Details	Error condition is received from the encoder, which could relate to overflow, over-speed, inner capacitor voltage drop, or LED error on the connecting servo gun.
Measure	Connect compulsory encoder power to the Servo-gun using the R359 function and execute the encoder reset function. Replace the servo-gun motor if the error is still not cleared.

Code	E0231 Encoder disconnection/communication error during servo gun connection
Details	An error has occurred while receiving location data from serial encoder on the connecting servo gun.
Measure	Check encoder voltage, connections of cables, controller, grounding status of robot side.

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	E1049 Robot gun already connected.
Details	As the welding-gun is already connected to the system, reconnection (GUNCHNG ON or manual connection etc) was attempted. This cannot be achieved.
Measure	Check welding gun connection status.

Code	E1050 Robot gun already separated.
Details	GUNCHNG OFF command or manual disconnection was achieved again when gun was already disconnected from the system.
Measure	Check gun connection status.

Code	E1051 Spot gun change environment inappropriate.
Details	This is a case in which the GUNCHNG command or manual gun connection or disconnection was performed in conditions that did not require a spot gun change.
Measure	Set the controller to spot-gun change environment again.

Code	E1052 Gun change manual execution time exceeded.
Details	This is a case in which the welding gun connection or separation command is not completed within 5 seconds.
Measure	Contact our company.

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 Tool number designation of step is incorrect.
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	Match the gun number of function and the tool number (G1->T0, G2->T1) of the step by confirming the setting status from Tool No. corresponding to Gun No., and gun-type set.

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.

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.

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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.

Code	E1348 Servo gun connection completion wait time exceeded.
Details	Welding gun connection was not completed within the set time.
Measure	Configure the automatic tool changer in the manner that it will send a welding gun connection confirmation signal to the controller when connection is completed at the automatic tool changer. In addition, the GUNCHNG ON command should be programmed to be executed after the connection between the welding gun and the automatic tool changer is completed.

5.2. Warning messages

Code	W0109 Brake slip has occurred (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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Code	W0125 Location error of connected servo gun
Details	The location of the servo gun attached by the GUNCHNG ON command or the manual gun connection command is different from the location saved when separating servo-gun.
Measure	This is normal if it occurs when the servo-gun is initially connected. If it occurs at a time other than the initial connection, you must first confirm the servo-gun number, as it may mean that an incorrect servo-gun number was selected. Next, check to ensure that the encoder battery of the servo gun is sufficient.

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