



WARNING

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LOCAL CODES





Hi5a-S/N/P/C/T/J Controller Operation Manual





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Contents

1. Safety	1-1
1.1. Introduction.....	1-2
1.2. Relevant Safety Regulations	1-6
1.2.1. Explosion-proof safety regulations.....	1-6
1.3. Safety Training.....	1-6
1.4. Safety Related Nameplate.....	1-7
1.4.1. Safety Marking	1-7
1.4.2. Safety Nameplate.....	1-7
1.5. Definition of Safety Functions.....	1-8
1.6. Installation.....	1-9
1.6.1. Safety Fence.....	1-9
1.6.2. Placement of Robot & Peripheral Equipment	1-11
1.6.3. Installing the Robot.....	1-15
1.6.4. Space for Robot Installation.....	1-18
1.7. Safety Operation for Robot Handling	1-19
1.7.1. Safety Precautions for Robot Handling.....	1-19
1.7.2. Safety Precautions for Operating Test.....	1-23
1.7.3. Safety Precautions for Automatic Operation	1-24
1.8. Safety Precautions for Access to Safety Fence	1-25
1.9. Safety Precautions for Maintenance and Repair	1-26
1.9.1. Safety Precautions for Controller Maintenance and Repair	1-26
1.9.2. Safety Precautions for Robot System & Manipulator Maintenance.....	1-27
1.9.3. Necessary Actions after Maintenance and Repair	1-27
1.10. Safety Functions	1-29
1.10.1. Operating a Safety Circuit	1-29
1.10.2. Emergency stop.....	1-31
1.10.3. Operating Speed	1-32
1.10.4. Connecting the Safety Devices.....	1-32
1.10.5. Restricting the working Envelope	1-32
1.10.6. Monitoring Function	1-32
1.11. Safety Related to End Effectors.....	1-33
1.11.1. Gripper.....	1-33
1.11.2. Tool / Workpiece	1-33
1.11.3. Pneumatic and Hydraulic Systems.....	1-33
1.12. Liabilities.....	1-34
2. Basic Operation	2-1
2.1. Outline	2-2
2.2. System Overview	2-3
2.2.1. General.....	2-3
2.2.2. Teach Pendant	2-5
2.3. Manual Operation	2-21
2.3.1. Power Input.....	2-21

Contents

2.3.2. Initial Setting	2-22
2.3.3. Manual Operation	2-24
2.3.4. Manual Operation Speed.....	2-26
2.3.5. Step Forward/Backward	2-28
2.4. Auto Operation	2-31
2.4.1. Auto Operation	2-31
2.4.2. Power Release	2-31
2.4.3. Auto operation speed ratio	2-32
2.5. Step.....	2-33
2.5.1. Basic matters for step.....	2-33
2.5.2. Parameter of step command sentence	2-33
2.5.3. Record/Modify of Step Position	2-42
2.6. R Code Key	2-45
2.7. Error Information	2-46
2.8. User Key.....	2-47
2.8.1. User key assignment	2-47
2.8.2. User key use	2-48
2.9. History	2-49
2.10. Coordinate System	2-50
2.10.1. JOG Operation Key	2-50
2.10.2. Axis Coordinate System	2-52
2.10.3. Robot coordinate system	2-53
2.10.4. User Coordinate System	2-55
2.10.5. Tool Coordinate System	2-56
2.11. Axis origin and tool length optimization setting	2-57
2.12. Tool data automatic calibration	2-58
3. Program preparation	3-1
3.1. Program Selection.....	3-2
3.2. Program Deletion	3-3
3.3. Program Preparation	3-4
3.3.1. What is Command?	3-4
3.3.2. Record condition.....	3-5
3.3.3. Command Entry	3-5
3.3.4. Command Composition	3-6
3.3.5. Command Edit	3-7
3.3.6. Summary of Operation Key	3-8
3.4. Parameter, Formula and Character Edit	3-10
3.4.1. Parameter Edit	3-10
3.4.2. Formula and Character Edit	3-11
3.5. Line Number Edit	3-12
3.6. Block Edit	3-13
4. Service.....	4-1
4.1. Initial Service Screen.....	4-2

4.2. Monitoring	4-4
4.2.1. Data of each axis	4-6
4.2.2. Input/Output Signal	4-7
4.2.3. Field bus signal	4-15
4.2.4. Spot welding data.....	4-18
4.2.5. Sensor synchronization.....	4-22
4.2.6. PLC relay data	4-23
4.2.7. Analog Data	4-35
4.2.8. Cooperation control data	4-36
4.2.9. Various data.....	4-39
4.2.10. Work program HotEdit.....	4-41
4.2.11. Arc welding data.....	4-44
4.2.12. Operating information	4-45
4.2.13. Embedded field bus node state.....	4-47
4.2.14. System characteristic data.....	4-49
4.2.15. Arc welding operating information	4-53
4.2.16. Multi-tasking state	4-54
4.2.17. Servo tool change.....	4-55
4.2.18. Ladder edit.....	4-56
4.2.19. Roller hemming data	4-57
4.2.20. Force sensor data	4-58
4.2.21. Playback speed automatic adjustment state	4-59
4.3. Register	4-60
4.3.1. XYZ Shift Register.....	4-61
4.3.2. Shift Buffer	4-62
4.3.3. Online shift register	4-64
4.3.4. Counter register	4-65
4.3.5. Sensor simulation data.....	4-66
4.3.6. Program reservation execution	4-67
4.4. Variable.....	4-68
4.5. Data comment	4-70
4.6. File manager	4-73
4.6.1. Copy/Paste/Delete file.....	4-76
4.6.2. Copy/Paste/Cut folder.....	4-79
4.6.3. Rename file	4-81
4.6.4. Rename folder	4-83
4.6.5. Create new folder.....	4-84
4.6.6. Edit property.....	4-85
4.7. Program conversion	4-87
4.7.1. Record condition.....	4-88
4.7.2. Record Speed	4-89
4.7.3. Record Position	4-91
4.7.4. Record Coordinate	4-92
4.7.5. Coordinate conversion.....	4-93
4.7.6. Mirror image	4-95
4.7.7. Step copy.....	4-98
4.7.8. Command statement comment	4-100
4.8. System diagnosis.....	4-104

Contents

4.8.1. System version	4-105
4.8.2. Error logging.....	4-115
4.8.3. Operation history	4-117
4.8.4. Average load rate diagnosis	4-119
4.8.5. History of Maintenance and Repair	4-121
4.9. Date, time setting	4-122
4.10. Applet.....	4-123
4.11. Teach pendant option.....	4-126
4.12. Teach pendant sharing	4-128
4.13. History Logging	4-129
5. Condition Setting.....	5-1
5.1. Operation cycle type.....	5-3
5.2. Step FWD/BWD maximum speed.....	5-3
5.3. Function execution during step FWD.....	5-3
5.4. Re-execution of the function after step backward and forward	5-4
5.5. Path recovery during step FWD/BWD.....	5-4
5.6. Playback speed rate.....	5-4
5.7. Robot Lock.....	5-5
5.8. Interpolation tool	5-5
5.9. Select user coordinate	5-6
5.10. Playback speed automatic adjustment	5-7
6. Application Condition	6-1
6.1. Robot search reference pose record	6-3
6.2. Robot search range	6-3
6.3. Embedded PLC mode.....	6-4
7. System setting	7-1
7.1. User environment.....	7-3
7.1.1. Pose Record Type.....	7-4
7.1.2. Confirm delete command.....	7-5
7.1.3. WAIT (DI/WI) release.....	7-5
7.1.4. Program strobe signal use	7-5
7.1.5. Ext. update of playback program	7-5
7.1.6. Collision sensor	7-6
7.1.7. P* Coordinate.....	7-6
7.1.8. P* Selection.....	7-6
7.1.9. Manual oper. For stop signal input	7-7
7.1.10. Teach pendant disconnect	7-8
7.2. Control parameter.....	7-9
7.2.1. Control environment setting	7-10
7.2.2. Input/output signal setting	7-17

7.2.3. Serial port.....	7-34
7.2.4. Robot ready condition.....	7-37
7.2.5. Registration of home position.....	7-38
7.2.6. Shift limit.....	7-39
7.2.7. Coordinate registration.....	7-40
7.2.8. Program reservation execution.....	7-45
7.2.9. Network.....	7-46
7.2.10. Register license key of option function.....	7-51
7.2.11. Automatic backup and recovery.....	7-54
7.3. Robot parameter.....	7-55
7.3.1. Tool data.....	7-56
7.3.2. Axis origin.....	7-61
7.3.3. Soft limit.....	7-62
7.3.4. Encoder offset.....	7-63
7.3.5. B axis dead zone.....	7-65
7.3.6. Accuracy.....	7-66
7.3.7. Additional weight on each axis.....	7-67
7.3.8. Collision detection.....	7-69
7.3.9. Maintain current reduction.....	7-74
7.3.10. Jog inching level.....	7-75
7.4. Application parameter.....	7-77
7.5. Initialize.....	7-78
7.5.1. System format.....	7-79
7.5.2. Robot type selection.....	7-80
7.5.3. Usage setting.....	7-81
7.5.4. Serial encoder reset.....	7-83
7.5.5. Additional axis parameter setting.....	7-84
7.5.6. Mechanism setting.....	7-85
7.5.7. Unit setting.....	7-88
7.6. Auto calibration.....	7-91
7.6.1. Optimize axis origin and tool length.....	7-92
7.6.2. Positioner calibration.....	7-95
7.6.3. Laser vision sensor coordinate calibration.....	7-96
7.6.4. Load estimation function.....	7-96
7.6.5. Common coordinate of cooperate robots.....	7-100
7.6.6. Base axis calibration.....	7-100
7.6.7. Coordinate system calibration for OLP.....	7-105
7.6.8. Gravitation direction automatic setting.....	7-106
7.6.9. Robot and tool calibration.....	7-108
7.6.10. Additional axis auto tuning.....	7-111
8. R Code.....	8-1
8.1. R Code.....	8-2
8.2. R0 Step counter reset.....	8-4
8.3. R10 operating information display.....	8-4
8.4. R17 File manager.....	8-5
8.5. R18 Counter register display/settings.....	8-6

Contents

8.6. R24 Online coordinated cancel/restore	8-7
8.7. R44 Sensor synchronization data clearing.....	8-8
8.8. R45 Sensor moving distance manual input	8-9
8.9. R46 Limit switch manual input.....	8-10
8.10. R55 Palletizing reset.....	8-11
8.11. R115 Copy program.....	8-12
8.12. R116 Rename program	8-13
8.13. R117 Delete program	8-14
8.14. R136 Change step accuracy	8-15
8.15. R137 Change step MX.....	8-16
8.16. R163 Cancel online shift.....	8-17
8.17. R210 Spot gun number selection	8-18
8.18. R211 Servo gun squeeze force setting	8-19
8.19. R212 SVG moving tip consumption preset	8-20
8.20. R213 Servo-gun fixed tip consumption preset.....	8-21
8.21. R214 Simultaneous welding gun selection	8-22
8.22. R215 Spot welding condition squeeze setting	8-23
8.23. R220 Panel thickness settings (Sv).....	8-24
8.24. R249 PLC all relay clear.....	8-25
8.25. R250 Laser sensor data display	8-26
8.26. R269 Program protection.....	8-27
8.27. R286 Software version display.....	8-29
8.28. R350 Endless axis manual reset.....	8-30
8.29. R351 Change cooper. State of manual mode	8-33
8.30. R352 HiNet I/O manual setting	8-35
8.31. R353 Robot cooperation status reset	8-36
8.32. R354 Endless ZERO execution	8-37
8.33. R358 Servo tool change	8-39
8.34. R359 Servo tool encoder power ON Relay	8-41
8.35. R360 CONPATH manual setting	8-42
8.36. R361 Jog inching level setting	8-43
8.37. R362 Axis control state manual setting.....	8-44
9. Quick Open	9-1
9.1. Outline of function.....	9-2
9.2. MOVE – Step location.....	9-5
9.2.1. Hidden pose MOVE sentence	9-5
9.2.2. Pose record MOVE sentence, Post substitute sentence.....	9-7
9.3. Program edit during the operation (Hot Edit)	9-9
9.4. Spot welding function	9-10
9.5. Arc welding condition setting.....	9-11
10. Robot Language.....	10-1
10.1. Robot Language Guide	10-2
10.2. Menu Overview	10-3

10.3. Basic Elements	10-4
10.3.1. Row	10-4
10.3.2. Character	10-4
10.3.3. Address	10-4
10.3.4. Constant.....	10-5
10.3.5. Pose CFG information.....	10-7
10.3.6. Shift CFG information.....	10-9
10.4. Variable and expression.....	10-11
10.4.1. Predefined variable	10-11
10.4.2. Input/Output Variable	10-13
10.4.3. PLC variable	10-16
10.4.4. ID Variables	10-16
10.4.5. Variable dialog box	10-28
10.4.6. System Variable.....	10-34
10.4.7. HiNet variable	10-38
10.4.8. B (BUFV)	10-42
10.4.9. Operator	10-43
10.4.10. Expression	10-44
10.5. Statement.....	10-45
10.5.1. Motion, I/O	10-45
10.5.2. FLOW control.....	10-76
10.5.3. Others.....	10-85
10.5.4. Spot welding.....	10-114
10.5.5. Arc Welding.....	10-122
10.5.6. Handling.....	10-131
10.5.7. Paint.....	10-142
10.5.8. Statements related to variables.....	10-143
10.5.9. ENET Member Variable/Command	10-144
10.6. Function	10-148
10.6.1. Arithmetic Function	10-148
10.6.2. String Function	10-150

Figure of contents

Figure 1.1 Recommended size for safety net and entrance gate (slot type entrance gate)	1-9
Figure 1.2 Recommended size for safety net and entrance gate (square type entrance gate) ..	1-10
Figure 1.3 Arrangement of LCD robot peripheral devices and workers	1-13
Figure 1.4 Arrangement of general robot peripheral devices and workers	1-14
Figure 1.5 Assembling of payload area.....	1-17
Figure 1.6 Configuration for safety chain	1-29
Figure 1.7 Connection with external emergency halt switch through system board terminal block TBEM.....	1-31
Figure 2.1 Basic Components of Manipulator and Controller (LCD Robot)	2-3
Figure 2.2 Teach Pendant (LCD Robot)	2-3
Figure 2.3 Basic configuration drawing of the Robot system (Vertical Articulated Robot)	2-4
Figure 2.4 Teach Pendant (Vertical Articulated Robot)	2-4
Figure 2.5 External Appearance of Teach Pendant (left: TP511, right: TP520)	2-5
Figure 2.6 Teach pendant screen	2-6
Figure 2.7 Status display bar.....	2-7
Figure 2.8 Icon for the external operation mode.....	2-8
Figure 2.9 Task program edit window	2-9
Figure 2.10 Monitoring window.....	2-9
Figure 2.11 F buttons display window	2-10
Figure 2.12 L button bar, R button bar	2-11
Figure 2.13 Command being executed.....	2-11
Figure 2.14 TP screen in the adjust window menu	2-12
Figure 2.15 Adjust window F menu	2-12
Figure 2.16 TP screen horizontally split	2-13
Figure 2.17 Monitoring type selection menu	2-14
Figure 2.18 Private input signal monitoring screen	2-14
Figure 2.19 TP screen after the display type is clicked.....	2-15
Figure 2.20 Initialization menu screen	2-22
Figure 2.21 Program selection window implemented	2-24
Figure 2.22 Program selection window with a list displayed.....	2-24
Figure 2.23 Manual speed setting window	2-26
Figure 2.24 Cmd/Step mode playback forward/backward path.....	2-28
Figure 2.25 End mode playback forward/backward path.....	2-29
Figure 2.26 The state in which the automatic stopping occurred at the cornering start point after the backward movement during the cornering.	2-29
Figure 2.27 Changing of the path of the robot when moving forward after the step backward process.	2-30
Figure 2.28 Auto operation speed ratio setting screen	2-32
Figure 2.29 Playback speed setting window	2-33
Figure 2.30 Example of tool end path of P-PTP interpolation.....	2-34
Figure 2.31 Example of L-linear interpolation	2-34
Figure 2.32 C – Example 1 of circular interpolation.....	2-35
Figure 2.33 C – Example 2 of arc interpolation.....	2-35

Figure 2.34 Pose data dialogue box.....	2-37
Figure 2.35 Path change depending on accuracy of P2	2-39
Figure 2.36 Cornering path according to the value of the accuracy level.....	2-40
Figure 2.37 All the points on the cornering path exist within the convex polygon (The part with slant lines)	2-40
Figure 2.38 Example of stop condition	2-41
Figure 2.39 Quick Open from MOVE command	2-42
Figure 2.40 Posture of H and V axes: Upper (Left), Lower (Right).....	2-43
Figure 2.41 Flip (Left)/Non-flip (Right) posture	2-44
Figure 2.42 R code entering window	2-45
Figure 2.43 Display R code list with [Help] key	2-45
Figure 2.44 Error display screen	2-46
Figure 2.45 Error detail and action.....	2-46
Figure 2.46 User key setting screen.....	2-47
Figure 2.47 User key screen	2-48
Figure 2.48 History	2-49
Figure 2.49 Axis Coordinate System	2-52
Figure 2.50 Robot coordinate system	2-53
Figure 2.51 Direction and rotation direction of coordinate system	2-54
Figure 2.52 User coordinate system	2-55
Figure 2.53 Tool coordinate system (for torch adhesion)	2-56
Figure 2.54 Tool coordinate system (without tool)	2-56
Figure 3.1 Program number entering window	3-2
Figure 3.2 Program list show	3-2
Figure 3.3 File manager	3-3
Figure 3.4 Record condition editing.....	3-5
Figure 3.5 Address area	3-6
Figure 3.6 Command area	3-6
Figure 3.7 Command edit	3-7
Figure 3.8 Parameter edit.....	3-10
Figure 3.9 Soft keyboard.....	3-11
Figure 3.10 Reflected into the editing.....	3-11
Figure 3.11 Line number edit 1	3-12
Figure 3.12 Line number edit 2	3-12
Figure 3.13 Block edit 1.....	3-13
Figure 3.14 Block edit 2	3-13
Figure 3.15 Block edit 3.....	3-14
Figure 3.16 Block edit 4	3-15
Figure 4.1 Initial service screen	4-2
Figure 4.2 Monitoring Items 1.....	4-4
Figure 4.3 Monitoring Items 2	4-4
Figure 4.4 Monitoring the data of each axis	4-6
Figure 4.5 Selection of input and output signals	4-7
Figure 4.6 Selection of details of input and output signals	4-7
Figure 4.7 Private input signal.....	4-8
Figure 4.8 Private output signal.....	4-9
Figure 4.9 Public input signal.....	4-10
Figure 4.10 Input signal flow diagram.....	4-11

Contents

Figure 4.11 Public output signal	4-12
Figure 4.12 Output signal flow diagram	4-13
Figure 4.13 Input signal name display	4-14
Figure 4.14 Field bus signal details	4-15
Figure 4.15 FB1 field bus input signal monitoring	4-16
Figure 4.16 FB5 field bus input signal monitoring	4-17
Figure 4.17 Spot welding data details	4-18
Figure 4.18 Spot gun axis data	4-19
Figure 4.19 Spot welding input and output signals	4-20
Figure 4.20 Spot welding operating information	4-21
Figure 4.21 Spot welding operating information clear	4-22
Figure 4.22 Sensor synchronization monitoring	4-22
Figure 4.23 PLC relay data details	4-23
Figure 4.24 PLC X Relay (External Input)	4-24
Figure 4.25 PLC Y Relay (External Output)	4-25
Figure 4.26 PLC R Relay (Auxiliary)	4-26
Figure 4.27 PLC K Relay (Nonvolatile)	4-27
Figure 4.28 PLC T Relay (Timer)	4-28
Figure 4.29 PLC C Relay (Counter)	4-29
Figure 4.30 PLC SP Relay (Special)	4-30
Figure 4.31 PLC DI Relay (PLC Output)	4-31
Figure 4.32 PLC DO Relay (PLC Input)	4-32
Figure 4.33 PLC MW Relay (Data Memory)	4-33
Figure 4.34 PLC SW Relay (System memory)	4-34
Figure 4.35 Analog data monitoring	4-35
Figure 4.36 Cooperation control status monitoring	4-36
Figure 4.37 HiNet I/O monitoring	4-38
Figure 4.38 HiNet-IO connection state	4-38
Figure 4.39 Various data monitoring	4-39
Figure 4.40 Hot Edit execution screen	4-41
Figure 4.41 Edit during operation	4-42
Figure 4.42 Arc welding data monitoring screen shifting	4-44
Figure 4.43 Operating information	4-45
Figure 4.44 Operating information clear dialog box	4-46
Figure 4.45 Embedded field bus node condition monitoring - 1	4-47
Figure 4.46 Embedded field bus node condition monitoring - 2	4-48
Figure 4.47 Display window of the internal temperature of the controller	4-49
Figure 4.48 Initialization of the maximum internal temperature value of the controller	4-50
Figure 4.49 PRM Input signal monitoring	4-51
Figure 4.50 PRM information monitoring	4-52
Figure 4.51 Arc welding operating information monitoring	4-53
Figure 4.52 Arc welding operating information clear dialog box	4-54
Figure 4.53 Multitasking state monitoring	4-54
Figure 4.54 Servo tool change monitoring	4-55
Figure 4.55 Ladder edit screen	4-56
Figure 4.56 Roller hemming data	4-57
Figure 4.57 Force sensor data	4-58
Figure 4.58 Monitoring of the playback speed automatic adjustment state	4-59

Figure 4.58 Register details selection screen.....	4-60
Figure 4.59 XYZ shift	4-61
Figure 4.60 XYZ shift register screen	4-61
Figure 4.61 Shift buffer screen.....	4-62
Figure 4.62 Horizontal move shift	4-63
Figure 4.63 Angle revision shift	4-63
Figure 4.64 Online shift register screen	4-64
Figure 4.65 Counter register screen	4-65
Figure 4.66 Sensor simulation data screen	4-66
Figure 4.67 Program reservation execution screen	4-67
Figure 4.68 Variable type selection screen	4-68
Figure 4.69 Variable value setting screen	4-68
Figure 4.70 Screen for setting the variable to move	4-69
Figure 4.71 Return to the variable type selection screen	4-69
Figure 4.72 Data comment screen	4-70
Figure 4.73 Data comment object setting	4-70
Figure 4.74 Data comment display method setting	4-71
Figure 4.75 Moving the cursor	4-71
Figure 4.76 Jumping quickly to the relay of the set number	4-71
Figure 4.77 Editing the data comment by using the soft keyboard	4-72
Figure 4.78 File manager screen.....	4-73
Figure 4.79 Moving in the file hierarchy	4-74
Figure 4.80 File list.....	4-74
Figure 4.81 File type selection.....	4-75
Figure 4.82 Folder selection screen.....	4-76
Figure 4.83 Selecting multiple files.....	4-76
Figure 4.84 Selecting the target folder of paste action	4-77
Figure 4.85 Job file overlapped setting	4-77
Figure 4.86 Non job file overlapped setting	4-78
Figure 4.87 Deleting multiple selected files	4-78
Figure 4.88 Selecting the folder to copy	4-79
Figure 4.89 Selecting the target folder of paste action	4-79
Figure 4.90 Folder pasting	4-80
Figure 4.91 Folder deletion	4-80
Figure 4.92 Selecting a file to rename	4-81
Figure 4.93 File renaming	4-81
Figure 4.94 Cursor operation when renaming a file	4-81
Figure 4.95 File renaming and editing completed	4-82
Figure 4.96 Limitation to renaming a file in M/B	4-82
Figure 4.97 Using the soft key to enter characters	4-82
Figure 4.98 Selecting a folder to rename	4-83
Figure 4.99 Editing the folder name	4-83
Figure 4.100 Folder name editing completed.....	4-83
Figure 4.101 Selecting a parent folder to create a new folder in	4-84
Figure 4.102 Creating a new folder and editing its name	4-84
Figure 4.103 Changing file properties.....	4-85
Figure 4.104 Program conversion screen.....	4-87
Figure 4.105 Record condition conversion screen.....	4-88

Figure 4.106 Record speed conversion screen.....	4-89
Figure 4.107 Record pose conversion screen.....	4-91
Figure 4.108 Record coordinate conversion screen.....	4-92
Figure 4.109 Coordinate conversion	4-93
Figure 4.110 Coordinate conversion Program.....	4-93
Figure 4.111 Coordinate transfer screen	4-94
Figure 4.112 Source program → Converted program by using Mirror Image	4-95
Figure 4.113 Mirror image setting screen.....	4-96
Figure 4.114 Range exceeded steps warning screen	4-97
Figure 4.115 Step copy setting screen	4-98
Figure 4.116 Copy step	4-99
Figure 4.117 Copy step in reverse direction	4-99
Figure 4.118 Change in the program – example 1 of performing command statement comment function (Signal assignment statement, WAIT statement)	4-100
Figure 4.119 Change in the program – example 2 of performing command statement comment function (SPOT statement)	4-100
Figure 4.120 Command statement comment screen	4-101
Figure 4.121 Apply the comment of a command statement in block editing mode	4-103
Figure 4.122 Screen when installing USB attachment for software updates	4-105
Figure 4.123 Compressed file selection screen of the software	4-106
Figure 4.124 Configuration device selection screen for software update.....	4-106
Figure 4.125 Software update completion screen.....	4-107
Figure 4.126 System version screen page 1.....	4-108
Figure 4.127 System version screen page 2.....	4-109
Figure 4.128 System version screen page 3	4-109
Figure 4.129 Main S/W version information	4-110
Figure 4.130 S/W update file search	4-111
Figure 4.131 S/W update process monitoring screen.....	4-111
Figure 4.132 T/P version information	4-112
Figure 4.133 Multilanguage T/P batch version.....	4-112
Figure 4.134 T/P single version.....	4-113
Figure 4.135 T/P information in sub folder	4-113
Figure 4.136 Single T/P version update.....	4-113
Figure 4.137 Sound effect/help not recognized	4-114
Figure 4.138 Sound effect/help recognized	4-114
Figure 4.139 Error logging screen	4-115
Figure 4.140 Error logging/private input signals.....	4-116
Figure 4.141 Operation history screen.....	4-117
Figure 4.142 Operation history/private output signals.....	4-118
Figure 4.143 Average load rate diagnosis	4-119
Figure 4.144 History of Maintenance and Repair	4-121
Figure 4.145 Date and time setting screen	4-122
Figure 4.146 Applet dialog box.....	4-123
Figure 4.147 Applet folder screen	4-124
Figure 4.148 Applet Ex.: LCD Easy Teaching.....	4-124
Figure 4.149 Applet shortcut key setting.....	4-125
Figure 4.150 Teach pendant options setting.....	4-126
Figure 4.151 Setting history logging function	4-129

Figure 5.1 Condition setting screen	5-2
Figure 6.1 Application condition screen	6-2
Figure 6.2 Search range setting	6-3
Figure 7.1 System setting menu	7-2
Figure 7.2 User environment menu (1)	7-3
Figure 7.3 User environment menu (2)	7-3
Figure 7.4 Difference between U and Un	7-4
Figure 7.5 Control parameter menu	7-9
Figure 7.6 Control environment setting menu (1)	7-10
Figure 7.7 Control environment setting menu (2)	7-10
Figure 7.8 Input/output signal setting menu.....	7-17
Figure 7.9 Input signal properties menu.....	7-18
Figure 7.10 Positive and negative logic of common input signal	7-18
Figure 7.11 Output signal properties menu.....	7-20
Figure 7.12 Positive and negative logic of common output signal.....	7-20
Figure 7.13 Example of pulse output.....	7-21
Figure 7.14 Example of delay output	7-21
Figure 7.15 Input signal assignment menu.....	7-22
Figure 7.16 External program selection diagram when the program strobe signal is "Enable" ..7-23	
Figure 7.17 External program selection diagram when the program strobe signal is "Disable" ..7-23	
Figure 7.18 Output signal assignment - Main task.....	7-25
Figure 7.19 8-bit output.....	7-25
Figure 7.20 16-bit output	7-26
Figure 7.21 Key signal output.....	7-27
Figure 7.22 Analog input filter	7-28
Figure 7.23 BD521/BD522 field bus information and setting menu	7-29
Figure 7.24 BD57X field bus (CC-Link) information and setting menu	7-30
Figure 7.25 Embedded field bus setting screen	7-31
Figure 7.26 Node scanning for setting the embedded field bus.....	7-32
Figure 7.27 Node scanning results for setting the embedded field bus - 1.....	7-32
Figure 7.28 Embedded field bus Get/Set Object	7-33
Figure 7.29 Embedded field bus combo box list.....	7-33
Figure 7.30 Serial port menu	7-34
Figure 7.31 Serial port #1 setting menu	7-35
Figure 7.32 Serial port #2 setting menu.....	7-36
Figure 7.33 Robot ready condition menu.....	7-37
Figure 7.34 Registration of home position	7-38
Figure 7.35 Shift limit menu	7-39
Figure 7.36 User coordinate menu	7-40
Figure 7.37 Teaching method of 3 standard steps to define the user coordinate	7-41
Figure 7.38 Example of the sealing work.....	7-42
Figure 7.39 Stationary tool coordinate setting method	7-43
Figure 7.40 Teaching method when using the auto setting function	7-44
Figure 7.41 Example of program preparation for using stationary tool coordinate.....	7-44
Figure 7.42 Network menu screen	7-46
Figure 7.43 Network/Environment setting screen	7-47

Contents

Figure 7.44 Ethernet state monitoring screen.....	7-47
Figure 7.45 Network/Service menu screen.....	7-47
Figure 7.46 Cooperation control setting screen	7-48
Figure 7.47 HR-RPC initialization screen	7-49
Figure 7.48 HRMS setting screen	7-50
Figure 7.49 License key registration screen	7-51
Figure 7.50 Optional function license key registration screen.....	7-52
Figure 7.51 Optional function license key registration screen	7-53
Figure 7.52 Remaining days of the optional function license key	7-54
Figure 7.53 Displayed warning message when a temporary key is issued more than once	7-54
Figure 7.54 Robot parameter menu screen	7-55
Figure 7.55 Flange coordinate system by robot type	7-56
Figure 7.56 Tool angle.....	7-57
Figure 7.57 Tool data setting screen	7-58
Figure 7.58 Tool data automatic calibration screen.....	7-59
Figure 7.59 Tool angle calibration screen.....	7-60
Figure 7.60 Tool angle calibration screen.....	7-60
Figure 7.61 Axis origin setting screen.....	7-61
Figure 7.62 Soft limit setting screen.....	7-62
Figure 7.63 Encoder offset screen	7-63
Figure 7.64 Axis-position input dialog box.....	7-64
Figure 7.65 B axis dead zone setting screen	7-65
Figure 7.66 Accuracy setting screen.....	7-66
Figure 7.67 Individual axis additional weight setting screen	7-67
Figure 7.68 Zero point of each axis coordinates	7-68
Figure 7.69 Collision detection menu screen	7-69
Figure 7.70 Screen for setting the collision detection (for each axis)	7-70
Figure 7.71 Collision detection (of each axis) setting screen	7-72
Figure 7.72 Magnification selection and entry screen	7-74
Figure 7.73 Holding current reduction setting screen	7-74
Figure 7.74 Jog inching level setting screen	7-75
Figure 7.75 Robot activity when the key is off after the inching distance is reached.	7-76
Figure 7.76 Robot activity when the key is off before the inching distance is reached.....	7-76
Figure 7.77 Applied parameter selection (Display different information in accordance with the setting)	7-77
Figure 7.78 Initialize.....	7-78
Figure 7.79 Initialization selection screen.....	7-78
Figure 7.80 System initialization.....	7-79
Figure 7.81 Robot type selection and initialization screen	7-79
Figure 7.82 Robot type selection.....	7-80
Figure 7.83 Vertical articulated robot type selection	7-80
Figure 7.84 Usage setting	7-81
Figure 7.85 Usage setting (Arc).....	7-82
Figure 7.86 Serial encoder resetting.....	7-83
Figure 7.87 Additional axis constant setting	7-84
Figure 7.88 Mechanism setting.....	7-85
Figure 7.89 Unit setting	7-88
Figure 7.90 Robot coordinates setting for the step	7-89

Figure 7.91 Auto calibration setting items	7-91
Figure 7.92 Teaching method for optimizing the axis origin and the tool length.....	7-92
Figure 7.93 Results of the axis origin and tool length optimization	7-93
Figure 7.94 Axis 1 and 2 positioners.....	7-95
Figure 7.95 Tool data setting screen	7-96
Figure 7.96 Tool data.....	7-97
Figure 7.97 Load estimation function screen	7-98
Figure 7.98 Base axis calibration.....	7-100
Figure 7.99 Base axis calibration program teaching	7-102
Figure 7.100 Base axis calibration execution screen.....	7-103
Figure 7.101 Operation after calibration for base axis.....	7-104
Figure 7.102 Example of coordinate calibration for OLP	7-105
Figure 7.103 Gravitation direction of a robot on a ground surface.....	7-106
Figure 7.104 Gravitation direction of a robot on an inclined surface.....	7-106
Figure 7.105 Gravitation direction selection results	7-107
Figure 7.106 Robot data measurement method.....	7-108
Figure 7.107 Measured robot position data.....	7-109
Figure 7.108 Robot calibration data entry	7-109
Figure 7.109 Robot calibration execution screen	7-110
Figure 7.110 Additional axis auto tuning execution screen.....	7-111
Figure 8.1 R Code input dialog box	8-2
Figure 8.2 R code help screen (1).....	8-3
Figure 8.3 R code help screen (2).....	8-3
Figure 8.4 R17 File manager execution screen	8-5
Figure 8.5 R18 Counter register display/setting screen	8-6
Figure 8.6 R24 Online coordinated cancel/restore input screen.....	8-7
Figure 10.1 Menu Overview.....	10-3
Figure 10.2 Variable dialog box	10-28
Figure 10.3 Variable dialog box	10-31
Figure 10.4 Cooperative Group / robot and HiNet I/O	10-38
Figure 10.5 Examples using the HiNet I/O (Group Nos. 1-4 robots)	10-39
Figure 10.6 Relative program call	10-86
Figure 10.7 User coordinates system	10-87
Figure 10.8 One-dimension Search.....	10-92
Figure 10.9 Two-dimension search.....	10-93
Figure 10.10 Online coordinates conversion.....	10-97
Figure 10.11 Robot interrupt (Analog signal)	10-99
Figure 10.12 P3 work location.....	10-103
Figure 10.13 P10 work location.....	10-104
Figure 10.14 CalXPoint usage	10-109
Figure 10.15 CalXLine usage	10-110

Table of contents

Table 1-1 Safety marking	1-7
Table 1-2 State of Robot Stop	1-21
Table 2-1 Key description	2-16
Table 2-2 AUTO/MANUAL switch, safety plug condition	2-21
Table 2-3 Operation pattern of Robot in every coordinate system	2-50
Table 2-4 Operation form on an additional axis-related jog key	2-51
Table 3-1 Summary of operation key	3-8
Table 4-1 Reflection timing	4-42
Table 4-2 Reflected timing	4-46
Table 7-1 Output of signal assignment by assigned signal	7-12
Table 7-2 Output signal assignment for each assigned signal	7-20
Table 7-3 Job inching function specification	7-75
Table 7-4 Specifications of positioner functions	7-95
Table 8-1 R44 sensor synchronization data clear specification	8-8
Table 8-2 R269 Display of each program protection specification	8-28
Table 8-3 "R352 HiNet I/O manual setting" specification	8-35
Table 8-4 R358 Example of Servo tool change parameter	8-39
Table 8-5 R361 Jog inching level setting	8-43
Table 9-1 Contents appearing when pressing the [Quick Open] key in command	9-3
Table 10-1 Robot language characters	10-4
Table 10-2 Robot language addresses	10-4
Table 10-3 Robot language integer and real number	10-5
Table 10-4 Robot language pose and shift	10-5
Table 10-5 .CFG element value structure of pose constant or pose variable	10-7
Table 10-6 Pose member	10-8
Table 10-7 Configuration of the shift CFG element value	10-9
Table 10-8 Shift member	10-10
Table 10-9 Robot language global variables	10-11
Table 10-10 Robot language local variables	10-12
Table 10-11 Robot language input and output variables	10-13
Table 10-12 Variables in the embedded PLC accessible by robot language	10-16
Table 10-13 ID Example of ID variable syntax	10-16
Table 10-14 Conventions for prefixes for ID variables for individual variable types	10-18
Table 10-15 Example of using ID variables as global variables	10-19
Table 10-16 Examples of using ID variables as local variables	10-20
Table 10-17 Array of ID variables	10-21
Table 10-18 Examples of using parameters	10-22
Table 10-19 Calling by reference and by value	10-23
Table 10-20 Example 1 of the value being maintained through calling by value	10-23
Table 10-21 Example 2 of the value being maintained through the calling by value	10-24
Table 10-22 Example of a value being changed due to calling by reference	10-24
Table 10-23 Method of delivering the value of an ID variable through calling by value	10-25
Table 10-24 Practical examples of ID variables	10-26
Table 10-25 Robot language system variable	10-34

Table 10-26 Setting details by member parameter	10-36
Table 10-27 Setting details by member parameter	10-37
Table 10-28 Group number, output/input area in accordance with the robot number	10-39
Table 10-29 Operator priority	10-43
Table 10-30 Types of robot language expressions	10-44
Table 10-31 Robot language for handling.....	10-131
Table 10-32 ENET member variables.....	10-144
Table 10-33 Arithmetic functions of the robot language	10-148
Table 10-34 String functions of the robot language	10-150







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ROBOTICS

1

Safety



1. Safety

1.1. Introduction

The main purpose of this chapter is to describe the safety of personnel who use, repair, and operate the industrial robot. While this manual is written mainly for the handling of the controller, the performance of the explosion-proof function is an item certified, together with the manipulator, for the whole system. Therefore, you should carefully read and understand the instruction manual of the machine.

This manual describes safety precautions for robot manipulator and controller, in complies with the safety regulation of EU Machinery Directive 98/37/EC(2006/42/EC) and US OSHA. And the robot manipulator and controller is manufactured to comply with the safety standards EN ISO 10218-1:2011 and ANSI/NFPA 79:2021.

Every operator, who installs, replaces, adjusts, manipulates, maintains, and repairs, must read thoroughly and fully understand the manipulation and maintenance manual, in particular, the special attention must be paid to the WARNING symbol, the most important marking related to the safety.

Installation, replacement, adjustment, manipulation, maintenance, and repair of robot system must be performed by the personnel who was duly trained for these purposes, following the indicated operating procedure.

This company is planning and carrying out the relevant training such as maintenance, repair, and manipulation for the above operations, so robot users make sure that robot operators should get the relevant training. And make sure that the robot handling work should be carried out only by the operators who completed this training course.

Hyundai Robotics user of industrial robot has responsibility to observe the safety regulation related to robot adopted in corresponding countries and responsibility to design, install and operate safety equipment well in order to protect workers who work at robot system.

The dangerous zone of robot system, that is the working range in which the robot, tool, and peripheral equipment are operated, must be safeguarded to prevent workers or workpiece from entering the zone. If a person or object should nevertheless enter the dangerous zone, make sure that the robot system is immediately shut down by emergency stop system. The operators of robot system have a responsibility to take all necessary steps to make correct installation, examination and operation of the relevant safety devices.

The areas for which the robot can be applied and the environment in which it can be used are as follows.

Applicable areas

It is applied to the industrial robot used by installing on the surface of wall or plane (axes addable). It is also appropriate for controlling operation in the dotted section or consecutive section.

Major application is

- Spot welding
- Arc welding
- Cutting
- Handling
- Assembly
- Application such as Sealing
- Palletizing
- Grinding
- LCD manufacturing process

For the other use than the above emergency application, make a contact with our company to consult on the robot use and possible applications.

Disable environment

Our robot must not be used in a highly explosive environment and the areas contaminated by oil, flammable materials or chemical materials. (Prohibited to be installed and manipulated.)

● Hi5a-P10

The areas for which the robot can be applied and the environment in which it can be used are as follows.

➤ Applicable areas

It is applied to the Painting robot used by installing on the surface of wall or plane (axes addable). It is also appropriate for controlling operation in the dotted section or consecutive section.

For the other use than the above emergency application, make a contact with our company to consult on the robot use and possible applications.

➤ Disable environment

Our robot must not be used in a highly explosive environment and the areas contaminated by oil, flammable materials or chemical materials.

It is recommended to use it in the environment of Zone I. (Prohibited to be installed and manipulated.)

EXPLOSION-PROOF SPECIFICATION

This robotic system is built in a complex explosion-proof structure that integrates the pressurized explosion-proof structure with the intrinsically safe explosion-proof structure.

The structure of the robot and the painting equipment realizes the explosion-proof function that uses pressure. The pressure inside the machine is retained higher than the air pressure of the painting booth, thereby preventing the inflow of gas from the outside as well as possible hazards that could occur to electric connections, for example, between the motor and the encoder inside the manipulator.

The robot should maintain a pressure higher than the atmospheric pressure to start normally. If this condition is not satisfied, the electrical connection will be cut off.

Purge any explosive gas before supplying power to the equipment in the booth. Perform air purging when the controller power is turned on so that explosive gas can be purged below the reference concentration. If stable pressure is maintained, the robot will be set to a state in which it can operate. If the internal air pressure does not reach the reference pressure, the controller immediately cuts off the power supply.

The robot cannot be started until the air purging operation is performed again to purge the gas surely even after the fault is cleared.

The pressure switch is always in operation to monitor the manipulator's pressure. The energy supplied for the operation of the system is limited by the intrinsically safe explosion-proof structures, so the energy supply cannot exceed the explosion threshold within the paint booth.

This robotic system is certified for explosion-proofness by an international certification institute. To sustain its explosion-proof performance, adding or changing any system or parts that may affect the system is prohibited. Only approved products shall be used for maintenance. If these parts fail or need to

be replaced, please contact Hyundai Robotics.

The pressurized explosion-proof structure prevents the motor and internal wirings inside the manipulator from exploding. However, such protection does not cover the separate harness that connects the manipulator and the controller. If the harness is exposed to a solvent, the cable can be damaged, and ground-fault circuiting or short-circuiting could take place, which could possibly lead to a fire. Make sure that the external harness is exposed to a large amount of solvent.

It is also recommended to regularly test the surface of the cable and the protective tube to prevent damage, and to replace the harness every three to five years.

Purge the explosive gas inside the booth before supplying power to the robotic system and equipment. Install and activate a pressure detection system inside the booth.



Explosion-proof robots are certified for explosion-proofness to ensure safe operation in gas or explosive atmospheres (integration of pressurized and intrinsically safe structures to realize the explosion-proof specification). Take extreme precautions to handle this system properly. Otherwise, serious accidents, such as explosions, could take place.



1.2. Relevant Safety Regulations

The robot is designed as per ISO 10218-1:2011 safety standards for industrial robots, and furthermore in comply with ANSI/NFPA 79:2021 regulations.

1.2.1. Explosion-proof safety regulations

Electrical systems that perform explosion-proof function and any approved changes should conform to the following standards.

IECEX	Ex ib [ib] pxb IIB T4 Gb

IECEX Standards:

IEC 60079-0: 2011 Ed.6

"Electrical apparatus for explosive gas atmospheres,
Part 0 : General Requirements"

IEC 60079-2:

2014 Ed 6

"Electrical apparatus for explosive gas atmospheres,
Part 2 : Equipment protection by pressurized enclosure 'p'"

IEC 60079-11: 2011 Ed 6

"Electrical apparatus for explosive gas atmospheres,
Part 11 : Equipment protection by Intrinsic safety 'i'"

1.3. Safety Training

All the personnel who intend to teach, operate or inspect the robot must be trained in an approved robotic operation and safety training course before start-up. The safety training course includes the following details.

- Purpose and functions of safety devices
- Safety procedure to handle the robot
- Performance of robot or the robot system and possible hazards
- Tasks associated with any specific robot applications
- Safety concepts, etc.

1.4. Safety Related Nameplate

1.4.1. Safety Marking

For the purpose of effective safety instructions, the following safety symbols are used in this manual.

Table 1-1 Safety marking

Symbols		Descriptions
Warning		Indicate a highly dangerous situation, meaning that operating or handling in a wrong manner could result in death or serious injury to personnel, or damage to equipment. Attention should be paid to the operation and handling.
Mandatory		Indicate the compulsory measures that should be taken
Prohibited		Indicate the prohibited actions and/or operations that should not be performed.

1.4.2. Safety Nameplate

Identification plates, warning label and safety symbols are attached to the robot and to the inside and outside of control panel. The designation labels and cable Mark for wire harness between the robot and control panel, and the cables inside/outside of control panel are provided.

All of these plates, labels, symbols and marks constitute safety-relevant parts of the robot and the control panel. They must remain attached to the robot manipulator and control panel at their clearly visible positions all the time for the safety and their full performance.

The painted markings on the floor and signs indicating dangerous zones must be clearly distinguished in form, color, and style from other markings on the machine near the robot system or inside the plant facilities where the robot system is installed.



It is forbidden to remove, cover, or paint over by way of spoiling the clearly visible identification plates, warning labels, safety symbols, designation labels and cable marks.

1.5. Definition of Safety Functions

▶▶ Emergency Stop Functions – IEC 204-1,10,7

There is one emergency stop button on the controller and teach pendant respectively. If necessary, additional emergency buttons can be connected to the robot's safety chain circuit. The emergency stop function, which overrides all other robot controls, can bring the current operation to a halt by cutting off the power supply to the motors of individual axes. This function will also shut down the power supply to other dangerous functions, which are controlled by the robot, to prevent them from being used

▶▶ Safety Stop Function – EN ISO 10218-1:2011

A safety stop circuit needs to be configured, and, through this circuit, each robot should be connected with the safeguards and interlocks. The robot should have a number of electrical input signals which can be used to connect external safety devices, such as safety gates, safety pads, and safety lamps. These signals allow the robot's safety functions to be activated by all equipment, including peripheral equipment and the robot itself.

▶▶ Speed Limitation Function – EN ISO 10218-1:2011

In a manual mode, the maximum speed of the robot is limited to 250 mm per second. The speed limitation applies not only to the TCP (Tool Center Point), but to all parts of manual mode robot. The speed of equipment mounted on the robot should be possibly monitored.

▶▶ Restricting working Envelope – ANSI/NFPA 79:2021

Operation area of each axis is restricted by soft limit and hardware limit. Axis 1, 2, and 3 can also be restricted by means of mechanical stopper.

▶▶ Operation Mode Selection – ANSI/NFPA 79:2021

The robot can be operated either in the manual mode or auto mode. In the manual mode, the robot can be operated only by using the teach pendant.

1.6. Installation

1.6.1. Safety Fence



Install safety fence against the possible collision between the robot and workers, so that no worker may approach the robot.

Install safety fence against the possible collision between the robot and workers, so that no worker may approach the robot. When operators or other personnel enter the robot's working envelope by accident, it may cause an accident. Install the safety fence to stop the robot when one, who intends to replace for TIP DRESSING or TIP changing replacement, or to inspect welding equipment, opens the fence gate and approaches the equipment during operation.

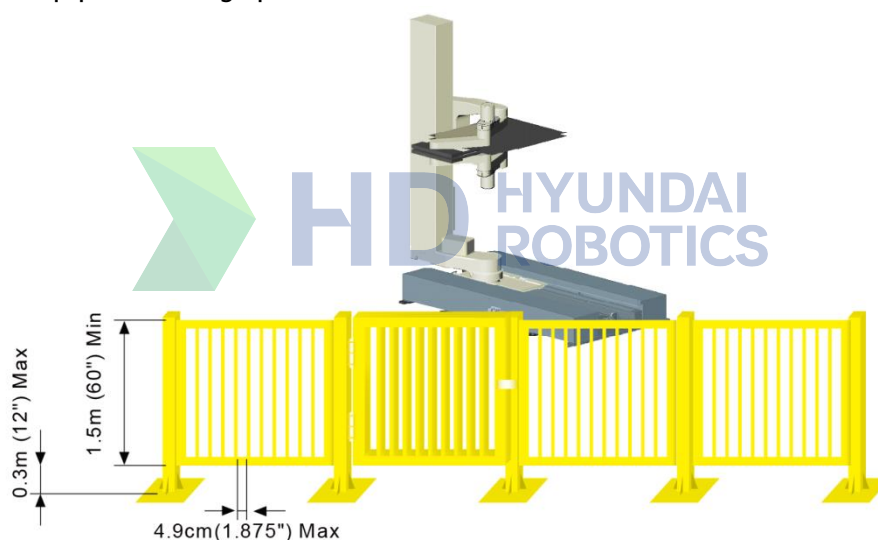


Figure 1.1 Recommended size for safety net and entrance gate (slot type entrance gate)

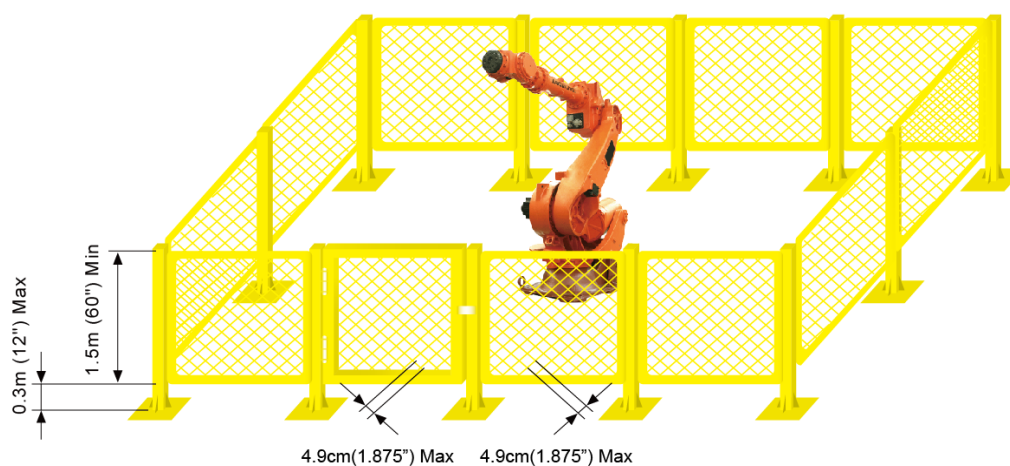


Figure 1.2 Recommended size for safety net and entrance gate (square type entrance gate)

- (1) Enough space for safety net should be secured by covering robot operating area so as that workers would not have difficulty in teaching work or repairing work, and the safety net should have solid structure in order that it would not move easily and man cannot enter over easily.
- (2) Safety net should be installed by static type in principle, and should not have hazardous parts such as prominence and depression or keen part, etc.
- (3) Install the safety fence with an entrance gate, and register the safety plug at the gate so that it does not open unless pulling the plug out. Wiring should be carried out in a way that the robot should be in the operation ready OFF status as well as in the motor OFF status when the safety plug is pulled out or safety net is open.
- (4) In order to operate the robot with the safety plug pulled out, wiring should be carried out in a way that will allow the playback to take place at a low speed.
- (5) The emergency stop button should be installed at a place where it can be pushed quickly by the operator.
- (6) If no safety net is to be installed, devices such as photoelectric switches, and mat switches, should be installed, instead of the safety plug, to cover the overall area within the robot's operation range in a way that the robot can be stopped automatically when a person enters the robot's operation range.
- (7) Operation area of robot (hazardous area) should be distinguished by the method like painting on floor.

1.6.2. Placement of Robot & Peripheral Equipment



Please make sure that robot and peripheral equipment should be arranged by following method.

- (1) In case of connecting primary power of controller or peripheral devices, please work after checking whether supply power has been deleted. There is a possible danger of electric shock because the high voltage such as 220V and 440V is used as its primary power.
- (2) Post a sign [No enter during operation] up the safety fence gate, and inform the operators of its purport.
- (3) Arrange such devices as controller, interlock panel, and other manipulation panels to be handled outside of the safety fence.
- (4) When installing operation stand, install the emergency stop button on the stand. Make sure that stopping in an emergency situation can be initiated from any place from which the robot is operated.
- (5) Make sure that the robot manipulator and the wiring and piping of controller, interlock panel, and timer should not be placed in the way of operator's working range so that they would not be directly stepped on by FORK and LIFT. Otherwise, the operator may suffer electrocution or the wire may suffer disconnection.
- (6) Place the controller, interlock panel, and handling stand within the sight of robotic performance. It may cause a major accident to operate the robot while the robot is malfunctioning in an area where the robot's activity can not be observed, or while the operator is working on it.
- (7) Restrict the robot's working envelope by using the soft limits and the mechanical stopper if the necessary working envelope is narrower than the robot's workable envelope. When the robot is to move beyond the restricted envelop due to abnormal operation, such as the robot being handled in a wrong way, the robot will be stopped automatically in advance thanks to the function that restricts the workable envelop.
- (8) During the welding work, spatter could fall down to workers or the workers could be injured by burning, or fire could break out. Install such devices as a glare shield or a cover in the full sight of robot's working envelope.
- (9) Make sure that the device indicating the robot's running condition, whether automatic or manual mode, can be noticeable even from a slightly distant location. In the case of automatic start-up, a buzzer or a warning lamp will be useful.
- (10) Make sure that there is no projecting part in the robot's peripheral equipment. Cover it, if necessary. It usually could cause an accident if the operator comes in touch with it. And it may cause a major accident when the operator tumbles while being astonished at the sudden

movement of the robot.

- (11) Don't make the system designed to allow the workers to carry the Work in and out using their hands through the safety fence. It could be a cause of accident associated with compressing or amputating.



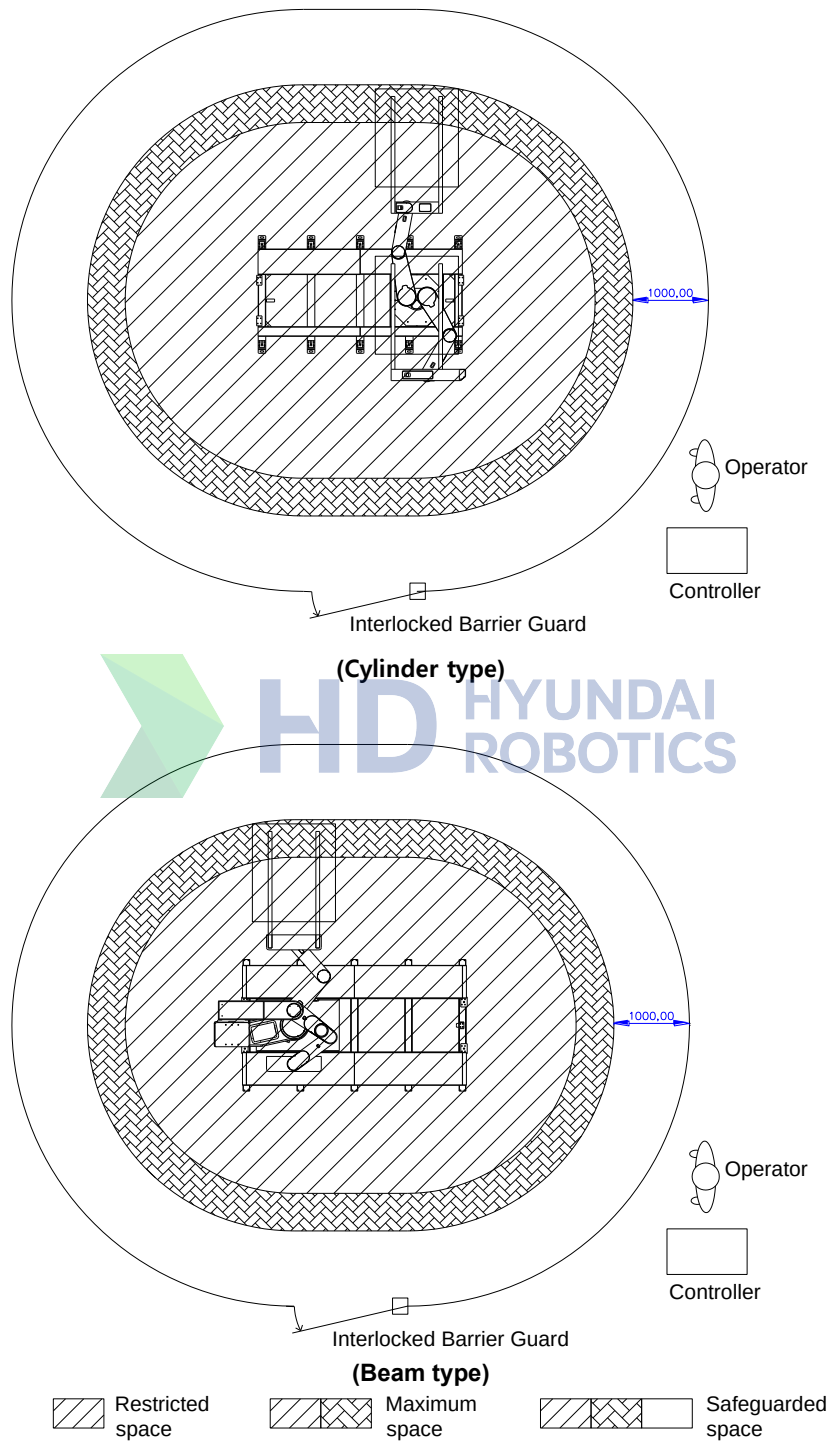


Figure 1.3 Arrangement of LCD robot peripheral devices and workers

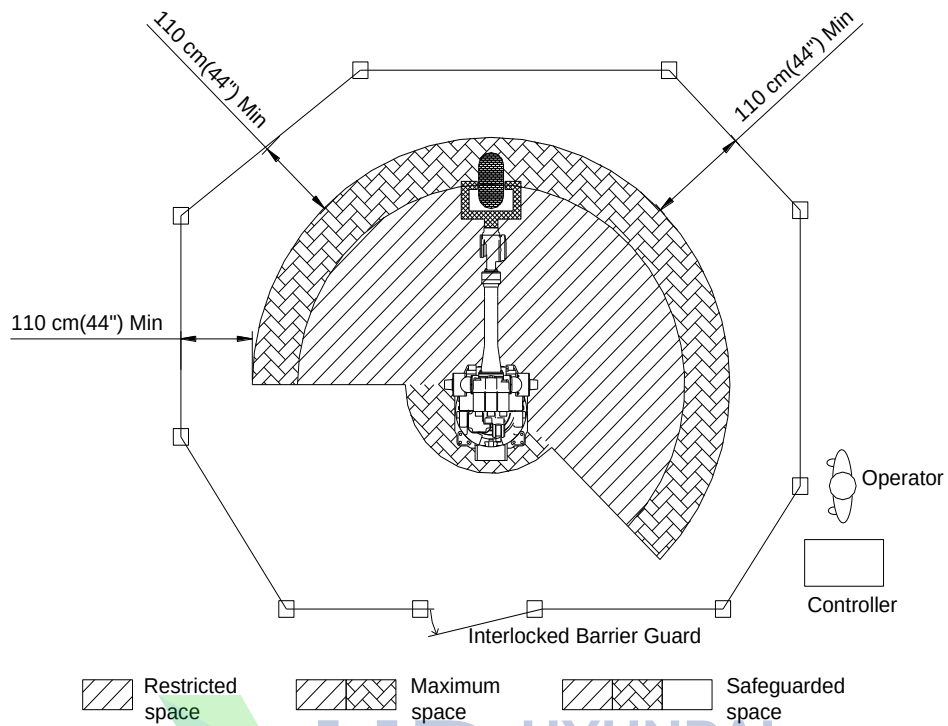


Figure 1.4 Arrangement of general robot peripheral devices and workers

1.6.3. Installing the Robot



Please install the robot in accordance with following method surely.

Install the robot as per the planning and layout which has been previously reviewed and studied for its optimized performance and functionality. In case of poor conditions for robot installation, the serious problems can take place, including error of relative position between robot and workpiece during operation, bad performance quality of robot caused by vibration, shortening lifetime, and cause of serious accidents. Thus, pay attention to the following precautions when installing the robot.

General Safety Precautions

- (1) Design and install the robot system properly in compliance with laws, regulations, and safety requirements enable in the country where the robot system is installed.
- (2) All the workers for the robot system must have the complete knowledge on the information specified in the application and supplementary manual, and proficiently operate and handle the industrial robot.
- (3) Installation workers of robot must follow the safety instructions and apply them to the installation when they face any safety problems.
- (4) System provider must ensure that all the circuits utilizing safety functions perfectly perform in a safe way.
- (5) Install main power supply to be disconnected from outside of the robot's working envelope.
- (6) System provider must ensure that all the circuits utilizing emergency stop function perfectly perform in a safe way.
- (7) For the immediate emergency stop, install emergency stop button within the accessible distance for the operator.

Technical Safety Precautions

- (1) Eliminate any interference with peripheral equipment considering the dimension and working envelope.
- (2) Avoid such place for installing which is directly exposed to the sun, extremely humid, contaminated by oil or chemicals, and containing a large amount of metal powder and explosive gas.
- (3) Install at the ambient temperature ranged 0~45°C.
- (4) Secure sufficient space for the easier disassembly and maintenance.
- (5) Install safety fence with a gate, and prohibit any person from entering the robot's working envelope.
- (6) Remove any obstacles out of the robot's working envelope.
- (7) Take a special measure, considering thermodynamics of controller, if the robot is installed near the heating elements or places exposed directly to the sun.
- (8) Take a special measure if the robot is installed in a place of abundant dust such as metal powder in the air.
- (9) Install the robot not to transmit welding electric current. In other word, insulate SPOT GUN with/from the robot's wrist.
- (10) Grounding is very critical in preventing electric shock and malfunction caused by noise, and thus install as following instructions.
 - ① Install an exclusive grounding terminal using class 3 or higher. (For the input voltage of 400V or higher, use special class 3 or higher.)
 - ② Connect grounding line into the grounding bus-bar inside of the control panel.
 - ③ In case of direct grounding on the floor by anchoring, two-point grounding both by robot manipulator and by controller can produce a "ground loop" and contrariwise cause abnormal operation. In this case, connect the grounding line to the base of robot manipulator and disconnect the second grounding point to the controller. If the robot vibrates even after stopping, double-check the grounding status because the possible main causes could be an incomplete grounding or "ground loop".
 - ④ In the use of internal transgun (GUN), there is a possible danger of dropping because the primary power cable is directly connected to the spot gun. In this case, directly connect the grounding line to the base of robot manipulator in order to prevent any electric shock and protect the control panel, but do not connect it to the controller.
- (11) This equipment includes an intrinsically safe circuit. Relevant instructions can be checked in

Section 3.7.4.

- (12) No battery shall not be installed in the payload area without approval.
- (13) All of the user electric systems of the J2, J3 and wrist payload areas, should have Grade Ga or Grade Gb of the Equipment Protection Level (EPL) of IECEx.
- (14) The total internal volume of all electrical equipment to be installed in the J2 area shall not exceed 1L.
- (15) The temperature grade of the explosion-proof equipment to be installed in the J2 payload area shall meet T4, T5 and T6. Also, the minimum ambient temperature specification should be 60 degrees.
- (16) The temperature grade of the explosion-proof equipment to be installed in the J3 payload area shall meet T4, T5 and T6. Also, the minimum ambient temperature specification should be 40 degrees.
- (17) The maximum rating of the electrical equipment to be installed in the J2 are should be limited to AC240V / DC60V and 9A.

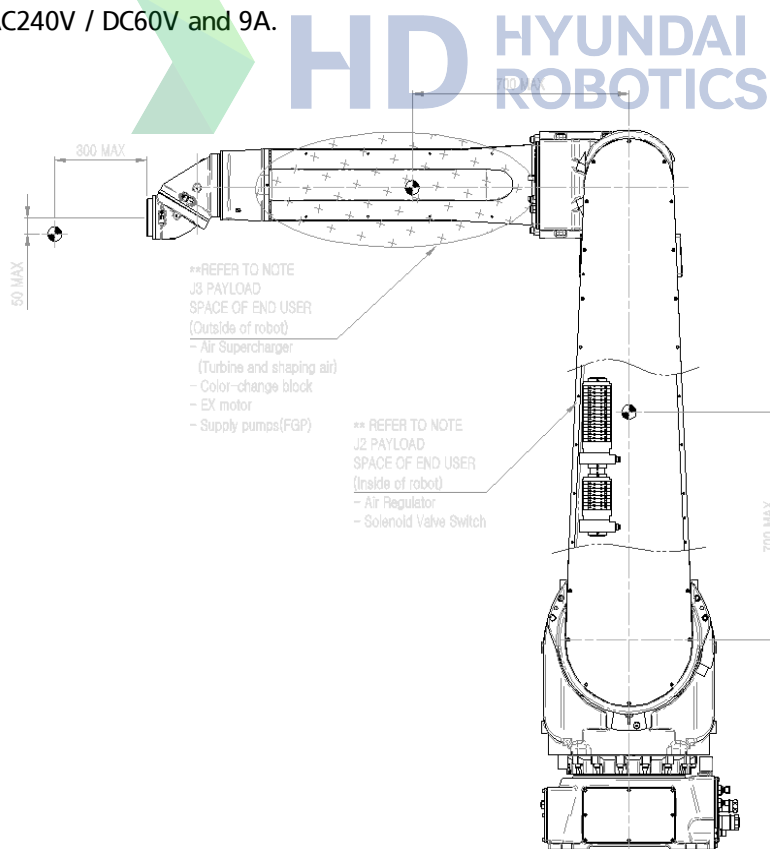


Figure 1.5 Assembling of payload area

- (18) The wiring connection between the manipulator and the controller must comply with the

installation regulations related to IEC 60079-14.

1.6.4. Space for Robot Installation

Install robot after securing sufficient space for maintaining the robot manipulator, controller, and other peripheral equipment. To install the main body and controller, please secure the above mentioned installation area. Install controller outside of the safety fence in order to monitor the robot manipulator and to operate in a safe way.

When installing, be sure to make it easier to perform the maintenance when opening the Controller door. Secure the available space. The specifications of the controller can change according to the type of the controller. (For more details, please refer to the "Maintenance manual".)



1.7. Safety Operation for Robot Handling

Follow the safety instructions to prevent any accidents. Don't modify nor ignore safety devices or circuits at any time, and be careful of electric shock.

All the normal operations in an automatic mode must be performed outside of the safety fence. Check the robot's working envelope if anyone is inside before operating.

1.7.1. Safety Precautions for Robot Handling



Please observe following countermeasures because safety is very important for the test operation of the robot.

- (1) Do not handle the robot other than such personnel as operators handling the robot and other possible operators and supervisors who were designated as whom duly trained in an approved robotic training course and become familiar enough with the proper operation of the safety and robotic functions.
- (2) Be sure to wear helmets, goggles, and safety shoes.
- (3) Perform the work in pairs. One person must be ready to press the emergency stop button in an emergency while the other must perform his work quickly but carefully within the robot's working envelope. Always check the escape route before working.
- (4) Make sure that there is no one in the working envelope when the power source is on.
- (5) Operations such as teaching must be performed outside of the robot's working envelope. However, if the operation is performed within the working envelope after stopping the robot, enter the envelope with safety plug or key switch for converting to automatic mode. Make sure that other operators do not change it into automatic mode by accident. Also, pay close attention to the specific direction of robotic movement in case of abnormal operation and malfunction.
- (6) Supervisors should follow the instructions below.
 - ① Be located at a place where you could take an entire view of robot, and commit yourself to monitoring.
 - ② Press the emergency stop button immediately when abnormality is found.
 - ③ Anyone is forbidden to be near the operating area other than those who are engaged in the operation.
- (7) In a manual mode, the speed of teaching is limited to 250mm/sec.
- (8) In teaching, post a sign [Under Teaching].
- (9) Operators must pull the safety plug out, and enter the safety fence with the plug.

(10) Do not use any devices causing noise in and around the teaching area.

(11) Handle the teach pendant button, while checking the teaching point with your naked eyes, and do not handle it just relying on your sense.



(12) It is a repairing part to be prepared for when you buy many sets.



- (13) In teaching, check and examine carefully under your feet. In particular, in high teaching for more than 2M, secure a safe zone on which you may step before teaching.



- (14) Instructions for any abnormal operations.

- ① Press immediately the emergency stop button when any abnormal operations are found.
- ② Be sure to check if the relevant equipment is stopped when checking the abnormality in an emergency stop.
- ③ In case that the robot stops automatically due to power failure, investigate possible causes and take actions after confirming that the robot completely stops.
- ④ In case of malfunction of emergency stop devices, immediately disconnect the main power and investigate possible causes to take necessary actions.
- ⑤ Investigation of the failure must be conducted only by a designated person. For the re-operation after emergency stop, operators must clarify the cause of failure and take necessary actions, and then operate the robot again following the proper procedure.

- (15) Write out the operating rules proper to working details and installing location regarding the operation and handling method for the robot, and the necessary actions for robot's any failure. In addition, it is recommended to operate the robot in accordance with the operating rules.

- (16) Instructions when the robot stops

Make sure not to approach the robot even when it seems to be stopped. Most accidents occur from a sudden movement of robot which seemed to be stopped when one approaches it. The conditions that the robot stops are as follows.

Table 1-2 State of Robot Stop

No.	State of Robot	Drive Power	Access
1	Pause (Minor failure, Pause switch)	ON	X
2	Emergency stop (Major failure, Emergency stop switch, Safety gate)	OFF	O
3	Input signal standby of peripheral equipment (START INTERLOCK)	ON	X
4	Playback Completion	ON	X
5	Standby	ON	X

Even in the accessible state of robot, be watchful against any possible sudden movement of robot. Make sure to avoid approaching the robot without precautions for emergency under all circumstances.

- During temporary halt, the entrance countermeasure same as entrance of teaching work should be considered at the case (nozzle contact, welded part detected, arc error, and so on) of opening entrance gate for simple management against error.

- (17) Clean up any split oil, tools, and impurities in the safety fence after completing robotic operation. Accidents such as conduction may occur in the working envelope contaminated by oil, or scattered tools on its floor. Make a habit of organizing and cleaning things up.



1.7.2. Safety Precautions for Operating Test



Please observe following countermeasures because safety on robot operation is very important.

In case of operating test, errors in design or teaching and inferiority in manufacturing are possibly seen in the entire system such as teaching program, jig, and sequence. Thus, be more careful and safe in case of operating test. Accidents may occur by these combined causes.

- (1) Before handling, check the stop buttons and signal functions to stop the robot such as emergency stop button or stop button. And then, check the abnormality - detective movements. Above all, it is the most critical to check all the stop signals. It would be the most important to stop the robot when any possible accidents are predicted.
- (2) In case of operating test, start the robot at low speed(approximately 20%~30%) in the variable speed function, and repeat it more than one cycle to check the movements. If any errors are found, immediately correct them. After then, increase in speed (50% → 75% → 100%) gradually, and repeat more than one cycle respectively to check the movements. Operating at high speed from the very beginning may cause a serious accident.
- (3) In case of operating test, it is hard to predict what problems would happen. Do not enter the safety fence during operating test. Unexpected accidents are likely to occur because of its low reliability.

1.7.3. Safety Precautions for Automatic Operation



Please observe following countermeasures because safety on robot automatic operation is very important.

- (1) While posting a sign [Do Not Enter During Operation] up the safety fence gate, ask the operators not to enter during operation. If the robot stops, you may enter the safety fence under your full understanding of the situation.



- (2) Be sure to check if any operators are inside of the safety fence when starting the automatic operation. Operating without checking the presence of operators may cause a personal injury.
- (3) Before starting the automatic operation, check and confirm that the program number, step number, mode, and starting selection are in the possible state for automatic operation. If starting with the other programs or steps selected, the robot could move in an unpredicted way, and lead to an accident.
- (4) Before starting the automatic operation, check if the robot is properly located to get started. Check whether the program number or step number is identical with the location of robot. Even if it's all identical, accidents are still possible to occur due to an abnormal movement when the robot is differently located.
- (5) Be prepared to immediately press the emergency stop button when starting the automatic operation. Immediately press the emergency stop button in case of robot's unexpected movements or emergency.
- (6) Be sure to detect any abnormalities by checking the route, condition, or sound of robot movement. Sometimes the robot may be abnormally operated including a sudden break down. However, it will show a certain indication before the break down. Understand the robot's normal condition well in order to catch the symptom in advance.



- (7) When any abnormality is detected from the robot, immediately stop and take proper actions on it. Using the robot before any proper actions taken may cause an interruption of produce as well as serious failure leading to a very serious personal injury.



- (8) When checking the robot's movement after the proper actions taken for the abnormality, do not operate the robot with operators inside of the safety fence. Unexpected accidents are possibly to occur because its low reliability may cause another abnormality.

1.8. Safety Precautions for Access to Safety Fence



Please observe following countermeasures because safety on robot automatic operation is very important.

The robot is very heavy and strong, even at low speeds. When entering the safety fence, one must observe the relevant safety regulations of its pertinent country.

The operators always must be aware of the unexpected movements of robot. Robots are able to move fast shortly after being stopped. The operators should know that the robot is able to move in a different route, without any notice, by means of external signals. Thus, when trying to stop the robot during teaching or operating test, one should be able to stop the robot with a teach pendant or control panel.

When entering the working envelope through the safety gate, you must take the teach pendant with yourself so that other people cannot operate the robot. Make sure to post up the control panel a sign indicating the state of robot handling.

People must understand the followings when they are to enter the robot's working envelope

- (1) Do not enter the working envelope other than teaching person.
- (2) Operation set-up mode of controller must be a manual mode in the control panel.
- (3) Always wear the approved working suite.(Do not wear a loose clothes as you please)
- (4) Do not wear gloves when handling controller.
- (5) Do not leave innerwear such as underwear, shirts, or necktie out of the working suite.
- (6) Do not wear personal accessories such as big earrings, rings, or necklaces.
- (7) Make sure to wear safety shoes, helmet, and goggles and if necessary, wear other self-protective outfit such as safety gloves.
- (8) Make sure that the emergency stop circuit is working correctly and in its proper function, turns MOTOR OFF when pressing the emergency stop button in the control panel and teach pendant before handling the robot.
- (9) Make your posture face-to-face with the robot manipulator when performing your work.
- (10) Follow the predetermined working procedure.
- (11) Be prepared for emergency exit or safe place considering that the robot may unexpectedly rush at you.

1.9. Safety Precautions for Maintenance and Repair

1.9.1. Safety Precautions for Controller Maintenance and Repair



Please observe following safety countermeasures on repair and check for robot controller.

- (1) Maintenance and repair of the robot must be performed by the personnel who was duly trained in the special maintenance training course and has a good knowledge of maintenance.
- (2) Perform your work following the maintenance procedures for controller.
- (3) Perform your maintenance and repair in a safe way by securing emergency exit or safe place.
- (4) Before the daily maintenance, repair, or changing parts, be sure to power down. In addition, post a warning sign [Do Not Input Power] up the primary power so that other operators may not input power by accident.
- (5) When changing parts, be sure to use the specified ones.
- (6) When you open the door of controller, you should turn off power, and please start working after 3 minutes.
- (7) If sufficient illuminance is not secured when you perform maintenance and inspection inside the controller, you should use external lights.
- (8) Please do not touch heat radiating plate of servo AMP and recovery resistance because they are very hot.
- (9) After completing maintenance, be sure to close the door completely after checking if tools or other things are still remained in the controller.
- (10) Maintenance and inspection personnel should ensure that they participate in regular trainings and use the regulated specifications and tools for all types of assembly and wiring works in order to prevent defects from taking place.
- (11) Training should be carried out so that the operators can have sufficient prior knowledge of explosion-proof equipment. In addition, training materials and records should be maintained.
- (12) To verify the product, the operators should be skilled and their competence should be documented and adequately assessed.

1.9.2. Safety Precautions for Robot System & Manipulator Maintenance



Please observe following safety countermeasures on repair and check for robot controller.

- (1) Refer to the safety precautions for Controller maintenance and repair.
- (2) Perform your maintenance and repair for the robot system and manipulator, following the indicated procedures.
- (3) Be sure to disconnect the primary power of controller. Post the warning sign [Do not input power] up the primary power to prevent other workers from connecting the power.
- (4) Make sure that the Arm is fixed and immovable before maintenance and repair since dropping or moving of the robot's Arm may cause a danger during maintenance and repair. (Refer to the 『Robot manipulator maintenance manual』 .)
- (5) Take precautions **not to allow** non-metallic paint to build up on the surface of the operating device, causing static electricity as a result. Periodically check the surface of the product and remove the non-metallic paint.

1.9.3. Necessary Actions after Maintenance and Repair



Please install the robot in accordance with following method surely.

- (1) Check if the cables or parts of controller are properly connected.
- (2) After maintenance is completed, carefully check that no tools are left around or inside of the controller and manipulator. Make sure that the door is firmly closed.
- (3) Do not turn on the power if any problems or critical failures are detected.
- (4) Be sure that there is no one within the working envelope, and that you are in a safe place before turning on the power.
- (5) Turn on the main circuit breaker on the control panel.
- (6) Check the current position and status of robot.
- (7) Operate the manipulator at low speed.



1.10. Safety Functions

1.10.1. Operating a Safety Circuit

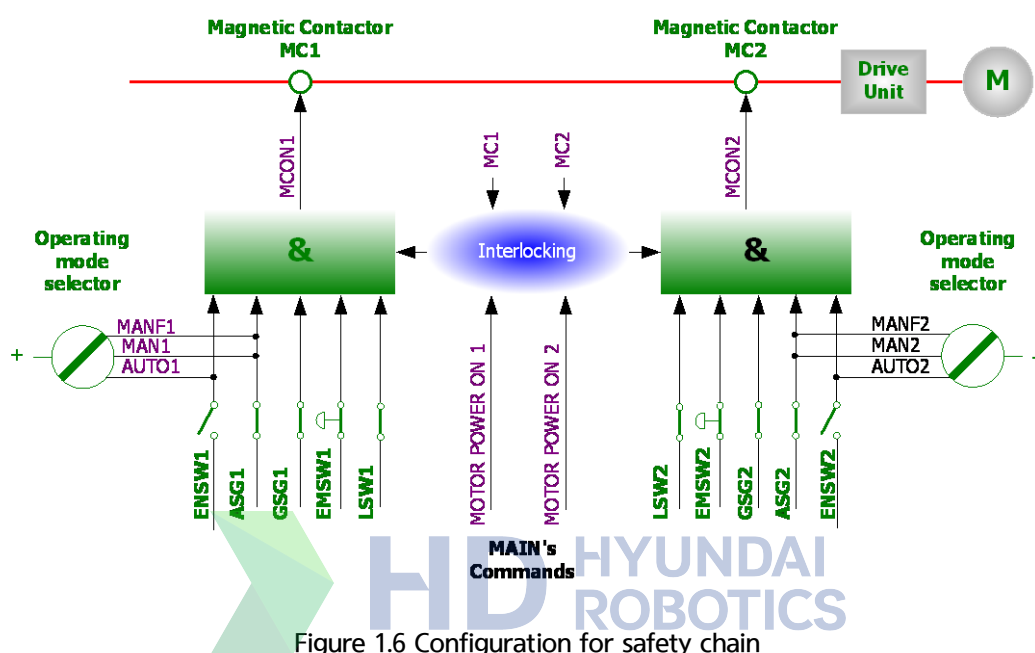


Figure 1.6 Configuration for safety chain

The robot's safety system is based on a two-channel safety circuit that is continuously monitored. If an error is detected, the power supply to the motors is disconnected and the motor brake is applied. To return the robot to MOTOR ON mode, the switches of two-channel circuit must be connected. If one of the two-channel circuit switches shorts, the contactor of motor will be disconnected leading to the application of brake, and finally the robot will be stopped. Furthermore, when safety circuit is disconnected, the interrupting call will be sent automatically to the controller to find out the possible reason for the interruption.

The safety control circuit of operation is based on dual safety electric circuit in which the controller and MOTOR ON mode are operated interactively. In order to be in MOTOR ON mode, the safety circuit consisted of several switches must be all connected. MOTOR ON mode indicates that drive power is supplied to the motors. If one of the contactors is disconnected, the robot will always return to MOTOR OFF mode.

MOTOR OFF mode indicates that drive power is removed from the robot's motors and the brakes are applied. The status of the switches is displayed on the teach pendant. (Refer to the I/O monitoring screen of "SERVICE" menu, 『Operation manual』.)

Safety circuit

The emergency stop buttons on the controller panel and on the teach pendant and external emergency stop buttons are included in the safety circuit of operation. Users may install the safety devices (safety plug, safety stop device for safe place) which are operated in the AUTO mode. In a manual mode, the signals of these safety devices are ignored. You can connect the general safety stop devices that is active in all operating modes. No one can enter the working envelope in an automatic operation mode due to the unconditional operation of the safety devices (door, safety mat, safety plug etc.). These signals are also generated in a manual mode, but the controller will keep the robot operating while ignoring the robot's teaching. In this case, maximum speed of robot is restricted to 250mm/s. Thus, the purpose of this safety stop function is to secure the safe area around the manipulator while one approaches the robot for maintenance and teaching.

When the robot is stopped with the limit switch, change the robot's position by operating it with the pendant key at the constant setting mode. (Constant setting mode refers to the state of entry into the menu 『[F2]: System』 menu)



The safety circuits must never be by-passed, modified or changed in any way.



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1.10.2. Emergency stop

An emergency stop should be activated when people or equipment is located at the dangerous area. The emergency stop buttons are located both on the control panel and on the teach pendant.

All safety control devices such as emergency stop buttons on the control panel must be located outside the working envelope and easily accessible at any time.

► Status of Emergency stop

When the button is pressed, the robot will operate as follows.

Robot stops immediately in any cases.

- Disconnect the servo system power.
- Motor brake is activated.
- Emergency stop message is displayed on screen.

For the emergency stop, the following two methods can operated simultaneously.

- (1) Emergency stop for control panel and teach pendant (Basic)

Above the control and teach pendant console.

- (2) Emergency stop of external system

External emergency stop device (button etc.) can be connected to the safety electric circuit in accordance with applied standard for the emergency stop circuit.

(Please refer to system board in “basic configuration of controller”) At this time, the emergency stop must be connected to be “Normal On” and it must be check for proper operation during test run.

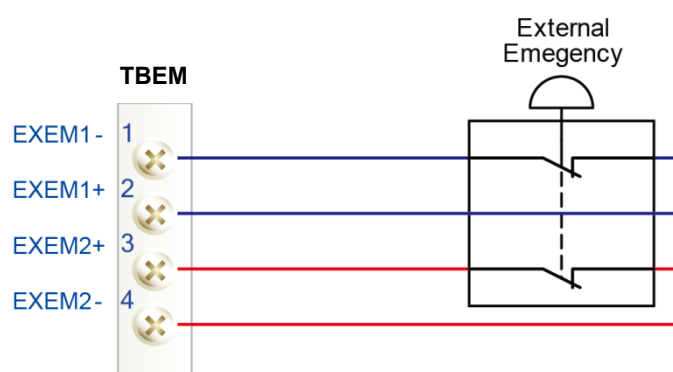


Figure 1.7 Connection with external emergency halt switch through system board terminal block TBEM

1.10.3. Operating Speed

To teach the robot, the operating mode switch must be in a MANUAL mode. Then the maximum speed of robot is limited to 250mm/s.

1.10.4. Connecting the Safety Devices

External safety devices such as light beams, light curtains, safety plug, and safety mats which can be adapted by the system builder execute interlocking the controller by way of connecting with safety circuit within the controller. These devices are used for safety device during execution of normal program in an automatic mode.

1.10.5. Restricting the working Envelope

When the robot is not necessary to reach certain area for specific applications, working envelope of the robot can be limited to secure the sufficient safety working area. This will reduce the damage or loss in case of robot's collision with external safety devices such as safety fence, etc. The movement of axes 1, 2, and 3 of HR, HX, HS and HA can be limited by means of mechanical stopper or electrical limit switches. In this case, the corresponding software limitation parameters must be also changed. If necessary, movement of wrist 3 axes can be restricted, too. Limitation of working envelope for all the axes could be carried out by the user. The robot is delivered to customer as the status of full working envelope setting.

- **Manual mode : Maximum speed is 250mm/s.**
In a manual mode, by means of worker's selection, workers may enter the safeguard area.
- **Auto mode : The robot can be operated via remote controller.**
All safety devices such as safety door, safety mats, etc. are activated.
No one may enter the safety device area of robot.

1.10.6. Monitoring Function

- (1) Motor monitoring function
Motors are protected against overload by means of onboard sensors.
- (2) Voltage Monitoring Function
For the protection of, the servo amp module turns off the power switch when the voltage is too low or too high.

1.11. Safety Related to End Effectors

1.11.1. Gripper

- (1) When a gripper is used to grip a workpiece, there should be safety precautions for unexpected dropping of the loaded workpiece.
- (2) When any end effectors or devices are installed on the robot arm, use the required size and piece of bolt, and securely fasten as per the required torque using torque wrench. Do not use the bolt which has rust or dirt on its surface.
- (3) End effector must be designed and manufactured not to exceed the maximum allowable load at the wrist of robot. Even though power or air supply stops, the gripped workpiece must not be dropped from the gripper. In order to remove any risks and problems which may cause personal injury and/or physical damage, the sharp edge and projecting part of end effector must be made dull and smooth.

1.11.2. Tool / Workpiece



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- (1) It must be possible to replace tools such as milling cutters in a safe manner. Make sure that safety devices are working correctly until the cutters stop rotating.
- (2) Tool must be designed to keep in gripping workpiece securely even though a power failure or a control failure takes place. It must be possible to release workpiece from the gripper in a manual mode.

1.11.3. Pneumatic and Hydraulic Systems

- (1) The special safety regulations will apply to pneumatic and hydraulic systems.
- (2) Since residual energy of pneumatic and hydraulic systems can be still remaining even after the robot stops, particular care and attention must be paid by users. Internal pressure of equipment must be removed whenever starting the repair work for pneumatic and hydraulic systems.

1.12. Liabilities

The robot system has been built in accordance with the latest technical standards and approved safety rules. Nevertheless, the serious accidents such as death or personal injury still may take place due to the collision between the robot system and peripheral equipment.

The robot system must be used by operator who has a full technical knowledge on its designated use and also pay his close attention to the possible dangers and risks involved in its operation. The use of robot system is subject to compliance with these operating instructions and the operation and maintenance manual supplied together with the robot system. The safety related functions of robot system must not be used for any purposes other than safety.

When you use the robot system for any other or additional purposes than its designated usage, you must review whether it is enable in accordance with design criteria. The manufacturers cannot take any responsibility for any damage or loss which resulted from such misuse or improper use. The users shall have the full responsibility for the risks caused by such misuse or improper use. When you use and operate the robot system for its designated use, you must have a good command of all the information contained at these operating instructions as well as the maintenance manual.

The robot system may not be put into operation until it is ensured that the functional machine or plant into which the robot system has been integrated conforms to the specifications of the EU Machinery Directive 98/37/EC(2006/42/EC) and US OSHA.

The following harmonized standards in particular were taken into account with regard to the safety of the robot system.

- ANSI/RIA R15.06-1999
Industrial Robots and Robot Systems - Safety Requirements
- ANSI/RIA/ISO 10218-1-2007
Robots for Industrial Environment - Safety Requirements - Part 1 - Robot
- ISO 11161:2007
Safety of machinery - Integrated manufacturing systems - Basic requirements
- EN ISO 13849-1:2008
Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design (ISO 13849-1:2006)
- EN 60204-1:2006
Safety of machinery - Electrical equipment of machines - Part 1: General requirements (IEC 60204-1:2005 (Modified))
- EN ISO 10218-1:2006
Robots for industrial environments - Safety requirements - Part 1: Robot (ISO 10218-1:2006)
- IEC 60079-0 : 2011 Ed.6
"Electrical apparatus for explosive gas atmospheres,
Part 0 : General Requirements"
- IEC 60079-2: 2014 Ed 6
"Electrical apparatus for explosive gas atmospheres,
Part 2 : Equipment protection by pressurized enclosure 'p'
- IEC 60079-11: 2011 Ed 6

"Electrical apparatus for explosive gas atmospheres,
Part 11 : Equipment protection by Intrinsic safety "i"“

Users must take the full responsibility for any accident caused by their negligence or non-observance of these instructions. The manufacturer will not take any liabilities and responsibilities for any damages or losses caused by the misuse or malfunction of such equipment which is not included in the contract between manufacturer and user and provided by user, or such equipment which is installed around the robot system arbitrarily by the user. User must take the full liabilities and responsibilities for any risks and damages caused by such equipment.







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2

Basic
Operation



2. Basic Operation

Hi5a-S/N/P/C/T/J
Controller Operation Manual

2.1. Outline

This manual describes basic matters to handle and operate Robot.

This manual is divided into several chapters. Necessary various application functions for basic operation of Robot are included in each chapter.

Industrial Robot is 『a robot used in the industry that all types of work are executed by program by using manipulation function or movement operation function by AUTO control』 .

Most of industrial Robot uses Manual operation method and AUTO operation method that are called as [Manual & AUTO operation method]. Manual operation is to instruct work contents to Robot and AUTO operation is to force that Robot repeats and executes instructed work contents.

In this manual, application functions such as 『Spot welding function』 , 『Arc welding function』 , 『Palletize function』 , 『Embedded PLC function』 , 『Positioner synchronization function』 and 『Sensor synchronization function』 are not handled in detail. See functional manual about each function for detailed description of application function. See functional manual about each function for detailed description of application function.



2.2. System Overview

Robot is divided into Robot main body and controller for operating the main body.

2.2.1. General

Following Figure represents basic configuration drawing of the Robot system:

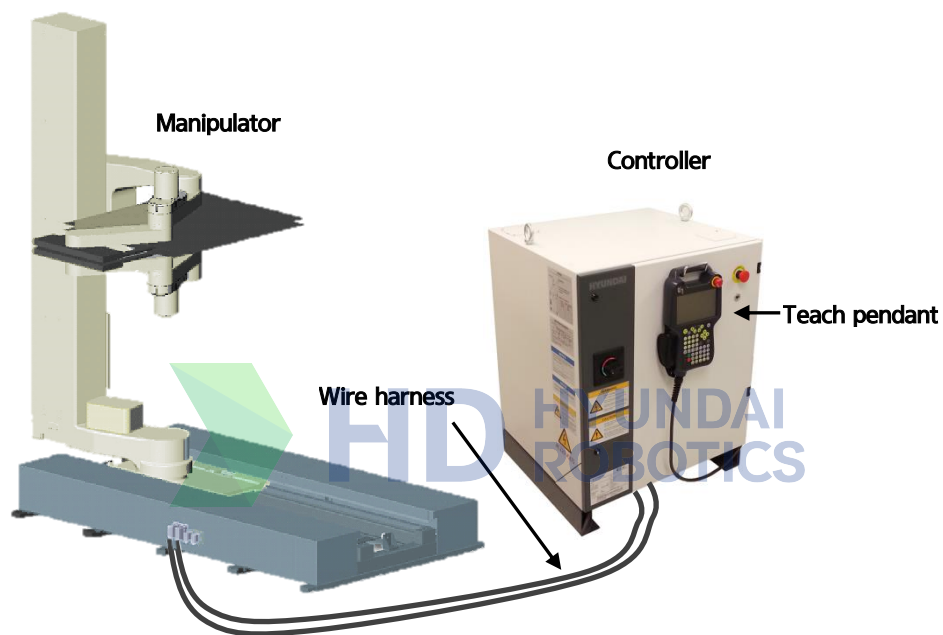


Figure 2.1 Basic Components of Manipulator and Controller (LCD Robot)



Figure 2.2 Teach Pendant (LCD Robot)

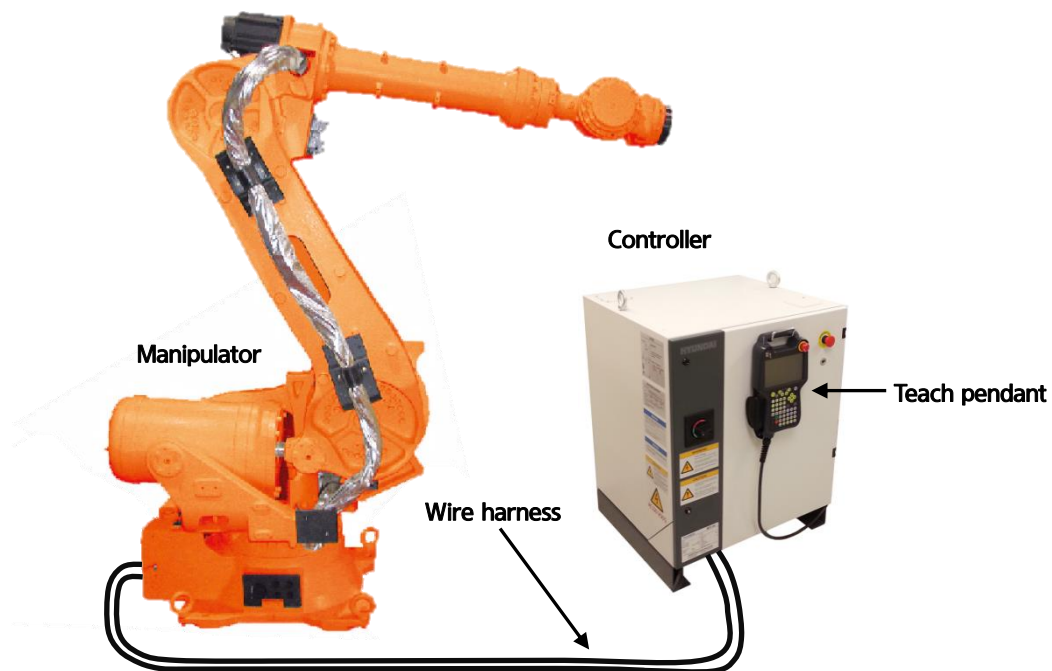


Figure 2.3 Basic configuration drawing of the Robot system (Vertical Articulated Robot)

Robot can be moved by using the teach pendant attached to the controller.



Figure 2.4 Teach Pendant (Vertical Articulated Robot)

2.2.2. Teach Pendant

2.2.2.1. External Appearance of Teach Pendant

The teach pendant is composed of keys and buttons for manually operating the Robot main body and preparing work program.



Figure 2.5 External Appearance of Teach Pendant (left: TP511, right: TP520)

2.2.2.2. Teach Pendant Screen

Following figure represents the screen displayed on teach pendant. Teach pendant screen is composed of 10 screen windows of color touch screens.

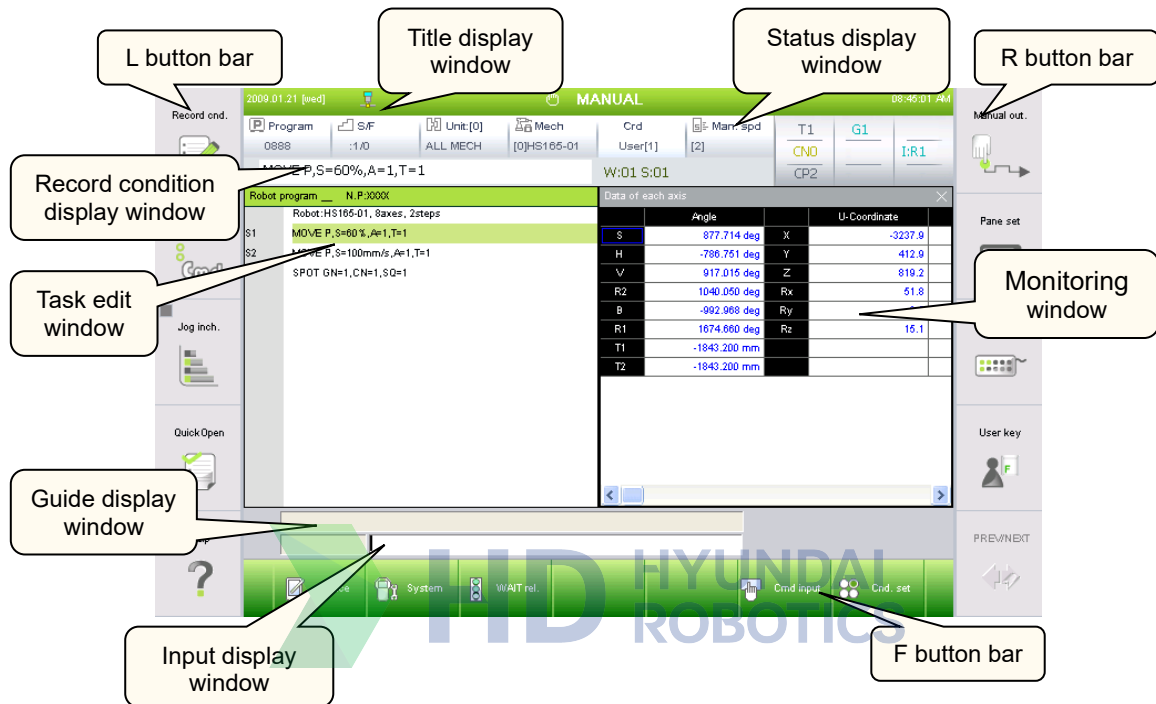


Figure 2.6 Teach pendant screen

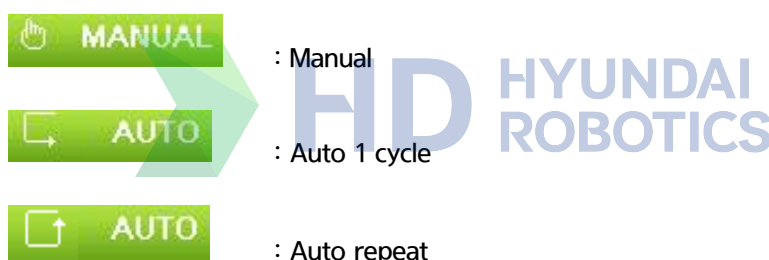
■ Contents of screen

(1) Title display window

The date (Year, month, date), title (Mode), operation cycle and time (Hour: minute: second) are displayed.



- ▶ Current time: This displays year, month, date, day, hour, minute and second.
To change the current time, refer to 『[F1]: Service』 → 『8: Date, time setting』.
- ▶ Title: This displays the operating mode or title of the set screen.
Depending on the [REMOTE/AUTO/MANUAL] switch on the operating panel, it will display MANUAL or AUTO. In MANUAL mode, it directs the robot work and in AUTO mode, the robot operates according to the directed work format (1Cycle, Continuous). Select the operation cycle in the Condition Setting menu



(2) Status display window

This displays various statuses of robot operation. You can set the displayed information by touching the applicable section from Program – 6 manual speeds.

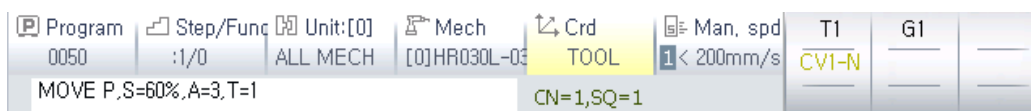


Figure 2.7 Status display bar

- ▶ Program
This displays the currently selected work program number. When a recorded program exists, the program will be opened on the screen edit window. When external program is selected, icon is displayed and when external operation mode is selected, icon is displayed as shown below.

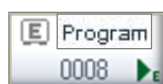


Figure 2.8 Icon for the external operation mode

- ▶ S/F
This displays the number of the step or function within the currently selected program. The function number is not the total number of functions recorded within the program but the number of the function recorded between the steps.
- ▶ Unit/Mech
Mechanism displays the robot type or the number of the selected additional axis. The robot is 0, and for the user refer to 『F2]: System』 → 『5: Initialize』 → 『6: Mechanism setting』 . Unit displays the assembled condition of the mechanism configured by the user. For setting of the status, refer to 『F2]: System』 → 『5: Initialize』 → 『7: Unit setting』 .
- ▶ Crd
This displays the status of the robot coordinate system selected with  key for manual operation.
Status display of “JOINT, CART., TOOL” change in order. For robot movement during axis operation according to the coordinate system, refer to manual operation in chapter 2.3.
- ▶ Man. spd
Determine the speed to operate the robot in the manual mode. In the manual mode, there are 2 different types of operation. One is to run it manually and the other is the step forward/backward operation. There are 8 different steps (1~8) in the level of the speed of manual operation.

Speed level increases by a step if pressing the speed  key of teach pendant, and decreases by a step if pressing the speed  key.
Speed level is set to 8 if pressing the [SHIFT (FAST)] + Speed  key, and is set to 1 if pressing the [SHIFT (FAST)] + Speed  key

When it comes to the step forward/backward speed, it should be set at the maximum level in the menu for setting the conditions.

By pressing the [CTRL] + [Speed HI/LOW] keys, the speed limit for the step forward/backward operation can be changed. Please refer the items at 2.3 to Manual Operation for more details.
- ▶ This displays the tool number, the gun number and the on/off status of various functions. When the status of various functions including tool number, GUN number etc. changes the changed number or status is displayed.

(3) Record condition display window

This is the window to edit the condition of the step to record (Speed, accuracy, tool option etc.). Press the 『L1]: Record condition』 to edit.

```
MOVE L,S=100%,A=5,T=1
```

(4) Task edit window

This is the window to edit the program.

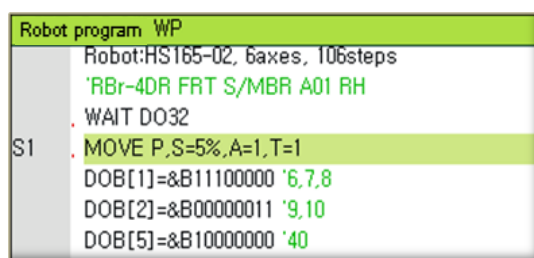


Figure 2.9 Task program edit window

► Protection status

“Robot program WP” displays the protected condition of the selected robot. For details on the program protection, refer to 『[F1]: Service』 → 『5: File manager』 → 『F7: Attribute』.

(5) Monitoring window

This is the window to display the location data, I/O data and status data of each application by

each axis in real time. Select and adjust window (Split, close) using the  key. You can display total of 3 monitors. (Refer to the “2.2.2.3. Window control function”).

Data of each axis			
	Angle		Coordinate
S	877,714deg	X	-1394,7
H	-786,751deg	Y	412,9
V	917,015deg	Z	819,2
R2	1040,050deg	Rx	51,8
B	-992,968deg	Ry	-2,5
Private input signal			
Mode switch (Auto)		Mode switch (Manual)	
Mode switch (High spd)		Mode switch (TP)	
Motor on (OP)		Motor on (External)	
Start switch (OP)		Stop switch (OP)	
TP Enabling switch		-	
MC1(PreCharge)		MC2(Motors Power)	

Figure 2.10 Monitoring window

(6) Guide display window

This displays the guide or direction message for the user to operate and is the area that displays the print message when the print direction is set to T/P in the PRINT command.

Enter the speed.(0.1-100.0)

(7) Input display window

Displays input value of contents to edit such as command language, character or function.

S(%)= 80

(8) F button bar

7 F buttons are displayed. You can use the F button by pressing the [F1] ~ [F7] key of the key pad or by pressing the F button on the display window screen.

F button changes according to the current operating screen with appropriate composition. For example in the highest level screen, the button to switch to Service menu or System menu is displayed. Also during task program editing, the button for command list or command parameter setting is displayed.

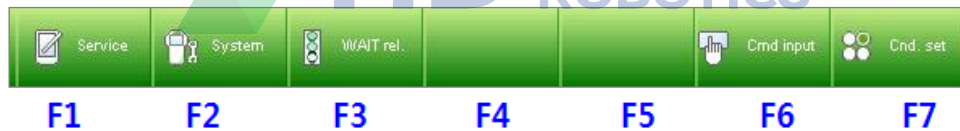


Figure 2.11 F buttons display window

When there are more than 7 buttons in the current screen,  button will be activated, and every time this button is pressed, it will switch to the next button. (When you press [SHIFT] +

 button, it will switch back in the reverse direction.)

2. Basic Operation

(9) L (Left) button bar, R (Right) button bar

5 buttons are displayed on both the left and right side of the screen, and you can touch the screen to press the buttons. Inactive buttons will be grayed out. It can be understood when looking at the following automatic mode that the record condition, jog inching, and prev/next functions are disabled, making it impossible to use those functions.



Figure 2.12 L button bar, R button bar



Reference

- The highlighted part in yellow green color of screen S1 means that the current step is at No. 1. ‘.’ in front of the command prior to step No. 1 refers to the executed command, and the command after step No. 1 refers to the commands to be executed in the future. ‘)’ of step No.1 indicates that currently step No.1 is in progress.

Robot program __ N.P.:0000	
S1	. DO6=1
	. DO16=1
	MOVE L,S=100,0%,A=3,T=1
	WAIT DI11
	WAIT DI6
	DO6=0

Figure 2.13 Command being executed

2.2.2.3. Window control function

It can simultaneously display up to three monitoring information aside from the edit window of a job program by partitioning the full screen.

- (1) Press the  button from the initial screen to enter the adjust window F menu.

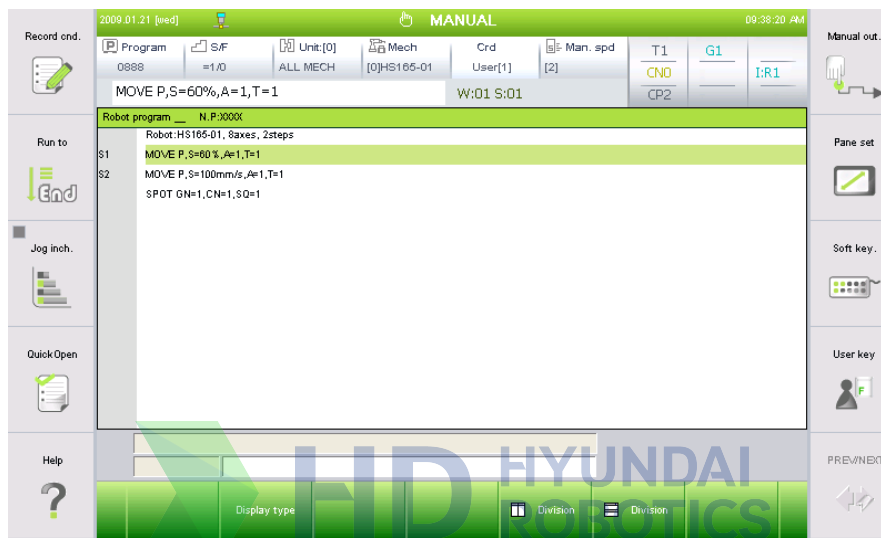


Figure 2.14 TP screen in the adjust window menu

For the adjust window F menu, appropriate buttons are displays depending on the current situation of the window split. The following picture shows all the buttons of the adjust window F menu.



Figure 2.15 Adjust window F menu

2. Basic Operation

- (2) Click on  Division to split the currently selected window horizontally. The basic data of each axis is displayed on the monitoring content of the newly created window.



Figure 2.16 TP screen horizontally split

When the window is split, the title bar of the currently selected window is displayed in green as shown below. Cursor movement using the key pad or adjusting the window will apply to the currently selected window.

Data of each axis			
	Angle		U-Coordinate
S	877.714 deg	X	-3237.9
H	-786.751 deg	Y	412.9
V	917.015 deg	Z	819.2

When you want to select a different window, click on the window you want to select through the touch screen.

Robot program __ N.P:XXXX		Data of each	
Robot:HS165-01, 8axes, 2steps			
S1	MOVE P,S=60%,A=1,T=1	S	
S2	MOVE P,S=100mm/s,A=1,T=1	H	

- (3) When you click on the  Division button, the currently selected window will be split into 2 windows vertically.

- (4) When you click on the  Extension button, the currently selected window will be expanded horizontally. The existing window in the expanded space will be reduced or closed.

- (5) When you click on the  button, the currently selected window will be expanded vertically. The existing window in the expanded space will be reduced or closed.
- (6) When you click on the  button, you can designate the monitoring information to display on the currently selected window.
(The upper left split window can only display the current robot program edit screen.)
(Applied items such as spot, palletize etc. is displayed only when set to “Enable”).

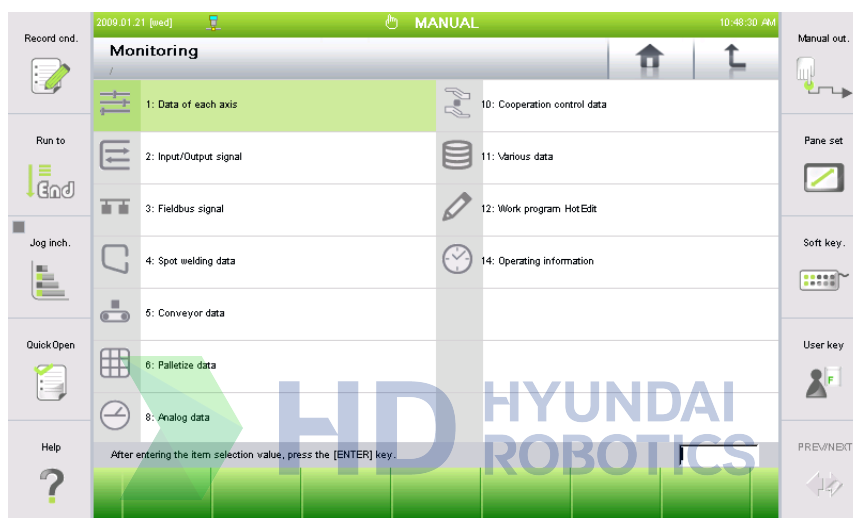


Figure 2.17 Monitoring type selection menu

The item on the list menu is the same as when you enter by pressing 『[F1]: Service』 → 『1: Monitoring』. If you select 『2: Input/output signal』 → 『1: Private input signal』, for example, the following screen will be displayed.



Figure 2.18 Private input signal monitoring screen

2. Basic Operation

When you click on the  button, the format in which the information is displayed will be changed.

In the current version, you can only change the font size of the robot program. While the robot program edit window is selected, if the display type button is clicked, the font size will be changed.

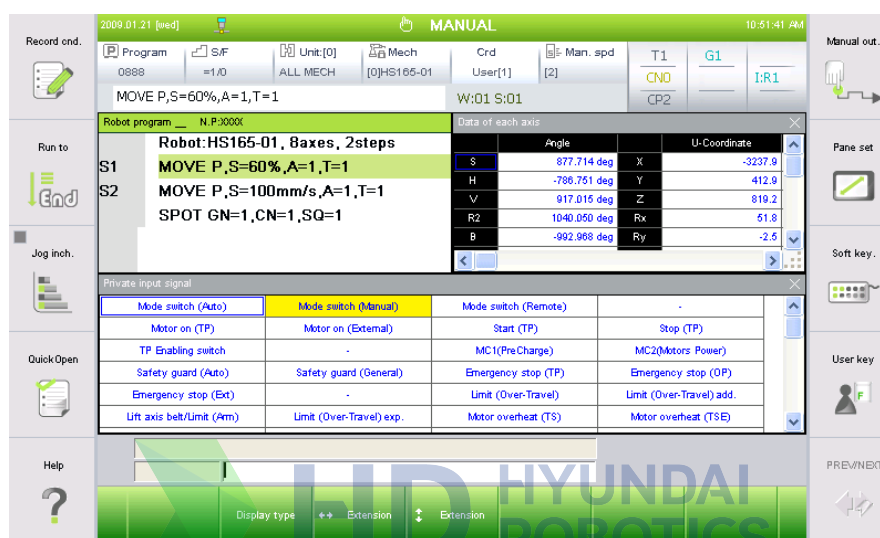
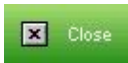


Figure 2.19 TP screen after the display type is clicked

- (7) When you click on the  button, the currently selected window will be closed. Or you can click on the  button on the upper right corner of the window to close the window. (You cannot close the robot program edit window on the upper left side.)

- (8) When you press [ESC] , the window adjustment mode will be finished.

- (9) When you press [SHIFT]  + [ESC] , the selected window will be maximized. When you press it again, it will be restored to its original size. (This function can be used when you want to see a certain window in wide mode.)

2.2.2.4. Key Description

Table 2-1 Key description

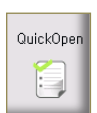
Button	Description
	[REMOTE/AUTO/MANUAL] This is the switch to change among  (REMOTE),  (AUTO) and  (MANUAL) mode. In the REMOTE mode, the mode is decided by the MANUAL mode and AUTO mode signal of the input allocation signal.
	[MOTOR ON] Button used to supply Servo power to the motor in each axis of Robot. If becoming [MOTOR ON] status by pressing this button, the [MOTOR ON] lamp flickers in Manual mode, and the [MOTOR ON] lamp turns on in AUTO mode.
	[START] Button used to automatically operate created program. If AUTO operation of Robot is started, the [START] lamp turns on and the [STOP] lamp turns off.
	[STOP] Used to temporarily stop Robot during AUTO operation. If Robot stop, the [STOP] lamp turns on and the [START] lamp turns off. When the robot stops, there is no risk of colliding with other devices because it stops on the originally planned path.
	[EMERGENCY STOP] Used in emergent status where there is risk that Robot may collide against peripheral units during operation. This is button for Motor Off breaking Servo power to Robot motor and the [MOTOR ON] lamp turns Off.
	[F1], [F2], [F3], [F4], [F5], [F6], [F7] Used when selecting every menu of menu frames on the screen. Press the [F1] if selecting the first menu of menu frame.
	[SHIFT(FAST)] You must use this button when you want to execute the function displayed on the top part of the key (Light green). When this key is pressed together while operating the [Fast step forward/backward] functions, the step forward/backward can be activated in high speeds. When editing a string from the input display window, you can move the cursor by pressing the button with the [←][→] key, From the task edit window, you can move the cursor by each screen by pressing the button with the [↑][↓] key.

2. Basic Operation

Button	Description
	[STEP FWD/BWD] Used when going forward or backward step by step from Manual mode. See the 『F7]: Condition setting』 → 『2: Step fwd/bwd max. speed』 for detailed description. When this key is pressed together with [SHIFT (FAST)], fast step forward/backward functions can be activated.
	[SPEED] Select the robot movement speed. In the manual mode, the manual jog and the step forward/backward functions exist. The manual jog has 8 different steps ranging from 1 to 8, while the speed of the step forward/backward activity will be increased by 50mm/s when the [CTRL] key is used together. Speed will change to the highest speed (S:8) / lowest speed (S:1) if the [SHIFT(FAST)] key and the  key are pressed together. In the automatic mode, when used together with the [CTRL] key, this key will allow the automatic operation speed rate to be adjusted. For more details, refer to 2.3 Manual Operation and 2.4 Auto Operation.
	[ESC] Used to cancel key inputs or various status process. This key has also function to convert the F menu to the upper level.
	[Axis Operation Key] Used for operation of each axis of Robot.
	[Direction Key] Used when moving step or function by pressing the [↑/↓] key or when moving Parameters of recorded step or function by pressing the [←/→] key.
	[R..(NO)] Used when performing function registered as R-code or when reset function is required. When you press the [ENTER(YES)] key after pressing the [R..(NO)] key, the same RESET function as "R0 : Step counter reset" of R code will be executed. See function of R-code for detailed description. This key can be also used when selecting refuse (No) for response of Permit/Refuse (Yes/No).
	[ENTER(YES)] Contents of Input frame is reflected on Edit frame if using this key for completing number input. This key can be also used when selecting permit (Yes) for response of Permit/Refuse (Yes/No). Additionally, this key can be used when modifying command sentence in the Manual mode. When you press this key from the

Button	Description
	sentence cursor, it will switch to the word cursor, with which the parameter can be edited.
	[GUN] This decides whether to record the GUN signal while recording the steps. Function selection status is displayed in the LED on the left side. When you press this button with the [SHIFT (FAST)] key, GUN1 signal will be outputted manually. When this LED is turned on during automatic operation using the arc welding, the robot will actually execute the arc welding. When this LED is turned off, it will not execute arc welding and just check the taught trace.
	[TOOL / COORD] You can select the coordinate system (axis, Cartesian, tool) to move the robot when pressing the axis operation key. When you press this with the [SHIFT] button, the message box to select the tool number will open.
	[POS.MOD / REC] This key is used when recording step in program, namely when adding MOVE command. MOVE command entered in this time is command consisted of hidden pose. You can insert the next step when the cursor is placed at a step This key is used when modifying position of selected step if pressing this key with the [SHIFT] key.
	[PROG / STEP] Used when selecting step. This key is selected when selecting program if pressing this key with the [SHIFT] key. When you press the [PROG] key twice, the program list will be displayed. In the step selection window, the functions for directly moving to {PSF(Program/Step/Function for which moving is taking place)}, {PSF for which execution is taking place}, and { PSF saved in the call stack} will supported.
	[UNIT / MECH] You can use this button to select the mechanism and unit. For the mechanism, the robot is 0 and for additional axis, it follows the setting set by the user in the initial setting menu. When you press this button with the SHIFT key, you can use this button for the unit. Unit is used when the user wants to configure the program in specific combination of units.
	[History] This displays the History message box that records the execution history, error history, message history etc. of task command. When you press this once, it shows the output history of the main board and when you press it again, it shows the output history of the teach pendant.

2. Basic Operation

Button	Description
	[Number Key] Inputs numbers. A [←] is a Backspace key to delete character by character backward. Current value is displayed in reverse phase if firstly selecting Parameters when editing command sentence. In this case, all Parameter values are deleted if pressing this key. In case of arc application, this button can be used as a short key for the arc application function if pressed together with the [SHIFT(FAST)] key, while it can be also used to enter the '+' and '-' signs or to delete a command sentence or a parameter
	[Record condition] This is the key used to edit conditions including speed, accuracy, tool number, step option etc. of the recording step. Editing is done in the record condition window.
	[Run to] This selects whether to execute in steps or in functions when moving the steps forward/backward or whether to continuously execute up to the end of the task program. Currently selected condition is displayed on the button as an icon.
	[JOG inching] This is the key to use when you want to manually move the robot by the designated amount in inching level. This key will be displayed in green color when the jog inching is selected.
	[Quick Open] If this key is pressed while the cursor is placed at a certain command sentence, the Quick Open function related to the command sentence will be executed. See the Quick Open for detailed description.
	[Help] Displays relevant Help depending on each status. Grammar form for command sentence is shown if pressing this key when the cursor exists in command sentence. Description for R-code function is shown if pressing this key after pressing the [R..(NO)]  key when desiring to use function registered as R-code. You can view contents, measures or diagnosis methods for error pressing this key in occurrence of error.
	[Manual output] This manually outputs common output, field bus output etc. or manually sets the value to the parameter.

Button	Description
 Window adjustment	[Window adjustment] This will split the monitoring window, or combine the split windows.
 Soft keyboard	[Soft keyboard] This is used to edit a command sentence or a note. As a touch screen, it can be used just like a keyboard.
 User key	[User key] This is used to define and use a user key in the F button bar.
 PREV/NEXT	[PREV/NEXT] This is used to move to another page of the menu on the F button bar.

2.3. Manual Operation

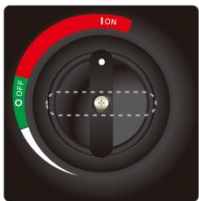
This means behavior to direct work contents to Robot and check the contents. Manual operation also means an operational activity to teach and check the robot at a safe speed.



To perform manual operation, firstly convert the [REMOTE/AUTO/MANUAL] switch of the teach pendant to  [MANUAL] direction as shown in left figure.

2.3.1. Power Input

To operate a Robot, power must be firstly supplied to the Robot controller.



To supply main power of the controller, convert power switch on the left top of the controller to [ON] direction as shown in left figure.



Reference

Whether the supply power to the motor and the possible operating condition are decided by the [REMOTE/AUTO/MANUAL] switch on the teach pendant and the condition of the safety plug as shown in the following table.

The safety plug is used for general industrial robots. But for the LCD robot, the light curtain will replace the role of the safety plug.

Table 2-2 AUTO/MANUAL switch, safety plug condition

[REMOTE/AUTO/MANUAL]		MANUAL	AUTO
Safety plug	OFF	Motor ON Step forward/backward	Emergency (Motor Off)
	ON	Motor ON Step forward/backward	Motor ON Normal speed operation

2.3.2. Initial Setting

Initial setting is executed only when firstly installing Robot or when the Robot controller does not properly operate and the procedure is as follow:

- (1) Check whether the title display window of the teach pendant is in MANUAL mode. If it is in AUTO mode, switch the [REMOTE/AUTO/MANUAL] switch on the teach pendant to [MANUAL].
- (2) Select the 『[F2]: System』 → 『5: Initialize』 → 『1: System format』. When you reset the system, not just the control parameter file and mechanical parameter file, but all programs will be deleted. Therefore, do not use this function except for when you are installing the system for the first time.

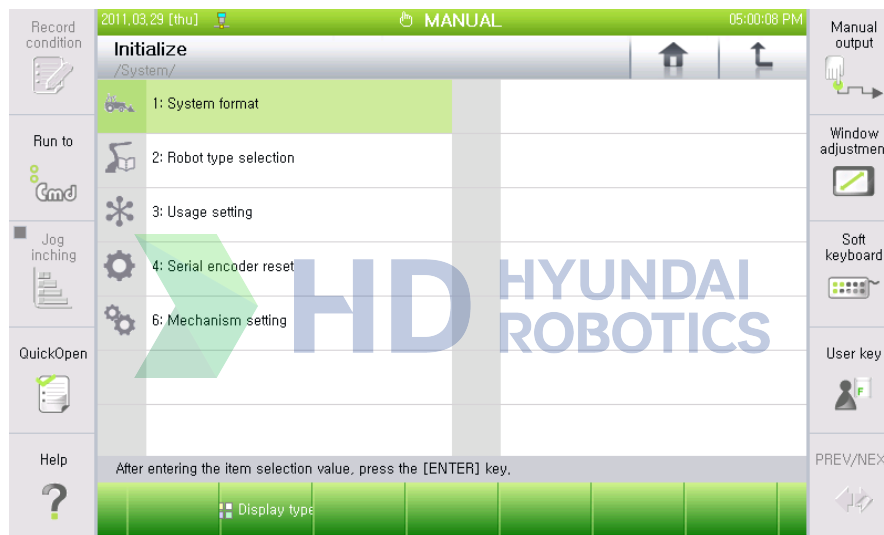


Figure 2.20 Initialization menu screen

- (3) Select the type of Robot which the controller is attached to.
- (4) If you have additional axis, enter the number of additional axes and press the 『[F7]: Complete』 key.
- (5) Turn power of the controller from 'Off' to 'On' by using the main power switch in the left top end in the front of the controller.
- (6) Execute encoder offset calibration from the 『[F2]: System』 → 『3: Robot parameter』 → 『4: Encoder offset』. The Motor On function can be made operable only when the Encoder Offset function is implemented, even when the robot may not in a reference posture
- (7) Turn power of the controller from 'Off' to 'On'.
- (8) Supply power to the motor. (Motor ON)

- (9) Move Robot as standard posture with Manual operation and then execute encoder offset calibration once again. These values are used as position to reset the encoder when replacing the motor.
- (10) Select program No. 9999 by pressing the [SHIFT(FAST)]+[PROG/STEP] key of the teach pendant and then record a step. This position is used as standard position of Robot.



Reference

- To reset the system, consult the engineer.



2.3.3. Manual Operation

Means all behaviors such as instructing work contents to Robot by using the Manual Jog key and checking work contents as instructed and the procedures are as follow:

- (1) Check whether there is a person within a safety fence or there are obstacles within operation scope of Robot.
- (2) Check that Title frame of teach pendant is manual mode. If AUTO mode, convert the [REMOTE/AUTO/MANUAL] switch of the teach pendant to [MANUAL] direction.
- (3) Select desired program by pressing the [Shift (FAST)]+[PROG/STEP] key. (1-9999)

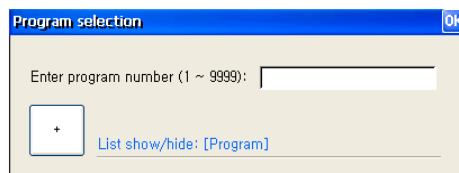


Figure 2.21 Program selection window implemented

- Method to confirm program list
1: When the List show / Hide: [Program] is selected, a program list will appear as below.

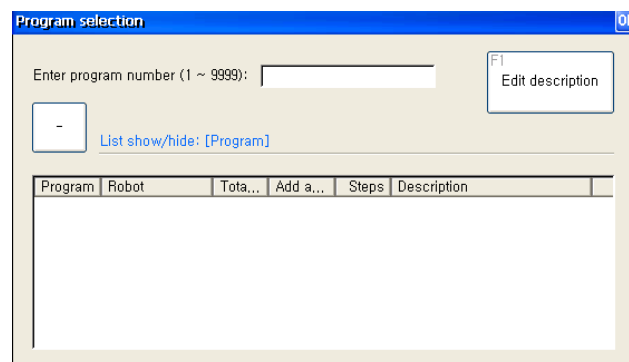


Figure 2.22 Program selection window with a list displayed

- 2: The program selection window can also be displayed even when the [SHIFT [FAST]] + [PROG/STEP] keys are pressed one more time.
- 3: All the files will be listed when selecting 『F1: Service』 → 『5: File manager』.
- 4: All the files can be also listed by using R code No. 17.
- (4) After you press the [Motor ON] button on the teach pendant, check the on/off condition of the [MOTOR ON] lamp. This operation is the preparation step to supply the servo power to the motor of each axis of the robot.
- (5) After you press the [ENABLE] switch on the rear side of the teach pendant, check the on/off condition of the [MOTOR ON] lamp. This operation will operate the MSPR and MSHP relay to

release the motor brake and turn the servo on. That is, the robot can move now.

- (6) Operation to move the Robot is available depending on movement condition of speed level or coordinate system.
- (7) Press the [POS.MOD / REC] key at a position to memorize current position of Robot, then, the step will be recorded.
- (8) Record the function for the step by using the 『[F6]: Command Input』 key.
- (9) Check working contents by using the [STEP FWD/BWD] key. Robot moves while the [STEP FWD/BWD] key is pressed. If Robot arrives at the target step, a 『.』 as mark of completing performance is displayed in front of relevant commands.
- (10) When you carry out the motor on operation or jog operation after entering 『[F2]: System』 menu, the soft limit and the arm interference error will be deactivated. Therefore, the operations must be performed by only the authorized personnel under a condition in which safety is secured.
There is a risk of collision between axes or with surrounding facilities. The manufacturer is not responsible for any accidents caused by mistakes in operation (Refer to Section 1.12, “Responsibility”).

2.3.4. Manual Operation Speed

In the manual mode, the robot can be activated through the manual jog operation and the step forward/backward operation. The individual control methods are as follows. Below the top right side of TP, the currently set speed is shown in the speed window.



The 'manual speed' window shown above is to be displayed only in the manual mode, while the 'playback speed' window will be displayed in the automatic mode. The number '8' on the left bottom of the speed window indicates the level of jog speed, while the numeric datum '250mm/s' on the right of the speed window signifies the speed limit for the step forward/backward. In this case, the speed limit means the speed within which the speed for the step forward/backward activity is restricted. The sign '<' in front of the numeric datum means the speed is equal or slower. For example, when the recorded step speed is 1000mm/s and the speed limit for the manual mode is 250mm/s, then the step movement speed limit during the step forward/backward activities will be restricted to 250mm/s. If the recorded speed is 100mm/s, which is slower than the manual speed 250mm/s, so, the robot will move at the speed of 100mm/s.

For the jog operation, the [SPEED] key is used to adjust the speed by the unit of one level within the range from Level 1 to Level 8. Even in this operation, the maximum speed for the robot tool and link will be restricted below 250mm/s.

For the step forward/backward activities, the [CTRL] + [SPEED] keys are used to adjust the speed by the unit of 50mm/s within the range from 50mm/s to 250mm/s. The maximum speed for the robot tool and link will be restricted below the set speed.

The speed can be adjusted by manipulating the keys as illustrated above, the adjustment can be made also by applying the touch method. When the manual speed window is touched, the window shown below will appear, allowing the speed to be adjusted conveniently

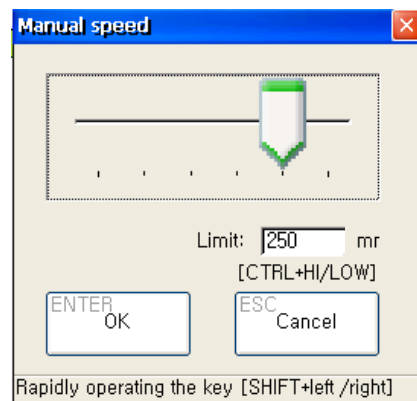


Figure 2.23 Manual speed setting window



If the length and angle values in the tool data are set differently from the actual ones, the tool could run in a very high speed when operated in the manual mode. So, it must be checked before the operation whether the tool data are correctly set.



2.3.5. Step Forward/Backward

The step forward/backward function refers to the playback of the recorded program in the manual mode. This function is used to check, within a safe speed range, the path of the recorded programs and their mutual interlocking relationship.

In the step forward/backward operation, there are totally 3 different modes depending on the unit of execution.

- Execution Unit Cmd: Execute the program line by line
- Execution Unit Step: Execute the program step by step
- Execution Unit End: Execute the program to the end command

When Cmd or Step is set as the execution unit, the robot will reach the recorded step regardless of the set accuracy region. When End is set as the execution unit, the operation will take place along the same path as that of the playback in the automatic mode.

When the step forward/backward activity is to be executed in the Cmd/Step mode, the robot will be activated along the path without cornering as shown in the following picture. More detailed information regarding the cornering is illustrated in 7.3.6 Accuracy.

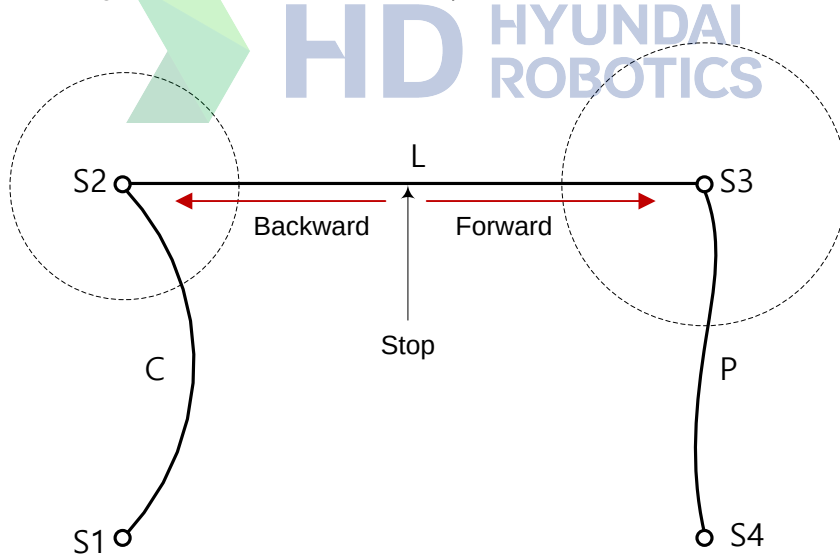


Figure 2.24 Cmd/Step mode playback forward/backward path

When the step forward/backward activity is performed in End mode, the path for the robot will vary depending on the stop position as shown in the following picture. In other words, when the robot tries to move forward after stopping at a location, while not cornering, the path for the cornering will be recovered. However, when moving backward is tried, the movement to the recorded step will be made. Then, the robot will stop at the recorded step, and, right after it, will move back to the previous step. When trying to move forward/backward after the robot stops while cornering, the robot will maintain all the previous paths. However, when the robot moves backwards, it will stop at the cornering starting point automatically, and, then, the relevant step of the TP screen will show 'a' (Refer to the TP screen hereinafter).

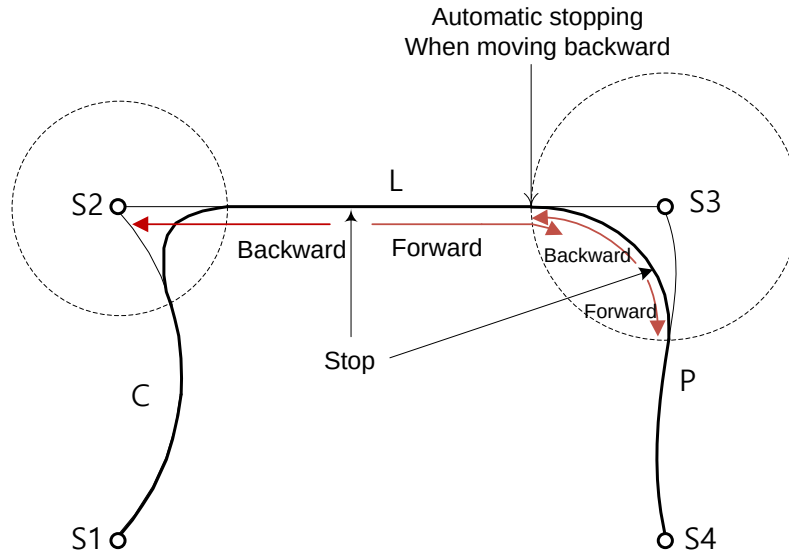


Figure 2.25 End mode playback forward/backward path

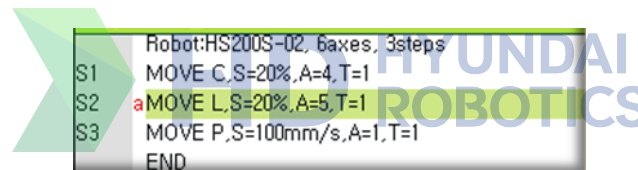


Figure 2.26 The state in which the automatic stopping occurred at the cornering start point after the backward movement during the cornering.

When the robot tries to move forward after stopping at a corner, the robot will run along the original cornering path. In this situation, if the robot tries to move backward, and, while not reaching the previous step completely, tries to move forward again, the original cornering path will not be made in some cases as shown in the picture below. In other words, when the step distance is shortened than the original one, causing the conditions of accuracy not to be fulfilled, the cornering path will be made in a smaller scale than the original cornering path.

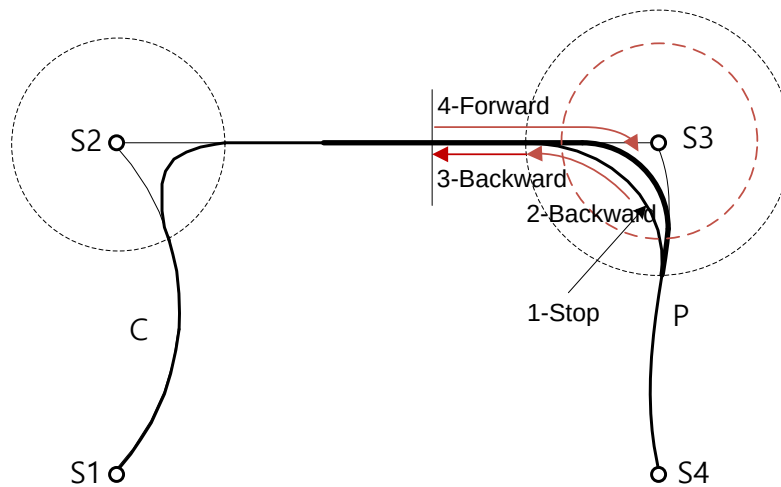


Figure 2.27 Changing of the path of the robot when moving forward after the step backward process.

The “Step fwd/bwd max. speed” and the “Function during step fwd/bwd” can be set in the menu for condition setting menu.

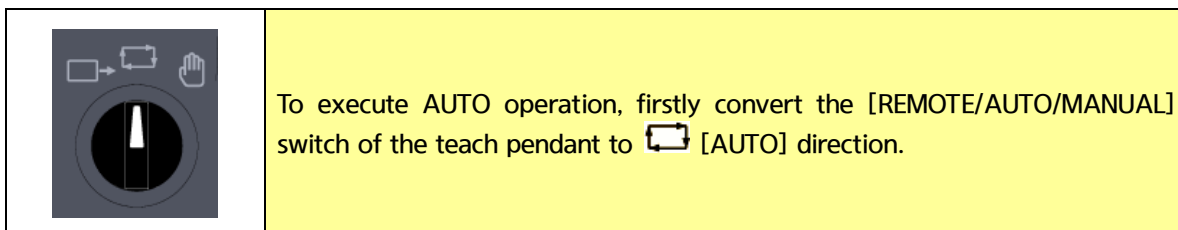
The “Step fwd/bwd max. speed” is the same as the one set for the manual speed.

There are 3 different methods, Off, On and I On, for setting the “Function during step fwd/bwd”.

- Off : Functions will not be executed during the step forward/backward activity.
Regardless of the external I/O conditions, so only the path of the robot can be checked.
Attention is required as the interlocking with the external systems will not be activated
- On : All the functions will be executed.
After the completion of the external interlock is used.
- I On : Only the input wait function will be executed.
To be used to check the security associated with the external interlocking.

2.4. Auto Operation

The operation, which will actually makes the robot carry out the work after teaching is done about the contents that the robot is required to execute, is referred to as AUTO operation.



2.4.1. Auto Operation

Procedure of AUTO operation is as follow:

- (1) Turn the [REMOTE/AUTO/MANUAL] switch of the teach pendant to [AUTO] direction, and check whether the title on the display panel shows auto mode.
- (2) Set condition of the desired operation cycle from the 『F7』: Condition setting → 『1: Operation cycle type= <1 cycle, Continuous>』.
- (3) Set operation speed of Robot from the 『F7』: Condition setting → 『6: Playback speed ratio』. If set to 100, Robot moves at recorded speed. If set to 50, Robot moves at 50% rate of recorded speed.
- (4) Press the [Start] button of the teach pendant and check the on condition of the [Start] lamp and check whether the robot operates according to the direction of the worker.

2.4.2. Power Release

This means all operations of stopping Robot and turning off power switches after the operator performed all desired works. The procedure is as follow:

- (1) Check On status of the [STOP] lamp by pressing the [STOP] button of the teach pendant and then check that Robot stops. If the power is to be released for long hours, it is recommended to bring the robot to the reference location, before releasing the power, in an effort to prepare for the battery being discharged.
- (2) Press the [Emergency Stop] button of operation panel or teach pendant. It becomes motor off status by this operation.
- (3) Turn the main power switch in the controller main body to Off direction and release power of the controller. (Encoder data may be extinguished depending on status of battery.) However, when the power is released while an alarm is being generated due to the battery low voltage, the data in the encoder could be destroyed. The data in the encoder could be also destroyed

while the power is in the released state depending on the state of the battery.

2.4.3. Auto operation speed ratio

In the automatic operation condition, it is possible to change the automatic operation speed in the Condition Setting menu to adjust the robot operation speed without changing the program.

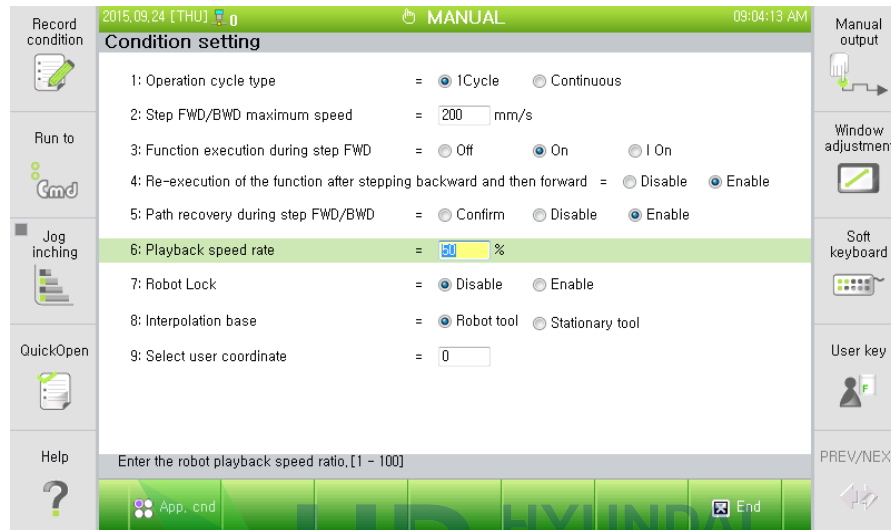


Figure 2.28 Auto operation speed ratio setting screen

In the auto operation mode, the auto operation speed ratio, currently set, is displayed on the top right of the TP as the playback speed as shown below. In the manual mode, this window changes to the manual speed window.



For adjusting the playback speed, the [CTRL] + [SPEED] keys are used to adjust the speed ranging from 1% to 100%, while the speed above 10% is to be adjusted by the unit of 10%. The speed can be adjusted by manipulating the keys as illustrated above, the adjustment can be made also by applying the touch method. When the manual speed window is touched, the window shown below will appear, allowing the speed to be adjusted conveniently

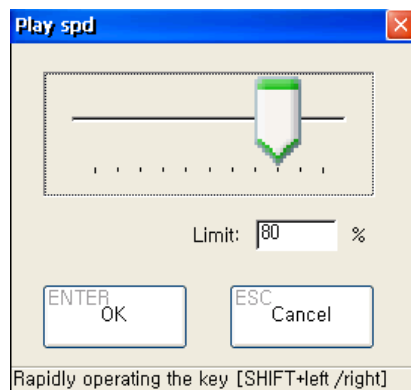


Figure 2.29 Playback speed setting window

2.5. Step

Step is a term to display the robot's specific posture (or position of the tool end) recorded in the work program. Namely step is referred to every position where Robot will arrive at.

2.5.1. Basic matters for step

Robot also performs other different functions while it moves from optional step to other step.

The movement command, MOVE is command language to instruct movement of the Robot main body, which is most basically of Robot programming. In other words, the items such as the position of the robot, the type of interpolation, speed, accuracy and tool number are included in a step.

2.5.2. Parameter of step command sentence

Move conditions are required as well as Move, as movement command in order that the Robot moves from optional step to other step. Such movement conditions are referred to as parameter of step command sentence and are divided into basic parameter and selective parameter. The basic parameter is parameter essential for step, while selective parameter is parameter that operator can add if necessary. Step command sentence consists of follows:

(Basic Parameter)					(Selective Parameter)			
MOVE L, P1, S=100%, A=0, T=0,					X1, X2, UNTIL I4, V6% '			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

- (1) Interpolation
P (Interpolation Off), L (Linear interpolation), C (Circular interpolation), SP (Stationary tool interpolation off), SL (Stationary tool linear interpolation), SC (Stationary tool arc interpolation)
- (2) Pose (X, Y,Z, Rx, Ry, Rz, Cfg) {coordinate system} + Shift (X, Y, Z, Rx, Ry, Rz) {coordinate system}
Hidden pose means that no pose variable is specified.
- (3) Speed (Unit : mm/sec, cm/min, %, sec)
- (4) Accuracy : 0 ~ 7
- (5) Tool number : 0 ~ 31
- (6) Step option: Spot: X1, X2, X3, X4, Palletize: PK, PU, PS
- (7) Stop condition
- (8) Stop status parameter

(9) Note

2.5.2.1. Interpolation

Refers to trace pattern between steps and interpolation method of [step N] determines trace pattern between [step N-1] and [step N].

■ P - PTP (point to point)

As the interpolation method of using each axis reference, rather than the tool end, for the path interpolation between two steps, generally this method is the fastest interpolation method among the various interpolation methods. Due to the characteristics of the industrial robots that are composed of rotational joints, the path of the tool end is generally in C shape.

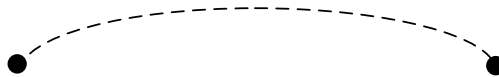


Figure 2.30 Example of tool end path of P-PTP interpolation

■ L - Linear interpolation

Moves to linear trace between both steps. It is used in the case that requires linear trace such as arc welding zone. It moves while automatically changing wrist posture as in following figure.

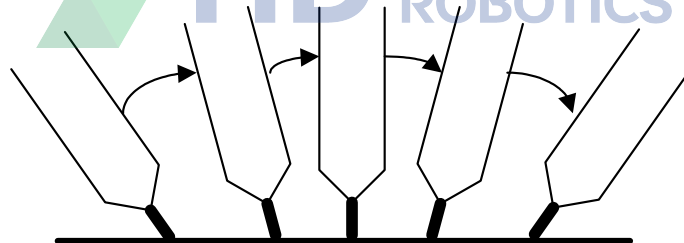


Figure 2.31 Example of L-linear interpolation

Linear interpolation moves while automatically changing wrist posture of the Robot and fails to automatically change wrist posture in specific condition. This condition is called Singular position.



Reference

The following is the Singular position and position calibration cannot be done.

- Where B-axis is located at near the dead zone. See the 『F2』: System → 『3』: Robot parameter → 『5』: B axis dead zone for dead zone setting.
- Where symbol is changed. Namely, where symbol of B-axis angle is change from 『-』 to 『+』 or from 『+』 to 『-』.

2. Basic Operation

- Where change of the R2, R1-axis angle exceeds 180 degree.
- Where the B-axis center or tool end passes by center of S-axis rotation. Trace error or other error as well as posture may occur.
- Where change of the S-axis angle exceeds 180 degree. Error unconditionally occurs.
- C – Circular interpolation

Moves between both steps to circular trace. To determine a circle, 3 points are needed. Standard to select it is as follow :

The next step [step n+2] needs to be referred to if interpolation method of the [step n+1] is arc interpolation C. Determine a circle with the [step n] [step n+1] or [step n+2] if interpolation method of the [step n+2] is also arc interpolation C, and move along with arc of the [step n] ~ [step n+1] zone of them. If interpolation method of the [step n+2] is not circular interpolation, determine a circle with the [step n-1] [step n] or [step n+1] be referring to the previous step of the [step n-1], and move along with arch of the [step n] ~ [step n+1] zone.

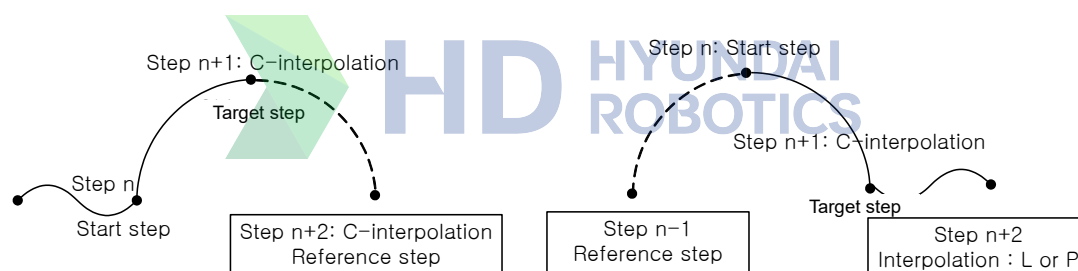


Figure 2.32 C – Example 1 of circular interpolation

You can create program by using double registration of same point even for consecutive arc if using standard as above described.

Considering trace to move to like this, you can create program as you want if determining interpolation method of step and using double registration of the same point.

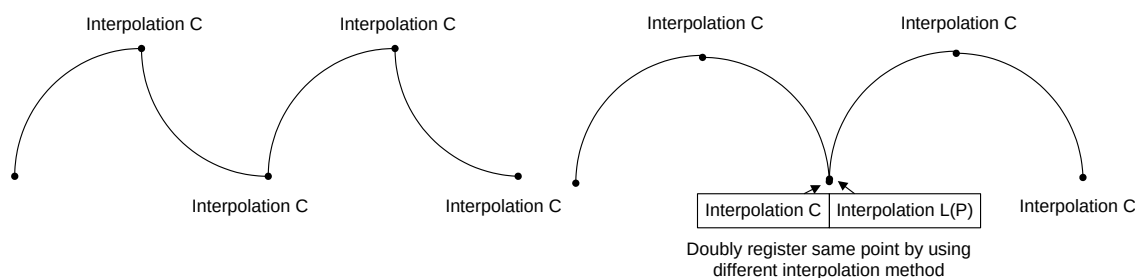


Figure 2.33 C – Example 2 of arc interpolation



Reference

- Stationary tool interpolation is function used Robot holds works and performs work on the works by using outside fixed tool. In this case, interpolation operation is done based on works that Robot owns.
- See 『7.2.7.2. Stationary tool interpolation function』 for description concerning the type of stationary tool interpolation.



2.5.2.2. Pose

Parameter to record position is referred to as pose, and pose parameter must be always used in case of inputting MOVE, movement command by using the “『F6』: Command input_” key. No pose formula appears in case of inputting MOVE sentence by pressing the [POS.MOD / REC] key (Hidden pose). At that time, position and posture of Robot is recorded as possible as the [POS.MOD / REC] key is pressed.

Input Method

- 『F6』: Command input_ key → 『F1』: MOVE, I/O_ → 『F1』: MOVE_
- [Quick Open] key → Pose number selection → 『F1』: Current pose_ → 『F7』: REC_

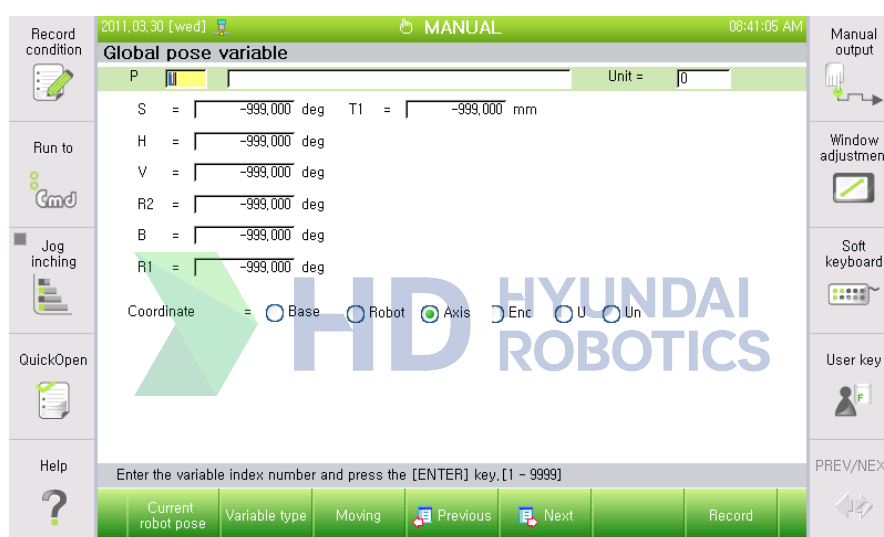


Figure 2.34 Pose data dialogue box

The pose and shift parameters are to be saved in the following format.

- (1) Pose : (X, Y, Z, Rx, Ry, Rz, Cfg) {Coordinate system}
 {Coordinate system} : ' ' = Base coordinate system
 R = Robot coordinate system
 U = User coordinate system
 A = Axis coordinate
 E = Encoder
 M = Master tool end coordinate (Cooperation control)
- (2) Shift : (X, Y, Z, Rx, Ry, Rz) {Coordinate system}* R1 ~ R8 is same as Online Shift Register.
 {Coordinate system} : ' ' = Base coordinate system
 R = Robot coordinate system
 T = Tool coordinate system
 U = User coordinate system
 M = Master tool end coordinate (Cooperation control)

2.5.2.3. Speed

The unit of speed is totally 4, which are mm/s, cm/min, sec and %. They can be used for all different interpolation methods.

Mm/s, cm/min: Means the TCP maximum speed.

Only when the recorded TCP speed is lower than the maximum speed of the robot, the robot can run at the recorded speed. If the recorded speed is higher than the maximum speed of the robot, the robot will run at its maximum speed. The maximum speed of the robot will be automatically calculated in the controller according to position or acceleration or deceleration parameters

sec: Time taken for the robot to move.

Only when the recorded robot's movement time is longer than the shortest movement time within which the robot can move within a physical boundary, the robot can move in the recorded time. If the recorded time is shorter than the shortest movement time of the robot, the robot will run at its shortest movement time. The shortest movement time of the robot will be automatically calculated in the controller according to position or acceleration or deceleration parameters

%: Ratio for the maximum speed of the robot.

If it is 100%, the robot will move at the fastest speed. Regardless of the unit of the recorded speed, the robot will always run at a speed equal to or lower than the speed at 100%

2.5.2.4. Accuracy

Determines precision level (approaching level for recording position) passing through the step when Robot proceeds the target step. Robot moves to the next step if difference between current position and recording position is less than fixed level (accuracy OK) when the robot moves to the target step.

Thus allowed difference called is accuracy.

As shown in the picture below, the path newly created by the accuracy within the accuracy range is the cornering path. Generally, as the accuracy increases, the cornering speed goes up, which is advantageous in terms of the movement time.

Accuracy 0 is most precise and accuracy 7 represents a case where difference is largest.

Accuracy is not applied more than $\frac{1}{2}$ of the length of the shorter trace between both traces of the target step. That is, the following formula will be applied in the example of the following figure.

$$\text{Accuracy} \leq \min(P1-P2, P2-P3) / 2$$

In the above formula, explanation is made using the TCP distance, while the same concept can be applied to the angle.

When it comes to the applied values of the accuracy level, they are defined by the robot's tool end distance and posture angle in case of the robot. When it comes to the additional axis, the values are defined by the length in case of the operating axis and by the angle in case of the rotating axis. These values can be changed directly from 『F2』: System → 『3』: Robot parameter → 『6』: Accuracy. Refer to 7.3.6 Accuracy for more details

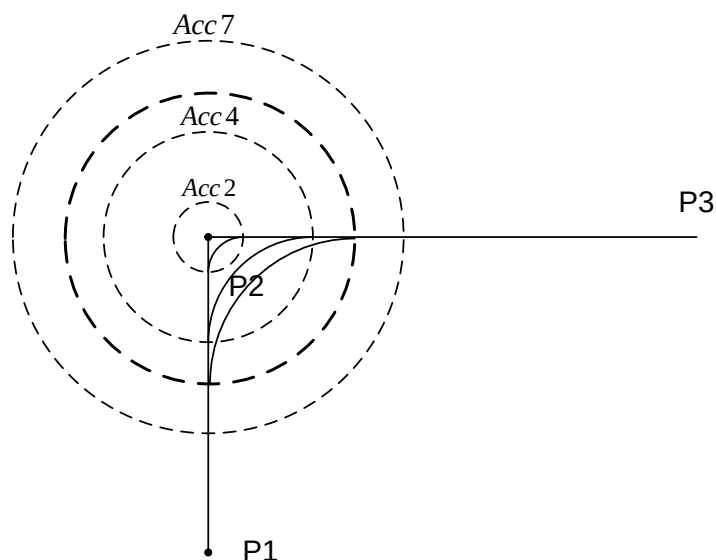


Figure 2.35 Path change depending on accuracy of P2

The following picture shows how the cornering path is created according to the values of the accuracy level. When it is the case of a 6-axis multi-joint robot and there is an auxiliary axis, the accuracy value, in other words, the tool end distance (TCP), the posture angle (ORN) and the auxiliary axis distance (AUX) can be set separately. As the cornering path is required to meet all the values of the relevant accuracy level, the path will be created based on the lowest value among the TCP, ORN and AUX values. The cornering path always meets the convex hull property (Refer to the Figure) while being created in a certain curved form regardless of the change of speed. However, an error of a few mm could occur in low speed and high speed due to the servo delay

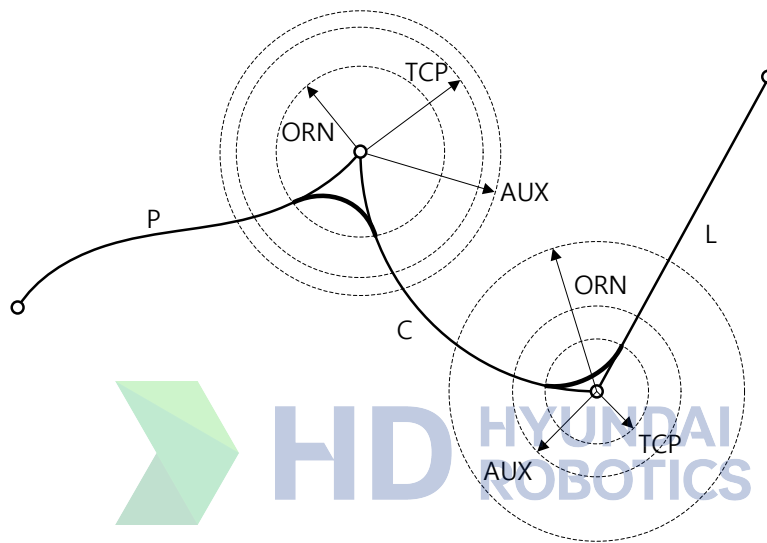


Figure 2.36 Cornering path according to the value of the accuracy level

The method for creating a cornering path according to the accuracy, as explained above, is applicable to all kinds of interpolation. In case of the P interpolation, the TCP distance accuracy is applied, with possible errors. However, the path will be bound inside the shaded area because of the "convex hull property".

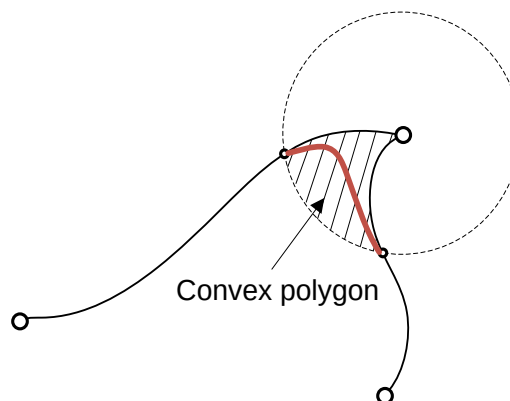


Figure 2.37 All the points on the cornering path exist within the convex polygon (The part with slant lines)

2.5.2.5. Tool Number

Robot position is determined by position and posture of the tool end. Designate number of the tool used.

2.5.2.6. Step Option

Step option as the spot welding output option, this is to select the X1, X2, X3 and X4 signals that are assigned for the small opening and closing of the air pressure gun.

As the palletizing option, this is to decide the shift application method for the PK (Picking), PU (Picking up), and PS (Place Shift) palletizing works

2.5.2.7. Stop Condition

If conditions formula after UNTIL is met, Robot stops to move and performs following command (step or function).

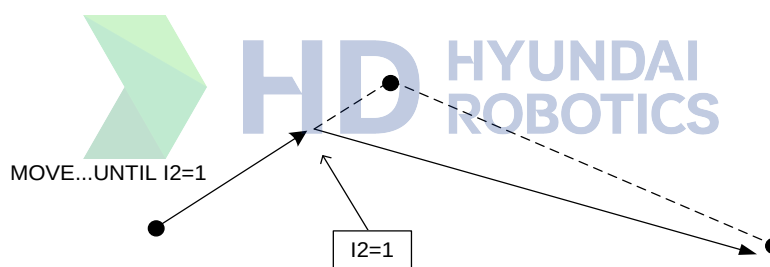


Figure 2.38 Example of stop condition

2.5.2.8. Stop Status Parameter

Resulting value of stop condition formula (condition formula after UNTIL) is kept. You can know whether MOVE operation is terminated by condition formula.

2.5.2.9. Note

This is used to allow notes to be entered to provide explanation about the step. The note information can be entered conveniently by using the [Soft keyboard]



2.5.3. Record/Modify of Step Position

Press the [POS.MOD/REC] key to record or change the location and position of the robot for the recorded step.

2.5.3.1. Axis Recording Coordinate

Following screen is displayed if pressing the [Quick Open] key in the MOVE command sentence selected and recorded as 『F2]: System』 → 『1: User environment』 → 『1: Pose record type =〈Axis〉』 in the Manual Mode.

For position of Robot recorded as encoder, only position can be identified and you cannot modify position data.

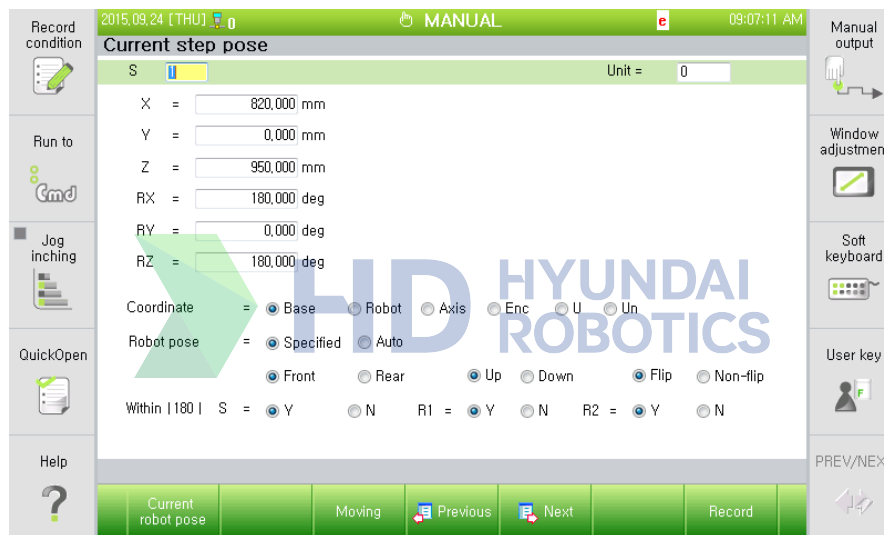


Figure 2.39 Quick Open from MOVE command

2.5.3.2. Base or Robot Recording Coordinate

Location and position of the robot may be different depending on the coordinate. Generally if there is no driving axis, the Base coordinate and the Robot coordinate are the same. But when the driving axis is defined, the location and position of the robot tool will be different for the Base coordinate and Robot coordinate.

You can check by pressing the [Quick Open] key from the recorded MOVE command by selecting 『[F2]: System』 → 『1: User environment』 → 『1: Pose record type =〈Base〉 or 〈Robot〉』 in manual mode.



Reference

- To change the pose record format, consult the engineer.
- Because multiple positions exist for one tool end location/direction due to the mechanical characteristics, you must designate the robot type to define a unique position.
The robot type will be saved in [Pose parameter].CFG (P1.CFG, LP1.CFG) and each bit assignment of CFG is as the following.

bit 0 : (0: Designated, 1: Not designated)

Determines whether or not configuration pattern will be designated for posture that Robot currently poses. (If not designated, this will be automatically decided.)

bit 1 : (0: Front, 1: Rear)

If the tool end of the robot is in X axis + direction of the robot coordinate, select the front side, and if in - direction, rear side.

bit 2 : (0: Up, 1: Down)

This is the relationship between H axis and V axis.

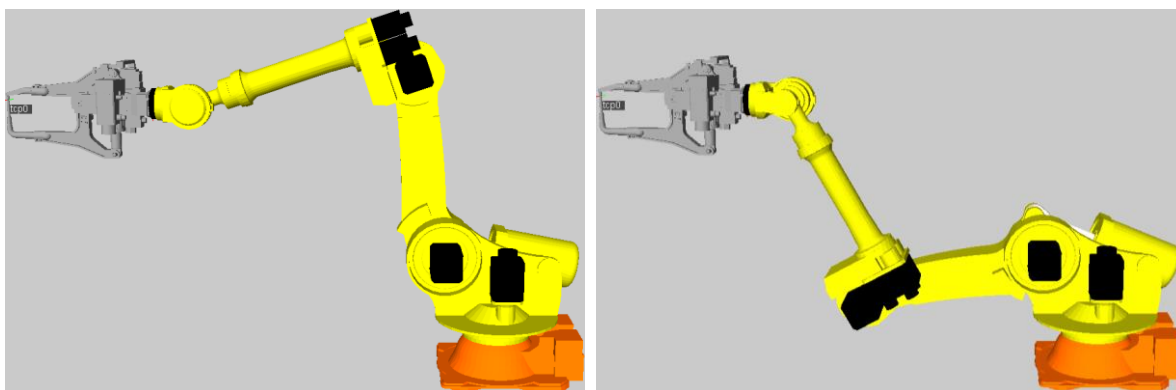


Figure 2.40 Posture of H and V axes: Upper (Left), Lower (Right)

bit 3 : (0: Flip, 1: Non-flip)

Decide whether the B axis coordinate is flip, meaning a “+” value, or non-flip, meaning a “-” value.

The red arrow shown in the figure indicates the upper part direction of the wrist axis.

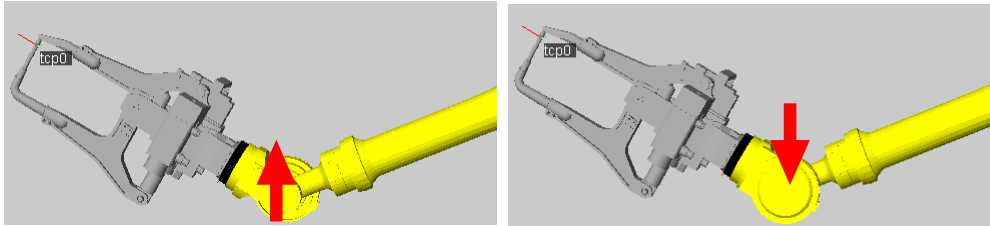


Figure 2.41 Flip (Left)/Non-flip (Right) posture

bit 4 : (0: $|S| < 180$, 1: $|S| = 180$)

Select where angle of the S-axis is located at.

bit 5 : (0: $|R2| < 180$, 1: $|R2| = 180$)

Select where angle of the R2-axis is located at.

bit 6 : (0: $|R1| < 180$, 1: $|R1| = 180$)

Select where angle of the R1-axis is located at.

bit 7~9 : Represents coordinate system.

(0: Base, 1: Robot, 2: Angle, 3: Encoder, 4: User, 6: Master tool end)

bit 10~13 : User coordinate system number. (1~10)

bit 14 : Reserved

It is an unused area and can be changed without future notice.

bit 15 : (0: $|B| < 180$, 1: $|B| = 180$)

Choose the location where the B axis angle is is. (It only makes sense if the B-axis operating range of the model is more than 180° .)

- Designation of coordinate system is separated by additional character in the last for convenience of user as follow :

Base coordinate system = (X,Y,Z,Rx,Ry,Rz,cf)g

Robot coordinate system = (X,Y,Z,Rx,Ry,Rz,cf)R

Axis coordinate system = (S,H,V,R2,B,R1)A

Encoder = (S,H,V,R2,B,R1)E

User coordinate system = (X,Y,Z,Rx,Ry,Rz,cf)U

User coordinate system = (X,Y,Z,Rx,Ry,Rz,cf)Un

➔ Number non-define method

➔ Number define method (1~10)

2.6. R Code Key

R code is the unique code assigned to the frequently used function for quick operation.

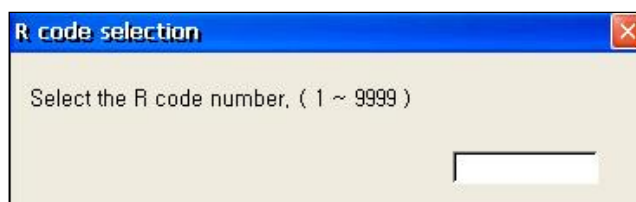


Figure 2.42 R code entering window

Press the [R..[NO]] key and enter the number so that you can use the quick function. You can press the [Help] key to show the list of R codes and select the code to use.

See 『Chapter 8, R-code』 for detailed description about R-code.

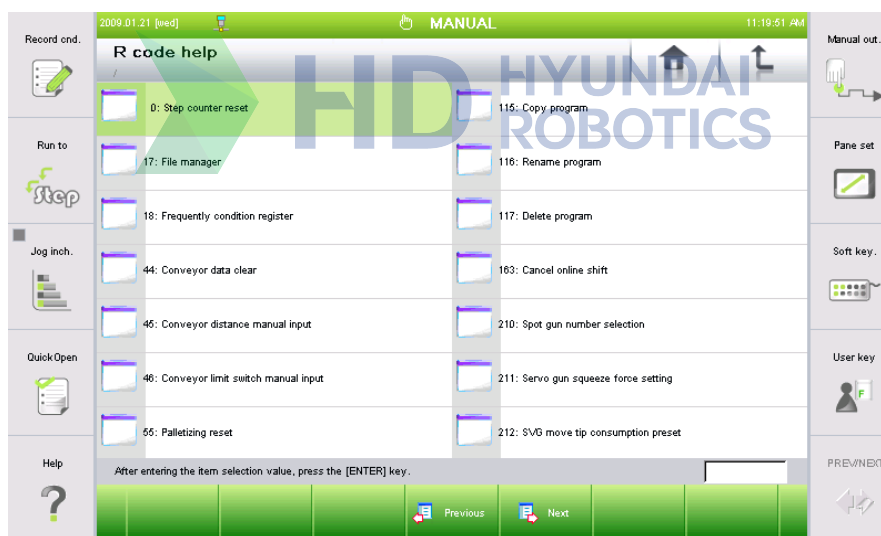


Figure 2.43 Display R code list with [Help] key

2.7. Error Information

You can know contents and measure method about error occurred by pressing the [Help] key when all types of error such as system error or operation error.

Error occurred is displayed in following method if error occurs in the controller.

- (1) Up to 100 errors recently occurred are recorded in 『[F1]: Service』 → 『7: System diagnosis』 → 『2: Error logging』.
- (2) Numbers and messages about errors are displayed when all types of error occur in the Guide frame as below screen :
Items with yellow background refer to the newly generated errors.

#	Code	Message	Date	Time	Prog	Step
1	E1111	Arm angle is too big	2009/01/21	08:43:52	P0888	S001
2	E1101	T2 Axis/Soft limit exceeded	2009/01/21	08:43:52	P0888	S001
3	E1101	T1 Axis/Soft limit exceeded	2009/01/21	08:43:52	P0888	S001
4	E1101	R1 Axis/Soft limit exceeded	2009/01/21	08:43:52	P0888	S001
5	E1101	B Axis/Soft limit exceeded	2009/01/21	08:43:52	P0888	S001
6	E1101	R2 Axis/Soft limit exceeded	2009/01/21	08:43:52	P0888	S001
7	E1101	V Axis/Soft limit exceeded	2009/01/21	08:43:52	P0888	S001
8	E1101	H Axis/Soft limit exceeded	2009/01/21	08:43:52	P0888	S001
9	E1101	S Axis/Soft limit exceeded	2009/01/21	08:43:52	P0888	S001
10	E1044	Motor turned ON without calibrating encoder offset	2009/01/20	17:05:18	P0888	S002
11	E1111	Arm angle is too big	2009/01/20	09:23:58	P0888	S000
12	E1101	T2 Axis/Soft limit exceeded	2009/01/20	09:23:58	P0888	S000
13	E1101	T1 Axis/Soft limit exceeded	2009/01/20	09:23:58	P0888	S000
14	E1101	R1 Axis/Soft limit exceeded	2009/01/20	09:23:58	P0888	S000
15	E1101	B Axis/Soft limit exceeded	2009/01/20	09:23:58	P0888	S000
16	E1101	R2 Axis/Soft limit exceeded	2009/01/20	09:23:58	P0888	S000
17	E1101	V Axis/Soft limit exceeded	2009/01/20	09:23:58	P0888	S000
18	E1101	H Axis/Soft limit exceeded	2009/01/20	09:23:58	P0888	S000

Figure 2.44 Error display screen

- (3) You can know contents and measure methods about error occurred by pressing the [Help] key of teach pendant as in following screen :

#	Code	Message	Date	Time	Prog	Step
2	E1101	T2 Axis/Soft limit exceeded	2009/01/21	08:43:52	P0888	S001
3	E1101	T1 Axis/Soft limit exceeded	2009/01/21	08:43:52	P0888	S001
4	E1101	R1 Axis/Soft limit exceeded	2009/01/21	08:43:52	P0888	S001
5	E1101	B Axis/Soft limit exceeded	2009/01/21	08:43:52	P0888	S001
6	E1101	R2 Axis/Soft limit exceeded	2009/01/21	08:43:52	P0888	S001
7	E1101	V Axis/Soft limit exceeded	2009/01/21	08:43:52	P0888	S001
8	E1101	H Axis/Soft limit exceeded	2009/01/21	08:43:52	P0888	S001
9	E1101	S Axis/Soft limit exceeded	2009/01/21	08:43:52	P0888	S001
10	E1044	Motor turned ON without calibrating encoder offset	2009/01/20	17:05:18	P0888	S002
11	E1111	Arm angle is too big	2009/01/20	09:23:58	P0888	S000
12	E1101	T2 Axis/Soft limit exceeded	2009/01/20	09:23:58	P0888	S000
13	E1101	T1 Axis/Soft limit exceeded	2009/01/20	09:23:58	P0888	S000
14	E1101	R1 Axis/Soft limit exceeded	2009/01/20	09:23:58	P0888	S000
15	E1101	B Axis/Soft limit exceeded	2009/01/20	09:23:58	P0888	S000
16	E1101	R2 Axis/Soft limit exceeded	2009/01/20	09:23:58	P0888	S000
17	E1101	V Axis/Soft limit exceeded	2009/01/20	09:23:58	P0888	S000
18	E1101	H Axis/Soft limit exceeded	2009/01/20	09:23:58	P0888	S000

Figure 2.45 Error detail and action

2.8. User Key

The user can use this function to assign specific keys to F1 ~ F7 of the teach pendant to enhance the convenience of the robot teaching.

2.8.1. User key assignment

The user assigns a specific key to F1 ~ F7 of teach pendant. To automatically assign the keys depending on the task usage of spot/arc/palletizing, refer to 『F2]: System』 → 『5]: Initialize』 → 『3]: Usage setting』.

- (1) Press the [SHIFT] + [User key] button to enter this function.
- (2) Select the F key to assign using the direction key ([←/→]).
- (3) Select the function to assign using the direction key ([↑/↓]).
- (4) When you press the 『F1]: Selection』 key or [Enter] key, you can assign the function you selected to the F key.
- (5) When you press the 『F2]: Delete』 key or select the “No. 0: Cancel setting” item, you can reset the allocation of the selected F key.
- (6) When you press the 『F7]: Complete』 key, the setting will be saved.



Figure 2.46 User key setting screen

2.8.2. User key use

This describes how to use the user key assigned to F1 ~ F7 of the teach pendant.

- (1) When you press the [User key] button from the initial screen, the assigned F key menu will be displayed.
- (2) Execute the function by pressing the [F?] or [SHIFT] + [F?] key depending on the assigned F key.



Figure 2.47 User key screen



Reference



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- For functionality of key related to spot welding for the user key, refer to 『Hi5a spot welding function manual』 .
- For functionality of key related to arc welding for the user key, refer to 『Hi5a controller arc welding function manual』 .

2.9. History

This displays the History message box that records the execution history, error history, message history etc. of task command. When you press this once, it shows the output history of the main board and when you press it again, it shows the output history of the teach pendant. (Toggle operation)

The function of the history screen can be conveniently used to understand the flow of the program or analyze the causes for problems that could occur during the operation of the robot.

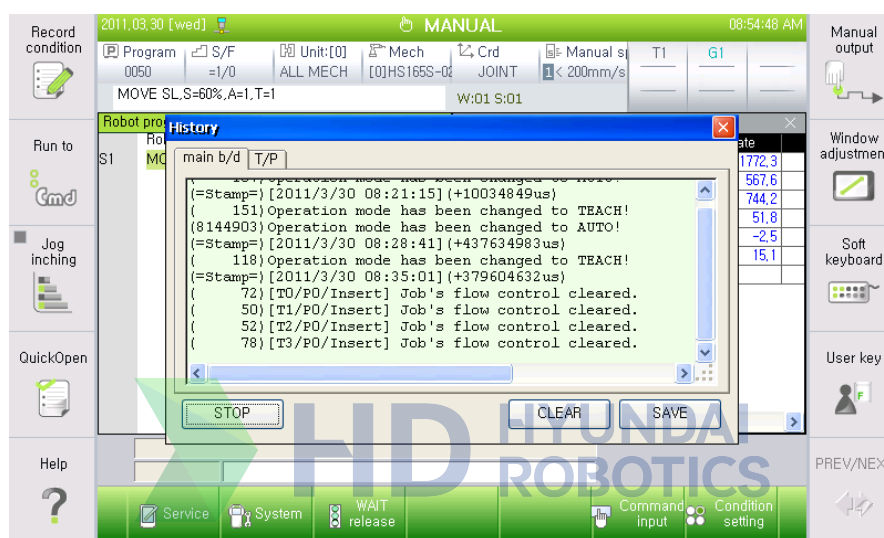


Figure 2.48 History

The [STOP] function is used to check the content of the screen by stopping the updating of the screen while the screen keeps changing as the work program is being executed.

The [CLEAR] function is used to clear out the overall screen and create a new one.

The [SAVE] function is used to save the history of the previous screen in files. 10 files, ranging from History0.txt to history9.txt, can be created.

When it is required to analyze the causes for the problems that could occur during the operation of the robot, the history of the previous screen can be saved in files, which would make it possible to check the flow of the problematic program always.

2.10. Coordinate System

A coordinate in space is required to determine direction that Robot moves on space. At this time, the coordinate system defined for the robot to move is called the coordinate system, and Hi5a controller supports axis coordinate system, robot coordinate system, user coordinate system and tool coordinate system.

2.10.1. JOG Operation Key

Following table represents direction that Robot actually moves in axis coordinate system, Robot coordinate system, user coordinate system and tool coordinate system when pressing the [axis operation] key of teach pendant.

You can understand the robot's operation pattern in every coordinate system based on following table.

Table 2-3 Operation pattern of Robot in every coordinate system

Operation Operation Key	[Coordinate system]			
	Axis-Coord	Robot (Robot-Coord)	Robot (User-Coord)	Tool-Coord
X-	S [-]	Xr (-)	Xu (-)	Xt (-)
X+	S [+]	Xr (+)	Xu (+)	Xt (+)
Y-	H [-]	Yr (-)	Yu (-)	Yt (-)
Y+	H [+]	Yr (+)	Yu (+)	Yt (+)
Z-	V [-]	Zr (-)	Zu (-)	Zt (-)
Z+	V [+]	Zr (+)	Zu (+)	Zt (+)
Rx-	R2 [-]	Rxr (-)	Rxu (-)	Rxt (-)
Rx+	R2 [+]	Rxr (+)	Rxu (+)	Rxt (+)
Ry-	B [-]	Ryr (-)	Ryu (-)	Ryt (-)
Ry+	B [+]	Ryr (+)	Ryu (+)	Ryt (+)
Rz-	R1 [-]	Rzr (-)	Rzu (-)	Rzt (-)
Rz+	R1 [+]	Rzr (+)	Rzu (+)	Rzt (+)

Table 2-4 Operation form on an additional axis-related jog key

Operation Operation Key	[Coordinate system]	
	Axis coordinate system	Rectangular coordinate system (Robot, User, Tool)
J7- (R3-)	Allocated additional axis1 [-] R3 [-]	Allocated additional axis1 [-] R3 [-]
J7+ (R3+)	Allocated additional axis1 [+] R3 [+]	Allocated additional axis1 [+] R3 [+]
J8-	Allocated additional axis2 [-]	Allocated additional axis2 [-]
J8+	Allocated additional axis2 [+]	Allocated additional axis2 [+]

The J7, J8 key operates differently in accordance with the robot type and setting condition of the additional axis. For a 7-axis robot, J7 operates with a jog key allocated R3 axis, which is the third axis. For other models, each additional axis can be allocated in accordance with the mechanism setting if it is set using the jog key in the “teach pendant option” menu.

In cases when the selected mechanism is a mechanism [0] robot when you jog, it is individually allocated in accordance with the order of registered additional axis when the number of the whole axes of the next mechanism is less than two. In this case, if a key that is not assigned in the mechanism [1] remains, and if the following mechanisms are within the number of axes that can be assigned to the remaining keys, they are sequentially assigned. The following is an example of whether or not to assign J7, J8 axes in accordance with the number of axes of the additional axis mechanism.

Example 1) Mechanism[0]: robot 6 axis, Mechanism[1]: traveling axis 1 axis, Mechanism[2]: positioner 1 axis

➔ J7 : traveling axis, J8 : Positioner assigned

Example 2) Mechanism[0]: robot 6 axis, Mechanism[1]: traveling axis 1 axis, Mechanism[2]: positioner 2 axis

➔ J7 : traveling axis, J8 : Unassigned

Example 3) Mechanism[0]: robot 6 axis, Mechanism[1]: traveling axis 2 axis, Mechanism[2]: positioner 2 axis

➔ J7 : traveling axis 1, J8 : traveling axis 2

Example 4) Mechanism[0]: robot 6 axis, Mechanism[1]: traveling axis 3 axis, Mechanism[2]: positioner 1 axis

➔ J7 : Unassigned, J8 : Unassigned

2.10.2. Axis Coordinate System

Press the [ENABLE] switch of the teach pendant when the motor is turned ON in MANUAL mode.

Press the coordinate system key of the teach pendant so that the coordinate of the status bar shows the axis. When you press the axis operation key, the robot will operate as follows.

When you operate the robot in the axis coordinate, each axis of the robot will move independently.

For proceeding direction of the robot by the axis operation key, refer to the 2. 10. 1 JOG operation key.

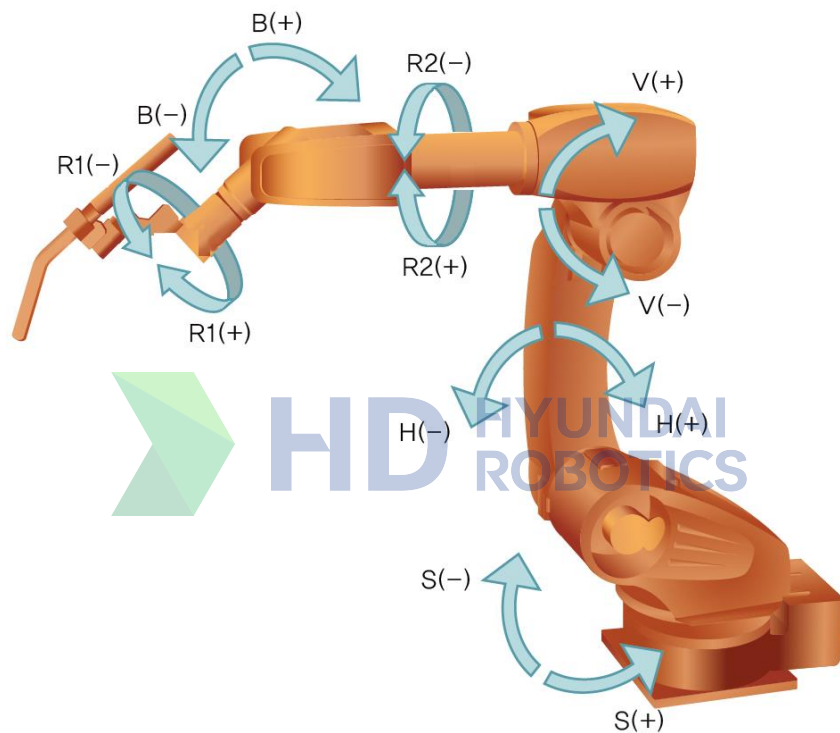


Figure 2.49 Axis Coordinate System

2.10.3. Robot coordinate system

Press the [ENABLE] switch of the teach pendant when the motor is turned ON in MANUAL mode.

Press the coordinate system key of the teach pendant so that the coordinate of the status bar shows the axis. When you press the axis operation key, the robot will operate as follows.

For proceeding direction of the robot by the axis operation key, refer to the 2.10.1 JOG operation key.

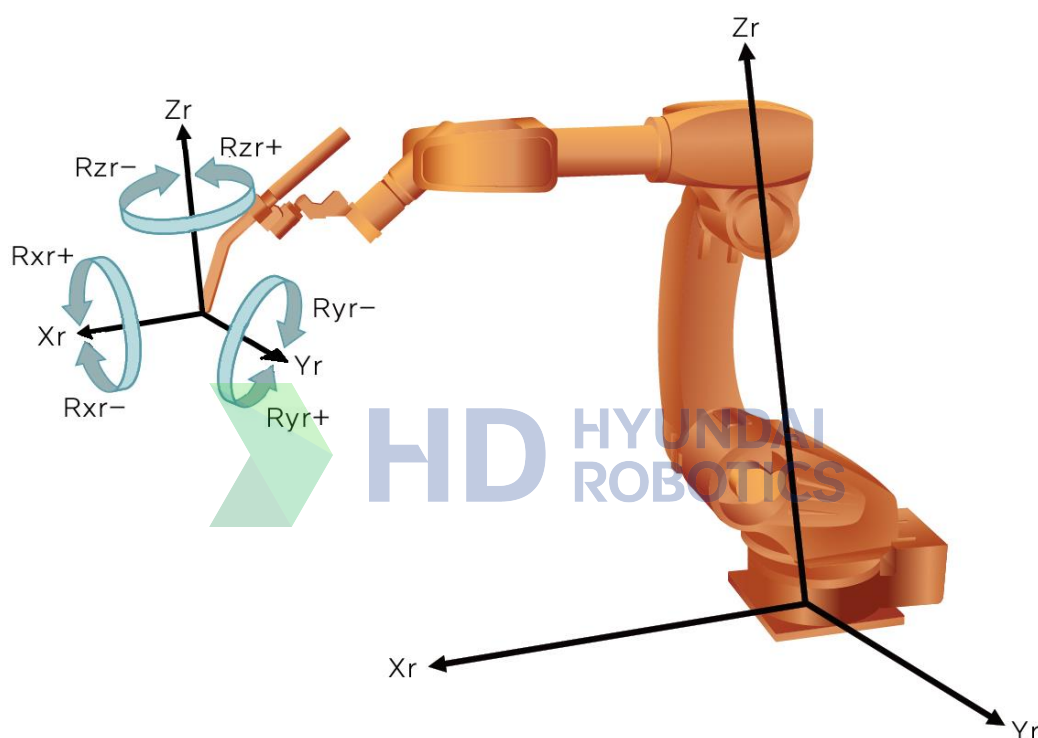


Figure 2.50 Robot coordinate system



Reference

- Following figure shows method to conveniently determine direction that the Robot progresses when spreading thumb, second finger, middle finger at a right angle. When laying progress direction of the left finger at the rear of Robot to Y-direction of the Robot coordinate system, progress direction of the thumb finger becomes Z-direction, and progress direction of the middle finger becomes X-direction. If utilizing such principle, you can conveniently understand operation of Robot in the Robot coordinate system.
- When it comes to the rotational direction, the direction in which you can hold your fingers of right hand while placing the thumb in the axial direction of the rotation is the '+' direction of the rotating direction

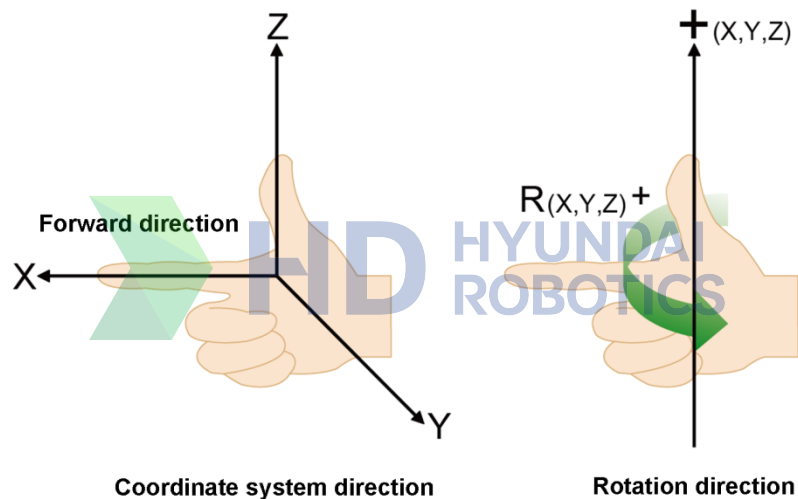


Figure 2.51 Direction and rotation direction of coordinate system

2.10.4. User Coordinate System

Register the user coordinate system by selecting the 『F2』: System → 『2』: Control parameter → 『7』: Coordinate registration → 『1』: User coordinate. Robot operates as following figure if reproducing program after selecting the 『F7』: Condition setting → 『9』: Select user coordinate.

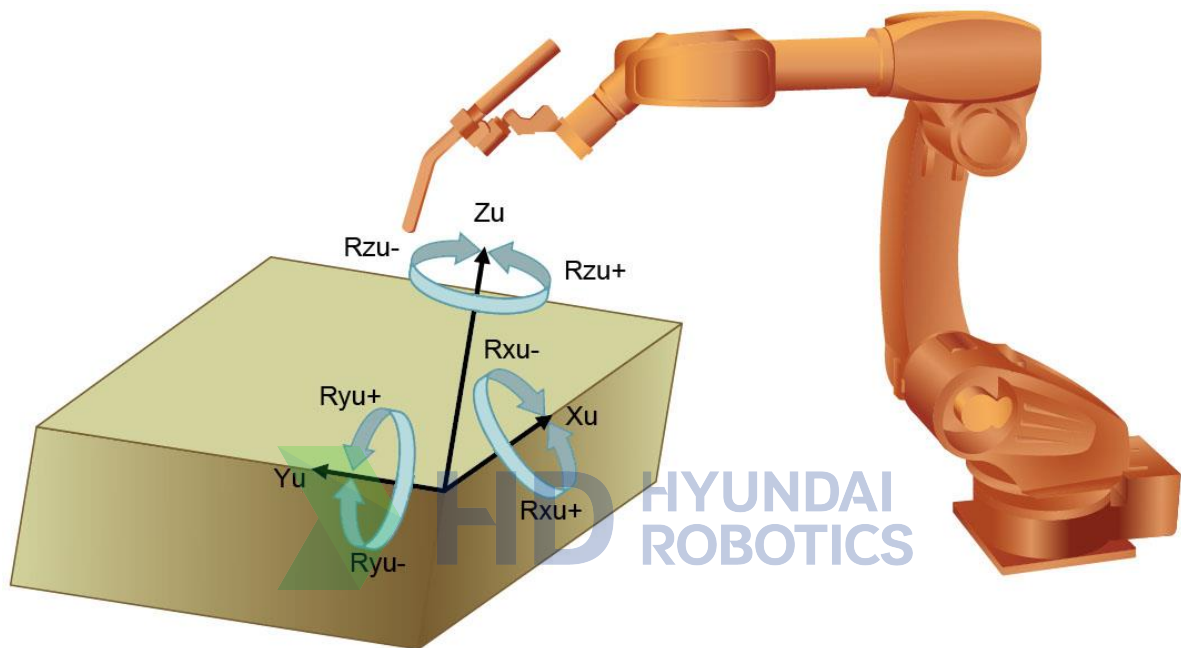


Figure 2.52 User coordinate system

2.10.5. Tool Coordinate System

Press the [ENABLE] switch of the teach pendant when the motor is turned ON in MANUAL mode.

Press the coordinate system key of the teach pendant so that the coordinate of the status bar shows the axis. When you press the axis operation key, the robot will operate as follows.

For proceeding direction of the robot by the axis operation key, refer to the 2.10.1 JOG operation key.

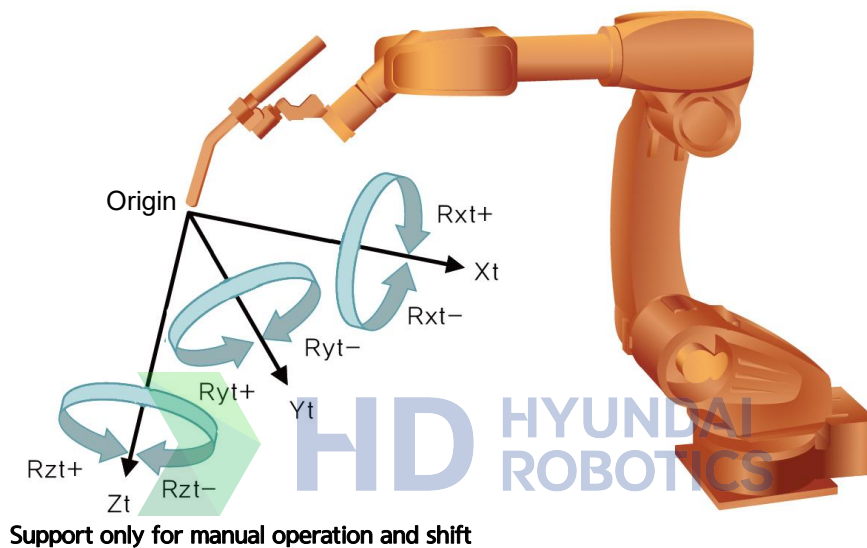


Figure 2.53 Tool coordinate system (for torch adhesion)

Following figure represents case that a torch is not adhered to Robot :

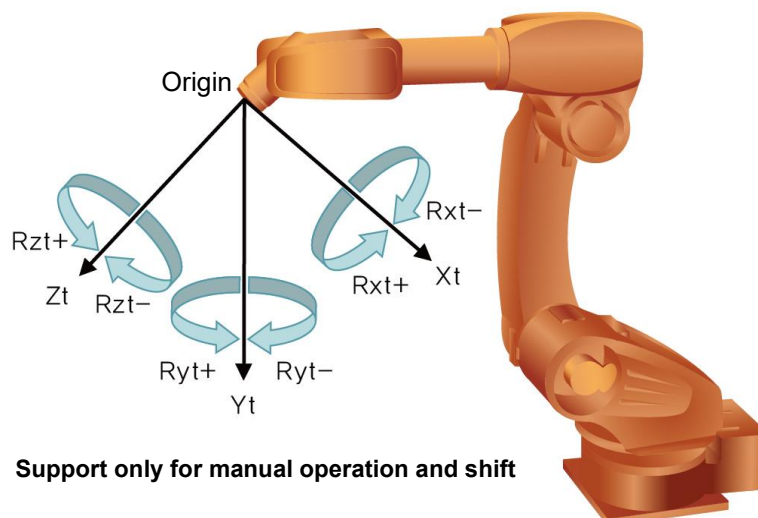


Figure 2.54 Tool coordinate system (without tool)

2.11. Axis origin and tool length optimization setting

This is the function to improve the accuracy of the linear interpolation trace and coordinate conversion by automatically setting the axis number and tool length.

This function can automatically set the distance to the tip of tool, which is difficult to measure in 3D.

Corrected parameters are the axis origins of H, V, R2, and B axes, as well as the tool length of the X, Y, and Z directions.

The 'axis origin and tool length' optimization and the 'tool length' optimization can be performed. Paying attention is required because the position of the existing program changes when the 'axis origin and tool length' optimization is performed if the robot program is already made.

- (1) Shift the [Mode] switch to a manual mode.
- (2) Press the both [SHIFT] key and the [PROG] key of teach pendant and select optional program.
- (3) Press the [MOTOR ON] button of the operation panel and check that the MOTOR ON lamp flickers.
- (4) Presses the [ENABLE] switch in the rear of teach pendant and then check Robot manually operates by the [axis operation] key.
- (5) Place optional pointed point within operation scope of Robot and correspond tool end of Robot.
- (6) Record step by pressing the [REC] key of teach pendant.
- (7) Change the robot's posture (Overall posture of the axis 6, if possible) in a wide scope by more than 30deg, then repeat and perform No. (5), (6) by more than 4 times.
- (8) Select 『F2』: System → 『6』: Auto calibration → 『1』: Optimize axis origin and tool length .
- (9) When you set a program number for auto calibration, tool number, and tolerance range of step position, press the "[F1] execution" key. The selected axis origin and tool length will be then set up.
- (10) When you use multiple tools, choose "tool length" from the "Optimization selection = **Tool length**, axis origin & tool length" on the screen. When the axis origin and the tool length are selected, the previously set tool information will not be matching.



Reference

- See the 『F2』: System → 『6』: Auto calibration → 『1』: Optimize axis origin and tool length .

2.12. Tool data automatic calibration

This is a method that determines new tool data during modification. Changes occur to the tool because of various factors after deciding on the axis origin and tool length using the auto calibration function. However, it is possible under the premise that the axis origin has to be determined and maintained. To use this function, you need to keep teaching a fixed reference point after determining the tool length and completing the angle correction. When a tool deformation occurs, locate in the same tool posture in the reference point that was specified before deformation. Then, run the auto correction of the tool data.

Following figure is displayed if accessing the 『F1』: Auto comp』 menu in the 『F2』: System』 → 『3: Robot parameter』 → 『1: Tool data』 setting screen. Moves to the changed tool end to the position by using the [Axis operation] key. Set 『F7』: Complete』 after confirming the program number, step number and tool number to be set, all of which are associated with the previously determined standard point.



Reference

- See the 『F2』: System』 → 『3: Robot parameter』 → 『1: Tool data』 .



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3

Program
preparation



3. Program preparation

3.1. Program Selection

- (1) If you press the 『[SHIFT] + [PROG]』 key when the robot is stopped, you will see the following screen.

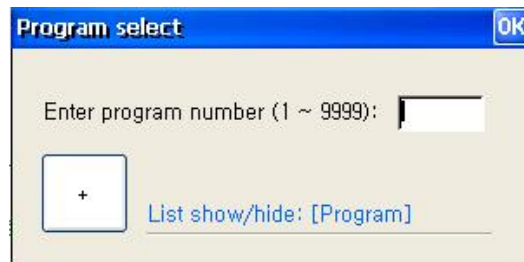


Figure 3.1 Program number entering window

- (2) If you cannot remember the program number in the above condition, select the List show/hide: [Program] or press the 『[SHIFT] + [PROG]』 key one more time, and the following screen will be displayed.

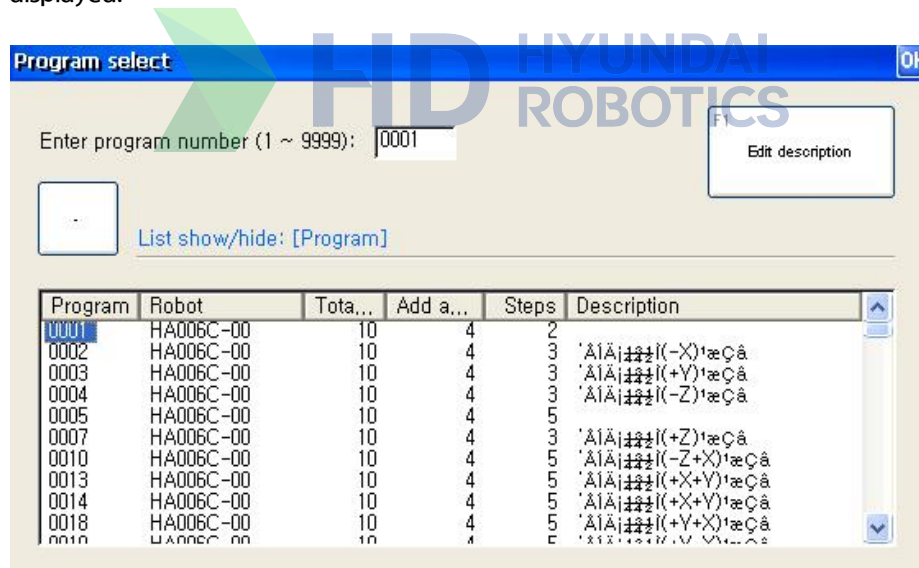


Figure 3.2 Program list show

You can check the detail content of the program already prepared from the above picture and make selections with the cursor. You can also edit the description of the program by pressing the [F1] key.

3.2. Program Deletion

There are two methods to delete the program. This can only be done after the robot is stopped.

- (1) Move the cursor to the applicable file location through 『F1]: Service』 → 『5: File manager』, and press 『F4]: Cut』 as shown in the following picture.

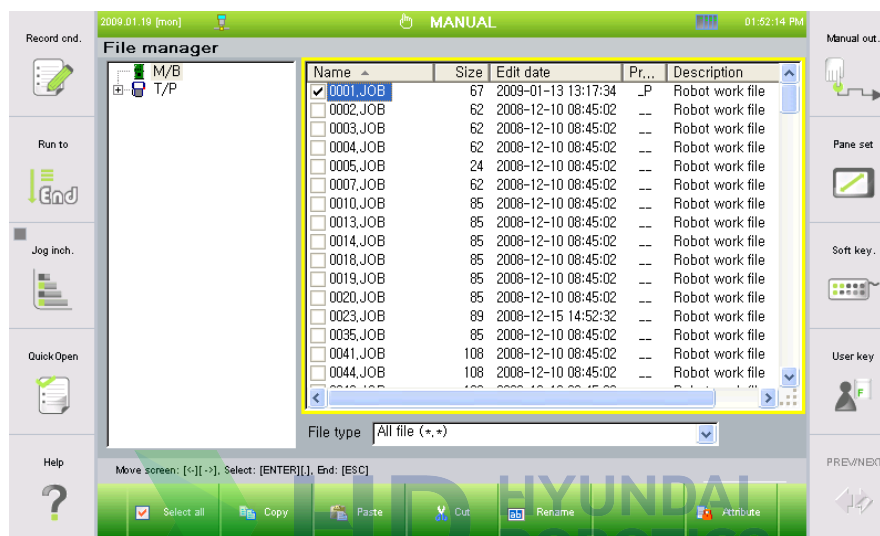


Figure 3.3 File manager

- (2) A work program can be also deleted using the R117 shorthand command of 『Chapter 8. R code』.

3.3. Program Preparation

Preparing a robot program is for the user to compose a program by using commands to move and work in a way to achieve a specific output from the robot.

Program preparation can be executed in the manual mode.

3.3.1. What is Command?

A general program consists of step commands to move the robot and function command to process an operation. These commands are composed of command and properties (additional option). Properties include mandatory base properties and optional properties.

(Basic Parameter)	(Selective Parameter)
MOVE L, P1, S=100%, A=0, T=0,	X1, X2, UNTIL DI4, V6% ‘

When you enter a command, the default values are saved in the base properties, which can be changed. Optional properties are displayed with 『_』 in work cursor, and when you move to this item, you will see the properties in the main frame that can be entered.

When editing the properties of the command, you can directly enter the changes using the [Number] key, you can select the parameter or function from the menu and enter the index (the content in the parenthesis of parameter or function) or you can edit by Character units using a Formula or Character entry.

3.3.2. Record condition

- (1) What is record condition?

This is the function to record the MOVE command in same format by pre-designating the format of MOVE command that is recorded when the [REC] key is pressed, and you can designate the interpolation type, moving speed and speed unit, ACC and tool number.

- (2) Edit record condition

When you press the [Record condition] key, you can edit the following record condition as shown in the following picture.

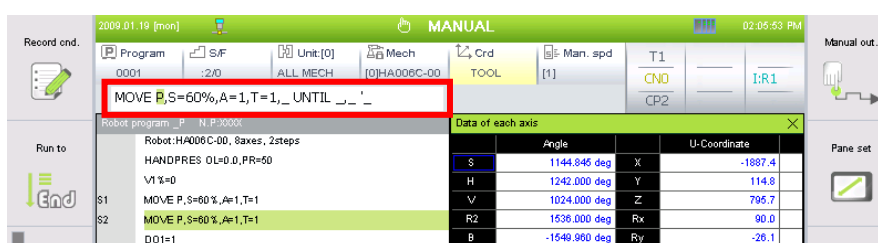


Figure 3.4 Record condition editing

3.3.3. Command Entry

- (1) Step command entry in hidden pose

If you move the robot with [Axis operation] key and press the [REC] key of teach pendant, the movement command to the current position will be recorded.

Differently from the way that the Move command is used as a method for using a command generally, the pose parameter is not shown in the step, which is why it is called hidden pose.

- (2) General command entry

- To enter the command, press the [F6: Command input] key from the initial screen in manual mode. If you press this key, you will see the following screen.



- Use the [F] key to enter the command in main frame. Please refer to 『Chapter 10. Robot language』 for details on menu composition and description of each command.

3.3.4. Command Composition

(1) Address area

The area where the line number (1 ~ 9999) or step number (S1 ~ S999) is displayed is called the address area.



Figure 3.5 Address area

(2) Command area

The area where the command line is displayed is called the command area. When one whole line is selected in this area it is called sentence cursor condition.



Figure 3.6 Command area

Use the [Direction] key to move between address area and command line area.

3.3.5. Command Edit

To edit a command, it must be in word cursor condition, which refers to the situation when the cursor is located in the property of the command as shown below. In word cursor condition, you can use the [Direction] keys to move the cursor to the property you want to edit. To switch from sentence cursor to word cursor, press the [ENTER] key.

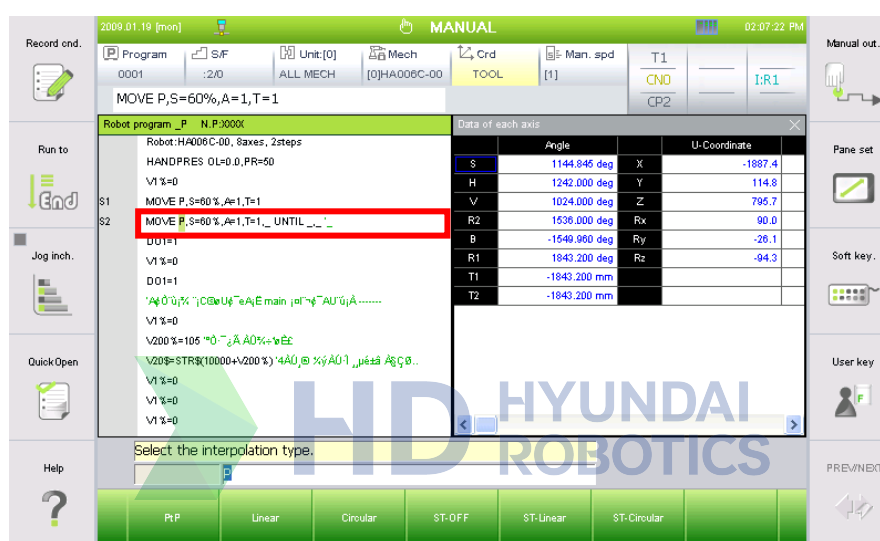


Figure 3.7 Command edit

Press the [ENTER] key to reflect the content in the input frame to the edit frame. To finish the property edit and return to the word cursor before [Command edit], press the [ENTER] key one more time.

As shown, command edit can be divided into command selection and property entry. And property entry can be divided into 3 parts.

- ① Numeric type
 - Numeric parameter (V%, V!, ...) and integer, real number, numeric function etc.
- ② Character type – Character constant, Character parameter, Character function etc.
- ③ Pose type – Pose constant, pose parameter, shift parameter etc.

3.3.6. Summary of Operation Key

Table 3-1 Summary of operation key

Operation key	Address area	Command area	
		Sentence cursor	Word cursor
[SHIFT]+ [POS. MOD]	Current step position edit (Hidden pose correction)	Same as address area	-
[ESC]	Moves the cursor to command area and changes content of menu frame	-	Cancels the entered value in input frame, shifts to sentence cursor and changes the content of menu frame
[REC]	Hidden pose move Add command	Same as address area	-
[SHIFT]+[DEL]	-	Delete selected command	-
[ENTER]	Reflects the line number entered in input frame to address area	Shifts to word cursor	Reflects property value entered in input frame to cursor location or shifts to sentence cursor when data setting is completed
[SPEED]	Increase/decrease speed level in title frame, changes the step record speed in edit frame	Same as address area	Same as address area
[F2] in initial screen	Shows [Block edit] and enables block editing	Shows [System] and enables various system parameter settings	Varies by command and property
[Direction][↑][↓]	Moves the cursor up and down	Same as address area	Same as address area
[Direction][←]	Moves the cursor to command area	Moves the cursor to address area	Moves the word cursor to the left property
[Direction][→]	Moves the cursor to command area	Moves the cursor to address area	Moves the word cursor to the right property
[SHIFT]+[↑][↓]	Page Up/Down	Same as address area	-
[SHIFT]+[←][→]	Moves the cursor left/right in input frame	-	Moves the cursor left/right in input frame and moves the cursor by 5 Characters in Character input condition

3. Program preparation

Operation key	Address area	Command area	
		Sentence cursor	Word cursor
[←]	First, it deletes the input frame address and during data entry, it deletes the number left to the cursor	-	First, it deletes the content in the input frame and during data entry, it deletes the number left to the cursor
[SHIFT]+[PROG]	Receives the program number and loads the applicable program	Same as address area	Same as address area
[STEP]	Receives the step number, moves to the directed step	Same as address area	Same as address area
[?] HELP	Shows help screen of each command	Same as address area	Same as address area
[QuickOpen]	Shows you content or condition screen of each status	Same as address area	-

3.4. Parameter, Formula and Character Edit

This explains how to edit parameter, Formula or Character during command property editing process.

3.4.1. Parameter Edit

- (1) We will use speed entry screen as an example. To edit the speed with parameter,
- (2) Press the 『F6』: Variable』 key and move to parameter entry condition.
- (3) Select V parameter by pressing 『F1』: V』 key.
- (4) Select the parameter type by pressing 『F3』: V%[]』 key.
- (5) If you select a parameter type with scripts, the cursor is located to the script entry position Use the [Number] key to enter the script in the input frame and the script will be added right before the cursor.
- (6) Press the 『F6』: Variable.』 → 『F1』: V』 → 『F1』: V%』 key and select the parameter with script again.
- (7) Enter the number 2 using the [Number] key and press the [ENTER] key to reflect it to the edit frame.

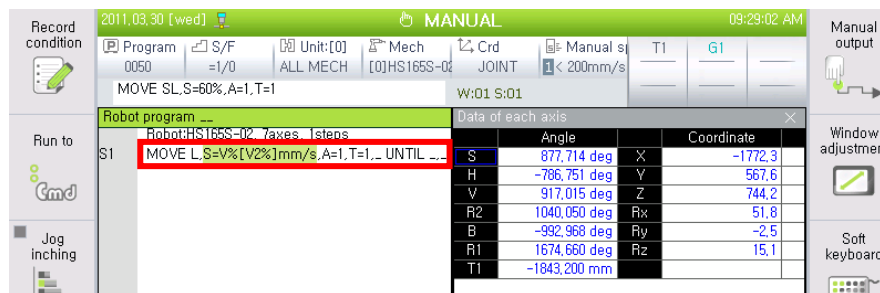


Figure 3.8 Parameter edit

- (8) Press the [ENTER] key one more time to return to sentence cursor.

3.4.2. Formula and Character Edit

- (1) We will use speed entry screen as an example. Assuming that the current speed is “V%[V2%]mm/sec”, to edit the speed using the Formula.
- (2) Press the [Soft keyboard] on the right side of TP to activate the soft keyboard.

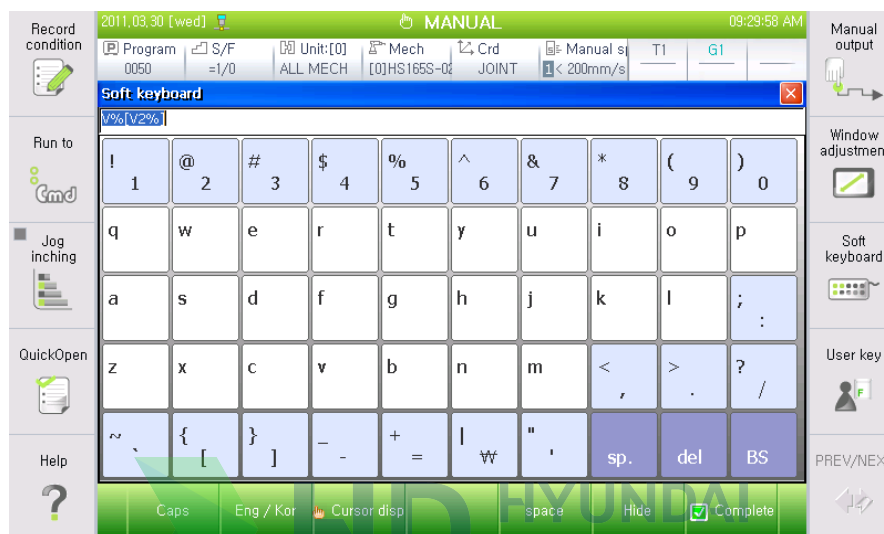


Figure 3.9 Soft keyboard

- (3) The reason the current value is highlighted in the input frame is because it is in a condition to ignore the existing data and enter new data. If you want to add value after the current input value, press the direction key to change the cursor location.
- (4) When you enter 1000 and select “/” with the arrow key or touch and enter 60, and then press the 『[F7]: Complete』, the following screen will be displayed.
- (5) Press the [ENTER] key to reflect the content in input frame to the edit frame.

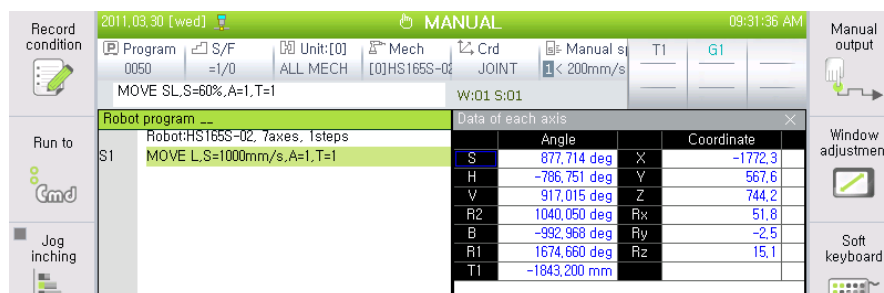


Figure 3.10 Reflected into the editing

- (6) Press the [ENTER] key one more time to change to new command and return to sentence cursor.

3.5. Line Number Edit

Line number can be set from 1 ~ 9999. You can enter the line number by using the [Number] key in address area and press the [ENTER] key when done.

- (1) First, move the cursor to the address area and you will see the following screen.

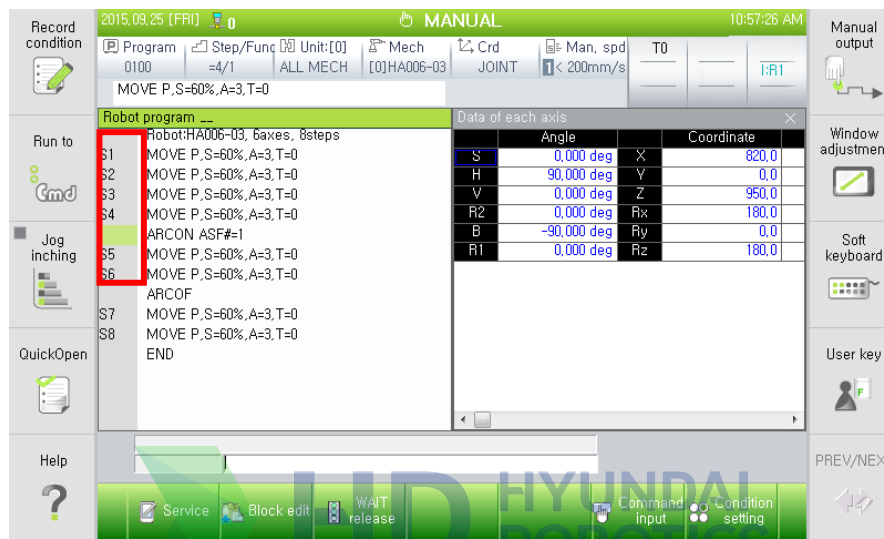


Figure 3.11 Line number edit 1

- (2) Use the [Number] key to enter the number 10 and press the [ENTER] key.



Figure 3.12 Line number edit 2

- (3) The line number will be reflected in the edit frame.

3.6. Block Edit

This copies a block of the program and enables the user to copy, cut or delete the block. The number of the control line including the step number is automatically changed after copying.

- (1) To copy/cut/delete in line units, move the cursor to the address area press the 『F2]: block edit』 key. This will highlight all address and command area. Use the [Direction] key to move the cursor to the starting line of the block selection.

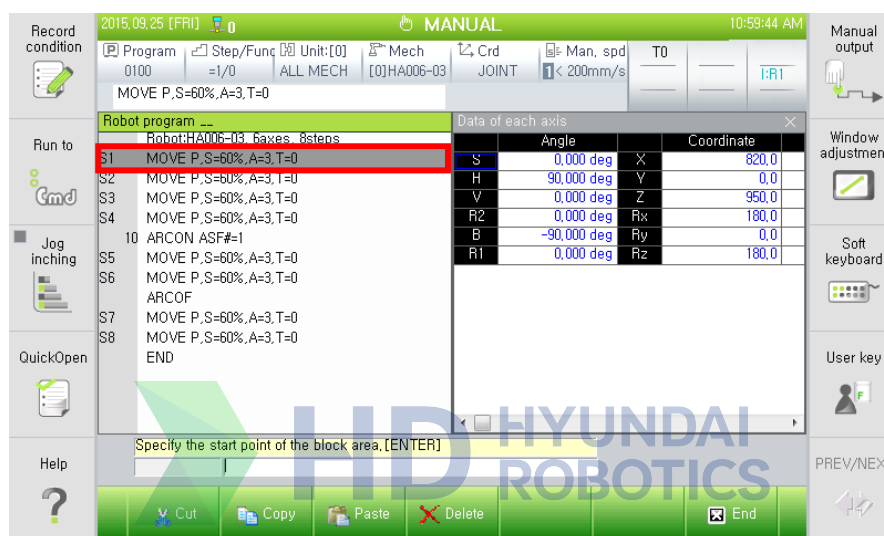


Figure 3.13 Block edit 1

- (2) Press the 『ENTER』 key at the starting line of the block to select. Move to the last line of the block to select using the [Direction] key. You will see the highlighted block as shown in the following screen.

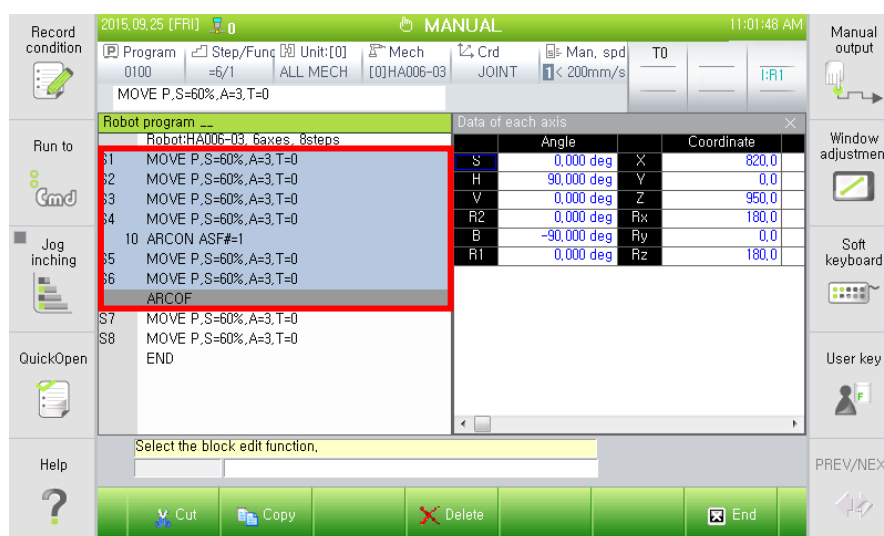


Figure 3.14 Block edit 2

- (3) Move to the selected area and press the 『F2]: Copy』 key to save the selected block to the clipboard and then the following 『F3]: Paste』 menu will be displayed. Use the [Arrow] key to move the cursor to the previous row (S4 row) before the row to copy, and press 『F3]: Paste』 to copy the saved block from the clipboard as follows.

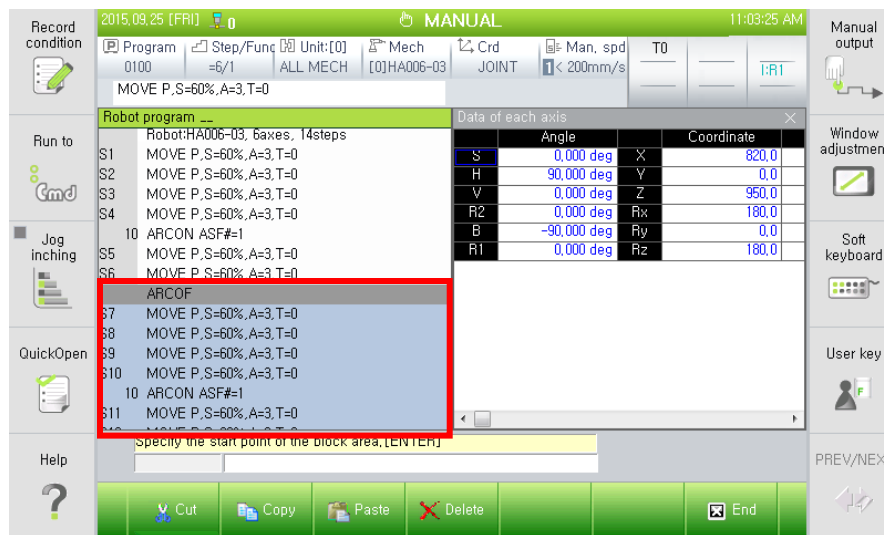


Figure 3.15 Block edit 3

- (4) If you use the 『F5]: Auto comment』 key, you can enter or delete an annotation of an imperative sentence based on the argument of each statement in the selected range. For more information about automatic annotation input, see first the “4.7.8. Command statement comment.”

(This feature is available from the Hi5a V40.06-00 and later versions)

- In the state in which a block is selected when you press the 『F5]: Auto comment』 key, the command statement comment is automatically entered. It applies to the following: pose-expression-MOVE statement, assignment statement, WAIT statement, IF statement, SELECT statement, and SPOT statement.
- If there is an existing command statement comment, it is treated with overwriting.
- If the block contains a SPOT statement, you first need to select the starting number of the SPOT serial number as shown in the figure.
- The prefix of a SPOT serial number is applied as the setting of a command statement comment screen.

3. Program preparation

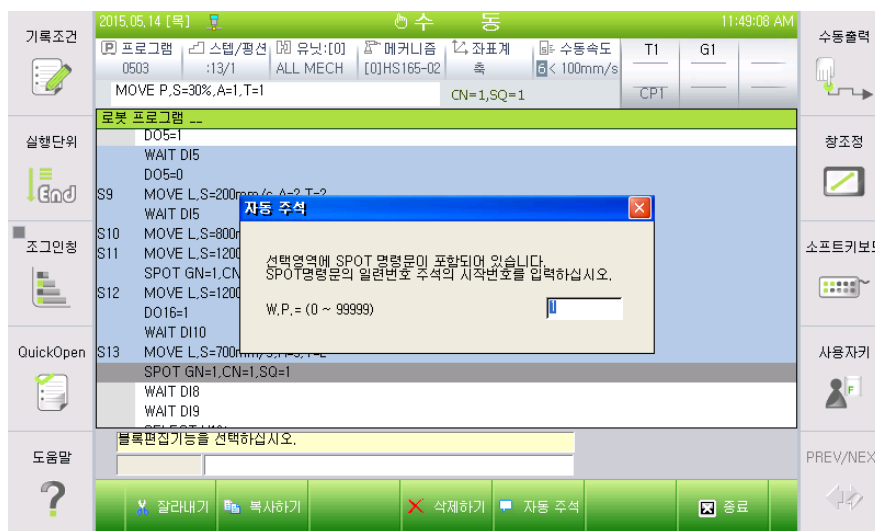


Figure 3.16 Block edit 4

When you press the 『F5]: Auto comment』 key with the [SHIFT] key, it will delete all the comments in the selected range. (However, it does not delete comments such as REM.)







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4

Service



4. Service

Hi5a-S/N/P/C/T/J

Controller Operation Manual

4.1. Initial Service Screen

On the initial service screen, various convenience items, such as Monitoring, Variable, and File Manager, can be set as desired.

When 『[F1]: Service』 key is pressed on the initial screen of either manual or auto mode, the following screen appears.



Figure 4.1 Initial service screen



Reference

- How to select submenus
 - (1) When a submenu needs to be selected, move the reverse bar to the desired item by using the [Direction] key, and then press the [Enter] key.
 - (2) Enter the number of the desired item into the input text box by using the [Number] key and then press the [Enter] key.
 - (3) Touch the desired item on the touch screen directly.

The following services will be provided for individual items.

- (1) Monitoring: Checks the states of various inputs, outputs, and applications
- (2) Register: Sets the shift and count register
- (3) Variable: Checks and sets various variables
- (4) Data comment: Sets notes for the input/output signals and variables
- (5) File manager: Manages files in the main board, teach pendant, and USB memory (Move, copy, and delete)
- (6) Program conversion: Converts the conditions and positions of prepared individual programs in a batch process or individually
- (7) System diagnosis: Upgrades the system version and checks the state of the robot and controller
- (8) Date and time setting: Sets the date and time of the teach pendant
- (9) Application program end: Ends the programs of the teach pendant
- (10) Applet: Sets various applets and their usage
- (11) Teach pendant option: Sets the sound effects, screen protection, and auto restart duration
- (12) Teach pendant sharing: Sets the teach pendant sharing function
- (13) Previous screen record: Checks the renewal state of input and output signals

In Chapter 4, the details on the services described above will be explained.



4.2. Monitoring

This function displays the condition of various data inside the controller.

On the initial screen, enter 『[F1]: Service』 → 『1: Monitoring』 to display the following submenus.

The items that can be monitored will vary depending on the controller setting. The following figure displays all items that can be monitored.

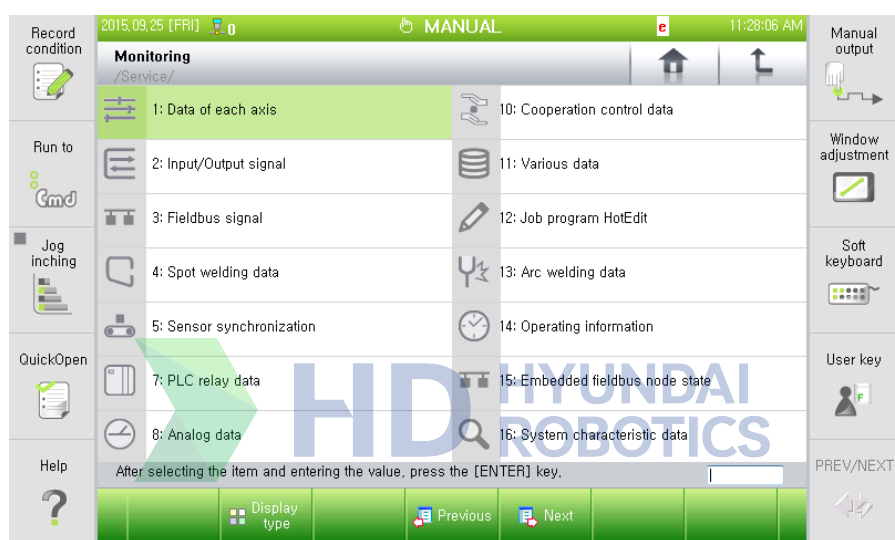


Figure 4.2 Monitoring Items 1

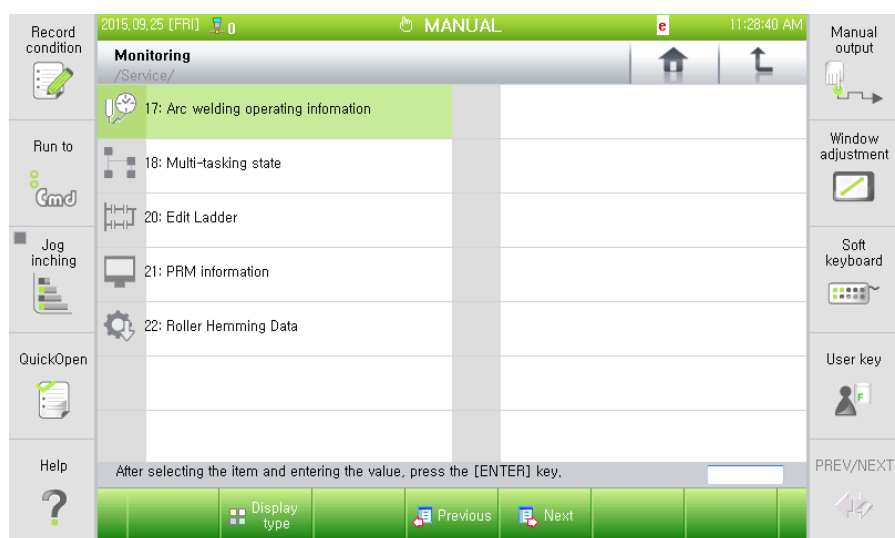


Figure 4.3 Monitoring Items 2



Reference

- For more details, refer to “2.2.2.3 Window control function” section of the Hi5 operations manual for window (TP screen) split function.

The following shows the items that can be monitored depending on the controller setting.

(1) Data of each axis:	All settings
(2) Input/output signal:	All settings
(3) Field bus signal:	All settings
(4) Spot welding data:	Valid spot welding setting
(5) Sensor synchronization:	Conveyor / press setting
(6) PLC relay data:	All settings
(7) Analog data:	All settings
(8) Cooperation control data:	Valid cooperation control setting
(9) Various data:	All settings
(10) Work program data Hot Edit:	All settings
(11) Arc welding data:	Arc welding valid setting
(12) Operating information:	All settings
(13) Embedded field bus node state:	All settings
(14) System property data:	Engineer mode
(15) Arc welding operating data:	Valid arc welding setting
(16) Multi-tasking state:	All settings
(17) Servo tool change:	Valid servo tool change setting
(18) Ladder edit:	All settings
(19) Roller hemming data:	Valid roller hemming squeeze control setting
(20) Force sensor:	Valid force control setting
(21) Playback speed automatic adjustment state:	Enables automatic adjustment of the playback speed

Controller Operation Manual

4.2.1. Data of each axis

“Data of each axis” displays the current angles of the robot’s individual axes, the coordinate value of TCP, the encoder’s current and command values.

Can be set by selecting 『F1]: Service』 → 『1: Monitoring』 → 『1: Data of each axis』.

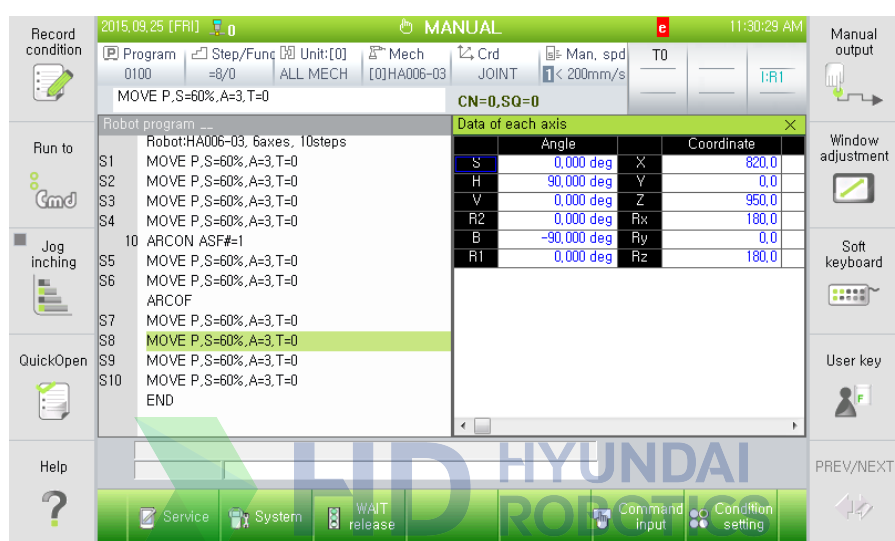


Figure 4.4 Monitoring the data of each axis

4.2.2. Input/Output Signal

“Input/Output Signal” checks the state of the private and public input/output signals and the state of the extension brake input/output signals. In addition, it shows the names of the input/output signals.

Selection 『[F1]: Service』 → 『1: Monitoring』 → 『2: Input/Output signal』 and choose an item to be monitored.

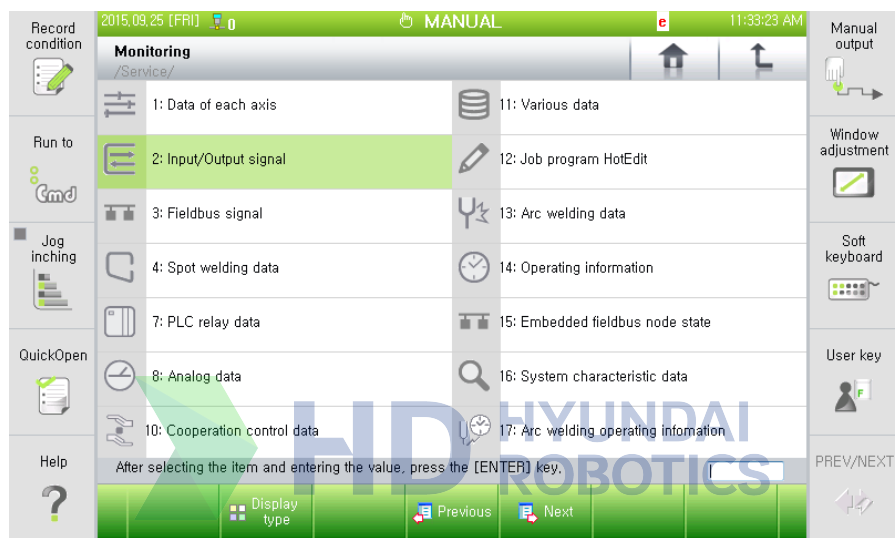


Figure 4.5 Selection of input and output signals

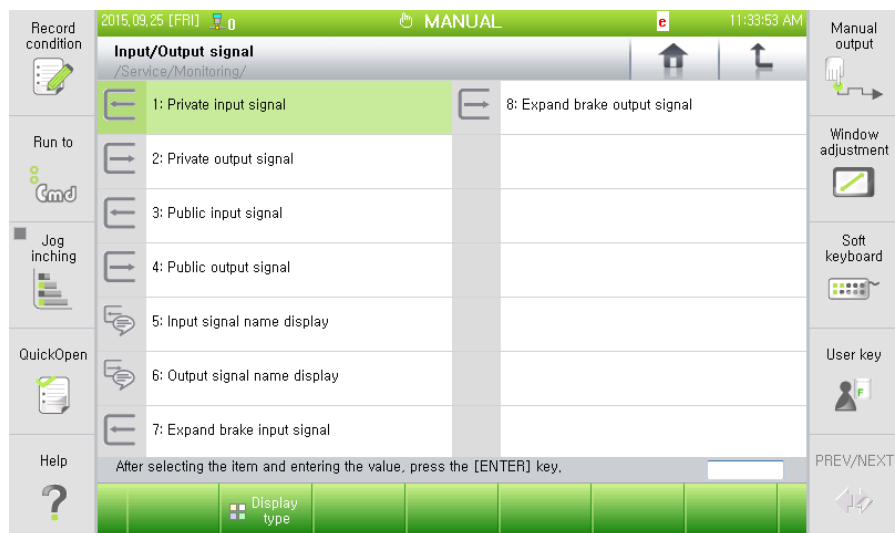


Figure 4.6 Selection of details of input and output signals

Controller Operation Manual

4.2.2.1. Private input signal

“Private input signal” displays the state of the pre-assigned signals in order to detect any abnormalities with the signals related to the robot operation and with the controller and the robot. The current private input signals will be highlighted in yellow (Ex.: Mode switch (Manual)).

Can be set by selecting 『[F1]: Service』 → 『1: Monitoring』 → 『2: Input/Output signal』 → 『1: Private input signal』.

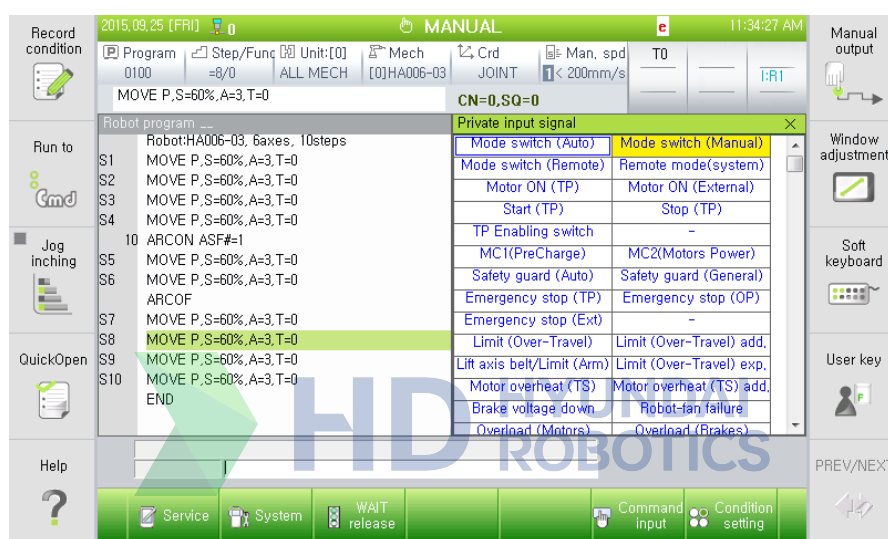


Figure 4.7 Private input signal

4.2.2.2. Private output signal

“Private output signal” displays the state of the signals as well as the brake control state related to the robot operation. The current private output signals will be highlighted in yellow (Ex.: Stop (TP)).

Selection 『[F1]: Service』 → 『1: Monitoring』 → 『2: Input/Output signal』 → 『2: Private output signal』.

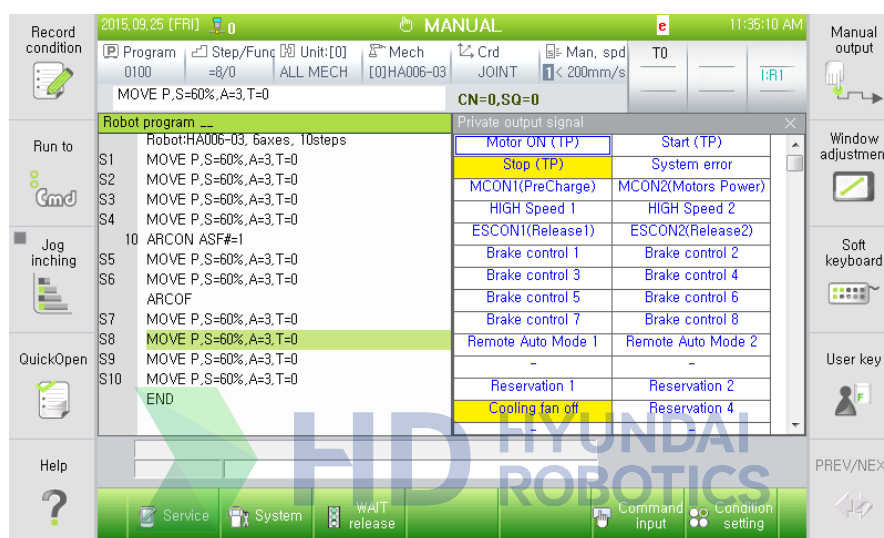


Figure 4.8 Private output signal

Controller Operation Manual

4.2.2.3. Public input signal

This displays the state of the public input signals. Generally speaking, the public input signals are the signals that are inputted through the CNIN connector of the I/O board in the controller. However, if signals, such as the field bus signals, are put through the mapping process by using the embedded PLC, the on/off state of the input and output signals may appear different.

Can be enter by selecting 『F1』: Service』 → 『1: Monitoring』 → 『2: Input/Output signal』 → 『3: Public input signal』 .

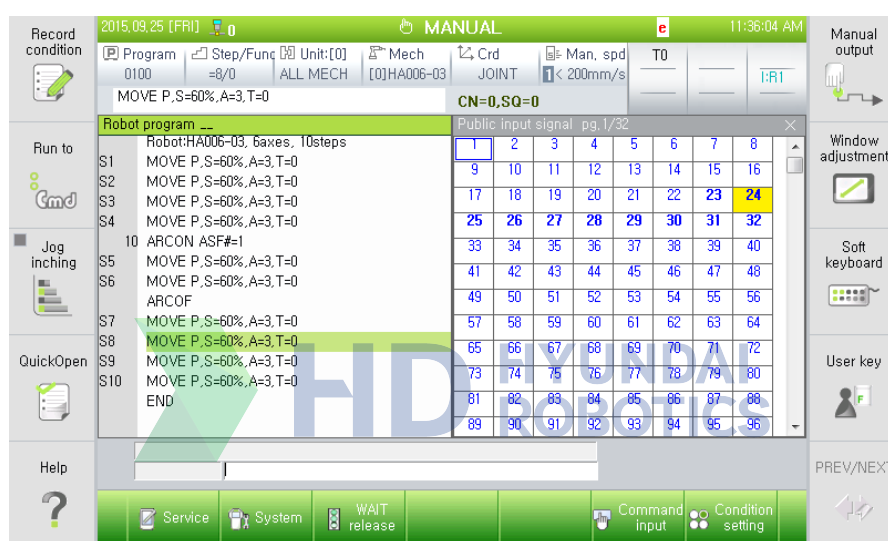


Figure 4.9 Public input signal



Reference

- The public input signals that are based on the system's basic specifications or assigned by the user will be displayed in bold characters. The current input signals will be highlighted in yellow.
 - Appearance if not assigned: 24
 - Appearance if assigned: **24 (Signal input)**, 24 (No signal input)
- In normal conditions, the input logic value after the positive/negative logic property stage is displayed. While the 『F2: Physical value』 key is being pressed, the input physical value before the positive/negative logic property stage will be displayed.

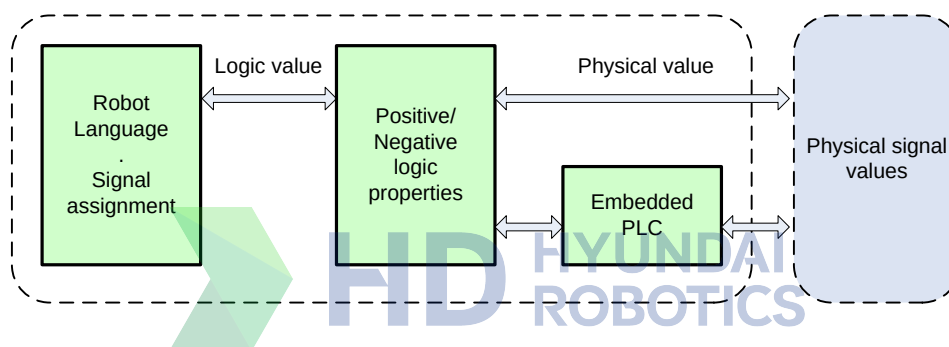


Figure 4.10 Input signal flow diagram

- The number of public input signals that can be monitored is 4096 and 128 signals can be monitored on each page. Next to the monitoring window, the page that is being checked currently and the total page number will be displayed (Ex.: pg.1/32).

In order to check the previous or next page, press the 『F6: Previous』 or 『F7: Next』 button.

In order to find the desired signal directly, press 『F4: Find』 and then enter the number of the desired signal. Then, you can move to the desired page to check the signal.

Controller Operation Manual

4.2.2.4. Public output signal

This displays the state of the public output signals. Generally speaking, the public output signals are the signals that are outputted through the CNOUT connector of the I/O board in the controller. However, if signals, such as the field bus signals, are put through the mapping process by using the embedded PLC, the on/off state of the input and output signals may appear different.

Selection 『[F1]: Service』 → 『1: Monitoring』 → 『2: Input/Output signal』 → 『4: Public output signal』.

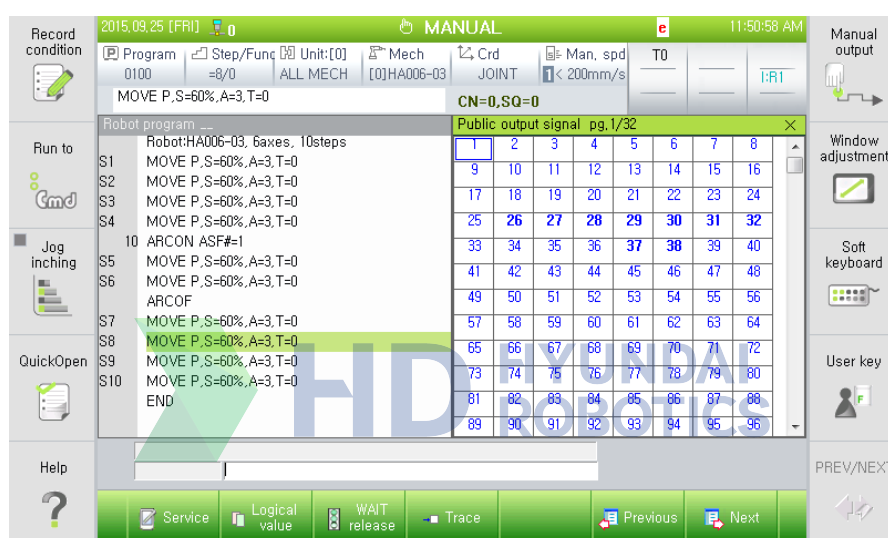


Figure 4.11 Public output signal



Reference

- The public output signals that are based on the system's basic specifications or assigned by the user will be displayed in bold characters. The current output signals will be highlighted in yellow.
 - Appearance if not assigned: 26
 - Appearance if assigned: **26 (Signal output)**, **26 (No signal output)**
- In normal conditions, the output logic value after the positive/negative logic property stage is displayed. While the 『F2』: Physical value』 key is being pressed, the output logic value before the positive/negative logic property stage will be displayed.

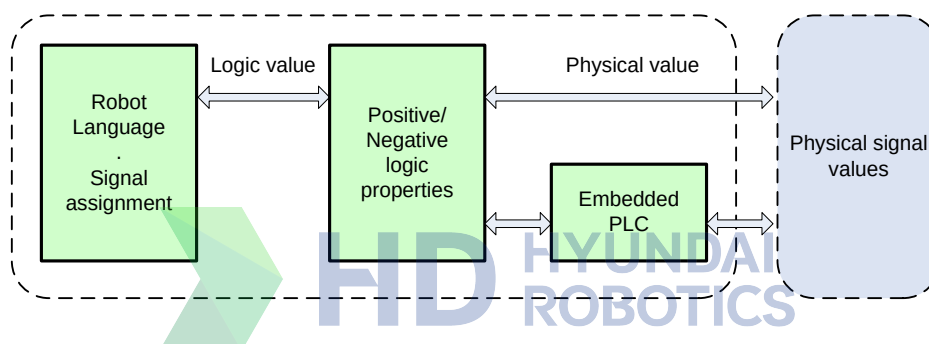


Figure 4.12 Output signal flow diagram

- The number of public output signals that can be monitored is 4096 and 128 signals can be monitored on each page. Next to the monitoring window, the page that is being checked currently and the total page number will be displayed (Ex: pg.1/32).

In order to check the previous or next page, press the 『F6』: Previous』 or 『F7』: Next』 button.

In order to find the desired signal directly, press 『F4』: Find』 and then enter the number of the desired signal. Then, you can move to the desired page to check the signal.

This is used to check the names of the input and output signals and their states.

The screenshot shows the HYUNDAI ROBO-MASTER manual control interface. At the top, the date and time are 2015.09.25 [FRI], and the mode is MANUAL. The left sidebar contains icons for Record condition, Run to, Jog inching, QuickOpen, and Help. The main window displays a robot program for Robot:HA006-03, axes 10steps. The program steps are S1 through S10, with S8 highlighted. A right-hand panel shows input signal names D124 (External Stop) and D1256 (Auto Mode). The bottom status bar includes Service, System, WAIT release, Command Input, Condition setting, and navigation arrows.

Figure 4.13 Input signal name display



- The input/output signal names displayed on the monitoring window are the names recorded through 『F2: System』 → 『2: Control parameter』 → 『2: Input signal setting』 → 『1: Input signal properties』 / 『2: Output signal properties』

4.2.3. Field bus signal

“Field bus signal” displays the state of the I/O signals (FB1, 3) of the field bus channels 1 and 3 of BD52X and also of the signals (FB5) of Device Net Slave and CC-Link.

Can be entered by selecting 『[F1]: Service』 → 『1: Monitoring』 → 『3: Field bus signal』.



Figure 4.14 Field bus signal details

4.2.3.1. FB1/3 Field bus input/output

This displays the state of the I/O signals of the field bus channels 1 and 3 of BD52X.

Select 『[F1]: Service』 → 『1: Monitoring』 → 『3: Field bus signal』 → 『1/2: FB1 Field bus input/output』 / 『5/6: FB3 field bus input/output』 .



Figure 4.15 FB1 field bus input signal monitoring

4.2.3.2. FB5 field bus input/output

This displays the I/O signals of the embedded DeviceNet slave and CC-Link.

Select 『[F1]: Service』 → 『1: Monitoring』 → 『3: Field bus signal』 → 『9/10: FB5 Field bus input/output』 .

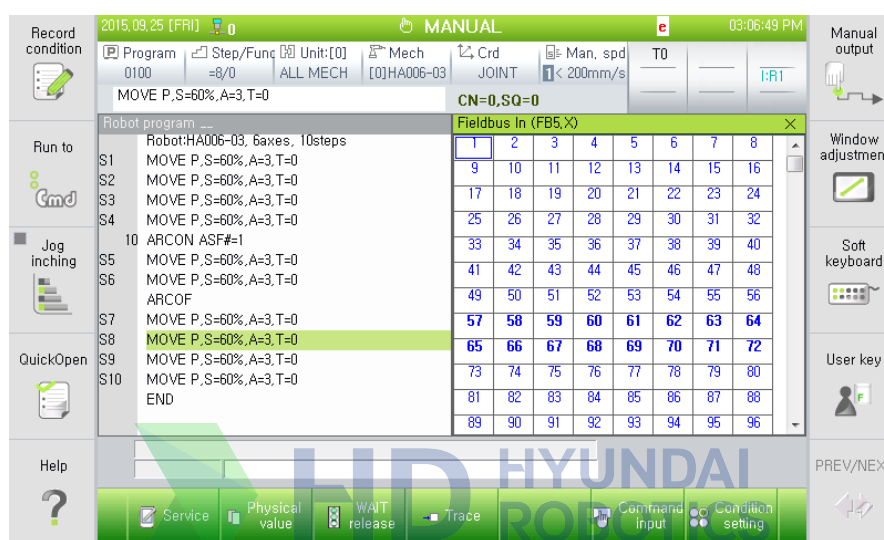


Figure 4.16 FB5 field bus input signal monitoring

4.2.4. Spot welding data

This displays the spot gun axis data, the input/output signals and operating information of spot welding.

Selection 『[F1]: Service』 → 『1: Monitoring』 → 『4: Spot welding data』 .

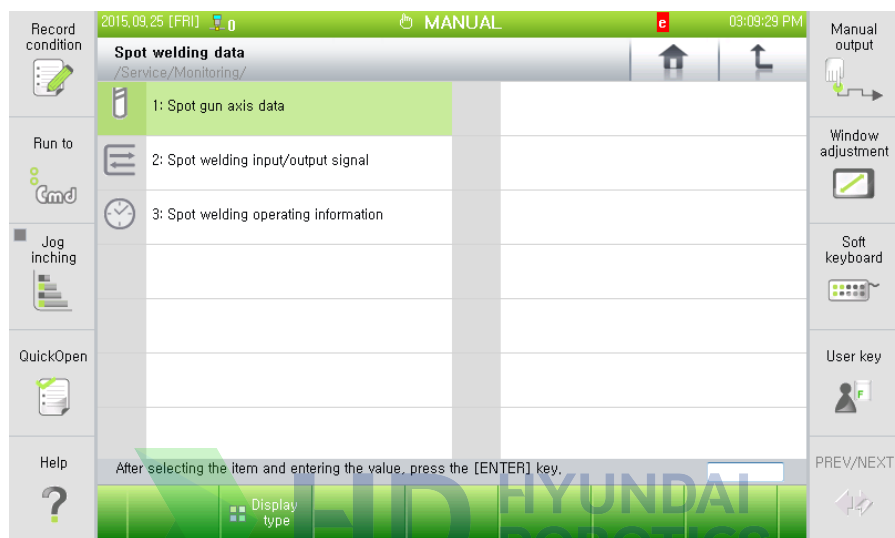


Figure 4.17 Spot welding data details

4.2.4.1. Spot gun axis data

This displays the current while using the servo gun, the squeeze data and the actual squeeze data applied in welding, and the distance and consumption of the moving and fixed tips. For more details, refer to 『Spot Welding Function Manual』.

Can be entered by selecting 『[F1]: Service』 → 『1: Monitoring』 → 『4: Spot welding data』 → 『1: Spot gun axis data』 in the initial screen of manual or auto mode.

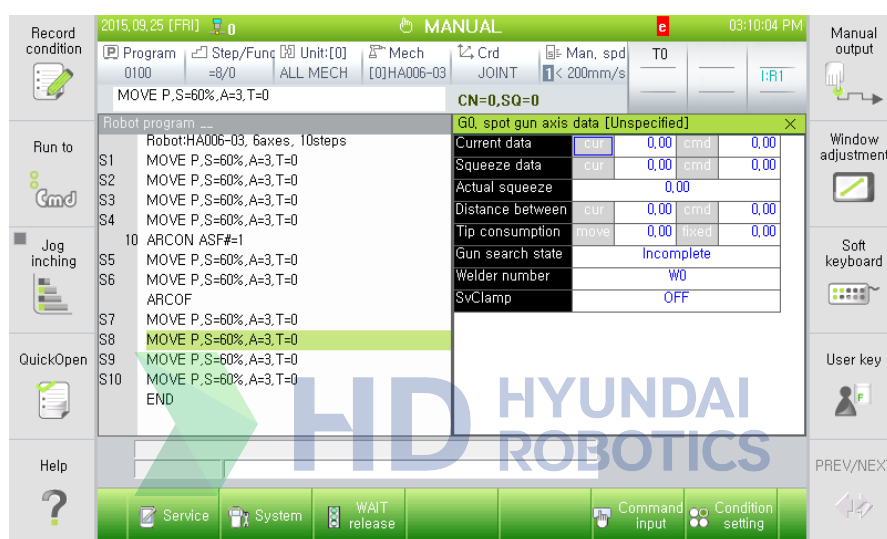


Figure 4.18 Spot gun axis data

Controller Operation Manual

4.2.4.2. Spot welding input/output signal

This displays the state of the input and output signals that are in communication with the welder while the spot welding gun is in use. For more details, refer to 『Spot Welding Function Manual』.

Can be checked by selecting 『F1]: Service』 → 『1: Monitoring』 → 『4: Spot welding data』 → 『2: Spot welding input and output signals』.



Figure 4.19 Spot welding input and output signals

4.2.4.3. Spot welding operating information

This displays the time and count of welding when using the spot welding gun.

Can be checked by selecting 『F1』: Service』 → 『1: Monitoring』 → 『4: Spot welding data』 → 『3: Spot welding operating information』 .

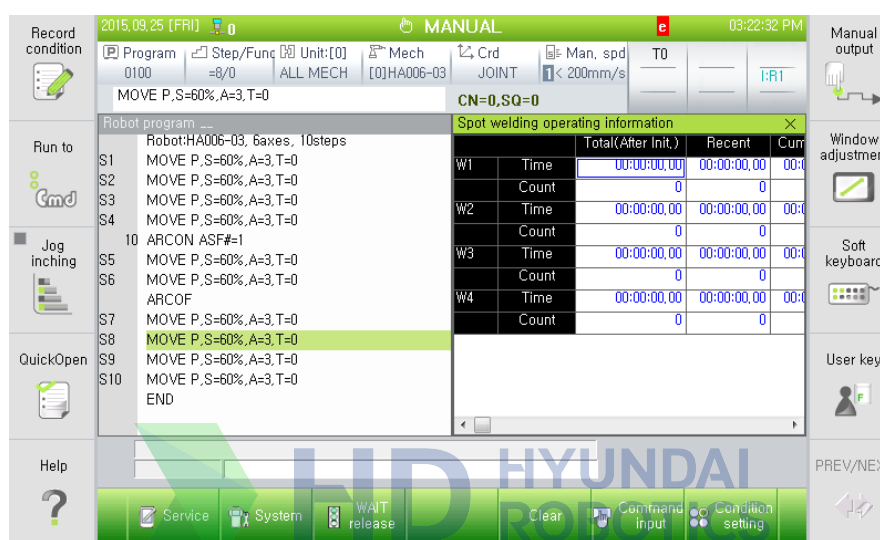


Figure 4.20 Spot welding operating information

- Spot welding operating information clear

This supports initialization of the spot welding operating information displayed on the monitoring screen. In order to clear the operation information, select the [Spot welding operating information] monitoring window and activate it. Then, 『F5』: Clear』 will be displayed, and then pressing the relevant key will bring up the following dialog box. Select one of the buttons of the displayed dialog box to initialize the desired item.

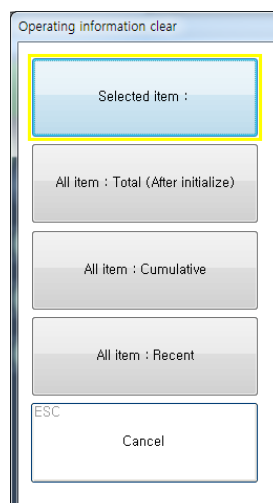


Figure 4.21 Spot welding operating information clear

4.2.5. Sensor synchronization

This displays various information related to the conveyor/press synchronization.

In order to display the relevant item, select 『[F1]: Service』 → 『1: Monitoring』 → 『5: Sensor synchronization』.

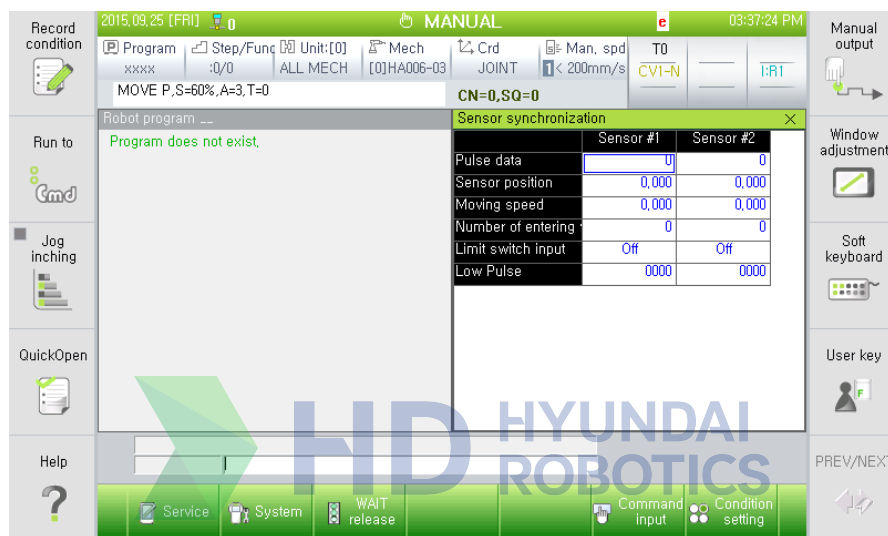


Figure 4.22 Sensor synchronization monitoring



Reference

- For the sensor synchronization, the sensor synchronization function of 『[F2]: System』 → 『4: Application parameter』 → 『4: Sensor synchronization』 → 『1: Whether to use the function』 → “1st sensor” or “2nd sensor” must be set to <Conveyor> or <Press>.
- For more details, refer to 『Sensor Synchronization Function Manual』

4.2.6. PLC relay data

“PLC relay data” displays the state of the various relay contacts of the embedded PLC.

To use the function, select 『F1』: Service』 → 『1: Monitoring』 → 『7: PLC relay data』 .

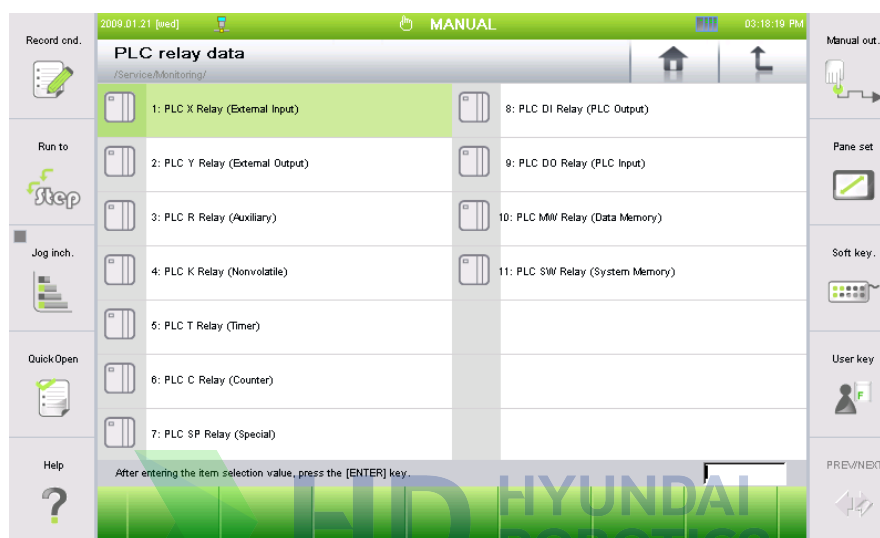


Figure 4.23 PLC relay data details

Controller Operation Manual

4.2.6.1. PLC X Relay (External Input)

This displays the state of the signals inputted through the standard/extension IO board and the state of the input signals of DeviceNet master.

On the manual or auto mode initial screen, select 『F1]: Service』 → 『1: Monitoring』 → 『7: PLC relay data』 → 『1: PLC X Relay (external input)』.



Figure 4.24 PLC X Relay (External Input)



Reference

- Pressing the 『F1]: Node state』 button allows verification of the activation status of the embedded field bus of the selected node number (Green background: Activated. Red background: Not activated).
- When the 『F2]: Physical value』 button is pressed, the physical input/output state before the logic of the relevant signal is actualized will be displayed. For example, when the signal FN1.5 is negative logic and the actual signal is not actually inputted, the basic monitoring screen will display that the value of the relevant signal is being inputted. However, if the [F2: Physical value] button is pressed, a no-input state will be displayed because no signal is actually inputted.
- Pressing the 『F3]: X/Y』 button will allow verification of the current input and output of the current node while modifying them.
- Pressing the 『F4]: Find』 button will bring up a dialog box that will allow a search for the page where signals exist. Enter the desired signal into the dialog box. For example, in order to find the FN20.3 signal, you just need to enter “20.3”
- Every time the 『F5]: Display type』 button is pressed, the displayed data format will change as the following.
Byte type (XB) → word type (XW) → long type (XL) → byte type (XB)
- Pressing the 『F6]: Prev FN』 / 『F7]: Next FN』 button will allow movement to the next node that is currently connected.

4.2.6.2. PLC Y Relay (External Output)

This displays the state of the signals outputted through the standard/extension IO board and the state of the embedded DeviceNet master output signals.

In manual or auto mode initial screen, select 『[F1]: Service』 → 『1: Monitoring』 → 『7: PLC relay data』 → 『2: PLC Y Relay (External output)』

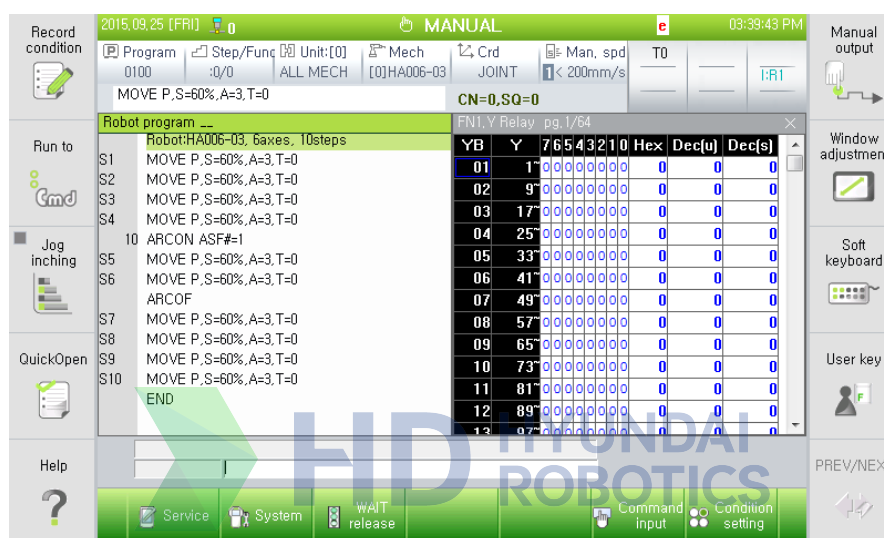


Figure 4.25 PLC Y Relay (External Output)

The explanation of the F menu at the bottom is the same as the details of [PLC X Relay (External input)].

Controller Operation Manual

4.2.6.3. PLC R Relay (Auxiliary)

PLC R Relay (Auxiliary) indicates the state of auxiliary relay used for PLC program.

Can be used by selecting 『F1]: Service』 → 『1: Monitoring』 → 『7: PLC relay data』 → 『3. PLC R Relay (Auxiliary)』.

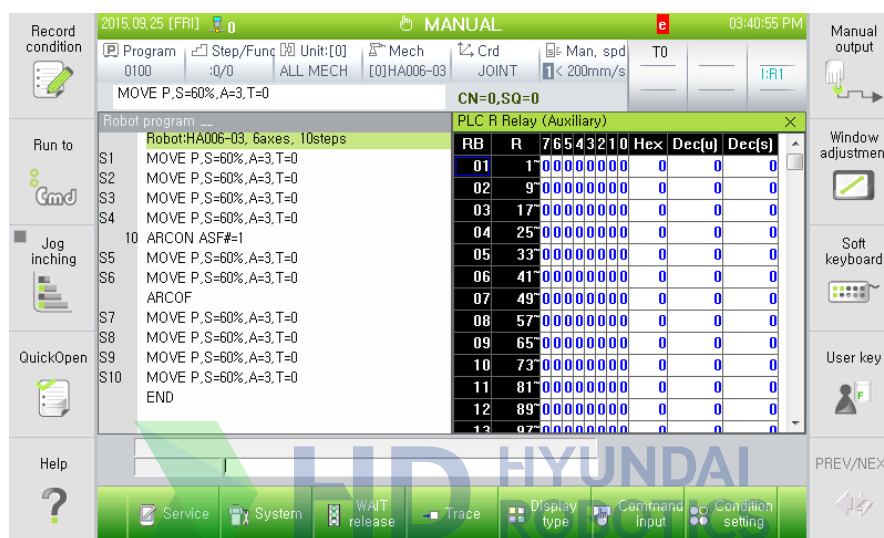


Figure 4.26 PLC R Relay (Auxiliary)

The explanation of the F menu at the bottom is the same as the details of [PLC X Relay (External input)].

4.2.6.4. PLC K Relay (Nonvolatile)

PLC K Relay (Nonvolatile) indicates ON/OFF state is kept while power is off.

Can be used by selecting 『F1: Service』 → 『1: Monitoring』 → 『7: PLC relay data』 → 『4. PLC K Relay (Nonvolatile)』.

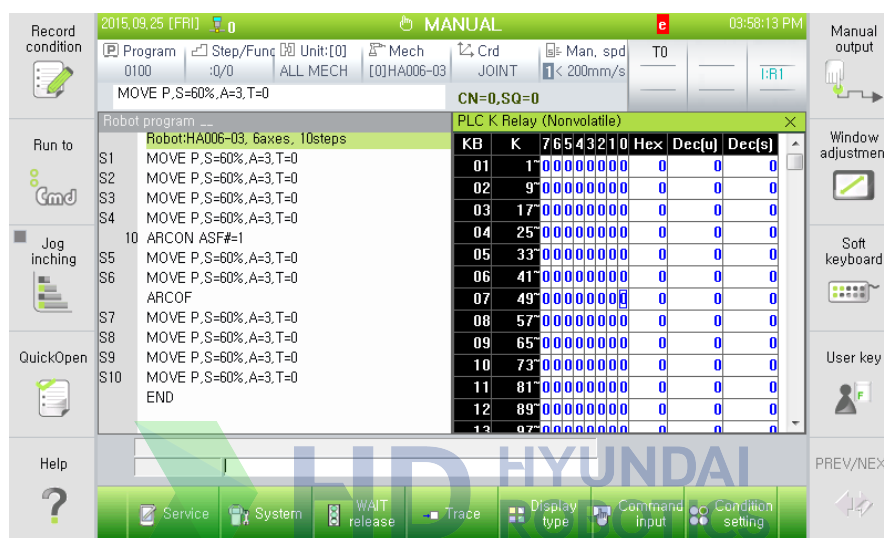


Figure 4.27 PLC K Relay (Nonvolatile)

Controller Operation Manual

4.2.6.5. PLC T Relay (Timer)

PLC T Relay is for timer function. When the value is 0, contact point is ON. Even in case of electricity failure, the value of PLC T Relay (Timer) is maintained.

Can be used by selecting 『[F1]: Service』 → 『1: Monitoring』 → 『7: PLC relay data』 → 『5: PLC T Relay (Timer)』.

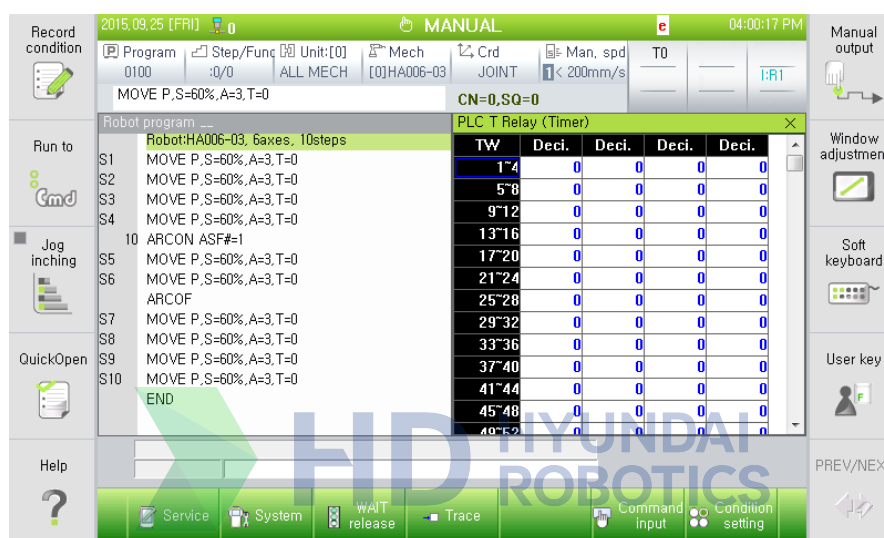


Figure 4.28 PLC T Relay (Timer)

4.2.6.6. PLC C Relay (Counter)

PLC C Relay is for counter function. When the value is 0, contact point is ON. Even in case of electricity failure, the value of PLC C Relay (Counter) is maintained.

Can be used by selecting 『[F1]: Service』 → 『1: Monitoring』 → 『7: PLC relay data』 → 『6. PLC C Relay (Counter)』.

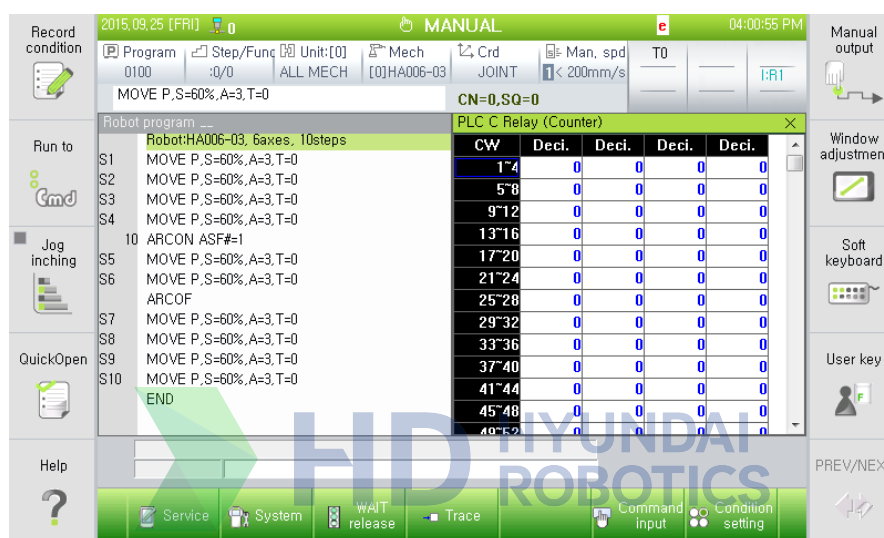


Figure 4.29 PLC C Relay (Counter)

Controller Operation Manual

4.2.6.7. PLC SP Relay (Special)

PLC SP Relay (Special) is for a special purpose. Refer to 『Embedded PLC Function Manual』 for details.

Can be used by selecting 『F1]: Service』 → 『1: Monitoring』 → 『7: PLC relay data』 → 『7: PLC SP Relay (Special)』.

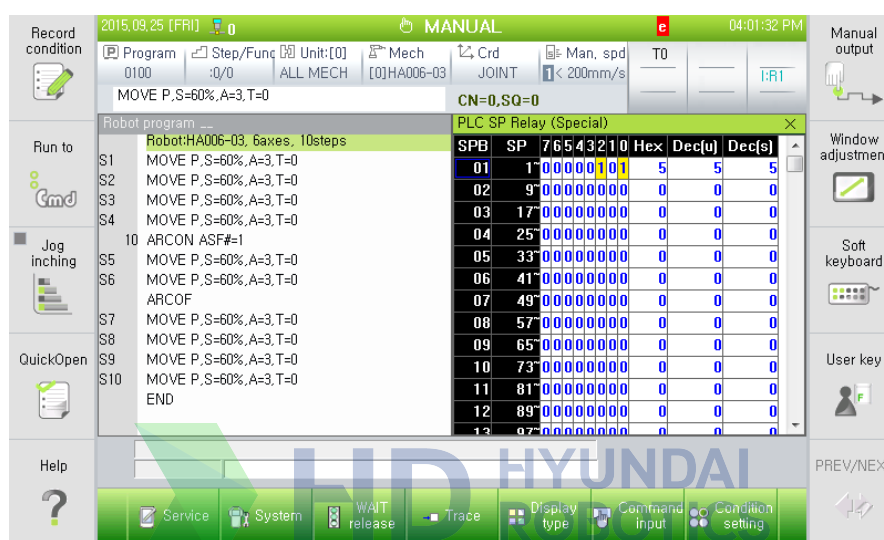


Figure 4.30 PLC SP Relay (Special)

4.2.6.8. PLC DI Relay (PLC Output)

This is a relay that monitors the output value from PLC. The PLC output corresponds to the input (DI) of the controller side.

Can be used by selecting 『F1: Service』 → 『1: Monitoring』 → 『7: PLC relay data』 → 『8: PLC DI relay (PLC output)』.

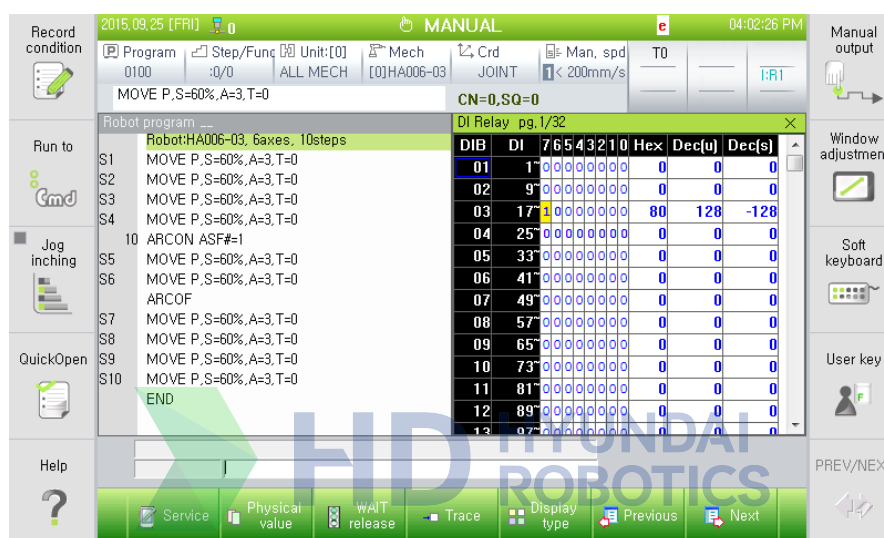


Figure 4.31 PLC DI Relay (PLC Output)

The explanation of the F menu at the bottom is the same as the details of [PLC X Relay (External input)].

Controller Operation Manual

4.2.6.9. PLC DO Relay (PLC Input)

This is a relay that monitors the input value into PLC. The PLC input corresponds to the output (DO) of the controller side.

Can be used by selecting 『F1]: Service』 → 『1: Monitoring』 → 『7: PLC relay data』 → 『9: PLC DO relay (PLC input)』.

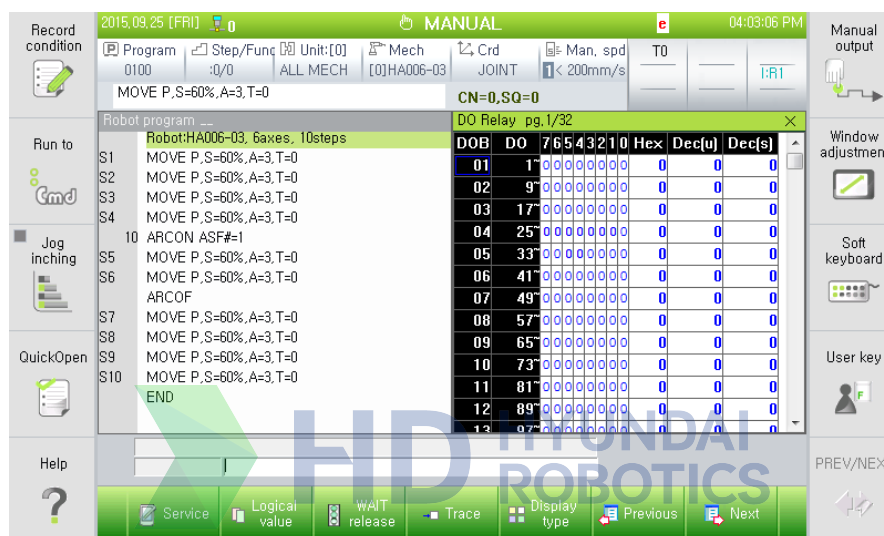


Figure 4.32 PLC DO Relay (PLC Input)

The explanation of the F menu at the bottom is the same as the details of [PLC X Relay (External input)].

4.2.6.10. PLC MW Relay (Data Memory)

This is used for saving or importing data saved with applied command. This relay value will be maintained even when the power is out.

Can be used by selecting 『F1]: Service』 → 『1: Monitoring』 → 『7: PLC relay data』 → 『10: PLC MW relay (data memory)』.

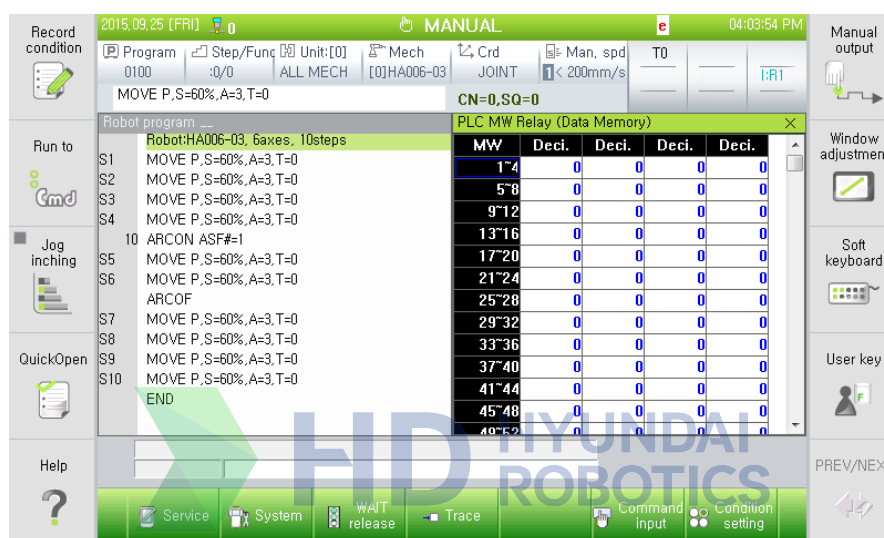


Figure 4.33 PLC MW Relay (Data Memory)

Controller Operation Manual

4.2.6.11. PLC SW Relay (System memory)

PLC SW Relay (System Memory) is for a special purpose. Refer to 『Hi5a Controller Embedded PLC Function Manual』 for details.

Can be used by selecting 『[F1]: Service』 → 『1: Monitoring』 → 『7: PLC relay data』 → 『11: PLC SW relay (system memory)』.

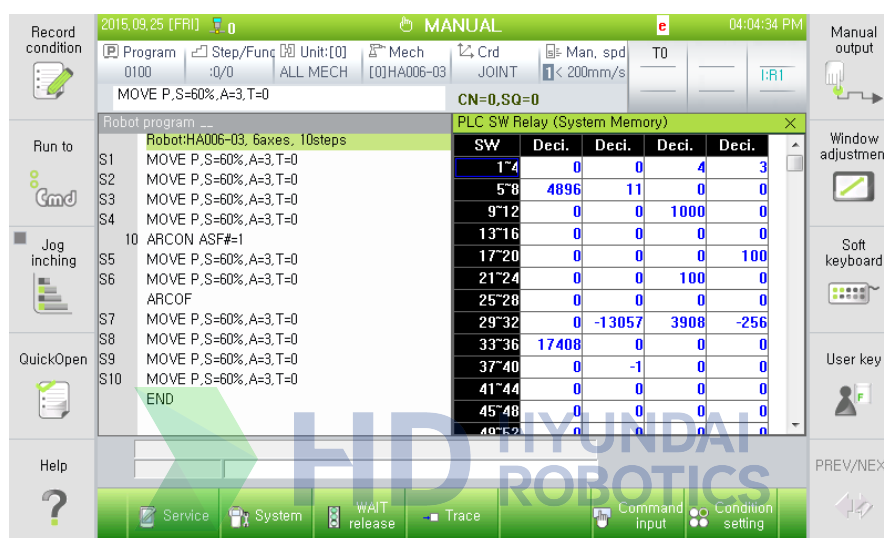


Figure 4.34 PLC SW Relay (System memory)

4.2.7. Analog Data

This displays the analog voltage input/output through the analog input/output port of arc interface board. When using the function of 『F2]: System』 → 『4: Application parameter』 → 『5: Speed vs. voltage output』 function, the voltage output will be proportionate to the linear end speed of the robot. Refer to 『F2]: System』 → 『4: Application parameter』 → 『5: Speed vs. voltage output』 for details.

Can be used by selecting 『F1]: Service』 → 『1: Monitoring』 → 『8: Analog data』.

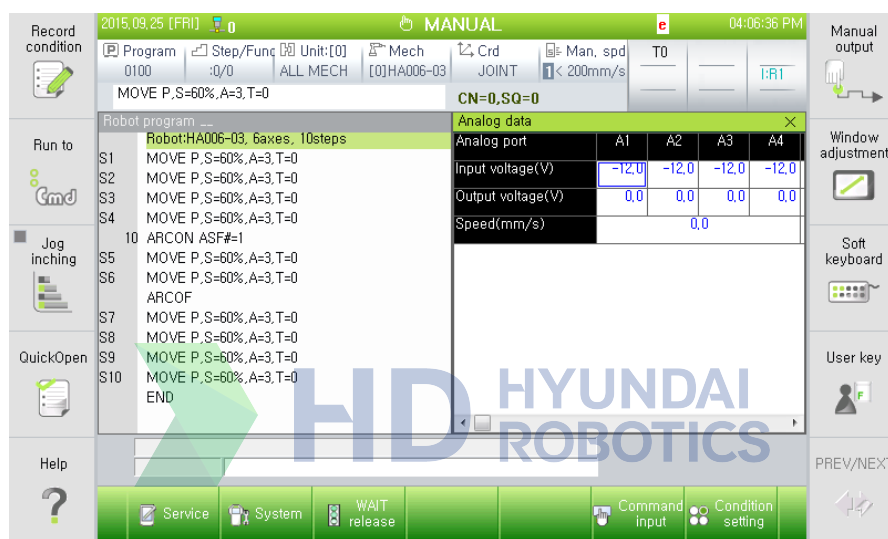


Figure 4.35 Analog data monitoring

4.2.8. Cooperation control data

This monitors the cooperation control state and HiNet I/O.

Can be used by selecting 『F1]: Service』 → 『1: Monitoring』 → 『10: Cooperation control data』

4.2.8.1. Cooperation control condition

It will display the status of a number of robots that are under cooperative control. Possible monitoring states include motor on, operation mode, manual cooperation, automatic cooperation, error state, interference possible axis, and interference distance.

Can be used by selecting 『F1]: Service』 → 『1: Monitoring』 → 『10: Cooperation control data』 → 『1: Cooperation control status』.



Figure 4.36 Cooperation control status monitoring

- Motor on: Indicates operation readiness (ON/OFF) of each robot.
- Operation mode: Indicates the manual/auto mode status of each robot.
- Manual cooperation: Indicates robot's manual mode cooperative state.
 - Individual: Individual manipulation state
 - Master: Set as MASTER in a cooperative manipulation state
 - Slave: Set as SLAVE in a cooperative manipulation state
- Automatic cooperation: Indicates the cooperative state when a robot performs a task.
 - Stop: Not performing.
 - Independent: Independently performing a task
 - Wait:
 - Under COWORK command, waiting for a partner robot to be ready for cooperative position.
 - Cooperation: performing cooperation work.
- Error status:
 - Indicates recent error states of each robot. Error state clears when a robot moves.
- Axis with possible interference:
 - When an arm interference prevention is effective, it displays the name of the nearest axis to the other robot.
- Interference distance [mm]:
 - When an arm interference prevention is effective, the distance to the interference possible axis is displayed in mm.



Controller Operation Manual

4.2.8.2. HiNet I/O [GE1~GE16]

This monitors the input/output signal condition for HiNet. Each signal is displayed in binary (Bit), hexadecimal (Hex) and decimal (Dec.), and displays whether it is an output parameter or an input parameter depending on the role of the robot itself. (I/O)

Can be used by selecting 『[F1]: Service』 → 『1: Monitoring』 → 『10: Cooperation control data』 → 『2: Hinet I/O [GE1~GE128』.



Figure 4.37 HiNet I/O monitoring

『[F5]: Overall configuration』 displays the connection status for all robots that participated in HiNet. The robot displayed in green is the one that participated in HiNet.

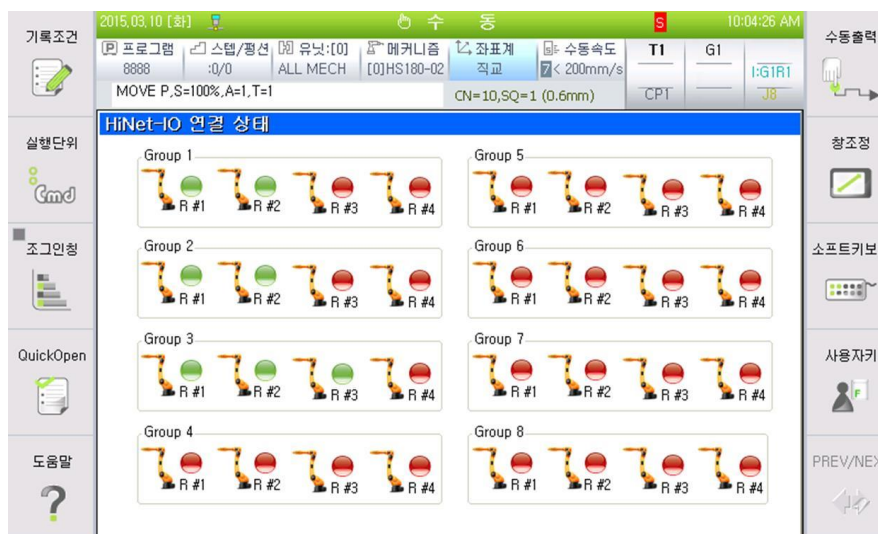


Figure 4.38 HiNet-IO connection state

4.2.9. Various data

This is the function to prepare the list of data you want and monitor in one window.

- (1) Can be used by selecting 『[F1]: Service』 → 『1: Monitoring』 → 『11: Various data』.

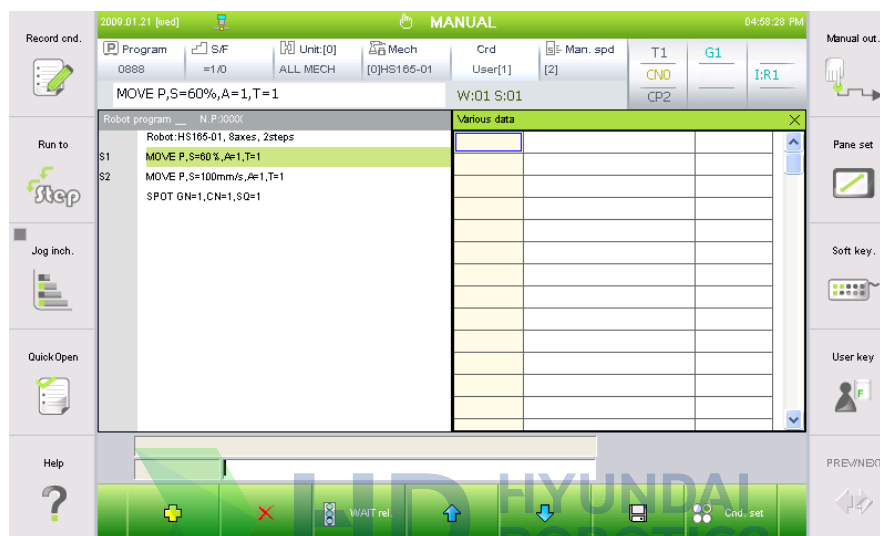


Figure 4.39 Various data monitoring

- (2) Set the cursor on the most left column and press the, [Soft keyboard] key to enter the name of the data.
- (3) The current value for the entered data is displayed respectively. For data of which a note is set, the note is automatically displayed as well.

Various data		
YW2	100	type#
FB3.Y11	0	1st WOEKCOMPL
V1%	0	index

- (4) For integer data, the current value is displayed in decimal format. If you add a suffix of “,x” at the end, it can be displayed in hexadecimal format.

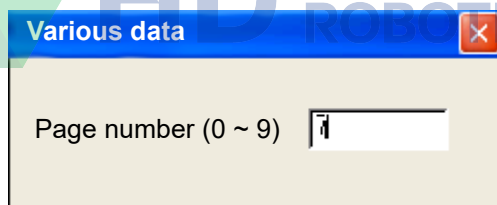
YW2,x	&H64	
FB3.Y11	0	1st WOEKCOMPL

Controller Operation Manual

- (5) You can also adjust the current data value. Place the cursor on the current value, press the [ENTER] key, and enter a new value. Then, press the [ENTER] key again.

YW2,x		&H64	
FB3.Y11		01st WOEKCOMPL	
V1%	100	index	

- (6) When you press the 『F1』: + key, a blank item will be added right on top of the current cursor.
- (7) When you press the 『F2』: x key, the currently selected item will be deleted.
- (8) When you press the 『F4』: ↑ / 『F5』: ↓ key, the order of the currently selected item moves up/down.
- (9) When you press the 『F6』:  key, the entered condition is saved. That is, the entered condition will be saved even when the power is turned off.
- (10) When you press the 『F7』:  key, the page selection dialog box appears. You can create a list to be monitored using the Group Management page. A total of 10 pages are provided.



4.2.10. Work program HotEdit

This is the function to edit the program during playback.

- (1) Can be used by selecting 『F1』: Service』 → 『1』: Monitoring』 → 『12』: Job program HotEdit』 or by pressing the [QuickOpen] button while playing back the program.

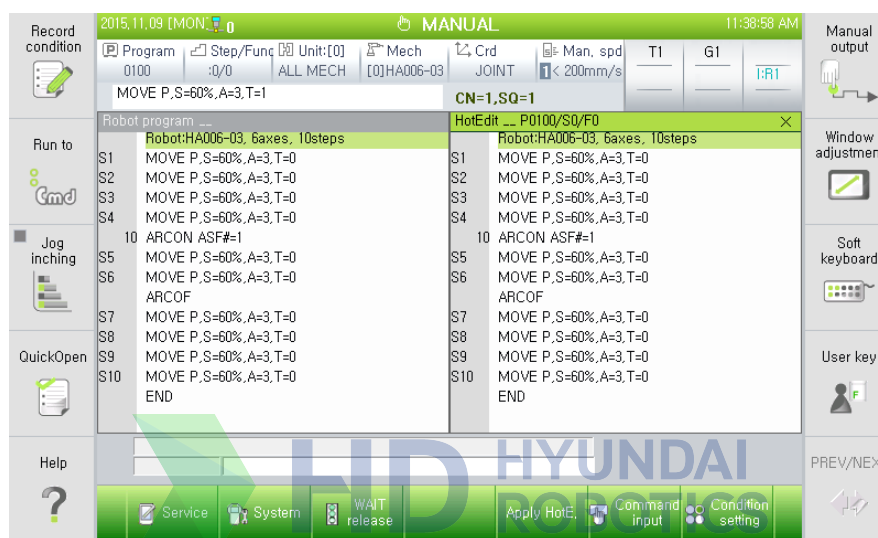


Figure 4.40 Hot Edit execution screen

- (2) After editing the program, select 『F5』: Apply HotE.』 .
- (3) The following shows the details of the work program Hot Edit.

○ Entry

You can enter the edit mode during operation even when the robot is operating by using the [Quick Open] key or 『F1』: Service』 → 『1』: Monitoring』 → 『12』: Work program HotEdit』 .

○ Type of possible edit

Although the following functions cannot be used, the operating method is the same as that of manual mode.

- ① [Axis operation] key use: Ignores the input of the relevant key.
- ② [REC] key (Record hidden pose MOVE): Displays the "Operation not allowed while in Hot Edit" message.
- ③ [POS. MOD] key: Displays the "Operation not allowed while in Hot Edit" message

○ Reflection

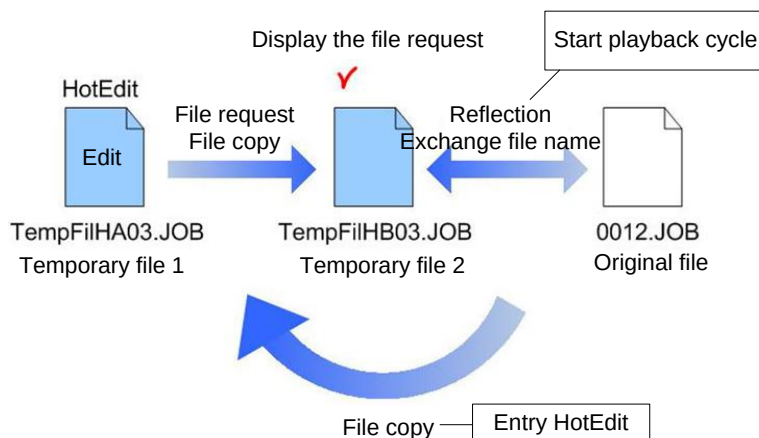


Figure 4.41 Edit during operation

Edit during operation is the method used by the user to edit the copy version by creating a copy, not the original file, for safety purposes.

When you execute edit during operation, the original file is copied as temporary file 1 as shown above. After editing the program, when the user presses the 『[F5]: Apply HotE』 key, temporary file 1 will be copied as temporary file 2, and a dialog box will ask whether to apply this copy action. The reflection is applied by renaming the temporary file 2 with the file name of the original file.

The actual timing of the reflection is displayed in the following table.

Table 4-1 Reflection timing

	Classification	Reflection timing
Executing during work	Work in execution Work executed by calling with CALL command	When the play cycle starts (All files requested for reflection are reflected.)
	Other work	Immediately request for reflection

If the program is not in execution or in operation, it cannot be edited. But if the program stops while in edit mode during operation, the reflection is requested but not reflected until the play cycle restarts.

Press the [YES] key to first reflect the edit details during operation and press the [NO] key to cancel the request for reflection and delete temporary file 2 (Edit detail during operation).

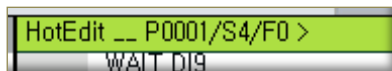
At this time, if the program that used the CALL command was in progress, you must restart from the beginning because it is not a normal program flow.

○ Program counter information

The following details are displayed on the title bar of the Hot Edit window.



- ① Program number/Step number/Function number: This displays the location of the cursor used for editing in the edit during operation mode.
- ② '*': '*' is displayed when edited from the original copy.
- ③ '>': When the reflection request condition from the original copy is in effect, '>' is displayed.



○ Select different program

When you press the [SHIFT] + [PROG] key, you can select a different program. You can also create a new program.

Warning

- When you edit and apply the program that is currently in auto operation or program that will be called, it will be applied from the next cycle (After the program end is executed) and play back the robot with the edited program. Please take maximum precaution since the wrongly implemented editing can cause major accident such as collision between robot and jig.

4.2.11. Arc welding data

This function displays the data and states when carrying out arc welding.

Can be used by selecting 『F1]: Service』 → 『1: Monitoring』 → 『13: Arc welding data』.

Pressing the [F5] button from each monitoring screen will cycle through the monitoring screens as shown below.

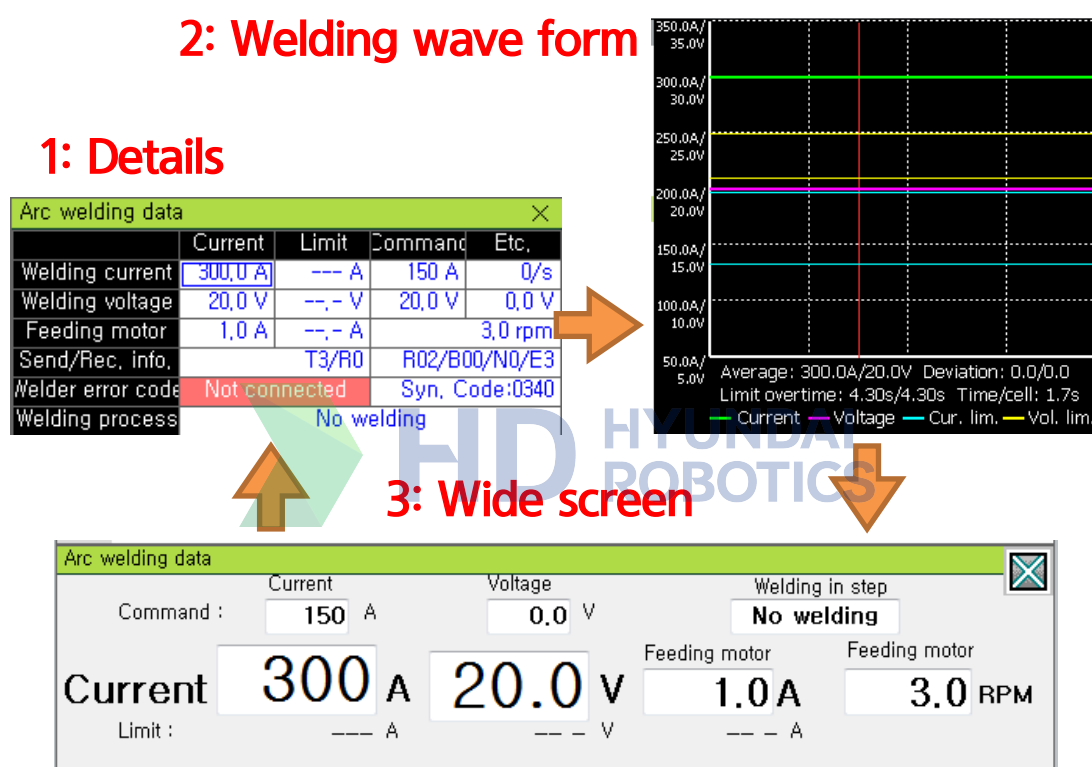


Figure 4.42 Arc welding data monitoring screen shifting



Reference

- Arc Welding data monitoring function will displays different contents according to the selected arc welding settings.
- Carry out the arc welding setting by selecting 『F2]: System』 → 『5: Initialize』 → 『3: Usage setting』
- Please refer to the “Hi5a Controller Arc Welding function manual” for the detailed information

4.2.12. Operating information

This displays the operating information of the controller. It displays the information regarding the accumulation after system initialization, the accumulation after power on, and the recent cycle.

Can be used by selecting 『F1]: Service』 → 『1: Monitoring』 → 『14: Operating information』.

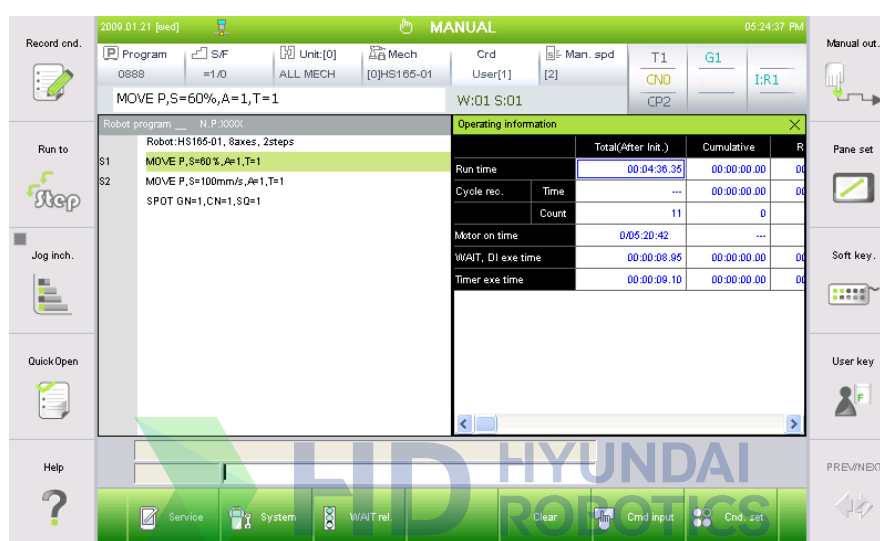


Figure 4.43 Operating information

- Operating information clear
When the [Operating information] monitoring window is selected and activated, the 『F5]: Clear』 button will be displayed. Pressing this button will bring up the following dialog box. Carry out initialization by pressing the appropriate button in the dialog box.

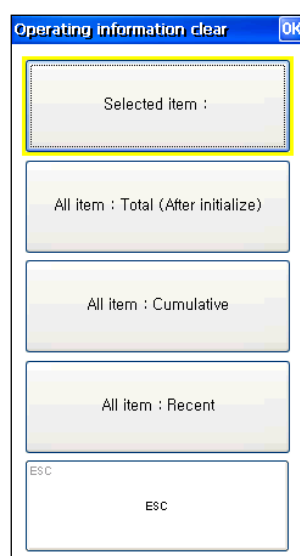
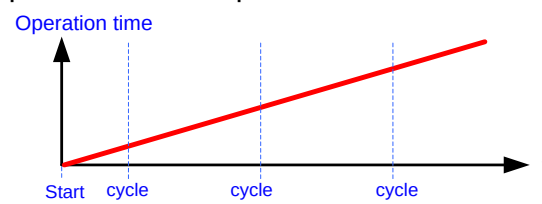
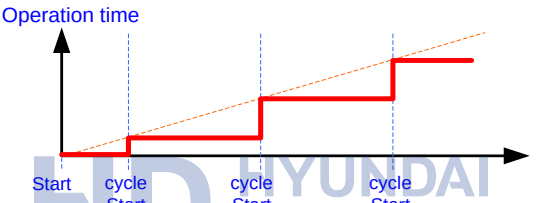
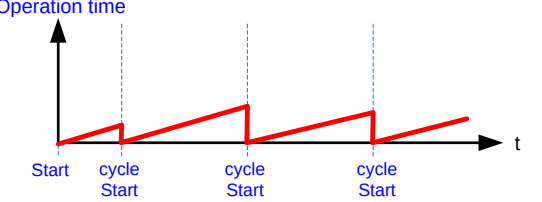
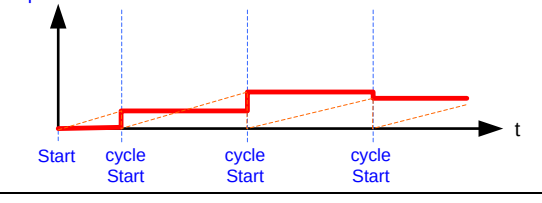


Figure 4.44 Operating information clear dialog box

Table 4-2 Reflected timing

All (After resetting)	Measured time	Operation time from system reset to now
	Motor ON time	Motor ON time from system reset to now
Accumulative	Measured time	Operation time from power ON to now 
	Cycle recording time	Operation time from power ON to previous cycle 
Latest	Measured time	Operation time from start of cycle (Or power ON) to now 
	Cycle recording time	Operation time from start of cycle (Or power ON) to previous cycle 

4.2.13. Embedded field bus node state

Displays the embedded field bus node condition. The node state shows the connected node number, while the node #0 is the master. In the node state monitoring screen, the states of relevant nodes, associated not only with the input and output signals, but also with the errors and the executed state of the master, can be monitored, and accessing the embedded field bus setting screen is possible.

Can be used by selecting 『F1: Service』 → 『1: Monitoring』 → 『15: Embedded field bus node condition』

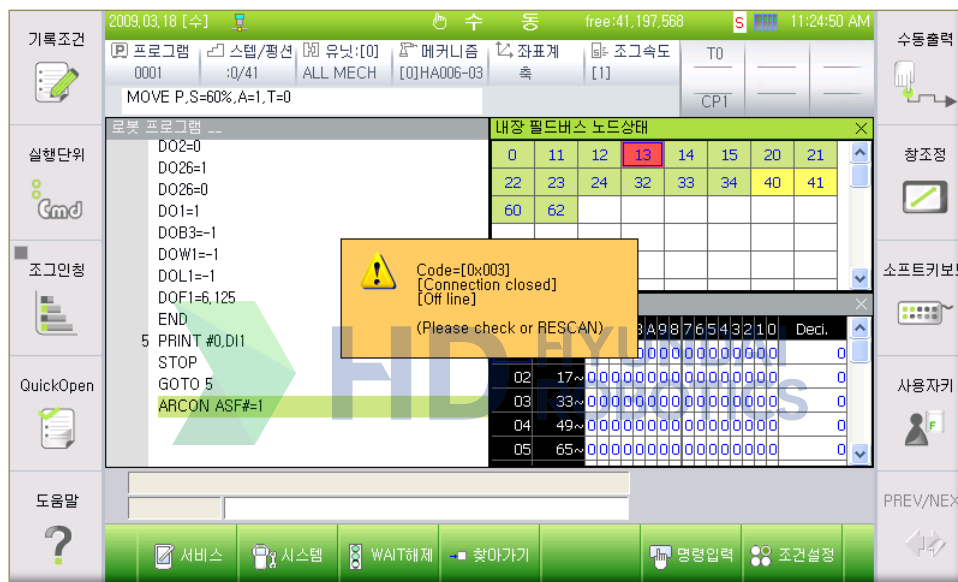


Figure 4.45 Embedded field bus node condition monitoring - 1

■ Embedded field bus setting

Press the [ENTER] key at the node #0 of the above embedded field bus node state monitoring screen, then, the screen will change to the embedded field bus setting screen, making it possible to search through nodes or check the detailed information of the connected nodes. Refer to 『F2: System』 → 『2: Control parameter』 → 『2: Input/output signal setting』 → 『12: Embedded field bus (Device Net) information and setting』 for explanation and details.

■ Node error state

The node colored in red on the monitoring screen is the one that has a problem. As shown in the above screen, the details associated with the error can be checked by moving the cursor to the relevant node and pressing the [ENTER] key.

■ Master IDLE state

If “IDLE” is displayed in the node #0, it is the case that the PLC is in the stopped state. When the PLC is off, the IDLE state that the robot controller’s output signal is not delivered to the node is displayed.

Controller Operation Manual

■ Input/output signal monitoring

When you bring the cursor to the number of the node that is operating normally, and press the [ENTER] key, you can change to a screen that allows you to monitor the state of the input and output of the node, as the following figure.



Figure 4.46 Embedded field bus node condition monitoring - 2

When the node input/output state monitoring window, is selected, as shown in the above figure, the F keys for node state, physical/logic, X/Y, Trace, display type, node (Prev FN), and next node (Net FN) will be shown, allowing you to change to the screen for monitoring the relevant items.

4.2.14. System characteristic data

It displays various data of the robot system.

4.2.14.1. Controller information

“Controller information” shows the monitoring results in the controller.

Through 『[F1]: Service』 → 『1: Monitoring』 → 『16: System characteristic data』 → 『10: Controller information』, you can enter the “controller information” menu.

4.2.14.1.1. Internal temperature of the controller

It offers an “internal temperature of the controller” as the monitoring information in the controller. The internal temperature of the controller displays the temperature of the Main B/D and the temperature of the CPU, which is measured in real time.

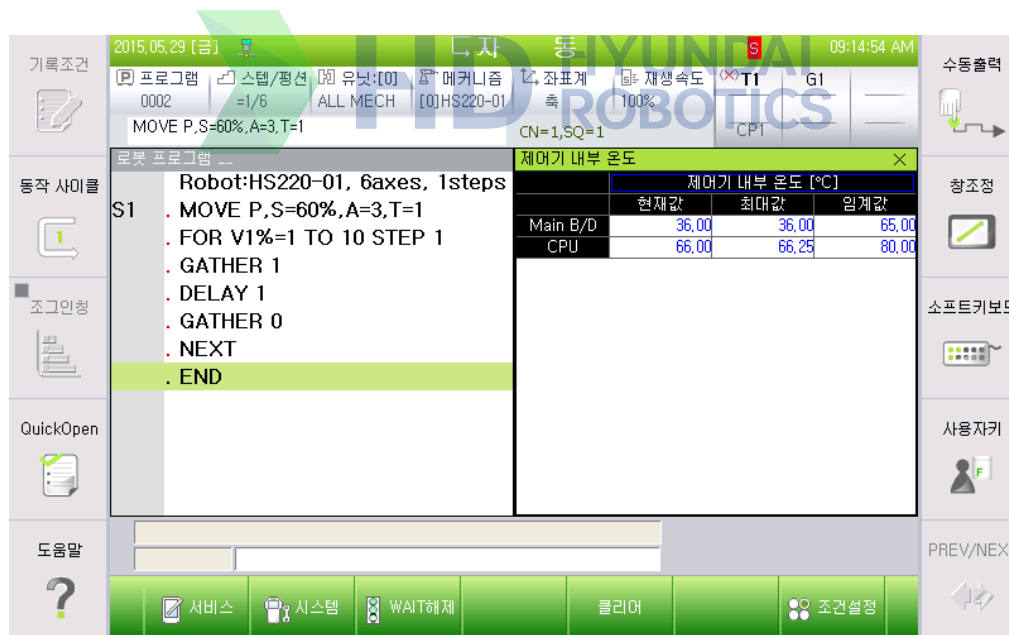


Figure 4.47 Display window of the internal temperature of the controller

Controller Operation Manual

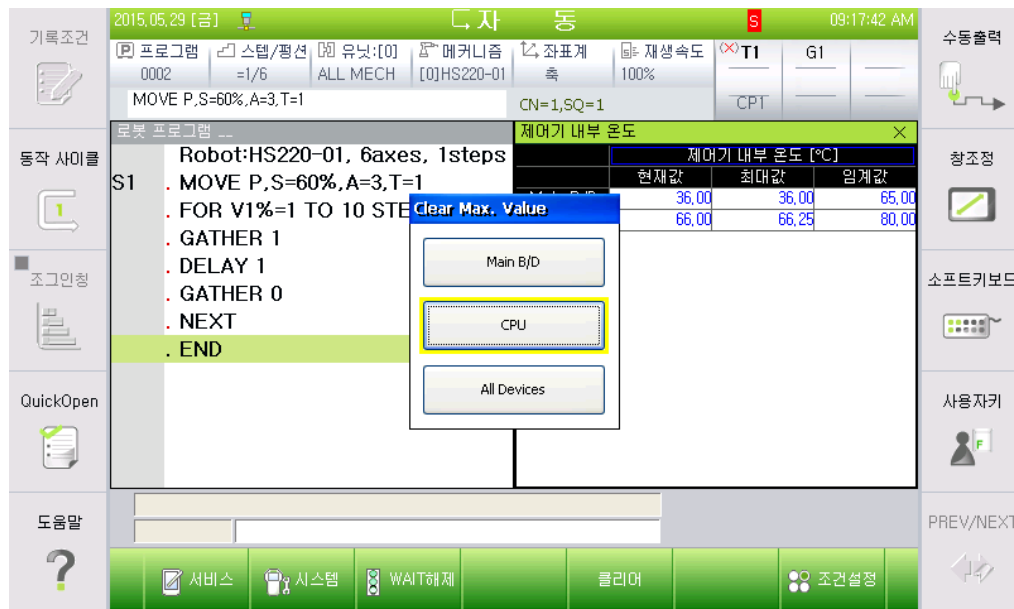


Figure 4.48 Initialization of the maximum internal temperature value of the controller

The current value of the internal temperature of the controller is the latest result, which is measured in real time. The maximum value indicates a maximum value of up to the present from the time of starting the temperature measurement. When you click the “Clear” menu from the bottom of the screen, a dialog box that can initialize the maximum value for each device appears. When you select a device that you want to initialize the maximum value of, it initializes the maximum temperature of the device.

4.2.14.2. PRM information

“PRM information” allows verification of the state of the PRM input signal and PRM information.

You can use it through the 『F1]: Service』 → 『1: Monitoring』 → 『16: System characteristic data』 → 『11: PRM information』.

4.2.14.2.1. PRM input signal

In the “PRM input signal,” you can check the signal quality associated with the PRM as shown below.

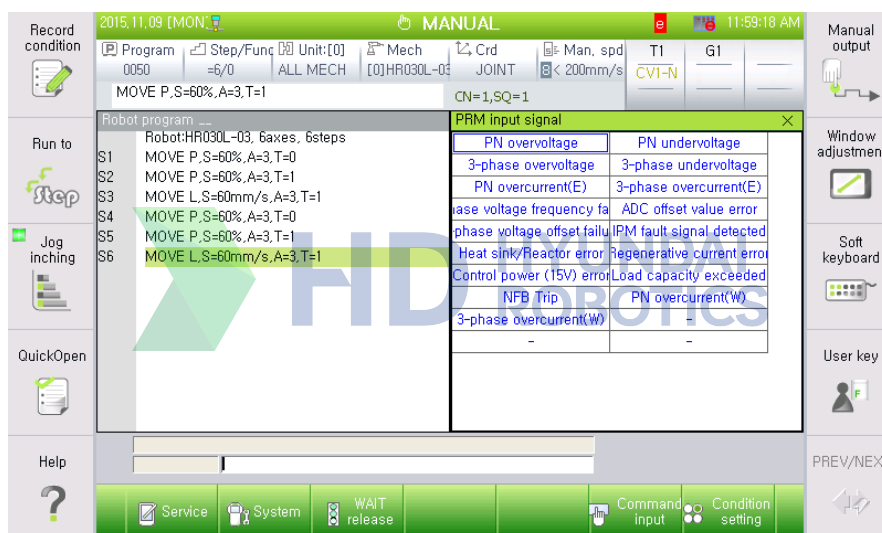


Figure 4.49 PRM Input signal monitoring

4.2.14.2.2. PRM information

“PRM information” allows verification of the information related to PRM while in Motor On.

The information that can be verified is as shown below.

- (1) Input voltage (current value, max value, and frequency)
- (2) Regenerative level (start voltage, stop voltage)
- (3) Regenerative power (current value, value accumulated since initialization, and the average value during the last 5 minutes)

PRM information								
	Voltage(v)		Frequency(Hz)		Regeneration level (V)		Regenerative p	
	Current	Max.	Current		Start	Stop	Current(W)	culated value
R	0	0	0	PN	0	0	0	0.0
S	0	0	0	-				
T	0	0	0	-				

Figure 4.50 PRM information monitoring

The PRM (Power Regenerative Module) allows you to take advantage of the energy wasted by reverse-transmitting the reverse torque generated from the motor side toward KEPCO. Through PRM monitoring, you can indirectly know the power consumption state.

4.2.15. Arc welding operating information

This displays the operating information of arc welding. It provides information on the accumulated welding time, the recent welding time, and the tip use time. In addition, the accumulated count of retrials and restarts that were made because of abnormal arc generation will be displayed.

Can be used by selecting 『F1]: Service』 → 『F1: Monitoring』 → 『F17: Arc welding operating information』.

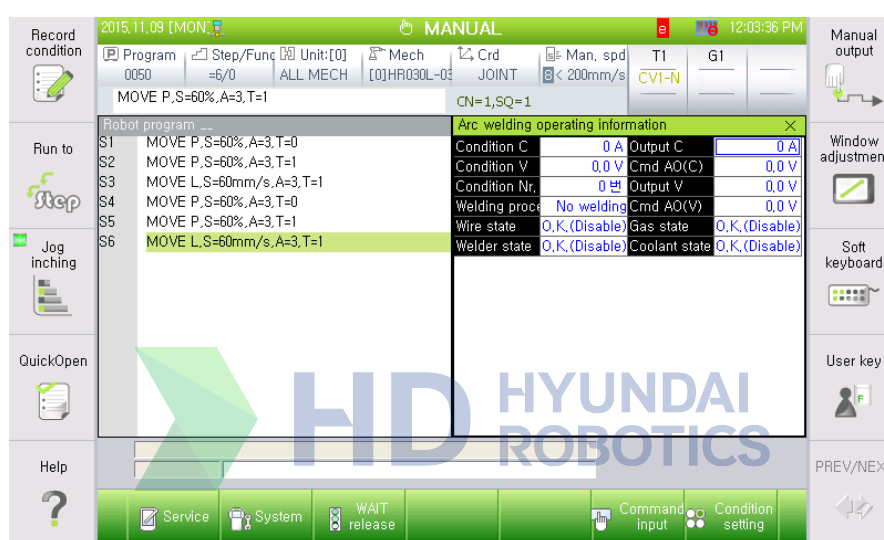


Figure 4.51 Arc welding operating information monitoring

- Arc welding operating information clear

When the [Arc welding operating information] monitoring window is selected and activated, the 『F5]: Clear』 button will be displayed. Pressing this button will bring up the following dialog box. Carry out initialization by pressing the appropriate button in the dialog box.

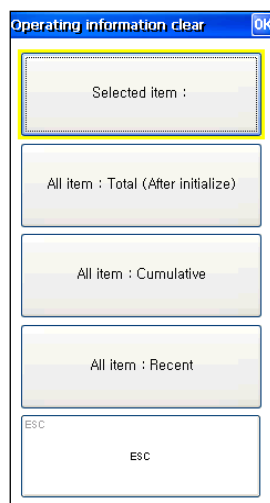


Figure 4.52 Arc welding operating information clear dialog box

4.2.16. Multi-tasking state

This displays the programs that are run automatically in the main task and the sub tasks 1 – 7, including the steps, functions, operating state, and work state.

Can be used by selecting 『F1]: Service』 → 『1: Monitoring』 → 『18: Multitasking state』 .



Figure 4.53 Multitasking state monitoring



Reference

- Refer to 『Multitasking Function Manual』 for details.

4.2.17. Servo tool change

This displays the state of the servo tool and the encoder power supply's input/output state when the servo tool change function is used.

Can be used by selecting 『F11: Service』 → 『1: Monitoring』 → 『19: Servo tool change』.

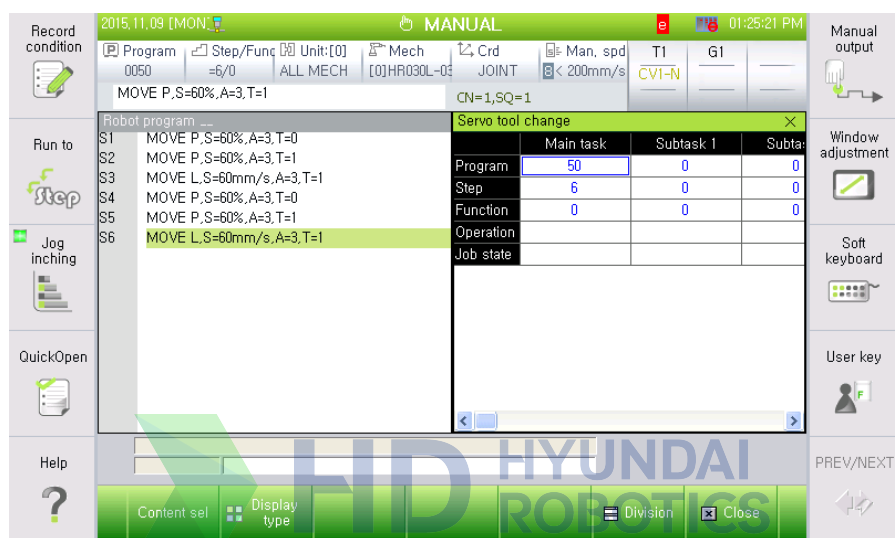


Figure 4.54 Servo tool change monitoring



Reference

- For more details, refer to 『Servo Tool Change Function Manual』

4.2.18. Ladder edit

“Ladder edit” allows the editing of the PLC ladder program.

The “Ladder edit” function allows most of the functions supported in the HRLadder program to be used in TP. The following shows the functions that are supported.

- (1) File: Generates new files and loads and stores ladder files.
- (2) Edit: Copies, pastes, and finds ladder files.
- (3) View: Views the whole screen and adjusts the branch interval.
- (4) Insert: Inserts rung, branch, and commands.
- (5) Tool: Inspects and compares grammar, and carries out Remote Stop, Remote Run.

Can be used by selecting 『F1]: Service』 → 『F1: Monitoring』 → 『20: Ladder edit』.

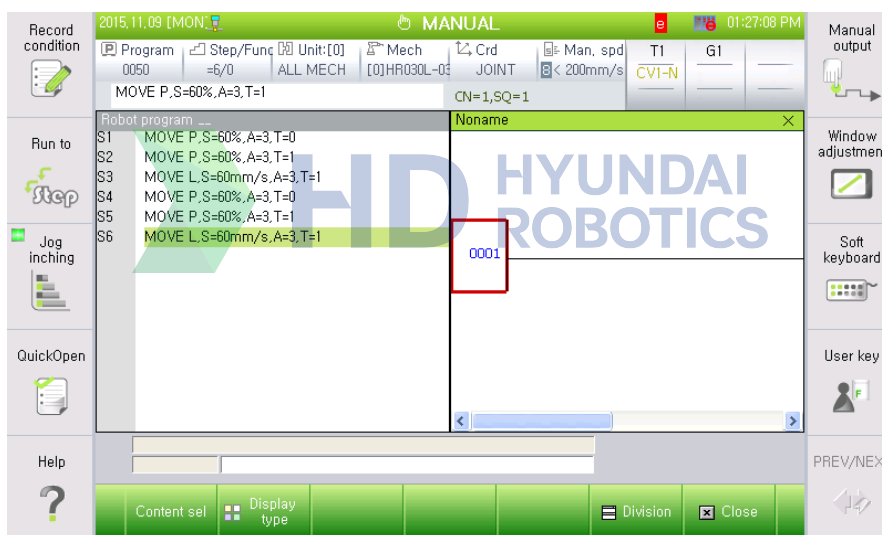


Figure 4.55 Ladder edit screen



Reference

- For more details, refer to 『Help for HRLadder』.

4.2.19. Roller hemming data

This displays the roller hemming squeeze and the adjustment distance when the roller hemming function is used.

Can be used by selecting 『F1]: Service』 → 『1: Monitoring』 → 『22: Roller hemming data』.

The roller hemming function can be activated by setting the function as “Enable” in 『F2]: System』 → 『4: Application parameter』 → 『12: Roller hemming squeeze control』

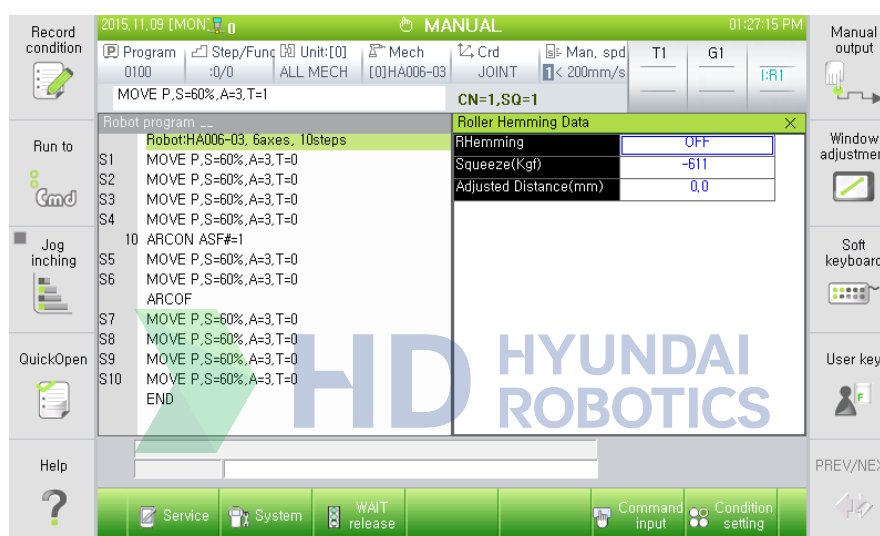


Figure 4.56 Roller hemming data



Reference

- For more details, refer to 『“Roller Hemming Squeeze Control” Function Manual』.

4.2.20. Force sensor data

This allows the verification of the force sensor information that will be inputted when using the force control function. It is possible to verify the force and torque of each axis as shown below.

Can be used by selecting 『F1』: Service』 → 『1: Monitoring』 → 『23: Force sensor data』.

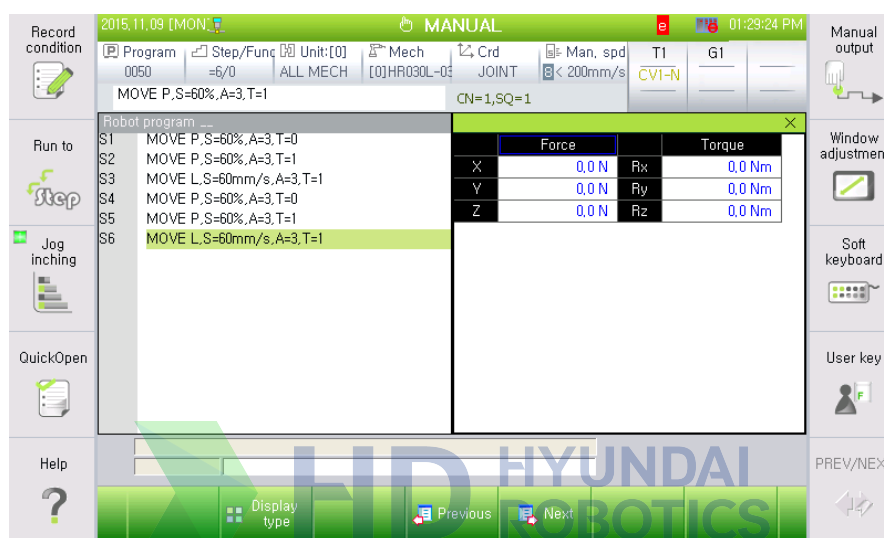


Figure 4.57 Force sensor data

The force control function can be activated by selecting “Enable” in 『F2』: System』 → 『4: Application parameter』 → 『14: Force control』 → 『1: Usage environment setting』.



Reference

- For more details, refer to 『“Sensor Based Force Control” Function Manual』.

4.2.21. Playback speed automatic adjustment state

When the playback speed automatic adjustment function is used, it is possible to compare and check the nonoperation time, low-speed operation time, and variation of the encoder temperature with the individual reference values.

You can use the function by selecting “[F1]: Service” → “1: Monitoring” → “24: Playback speed automatic adjustment state.”

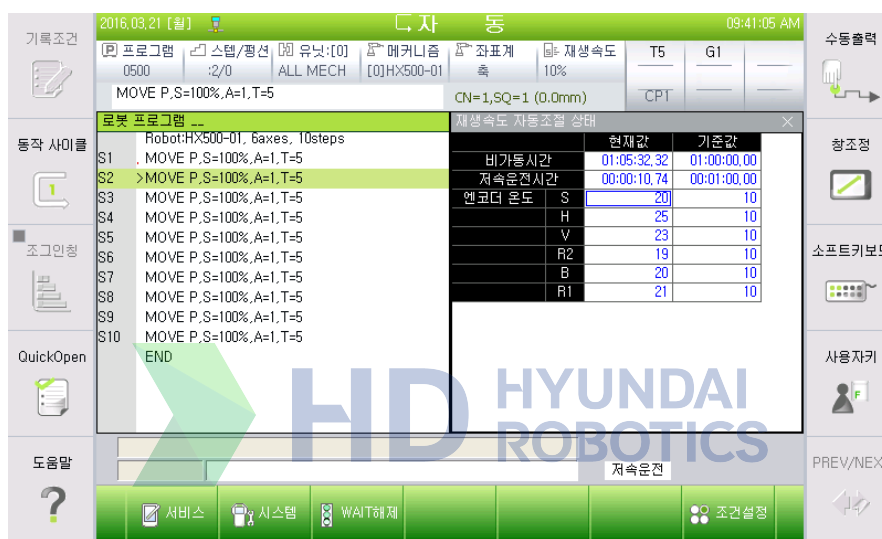


Figure 4.58 Monitoring of the playback speed automatic adjustment state

The playback speed automatic adjustment function can be activated by selecting and enabling it in “[F7]: Condition setting” → “10: Playback speed automatic adjustment.”

4.3. Register

You can display or change various registry value.

- (1) Selection 『[F1]: Service』 → 『2: Register』 . The register menu screen will be displayed as shown below. Detailed configuration of the menu will vary depending on the setting of the robot.

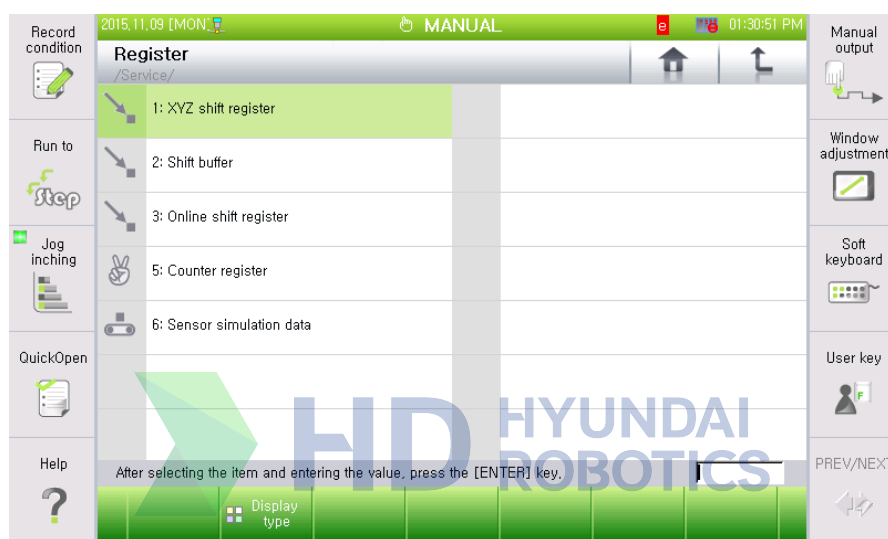


Figure 4.59 Register details selection screen

- (2) Selection the necessary item and enter the sub menu.

4.3.1. XYZ Shift Register

XYZ shift register can be changed manually without 『SXYZ』 command.

XYZ shift is a horizontal move function which shifts to other XYZ coordinates, maintaining a previously taught position. As seen on the right side, a source program with A, B, C, D can be horizontally shifted to a, b, c, d without additional teaching by using the XYZ shift function. Initialization to 0 will take place after the relevant cycle (Program end is executed).

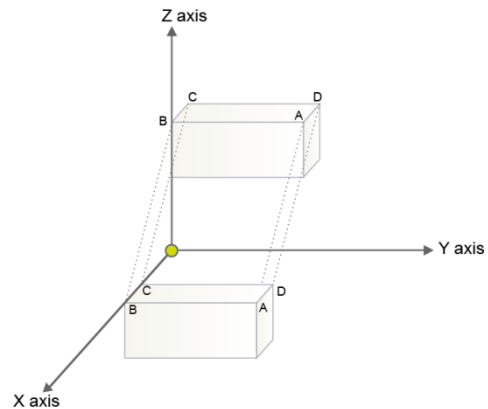


Figure 4.60 XYZ shift

- (1) Selection 『F1: Service』 → 『2: Register』 → 『1: XYZ Shift Register』.

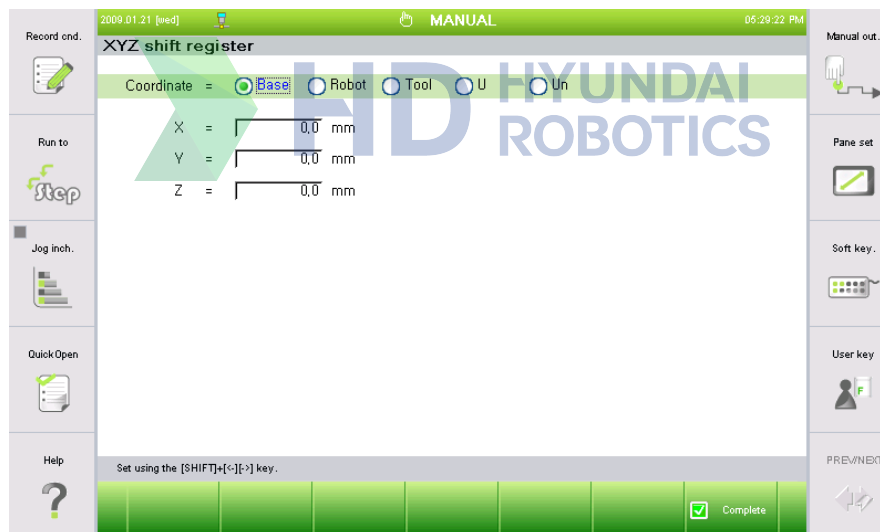


Figure 4.61 XYZ shift register screen

- (2) Input data in X, Y, Z and press [ENTER]. To store changed setup, press 『F7: Complete』. If [ESC] is pressed, changed data will not be stored.



Reference

- If a shift value is set in 『SXYZ』 command, a register value will be automatically renewed.
- The change in the XYZ shift register during the operation of the robot is to be reflected when the next execution is implemented, once after the operation of the robot stops.

4.3.2. Shift Buffer

Shift Buffers inputs shift amount in shift buffers and indicates the value when shift is performed by the online shift 『SONL』 function.

- (1) Selection 『[F1]: Service』 → 『2: Register』 → 『2: Shift Buffer』 .

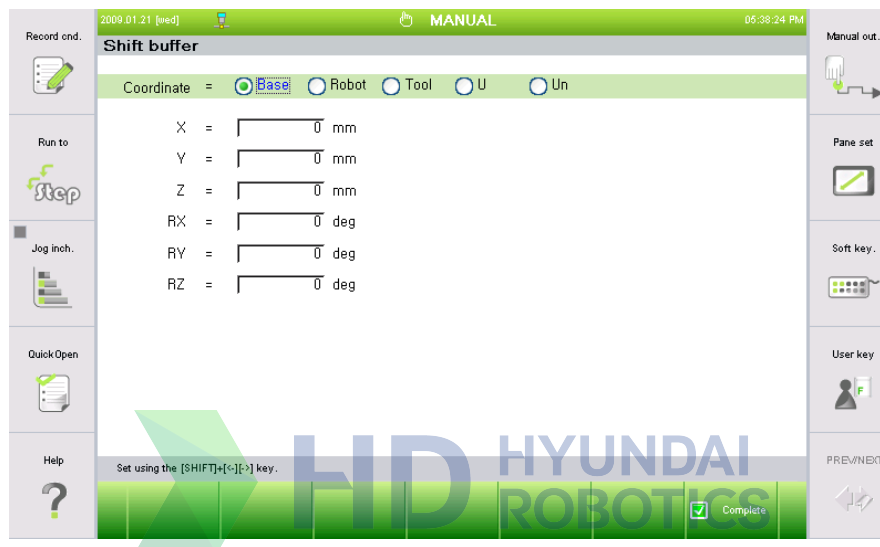


Figure 4.62 Shift buffer screen

- (2) Set a shift standard coordinates. Options are robot, tool and base coordinates
- (3) Input shift data and press [ENTER]. To store changed setup, press 『[F7]: Complete』 . If [ESC] is pressed, changed data will not be stored.



Reference

- Horizontal move shift (in case of ' $R_x=R_y=R_z=0$ ')
As seen below, horizontal move shift is used when point A, B, C, D and point a, b, c, d are parallel.

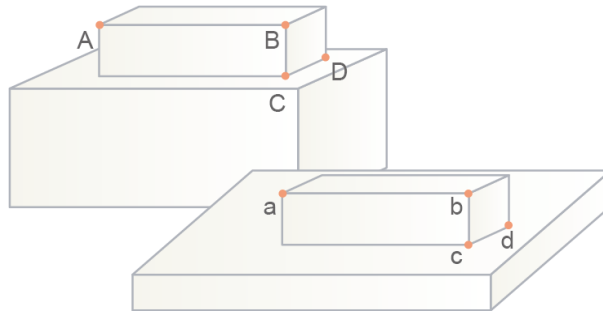


Figure 4.63 Horizontal move shift

- Angle Revision Shift (in case that at least one of R_x , R_y , R_z is not 0)
Usually, workpieces are not located parallel. Workpieces can be shifted by revising their location and position. Users should calculate the relation between location and position of workpieces (A and a) in advance.

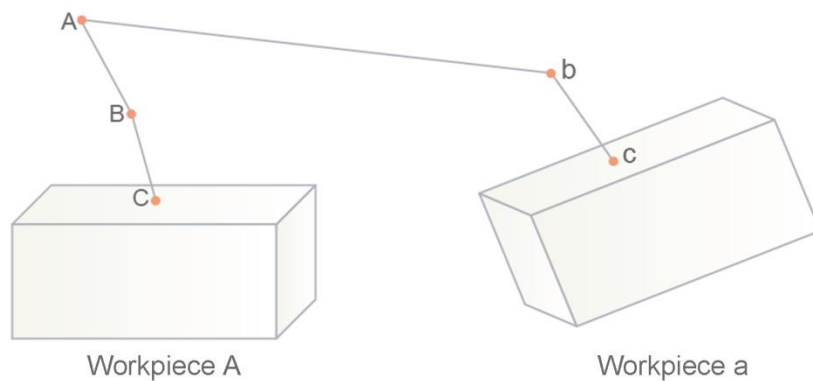


Figure 4.64 Angle revision shift

4.3.3. Online shift register

On-line shift register group stores shift amount received from external devices or palletizing length and spin value. There are eight groups in total.

- (1) Selection 『[F1]: Service』 → 『2: Register』 → 『3: Online shift register』



Figure 4.65 Online shift register screen

- (2) Input data and press [ENTER]. To store changed setup, press 『[F7]: Complete』. If [ESC] is pressed, changed data will not be stored.
- Request port: Sets serial port number which receives shift amount from external devices
 - Input status: It is set as 1 if the shift amount is reflected into the step position data.

4.3.4. Counter register

You can set the value for the counter register of the system parameter or check the current setting value. The counter register is a constant type register as well as a counter parameter with a constant value. This is mainly used for the branch condition and the counting, for example, on the program, while the value saved in the register can be checked and changed using this menu.

Selection 『[F1]: Service』 → 『2: Register』 → 『5: Counter register』 .

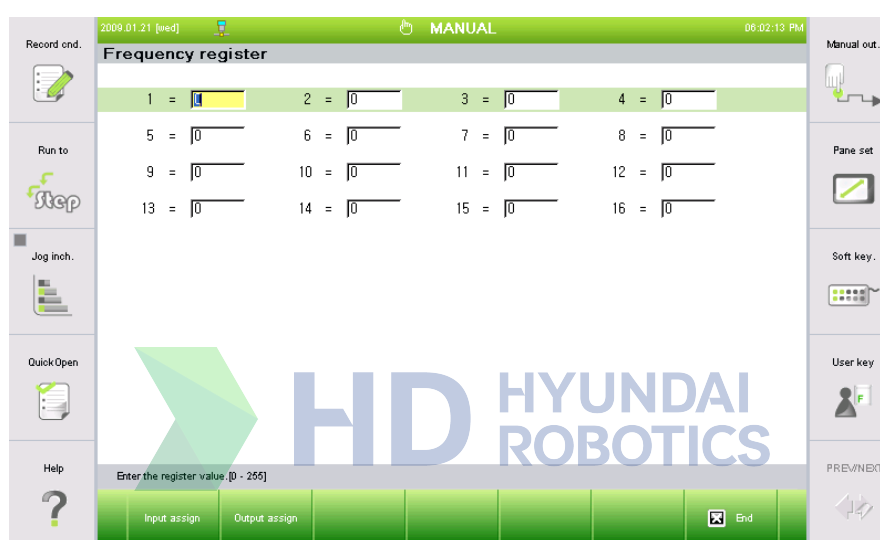


Figure 4.66 Counter register screen



Reference

- This menu can be accessed through 『R18: Frequency condition register』 of R code.

4.3.5. Sensor simulation data

Refer to 『Hi5a Controller Sensor Synchronization Function Manual』 for details. If set when the sensor synchronization function is enabled as the conveyor or press mode is used, the robot performs the playback of the simulation according to the speed and distance set by the user.

- (1) Select 『[F1]: Service』 → 『2: Register』 → 『6: Sensor simulation data』.
- (2) To save the changed setting, press the 『[F7]: Complete』 key. When you press the [ESC] key, the changed data will not be saved.

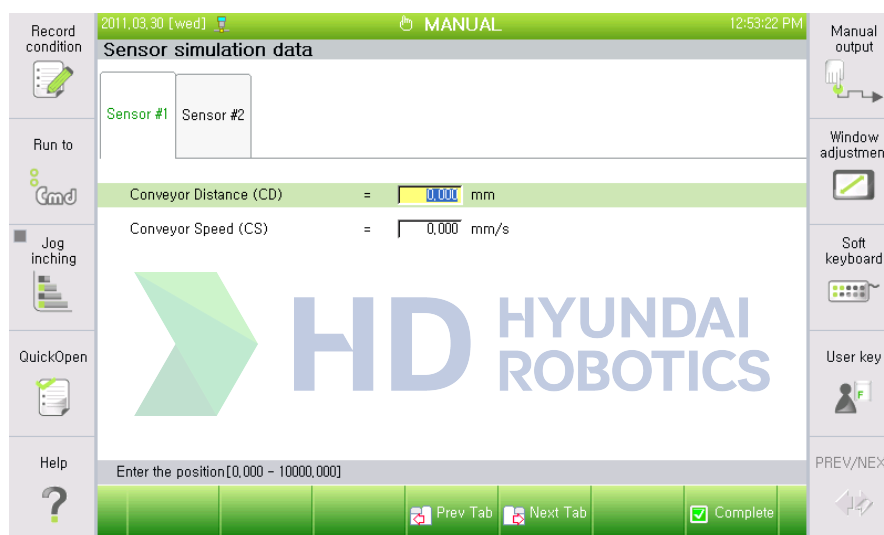


Figure 4.67 Sensor simulation data screen

- Conveyor Distance/Press Distance: Indicates the current position of the conveyor/press.
- Conveyor speed/Press speed: Designate the conveyor/press moving speed



Reference

- The sensor simulation data menu will not be activated if the 『Sensor #1』 and 『Sensor #2』 are set as “Disable” in 『[F2]: System』 → 『4:Application parameter』 → 『4: Sensor synchronization』 → 『1: Function usage』.

4.3.6. Program reservation execution

When reserving the program through external signal and executing the program in order, this is the function to check, change, insert or delete the currently reserved program. When reserving the program through external signal and executing the program in order, this is the function to check, change, insert or delete the currently reserved program. Depending on the setting, 20 or 1 program can be set for reservation wait. If a program is executed through the remote control once after the setting is finished, the reserved program will be automatically executed after the currently running program ends. For more details, refer to 『Hi5a Controller “Program reservation execution” Function Manual』.

- (1) Selection 『[F1]: Service』 → 『2: Register』 → 『7: Program reservation execution』.



Figure 4.68 Program reservation execution screen

- (2) 『[F1]: Insert』 : Add or insert the reserved program.
- (3) 『[F2]: Delete』 : Delete the reserved program.



Reference

- This menu will be activated when the sensor synchronization function is set for the use of conveyor or press.
- This menu will not be activated if 『Applied register count』 is set as “Enable” in 『[F2]: System』 → 『2: Control parameter』 → 『8: Program reservation execution』.

4.4. Variable

The current value of global Variable and local Variable can be checked and changed.
Refer to 『Chapter 10. Robot Language』 → 『Variable』 for details.

- (1) Selection 『[F1]: Service』 → 『3: Variable』 .

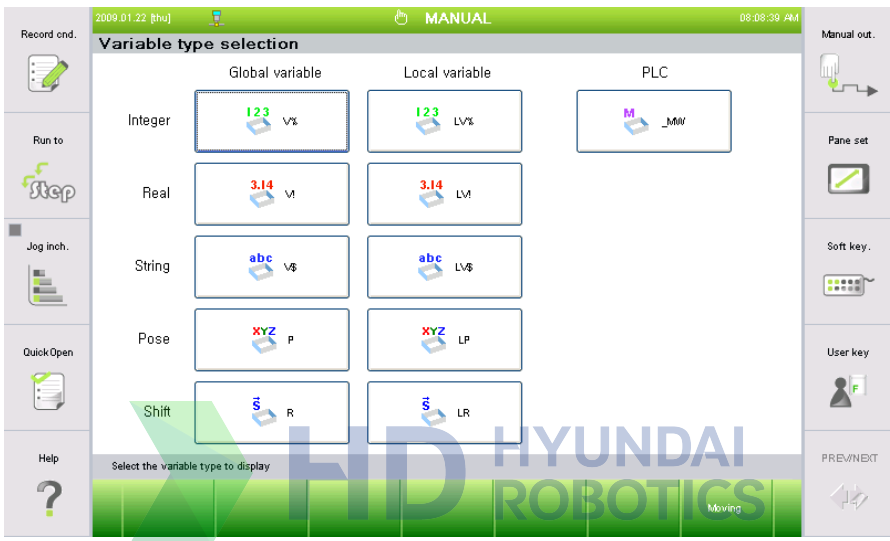


Figure 4.69 Variable type selection screen

- (2) All parameters of the selected type will be displayed. Use the arrow direction key to move to the desired parameter and enter the new value. And then when you press the [ENTER] key, the entered value will be set.

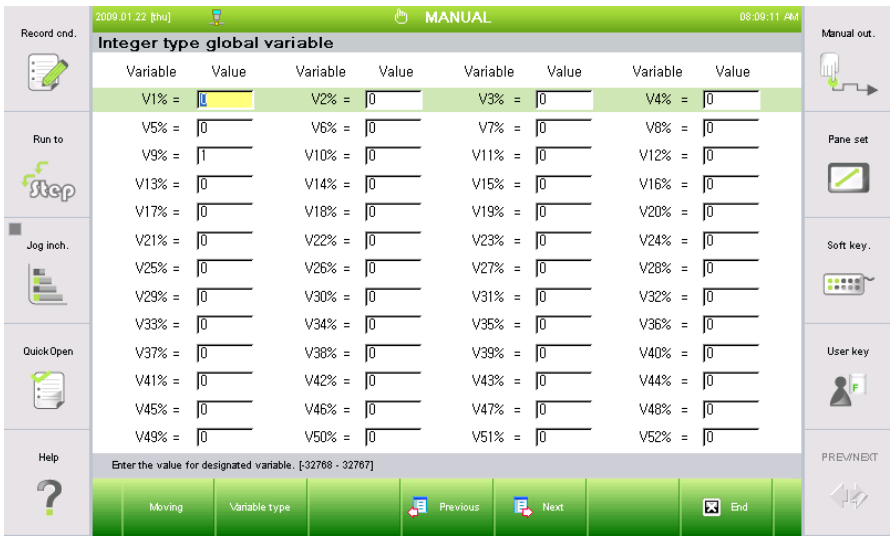


Figure 4.70 Variable value setting screen

- (3) You can press the 『F1]: Moving』 key and move to the parameter of the specific number.

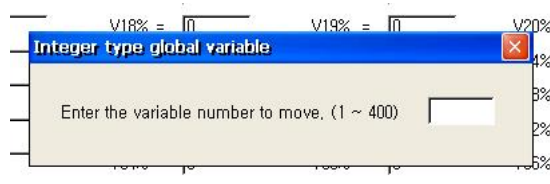


Figure 4.71 Screen for setting the variable to move

- (4) When you press the 『F2]: Variable type』 key, it will return back to the parameter type selection screen.

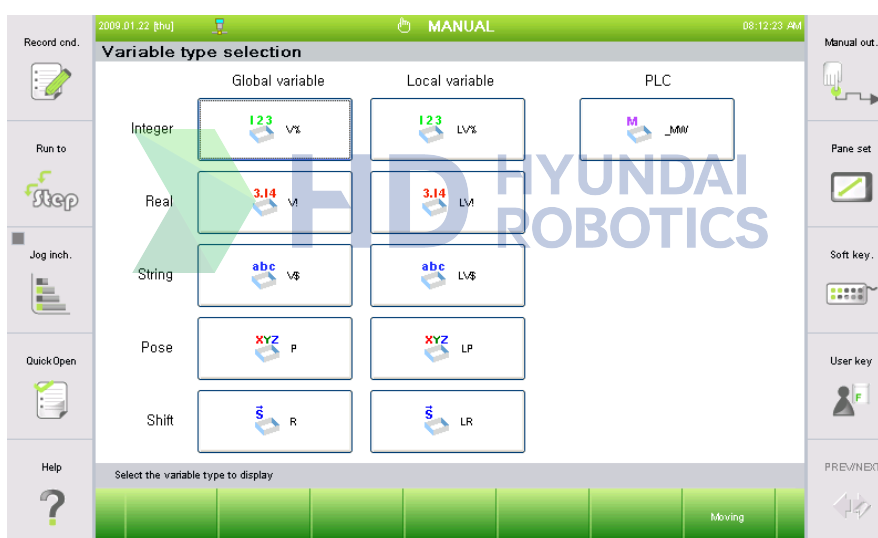


Figure 4.72 Return to the variable type selection screen

4.5. Data comment

You can add a note for each relay of the embedded PLC. Set note is displayed on the various data monitoring windows and saved as `WResident Flash\datacmnt.txt` file. This file format is compatible with the function of 『Import relay description』 / 『Export relay description』 of HRLadder.

- (1) Select 『[F1]: Service』 → 『4: Data note』.

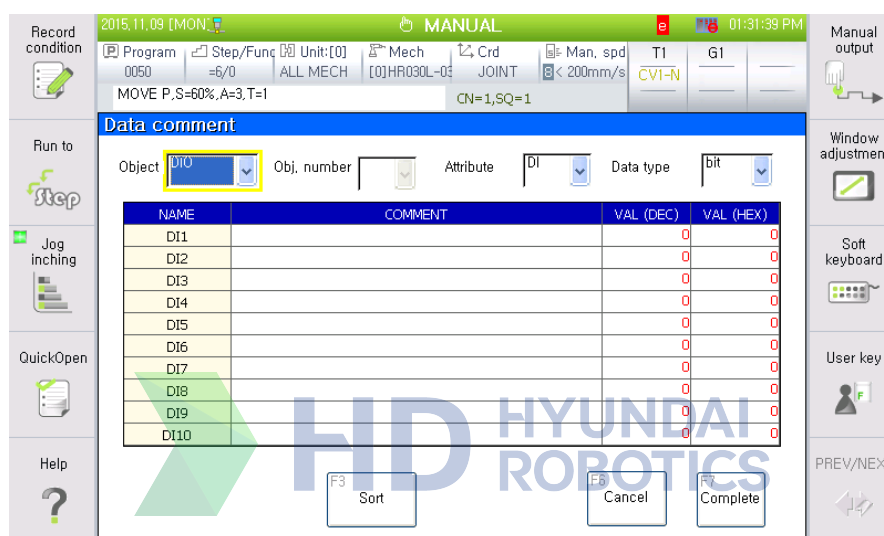


Figure 4.73 Data comment screen

- (2) Yellow rectangular label shows which control is the focus of the current key pad operation. When you press the arrow key, you can move this focus to the prior/next control.
- (3) When you set the focus on the dropdown list on the top of the screen and press the [ENTER] key, the items that can be selected will be displayed. First, select the object and object number and then select the detail item through property.

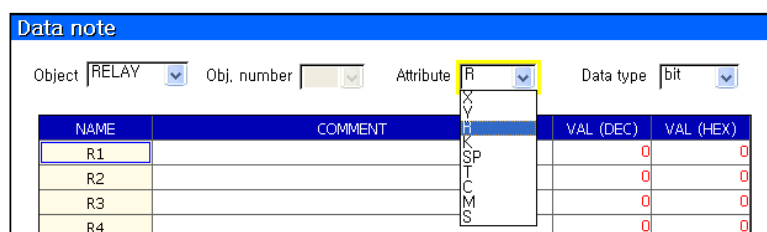


Figure 4.74 Data comment object setting

- (4) Adjust the data type dropdown list to change the display method.

Data note

Object: RELAY Obj. number: Attribute: R Data type: word

NAME	COMMENT	VAL (DEC)	VAL (HEX)
RW1		0	0000
RW2		0	0000
RW3		0	0000
RW4		0	0000

Figure 4.75 Data comment display method setting

- (5) When the focus is on the note table, you can use the arrow key [↑] [↓] to move the cursor to another relay. When you press [SHIFT] + [↑] [↓], you can move faster.

NAME	COMMENT	VAL (DEC)	VAL (HEX)
R10	BUZZER_STOP_AUX	0	0
R11	RBT_GUN PRESSINGAUX	0	0
R12	RBT_GUN WELDING COMPLETEAUX	0	0
R13	RBT_GUN2PRESSINGAUX	0	0
R14	RBT_GUN2WELDING COMPLETEAUX	0	0
R15	WELDING CONDI.OKAUX	0	0
R16	ATD WELDING CONDI.OKAUX	0	0
R17	WELDING POSSIBLEAUX	0	0
R18	ATD CONDI.OKAUX	0	0
R19	RBT GUN ATD RUN AUX	0	0

Figure 4.76 Moving the cursor

- (6) Enter the relay number next to the name and press the [ENTER] key to immediately move to the applicable relay.

R13	RBT_GUN2PRESSIN	R98	BODY TYPE12E
R14	RBT_GUN2WELDIN	R99	
100	WELDING CONDI.O	R100	
R16	ATD WELDING C	R101	PED_GUN ATD RL
R17	WELDING POSSIBL	R102	PED_GUN ATD RL

Figure 4.77 Jumping quickly to the relay of the set number

Controller Operation Manual

- (7) When you press the [Soft keyboard] key in the note column, you can edit the note.



Figure 4.78 Editing the data comment by using the soft keyboard

- (8) When you press the 『[F3]: Alignment』 key, you can sort the whole data comment in an appropriate order. Be careful that sorting can take a long period of time depending on the condition. Because the data comments are displayed in sorted format, you do not need to sort every time. Unsorted datacmnt.txt file is imported externally and execute this function once only when you want to sort and save the file.

4.6. File manager

You can manage the file of internal memory of the main board, teach pendant or USB memory.

- (1) Selection 『F1]: Service』 → 『5: File manager』.

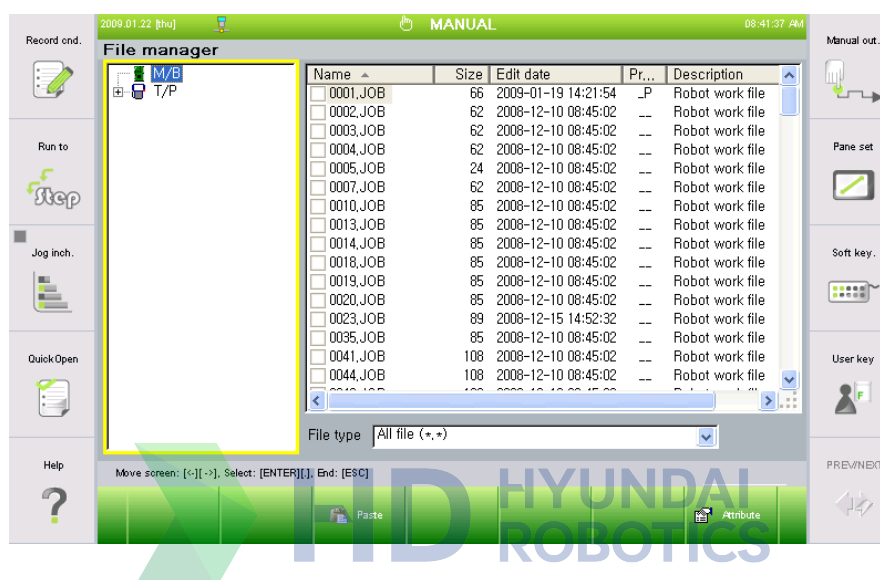


Figure 4.79 File manager screen

- (2) Yellow rectangular label shows which window is currently the focus of the current key pad operation. You can use the arrow key [←] / [→] to move this focus to a different window.



Reference

- This is the same function as the 『R17: File Manager』 of R Code
- Once USB memory is installed, the  icon will appear the title bar. Please do not remove the USB memory while a file management (copy, delete) is being operated.

Controller Operation Manual

- (3) The left side of the screen shows the tree window that shows the 3 devices, M/B (Main board), T/P (Teach pendant) and USB (USB external memory) and the sub folders. The M/B files are applied to actual robot operation, while the T/P and USB are spaces for backup. (USB is displayed when the USB memory is installed on the teach pendant.)
- When you press the arrow keys [$\uparrow$] [$\downarrow$], you can move the cursor between the nodes of the tree. Pressing [SHIFT]+ [$\uparrow$] [$\downarrow$] will move the cursor fast.
- Select the node with the $\oplus$ sign and press the [ENTER] key to display the sub nodes. Select the node with the $\ominus$ sign and press the [ENTER] key to hide the sub nodes.

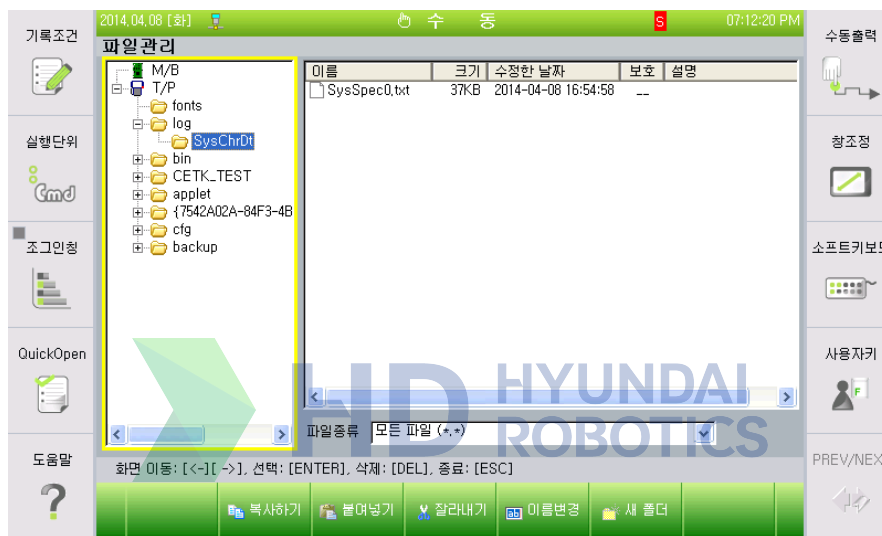


Figure 4.80 Moving in the file hierarchy

- (4) The top right part of the screen is the file list window that displays the file list within the selected folder from the tree window. This displays the name, size, edited date, protection and description of each file.

Name	Size	Edit date	Pr...	Description
☐ 0001.JOB	14	2008-03-12 09:43:14	--	Robot work file
☐ 0002.JOB	14	2008-03-12 09:56:38	--	Robot work file
☐ 0003.JOB	15	2008-03-12 10:23:14	--	Robot work file
☐ 0004.JOB	5	2008-03-12 10:35:14	--	Robot work file
☐ ROBOT,AAE	65	2008-03-12 09:55:12	--	Arc welding end cor
☐ ROBOT,AAP	129	2008-03-12 09:55:12	--	Arc welding unique

Figure 4.81 File list

- (5) [Size] column displays the file size and the unit for M/B is number of blocks, and for T/P or USB, the unit is byte.

- (6) [Protection] column displays the file protection condition. The meaning of the displayed symbol is as follows.

--	No protection	W_	Complete protection
WP	(Complete + Playback) protection	S_	Partial protection
SP	(Partial + Playback) protection	_P	Playback protection

- (7) There is a dropdown list box that you can select the file type to display from the file list at the bottom right side of the screen.
 You can use the arrow keys [←] [→] to set the focus on the file type list box and then use the arrow keys [↑] [↓] to select the type. (You can press the [ENTER] key to open and close the dropdown menu of the file type list box.)

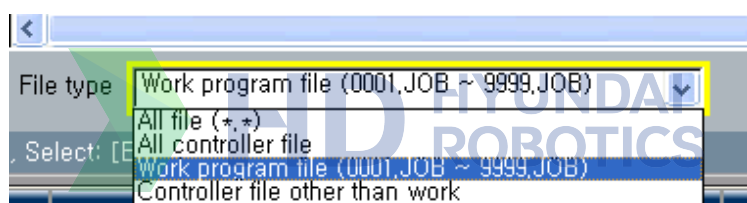


Figure 4.82 File type selection

4.6.1. Copy/Paste/Delete file

You can copy, paste and delete one or several files.

(When copying the file within the main board, the property of the copied file will not be included because the property or date cannot be copied. The current time will be copied as the date. When copying the file within T/P or USB memory, the date and property are also copied.)

- (1) Set the focus to the folder tree window and select the folder you want.

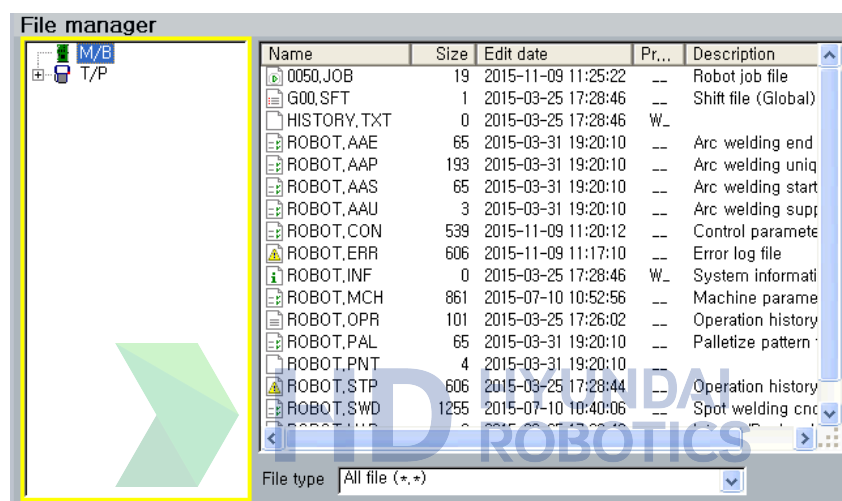


Figure 4.83 Folder selection screen

- (2) Move the focus to the file list window.

Use the arrow keys [↑] [↓] to set the cursor to the file you want to copy and select the file by press the [ENTER] key. A check sign is displayed on the left side of the selected file name. You can select several files in the same method.

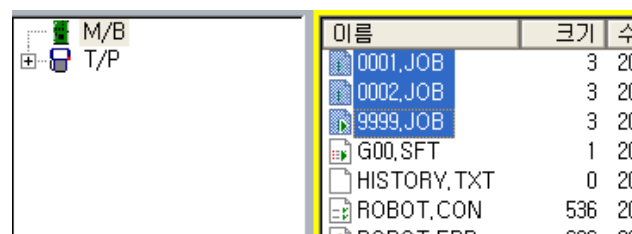


Figure 4.84 Selecting multiple files

- (3) To cancel the selection, press the [ENTER] key one more time.

When you press the 『[F1]: Select all』 key, all the files currently displayed will be marked with the check sign. If you press [ESC], all the “marked” will be canceled

4. Service

- (4) When you press the 『F2]: Copy』 key, all the selected files will first be copied to the clipboard of the teach pendant (actually to a temporary folder).
(If there is only 1 file to copy, you can also press the 『F2]: Copy』 key without checking the file.)
- (5) After moving the focus to the folder tree window again, select the target folder to copy the files.

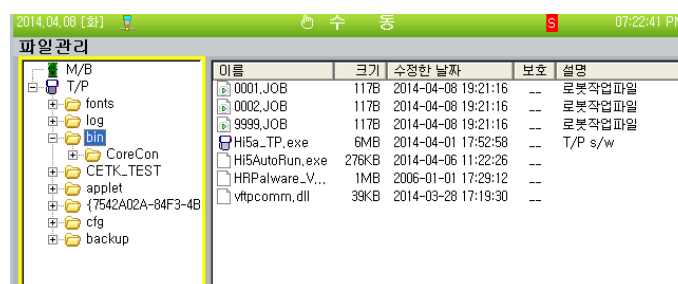


Figure 4.85 Selecting the target folder of paste action

- (6) Press the 『F3]: Paste』 key to copy the files on the clipboard to the selected folder. If the job file of same number already exists, it will request for a different job number. Enter an appropriate number in this case.
(You can use this function to copy the same job file in the same folder to a different number.)

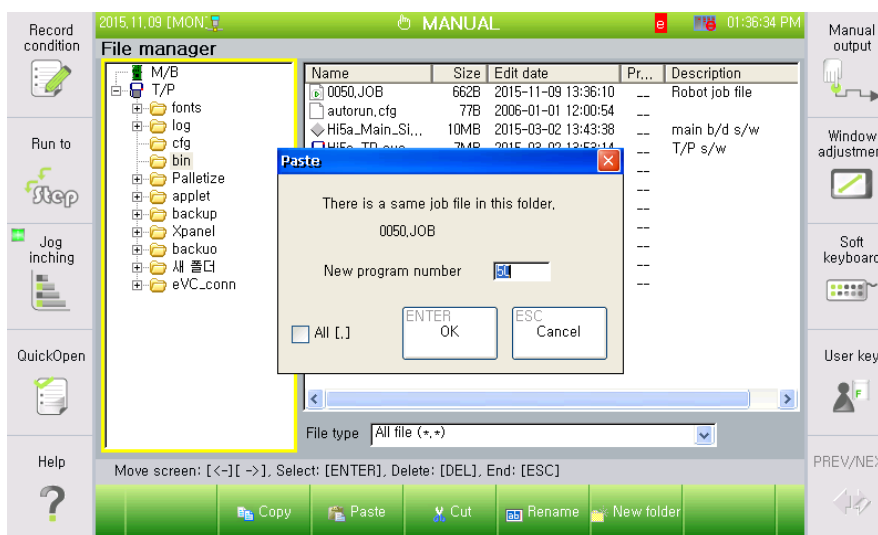


Figure 4.86 Job file overlapped setting

- (7) If there is a file with the same file name as the job file, it will prompt you to ask whether to overwrite the file.

Controller Operation Manual

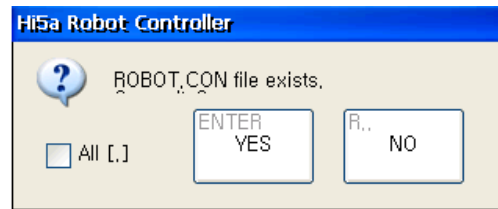


Figure 4.87 Non job file overlapped setting

(If this dialog appears when number of files are selected, you may press [.] to mark “Apply to all” and select “Yes” or “No”. This will apply the same selection to the all other files.)

- (8) To delete the file, set the focus to the file list window and select the file you want to delete. And then press the 『DEL』 key.
(When the file property is set to fully protect or partially protected, the file cannot be deleted.)

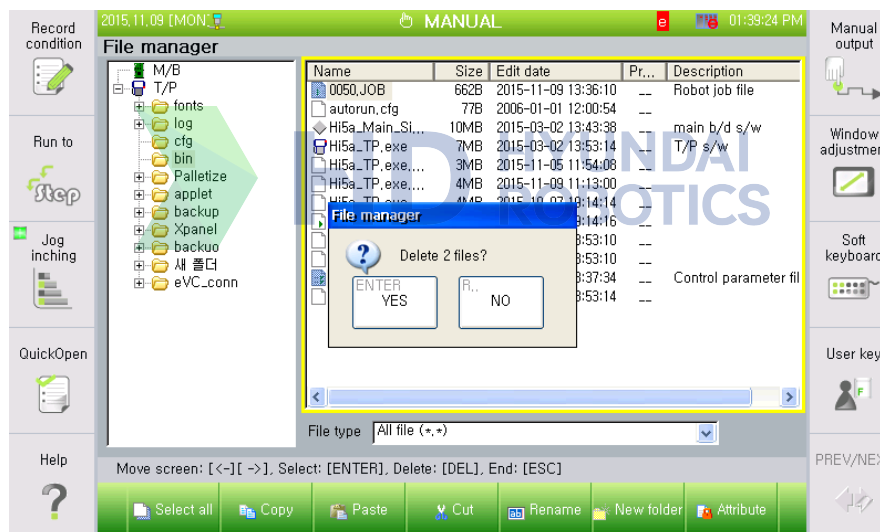


Figure 4.88 Deleting multiple selected files

- (9) A message box will be displayed to confirm to delete the file and then press the [ENTER] key to delete the file.
(When there is only 1 file to delete, you can use the 『DEL』 key directly without checking the file.)

4.6.2. Copy/Paste/Cut folder

You can copy, paste and delete one folder and all the folders and files under that folder.

- (1) Set the focus on the folder tree window and move the cursor to the folder you want to select.

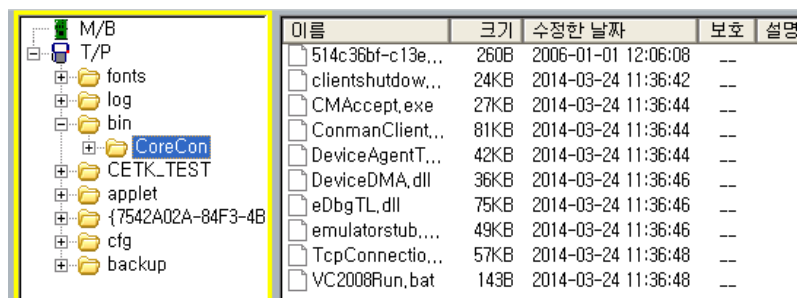


Figure 4.89 Selecting the folder to copy

- (2) When you press the 『[F2]: Copy』 key, you can copy the selected folder and all the folders and file under that folder to the clipboard (actually to a temporary folder).
- (3) Select the target folder to paste the folder copied from the folder tree window.

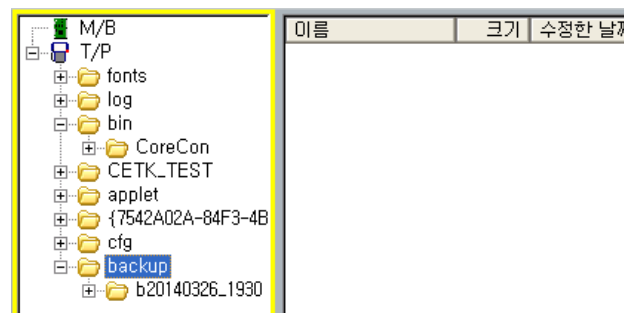


Figure 4.90 Selecting the target folder of paste action

- (4) When you press the 『[F3]: Paste』 key, the folder copied to the clipboard will be copied as the sub folder under the selected folder.

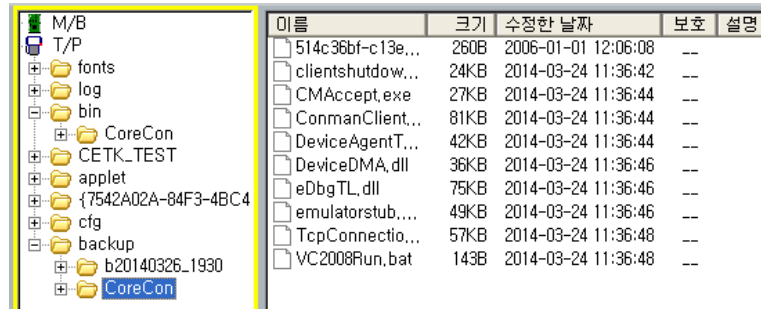


Figure 4.91 Folder pasting

- (5) To delete the folder, set the focus to the folder tree window and select the folder you want to delete, and then press the 『[F4]: Cut』 key. A message box will be displayed to confirm to delete the folder and then press the [ENTER] key to delete the file.

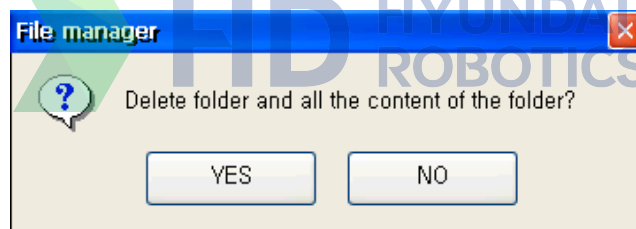


Figure 4.92 Folder deletion

4.6.3. Rename file

You can change one or several file names.

When the number is changed, all information [Date, property...] will be maintained. You can change the number for the protected file as well. R116 of R code: This is the same function as the change in program number.

- (1) Set the focus on the file list window and select the file to rename.

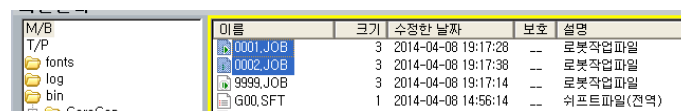


Figure 4.93 Selecting a file to rename

- (2) When you press the 『[F5]: Rename』 key, the selected file names will switch to edit condition.

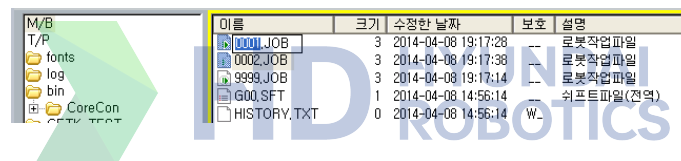


Figure 4.94 File renaming

- (3) When you are entering only the numbers, you can use the [SHIFT] + [←] [→] key to move the cursor and use the [Backspace / DEL] and number keys to rename the file.

이름	크기	수
0001.JOB	909B	20
0002.JOB	79KB	20
0015.JOB	702B	20
0007.JOB	284B	20
0567.JOB	2KB	20
9999.JOB	164B	20
ROBOT.CON	10KB	20

Figure 4.95 Cursor operation when renaming a file

- (4) When you press the [ENTER] key the edit will be completed, and the next file will be in edit condition.

이름	크기	수
0001.JOB	909B	20
0002.JOB	79KB	20
0015.JOB	702B	20
0007.JOB	284B	20
0567.JOB	2KB	20
9999.JOB	164B	20
ROBOT.CON	10KB	20

Controller Operation Manual

Figure 4.96 File renaming and editing completed

- (5) You can only rename files other than the job file in the T/P or USB mode. You can only rename the job file in M/B.

이름	크기	수정
0001.JOB	909B	200
0002.JOB	79KB	200
0015.JOB	702B	200
0017.JOB	284B	200
0567.JOB	2KB	200
9999.JOB	164B	200
ROBOT3.CON	10KB	200
ROBOT.ERR	16KB	200

Figure 4.97 Limitation to renaming a file in M/B

- (6) When you have to enter characters besides numbers, press the [Soft keyboard] key in the edit condition of the file name and use the soft keyboard to edit the name.



Figure 4.98 Using the soft key to enter characters

4.6.4. Rename folder

You can rename the folder.

- (1) Set the focus on the folder tree window and select the folder you want to rename by moving the cursor.

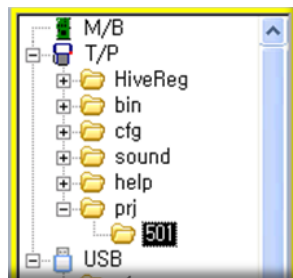


Figure 4.99 Selecting a folder to rename

- (2) When you press the 『[F5]: Rename』 key, the folder name will switch to edit condition.

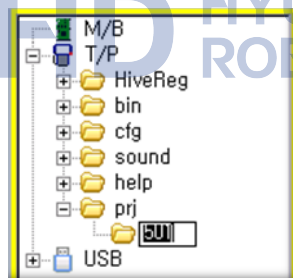


Figure 4.100 Editing the folder name

- (3) When you are entering only the numbers, you can use the [SHIFT] + [←]/[→] key to move the cursor and use the [Backspace / DEL] and number keys to rename the folder. When you press the [ENTER] key, the edit will be completed.

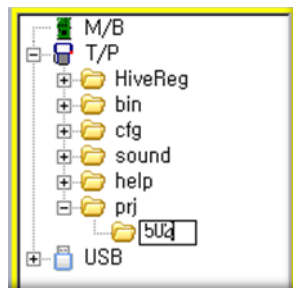


Figure 4.101 Folder name editing completed

- (4) When you have to enter characters besides numbers, press the [Soft keyboard] key in the edit

condition of the folder name and use the soft keyboard to edit the name.

4.6.5. Create new folder

You can create a new folder in T/P or USB.
(You cannot create a new folder in M/B.)

- (1) Set the focus on the folder tree window and move the cursor to the folder you want to create a new folder.

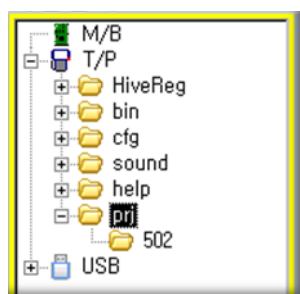


Figure 4.102 Selecting a parent folder to create a new folder in

- (2) Press the 『[F6]: New folder.』 key to create a new folder as a sub folder of the selected folder.

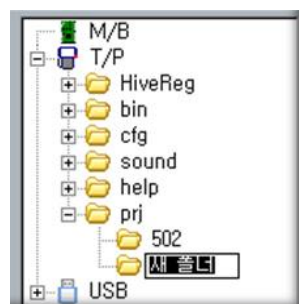


Figure 4.103 Creating a new folder and editing its name

- (3) Use the rename method to designate a new name.

4.6.6. Edit property

You can edit the property of one or several file names.

You can protect important files by prohibiting changing the program or deleting the file. When you set to fully protected, the file cannot be edited or deleted, and if you set the file to partially protected, only the location can be edited from the fully protected and when the playback function is set to be protected, the program protects the file from playing or moving the steps forward. For the files within T/P or USB, you can only enable fully protected option.

- (1) Set the focus on the file list window and select one or several files to change the property of, and then press the 『F7: Attribute』 key. The following property change message box will be displayed.

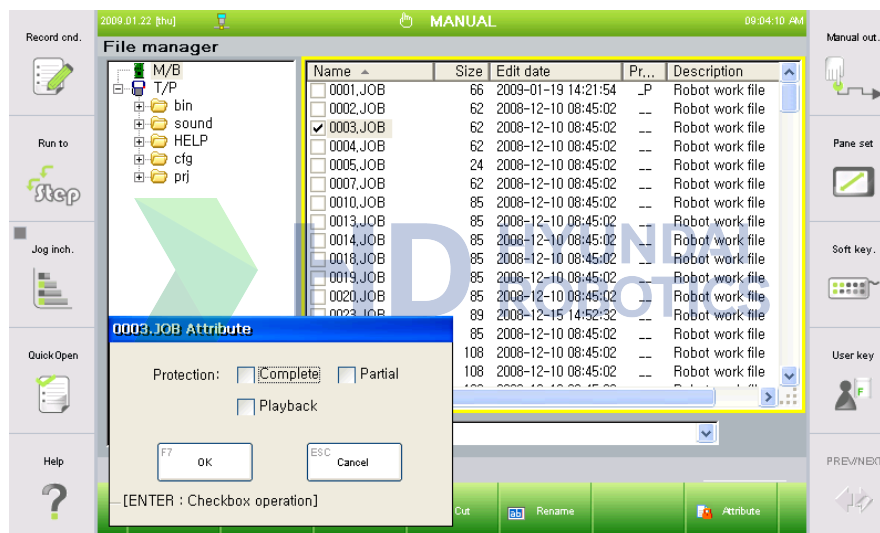


Figure 4.104 Changing file properties

- (2) You can use the arrow key to move the cursor and toggle the check mark with the [.] key. After editing the property, press the [ENTER] key to complete the edit.
(When you have selected several files, new property will be applied to all the files in a batch process.)



Reference

- The properties of M/B files are only to be modified by the engineer for safety reasons.
- You can apply all properties for the job file of M/B.
- You cannot apply the playback protection for other files of M/B besides the job file.
- You can only apply fully protected option for the T/P or USB file.
(Fully protected corresponds to read only in the Windows file system.)
- Even though the record file is fully protected, it will still continue to be updated.
- Even through the program is playback protected, you can still execute the program is you execute from the midpoint of the program and not the start.
- You can only set between complete protection (W) and partial protection (S). But playback protection (P) can be applied with complete protection (W) or partial protection (S).



4.7. Program conversion

This provides the function of editing various record conditions and locations of the existing program individually or in a batch process, or the function of creating a new program with the coordinates converted.

Selection 『[F1]: Service』 → 『6: Program conversion』 .

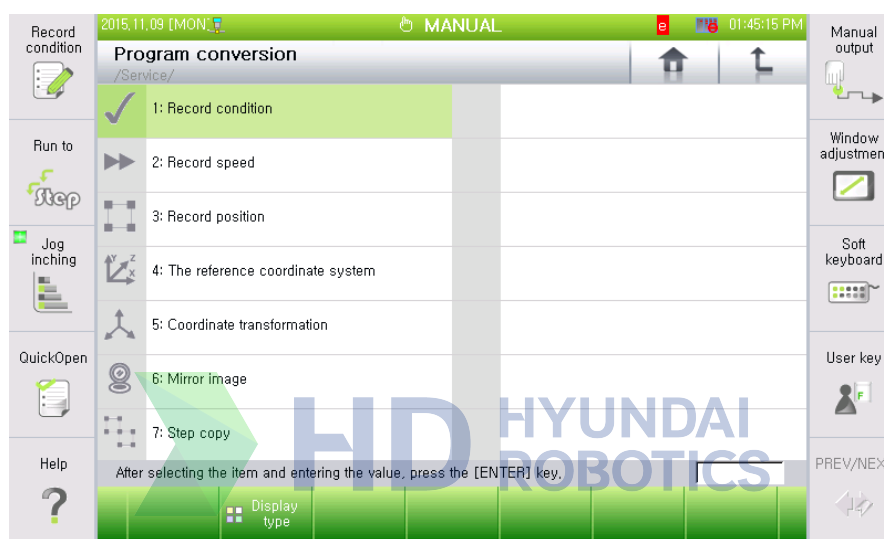


Figure 4.105 Program conversion screen



Reference

- You cannot enter the 『4: Record coordinate』 , 『5: Coordinate transfer』 , 『6: Mirror image』 , 『7: Step copy』 while the robot is operating.

4.7.1. Record condition

You can change the condition recorded for various steps within the program to create the same or new program.

- (1) Select 『F1: Service』 → 『6: Program conversion』 → 『1: Record condition』 .

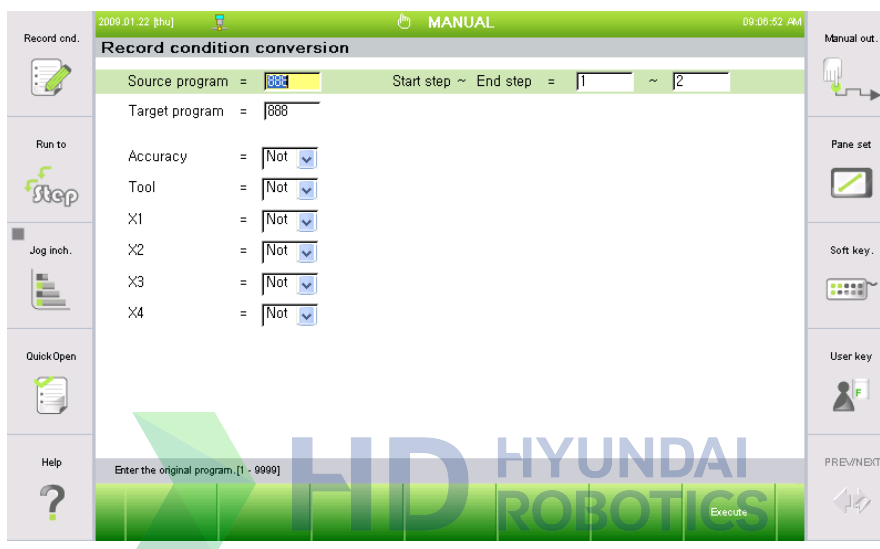


Figure 4.106 Record condition conversion screen

- (2) Execute with 『F7: Execute』 key after changing the condition.

- Source program : Number of the source program to change the condition
- Target program
Number of the target program to save after changing the condition
If the number is the same as that of the source program, it will be overwritten.
- Start step ~ End step
Range of steps to change the record condition. (Default value 1~ End step)
- User sets the conditions including accuracy, tool, X1, X2, X3 and X4 condition from the start to end step.

4.7.2. Record Speed

You can change the speed of several steps of the program at once.

- (1) Select 『F1』: Service』 → 『F6: Program conversion』 → 『F2: Record speed』

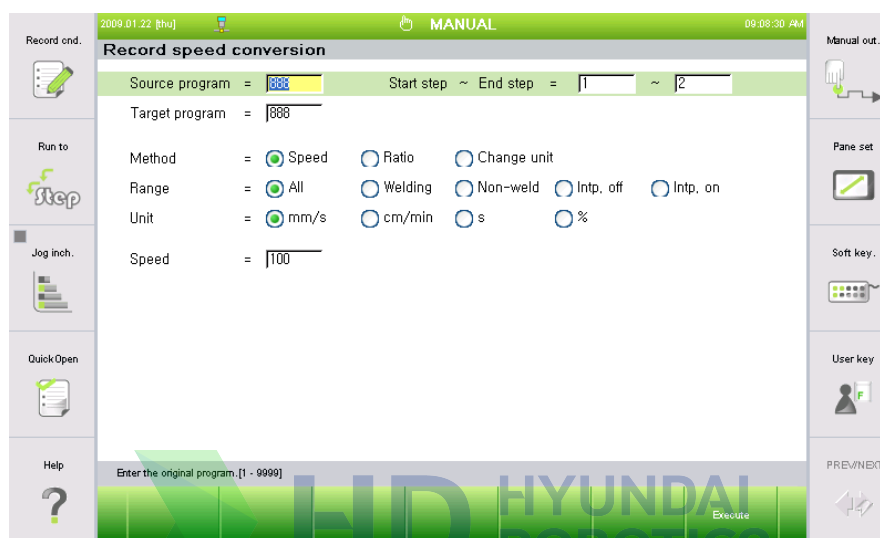


Figure 4.107 Record speed conversion screen

- (2) To save the changed setting, press the 『F7』: Execute』 key. When you press the [ESC] key, the changed data will not be saved.

- Source program
Number of source program to change the speed.
(Default value is the program number currently selected)
- Target program
Number of the target program to newly save after changing the speed
If the number is the same as that of the source program, it will be overwritten.
- Start step ~ End step
Range of steps to change the speed. (Default value is 1~ End step)
- Method: Decide the speed designation method.
Speed designation: Batch conversion of recorded speed
Percentage designation: When the speed unit recorded is the same as the designated unit in [Unit], you can use this to convert to a specific percentage for the recorded speed
Unit conversion: Use this to convert the unit of the recorded speed
- Range
Select from the range (steps) to change the speed whether to apply to all intervals or just

to the welding, non-welding, interpolation OFF (P) or interpolation On (L, C) part.

- Unit
If the [Method] is set to <Speed> or <Change unit>, then you can change the speed in the set unit here. If it is set to <Ratio>, it will convert to the ratio of the percentage only when the recording speed unit on the step is aligned.
- Speed: (Changes by the selection of [Method])
When the [Method] is set to <Speed>, it refers to the speed value and if set to <Ratio>, it refers to the percentage value.



4.7.3. Record Position

You can change the coordinate system of the step location recorded with hidden pose.

- (1) Select 『F1』: Service』 → 『F6』: Program conversion』 → 『F3』: Record position』 .

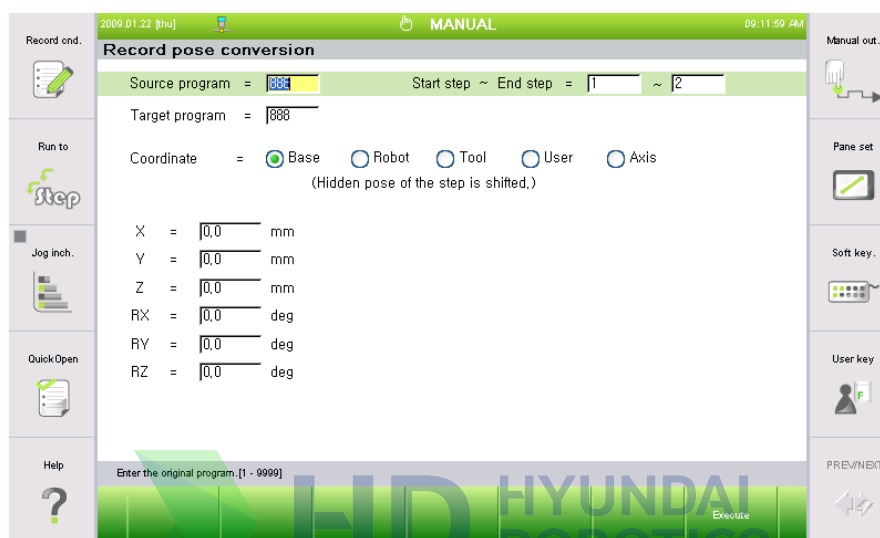


Figure 4.108 Record pose conversion screen

- (2) After entering the data, press the 『F7』: Execute』 key. When you press the [ESC] key the changed data will not be saved.

- Source program: Number of the source program to change
- Target program
Location where the changed program will be saved.
If the number is the same as that of the source program, it will be overwritten.
- Start step ~ End step
Range of steps to change the record location. (Default value is 1~ End step)
- Coordinate
Select the coordinate system to shift the location data recorded in the step. Base, robot, tool and user coordinate systems can be shifted in Cartesian coordinate value and axis can be shifted in axis angle.

4.7.4. Record Coordinate

You can change the coordinate system of the step location to record with hidden pose. You can change the coordinate system of the step location to record with hidden pose. The changed coordinate system can be checked by pressing the Quick Open button in the relevant step.

- (1) Select 『[F1]: Service』 → 『6: Program conversion』 → 『4: Record coordinate』

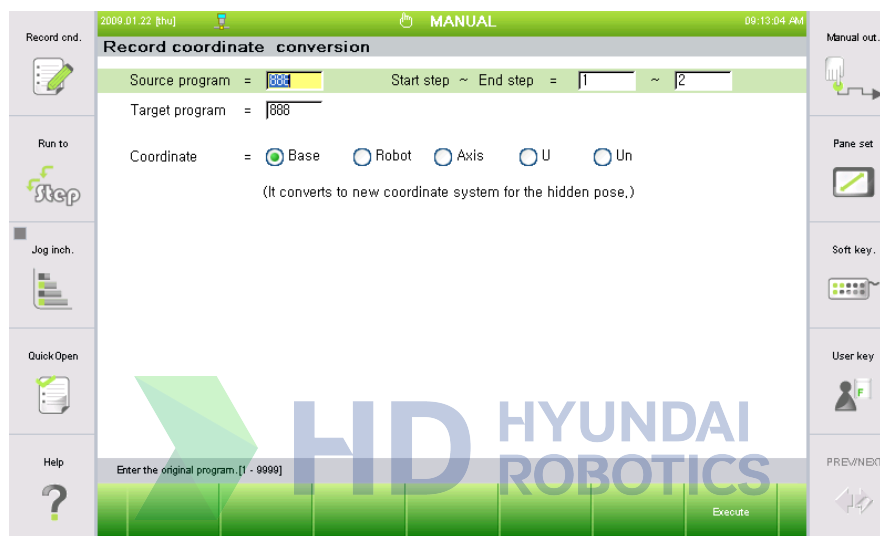


Figure 4.109 Record coordinate conversion screen

- (2) After entering the data, press the 『[F7]: Execute』 key. When you press the [ESC] key the changed data will not be saved.

- Source program : Number of the source program to change
- Target program
Location where the changed program will be saved.
If the number is the same as that of the source program, it will be overwritten.
- Start step ~ End step
Range of steps to change the record location. (Default value is 1~ End step)
- Coordinate
Select the new coordinate system to designate. You can select from base, robot, axis, Encoder (Enc), current user (U) and number designation user (Un) coordinate system.

4.7.5. Coordinate conversion

Through this coordinate conversion function, once after teaching a program for the workpiece shown in the (Figure 1), the program can be easily prepared for another workpiece of the same shape placed in a different position as shown in (Figure 2) without additional teaching

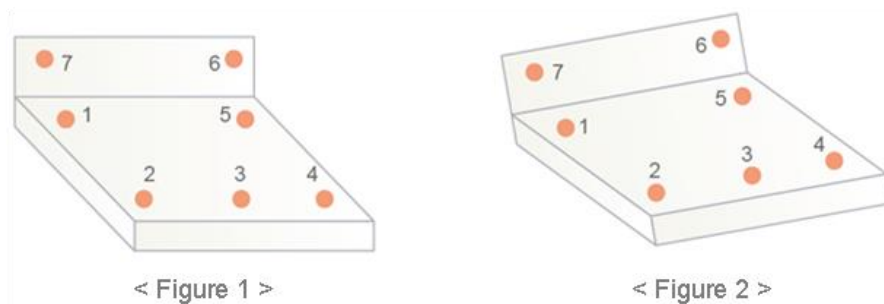


Figure 4.110 Coordinate conversion

To convert coordinates, three standard points are needed. In the original position, mark three standard points on the workpiece, and record the three points in [Program A]. After moving the workpiece to the other position, mark the same standard points in [Program B].

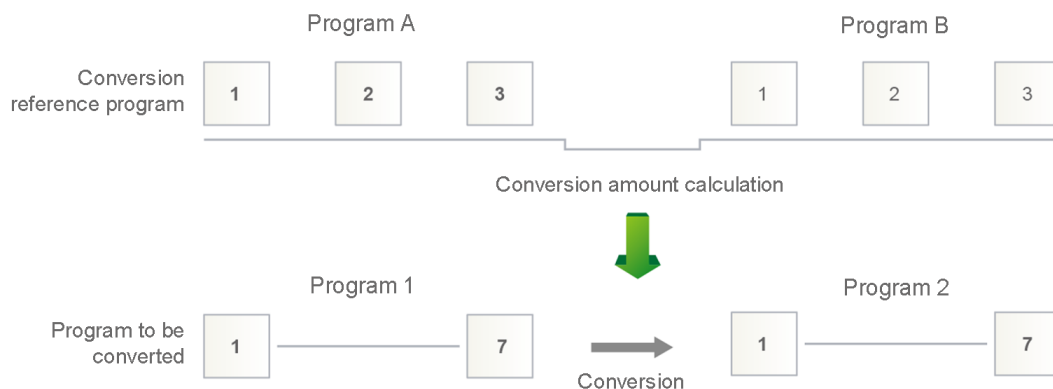
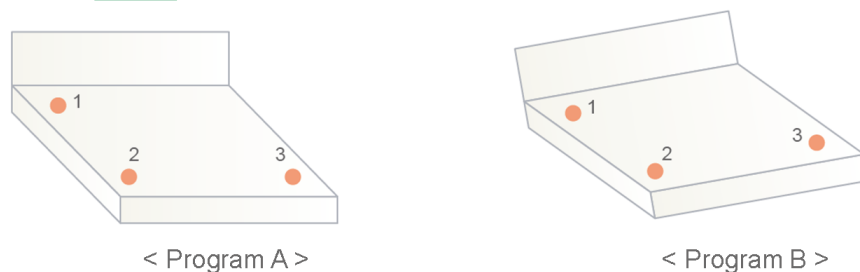


Figure 4.111 Coordinate conversion Program

Controller Operation Manual

By calculating Coordinate Transfer quantity from Program A and B and the standard three steps, convert the source program [Program 1] to a new one [Program 2].

- (1) Selection 『F1』: Service』 → 『6』: Program Conversion』 → 『5』: Coordinate transfer』 .

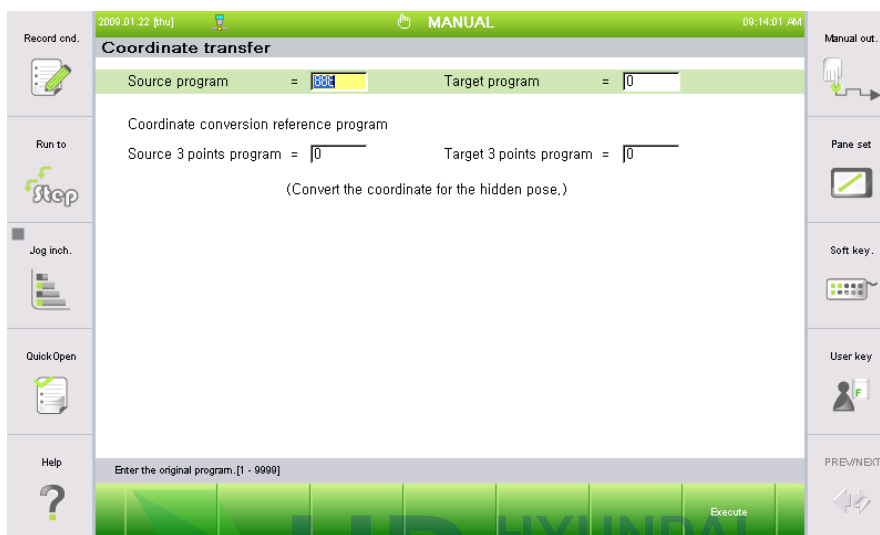


Figure 4.112 Coordinate transfer screen

- (2) After data setup, press 『F7』: Execute』 .

- Source program : Existing teaching program number (Program number of [Figure. 1])
- Target program
Program number to newly create by executing coordinate conversion (Program number of [Figure. 2])
- Source 3 points program
Program number in which the 3 points of reference for conversion are recorded ([Program A] number)
- Target 3 points program
Program number in which the 3 points of reference for conversion are recorded ([Program B] number)



Reference

- The teaching level regarding 3 standard points affects accuracy of a Coordinate Transfer program. Teaching the 3 standard points should be as accurate as possible.

- The distance between the 3 standard points should be as far as possible.

4.7.6. Mirror image

A program which sets the position of Axis S and that of wrist axis symmetrical can be drawn up. (Y-Z plane is the center of the symmetry.)

Mirror Image is useful when the same motions (including body welding of vehicles, etc.) for two robots on the opposite sides are required. After teaching a program to one robot, the other one on the opposite side retrieves and converts the program by using Mirror Image. Then, a new program which sets the symmetry about Axis S is created.

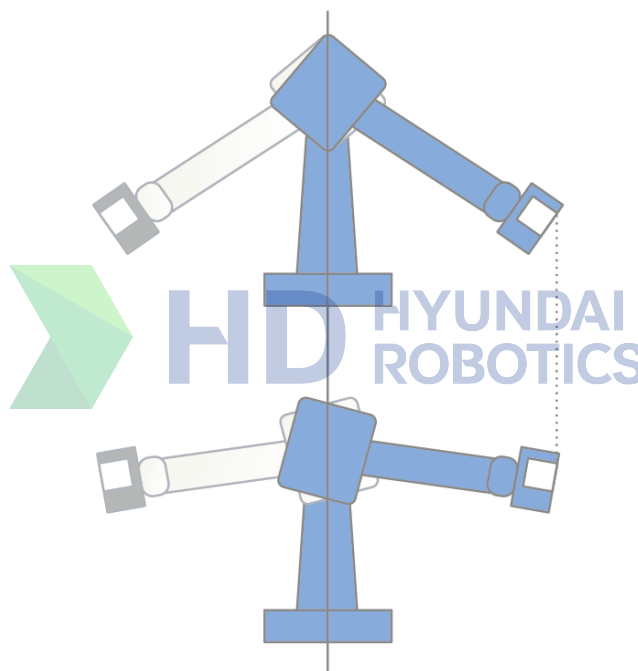


Figure 4.113 Source program → Converted program by using Mirror Image

Controller Operation Manual

(1) Selection 『F1』: Service』 → 『6: Program conversion』 → 『6: Mirror image』 .

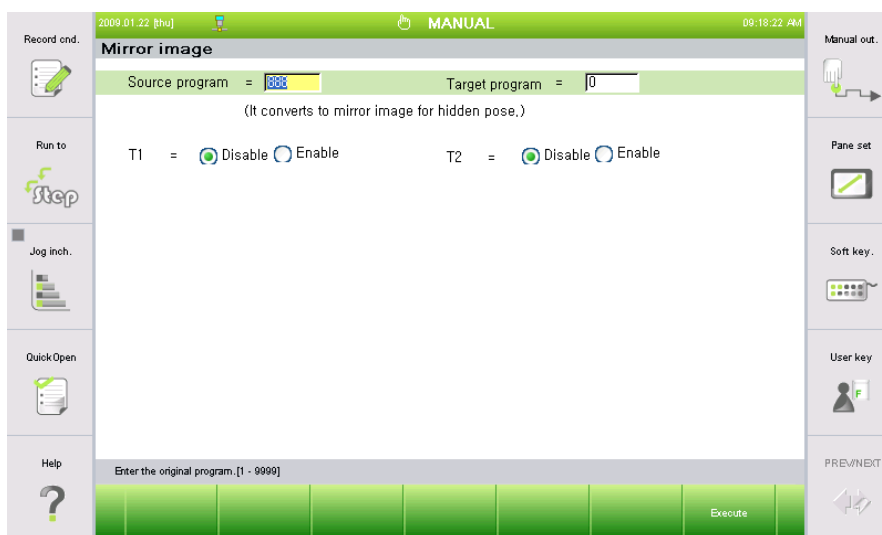


Figure 4.114 Mirror image setting screen

(2) Input data, press 『F7』: Execute』 .

- Source program: Number of the source program
- Target program: Number of a program to be created by using Mirror Image
- T1: Set as <Enable>, if the Mirror Image conversion of main axis is needed.



Reference

- If any axis exceeds soft limit in the process of Mirror Image conversion, such axis will be indicated in 'Range exceeded steps.'

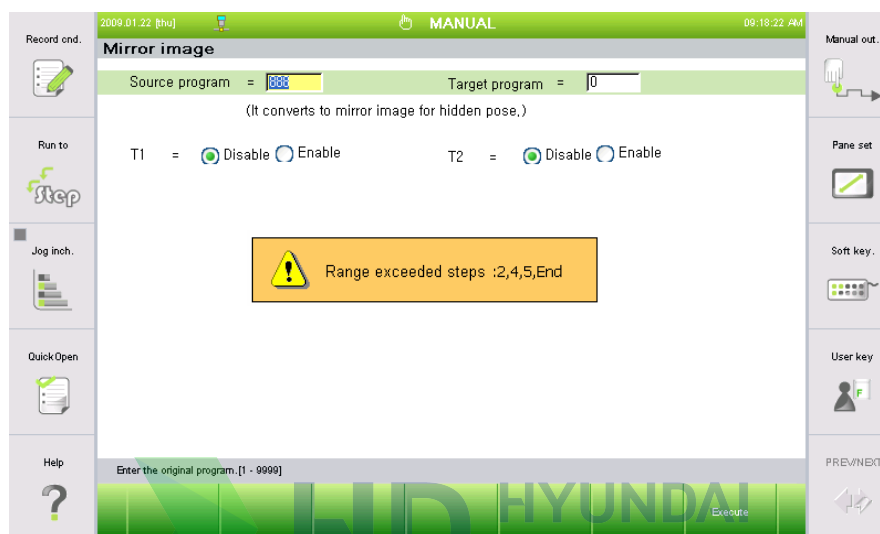


Figure 4.115 Range exceeded steps warning screen

If 'Range exceeded steps' indicates 'End,' it means review is over. If 'Range exceeded steps' indicates '⇒,' it means there are more steps exceeding limit.

- Check which axis exceeds soft limit in person, and adjust it.
- Use the Mirror Image function for the same type of robots, because soft limits are different according to each robot type.
- Set the standard position of encoder and 0 degree position of each axis to be the same for the robots on the both sides.
- Use symmetrical guns and tools, or attach guns and tools symmetrically.

4.7.7. Step copy

This is the function to copy part of the program to another program or to the same program. The function recorded on the step is also copied at the same time and the step number designated with step jump (GOTO, GOSUB) is also automatically changed.

- (1) Select 『[F1]: Service』 → 『6: Program conversion』 → 『7: Step copy』 .

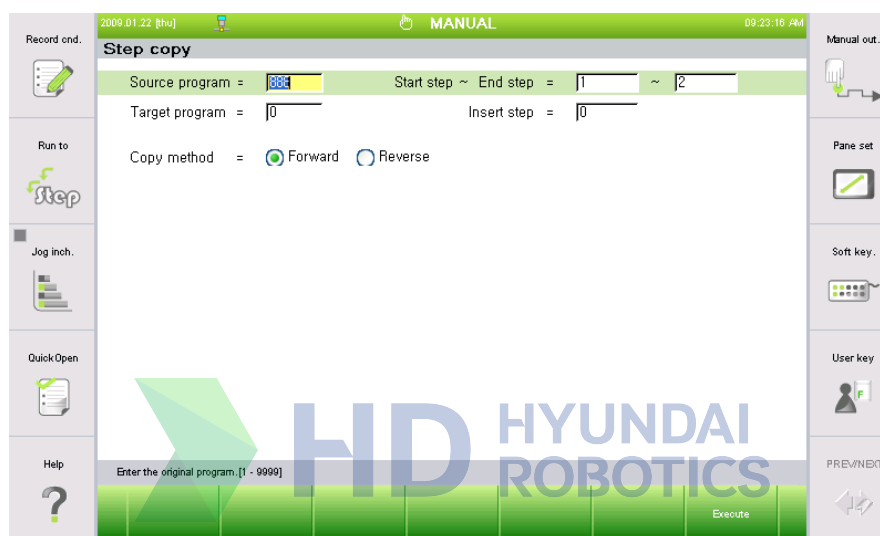


Figure 4.116 Step copy setting screen

- (2) Enter the data and press the [ENTER] key. And then press the 『[F7]: Execute』 key to complete the process.



Reference

- The following picture shows the case of copying the forward and reverse direction to step 2 of program 2 from step 2 to 5 of program 1.

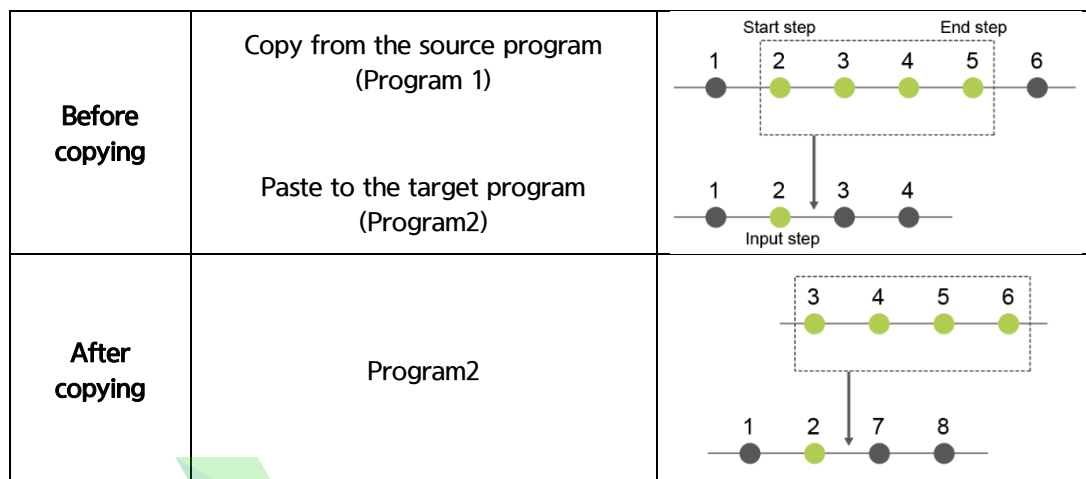


Figure 4.117 Copy step

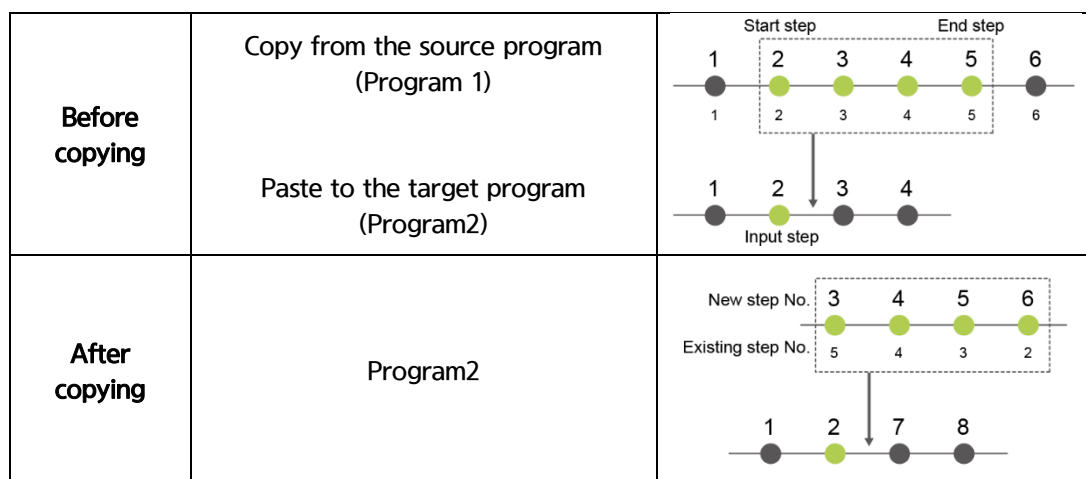


Figure 4.118 Copy step in reverse direction

- Insert the program to after the insertion step number of the program to copy.
- Because the step that includes the END copies the END function as well, you may need delete depending on the need.
- You cannot copy the program that is protected.

Controller Operation Manual

- If there is a step jump (GOTO, GOSUB) outside of the range to copy from the program to copy, the number will not change and you must change after the coping is completed.

4.7.8. Command statement comment

(This feature is available from the Hi5a V40.06-00 and later versions.)

This function automatically puts annotation on imperative sentences that utilize a preset variable annotation. It also contains a function to delete an annotation en bloc and to assign a serial number to the SPOT statement, spot welding statement.

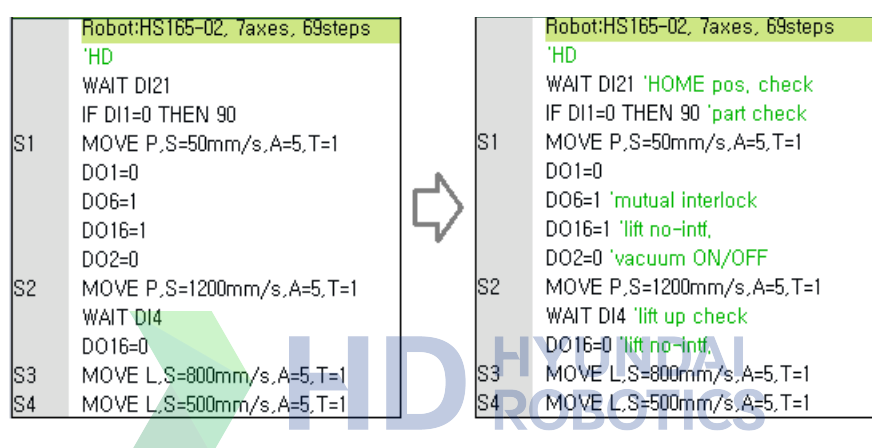


Figure 4.119 Change in the program – example 1 of performing command statement comment function (Signal assignment statement, WAIT statement)

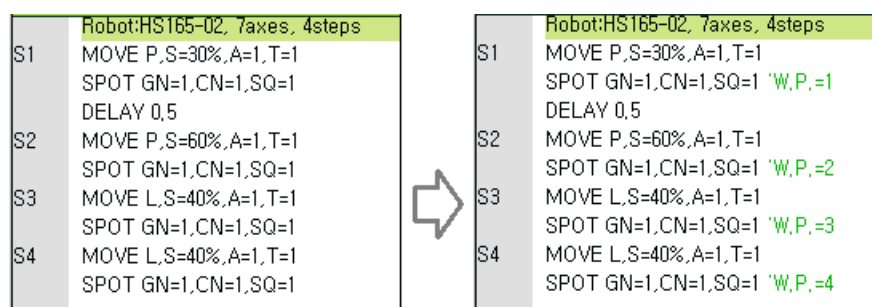


Figure 4.120 Change in the program – example 2 of performing command statement comment function (SPOT statement)

4. Service

- (1) Select 『F1]: service』 → 『6: program conversion』 → 『9: Command statement comment』 .



Figure 4.121 Command statement comment screen

- (2) After setting the conditions, run with the 『F7]: execution』 key.

- Source program
Number of the source program where you want to apply comment
If you set it to 0, it is performed on the entire area of all the JOB.
- Target program
Number of new target program to be saved after saving the comment
If it is the same as the source program number, it will be overwritten.
- Start step ~ End step
Range you want to change the recording conditions (The initial value is 0 – the last step)
For example, if it is set to 2–5, it will be applied from the MOVE sentence of step 2 until the end of the function of Step 5.
- Existing comment

Delete all	Delete statements where annotation is not applied to. Annotation statements, such as REM, are also deleted.
Overwrite	If the command sentence has an existing comment, it will be overwritten.
Skip	If the command sentence has an existing comment, it is not processed for the sentence.

Controller Operation Manual

- Application target (If you select “delete all” the existing comment, it will be hidden.)

Select target commands to apply the comment.

Target command statement	Automatic comment
MOVE	Against the MOVE statement containing a pose expression, use the comment of the first pose variable of the pose expression as a comment of the command statement. (You can set the comment of a pose variable in the entire pose screen of the 『F1]: service』 → 『3: variable』 or in the QuickOpen screen for the entire pose. It isn't applied to a hidden pose MOVE statement.
Left-hand side of assignment statement	Use the comment of left side variable in the assignment statement as a comment of a command statement.
WAIT IF (Including ELSE IF) SELECT	Use the comment of a variable specified as a condition parameter as a comment of a command statement. (Comment of a variable can be set through the screen of 『F1]: service』 → 『4: data comment』.)
SPOT	Use the serial number in the range of JOB as a comment of a command statement. For example, if you set the prefix to “WP #” and the starting number to 101, the comment is automatically entered like WP #101 for the first SPOT statement and WP #102 for the second SPOT statement.

- Prefix
It defines the prefix of the serial number to be applied to a comment of the SPOT statement.
Edit using the soft keyboard.
- Starting number
It sets the starting number of the serial number to be applied to a comment of the SPOT statement.



Reference

- If the condition parameters of the statement is in the equation, a comment is determined based on a variable that occupies the first character of the equation. For example, if DI1 is “part check” and DI2 is “vacuum check,” the comment of “part check” is applied to the IF statement below.

IF DI1=0 AND DI2=0 THEN 90 'part check

- In the block editing mode of the JOB edit screen, you can automatically enter an annotation to the currently selected statement by pressing the [F5: auto comment] key. Also, when you press the [SHIFT] + [F5 auto comment] key, it will automatically delete the comment of the selected statement. The related content is described in the “3.6 Block Edit” section.

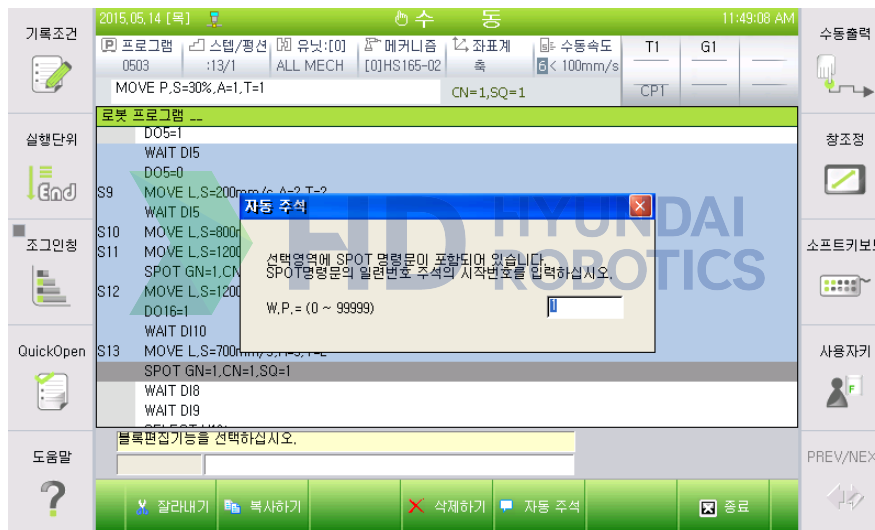
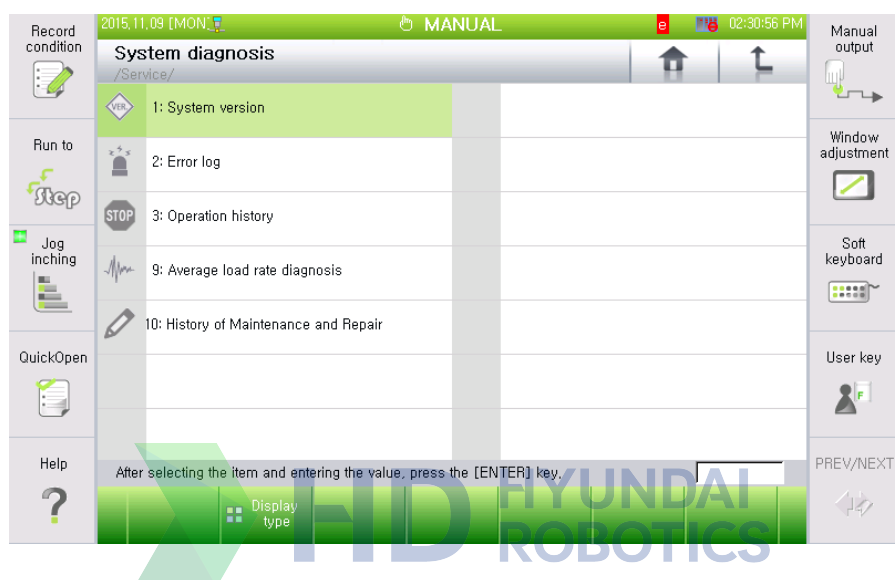


Figure 4.122 Apply the comment of a command statement in block editing mode

4.8. System diagnosis

System Checking helps robot maintenance by inspecting the state of robots and controllers.

Selection 『[F1]: Service』 → 『7: System diagnosis』 .



4.8.1. System version

It displays the system environment (software version) of a Hi5a controller. There are two ways to update the software version of a Hi5a controller. The first method uses an integrated compressed file containing the updated file. The software update file in the integrated compressed file is distributed according to compatibility between devices. Therefore, a malfunction caused by version incompatibility can be avoided. The second method is to specify the file to perform a software update for each component device.

In order to prevent a version incompatibility error, it is recommended to use the first method using an integrated compressed file.

The first method [recommended method]: software update with integrated compressed file

- (1) Create a folder to save the integrated compressed file to the top of the path of a USB memory. The folder name must be specified as "Hi5a_rel."
- (2) Then, save it in the Hi5a_rel folder where you created an integrated compressed file.
 - When the integrated compressed file is "Hi5aV400607.zip": W\Hi5a_rel\Hi5aV400607.zip
- (3) Attach the USB memory where you saved the integrated compressed file to the teach pendant USB slot. The screen is changed as follows.

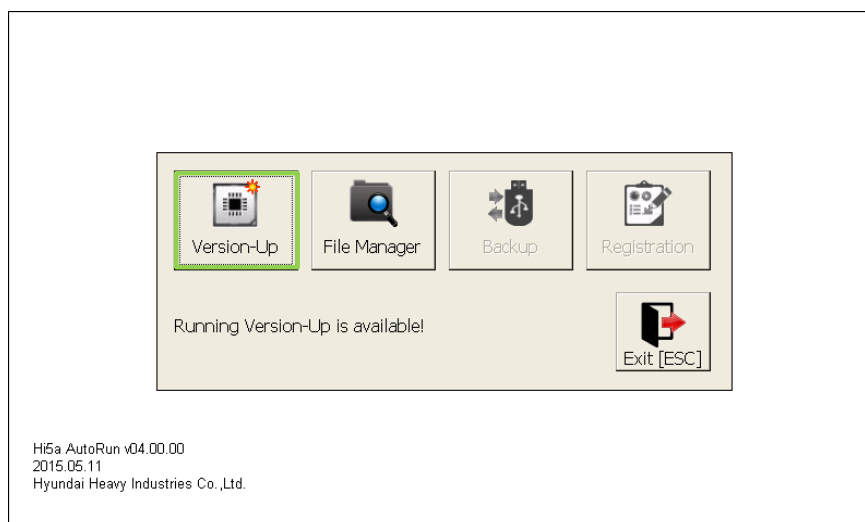


Figure 4.123 Screen when installing USB attachment for software updates

Controller Operation Manual

- (4) Currently, you can use the “Version-Up” and “File Manager” functions. To update the software, select “Version-Up.” If you select the “File Manager,” you’ll enter the 『F1』: service_ → 『5』: file management_ at a time

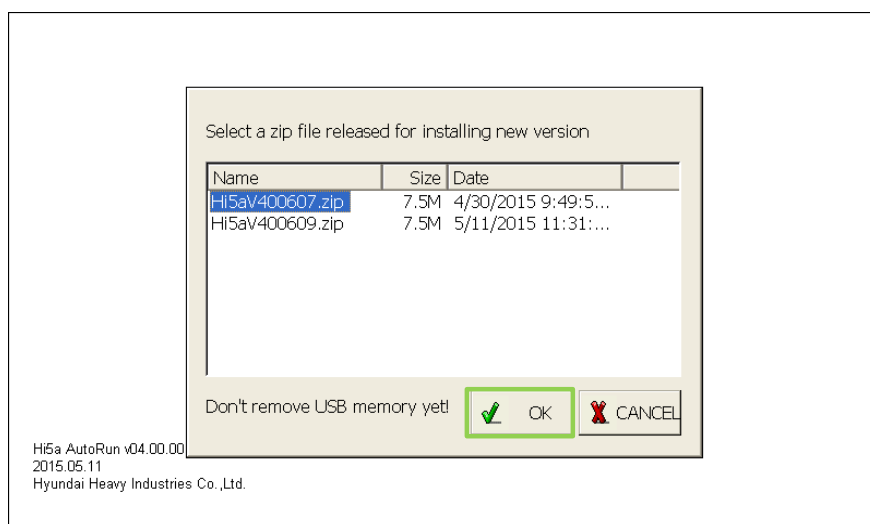


Figure 4.124 Compressed file selection screen of the software

- (5) The list of the integrated compressed file that you saved to a USB memory appears. Select the file to proceed with the software update. Then, press the 『OK』 button
- (6) After completing the initialization work for software updates, you will see the version information screen as follows.

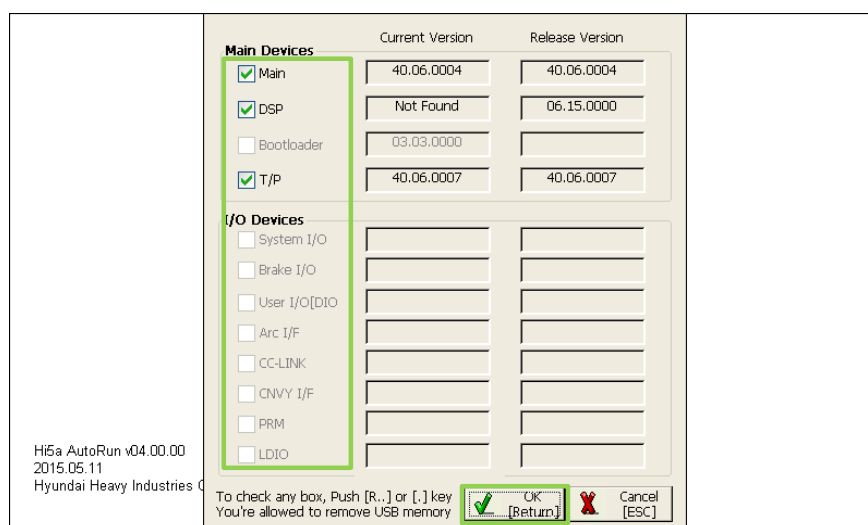


Figure 4.125 Configuration device selection screen for software update

- (7) You can move the cursor using the arrow keys. Place the cursor on the configuration device that you want to have its software updated. Then, check it by pressing the [ENTER] key or [R ..] key. Press the “OK” button to begin the software update for the selected configuration device.
- (8) To match the compatibility of the software versions between configuration devices, it is recommended to update the software of all the configuration devices.
- (9) After completing the software update, the system automatically restarts.

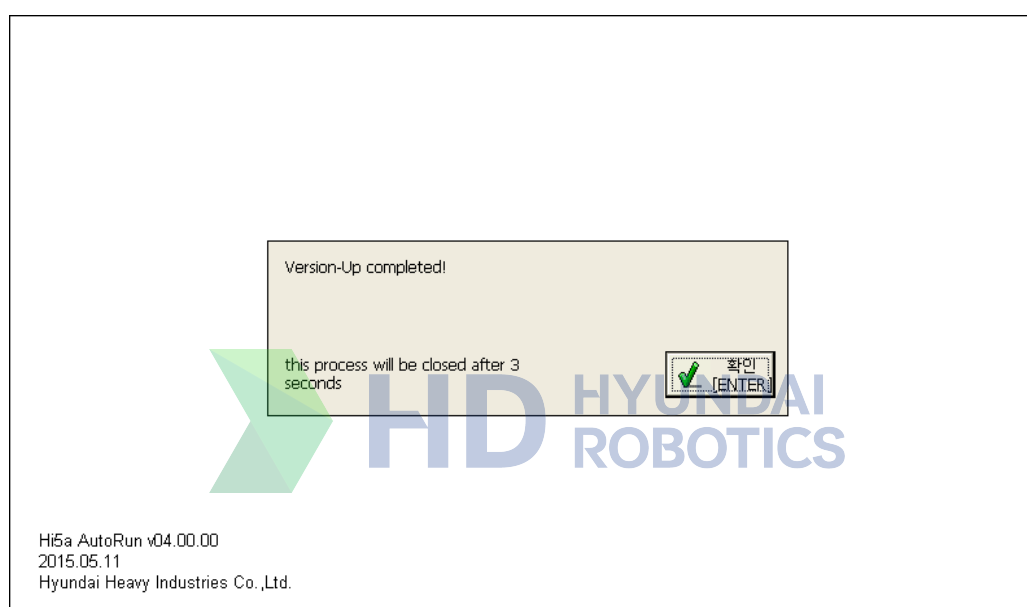


Figure 4.126 Software update completion screen

The second method: Software update by configuration device

(1) Selection 『F1: Service』 → 『7: System diagnosis』 → 『1: System Version』 .

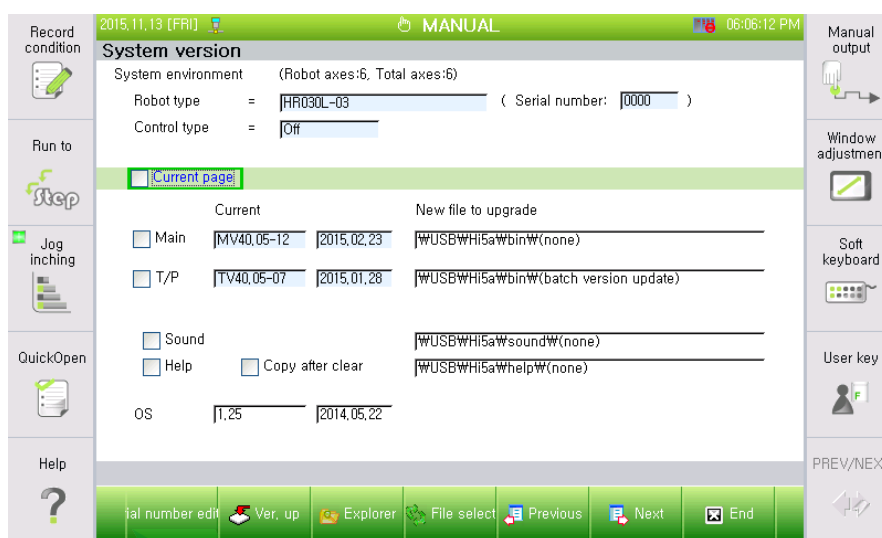


Figure 4.127 System version screen page 1

Page 1 (System environment, Main board, T/P, Auto Run, Sound, Help.)

Designate the new software file for the items to update the version and check by pressing the [ENTER] button. When you press the 『F2: Ver. up』 button, the designated items will be updated in order.

- **System environment**
Robot type, number of basic axes, total number of axes including additional axis and condition of anti-vibration control function application will be displayed.
- **Current page:** Check all the items that can be update din the current page.
- **Current:** This displays the current version and date of each device.
- **New file to upgrade**
When you want to upgrade the version of the device, you must designate the path and name of the software file that you want to newly download. The software file must be saved in T/P or USB memory.

4. Service

- (2) It is composed of total of 3 pages. You can move between pages using the 『F5: Previous』 and 『F6: Next』 button.

2011.04.12 [thu] 08:59:30 AM MANUAL

System version

Current New file to upgrade

☒ DSP ☐ WUSBWHI5WbinW(none)

Stored information at Flash ROM of Main Board

Updated date :

Status :

DSP	HW	PLD
DSP #1-1	BD542V05,99	0020,12,31
DSP #1-2	BD542V05,99	0020,12,31
DSP #2-1	no info,	no info,
DSP #2-2	no info,	no info,

☐ Sys,IO ☐ WUSBWHI5WbinW(none)

SW : HW : PLD :

☐ Brake,IO ☐ WUSBWHI5WbinW(none)

SW : HW : PLD :

Ver. up Explorer File select Previous Next End

Figure 4.128 System version screen page 2

2011.04.12 [thu] 09:00:09 AM MANUAL

System version

	Current HW	SW	New file to upgrade
☒ DIO#1	no info,	no info,	no info,
☐ DIO#2	no info,	no info,	no info,
☐ DIO#3	no info,	no info,	no info,
☐ DIO#4	no info,	no info,	no info,
☐ DIO#5	no info,	no info,	no info,
☐ DIO#6	no info,	no info,	no info,
☐ DIO#7	no info,	no info,	no info,
☐ DIO#8	no info,	no info,	no info,
☐ Arc I/F #1	no info,	no info,	no info,
☐ Arc I/F #2	no info,	no info,	no info,
☐ Arc I/F #3	no info,	no info,	no info,
☐ Arc I/F #4	no info,	no info,	no info,
☐ CC-Link	no info,	no info,	no info,
☐ Cnvy I/F	no info,	no info,	no info,

Information up Ver. up Explorer File select Previous Next End

Figure 4.129 System version screen page 3

Because the operating methods of the following items are similar, examples of only certain items will be described.

4.8.1.1. Main board

- (1) Prepare the USB memory with the new files to update the version with. It is convenient to select the files if they are located in the following directory.

{USB Memory}/hi5a/bin/hi5a_main*.hdi

- (2) Install the USB memory to the teach pendant. When the USB memory device is recognized, the icon will appear on the title bar of the teach pendant screen.
- (3) Enter the 『[F1]: Service』 → 『7: System diagnosis』 → 『1: System version』 screen.
- (4) Locate the cursor on the main item and check with the [ENTER] key. <Current> row displays the version and date of the current S/W installed on the main board.



Figure 4.130 Main S/W version information

- (5) The new file you want must be displayed in the <New file to upgrade> row. If the file you are trying to select has the same path and file name as shown in the following table, you can easily select the applicable file by switching the file name by pressing the 『[F4]: Refresh』 key.

T/P software	{USB memory}/Hi5a/bin/Hi5a_TP*.exe
Main board software	{USB memory}/Hi5a/bin/Hi5a_main*.hdi or {USB memory}/Hi5a/bin/hi5a_sim*.hdi
DSP I/O	{USB memory}/Hi5a/bin/sv5_*.hex
System I/O	{USB memory}/Hi5a/bin/bd530v*.hex
User I/O	{USB memory}/Hi5a/bin/bd580v*.hex
Arc Welding Interface	{USB memory}/Hi5a/bin/bd584v*.hex
CC-Link	{USB memory}/Hi5a/bin/bd570v*.hex
Conveyor Interface	{USB memory}/Hi5a/bin/bd585v*.hex

4. Service

- (6) When the file is located in a different directory, press the 『[F3]: File select』 key to open the file selection message box to find the file. Set the cursor on the file you want and press the [ENTER] key to display the path and name of the file selected from [New file to upgrade].

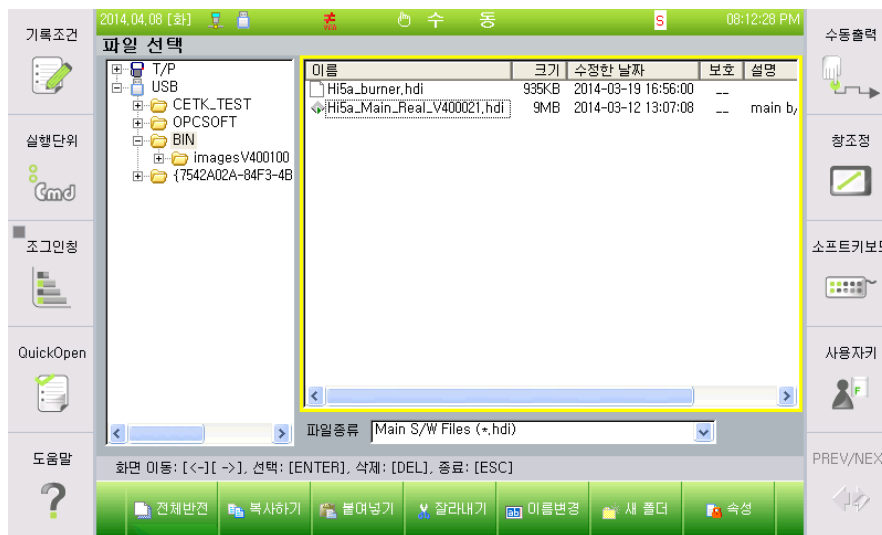


Figure 4.131 S/W update file search

- (7) Now press the 『[F2]: Ver. up』 to carry out the version updating. During the version-up process, you should follow instructions, without doing any operation.

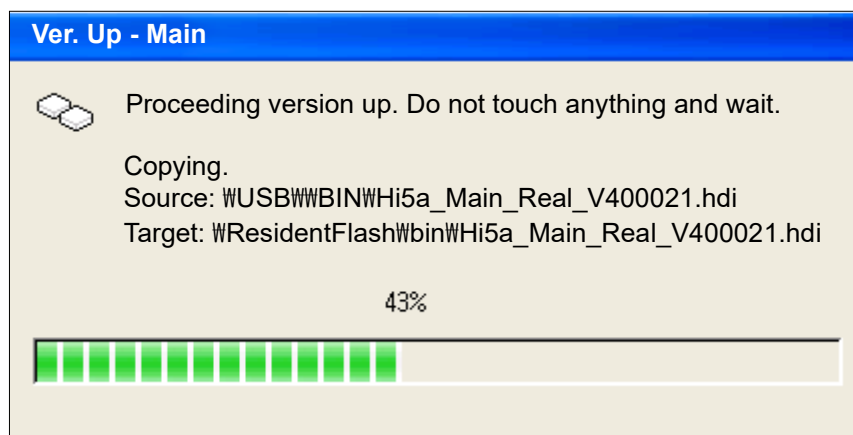


Figure 4.132 S/W update process monitoring screen

4.8.1.2. Teach pendant batch version update

- (1) If you see the following, it is in teach pendant batch version update mode. This is the function to update the version of the teach pendant software of various language versions in a batch. (Only the teach pendant of all devices for Hi5a Controller has software files by language.)



Figure 4.133 T/P version information

- (2) You must have the new software files prepared in the USB memory according to the following directory structure. It doesn't matter what the name of the subfolder is and as long as the file name starts with 'hi5a_tp' and has an extension of exe, it will be recognized as the software file for teach pendant. Folders not including any part of hi5a_tp*.exe will be ignored. That is, subfolders must exist with only 1 file for each language at the bottom of {USB}/hi5a/bin/. (If there are more than 1 software files included, only 1 file will be used for the update.)

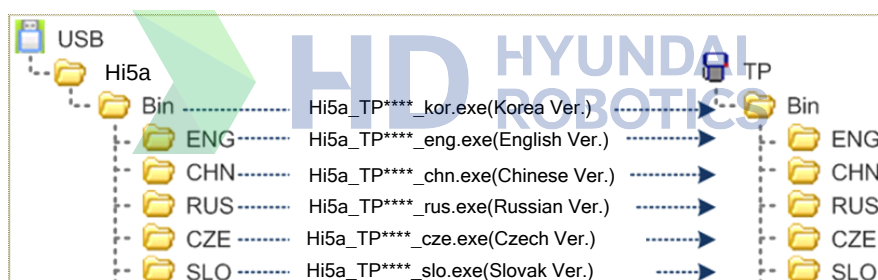


Figure 4.134 Multilanguage T/P batch version

- (3) After checking by pressing the [ENTER] key, press the 『[F2]: Ver. up』 to execute batch version update for all folders. That is, language folders will be created under the bin/ folder of the teach pendant flash memory and the software files will be copied.

4.8.1.3. Teach pendant single version update

- (1) Every time you press the 『[F4]: Refresh』 key, the software file name for teach pendant at the bottom of {USB}/hi5a/bin/ will be displayed in order. (When all file names are displayed, it will return to batch version update mode.)

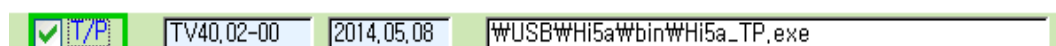


Figure 4.135 T/P single version

- (2) When you press [SHIFT]+ 『[F4]: Refresh』, you can switch to the sub folder. Every time you press the 『[F4]: Refresh』 button in this condition, the file name of the applicable sub folder will be displayed in order.



Figure 4.136 T/P information in sub folder

- (3) After checking by pressing the [ENTER] key, press the 『[F2]: Ver. up』 to execute single version update by using the indicated file.

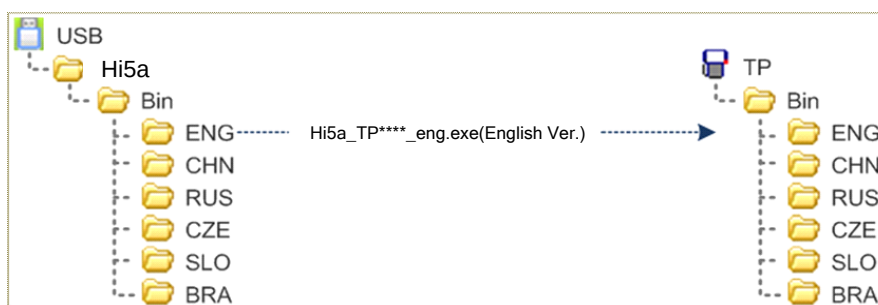


Figure 4.137 Single T/P version update

4.8.1.4. Auto Run

AutoRun utility is responsible for automatically running the teach pendant executable file. Please run the teach pendant software update using the integrated compressed file for the AutoRun utility update. The AutoRun utility with the mutual compatibility of the teach pendant software will be automatically installed.

4.8.1.5. Sound effect, help

- (1) The version update for sound effect and help function is done by copying the entire folder and not just 1 file. Create a new folder for the new version in the directory as shown in the following figure in the USB memory, and then connect the USB memory. (You cannot change the directory.) If you do not see the (none) message, it means that it is recognized correctly.

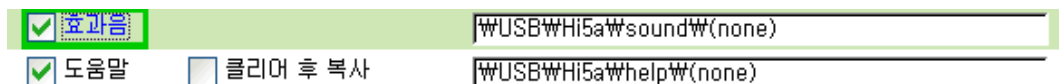


Figure 4.138 Sound effect/help not recognized

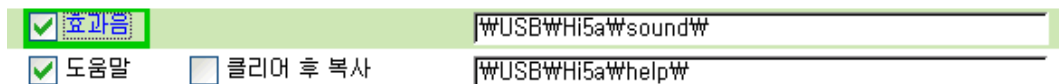


Figure 4.139 Sound effect/help recognized

- (2) After checking by pressing the [ENTER] key, press the 『[F2]: Ver. up』 to update the version.



Reference

- Sound effects are only played in the TP511 teach pendant and not in TP520.
- 『R286: System version display』 of R code has the same function.
- To update the version, the motor must be turned OFF.
- When the version is upgraded, the system will reboot if necessary

4.8.2. Error logging

History of error and warning is indicated. When an error occurs, details, time, program number, step number, axis data and input/output state can be checked. The content of errors can be recorded to manage the history of errors. History can be initialized by pressing 『[F1]: Remake』 key. Cause of error and restoration work can be precisely determined by referring to history.

(1) Selection 『[F1]: Service』 → 『7: System diagnosis』 → 『2: Error logging』 .

#	Code	Message	Date	Time	Prog	Step
1	E1111	Arm angle is too big	2009/01/22	08:05:08	P0888	S001
2	E1101	T2 Axis)Soft limit exceeded	2009/01/22	08:05:08	P0888	S001
3	E1101	T1 Axis)Soft limit exceeded	2009/01/22	08:05:08	P0888	S001
4	E1101	R1 Axis)Soft limit exceeded	2009/01/22	08:05:08	P0888	S001
5	E1101	B Axis)Soft limit exceeded	2009/01/22	08:05:08	P0888	S001
6	E1101	R2 Axis)Soft limit exceeded	2009/01/22	08:05:08	P0888	S001
7	E1101	V Axis)Soft limit exceeded	2009/01/22	08:05:08	P0888	S001
8	E1101	H Axis)Soft limit exceeded	2009/01/22	08:05:08	P0888	S001
9	E1101	S Axis)Soft limit exceeded	2009/01/22	08:05:08	P0888	S001
10	E1111	Arm angle is too big	2009/01/21	08:43:52	P0888	S001
11	E1101	T2 Axis)Soft limit exceeded	2009/01/21	08:43:52	P0888	S001
12	E1101	T1 Axis)Soft limit exceeded	2009/01/21	08:43:52	P0888	S001
13	E1101	R1 Axis)Soft limit exceeded	2009/01/21	08:43:52	P0888	S001
14	E1101	B Axis)Soft limit exceeded	2009/01/21	08:43:52	P0888	S001
15	E1101	R2 Axis)Soft limit exceeded	2009/01/21	08:43:52	P0888	S001
16	E1101	V Axis)Soft limit exceeded	2009/01/21	08:43:52	P0888	S001
17	E1101	H Axis)Soft limit exceeded	2009/01/21	08:43:52	P0888	S001
18	E1101	S Axis)Soft limit exceeded	2009/01/21	08:43:52	P0888	S001

Figure 4.140 Error logging screen

Controller Operation Manual

- (2) When you select a specific error item, and click on one of 『F2』: Public input, 『F3』: Public output, 『F4』: Axis data, 『F5』: Private input, 『F6』: Private output, you can check the status in case of an error. For example, if you select 『9: E0016 Servo drive error』 with the arrow key and press the 『F5』: Private input key, the following screen will be displayed.

Mode switch (Auto)	Mode switch (Manual)	Mode switch (Remote)	-
Motor on (TP)	Motor on (External)	Start (TP)	Stop (TP)
TP Enabling switch	-	MC1(PreCharge)	MC2(Motors Power)
Safety guard (Auto)	Safety guard (General)	Emergency stop (TP)	Emergency stop (OP)
Emergency stop (Ext)	-	Limit (Over-Travel)	Limit (Over-Travel) add.
Lift axis belt/Limit (Arm)	Limit (Over-Travel) exp.	Motor overheat (TS)	Motor overheat (TSE)
Check Brake voltage	-	Overload (Motors)	Overload (Control)
Overload (Brakes)	Overload (SMPS)	FLT(AMP Fault)	OV(AMP Overvoltage)
UV(AMP Undervoltage)	OC(AMP Overcurrent)	SV_BK (Servo brake)	/SVON (Servo ON)
Converter type	/PVMON	Check OP board	ESCAPE
Reservation 1	Reservation 2	Reservation 3	Reservation 4

Figure 4.141 Error logging/private input signals



Reference

- Pressing the 『F1』: Remake key allows the user to enter the maximum count of logging.
- The Error record basically holds up to 100 error histories. However, the number of error histories can be set within the range of 1~1000 depending on the needs of the user. When the user enters the maximum number of histories and press the [Enter], all the histories saved up to now will be deleted, making it possible to save the error histories in the number set by the user.

4.8.3. Operation history

This displays the operation history. This function displays the input content, the time, the program number at the time of input, the step number, the axis data, and the input/output state when signals related to operation, such as stopping of the robot, starting, and changing of the mode switch are inputted, providing the user reference information for robot maintenance and repair. The operation history's default recording is 100 times and it can be recorded up to 1000 times by the user. History can be initialized by pressing the 『[F1]: Remake』 key.

(1) Selection 『[F1]: Service』 → 『7: System diagnosis』 → 『3: Operation history』 .

The screenshot shows the '운전이력' (Operation History) screen. The table contains the following data:

#	Code	Message	Date	Time	Prog	Step	Func
1	S-50	제어반내 기동이 입력되었습니다.	2014/04/07	09:29:50	P3012	S000	F000
2	S-50	제어반내 기동이 입력되었습니다.	2014/04/07	09:20:42	P3012	S000	F003
3	S-03	티치펜던트의 비상정지가 입력되었습니다.	2014/04/07	09:20:34	P3012	S000	F003
4	S-50	제어반내 기동이 입력되었습니다.	2014/04/07	09:18:50	P3012	S000	F003
5	S-10	제어반내 정지가 입력되었습니다.	2014/04/07	09:15:54	P3012	S000	F002
6	S-50	제어반내 기동이 입력되었습니다.	2014/04/07	09:15:34	P3012	S000	F002
7	S-07	자동운전 중 모드스위치가 변경되었습니다.	2014/04/07	09:06:16	P3012	S000	F002
8	S-50	제어반내 기동이 입력되었습니다.	2014/04/07	09:05:58	P3012	S000	F000
9	S-50	제어반내 기동이 입력되었습니다.	2014/04/07	09:05:50	P3012	S000	F002
10	S-10	제어반내 정지가 입력되었습니다.	2014/04/07	09:05:46	P3012	S000	F002
11	S-50	제어반내 기동이 입력되었습니다.	2014/04/07	09:02:08	P3012	S000	F002
12	S-10	제어반내 정지가 입력되었습니다.	2014/04/07	09:02:00	P3012	S000	F002
13	S-50	제어반내 기동이 입력되었습니다.	2014/04/07	09:01:38	P3011	S030	F002
14	S-10	제어반내 정지가 입력되었습니다.	2014/04/07	09:01:22	P3011	S030	F002
15	S-50	제어반내 기동이 입력되었습니다.	2014/04/07	08:46:32	P3011	S061	F006
16	S-07	자동운전 중 모드스위치가 변경되었습니다.	2014/04/07	08:46:24	P3011	S061	F006
17	S-50	제어반내 기동이 입력되었습니다.	2014/04/07	08:45:18	P3011	S042	F004
18	S-10	제어반내 정지가 입력되었습니다.	2014/04/07	08:41:42	P3011	S042	F004

Below the table are buttons: 재작성, 범용입력, 범용출력, 축데이터, 전용입력, 전용출력. On the right side, there are icons for 수동출력, 참조정, 소프트웨어보드, 사용자키, and PREV/NEXT.

Figure 4.142 Operation history screen

Controller Operation Manual

- (2) When a specific item is selected, and one of 『[F2]: Public input』, 『[F3]: Public output』, 『[F4]: Axis data』, 『[F5]: Private input』 or 『[F6]: Private output』 is pressed, the status at the time of relevant history generation can be verified. For example, if you select 『1: S-07 Mode switch is changed while in the auto operation』 with the arrow key and press the 『[F6]: Private output』 key, the following screen will be displayed.

모터 ON(TP)	기동(TP)	정지(TP)	시스템 이상
MCON1(PreCharge)	MCON2(Motors Power)	HIGH Speed 1	HIGH Speed 2
ESCON1(Release1)	ESCON2(Release2)	브레이크제어 1	브레이크제어 2
브레이크제어 3	브레이크제어 4	브레이크제어 5	브레이크제어 6
브레이크제어 7	브레이크제어 8	완전 자동모드 1	완전 자동모드 2
-	-	예약 1	예약 2
냉각팬 개입	예약 4	-	-

Figure 4.143 Operation history/private output signals



Reference

- Pressing the 『[F1]: Remake』 key will bring up a dialog box for entering the maximum number of histories.
- The operation history holds up to 100 histories. However, the number of operation histories can be set within the range of 1~1000 depending on the needs of the user. When the user enters the maximum number of histories and presses [Enter], all the histories saved up to that point will be deleted, allowing new histories to be saved in the number set by the user.

4.8.4. Average load rate diagnosis

This is to display the average load rate of the motor torque applied for each axis during the robot operation. The calculation of the average load rate is to be made only during the normal operation without the robot suffering any servo errors or emergency stops, excluding the excessive torque that will be generated during the abrupt stop.

The average load rate is calculated based on the motor torque I/I_r , and the calculation takes place by using the buffer fixed inside the robot controller, so, the average load rate renewal time will vary depending on the characteristics of the work program of the robot. When it comes to each axis, the average value is calculated by taking into consideration the moving time of each axis, so the torque during the stop of the robot operation will not be taken into the calculation of the average load rate.

Select 『[F1]: Service』 → 『7: System diagnosis』 → 『9: Average load rate diagnosis』.

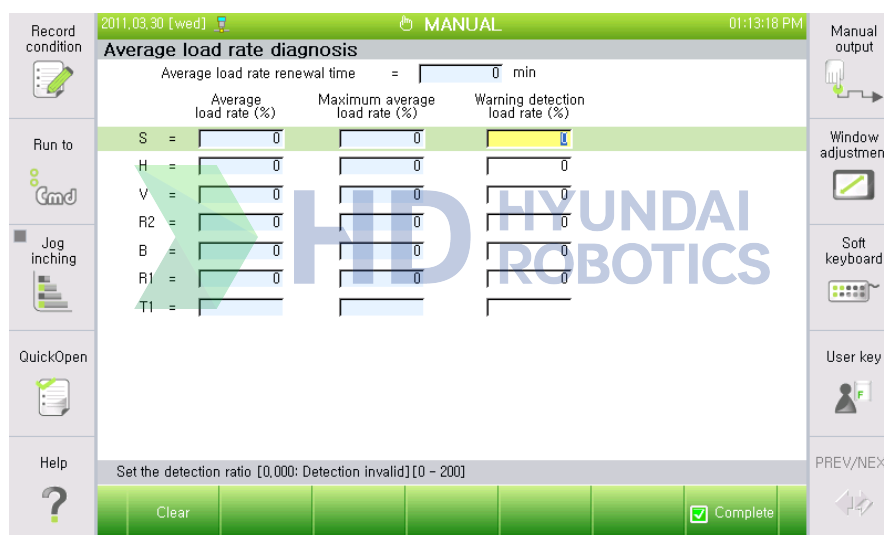


Figure 4.144 Average load rate diagnosis

(1) Average load rate renewal time [min]

This is the time of the robot operation by calculating the average load rate. In those cases where servo errors or emergency stops occur, their load factors will not be taken into the calculation.

(2) Average load rate (%)

This is the average load rate (I/I_r) of the motor of each axis generated during the average load rate renewal time. The average load rate will start to be displayed when the targeted buffer is filled in the robot controller, while '0' for it is displayed before that. The time required for the buffer to be filled will vary depending on the characteristics of the work of the robot.

(3) Maximum average load rate (%)

This is the maximum value of the average load rate generated during the robot operation. When the controller power is turned off, or 『[F1]: Clear』 is selected, the value can be measured again. However, the data will be displayed '0' during the average load rate renewal time.

(4) Warning detection load factor (%)

This needs to be set to generate a warning for the user if the average load rate of each axis exceeds the general usage level. If it is '0', detection will not occur, so it is required to set the value. When an warning occurs, the "W0142 axis) Average load rate error during task." notification will be displayed on the teach pendant, while the set output will be generated according to the average load rate diagnosis of 『[F2]: System』 → 『2: Control parameter』 → 『2: Input/output signal setting 』 → 『4: Output signal assignment』 . Even when the warning occurs, the robot will continue the work without stopping.

(5) 『[F1]: Clear』

Measuring will start again. Even in this situation, waiting for the buffer to be filled is still required



Reference

- Pressing the [F1]: Clear』 key will bring up a message asking whether to initialize the content of the average load rate.
- When the [Yes] key is selected, all the average load rates saved up to now will be deleted and initialization will take place.

4.8.5. History of Maintenance and Repair

The history of maintenance and repair function is used by the users to save the maintenance records for reference. The current time can be inputted easily by using the time input button and the relevant content can be inputted by activating the soft keyboard. In addition, this can be used as a memo pad as it can be accessed easily from any section by using [R.(NO)]key → [255]→ [ENTER(YES)].

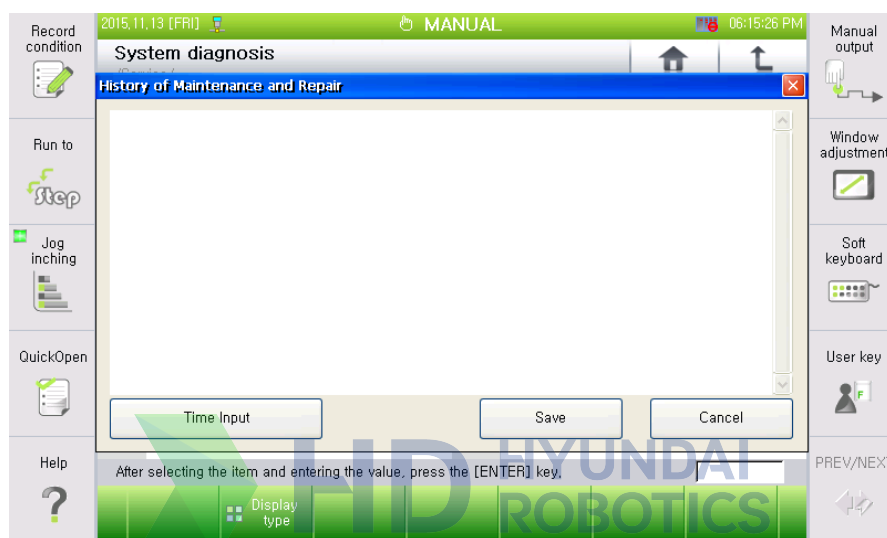


Figure 4.145 History of Maintenance and Repair

4.9. Date, time setting

Date and time of controller can be changed.

- (1) Selection 『F1』: Service』 → 『8』: Date, time setting』 .



Figure 4.146 Date and time setting screen

- (2) When you press the [↑][↓][←][→] using arrow keys, the cursor moves between year/month/day/hour/minute/second/am:pm.
- (3) Set the cursor to the item you want and press [SHIFT] + [↑][↓] to change the value.
- (4) You can also select a date by touching the numbers from the right-hand side of the screen calendar. If you touch the left/right triangle from the top of the calendar, it will be changed into last month or next month.
- (5) When you enter a date and time and press the 『F7』: complete』 key, the setting will be applied.

4.10. Applet

For special requirements for special robot construction difficult to correspond with the common functionality of Hi5a Controller, you can create and execute an Applet, a separate Add-on execution file. Applet for Hi5a Controller must be created and registered in accordance with the set specification and it cannot be guaranteed to run normally, if it does not comply the rules. (Please contact the manufacturer for requests related to creating applets.)

When you 『[F1]: Service』 → 『10: Applet』, Applet management screen will be opened

If applets are installed, their icons will be displayed. Selecting a specific icon with an arrow key will bring up simple information, such as its version and manufacturer at the bottom of the screen.

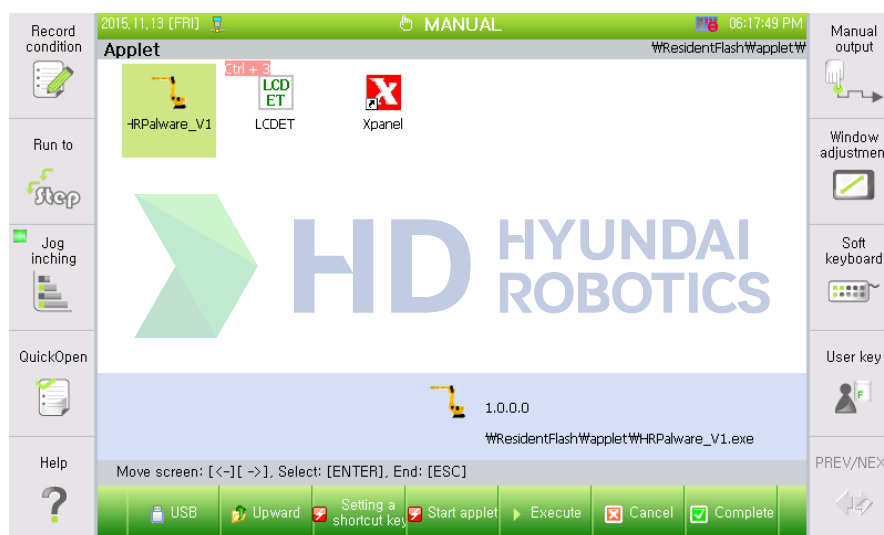


Figure 4.147 Applet dialog box

Pressing the 『[F1]: TP/USB』 toggle key will allow movement between applet folders.

TP	Teach pendant's / Resident Flash / applet / folder
USB	Mounted USB memory's / Hi5a / applet / folder

Controller Operation Manual

When there are sub folders, it is possible to enter a sub folder by placing the cursor on its icon and pressing the [ENTER] key. Pressing 『[F2]: Upward』 will allow movement to the parent folder.

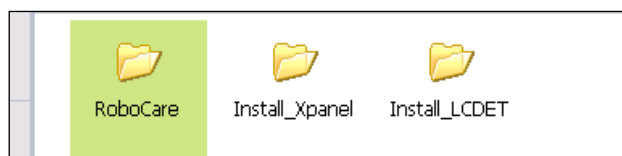


Figure 4.148 Applet folder screen

A selected applet can be executed by pressing the [ENTER] or 『[F5]: Execute』 key. The figure below shows an example of an LCD Easy Teaching applet.

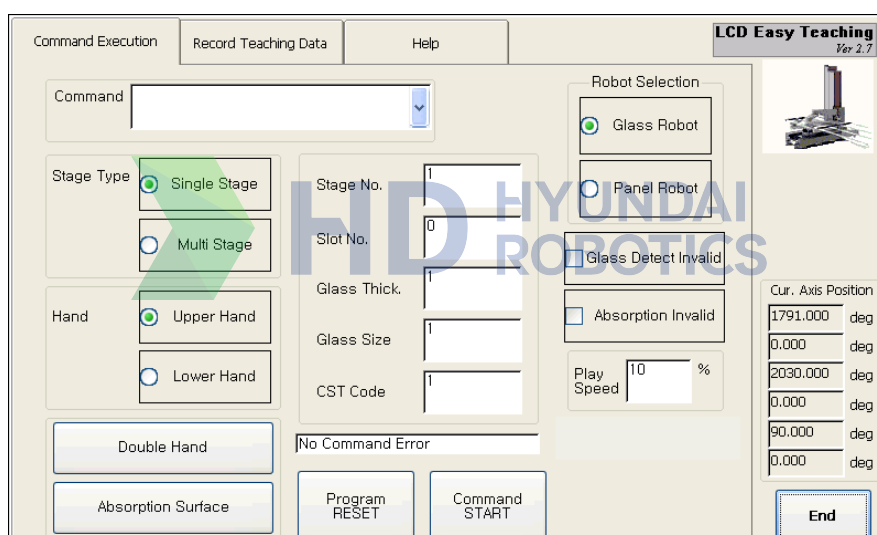


Figure 4.149 Applet Ex.: LCD Easy Teaching

4. Service

For frequently used applets, they can be executed promptly by assigning shortcut keys to them. Pressing the 『[F3]: Shortcut key』 key will bring up a dialog box. Press Ctrl + one of 1~9 keys and then press the [ENTER] key. The figure below shows an example of Ctrl+8 assigned to the LCDET applet. Save the assigned information by pressing the 『[F7]: Complete』 key. Then, it is possible to execute the LCDET by pressing Ctrl+8 from any screen.

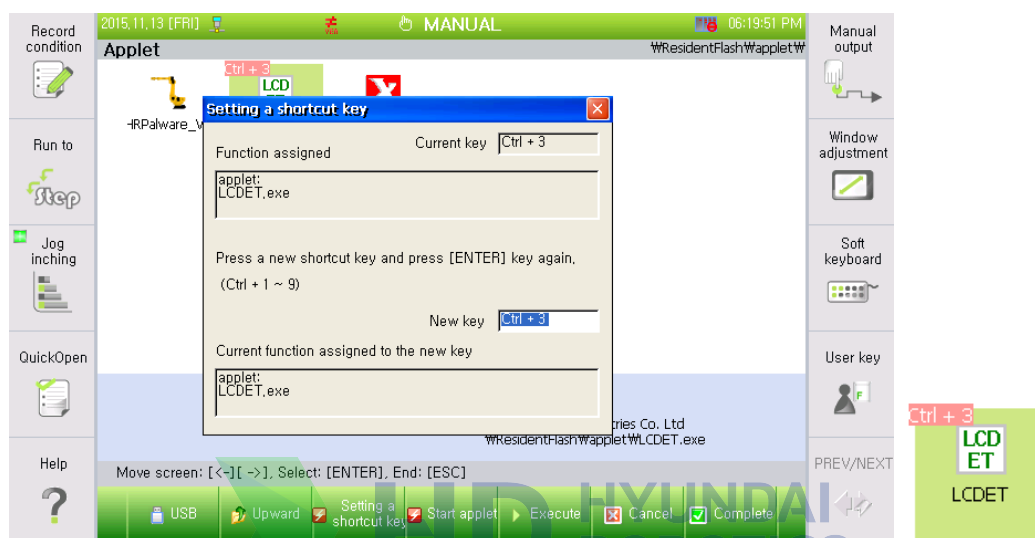


Figure 4.150 Applet shortcut key setting

When the 『[F4]: Start applet』 key is pressed, the selected applet will be assigned as the start applet and its icon will be marked with (st). Save the assigned information by pressing the 『[F7]: Complete』 key. The start applet will be executed automatically when the power is turned on. When the start applet is finished, the basic teach pendant operation screen will be displayed. When the user interface of the teach pendant needs to be simplified for a special purpose, the start applet function can be used.



4.11. Teach pendant option

This is the screen to set only the function related to the user interface of the teach pendant itself.

- (1) Select 『[F1]: Service』 → 『11: Teach pendant option』.

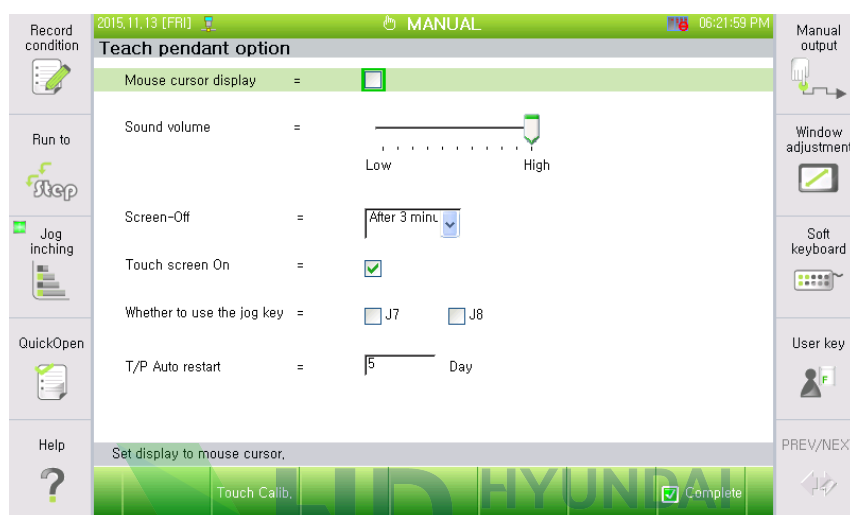


Figure 4.151 Teach pendant options setting

- **Mouse cursor display**
Even though you can execute all the operations using the key pad and touch screen, you can connect the mouse to the USB terminal at the bottom of the teach pendant. At this time, check this option so that the cursor of the mouse can be displayed.
- **Sound volume**
This adjusts the volume of the sound effect generated through the speakers of the teach pendant. It is an option only used in the TP511 teach pendant and it is not displayed in TP520.
- **Screen-off**
If there is no input by the user within the present time, the screen will change to the saving mode, turning off the screen of the teach pendant.
- **Touch screen On**
When you turn off this option, the touch screen operation function does not operate. If you want to prevent an erroneous and unintended operation of the touch screen, you can turn this option off.
- **Whether to use the jog key or not**
Choose the jog key to use among J7-/J7+ and J8-/J8+, respectively. When you are concerned about the positioner collision caused by mishandling the jog key, turn off this option.

- T/P automatic restarting

The teach pendant will be restarted automatically after a designated date in order to clean the memory (there is no impact on the robot operation). When it is time for a restart, a countdown will be displayed on the screen. Even when a restart is pending, it will be postponed for a short while if the user is working on the keypad.

- (2) After an option is set, press the 『F7]: Complete』 key. The setting information will be saved in the teach pendant and not in the main board.



4.12. Teach pendant sharing

Teach pendant sharing is a function where a single teach pendant is made for common use by connecting it with the body of multiple Hi5a robot controllers. The robot controller can be an actual Hi5a controller or a virtual Hi5a in the HRSpace software on your PC. This feature is used for the following purposes.

- Teach/control a number of robots with a single teach pendant
(Mainly, robot cooperative control system)
See the “Teach Pendant sharing feature” function manual.
- Teaching practice for utilizing the HRSpace virtual environment
(When there is no actual robot but there’s an actual teach pendant)
Refer to the section of HRSpace Help “8.4 Actual teach pendant” section.



4.13. History Logging

It is a function that allows you to record the history of the FB1, FB3, and FN input, including the output signal change of the Hi5a controller. When you set up to four trigger conditions and whether they should be used, set it to On and click the completion button. The changes are then recorded in the HYSTORY.TXT file. Each time the signal is changed in accordance with the trigger condition.

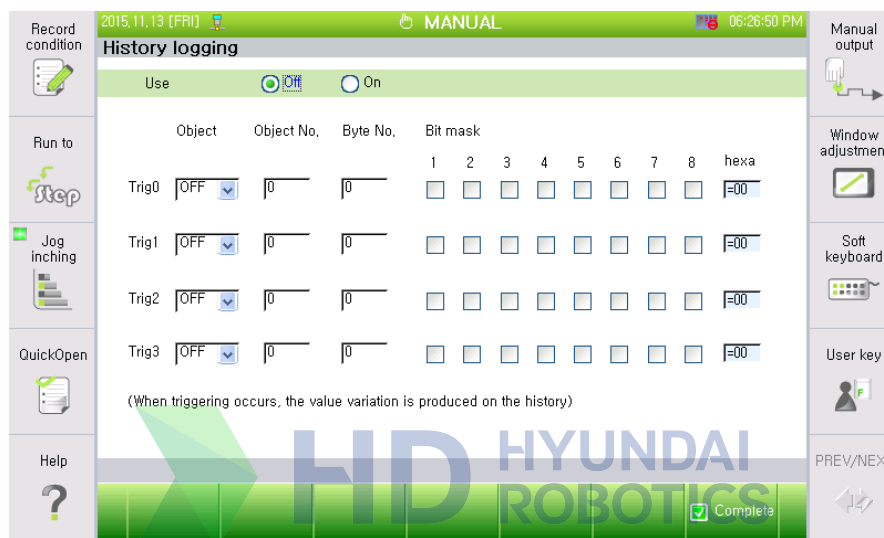


Figure 4.152 Setting history logging function

- Object: Choose the signal object that you want among FB.X, FB.Y, FN.X, and FN.Y.
- Object number: Enter the object number.
- Byte number: Enter the digit number of the signal byte to monitor the selected object.
- Bit mask: Enter the digit number of the bit to monitor the selected object byte.

For example, for the setting shown above, if you set the past screen recording,

- ① Trig0: records the upper 4-bit signal change history of FB5.XB9 to HYSTORY.TXT file.
- ② Trig1:
Records the upper 1-, 2-, 3-, and 8-digit bit signal change history of FB5.YB2 to HYSTORY.TXT file.
- ③ Trig2: records the upper 3-digit bit signal change history of FN1.XB3 to HYSTORY.TXT file.

The signal change history is recorded to HYSTORY.TXT file in the following forms.

```
( 10151)[Log.I/O] FB1.XB[2]=0Ch (<-00h)
(9100037)[Log.I/O] FB1.XB[2]=08h (<-0Ch)
(3949966)[Log.I/O] FB1.XB[2]=02h (<-08h)
```





HD

HYUNDAI
ROBOTICS

5

Condition
Setting



5. Condition setting

Hi5a-S/N/P/C/T/J

Controller Operation Manual

The condition setting menu is to change the operation condition easily without changing the program. The set values will be maintained even when the controller power is supplied again.

Press the 『F7』: Condition setting』 from the initial screen of manual or auto mode to see the following screen.

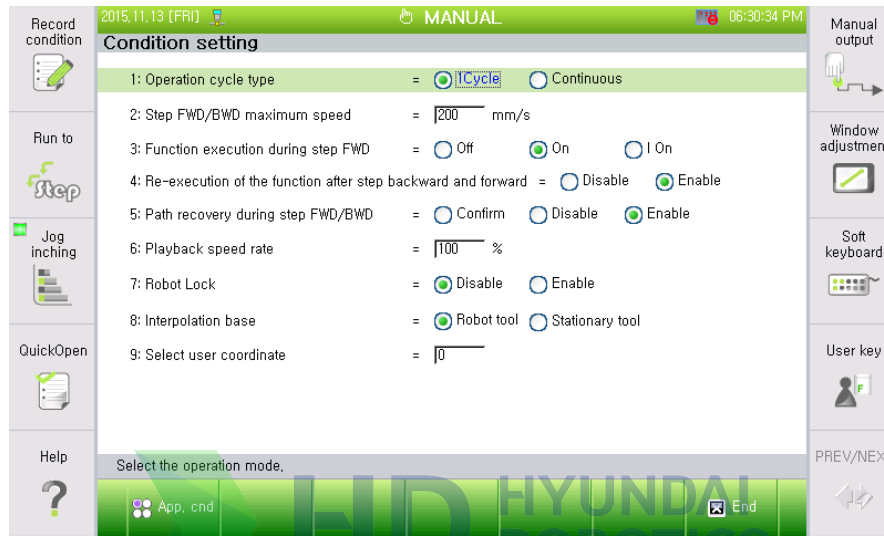


Figure 5.1 Condition setting screen



Reference

- Move the cursor to this item. When entering a number, enter the number in the input frame. Key in the number using the [Number] key and press the [ENTER] key to reflect the input.
- When you select one of the items used with the radio button and press the [SHIFT] + (Left/Right), the highlighted bar moves and is immediately reflected.
- Condition-setting data have been stored in the control parameter file (ROBOT.CON).
- Even if the control parameter file (ROBOT.CON) attribute is fully protected, it can be changed.

5.1. Operation cycle type

This is to decide whether to carry out the repetition of the program to be implemented during the auto operation, while changing in the middle of the operation can be also allowed, but not applicable for the manual operation.

- 1Cycle
This wills operation the work program for one cycle when you press the move button.
(The robot will stop at program end.)
- Continuous
This repeats the prepared program and operation continuously.
(The robot will stop when there is an external stop operation.)

5.2. Step FWD/BWD maximum speed

The speed limit for the step forward/backward operation can be entered directly. Refer to the manual operation of the basic operation for details.

5.3. Function execution during step FWD

This determines whether to execute the function recorded in the job program during step FWD. This can be set in 3 ways: Off, On and I On for deciding whether to execute the function.

- Off: This only executes the work program END function and ignores all other functions.
- On: This executes all the functions recorded within the work program.
- I On: This only executes the input signal standby function and program END function.



Reference

- For step backward movement, all other functions besides the input signal standby function are not executed.

5.4. Re-execution of the function after step backward and forward

This determines whether to execute the function recorded in the work program during step BWD

- Disable
Does not execute previously executed functions.
- Enable
Executes previously executed functions.

5.5. Path recovery during step FWD/BWD

This is to decide the procedure for the path recovery during step FWD/BWD

- Confirm
Checks with the user before executing path recovery
- Disable
Does not execute the path recovery during step FWD/BWD
- Enable
Executes path recovery without checking during step FWD/BWD

5.6. Playback speed rate

For the speed recorded on the step during the playback of the program in the auto mode, the moving speed of the robot varies within the range of [1 ~ 100] % in an overall manner. The speed value recorded on the step of the work program does not change.



Reference

- For low speed operation mode by external input during AUTO operation, the AUTO operation speed percentage is not applied. Instead, the max manual speed (250 mm/s) is applied.

5.7. Robot Lock

This plays back the program without actually moving the robot. By using this function, you can check the input/output condition with peripheral devices, soft limit and cycle time etc.



Reference

- When you set 『Robot lock = <Enable>』, yellow lock icon as  will be displayed with the robot on the status display window in MANUAL or AUTO mode.

5.8. Interpolation tool

The interpolation reference setting is for selecting a tool that will be the reference for the manual jog-operation of the robot. The tool reference is available in 2 types, robot tool and stationary tool. In general, the interpolation reference is robot tool.

- Robot tool: Interpolation is done based on the tool attached to the robot's end.
- Stationary tool: Interpolation is done based on the tool attached to the fixture such as the floor.



Reference

- When selecting the interpolation reference as stationary tool,  sign is displayed on the top and you must set the stationary tool coordinate system. Refer to the setting in 『[F2]: System』 → 『2: Control parameter』 → 『7: Coordinate Registration』 → 『2: Stationary tool coordinate』.
- To select the stationary tool number during AUTO operation, use the SELPTNO command.
- For details, refer to “Hi5a Controller Stationary Tool Interpolation Function Manual”.

5.9. Select user coordinate

When manually operating the jog based on the user coordinate defined by the user, select the user coordinate number for Cartesian operation. At this time, the robot executes the orthogonal coordinate operation in X, Y and Z axis direction of set user coordinate. Also when using the monitoring function, the X, Y and Z coordinates of the tool end displayed in the screen is displayed in coordinates in user coordinate system.



Reference

- If the user coordinate system number is set to "0", the operation is canceled for the user coordinate and the orthogonal operation and monitoring is done in the robot coordinate.



is displayed on the top of the screen. When you select the axis data monitoring, the following screen will be displayed.

Data of each axis				
	Angle		Coordinate	
S	1144.845 deg	X		-1887.4
H	1242.000 deg	Y		114.8
V	1024.000 deg	Z		795.7
R2	1536.000 deg	Rx		90.0
B	-1549.960 deg	Ry		-26.1
R1	1843.200 deg	Rz		-94.3
T1	-1843.200 mm			
T2	-1843.200 mm			

- Number besides 0 displayed on the edit box is displayed as the number off the coordinate system registered as user coordinate system in the registration process of 『F2』: System → 『2』: Control parameter → 『7』: Coordinate registration → 『1』: User coordinate .

Crd

User[1]

- When you select the user coordinate system number, User[1] is displayed on the top of the screen. When you select 『F1』: Service → 『1』: Monitoring → 『1』: Data of each axis , the following screen will be displayed. At this time, the changed coordinate value by [Axis operation] key changes to the value based on the user coordinate system.

Data of each axis				
	Angle		U-Coordinate	
S	1144.845 deg	X		-1887.4
H	1242.000 deg	Y		114.8
V	1024.000 deg	Z		795.7
R2	1536.000 deg	Rx		90.0
B	-1549.960 deg	Ry		-26.1
R1	1843.200 deg	Rz		-94.3
T1	-1843.200 mm			
T2	-1843.200 mm			

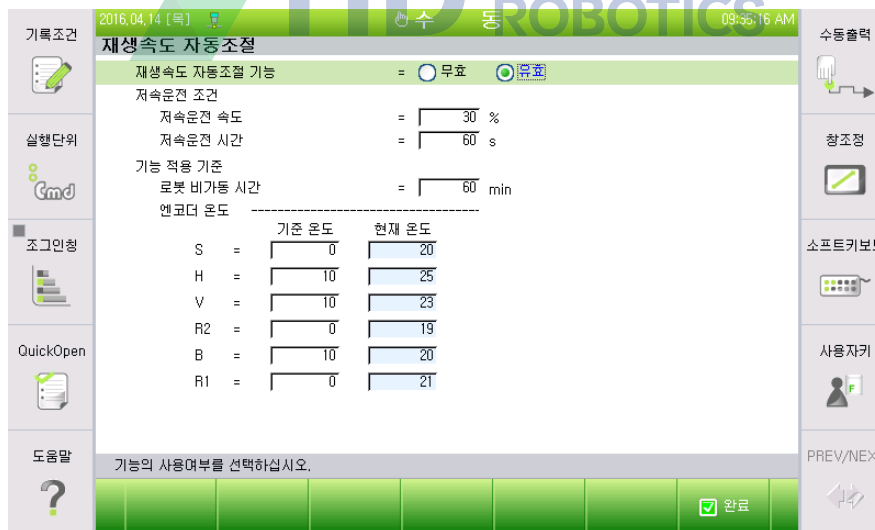
- For the user coordinate registration, refer to the 『[F2]: System』 → 『2: Control parameter』
→ 『7: Coordinate registration』 → 『1: User coordinate』

5.10. Playback speed automatic adjustment

At low temperatures in winter, friction in the driving part may increase during the initial operation, causing errors. As such, the playback speed automatic adjustment function allows the robot to operate at a low playback speed (warm-up effect), helping eliminate error-causing factors and carry out the work continuously. Before setting the function, it is first required to check whether the work output of the program to be used is independent of any change in the playback speed. You can set whether to execute the function in the condition setting.

- Disable
Does not execute the playback speed automatic adjustment function
- Enable
Executes the playback speed automatic adjustment function

When the setting is “Playback speed automatic adjustment = Enable,” the “F2” button will be activated to allow you to enter the menu for detailed function settings.



Menu for setting the playback speed automatic adjustment

- Playback speed automatic adjustment function
Selects whether to use the function
- Conditions for low-speed operation
Set the condition to be applied during low-speed operation.
 - Low-speed operation speed: Designates the rate to be used for low-speed operation
 - Low-speed operation time: Sets the time to be maintained for low-speed operation. Sets the duration by including the time for restoring to the previous speed (= low-speed operation time/3)

■ Criteria for applying the function

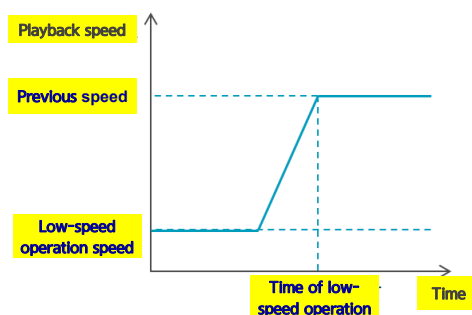
Set the references for the activation of the function.

- Robot nonoperation time: This refers to the time when the robot does not operate and includes the period of operations, except for automatic and jog operations, the stop time of the robot because of a delay or external signal during automatic operation, the time of controller power off, the time of motor off, and the time of activation of the power-saving mode. The function will be activated if the actual time the robot has not functioned is greater than the set robot nonoperation time.
- Encoder temperatures: Set the reference encoder temperatures that will activate the function. This will be enabled when the current temperatures are lower than the reference temperatures. If the current temperatures become higher than the reference temperatures because of low-speed operation, the playback speed will be changed to the previous speed, and the function will be ended.



Notes

- The playback speed automatic adjustment function does not apply to functions for which a constant speed must be maintained. Such functions include the system variable _SPDRATE, sensor synchronization, and arc.
- Even after the set low-speed operation time, if the current temperature of an encoder is below the reference temperature, the low-speed operation will be maintained. After that, if the encoder temperature satisfies the reference temperature, the speed will be restored to the previous speed.
- Restoration to the previous speed from low-speed operation speed will occur linearly over time (low-speed operation time/3). The previous speed refers to the automatic operation speed ratio inputted, as described in Phrase 5.6, before setting the function. The automatic operation speed ratio changed after the function is set will not be stored as the previous speed.





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6

Application
Condition



6. Application condition

Applied condition is the menu to set various applied functions (Ex.: Welding, handling, embedded PLC etc.) during automatic operation of the program. Changing the setting value does not change the content of the program. Also the set condition values are saved in the internal system file (ROBOT.CON) of the controller and are maintained even when the power is interrupted.

Select 『[F7]: Condition setting』 from the initial screen of manual or auto mode. You will see the 『Application Condition』 label on [F1] key in the condition setting screen. Press the 『[F1]: App. cnd』 and you will see the following screen.

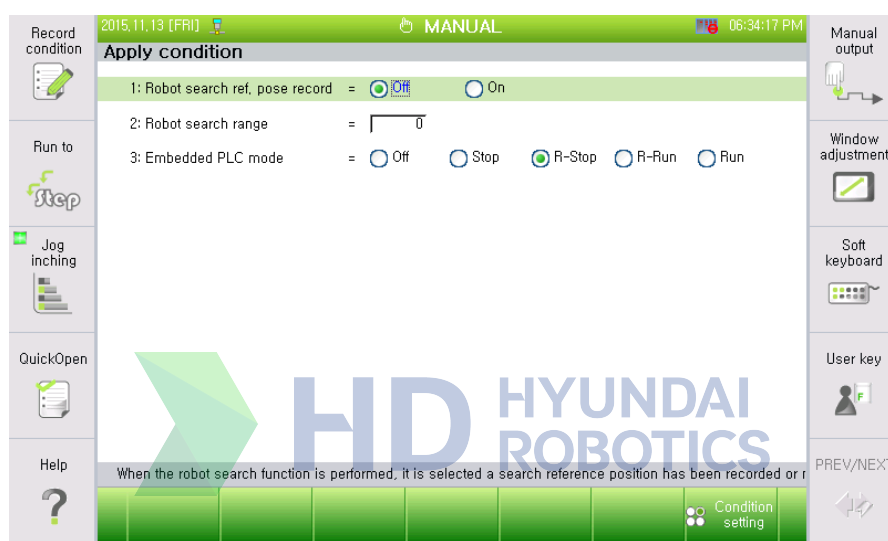


Figure 6.1 Application condition screen



Reference

- Move the highlighted bar to the item. When entering numbers, enter the numbers in the editor box. After entering the numbers you want using the [Number] key, press the [ENTER (YES)] key to reflect the details.
- After selecting one among the items used with the radio button, press the [SHIFT] + direction key ([→],[←]) to move the highlighted bar to reflect the change immediately.
- Condition setting data is saved in control constant file (ROBOT.CON).
- You can make changes to the control constant file (ROBOT.CON) even when the file is completely protected.

6.1. Robot search reference pose record

The robot search reference pose record provides the option to record the search reference pose. The steps in recording the reference pose are as shown below.

First, after teaching, including the robot search function, is completed, set this condition as on while a workpiece is placed. Next, set the operating cycle as 1 cycle and execute the auto operation. The reference pose value of the workpiece will be recorded automatically.

- Off
Do not use the robot search reference pose record function.
- On
Use the robot search reference pose record function.



Reference

- If you set the robot search reference pose record function to ON, you will see the “?” on the top left side of the screen.
- The AUTO operation speed to record the robot search reference pose data and common AUTO operation speed must be the same.

6.2. Robot search range

This decides the range to search when using the robot search function.

Select 『[F7]: Condition setting』 → 『[F1]: App. cnd』 → 『2: Robot search range』 from the initial screen of manual or auto mode.



Reference

- X can be set from 0.0 to 3.0 and the range setting is as follows.

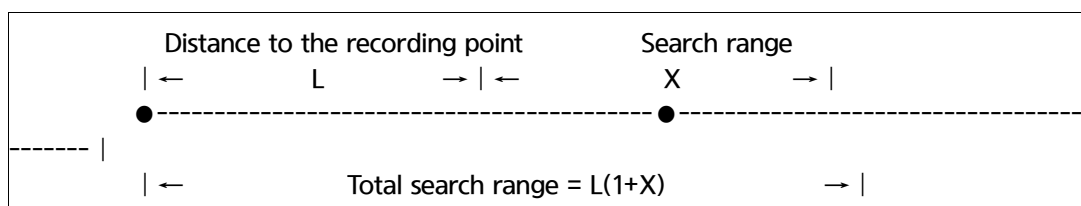


Figure 6.2 Search range setting

6.3. Embedded PLC mode

This sets the mode to control the Embedded PLC when controlling the input/output signal using the embedded PLC. There are 4 embedded PLC modes totally. Please refer to 『Hi5a Controller Embedded PLC Function Manual』 for more details.

Select 『[F7]: Condition setting』 → 『[F1]: App. cnd』 → 『5: Embedded PLC mode』 from the initial screen of manual or auto mode.

- Off
Set the function as disable.
- Stop
This stops the embedded PLC operation. DI, Y, R relay are cleared with the Stop.
- R-Stop (Remote Stop)
This is the remote mode and stops the embedded PLC operation from HRLadder of PC connected to the controller. DI, Y, R relay are cleared with R-Stop
- R-Run (Remote Run)
This is the remote mode and stops the embedded PLC operation from HRLadder of PC connected to the controller.
- Run
The controller operates the PLC program downloaded to controller.
This is enabled only for the monitoring in HRLadder of the PC.



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7

System setting



7. System setting

Controller Operation Manual

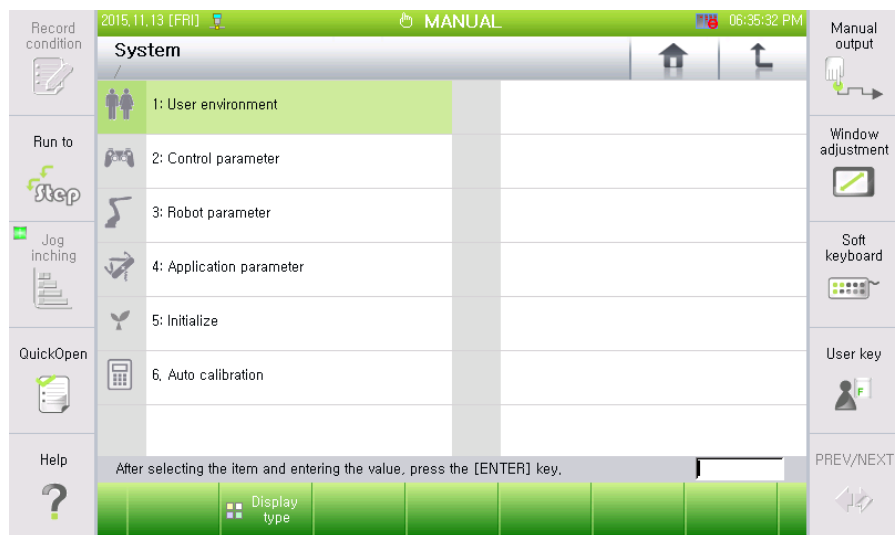


Figure 7.1 System setting menu



7.1. User environment

This is the function for the user to set various conditions to execute necessary tasks.

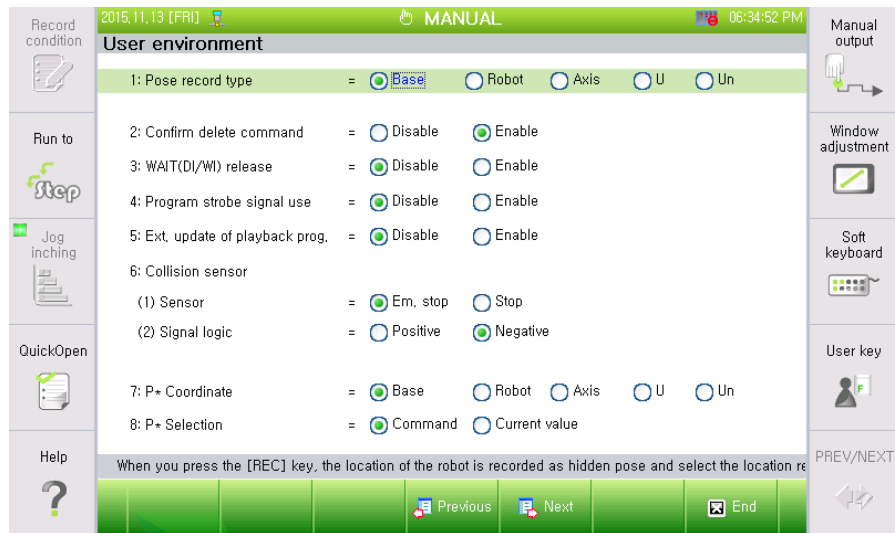


Figure 7.2 User environment menu (1)

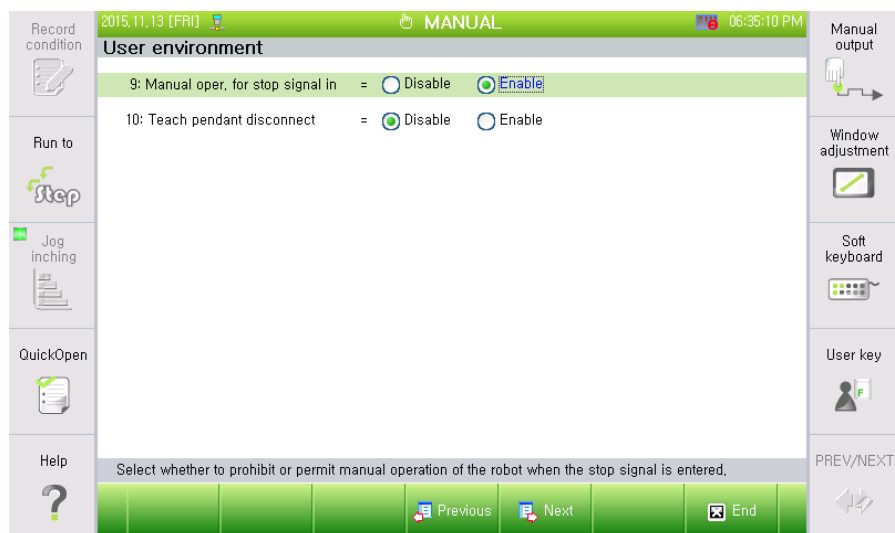


Figure 7.3 User environment menu (2)

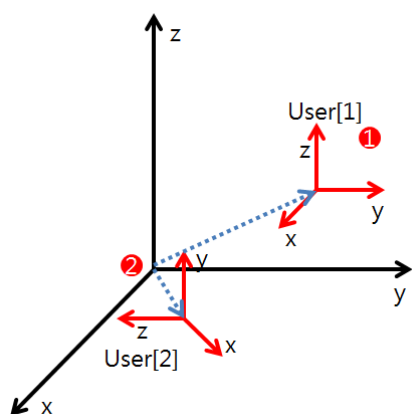
7.1.1. Pose Record Type

When you move the robot and press the [REC] key, the position of the robot is recorded in a hidden position. This function sets the robot's recording position.

- Base: The position is recorded based on the base coordinate.
- Robot: The position is recorded based on the robot's coordinate.
- Axis: The position is recorded in axis angel value.
- U
When the user coordinate is not set, the position in the currently set user coordinate will be recorded.
- Un
Records the currently set user coordinate number and the position at this number. The step recorded through this method will follow the coordinate number recorded in the hidden pose unconditionally, differently from U. Accordingly, when required to move/change the coordinate, the setting of the coordinate number of the hidden pose or the user coordinate of the number should be changed.



Reference



If the current coordinate is set as User [1] and the robot is positioned on ①.

- (1) When recorded as U
 - Change the coordinate to User [2] and move to the relevant step. Then, the robot will move to ②
- (2) When recording with Un set to 1
 - Even when the coordinate is changed to User [2], movement to ① will occur when the movement to the relevant step occurs.
 - However, when the set coordinate of UN is changed to 2, the robot will move to ②

Figure 7.4 Difference between U and Un

7.1.2. Confirm delete command

This function decides whether to confirm one more time with the user through the message box, when a command is to be deleted.

7.1.3. WAIT (DI/WI) release

This function decides whether to force cancellation or not for signal waiting when [SHIFT] + 『[F3]: WAIT rel.』 keys are pressed for the waiting input signal or welding completion signal during manual or auto mode.

7.1.4. Program strobe signal use

When you receive the external digital signal and select the external program, this function decides the time the external program is selected.

- Disable: Only reads the external program selection signal and selects the external program.
- Enable
Reads the external program selection signal at the timing the program strobe is entered to select the program.

7.1.5. Ext. update of playback program

This function decides whether to allow the program, currently in playback, to be edited externally (PC) and downloaded into the controller. (When it comes to the program currently in playback, its newly downloaded version will be applied from the next time.)

Warning

- Editing the program currently in playback and downloading it with the controller has a fairly dangerous aspect. Please consult the engineer before using this function.

7.1.6. Collision sensor

When the collision sensor is operating, this function decides the method to stop the robot.

(1) Sensor

- Em. Stop: When the collision sensor operates, it sets the operation preparation to OFF (Motor OFF) and stops the robot.
- Stop: When the collision sensor operates, it sets the operation preparation to ON (Motor On) and stops the robot.

(2) Signal logic

- Positive: This sets the input signal logic of the collision sensor to positive logic.
- Negative: This sets the input signal logic of the collision sensor to negative logic.



Reference



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ROBOTICS

- When entering the 『[F2]: System』 menu while the motor is turned off by the activation of the collision sensor, the Motor On and jog operations can be carried out. The robot that collided can be moved by using this function.
- If a collision sensor activates when "Sensor" is set to "STOP", only the jog operation of the robot is possible.

7.1.7. P* Coordinate

This allows designation of the coordinate of the pose that will be secured when using the pose formula (P*) that is needed for securing the current position of the robot in the work program.

7.1.8. P* Selection

This provides the option of using the robot command value or the current value to get the current position that will be secured when using the pose formula (P*) that is needed for securing the current position of the robot in the work program. Deviation can occur between the current value and command value because of a servo delay, so please set them to suit your environment and purpose.

7.1.9. Manual oper. For stop signal input

This sets whether to enable jog operation when external stop signal is entered.



7.1.10. Teach pendant disconnect

This needs to be set in order to operate the robot in auto mode while the teach pendant is disconnected from the controller. If it is set as 〈Enable〉, there will be no “E0015 Teaching pendant operation abnormal” error, which would otherwise occur when the communication between the teach pendant and the controller is severed.

When it is set as 〈Enable〉 and the teach pendant is disconnected from the controller, and power is supplied, the controller will recognize the current mode as remote mode, allowing the robot to be auto-operated through external Motor On and external start-up.

But because the emergency switch and mode conversion switch are separately connected through a signal wire to the teach pendant, you must appropriately wire this signal wire.

Connect CNRTP connector pin #9 (Auto) to #2 (M1) and pin #5 (Emergency stop 1) to #2 (M1), and use the exclusive CNRTP connector with pin #6 (Emergency stop 2) connected to #1 (P1) instead of the teach pendant.



7.2. Control parameter

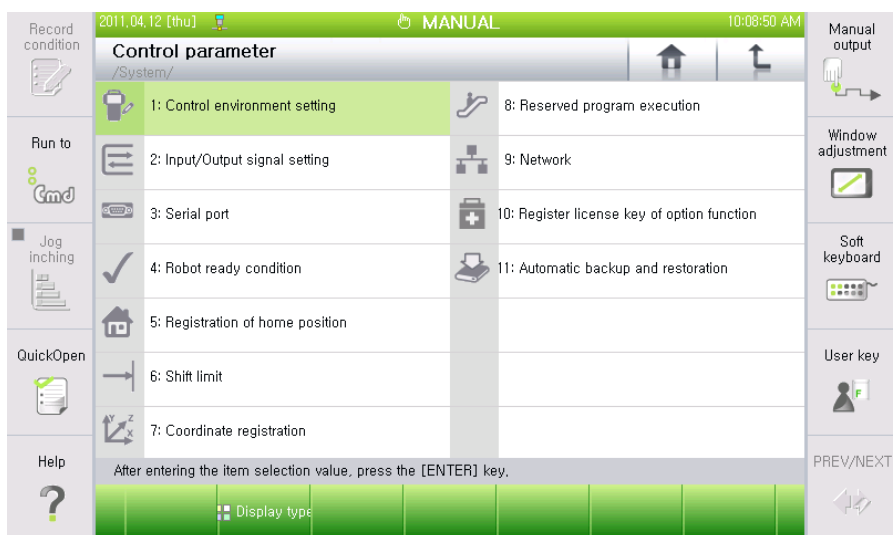


Figure 7.5 Control parameter menu



7.2.1. Control environment setting

This function sets various conditions of the controller and executes the necessary work.

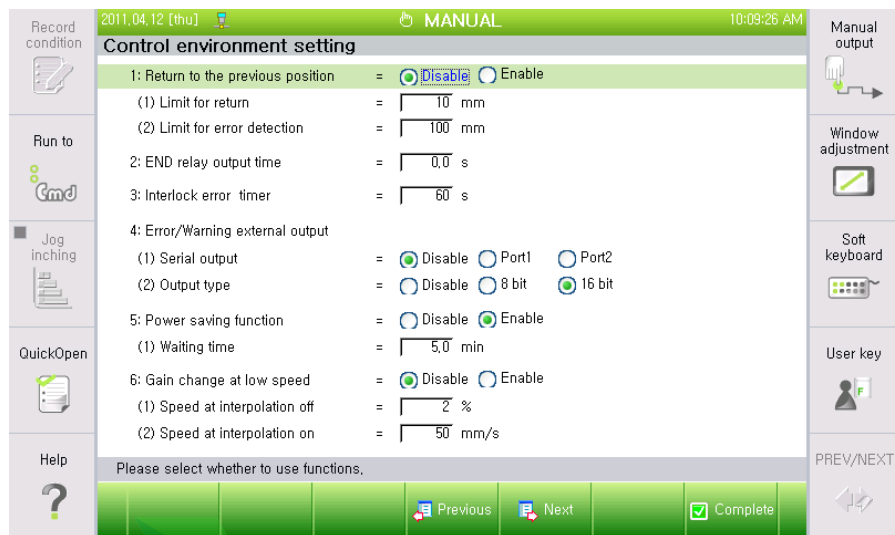


Figure 7.6 Control environment setting menu (1)

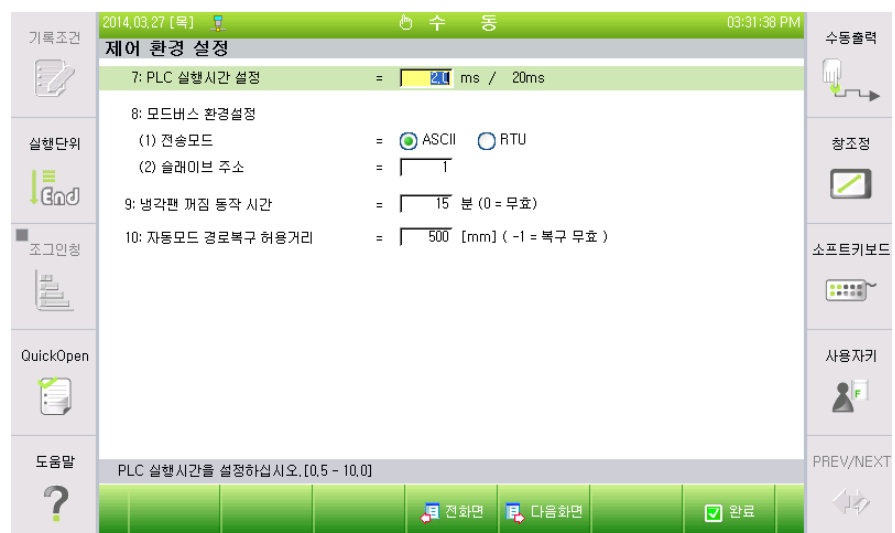


Figure 7.7 Control environment setting menu (2)

7.2.1.1. Return to the previous position

When the motor is off because an emergency stop or other factors occurred, the robot can be stopped at an off-course position from the position before the motor is switched off because of an external force such as gravity. In such a case, it is a feature that enables a robot to automatically return to the original position when you turn the operation preparation to On.

- Distance of return

It sets the limit value of the distance that the robot can return. If the position of the robot is changed to more than the value set here, a warning message is displayed.

- Distance for error detection

If the position deviation occurs at more than the set value, an error will occur. Also, it does not automatically return to its original position. As there is a high possibility of a collision with the peripheral devices after an error occurs, it does not allow automatic playback if you do not specify the step or move it to a safe place with a jog.



7.2.1.2. END relay output time



This function set the wait time after executing program END until the program head is executed again during program execution in continuous AUTO mode

7.2.1.3. Interlock error timer

This function sets the maximum wait time of the input signal. When the time of input signal wait condition during playback exceeds the regulated time, it outputs interlock error signal. This regulated time is the interlock error time.

Interlock error signal is the signal assigned from 『F2』: System → 『2』: Control parameter → 『2』: Input/output signal setting → 『4』: Output signal assign .

7.2.1.4. Error external output

This function outputs the detected error number to the external party through the serial port.

■ Serial output

Use the serial port (RS232C) to output ASCII code to the external device.

Output formats are

1st byte : "\$"
 2~6th byte : "ERROR"
 7th byte : " " (Blank)
 8~11th byte : Error number
 12th byte : CR
 13th byte : LF

Ex) For error 0101 (E0101)

\$	E	R	R	O	R		0	1	0	1	CR	LF
1	2	3	4	5	6	7	8	9	10	11	12	13

■ Number pre-designation output

Output of pre-designated number outputs the error/warning number of the signal assigned

『F2: System』 → 『2: Control parameter』 → 『2: Input/output signal setting』 → 『4: Output signal assign』.

Table 7-1 Output of signal assignment by assigned signal

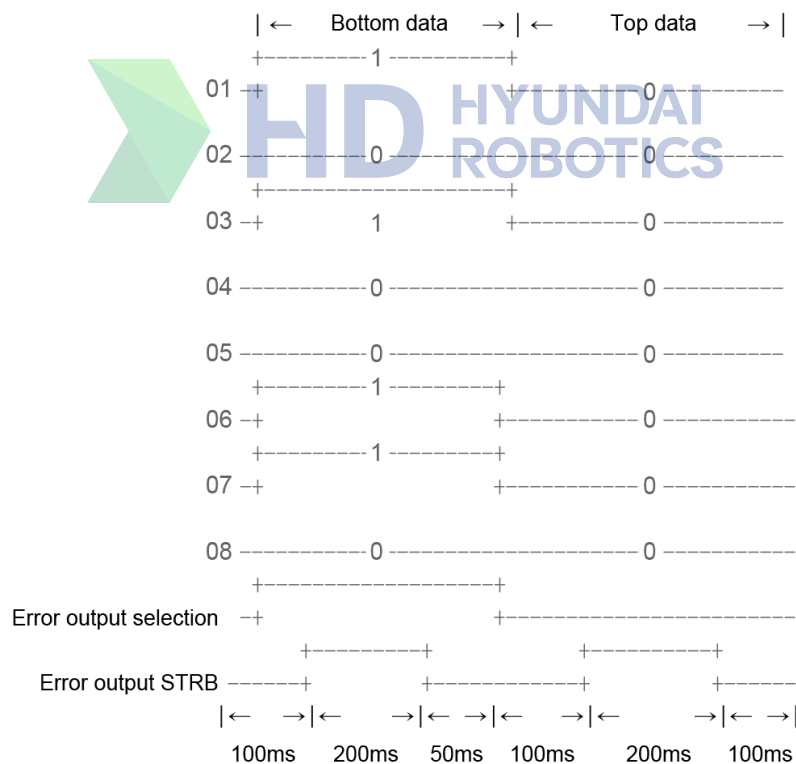
Assigned signal name	Whether to assign and how many	
	8 bit	16 bit
Error/Warning output selection	○: 1	×
Error/Warning output STRB	○: 1	×
Error/Warning output Bit	○: 8	○: 16
System error, operation error	○: 1	○: 1
Warning generated	○: 1	○: 1



Reference

- If the warning generation output signal is '0', it is an error number. If it is '1', it is a warning number.
 - When a warning is generated, system error signals as well as operation error signals will not be turned on.
- ① 8 bit – Convert the error/warning number to a binary number and divide the bottom 8 bit and top 8 bit for output. The signal to classify the bottom and top data is the error/warning output selection signal. The strobe function that decides the data check timing is the error output STRB signal.

Ex) In case of E0101, the timing as well,
 $(101_{10} = 0065_{16} = 0000\ 0000\ 0110\ 010_{12})$



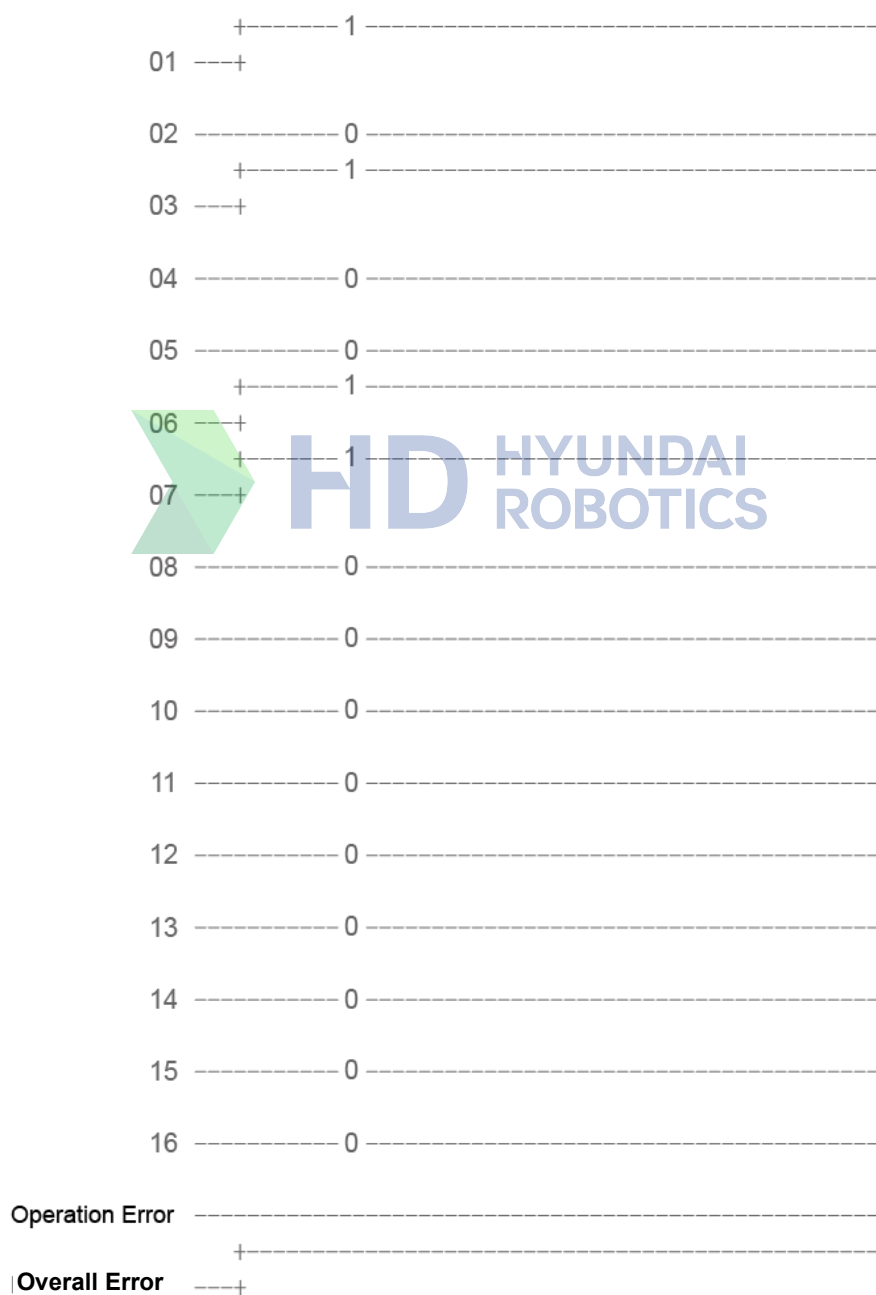
Controller Operation Manual

- ② 16 bit – Convert the error number into 2digit number and output the 16 bit data.

The strobe signal that decides the data check timing

- System error ⇒ Overall error
- Operating error ⇒ Operational error or above.

Ex) In case of E0101, the time as well (System error)



7.2.1.5. Power saving function

This is the function to set whether to activate/deactivate the power save function and to set the standby time. If the robot is in stopped condition during operation standby or input signal standby during auto mode for more than the set standby time, the power supply to the motor will be blocked to save power consumption. When the robot operation command is received, the power will be supplied to the motor to exit from the power save function and the robot will start to operate. Because there is a delay element during this process compared to the normal operation, you must deactivate the power save function when you are executing a task that projects the expected speed of the robot.

7.2.1.6. Gain change at low speed section

Sometimes unnoticed vibration in normal speed occurs in low speed interval. This occurs due to the characteristics of the motor. In this case, set the gain for low speed interval separate to reduce the vibration.

- Speed at interpolation off
This is the reference speed to change the gain in the interval where interpolation is Off.
- Speed at interpolation on
This is the reference speed to change the gain in the linear or arc interpolation interval.

7.2.1.7. Embedded PLC execution time

When using the embedded PLC, you can adjust the PLC execution time within the controller. The controller executes the PLC ladder program every 20ms internally and you can set the level to assign PLC execution. The longer this time is set, the shorter the scan time of the PLC program will be. But if set to high, the CPU execution time will be insufficient to cause “E0047 Motion processing time exceed” error or “E0186~E0189 1st/2nd/3rd/4th DSP detected main watchdog” error.

7.2.1.8. Modbus environment setting

This function sets the environment to use the mod bus.

7.2.1.9. Cooling fan turn off time

When the robot is operating, the temperature inside the controller increases due to the regenerative resistor. In order to prevent the temperature from increasing, the cooling fan should run.

When the robot is inactivated, the temperature inside the controller does not go up any more. In such condition, there is no reason for the cooling fan to run. However, if the cooling fan runs even in such condition, reverse effects such as shortening of the fan's lifetime, generation of noise, and increasing of power consumption, will be caused.

When the robot is activated (Motor On), the cooling fan should run immediately. When the robot is deactivated, (Motor Off or Power Saving), the cooling fan should stop running after a certain time. If the cooling fan cannot run immediately, the latent heat of the regenerative resistor will cause the temperature inside the controller to go up.

The output for controlling the cooling fan's on/off activity is provided through DO3 of TBIO of the system board. The circuit for controlling the cooling fan power should be configured using the output signal.

7.2.1.10. Allowable distance of the path recovery on auto mode

This detects an error when the allowable distance of path recovery in auto mode exceeds the designated value.

If it is set as "-1", path recovery will not occur.

7.2.2. Input/output signal setting

This function enables the user to configure the properties of the input and output signal, the assignment of signals, and the setting of the field bus, for example.

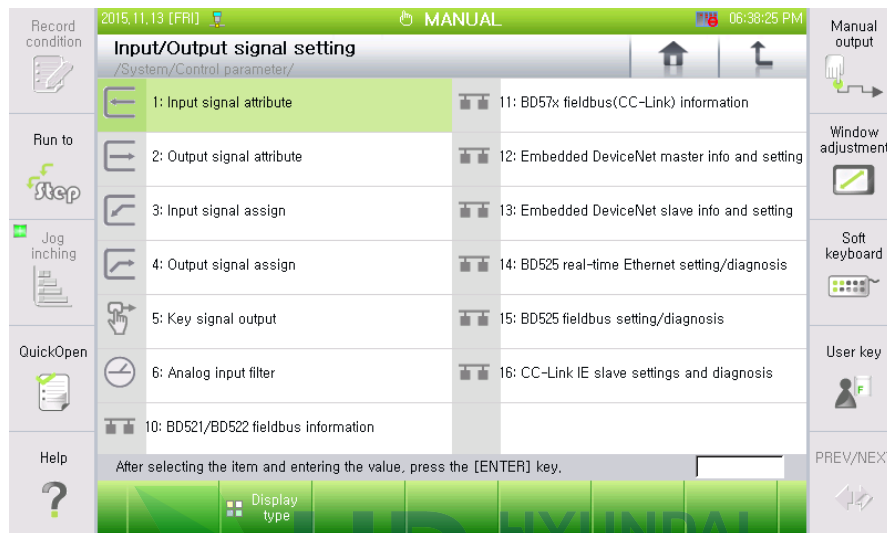


Figure 7.8 Input/output signal setting menu

7.2.2.1. Input signal attribute

This function sets the positive or negative logic of the common input signal.

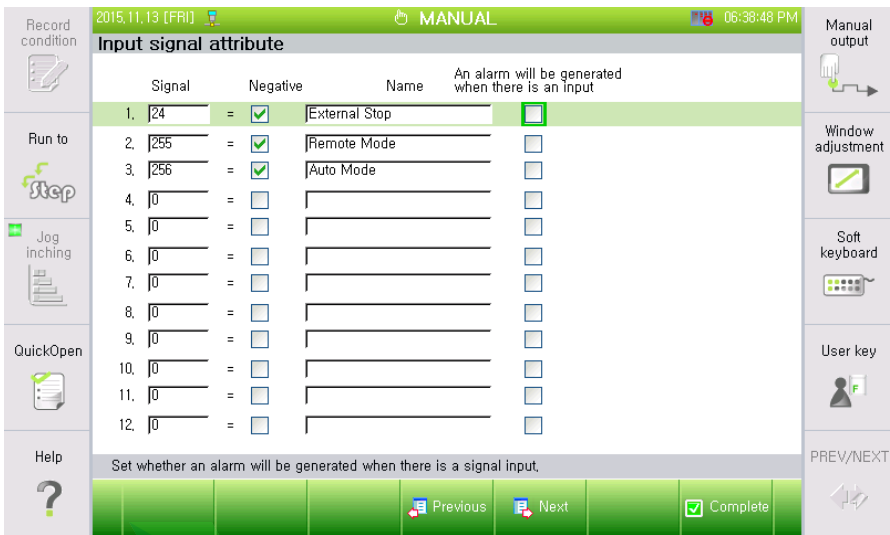


Figure 7.9 Input signal properties menu

- Signals
The user is required to set as the following depending on the types of input.

Type	Setting range	Setting example
Hardwired	0 ~ 4096	35 → DI35
Field bus	1.1 ~ 1.960 3.1 ~ 3.960 5.1 ~ 5.960	5.48 → FB5.DI48
Embedded field bus	.1~64.1~128	.61.108 → FN61.DI108

- Negative logic

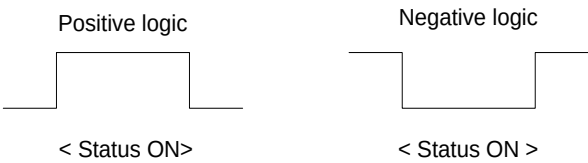


Figure 7.10 Positive and negative logic of common input signal

- Name

You can check the name of the set signal and the status in the function of 『F1]: Service』 → 『1: Monitoring』 → 『2: Input/output signal』 → 『5: Input signal name display』 .

- An alarm will be generated when there is an input

This provides the option of outputting an alarm message, including the signal number and name when the relevant signal is turned on. This can be used to check from the TP of the robot when there are problems with the surrounding facilities.



7.2.2.2. Output signal attribute

This function sets the signal logic, pulse property and name for the common output signal.

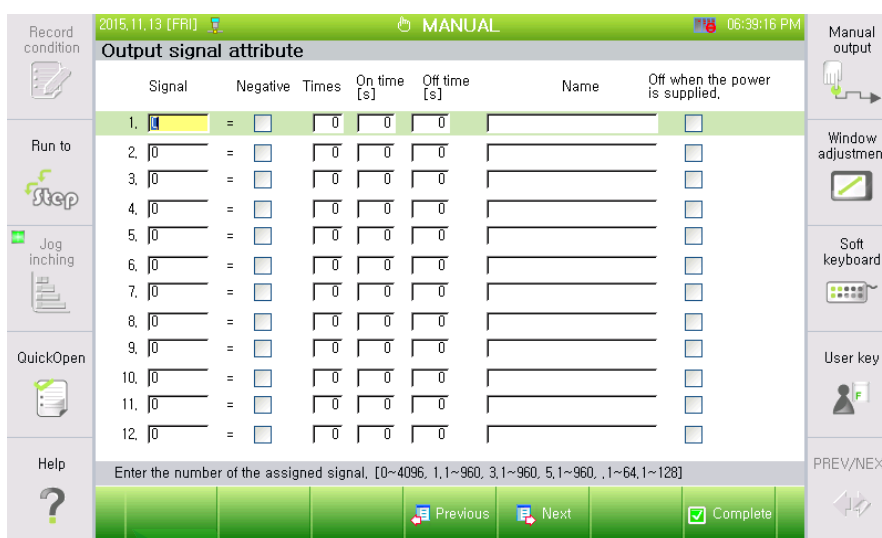


Figure 7.11 Output signal properties menu

■ Signals

The user is required to set as the following depending on the types of output.

Table 7-2 Output signal assignment for each assigned signal

Type	Setting range	Setting example
Hardwired	0 ~ 4096	35 → DO35
Field bus	1.1 ~ 1.960 3.1 ~ 3.960 5.1 ~ 5.960	5.48 → FB5.DO48
Embedded field bus	.1~ 64.1~128	.61.108 → FN61.DO108

■ Logic

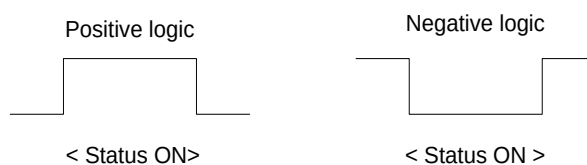


Figure 7.12 Positive and negative logic of common output signal

■ Times

When set to 0, it is the delayed output and when set in the range of 1~100, it is the pulse output.

Example of pulse output

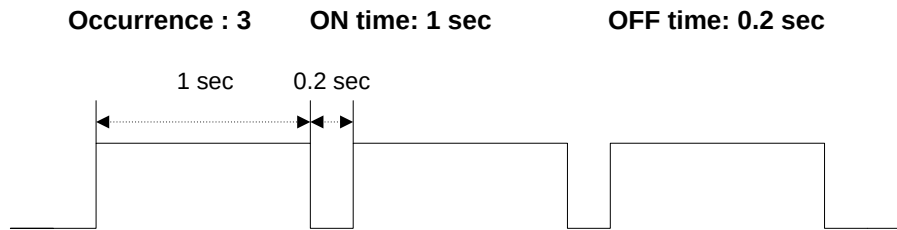


Figure 7.13 Example of pulse output

Example of delay output

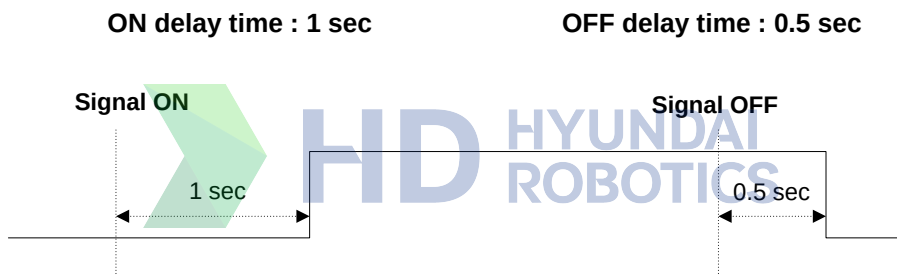


Figure 7.14 Example of delay output

- On time: Set the On time of the output signal for pulse output or delayed output.
- Off time: Set the Off time of the output signal for pulse output or delayed output.
- Name
You can check the name and the status of the set signal in the function of 『F1』: Service』 → 『1: Monitoring』 → 『2: Input/output signal』 → 『6: Output signal name display』 .
- Off when the power is supplied.
Provides the option of changing the output signal to the off state when the robot controller is powered on.

7.2.2.3. Input signal assign

The state and activity of the controller can be remote-controlled through the controller's input signal. This function is to assign the input signal number for each remote control items.

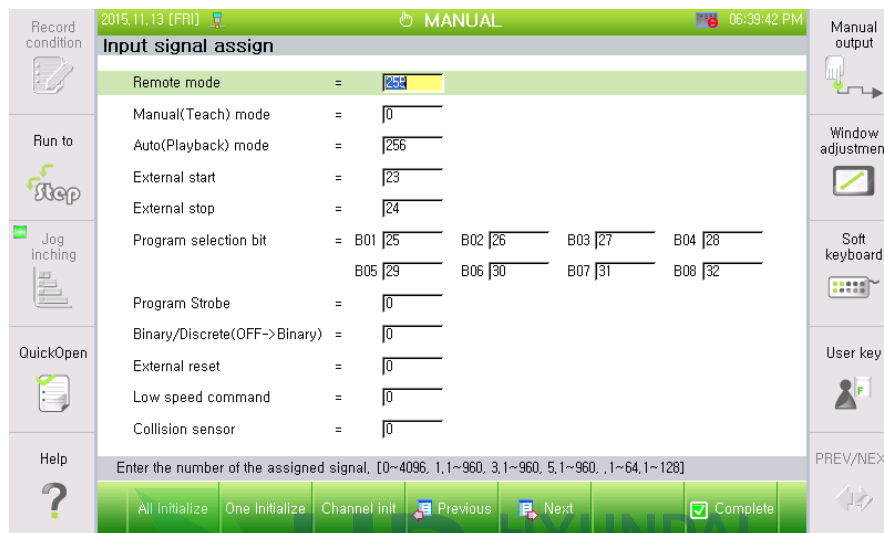


Figure 7.15 Input signal assignment menu



Reference

- All Initialize: This initializes all the input allocation signals.
- One Initialize: This initializes the currently selected input allocation signal to its default value.
- Channel init
This function resets the input channel for the assigned signals.
(0: Digital signal, 1, 3: BD52X field bus, 5: BD57X field bus (CC-Link))

- External program selection

In case of the externally started operation, the time, in which the external program is confirmed as it is after the program selection bit is read, varies depending on whether the strobe signal is used.

- If the program strobe signal use is <Enable>

When the external start input is made, if the program strobe signal is on, the program selection bit will be read. Then, the read value will be confirmed as the program number.

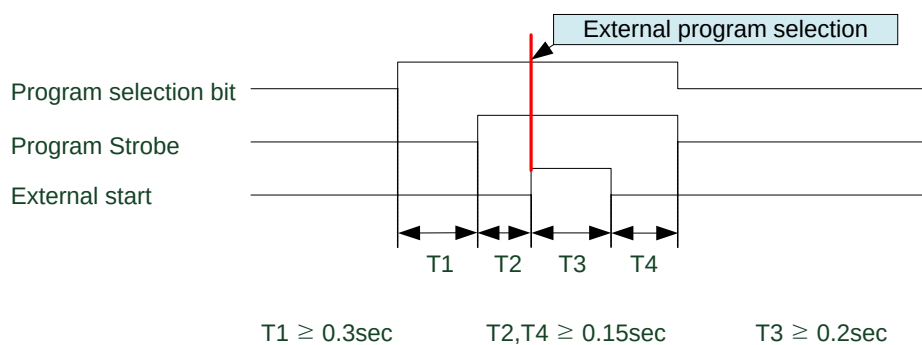


Figure 7.16 External program selection diagram when the program strobe signal is "Enable"

- If the program strobe signal use is <Disable>

After the external start input is made and the program selection bit is read, then, if this read value does not change for 90ms, it will be confirmed as the program number

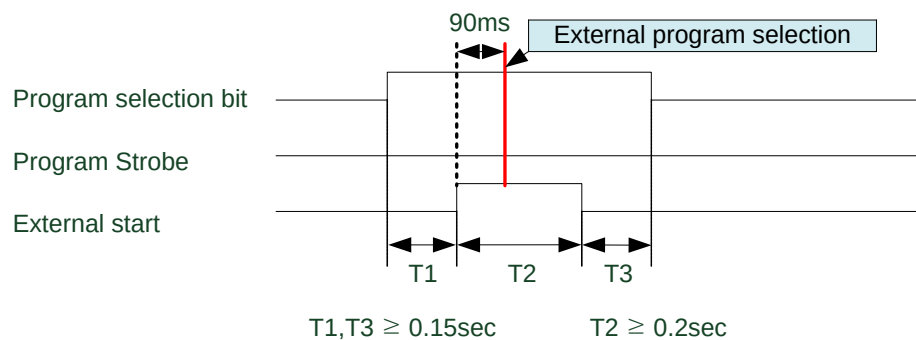


Figure 7.17 External program selection diagram when the program strobe signal is "Disable"

Controller Operation Manual

- Program selection bit and binary/discrete (OFF → Binary)

Program selection bit is a combination of signals for selecting a program for execution when there is an external start signal input. Currently, it is only applied when the STEP of HEADER or END is being taught from the TP. When the program is running, it is executed until the end. The binary/discrete signal is an option for deciding the interpretation of the program selection bit. If it is "0", it will be recognized as binary and if it is "1", it will be recognized as discrete.

Example) Jobs to be performed according to input when the program selection bit is assigned as shown in Figure 7.15 Input signal assignment menu.

Bit	32	31	30	29	28	27	26	25
Assigned value	0	0	0	0	0	0	0	1

*) In case of Binary: Job 1 will be performed

*) In case of Discrete: Job 1 will be performed

Bit	32	31	30	29	28	27	26	25
Assigned value	0	0	0	0	0	1	0	1

*) In case of Binary: Job 5 will be performed

*) In case of Discrete: Job 1 will be performed

Bit	32	31	30	29	28	27	26	25
Assigned value	0	0	0	1	0	0	0	0

*) In case of Binary: Job 16 will be performed

*) In case of Discrete: Job 5 will be performed

Bit	32	31	30	29	28	27	26	25
Assigned value	0	0	0	1	1	0	0	0

*) In case of Binary: Job 24 will be performed

*) In case of Discrete: Job 4 will be performed

7.2.2.4. Output signal assign

This is to allow the event data or state data generated from the controller to be transferred externally through the output signal. This function is to assign the output signal number for such data individually.

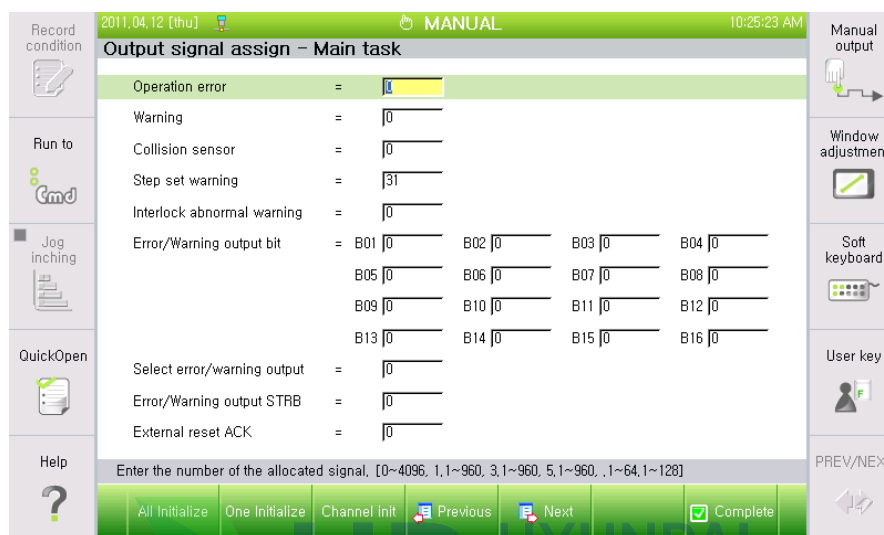


Figure 7.18 Output signal assignment - Main task

Refer to the following sequence for the output signals related to error/warning output bit, error/warning STRB, overall error, operation error and alarm. The sequence will vary depending on whether the “『F2』: system』 / 『1: Control environment setting』 / 『4: Error/Warning external output』 / (2) output type” are set in 8-bit or 16-bit. Refer to the following.

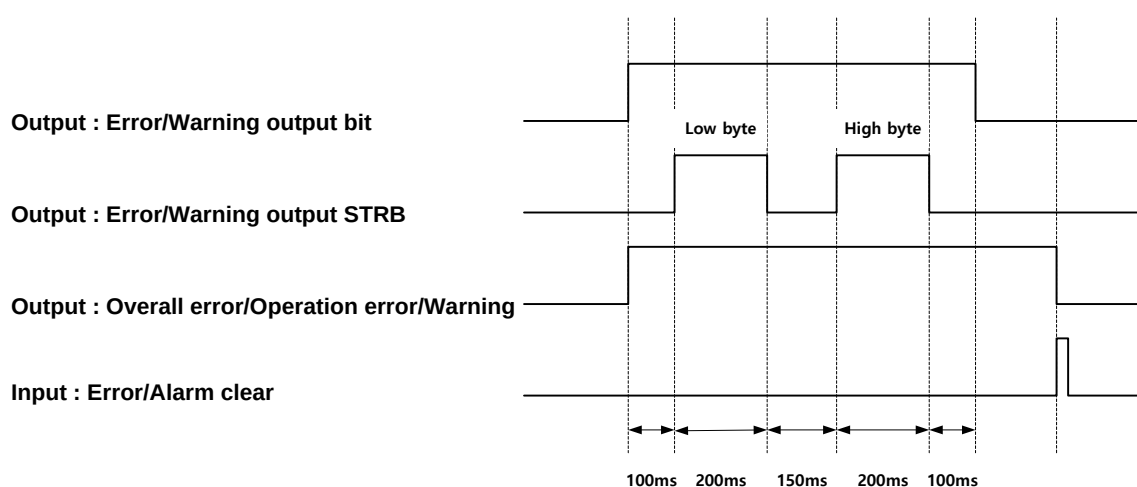


Figure 7.19 8-bit output

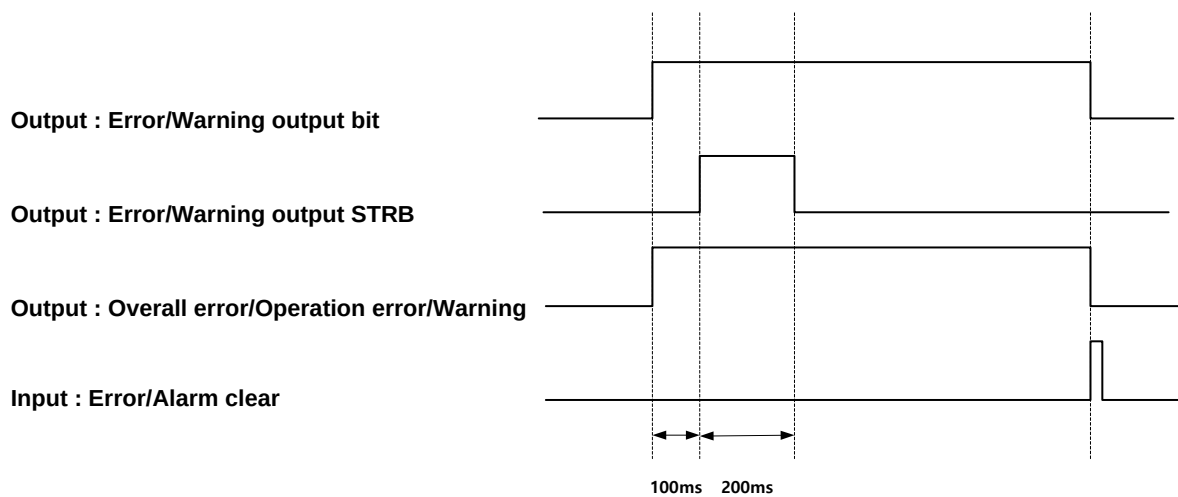


Figure 7.20 16-bit output



Reference

- All Initialize: This initializes all the output allocation signals.
- One Initialize: This initializes the currently selected output allocation signal to its default value.
- Channel init
This resets the output channel for the assigned signals.
(0: Digital signal, 1, 3:BD52X field bus, 5:BD57X field bus (CC-Link))

7.2.2.5. Key signal output

This is to set in a way to allow the desired output signal to be turned on/off by using the signal keys of the teach pendant ([SHIFT] + [F1] ~ [F7]).

For more details, refer to 『Hi5a Controller “Key Signal Output” Function Manual』.

Label (12byte)	Positive signal	Negative signal	Toggle	Permit for auto mode	OFF when switching to auto mode
F1	0	0	☐	☐	☐
F2	0	0	☐	☐	☐
F3	0	0	☐	☐	☐
F4	0	0	☐	☐	☐
F5	0	0	☐	☐	☐
F6	0	0	☐	☐	☐
F7	0	0	☐	☐	☐

(Call signal key with [SHIFT]+[Manual output])

Edit the label with [Soft keyboard]

Complete

Figure 7.21 Key signal output

7.2.2.6. Analog input filter

You can use the digital filter for the analog input signal.

Set this when you need to reduce the noise level in the noisy analog input

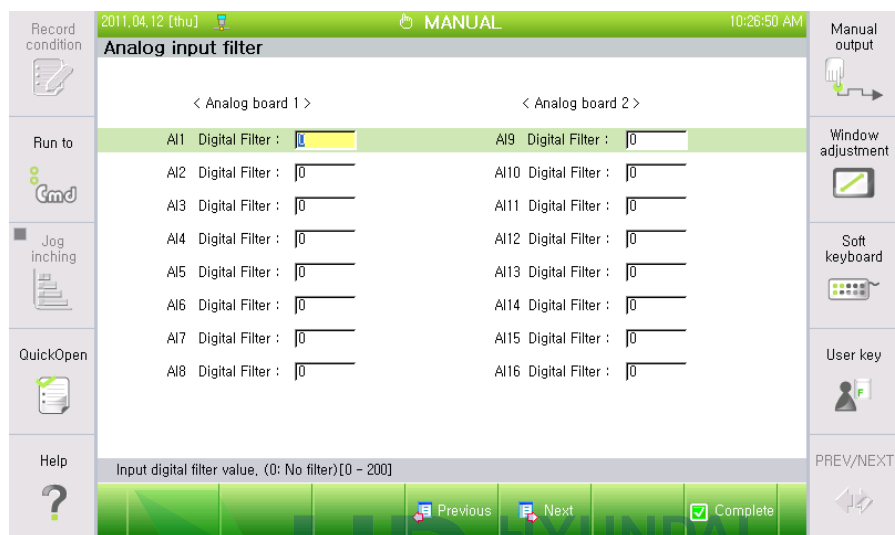


Figure 7.22 Analog input filter



Reference

- You can set the arc sensing analog input filter for arc welding in the “Input signal setting” screen by selecting 『[F2]: System』 → 『4: Application parameter』 → 『2: Arc welding』.
- There are 8 analog input ports per BD58X board.
- Maximum number of analog input port is 32.

7.2.2.7. BD521/BD522 field bus information & setting

This is to set the BD521/BD522 field bus function, and is to be used for the Device Net master or slave functions, and profibus-DP master or slave functions. The screen configuration varies depending on the installed field bus module.

Refer to 『Hi5a Controller BD52X Multi-Communication Function Manual』

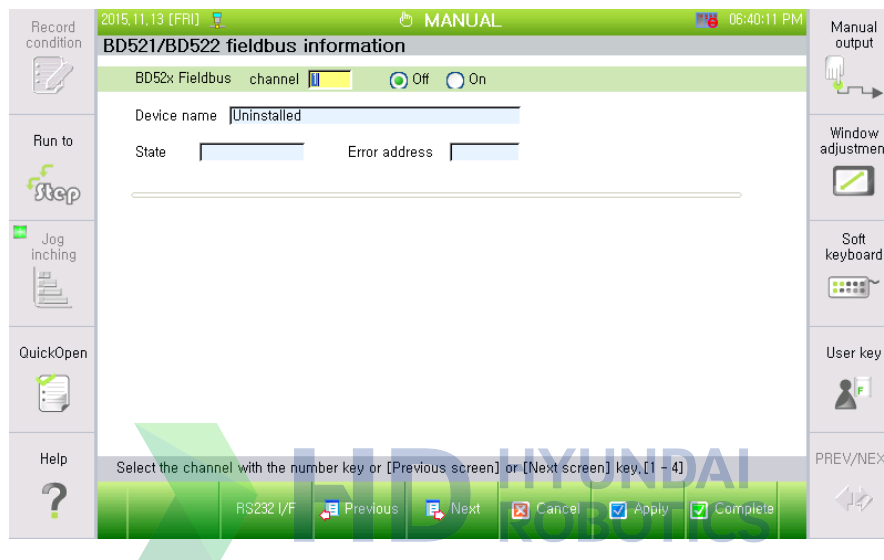


Figure 7.23 BD521/BD522 field bus information and setting menu

- Channel: This displays the number of the currently selected channel. Use 『[F3]: Previous』 and 『[F4]: Next』 to shift between channels.
- Use: Select whether to operate the field bus module of the applicable channel.
- Device: This displays the name of the module installed in the applicable channel.
- Status: This displays whether the module is executing the network operation normally.
- Error address: For the field bus master module, this displays the address (Node number etc.) when the slave that caused the problem within the network is identified.

7.2.2.8. BD57X field bus (CC-Link) information and setting

This function sets the CC-LINK of BD57X (Or, BD58A).

Refer to 『Hi5a Controller CC-Link Function Manual』 for more details.

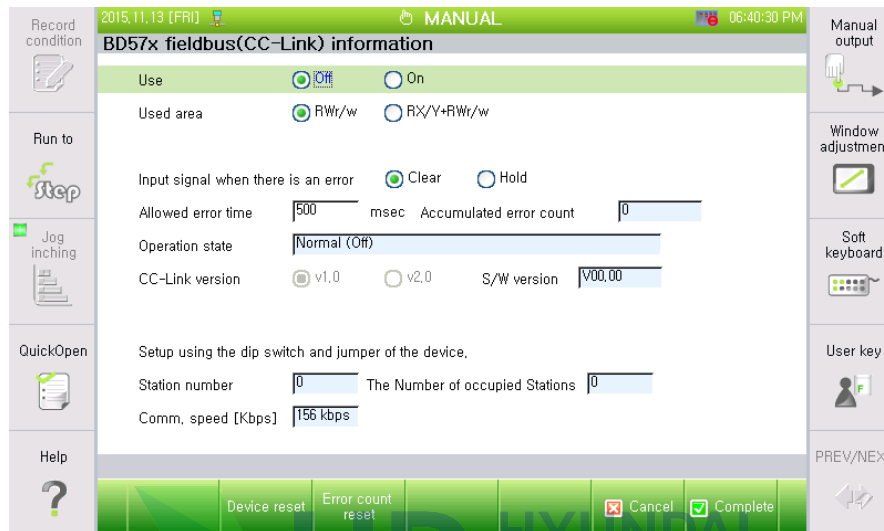


Figure 7.24 BD57X field bus (CC-Link) information and setting menu

- Whether used: Select whether to use the function.
- Used area: Select the utilization method of I/O area.
- Operating condition :
This displays whether the module is executing the network operation normally.
- Station number: Displays the station number of the CC-Link set by the BD57X dip switch.
- Station number:
Displays the communication speed of the CC-Link set by the BD57X dip switch.
- Number of stations:
Displays the number of occupied stations of the CC-Link set by the BD57X jumper.



Reference

- Device reset: This function is to re-initialize the BD57X CC-Link board.

7. System setting

7.2.2.9. Embedded DeviceNet Master information and setting

This function sets the embedded DeviceNet master. In case of the embedded DeviceNet master function, no additional tool for the network configuration is to be used.

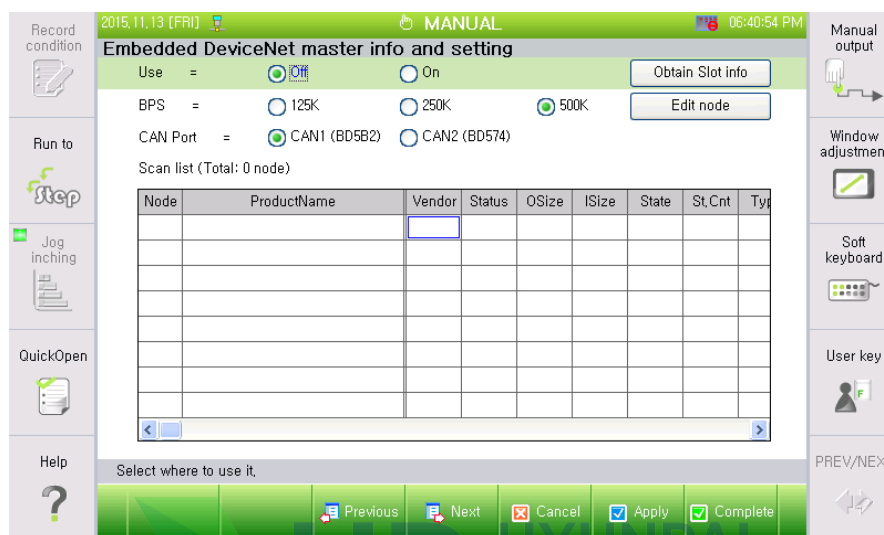


Figure 7.25 Embedded field bus setting screen

- Use: Select whether to use.
- Communication speed: Select the one communication speed for the Device Net among the speeds, 125kbps, 250kbps, and 500kbps

When you press 『[F6]: Apply』 after setting the above, the setting will be saved in the main board. After a short while, 『[F1]: Scan node』 will be shown as below.

Controller Operation Manual

When you press 『[F1]: Scan node』 after connecting the slave device that you will use, the connected nodes will be automatically scanned as shown below.

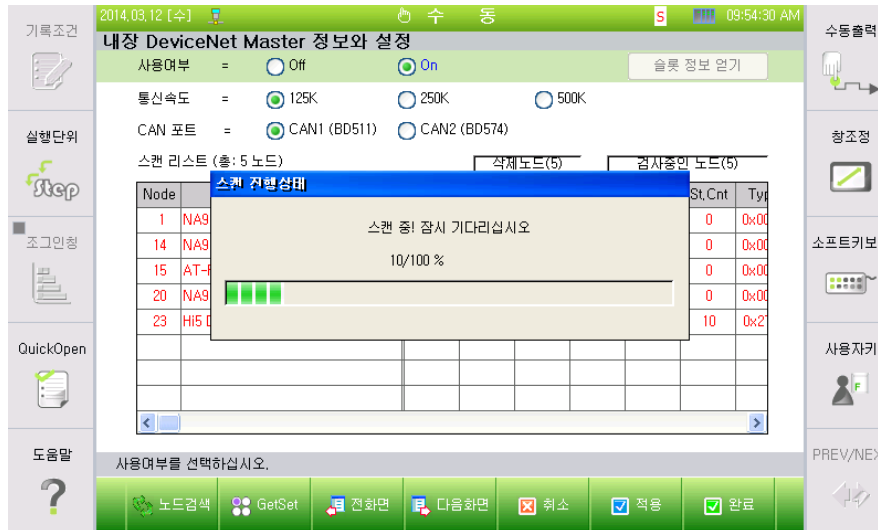


Figure 7.26 Node scanning for setting the embedded field bus

The scanned results to be displayed include, as shown below, the product name, vendor ID, status, count of output bytes (Osize), count of input bytes (Isize), state (42=IO Polling), state change counter (St. Cnt), device type, CCV, and the serial number

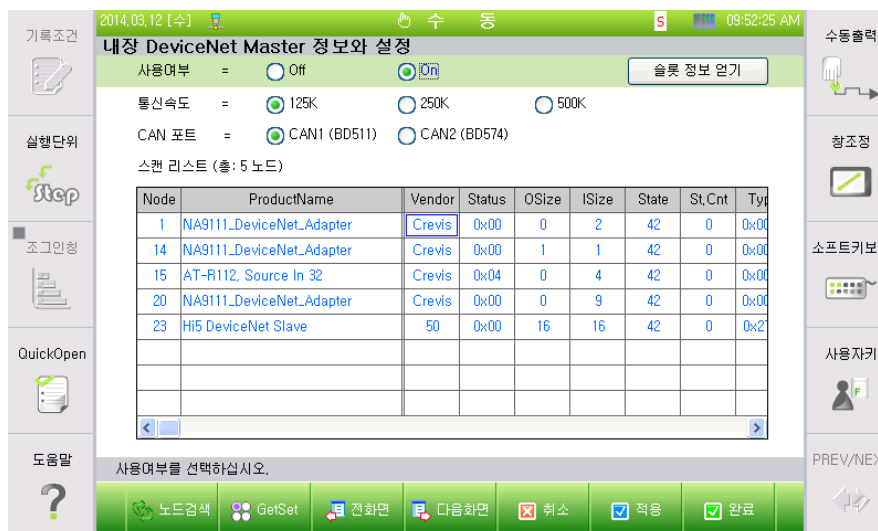


Figure 7.27 Node scanning results for setting the embedded field bus - 1

When there is no error, just like the case shown above, the Get Set Object function, 『[F2]: Get Set』, which will make it possible to have a direct access to the node object, will be displayed.

7. System setting

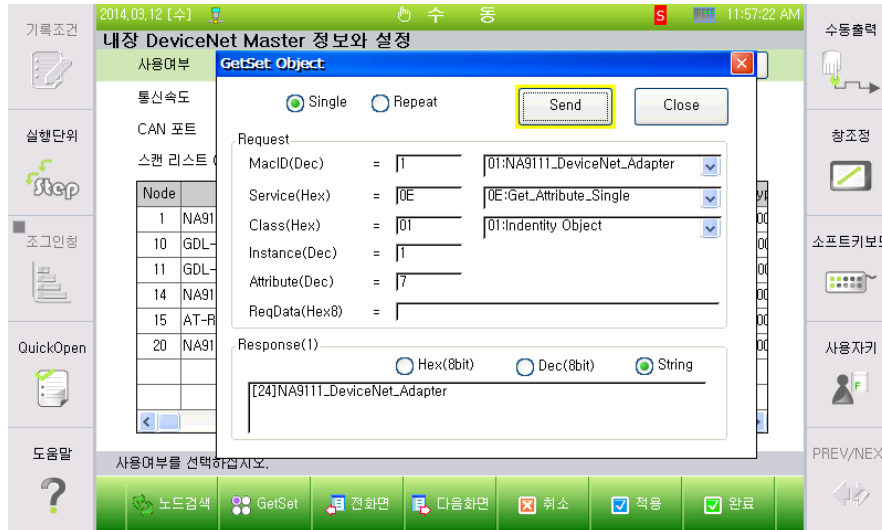


Figure 7.28 Embedded field bus Get/Set Object

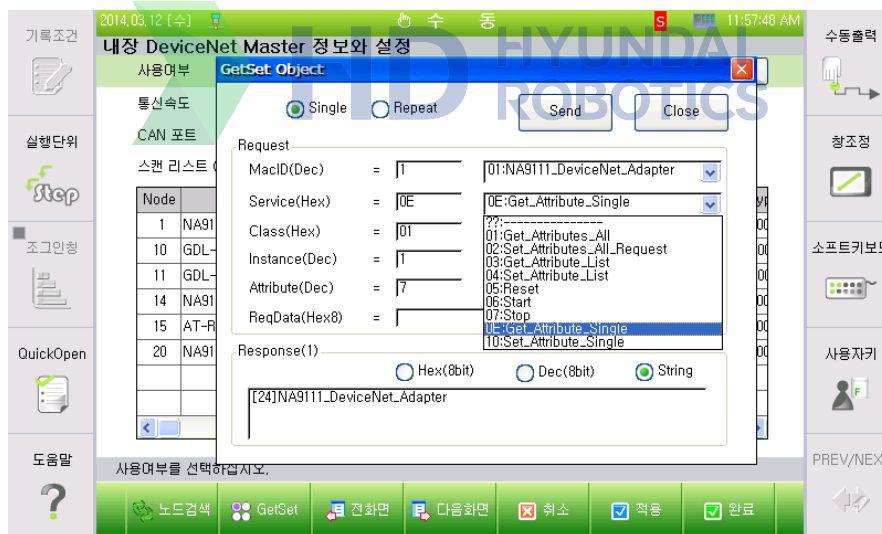


Figure 7.29 Embedded field bus combo box list

As shown in the above screen, in the case of the Mac ID, Service, and Class items, values can be entered or a list can be selected from the combo box. This function can check the internal state of each node or make a change in it. For example, if the communication with the master is disconnected, a change can be made in a way that the state of the output is maintained, or turn 0 or 1, Refer to the information provided by the maker of each connected node.

7.2.3. Serial port

This sets up the parameters for RS232, RS422 and RS485, and sets up the usage for serial ports.



Figure 7.30 Serial port menu

7.2.3.1. Serial port #1

This function sets the communication information when communicating with serial port #1.

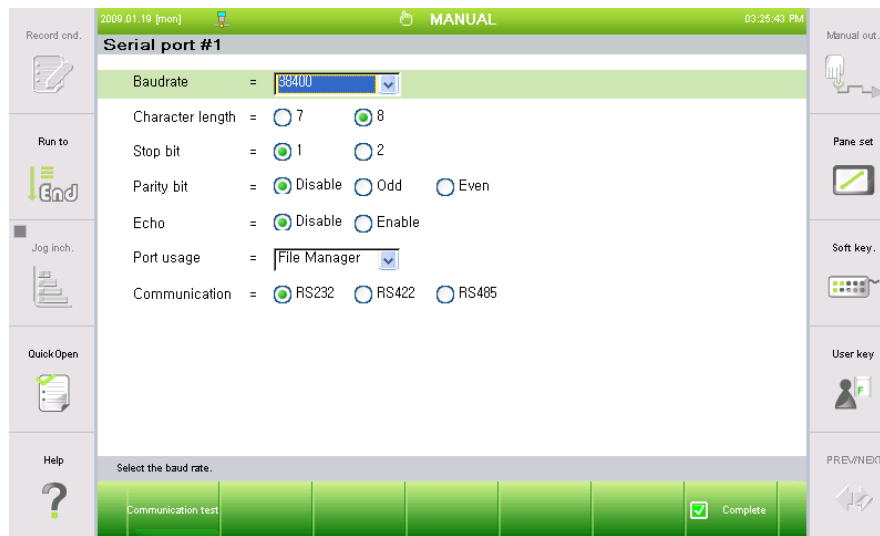


Figure 7.31 Serial port #1 setting menu



Reference

- Serial port usage
 - ① File Manager
This is used for saving or opening files (HR-View) for the interface with the computer.
 - ② Sensor
This is used for the usage of receiving the shift data by interfacing with the vision sensor.
 - ③ LVS
This is used for the usage of connecting the laser vision sensor to track the welding line.
 - ④ MODBUS
This is used for the usage of using the MODBUS slave function of Hi5a.
- [F1: Communication test]

This function is to check whether the serial port communication connection is normal. If there is a problem, this function provides procedures for identifying the cause of the problem.

7.2.3.2. Serial port #2

This function sets the communication information when communicating with serial port #2.

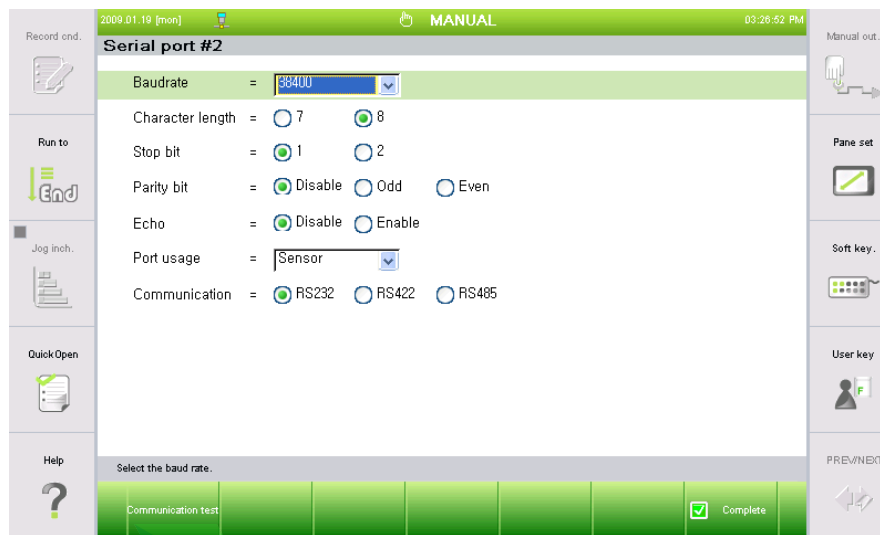


Figure 7.32 Serial port #2 setting menu



Reference

- Serial port usage
 - ① File Manager
This is used for saving or opening files (HR-View) for the interface with the computer.
 - ② Sensor:
This is used for the usage of receiving the shift data by interfacing with the vision sensor.
 - ③ LVS
This is used for the usage of connecting the laser vision sensor to track the welding line.
 - ④ MODBUS
This is used for the usage of using the MODBUS slave function of Hi5a.
- [F1: Communication test]

This function is to check whether the serial port communication connection is normal. If there is a problem, this function provides procedures for identifying the cause of the problem.

7.2.4. Robot ready condition

This sets the conditions to generate the ready signal for robot preparation.

Robot ready signal is the DO signal allocated in 『[F2]: System』 → 『2: Control parameter』 → 『2: Input/output signal setting』 → 『4: Output signal assign』.

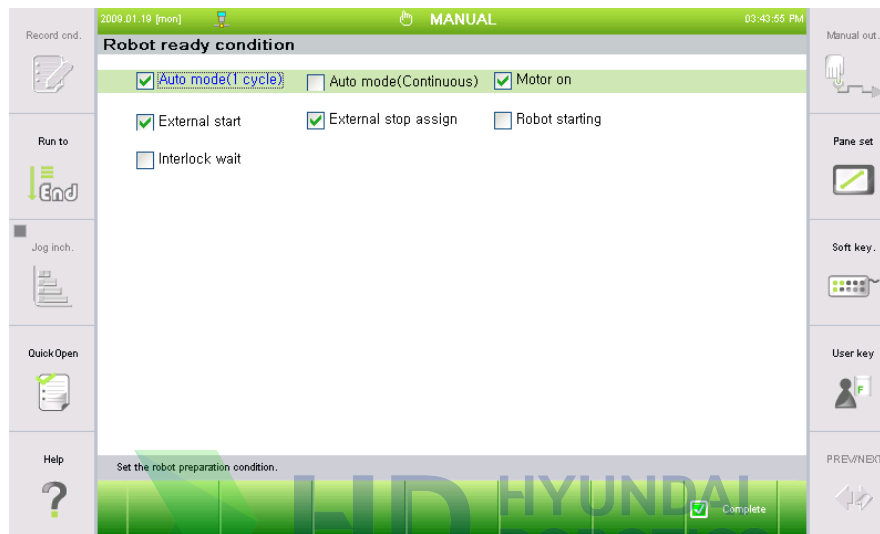


Figure 7.33 Robot ready condition menu

7.2.5. Registration of home position

This is the function to output the original location signal, set in the output signal section, if the user registered an arbitrary posture of the robot as its original location and the robot came into that location. The original location is designated by each axis posture and here the margin by each axis can be set.

Up to 8 original locations can be registered and used.

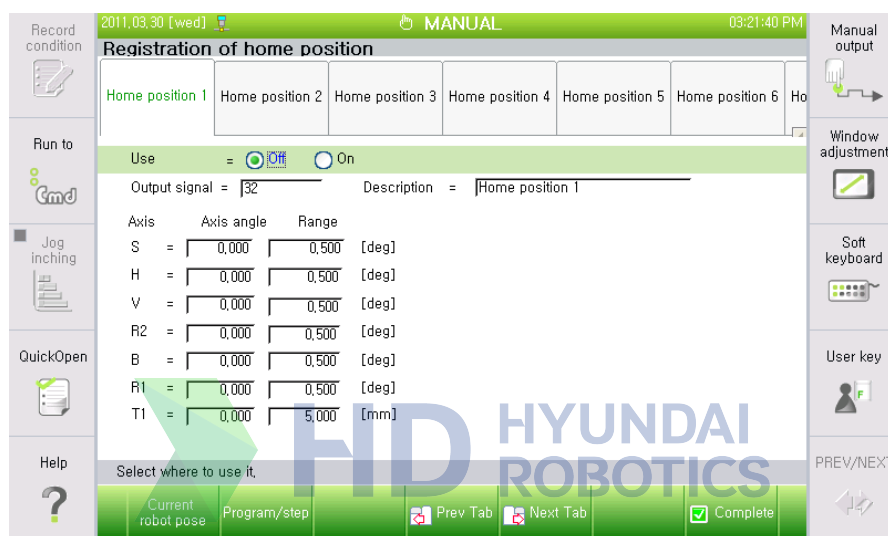


Figure 7.34 Registration of home position

- Axis angle, range**
 Enter the range of position for each axis of the robot at the home position. When the range value is set to 0, the home position check will not be carried out for the relevant axis. The range value is used in the '+' direction and '-' direction ranges of the original location point. For example, when it is set to 0.5, the output range of the original location signal becomes 1.
- [F1: Current robot pose]**
 This function is to allow the axis angle of the current posture of the robot to be entered into the screen automatically.
- [F2: Program/Step]**
 This function is to allow the axis angle of the relevant step to be entered into the screen automatically after the program and step number are entered by the user

7.2.6. Shift limit

This is the function to set the shift limit of the robot to improve the stability when using the shift function. Set the shift limit of XYZ shift or online shift function, and an error is generated when the shift exceeds this setting.

By setting the shift limit, you can process the error when incorrect shift data is received externally.

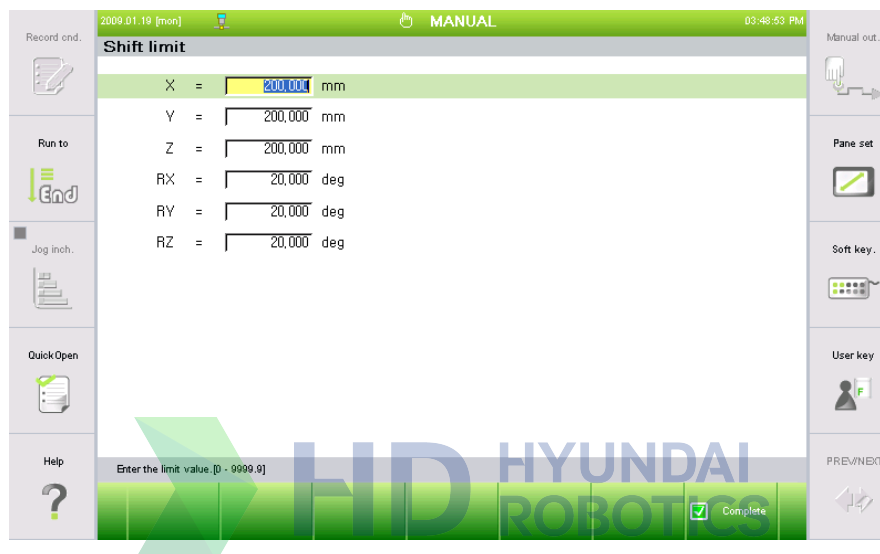


Figure 7.35 Shift limit menu

7.2.7. Coordinate registration

It is used for setting up the user coordinate or stationary tool coordinate.

Select and access 『F2』: System → 『2』: Control parameter → 『7』: Coordinate registration

7.2.7.1. User coordinate

User coordinate refers to the coordinate set to the location set by the user. In order to use the user coordinate, first you must follow the 3 standard teaching to define the user coordinate mentioned below. This menu designates the program number and user coordinate number that has taught so that the user coordinates can be registered to Hi5a controller.

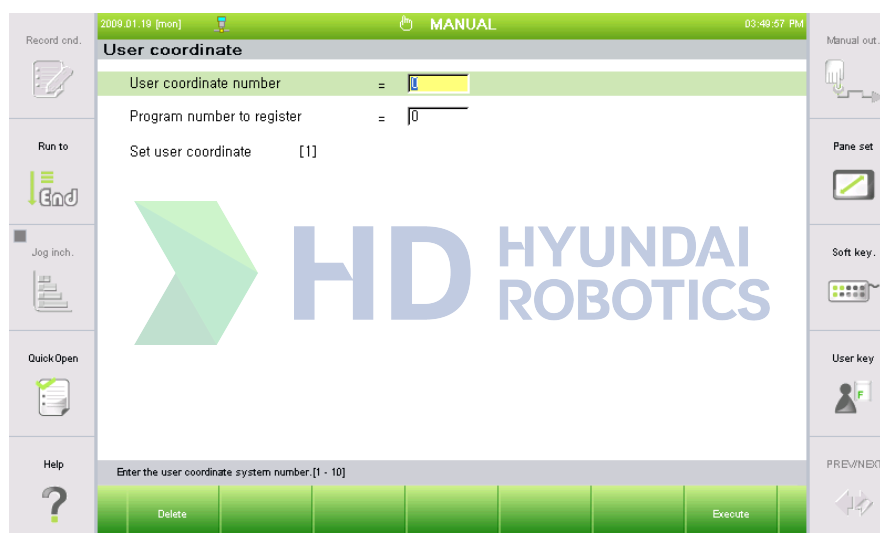


Figure 7.36 User coordinate menu



Reference

- Teaching method of 3 standard steps to define the user coordinate

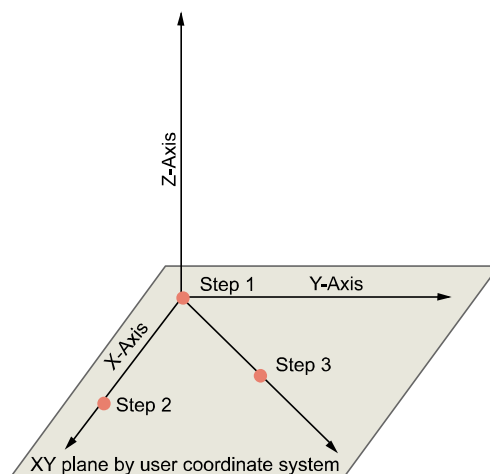


Figure 7.37 Teaching method of 3 standard steps to define the user coordinate

- ① Step 1 : Step to define the 0 position in the user coordinate
- ② Step 2 :
Step to define the X axis of the user coordinate. Teach any point on the X axis. It is recommended to set a point more than 200mm away from the 0 point.
- ③ Step 3 :
Step to define the XY surface of the user coordinate. It defines the Y and Z axis. Teach any point on the surface that X and Y axis creates. It is recommended to set a point more than 200mm away from the 0 point.

※ When teaching the program to set the user coordinate, the TCP (Tool Center Point) must be set accurately. Check the currently set tool number. To set the TCP, use the 'Automatic constant setting' function or check if the accurate value has been entered in the tool data.

- You can register up to 10 user coordinates.
- Note when recording the reference point to define the coordinate
 - ① 3 references points cannot be in one line.
 - ② Make sure the distances among the 3 reference points are not too close.
 - ③ A step after step 4 does not affect the coordinate registration.

7.2.7.2. Stationary tool coordinate

The stationary tool coordinate system is to perform the setting necessary for using the stationary tool interpolation.

- About the stationary tool interpolation

A robot tool is a tool that is attached at the front end of the robot. Generally, the work to be done by the robot is carried out by using those attached tools. Arc welding is the representative case. The arc welding tool is commonly attached at the front end of the robot and carries out welding for the workpiece that is externally attached.

On the contrary, the stationary tool is a working tool that is attached externally, not to the robot. In case of the stationary tool, the robot handles and places the workpiece at the externally fixed tool in order to process the work.

Sealing is the representative work for which a stationary tool is used. Generally, the sealing work is carried out in a way that the externally fixed tool discharges the solvent necessary for the sealing work, and then, the robot picks up the workpiece and creates the trajectory necessary for the sealing work while carrying out sealing.

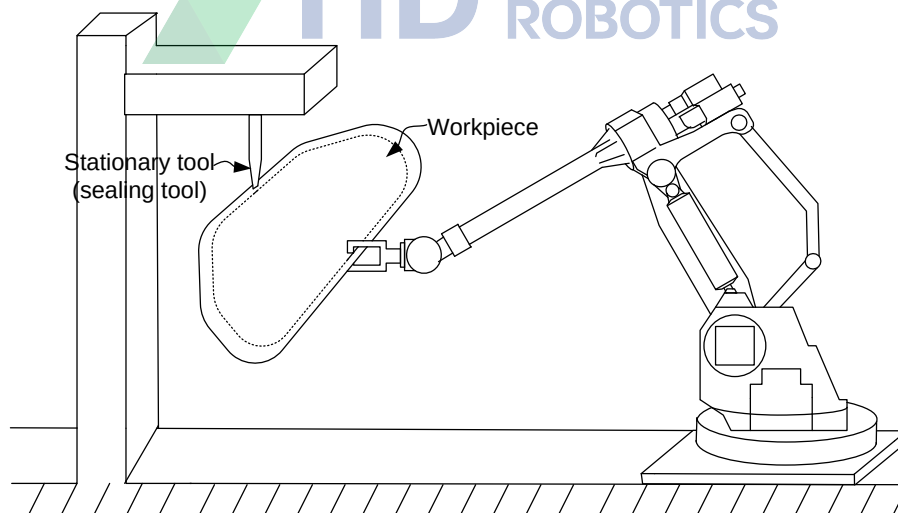


Figure 7.38 Example of the sealing work

In order for the robot to create the trajectory, the robot is required to perform the linear (L) and circular (C) interpolations based on the tool that is externally attached, not based on the tool that is attached to the robot itself. The stationary tool interpolation function is required in such situation.

When the stationary tool interpolation function is used, the moving linear and circular paths of the stationary tool on the work can be maintained even when the posture of the workpiece that

is attached by the robot.

Accordingly, in case of such works for which the moving path against the external tool is so critical, the stationary tool interpolation function must be used.

- Stationary tool coordinate system setting

Select 『F2]: System』 → 『2: Control parameter』 → 『7: Coordinate registration』 → 『2: Stationary tool coordinate』.

Register the position in the stationary tool coordinate system as the robot base coordinate reference. In order to set the position of the stationary, TCP needs to be located correctly and, as shown in the below picture, the stationary tool and the robot tool need to be matched, and F1 'Auto setting' needs to be carried out, then the current TCP location can be registered.

Totally 4 stationary tools can be set ranging 0~3.

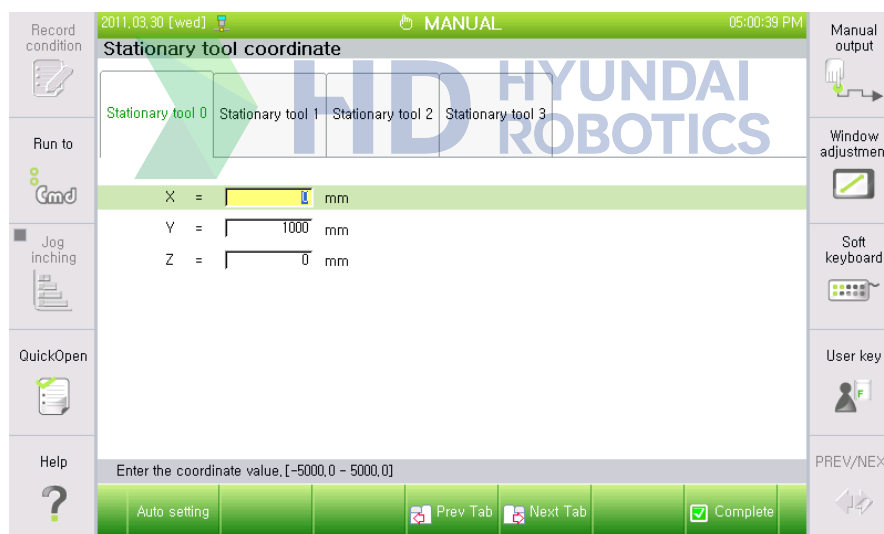


Figure 7.39 Stationary tool coordinate setting method

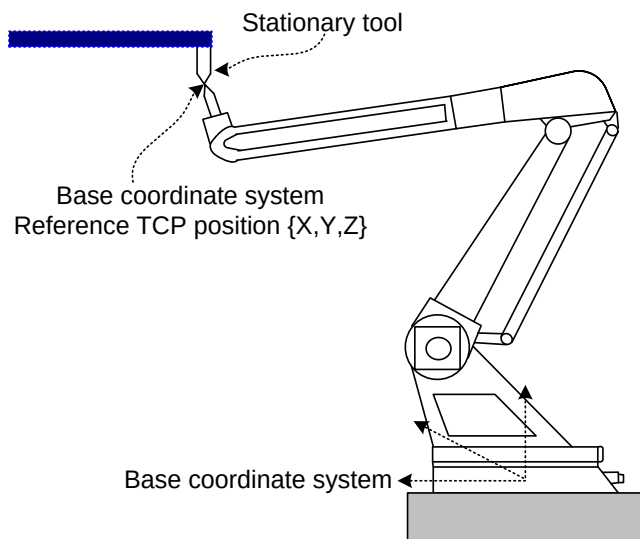


Figure 7.40 Teaching method when using the auto setting function

- Program preparation

The step needs to be as SL or SC to make the recording as the stationary tool interpolation. Use the record condition key to change the record condition as SL or SC and use it.

For example, when the stationary tool coordinate system #1 is to be registered and used, the program needs to be prepared as shown below. .



Figure 7.41 Example of program preparation for using stationary tool coordinate



Reference

- There is no need to use the stationary tool interpolation function for the stationary servo gun. In case of the servo gun welding, there is no need for the path of the work to be made in linear or circular line against the stationary servo gun, as only the welding points matter.
- Refer to the method for using the command SELPTNO.

7.2.8. Program reservation execution

Refer to 『Hi5a Controller Program reservation execution function manual』



7.2.9. Network

Set the environment when using the network.

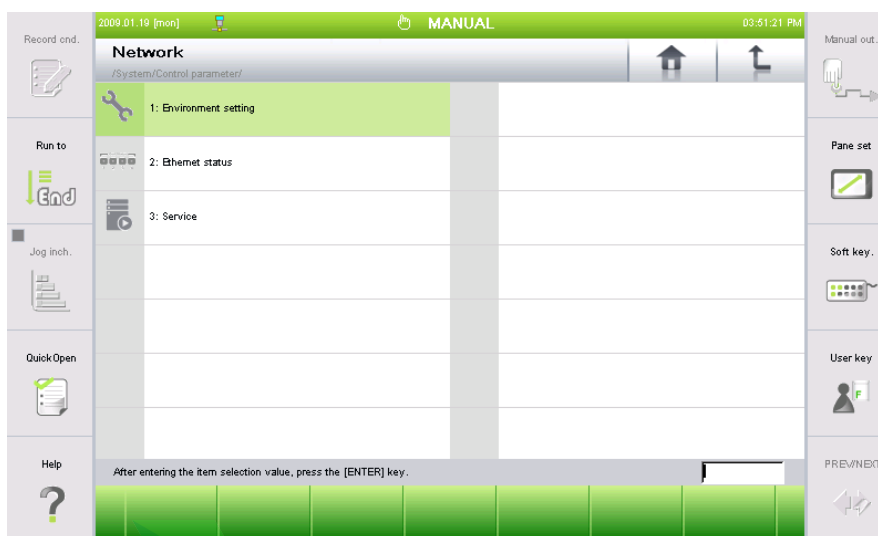
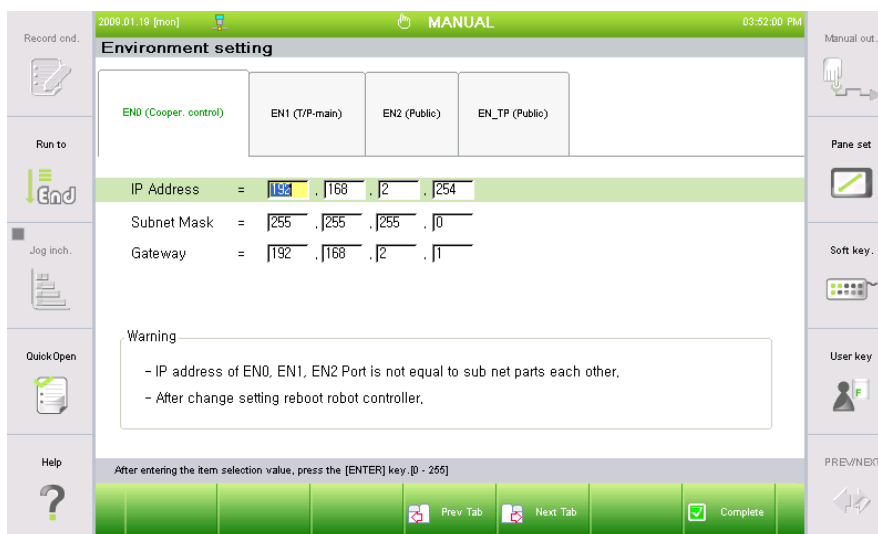


Figure 7.42 Network menu screen

7.2.9.1. Environment setting

3 network ports (EN0, EN1, EN2) for main board of the controller and 1 network port (EN_TP) for the teach pendant are provided, and this sets the environment for these network ports. Set the IP address, sub net mask and gateway information so that the controller fits the installed network after the setting, the power must be rebooted to reflect the setting.

(EN0: For Cooperation control, EN1: For TP communication, EN2: Public, EN_TP: Teach pendant)



7. System setting

Figure 7.43 Network/Environment setting screen

7.2.9.2. Ethernet status

This monitors the various types of status for the network port provided on the main board of the controller.

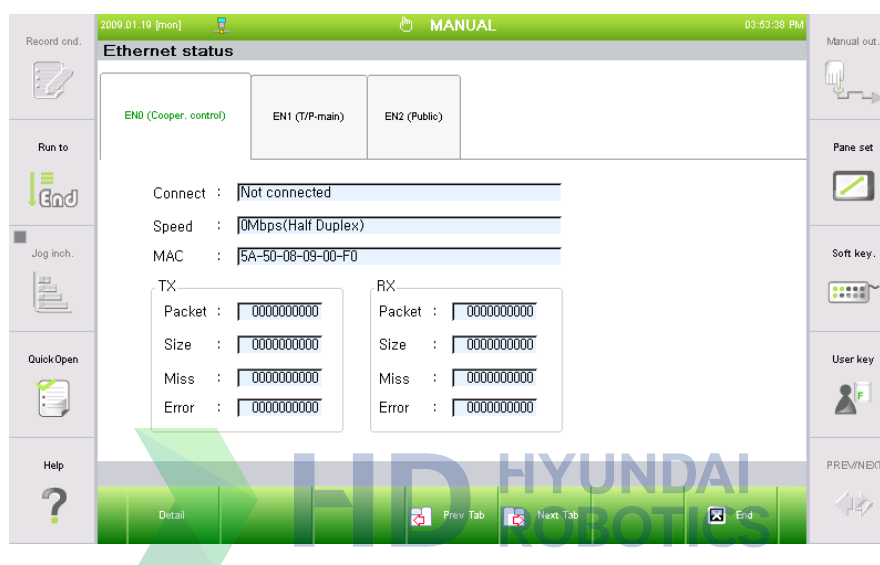


Figure 7.44 Ethernet state monitoring screen

7.2.9.3. Service

This function sets the service environment for the network.



Figure 7.45 Network/Service menu screen

7.2.9.3.1. Cooperation control

This function sets the environment to use the robot Cooperation control function.
For details, refer to 『Hi5a Controller cooperation control function manual』

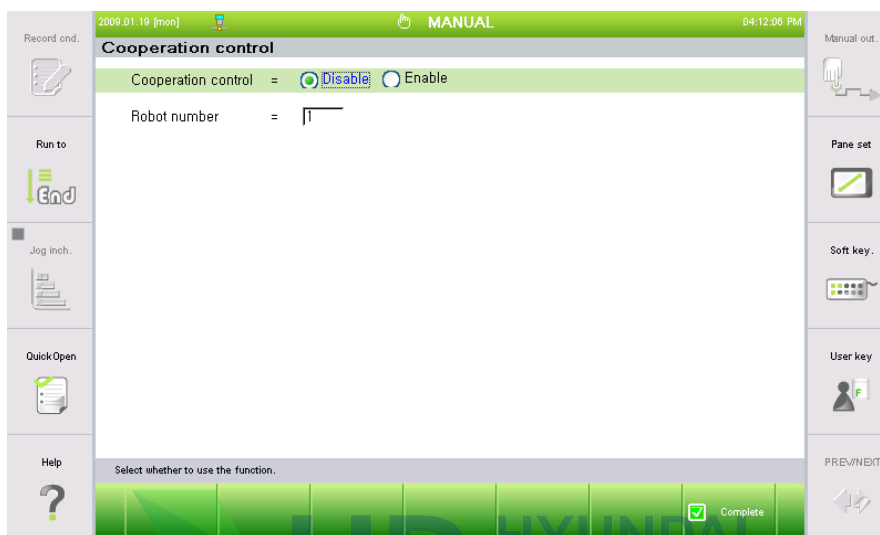


Figure 7.46 Cooperation control setting screen

7.2.9.3.2. HR-RPC

This function re-initializes the HR-RPC service that performs various types of monitoring and remote control through Ethernet.

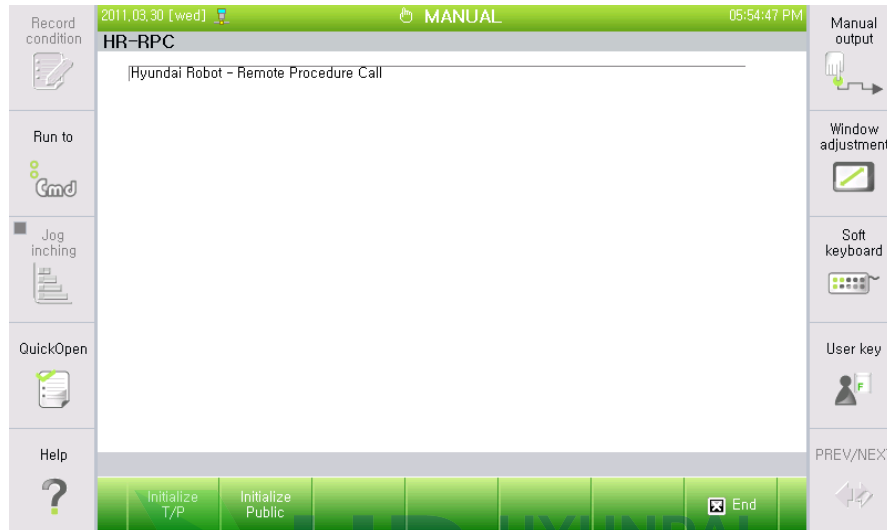


Figure 7.47 HR-RPC initialization screen

- [F1: Initialize T/P]
Re-initialize the HR-RPC service of the main board for the teach pendant.
- [F2: Initialize Public]
Re-initialize the HR-RPC service of the main board for the external Ethernet connection (PC).

7.2.9.3.3. HRMS

HRMS (Hyundai Robot Monitoring System) is a centrally integrated PC-based robot management solution, which, through the Ethernet connection of scattered multiple robots, provides the real-time monitoring service in which the operation time, activation state, error/repair history, preserved data and the like can be available, as well as the version management service. Refer to 『HRMS Manager Manual』 and 『HRMS User Manual』 for more details.

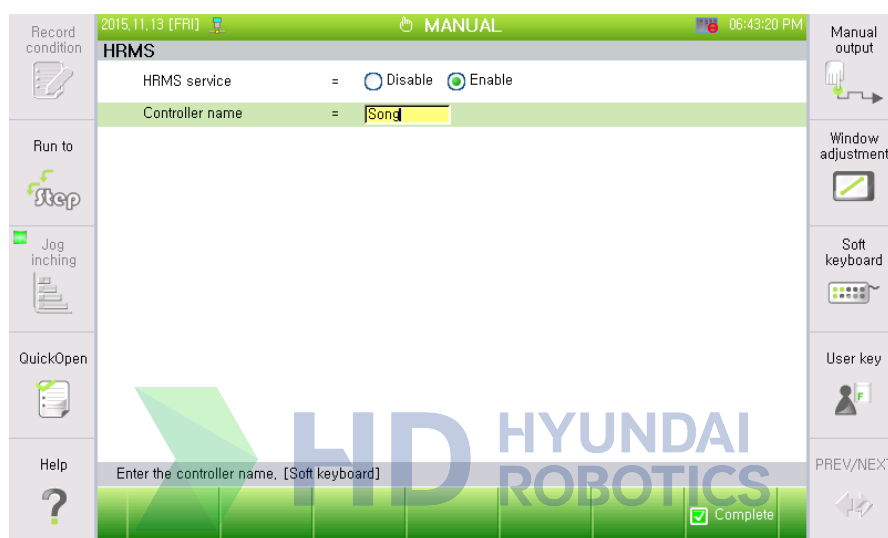


Figure 7.48 HRMS setting screen

- HRMS service: Set the service to be enable/disable.
- Controller name: Set the controller name on the network.

7.2.10. Register license key of option function

7.2.10.1. What is the optional function license key?

Of the functions of the Hi5a robot controller, some specific optional functions are to be sold separately. In order to use those functions, users need to purchase them.

The license keys of those options are generated by a separate license key generation program, which combines the unique number assigned to the robot controller's main board and the purchased optional functions, so the purchased function will operate only through the purchased controller.

Accordingly, the robot controller's main board that uses those optional functions cannot be replaced with other controller.

If the main board has a problem, so it needs to be replaced with the spare one, you can use a temporary key that can be used for 30 days.

In this situation, you are required to contact our A/S department to get the official license key before the 30 days expire.

- Function configuration
Set whether to purchase the optional functions
Set the license key

7.2.10.2. License key registration procedure

- Purchase the license key of the optional function matching with the system serial number. The system serial number is saved in the license registration screen or the ROBOT.INF file.

■ Optional function license key registration screen

Figure 7.49 License key registration screen

■ ROBOT.INF

```
=(< Main Board Information >)=
Main S/W   =V40.00-17, 2014.02.08
Built it at Feb 26 2014, 10:31:43
Main B/D Serial Number = BD511V10-1405-004
Main B/D PLD = V0.A
Dip Switch=FF
```

- Select whether to purchase the options first, and then, enter the license key.
If the selected data regarding whether to purchase and the license key do not match, an error will occur when the relevant function is run.

7.2.10.3. License key registration

- Registration screen
『[F2]: System』 → 『2: Control parameter』 → 『10: Register license key of option function』

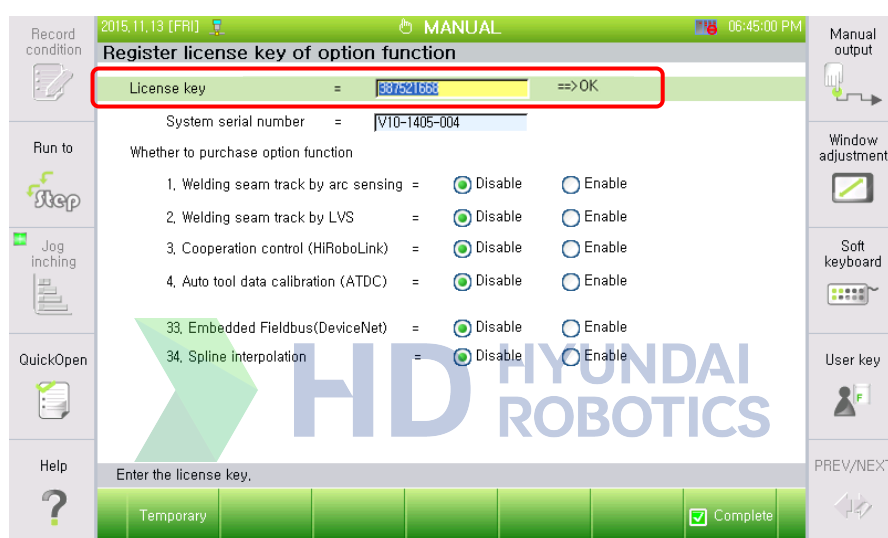


Figure 7.50 Optional function license key registration screen

- When the license key is entered correctly, “==>OK” will be displayed at the right side of the space for entering the license key.
- If “==> NG” is displayed, it means that the license key is incorrect or the selection regarding whether to purchase is wrongly made.

7.2.10.4. What is the temporary key?

- The temporary key can be used only for 30 days, it will be issued only for one time in case of Hi5a controller.
- When the remaining days for the temporary key are within 10 days, then, every time the controller is booted, the following warning will be generated.

W0025

Only (n) days for free usage of temporary license key of option function are remained.

- The temporary key is to be used until our A/S section reissues its license key, if the main board of the controller suffer problems and should be replaced with a spare one.

7.2.10.5. Temporary key issue

- Press the [F1] key to get the temporary key issued.

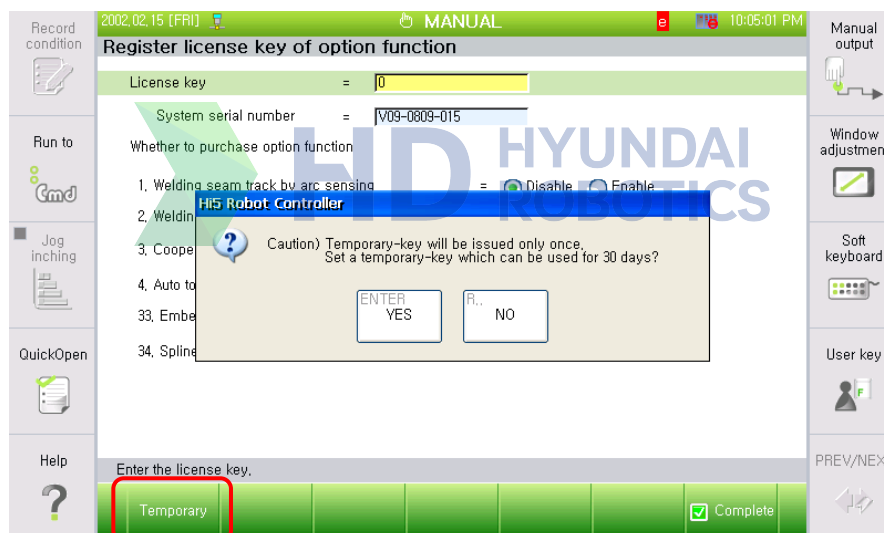


Figure 7.51 Optional function license key registration screen

- If the issuing is processed normally, the remaining days will be display as shown below.

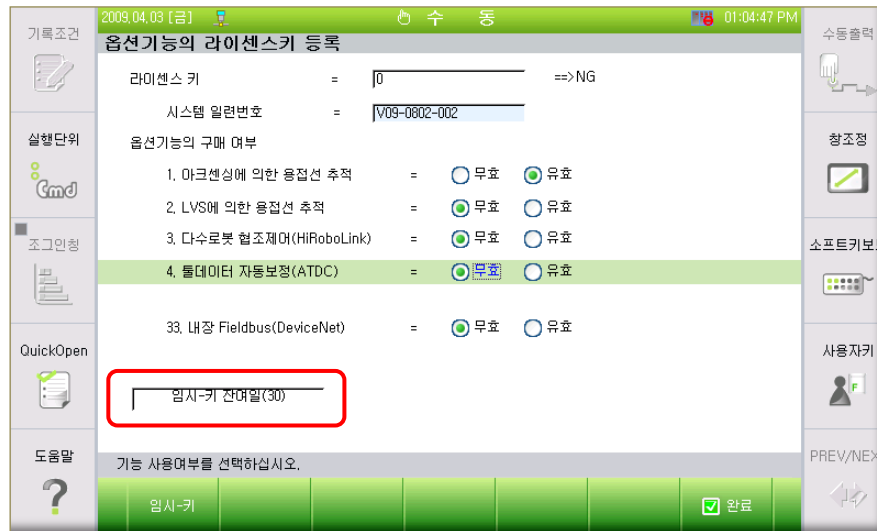


Figure 7.52 Remaining days of the optional function license key

- Caution) when the remaining day is 0, the optional function cannot be used any longer and the temporary key will not be re-issued.
- When you get your temporary key issued due to the malfunctioning main board after purchasing the normal optional function, the production line could be stopped due to the optional function. You must contact us to get the official license key issued before the remaining day is 0.

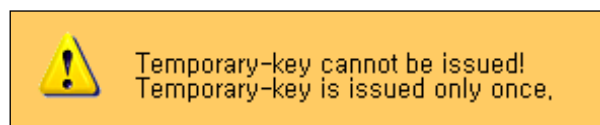


Figure 7.53 Displayed warning message when a temporary key is issued more than once

7.2.11. Automatic backup and recovery

Refer to 『Hi5a Controller Auto Backup Function Manual』 .

7.3. Robot parameter

This sets up various parameters for the robot body.



Figure 7.54 Robot parameter menu screen

7.3.1. Tool data

This function is for setting the distance and angle of TCP (Tool Center Point) based on the robot's R1 axis flange and also the registered tool weight, center of gravity, and inertia. In this screen, the user can input these values manually.

In other setting methods, the tool length can be set by using the "auto calibration" function, and the tool weight, center of gravity, and inertia can be registered by using the load estimation function.

Before teaching, the tool length and angle should be set accurately. This is because when linear or circular interpolation is performed, the trajectory will be created based on the TCP.

Hi5a controller is controlled based on the robot dynamics. The weight, inertia and center of the tool must be set accurately for the robot to operate quickly and safely. When this value is incorrect, it can cause serious problems to the performance and life of the robot.

Especially if you are using the tool change function, you must allocate a separate tool number not just for the condition in which the tool is separated but also for the information of each tool to enter and use the tool information for the tool change function.

Also for the handling of heavy objects, each tool number must be allocated for the attach/detach condition of the object for use.

Tool length is the length by each direction in the flange coordinate system shown as follows.

- (1) Distance in X axis : X_t
- (2) Distance in Y axis : Y_t
- (3) Distance in Z axis : Z_t

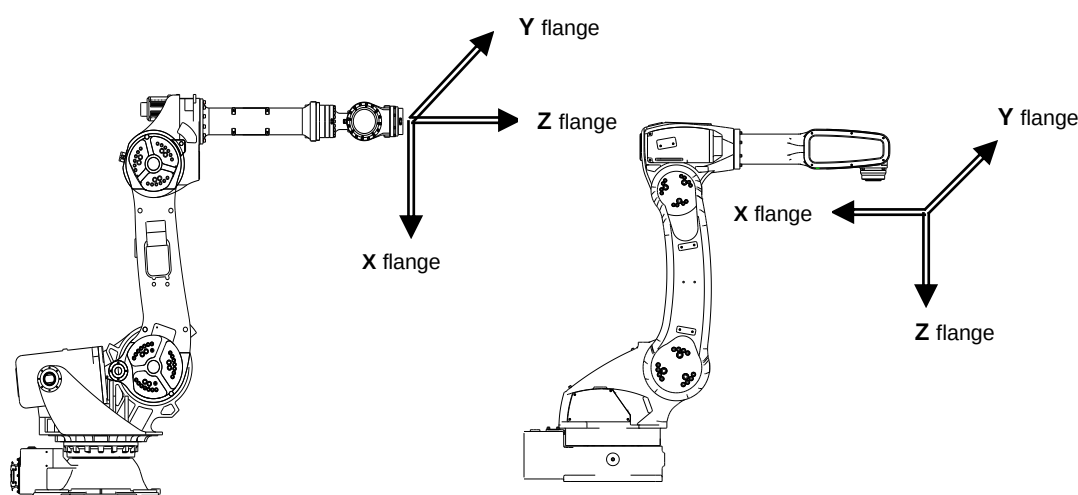


Figure 7.55 Flange coordinate system by robot type

Tool angle is the amount of position change in each direction in the flange coordinate system.

- (1) Angle in X axis : Rx
- (2) Angle in Y axis : Ry
- (3) Angle in Z axis : Rz

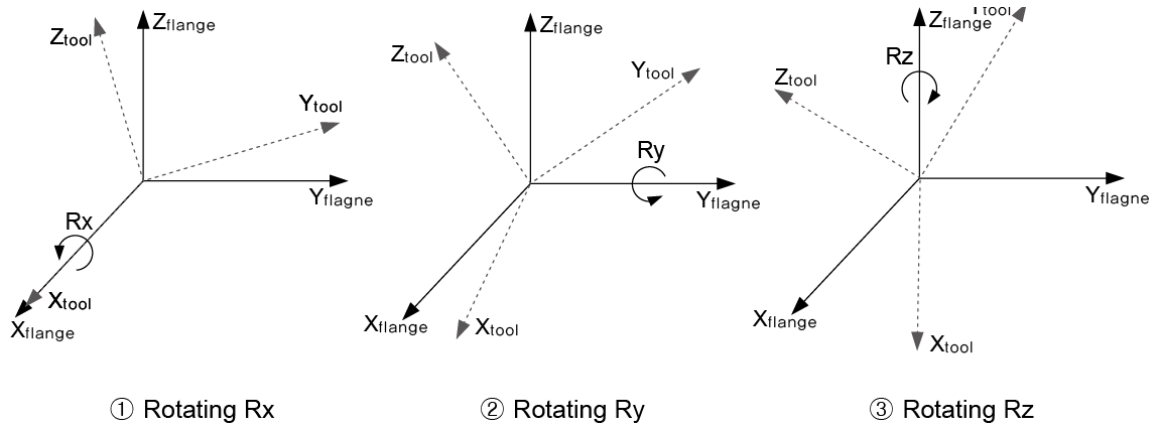


Figure 7.56 Tool angle

Therefore, the tool distance and angle is set based on the flange coordinate. Tool distance is the set between the center of the flange coordinate and TCP.

The tool position is the rotated values of X, Y and Z axis direction in reference to the tool flange coordinate according to the set tool angle.



Reference

$$R_{xyz} = \text{Rot}(z, R_z) \text{Rot}(y, R_y) \text{Rot}(x, R_x)$$

R_{xyz} is the tool position rotation matrix based on tool flange

$\text{Rot}(z, R_z)$ is the rotation matrix that shifted by R_z to the Z axis direction of flange coordinate

$\text{Rot}(y, R_y)$ is the rotation matrix that shifted by R_y to the Y axis direction of flange coordinate

$\text{Rot}(x, R_x)$ is the rotation matrix that shifted by R_x to the X axis direction of flange coordinate.

Controller Operation Manual

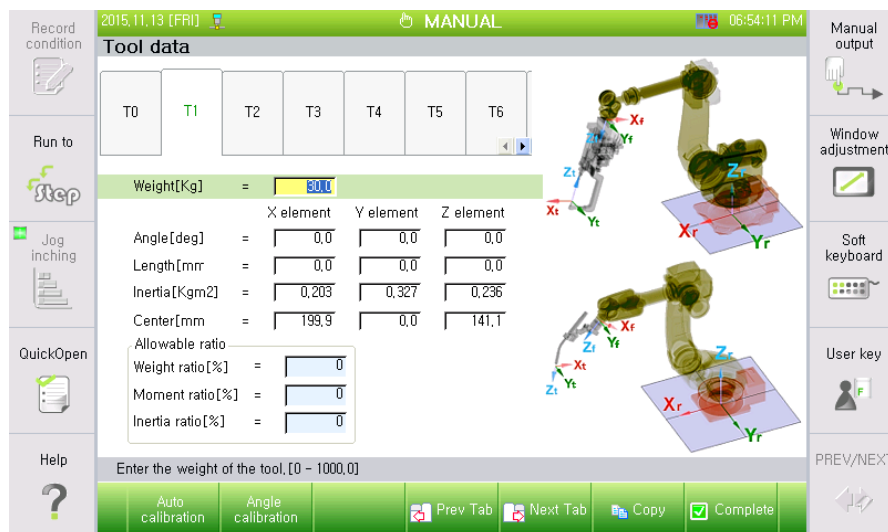


Figure 7.57 Tool data setting screen

- Weight (Kg) : Weight of tool
- Angle (deg.): Angle of Tool.
The “auto calibration” or 『F2]: Angle calibration』 function can be used.
- Length (mm): Length of Tool.
The “auto calibration” or 『F1]: Auto calibration』 function can be used.
- Inertia (Kgm2): Tool inertia for the tool coordinate
You can use the “load estimation function”.
- Center (mm): Weight center location of the tool based on the flange center
You can use the “load estimation function”.
- Tolerance rate (High load mode is only applied to robot models.)
It will show the percentage of the standard allowable value to the current settings. Robot operation, in accordance with the tolerance rate, is as follows. (Tolerance rate can be changed in accordance with the version of the robot model and controller software.)

	Normal	High load mode	Playback is not possible.
Weight ratio (%)	~100	100 ~ 110	110 ~
Moment ratio (%)	~100	100 ~ 120	120 ~
Inertia ratio (%)	~100	100 ~ 130	130 ~



Reference

- At the top of the tool number not to estimate the load, “(x)” is displayed. (Such as T0 in the figure above)
It may cause problems to the speed and durability of the robot when a tool without load estimation is used. Thus, please be sure to use after the load estimation.
- In some cases, when the cursor is moved to the angle or length input box and data is entered, the guide frame could display the “Please, consult the engineer” message. When this is shown, press the 『F1]: Auto calibration』 or 『F2]: Angle calibration』 key. Refer to the following content for auto calibration and angle calibration.
- Automatic calibration
 - If you locate new tool for setting to the step location where existing step was, and then the distance and the angle for the new tool is calculated.

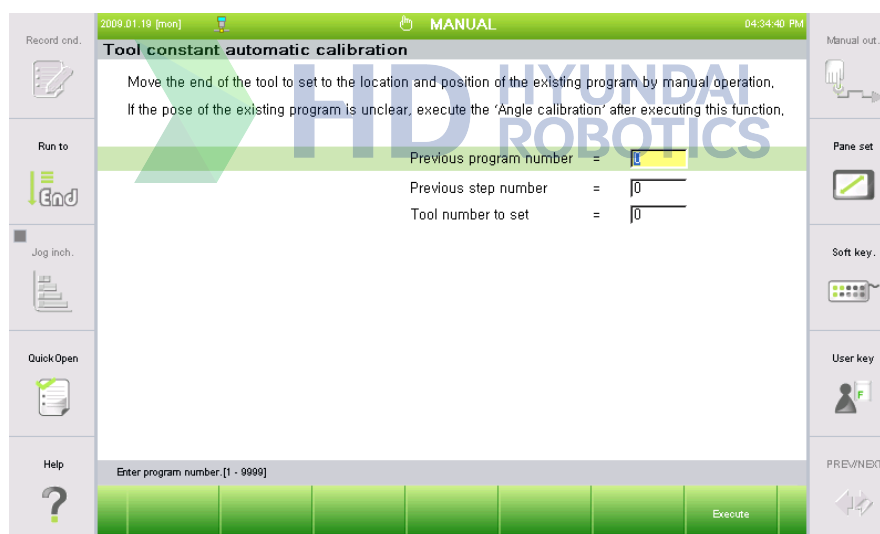


Figure 7.58 Tool data automatic calibration screen

- Previous program number
Enter the program number taught before the tool change.
 - Previous step number
Enter the step number to execute tool constant auto calibration.
 - Tool number to set: Enter the tool number to newly set.
- Through the automatic calibration function, you can easily generate the tool data and also use the existing program as it is.

- **Angle calibration**
This function calibrates the tool angle.

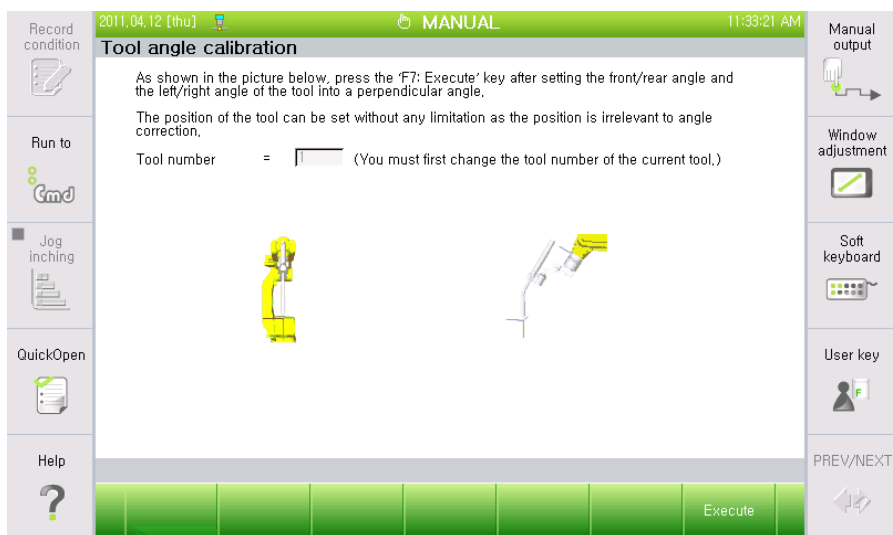


Figure 7.59 Tool angle calibration screen

- **Copy**
This enables you to copy the selected tool data to other tools. When copying tool data, load estimation data are also copied together. This function can only be executed on the executed tool number tab where a load estimation is performed. For the tool arbitrarily changed by the user, weight can be changed into load estimate value using the “estimate value” button.

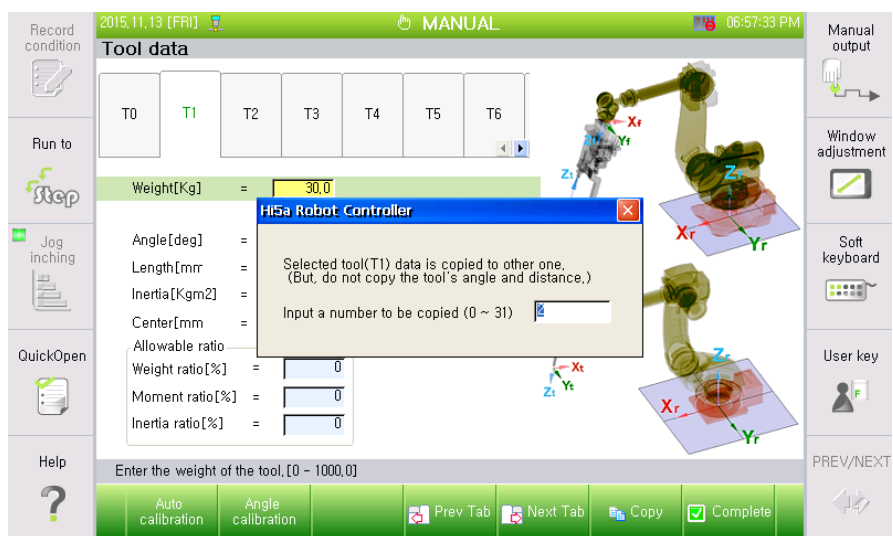


Figure 7.60 Tool angle calibration screen

7.3.2. Axis origin

This allows the mechanical origin of each axis to be registered. For the axis origin setting, it is required to change to accurate values as it could impact the accuracy of the orthogonal operation of the robot.

Initially, standard values are set at the factory. It is possible to change the S axis origin according to the installed state of the robot and the adjacent jigs or change the R1 axis origin in line with the tool attachment direction by using this function.

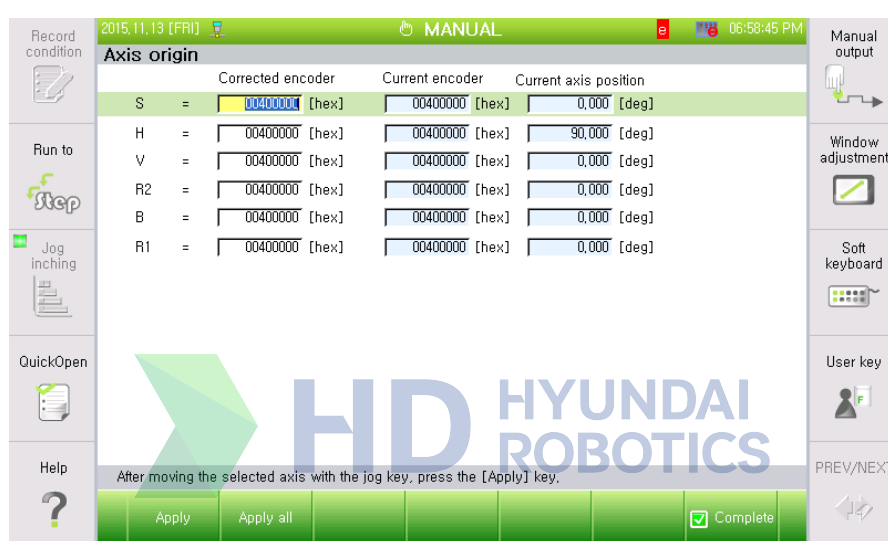


Figure 7.61 Axis origin setting screen



Reference

- The axis origin setting must be done after completing the 『Encoder offset』 setting. When the encoder offset setting is changed, the axis origin needs to be set again.
- For H, V, R2, and B axes, settings can be performed automatically by using the “Auto calibration” function.
- When you change the axis origin setting, the location in the existing program will change also. Thus, the axis origin setting must be done only during the initial installation stage.

7.3.3. Soft limit

This limits the operating range of the robot in each axis. The factory default is set to maximum range. Make adjustments according to the installation environment.



Figure 7.62 Soft limit setting screen

7.3.4. Encoder offset

You can set the current location of the encoder as the zero point location of the encoder (0X400000 locations). Decide the zero point of the encoder from the reference location (Location where scale is attached for each axis) of each axis of the robot.

Because this value is set as factory default value, reset it as needed for cases such as motor, encoder exchange etc.

Operate each axis of the robot to set the offset value of the encoder. The recorded encoder value is hexadecimal value.

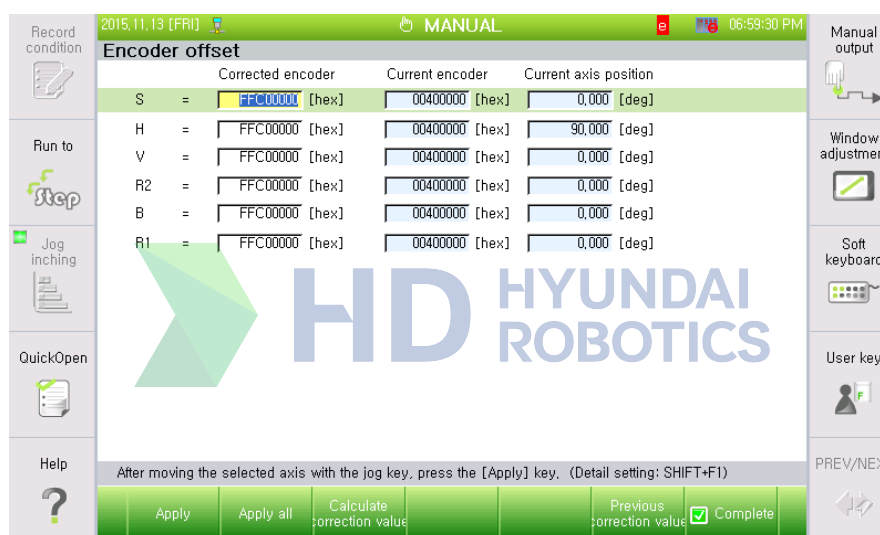


Figure 7.63 Encoder offset screen

If you need to back up the current task program and execute 『[F2]: System』 → 『5: Initialize』 → 『1: System format』 for any reason during the task, the robot must be maintained at the same location as the reference location prior to the resetting. For this, write down the encoder offset value and enter the value to use it. You can enter the calibration value by opening the soft keyboard on the right side of the screen and directly entering as hexadecimal value.

If you write down the value of the axis position (mm or degree) rather than the encoder offset (hexadecimal) value, press [F1: Apply]. When the axis position input dialog box appears, enter the value of the position that you wrote down here. Then, press the [ENTER] key.

(As the default value of the dialog box is the reference posture value, just press the [ENTER] key without any input value. Then, the current encoder value is set to the home position (0X400000).)

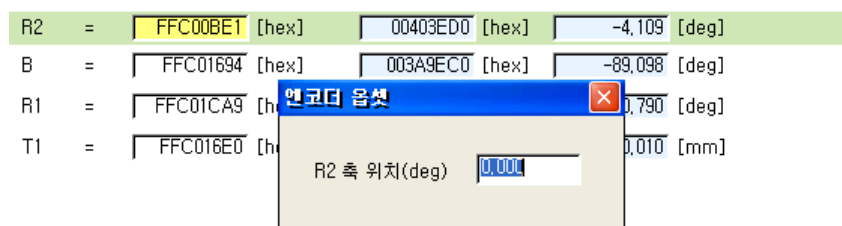


Figure 7.64 Axis-position input dialog box



7.3.5. B axis dead zone

This sets the dead zone of the B axis.

Near the 0-degree area of the B axis, the center of the R1 axis rotation and the center of the R2 axis rotation are nearly in parallel. When the robot's TCP performs a linear or circular interpolation, the wrist axis will move abruptly in short spurts.

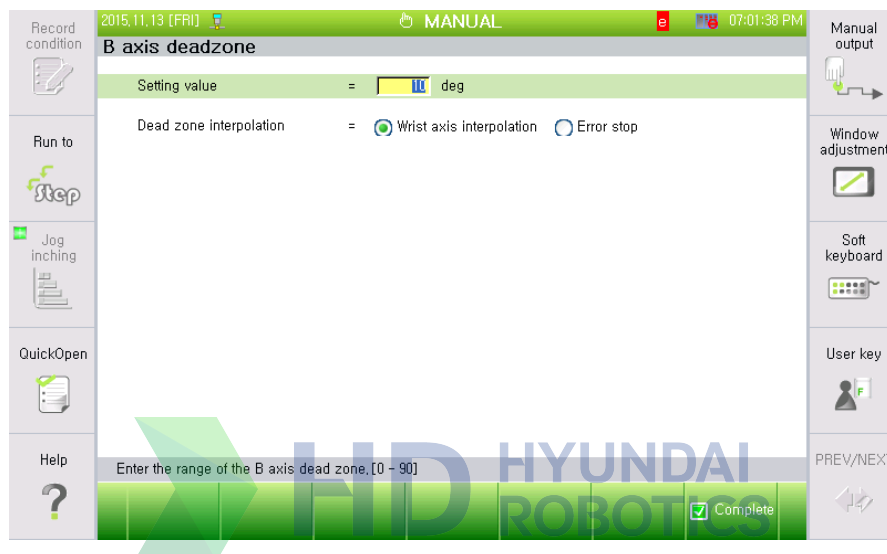


Figure 7.65 B axis dead zone setting screen

- Setting value: Enter the angle for B axis dead zone.
- Dead zone interpolation
When the robot trajectory needs to go through the B axis' dead zone in the interpolation operation, this function provides the option of treating it as an error and stopping the robot.

7.3.6. Accuracy

Review the 2.5 Step section first to understand this section. This section provides the values of the accuracy level that was explained in the 2.5 Step section.

The accuracy level can be set within the range from 0 – 7, and the level will be recorded as one of the parameters of the step. Except for the accuracy level 7, the TCP distance and posture values as well as the additional axis distance and angle values can be entered in each level (Picture below). If a robot does not provide support for the linear or circular interpolation, just like the case of a LCD robot, the same method as that for the additional axis will be applied.

When the accuracy level 7 is used, the maximum cornering path that can meet the condition of being 1/2 of the step distance will be created. The value for a level is calculated automatically in the controller, not to be entered directly. Generally speaking, the accuracy level 7 is useful when it is required to operate the robot with the most smoothness but also with swiftness.

For example, if this is used when the LCE hand moves in and out, a smoother and quicker operation can be achieved.

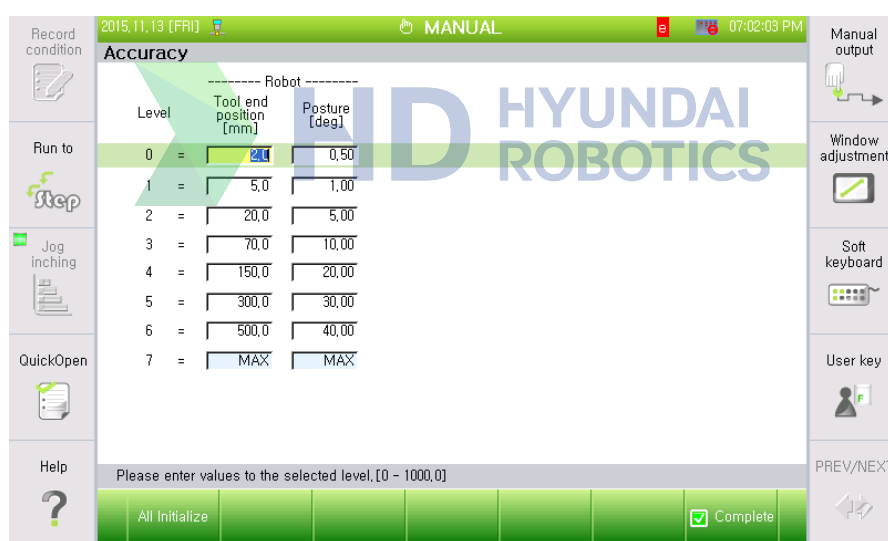


Figure 7.66 Accuracy setting screen



Reference

- When it comes to the welding steps of the servo gun and equalizer gun, restriction will be performed automatically by the controller regardless of the set accuracy level.

7.3.7. Additional weight on each axis

It registers the information of transformer or the supporting structure for wiring which is equipped on the basic axis of robot. If the additional weight is not registered accurately, it can cause an error when calculating the tool load to cause problems including vibration and reduced life span of the robot. When the robot has additional weight besides the tool, you must enter the data for the additional weight.

The screenshot shows the 'Additional weight on each axis' screen in the HYUNDAI ROBOTICS manual mode. The interface includes a top status bar with the date '2015.11.13 (FRI)', the mode 'MANUAL', and the time '07:02:29 PM'. The main area is titled 'Additional weight on each axis' and contains several input fields and buttons. On the left, there are buttons for 'Record condition', 'Run to', 'Jog inching', 'QuickOpen', and 'Help'. On the right, there are buttons for 'Manual output', 'Window adjustment', 'Soft keyboard', 'User key', and 'PREV/NEXT'. The main input area includes a 'Weight[Kg]' field with a value of '0.0', and a table for 'Inertia[Kgm2]' and 'Center[mm]' for 'X element', 'Y element', and 'Z element'. The 'Inertia' values are all '0.000' and the 'Center' values are all '0.0'. There are also dropdown menus for 'Spot' and 'Standard dress quick input'. At the bottom, there are buttons for 'Prev Tab', 'Next Tab', and 'Complete'. A large 'HYUNDAI ROBOTICS' watermark is visible across the center of the screen.

Figure 7.67 Individual axis additional weight setting screen



Reference

- For the zero point of each axis coordinate, please refer to Figure 7.68. The direction of each X, Y and Z axis is same as the one set in robot coordinate.

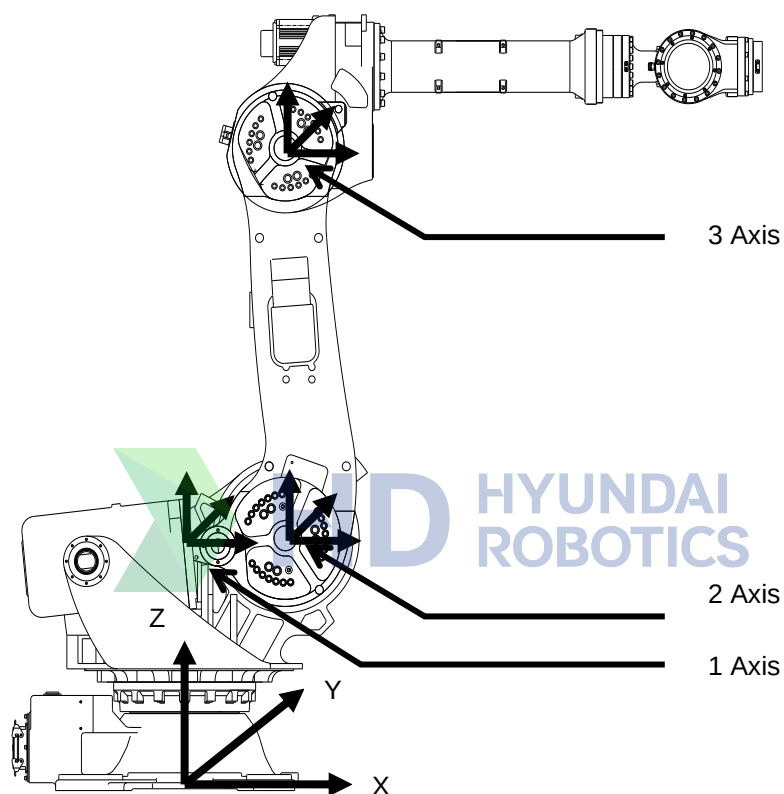


Figure 7.68 Zero point of each axis coordinates

7.3.8. Collision detection

When a collision occurs during robot operation, the collision detection function makes it possible to compare the torque normally generated during robot operation with the torque currently generated. If an abnormal torque is generated, process it as an error to minimize the damage from the collision.

In the Hi5a controller, the overcurrent, overload, overspeed, and location deviation error detection functions, which are the existing safety functions when a robot operates abnormally, are complementarily working with the collision detection function to help enhance robot safety.

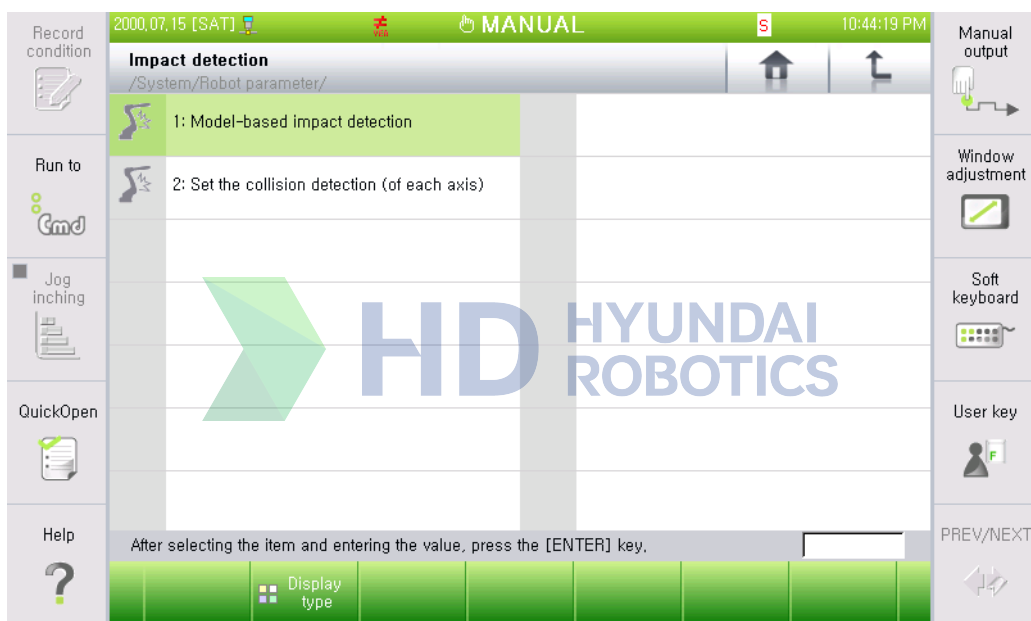


Figure 7.69 Collision detection menu screen

7.3.8.1. Setting of model-based collision detection

The model-based collision detection function enables the detection of a collision by calculating the difference between the torque the robot should normally generate during operation and the torque actually measured, based on the robot's dynamic model. It is possible to adjust the responsiveness to collision by setting the sensitivity and detect any external contact that may occur when the robot moves at a low speed. In addition, adjusting the sensitivity of the collision detection for each operation section using a command is also possible.

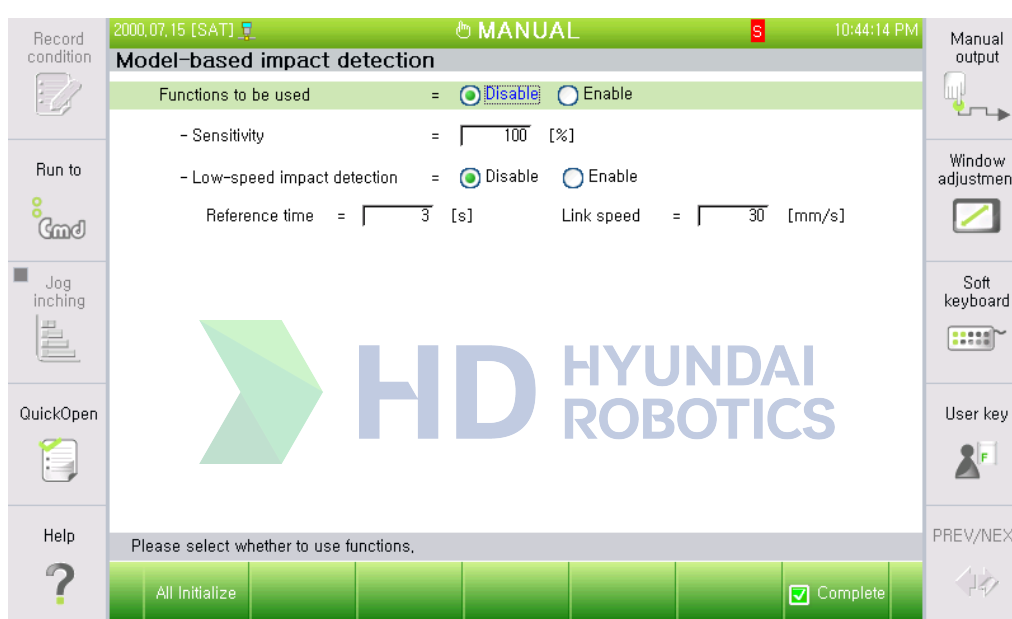


Figure 7.70 Screen for setting the collision detection (for each axis)

- Use of function: Sets whether to use the collision detection function
- Sensitivity: Sets the sensitivity of collision detection. The larger the value, the more sensitively responsiveness to the impact occurs (0%–200%)

It is possible to adjust the sensitivity for each section using the command ColDet Sensitivity in the job program. However, the sensitivity set using the command will be initialized to the sensitivity set in the menu of this function when the main program is ended or the step counter is reset.

Example of use of the command

Input of the command: “[F6]: Command inputting” → “[F1]: Motion, I/O” → “ColSense”

```

S1  MOVE P,S=60%,A=3,T=1
S2  MOVE P,S=60%,A=3,T=1
S3  MOVE P,S=60%,A=3,T=1
S4  MOVE P,S=60%,A=3,T=1
    ColDet Sensitivity=50
    CALL 10
S5  MOVE P,S=60%,A=3,T=1
S6  MOVE P,S=60%,A=3,T=1
S7  MOVE P,S=60%,A=3,T=1
    END
  
```

If the sensitivity is set to 100% in the collision detection menu

- S1-S4: Detection occurs at 100% sensitivity.
- CALL 10-S7: Detection occurs at 50% sensitivity.

■ Low-speed collision detection

- ① Use of function: Sets whether to use the low-speed collision detection function that applies to a collision with a low impact force
- ② Reference time: Reference time for determining a collision. If an impact force is applied for longer than the reference time, it will be identified as a collision.
- ③ Link speed: Reference speed for determining a low speed
Low-speed collision detection will occur only at a speed below the link speed.

The following menus can be displayed and edited only in Engineer mode or above.

- Detection reference for each axis: This refers to the allowable ratio of the low-speed collision torque error. The lower it is, the more sensitively responsiveness to a low-speed collision occurs.
- To: This is a time constant for detecting sudden changes in the torque caused by a collision. The lower the value, the more sensitively responsiveness to the collision occurs.



Notes



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- Because this function enables the detection of a collision on the robot axis, collision detection will not occur if the impact cannot be transmitted to the robot.
- This function only enables the detection of a collision on the robot when the motor is on.
- Some special custom robots do not support this function.
- Collision will not be detected when any of the load estimation and sensor-based/sensorless force control functions are activated.
- If the tool weight and additional weight for each axis are different from the actual values, false detection may occur.
- This function is supported by a Hi5a controller of version V40.17-00 or higher.

7.3.8.2. Set the collision detection (of each axis)

The collision detection function monitors the disturbance torque generated from each axis and the disturbance torque rate, and sends an error when the measured value exceeds the set value.

- 『E0160 (○ axis) Collision detected』 when the disturbance torque exceeds the set value.
- 『E0161 (○ axis) Impact detected』 when the disturbance torque rate the set value.

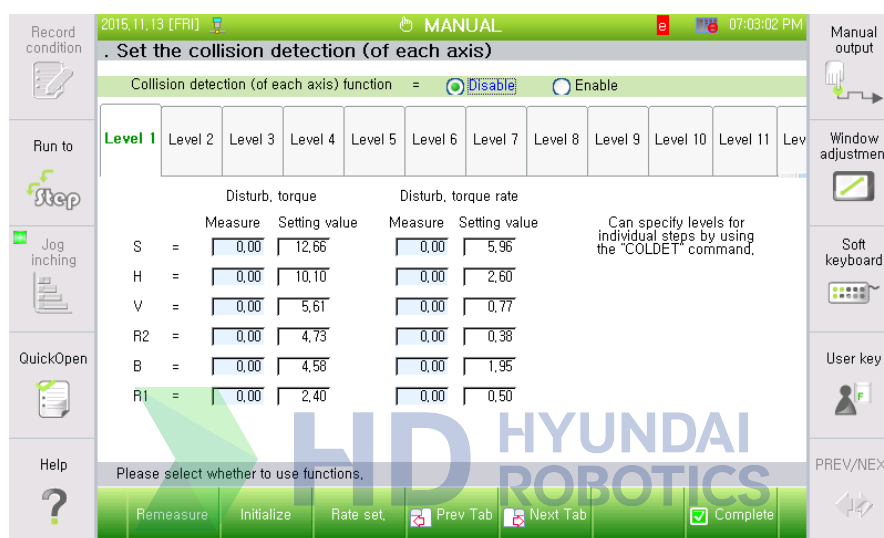


Figure 7.71 Collision detection (of each axis) setting screen

■ Collision detection

Select whether to use the collision detection function. But, the collision detection function only applies to the robot main unit and not to the additional axis.

You might have to adjust the detection level according to the installation location or environment, and for the step that requires high sensitivity for collision detection, you will have to adjust it very accurately. Even with the collision detection function enabled, it will not operate during GUN squeeze force. Collision detection function operates only while the robot is moving and does not operate when the robot is in stopped condition.

■ Measure

This displays the maximum values of the disturbance torque and the rate of change of the disturbance torque that are generated in the section where the collision detection (COLDET) command is enabled. The user can refer to these values to set the disturbance torque and the rate of change of disturbance torque for each level.

■ Level

If the detection level or collision detection function, which is used in the jog operation or the step forward/backward operation in manual mode, is enabled, Level 1 will be applied as a default. The user can set the detection level in the program, and the commands that can be used are as follows.

COLDET level

The level can be set as 1 ~ 16. In case of the axes for which 0.0 is set, collision detection will not be performed. Set level is valid until the next COLDET command is executed.

For example, when the collision detection function is enabled and the work program is as follows

```
S1 MOVE  
S2 MOVE  
COLDET 2  
S3 MOVE  
COLDET 0  
S4 MOVE  
S5 MOVE  
S6 MOVE  
END
```



Step S1 and S2 are detected in level 1 and S3 with level 3. S4, S5 and S6 do not detect collision.

■ 『[F1]: Remeasure』

Measure the values of the individual axis disturbance torque and the rate of change of the disturbance torque (Maximum value) again.

■ 『[F2]: Initialize』

Set to initialize the values of all the set levels of individual axes. .

■ 『[F3]: Rate set.』

Quickly set the values of the error detection levels of all the axes for each selected level, by applying the magnification based on the measured value.

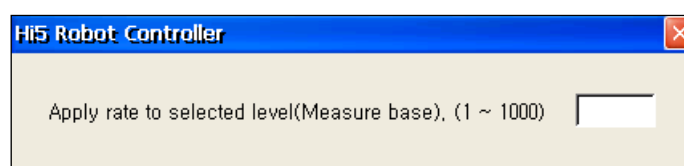


Figure 7.72 Magnification selection and entry screen

7.3.9. Maintain current reduction

This function reduces the gravitational load applied to the motor while the robot is stopped.

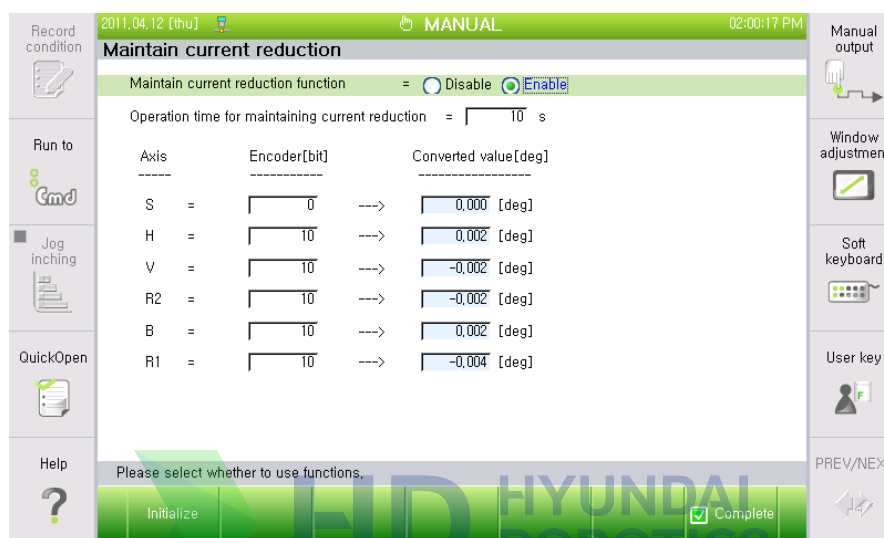


Figure 7.73 Holding current reduction setting screen

- **Maintain current reduction:** Option to either enable or disable the function
- **Operating time for maintaining current reduction**
Designates the time until the Maintain current reduction function is activated after the robot stops. If the time is set too short, the function will be activated frequently, making the cycle time longer.
- **Encoder and Converted value**
This is the allowable operation value of each axis for performing the Maintain current reduction function. If the encoder set value is high, the operating distance of the tool end will be increased. Thus, a proper encoder value needs to be set.



Reference

While the Maintain current reduction function is activated, if the start input is fed, operation will be completed before the robot starts. Because the Maintain current reduction function will be activated for about 1 second, this operation could cause some problems by performing synchronous motion with external systems. When this problem occurs, you must change the Maintain current reduction function to "Disable".

7.3.10. Jog inching level

This function restricts the operation while in jog operation in manual mode, within the designated moving distance. This can be applied usefully in the jog operation for a desired distance.



Figure 7.74 Jog inching level setting screen

Table 7-3 Job inching function specification

Major function	Remarks
Inching enabled coordinate	Axis, Rectangular, Tool, User
Inching distance speed level	8

- Inching support for joint coordinate
Movement will occur according to the set moving distance (mm) and angle (deg) for each axis.
- Inching support for Cartesian coordinate
- Inching support for tool coordinate
- Inching support for user coordinate
Moves as much as set for the X, Y Z positions (mm) and the Rx, Ry and Rz (deg.) postures.
- Inching level
If you set the same level of inching distance as the existing job speed in 8 levels. You can set the inching distance for each level.

■ Inching jog operation

- ① If you press the key for longer than to reach the inching distance, even with the jog key, the speed decelerates to the inching distance and stops as shown below.

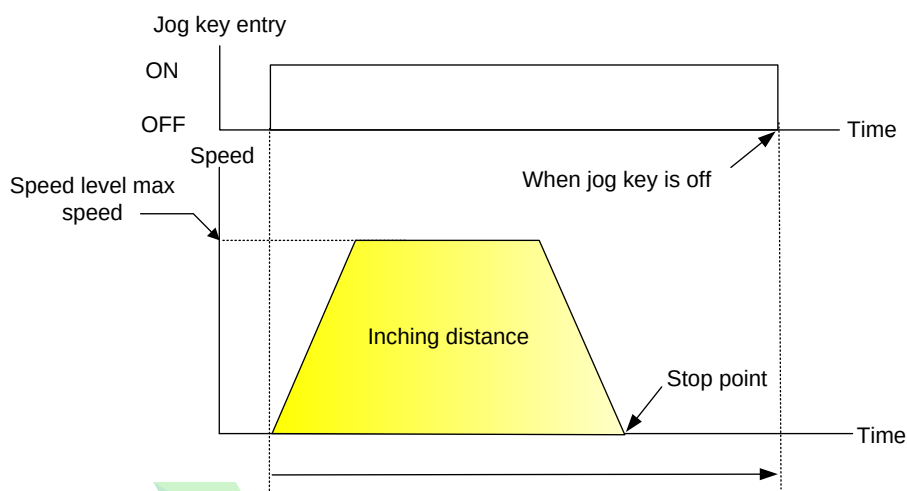


Figure 7.75 Robot activity when the key is off after the inching distance is reached.

- ② If you release the key before reaching the inching distance, it decelerates from the release point and stops as shown below. This is same as general jog mode.

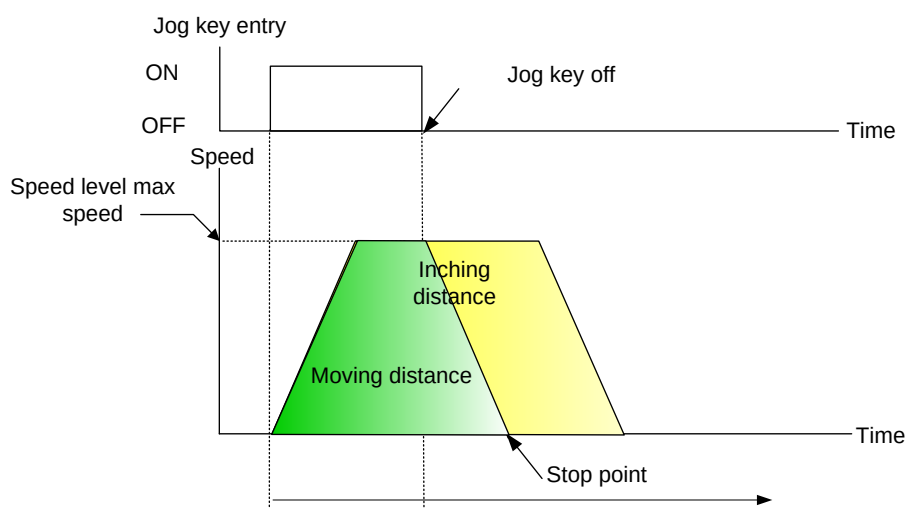


Figure 7.76 Robot activity when the key is off before the inching distance is reached

- ③ Inching function limits the maximum distance per push as shown above.

■ Others

When the speed level is 1 in the axis coordinate system, it is fixated for the encoder to move by 1 bit.

7.4. Application parameter

This is the function to set various parameters to use the robot applied function.

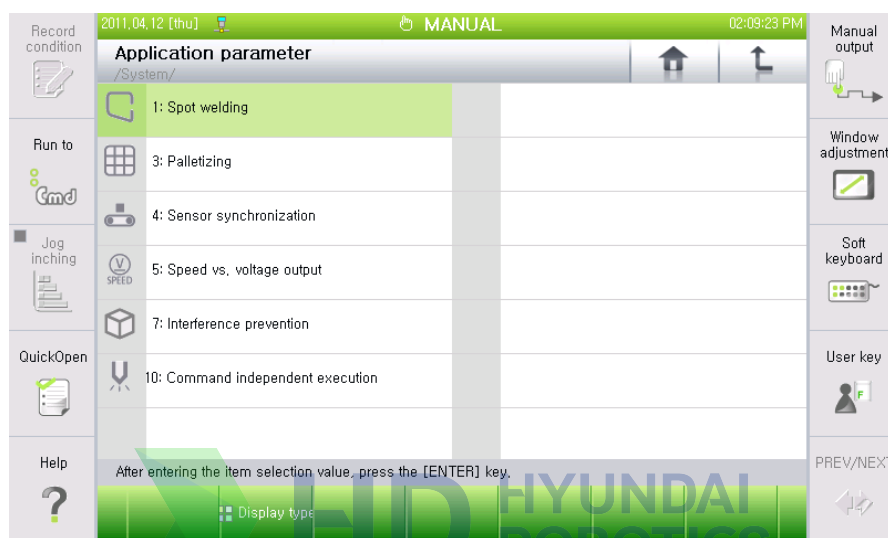


Figure 7.77 Applied parameter selection (Display different information in accordance with the setting)

For details, refer to the 『Function manual』 by each applied function.

7.5. Initialize

When the controller is to be used for the first time after installing the robot, this menu is used for setting the necessary items for the initial setting. This includes the menu that will initialize the serial encoder.

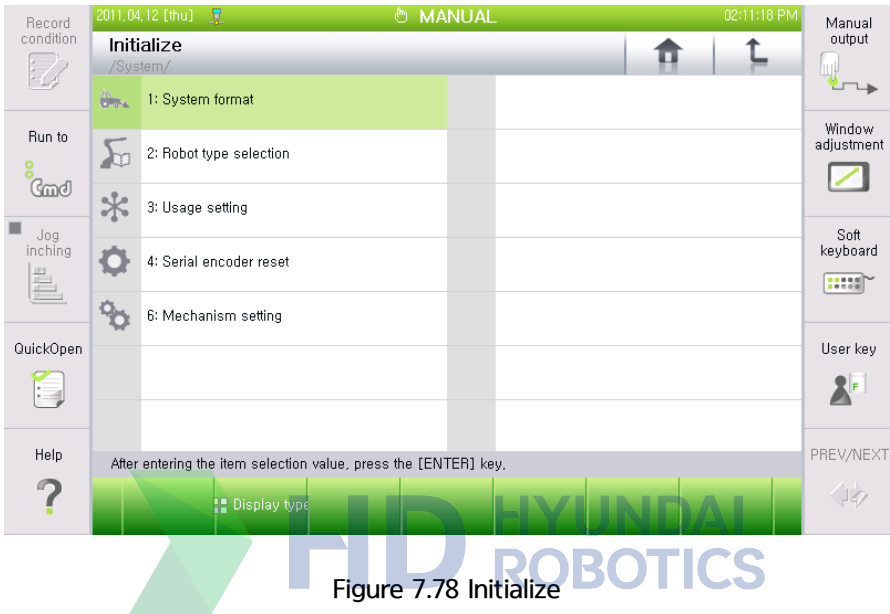


Figure 7.78 Initialize

Some specific items are displayed in the engineer mode and some others are displayed only when additional axes of certain type are selected. When the user enters the initialize menu in the engineer mode, the following screen will be displayed.

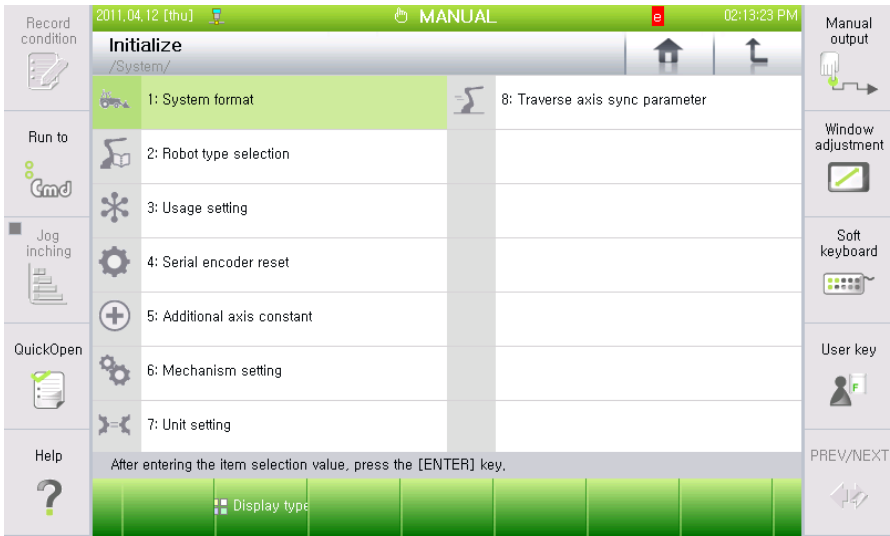


Figure 7.79 Initialization selection screen

7.5.1. System format

When “1: System format” is selected, all the backup data in the controller will be deleted. Backup files of necessary programs and files in the controller should be made in advance.

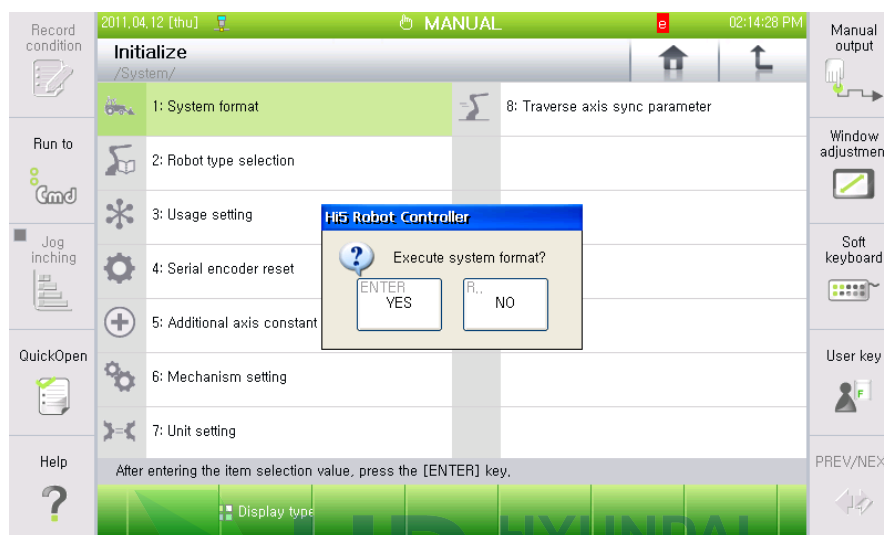


Figure 7.80 System initialization

When the system is initialized, the control constant file (ROBOT.CON) will be set to the factory default value. After the system is initialized, select the type of robot.

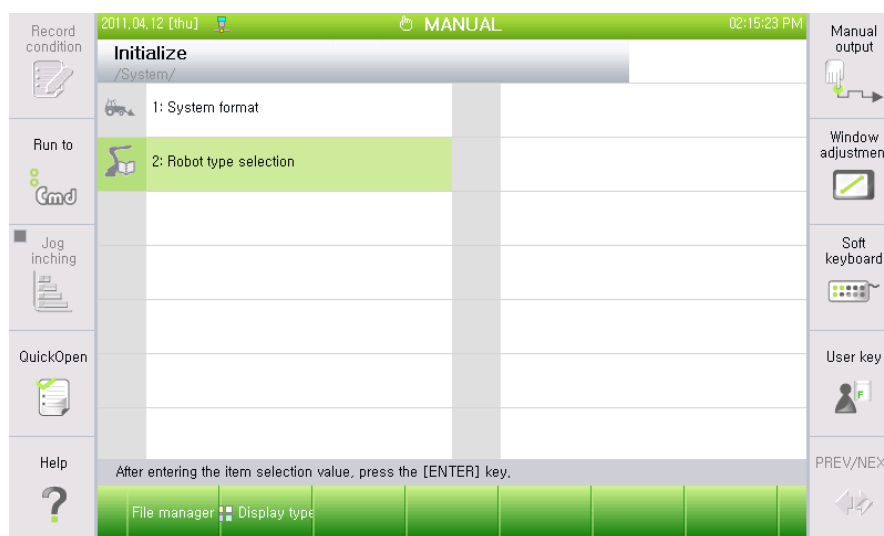


Figure 7.81 Robot type selection and initialization screen

In order to prevent faulty operation, this menu can be used only by a qualified engineer.

7.5.2. Robot type selection

When '2: Robot type selection' is selected, the list of robots that can be selected will be displayed as shown below. When the robot type is selected, the mechanical parameter file (ROBOT.MCH) will be set to the initial values provided upon the shipping of the controller, and other history files will be initialized also. The robots are classified according to each weight-bearing capacity of the vertical articulated robot, and also the classification is also made according to the generation (G) of the LCD transfer robot.

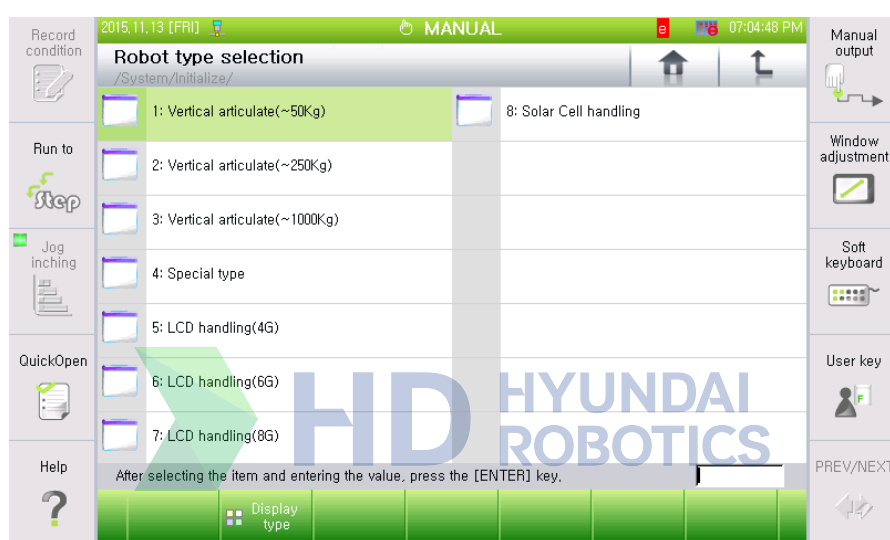


Figure 7.82 Robot type selection

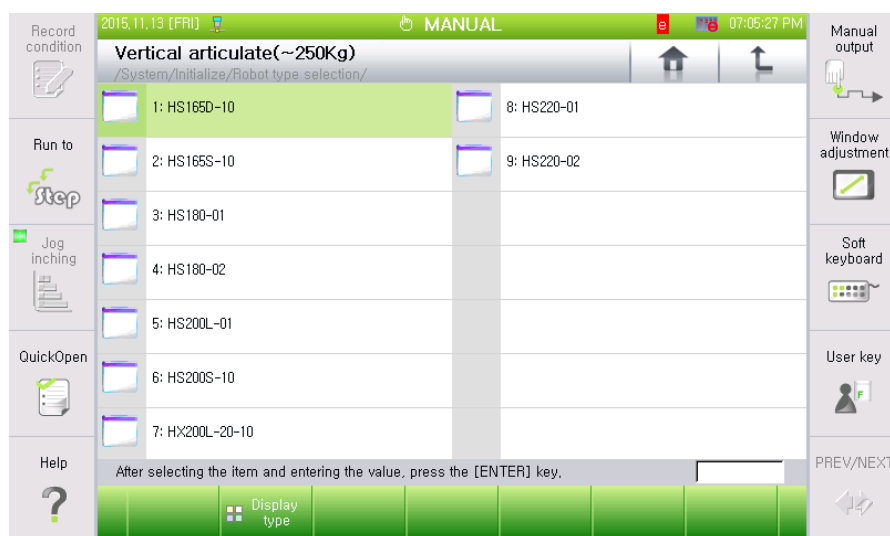


Figure 7.83 Vertical articulated robot type selection

When shipped, the robot controller and the robot main body are configured into one system. In the robot controller, a drive that fits the drive capacity of the robot is installed. Accordingly, if a reset needs to be

7. System setting

performed according to the needs of the user, before performing settings, it is required to carefully check the type of robot set.

7.5.3. Usage setting

This function sets the purpose of work and properly initializes the user key and input/output assignment.

- 1) When the spot welding is “Enable” :
 - The SPOT command can be used.
 - In ‘『F2』: System』 → 『4』: Application parameter』 → 『1』: Spot welding』’, the spot welding parameters can be set.
 - When the servo gun change function (GUNCHNG) is used, the number of guns needs to be set in ‘Gun change number’.
 - The user key initialization and the input/output assignment initialization are to be set as ‘Spot’.

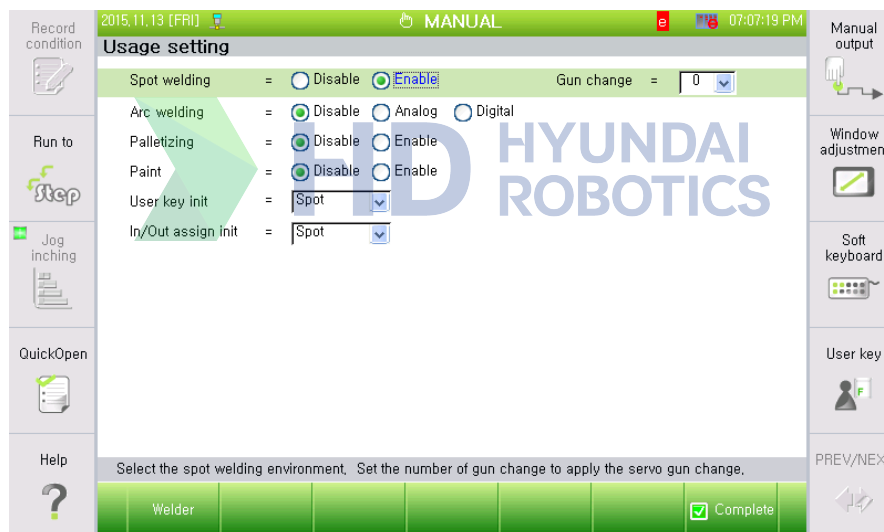


Figure 7.84 Usage setting

Controller Operation Manual

2) When arc welding is used

- Commands related to the arc welding can be used.
- Menus related to the arc welding can be accessed.
- Select whether to use an analogue or digital welding device.
- The welding devices displayed on the screen are provided by our company. Select the number of the relevant welding device.
- The user key initialization and the input/output assignment initialization are to be set as 'Arc'.

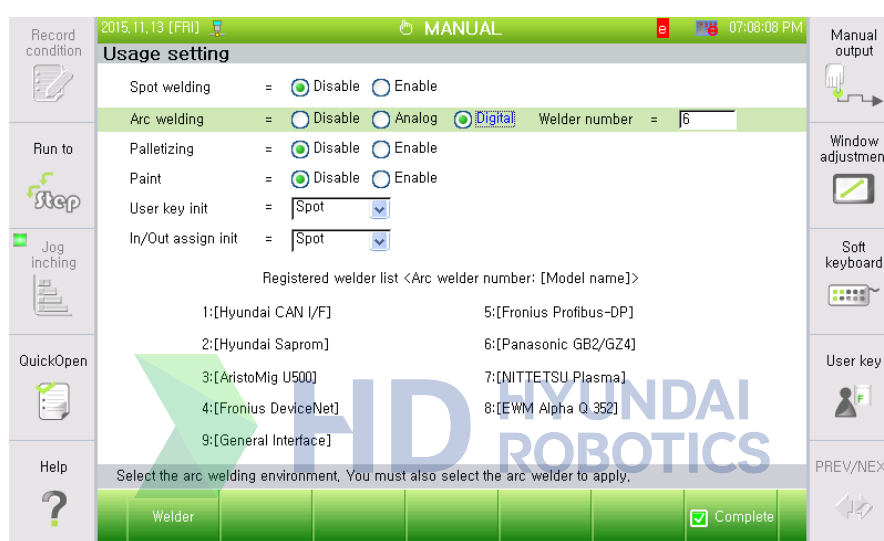


Figure 7.85 Usage setting (Arc)

3) When the palletizing is set to be "Enable"

- Commands related to the palletizing can be used.
- Menus related to the palletizing can be accessed.

7.5.4. Serial encoder reset

The serial encoder reset function is to release the error state of the motor or to newly set the zero-point of the encoder.

When an encoder reset is performed, the rotation frequency of encoder will be cleared to 0.

The internal memory of the serial encoder stores the rotational frequency information of the encoder. The encoder reset function needs to be carried out at the initialization work stage, while the function must not be used at all when the robot is operating normally.

However, when there are errors related to encoders, such as errors with encoder communication or encoder battery drainage, it is necessary to perform a reset. At this time, a difference from the previous robot origin position could have been caused. Thus, it is necessary to check and alter the actual position of the robot program.

The serial encoder reset can be performed by setting the encoder reset mode for each axis. If it is necessary to release the encoder-related errors without clearing the encoder rotation frequency, the encoder reset mode should be set to "Error release."

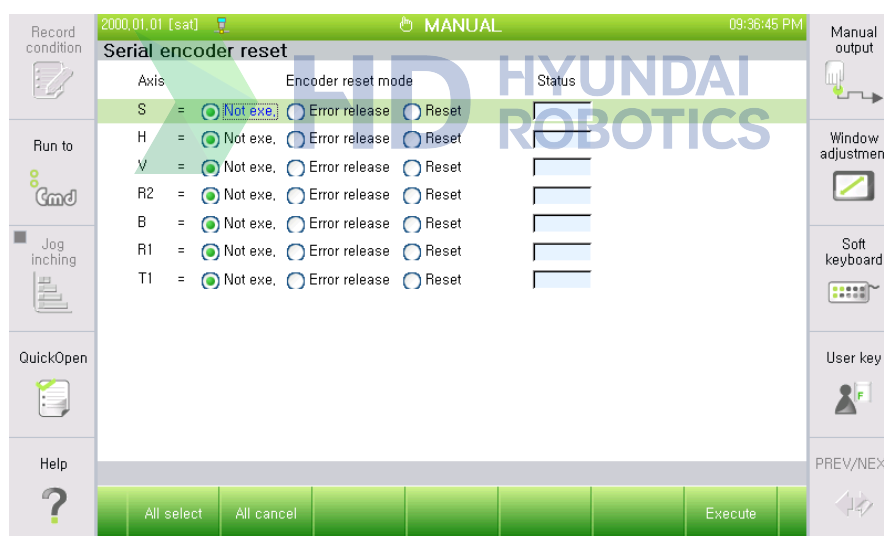


Figure 7.86 Serial encoder resetting



Reference

- In order for the serial encoder to memorize the location even when the power of the controller is out, there is a battery attached for the encoder. If both the power for the controller and the battery power for the encoder are not supplied at all, the location information of the encoder will be deleted, causing you to suffer some difficulties in using the work program.
- Accordingly, in case of encoder battery voltage error, the replacement of the encoder battery must take place only when the power of the controller is turned on.

7.5.5. Additional axis parameter setting

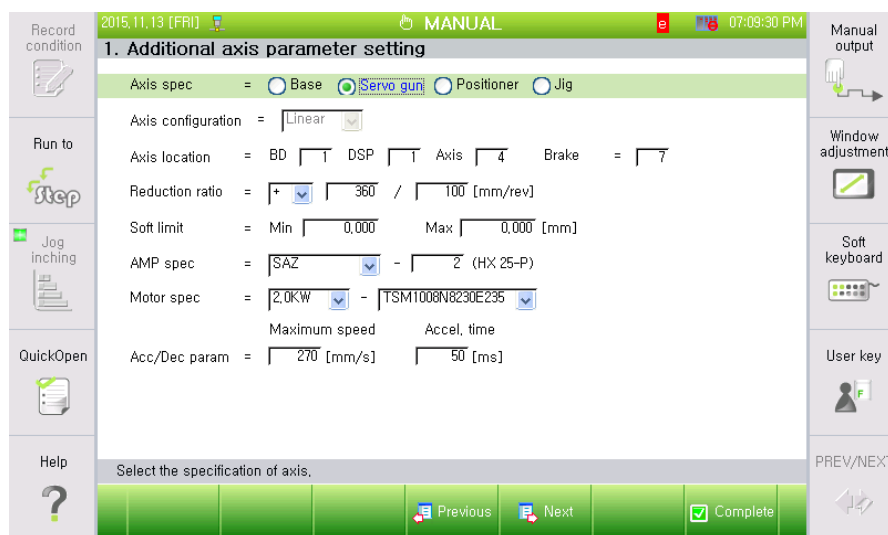


Figure 7.87 Additional axis constant setting

- In addition to the robot, when an additional axis needs to be used, its setting can be carried out in this menu. Additional axes include the robot's base axis (travelling axis), servo gun axis, positioner axis, jig axis and servo hand axis. This menu is to set the specification and configuration of these additional axes. For more details, refer to 『Hi5a Controller Additional Axis Function Manual』.

7.5.6. Mechanism setting

Mechanism is a component that forms the unit and is to be utilized as a group when the jog is operated.

When the setting of mechanism is carried out, the mechanism number (M#) will be assigned to each group of individual axes. This menu is to set the endless function as enable/disable, and set the positioner group.

- (1) Select 『[F2]: System』 → 『5: Initialize』 → 『6: Mechanism setting』 from the initial screen of MANUAL mode.

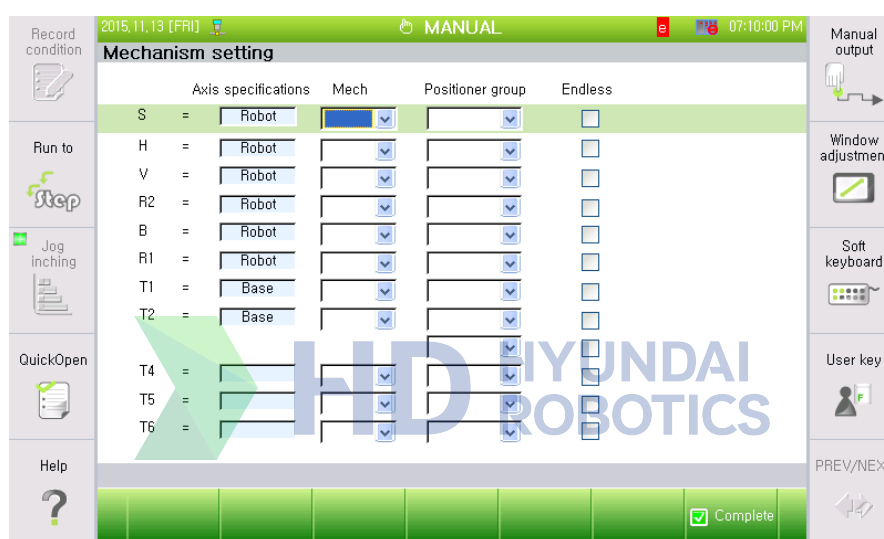


Figure 7.88 Mechanism setting

- (2) Set the mechanism number, endless function Enable/Disable and positioner group number of each axis.
- (3) The content of each item is as follows.

- Mechanism
 - Set the mechanism number of the relevant axis.
 - When the axis specification is a robot, this will be fixed as mechanism MO.
 - Mechanism 1~7 can be assigned starting from the additional axis.
 - Those axes set with the identical mechanism number will be managed as the same group.
 - For the jog of the additional axis, the [Mechanism] key is used to shift between mechanism groups, and, if the jog is pressed at that time, the jog activity will take according to the sequence of the axes of the mechanism.
- Endless
 - Set whether to use the endless function in the relevant axis in the enable/ disable state
- Positioner group

Controller Operation Manual

- Set the positioner group number of the positioner axis.
 - You can only set the positioner group number to the axis set with the positioner.
- (4) To save the set data, press the 『[F7]: Complete』 key. When you press the [ESC] key, the changed data will not be saved.



Reference

- The combination of set mechanisms can be used by being assigned as a unit. For concept and content related to the unit, consult the following paragraph.
- How to designate the positioner group
 - ① Designate the group in the order from the lowest axis.
 - ② The asynchronous groups will be designated as “Disable”.
 - ③ Because only 2 axes are supported for the same group of the positioner, you must not set 3 axes for one group.
 - ④ As the previously specified calibration data of the positioner are invalidated when you redefine the group settings, you must reexecute the calibration of the positioner.
- Mechanism jog rules
 - ① Hi5a controller provides a total of 8 jog keys.
 - ② Mechanism is a group that will be used for the jog operation.
 - ③ When the mechanism number is selected as [M0], the axis 7/8 jog keys will be operated as an exception. It is possible to operate M1 and M2 within the range of the 8 axes, including the following mechanisms. In this case, if the mechanism number is set as [M1], it will be possible to perform jog operation of the components of M1.
 - ④ The examples of function usage are as shown below.

Ex1) M0: Robot (axis 1~6), M1: Traverse axis (axis 7), M2: Servo gun (axis 8)
 Select [M0] → Axis 1~6 jog key: M0, Axis 7 jog key: M1, Axis 8 jog key: M2
 Select [M1] → Axis 1 jog key: M1
 Select [M2] → Axis 1 jog key: M2

Ex2) M0: Robot (axis 1~6), M1: Traverse axis (axis 7), M2: Servo gun (axis 8~9)
 Select [M0] → Axis 1~6 jog key: M0, Axis 7 jog key: M1.
 Select [M1] → Axis 1 jog key: M1
 Select [M2] → Axis 1~2 jog key: M2

Ex3) M0: Robot (axis 1~7), M1: Traverse axis (axis 8), M2: Servo gun (axis 9~10)
Select [M0] → Axis 1~7 jog key: M0. Axis 8 jog key: M1
Select [M1] → Axis 1 jog key: M1
Select [M2] → Axis 1 jog key: M2



7.5.7. Unit setting

Unit refers to setting the combination of axes that can be moved by the task program. Through this message box, you can set each unit with various combinations of mechanisms.

A mechanism is the combination of individual axes, so, consequently, a unit is also the combination of individual axes. However, there is difference because mechanism is used during the jog activity, while the unit is used for recording the step position in the program. In general conditions, a unit is set as being unit#0, which signifies the state in which all mechanisms are included, meaning the state in which all axes are included. In this state, if the robot program is recorded, the positions of all of the axes are recorded. During the playback, all the axes move to those positions.

If the user wants to prepare a program that will run only some specific mechanisms (axes), units need to be assigned through this menu and used.

- (1) Because the unit change of the system has a big impact to the operation of the controller, only the engineer can set it up and make changes.
- (2) Select 『F2]: System』 → 『5: Initialize』 → 『7: Unit setting』 from the initial screen of the manual mode.

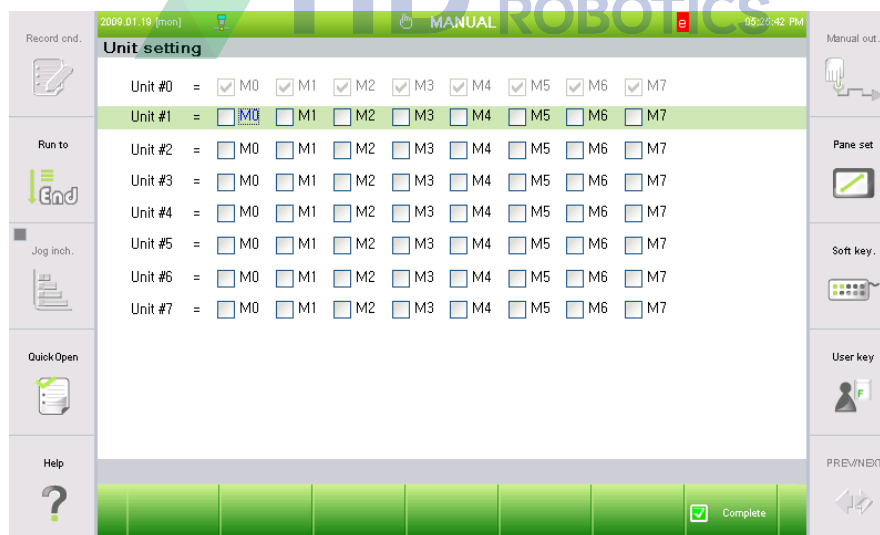


Figure 7.89 Unit setting

- (3) Unit #0 is fixed to all mechanism.
- (4) For unit #1 to #7, the user can select various mechanisms.
- (5) In order to record a step of a program in manual mode, the user can select the unit number using the [Unit] key. While the unit number is selected, only the location of the axis relevant to the unit can be saved by pressing the [REC] key.

- (6) If you proceed the step by changing or executing the step with the cursor, the current unit number recorded will automatically change to the unit number recorded on the step.
- (7) When you press the [POS. MOD] key from the recorded step, the location of the unit saved on the step will be changed.



Reference

- Refer to the following function related to the unit.
 - ① You can change the unit of pose parameter. (Ex, "P1.Unit=2")
 - ② You can designate the unit of the pose constant. (Ex, "P1=(12.00,13.00)UNIT2")
 - ③ When you look at the task program from the PC, the unit is included in the hidden pose. (Ex, "S3 MOVE, P,S=50%,A=0,T=0 (12.00,27.00)UNIT2")
(When the unit is 0, UNIT0 is not included.)
- Robot coordinates interpolation function
 - (1) Conditions for the usage of this function:
 - ① At a system with a travelling axis, a unit with a travelling axis needs to be set, and the coordinates for the step should be set as 'Robot'.
 - ② Processing will be performed by differentiating between the steps (support only for the base coordinate interpolation) that include the traveling axis and steps (support only for the robot coordinate interpolation) that do not include the traveling axis.
(Non-applicable for a system that has no travelling axis.)

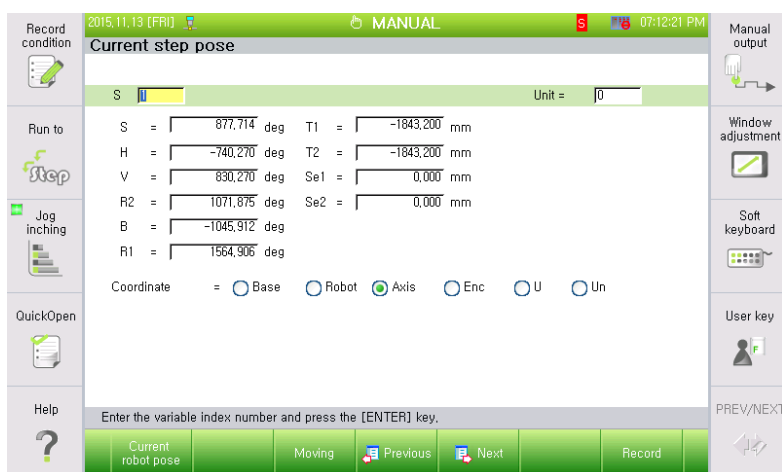


Figure 7.90 Robot coordinates setting for the step

(2) Explanation about the function:

- ① If the unit of a step is set as 'robot' only.
 - The coordinates are recorded as 'robot' or 'axis angle'
 - ➔ The liner interpolation (L) and the circular interpolation (C) need to be executed based on the coordinates of the robot. .
 - If the coordinates are recorded as 'base', when playing back is in progress, it will be handled as an error.
 - ➔ "E1483 Setting of the coordinate system and unit of step doesn't match." error occurs.
 - It is impossible to execute the stationary tool interpolation, the conveyor synchronization and the positioner synchronization.
 - ➔ "E1484 Error in unit setting - Unable to use synchronous feature" error occurs.
- ② If the unit of a step is set as 'all travelling axes + robot'
 - If the coordinates are recorded as 'base' or 'User U, Un'
 - ➔ The L and C interpolation should take place using the designated 'base coordinates' or 'user coordinates'. The robot coordinates interpolation (L, C) is not to be supported.
 - However, if the unit is 'travelling axis + robot', all the travelling axes are included in the unit. When there are multiple travelling axes, they need to be included in the unit. If not, it will be considered as 'robot only'.

(3) How to use the function

- ① Even when the standalone operation needs to take place by using the 'multitasking' or 'command standalone execution' function needs to be used, the operation will be possible when operating through the L and C interpolations.
- ② When the unit function is used, the robot coordinates P, L and C interpolations will be possible.
 - Support for the servo gun and Eqlless gun
 - Support for the shift function
- ③ A program can be prepared in an instinctive and simple manner.
 - It will be made easier to prepare a program that can carry out the same work only shifting the base axis.
 - It will be made easier to prepare a program that can carry out the gun search regardless of the location of the base axis.

7.6. Auto calibration

Auto calibration uses a teaching program or auto movement to find the axis origin, tool length, overload mass, and base axis direction to achieve the proper robot usage calibration.

Values calibrated by this function are reflected automatically in the robot.

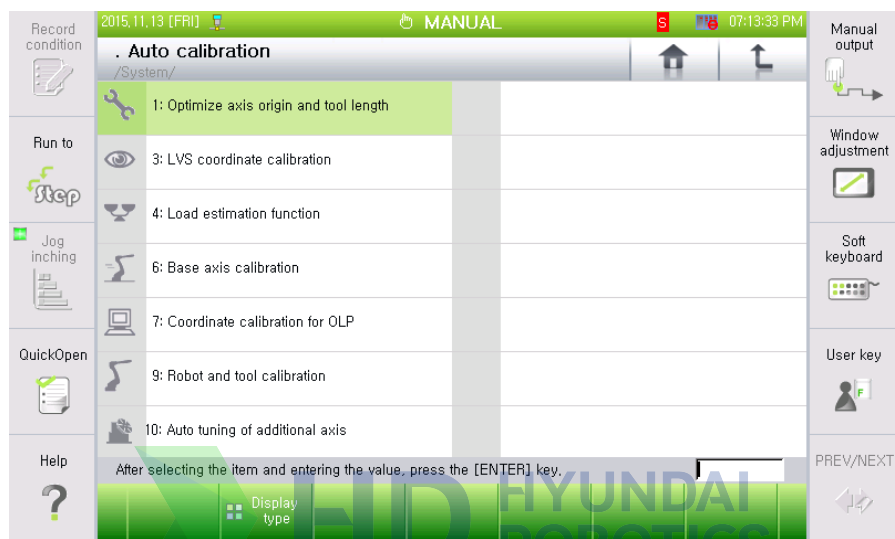


Figure 7.91 Auto calibration setting items

7.6.1. Optimize axis origin and tool length

This is to calibrate the zero point of each axis of the robot as well as the tool length, without using an external measuring sensor.

When it comes to the teaching method, you need to prepare two pointed tips, and then fix one tip externally and the other one at the tool. After that, you need to carry out the recording for multiple points by using the robot program only by changing the posture of the tool end of the robot against the externally fixed tip.

At this time, 7 points should be taught when both the axis origin and the tool length are to be found, while 4 points or more should be taught when only the tool length is to be found

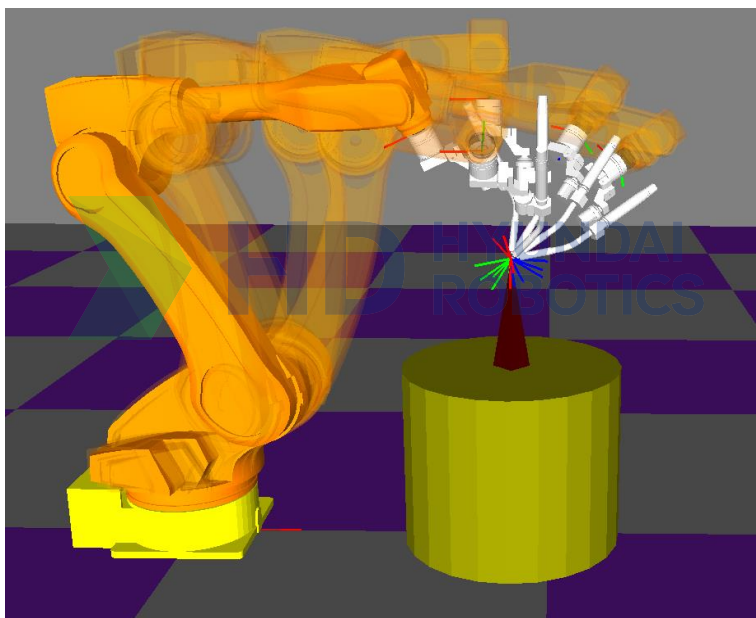


Figure 7.92 Teaching method for optimizing the axis origin and the tool length

When this function is used, not only the tool lengths, X, Y and Z, which have no CAD data, but also the zero points of the H, V, R2, and B axes of the robot can be located by using the optimization method.

Warning

- When this function is used, the encoder offset and the tool length will be changed, leading to a change in the work position of the previously taught program. Thus, the user must use this function before performing work.

7. System setting

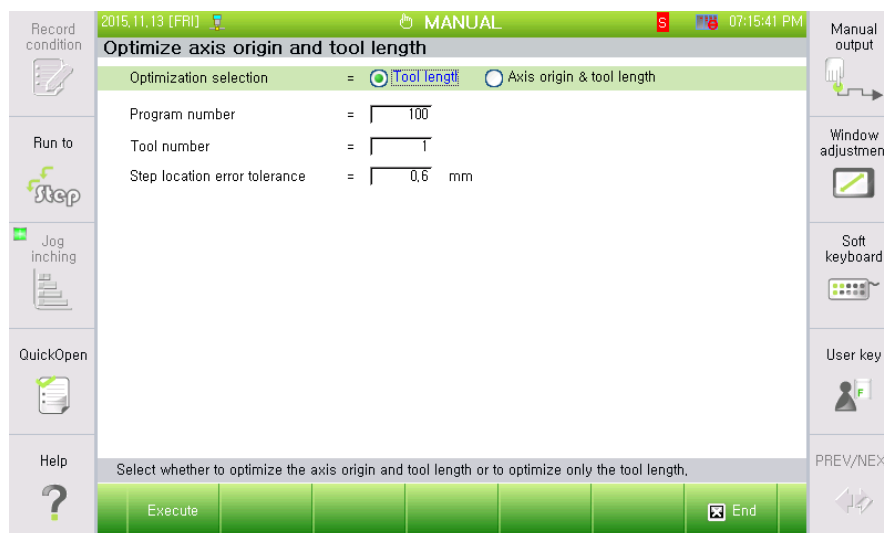


Figure 7.93 Results of the axis origin and tool length optimization

■ Setting

① Tool length

The set value is adjusted from the tool length set in 『F2』: System → 『3』: Robot parameter → 『1』: Tool data

② Axis origin & tool length

- This function needs to be selected to calibrate both the zero point and the tool length of the robot. Generally, this is used to set the correct zero point initially after installing the robot.
- The tool length that should be set from 『F2』: System → 『3』: Robot parameter → 『1』: Tool data and the robot's zero point that should be set from 『F2』: System → 『3』: Robot parameter → 『2』: Axis origin will be automatically calculated.
- When you need to execute 『F2』: system → 『3』: Robot parameter → 『1』: tool data → 『angle calibration』, it is necessary to implement 『angle calibration』 after completing the 『Optimize axis origin and tool length』. Also, precise data tool should be set.
- Once after the robot's zero point is set correctly, you need to shift the optimization selection method to the 'tool length' option in order to calibrate the tool length only. When the 'axis origin and tool length' is changed, the zero points of all of the robots will change. So pay attention as the location of the previously prepared program will change.

■ Program number

This sets the program number that records the same point in various positions.

■ Tool number

This is the tool number to automatically set and it must be same with the tool number recorded in the program for setting.

Controller Operation Manual

■ Allowed position error

If the expected error following the auto calibration setting is smaller than the value set here, the constant data will be updated automatically. If the expected error is bigger than value set here (Initial set value 0.1mm), it will be checked with the user first whether to reflect the constant, before making it reflected.



Reference

- In this function, the correctness of the teaching is proportionate to the correctness of the maximum step position error result. Accordingly, it is required to prepare, if possible, two pointed tips and carry out the teaching in a way that correct matching can be made possible. Make sure that the correctness in matching between the tool end and the fixed point in space is within 0.5mm when visually checked.
- Teach so that the posture of each step should not be similar to each other, and the new posture should be different (Different by 30deg or higher) from the previous one.
- Teach so that the movement of the wrists (R2, B, and R1) of each step is large as possible and so that the angle difference of each step is enough (as wide as possible).
- When the machine parameter file (ROBOT.MCH) is set as being protected, this function cannot be run. Try after canceling the file protection

7.6.2. Positioner calibration

The positioner calibration function allows the robot to perform tracking or perform linear or circular operation corresponding to a jig through the synchronization with the operation of the jig installed outside the robot. The external jig unit, which will be applied for the positioner calibration, is called positioner or station.

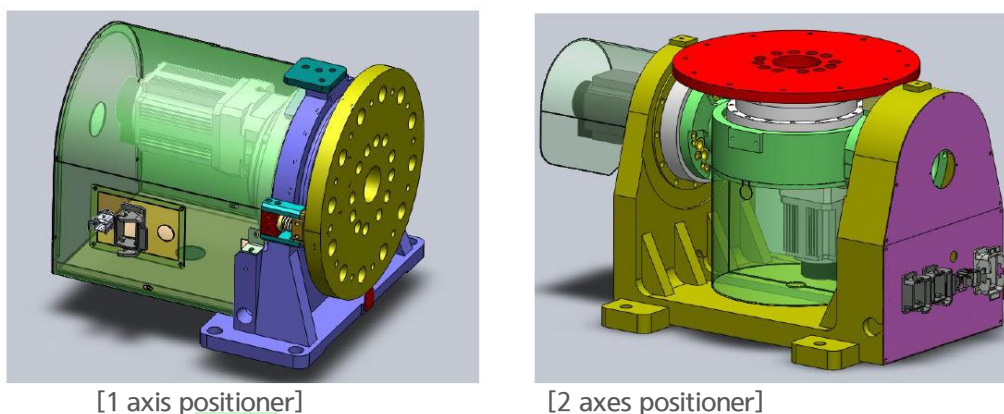


Figure 7.94 Axis 1 and 2 positioners

When this function is applied, it is possible to compensate for the difficulties in work due to restrictions of the working area. The positioner is designed to allow a workpiece fixed on the positioner to move with the positioner. The robot tracks the movement of the positioner and performs linear or circular operations on the workpiece.

The specifications of the key functions are as shown below.

Table 7-4 Specifications of positioner functions

Specifications of key functions	Features
Positioner group	Support for 1~4 groups
Number of axes of a positioner	Support for a positioner with 1 axis or 2 axes (rotational axis)
Interpolation method	Support for linear and circular interpolation
External input independent jog (SELSTN)	Support for the jog operation regardless of the robot for a positioner selected in auto mode.
External input independent playback (AXISCTRL)	Support for the independent playback (Move) function regardless of the robot for a positioner selected in auto mode.

This function can be used when the positioner group is set.

In order to set the coordinate for the positioner, the positioner calibration will be performed simply through a 3-point teaching for a 1-axis positioner and a 5-point teaching for a 2-axes positioner.

For details, please refer to 『Hi5a Controller Positioner function manual』.

7.6.3. Laser vision sensor coordinate calibration

Hi5a controller supports the LVS-based welding line detection and tracking with which the robot can search the position of a specific shape and keep tracking by using a laser vision sensor (LVS). In order to use this function, it is necessary to calibrate the position between the LVS and the robot. The “Laser vision sensor coordinate calibration” function allows the information necessary for calibrating the position between LVS and the robot, and also the information necessary for the LVS interface to be set.

Please, consult the manufacturer when the LVS-based welding line detection and tracking function have to be used as an option related to this function.

7.6.4. Load estimation function

The load estimation automatically secures the physical values (mass, center of position, inertia) of a tool attached at the front end of the robot through a certain operation. The physical values of the tool attached at the end need be entered to use the robot correctly and safely.

The mass, center of mass and inertia of each link of the robot's main body is registered in the controller. However, in case of individual tools, the user needs to enter the values because the tools are attached because of the user's purpose. If the mass and center of gravity of the tool are known already through the CAD data, the values can be entered directly by the user. The mass (kg), center and inertia of the tool can be entered ' 『F2]: System』 → 『3: Robot parameter』 → 『1: Tool data』'.

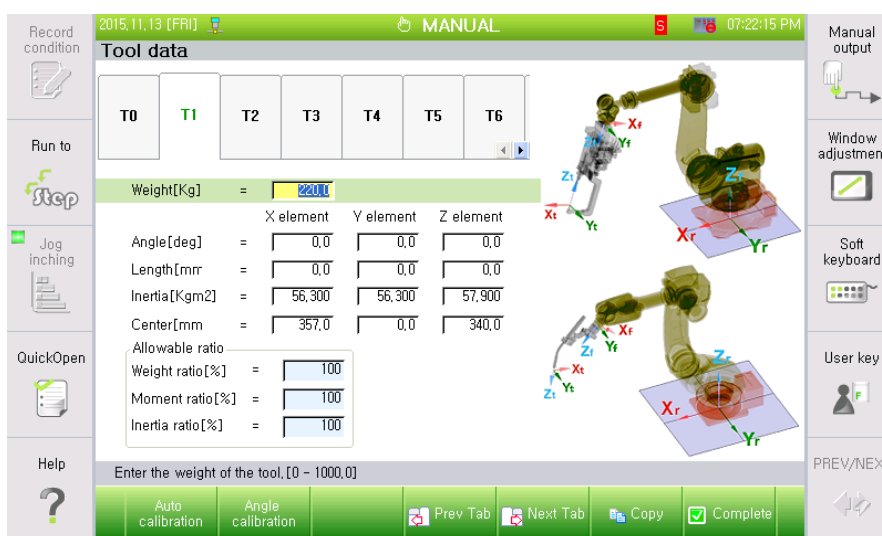


Figure 7.95 Tool data setting screen

Individual items regarding the tool data are as shown below.

- Weight (Unit: Kg): Indicates the total weight of the tool mounted at the end of the robot.
- Inertia (Unit: $\text{Kg}\cdot\text{m}^2$): Indicates the inertia momentum of the tool. It will be determined by the distribution of mass around the circumference of X, Y, and Z axes based on the center of gravity. The more distant the mass of a load is distributed from the rotation axis, the higher the value will get.
- Center (Unit: mm): Indicates the distance in the x, y, and z directions from the center of the robot flange surface to the center of gravity of the tool. It is measured in the unit of mm.
- Tool data coordinate: The inertia and the center are to be displayed in the values in the X, Y, and Z directions as shown in "Figure 7.96 Tool Data".

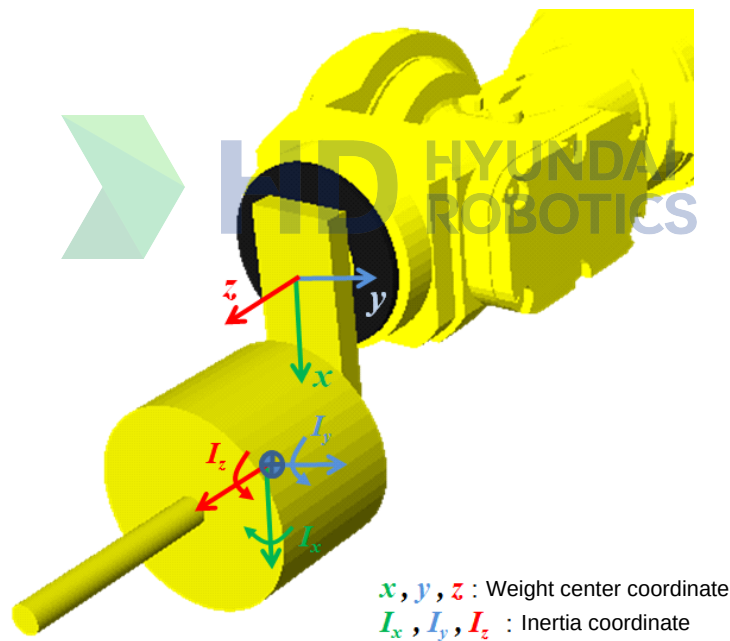


Figure 7.96 Tool data

However, in general, it is not easy to secure the weight, inertia and center of gravity of a tool from the CAD data. That is why the load estimation function is used to calculate the physical values of a tool automatically from the robot controller.

Controller Operation Manual

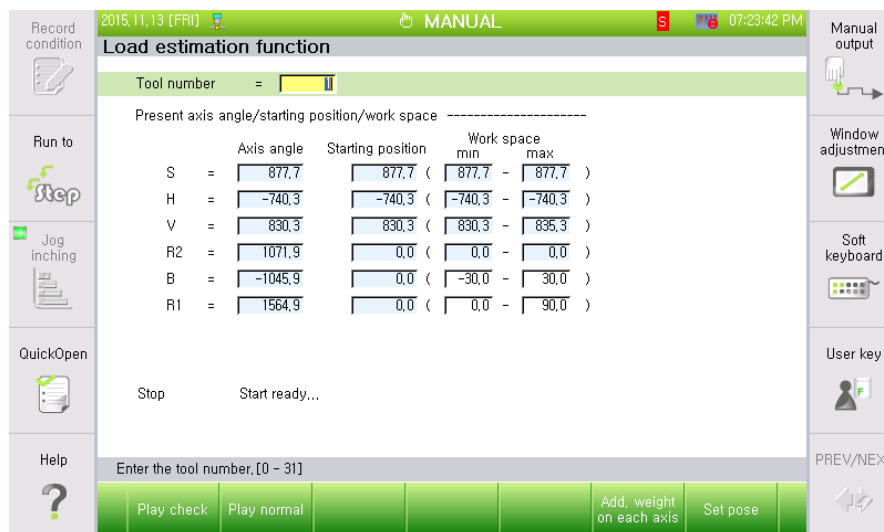


Figure 7.97 Load estimation function screen

The procedure of the load estimation function is as shown below.

- ① Selection of the load estimation function
- ② Each axis' additional weight input
 - Additional weight refers to all types of devices that the user installs to the robot, such as welding dressing devices and welding signal line relay box, but not including the tools that are installed at the front end of the robot.
 - The load estimation function calculates only the physical values of the tools installed at the front end of the robot.
 - If the load estimation function is performed when additional weights are applied, all other weights installed on the robot are considered as weights on the front end.
 - Thus, it is necessary to input the additional weight information by selecting 『[F6]: Additional weight of each axis』 for accurate load estimation.
- ③ Main axis posture designation
 - In the load estimation menu, it is possible to operate the robot's main axis to move the robot to an area where the load estimation operation can be performed safely.
 - After moving the robot to a safe area where load estimation can be performed, select 『[F7]: Set pose』.
- ④ Wrist axis operation area input
 - The user can designate the operation area of the wrist axis that is to be used in the load estimation operation. With this function, it is possible to perform load estimation in an operation area where there is no interference with adjacent facilities or the robot main body.

(※ This function may not be supported in some robots.)

- ⑤ Check operation
 - In order to check for any interference with adjacent facilities or the robot main body during the load estimation process, operate the robot at low speeds by selecting 『[F1]: Check operation』.
- ⑥ Tool number input and normal operation
 - Set the tool number that needs to be used and select 『[F2]: Play normal』 to perform load estimation.
- ⑦ Estimation result reflection
 - Check the estimation result and select 『[F7]: End』 to register the result of the load estimation into the defined tool number.

For more details, refer to 『Hi5a Controller “Load Estimation” Function Manual』.



Reference

- It may be impossible to perform load estimation depending on the condition of the wrist axis operation area.
- In some robots, it may be impossible to designate the condition of the wrist axis operation area.

7.6.5. Common coordinate of cooperate robots

This menu is for setting the common coordinate for the robot to identify the location of the counterpart robot when using the cooperation control and arm interference detection function. For more details, refer to 『Hi5a Controller “Cooperation Control” Function Manual』.

7.6.6. Base axis calibration

7.6.6.1. Introduction

This function is to calibrate the direction in which the axis is installed. It is impossible to install the base axis accurately aligned to the direction (X, Y and Z) of robot coordinate. Therefore this function calculates the direction of the base axis and improves the straight line interpolation path performance including the main axis.

As shown in the figure, install the robot in the base axis and find an arbitrary direction vector to do the location calibration of the robot.

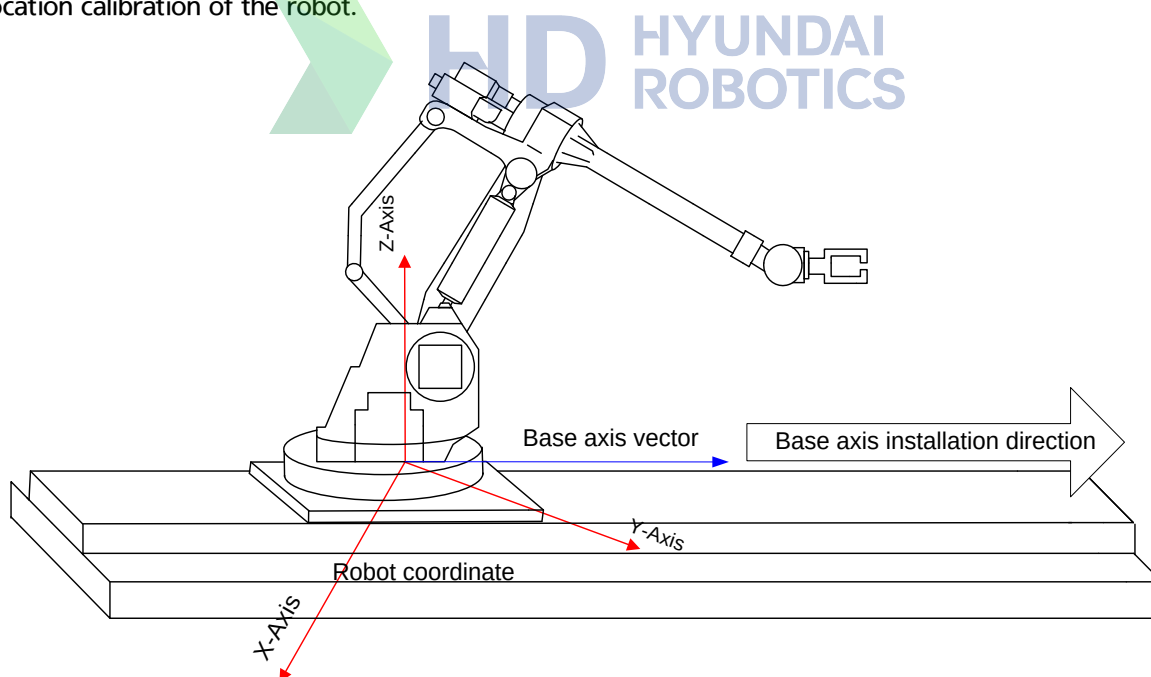


Figure 7.98 Base axis calibration

7.6.6.2. Function usage

Generally the use of main axis is to move the robot to the work location but in special cases call for the base axis to ensure straight path.

- When two robots are moving back the work object in cooperative control
- When the robot is doing interpolation along the base axis

7.6.6.3. Initial setting of base axis

- (1) Select 『[F2]: System』 → 『5: Initialize』 → 『5: Additional axis parameter setting』 from initial screen of manual mode. (Or additional axis setting menu appears during system initialization.)

As an additional axis-parameter setting menu is a function for engineers, general users are not able to check this menu. For more information, please contact your engineer.

- (2) Set the axis position to 〈Base〉 and set the application to 〈Any〉 and set the other parameters to the device design value and controller composition specification.

Warning

- You can only use the calibration function for the first base axis. Therefore, only the first base axis should be set to 〈Any〉. Do not set it as Arbitrary from second on.

7.6.6.4. Calibration program teaching

- (1) Establish the reference point in space and record the first reference point.
- (2) Move the main axis more than 200mm and record the same point in the second step
- (3) Just like the prior step, do the same for 1st and 2nd point and record 3rd and 4th point at least 200mm apart.

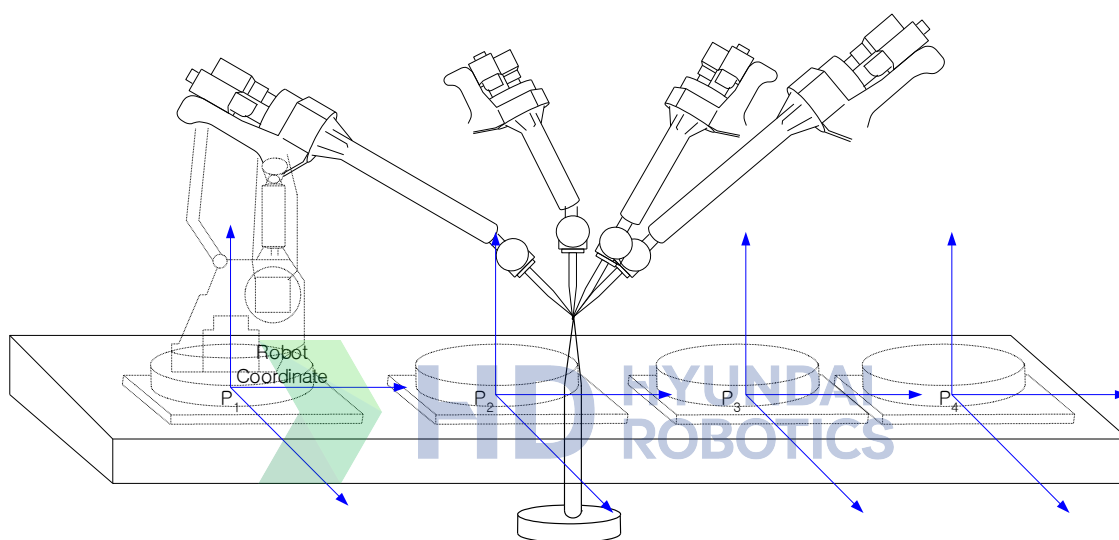


Figure 7.99 Base axis calibration program teaching

Warning

- Teach the driving axis calibration program by using the tool for which the robot calibration (Optimize axis origin and tool length) is completed
- Keep the tool number in mind when recording. You must enter the tool number for base axis calibration.
- Record the locations as farther away as you can for between steps.

7.6.6.5. Base axis calibration Executing

After entering the program number for base axis calibration, execute [F1]. The installation directional vector value of base axis. Press the [F7] key to complete.

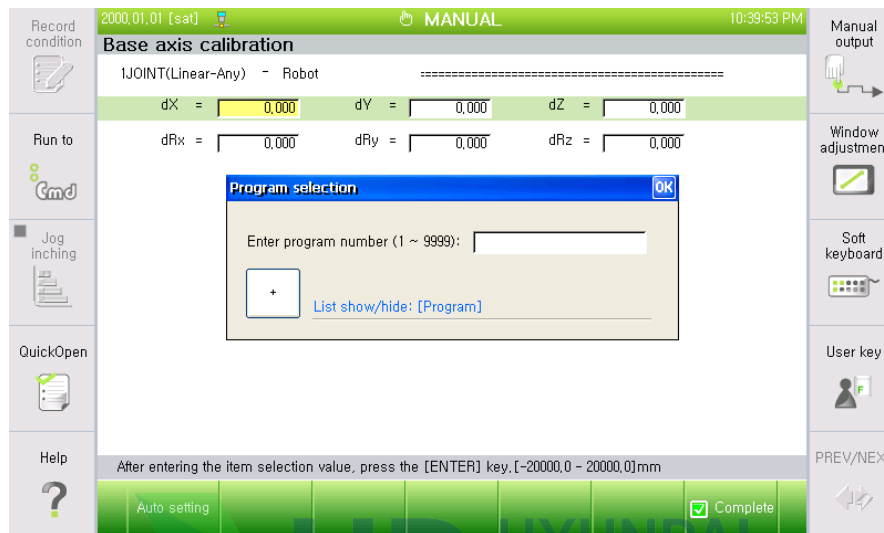


Figure 7.100 Base axis calibration execution screen

7.6.6.6. Operation after calibration for base axis

When you operate the jog for the base axis after the base axis calibration, the driven distance in the directional vector of the base axis generated through jog operation of the base axis is calculated to the current coordinate value.

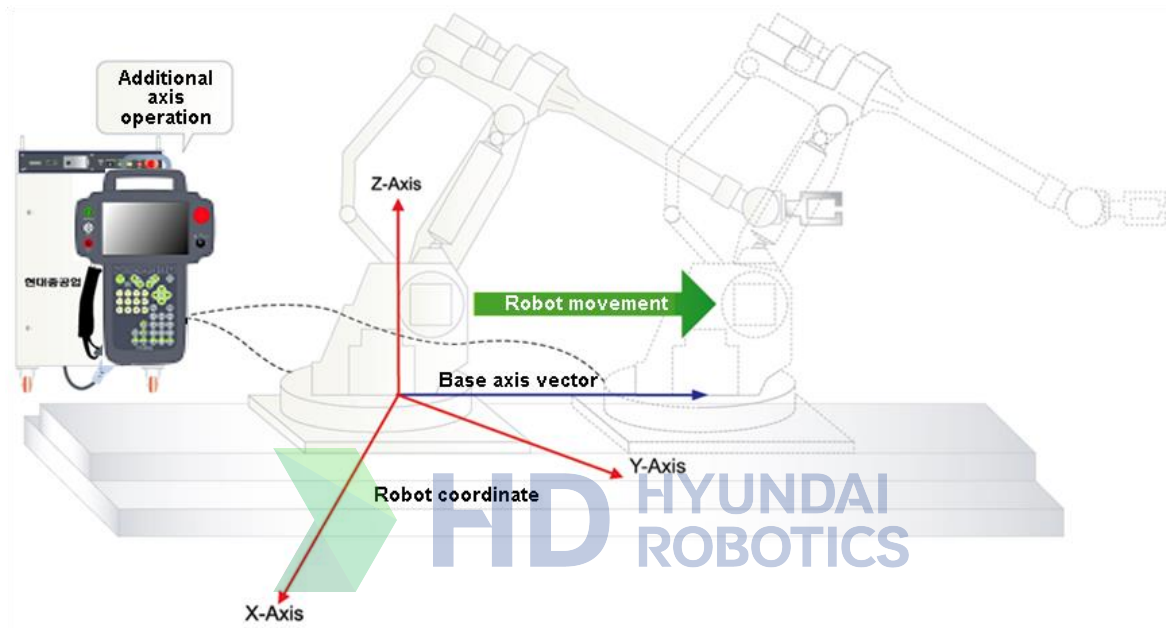


Figure 7.101 Operation after calibration for base axis

- (1) Select 『F1: Service』 → 『1: Monitoring』 → 『1: Data of each axis』 and you can check the calculated coordinate value from base axis movement.
- (2) Jog operation and coordinate check
When you execute the jog operation of the base axis when the data monitoring of each axis from the teach pendant is selected, it calculates the driven distance in the base axis direction and calculates the XYZ value to display on the monitoring screen of teach pendant.
- (3) Step recording and playback are same as typical steps.

Warning

- Set the jog coordinate to tool coordinate after calibration and execute the jog operation for base axis to make it a static operation for the tool end. Using this method, check whether the calibration is normally executed.

7.6.7. Coordinate system calibration for OLP

OLP (Off-Line Programming) is used to minimize additional teaching at real sites by planning them in a simulation. The program prepared by using OLP can be downloaded as it can theoretically replace the actual work. However, in real work spaces, there could be various errors, such as errors related to accuracy of the robot, the installed position accuracy of the robot, and the installed position accuracy of a workpiece. These errors are the reasons that the program prepared in OLP cannot be applied to the actual sites.

Accordingly, there is a need to calibrate between the position calculated in OLP and the actual work position. The function to perform this calibration is “OLP installation error calibration”. This function can correct the OLP installation errors by creating the difference relationship between two coordinate systems and teaching the robot at the same location as the reference program of the CAD used in the OLP.

In the calibration method provided by this function, the user coordinate is used. The user teaches the robot program by using the user coordinate.

If the reference program created in the OLP and user-created programs are inputted, the difference value between the two programs is added to the previously designated user coordinate.

As a result, the program's work position taught based on the user coordinate will be calibrated to match the actual workpiece position.

As shown in the following figure, the workpiece 1 was placed in the U1 position in OLP. However, if it is actually installed in the U1' position, there will be differences between the two coordinates, -50mm, 70mm, and 0mm in the X, Y, and Z directions, respectively. Also, there will be differences of 0 deg, 0 deg and, -15 deg in the Rx, Ry, and Rz directions, respectively. This function will calibrate the error in installation by calculating U1' instead of U1.

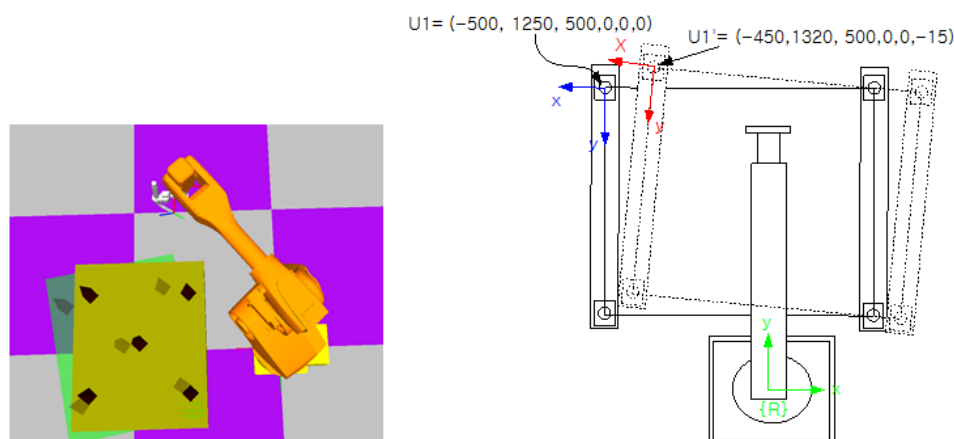


Figure 7.102 Example of coordinate calibration for OLP

Hi5a controller supports 10 user coordinates. Accordingly, it is possible to set each user coordinate for each workpiece to calibrate the error in installation.

For more details, refer to 『“Coordinate calibration for OLP” Function Manual』.

7.6.8. Gravitation direction automatic setting

As the Hi5a controller is based on the dynamics control, the gravitation direction setting is critical. Generally, the robot installation direction is perpendicular to the gravitational direction as shown below.

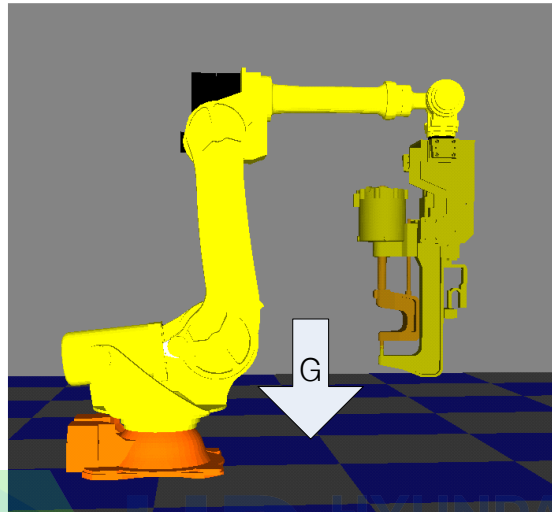


Figure 7.103 Gravitation direction of a robot on a ground surface

In a case in which the robot is installed in an inclined direction, not perpendicular to the ground surface, the gravitation direction should be set in the robot controller. In order for such setting, the gravitation direction automatic setting function is used.

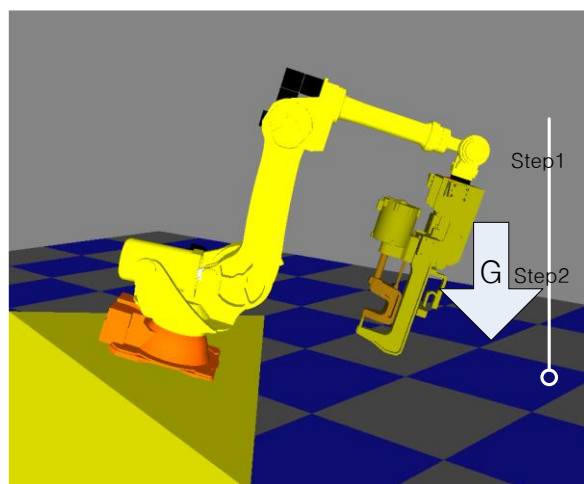


Figure 7.104 Gravitation direction of a robot on an inclined surface

In order to set the gravitation direction, a weight needs to be hanged externally to indicate the

7. System setting

gravitational direction, and teaching about the two points (Step 1, Step 2) in the gravitational direction needs to be performed.

When the relevant program is selected and the execution key F1 is pressed, the direction vector will be calculated. When the completion key [F7] is pressed then, this direction will be set as the gravitation direction.

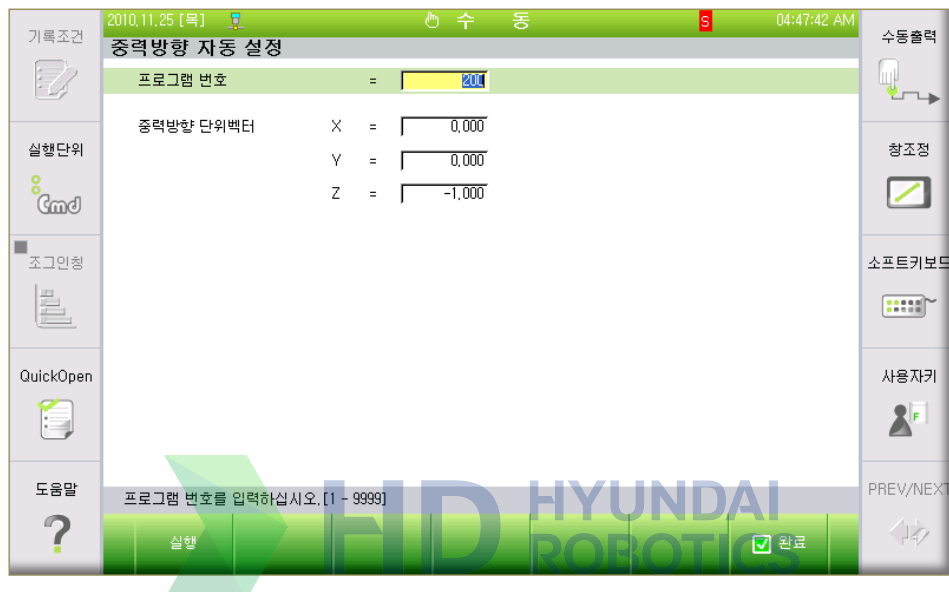


Figure 7.105 Gravitation direction selection results

7.6.9. Robot and tool calibration

This function is to be used in an environment in which the position of a robot can be measured using by a 3-dimensional measuring device.

- (1) Set the position, targeted for the measurement, at the end of the tool. While moving the robot in various positions and postures, measurement should be taken at more than 15 points. The positions measured while doing this need to be recorded using the program.

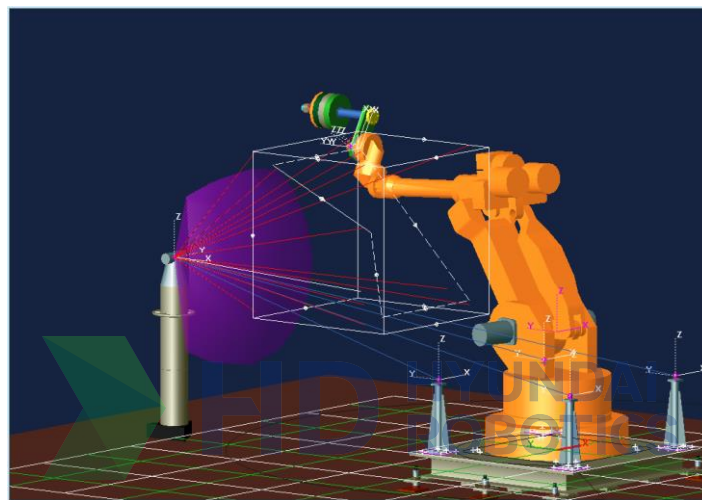
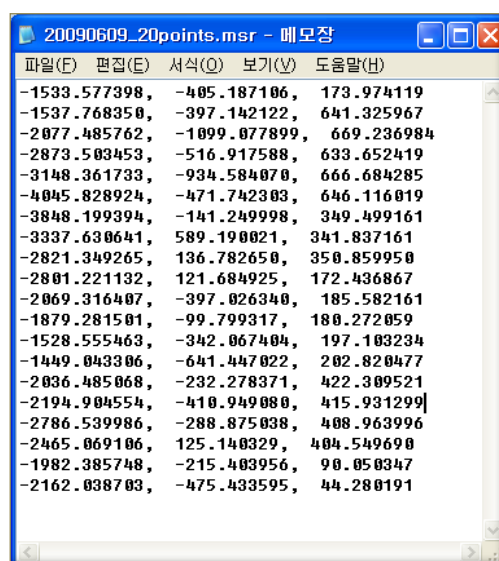


Figure 7.106 Robot data measurement method

- (2) The data of the measured points need to be arranged in the X, Y and Z formats and saved in ASCII file format. However, the extension should be *.msr for saving the file. This file needs to be copied and inserted into the teaching pendant using a USB memory



7. System setting

Figure 7.107 Measured robot position data

- (3) Access the robot and tool calibration menu and use the explorer key [F3] to select the relevant msr file.
- (4) Select the robot program that was used for the measurement.

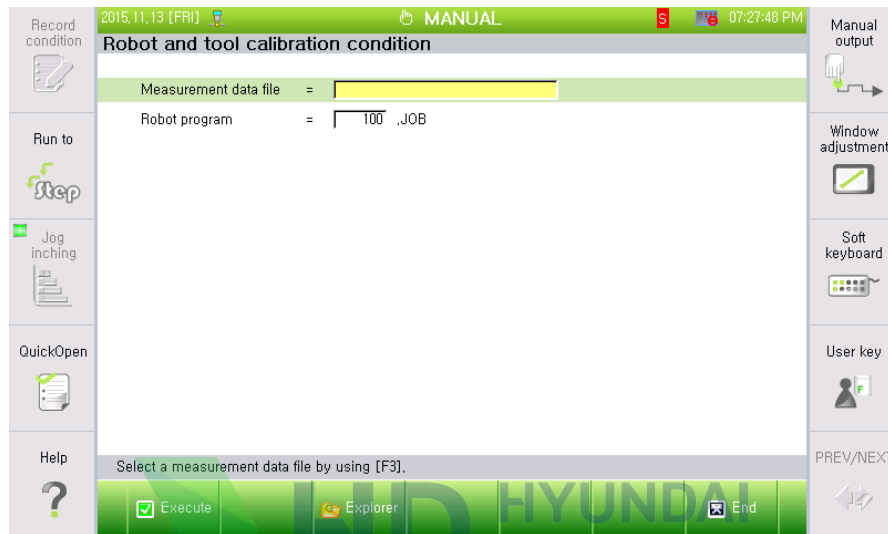


Figure 7.108 Robot calibration data entry

- (5) Press the execution key [F7], then, the calibration screen will show up. Then, if you press the execution key [F1], the calibration results will be displayed.

Controller Operation Manual

- (6) Press the completion key [F7], then the following message will show up. Then, if you select 'Yes', the calibrated values will be applied to the axis origin and tool constant automatically

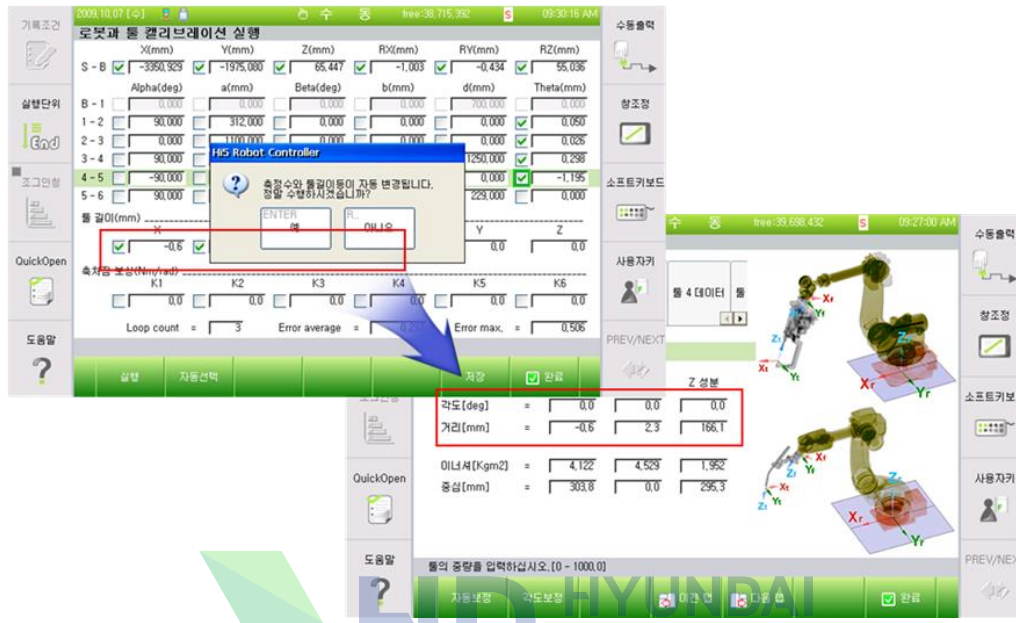


Figure 7.109 Robot calibration execution screen



Reference

- The basically selected calibration parameters are the axis constants of the H, V, R2 and B axes, as well as the X, Y, and Z values of the tool length. In order to calibrate the tool only, the marked check box for each axis should be unchecked before the execution.

7.6.10. Additional axis auto tuning

This function is for auto-tuning the servo parameter of the axis that is set as a positioner among the additional axes. Thus, this function cannot be used for the robot axis and other additional axes.

On the initial screen, select 『F2』: System』 → 『6』: Auto calibration』 → 『10』: Auto tuning of additional axis』 .

- 1) Enter the additional axis number.
- 2) Start the function by pressing the [F7] or “Execute” button.
- 3) The progress status of each stage of 『1』: Frequency analysis』 , 『2』: System identification』 , 『3』: Gain tuning』 will be displayed on the progress status bar in real time.
- 4) The execution time of each state is as shown below, and it takes approximately 1 hour to complete.
 - Frequency analysis: About 10 seconds
 - System defining: About 3 minutes
 - Gain tuning: Approximately 1 hour
- 5) After all the stages are finished, the tuned servo parameter will be saved automatically.

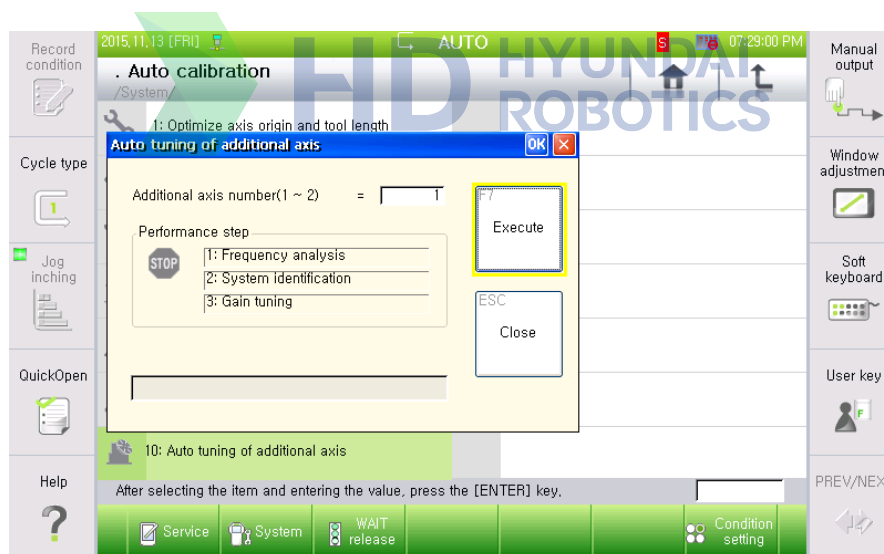


Figure 7.110 Additional axis auto tuning execution screen

Warning

- While the additional axis auto tuning function is being executed, some noise and vibration could occur. In addition, while the function is being executed, the robot will stop and start repeatedly, causing an extended length of time for the robot to be stopped. Users need to pay extra attention to safety.





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8

R Code



8. R Code

Hi5a-S/N/P/C/T/J

Controller Operation Manual

8.1. R Code

R-code is function equivalent to the [R..(NO)] of teaching pendant. (R means 『Reset』 and 『Rapid』) This function enables to rapidly manipulate operation procedure such as contents modify of program or change of controller setting status by abbreviating them to one service code.

- (1) When you press the [R..(NO)] key, the edit box shown as the following is displayed on the main screen.

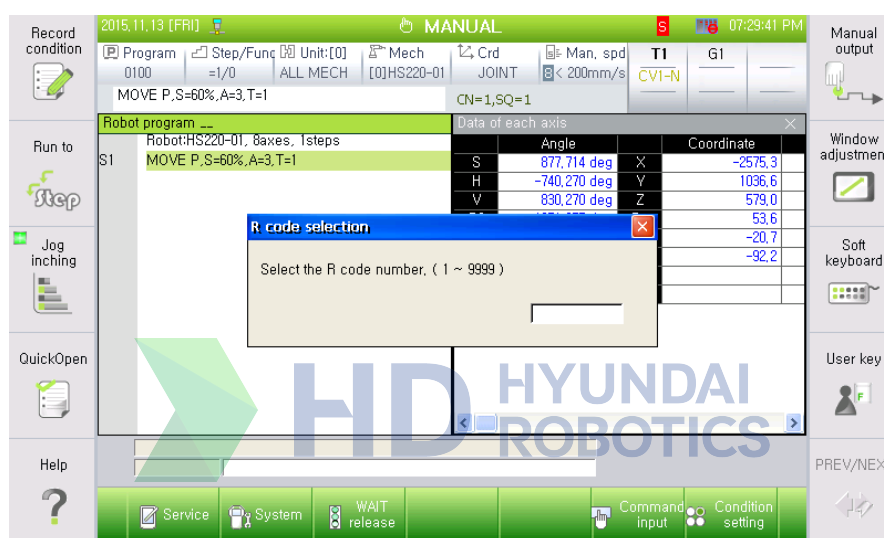


Figure 8.1 R Code input dialog box

- (2) Relevant function is executed if inputting desired code number and then pressing the [ENTER (YES)] key.

- (3) The following screen is displayed when pressing the [Help] key in the above screen. In this screen, the function can be executed by using a cursor key or inputting numbers

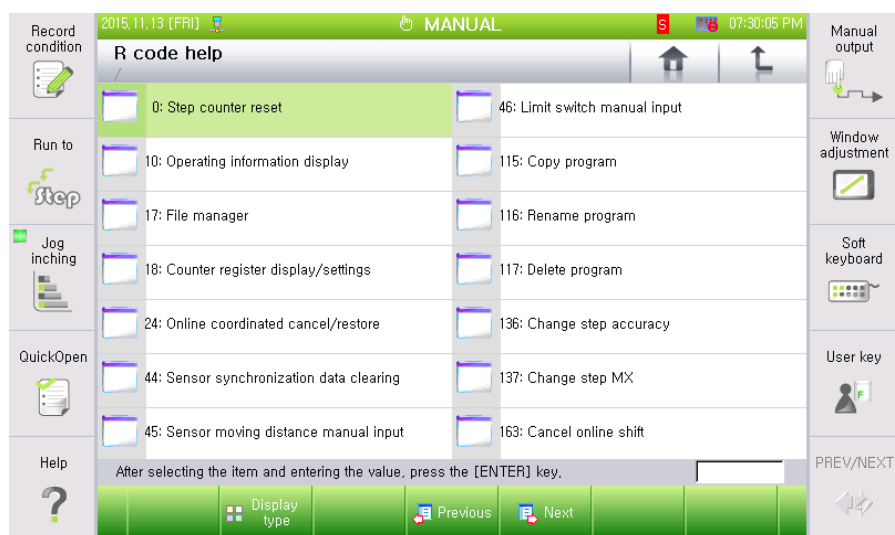


Figure 8.2 R code help screen (1)

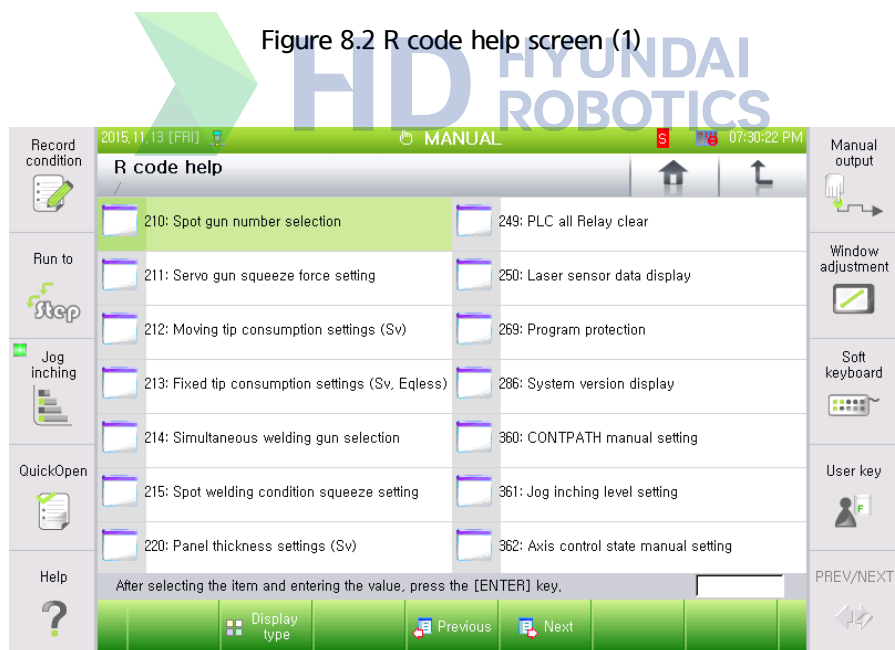


Figure 8.3 R code help screen (2)

8.2. R0 Step counter reset

Initialize step counter. Namely, move to the STEP0.

Besides,

- Clear playback execution status
- Turn Off general failure signal lamp
- Turn off alarm signal
- WAIT condition clear
- Clear various applied function conditions and signal.

Press the [R..(NO)] key → [0] → [ENTER(YES)] key.



Reference

- This function cannot be used when Robot operates.
- Robot operates in the same manner even by pressing the [R..] [ENTER(YES)] key.

8.3. R10 operating information display

Displays the 'operation information' monitoring window.

When the spot welding is set, the 'spot welding operating information' monitoring window will be executed together.

8.4. R17 File manager

This function displays the system file and job file in the internal memory for example, and also edit and manages the file including copying file, deleting file or changing the file property, renaming the file etc.

Following screen is displayed if pressing the [R..(NO)] key → [17] → [ENTER (YES)] key.

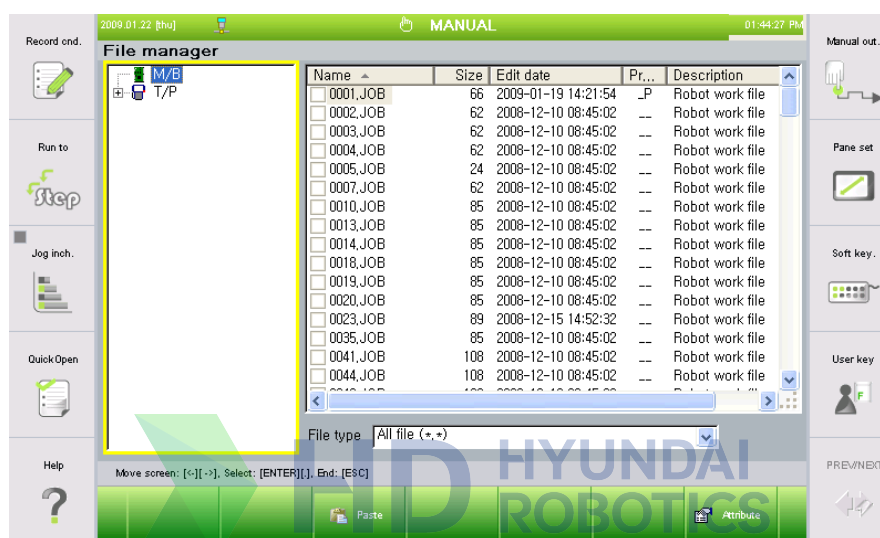


Figure 8.4 R17 File manager execution screen



Reference

- The WSP_ displayed in the end displays protection of file.
W: Complete protection (prohibition of various delete/change)
S: Partial protection (only position modification allowed in complete protection)
P: Playback protection (prohibition of replay/step forward from step No. 0)
_: No protection
- You can scroll the screen by using the [Arrow] key.
- This is same function as 『F1]: Service』 → 『F5: File manager』.

8.5. R18 Counter register display/settings

This function allows the content of the counter register to be checked and edited.

Following screen is displayed if pressing the [R..(NO)] key → [18] → [ENTER (YES)] key.



Figure 8.5 R18 Counter register display/setting screen



Reference

- This cannot be used while the robot is in operation.
- The value displayed on the screen is the counter currently set for the number of times.
- This is same function as 『[F1]: Service』 → 『2: Register』 → 『5: Counter register』.

8.6. R24 Online coordinated cancel/restore

This function provides the option to move to the original position or move by reflecting the coordinate conversion amount when executing the online coordinate conversion according to the “TONL” command statement.

This function can be used by the user to manually set whether to move back to the originally recorded position into which the coordinate conversion amount is reflected or to move the robot by reflecting the coordinate amount again.

- (1) Enter the [R..(NO)]key → [24] → [ENTER(YES)] key as shown below.

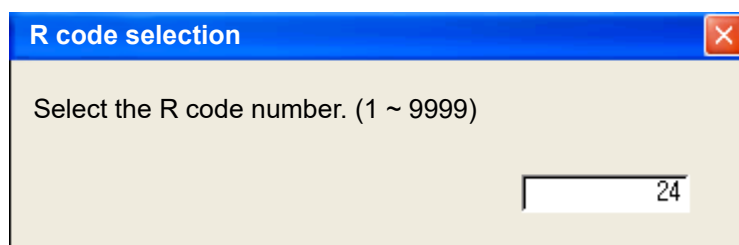
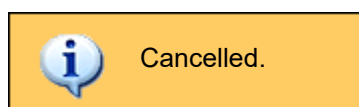


Figure 8.6 R24 Online coordinated cancel/restore input screen

- (2) If the following message is displayed, the robot will move to the originally recorded position into which the coordinate conversion amount is not reflected.



- (3) If the following message is displayed, the robot will move to the position into which the coordinate conversion amount is reflected.



8.7. R44 Sensor synchronization data clearing

Clear the sensor synchronization data.

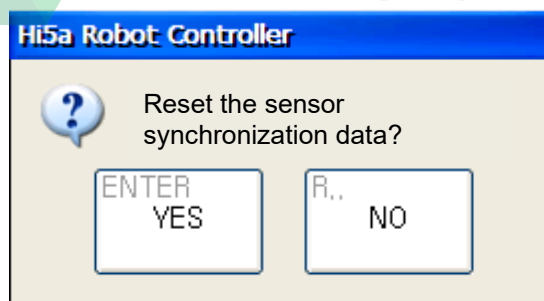
Then, the items to be cleared are as follows depending on the sensor activation mode.

The sensor activation mode can be set from 『[F2]: System』 → 『4: Application parameter』 → 『4: Sensor synchronization』 → 『2: Environment setting』 → 『Sensor operation= (Normal, Simulation, Test)』.

Table 8-1 R44 sensor synchronization data clear specification

	Normal	Simulation	Test
Pulse data	Clear	Maintains current pulse	Clear
Sensor location	Clear	Clear	Clear
Moving speed	Clear	Clear	Always "0"

- (1) Following screen is displayed if pressing the [R..(NO)] key → [44] → [ENTER (YES)] key.



- (2) Press the [ENTER(YES)] key to clear the sensor data



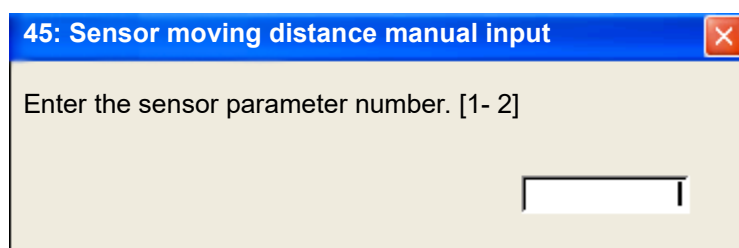
Reference

- This function cannot be used when Robot operates.
- Input status of limit switch is also cleared. Therefore, new limit switch input must be done to start pulse counting.
- This cannot be used if the sensor synchronization function is "Disable"

8.8. R45 Sensor moving distance manual input

Set the sensor distance manually.

- (1) Following screen is displayed if pressing the [R..(NO)] key → [45] → [ENTER(YES)] key.



- (2) Use the [Number] key to enter the sensor distance and press the [ENTER(YES)] key.



Reference

- This function cannot be executed in AUTO mode.
- The pulse data/sensor position value does not increase even though the conveyor goes unless the limit switch does not operate if the sensor distance is changed (Even if not being '0').
- The changed sensor distance can be checked through the sensor synchronization monitoring

Sensor synchronization		
	Sensor #1	Sensor #2
Pulse data	0	0
Sensor position	0,000	0,000
Moving speed	0,000	0,000
Number of incoming	0	0
Limit switch input	Off	Off
Low Pulse	0000	0000

- This is same function as that for changing the conveyor/press position on the screen of 『[F1]: Service』 → 『2: Register』 → 『6: Sensor simulation data』.
- This cannot be used if the sensor synchronization function is “Disable”.

8.9. R46 Limit switch manual input

Starts pulse counting by compulsorily inputting limit switch operation signal from teaching pendant irrespective of operation of actual limit switch.

- (1) When you press the [R..(NO)] key → [46] → [ENTER(YES)] key, the limit switch forced input selection window will be displayed.
- (2) If pressing the [ENTER (YES)] key, the limit switch is compulsorily input so as to start pulse counting or enter into multiple of works. This function is cancelled if pressing the [R..(NO)] key.



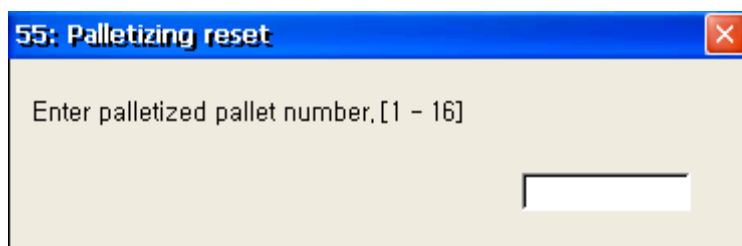
Reference

- This function cannot be executed in AUTO mode. Always use it in Manual mode.
- This is a function that will operate only when set to Simulation Test or Test in 『[F2]: System』
→ 『4: Application parameter』 → 『4: Sensor synchronization』 → 『2: Environment setting』
→ 『Sensor operation = (Normal, Simulation, Test)』

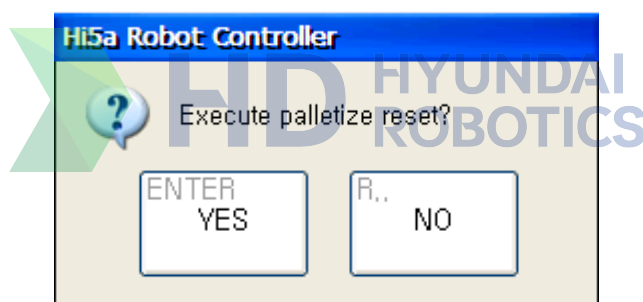
8.10. R55 Palletizing reset

This function is used when using palletize function and initializes contents of palletize pattern register.

- (1) Following screen is displayed if pressing the [R..(NO)] key → [55] → [ENTER (YES)] key.



- (2) Following screen is displayed if pressing the [ENTER (YES)] key after inputting desire pallet number (palletize pattern register number).



- (3) Setting value of the selected palletize pattern register is initialize if pressing the [ENTER (YES)] key. This function is cancelled if pressing the [R..(NO)] key.



Reference

- This function cannot be used when Robot operates.

8.11. R115 Copy program

Copies program of inner memory to different program number of inner memory. First program number to copy and then input program number to be copied.

- (1) When you press the [R..(NO)] key → [115] → [ENTER (YES)] key, screen to enter the number of the original program will be displayed.
- (2) Enter the number of the program to copy using the [Number] key and select [ENTER (YES)] key, and the screen to enter the target program number to copy will be displayed.
- (3) Program copy is done if selecting the [ENTER (YES)] key after inputting program number to be copied with the [Number] key.



Reference

- This function cannot be executed in AUTO mode. Always use it in Manual mode.
- This is the screen to select whether to overwrite or not when the program to copy already exists.
- Overwrite is executed if selecting the [ENTER (YES)] key. This function is cancelled if pressing the [R..(NO)] key
- When the original file to copy does not exist, a message saying that the “Original file does not exist” will be displayed.

8.12. R116 Rename program

Changes program number of inner memory to different program number of inner memory. Firstly input program number to change and then input program number to be changed.

- (1) When you select [R..(NO)] key → [116] → [ENTER(YES)] key, the screen to enter the program number to change will be displayed.
- (2) Enter the program number to change with [Number] key and press the [ENTER (YES)] key, and the screen to enter the program number to change will be displayed.
- (3) Pressing the [ENTER (YES)] key after inputting program number to change with the [Number] key.



Reference

- This function cannot be executed in AUTO mode. Always use it in Manual mode.
- When the program to copy already exists, a message saying the “File to change exists.” will be displayed.
- When the program to change does not exist, a message saying that the “Original file does not exist.” will be displayed.

8.13. R117 Delete program

This is function to individually delete program of inner memory.

- (1) When you select [R..(NO)] key → [117] → [ENTER (YES)] key, the screen to enter the program number to delete will be displayed.
- (2) Enter the program number to delete with [Number] key and press the [ENTER (YES)] key, and the screen to confirm the delete process will be displayed.
- (3) When you press the [ENTER (YES)] key, the program will be deleted.



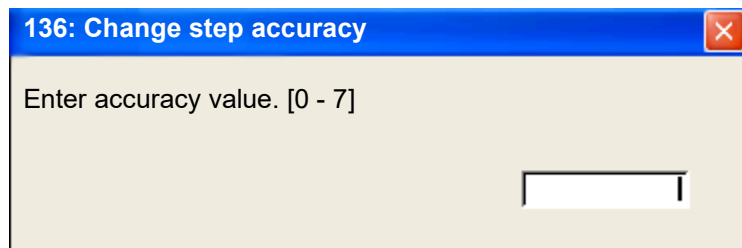
Reference

- This function cannot be executed in AUTO mode. Always use it in Manual mode.
- If you try to delete a program that does not exist, a message saying “File does not exist” will be displayed.
- If you try to delete a protected program, a message saying “File is protected” will be displayed.

8.14. R136 Change step accuracy

This function is to change the accuracy value of the currently selected step.

- (1) Press the [R..(NO)] → [136] → [ENTER (YES)] keys. Then, the following screen will be displayed.



- (2) Enter the value, then, the accuracy value of the step where the cursor is currently placed will be changed.



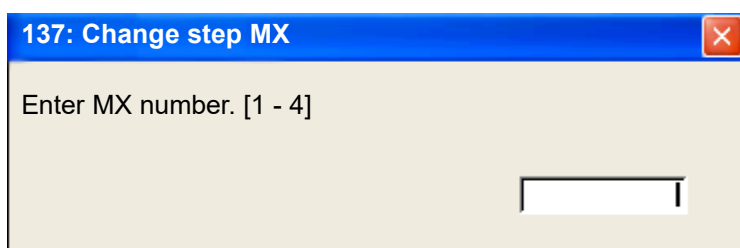
Reference

- This cannot be used while the robot is operating.
- If the line where the cursor is currently placed is not the Move command, the accuracy of the Move command that is placed the nearest the top will be changed.

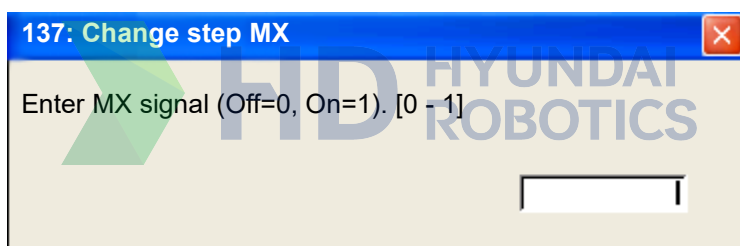
8.15. R137 Change step MX

This function is to change the MX setting value of the currently selected step.

- (1) Press the [R..(NO)] → [137] → [ENTER (YES)] keys. Then, the following screen will be displayed.



- (2) Enter the desired MX value and press the [ENTER (YES)] key. Then, the following screen will be displayed.



- (3) Enter the value that is for setting the MX signal, and press the [ENTER (YES)] key. Then, the result of the change will be reflected into the selected step.



Reference

- This cannot be used while the robot is operating.
- If the line where the cursor is currently placed is not the Move command, the MX signal change will be reflected into the Move command that is placed the nearest the top

8.16. R163 Cancel online shift

The online shift function is for the robot to receive the input of the shift data quantity from vision units, for example, and to carry out the shifting. The R163 function initializes the shift quantity saved in the shift buffer to 0 in order to stop the shift function.

- (1) When you press [R..(NO)] key → [163] → [ENTER(YES)] key, the screen to cancel online shift will be displayed.
- (2) To cancel the online shift and reset the content within the shift butter to 0, enter [1] and press the [ENTER (YES)] key.



Reference

- This function cannot be used when Robot operates.

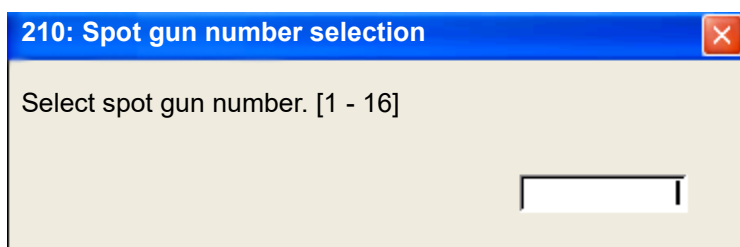


8.17. R210 Spot gun number selection

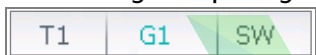
This function is to select the servo guns to be used, when planning to use multiple spot welding guns (Servo gun or air pressure gun).

For details, refer to 『Hi5a Controller Spot Welding Function Manual』

- (1) Following screen is displayed if pressing the [R..(NO)] key → [210] → [ENTER(YES)] key.



- (2) Press the [ENTER (YES)] key after inputting gun number to select with the [Number] key.
The changed spot gun numbers are displays on the status display screen as



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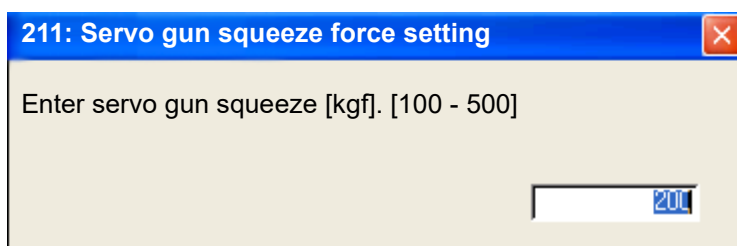
Reference

- This function cannot be used when Robot operates.
- This can only be set in the spot welding environment. The spot welding item in 『[F2]: System』 → 『5: Initialize』 → 『3: Usage setting』 must be set to “Enable”.
- When you select the gun number, the tool number designated to the tool number corresponding to the spot gun automatically changes with the schedule. For the spot gun corresponding tool number, refer to 『[F2]: System』 → 『4: Application parameter』 → 『1: Spot welding』 → 『1: Set tool number and gun-type』.

8.18. R211 Servo gun squeeze force setting

This function is to manually set the pressurizing force when performing the servo gun pressurization. For details, refer to 『Hi5a Controller Spot Welding Function Manual』

- (1) Following screen is displayed if pressing the [R..(NO)] key → [211] → [ENTER(YES)] key.



- (2) Press the [ENTER (YES)] key after inputting applied pressure to set with the [Number] key.

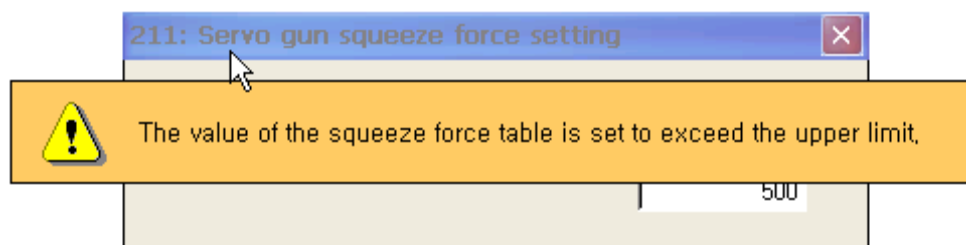


Reference



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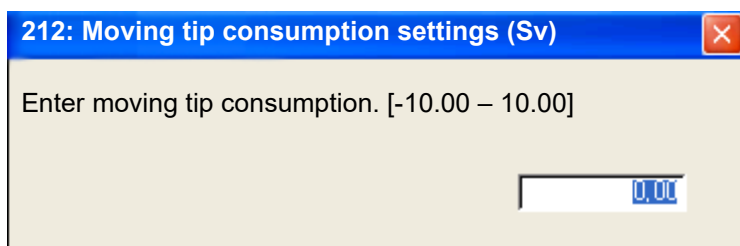
- This function cannot be used when Robot operates.
- This can only be set in the spot welding environment. The spot welding item in 『[F2]: System』 → 『5: Initialize』 → 『3: Usage setting』 must be set to “Enable”.
- Applied pressure of welding condition file is not changed.
- When the set pressurization force is higher or lower than the upper limit value of the current pressurization force table of the servo gun parameter, the following message will be displayed.



8.19. R212 SVG moving tip consumption preset

User can manually set wearing quantity of move tip of Servo gun.
For details, refer to 『Hi5a Controller Spot Welding Function Manual』

- (1) Following screen is displayed if pressing the [R..(NO)] key → [212] → [ENTER(YES)] key.



- (2) Press the [ENTER (YES)] key after inputting wearing quantity of move tip with the [Number] key.



Reference



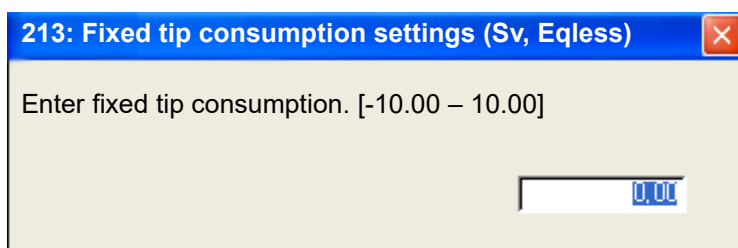
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- This function cannot be used when Robot operates.
- This can only be set in the spot welding environment. The spot welding item in 『[F2]: System』 → 『5: Initialize』 → 『3: Usage setting』 must be set to "Enable".
- When the actual abrasion of the tip is higher or lower than the set value, be careful since it can cause pressurization force misalignment or workpiece interference etc.

8.20. R213 Servo-gun fixed tip consumption preset

This is function to allow that user can manually set wearing quantity of fixed tip of Servo gun.
For details, refer to Hi5a servo gun function manual.

- (1) Following screen is displayed if pressing the [R..(NO)] key → [213] → [ENTER(YES)] key.



- (2) Press the [ENTER (YES)] key after inputting wearing quantity of fixed tip with the [Number] key.



Reference

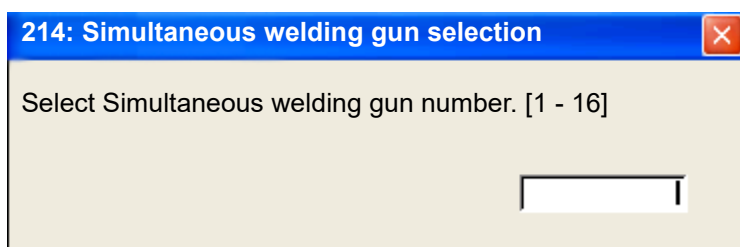
- This function cannot be used when Robot operates.
- This can only be set in the spot welding environment. The spot welding item in 『[F2]: System』 → 『5: Initialize』 → 『3: Usage setting』 must be set to “Enable”.
- When the actual abrasion of the tip is set higher or lower than the setting, you must be careful not to cause pressurization force misalignment or workpiece interference etc.

8.21. R214 Simultaneous welding gun selection

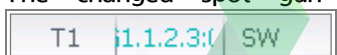
This function is to select the numbers of the spot welding guns that are to be used simultaneously when multiple spot welding guns (Servo guns or air pressure guns) are to be used to execute the welding works simultaneously,

For the selected spot welding gun, manual operation is possible. For details, refer to 『Hi5a Controller Spot Welding Function Manual』

- (1) Following screen is displayed if pressing the [R..(NO)] key → [214] → [ENTER(YES)] key.



- (2) Use the [Number] key to enter the gun number to select and press the [ENTER (YES)] key. The changed spot gun numbers are displays on the status display screen as



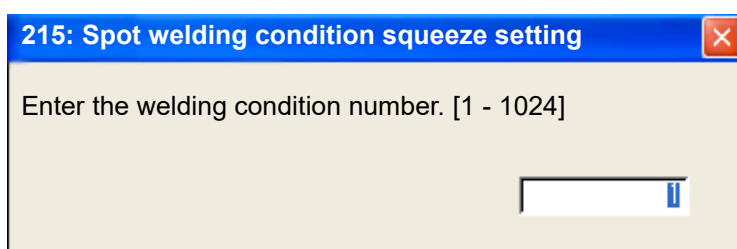
Reference

- This cannot be used when the robot is in operation.
- This can only be set in the spot welding environment. The spot welding item in 『[F2]: System』 → 『5: Initialize』 → 『3: Usage setting』 must be set to “Enable”.
- When the type of the spot welding gun to select is different, a message saying “The type of the currently selected GUN type is set incorrectly” will be displayed.
- For the type where the spot welding gun is designated, refer to 『[F2]: System』 → 『4: Application parameter』 → 『1: Spot welding』 → 『1: Set tool number and gun-type』.
- When you select the multi sink gun, manual pressurization and open/close operation is executed with the previously selected gun.
- When the multi sink gun is selected and the GUN LED is turned ON, SPOT command is recorded in multi sink spot type. Ex) SPOT GN=1,CN=1,SQ=1,MG=2

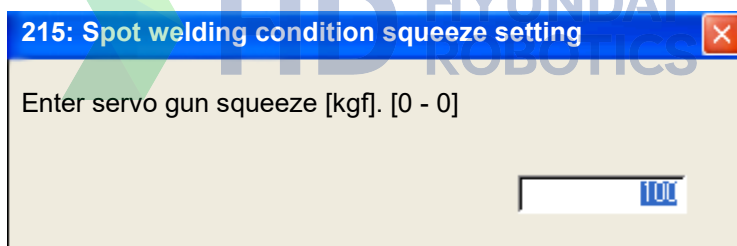
8.22. R215 Spot welding condition squeeze setting

This function sets the welding condition table of the necessary pressurization force during servo gun welding. This is the same as setting pressurization force (Kgf) in 『[F2]: System』 → 『4: Application parameter』 → 『1: Spot welding』 → 『4: Spot gun welding data (Cnd, Seq)』 → 『2: Welding condition』.

- (1) Following screen is displayed if pressing the [R..(NO)] key → [215] → [ENTER (YES)] key.



- (2) Use the [Number] key to enter the welding condition number and press the [ENTER (YES)] key.



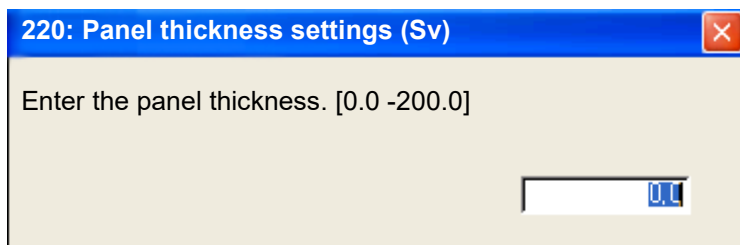
- (3) Use the [Number] key to enter the servo gun pressurization force and press the [ENTER (YES)] key.

8.23. R220 Panel thickness settings (Sv)

This function allows the panel thickness for the recording of the servo gun spot welding steps to be set manually.

While only the servo gun fixed tip touches the panel, if the user carries out one-touch recording in which the Move statement and Spot command statement are recorded at the same time, the moving tip position to be recorded in the Move statement will be recorded automatically by reflecting the panel thickness and the tip consumption amount.

- (1) Following screen is displayed if the [R..(NO)]key → [220] → [ENTER(YES)] key is pressed.



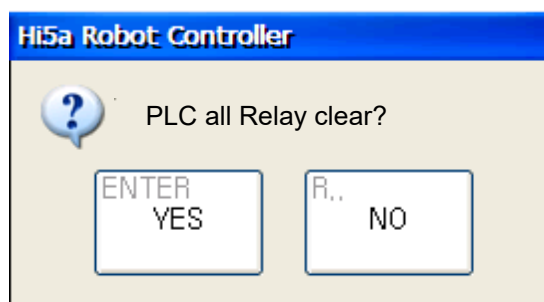
- (2) Enter the thickness by pressing the [NUMBER] key and then pressing the [ENTER(YES)] key.

For more details, refer to 『Hi5a Controller “Spot Welding” Function Manual』.

8.24. R249 PLC all relay clear

This clears all relays related to PLC when the PLC is stopped.

- (1) When you press the [R..(NO)] key → [249] → [ENTER (YES)] key, PLC all relay clear screen will be displayed.



- (2) When you press the [ENTER (YES)] key, the function will be executed.



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- This function only works when the embedded PLC is used and when the embedded PLC is stopped or remotely stopped.

8.25. R250 Laser sensor data display

This function is to display the message box to check the sensor data when the laser vision sensor is used. Refer to 『Hi5a Controller LVS Tracking Function Manual』 for more details.

- (1) Press the [R..(NO)] → [250] → [ENTER (YES)] keys. Then, the following message box will be executed to display the laser sensor data as shown below.

	Yo	Zo	Area	Gap	Mismat	Roll1	Roll2	
Average	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Deviation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Min.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Max.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	

- (2) Press the [Start] button. Then, the sensor will be activated



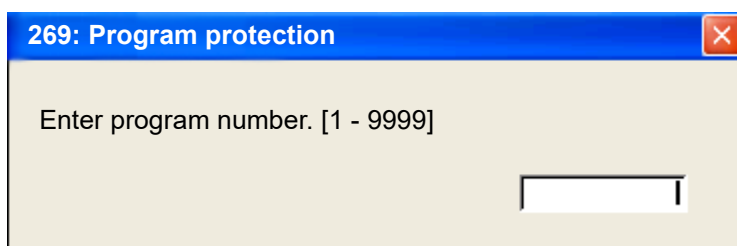
Reference

- This function can be operated normally when the laser vision sensor is installed.
- The LVS tracking function can be operated only in a controller in which the license is entered.

8.26. R269 Program protection

Sets protection function for program within inner memory.

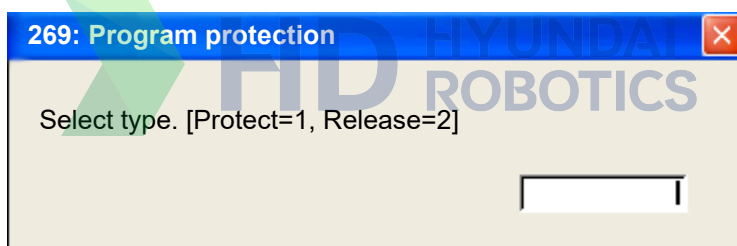
- (1) When you press the [R..(NO)] key → [269] → [ENTER (YES)] key, the screen to enter the program number to set will be displayed.



269: Program protection

Enter program number. [1 - 9999]

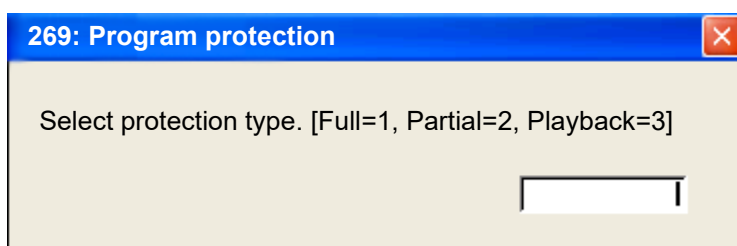
- (2) When you enter the program number with the [Number] key and press the [ENTER (YES)] key, the screen to select the function to protect or cancel will be displayed.



269: Program protection

Select type. [Protect=1, Release=2]

- (3) When you press the [1] key to protect and then the [ENTER (YES)] key, the screen to select the type of protection will be displayed.



269: Program protection

Select protection type. [Full=1, Partial=2, Playback=3]

- (4) Input type of protection with the [Number] key and then press the [ENTER (YES)] key



Reference

- This cannot be used when the robot is in operation.
- Protection status is displayed as follow in the rear of fine name when performing display of inner memory or file name depending on type of protection selected.

Table 8-2 R269 Display of each program protection specification

__ : No protection	W_ : Complete protection
WP : [Complete + Playback] protection	S_ : Partial protection
SP : [Partial + Playback] protection	_P : Playback protection

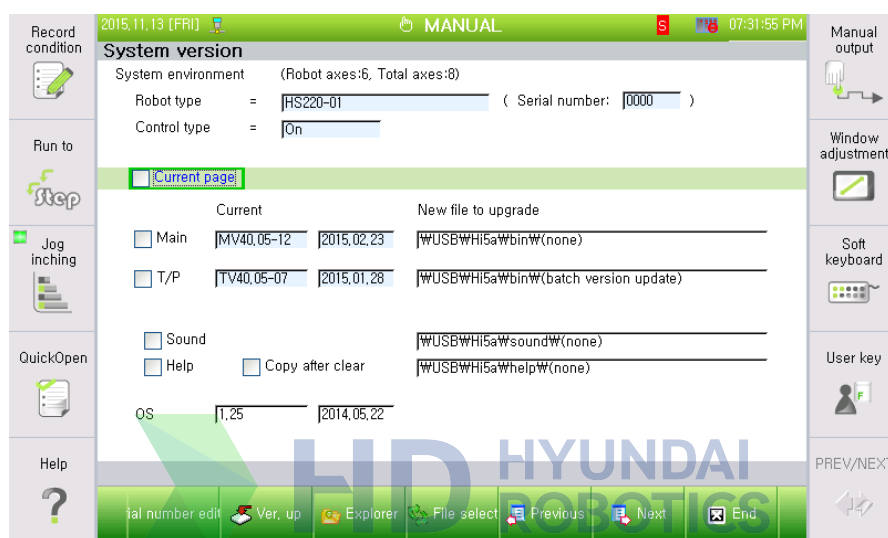
- If you do not enter the engineer code when canceling the program protection, a message saying “Consult the engineer” will be displayed.



8.27. R286 Software version display

This displays the system environment of the controller (Robot type, software version by system board, operating use environment) or upgrades the system version.

Following screen is displayed if pressing the [R..(NO)] key → [286] → [ENTER(YES)] key.



Reference

- This is same function as 『[F1]: Service』 → 『7: System diagnosis』 → 『1: System version』.

8.28. R350 Endless axis manual reset

For the axis of which the endless function is set to “Enable” in 『F2]: System』 → 『5: Initialize』 → 『6: Mechanism setting』, this function resets the rotation of the rotating axis manually.

- (1) Assume that data for each axis of current Robot is as in below screen after setting endless function to “Enable” for the R1 axle of Robot.

각축 데이터			
	각도		좌표치
S	4.840deg	X	1835.4
H	85.373deg	Y	134.7
V	0.000deg	Z	1778.6
R2	-8.918deg	Rx	133.2
B	-35.590deg	Ry	21.1
R1	-286.312deg	Rz	106.8
T1	0.000mm		

- (2) When you press the [R..(NO)] key → [350] → [ENTER (YES)] key, the screen to enter the axis number to reset will be displayed.

350: Endless axis manual reset

Enter the axis number to initialize. [0:ALL, 6 - 16]

- (3) Performs initialization function within scope of -180 ~ 180 degree for all axis if pressing the [ENTER (YES)] key after inputting 0 (zero). Performs initialization function within scope of -180 ~ 180 degree for relevant axis if pressing the [ENTER (YES)] key after inputting axis number. Following screen is displayed when selecting axle number to initialize to 6.

각축 데이터			
	각도		좌표치
S	4.840deg	X	1835.4
H	85.373deg	Y	134.7
V	0.000deg	Z	1778.6
R2	-8.918deg	Rx	133.2
B	-35.590deg	Ry	21.1
R1	73.687deg	Rz	106.8
T1	0.000mm		





Reference

- This function cannot be used when Robot operates.
- This can be set only when the motor is turned on. When you try to set this when the motor is turned off, a message saying “This can only be executed while motor ON.” will be displayed.

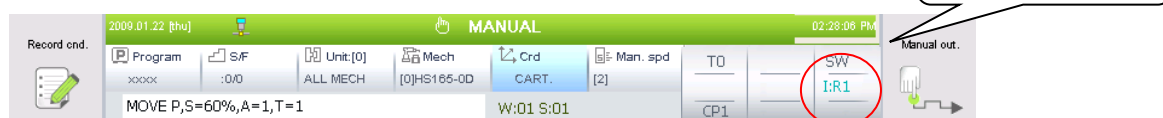


8.29. R351 Change cooper. State of manual mode

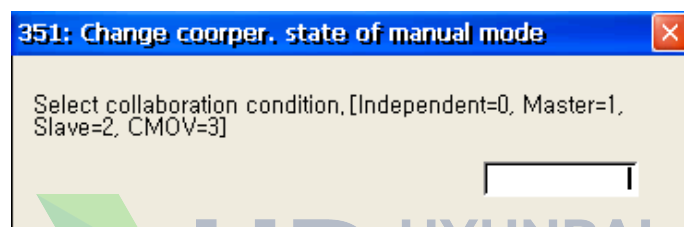
This is to set the jog role necessary for the robot cooperative control mode.

For more details, refer to 『Hi5a Controller Cooperative Control Function Manual』.

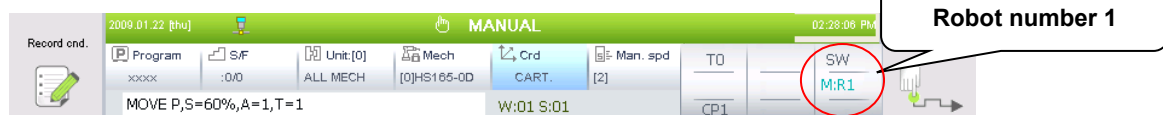
The current role of the robot is displayed at the top of the screen.



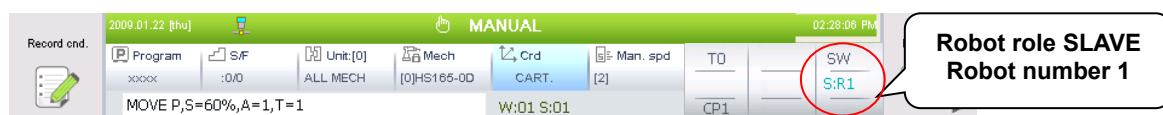
- (1) Following screen is displayed if pressing the [R..(NO)] key → [351] → [ENTER (YES)] key.



- (2) Input R351, 1 when desiring to change role of Robot to master. Role of Robot on the top of screen is changed to M.



- (3) Input R351, 2 when desiring to change role of Robot to slave. Role of Robot on the top of screen is changed to S.



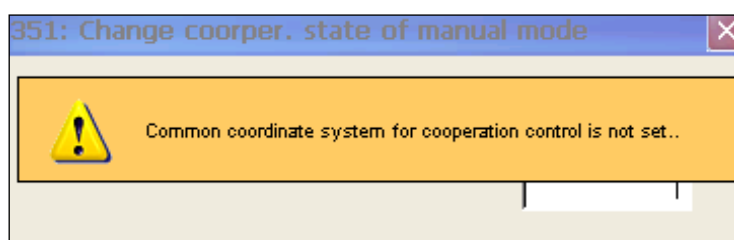
- (4) Input R351, 3 in Slave status when desiring to change role of Robot to CMOV record status. Robot role is displayed as S and the font color is white.





Reference

- This cannot be used when the robot is in operation.
- When the common coordinate system between the robots for cooperative control is not set, the following message will be displayed.



- Refer to 『[F2]: System』 → 『6. Auto calibration』 → 『5: Common coordinate of cooperate robots』.



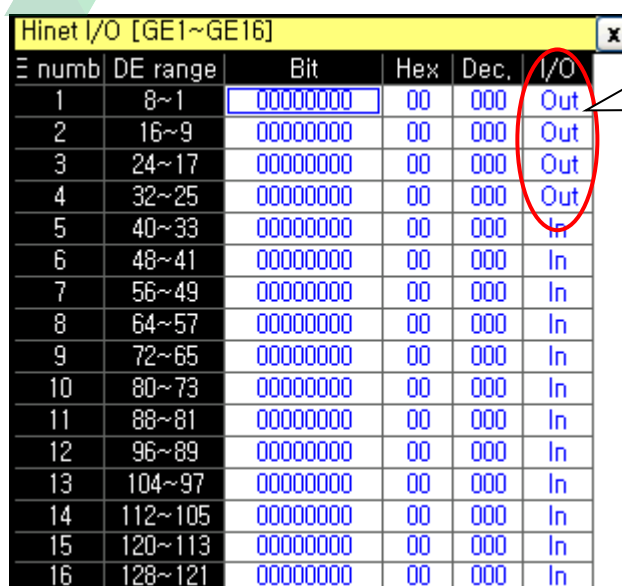
8.30. R352 HiNet I/O manual setting

This function is to manually output the HiNet I/O signal for cooperative control.

Table 8-3 “R352 HiNet I/O manual setting” specification

Operation	Output signal
R352, Group number(1~16), output value(0~255) Robot 1 : Group 1~4 Robot 2 : Group 5~8 Robot 3 : Group 9~12 Robot 4 : Group 13~16	Output signal equivalent to group number When the output of 255 in Group 2 is made in case of the robot 1 Ex) R352,2,255

- (1) When you press the [R..(NO)] key → [352] → [ENTER (YES)] key, the screen to enter the group number to set will be displayed.
- (2) When you enter the group number with the [Number] key and press the [ENTER (YES)] key, the screen to enter the data to print manually will be displayed.
- (3) After outputting R352, 2, 255, you can check the output status through the monitor. All other than the group number applicable is the input area.



numb	DE range	Bit	Hex	Dec.	I/O
1	8~1	00000000	00	000	Out
2	16~9	00000000	00	000	Out
3	24~17	00000000	00	000	Out
4	32~25	00000000	00	000	Out
5	40~33	00000000	00	000	In
6	48~41	00000000	00	000	In
7	56~49	00000000	00	000	In
8	64~57	00000000	00	000	In
9	72~65	00000000	00	000	In
10	80~73	00000000	00	000	In
11	88~81	00000000	00	000	In
12	96~89	00000000	00	000	In
13	104~97	00000000	00	000	In
14	112~105	00000000	00	000	In
15	120~113	00000000	00	000	In
16	128~121	00000000	00	000	In

This is the group number applicable to robot 1, and shows output status of 255 in GE2



Reference

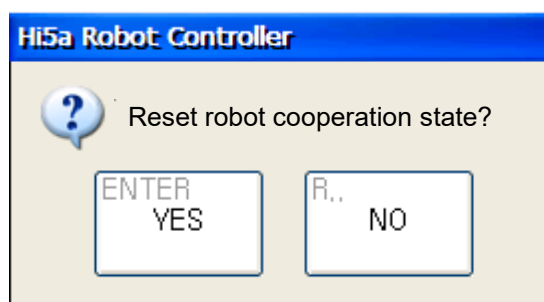
- This cannot be used when the robot is in operation.

8.31. R353 Robot cooperation status reset

This function is to be used to perform the playback of individual robots after they stopped in the middle of the cooperative operation.

This function is necessary when stopping the robot in the cooperative interval COWORK ~ COWORK END and then changing the step.

- (1) Following screen is displayed if pressing the [R..(NO)] key → [353] → [ENTER(YES)] key.



- (2) Press the [ENTER (YES)] key. Then, the cooperation condition of the robot will be reset.



Reference

- This cannot be used when the robot is in operation.
- When the cooperative condition is reset, the robot is individually controlled. Therefore you must operate after checking whether there is any interference between the workpiece and corresponding robot.

8.32. R354 Endless ZERO execution

For the axis with the endless function set to “Enable” in 『F2]: System』 → 『5: Initialize』 → 『6: Mechanism setting』, this function completely resets not only the rotation of the rotating axis but also the residual angle manually.

- (1) Set the endless function for the R1 axis of the robot to “Enable” and assume that the data of each axis of the current robot is as follows.

Data of each axis				
	Angle		Coordinate	
S	83,101 deg	X	199,0	
H	49,878 deg	Y	1023,7	
V	-13,312 deg	Z	301,4	
R2	-64,810 deg	Rx	178,8	
B	-55,556 deg	Ry	48,4	
R1	135,000 deg	Rz	175,7	
T1	0,000 mm			
T2	-0,002 deg			

- (2) When you press the [R..(NO)] key → [350] → [ENTER(YES)] key, the screen to enter the axis number to reset will be displayed.

354: Endless ZERO execution

Enter the axis number to initialize. [0:All, 6 - 16]

- (3) After entering 0, press the [ENTER (YES)] key to reset the range -180 ~ 180 degrees. After entering the axis number to reset from axis 6 to 12, press the [ENTER (YES)] key to reset the range of -180 ~ 180 degrees for the applicable axis. When you selected 6 as the axis number to reset, the following screen will be displayed.

Data of each axis				
	Angle		Coordinate	
S	83,101 deg	X	199,0	
H	49,878 deg	Y	1023,7	
V	-13,312 deg	Z	301,4	
R2	-64,810 deg	Rx	-140,9	
B	-55,556 deg	Ry	-31,3	
R1	0,000 deg	Rz	-60,1	
T1	0,000 mm			
T2	-0,002 deg			



Reference

- This cannot be used when the robot is in operation.
- This can be set only when the motor is turned on.



8.33. R358 Servo tool change

This function allows connection/disconnection of the servo tool to/from the servo tool change system. In order to change the servo tool in the servo tool change system, it is necessary to disconnect/connect the power and various signal lines by using the ATC (Auto tool change) system. If the servo tool is the servo gun and the tool change work needs to be performed manually, it is necessary to move the robot to the stand of the servo gun, which needs to be connected/disconnected while in the Motor On state (Enable switch is on), before carrying out the tool change. For other servo tools, such as positioners, it is necessary to perform the change work after completing the preparation for the connection and disconnection work. For details, refer to 『Hi5a Controller Spot Welding Function Manual』.

Table 8-4 R358 Example of Servo tool change parameter

Operation	Parameter	#1	#2
R358,#1,#2	Meaning	Disconnection/Connection/Fixed	Gun number
	Setting value	0: Disconnection, 1: Connection, 2: Fixed 0	1~16
	Example of use	R358,1,2 (Servo tool #2 connection) R358,0 (Servo tool disconnection)	

- (1) Press the [R..(NO)]key → [358] → [ENTER(YES)] key, and then the servo tool change operation dialog box will be displayed.

- (2) Enter one of 0 (Disconnection), 1 (Connection), and 2 (Fixed) and then press the [ENTER(YES)] key. Then, the spot gun number input dialog box will be displayed.

- (3) Enter the welding gun number to change and press the [ENTER(YES)] key. The change welding gun number is displayed on the status display screen.



Reference

- This function cannot be executed in AUTO mode.
- When you select the gun number, the spot gun corresponding to the tool number will automatically be changed to the designated tool number. For the spot gun corresponding tool number, refer to 『[F2]: System』 → 『4: Application parameter』 → 『1: Spot welding』 → 『1: Set tool number and gun-type』.
- This can be set only when the motor is turned on.

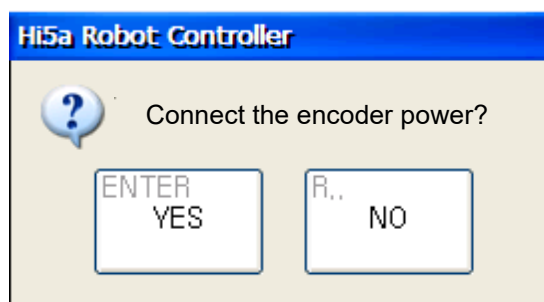


8.34. R359 Servo tool encoder power ON Relay

This function resets the encoder of the servo gun axis when initially installing the servo gun with the servo gun applied in the servo tool change system.

For detail content, refer to 『Hi5a Controller Spot Welding Function Manual』

- (1) Following screen is displayed if pressing the [R..(NO)] key → [359] → [ENTER (YES)] key.



- (2) Press the [ENTER (Yes)] key to connect the power to the encoder.



Reference

- This cannot be executed in AUTO mode.
- Turn off the controller power and turn it back on to release the compulsory input of the servo gun encoder power. Therefore, after the encoder resetting is completed, you need to turn the controller power off and turn it back on in order to progress the manual assembly of the servo gun.
- Because this function is for the engineer, general operator cannot use this function.



Warning

- Never mechanically assemble or separate Servo gun in compulsory input status of encoder power.

8.35. R360 CONPATH manual setting

This is function to compulsorily change execution of CONTPATH. Scope of input is 0, 1, 2 and explanation by each number is as follow. (Same as CONTPATH number)

0:

For step where command (function) is included in step, execute command (function) in status Robot stops and move to the next step.

1:

After executing commands recorded in target step during step movement, Robot moves to the next step via the target step without Robot stopping.

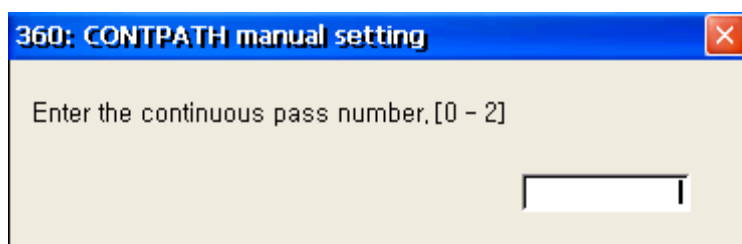
However, for output command, time actually output outside is when command value arrives within scope of accuracy.

Non-consecutive is done for case using input signal in parameter of command. If command value arrives within scope of accuracy, execute command in status Robot stops and moves to the next step.

2:

Even for command that input signal is included, Robot consecutively moves through previous interpretation.

(1) Following screen is displayed if pressing the [R..(NO)] key → [360] → [ENTER (YES)] key



(2) Enter the number you want (0~2) using the [Number] key and the [ENTER (YES)] key. You can check the input condition from the status screen.



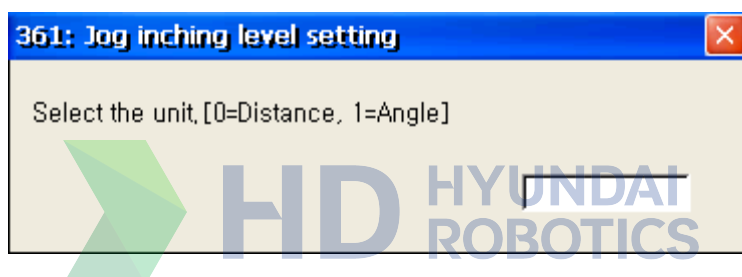
8.36. R361 Jog inching level setting

Use this to change the inching distance of the currently set level.

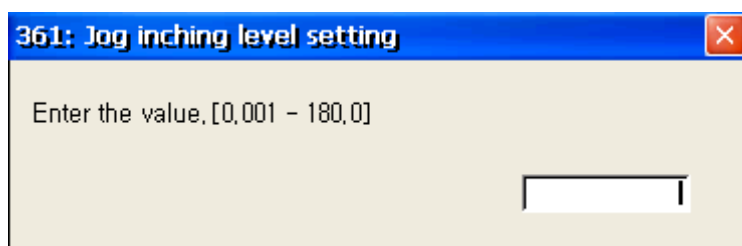
Table 8-5 R361 Jog inching level setting

Operation	#1 (Unit)	#2 (Input value range)
R361,#1, #2	0 : Distance	0.001 ~ 1000.00 mm
	1 : Angle	0.001 ~ 180.0 deg

- (1) Following screen is displayed if pressing the [R..(NO)] key → [361] → [ENTER (YES)] key.



- (2) To set the distance of the currently set jog inching level, enter 0. To set the angle, enter 1 and press the [ENTER (Yes)] key. When 1 (Angle) is entered, the following screen will be displayed.



- (3) Enter the inching angle and press the [ENTER (Yes)] key.



Reference

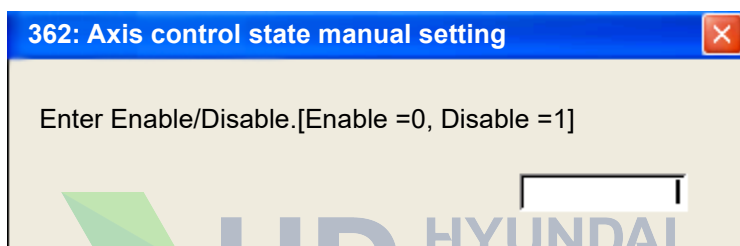
- This function cannot be executed in AUTO mode.
- Inching distance set by R361 code is set for jog level currently set. Therefore, inching distance is changed equivalent to 8i where current jog level is 8.
- Jog inching operation can only be done when the jog inching key is activated (LED On).

- Because this function is for the engineer, general operator cannot use this function.

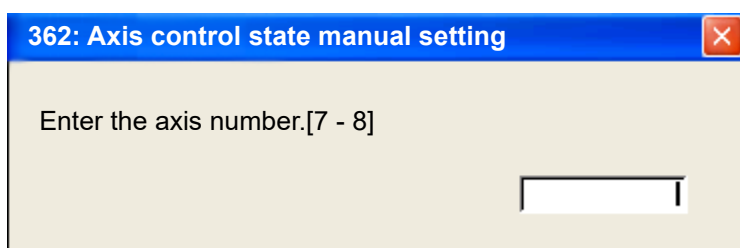
8.37. R362 Axis control state manual setting

This function sets the control state (AXISCTRL ON/OFF) of the additional axis. When the robot and the additional axis need to move in a synchronized motion, the control state of the additional axis should be set as “Enable.” However, when the robot needs to move independently of the additional axis, the control state of the additional axis should be set as “Disable.”

- (1) Following screen will be displayed when the [R..(NO)]key → [362] → [ENTER(YES)] key is pressed.



- (2) The following screen will be displayed when selecting Enable/Disable with the [NUMBER] key and pressing the [ENTER(YES)] key.



For more details, refer to “Multitasking Function Manual”.



Reference

- Cannot be used in auto mode.
- Cannot be set as “Disable” when the specification of the additional axis is base.



HD

HYUNDAI
ROBOTICS

9

Quick Open



9. Quick Open

9.1. Outline of function

Detailed setting of exclusive functions of arc such as weaving, retry/restart features of welding machine as well as welding-related conditions including voltage, current if teaching program for arc welding work. In addition, there is also a case of checking position of step or auxiliary point basically. Quick Open function is function to easily and rapidly such condition setting and position check with one-stroke of key manipulation.

For example, contents equivalent of condition number currently used in command of various welding start conditions if pressing the [Quick Open] key, when the cursor is located at ARCON command that plays role of Arc On function. You can check or change details of welding start conditions from this screen. In addition, where other condition files exist in relation with the relevant condition files, you can directly move to there. In other words, this is function to easily and rapidly check, change detailed contents such as conditions files related with specific command or step position.



9. Quick Open

Related files or detailed contents are displayed on the screen if pressing the [Quick Open] key in specific command. Press the 『[F7]: Record』 key to exit after saving, and press the [ESC] key to exit without changing.

Table 9-1 Contents appearing when pressing the [Quick Open] key in command

Command sentence	File, contents	Detailed contents
MOVE	Step position	Current step position or global pose parameter X Y Z (mm), Rx Ry Rz (°), T1~T10 Unit, Coordinate, Robot configuration
REFP	Reference location	
CALL	Called program	You can open to check or edit the applicable program.
JMPP		
Replacement statement	Variable check and change	You can monitor and change the applicable variable depending on the variable type of the replacement statement. V%, V!, V\$, P, R, LV%, LV!, LV\$, LP, LR, system variable etc.
ARCON ASF#=#	Arc welding start condition Arc welding auxiliary condition Arc welder condition	● Arc welding start condition Condition number, Description, Voltage Confirm, Retry function, Operation mode, Output current, Output voltage, WCR wait time, Robot delay time, etc. ● Arc welding auxiliary condition - RETRY: Count, RETRACT time/speed, Reentr./Path Dist., Shift Distance, speed, current, voltage - RESTART: Count, Overlap, Moving speed, Welding current, Voltage, Current - Overlap Condition setting(while in welding): Arc, gas, wire, coolant ● Arc welder condition Welder number, Name, Description, Power control mode, Wire diameter, stick out length, Stick detection time, Arc Off detection time, etc. - Current characteristics: Polarity, command value(V), measured value (A), and calibrated value - Voltage characteristics: Polarity, command value(V), measured value (V), and calibrated value
ARCOF AEF#=#	Arc welding end condition Arc welding auxiliary condition	● Arc welding end condition Condition number, Description, Voltage Confirm, Output current, Output voltage, Down slope, Condition hold time, Gas postflow ● Arc welding auxiliary condition auto stick recovery: Count, Current, Voltage, delay time
WEAVON WEV#=#	Weaving condition	● Weaving condition Condition number, Weaving type, Frequency, Basic

Controller Operation Manual

		pattern, Forward angle, Boundary limit, Moving Time, Timer ● Arc sensing condition Arc sensing, Side sensing start cycle, Height sensing start cycle, Voltage coefficient, Tracking distance per sampling, etc.



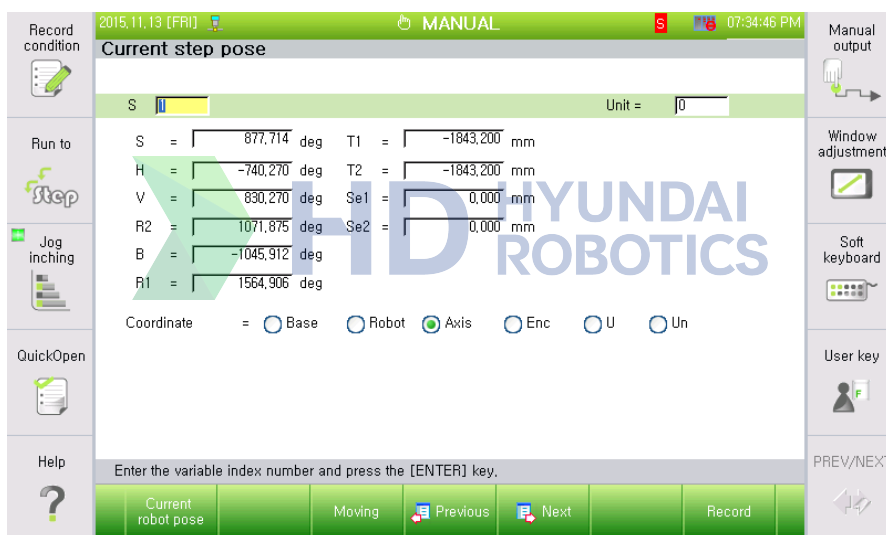
9.2. MOVE – Step location

This is function to check or modify step location where the reverse bar is currently located at in work program.

9.2.1. Hidden pose MOVE sentence

This is a function that confirms, or modifies the current step location from the hidden pose MOVE sentence (step that recorded by the [REC] key of Teach Pendant, which is the MOVE sentence that does not include the post variable).

- (1) Position of current step appears as in following screen if pressing the [Quick Open] key in the MOVE sentence recorded as hidden pose.



- (2) Move the cursor line to the item. If inputting figure, contents are reflected if pressing the [ENTER] key after numbers in the Input frame.
- (3) Please press the [SHIFT] + [←] [→] key to control the radio button.
- (4) Step number (S)
It displays the current step number. If you enter another step number and press [ENTER], it will move to the step.
- (5) Coordinates value of the current step
It displays the factor values of the step. Use cursor key to select the item that you wish to make changes. Enter the integer value and press [ENTER] to reflect the changes. However the changes will not be made if the Encoder has been selected as the type of coordinates system.

Controller Operation Manual

- (6) Types of coordinates system
It selects the types of coordinates system (among the Base coordinates system, Robot coordinates system, axis angle, User coordinates system, Encoder value) that will represent the current step location
- (7) Robot's structure component
It is displayed when the type of coordinates system is Base or Robot.
When Robot's location is to be recorded, plural value may exist due to the characteristics of the equipment, so the Robot's structure component must be configured in order to record the unique value for its location
For more details on the configuration type of a robot, refer to "2.5.3. Record/modify of step position".
- (8) 『[F1]: Current robot pose / Original value』
If press once, the value of the Robot's current pose will be displayed. If press once more, the hidden original value of the current step will be displayed (Toggle operation)
- (9) 『[F3]: Moving』
While pressed, the Robot will move to the location of recorded step (Jog)
- (10) 『[F4]: Previous』 / 『[F5]: Next』
It displays the information regarding the previous step/next step.
- (11) 『[F7]: Record』
Reflect to the job program. If press [ESC] to finish without records it, the contents that displayed on the screen will not be reflected.



Reference

- If the robot configuration type is set as "not specified," the robot will specify a robot type most approximately to the current position.
- The robot type will be formed in the configuration as shown below depending on the type of the configuration at the front and rear side.

Front side	Rear side
- The robot type will be formed in the configuration as shown below depending on the type of the configuration at the top and bottom side.

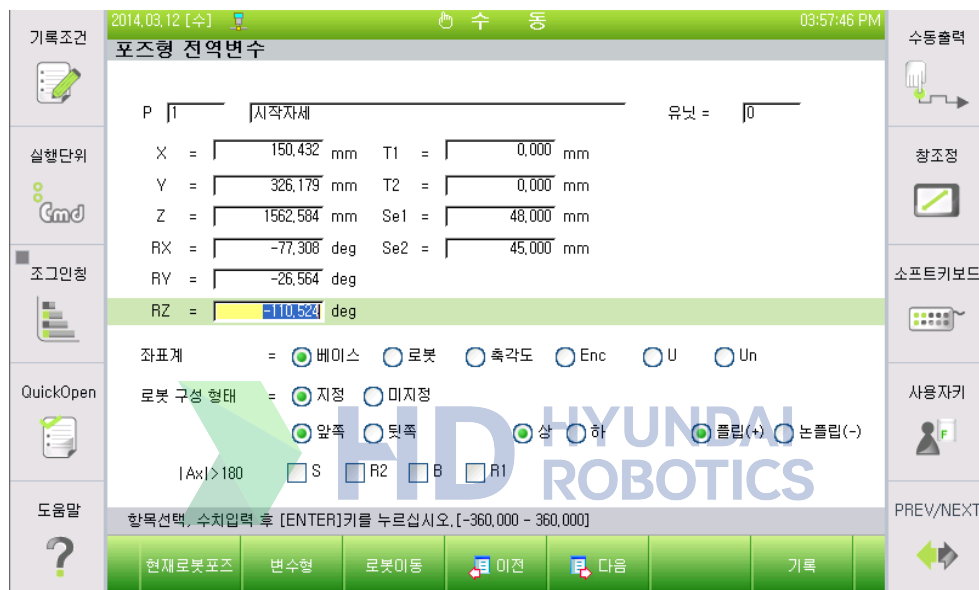
Front side	Rear side
- The robot type will be formed in the configuration as shown below depending on the type of the flip (+) and non-flip(-) configuration.

Front side	Rear side

9.2.2. Pose record MOVE sentence, Post substitute sentence

This is a function that modifies the pose variable values of the MOVE sentence that includes the post variables, or the substitute sentence

- (1) For the Move command statement recorded in the pose variable, if the [Quick Open] key is pressed, the following screen for setting the pose variable will be displayed.



- (2) Move the cursor line to the item. Contents are reflected if pressing the [ENTER] key after entering numbers in the Input frame for inputting numbers.
- (3) Please press the [SHIFT] + [←] [→] key to control the radio button
- (4) Post number (P)
It displays the current post number. If you enter another variable number and press [ENTER], it will move to the variable.
- (5) Comments
It displays the comments that explain the current pose variable. Comments can be edited with the key pad or the soft keyboard. (Entered comments will be saved in the /Resident Flash /CataCmtP.txt file of Teach Pendant and it can be edited on PC
- (6) Coordinates value of the current pose variable
It displays the factor values of the pose variable. Use cursor key to select the item that you wish to make changes. Enter the integer value and press [ENTER] to reflect the changes. However the changes will not be made if the Encoder has been selected as the type of coordinates system
- (7) Types of coordinates system

Controller Operation Manual

It selects the types of coordinates system (among the Base coordinates system, Robot coordinates system, axis angle, User coordinates system, Encoder value) that will represent the location of pose variable.

(8) Robot's structure component

It is displayed when the type of coordinates system is Base or Robot.

When Robot's location is to be recorded, plural value may exist due to the characteristics of the equipment, so the Robot's structure component must be configured in order to record the unique value for its location

For more details on the configuration type of a robot, refer to "2.5.3. Record/modify of step position".

(9) 『[F1]: Current robot pose / Original value』

If press once, the value of the Robot's current pose will be displayed. If press once more, the hidden original value of the current step will be displayed (Toggle operation)

(10) 『[F3]: Moving』

While pressed, the Robot will move to the location of recorded pose variable (Jog)

(11) 『[F4]: previous』 / 『[F5]: next』

Move to the previous variable / Next variable.

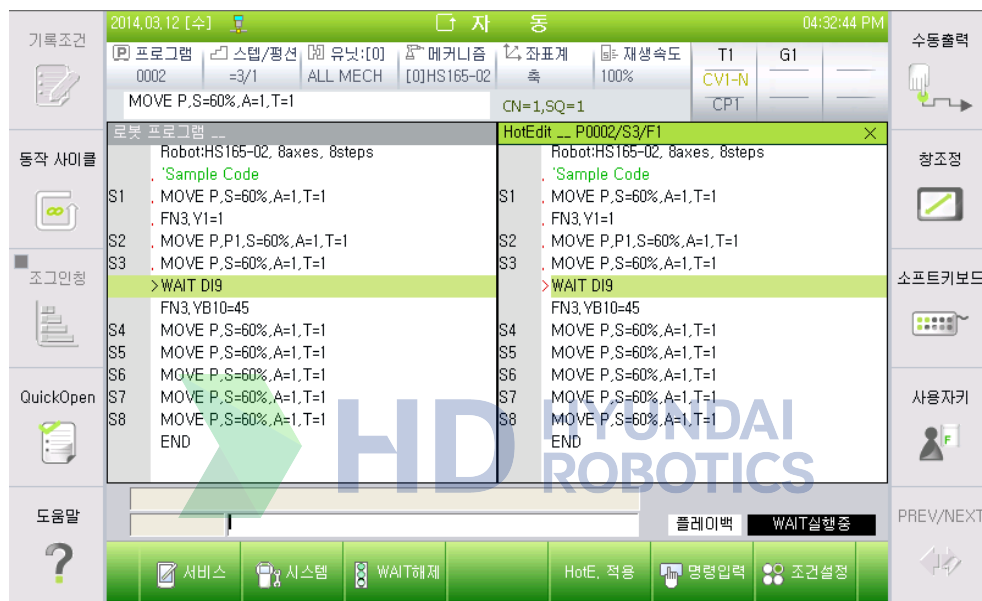
(12) 『[F7]: Record』

Reflect to the pose variable. If press [ESC] to finish without records it, the contents that displayed on the screen will not be reflected.

9.3. Program edit during the operation (Hot Edit)

This is function used to modify conditions, command or function recorded in step without stopping Robot during operation.

- (1) When you press the [Quick Open] key during the operation, you can enter the program edit (Hot Edit) during operation as shown below.



- (2) After editing the program in the same method as MANUAL mode, press the 『[F5]: Apply HotE.』 key to apply the changed results.

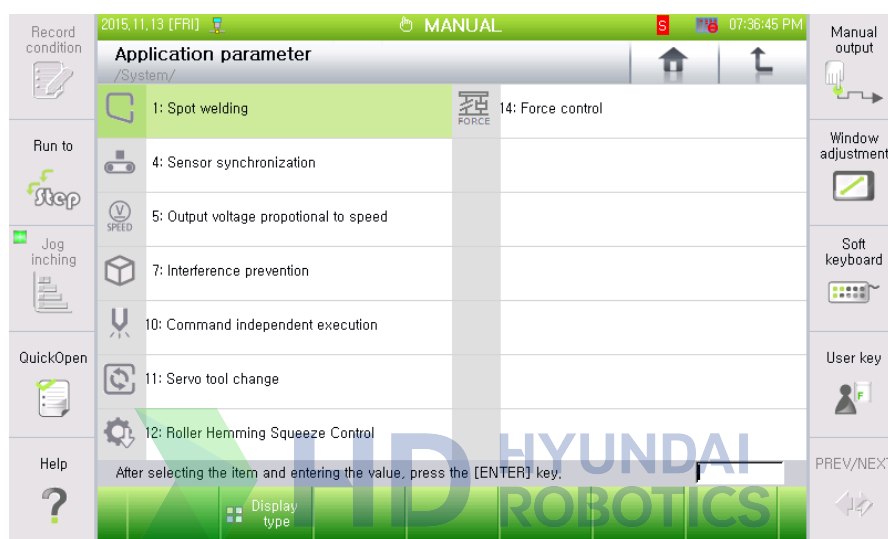


Reference

- For more details on the program edit during operation (Hot Edit), refer to 『[F1]: Service』 → 『1: Monitoring』 → 『12: Job program HotEdit』.

9.4. Spot welding function

When preparing the program and you have recorded the “SPOT” command, move the cursor to the location of this function in MANUAL mode and press the [Quick Open] key. The following screen will be displayed. The purpose of this function is to quickly edit the content of the welding condition and welding sequence during the spot welding using the servo gun.



Reference

- Refer to [F2]: System → 『4: Application parameter』 → 『1: Spot welding』.
- For more details on the spot welding function, refer to 『Hi5a Controller Spot Welding Function Manual』.

9.5. Arc welding condition setting

You can edit condition setting of relevant commands if pressing the [Quick Open] key in ARCON, ARCOF, WEAVON, REFP, LVSON, CHGLVS as commands related with arc welding.

For more details on the condition settings of each command, refer to 『Hi5a Controller “Arc Welding” Function Manual』 .

For more details on the LVSON and CHGLVS commands, refer to 『Hi5a Controller “LVS Tracking” Function Manual』 .







HD

HYUNDAI
ROBOTICS

10

Robot
Language



10. Robot Language

Controller Operation Manual

10.1. Robot Language Guide

There are roughly two industrial robot programming languages: command code and robot language. Between these methods, Hi5a controller creates the program using the robot language method.

With the command code method, you can create work program that can control the robot operation in detail using hundreds of command codes. But, processing formula or string, saving and processing large scale data is difficult or impossible to process using the command code. Also because the command is composed of number codes, it is difficult for the novice user to analyze the program.

Unlike command code, robot language provides English statement set, various arithmetic and string variables, functions and numerical forms.

As industrial robot makers usually offer their own robot language, Hyundai Hi5a offers 'HR-BASIC,' Hyundai's own robot language. HR-BASIC is similar to BASIC, a programming language used for PC.



10.2. Menu Overview

Menu overview indicates initial menu and command groups under command input.

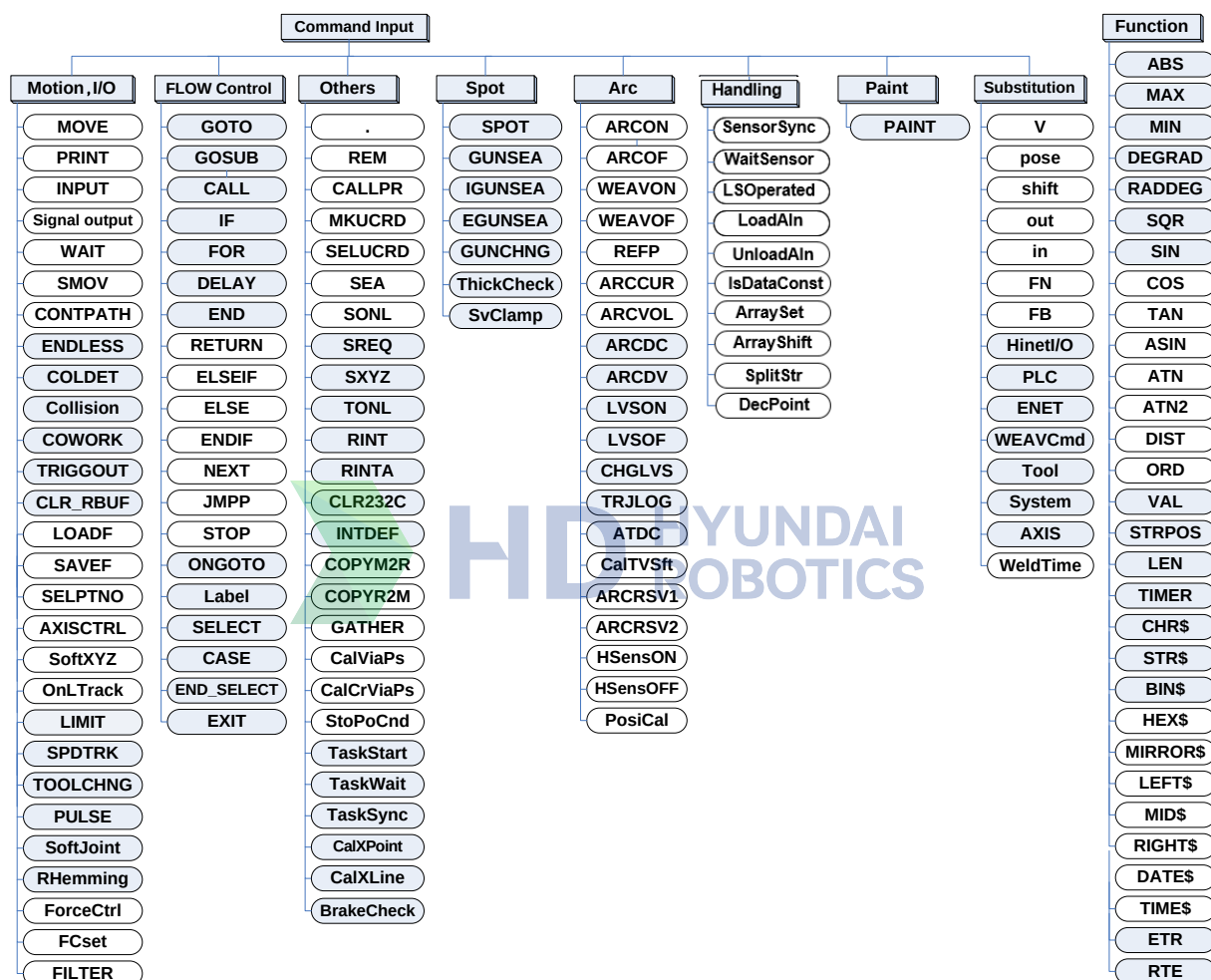


Figure 10.1 Menu Overview

10.3. Basic Elements

10.3.1. Row

Except for step statements (MOVE statement, SMOVE statement, etc.) for moving a robot, row numbers (1~9999) may be optionally attached in front of rows.

A row may have up to 254 characters. Only one statement is allowed for a row.

10.3.2. Character

Table 10-1 Robot language characters

Letter	A ~ Z, a ~ z, Korean letters
Digit	0 ~ 9
Symbol	! " ' # \$ % & () * + - . , / \ : ; = < > ? @ ` [\] ^ { } _
Space	<space>, <tab>(Before being transferred to the controller, <tab> is converted to <space>.)

10.3.3. Address

Table 10-2 Robot language addresses

Explanation	Address includes row number, step number and label. Address is used for branch such as GOTO and GOSUB. Row number can be omitted.	
Step number	S0~S999	Step number is automatically marked when step statement (MOVE statement, etc.) is inputted.
Row number	1~9999 (Arithmetic)	Order of row numbers is not relevant to program operation order.
Label	*<Label>	Label should be in English letters, numbers and underline and cannot be over 8 characters. The first letter should be an English letter.
Example	50 PRINT.... *ERRHDL	GOTO 10 GOTO V1% GOSUB *CALC
Remark	Only integers without signs can be used for step number. Arithmetic can be used for row number. Number of row numbers per program cannot be over 1000. Number of labels preprogram should not be over 100.	

10.3.4. Constant

Table 10-3 Robot language integer and real number

Constant		Range	Example
Integer	Short type	-32768 ~ 32767	2150, -440
	Long type	-2,147,483,648 ~ 2,147,483,647	-8174, 93126620
	Expressed in binary number	&B0 ~ B1111111111111111	&B01101011, &B1000
	Expressed in hexadecimal number	&H0 ~ &HFFFF	&H3F77, &H2A
Real number	Single precision floating point	-1.17E-38 ~ 3.4E+38 (7 digit)	55.6, 0.5E-2
	Single precision floating point	1.7E +/-308 (15 digits)	3.141592653589
	Fixed point	-2147483.648 ~ 2147483.647	3050.76, -2.714
String		Up to 240characters	"INPUT WORK NUMBER:", "INVALID DATA"

※The predefined variable stores the short type integer and single precision floating point, while the ID variable stores long type integer and the double precision floating point. (Pre-definitions and ID parameters are described in Section 10.4.)

Table 10-4 Robot language pose and shift

Constant	Coordinates System	Range	Example
Pose	Base coordinates System	Real number with fixed decimal point	(204.5, 3719.35, 277.94, 0, 50, 0, &H0001) (P* is the current pose of a robot.)
	Robot coordinates System	Real number with fixed decimal point	(204.5, 3719.35, 277.94, 0, 50, 0, &H0001)R
	Axis angle coordinates system	Real number with fixed decimal point	(0, 0, 30, 0, 0, 0, &H0001)A
	Encoder coordinates system	32bit hexadecimal number	(&H00400000, &H00400000, &H00400000, &H00400000, &H00400000, &H00400000)E
	User coordinates system (Number not designated)	Real number with fixed decimal point	(204.5, 3719.35, 277.94, 0, 50, 0, &H0001)U (The coordinates system number is that of the condition setting)
	User coordinates system	Real number with fixed decimal point	(204.5, 3719.35, 277.94, 0, 50, 0, &H0001)U4

Controller Operation Manual

Constant	Coordinates System	Range	Example
	Master coordinates system	Real number with fixed decimal point	(0, 50, 0, 0, 0, 0, &H0001)M
Shift	Base coordinates system	Real number with fixed decimal point	(0, 50, 0, 0, 0, 0)
	Robot coordinates System	Real number with fixed decimal point	(0, 50, 0, 0, 0, 0)R
	Tool coordinates System	Real number with fixed decimal point	(0, 50, 0, 0, 0, 0)T
	User coordinates system (Number not designated)	Real number with fixed decimal point	(0, 50, 0, 0, 0, 0)U (The coordinates system number is that of the condition setting)
	User coordinates system	Real number with fixed decimal point	(0, 50, 0, 0, 0, 0)U4 (U4 is the number 4 of the user coordinates system)
	Master coordinates System	Real number with fixed decimal point	(0, 50, 0, 0, 0, 0)M
	Axis angle coordinates System	Real number with fixed decimal point	(0, 0, 30, 0, 0, 0)A



Reference

- There is no suffix for base coordinate but the robot coordinate uses the suffix R, axis coordinate A and user coordinate U or Un. (n is the user coordinate number, if n=0, use the User coordinates system's designated number of condition setting)
- For the base coordinate or robot coordinate, each element is (X, Y, Z, RX, RY, RZ, cfg.). If there is an additional axis, it continues after RZ. X, Y and Z is the coordinate (Unit: mm), and RX, RY and RZ is the rotating angle (Unit: degree) from respective X, Y and Z axis. cfg. (Configuration) is composed of the information setting for shape of 14 bit robot (0~&H3FFF). (Coordinates system information will be ignored from the bit components of cfg. Coordinates system will follow the suffix.)
- If there is no additional axis, it is the same whether coordinates has R or not, because base coordinates system and robot coordinates system are the same.
- If T is attached, user coordinates system is ignored even though it is already set, because only tool coordinates system is applied.

10.3.5. Pose CFG information

The CFG of the pose consists of the robot's recording form (configuration) and coordinate system as shown in the table below.

Table 10-5 .CFG element value structure of pose constant or pose variable

6 bit	5 bit	4 bit	3 bit	2 bit	1 bit	0 bit
0: IR1<180 1: IR1>=180	0: IR2<180 1: IR2>=180	0: IS<180 1: IS>=180	0: flip 1: nonflip	0: Up 1: Down	0: Front 1: Back	0: Designated (manual) 1: Undesignated (auto)
		15 bit	14 bit	13~10 bit	9~7 bit	
		0: IB<180 1: IB>=180 (for the painting robots)	reserved	0~10 User coordinate number	0: base 1: robot 2: angle	3: encoder 4: user 6: master



Reference



HD HYUNDAI
ROBOTICS

- For the robot's recording form, refer to "2.5.3.2. Base or Robot recording coordinate" section.
- 0 bit :
If 0 is set, the type information designated in 1 bit ~ 6 bit and 12 bit will be applied. If 1 is set, the auto.config function, which ignores the designated type and generates a proper type, will be used.
- 9~7 bit :
Coordinates system form of pose. This bit is used, when coordinates system data of pose within program routine should be retrieved. If coordinates system suffix and this bit are different, follow the suffix. "CRD" is provided as a member of CFG to make it easy to access this bit. For example, when P1.CFG.CRD=4 is executed, the coordinate system form of P1 is set as user.
- 10~13 bit :
User coordinates system number of pose. When the coordinate's system form is user, the user coordinates system number is essentially used. If the user coordinates system number needs to be read or changed, this bit needs to be used.
"UCRD" is provided as a member of CFG to make it easy to access this bit. For example, when P1.CFG.UCRD=2 is executed, the user coordinates system number of P1 is set as 2

Controller Operation Manual

Table 10-6 Pose member

Member	Meaning	Scope or unit	Example and description
X, Y, Z	Cartesian position	mm	P9.X=V200!*1000 IF P3.Z<0 THEN *ERR (Accessible only in the Cartesian coordinate system)
RX, RY, RZ	Cartesian angle	deg.	P9.RY=V210! IF P3.RZ=0 THEN 100 (Accessible only in the Cartesian coordinate system)
T1~T10	Additional axial value	mm or deg.	P15.T1= P15.T1+100
J1~J16	Axial value	mm or deg.	PRINT #0,"R1=";P20.J6 (Accessible only in the axial coordinate system)
CFG	Robot shape	bit-field (16bit)	P9.CFG=&H0001 (See the Pose Configuration Table.)
CFG.CRD	Type of coordinate system	0~6	P9.CFG.CRD=2 (This sets the coordinate system of Parameter P9 as the axial coordinate system. When the type of coordinate system is changed, coordination system conversion will be carried out.)
CFG.UCRD	User coordinate system number	0~10	P9.CFG.UCRD=1
UNIT	Unit number	0~7	P50.UNIT=2 (This sets the unit number of Parameter P50 at 2.)
EXIST	Existence of parameter (read-only)	1 (Yes) 0 (No)	IF P35.EXIST=0 THEN *NO_POSE (If Parameter P35 is not defined, it branches to *NO_POSE.)

10.3.6. Shift CFG information

Table 10-7 Configuration of the shift CFG element value

13~10 bit	5 bit (Reception state)	4, 3 bit (Online shift request)	2, 1, 0 bit (Shift coordinates system)	
0~10 User coordinates system number	0: no reception 1: reception completed	0: OFF 1: COM 1 2: COM 2	0: base, 1: robot 2: tool	4: user 5: master 6: angle

- 3, 4, 5 bit are not usually used by users. However, after string shift value in register and setting 5 bit as 1 as if reception is completed, users can apply them to online shift or online coordinates conversion (SONL, TONL1 and TONL2).
- 4, 3 bit is used for storage of whether online shift request (SREQ) is forwarded and to which serial port the request is forwarded.
“.REQ” is provided as a member of CFG to make it easy to access this bit, For example, when R1.CFG.REQ=1 is executed, request for the online shift data is made through the serial port 1.
- 5 bit is used for storage of whether online shift response is received.
“.ASSIGN” is provided as a member of CFG to make it easy to access this bit. The setting will be made in a way that, for example, when R1.CFG.ASSIGN=1 is executed, it is considered that the online shift data is received through the serial port #1.
- 0~2 bit :
Coordinates system form of shift. This bit is used when the coordinates system data of the shift parameter within the program routine should be retrieved and used.
“.CRD” is provided as a member of CFG to make it easy to access this bit. For example, when P1.CFG.CRD=4 is executed, the coordinate system form of P1 is set as user.
- 10~13 bit :
User coordinates system number of shift. When the coordinates system from of shift is user, the user coordinates system number is to be used essentially. Then, this bit needs to be used when the user coordinates system number is to be retrieved and changed.
“.UCRD” is provided as a member of CFG to make it easy to access this bit. For example, when P1.CFG.UCRD=2 is executed, the user coordinates system number is set.

Controller Operation Manual

Table 10-8 Shift member

Member	Meaning	Scope or unit	Example
X, Y, Z	Cartesian position	mm	R9.X=V200!*1000 IF R3.Z<0 THEN *ERR (Accessible only in the Cartesian coordinate system)
RX, RY, RZ	Cartesian angle	deg.	R9.RY=V210! IF R3.RZ=0 THEN 100 (Accessible only in the Cartesian coordinate system)
J1~J16	Axial value	mm or deg.	PRINT #0,"R1=";R20.J6 (Accessible only in the axial coordinate system)
CFG	Robot shape	bit-field (14bit)	R9.CFG=&H0001 (See the Shift Configuration Table.)
CFG.CRD	Type of coordinate system	bit-field	R9.CFG.CRD=1 (This sets the coordinate system of Parameter P9 as the robot coordinate system. When the type of coordinate system is changed, coordination system conversion will be carried out..)
CFG.UCRD	User coordinate system number	0~10	R9.CFG.UCRD=1
CFG.REQ	Whether online shift data were requested	0~3	R1.CFG.REQ=1 (This sets that online shift data were requested through Serial Port 1.)
CFG.ASSIGN	Whether online shift data were received	0: Not received 1: Received	R1.CFG.ASSIGN=1 (This sets that online shift data were received through Serial Port 1.)
NJ	Number of axes	0~16	Number of the effective axes of the shift parameter
EXIST	Existence of parameter (read-only)	1: Yes 0: No	IF R35.EXIST=0 THEN *NO_SFT (If Parameter R35 is not defined, it branches to *NO_SFT.)

10.4. Variable and expression

10.4.1. Predefined variable

There is no need for the user to define predefined variables. Variables of each type have their own differentiating prefixes, symbols, and indices. It may be easy to enter them by using the key pad of the teach pendant. However, the drawback is that programs using them are difficult to read compared with the programs using ID variables.

(Refer to 10.4.4 for ID variables).

10.4.1.1. Global Variable

Global variables are shared and used by all types of tasks and job programs. For example, as shown below, the value of the global variable V10% can be read and written in all job programs of all tasks, including 0001.JOB and 0005.JOB. For example, when 5 is assigned to V10% in JOB 1 and JOB 5 outputs V10%, 5 will be outputted.

Table 10-9 Robot language global variables

Variable		Syntax	Example
Arithmetic	Integer (short)	V1%~V600% or V%[1]~V%[600]	V10%, V%[20], V%[50+V2%] (Formulas should be in [].)
	Real number (float)	V1!~V600! or V![1]~V![600]	V10!, V![20], V![50+V2%]
String		V1\$~V999\$ or V\$[1]~V\$[999]	V10\$, V\$[20], V\$[V2%]
Pose		P1~P9999 or P[1]~P[9999]	P50, P[70], P[50+V2\$], P[20].RZ, P[10].X (Elements (X, Y, Z, RX, RY, RZ, T1, T2,... T10, CFG) are accessible.)
Shift		R1~R9999 or R[1]~R[9999]	R20, R[30], R[20+V2\$], R[20].RZ, R[10].X (Elements (X, Y, Z, RX, RY, RZ) are accessible.)



Reference

- The pose elements and shift elements will be treated as fixed point real numbers.
- Number of pose elements T1, T2... should be the same as the number of additional axes.
- As soon as controller system is initialized, all arithmetic variables, pose, shift variables become 0 and string variables are initialized to empty string. When a new cycle begins or a program is changed, they are not automatically initialized.
- All variable values remain, even though the power is off.
- R1~R8 are mapped to online shift register as they are. For example, assignment statements such

Controller Operation Manual

as R2 = (shift constant) are used for No. 2 online shift register setup.

10.4.1.2. Local Variable

A main program and each called assistant program have its own local variable. Each program cannot access local variable of other programs.

Table 10-10 Robot language local variables

Variable		Syntax	Example
Arithmetic	Integer (short)	LV1%~LV50% or LV%[1]~LV%[50]	LV10%, LV %[5], LV %[5+LV2%] (Formulas should be in [].)
	Real number (float)	LV1!~LV50! or LV![1]~LV![50]	LV10!, LV![5], LV![5+LV2%]
String		LV1\$~LV100\$ or LV\$[1]~LV\$[100]	LV10\$, LV\$[5], LV\$[LV2%]
Pose		LP1~LP100 or LP[1]~LP[100]	LP5, LP[7], LP[5+LV2\$], LP[2].RZ, LP[10].X (Elements (X, Y, Z, RX, RY, RZ, T1, T2,... T6, CFG) are accessible.)
Shift		LR1~LR50 or LR[1]~LR[50]	LR2, LR[3], LR[2+LV2\$], LR[2].RZ, LR[10].X (Elements (X, Y, Z, RX, RY, RZ) are accessible.)



Reference

- The pose elements and shift elements will be treated as fixed point real numbers.
- Number of pose elements T1, T2... should be the same as the number of additional axes.
- As soon as controller system is initialized, all arithmetic variables, pose, shift variables become 0 and string variables are initialized to empty string. When a new cycle begins or a program is changed, they are not automatically initialized.
- All variable values remain, even though the power is off.

10.4.2. Input/Output Variable

Table 10-11 Robot language input and output variables

Variable			Syntax	Example
Output parameter	Digital	DO (bit)	DO[1~4100] (DO4097~DO4100: Preliminary output signals 1~4)	DO2=1 (Reset if it is 0. Set if it is not 0)
		DOB (byte)	DOB[1~512]	DOB3=&B00001111, DOB3=&H0F
		DOW (word)	DOW[1~256]	DOW7=30000, DOW3=&HFF38, V25%=DOW5
		DOL (long)	DOL[1~128]	DOL5=10000000000, DOL2=&H4000FFA0
		DOF (float)	DOF[1~128]	DOF3=3.141592, DOF7=31459.2E-4
	Exclusive	SO (bit)	SO[1~8, 101~104] (SO101~SO104: Preliminary output signals 1~4)	SO4=0 (Reset if it is 0. Set if it is not 0)
	Analogue	AO(float)	AO[1~32]	AO1 = 3.5 (3.5V output at the analogue #1 output channel)
	Embedded field bus	FNi.Y	FN[1~64].Y[1~128]	FN3.Y2=1, FN[LV3%].Y[LV1%]=1
		FNi.YB	FN[1~64].YB[1~16]	FN4.YB2=54, FN[LV3%].YB[LV1%]=54
		FNi.YW	FN[1~64].YW[1~8]	FN1.YW2=1234, FN[LV3%].YW[LV1%]=1234
		FNi.YL	FN[1~64].YL[1~4]	FN32.YL2=12345, FN[LV3%].YL[LV1%]=12345
		FNi.YF	FN[1~64].YF[1~4]	FN25.YF2=12.34, FN[LV3%].YF[LV1%]=12.34
	Field bus (ch1, ch3, ch5)	FBj.Y	FB[1/3/5].Y[1~960]	FB1.Y2=1, FB[LV3%].Y[LV1%]=1
		FBj.YB	FB[1/3/5].YB[1~120]	FB3.YB2=54, FB[LV3%].YB[LV1%]=54
		FBj.YW	FB[1/3/5].YW[1~60]	FB1.YW2=1234, FB[LV3%].YW[LV1%]=1234
		FBj.YL	FB[1/3/5].YL[1~30]	FB3.YL2=12345, FB[LV3%].YL[LV1%]=12345
		FBj.YF	FB[1/3/5].YF[1~30]	FB5.YF2=12.34, FB[LV3%].YF[LV1%]=12.34
Input parameter	Digital	DI (bit)	DI[1~4096] (DI4097~DI4100: Preliminary input	V2%=DI2, WAIT DI[V1%]

Controller Operation Manual

Variable			Syntax	Example
			signals 1~4)	
		DIB (byte)	DIB[1~512]	V1%=DIB3, WAIT DIB2=123
		DIW (word)	DIW[1~256]	V1%=DIW2, WAIT DIW2=456
		DIL (long)	DIL[1~128]	V1%=DIL3, WAIT DIL3=12345
		DIF (float)	DIF[1~128]	V1!=DIF2, WAIT DIF2<12.345
	Exclusive	SI (bit)	SI[1~8,101~104] (SI101~SI104: Preliminary input signals 1~4)	V3%=SI4
	Analogue	AI(float)	AI[1~32]	V2!=AI2 Put the value of the analogue #2 input channel in the V2!)
	Embedded field bus	FNi.X	FN[1~64].X[1~128]	V2%=FN3.X2, WAIT FN[LV3%].X[LV1%]
		FNi.XB	FN[1~64].XB[1~16]	V2%=FN4.XB2, WAIT FN[LV3%].XB[LV1%]=23
		FNi.XW	FN[1~64].XW[1~8]	V2%=FN1.XW2, WAIT FN[LV3%].XW[LV1%]=1234
		FNi.XL	FN[1~64].XL[1~4]	V2%=FN32.XL2, WAIT FN[LV3%].XL[LV1%]=78
		FNi.XF	FN[1~64].XF[1~4]	V2%=FN25.XF2, WAIT FN[LV3%].XF[LV1%]<34.6
	Field bus (ch1, ch3, ch5)	FBj.X	FB[1/3/5].X[1~960]	V2%=FB3.X2, WAIT FB[LV3%].X[LV1%]
		FBj.XB	FB[1/3/5].XB[1~120]	V2%=FB5.XB2, WAIT FB[LV3%].XB[LV1%]=23
		FBj.XW	FB[1/3/5].XW[1~60]	V2%=FB1.XW2, WAIT FB[LV3%].XW[LV1%]=1234
		FBj.XL	FB[1/3/5].XL[1~30]	V2%=FB1.XL2, WAIT FB[LV3%].XL[LV1%]=78
		FBj.XF	FB[1/3/5].XF[1~30]	V2%=FB3.XF2, WAIT FB[LV3%].XF[LV1%]<34.6



Reference

- When using the index in numeric format, use the [] as shown in DO[], DOB[] and AO[].
- DOB, DOW, DOL, DIB, DIW and DIL are recognized as number with a sign.

- Analog input/output values are between -12V~12V, when BD58X is attached.
- DO/DI4097~DO/DIO4100 refers to preliminary signals, such as SO/SI101~SO/SI104. These signals are inputted and outputted through the TBIO terminal of the system IO board.



10.4.3. PLC variable

Variables in the embedded PLC accessible by robot language

Table 10-12 Variables in the embedded PLC accessible by robot language

_MB (byte)	_MB1~2000	Byte with sign _MB850=-120, _MB[V5%]=V8%
_MW (word)	_MW1~1000	Word with sign
_ML (long)	_ML1~500	Double word with sign
_MF (float)	_MF1~500	Real number with adjustable decimal point

10.4.4. ID Variables

The ID variables are defined and used by the users. As they consist of alphabetical and numerical characters, it may be somewhat difficult to enter them using the keypad of the teach pendant. However, they are advantageous in that the programs using them are very easy to read compared with the programs using predefined variables.

(For more details about predefined variables, refer to 10.4.1)

※ The function described in the chapter cannot be used for controllers with version lower than Hi5.

10.4.4.1. Rules and conventions related to variables

According to the rules, the global variables should begin with “g” and the formal parameters and local variables should begin with “l” and an ID (identifier) of up to 12 characters should be appended. An ID should begin with alphabetical characters (A~Z, a~z) and consist only of alphabetical and numerical (0~9) characters, including the underscore (_) character. Uppercase and lowercase characters will be recognized as different characters.

In case of arrays, a bracketed index should come after the name of a variable. An index begins with 1 and an expression can be used also.

Table 10-13 ID Example of ID variable syntax

Example of legal syntax	giWorkNum gdWidth ldaVoltage[4] gtaMsg[(giWorkNum%10)+1]

Example of illegal syntax	iCmdNum: Not started with g or l IdDefaultPositionX: ID exceeding 12 characters g3tErrMsg: ID not starting with alphabetical characters. g_SysCode: ID not starting with alphabetical characters. gtaString[0]: Array index small than 1



Controller Operation Manual

ID variables are in 5 different types, including long type integer, double precision real number, string, pose, and shift.

There is no rule related to the variable type. However, it is strongly recommended, according to conventions, to add prefixes to easily identify the type of variables only by the name of the variables.

The following information shows the conventions that are recommended to differentiate the types of variables.

Table 10-14 Conventions for prefixes for ID variables for individual variable types

Variable type		Previs	Example	Remarks
Arithmetic	Integer	i	gildx, lildx	32 bit signed
	Real number (double)	d	gdPie	64 bit float point
String		t	gtMsg	Max. 240 characters 'ascii text'
Pose		p	gpHome, lpPrev	Same as predefined variables
Shift		sh	gshMeasure	Same as predefined variables
Output		y	lyMode	Refer to output variables
Input		x	gxSensOk	Refer to input variables
M relay		m	gmTmp	Refer to the M relay
Array		a	liaNum[8], lpaTraj[25]	To be appended after the prefix of variables

10.4.4.2. Global variables

※ A few examples of robot languages are presented to explain the concept of variables. For the command statements, such as PRINT and CALL, a separate explanation will be provided in 10.5. Examples are provided based on what is extracted for the purpose of explanation.

Global variables are shared and used by all types of task and job programs. For example, as shown below, if gdX is defined as a global variable, it can be read and written in all job programs of all tasks, including 0001.JOB, and 0005.JBO. For example, when 11.5 is assigned in JOB 1 and JOB 5 outputs the value, 11.5 will be outputted.

Table 10-15 Example of using ID variables as global variables

G00.IDV (Global variable)	gdX AS Double
0001.JOB	gdX=11.5 CALL 5 PRINT #0,"0001.JOB:";gdX
0005.JOB	PRINT #0,"0005.JOB:";gdX gdX=55.5 END
Execution results	0005.JOB: 11.5 0001.JOB: 55.5

Global variables are not to be defined in job programs but are to be inputted and edited by using the variable dialog box of the teach pendant (Refer to 10.4.5). The list of defined variables and the stored values are to be kept in the G00.IDV file. If it is difficult to edit the names of variables by using the soft key, the G00.IDV file can be copied to a PC and edited by using a text file editor, and then copied back to the controller.

10.4.4.3. Local variables

Local variables can be accessed only within the current job program. They are enumerated in the DIM command statement at the front part of a job. Press the 『F6』: Command input』 – 『F5』: PREV/NEXT』 keys in order, then the 『F2』: DIM』 button will be displayed.

The variable type will be defined after AS. Multiple variables can be enumerated in one line of the DIM statement as long as they are the same type. If their types are different, variables need to be defined continuously in the next DIM command sentence.

```
DIM liA,liB[8],liC AS Integer
DIM lpPosition,lpHome AS Pose
```

In a DIM command statement, it is impossible to set default values. Default values must be set in an assignment statement before the use.

```
liA=0
```

In the examples shown below, both 0001.JOB and 0005.JOB have the same local variable, lidx, in DIM statements. Although their names are the same, they are different variables. In job 5, the value is set as 555 before returning. However, when returning to job 1, the previous value, 111, is saved in lidx.

Table 10-16 Examples of using ID variables as local variables

0001.JOB	<pre>DIM lidx AS Integer lidx=111 CALL 5 PRINT #0,"0001.JOB:";lidx</pre>
0005.JOB	<pre>DIM lidx,liStep AS Integer lidx=555 PRINT #0,"0005.JOB:";lidx END</pre>
Results	<pre>0005.JOB: 555 0001.JOB: 111</pre>

10.4.4.4. Array

In DIM statement, [] can be added to a global variable or a local variable to define a one-dimensional array. The elements of the integer, real number, string, pose, and shift variables can be generated according to the array size set in [].

```
DIM liaB[8],lildx AS Integer
```

```
FOR lildx=1 TO 8
```

```
  liaB[lildx]=100 'Initialize all the variable elements as 100
```

```
NEXT
```

The array subscript begins with 1. In terms of size, it can be increased up to 65536 theoretically. In reality, it is restricted by the available memory of the robot controller.

In case of input and output variables or M relay variables, the storage space will refer to actual variables as much as the size of the array, while not to be generated as much as the size of array. For example, the following command defines the reference relationship as shown in the following table.

```
DIM gmaTmp[3] AS _MW11
```

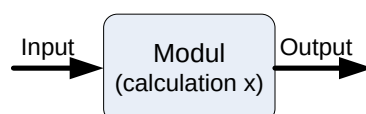


Table 10-17 Array of ID variables

ID variables	Refer to
gmaTmp[1]	_MW11
gmaTmp[2]	_MW12
gmaTmp[3]	_MW13

10.4.4.5. Parameters

A well-made job can be reused as a kind of a software module. A module returns result values after carrying out predefined operations by using delivered input values. When the type of inputs, content of operation, and type of output are well understood, a module can be utilized. There is no need to pay attention to its internal operating procedure.



A job program uses formal parameters as a channel that delivers inputs and outputs. Formal parameters are defined in a PARAM command statement at the front end of the job program. Variable type will not be designated in AS. Press the 『[F6]: COMMAND INPUT』 – 『[F5]: PREV/NEXT』 keys in order, the 『[F1]: PARAM』 button will be displayed.

The name of variables should have a prefix “I” similar to local variables.

In an example shown below, the job 105 is a sub job that acquires the Euclidean distance from the origin to the coordinate (IdX, IdY) and returns it to IdLen. The function is named as Dist2D.

Table 10-18 Examples of using parameters

0001.JOB	DIM IdRes,IdX,IdY AS Double IdX=5 IdY=12.8 CALL 105_Dist2D (IdRes,IdX,IdY) PRINT #0,IdRes
0105_Dist2D.JOB	‘Calc. Euclide distance 2D PARAM IdLen,IdX,IdY DIM IdTmp AS Double ‘ IdTmp=IdX*IdX+IdY*IdY IdLen=SQR(IdTmp) ‘distance from origin END
Results	13.742

In the job 1, the Dist2D function is called using the CALL statement and the real number local variables, IdRes, IdX, and IdY are delivered in brackets. IdLen, IdX, and IdY defined in the PARAM statement in the Dist2D function are formal parameters. IdRes, IdX, and IdY delivered to the CALL statement are actual parameters.

The actual parameters and formal parameters should be equal in their count. The formal parameters have no specifically designated forms and follow the variable type of the actual parameters as is. However, it needs to be taken into consideration that errors would not be caused during execution when actual parameters of the variable type, which can meet the intention of the job programmer who understands the operation of the function, are delivered. Thus, it is a convention to add a prefix to the name of a formal parameter for the purpose of inducing actual parameters of a proper variable type to be added

when preparing the CALL statement.

The DIM definition of local variables must be arrayed next to the formal parameters. Once the DIM statement is executed, if the PARAM statement in the same job is executed, errors would occur. In addition, formal parameters may be used only in a job similar to local variables.

All kinds of forms, such as constants, predefined variables, ID variables, ID variable array elements, and formulas can be used as actual parameters. However, the methods of parameters are divided into two types as shown below. These two concepts may not be familiar to beginners but should be understood at this stage.

Table 10-19 Calling by reference and by value

	Target actual parameters (Main usage)	Example
Call by reference	Cases of writing the names of ID variables. Array elements of ID variables are excluded. (mainly output of modules)	DIM liCnt, liaData[10] AS Integer CALL 3_FuncA (liCnt) CALL 5_FuncB (liaData)
Call by value	All the rest except for the above (input of modules)	CALL 3_FuncA (1.618) CALL 3_FuncA (liaData[6]) CALL 7_FuncC (V3%) CALL 3_FuncA (liCnt+10)

The method of calling by value is used for channels through which values are inputted inside the module. The channels are input parameters.

The three actual parameters of the below CALL statement are real number constant (1.618), string constant ("no"), and predefined global real number variable (V5!), which are the examples of calling by value. In this case, the values of the actual parameters are copied into the formal parameters. In the job 1, the default of V5! is 0 and copied into IdC in FuncX through the CALL statement. The value of V5! is still 0 even when 2.72 is assigned to IdC in FuncX because IdC is just a parameter that copies the value of V5!, not V5! itself.

Table 10-20 Example 1 of the value being maintained through calling by value

0001JOB	V5!=0. CALL 100_FuncX (1.618,"none",V5!) PRINT #0,V5!
0100_FuncXJOB	PARAM IdA,ItB,IdC , ItB="yes" IdC=2.72 END
Result	0

Controller Operation Manual

An arithmetic formula ($liNum/2$) and an array element $IdaR[2]$ will be processed through the calling by value.

Table 10-21 Example 2 of the value being maintained through the calling by value

0001.JOB	<pre> DIM liNum AS Integer DIM IdaR[3] AS Double ' liNum=100 Ida[2]=0 CALL 100_FuncX (liNum/2,IdaR[2]) PRINT #0,liNum,IdaR[2] </pre>
0100_FuncX.JOB	<pre> PARAM liA,IdB ' liA=7 IdB=3.1415 END </pre>
Result	100 0

The method of calling by reference is used for channels through which output values of the module are delivered. The channels are output parameters.

The two actual parameters of the below CALL statement are a real number ID variable ($IdGoldRt$) and the array name of a string ID variable ($ItaName$), both of which are called by reference. Formal parameters are the names referring to actual parameters. Assigning 1.618 in IdA in $FuncX$ is equivalent to assigning 1.618 in $IdGoldR$. The relationship between $ItaName$ and $ItaB$ is the same.

Table 10-22 Example of a value being changed due to calling by reference

0001.JOB	<pre> DIM IdGoldRt AS Double DIM ItaName[3] AS String ' IdGoldRt=0 ItaName[2]="no.init" CALL 100_FuncX (IdGoldRt,ItaName) PRINT #0,IdGoldRt,ItaName[2] </pre>
0100_FuncX.JOB	<pre> PARAM IdA,ItaB ' IdA=1.618 ItaName[2]="Bravo" END </pre>
Result	1.618 Bravo

How do you deliver the value of the ID variable into the CALL statement through calling by value? It would be ok to copy the value into a predefined value and then deliver it to the CALL statement. The simpler method is adding + to the front of the variable. A variable with + will be interpreted as a formula, meaning it will be processed through calling by value.

Table 10-23 Method of delivering the value of an ID variable through calling by value

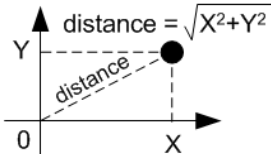
0200.JOB	DIM IdX,IdY AS Double DIM ItZ AS String ‘ IdX=1.2 IdY=3.4 ItZ="ABC" V20!=IdX CALL 201_FuncZ (V20!,+IdY,+ItZ) PRINT #0,IdX,IdY,ItZ
0201_FuncZ.JOB	PARAM IdA,IdB,ItC ‘ IdA=6.7 IdB=8.9 ItC="XYZ" END
Result	1.2 3.4 ABC

10.4.4.6. Practical examples of ID variables

Let's try a job of acquiring an average of the distances from individual origins to multiple 2D coordinate points.

Suppose that the 2D coordinate is already stored in gdaCrd[], which is a one-dimensional array global variable ([Odd number] is for the X value and [Even number] is for the Y value). The number 4, which is the count of the coordinate points, is stored in giNCrd.

Table 10-24 Practical examples of ID variables

G00.IDX Global variable file ※ The method of setting global variables using a variable dialog box or a text file will be explained in the next section. 	Entry Text File Format Version: 1.0 _G00.IDV(ID Variable) giDbg AS Integer giNCrd AS Integer = 4 gdaCrd[8] AS Double [1]=5 [2]=12.8 [3]=6.4 [4]=11.7 [5]=6.1 [6]=10.9 [7]=4.7 [8]=10.4 gdAvg AS Double <table><tr><th>#</th><th>X</th><th>Y</th><th>Distance</th></tr><tr><td>1</td><td>5</td><td>12.8</td><td>13.742</td></tr><tr><td>2</td><td>6.4</td><td>11.7</td><td>13.336</td></tr><tr><td>3</td><td>6.1</td><td>10.9</td><td>12.491</td></tr><tr><td>4</td><td>4.7</td><td>10.4</td><td>11.413</td></tr><tr><td colspan="3">Average</td><td>12.745</td></tr></table>	#	X	Y	Distance	1	5	12.8	13.742	2	6.4	11.7	13.336	3	6.1	10.9	12.491	4	4.7	10.4	11.413	Average			12.745
#	X	Y	Distance																						
1	5	12.8	13.742																						
2	6.4	11.7	13.336																						
3	6.1	10.9	12.491																						
4	4.7	10.4	11.413																						
Average			12.745																						
0001_Main.JOB A program for acquiring the average of distances of 2D coordinates in the number of giNCrd stored in gdaCrd []	DIM lildx AS Integer DIM lidaDist[4],ldRes,ldX,ldY AS Double ‘ FOR lildx=1 TO giNCrd ldX=gdaCrd[lildx*2-1] ldY=gdaCrd[lildx*2] CALL 105_Dist2D (ldRes,ldX,ldY) lidaDist[lildx]=ldRes NEXT CALL 108_Avg (gdAvg,lidaDist,giNCrd) END																								
0105_Dist2D.JOB A function for receiving an input of a coordinate (X, Y) of a 2D point and acquiring the distance from the origin and returning it to ldLen.	‘Calc. Euclid dist. 2D PARAM ldLen,ldX,ldY DIM ldTmp AS Double ‘ ldTmp=ldX*ldX+ldY*ldY ldLen=SQR(ldTmp) END 																								

0108_Avg.JOB A function for calculating the average of the real numbers according to the account of "liNData" stored in "IdaData[]" and returning it to "IdAvg."	<pre> 'Calc. Average PARAM IdAvg,IdaData,liNData DIM lildx AS Integer DIM IdSum AS Double ' IdSum=0. FOR lildx=1 TO liNData IdSum=IdSum+IdaData[lildx] NEXT IdAvg=IdSum/liNData END </pre>

This job consists of Program 1, the main program, and Program 105 and 108, the sub programs, The 105 program is a function for acquiring the Euclidean distance from the origin to the coordinate (IdX, IdY) and returning it to the IdLen, the output parameter. The 108 program is a function for acquiring the average of elements in a real number array, delivered into IdaData in the number of liNData, and returning it to the IdAvg, the output parameter. As the Euclidean distance or the average is frequently calculated, the two functions will be reused usefully in other future projects.



10.4.5. Variable dialog box

The function described in this chapter cannot be used for controllers whose version is lower than Hi5

The variable dialog box is an interface for the users to check and edit the current configuration and value. Pressing [Ctrl] + [F4] will bring up the variable dialog box.

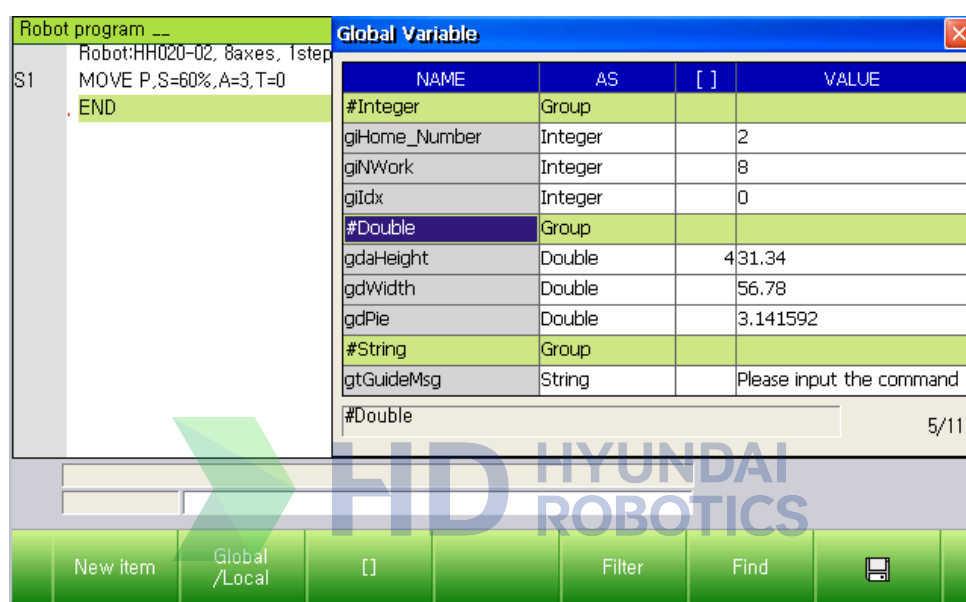


Figure 10.2 Variable dialog box

10.4.5.1. Edit

When 『[F1]: New item』 is pressed, a new item will be inserted into the position of the cursor. Press the [ENTER] key in the Name line and enter the variable name by using the soft keyboard.



The item in the current position of the cursor can be deleted by pressing [SHIFT] [DEL/←].

Place the cursor in the “As” line and press [ENTER] and then the variable type can be set by using the F key.

10. Robot Language

#String	Group		
gtGuideMsg	String		
<end>			
String			

10/10

Group	Integer	Real number	String	Pose	Shift

For the reference variables of input, output and M relay, simply enter the input variable, the output variable, and the _M variable name in the “As” line.

gyMode	DOB5		0
<end>			
DOB5			

11/11

Group	Integer	Real number	String	Pose	Shift

When the editing of all global variables is completed, press the 『[F7]: save』 button to copy and save the edited content into the “G00.IDV” file and apply it to the system at the same time.

If the title bar of the dialog box is marked with *, it means that the current value is being edited. In this state, the current value of each variable in the value line will not be monitored. Press the 『[F7]: save』 button. Then, the * mark will disappear and the current value of each variable can be monitored through the value line.

The following is an example of a saved “G00.IDV” file. HRView or USB memory can be used to copy it to a PC, then edited using a text editor, and copied back to the controller.

Controller Operation Manual

```

Entry Text File Format Version: 1.0
_G00.IDV( ID Variable )
giDbg          AS Integer = 0
giNCrd         AS Integer = 4
gdaCrd[8]      AS Double
  [1]=5
  [2]=12.8
  [3]=6.4
  [4]=11.7
  [5]=6.1
  [6]=10.9
  [7]=4.7
  [8]=10.4
gdAvg          AS Double = 0
gtMsg          AS String = "Input next work number:"
gtaErr[2]      AS String
  [1]="Invalid number"
  [2]="Time-over"
gpStart        AS Pose = (1402.813,-127.784,1335.716,47.603,83.119,48.069,&H0000)
gpaMid[3]      AS Pose
  [1]=(0.658,79.832,15.117,13.971,8.34,-1.872)A
  [2]=(0.566,76.387,15.747,6.947,2.518,-1.872)A
  [3]=(0.42,71,15.117,6.947,8.34,-1.872)A
gmTmp          AS _MW3
gxSensOk       AS FB3.X22
gyMode         AS DOB5

```

10.4.5.2. Monitoring and modifying of values

The value line monitors the current value of each variable (However, it does not monitor while in the editing (* mark) mode)

In the value line, press the [Enter] key and input a new value, and then press the [Enter] key to assign the newly entered value to the variable (In this process, there is no need to press the 『[F7]: save』 button because this process is for editing the value, not the variable type.)

Pose and shift variables can be edited easily in this way. However, considering that in this method, the values of pose and shift constants need to be typed in directly, it may be difficult to convert coordinates or modify “config.”. Place the cursor on the pose or shift variable line and press the [QuickOpen] key. Then, the pose dialog or the shift dialog will be displayed, allowing easy editing.

Pose-type ID variable

ID []

Unit =

S	=	0.658	deg	T1	=	0.000	mm
H	=	79.832	deg				
V	=	15.117	deg				
R2	=	13.971	deg				
B	=	8.340	deg				
R1	=	-1.872	deg				

Coordinate = ☐ Base ☐ Robot ☒ Axis ☐ Enc ☐ U ☐ Un

Figure 10.3 Variable dialog box

10.4.5.3. Array

gdaCrd	Double	0	5

If the variable is an array, the value of the first element will be displayed in the value line. In order to check or edit the values of all elements, press the 『[F3]: []』 key to enter the array mode. In order to exit the array mode, press the [ESC] key.

Global Variable

NAME	AS	[]	VALUE
gdaCrd	Double		15
			212.8
			36.4
			411.7
			56.1
			610.9
			74.7
			810.4

Double3/11



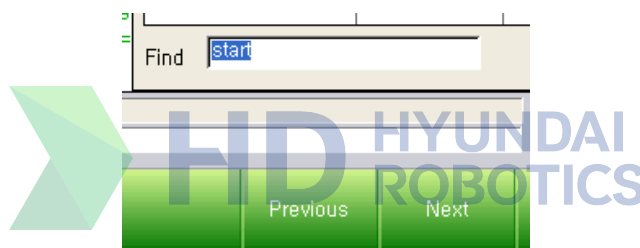
10.4.5.4. Variable group, filter and find

If the “As” line is designated as Group, the relevant item will be the group name, not the variable. As the group name will be displayed in a different color in the variable dialog box, it can be used to sort variables by type.

At the top of the variable dialog, the variable type filter buttons are available. When a filter button is pressed, variables of the relevant variable type will be displayed on the dialog box. In order to display all variables, press the [All] button.



It is possible to use the find function to search the variable name that contains specific strings. Press the 『[F6]: Find』 key and enter the string for the search by using the soft keyboard. Then, press 『[F7]: Complete』 key to enter the find mode.



Press the [F4: Previous], [F5: Next] buttons, and then the cursor will move to the position of the previous or next name that contains the string (compared regardless of uppercases and lower cases.)

10.4.6. System Variable

These variables are used for the acquisition or setup of internal state of the system.

Values cannot be inputted in read-only variable. In other words, read-only variable cannot be on the left side of assignment statement.

Table 10-25 Robot language system variable

Command	Description	property	Supported version
_RN1~16 or _RN[1]~_RN[16]	Counter register 1~16		V40.01-00~
_TEINPUT	Variable to set the method for recognizing the end of a string when entering the string through the controller by using the serial port. + value: When they entered ASCII code value matches with the set value of _TEINPUT, the end of the string will be recognized. - value: When the absolute value of the set value of _TEINPUT matches with the count of the entered strings, the end of the string will be recognized.		V40.01-00~
_PALCNT	To count the work corresponding to the pallet number when the palletizing process is carried out.		V40.01-00~
_SPDRATE	To select the ratio of the playback speed of the robot when trying to arbitrarily change and apply it in the program. Its unit is %.		V40.01-00~
_ACCRATE	To select the ratio of the acceleration speed of the robot when trying to arbitrarily change and apply it in the program. Its unit is %.		V40.01-00~
_DECRATE	To select the ratio of the deceleration speed of the robot when trying to arbitrarily change and apply it in the program. Its unit is %.		V40.01-00~
_INT.NO	Variable to gain the number of the interrupt that occurs in the interrupt function.	Read only	V40.01-00~
_INT.TARGET	Select the arrival completion of the step which is in the process of moving when the interrupt function is being executed. 0: After the interrupt activity is completed, moving to the step, which was in the process of moving previously, will occur. 1: After the interrupt activity is completed, moving to the next step of the step that was in the process of moving previously will occur.	Read only	V40.01-00~
_SensorPos	Sensor position in the sensor synchronization function (Distance between the start limit switch and the work)	Read only	V40.01-00~
_StoPoDt1~10 or _StoPoDt[1] ~ _StoPoDt[10]	Variable for the axis data to be saved by StoPoCnd statement		V40.01-00~

10. Robot Language

_MacInSpd	(Macro Inspection Speed) LCD inspection robot speed. The unit is %	Read only	V40.01-00~
_TIPWEAR	Total abrasion of the servo gun or the equalizer less gun		V40.01-00~
_OrtAcDcR	Posture interpolation ratio variable. 1 ~ 100 can be entered		V40.01-00~
_SensorPls1	Encoder pulse count of the conveyor board channel 1	Read only	V40.01-00~
_SensorPls2	Encoder pulse count of the conveyor board channel 2	Read only	V40.01-00~
_SensorStat	Conveyor board state Bit 0: Encoder disconnection error state (active high) Bit 1: Start limit switch (active high)	Read only	V40.01-00~
_MECHTYPE	Type number of the robot's main body currently selected in the system.	Read only	V40.01-00~
_TOTAL_AX	Total number of axes currently set in the system.	Read only	V40.01-00~
_AUX_AX	Total number of additional axes currently set in the system.	Read only	V40.01-00~
_AX_{name}	Axis number (1-base) for the selected axis name ({Name})	Read only	V40.01-00~
_CnstOrnt	Set whether to fix the TCP angle during the CMOV and SMOV movement. 0: Change the TCP angle, 1: Fix the TCP angle		V40.01-00~
_ZRATIO	Retrieve the distance ratio ($Z2/(Z1+Z2)$) of Z1 and Z2, when the distance of the lift axis (Z1, Z2) of the LCD transfer robot is different Example: V1!:=_ZRATIO	Read only	V40.01-00~
_Faststop	Sets whether to execute Faststop when the Until condition is met. Faststop: Erases the servo filter and outputs the current value as the instruction value.		V40.01-00~
_WrstIntp	Sets whether to handle the passing the B axis dead zone while executing the MOVE command as an error. 0: Move without an error through interpolation for the wrist axis 1: Handle it as an error		V40.01-00~
_SpotRunNo1~4	Count of weldings normally performed by the spot welders To be cleared automatically when the program starts. 1~4: Spot welder number		V40.01-00~
_SensorSpd1~4	Acquires the moving speed of the conveyor or press when using the sensor synchronization function. 1~4: Sensor number	Read only	V40.01-00~
_F*	Loads the sensor value when using the force sensor (X,Y,Z,Rx,Ry,Rz) Example of use: _F*.X	Read only	V40.01-00~

Controller Operation Manual

ArcOnTime	Actual welding time The time when the signal (WCR) is input during welding from the welding machine between ARCON and ARCOF (in seconds) commands	Read only	V40.06-00~
WCRTIME	Welding command time Elapsed time from ARCON to ARCOF (in seconds)	Read only	V40.06-00~

10.4.6.1. ENET parameter

10.5.9. Refer to ENET member parameter/command.

10.4.6.2. WEAVCmd member parameter

This is the member parameter used to set the parameter of the weaving function used in the arc welding. For details and using method of each member parameter, refer to the 『Hi5a controller arc welding function manual』

Table 10-26 Setting details by member parameter

Parameter name	Description	Example [Scope]
Type	Set the weaving type. [Simple, triangle, L type]	WEAVCmd.Type=0 [0,1,2]
Freq	Set the weaving frequency. [0Hz : Apply moving time]	WEAVCmd.Freq=1 [0.5 ~ 10.0 Hz]
PatVert	Set the oscillating distance in vertical direction (Wall direction)	WEAVCmd.PatVert=2.5 [1.0 ~ 25.0 mm]
PatHori	Set the oscillating distance in horizontal direction (Bottom surface direction)	WEAVCmd.PatHori=2.5 [1.0 ~ 25.0 mm]
PatAngle	Enter the angle between wall direction and bottom surface direction	WEAVCmd.PatAngle=90 [0.1~180 deg]
PatWalDi	Select the weaving wall direction. [Vertical, Horizontal]	WEAVCmd.PatWalDi=0 [0,1]
FwdAngle	Set the proceeding angle (Weaving direction vs welding line direction). [Execute weaving perpendicular to welding line when set to 0 degrees]	WEAVCmd.FwdAngle=0 [-90 ~ 90 deg]
BoundLmt	Set whether to use the boundary limit. [Enable, Disable]	WEAVCmd.BoundLmt=1 [0,1]
MoveTime	Set the moving time by each interval. The interval is classified by the script at the end of the parameter name.	WEAVCmd.MoveTime1=1 WEAVCmd.MoveTime2=1 [0.04 ~ 9.99 sec]
Timer	Set the time to stop only the weaving operation (Welding movement continues) between each interval. The interval is classified by the script at the end of the parameter name.	WEAVCmd.Timer1=1 WEAVCmd.Timer2=1 [0.0 ~ 2.00 sec]

10.4.6.3. AXIS member parameter

The member variable to obtain the state value of each.

Table 10-27 Setting details by member parameter

Parameter name	Description	Example [Scope]
CurFBack	Feedback current value of the corresponding axis [unit: Apeak] (Read-only) Support from V40.03-00	V45! = AXIS3.CurFBack
Softness	Setting the Softness value of the corresponding axis within the SoftJoint ON – SoftJoint OFF interval [unit:%] Support from V40.03-00	AXIS[V5%]. Softness = 50 [0 ~ 100]
TRC	Set whether its axis TRC function should be used. (This function is for engineers.) Currently supported robot: HS165-02, HS165S-02, HA010L-03, HA020-03 (Supported robots may be changed without notice.) Support from V40.07-00	AXIS[V5%]. TRC = 0 [1=ON / 0=OFF]

10.4.7. HiNet variable

You can send the variable status through HiNet connected to the collaborative network. Each controller monitors the signal between the collaborative robots and assigns the I/O for the part that is set to share so that the input and output are freely used. The size of the output that each controller can use is 4byte.

Use this variable so that the collaborative network can be applied to usages including detection of signal I/O without external interlock signal based on the robot language (HR-BASIC).

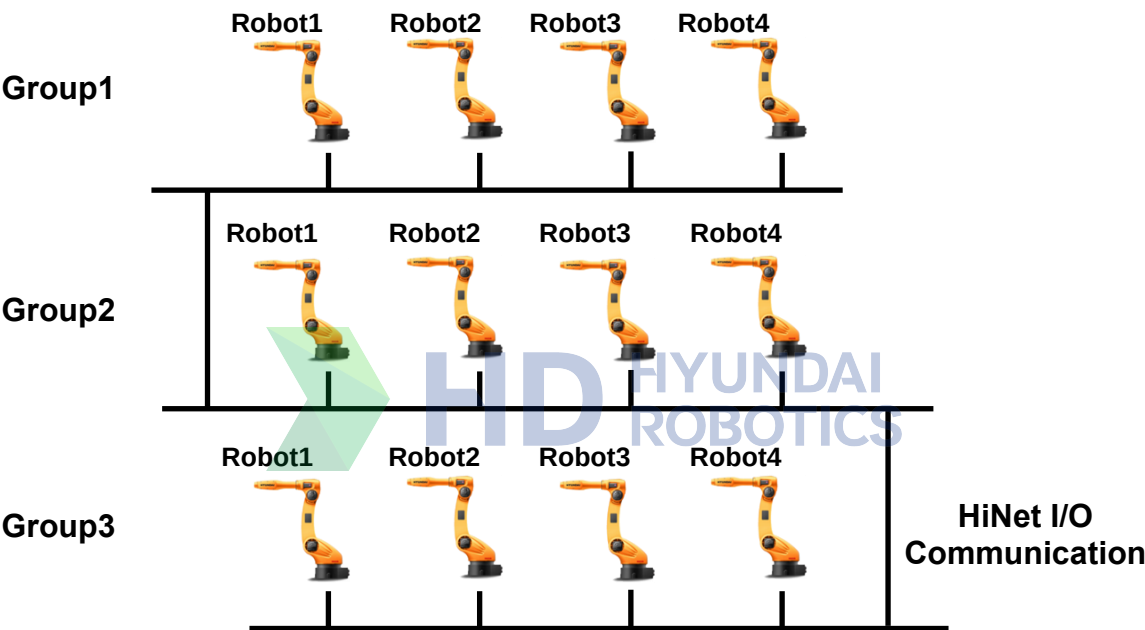


Figure 10.4 Cooperative Group / robot and HiNet I/O

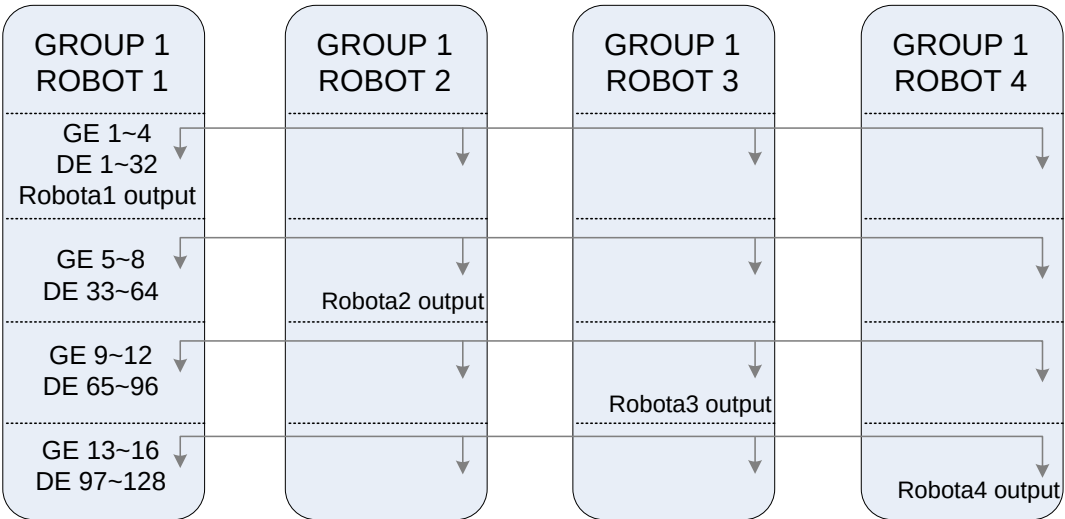


Figure 10.5 Examples using the HiNet I/O (Group Nos. 1–4 robots)

Table 10-28 Group number, output/input area in accordance with the robot number

Group(G) number Robot(R) number	GE (OUT)	GE (IN)	DE (OUT)	DE (IN)
	Output area assigned	Input area assigned	Output area assigned	Input area assigned
G# R#	$\{(G\#-1)*4+(R\#-1)*4+1$ ~ $\{(G\#-1)*4+(R\#-1)*4+4$	Among the 1~128 regions, excluding the allocated region of the output	$\{(G\#-1)*4+(R\#-1)*32+1$ ~ $\{(G\#-1)*4+(R\#-1)*32+32$	Among the 1~1024 regions, excluding the allocated region of the output
G1 R1	1~4	5~128	1~32	33~1024
G1 R2	5~8	1~4, 9~128	33~64	1~32, 65~1024
G1 R3	9~12	1~9, 13~128	65~96	1~64, 97~1024
G1 R4	13~16	1~12, 17~128	97~128	1~96, 129~1024

Controller Operation Manual

(1) DE/DE[] command

DE command is the variable used to access and assign the self-output area in HiNet I/O function in 1 bit unit.

DE[{subscript}]= {Parameter}	
Subscript	. Designate I/O output signal (1~1024) 0 : Select all I/O bit 1~1024 : Select applicable I/O bit
Parameter	. On/Off setting 1 : On 0 : Off

(2) GE/GE[] command

GE command is the variable to access and assign the self-output area in HiNet I/O function in 1 byte unit. It can read the value in 1byte for all areas including the self.

GE[{subscript}]= {Parameter}	
Subscript	. Designate input signal group (1~128) 0 : Select all I/O group 1~128 : Select applicable I/O group
Parameter	. Designate I/O signal of 1byte. (0~255)

(3) Example of application

Even though we can't describe all the examples of various applications using the robot language, the following screen displays a simple example. Because DE and GE are I/O that can be used as a variable, it has the advantage of being applied to various applications.

Robot program __	
S1	MOVE P,S=100%,A=1,T=0
S2	MOVE P,S=100%,A=1,T=0
S3	MOVE P,S=100%,A=1,T=0
	WAIT GE5=6
S4	MOVE P,S=30%,A=0,T=0
S5	MOVE L,S=500mm/s,A=0,T=0
S6	MOVE L,S=300mm/s,A=0,T=0
	DE1=1
S7	MOVE P,S=100%,A=0,T=0
	DE3=0
S8	MOVE P,S=50%,A=1,T=0
	IF DE2=1 THEN S11 ELSE S12
	ENDIF
S9	MOVE P,S=50%,A=0,T=0
S10	MOVE P,S=50%,A=0,T=0

Wait when data of group number 5 becomes 6

Turn on number 1 bit

Clear number 3 bit to 0

When number 2 bit is turned on, jump to step 11. If not jump to step 12



10.4.8. B (BUFV)

This buffer can store binary data regardless of the data type with a total size of 64 Kbytes. The argument(index) starts with 0 (0-based).

When multitasking is used, each task will have an independent BUFV.

BUFV0 ~ BUFV65535

or

BUFV[0] ~ BUFV[65535]

When the binary at a specific position in the buffer is to be handled as the desired type, the type property can be used.

The type property types for use are as follows.

endian	Property	type
Big endian	S1	signed integer (1byte)
	S2	signed integer (2byte)
	S4	signed integer (4byte)
	U1	unsigned integer (1byte)
	U2	unsigned integer (2byte)
	U4	unsigned integer (4byte)
	F4	single prec. real (4byte)
	F8	double prec. real (8byte)
Little endian	s1	signed integer (1byte)
	s2	signed integer (2byte)
	s4	signed integer (4byte)
	u1	unsigned integer (1byte)
	u2	unsigned integer (2byte)
	u4	unsigned integer (4byte)
	f4	single prec. real (4byte)
	f8	double prec. real (8byte)

Example No.1 :

If the 4 bytes starting from the position of offset 24 in BUFV are to be interpreted as integer values in the little-endian format and then assigned to the g_iY variable, the assignment statement shown below must be executed.

```
g_iY = BUFV[24].s4
```

“.s4”. represents the type property. “s” refers to the signed integer, and “4” refers to 4 bytes. Because

“s” in lowercase, it shall be interpreted as little-endian.

Example No. 2 :
If the operation result is to be saved in 8 bytes, starting from the position of offset 1500 in BUFV in the big-endian double precision real number format, the assignment statement shown below must be executed.

```
BUFV[1500].f8=(V5!+140.8)/2.5
```

10.4.9. Operator

Table 10-29 Operator priority

()	↑ High priority
Symbols (+ -)	
^	
* / W MOD	
+ -	
= <> < > <= >=	
NOT	
AND OR XOR	↓ Low priority

Example V10! = (V1!^2 + V2!^2 + V3!^2)*2.5
IF(V24!)>V50! AND V10\$= "WELD")

 Reference

- For string operation, only three operators – ‘+ (connecting two strings),’ ‘= (equal)’ and ‘<> (not equal)’ – are available.
- Pose calculation can only be done in <Pose>+<Shift>+<Shift>+<Shift>+... format.
- “W” is the integer division that divides the left value by the right value and then rounds up.
- MOD is an operation to calculate a remainder of a division.

Controller Operation Manual

- AND, OR and XOR are bit operators. If these operators need be used as logical operators, operand should be 0 or 1 to assure correct results.
- NOT is only used as bit operator. There is no logical NOT. Deal with such problems using <> properly.
- In case of operation between integers and real numbers, execute operation after automatic type conversion of integer into real number. (Operation result is real number.)

10.4.10. Expression

Table 10-30 Types of robot language expressions

Arithmetic expression	Integer, real number, integer variable, real number variable, input/output variable, arithmetic function, pose element, shift element and operation formula whose result is integer or real number are included. Example: -10, 10.12, V1%, V1!, SQR(V1%), P1.X, R2.Y, (V2!+V3!)/2+&HC000, V1%+GI2, DI1+DI2*2+DI3*4, AI3<5.2
String expression	String constant, string variable, string function and operation formula whose result is string are included. Example : "COMM ERR", "ABCD"+"EFCD", LEFT\$("ROBOT INIT", 5)
Pose expression	Pose constant, pose variable and operation formula whose result is pose are included. Example: (204.5, 37.35, 2.94, 0, 50, 0, 24)R+(0, 10, 0, 0, 0, 0)T, P1+R1

10.5. Statement

10.5.1. Motion, I/O

10.5.1.1. MOVE

Explanation	Ends of robot tool move to target pose.		
Syntax	MOVE <Interp.>, [<Pose>], S=<Speed >, A=<Accu.>, T=<Tool number> [,<Output option>] [UNTIL <Condition>[,<Interrupt state variable>]]		
Parameter	Interp.	P : Axis interpolation, L: linear interpolation, C: circular interpolation SP: Static tool axis interpolation, SL: Static tool linear interpolation, SC: Static tool arc interpolation	
	Pose	Target pose. In case of hidden pose, it is omitted, or only shift formula is assigned.	Pose formula
	Speed	Moving speed of tool ends. Unit (mm/sec, cm/min, sec, %) should be accompanied.	Arithmetic formula
	Accu.	Arithmetic formula. The lower, the more precise In the case of 0, discontinue operation	0~7
	Tool number	Number of tools to be used during robot operation	0~15
	Output option	X1, X2, X3, X4, PU, PK, PS (Multiple assignments are possible.)	
	Condition	When a conditional formula is true, robot motion is ended, and is considered to reach the assigned pose.	If not 0, true. If 0, false.
	Interrupt state variable	Result value of conditional formula is kept. This indicates whether MOVE motion is ended by conditional formula.	Used with UNTIL command.
Example	MOVE C,P[0]+R[1],S=800mm/s,A=0,T=1 MOVE P,R1, S=80%,A=1,T=3 UNTIL DI1 (Hidden pose) MOVE L,S=0.5sec,A=0,T=0, X1 UNTIL DI2=&H7F,V1% (Hidden pose)		



Reference

- If MOVE command is inputted by a <REC> key on T/P, it becomes hidden pose form.
- If shift formula is recorded in <pose> on T/P, it becomes hidden pose form and the target pose becomes (hidden pose + shift formula).
- Output options are X1, X2, PU, PK and PS in the palletizing mode. 'X1 and X2' and 'PU, PK, PS'

Controller Operation Manual

cannot be assigned at the same time. Refer to 『Hi5a Controller Palletize Function Manual』 for detailed explanation about the individual member variables.

10.5.1.2. PRINT

Explanation	Assigned data is printed on teach pendant screen or serial port.	
Syntax	PRINT <output direction>,<info,...>	
Parameter	Output direction	#0 : teach pendant #1 : serial port COM 1 #2 : serial port COM 2 ENET1 : Common Ethernet port (EN2) object 1 ENET2 : Common Ethernet port (EN2) object 2 ENET3 : Common Ethernet port (EN2) object 3
	Information	Arithmetic formula, string formula
Example	PRINT #0, "SIGNAL VALUE = "; V1!	
Remark	If there is ';' in the space between data, the data are distinguished by printed space as a character. If there is ';' no space is printed. If there is ';' at the end, new-line character is not attached.	

10.5.1.3. INPUT

Explanation	Data is inputted from teach pendant screen or serial port in the form of variables.		
Syntax	INPUT <input direction>, <variable> , [<timeout time>], <shelter address>]		
Parameter	Input direction	#0 : teach pendant #1 : serial port COM 1 #2 : serial port COM 2 ENET1 : Common Ethernet port (EN2) object 1 ENET2 : Common Ethernet port (EN2) object 2 ENET3 : Common Ethernet port (EN2) object 3	
	Variable	Arithmetic variable, string variable	
	Timeout	Arithmetic formula: When the designated time passes, it moves to the next row. When it is 0, the key value entered prior to the execution is saved to the parameter, and if there was no key entry, the parameter value is maintained.	Sec unit 0.0~60.0
	Shelter address	Branch address when timeout is over	shelter address
Example	INPUT #1, V20!, 5 INPUT #0, V1\$ INPUT ENET3, BUFV[0], 10		
Remark	On teach pendant, input is completed by [ENTER]. On serial port, input is completed by recognizing NULL character (ASCII code 0). When a string that cannot be interpreted as a number when the numeric parameter is entered, the existing value of the parameter is maintained. When it is not entered within the designated time, the existing value of the parameter will be maintained. When the timeout period is set to 0, the value entered using the [Number] key of the teach pendant beforehand will be entered and if there is not key value entered, the existing value of the parameter will be maintained.		

10.5.1.4. Signal output

Explanation	Output signal to designated port as output variable.	
Syntax	〈Output variable〉 = 〈Output value〉	
Parameter	Output variable	Parameter corresponding to the output signal. DO, DOB, DOW, DOL, DOF parameter corresponding to common output AO variable corresponding to analog output signal SO variable corresponding to exclusive output signal
	Output value	Calculation formula. (If the number is a real number, drop the decimal points) For single signal output(DO), 0 is OFF and non-zero is ON Because the DOF or analog output uses a real number, the decimal points are also used.
Example	DO3 = 1 DOB2 = &H7F AO2 = 3.4	

**Reference**
HD HYUNDAI
ROBOTICS

- For details on signal output, refer to I/O variable.

10.5.1.5. WAIT

Explanation	Program waits until condition formula is satisfied. If timeout time is up, the program is branched to withdrawal address.		
Syntax	WAIT <condition>[,<timeout time>,<shelter address>]		
Parameter	Condition	Arithmetic formula. Standby until the condition formula is satisfied.	If 0, true. If not, false.
	Timeout time	Arithmetic formula. Waiting limit time	Unit : sec (0.0~60.0)
	Shelter address	Branch address when timeout is over.	
Example	WAIT D120=1, 1.5, *ERR		

10.5.1.6. SMOV

Explanation	Ends of robot tool move to target pose. Positioner synchronous motion.		
Syntax	SMOV <Positioner No.>,<Interp.>,<Pose>], S=<Speed>, A=<Accu.>, T=<Tool> [,<Output option>] [UNTIL <Condition>[,<Interrupt state variable>]]		
Parameter	Positioner No.	Refer to "Positioner Synchronous Function Manual."	
	Interp.	P : Axis interpolation, L : linear interpolation, C : circular interpolation SP : Static tool axis interpolation, SL: Static tool linear interpolation, SC: Static tool arc interpolation	
	Pose	Pose formula. Target pose. In case of hidden pose, it is omitted, or only shift formula is assigned.	
	Speed	Arithmetic formula. Moving speed of tool ends. Unit (mm/sec, cm/min, sec, %) should be accompanied.	
	Accu.	Arithmetic formula. 0~7. 0 is the most accurate.	
	Tool	Arithmetic formula. 0~15	
	Output option	X1, X2, X3, X4, PU, PK, PS (Multiple assignments are possible.)	
	Conditional formula	When a conditional formula is true, robot motion is ended, and is considered to reach the assigned pose.	If not 0, true. If 0, false.
	Interrupt state variable	Result value of conditional formula is kept. This indicates whether MOVE motion is ended by conditional formula.	Used with UNTIL command.
Example	SMOVE S1,C,P[0]+R[1],S=800mm/s,A=0,T=1 SMOVE S1,P,R1,S=80%,A=1,T=3 UNTIL DI1 (Hidden pose) SMOVE S1,L,S=0.5sec,A=0,T=0,X1 UNTIL DI2=&H7F,V1% (Hidden pose)		

**Reference**

- Refer to "Positioner Synchronous User Guide" for details about SMOV.
- If [REC] key is pressed in the positioner synchronous mode, SMOV command, not MOVE command, is inputted.
- If shift formula is recorded in <pose>, it becomes hidden pose form.
- Output options are X1, X2, PU, PK and PS in the palletizing mode. 'X1 and X2' and 'PU, PK and PS' cannot be assigned at the same time. Refer to 『Hi5a Controller Palletize Function Manual』 for details.

10.5.1.7. CONTPATH

Explanation	Consecutive path is selected.		
Syntax	CONTPATH <Option>		
Parameter	Option	0: If the step includes command (function), the command (function) is executed after reaching step position, and moves to the next step.	
		1: Commands recorded in the target step do not stop after execution, and pass the target step to the next step. If the command is output command, it is outputted when the order value reaches in the accuracy range. Also, if input signal is used for command parameter, it is treated as discontinuous. When the order value reaches in the accuracy range, the command is executed and moves to the next step.	
		2: Even commands including input signals are analyzed and consecutively move.	
Example	CONTPATH 0 CONTPATH 1 'Consecutive handling (except for input signals) CONTPATH 2 'Consecutive handling including input signals		

**Reference**

- If CONTPATH command is not explicitly executed, CONTPATH 1 will be applied by default. Even when the command is explicitly designated, it will be reset to CONTPATH 1 before the cycle starts.
- Input signal: DI, GI, FBn., AI, DE, GE, INPUT
- Output signal: DO, GO, FBn., AO, DE, GE, PRINT, ENET
- Other discontinuous conditions
 - ① When RINT(Robot interrupt) or UNTIL command is in operation
 - ② Discontinuous operation: Under Step FWD and discontinuous conditions, Step BWD and one step are executed.
 - ③ Steps with GUN1 or GUN2
 - ④ When Acc=0 and the value is 0
 - ⑤ When tool number is changed

10.5.1.8. ENDLESS

Explanation	This function is to reset or revolve the assigned axis for recorded number of rotations. (Set this function available on the ENDLESS axis setup screen.)	
Syntax	ENDLESS <Axis name>=<The num. of rot.> ENDLESS RESET ENDLESS ZERO	
Parameter	Axis name	R1: Axis R1, T1~T16 : additional axis 1~16
	The num. of rot.	Number of rotations of an axis to be applied to the first step after command is given. (1=360deg, -1=-360deg)
	RESET	Current axis rotation value is converted to “-180deg ~ 180deg” value.
	ZERO	Always set the current axis rotation value to 0deg.
Example	<pre> S1 MOVE P,S=50%,A=0,T=0 ENDLESS R1=10 S2 MOVE P,S=50%,A=0,T=0 (→ Axis R1 moves to where 10 more rotations than the recorded position of step.) ENDLESS T1=10 ENDLESS T2=10 S3 MOVE P,S=50%,A=0,T=0 (→ Axis T1 and Axis T2 move to where 10 more rotations than the recorded position) ENDLESS T1=10 S4 MOVE L,S=800mm/s,A=0,T=0 (→ ENDLESS rotation command is not executed except MOVE P.) ENDLESS RESET (→ Axis out of one rotation range is converted to -180deg ~ +180deg value.) END </pre>	

**Reference**

- Steps where ENDLESS command is executed are automatically converted to the value within one rotation after revolving for the assigned times.

10.5.1.9. COLDET

When the collision detection function is available, COLDET command sets collision detection level of a robot. For collision detection function availability setup and collision detection value according to level, go to 『[F2]: System』 → 『3: Robot parameter』 → 『8: Set the collision detection (of each axis)』 . (This menu is shown only when the robot that can use the collision detection function is selected.)

When the collision detection function is enabling, its detection level is level 1 without COLDET command. Under COLDET command, collision detection is executed at the proper level until next COLDET command is given. If COLDET is 0, the collision detection function becomes disabling. In manual operation mode, Level 1 is applied.

Explanation	Collision detection level setup	
Syntax	COLDET <level>	
Parameter	level	0~4
Example	When the collision detection (of each axis) function is available and operation program is as follows: <pre> S1 MOOE S2 MOVE COLDET 2 S3 MOVE COLDET 0 S4 MOVE S5 MOVE END </pre> Detection level is 1 at step 1 and step 2, the level is 2 at step 3, and collision detection is unavailable after step 4.	
Remark		

10.5.1.10. Collision

Users can set the collision detection level while the TCP-based collision detection function is set as enable. The menu for setting the collision detection function as Enable/Disable and the collision detection value based on sensitivity can be entered by selecting 『[F2]: System』 → 『3: Robot parameter』 → 『8: Collision detection (TCP) setting』 (This menu will be displayed only when a robot supports the collision detection menu).

When the collision detection function is set as “Enable”, detection will occur based on the default sensitivity set in the menu window if there is no collision command. In auto mode, detection will occur based on the sensitivity set in “sensitivity (auto mode)”, and in jog mode, detection will occur based on the sensitivity set in “sensitivity (jog mode)”. If there is a collision command, detection will occur based on the relevant sensitivity until the next collision command is received. As the sensitivity gets closer to 0, collision detection will occur with higher sensitivity.

Explanation	Sets the collision detection level	
Syntax	Collision <Sensitivity>	
Parameter	Level	0~100
Example	When the collision detection (TCP) function is set as enable and the work program is as shown below. <pre> S1 MOOE S2 MOVE Collision 30 S3 MOVE Collision 10 S4 MOVE S5 MOVE END </pre> In Step 1 and Step 2, detection will occur based on the sensitivity of 100. In Step 3, detection will occur based on the sensitivity of 30 and from Step 4, detection will occur based on the sensitivity of 10.	
Remark		

**Warning**

- If the sensitivity is set too low, errors in detection will occur.

10.5.1.11. COWORK

Explanation	This command designates master robot and slave robot by using the cooperative handling function, and starts and ends the synchronous motion of the robots.	
Syntax	COWORK <Robot role>,<Relative robot number>,T=<Standby time>	
Parameter	Robot role	M: master robot, S: slave robot, END: cooperative control end WITH : Standby until another robot meets COWORK WITH
	Relative robot number	Role and number of relative robot are designated. When robot role is designated as M, slave robot number is assigned. S = Number 1, number 2, number 3 When robot role is designated as S, master robot number is assigned. M = robot number
	Standby time	Waiting time until relative robots reach the COWORK command
Example	<pre> S1 MOVE P,S=100%,A=0,T=0 S2 MOVE P,S=100%,A=0,T=0 S3 MOVE P,S=100%,A=0,T=0 DO1=1 COWORK M,S=2,T=30 → Robot role is master, cooperative control begins, and slave waiting time is 30 seconds. S4 MOVE L,S=800mm/sec,A=0,T=0 S5 MOVE L,S=500mm/sec,A=0,T=0 S6 MOVE L,S=800mm/sec,A=0,T=0 COWORK END → Cooperative control ends. DO1=0 S7 MOVE P,S=100%,A=0,T=0 </pre>	

**Reference**

- To use the COWORK function, more than two robots should be connected to the cooperative control network.
- Refer to 『Hi5a Controller “Cooperation Control” Function Manual』 for details.

10.5.1.12. TRIGGOUT

Explanation	This commands adjusts the signal output time to First Out (-) or Last Out (+) that occurs from the command location where the accuracy is OK in the interval where it is processed continuously with CONTPATH 1 or 2.	
Syntax	TRIGGOUT <Output variable>=<Output value>, OT=<FO, LO time>	
Parameter	Output variable	Parameter corresponding to the output signal. DO, DOB, DOW, DOL, DOF parameter corresponding to common output AO variable corresponding to analog output signal SO variable corresponding to exclusive output signal
	Output value	Calculation formula. (If the number is a real number, drop the decimal points) For single signal output(DO), 0 is OFF and non-zero is ON For analog output, the decimal in real number is also used
	FO(-), LO(+)time	-10.00 ~ 2.00 [sec] When (-), the signal is outputted first and when (+) later.
Example	TRGGOUT DO3 = 1,OT=1.23 TRGGOUT DOB2 = &H7F,OT=-2.34 TRGGOUT AO2 = 3.4,OT=0.12	

10.5.1.13. CLR_RBUF

Explanation	If you don't know if there is a residual string not recognized in the received buffer of the INPUT statement before receiving the new string with the INPUT command, you can empty the buffer with this command.	
Syntax	CLR_RBUF <Input direction>	
Parameter	Input direction	#0 : Teach pendant #1 : Serial port COM 1 #2 : Serial port COM 2 ENET1 : Common Ethernet port (EN2) object 1 ENET2 : Common Ethernet port (EN2) object 2 ENET3 : Common Ethernet port (EN2) object 3
Example	CLR_RBUF #1 CLR_RBUF ENET2	

10.5.1.14. MKDIR

Explanation	This command creates a designated folder in a T/P flash memory, a USB memory, or an external PC.		
Syntax	MKDIR < Result parameter >,< File location >,< File path >		
Parameter	Result parameter	Result is saved after the execution. 1: Success -1: Failed Path type error (The file path should be an absolute path.) -2: Failed No intermediate path -3: Failed An existing directory -9: Other error	
	File location	TP: Teach Pendant USB: / (root) of USB memory EXT: External PC	
	File path	New file path (It should be an absolute path, namely a path starting with "/".)	
Example	V9%=0 MKDIR V9%,TP,"/work/L709" WAIT V9% (This creates a new Directory, L709, in the path, /work/, of the teach pendant, and waits until completion.)		

**Reference**

- This function is available in Hi5a V40.08-00 or higher versions.
- When using the original location as EXT, LOADF/SAVEF service must be running on the external PC.
- The path created in the example will be expressed in the File Manager as the path, /work/L709, under the T/P.
(It corresponds to the /ResidentFlash/work/L709 path in the T/P.)
- No intermediate path will be created. (For example, in the example, the intermediate directory, /work/, should exist before the file creation.)

10.5.1.15. LOADF

Explanation	This is the command to copy the controller file located in T/P flash memory, USB memory or external PC to the main board. This is the function to store large scale step data in large supplementary memory device to open and play during the task.		
Syntax	LOADF <Result parameter>,<Original location>,<Original path file name>[,<Target file name>]		
Parameter	Result parameter	Result is saved after the execution. 1 : Success -1 : Failed to open original file -2 : Failed to open target file -3 : Failed to record target file -4 : Unsupported file type -5 : Target file is protected -6 : Cannot copy during playback -9 : Other error	
	Original location	TP : /prj/ of teach pendant USB : / (root) of USB memory EXT : External PC	
	Original path file name	Path + File name of original file to copy	
	Target file name	If the target file name to copy to main board is omitted, apply the same file name as the original file name	
Example	V9%=0 LOADF V9%,TP,"L203/2500.JOB","0001.JOB" WAIT V9% (This copies the /prj/L203/2500.JOB file of the T/P to the 0001.JOB file of the mainboard, and waits until the completion.)		

**Reference**

- When using the original location as EXT, LOADF/SAVEF service must be running on the external PC.
- In the example, the file designated as the original path file name parameter will be expressed in the File Manager as the 2500.JOB file in the /prj/L203 folder under the T/P. (It corresponds to the /ResidentFlash/prj/L203/2500.JOB file in the T/P.)
- (Available in Hi5a V40.08-00 or higher versions) The original path file name may start with "/". The difference is as follows: When "/" is omitted, TP/prj/ will be the basis; and when the file name starts with "/", TP/ will be the basis.

Original path file name parameter	Location in the File Manager.
"L203/2500.JOB"	TP/prj/L203/2500.JOB

"/L203/2500.JOB"	TP/L203/2500.JOB

- Wildcards may be used in the original path/file name. When a wildcard is used in the file name, the target file name should be omitted.
(e.g. LOADF V1%,TP,"L203/2*.JOB")



10.5.1.16. SAVEF

Explanation	This is the command to copy the controller file located in main board to T/P flash memory, USB memory or external PC. This is the function to back up the task program edited on the main board in robot language command.		
Syntax	SAVEF <Result parameter>,<Target location>,<Target path file name>[,<Original file name>]		
Parameter	Result parameter	Result is saved after the execution. 1 : Success -1 : Failed to generate target file -2 : Failed to open original file -9 : Other error	
	Target location	TP : /Resident Flash/prj/ of teach pendant USB : / (root) of USB memory EXT : External PC	
	Target path file name	Path + File name of target file to be copied	
	Original file name	If the original file name to copy from the main board is omitted, apply the same file name as the target file name.	
Example	V9%=0 SAVEF V9%,TP,"L203/2500.JOB","0001.JOB" WAIT V9% (This copies the 0001.JOB file of the mainboard to the /prj/L203/2500.JOB file of the T/P, and waits until the completion.)		

**Reference**

- When using the original location as EXT, LOADF/SAVEF service must be running on the external PC.
- In the example, the file designated as the target path file name parameter will be expressed in the File Manager as the 2500.JOB file in the /prj/L203 folder under the T/P.
- (Available in Hi5a V40.08-00 or higher versions) The target path file name may start with "/". The difference is as follows: When "/" is omitted, TP/prj/ will be the basis; and when the file name starts with "/", TP/ will be the basis.

Original path file name parameter	Location in the File Manager
"L203/2500.JOB"	TP/prj/L203/2500.JOB
"/L203/2500.JOB"	TP/L203/2500.JOB

- (Available in Hi5a V40.08-00 or higher versions) When the target path file name parameter ends with "/", it will be recognized as a path. In this case, the original file name may not be omitted. (e.g. SAVEF V1%,TP,"/work/RF705/", "G00.POS")

- (Available in Hi5a V40.08-00 or higher versions) Wildcards may be used in the original file name. When a wildcard is used in the designated file name, the target path file name parameter should be designated as a path.
(e.g. SAVEF V1%,TP,"/work/RF705/", "2*.JOB")



10.5.1.17. SELPTNO

Explanation	Enter the stationary tool number. This command sets the XYZ value of the stationary tool coordinate system according to the selected stationary tool number.	
Syntax	SELPTNO TN=<Stationary tool number>	
Parameter	Stationary tool number	0 ~ 3
Example	S1 MOVE L,S=300mm/s,A=0,T=0 SELPTNO TN=1 → Select stationary tool number 1 S2 MOVE SL,S=300mm/s,A=0,T=0 → Linear interpolation step by stationary tool number 1 coordinate S3 MOVE L,S=300mm/s,A=0,T=0 → Linear interpolation step by robot tool coordinate SELPTNO TN=0 → Select stationary tool number 0 S4 MOVE SL,S=300mm/s,A=0,T=0 → Linear interpolation step by stationary tool number 0 coordinate S5 MOVE SL,S=300mm/s,A=0,T=0 → Linear interpolation step by stationary tool number 0 coordinate S6 MOVE L,S=300mm/s,A=0,T=0 → Linear interpolation step by robot tool coordinate END	

**Reference**

- Stationary tool number runs from 0 to 3, and 0 is the default value.
- Set the stationary tool coordinate system from 『F2』: System → 『2』: Control parameter → 『7』: Coordinate registration → 『2』: Stationary tool coordinate menu.
- For the stationary tool number, when “Stationary tool” of 『F7』: Condition setting → 『8』: Interpolation base is selected, you can check the tool number of the status display window of the MANUAL or AUTO main screen.

10.5.1.18. AXISCTRL

Explanation	Set whether to move the additional axis to its targeted position when the position of each axis is moving due to the execution of the MOVE statement.		
Syntax	AXISCTRL <ON/OFF>, <Additional axis>, [<Additional axis>], [<Additional axis>], [<Additional axis>]		
Parameter	ON/OFF	ON : Enable, OFF : Disable	
	Additional axis	Totally up to 4 additional axes can be selected.	
Example	AXISCTRL OFF,T1,T2 : Select the enable state for the axis control of T1 and T2 MOVE P,S=80%,A=1,T=1 : Move except for the T1 and T2 axes AXISCTRL ON,T1 : Select the enable state for the axial control T1 MOVE P,S=60%,A=1,T=1 : Move, with the axis T1 included		

**Reference**

- Does not provide the axis control function for the axis of the robot.
- The relevant step does not perform the cornering due to being processes as discontinuous statement.

10.5.1.19. SoftXYZ

Explanation	As one of the sensor-less force control functions, this function allows the robot to be pushed based on the orthogonal coordinate by an external force	
Syntax	SoftXYZ <ON/OFF>,CRD=<reference coordinate>,[<user coordinate number>]	
Parameter	ON/OFF	ON: Enable, OFF: Disable
	CRD	Reference coordinated for the robot to be pushed. User coordinate numbers when the reference coordinates are U and Un.
Example	(Example 1) Allowing the robot to be pushed in the X, Y, and RY directions to be assembled in the Z direction. : Sets the root to be pushed, based on the robot coordinate (CRD=1), in 5mm/s for maximum within the range of -50~+50mm in the X and Y directions, and in 3 deg/s for maximum within the range of -3~+3 in the RY direction. <pre> S1 MOVE P,S=100mm/s,A=1,T=0 DELAY 2 LIMIT XnR,X=50, Y=50,RY=3 LIMIT VEL,X=5,Y=5,RY=3 SoftXYZ ON,CRD=1 'function start S2 MOVE ... SoftXYZ OFF 'function end END </pre>	
	(Example 2) Handling of injection-molded objects : Sets the robot to be pushed up to 300mm, based on the robot coordinate (CRD+1), in 200mm/s for maximum in the +Y direction. Sets the robot to be pushed only when 10% or more of the maximum torque is applied on the S, H, and V axes through the LIMIT THR command. <pre> S1 MOVE P,S=100mm/s,A=1,T=0 DELAY 2 LIMIT POS, +Y=300 LIMIT VEL,Y=200 LIMIT THR,S=10, H=10, V=10 SoftXYZ ON,CRD=1 S2 WAIT ... SoftXYZ OFF END </pre>	



Reference

- Before using the function through SoftXYZ ON, the maximum push distance, the maximum push speed, and axis threshold need to be set through the LIMIT POS, XnR, VEL, and THR commands.

- In order to increase the robot's sensitivity to the external force, it is recommended that the robot must be held for 1~2 seconds through the DELAY command before SoftXYZ ON.



10.5.1.20. OnLTrack

Explanation	Controls the robot by reflecting the positional increment when it is entered through the Ethernet by UDP/IP	
Syntax	OnLTrack <ON/OFF>,IP=<IP address>,PORT=<Port number>,CRD=<Base coordinate system>,[<User coordinate system number>],[Bypass],[Fn=<Frequency>]	
Parameter	ON/OFF	ON : Enable, OFF : Disable
	IP address	IP address of a PC for the Ethernet communication.
	Port number	Port number for the Ethernet communication.
	Base coordinate system	Arithmetic formula. The user coordinate system when the base coordinate system is U and Un (0=Base, 1=Robot, 2=Tool, 3=U, 4=Un).
	User coordinate system number	Arithmetic formula. The user coordinate system when the base coordinate system is U and Un
	Bypass	Whether to go through the filter (ON=Through, OFF=Not through).
	Frequency	Frequency to be applied when not going through the filter (Bypass ON).
Example	OnLTrack ON,IP=192.168.1.254,PORT=7127,CRD=1,Bypass,Fn=10 'OnLTrack function activating MOVE P,S=60%,A=1,T=1 'Moves the robot by reflecting the positional increment when it is entered through the Ethernet by UDP/IP OnLTrack OFF 'OnLTrack function ending	

**Reference**

- To be activated only in the OnLTrack ON ~ OFF range.
- Frequency will be meaningful only when the Bypass function is on.

10.5.1.21. LIMIT

Explanation	Statement for designating the robot's movement distance and speed when controlling the robot by reflecting the position increment through the SoftXYZ, SoftJoint, RHemming, ForceCtrl, and OnLTrack functions.	
Syntax	LIMIT POS,[+X=<+Xdistance>],[−X=<−X distance>],[+Y=<+Y distance>], [−Y=<−Y distance>],[+Z=<+Z distance>],[−Z=<−Z distance>] LIMIT VEL,[X=<X speed>],[Y=<Y speed>],[Z=<Z speed>], [RX=<RX speed>],[RY=<RY speed>],[RZ=<RZ speed>] LIMIT SFT,[S=<S softness>],[H=<H softness>],[V=<V softness>], [R2=<R2softness>],[B=<B softness>],[R1=<R1 softness>] LIMIT THR,[S=<S threshold>],[H=<H threshold>],[V=<V threshold>], [R2=<R2 threshold>],[B=<B threshold>],[R1=<R1 threshold>] LIMIT ANG,[S=<S angle>],[H=<H angle>],[V=<V angle>], [R2=<R2 angle>],[B=<B angle>],[R1=<R1 angle>] LIMIT XnR,[X=<X distance>],[Y=<Y distance>],[Z=<Z distance>], [RX=<RX angle>],[RY=<RY angle>],[RZ=<RZ angle>]	
Parameter	POS	Sets the robot's maximum movement distance (X,Y,Z directions)
	VEL	Sets the robot's maximum operating speed (X,Y,Z,Rx,Ry, Rz directions)
	SFT	Sets the robot's softness of each axis (S,H,V,R2,B,R1 axes)
	THR	Sets the robot's threshold of each axis (S,H,V,R2,B,R1 axes)
	ANG	Sets the robot's rotational angle of each axis (S,H,V,R2,B,R1 axes)
	XnR	Limits the robot's maximum movement distance and angle (X,Y,Z,Rx,Ry,Rz) Designated values will be applied equally in the + and − directions. The robot's maximum operation area is determined by the union of POS and XnR.
Example	LIMIT POS,+Z=300 'Sets 300m as the maximum movement distance in the +Z direction LIMIT VEL,Z=40 'Sets 40mm/s as the maximum movement speed in the Z direction LIMIT SFT,B=50 'Sets 50 as the B axis softness LIMIT THR,H=10 'Sets 10% of the maximum torque as the H axis threshold LIMIT ANG,S=10 'Sets -10 ~ 10 deg as the S axis maximum rotational angle LIMIT XnR,X=200 'Sets -200mm~200mm as the maximum movement distance in the X direction	

**Reference**

- Needs to be used properly when necessary considering that this function is commonly used for SoftXYZ, SoftJoint, RHemming, ForceCtrl and OnLTrack.

10.5.1.22. SPDTRK

Explanation	Statement that changes the moving speed of the robot according to the ratio of the reference value against the input value in real time.		
Syntax	SPDTRK [ST=<ON/OFF>],[Input variable],[REF=<Reference value>],		
Parameter	ON/OFF	SPDTRK function On/Off setting	0:OFF, 1:ON
	Input variable	Input variable to change the moving speed of the robot.	
	Reference value	Input of the reference value equivalent to 100% of the robot's moving speed. Maximum moving speed ratio: 500%	0.0001 ~ 10000
Example	SPDTRK ST=1,AI3,REF=10.0 'SPDTRK function On, analogue input #3 value-induced moving speed. Ratio change. When 10.0V is inputted, movement occurs in the MOVE statement record speed (100%) MOVE L,S=10mm/s,A=1,T=0 'Robot's moving speed changes due to the analogue input value ratio SPDTRK ST=0,AI3,REF=10 'SPDTRK function Off		

**Reference**

- As the input values, the analogue input signals and general input signals can be used.

Controller Operation Manual

10.5.1.23. TOOLCHNG

Explanation	When a servo tool needs to be connected when another tool had been disconnected, there is a need for a series of processes involving the connection and disconnection of the servo tools. This function is for the automatic handling of those processes.		
Syntax	TOOLCHNG <ON/OFF/Fixed>,<Change target>,<Mechanical connection check>, <Check complete wait time>,<Multi-tool change target>		
Parameter	ON/OFF/Fixed	ON : Connection OFF : Disconnection Fixed : Changing only of the servo gun's fixed tips	
	Change target	G? : Servo gun number P? : Positioner number J? : Jig number	1~16
	Mechanical connection check	For checking whether a servo tool is connected mechanically.	condition formula
	Check complete wait time	Time to wait until a servo tool is electrically connected. If the wait time is not designated, waiting for the complete connection will continue. If the wait time is designated, an error will occur when the time set for the completion of connection is exceeded.	0.0~5.0
	Multi-tool change target	To be used when a dual-head servo gun is connected to or disconnected from more than 2 axes at the same time.	1~16
Example	MOVE P,S=60%,A=1,T=1 TOOLCHNG ON,C=G1,DI1 'Servo gun 1 connected MOVE P,S=60%,A=1,T=1 ... MOVE P,S=60%,A=1,T=1 TOOLCHNG OFF,C=G1 'Servo gun 1 disconnected		

10.5.1.24. PULSE

Explanation	Statement for outputting pulse type signals. Outputting pulses of On (High) type during the Ton time and Off (Low) type during the Toff time in the number of CNT	
Syntax	PULSE <Output variable>=<Default>,Ton=<On time>,Toff=<Off time>, CNT=<Output count>	
Parameter	Output variable	Y1~Y8192 FN1.Y1~FN64.Y128 DO1~DO4096 FB1.Y1~FB1.Y960 FB2.Y1~FB2.Y960 FB3.Y1~FB3.Y960 FB5.Y1~FB5.Y960
	Default	Arithmetic expression Constant (Pulse output is Off (Low) when the initial value is 0(Low) If not 0, it starts with On(High))
	On time	0.01~60.00[sec]
	Off time	0.01~60.00[sec]
	Output count	0~65535
Example	PULSE DO1=1,Ton=0.2,Toff=0.3,CNT=3 PULSE FB1.Y1=&H7F,Ton=0.3,Toff=0.2,CNT=1	

10.5.1.25. SoftJoint

Explanation	As one of the sensor-less force control functions, this function allows the robot to be pushed on each axis by an external force.	
Syntax	SoftJoint <ON/OFF>	
Parameter	ON/OFF	ON: Enable, OFF : Disable
Example	<u>(Example) SFT 50 is set for the S axis and SFT 90 is set for the B axis</u> <pre> S1 MOVE P,S=100mm/s,A=1,T=0 DELAY 2 LIMIT SFT,S=50,B=90 SoftJoint ON S2 MOVE ... SoftJoint OFF END </pre>	

**Reference**

- Set softness of each axis through LIMIT SFT before using the function through SoftJoint On.

**Warning**

- Check whether the tool information (mass, center of mass) is inputted correctly before using SoftJoint.
- If SFT is set as large, there is a risk of an axis dropping. Please pay attention to it.

10.5.1.26. RHemming

Explanation	Sets variables for the roller hemming squeeze control function and turns on or off the relevant function.		
Syntax	RHemming ON, Fd=_,K=_,V=_,TOL_W=_,TOL_E=_,CTRL=_ RHemming OFF		
Parameter	Fd	Desired squeeze [kgf] or [N]	-
	K	Control gain	Default : K=4
	V	Max. speed limit [mm/s]	Default : V=10
	TOL_W	Warning generation tolerance [kgf] or [N]	A warning will occur when the squeeze exceeds $Fd - TOL\_W \sim Fd + TOL\_W$ (In auto mode) ※A parameter to be used in real time when controlling the squeeze while the robot is moving. Not to be used when the teaching point is changed.
	TOL_E	Error generation tolerance [kgf] or [N]	An error will occur when the squeeze exceeds $Fd - TOL\_E \sim Fd + TOL\_E$ (In auto mode) ※A parameter to be used in real time when controlling the squeeze while the robot is moving. Not to be used when the teaching point is changed.
	CTRL	Squeeze control function On or Off (1: On, 0: Off)	Needs to be changed to CTRL=0 in order to not perform squeeze control while the robot is moving after the teaching point is changed.
Example	RHemming ON, Fd=10,K=4,V=10,TOL_W=2,TOL_E=5,CTRL=0		

**Reference**

- Control the robot along the Z axis of the tool coordinate to allow the user's set hemming squeeze to be applied.
- Can monitor whether squeeze or relevant functions are activated through the robot T/P and G/P.
- A warning or an error will be generated when the user's set range is exceeded during the hemming.
- Can select the squeeze unit between [kgf] and [N].
- Can set the robot's maximum moving distance along the Z axis of the tool coordinate.
- Load cell that is supported: 8532-6005 with In-Line Amp (Manufactured by burster)

**Warning**

- In order to use this function, set the function as "Enable" in 『System』 → 『Application』

parameter』 → 『Roller hemming squeeze control』 → 『Function use』 .

- Check whether the load cell attached to the tool is “8532-6005” with an amp’
- Before using this function, it is necessary to initialize the sensors while there is no contact with the outside.



10.5.1.27. ForceCtrl

Explanation	Sets variables for the sensor-based force control function and turns on or off the relevant function.	
Syntax	ForceCtrl <ON/OFF>,CRD=<Reference coordinate>,[<User coordinate number>], T=<Force control tool number>, BC=<Bias Clear>	
Parameter	ON/OFF	ON : Enable OFF : Disable
	Reference Coordinate	Arithmetic expression. Reference coordinate for the robot to be pushed (0=Base,1=Robot,2=Too,3=U,4=Un).
	User Coordinate Number	Arithmetic expression. The user coordinates number when the reference coordinate is U and UN.
	Force Control Tool Number	Selects the force control tool number (0 ~ 15) that stores the tool data
	Bias Clear	Initialize the sensor's default to 0 again because the default will be changed after a work. (0=No use, 1=Use)
Example	ForceCtrl ON,CRD=1,T=0,BC=1 'ForceCtrl function operating MOVE P,S=60%,A=1,T=1 'Robot moving by reflecting the position increment by the force sensor ForceCtrl OFF 'ForceCtrl function ending	

**Reference**

- In order to use this function, set the function as “Enable” in 『System』 → 『Application parameter』 → 『Force control』 → 『Usage environment setting』 .
- Before using the command, set the distance and speed through the LIMIT command and set the necessary factors through the FCset command.
- For more details, refer to 『Hi5a Controller Sensor Based Force Control Function Manual』

Controller Operation Manual

10.5.1.28. FCset

Explanation	Sets the factors necessary for executing the sensor-based force control function.	
Syntax	FCset Fd, X=<X force>, Y=<Y force>, Z=<Z force>, Rx=<Rx force>, Ry=<Ry force>, Rz=<Rz force> FCset Dmp, Dt=<Translation direction>, Dr=<Rotation direction> FCset FLT, Ff=_, Bf=_, St=_, Ft=_, Sr=_, Fr=_	
Parameter	Fd	Sets the scale and direction of the contact force that should be maintained Unit: X,Y,Z-[N], Rx,Ry,Rz-[Nm]
	Dmp	Sets the softness of the robot (1 ~ 10 : The lower the number gets, the more quickly and swiftly the robot moves) Dt: Sets the value of the Translation(X,Y,Z) direction Dr: Sets the value of the Rotation(Rx,Ry,Rz) direction
	FLT	Sets the filter that is to be used for force control Ff: cut-off frequency [Hz] of the force information filter Bf: cut-off frequency [Hz] of the Bypass filter St,Ft: Variable scale [N] for the translation operation Sr,Fr: Variable scale [Nm] for the rotation operation
Example	FCset Fd, X=0,Y=0,Z=-50,Rx=0,Ry=0,Rz=0 'For maintain the force of 50N in the -Z direction FCset Dmp, Dt=5,Dr=3 FCset FLT, Ff=40,Bf=300,St=0,Ft=0,Sr=0,Fr=0	

**Reference**

- To be used together with the ForceCtrl command for the sensor-based force control function.

10.5.1.29. FILTER

Explanation	This is used to change the operation characteristics of the robot by forcibly changing the filter value, which is used inside the controller, in the work program.		
Syntax	FILTER <Setting/Acquiring>,<Filter 1>, <Filter 2>		
Parameter	Setting/Acquiring	Setting: Change current values to the designated values for all axes Acquiring: Stores the value of the robot axis 1 in the designated variable	
	Filter 1	The filter value to be set or the variable name to be stored	1~1536
	Filter 2	The filter value to be set or the variable name to be kept	1~768
Example	MOVE P,S=60%,A=1,T=1 FILTER GET,F1=LV1%,F2=LV2% 'Stores the filter that is used FILTER SET,F1=250,F2=150 'Change the filter to the designated value MOVE P,S=60%,A=1,T=1 MOVE P,S=60%,A=1,T=1 MOVE P,S=60%,A=1,T=1 FILTER SET,F1=LV1%,F2=LV2% 'Change the filter to the stored value MOVE P,S=60%,A=1,T=1		

**Warning**

- It may be dangerous to change values that are used in the controller. Apply the function only when it is absolutely required.

10.5.2. FLOW control

10.5.2.1. GOTO

Explanation	Branching to assigned address	
Syntax	GOTO <address>	
Parameter	Address	Address for branching Arithmetic formula can be used, if the address is row number.
Example	GOTO 99 GOTO V1% GOTO *ERRHDL	

10.5.2.2. GOSUB ~ RETURN

Explanation	Calling the address assigned by GOSUB. When RETURN statement is given, data returns to the next row of the called GOSUB statement.	
Syntax	GOSUB <address>..... RETURN	
Parameter	Address	Address to call Arithmetic formula can be used, if the address is row number.
Example	GOSUB 150 END 150 REM ---- sub routine for test ---- PRINT #0, "Subroutine Start" PRINT #1, "Subroutine End" RETURN	

10.5.2.3. JMPP

Explanation	Branches to a designated sub program (Does not return when END is reached)		
Syntax	JMPP <program number>[<Note>]		
Parameter	Program number	Arithmetic formula. Program number to call.	1~9999
	Note	To be allowed only when the program number is constant. For better readability, explanation consisting of alphabetical characters and underscores can be added. Notes will be ignored during execution. The program number and notes together should not exceed 18 characters.	
Example	<pre>IF DI29 THEN REM --- subprogram 909 - ERROR STOP JMPP 909 PRINT #0, "Unrecoverable Error!!!", TIME\$ ENDIF END</pre>		

10.5.2.4. CALL

Explanation	Calling the assigned program. When END statement is given, data returns to the next row of the called CALL statement. Can call up to 10 times without recovering (Max. calling depth is 10)		
Syntax	CALL <program number>[<Note>] [[<Actual parameter>,<Actual parameter>,.....]]		
Parameter	Program number	Arithmetic formula. Program number to call.	1~9999
	Note	To be allowed only when the program number is constant. For better readability, explanation consisting of alphabetical characters and underscores can be added. Notes will be ignored during execution. The program number and notes together should not exceed 18 characters.	
	Actual parameter	Value to be delivered to the sub program. Should have a blank in front of the left bracket. (Refer to 10.4.4.4 Parameter)	Max. 10
Example	<pre>Distance calculation between 'P4 and P7. P300=P4 REM --- subprog. 902 ----- P301=P7 ----- CALL 902 REM V300! = <distance between P300 and P301> 'Result output REM -----</pre>		

Controller Operation Manual

```
PRINT #0, "Dist = "; V300!
```

```
-----  
V300! = (P300.X-P301.X)^2 + (P300.Y-P301.Y)^2  
        + (P300.Z-P301.Z)^2  
V300! = SQR(V300!)
```

※ Parameters cannot be used for controllers lower than version Hi5.



Max. 18 characters are allowed for the name of work file except for periods and extensions (JOB). The front side of a file name begins with the program number (1~9999) and a note string for readability can be appended. In reality, when the controller selects the JMPP statement, the Call statement or an external program, it only uses the program number of the Job file name while ignoring the appended string. In a situation shown below, all JMPP statements, presented as examples, are legitimately branched to JOB 20.

File list	0001.JOB 0020.SUBFUNC.JOB
0001.JOB Content	V5%=20 CALL 20 CALL 0020 CALL V5% CALL (10+10) CALL 20.SUBFUNC

10.5.2.5. ON~GOTO

Explanation	Branching to various addresses according to the condition number after ON.	
Syntax	ON <num.> GOTO <addr>[,<addr>,<addr>,...]	
Parameter	num.	Arithmetic formula. This number determines the address for branching. If this number is real number, drop numbers after the decimal point. If the number is less than 1 or more than the number of addresses, the next statement is processed.
	Add.	The address is branched as follows: If condition formula is one, the first address, if two, second... The addresses can be inputted up to 10.
Example	ON V5% GOTO 210, 220, *CONT GOTO *ERR 210 PRINT #0, "V5%=1" GOTO *CONT 220 PRINT #0, "V5%=2" *CONT	

10.5.2.6. DELAY

Explanation	Delay as assigned.		
Syntax	DELAY <time>		
Parameter	Time	Arithmetic formula. Waiting time	Unit : sec (0.1~60.0)
Example	DELAY 0.5		

10.5.2.7. STOP

Explanation	Program is stopped. When restarted, the program is executed from the next row.		
Syntax	STOP		
Example	IF DI9 THEN STOP ENDIF		

10.5.2.8. END

Explanation	Program is stopped. When restarted, the program is executed from the beginning.		
Syntax	END		
Example	MOVE P,S=50%,A=0,T=0 MOVE P,S=50%,A=0,T=0 END		

10.5.2.9. IF~ELSEIF~ELSE~ENDIF

Explanation	Program is branched according to condition. Or, blocs after this statement are executed or not executed.		
Syntax	Simple sentence IF	IF <condi.> THEN <addr.> [ELSE <addr.>] IF <condi.> THEN CALL <program No.> IF <condi.> THEN JMPP <program No.> IF <condi.> THEN GOSUB <addr.>	
	Compound sentence IF	IF <condi.> THEN ~ [ELSEIF <condi.> THEN ~] (Multiple times) [ELSE ~] ENDIF	
Parameter	Condition	Arithmetic formula, string condition formula	If 0, true. If not, false.
	Address	THEN: If the condition is true, the address is branched. ELSE: If the condition is false, the address is branched.	
Example	Example of simple sentence IF	IF V2!>SQR(V50!^2+V51!^2) THEN 150 ELSE *AGAIN	
	Example of compound sentence IF	IF G1!>=10 THEN PRINT #0, "HIGH" PRINT #1, "HR-MSG: HIGH" ELSEIF G1!>=0 THEN PRINT #0, "LOW" ELSE GOTO *ERR ENDIF	

10.5.2.10. FOR~NEXT

Explanation	As long as variable is equal to or less than ending value, the variable value is increased, and bloc is repeatedly executed.	
Syntax	FOR <variable>=<init.value> TO <end value> [STEP <increment >] ~ NEXT	
Parameter	Variable	Arithmetic variable. This variable determines whether to repeat the execution.
	init.value	Arithmetic variable. A value for initial setup.
	End value	Arithmetic variable. When the variable is equal to or less than this ending value, bloc is repeatedly executed. When there is no interval or is positive, it is repeated only when the variable value is smaller than the end value. When the internal is negative, it is repeated only when the variable value is equal to or higher than the end value.
	increment	Arithmetic variable. Increase amount value to increase the variable value.
Example	'Slowly moving to R1 shift direction. FOR V1:=300 TO 0 STEP -33.3 P1=P1+R1 MOVE L,P1,S=V1!mm/sec,A=3,T=1 UNTIL DI1 NEXT	

**Reference**

- If the command exits from or to the command block of GOSUB~RETURN, IF~ENDIF and FOR~NEXT command for Hi4 and Hi4a controller, the task execution can malfunction or cause 『E1245 Block stack exceeded』 error.
- Hi5 controller does not have this restriction. But, if you execute the CALL command too many times without an END command, or if you have too many GOSUB without any RETURN, you must be careful because it can cause a 『E1245 Block stack exceeded』 error.

10.5.2.11. SELECT~CASE~END_SELECT

Explanation	Evaluate the <Condition formula> value, and branch into the CASE statement that satisfies one condition of <Item>. If there is no CASE statement that satisfies <Item>, branch into the CASE ELSE statement. When meeting the next CASE statement, branch into the END_SELECT statement. When the EXIT SELECT statement is executed, immediately branch into the END_SELECT statement.		
Syntax	<pre> SELECT <Condition formula> CASE <Item>[,<Item>...] : [CASE ELSE] END_SELECT </pre>		
Parameter	Condition formula	Arithmetic formula, string formula.	
	Item	<pre> [<Comparison operator>]<Condition formula> <Condition formula> TO <Condition formula> </pre>	The comparison operator or TO can be used only in the arithmetic formula
	Comparison operator	<, >, <=, >=, <	If failing to consider, take it as =
Example	Arithmetic comparison example	<pre> SELECT V3%*2 CASE 1,2,3,<0,<>-9 V4%=400 IF V3%=50 THEN EXIT SELECT ENDIF V5%=500 CASE 4 TO 6, 7, 8, 9 V4%=800 CASE 10 STOP CASE ELSE GOTO _ERR END_SELECT </pre>	
	String comparison example	<pre> SELECT V5\$ CASE "ROBOT","HUMAN" V4%=400 CASE "DOG" V4%=800 CASE ELSE GOTO _ERR END_SELECT </pre>	

10.5.2.12. EXIT

Explanation	If it is to be used within the FOR ~ NEXT block, stop the FOR repetition and branch into the next statement of NEXT If it is to be used within the SELECT ~ CASE ~ END_SELECT block, stop processing the SELECT statement and branch into the next statement of END_SELECT.	
Syntax	EXIT <Kinds of statements>	
Parameter	Kinds of statement	FOR : Stop the FOR statement repetition SELECT : Stop the SELECT statement branching
Example	<pre> FOR V1%=1 TO 50 V20%=V20%-V25% IF V20%<=0 THEN EXIT FOR 'Stop processing the FOR statement block and branch into the next step of NEXT ENDIF NEXT MOVE P,S=50%,A=0,T=0 </pre>	

10.5.3. Others

When the [Command input] key is pressed on the initial screen in the manual mode, items appears on the F menu. When 『[F3]: Other』 key is pressed among the items, the following statements are included. Arithmetic formula can be used as all factor values.

10.5.3.1. Note

Explanation	Note is inserted to explain program motions, and does not affect execution. This is a statement which has the same function 'REM (Remark) statement'.	
Syntax	' <comment> REM <comment>	
Parameter	Explanation	String for explanation. Up to 254 simplified characters are allowed.
Example	'Variables Setting ----- REM SPOT WELDING #1 ' Call program No.25!!	



10.5.3.2. CALLPR

There are repeated motions in several places in the working space, when one robot handles two and more workpieces of the same shape in different places, or a series of loading/unloading jobs (in handling, etc.) is repeated.

When such movements have the same relative position and direction, although the absolute position and direction are different, a separate program (a relative program) for repeated movements can be written. Then, the relative program can be called to execute the job in all position where the motions should be executed. This function is different from a simple program call function in that the called relative program is executed based on the current position and pose at the point of which the program is called.

The following figure shows the result that the main program No.1 called program No.2 as a relative program.

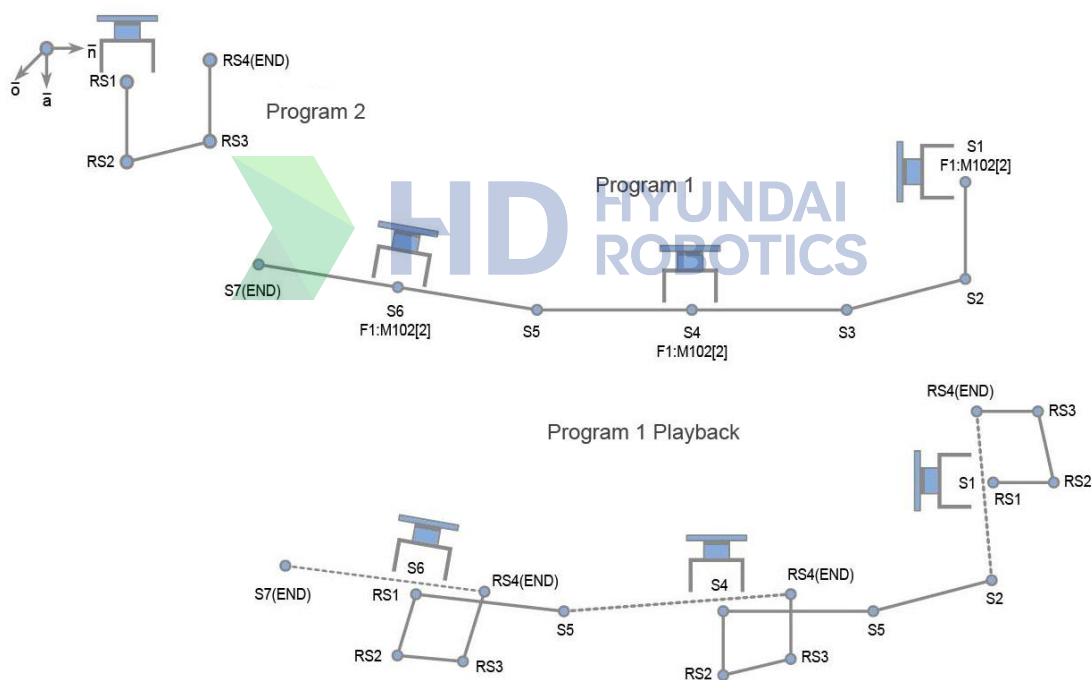


Figure 10.6 Relative program call

Explanation	Relative program call (unconditional)		
Syntax	CALLPR <program number>		
Parameter	Program number	Program number to be called	1~9999
Example	CALLPR 2		

Remark	When the called relative program execution is completed, the next function or step of the original program is executed.

10.5.3.3. MKUCRD

This function creates a user coordinates system based on three poses.

Explanation	This is the function to generate the user coordinate with 3 (or 1) poses		
Syntax	MKUCRD <coord. number>,<origin pose>,<X dir. pose>,<XY plane pose>		
Parameter	Coord. number	User coordinates system to be created	0~10
	Origin pose	Pose at the starting point	
	X dir. pose	Pose on the axis X	
	XY plane pose	Pose on the XY plane	
Example	MKUCRD 1,P1,P2,P3 MKUCRD 1,P1 (When you designate only 1 pose, the coordinate is designated in the location/direction of the pose)		

The user coordinates system function is that a user sets a coordinates system in a certain position, and manual manipulation or shift manipulation is available on the set user coordinates system. Also, step position can be taught based on the user coordinates system.

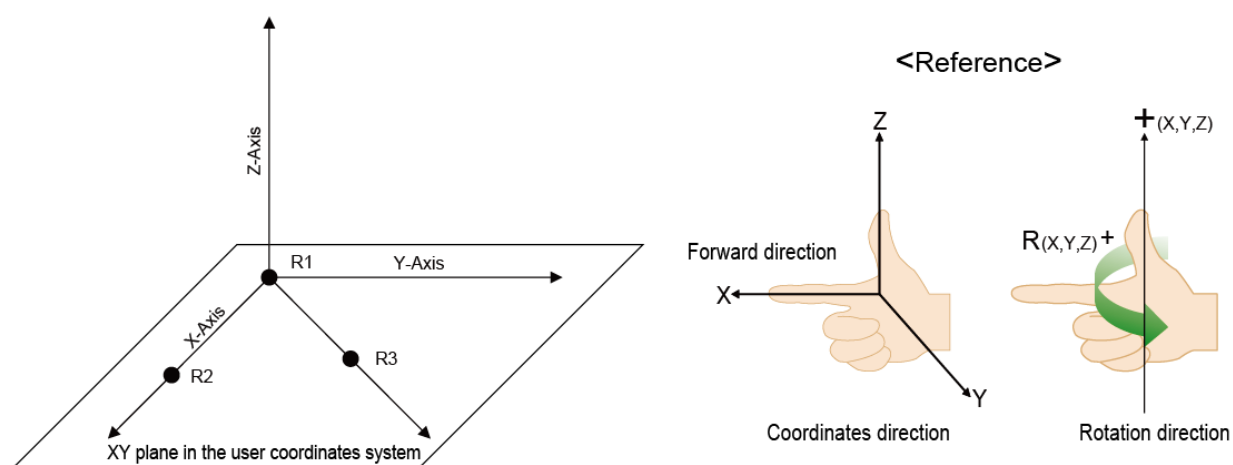


Figure 10.7 User coordinates system



Warning

- 『E1010 Number of teaching step is insufficient』
This warning occurs when steps recorded in the teaching program for coordinate system registration are less than three. There should be three teaching steps in the assigned program.
- 『E1011 Recorded dots are too close』
This warning occurs when the distance between the three points in the teaching program is less than 1mm. teaching steps should be corrected.
- 『E1012 Recorded dots exist on a straight line』
This warning occurs when the three points recorded in the teaching program for coordinate system registration are almost on the same straight line. In this case, the direction of each axis in the user coordinates system cannot be determined. The teaching program should be checked.
- 『Check coordinate system / Jog status [Any]』
When a user coordinates system is selected (『[F7]: Condition setting』 → 『9: Select user coordinate』), if the coordinates system is set as an axis or tool coordinates system, or a robot is in jog operation, user coordinates system cannot be selected and changed.

10.5.3.4. SELCRD

This is the function to change the user coordinate system number that is designated in the user coordinate system of the condition setting.

Explanation	User coordinates system selection of condition setup		
Syntax	SELCRD <coordinate system number>		
Parameter	coordinate system number	User coordinates system to be selected	0, 1~10
Example	SELUCRD 1 SELUCRD DI1+DI2*2+DI3*4		

**Reference**

- Through the 『[F7]: Condition setting』 → 『9: Select user coordinate』, you can change the function of the user coordinate system.

**Warning**

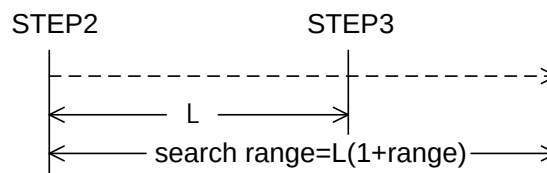
- 『E1336 Unregistered user coordinate system.』
You must register the coordinate system to use. After creating the program to register the coordinate system, register the coordinate system through 『[F2]: System』 → 『2: Control parameter』 → 『7: Coordinate registration』.

10.5.3.5. SEA

The search function is for detecting the difference of workpiece position and compensating the difference. Not only robot coordinates system but also tool coordinates system and base coordinates system can be used as the standard to detect and compensate the position difference. This command is used when the moving robot is stopped by the detection signal and its position is compared with the reference position to calculate the shift amount. The calculated shift amount through this method by using the online shift command can be applied to changing existing work areas en bloc. You can get the search and operation function that you want when you use this command in conjunction with the RINT/RINTA, SONL commands. Also, setting the search reference position and the range must be set in the 『F7』: condition setting』 → 『F1』: App. cmd』 menu.

Explanation	Search function		
Syntax	SEA ST=<On/Off>, CRD=<Reference coordinate>[,<User coordinate number>], R=<register number>		
Parameter	On/Off	If 1, on. If 0, off.	0~1
	Reference coordinate	0=Base, 1=Robot, 2=Tool, 3=User, 4=User n	0~4
	User coordinate number	User coordinate number when reference coordinate is used	0,1~10
	Register number	Number to be used for online shift	1~8
Example	SEA ST=1,RF=0,R=1		

- (1) Assign search range. (From 『F7』: Condition setting』 menu 『F1』: App. cmd』 → 『2』: Robot search range』) If you move and search from step 2 to step 3, the range is shown in the following figure.



- (2) Perform program teaching and set the search function for teaching.
- ① Add a search start command (ST=1)
 - ② Robot interrupt (RINT or RINTA) (Setting of the interrupt input signal , RC = 1 input)
X, Y, and Z are not required to be set because they are automatically updated when the search reference position is recorded.
 - ③ Moving step recording of a robot
 - ④ Add a search end command (ST=0).
 - ⑤ Add online shift.

- ⑥ Perform a work where shift is required.
 - ⑦ End online shift.
- (3) Set search standard position record 'ON.' From 『[F7]: Condition setting』 menu 『[F1]: App. cnd』 → 『1: Robot search ref. pose record』)
- (4) Operate the program in the 1Cycle Mode to retrieve the standard position of workpiece through robot interrupt.
The position value is recorded in the X, Y, and Z entries of the RINT/RINTA commands, which were previously executed.
- (5) Set search standard position data record 'OFF.' From 『[F7]: Condition setting』 menu 『[F1]: App. cnd』 → 『1: Robot search ref. pose record』)
- (6) Operate the program ordinarily.
- (7) It runs the task with shifting by the difference between the detected interrupt position and reference position.





Reference

- The search section must be moved to the linear interpolation operation, which enables accurate position detection.
- Application of the search function

① One-dimension search

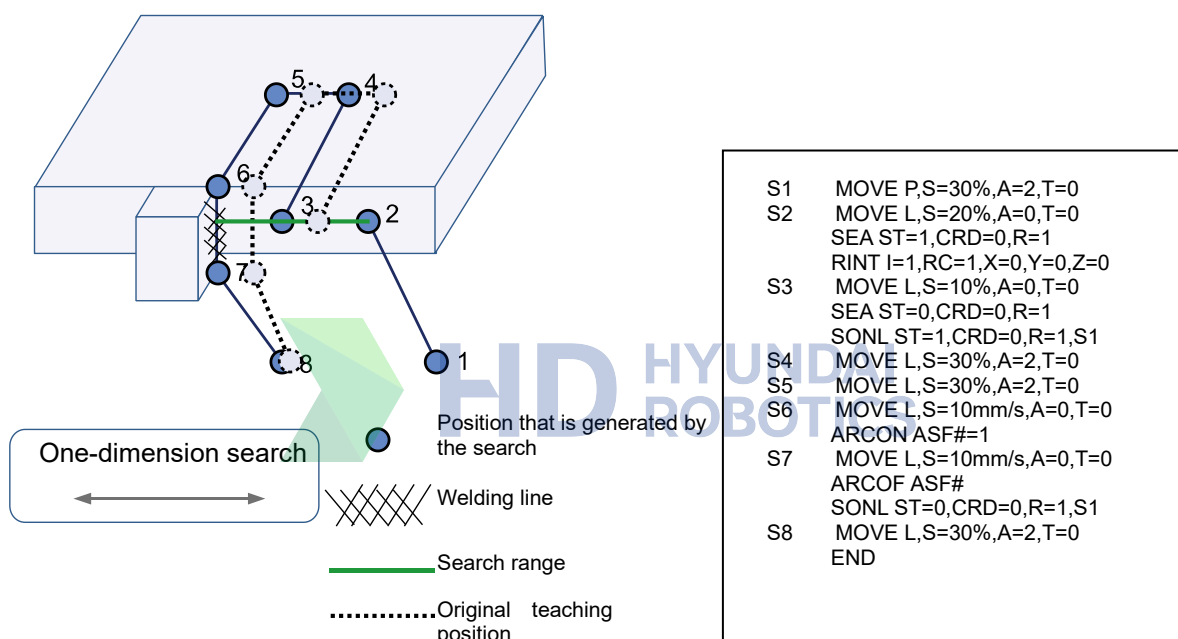


Figure 10.8 One-dimension Search

Figure 10.8 shows the error is corrected by one-dimension search when workpieces of the same kind or of the same shape and different size move.

The search function is used with robot interrupt as shown above. The difference in shift amount is corrected by the online shift function after the amount is recorded in shift register.

Search function begins to be executed through a SEA command after moving to the step no. 2 position. X, Y, and Z values of the RINT command in the figure above are updated to the actual interrupted position when the search reference position is recorded.

While moving to the step no. 3 position, it detects the range set to "Robot search range." When the interrupt signal is input, it assigns the shift amount to the register after generating shift amount by assigning values to the X, Y, and Z items of the RINT commands (when the reference position recording mode is ON) or when comparing them to X, Y, and Z items. (When the reference position recording mode is OFF)

Refer to the shift register, which works by shifting the step 4 – step 7 programs.

② Two-dimension search

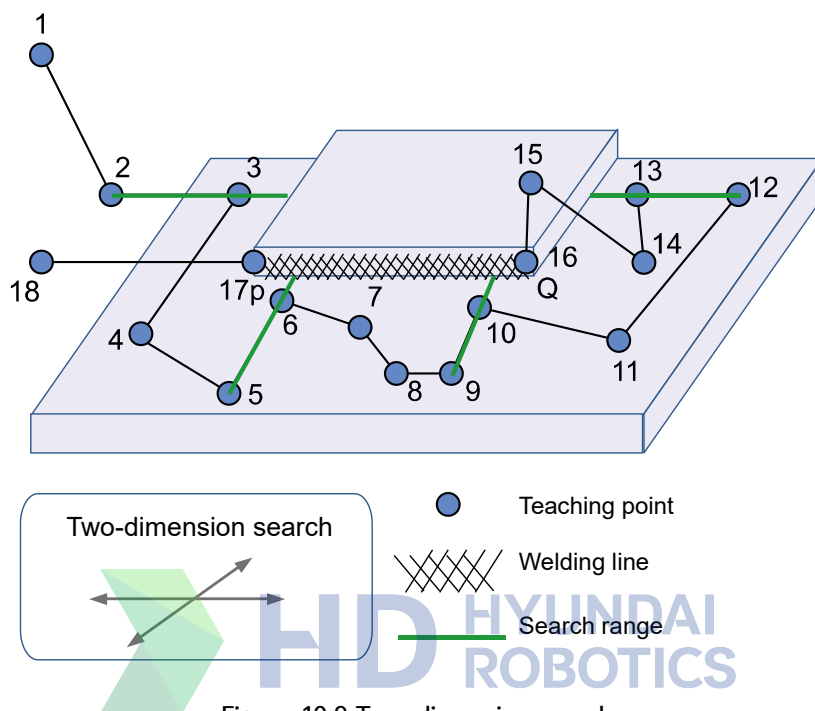


Figure 10.9 Two-dimension search

S1	MOVE P,S=20%,A=2,T=0	S11	MOVE L,S=20%,A=0,T=0
S2	MOVE L,S=20%,A=0,T=0	S12	MOVE L,S=20%,A=0,T=0
	SEA ST=1,CRD=0,R=1		RINT I=1,RC=1,X=0,Y=0,Z=0
S3	MOVE L,S=20%,A=0,T=0	S13	MOVE L,S=20%,A=0,T=0
S4	MOVE L,S=20%,A=0,T=0	S14	MOVE L,S=20%,A=0,T=0
S5	MOVE L,S=20%,A=0,T=0	S15	MOVE L,S=20%,A=0,T=0
	RINT I=1,RC=1,X=0,Y=0,Z=0		SEA ST=0,CRD=0,R=2
S6	MOVE L,S=20%,A=0,T=0		SONL ST=1,CRD=0,R=2,S1
S7	MOVE L,S=20%,A=0,T=0	S16	MOVE L,S=20%,A=0,T=0
	SEA ST=0,CRD=0,R=1		SONL ST=0,CRD=0,R=2,S1
S8	MOVE L,S=20%,A=0,T=0		SONL ST=1,CRD=0,R=1,S1
S9	MOVE L,S=20%,A=0,T=0	S17	MOVE L,S=20%,A=0,T=0
	SEA ST=1,CRD=0,R=2		SONL ST=0,CRD=0,R=1,S1
	RINT I=1,RC=1,X=0,Y=0,Z=0	S18	MOVE L,S=20%,A=0,T=0
S10	MOVE L,S=20%,A=0,T=0		END

Two-dimension search records shift amounts of each point (P and Q) by using the search function twice. The shift amount of point P is stored in R1 register and referred to when P is shifted. The shift amount of point Q is stored in R2 register and referred to when Q is shifted.

10.5.3.6. SONL

The online shift function is for parallel shift of a previous teaching position to any position on X, Y, Z coordinates based on the shift amount transmitted from outside devices such as visual equipment. Usually, online shift is based on robot coordinates system, but tool coordinates system or base coordinates system can be also used.

Explanation	Online shift		
Syntax	SONL ST=<st./end>,CRD=<ref.>[,<User coordinate number>], R=<register number>, <shelter address>		
Parameter	st./end	If 1, shift application starts. If 0, it ends, and the rest factors are ignored.	0~1
	Reference coordinate	0=Base, 1=Robot, 2=Tool, 3=User, 4=User n	0~4
	User coordinate number	User coordinate number when reference coordinate is used	0,1~10
	Register number	Register in which transmitted shift amount is inputted.	1~8
	Shelter address	Address to exit to when shift is not entered within the given time	Row number Step number Label
Example	SONL ST=1,CRD=1,R=1,S99		



Reference

- Related function
 - ① Shift request amount function (SREQ)
 - ② Timer conditional shift amount request function (SREQT)

10.5.3.7. SREQ

This function requests the shift amount measured from the external device and saves the shift data to the online shift register after receiving the data.

Explanation	Shift amount request		
Syntax	SREQ R=< register num. >,PT=<Port num. > [,<Standby time>,<Shelter address>]		
Parameter	Register num.	Register in which transmitted shift amount is stored.	1~8
	Port num.	RS232C port number to be used for shift amount request and transmission	1~2
	Standby time	Standby time until the shift is received	0.0~60.0 (sec)
	Shelter address	Address to exit when the standby time is exceeded	
Example	SREQ R=1,PT=1 SREQ R=1,PT=1,3,999		

**Reference**

- The received shift amount is saved as the data in online shift register number designated in 『[F1]: Service』 → 『2: Register』 → 『3: Online shift register』.
- When this function is executed, SHIFT ※1 CR LF (※1: register number) is outputted through RS232C port, and SHIFT X, Y, Z, θ X, θ Y, θ Z, CR is inputted from an outside device through RS232C port. Inputted data is stored in ※1 register. Transmitted/received data is ASCII code.

10.5.3.8. SXYZ

This function is for parallel shift of previous teaching points while tool angle is maintained on XYZ plane. Three-dimension shift amount is executed after being stored in XYZ shift register.

Explanation	XYZ shift		
Syntax	SXYZ CRD=<reference>[,<User coordinate number>],X=<X shift amount>,Y=<Y shift amount>,Z=<Z shift amount>		
Parameter	Reference coordinate	0=Base, 1=Robot, 2=Tool, 3=User, 4=User n	0~4
	User coordinate number	User coordinate number when reference coordinate is used	0,1~10
	Shift amount	Shift amount for three-dimension parallel shift	-3000.0~3000.0
Example	SXYZ CRD=0,X=10.50,Y=20.50,Z=0.00		

**Reference**

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- XYZ shift function operation
The length of X, Y, Z should be exactly equal to the length to GUN mechanical interface, because the slant angle of GUN should be maintained for this parallel shift.

10.5.3.9. TONL

If the new locations of the 3 reference steps are measured with the external detection device (RS232C port) such as visual device as shown in Fig. 10.10, and each shift is transmitted to the robot controller, the robot controller will use the 3 reference points and 3 shifted points to calculate the absolute location or shift. This is the function to execute and play the location calibration for the steps between TONL start and end.

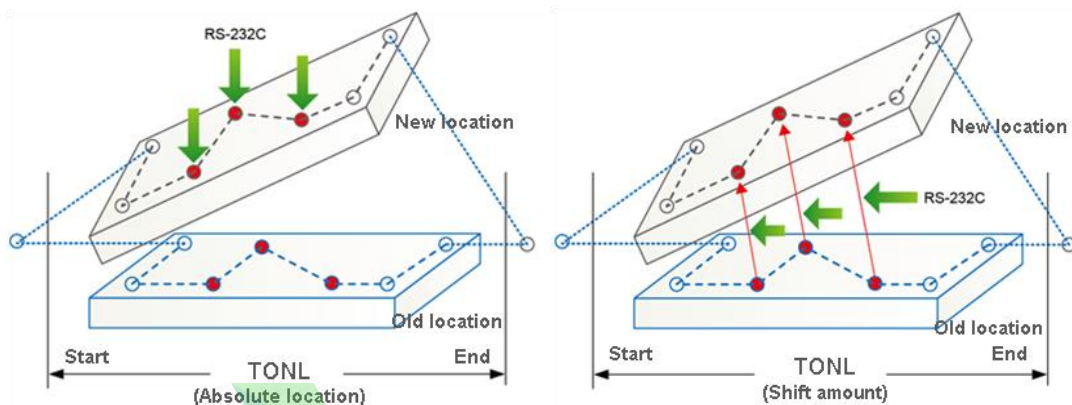


Figure 10.10 Online coordinates conversion

Explanation	Online coordinates conversion (shift amount)		
Syntax	TONL SFT=<Receipt format>, ST=<start/end>, <ref.step num.1>, <ref.step num.2>, <ref.step num.3>		
Parameter	Receipt format	Data receipt format. 0=Absolute coordinate, 1=Shift	0~1
	start/end	If 1, coordinates conversion begins. If 0, coordinates conversion ends.	0~1
	ref.step num.	Steps to be assigned as the three standard points	0~999
Example	TONL SFT=0,ST=1,S1,S5,S7		
Remark	To execute this function, SREQ statement is required before TONL statement. This function receives the new locations of the 3 reference steps in 3 absolute location or shifts to calculate the shifts.		

10.5.3.10. RINT

While a robot is moving to the target step, if an assigned DI signal (input signal) is inputted, the robot is immediately stopped by interrupt. Then, the robot executes a command recorded in the step, and restarts moving to the next step.

Explanation	Robot interrupt (DI signal)		
Syntax	RINT I=<DI signal>,RC=< ref. complete >,[X=< ref.X >,Y=< ref.Y >, Z=< ref.Z >]		
Parameter	Number of DI signal	Number of DI signal to receive interrupt signal	1~4096
	ref. complete	If 0, general robot interrupts function. If 1, search function. Refer to the SEA (search) function.	0, 1
	ref. X, Y, Z	These are used for the search function.	-3000.0 ~ 3000.0
Example	RINT I=8, rc=0, X=0, Y=0, Z=0 ← X, Y, Z be ignored RINT I=8, rc=1, X=1000, Y=2000, Z=3000		



10.5.3.11. RINTA

While a robot is moving toward the target step, if analog voltage satisfies the range set by the user, interrupt occurs to stop the robot immediately. Then, the robot executes commands recorded in the step, and moves to the next step.

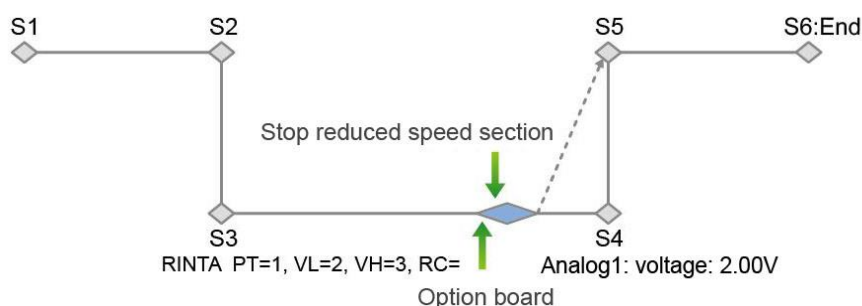


Figure 10.11 Robot interrupt (Analog signal)

Explanation	Robot interrupt (Analog signal)		
Syntax	RINTA PT=<Port number>,VL=<Voltage low limit>,VH=<Voltage high limit>,RC=<Reference complete>,[X=<ref.X>,Y=<ref.Y>,Z=<ref.Z>]		
Parameter	Port number	Analog port which will receive interrupt signal	1~32
	Voltage low limit	If analog value is between lowest voltage and highest voltage, interrupt occurs.	-10.0~10.0
	Voltage high limit		
	Reference complete	0 is general robot interrupt and 1 is the search function. Refer to the SEA (Search) function.	0, 1
	ref. X, Y, Z	These are used for the search function. If RC = 0 is ignored.	-3000.0~3000.0
Example	RINTA PT=1, VL=2, VH=9, RC=0, X=0, Y=0, Z=0 ← X, Y, Z be ignored RINTA PT=1, VL=2, VH=9, RC=1, X=1000, Y=2000, Z=3000		

10.5.3.12. CLR232C

Explanation	RS232C buffer initialization		
Syntax	CLR232C <port number>		
Parameter	Port number	Serial (RS232C) port number	1~2
Example	CLR232C 1		

10.5.3.13. INTDEF

When the interrupt function is used, this function defines new interrupt state or deletes previously defined interrupt. Refer to the 『Hi5a Controller Interrupt Function Manual』 for details.

Explanation	This function defines new interrupt or deletes defined interrupt.		
Syntax	INTDEF <Define/Dele>, NO=<Interrupt number>, <Interrupt condition>, PN=<Call program>, [1times Permitted]		
Parameter	Define/Dele	Interrupt is newly defined or defined interrupt is deleted. When interrupted is deleted, third and the rest of parameters are ignored.	ON/OFF
	Interrupt number	Interrupt to be defined or deleted	1~2
	Interrupt condition	Condition for interrupt occurrence (EX. DI1=1,AI4=3.5,P*.X=P1.X)	
	Call program	Program to be called, when interrupt condition is satisfied.	1 ~9999
	1times Permitted	Only the first interrupt is handled, even though interrupts occur many times within the interrupt watch section.	SINGLE
Example	INTDEF ON,NO=1,DI5=1,PN=991,SINGLE INTDEF OFF,NO=1		

10.5.3.14. COPYM2R

This command replaces the shift variable R with the MW variable for embedded PLC sequentially. This command reduces the execution time when many MW, R variables are repeatedly replaced.

Explanation	This is the function of replacing the X, Y, Z, Rx, Ry, Rz and cfg item of R variable with the values in MW variable.		
Syntax	COPYM2R SM=<MW start number>,SR=<R variable start number>,Rcnt=<Number of R variable to copy>,MWInt=<Number to variables to jump between the 7 MWs>		
Parameter	MW start number	Enter the number of MW variable to start copying.	1~1000
	R variable start number	Enter the number of R variable to start copying.	9~100
	Number of R variable to copy	Enter the number of R variable to copy. 7 MW variable values are entered to one R variable.	1~92
	Number to variables to jump between the 7 MWs	Enter the number of variables to jump after copying 7 MW variables and before copying 7 variables. That is, if the value is 3, it copies to 1~7 and then to 11~17.	0~15
Example	COPYM2R SM=1,SR=9,Rcnt=1,MWInt=0		

**Reference**

- Enter the X, Y and Z item of R variable with MW/10 value, and Rx, Ry and Rz item with MW/100. But for cfg, replace the value as is.

Controller Operation Manual

10.5.3.15. COPYR2M

This command replaces the saved value of each item of shift variable R to the MW variable for embedded PLC sequentially. This command reduces the execution time when many MW, R variables are repeatedly replaced.

Explanation	This is the function of replacing the MW variable with the values entered in X, Y, Z, Rx, Ry, Rz and cfg item of R variable.		
Syntax	COPYR2M SR=<R variable start number>,SM=<MW start number>,Rcnt=<Number of R variables to copy>,MWInt=<Number to variables to jump between the 7 MWs>		
Parameter	R variable start number	Enter the number of R variable to start copying.	9~100
	MW variable start number	Enter the number of variable to start copying MW.	1~1000
	Number of R variables to copy	Enter the number of R variables to copy. 7 MW variable values are entered to one R variable.	1~92
	Number to variables to jump between the 7 MWs	Enter the number of variables to jump after copying 7 MW variables and before copying 7 variables. That is, if the value is 3, it copies to 1~7 and then to 11~17.	0~15
Example	COPYR2M SR=9,SM=1,Rcnt=1,MWInt=0		

**Reference**

- Among the values entered to MW variable, 10 times the X, Y and Z item of R variable is entered and 100 times the Rx, Ry and Rz item. But, cfg value is replaced as is.

10.5.3.16. GATHER

When the data gathering function is used, this function appoints a data gathering start step and an end step. Refer to the data gathering function manual for details.

Explanation	This function appoints data gathering start and end.		
Syntax	GATHER <Start/End>		
Parameter	Start/End	If 1, start. If 0, end.	0~1

Example	GATHER 1

10.5.3.17. CalViaPs

This saves the pose value to the pose variable considering the location and position in arbitrarily number of times by dividing the distance between the start location and target location evenly.

Explanation	CalViaPs (Calculate Via Points) passing point calculation command	
Syntax	CalViaPs <Start pose>,<End pose>,<DivNo=Number of divisions>,<CntNo=Counter>,<Output pose>	
Parameter	Start pose	Start location
	End pose	Target location
	Number of divisions	It can be divided between 1 and 30000 The number of division cannot be 0.
	Counter	It can be entered between 0 and 30000 Start pose is 0.
	Output pose	Save the calculated pose. The config value of created pose variable is undesignated and the additional axis is considered.
Example	<pre> V10%=100 FOR V2%=1 TO 10 CalViaPs P1,P2,DivNo=10,CntNo=V2%,P[V10%] MOVE P,P[V10%],S=300mm/sec,A=0.T=0 V10%=V10%+1 NEXT END </pre>	



Figure 10.12 P3 work location

For example, for CalViaPs P1,P2,DivNo=3,CntNo=2,P3,
Divide the distance from P1 start location to P2 target location evenly in 3 divisions and save the pose value considering the location and position of designated 2nd pose to the P3 pose variable.

10.5.3.18. CalCrViaPs

This saves the pose value to the pose variable considering the location and position in an arbitrary number of times by evenly dividing the circular distance consisting of the start location, passing point and target location.

Explanation	Statement to calculate the passing points evenly divided on a circular line consisting of the 3 input points.		
Syntax	CalCrViaPs <Start pose>,<Passing pose>,<End pose>,<DivNo= Number of divisions>,<CntNo=Counter>,<Output pose>		
Parameter	Start pose	Start location	
	Passing pose	Passing location	
	End pose	Target location	
	Number of divisions	It can be divided between 1 and 30000. The number of divisions cannot be 0.	
	Counter	It can be divided between 0 and 30000. Start pose is 0	
	Output pose	Save the calculated pose. The config value of created pose variable is undesignated and the additional axis is considered.	
Example	<pre> V10%=100 FOR V2%=1 TO 10 CalCrViaPs P1,P2,P3,DivNo=10,CntNo=V2%,P[V10%] MOVE P,P[V10%],S=300mm/sec,A=0.T=0 V10%=V10%+1 NEXT END </pre>		

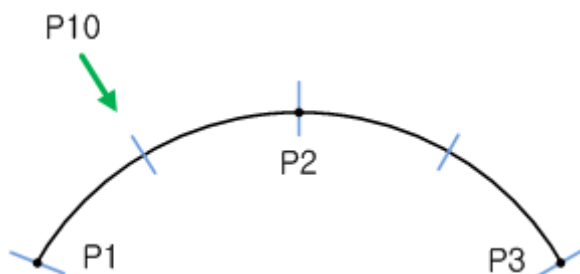


Figure 10.13 P10 work location

For example, CalCrViaPs P1, P2, P3, DivNo=4, CntNo=2, P10,
Divide the circular distance, which consists of P1 start pose, P2 passing pose, and P3 target pose, evenly

in 4 divisions and save the pose value, which considers the location and position of the designated 2nd pose, to the P10 pose variable.

10.5.3.19. StoPoCnd

This is the axis data save function command. This function is to save the location of the designated axis to the _StoPoDt[] system parameter when the input signal is entered, and to read the save value through the HRBASIC command.



Controller Operation Manual

Explanation	StoPoCnd (Store Pose Condition) : Command to save the axis data _StoPoDt[] : System parameter to retrieve the saved location (Read/Write)		
Syntax	StoPoCnd StoNr=<System parameter number>, DI=<Input signal number>, Axis=<Axis number>		
Parameter	System parameter number	Set the system parameter number to store the axis data	1~10
	Input signal number	Positive logic: When the input signal number goes up, the axis location designated by the axis number is saved to the parameter. Negative logic: When the input signal number goes down, the axis location designated by the axis number is saved to the parameter.	1~255
	Axis number	The axis number to store the axis data When the axis designated by Axis is a rotational axis, the angle value is to be saved, while the length value will be saved in case of linear axis.	1~16
Example	StoPoCnd StoNr=1,DI=11,Axis=V1% (At the moment when DI11 is entered, the location of the 5ths axis is saved to _StoPoDt1[V1%]) V1!=_StoPoDt2 Retrieve the value saved in the 2nd number of V1! (Real number parameter). V1!=_StoPoDt[V1%] Can designate the location, to be retrieved, as V1%. _StoPoDt2=100.0 Set the value saved in the 2nd number as 100.0. _StoPoDt2=0 Set the value saved in the 2nd number as 0. IF _StoPoDt2<50 OR _StoPoDt2>60 THEN 10 If the value saved in the 2nd number exceeds the 50~60 range, jumping to the row number 10 will be executed		

10.5.3.20. TaskStart

Explanation	Creates the sub-task, and starts the program designated to the created subtask.		
Syntax	TaskStart SUB=〈Subtask〉,JOB=〈Program〉		
Parameter	Subtask	Designate the subtask to be created	1~3
	Program	Program to be started in the created subtask	1~9999
Example	TaskStart SUB=1,JOB=10 'Start the program 10 using the subtask 1		

**Reference**

- If a program is in the middle of being started by a previously created subtask, this statement will be disregarded.



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10.5.3.21. TaskWait

Explanation	Waits for the relevant subtask to be destroyed and a subtask will be automatically destroyed when the program end is executed.		
Syntax	TaskWait SUB=〈Subtask〉		
Parameter	Subtask	Designate the subtask to be destroyed	1~3
Example	TaskWait SUB=1 'Waits for the subtask 1 to be destroyed		

**Reference**

- Generally, this is to be used together with the TaskStart statement.

10.5.3.22. TaskSync

Explanation	- Synchronization wait between tasks Wait for the TaskSync statements with an identical ID to be executed in the same number as designated. In other words, this can be used conveniently when synchronizing between tasks.		
Syntax	TaskSync ID=<Identifier>,NO=<Number of tasks>		
Parameter	Identifier	Designate the identifier	1 ~ 32
	Number of tasks	Designate the number in which a same identifier is executed	2 ~ 4
Example	TaskSync ID=1,NO=2 'Wait for the ID=1 TaskSync statement to be executed 2 times.		

**Reference**

- Using this requires your attention as it is identical to the mutual interlock

10.5.3.23. CalXPoint

Explanation	This function is to acquire a point where one linear line consisting of 2 points meets with another point in the shortest distance.	
Syntax	CalXPoint <Linear line reference pose 1>,< Linear line reference pose 2>,<Location reference pose>,<Result pose>	
Parameter	linear line reference pose 1	First reference pose to calculate the linear line
	linear line reference pose 2	Second reference pose to calculate the linear line
	Location reference pose	Reference pose to acquire the location in the shortest distance from the linear line
	Result pose	The pose which is the closest to the location reference pose on the calculated linear line
Example	CalXPoint P1,P2,P3,LP1	'Put into LP1 the cross pose, where the extension line of the linear line, calculated using P1 and P2, cross the liner line which connects to the location reference pose P3 in the shortest distance.

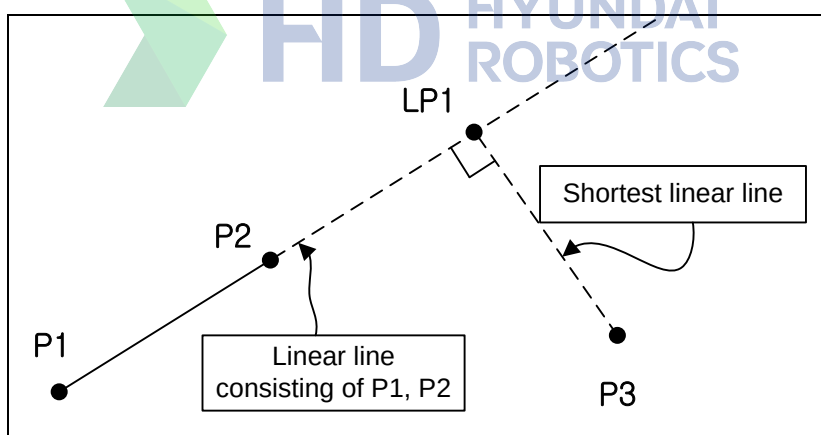


Figure 10.14 CalXPoint usage

**Reference**

- Useful when used in setting the user coordinate system while used together with the touch sensing function of the arc welding function.

10.5.3.24. CalXLine

Explanation	This function is to acquire the point on the linear line, where one linear line consisting of 2 points meets with another linear line consisting another 2 points in the shortest distance	
Syntax	CalXLine <Linear line reference pose1>,< Linear line reference pose2>,< Linear line reference pose3>,< Linear line reference pose4>,<Result pose>	
Parameter	Linear line reference pose 1	First reference pose to calculate the first linear line
	Linear line reference pose 2	Second reference pose to calculate the first linear line
	Linear line reference pose 3	First reference pose to calculate the second linear line
	Linear line reference pose 4	Second reference pose to calculate the second linear line
	Result pose	The crosses pose, where the liner line that connects the two lines in the shortest distance cross the first linear line.
Example	CalXLine P1,P2,P3,P4,LP1 'Put into LP1 the cross pose, where the linear line, which connects the linear line that consists of P1 and P2 to the linear line that consists of P3 and P4 in the shortest distance, cross the first linear line.	

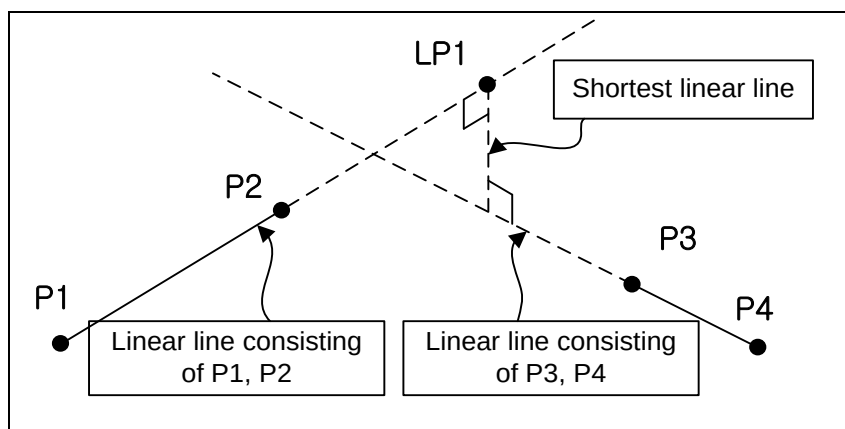


Figure 10.15 CalXLine usage

**Reference**

- Useful when used in setting the user coordinate system while used together with the touch sensing function of the arc welding function.

10.5.3.25. BrakeCheck

This function is for inspecting the state of motor brakes of each axis of the robot and performs diagnosis on failures.

Explanation	Inspects whether the motor brake of each axis of the robot is normal.		
Syntax	BrakeCheck <Return value>		
Parameter	Return value	It returns the axis number if an error occurs during inspection. If there is no error, return to 0.	0: Failure 1:Success
Example	<pre> 'Move to the retraction step if an error occurs after its brake test. BrakeTest RET=LV10% IF LV10% >0 THEN PRINT #0," An error occurred during the brake test: ",LV10% CALL 9900 'Retraction program when a brake error occurs ENDIF 'Retraction program 9900.JOB S1 MOVE P,S=5%,A=1,T=1' Retraction position against the axis fall DO200=1 'Brake test error signal output STOP 'Robot standby with a stationary state END </pre>		

**Warning**

- 『Brake inspection posture』
Considering that each axis could move while inspecting the brake, it is necessary to inspect brakes based on a safe posture by taking into account possible interference.
- 『Brake failure』
When it is decided that a brake has failed, it is necessary to stop using the robot and put the motor's brake through a complete inspection. Replace the motor if it is found to have problems.

10.5.3.26. SectStat

Records the torque value and encoder value of each axis in the variables

Description	Stores the maximum torque value, torque length, maximum encoder error value, and encoder length of each axis of the robot		
Syntax	SectStat <Start/End> <Variable Name>		
Parameter	Start/End	Start if 1 and end if 0	0: End 1: Start
	Variable Name	Real variable to start storing for each axis	Real type variable such as V1!
Example	<pre> SectStat 1, V1! S1 MOVE P,S=5%,A=1,T=1 S2 MOVE P,S=5%,A=0,T=1 SectStat 0 END </pre> Based on the six-axis robot, with this program, it is possible to record the maximum torque value (V1!–V6!), torque length (V7!–V12!), maximum encoder error value (V13!–V18!), and torque length (V19!–V24!) for each axis, among V1!–V24!, in the variables.		

**Caution :**

- “Variable overriding”
Because the last variable will be stored, the previous variable may be lost.
- “Condition for ending”
When multiple SectStat commands are started, each should be ended individually.

10.5.3.27. ActuStat

Records the motor load factor and encoder value of each axis in the variables

Description	Stores the maximum motor load factor (I/Ir), load factor length, maximum encoder error value, and encoder length of each axis of the robot		
Syntax	SectStat <Start/End> <Variable Name>		
Parameter	Start/End	Start if 1 and end if 0	0: End 1: Start
	Variable Name	Real variable to start storing for each axis	Real type variable such as V1!
Example of use	<pre> ActuStat 1, V1! S1 MOVE P,S=5%,A=1,T=1 S2 MOVE P,S=5%,A=0,T=1 SectStat 0 END </pre> Based on the six-axis robot, with this program, it is possible to record the maximum motor load factor (V1!–V6!), load factor length (V7!–V12!), maximum encoder error value (V13!–V18!), and torque length (V19!–V24!) for each axis, among V1!–V24!, in the variables.		

**Caution :**

- “Variable overriding”
Because the last variable will be stored, the previous variable may be lost.
- “Condition for ending”
When multiple ActuStat commands are started, each should be ended individually.

10.5.4. Spot welding

10.5.4.1. SPOT

This is a spot welding command that is commonly applicable for the air pressure gun and servo gun. This command is to set the following 3 parameters shown below.

For example, if there is a need to select more than 2 servo guns and operate them or use them for welding simultaneously, you need to select more than 2 guns simultaneously (R214) and, while turning on the GUN LED, record and use their locations, which will allow the record to be recorded as multi synch gun step.

Explanation	Spot welding (SPOT)		
Syntax	SPOT GN=<Gun number>, CN=<Welding condition number>, SQ=<Sequence number>, MG=<Multi gun>, MC=<Multi welding condition>, MS=<Multi welding sequence>		
Parameter	Gun number/Multi gun	Number of gun used in welding / Gun number to execute the welding simultaneously	1~8
	Welding condition number/ Multi welding condition	Welding condition which specifies pressure and welding condition output data	1~64
	Sequence number/ Multi welding sequence	Welding sequence which specifies pressure signal, electric current sending signal, etc.	1~64
Example	SPOT GN=1,CN=1,SQ=10,MG=2 Weld the server gun 1 and 2 to welding condition 1 and sequence 10 simultaneously.		



Reference

- When you select multiple servo guns (Multi-Sync Servogun) by using R214, or change the gun number by using R210, the tool number will be changed automatically. However, even when you change the tool number (R29), the gun number will not be changed automatically.
- The SPOT command must be recorded as the first function of a step. If not, the spot welding function may not be carried out correctly.
- Recording while the GUN LED is on is called one-touch recording function. In this, the SPOT command is to be recorded automatically as the first function, and, in terms of the step location, the location for which the compensation for the abrasion is made will be recorded automatically.
- When you execute the multi-sync spot command (SPOT GN=1,...,MG=2), which will allow multiple spot guns to be executed simultaneously, all the designated guns will be selected. Accordingly, when the manual pressurizing/opening and closing activities are performed in this condition, all the designated multiple guns will be activated.

10.5.4.2. GUNSEA

The GUNSEA statement is used to detect the reference location and abrasion location to measure the abrasion of the electrode of the servo gun. When this function is executed, the servo gun moves from the start location to the location where two tips touch each other. When the pressure designated in the command statement is reached during the movement, the location will be used for calculating the abrasion.

Explanation	Measure servo gun abrasion (GUNSEA)		
Syntax	GUNSEA GN=<Gun number>, SE=<search num.>, PR=<gun pressure>, SP=<Search speed>, MG=<Multi gun number>, MP=<Multi gun pressurization force>		
Parameter	Gun number/ Multi gun number	Servo gun for welding operation / Servo gun number to execute gun search simultaneously	1~8
	Search number	1 : gun search 1 movement, 2 : gun search 2 movement	1~2
	Gun pressure / Multi gun pressurization force	Ordered pressure / Multi gun pressurization force	50~999
	Search speed	Operating speed of the gun axis during search operation	1.0~250.0 (mm/sec)
Example	Ex) When you set the pressurization force to 100, 200 and 300kgf respectively for gun 1, 2 and 3 while executing the gun search. GUNSEA GN=1, SE=1, PR=100, MG=2,3,MP=200,300		



Reference

- For the initial use, the tip without abrasion needs to be mounted and the reference location needs to be recorded. This is called gun search reference location recording.
- For the gun search reference record, the condition setting/application condition/gun search reference location record need to be shifted to the ON state, before executing the GUNSEA command. The location detected then will be used as the reference value for measuring the abrasion.
- When a certain value is set for the moving electrode abrasion/overall abrasion (%) ratio in the servo gun parameter, it is called 'single gun search 1 environment'. In that condition, only the gun search 1 is to be executed to calculate the abrasion both at the moving and the fixed electrodes. If the gun search is executed in the single gun search 1 environment, an error will occur.
- When 0 is set for the moving electrode abrasion/overall abrasion (%) ratio in the servo gun parameter, it means that in that condition, both the gun search 1 and 2 can be executed. In this case, the gun searches 1 and 2 need to be executed sequentially to calculate the abrasion.

Controller Operation Manual

- GUNSEA step must be recorded in the open location of 20mm or more from the abrasion detection target location.

10.5.4.3. IGUNSEA

The IGUNSEA command performs the same function as GUNSEA command. In case of the GUNSEA command, the servo gun's pressure is used to detect the location, while the IGUNSEA command is used when using the external sensor to detect the On or Off signals of this sensor in order to detect the abrasion. However, the gun search 1 command cannot be replaced with the IGUNSEA command. Only in case of the gun search 2, the IGUNSEA command can be used instead.

IGUNSEA GN=gun number, SP=search speed, DI=DI signal, DT=On/Off

Item	Range	Content
GUN number	1~8	Designate servo gun number to measure abrasion
Search speed	1.0~250mm/s	During the search movement, speed of gun axis is assigned. Search speed by input signal as based on safety speed. Recommended speed is 10mm/sec.
DI signal	1~256	Designate number for accessing input signal for photo electric tube
On/Off	0~1	Detection condition of signal is assigned. 0 = Detection when Low (Normal High) 1 = Detection when High (Normal Low)

Input signal logic of assigned I signal	IGUNSEA I signal On/Off	Output signal of photo electric tube during signal detection
Positive	On (1)	Detected high (Normal Low)
	Off (0)	Detected low (Normal High)
Negative	On (1)	Detected low (Normal High)
	Off (0)	Detected high (Normal Low)



Reference

- When setting I signal On/Off, check 『F2: System』 → 『2: Control parameter』 → 『2: Input/output signal setting』 → 『1: Input signal attribute』.

- It is convenient that assigned input signal logic is set as 'POSITIVE' before phototube logic setup.
- If input signal logic is set as 'NEGATIVE,' the signal outputted as HIGH in phototube is detected as LOW in controller.



10.5.4.4. EGUNSEA

The EGUNSEA statement is the function used to calculate the tip abrasion of the fixed electrode when using the equalizer less air pressure gun.

When this command is executed, the gun will move for the designated search distance until the sensor detects a signal. When the sensor detects a signal at a certain location, the location will be used for calculating the abrasion

EGUNSEA GN=gun number, SP=search speed, SD= Search distance, DI=DI signal,

Item	Range	Content
GUN number	1~8	Designate the equalizer less gun number to measure the abrasion
Search speed	1.0~250mm/s	During the search movement, speed of gun axis is assigned. Search speed by input signal as based on safety speed. Recommended speed is 10mm/sec.
Search distance	1.0~1000.0mm	Designate the maximum gun search distance of the fixed electrode
DI signal	1~256	Designate number for accessing input signal for photo electric tube
On/Off	0~1	Detection condition of signal is assigned. 0 = Detection when Low (Normal High) 1 = Detection when High (Normal Low)



Reference

- For the initial use, the tip without abrasion needs to be mounted and the reference location needs to be recorded. This is called gun search reference location recording.
- For the gun search reference record, the condition setting/application condition/gun search reference location record need to be shifted to the ON state, before executing the EGUNSEA command. The location detected then will be used as the reference value for measuring the abrasion.

10.5.4.5. GUNCHNG

The GUNCHNG statement is used for connecting and disconnecting the welding gun when trying to exchange it for the use. When executing GUNCHNG ON, supply the power to the motor and encoder of the gun to connect and execute the preparation for operation. When executing GUNCHNG OFF, disconnect the power to the motor and encoder of the servo gun axis to switch to the condition which can be separated.

GUNCHNG ON/OFF, GN=gun number, DI=connection completion input, WT=connection completion wait time			
ON/OFF	ON	Connection command of gun	
	OFF	Disconnection command of gun	
Gun number	0	Select gun number by external input signal	Ignored parameter when the GUNCHNG is OFF
	1~8	Select gun number to exchange	
Connection completion input	1~256	Select input signal number for mechanical connection completion of the servo gun	
Connection completion wait time <0~5.0> (sec)		Wait time until servo gun connection completion signal input until the gun is connected	



Reference

- When you set the connection completion wait time to 0, it waits until the connection completion signal is received.

Controller Operation Manual

10.5.4.6. ThickCheck

Explanation	During spot welding by the servo gun, the panel thickness will be measured. If there is an abnormality with the measured value, an error will be generated and notified to the user, and the welding work will be stopped.		
Syntax	ThickCheck <Store the measured value>,<Reference value>,<Error value>		
Parameter	Store the measured value	Stores the values of panel thickness measured while the servo gun is squeezed when executing the SPOT command.	
	Reference value	Reference value measured in case of a normal panels	0.1~200.0
	Error value	Error value against the reference value with which a panel is judged to be normal	0.1~200.0
Example	<pre> MOVE P,S=60%,A=1,T=1 ThickCheck MEA=LV1!,REF=4.0,TOL=1.0 'Normal when the measured thickness is in the range of 3.0~5.0 SPOT GN=1,CN=1,SQ=1 'Carries out welding when the thickness is tested to be normal ... MOVE P,S=60%,A=1,T=1 SPOT GN=1,CN=1,SQ=1 'Carries out welding without inspecting thickness </pre>		

10.5.4.7. SvClamp

Explanation	When a workpiece is required to be handled by a servo gun, there should be a series of processes, such as the squeezing of the workpiece by the moving and fixed tips of the servo gun, movement to the target position, and opening of the two tips. This will allow the processes to occur.		
Syntax	SvClamp <ON/OFF>,<Gun number>,<Condition number>,<Multi gun number>, <Multi gun condition number>		
Parameter	On/Off	ON : Servo gun squeeze operation OFF : Servo gun open operation	
	Gun number	The number of the gun that needs to be operated	1~16
	Condition number	Welding condition for the operation	1~1024
	Multi gun number	To be designated when operation of more than 2 guns is required	1~16
	Multi gun condition number	To be designated when more than 2 guns require different operation conditions	1~1024
Example	<pre> SvClamp ON,GN=1,CN=1 'Servo gun squeeze operation MOVE P,S=60%,A=1,T=1 MOVE P,S=60%,A=1,T=1 </pre>		

	WAIT DI1 MOVE P,S=60%,A=1,T=1 SvClamp OFF,GN=1 'Servo gun open operation



10.5.5. Arc Welding

10.5.5.1. ARCON

ARCON statement is the command that starts the arc welding.

Explanation	Start arc welding. This can be used in 3 formats.		
Syntax	ARCON ARCON ASF#=<Arc start condition number> ARCON C=<Current output value>, V(VP)=<Voltage output value>, ASF#=<Arc start condition number>		
Parameter	Arc start condition number	Arc welding start and welding condition number used for this condition But, if there is current or voltage output in the previous article, the condition set in the previous article is reflected to the current and voltage of the applicable arc welding start condition.	1~32
	Current output value	Output current for arc welding	0~500
	Voltage output value(V) Voltage output value(VP)	Output voltage value for individually set arc welding Output voltage value for one source set arc welding	0.0~40. 0 -20~200
	Stop time	Enter the stop time after the arc ignition until the start.	0.00 ~10.00
	RETRY	Set whether to use the RETRY function when arc welding fails.	RETRY
Example	ARCON ARCON ASF#=1 ARCON C=200,V=22,T=1,RETRY		



Reference

- To use all of the 3 formats of the command statement, you must set the arc welding to analog in 『[F2]: System』 → 『5: Initialize』 → 『3: Usage setting』.
- When setting the arc welding to digital, you can only use the format of using the condition number.

10.5.5.2. ARCOF

ARCOF statement is the command to end the arc welding.

Explanation	End arc welding. This can be used in 4 formats.		
Syntax	ARCOF ARCOF ASF# ARCOF AEF#=<Arc end condition number> ARCOF C=<Current output value>,V(VP)=<Voltage output value>,AEF#=<Arc welding end condition number>		
Parameter	Arc end condition number	Number of welding condition used when ending arc welding But, if there is current or voltage output in the previous article, the condition set in the previous article is reflected to the current and voltage of the applicable arc welding start condition.	1~32
	Current output value	Output current value when ending arc welding	0~500
	Voltage output value (V) Voltage output value (VP)	Output voltage when ending individually set arc welding. Output voltage when ending one source set arc welding	0.0~40.0 -20~200
	Stop time		0.00~10.00
	Whether to cancel auto deposition	In case of wire stick after ending arc welding, set whether to use the auto deposition cancel function.	ANTSTK
Example	ARCOF ARCOF ASF# ARCOF AEF#=1 ARCOF C=200,V=22,T=1,ANTSTK		



Reference

- When the arc welding is set to digital in 『F2』: System → 『5』: Initialize → 『3』: Usage setting item, command statement of 'ARCOF ASF#' format can only be used.
- When setting the arc welding to analog, all 3 formats excluding the above format can be used.

10.5.5.3. WEAVON

WEAVON statement is the command to start the weaving operation.

Explanation	Start weaving operation.		
Syntax	WEAVON WEV#=<Weaving condition number>		
Parameter	Weaving condition number	Condition number to use during weaving operation from weaving condition saved file	1~32
Example	WEAVON WEV#=1		

10.5.5.4. WEAEOF

WEAEOF statement is the command to end the weaving operation.

Explanation	End weaving operation.		
Syntax	WEAEOF		
Example	WEAEOF		

10.5.5.5. REFP

REFP statement is the command to enter the reference point necessary for weaving operation.

Explanation	Enter the reference point.		
Syntax	REFP <Reference point number>,<Pose number> REFP <Reference point number>		
Parameter	Reference point number	Number to set the type of reference point	1~8
	Pose number	Enter the pose of reference point. But, when entered as hidden pose, it is omitted.	
Example	REFP 1,P1 REFP 1		

10.5.5.6. ARCCUR

ARCCUR statement sets the welding current output value to designated value.

Explanation	Set the welding current output value.		
Syntax	ARCCUR C=<Current output value>		
Parameter	Current output value	Set the current output value to use in the arc welding condition.	0~500
Example	ARCCUR C=200		

10.5.5.7. ARCVOL

ARCVOL statement sets the welding voltage output value to the designated value.

Explanation	Set the welding voltage output value.		
Syntax	ARCVOL V(VP)=<Voltage output value>		
Parameter	Voltage output value(V) Voltage output value (VP)	Output voltage when ending individually set arc welding. Output voltage when ending single source set arc welding	0.0~40.0 -20~200
Example	ARCVOL V=20 ARCVOL VP=100		

10.5.5.8. ARCDC

ARCDC statement is the command that sets the voltage value outputted through analog port assigned to welding current.

Explanation	Set the voltage value outputted through analog port assigned for welding current.		
Syntax	ARCDC <Current command value [V]>		
Parameter	Current command value	Set the voltage value outputted through the current output port of analog arc welding.	-14.0~14.0

Example	ARCDC 10

10.5.5.9. ARCDV

ARCDV statement is the command to set the voltage value outputted through the analog port assigned with welding voltage.

Explanation	Set the voltage value outputted through analog port assigned with welding voltage.		
Syntax	ARCDV <Voltage command value [V]>		
Parameter	Voltage command value	Set the voltage value outputted through voltage output port of analog arc welding.	-14.0~14.0
Example	ARCDV 10		

10.5.5.10. LVSON



LVSON statement starts the welding line search or tracking by LVS.

Explanation	Start the welding line search or tracking by LVS.		
Syntax	LVSON LVS#=<LVS condition file number>		
Parameter	LVS condition file number	LVS condition file number to be used for LVS welding line search or tracking	1~32
Example	LVSON LVS#=1		

10.5.5.11. LVSOFF

LVSOFF statement is the command to end the welding line search or tracking by LVS.

Explanation	Ends the welding line search or tracking by LVS.		
Syntax	LVSOFF		
Example	LVSOFF		

10.5.5.12. CHGLVS

CHGLVS statement is the command to change the welding line search or tracking setting by LVS.

Explanation	Change the welding line search or tracking setting condition number by LVS.		
Syntax	CHGLVS LVS#=<LVS condition file number>		
Parameter	LVS condition file number	LVS condition file number to be used for LVS welding line search or tracking	1~32
Example	CHGLVS LVS#=2		

10.5.5.13. TRJLOG

TRJLOG statement is the command to save the moving trace of arc sensing.

Explanation	Save the moving trace by arc sensing.		
Syntax	TRJLOG ST=<Start/End>,SC=<Sampling cycle>,LSP=<Record start pose variable>,LCV=<Number of records LV% number for exchange>		
Parameter	Start/End	1 : Start trace record 0 : End trace record	0, 1
	Sampling cycle	0 : Save path step 1~100 : Sampling weaving cycle	0~100
	Record start pose variable	Pose variable number that starts the record	1~999
	Number of records LV% number for exchange	Number of LV% variable to designate/check the number of record. Designate the maximum value to record before executing the command and reduce by -1 for every recording	1~50
Example	TRJLOG ST=1,SC=5,LSP=0,LCV=1		

10.5.5.14. ATDC

ATDC statement is the command to execute auto tool data calibration function.

Explanation	Execute auto tool data calibration function.		
Syntax	ATDC T=<Tool number>,OrgP=<Original pose>,NewP=<Current pose>		
Parameter	Tool number	Tool number to execute auto tool data calibration function	0~15
	Original pose	Pose originally saved	
	Current pose	Deformed current pose	
Example	ATDC T=1,OrgP=P1,NewP=P2		

10.5.5.15. CalTVSft



CalTVSft statement is the command to calculate the shift value that can set the tool from the two pose variables entered.

Explanation	Calculate the shift value to set the tool from the two pose variables entered.		
Syntax	CalTVSft <Pose 1>,<Pose 2>,<Shift variable>		
Parameter	Pose 1	Pose 1 calculated by sensing	
	Pose 2	Pose 2 calculated by sensing	
	Shift variable	Shift variable to set the tool slope calculated by two pose values	
Example	CalTVSft LP1,LP2,LR1		

10.5.5.16. ARCRSV1, ARCRSV2

The ARCRSV1 and ARCRSV2 statements are the commands to generate the analogue instruction output, besides the outputs for the current and voltage, in the analogue arc welding

Explanation	Generate the analogue instruction output in the analogue arc welding.		
Syntax	ARCRSV1 RSV1=<Auxiliary variable 1 output value> ARCRSV2 RSV2=< Auxiliary variable 2 output value >		
Parameter	Auxiliary variable 1	Auxiliary variable for the arc welding. Generates the instruction value, proportionate to the variable, to the auxiliary 1 port assigned in the arc welding output port.	-200 ~ 1000
	Auxiliary variable 2	Pose 2 acquired through sensing Generates the instruction value, proportionate to the variable, to the auxiliary 2 port assigned in the arc welding output port.	-200 ~ 1000
Example	ARCRSV1 RSV1=100 ARCRSV2 RSV2=-50		

**Reference**

- Only when you select the arc welding as analogue in 『F2』: System』 → 『5』: Initialize』 → 『3』: Usage setting』, and set the 'analogue signal add' as +2 (Auxiliary 1~2) in the 『F1』: Welder』 item.
- The variable values and the analogue voltage output table can be set in the 'Auxiliary A01' and 'Auxiliary A02' message box.

10.5.5.17. HSensON

Explanation	HSensON statement is the command to start the height sensing (AVC, Arc length control). Refer to "Height sensing" for more details.		
Syntax	HSensON AVC#=<Height sensing condition number>		
Parameter	Height sensing condition number	Condition number to be used when executing height sensing	0 ~ 8

Controller Operation Manual

Example	HSensON AVC#=1 ← Starts height sensing with the height sensing condition No 1
Details	Refer to 『Hi5a Controller Arc Welding Function Manual』 for more details

10.5.5.18. HSensOFF

Explanation	HSensOFF statement is the command to end height sensing (AVC, Arc length control).
Syntax	HSensOFF
Example	HSensOFF ← Ends the height sensing execution
Details	Refer to 『Hi5a Controller Arc Welding Function Manual』 for more details



10.5.5.19. PosiCal

Explanation	PosiCal statement is the command to calibrate designated stations by using the inputted program number. This command is to be used together with the servo axis change function. With this function, it is possible to calibrate the servo axis positioner that changes while the robot is performing work.		
Syntax	PosiCal Prog=<Program number>,Station=<Station number>		
Parameter	Program number	Number of the work program for which station calibration teaching is performed	1 ~ 9999
	Station number	Number of the station for which calibration needs to be performed	S0, S1, S2, S3, All
Example	PosiCal Prog=9997,Station=2 ← Calibrates Work station #2 of 9997.JOB.		

10.5.6. Handling

When you press the [Command input] key from the initial screen of the MANUAL mode, and press the 『[F6]: Handling』 key from the item displayed in F menu, the commands included are described as follows. Arithmetic formula can be applied with all parameter values. Handling items include the robot language used in handling and conveyer synchronization function.

Table 10-31 Robot language for handling

Robot language	Explanation
SensorSync	Sensor synchronization playback
WaitSensor	Function to set the work start location
LSOperated	Forced assignment of a sensor synchronization limit sensor input
LoadAln	Alignment correction amount calculation commands when loading non-traveling alignment robot (HC2503B2DA, HC1852B2DA) among LCD-handling robots
UnloadAln	Alignment correction amount calculation commands when unloading non-traveling alignment robot (HC2503B2DA, HC1852B2DA) among LCD-handling robots
IsDataConst	Function to check if the data entered as a string is a number or a character
ArraySet	Function to initialize the designated scope of a variable array to a specific value
ArrayShift	Function to move the data of the designated scope of a variable array space by space
SplitStr	Divide the inputted string based on ' '(spacing).
DecPoint	Express a resolution and a decimal place.

10.5.6.1. SensorSync

The SensorSync statement determines whether to execute the sensor synchronous operation. When the sensor synchronous operation (Sync=1) is executed, a robot applies the shift as much as the distance that the sensor moves to the rest of the steps until the sensor synchronous operation is off (Sync=0) or the sensor synchronous reset is executed (Sync=2).

Explanation	Sensor synchronous playback		
Syntax	SensorSync Sensor=<Synchronization parameter number>,Sync=<Synchronized state>		
Parameter	Synchronization parameter number	Synchronization parameter number for the application of the sensor synchronization	1~2
	Sync state	0 : Sensor synchronous operation OFF 1 : Sensor synchronous operation ON 2 : Sensor synchronous operation OFF and conveyer data reset 3 : Completion of the current work	0~3
Example	SensorSync Sensor=1,Sync=1		

10.5.6.2. WaitSensor

The WaitSensor statement is the function to determine whether to make the robot start the work when the work passes through the start limit switch and arrives at a certain location, during the sensor synchronized operation.

Explanation	This function determines the job starting point.		
Syntax	WaitSensor Sensor=<Synchronization parameter number>,Sync=<Wait status>, Pos=<Wait distance>		
Parameter	Synchronization parameter number	Synchronization parameter number for the application of the sensor synchronization	1~2
	Wait status	Determines whether to make the robot wait by turning on or off the sensor synchronization.	0~1
	Wait distance	Enter the work start distance by using the unit of mm and deg, beginning form the start limit switch.	0~20,000
Example	WaitSensor Sensor=1,Sync=1,Pos=400		

10.5.6.3. LSOperated

Explanation	This is used when the work program needs to manage the number of workpieces that enter when using the sensor synchronization function. For example, when the robot handles workpieces on the conveyor by using vision cameras, it is needed for the controller to recognize the same number of workpieces that the cameras recognize at once. This function is useful in this case.		
Syntax	LSOperated <Synchronization parameter number>		
Parameter	Synchronization parameter number	Synchronization parameter number that corresponds to the sensor number	1~2
Example	<pre>FOR V1%=1 TO 3 'As many workpieces as recognized by the cameras LSOperated Sensor=1 'Sets the state of the workpieces that enter NEXT</pre>		

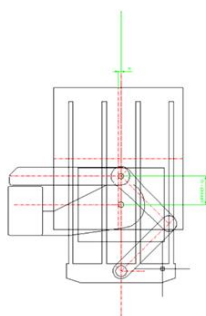


10.5.6.4. LoadAln (Only available to LCD-handling non-traveling alignment robots)

Explanation	X alignment amount received through Load With Alignment command can only be used when calculating the correction amount of the TH axis, R(L) axis, and RA(LA) axis for LCD-handling non-traveling alignment robots.		
Syntax	LoadAln (Delta_X, iRorL, Offset_Arm_TH, popValue, DeltaTheta_TH , DeltaTheta_RL, DeltaTheta_RALA)		
Parameter	Delta_X	Glass displacement in the X direction	(mm)
	iRorL	Select the upper and lower hand.	(mm)
	Offset_Arm_TH	Distance from TH axis to the Arm	(mm)
	popValue	Pose of step to departure (Load Wait)	Pose variable
	DeltaTheta_TH	Correction amount to reflect on TH axis for alignment	(deg)
	DeltaTheta_RL	Correction amount to reflect on R(L) axis for alignment	(deg)
	DeltaTheta_RALA	Correction amount to reflect on RA(LA) axis for alignment	(deg)
Example	LoadAln V![327+V%[8]],V%[8],V![323],P[2321],V![318],V![319],V![320]		

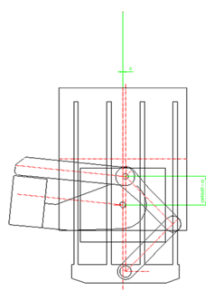
X Align [Translational direction]

①



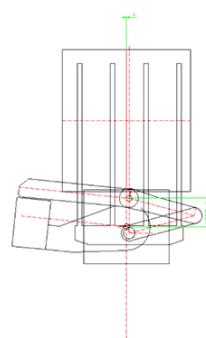
When the glass is twisted by m-mm (Check with a displacement sensor.)

②



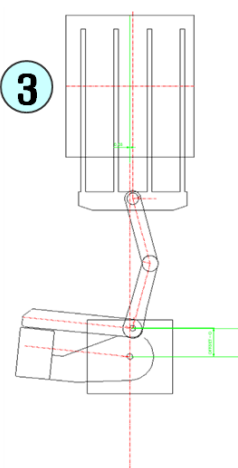
Correct the translational direction to the twisted distance (m) ($e^\circ \approx \sin(m/k)$) (Pivot axis, J1 co-rotating)

③

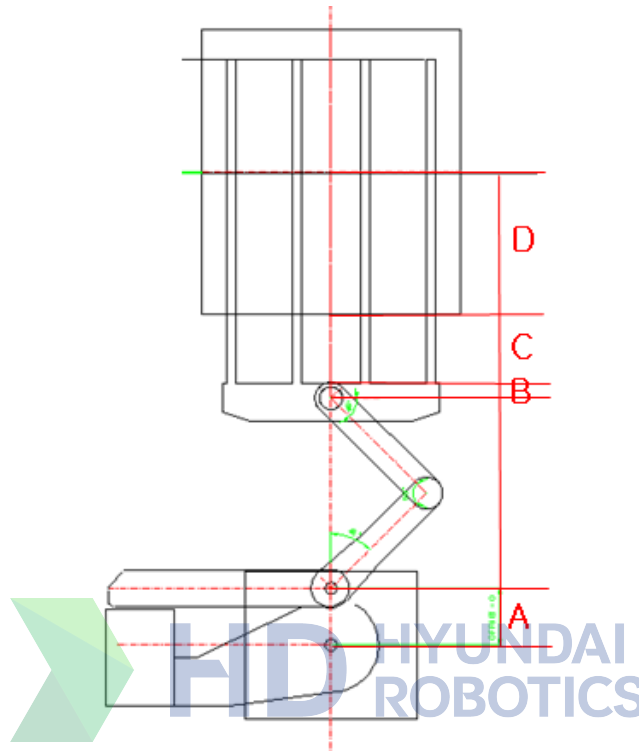


Arm operation

④



10.5.6.5. UnloadAln (Only available to LCD-handling non-traveling alignment robots)



A: Distance from TH axis to the Arm

B: Distance from the hand center to the fork bracket tip

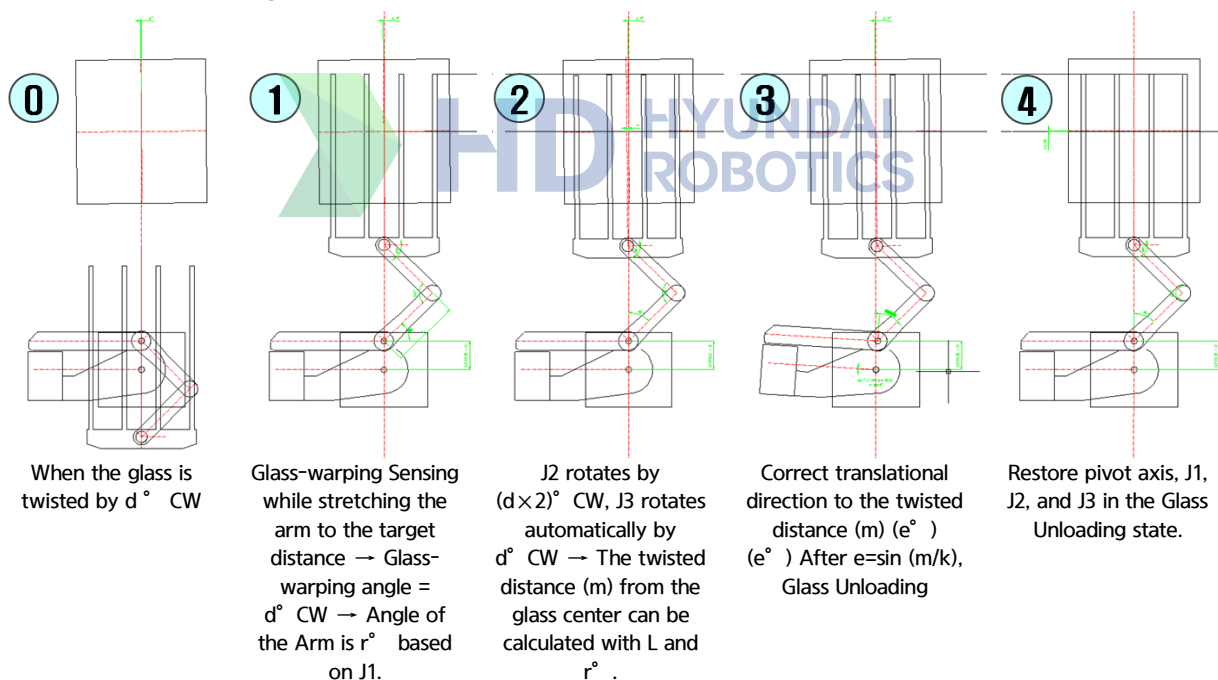
C: Distance from the fork bracket tip to the glass end

D: 1/2 of the glass size

Explanation	It can only be used while the Unload With Alignment command is performed when calculating the correction amount of the TH axis, R(L) axis, and RA(LA) axis for LCD-handling non-traveling alignment robots.		
Syntax	UnladAln <InTheta, InY, RorL, Offset_Arm_TH, Offset_ForkBracket, Offset_Hand , Offset_HalfGlass , Theta_TH , Theta_RL, Theta_RALA>		
Parameter	InTheta	Glass displacement, which returns to Theta	Displacement (rad)
	InY	Glass displacement in the Y direction	Displacement (mm)
	RorL	Select the upper and lower hand.	(0:R, 1: L)
	Offset_Arm_TH	Distance from TH axis to the Arm	(mm)
	Offset_ForkBracket	Distance from the hand center to the fork bracket tip	(mm)

Controller Operation Manual

	Offset_Hand	Distance from the fork bracket tip to the glass end	(mm)
	Offset_HalfGlass	Glass size	(mm)
	Theta_TH	Correction amount to reflect on TH axis for alignment	(deg)
	Theta_RL	Correction amount to reflect on R(L) axis for alignment	(deg)
	Theta_RALA	Correction amount to reflect on RA(LA) axis for alignment	(deg)
Example	UnloadAln LV2!,V![326],V%[8],V![323],V![340],V![343],V![344],V![318],V![319],V![320]		

 θ & Y Align [Rotating direction]

10.5.6.6. IsDataConst

Explanation	This is used to check if the data entered as a string is a number or a character.		
Syntax	IsDataConst <src>,<dst>		
Parameter	src	Inputted data	V\$, LV\$
	dst	Return the analysis result.	V%, LV% 1: number 0: string
Example	IsDataConst V\$[6],V%[41]		
Version	Operation after the V40.23-04_20200730 version		



10.5.6.7. ArraySet

Explanation	This is used to initialize the designated scope of a variable array to a specific value. In the case of an ID variable array, initialize the array scope of src3–src4 based on the array index of src1. In the case of a V variable array, initialize all scopes of the array.		
Syntax	ArraySet <src1>,<src2>,<src3>,<src4>		
Parameter	src1	Array name	
	src2	Value to initialize (strings/numbers)	
	src3	Start index of array	V%, LV%, number
	src4	End index of array	V%, LV%, number
Example	1. ArraySet V10%, V1%, 3, 5 => Initialize V%[13] – V%[15] to V1%. 2. ArraySet gtTestArr[6],LV\$[10],7,12 => Initialize gtTestArr[7] – gtTestArr[12] to LV\$[10]. => The array of src1 is [7]. However, ignore it.		
Version	Operation after the V40.23-04_20200730 version		

10.5.6.8. ArrayShift

Explanation	This is used to move the data of the designated scope of a variable array space by space. Based on the array index of src1, move the src3–src4 array scope. For the last value of an array to move, insert 0 in the case of a number array, or null in the case of a string array.		
Syntax	ArrayShift <src1>,<src2>,<src3>,<src4>		
Parameter	src1	Array name	
	src2	Data movement direction	1: ascending order 0: descending order
	src3	Start index of array	V%, LV%, number
	src4	End index of array	V%, LV%, number
Example	1. ArrayShift V10%, 1, 3, 5 => Set V%[15] to V%[14], V%[14] to V%[13], and V%[13] to 0. 2. ArrayShift gtTestArr,0,1,8 => Set gtTestArr[1] to gtTestArr[2], gtTestArr[2] to gtTestArr[3], and gtTestArr[8] to null.		
Version	Operation after the V40.23-04_20200730 version		

10.5.6.9. SplitStr

Explanation	This is used to divide the inputted string based on ' '(spacing). There are up to 20 split strings. The split first string is divided into the first three characters and last characters (responding to For SDC). Ignore “#” in the last word.		
Syntax	SplitStr <src>,<dst>		
Parameter	src	Inputted string	
	dst	Array of a split string	
Example	SplitStr “013Commnd CM1 4 15 1#”, V10\$ → V10\$: 013, V11\$:Command, V12\$: CM1, ... , V15\$: 1 → No other role assignments until V29\$ -> Fixed space is needed for up to 20 items.		
Version	Operation after the V40.23-04_20200730 version		

10.5.6.10. DecPoint

Explanation	This is used to express resolution and decimal places.		
Syntax	DecPoint <src1>,<src2>,<src3>,<dst>		
Parameter	src1	Real number to convert	
	src2	Resolution	1: 1/10 times 2: 1/100 times 3: 1/1000 times
	src3	Decimal place	
	dst	Variable to save the converted result	String
Example	DecPoint V![21],V![11],V![17],V\$[31] 1. In the case of V![21] = 31415, V![11] = 2, V![17] = 3 -> V\$[31] = 314.150 2. In the case of V![21] = 31415, V![11] = 1, V![17] = 3 -> V\$[31] = 3141.500		
Version	Operation after the V40.23-04_20200730 version		

10.5.7. Paint

The statements explained in this section are related to “paint” application and are to be displayed only when the paint item is set as “Enable” in the 『F2]: System』 → 『5: Initialize』 → 『3: Usage setting』 dialog box.

Refer to 『Hi5a Controller Painting Function Manual』 for more details about statements.

10.5.7.1. PAINT

PAINT statement is for generating output signals for the set painting gun.

Explanation	Turns on or off the painting gun. (Turns on or off the painting output signal)	
Syntax	PAINT <Gun number>=<Gun On/Off> PAINT <Gun number>=<Gun On/Off>, ANT=<Earlier/Delayed Spray>	
Parameter	Gun number	G1 : Gun1 G2 : Gun 2
	GunOn/Off	1: On 0: Off
	Earlier/delayed spray	“<0” : Earlier spray as much as the absolute value “>0” : Delayed spray as much as the absolute value
Example	PAINT G2=1, ANT=-0.5 PAINT G2=0	

```

S1      MOVE P,S=80%,A=3,T=0
S2      MOVE P,S=60%,A=1,T=0
        PAINT G1=1,ANT=-0.5 'Gun 1 spray start (0.5 seconds earlier)
S3      MOVE L,S=300mm/s,A=1,T=0
S4      MOVE L,S=300mm/s,A=1,T=0
S5      MOVE L,S=300mm/s,A=1,T=0
S6      MOVE L,S=300mm/s,A=1,T=0
        PAINT G1=0,ANT=-0.5 'Gun 1 spray end (0.5 seconds earlier)
S7      MOVE P,S=60%,A=1,T=0

```

For example, in the above case, the paint output signal will be turned on when the robot tool end passes through the S2 position and turned off when passing through the S6 position. After the Paint command is executed, it will take a little bit of time before paint is actually sprayed. Thus, the paint output signal should be outputted much earlier than the delay in order to allow the paint to form on correct position. Accordingly, it is required to allow signals to be outputted earlier by setting a proper negative value in the ANT parameter.

10.5.8. Statements related to variables

※ The functions described in this section cannot be used for controllers lower than version Hi5.

10.5.8.1. PARAM

Explanation	Enumerates formal parameters of sub jobs. It is preferred to put it at the front of a job. It must be executed earlier than DIM statement.		
Syntax	PARAM [<Formal parameter>,<Formal parameter>,...]		
Parameter	Formal parameter	Names to be mapped to the actual parameters of Call statement. Should start with the prefix "I". (Refer to 10.4.4.4 Parameters)	Up to 10
Example	<pre>'Calc. Euclide distance 2D PARAM IdLen,IdX,IdY DIM IdaMid[3],IdTmp AS Double DIM ItMsg AS String ' IdTmp=IdX*IdX+IdY*IdY IdLen=SQR(IdTmp) 'distance from origin</pre>		

10.5.8.2. DIM

Explanation	Defines the local variables of sub jobs. It is preferred to put it at the front of a job. It needs to be executed later than PARAM statement		
Syntax	DIM [<Local variable >,<Local variable >,...] AS <Variable type>		
Parameter	Local variable	Names of the local variables to be used for sub jobs. Should start with the prefix "I" (Refer to 10.4.4.3 Local variables)	Up to 10
	Variable type	One of Integer, Double, String, Pose and Shift	
Example	<pre>'Calc. Euclide distance 2D PARAM IdLen,IdX,IdY DIM IdaMid[3],IdTmp AS Double DIM ItMsg AS String ' IdTmp=IdX*IdX+IdY*IdY IdLen=SQR(IdTmp) 'distance from origin</pre>		

10.5.9. ENET Member Variable/Command

You can use the ENET object to send/receive the string with the external device through Ethernet UDP communication. Because there are 3 ENET objects, you can communicate with 3 targets simultaneously.

First, set the IP address and port number as member parameter and open the communication channel with the OPEN command. And then execute the send/receive with PRINT and INPUT commands.

10.5.9.1. Member Variable

Table 10-32 ENET member variables

Variable name	Explanation		Example
IP	String variable. Read/write allowed. IP address of communication partner is appointed or returned. ※ This is applied only when OPEN statement is called.		ENET2.IP = "10.7.4.136"
RPORT	Integer variable. Read/write allowed. Port number of communication partner (Remote) is appointed or returned. ※ This is applied only when OPEN statement is called.		ENET3.RPORT = 1042
LPORT	Integer variable. Read/write allowed. You can designate or obtain the local port number of the controller. Default value is 0 (When not designated), and in this case, the local port number is automatically generated. ※ This only applies when the OPEN statement is called.		ENET2.LPORT = 500
STATE (read only)	Integer variable. Read-only. For checking status after executing the OPEN command		IF ENET1.STATE<1 THEN *ERR
	1	Connected.	
	0	Not connected.	
	-1	UDP OPEN failure	
	-2	Ethernet device BIND failure	

10.5.9.2. OPEN

Explanation	Communication channel for monitoring communication is opened or closed.		
Syntax	〈ENET object〉.OPEN 〈connection status〉		
Parameter	Connection status	0: Communication channel is closed. 1: Communication channel is opened and ENET object is initialized.	0~1
Example	ENET1.OPEN 0 ENET1.OPEN 1		

10.5.9.3. SEND

Explanation	Transmits binary data via the Ethernet communication channel (You may use the PRINT statement when transmitting string data that terminates with null.)		
Syntax	〈ENETObject〉.SEND 〈BUFV Variable〉,〈Byte count〉		
Parameter	BUFV Variable	Buffer variable that stores binary data to be transmitted	
	Byte Count	Count of bytes to be transmitted	1~1400
Example	ENET1.BUFV[0],24 'Transmit the data of 24 bytes starting from the position of offset 0 in BUFV. ENET1.BUFV[1000],24 'Transmit the data of 4 bytes starting from the position of offset 1000 in BUFV.		

When null (0)-terminated string data is to be transmitted, the PRINT statement is generally used. However, as the binary data may have null (0) values in the middle position, the transmission may be terminated in the data's middle position if the data is transmitted using the PRINT statement.

Accordingly, when binary data is to be transmitted, the ENET.SEND statement capable of transmitting the designated count of bytes should be used.

Work	Data type	Appropriate statement
Transmission	null-terminated string	PRINT
	binary	ENET.SEND
Reception	null-terminated string	INPUT
	binary	INPUT

10.5.9.4. Example 1 – String communication

This work program sends a string message requesting a work file transfer to a remote PC and receives the results in a string message.

```

_TEINPUT=0 'INPUT Ending character
'
'Ethernet setting -----
ENET1.IP="192.168.1.172"
ENET1.LPORT=500
ENET1.RPORT=7000
ENET1.OPEN 1
CLR_RBUF ENET1
'
'Request for file transmission
PRINT ENET1,"LDFILE ";V200%; 'V200% is the task number to request

'Standby for result response
INPUT ENET1,V20$,8,*NO_RESP
ENET1.OPEN 0

'Result interpretation
V21$=LEFT$(V20$,11)
IF V21$<>"LDFILE RES=" THEN *INV_RES
V21$=MID$(V20$,12,4)
V201%=VAL(V21$) 'Return value'
IF V201%<0 THEN *ERR_RES
'

'Call sub robot task
CALL V200%
END
'

'Exception processing -----
*NO_RESP
PRINT #0,"There is no response for LDFILE request."
END
*INV_RES
PRINT #0,"LDFILE response is not valid."
END
*ERR_RES
PRINT #0,"LDFILE response error code =";V201%
END

```


10.5.9.5. Example 2 – Binary communication

This work program receives 10 shift data in binary format from a remote PC and transmits the result data in binary format.

```

    DIM liR,liB AS Integer
    _TEINPUT=-(4*6*10) "Count of bytes to be received: 4-byte integer*6 elements * 10
    '
    'Ethernet setting -----
    ENET1.IP="192.168.1.172"
    ENET1.LPORT=500
    ENET1.RPORT=7000
    ENET1.OPEN 1
    CLR_RBUF ENET1
    '
    'Shift data transfer request
    PRINT ENET1,"REQ_SHIFT" 'Shift data request
    '
    'Wait for result response
    INPUT ENET1,BUFV[0],8,*NO_RESP
    '
    'Interpretation of the result (signed integer, little endian, 4byte, x1000 normalization)
    'R101~R110 <= BUFV[0~239]
    R1=(0,0,0,0,0,0)
    FOR liR=101 TO 110
        R1.X=BUFV[liB+0].s4/1000.
        R1.Y=BUFV[liB+4].s4/1000.
        R1.Z=BUFV[liB+8].s4/1000.
        R1.RX=BUFV[liB+12].s4/1000.
        R1.RY=BUFV[liB+16].s4/1000.
        R1.RZ=BUFV[liB+20].s4/1000.
        R[liR]=R1
        liB=liB+4*6
    NEXT
    '
    'Transmission of the result
    BUFV[500].s4=1 'ACK
    ENET1.SEND BUFV[500],4
    ENET1.OPEN 0
    END
    '
    'Handling as an exception -----
    *NO_RESP
    PRINT #0,"There is no response to the shift data request."
    END

```

10.6. Function

10.6.1. Arithmetic Function

Returned value of arithmetic function is numeral.

Example: V1!=10, V2!=-1.23, V3!=3.14152, V20%=16, V21%=5, V7\$="XDIST:20"

Table 10-33 Arithmetic functions of the robot language

Function name	Explanation	Example	Returned value
ABS(a)	Absolute value of 'a' is returned.	ABS(V2!)	1.23
MAX(a, b)	Bigger value between 'a' and 'b' is returned.	MAX(V2!,-3)	-1.23
MIN(a, b)	Smaller value between 'a' and 'b' is returned.	MIN(V2!,-3)	-3
DEGRAD(a)	Radian value of 'a' is returned in a degree form.	DEGRAD(270)	4.712389
RADDEG(a)	Degree value of 'a' is returned in a radian form.	RADDEG(2*V3!)	359.997
SQR(a)	Square root of 'a' is returned.	SQR(V20%)	4
SIN(a)	Sine value of 'a' is returned in a radian form.	SIN(V3!/6)	0.5
COS(a)	Cosine value of 'a' is returned in a radian form.	COS(V3!/6)	0.866
TAN(a)	Tangent value of 'a' is returned in a radian form.	TAN(V3!/6)	0.577
ATN(a)	Arctangent value of 'a' is returned in a radian form.	ATN(0.5)	0.464
ATN2(a,b)	Arctangent value of a triangle whose 'y' length is 'a' and 'x' length is 'b' is returned in a radian form.	ATN(-2,0)	-1.571
DIST(a,b)	Distance to a point whose 'x' coordinate is 'a' and 'y' coordinate is 'b' is returned.	DIST(V21%,V21%)	7.071
ORD(a)	ASCII code of the first character in 'a' string is returned.	ORD("ERROR")	69
VAL(a)	Value expressed in 'a' string is returned.	VAL("29.38E-2")	0.2938
STRPOS(a,b)	First point where part of 'a' string corresponds to 'b' string is returned. (First character point is 1.)	STRPOS(V7\$,":")	6

10. Robot Language

Function name	Explanation	Example	Returned value
LEN(a)	Length of 'a' string is returned.	LEN(V7\$)	8
TIMER	Passed time from the power input time is returned in second(s).	TIMER	2796.37
ETR(a,b)	Return the radian value of the axis angle for the encoder value 'b' of the axis in the order 'a'(1~).	ETR(2,&H400000)	1.571
RTE(a,b)	Return the encoder value 'b' for the axis angel radian value of the axis in the order 'a'(1~).	RTE(2,1.3)	4120080



10.6.2. String Function

Returned value of string function is string.

Table 10-34 String functions of the robot language

Function name	Explanation	Example	Returned value
CHR\$(a)	Character whose ASCII code is 'a' is returned.	CHR\$(65)	"A"
STR\$(a)	Decimal digit string of numeral 'a' is returned.	STR\$(13.25)	"13.25"
BIN\$(a)	Binary digit string of numeral 'a' is returned.	BIN\$(&B0010)	"10"
HEX\$(a)	Hexadecimal digit string of numeral 'a' is returned.	HEX\$(&H7A2F)	"7A2F"
MIRROR\$(a)	Reversed string of string 'a' is returned.	MIRROR\$("HELLO")	"OLLEH"
LEFT\$(a,b)	String with first 'b' character(s) of string 'a' is returned.	LEFT\$("HELLO",2)	"HE"
MID\$(a,b,c)	String with 'c' character(s) from 'b' character of string 'a' is returned.	MID\$("HELLO",2,3)	"ELL"
RIGHT\$(a,b)	String with last 'b' character(s) of string 'a' is returned.	RIGHT\$("HELLO",2)	"LO"
DATE\$	Current date converted into string is returned. (YYYY/MM/DD)	DATE\$	"2001/02/18"
TIME\$	Current time converted into string is returned. (HH:MM:SS)	TIME\$	"08:48:14"
FULLBIN\$(a,b)	Convert a decimal number to a binary, and insert zeros in front of the binary digit until the total digits are as many as the b digits. a: Decimal number to convert b: Binary digit (Operation after the V40.23-04_20200730 version)	FULLBIN\$(17,8)	"00010001"



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