HYUNDAI ROBOTICS

WARNING

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

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Hyundai Robot

Hi5aST230427FMEN3

Hi5a Controller Function Manual

Servo Tool Change

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1 Overview

1.1. What is multi (servo) tool change?

Refers to an action wherein a robot automatically replaces a tool using a tool changer (ATC) when it comes to more than two tools (jig, positioner, and servo gun) attached to the servo motor.

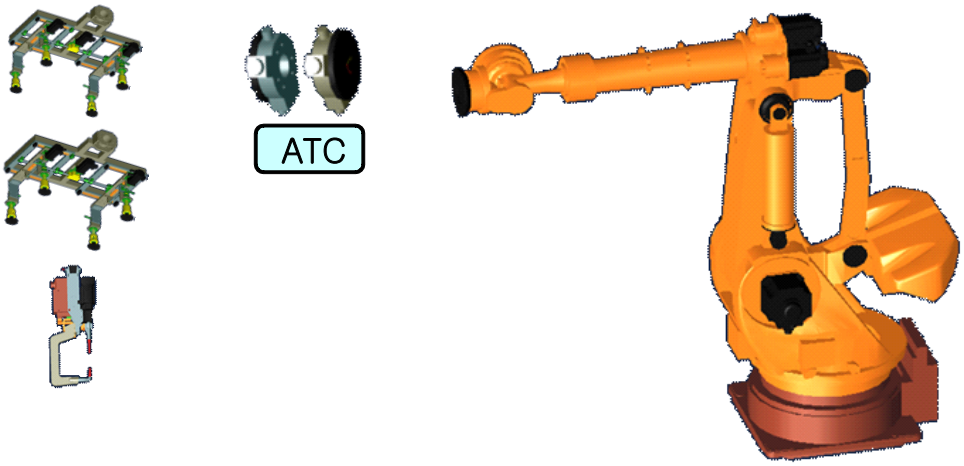


Figure 1.1 Servo Tools and Robot

In this manual, the explanation will be given based on the following system. Considering that the systems to be provided on individual sites could be different form this system, the operator on each site is required to refer to this manual in a way that is suitable for the system on the given site.

Specification of the system to handled in this manual

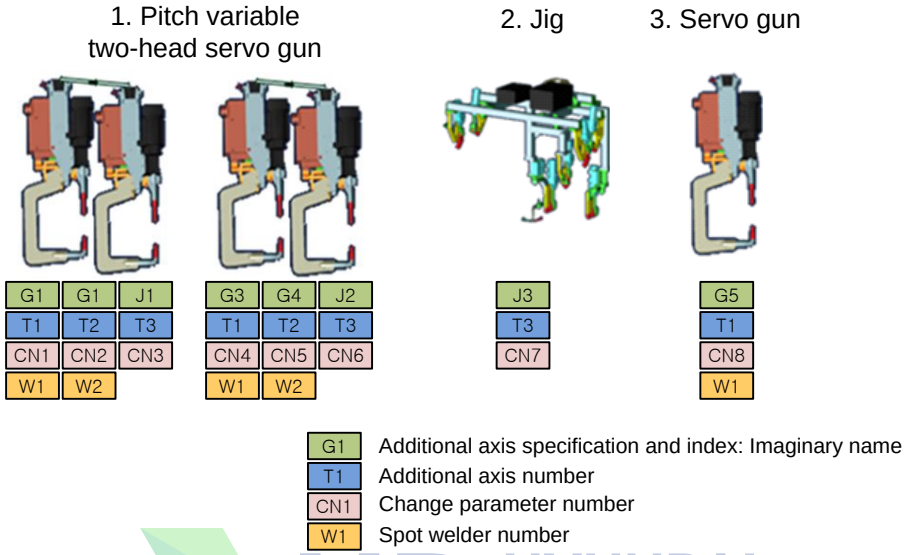


Figure 1.2 Kinds of Servo Tool Handled in the Manual

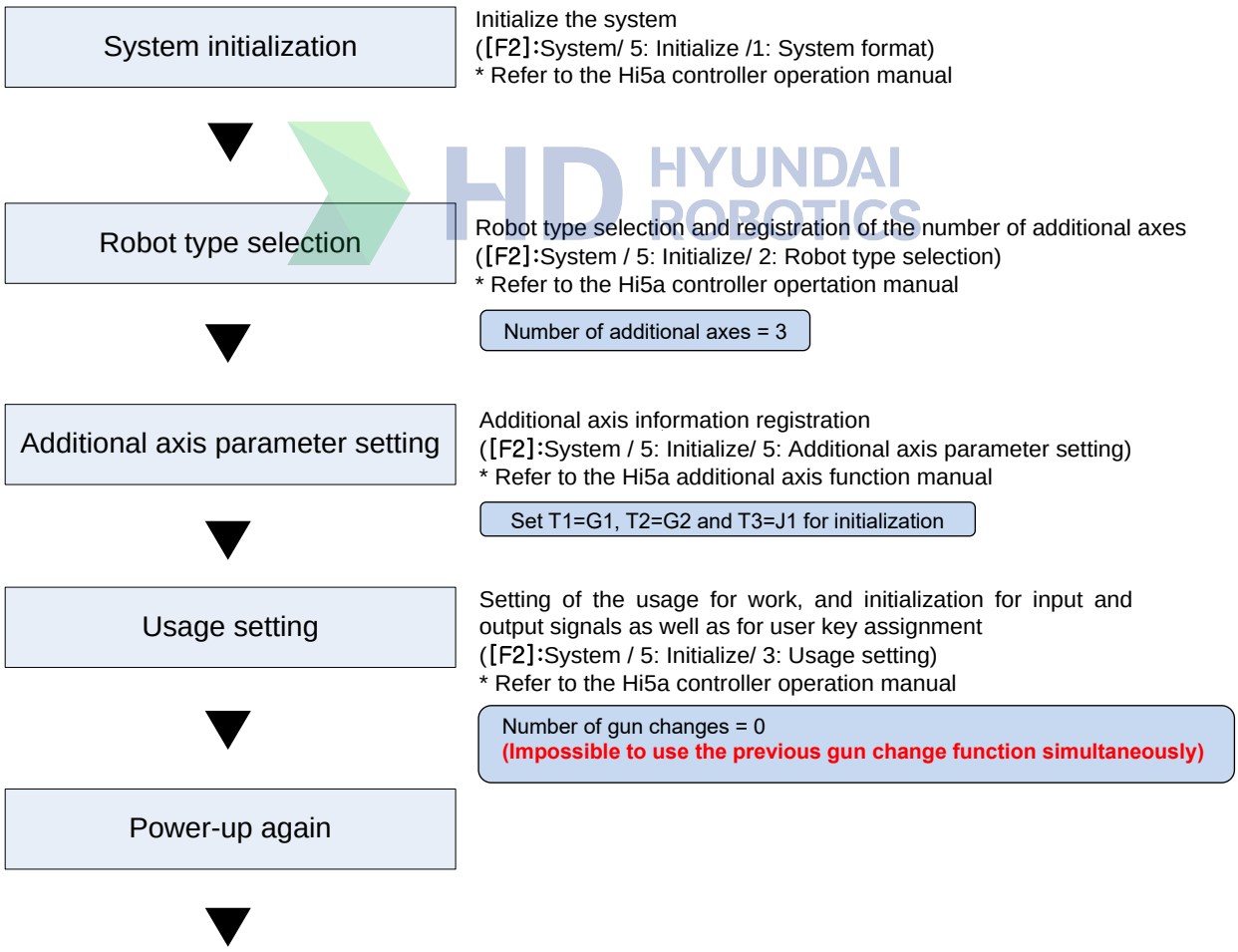
Essential manuals

(1) Hi5a Controller Operation Manual
(2) Hi5a Controller Additional Axis Function Manual
(3) Hi5a Controller Positioner Synchronization Function Manual
(4) Hi5a Controller Spot Welding Function Manual

1.2. Key specifications

Item	Specification
Max. number of motors that can be changed	16
Specification of the change axis	Servo gun, Positioner, Jig
Max. number of simultaneous change	4

1.3. Operation sequence



Encoder offset setting

Encoder zero-point registration
([F2]: System / 3: Robot parameter /4: Encoder offset)
* Refer to Hi5a controller operation manual

▼

Axis origin setting

Axis origin setting, Auto calibration execute
([F2]: System / 3: Robot parameter/ 2: Axis origin)
* Refer to Hi5a controller operation manual

▼

Setting of the tool number and gun type corresponding to the gun number

Setting of tool numbers and gun types corresponding to gun numbers in case of the spot welding
([F2]: System / 4: Application parameter/ 1: Spot welding/ 1: Set tool number and gun-type)
* Refer to Hi5a spot welding function manual

▼

Setting for the servo tool change

Diverse settings for the function of servo tool change
([F2:]System / 4: Applicable parameter/ 11: Servo tool change)

2. Refer to the user interface

▼

Tool data setting

Use of the load estimation function
([F2]: System / 6: Auto calibration/ 4: Load estimation function)
* Refer to the Hi5a controller operation manual

Performing the load estimation in line with the separation and connection of a tool.

▼

Positioner calibration executing

In case of changing servo tools using positioners, calibration programs need to be prepared for individual positioners
*Refer to the Hi5a positioner synchronization function manual

▼

Program preparation

Execution of connection/disconnection using the TOOLCHNG command
When a positioner is connected, the PosiCal command needs to be carried out to execute calibration for each connected positioner.

▼

Auto operation

※ Setting of the tool number and gun type corresponding to the gun number (**To be set only in case of spot welding**)

Designate all the tool numbers, additional axis numbers and Welder numbers corresponding to individual gun numbers.
Can only set the servo tool parameter in the servo tool change for the gun number set in this item.

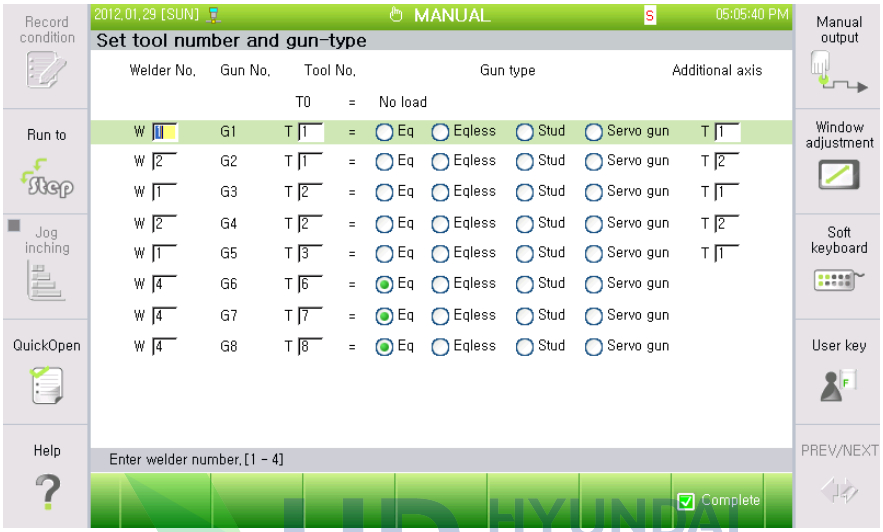


Figure 1.3 Setting of Tool Numbers and Gun Types Corresponding To Gun Numbers

Welder	Gun number	Tool number	Gun type	Additional axis
W1	G1	T1	Servo gun	T1
W2	G2	T1	Servo gun	T2
W1	G3	T2	Servo gun	T1
W2	G4	T2	Servo gun	T2
W1	G5	T3	Servo gun	T1

2 User Interface

2.1. Setting of usage conditions

Sets the change environment for a servo tool.

『[F2]: System』 → 『4: Application parameter』 → 『11: Servo tool change』 → 『1: Use environment setting』

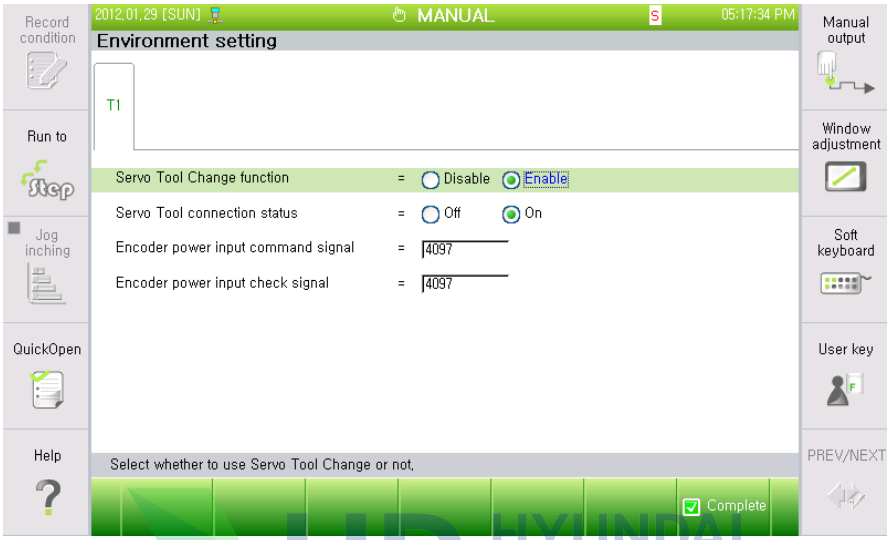


Figure 2.1 Setting of Servo Tool Change Usage Conditions

(1) Servo tool change function
Set whether to use the change function for the additional axes.

(2) Servo tool connection status
Monitors whether the servo tool is connected or separated currently.
When the servo tool is connected currently, it is possible to separate it forcibly. In order to separate it, it is required to shift to <Off>, while the motor is off, and supply the power for the controller again. However, when the servo tool is separated, it is impossible to connect it forcibly.

(3) Input signal of encoder power input
Assign the output signal for the encoder power control during the connection or disconnection. When the signal is ON, the relay that controls the encoder's 5V power cable will be activated.

(4) Output signal of encoder power input
Assign the input signal for checking the encoder power control status during the connection or disconnection. Check the status of the relay that controls the encoder's 5V power cable.

Reference)

- The logic of the input and output signals can be set by going through 『[F2]: System』 → 『2: Control Parameter』 → 『2: Input/Output signal setting』 → 『1: Input signal attribute』 / 『2: Output signal attribute』.
- The BD530 TBIO signals can be set in the number ranging 4097~4100.
- The TBIO signals of the robot program corresponds to SI[101~104]/SO[101~104] individually.

2.2. Servo tool parameter setting

Manages the axis specification and servo tool number of each servo motor including the additional number when changing

『[F2]: System』 → 『4: Application parameter』 → 『11: Servo tool change』 → 『2: Servo tool parameter setting』

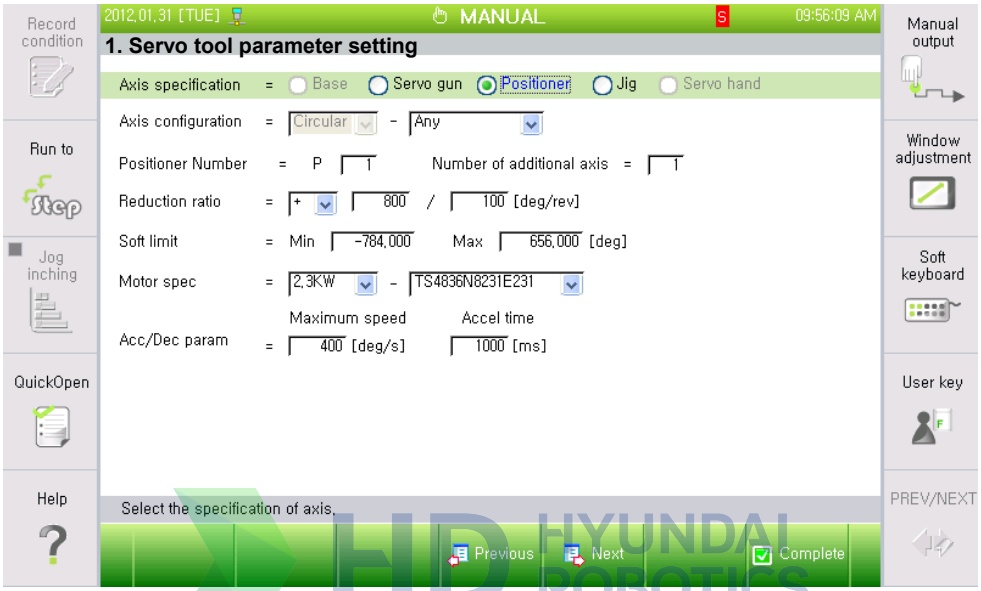


Figure 2.2 Servo Tool parameter Setting

(1) Axial specification
Selects the specification of the change axis. Can select one among <Servo gun, Positioner, Jig>

(2) Axial configuration
Selects whether the configuration of the axis for the change is “Linear” or “Circular”

(3) Servo gun/Positioner/Jig Numbers
Sets the numbers for the axis specification.
There should be a 1:1 correspondence between the servo tool parameter and the servo gun/positioner/jig numbers. Accordingly, the same numbers for the servo guns/positioner/jig numbers can not be set for mutually different servo tool parameters.
Just set to 0 if there is no more servo tool to be set.

(4) Additional axis number
Sets the number of the additional axis to be controlled when connecting or disconnecting. If the axial configuration is for the servo gun, the additional axis number set at the ‘Tool No. corresponding to Gun No., and gun-type set’ will be set automatically. Users need to carry out the setting in case of positioner/jig axes. When multiple positioners/jigs are needed to be changed for one additional axis, it is required to register the servo tool parameter to as many as the number of positioners that will be changed.

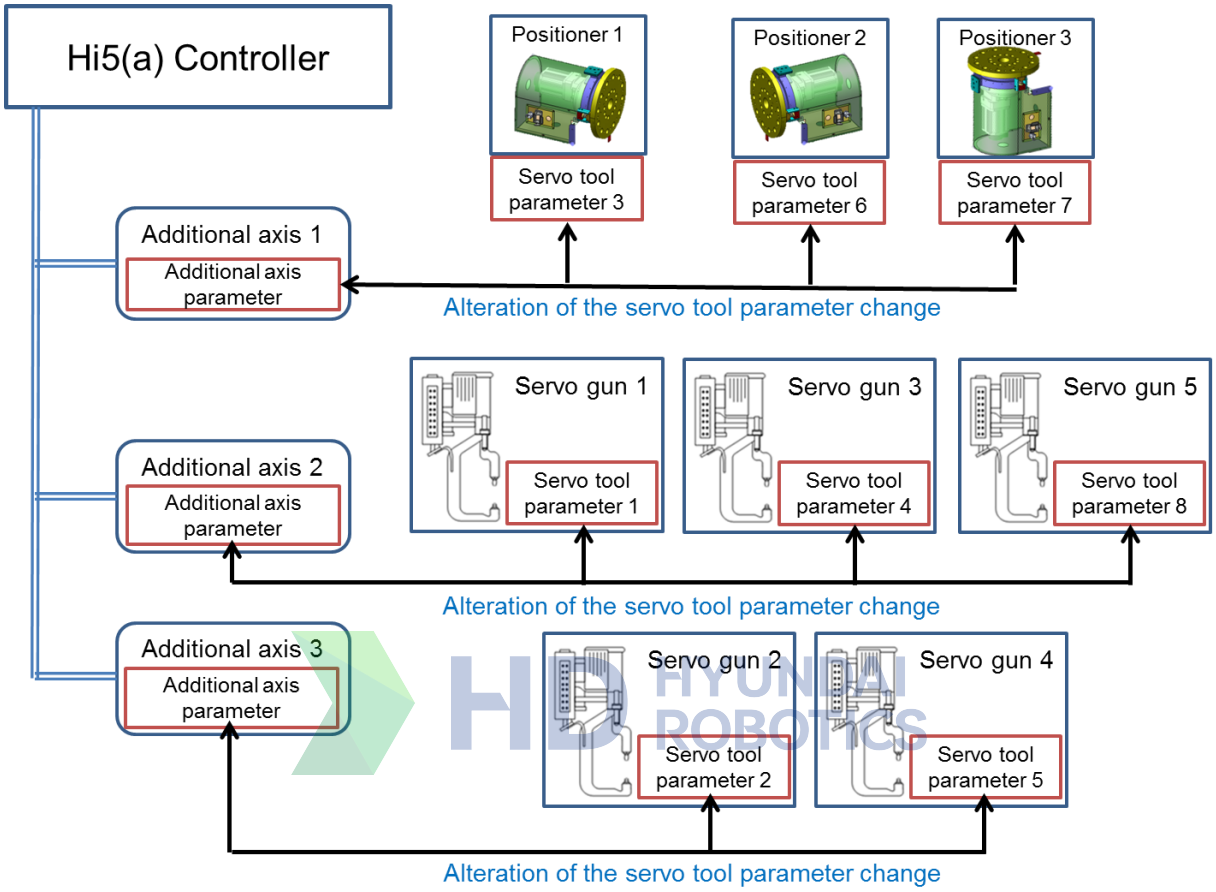
※ Example of usage

The following setting shows the axis specification to be used for each servo tool and the servo gun/positioner/jig number including the additional axis number.

- P1, P2, P3: Servo to be changed also for additional axis #1
- G1, G3, G5: Servo tool to be changed for additional axis #2
- G2, G4: Servo tool to be changed for additional axis #3

To be changed	Axis specification	Axis configuration	Servo gun/Jig numbers	Additional axis number
1. Servo tool	Servo gun	Linear	G1	2
2. Servo tool	Servo gun	Linear	G2	3
3. Servo tool	Positioner	Linear	P1	1
4. Servo tool	Servo gun	Linear	G3	2
5. Servo tool	Servo gun	Linear	G4	3
6. Servo tool	Positioner	Linear	P2	1
7. Servo tool	Positioner	Linear	P3	1
8. Servo tool	Servo gun	Linear	G5	2

The following shows the application of the parameters of the additional axes and servo tools in the actual servo tool change system.



2.3. Axis origin

Managers the axis origin of individual servo motors.

『[F2]: System』 → 『4: Application parameter』 → 『11: Servo tool change』 → 『3: Axis origin』

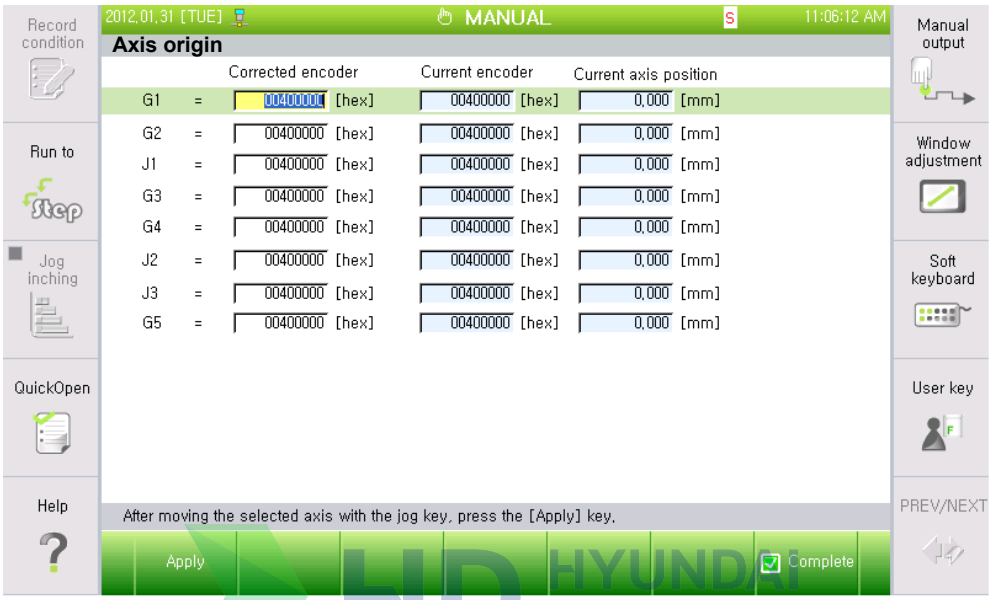


Figure 2.3 Setting of Servo Tool Axis origin

When the servo tool is connected, the axis origin of the relevant additional axis will be updated as the axis origin of the servo tool for the change. In other words, the set values of 『[F2]: System』 → 『4: Application Parameter』 → 『11: Servo Tool Change』 → 『3: Axis origin』 will be updated as the values of 『[F2]: System』 → 『3: Robot Parameter』 → 『2: Axis origin』.

In addition, when it comes to the additional axes' soft limit, encoder offset, servo parameter, and acceleration/deceleration parameter will be automatically updated to the values of the servo tool that will be put in when accessing the servo tool, just like the case of the aforementioned axis origin.

2.4. Monitoring

Helps the user monitor the state related to the servo tool change.

『[F1]: Service』 → 『1: Monitoring』 → 『19: Servo tool change』

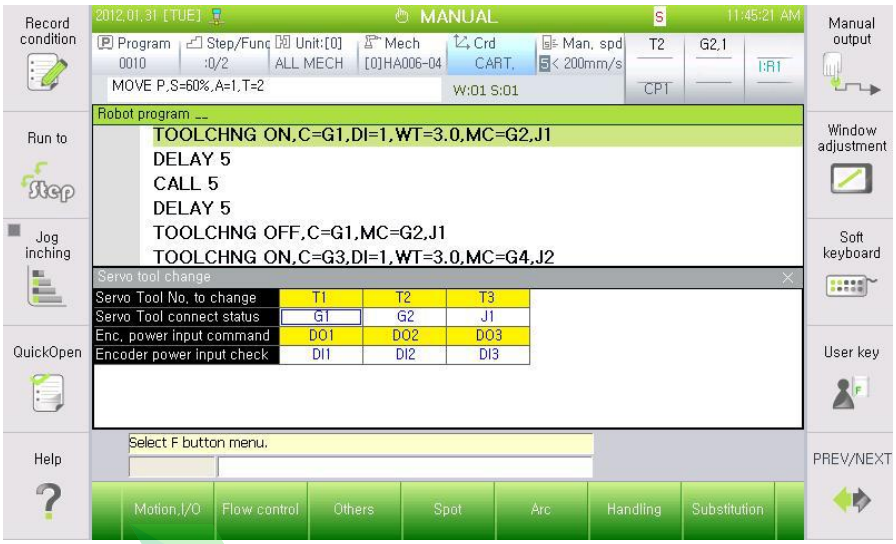


Figure 2.4 Servo Tool Change Monitoring

(1) Servo tool change function
Indicates whether the servo tool change function for the additional axis will be used

(2) Servo tool connection state
Indicates the connection/separation states of the servo tool for the additional axis. If it is connected, the item for the change will be displayed and if it is separated, “--”will be displayed.

(3) Output of encoder power connection
Indicates the state of the output, together with the output signal for the encoder power supply

(4) Input of encoder power connection
Indicates the state of the input, together with the input signal for the encoder power supply

Reference)

- The logic of the input and output signals can be set by going through 『[F2]: System』 → 『2: Control Parameter』 → 『2: Input/Output signal setting』 → 『1: Input signal attribute』 / 『2: Output signal attribute』.
- The BD530 TBIO signals can be set in the number ranging 4097~4100.
- The TBIO signals of the robot program corresponds to DI [4097~4100]/ DO [4097~4100].

2.5. Connection/Disconnection commands (TOOLCHNG)

This is a servo tool change function in line with the execution of the work program.

Table 2.1 TOOLCHNG Command Parameters

TOOLCHNG ON/OFF,*C=<Item for the change>,DI=<Connection completion signal>, WT=<Connection completion waiting time>,MC=<Item for the change>*			
ON/OFF	**ON**	Servo tool connection	
	OFF	Servo tool disconnection	
Item for the change	**G1~G16**	The numbers of the welding guns to be connected/disconnected	Connection/disconnection of the relevant additional axis
	P1~P16	The numbers of the positioners to be connected/ disconnected	
	J1~J16	The numbers of the jigs to be connected/ disconnected	
Mechanical connection completion confirmation signal	**1~4096**	The numbers of the mechanical connection completion confirmation signals	Parameters to be ignored during the off state
Connection completion waiting time	**<0~5.0> (sec)**	Connection completion waiting time (Infinite waiting if there is no parameter or it is 0)	
Item for the change (Simultaneous connection/disconnection)	**G1~G16**	The numbers of the welding guns to be connected	
	P1~P16	The numbers of the positioners to be connected	
	J1~J16	The numbers of the welding jigs to be connected	

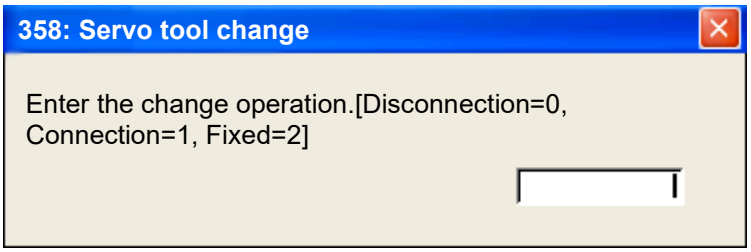
2.6. Manual connection/disconnection functions

This is a function to connect/disconnect servo tools. The connection/disconnection of the servo tools can be carried out by entering '[R..]+358'. The connection/disconnection of other servo tools including jigs/positioners can be implemented by entering '[R..]+365'

(1) Manual connection/disconnection of a servo tools

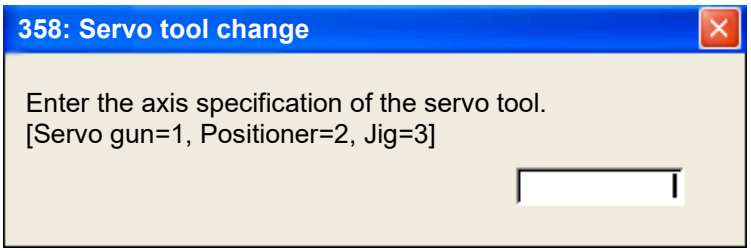
This can be used only when the mode is manual and the Servo tool change is 'Enable'.

Enter [R..]+358.

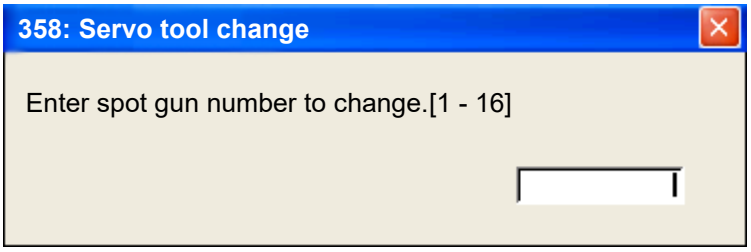


A window for inputting the change operation will appear.
Input 0 for separating the servo tool, 1 for accessing it, and 2 for fixing it.
※ "Fixed": A function for changing only the servo tool number and not the actual tool.

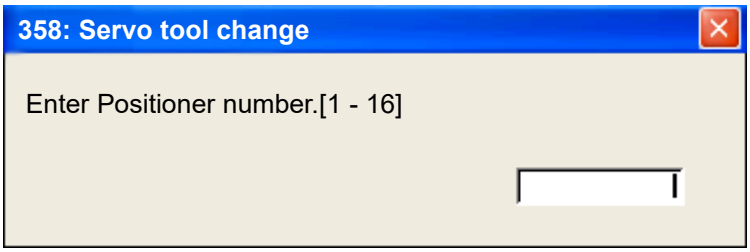
Input the specification of the servo tool that needs to be operated when inputting for the change operation.



'Input the number of the spot gun that needs to be changed when inputting "Servo gun=1."



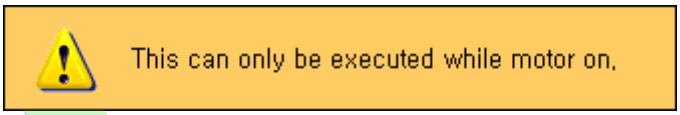
Input the number of the positioner that needs to be changed when inputting “Positioner=2.”



‘Input the number of the jig that needs to be changed when inputting “Jig=3.”

Caution

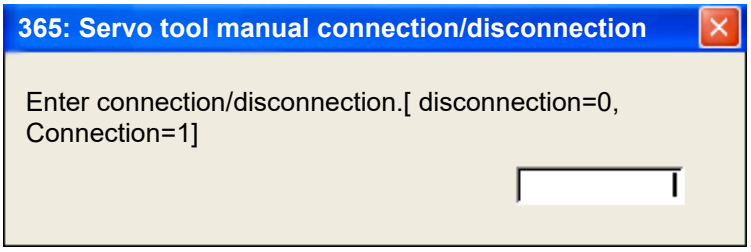
If the motor is not in the ‘ON’ mode, the following message will be produced, while the connection/disconnection will not be carried out.



(2) Manual Connection/Disconnection of Servo Tools

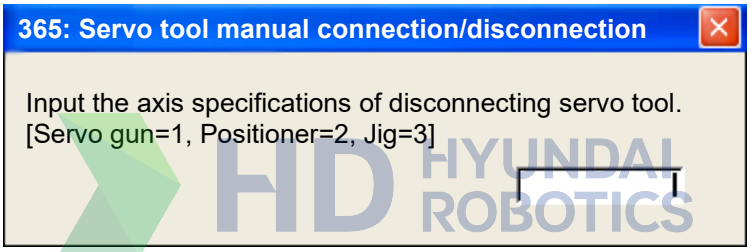
This can be used only when the mode is manual and the servo tool change function is 'Enable'.

Enter [R..]+365.

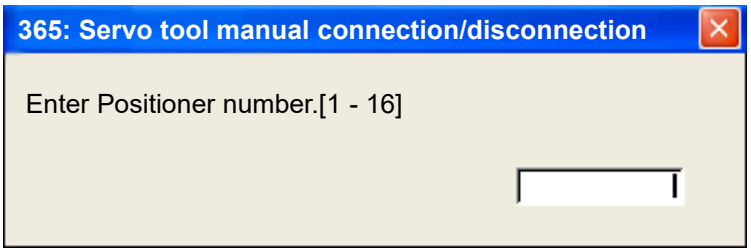


Enter '0' for disconnecting and '1' for connecting the spot gun.

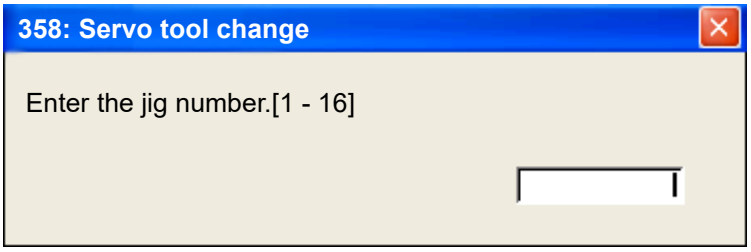
Select the kind of the servo tool for the connection/disconnection [Servo Gun=1, Positioner=2, Jig=3]



When connecting a servo tool needs to take place, the servo tool number for the change needs to be entered.

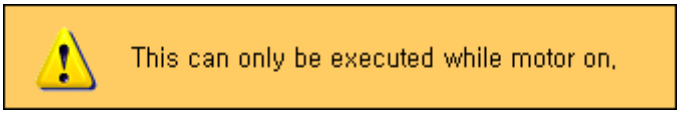


The connection/disconnection of a servo tool will take place.



Caution

If the motor is not in the 'ON' mode, the following message will be produced, while the connection/disconnection will not be carried out.



2.7. Connection/Disconnetion timing

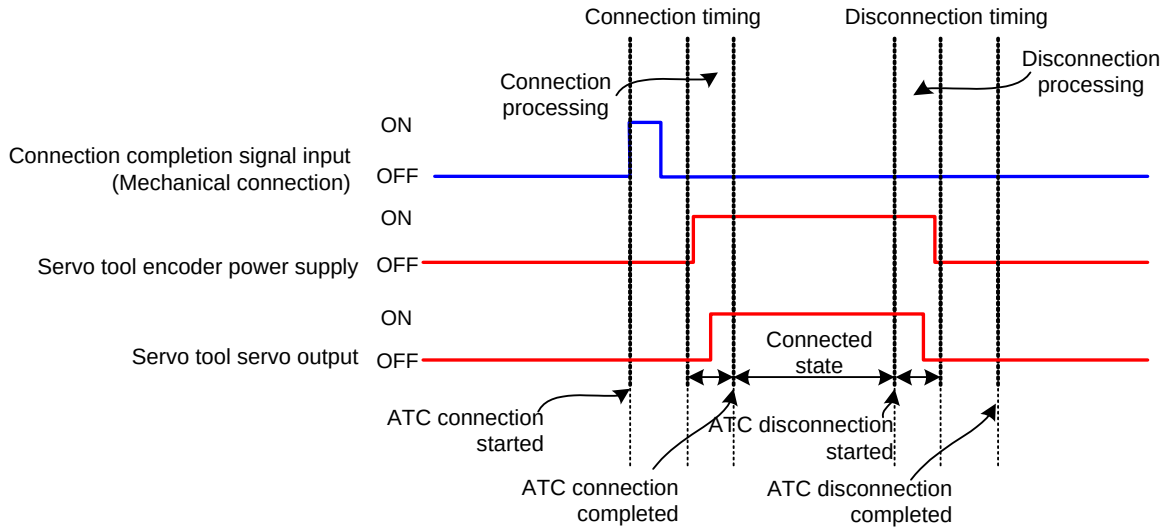


Figure 2.5 Servo Too Change Connection/Disconnection Timing

(1) Connection
While the connection command (TOOLCHNG ON) is being executed, if there is a mechanical connection between the robot and the servo tool, the connection completion signal will be received and the processing for the connection will be carried out internally by the controller. In addition, the encoder power supply and motor-on activities will be added to run the servo tool axis.

(2) Disconnection
The disconnection command (TOOCHNG OFF) will be carried out according to the reverse sequence of the connection process.

2.8. Positioner calibration command (PosiCal)

This command is for executing the positioner calibration necessary for the positioner to move in a synchronized manner with the robot. Generally, the positioner calibration is carried out through a setting dialogue box. However, when the positioner needs to be changed to a servo tool, the calibration needs to be changed during the robot operation. For the purpose of executing such activity on the program, the positioner calibration command (PosiCal) is used.

(1) PosiCal command

Table 2.2 PosiCal Command Parameter

PosiCal *Prog=<Calibration Program No.>,Station=<Station No.>*		
Calibration Program No	**1~9999**	Positioner calibration program number
Station No.	**S1~S3**	No. of the station to be calibrated

(2) Example of the use of the positioner calibration command

- Connect between the positioner that needs to be calibrated and the robot.
- Prepare the positioner calibration program.

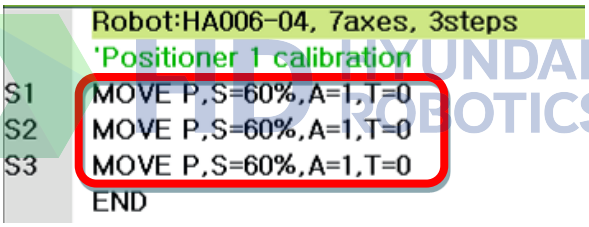


Figure 2.6 Axis Positioner Calibration Program

- Execution can be carried out by selecting 『Command input』 → 『Arc』 → 『PosiCal』 and inserting the PosiCal command. Another way is to enter 『[F2]: System』 → 『6: Auto Constant Setting』 → 『2: Positioner Calibration』 dialogue box and carry out the positioner calibration using the prepared program.

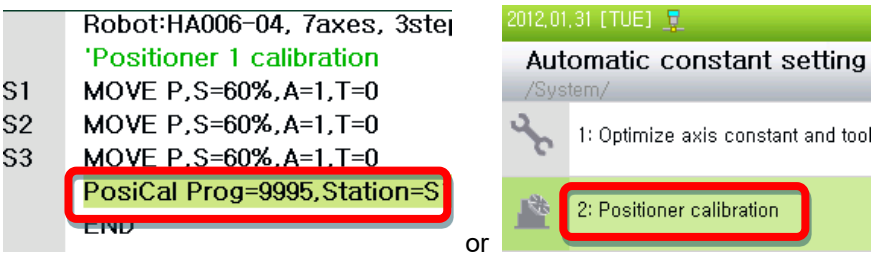


Figure 2.7 Execution of Positioner Calibration

- Check whether the positioner synchronization occurs normally, by operating the jog for the synchronized operation of the additional axis.

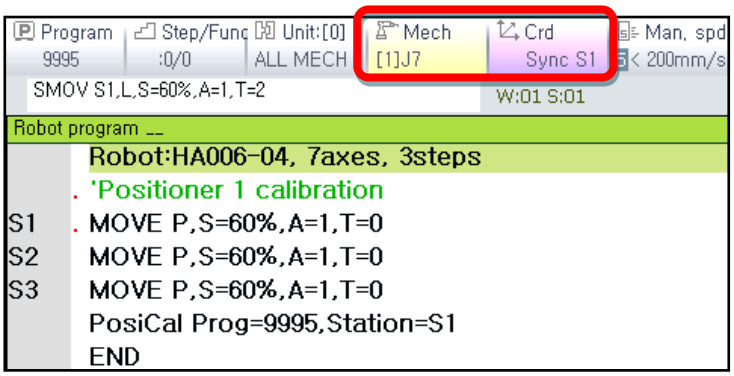


Figure 2.8 TP Screen When Positioner Synchronization Occurs

- Check whether the robot operates in an accurately synchronized way when the positioner rotates.

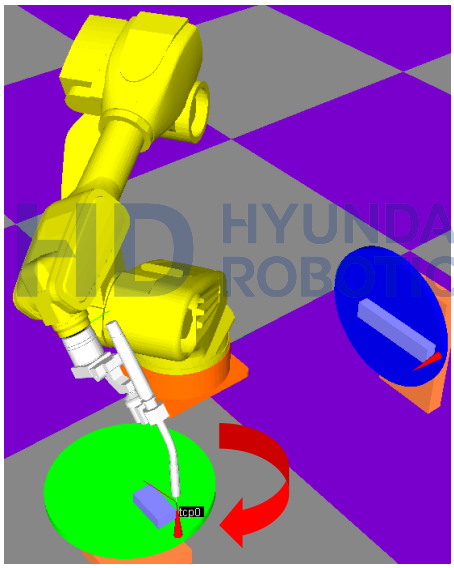


Figure 2.9 Checking Positioner Synchronized Operation

- In an actual work program, Change of a positioner occurs through the TOOLCHNG command, and then PosiCal is executed.

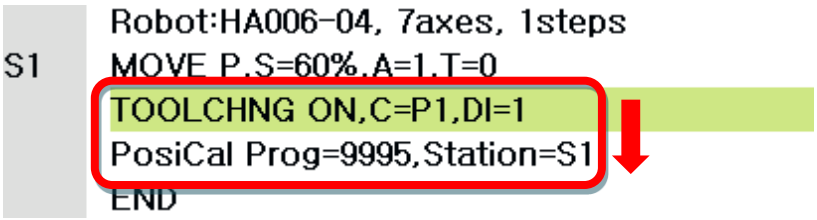


Figure 2.10 Example of Positioner Calibration Executed After A Tool Is Changed

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3
Work Examples

3.1. Sample programs

Table 3.1 Examples of Usage of Servo Tool Change

Disconnection / Connection programs		Definition of the commands	Remarks		Signal direction	
Step B	**....**	(Servo tool separation position)		ROBOT		ATC
	TOOLCHNG OFF,C=G1	Servo tool separation execution				
	DO11=1	ATC cam opening output			→	
	WAIT DI11	ATC cam opening completion confirmation	Signal check		←	
	MOVE L, ...	I				
	MOVE L, ...	Robot moving				
	MOVE L, ...	I				
Step K		(Servo tool connection position)				
	WAIT DI12	Check whether the connection is possible	Signal check		←	
	DO11=0	ATC cam closing output			→	
	TOOLCHNG ON,C=G1,DI1	Mechanical connection completion input			←	
		Servo tool connection handling				
		i				
	MOVE L, ...	Robot moving				

3.2. Example of Connection/Disconnection of Positioners

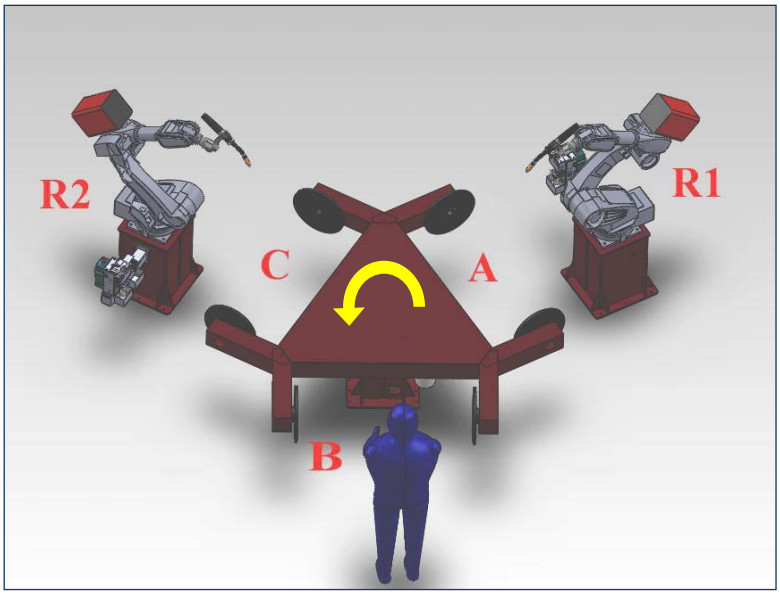

Figure 3.1 2 Robots and 3 Positioners(Systems of the “C” company in Italy)

(1) Components of the positioner change system
- System components: 2 robots + 3 positioners
- Necessary equipment: ATC (Auto Tool Changer) for connecting individual positioners and robots. A Servo gun changer for the company’s robot.

(2) Work content
- The robot #1 is connected with the positioner A and then carries out work. The robot #2 carries out work with the positioner C. The operator needs to mount the work object to the positioner B.
- When the work at each positioner is completed, the connection between the robot and the positioners need to ended.
- When work at #3 is completed, the overall positioner system will rotate 120 degrees counterclockwise.
- The robot #1 is connected with the positioner B and carries out work. The robot #2 carries out work with the positioner A. The operator mounts the work object to the positioner C.
- The work needs to be repeated afterwards.

(3) Caution
- It is recommended to separate/connect each positioner at the same position if possible.

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4

FAQs

- Is it possible to change a pneumatic gun?

  If a gun needs to be changed and the gun is pneumatic, the connection/separation process will be carried out for the pneumatic gun.

GRC: 경기도 성남시 분당구 분당수서로 477
대구: 대구광역시 달성군 유가읍 테크노순환로 3 길 50
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