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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Hi5a Controller Function Manual

Sealer Application

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1 Overview

1.1. Overview

A sealer application is used for the robot controller to directly control the application amount of the sealing process to apply the sealer solution on a workpiece for adhesion, waterproofness, or vibration control. Generally, the sealer application process consists of a pump, filter unit, and a gun booster unit, but this function covers the control of a gun booster unit that has a direct connection with the application amount control.
This function provides initial pressurization control before discharge for initial quality and support for different application methods based on process characteristics through constant quantity and speed discharges as well as robot speed-synchronized discharge control modes.

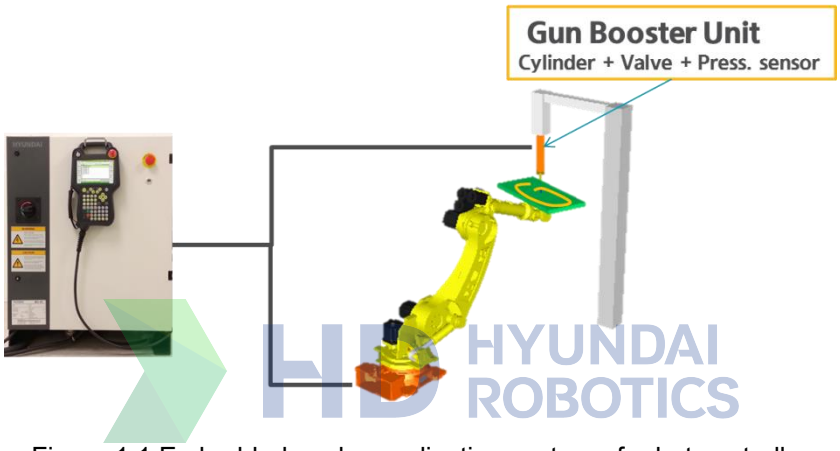

Figure 1.1 Embedded sealer application system of robot controller

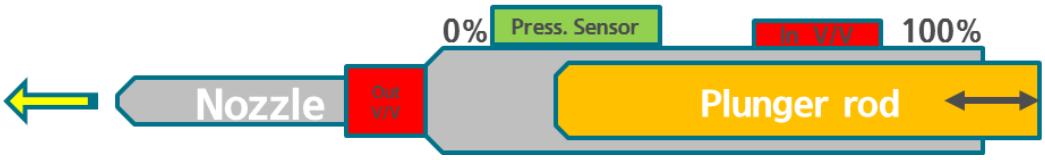

Figure 1.2 Gun booster unit (Cylinder type)

State	DAMPING V/V	Outlet V/V	Rod Position	Pressure State	Fluid State
Standstill	Closed	Closed	-	Waiting pressure	Standstill
Pressurizing	Closed	Closed	-	<>Set pressurization	Standstill
Pressurized	Closed	Closed	-	≒Set pressurization	Standstill
Discharge	Closed	Open	0–100%	Discharge pressure	Discharge
Filling	Open	Closed	0 → 90%	Pump pressure	Filling

1.2. Mechanism of Sealer Aplication

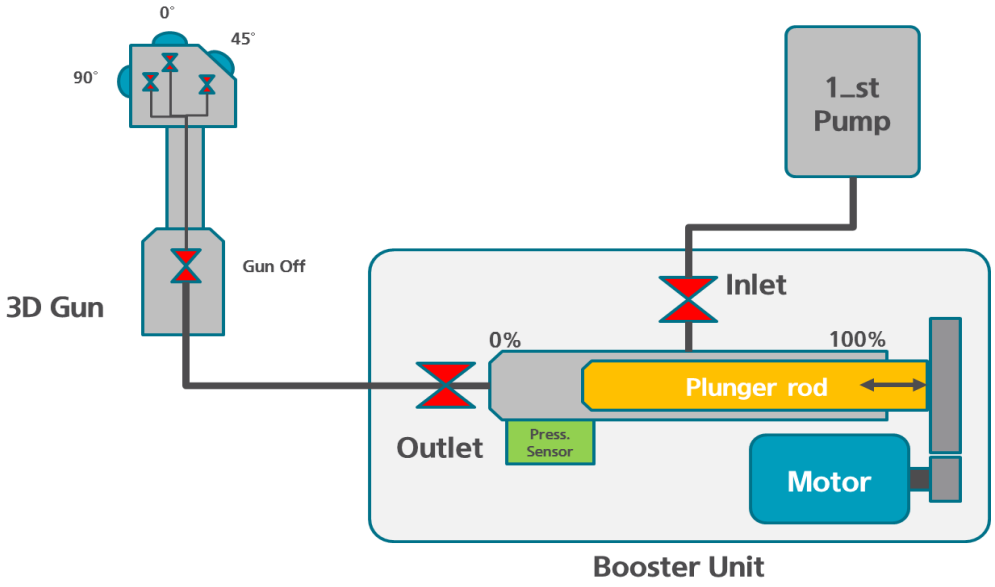

Figure 1.3 Sealing system with a 3-D gun

The configuration of the sealing system depends on site conditions or equipment. For instance, a gun can be an integrated type consisting of a gun and a booster unit, but a 3-D gun can be applied to configure the system as shown above. However, the basic system consists of a primary pump, a booster unit, and a gun.

This function enables the robot controller to control the opening/closing of valves and the pressurization for the booster unit and gun. For example, the cylinder is filled with a sealing solution from the primary pump by retracting the cylinder with only the input valve open for filling. If the cylinder reaches the filling-complete position, it waits until the filling-complete pressure is reached when the sealing solution fills the cylinder, and then closes the input valve; opens the output valve; and adjusts the position of the cylinder to reach the atmospheric pressure.

When applying the sealer, the sealing solution is applied onto a workpiece by opening the gun-off valve and specified gun valve and then pushing the cylinder. If the discharged flow cannot reach the target with the advancing speed of the cylinder as soon as the valve opens, a set pressure is applied before discharging so that the application amount can be adjusted at the beginning of discharge. Here is an example of an application shape at the beginning of discharge based on the initial pressure. Set adequate advance pressurization based on the state of the starting point of the bead after a test application.

Appropriate pressure

With a lower pressure

With a higher pressure

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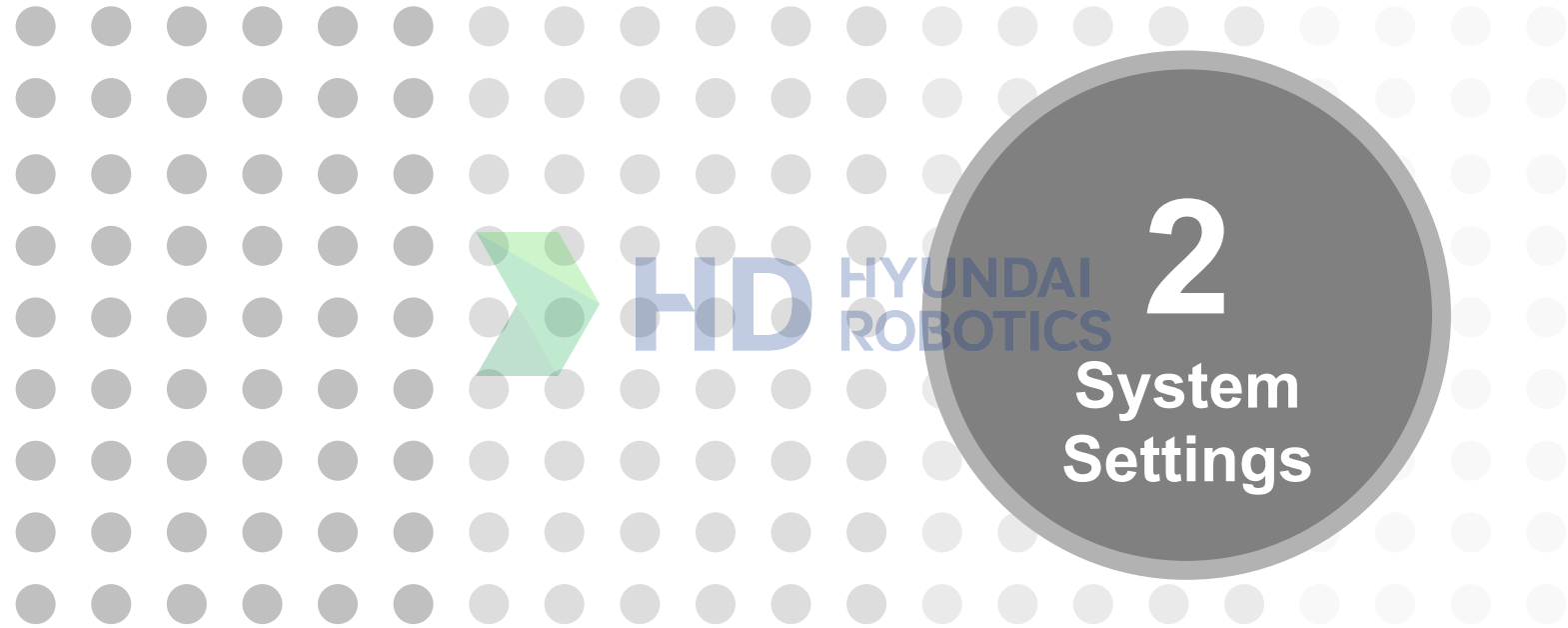


2 System Settings

2.1. Parameter Settings for an Additional Axis

For the sealer application, an additional axis needs to be included to control the sealer flow. After initializing the system, input the total number of additional axes to be used when selecting a robot type. Then, go to the additional axis integer setting screen or "[System] → [Initialize] → [Additional axis parameter setting]" to move to the additional axis parameter setting screen as follows.

Select the sealer for axis specifications for the additional axis installed in the sealer discharge control. Enter additional axis parameters in the order of the input windows of the setting screen. For more details on how to enter parameters, refer to "Additional Axis Instructions."

Specify the sealer discharge ratio for the sealer axis. Enter the volume of the discharged sealer per m of cylinder for a direct-acting axis. It is important to enter the discharged amount per m instead of the cylinder capacity. For instance, if the cylinder has the capacity of 50 cc and a maximum stroke of 500 mm, enter "1,000 cc/m" for the sealer discharge ratio.

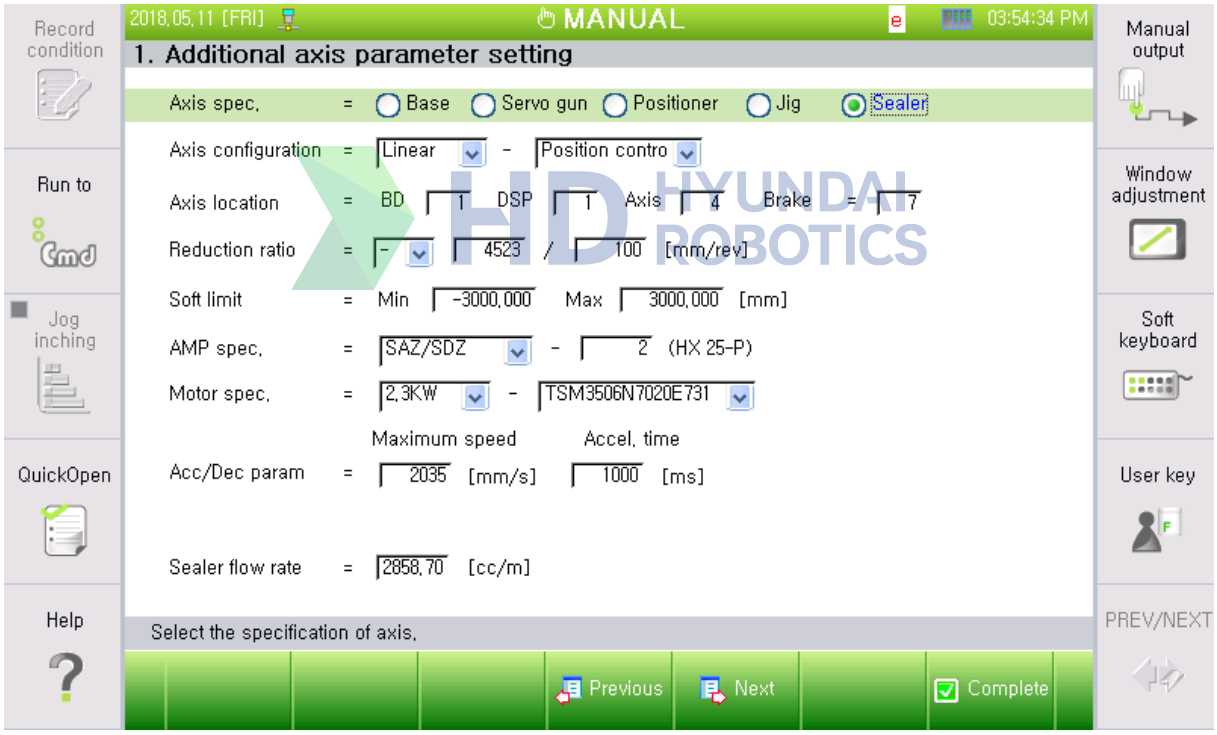


Figure 2.1 Additional axis parameter-setting screen

2.2. Sealing Settings

The sealing settings menu sets parameters for the different signal specifications and operating environment required for this function. This menu is only displayed for the sealer axis.
"[F2]: System" → "4: Application parameter" → "20: Sealing settings"

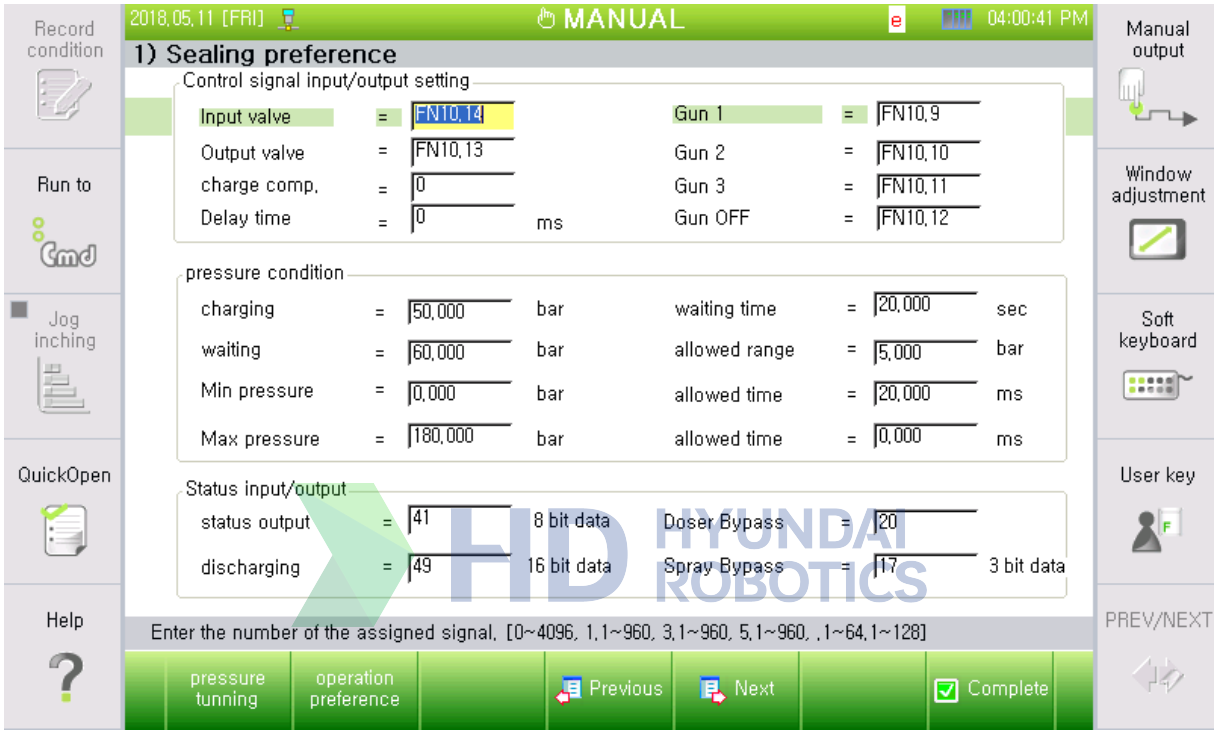


Figure 2.2 Sealing settings

(1) Input/output valve

Input and output valve signals are output allocation signals to output the open/close signal of the input/output valve of the booster to DeviceNet. If input/output valve signals are not set as essential input signals, the operation of the sealer axis will be limited.

The filling-complete signal is an input allocation signal for the robot controller to receive the signal from the booster when the cylinder reaches the filling-complete position. If it is not set, the filling state is determined when the pressure reaches the filling pressure after moving to the filling-complete position.
The operation delay is a setting to operate the cylinder after waiting for a specified time after outputting a valve signal.

For the gun signal, specify the corresponding valve signals for individual guns if the system has a 3-D gun that has three nozzles. If not, enter "0."

(2) Pressure condition

Filling pressure is a reference to wait for filling until a pressure above the set pressure is detected at the filling-complete position if the filling-complete signal is not set. An error will be detected if the measured pressure does not meet the filling-complete condition during filling-pressure waiting time. For the waiting pressure, enter a pressure to keep while waiting after filling the sealer. Enter a pressurization adjustment tolerance.

For the minimum and maximum pressures, set references to protect the sealing equipment. If an excessive or poor pressure is detected over the allowed time, an incorrect pressure error will occur.

(3) State input/output

Allocate the state output signal for the robot controller to send out the operation state of the booster (“Standstill,” “Pressurizing,” “Pressurized,” “Discharge,” “Filling,” and “Waiting pressure adjustment”). If the state output signal is set to “0,” the current state is not outputted; 8-bit output state data is consecutively outputted from a specified output signal port. However, the top bit is outputted if the booster is full with the sealer solution.

MSB:B7	B6	B5	B4	B3	B2	B1	LSB:B0
Full	reserved	-	-	Dozer state			

B3	B2	B1	B0	State
0	0	0	0	Standstill
0	0	0	1	Pressurizing
0	0	1	0	Pressurized (Pulse)
0	0	1	1	Discharging
0	1	0	0	Filling
0	1	0	1	Adjusting the atmospheric pressure

The discharge-amount output signal is outputted as an integer data without a code by multiplying the volume of the discharged sealer solution (in cc) through 16-bit data with 100. That is, the discharged amount can be calculated by dividing the received data with 100 on the receiving side. However, the calculated discharge amount is a simple calculation using the current cylinder position from the filling-charge position; thus, it may be different from the actual discharge.

The Dozer Bypass signal is an emergency action for booster failure, and it is used to receive the operation state of the dozer bypass to bypass the booster and directly discharge the sealer solution from the pump. The dozer bypass mode does not allow the booster control motor to move; thus, the pressure and discharge amount cannot be controlled. It controls the open/close signal only for application; thus, the quality is not guaranteed.

The Spray Bypass signal is a 3-bit input signal to receive the operation state of the spray bypass mode to check the robot motion route only without applying the sealer solution. For 3-D guns with three nozzles, the spray bypass mode can be individually set for the guns.

2.3. Sealer Pressure Sensor Tuning

The sealer pressure sensor tuning has different settings to receive data, which is measured with a pressure sensor of the gun booster on the robot controller. For the pressure sensor settings, press the "<F1>" key in the sealing settings menu to move to the pressure sensor-setting screen.
"[F2]: System" → "4: Application parameter" → "20: Sealing settings" → "<F1> Pressure sensor settings"

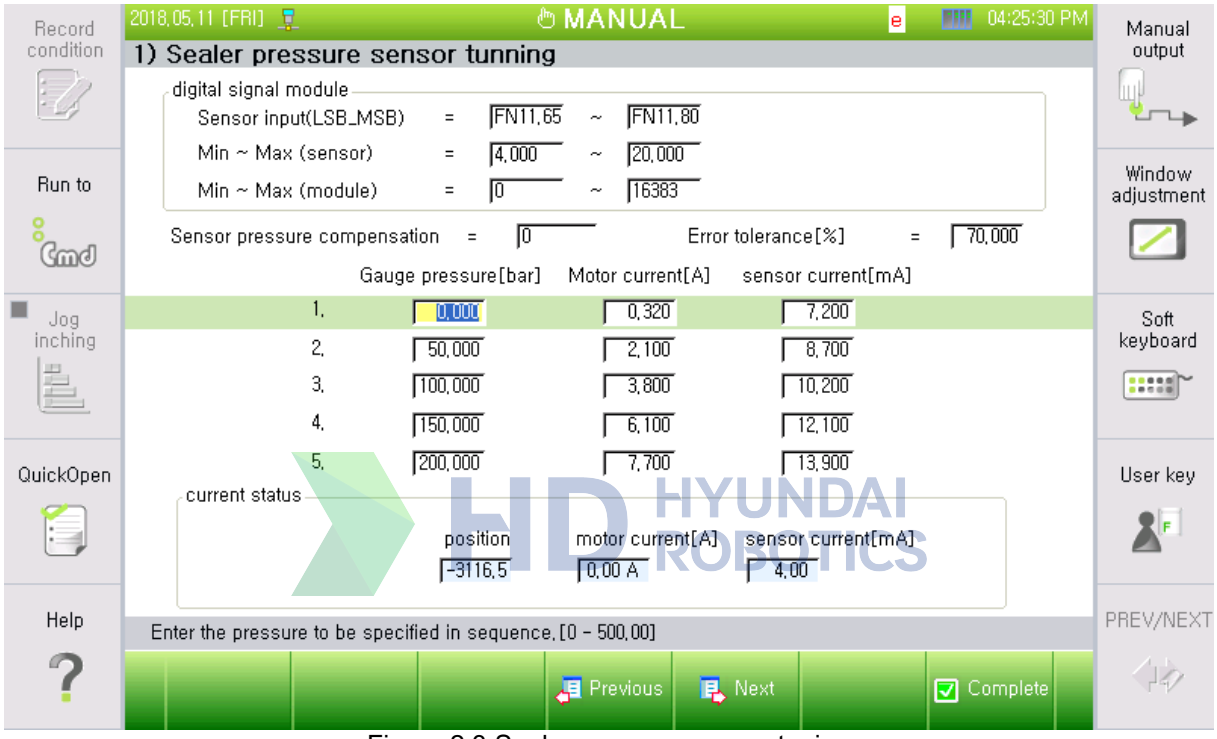


Figure 2.3 Sealer pressure sensor tuning

(1) Digital signal input module
Set a port to receive the digital data signal of the measurement of the pressure sensor for the sensor input. Enter the minimum and maximum current values of the analog signal for those of the sensor. Specify the minimum and maximum values of the digital conversion module for those of the module. Convert the received data of the digital module into current values on the basis of setting values to display the sensor current values on the current state window in real time.

(2) Sensor pressure compensation
Sensor pressure compensation can be set if there is a certain error with pressure measured with the pressure sensor.

(3) Allowed failure detection range
If the error of an estimated pressure based on a sensor-measured pressure and motor current is the same or is higher than a specified value in the allowed failure detection range, the failure can be detected with the error.
If it is set to "0," the values will not be compared.

(4) Pressurization table

This is a table to define the relations among the pressure in the booster, motor current at the pressure, and output current of the pressure sensor. Set the gauge pressure in a manner that the pressure for tuning the pressure sensor is gradually increased. Enter the motor current value of the specified gauge pressure state for the command current. Enter the sensor current value of the corresponding gauge pressure of the sensor current.

Jog the sealer axis in a “<+/->”direction with the “<SHIFT>” key pressed to change the cylinder pressure. Adjust the pressure to reach the gauge pressure to set by pressing the jog key, and then enter the motor current and sensor current values in the pressurization table on the current state window.

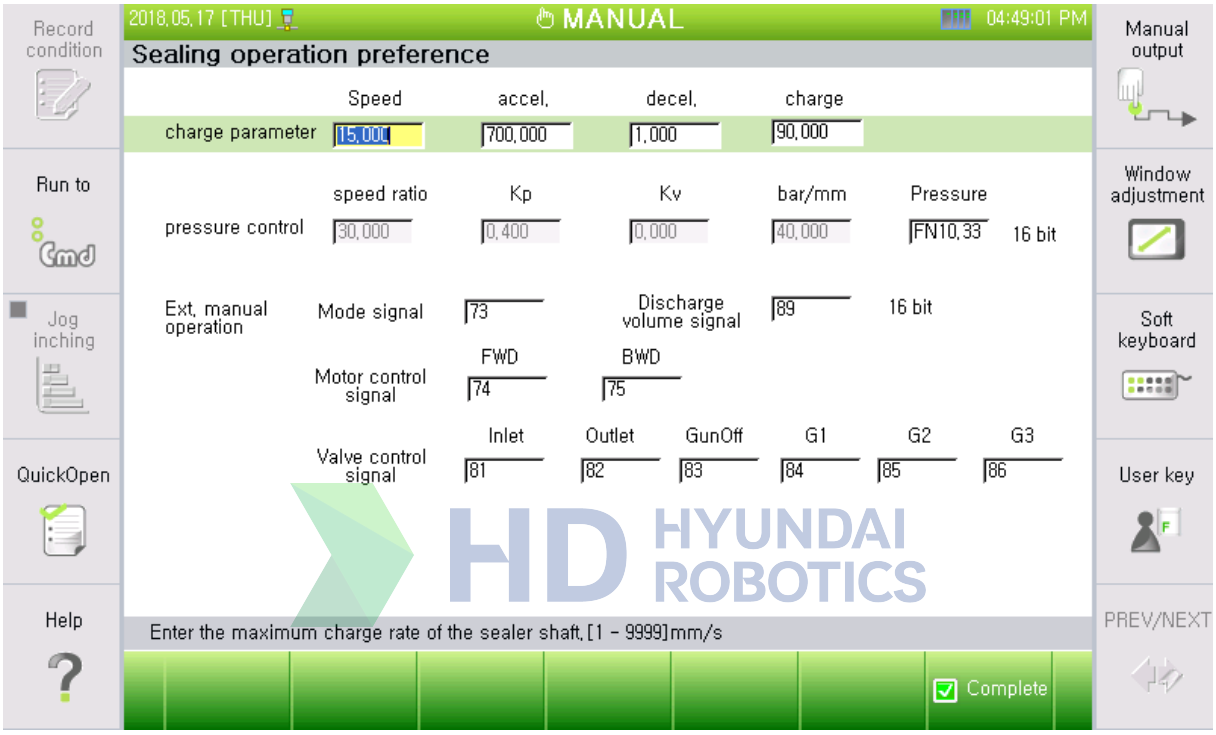
The sensor pressure will be measured within the specified pressure range for the gauge pressure. Thus, allow tuning up to a high pressure in the good range for the equipment if possible.

(5) Current state

The current values of the sealer axis position, motor current, sensor current, and more are displayed in real time.

2.4. Sealer Operation Property Settings

Filling, operation property of pressurization adjustment, and external manual operation parameters can be set for the sealer operation property settings. “[F2]: System” → “4: Application parameter” → “20: Sealing settings” → “<F2> Operation property”



(1) Filling parameter

Specify the filling speed and the acceleration/deceleration of the motor for the filling sealer. An excessively fast filling will cause an error of unreached minimum pressure.

Specify the ratio of filling to the total booster capacity for the filling ratio. If the primary pump pressure to the booster is higher than the atmospheric pressure setting, the cylinder will retract when adjusting the atmospheric pressure after filling. Thus, it is recommended to set the filling ratio under 100%.

(2) Pressurization control

Enter the cylinder speed control ratio and the control parameter for pressurization control.

Only skilled engineers will be allowed to adjust it if required.

Allocate a signal to output the measured pressure of the pressure sensor externally for the pressure output signal. The pressure is outputted in an integer-type, 16-bit data that multiplies measured pressure with 100.Thus, the measured pressure should be converted by dividing it with 100 on signal-receiving equipment.

(3) External manual operation

Specify the control signal to be received when manually controlling the sealing booster externally on a process control panel. With the mode selection signal input, the external manual operation mode will work. The input/output valve and gun valve are open/closed based on the external input signal on the external manual operation mode. The discharge amount selection signal is composed of 16-bit data from the specified input port; thus, the discharge amount can be received in cc. With the specified discharge amount and cylinder advance signal input, it discharges a specified amount and then stops. However, the cylinder will move forward or backward only if the valve open/close state meets requirements. For instance, it will move backward if the input valve is open while the output valve is closed. To move the booster motor through external manual operation, the controller must have a motor on in the remote mode.

3 Operation and Use

3.1. Manual Mode Operation

Operate the sealer gun booster unit for discharging and filling. Jog the jog key for the booster in a “(-)” direction to discharge the sealer or a “(+)” direction to fill the sealer with the cylinder. When jogging with the “<SHIFT>” key pressed, the motor will work without opening the valves so the cylinder pressure depends on the position. It will help in the inspection of sensor signals and the sealing of valves.
The manual mode does not discharge the sealer solution even with the “SEALER ON” command. However, the pressurization settings will work even in the manual mode if bypass is not enabled. It is important to remember to stop the operation and turn off the motor if the “Enable” key is released without completing the filling or pressurization adjustment.

3.2. Command

■ **SEALER ON (Application Start)**

Specify a section to apply the sealer for program recycling.

SEALER ON,P=<Pressurization,F=<Flow><Unit>,OT/OD=<Pre/Post Loading>,G=<Gun Number>

	Description	
Pressurization	Set pressurization just before discharge.	
Flow	Specify discharge amount.	
Unit	cc	Capacity to discharge for a constant amount of discharge
	cc/sec	Specified amount to discharge per second for a constant speed discharge
	cc/m	Discharge amount control by robot-moving distance (Speed sync discharge)
OT/OD	OT	Specify pre/post loading time for application start.
	OD	Specify pre/post loading distance for application start.
G	End-number settings Not required for a single gun Specify numbers if multiple guns are connected to the booster.	

■ **SEALER OFF (Application End)**

SEALER OFF,CRG=<Filling>,OT/OD=<Pre/Post Loading>

	Description	
Filling	0	No filling after finishing discharge
	1	Filling after finishing discharge
OT/OD	OT	Specify pre/post loading time for end point.
	OD	Specify pre/post loading distance for end point.

■ **SEALER PRS (Pressurization Settings)**

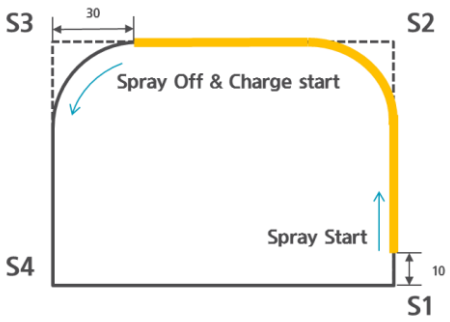
SEALER PRS,P=<Pressure>

Specify the pressurization to set if it is required to adjust the atmospheric pressure. If the “SEALER ON” command is executed while adjusting the atmospheric pressure with this command, the robot will wait until the atmospheric pressure adjustment finishes.

3.3. Example of Applying Teaching

Add the “SEALER ON/OFF” command to the start and end points of the application to apply the sealer as shown below. Adjust the OT or OD parameter for a finer application section adjustment.

```
S1      MOVE L, S=60%, A=0, T=1
        SEALER ON, P=20, F=4 cc/m, OD=10 Application
start
S2      MOVE L, S=200 mm/s, A=3, T=2
S3      MOVE L, S=200 mm/s, A=3, T=2
        SEALER OFF, CRG=1, OD=-30 Filling start
S4      MOVE L, S=200 mm/s, A=3, T=2
        END
```



4 Error and Warning

Code	E6310 Axis sealer pressurization error too high
Description	Tolerances of pressure sensor measurement and motor measurement pressure exceeds allowed ranges.
Action	1) Check the sealer pressurization tuning. 2) Check the pressure sensor operation.
Code	E6311 Sealer pressurization too high for filling
Description	Measured pressure exceeds maximum pressure.
Action	1) Check if the pump pressure is set too high. 2) Check the pressure sensor operation.
Code	E6312 Sealer pressurization too high for waiting for axis
Description	Sealer pressure exceeds the allowed range.
Action	Check the sealing equipment.
Code	E6313 Sealer pressurization too low
Description	Sealer pressurization is lower than the allowed range.
Action	Check for sealer leakage and pressure sensor operation.
Code	E6314 Axis sealer pressurization exceeded maximum value.
Description	Sealer pressurization exceeds the allowed maximum range.
Action	1) Check if the discharge amount is too high. 2) Check if the viscosity of the sealer solution has increased because of low temperature. 3) Check the discharge valve for opening/closing and the sealing equipment.
Code	E6315 Axis sealer pressure control time out
Description	Exceeded time to reach target pressurization for sealer.
Action	1) Check the specified value and pressure tuning. 2) Check the valve for opening/closing and any leakage.
Code	E6317 Sealer filling complete time out
Description	Filling complete condition was not met within the time limit.
Action	1) Check the input valve operation and supply pump pressure. 2) Check the operation of the filling-complete signal or pressure sensor.
Code	E6318 Sealer pressure sensor data error
Description	Pressure sensor data failed.
Action	Check for sensor connection.

Code	E6319 Sealing equipment communication error
Description	There is an error for communication with the sealing equipment.
Action	Check for connection with the equipment.
Code	E6320 Sealer valve control signal output unavailable
Description	The valve control signal cannot be outputted.
Action	Stop internal PLC or set SP11 to “On” to run it.
Code	E8020 Jog is not available for the sealer axis.
Description	The jog function is not available because parameter settings are not complete.
Action	Set sealing parameters.
Code	E12120 Sealer commands cannot be executed.
Description	Sealing condition settings are not complete.
Action	Set sealing conditions.
Code	E12121 Sealer gun number setting error
Description	The sealing gun number setting is not valid.
Action	Check the gun number setting and gun allocation signal setting.
Code	E18106 Sealer discharge amount setting is not appropriate.
Description	The sealer discharge amount setting value is not specified.
Action	Set the sealer discharge amount for additional axis settings.

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