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WARNING

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

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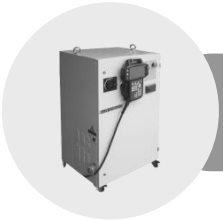

Hi5a Controller Function Manual

Gas spring pressure test

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1 Overview

1. Overview

This manual gives descriptions based on industrial robot systems for general purposes. Regarding nonstandard system equipment on site, please contact our engineers for application.

◆ 【Essential manual】 ◆

- Hi5a Controller Operation Manual

◆ 【Note】 ◆

This function manual is based on Hi5a V40.17-00.

1.1. Specifications

1.1.1. Tool load validation

Item	Specifications
Tool load validity	Enter at the dialog box for the function of gas spring pressure check
Type of check	Wait for longer than 30 seconds with the H-axis at 90° and the V-axis at 0° (tolerance: 1°) before carrying out the validation.
Effective range by torque difference	When the H-axis and V-axis torque is equal to or more than 10 Nm, 20% shall be valid; and when the torque is less than 10 Nm, 2 Nm or less shall be valid.
Follow-up actions for the validation results	The dialog box for the function of the gas spring pressure check will display 〈Tool load validity checked / not checked status〉.

◆ 【 Note 】 ◆

This function requires engineer privilege.

1.1.2. Command-type gas spring pressure test

Item	Specifications
Gas spring pressure test execution	Command-specified (GasPTest) auto operation
Test type	1 cycle of -20° at a certain point of axis H (140° recommended)
Test time	2 s
Test reference scope setting	Reference pressure warning and error range (%)
Follow-ups for test results	Warning: Operation is continued with warning output. Error: Robot is stopped with error output.

◆ 【Note】 ◆

This function requires engineer privilege.
For a more detailed motion range, refer to Section 3.3.

1.1.3. Gas spring pressure test in stop state

Item	Specifications
Test conditions	- Wait for 60 s or longer with the motor on. - Axis H is larger than 120 or smaller than 30°. - It is actuated when it is stopped while moving in the direction where H-axis is pulled up. - Enable gas pressure estimation in stop state.
Test type	Auto calculation upon stoppage
Test time	Recalculation is repeated after waiting for 60 s.
Test reference scope setting	Reference pressure warning and error range (%)
Follow-ups for test results	For errors and warnings out of test state - Warning: Operation is continued with warning output. - In the stop location check, only the alarm will be output according to the result. No error will be output.

◆ 【Note】 ◆

An estimated pressure in stop state is less accurate than the one in the command type. If abnormal pressure is detected in the stop state, estimate it in the command type or measure the actual pressure using a pressure meter.
If the estimated pressure in the stop state is continuously far different from the command-type estimated pressure, set "Gas Pressure Estimation in the Stop State" to "Estimate" or "Invalid."

1.2. Command-type test process

Execute robot load estimation

* Check the instrument for any noise or problem with the drive.
* Set the additional weight by axis.
* Execute load estimation on the tool for the gas spring test.

▼

Gas spring pressure test setting Enter the dialog

(『[F2]: System』 → 『3: Robot Parameter』 → 『13: System Diagnosis』 → 『3: Gas Spring Pressure Test』)
* Engineer privilege is required.
* It can be entered by pressing the [QuickOpen] key on the gas spring command.

▼

Tool load validation

Enter by clicking the F1 key at the dialog box for “3: Function of gas spring pressure check”.
* Wait for 30 seconds with the H-axis at 90° and the V-axis at 0°at the stop state.
* Then, carry out validation by clicking the F6 key.
* When the load is not valid, repeat the additional weight setting and the load estimation.

▼

Error and warning criteria setting Allocate the abnormal gas pressure output signal

Set in ratio with the gas spring reference pressure.
* Continue the job while displaying a warning if the warning range has been exceeded.
* Stop robot operation and display the error if the error range has been exceeded.

▼

Record the gas spring test execution position Insert the gas spring test command

Record the gas spring pressure test execution position or move to the corresponding step.
* Gas spring pressure test position: Around 140°of axis H
* Any position for other axes, without any interference

▼

Execute gas spring test monitoring

『[F1]: Service』 → 『1: Monitoring』 → 『17: System Diagnosis Data』 → 『3: Gas Spring Pressure Test Data』
* Engineering privilege is required.
* After splitting the window, the same can be selected with the 『F1: Select Details』 button menu.

▼

Execute the gas spring test in Auto Mode

Check the robot for any interference at 140° of axis H, and execute the program.

▼

Check the estimated pressure

* The estimated pressure can be changed by 10%–20% compared to the reference pressure according to the temperature, the operation state before the test, and the accuracy of load estimation.
* If the pressure estimation error exceeds 20%, reset the additional weight and load estimation.

▼

Write the actual job program

Write the robot program to run the test at desired intervals.
* Monthly, weekly, daily, and each cycle can be set.

▼

Early check and repair of abnormal gas spring pressure

Refill or replace the gas when the gas spring pressure is reduced.
* Check the phenomenon before finding any robot issue, and take actions during nonoperation.

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2

Function setting and monitoring

2.1. Gas spring pressure test setting

2.1.1. Gas spring pressure test setting dialog

(1) The gas spring pressure test setting can be changed with engineer privilege because it requires accurate motion and maintenance.

(2) Select 『[F2]: System』 → 『3: Robot Parameter』 → 『13: System Diagnosis』 → 『3: Gas Spring Pressure Test』.

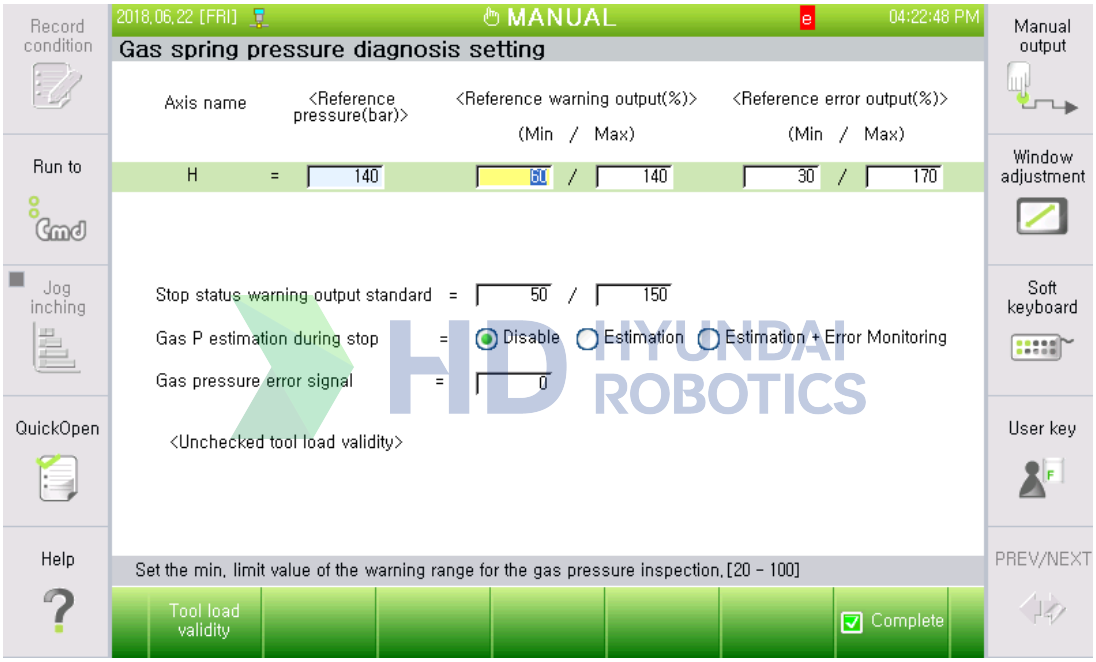


Figure 2.1 Gas spring pressure test setting dialog

2.1.2. Gas spring pressure test setting items

(1) Reference pressure (bar)
Reference pressure is displayed for the gas spring currently in use. Gas pressure is a value fixed according to robot models and springs. In general, the reference pressure is 140 bar.

(2) Warning output reference (%)
Set the pressure warning output reference for a gas spring estimated with the command method. Warning will be output if an estimated pressure is below minimum value or over maximum value of reference value. If the warning is output, warning messages and abnormal gas pressure signal are displayed but the robot continues to operate.

(3) Error output reference (%)
Set the pressure error output reference for a gas spring estimated with the command method. Error will occur if an estimated pressure is below the minimum value or above the maximum value of reference value. If the error is output, error messages and abnormal gas pressure signal are displayed, but the robot discontinues.

(4) Warning output reference for the stop state
To use gas pressure estimation in the stop state (for estimating gas pressure while the robot is waiting without executing any command), set the warning output reference for the estimated gas spring pressure..

(5) Gas pressure estimation in stop state
Set it to use the gas pressure estimation function without executing a separate command, with the robot waiting.

- Disable: Gas pressure is not estimated in the waiting state.
- Estimate: Gas pressure is estimated in the waiting state. An estimated pressure is not tested to see if it is out of error or warning range.
- Estimate + monitor abnormality: Gas pressure is estimated in the waiting state. If the robot is not in the waiting state, test if the error or warning range is exceeded using a final estimated value.

(6) Abnormal gas pressure signal
If an estimated gas pressure is out of warning or error output reference, the abnormal gas pressure signal is output with defined signal.

(7) Tool load validity checked / not checked status
This is the result of the checking whether the load of the current tool data is valid. When the indication of this item is “not checked,” you may enter the dialog box for “Function of gas spring pressure check” by clicking “F1: Tool load validity,” and carry out tool load validation.

2.1.3. Dialog box for load validation

(1) For using the industrial robot with optimal performance, it is necessary to input the correct load. The function of the gas spring pressure check can be used normally when the correct load is set.

(2) Enter the dialog box for “Load validation” by clicking “F1: Tool load validity” in the dialog box for the “function of gas spring pressure check.”

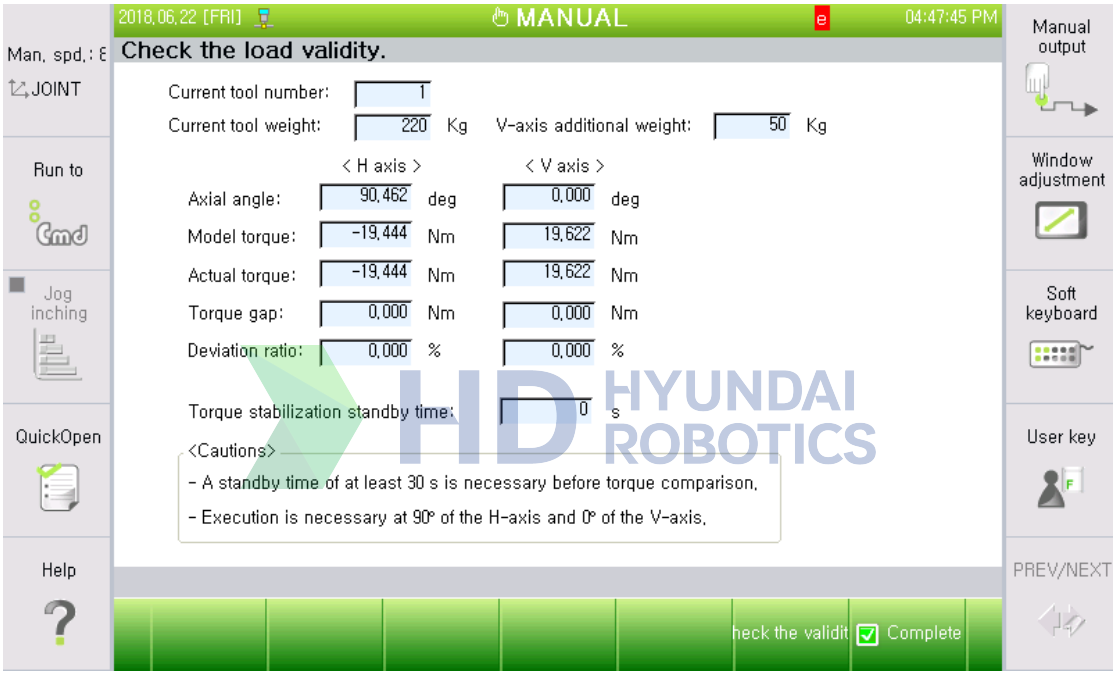


Figure 2.2 Dialog box for load validation

(3) Check whether the current tool weight and the additional weight values are normal.

(4) By manipulating the jog, move the H-axis to 90° and the V-axis to 0 ° positions. (They may be set within +/- 1° of the target angle.)

(5) Wait for longer than 30 seconds at the motor on and the stop state until the torque is stabilized. Depending on the function setting of the robot, the waiting time may be extended to 1 minute.

(6) When the waiting time becomes 0, the torque difference and the error ratio will be displayed.

(7) Carry out “validation” by clicking the F6 key. When it is determined that the load is valid, the “Tool load validity” display item in the dialog box for setting the gas spring pressure check will be changed to the “checked” status.

(8) If the error ratio exceeds 20%, and if the torque difference is equal to or more than 2 Nm occurs while the model torque is equal to or less than 10 Nm, it will be determined that the tool load is

not valid. In this case, enter the additional weight of the V-axis correctly, and carry out load estimation again.

2.2. Gas spring pressure test data monitoring

(1) This monitoring can check the gas spring pressure test data.

(2) Select 『[F1]: Service』 → 『1: Monitoring』 → 『17: System Diagnosis Data』 → 『3: Gas Spring Pressure Test Data』.

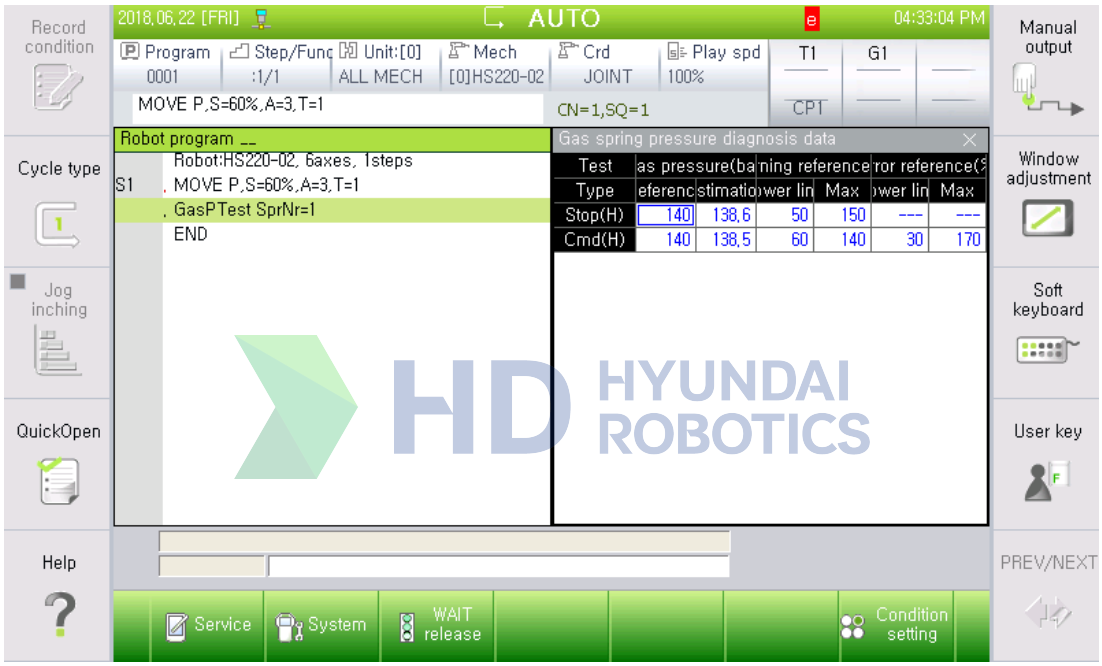


Figure 2.3 Gas spring pressure test data monitoring

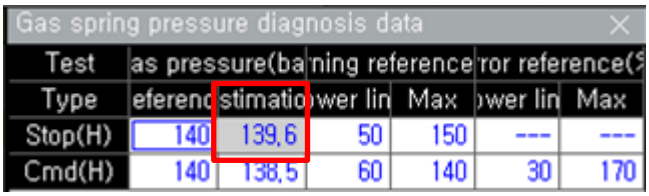
(3) Before the gas spring test is run, the estimation item is displayed with "-."

(4) If the gas spring test command is correctly executed, the command item is refreshed in the monitoring window.

(5) The current test result is maintained until the next gas spring test is executed.

(6) If the robot can estimate the gas pressure in stop state, the stop item is refreshed in the monitoring window.

(7) If it is inevitable to estimate the gas pressure in stop state, the stop item is changed to gray, with the previous estimation maintained.


Gas spring pressure diagnosis data

Test	as pressure(ba	ning reference		ror reference(%	
Type	eferenc	stimatio	wer lin	Max	wer lin	Max
Stop(H)	140	139.6	50	150	---	---
Cmd(H)	140	138.5	60	140	30	170

Figure 2.4 Monitoring gas spring pressure check data when estimation is not possible

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3 Examples

3.1. Load estimation setting

(1) Run 『[F2]: System』 → 『6: Auto Calibration』 → 『4: Load Estimation』.

(2) Set additional weight for each axis.

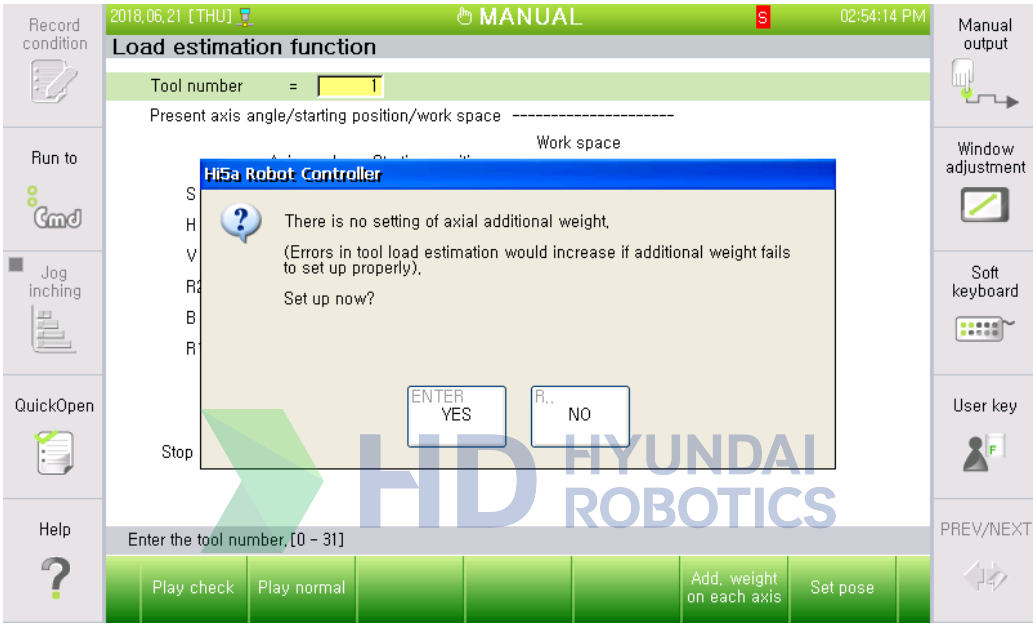

Figure 3.1 Load estimation setting dialog

(3) Run load estimation.

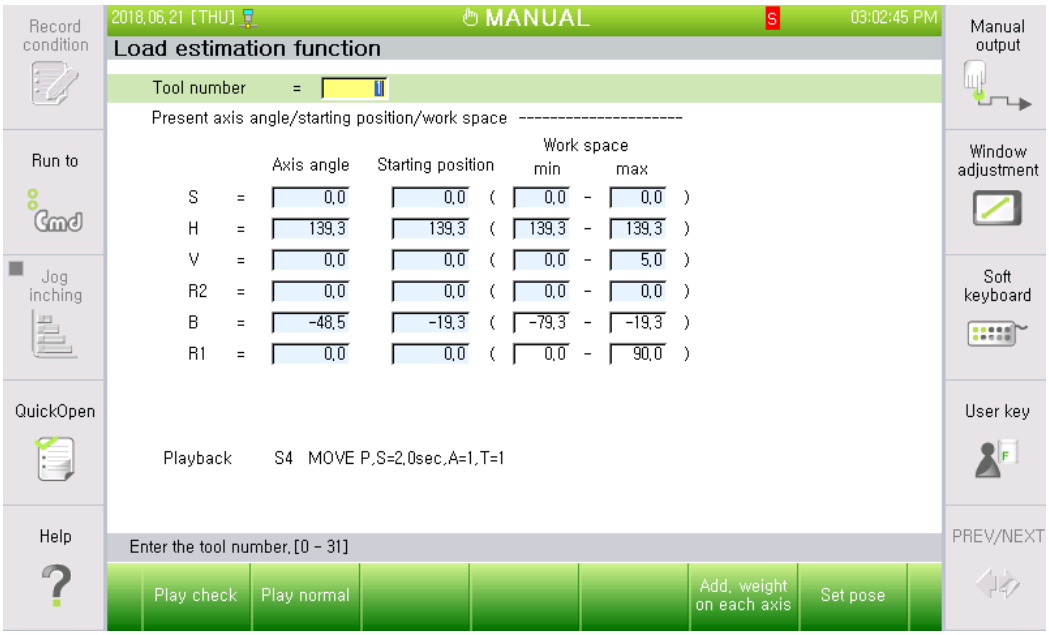

Figure 3.2 Load estimation

(4) Check the load estimation result.

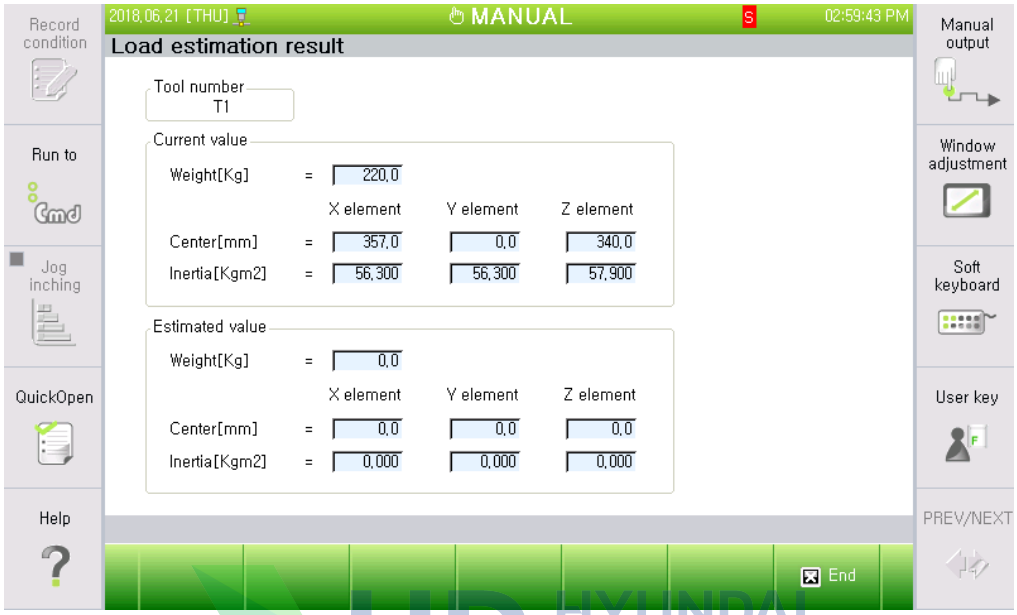

Figure 3.3 Load estimation result (example)

3.2. Tool load validity checked

(1) Select “[F2]: System” → “3: Robot parameter” → “13: System fault diagnosis” → “3: Function of gas spring pressure check.”

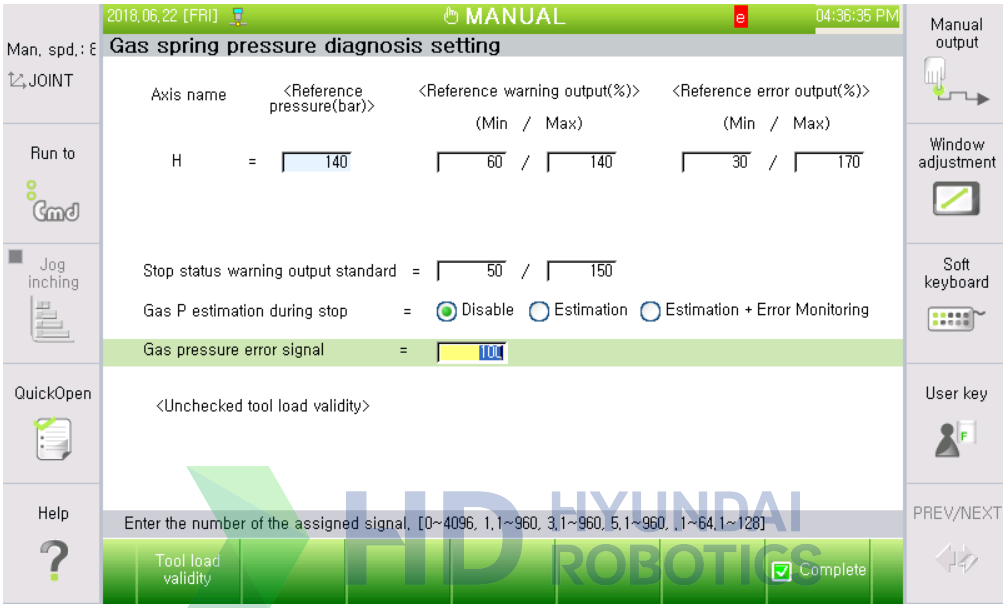

Figure 3.4 Window for the function of gas spring pressure check

(2) Enter the dialog box for “Load validation” by clicking “[F1]: Tool load validity.”

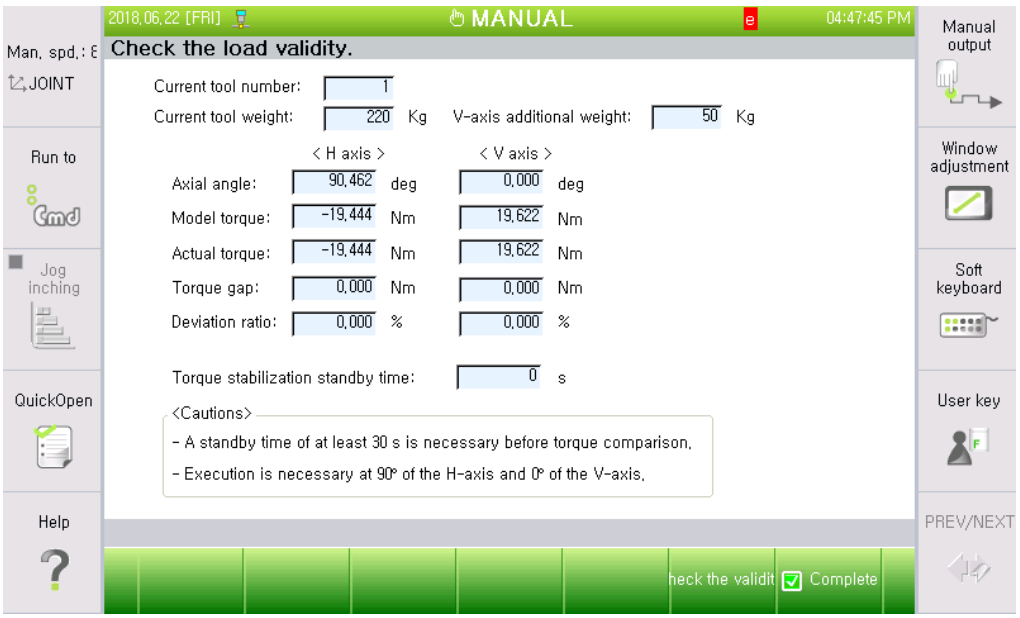

Figure 3.5 Window for tool load validation

(3) Move the H-axis and V-axis to the specified locations, wait for the waiting time, click “[F6]:

Validation," check that the "tool load setting status is valid" message is displayed, and leave the dialog box.

3.3. Gas spring pressure test setting

(1) Select 『[F2]: System』 → 『3: Robot Parameter』 → 『13: System Diagnosis』 → 『3: Gas Spring Pressure Test』 .

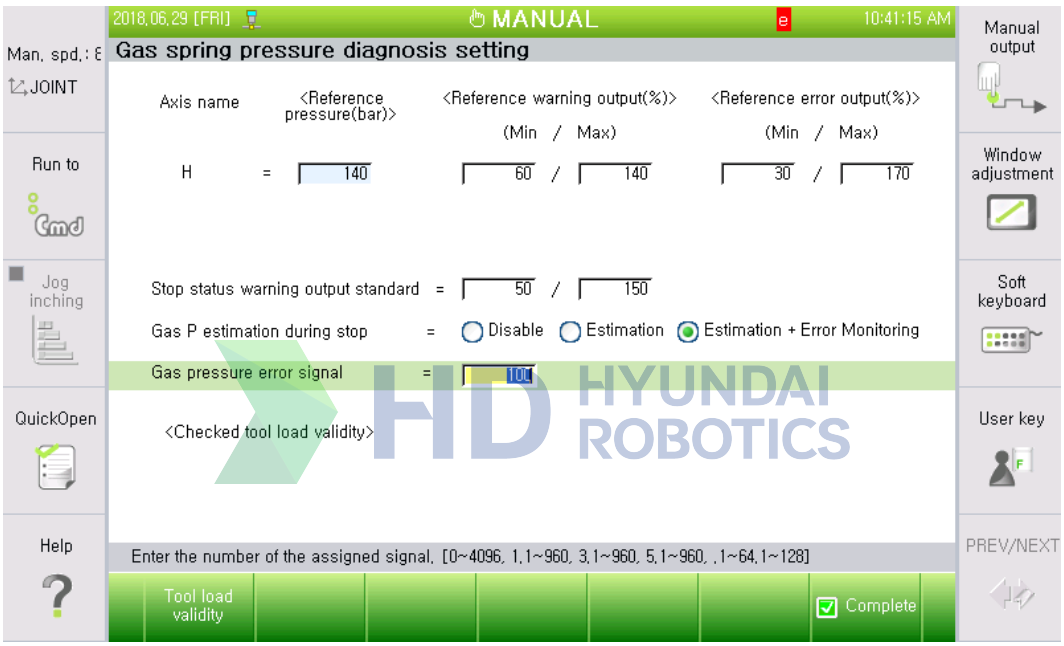

Figure 3.6 Gas spring pressure test screen

(2) Warning and error output references
Set the warning and error output references for the gas spring estimated with the command test. If the normal range (Min–Max) is too small, false gas pressure problem may be detected. If false detection occurs using the aforementioned reference value as default, adjust the range.

(3) Warning output reference in the stope state
Set the warning output reference for the automatic test function in the static state. In general, gas pressure estimation in the stop state has 10% or more errors than the command test. Thus, it is recommended to set it with 10% or more margin than that of the warning output reference of the command test.

(4) Gas pressure estimation in the stop state
Set a function to automatically estimate gas pressure in the stop state. If the difference is 20% or more between gas pressure estimation in the stop state and command test estimation, set it to "Estimate" or "Invalid."

(5) Abnormal gas pressure signal

Set signals to output if a warning or error occurs. DO100 is used as the abnormal signal in this example.

(6) Press the [F7:Complete] button to save the settings and then exit the dialog.

3.4. Example of command-based gas spring pressure test

(1) Record appropriate potion for the gas spring pressure test. It is recommended to perform the test with the axis X positioned at 140° . If the command is executed at 140° , the robot moves back and forth between 120 and 140° . The estimation performance is decreased with the axis H positioned between 50 and 120° . The positions of the other axes are not considered.

(2) Here is the robot position to test the gas spring pressure in this example.

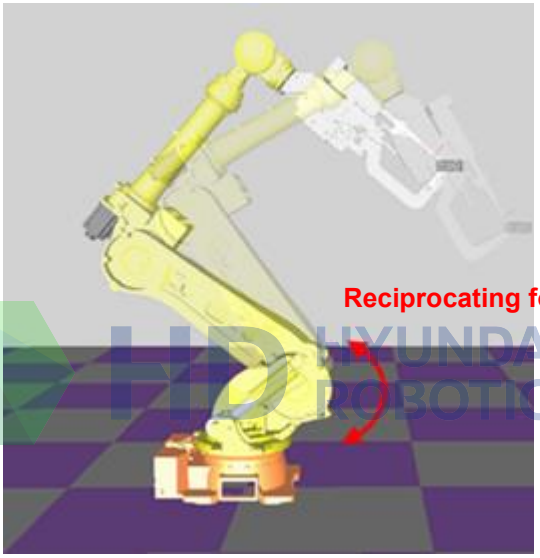

Figure 3.7 Robot movement for gas spring test

(3) Here is the gas spring pressure test program.

```
Robot program __
     Robot:HS220-02, 6axes, 1steps
S1   MOVE P,S=60%,A=3,T=1
     GasPTest SprNr=1
     END
```

Figure 3.8 Example of a gas spring test program

(4) Execute the program, and check the result on the monitoring window. Check the identified result and reference values to adjust the warning or error range.

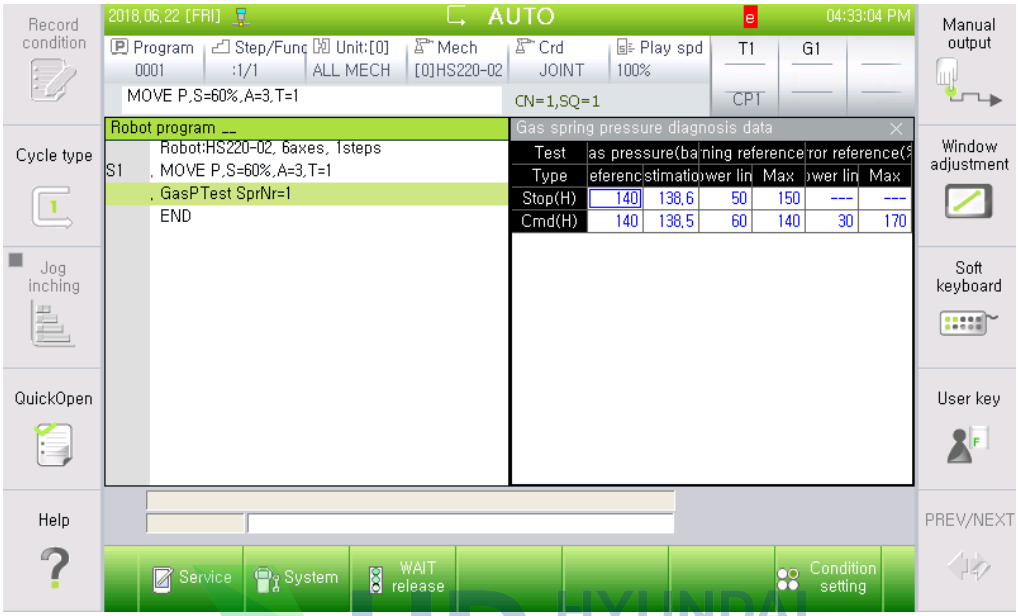

Figure 3.9 Example of a gas spring test program

If the estimated pressure has little difference with the reference in the gas spring pressure test, set a more restraint warning reference to find any gas issue seen earlier. Or, if the difference is large, lower the warning reference to reduce possible misdetection.

◆【Note】◆

Pressure estimation error can occur because of actual load to the robot, additional weight, and outdoor temperature.
Adjust the reference value according to the estimation result after the initial system setting.

3.5. Gas spring pressure estimation in stop state

(1) It may be difficult to add a separate test command or execute an additional program on a robot in production. In this case, the pressure can be estimated with a slightly lower accuracy.

(2) Set “Gas Pressure Estimation in Stop State” in the gas spring pressure test setting dialog.

(3) If the robot waits for 60 s or more after the raising and stopping of the H-axis, the pressure estimation starts automatically. (Estimation condition: H ≥ 120° , H≤30°)
The automatically estimated pressure is displayed in the “Stop” item in the monitoring window.

(4) If the robot is out of the waiting state, the “Stop” item of the monitoring window turns gray, with the last estimated value maintained.

(5) If the last estimated value comes out with a warning reference when the robot exits the waiting state, warning occurs but the robot continues to operate.

(6) The output of the abnormal gas pressure signal can be released with [R..]+[R..] or [R..]+[ENTER].

◆ 【Note】 ◆

An estimated pressure in the stop state is less accurate than that in the command type. If an abnormal pressure is detected in the stop state, estimate it in the command type or measure the actual pressure using a pressure meter.
If the estimated pressure in the stop state is continuously far different from the command-type estimated pressure, set "Gas Pressure Estimation in the Stop State" to "Estimate" or "Invalid."

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4 History graph

4.1. Gas spring pressure test history graph

* This function is supported after V40.20-00

(1) Clicking [F1: Service] → [7: System diagnosis] → [4: System fault diagnosis history graph] → [3: Gas spring pressure test history graph] will display the following window for gas spring pressure test history graph.

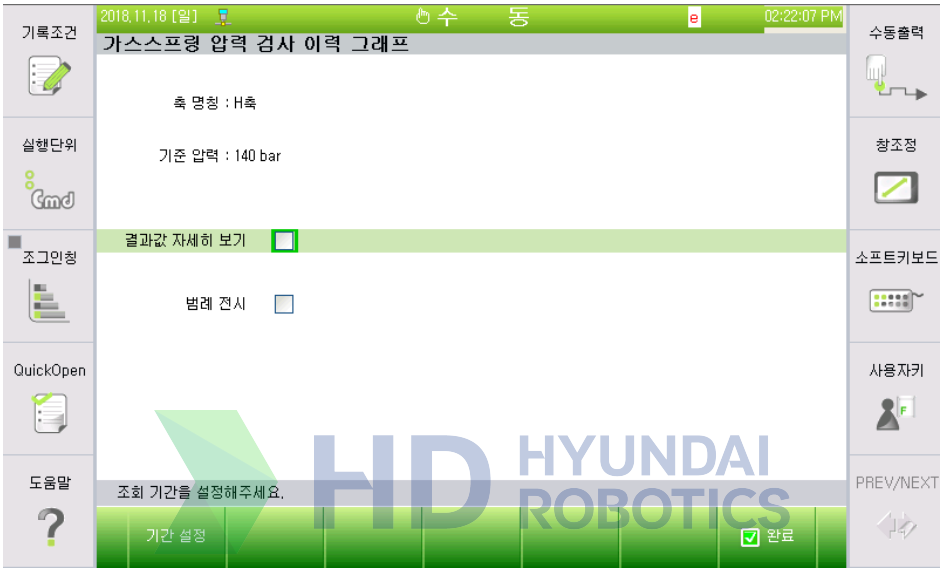

Figure 4.1 Initial window for gas spring pressure test history graph

(2) The graph will be displayed when you set the query period on the window.
Clicking [F1] or the period setting button will prompt the following popup window, in which you can set the period to be queried.

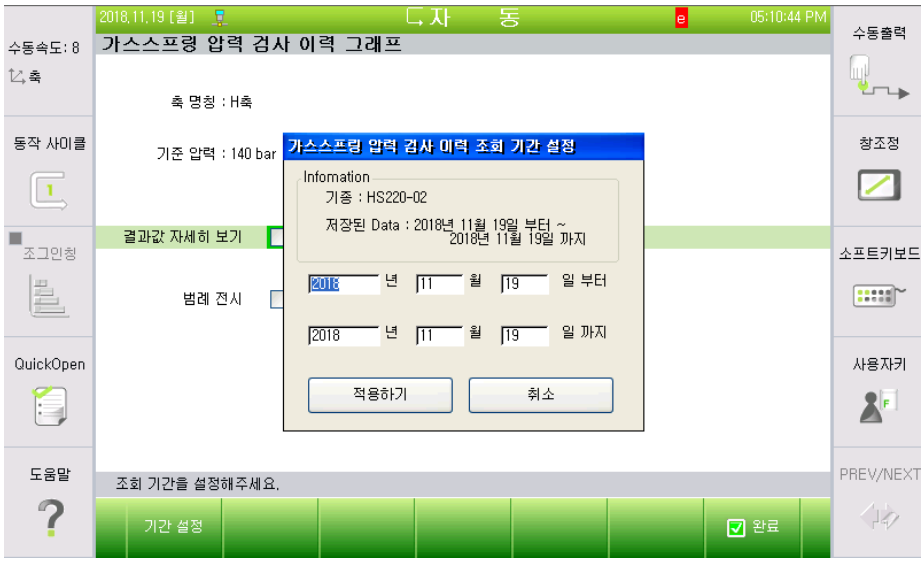

Figure 4.2 Popup display window for Period setting

(3) By default, the popup window automatically displays the first and the last dates of the saved data. Modifying the start and the end dates to be queried, and clicking the [Apply] button will call the data of the specified period as shown in the following figure, and the guiding message at the bottom will display the information on the current graph.

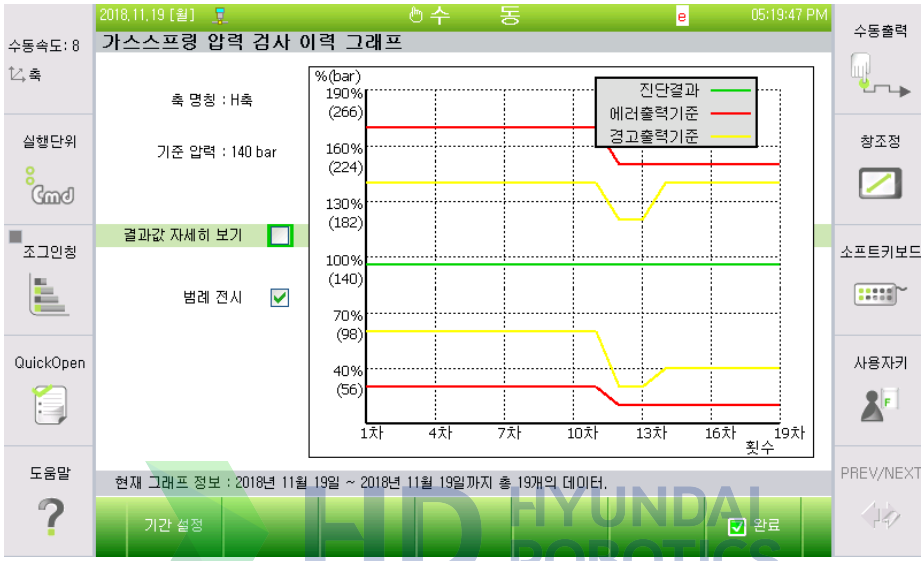

Figure 4.3 Initial window for gas spring pressure test history graph with successful period setting

The gas spring pressure test history graph will be displayed in two lines indicating the maximum and minimum values of the error output criteria and the warning output criteria.
The displayed graph will be changed depending on the details view of result values on the left of the graph, and on the selection of legend display. You can adjust the graph as desired.

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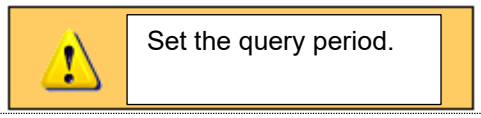
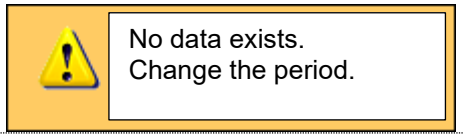
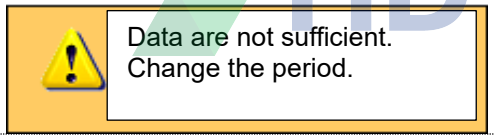
5 Error and warning

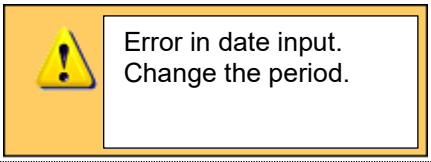
5.1. Error message

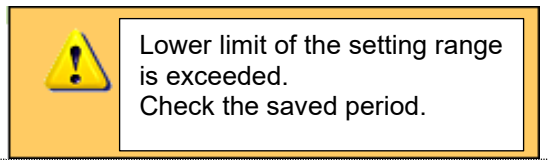
E21011	The gas spring pressure is below the minimum error reference.	The pressure estimated through the gas spring pressure test is below the minimum error reference for the gas spring.	1) Check if the load has been correctly estimated for the robot. 2) Check the load information, and reestimate the gas pressure. 3) If the error recurs, check the actual pressure of the gas spring.
E21012	The gas spring pressure is above the maximum error reference.	The pressure estimated through the gas spring pressure test is above the maximum error reference for the gas spring.	1) Check if the load has been correctly estimated for the robot. 2) Check the load information, and reestimate the gas pressure. 3) If the error recurs, check the actual pressure of the gas spring.
E21013	The robot does not support the gas spring pressure test.	The robot model does not support the gas spring pressure test.	Delete the gas spring pressure test command.
E21014	The gas spring pressure test section is too short.	The gas spring pressure test section is too short that the data are not enough for estimation.	1) Record two or more steps between the start and the end. 2) Record the different movement directions of axis X in the operation program section. 3) If the movement time is too short, reduce the speed or increase the distance.
E21015	The gas spring pressure test has been abnormally stopped.	The gas spring pressure test has been stopped because of a problem.	Redo the gas spring pressure test.
E21016	An error occurred during the gas spring pressure test calculation.	The data are abnormal for the gas spring pressure test.	1) Run the gas spring command after a correct MOVE statement. 2) Check if the gas spring number is correct and then rerun it.

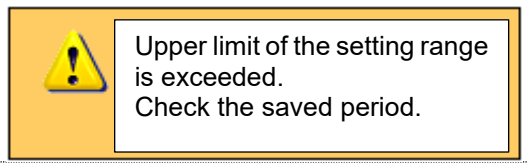
Code	
Message	You have tried operation without setting a query period for the history graph.
Action	Set a query period, and retry operation.

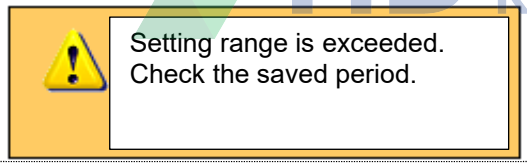
Code	
Message	No test history exists for the set period.
Action	1) Conduct system fault diagnosis, and retry graph viewing. 2) Change the period. ※ In the brake analysis and the driving parts diagnosis history graphs, the number of data may vary for an identical period depending on selected conditions.

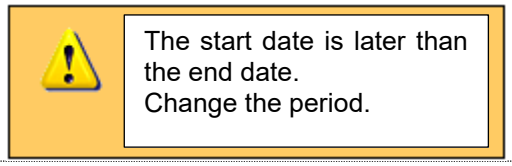
Code	
Message	For drawing a graph, 2 or more data are required. Only 1 data exists in the set period.
Action	1) Conduct system fault diagnosis, and retry graph viewing. 2) Change the period. ※ In the brake analysis and the driving parts diagnosis history graphs, the number of data may vary for an identical period depending on selected conditions.

Code	
Message	In the period setting, you have input abnormal dates. e.g.) Month 1111, date 1, year 2018; Month 11, date 11111, year 2018
Action	Input normal dates.

Code	
Message	In setting the period, you have set the query start date at an older date than the oldest date of the saved data.
Action	Set the date within the range of saved period.

Code	
Message	In setting the period, you have set the query end date at a later date than the latest date of the saved data.
Action	Set the date within the range of saved period.

Code	
Message	In setting the period, you have set both the query start date and the query end date out of the period of the saved data.
Action	Set the dates within the range of saved period.

Code	
Message	In setting the period, you have set the query start date later than the query end date.
Action	Set the query start date earlier than the query end date.

5.2. Warning message

W21011	The gas spring pressure(Command) is below the minimum warning reference.	The pressure estimated through gas spring pressure test is below the minimum warning reference for the gas spring.	1) Check if the load has been correctly estimated for the robot. 2) Check the load information and re-estimate the gas pressure. 3) If the error recurs, check the actual pressure of the gas spring.
W21012	The gas spring pressure(Command) is above the maximum warning reference.	The pressure estimated through the gas spring pressure test is above the maximum warning reference for the gas spring.	1) Check if the load has been correctly estimated for the robot. 2) Check the load information and reestimate the gas pressure. 3) If the error recurs, check the actual pressure of the gas spring.
W21013	The robot does not support the gas spring pressure test.	The robot model does not support the gas spring pressure test.	Delete the gas spring pressure test command.
W21014	Abnormal gas spring pressure(Command) (without load estimation)	The gas spring pressure is abnormal without load estimation.	1) Estimate the load and then test the gas spring pressure. 2) If it is not possible to estimate the load, change the gas spring test options to perform the estimation only.
W21015	The gas spring pressure(Stop) is below the minimum warning reference.	The pressure estimated through gas spring pressure test is below the minimum warning reference for the gas spring.	1) Check if the load has been correctly estimated for the robot. 2) Check the load information and re-estimate the gas pressure. 3) If the error recurs, check the actual pressure of the gas spring.
W21016	The gas spring pressure(Stop) is above the maximum warning reference.	The pressure estimated through the gas spring pressure test is above the maximum warning reference for the gas spring.	1) Check if the load has been correctly estimated for the robot. 2) Check the load information and re-estimate the gas pressure. 3) If the error recurs, check the actual pressure of the gas spring.
W21017	Abnormal gas spring pressure(Stop) (without load estimation)	The gas spring pressure is abnormal without load estimation.	1) Estimate the load and then test the gas spring pressure. 2) If it is not possible to estimate the load, change the gas spring test options to perform the estimation only.
W21018	Gas spring pressure. (stop) error. (load	A gas spring pressure error has occurred	1) Carry out tool load validity setting. 2) When the tool load validity cannot be

	validity not checked status)	while the load validity is not checked.	checked, enter the correct additional weight for the axes, and carry out load estimation. 3) When the tool load validity cannot be checked, change “stop state gas pressure estimation” to “invalid.”

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