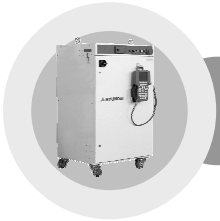
WARNING

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

Hyundai Robot

Hi4aSG071001FMEN3



Hi4a Controller Function Manual

Servo Gun

HYUNDAI
HEAVY INDUSTRIES CO.,LTD.

HYUNDAI
HEAVY INDUSTRIES CO.,LTD.

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1 Overview

[ATTENTION]

- When abnormal or halt is occurred, GUN open is always set up as [ENBL] and the set value can not be changed.
- Welding Condition No. can be designated from 1 to 64. Output data according to welding condition can be designated from 1 to 255.
- Welding Condition Signal, Squeeze Signal, Welding Signal, and ENBL/DSBL Settings of WI Wait can not be changed and it can be set up automatically according to tip dressing existed or not existed.
- The Welding Condition Signal output in advance function is not supported.
- Stick detection can only be done through the external signal.
- After applying power supply, the initial operation should be moved to Large Open.
- Moving speed of Manual Open/Close is determined by the 2nd of condition settings.
- While operating Opening & Closing, it halts the movement by not pressing [f] key, however, it doesn't halt the movement by not pressing [SHIFT] key.
- Limited squeeze force is set up by the value executed finally between the squeeze force of welding condition designated in Spot Welding executed last or squeeze force designated as R211.
- A GUN is not working when squeeze force is low too much.
- It is not working when Large/Small open is inputted simultaneously.
- Program playback is not allowed in case external signal is inputted.
- Spot Welding Function should be recorded as the first function of step. If you record it by one-touch record function, consumption offset is performed correctly.
- In case of recording or adjusting welding point, apply low squeeze force to prevent the object from distortion. The step recorded in the state of distortion applies welding as distorted state during playback. Therefore, you should be careful about it.
- When adjusting the SPOT command step, it is adjusted as the position considering consumption automatically. However, other steps are recorded without considering consumption.
- When writing GUNSEA Program, record a GUNSEA1 and then record a GUNSEA2 with GUN Open. (about 5mm).
- You should execute the GUNSEA program after recording GUNSEA reference position.

1.1. What is SERVO GUN?

This is an equipment for SPOT welding. And the process is transferring the turning effect of servo motor to ball screw and then working GUN TIP. In the process, the SERVO GUN axis is controlled by the Additional Axis of the Robot.

1.2. The merits of SERVO GUN

- Improve welding quality
- Shorten CYCLE TIME
- Improve factory environment (Reduce noise, & Welding SPATTER)

1.3. Comparing AIR GUN/SERVO GUN

Table 1-1 AIR GUN/SERVO GUN Comparison

Div.	AIR GUN	SERVO GUN
Squeeze force Source	AIR Pressure	SERVO MOTOR Current
TIP consumption Offset	Impossible	Possible
Squeeze force Adjustment	Impossible	Possible
Welding Quality	Regular	Good
Working Noise	Occurred	Not occurred
Tip Gap Adjustment	Impossible	Possible

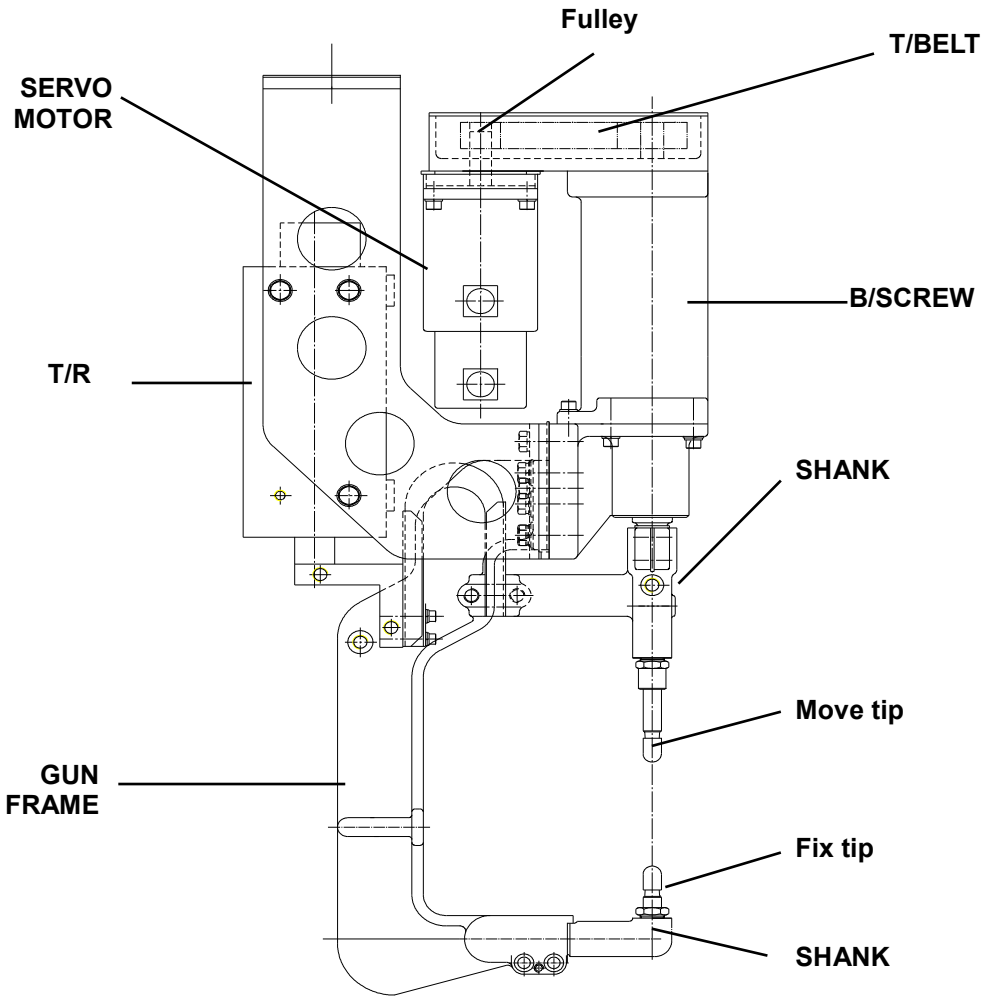
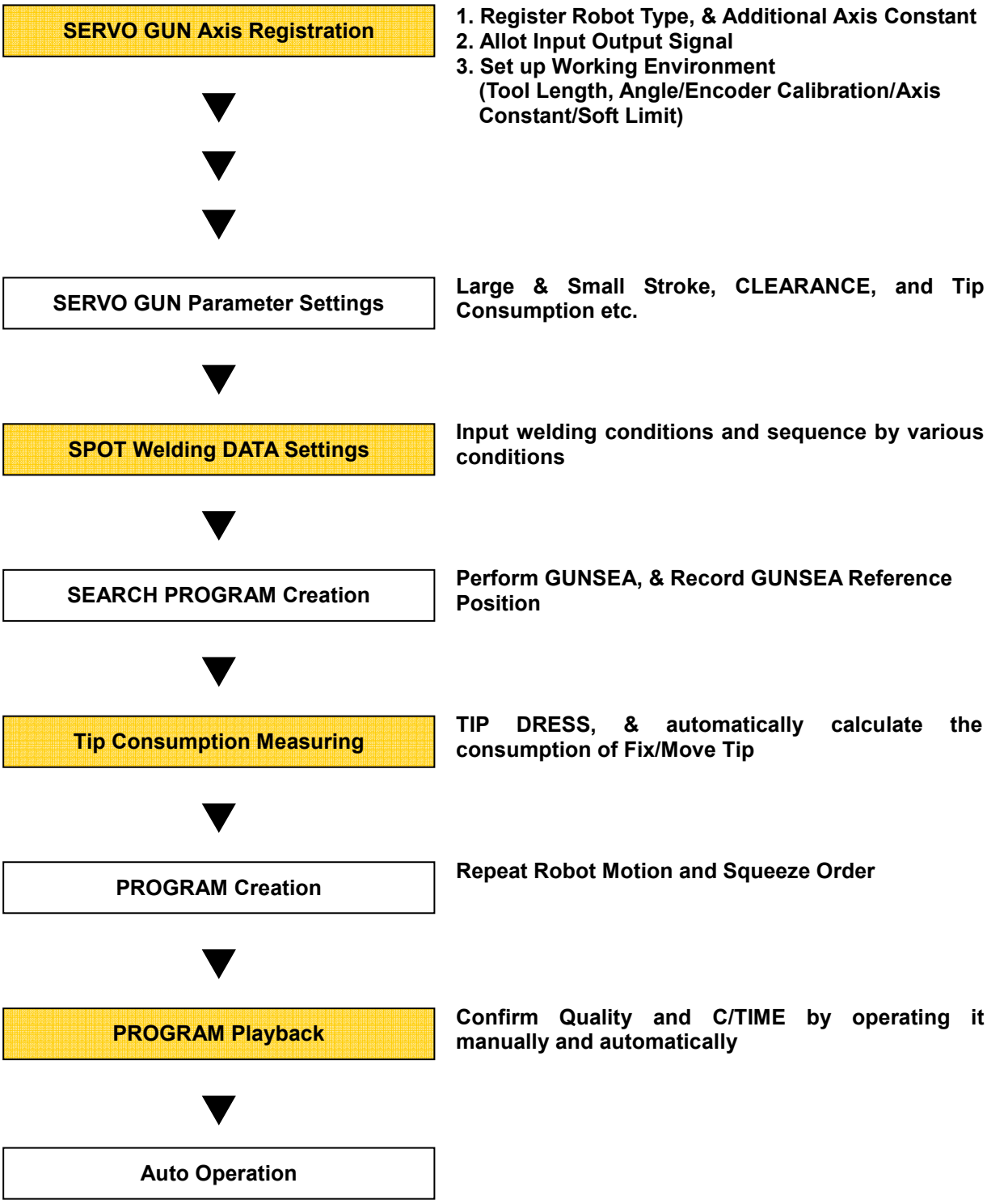


Figure 1.1 SERVO GUN Outline

1.4. SERVO GUN Control Flow



1.5. Getting started with SERVO GUN Operation

Hi4a Control Training Course is required before operating SERVO GUN.
For not qualified operators, basic items needed to SERVO GUN Operation are mentioned.

- Hi4a Control Flow Chart
- Teach Pendant
- Menu Tree

1.5.1. Hi4a Operation Flow Chart

Table 1-2 Hi4a Operation Flow Chart

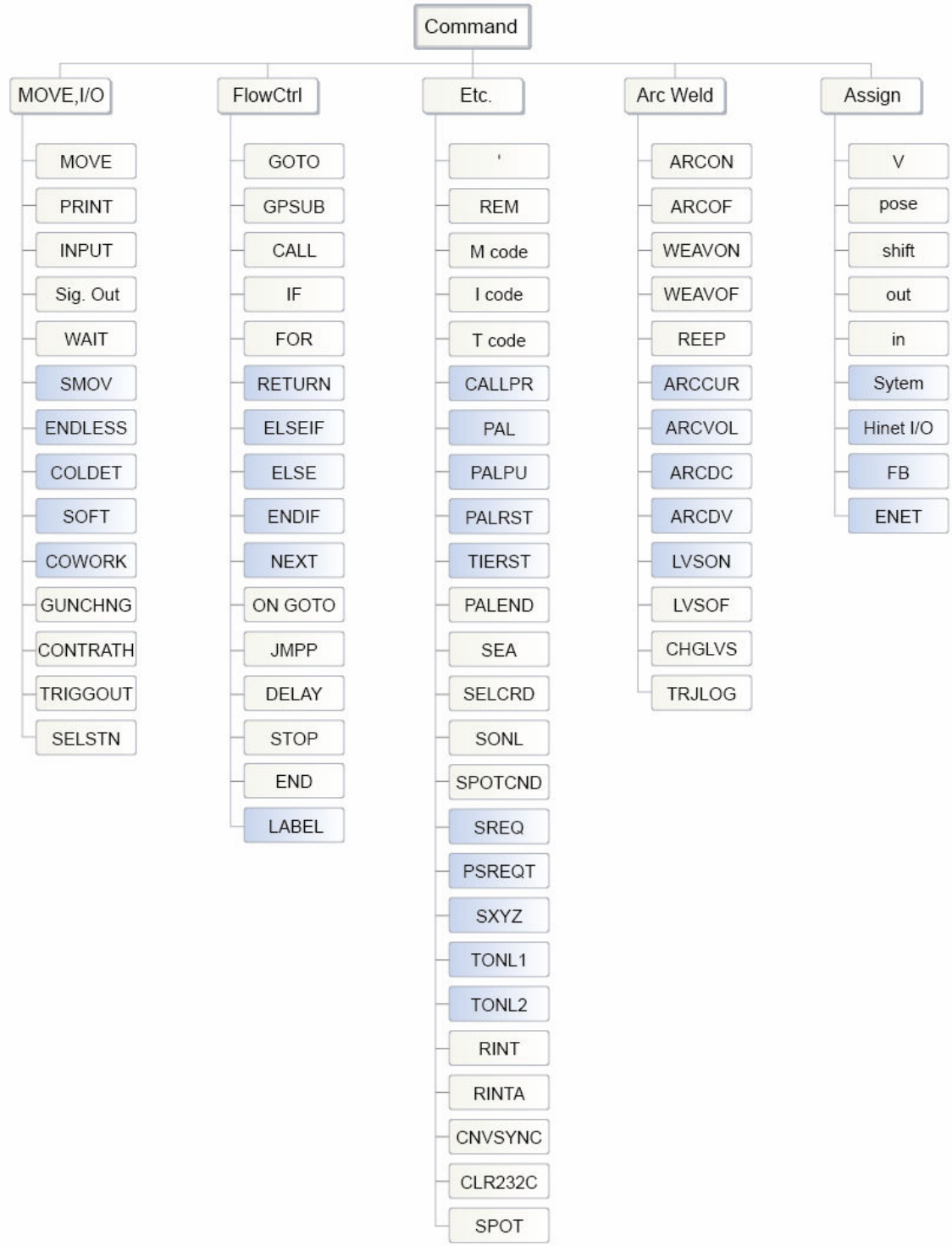
Service		1 Monitoring	5 File Manager
Manual	1. Monitoring	0. Monitor OFF	1. Show file names in memory
Auto	2. Register setting	1. Axis data	2. Show the headline of program
	3. Variables	2. DIO Signal	3. Show the number of axes for Prog.
	4. Program modify	3. Spot/Stud Welding data	4. Rename
	5. File Manager	4. Conveyor data	5. Copy
	6. Program Conversion	5. Palletize data	6. Delete
	7. System checking	6. PLC Relay data	7. Protect
	8. Date Setting(Day,Time)	7. Analog data	8. Storage media format
		9. Servo hand data	9. Save/load all files. (SRAM card)
		10. Cooperation control data	
		11. System characteristic data	
		12. Input Signal Of Digital Arc Welder	
System		1 User parameter	2 Controller parameter
Manual	1. User parameter	1. Lang1uage	1. Setting input & output signal
	2. Controller parameter	2. Pose REC type	2. Serial ports
	3. Machine parameter	3. Robot start type	3. Robot ready
	4. Application Parameter	4. Cursor Change on AutoMode	4. Registration of home position
	5. Initialize	5. Confirm delete command	5. Return to the previous position
	6. Automatic constant setting	6. WAIT(DI/WI) release	6. End relay timer
		7. Separation of T/P	7. Interlock timer
		8. Power failure detection	8. Error-output to the outside
		9. External program select	9. Power saving : PWM Off
		10. Program strobe signal use	10. Shift limit
		12. Cursor Max. line ratio	11. f-key setting
		13. Collision sensor	12. Coordinate setting
		14. FIFO Function	13. Reserve program setting
		15. Ext-update PBack prog	14. Network
		16. When STOP,manual operat'g	15. Gain change at low speed
		17.Make prog. diagnosis file	17. Position error checking in waiting
		18. Record for servogun open	18. MODBUS environment setting
			19. Register License key
		4 Application parameter	3 Machine parameter
		1. Spot & Stud	1. Tool data
		2. Arc	2. Axis constant
		3. Palletizing	3. Softlimit
		6. Conveyor	4. Arm Interference angle
		7. Volt. output proportional to speed	5. Setting encoder offset
		8. Independent positioner control	6. Accel & Decel parameters
		9: Cube interference prevention	7. B Axis dead zone
CondSet	1. Cycle type		8. Accuracy
Manual	2. Step go/back max.speed(mm/s)		9. Speed
Auto	3. Func in step GO/BACK		11. Additional weight on each axis
	4. Speed rate		13. Collision detection setting
	5. Robot lock		14 .Soft floating
	6. Rec speed type		16. Set reduce holding current
	7. Interpolation base		17. Jog inching level setting
	8. Select user coordinate		18. Variable accel decel parameter

1.5.2. Teach Pendant

Figure 1.2 Teach Pendant Outline

1.5.3. Menu Tree

Table 1-3 Menu Tree



2

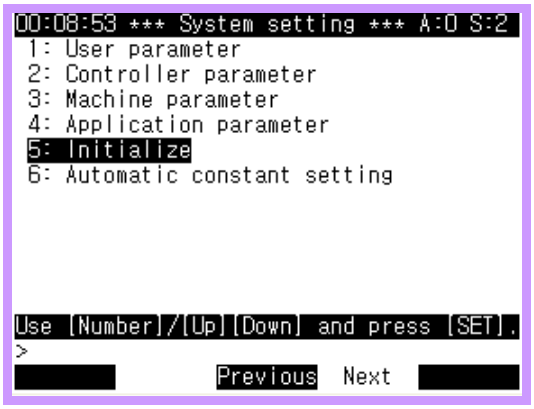
Registering SERVO GUN Axis

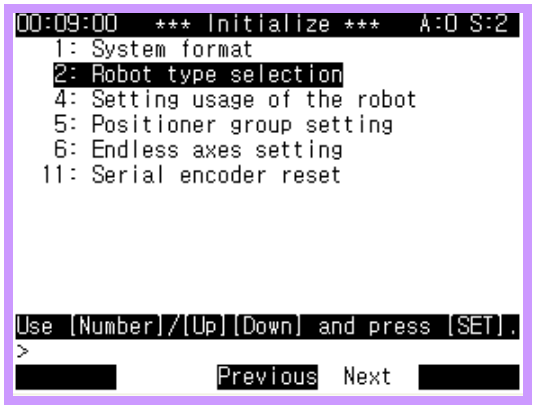
2.1. Registering Robot Type & Additional-Axis Constant

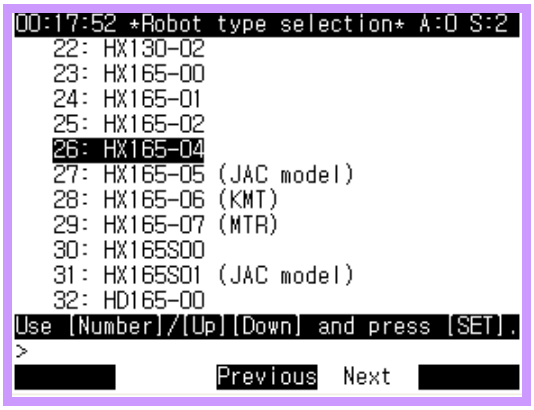
2.1.1. Robot Type & Additional-Axis Settings

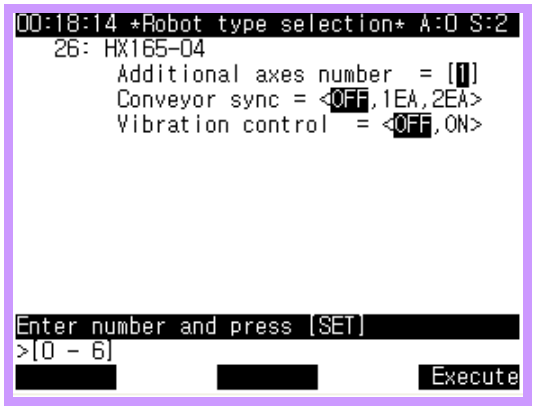
This is set up by test operator in the process of testing operation after installing Robot.

(1) 『[PF2]: System』 → 『5: Initialize』 → 『2: Robot type selection』 and then press [SET] key.

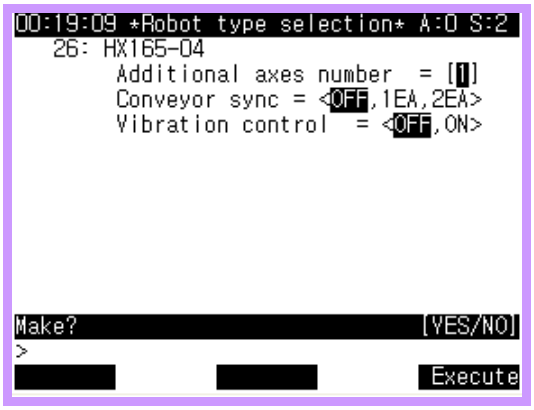


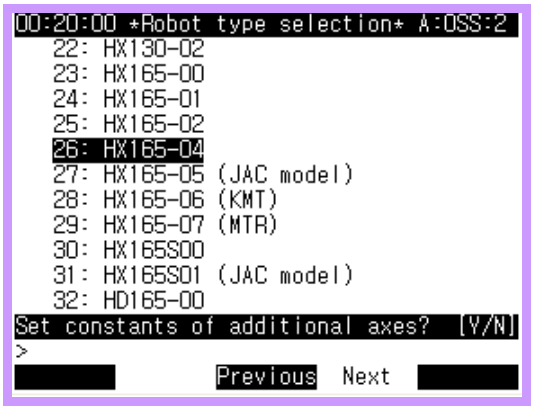






(2) Input the number of additional-axes and press 『[PF5]: Execute』 key. And then below message appears.

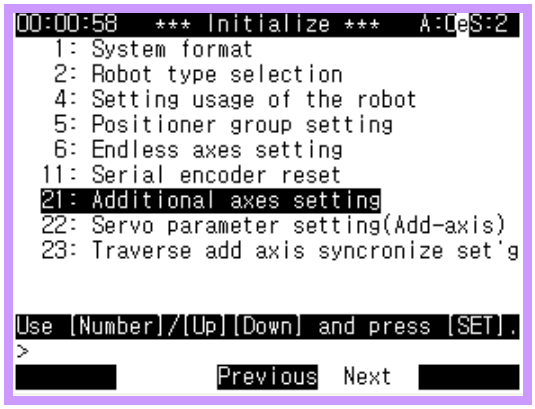




(3) Pressing 『Yes』, item (2) screen of 2.1.2 is appeared instantly and in case of 『Yes』, it doesn't need to set up item 2.1.2 optionally.

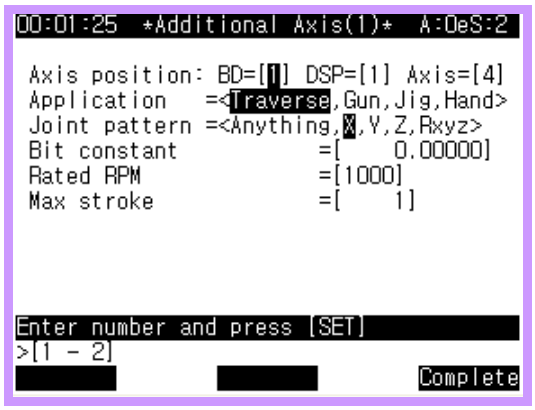
2.1.2. Additional axes setting

(1) Select 『[PF2]: System』 → 『5: Initialize』 → 『21: Additional axes setting』



※In case of being possible to select above items,
- ■ Input Engineer code(R314) on manual mode
- ■ Motors off condition
- ■ In case Additional-Axis is existed

(2) Set up Additional Axis Constant. (Total Additional-Axes are max 6 axes (SERVO GUN Axes are max 2 axes.))



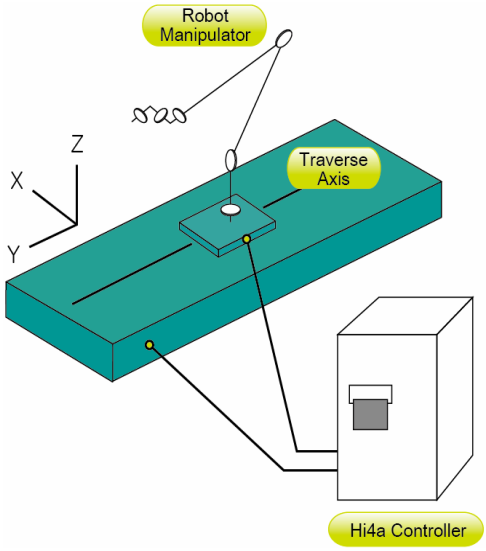
Reference

◆【Additional-Axis Constant Explanation 】◆

① Axis position
Users can use it by designating physical configuration of Additional-Axis.
BD =[1](1~2) => Designate the number of BD440 Board.(2DSP/1Board)
DSP =[1](1~2) => Save the number of DSP in BD440 Board.(4 Axis/1DSP)
Axis=[4](1~4) => Designate Axis No.

Ex) In case of designating it as 1,1,4 to set up 7th Additional-Axis,
Basic axis 6 axis – Main 3 axis (1st BD440, 1st DSP, 1~3 axis)
Wrist 3 axis (1st BD440, 2nd DSP, 1~3 axis)
Additional 1 axis (1st BD440, 1st DSP, 4th axis)

② Application
Select a kind of Additional-Axis between <Traverse, GUN, JIG,Hand>.
When deciding Additional-Axis spec. , you should follow Traverse → GUN → JIG → Hand followed by logical Additional-Axis order.



③ Gun Change
Select the number of gun change <DSBL, 1, 2, 4, 6, 8>.
In case of GUN axis, you can select whether use of servo-gun change function or not. If you select DSBL, servo-gun change function will not be activated. Or you might select the number of changeable guns.

④ Bit constant [-9999.99999 ~ 9999.9999] :
Register moving quantity according to Encoder pulse process of 10000bit.
Register rotation axis as deg/10000bit, and direct-acting axis as mm/10000bit.

Encoder pulse per 1 rotation used inside Hi4a controller is fixed as 8192bit.

Please refer to below example.
However, the code of value is fixed as below.
In case forward direction of motor is correspond with the rotation direction of speed reducer, fix it as “+” if coordinate value is increased, and reversely fix it as “-“ if coordinate value is decreased.

Ex 1) If this is the rotation axis using 1/100 speed reducer only,
the axis rotates 360deg by 100 rotations of motor.
Therefore Bit Constant = 360[deg] / (100[rev] X 8192[bit]/[rev]) X 10000[bit] = 4,39453

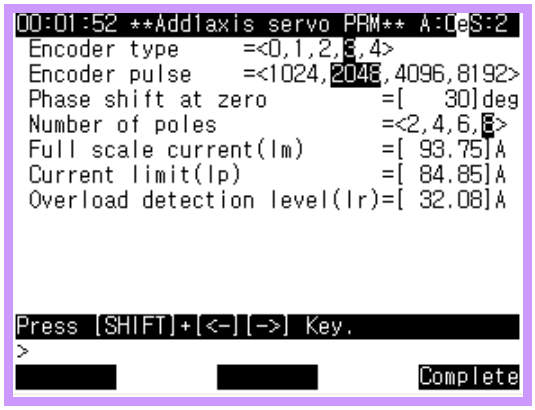
Ex 2) If it is the direct-acting axis using 1/20 speed reducer and rack pinion of PCD 110mm,
110xPhi(=3.14159)[mm] is moved by 20 rotation of motor.
Bit Constant = 110xPhi[mm] / (20[rev] x 8192[bit]/[rev]) X 10000[bit] = 21.09223

Ex 3) If it is the direct-acting axis using speed reducer and ball screw of Lead 5mm,
The axis moves 5mm by 5 rotation of motor.
Therefore, Bit Constant = 5[mm] / (5[rev] × 8192[bit/rev]) = 1.22070

⑤ Rated RPM [1000 - 5000] :
Fix rotation speed of motor used in Additional-Axis. Decide it in the range of not exceeding nominal speed of motor. By the speed and bit constant, max speed of additional axis is set up automatically in 『[PF2]: System』 → 『3: Machine Parameter』 → 『6: Accel & Decel parameters』.
It is possible to change the speed of axis directly in Accel & Decel Parameters menu.
However, users should reset accelerating time and decelerating rate in the process of system tuning because accel/decelerating time is designated by minimum value.

⑥ Max. Stroke [1 - 30000] :
This is the information to set up Robot valid moving region (Additional-Axis soft limit) of 『[PF2]: System』 → 『3: Machine Parameter』 → 『3: Softimit』automatically.

(3) Press 『[PF5]: Complete』key for closing input. And set up Servo Parameter of Additional-Axis.



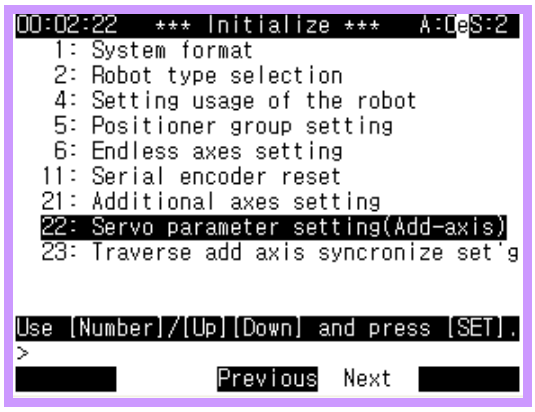
※ Please refer to Clause 2.1.3 for further information.

(4) Press 『[PF5]: Complete』key for closing input.
After inputting complete key, press 『YES』key to save.

2.1.3. Servo Parameter Setting

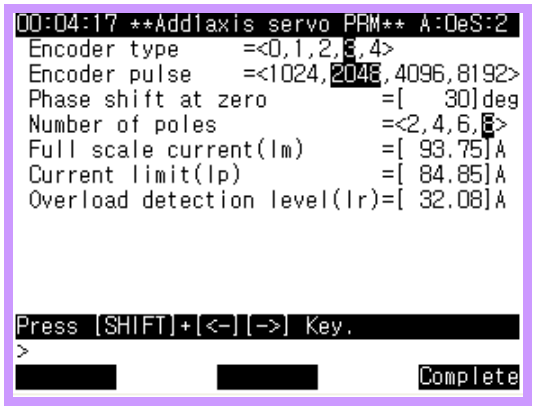
Set up Servo Parameter to fit Additional-Axis driving condition (Servo Loop Control).
There are two methods for settings. Firstly, referring motor spec., users collect information without calculation process and then input it easily. Secondly, obeying Servo Parameter form, input method(Attachment - Additional-Axis Servo Parameter Separate Settings) is followed by the calculation of users. This is the first method as below,

(1) After completing Additional-Axis constant settings, select『[PF2]: System』 → 『5: Initialize』 → 『22: Servo Parameter Setting(Add-Axis)』.



※ To select item 22,
- ■ Input Engineer code (R314) on Teach Mode.
- ■ Motors off
- ■ Additional-Axis is existed.

(2) Set up Additional-Axis Servo Parameter.(Max 6 Axes)



(3) When closing input, press 『[PF5]: Complete』 key.

◆【Additional-Axis Servo Parameter Explanation】◆

- Please use it for reference only because written as Commonly below the explanation can be changed by manufactures.
- After setting up each items, followed by load state 『[PF2]: System』 → 『3: Machine Parameter』 → 『6: Accel & Decel parameters』 → Accel/decelerating information, 『[PF2]: Service』 → 『3. Machine parameter』 → 『12: Servo Parameter Setting』 → 『1: Servo Loop Gain』 → Use it adjusting Position Loop Proportional Gain(Kp) of and Speed Loop Proportional Gain (Kv).

① Encoder Type
0 : Yaskawa, 1 : Tamakawa, 2 : Panasonic, 3 : PanasonicCompact
In Hi4a controller, it corresponds with absolute value encoder only.
Currently the encoder of motor used in our mass production(MP) model robot corresponds to 『3 : PanasonicCompact』.
Motors are supplied by Tamagawa is supplied to our company mounting the encoder of 『3 : PanasonicCompact』 Type.

② Encoder Pulse
< 1024, 2048, 4096, 8192 >
This is the number of Incremental Purse outputted by the encoder per motor 1 rotation.
Setting up the encoder pulse outputted by motor, the inside of Hi4a controller calculates it by converting all encoders to 8192 pulse automatically. Therefore, when calculating Additional-Axis Bit Constant, it is always calculated in the basis of 8192 pulse regardless of encoder pulse setting value.
Commonly Yaskawa 12bit Encoder is 1024, Yaskawa 15bit Encoder is 8192, Panasonic is 2048, and Tamakawa is 4096.
Currently the encoder of motor used by our MP model robot same as encoder type is 2048 pulse, and motors supplied by Tamagawa are supplied by mounting encoder of 2048 pulse.

③ Phase shift at zero
θ [deg]
Input current phase angle at encoder zero point.
Commonly Yaskawa & Tamakawa are 0, and Panasonic is 30.
Current phase angle at encoder zero point of the motors used by our MP model robot currently same as encoder type is 30deg, and motors supplied by Tamagawa are supplied by fitting in the phase angle of 30 deg.

④ Number of poles
< 2, 4, 6, 8 >
Input the number of motor pole.
Currently the number of motor pole used by our MP model robot is 8 pole.

⑤ Full Scale Current
Im [Apeak]
This is the current value corresponded to full scale of current variable(torque command) when calculating S/W Servo Controller. Full Scale Current Value is saved by Formula 1) and it is changed by Shut Resistance and Hall Sensor Output Spec.

$$Fullscale\ \ Current = Current\ value\ in\ case\ of\ \ current\ \ feedback\ Voltage\ 8Volt \times \frac{7.5}{8}$$ --- Formula 1)

AMP Model	Hall Sensor Signs (Specifications)	Shunt Resistance Sign (Resistance Value)	Full Scale Current(Im)	Usable IPM (rated Current)
Large-sized 6Axis /Additional-Axis AMP	0 (4V/75A)		**140.62Apeak**	PM150CSD060 (150A)
	1 (4V/50A)		**93.75Apeak**	PM150CSD060 (150A) PM100CSD060 (100A) PM75CSD060 (75A)
	2 (4V/25A)		**46.87Apeak**	
	3 (4V/15A)		**28.12Apeak**	
	4 (4V/10A)		**18.75Apeak**	
	5 (4V/5A)		**9.37Apeak**	
Medium-sized 6 Axis /Additional-Axis AMP		1 (2mΩ)	**93.75Apeak**	PM100CSD060 (100A) PM75CSD060 (75A)
		2 (4mΩ)	**46.87Apeak**	
		3 (8mΩ)	**23.44Apeak**	
		4 (12mΩ)	**15.58Apeak**	
		5 (16mΩ)	**11.72Apeak**	
Small-sized 6 Axis /Additional-Axis AMP	1 (4V/15A)		**28.12Apeak**	PM30CSJ060(30A)
	2 (4V/10A)		**18.75Apeak**	PM30CSJ060(30A)
	3 (4V/5A)		**9.37Apeak**	PM30CSJ060(30A) PM10CSJ060(10A)

⑥ Current limit
Ip [Apeak]
This means Motor Output Max. Current. The setting of current limit value sets up necessary current value from motor to satisfy working spec of applied equipment. Available range for setting should satisfy three conditions as below, and for improvement of control performance, set up to use Full Scale Current nearby as possible as it can.

Condition 1) Within Instantaneous Max. Current on Motor Catalog
Condition 2) Within AMP Max. Output Current
Condition 3) Full Scale Current(Im) 97%≥ Current Limit (Ip)≥ Full Scale Current(Im) 40%

※ AMP Max./Continuous Output Current(IPM Max. rated)

AMPMax. Output Current is limited as Formula 2) by the rated of use IPM. Also for the continuously used current, the range of use calculated through the evaluation test with the junction temperature within the permitted range by the heating condition of IPM (Heat sink, forced cooling etc.) and operating condition (Switching loss, on resistance etc.), is about within 60% of the rated current of IPM.

However, instantaneous Max. Output of Large-sized AMP is limited as allowable current of below table related to the structure of AMP regardless of Formula 2).

$$IPM\ Rated\ Current \geq MaxCurrent \times 1.1(10\%\ margin\ of\ Current)$$---------- Formula 2)

IPM Type	Rated Current[Sign]	Item	Allowable Current(Apeak)	Use Model
PM150CSD060	150A [L]	**AMP Max. OutputCurrent**	**125**	Large-sized 6 Axis AMP
		AMP Continuous OutputCurrent	**60**	
PM100CSD060	100A [X]	**AMP Max. OutputCurrent**	**90.9**	Large-sized 6 Axis AMP, medium-sized 6 Axis AMP, Large-sized Additional-Axis medium-sized Additional-Axis
		AMP Continuous OutputCurrent	**60**	
PM75CSD060	75A [Y]	**AMP Max. OutputCurrent**	**68.18**	
		AMP Continuous OutputCurrent	**45**	
PM30CSJ060	30A [A]	**AMP Max. OutputCurrent**	**27.27**	Small-sized 6 Axis AMP, Small-sized Additional-Axis
		AMP Continuous OutputCurrent	**18**	
PM10CSJ060	10A [D]	**AMP Max. OutputCurrent**	**9.09**	
		AMP Continuous OutputCurrent	**6**	

■ The case below 40% of Full Scale Current(Im) corresponds with changing Shunt Resistance/ Hall Sensor.

AMP Model	IPM Sign	Hall Sensor/ Shunt Resistance Sign	Available Range for Current Limit Settings (Apeak)
Large-sized 6 Axis/ Additional-Axis AMP	L	0	125 ~ 70.31
	L,X	1	90.90 ~ 37.50
	Y		68.18 ~ 37.50
	L,X,Y	2	45.46 ~ 18.75
	L,X,Y	3	27.27~11.25
	L,X,Y	4	18.19~7.50
	L,X,Y	5	9.08 ~ 3.75
medium-sized 6 Axis / Additional-Axis AMP	X	1	90.90 ~ 37.50
	Y		68.18 ~ 37.50
	X,Y	2	45.46 ~ 18.75
	X,Y	3	22.75 ~9.38
	X,Y	4	15.11~6.23
	X,Y	5	11.37~4.69
Small-sized 6 Axis / Additional-Axis AMP	A	1	27.27~11.25
	A	2	18.19~7.50
	A,D	3	9.08 ~ 3.75

⑦ Overload detection level
Is [Apeak]
This means Motor Output Continuous Current. The setting of overload detecting level sets up current value corresponded by calculating or measuring Trms(Max. Load, Max. Speed, torque mean value of Max. repeat working pattern). Available range for setting should satisfy below two conditions.

Condition **1)** Within rated Current on **Motor Catalog**
Condition **2)** Within **AMP** Continuous OutputCurrent

◆ 【ATTENTION】 ◆

- When setting up Traverse axis and Gun axis at the same time, please register Additional-Axis in order as first Traverse axis and then SERVO GUN axis.
- In case of setting up JIG axis, please register Additional-Axis in order as first Traverse axis, second SERVO GUN axis and then JIG axis.
- Additional-Axis can register Max. 6 axis.
- SERVO GUN Axis can register Max. 2 axis.

This is examples for setting up Additional-Axis.

Ex 1] In case of setting up Gun Axis:

Additional-Axis	Axis Spec.	Gun No.
The 1st Axis	GUN	1

[Ex 2] Traverse Axis + Gun Axis

Additional-Axis	Axis Spec.	Gun No.
The 1st Axis	Traverse	-
The 2nd Axis	GUN	1

[Ex 3] Traverse Axis + Gun 2 Axis

Additional-Axis	Axis Spec.	Gun No.
The 1st Axis	Traverse	-
The 2nd Axis	GUN	1
The 3rd Axis	GUN	2

[Ex 4] Traverse Axis + Gun 2 Axis + JIG 2 Axis

Additional-Axis	Axis Spec.	Gun No.
The 1st Axis	Traverse	-
The 2nd Axis	GUN	1
The 3rd Axis	GUN	2
The 4th Axis	JIG	-
The 5th Axis	JIG	-

2.2. Assigning Input Output Signal

■ 『[PF2]: System』 → 『2: Controller parameter』 → 『1:Setting input & output signal』 → Assign input output signal.

2.2.1. Input Signal

■ 『[PF2]: System』 → 『2: Controller parameter』 → 『1:Setting input & output signal』 → 『7: Input signal assigning』 → Input signal.

Below input signal is used for a SERVO GUN.

(1) WI (Welding complete)
Default value is assigned for the number of signal corresponded to Gun1.

(2) Weld stick of a spot gun
This is the assigned number when processing it receiving sticking of weld signal of a Gun. It can be used for both a Air Gun and a SERVO GUN.

(3) Consumption reset(move-tip)
Use it when resetting consumption of the moving tip by external input signal.

(4) Consumption reset(fix-tip)
Use it when resetting consumption of the fixed tip by external input signal.

(5) Servo gun large open
This is used for moving SERVO GUN to Large Open position in auto mode by external input signal.

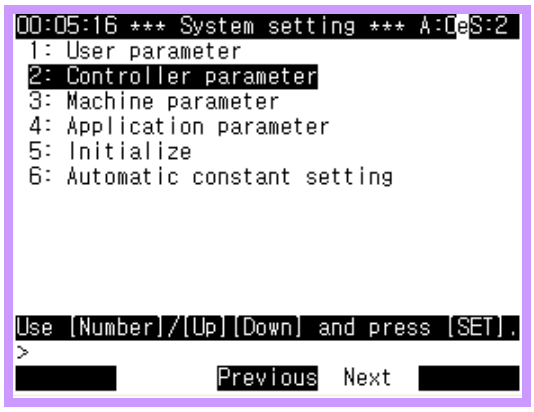
(6) Servo gun small open
This is used for moving SERVO GUN to small open position in auto mode by external input signal.

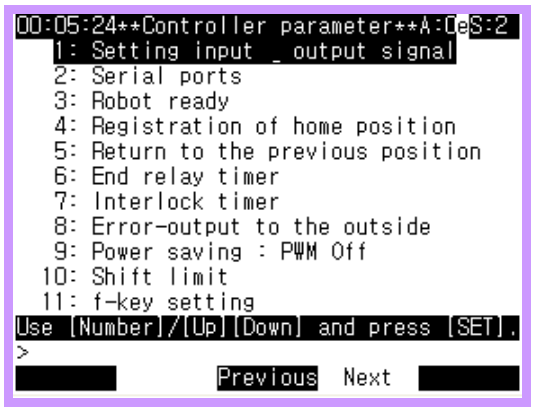
(7) Welding system error
This is used when halting the working of robot in case of the abnormal of welder is inputted.

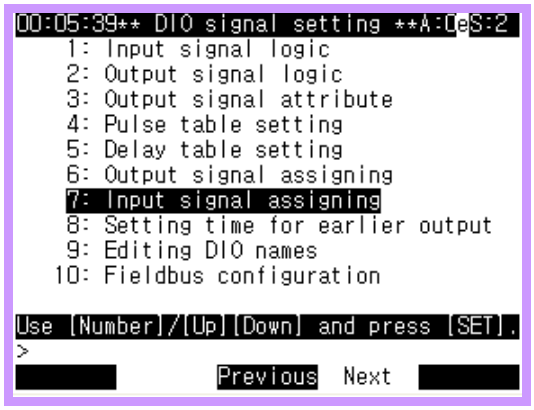
2.2.2. How to assign Input Signals

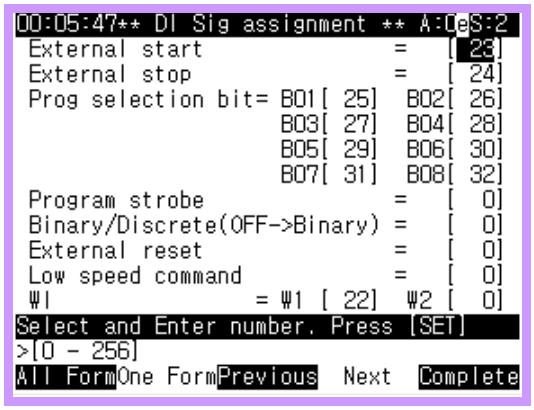
(1) 『[PF2]: System』 → 『2: Controller parameter』 → 『1:Setting input & output signal』 → 『7: Input signal assigning』

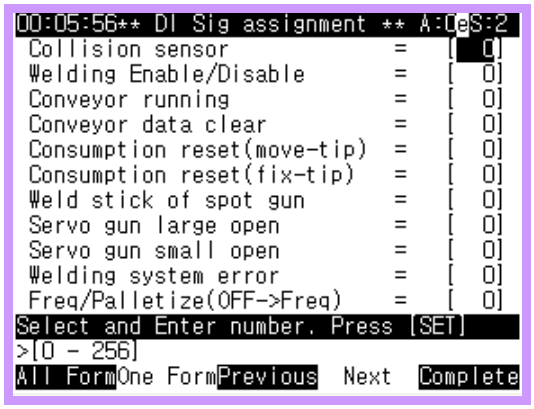
(2) Pressing 『[PF4]: Next』 key, below screen appears.

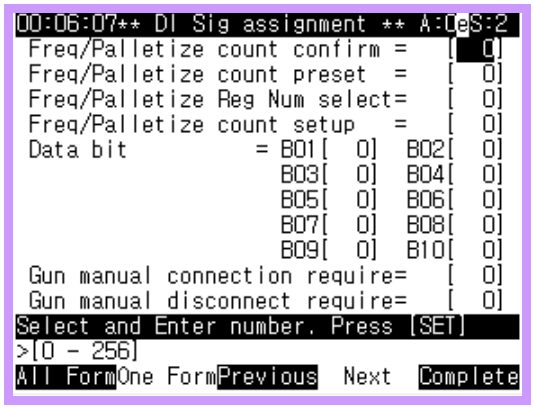












(3) After inputting values, press [SET] key.

(4) When closing settings, press 『[PF5]: Complete』 key.

◆ 【ATTENTION】 ◆

- When welder abnormal signal is inputted, SPOT step is not processed though WI signal is inputted.

2.2.3. Output Signal

■ 『[PF2]: System』 → 『2: Controller parameter』 → 『1: Setting input & output signal』 → 『6: Output signal assigning』 → Assign output sign.

Below output signal is used for SERVO GUNs.

(1) WELDg Cond output
Assign the number of signal to output for welding condition of SPOT command. Assigning welding condition signal of Max. 8 bit up to B01 ~ B08, you can set up welding condition number of Max.256.
In case of setting up 2 units of SERVO GUN, you should set up each <<GUN1>> and <<GUN2>>.

(2) Servo gun squeezing
Assign the signal to be ON when starting squeeze as SPOT command is executed and to be OFF on Open Start.

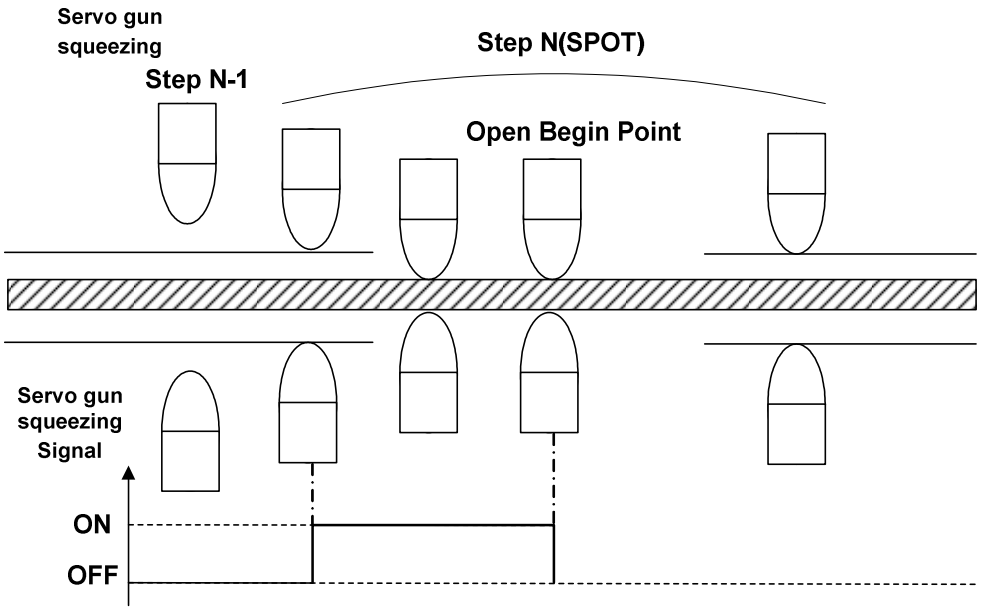


Figure 2.1 Signal Output Timing on pressing

(3) Servo gun searching
After ON is done when starting squeeze as GUNSEA command is executed, assign the signal to be OFF on Open Start.

(4) Tip consumption alarm
In case consumption detected by GUNSEA is bigger than Tip Change Consumption, assigned signal is ON here. When turning this signal OFF, please follow below operation.

☞ After changing Tip, make monitor consumption smaller than Tip Change Consumption with Tip Consumption Preset(R212, R213).
☞ Inputting [Reset]+[Set], turn OFF the signal.
☞ Perform Consumption Reset by external input signal.

(5) Welding command
When performing SPOT command, it is ON when starting welding by designated welding sequence and it is OFF when finishing welding.

(6) Servo gun output method(Wd-On)
On condition setting menu, “Spot Welding Output Type” of application condition can be set between Wd-On/ Sq-On/ Sq-Off. Therefore, this is used when the signal is assigned to be output only in case of being set up as Wd-On.

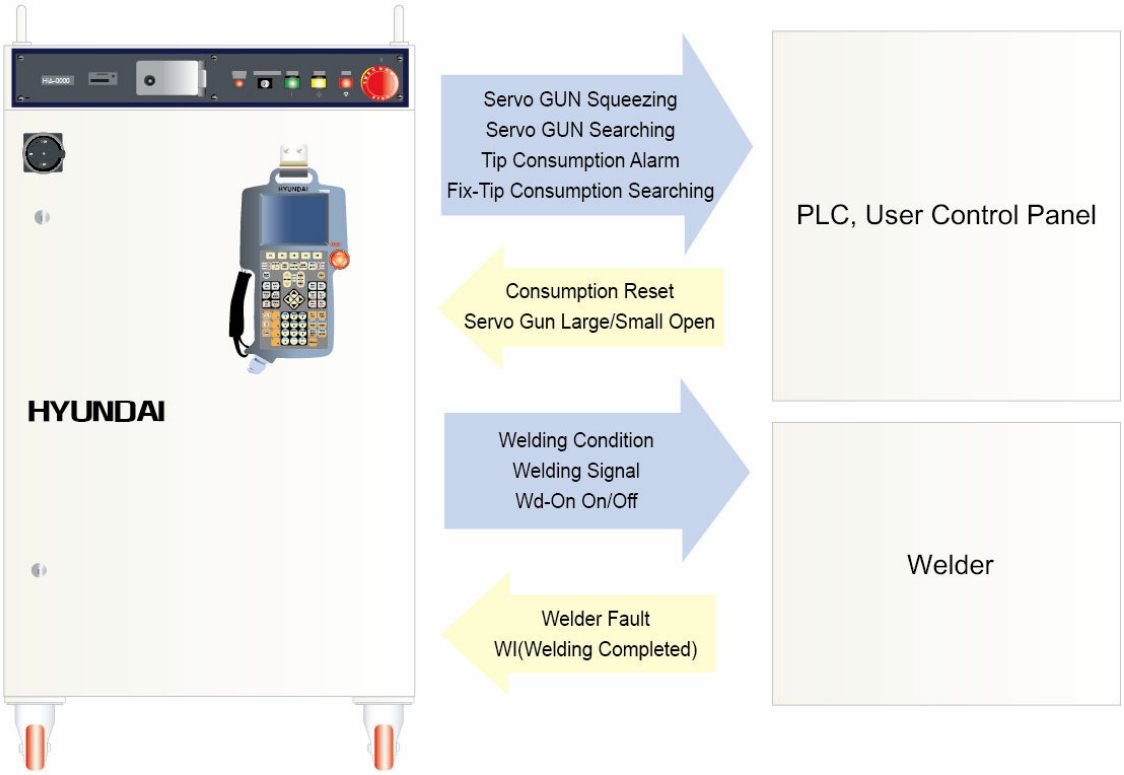
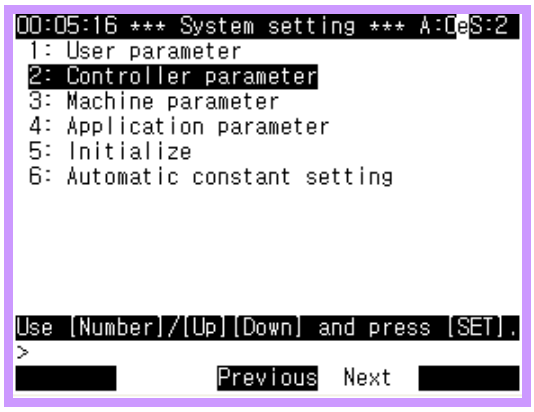


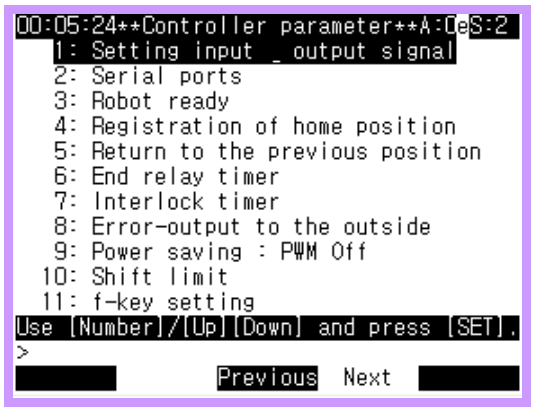
Figure 2.2 SERVO GUN Input Output Signal of Controller

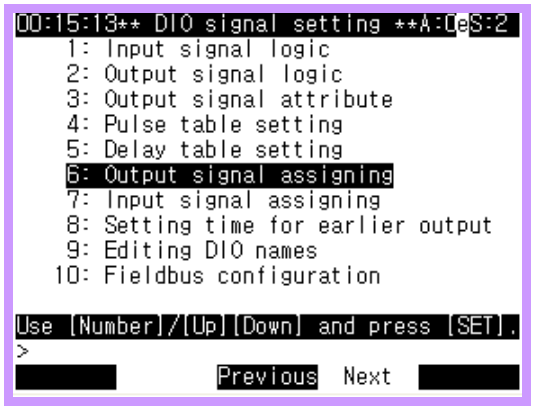
2.2.4. How to assign Output Signals

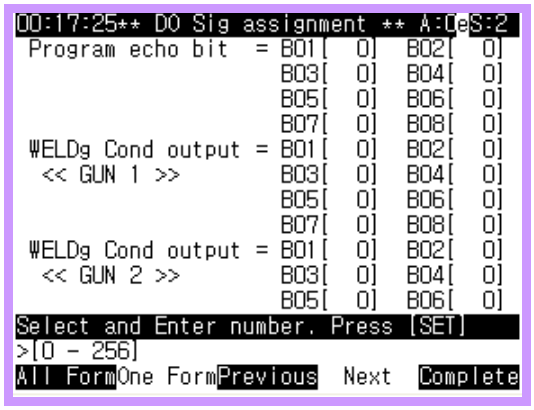
(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『1: Setting input & output signal』 → 『6: Output signal assigning』.

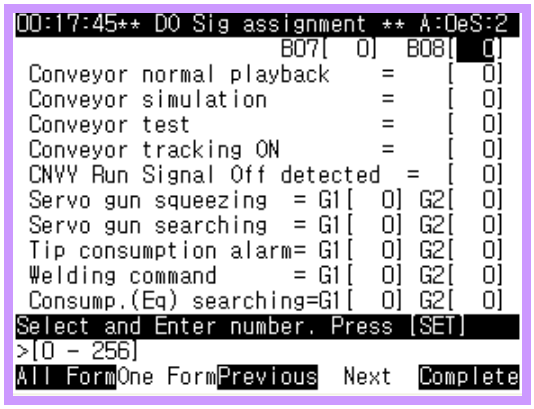
(2) Appear below screen by pressing 『[PF4]: Next』 key.

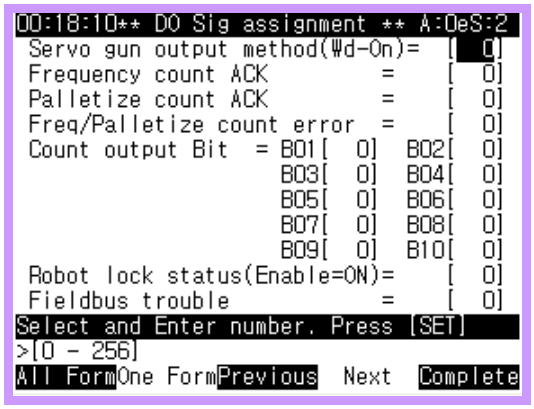












(3) Press [SET] key after inputting numbers.

(4) Press 『[PF5]: Complete』 key for completing settings.

2.3. Working Environment Settings

2.3.1. Tool Length & Angle Settings

Set up the length and angle of SERVO GUN.

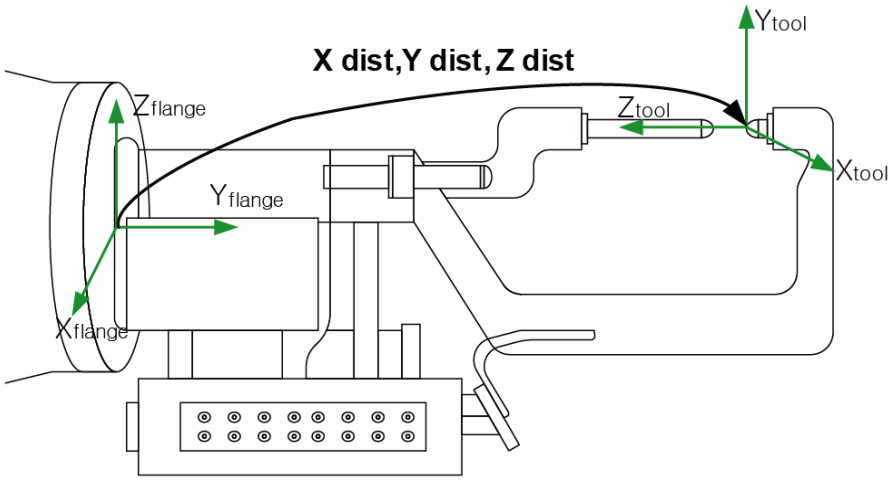


Figure 2.3 Tool length and angle settings of SERVO GUN

Refer to 『Hi4a Controller Operation Manual-Tool Data』 for setting method of tool length and angle.

(1) Tool Length
Input the length from Robot R1 Axis Flange center to Tool nose (upper part of Fix Tip) in the state of attaching new Tip which is not worn.
Put coordinate direction of standard Tool coordinate system of above picture as positive (+) and input measured length X,Y,Z values, or set up tool length using auto constant setting function.

(2) Tool angle
Input rotation angle (Rx,Ry,Rz) of 3 direction on the basis of flange coordinate system to use 『angle setting』 function.
Set up tool angle so that upper direction of Fix Tip goes to Z. To confirm it, put [coordinate system] LED of Teach Pendant and press [UP] key of jog key and then correspond it to Z+direction (squeeze direction of Fix Tip). In case it is same as above figure, set up tool angle as {X component, Y component, Z component } ={ 90deg, 0, 0}.

2.3.2. Encoder calibration(Position Rec)

- Offset zero point of encoder.
- Set up encoder value of SERVO GUN Axis to be 0x400000.
- Set up encoder zero point in the state of Max. open for common Move Tip.

2.3.3. Axis constant (Position record)

- Record reference position of Record SERVO GUN.
- Set up the position where Move Tip and Fix Tip are met each other. In the process, take care of Move Tip not to press Fix Tip. Large Stroke of SERVO GUN Parameter, Small Stroke, and distance and consumption Servo Gun Monitoring are calculated in the basis of the position of axis constant.

2.3.4. Soft Limit

Set up available motion region of robot.

It is set up by the stroke which is set up at 『**2.1.2 Additional axes setting**』. However, when it is needed, please change it. Please set up as Soft Limit of Open Direction is bigger than Large Stroke. For Soft Limit of squeeze direction, remove Tip, and operate Servo Gun Axis, and then set up the position in the region that interference with Servo Gun is not occurred.

◆ **【ATTENTION】** ◆

- In case of using Multi Gun (register 2 units for Servo Gun), input above data for each axis.
- In case of using Multi Gun, set up tool angle and length with care to correspond Tool No. to Gun No.

2.4. Glossary according to the movement between Tips

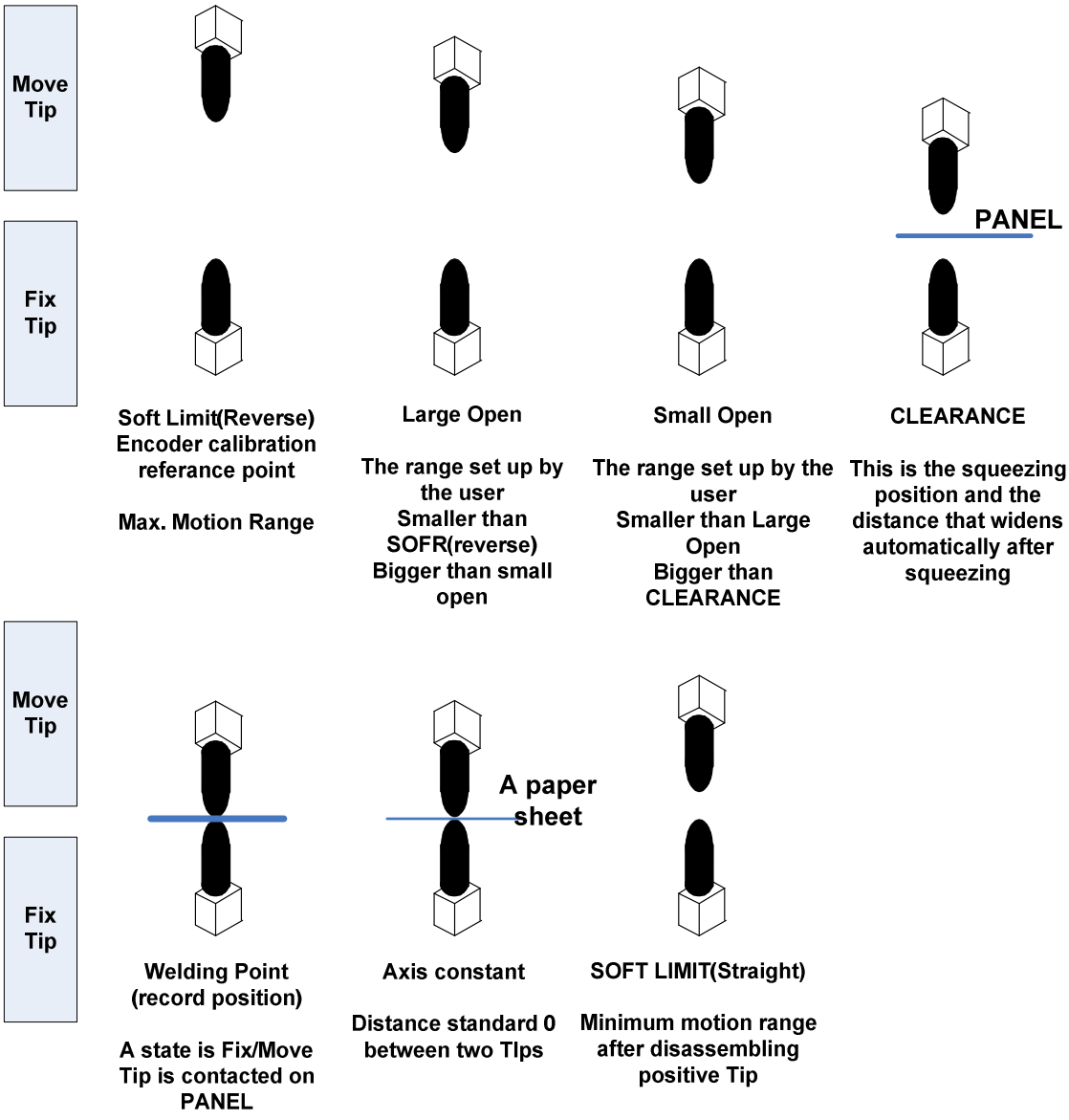


Figure 2.4 Glossary according to the movement between Tips

3

SERVO GUN Parameter Settings

Set up Parameter used by SERVO GUN. For initial registration, default value of SERVO GUN Parameter is not designated. Please use it changing setting value according to user's environment.

3.1. Parameter

(1) Large Stroke (mm)
In SERVO GUN Manual Open (SHIFT+f*) Motion and Servo Gun Large Open Operation by External Input Signal, designate the length that Move Tip and Fix Tip are open as Max.

(2) Small Stroke (mm)
In SERVO GUN Manual Open (SHIFT+f*) Motion and Servo Gun Small Open Operation by External Input Signal, designate the length that Move Tip and Fix Tip are close as Max.
Also, operating SERVO GUN Manual squeeze (SHIFT+f*), designate the length that Move Tip and Fix Tip are open as Max.

- SERVO GUN Manual Squeeze / 『[PF2]: System』 → 『2: Controller Parameter』 → 『11: f-key Setting』Menu for f key settings for manual opening/closing.

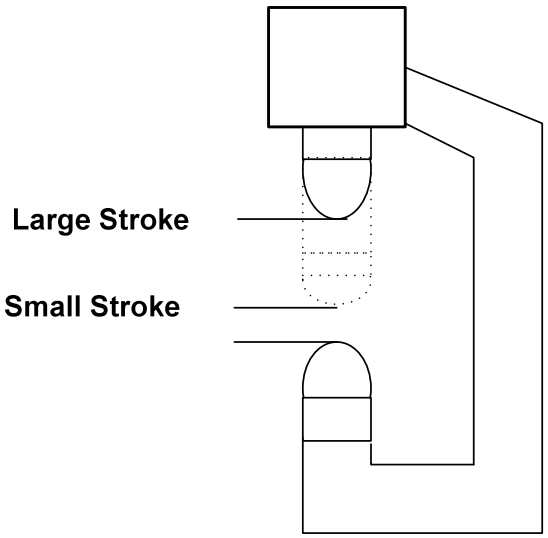


Figure 3.1 Large Stroke & Small Stroke

(3) Move Tip Clearance, Fix Tip Clearance (mm)
In case of regenerating Spot Welding Function (SPOT), it is operated as below Figure. Please refer to the playback of Spot Welding Function.
(In case of replaying Spot Welding Function (SPOT), it is operated as below Figure. Please refer to the playback of Spot Welding Function.

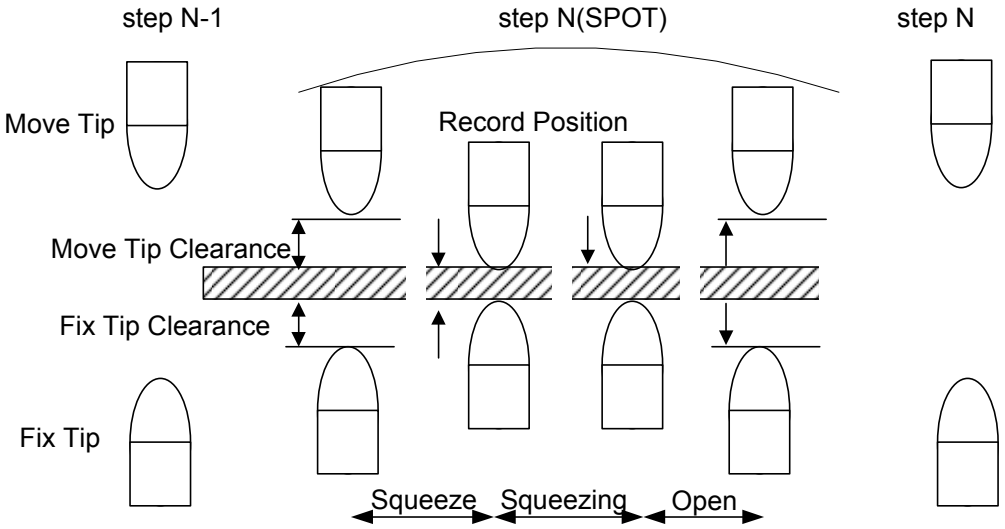


Figure 3.2 Move Tip Clearance, Fix Tip Clearance

① During the playback of welding step recording SPOT command, Move Tip from the position of previous step moves to the position offsetting the clearance distance of the Move Tip, and the Fix Tip from the position of previous step moves to the position offsetting the clearance distance of the Fix Tip.
② Move Tip and Fix Tip move to record positions of each steps.
③ Apply the squeeze as designated squeeze force.
④ Inputting Welding Complete(WI), each Move Tip and Fix Tip is open as much as Move Tip Clearance and Fix Tip Clearance.
⑤ Move to next step.

(4) Max tip consumption(mm)
Decide search range in case of using GUNSEA function. Two times value of The Max Tip Consumption. Tip Consumption is the range of GUNSEA. Also, in case previous Tip Consumption detected by GUNSEA excesses The Max Tip Consumption. Tip Consumption, display “E0154 Tip consumption exceeded maximum.” and halt playback. In case of being designated as 0mm, abnormal of consumption is not detected.

(5) Tip Change Consumption(mm)
In case the consumption detected by GUNSEA excesses Tip Change Consumption, display alarm message “W0105 Tip consumption exceeded limit!” and output tip consumption alarm signal, and then notify exchange of Tip. (In the process, do not halt the playback.) In case of being set as 0mm, the abnormal of consumption is not confirmed.

(6) Gun arm bent offset (mm)
The bending of Gun is occurred by the squeeze force while performing SERVO GUN Squeeze. To consider the bending of Gun, set up the amount of Gun Arm Bending and Gun Arm Bending Offset. Technically, the amount of Gun Arm being offset sets up the amount of the bending of Gun that pressure is 0.
Practically, the bending of Gun is not occurred if there is no pressure on Tip. However, this is Parameter to consider linearity within the range of the pressure used by Gun mainly. When playback Spot Welding Function, offset the positions of Move Tip and Fix Tip as much as the amount of this offset and then press it.

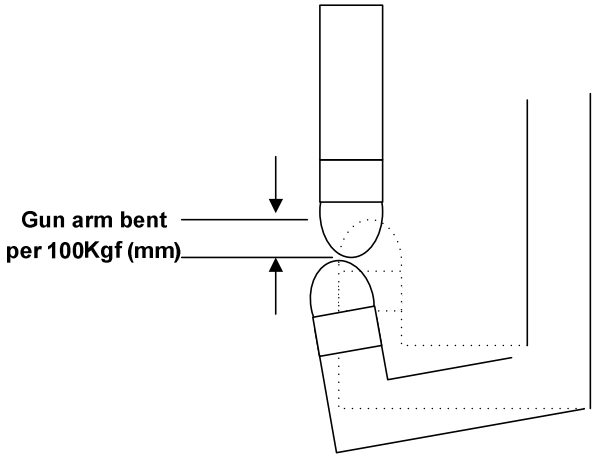


Figure 3.3 The amount of Gun Arm Bent

(7) Gun arm bent per 100Kgf (mm)
Set up the amount of Gun Arm bending by squeeze force as the gun arm bent per 100Kgf. When playback Spot Welding Function, For the location of the fix tip, estimate the gun arm bending range from this value and the commanded pressure, and adjust with pressure. The amount of bending of Move Tip is not offset.

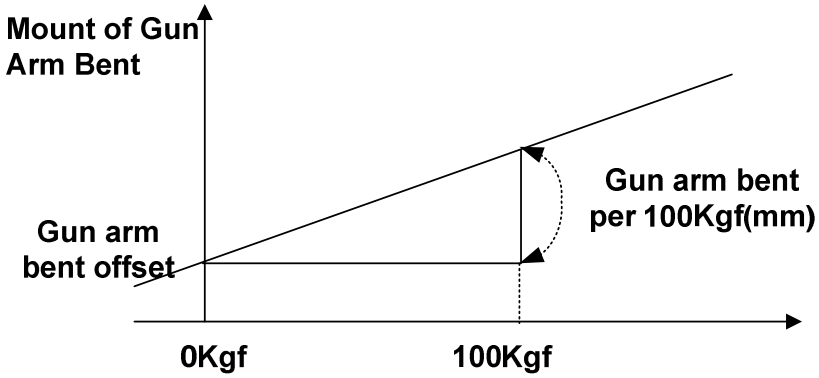


Figure 3.4 Gun arm bent per 100Kgf (mm)

(8) Fix tip bent rate(%)
When squeezing, set up the rate of the amount of Fix Tip bending about the amount of total bending in case both of Fix Tip and Move Tip are bent.

(9) Pressure match rate(%)
Comparing practical pressure to command pressure through pressure identity detector, detect it as pressure identity when it is reached within the degree of pressure. If it is set up as 0, pressure identity detection is not performed.

(10) Pressure fault check time (s)
Set up time from pressure operation start to pressure identity. In case pressure identity is done within the time, output welding signal as soon as pressure identity is done/ In case pressure identity is not done within the time, output error message- 『E1314 Squeeze force delay time is over』 and then halt it. When it is set up as 0.0 second, output welding signal without detecting pressure identity.

(11) Max move tip consumption(mm)
In case the amount of Move Tip detected by GUNSEA is excessive over the value designated here, output error message "E0155 Move-tip consumption exceeded max." When it is set up as 0.0 mm, abnormal detection is not performed.

(12) Max fix tip consumption(mm)
In case the amount of Fix Tip detected by GUNSEA is excessive over the value designated here, output error message 『E0156 Fix-tip consumption exceeded max.』 and halt it. When it is set up as 0.0 mm, abnormal detection is not performed.

◆ 【ATTENTION】 ◆

- In case the Max Tip Consumption is smaller than the Max. Move Tip Consumption or the Max. Fix Tip Consumption, or it is same as them, compare The Max. Tip Consumption firstly and detect the abnormal. Therefore, if you want to compare the Max. Move Tip Consumption and Max. Fix Tip Consumption firstly and detect the abnormal, please set the value which is smaller than the Max. Tip Consumption.

(13) Move Tip Change Consumption
In case the Move Tip detected by GUNSEA is excessive over the value, output alarm message 『W0106 Move Tip excessive the amount of Exchange Consumption.』 and output Tip consumption alarm signal and then notice the exchange of Tip. (In the process, playback is not halted.) When it is set up as 0.0 mm, abnormal detection is not performed

(14) Fix Tip Change Consumption
In case the Fix tip consumption detected by GUNSEA is excessive over the value, output alarm message 『W0107 Fixed-tip consumption exceeded LMT』 and output Tip consumption alarm signal and then notice the exchange of Tip. (In the process, playback is not halted.) When it is set up as 0.0 mm, abnormal detection is not performed

(15) Pressure Speed(mm/sec)
When performing pressure movement for SERVO GUN Manual squeeze(SHIFT+f*), Pressure of GUNSEA, and Spot Welding Function Playback, designate moving speed of Fix Tip and Move Tip. (To prevent mis-input from editing, the change is possible only when inputting Engineer Code(R314) on Teaching Mode or Playback Mode.)

(16) Command Offset (mm)
To generate pressure when playback Spot Welding Function, output the command as much as command offset distance from record position to pressure direction for Move Tip.(To prevent mis-input from editing, the change is possible only when inputting Engineer Code(R314) on Teaching Mode or Playback Mode.)

(17) Move tip consumption rate (%)

The methods detecting the amount of Servo Gun are detecting it by GUNSEA 1 only and detecting it by both GUNSEA 1 and GUNSEA 2.

In case of setting the amount of Move Tip Consumption/total amount of Consumption Parameter as 0, calculate the consumption amount using both GUNSEA 1 and GUNSEA 2. In case of setting this Parameter as the value except 0, calculate it by assigning the amount of Move Tip Consumption and Fix Tip Consumption as much as the rate(%) setting the total Tip consumption calculated by GUNSEA 1.

◆ 【ATTENTION】 ◆

- In case the amount of Tip Change Consumption is smaller than The amount of Move Tip Consumption or Fix Tip Consumption, or it is same as them, compare the amount of Tip Change Consumption firstly and detect the abnormal. Therefore, if you want to compare the amount of Move Tip Change Consumption and Fix Tip Change Consumption firstly and detect the abnormal, please set the value which is smaller than the amount of Tip Change Consumption.

(18) Current Table

This is used to adjust in case setting pressure or actual pressure excesses tolerance level from measured value of pressure system. Condition 1 is used in case pressure direction is gravity direction and condition 2 is used in case pressure direction is reverse gravity direction. (To prevent mis-input from editing, the change is possible only when inputting Engineer Code(R314) on Teaching or Playback Mode.)

This pressure-current table sets up current value about the pressure of level 5.

Set it as when each level is increased the value of pressure-current is also increase.

Max. value and Min value inputted here is used as limit range of playback or pressure when doing manual operation.

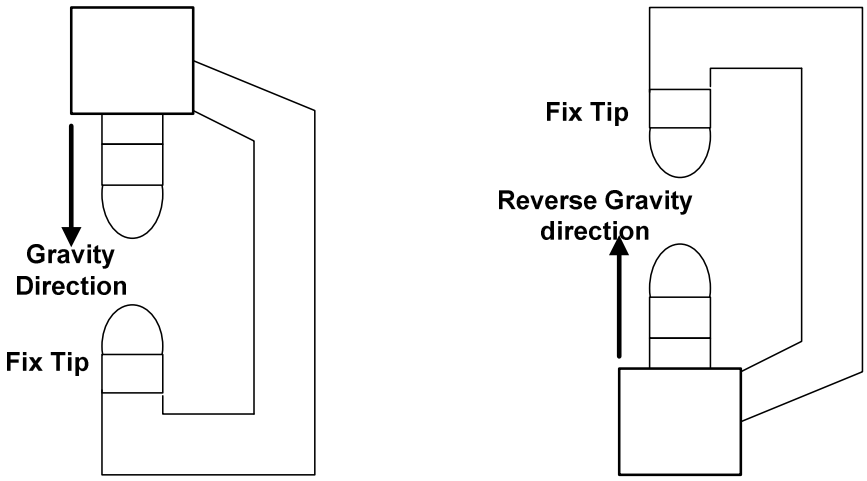


Figure 3.5 Gravity & Reverse Gravity Direction

◆ 【ATTENTION】 ◆

- Pressure of Spot Welding Condition or pressure setting(R326) can not be set up out of the range set in pressure-current table of SERVO GUN Parameter.

(19) Gun Type

Select Robot Gun or Stationary Gun for selected Servo Gun.

In case of using Stationary Gun, set up coordinate system of Stationary Gun as user coordinate system which is set up in advance. Set up user coordinate system the Fix Tip direction goes to Z direction.

In case coordinate No. is “0”, it is set up as Robot coordinate system.

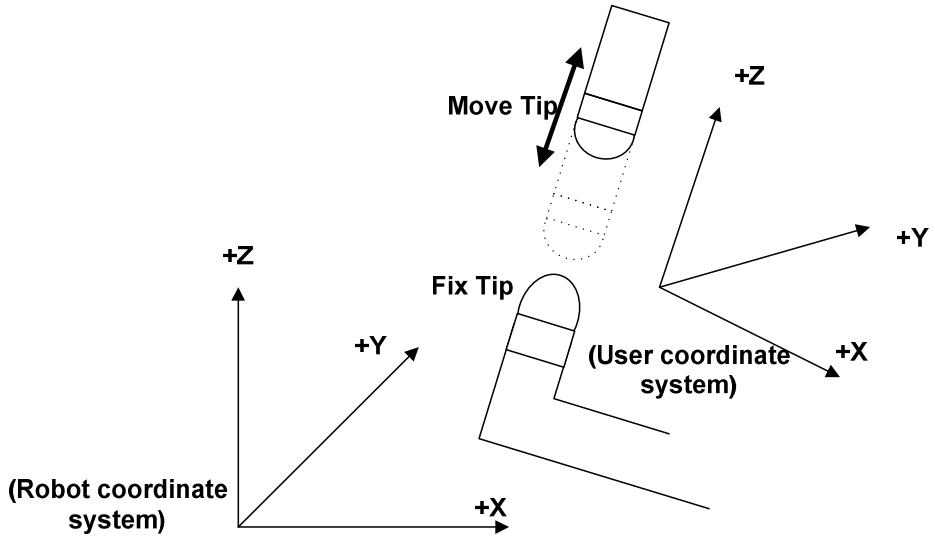


Figure 3.6 Coordinate System

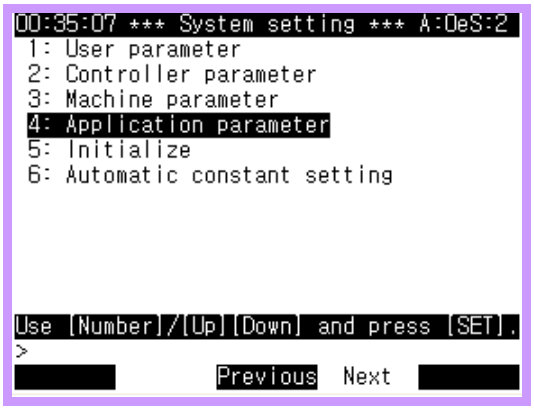
◆ 【ATTENTION】 ◆

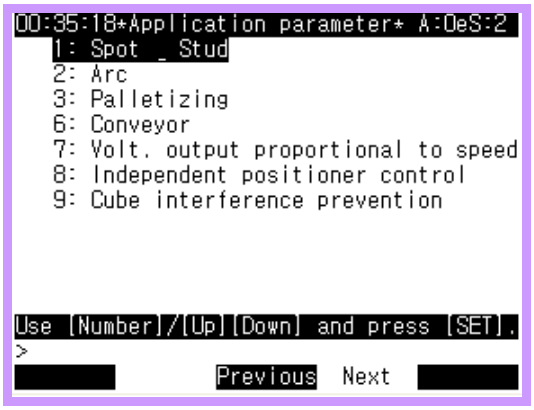
- In case of selected by Stationary Gun, offset the consumption amount detected by GUNSEA as user coordinate system. Therefore, set up the direction of user coordinate system correctly.

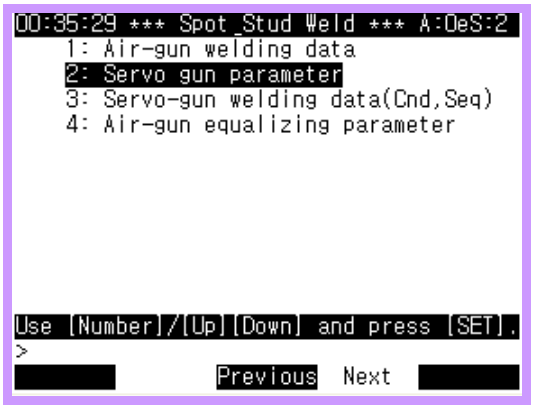
3.2. SERVO GUN Parameter operate method

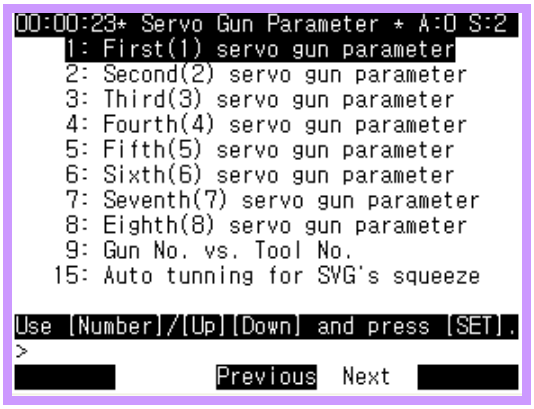
(1) Select 『[PF2]: System』 → 『4: Application Parameter』 → 『1: Spot & Stud』 → 『2: Servo gun parameter』.

(2) Below screen appears.



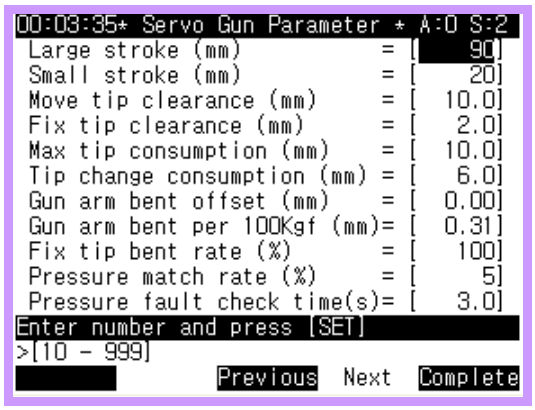




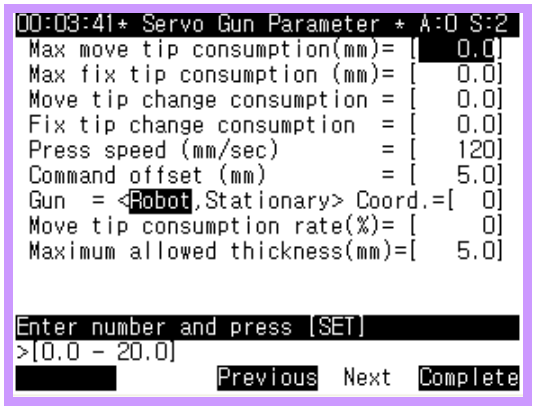


(3) Press [SET] key selecting 『1: First(1) servo gun parameter』 or 『2: Second(2) servo gun parameter』 followed by Gun to set up.
(In case it is not Multi Gun, it can not be accessed as setting item of 『2: Second(2) servo gun parameter』.)

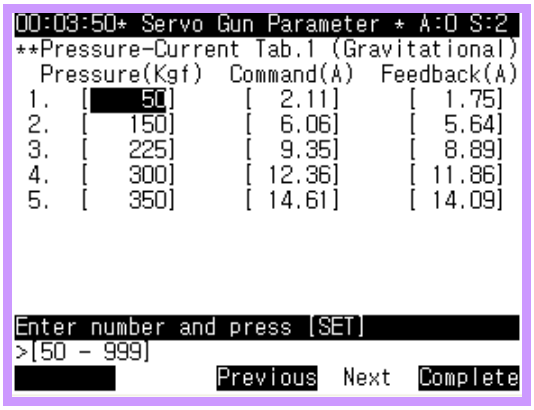
(4) Below screen appears.

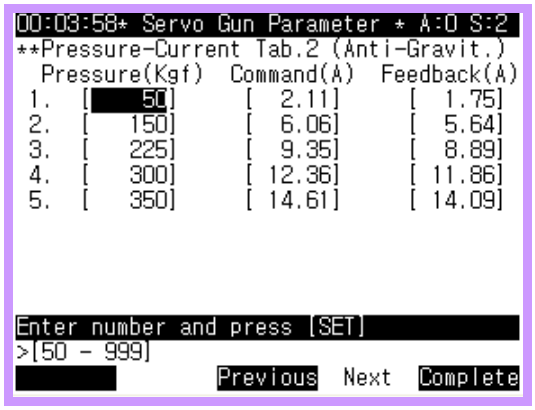


(5) Pressing 『[PF4]: Next』 key, below screen appears.



(6) Pressing 『[PF4]: Next』 key, below screen appears.





(7) After inputting numbers, press [SET] key.

◆ 【ATTENTION】 ◆

- In case setting value is inappropriate, the setting value is not changed by pressing 『[PF5]: Complete』 key. Therefore, please reset as appropriate value same as below.

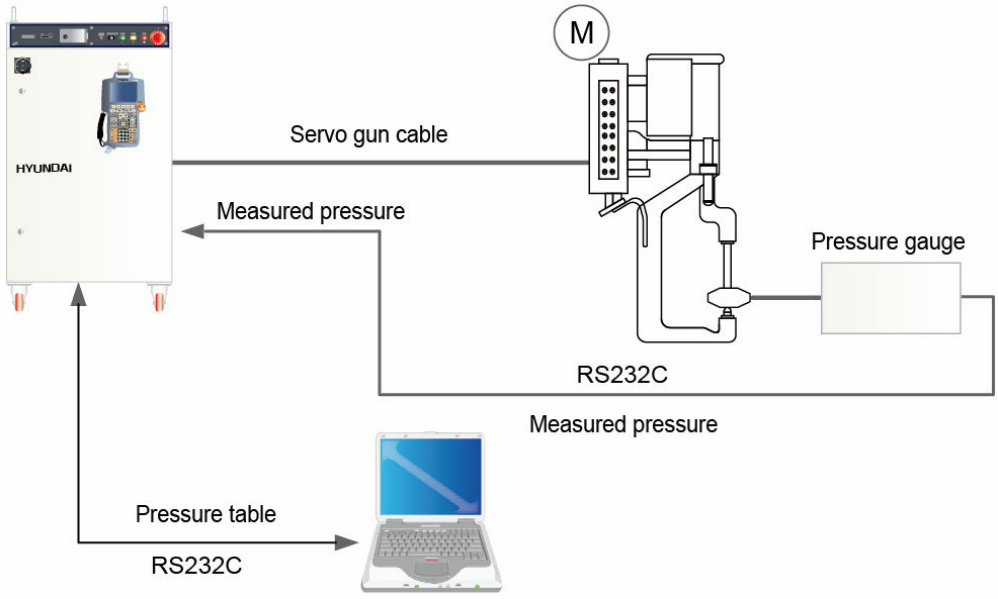
  ① Set up Large Stroke within limit range.
  ② Set up Small Stroke which is smaller than Large Stroke.
  ③ Set up Move Tip Clearance which is smaller than Small Stroke.

3.3. Automatic pressure tuning function of servo gun

You can use this function to automatically prepare the pressure table of the servo gun parameter. To use this function, you must use the digital pressure gauge that is supported by HHI robot controller.

(1) Introduction

The automatic pressure tuning function is the function of which the controller finds the right pressure for the servo gun from the table by transferring the pressure table measured from the servo gun to the controller via RS232C as shown below.
The tuned pressure table can automatically be reflected to the controller.
It can also be transmitted to the PC through PCRS232C communication. At this time, the PC must have the software provided by HHI and must use 2 serial ports of the Hi4a controller.



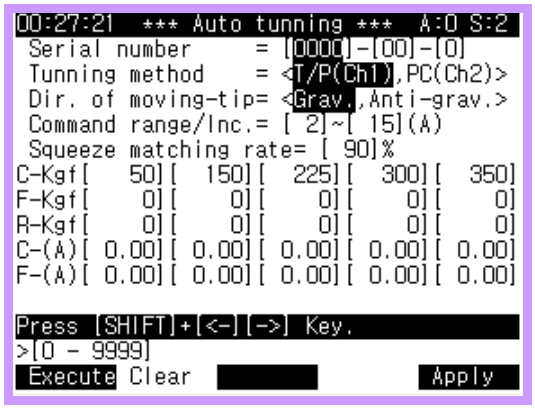
[Pressure measurement composition diagram in PC, use 2 serial ports of the controller]

(2) Operating method

① Connect the communication cable of the pressure gauge to the serial port of the controller, and equalize the serial communication speed of both the robot controller and the pressure gauge.

② Select 『[PF2]: System』 → 『4: Application parameter』 → 『1: Spot & stud』 → 『2: Servo gun parameter』 → 『15: Automatic pressure tuning function of servo gun』.

③ You will see the following screen.



④ The meaning of each menu is as follows.

- Serial number
  This sets the serial number of the servo gun.
  When you set the pressure tuning method to PC, this is used to identify the servo gun.

- Tuning method <T/P(Ch1),PC(Ch2)>
  ➔ T/P only uses the pressure value coming from the pressure gauge and only uses the serial port #1.
  ➔ PC transmits the calculated results to the PC and uses both serial port #1 (pressure receipt) and #2 (transmission to PC).

- Dir. of moving-tip=<Gravity,Anti-gravity >
  ➔ This decides whether to set the table direction to gravity direction or anti-gravity direction.

- Command range/Inc.
  ➔ This sets the range of the command current of the servo gun to measure the pressure.
  (It must be set below the peak current of AMP)

- Squeeze matching rate
  ➔ Acccuracy to verify the pressure

- C-Kgf – Command force
  ➔ Command force to prepare the pressure table

- F-Kgf – Feedback force
  (This is used for monitoring the use of pressure calculated from return current during the verification process.

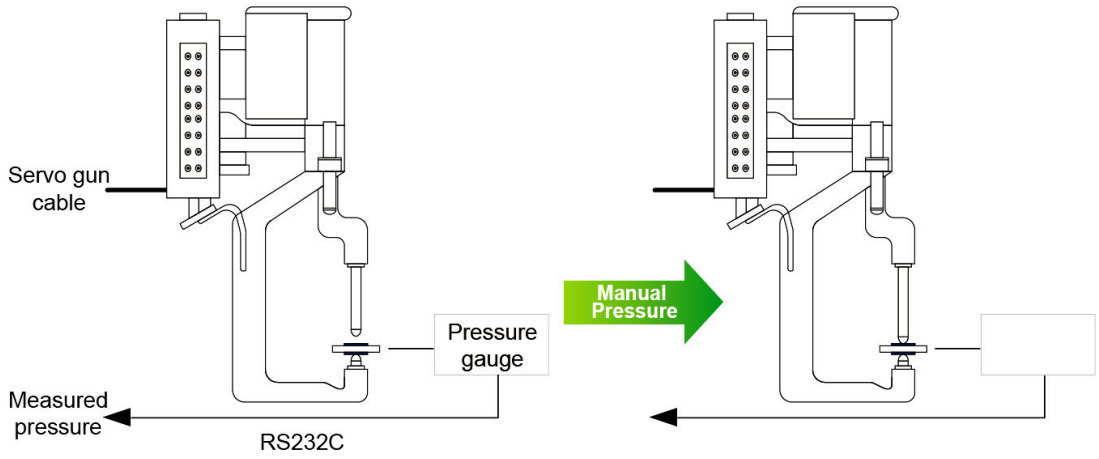
- R-Kgf – Real force
  (This is used for monitoring the real force coming from the external sensor.

- C-(A) - Command current
  (Command current controlled in the current tuning process

- F-(A) – Feedback current
  (Feedback current of current tuning process

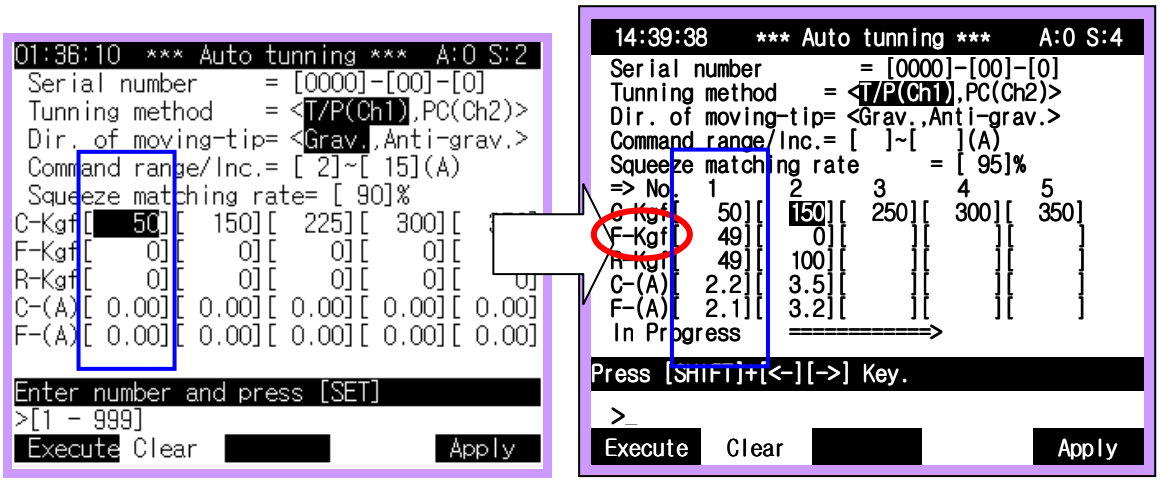
※ Items 5) to 9) are for monitoring the current status during the turning process, and when the tuning is completed, the cursor will move to the side and the tuning results and the verification results will be shown.
※ Only items 5), 8) and 9) are used for calculating the pressure-current table.

⑤ Manually apply the pressure (Use SHIFT+F key) to the pressure gauge at low level of pressure (set to 50kgf) to the servo gun.

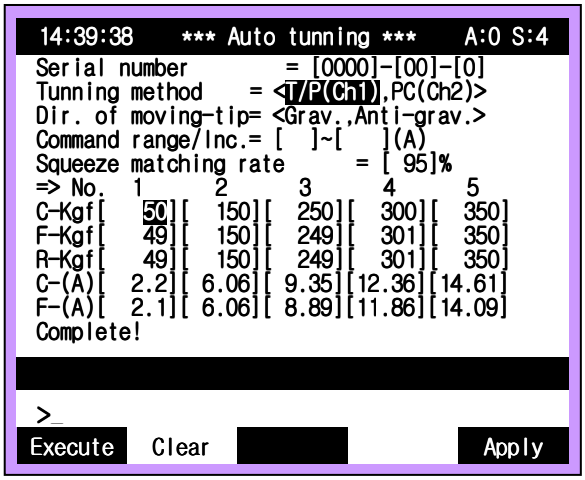


⑥ Press the “[PF1]:Execute” key to automatically apply the pressure, and automatically the pressure will applied and released repeatedly to execute the automatic pressure tuning.

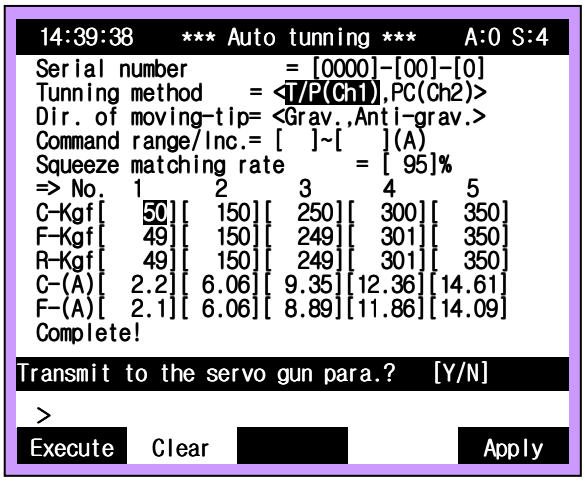
⑦ As shown below, C-Kgf of current tuning stage will be shown in inverse, and it will move to the next stage when this stage is complete. When total of 5 stage pressure-current is calculated for the pressure table, the tuning will be completed.



⑧ Press the Apply (PF5) key to reflect to the pressure table. It will prompt the message asking “Save servo gun parameter?”. If you press the Yes key, it will be saved and reflected to the servo gun parameter of the currently selected gun number in the selected table of either gravity or anti-gravity direction.



⑨ If you have selected the pressure tuning method to PC, it will be transmitted to the PC.



◆ 【ATTENTION】 ◆

- Because this function can only be used with the pressure gauge sold by HHI, consult HHI for more details.

3.4. Saving Settings

After completing constant file,

1. Access 『[PF1]: Service』 → 『5: File Manager』 → 『5: Copy』Menu
2. Copy constant files of internal memory(ROBOT.C01, ROBOT.C00) into SRAM card.

As the result, it will be useful when restoring it as the initial state.

4

Spot Welding & Data Settings

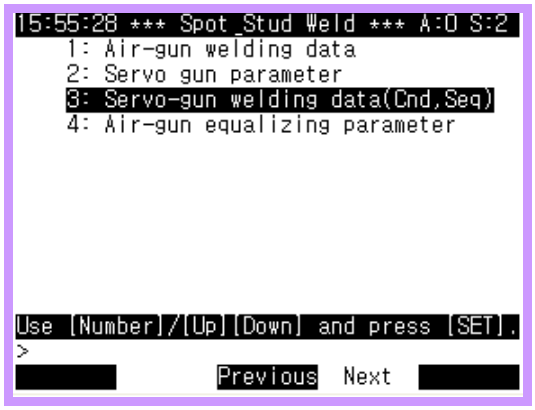
When being welding using SERVO GUN, decide welding condition and sequence designating welding condition and welding sequence which are recorded in Spot welding file (ROBOT.WSD).

4.1. How to use Spot Welding Data

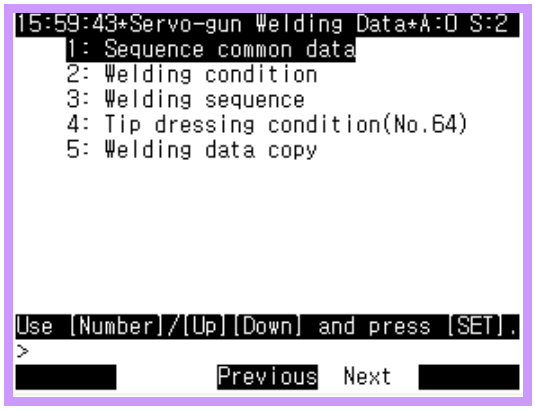
Welding data recorded in Spot Welding File is only used when using Servo Gun. To adjust welding condition and welding sequence is possible while processing playback. On playback, you can adjust welding condition and welding sequence using the Hot-Edit function.

4.1.1. How to operate

(1) Select 『[PF2]: System』 → 『4: Application parameter』 → 『1: Spot & Stud』 → 『3: Servo-gun welding data(Cnd,Seq)』.



(2) Below screen appears.



(3) Select the item to adjust.

◆ 【ATTENTION】 ◆

- Spot Welding Data is not applied in case of using Air Gun.
  Please refer to 『Hi4a Controller Operation Manual』 in case of using Air Gun.
- ROBOT.WSD File is possible to write only in SERVO GUN Use Environment.

4.2. Common Data Editing

Set up data which are applied commonly regardless of Spot Welding Sequence.

(1) WI Error processing
Select the method to process the error occurred by not inputting WI even though designated WI input wait item is over. The method is Wait or Robot Halt. In case of Wait, do not halt and wait until welding complete signal is inputted.

(2) GUN open to error stop
When abnormal or halt is occurred on welding working, terminate the welding execution forcefully, open the Move Tip as Move Tip clearance, open the Fix Tip as Fix Tip clearance and then halt it. Set up it as being effective only for this menu.

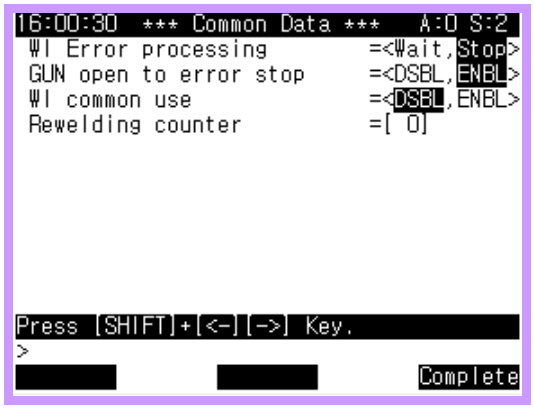
(3) WI common use
In case of MultiGun, it sets up each WI signals to GUN1 and GUN2 commonly. However, it sets up the parameter as [ENBL] in case of applying it to GUN1 and GUN2 as same WI signal of 1 unit.

(4) Rewelding counter
Perform welding again in case of WI is not inputted during WI input wait time. The frequency of re-welding can be designated up to Max. 3 times. If WI is not inputted after retrial as many as the frequency of re-welding, generate error and follow the method-'WI Error processing'.

4.2.1. How to operate

(1) Select『[PF2]: System』 → 『4: Application Parameter』 → 『1: Spot & Stud』 → 『3: Servo-gun welding data(Cnd,Seq)』 → 『1: Sequence common data』.

(2) Below screen appears.



(3) It is moved to the item to set up and then select the item.

(4) Completing settings, press [PF5] key.

◆ 【ATTENTION】 ◆

- Gun open when abnormal or halt is occurred is set up as [ENBL] only.

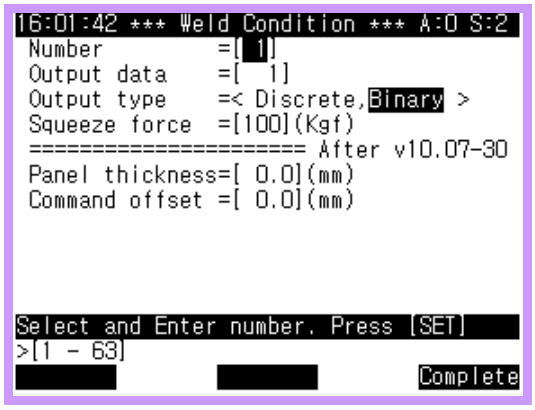
4.3. Welding Condition Editing

Spot Welding Condition sets up the pressure of Servo Gun and Welding Condition Output Data. Welding Condition of Max. 64 units can be edited.

4.3.1. How to operate

(1) Select『[PF2]: System』 → 『4: Application Parameter』 → 『1: Spot & Stud』 → 『3: Servo-gun welding data(Cnd,Seq)』 → 『2: Welding Condition』.

(2) Below screen appears.



(3) Input Welding Condition No. to edit.

(4) It is moved to the item to designate and then input Welding Condition Output Data and pressure.

(5) Completing the settings, press 『[PF5]』 key.

◆ 【ATTENTION】 ◆

- Welding Condition No. can be designated up to 1 to 63, and output data according to welding condition can be designated up to 0 to 255.

4.4. Welding Sequence Editing

Spot Welding Sequence sets up welding sequence when playback Spot Welding Function(SPOT). Welding Sequence Editing of Max. 63 units is possible.

(1) Number
The welding sequence number to edit will be selected.

(2) Condition Signal Output (ENBL only)
Output Welding Condition No. when performing SPOT command.

(3) Squeeze Signal Output (DSBL only)
Squeeze Signal is not outputted.

(4) Welding Signal Output (ENBL only)
Output Welding Signal when performing SPOT command.

(5) WI Wait (ENBL only)
Do WI Wait when performing SPOT command.

(6) Welding Sig. Wait Time
'Welding Sig. Wait Time' is the delay time from squeeze force correspondence to WI detection. Therefore, WI input is not detected during the delay time though squeeze force is corresponded.

(7) WI Wait Time
This is wait time for WI. Setting this value as 0, it does Wait until WI is inputted.

(8) Wait Time after WI
This is the time for wait completing welding after inputting WI. It sets up for common stick detection. It is recommended to input the value over 0.3 sec(300msec) when using the stick detection signal. However, if the value is big, it causes that welding time is longer and cycle time is increased.
If Gun open time is shorter than this time, it is allowed to finish welding completion wait at the same time of open completion. If it is set up as 0.0, it is allowed to finish wait at the same time of starting open working.

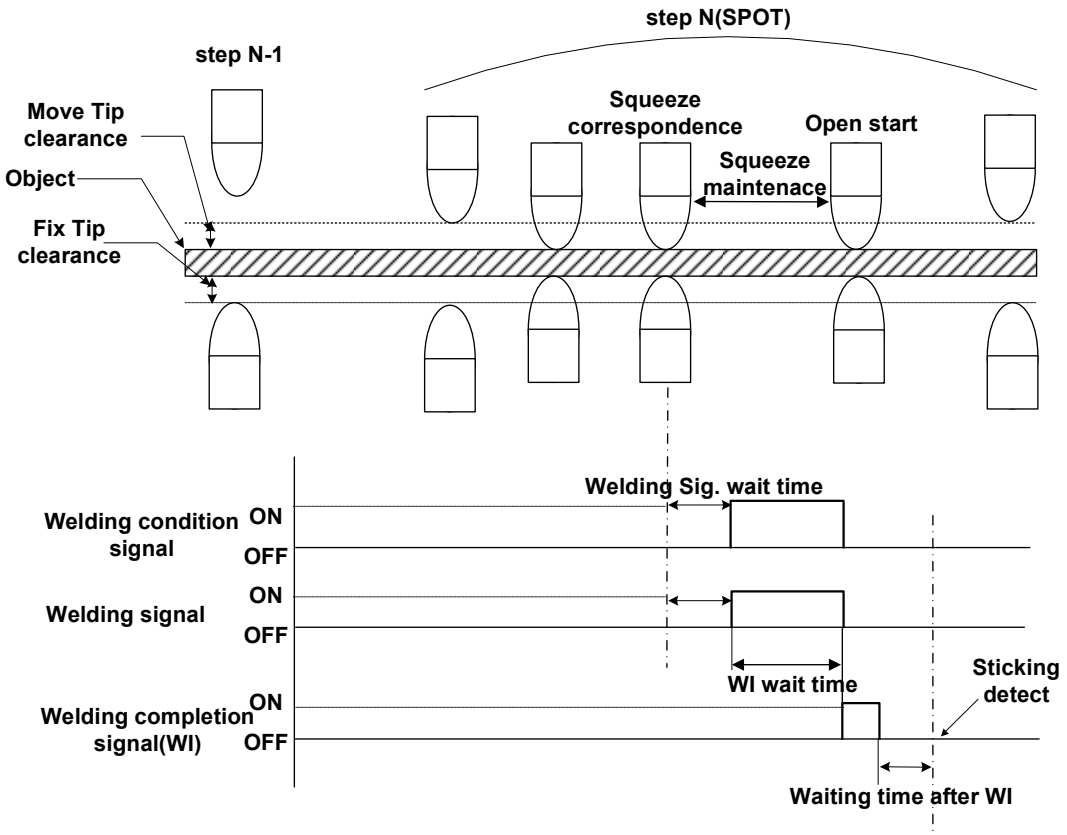
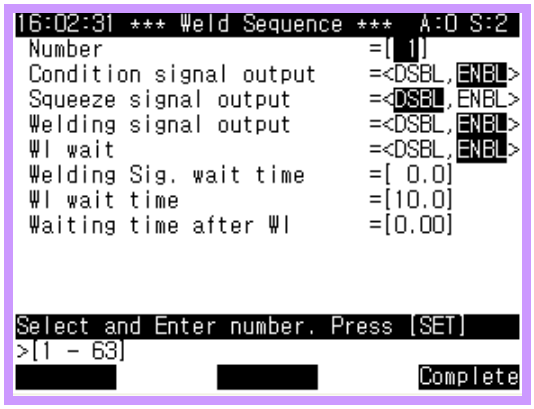


Figure 4.1 Welding Sequence

4.4.1. How to operate

(1) Select『[PF2]: System』 → 『4: Application Parameter』 → 『1: Spot & Stud』 → 『3: Servo-gun welding data(Cnd,Seq)』 → 『3: Welding Sequence』.

(2) Below screen appears.



(3) Input Welding Sequence No. to edit.

(4) It is moved to the item to set up and then set up Data.

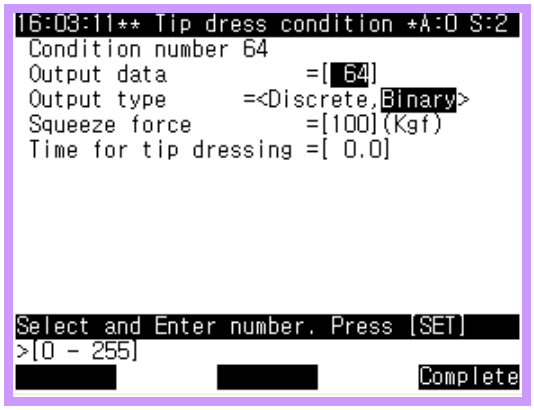
(5) Completing settings, press 『[PF5]』 key.

◆ 【ATTENTION】 ◆

- ENBL/DSBL Settings of welding condition signal, squeeze signal, welding signal and WI Wait can not be changed.
- The pre-output function of welding condition signal on Servo Gun is not supported.
- Stick detection of a Servo Gun can be done only by external signal.

4.5. Tip dressing condition(No.64)

(1) Select『[PF2]: System』 → 『4: Application Parameter』 → 『1: Spot & Stud』 → 『3: Servo-gun welding data(Cnd,Seq)』→『4: Tip dressing condition(No.64)』.



(2) Output Data
Set up data for Welding Condition No. 64 to output.

(3) Output Type
Put output type as binary number.

(4) Squeeze force
Set up Squeeze force to use for tip dressing.

(5) Time for tip dressing
Set up the time for tip dressing outputting welding condition No.64 signal.

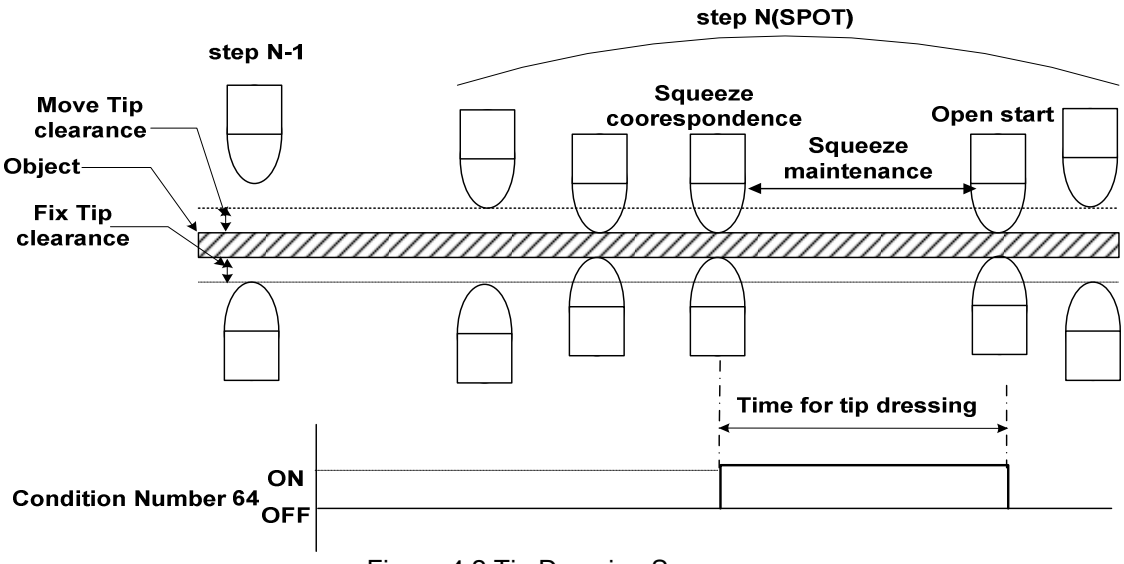


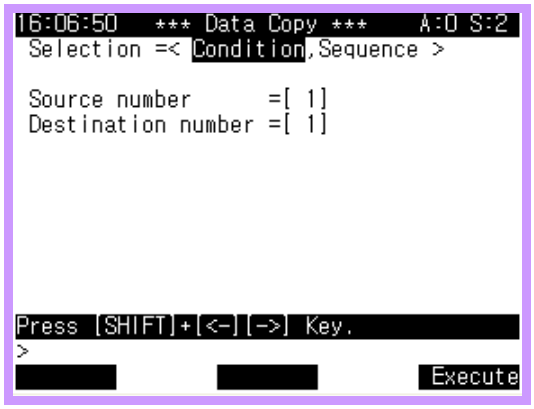
Figure 4.2 Tip Dressing Sequence

4.6. Data Copy

It is possible to copy the data of Spot Welding Condition or Spot Welding Sequence as other number. Copy 'Spot Welding Condition or Spot Welding Sequence designated from data number to copy' as 'Spot Welding Condition or Spot Welding Sequence designated from data number to be copied'.

4.6.1. How to operate

(1) Select『[PF2]: System』 → 『4: Application Parameter』 → 『1: Spot & Stud』 → 『3: Servo-gun welding data(Cnd,Seq)』 → 『5: Weding data copy』.



(2) Select data to copy and input data number to copy and data number to be copied and then press 『[PF5]: Execute』 key.

4.7. Settings Save

After the constant file is completed,
access 『[PF1]: Service』 → 『5: File Manager』 → 『5: Copy』Menu, copy Spot Welding File(ROBOT.WSD) of internal memory into SRAM card and then you can apply the existing written welding sequence to other controllers.

5

GUNSEA PROGRAM WRITING

GUNSEA Function is the function detecting the Tip consumption caused by Tip abrasion by Tip Dressing or consumption by Welding. When playback Spot Welding Step, welding quality is improved because squeeze position is adjusted automatically by the consumption detected by GUNSEA.
GUNSEA movement is consisted of GUNSEA 1 Movement and GUNSEA 2 Movement.
When executing the GUNSEA 1 function, you can get the total amount of consumption pressing Fix Tip by Move Tip.

When executing the GUNSEA 2 function, you can get the total amount of Move Tip consumption. It is possible for GUNSEA 2 Movement to use the methods using either pressure detection or sensor detection.

To get the consumption amount of tip, there are the methods using GUNSEA 1 and 2 and using GUNSEA 1 only which is called Single GUNSEA 1 Method.

5.1. Parameter GUNSEA Function

(1) GUNSEA Function should set up parameter of 3 units as below,

GUNSEA GN= <servo gun num.>., SE=<search num.>, PR=<gun pressure>

(2) Servo gun num. : Input Gun No. to search.

(3) Search num. : Designate GUNSEA 1 Movement or GUNSEA 2 Movement.

(4) Gun pressure : Set up Command Pressure.

5.2. How to operate GUNSEA Function (GUNSEA)

■ **Teaching Method of GUNSEA 1**

(1) Select Gun No. to search it with R210.

(2) Record the step on the position which opens Gun.

(3) Press CMD key. Select 『[PF3]: Etc.』. Search GUNSEA using Up↑/Down↓ keys of Teach Pendant or press Set key inputting Cmd. No= 396 as number.

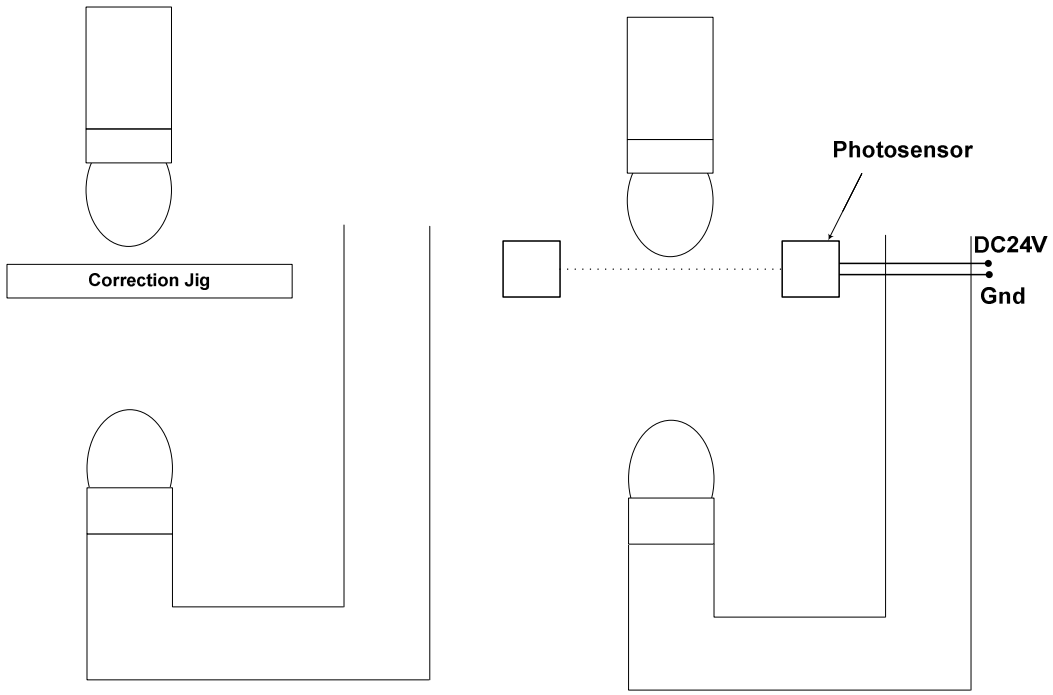
(4) Below screen appears.

(5) Set up Gun No., Search No. and Pressure with cursor.

■ **Teaching Method of GUNSEA 2**

(1) Select Gun No. to search it with R210.

(2) Record the step as Gun is open position near Correction Jig.



1) GUNSEA 2 using Correction Jig 2) GUNSEA 2 by external input signal

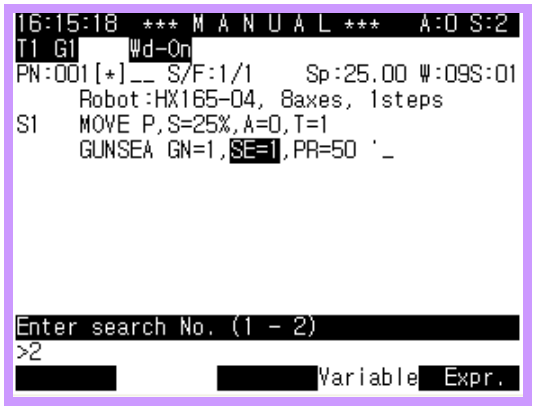
Figure 5.1 Teaching Method of GUNSEA 2

※ In case of GUNSEA by external input signal, do teaching GUN near sensor to open position.

(3) Press CMD key of Teach Pendant. Select 『[PF3]: Etc.』. Search GUNSEA using Up↑/Down↓ keys of Teach Pendant or press Set key inputting Cmd. No= 396 as number.

※ Use IGUNSEA Command using GUNSEA Function by external input signal.

(4) Below screen appears.



(5) Inputting Search No. as 2, press [SET] key.

◆ **【ATTENTION】** ◆

① Record GUNSEA 2 after recording GUNSEA 1 firstly.

② Teaching position should be teaching on the position that GUN is open and in the state that pressure is undone.

- ◆ Teaching position of GUNSEA do teaching in the state of opening GUN over 5mm.
- ◆ In case of teaching in the state of pressing, error can be occurred when playback 『**E0171 Gun open time is over.**.』

③ This is the environment performing GUNSEA 1 only in case of setting up the value except 0 of Move Tip Consumption rate(%) at the SERVO GUN Parameter settings.

- ◆ In this case, calculate the consumption amount of Move Tip and Fix Tip by GUNSEA 1 only.
- ◆ 『E1326 Invalid environment of GUN search2』 error is occurred when performing GUNSEA 2.
- ◆ When performing consumption off by GUNSEA 1 only, calculate it by dividing the total amount of consumption detected by GUNSEA 1 as the rate which is set in the SERVO GUN Parameter.

『E1306 GUNSEA Reference position is undone.』 error is occurred when performing GUNSEA without recording GUNSEA reference position.

■ **Single GUNSEA 1 Consumption Off Function**

(1) Single GUNSEA 1 Environment Settings
Set up Move Tip Consumption/consumption rate (%) in the SERVO GUN Parameter. If this rate is set up as 0, the environment needs to use both GUNSEA 1 and GUNSEA 2.

(2) Calculating the consumption
Calculate it dividing the amount of total consumption of the Tip calculated by GUNSEA 1 as the rate of Move Tip and Fix Tip.

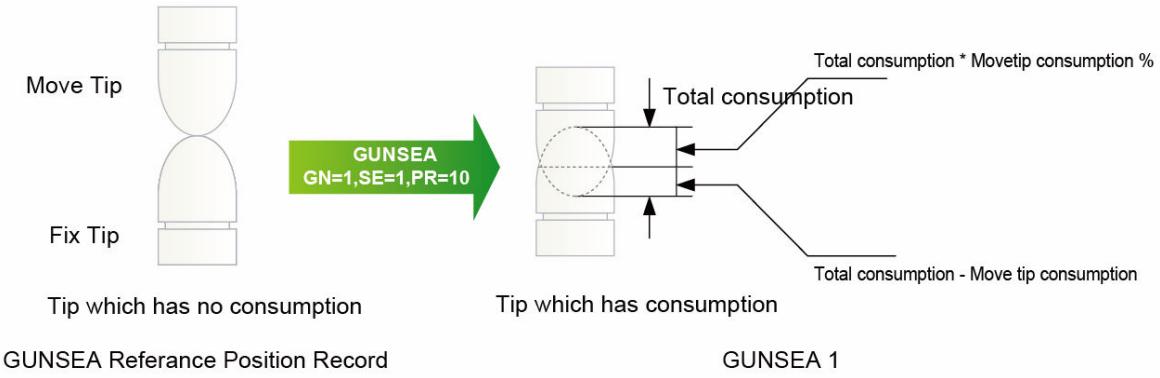


Figure 5.2 Calculating the consumption amount of Single GUNSEA1

5.3. Playback of GUNSEA

5.3.1. Playback of GUNSEA Function

The gun search operation is composed of gun search operation 1 and 2 as shown below. To operate the gun search, set the 『[PF5]: Cond Set』 → 『[PF1]: AppliCnd』 → 『5: Gun search Ref.point record』 to OFF and calculate the wear-off of the electrode through playback.

■ **Executing process of GUNSEA 1 Movement**

(1) Reach it as record position of step.

(2) In case of executing GUNSEA without recording GUNSEA Reference position, display the error message-“E1306 Base position data is not recorded.” and then halt it.

(3) Clear the tip consumption-fix tip Monitoring.

(4) Press Fix Tip by Move Tip.

(5) When pressure identity is detected, detect the total amount of consumption and execute open movement. The total amount of Tip consumption = Detecting position of pressure identity – GUNSEA 1 Reference position.

(6) When being open up to record position of step, move to next step.

(7) In the SERVO GUN Parameter, calculate the consumption amount of both Move Tip and Fix Tip with GUNSEA1 in case of the value ‘Move Tip Consumption rate(%)’. In the process, GUNSEA2 can not be executed.

$$Movetip\,consumption = Total\,consumption\ \det ected\,by\,GUNSEA1 \times \left(\frac{Movetip\,consumption}{Total\,consumption(\%)} \right) \div 100$$

$$Fixtip\,consumption = Total\,consumption\,before \det ecting it\,with\,GUNSEA1 \times 100 - \frac{Movetip\,consumption}{Total\,consumption(\%)}$$

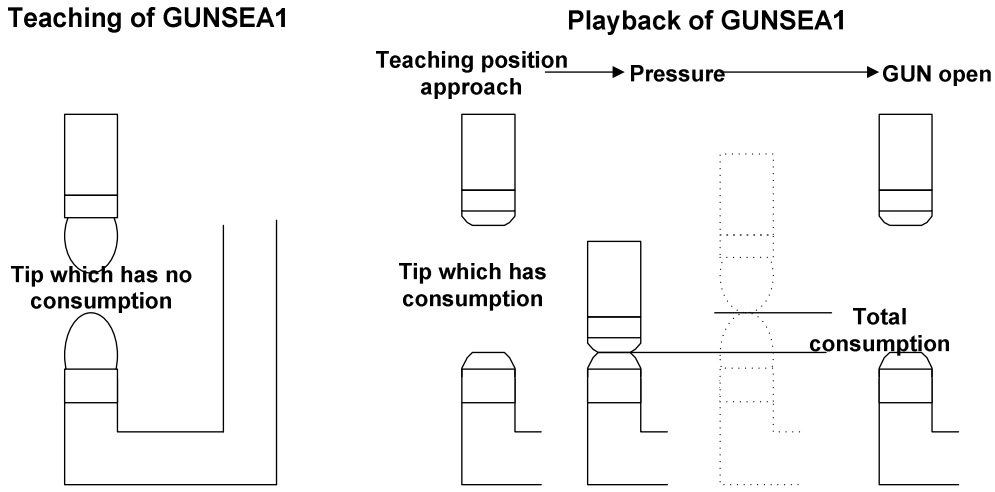


Figure 5.3 GUNSEA 1 movement

■ **Executing process of GUNSEA2 Movement**

(1) Reach it as record position of step.

(2) In case of not executing GUNSEA1, display the error message-“E1307 Gun search program is abnormal.” and then halt it.

(3) Press search-correction jig with Move Tip.

(4) When pressure identity is detected, detect the total amount of Move Tip consumption and execute open it.
※ In case of GUNSEA by external input signal, when sensor input is detected, detect the consumption amount and open it.

Move Tip Consumption = Detecting Position of Pressure Identity– GUNSEA Reference position
Fix Tip Consumption = The total consumption detected by GUNSEA1– Move Tip Consumption

(5) When open is completed, Move Tip and Fix Tip Consumption are updated.

(6) Move to next step.

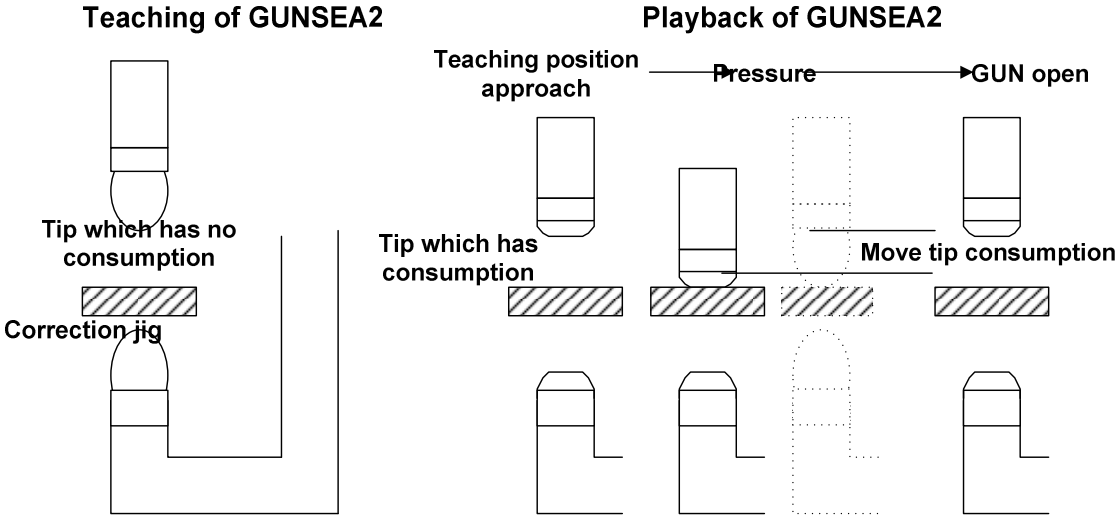


Figure 5.4 GUNSEA 2 Movement

■ **Executing process of GUNSEA 2 by external input signal**

(1) Reach it as record position of step.

(2) In case of not executing GUNSEA1, display the error message-"E1307 Gun search program is abnormal." and then halt it.

(3) Move Tip is approached as search speed and switching phototube contact signal.

(4) When signal is detected in phototube, detect the Move tip consumption and execute open.

Move Tip Consumption
= Detecting Position of Pressure Identity - External Input GUNSEA2 Reference position
Fix Tip Consumption
= The total consumption detected by GUNSEA1 - Move Tip Consumption

(5) When open is completed, Move Tip and Fix Tip Consumption are updated.

(6) Move to next step.

◆ **【ATTENTION】** ◆

- GUNSEA should be executed after recording reference position.
- When playback by step forward/backward of manual mode, GUNSEA is not executed regardless of 『[PF5]: Cond Set』 → 『3: Func in step GO/BACK』
- The monitored amount of Fix Tip displayed on SERVO GUN monitoring screen after adjusting the consumption with the gun search, refers to the distance from the reference position designated at axis constant to Fix Tip.
- Executing GUNSEA2 not executing GUNSEA1 normally, display the error message-『E1307 Gun search program is abnormal.』 and then halt it.
- GUNSEA Retry
  In case of retrying it after being halted in the state of not completing GUNSEA movement, retry GUNSEA step.
- Detecting method for the consumption amount (Absolute value)
  In case of executing GUNSEA after attaching the Tip which is longer than the length of Tip performing GUNSEA Reference position Record, the consumption amount which is detected can be the negative value.
- Please refer to 『**5.4. GUNSEA Reference position Record**』 for GUNSEA Reference position Record.
- In case the amount of Tip consumption is bigger than 『**The amount of Max. Tip Consumption of SERVO GUN Parameter**』 when playback GUNSEA, the error message -『E1314 Squeeze force delay time is over』 can be occurred. In case the error is occurred, exchange the Tip which is consumption or set 『The amount of Max. Tip consumption of **SERVO GUN Parameter**』 as small. Therefore, reset it.

5.4. GUNSEA Reference position Record

Record GUNSEA Reference position playback GUNSEA as 1 cycle. Before performing GUNSEA, Reference position should be recorded.
After selecting GUNSEA Reference position Record of [PF5:Cond Set] / Application Condition as being On, attach new Tip which is not worn, and then playback GUNSEA Program as 1 cycle.

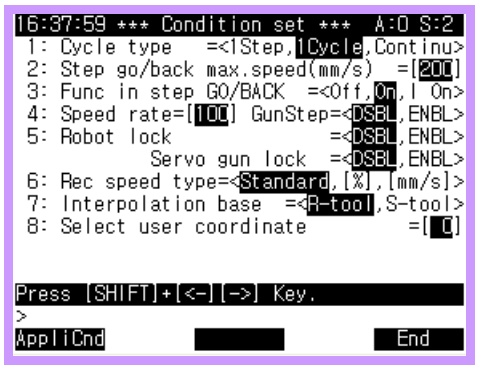
※ By recording the GUNSEA Reference position, the length from reference position of axis constant to recorded reference position is monitored by the amount of Fix Tip consumption and it is possible to confirm by the Servo GUN Monitoring Function.

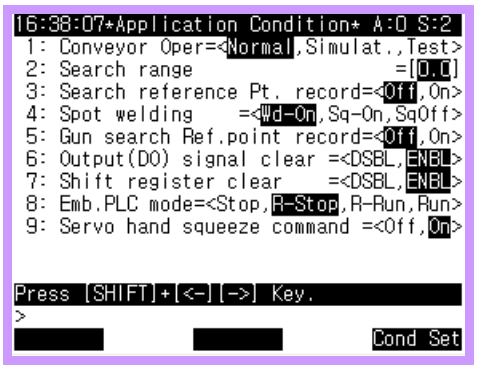
5.4.1. How to operate

Before recording GUNSEA Reference position, you should attach new tip which is not worn and execute it as below,

(1) Settings can be done in both manual mode and auto mode.

(2) After selecting 『[PF5]: Cond Set』, below screen is appeared by selecting 『[PF1]: AppliCnd』.





(3) After setting『5: GUN search Ref.point record』as being On, select 『[PF5]: End』.

(4) On upper part of screen, SW(Search Write) is reversed ad appeared as below,

(5) After selecting Program that GUNSEA Function is recorded, playback it as 1 cycle.

(6) 『[PF5]: Cond Set』 → Set 『5: Gun search Ref.point record』of 『[PF1]: AppliCnd』as being Off.

◆ 【ATTENTION】 ◆

- After System Initialization or when rewriting GUNSEA Program, you should do GUNSEA Reference position Record again.
- Please record the gun search reference position once during the servo gun installation. Using the servo gun can cause deformation. Unlike the initial recording of the reference position with gun search, do not record the reference position with gun searach again. In this case, the it can cause the reference position to change and change the calculation of the consumption amount, making the existing welding program unusable..
- When playback GUNSEA Function without recording GUNSEA Reference position, the error - E1306 Base position data is not recorded』 is occurred.
- Recording GUNSEA1 Reference position at GUNSEA Reference position Record, the consumption amount of SERVO GUN Monitor Screen is cleared when trying GUNSEA.
- When recording GUNSEA1 Reference position, the amount of Fix Tip monitor displayed on SERVO GUN Monitoring Screen means the length from the axis to reference position of GUNSEA 1.

5.5. External Signal Input GUNSEA2 Function (IGUNSEA)

To measure the amount of Move Tip Consumption of Servo Gun, commonly robot moves the Tip. This method measures the Fix Tip consumption that the robot measures pressure of GUN using solid jig fixed outside. However, in case of stationary Servo Gun, the method using the jig for measuring pressure is not useful because Servo Gun is not attached in robot. At this point, the function to be available is **external signal input GUNSEA2 function.**

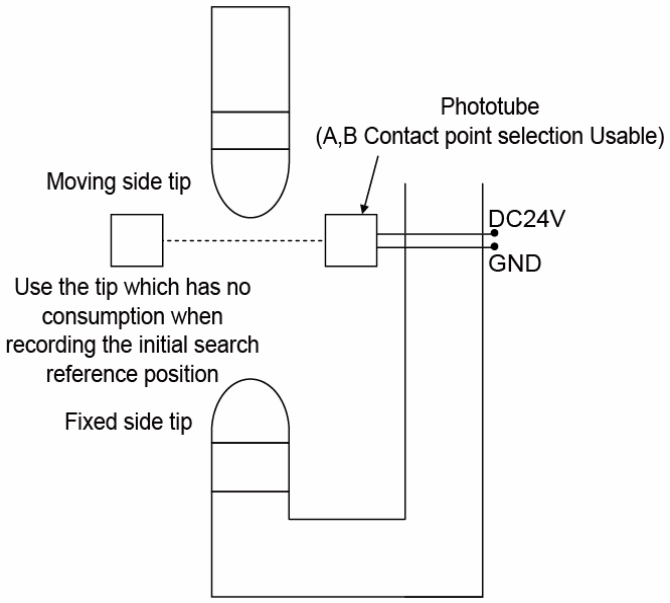


Figure 5.5 External Signal Input GUNSEA2 Function

As you see above Figure, detect the position of bottom point of Move Tip tool inputting the signal that the signal of phototube is changed from ON to OFF or converted from OFF to ON using the phototube when Move Tip moves.

5.5.1. Execution Order

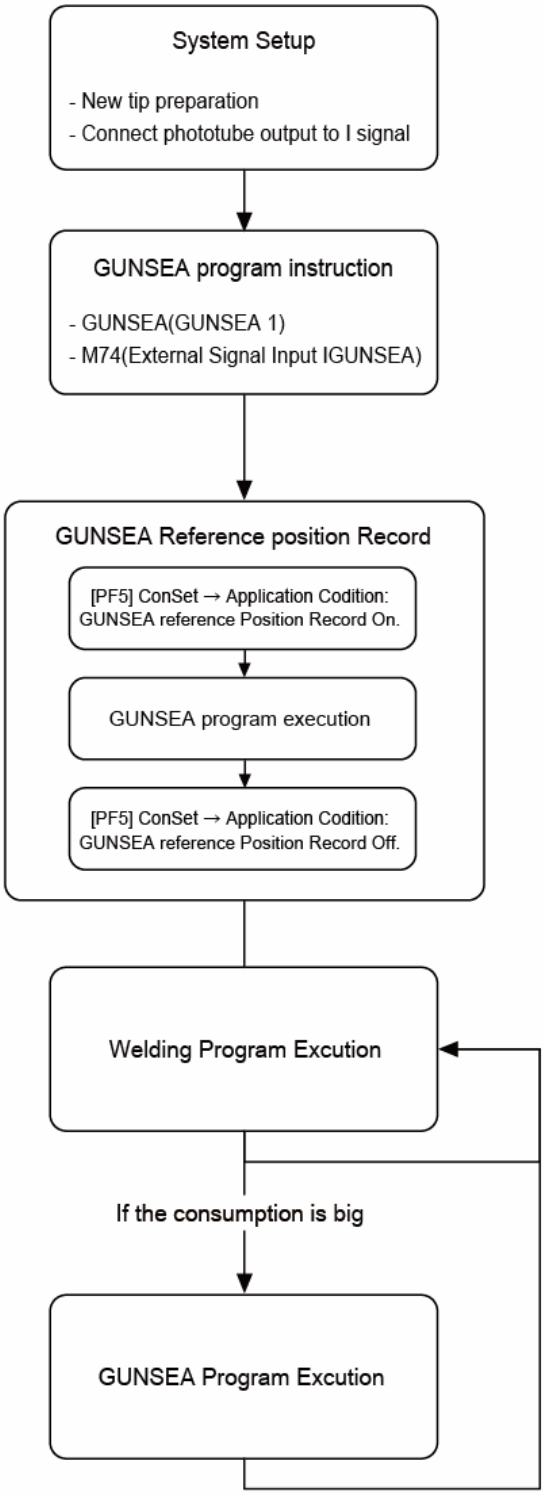
(1) Connect output of phototube to I signal.

(2) Do Teaching for Consumption Measuring Program.
GUNSEA Function should be follow the order. That is executing GUNSEA2 after executing. GUNSEA1. In case of External Input GUNSEA2(M74), this is used for measuring the amount of Fix Tip which is same as GUNSEA2 of GUNSEA. Therefore, in case of using M74, IGUNSEA Function should be used after GUNSEA1

(3) Do GUNSEA Reference position Record.

(4) Execute Welding Program.

(5) Executing GUNSEA Program, offset the amount of tip consumption.



◆ 【ATTENTION】 ◆

- Move Tip is moved as designated search speed, and target position of search is the axis constant position of SERVO GUN.
- If I signal is not inputted up to target position on executing external signal input GUNSEA2, the error-『E1320 Sensor doesn't search operation.』is occurred.

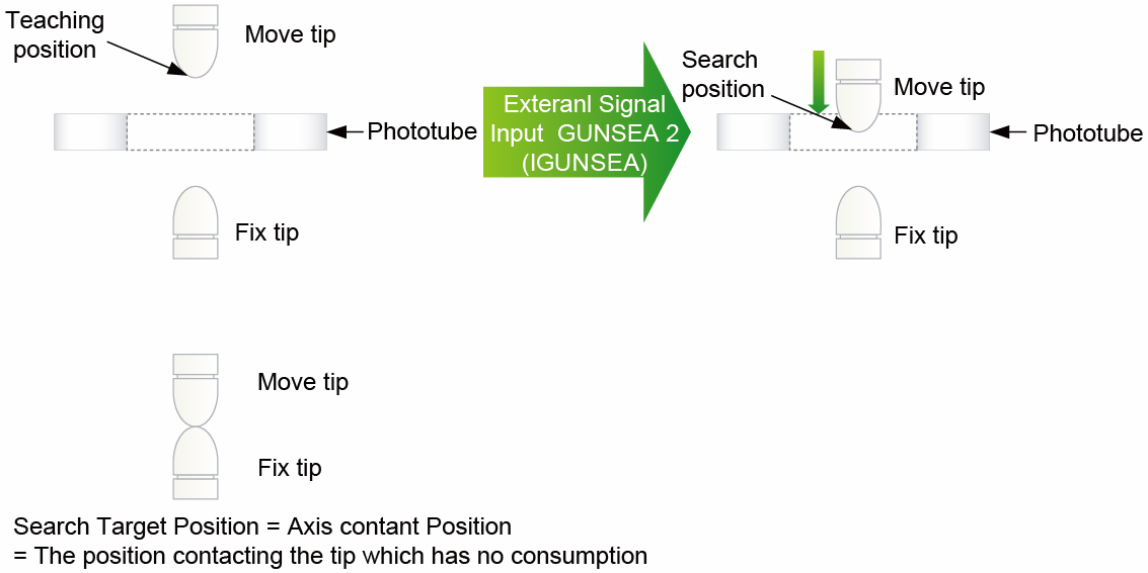


Figure 5.6 External Signal Input GUNSEA2

5.5.2. IGUNSEA Parameter

IGUNSEA GN=<gun num.>,SP=<search speed> DI=<input sig.>,DT=<detection log.>

Item	Range	Details
gun num.	1~2	Designate Gun No. to measure the consumption amount.
Search Speed	1.0~250mm/s	Gun axis designates movement speed when doing search movement. Search speed by input signal is in the basis of safety speed and recommended speed is 10mm/s.
input sig.	1~44	Phototube Output designates the number about accessed input signal.
detection log.	0~1	Designate the detecting level of signal. When it is 0 = Low, detect it. (Normal High) When it is 1 = High, detect it. (Normal Low)

◆ 【ATTENTION】 ◆

- When doing I signal On/Off settings, confirm『[PF2]: System』 → 『2: Controller parameter』 → 『1: Setting input & output signal』 → 『1: Input signal logic』.
- Assigned input signal logic is easy to set up the logic of phototube after setting up it as 'Positive."
- In case input signal logic is 'negative', the signal is outputted as high in the phototube. However, the same signal is detected as Low.

Input Signal Logic of assigned I signal	IGUNSEA I Signal On/Off	Output Signal of the phototube when detecting signal
Positive	On(1)	When it is High, detect it. (Normal Low)
	Off(0)	When it is Low, detect it. (Normal High)
Negative	On(1)	When it is Low, detect it. (Normal High)
	Off(0)	When it is High, detect it. (Normal Low)

6
PROGRAM WRITING

Using SERVO GUN, it is teaching Spot Welding Step(Spot Welding Function-Step: SPOT is recorded) or GUNSEA Step (GUNSEA Function-Step: GUNSEA is recorded.)

Before starting teaching, you should execute it as below,

- Confirm the completion of constant settings of Robot body.
- In case of recording reference position using GUNSEA1 and GUNSEA2, please execute GUNSEA reference position record after attaching the Tip which is not worn.
- In case of teaching step, please confirm that the consumption amount is set up correctly in advance.
- In case of teaching Spot Welding Step, please you should use one-touch record function(This is the operating function pressing [record]key while GUNLED of T/P is turned on)

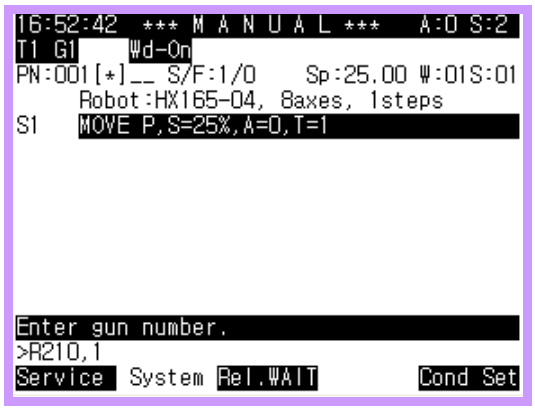
6.1. Selecting Gun No.

This is the function to select Gun in case of using MultiGun. You should select Gun to operate before performing manual opening/closing and manual Gun pressure. Also, tool No. is changed automatically by correspondence of Gun No. and Tool No.

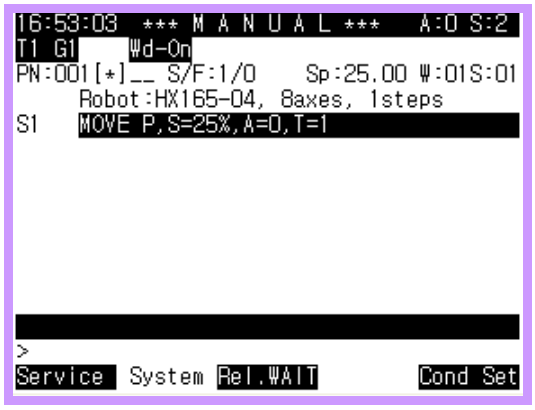
6.1.1. How to operate

(1) Select Manual Mode.

(2) Inputting R210[SET], input Gun No. to select.



(3) Gun No. and Tool No. are changed by Gun No. Correspondence Tool No. as below.



◆ 【ATTENTION】 ◆

- When using Gun Change Function, you can not select Gun No. with R210.

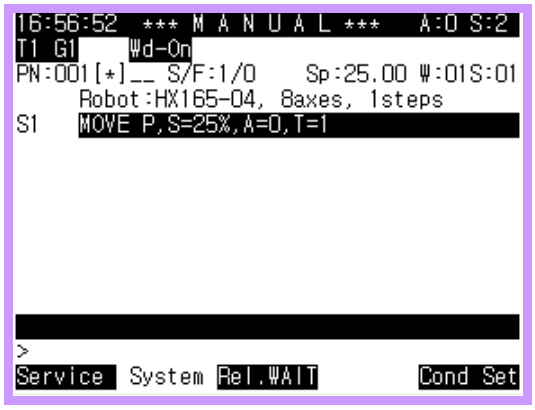
6.2. Selecting Condition No. & Sequence No.

6.2.1. How to operate SERVO GUN Welding Condition No. Selection Function

In one-touch record, select Welding Condition No. recorded in Spot Welding Function(SPOT). Before operating it, assign 『Welding condition selection』at 『[PF2]: System』 → 『2: Controller parameter』 → 『11: f-key Settings』.

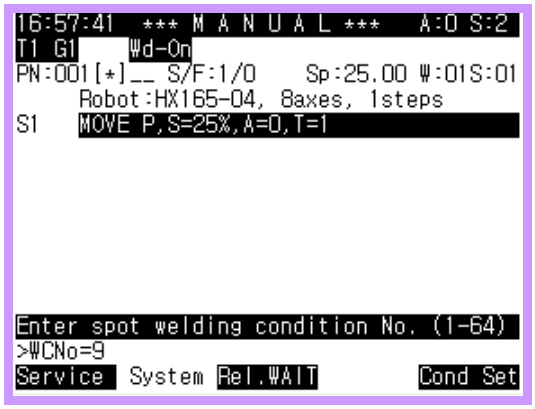
(1) This can be used in both manual mode and auto mode.

(2) In case Welding Condition is not selected, Welding Condition & Sequence is designated as 1.



(3) Press [f*] key simultaneously assigning 『SERVO GUN Welding Condition No.』on Teach Pendant.

(4) At the bottom of screen, you can input Welding Condition No.



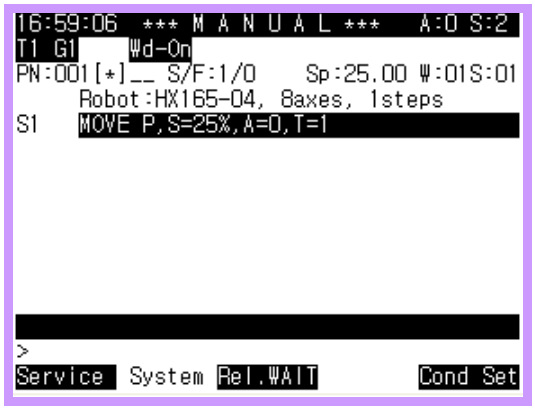
(5) Inputting corresponding No, Welding Condition No. is changed.

6.2.2. How to operate Welding sequence selection Function

When sing one-touch record function, select Welding Sequence No. recorded in Spot Welding Function(SPOT). Before operating it, assign 『Welding sequence selection』at 『[PF2]: System』 → 『2: Controller parameter』 → 『11: f-key Setting』

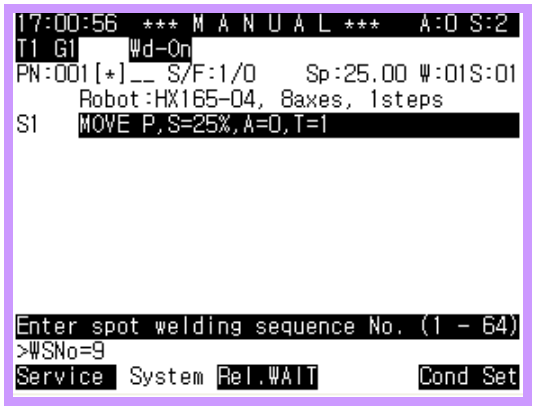
(1) This can be selected in both manual mode and auto mode.

(2) In case Welding Condition is not selected, Welding Condition & Sequence is designated as 1.

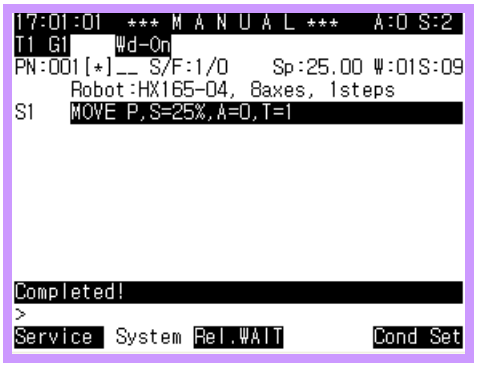


(3) Press [f*] key simultaneously assigning 『Servo gun welding sequence No.』on Teach Pendant.

(4) At the bottom of screen, you can input Welding Condition No.



(5) Inputting corresponding No, Welding Condition No. is changed.



6.3. SERVO GUN Manual Open/Close

In manual mode, perform opening & closing of Servo Gun Axis. Through this simple operation, it can move Servo Gun to the position of Large Stroke or Small Stroke. It offers convenience for teaching operation.

6.3.1. How to operate

Before performing Manual Open/Close, assign 『[PF2]: System』 → 『2: Controller parameter』 → 『11: f-key Setting』

(1) Jog on in manual mode and prepare running.

(2) Press [f] key simultaneously assigning [SHIFT] key and 『SERVO GUN Manual Open/Close』 of Teach Pendant.

(3) Perform opening & closing same as below Figure.

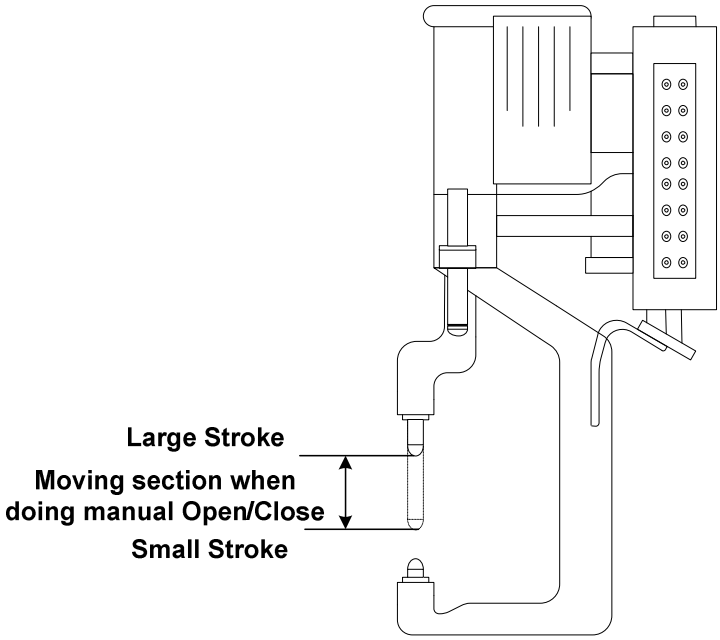


Figure 6.1 SERVO GUN Manual Open/Close

◆ 【ATTENTION】 ◆

- Reaching Large Stroke or Small Stroke, halt it.
- After inputting controller supply, move to Large Stroke for the initial operation.
- Movement speed of Servo Gun Manual Open/Close is moved to 『2: Step go/back max.speed』 of condition settings.
- While operating Servo Gun Manual Open/Close, it halts the movement by not pressing [f] key, however, it doesn't halt the movement by not pressing [SHIFT] key.

6.4. SERVO GUN Manual Squeeze

In the state of limiting pressure in manual mode, it is possible to do manual squeeze of Gun or open it up to Small Stroke. When teaching Welding Step, you should use Servo Gun Manual squeeze because it is recorded in the state of being pressure.

6.4.1. How to operate

Before performing Servo Gun Manual squeeze, assign SERVO GUN Manual squeeze at [f] key to assign it at 『[PF2]: System』 → 『2: Controller parameter』 → 『11: f-key Setting』

(1) Select Manual Mode, prepare running and then confirm Jog which is ON.

(2) Set up pressure when performing Servo Gun Manual squeeze by R211 code.

(3) Press them simultaneously both [SHIFT] key of Teach Pendant and [f] key assigning 『SERVO GUN Manual squeeze』

(4) Perform pressure movement or open movement within Small Stroke range same as below Figure.

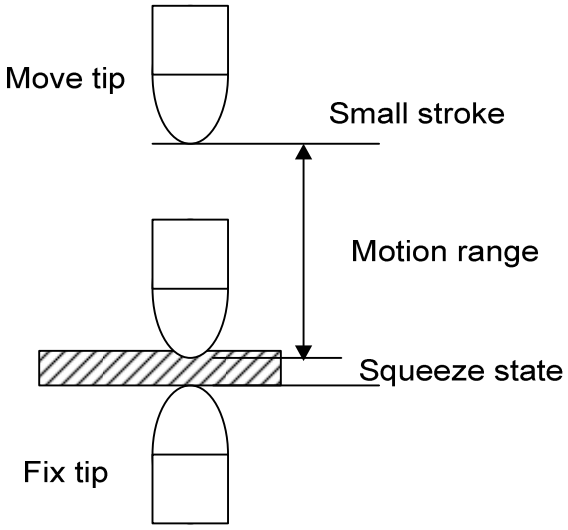


Figure 6.2 SERVO GUN Manual squeeze

◆ 【ATTENTION】 ◆

- Reaching Small Stroke or pressure to designated value, halt it.
- Limited pressure is set up by the value executed finally between the pressure of welding condition designated in Spot Welding executed last or pressure designated as R211.
- In case designated pressure is not enough, it might be not moving. Therefore, set up enough pressure.

6.5. SERVO GUN Large Open by External Input Signal

This is used for moving SERVO GUN to Large Open position without operating Teach Pendant in auto mode. In auto mode, operation of Servo Gun is not done by external input signal.

6.5.1. Assigning external input signal

Please refer to 『2.2 Assigning Input Output Signal』 for assignment method of input signal.

6.5.2. Assigning External Input Signal

(1) Confirm selected GUN No. of Servo Gun and then change it as GUN No. to change.

(2) Select auto mode. Turn running preparation on if it is not done.

(3) Input Servo Gun Large Open Signal to designated No.

(4) While the signal is inputted, Servo Gun moves to target position.

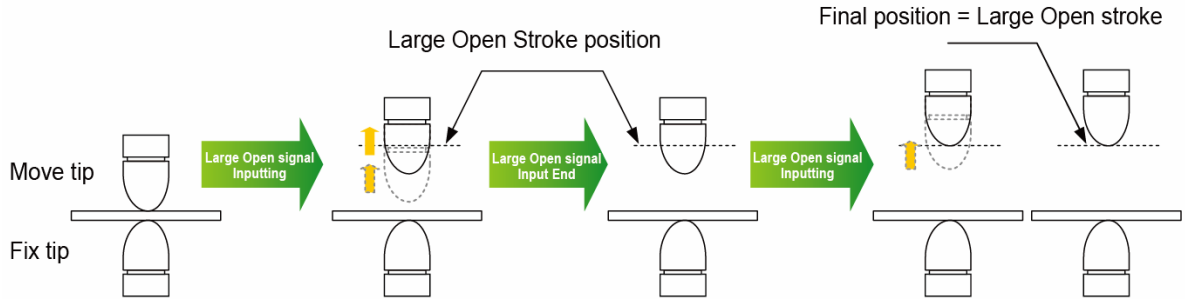


Figure 6.3 SERVO GUN Large Open by External Input Signal

(5) Target position of Servo Gun is the position designated by Large Stroke of parameter.

◆ 【ATTENTION】 ◆

- When reaching Large Open Position, Tip is halted.
- Fix Tip does not move.(Equalizing movement does not perform)
- When SERVO GUN Large Open Signal is OFF, it is halted.
- It can not use on Teaching Mode or Playback.
- When SERVO GUN Large Open/Small Open Signal are inputted at the same time, SERVO GUN does not perform Open Movement.
- In case External Input Signal is inputted continuously, playback of program is impossible.

6.6. SERVO GUN Small Open by External Input Signal

This is used for moving SERVO GUN to small open position without operating Teach Pendant in auto mode. In manual mode, operation of Servo Gun is not done by external input signal.

6.6.1. Assigning External Input Signal

Please refer to 『2.2 Assigning Input Output Signal』 for assignment method of input signal.

(1) Confirm selected GUN number of Servo Gun and then change it as GUN No. to operate.

(2) Select auto mode. Turn running preparation On if it is not done.

(3) Input Servo Gun Large Open Signal to designated No.

(4) While the signal is inputted, Servo Gun moves to target position.

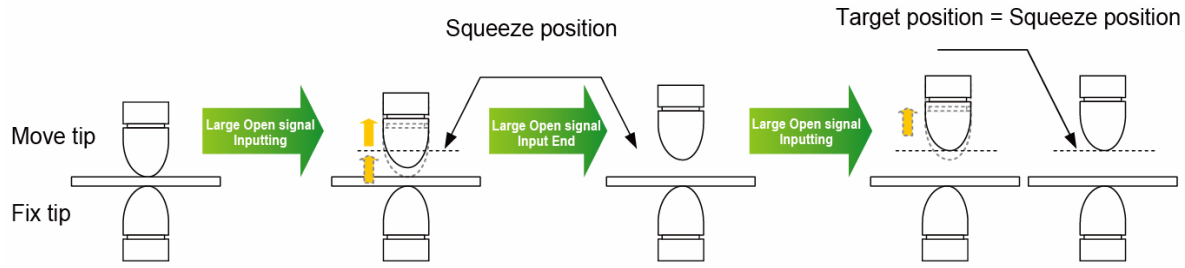


Figure 6.4 SERVO GUN Small Open by External Input Signal

◆ 【ATTENTION】 ◆

- When reaching Small Open Position, Tip is halted.
- Fix Tip does not move.(Equalizing movement does not perform)
- When SERVO GUN Small Open Signal is OFF, it is halted.
- It can not use on Teaching Mode or Playback.
- When SERVO GUN Large Open/Small Open Signal are inputted at the same time, GUN does not perform Open Movement.
- In case External Input Signal is inputted continuously, playback of program is impossible.

6.7. JOG Movement

Pressing [AUX AXIS] key of Teach Pendant, auxiliary axis LED of upper part of Teach Pendant is On, and pressing [Left/T1(Positive)], [Right/T1(Reverse)] key, you can do manual operation of Servo Gun Axis. At this point, when LED is On, jog key of Additional-Axis is performed only. Therefore, jog movement of robot is not available.
Jog movement of Servo Gun Axis moves regularly regardless of coordinate system. Jog Movement Speed(Speed Level 8 Standard) is 25% of Additional-Axis Max. Speed. (However, it is limited as Max 250mm/sec)
When moving Jog, 『W0108 In jog moving, Pressure exceeded!』in case actual pressure is bigger that designated pressure.

◆【ATTENTION】◆

- To operating pressure by teaching step or limiting pressure, 『SERVO GUN Manual squeeze』should be required. When moving Jog, it applies pressure limit. Therefore,『W0108 In jog moving, Pressure exceeded!』is occurred in case the designated pressure is rather low but Jog movement is available.

6.8. Teaching of SPOT Steps

The position of SERVO GUN Axis is recorded as auxiliary axis by [REC]key of TeachPendant same as Robot Axis.

6.8.1. Parameters of Spot Welding Function (SPOT)

Spot Welding Function sets up parameters of 3 units as below,

Spot Welding Function sets up parameters of 3 units as below,

```
SPOT GN=<gun num.>, CN=<weld.cond.num.>, SQ=<sequence num.>
```

(1) Gun num. [1 - 2] : Designate Gun No. to weld.

(2) Welding Cond. num. [1-63] : Designate Welding Condition No. that pressure and Welding Condition Output Data are set up.

(3) Sequence num.[1-63] : Designate Welding Sequence No. that pressure signal and welding signal existed/not existed etc. are set up.

【ATTENTION】

- When using Multi Servo Gun and selecting Gun No.(R210), Tool No. is changed automatically. However, when selecting tool No., Gun No. at R29 is not changed automatically.
- Spot Welding Function should be recorded as the first function of a step. If it is not recorded as the first function, it is not executed. In case of recording it that GUN LED is ON, SPOT command is recorded as the first function by one-touch record function. Also, consumption offset is performed correctly.

6.8.2. Parameter of Spot Welding Function(SPOT)

One-touch record function is the function registering SPOT command in the aggregate by pressing [REC] key in the state that GUN LED is turned on. At this point, record position is recorded by consumption offset of Tip.

Parameter of SPOT Command is same as below,

- Gun No. : Gun No. which is selected as Gun No. Selection (R210) is recorded.
- Welding Cond. num.
  Welding Condition No. which is selected as Spot Welding Condition Selection (SHIFT+f*) is recorded. (Refer to Manual Spot Welding Condition Selection.)
- Sequence num.
  Welding Sequence No. selected as Spot Welding Sequence Selection(SHIFT+f*) is recorded. (Refer to Manual Spot Welding Sequence Selection.)

6.8.3. How to operate

(1) Select Manual Mode.

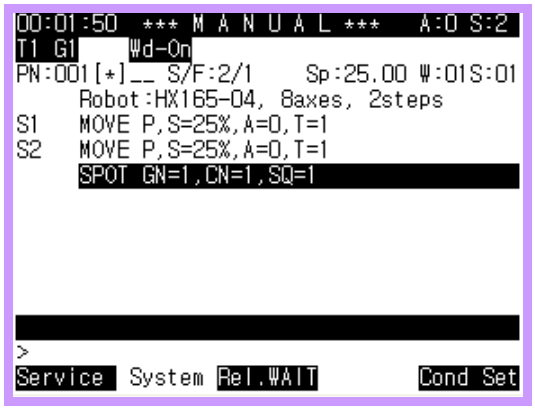
(2) Select Spot Welding Condition& Spot Welding Sequence.

(3) Set pressure with Squeeze force setting (R211).

(4) After contacting Fix Tip on the workpiece by robot jog movement, press the workpiece to weld by Servo Gun Manual squeeze Movement.

(5) Confirm it by pressing [GUN] key that GUN LED of TeachPendant is turned on.

(6) Recording Step by pressing [REC] key, below screen apears.



(7) Perform pressure release and opening for Move Tip by SERVO GUN Manual squeeze Movement (SHIFT + f*).

(8) Move robot to next step record position.

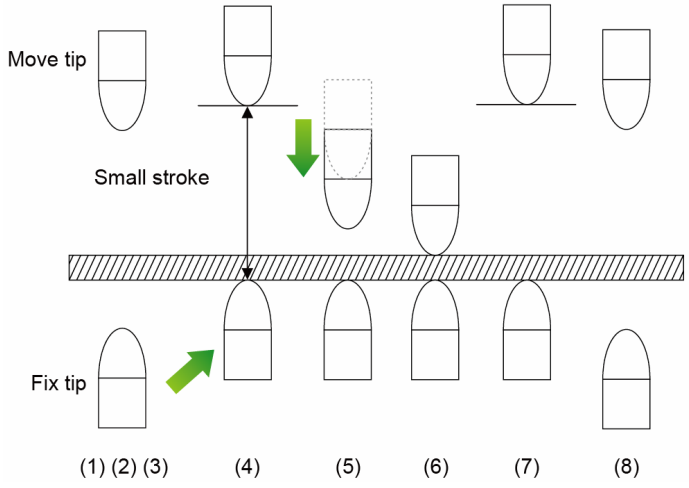


Figure 6.5 How to operate Teaching in order for Servo Gun

◆【ATTENTION】◆

- When recording one-touch, the record of Spot Welding Function should be recorded by one-touch record only because the position offsetting the amount of Tip value. In case of not recording one-touch, it records the position of step without offsetting the amount of Tip consumption.
- In case of recording & adjusting welding point, you should apply low pressure to prevent the welding object from distortion by pressure when operating Servo Gun Manual squeeze.
- In case of not applying Servo Gun Manual squeeze by low pressure, move the position of Fix Tip to prevent the welding object from bending in pressure state and then operate it.
- In case of adjusting Step recording SPOT command, it is adjusted to the position considering the consumption amount automatically.

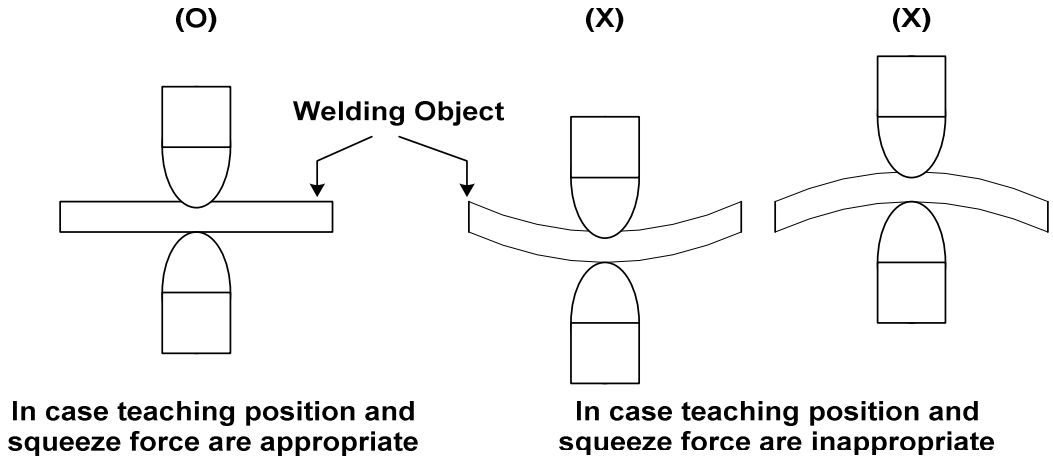


Figure 6.6 Example of Step Teaching

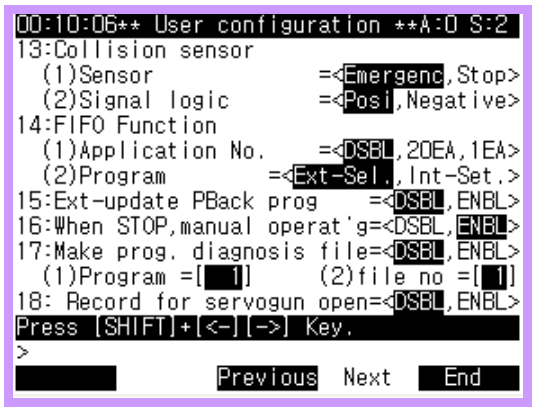
6.9. Servo gun open teaching

This function is only valid from the versions of which the ※ main software version is 20.01-04 or after of the Hi4a controller.

The servo gun open teaching is the method of contacting only the Fix Tip to the spot welding workpiece when the panel thickness is registered to the welding condition. This method can save a considerable amount of teaching time compared to the existing teaching method be eliminating the teaching step of Move Tip location.

6.9.1. Effectiveness setting of servo gun open teaching

(1) Select 『[PF2]: System』 → 『1: User parameter』.



(2) 18: Record for servogun open to ‘ENBL’.

◆ 【ATTENTION】 ◆

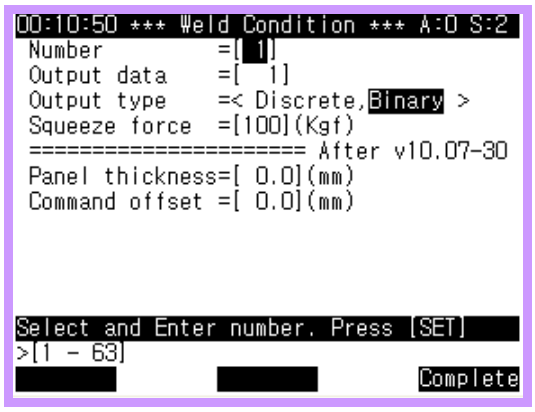
- When the “Record for servogun open” set to ‘DSBL’, the servo gun open teaching cannot be executed.

6.9.2. Panel thickness registration

Because the servo gun open teaching uses the panel thickness that has been saved beforehand, and calculates the location of the Move Tip, the panel thickness must be registered.

You can register the panel thickness by directly entering the values or by using the pressure teaching method.

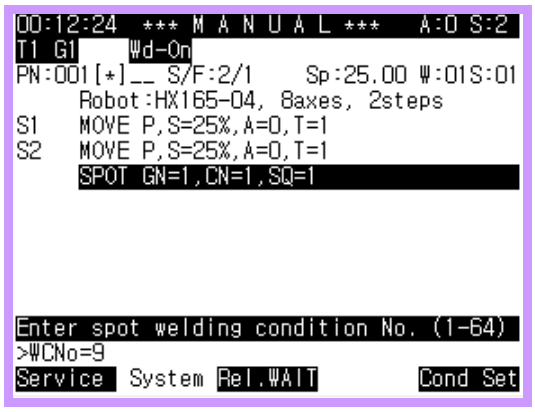
(1) Select 『[PF2]: System』 → 『4: Application parameter』 → 『1: Spot & stud』 → 『3: Servo gun welding data (condition, sequence)』 → 『2: Welding condition』.



(2) Set the value of panel thickness and command offset.

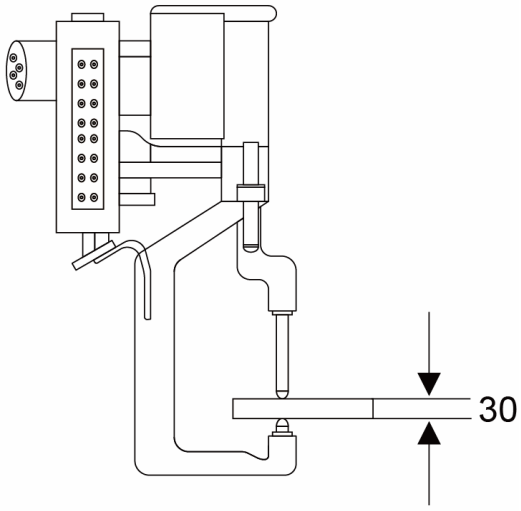
- Panel thickness: Enter the value when you want to manually enter the value.
- Command Offset
  This is only effective when the servo gun open teaching is set to 'Effective'. If you set to any non-zero value, it will ignore the the offset set value of the set command value in the servo gun parameter, and apply the set value from this location.

(3) When you want to automatically register the panel thickness, you can use the manual selection function for the welding condition. (Use the user key setting to assign the F key.)

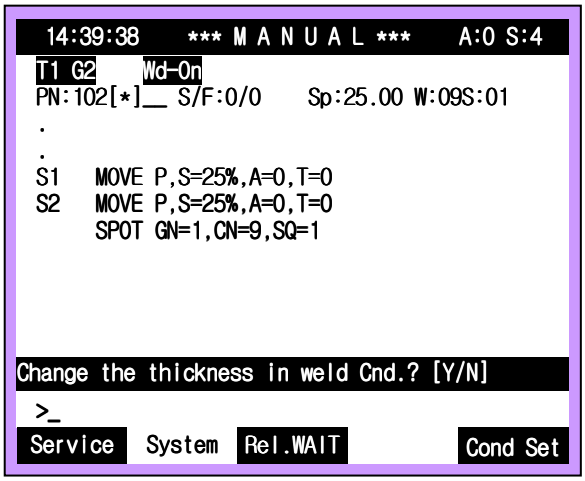


(4) Select the welding condition number.

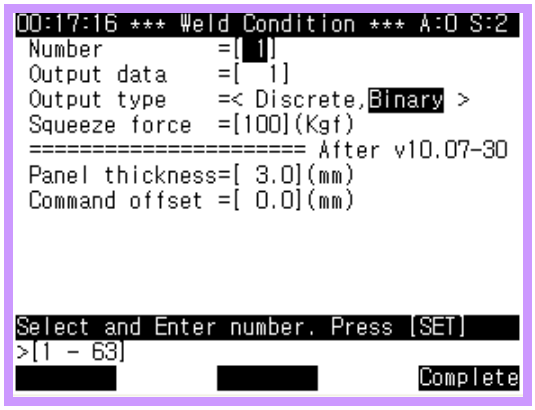
(5) With the 'GUN' LED on, press the 'REC' key while the servo gun is applying the pressure to the panel.



(6) When you press the "REC" key in the pressuring condition, it will prompt the message asking "Change the thickness in weld Cnd.?".



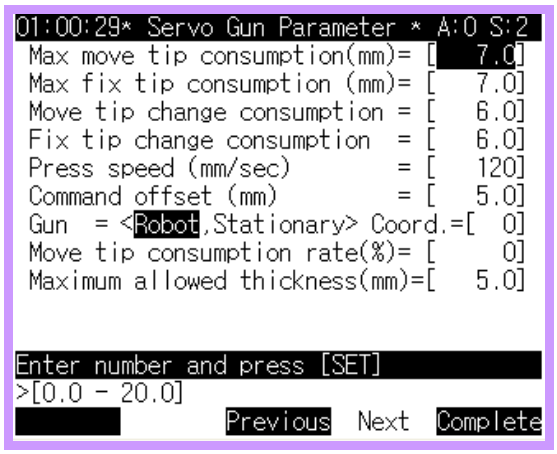
(7) Select Yes and register the panel thickness. When you enter the applicable welding condition menu, you can check the changed panel thickness.



◆ 【ATTENTION】 ◆

- Register the panel thickness after checking the welding condition number to set. If you select the welding condition to register the panel thickness and teach the thickness with the pressure, it can change the panel thickness to a new value.

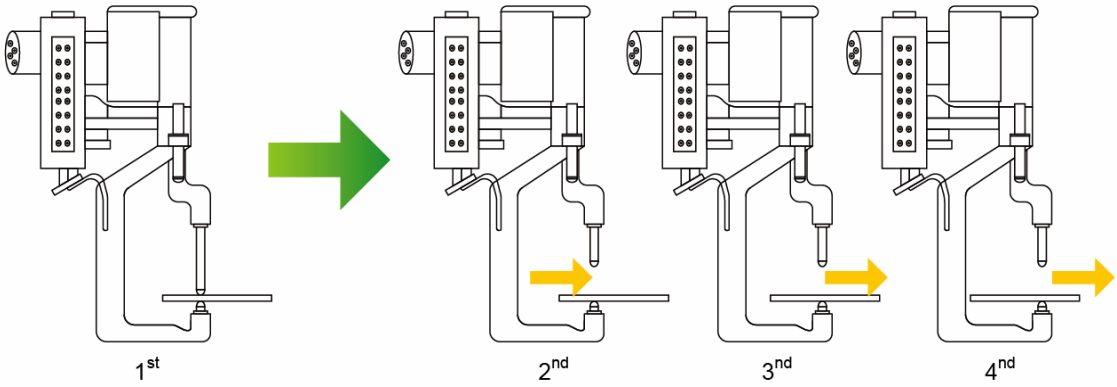
- When the measured value exceeds the maximum permitted plate thickness set in the servo gun parameter, it will generate an error, and the panel thickness will not be registered to the step recording and welding condition.



6.9.3. Teaching method If the panel thickness is not registered, you must at least once initially apply the pressure to register the panel.

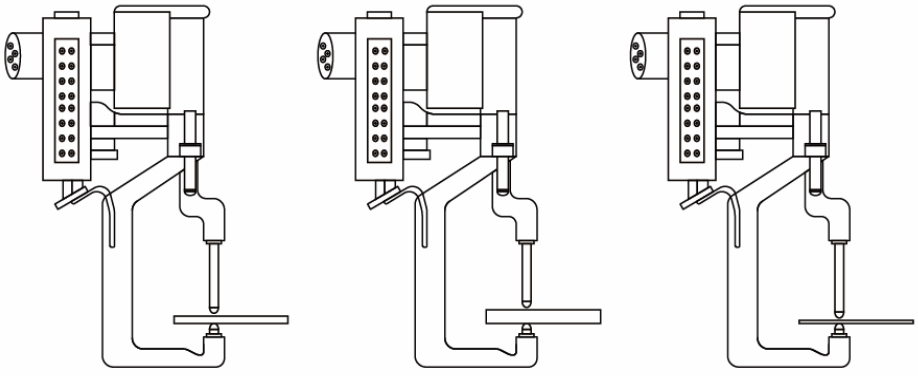
(1) If the panel thickness is not registered, you must at least once initially apply the pressure to register the panel.

(2) From the second teaching, you can proceed the teaching by letting only the Fix Tip touch the panel and keep the Move Tip open.



Register panel thickness ➔ Teach servo gun opening
Work method of same panel thickness

(3) If there are several types of panel thickness to weld, register the several panel thicknesses to the welding condition, and select/teach the panel thickness by selecting the welding condition that fist the panel thickness.

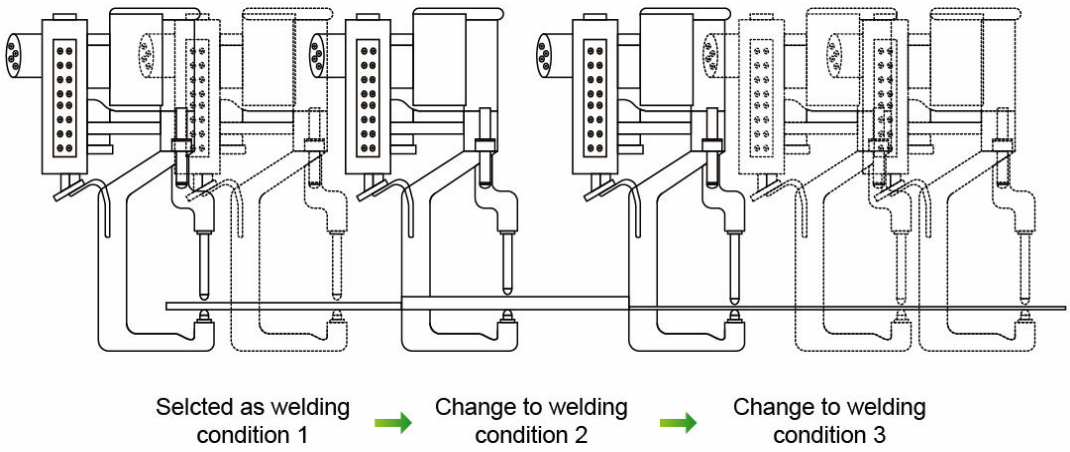


Weding condition 1
Pressrue = 150kgf
Panel thickness = 30mm
Command OFFSET = 5mm

Weding condition 2
Pressrue = 350kgf
Panel thickness = 60mm
Command OFFSET = 5mm

Weding condition 3
Pressrue = 100kgf
Panel thickness = 5mm
Command OFFSET = 3mm

As shown below, record the Fix Tip in open condition while changing the welding condition.



7 Program Playback

7.1. System Setting

It shows the SERVO GUN axis and Robot axis' movement when the step is playback.

- Shift (Consumption offset function excepted)
  All the functions for Shift(Offline, Online, Search, Palletize) are applied only to Robot, and SERVO GUN axis is moved to the recorded location.

- Coordinate change
  The movement components for Robot are changed but SERVO GUN axis is not changed.

- Relative Program call function application
  The Robot's opponent location is separately applied and shifted.

- Mirror image
  It is applied only when the selected Additional-Axis' components are on the running axis. The SERVO GUN axis is not related.

7.2. Spot welding function playback

The playback of the spot welding function is operated same as below,

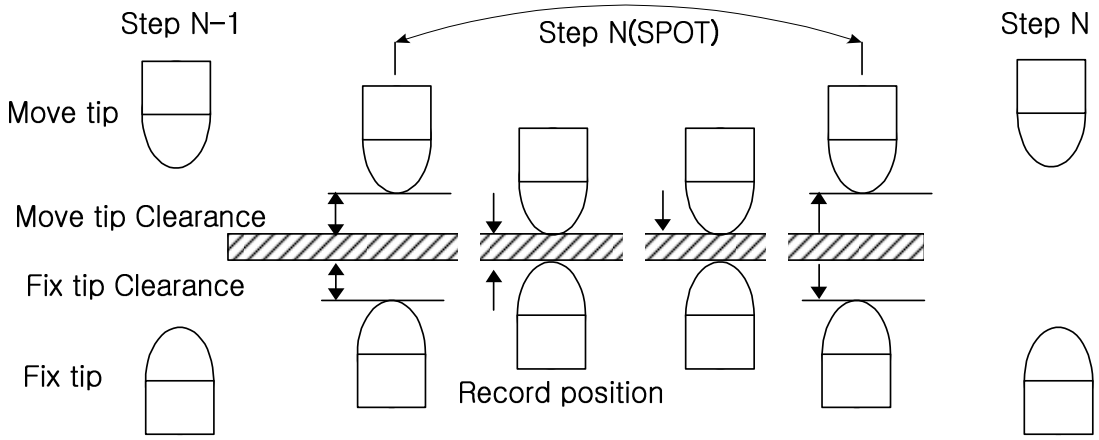


Figure 7.1 Spot welding playback

(1) When you playback the SPOT recorded step-welding step, the Move Tip moves from the former step location as much as the Move Tip clearance on the record position and, the Fix Tip moves as much as the Fix Tip clearance on the record position. When this procedure occurs, the Move Tip and the Fix Tip's location are determined after compensating each Tip's consumption amount. These Tips will be arrived simultaneously from the clearance location to the pressure location.

(2) The Move Tip and the Fix Tip move to the step's record position as much as each Clearance.

(3) Apply pressure with the set amount.

(4) When Welding complete(WI) is entered, the Move Tip and the Fix Tip are opened as much as each Clearance.

(5) Move to the next step.

◆【ATTENTION】◆

- When playback step Forward/Backward in the manual mode, without regard to the option status,『[PF5]: Cond Set』 → 『3: Func in step GO/BACK』, always carry out.
- In case of the ROBOT GUN, when the spot welding function recorded step is playback, shift as much as the Move Tip and Fix Tip's consumption amount on the tool coordinates then playback.
- In case of Stationary GUN, when the spot welding function recorded step is playback, shift as much as the Move Tip and Fix Tip's consumption amount on the user coordinate system then playback.
- Without recording the GUNSEA's reference position, spot step's playback is possible
- In case of playback a step that doesn't have spot welding function record, it reaches to the original record position without consumption compensation.
- When using the multi SERVO GUN type as a robot gun, if the step condition's tool number and spot welding function's gun number are not accord with the tool number(G1→T0, G2→T1), error message,『E1308 Tool No. of selected step is wrong』appears.
- In case of using multi servo gun type as a Stationary GUN, an error doesn't occur although a tool number and a gun number are not accord with each other.

7.3. Spot welding output method

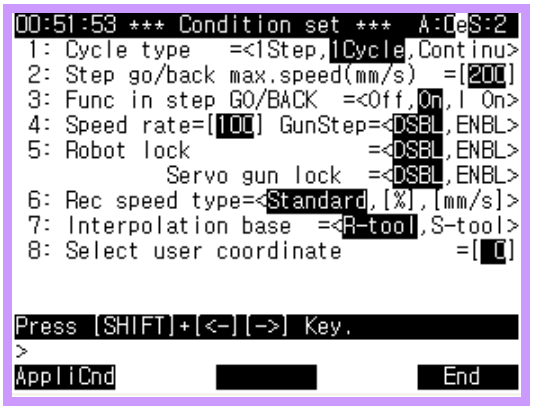
You can restrict the output of pressure fulfilling and electric current signal without regard to the designated welding sequence that has been confirmed when carrying out the spot welding function. This function is useful to confirm a teaching location.

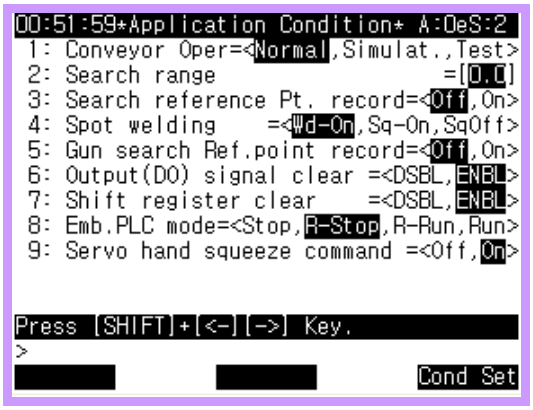
Output method	Contents
Wd-On	It fulfills all welding sequence designated on the spot welding function.
Sq-On	It fulfills welding sequence except electric current signal. You can identify the pressure location because the WI Wait is happened while maintaining the pressure.
Sq-Off	Pressure motion, electric current signal output, WI wait are not carried out.

7.3.1. How to operate

(1) The setting is possible in both the manual and auto mode.

(2) After selecting 『[PF5]: Cond Set』, if you select『[PF1]: AppliCnd』, below screen appears.

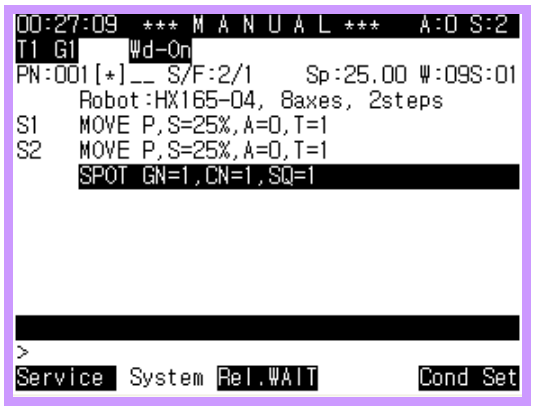




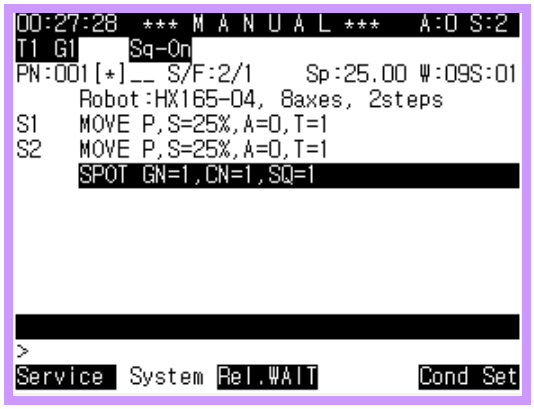
(3) After selecting pertinent item in『4: Spot welding』, select 『[PF5]: End』.

(4) In accordance with the selected item, the state is appeared on the upper part of a screen.

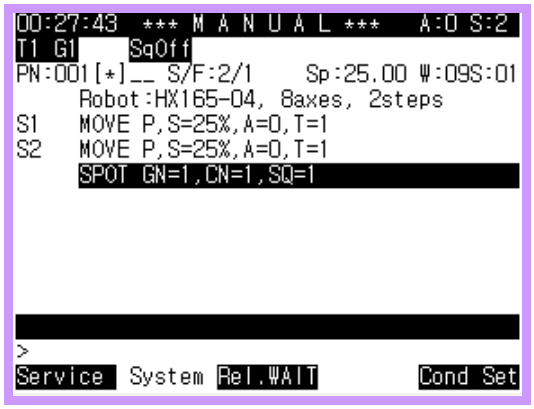
▣ In Wd-On setting



▣ In Sq-On setting



▣ In SqOff setting



(5) Playback the step.

(6) After identifying the welding step location, set to the 『Wd-On』, certainly.

◆【ATTENTION】◆

- When you playback in『SqOff』set, after moving to clearance location without pressure, it moves to the next step like below.

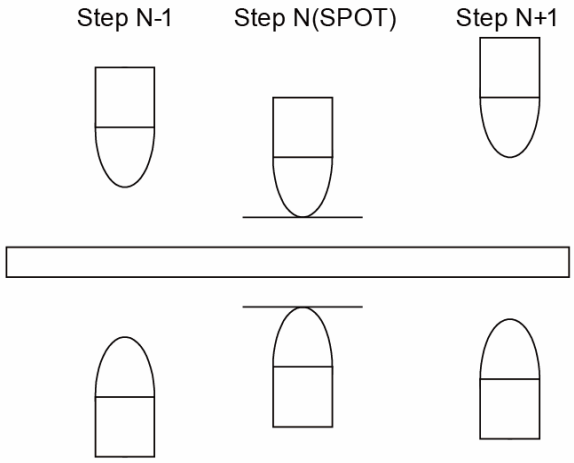
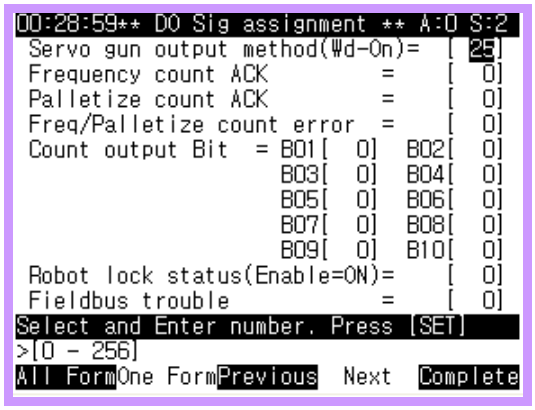


Figure 7.2 SqOff playback

7.3.2. Assignment of the Wd-On signal output

Without identifying the spot welding output method setting in the condition settings, by using the external signal, the user can allocate the output signal to identify whether a current condition setting's spot welding output method is set to Wd-On. This function is, using external signal, to identify whether the condition is possible to weld or not.

(1) Select the sequence of 『[PF2]: System』 → 『2: Controller parameter』 → 『1: Setting input & output signal』 → 『6: Output signal assigning』.



(2) Identify the number that has been allocated to the servo gun welding output method. When it is set to 0, it means that there is no allocation.

(3) In case of Wd-On, the signal comes out with On to the allocated port and, in case of Sq-on or Sq-off, there is no signal.

7.4. Tip dressing

7.4.1. Tip dressing function's condition setting

- Welding condition / Welding Sequence

(1) Set the welding condition. About this, please refer to 3.3 Welding condition Edit.

(2) To use as a signal to drive the motor of the tip dresser, set the number of the welding condition No. 64 that is exclusive for the tip dressing.

(3) Set the 『Tip dressing time』 on the welding condition No. 64 that has been allocated for the tip dressing.

- Signal's connection.

(1) Allocate the welding condition signal.

(2) Connect the signal that is used for driving the tip dresser to the output signal of the welding condition No. 64.

(3) About the allocation of the welding condition signal output, please refer to 『2.2 Assigning Input Output Signal』.

7.5. Gun Unlock

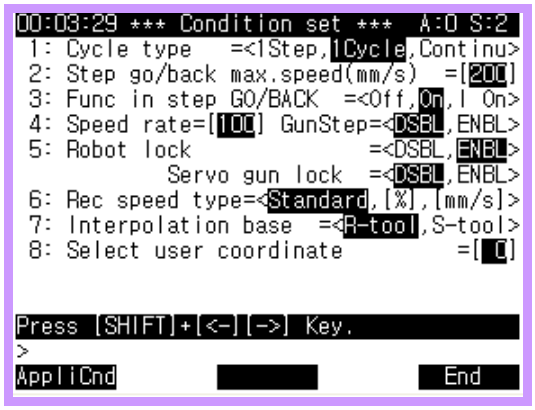
7.5.1. Outline

This function is used only when replaying the program using the robot lock function.
Because in case of the robot lock status, all axes of the robot are not moved, So, when you playback after setting the robot lock, pressures would not be in accordance with the presetted pressure. This means the robot doesn't playback any more. But although the robot lock is in <ENBL>, this function makes the moves servo gun's axis move normally except the other axes.

7.5.2. Functional outline

(1) Before playback the program, select『[PF5]: Cond Set』.

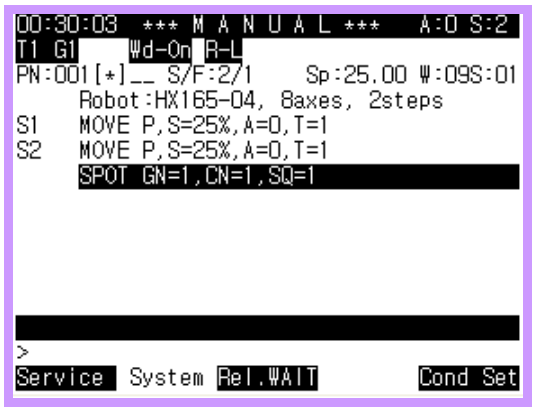
(2) To use the Gun Unlock function, set the robot lock in <ENBL> and servo gun lock in <DSBL>.



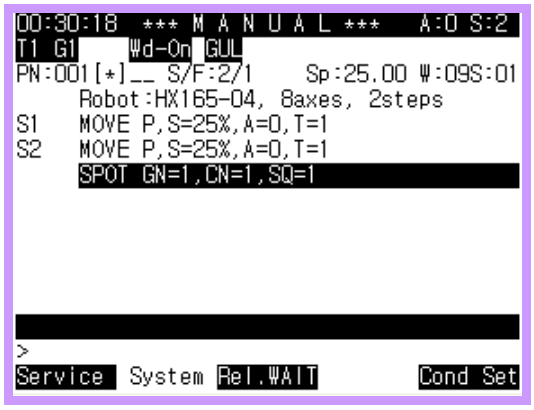
7.5.3. Playback

(1) When returning to the auto or manual mode after completing the condition setting, the flowing signal will be flashed on the upper screen.

▣ In case of robot lock(Robot Lock<ENBL>, SERVO GUN axis Lock<ENBL>)



▣ In case of Gun Unlock(Robot Lock<ENBL>, SERVO GUN axis Lock<DSBL>)



(2) When you playback in the robot lock, the axis monitoring on the teach pendant moves both the robot and the servo gun. However, both of them are not moved.

(3) In case of the gun unlock, the axis monitoring on the teach pendant moves both the robot and the servo gun but, only the servo gun axis is actually moved.

8

R code and Monitoring Function

8.1. Gun number selection (R210)

When you use the multi servo gun, you can use this function to select a gun. Before the manual open/shut and pressure of the servo gun, it is used to select a gun to operate. In case of changing the number of a gun, the tool number will be changed to accord the gun number and the tool number. For more details, please refer to 『**4.1. Gun number selection**』

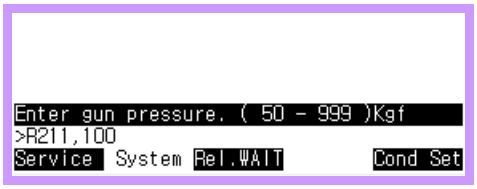
8.2. Squeeze force setting (R211)

It designates the pressure for the SERVO GUN manual squeeze.

8.2.1. Operation

(1) Select the teaching mode.

(2) When you enter the R211+[SET], below screen is appeared.



(3) After entering the pressure, push the [SET] key.

◆【ATTENTION】◆

- The pressure of the welding condition file is not changed.
- The pressure can not be set beyond the range of the servo gun parameter's current pressure table.

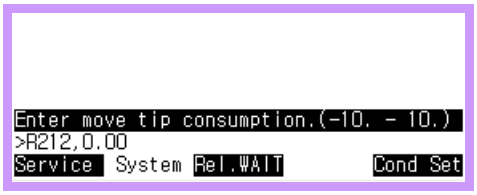
8.3. Moving-Tip Consumption Preset(R212) and Fixed-Tip Consumption Preset(R213)

Using this function, you can designate the consumption of the Fixed and Move Tip as you want.

8.3.1. R212 Operation

(1) You can operate both in manual and auto mode.

(2) When entering R212+[SET], below screen is appeared.

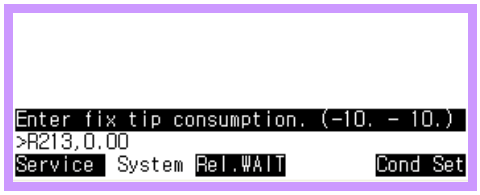


(3) After entering the Consumption, press the [SET] key.

8.3.2. R213 Operation

(1) You can operate both in manual and automatic mode.
(You can operate both in manual and auto mode.

(2) When entering R213+[SET], below screen is appeared.



(3) After entering the Consumption, press the [SET] key.

◆ 【ATTENTION】 ◆

- When the Moving-tip consumption preset (R212) is fulfilled, using this function, you can temporarily set the current tip's consumption as you want without GUNSEA process before another GUNSEA execution.

- When the Fixed-tip consumption preset (R213) is fulfilled, the current Fix Tip's consumption is changed as you designate. Therefore, the reference position for the GUNSEA 1 and the Fix Tip's monitoring amount are changed.
(When the Fixed-tip consumption preset (R213) is fulfilled, the current Fix Tip's consumption is changed temporarily as you designate without GUNSEA process before another GUNSEA execution.

8.4. SERVO GUN monitoring function

8.4.1. Operation time display

It indicates, in real-time, the Servo gun axis' encoder, current, pressure, consumption and so on.

(1) Axis encoder
It indicates the encode value of the selected Servo gun axis.

(2) Axis Current
The present value indicates the feedback current flowing on the servo gun axis and the command value indicates the current restrictive command current (A).

(3) Squeeze force

- Present value: It indicates the actual pressure that conversed from the return value in Pressure-Current table of the servo gun parameter (Kgf).
- Command value: It indicates the conversed pressure value that changed from the current command value in the command-current table (Kgf).

(4) Realistic squeeze force
It indicates the mean pressure between the pressure accordance point and the opening point (Kgf).

(5) Length
It indicates the distance between servo gun axis' Fixed and Move Tips from the reference position (mm).

(6) Consumption

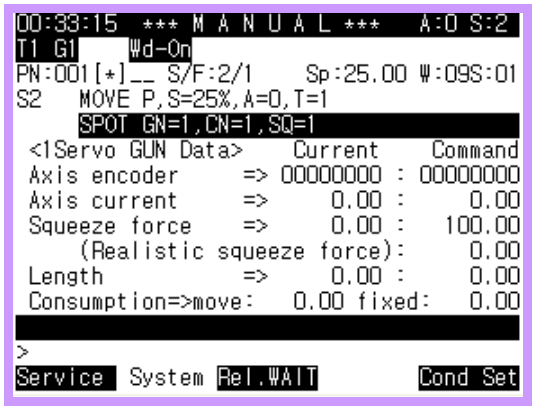
- It indicates the consumption amount of the Move Tip that is detected by the moving-GUNSEA (mm).
- It indicates the consumption amount of the Fix Tip that is detected by the fixed-GUNSEA (mm).

(7) Monitoring data of fixed tip :
It indicates the displacement between the axis constant and the recorded location of the GUNSEA 1 reference position (mm).

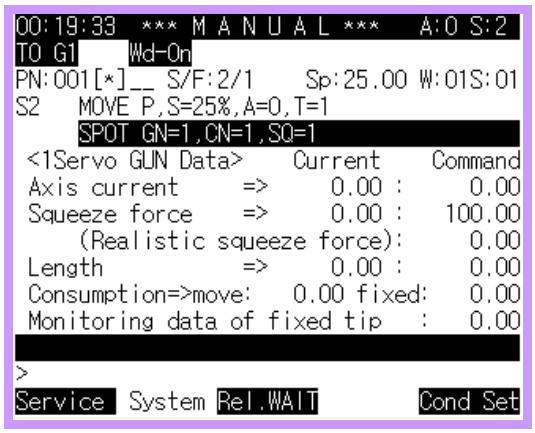
8.4.2. How to operate

(1) Select in order,『[PF1]: Service』 → 『1: Monitoring』 → 『3: Spot/Stud welding Data』→『1: Servo GUN data』.

(2) If you select 『1: Servo GUN data』, the following screen will appear. (In case of being 7display lines.)



(3) If you press SHIFT + ↓, you can get the information about the Monitoring data of fixed tip.



9

Troubleshooting and Errors

9.1. Troubleshooting

Following errors may occur during the operation of SERVO GUN including the function of Additional-Axis.

When E0103 ~ E0108 errors occur,
the Encoder and/or the main body's wiring & connections may have some problems.
To solve the problems, refer to 「Hi4a Controller Maintenance Manual.」

Code	E0103 (○ AX) Enc Err:Process time over
Cause	Encoder data is not received within communication processing time.
Action	Refer to『Hi4a Controller maintenance manual - 5.Troubleshooting』

Code	E0104 (○ AX) Enc Err:Process time over
Cause	Data is received but it is not a specified form.
Action	Refer to『Hi4a Controller maintenance manual - 5.Troubleshooting』

Code	E0105 (○ AX) Enc Err:Cable not connected
Cause	Communication is impossible because of encoder disconnection.
Action	Refer to『Hi4a Controller maintenance manual - 5.Troubleshooting』

Code	E0106 (○ AX) Enc Err:Bad input data
Cause	Data is received but it is not a specified form.
Action	Refer to『Hi4a Controller maintenance manual - 5.Troubleshooting』

Code	E0107 (○ AX) Enc Err:Bad bit sequence
Cause	Data is received but it is not a specified form.
Action	Refer to『Hi4a Controller maintenance manual - 5.Troubleshooting』

Code	E0108 (○ AX) Enc Err:Encoder reset needed
Cause	Encoder data is out of the offset function application range.
Action	Refer to『Hi4a Controller maintenance manual - 5.Troubleshooting』

9.2. Error Messages

Following errors may occur during the operation of SERVO GUN.

Code	E0007 Sticking of weld detected
Cause	Sticking of weld signal is input when welding sequence ends
Action	- Check the sticking of weld detection signal. - Remove sticking of weld.

Code	E0154 Tip consumption exceeded maximum.
Cause	Total tip consumption detected by gun search is in excess of the max tip consumption set in the servo gun parameter.
Action	- Check the max tip consumption of servo gun parameter. - Replace the tip

Code	E0155 Move-tip consumption exceeded max.
Cause	Shift tip consumption detected by gun search is in excess of the masimum shift tip consumption set in the servo gun parameter.
Action	- Check the max tip consumption of servo gun parameter. - Repalce the tip.

Code	E0156 Fix-tip consumption exceeded max
Cause	Fixed tip consumption detected by gun search is in excess of the masimum shift tip consumption set in the servo gun parameter.
Action	- Check the maxi fixed tip consumption of servo gun parameter. - Repalce the tip.

Code	E0171 Gun open time is over
Cause	It took more than 5 seconds for the open time after applying pressure in spot welding and gun search functions.
Action	- Check if the gun is deposited on weldment or if any interference occurs. - Check any deposit or interference of shift gun.

Code	E0210 Fail of Init. of SVG Connection
Cause	Initializing the servo gun connection failured as GUNCHNG ON is instructiond or manual welding gun connection is instructioned.
Action	Check the DSP version is higher than 4.13. In case of lower version, make contact with our company to upgrade. Check if ATC connection is poor or if encoder power is not applied.

Code	E0211 SVG Servo On fail in time limit
Cause	Servo of servo gun is not ON within the limit time.
Action	It is because ATC does not normally process encoder signal due to its poor connection. Remove any foreign matters from ATC, and try again.

Code	E0212 SVG's Servo filter clear is failed
Cause	Filter clear failed during servo gun connection.
Action	Communication is poor between main board and servo board. Check the connection between each board and controller. If no error is found, replace board.

Code	E0213 SVG Servo Off fail in time limit
Cause	Servo is not OFF within the limit time while separating the servo gun.
Action	Check the condition of ATC connection. Replace the servo board.

Code	E0214 SVG Encoder power is not connected
Cause	When processing the servo gun connection, the encoder power connection failed.
Action	Check errors in power control system of servo gun axis encoder, and replay the corresponding part(relay, BD481).

Code	E0215 SVG Encoder power off is failed
Cause	When separating the servo gun axis, encoder power separation failed.
Action	Check errors in power control system of servo gun axis encoder, and replay the corresponding part(relay, BD481).

Code	E0216 SVG Encoder data error
Cause	The result of encoder receiving is abnormal in the processing of servo gun axis connection.
Action	Check the followings on the connected servo gun. Check if encoder battery is discharged, and replace it if so. After replacing battery, reset encoder first before retry.(Be aware that encoder offset reset is required after encoder reset.)

Code	E1036 Welding Interlock time is over
Cause	In case of srvo gun welding operation, welding competion(WI) signal is not input during WI input standby in system/applied parameter/spot & stud/servo gun welding data(condition, sequence)/welding sequence menu
Action	Check the connection of current Welding signal /welding condition signal/welding competin signal and relevant peripheral equipment. If errors occur, refer to “Processing without WI input” of system/applied parameter/spot & stud/servo gun welding data(condition, sequence)/common data in instruction to determine whether to standby until welding completion(WI) signal is input or stop the robot.

Code	E1038 Can't record tip consump. position
Cause	When calibrating the tip consumption and recording the position, robot is postured not to calibrate the tip consumption.
Action	Make sure that the robot posture for calibrating as much as the detected tip consumption should not be out of working envelope.

Code	E1046 Gun is openning by external signal
Cause	Automatic operation signal is input during manual operation of servo gun by external signal.
Action	Complete the manual operation of servo gun before execution.

Code	E1281 Detected welder error signal.
Cause	It occurs when welder error signal is input.
Action	1) Inspect the welder power unit. 2) If you intend to ignore the signal, set the input of corresponding input signal of Arc application as “Disable”.

Code	E1306 Base position data is not recorded
Cause	This error occurs when playing a gun search function or spot welding function without an execution of standard position recording for gun search after making a machine constant file.
Action	Attach a new tip , and execute the standard position recording for gun search.

Code	E1307 Gun search program is abnormal.
Cause	This error occurs when executing gun search 2 without an execution of gun search 1, or when playing spot welding function without a normal termination of gun search.
Action	Execute gun search 1,2 to detect tip wear before starting work.

Code	E1308 Tool No. of selected step is wrong
Cause	This error occurs when the tool numbers corresponding to servo gun numbers are incorrectly specified during a step execution in which spot welding & gun search functions are recorded.
Action	Match the tool numbers of step with gun search & spot function.

Code	E1310 Squeeze force exceeded current LMT
Cause	This error occurs when current limit calculated from instruction pressure is in excess of current limit(IP) of servo amp.
Action	Lower the set pressure, or increase the capacity of servo gun drive unit.

Code	E1311 Squeeze force exceeded overload.
Cause	This error occurs when the instruction pressure is in excess of overload detection level.
Action	Set a lower pressure in expectation of overload error.

Code	E1312 Squeeze target is out of workspace
Cause	This error occurs when result of servo gun pressure position(object position) is out of robot working envelope.
Action	Change the robot posture, and record it.

Code	E1313 Squeeze data out of range in table
Cause	This error occurs when the set pressure in welding condition data of spot welding function(M72) is out of the set pressure range in pressure table of servo gun parameter.
Action	Lower the set pressure

Code	E1314 Squeeze force delay time is over
Cause	This error occurs when the detected tip consumption is larger than the maximum tip consumption of servo gun parameter
Action	Replace the tip, or if necessary, reset the maximum tip consumption of servo gun parameter to an adequate value.

※(Note)

- When the Tip consumption is greater than 『**the max. tip consumption of SERVO GUN Parameter,**』 the error message 『E1314 Squeeze force delay time is over』 can occur during the execution of GUNSEA. If this message shows up, Tips should be replaced or, if necessary, 『**the max. tip consumption of SERVO GUN Parameter**』should be reconfigured with a right one.

Code	E1320 Sensor doesn't search operation.
Cause	This error occurs when sensor does not work even after the robot moved to the target position during wear detecting work with a sensor in a servo gun searching function or robot equalizer function for fixed tip consumption searching.
Action	1) Check if a sensor is working when tip approaches the sensor. 2) Check the connection and connector. 3) Check if the sensor contacting point is correctly specified.

Code	E1326 Disable environment of GUN search2
Cause	The environment is set to calibrate the gun wear only with gun search 1. In this case, the error occurs when executing gun search 2.
Action	Set the environment to calibrate the gun wear by using gun search 1,2. Set the move tip consumption rate(%) to be 0 in a servo gun parameter setting.

Code	E1348 Time out of connection complete.
Cause	Connection of welding gun is not completed within the specified time.
Action	Make sure to send the confirmation signal of welding gun to controller when completing the connection of automatic tool exchange device. Be sure to program it so as to execute GUNCHNG ON, instruction after welding gun completes connecting to ATC.

9.3. Warning Messages

Following warning messages may occur during the operation of SERVO GUN.

Code	W0105 Tip consumption exceeded limit!
Cause	It occurs when total tip consumption detected with gun search is in excess of tip exchange wear set in servo gun parameter.
Action	Inspect the unfixed tip and fixed tip consumption, and replace the tip.

Code	W0106 Move-tip consumption exceeded LMT
Cause	It occurs when unfixed tip consumption detected with gun search is in excess of unfixed tip exchange wear set in servo gun parameter.
Action	Inspect the unfixed tip, and replace the tip.

Code	W0107 Fixed-tip consumption exceeded LMT
Cause	It occurs when fixed tip consumption detected with gun search is in excess of unfixed tip exchange wear set in servo gun parameter.
Action	Inspect the fixed tip, and replace the tip.

Code	W0108 In jog moving, Pressure exceeded!
Cause	It occurs when actual value of pressure is in excess of set value in manual pressurizing. Here operate the servo gun axis in the opposite direction.
Action	Check if force is sufficiently set for the axis you intend to operate. Make contact with servo gun manufacturer because mechanical problem is anticipated in servo gun.

Code	W0109 Change gun No. to jog this SVG
Cause	The servo gun you intend to operate is different from the selected servo gun number.
Action	Servo gun should be operated by manual jog after being selected. Select the servo gun you intend to operate with R210 code before operating.

Code	W0125 Disable position of connected SVG
Cause	The position of servo gun attached by GUNCHNG ON instruction or instruction for manual gun connection is different from the one remained in its memory when separating.
Action	It is normal if it occurs when servo gun is initially connected. If it occurs other than the initial connection, check the followings. It may occur if an incorrect servo gun is selected. Thus, check this out. And check if encoder battery of servo gun is sufficient.

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