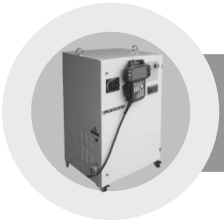
HYUNDAI ROBOTICS

WARNING

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

HD
HYUNDAI
ROBOTICS



Hi5a Controller Function Manual

Brake failure detection

HD HYUNDAI ROBOTICS

Printed in Korea – June 2023, 3rd Edition

Contents

List of Figures

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

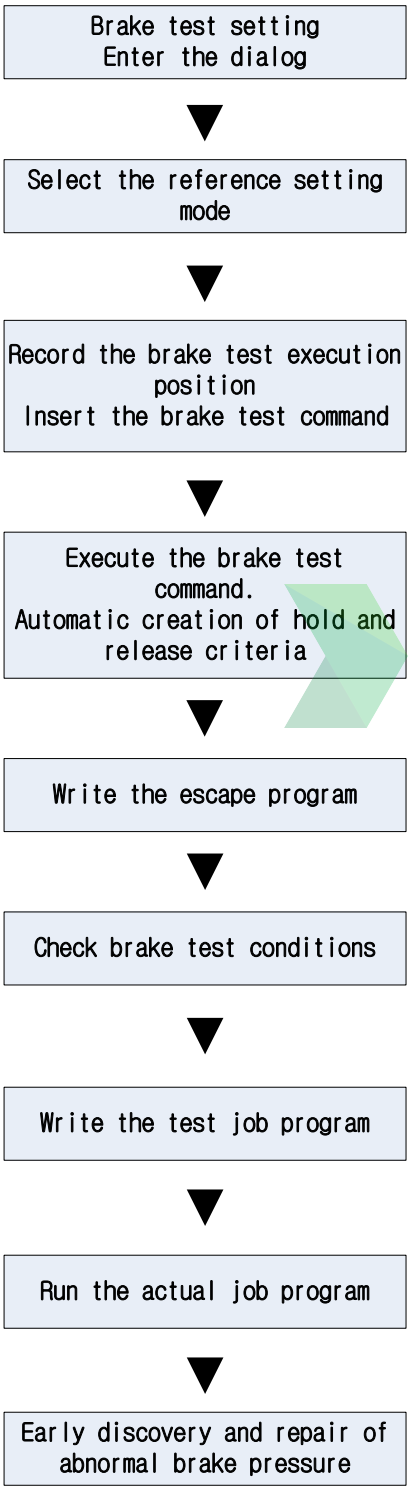
1.1. Specifications

Item	Specifications
Brake failure detection command	BrakeTest
Test type	Hold and release test
Test time	3 s x number of axes to test hold
Test reference setting	Auto or manual setting
Failure test handling	Warning is displayed with the number of failed axes returned to defined variable.
Escape program processing	With the method and robot language specified in the escape program

◆ 【Note】 ◆

This function requires engineer privilege.

1.2. Working procedure



(『[F2]: System』 → 『3: Robot Parameter』 → 『13: System Diagnosis』 → 『1: Brake test setting』)
* Engineer privilege is required.

Press the [F1] key to select in the brake test setting dialog.
* Test and reference items are disabled when selecting the reference setting mode.
* All axes are in the reference setting mode in the initial system setting.

Record the brake test position or move to the corresponding step.
* Enter the command->Others->BrakeTest

Run the brake test once in Auto Mode at the position.
* The reference is automatically created when the command is executed in the reference setting mode.

Record the position for the robot to stop safely.
Stop with the STOP command after processing such as an error signal output.

Check test items by axis, check the reference value, and specify the escape program number.

Add a test program CALL command in the actual job program.
* Add an execution condition such as daily or every 100 cycles.
  Add an escape program CALL command for an error.

Check the brake state with the brake test at desired intervals.

Check the brake problem, if any, and then inspect and repair it during nonoperation.

HYUNDAI ROBOTICS

2

Function setting and monitoring

2.1. Brake test setting

2.1.1. Brake test setting dialog

(1) The brake test setting can be changed only by an engineer because it requires accurate motion and maintenance.

(2) Select 『[F2]: System』 → 『3: Robot Parameter』 → 『13: System Diagnosis』 → 『1: Brake Test Setting』.

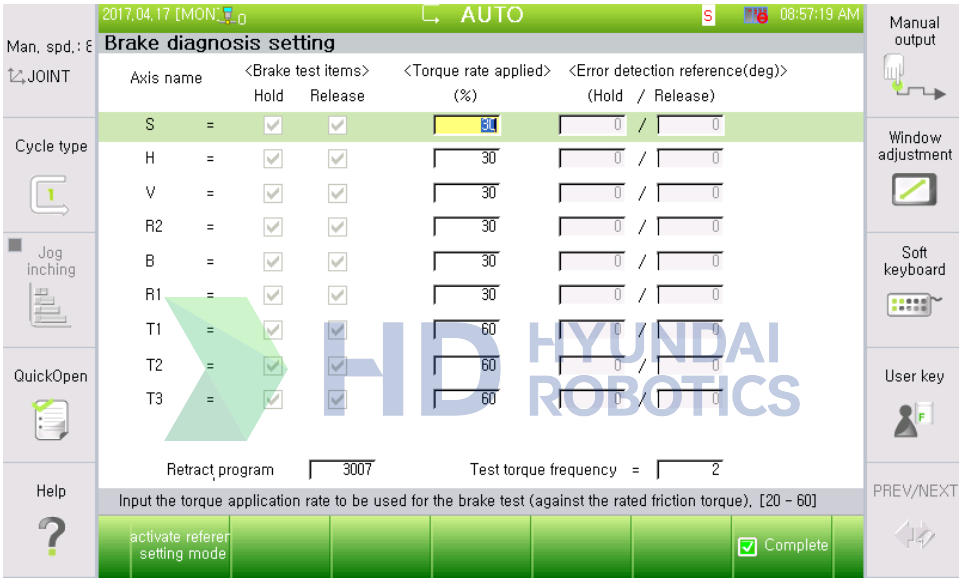


Figure 2.1 Brake test setting dialog

2.1.2. Detailed brake test items

(1) Brake test items

Select to test hold or release for each axis. In general, select both.

- Hold test
  Torque is applied for 3 s with the brake working.
  It checks if the movement of the motor angle exceeds the reference value within 3 s.
  The following warning is displayed if the reference value is exceeded:
  “Abnormality is detected in W0162 brake hold test.” And then the test continues with the next axis.

- Release test
  Torque is applied for 3 s with the brake open.
  It checks if the movement of the motor angle reaches the reference value within 3 s.

The following warning is displayed if the reference value is not reached:
"Abnormality is detected in W0163 brake release test." And then the test continues with the next axis.

(2) Torque application ratio

Set the ration of torque for a motor when testing each axis. The torque is a ratio for rating the friction torque of motor (maximum torque of motor brake).
The use of default ratio in most cases is recommended.
However, adjust the value in the following cases:

- If warning occurs because the change is too big in the hold test, decrease the torque application ratio.
- If warning occurs because the change is too small in the release test, increase the torque application ratio.

(3) Error detection reference (degree)

Set error reference values for axes in the hold or release test.

■ Hold
Reference value for hold test. Decrease the value for a more precise brake hold test.

■ Release
Reference value for release test. Increase the value for a more precise brake release test.

This value can be automatically set by executing the brake test command in the Reference Setting Mode.

(4) Escape program number

Specify the job program number that the robot escape position has recorded for errors. If the escape program is not set, an error will occur when executing the brake test command. The escape program is automatically run when an issue occurs during brake hold test after the test command is finished. For more details, refer to Chapter 3, Application Example.

(5) Reference setting mode

It is used to change the error detection reference according to the actual system. Press the F1 key to disable the Brake Test Item and Error Detection Reference of axis so as to enter Reference Setting Mode. Press F1 again to disable the Reference Setting Mode. For more details, refer to 2.3 Brake test data monitoring.

2.2. Automatic brake test reference setting

To test a brake, set reference values for tests. Values can be manually entered or automatically set for each axis. Setting the values automatically and then adjusting them manually are recommended. (Reference Setting Mode is set if the controller is set for the first time.)
The references can be automatically set as follows.

(1) Move the cursor to an axis to set the reference in the setting dialog and then press the F1 key.

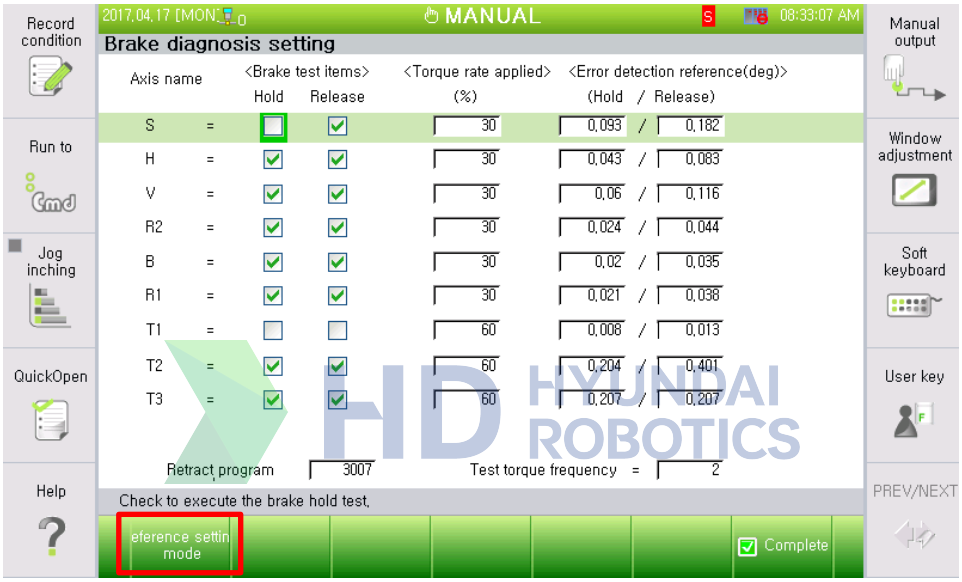


Figure 2.2 Brake test setting dialog

(2) Make sure that the brake test item and error detection reference are disabled for the axis.

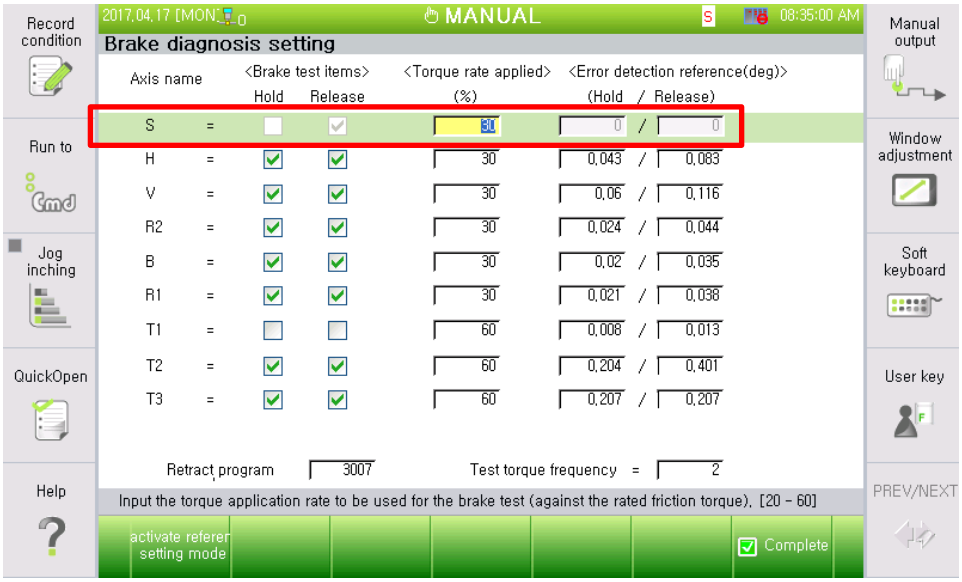


Figure 2.3 Reference Setting Mode is set

(3) Select other axes and then the Reference Setting Mode in the same manner.

(4) After all axes are disabled for automatic reference setting, finish the test setting.

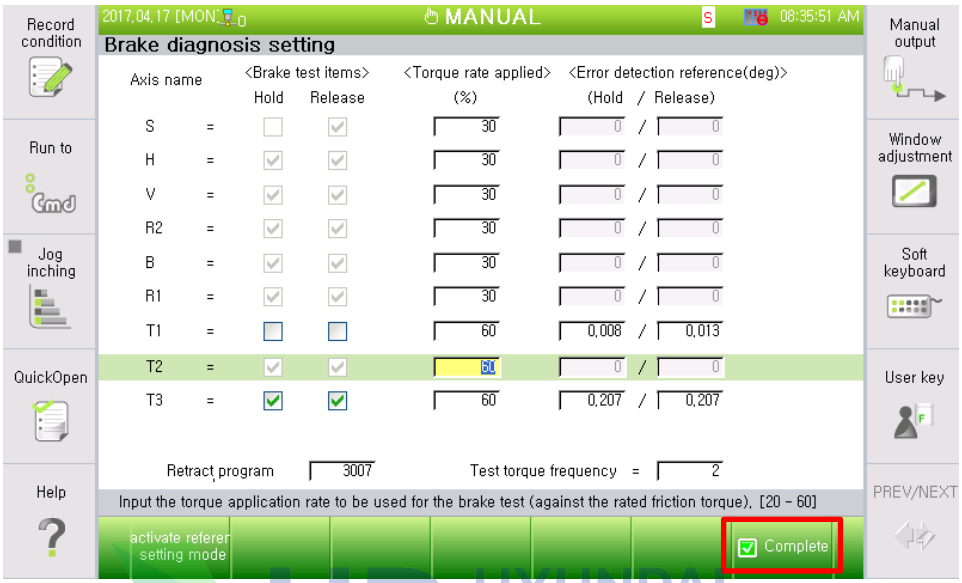


Figure 2.4 An axis is set to Reference Setting Mode

(5) Execute the brake test command in the auto mode. With the setting complete, the Reference Value Setting Mode is automatically released.

(6) After the command is executed in the Reference Value Setting Mode, make sure that the defined reference value is correct. A correct reference value must be above the hold test change but below the release test change.

(7) Go back to the brake test setting dialog, and select a brake test item to perform.

(8) Execute the brake test command to see if the brake works correctly.

2.3. Brake test data monitoring

(1) It monitors the brake test state and the maximum values of angle change for axes.

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

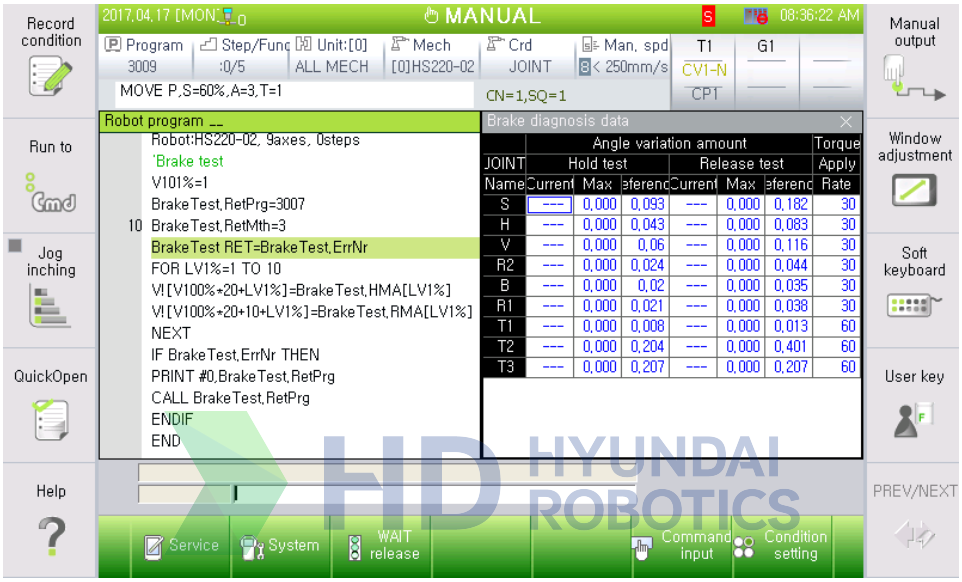


Figure 2.5 Brake test data monitoring

(3) Here is the brake monitoring information.
- Current: Axis angle change of axis to test
- Max.: Maximum axis angle change during test
- Reference: Reference value for hold/release test
- Torque application ratio: Ratio of test torque to rated friction torque

(4) In the brake test, the axis under test turns blue while the test item turns yellow.

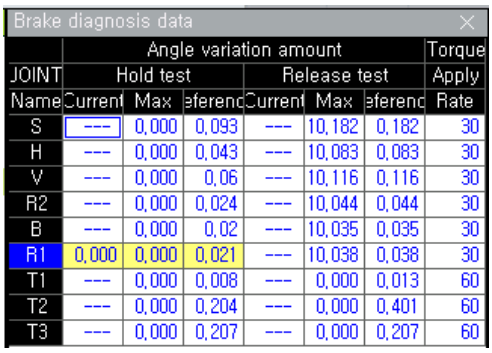


Figure 2.6 Brake test running

(5) In the Reference Value Setting Mode, the top of the monitoring and axis name blinks in yellow.

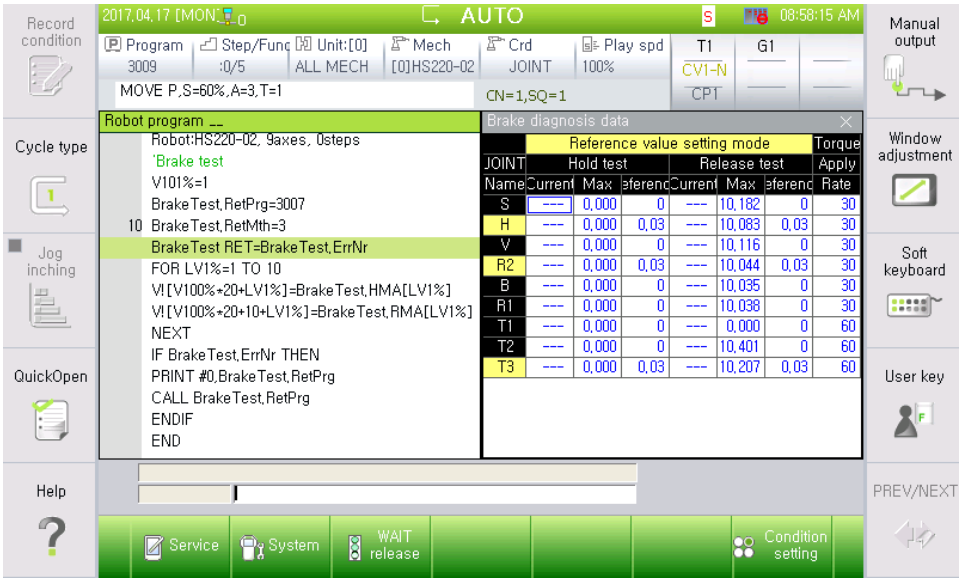


Figure 2.7 Monitoring in Reference Value Setting Mode

HD
HYUNDAI
ROBOTICS

HYUNDAI ROBOTICS

3 Example

3.1. Brake test setting

(1) This example requires engineer privilege.

(2) Select 『[F2]: System』 → 『3: Robot Parameter』 → 『13: System Diagnosis』 → 『1: Brake Test Setting』.

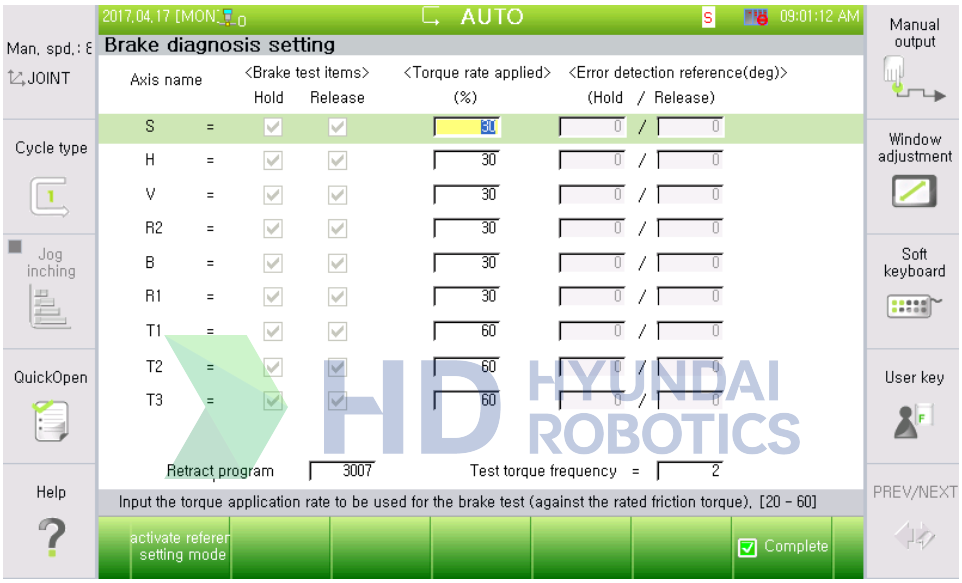


Figure 3.1 nitial brake test setting

(3) Make sure all axes are disabled (Reference Setting Mode). If an axis is not disabled for automatic reference setting, move the cursor to the axis and press F1: Reference Setting Mode to disable it.

(4) Press F7: Done button and then execute BrakeTest RET=BrakeTest.ErrNr command in the auto mode. While the command is being executed, the state of axis can be monitored.

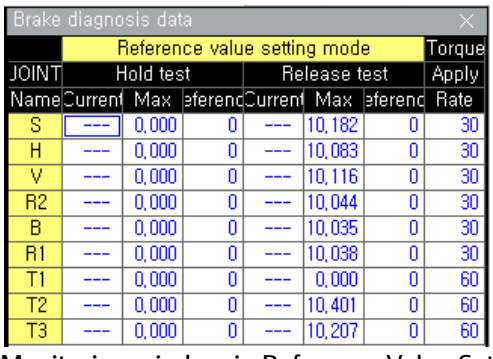


Figure 3.2 Monitoring window in Reference Value Setting Mode

(5) Go back to the brake test setting dialog. Make sure that the error detection reference is correct.

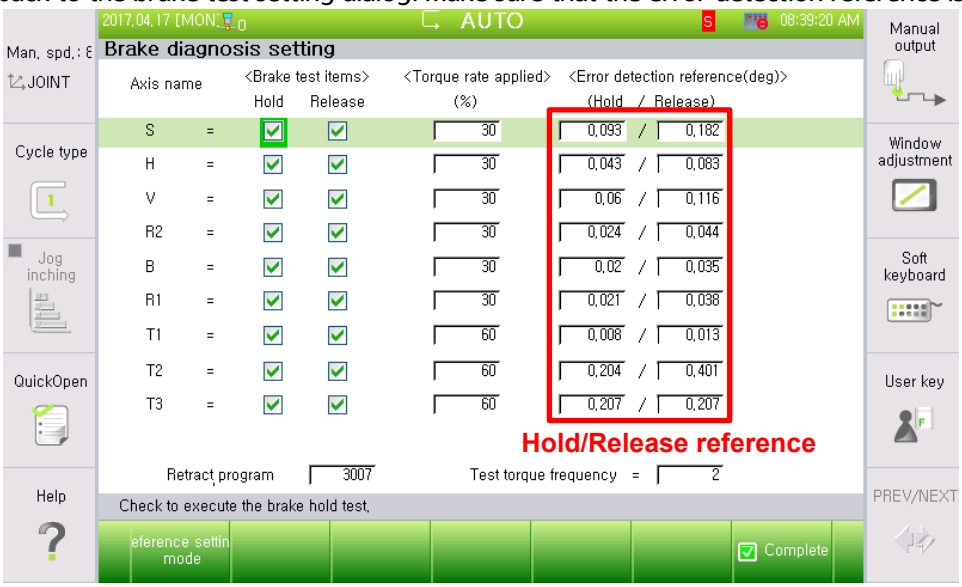


Figure 3.3 Automatic hold and release reference settings

(6) Select items to test for each axis.

- S: Release test
- H, V, R2, B, R1: Hold and release test
- T1: No test
- T2, T3: Hold and release test

(7) Enter the escape program number 9900. Here is the setting result.

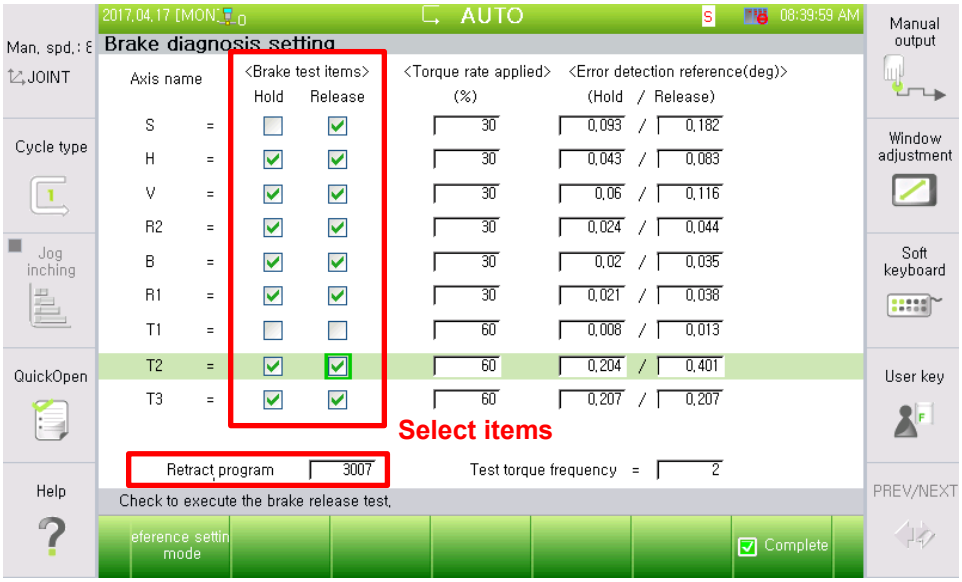


Figure 3.4 Escape program is set.

(8) After all settings are complete, press the F7: Done button to save the settings.

3.2. Escape program setting

(1) Write a program to move the robot to a safe position to change the motor in case of a brake failure.

(2) In this example, the robot escape position is as follows.

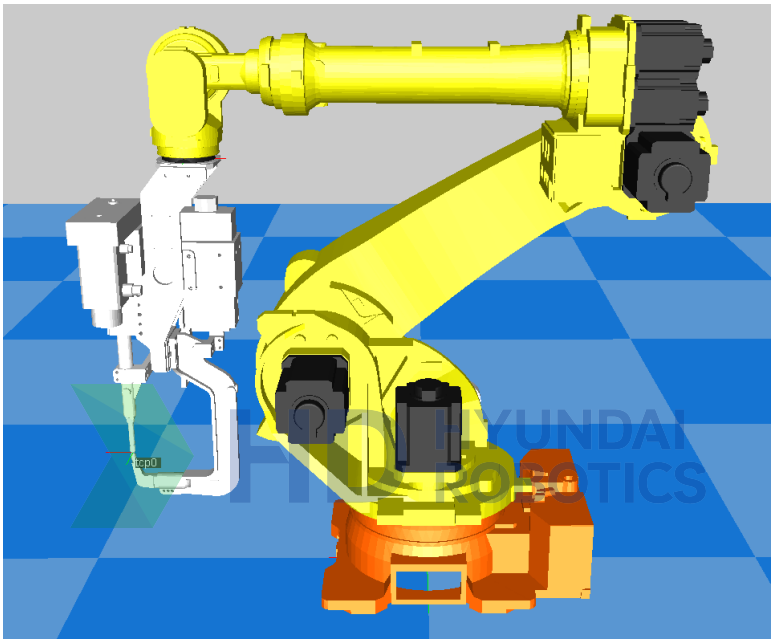


Figure 3.5 Robot escape position in case of a brake failure

(3) Here is the written 9900.JOB escape program.

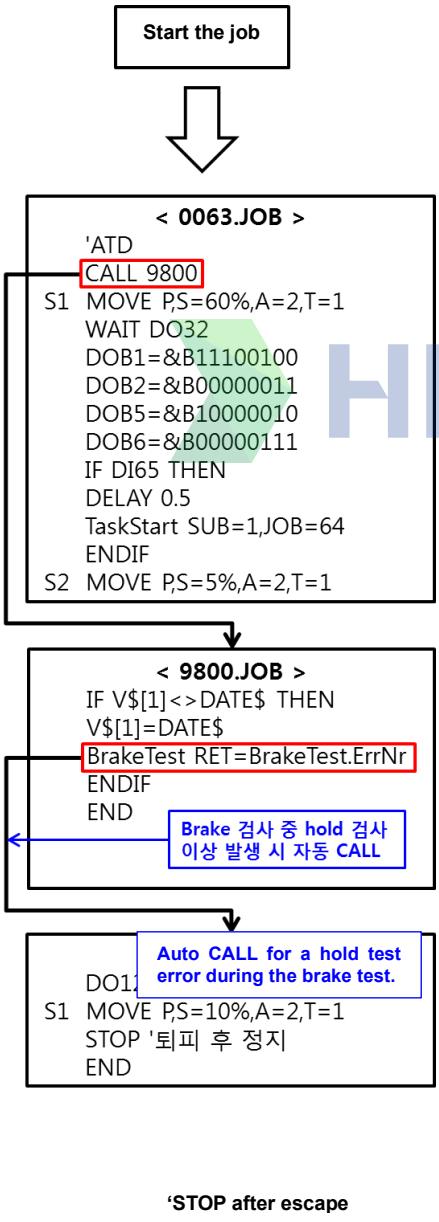
```
Robot program __
        Robot:HS220-02, 9axes, 1steps
        DO120=1 'Brake Error Signal
S1      MOVE P,S=60%,A=3,T=1 'Retract Pose
        STOP
        END
```

Figure 3.6 Example of a simple escape program

3.3. Applications

(1) Now that your program is ready to execute the brake test function, apply it to the actual job program.

(2) This example executes one brake test per day.



Job program

Call the brake test job on top of the program.
Execute the following if the brake test is OK.

Job to execute one brake test per day
Execute the following if the date of the day is different from V$[1].
Substitute the changed date of the day for V$[1].
Execute the brake test command.
Call the escape job automatically if a hold error occurs in the brake test.

Job to execute escape for a brake problem
Brake failure signal (DO120) is output.
Move to the escape position with 10% speed.
Stop after escape.

(3) 0063.JOB file is the job program of the robot. Call the test job program No. 9800 for the brake test just before starting the job.

(4) If the brake test has already been performed for the day, the date string is the same so it returns to the job program and executes the job.

(5) For the first brake test of the day, the date string is different, so change the comparison variable to the date of the day and then execute the brake test. If the test result is OK, it just returns to the job program and executes the job.

(6) If a hold error is found in the brake test, the escape job program No. 9900 is automatically called to move to the escape position.

(7) While the brake failure detection signal is for output, it moves to the safe position even though the brake is released, and then stops with the motor on.

HD HYUNDAI ROBOTICS

HYUNDAI ROBOTICS

4

Operation and UI description

4.1. Brake test history graph

*** This function is supported after V40.20-00**

(1) Clicking [F1: Service] → [7: System diagnosis] → [4: System fault diagnosis history graph] → [1: Brake test history graph] will display the following window for brake diagnosis history graph:

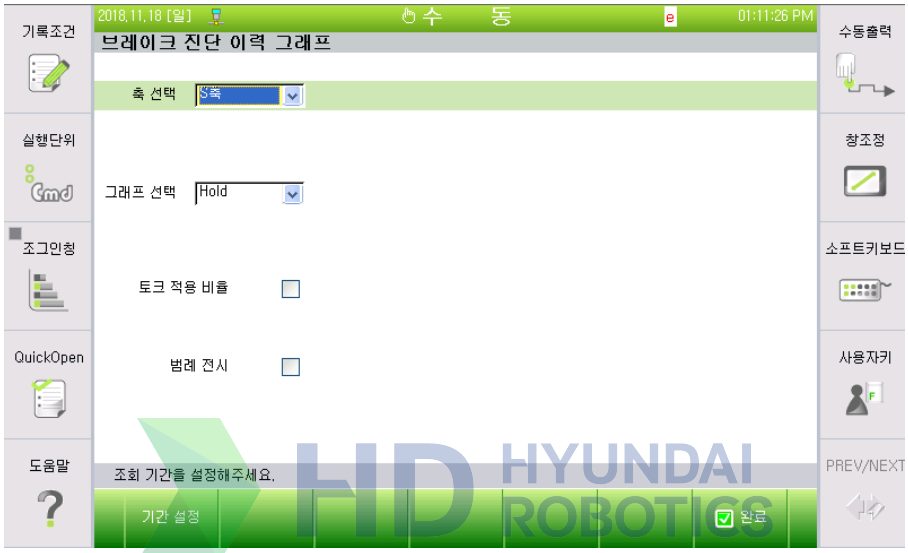


Figure 4.1 Initial window for brake test history graph

(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.
'Information' displays the model of the robot that is currently set and the time period in which the result of the model is saved.

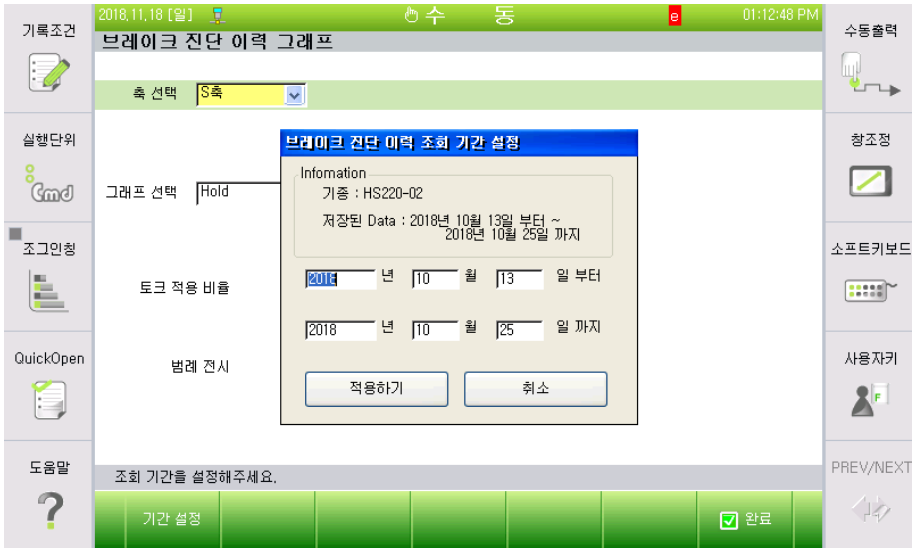


Figure 4.2 Popup window for setting query period

(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.

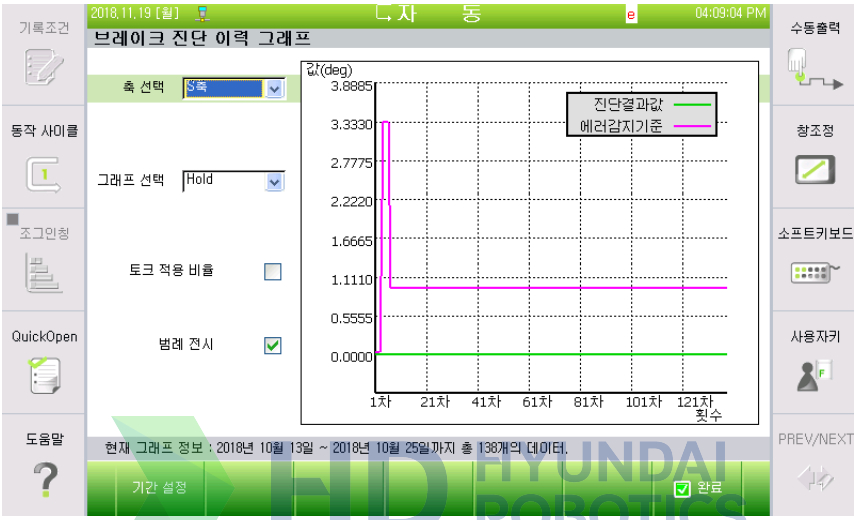


Figure 4.3 Window displaying the brake diagnosis graph

The displayed graph will be changed depending on the axis selection on the left of the graph, the selection of graph, the selection of the torque application ratio, and the selection legend display. You can adjust the graph as desired.

※ In the brake diagnosis, when changes are made in the axis and hold/release graph according to the testing setting, the data matching the conditions may not exist.

5 Error and warning

5.1. Error message

Code	E1509 The brake test has not finished in 6 s.
Description	The brake test has not been performed within 5 s because of an internal software error.
Action	1) Rerun the brake test command. 2) Exclude the axis of issue from the test items and then rerun the command. 3) If the problem still exists, contact us.

Code	E1510 The brake has not been released after the brake test.
Description	The brake was operated to test the brake test function, but it has not been released.
Action	1) Turn the controller off and then on, and then rerun the brake test command. 2) Check the motor of the axis of issue. 3) If the problem still exists, contact us.

Code	E1525 No escape program exists.
Description	There is no job program for the escape program number that was set in the brake test function.
Action	1) Add the escape program for the job number specified in the brake test setting dialog. 2) In the brake test dialog, set the job program number where the escape position and concerned handling are recorded.

Code	E1526 The escape program does not match the MCH file.
Description	The escape program of the specified number in the brake test setting dialog does not match the MCH file of the current robot.
Action	Write a new escape for the specified number in the brake test setting dialog.

Code	E1527 The number of axes of escape program is different.
Description	The number of axes of the escape program of a specified number in the brake test setting dialog does not match that of the current robot.
Action	Write a new escape for the specified number in the brake test setting dialog.

Code	E1529 The brake test is not available.
Description	The brake test is not available because of internal robot issues.
Action	1) If the robot is independently executing a command statement, perform the brake test after the independent execution is complete. 2) If the robot is moving, perform the brake test after the movement is complete. 3) If the robot has already started the brake test, wait until it is finished.

Code	E1530 The brake test has been delayed for 3 s or more.
Description	The robot waiting state has not been released for over 3 s so the brake cannot be tested.
Action	1) Release the Power Saving Mode and then test the brake. 2) Release the holding current reduction and then test the brake. 3) If the problem still exists, contact us.
Code	E21001 No axis is selected to test.
Description	All axes are released to test in the brake test setting.
Action	Select brake test items in the brake test setting dialog.

Code	E21002 An undefined error occurred during a brake test.
Description	An unexpected error occurred while performing a brake test.
Action	If the problem persists, contact out A/S staff.

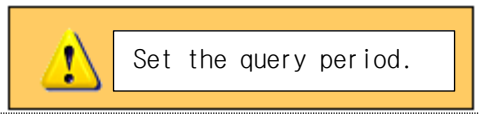
Code	E21003 An error occurred in the brake release test.
Description	The robot stopped because of brake release error.
Action	1) Check if the brake works correctly for the axis of issue. 2) Check if the brake can be released with a manual brake signal output from the system board. 3) Check if the tool information, test position, and gain value remain as set. 4) Check if the brake can be released with a manual brake signal output from the system board. 5) If the system board has no issue, check the brake signal cabling. 6) If the cabling has no issue, replace the motor.

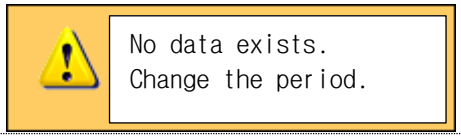
Code	E21004 Axis 0) A problem occurred while setting the brake test reference.
Description	The calculated data are too small to be set as the test reference.
Action	1) Check the cabling for the motors of axes, and make sure that the maximum values are 0s. 2) If the cabling has no issue, check the motor.

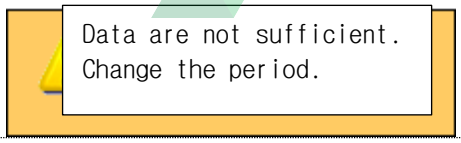
Code	E21005 Axis 0) The axis angle of the test result is incorrect (Hold>Release).
Description	The hold test angle is larger than the release test angle for the brake test reference test.
Action	1) Check the brake signal cabling. 2) Reset the reference after fixing cabling issues, if any.

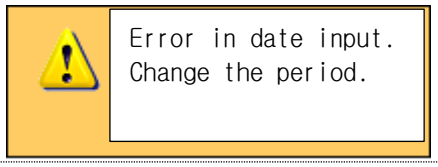
Code	E21006 Axis 0) The torque application ratio is out of range.
Description	The torque application ratio for brake test is out of the 20%-60% range.

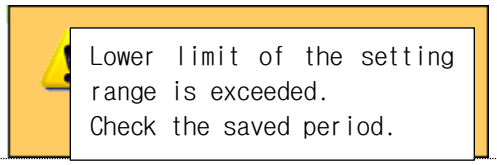
Action	1) Check the setting in the brake test setting dialog and then fix issues, if any. 2) If the problem persists, contact our A/S staff.

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

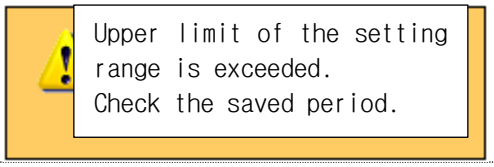
Code	
Message	No test history exists for the set period.
Action	1) Conduct system fault diagnosis, and retry graph viewing. 2) Change the period. ※ In the brake analysis and the driving parts diagnosis history graphs, the number of data may vary for an identical period depending on selected conditions.

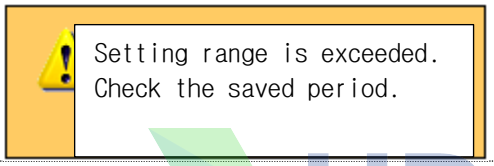
Code	
Message	For drawing a graph, 2 or more data are required. Only 1 data exists in the set period.
Action	1) Conduct system fault diagnosis, and retry graph viewing. 2) Change the period. ※ In the brake analysis and the driving parts diagnosis history graphs, the number of data may vary for an identical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

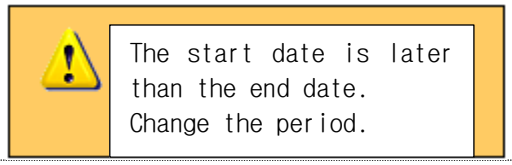
Code	
Message	In the period setting, you have input abnormal dates. e.g.) Month 1111, date 1, year 2018; Month 11, date 11111, year 2018
Action	Input normal dates.

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

Code	W0162 Axis %s) Abnormality is detected in the W0162 brake hold test.
Description	The motor angle change exceeds the reference value during the brake hold test.
Action	1) Check if the hold test reference value is too low for the axis. 2) Check if it escapes to a safe position with the motor on. 3) If the robot does not move to the escape position, move it manually. 4) Check the motor brake of the axis (brake operation, oil penetration, etc.). 5) Replace the motor of axis where a problem was found.

Code	W0163 Axis %2d) Abnormality is detected in the W0163 brake release test.
Description	The motor angle change was lower than the reference value during the brake release test.
Action	1) Check if the release test reference value is too high for the axis. 2) Check if the brake control signal of the axis has been set correctly. 3) Check if the brake works for the axis with the brake release sound. 4) If positional deviation error occurs and it is impossible to move the axis, move it to a safe position using another axis jog. 5) Check the brake of the axis motor (brake operation, motor power supply, etc.). 6) Replace the motor of axis where a problem was found.

Code	W21001 Axis 0) The test result is not good for the test.
Description	The angle change of the hold test exceeds half of that of the release test for the axis of issue.
Action	1) Increase the torque application ratio of axis where the warning occurred at a maximum value so as to automatically reset the reference value. 2) Check if there are no errors in the brake wiring. 3) Check if the brake hold and release outputs are correct on the system board. 4) Check the motor of axis at issue. 5) If no issue is found, test the brake with the axis excluded.

Code	W21002 Axis 0) The angle change is too large in the brake hold state.
Description	The motor angle change exceeds 0.01 rad in a brake hold state.
Action	1) Decrease the torque application ratio of axis where the warning occurred at a minimum value so as to automatically reset the reference value. 2) Check if there are no errors in the brake wiring. 3) Check if the brake hold and release outputs are correct on the system board. 4) Check the motor of axis at issue. 5) If there are no problems, test the brake with the setting values.

6) Replace the motor of axis where a problem was found.

● **Daegu Office (Head Office)**

50, Techno sunhwan-ro 3-gil, yuga, Dalseong-gun, Daegu, 43022, Korea

● **GRC**

477, Bundangsuseo-ro, Bundang-gu, Seongnam-si, Gyeonggi-do, Korea

● **대구 사무소**

(43022) 대구광역시 달성군 유가읍 테크노순환로 3 길 50

● **GRC**

(13553) 경기도 성남시 분당구 분당수서로 477

● ARS : +82-1588-9997 (A/S center)

● E-mail : robotics@hyundai-robotics.com