HYUNDAI
HEAVY INDUSTRIES CO.,LTD.

WARNING

THE INSTALLATION SHALL BE MADE BY QUALIFIED INSTALLATION PERSONNEL AND SHOULD CONFORM TO ALL NATIONAL AND LOCAL CODES

Hi5 Controller Maintenance Manual

- Hi5-C10/C20
- Hi5-N00/N30/N50

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Printed in Korea – May. 2015. 8th Edition

Contents

1. Safety 1-1

1.1. Introduction 1-2
1.2. Relevant Safety Regulations 1-4
1.3. Safety Training 1-4
1.4. Safety Related Nameplate 1-5
1.4.1. Safety Marking 1-5
1.4.2. Safety Nameplate 1-5
1.5. Definition of Safety Functions 1-6
1.6. Installation 1-7
1.6.1. Safety Fence 1-7
1.6.2. Placement of Robot & Peripheral Equipment 1-9
1.6.3. Installing the Robot 1-12
1.6.4. Space for Robot Installation 1-14
1.7. Safety Operation for Robot Handling 1-15
1.7.1. Safety Precautions for Robot Handling 1-15
1.7.2. Safety Precautions for Operating Test 1-17
1.7.3. Safety Precautions for Automatic Operation 1-18
1.8. Safety Precautions for Access to Safety Fence 1-19
1.9. Safety Precautions for Maintenance and Repair 1-20
1.9.1. Safety Precautions for Controller Maintenance and Repair 1-20
1.9.2. Safety Precautions for Robot System & Manipulator Maintenance 1-21
1.9.3. Necessary Actions after Maintenance and Repair 1-21
1.10. Safety Functions 1-22
1.10.1. Operating a Safety Circuit 1-22
1.10.2. Emergency stop 1-24
1.10.3. Operating Speed 1-25
1.10.4. Connecting the Safety Devices 1-25
1.10.5. Restricting the working Envelope 1-25
1.10.6. Monitoring Function 1-25
1.11. Safety Related to End Effectors 1-26
1.11.1. Gripper 1-26
1.11.2. Tool / Workpiece 1-26
1.11.3. Pneumatic and Hydraulic Systems 1-26
1.12. Liabilities 1-27

2. Specifications 2-1

2.1. The Detailed Specifications of Hi5 Robot Controller 2-2

3. Installation of Controller 3-1

3.1. Components 3-2
3.1.1. Basic Components of Controller and Robot Manipulator 3-2
3.1.2. Confirmation of Serial Number 3-4
3.1.3. Confirmation of Nameplates 3-5
3.2. Packing 3-14
3.3. Transportation of Controller 3-14
3.4. Unpacking 3-14
3.5. Controller Handling 3-15
3.5.1. Weight of Controller 3-15

3.5.2. Transportation of Controller Using Crane 3-16
3.5.3. Transportation of Controller Using Forklift Truck 3-17
3.6. Space for Installation 3-18
3.6.1. Installation of Controller 3-18
3.6.2. Space for Installation 3-19
3.6.3. Dimension of Controller 3-23
3.7. Connection 3-26
3.7.1. Connection of Teach Pendant 3-26
3.7.2. Connection of Manipulator and Controller 3-28
3.7.3. Connection of Controller and Primary Power 3-31
3.7.4. Controller and Grounding 3-34
3.7.5. Other Cautions 3-34
3.7.6. RS232C & Ethernet access of Small Door 3-35

4. Basic Components of Controller 4-1

4.1. Components 4-2
4.2. The Arrangement of Parts 4-4
4.3. The Function of Each Component 4-15
4.3.1. Rack and Backplane Board (BD501) 4-16
4.3.2. Main board(BD510) 4-17
4.3.3. System Board (BD530/BD531) 4-21
4.3.4. Servo Board (BD542) 4-53
4.3.5. Drive Unit 4-57
4.3.6. DC Multi Power Unit (SMPS: HDI-200) 4-78
4.3.7. Electrical Module and Electrical Board (BD5C0) 4-79
4.3.8. Small Door Board (BD5B1) 4-83
4.3.9. Teach pendant (TP510) 4-84

5. Controller Options 5-1

5.1. Public IO Board (BD580; Terminal Block) 5-2
5.1.1. Outline 5-2
5.1.2. Connector 5-3
5.1.3. Setting Unit 5-9
5.2. Relay Board (BD581) 5-10
5.2.1. Outline 5-10
5.2.2. Connector 5-11
5.3. Public IO Board (BD582 : Connector Type) 5-12
5.3.1. Outline 5-12
5.3.2. Connector 5-13
5.3.3. Setting Unit 5-22
5.4. CC-link Board (BD570) 5-23
5.4.1. Outline 5-23
5.4.2. Connector 5-24
5.4.3. Indication and Setting Units 5-27
5.5. Conveyor I/F Board (BD585) 5-29
5.5.1. Outline 5-29
5.5.2. Connector 5-30
5.5.3. Display Unit 5-32
5.6. LDIO Board (BD58A; For LCD) 5-33
5.6.1. Outline 5-33
5.6.2. Connector 5-35
5.6.3. Setting Unit 5-51

5.7. Safety Relay Board (BD58B) 5-54
5.7.1. Outline 5-54
5.7.2. Connector 5-55
5.8. Expansion Public IO Board (BD583 : 464-point I/O) 5-58
5.8.1. Outline 5-58
5.8.2. Connector 5-59
5.8.3. Setting Unit 5-67
5.9. Analog/Arc IF Board (BD584) 5-68
5.9.1. Outline 5-68
5.9.2. Connector 5-70

6. Troubleshooting 6-1

6.1. Troubleshooting Solution 6-2
6.1.1. E0002 Hardware limit switch operating 6-3
6.1.2. E0010 AMP recovery discharge resistance overheating 6-11
6.1.3. E0011 AMP overvoltage (P-N) 6-18
6.1.4. E0014 Instant contact of safety switch (EM, OTR, TS etc.) 6-23
6.1.5. E0015 Teaching pendant operation error 6-31
6.1.6. E0022 Communication error between internal modules 6-35
6.1.7. E0033 AMP under-voltage error 6-47
6.1.8. E0034 AMP over-current error 6-51
6.1.9. E0044 Lift axis belt disconnect sensor is operating 6-56
6.1.10. E0108 (Axis ○) Encoder error: Encoder reset required 6-61
6.1.11. E0112 (○ Axis) IPM fault signal detection 6-63
6.1.12. E0113 (○ Axis) Over-current 6-70
6.1.13. E0114 Operating device control voltage reduction 6-74
6.1.14. E0115 (Axis o) Received command code error 6-80
6.1.15. E0117 (Axis ○) Position deviation set value exceeded 6-86
6.1.16. E0119 (Axis ○) Overload 6-91
6.1.17. E0122 Servo ON limit time exceeded 6-99
6.1.18. E0127 MSHP operation error 6-104
6.1.19. E0140 MSPR operation error 6-104
6.1.20. E0133 (Axis ○) Command value error 6-118
6.1.21. E0134 (Axis ○) Maximum speed exceeded 6-123
6.1.22. E0165 (Axis o) Servo lock cannot be maintained 6-126
6.1.23. E0223 (Axis o) Encoder disconnection or communication failure 6-130
6.1.24. E0224 (Axis o) Encoder condition error 6-138
6.1.25. Instructions in examining the Controller’s input voltage (Single-phase) 6-140
6.1.26. Instructions in examining the Controller’s input voltage (3-phase) 6-142
6.1.27. Instructions in examining the Controller’s internal voltage (3-phase) 6-144
6.2. Instructions in Parts Replacement 6-145
6.2.1. Instructions in Substrate Replacement 6-145
6.2.2. Instructions in Servo AMP Replacement 6-148
6.2.3. Instructions in Battery Replacement 6-149
6.2.4. Instructions in SMPS Replacement 6-150
6.3. Instructions in Adjustment 6-151
6.3.1. Adjustment of Power System 6-151
6.3.2. Transformer (TR1) 6-152

7. Regular inspection 7-1

7.1. Inspection Schedule 7-2
7.2. General Instructions for Regular Inspection 7-3

Contents

7.3. Daily Inspection........7-4
7.4. First Inspection (750 hours inspection)........7-4
7.5. Daily Inspection........7-5
7.6. Inspection for Long-Term Idleness........7-7
7.7. Parts List for Maintenance........7-8

Figure contents

Figure 1.1 Recommended size for safety net and entrance gate (slot type entrance gate) .. 1-7
Figure 1.2 Recommended size for safety net and entrance gate (square type entrance gate) 1-7
Figure 1.3 Arrangement of LCD robot peripheral devices and workers 1-10
Figure 1.4 Arrangement of general robot peripheral devices and workers 1-11
Figure 1.5 Configuration for safety chain 1-22
Figure 1.6 Connection with external emergency halt switch through system board terminal block TBEM 1-24
Figure 3.1 Basic Components of Manipulator and Controller (LCD Robot) 3-2
Figure 3.2 Basic Components of Manipulator and Controller (Vertical Articulated Robot) 3-3
Figure 3.3 Location of Serial Number 3-4
Figure 3.4 Hi5-C10 Location of Controller Nameplate 1 3-5
Figure 3.5 Hi5-C10 Location of Controller Nameplate 2 3-6
Figure 3.6 Hi5-C20 Location of Controller Nameplate 1 3-7
Figure 3.7 Hi5-C20 Location of Controller Nameplate 2 3-8
Figure 3.8 Hi5-N** Location of Controller Nameplate 1 3-9
Figure 3.9 Hi5-N** Location of Controller Nameplate 2 3-10
Figure 3.10 Transportation of Controller Using Crane 3-16
Figure 3.11 Transportation of Controller Using Forklift Truck 3-17
Figure 3.12 Installing space for LCD robot 3-19
Figure 3.13 Installing space for Hi5-C20 controller 3-20
Figure 3.14 Install space for general type robot 3-21
Figure 3.15 Installing space for Hi5-C10, Hi5-N** controller 3-22
Figure 3.16 Dimension of Hi5-C20 (Unit: mm) 3-23
Figure 3.17 Dimension of Hi5-C10 Controller (Unit: mm) 3-24
Figure 3.18 Dimension of Hi5-N** Controller (Unit: mm) 3-25
Figure 3.19 Hi5-C20 Connection of Teach Pendant 3-26
Figure 3.20 Hi5-C10 Connection of Teach Pendant 3-27
Figure 3.21 Hi5-N** Connection of Teach Pendant 3-27
Figure 3.22 Connection of Robot Manipulator and Controller (Hi5-C20) 3-28
Figure 3.23 Connection of Robot Manipulator and Controller (Hi5-C10) 3-28
Figure 3.24 Connection of Robot Manipulator and Controller (Hi5-N00) 3-29
Figure 3.25 Connection of Robot Manipulator and Controller (Hi5-N30/N50) 3-30
Figure 3.26 Hi5-C20 Connection of Primary Power to Controller 3-31
Figure 3.27 Hi5-C10 Connection of Primary Power to Controller 3-31
Figure 3.28 Hi5-N** Connection of Primary Power to Controller 3-32
Figure 4.1 Hi5-N** Controller 4-2
Figure 4.2 Hi5-C** Controller 4-2
Figure 4.3 Teach pendant (TP510) 4-3
Figure 4.4 Internal Composition of Hi5 Controller 4-3
Figure 4.5 Hi5-N00 Part arrangement parts in the exterior of a controller 4-5
Figure 4.6 Part arrangement in the interior of the front surface of the Hi5-N00 controller 4-6
Figure 4.7 Part arrangement in the interior of the rear surface of the Hi5-N00 controller 4-6
Figure 4.8 Hi5-C10 Part arrangement parts in the exterior of the controller 4-9
Figure 4.9 Part arrangement in the interior of the front surface of the Hi5-C10 controller 4-9
Figure 4.10 Part arrangement in the interior of the rear surface of the Hi5-C10 controller . 4-10
Figure 4.11 Part arrangement in the interior of the left side of the Hi5-C20 controller 4-13
Figure 4.12 Part arrangement in the left side door of the Hi5-C20 controller 4-13
Figure 4.13 Part arrangement in the front and rear surfaces of the Hi5-C20 controller 4-14
Figure 4.14 Part arrangement in the interior of the right side of the Hi5-C20 controller 4-14
Figure 4.15 PCB Rack 4-16

Figure 4.16 Backplane Board (BD501) 4-16
Figure 4.17 Main board (BD510) 4-17
Figure 4.18 System Board (BD530/BD531) 4-21
Figure 4.19 The Arrangement of the Connectors of the System Board (BD530) 4-22
Figure 4.20 The Terminal Block of the System Board (BD530) 4-25
Figure 4.21 System board (BD530) terminal block TBIO 4-26
Figure 4.22 System board (BD530) terminal block TBRMT 4-27
Figure 4.23 System board (BD530) terminal block TBPLC 4-28
Figure 4.24 Pin arrangement in system CAN connector 4-29
Figure 4.25 The Display Unit of the System Board (BD530) 4-30
Figure 4.26 The Display Unit of the System Board (BD530V22) 4-31
Figure 4.27 The Setting Unit of the System Board (BD530) 4-33
Figure 4.28 The Setting Unit of the System Board (BD530V22) 4-34
Figure 4.29 Method for connecting the external emergency stop switch to terminal block TBEM 4-42
Figure 4.30 Management method when a contact point input type-external emergency stop is not used. 4-42
Figure 4.31 Method of connecting the automatic safety guard to an PNP output device 4-43
Figure 4.32 Management method in cases where the P-COM input external emergency stop is not used 4-43
Figure 4.33 Output the internal emergency stop switch of terminal block TBPLC 4-44
Figure 4.34 Method for connecting a typical safety guard to terminal block TBPLC 4-45
Figure 4.35 Management method in cases where a typical safety guard is not used 4-45
Figure 4.36 Method for connecting the contact point input automatic safety guard to terminal block TBEM 4-46
Figure 4.37 Management method in cases where a contact point input automatic safety guard is not used 4-46
Figure 4.38 Connecting method of an automatic safety guard with respect to an PNP output device 4-47
Figure 4.39 Management method in cases where P-COM input automatic safety guard is not used 4-47
Figure 4.40 Method for inputting the external motor power ON signal into terminal block TBEM 4-48
Figure 4.41 for inputting the remote switch signal into terminal block TBRMT 4-48
Figure 4.42 Management method in cases where remote switch input is not used 4-49
Figure 4.43 Connection method of Safety PLC/IO 4-50
Figure 4.44 Method for connecting digital output for a system to terminal block TBIO 4-51
Figure 4.45 Method for connecting digital input for a system to terminal block 4-51
Figure 4.46 Wiring of the system CAN communication line that comes via Small Door of BD530V22 4-52
Figure 4.47 Wiring of the system CAN communication line that does not come via Small Door of BD530V22 4-52
Figure 4.48 Servo Board (BD542) 4-53
Figure 4.49 BD552 Component Layout 4-60
Figure 4.50 BD551 Component Layout 4-61
Figure 4.51 BD561 Component Layout 4-65
Figure 4.52 BD553 Component Layout 4-68
Figure 4.53 BD563 Component Layout 4-69
Figure 4.54 BD554 Component Layout 4-74
Figure 4.55 BD556 Component Layout 4-76
Figure 4.56 External appearance of SMPS SR1 and configuration mounted in Rack 4-78
Figure 4.57 Electrical Module 4-79
Figure 4.58 The Interior of Electrical Module 4-79
Figure 4.59 Power system of controller Hi5 4-80
Figure 4.60 Connectors of the Electrical Board (BD5C0) 4-81
Figure 4.61 The Components of the Small Door Board (BD5B1) 4-83

Figure 4.62 The Exterior and Interior of the Small Door Board (BD5B1) 4-83
Figure 4.63 Appearance of teach pendant TP510 4-84
Figure 4.64 USB cover of teach pendant TP510 4-85
Figure 5.1 Public IO Board (BD580) 5-2
Figure 5.2 Pin Configuration of Digital Input Terminal Block of Public IO Board (BD580)..... 5-3
Figure 5.3 Wiring of Input Signals of the Public IO Board (BD580)...................................... 5-4
Figure 5.4 Pin Configuration of Digital Input/Output Terminal Block of the Public IO Board(BD580).. 5-5
Figure 5.5 Method for the Connection of the Output Signals of the Public IO Board (BD580) 5-6
Figure 5.6 Power Connectors of the Public IO Board (BD580), CNP1 and CNP2 5-7
Figure 5.7 Method for the Connection of CAN Connectors of the Public IO Board (BD580) 5-8
Figure 5.8 Relay Output Board of Public IO Board (BD581) 5-10
Figure 5.9 Method for the Installation of Relay Board 5-10
Figure 5.10 Public IO Board (BD582) 5-12
Figure 5.11 CNIN Connector (3M MDR 10240-52A2JL) of the Public IO Board (BD582) .. 5-13
Figure 5.12 3M MDR 10140-3000VE (HOOD:1030-55F0-008) of CNIN Connector Plug of the Public IO Board (BD582) 5-13
Figure 5.13 Method for Wiring Input Signals of the Public IO Board (BD582)..................... 5-16
Figure 5.14 CNOUT Connector (3M MDR 10250-52A2JL) of the Public IO Board (BD582) 5-17
Figure 5.15 3M MDR 10150-3000VE (HOOD;10350-52F0-008) of the CNOUT Connector Plug of the Public IO Board (BD582)... 5-17
Figure 5.16 Method for Connection of Output Signals of the Public IO Board (BD582)...... 5-20
Figure 5.17 Power Connector CNP1 of the Public IO Board (BD582) 5-21
Figure 5.18 Method for Connection of the CAN Connector of the Public IO Board (BD582) 5-21
Figure 5.19 CC-LINK Board (BD570) 5-23
Figure 5.20 CC-LINK Board (BD570V20)... 5-23
Figure 5.21 CC-LINK Communication Terminal Block of CC-LINK Board (BD570) 5-24
Figure 5.22 Power Connector CNP1 of CC-LINK Board (BD570)....................................... 5-25
Figure 5.23 Method for the Connection of the CAN Connector of the CC-LINK Board (BD570) 5-26
Figure 5.24 LED and Detail of Communication Status Indication of CC-LINK Board (BD570) 5-27
Figure 5. 25 Led For Displaying the Communication Conditions of the CC-link Board (Bd570v20) and the Information.. 5-27
Figure 5.26 Setting Station Number and Communication Speed of the CC-LINK Board (BD570) 5-27
Figure 5.27 Method for Setting of the Number of Stations of the CC-LINK Board (BD570) 5-28
Figure 5.28 Conveyor I/F Board (BD585) 5-29
Figure 5.29 Conveyor Connection Terminal Block of the Conveyor I/F Board (BD585)...... 5-30
Figure 5.30 Power Connector CNP1 of Conveyor I/F Board (BD585) 5-30
Figure 5.31 Method for the Connection of CAN Connector of the Conveyor I/F Board (BD585) 5-31
Figure 5.32 LED and Detail for Conveyor I/F Board (BD585) Status Indication 5-32
Figure 5.33 Appearance of the LDIO Board (BD58A)... 5-33
Figure 5.34 Appearance of the LDIO Board (BD58AV21) 5-34
Figure 5.35 Digital Input Connector CNI of LDIO Board (BD58A) 5-35
Figure 5.36 Digital Input Terminal Block TBI of LDIO Board (BD58A)................................ 5-38
Figure 5.37 Method for Wiring the Input Signal of LDIO Board (BD58A) 5-40
Figure 5.38 Digital Output Terminal Block TBO of LDIO Board (BD58A) 5-41
Figure 5.39 CNO Connector of LDIO Board (BD58A) 5-43
Figure 5.40 Method for Wiring the Output Signal of LDIO Board (BD58A) (Photo MOSFET) 5-45
Figure 5.41 Method for Wiring the Output Signal of LDIO Board (BD58A) (Relay Contact

Point) 5-46
Figure 5.42 How to Connect the FET Output Signal with the Versions of the LDIO Board BD58AV20 and Over. 5-46
Figure 5.43 Serial Communication Terminal Block TBC of LDIO Board (BD58A) 5-47
Figure 5.44 Power Connector CNP1 and CNP2 of LDIO Board (BD58A) 5-49
Figure 5.45 Method for Connecting the CAN Connector of LDIO Board (BD58A) 5-50
Figure 5.46 Safety Relay Board (BD58B) 5-54
Figure 5.47 Expansion Public IO Board (BD583) 5-58
Figure 5.48 Connector Configuration for Expansion Public IO Board (BD583) 5-59
Figure 5.49 Pin Configuration of Digital Input Terminal Block on Expansion Public IO Board (BD583) 5-60
Figure 5.50 Method for Wiring Input Signal of Expansion Public IO Board (BD583) 5-61
Figure 5.51 Pin Configuration of Digital Input/Output Terminal Block on Expansion Public IO Board (BD583) 5-62
Figure 5.52 Method for Wiring Output Signal of Expansion Public IO Board (BD583) 5-64
Figure 5.53 Power Connector CNP1 and CNP2 of Expansion Public IO Board (BD583) 5-65
Figure 5.54 Method of Connecting the CAN Connector of Expansion Public IO Board (BD583) 5-66
Figure 5.55 Method for Connecting Terminating Resistance 5-66
Figure 5.56 Analog/Arc IF Board (BD584) 5-68
Figure 5.57 Configuration of Analog/Arc IF Board (BD584) 5-69
Figure 5.58 Terminal Block for Digital Input on Analog Board (BD584) 5-70
Figure 5.59 Method for Connecting Digital Input on Analog Board (BD584) 5-71
Figure 5.60 Common Circuit of Digital Input from Analog Board (BD584) 5-72
Figure 5.61 Terminal Block for Digital Output on Analog Board (BD584) 5-73
Figure 5.62 Method for Connecting the Digital Output on Analog Board (BD584) 5-75
Figure 5.63 Common Circuit of Digital Output on Analog Board (BD584) 5-76
Figure 5.64 Terminal Block for Analog Input on Analog Board (BD584) 5-77
Figure 5.65 Method for Connecting Analog Input on Analog Board (BD584) 5-78
Figure 5.66 Analog Output Terminal Block on Analog Board (BD584) 5-79
Figure 5.67 Method of Connecting Analog Output on Analog Board (BD584) 5-80
Figure 5.68 Analog Stick Check Function on Analog Board (BD584) 5-81
Figure 5.69 Power Connector CNP1 of Analog Board (BD584) 5-82
Figure 5.70 Method of Connecting CAN Connector on Analog Board (BD584) 5-83
Figure 6.1 Installed Locations of Hardware Limit Switches for HS165/HS200 Robot 6-4
Figure 6.2 Operation Area for S-axis Limit Switch of HS165/HS200 Robot 6-4
Figure 6.3 Limit (Over-Travel) Monitoring is Displayed from the Private input signal Window 6-6
Figure 6.4 Wirings that are related to a Limit Switch Status Input 6-7
Figure 6.5 Locations of Components in Hi5-N00 Controller that are related to Recovery Resistance Overheat Error 6-12
Figure 6.6 Locations of Components in Hi5-N30 Controller that are related to Recovery Resistance Overheat Error 6-12
Figure 6.7 Measuring Resistance Value from Hi5-N00 Controller’s CNTR 6-13
Figure 6.8 Measuring Resistance Value from Hi5-N30 Controller’s CNTR 6-13
Figure 6.9 Replacement of BD530/BD531 6-14
Figure 6.10 Replacement of SD1L2C in Hi5-N00 Controller when Recovery Discharge Resistance is Overheated 6-14
Figure 6.11 Measuring Resistance Value from CNDR of Hi5-N00 Controller 6-15
Figure 6.12 Measuring Resistance Value from CNDR of Hi5-N30 Controller 6-15
Figure 6.13 Locations of Components in Hi5-N00 Controller that are Related to Overvoltage Occurrence Error 6-19
Figure 6.14 Locations of Components in Hi5-N30 Controller that are Related to Overvoltage Occurrence Error 6-19
Figure 6.15 Replacement of BD530/BD531 6-20
Figure 6.16 Replacement of SD1L2C in Hi5-N00 Controller when Overvoltage Occurred 6-20

Figure 6.17 Measuring Resistance Value from CNDR of Hi5-N00 Controller 6-22
Figure 6.18 Measuring Resistance Value from CNDR of Hi5-N30 Controller 6-22
Figure 6.19 Concept Diagram of Safety Circuit for Motor's Power ON/OFF 6-23
Figure 6.20 Method of Connecting DC24V Power and Measuring Voltage of the System Board (BD530).. 6-24
Figure 6.21 Location 7-SEG, LED and DIP Switch (CPUERR error related) on a System Board 6-25
Figure 6.22 CNMC Cable on the Electrical Module 6-29
Figure 6.23 Inner Structure of Electrical Module.. 6-29
Figure 6.24 Electrical Board (BD5C0).. 6-30
Figure 6.25 7-Segment is in a Normal Status. Others are Abnormal (see the above diagram) 6-32
Figure 6.26 CAN Communication Structure of Hi5 Controller 6-35
Figure 6.27 CAN Communication Cable Connection between a Main Board (BD510) and a System Board (BD530).. 6-37
Figure 6.28 LED CNP1 for a Power Purpose DC5V of a System Board (BD530) 6-38
Figure 6.29 Measuring a Voltage of DC 5V and Controlling Method.................................. 6-39
Figure 6.30 Method to Remove CAN Communication Connection from User's Module (BD58x)... 6-40
Figure 6.31 Location of 7-segment on a System Board (BD530)....................................... 6-41
Figure 6.32 Normal Display of 7-segment on a System board when Restarted................. 6-41
Figure 6.33 Location of CAN Communication Cable and a Main Board (BD510) 6-42
Figure 6.34 CAN Connector CANS1, CANS2 of User's Module 6-43
Figure 6.35 Connecting Method of Terminal Resistor on a CAN Communication Line 6-44
Figure 6.36 Bad example of CAN Communication Wiring Structure 6-44
Figure 6.37 Good example of CAN communication wiring structure.................................. 6-45
Figure 6.38 Remove the CAN Communication Cable that is Not in Use............................ 6-46
Figure 6.39 Example of Twist pair... 6-46
Figure 6.40 Locations of Hi5-N00 Controller's Under-Voltage Occurrence Error Related Parts 6-48
Figure 6.41 Locations of Hi5-N30 Controller's Under-Voltage Occurrence Error Related Parts 6-48
Figure 6.42 Replacement of BD530/BD531 6-49
Figure 6.43 Replacement of DS1L2C when an Under-Voltage Occurs at Hi5-N00 Controller 6-49
Figure 6.44 Locations of Hi5-N00 Controller's AMP Over-Current Occurrence Error Related Parts 6-52
Figure 6.45 Locations of Hi5-N30 Controller's AMP Over-Current Occurrence Error Related Parts 6-52
Figure 6.46 Locations of AMP Over-Current detection Fuse (in the SD1L2C) 6-53
Figure 6.47 Locations of AMP Over-Current Detection Fuse (in the SA3A3D) 6-53
Figure 6.48 Appearance of Disconnected AMP Over-Current Detection Fuse.................... 6-53
Figure 6.49 Replacement of BD530/BD531 6-54
Figure 6.50 Replacement of SD1L2C in Hi5-N00 Controller when AMP Over-Current Error Occurs 6-54
Figure 6.51 Checking the Lift axis belt from Private input signal 6-57
Figure 6.52 Checking the Relay Status of BD68B Board 6-57
Figure 6.53 Comparing the Normal and Error Status of BD58B Board's Relay 6-58
Figure 6.54 Checking the Location of Error Based on BD58B Board's Relay..................... 6-58
Figure 6.55 Replacement of BD530/BD531 6-59
Figure 6.56 Replacement of BD530/BD531 6-59
Figure 6.57 Lift Axis Belt and the Break Detection Sensor 6-60
Figure 6.58 Location of Encoder's Battery Replacement 6-62
Figure 6.59 Examining the Output Cable of Servo Drive Unit (Hi5-N00 controller)............. 6-64
Figure 6.60 Examining the Output Cable of Servo Drive Unit (Hi5-N30 controller)............. 6-64
Figure 6.61 Short Circuit Test on Switching Device of SA3X3Y 6-65

Figure 6.62 Short Circuit Test on Switching Device of SA3A3D 6-65
Figure 6.63 Locations of Components in Hi5-N00 Controller that are Related to Motor Drive 6-66
Figure 6.64 Locations of Components in Hi5-N30 Controller that are Related to Motor Drive 6-66
Figure 6.65 Locations of Each Axis's Motor (HS165 Robot) 6-67
Figure 6.66 Location of Wiring Examination for Each Axis (HS165) 6-68
Figure 6.67 Basic Installation Diagram of the Robot and Control Period 6-71
Figure 6.68 Robot's Internal Wiring 6-71
Figure 6.69 Controller's Internal Area (Power unit) 6-72
Figure 6.70 Controller's Internal Area (CNBS cable) 6-72
Figure 6.71 Locations of Components in Hi5-N00 Controller that are Related to Drive Unit Control Voltage Reduction 6-75
Figure 6.72 Locations of Components in Hi5-N30 Controller that are Related to Drive Unit Control Voltage Reduction 6-75
Figure 6.73 Locations of Components in SA3X3Y that are Related to 'POW' LED 6-76
Figure 6.74 Locations of Components in SA3A3Dthat are Related to 'POW' LED 6-76
Figure 6.75 Locations of '+15V' LED Related Components of SR1 6-77
Figure 6.76 Removal of CNBS cable 6-78
Figure 6.77 Removal of Servo Board from the Rack 6-78
Figure 6.78 Inserting Method of USB to TP 6-80
Figure 6.79 Location of Rack Inside of the Controller 6-84
Figure 6.80 Location of the Manual Brake Release Switch 6-87
Figure 6.81 Pin Locations of CNB2, CNB7 Connectors 6-87
Figure 6.82 Electronic Module 6-88
Figure 6.83 Brake Power Supply Test Pin 6-88
Figure 6.84 Monitoring Screen of the Maximum Measured Position Deviation Value from TP 6-89
Figure 6.85 Modifying Screen of Position Deviation Value from TP 6-89
Figure 6.86 Location of the Manual Brake Release Switch 6-95
Figure 6.87 Pin Locations of CNB2, CNB7 Connectors 6-96
Figure 6.88 Electronic Module 6-96
Figure 6.89 Brake Power Supply Test Pin 6-97
Figure 6.90 Inserting Method of USB to TP 6-99
Figure 6.91 Location of Rack Inside of the Controller 6-103
Figure 6.92 Concept Diagram of Safety Circuit for Motor Power's Opening/Closing 6-106
Figure 6.93 7-SEG Indicator of the System Board when a Communication Error Occurs 6-107
Figure 6.94 Indication of 7-SEG, LED (on System Board) when CPUERR Error is Occurred 6-108
Figure 6.95 Checking Method of Old System I/O Board (BD531V10) 6-109
Figure 6.96 Method to Ignore the External Emergency Stop Input 6-110
Figure 6.97 Method to Ignore the Safety Guard (Auto) Input 6-110
Figure 6.98 Method to Ignore the Safety Guard (General) Input 6-110
Figure 6.99 Method to Ignore the (P-COM input) External Emergency Stop(3,4 of SW6 is ON) 6-111
Figure 6.100 Method to Ignore the (P-COM) Safety Guard (Auto)(1,2 of SW6 is ON) 6-111
Figure 6.101 Good example of Safety Guard (Auto) wiring 6-112
Figure 6.102 Bad example of Safety Guard (Auto) wiring 6-113
Figure 6.103 Method of Magnetic Contactor Monitoring 6-114
Figure 6.104 Diagram of the Monitoring System – Magnetic Contactor 6-115
Figure 6.105 CNMC Cable on the Electrical Module 6-115
Figure 6.106 Inner Structure of Electrical Module 6-116
Figure 6.107 Electrical Board BD5C0) 6-116
Figure 6.108 Inserting Method of USB to TP 6-118
Figure 6.109 Location of Rack Inside of the Controller 6-122
Figure 6.110 Axis B Singular Point 6-125

Figure 6.111 Axis S Singular Point 6-125
Figure 6.112 Basic Installation Diagram of the Robot and Control Period......................... 6-127
Figure 6.113 Robot’s Internal Wiring.. 6-128
Figure 6.114 Controller’s Internal Area (Power Unit) 6-128
Figure 6.115 Controller’s Internal Area (CNBS Cable) 6-129
Figure 6.116 HS165 Locations of Each Axis’s Motor (HS165 Robot). 6-133
Figure 6.117 Basic Installation Diagram of the Robot and Control Period......................... 6-135
Figure 6.118 Connection Between the Robot’s Mainframe and the Controller.................. 6-135
Figure 6.119 Robot’s Internal Wiring.. 6-136
Figure 6.120 Locations of Each Axis’s Motor (HS165 Robot).. 6-139
Figure 6.121 Hi-5-C1X Controller’s Single-Phase Power Terminal Block 6-140
Figure 6.122 Hi-5-C0X Controller’s Single-Phase Power Terminal Block 6-141
Figure 6.123 Location of Hi5-N Controller’s Power Switch.. 6-142
Figure 6.124 Hi-5-C1X Controller’s 3-Phase Power Terminal Block 6-143
Figure 6.125Hi-5-C0X Controller’s 3-Phase Power Terminal Block 6-143
Figure 6.126 3-Phase Power Input to the Electrical Module 6-144
Figure 7.1 Inspection Schedule 7-2

Table contents

Table 1-1 Safety marking 1-5
Table 1-2 State of Robot Stop 1-16
Table 2-1 The specifications of Hi5 robot controller 2-2
Table 2-2 Power Supply Requirements 2-4
Table 3-1 Weight of Controller 3-15
Table 3-2 Weight of Hi5 Controller by Models 3-15
Table 3-3 Power Conditions 3-33
Table 3-4 Recommended Cable of Least Thickness 3-33
Table 3-5 Pin Descriptions (RS232 connector specifications: DSUB9S-M) 3-35
Table 3-6 Pin Descriptions (RJ45 connector specifications: RJ 45P SHIELD) 3-35
Table 4-1 The Name of Each Part of Hi5-N00 Controller 4-4
Table 4-2 The Name of Each Part of Hi5-C10 Controller 4-7
Table 4-3 The Name of Each Part of Hi5-C20 Controller 4-11
Table 4-4 The Summary on the Function of Each Component 4-15
Table 4-5 The Sorts and Uses of Main board (BD510) 4-18
Table 4-6 Main board (BD510) LED 4-18
Table 4-7 The Method for Setting of the [DIP 1] Switch of the Main board (BD 510) 4-19
Table 4-8 The Method for Setting of the [DIP 2] Switch of the Main board (BD510) 4-19
Table 4-9 The Method for Setting of the Serial Communications Jumper of the Main board (BD 510) 4-20
Table 4-10 The Method for Setting of CAN Communications Jumper of the Main board (BD510) 4-20
Table 4-11 The Sorts and Uses of the Connectors of the System Board (BD530) 4-23
Table 4-12 The Terminal Block TBEM of the System Board (BD530) 4-25
Table 4-13 Terminal Block TBIO of the System Board (BD530) 4-26
Table 4-14 System board (BD530) terminal block TBRMT description 4-27
Table 4-15 System board (BD530) terminal block TBPLC description 4-28
Table 4-16 Description of the displaying device for the system board (BD530) 4-32
Table 4-17 System board (BD530) DIP switch SW1 (error monitoring) setting method 4-35
Table 4-18 System board (BD530) DIP switch SW2 (AC power monitoring) setting method 4-35
Table 4-19 System board (BD530V22) DIP switch SW2 (AC power monitoring) setting method 4-36
Table 4-20 System board (BD530) DIP switch SW3 (Motor temperature sensor monitoring) setting method 4-36
Table 4-21 System board (BD530) DIP switch SW4 (Additional axis OVT limit switch) setting method 4-37
Table 4-22 System board (BD530) DIP switch SW5 (Arm interference, extending axis limit switch) setting method 4-37
Table 4-23 System board (BD530V22) DIP switch SW5 (Arm interference) setting method 4-38
Table 4-24 System board (BD530) DIP switch SW6 (Safety IO safety signal monitoring) setting method 4-38
Table 4-25 System board (BD530) DIP switch SW7 (Power for Safety IO signal) setting method 4-39
Table 4-26 Description of system board (BD530) toggle switch SWT1-9 operation 4-40
Table 4-27 System board (BD530V22) DIP switch SW10 (CANS Branch) setting method 4-41
Table 4-28 The Sorts and Uses of Servo Board (BD 542) Connectors 4-54
Table 4-29 Servo Board (BD542) LED 4-54
Table 4-30 The Method for the Setting of DIP Switches (S1) of the Servo Board (BD542). 4-55
Table 4-31 The Method for the Setting of DIP Switch (DS1) of the Servo Board (BD542).. 4-55
Table 4-32 The DIP Switch (DS2: Pin 1 and 2) of the Servo Board (BD542) 4-56

Table 4-33 The DIP Switch (DS2: Pin 3 and 4) of the Servo Board (BD542) 4-56
Table 4-34 The Components of SA3X3Y (Medium-Scale 6-Axis All-In-One Drive unit) 4-57
Table 4-35 The Mark of Type of Servo Driver Series 4-58
Table 4-36 The Specifications of Drive Unit 4-58
Table 4-37 IPM Capacity 4-59
Table 4-38 Hall Sensor Marks 4-59
Table 4-39 BD552 Connector 4-62
Table 4-40 BD551 Connector 4-62
Table 4-41 BD552 LEDs 4-62
Table 4-42 The Mark of Type of Driver Series 4-64
Table 4-43 The Specifications of Drive Power Unit 4-64
Table 4-44 The Specifications of Regenerative IGBT 4-64
Table 4-45 Chemical Condenser Capacity 4-64
Table 4-46 SD1L2C (Medium-Scale Diode Module Converter) 4-64
Table 4-47 Medium-Scale Drive Power Unit (SD1L2C) Connector 4-66
Table 4-48 Medium-scale Drive Power Unit (SD1L2C) LED 4-66
Table 4-49 Construction of SA3A3D (Small sized-6 axes integral type-driving apparatus). 4-67
Table 4-50 Description of connector BD553 4-70
Table 4-51 Description of BD553 LED 4-70
Table 4-52 Description of connector BD563 4-70
Table 4-53 Description of BD563 LED 4-71
Table 4-54 The Mark of Type of Driver Series 4-72
Table 4-55 IPM Capacity 4-73
Table 4-56 Hall Sensor Marks 4-73
Table 4-57 The Components of SA1X (Medium-Scale 1 Axis Drive Unit : Option) 4-75
Table 4-58 SA1X (Medium-Scale 1 Axis Drive Unit : Option) Connector 4-75
Table 4-59 The Composition of SA1A (Small-scale 1 Axis Drive Unit: Option) 4-77
Table 4-60 SA1A (Small-Scale 1 Axis Drive Unit: Option) Connector 4-77
Table 4-61 SMPS (SR1) Standards (Input Voltage; AC 45V~50V, 50/60Hz) 4-78
Table 4-62 The Sorts and Uses of Fuses in the Electrical Module 4-80
Table 4-63 Types and applications of fuses in the electronic control module 4-82
Table 5-1 Pin Configuration of Digital Input Terminal Block (TBln*) of Public IO Board (BD580) 5-3
Table 5-2 Pin Configuration of Digital Input/Output Terminal Block (TBOn*) of the Public IO Board (BD580) 5-5
Table 5-3 Settings of the DSW1 Switch of the Public IO Board (BD580) 5-9
Table 5-4 Pin Configuration of the Digital Output Terminal Block (TBOUT) of the Relay Board (BD581) 5-11
Table 5-5 Pin Configuration of Digital Input Connector CNIN of the Public IO Board (BD582) 5-14
Table 5-6 Pin Configuration of the Digital Input Connector CNOUT of the Public IO Board (BD582) 5-18
Table 5-7 Method for Setting of the DSW1 Switch of the Public IO Board (BD582) 5-22
Table 5-8 Cc Terminal Composition Of The Terminal Block TBFB For The CC-link Communication Of The CC-link Board (Bd570v20) 5-24
Table 5-9 How to Deal with the Can Communication Terminal of the CC-link Board (BD570) 5-26
Table 5-10 How to Set the CC-link Station Numbers and the Data Rate 5-28
Table 5-11 How to Set the Number of the CC-link Station Occupied By the CC-link Board (Bd570v20) 5-28
Table 5-12 Pin Configuration of the Digital Input Connector CNI of the LDIO Board (BD58A) 5-36
Table 5-13 Terminal Configuration of the Digital Input Terminal Block TBI of the LDIO Board (BD58A) 5-39
Table 5-14 Terminal Configuration of the Digital Output Terminal Block TBO of the LDIO Board (BD58A) 5-41

Table 5-15 Terminal Block TBO Terminal Composition of the Digital Output for Each Version of the LDIO Board (BD58A) 5-42
Table 5-16 Pin Configuration of the Digital Input Connector CNO of the LDIO Board (BD58A) 5-43
Table 5-17 Terminal Configuration of Serial Communication Terminal Block TBC of LDIO Board (BD58A) 5-48
Table 5-18 Pin Configuration of the Power Connector of the LDIO Board (BD58A) 5-49
Table 5-19 How to Deal with the CAN Communication Terminal of the LDIO Board (BD58A) 5-50
Table 5-20 Method for Setting Station Number and Communication Speed of CC-LINK in the LDIO Board (BD58A) 5-51
Table 5-21 How to Set the CC-LINK Station Numbers and the Data Rate of the LDIO Board (Bd58av21) 5-52
Table 5-22 Method for Setting the Number of Stations of CC-LINK of the LDIO Board (BD58A) 5-52
Table 5-23 How to Set the Number of the CC-LINK Station Occupied of the LDIO Board (BD58AV21) 5-53
Table 5-24 LDIO Jumper SWSEL for Selecting CC-LINK Set in the LDIO Board (BD58A) 5-53
Table 5-25 Pin Configuration of the Belt Sensor Terminal Block TBBO in the Safety Relay Board (BD58B) 5-55
Table 5-26 Pin Configuration of the Limit Sensor Terminal Block TBLS in the Safety Relay Board (BD58B) 5-56
Table 5-27 Pin Configuration of Power 24V Terminal Block (TBP124) in the Safety Relay Board (BD58B) 5-56
Table 5-28 Pin Configuration of Power GND Terminal Block (TBM124) in the Safety Relay Board (BD58B) 5-56
Table 5-29 Connector Type and Use of Safety Relay Board (BD58B) 5-57
Table 5-30 Pin Configuration of Digital Input Terminal Block (TBIn*) of Expansion Public IO Board (BD583) 5-60
Table 5-31 Pin Configuration of Digital Output Terminal Block (TBOn*) on Expansion Public IO Board (BD583) 5-62
Table 5-32 Method for Setting DSW1 Switch of Expansion Public IO Board (BD583) 5-67
Table 5-33 Pin Configuration of Digital Input Terminal Block (TBDI) of Analog Board (BD584) 5-70
Table 5-34 Pin Configuration of Digital Output Terminal Block (TBD01) on Analog Board (BD584) 5-73
Table 5-35 Pin Configuration of Digital Output Terminal Block (TBD02) on Analog Board (BD584) 5-74
Table 5-36 Pin Configuration of Analog Input Terminal Block (TBAI) on Analog Board (BD584) 5-77
Table 5-37 Pin Configuration of Analog Output Terminal Block (TBAI) on Analog Board (BD584) 5-79
Table 5-38 Pin Configuration of Power Connector CNP1 on Analog Board (BD584) 5-82
Table 5-39 Pin Configuration of CAN Connector on Analog Board (BD584) 5-83
Table 6-1 Location of Fans for Each Controller 6-17
Table 6-2 Method to Check the whether the Rated Voltage on System Board is Normal or Not 6-38
Table 6-3 Pin Locations for CAN Connector of User's Module 6-43
Table 6-4 Fan position of each controller 6-69
Table 6-5 Error on safety related device's wiring 6-113
Table 6-6 Power Standard 6-151
Table 7-1 Daily Inspection 7-4
Table 7-2 First Inspection 7-4
Table 7-3 Daily Inspection 7-5
Table 7-4 Maintenance Parts Inspection A 7-8
Table 7-5 Maintenance Parts A-1 (Standard accessory parts to prepare) 7-8

Table 7-6 Maintenance Parts A-2 (Major Backup Parts) 7-9
Table 7-7 Maintenance Parts A-3 (Regular Replacement Parts) 7-9
Table 7-8 Maintenance Parts Inspection B 7-10
Table 7-9 Maintenance Parts B-1 (Parts to purchase from HHI (Co., Ltd.)) 7-10
Table 7-10 Maintenance Parts B-2 (Purchasable Parts from Maker) 7-10

1
Safety

1.1. Introduction

The main purpose of this chapter is to describe the safety precautions for users and operators who repair and manipulate the industrial robot.

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 10218-1:2006 and ANSI/RIA R15.06-1999.

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.

HHI 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 objects 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.)

1.2. Relevant Safety Regulations

The robot is designed as per ISO 10218-1:2006 safety standards for industrial robots, and furthermore in comply with ANSI/RIA R15.06-1999 regulations.

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 10218-1:2006

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 10218-1:2006

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/RIA R15.06-1999

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/RIA R15.06-1999

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.

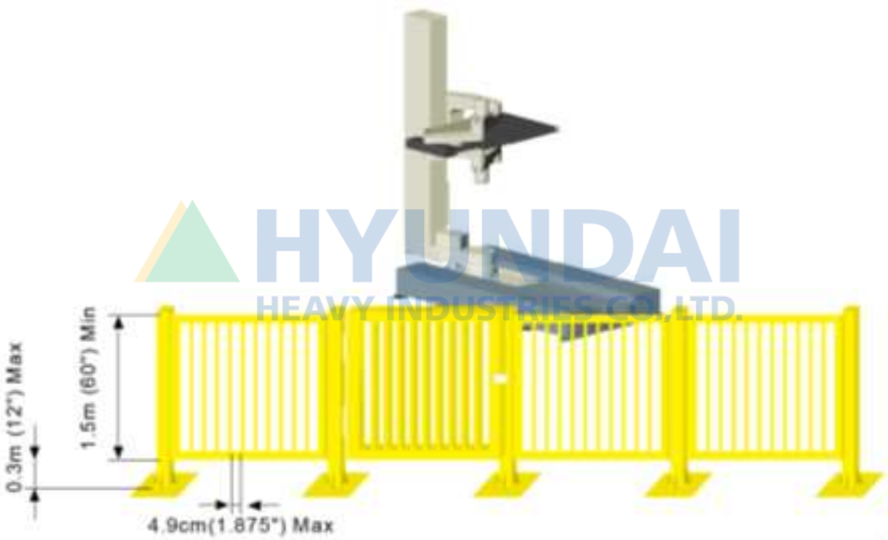


Figure 1.1 Recommended size for safety net and entrance gate (slot type entrance gate)

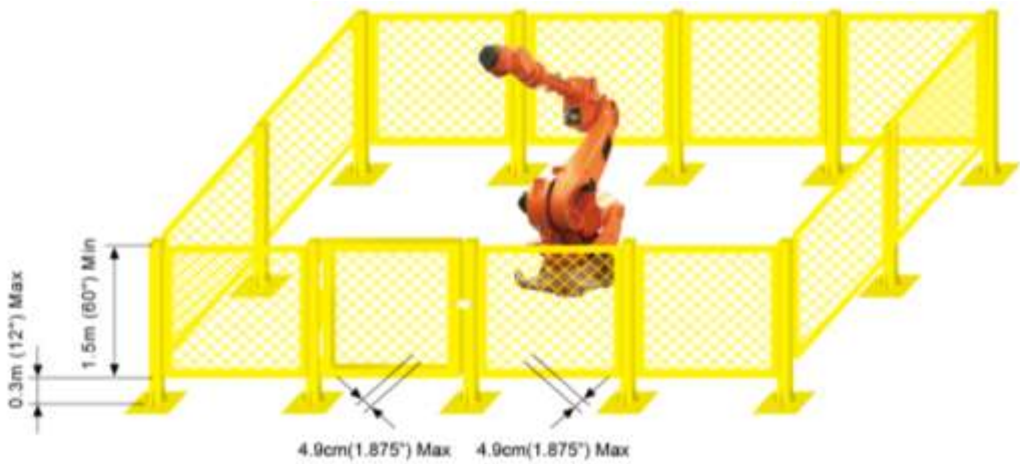


Figure 1.2 Recommended size for safety net and entrance gate (square type entrance gate)

(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.

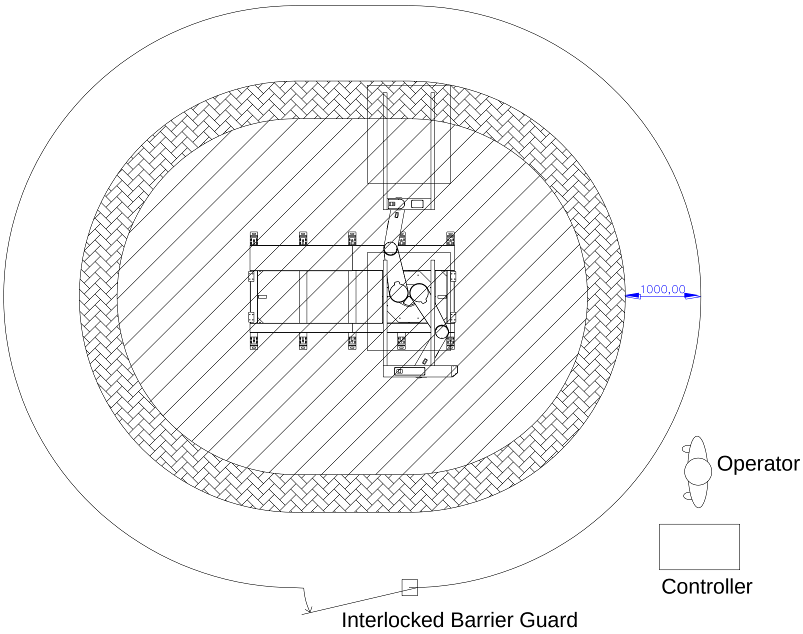
(7) Restrict the robot's working envelope by using the soft limits and the mechanical stopper if the necessary working envelope is narrower than the robot’s workable envelope. When the robot is to move beyond the restricted envelop due to abnormal operation, such as the robot being handled in a wrong 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.

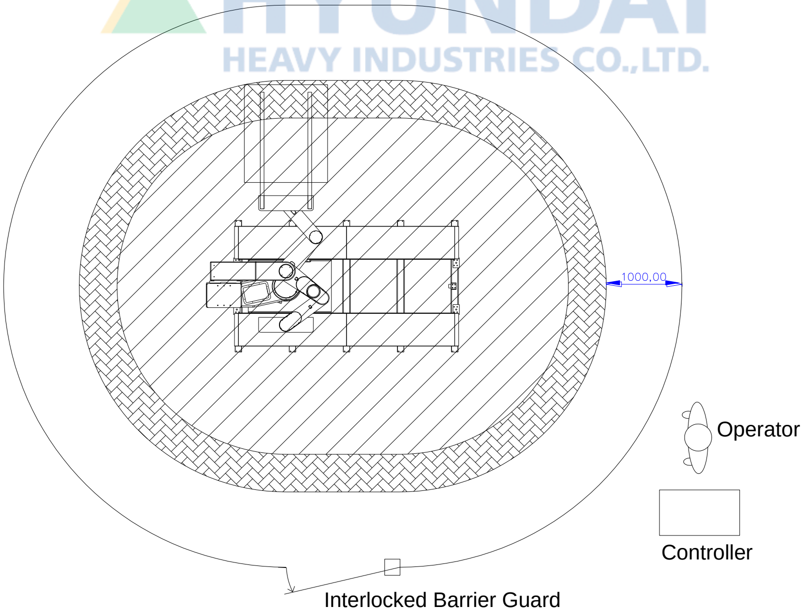
(9) Make sure that the device indicating the robot's running condition, whether automatic or manual mode, can be noticeable even from a slightly distant location. In the case of automatic start-up, a buzzer or a warning lamp will be useful.

(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.



(Cylinder type)



(Beam type)

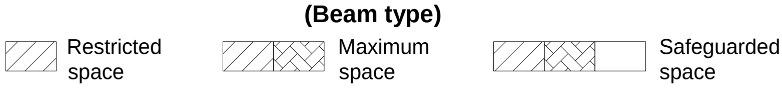


Figure 1.3 Arrangement of LCD robot peripheral devices and workers

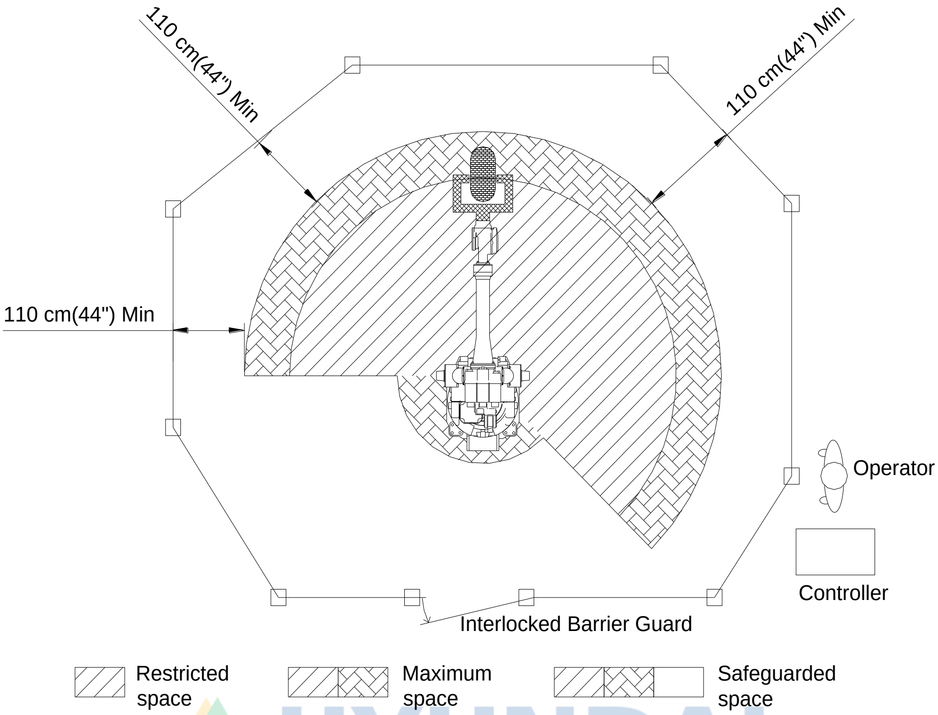


Figure 1.4 Arrangement of general robot peripheral devices and workers

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℃.

(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 of 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.

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 can not 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) Please do not touch heat radiating plate of servo AMP and recovery resistance because they are very hot.

(8) After completing maintenance, be sure to close the door completely after checking if tools or other things are still remained in the controller.

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』.)

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

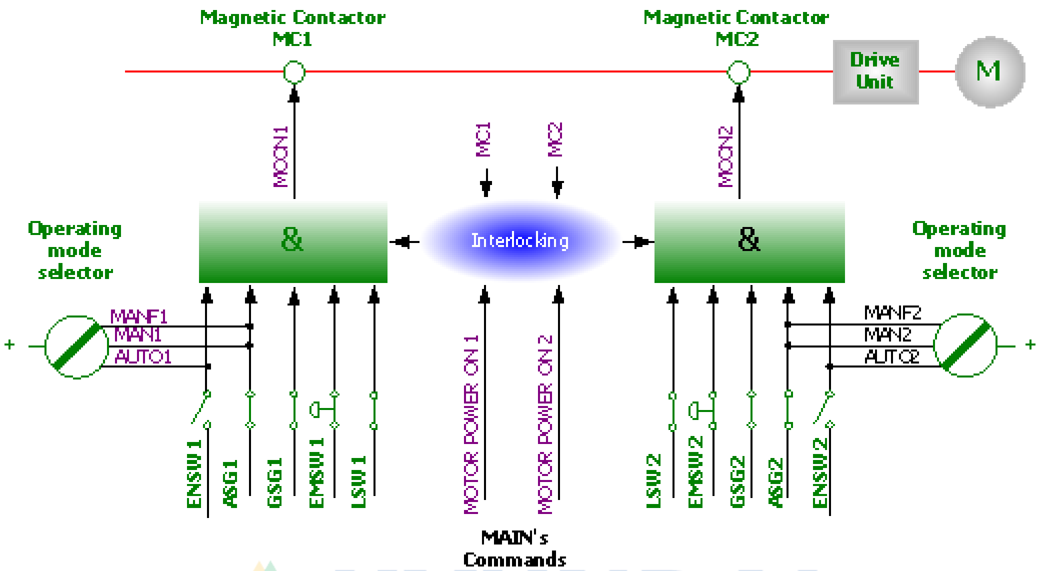


Figure 1.5 Configuration for safety chain

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.

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.

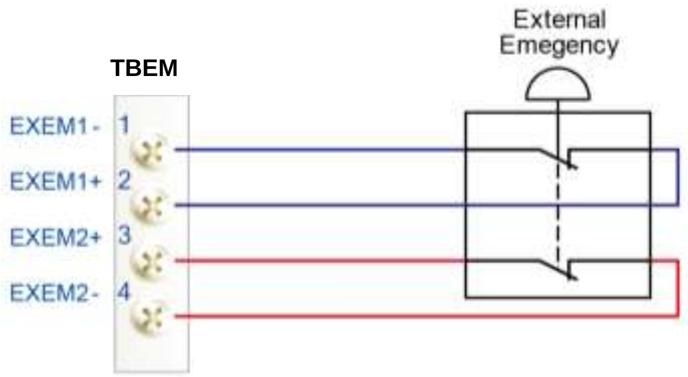


Figure 1.6 Connection with external emergency halt switch through system board terminal block TBEM

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

(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)

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.

2
Specifications

2.1. The Detailed Specifications of Hi5 Robot Controller

Table 2-1 shows the specifications of Hi5 robot controller.

Table 2-1 The specifications of Hi5 robot controller

Model		Hi5-N** (Medium Size)	Hi5-C10 (Clean)	Hi5-C20 (Clean)
CPU		64 bit RISC (450MHz)		
Program Execution Method		Teaching & Playback		
Operation Method		Menu-Based Method		
Interpolation Type		PTP, Linear, and Circular Interpolation		
Memory Back-Up Method		Battery Back-UP IC Memory		
Encoder Type		Absolute Encoder		
Servo Drive Unit		6-Axis All-In-One Type, Digital Servo		
Max. No. of Axes		Max. 16 Axes Simultaneously		
Step		20,000 Points		
Program Selection		255(Binary)/8(Discrete)		
Teach pendant Indication		7” Color LCD(800x480)		
Digital I/O		Input: 32 Points (Max. 256 Points) / Output: 32 Points (Max. 256 Points)		
Analog I/O (Option)		Input: 8 Points / Output: 4 Points		
Conveyor Pulse Counter		Line Driver / Open Collector		
Communications Interface		RS232C: 2 Ports(Also for RS485 1) / Ethernet: 2 Ports / CAN: 2 Ports		
Fieldbus Interface (Option)		CC-link, DeviceNet, Profibus-DP		
Board	CPU	BD510		
	DSP(Servo)	BD542		
	Back Plane	BD501		

<table>
<tr><th colspan="2">Model</th><th>Hi5-N** (Medium Size)</th><th>Hi5-C10 (Clean)</th><th>Hi5-C20 (Clean)</th></tr>
<tr><td rowspan="7"></td><td>System</td><td colspan="3">BD530/531</td></tr>
<tr><td>Small Door</td><td colspan="3">BD5B1</td></tr>
<tr><td>Electrical Part</td><td colspan="3">BD5C0</td></tr>
<tr><td>CC-LINK</td><td>BD570</td><td rowspan="2">BD58A</td><td>BD570</td></tr>
<tr><td>Digital In/Out</td><td>BD580, BD581, BD582</td><td>BD580, BD581</td></tr>
<tr><td>Analog/Arc I/F</td><td>BD584</td><td>-</td><td>-</td></tr>
<tr><td>Conveyor I/F</td><td>BD585</td><td>-</td><td>-</td></tr>
<tr><td rowspan="3">Servo Amp</td><td>Drive Unit (6 Axis)</td><td>SA3X3Y</td><td>SA1L5X</td><td>SA4X2Z</td></tr>
<tr><td>Drive Unit (1 Axis)</td><td>SA1X/SA1A</td><td>-</td><td>-</td></tr>
<tr><td>Diode Module</td><td colspan="3">SD1L2C</td></tr>
<tr><td colspan="2">Wire Harness</td><td>CMC1, CMC2, CEC1</td><td>CMC1, CMC2, CEC1, CIOC1</td><td>CMC1, CMC2, CEC1, AMC1, AEC1, CIOC1</td></tr>
<tr><td colspan="2">Teach pendant</td><td colspan="3">TP510</td></tr>
<tr><td colspan="2">Cooling Pan</td><td>10 EA</td><td>4 EA</td><td>5 EA</td></tr>
<tr><td colspan="2">Air Conditioner</td><td>Hi5-A000</td><td>-</td><td>-</td></tr>
<tr><td colspan="2">Rated Voltage</td><td>3-phase 220V(50/60Hz)±10%
Options: 380 V, 400 V, 440 V</td><td>Power: Three-phase 220V (50/60 Hz) ±10%</td><td>Control: Single-phase 220V (50/60 Hz) ±10%</td></tr>
<tr><td colspan="2">Max. Power Consumption</td><td>7.8 KVA</td><td>Power: 11.5 KVA
Control: 1 KVA</td><td>Power: 10 KVA
Control: 1 KVA</td></tr>
<tr><td colspan="2">Protection Class</td><td>IP54</td><td colspan="2">IP20</td></tr>
<tr><td colspan="2">Operating Temperature</td><td colspan="3">0~45℃</td></tr>
<tr><td colspan="2">Noise Level</td><td>Max. 58dB</td><td>Max. 68dB</td><td>Max. 65dB</td></tr>
<tr><td colspan="2">Operational Humidity</td><td colspan="3">75%</td></tr>
<tr><td colspan="2">Exterior Dimensions (WxHxD)</td><td>650x1,100x600(mm)</td><td>600x1,100x500(mm)</td><td>500x500x1,100(mm)</td></tr>
</table>

Model	Hi5-N** (Medium Size)	Hi5-C10 (Clean)	Hi5-C20 (Clean)
Weight	225Kg (Including power supply transformer)	150 kg	

Table 2-2 Power Supply Requirements

Controller Type	Capacity*1) [KVA]	Input Voltage*2) [V]	Frequency [Hz]	Peak Current [A]
Hi5-N00/N50	**Max. 7.8 KVA**	**220 V**	**50/60**	**30 A**
Hi5-N30	**Max. 4.4 KVA**	**220 V**	**50/60**	**15 A**
Hi5-C10	**Max. 12.5 KVA**	**220 V**	**50/60**	**30 A**
Hi5-C20	**Max. 11 KVA**	**220 V**	**50/60**	**30 A**

Note 1) Power capacity:
This refers to the capacity of the power supplied to the controller. Please refer to the “Robot Manipulator Maintenance Manual” for the power capacity of each robot.
Note 2) Voltage Range: ±10% (The power terminal of Hi5-CH5 terminal)

3

Installation of Controller

The Install of the equipments should be performed by qualified engineer, and related law and regulation should be observed.

3.1. Components

3.1.1. Basic Components of Controller and Robot Manipulator

Basic component of robot manipulator and controller is as follows.

- **Robot Manipulator**
- **Controller**
- **Teach pendant**
- **Wire Harness**

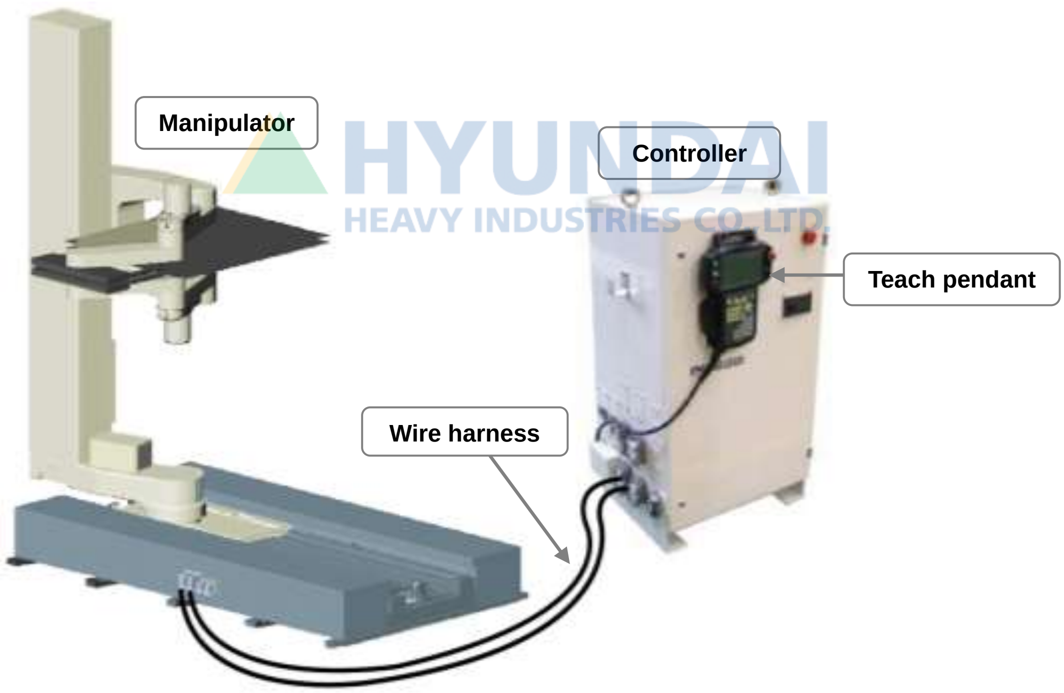


Figure 3.1 Basic Components of Manipulator and Controller (LCD Robot)

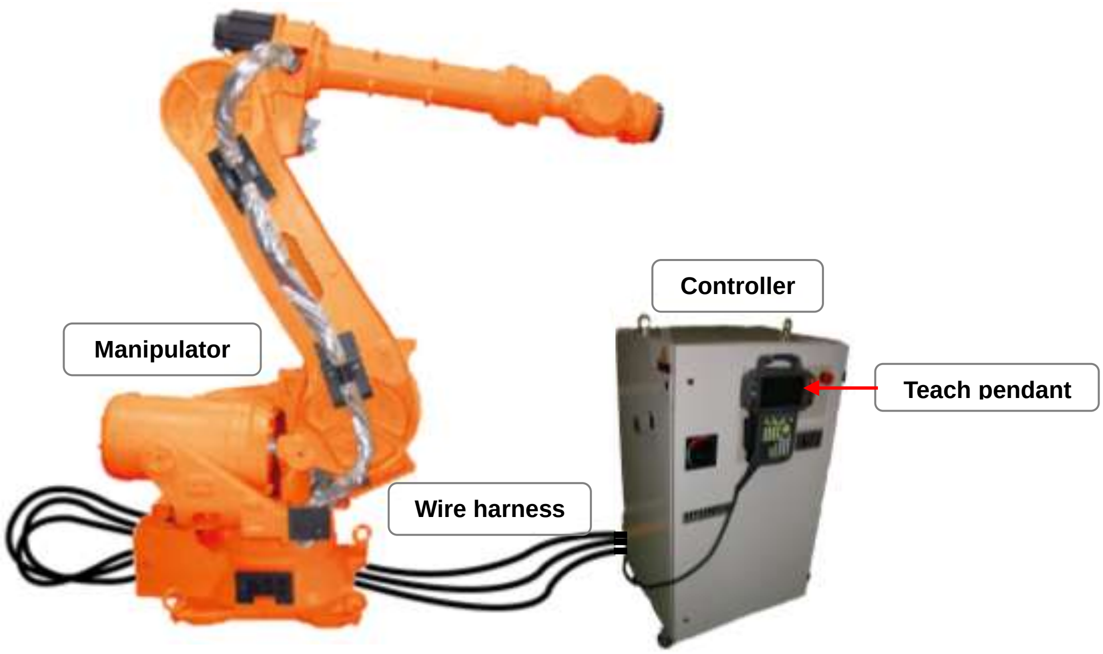


Figure 3.2 Basic Components of Manipulator and Controller (Vertical Articulated Robot)

3.1.2. Confirmation of Serial Number

Serial Number is located in the upper right of controller door.

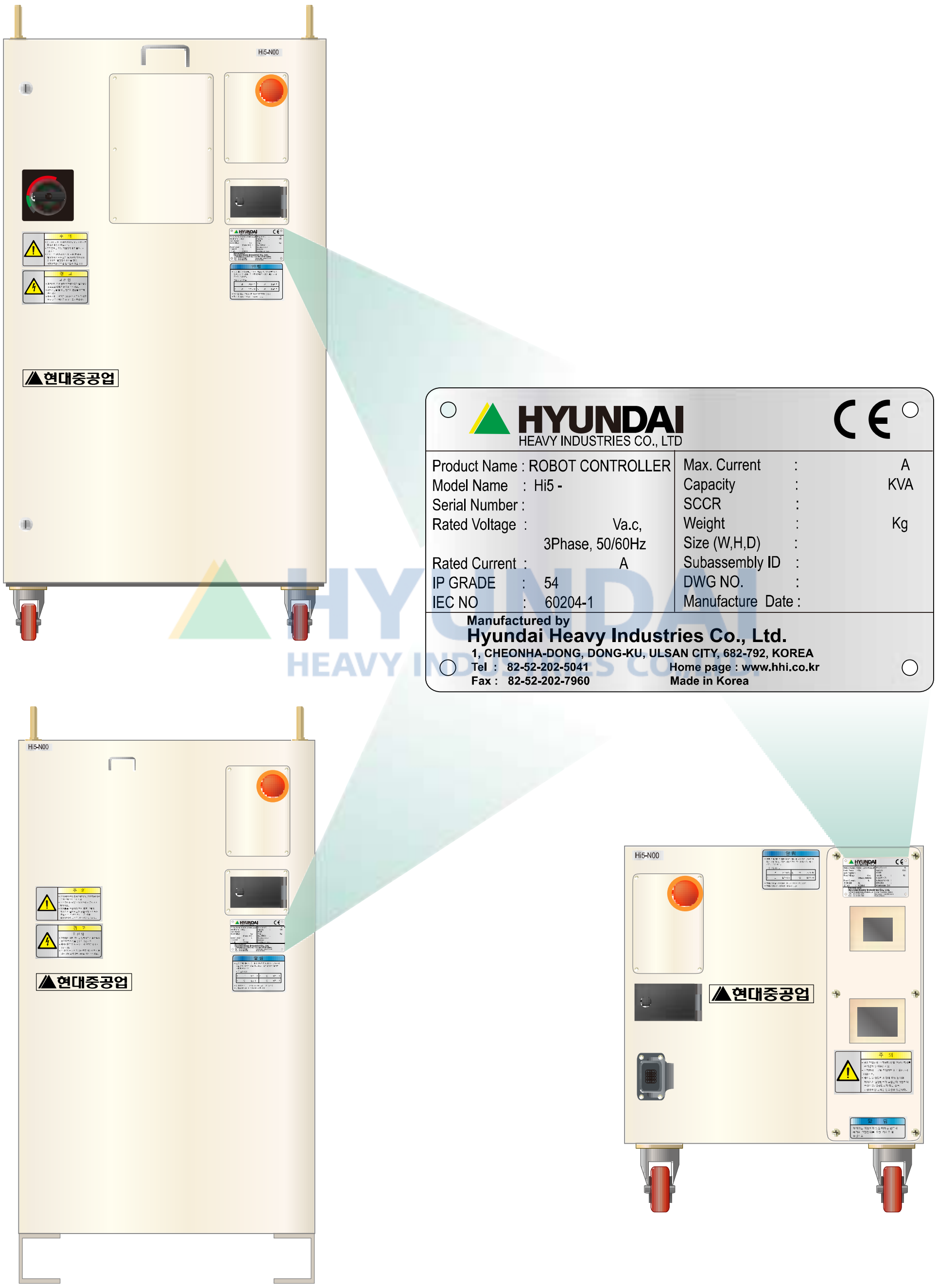


Figure 3.3 Location of Serial Number

3.1.3. Confirmation of Nameplates

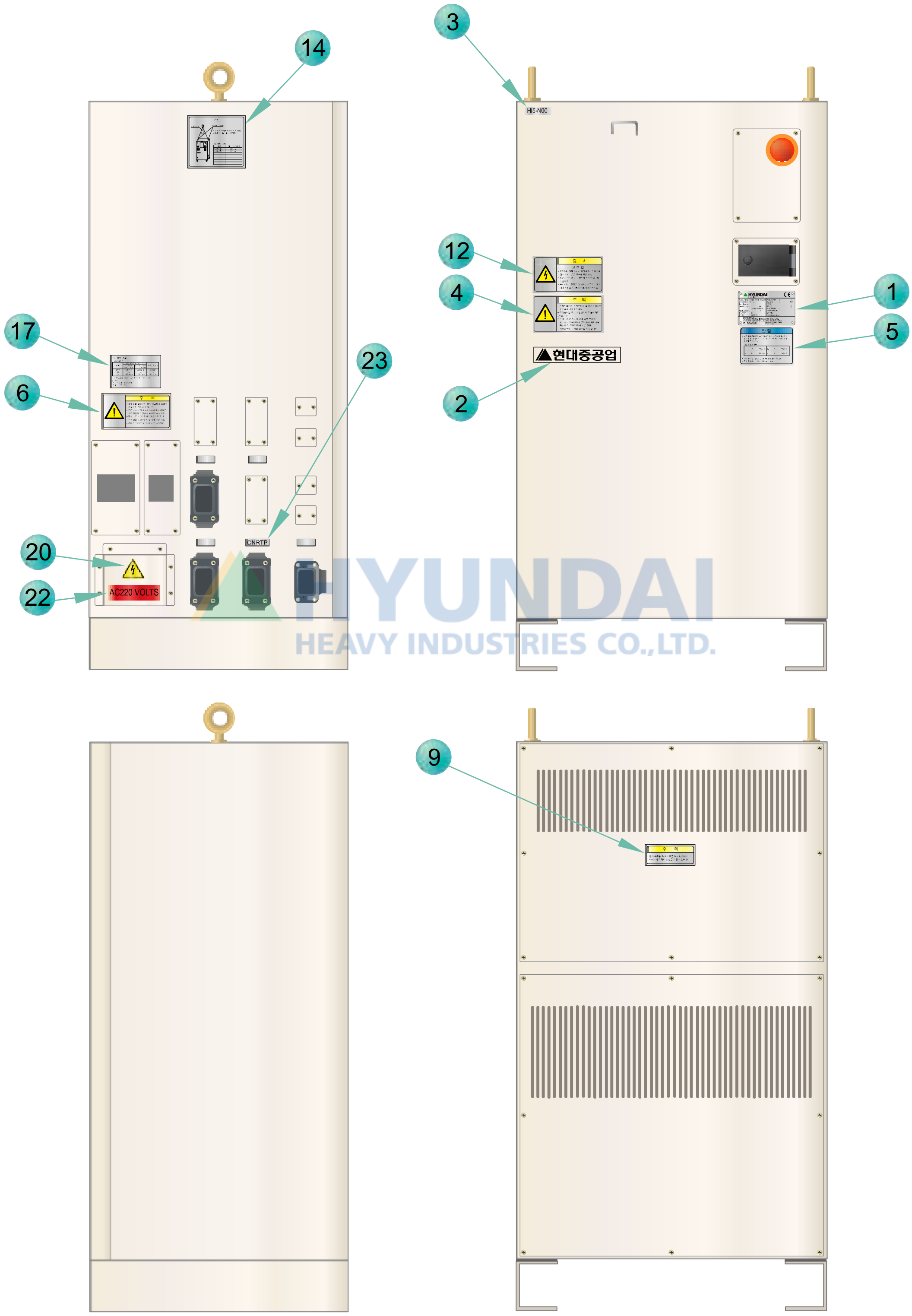


Figure 3.4 Hi5-C10 Location of Controller Nameplate 1

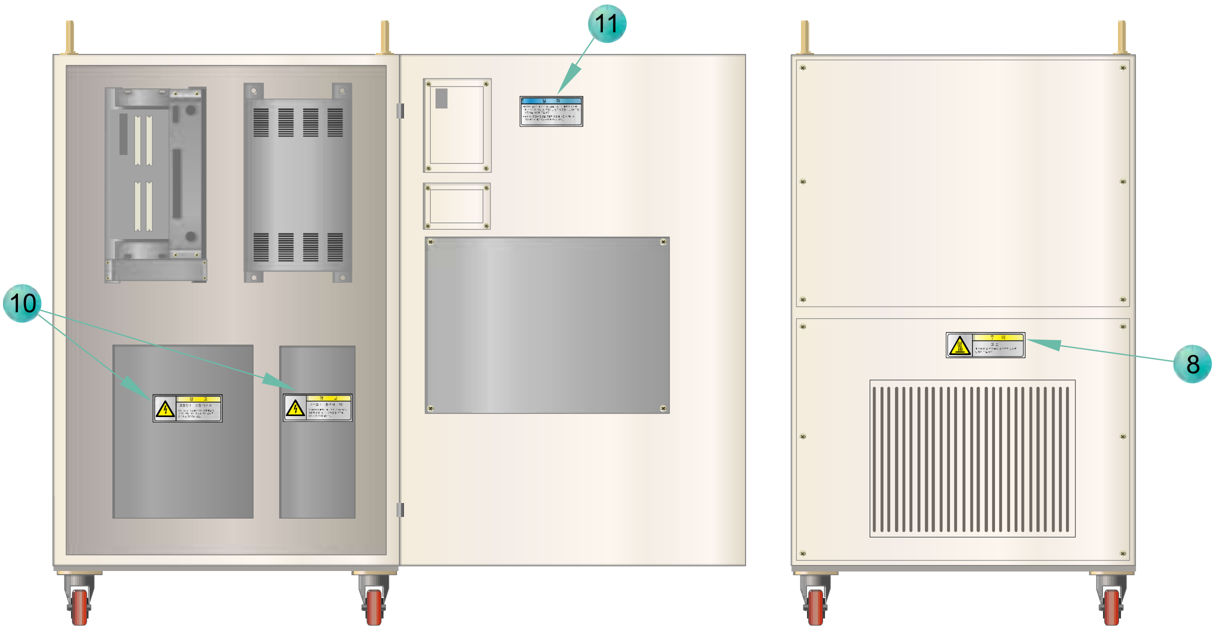


Figure 3.5 Hi5-C10 Location of Controller Nameplate 2

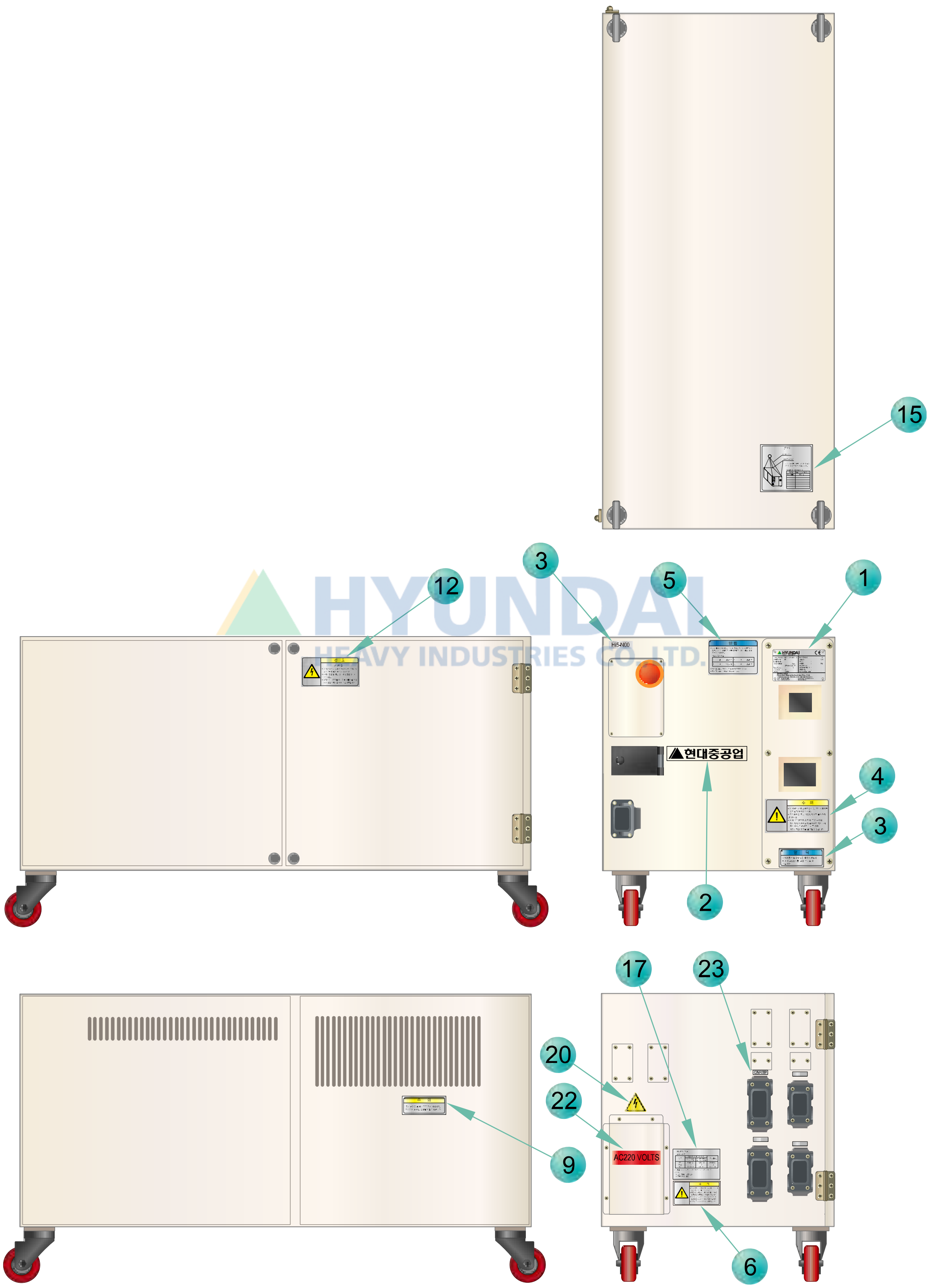


Figure 3.6 Hi5-C20 Location of Controller Nameplate 1

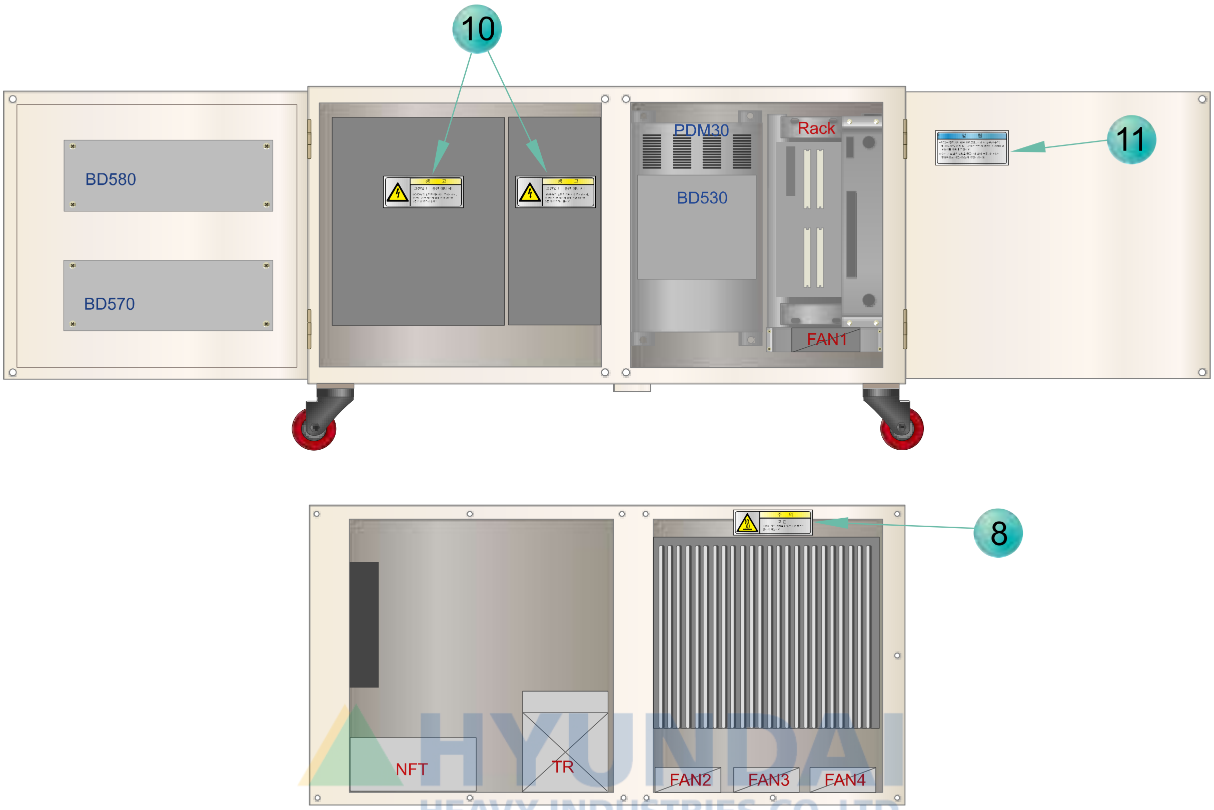


Figure 3.7 Hi5-C20 Location of Controller Nameplate 2

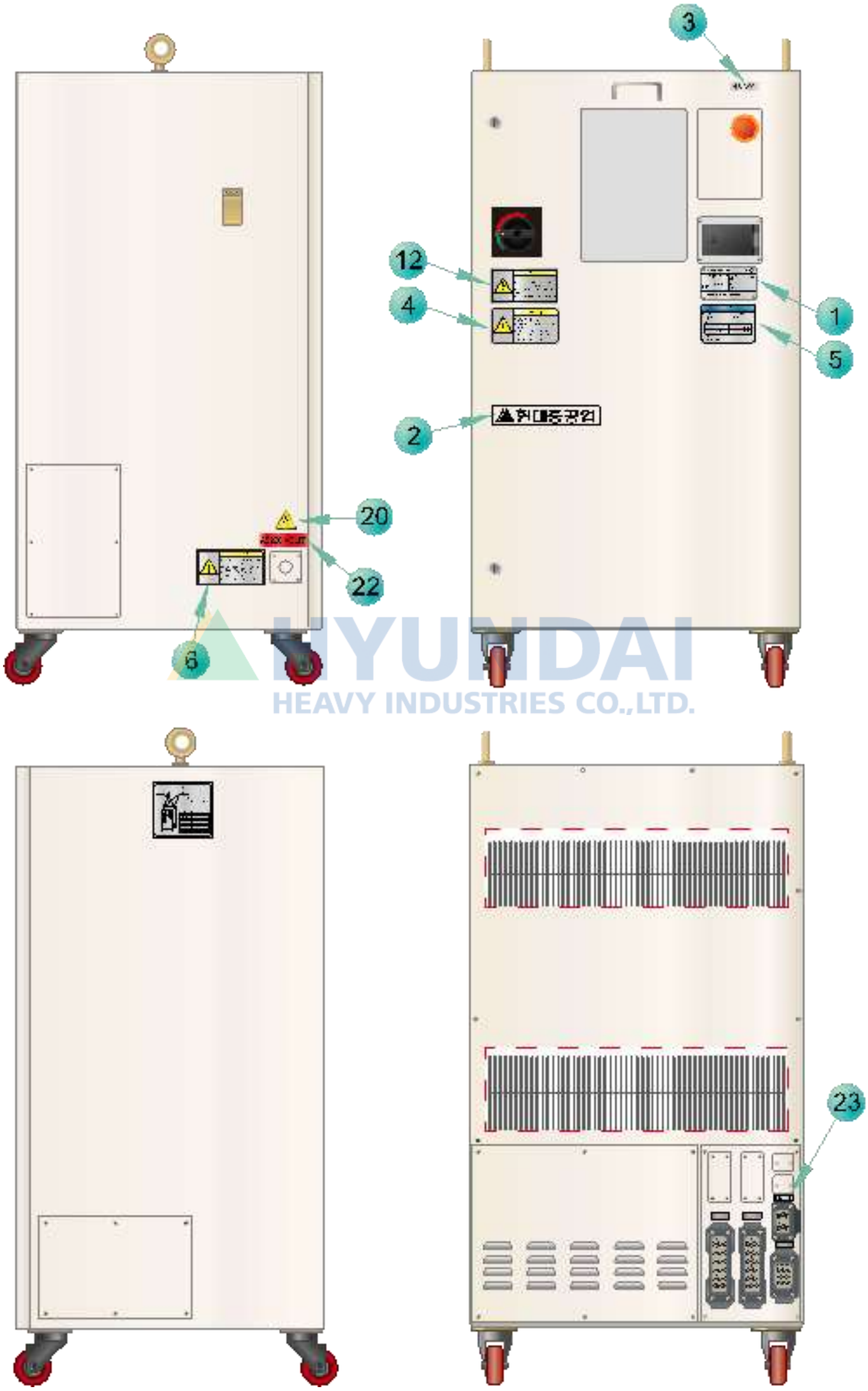


Figure 3.8 Hi5-N** Location of Controller Nameplate 1

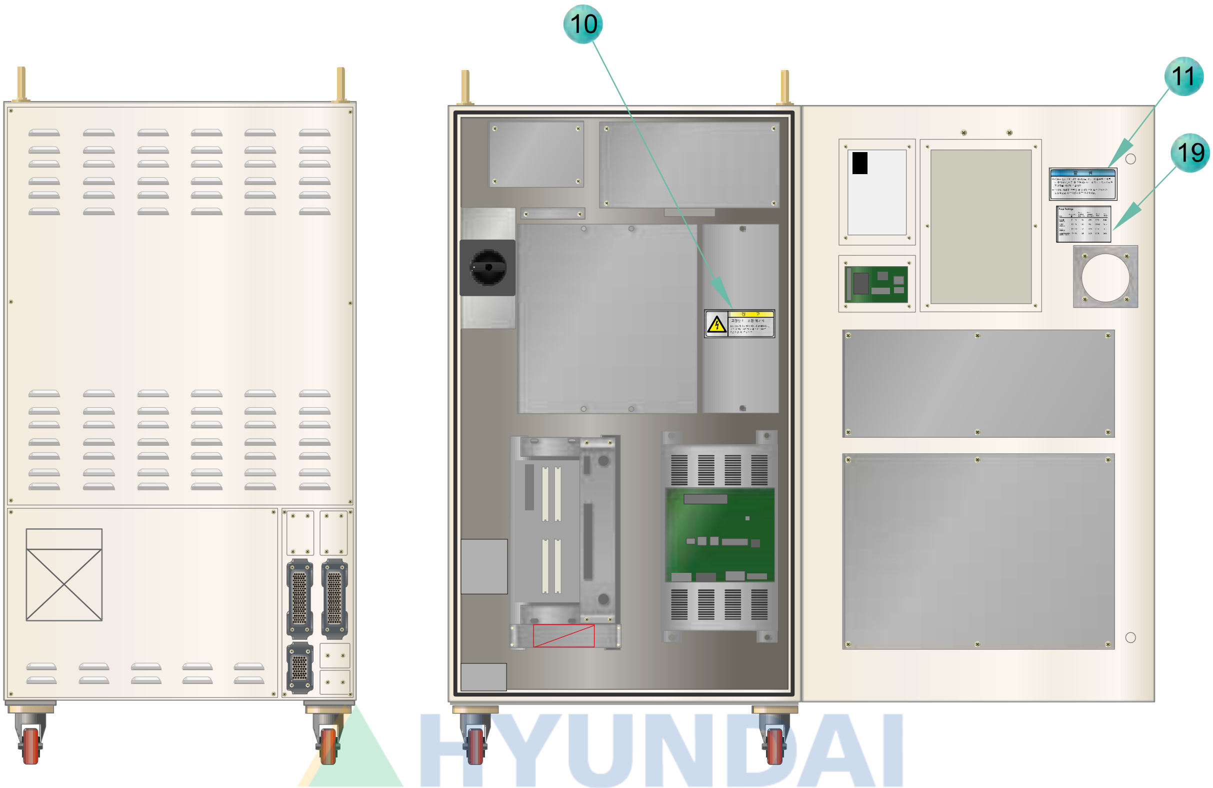
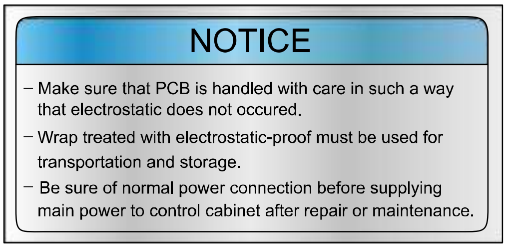
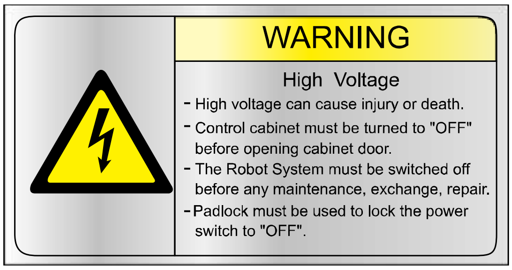


Figure 3.9 Hi5-N** Location of Controller Nameplate 2

No.	Name Plate	No.	Name Plate
1	HYUNDAI HEAVY INDUSTRIES CO., LTD CE Product Name : ROBOT CONTROLLER Model Name : Hi5 - Serial Number : Rated Voltage : Va.c, 3Phase, 50/60Hz Rated Current : A IP GRADE : 54 IEC NO : 60204-1 Max. Current : A Capacity : KVA SCCR : Weight : Kg Size (W,H,D) : Subassembly ID : DWG NO. : Manufacture Date : Manufactured by Hyundai Heavy Industries Co., Ltd. 1, CHEONHA-DONG, DONG-KU, ULSAN CITY, 682-792, KOREA Tel : 82-52-202-5041 Home page : www.hhi.co.kr Fax : 82-52-202-7960 Made in Korea	2	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
3	Hi5-N00	4	CAUTION – Carefully read the operation manual and the safety manual before installation and using application. – Do not enter the working range of the Robot system under operation. – Before cables connecting, check that the S/N is identical on the controller and on the manipulator. If the S/N is different, robot may be operated abnormally.
5	NOTICE Batteries for data backup are installed inside of both controller and manipulator. Batteries must be replaced in <u>every 2 years</u> regardless of operation hours. • Next date for replacement is 1. 2. 3. 4. • Battery type : ER6C(Lithium Battery, 3.6V) • Battery Maker : Hitachi Maxwell, Ltd.	6	CAUTION – Check appropriate supplied voltage before connection. – Check supplied voltage with setting voltage of transformer. – Make grounding which is 100Ω resistance or less for the robot independtly. – Use Grounding Cable more than 5.5mm² – Use power cable more than 5.5mm² (AWG10)
7	CAUTION Finger Injury Handling without care can cause fatal injury.	8	CAUTION High Temperature Do not touch! The temperature may be very high.
9	CAUTION Ensure no interference for air circulation of ventiduct. Interference may cause controller damage.	10	WARNING High Voltage ! Stored Energy! Be careful of stored energy of DC 400V. Wait more than 5 minutes for deenergizing after power off.

<table>
<tr><th>No.</th><th>Name Plate</th><th>No.</th><th>Name Plate</th></tr>
<tr><td>11</td><td>
</td><td>12</td><td>
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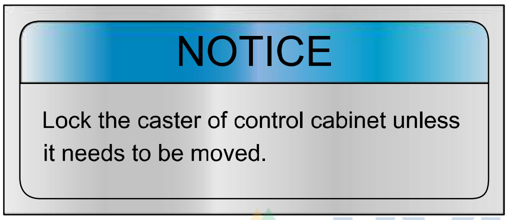
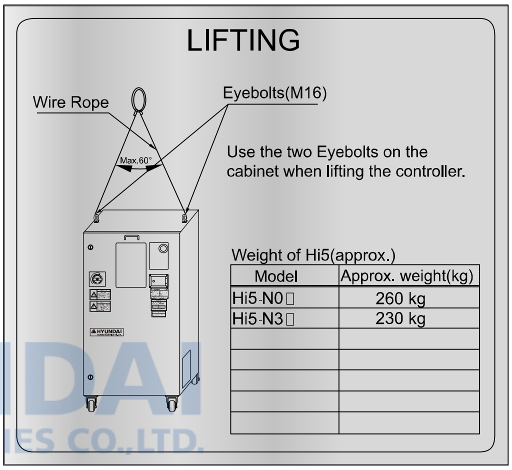
<tr><td>13</td><td>
</td><td>14</td><td>
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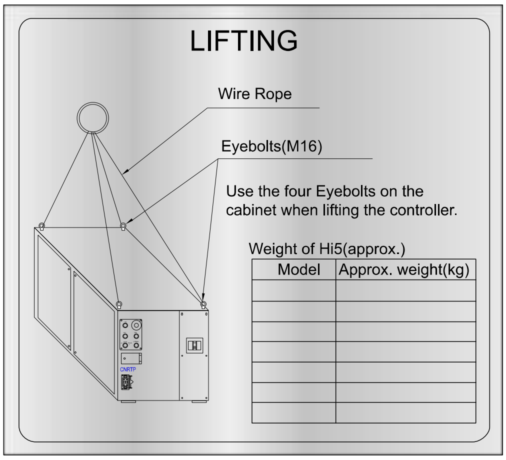
<tr><td>15</td><td>
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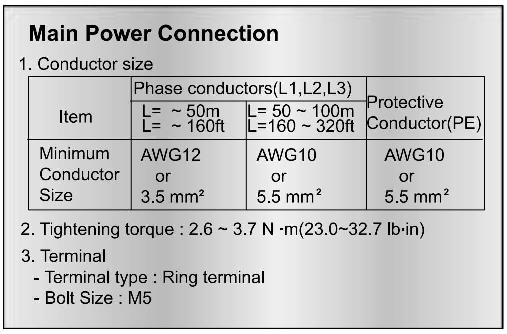
<tr><td>17</td><td>
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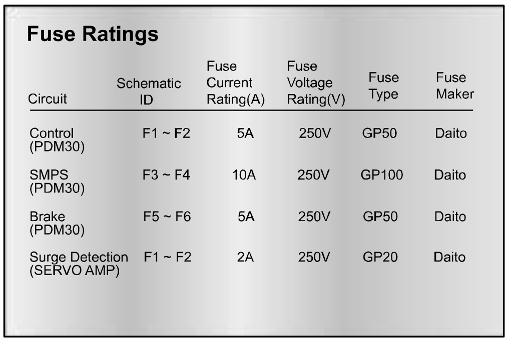
<tr><td>19</td><td>
Fuse Ratings
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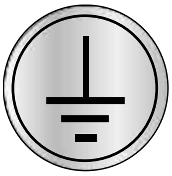
<tr><th>Circuit</th><th>Schematic ID</th><th>Fuse Current Rating(A)</th><th>Fuse Voltage Rating(V)</th><th>Fuse Type</th><th>Fuse Maker</th></tr>
<tr><td>Control (PDM30)</td><td>F1 ~ F2</td><td>5A</td><td>250V</td><td>GP50</td><td>Daito</td></tr>
<tr><td>SMPS (PDM30)</td><td>F3 ~ F4</td><td>10A</td><td>250V</td><td>GP100</td><td>Daito</td></tr>
<tr><td>Brake (PDM30)</td><td>F5 ~ F6</td><td>5A</td><td>250V</td><td>GP50</td><td>Daito</td></tr>
<tr><td>Surge Detection (SERVO AMP)</td><td>F1 ~ F2</td><td>2A</td><td>250V</td><td>GP20</td><td>Daito</td></tr>
</table></td><td>20</td><td></td></tr>
<tr><td>21</td><td></td><td>22</td><td>
</td></tr>
<tr><td>23</td><td>
</td><td>26</td><td>-</td></tr>
</table>

3.2. Packing

① Attach the nameplate of model to its box.
② Cover all the exposure connectors with dust cap or polyvinyl to protect.
③ For the packing of T/P in a box, use air cushioning materials to keep LCD intact from external impact during packing.
④ Attach the list of waterproof packing to the outer box.

3.3. Transportation of Controller

Since Hi5 controller is a sophisticated device, transport it using crane or forklift truck in an uneven ground or for long distance.

Be sure to check the following instructions when transporting.

① Check if the front door of controller is completely closed.
② Remove, if any, everything unfixed on the controller
③ Check if the Eye Bolt on controller is securely fastened.
④ Since the controller is a sophisticated device, transport it very carefully without any impacts.
⑤ The weight of controller is 250Kgf. If using a crane, prevent wires from damaging objects on controller.
⑥ If using a forklift truck, secure the controller to prevent shaking.
⑦ If using a vehicle, secure the manipulator and controller with a squid and so on.

3.4. Unpacking

Caution

① Be carefully aware of safety regulations and other instructions before unpacking and installing.
② Unpack the robot and controller, following the unpacking instructions.
③ Check if the place is safe enough to install the robot and controller.
④ Check if a traveling path is secured to safely move the robot and controller.
⑤ Transporting robot must be performed by a qualified personnel.
⑥ Check out any damages from transportation or unpacking.

3.5. Controller Handling

Transport the controller using crane or forklift truck.
Operating forklift truck must be performed by a qualified personnel

3.5.1. Weight of Controller

Table 3-1 Weight of Controller

Model	Power Supply Transformer	Weight	
		Kg	lb
Hi5-N00/N50	X/O (Option)	150/230	330/507
Hi5-N30	X/O (Option)	150/200	330/441
Hi5-C10	X	150	330
Hi5-C20	X	150	330

Table 3-2 Weight of Hi5 Controller by Models

Model	Weight	
	Kg	lb
Teach Pendant (7.5m, TP510)	4	9
Wire harness (5m, Hi5-N**)	15	33
Wire harness (5m, Hi5-C10, Hi5-C20)	18	40

3.5.2. Transportation of Controller Using Crane

Check the following instructions when transporting the controller using a crane.

① In general, for the transportation of controller, crane wire with Eye Bolt should be used.
② Check if the wire is strong enough to hold Controller.
③ Check if the eye bolt is securely fastened.

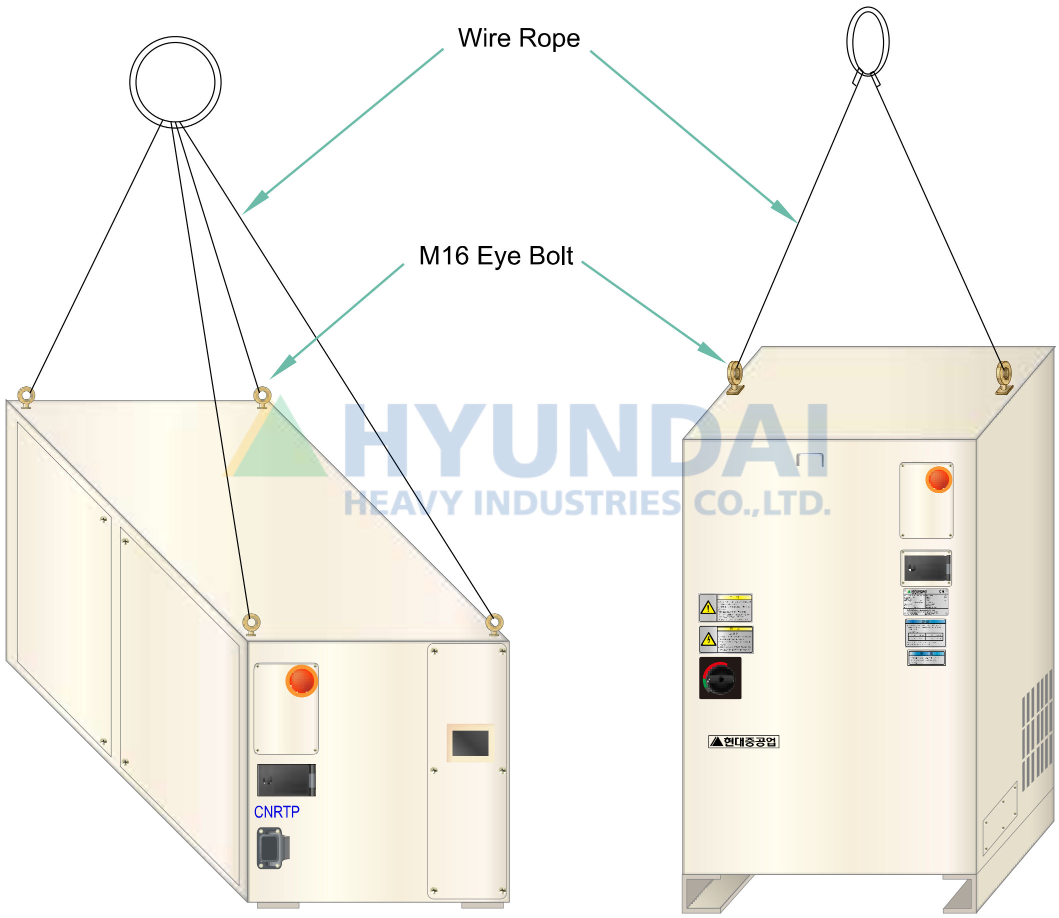


Figure 3.10 Transportation of Controller Using Crane

3.5.3. Transportation of Controller Using Forklift Truck

Check the following instructions when transporting the controller using a forklift truck.

① If transporting with wire rope, be sure to use a strong wire to hold controller.
② Check if the eye bolt is securely fastened.
③ Transport the controller as low as possible.

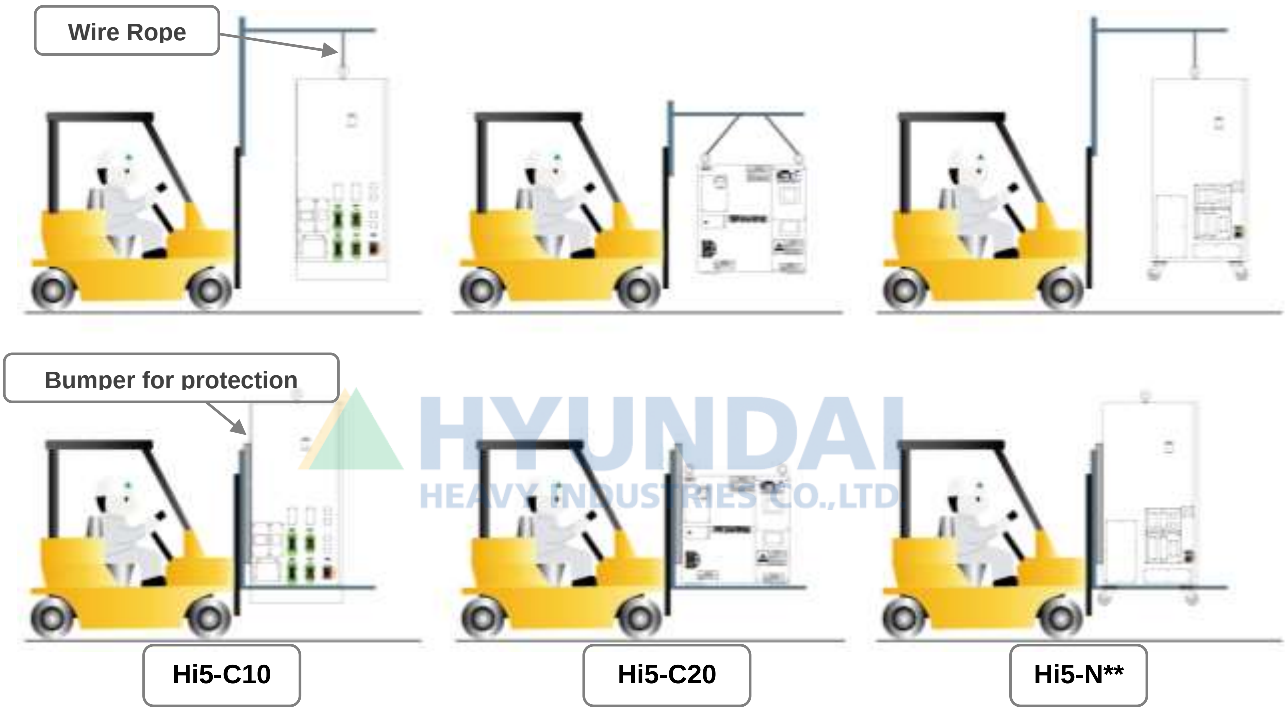


Figure 3.11 Transportation of Controller Using Forklift Truck

3.6. Space for Installation

Check the following instructions before installation.

① Secure the robot working envelope.
② Secure the space for maintenance of robot manipulator and controller.
③ Check if the installing place has such environment as follows.

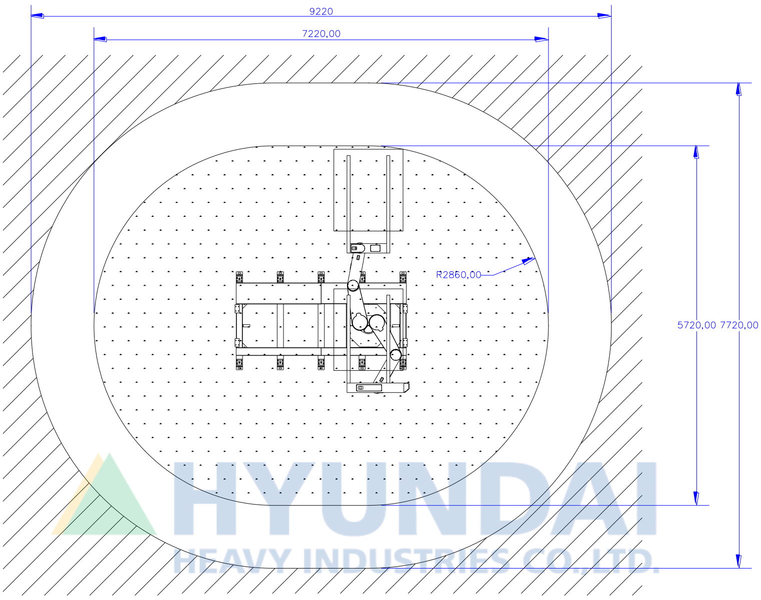
- Ambient Temperature ; $0^{o}C$ ~ $45^{o}C$
- No dust, oil, or moisture.
- No flammable, corrosive liquid or gas.
- No impact and shaking.
- Far from electrical noise generator.
- No exposed direct to the sun

3.6.1. Installation of Controller

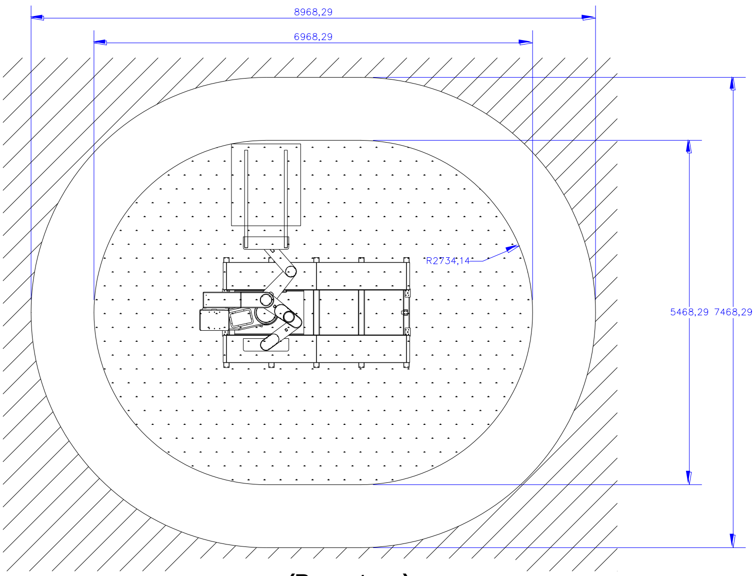
① Install the controller in a safe place outside of robot working envelope.
② If safety fence is located outside of robot working envelope, install the controller in a place where the robot's movement can be monitored from the outside of safety fence.
③ Open the front door and secure enough space for maintenance work.
④ Install the controller in a place where welding spatter and coolant are not reached.

3.6.2. Space for Installation

Secure enough space for robot manipulator and controller before installing. To install the manipulator and controller, secure the installing space as shown in the below figure. Install the controller outside of the safety fence to see the manipulator easily and to work safely. Install the controller at intervals of a minimum 500mm from the surrounding walls.



(Cylinder type)



(Beam type)

Robot operation area

Marginal space between operation area and safeguard area

Safeguarded area

Figure 3.12 Installing space for LCD robot

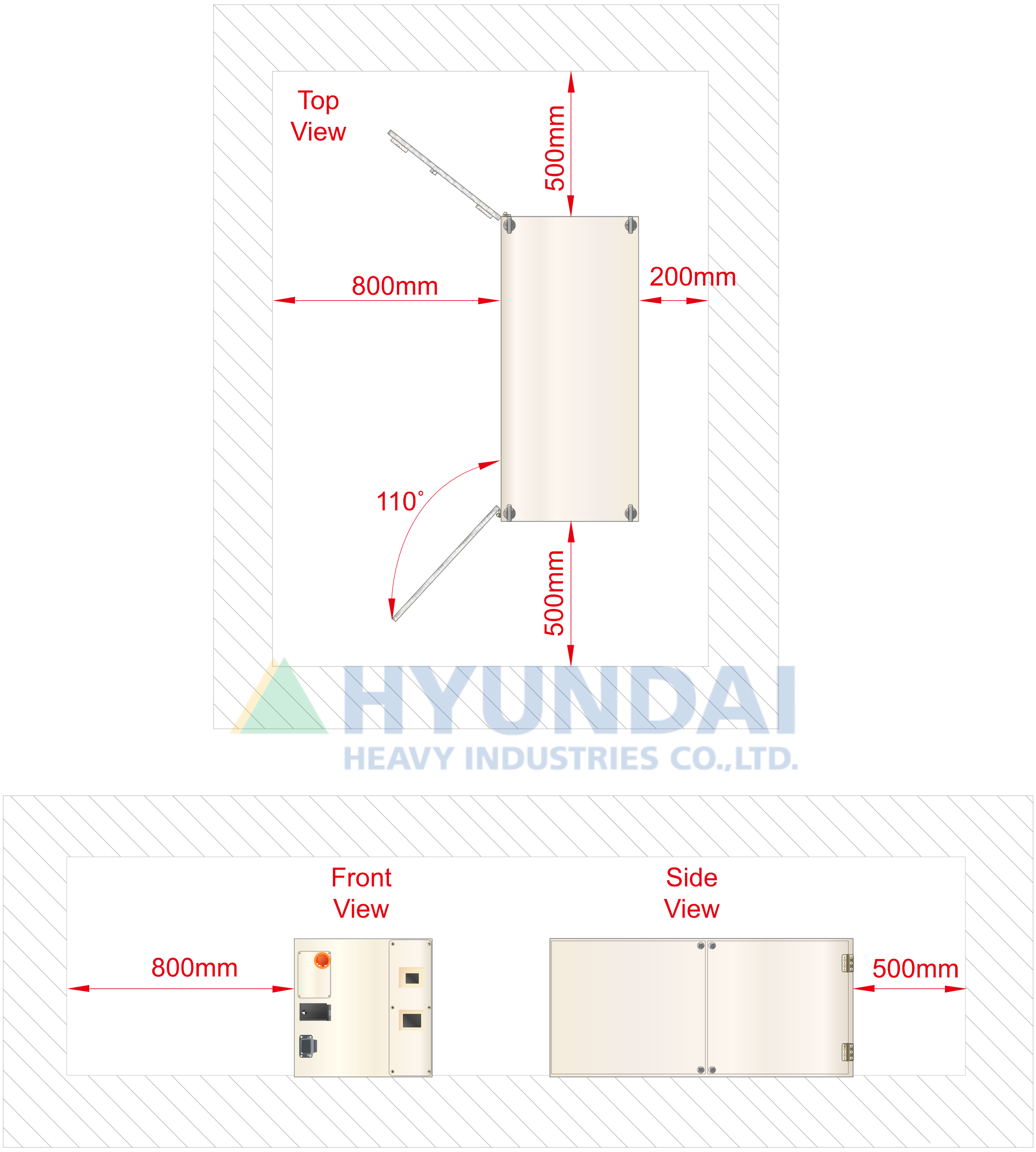


Figure 3.13 Installing space for Hi5-C20 controller

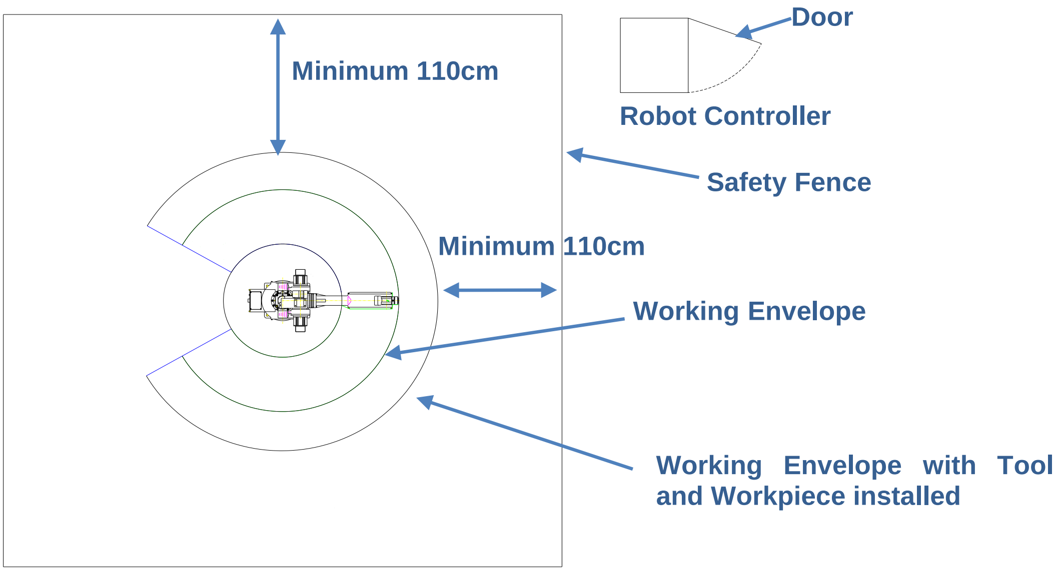


Figure 3.14 Install space for general type robot

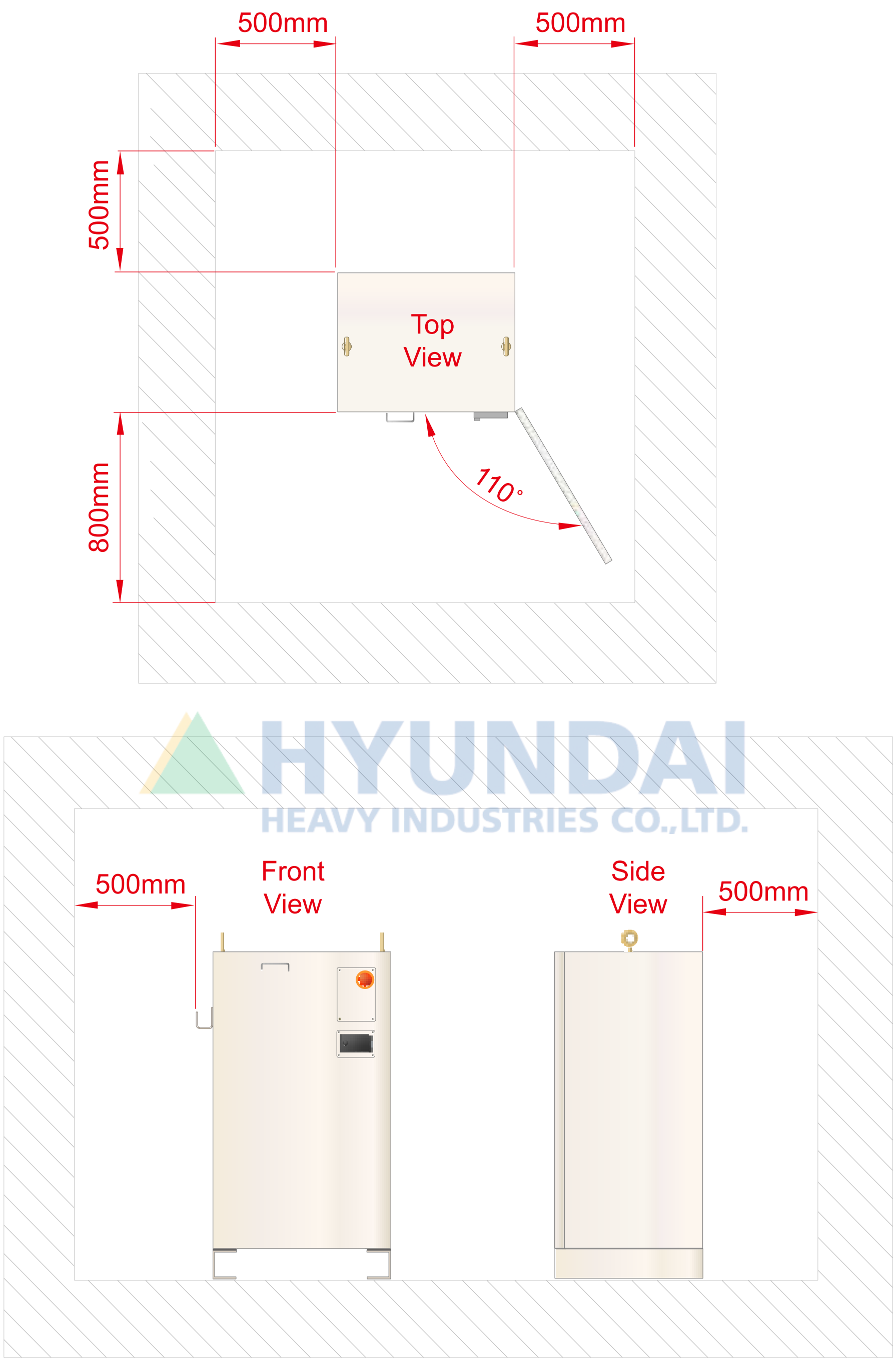


Figure 3.15 Installing space for Hi5-C10, Hi5-N** controller

3.6.3. Dimension of Controller

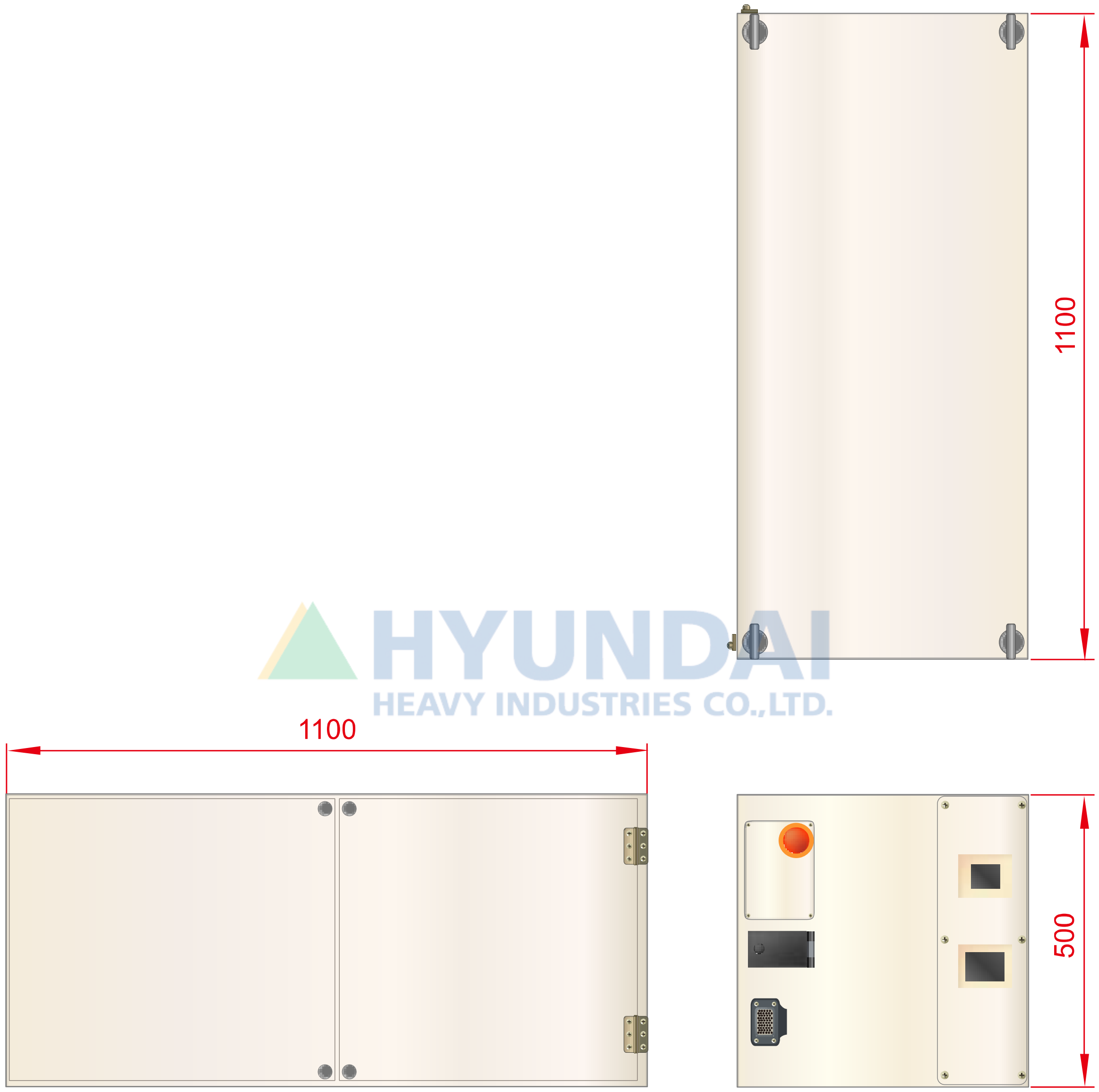


Figure 3.16 Dimension of Hi5-C20 (Unit: mm)

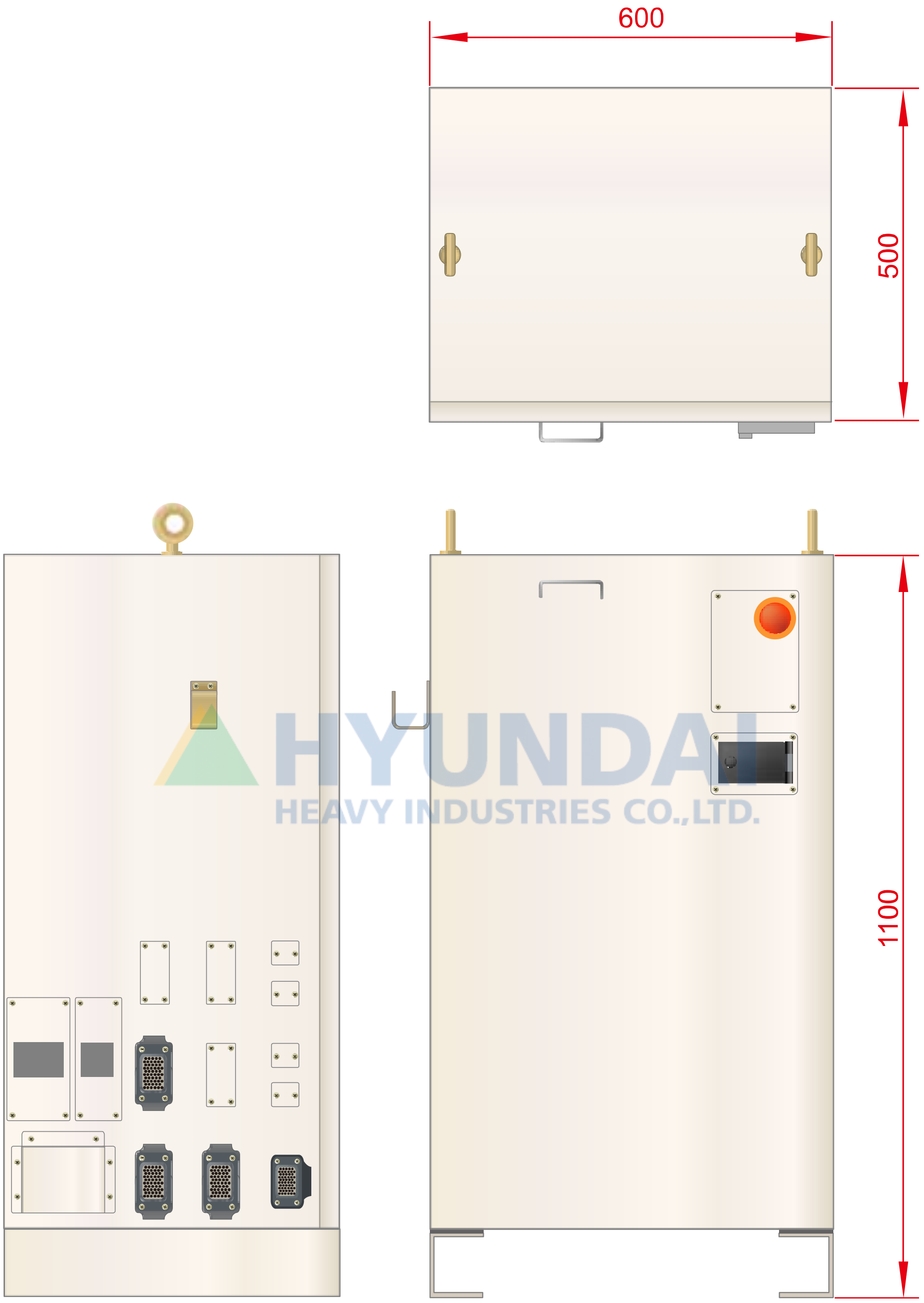


Figure 3.17 Dimension of Hi5-C10 Controller (Unit: mm)

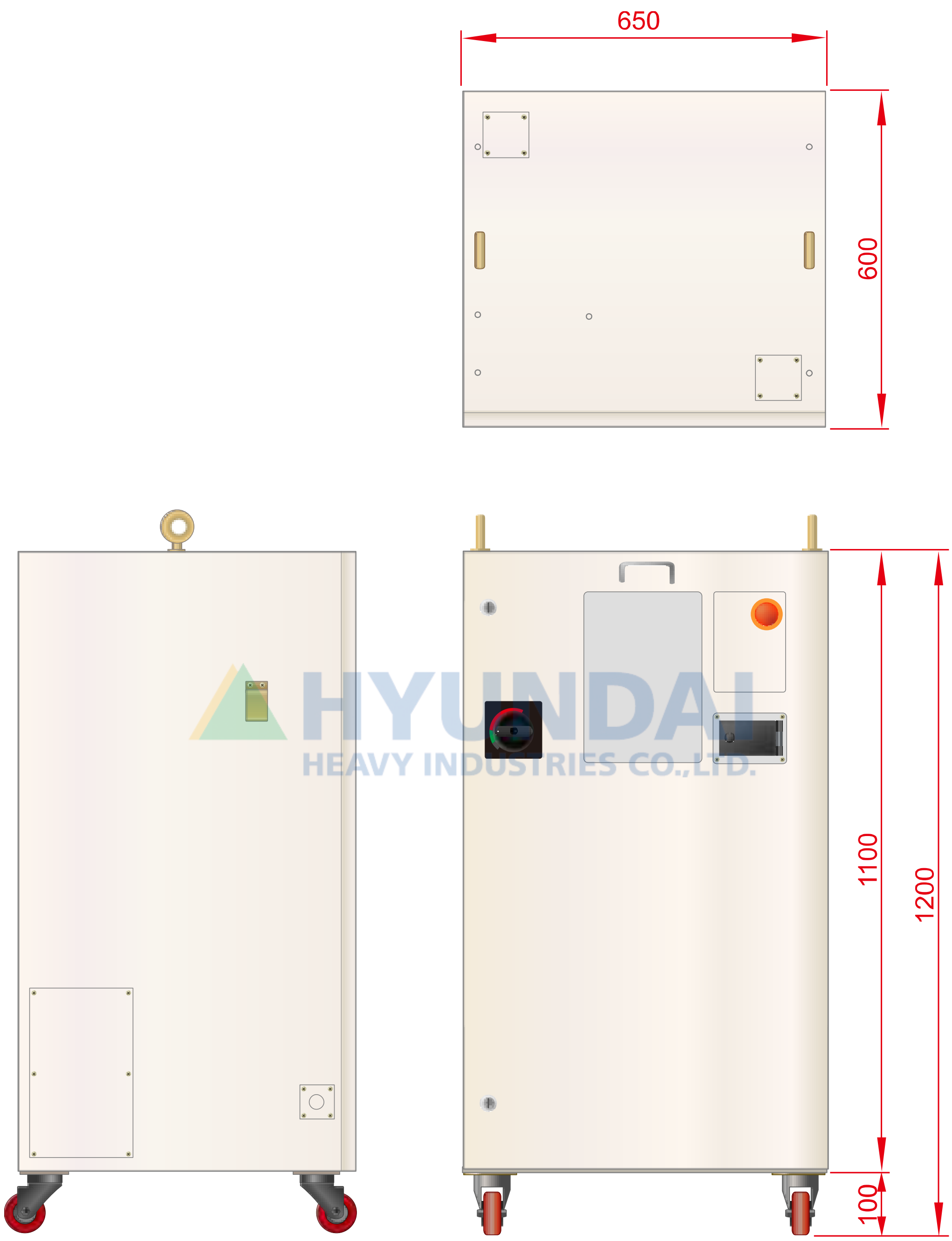


Figure 3.18 Dimension of Hi5-N** Controller (Unit: mm)

3.7. Connection

Caution

① Turn the main power switch of controller “OFF” before connecting cables, and use a lock to lock the main power switch.
② There is charged energy of DC 400V in the controller. Be careful. Turn the power switch “OFF” to discharge the energy, and wait for 5 minutes at least
③ When handling PCB, be careful of any damages from static electricity.
④ Wiring and interconnecting should be preformed by a qualified personnel .

3.7.1. Connection of Teach Pendant

Connect the cable connector of Teach Pendant to CNRTP receptacle in the side of controller.

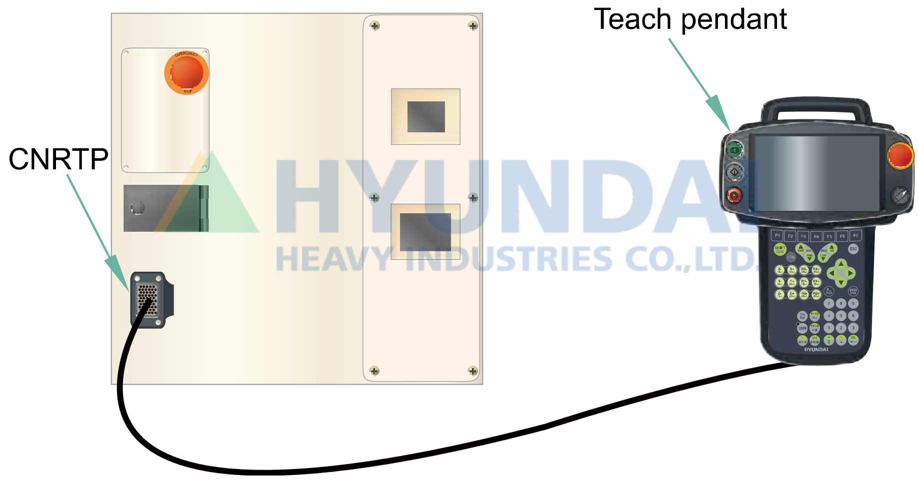


Figure 3.19 Hi5-C20 Connection of Teach Pendant

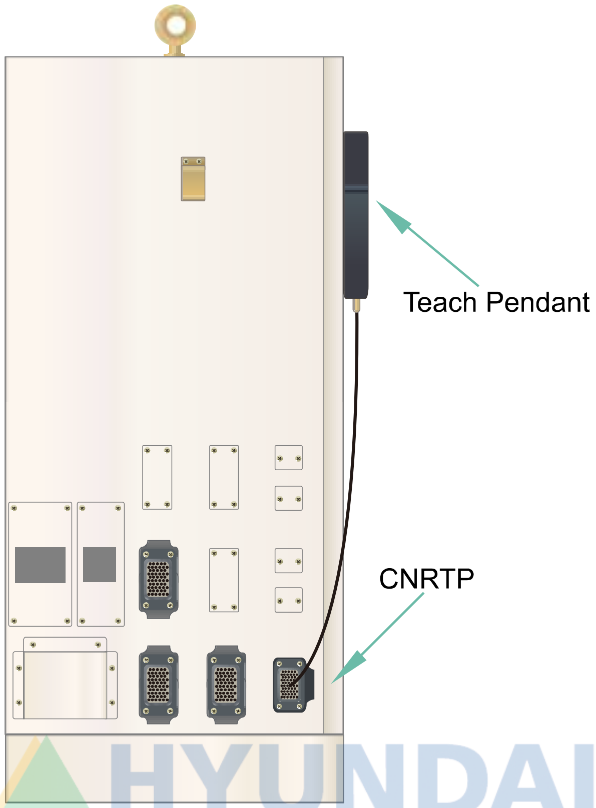


Figure 3.20 Hi5-C10 Connection of Teach Pendant

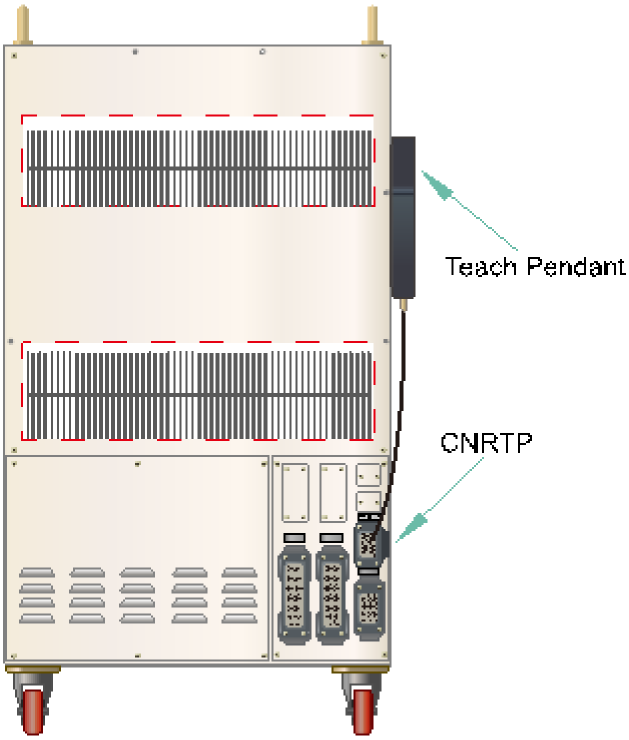


Figure 3.21 Hi5-N** Connection of Teach Pendant

3.7.2. Connection of Manipulator and Controller

Connect the robot manipulator to the controller by using wire harness. Check the respective name of receptacles before connecting.

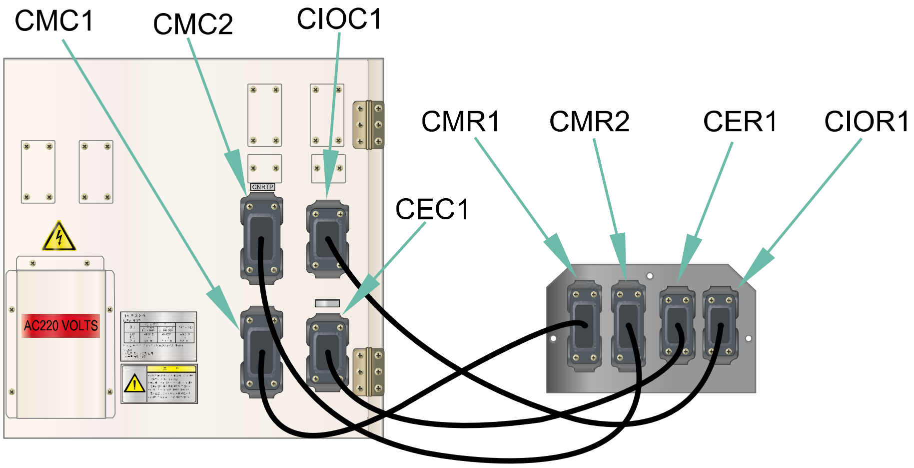


Figure 3.22 Connection of Robot Manipulator and Controller (Hi5-C20)

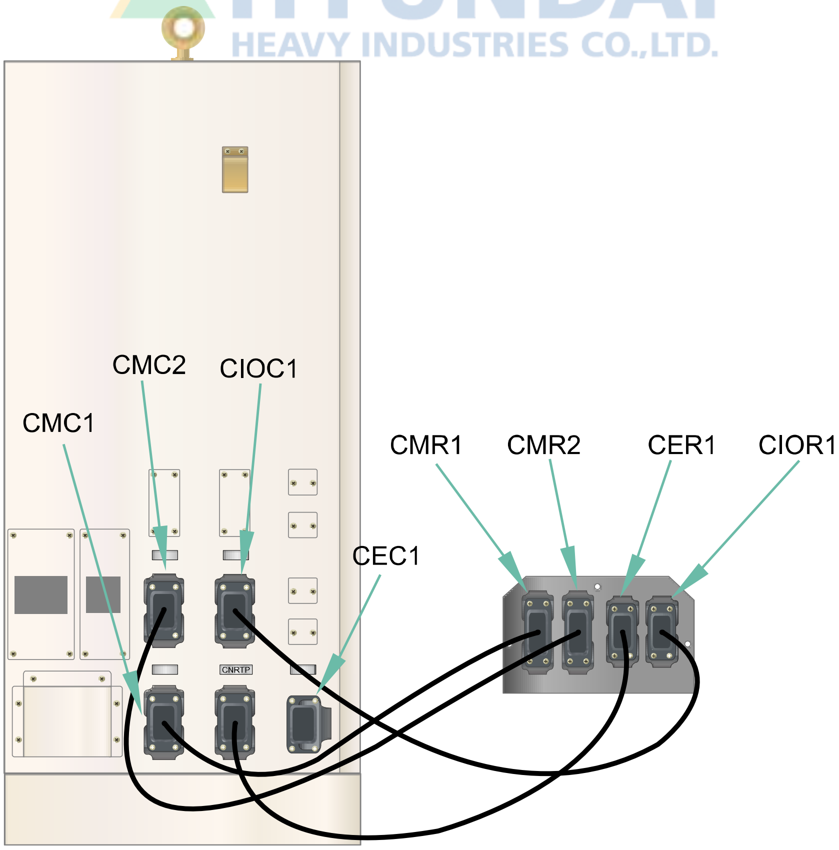


Figure 3.23 Connection of Robot Manipulator and Controller (Hi5-C10)

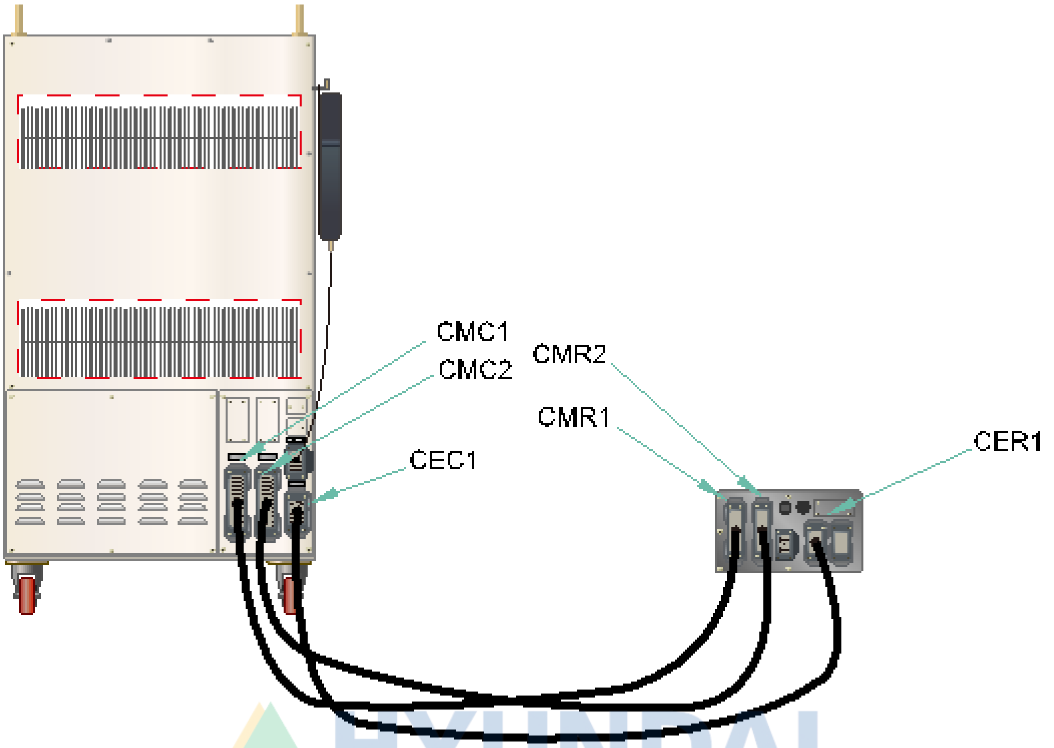


Figure 3.24 Connection of Robot Manipulator and Controller (Hi5-N00)

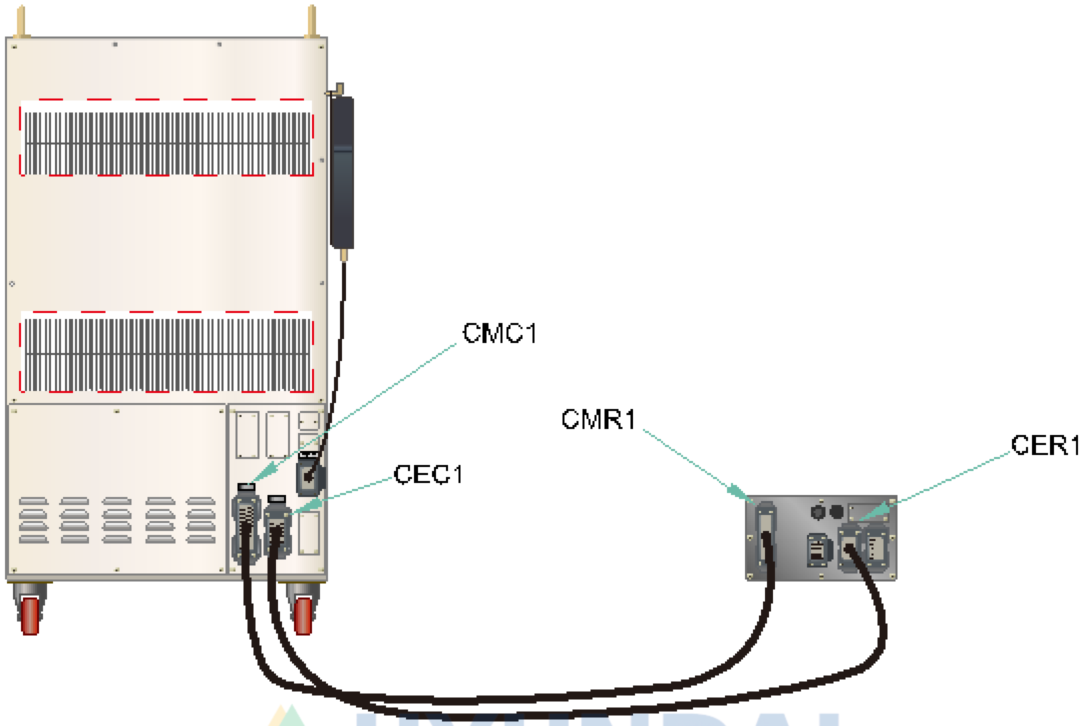


Figure 3.25 Connection of Robot Manipulator and Controller (Hi5-N30/N50)

3.7.3. Connection of Controller and Primary Power

Check if the power is removed from the primary power and braker(CB).
Connect the Hi5-C10 and C20 controllers to the terminal block (TBPW).
For the Hi5-N** controller, insert the power cable into the power service outlet to connect the breaker (NFB).
Here, use a proper size of terminal for the tip of primary power cable

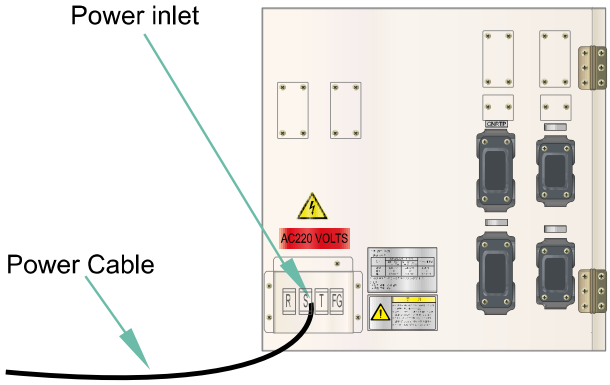


Figure 3.26 Hi5-C20 Connection of Primary Power to Controller

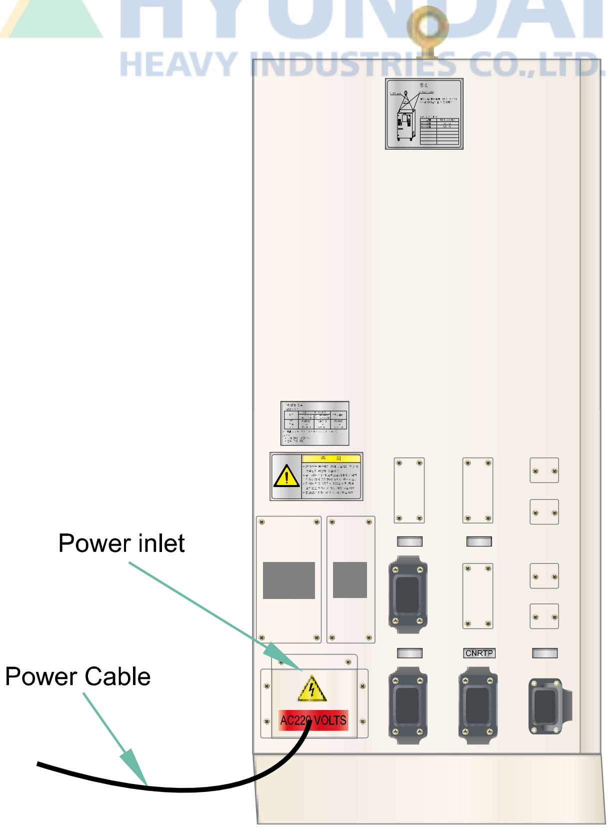


Figure 3.27 Hi5-C10 Connection of Primary Power to Controller

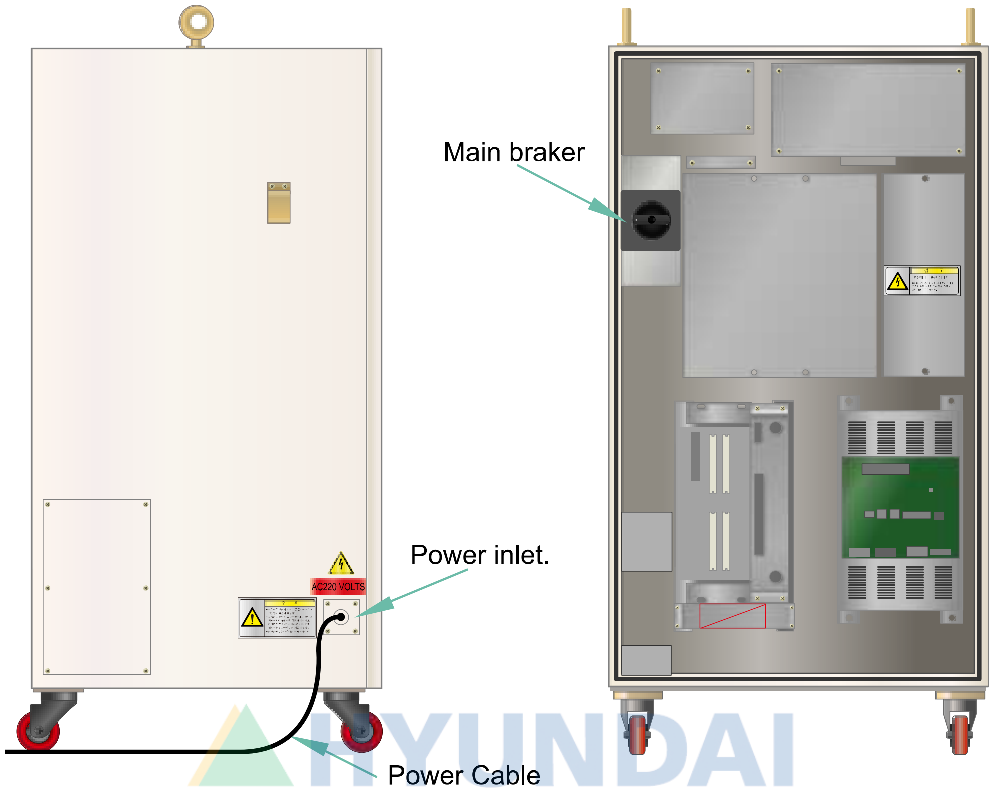


Figure 3.28 Hi5-N** Connection of Primary Power to Controller

3.7.3.1. Power Conditions

Table 3-3 Power Conditions

No.	Controller	Capacity*1) (KVA)	Input Voltage*2) (V)	Frequency (Hz)	Max. Current (A)
1	Hi5-N00/N50	Max. 7.8KVA	220V/380V/400V/440V	50/60	30A
2	Hi5-N30	Max. 4.4KVA	220V/380V/400V/440V	50/60	15A
3	Hi5-C10	Max. 12.5KVA	220V	50/60	30A
4	Hi5-C20	Max. 11KVA	220V	50/60	30A

Note 1) Power capacity:
This refers to the capacity of the power supplied to the controller. Please refer to the “Robot Maintenance Manual” for the power capacity of each robot.
Note 2) Voltage Range: ±10% (Controller Power Terminal)

3.7.3.2. Thickness of Power Cables

Table 3-4 Recommended Cable of Least Thickness

No.	Length of Cable m (feet)	Thickness of Cable (Hi5-N00, Hi5-N50 Hi5-C10, Hi5-C20)		Thickness of Cable (Hi5-N30)	
		㎟	AWG	㎟	AWG
1	0 ~ 50 (0 ~ 160)	5.5	10	3.5	12
2	50 ~ 100 (160 ~ 320)	5.5	10	3.5	12
3	100 ~ 180 (320 ~ 590)	8	8	5.5	10
4	180 ~ 300 (520 ~ 980)	8	8	5.5	10

3.7.4. Controller and Grounding

Connect the grounding conductor to the controller for safety.
Use the grounding conductor more than 5.5 ㎟. (Class 3 grounding)

3.7.5. Other Cautions

① **Please distinguish signal line and power line on wiring for controller and robot main body.** And use a separated DUCT between high power line and signal line for wiring.
② Shield the wires with protection cover against damages, and be careful of damage from traffic.
③ **Be sure to double-check the connecting relations, power specifications of controller, and specifications of power supply before primary power input.**

3.7.6. RS232C & Ethernet access of Small Door

The small door sector is located on the OP panel in the front of the controller, and is composed of an RS232C and Ethernet port for external connection. Interconnecting to PC and Pin Description is as follows.

Table 3-5 Pin Descriptions (RS232 connector specifications: DSUB9S-M)

DSUB9S-M Pin No.	Name	Abbreviation	Direction
2	Receive Data	RX	In
3	Transmit Data	TX	Out
5	Signal Ground	GND	
7	Request to Send	RTS	Out
8	Clear to Send	CTS	In

Table 3-6 Pin Descriptions (RJ45 connector specifications: RJ 45P SHIELD)

RJ45 Pin No.	Name	Abbreviation	Direction
1	Transmit Data +	TX +	Out
2	Transmit Data -	TX -	Out
3	Receive Data +	RX +	In
6	Receive Data -	RX -	In

4

Basic Components of Controller

Please learn the components of Hi5 controller, arrangement and functions of components before doing a repair work.

4.1. Components

Controller consists of the body and the teach pendant as seen in the following picture.

Figure 4.1 Hi5-N** Controller

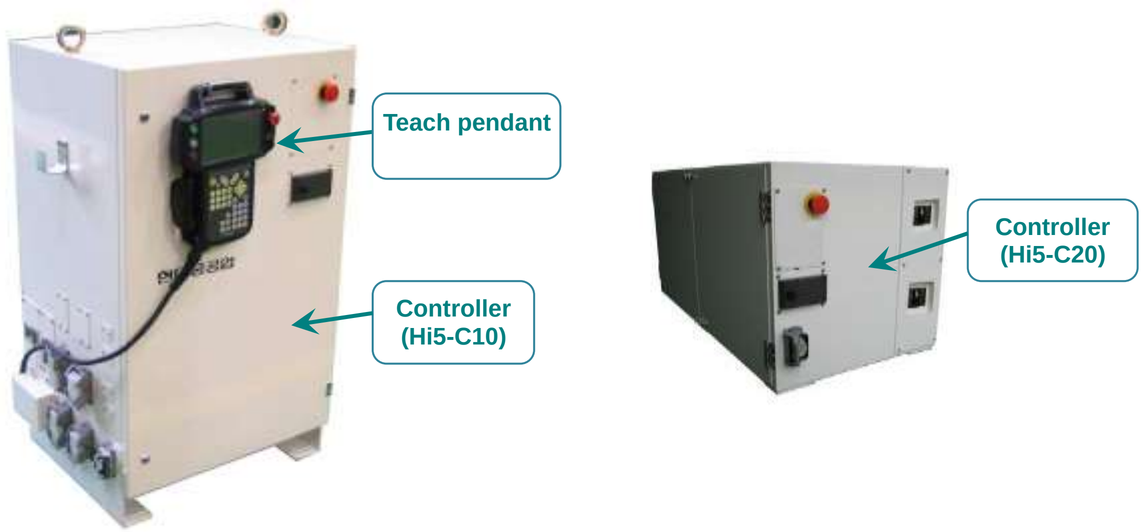


Figure 4.2 Hi5-C** Controller

Figure 4.3 Teach pendant (TP510)

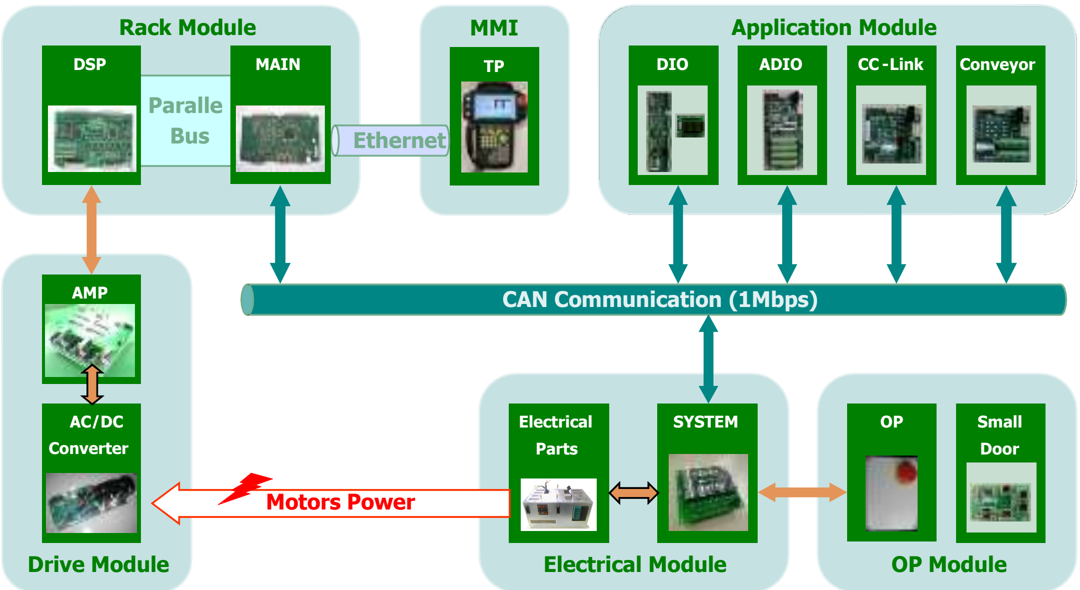


Figure 4.4 Internal Composition of Hi5 Controller

4.2. The Arrangement of Parts

Table 4-1 shows the main parts of Hi5-N00 controller and the name of each part, and Figure 4.5, 4.6 and 4.7 show the arrangement of them.

Table 4-1 The Name of Each Part of Hi5-N00 Controller

No.	Type	Item
1	RACK	Rack
2	BD501	Backplane Board
3	SR1	DC Multi Power Unit(SMPS: HDI-200)
4	BD510	Main Board
5	BD542	Servo Board
6	BD530/531	System Board
7	PDM30	Electrical Module
8	SD1L2C	Middle-Size Diode Module
9	SA3X3Y	Middle-Size 6-Axis Servo Drive Unit (Standard Specifications)
9-1	SA3A3D	Small-Size 6-Axis Servo Drive Unit (Standard Specifications, Including a DIOD module)
10	SA1X1X	Middle-Size 2-Axis Servo Drive Unit (Option)
10-1	SA1X1A	Middle-Size 1-Axis, Small-Size 1-Axis Servo Drive Unit (Option)
10-2	SA1A1A	Small-Size 2-Axis Servo Drive Unit (Option)
11	EM. SW	Emergency stop switch
12	BD5B1	Small Door Board
13	NFB	No Fuse Breaker
14	FAN1	Rack radiating fan
15	FAN2	Lower fan for upper circulation

No.	Type	Item
16~17	FAN3~5	Servo-drive unit radiating fan
18	NFT1	Line Noise Filter
19~20	DR1~2	Regeneration discharge resistance
21	TR1	Transformer
22	CMC1	Power Cable Lead-In Connector for Motor Drive 1
23	CMC1	Power Cable Lead-In Connector for Motor Drive 2
24	CEC1	Motor Encoder Communications Cable Lead-In Connector
25	CNRTP	Teach pendant Cable Lead-In Connector

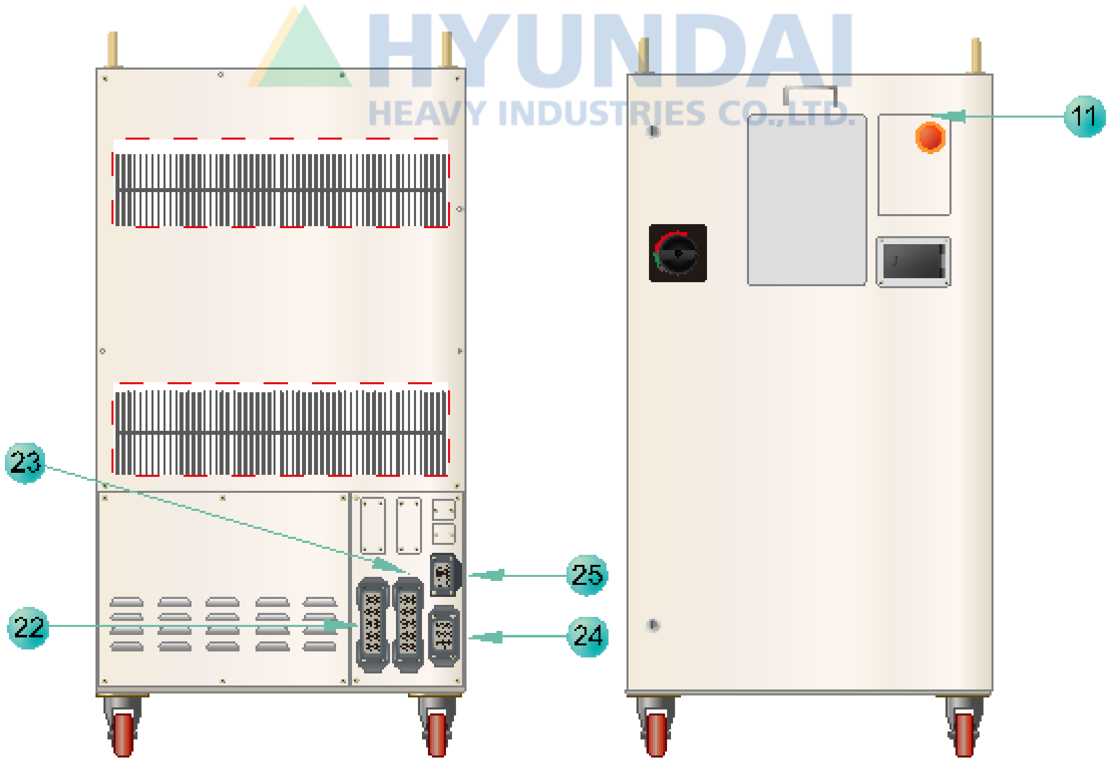


Figure 4.5 Hi5-N00 Part arrangement parts in the exterior of a controller

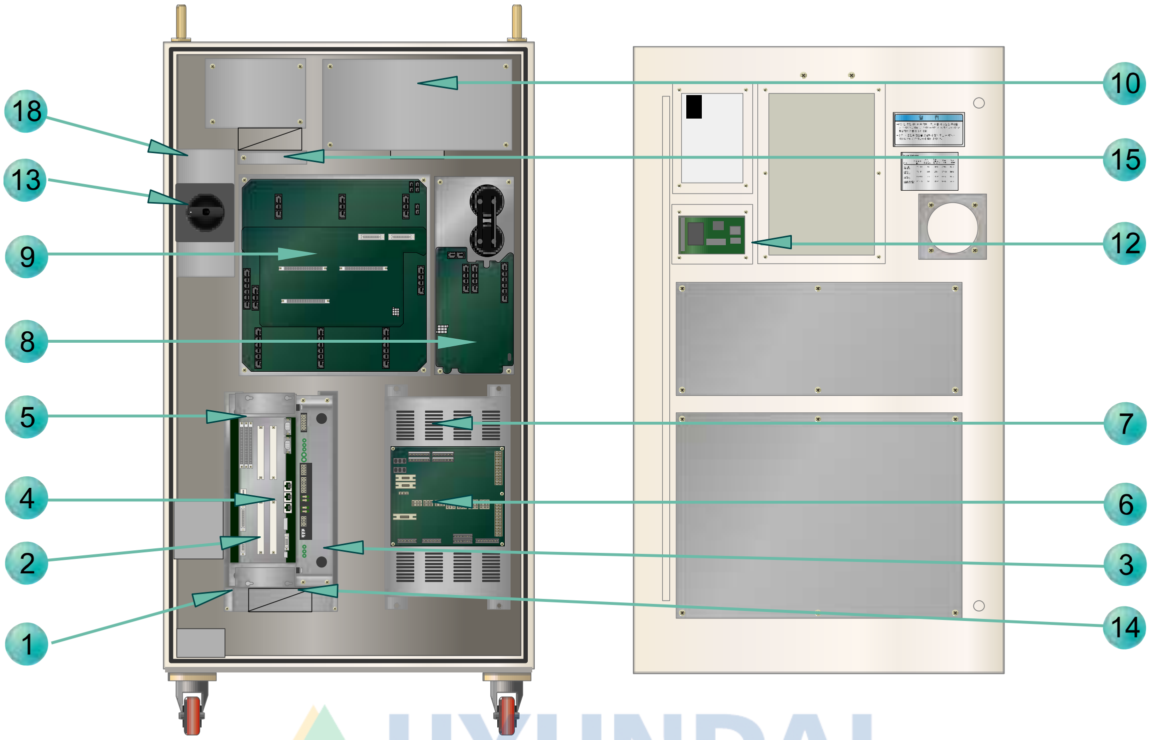


Figure 4.6 Part arrangement in the interior of the front surface of the Hi5-N00 controller

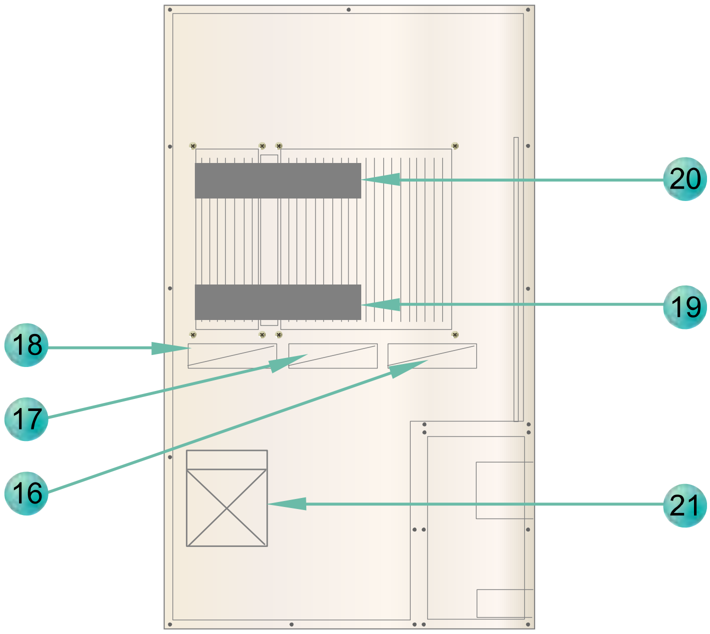


Figure 4.7 Part arrangement in the interior of the rear surface of the Hi5-N00 controller

Table 4-2 shows the main parts of Hi5-C10 controller and the name of each part, and Figure 4.8, 4.9 and 4.10 show the arrangement of them.

Table 4-2 The Name of Each Part of Hi5-C10 Controller

No.	Type	Item
1	RACK	Rack
2	BD501	Backplane Board
3	SR1	DC Multi Power Unit(SMPS: HDI-200)
4	BD510	Main Board
5	BD542	Servo Board
6	BD530/531	System Board
7	PDM30	Electrical Module
8	SD1L2C	Middle-Size Diode Module
9	SA3X3Y	Middle-Size 6-Axis Servo Drive Unit (Standard Specifications)
9-1	SA1L5X	Servo-drive apparatus for HC2500B2D-XXXX-10 (optional specifications)
9-2,3	SA3X3Z	Servo-drive apparatus for HC2500B2D-XXXX-00 (optional specifications) Servo-drive apparatus for HC2500B1D-XXXX-10 (optional specifications)
10	BD58A	LDIO board
11	BD58B	Safety relay board
12	BD5B1	Small Door Board
13	EM. SW	Emergency stop switch
14	SR2	DC power apparatus for a sensor
15	SR3	Elevation shaft fall prevention brake and DC power apparatus for a robot fan
16	NFB1	Breaker of driving device wiring (No Fuse Breaker)
17	NFB2	Breaker for control power wiring (No Fuse Breaker)

No.	Type	Item
18	TBMAIN1	Terminal Block for inputting driving device power (Terminal Block)
19	TBMAIN2	Terminal Block for inputting control power (Terminal Block)
20	TBPW1	Terminal Block for interior power (Terminal Block)
21	FAN1	Rack radiating fan
22~24	FAN2~4	Servo-drive unit radiating fan
25	TR1	Transformer
26	NFT1	Line Noise Filter
27~28	DR1~2	Regeneration discharge resistance
29	CMC1	Power Cable Lead-In Connector for Motor Drive 1
30	CMC2	Power Cable Lead-In Connector for Motor Drive 2
31	CEC1	Motor Encoder Communications Cable Lead-In Connector
32	CNRTP	Teach pendant Cable Lead-In Connector
33	CIOC1	Sensor cable inserted in the connector

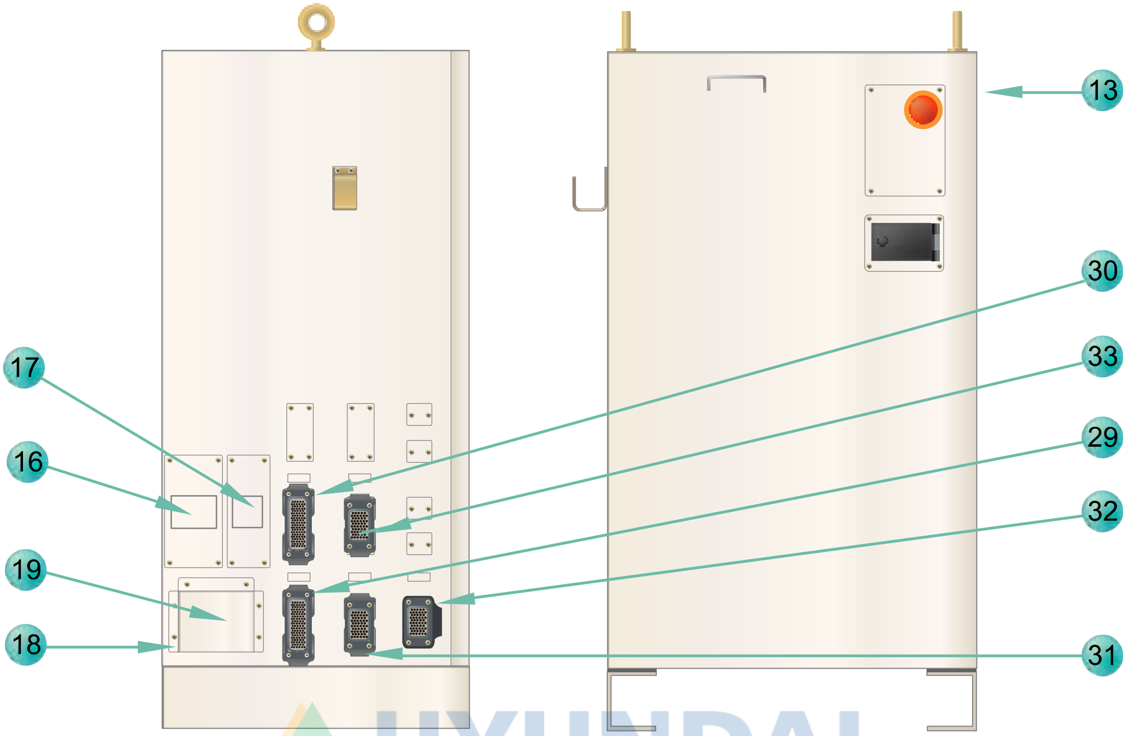


Figure 4.8 Hi5-C10 Part arrangement parts in the exterior of the controller

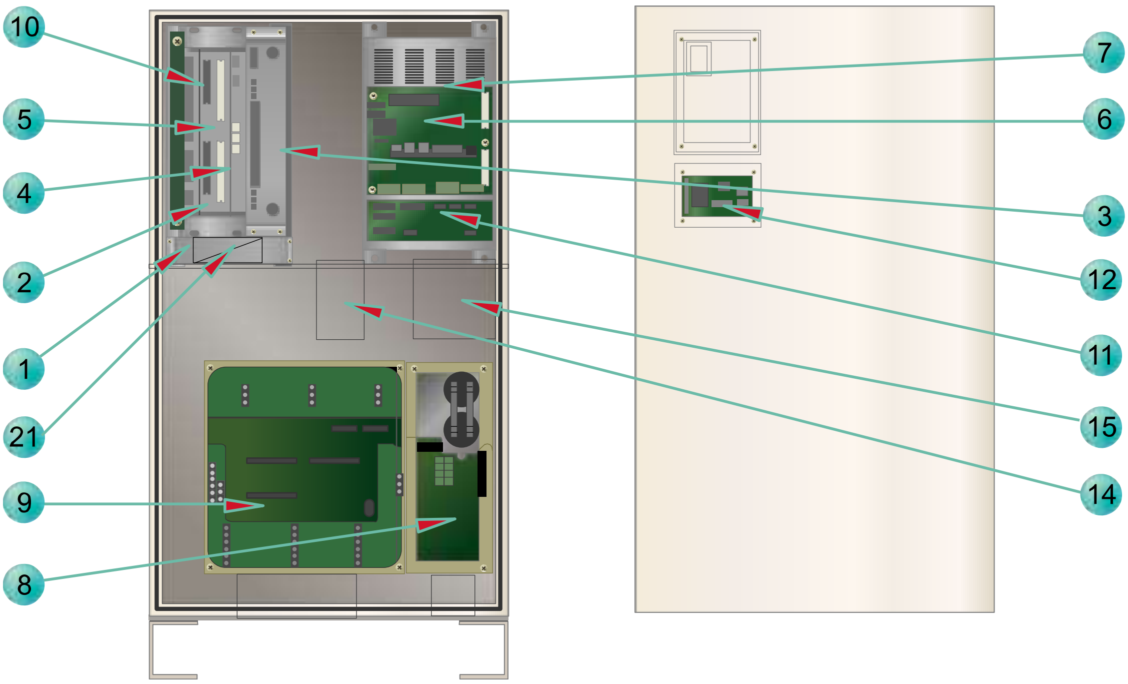


Figure 4.9 Part arrangement in the interior of the front surface of the Hi5-C10 controller

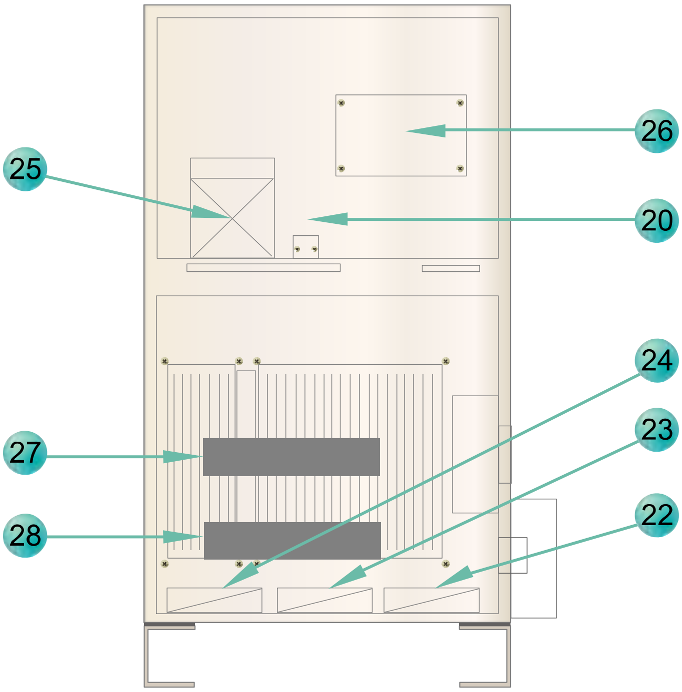


Figure 4.10 Part arrangement in the interior of the rear surface of the Hi5-C10 controller

Table 4-3 shows the main parts of Hi5-C20 controller and the name of each part, and Figure 4.11, 4.12 and 4.13 show the arrangement of them.

Table 4-3 The Name of Each Part of Hi5-C20 Controller

No.	Type	Item
1	RACK	Rack
2	BD501	Backplane Board
3	SR1	DC Multi Power Unit (SMPS: HDI-200)
4	BD510	Main Board
5	BD542	Servo Board
6	BD530/531	System Board
7	PDM30	Electrical Module
8	SD1L2C	Middle-Size Diode Module
9	SA3X3Y	Middle-Size 6-Axis Servo Drive Unit (Standard Specifications)
9-1	SA4X2Z	Servo-drive apparatus for HC2500IK-L0 (optional specifications) Servo-drive apparatus for HC2500IK-R0 (optional specifications)
10	BD580	DIO board
11	BD570	CC-link board
12	BD5B1	Small Door Board
13	EM. SW	Emergency stop switch
14	SR2	DC power apparatus for a sensor
15	SR3	Elevation shaft fall prevention brake and DC power apparatus for a robot fan
16	NFB1	Breaker of driving device wiring (No Fuse Breaker)
17	NFB2	Breaker for control power wiring (No Fuse Breaker)
18	TBMAIN1	Terminal Block for inputting driving device power

No.	Type	Item
19	TBMAIN2	Terminal Block for inputting control power (Terminal Block)
20	TBPW1	Terminal Block for interior power (Terminal Block)
21	FAN1	Rack radiating fan
22~24	FAN2~4	Servo-drive unit radiating fan
25	FAN5	Fan for front surface radiation
26	TR1	Transformer
27	NFT1	Line Noise Filter
28~29	DR1~2	Regeneration discharge resistance
30	CMC1	Power Cable Lead-In Connector for Motor Drive 1
31	CMC2	Power Cable Lead-In Connector for Motor Drive 2
32	CEC1	Motor Encoder Communications Cable Lead-In Connector
33	CNRTP	Teach pendant Cable Lead-In Connector
34	CIOC1	Sensor cable inserted in the connector 1
35	AMC1	Insertion connector 1 for the power cable to drive a motor in an additional axis
36	AEC1	Insertion connector 1 for the communication cable of a motor encoder in an additional axis

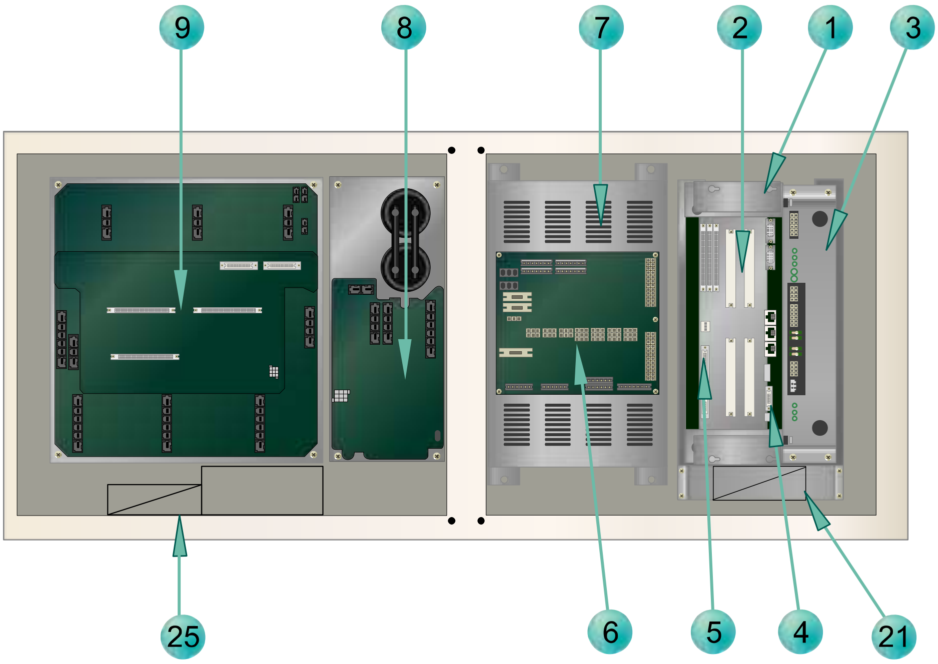


Figure 4.11 Part arrangement in the interior of the left side of the Hi5-C20 controller

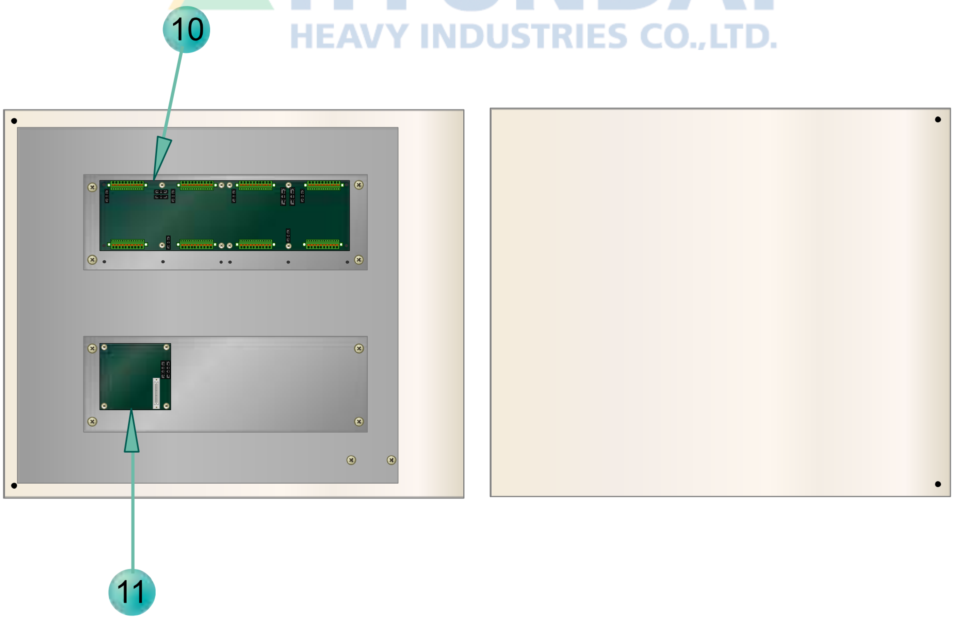


Figure 4.12 Part arrangement in the left side door of the Hi5-C20 controller

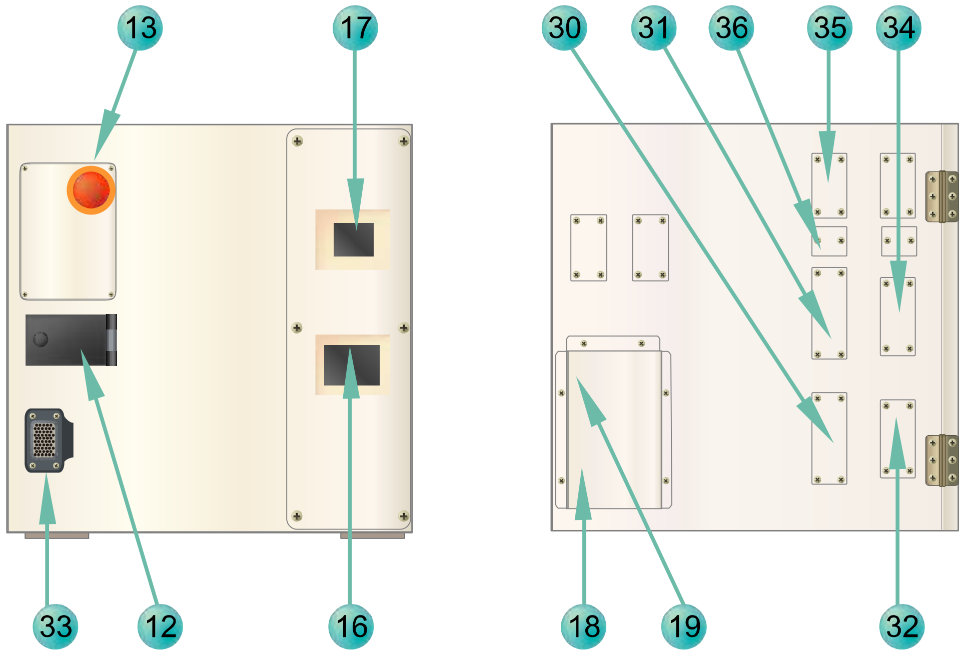


Figure 4.13 Part arrangement in the front and rear surfaces of the Hi5-C20 controller

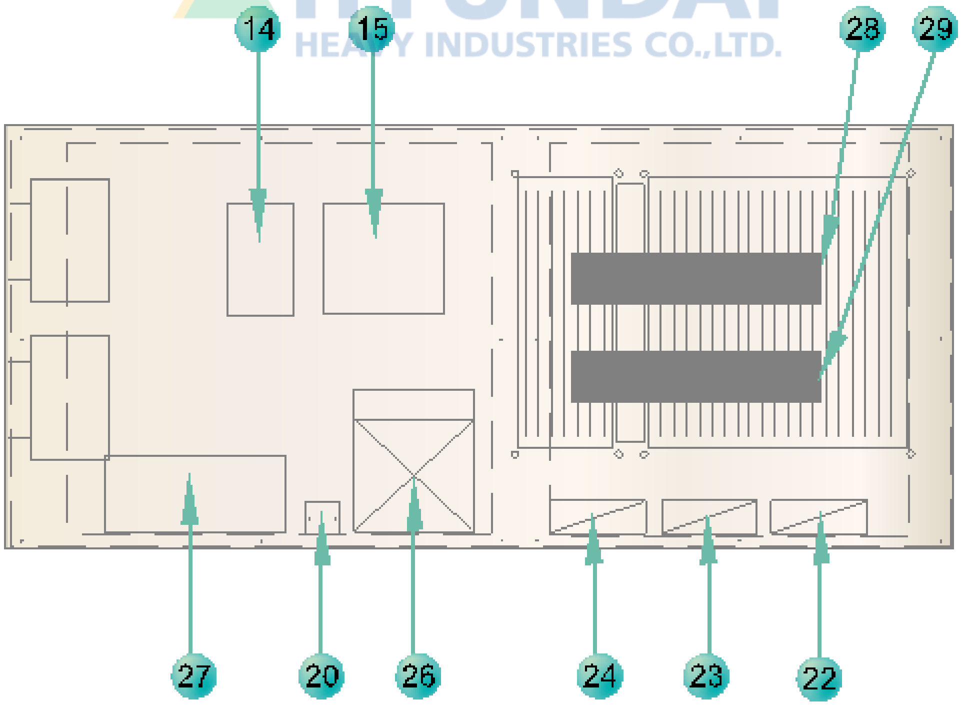


Figure 4.14 Part arrangement in the interior of the right side of the Hi5-C20 controller

4.3. The Function of Each Component

Table 4-4 The Summary on the Function of Each Component

Component		Function
Board	Backplane Board (BD501)	● Bus for inter-board signal connection (4 Slots)
	Main Board (BD510)	● Save point saving and operational route calculation ● Program and robot constant preservation ● Teach pendant Communications ● PC, PC Card, and Serial Communications Connection
	Servo Board(BD542)	● CPU for Servo Control ● Encoder Connection (Serial I/F)
	System Board(BD530/531)	● In/Out within controller (I/O for system) ● Internal sequence control ● Processing of various input signals from the main unit ● Open/close output of servo motor and brake ● Safety chain circuit
Drive Unit	· Middle-Size 6 Axis ; SA3X3Y · Small-Size 6 Axis ; SA3A3D	● Power generation for motor drive ● Regenerative power discharge ● Servo motor power amplifier circuit ● Various error reporting
DC Power Supply Unit (SMPS)	HDI-200 - Input power supply ; AC45~50V - Input frequency ; 50/60Hz	● Board power supply (DC+5V/8.29A) ● T/P(DC+24V/1A), ● I/O power supply (DC+24V/1.87A) ● Drive unit (DC+15V/3.5A, DC-15V/0.8A) ● encoder power supply (DC+5V/4A)
T/P (Teach Pendant)	TP510	● Various information display (LCD) ● Button switch input (Function/Jog) ● Emergency stop. Input of Enable and T/P On/Off
Cooling Device	Fan	● Internal air circulation ● Drive unit cooling

4.3.1. Rack and Backplane Board (BD501)

4.3.1.1. Outline

The rack has a structure as seen in Figure 4.15, which fixes various PCB boards such as SMPS, main board, and servo board. As many data and power supplies need to be connected one another in theses boards, the backplane board (BD501) as seen in Figure 4.16 should be installed at the back of the PCB rack.

Figure 4.15 PCB Rack

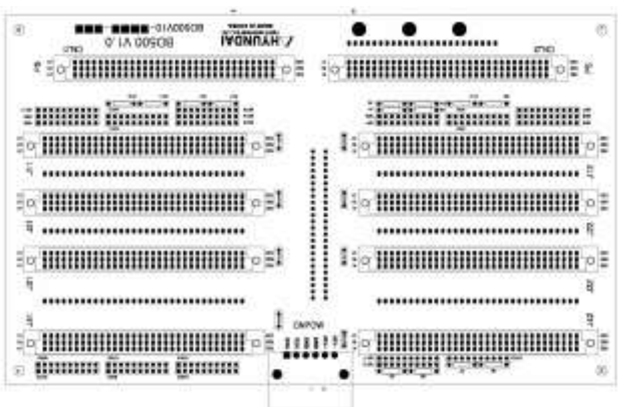


Figure 4.16 Backplane Board (BD501)

4.3.2. Main board(BD510)

4.3.2.1. Outline

The main board carries out operations and controls for the movement of a robot and has various communications interface functions. Various Man-Machine Interface (MMI) environments can be established through the connection with surrounding devices via various communication ports such as Serial, Ethernet, and CAN. Information files regarding, for example, controller constant, error history, operation history, and teaching program are controlled through teach pendant.

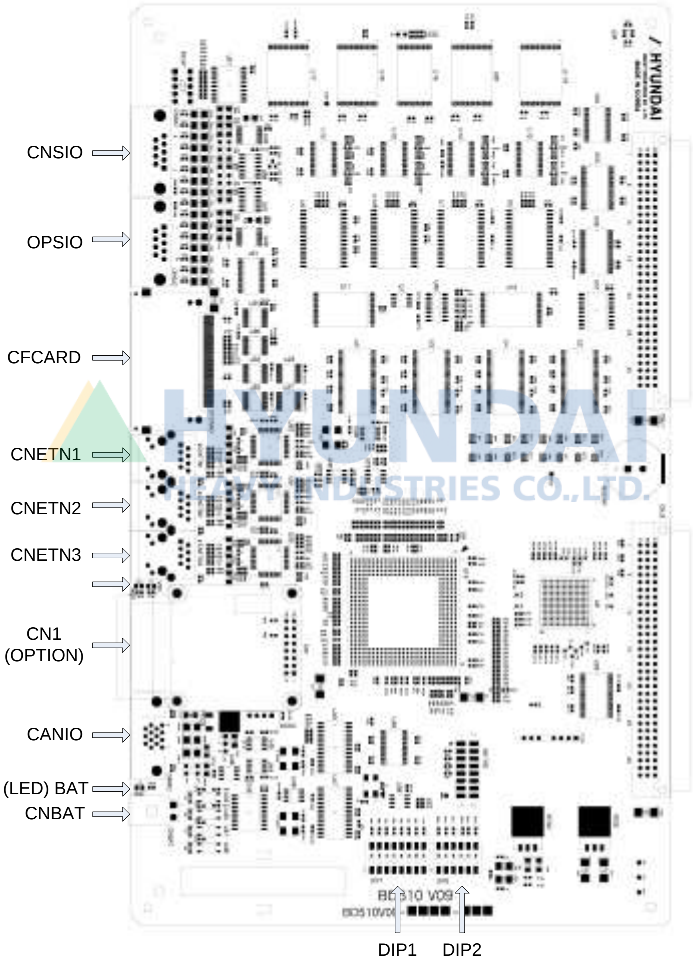


Figure 4.17 Main board (BD510)

4.3.2.2. Connector

Table 4-5 shows the use of connectors and external connecting devices.

Table 4-5 The Sorts and Uses of Main board (BD510)

Name	Use	External Connecting Device
CNSIO	Serial Port 1: (RS232/RS422/RS485)	The small door of the front panel of the controller
OPSIO	Serial Port 2: (RS232/RS422/RS485)	-
CFCARD	For system	-
CNETN1	Ethernet port: for cooperative control	-
CNETN2	Ethernet port: for communications between T/P	TP510 Connector (CNTP)
CNETN3	Ethernet port: for users (PC 1/F)	The small door of the front of the controller
CN1	CAN port: CAN3 (Option)	-
CANIO	CAN port: for stem (CAN1)/ for user (CAN2)	System board connector (CAN1)
BATCN	Battery connector for back up	Battery connector

4.3.2.3. Display Devices

Table 4-6 Main board (BD510) LED

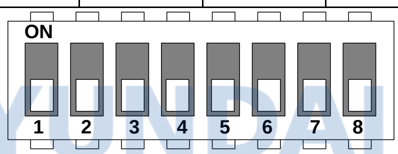
Status / Name	Color	Normal	Abnormal	Solution
V33	Green	On	Off	Check out REG1 of the board - DC 3.3V
WD1	Red	Off	On	Make a request for board repair
BAT	Yellow	On	Off	Replace the batteries for back up

4.3.2.4. Setting Unit

(1) DIP Switch Settings

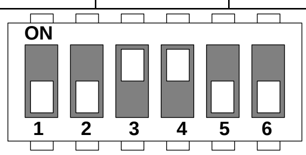
CAUTION: Users may not change the setting of DIP switch [DIP 1].

Table 4-7 The Method for Setting of the [DIP 1] Switch of the Main board (BD 510)

Switch No.		1	2	3	4	5	6	7	8
Content	**OFF**								
	ON								
Initial Setting		OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
The External Form of the Switch									

CAUTION: Users may not change the setting of DIP switch [DIP 2].

Table 4-8 The Method for Setting of the [DIP 2] Switch of the Main board (BD510)

Switch No.		1	2	3	4	5	6
Content	**OFF**	Not Changeable (For system)				Reserved	Main board BOOT
	ON						CF CARD BOOT
Initial Setting		OFF	OFF	ON	ON	OFF	OFF
The External Form of the Switch							

(2) Jumper Pin Settings

Caution: Users may not change the setting of the JP 1 set in production.

Table 4-9 The Method for Setting of the Serial Communications Jumper of the Main board (BD 510)

Jumper No.	**JP1**	**JP2**	**JP3**	**JP7**	**JP8**
Content	Not Changeable (For system)	[OPSIO] In using RS422/RS485 Termination		[CNSIO] In using RS422/RS485 Termination	
Initial Setting	SHORT	SHORT	SHORT	SHORT	SHORT

Table 4-10 The Method for Setting of CAN Communications Jumper of the Main board (BD510)

Jumper No.	**JP4**	**JP5**	**JP6**
Content	[CANIO] CAN2 Termination	[CANIO] CAN1 Termination	CAN2 External Power: No. 1-2 SHORT CAN2 Internal Power: No. 2-3 SHORT
Initial Setting	SHORT	SHORT	No. 2-3 SHORT

4.3.3. System Board (BD530/BD531)

4.3.3.1. Outline

The system board consists of the sequence part which open and close the power of the motor according to the status of safety and the system IO part which enables the communications between related IOs and super systems. It receives various safety signals from inside and outside of the robot controller and controls the power required for the drive of the robot.

- Input of various safety signals: Emergency stop, limit switch, and safeguard
- Safety duplex chain with interlock
- Signal interface of the servo drive unit: PWMON, UV, OV, and OC
- Brake operation/release:
  8 basic axes (3 main axes, 3 wrist axes, and 2 additional axes); 8 more axes extendable
- Other I/O interface

(a) Front: BD530 Board (In charge of sequence) (b) Back: BD531Board (In charge of system IO)

Figure 4.18 System Board (BD530/BD531)

4.3.3.2. Connector

The following Figure shows the location and use of various connectors on BD530 board.

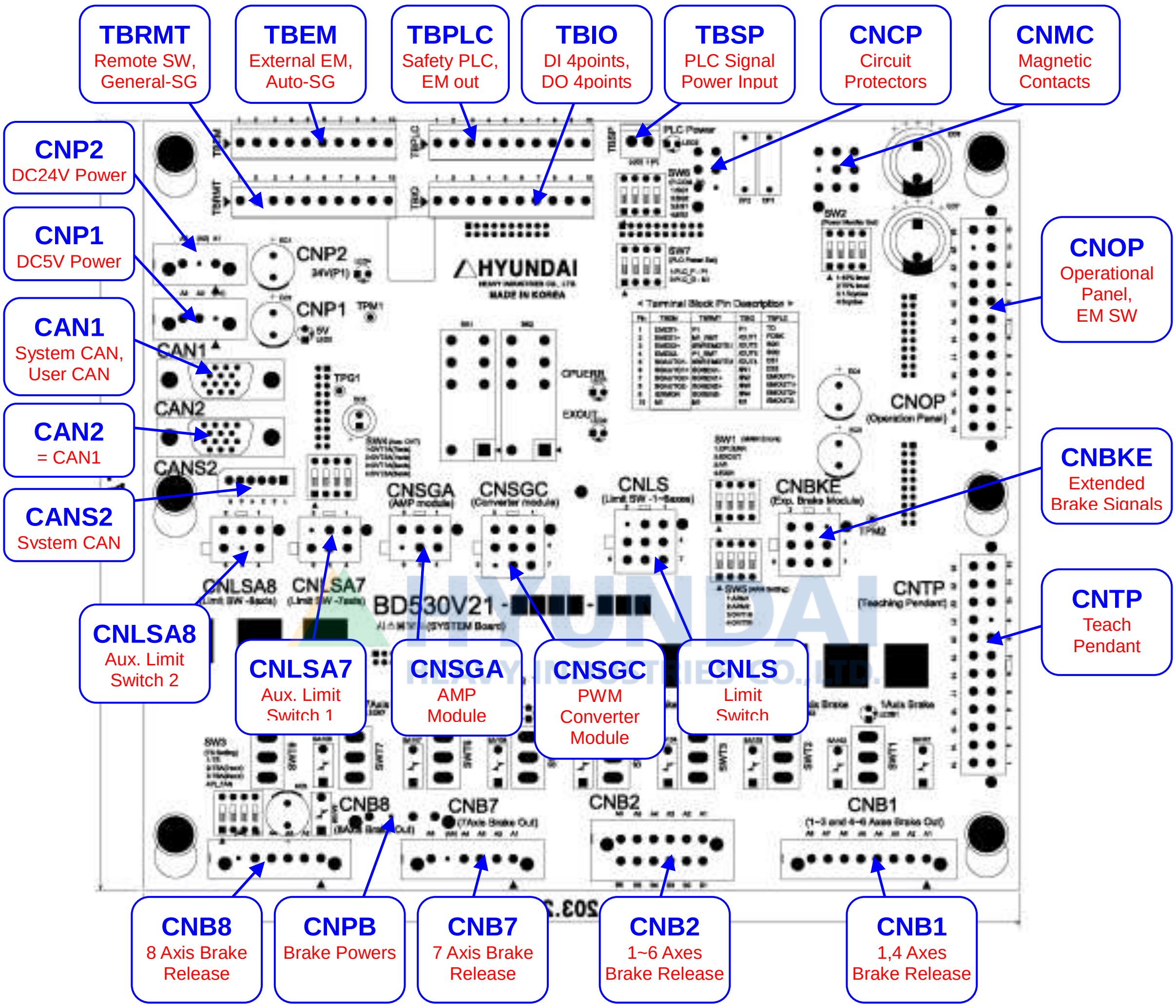


Figure 4.19 The Arrangement of the Connectors of the System Board (BD530)

Table 4-11 The Sorts and Uses of the Connectors of the System Board (BD530)

Name	Use	External Connecting Devices
CNP1	DC5V Power Supply	SMPS P5(DC5V), M5(DC5V GND)
CNP2	D24V Power Supply	SMPS P1(DC24V), M1(DC24V GND)
CAN1	CAN Communications Connection	Main CAN Output Port
CAN2	CAN Communications Connection	Small Door Board CAN Port
CANS2	CAN Communications Connection for System	Preparatory Purpose
CNOP	IN/OUT of Various Switches and LEDs of Control Panel	OP Board
CNTP	Input of Emergency Stop of T/P and Enabling Device Status	W/H CNTP
CNGD	GENERAL Safeguard Input	Safeguard Device of the Exterior of the Controller
CNLS	Arm interference, Input of the Limit Switch for Detection of Over-Travel	W/H CNE1
CNLSA7	Input limit switch for Over-travel detection of added axis 7	Additional Axes (7 Axis) W/H
CNLSA8	Input limit switch for Over-travel detection of added axis 8	Additional Axes (8 Axis) W/H
CNSGC	/PWMON Signal Output and Various Error Signals Input (OV and OC)	PWM Converter CNSGC
CNSGA	/PWMON Signal Output	AMP CNSGA
CNBKE	Safety signal I/F when brake output is extended	Brake extension board
CNMC	Connection of In/Out Signals Relating to Magnetic Contact (MC1 and 2)	CNMC of Electrical Board of Electrical Module
CNPC	Connection of Various Circuit Protectors and Fuses	CNMC of Electrical Board of Electrical Module
CNPB	Brake Power Supply (PB,MB,PREPB)	SMPS Brake SMPS of Electrical Module
CNB1	Output 2 points of brake release power (for 1-3 axes and 4-6 axes), error (TS) input	W/H CNM1
CNB2	Separately output 6 points of brake release power (1, 2, 3, 4, 5, and 6 axes), error (TS) input	W/H CNM1
CNB7	Output of Additional Axis Brake Release and Error Input	Additional Axis (7 axis) W/H

Name	Use	External Connecting Devices
CNB8	Output of Additional Brake Release and Error Input	Additional Axis (8 axis) W/H
TBEM	Input of Emergency Stop and AUTO Safeguard	Emergency Stop Switch of the Exterior of the Controller and Safeguard Device
TBIO	In/Out of Preparatory System DIO	Preparatory IO Device in the Controller
TBPLC	Connection of safety signal for safety PLC	Safety PLC
TBRMT	Remote mode signal input and general safety guard input	Remote mode operating device and general safety guard
TBSP	Signal processing power input for PLC connection (DC24V)	Power device in the side of PLC

* CNBKE : Deleted from V2.2

(1) Terminal Block for Exterior Safety Signals: TBEM

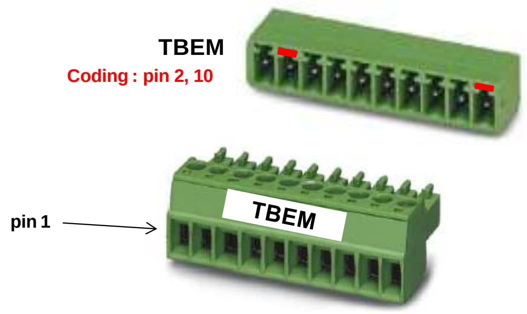


Figure 4.20 The Terminal Block of the System Board (BD530)

Table 4-12 The Terminal Block TBEM of the System Board (BD530)

Terminal No.	Terminal Name	Use	Others
1	EXEM1-	Input of External Emergency Stop Chain 1	SHORT unless external emergency stop chain 1 is used
2	EXEM1+		
3	EXEM2+	Input of External emergency Stop Chain 2	SHORT unless external emergency stop chain 2 is used
4	EXEM2-		
5	SGAUTO1-	Input of Auto Safeguard Chain 1	SHORT unless auto safeguard chain 1 is used
6	SGAUTO1+		
7	SGAUTO2+	Input of Auto Safeguard Chain 2	SHORT unless auto safeguard chain 2 is used
8	SGAUTO2-		
9	EXMON	External Motor ON Input	Input of ON/OFF with M1 being Common if the robot's motor ON is used at the external system
10	M1	External Motor ON Input (Common)	

(2) Digital input/output terminal block exclusively used for the system : TBIO

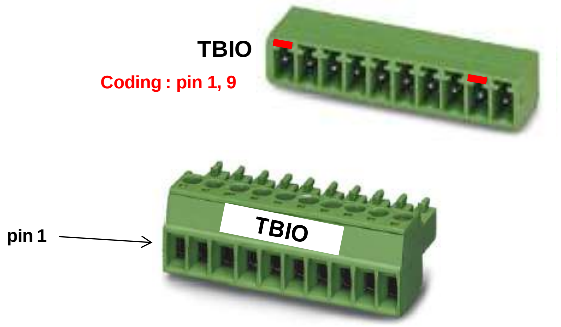


Figure 4.21 System board (BD530) terminal block TBIO

Table 4-13 Terminal Block TBIO of the System Board (BD530)

Terminal No.	Terminal Name	Use
1	P1	Digital output for the system (+) Common (DC24V)
2	DO1	Digital output signal 1 for the system (Open collector output)
3	DO2	Digital output signal 2for the system (Open collector output)
4	DO3	Digital output signal 3for the system (Open collector output)
5	DO4	Digital output signal 4for the system (Open collector output)
6	DI1	Digital input signal 1 for the system
7	DI2	Digital input signal 2for the system
8	DI3	Digital input signal 3for the system
9	DI4	Digital input signal 4for the system
10	M1	Digital input for the system (-) Common (DC24V GND)

(3) Terminal block for remote mode and general safety guard: TBRMT

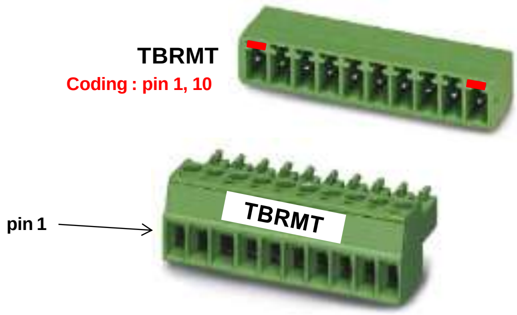


Figure 4.22 System board (BD530) terminal block TBRMT

Table 4-14 System board (BD530) terminal block TBRMT description

Node No.	Node Name	Use	
1	P1	Outputting power for the system (DC24V)	
2	M1_RMT	Outputting a remote state of controller 1 (output M1 in the case of a remote state)	
3	SWREMOTE1	Inputting a remote enable signal 1 (input M1 in the case of a remote state)	
4	P1_RMT	Outputting a remote state of controller 2 (output P1 in the case of a remote state)	
5	SWREMOT2	Inputting a remote enable signal 2 (input P1 in the case of a remote state)	
6	SGGEN1-	Inputting general safety guard chain 1	Providing shorting when general safety guard chain 1 is not used
7	SGGEN1+		
8	SGGEN2+	Inputting general safety guard chain 2	Providing shorting when general safety guard chain 2 is not used
9	SGGEN2-		
10	M1	Outputting system power (DC24V GND)	

(4) Terminal block for safety IO connection: TBPLC

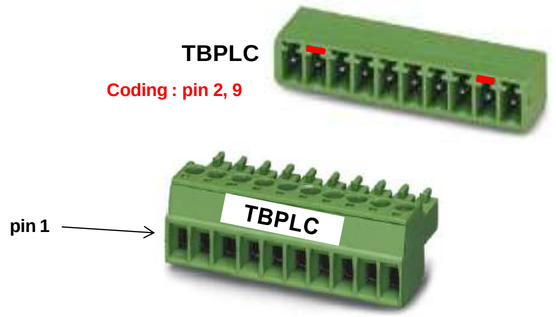


Figure 4.23 System board (BD530) terminal block TBPLC

Table 4-15 System board (BD530) terminal block TBPLC description

Node No.	Node Name	Use
1	T0	Input node for monitoring the output of safety IO
2	FDBK	Feedback signal output safety IO for TO
3	SG1	Safety guard input chain 1 from safety IO
4	SG2	Safety guard input chain 2 from safety IO
5	ES1	Emergency stop input chain 1 from safety IO
6	ES2	Emergency stop input chain 2 from safety IO
7	EMOUT1-	Internal emergency stop output chain 1
8	EMOUT1+	
9	EMOUT2+	Internal emergency stop output chain 1
10	EMOUT2-	

* Node Nos. 1-6 can be applied only to safety IO having an NPN output.

(5) Spare system CAN communication connector: CANS2

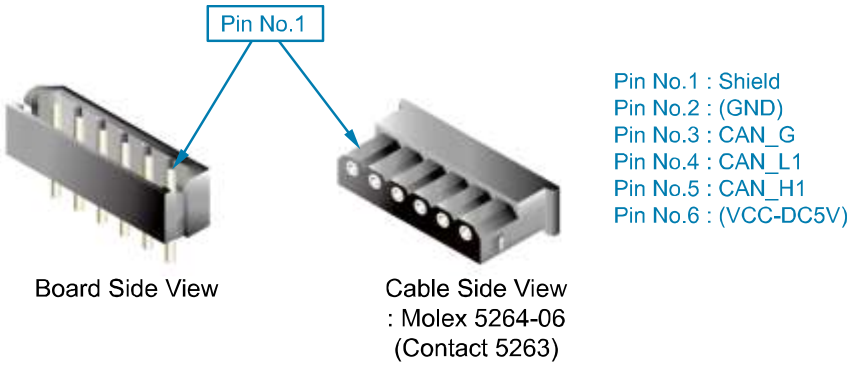


Figure 4.24 Pin arrangement in system CAN connector

4.3.3.3. Display Unit

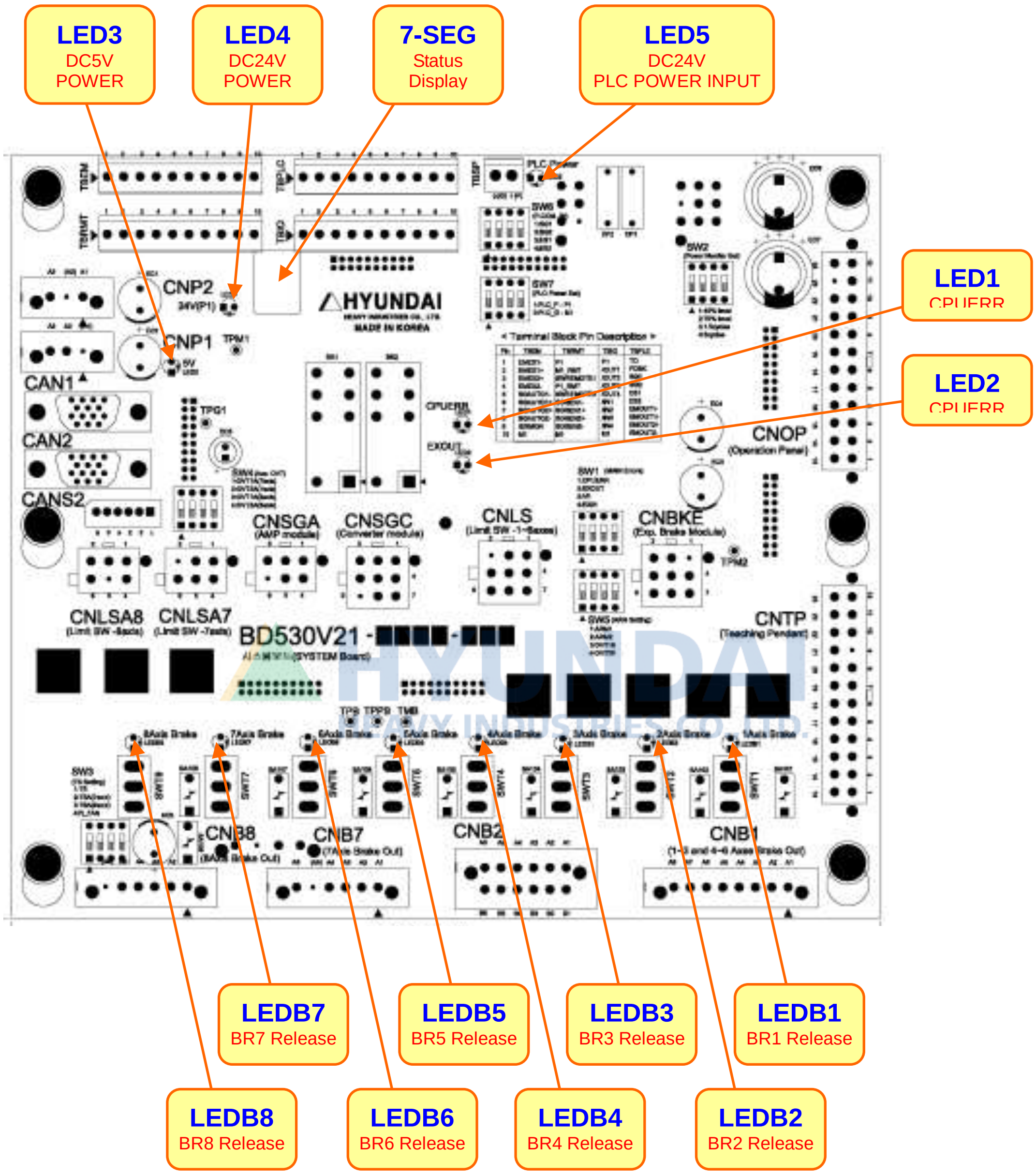


Figure 4.25 The Display Unit of the System Board (BD530)

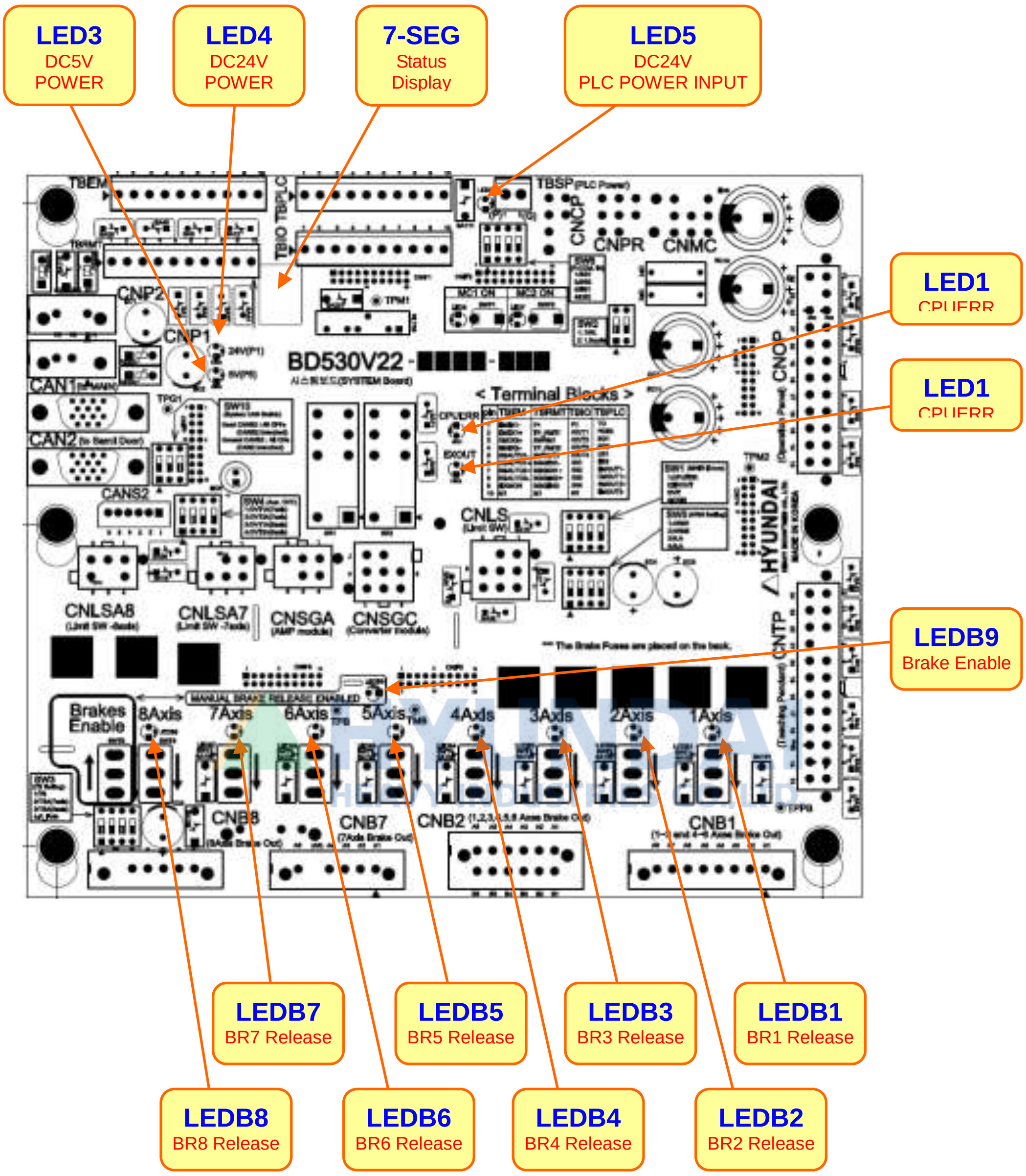


Figure 4.26 The Display Unit of the System Board (BD530V22)

Table 4-16 Description of the displaying device for the system board (BD530)

Name	Content	Color	In Normal Status	Solution
LED1	CPUERR	Green	On	1. Checking for errors in the MAIN board 2. Checking for the interruption of electric power 3. Checking the CNIO cable
LED2	EXOUT	Green	On	1. Checking for errors in the MAIN board 2. Checking the CNIO cable
LED3	5V POWER	Green	On	1. Checking 5V power within a board 2. Checking SMPS 5V power 3. Checking the power cable CNP1
LED4	24V POWER	Green	On	1. Checking 24V power within a board 2. Checking SMPS 24V power 3. Checking the power cable CNP2
LED5	PLC POWER (DC24V)	Green	On	1. Checking the input of PLC power 2.Checking SW7 when PLC power is not connected (internal power use setting)
LEDB 1~8	1-8 Axes Brake Release	Green	Hold: OFF Release: ON	1. Checking "lowering brake voltage" monitoring (input signal for Teach pendant) 2. Checking the brake power (TPPB-TMB; 24V) 3. Checking the power in brake release
7-SEG	Status Information	Red Code	Display of status information	Repair work according to status information.
LED9	BRAKE ENABLE	Green	OFF	1. Brake manual release switch check 2. Brake enable switch check

4.3.3.4. Setting and checking apparatus

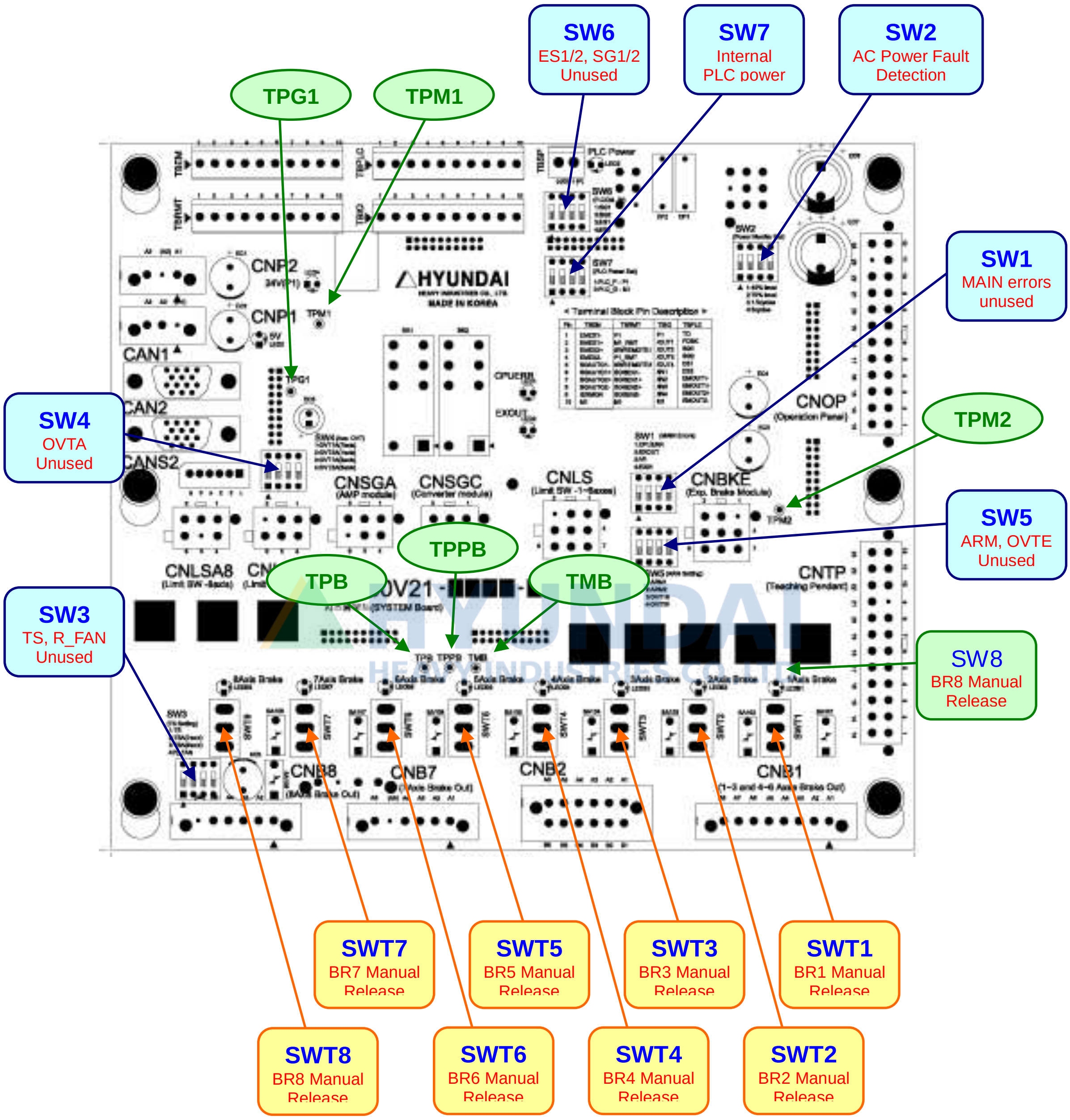


Figure 4.27 The Setting Unit of the System Board (BD530)

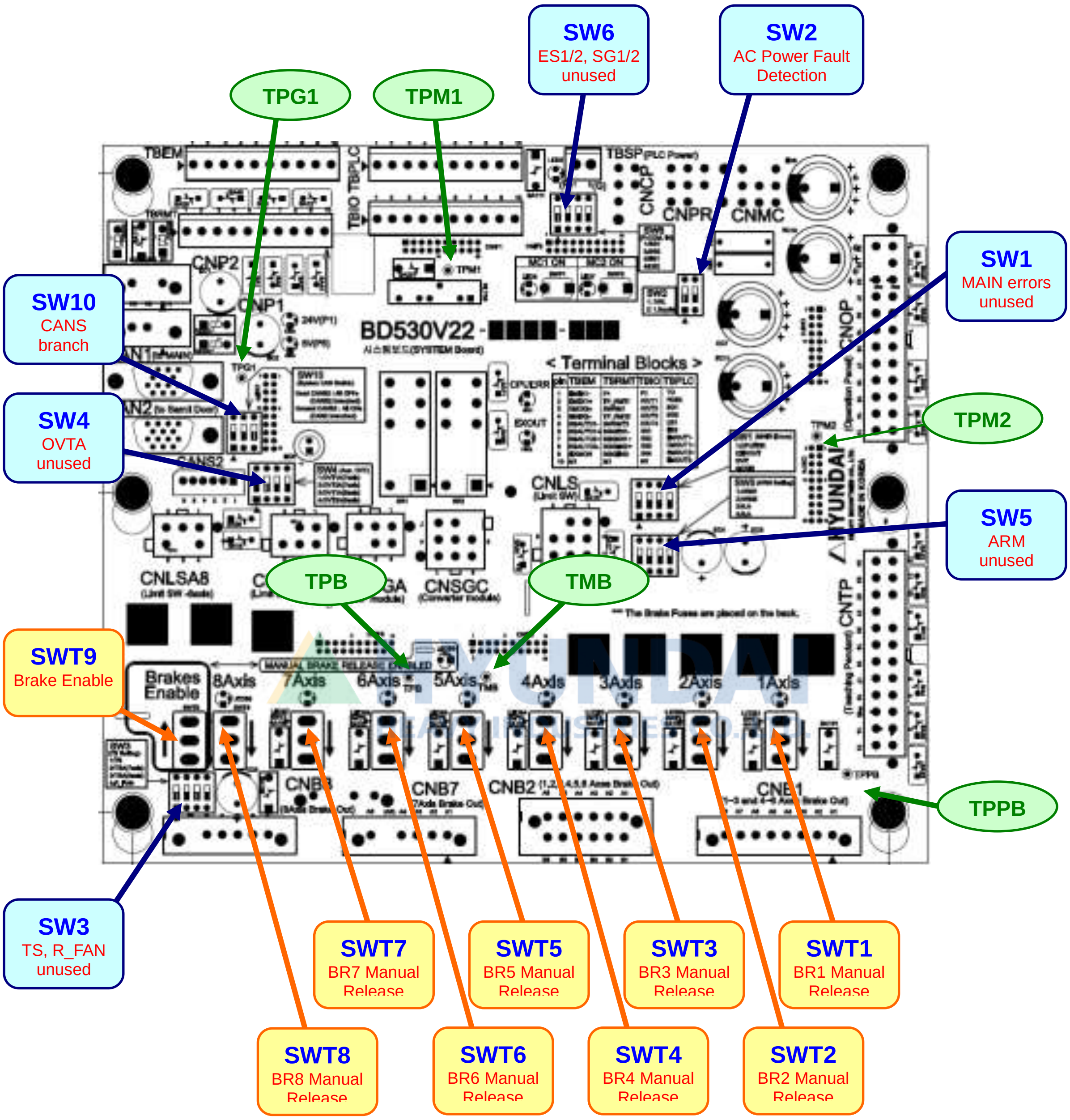


Figure 4.28 The Setting Unit of the System Board (BD530V22)

Table 4-17 System board (BD530) DIP switch SW1 (error monitoring) setting method

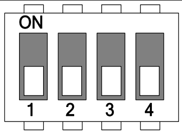
Switch No.		**1**	**2**	**3**	**4**
Use		CPUERR signal (MAIN → SYSTEM)	EXOUT signal (MAIN → SYSTEM)	Interruption detection (VE) (SYSTEM → MAIN)	EXIN signal (SYSTEM → MAIN)
Setting Content	**OFF**	Use	Use	Use	Use
	ON	Non-use	Non-use	Non-use	Non-use
Setting taking out time		**OFF**	**OFF**	**OFF**	**OFF**
Switch Appearance		 			

Table 4-18 System board (BD530) DIP switch SW2 (AC power monitoring) setting method

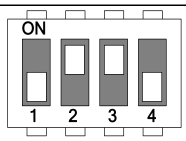
Switch No.		**1**	**2**	**3**	**4**
Use		AC power interruption detection level selection		AC power interruption detection cycle selection (based on 60Hz)	
Setting Content	**OFF**	-	-	-	-
	ON	Detection level: 45%	Detection level: 70%	1.5 cycles	3 cycles
Setting taking out time		**OFF**	**ON**	**ON**	**OFF**
Switch Appearance		 			

Table 4-19 System board (BD530V22) DIP switch SW2 (AC power monitoring) setting method

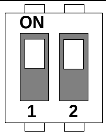
Switch No.		1	2
Use		AC power interruption detection level selection	AC power interruption detection cycle selection (based on 60Hz)
Setting Content	OFF	Detection level: 50%	3 cycles
	ON	Detection level: 70%	1.5 cycles
Setting taking out time		ON	ON
Switch Appearance			

Table 4-20 System board (BD530) DIP switch SW3 (Motor temperature sensor monitoring) setting method

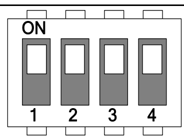
Switch No.		1	2	3	4
Use		TS detection (base axis)	TSA detection (7 axis)	TSA detection (8 axis)	R_FAN detection (FANs embedded in a robot)
Setting Content	OFF	Use	Use	Use	Use
	ON	Non-use	Non-use	Non-use	Non-use
Setting taking out time		ON	ON	ON	ON
Switch Appearance					

Table 4-21 System board (BD530) DIP switch SW4 (Additional axis OVT limit switch) setting method

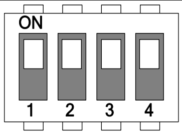
Switch No.		1	2	3	4
Use		Limit switch (chain 1) detection (7 axis)	Limit switch (chain 2) detection (7 axis)	Limit switch (chain 1) detection (8 axis)	Limit switch (chain 1) detection (8 axis)
Setting Content	OFF	Use	Use	Use	Use
	ON	Non-use	Non-use	Non-use	Non-use
Setting taking out time		ON	ON	ON	ON
Switch Appearance		 			

Table 4-22 System board (BD530) DIP switch SW5 (Arm interference, extending axis limit switch) setting method

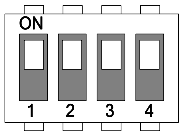
Switch No.		1	2	3	4
Use		Limit switch (chain 1) detection (Arm interference)	Limit switch (chain 2) detection (Arm interference)	Limit switch (chain 1) detection (Extending axis)	Limit switch (chain 2) detection (Extending axis)
Setting Content	OFF	Use	Use	Use	Use
	ON	Non-use	Non-use	Non-use	Non-use
Setting taking out time		ON	ON	ON	ON
Switch Appearance		 			

Table 4-23 System board (BD530V22) DIP switch SW5 (Arm interference) setting method

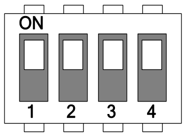
Switch No.		**1**	**2**	**3**	**4**
Use		Limit switch (chain 1) detection (Arm interference)	Limit switch (chain 2) detection (Arm interference)	-	-
Setting Content	**OFF**	Use	Use	-	-
	ON	Non-use	Non-use	-	-
Setting taking out time		**ON**	**ON**	**ON**	**ON**
Switch Appearance		 			

Table 4-24 System board (BD530) DIP switch SW6 (Safety IO safety signal monitoring) setting method

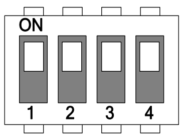
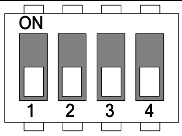
Switch No.		**1**	**2**	**3**	**4**
Use		Safety guard SG1 (chain 1) detection	Safety guard SG2 (chain 2) detection	Emergency stop ES1 (chain 1) detection	Emergency stop ES2 (chain 2) detection
Setting Content	**OFF**	Use	Use	Use	Use
	ON	Non-use	Non-use	Non-use	Non-use
Setting taking out time		**ON**	**ON**	**ON**	**ON**
Switch Appearance		 			

Table 4-25 System board (BD530) DIP switch SW7 (Power for Safety IO signal) setting method

Switch No.		**1**	**2**	**3**	**4**
Use		Selecting power for Safety IO signal		-	-
Setting Content	**OFF**	Power of Safety IO (DC24V)	Power of Safety IO (DC24V GND)	-	-
	ON	Controller power (P1)	Controller power (M1)	-	-
Setting taking out time		**OFF**	**OFF**	**OFF**	**OFF**
Switch Appearance		 			

* The system board of version BD530V22 does not provide the dip switch SW7

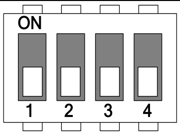
Table 4-26 Description of system board (BD530) toggle switch SWT1-9 operation

Switch NO.	Use
SWT1	Releasing robot basic axis 1 motor brake manually
SWT2	Releasing robot basic axis 2 motor brake manually
SWT3	Releasing robot basic axis 3 motor brake manually
SWT4	Releasing robot basic axis 4 motor brake manually
SWT5	Releasing robot basic axis 5 motor brake manually
SWT6	Releasing robot basic axis 6 motor brake manually
SWT7	Releasing added axis 7 motor brake manually
SWT8	Releasing added axis 8 motor brake manually
SWT9	Motor brake manual release enable switch

SWT1–8 are the motor brake manual release switches that should be used only when an emergency situation occurs during operation.
While the SWT9 is being manipulated, if one of the SWT1–8 for individual axes with which the brake needs to be released is operated, the motor brake of the relevant axis will be released.

When a motor brake is released, there is a risk that the clean robot's elevation axis and the H and V axes of a multi-joint robot could drop. With this, please be careful and take measures.

Table 4-27 System board (BD530V22) DIP switch SW10 (CANS Branch) setting method

Switch No.		1	2	3
Use		System CAN communication line branch setting		
Setting Content	OFF	System CAN line branch through the CANS2 connector		
	ON	CAN2 connector - System CAN line branch through Small Door		
Setting taking out time		ON	ON	ON
Switch Appearance		 		

4.3.3.5. Emergency stop connection

(1) Contact point input external emergency stop

External emergency stop is operated regardless of the mode of the controller, (automatic mode, manual mode). When the emergency stop switch input occurs, promptly remove motor power so as to secure safety. The emergency stop switch must be of a structure capable of contact point outputting. This is because a node is formed in a terminal block so as to connect the contact output of the external emergency stop switch to a duplicated safety chain as shown in the picture below. (※ Reference: Description of the node of terminal block TBEM)

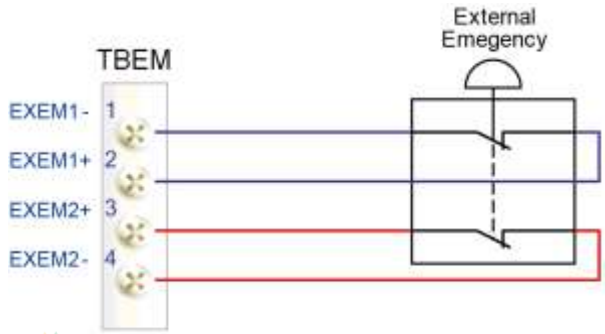


Figure 4.29 Method for connecting the external emergency stop switch to terminal block TBEM

In cases where the external emergency stop is not used, ensure input is ineffective by connecting the nodes of terminal block TBEM in the manner described below.

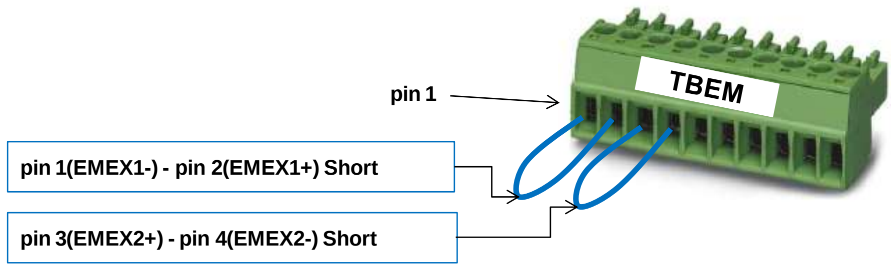


Figure 4.30 Management method when a contact point input type-external emergency stop is not used.

In cases where an external emergency stop switch is installed for use, a user must operate the robot only after checking that emergency stop is operating normally. Additionally, check if emergency stop input has become ineffective. This step is necessary for worker safety.

(2) P-COM input external emergency stop

Basically, an automatic safety guard can receive contact point input from terminal block TBEM. However, a device such as a safety PLC or safety IO transmits safety guard signals to the controller through PNP output. The Figure below shows a connecting method through terminal block TBPLC in which the controller can receive PNP type output. (※ Reference: Description of the node of terminal block TBPLC)

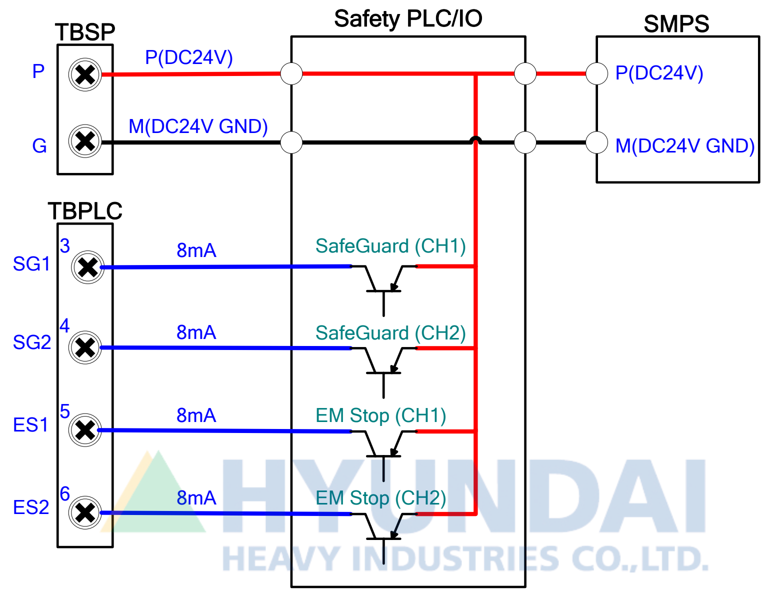


Figure 4.31 Method of connecting the automatic safety guard to an PNP output device

In cases where the P-COM input external emergency stop is not used, ensure the emergency stop input becomes ineffective by turning on switch No. 3 and switch No. 4 of DIP switch SW6, as shown below.
(※ Reference: DIP switch SW6 (safety IO safety signal monitoring) setting method)

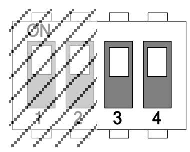


Figure 4.32 Management method in cases where the P-COM input external emergency stop is not used

In cases where an external emergency stop switch is installed for use, a user must operate the robot only after checking that emergency stop is operating normally. Additionally, check if emergency stop input has become ineffective. This step is necessary for worker safety.

(3) Internal emergency stop contact point output

When you want to use the emergency stop switch (operation panel, teach pendant, etc.) installed in the interior of the controller, or as external apparatus, use the emergency stop contact point output within terminal block TBPLC.

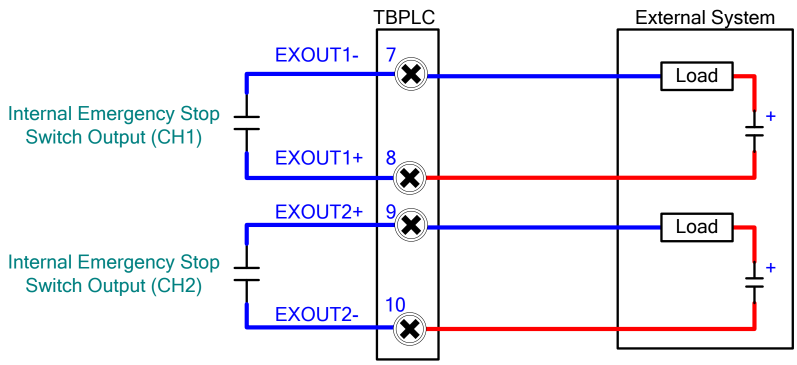


Figure 4.33 Output the internal emergency stop switch of terminal block TBPLC

4.3.3.6. Safety guard connection

(1) Typical safety guard

A typical safety guard operates regardless of the mode of the controller (automatic mode or manual mode). That is, when a person enters the interior of an installed safety guard or when the guard is cut off, the controller promptly removes motor power. The safety guard to use must have a structure capable of contact point outputting. A node is included in terminal block TBRMT so as to connect the contact point output of the safety guard to a safety chain in a duplicated manner, as shown in the Figure below. (※ Reference: Description of the node of terminal block TBRMT)

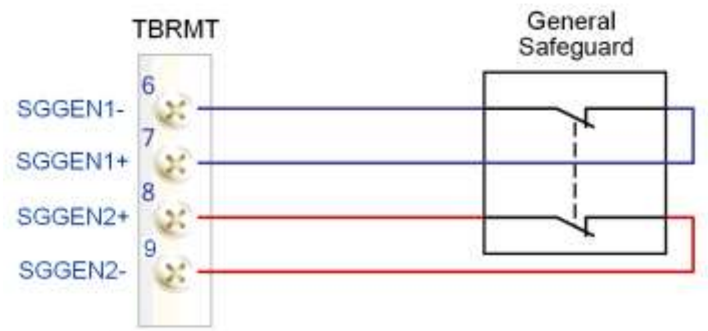


Figure 4.34 Method for connecting a typical safety guard to terminal block TBPLC

In cases where a typical safety guard is not used, ensure input becomes ineffective by connecting the nodes of terminal block TBRMT in the manner described below.

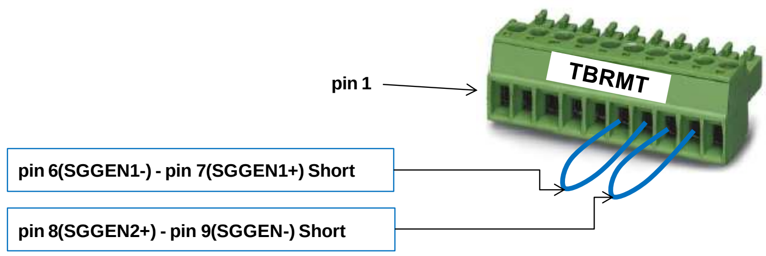


Figure 4.35 Management method in cases where a typical safety guard is not used

In cases where an external emergency stop switch is installed for use, a user must operate the robot only after checking that emergency stop is operating normally. Additionally, check if emergency stop input has become ineffective. This step is necessary for worker safety.

(2) Contact point input automatic safety guard

An automatic safety guard operates only when the controller is in automatic mode. Similarly to a typical safety guard, the automatic safety guard must have a structure capable of contact point outputting. A node is included in terminal block TBEM so as to connect the contact point output of the safety guard to a safety chain in a duplicated manner, as shown in the Figure below. (※ Reference: Description of the node of terminal block TBEM)

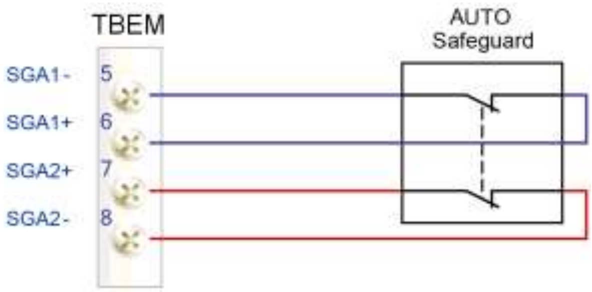


Figure 4.36 Method for connecting the contact point input automatic safety guard to terminal block TBEM

In cases where an automatic safety guard is not used, ensure input becomes ineffective by connecting the nodes of terminal block TBEM in the manner described below.

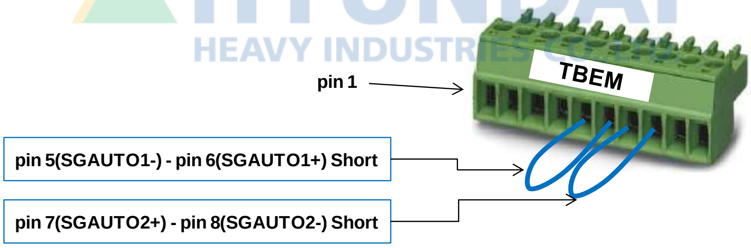


Figure 4.37 Management method in cases where a contact point input automatic safety guard is not used

In cases where an automatic safety guard is installed for use, a user must operate the robot only after checking that the safety guard is operating normally. Additionally, check if the safety guard input has become ineffective. This step is necessary for worker safety.

(3) P-COM input automatic safety guard

Essentially, an automatic safety guard can receive the contact point input from terminal block TBEM. However, a device such as safety PLC and safety IO, transmits safety guard signals to a controller through PNP output. The Figure below shows a connecting method through terminal block TBPLC in which the controller can receive PNP type output. (※ Reference: Description of the node of terminal block TBPLC)

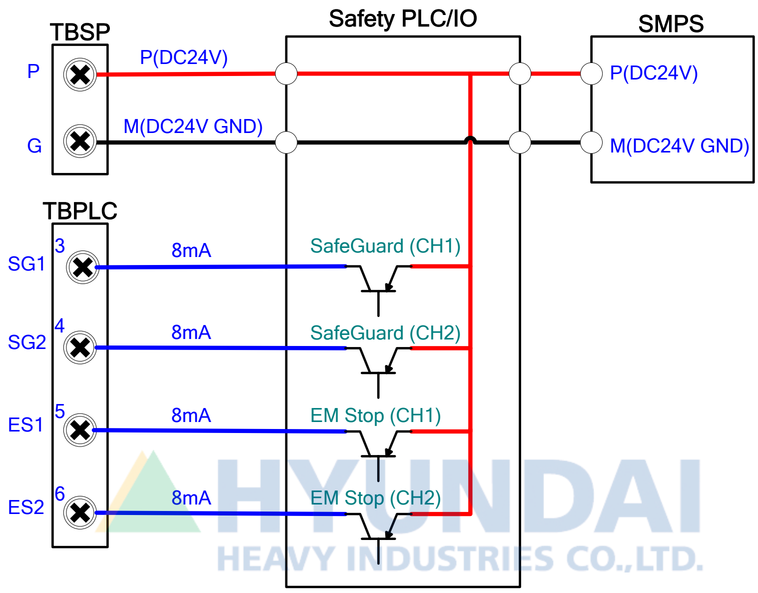


Figure 4.38 Connecting method of an automatic safety guard with respect to an PNP output device

In cases where a P-COM input automatic safety guard is not used, ensure input becomes ineffective by turning on switch No. 1 and switch No. 2 of the DIP switch SW6 as described below.
(※ Reference: DIP switch SW6 (safety IO safety signal monitoring) setting method)

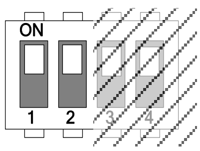


Figure 4.39 Management method in cases where P-COM input automatic safety guard is not used

In cases where an automatic safety guard is installed for use, a user must operate the robot only after checking that the safety guard is operating normally. Additionally, check if the safety guard input has become ineffective. This step is necessary for worker safety.

4.3.3.7. Remote control connection

In order to operate a remote control, the robot operation is possible only when a user has formed the wiring as below.

(1) External motor power ON signal

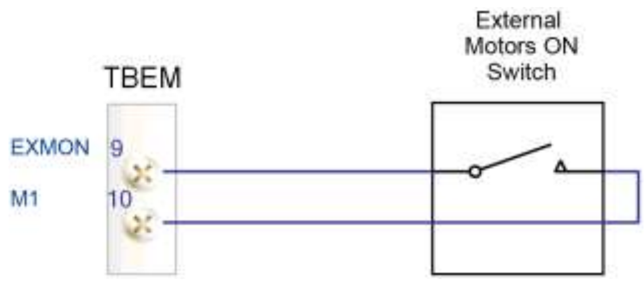


Figure 4.40 Method for inputting the external motor power ON signal into terminal block TBEM

(2) Remote switch input

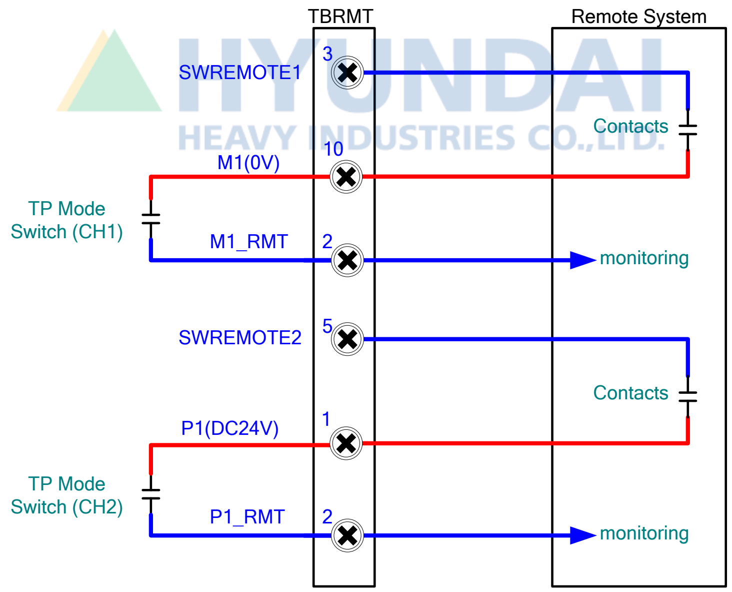


Figure 4.41 for inputting the remote switch signal into terminal block TBRMT

In cases where remote switch input is not used, ensure input becomes ineffective by connecting the nodes of terminal block TBRMT as described below.

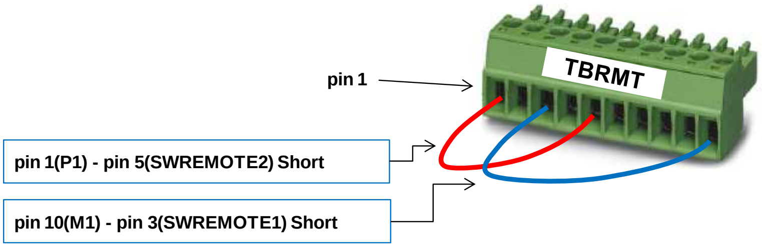


Figure 4.42 Management method in cases where remote switch input is not used

In cases where a remote switch is installed for use, a user must operate the robot only after checking that the remote switch is operating normally. Additionally, check if the remote switch input has become ineffective. This step is necessary for worker safety.

4.3.3.8. Safety PLC/IO connection

Between safety PLC or safety IO and a robot controller, emergency input signals and monitoring output signals are connected with each other as outlined below.

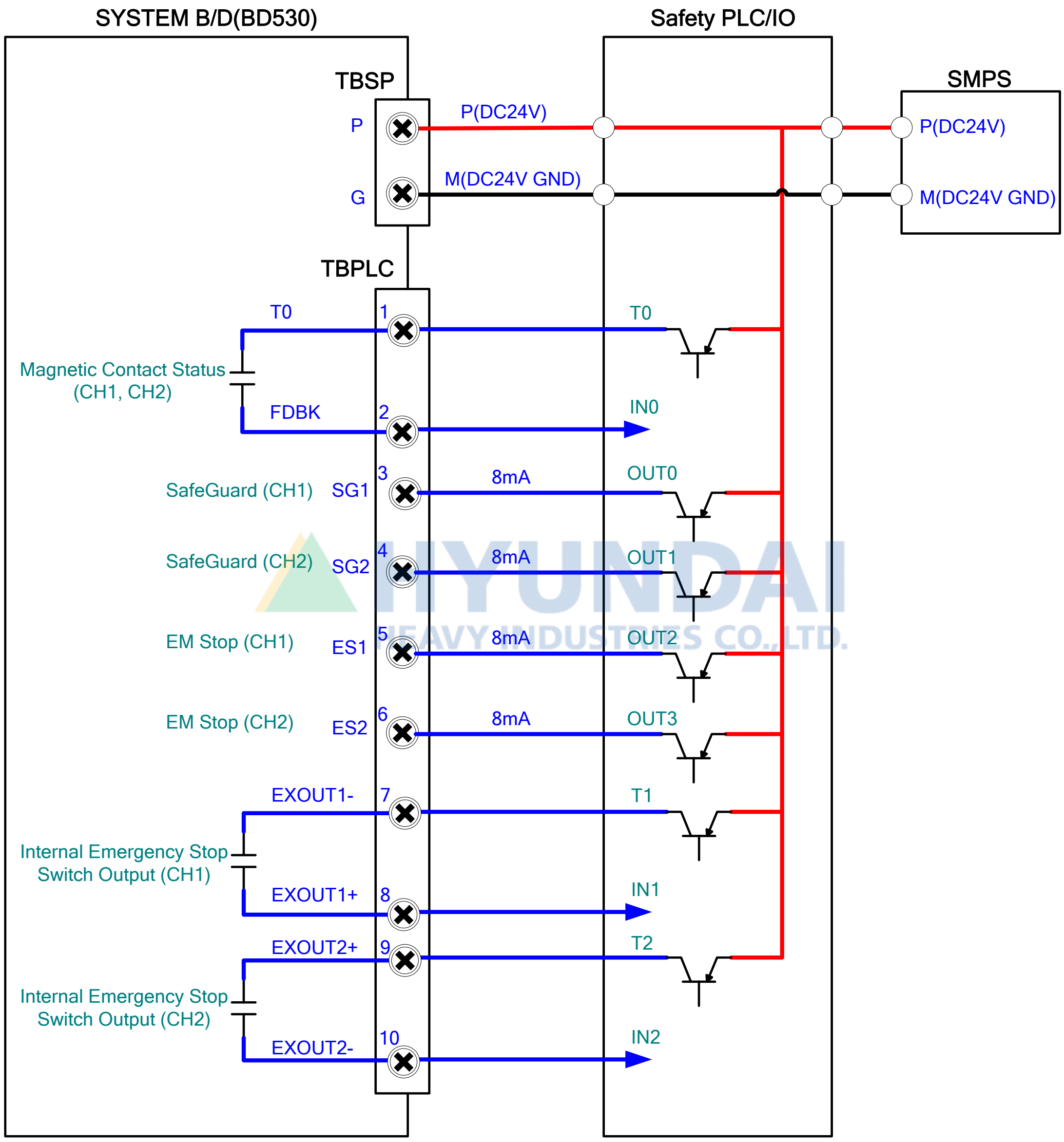


Figure 4.43 Connection method of Safety PLC/IO

In cases where external emergency stop is installed for use, a user must operate the robot only after checking that emergency stop is operating normally. Additionally, check if emergency stop input has become ineffective. This step is necessary for worker safety.

4.3.3.9. Connection of digital input/output signal for a system

(1) Digital output

Figure 4.44 Method for connecting digital output for a system to terminal block TBIO

(2) Digital input

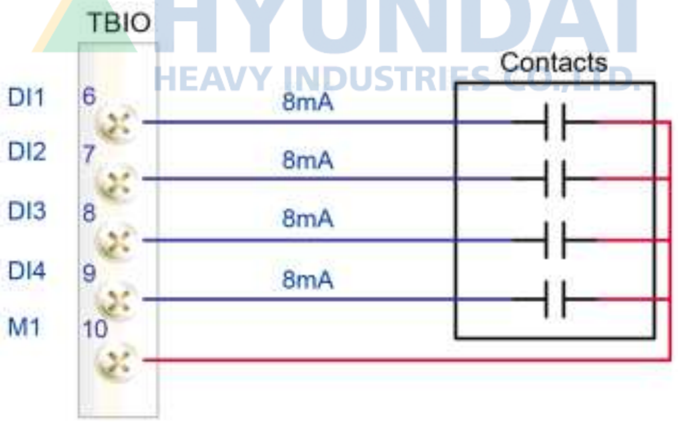


Figure 4.45 Method for connecting digital input for a system to terminal block

4.3.3.10. System CAN communication line wiring method (Version BD530V22 or higher)

There are two wiring methods for the system CAN communication line of the system board

(1) Main board - System board - Small door - Option board 1 - Option board 2

- Turn on all the elements of the dip switch SW10 of the system board
- Do not connect the CAN communication line to the CANS2 connector of the system board
- Use the system CAN connector of Small Door for the system CAN communication

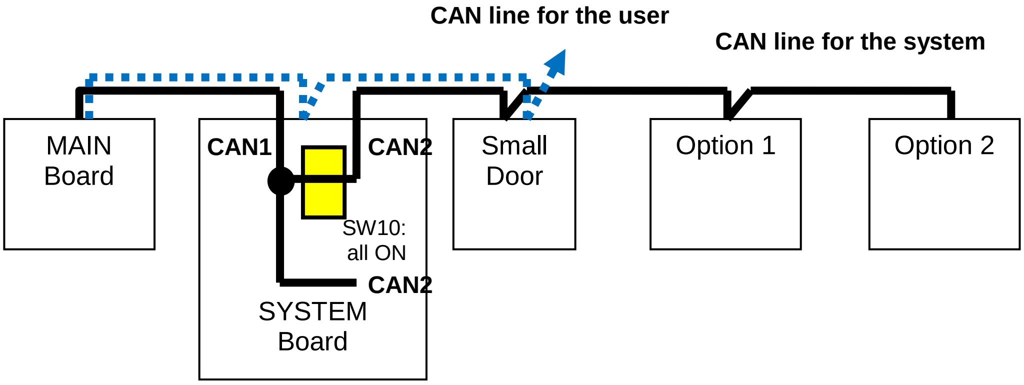


Figure 4.46 Wiring of the system CAN communication line that comes via Small Door of BD530V22

(2) Main board - System board - Option board - Option board 2

- Turn off all the elements of the dip switch SW10 of the system board.
- Wiring of the system CAN communication line by using the CANS2 connector of the system board.
- Do not use the system CAN connector of Small Door.

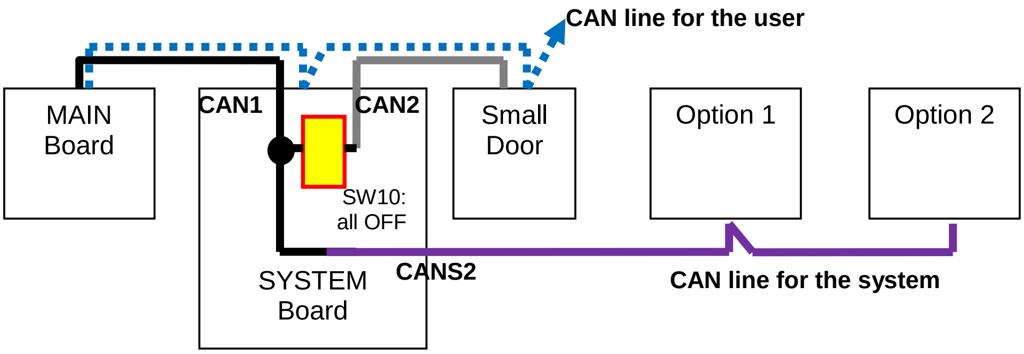


Figure 4.47 Wiring of the system CAN communication line that does not come via Small Door of BD530V22

4.3.4. Servo Board (BD542)

4.3.4.1. Outline

The servo board controls the actions of the motors for 6 axes (max. 8 axes) according to the position command form the main board, and creates PWM signals of encored signal processing, error status checking and the drive unit.

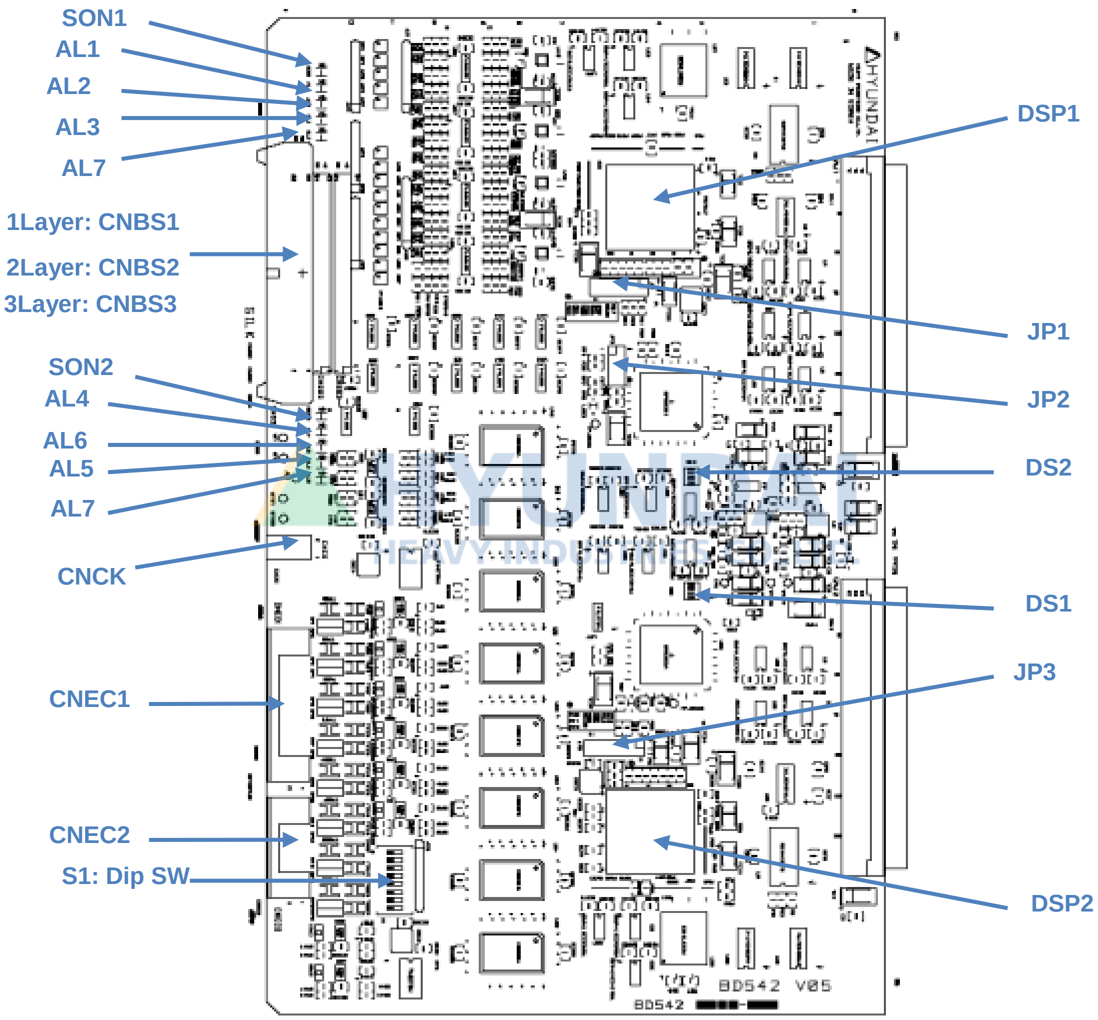


Figure 4.48 Servo Board (BD542)

4.3.4.2. Connector

Table 4-28 The Sorts and Uses of Servo Board (BD 542) Connectors

Name	Use	External Device Connection
CNEC1	Encoder signal connection	CNR4
CNEC2	Additional Axis encoder signal connection	CNR7,CNR8
CNBS1,2,3	Dive unit signal connection	CNBS1,2, and 3 of Drive Unit
CNCK	PWM clock synchronization between servo boards in controlling over 9 axes	Additional Servo Board (BD542) CNCK
JP1,3	JTAG Emulator Port (DSP1, DSP2)	JTAG Emulator
JP2	EPLD program download port	EPLD Program Download Tool

4.3.4.3. Display Unit

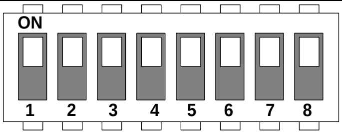
Table 4-29 Servo Board (BD542) LED

Status / Name	Color	Normal	Abnormal	Remark
AL1~8	Red	ON	OFF	ALX: X Axis (X=1~8)
SON1~2	Green	ON if Motor is ON	OFF if Motor is OFF	SON1: 1 DSP, SON2: 2 DSP

4.3.4.4. Setting Unit

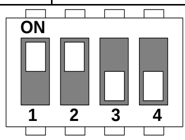
Caution: DIP switches are initially set as ON, and users may not change them.

Table 4-30 The Method for the Setting of DIP Switches (S1) of the Servo Board (BD542)

Switch No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Initial Setting	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**
External Form of Switch								

Caution: Users may not change the following settings, and if you want to expand DSP board, please contact with us.

Table 4-31 The Method for the Setting of DIP Switch (DS1) of the Servo Board (BD542)

Switch No.		**1**	**2**	**3**	**4**
Content	**OFF**	Boot Mode Settings (Pin 1, 2) **ON, ON: HPI/EMU Boot** OFF, ON: 8Bit Flash Boot ON, OFF: 16bit Flash Boot OFF, OFF: 32Bit Flash Boot		**Big Endian Mode**	**HPI Pin Enable** (Pin Functions Setting)
	ON			Little Endian Mode	HPI Pin disable
Initial Setting		**ON**	**ON**	**OFF**	**OFF**
Exterior Form of Switch					

Caution:
Users may not change the following settings, and if you want to expand DSP board, please contact with us.

Table 4-32 The DIP Switch (DS2: Pin 1 and 2) of the Servo Board (BD542)

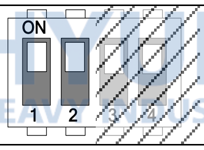
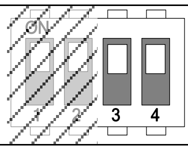
Content \ Name		DS2	
		1	2
DSP1(U27), DSP2(U30) Setting	Designate 1DSP(U27) and 2DSP(U30)	ON	ON
	Designate 3DSP(U27) and 4DSP(U30)	OFF	ON
	Designate 5DSP(U27) and 6DSP(U30)	ON	OFF
	Designate 7DSP(U27) and 8DSP(U30)	OFF	OFF
Initial Settings		ON	ON

Table 4-33 The DIP Switch (DS2: Pin 3 and 4) of the Servo Board (BD542)

Contents \ Name		DS2	
		3	4
Prohibition of Flash Write Function	Flash Write Prohibition	ON	X
	Flash Write Admission	OFF	X
DSP Reset	DSP's Own RESET + Admission of Main Reset Command	X	ON
	Use of DSP's Own Reset Only	X	OFF
Initial Setting		ON	ON

4.3.5. Drive Unit

4.3.5.1. SA3X3Y (Medium-Scale 6-Axis All-In-One Drive unit)

The drive unit plays a role of amplifying power by sending current to each motor according to the current command from the servo board. The 6 axis all-in-one drive unit can operate 6 motors at the same time, and the following table shows its components.

Table 4-34 The Components of SA3X3Y (Medium-Scale 6-Axis All-In-One Drive unit)

Component		Function
BD552 (Logic Board)		Separation of the PWM signal from the servo board into upper and lower IPM drive signals, and execution of error processing
BD551 (Strong Electric Board)	**Gate Drive Module**	Generation of IPM gate signals
	Gate Power Module	Generation of gate power
	Current Detection Unit	Detection of the current flowing into the motor
	DB Control	Control of dynamic brake according to the signals from the servo board
Other Parts	**Heat Sink**	Emission of heat generated from IPM
	IPM	Switching Device

■ The Reference Number of Servo Drive Unit

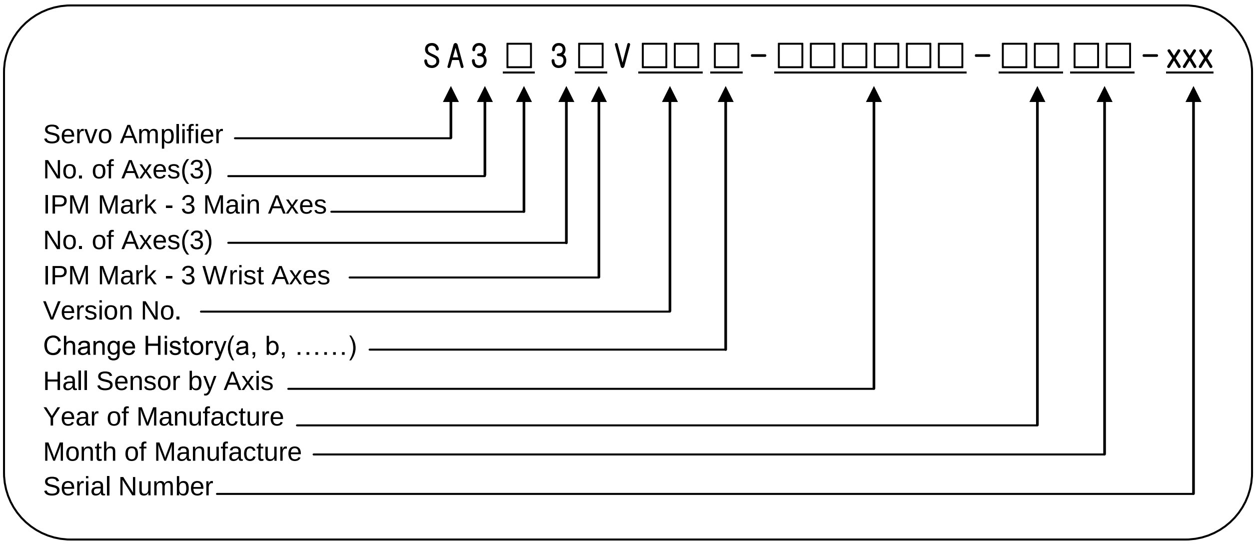


Table 4-35 The Mark of Type of Servo Driver Series

Classification	Mark of Type
Servo Amp	SA

Table 4-36 The Specifications of Drive Unit

Item	Classification		Application	
IPM Capa.	1L	4X	HC2500BD-10	6 Axis All-In-One Type
	3X	3Y	HS165 applied	
	3X	3Z	HC2500BD-00, HC2500IK	
Year	00 ~ 99		Year of Manufacture: 2000 ~ 2099	
Month	01 ~ 12		Month of Manufacture: 1 ~ 12	
Serial No.	001 ~ 999		No. of units manufactured per month: 1 ~ 999	

Table 4-37 IPM Capacity

Large/Medium Size	**L**	(IPM Rated Current) 150A, (Hall Sensor Rated Current) 4V/75A
	X	(IPM Rated Current) 100A, (Hall Sensor Rated Current) 4V/50A
	Y	(IPM Rated Current) 75A, (Hall Sensor Rated Current) 4V/50A
	Z	(IPM Rated Current) 50A, (Hall Sensor Rated Current) 4V/25A

Table 4-38 Hall Sensor Marks

AMP Model	Hall Sensor Mark (Spec.)	Full-Scale Current (Im)	AMP Feedback Constant (Iv)
Large/Medium –Scale (6 Axis) Amp	0 (4V/75A)	140.62Apeak	**PM150CSD060(150A)**
	1 (4V/50A)	93.75Apeak	**PM150CSD060(150A) PM100CSD060(100A) PM75CSD060(75A) PM50CSD060(50A)**
	2 (4V/25A)	46.87Apeak	
	3 (4V/15A)	28.12Apeak	
	4 (4V/10A)	18.75Apeak	
	5 (4V/ 5A)	9.37Apeak	

Caution:
As the drive unit varies depending on the robot, so please check out the form of it in replacing it.

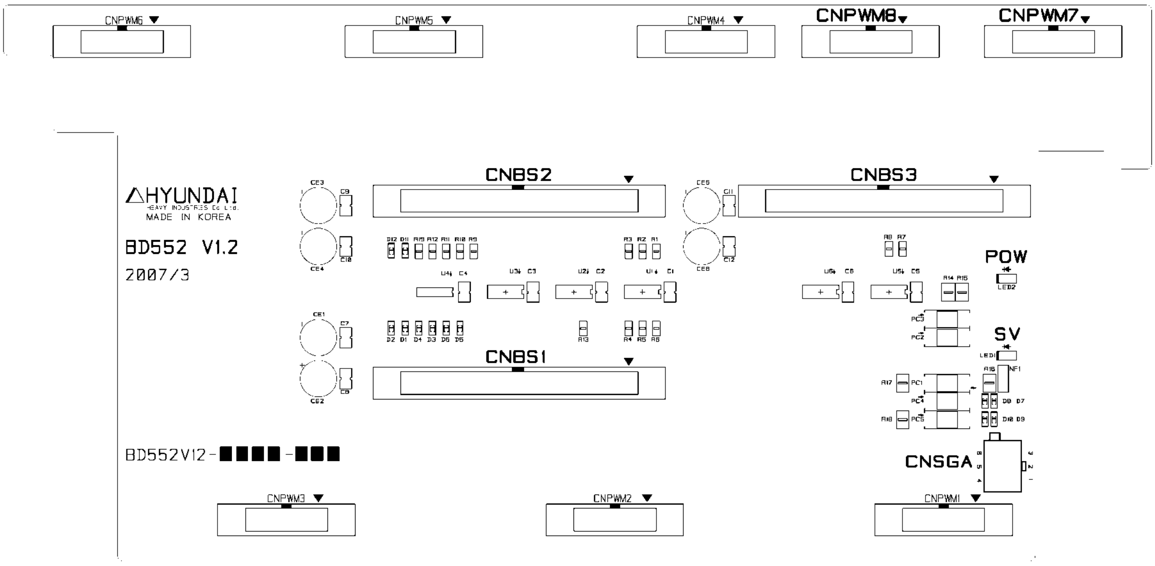


Figure 4.49 BD552 Component Layout

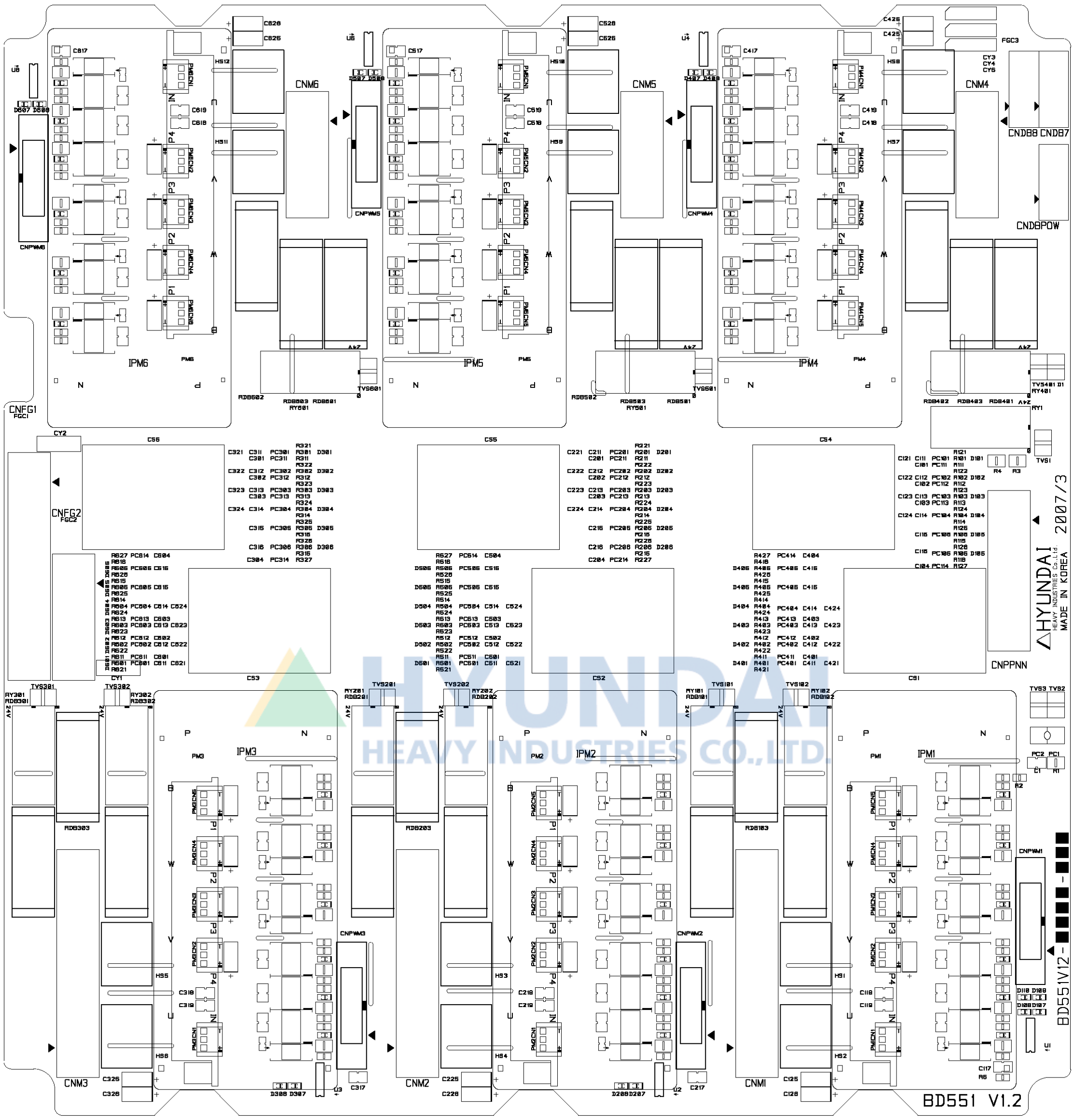


Figure 4.50 BD551 Component Layout

Table 4-39 BD552 Connector

Name	Use	External Device Connection
CNBS1, 2, 3	PWM Signal and Error Signal	Servo Board(BD542) CNBS1,2,3
CNSGA	/PWMON, SVERR, BRAKE	Sequence Board (BD530) CNSGA
CNPWM 1~6	PWM Signal and Error Signal	Servo Amp BD551 CNPWM1~6
CNPWM 7~8	Additional Axis PWM Signal and Error Signal	Option Board(BD554, BD556) CNPWM

Table 4-40 BD551 Connector

Name	Use	External Device Connection
CNDBPOW	Power for DB control	CNPB of BD5C0
CNDB7, 8	Additional Axis DB drive signal	Option board (BD554, BD555) CNDB
CNM 1~6	Motor Connection	CMC1, CMC2
CNPWM 1~6	PWM signal and error signal	Servo Amp BD552 CNPWM1~6
CNPPNN	Power for motor drive	Drive Power Unit (BD561) CNPN1
CNFG1	The frame ground of the Main axis motor	CMC1
CNFG2	The frame ground of the Wrist Axis motor	CMC2

Table 4-41 BD552 LEDs

Name	Color	Status Display
SV	Yellow	ON if PWM is ON
POW	Green	OFF if current dip/sag occurs

4.3.5.2. SD1L2C (Medium-Scale Diode Module Converter)

The medium-scale diode module converter changes the 3-phase current supplied from the electrical module into direct current by rectifying it through the diode module, and then store it in the electrolytic capacitor. The power generated from the motor in the robot slowing down is consumed through the transistor and resistance, and the following shows its components.

- The Specifications for Drive Power Unit

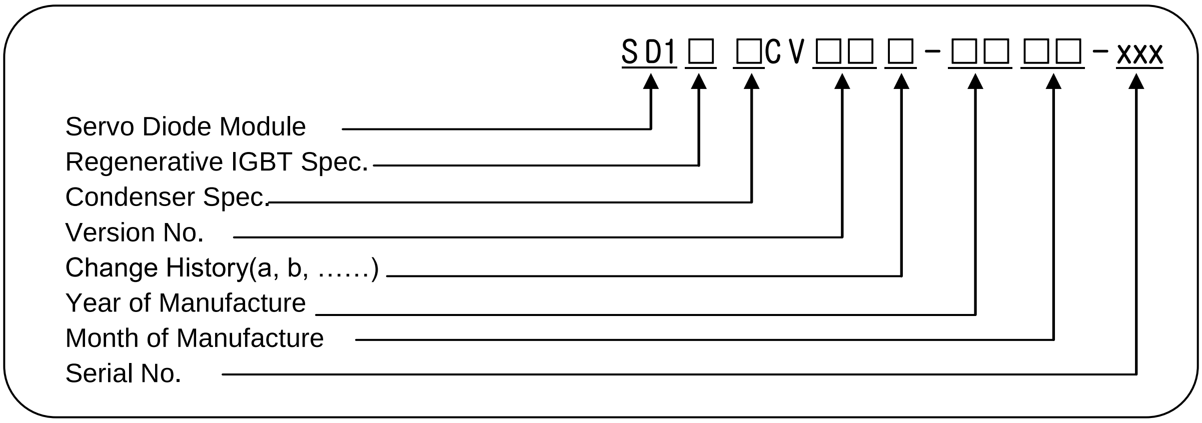


Table 4-42 The Mark of Type of Driver Series

Classification	Mark of Type
Servo Diode Module	SD

Table 4-43 The Specifications of Drive Power Unit

Item	Classification	Application
Year	00 ~ 99	Year of Manufacture: 2000 ~ 2099
Month	01 ~ 12	Month of Manufacture: 1~ 12
Serial No.	001 ~ 999	No. of units manufactured per month: 1 ~ 999

Table 4-44 The Specifications of Regenerative IGBT

Regenerative IGBT	**L**	150A, Regenerative Resistance: 2Ω 800W 2EA Applicable

Table 4-45 Chemical Condenser Capacity

Chemical Condenser	**2C**	3300uF 2EA (HA165, HA020 + Carriage)

Table 4-46 SD1L2C (Medium-Scale Diode Module Converter)

Components		Function
BD561 (Converter Board)	**Rectifier Unit**	Generation of DC power circuit provided from the AC input main power.
	Regenerative Control	Drive of IGBT if PN voltage increases
	Error Detection Unit	The detection of overvoltage, overheated regenerative resistance, and bibliographic data input errors
Other Components	**Heat Sink**	Emission of heat generated from the power device
	Capacitor	DC power smoothing
	Regenerative IGBT	Execution of regenerative control

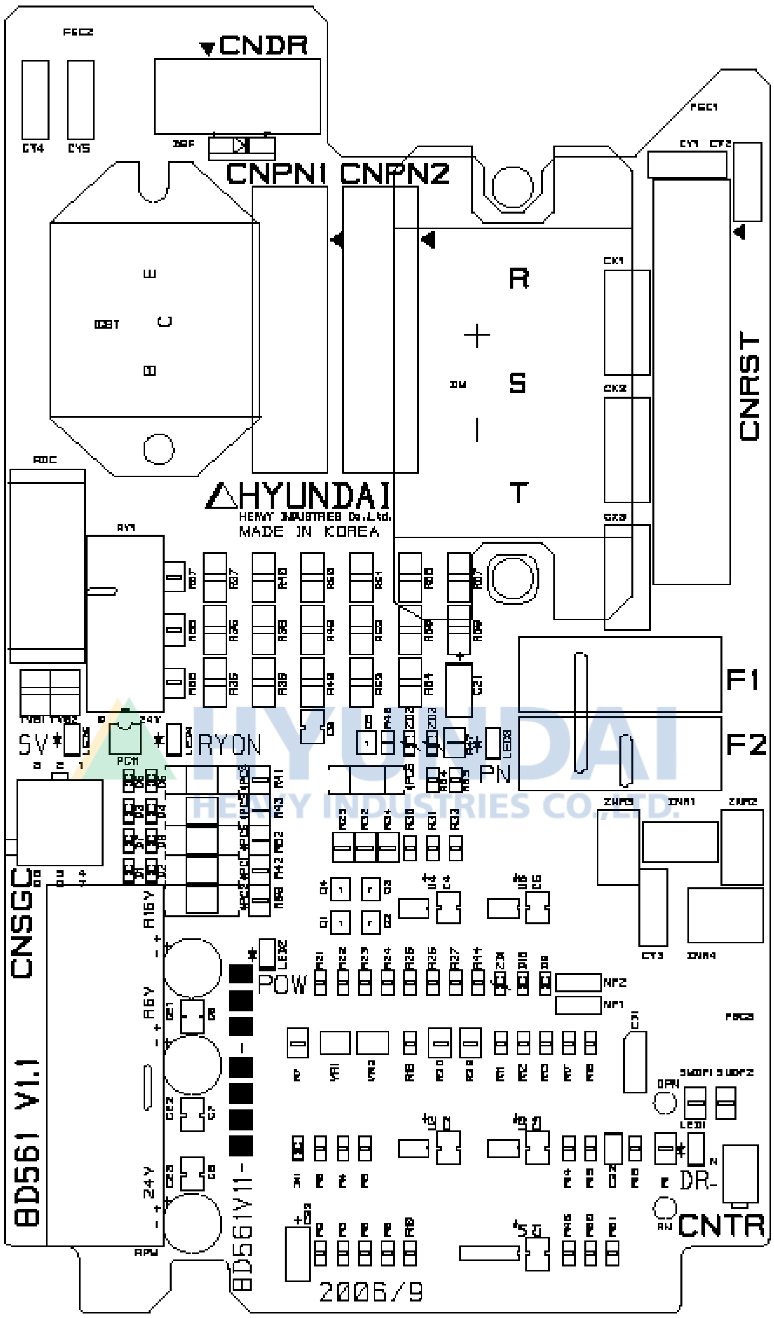


Figure 4.51 BD561 Component Layout

Table 4-47 Medium-Scale Drive Power Unit (SD1L2C) Connector

Name	Use	External Device Connection
CNRST	3-Phase Power Input	Electrical Module CNRST
CNSGC	/PWMON, OV, FLT, FB	Sequence Board(BD530) CNSGC
CNDR	Regenerative Power Output	Regenerative Resistance
CNTR	Detection of Overheated Regenerative Resistance	Thermal Sensor of Regenerative Resistance
CNPN1,2	For Supply of PN Power	6-Axis Servo Amp CNPPNN, Additional Axis CNPN

Table 4-48 Medium-scale Drive Power Unit (SD1L2C) LED

Name	Color	Status Display
SV	Yellow	ON if PWN is ON
POW	Green	OFF if control voltage sag occurs
DR	Red	ON if regenerative power discharge operates
PN	Red	ON if PN voltage is over 42V
RYON	Red	OFF if PN power discharge operates

4.3.5.3. SA3A3D (Small sized-6 axes integral type-driving apparatus)

The drive unit plays a role of amplifying power by sending current to each motor according to the current command from the servo board. The 6 axis all-in-one drive unit can operate 6 motors at the same time, and the following Table shows its components.

A small sized-diode module converter is formed integrally with a small-sized servo amplifier, and converts three-phase current provided from an electronic field module to direct current through the rectification of a diode module so as to store it in a smoothing capacitor. When the speed of the robot is reduced, power generated from a motor is consumed through a transistor and resistance. The diode module converter is constructed as shown below.

Table 4-49 Construction of SA3A3D (Small sized-6 axes integral type-driving apparatus)

Component		Function
BD553 (IPM board)	Gate Drive Module	Generation of IPM gate signals
	Gate Power Module	Generation of gate power
	Current Detection Unit	Detection of the current flowing into the motor
BD563 (Converter Board)	Rectifier Unit	Generation of DC power circuit provided from the AC input main power.
	Regenerative Control	Drive of IGBT if PN voltage increases
	Error Detection Unit	The detection of overvoltage, overheated regenerative resistance, and bibliographic data input errors
Other Parts	Heat Sink	Emission of heat generated from IPM
	Capacitor	DC power smoothing
	Regenerative IGBT	Execution of regenerative control
	IPM	Switching Device

Caution:
As the drive unit varies depending on the robot, so please check out the form of it in replacing it.

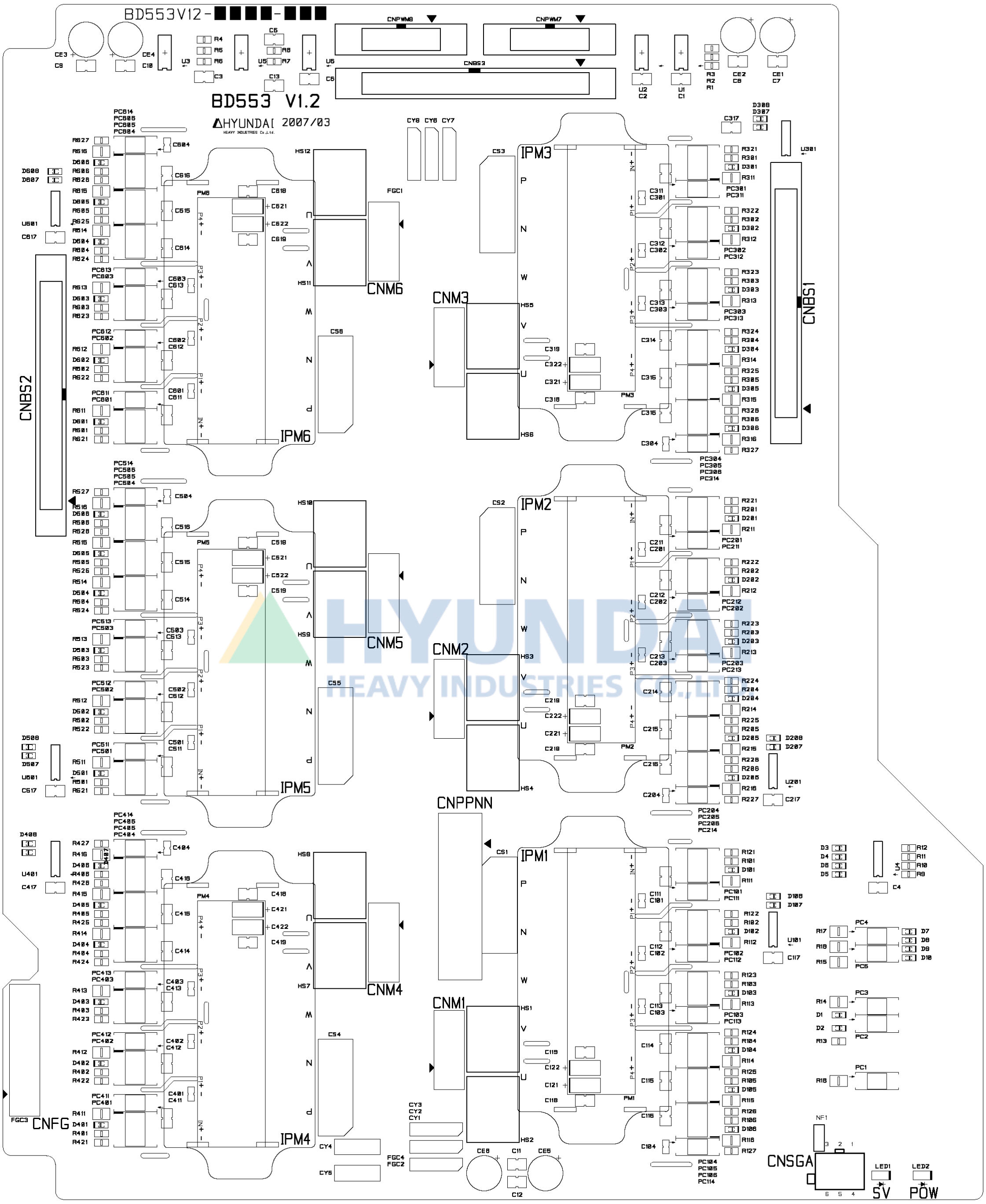


Figure 4.52 BD553 Component Layout

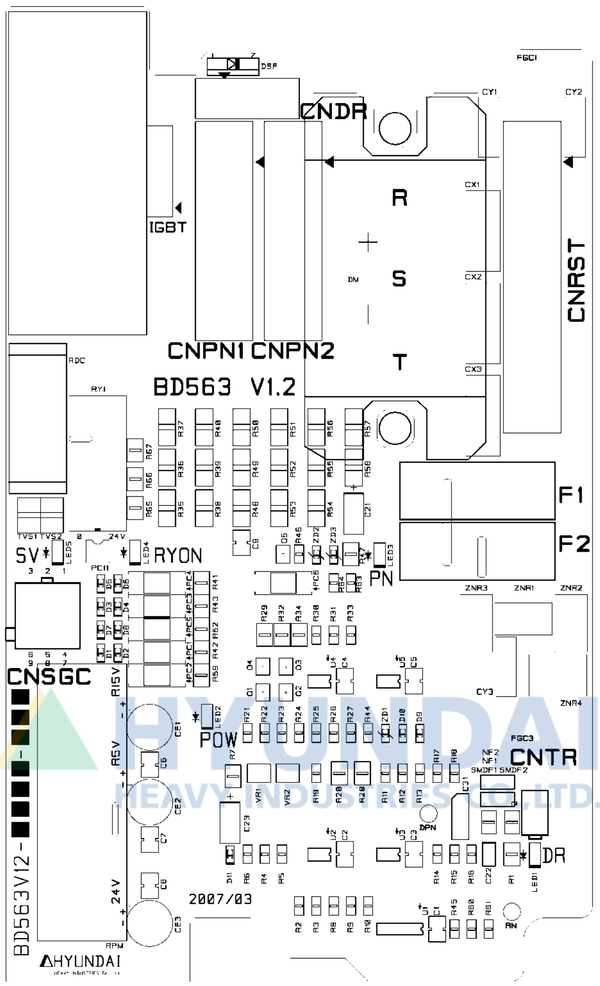


Figure 4.53 BD563 Component Layout

Table 4-50 Description of connector BD553

Name	Use	External Device Connection
CNBS1, 2, 3	PWM Signal and Error Signal	Servo Board (BD542) CNBS1,2,3
CNSGA	/PWMON, SVERR, BRAKE	Sequence Board (BD530) CNSGA
CNPWM7~8	Additional Axis PWM Signal and Error Signal	Option Board (BD554, BD556) CNPWM
CNM1~6	Motor Connection	CMC1
CNPPNN	Power for motor drive	Drive Power Unit (BD561) CNPN1
CNFG	The frame ground of the Main Axis motor	CMC1

Table 4-51 Description of BD553 LED

Name	Color	Status Display
SV	Yellow	ON if PWM is ON
POW	Green	OFF if current dip/sag occurs

Table 4-52 Description of connector BD563

Name	Use	External Device Connection
CNRST	3-Phase Power Input	Electrical Module CNRST
CNSGC	/PWMON, OV, FLT, FB	Sequence Board(BD530) CNSGC
CNDR	Regenerative Power Output	Regenerative Resistance
CNTR	Detection of Overheated Regenerative Resistance	Thermal Sensor of Regenerative Resistance
CNPN1,2	For Supply of PN Power	6-Axis Servo Amp CNPPNN, Additional Axis CNPN

Table 4-53 Description of BD563 LED

Name	Color	Status Display
SV	Yellow	ON if PWN is ON
POW	Green	OFF if control voltage sag occurs
DR	Red	ON if regenerative power discharge operates
PN	Red	ON if PN voltage is over 42V
RYON	Red	OFF if PN power discharge operates

4.3.5.4. The Specifications of Option Drive Unit

- AMP(DRIVER UNIT) type construction: When 2 axes are configured

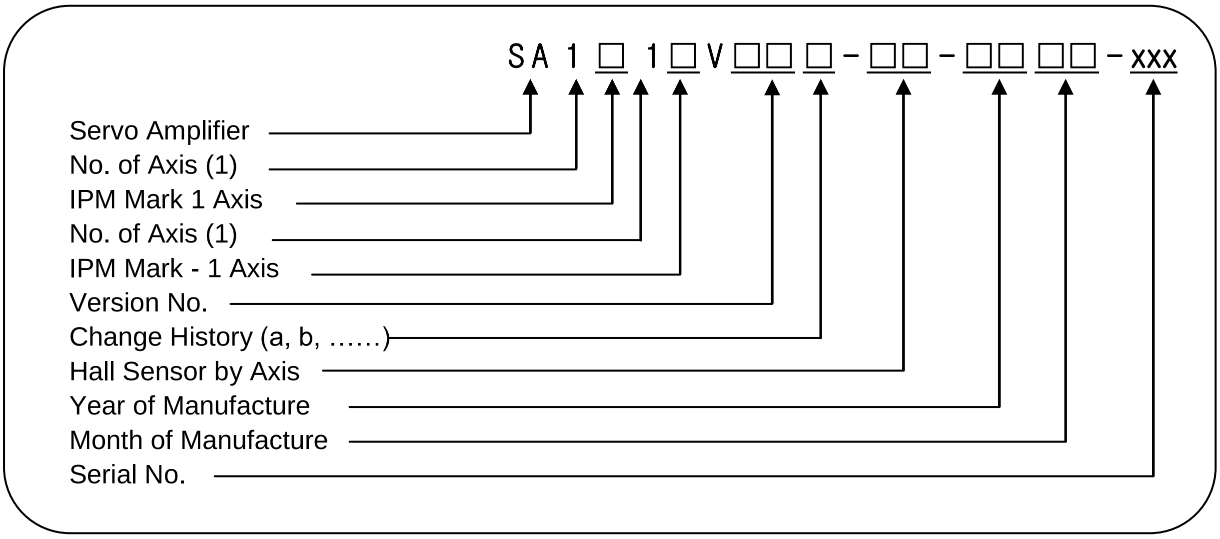


Table 4-54 The Mark of Type of Driver Series

Classification	Mark of Type
Servo AMP	SA

Table 4-55 IPM Capacity

Small Size	**A**	(IPM Rated Current) 30A, (Hall Sensor Rated Current) 4V/15A
	D	(IPM Rated Current) 10A, (Hall Sensor Rated Current) 4V/5A
Large/Medium Size	**L**	(IPM Rated Current) 150A, (Hall Sensor Rated Current) 4V/75A
	X	(IPM Rated Current) 100A, (Hall Sensor Rated Current) 4V/50A
	Y	(IPM Rated Current) 75A, (Hall Sensor Rated Current) 4V/50A
	Z	(IPM Rated Current) 50A, (Hall Sensor Rated Current) 4V/25A

Table 4-56 Hall Sensor Marks

AMP Model	Hall Sensor Mark (Spec.)	Full-Scale Current (Im)	AMP Feedback Constant (Iv)
Large/Medium –Scale (6 Axis) Additional axis Amp	0 (4V/75A)	140.62Apeak	**PM150CLB060 (150A)**
	1 (4V/50A)	93.75Apeak	**PM150CLB060 (150A) PM100CLB060 (100A) PM75CLB060 (75A) PM50CLB060 (50A)**
	2 (4V/25A)	46.87Apeak	
	3 (4V/15A)	28.12Apeak	
	4 (4V/10A)	18.75Apeak	
	5 (4V/5A)	9.37Apeak	
Small –Scale (6 Axis) Additional axis Amp	3 (4V/15A)	28.12Apeak	**PM30CSJ060 (30A)**
	4 (4V/10A)	18.75Apeak	**PM30CSJ060 (30A)**
	5 (4V/5A)	9.37Apeak	**PM30CSJ060 (30A) PM10CSJ060 (10A)**

4.3.5.5. SA1X (Medium-Scale 1 Axis Drive Unit : Option)

The drive unit plays a role of amplifying power by sending current to each motor according to the current command from the servo board. The medium-scale additional axis drive unit can drive one motor, and the following figure shows is components.

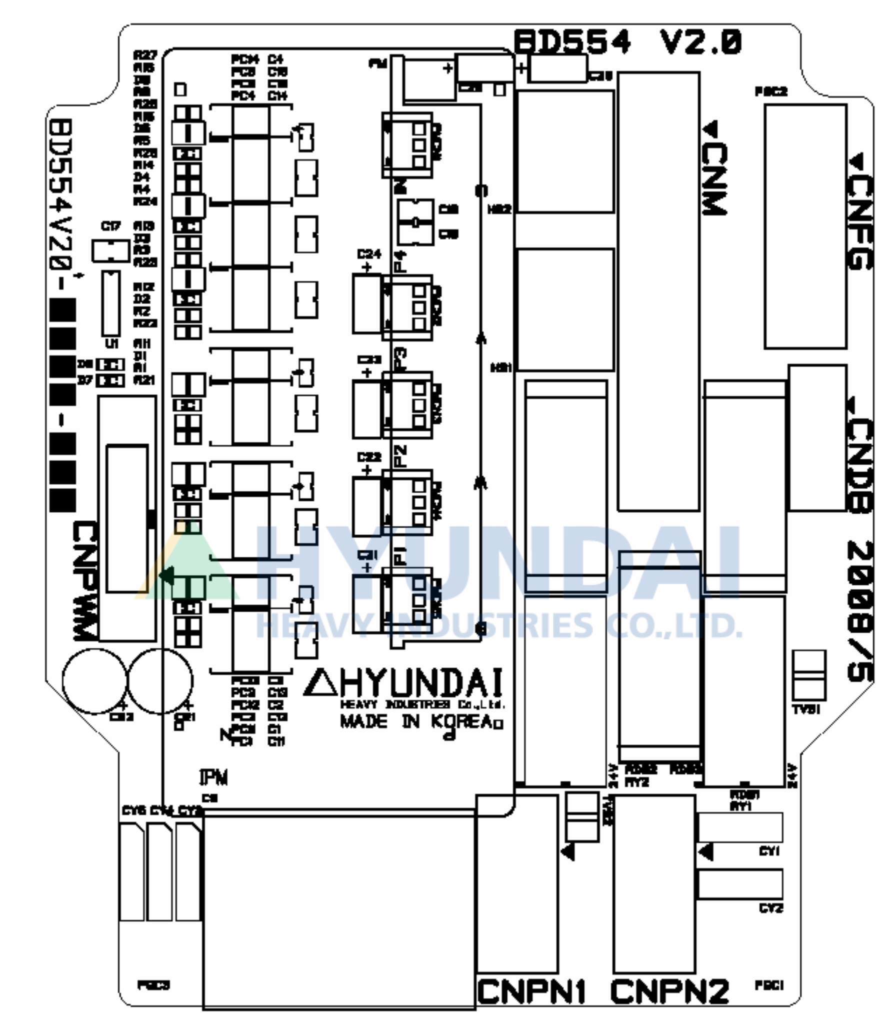


Figure 4.54 BD554 Component Layout

Table 4-57 The Components of SA1X (Medium-Scale 1 Axis Drive Unit : Option)

Components		Function
BD554 (Amp Board)	Logic Part	Conversion of PWM signal from the 6 axis servo amp into upper and lower drive signals of IPM and execution of error processing and regenerative control
	Gate Power Module	Generation of gate power
	Current Detection Unit	Detection of the current flowing into the motor
	DB Control	Control of dynamic brake according to the signals from the 6 axis servo amp
Other Components	Heat Sink	Emission of heat generated from IPM
	IPM	Switching Device

Table 4-58 SA1X (Medium-Scale 1 Axis Drive Unit : Option) Connector

Name	Use	External Device Connection
CNPWM	PWM signal and error signal	CNPWM7 or CNPWM8 of the 6-Axis Servo Amp (BD552 or BD553)
CNM	Power for motor drive	AMC1 or AMC2
CNFG	Motor frame ground	AMC1 or AMC2
CNPN1,2	PN voltage is inputted from the diode module	CNPN2 of the 6-Axis Servo Amp (BD561 or BD563)s
CNDB	DB drive of Additional Axis	6-Axis Servo Amp CNDB7, CNDB8

4.3.5.6. SA1A (Small-Scale 1 Axis Drive Unit ; Option)

The drive unit plays a role of amplifying power by sending current to each motor according to the current command from the servo board. The small-scale additional axis drive unit can drive one motor, and the following figure shows is components.

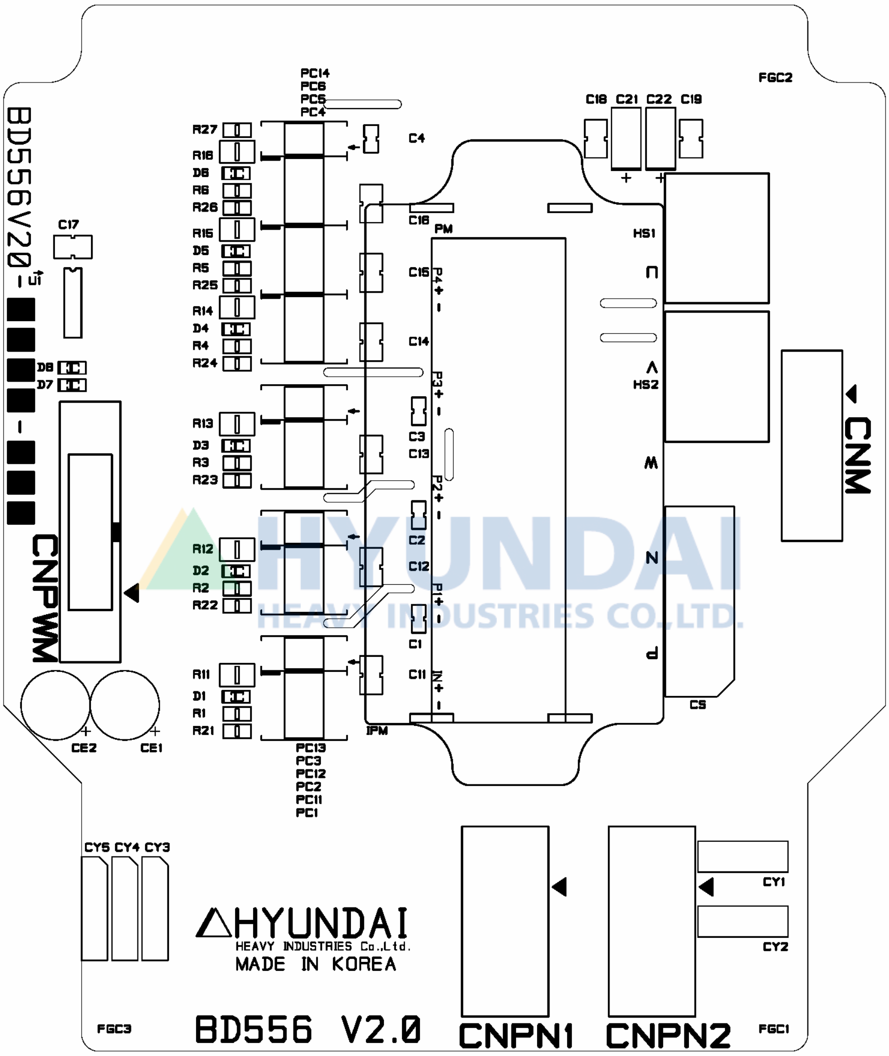


Figure 4.55 BD556 Component Layout

Table 4-59 The Composition of SA1A (Small-scale 1 Axis Drive Unit: Option)

Components		Function
BD556 (Amp Board)	**Logic Section**	Conversion of PWM signal from the 6 axis servo amp into upper and lower drive signals of IPM and execution of error processing and regenerative control
	Gate Power Module	Generation of gate power
	Current Detection Unit	Detection of the current flowing into the motor
Other Components	**Heat Sink**	Emission of heat generated from IPM
	IPM	Switching Device

Table 4-60 SA1A (Small-Scale 1 Axis Drive Unit: Option) Connector

Name	Use	External Device Connection
CNPWM	PWM signal and error signal	CNPWM7 or CNPWM8 of the 6-Axis Servo Amp (BD552 or BD553)
CNM	Motor drive output, Frame Ground	AMC1 or AMC2
CNPN	For input of drive power	CNPN2 of the 6-Axis Servo Amp (BD561 or BD563)

4.3.6. DC Multi Power Unit (SMPS: HDI-200)

The DC multi power unit supplies all the DC power within the controller. With the input voltage of AC48V, it is a multi power supply device which generates various kinds of stabilized DC voltages and supplies them to many boards, drive unit, system IN/OUT, and teach pendant within the controller.

Figure 4.56 External appearance of SMPS SR1 and configuration mounted in Rack

Table 4-61 SMPS (SR1) Standards (Input Voltage; AC 45V~50V, 50/60Hz)

Rated Output	Use	Connection
ENCODER (5V)	Motor Encoder Power: DC5V	W/H Connector(CNE1)
CONTROL (5V)	Board Power in Rack: DC5V	Backplane Board (BD501)
P1-M1	System I/O Power: DC24V	System board and other option boards
P2-M2	Teach pendant Power: DC24V	TP510 Connector (CNTP)
DC-15V	Drive Unit Control Power	Backplane Board (BD501)
DC+15V	The Control Power for Analog Section of the Servo Board	Backplane Board (BD501)

4.3.7. Electrical Module and Electrical Board (BD5C0)

4.3.7.1. Outline

The electrical module plays a role of opening/closing and distributing various electric powers supplied to the controller. The following picture shows the interior and exterior of the electrical module equipped with various connectors and fuses.

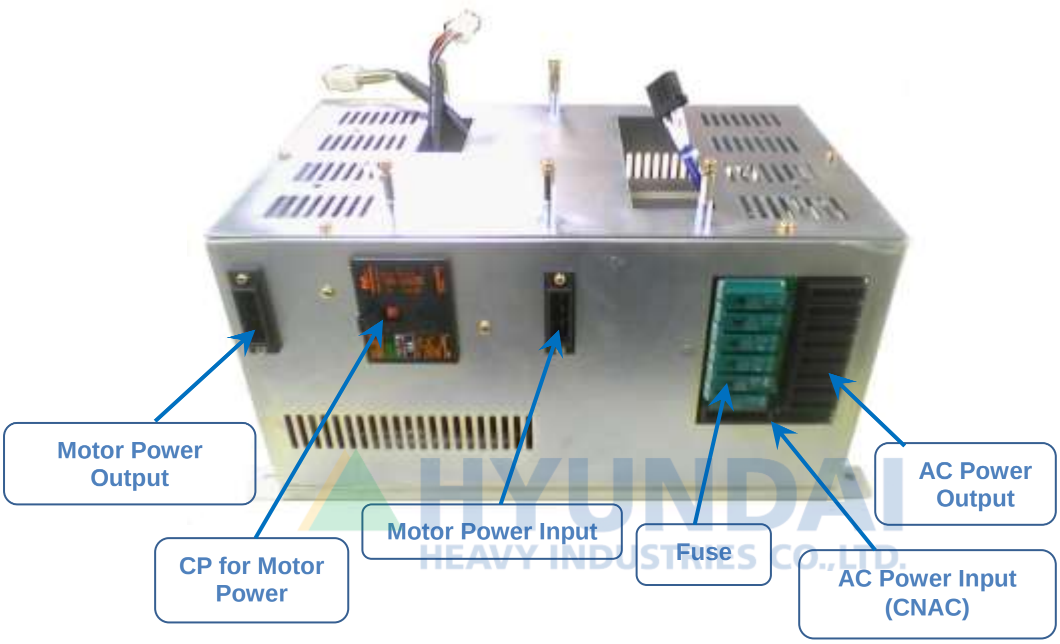


Figure 4.57 Electrical Module

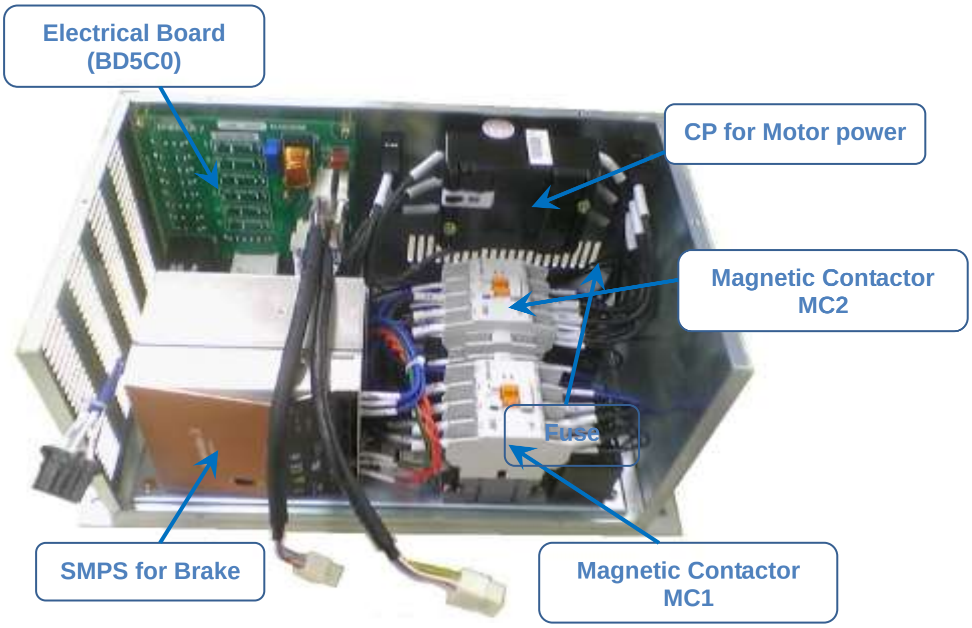


Figure 4.58 The Interior of Electrical Module

The following power flow chart shows the opening/closing of the 3-phase AC power for motor power supply, generation of brake power, AC control power such as fan operation, and the distribution of SMPS power for DC device power supply. Each power supply is equipped with a circuit breaker or fuse to protect components from over current. The electrical board (BD5C0) is used to minimize the use of the cables used for the distribution of power.

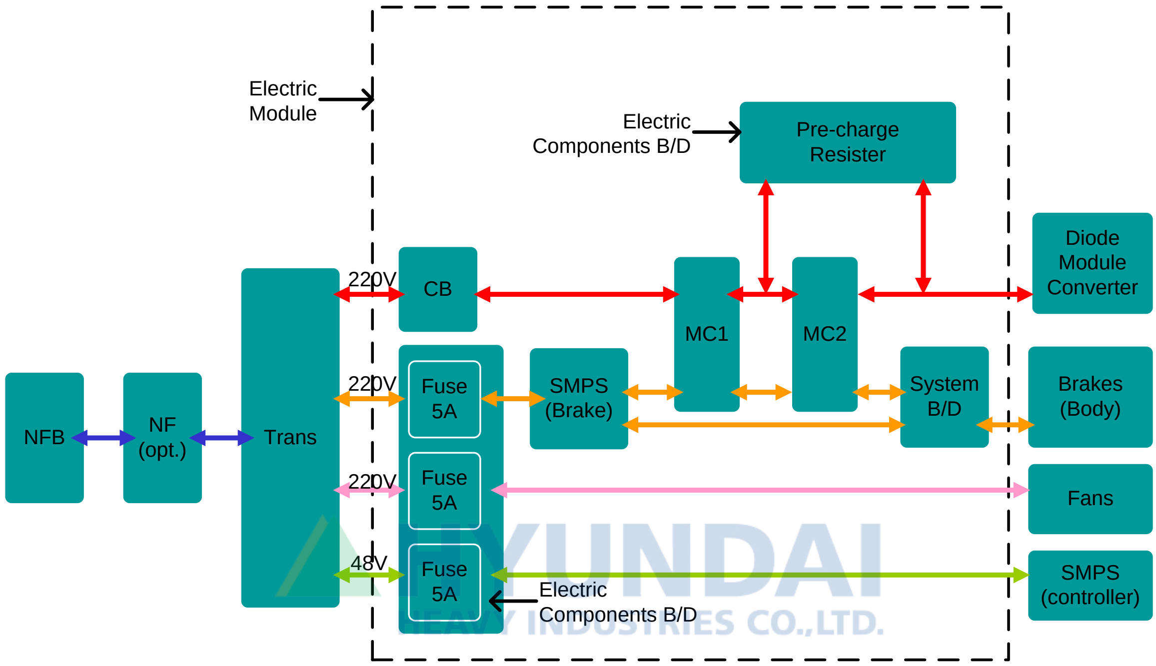


Figure 4.59 Power system of controller Hi5

Table 4-62 The Sorts and Uses of Fuses in the Electrical Module

Name	Use	Spec.
F1, F2	Overcurrent Protection Fuse of the Electrical Control Power(AC220)	AC220V 2A
F3, F4	Overcurrent Protection Fuse of the SMPS Power (AC48)	AC220V 10A
F5, F6	Overcurrent Protection Fuse of the Brake SMPS Power (AC220)	AC220V 5A

4.3.7.2. Connector

The following picture shows the layout of the electrical board (BD5C0)'s connectors, and the table shows the uses of each connector and other connection devices.

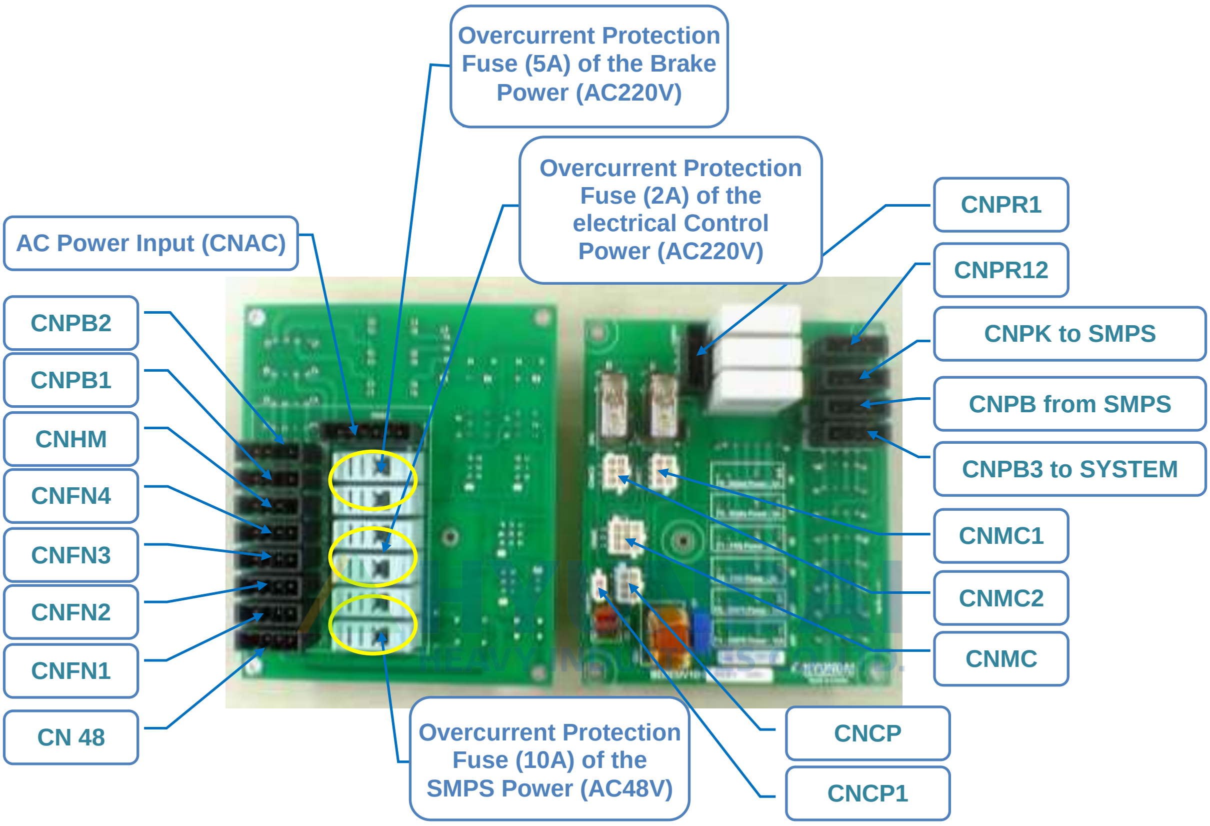


Figure 4.60 Connectors of the Electrical Board (BD5C0)

Table 4-63 Types and applications of fuses in the electronic control module

Name	Use	External Devices Connection
CNAC	Various AC power inputs	Transformer
CN48	SMPS Power Output (AC48V)	SMPS
CNFAN1~3	Power Output (AC220V) for Electrical Drive	FAN Module
CNHM	Power Output (AC220V) for Hour Meter	Hour Meter (Option)
CNPR1	Precharge Resistance Power Input	MC2 Input
CNPR2	Precharge Resistance Power Output	MC2 Output
CNPK	Brake Power Output (AC220V)	Brake Power SMPS Input
CNPB	Brake Power Input (DC24V)	Brake Power SMPS Output
CNPB1,2	Brake Power Output (DC24V)	Servo Amp and Extended Brake Board
CNPB3	Brake Power Output (DC24V)	System Board CNPB Input
CNCP1	Input of Motor Power Circuit Breaker Monitoring	Motor Power Circuit Breaker
CNCP	Output of the Monitoring of Circuit Breaker and Fuse	System Board CNCP Input
CNMC1,2	The Drive and Monitoring of Magnetic Contactor	Magnetic Contactor MC1, MC2
CNMC	Drive Signal and Monitoring Signal for Magnetic Contactor	System Board CNMC

4.3.8. Small Door Board (BD5B1)

The small door board (BD5B1) is the board with various input/output connectors for users to connect the controller with various communication lines such as Ethernet, RS232, and CAN. It is located under the control panel in the front side of the controller. If you open the door, you can connect RS232 and Ethernet through their ports.

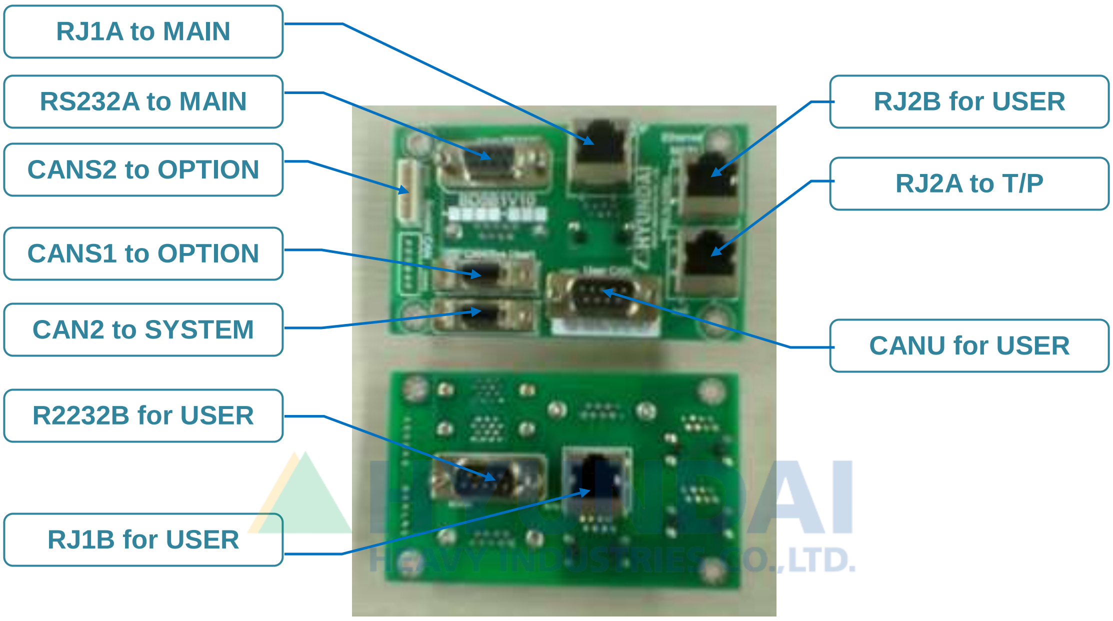


Figure 4.61 The Components of the Small Door Board (BD5B1)

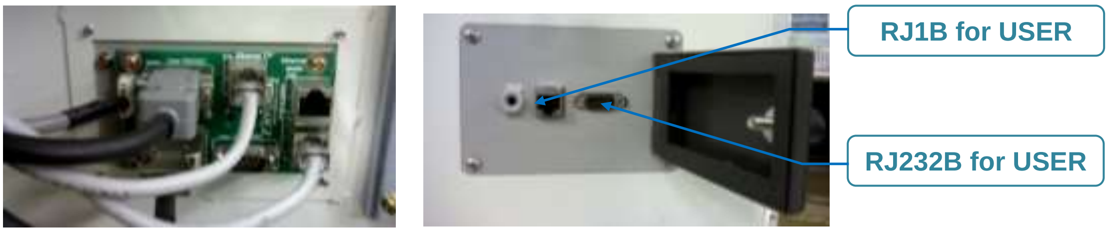


Figure 4.62 The Exterior and Interior of the Small Door Board (BD5B1)

4.3.9. Teach pendant (TP510)

4.3.9.1. Outline

TP510 (teach pendant) performs communication through a main board (BD510) of a controller and Ethernet, allowing a user to perform many functions as detailed below.

- Monitoring: Work program / data of each axis / input*output signal / robot state, etc.
- History management: System version / operating time / error history / stop history, etc.
- File management: Version & teaching program up/down
- Setting various parameters:
  User environment / control/ robot / application / automatic integral number, etc.
- Robot teaching: Jog & teaching program registration
- Robot operation: MOTOR ON / START / STOP / MODE setting

Additionally, the teach pendant is equipped with a three-step enable switch, an emergency stop switch, etc. to ensure worker safety.

Figure 4.63 Appearance of teach pendant TP510

4.3.9.2. USB cover

When you open a cover positioned at the lower side of the teach pendant, you can see the connectors such as those shown below. The meaning of each connector is the same as shown below.

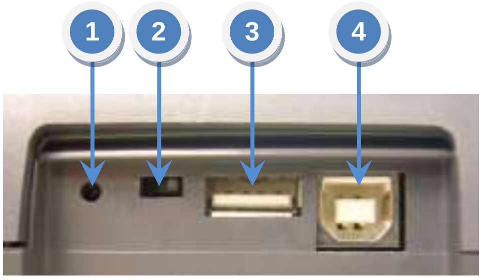


Figure 4.64 USB cover of teach pendant TP510

(1) RESET switch

When you want to re-operate the teach pendant, and not the controller, you can operate the RESET switch. However, do not operate this unnecessarily.

(2) Slide switch

When delivered, it is set on the right side (to the USB connector direction) as shown in the picture.

Notice:
Slide switch is set when it is produced so that the user cannot change the position thereof.

(3) USB - A type connector

The user can up/down load necessary files, such as data and teaching programs, etc. as well as different versions of boards.

(4) USB - B type connector

This connector is not intended for use by a user.

5

Controller Options

5.1. Public IO Board (BD580; Terminal Block)

5.1.1. Outline

Public DIO board can be used for interface or configuration with various devices through the digital input/output port. The specification of the basic board is as follows.

- Digital input (Photocoupler type): 32 points (4 ports)
- (+/-) Two-way digital output (Photo MOS type): 32 points (4 ports)
- 1Mbps CAN communication
- When relay contact point is required, the relay board can be installed

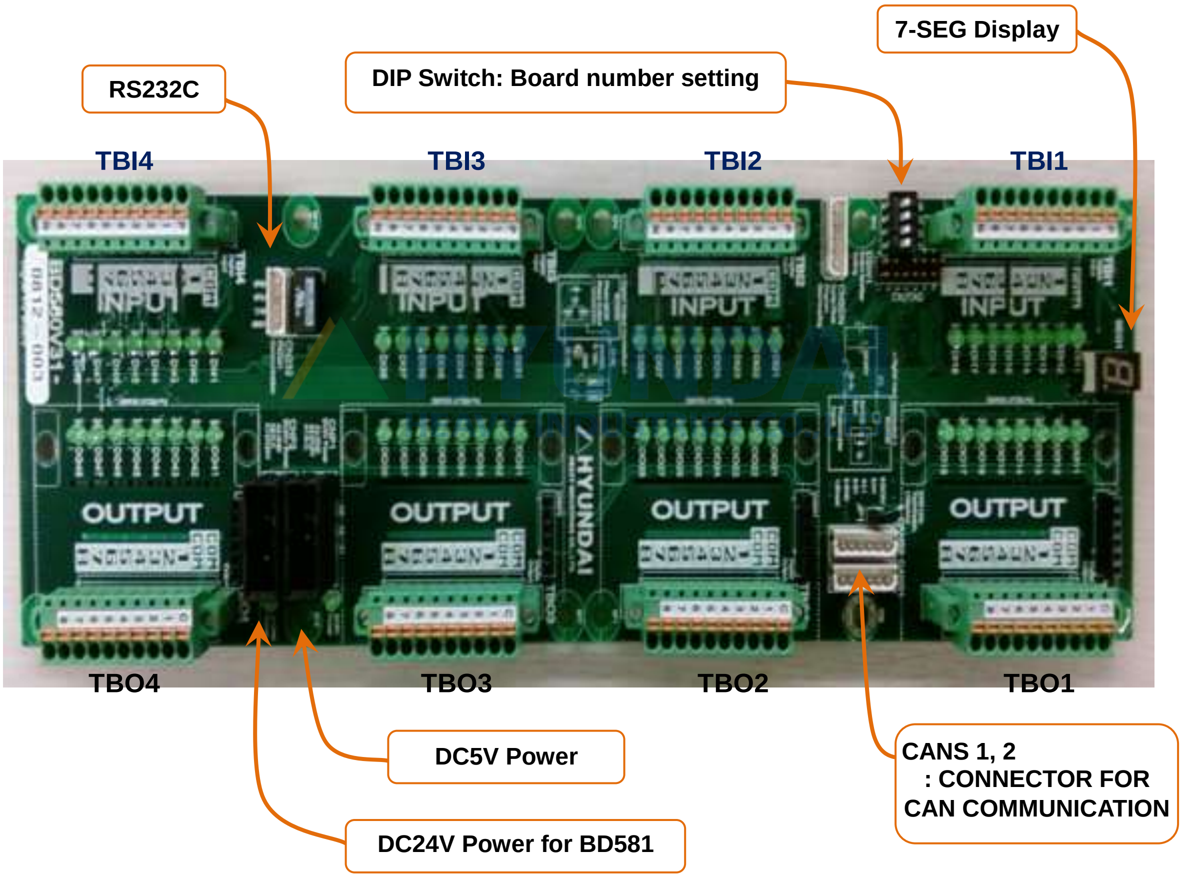


Figure 5.1 Public IO Board (BD580)

5.1.2. Connector

5.1.2.1. Digital Input

The following Figure and Table describe the pin composition of the terminal block (TBI1~4) for digital input. Each terminal block connects to 8 input signals, and different power can be used depending on the usage.

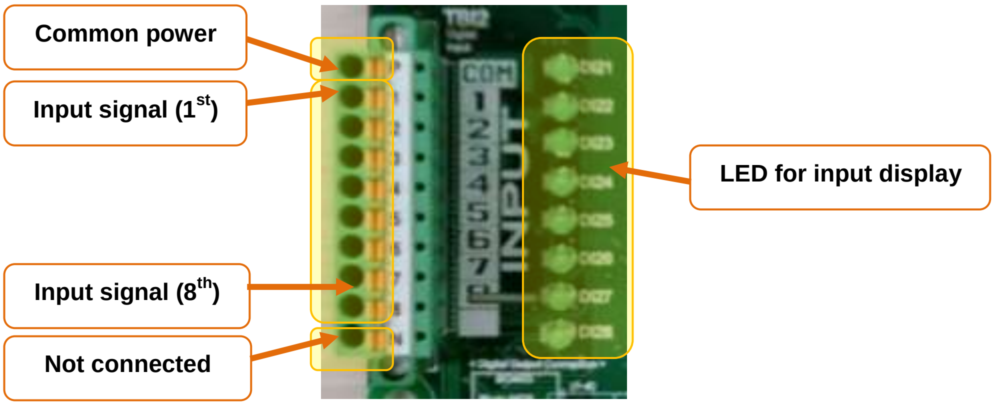


Figure 5.2 Pin Configuration of Digital Input Terminal Block of Public IO Board (BD580)

Table 5-1 Pin Configuration of Digital Input Terminal Block (TBIn*) of Public IO Board (BD580)

Pin Number	Signal Name	Signal Description
1	COMn*	COMMON power (Ground DC24V or DC24V)
2	DI n*1	1st input of nth public input signal port of user
3	DI n*2	2nd input of nth public input signal port of user
4	DI n*3	3rd input of nth public input signal port of user
5	DI n*4	4th input of nth public input signal port of user
6	DI n*5	5th input of nth public input signal port of user
7	DI n*6	6th input of nth public input signal port of user
8	DI n*7	7th input of nth public input signal port of user
9	DI n*8	8th input of nth public input signal port of user
10	N.C	No connection

Note *) Terminal block Number n = 1~4 (Ex, TBI1, TBI2, TBI3, TBI4)

The input specification of each port is as follows

- Input port component: AC input photocoupler
- Input impedance: 3 ㏀
- Common power: Ground 24VDC or 24VDC

The user connects the input signal through the method shown in Figure 5.3 below. First, connect the user power of +24V or the ground wire to the public IO board (BD580), and then connect each signal to the input pin according to the usage. For the power, 8 input ports can be composed as a unit, and can be used differently.

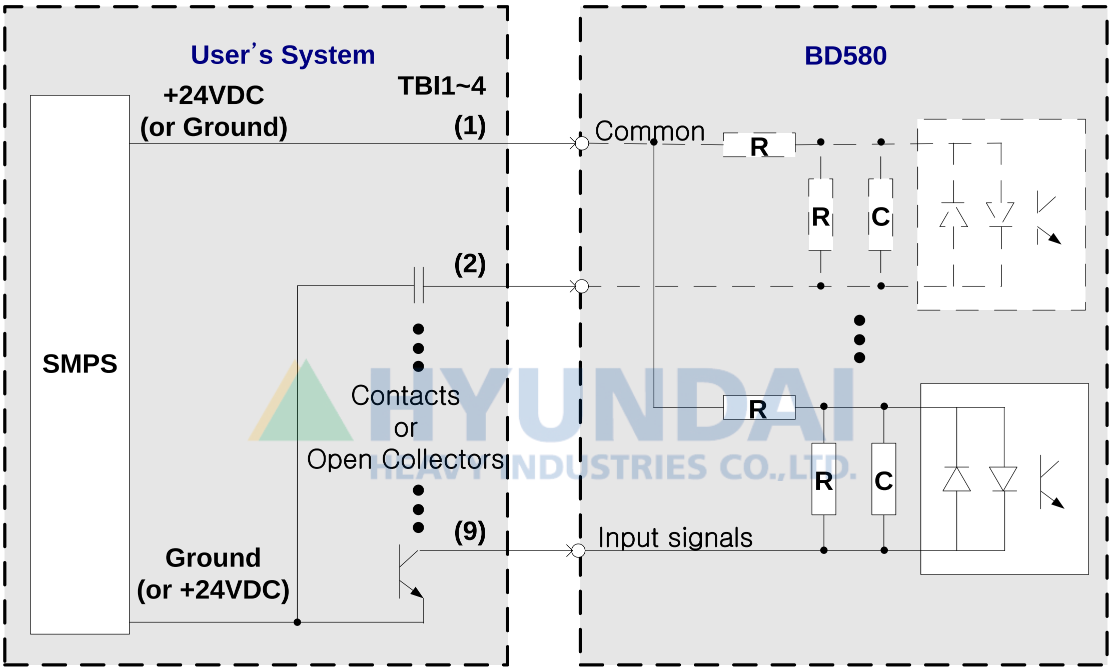


Figure 5.3 Wiring of Input Signals of the Public IO Board (BD580)

Caution:
Public IO Board V3.0 or lower does not support two-way digital input. For this reason, DC24V must be used for common power.

5.1.2.2. Digital Output

The following Figure and Table show the pin composition of terminal block (TB01~4) for digital output. Each terminal block can be connected to 8 output signals, and different power can be used depending on the usage.

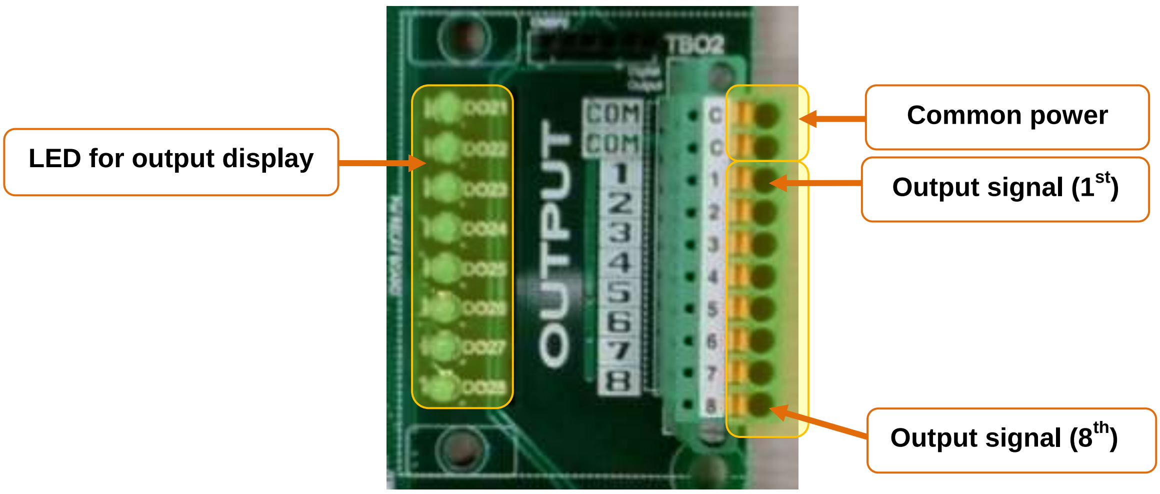


Figure 5.4 Pin Configuration of Digital Input/Output Terminal Block of the Public IO Board(BD580)

Table 5-2 Pin Configuration of Digital Input/Output Terminal Block (TBOn*) of the Public IO Board (BD580)

Pin Number	Signal Name	Signal Description
10	COMn*	COMMON power (Ground DC24V or DC24V)
9		
8	DOn*1	1st output of nth public output signal port of user
7	DOn*2	2nd output of nth public output signal port of user
6	DOn*3	3rd output of nth public output signal port of user
5	DOn*4	4th output of nth public output signal port of user
4	DOn*5	5th output of nth public output signal port of user
3	DOn*6	6th output of nth public output signal port of user
2	DOn*7	7th output of nth public output signal port of user
1	DOn*8	8th output of nth public output signal port of user

Note *) Terminal Block Number n = 1~4 (Ex, TBO1, TBO2, TBO3, TBO4)

The output specification of each port is as follows.

- Output component: Photo MOSFET output
- Rated output: 125mA (Continuous load current) / 24V DC
- Common power: Ground 24VDC or 24VDC

The user connects the output signal through the method shown in Figure 5.5 below. First, connect the common signal (COMMON) to the public IO board (BD580), and then connect each signal to the output pin according to the usage. For the power, 8 output signals can be composed as a unit and can be used differently.

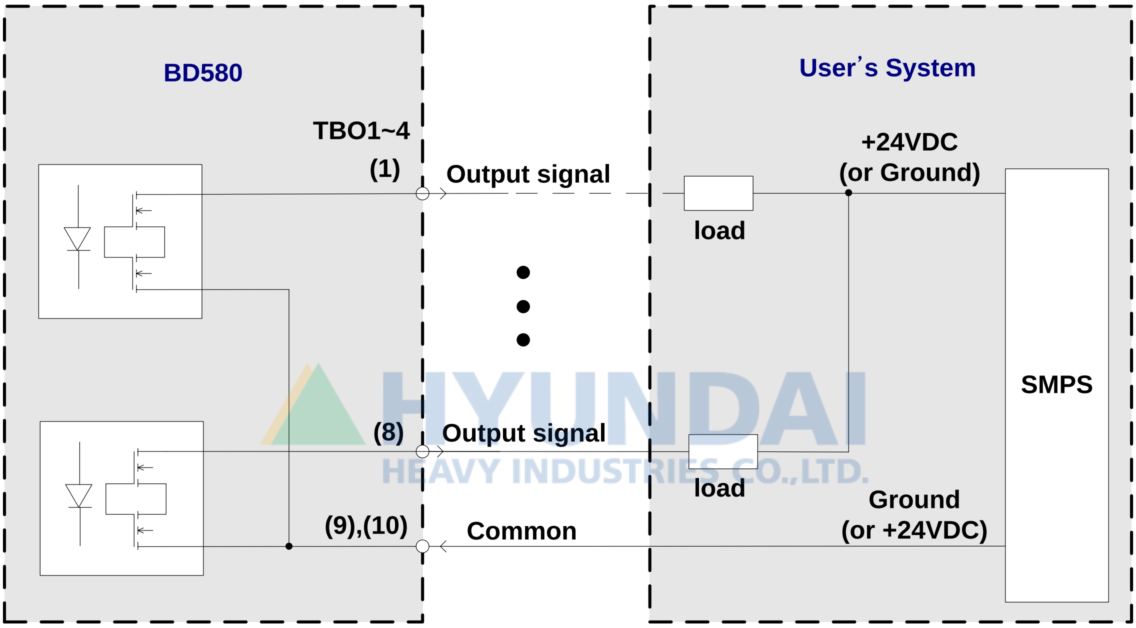
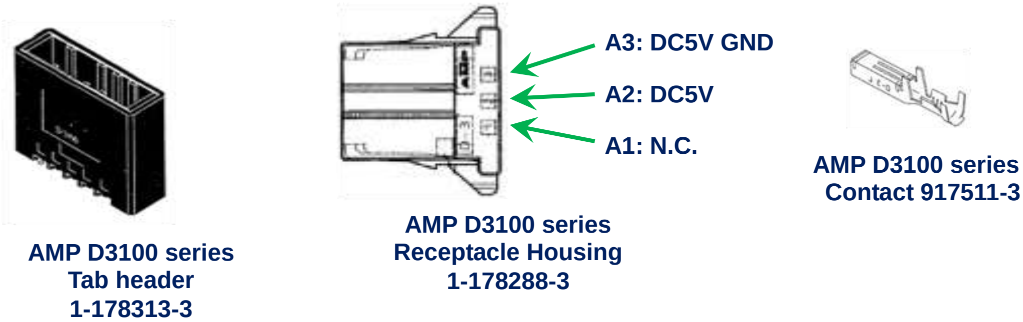


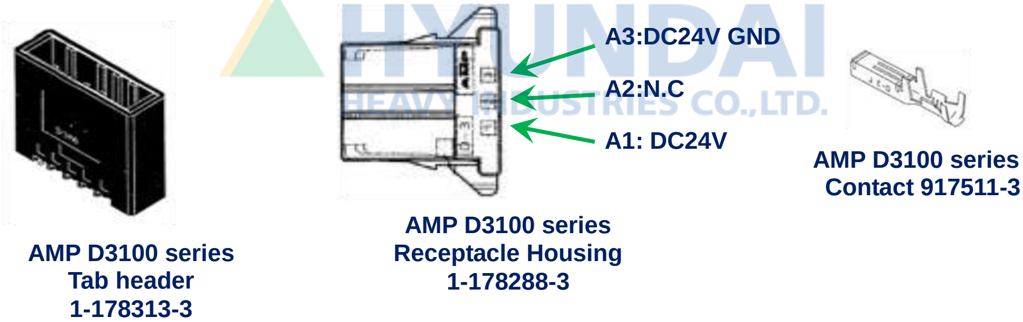
Figure 5.5 Method for the Connection of the Output Signals of the Public IO Board (BD580)

5.1.2.3. Power Connector: CNP1, CNP2

The Power Connector is the connector to supply the power to operate the public IO board (BD580), and is composed of connectors CNP1 for DC5V and CNP2 for DC24V, as shown in the Figure. As the power required for the basic operation of the board is DC5V, CNP1 must be connected. The connection of CNP2 for DC24V power can be made as required by the usage. The purpose of CNP2 is to operate the relay board that is additionally installed to the board. Therefore, CNP2 does not need to be connected for applications that do not require the relay board.



(a) CNP1 (DC5V power)



(b) CNP2 (DC24V power)

Figure 5.6 Power Connectors of the Public IO Board (BD580), CNP1 and CNP2

5.1.2.4. CAN Communications Connector: CANS1, CANS2

For the CAN Communications Connector, there are two identical connectors with the same pin specification, which are installed as shown in Figure 5.7 below. As CAN communication is conducted through cable, with a Daisy Chaining method, it therefore does not matter which side of the connector it is connected to, as it does not affect the operation.

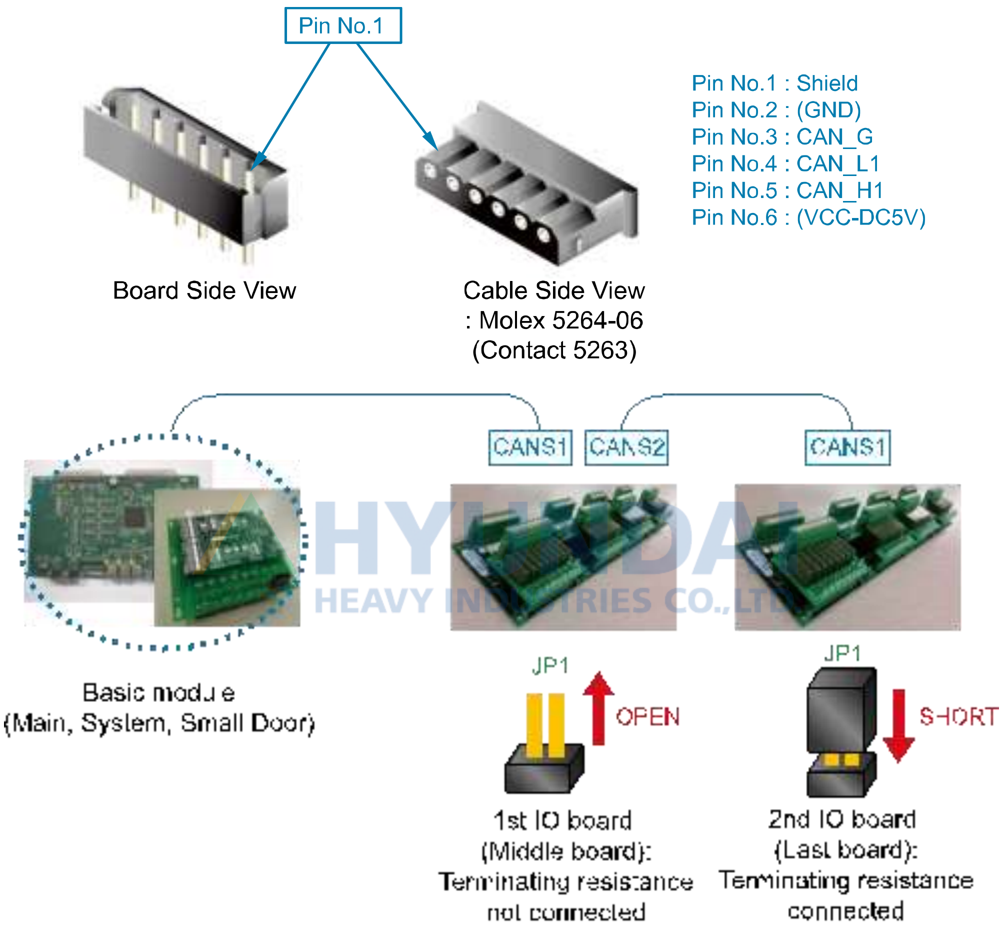


Figure 5.7 Method for the Connection of CAN Connectors of the Public IO Board (BD580)

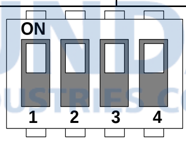
When connecting several boards, the terminating resistance must be processed precisely. CAN data communication uses the Daisy Chaining method. Therefore, only the board connecting the CAN communication cable at the end must be connected to the terminating resistance; all other boards must not be connected to the terminating resistance. For the connection of terminating resistance, use the JP1 jumper next to the CAN Connectors 1 and 2. When you short-circuit JP1, the terminating resistance is connected, and when opened, the terminating resistance is disconnected.

5.1.3. Setting Unit

5.1.3.1. DIP Switch Settings

DIP switch DSW1 sets the number of the board using a hexadecimal code. Based on the DIP switch settings, the number of the board is shown in Table 5-3 below.

Table 5-3 Settings of the DSW1 Switch of the Public IO Board (BD580)

Switch Number	**4**	**3**	**2**	**1**	**Setting (Board Number)**
Switch Condition	OFF	OFF	OFF	OFF	1
	OFF	OFF	OFF	ON	2
	OFF	OFF	ON	OFF	3
	OFF	OFF	ON	ON	4
Default setting	OFF	OFF	OFF	OFF	1
Switch exterior					

5.2. Relay Board (BD581)

5.2.1. Outline

The relay board is the board installed on the public IO board (BD580) to convert the semi-conductor output to contact point output in an 8-point unit.

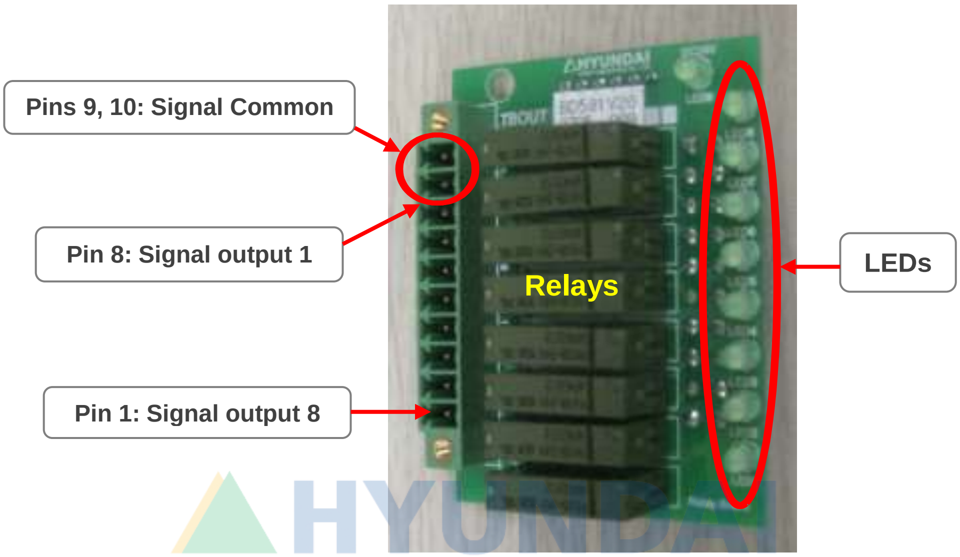


Figure 5.8 Relay Output Board of Public IO Board (BD581)

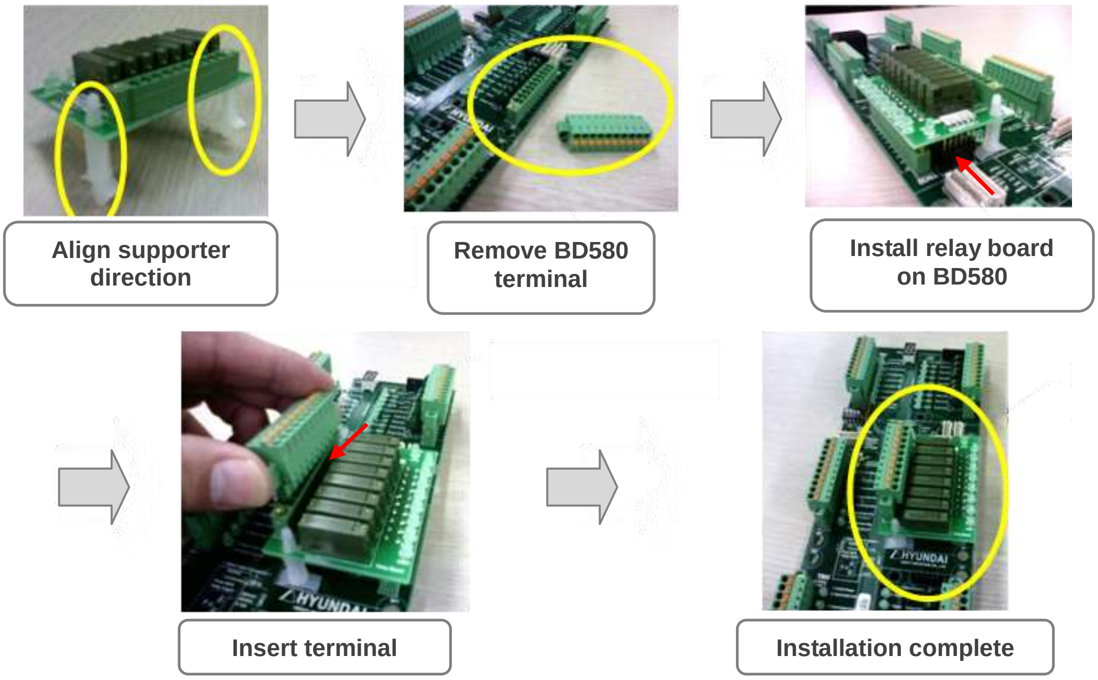


Figure 5.9 Method for the Installation of Relay Board

5.2.2. Connector

The output specification of the 8-point connector is as follows.

- Output component: Relay
- Rated output: 3A, 220VAC/24V DC

Table 5-4 Pin Configuration of the Digital Output Terminal Block (TBOUT) of the Relay Board (BD581)

Pin Number	Signal Name	Signal Description
10	COM	COMMON power (DC24V, DC24V ground, AC220V)
9		
8	DO1	1st user public relay output signal
7	DO2	2nd user public relay output signal
6	DO3	3rd user public relay output signal
5	DO4	4th user public relay output signal
4	DO5	5th user public relay output signal
3	DO6	6th user public relay output signal
2	DO7	7th user public relay output signal
1	DO8	8th user public relay output signal

5.3. Public IO Board (BD582 : Connector Type)

5.3.1. Outline

The Public DIO board can be used for interface or configuration with various devices through the digital IO port. The specification of the basic board is as follows.

- Digital input (Photocoupler type) 32 points (4 ports)
- (+/-) Two-way digital output (Photo MOS type) 32 points (4 ports)
- 1Mbps CAN communication
- Input/Output connector: MDR-type connector (3M)

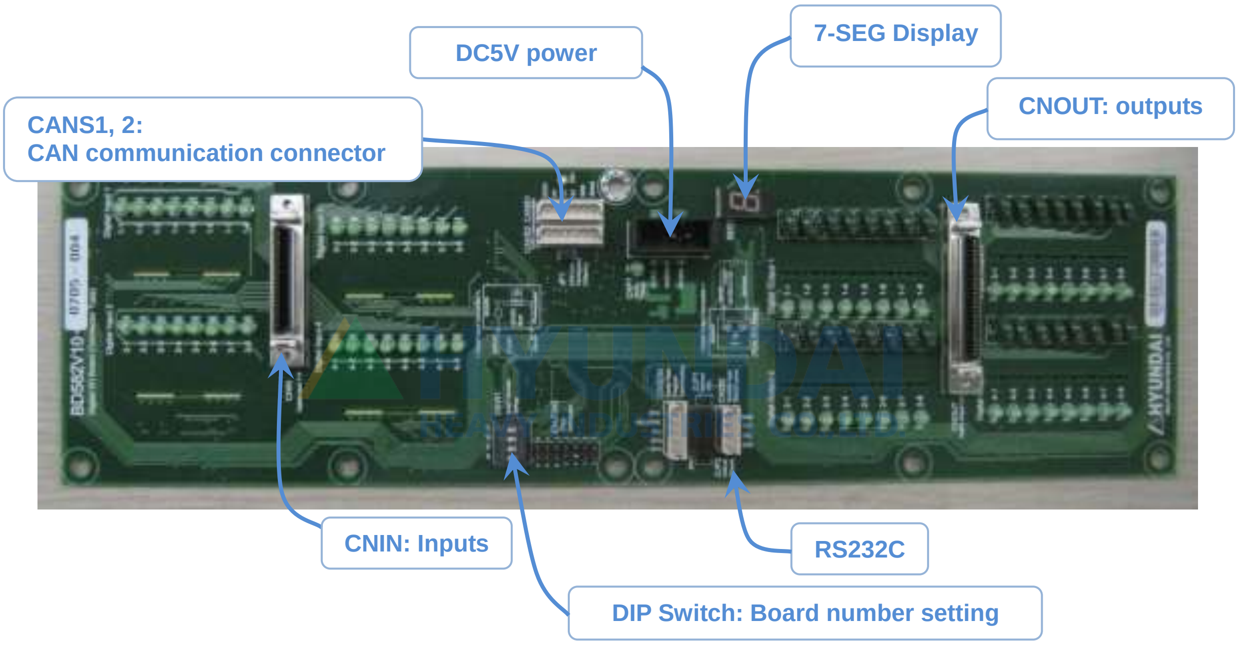


Figure 5.10 Public IO Board (BD582)

5.3.2. Connector

5.3.2.1. Digital Input

The following Figure and Table show the pin composition of connector CNIN for digital input. For the 32-point input pin, different power can be used for 8 input signals.

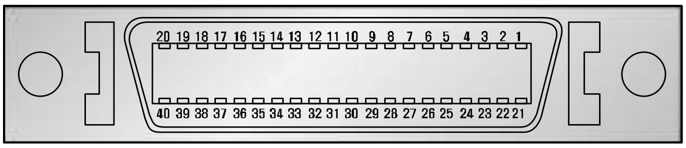


Figure 5.11 CNIN Connector (3M MDR 10240-52A2JL) of the Public IO Board (BD582)

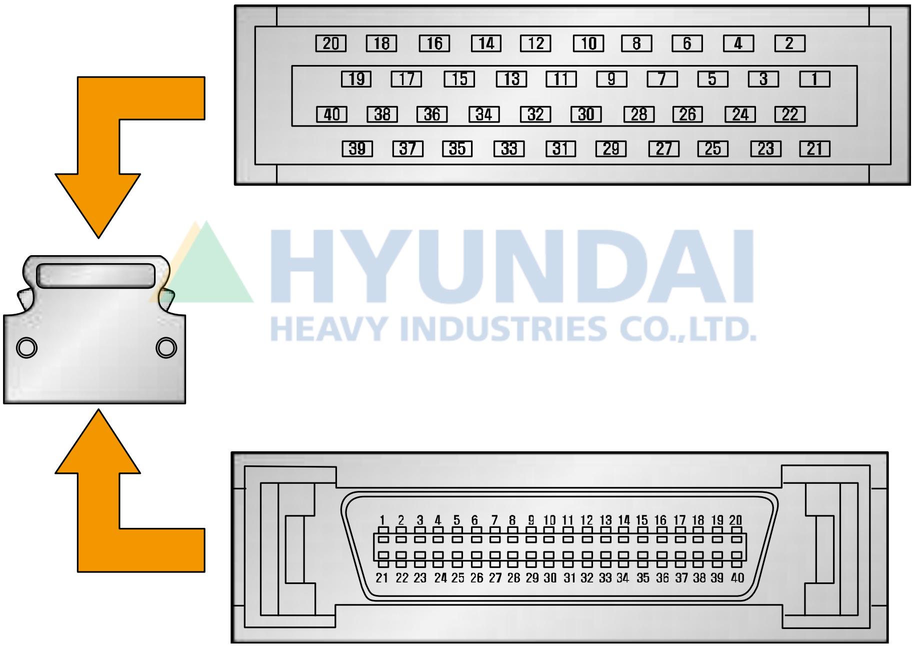


Figure 5.12 3M MDR 10140-3000VE (HOOD:1030-55F0-008) of CNIN Connector Plug of the Public IO Board (BD582)

Table 5-5 Pin Configuration of Digital Input Connector CNIN of the Public IO Board (BD582)

Pin Number	Signal Name	Function Description (Expansion Board/Basic Board)
1	DI01	Public input 1
2	DI02	Public input 2
3	DI03	Public input 3
4	DI04	Public input 4
5	DI05	Public input 5
6	DI06	Public input 6
7	DI07	Public input 7
8	DI08	Public input 8
9	COMIN0	External power input (User power): +24 V (For DI01~DI08)
10		
11	DI09	Public input 9
12	DI10	Public input 10
13	DI11	Public input 11
14	DI12	Public input 12
15	DI13	Public input 13
16	DI14	Public input 14
17	DI15	Public input 15
18	DI16	Public input 16
19	COMIN1	External power input (User power): +24 V (For DI09~DI16)
20		

Pin Number	Signal Name	Function Description (Expansion Board/Basic Board)
21	DI17	Public input 17
22	DI18	Public input 18
23	DI19	Public input 19
24	DI20	Public input 20
25	DI21	Public input 21
26	DI22	Public input 22
27	DI23	Public input 23 (Signal for external operation)
28	DI24	Public input 24
29	COMIN2	External power input (User power): +24 V (For DI17~DI24)
30		
31	DI25	Public input 25
32	DI26	Public input 26
33	DI27	Public input 27
34	DI28	Public input 28
35	DI29	Public input 29
36	DI30	Public input 30
37	DI31	Public input 31
38	DI32	Public input 32
39	COMIN3	External power input (User power): +24 V (For DI25~DI32)
40		

The input specification of each port is as follows.

- Input port component: AC input photocoupler
- Input impedance= 3 kΩ
- (+) Common input voltage = 24 VDC
- (-) Common input voltage = 0 VDC

The user connects the input signal through the method shown in Figure 5.13 below. First, connect the user power +24 V and ground wire to the public IO board (BD582), and then connect each signal to the input pin, depending on the usage. The power can be differently used by the 8 input port units.

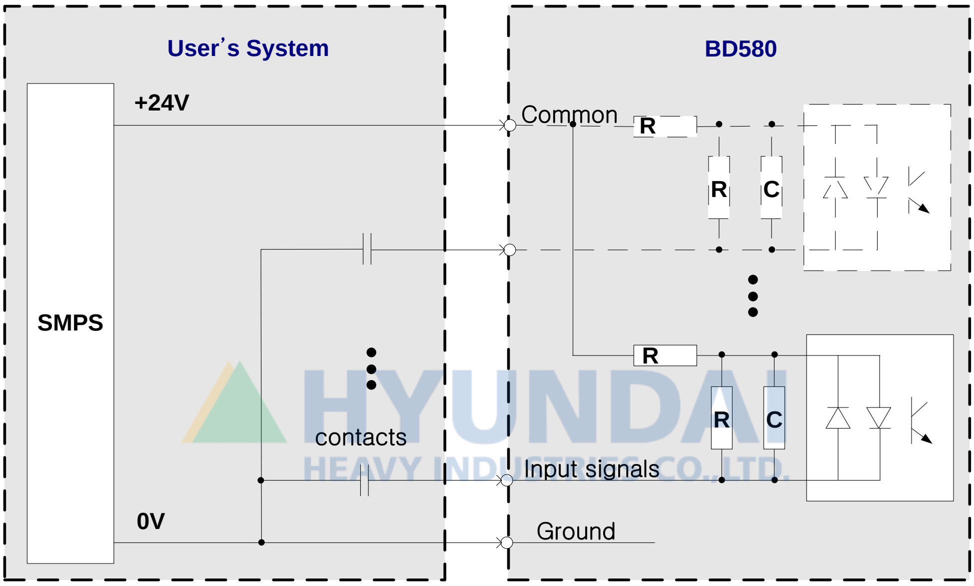


Figure 5.13 Method for Wiring Input Signals of the Public IO Board (BD582)

5.3.2.2. Digital Output

The following Figure and Table show the pin composition of connector CNOUT for digital output. For the 32-point output pin, different power can used for 8 output signals.

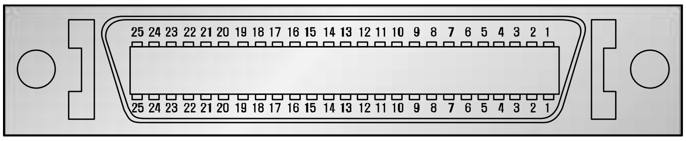


Figure 5.14 CNOUT Connector (3M MDR 10250-52A2JL) of the Public IO Board (BD582)

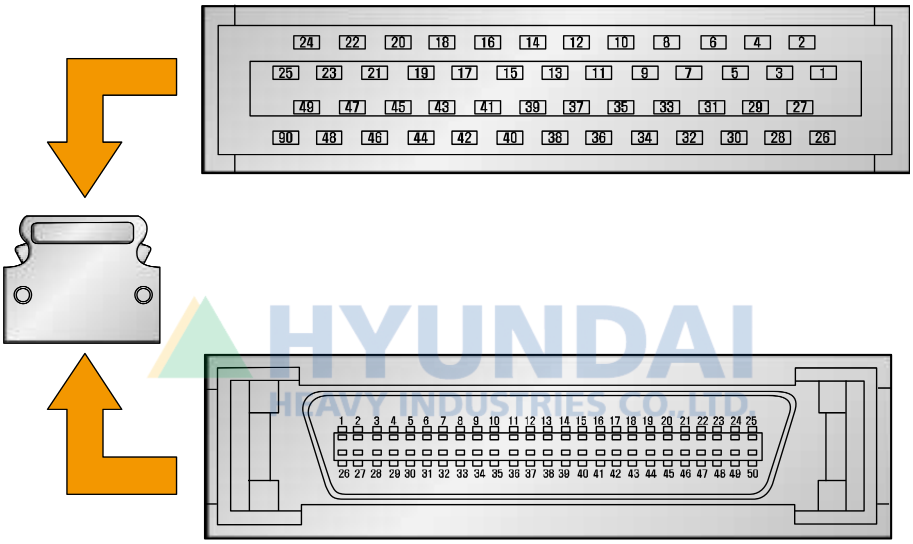


Figure 5.15 3M MDR 10150-3000VE (HOOD;10350-52F0-008) of the CNOUT Connector Plug of the Public IO Board (BD582)

Table 5-6 Pin Configuration of the Digital Input Connector CNOUT of the Public IO Board (BD582)

Pin Number	Signal Name	Function Description (Expansion Board/Basic Board)
1	DO01	Public output 1
2	DO02	Public output 2
3	DO03	Public output 3
4	DO04	Public output 4
5	DO05	Public output 5
6	DO06	Public output 6
7	DO07	Public output 7
8	DO08	Public output 8
9	COMOUT0	External power input (User power): COMMON (For DO01~DO08)
10		
11	DO09	Public output 9
12	DO10	Public output 10
13	DO11	Public output 11
14	DO12	Public output 12
15	DO13	Public output 13
16	DO14	Public output 14
17	DO15	Public output 15
18	DO16	Public output 16
19	COMOUT1	External power input (User power): COMMON (For DO09~DO16)
20		
21	N.C	Not used
22	N.C	Not used
23	N.C	Not used
24	N.C	Not used
25	N.C	Not used
26	N.C	Not used

Pin Number	Signal Name	Function Description (Expansion Board/Basic Board)
27	N.C	Not used
28	N.C	Not used
29	N.C	Not used
30	N.C	Not used
31	DO17	Public output 17
32	DO18	Public output 18
33	DO19	Public output 19
34	DO20	Public output 20
35	DO21	Public output 21
36	DO22	Public output 22
37	DO23	Public output 23
38	DO24	Public output 24
39	COMOUT2	External power input (User power): COMMON (For DO17~DO24)
40		
41	DO25	Public output 25
42	DO26	Public output 26
43	DO27	Public output 27
44	DO28	Public output 28
45	DO29	Public output 29
46	DO30	Public output 30
47	DO31	Public output 31
48	DO32	Public output 32
49	COMOUT3	External power input (User power): COMMON (For DO25~DO32)
50		

The output specification of each port is as follows.

- Output component: Photo MOSFET output
- Rated output = 125mA (Continuous load current), 24V DC
- (-) Common output voltage = 0V DC (OPEN COLLECTOR)

The user connects the output signal through the method shown in Figure 5.16 below. First, connect the COMMON signal to the public IO board (BD582), and then connect each signal to the output pin depending on the usage. The power can be differently used by each 8-output port unit.

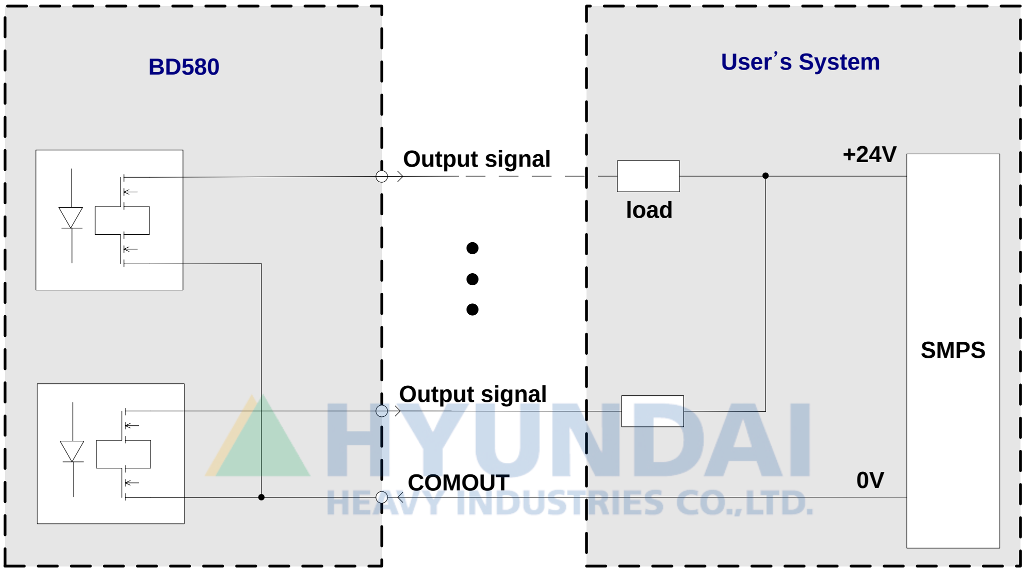


Figure 5.16 Method for Connection of Output Signals of the Public IO Board (BD582)

5.3.2.3. Power Connector: CNP1

Power Connector is the connector for DC5V power to operate the public IO board (BD582), and the pin specification is as shown in Figure 5.17 below.

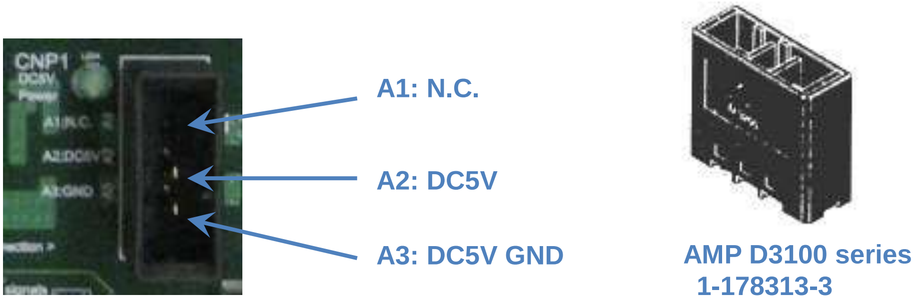


Figure 5.17 Power Connector CNP1 of the Public IO Board (BD582)

5.3.2.4. CAN Communications Connector: CANS1, CANS2

For the CAN Communications Connector, there are two identical connectors with the same pin specification, which are installed as shown in Figure 5.18 below. As CAN communication is conducted through cable, with a Daisy Chaining method, it therefore does not matter which side of the connector it is connected to, as it does not affect the operation.

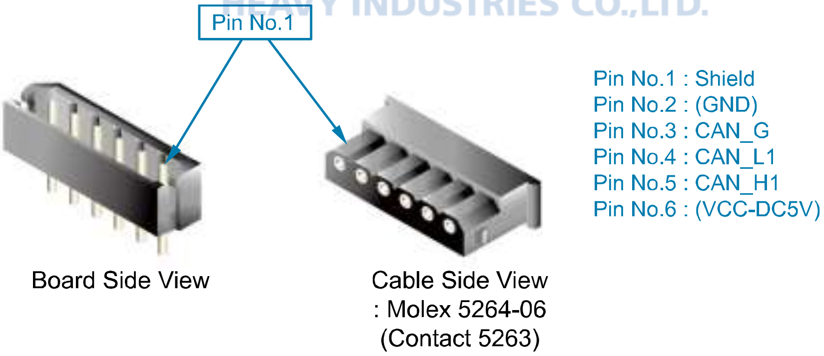


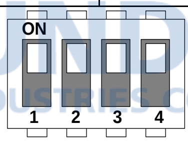
Figure 5.18 Method for Connection of the CAN Connector of the Public IO Board (BD582)

5.3.3. Setting Unit

5.3.3.1. DIP Switch Settings

DIP switch DSW1 sets the number of the board in hexadecimal code. Based on the setting of the switch, the number of the board is shown in the following Table.

Table 5-7 Method for Setting of the DSW1 Switch of the Public IO Board (BD582)

Switch Number	**4**	**3**	**2**	**1**	**Setting (Board Number)**
Switch Condition	OFF	OFF	OFF	OFF	1
	OFF	OFF	OFF	ON	2
	OFF	OFF	ON	OFF	3
	OFF	OFF	ON	ON	4
Default Setting	OFF	OFF	OFF	OFF	1
Switch Exterior					

5.4. CC-link Board (BD570)

5.4.1. Outline

To use the robot as the Slave from the field bus configured with CC-LINK communication, CC-LINK board (BD570) must be used, as shown in Figure 5.19 below. To block various types of noise and surges from the external environment of the robot, various signals are insulated from the external side.

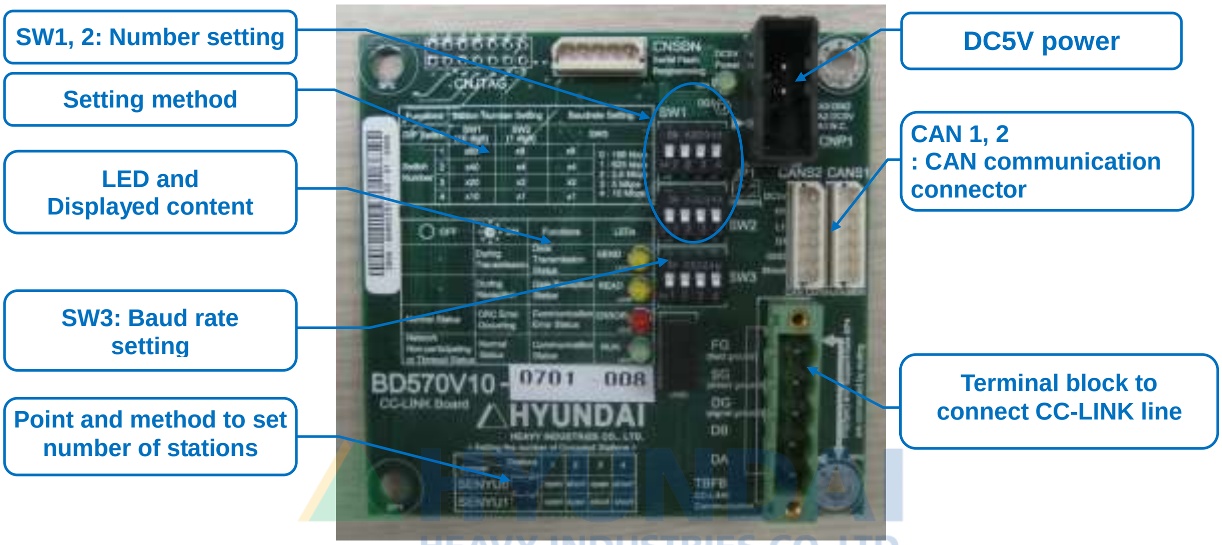


Figure 5.19 CC-LINK Board (BD570)

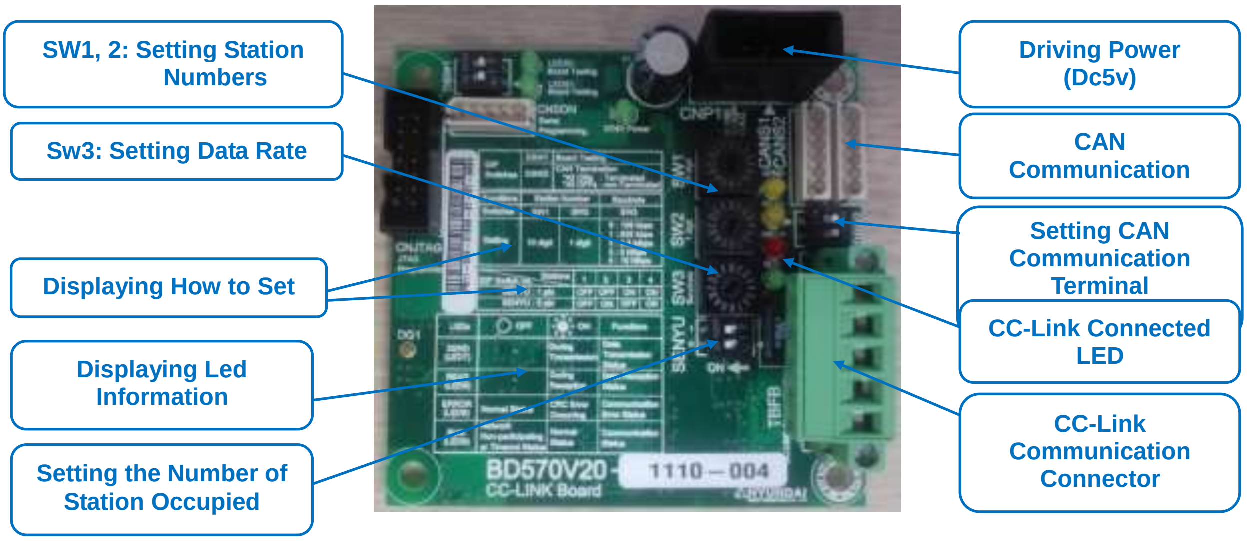


Figure 5.20 CC-LINK Board (BD570V20)

5.4.2. Connector

5.4.2.1. CC-link Communication Terminal Block: TBFB

Use the terminal block TBFB to connect to the CC-LINK communication line. Refer to the indicated properties of each pin, as shown in Figure 5.20 below.

Figure 5.21 CC-LINK Communication Terminal Block of CC-LINK Board (BD570)

Table 5-8 Cc Terminal Composition Of The Terminal Block TBFB For The CC-link Communication Of The CC-link Board (Bd570v20)

Name Of Terminal Block	Form	Terminal No.	Signal Name	Function
TBFB	 	5	FG	CC-link Cable Ground
		4	SG	CC-link Cable Shield
		3	DG	CC-link Ground
		2	DB	CC-link DB Line
		1	DA	CC-link DA Line

5.4.2.2. Power Connector: CNP1

The Power Connector is the connector for DC5V power to operate the CC-LINK board (BD570), and the pin specification is as shown in Figure 5.21 below.

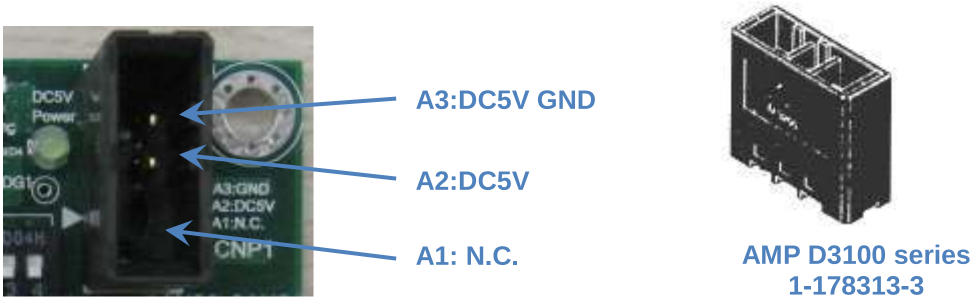
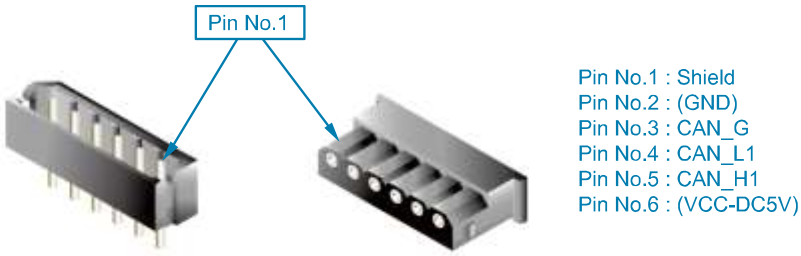


Figure 5.22 Power Connector CNP1 of CC-LINK Board (BD570)

5.4.2.3. CAN Communications Connector: CANS1, CANS2



Board Side View

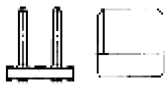
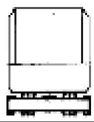
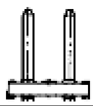
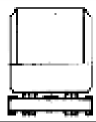
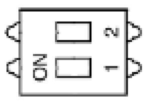
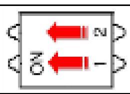
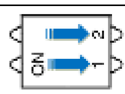
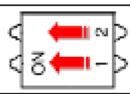
Cable Side View
: Molex 5264-06
(Contact 5263)

Figure 5.23 Method for the Connection of the CAN Connector of the CC-LINK Board (BD570)

For the CAN Communications Connector, there are two identical connectors with the same pin specification, which are installed as shown in Figure 5.22 above. As CAN communication is conducted through cable, with a Daisy Chaining method, it therefore does not matter which side of the connector it is connected to, as it does not affect the operation.

When the board is installed in the terminal of the CAN communication system, the terminal shall be handled according to the following methods.

Table 5-9 How to Deal with the Can Communication Terminal of the CC-link Board (BD570)

Board Type	Terminating Equipment	Form	How To Set		Set During Forwarding
			Terminal	Non-Terminal	
BD570V10	Jumper JP1				
			SHORT	OPEN	SHORT
BD570V20	Dip switch DSW2				
			ALL ON	ALL OFF	ALL ON

5.4.3. Indication and Setting Units

Various LEDs are used to display the communication status of the CC-LINK line. Indicated details of each LED are displayed on the board, as shown in Figure 5.23 below. You may also use the dip switch to set the number and communication speed of the CC-LINK board; relevant details are indicated on the board shown in Figures 5.24 and 5.25 below.

Figure 5.24 LED and Detail of Communication Status Indication of CC-LINK Board (BD570)

Figure 5. 25 Led For Displaying the Communication Conditions of the CC-link Board (Bd570v20) and the Information

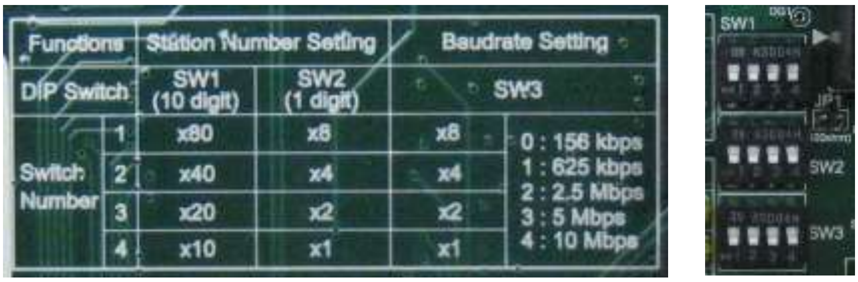
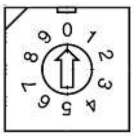
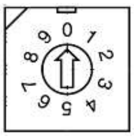
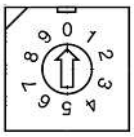


Figure 5.26 Setting Station Number and Communication Speed of the CC-LINK Board (BD570)

Table 5-10 How to Set the CC-link Station Numbers and the Data Rate

Switch Name	Use	Form	How To Set	Set During Forwarding
Sw1	Station No. (10 Units)		Setting Station Number= (Set Value Of Swz1 X 10) + Set Value Of Swz2	“0”
Sw2	Station No. (1 Unit)			“1”
Sw3	Data Rate		0 : 125 Kbps 1 : 625 Kbps 2 : 2.5 Mbps 3 : 5.0 Mbps 4 : 10 Mbps	“4”

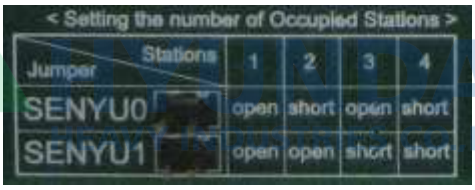
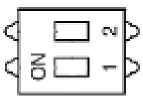


Figure 5.27 Method for Setting of the Number of Stations of the CC-LINK Board (BD570)

Table 5-11 How to Set the Number of the CC-link Station Occupied By the CC-link Board (Bd570v20)

Switch Name	Form	Switch No.	How To Set The No. Of Station Occupied				Set During Forwardin g
			1	**2**	**3**	**4**	
SENYU		**2 (Senyu1)**	Off	Off	On	On	On
		1 (SENYU0)	OFF	ON	OFF	ON	ON

5.5. Conveyor I/F Board (BD585)

5.5.1. Outline

When configuring the robot system to synchronize with the conveyor, an interface board must be used to receive the encoder signal to detect the location of the conveyor Figure 5.26 below shows the configuration of the Conveyor Interface Board (BD585). There are two input ports, for which you can select the line receiver method or the open collector method.

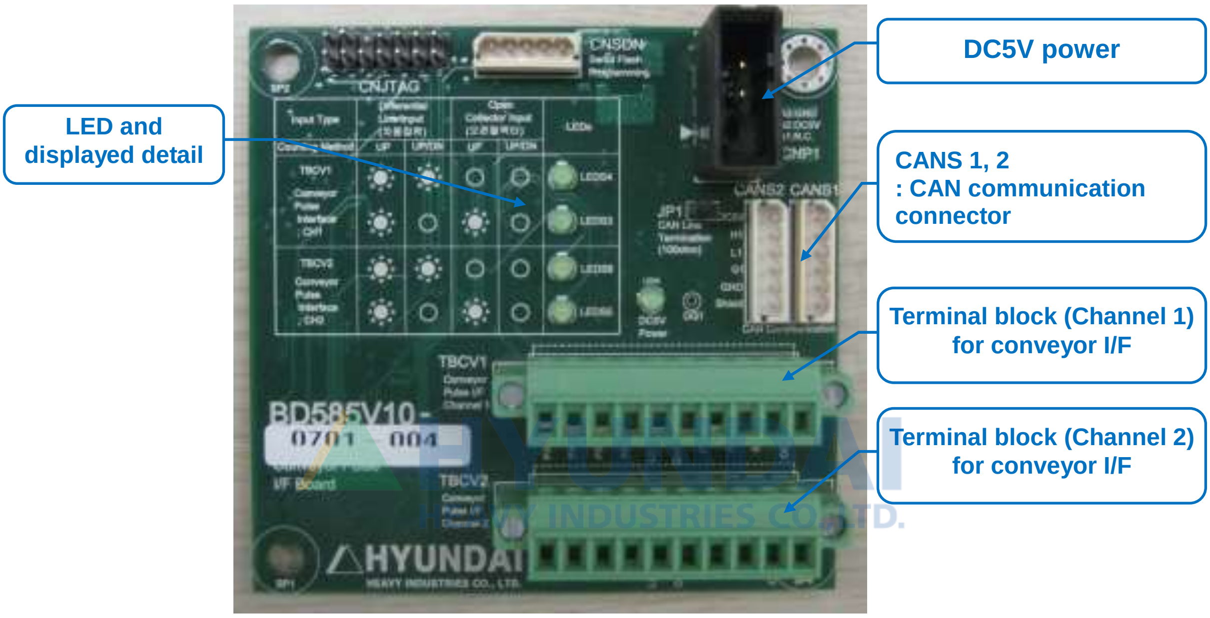


Figure 5.28 Conveyor I/F Board (BD585)

5.5.2. Connector

5.5.2.1. Conveyor I/F Terminal Block: TBCV1, TBCV2

The input of conveyor pulse can be connected to the two identical terminal blocks with the same pin specification, as shown in Figure 5.27 below. That is, two conveyors can be connected.

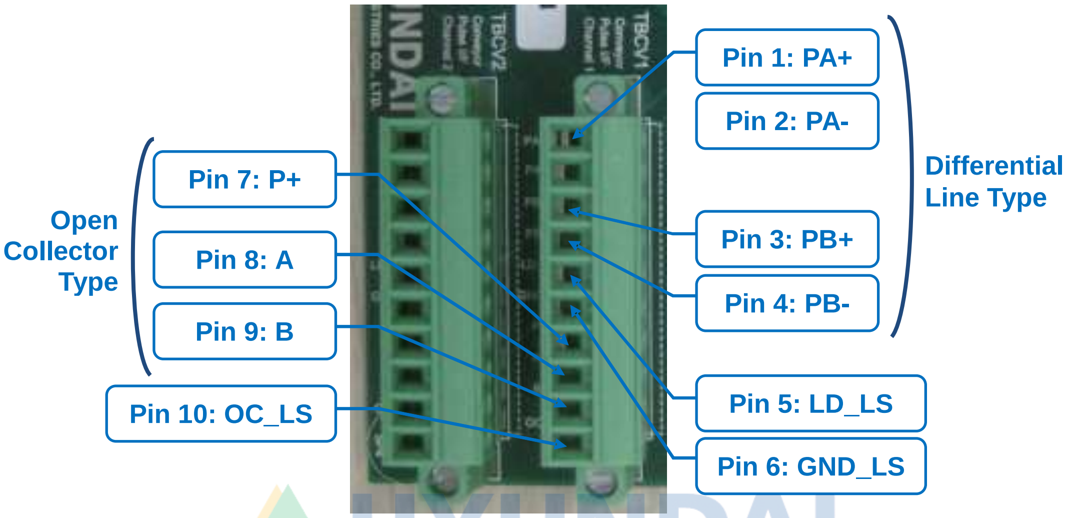


Figure 5.29 Conveyor Connection Terminal Block of the Conveyor I/F Board (BD585)

5.5.2.2. Power Connector: CNP1

The Power Connector is the connector for DV5V power to operate the Conveyor I/F Board (BD585), and the pin specification is as shown in Figure 5.28 below.

Figure 5.30 Power Connector CNP1 of Conveyor I/F Board (BD585)

5.5.2.3. CAN Communications Connector: CANS1, CANS2

For the CAN Communications Connector, there are two identical connectors with the same pin specification, which are installed as shown in Figure 5.29 below. As CAN communication is conducted through cable, with a Daisy Chaining method, it therefore does not matter which side of the connector it is connected to, as it does not affect the operation.

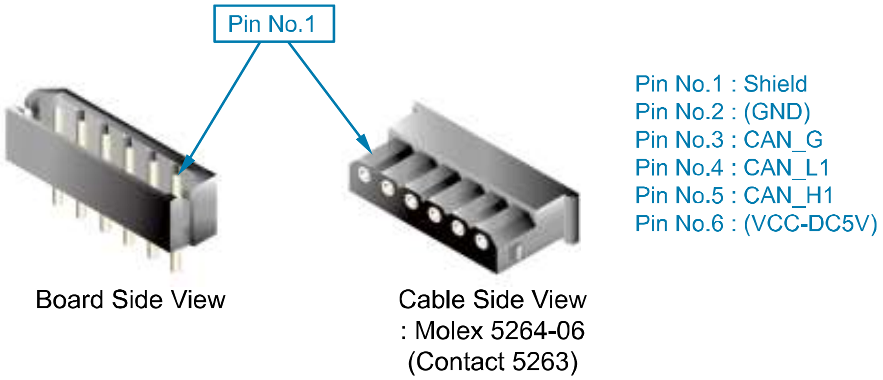


Figure 5.31 Method for the Connection of CAN Connector of the Conveyor I/F Board (BD585)

5.5.3. Display Unit

The method of counting the conveyor pulse that has been set is displayed with an LED, as shown in Figure 5.30 below. For each case, the description is shown on the board.

Figure 5.32 LED and Detail for Conveyor I/F Board (BD585) Status Indication

5.6. LDIO Board (BD58A; For LCD)

5.6.1. Outline

As a board exclusively for LCD, LDIO Board includes the DIO board and CC-LINK, and is installed on the RACK to ensure space inside the controller. The specification of the basic board is as follows.

- Digital input (Photocoupler type): 32 points
- BD58AV10 : Digital Output (Photo MOS Type) 24 Points, Relay Contact Output 8 Points
  BD58AV20 And Over : Digital Output (Photo MOS Type) 24 Points, FET (N Channel) Output 8 Points
- CC-LINK communication function included
- RS232 / RS485 select 1 channel
- Installation location: RACK
- 1 Mbps CAN communication

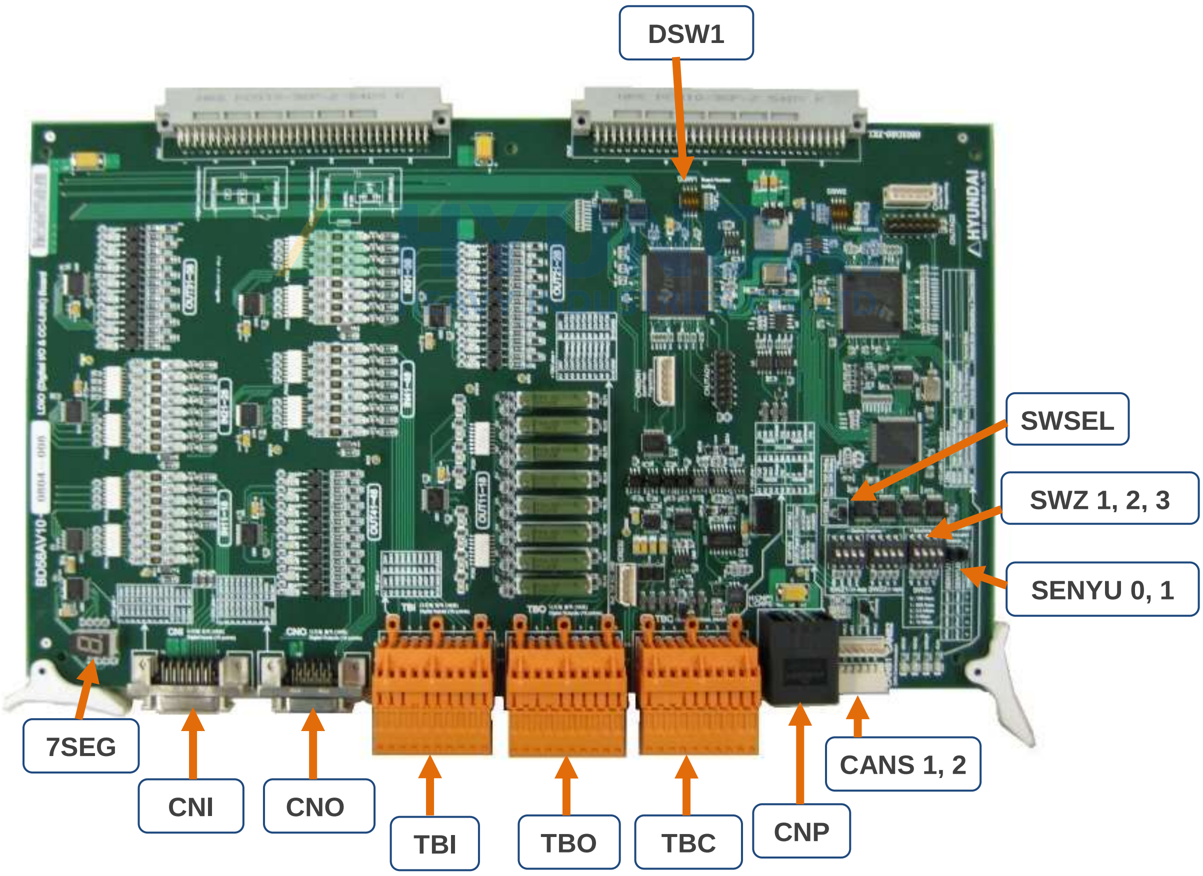


Figure 5.33 Appearance of the LDIO Board (BD58A)

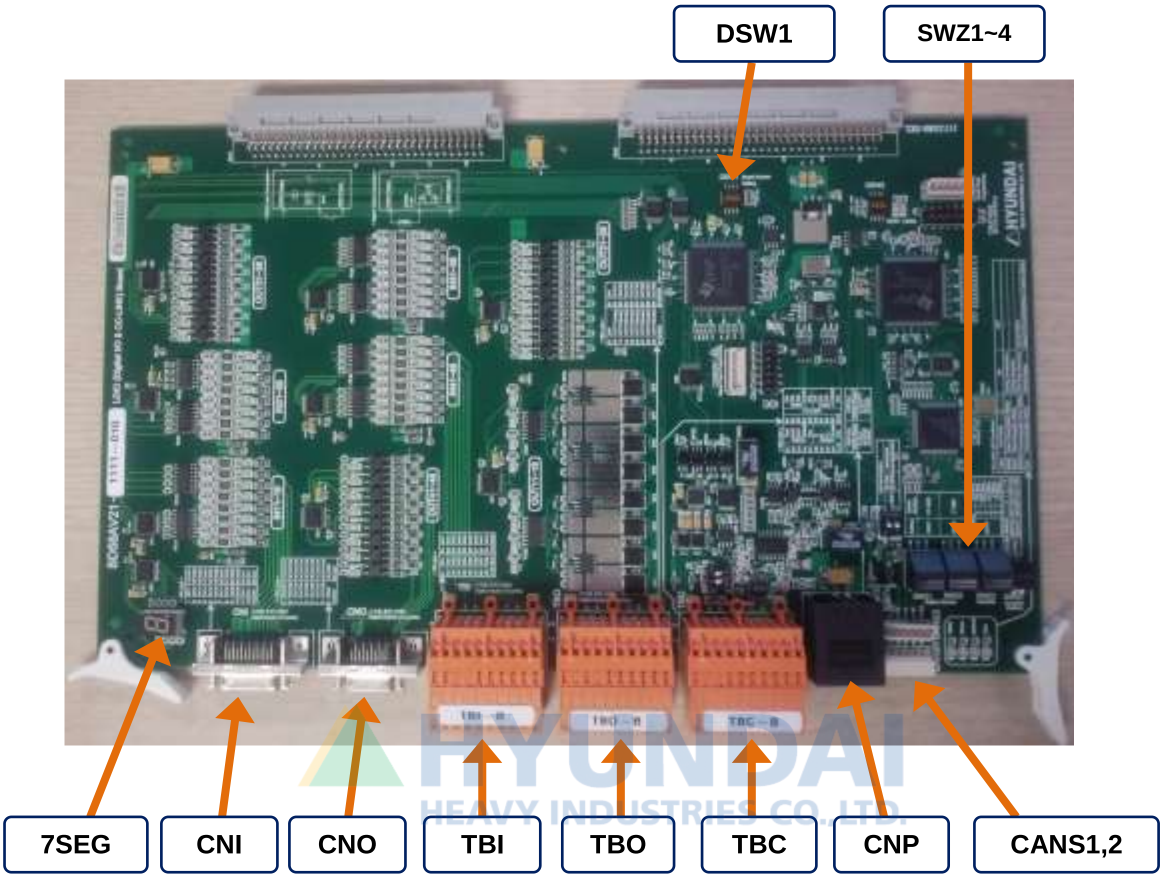


Figure 5.34 Appearance of the LDIO Board (BD58AV21)

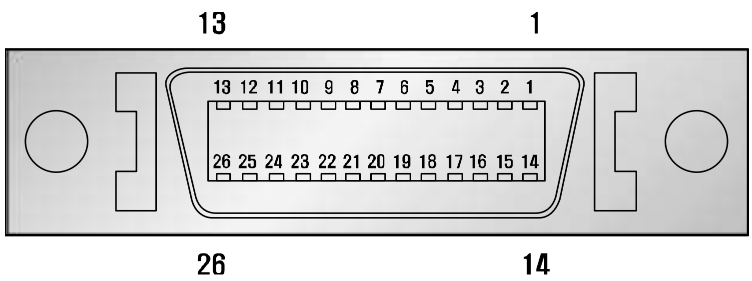
5.6.2. Connector

5.6.2.1. Digital Input

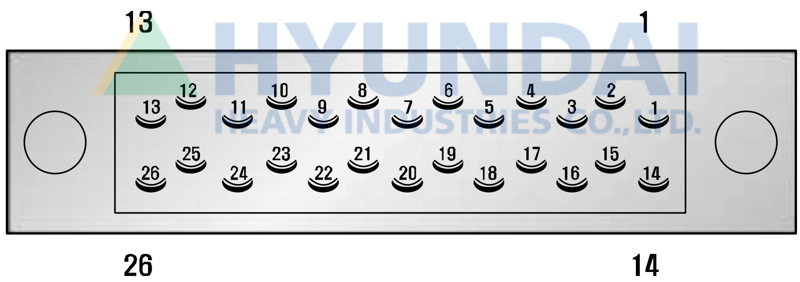
The photocoupler is used for digital input, and a total of 32 points are provided. The user can input each 16-point signal through the connector and terminal as required.

(1) Input through connector

The following Figure and Table show the pin composition of connector CN1 for digital input.



(a) Board side (3M MDR 10226-52A2JL)



(b) Plug side 3M MDR 10126-3000VE (HOOD: 10326-52F0-008)

Figure 5.35 Digital Input Connector CNI of LDIO Board (BD58A)

Table 5-12 Pin Configuration of the Digital Input Connector CNI of the LDIO Board (BD58A)

Pin Number	Signal Name	Function Description
1	IN11	Digital input 11
2	IN12	Digital input 12
3	IN13	Digital input 13
4	IN14	Digital input 14
5	IN15	Digital input 15
6	IN16	Digital input 16
7	IN17	Digital input 17
8	IN18	Digital input 18
9	M2	Power output: DC24V GND
10		
11	P2	Power output: DC24V
12		
13		
14	IN21	Digital input 21
15	IN22	Digital input 22
16	IN23	Digital input 23
17	IN24	Digital input 24
18	IN25	Digital input 25
19	IN26	Digital input 26
20	IN27	Digital input 27

Pin Number	Signal Name	Function Description
21	IN28	Digital input 28
22	M1	Power output: DC24V GND
23		
24	P1	Power output: DC24V
25		
26		

(2) Input through terminal block

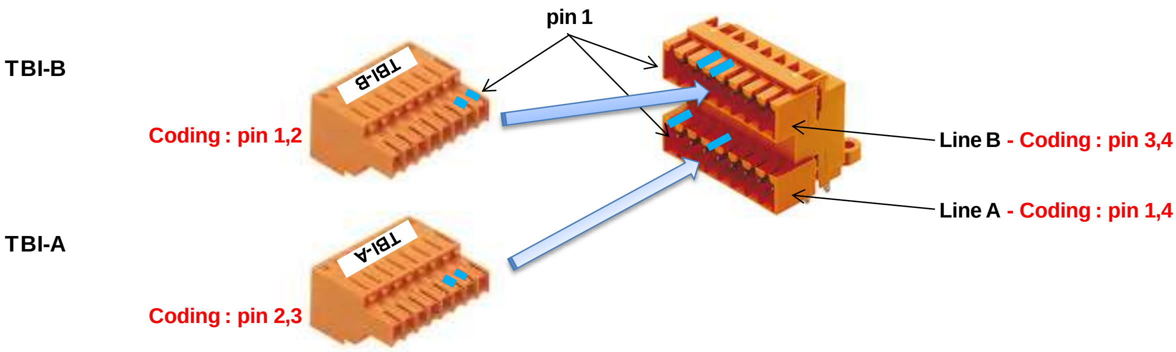


Figure 5.36 Digital Input Terminal Block TBI of LDIO Board (BD58A)

Table 5-13 Terminal Configuration of the Digital Input Terminal Block TBI of the LDIO Board (BD58A)

Terminal Block Name	Terminal Number	Signal Name	Function Description
TBI - A	1	P2	Power output: DC24V
	2	IN31	Digital input 31
	3	IN32	Digital input 32
	4	IN33	Digital input 33
	5	IN34	Digital input 34
	6	IN35	Digital input 35
	7	IN36	Digital input 36
	8	IN37	Digital input 37
	9	IN38	Digital input 38
	10	M2	Power output: DC24V GND
TBI - B	1	P2	Power output: DC24V
	2	IN41	Digital input 41
	3	IN42	Digital input 42
	4	IN43	Digital input 43
	5	IN44	Digital input 44
	6	IN45	Digital input 45
	7	IN46	Digital input 46
	8	IN47	Digital input 47
	9	IN48	Digital input 48
	10	M2	Power output: DC24V GND

The input specification of each port is as follows.

- Input port component: AC input photo coupler
- Input impedance= 3 ㏀
- (+) Common input voltage = 24 VDC
- (-) Common input voltage = 0 VDC

The user connects the input signal through the method shown in Figure 5.34 below.

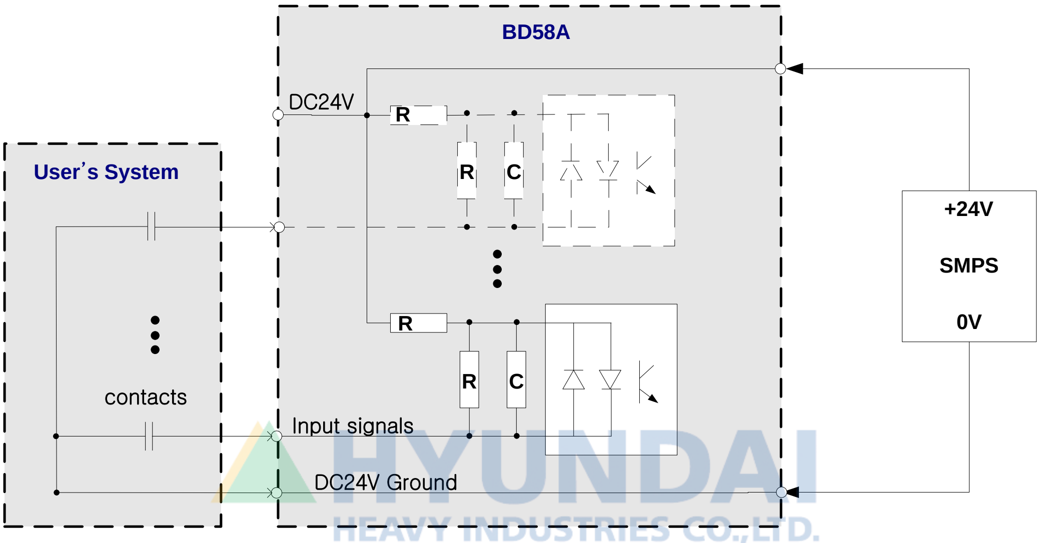


Figure 5.37 Method for Wiring the Input Signal of LDIO Board (BD58A)

5.6.2.2. Digital Output

Two-way output at 32 points using MOSFET is provided for the digital output. The user can output each 16-point signal through the connector and terminal as required, and the 8-point output is the relay contact point output.

(1) Output through terminal block

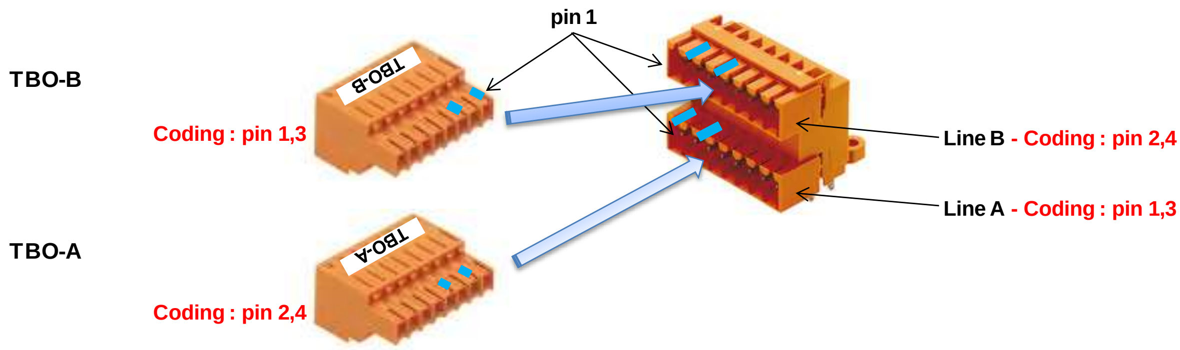


Figure 5.38 Digital Output Terminal Block TBO of LDIO Board (BD58A)

Table 5-14 Terminal Configuration of the Digital Output Terminal Block TBO of the LDIO Board (BD58A)

Terminal Block Name	Terminal Number	Signal Name	Function Description
TBO - A	1	P2	Power output: DC24V
	2	OUT11	Digital output 11 (Relay contact point output)
	3	OUT12	Digital output 12 (Relay contact point output)
	4	OUT13	Digital output 13 (Relay contact point output)
	5	OUT14	Digital output 14 (Relay contact point output)
	6	OUT15	Digital output 15 (Relay contact point output)
	7	OUT16	Digital output 16 (Relay contact point output)
	8	OUT17	Digital output 17 (Relay contact point output)
	9	OUT18	Digital output 18 (Relay contact point output)
	10	M2	Power output: DC24V GND

Terminal Block Name	Terminal Number	Signal Name	Function Description
TBO - B	1	P2	Power output: DC24V
	2	OUT21	Digital output 21
	3	OUT22	Digital output 22
	4	OUT23	Digital output 23
	5	OUT24	Digital output 24
	6	OUT25	Digital output 25
	7	OUT26	Digital output 26
	8	OUT27	Digital output 27
	9	OUT28	Digital output 28
	10	M2	Power output: DC24V GND

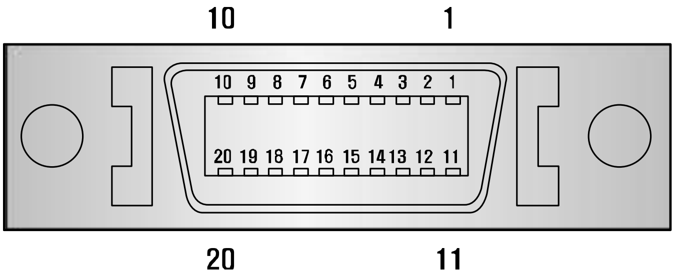
The versions of BD58AV20 board and over have changed the output from the 8-point relay contact provided by BD58AV10 to the N channel FET.

Table 5-15 Terminal Block TBO Terminal Composition of the Digital Output for Each Version of the LDIO Board (BD58A)

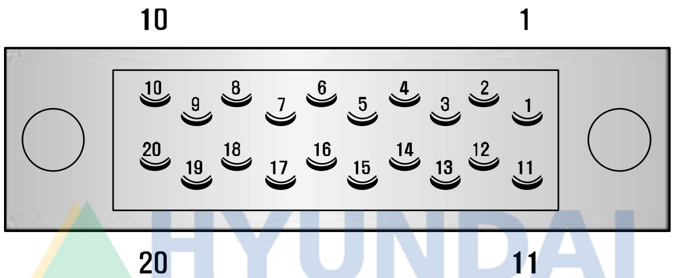
Board Name	Name Of Terminal Block	Terminal No.	Signal Name	Function
Common	**TBO - A**	1	P2	Power Output: DC24V
BD58AV10		2~9	OUT11~18	Digital Output 11~18 **(Output Of Relay Contact)**
Versions of BD58AV20 and Over				Digital Output 11~18 (**Output Of N Channel FET**)
Common		10	M2	Power Output: DC24V GND

(2) Output through connector

The following Figure and Table show the pin composition of the connector CNO for digital output.



(a) Board side (3M MDR 10220-52A2JL)



(b) Plug side 3M MDR 10120-3000VE (HOOD: 10320-52F0-008)

Figure 5.39 CNO Connector of LDIO Board (BD58A)

Table 5-16 Pin Configuration of the Digital Input Connector CNO of the LDIO Board (BD58A)

Pin Number	Signal Name	Function Description
1	OUT31	Digital output 31
2	OUT32	Digital output 32
3	OUT33	Digital output 33
4	OUT34	Digital output 34
5	OUT35	Digital output 35
6	OUT36	Digital output 36
7	OUT37	Digital output 37
8	OUT38	Digital output 38

Pin Number	Signal Name	Function Description
9	M2	Power output: DC24V GND
10	P2	Power output: DC24V
11	IN41	Digital input 41
12	IN42	Digital input 42
13	IN43	Digital input 43
14	IN44	Digital input 44
15	IN45	Digital input 45
16	IN46	Digital input 46
17	IN47	Digital input 47
18	IN48	Digital input 48
19	M2	Power output: DC24V GND
20	P2	Power output: DC24V

The output specifications using photo MOSFET are as follows.

- Output component: Photo MOSFET output
- Rated output = 125 mA (Continuous load current), 24V DC

The relay contact output specifications are as follows:

- Output element: relay contact output
- Rated output = 5A/24VDC, 5A/250VAC

The FET output specifications of the versions of BD58AV20 and over are as follows:

- Output element: N channel FET output
- Rated output = 1A/24VDC

The user connects the output signal as shown in Figures 5.40, 5.41 and 5.42 below.

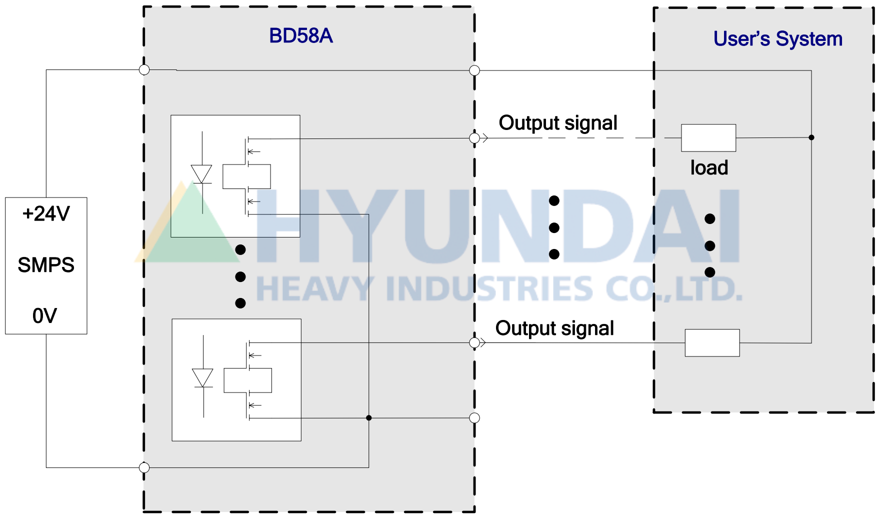


Figure 5.40 Method for Wiring the Output Signal of LDIO Board (BD58A) (Photo MOSFET)

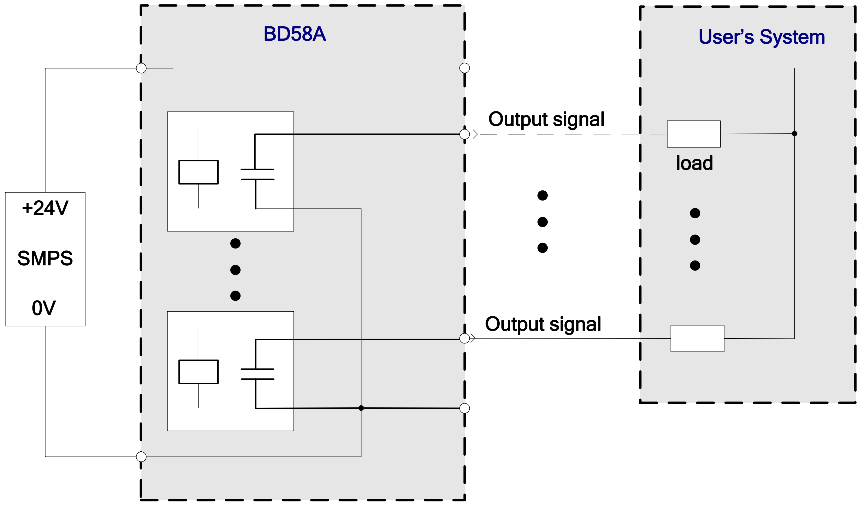


Figure 5.41 Method for Wiring the Output Signal of LDIO Board (BD58A) (Relay Contact Point)

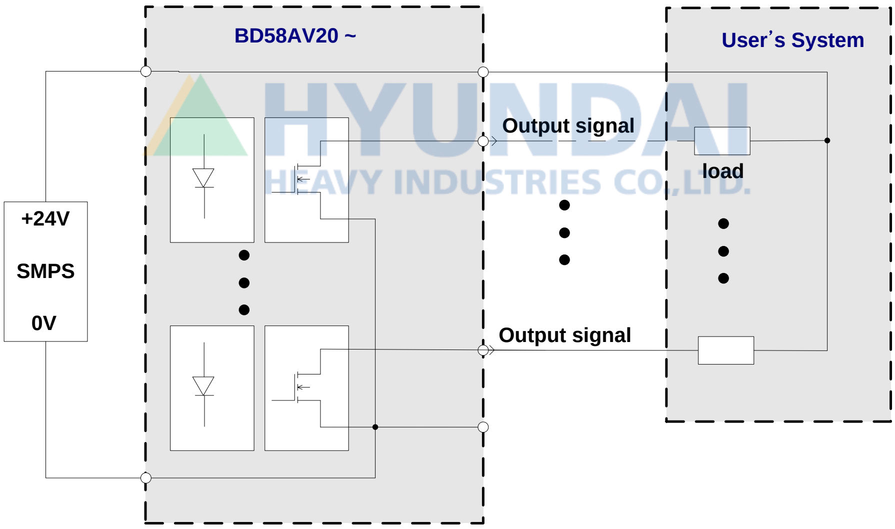


Figure 5.42 How to Connect the FET Output Signal with the Versions of the LDIO Board BD58AV20 and Over.

5.6.2.3. Communication Connection

LDIO board supports serial communication RS232 and RS485 of beam sensor, and includes the CC-LINK function to facilitate information connections among the robots. Each communication is connected using the terminal block TBC.

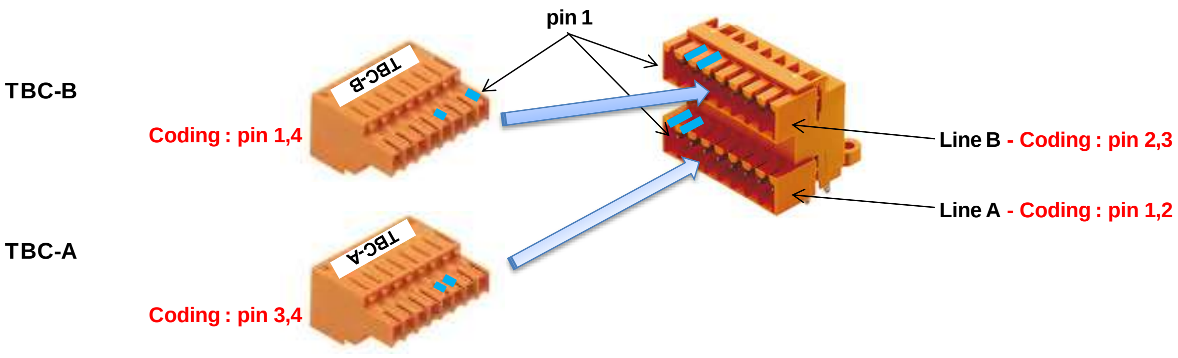


Figure 5.43 Serial Communication Terminal Block TBC of LDIO Board (BD58A)

Table 5-17 Terminal Configuration of Serial Communication Terminal Block TBC of LDIO Board (BD58A)

Terminal Block Name	Classification	Terminal Number	Signal Name	Function Description
TBC - A	RS232 (DSW1 #4 ON)	1	TxD	RS232 Transmission
		2	RxD	RS232 Receipt
		3	SG	RS232 Ground
		4	Shield1	RS232 Cable shield
		5	FG1	RS232 Cable ground
	RS485 (DSW1 #4 OFF)	6	A	RS485 + Side line
		7	B	RS485 – Side line
		8	G2	RS485 Ground
		9	Shield2	RS485 Cable shield
		10	FG2	RS485 Cable ground
TBC - B	CC-LINK	1	DA	CC-LINK DA line
		2	DB	CC-LINK DB line
		3	DG	CC-LINK Ground
		4	Shield3	CC-LINK Cable shield
		5	FG3	CC-LINK Cable ground
	CC-LINK	6	DA	CC-LINK DA line
		7	DB	CC-LINK DB line
		8	DG	CC-LINK Ground
		9	Shield3	CC-LINK Cable shield
		10	FG3	CC-LINK Cable ground

5.6.2.4. Power Connector: CNP1, CNP2

The Power Connector is the connector for DC 5 V power to operate the Conveyor I/F Board (BD585), and the pin specification is as shown in Figure 5.40 below.

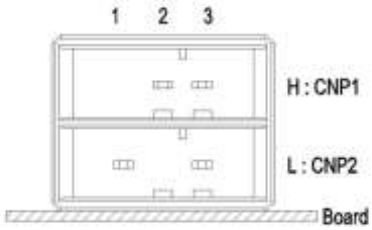


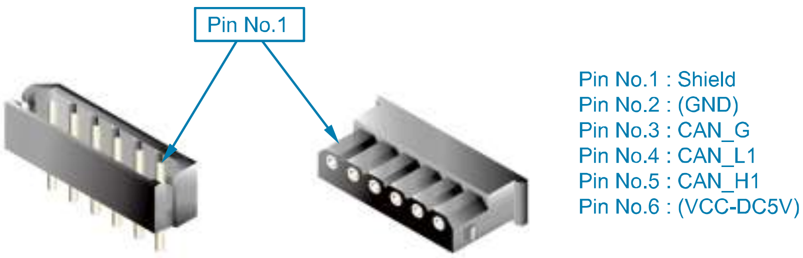
Figure 5.44 Power Connector CNP1 and CNP2 of LDIO Board (BD58A)

Table 5-18 Pin Configuration of the Power Connector of the LDIO Board (BD58A)

Connector Name	Terminal Number	Signal Name	Function Description
CNP1 (Upper level)	A1	-	N.C
	A2	P5	SMPS DC 5 V
	A3	M5	SMPS DC 5 V Ground
CNP2 (Bottom level)	A1	UP2	User power DC 24 V
	A2	-	N.C
	A3	UM2	User power DC 24 V Ground

5.6.2.5. CAN Communications Connector: CANS1, CANS2

For the CAN Communications Connector, there are two identical connectors with the same pin specification, which are installed as shown in Figure 5.41 below. As CAN communication is conducted through cable, with a Daisy Chaining method, it therefore does not matter which side of the connector it is connected to, as it does not affect the operation.



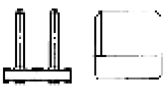
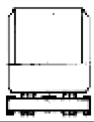
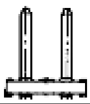
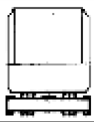
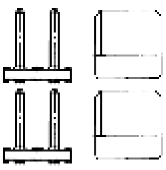
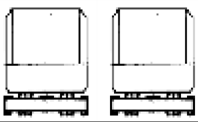
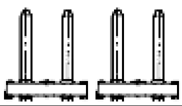
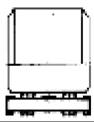
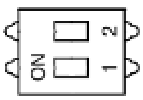
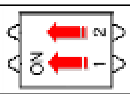
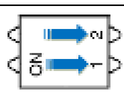
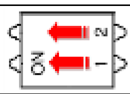
Board Side View

Cable Side View
: Molex 5264-06
(Contact 5263)

Figure 5.45 Method for Connecting the CAN Connector of LDIO Board (BD58A)

When the board is installed in the terminal of the CAN communication system, the terminal shall be handled according to the following methods

Table 5-19 How to Deal with the CAN Communication Terminal of the LDIO Board (BD58A)

Board Type	Terminating Equipment	Form	How To Set		Set During Forwarding
			Terminal	Non-Terminal	
BD58AV10	Jumper JP1		 SHORT	 OPEN	 SHORT
BD58AV20	Jumper JP1and JP3		 ALL SHORT	 ALL OPEN	 ALL SHORT
BD58AV21	DIP Switch SWC1		 ALL ON	 ALL OFF	 ALL ON

5.6.3. Setting Unit

5.6.3.1. DIP Switch Settings

The number and communication speed of the DIP switch SWZ1~3 related to CC-LINK are set in hexadecimal code, as shown in the Tables below.

Table 5-20 Method for Setting Station Number and Communication Speed of CC-LINK in the LDIO Board (BD58A)

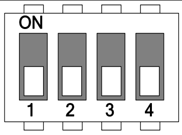
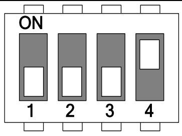
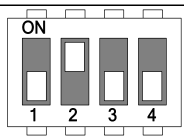
Switch Name	Use	1	2	3	4	Remarks
SWZ1	Station Number	X80	X40	X20	X10	1
SWZ2		X8	X4	X2	X1	2
SWZ3	Communication Speed	X8	X4	X2	X1	0: 125 kbps 1: 625 kbps 2: 2.5 Mbps 3: 5.0 Mbps 4: 10 Mbps
Factory Default Setting	SWZ1	OFF	OFF	OFF	OFF	
	SWZ2	OFF	OFF	OFF	ON	
	SWZ3	OFF	ON	OFF	OFF	

Table 5-21 How to Set the CC-LINK Station Numbers and the Data Rate of the LDIO Board (Bd58av21)

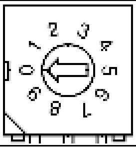
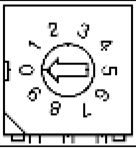
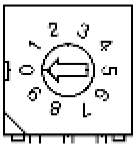
Switch Name	Use	Form	How To Set	Set During Forwarding
SWZ1	Station No. (10 Units)		Setting Station No. = (Set Value Of Swz1 X 10)+ Set Value Of Swz2	“0”
SWZ2	Station No. (1 Unit)			“1”
SWZ3	Data Rate		0 : 125 kbps 1 : 625 kbps 2 : 2.5 Mbps 3 : 5.0 Mbps 4 : 10 Mbps	“4”

Table 5-22 Method for Setting the Number of Stations of CC-LINK of the LDIO Board (BD58A)

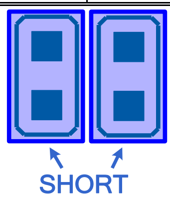
Jumper Name	**Number of Stations**			
	1	**2**	**3**	**4**
SENYU0	OPEN	SHORT	OPEN	SHORT
SENYU1	OPEN	OPEN	SHORT	SHORT
Factory Default Setting		SENYU0: SHORT SENYU1: SHORT		

Table 5-23 How to Set the Number of the CC-LINK Station Occupied of the LDIO Board (BD58AV21)

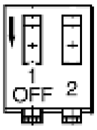
Switch Name	Form	Switch No.	How To Set The No. Of Station Occupied				Set During Forwarding
			1	2	3	4	
SWZ4		1 (SENYU0)	OFF	ON	OFF	ON	ON
		2 (SENYU1)	OFF	OFF	ON	ON	ON

Table 5-24 LDIO Jumper SWSEL for Selecting CC-LINK Set in the LDIO Board (BD58A)

Jumper Name	Number of channel	
	OPEN	SHORT
SWSEL	CC-LINK communication setting by DIP switch and jumper	CC-LINK communication setting by software
Factory default	 SHORT	SHORT

The D58AV21 board does not have the option of setting the CC-LINK.

5.7. Safety Relay Board (BD58B)

5.7.1. Outline

To detect axis limit and power belt failure with an installed sensor on the robot, the sensor signal must be received and converted to a contact point format to use the Safety Relay Board (BD58B) connected to the system board. Figure 5.42 below shows the configuration of the Safety Relay Board (BD58B), which includes the control power connector, the terminal block to supply the power to the sensor and receive the signal, and the connector for the brake to prevent falling.

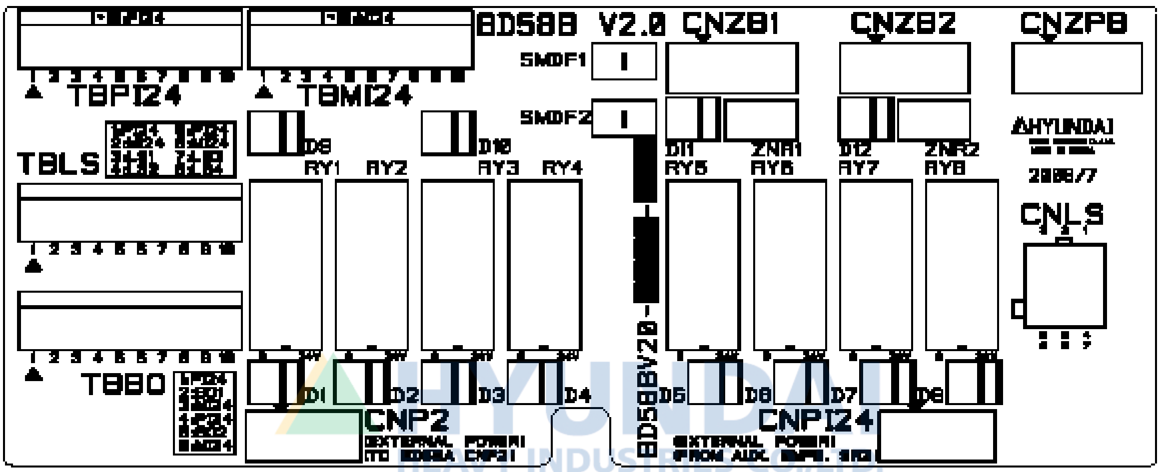


Figure 5.46 Safety Relay Board (BD58B)

5.7.2. Connector

Table 5-25 Pin Configuration of the Belt Sensor Terminal Block TBBO in the Safety Relay Board (BD58B)

Pin Number	Signal Name	Signal Description
1	PI24	24V power for belt sensor
2	BO1	Belt sensor output 1
3	MI24	GND power for belt sensor
4	PI24	24V power for belt sensor
5	BO1	Belt sensor output 2
6	MI24	GND power for belt sensor
7	NC	
8	NC	
9	NC	
10	NC	

Table 5-26 Pin Configuration of the Limit Sensor Terminal Block TBLS in the Safety Relay Board (BD58B)

Pin Number	Signal Name	Signal Description
1	PI24	24V power for limit sensor
2	MI24	GND power for limit sensor
3	LS1	Limit sensor output 1
4	LS2	Limit sensor output 2
5	PI24	24V power for limit sensor
6	MI24	GND power for limit sensor
7	LS3	Limit sensor output 3
8	LS4	Limit sensor output 4
9	NC	
10	NC	

Table 5-27 Pin Configuration of Power 24V Terminal Block (TBP124) in the Safety Relay Board (BD58B)

Pin Number	Signal Name	Signal Description
1-10	PI24	24V power

Table 5-28 Pin Configuration of Power GND Terminal Block (TBM124) in the Safety Relay Board (BD58B)

Pin Number	Signal Name	Signal Description
1-10	MI24	GND power

Table 5-29 Connector Type and Use of Safety Relay Board (BD58B)

Name	Use	External Device Connection
CNPI24	Power input for sensor	SR2
CNP2	Power output for BD58A	BD58A
CNZPB	Power input for fall preventive brake	SR3
CNZB1	Cancel fall preventive brake 1	CMC1
CNZB2	Cancel fall preventive brake 2	CMC2
CNLS	Transmit safety relay contact point status to system board	BD530

5.8. Expansion Public IO Board (BD583 : 464-point I/O)

5.8.1. Outline

The Expansion Public DIO board can interface and be configured with various devices through the digital input/output port. The specification of the basic board is as follows.

- 2-way digital input
  Photocoupler type input: 64 points (8 ports)

- 2-way digital output
  Photo MOS type at 32 points (4 ports)
  Relay contact point type at 32 points (4 ports)

- CAN communication between modules: 1Mbps

- Scan time: Maximum of 1msec

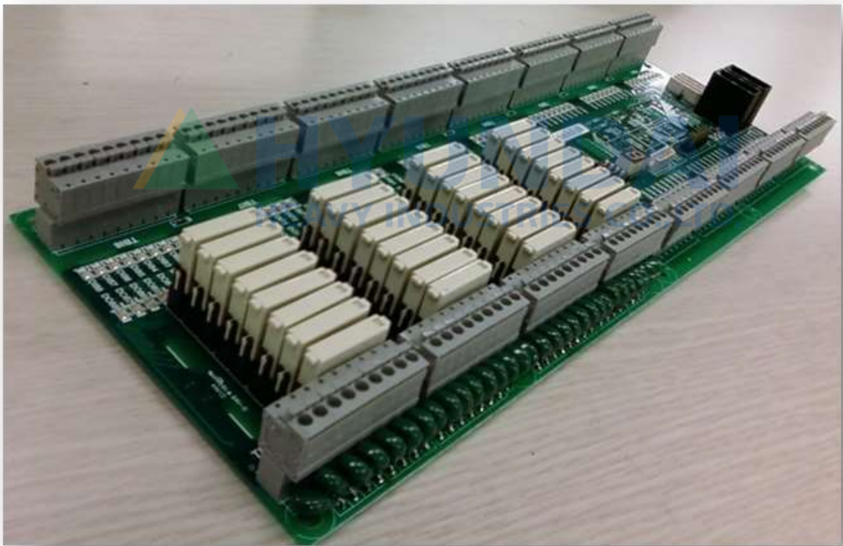


Figure 5.47 Expansion Public IO Board (BD583)

5.8.2. Connector

There are 4 types of connectors for Expansion Public IO Board (BD583), which are as follows.

- Digital input: TBI1~8
- Digital output: TBO1~8
- Power: CNP1, CNP2
- CAN communication: CANS 1, 2

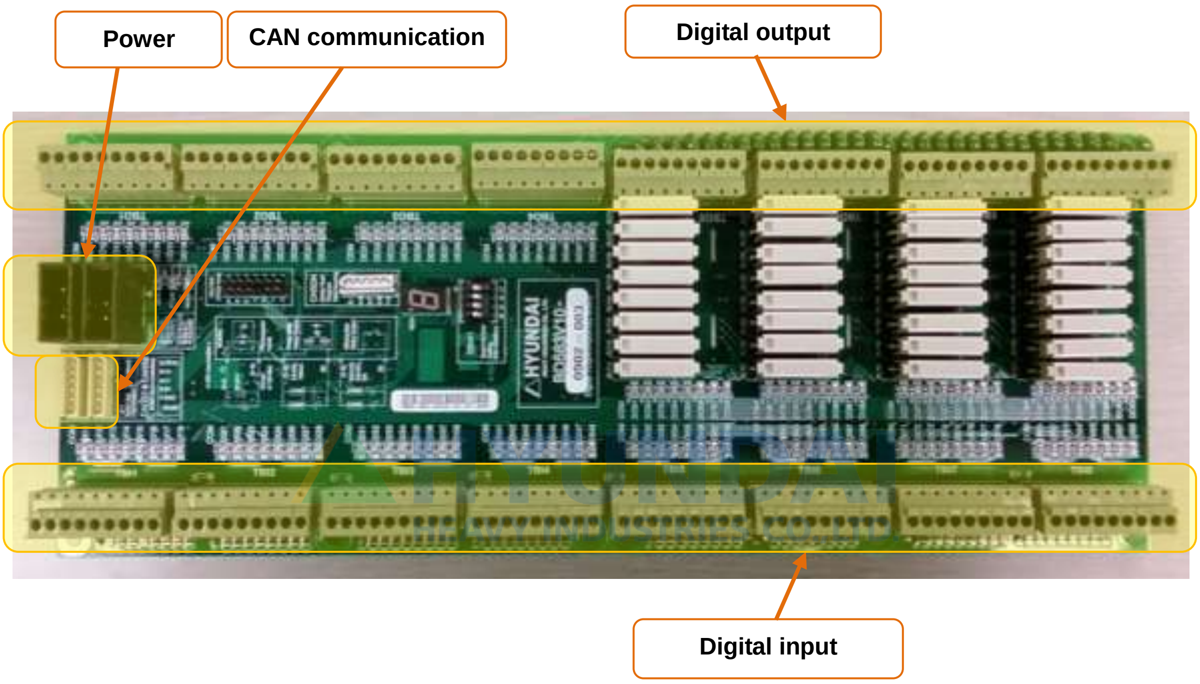


Figure 5.48 Connector Configuration for Expansion Public IO Board (BD583)

5.8.2.1. Digital Input

Figure 5.45 below shows the pin composition of the terminal block (TBI1~8) for digital input. Each terminal block can be connected to the common power for 8 input signals, and can use a different power supply than the common power of the terminal block for other input.

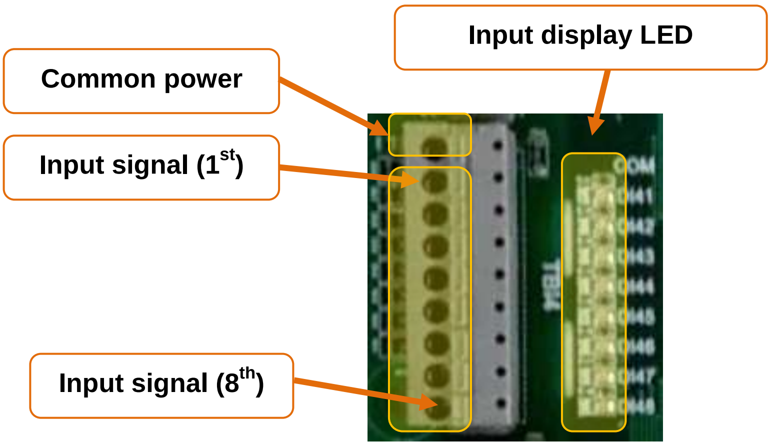


Figure 5.49 Pin Configuration of Digital Input Terminal Block on Expansion Public IO Board (BD583)

Table 5-30 Pin Configuration of Digital Input Terminal Block (TBIn*) of Expansion Public IO Board (BD583)

Pin Number	Signal Name	Signal Description
1	COMn*	COMMON power (Ground DC24V or DC24V)
2	DI n*1	1st input of nth public input signal port of user
3	DI n*2	2nd input of nth public input signal port of user
4	DI n*3	3rd input of nth public input signal port of user
5	DI n*4	4th input of nth public input signal port of user
6	DI n*5	5th input of nth public input signal port of user
7	DI n*6	6th input of nth public input signal port of user
8	DI n*7	7th input of nth public input signal port of user
9	DI n*8	8th input of nth public input signal port of user

Note *) Terminal Block Port Number n = 1~8 (Ex, TBI1, TBI2, TBI3, TBI4)

The electric specification of each input signal is as follows.

- Input terminal component: AC input photocoupler
- Input impedance: 3 kΩ
- Common power: Ground 24VDC or 24VDC

The user connects the input signal through the method shown in Figure 5.46 below. First, connect the user power +24V or the ground wire to the IO board (BD583), and then connect each signal to the input pin according to the usage. The power can be grouped by 8 input signals, and can be applied differently by port.

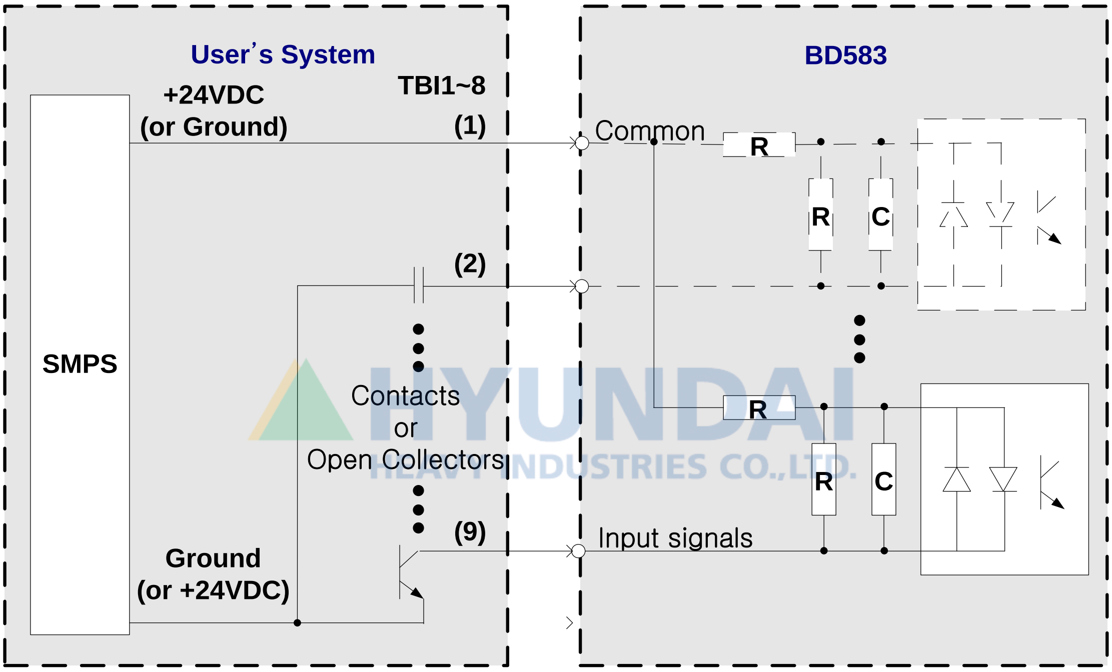


Figure 5.50 Method for Wiring Input Signal of Expansion Public IO Board (BD583)

5.8.2.2. Digital Output

Figure 5.47 below shows the pin composition of the terminal block (TBO1~8) for digital output. Each terminal block can be connected to the common power for 8 input signals, and can use a different power supply than the common power of the terminal block for other input.

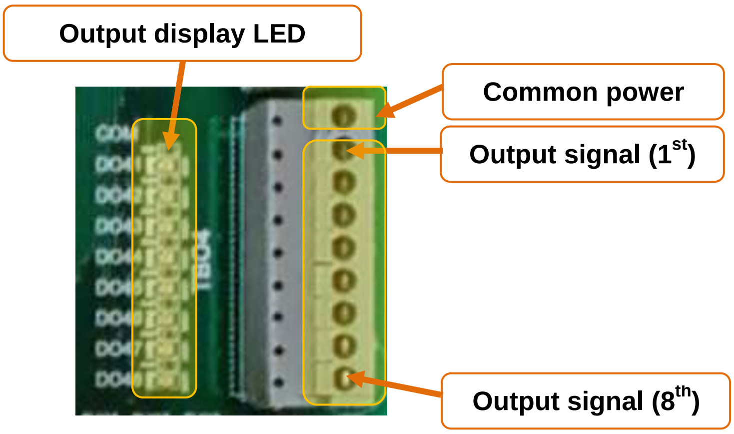


Figure 5.51 Pin Configuration of Digital Input/Output Terminal Block on Expansion Public IO Board (BD583)

Table 5-31 Pin Configuration of Digital Output Terminal Block (TBOn*) on Expansion Public IO Board (BD583)

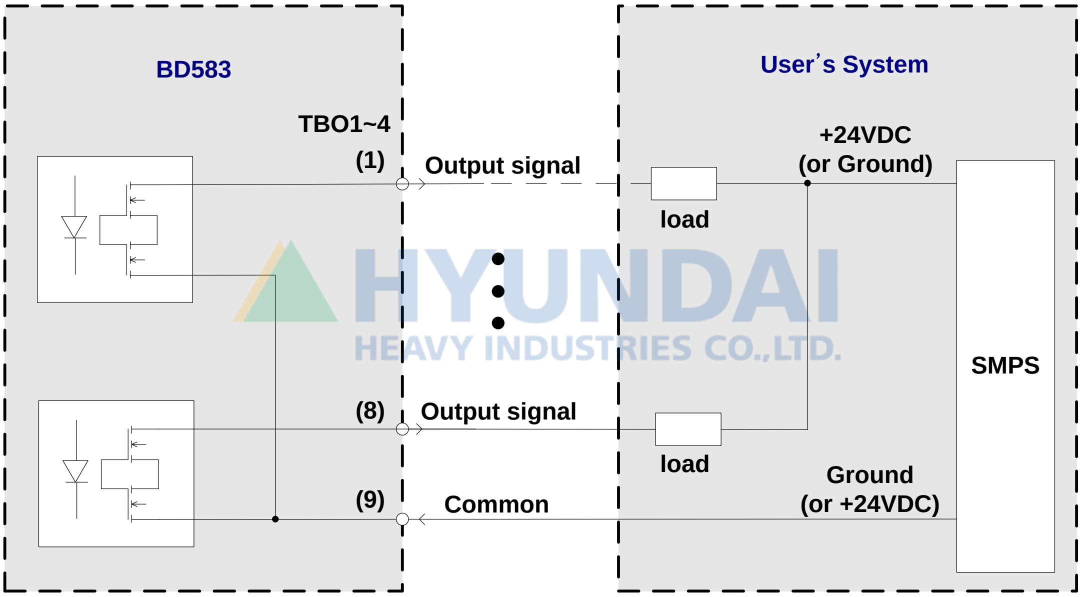
Pin Number	Signal Name	Signal Description
9	COMn*	COMMON power (Ground DC24V or DC24V)
8	DOn*1	1st output of nth public output signal port of user
7	DOn*2	2nd output of nth public output signal port of user
6	DOn*3	3rd output of nth public output signal port of user
5	DOn*4	4th output of nth public output signal port of user
4	DOn*5	5th output of nth public output signal port of user
3	DOn*6	6th output of nth public output signal port of user
2	DOn*7	7th output of nth public output signal port of user
1	DOn*8	8th output of nth public output signal port of user

Note *) Terminal Block Number n = 1~8 (Ex, TBO1, TBO2, TBO3, TBO4)

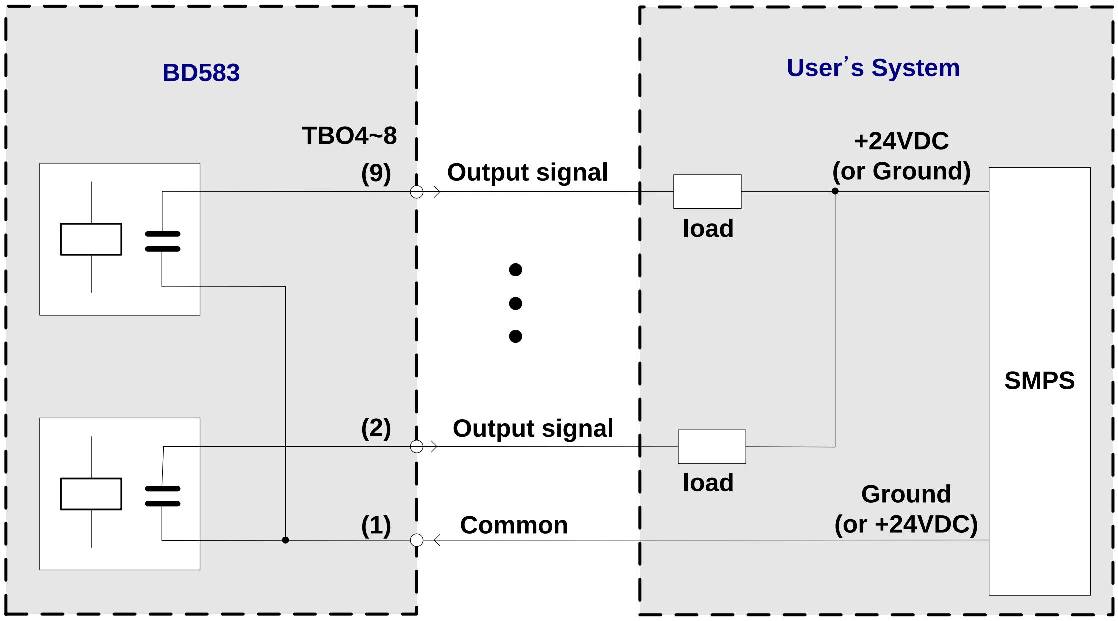
The electric specification of each output signal is as follows.

- Output component: Photo MOSFET (TBO1~4), relay (TBO5~8)
- Rated output
  Photo MOSFET 125mA (Continuous load current) / 24V DC
  Relay: 3A / DC 24V, AC250V
- Common power: Ground 24VDC or 24VDC

The user connects the output signal through the method shown in Figure 5.48 below. First, connect the common signal (COMMON) to the Expansion Public IO Board (BD583), and then connect each signal to the output pin according to the usage. The power can be grouped by 8 output signals, and can be applied differently by port.



(a) Photo MOSFET type output type

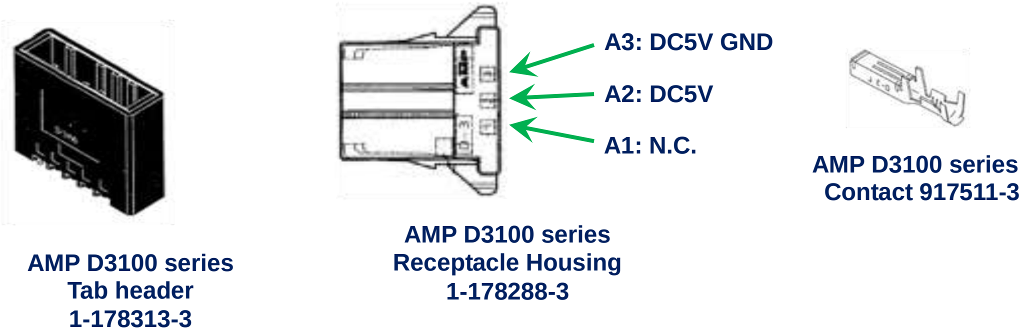


(b) Relay output type

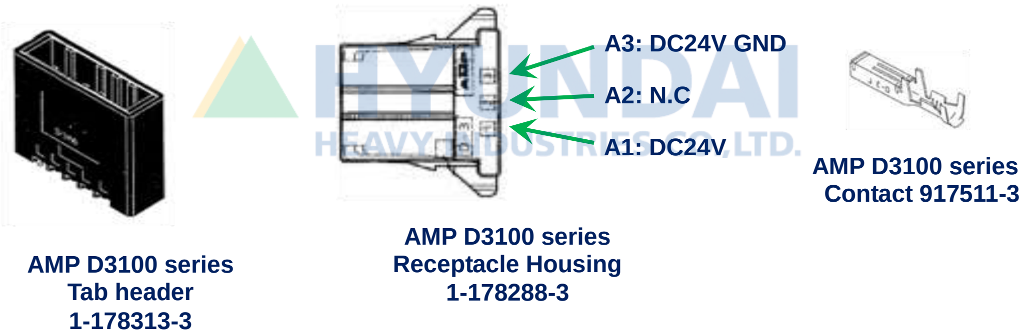
Figure 5.52 Method for Wiring Output Signal of Expansion Public IO Board (BD583)

5.8.2.3. Power Connector: CNP1, CNP2

The Power Connector is the connector to supply the power to operate the Expansion Public IO Board (BD583), and is composed of connector CNP1 for DC5V and CNP2 for DC24V, as shown in Figure 5.49 below. CNP1 supplies the power required for the basic operation of the board, and CNP2 supplies the power required to operate the 32-point output relay from the SMPS.



(a) CNP1 (DC5V power)



(b) CNP2 (DC24V power)

Figure 5.53 Power Connector CNP1 and CNP2 of Expansion Public IO Board (BD583)

5.8.2.4. CAN Communications Connector: CANS1, CANS2

For the CAN Communications Connector, there are two identical connectors with the same pin specification, which are installed as shown in Figure 5.50 below. As CAN communication is conducted through cable, with a Daisy Chaining method, it therefore does not matter which side of the connector it is connected to, as it does not affect the operation.

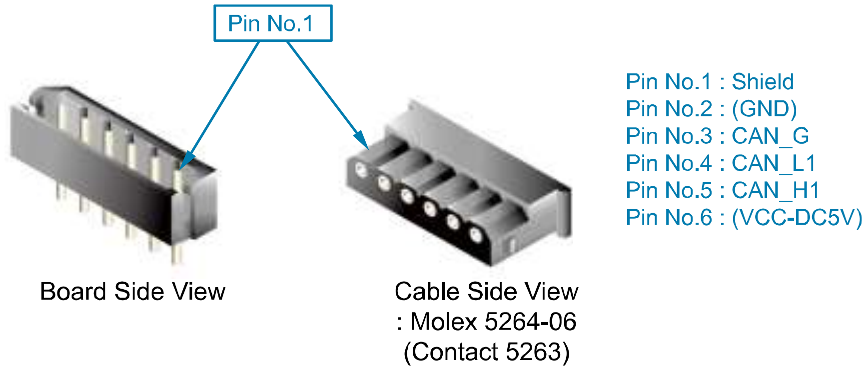


Figure 5.54 Method of Connecting the CAN Connector of Expansion Public IO Board (BD583)

When connecting several boards, the terminating resistance must be processed precisely. CAN data communication uses the Daisy Chaining method. Therefore, only the board connecting the CAN communication cable at the end must be connected to the terminating resistance; all other boards must not be connected to the terminating resistance. For the connection of terminating resistance, use the JP1 jumper next to CAN Connectors 1 and 2. When you short-circuit JP1, the terminating resistance is connected, and when opened, the terminating resistance is disconnected. Please refer to Figure 5.51 below.

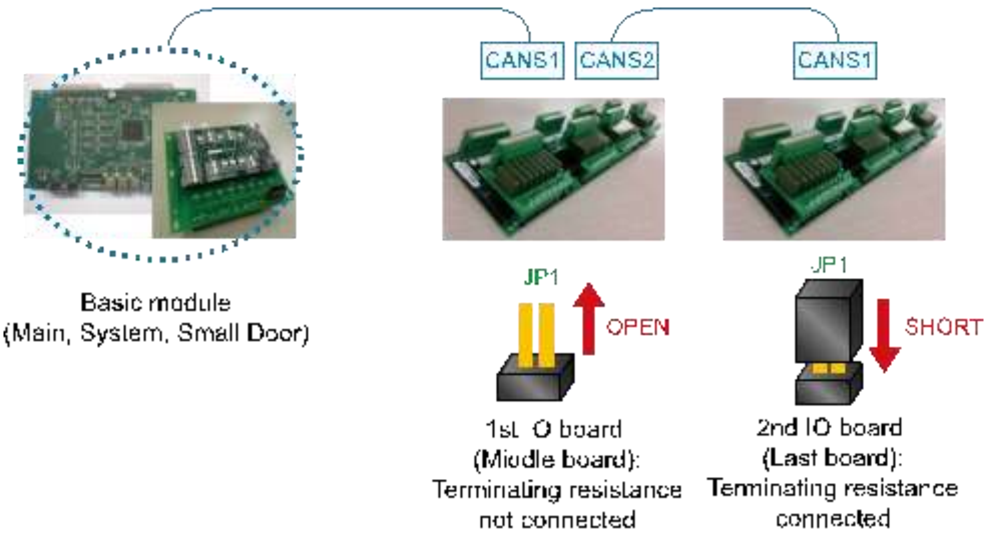


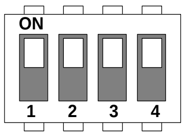
Figure 5.55 Method for Connecting Terminating Resistance

5.8.3. Setting Unit

5.8.3.1. DIP Switch Settings

The board number of the DIP switch DSW1 is set in hexadecimal code. Based on the setting condition of the switch, the board number is shown in Table 5-24 below.

Table 5-32 Method for Setting DSW1 Switch of Expansion Public IO Board (BD583)

<table>
<tr><th>Switch Number</th><th>4</th><th>3</th><th>2</th><th>1</th><th rowspan="3">Setting</th></tr>
<tr><th rowspan="2">Setting</th><th rowspan="2">Preliminary</th><th colspan="3">Board Number (hex)</th></tr>
<tr><th>X4</th><th>X2</th><th>X1</th></tr>
<tr><td rowspan="4">Example of Setting</td><td>OFF</td><td>OFF</td><td>OFF</td><td>OFF</td><td>1st board</td></tr>
<tr><td>OFF</td><td>OFF</td><td>OFF</td><td>ON</td><td>2nd board</td></tr>
<tr><td>OFF</td><td>OFF</td><td>ON</td><td>OFF</td><td>3rd board</td></tr>
<tr><td>OFF</td><td>OFF</td><td>ON</td><td>ON</td><td>4th board</td></tr>
<tr><td>Factory Default Setting</td><td>OFF</td><td>OFF</td><td>OFF</td><td>OFF</td><td>1st board</td></tr>
<tr><td>Exterior of Switch</td><td colspan="5"></td></tr>
</table>

5.9. Analog/Arc IF Board (BD584)

5.9.1. Outline

The Analog/Arc IF board provides the analog input/output and digital input/output required to connect with external devices. The specification of the basic board is as follows.

- Digital input: 8 points
- Digital output: 8 points (Photo MOS type)
- Analog input: 8 points (12-bit resolution)
- Analog output: 8 points (12-bit resolution)
- Analog stick check function

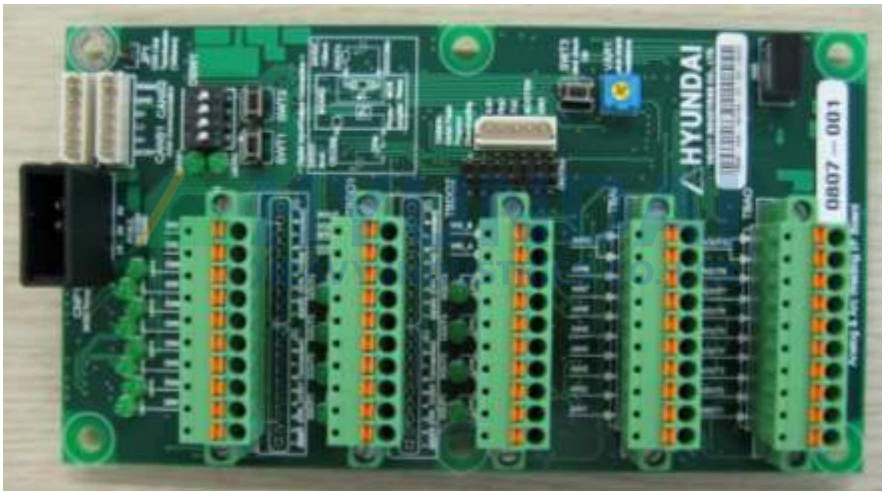


Figure 5.56 Analog/Arc IF Board (BD584)

The board is 86mm(L) x 156mm(H) in size, and has many functions, which are shown in Figure 5.57 below.

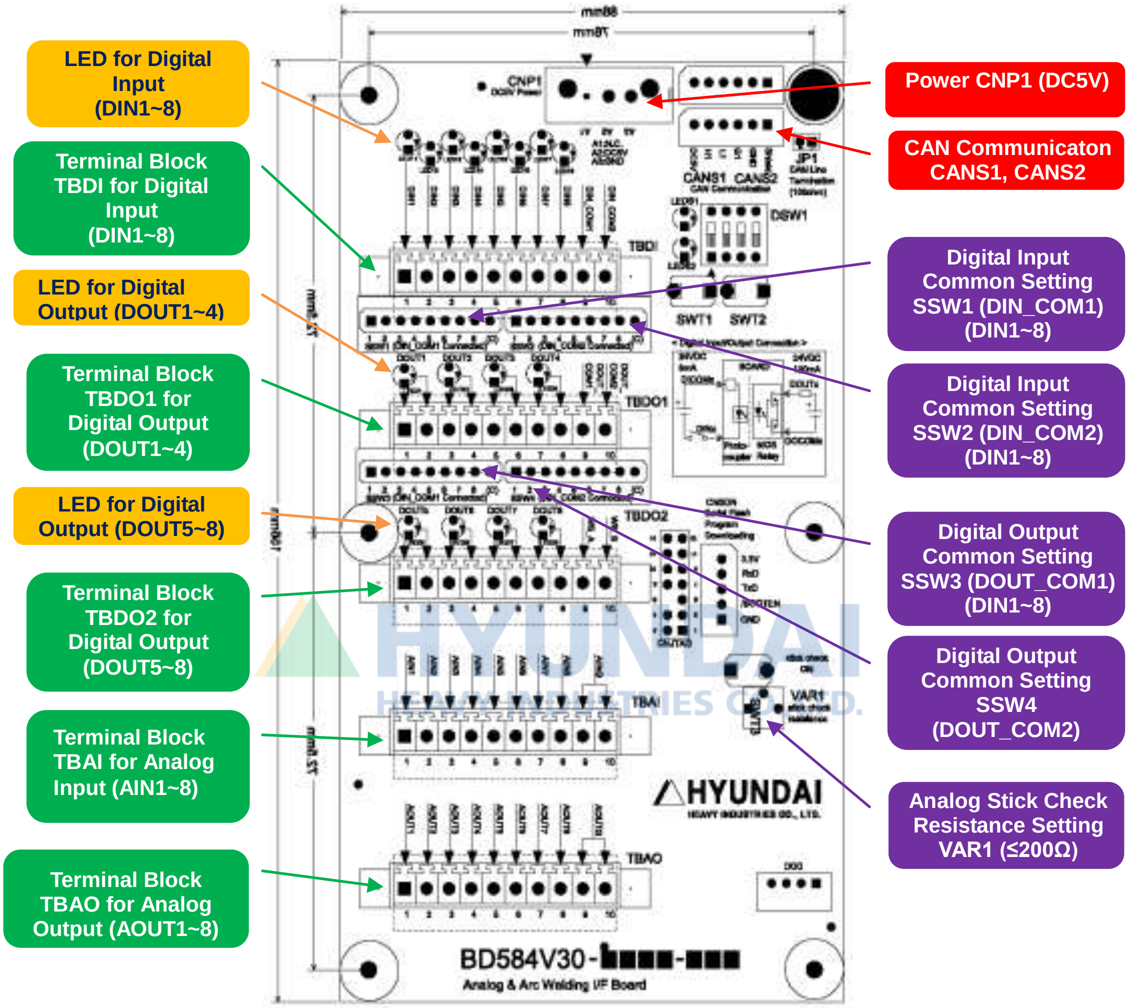


Figure 5.57 Configuration of Analog/Arc IF Board (BD584)

5.9.2. Connector

5.9.2.1. Digital Input

The board has 8 digital input ports that can receive ON/OFF input. The photocoupler is used to electrically insulate from the external device. To expand the applied scope, each input can select and use the common input signal of two types.

The current used in the unit input is 5mA at 24V voltage. Therefore, if all 8 inputs are used, a total of 40mA of current is consumed.

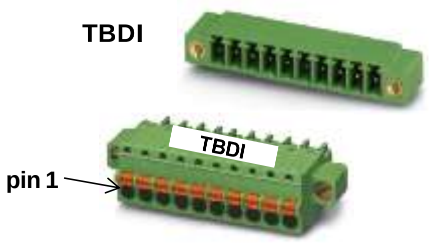


Figure 5.58 Terminal Block for Digital Input on Analog Board (BD584)

Use the assigned input to connect the arc welder. Details are shown in Table 5-25 below.

Table 5-33 Pin Configuration of Digital Input Terminal Block (TBDI) of Analog Board (BD584)

Number	Name	Name for Arc Welder Connection	Remarks
1	DIN1	WCR	
2	DIN2	SHOCK_SENSOR	
3	DIN3	WIRE_STICK	
4	DIN4	WELDER_ERR	
5	DIN5	WIRE_STATE	
6	DIN6	GAS_STATE	
7	DIN7	Reserved 1	
8	DIN8	Reserved 2	
9	DI_COM1	Signal Common 1	
10	DI_COM2	Signal Common 2	

The method of connecting the digital input port is shown in Figure 5.55 below. The example depicts the connection of 4 sensors with contact point or NPN-type output. Sensors 6 and 8 are configured with SMPS1 power, and Sensors 1 and 4 are configured with SMPS2 power. That is, two different types of power input can be used. This is set and classified by the SIP switches, SSW1 and SSW2 inside the board. For example, sensor 8 is connected to input port 8. Because this sensor uses SMPS1 power, the circuit must be configured through the COMMON power connected to 9. Therefore, turn on SSW1 switch 8, and then turn off SSW2 switch.

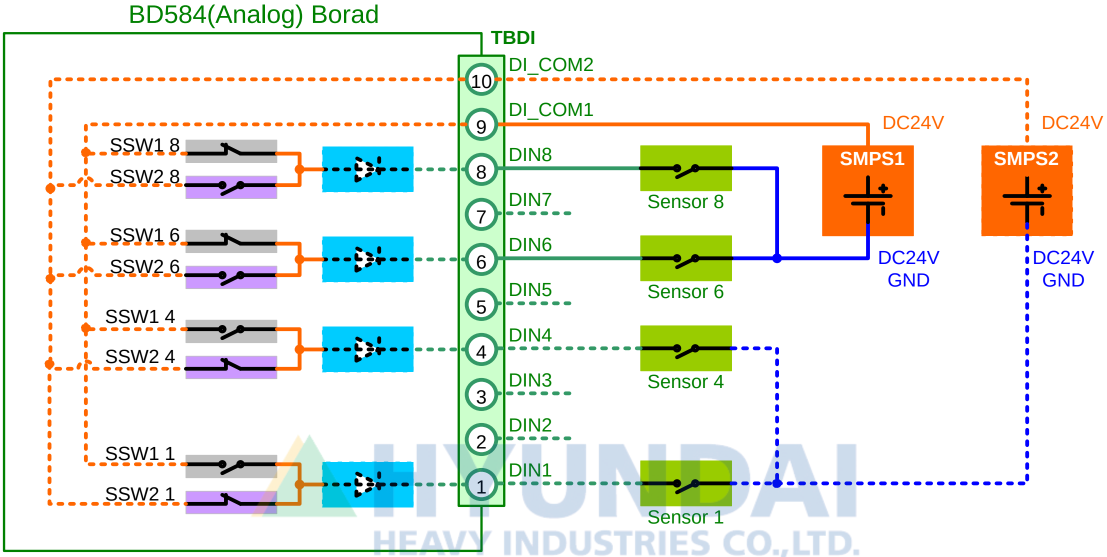


Figure 5.59 Method for Connecting Digital Input on Analog Board (BD584)

The installation order can be summarized as follows.

① First, turn off both SIP switches (SSW1 and SSW2).
② Connect the sensor and external power to the input terminal block TBDI.
③ SIP switch (SSW1 and SSW2) setting: For the power configuration, turn the SIP switches SSW1 and SSW2 ON or OFF according to the applicable sensor.

Caution:
You must not set the same switch number for SIP switches SSW3 and SSW4 to ON simultaneously. Doing so can short-circuit two different power supplies.

SIP switches SSW1 and SSW2 are connected within the board, as shown in Figure 5.56 below. Because the DI_COM1 (#9 pin) of digital input terminal block TBDI is connected to the common connecting pin (#9 pin) of SIP switch SS1, when you turn ON switches #1~#8 of SSW1, the same power as DI_COM1 is connected to the input signal processing circuit.
In addition, because the DI_COM2 (#10 pin) of TBDI is connected to the common connecting pin (#9) of SIP switch SSW2, when you turn ON switches #1~#8 of SSW2, the same power as DI_COM2 is connected to the input signal processing circuit.
Switches #1~#8 of SSW1 and SSW2 are connected to each other for each number. Therefore, if you turn ON both SSW1 and SSW2 for the input signal number, the common power will be short-circuited. For this reason, you must only turn ON one of the two.

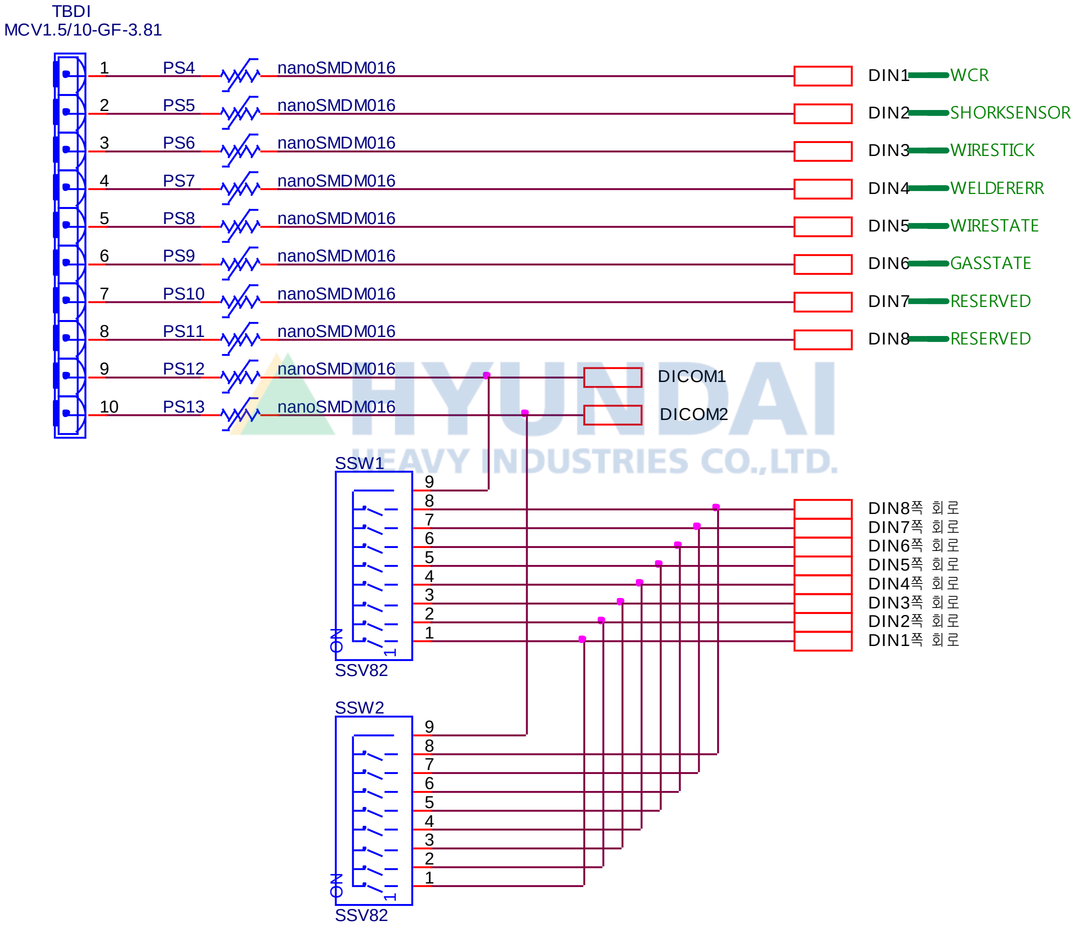


Figure 5.60 Common Circuit of Digital Input from Analog Board (BD584)

Caution:
You must not set the same switch number for SIP switches SSW3 and SSW4 to ON simultaneously. Doing so can short-circuit two different power supplies.

5.9.2.2. Digital Output

The board has 8 digital output ports that can output ON/OFF. These are electrically insulated from the external device using the photo MOSFET. To expand the applied scope, each input can select and use common output signal and individual contact point output of two types.
Maxim3um permitted current of unit output is 125mA at 24V voltage. Therefore, when all 8 of the outputs are used, the total current consumption is about 1000mA.

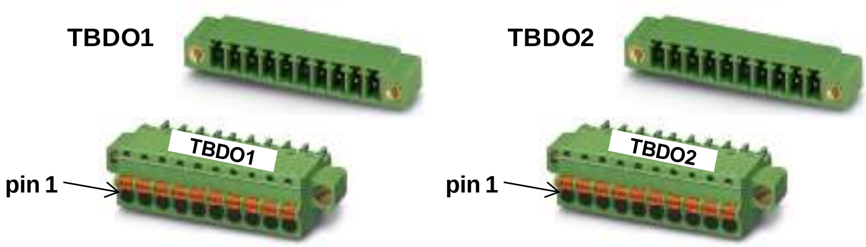


Figure 5.61 Terminal Block for Digital Output on Analog Board (BD584)

Use assigned output to connect the arc welder. Details are shown in Table 5-26 below.

Table 5-34 Pin Configuration of Digital Output Terminal Block (TBD01) on Analog Board (BD584)

Number	Name	Name for Arc Welder Connection	Remarks
TBDO1 1	DOUT 1	TORCH_SW	
TBDO1 2	DOUT 1 COM		
TBDO1 3	DOUT 2	INCHING	
TBDO1 4	DOUT 2 COM		
TBDO1 5	DOUT 3	RETRACT	
TBDO1 6	DOUT 3 COM		
TBDO1 7	DOUT 4	STICK_CHECK	
TBDO1 8	DOUT 4 COM		
TBDO1 9	DO_COM1	Signal Common 1	
TBDO1 10	DO_COM2	Signal Common 2	

Table 5-35 Pin Configuration of Digital Output Terminal Block (TBD02) on Analog Board (BD584)

Number	Name	Name for Arc Welder Connection	Remarks
TBDO2 1	DOUT 1	GAS_VALVE	
TBDO2 2	DOUT 1 COM		
TBDO2 3	DOUT 2	Reserved 1	
TBDO2 4	DOUT 2 COM		
TBDO2 5	DOUT 3	Reserved 2	
TBDO2 6	DOUT 3 COM		
TBDO2 7	DOUT 4	Reserved 3	
TBDO2 8	DOUT 4 COM		
TBDO2 9	WS_A	Check connecting terminal A of Analog Wire Stick	
TBDO2 10	WS_B	Check connecting terminal B of Analog Wire Stick	

The connecting method for the digital output port is shown in Figure 5.58. The example shows how to connect 4 loads in 3 formats. Loads 1 and 3 are connected to SMPS1 power, load 5 is connected to SMPS3 power and load 7 is connected to SMPS3 power. That is, you can use 3 different power supplies for the output. This can be set and classified by SIP switches SSW3 and SSW4 inside the board.

For example, load 1 is connected to output port #1. Because this sensor uses SMPS1 power, the circuit must be configured through the COMMON power connected through #9. Therefore, turn #1 of SSW3 switch ON, and then #1 of SSW4 switch OFF.

For load 7, the COMMON power is not used, and SMPS3 is separately used to use the output port independently. Turn both SIP switches SSW3 and SSW4 OFF, and connect the Ground wire from SMPS3 directly to the terminal block.

Caution:
You must not set the same switch number for SIP switches SSW3 and SSW4 to ON simultaneously. Doing so can short-circuit two different power supplies.

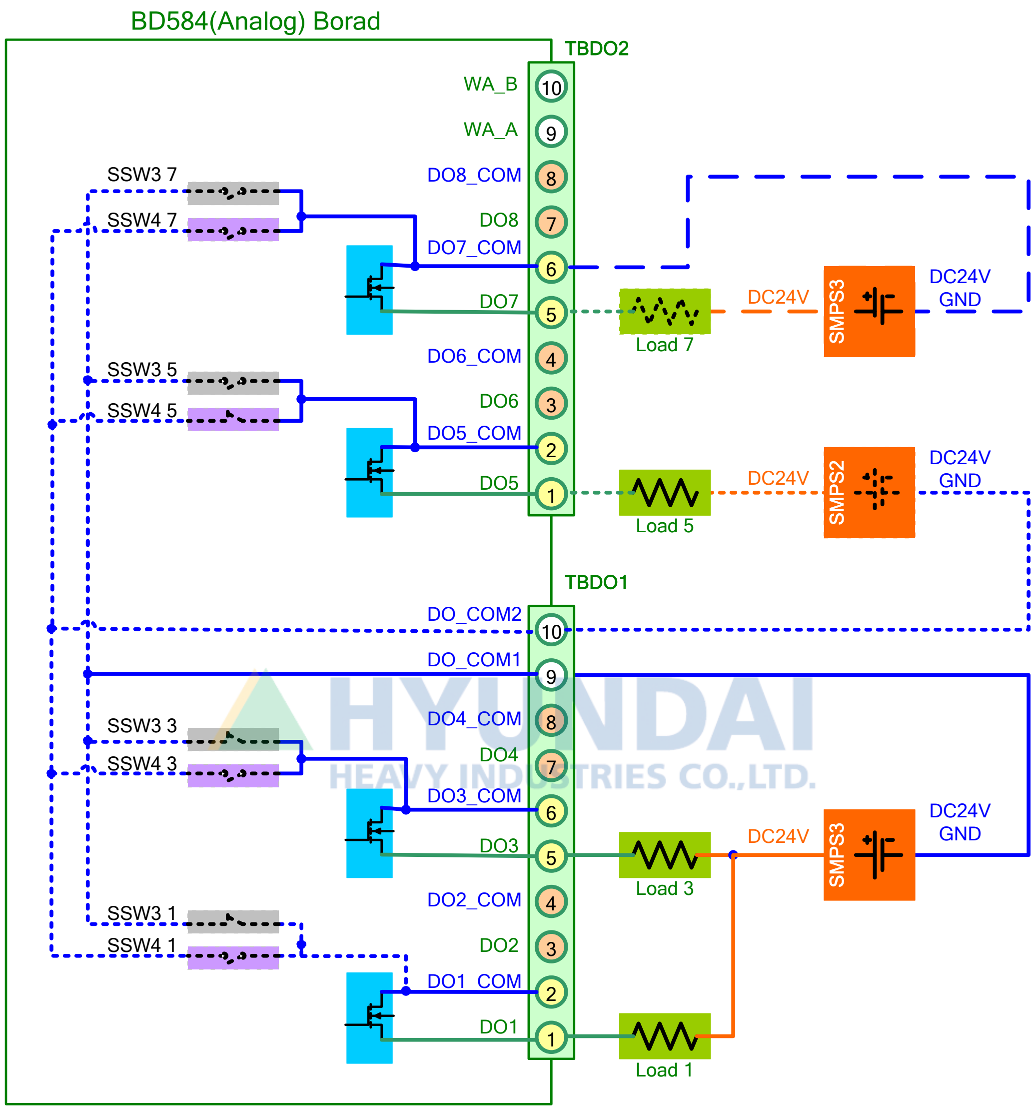


Figure 5.62 Method for Connecting the Digital Output on Analog Board (BD584)

The installation order can be summarized as follows.

① First, turn off both SIP switches (SSW3 and SSW4).

② Connect the load and external power to the output terminal blocks TBDO1 and TBDO2.

③ SIP switch SSW3 and SSW4 setting: For the power configuration, turn the SIP switches SSW3 and SSW4 ON or OFF according to the applicable load.

Caution:
You must not set the same switch number for SIP switches SSW3 and SSW4 to ON simultaneously. Doing so can short-circuit two different power supplies.

Similarly to the input, the SIP switches SSW3 and SSW4 are connected inside the board, as shown in Figure 5.59 below.

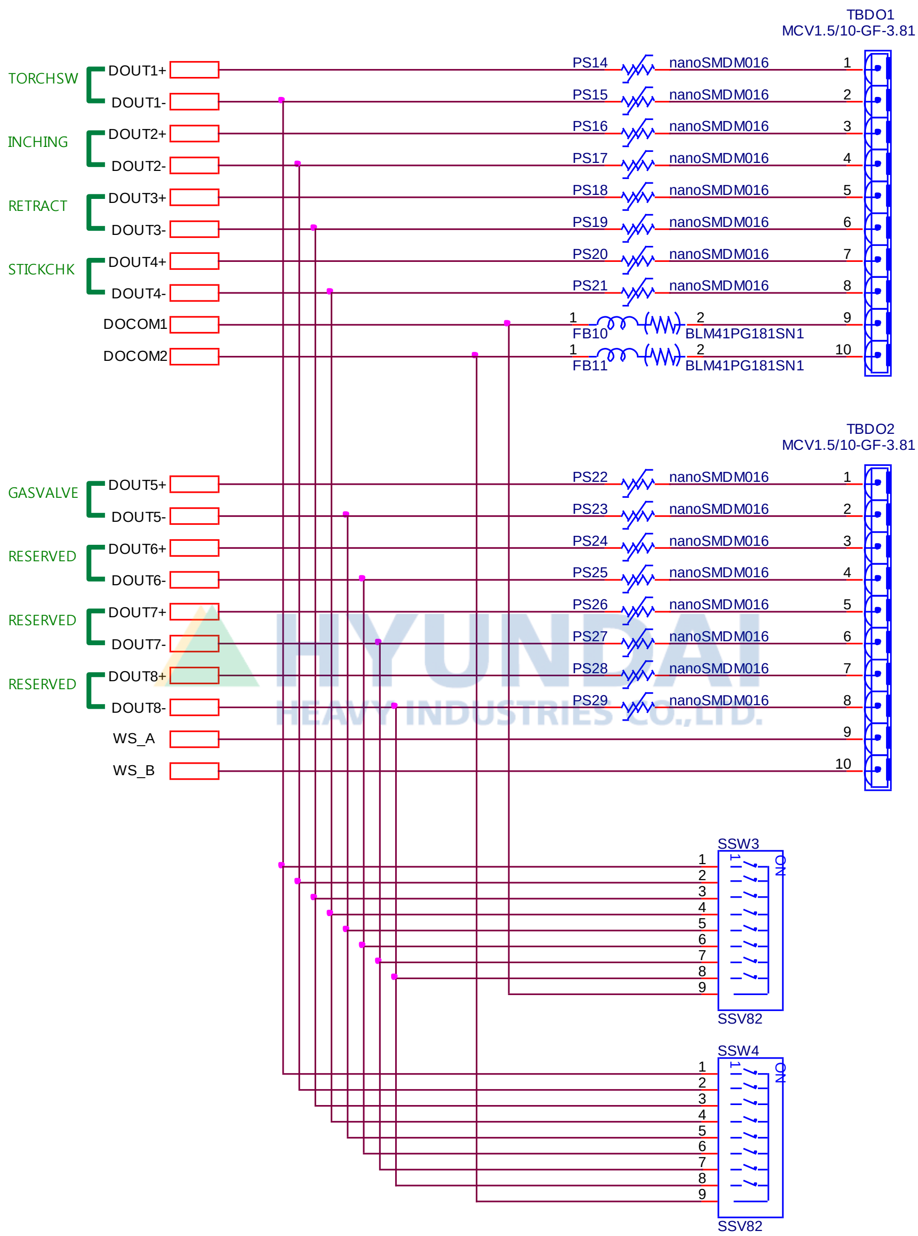


Figure 5.63 Common Circuit of Digital Output on Analog Board (BD584)

Caution:
You must not set the same switch number for SIP switches SSW3 and SSW4 to ON simultaneously. Doing so can short-circuit two different power supplies.

5.9.2.3. Analog Input

The board can receive analog voltage input of 8 channels. Each channel has 12-bit resolving power in the range of -12V~+12V. The input impedance is 20kΩ, and output impedance of the connected device should ideally be infinite. As the analog value of all 8 channels is transmitted to the MAIN board every 1msec, the scan time is 1msec.

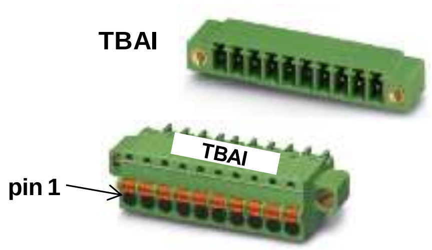


Figure 5.64 Terminal Block for Analog Input on Analog Board (BD584)

The pin allocation of terminal block TBAI for analog input is shown in the following Table.

Table 5-36 Pin Configuration of Analog Input Terminal Block (TBAI) on Analog Board (BD584)

Number	Name	Use	Remarks
1	AIN1	Analog Input Channel 1	
2	AIN 2	Analog Input Channel 2	
3	AIN 3	Analog Input Channel 3	
4	AIN 4	Analog Input Channel 4	
5	AIN 5	Analog Input Channel 5	
6	AIN 6	Analog Input Channel 6	
7	AIN 7	Analog Input Channel 7	
8	AIN 8	Analog Input Channel 8	
9	AING	Analog Input Ground	
10	AING	Analog Input Ground	

The method of connecting the analog input port is shown in Figure 5.61 below. This example shows the method of connecting 5 analog signals. Each signal sends input to AIN1~AIN5, and the ground is connected to AING pin #9 or #10. The input signal is AD converted through the signal control circuit inside the board. The power used in the analog input circuit uses the insulation separated type DC/DC converter, and is separated from the internal power of the controller.

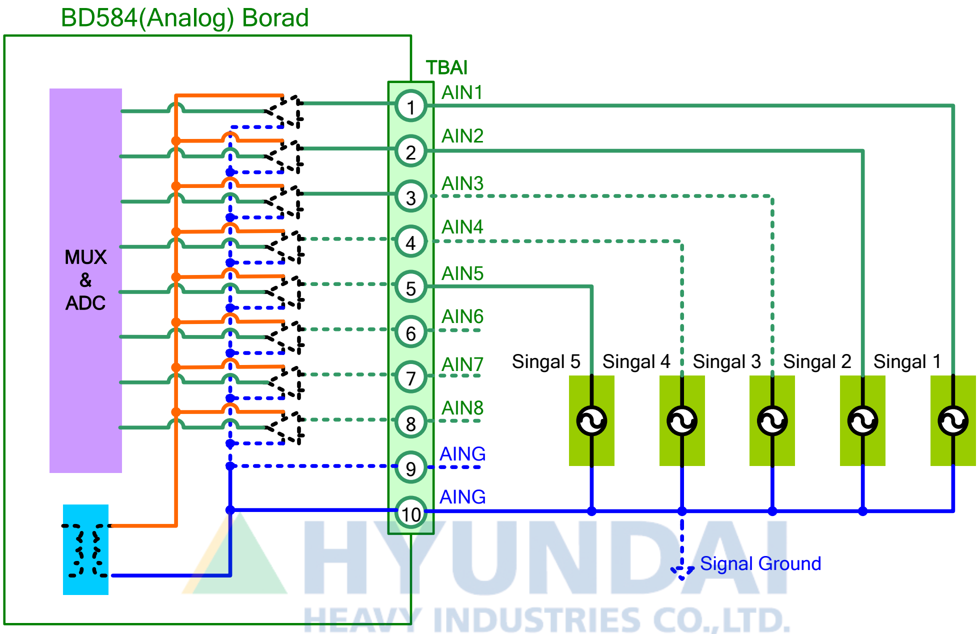


Figure 5.65 Method for Connecting Analog Input on Analog Board (BD584)

5.9.2.4. Analog Output

The board can output analog voltage on 8 channels. Each channel has 12-bit resolving power in the range of -12V~+12V. The analog voltage value of all 8 channels is transmitted from the MAIN board every 5msec, to renew the output voltage.

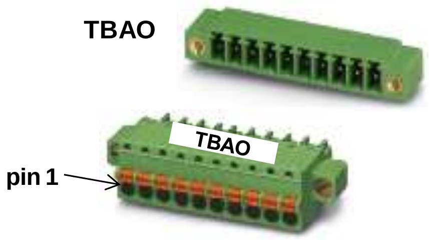


Figure 5.66 Analog Output Terminal Block on Analog Board (BD584)

The pin allocation of terminal block TBAO for analog output is shown in Table 5-37 below.

Table 5-37 Pin Configuration of Analog Output Terminal Block (TBAI) on Analog Board (BD584)

Number	Name	Use	Remarks
1	AOUT 1	Analog Output Channel 1	
2	AOUT 2	Analog Output Channel 2	
3	AOUT 3	Analog Output Channel 3	
4	AOUT 4	Analog Output Channel 4	
5	AOUT 5	Analog Output Channel 5	
6	AOUT 6	Analog Output Channel 6	
7	AOUT 7	Analog Output Channel 7	
8	AOUT 8	Analog Output Channel 8	
9	AOUTG	Analog Output Ground	
10	AOUTG	Analog Output Ground	

The method of connecting the analog output port is shown in Figure 5.63 below. The example shows the method of connecting to use 4 analog voltage outputs, AOUT1, AOUT3, AOUT5 and AOUT7. Ground of voltage is connected to AOUTG pin #9 or #10. The power used in the analog output circuit uses the insulation separation type DC/DC converter to separate from the internal power of the controller.

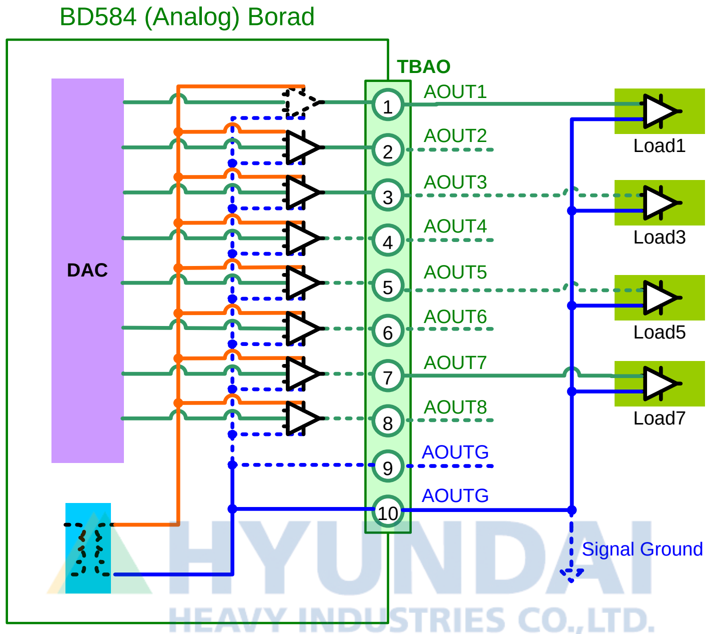


Figure 5.67 Method of Connecting Analog Output on Analog Board (BD584)

5.9.2.5. Analog Stick Check

The board includes a function to check the wire stick of the arc plate through an analog method. As shown in the Figure 5.64 below, connect to #9 (WS_A) and #10 (WS_B) of TBD02 to check the stick. The criteria for checking the stick can be set up to 200Ω by using the variable resistance VAR1 of the board.

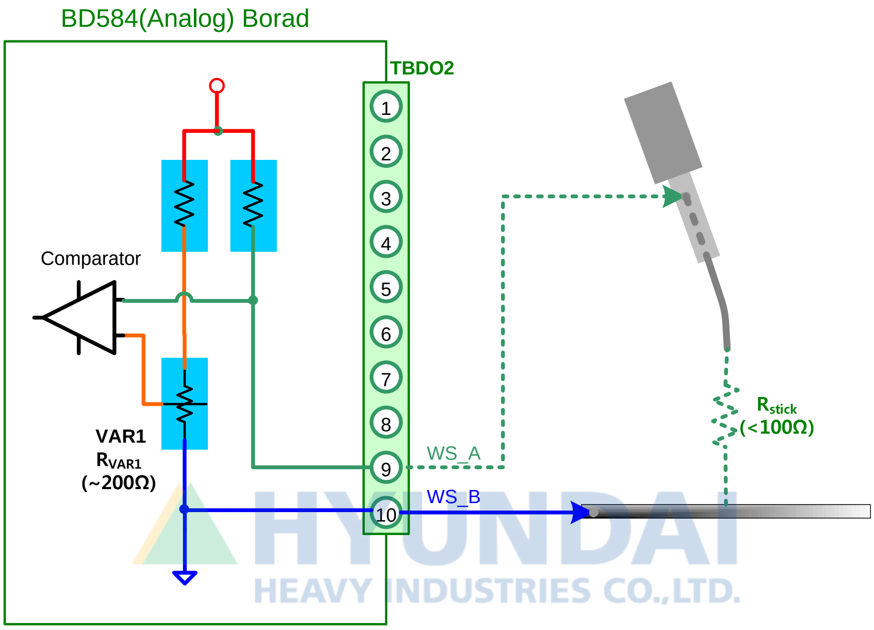


Figure 5.68 Analog Stick Check Function on Analog Board (BD584)

5.9.2.6. Power Connector: CNP1

Power is supplied to the board through CNP1 connector. Figure 5.65 describes the exterior and pin allocation of CNP1.

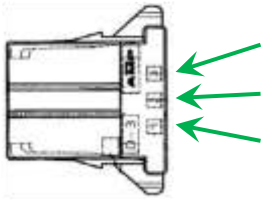


Figure 5.69 Power Connector CNP1 of Analog Board (BD584)

Table 5-38 Pin Configuration of Power Connector CNP1 on Analog Board (BD584)

Number	Name	Use	Remarks
A1	N.C.	No connection	
A2	DC5V	DC 5V power	
A3	DC5V GND	DC 5V power ground	

5.9.2.7. CAN Communications Connector: CANS1, CANS2

Data communication with the MAIN board uses the CAN of Half Duplex method. Bottom modules of the controller are configured for CAN data communication using a Daisy Chain method. Therefore, there are two CAN connectors on the board. Figure 5.66 below describes the CAN connector exterior and pin allocation. Even though you can connect the power through #6 (VCC-DC5V) and #2 (VCC Ground) to the board, it is recommended to use the CNP1 power connector.

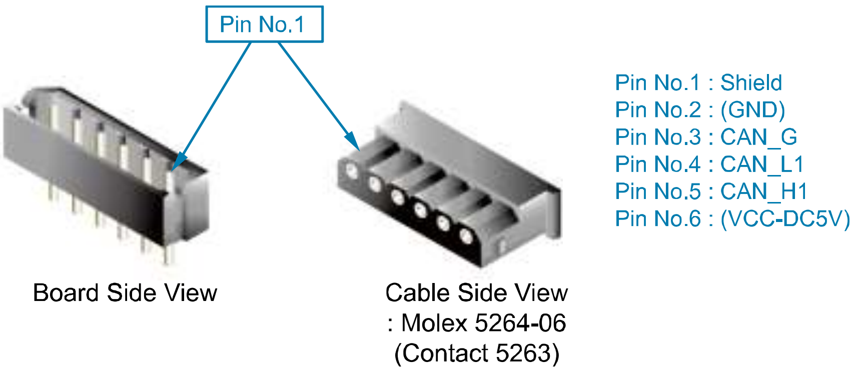


Figure 5.70 Method of Connecting CAN Connector on Analog Board (BD584)

Table 5-39 Pin Configuration of CAN Connector on Analog Board (BD584)

Number	Name	Use	Remarks
1	Shield	Connect shield of CAN cable	
2	DC5V GND	Connect board power DC5V ground (Recommended to connect through CNP1)	
3	CAN_G	Connect ground for CAN communication	
4	CAN_L1	Connect L signal of CAN communication	
5	CAN_H1	Connect H signal of CAN communication	
6	DC5V	Connect board power DC5V ground (Recommended to connect through CNP1)	

When connecting several boards, the terminating resistance must be processed precisely. CAN data communication uses the Daisy Chaining method. For this reason, only the board connecting the CAN communication cable at the end must be connected to the terminating resistance; all other boards must not be connected to the terminating resistance. For the connection of the terminating resistance, use the JP1 jumper next to CANS connectors 1 and 2. When you short-circuit JP1, the terminating resistance is connected, and when opened, the terminating resistance is disconnected.

6

Troubleshooting

Hi5 controller emphasizes on high-precision and high-speed(promptness). So, it is designed to facilitate troubleshooting when troubles occur.
Please be fully aware of this MANUAL for troubleshooting.

6.1. Troubleshooting Solution

Troubleshooting cases are explained hereinafter.

6.1.1. E0002 Hardware limit switch operating

6.1.1.1. Outline

Limit switch that is installed at the end of operation area of Robot’s each axis has been activated. The Robot will be immobilized immediately for a safety reason and will not be operational until it is moved to a safe operation area by an appropriate method.

6.1.1.2. Causes and checking methods

(1) Please confirm if the Robot actually went out of operation area.
- Actions to be taken when a Robot went out of operation area

(2) If an error occurs though a Robot is in the operation area.
- Checking method from a System Board Connector (CNLS)
- Checking method from a Wire Harness (CER1 or CEC1)
- Checking method by examining a limit switch and internal wiring of main frame

(1) Please confirm if the Robot actually went out of operation area

Please confirm if the Robot actually went out of operation area. If a soft limit error has occurred simultaneously, the Robot did go out of operation area.

Please take an appropriate action to move the Robot back into the operation area.

Operation area may vary to the each Robot model, so as the installed location of limit switches. Please refer to the corresponding Robot's maintenance manual - "Limitations of Operation area"

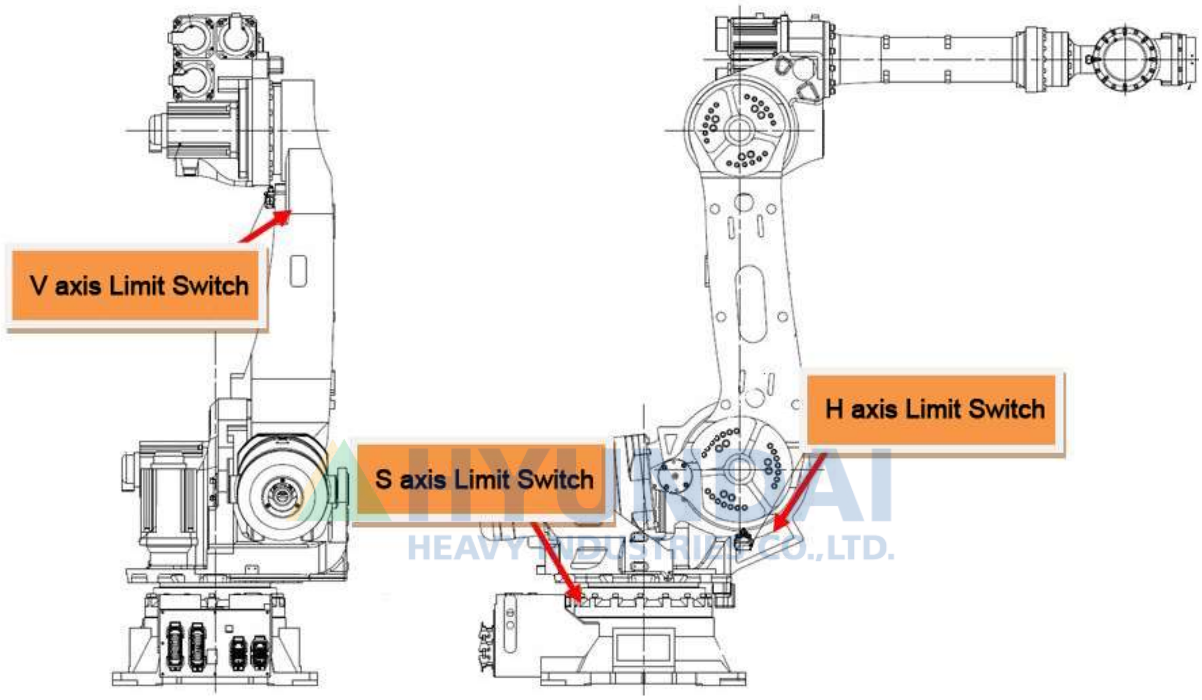


Figure 6.1 Installed Locations of Hardware Limit Switches for HS165/HS200 Robot

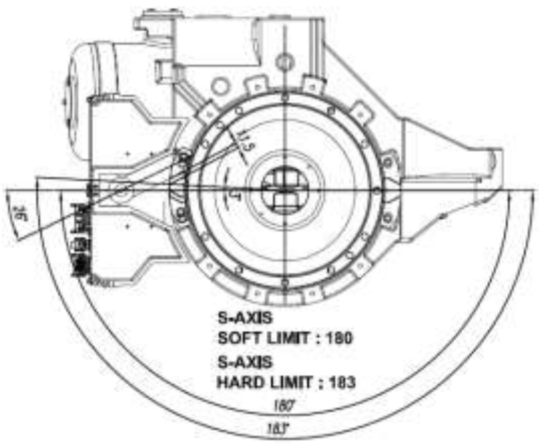


Figure 6.2 Operation Area for S-axis Limit Switch of HS165/HS200 Robot

- Actions to be taken when a Robot went out of operation area

  Please take following actions in order to move a Robot while a hardware limit switch is on. Firstly, enter the system with a manual mode and turn on the enabling switch of Teach Pendant.

  From this stage, execute the Motor On command and move the Robot back into the operation area by using a jog key.

(2) If an error occurs though a Robot is in the operation area

Firstly, check if the limit (Over-Travel) is being entered consecutively from the Private input signal window of Teach Pendant.

This window can be accessed by selecting “『[F1]: Service』 → 『1: Monitoring』 → 『2: Input/output Signal』 → 『1: Private input signal』”

A yellow color status on limit (Over-travel) indicates an error status

- Cautions:
  On manual mode, a monitoring is enabled only when a Teach Pendant’s enabling switch is on.
  On automatic mode, a monitoring is enabled regardless of a status of enabling switch.

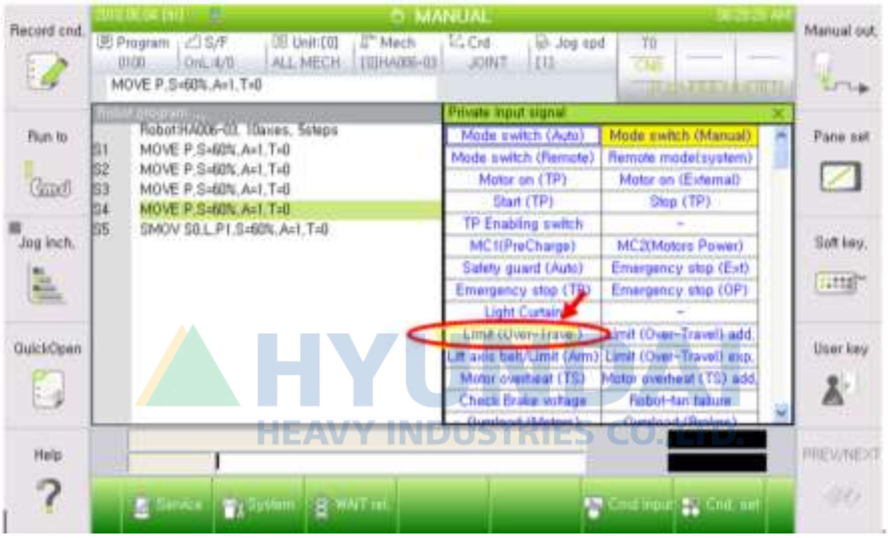


Figure 6.3 Limit (Over-Travel) Monitoring is Displayed from the Private input signal Window

In these cases, cause of this error can be found from the components that are related to the limit switch. As shown in the diagram below, the limit switch is connected to a controller’s System Board from a main frame by using “CER1 – CEC1” cables.

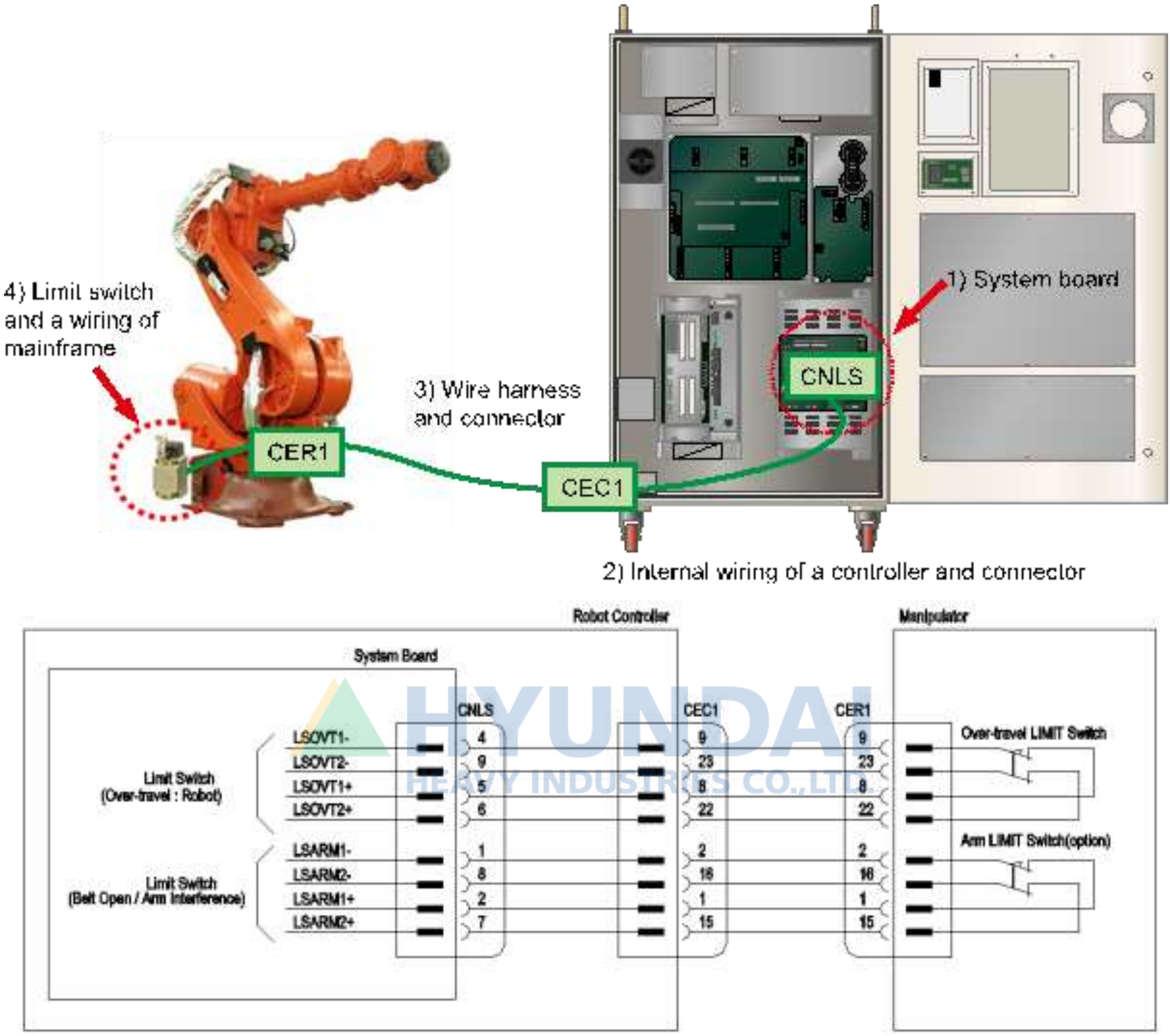


Figure 6.4 Wirings that are related to a Limit Switch Status Input

Main check points and their orders are

① System Board
② Internal wiring of a controller and connector
③ Wire harness and connector
④ Limit switch and a wiring of mainframe

And please jump the input line of limit switch at an appropriate point in order to check if a limit (Over-Travel) from monitoring windows turns to white color.

Please proceed as follows.

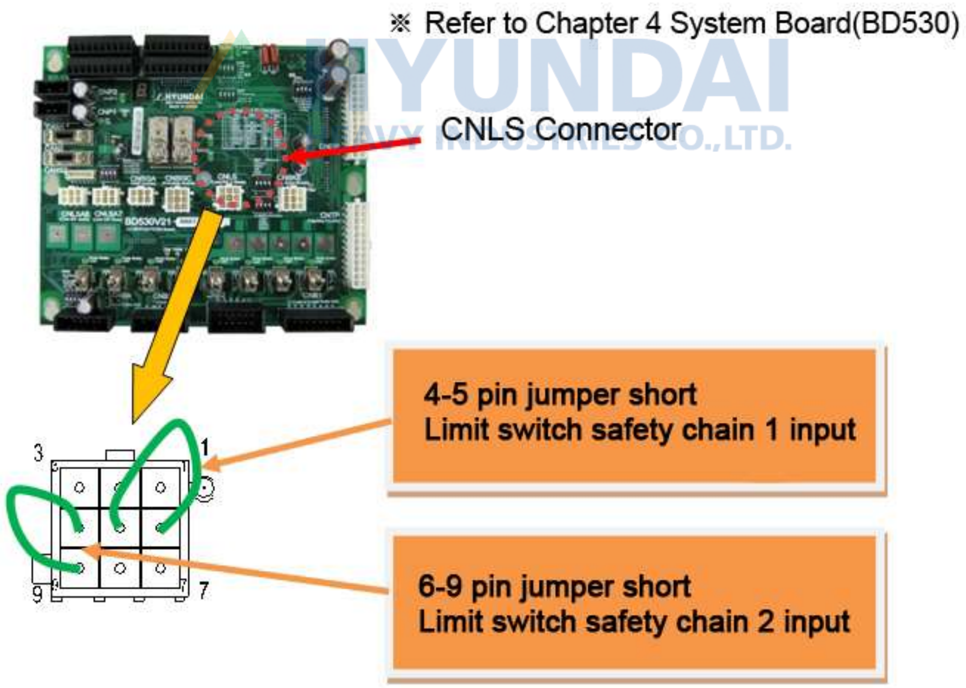
■ **Checking method from a System Board Connector (CNLS)**

Warning
Please make sure the power of a controller has been completely turned off before you connect or remove any cables. Electrocution may cause personal injuries or a property damages

This method uses a CNLS connector of System Board to judge if the board malfunction caused this error.
Please jumper short the pins that are related to the limit switch's input from a CNLS connector as shown below. At this stage, please check the limit (Over-Travel) from the Private input signal monitoring windows.

① If it turned to a white color, System Board malfunction caused this error. Please replace the board.
② If it is still yellow which indicates that the error persists.

Please search a problem that caused this error in an area between the System Board and the limit switch of main frame.



■ **Checking method from a Wire Harness (CER1 or CEC1)**

Warning
Please make sure the power of a controller has been completely turned off before you connect or remove any cables. Electrocution may cause personal injuries or a property damages

This method uses a Wire Harness connector (CER1 or CEC1) to judge if the cable malfunction caused this error.
Please remove CEC1 Wire Harness, and jumper short the pins that are related to the limit switch from a CEC1 connector which is attached to a controller. At this stage, please check the limit (Over-Travel) from the Private input signal monitoring windows.

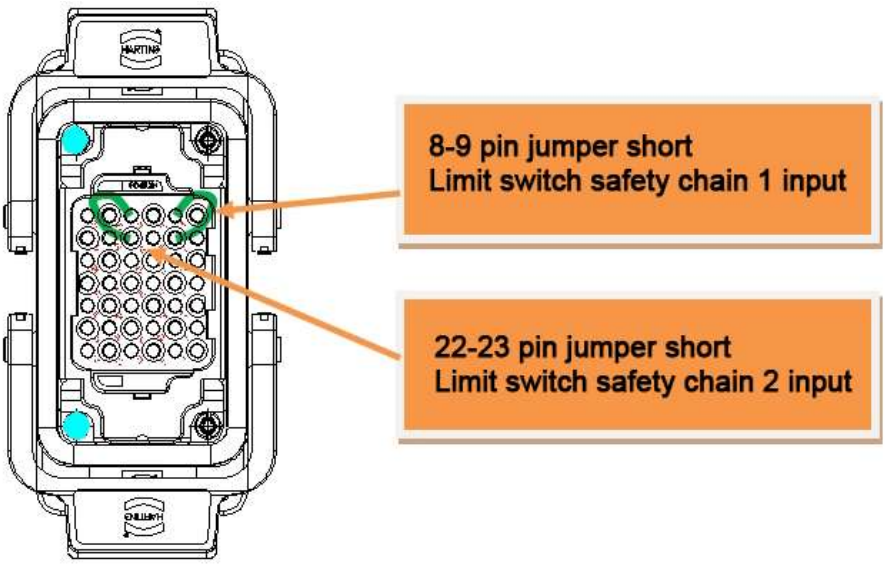
① If it turned to a white color, internal CEC1 Connector (of a controller) - System Board cable or a connector malfunction caused this error. Please examine them or replace them.

② If it is still yellow which indicates that the error persist, please search a problem that caused this error in an area between the CEC1 connector and the limit switch of main frame.

Please reconnect CEC1 Wire Harness, and remove the CER1 Wire Harness from a main frame. After that, please jumper short the pins that are related to a limit switch from a CER1 connector.
At this stage, please check a limit (Over-Travel) from the Private input signal monitoring windows.

① If it turned to a white color, Wire Harness cable between CER1 Connector-CEC1 Connector or a connector malfunction caused this error. Please examine them or replace them.

② If it is still yellow which indicates that the error persist, please search a problem that caused this error in an area between the mainframe side's CER1 connector and the limit switch.



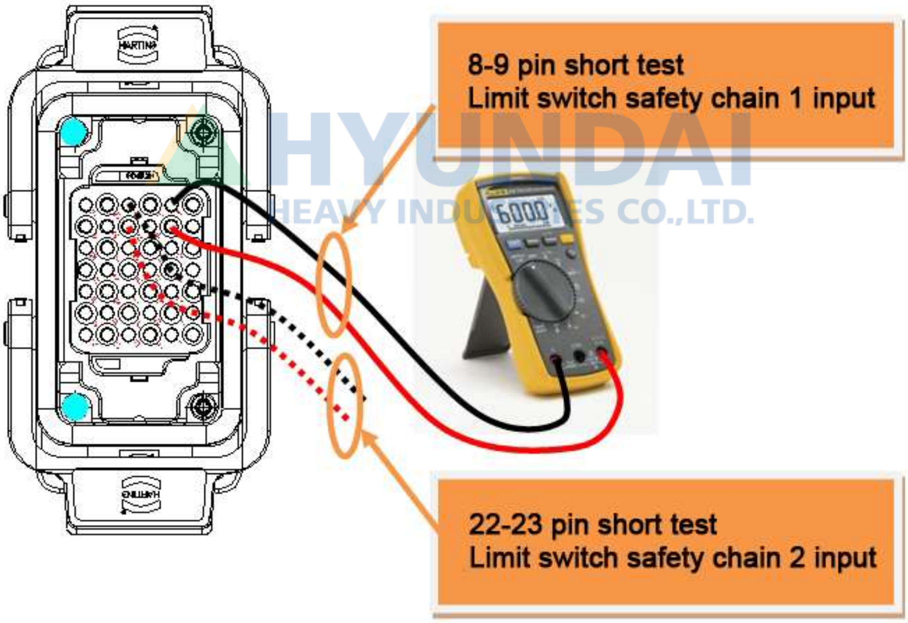
■ **Checking method by examining a limit switch and internal wiring of main frame**

Warning
Please make sure the power of a controller has been completely turned off before you connect or remove any cables. Electrocution may cause personal injuries or a property damages.

Please remove the CER1 Wire Harness from a main frame, and use a multi meter to run a short (shortage) test to examine the lines that are related to the limit switch from a main frame's CER1 connector.

① If resistance is measures as open status, limit switch or a limit switch – CER1 connector or a connector malfunction is suspected. Please examine or replace them.

② If resistance is measured as short (shortage) status, other parts need to be examined. Please make an enquiry to our office.



6.1.2. E0010 AMP recovery discharge resistance overheating

6.1.2.1. Outline

Recovery electric power that generated when Robot reduces a speed or moving toward to a gravity direction is discharged by resistance.
This error is related to an overheat that caused by the resistance.
This error may occurs due to a reduced performance of cooling fan, overheat detection sensor's circuit malfunction, disconnection of the resistor, overload of recovery discharge capacity that caused by momentary rapid movement or a continuous movement of robot.

6.1.2.2. Causes and checking methods

<Case: Error always occurs even when the motor is off>

(1) Please examine the components that are related to the overheat error detection
- Please examine the resistor of CNTR cable
- Please replace CNSGC cable and examine it
- Please replace BD530/BD531 board and examine it
- Please replace diode module and examine it

<Case: Error always occurs at the moment when the motor turns on>

(2) Please examine the components that are related to the power
- Please examine the resistance value of CNDR cable
- Please replace diode module and examine it
- Please examine the 3-phase voltage from the inside of controller
- Please examine the controller's 3-phase input voltage

<Case: Error occurs at a certain step according to the Robot's operation speed>

(3) Please make changes on a speed of Robot's operation in order to confirm the error
- Please reduce the speed of Robot's operation in order to confirm the error
- Please examine the recovery discharge resistance value

<Case: Error occurs after 5 minutes from the start up of Robot's operation>

(4) Please examine the controller's cooling system and recovery electric power level
- Please examine the operational status of each fan
- Please examine the power voltage of each fan
- Please reduce the speed of Robot's operation in order to confirm the error

(1) Please examine the components that are related to the overheat error detection

Recovery resistance overheat error is detected by Servo Drive Unit. Each end's On/Off status of overheat sensor that are attached to a recovery resistor is being monitored by CNTR connector. Detected error will be sent through CNSGC cable to be handled by software at the BD530/BD531 board.

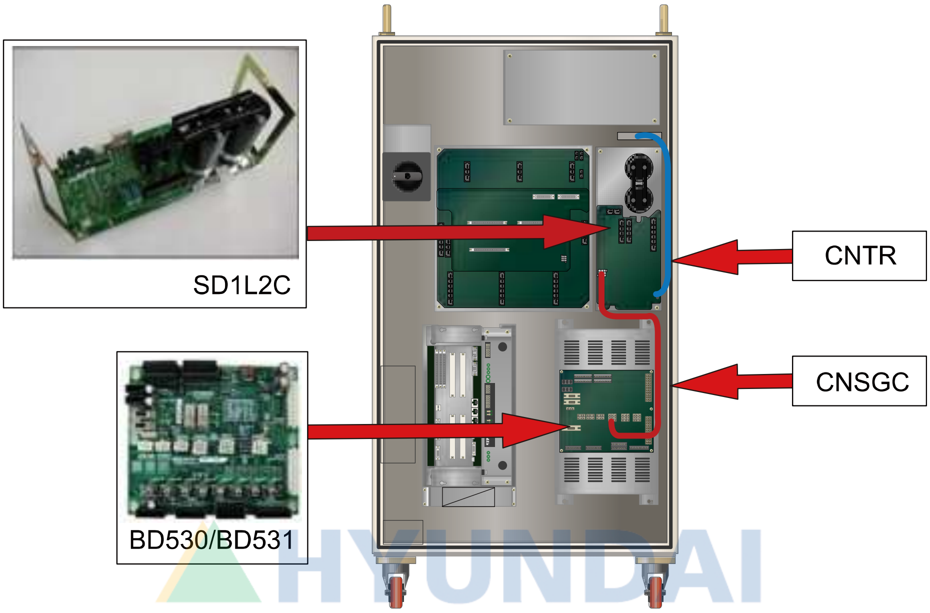


Figure 6.5 Locations of Components in Hi5-N00 Controller that are related to Recovery Resistance Overheat Error

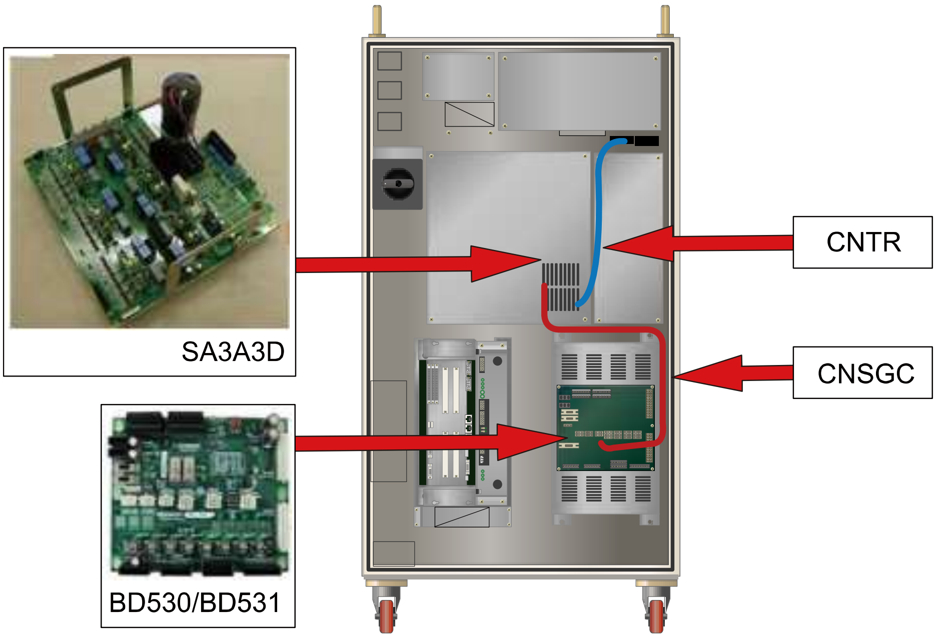


Figure 6.6 Locations of Components in Hi5-N30 Controller that are related to Recovery Resistance Overheat Error

- **Examining the CNTR cable**
  Please examine the sensor from a CNTR connector that connects the overhear detection sensors.
  In a normal status, sensor must be measured less or than 0.1 ohm

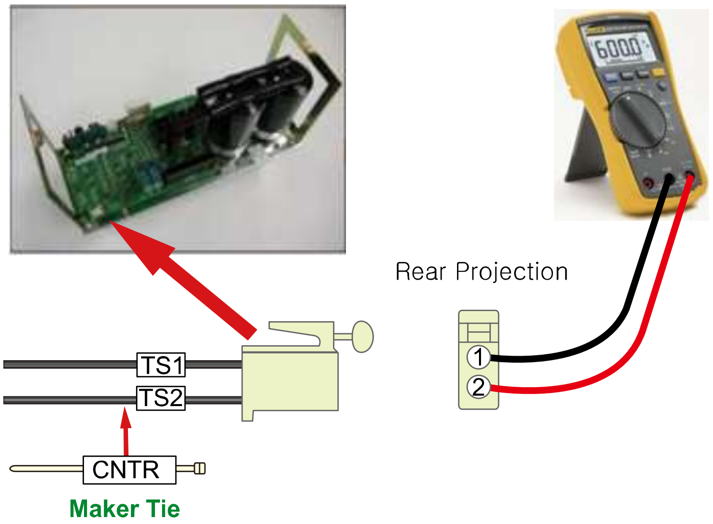


Figure 6.7 Measuring Resistance Value from Hi5-N00 Controller's CNTR

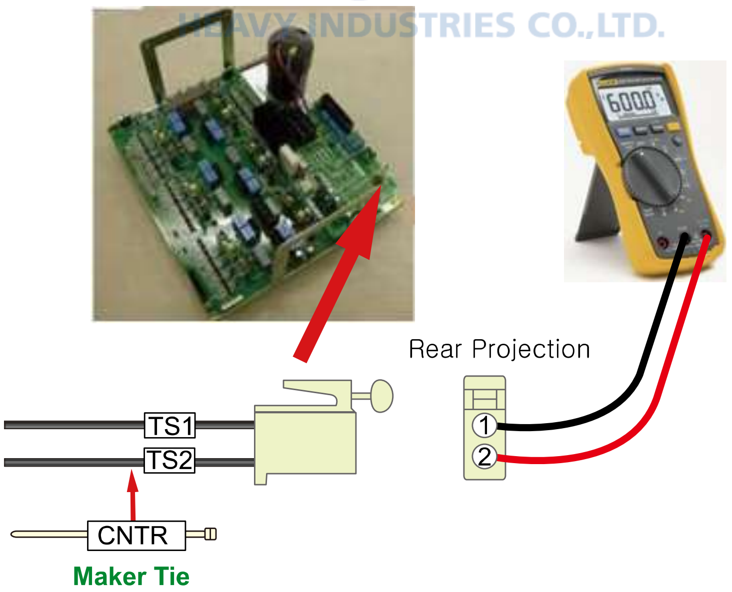


Figure 6.8 Measuring Resistance Value from Hi5-N30 Controller's CNTR

- Replacement and examining of CNSGC cable
  Replace the CNSGC cable with new one and test it. If the error does not persist, cable connection problem caused this error. Please replace the CNSGC cable with new one.

- Replacement and examining of BD530/BD531
  Replace the BD530/BD531 with new one and test it. If the error does not persist, the board malfunction caused this error. Please replace the BD530/BD531 with new one.

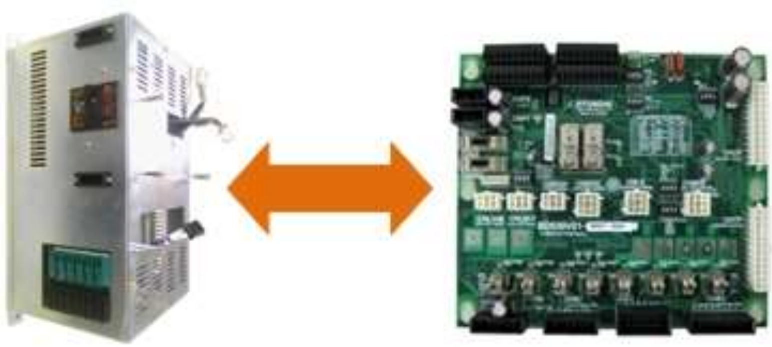


Figure 6.9 Replacement of BD530/BD531

- Replacement and examining of diode module
  Components that detects the recovery discharge resistance overheats error are SD1L2C (large size) and SA3A3D (small size). Please check the components in the controller that you are currently using and examine it. Please replace it with new one and see if the error persists.

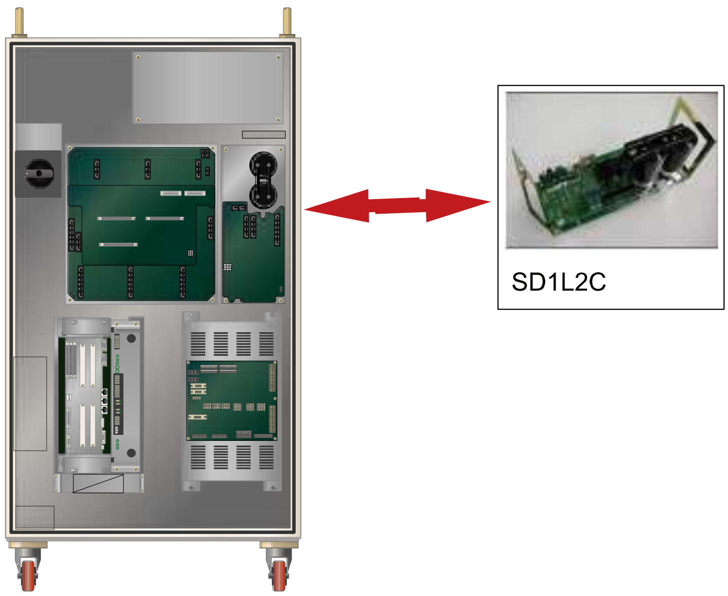


Figure 6.10 Replacement of SD1L2C in Hi5-N00 Controller when Recovery Discharge Resistance is Overheated

(2) Please examine the components that are related to the power

Overhear error may occurs in a case when resistor has disconnection or discharge control malfunction. It also can occur when recovery discharge resistance value and a 3-phase voltage increases.

- Examining recovery discharge resistor's disconnection
  If measured resistance value at the end of CNDR cable is many M ohm, the resistor's disconnection or connection problem of internal wiring caused this error. Please replace the recovery resistor with new one or repair the wiring.

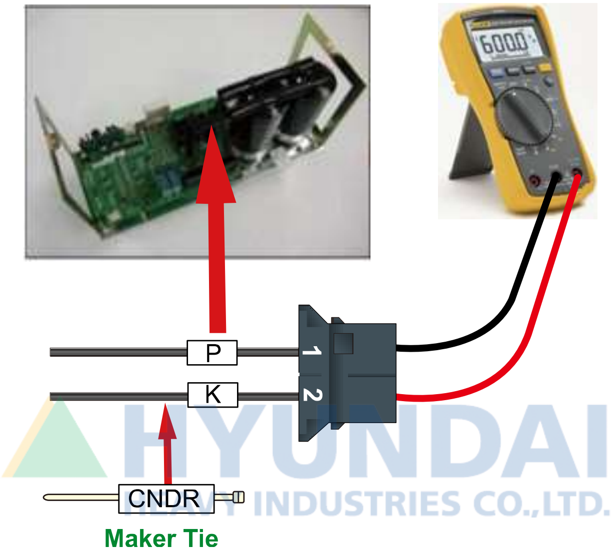


Figure 6.11 Measuring Resistance Value from CNDR of Hi5-N00 Controller

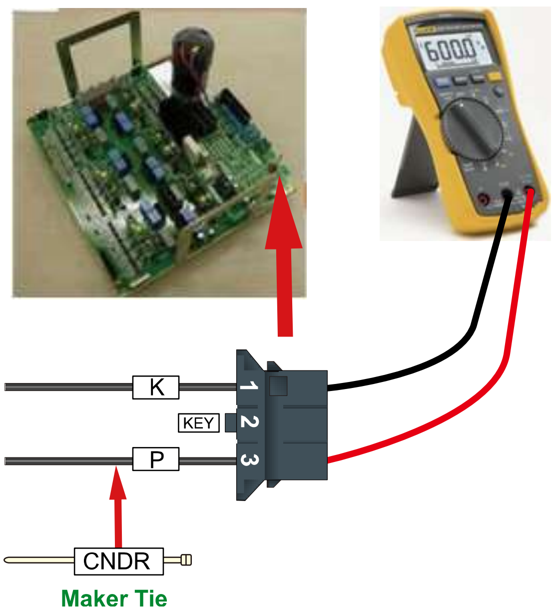


Figure 6.12 Measuring Resistance Value from CNDR of Hi5-N30 Controller

- Replacement and examining of diode module
  Please replace a module (SD1L2C for large size, SA3A3D for small size) that detects a recovery discharge resistance overheat error and check if an error persists. An error may occur continuously due to a module's internal circuit malfunction. For a large size controller, diode module is separated from the Servo Drive Unit, and for a small size controller, it is located inside of the Servo Drive Unit.

  - Large size Robot's diode module: SD1L2C
  - Small size Robot's Servo Drive Unit: SA3A3D

- Examine the 3-phase voltage (inside of the controller)
  Recovery discharge operation activates from approximately DC 375V
  If a voltage over AC242 V enters to the Servo Drive Unit, a recovery discharge resistance overheat error may occur when the motor turns on.
  If the input voltage exceeds the allowed range, please examine according to a controller's input voltage examination procedures and a controller's 3-phase internal voltage examination procedures.

  - Servo Drive Unit input voltage specification: 3-phase AC 220V
  - Allowed range when motor turns on: 198 V ~ 242 V

(3) Please make changes on a speed of Robot's operation in order to confirm the error

In case when a Robot's speed is reducing, or moving toward to gravity direction, direct current voltage of a Servo Drive Unit increases, and the voltage will be discharged with a recovery discharge resistance in order to prevent damages on components that may caused by voltage increase.
If a Robot reduces its speed rapidly, or make a high speed movement toward to gravity direction, it may cause this error. Please confirm if this error occurs according to the speed of Robot's operation.

- Make changes on a speed of Robot's operation
  If a recovery electric power that generated by Robot's operation exceeds the controller's designed specification, recovery resistance overheat error may occurs. Please reduce the speed of a step that the error occurs and re-operate in order to confirm if the error persists.

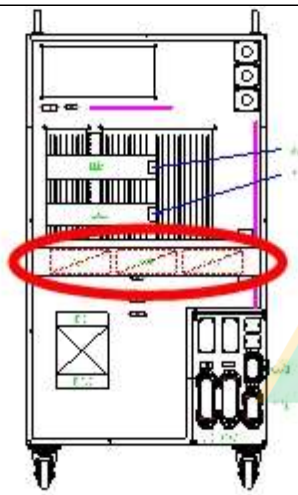
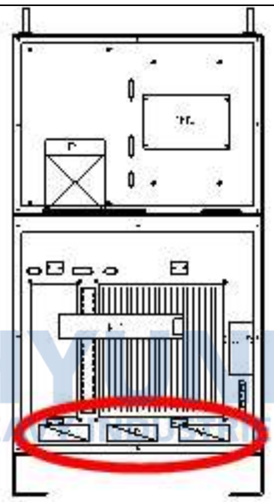
- Examining recovery discharge resistance value
  If a measured resistance value at the end of CNDR cable exceeds over 10% of the value described in the manual, the resistor malfunction is the cause of this error. Please replace the resistor. Please refer to the previous page for the measuring method.

  - Large size (SD1L2C) recovery discharge resistance value: 5 ohm
  - Small size (SA3A3D) recovery discharge resistance value: 15 ohm

(4) Please examine the controller’s cooling system and recovery electric power level

If recovery resistance overheats error occurs after 5 minutes from the start up of Robot’s activation, the cause would be either the controller’s cooling system malfunction or a speed of Robot’s operation exceeded the designed specification of the controller.
Fans are being used at rear of the controller in order to cool down the Servo Drive Unit’s heat sink and the recovery discharge resistor.

Table 6-1 Location of Fans for Each Controller

Hi5-N**	Hi5-C1*	Hi5-C0*
		

- Examining the operational status of each fan
  Please replace a fan if it does not spin, or the speed is abnormally slow. Lifetime of a fan may vary according to a operating environment or a amount of operated hours.

- Examining fan’s power voltage
  Please check the input voltage of fans if all of them do not operate. Input voltage of a fan is set to AC220V and the allowed range is within 10% of the standard voltage. If voltage is lower than 10% of the standard voltage, the cooling effect will be reduced due to slow spinning speed of a fan. In case when the voltage is low, please check the input voltage for fan’s power supply connector (CNFN2) and a controller.

- Please confirm an occurrence of an error according to the speed of Robot’s operation
  If an overheat error occurs during a continuous operation over 5 minutes, it is because of the consecutive operation of Robot exceeded the cooling capacity of a controller.
  Please reduce the speed of Robot’s operation and check if the error persists.
  In order to resolve this error, if you had to reduce the operation speed too much just to resolve this error, please enquire at our office.

6.1.3. E0011 AMP overvoltage (P-N)

6.1.3.1. Outline

Direct current voltage (P-N) of Servo Drive Unit that drives the motor exceeded the set value.

6.1.3.2. Causes and checking methods

<Case: Error always occurs even when the motor is off>

(1) Please examine the components that are related to the overvoltage error detection.
- Please replace CNSGC cable and examine it CNSGC.
- Please replace BD530/BD531 board and examine it BD530/BD531.
- Please replace diode module and examine it.

<Case: Error always occurs at the moment when the motor turns on>

(2) Please examine the components that are related to the power.
- Please replace diode module and examine it.
- Please examine the 3-phase voltage from the inside of controller.
- Please examine the controller's 3-phase input voltage.

<Case: Error occurs at a certain step according to the Robot's operation speed>

(3) Make changes on a speed of Robot's operation in order to confirm the error.
- Please reduce the speed of Robot's operation in order to confirm the error.
- Please examine the recovery discharge resistance value.

(1) Please examine the components that are related to the overheat error detection.

AMP overvoltage occurrence error is detected by diode module when direct current voltage (P-N) that supplied to the Servo Drive Unit exceeds the configured level. Detected error will be sent through CNSGC cable to be handled by BD530/BD531 board.

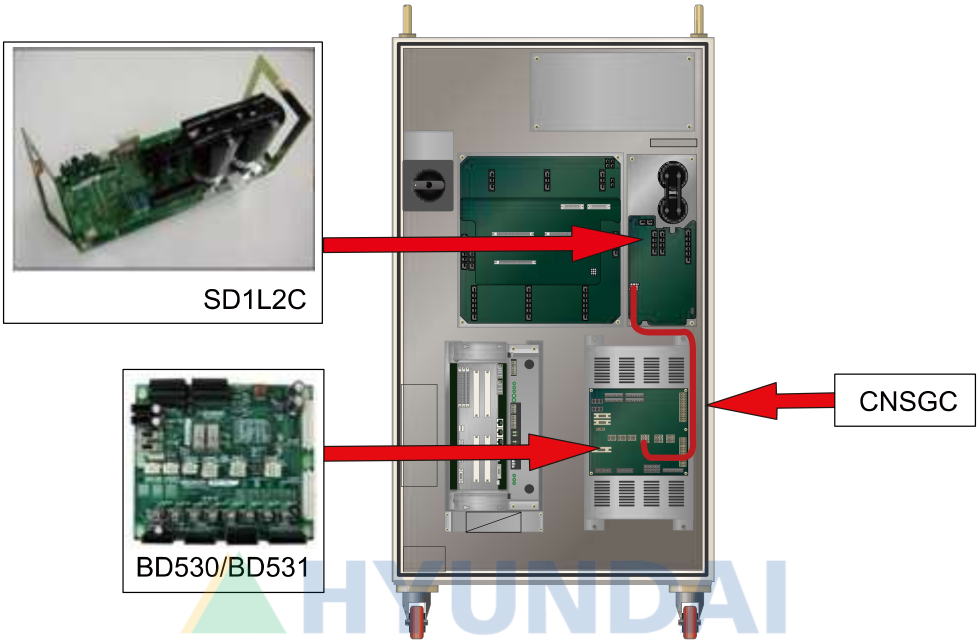


Figure 6.13 Locations of Components in Hi5-N00 Controller that are Related to Overvoltage Occurrence Error

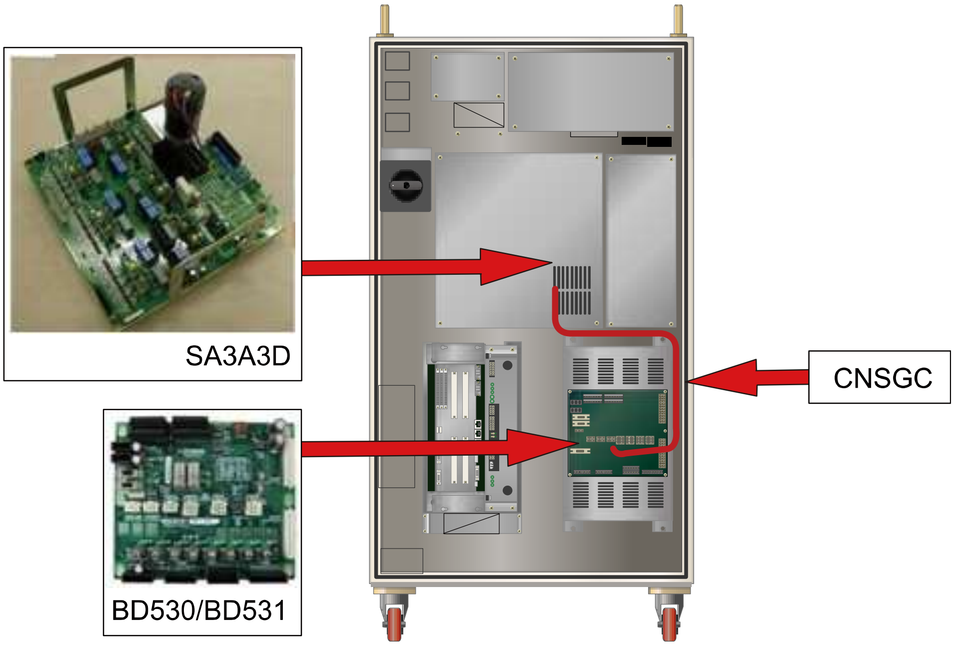


Figure 6.14 Locations of Components in Hi5-N30 Controller that are Related to Overvoltage Occurrence Error

- Replacement and examining of CNSGC cable
  Replace the CNSGC cable with new one and test it. If the error does not persist, cable connection problem caused this error. Please replace the CNSGC cable with new one.

- Replacement and examining of BD530/BD531
  Replace the BD530/BD531 with new one and test it. If the error does not persist, the board malfunction caused this error. Please replace the BD530/BD531 with new one.

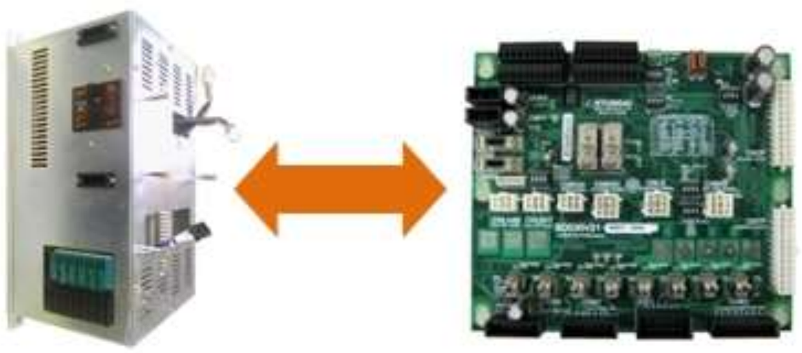


Figure 6.15 Replacement of BD530/BD531

- Replacement and examining of diode module
  Components that detects the AMP overvoltage occurrence error are SD1L2C (large size) and SA3A3D (small size). Please check the components in the controller that you are currently using and examine it. Please replace it with new one and see if the error persists.

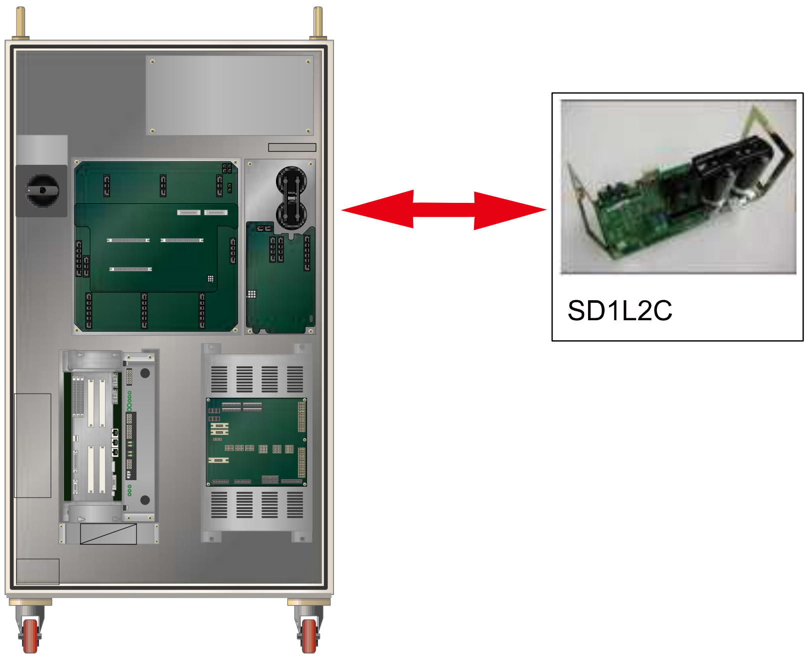


Figure 6.16 Replacement of SD1L2C in Hi5-N00 Controller when Overvoltage Occurred

(2) Please examine the components that are related to the power.
Overvoltage error occurs when direct current voltage that exceeds DC395V due to 3-phase input voltage over AC 220V enters to the Servo Drive Unit.

- Replacement and examining of diode module
  Please replace a module (SD1L2C for large size, SA3A3D for small size) that detects AMP overvoltage error and check if the error persists. An error may occur continuously due to module's internal circuit malfunction.

  - Large size Robot's Servo Drive Unit: SD1L2C
  - Small size Robot's Servo Drive Unit: SA3A3D

- Examine the 3-phase voltage
  AMP overvoltage error is activated from approximately DC 395V
  If voltage over AC242 V enters to the Servo Drive Unit, a recovery discharge resistance overheat error may occur when the motor turns on.
  If the input voltage exceeds the allowed range, please examine according to a controller's input voltage examination procedures and a controller's 3-phase internal voltage examination procedures.

  - Servo Drive Unit input voltage specification: 3-phase AC 220V
  - Allowed range when motor turns on: 198V ~ 242V

(3) Please confirm the occurrence of error according to the speed of Robot's operation.
If a robot reduce the speed rapidly, or make a high speed movement toward to gravity direction, it can cause an overvoltage error. Please confirm if an error occurred according to a speed of Robot's operation.
AMP overvoltage occurrence error also can be caused by an invalid recovery discharge resistance value or recovery discharge control malfunction.
In case when a Robot's speed is reducing, or moving toward to gravity direction, voltage of the Servo Drive Unit increases, and the voltage will be discharged with a recovery discharge resistance in order to prevent damages on components that may caused by an increased voltage.

- Make changes on a speed of Robot's operation
  If a recovery electric power that generated by Robot's operation exceeds the controller's designed specification, overvoltage error may occurs. Please reduce the speed of a step that the error occurs and re-operate in order to confirm if the error persists. If the error does not occur when the speed is reduced, please change the speed of step and use it.

- Examining the recovery discharge resistance value
  If a recovery resistance value is greater than the specification, recovery discharge does not perform well and it will cause the overvoltage error. Recovery resistance specifications are subject to be changed according to the controller's specification. Please refer to a manual and a controller check sheet that provided upon a purchase.
  If the resistance value exceeds 10 % of specification, please replace it.

  - Large size (SD1L2C) recovery discharge resistance value: 5 ohm
  - Small size (SA3A3D) recovery discharge resistance value: 15 ohm

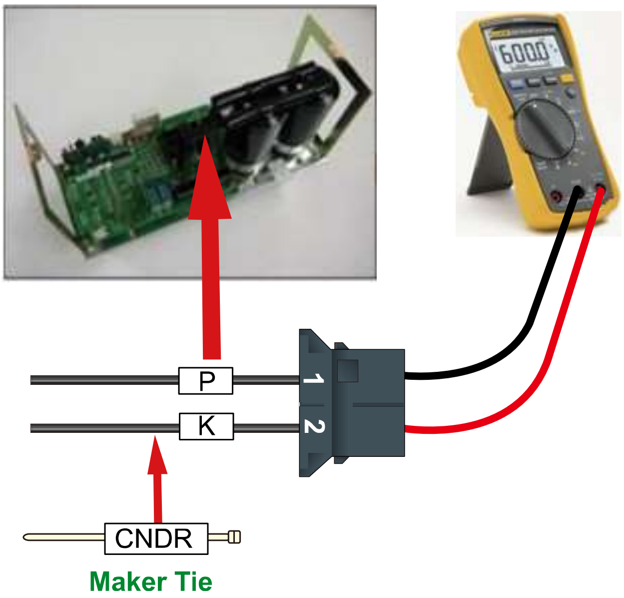


Figure 6.17 Measuring Resistance Value from CNDR of Hi5-N00 Controller

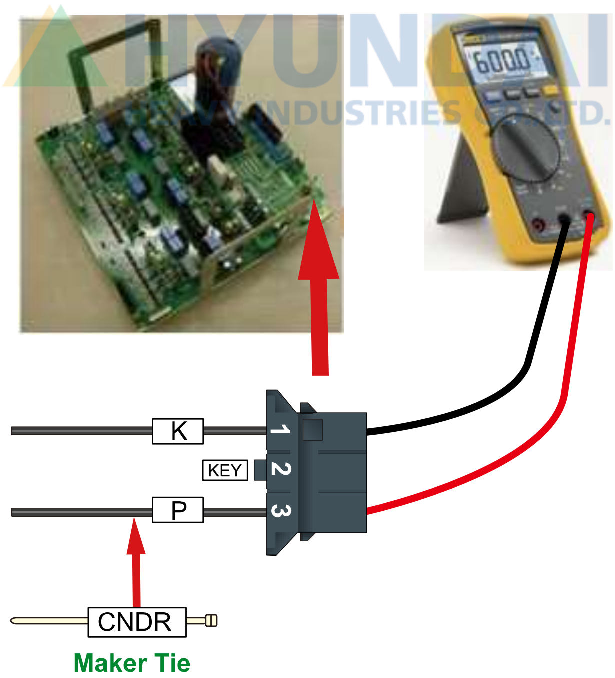


Figure 6.18 Measuring Resistance Value from CNDR of Hi5-N30 Controller

6.1.4. E0014 Instant contact of safety switch (EM, OTR, TS etc.)

6.1.4.1. Outline

For some reason the motor's power supply to AMP has been shut down. Main examines the safety signals in order find the reason of the motor's power shut down. If no reason is found, this message will be displayed.

.

Following diagram shows compositions of various safety signals that can shut down the motor's power. Main periodically examines the ON/OFF status of those safety signals. If a momentary contact malfunction occurs between the periods, main will not be able to detect it and displays this message instead.

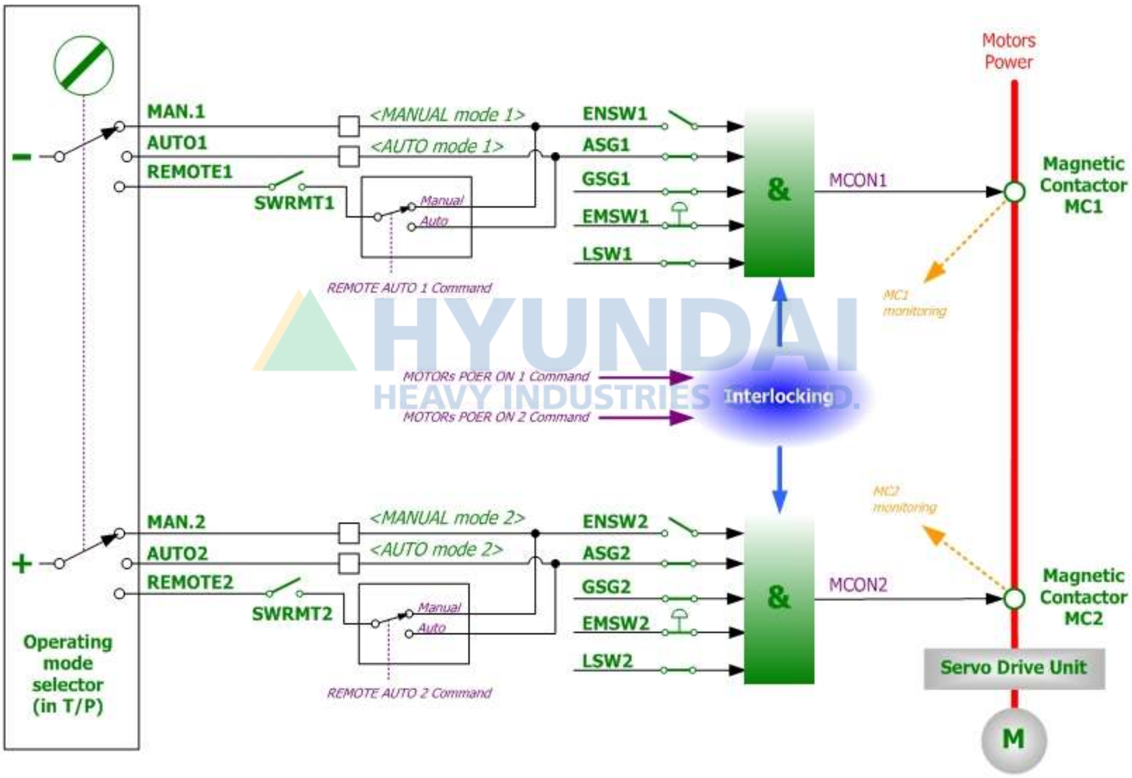


Figure 6.19 Concept Diagram of Safety Circuit for Motor's Power ON/OFF

6.1.4.2. Causes and checking methods

(1) Please check the status of DC 24V (P1-M1) power and cables

(2) Please check if there is a problem with CPUERR, EXOUT signals

(3) Please check the safety switch and signal wirings

(4) Please check the System Board, Electrical Module

(1) Please check the status of DC 24V (P1-M1) power and cables.

Please check if the System Board is being supplied with DC 24V control power (P1, M1) properly. This error can be caused if there is a problem with the power as it will effect the safety sequence of the System Board. Power is to be supplied by SMPS's CN6 Connector-System Board CNP2 Connector. Please check if the power level is varying or is there any problem with the cable.

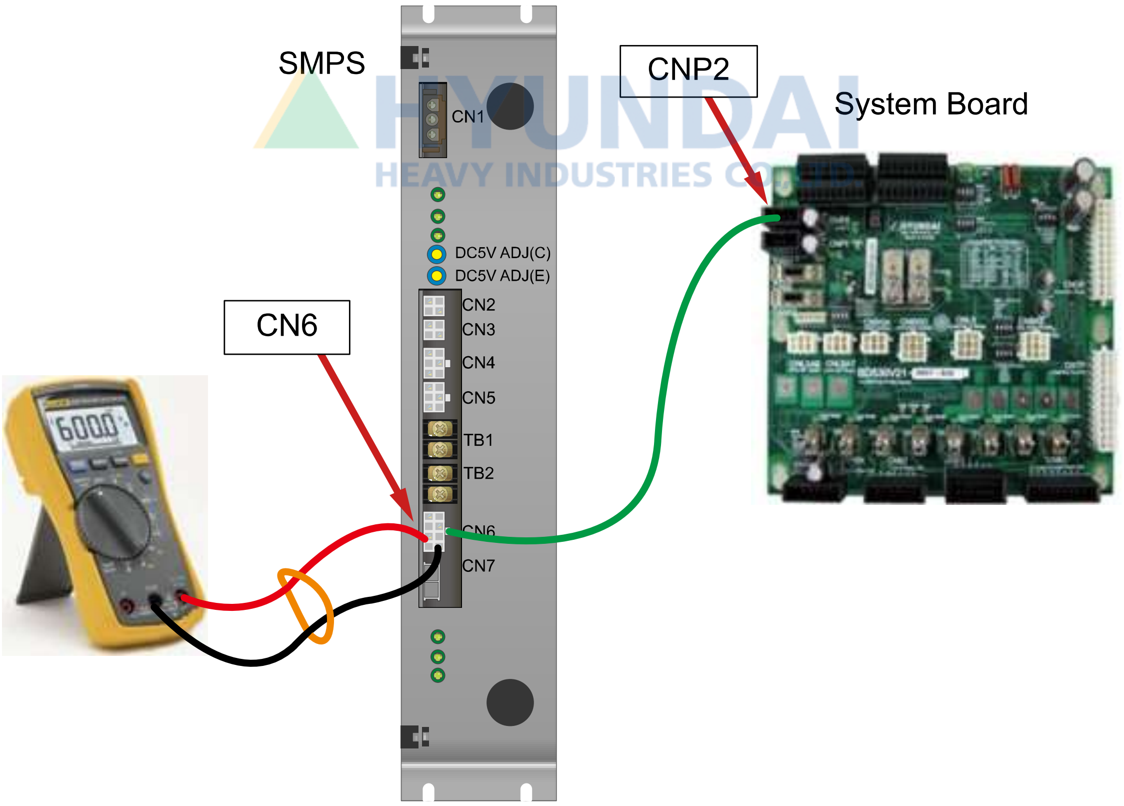


Figure 6.20 Method of Connecting DC24V Power and Measuring Voltage of the System Board (BD530)

(2) Please check if there is a problem with CPUERR, EXOUT signals

Main board generates CPUERR or EXOUT signals in a case when systemic error has occurred (e.g. power shut down, Servo error). This signal will be transferred to the System Board and block the motor on command in terms of hardware. Motor's power will be immediately shut down for a safety reason. However, these signals may be generated abnormally, and it will shut down the motor's power.

- How to judge:
  System Board's 7-segment index may give you an indication of the situation.7-segment displays "H" when CPUERR is being transmitted to the System Board. Also the CPUERR, EXOUT LED which located at the center of the System Board indicate the error situation (figure 6.21) These LED lights will be on if it is a normal status, and the lights will be off if it is not.

  However if the signal appears time to time for a very short moments, 7-segment and LED won't be able to indicate it. In such case, error occurrence must be observed while ignoring the two signals by using DIP switch SW1. Method to ignore the signal is to, as shown in the figure 6.21, turn on the No 1(to ignore CPUERR) and the No 2 (to ignore EXOUT) of the DIP switch SW1. At this point all LED lights will be on.

  If the error no longer persists after the system restart, main board generated these signals or CANS1 Connector/Cable malfunction is suspected.

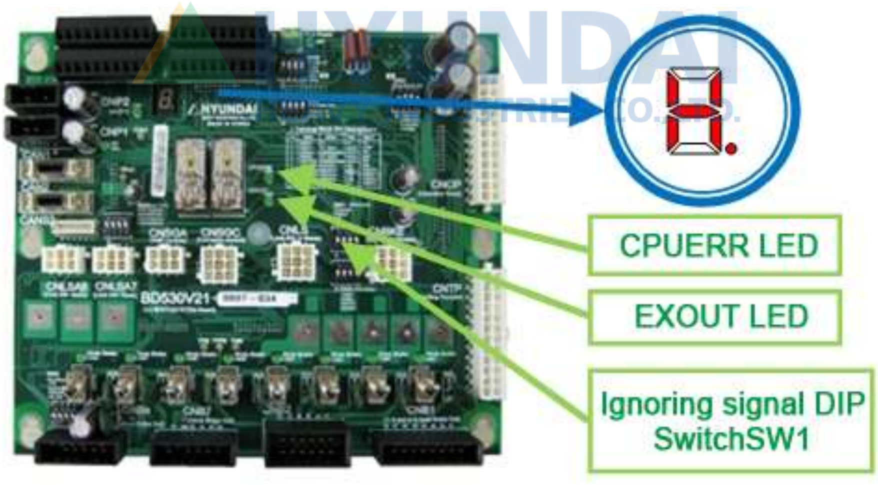


Figure 6.21 Location 7-SEG, LED and DIP Switch (CPUERR error related) on a System Board

- Actions:
  If a Main Board generating this signal without any other indication of errors, please check the PLD version of the Main Board. Over V0.7 is normal. If main board's PLD version is normal, please examine the CANS1 connector and cables.

Cautions: Please use only No 1 (to ignore CPUERR) and No2 (to ignore EXOUT) of the DIP switch SW1 for a testing purpose and please switch it back to normal after the test. This ignores the emergency safety related functions and it may cause safety related problems if operates while ignoring these functions.

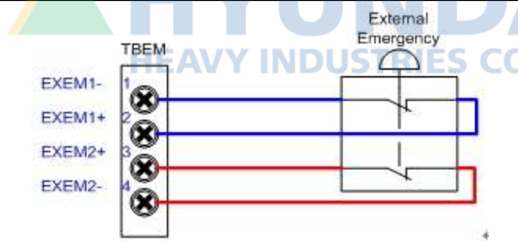
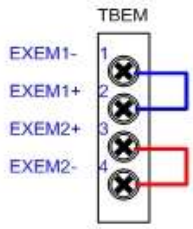
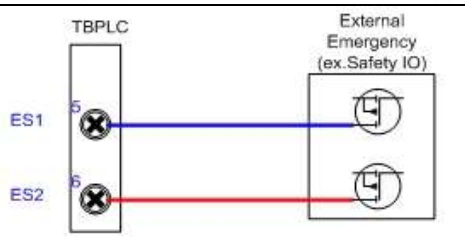
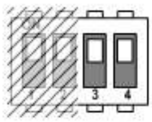
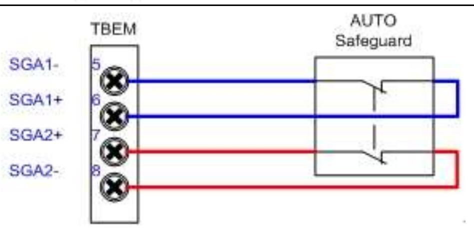
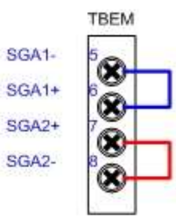
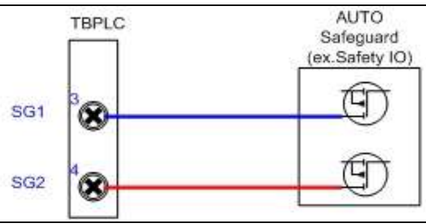
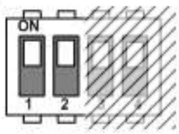
(3) Please check the safety switch and signal wirings.

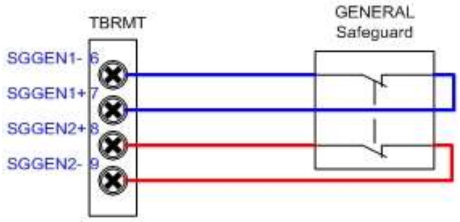
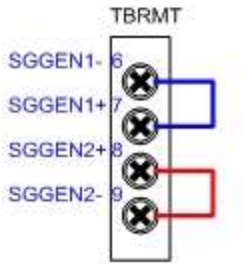
Safety switch input may goes OFF for a short moment which cannot be detected by the Main Board for following reasons.

- Switch malfunction
- Wiring malfunction: Exposure or damage on a cable
- Wirings installation problem:
  Separated distance between power lines, cables that consume a large amount of electric power must be greater than 10 CM. Alternatively electrical shielding by using a metal marital plates are required.

Cautions: Please use only for a testing purpose and please switch it back to normal after the test. This ignores the emergency safety related functions and it may cause safety related problems if operates while ignoring these functions.

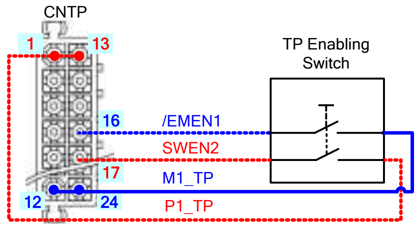
Available safety switches are as below, and they can be connected through a System Board. Please check the above for the safety switches that are being used.

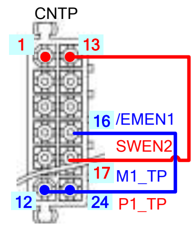
Types	Connecting method	Disabling method
Emergency stop switch(External) –point of contact type		
Emergency stop switch(External)-semi conductor type		No3, No4 of SW6 is ON 
Safety guard (Auto)-point of contact type		
Safety guard (Auto)-semiconductor type		No1, No2 of SW6 is ON 

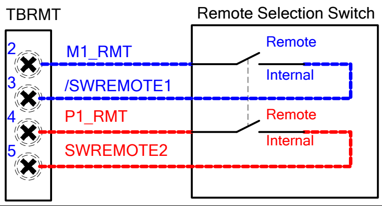
<table>
<tr><th>Types</th><th>Connecting method</th><th>Disabling method</th></tr>
<tr><td>Safety guard
(General)</td><td>
</td><td>
</td></tr>
</table>

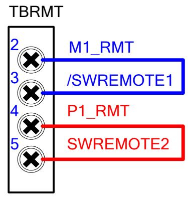
Cautions:
Please use only for a testing purpose and please switch it back to normal after the test. This ignores the emergency safety related functions and it may cause safety related problems if operates while ignoring these functions.

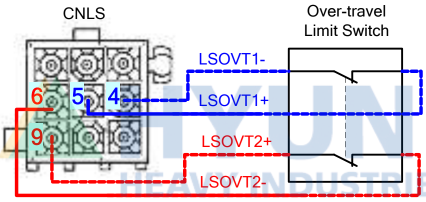
Other switches that are related to a safety and system operation which may effect to this error are as below.

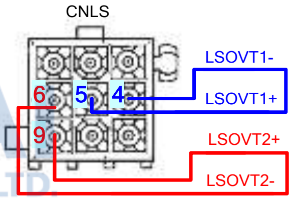
<table>
<tr><th>Types</th><th>Connecting method</th><th>Disabling method</th></tr>
<tr><td>Enabling switch (TP)</td><td>


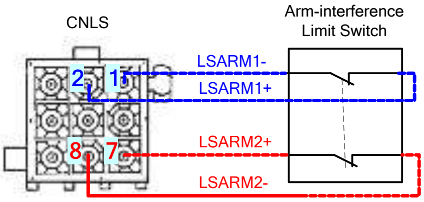
</td><td>


</td></tr>
<tr><td>Remote mode input</td><td>


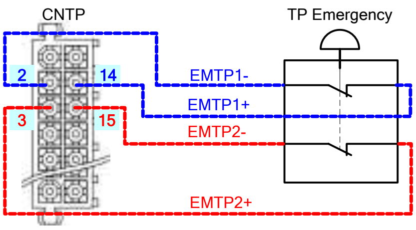
</td><td>


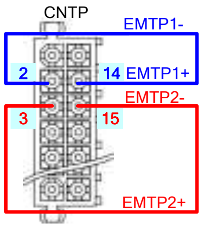
</td></tr>
<tr><td>Limit switch</td><td>


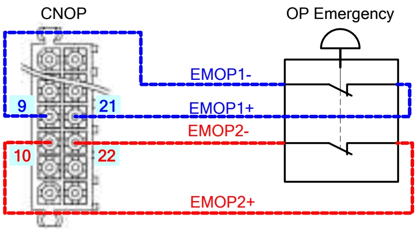
</td><td>


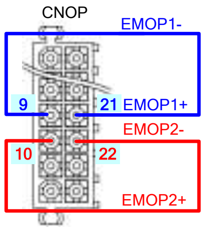
</td></tr>
<tr><td>Arm interference switch</td><td>


</td><td>


</td></tr>
<tr><td>Emergency stop switch (TP)</td><td>
System Board – Wiring between Teach Pendants


</td><td>


</td></tr>
<tr><td>Emergency stop switch (OP)</td><td>


</td><td>


</td></tr>
</table>

(4) Please check the System Board, Electrical Module.

- Cabling (wires, connector etc) malfunction
  Please check the cabling between the Electrical Module (PDM30) that an electrical connector is installed and the System Board (BD530) that collects monitoring signals.
  The cable name is CNMS and it enters to the Electrical Module through the top rear of the System Board (figure 6.22). Please check the connection status of this cable's connector.

Figure 6.22 CNMC Cable on the Electrical Module

- System Board malfunction
  Input signal processing unit malfunction from the inside of System Board can be a cause of this error. Please replace the System Board and examine it.

- Electrical Module malfunction
  Internal electrical module malfunction can be categorized as a electrical board (BD5C0), Electrical connector (MC1, MC2), and wirings between the electrical board and the electrical connector (figure 6.23) However it is difficult to examine the inside of Electrical Module in a field where a Robot has already been installed, so alternatively please replace the Electrical Module.

Figure 6.23 Inner Structure of Electrical Module

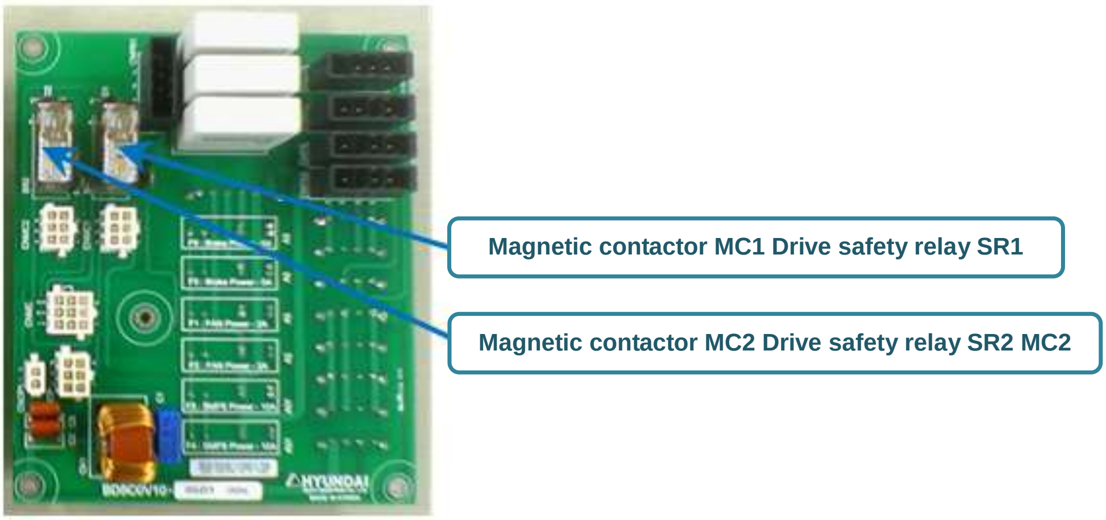


Figure 6.24 Electrical Board (BD5C0)

6.1.5. E0015 Teaching pendant operation error

6.1.5.1. Outline

This error occurs when communication between a Main Board (BD510) and a Teach Pendant (TP510) has been disconnected due to a bad communication status. If this error occurring during an operation (AUTO mode), a robot will be immobilized.

6.1.5.2. Causes and examine methods

(1) Please check if the Main Board inside of a controller is in a normal status.

(2) Case: Status of 7-Segment from a Main Board is "." (normal)
- Case: TP communication status indicator icon is white
- Case: TP communication status indicator icon is x

(3) Case: Status of 7-Segment from a Main Board is "u."
- TP communication status indicator icon will be x

(4) Case: Status of 7-Segment from a Main Board is abnormal
- TP communication status indicator icon will be x

(1) Please check if the Main Board inside of a controller is in a normal status

Communication can be disconnected if a Main Board or a Teach Pendant is in a abnormal status for any reasons. Please see the 7-Segment from a Main Board to confirm if a Main Board's status is normal or abnormal.

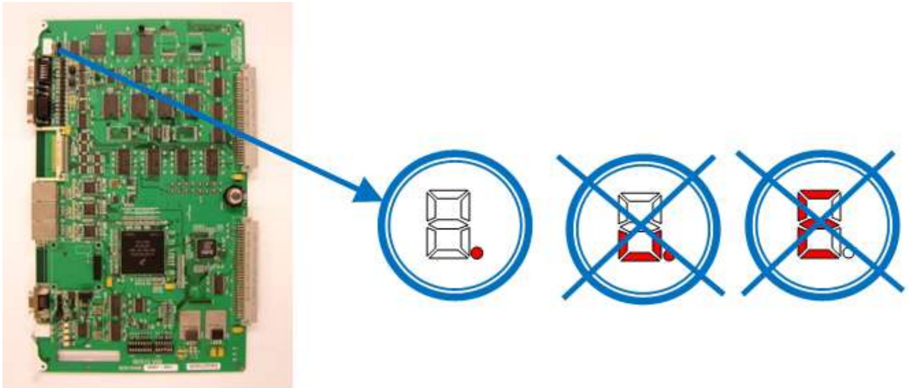
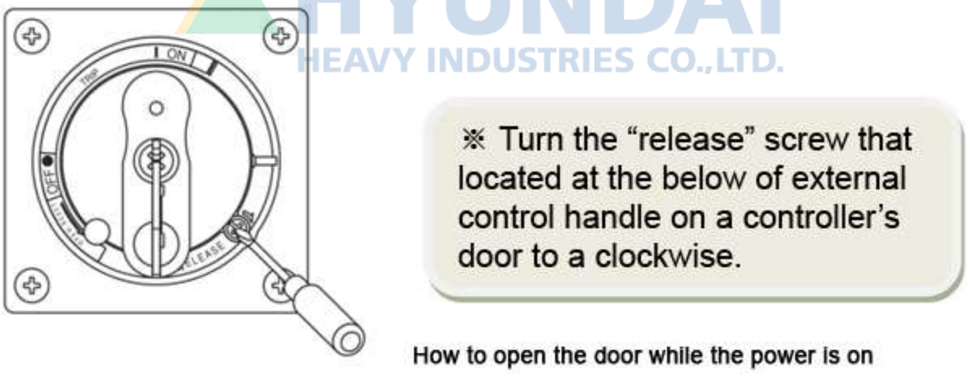


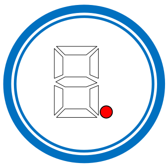
Figure 6.25 7-Segment is in a Normal Status. Others are Abnormal (see the above diagram)

If a controller's door is shut when the power is on, please refer to the below diagram in order to open the door to check.



How to open the door while the power is on

Caution
Once a controller is opened, please only check the main board's status and do not touch anything else for a safety reasons.
Please make sure to close it after you check the main board's status.



(2) Case: Status of 7-Segment from a Main Board is "." (normal)

Please check the status of "TP communication indicator icon" that located on a left side of "Titles" from TP510.

■ If a TP communication status indicator icon is blue, it is a normal status.

■ If a TP communication status indicator icon is white,

➢ LAN cable between a Main Board and TP has a problem (not open) or an abnormal status of Teach Pendant is suspected.

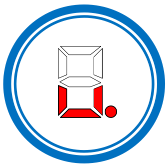
① Please download Main Board's application program as same version as a TP.
② Please replace TP510 and test it.
③ Please replace a LAN cable between TP connector and Main Board in a controller and test it.
④ If a same status persists, please contact to our AS department.

■ If a TP communication status indicator icon is x,

➢ Disconnection (open) of LAN cable between a Main Board and TP is suspected.

① Please replace TP and test it.
② Please replace a LAN cable between TP connector and Main Board in a controller and test it.
③ If a same status persists, please contact to our AS department.

(3) Case: Status of 7-Segment from a Main Board is “u.”

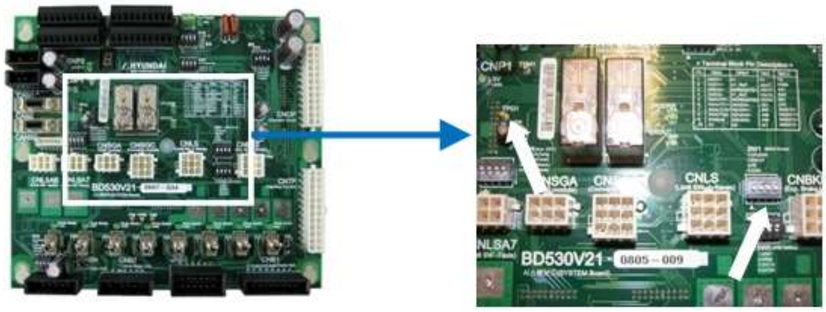


- TP communication status indicator icon will be x.

➢ Cable between a main and System Board, or a System Board is suspected.

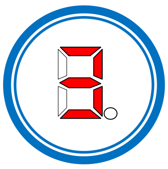
① Please check if a connector at the both ends of cable has been plugged properly.
② Please check if a power for CNMC connector is AC48V.

③ Please check if VE (3pin) of SW1 is DC0V.



④ Please replace a (CANIO↔CAN1)Cable and test it.
⑤ Please replace a System Board and test it.
⑥ If a same status persists, please contact to our AS department.

(4) Case: Status of 7-Segment from a Main Board is abnormal



- TP communication status indicator icon will be x.

➢ The cause for this case is a Main Board malfunction.
① Please replace a Main Board and test it.
② If a same status persists, please contact to our AS department.

6.1.6. E0022 Communication error between internal modules

6.1.6.1. Outline

Internal modules of controller use CAN communication in order to transfer data. E0022 is an error code that indicates the Main Board has detected an error in a CAN communication between internal module System Boards. E0032 error code will be used for users board (BD58x) that uses a same CAN communication channel.

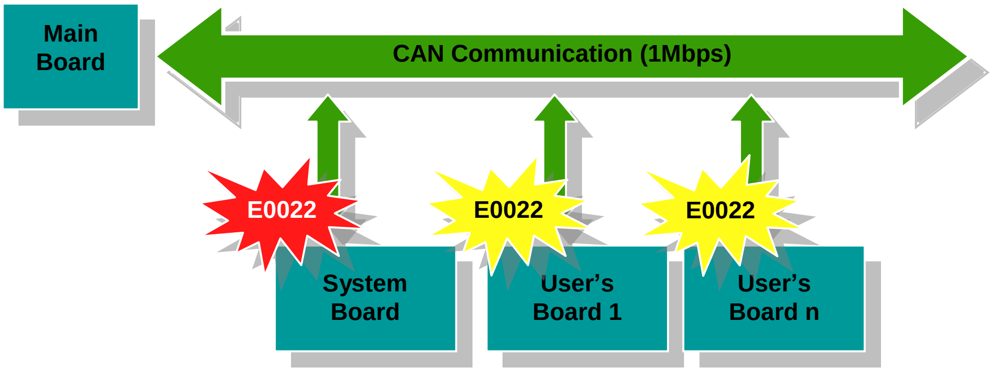


Figure 6.26 CAN Communication Structure of Hi5 Controller

System Board is a module that controls an input/output of controller's power sequence. Once this error occurs, all functions related to this will be stopped and main stops CAN communication. In order to re active all the functions, a controller must be restarted.

6.1.6.2. Causes and examine methods

(1) General examine

- Please check the connection status of CAN communication cable.
- Please check the power status. (power voltage or connection status of cable)

(2) If an error persists even after a restart of controller

- Please check a System Board malfunction.
- Please replace a malfunction parts and test it (Main Board, System Board, cables)

(3) If an error occurs while a controller is normally operating

- Please observe a changes in surrounding environment.
- Please examine the CAN communication line.
    - Please examine the CAN communication connector for users module.
    - Please examine the connection of termination resistor.
    - Please examine the wiring structures.
    - Please examine if a communication cable uses a twist line.

(1) General examine

If this error occurred while a system is normally operating, please examine the following for a start.

Reference

Once "E0022 Communication error between internal modules" occurs, mainboard will not establish a communication with system board even if a system board initiates communication. Controller must be restarted in order to reestablish a communication.

- Please check the connection status of CAN communication cable

  Please check if a CAN cable between Main Board and System Boards are well connected. Please remove and reconnect the CAN connectors of Main Board and System Board and check if an error persists, in order to check connector's connection status.

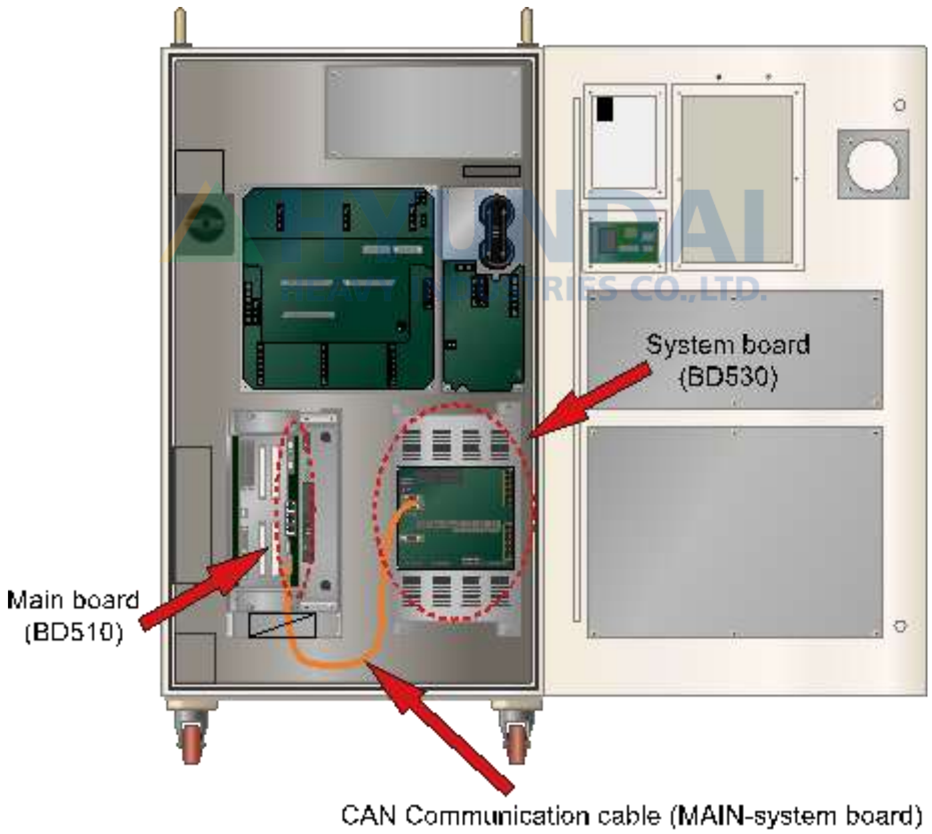


Figure 6.27 CAN Communication Cable Connection between a Main Board (BD510) and a System Board (BD530)

- Please check the power status (power voltage or connection status of cable).
  Please check if a DC 5V control power is being supplied to System Board properly. If there is a problem with a power, this error may occur as the System Board will not operate.
  Please check if a power is being supplied or not by using a simple method. As a below diagram, there are LED CNP1 that indicates DC 5V voltage and 7-segment that indicates the board operating status on an upper right side of System Board.

Table 6-2 Method to Check the whether the Rated Voltage on System Board is Normal or Not

Category	LED CNP1	7-SEG	Result
1	Off	Off	Power on a System Board is has not been authorized properly. Please examine the power related parts such as SMPS, Cable, Connector connections etc.
2	On	Off	Power of IO related board (BD531) that located at the rear of system is not authorized or malfunction.
3	On	On	Please check the power voltage.

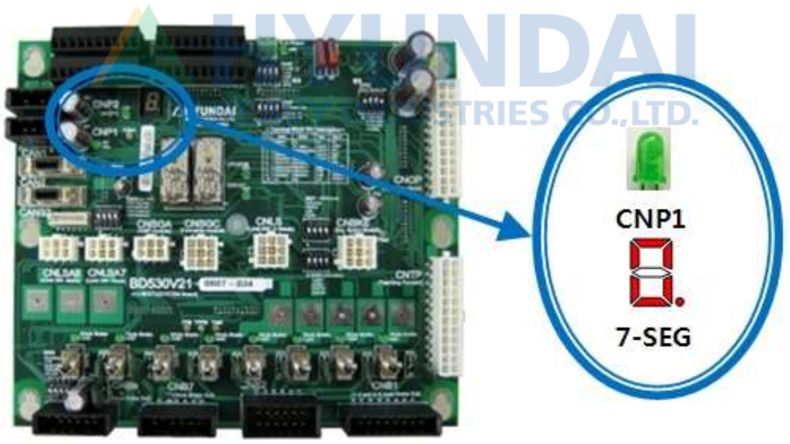


Figure 6.28 LED CNP1 for a Power Purpose DC5V of a System Board (BD530)

If the lights of LED CNP1 and 7-segment DC are all on as above table, please check if the DC 5V control power that authorized on a board is in a range of 5.0V~5.3V.
If the voltage is out of this range, it may effect to the communication. Check points are as below diagram and it the voltage is out of range, please configure it to a range of 5.0V~5.3V from a SMPS.

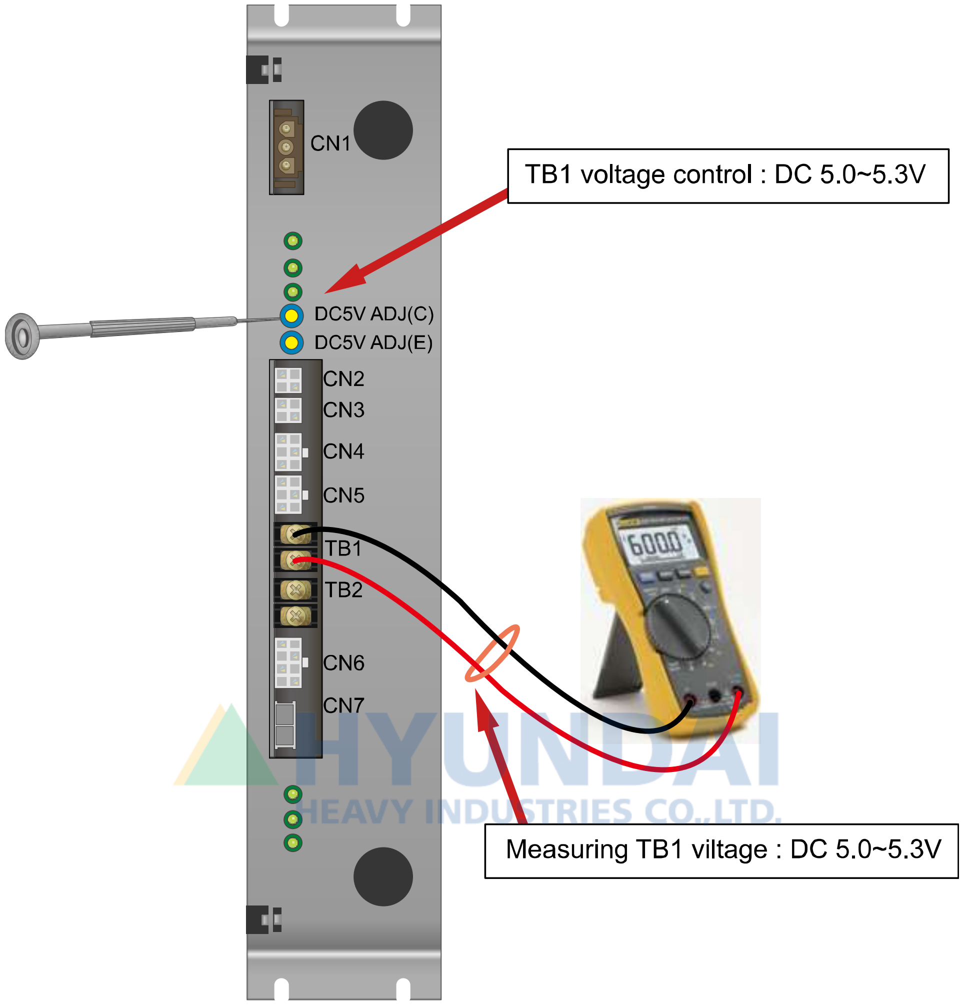


Figure 6.29 Measuring a Voltage of DC 5V and Controlling Method

(2) If an error persists even after a restart of controller

If a error message displayed because the error is already occurring even after the controller has been restarted, the faulty area can be identified by performing a series of examines.

Reference

If you are usings a user's module (BD58x), please remove a CAN cable that connected to this module before you perform this test. It is to eliminate possible elements that will effect to the test. If this error does not persists after a restart of a controller followed by a removal of user's module cable, the cause of an error is related to a user's module. Please refer to the following paragraph.

In order to remove a user's module CAN communication from a controller, please unplug the CAN2 and CANS2 connectors from a System Board as below diagram. If you restart the controller, only a Main Board and System Board will keep the CAN communication.

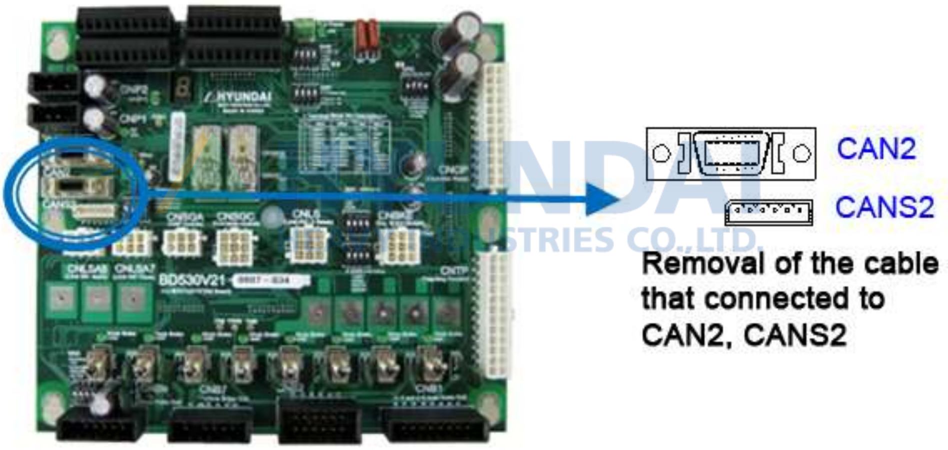


Figure 6.30 Method to Remove CAN Communication Connection from User's Module (BD58x)

- Please check the malfunction status of System Board
  System Board has a 7-segment that indicates a various status. By examining it, you may determine if a System Board is malfunctioning or not. After a controller has been restarted, if the indicator does not display the content in a rotation as below, System Board malfunction is suspected. Please replace it.

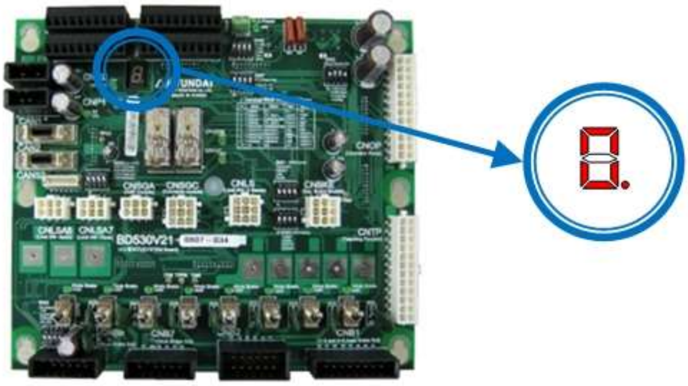


Figure 6.31 Location of 7-segment on a System Board (BD530)

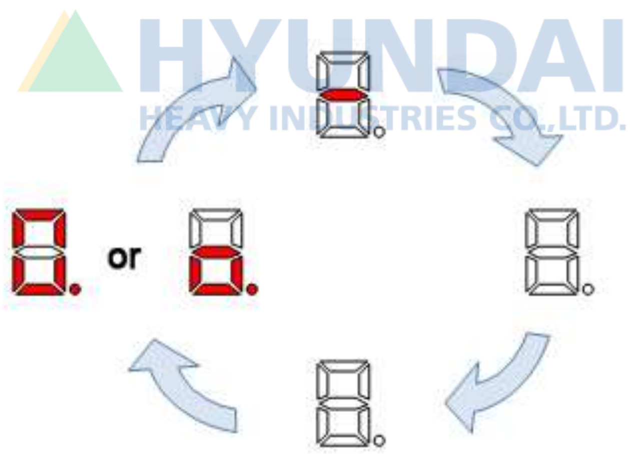


Figure 6.32 Normal Display of 7-segment on a System board when Restarted

- Please replace a malfunction part and test it.
  If above examines do not resolve an error, you will have to replace the parts that related to this error and test them. The cause might be a circuit malfunction that related to CAN communication inside of the board and it is difficult to be identified from an outside.
  There are 3 parts as below diagram – System Board (BD530), Main Board (BD510), Cable. (If a Main Board and other option module (BD58x) were having a CAN communication, the cause of an error is not likely from Main Board or cable. Please replace a System Board and test it).

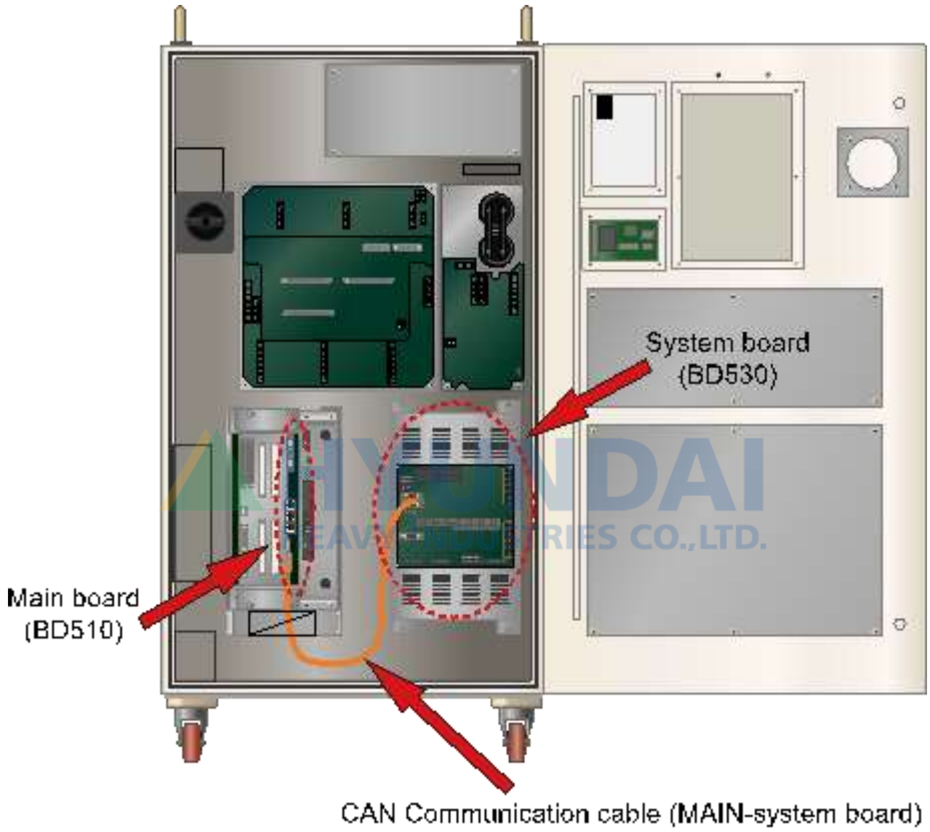


Figure 6.33 Location of CAN Communication Cable and a Main Board (BD510)

(3) Error occurring while a controller is operating normally

- Please observe changes in surrounding environment.
  Please observe if there have been any changes in the surrounding field. Check if a new large capacity electric power device has been installed. Quality of electric power and a shortage may effect to the communication and cause this error.

- Please examine a CAN communication line CAN.
  Property of matter CAN communication line may be connected with a users module (BD58x) as well as a System Board and this may cause an error due to a effect caused by a property of line's material. So, if a users module is being used, please run the following examines.

  - Please examine a CAN communication connector for user's module.
    Data communication with a Main Board uses a half duplex CAN. Sub modules of controllers are consists of a Daisy chain that uses CAN data communication. So the board has 2 CAN connectors that indicated as CANS1, CANS2. Please check if those connections are valid.

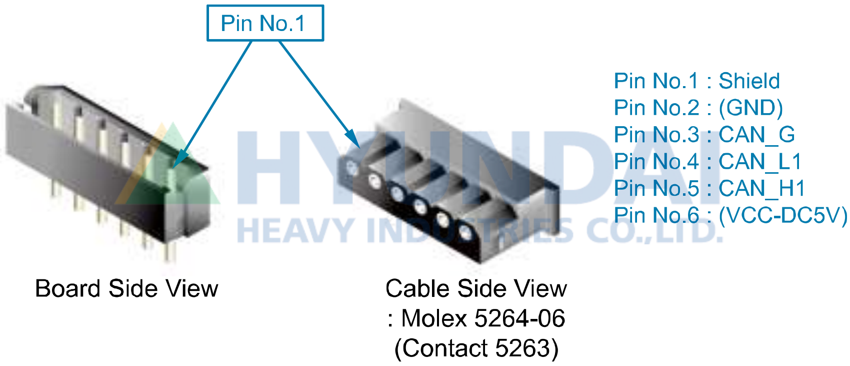


Figure 6.34 CAN Connector CANS1, CANS2 of User's Module

Table 6-3 Pin Locations for CAN Connector of User's Module

Number	Title	Use
1	Shield	To connect the electric shield line of CAN cable
2	(DC5V GND)	To connect board power DC5V ground (Connection with CNP1 is recommended)
3	CAN_G	To connect a ground for CAN communication
4	CAN_L1	To connect L signal of CAN communication
5	CAN_H1	To connect H signal of CAN communication
6	(DC5V)	To connect board power DC 5V (Connection with CNP1 is recommended)

➢ Please examine the connection of terminal resistor.
If numbers of boards are connected to each other, a terminal resistor must be handled clearly. CAN data communication uses daisy chain method. So the terminal resistor only should be connected to the last CAN communication cable and the terminal resistor must not be connected to any boards in between. Terminal resistor's connection uses a JP1 jumper that located next to the CANS1 and CANS2 connector on a board. If JP1 has been shorted it means that the terminal resistor is connected, and if JP1 has been opened, it eliminates the terminal resistor connection. Please refer to the following diagram.

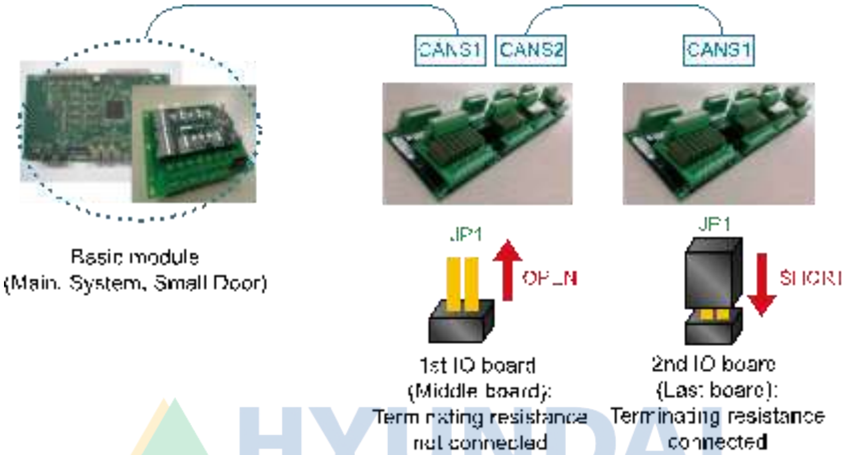


Figure 6.35 Connecting Method of Terminal Resistor on a CAN Communication Line

➢ Please examine the wiring structure
CAN communication wiring must not have a branch wiring. All connections must have a series connection from one module to the next module. Following diagram describes a wrong wiring structure.

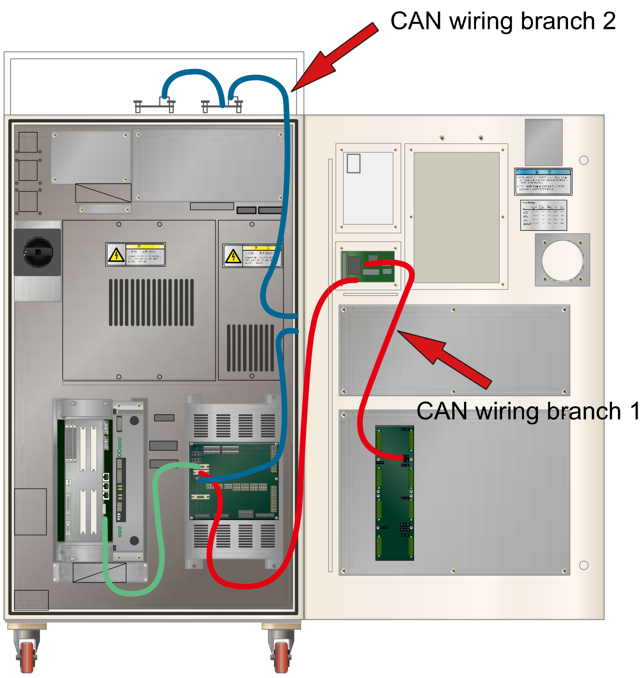


Figure 6.36 Bad example of CAN Communication Wiring Structure

In a diagram, CAN communication line that starts from a System Board has two branches.

- Branch 1:
  System Board CAN 2 Connector → Small Door Board → Controller door DIO board
- Branch 2:
  System Board CNAS2 Connector → Analog board on Controller's side → DIO boards on a controller

These can have a negative effect on a quality of communication, so please change the wiring structure as below.

- Branch 1:
  System Board CAN 2 Connector → Small Door Board → Controller door DIO board → Analog board on Controller's side → DIO boards on a controller
- Branch 2: Eliminated

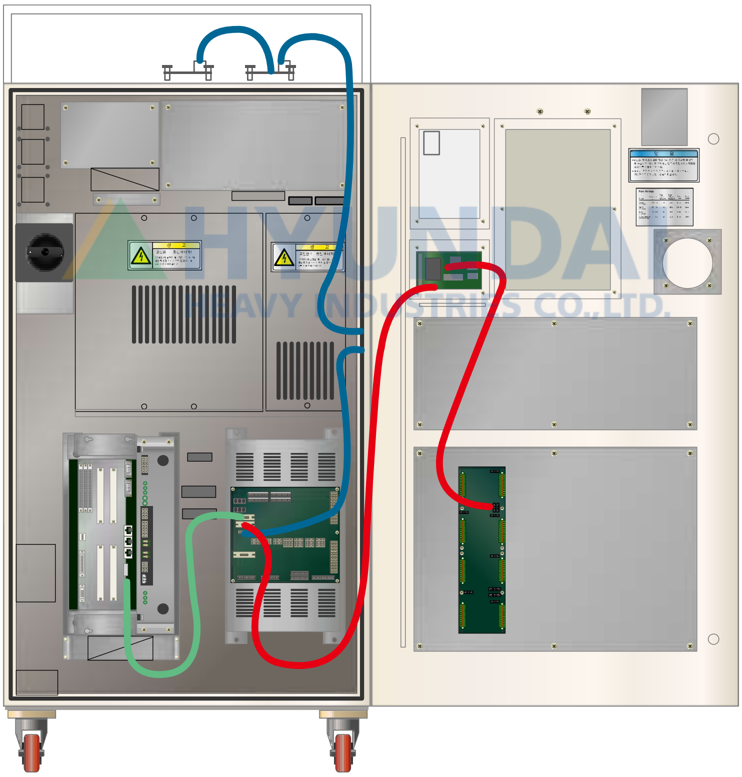


Figure 6.37 Good example of CAN communication wiring structure

If user module that used for a controller's door is not available, please remove the CAN cable that connects a System Board to a small door board as shown in a below diagram. Also making a wiring in order to keep the cable between modules at a minimum distance can increase a quality of communication

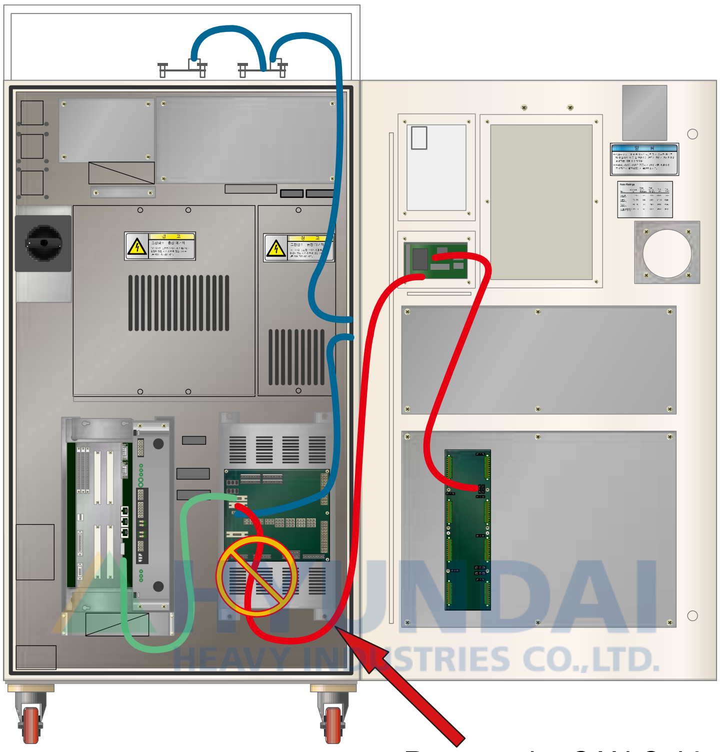


Figure 6.38 Remove the CAN Communication Cable that is Not in Use

(4) Please examine if a communication cable uses a twist line.
CAN communication uses twist pair wiring in order to ensure a high quality of communication against external noise. CAN_H1 and CAN_L1 signal line must be twisted to each other (please refer to figure 6.39).

Figure 6.39 Example of Twist pair

6.1.7. E0033 AMP under-voltage error

6.1.7.1. Outline

Direct current voltage (P-N) that activates a motor in a Servo activation device has been measured under the under-voltage set value.

6.1.7.2. Causes and examine methods

<Case: Error occurs even when the motor is off>

(1) Please examine the parts that related to under-voltage error detection.
- Please replace CNSGC cable and test it CNSGC.
- Please replace BD530/BD531 board and test it.
- Please replace a diode module and test it.

.

<Case: Error always at the moment when motor turns on>

(2) Please examine power related parts.
- Please replace a diode module and test it.
- Please examine a 3-phase voltage inside of a controller.
- Please examine a input 3-phase voltage of a controller.

<Case: Error occurs at a certain step according to the robot's operation speed>

(3) Please make changes on a speed of robot's operation in order to confirm an error.
- Please reduce the speed of robot's operation in order to confirm an error.
- Please examine a input 3-phase voltage of a controller while a robot is in operation.
- Please examine a internal 3-phase voltage if a input voltage is not 220V.

(1) Please examine the parts that related to an under-voltage error detection.
Occurrence of under-voltage at AMP error is detected by a diode module when a direct current voltage (P-N) that supplied to Servo activation device has been measured under the under-voltage set value. Generated error will be handled by software at BD530/BD531 through a CNSGC cable

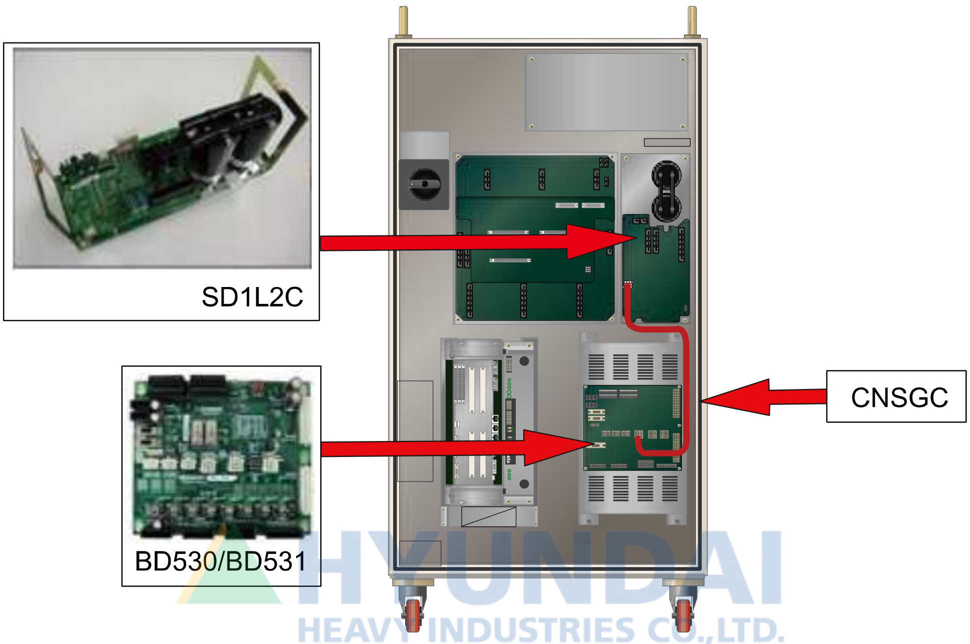


Figure 6.40 Locations of Hi5-N00 Controller's Under-Voltage Occurrence Error Related Parts

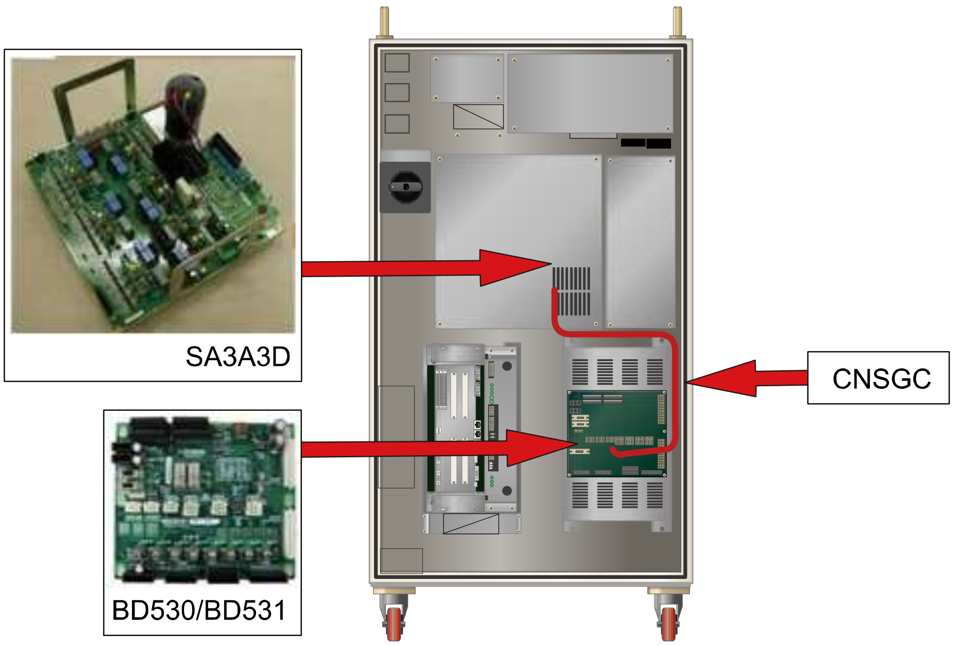


Figure 6.41 Locations of Hi5-N30 Controller's Under-Voltage Occurrence Error Related Parts

- Replacement of CNGSC and examine CNSGC
  Please replace CNGSC cable with a proper one and if an error does not persist, cable connection fault caused an error. Please replace the CNGSC cable with new one and use.

- Replacement of BD530/BD531 and examine
  Please replace BD530/BD531 with a proper one and if an error does not persist, the board malfunction caused an error. Please replace the BD530/BD531 with new one and use.

Figure 6.42 Replacement of BD530/BD531

- Replacement of diode module and test
  A module that detects an under-voltage error of AMP is SD1L2C for a large size and SA3A3D for a small size. Please check the parts of a controller that currently used. Please replace it with new one to test the persistence of an error.

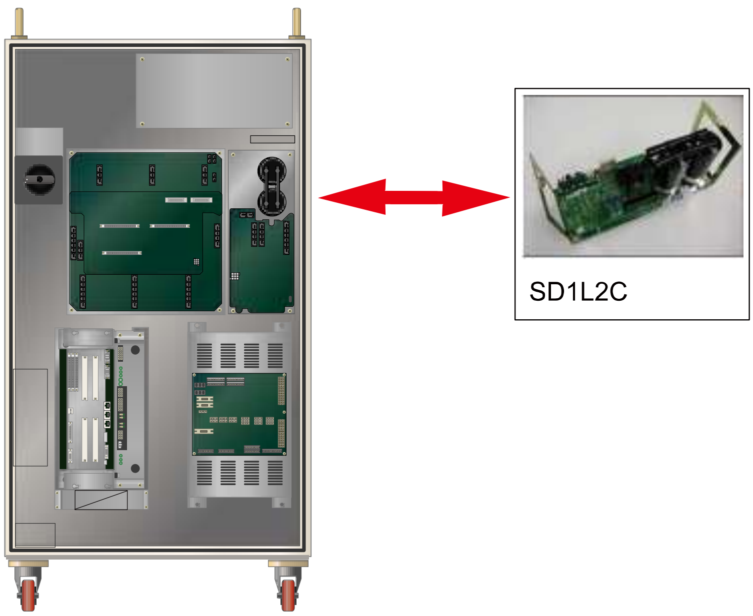


Figure 6.43 Replacement of DS1L2C when an Under-Voltage Occurs at Hi5-N00 Controller

(2) Please examine the components that are related to power.
AMP under-voltage occurrence error occurs when the 3-phase AC 220V that enters to the Servo Drive Unit exceeds the allowed range. Also this error may occur when recovery discharge happens at a moment of motor turns on due recovery discharge control circuit malfunction.

- Replacement and examining of diode module
  Please replace a module (SD1L2C for large size, SA3A3D for small size) that detects AMP under-voltage error and check if an error persists. For a large size controller, diode module is separated from the Servo Drive Unit, and for a small size controller, it is located inside of the Servo Drive Unit.

  - Large size Robot's diode module: SD1L2C
  - Small size Robot's Servo Drive Unit: SA3A3D

- Examine the 3-phase voltage
  AMP under-voltage error starts from approximately DC 210V (or 148V)
  If a voltage under AC148V (or 100V) enters to the Servo Drive Unit, under-voltage error may occur when the motor turns on.
  If the input voltage exceeds the allowed range, please examine according to a controller's input 3-phase voltage examination procedures and a controller's 3-phase internal voltage examination procedures.

  - Servo Drive Unit input voltage specification: 3-phase AC 220V
  - Allowed range when motor turns on: 198V ~ 242V

(3) Please confirm the occurrence of error according to the speed of Robot's operation.
If a robot reduce the speed rapidly, or make a high speed movement toward to gravity direction, it can cause AMP under-voltage error. Please confirm if an error occurred, or the changes of input 3-voltage supplied to Servo Drive Unit according to a speed of Robot's operation.

- Make changes on a speed of Robot's operation
  If a recovery electric power that generated by Robot's operation exceeds the controller's designed specification, under-voltage error may occurs. Please reduce the speed of a step that the error occurs and re-operate in order to confirm if the error persists. If the error does not occur when the speed is reduced, please change the speed of step and use it.

- Examine the 3-phase voltage at the error occurrence step
  AMP under-voltage error starts from approximately DC 210V (or 148V)
  If a voltage under AC148V (or 100V) enters to the Servo Drive Unit at the error occurrence step, under-voltage error may occur when the motor turns on.
  If the input voltage exceeds the allowed range, please examine according to a controller's input voltage examination procedures and a controller's 3-phase internal voltage examination procedures.

  - Servo Drive Unit input voltage specification: 3-phase AC 220V
  - Allowed range when motor turns on: 198V ~ 242V

6.1.8. E0034 AMP over-current error

6.1.8.1. Outline

Over-current on the 3-phase voltage(R, S, T) that supplied to the diode module, or inflow of surge voltage generated the over-current on a surge protector and it caused a cut-off of safety fuse.

6.1.8.2. Causes and checking methods

(1) Please examine the diode module's fuse.
- Please examine if the diode module's fuse has been cut-off.

<Case: Fuse has not been cut-off>

(2) Please examine the components that are related to the over-current error detection error.
- Please replace CNSGC cable and examine it CNSGC.
- Please replace BD530/BD531 and examine it.
- Please replace diode module and examine it.

<Case: Fuse has been cut-off>

(3) Please examine the components that are related to power.
- Please examine the 3-phase voltage from the inside of controller.
- Please examine the controller's 3-phase input voltage.
- Please replace diode module and examine it.

(1) Please examine the fuse in the Servo Drive Unit

Occurrence of AMP over-current error is detected by a diode module when the input 3-phase voltage exceeds the specification. Generated error will be handled by the BD530/BD531 through a CNSGC cable.

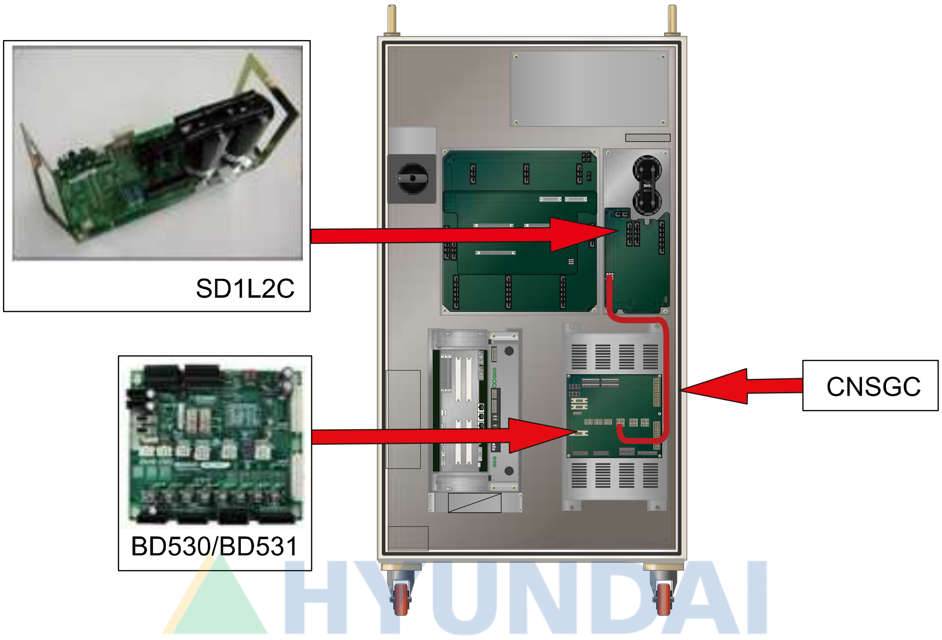


Figure 6.44 Locations of Hi5-N00 Controller's AMP Over-Current Occurrence Error Related Parts

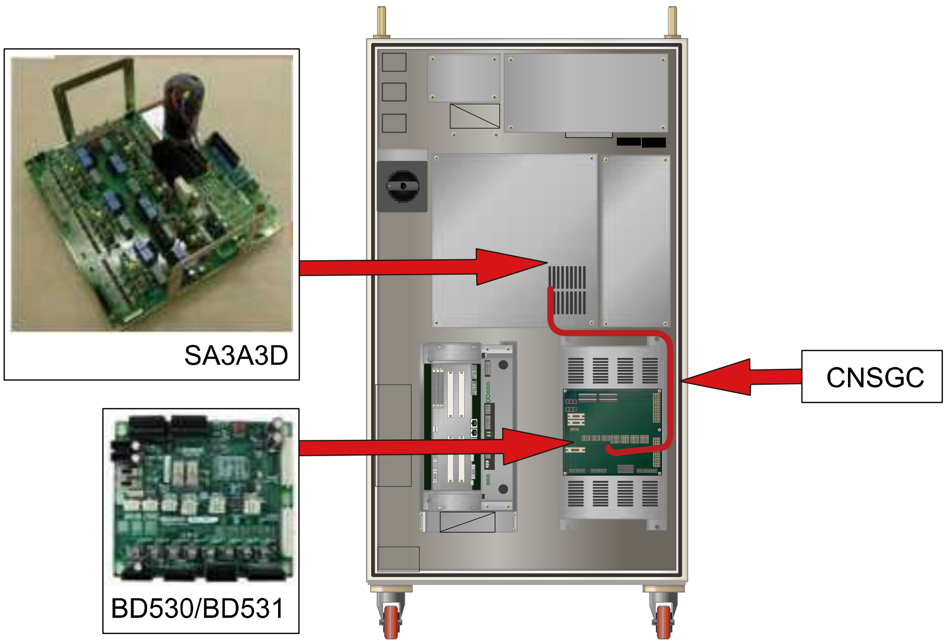


Figure 6.45 Locations of Hi5-N30 Controller's AMP Over-Current Occurrence Error Related Parts

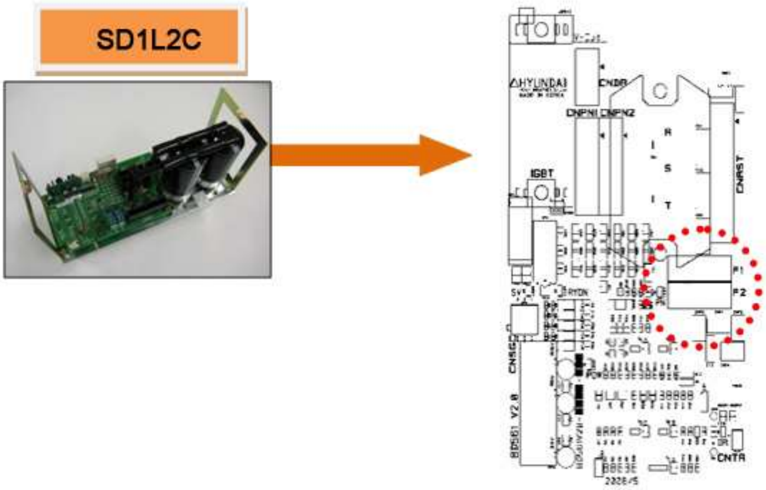


Figure 6.46 Locations of AMP Over-Current detection Fuse (in the SD1L2C)

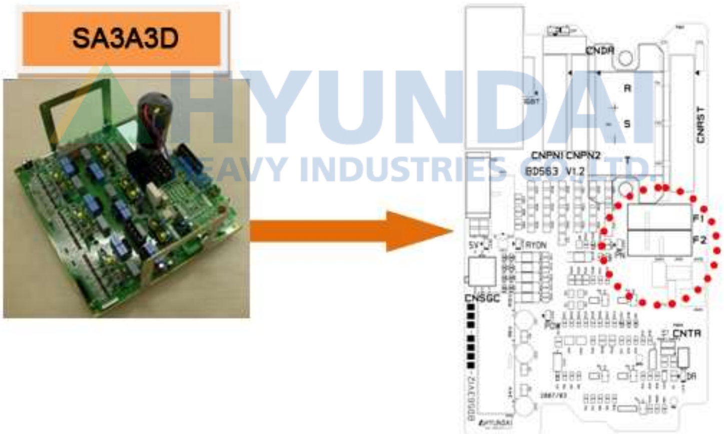


Figure 6.47 Locations of AMP Over-Current Detection Fuse (in the SA3A3D)

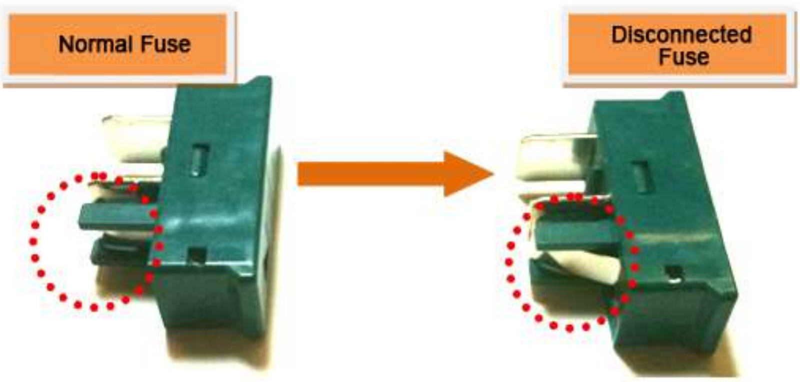


Figure 6.48 Appearance of Disconnected AMP Over-Current Detection Fuse

(2) Please examine the parts that are related to over-current error detection

If AMP over-current error occurs while the fuse has not been cut-off, CNSGC, BD530/BD531 or the Servo Drive Unit is faulty. Please refer to the compositions of controller from the manual and examine the each component.

- Replacement and examining of CNSGC cable CNSGC
  Replace the CNSGC cable with new one and test it. If the error does not persist, cable connection problem caused this error. Please replace the CNSGC cable with new one.

- Replacement and examining of BD530/BD531
  Replace the BD530/BD531 with new one and test it. If the error does not persist, the board malfunction caused this error. Please replace the BD530/BD531 with new one.

Figure 6.49 Replacement of BD530/BD531

- Replacement and examining of diode module
  Components that detects the AMP over-current error are SD1L2C (large size) and SA3A3D (small size). Please check the components in the controller that you are currently using and examine it. Please replace it with new one and see if the error persists.

  - Large size Robot's diode module: SD1L2C
  - Small size Robot's Servo Drive Unit: SA3A3D

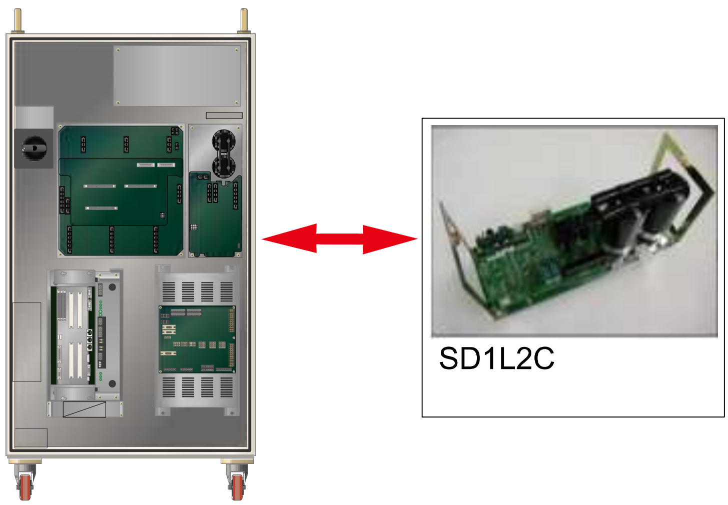


Figure 6.50 Replacement of SD1L2C in Hi5-N00 Controller when AMP Over-Current Error Occurs

(3) Please examine the components that are related to the power.

Over-current error occurs when an over-voltage or surge voltage that exceeds 3-phase AC 220V enters to the Servo Drive Unit. Over-voltage will trigger the surge protector, and the serial connected fuse gets disconnected, so the error will occur.

- Examine the input voltage
  If a voltage over AC242 V enters to the Servo Drive Unit, over-current error may occur when the motor turns on.
  If the input voltage exceeds the allowed range, please examine according to a controller's input voltage examination procedures and a controller's 3-phase internal voltage examination procedures.

  - Servo Drive Unit input voltage specification: 3-phase AC 220V
  - Allowed range when motor turns on: 198V ~ 242V

- Replacement and examining of diode module
  Please replace a module (SD1L2C for large size, SA3A3D for small size) that detects AMP over-current error and check if an error persists. An error may occur continuously due to a module's internal circuit malfunction. For a large size controller, diode module is separated from the Servo Drive Unit, and for a small size controller, it is located inside of the Servo Drive Unit.

  - Large size Robot's diode module: SD1L2C
  - Small size Robot's Servo Drive Unit: SA3A3D

6.1.9. E0044 Lift axis belt disconnect sensor is operating

6.1.9.1. Outline

A sensor that is installed on an axis (one of Robot's operating axis) which transfers the power to the belt is determining whether the belt exists or not. This error will occur, if a belt does not exist in the detection range of the sensor as the belt is broken.
This error also can be caused by an abnormal connection between the sensor and the board that is installed on a controller.

6.1.9.2. Causes and examine methods

(1) Please check the status of the error.
- Please check the Private input signal monitoring window.
- Please check the status of BD58B board's relay operation.

<Error status on monitoring window, but replay is normal(ON)>

(2) Please examine the components that are related to the error detection.
- Please replace CNSGC cable and examine it CNSGC.
- Please replace BD530/BD531 board and examine it.

<Error status on monitoring window, and replay is abnormal(OFF)>

(3) Please examine the Robot.
- Please check the status of belt in the Robot's drive unit.
- Please check the operation of the sensor that detects the broken belt.

(1) Please check the status of the error.

- Check the Private input signal from the monitoring window of TP510
  Firstly, check if the Lift axis belt/Limit (Arm) is being input. This window can be accessed from 『[F1]: Service』 → 『1: Monitoring』 → 『2: Input/output signal』 → 『1: Private input signal』. If the Lift axis belt/Limit (Arm) is highlighted in yellow, it indicates an error status.

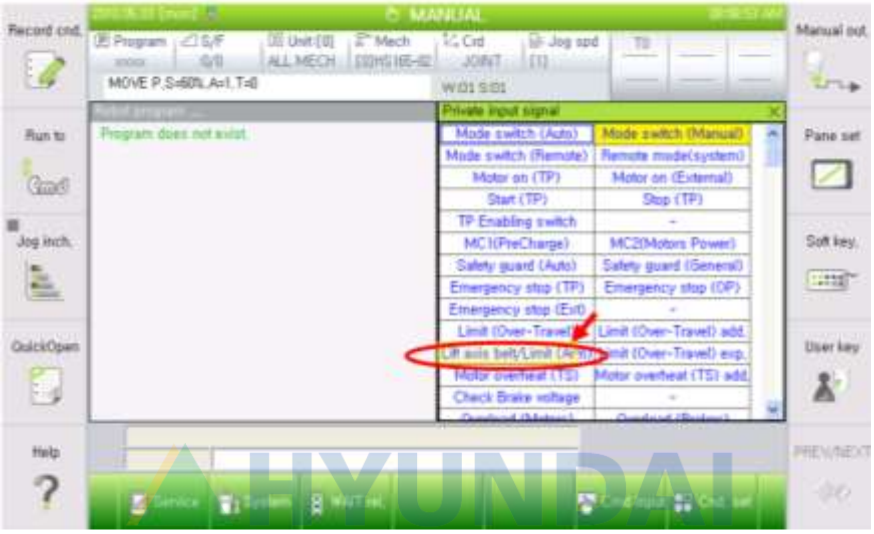


Figure 6.51 Checking the Lift axis belt from Private input signal

- Checking the status of BD58B board's relay operation
  Proximity sensor that attached at the Robot's operation part detects a break based on the light reflection from surface of the belt and transmits the ON/OFF signal to the controller. The received signal will be transferred to BD58B board for the fall prevention brake system and as well as to the BD530 (the System Board). Please check the sensor's operation status based on the relay operation status of BD58 board.

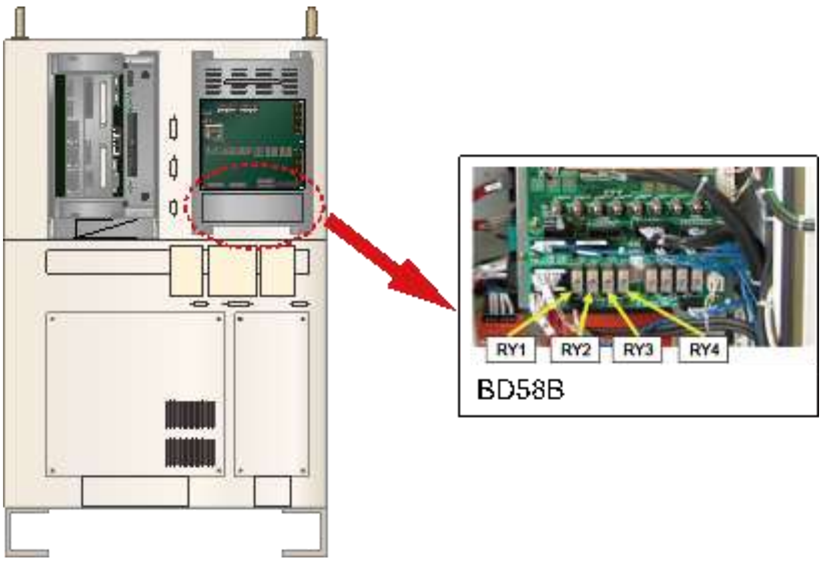


Figure 6.52 Checking the Relay Status of BD68B Board

Relay operation status of BD58B board can be checked as below diagram. Normal status relay operates the coil and can see the empty space at the center.

Figure 6.53 Comparing the Normal and Error Status of BD58B Board's Relay

You may confirm which (in the Robot) axis's detection sensor is operating based on the status of BD58B board's relay operation.

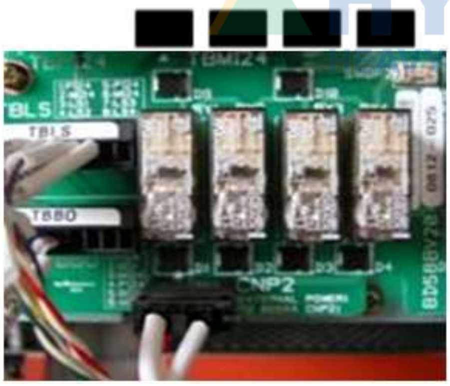
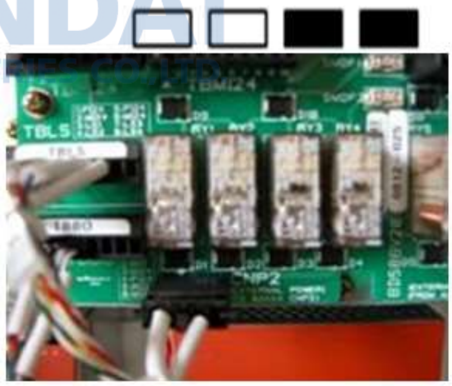
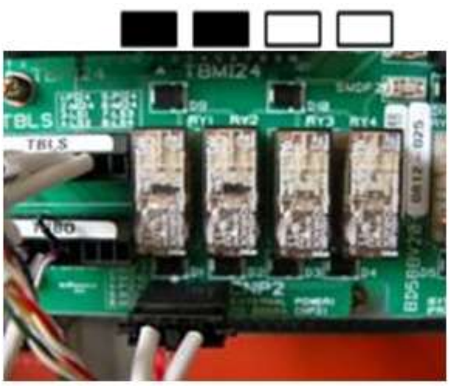
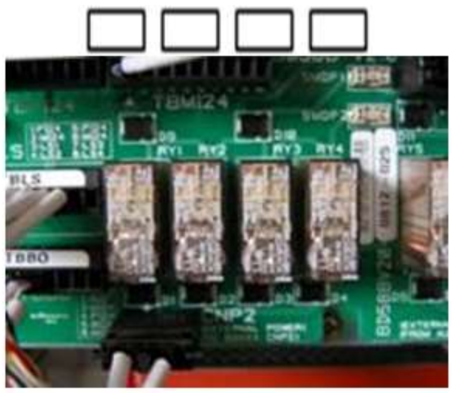
① Normal	② Z1 sensor is off (Z1 axis is broken)
	
③ Z2 sensor is off (Z2 axis is broken)	④ Both Z1/Z2 sensor are off (Z1/Z2 axis are broken)
	

Figure 6.54 Checking the Location of Error Based on BD58B Board's Relay

(2) Please examine the components that are related to the error detection.
If the Private input signal from the monitoring window and the relay status of BD58B board are different, CNLS cable that connects the BS58B and BD530/BD531, or the BD530/BD531 is faulty. Please refer to the compositions of controller from the manual and examine the each component.

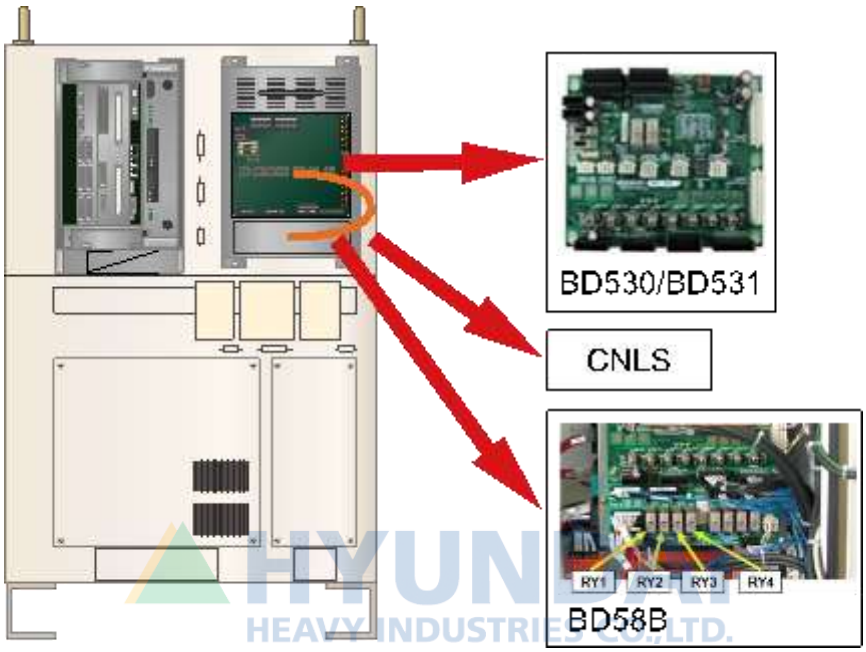


Figure 6.55 Replacement of BD530/BD531

- Replacement and examining of CNSGC cable
  Replace the CNSGC cable with new one and test it. If the error does not persist, cable connection problem caused this error. Please replace the CNSGC cable with new one.

- Replacement and examining of BD530/BD531
  Replace the BD530/BD531 with new one and test it. If the error does not persist, the board malfunction caused this error. Please replace the BD530/BD531 with new one.

Figure 6.56 Replacement of BD530/BD531

(3) Please examine the Robot

If the Private input signal from the monitoring window and the status of BD58B board's relay, BD58B actually acknowledged the error operation of the sensor. Robot's belt and detection sensor must to be checked. Please remove the CNZB1 and CNBZ2 connector of BB58B board in order to prevent a fall of lift axis that may caused by sensor malfunction during the examination of Robot.

> **Warning**
> **Make sure the CNZB1 and CNBZ2 connectors of BD58B are removed while examining the Robot's belt and break detection sensors in order to prevent the fall of list axis.**

- Check the belt's status of Robot's operation part
  Please check the belt of the axis that confirmed by a status of BD58B relay from the Robot. Applicability and location of the belt may be different to each Robot's model. Please check the status of belt according to the Robot's specification and maintenance manual.

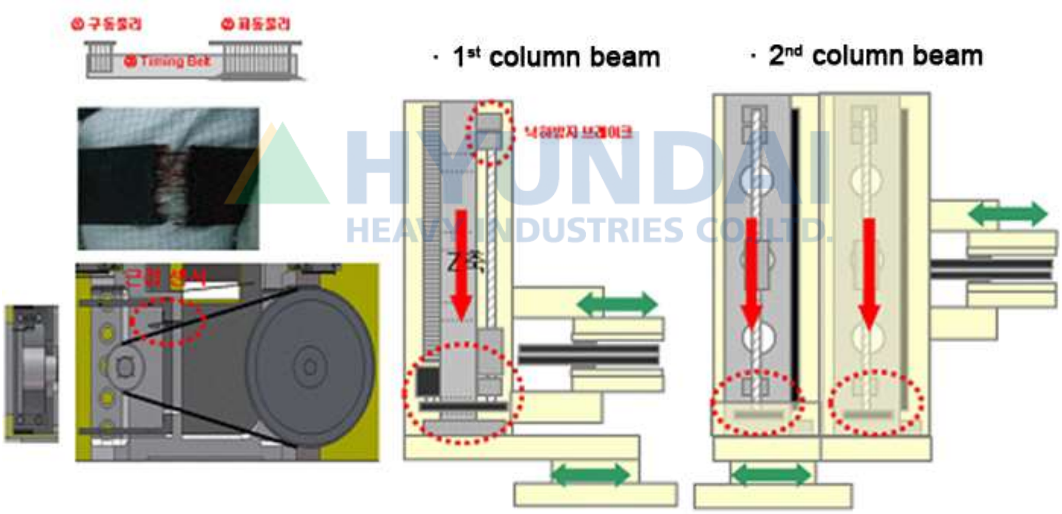


Figure 6.57 Lift Axis Belt and the Break Detection Sensor

- Checking the operation of belt break detection sensor
  Detection sensor is an optical type and it can only detect when the object is within a certain distance. If the object if out of the distance, it will process an error. Please change the distance to the object at the front of detection sensor and check the status of TP510's Private input signal. If the sensor's operation and the result of monitoring do not match, please check the connection of signal line between the sensor and the TBBO terminal block (inside of BD58B board) in the Robot. Sensor's LED green indicates normal status and red indicates error status.

6.1.10. E0108 (Axis ○) Encoder error: Encoder reset required

6.1.10.1. Outline

Power must be supplied to the encoder at all time for it to be able to store the motor's location data. Encoder's power will be supplied when the controller's power is on or from the encoder's back up battery. This error will occur, if the controller's power goes off while the encoder's back up battery is discharged. (as it will cause the encoder to lose the location data)
The same error will also occur when the motor is being replaced, because the new motor's encoder is not supplied with power.
Please move the Robot to reference position by using an axis coordinate manual control to re-adjust the axis's encoder as encoder reset will change the reference position data of the axis.

6.1.10.2. Causes and examine methods

(1) Please check the voltage of encoder's battery.

(2) Please examine the Encoder's battery connection status.

(3) Please replace the motor and test it.

(4) Re-adjustment of the encoder from Robot's reference position must be done after the encoder reset

(1) Please check the voltage of encoder's battery.

Encoder's batter uses 3.6V. If the voltage decreases to 3.0V~3.2V, a message of "W0104 (○ Axis) Encoder battery voltage is low" will be displayed. Please replace the encoder's battery if this warning occurs. Replacement of encoder's battery must be done while the controller's power is on. If the encoder battery is replaced at this stage, Robot's operation will not be interrupted.

If you miss the time to replace the encoder's battery, and the battery voltage reaches to 2.5V~3.0V, and error of "E0108 ○ Axis) Encoder error: Encoder reset required" will occur.
At the point of this error occurs, the encoder already lost the location data.
Please move the Robot to reference position by using an axis coordinate manual control to re-adjust the axis's encoder followed by a replacement of encoder's battery and the reset of encoder.

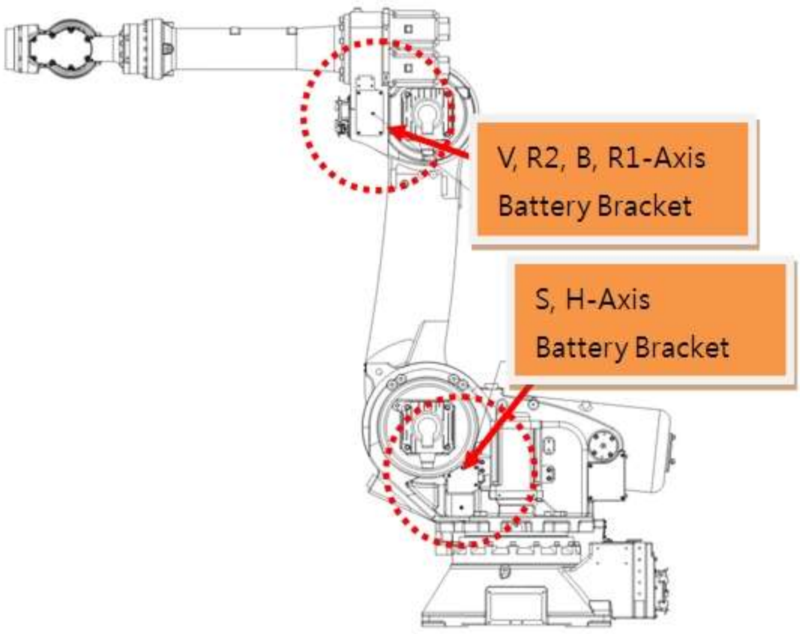


Figure 6.58 Location of Encoder's Battery Replacement

Encoder reset can be executed from the below menu.

- System
- 5. Initialize
- 4. Serial encoder reset

(2) Please examine the Encoder's battery connection status.
Please examine the connection status from encoder's battery to the motor.

(3) Please replace the motor and test it.
If the above do not solve the problem, there is a high possibility that the encoder itself is the cause. Please replace the motor and test it.

6.1.11. E0112 (○ Axis) IPM fault signal detection

6.1.11.1. Outline

A fault output has occurred from an IPM (Intelligent Power Module) – a switch device inside of Servo Drive Unit that drives the motor. IPM fault may occur due to an increased temperature of heat sink, IPM's control voltage reduction or an over-current output.

6.1.11.2. Causes and examine methods

<Error occurs non periodically when the motor turns on>

(1) Please examine the motor drive components.
- Please examine the output cable that connects to the Servo Drive Unit.
- Please examine the terminal(socket) of switching device in the Servo Drive Unit.
- Please replace CNBS1,2,3 cables and confirm the error.
- Please replace the Servo Board(BD542) and confirm the error.
- Please replace the Servo Drive Unit and confirm the error.
- Please replace the Servo motor and confirm the error.

<Error occurs at a certain step>

(2) Please examine the Robot at the step that an error occurs.
- Please examine the Robot's wiring at the location where the error occurs.
- Please reduce the speed of Robot's operation in order to confirm the error.
- Please make changes on Teached step's interpolation and confirm the error.

<Case: Error occurs after 5 minutes from the start up of Robot's operation>

(3) Check the controller's cooling fan
- Please examine the operational status of each fan
- Please examine the power voltage of each fan

(1) Please examine the components that are related to the motor drive.
Servo Drive Unit that drives the motor receives a command from the Servo Board (BD542) through CNBS cable, and the current output of internal amplification circuit will be transferred to the motor through wirings that connected to each connectors of axis.

- Examine the output cable that connects to the Servo Drive Unit
  Examine the wirings that connect the Servo Drive Unit to the motor. Please turn off the power of controller, and remove the connector from the Servo Drive Unit and measure the resistance value between grounds to inspect the occurrence of short circuit.

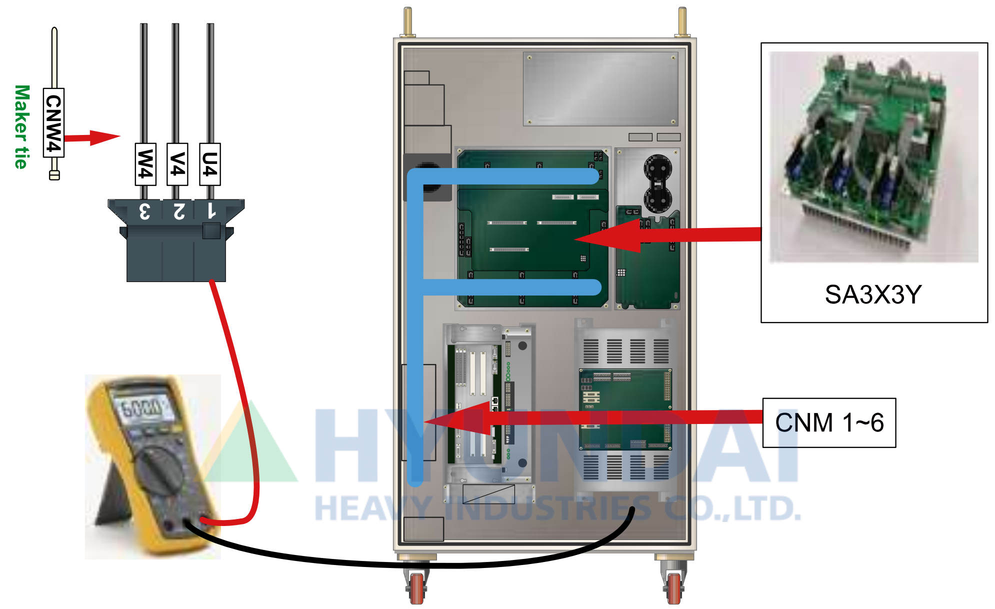


Figure 6.59 Examining the Output Cable of Servo Drive Unit (Hi5-N00 controller)

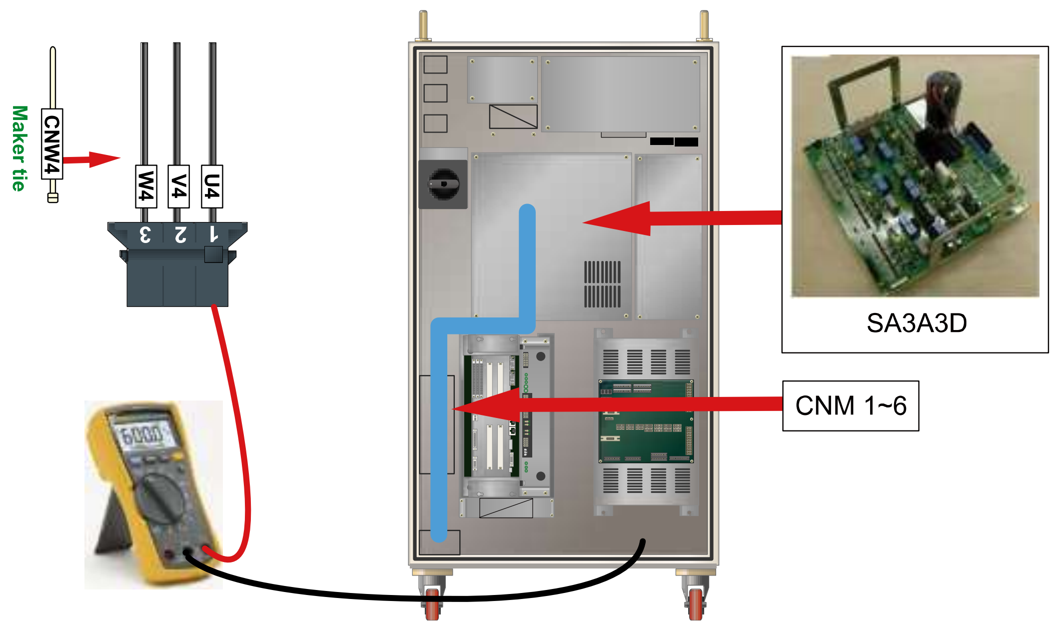


Figure 6.60 Examining the Output Cable of Servo Drive Unit (Hi5-N30 controller)

- Examine the switch device of Servo Drive Unit
  Switch device of Servo Drive Unit switches the direct current voltage that supplied from diode module and output the alternating current for each phases. If a short circuit occurs at the internal terminal of switch device, over-current flow and it will cause an IPM fault error. Please remove the connector and check if a short circuit has occurred between the output terminal in a switch device of Servo Drive Unit and the P (or N).
  If a short circuit exists, the Servo Drive Unit need to be replaced and also the cable that connects the Servo Drive Unit to the motor needs to be examined.

  - Large size Robot's Servo Drive Unit: SA3X3Y
  - Small size Robot's Servo Drive Unit: SA3A3D

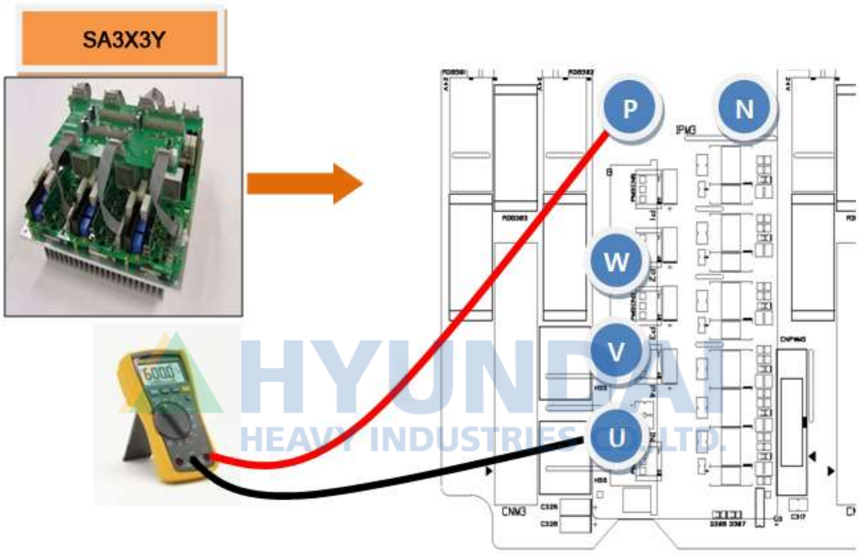


Figure 6.61 Short Circuit Test on Switching Device of SA3X3Y

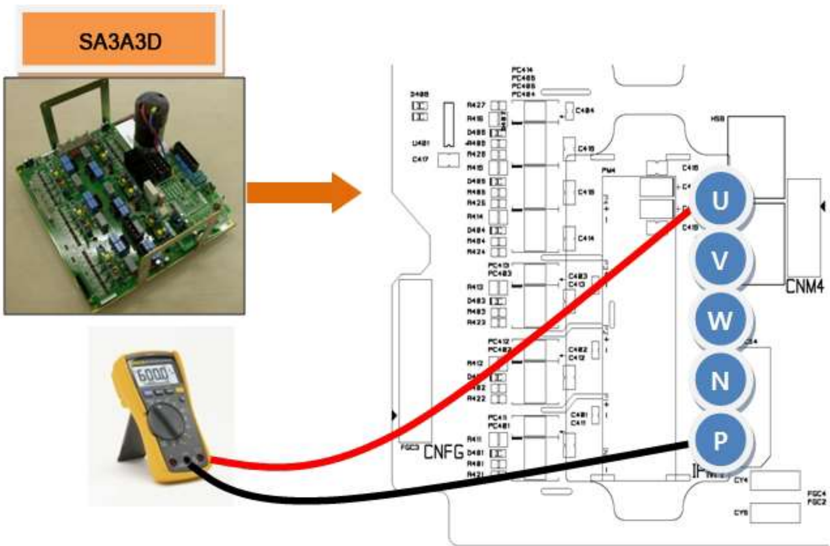


Figure 6.62 Short Circuit Test on Switching Device of SA3A3D

■ Replacement of CNBS cable and examining the error CNBS
Servo Drive Unit that drives the motor receives a command from the Servo Board (BD542) through CNBS cable, and the current output of internal amplification circuit will be transferred to the motor through wirings that connected to each connectors of axis.
If the error does not persist after the replacement of cable, cable is faulty. Please replace the CNBS cable with new one.

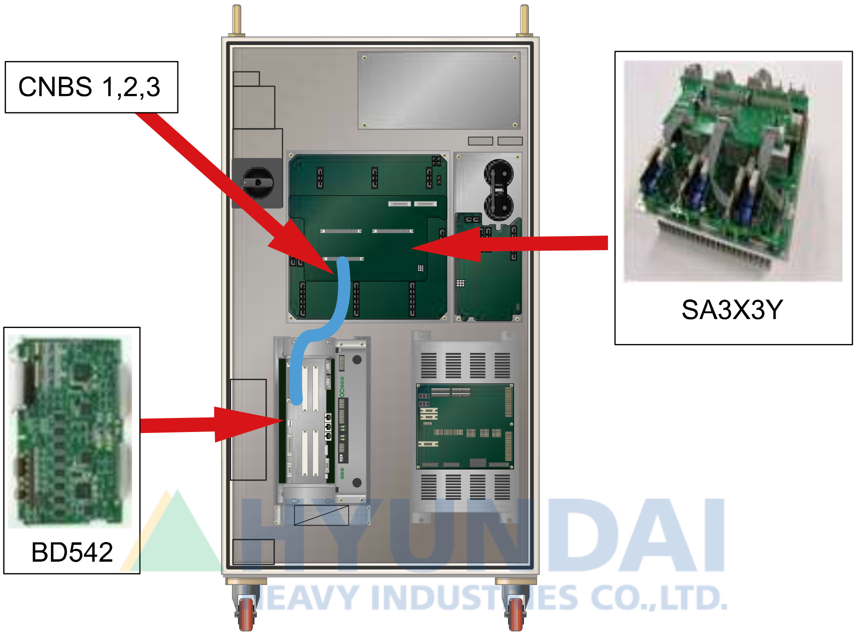


Figure 6.63 Locations of Components in Hi5-N00 Controller that are Related to Motor Drive

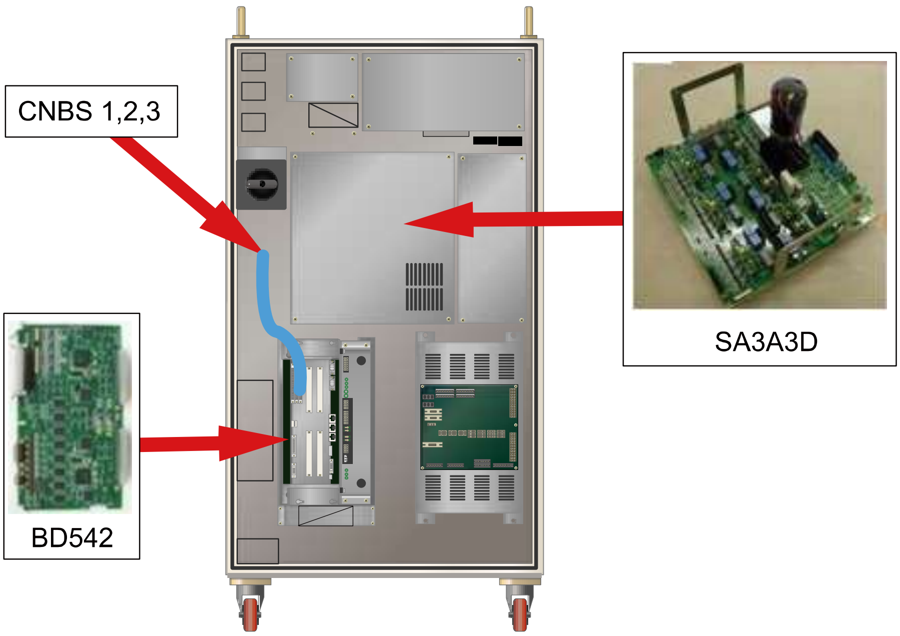


Figure 6.64 Locations of Components in Hi5-N30 Controller that are Related to Motor Drive

- Replacement of Servo Board (BD542) and examine it
  If the error does not persist after the replacement of Servo Board (BD542), Servo Board (BD542) is faulty. Please replace the Servo Board (BD542) with new one.

- Replacement of Servo Drive Unit and examine it
  If the error does not persist after the replacement of Servo Drive Unit, Servo Drive Unit is faulty. Please replace the Servo Drive Unit with new one.

  - Small size Robot's Servo Drive Unit: SA3X3Y
  - Small size Robot's Servo Drive Unit: SA3A3D

- Replacement of Servo Motor and examine it
  If the error does not persist after the replacement of Servo Motor, Servo Motor is faulty. Please replace the Servo Motor with new one. Below diagram describes the locations of each axis's motor (HS165 Robot). For other Robot, please refer to the Robot's maintenance manual to replace it.

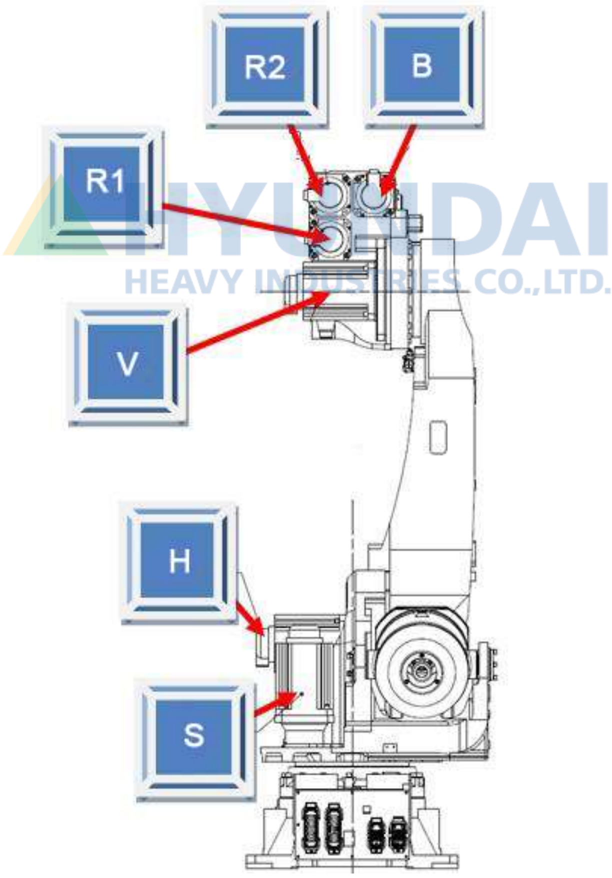


Figure 6.65 Locations of Each Axis's Motor (HS165 Robot)

(2) Please examine the Robot at the step that an error occurs
If IPM fault error occurs at a certain step, it may occur when the device wiring has been damaged at Teached step or the axis speed changed greatly when the Teached program changes the position. ,

- Examine the internal wiring at the location of an error
  Examine the wiring status of corresponding axis that connected to the motor (inside of Robot). During the examination, please turn off the controller's power and remove the output connector from the Servo Drive Unit. After that please measure the resistance value between ground of each phases (cable side) to test a short circuit.

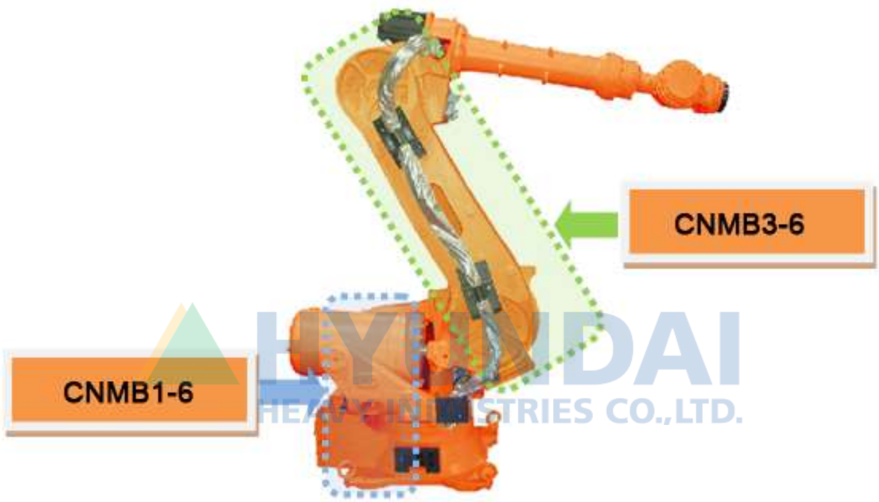


Figure 6.66 Location of Wiring Examination for Each Axis (HS165)

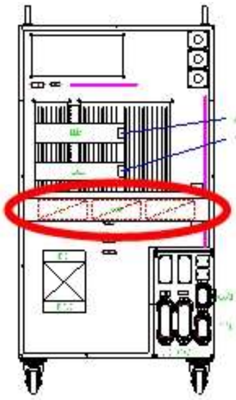
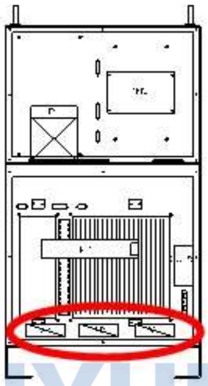
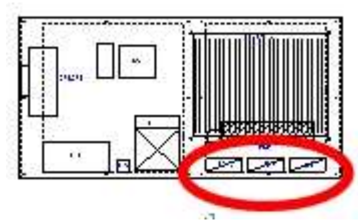
- Reduce the speed of Robot's operation in order to confirm the error
  If an error occurs at a step that generates rapid changes of axis speed which is caused by the position changes of Robot, reduce the operation speed to confirm the error. If the error does not persist after the speed is reduced, please change the Teach speed of corresponding step and record the job program to use.

- Change the Teached step's interpolation to confirm the error
  If the axis speed rapidly changes even after the operation speed is reduced by 75%, please change the Teached step's interpolation to 'P' and confirm the error. If the changes on interpolation resolve the error, (at the same operation speed) please modify the Teach.

(3) Check the controller's cooling fan.

If the IPM fault error occurs after over 5 minutes since the start of the robot, it means that the controller's cooling system has caused abnormalities, surpassing the allowable temperature specifications of the IPM motion. The rear face of the controller is equipped with the heat sinking plane of the servo driving gear and the fan for cooling the regenerative discharge resistance.

Table 6-4 Fan position of each controller

Hi5-N**	Hi5-C1*	Hi5-C0*
		

- Checks for the motion of each fan
  When the fan does not rotate or the speed is abnormally low, change the involved fan, please. The fan's life span changes depending on motion, environments and time.

- Checks for the voltage of fan power supply
  If all fans do not work, check the fan for the input voltage, please. The input voltage has been set as AC 220V, and the allowable range is within 10 % of rated voltage. When the voltage is low more than 10 %, the fan's reduced RPM causes the decline in cooling effectiveness. When the voltage is low, check the connector (CNFN2) used for the fan and the input voltage of the controller.

6.1.12. E0113 (○ Axis) Over-current

6.1.12.1. Outline

Current that flows in the motor or the drive unit exceeds the allowed voltage range. When the current that generated by the Servo control to operate the Robot (or the drive unit) exceeds the allowed safe voltage range, the Servo Board will detect an error and immobilize the Robot.

6.1.12.2. Causes and examine methods

(1) Check if the axis with an error has mechanical interference with other equipments.

(2) Examine the Motor power line.
- Check the wiring that connects the Robot and Controller.
- Check the Robot's internal wiring.
- Check the Controller's internal wiring.

(3) Examine the CNBS cable between the Controller's internal Servo Board and the Drive Unit

(4) Replace other components

(1) Check if the axis with an error has mechanical interference with other equipments
This error may occur if the Robot had a mechanical interference or collisions. If the Robot is out of the operation area, please move it back into the operation area by using a manual control.

(2) Examine the Motor power line
Please turn off the primary power and remove the U, V, W of drive unit for the corresponding axis and examine if short circuit exists in each phase. Please use an equipment such as the multi meter (tester) and examine each phase's wiring one by one.

Warning
Be cautious. Examination while the power is on may cause an electrocution.

- Check the wiring that connects the Robot and Controller.
  Please remove the wirings that connect the controller, Robot or the drive unit to examine each phases (U, V, W) for ground, or a short circuit. If a short circuit is found, please replace the wire.

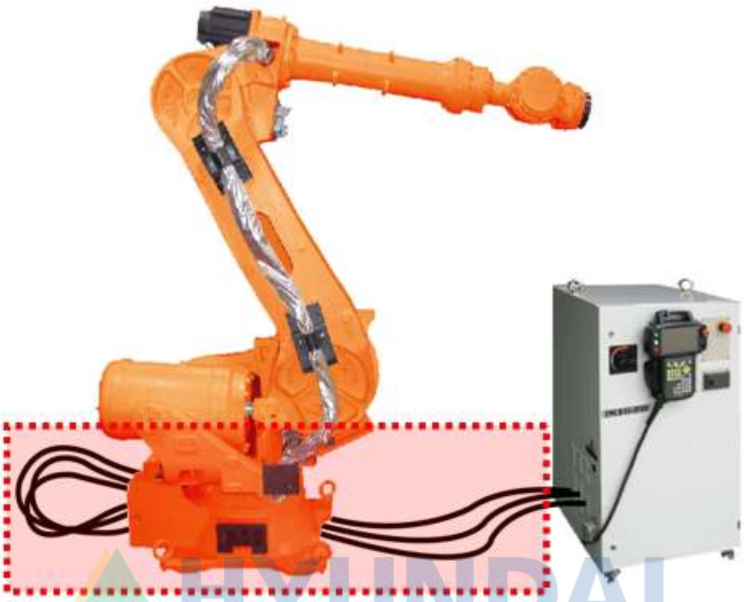


Figure 6.67 Basic Installation Diagram of the Robot and Control Period

- Check the Robot's internal wiring
  Examine for a short circuit, faulty on a wiring that connected to Robot's internal motor is required

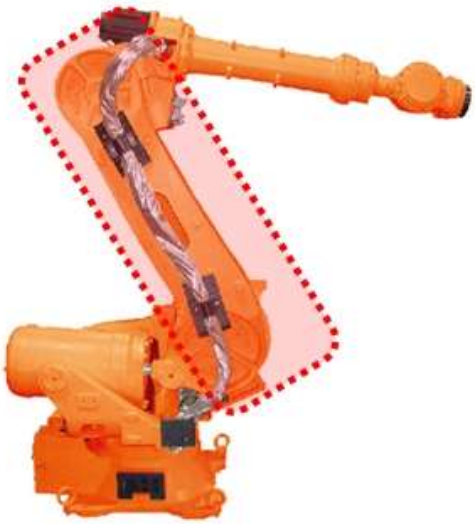


Figure 6.68 Robot's Internal Wiring

- Check the Controller’s internal wiring.
  Examine on a controller’s internal AMP and installed wiring is required.

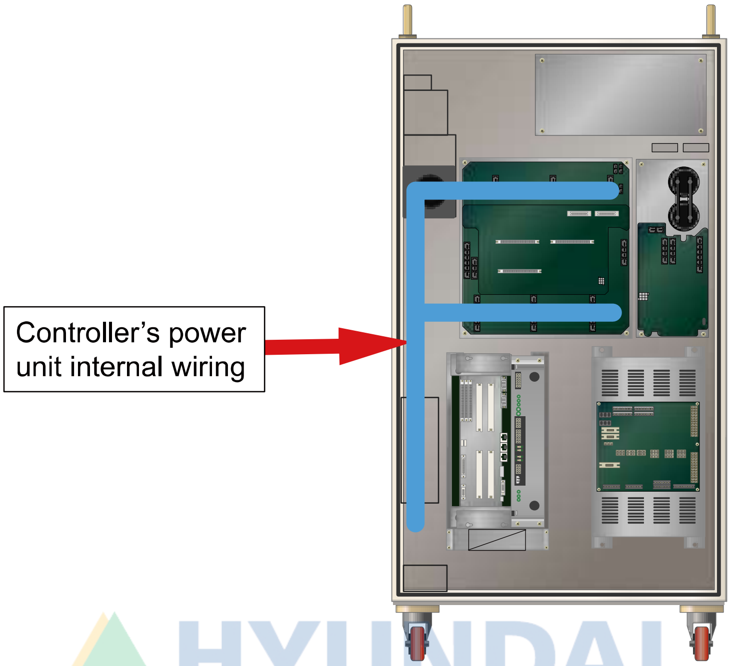


Figure 6.69 Controller’s Internal Area (Power unit)

(3) Examine the CNBS cable between the Controller’s internal Servo Board (DSP board) and the Drive Unit.

Please examine if the CNBS cable is installed properly. If the cable is not installed properly, or the cable is faulty, this error may occur.

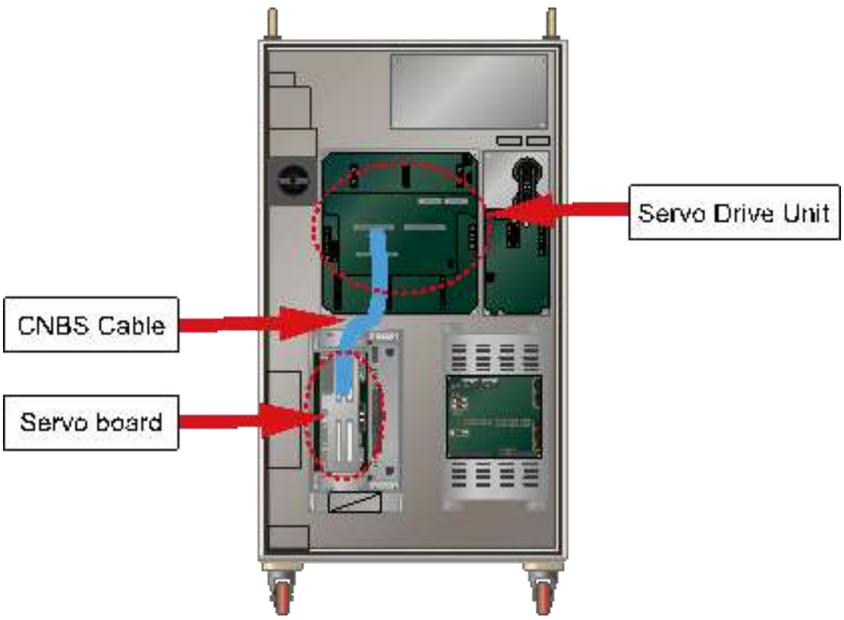
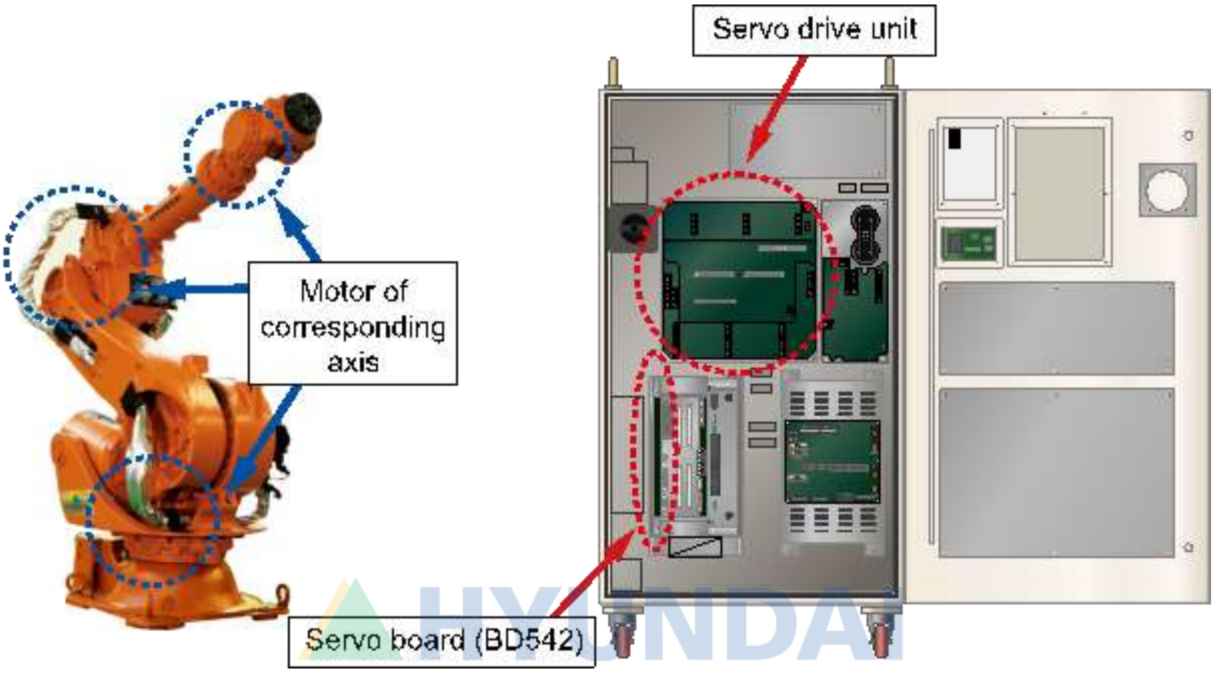


Figure 6.70 Controller’s Internal Area (CNBS cable)

(4) Replace other components

Replace the component in order of Servo Board (BD542) → Servo Drive Unit → Motor to confirm the occurrence of an error.



6.1.13. E0114 Operating device control voltage reduction

6.1.13.1. Outline

Control power that supplied to the Servo Drive Unit +15V has been reduced. This error is detected by the Servo Drive Unit and transferred to the Servo Board through CNBS cable.

6.1.13.2. Causes and examine methods

(1) Please check the power indicator LED.
- Please check the 'POW' LED of Servo Drive Unit.
- Please check the '+15V' LED of SR1 (control power supply unit).

<Case: Both of module's LED are OFF>

(2) Please check the output of SR1. (control power supply unit)
- Please remove CNBS cable from BD542 and check the LED.
- Please remove the Servo Board from the Rack and check the LED.

(3) Please examine the SR1. (control power supply unit)
- Please check the input voltage to SR1.
- Please replace the SR1 and check the LED.

<Case: Only the Servo Drive Unit's 'POW' LED is OFF>

(4) Please replace the related components and check the power indicator LED.
- Please replace CNBS cable and check the LED.
- Please replace the Servo Board and check the LED.
- Please replace the Servo Drive Unit and check the LED.

(1) Please check the power indicator LED.

Drive unit control voltage reduction error is caused by a reduction of control voltage +15V. This error will be detected by the Servo Drive Unit and transferred to the Servo Board (BD542) through CNBS1, 2, 3 cables to be handled.

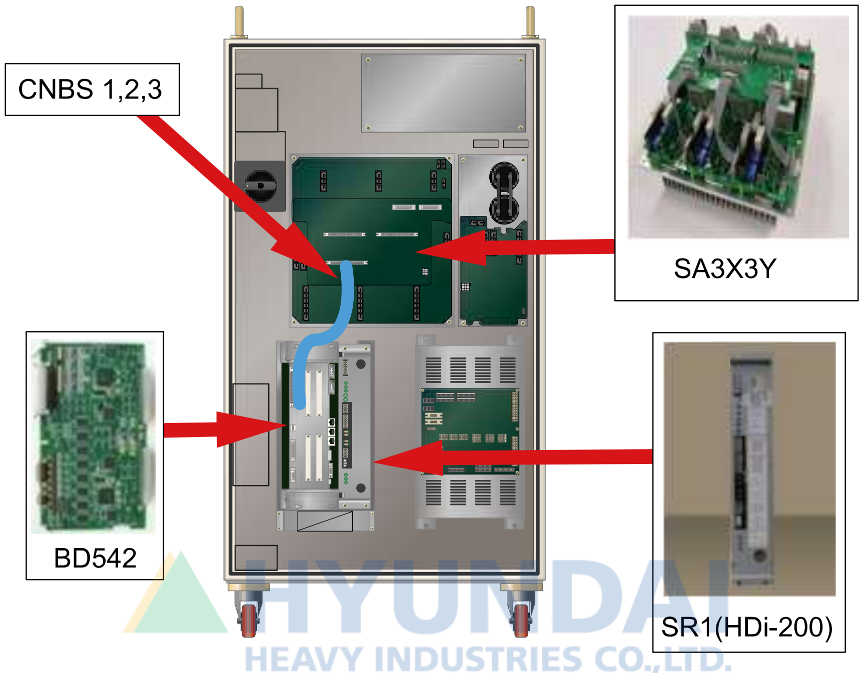


Figure 6.71 Locations of Components in Hi5-N00 Controller that are Related to Drive Unit Control Voltage Reduction

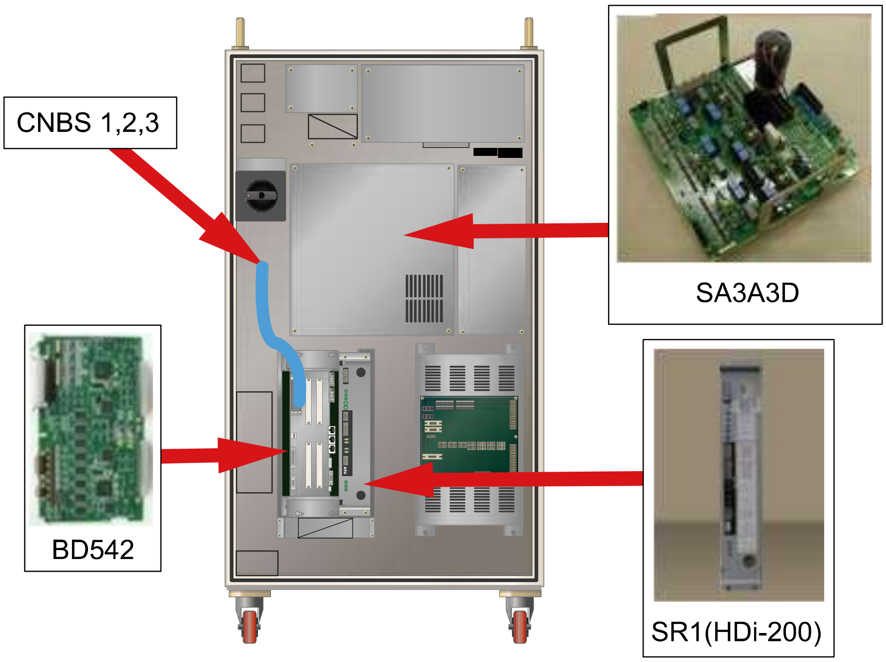


Figure 6.72 Locations of Components in Hi5-N30 Controller that are Related to Drive Unit Control Voltage Reduction

- Examine the 'POW' LED of Servo Drive Unit
  Please check the 'POW' of drive unit control voltage error detection module (SA3X3Y-large, and SA3A3D-small) If the power is being supplied normally, the LED light should be stays on.

  - Large size Robot's Servo Drive Unit: SA3X3Y
  - Small size Robot's Servo Drive Unit: SA3A3D

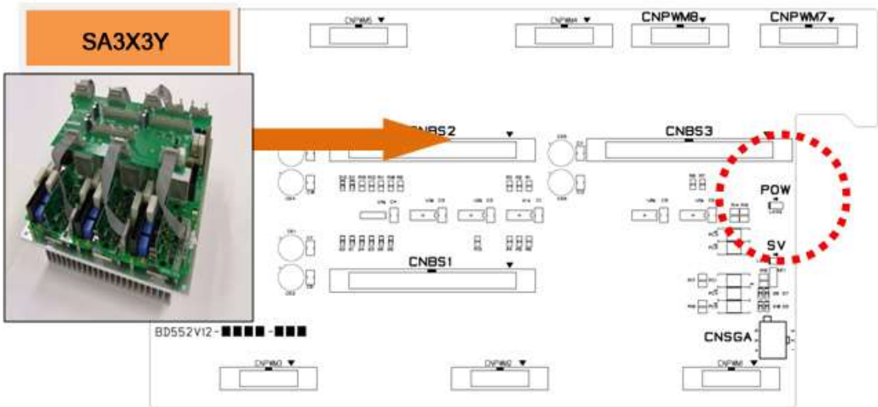


Figure 6.73 Locations of Components in SA3X3Y that are Related to 'POW' LED

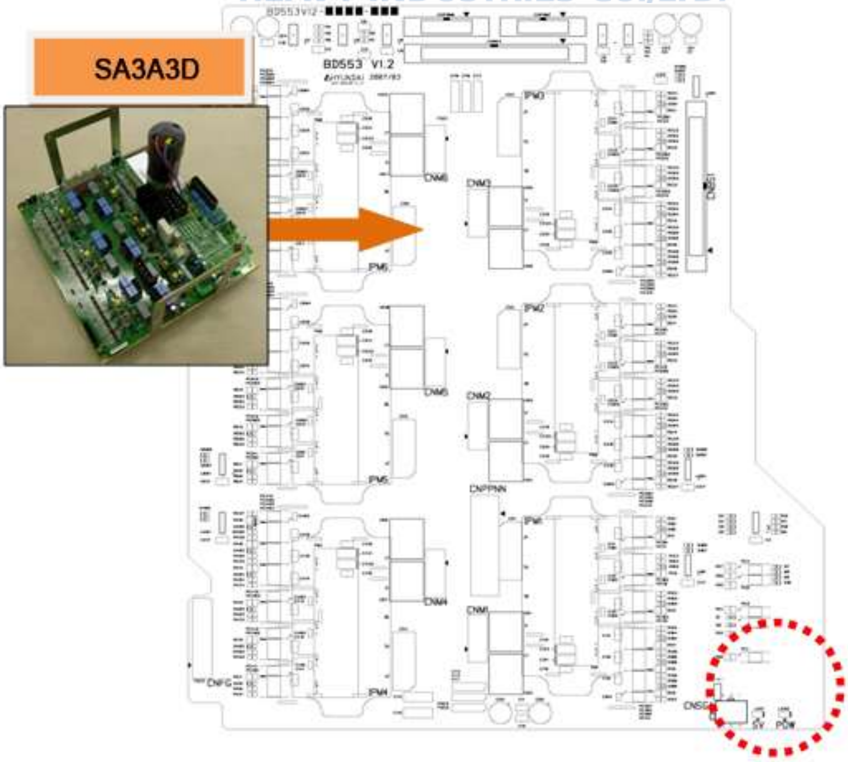


Figure 6.74 Locations of Components in SA3A3Dthat are Related to 'POW' LED

- Examine the '+15V' LED of SR1

  Please check the LED of SR1 if the Servo Drive Unit's 'POW' LED light is off.
  Please check if the LED of SR1 and the LED of Servo Drive Unit are both off at the same time.

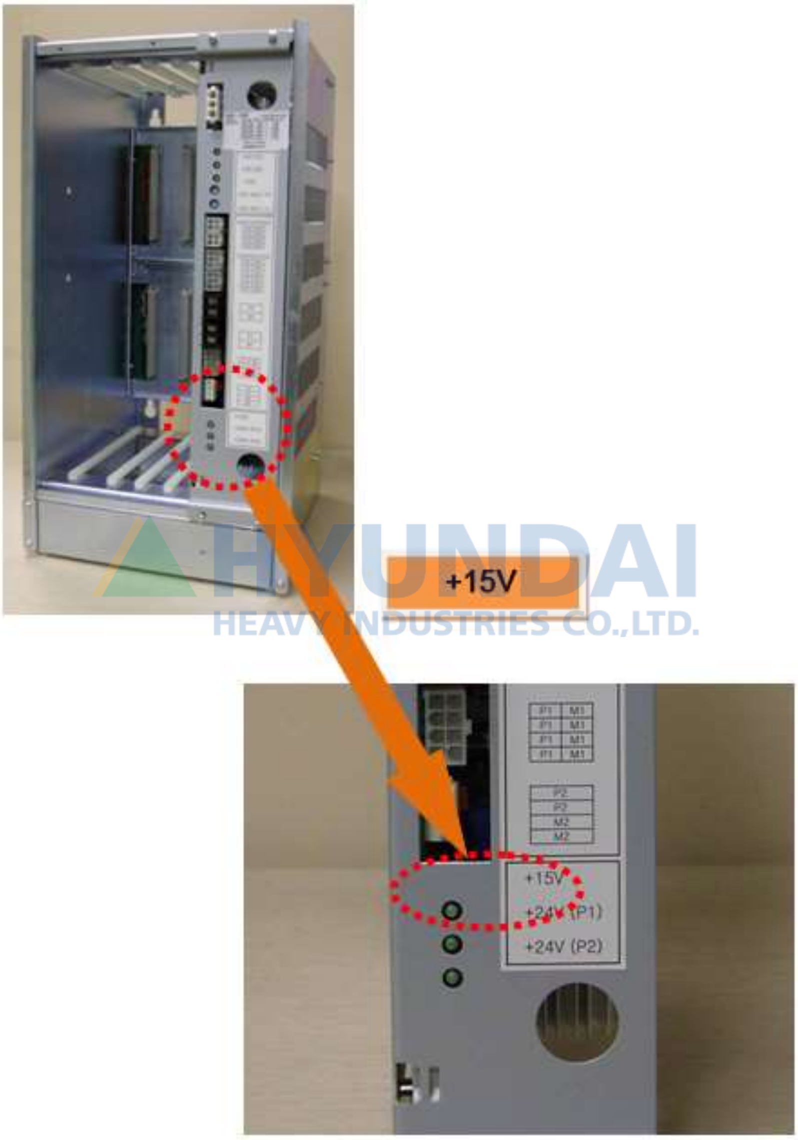


Figure 6.75 Locations of '+15V' LED Related Components of SR1

(2) Please check the output of SR1.
Please remove the wirings and components that are connected to the Servo Drive Unit and examine the '+15V' LED in order to check the output of SR1 itself.

- Remove CNBS cable and check the LED
  Please remove the CNBS1, CNBS2, CNBS3 that connect the Servo Drive Unit and the Servo Board. After the removal, please check the LED of SR1. If the '+15V LED' of SR1 turns to ON after the removal of cables, the Servo Drive Unit is faulty. Please replace the Servo Drive Unit with new one.

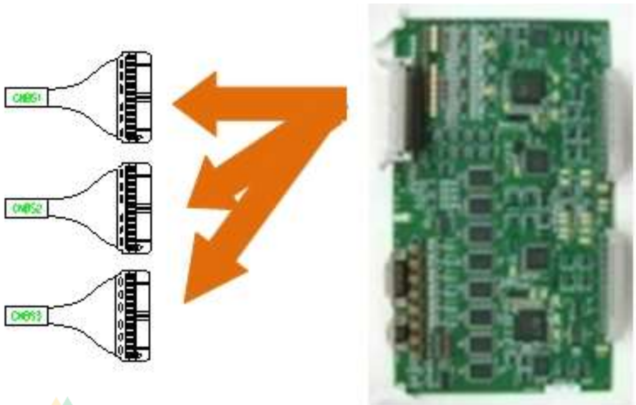


Figure 6.76 Removal of CNBS cable

- Remove the Servo Board (BD542) and examine the LED
  Please check the SR1's LED after you remove the Servo Board from a Rack. If the '+15V LED' of SR1 turns to ON after the removal of Servo Board, the Servo Board is faulty. Please replace the Servo Board with new one.

Figure 6.77 Removal of Servo Board from the Rack

(3) Please examine the SR1 (control power supply unit)
Control power supply unit received AC 48V (input) and output the necessary control power to each board from the internal circuit.

- Examine the input voltage of SR1
  If the input voltage to SR1 exceeds the specification, the output of control power may have an error. If the input voltage exceeds the allowed range, please examine according to a controller's input voltage examination procedures and a controller's single-phase internal voltage examination procedures.

  - SR1 input voltage specification: single-phase AC 48V
  - Allowed range: 44V ~ 52V

- Replace the SR1 and check the LED
  Please replace the SR1 with new one and check the '+15V' LED. If the LED is ON after the replacement, SR1 is faulty. Please replace it and use.

(4) Please replace the related components and check the power indicator (LED)
Please replace the Servo Drive Unit, Servo Board, CNBS cable and check the 'POW' LEF of the Servo Drive Unit.

- Replace the CNBS cable and check the 'POW' LED
  Please replace the CNBS1, CNBS2, CNBS3 that connects the Servo Drive Unit and the Servo Board, and check the 'POW' LED. If the 'POW' LED is ON after the replacement, cable is faulty. Please replace it with new one.

- Replace the Servo Board and check the 'POW' LED
  Please replace the Servo Board, and check the 'POW' LED. If the 'POW' LED is ON after the replacement, the Servo Board is faulty. Please replace it with new one.

- Replace the Servo Drive Unit and check the 'POW' LED
  Please replace the Servo Drive Unit, and check the 'POW' LED. If the 'POW' LED is ON after the replacement, the Servo Drive Unit is faulty. Please replace it with new one.

  - Large size Robot's Servo Drive Unit: SA3X3Y
  - Small size Robot's Servo Drive Unit: SA3A3D

6.1.14. E0115 (Axis o) Received command code error

6.1.14.1. Outline

Main Board's command code that received by the Servo Board does not meet the mutual regulation of Main Board and the Servo Board. This error may occur due to the communication error or the version differences between the Main Board and the Servo Board.

6.1.14.2. Causes and examine methods

(1) Please examine if the Main Board and the Servo Board are installed properly. ■ Examine if the board is installed properly. ■ Examine if board is faulty (2) Examine if the versions of the Main Board and the Servo Board matches

(1) Please examine if the Main Board and the Servo Board are installed properly.
This error may be caused by a communication problem if the Main Board and the Servo Board is not installed properly on a rack, or the board has an error.

Warning
In order to protect the previous job programs, please back up all the files of Main board to the USB memory before you remove the board from the Rack.

Method to back up the files from Main Board to USB memory is as below.

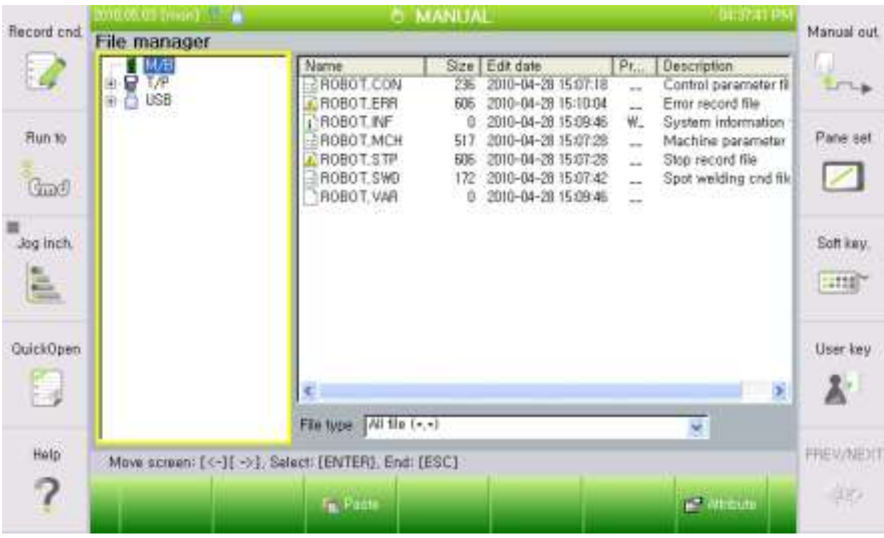
Figure 6.78 Inserting Method of USB to TP

Once the USB is recognized by TP, the below icon will be displayed on a screen.

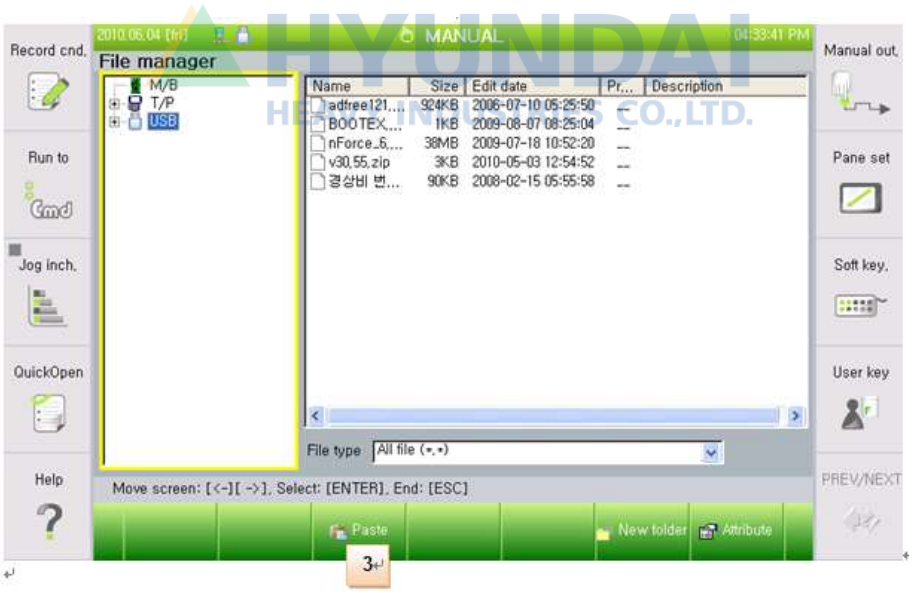
To back up the files enter to,

- Service
- 5. File manager

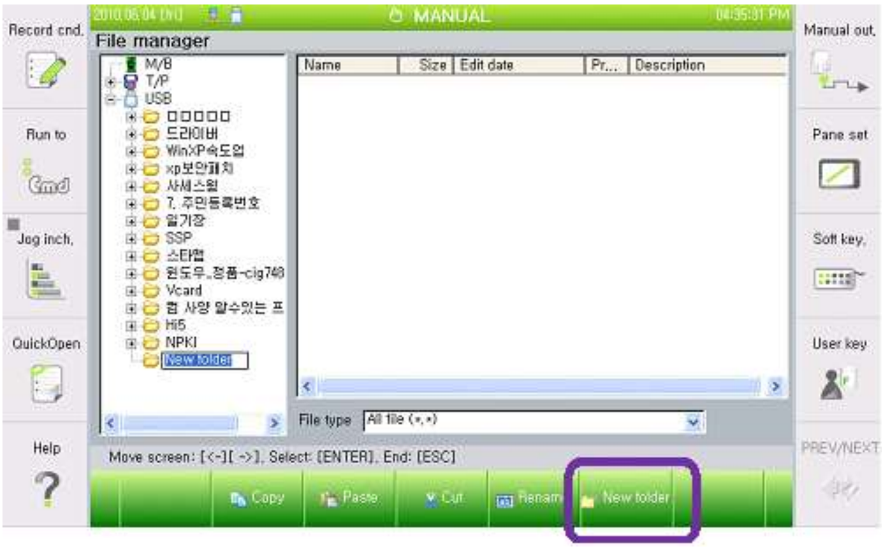
And the screen that is similar to windows explorer will be displayed.



At this stage, please copy the files shown in M/B and move them to USB.



You may create a new folder on USB, or can rename the folder by using the soft keyboard just like the windows explorer.



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- Examine if the board is installed properly
  Please remove the Main Board and the Servo Board from the Rack and re-install them again.

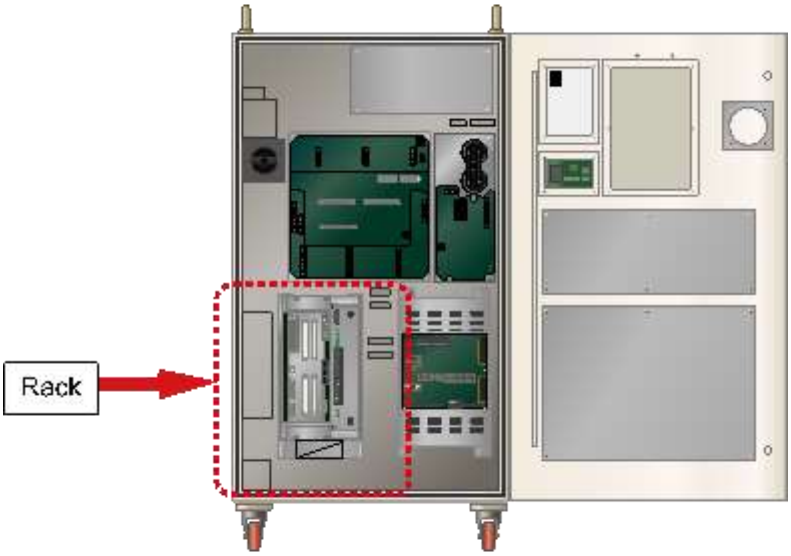


Figure 6.79 Location of Rack Inside of the Controller

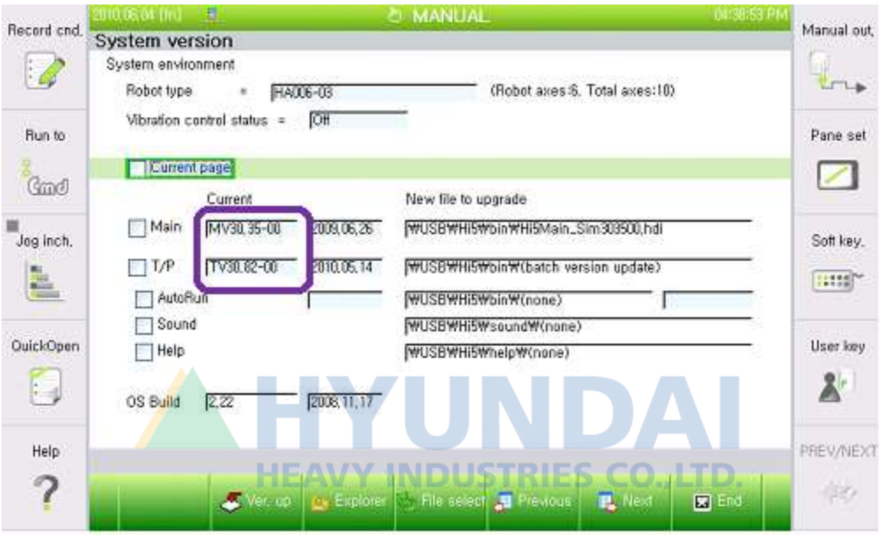
- Examine if the board is faulty.
  To examine if the board is faulty, please replace it with new one.

(2) Examine if the versions of the Main Board and the Servo Board matches

When the controller turns on, it will check the versions of Main Board and the Servo Board
If the version does not match, an error of "E0179~E181 DSP version is old" will be displayed.
Please contact to our A/S department in order to update the system with a proper version.

Versions of the Main Board and the Servo Board can be checked from the below menu.

- ➢ Service
- ➢ System diagnosis
- ➢ System version



Press [F6: next page] to check the version of Servo Board

6.1.15. E0117 (Axis ○) Position deviation set value exceeded

6.1.15.1. Outline

Position (speed) deviation exceeds the set value. If the difference between the location of moving command and the actual location is too large during the operation of Robot that controlled by the Servo, the Servo Board will detect an error (during Servo operation) and immobilize the Robot.

6.1.15.2. Causes and examine methods

(1) Check if the axis with an error has mechanical interference with other equipments.

(2) Check if the brake release works properly.
- Examine if the brake release of each axis has an error
- Examine the error on brake's power supply.

(3) Examine the wiring status.

(4) Check if the rated load is used.

(5) Position deviation setting level error.

(6) Please replace other components.

(1) Check if the axis with an error has mechanical interference with other equipments.
This error may occur if the Robot had a mechanical interference or collisions. If the Robot is out of the operation area, please move it back into the operation area by using a manual control.

(2) Check if the brake release works properly.
Brake release functions of the corresponding axis maybe have an error, or the release voltage of the brake release may have problem.

- Examine if the brake release of each axis has an error
  Please remove the motor's power supply (motor OFF) and check if you can release the brake of the axis with manual brake switch. You can confirm it with the sound of brake release from the motor.

Warning
Please be cautious. The Robot's axis may fall once the brake is released.

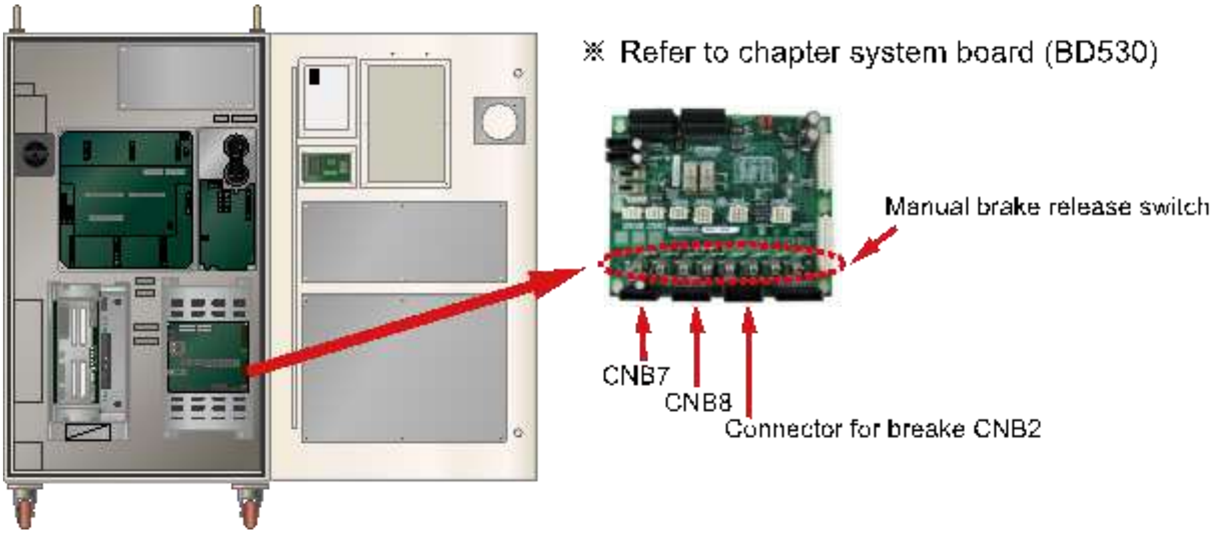
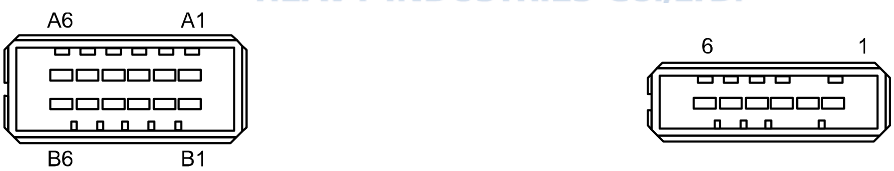


Figure 6.80 Location of the Manual Brake Release Switch

If the corresponding axis's brake cannot be released, output status of the brake release voltage in the System Board need to be examined. Please remove the brake wiring (CNB2, CNB7, CNB8 connector) and use the manual brake switch for the brake voltage's output.
Please measure the brake voltage of corresponding axis output (from the CNB2, CNB7, CNB8 connector) to check if it is over 20V. If there is an axis which has a voltage output under the 20V, System Board (BD530) is faulty. Please replace it.



CNB2

PIN	DESCRIPTION	PIN	DESCRIPTION
A1	BA1	B1	MB
A2	BA2	B2	MB
A3	BA3	B3	/R_FAN
A4	BA4	B4	MONL
A5	BA5	B5	PREPB
A6	BA6	B6	/TS

CNB7

PIN	DESCRIPTION	PIN	DESCRIPTION
1	BA7	4	/TS
2	PREPB	5	-> Key Pin
3	MB	6	/TS7

CNB8

PIN	DESCRIPTION	PIN	DESCRIPTION
1	BA8	4	/TS7
2	PREPB	5	/TS8
3	MB	6	-> Key Pin

Figure 6.81 Pin Locations of CNB2, CNB7 Connectors

- Examine the error on brake's power supply.
  If "E0012 Brake power supply error message is displayed at the same time, there is an error on Brake's power supply unit. From TP, please access 『[F1]: Service』 → 『1:Monitoring』 → 『2:I/O signals』 → 『1:Private input signal』 → 『Overload (Brake Power supply)』. If it is highlighted as yellow, the fuse for Brake (in the Electrical Module)'s power supply has been disconnected. Please replace the fuse.

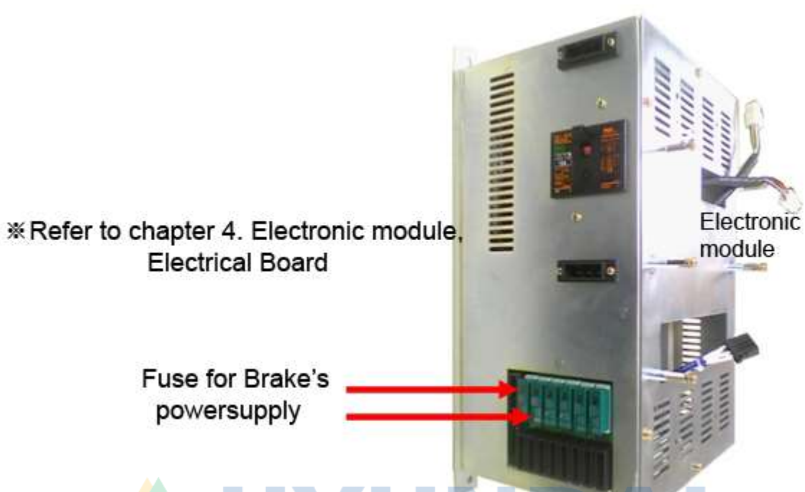


Figure 6.82 Electronic Module

If the fuse is normal, please measure the Brake power supply (DC24V) from the System Board. There are 3 test pins at the center of the board. Use the TMB as a reference terminal and the TPPB terminal value should be over DC20V. If it is below 20V, the power supply unit that generates the power for the brake has an error. Please replace the Electrical Module.

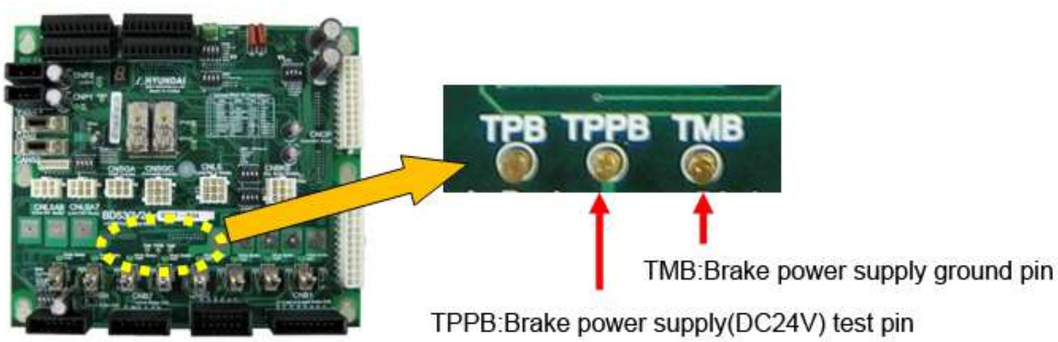


Figure 6.83 Brake Power Supply Test Pin

(3) Examine the wiring status.
Check if the motor wiring (U, V, W phase) has been short-circuit from the other wiring or ground lines (FG).

(4) Check if the rated load is used.
If the total weight exceeds the rated load, please refer to the Robot's specification and adjust the load to within the rated load.

(5) Position deviation setting level error

If the position deviation setting value is smaller than the next maximum measured value, please increate the setting value.

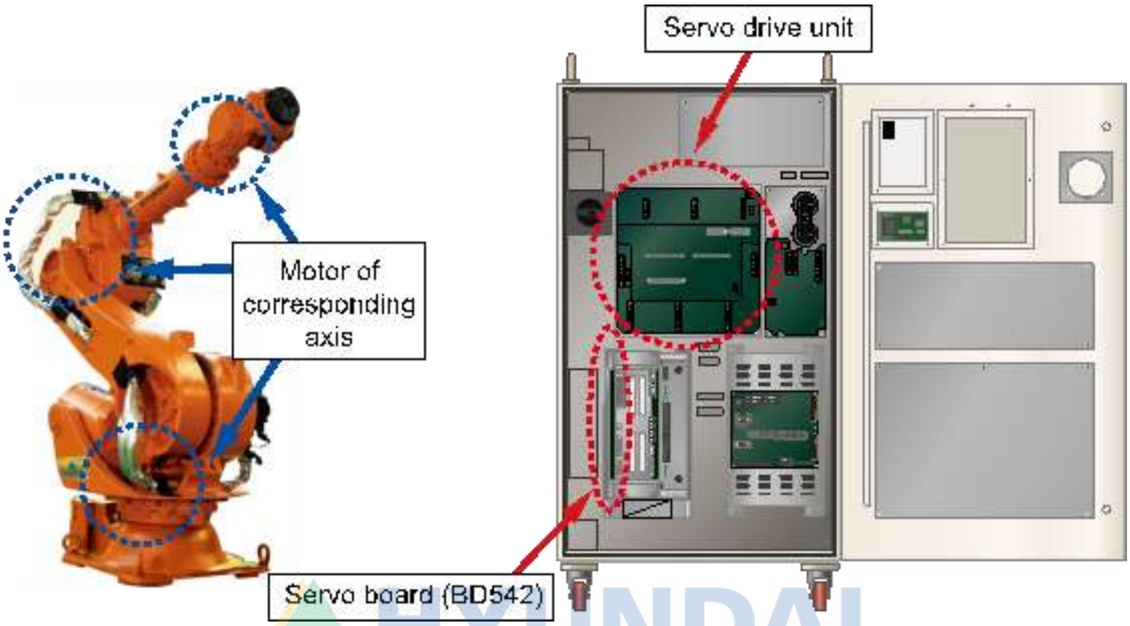
Maximum measured value of position deviation after few cycles of operation x 1.5

Figure 6.84 Monitoring Screen of the Maximum Measured Position Deviation Value from TP

Figure 6.85 Modifying Screen of Position Deviation Value from TP

(6) Please replace other components.

Replace the component in order of Servo Board (BD542) → Servo Drive Unit → Motor to confirm the occurrence of an error'.



6.1.16. E0119 (Axis ○) Overload

6.1.16.1. Outline

Motor or the drive unit is being overloaded. If motor or the drive unit is overloaded, the Servo Board detects an error and immobilizes the Robot.

6.1.16.2. Causes and examine methods

(1) Please check if the Robot is loaded within its rated load. (2) Please examine if there is a possible collision point during the Robot's operation. (3) Please check if the axis brake works properly. (4) Please replace the Servo Board and examine an error. (5) Please examine if the Drive Unit operates normally.

(1) Please check if the Robot is loaded within its rated load.

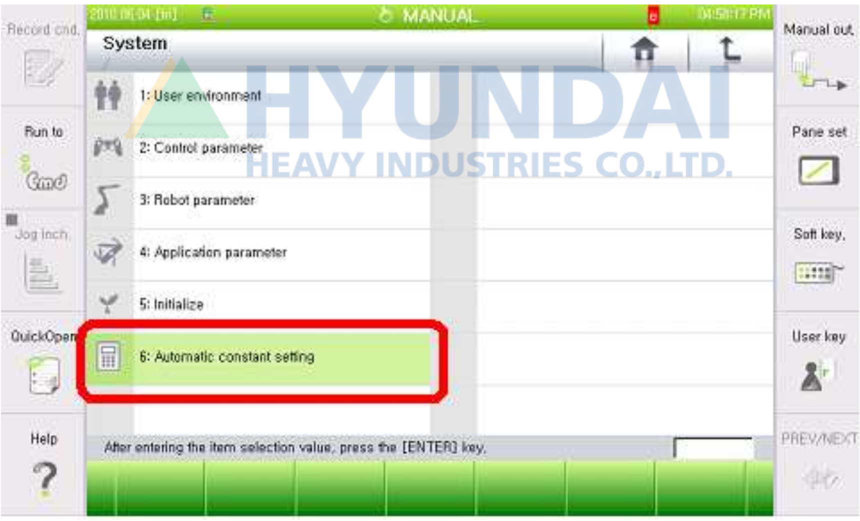
Please check if the Robot is loaded within its rated load. This error may occur if the load exceeds Robot's specification (load does not only include the tools that can be attached at the end of Robot, but also include all the cables and other components that can be attached to the Robot.

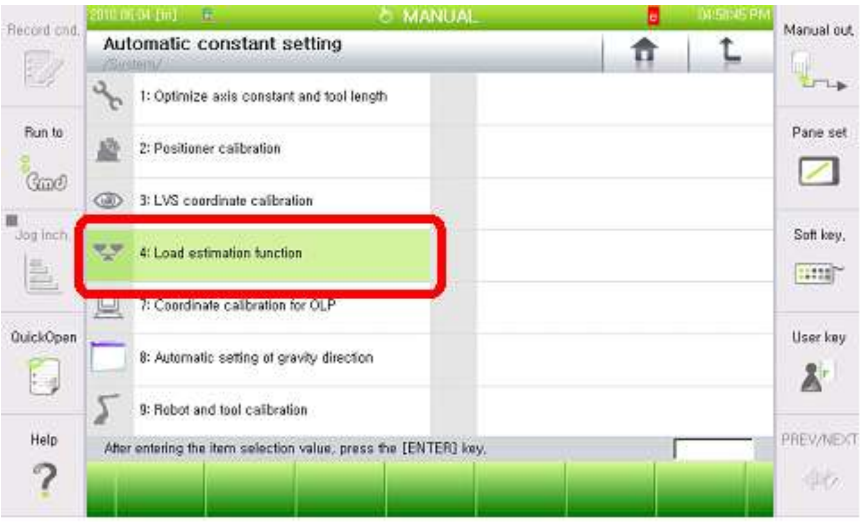
Using measuring equipment is recommended, but if it is not an option, load can be measured by using a 'load estimation function' from the controller. However this function only can measure the load of a tool that attached at the end of the Robot.

Method to estimate the load is as below.

- Enter to the load estimate function

  『[F2]: System』 → 『6: Automatic constant setting』 → 『4: Load estimation function』

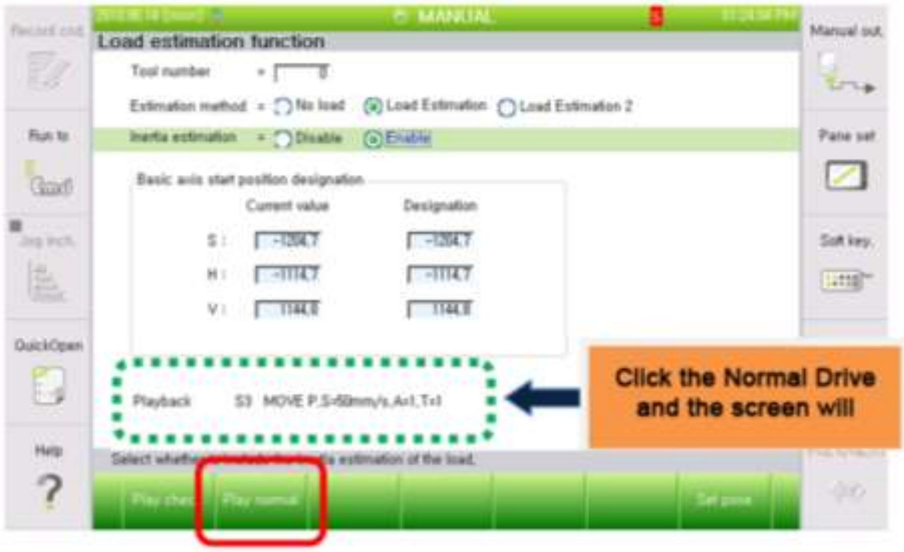




■ Select the tool number, estimation method, enable status of inertia estimation from the load estimation function.

- ➢ Tool number to save after the load estimation
- ➢ Estimation method: Load estimation 2
- ➢ Inertia estimation: Enable

- Click Normal Drive to execute.
  Press the Motor On switch, and hold the deadman and click the Play Normal.



Decide if you want to register the result of load estimation.

- Once the load estimation drive has completed, the estimated result will be displayed on the screen.

If you press the close button, a message box will appear to ask you if you want to reflect the result. If you click ‘yes’ it will be saved.

(2) Please examine if there is a possible collision point during the Robot's operation.
Please check if there is a point where the Robot may be interfered or have a collision in the operation area. This error may occur if the Robot is interfered by other equipments. In that case, please modify the job program so the interference will not occur.

(3) Please check if the axis brake works properly.
Brake release function of the corresponding axis maybe have an error, or the release voltage of the brake release may have problem.

- Examine if the brake release of each axis has an error
  Please remove the motor's power supply (motor OFF) and check if you can release the brake of the axis with manual brake switch. You can confirm it with the sound of brake release from the motor.

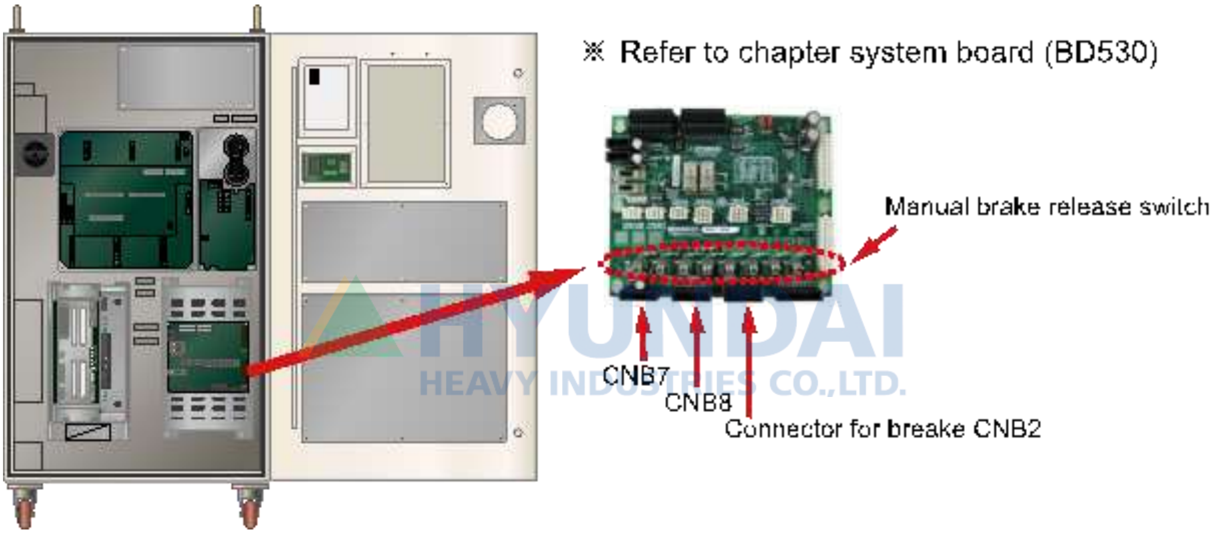
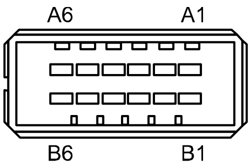


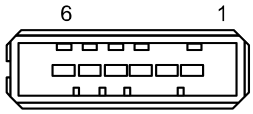
Figure 6.86 Location of the Manual Brake Release Switch

If the corresponding axis's brake cannot be released, output status of the brake release voltage in the System Board need to be examined. Please remove the brake wiring (CNB2, CNB7, CNB8 connector) and use the manual brake switch for the brake voltage's output.
Please measure the brake voltage of corresponding axis output (from the CNB2, CNB7, CNB8 connector) to check if it is over 20V. If there is an axis which has a voltage output under the 20V, System Board (BD530) is faulty. Please replace it.



CNB2

PIN	DESCRIPTION	PIN	DESCRIPTION
A1	BA1	B1	MB
A2	BA2	B2	MB
A3	BA3	B3	/R_FAN
A4	BA4	B4	MONL
A5	BA5	B5	PREPB
A6	BA6	B6	/TS



CNB7

PIN	DESCRIPTION	PIN	DESCRIPTION
1	BA7	4	/TS
2	PREPB	5	-> Key Pin
3	MB	6	/TS7

CNB8

PIN	DESCRIPTION	PIN	DESCRIPTION
1	BA8	4	/TS7
2	PREPB	5	/TS8
3	MB	6	-> Key Pin

Figure 6.87 Pin Locations of CNB2, CNB7 Connectors

- Examine the error on brake's power supply.
  If "E0012 Brake power supply error message is displayed at the same time, there is an error on Brake's power supply unit. From TP, please access 『[F1]: Service』 → 『1:Monitoring』 → 『2:I/O signals』 → 『1:Private input signal』 → 『Overload(Brake Power supply)』. If it is highlighted as yellow, the fuse for Brake (in the Electrical Module)'s power supply has been disconnected. Please replace the fuse.

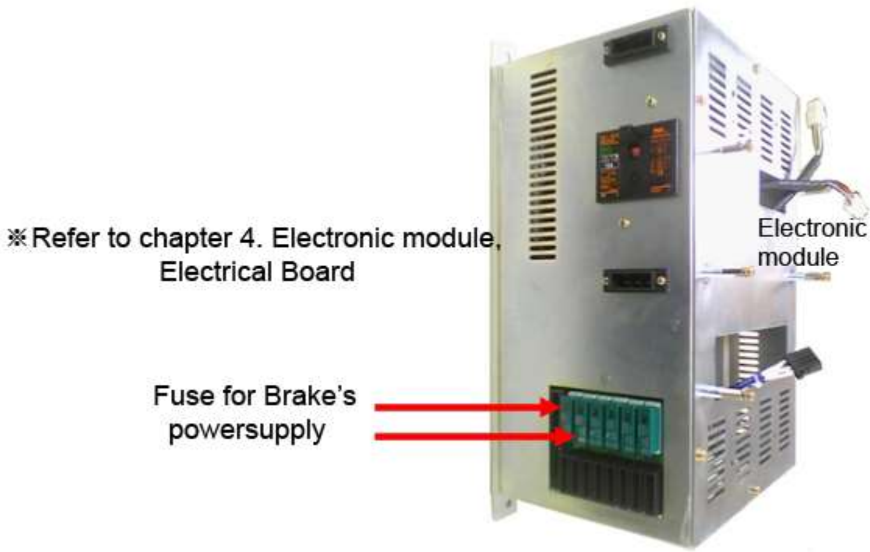


Figure 6.88 Electronic Module

If the fuse is normal, please measure the Brake power supply (DC24V) from the System Board. There are 3 test pins at the center of the board. Use the TMB as a reference terminal and the TPPB terminal value should be over DC20V. If it is below 20V, the power supply unit that generates the power for the brake has an error. Please replace the Electrical Module.

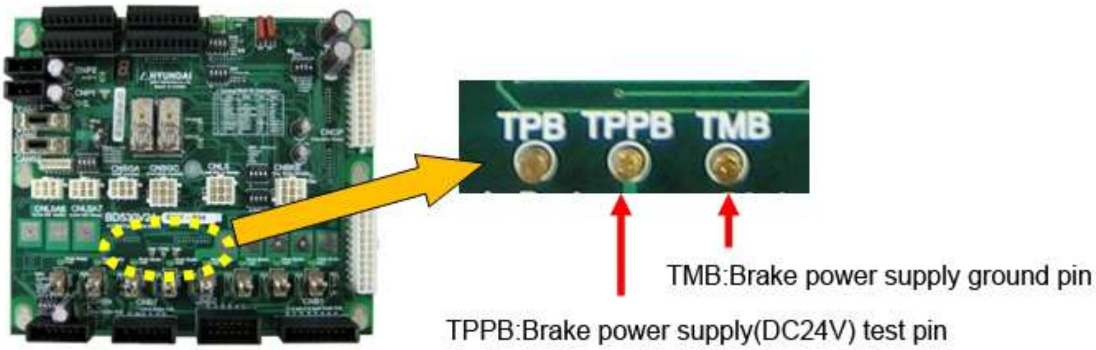
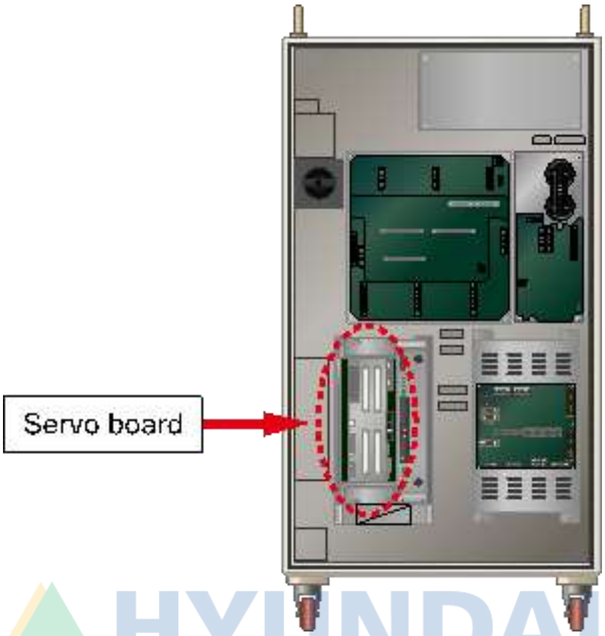
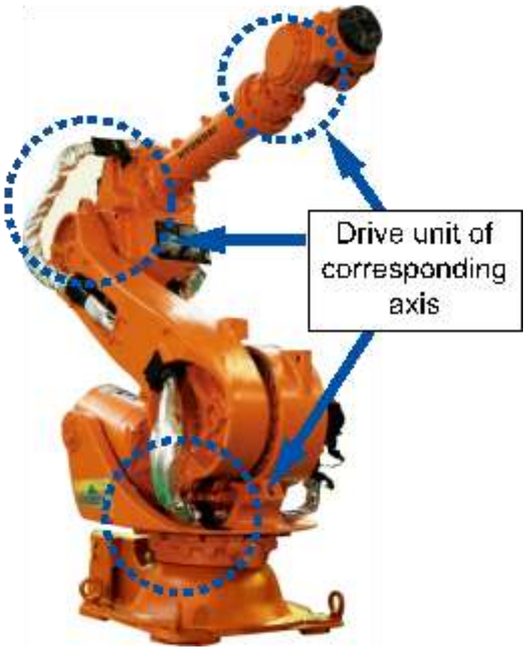


Figure 6.89 Brake Power Supply Test Pin

(4) Please replace the Servo Board and examine an error.
This error may occur if there is an error on the Servo Board. Please replace the board to check.



(5) Please examine if the Drive Unit operates normally.
Please check if the Drive Unit of corresponding axis (Motor, Decelerator) works properly.



6.1.17. E0122 Servo ON limit time exceeded

6.1.17.1. Outline

This error occurs if the Servo motor does not turn on when the main send out the motor on command to the Servo. The cause might be a communication problem between the main and the Servo.
Main send Servo error clear command prior to sending motor on, and once the Servo error is cleared motor on command will be sent out. If the Servo error did not clear, the same error persists and motor on command will go out. In other words, if the communication between the main and the Servo does not have a problem, the motor on command will be received, or other Servo error will occur.

6.1.17.2. Causes and examine methods

(1) Please examine if the Main Board and the Servo Board are installed properly. ■ Examine if the board is installed properly. ■ Examine if board is faulty

(1) Please examine if the Main Board and the Servo Board are installed properly.
This error may be caused by a communication problem if the Main Board and the Servo Board is not installed properly on a rack, or the board has an error.

Warning
In order to protect the previous job programs, please back up all the files of Main board to the USB memory before you remove the board from the Rack.

Method to back up the files from Main Board to USB memory is as below.

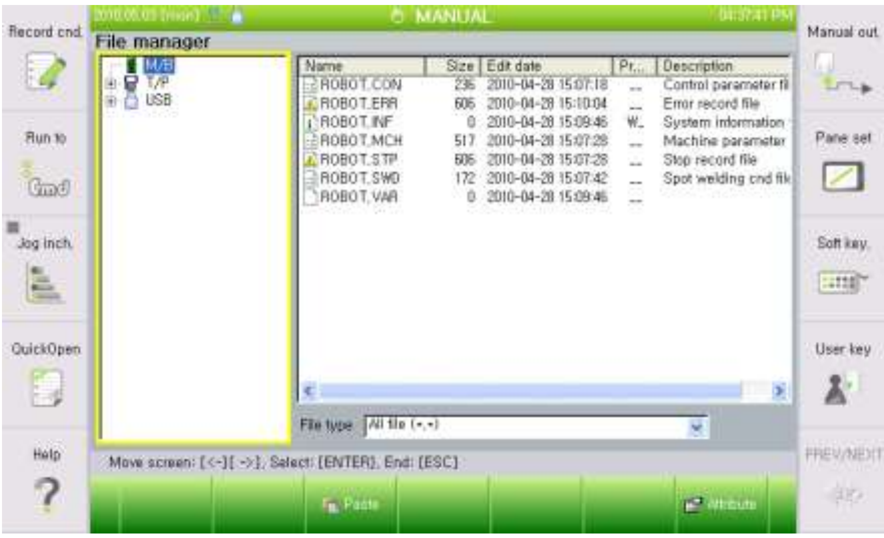
Figure 6.90 Inserting Method of USB to TP

Once the USB is recognized by TP, the below icon will be displayed on a screen.

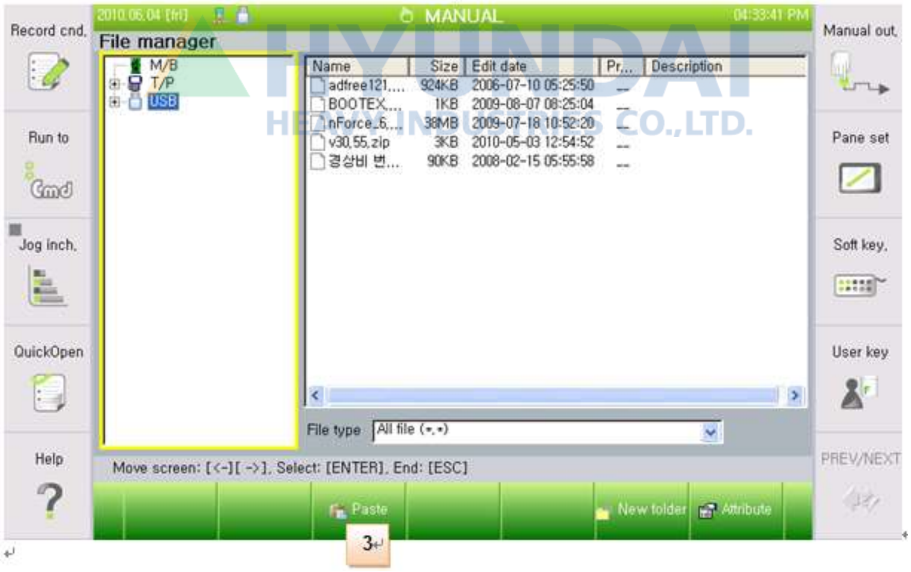
To back up the files enter to

- ➢ Service
- ➢ 5. File manager

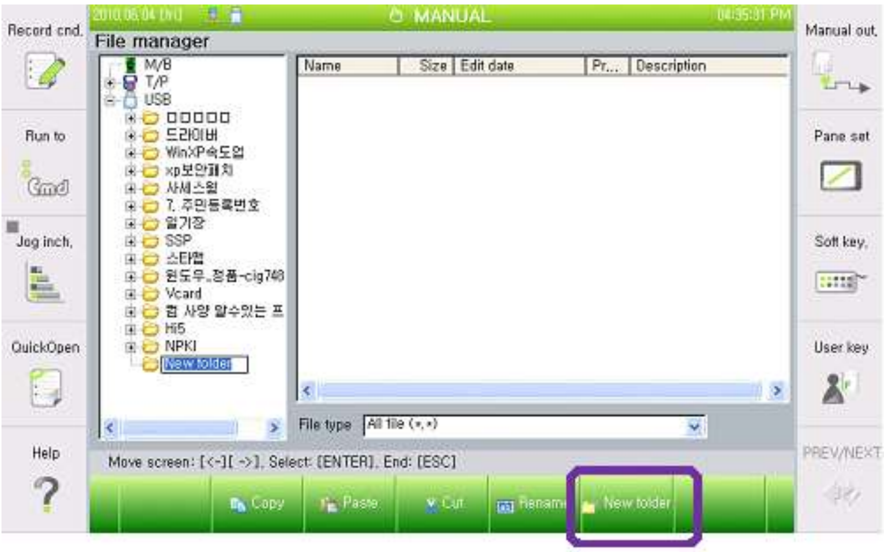
And the screen that is similar to windows explorer will be displayed.



At this stage, please copy the files shown in M/B and move them to USB.



You may create a new folder on USB, or can rename the folder by using the soft keyboard just like the windows explorer.



- Examine if the board is installed properly
  Please remove the Main Board and the Servo Board from the Rack and re-install them again.

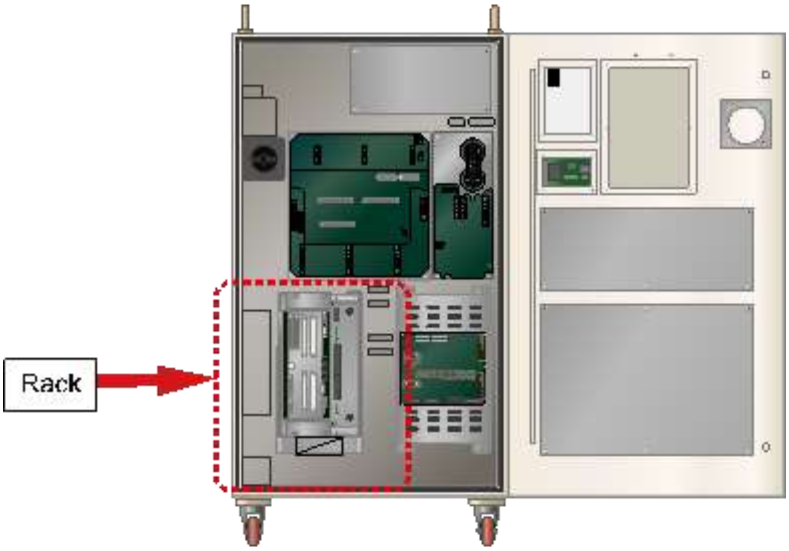


Figure 6.91 Location of Rack Inside of the Controller

- Examine if the board is faulty.
  To examine if the board is faulty, please replace it with new one.

6.1.18. E0127 MSHP operation error
6.1.19. E0140 MSPR operation error

6.1.19.1. Outline

Motor's power supply is supplied to the AMP according to the open/close status of Magnetic contactor MC1, and MC2.
Status of MC1 and MC2 are being monitored by Main's conditions and E127 (MSHP operation error) or E140 (MSPR operation error) will be generated when an abnormal operation is detected.

(1) E0140 (MSPR operation error)
For a reason that cannot be identified by Main, the Magnetic contactor MC1
① Does not turn On while an attempt is made,
② Turns off while it should stays on

(2) E0127 (MSHP operation error)
For a reason that cannot be identified by Main, the Magnetic contactor MC2
① Does not turn On while an attempt is made,
② Turns off while it should stays on

In order for MC1 or MC2 to on, many conditions need to be satisfied, and even if when they are on, they can be off for some reasons. Main can identify the causes for Magnetic contactor's operation error if it is a case that provides a monitoring function such as safety signals. However if the main cannot identify the Magnetic contactor's operation error, a number of examines are required.

6.1.19.2. Causes and examine methods

(1) Command system malfunction
- Error on receiving data from the Main
- CPUERR or EXOUT signal has occurred, or an error of the corresponding line
- Old system I/O Board (BD531V10) is used from the remote mode
- Error on the safety signal system
- Error that occurred due to the safety related unit’s wiring malfunction
- System Board malfunction

(2) Monitoring system malfunction
- Cabling (Wire, Connector etc) malfunction
- Electrical Module malfunction
- System Board malfunction

(3) Other malfunction
- Case when E0043 and E0140 both occurs at the same time

To identify the cause of these two errors (MSPR operation error, and MSHP operation error), you must understand the Motor’s power supply insertion system. Basic concept of Motor’s power supply to the Amp (Drive Unit) is as below.
Main will send out the MC1 Motor power on 1 command (MCON1) and waits (while monitoring the sub point of contact) until the MC1 is activated. At this stage, if the MC1 does not activates within certain amount of time, E0140 (MSPR operation error) will occur. On the other hand, if MC1 successfully operated, Main will send out the MC2 Motor power on 2 command (MCON2) and waits (while monitoring the sub point of contact) until the MC2 is activated. Again, if the MC1 does not activates within certain amount of time, E0127 (MSHP operation error) will occur.
If the Magnetic contact MC1 and MC2 turns on according to the Main’s command, AC220V R, S, T 3-phase power supply will be supplied to the Amp.

While the motor is on, the Main will monitor if the MC1, and MC2’s status is on at all time.
If the Magnetic contact goes off for a reason that cannot be identified by the Main, these errors will occur.

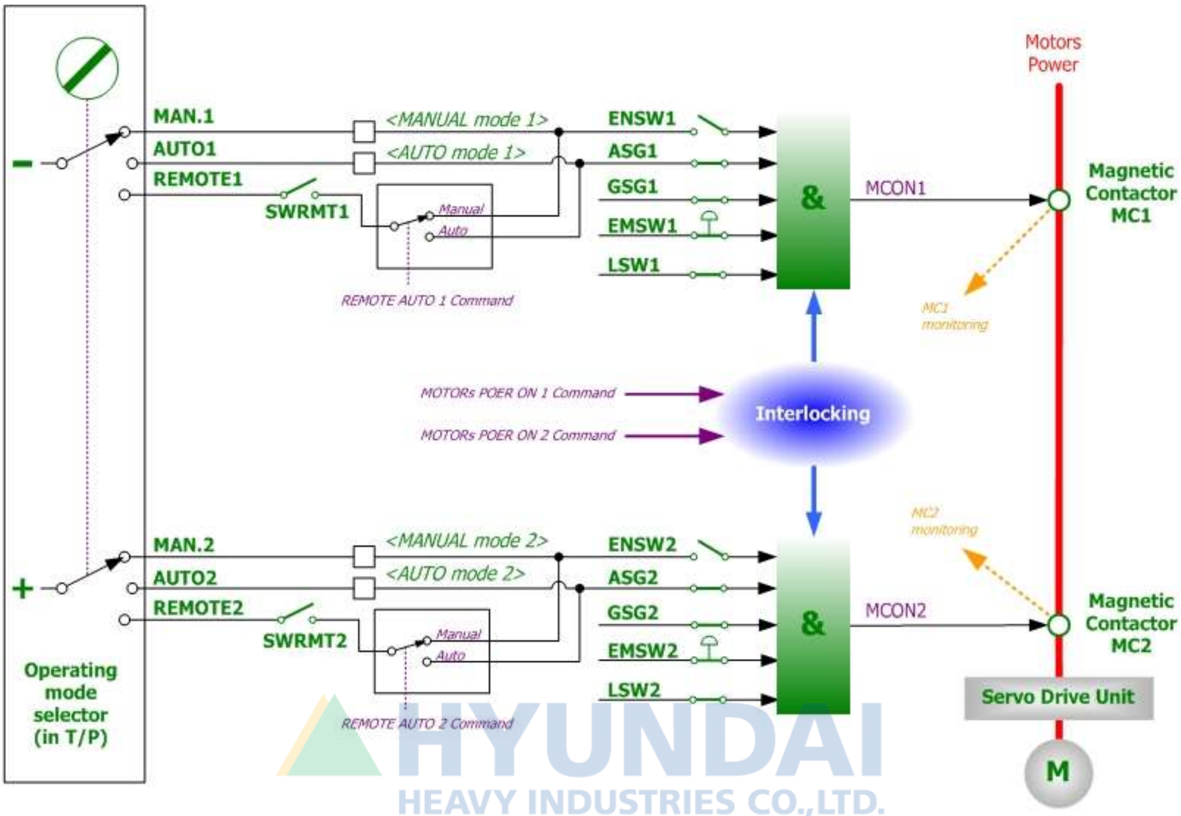


Figure 6.92 Concept Diagram of Safety Circuit for Motor Power’s Opening/Closing

(1) Command system malfunction

Motor on command from the main has been blocked for some reason, if you do not hear any sound of operation and a message of 'MSPR operation error' is displayed while the motor on attempt is made.

- Error on receiving data from the Main
  If a communication error occurs between the Main Board and the System Board, the System Board will block the Motor On command for a safety reason. Generally the Main Board also detects the communication error at the same time, so the MSPR operation error or MSHP operation error will not occur. However if the Main cannot detect the communication error, these errors can be generated. This is a case when the control status of safety switch related components (Teach Pendant emergency stop switch input, OP panel's emergency stop switch input) are being transmitted to the Main Board, but output from the Main Board (Motor ON) will not be transmitted to the System so the hardware wise Motor On command is cannot be executed.

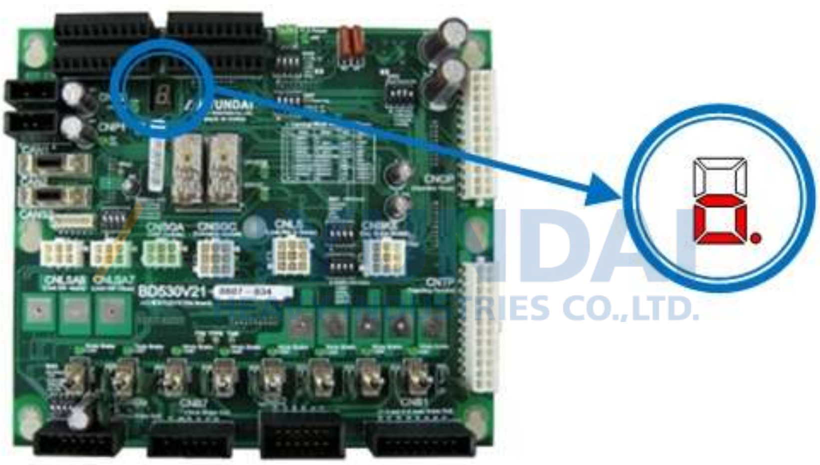


Figure 6.93 7-SEG Indicator of the System Board when a Communication Error Occurs

- How to judge:
  System Board's 7-segment index may give you an indication of the situation. 7-segment displays "o." to indicate that the current communication with the Main Board is in abnormal status.

- Actions:
  Firstly, please restart the controller and observe if the same error persists. If it does, the communication input unit of the System Board has an error. Please replace the System Board.

■ CPUERR or EXOUT signal has occurred, or an error of the corresponding line
Main Board generates CPUERR or EXOUT signals in a case when systemic error has occurred (e.g. power shut down, Servo error). This signal will be transferred to the System Board and block the motor on command in terms of hardware. Motor's power will be immediately shut down for a safety reason. However, these signals may be generated abnormally, and it will shut down the motor's power.

- How to judge:
  System Board's 7-segment index may give you an indication of the situation. 7-segment displays "H." when CPUERR is being transmitted to the System Board. Also the CPUERR, EXOUT LED which located at the center of the System Board indicate the error situation (Figure 6.93) These LED lights will be on if it is a normal status, and the lights will be off if it is not.

However if the signal appears time to time for a very short moments, 7-segment and LED won't be able to indicate it. In such case, error occurrence must be observed while ignoring the two signals by using DIP switch SW1. Method to ignore the signal is to, as shown in the Figure 6.94, turn on the No 1 (to ignore CPUERR) and the No 2 (to ignore EXOUT) of the DIP switch SW1. At this point all LED lights will be on.

If the error no longer persists after the system restart, Main Board generated these signals or CANS1 Connector/Cable malfunction is suspected.

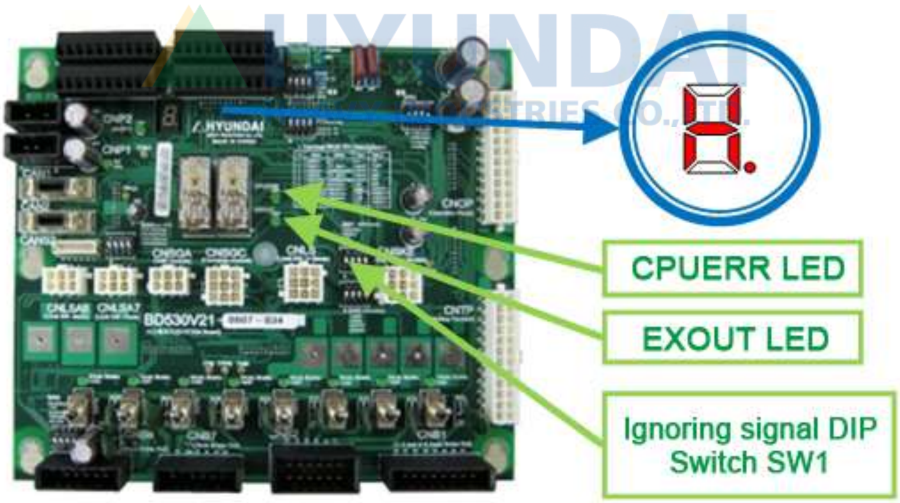


Figure 6.94 Indication of 7-SEG, LED (on System Board) when CPUERR Error is Occurred

- Actions:
  If a Main Board generating this signal without any other indication of errors, please check the PLD version of the Main Board. Over V0.7 is normal. If Main Board's PLD version is normal, please examine the CANS1 connector and cables.

Cautions: Please use only No 1 (to ignore CPUERR) and No2 (to ignore EXOUT) of the DIP switch SW1 for a testing purpose and please switch it back to normal after the test. This ignores the emergency safety related functions and it may cause safety related problems if operates while ignoring these functions.

- Old system I/O Board (BD531V10) is used from the remote mode
  If an old system IO board (BD531V10) is used on a remote mode, this error may occur. Motor on command will not be executed because this type of board does not have remote mode function.

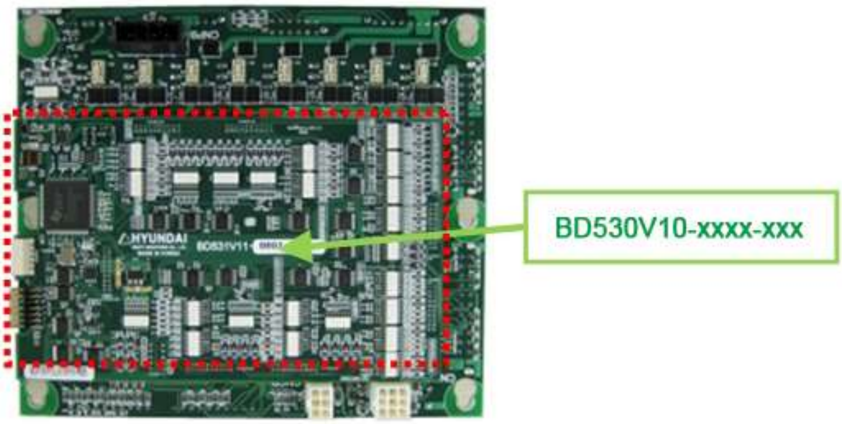


Figure 6.95 Checking Method of Old System I/O Board (BD531V10)

- How to judge:
  This board is attached at the back of the System Board. Please remove the System Board from Electrical Module and check the system I/O board number at the back (Figure 6.95).

- Actions:
  If the installed board is "BD531V10", please replace it with a board with the hardware version above "BD531V11".

- Error on the safety signal system
  Motor on command from the main has been blocked for some reason, if you do not hear any sound of operation and a message of ‘MSPR operation error’ is displayed while the motor on attempt is made without any other error messages.

  The motor on command will not be executed if there is a problem on a safety signal system as explained earlier (Figure 6.92). Safety devices (Safety guard, emergency stop switch etc) are mechanically operating devices, but their monitoring is operated electronically. So a safety device malfunction, or any electronic shock (noise, surge), wiring error, short circuit can cause an error. To confirm, please remove the connected safety device’s wiring and rewire them to ignore the input. (Figure 6.96, Figure 6.97, Figure 6.98, Figure 6.99, Figure 6.100).

Cautions: Please use only for a testing purpose and please switch it back to normal after the test. This ignores the emergency safety related functions and it may cause safety related problems if operates while ignoring these functions.

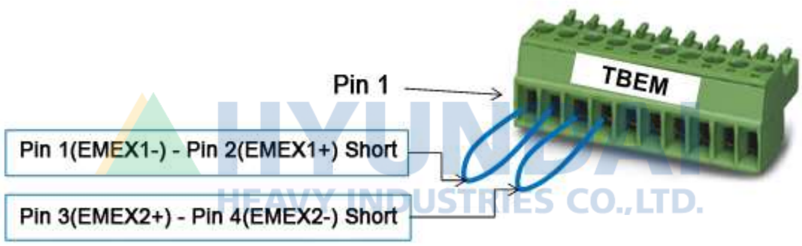


Figure 6.96 Method to Ignore the External Emergency Stop Input

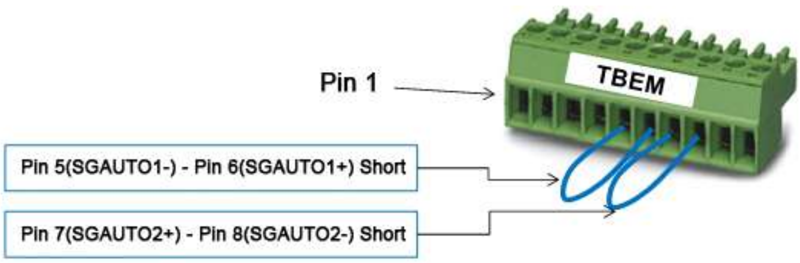


Figure 6.97 Method to Ignore the Safety Guard (Auto) Input

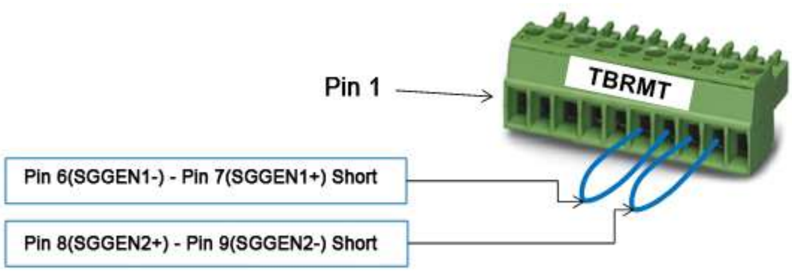


Figure 6.98 Method to Ignore the Safety Guard (General) Input

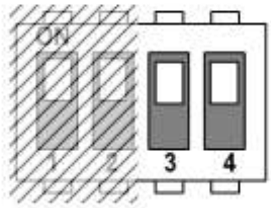


Figure 6.99 Method to Ignore the (P-COM input) External Emergency Stop(3,4 of SW6 is ON)

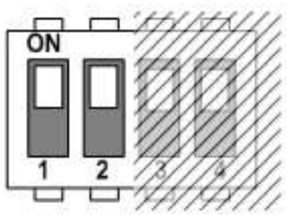


Figure 6.100 Method to Ignore the (P-COM) Safety Guard (Auto)(1,2 of SW6 is ON)

As explained, if the error does not persist when these safety switch inputs are ignored, the problem exists in the safety switches and wirings. Please check them.

Cautions: Please use only for a testing purpose and please switch it back to normal after the test. This ignores the emergency safety related functions and it may cause safety related problems if operates while ignoring these functions.

- Error that occurred due to the safety related unit's wiring malfunction
  If there is a problem in a wiring of devices that are related to the safety such as Safety guard(Auto), the error for a corresponding safety signal may not be detected and it will generate E0140 (MSPR operation error).
  This error occurs from a waiting of manual mode drive preparation (Status that the Teach Pendant's motor on LED is flickering) switches to automatic mode, and motor on attempt is made on an automatic mode.

  For example, there is a case when the wiring of Safety guard (Auto) is faulty. There are two types of input method (point of contact input, P-common input) that enters safeguard to the System Board (BD530) and the point of contact input's wiring error may cause a problem. Proper wiring separates each safe chain and connects the each end of point of contact (Figure 6.101) However if the chain's wiring is mixed and connected, the controller will not be able to detect the Safety guard's error due to an electronic error. (Figure 6.102). If the motor on is attempted at this time, not sufficient power supply for Magnetic contactor's safe relay operation will be supplied and it will generate E0140 (MSPR operation error).

  - How to judge:
    Phenomenon of Safety guard wiring malfunction is as below.

    - If a safe chain connection is removed (5, 6 wiring or 7, 8 wiring), Safety guard error will be detected in automatic mode and displays E0043 error.

    - However, if all chains are connected (5, 6, 7, 8 wiring are all connected), Safety guard error will not be detected in automatic mode (E0043 error does not occur).

    If the above phenomenon appears, please examine the Safety guard (Auto)'s wiring. Firstly, please remove the terminal block TBEM from the board, and perform a short circuit test from a removed terminal block connector's (TBEM) safeguard input terminal (socket) while activating the guard device.

    - If you close the guard device (point of contact – close status), 5, 6 terminal (socket) will be shorted. Also 7,8 terminal (socket) will be shorted.

    - If you open the guard device (point of contact – open status), 5, 6 terminal (socket) will be open. Also the 7,8 terminal (socket) must be open status.

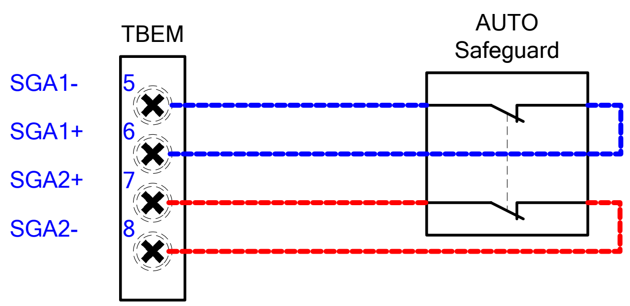


Figure 6.101 Good example of Safety Guard (Auto) wiring

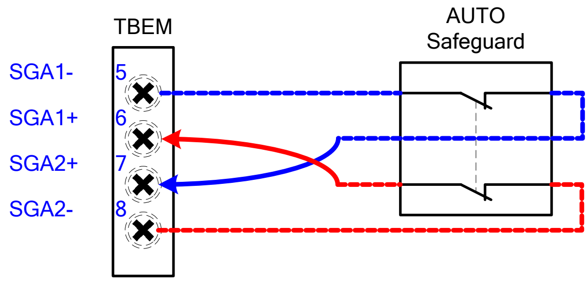
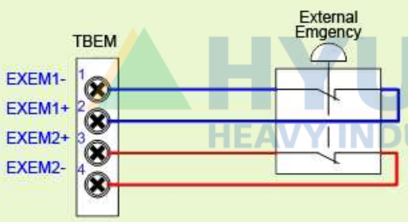
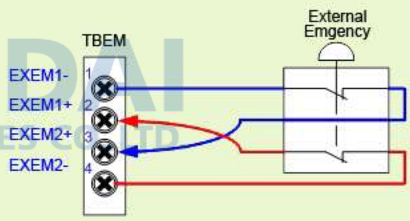
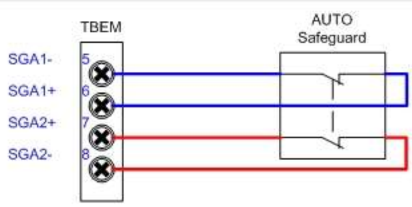
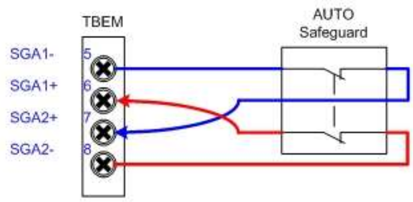
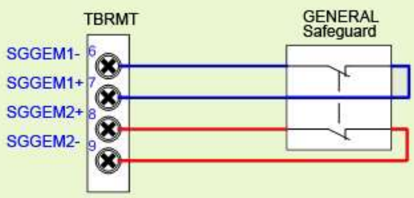
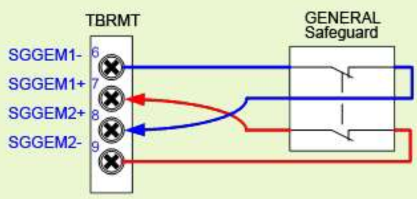


Figure 6.102 Bad example of Safety Guard (Auto) wiring

- Actions: Please modify the wiring of Safety guard (Auto) correctly (Figure 6.102)

  Error occurrence caused by the wiring error of safeguard has been explained in above. This applies same to all safety related signals (Safety guard (General), Safety guard (Auto), external emergency stop switch, various limit switches), so please refer to (table 6-4) to compare the normal and abnormal wiring examples.

Table 6-5 Error on safety related device's wiring

Classification	Normal wiring	Abnormal wiring
External emergency stop switch		
Safety guard (Auto)		
Safety Guard (General)		

- System Board malfunction
  When motor on is attempted, if you do not hear the activating sound of controller's internal Magnetic contactor (MC1) and a message of "MSPR operation error" is displayed, please examine all the above. If no problem is found from the above examinations and same error persists, System Board malfunction might be the cause. Please replace it.

(2) Monitoring system malfunction

When motor on is attempted, if you do hear the activating sound of controller's internal Magnetic contactor (MC1) and a message of "MSPR operation error" or "MSHP operation error" is displayed, the cause of an error might be the Monitoring system malfunction. In order to confirm the Monitoring system malfunction, please do as below.

The status of Magnetic contactor MC1 and MC2 is monitored by using the sub point of contact and can be accessed by the Teach Pendant. (Figure 6.103) From the Teach Pendant, MC1 (PreCharge) and MC2 (Motors Power) signal can be accessed by Private input signal monitoring window. Motor off status will be displayed as a white color background and motor on status will be displayed as yellow color background.

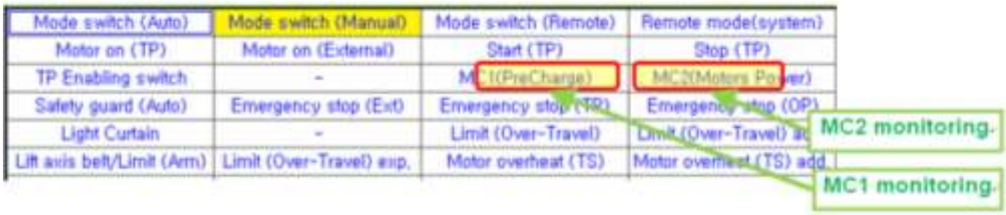


Figure 6.103 Method of Magnetic Contactor Monitoring

Please attempt the motor on in automatic or manual mode and confirm the activation sound of the Magnetic contactor as well as the displayed status of MC1, and MC2.

- At first, if MC1 is displayed with a yellow color for a moment (with the sound of Magnetic contactor's activation) and E0140 (MSPR operation error) message is appears, it means that there is no error in MC1's sub point of contact and the monitoring system.

- After the activation of MC1, if MC2 is displayed with a yellow color for a moment (with second sound of Magnetic contactor's activation) and E0127 (MSHP operation error) message is appears, it means that there is no error in MC1's sub point of contact and the monitoring system.

With the above methods, if you confirmed that the monitoring of MC1 and MC2 is not working (Monitoring signal is not displayed in yellow while you can hear the sound of Magnetic contactor's activation), the following devices has to be examined (Figure 6.104).

① Cable CNMC
② Electrical Board relay SR1, SR2 (inside of Electrical Module)
③ Sub point of contact for MC1 and MC2 – Magnetic contactor (inside of Electrical Module)
④ Wiring between the Electrical Board and the Magnetic contactor (inside of Electrical Module)
⑤ System Board (input signal processing unit)

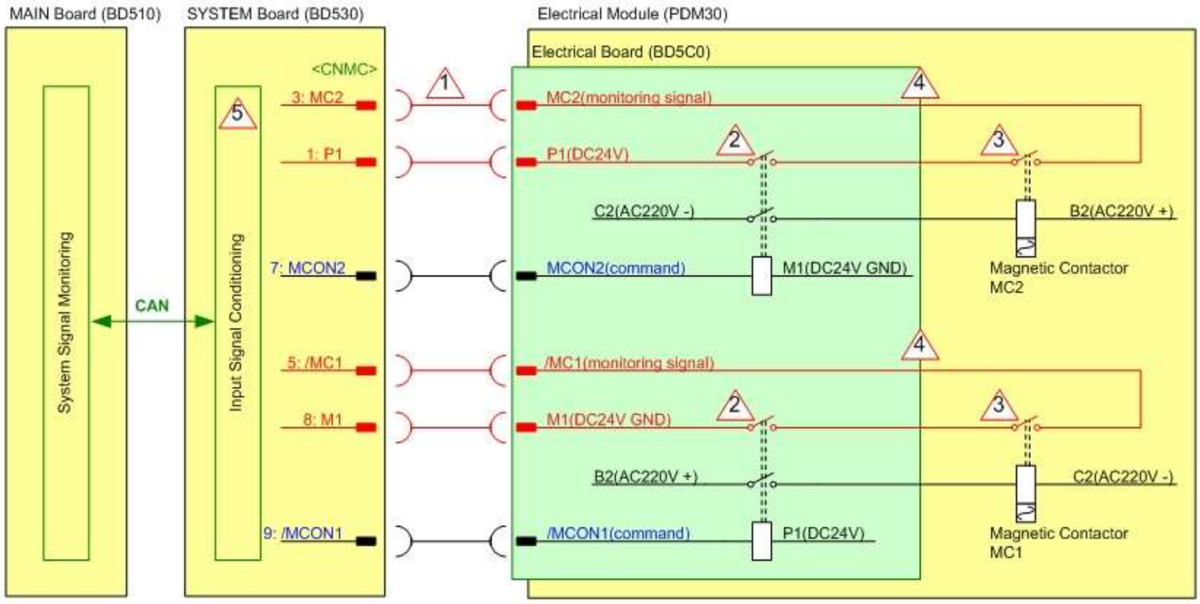


Figure 6.104 Diagram of the Monitoring System – Magnetic Contactor

- Cabling (wires, connector etc) malfunction
  Please check the cabling between the Electrical Module (PDM30) that an electrical connector is installed and the System Board (BD530) that collects monitoring signals.
  The cable name is CNMS and it enters to the Electrical Module through the top rear of the System Board (Figure 6.105). Please check the connection status of this cable's connector.

Figure 6.105 CNMC Cable on the Electrical Module

- Electrical Module malfunction
  Monitoring signal of the Magnetic contactor is transmitted to the System Board through many devices that are inside of the Electrical Module. So if one of those devices has an error, the Main will not be able to detect even if the Magnetic contactor is operated. Internal electrical module malfunction can be categorized as a electrical board (BD5C0), Electrical connector (MC1, MC2), and wirings between the electrical board and the electrical connector (Figure 6.106) However it is difficult to examine the inside of Electrical Module in a field where a Robot has already been installed, so alternatively please replace the Electrical Module

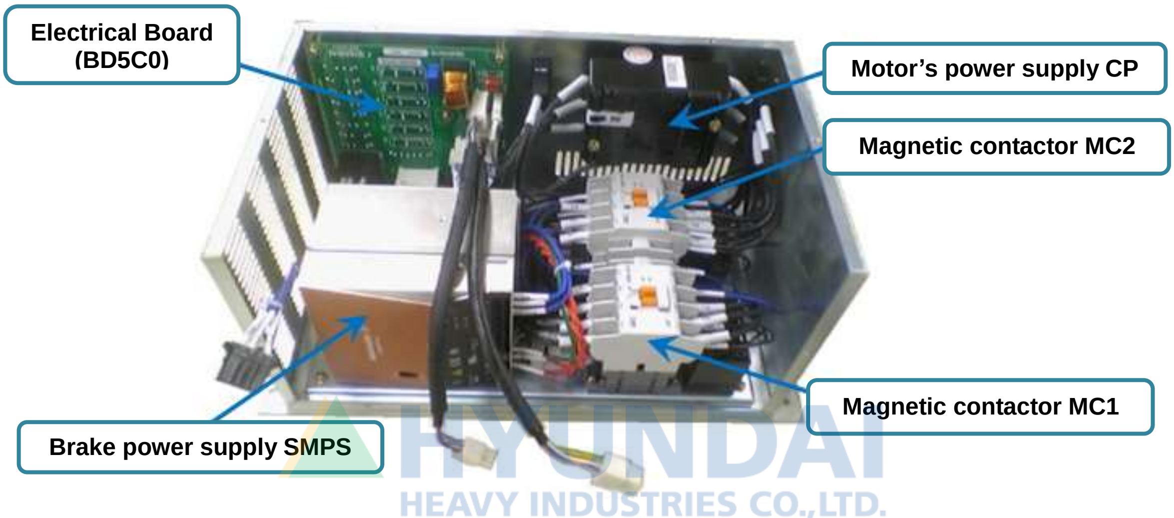


Figure 6.106 Inner Structure of Electrical Module

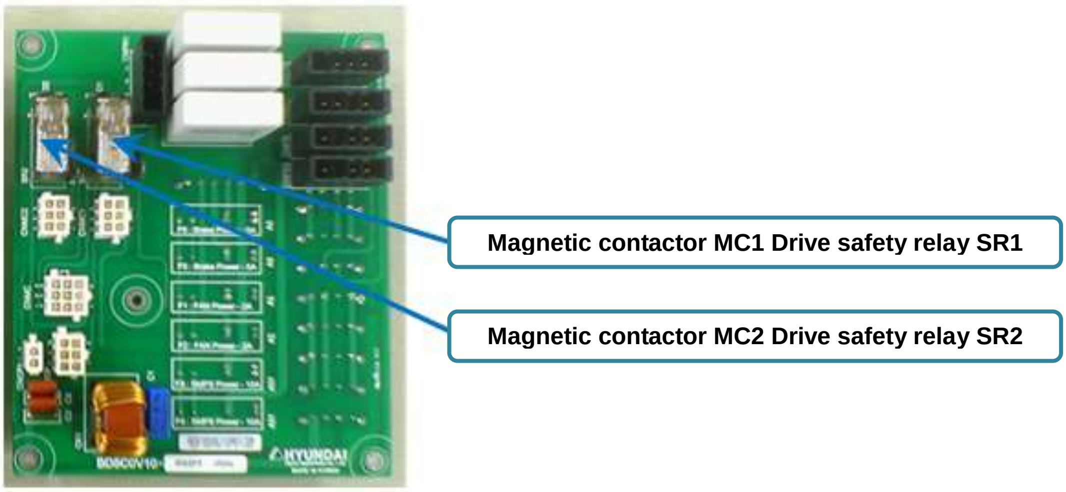


Figure 6.107 Electrical Board BD5C0)

- System Board malfunction
  Input signal process unit malfunction of the System Board can be the cause of this error. Please replace the System Board and check.

(3) Other malfunction

- Case when E0043 and E0140 both occurs at the same time
  E0043(Safety Plug or Light Curtain) with the E0140(MSPR operation error) can occurs from a waiting of manual mode drive preparation (Status that the Teach Pendant's motor on LED is flickering) switches to automatic mode, and motor on attempt is made when the Safety guard (Auto) is open (and the Main software version is below V30.07-00). Please check the Main software version from the Teach Pendant and upgrade if the version is low.

6.1.20. E0133 (Axis ○) Command value error

6.1.20.1. Outline

This error may occur due to a communication error between the Main Board and the Servo Board, or a rapid changes of motion. When a communication error occurs, a valid command cannot be transferred from the Main Board to the Servo Board, so this error will occur and immobilize the Robot to prevent the Robot’s abnormal operation based on an invalid command.
Also this error will occur and immobilized the Robot because the drive unit may not follow the rapid changes of motion command.

6.1.20.2. Causes and examine methods

(1) Please examine if the Main Board and the Servo Board are installed properly.
- Examine if the board is installed properly.
- Examine if board is faulty.

(2) Examine if there is a job program that operates a Robot rapidly.

(1) Please examine if the Main Board and the Servo Board are installed properly.
This error may be caused by a communication problem if the Main Board and the Servo Board is not installed properly on a rack, or the board has an error.

Warning
In order to protect the previous job programs, please back up all the files of Main board to the USB memory before you remove the board from the Rack.

Method to back up the files from Main Board to USB memory is as below.

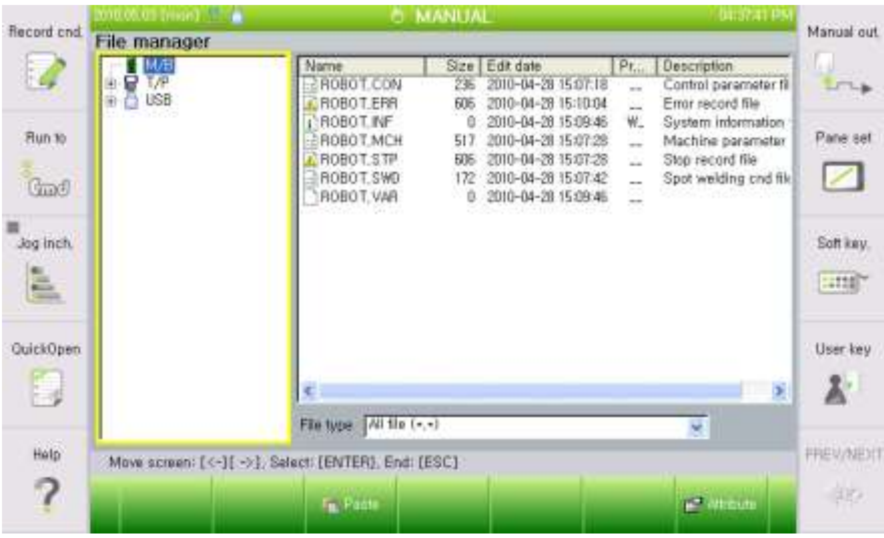
Figure 6.108 Inserting Method of USB to TP

Once the USB is recognized by TP, the below icon will be displayed on a screen.

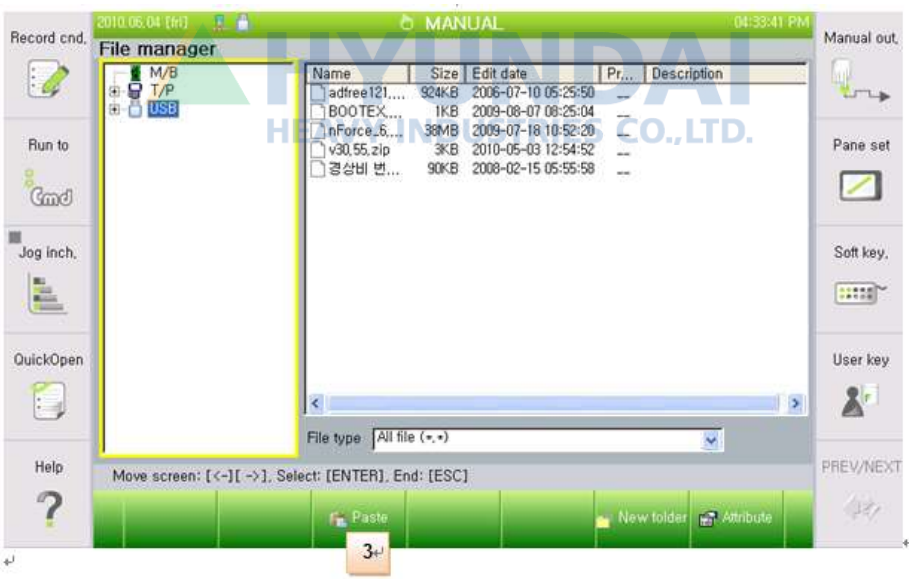
To back up the files enter to

- Service
- 5. File manager

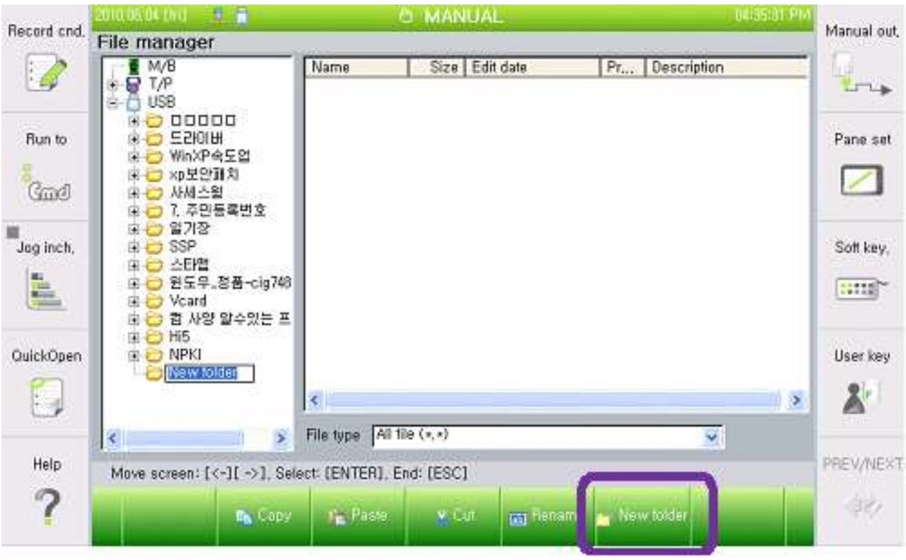
And the screen that is similar to windows explorer will be displayed.



At this stage, please copy the files shown in M/B and move them to USB.



You may create a new folder on USB, or can rename the folder by using the soft keyboard just like the windows explorer.



- Examine if the board is installed properly.
  Please remove the Main Board and the Servo Board from the Rack and re-install them again.

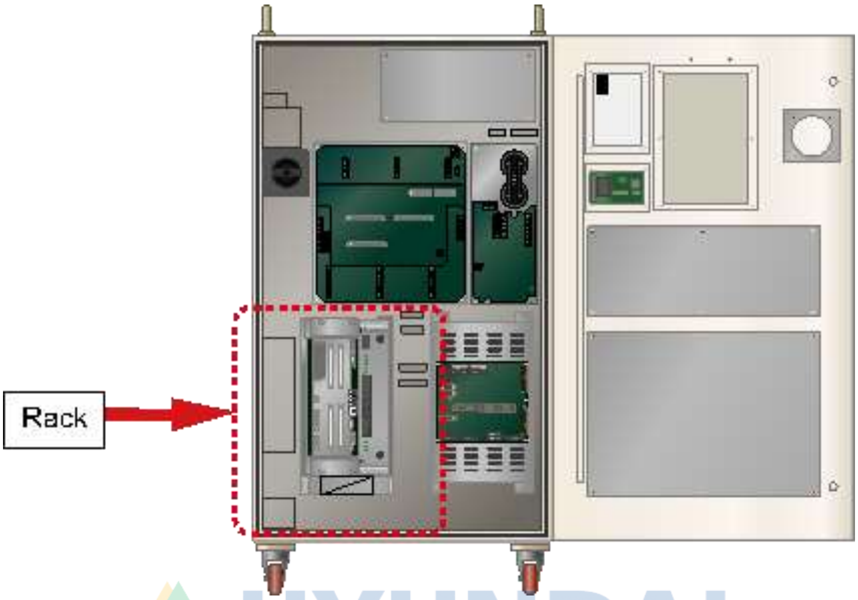


Figure 6.109 Location of Rack Inside of the Controller

- Examine if the board is faulty.
  To examine if the board is faulty, please replace it with new one.

(2) Examine if there is a job program that operates a Robot rapidly

Please check if the error occurs at a point where the Robot's motion changes rapidly. If the error occurs during the rapid motion, modification of job program is required.

The reason that this error occurs during the rapid motion is as below. During the execution of job program, Robot's position may be twisted in order do move a short distance. At that point, the speed of Robot's axis suddenly increases, and the error may occur if the Servo Board follows the movement. In order to resolve this, please modify the Teaching point of the location (where the position changes rapidly) or make changes on the position of Robot.

6.1.21. E0134 (Axis ○) Maximum speed exceeded

6.1.21.1. Outline

Speed of Robot's axis exceeded the maximum speed limit while an operation. An error will be generated and the Robot will be immobilized since the Robot is not being controlled normally.
When the Main Board sends a command to the Servo Board, it will send a limited command so that the Robot will not exceed the maximum speed limit. Maximum speed exceeded error may occurs if the Robot's speed triggers an overshoot because the Robot could not follow the command.

6.1.21.2. Causes and examine methods

(1) Please check if the tool data has entered correctly.

(2) Please check if the position of Robot is close to the singular point.

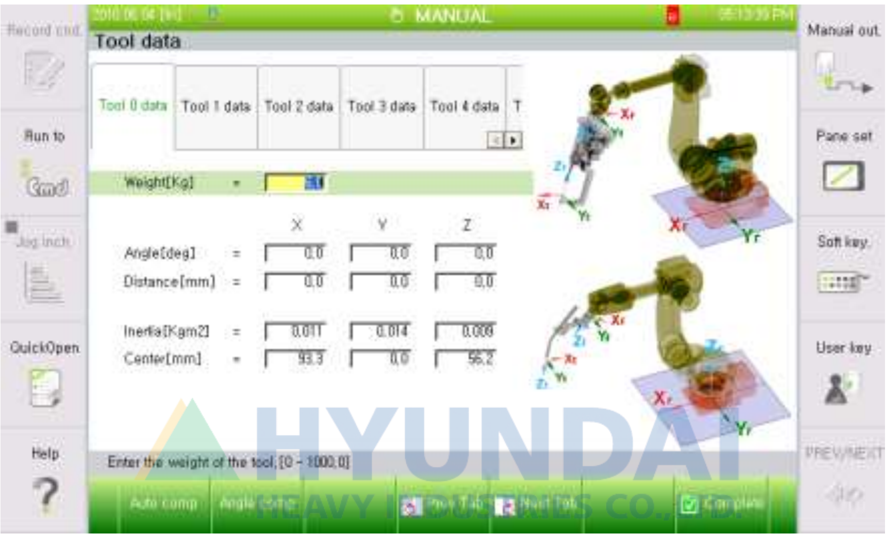
(3) Please check the setting value of condensation acceleration/deceleration parameter and the load factor.

(4) Please adjust the job program.

(1) Please check if the tool data has entered correctly.

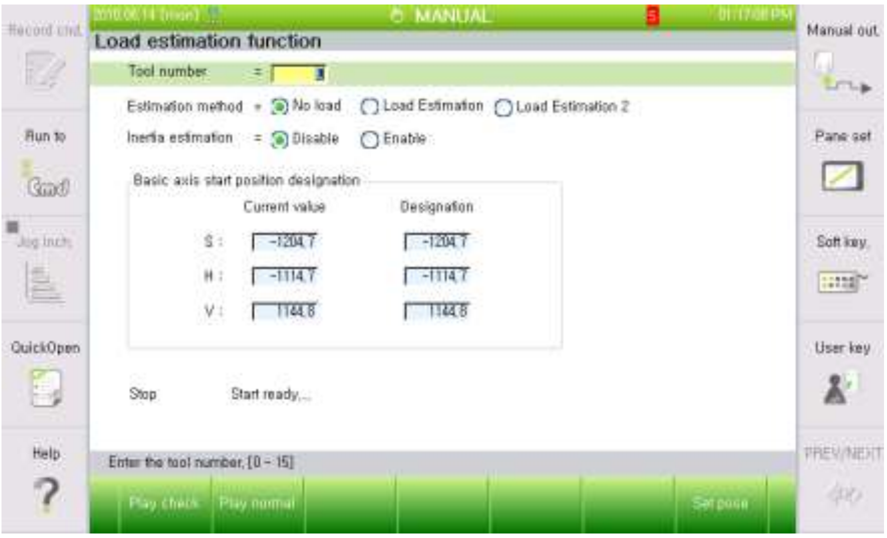
If the weight or the inertia of tool is different from the registered value at the controller, Robot's control performance will be reduced and the maximum speed limit exceeded error can occur. Tool's weight and the inertia can be registered from the below menu according to the number of tools.

- ➢ System
- ➢ 3. Robot Parameter
- ➢ Tool data



You may use the load estimation function in order to set the weight of tool or the inertia automatically.

- ➢ System
- ➢ Automatic constant setting
- ➢ 4. Load estimation function



(2) Please check if the position of Robot is close to the singular point.
This error may occur, if you execute L interpolation or C interpolation instead of PtP interpolation near the position of singular point.
Singular point occurs when the B axis is close to 0 deg, or the center of wrist part is close to the spin central axis of S axis. When passing near the singular point is required, please change the corresponding step to PtP interpolation.

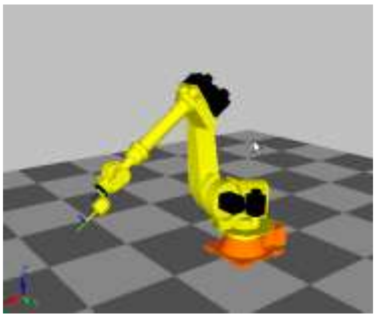


Figure 6.110 Axis B Singular Point

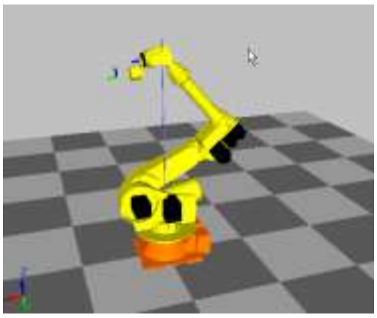


Figure 6.111 Axis S Singular Point

(3) Please check the setting value of condensation acceleration/deceleration parameter and the load factor.
Motor torque is insufficient, because maximum speed of condensation acceleration /deceleration parameter is too high or the acceleration time is too short. I/lp maximum speed had to be reduced with an observation of load factor (while the Robot's operation) or increase the acceleration time.

- System
- 3. Robot Parameter
- 34. Acceleration /Deceleration Parameter

Acceleration /Deceleration Parameter of condensation can be modified from the above.

(4) Please adjust the job program.
Please make changes of conditions (from the job program) on a corresponding step, or the one step prior to it. Firstly, try "Acc=0", secondly, reduce the step speed, and thirdly, add one more step on a movement routine.

6.1.22. E0165 (Axis o) Servo lock cannot be maintained

6.1.22.1. Outline

Power for the drive of Motor or the drive unit is not being supplied. The current that generated by a Servo control for the Robot or drive unit’s operation is not being supplied. For such cases, the Servo Board detects an error and the controller will stop the release of brake and block the current that supplied to the motor or the drive unit.

6.1.22.2. Causes and examine methods

(1) Examine the Motor power line.
- Check the wiring that connects the Robot and Controller.
- Check the Robot’s internal wiring.
- Check the Controller’s internal wiring.

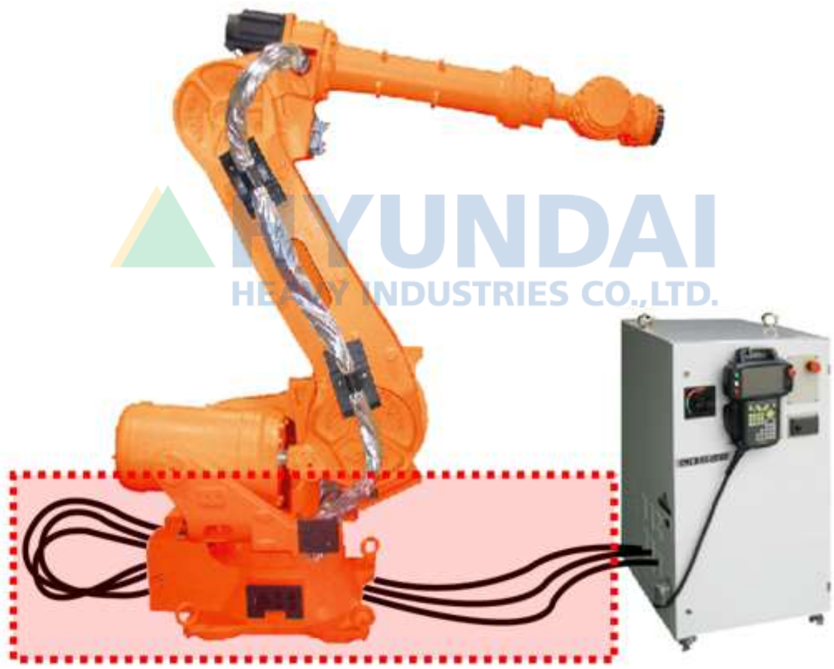
(2) Examine the CNBS cable between the Controller’s internal Servo Board and the Servo AMP.

(3) Replace other components.

(1) Examine the power line
Please turn off the primary power and remove the U, V, W of drive unit for the corresponding axis and examine if short circuit exists in each phase. Please use an equipment such as the multi meter (tester) and examine each phase's wiring one by one.

Warning
Be cautious. Examination while the power is on may cause an electrocution.

- Check the wiring that connects the Robot and Controller
  Please remove the wirings that connect the controller, Robot or the drive unit to examine each phases (U, V, W) for ground, or a short circuit. If a short circuit is found, please replace the wire.



<External wiring>

Figure 6.112 Basic Installation Diagram of the Robot and Control Period

- Check the Robot's internal wiring.
  Examine for a short circuit, faulty on a wiring that connected to Robot's internal motor is required.

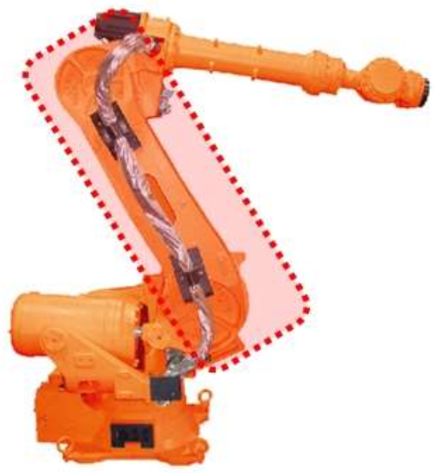


Figure 6.113 Robot's Internal Wiring

- Check the Controller's internal wiring.
  Examine on a controller's internal AMP and installed wiring is required.

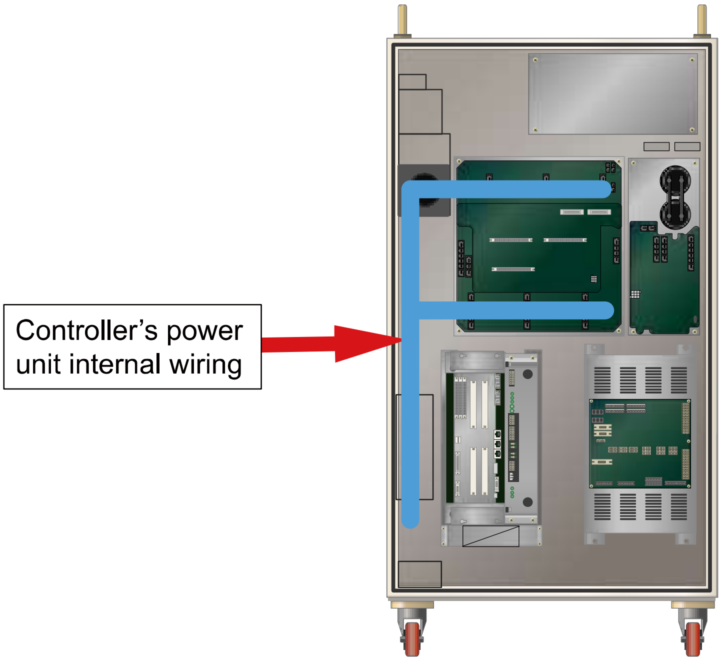


Figure 6.114 Controller's Internal Area (Power Unit)

(2) Examine the CNBS cable between the Controller's internal Servo Board (DSP board) and the Drive Unit.
Please examine if the CNBS cable is installed properly. If the cable is not installed properly, or the cable is faulty, this error may occur.

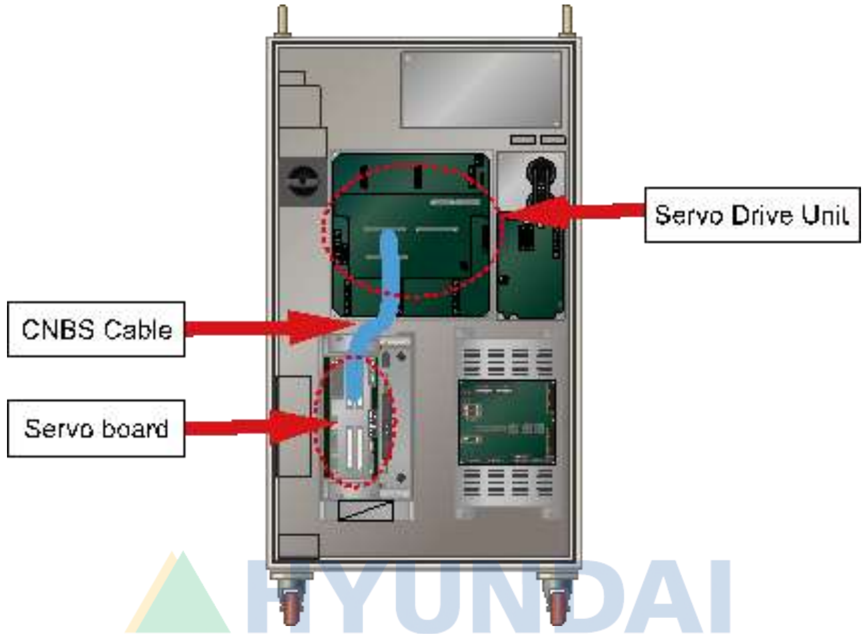
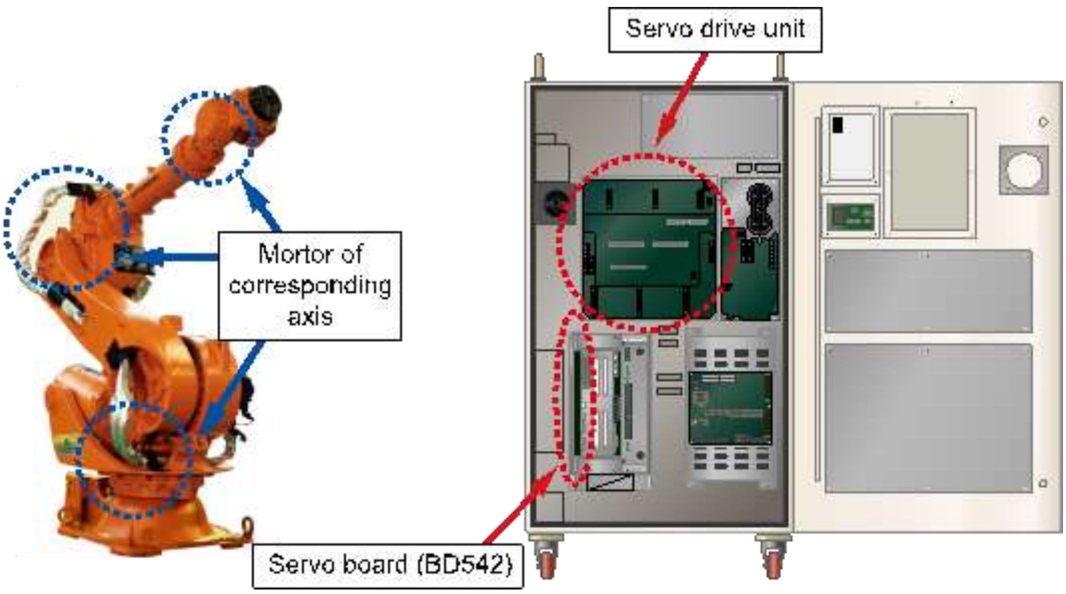


Figure 6.115 Controller's Internal Area (CNBS Cable)

(3) Replace other components.
Replace the component in order of Servo Board (BD542) → Servo Drive Unit → Motor to confirm the occurrence of an error'.



6.1.23. E0223 (Axis o) Encoder disconnection or communication failure

6.1.23.1. Outline

Servo Board receives data from the encoder periodically through a serial communication in order to perform a Servo control on the motor. This error occurs if the received data from the encoder violates the communication protocol.

This error may occurs due to a fault of components that received the data from the encoder, or the problems in a encoder shield lines or the wiring.

6.1.23.2. Causes and examine methods

(1) Please check the supply voltage to the Encoder.

(2) Please replace the Servo Board and test it.

(3) Please replace the Motor and test it.

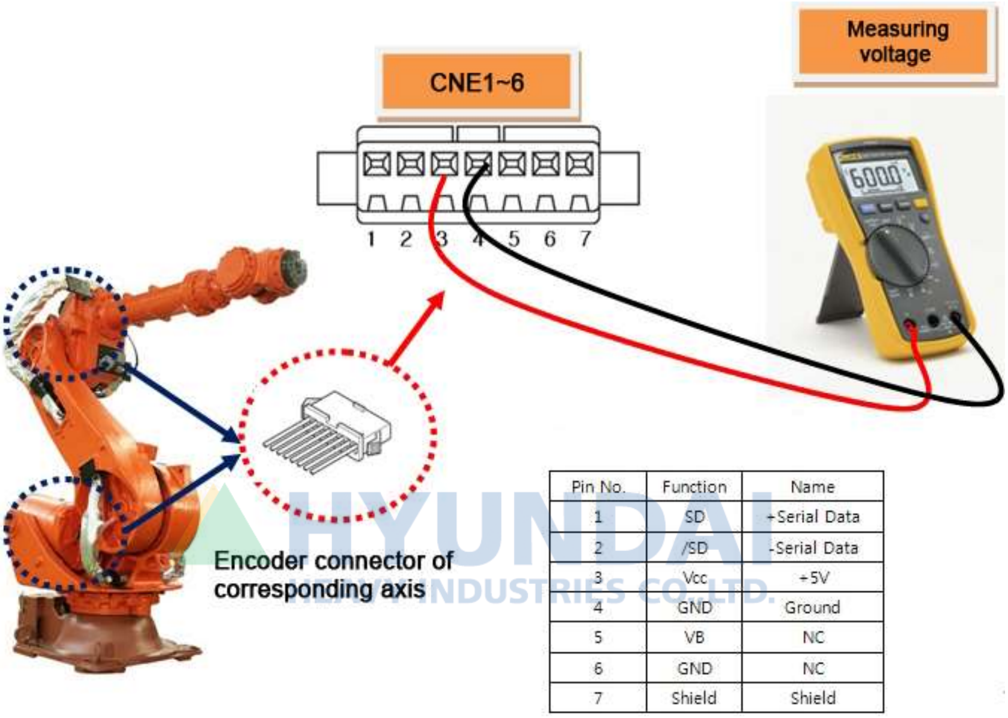
(4) Please examine the wiring.

(5) Please examine the communication status of wiring after the repair.

(1) Please check the supply voltage to the Encoder.

Power supply voltage to the encoder must be in a range of 5V±5% (4.75V ~ 5.25V) - (encoder side connector's supply voltage). If the voltage is reduced below 4.75V, encoder may not operate normally and it will cause this error.

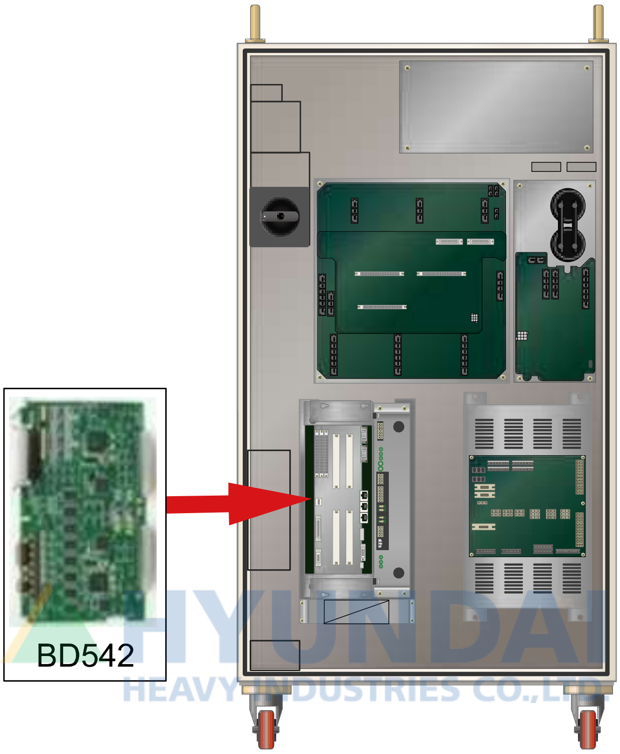
Please measure the voltage of encoder side's connector-pin (3-4).



Pin No.	Function	Name
1	SD	+Serial Data
2	/SD	-Serial Data
3	Vcc	+5V
4	GND	Ground
5	VB	NC
6	GND	NC
7	Shield	Shield

If the measured voltage is below the standard voltage, please adjust the +5V ADJ (E) voltage control terminal (socket) in the encoder's power supply unit, so that the encoder side's connector voltage can be adjusted according to the standard.

(2) Please replace the Servo Board and test it.
After the replacement of the Servo Board, if the error does not persist, the Servo Board is faulty. Please replace the Servo Board with new one.



(3) Please replace the Servo Motor and test it.

If the error does not persist after the replacement of Servo Motor, Servo Motor is faulty. Please replace the Servo Motor with new one. Below diagram describes the locations of each axis's motor (HS165 Robot). For other Robot, please refer to the Robot's maintenance manual to replace it.

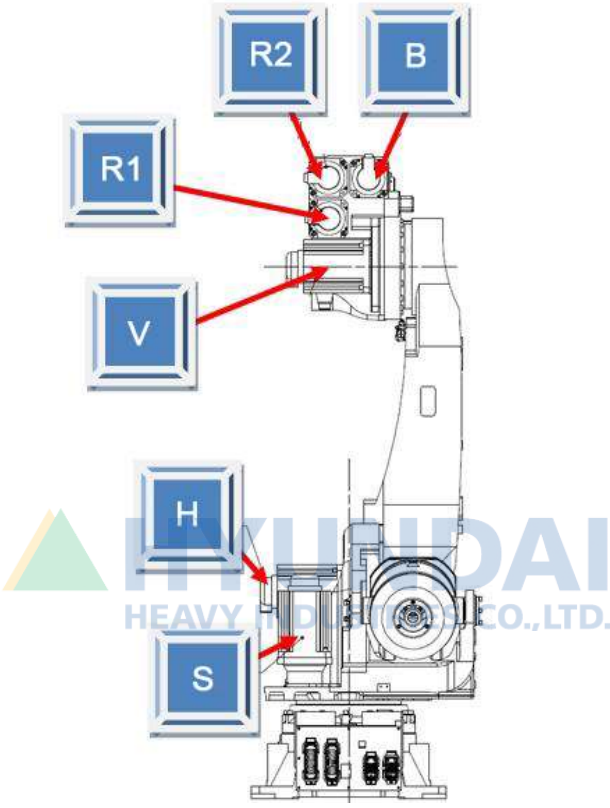


Figure 6.116 HS165 Locations of Each Axis's Motor (HS165 Robot).

(4) Please examine the wiring.

Encoder's wiring examination orders are as below.

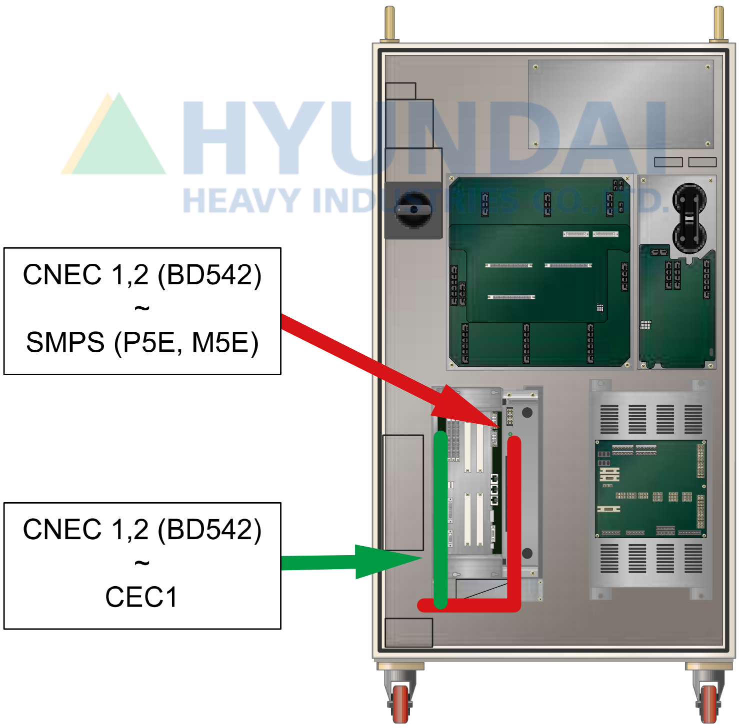
Firstly, examine the loose contact of the connectors that are related to the Encoder's wiring.

Secondly, examine the short-circuit of encoder's wiring. Please use equipment such as the multi meter (tester) and examine each phase's wiring one by one.

Thirdly, replace the encoder's wiring and test it.

If the encoder's wiring has not been disconnected and if the error caused by certain problems (loose contact of shield line, contact between the encoder's signal line and other electric power line, or a contact with the metal part of Robot's main frame) it cannot be detected by short-circuit test. So please replace the wiring and test it.

- Please examine the internal wiring of the Controller
  Please examine the wiring between the CNEC1,2 (DB542) connector and the SMPS (P5E,M5E).
  Please examine the wiring between the CNEC1,2 (BD542) connector and the CEC1.



- Please examine the wiring between the Controller and the Robot.
  Please examine the wiring between the CNEC1 and the CER1.

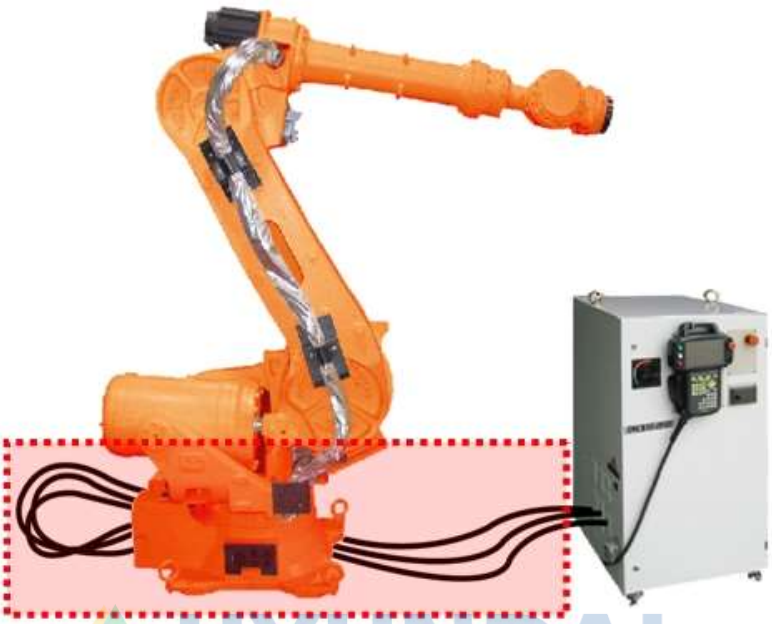


Figure 6.117 Basic Installation Diagram of the Robot and Control Period

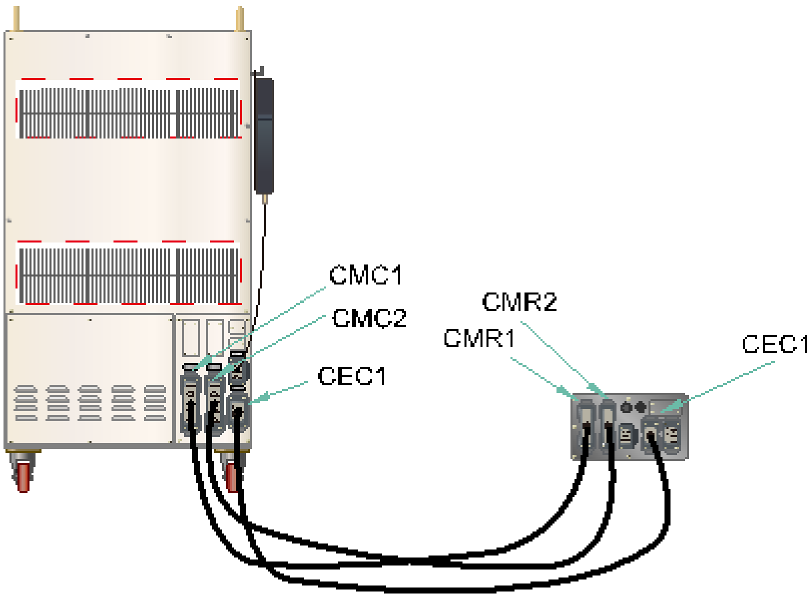


Figure 6.118 Connection Between the Robot's Mainframe and the Controller

- Please examine the wiring of the mainframe.
  Please examine the wring between the CER1 and CNE1~6 (Encoder side's connector).
  Please refer to the wiring diagram of Robot's maintenance manual.

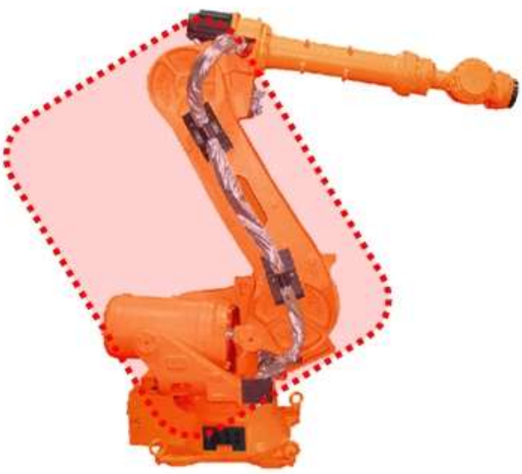


Figure 6.119 Robot's Internal Wiring

(5) Please examine the communication status of wiring after the repair.

Once actions for the problem are taken, please refer to 『Count of encoder communication failure display function manual』 to check the communication status.

Count of communication failure	Encoder's status	Content
0~2	Normal	Normal status
3~5	Examine required	Wiring, encoder or the board need to be examined
6~8	Warning	Dangerous status. Robot may be immobilized

6.1.24. E0224 (Axis o) Encoder condition error

6.1.24.1. Outline

Servo Board receives data from the encoder periodically through a serial communication in order to perform a Servo control on the motor. This error occurs when the data that received from the encoder is normal, but the result of encoder's self status check shows an error.

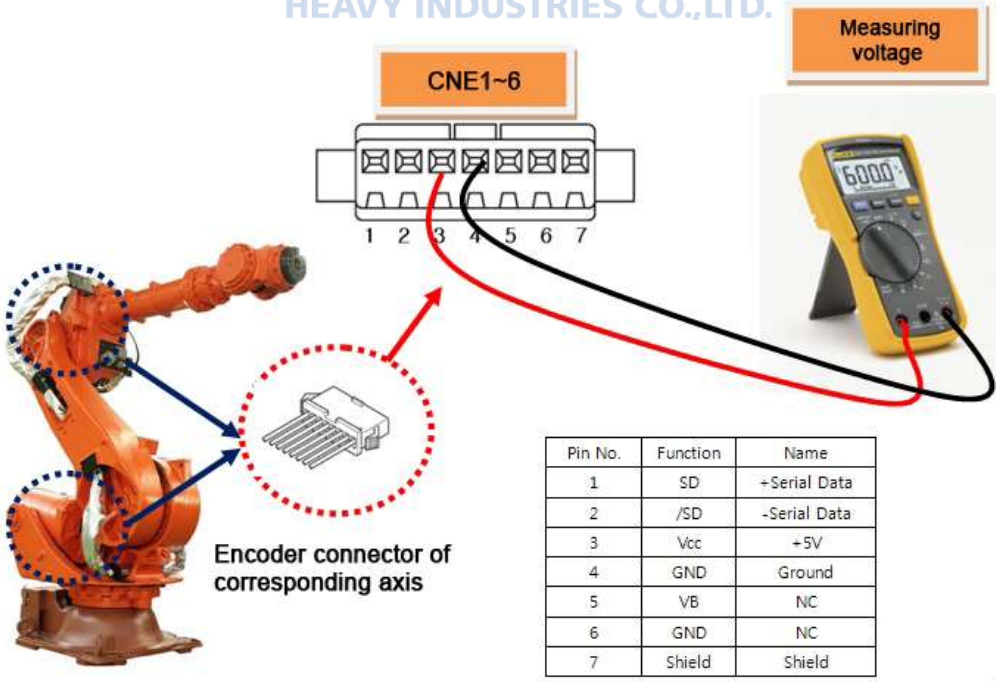
6.1.24.2. Causes and examine methods

(1) Please check the supply voltage to the Encoder. (2) Please replace the Motor and test it.

(1) Please check the supply voltage to the Encoder.

Power supply voltage to the encoder must be in a range of 5V±5% (4.75V ~ 5.25V) - (encoder side connector's supply voltage). If the voltage is reduced below 4.75V, encoder may not operate normally and it will cause this error.

Please measure the voltage of encoder side's connector-pin (3-4).



Pin No.	Function	Name
1	SD	+Serial Data
2	/SD	-Serial Data
3	Vcc	+5V
4	GND	Ground
5	VB	NC
6	GND	NC
7	Shield	Shield

If the measured voltage is below the standard voltage, please adjust the +5V ADJ (E) voltage control terminal (socket) in the encoder's power supply unit, so that the encoder side's connector voltage can be adjusted according to the standard.

(2) Replacement of Servo Motor and examine it

If the error does not persist after the replacement of Servo Motor, Servo Motor is faulty. Please replace the Servo Motor with new one. Below diagram describes the locations of each axis's motor (HS165 Robot). For other Robot, please refer to the Robot's maintenance manual to replace it.

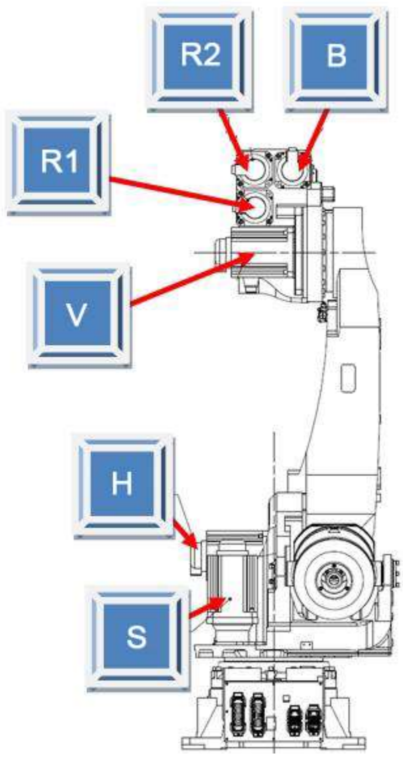


Figure 6.120 Locations of Each Axis's Motor (HS165 Robot)

6.1.25. Instructions in examining the Controller’s input voltage (Single-phase)

(1) Please check the voltage on the rating plate and the actual input voltage.
Please check if the voltage of controller’s power supply is within the allowed voltage range as described on the rating plate. Allowed range of input voltage is within the 10% of describe value on the rating plate, and it should be over 198V (AC220V standard). Below describes how to measure the input voltage of controller. If the measured voltage is out of the allowed range, please examine the power supply units.

Warning
Please be cautious. Short-circuit between phases or with surrounding components can occur while measuring the high voltage.

- Hi5-C1X Controller: Measuring the Side terminal block’s single-phase terminal (socket)

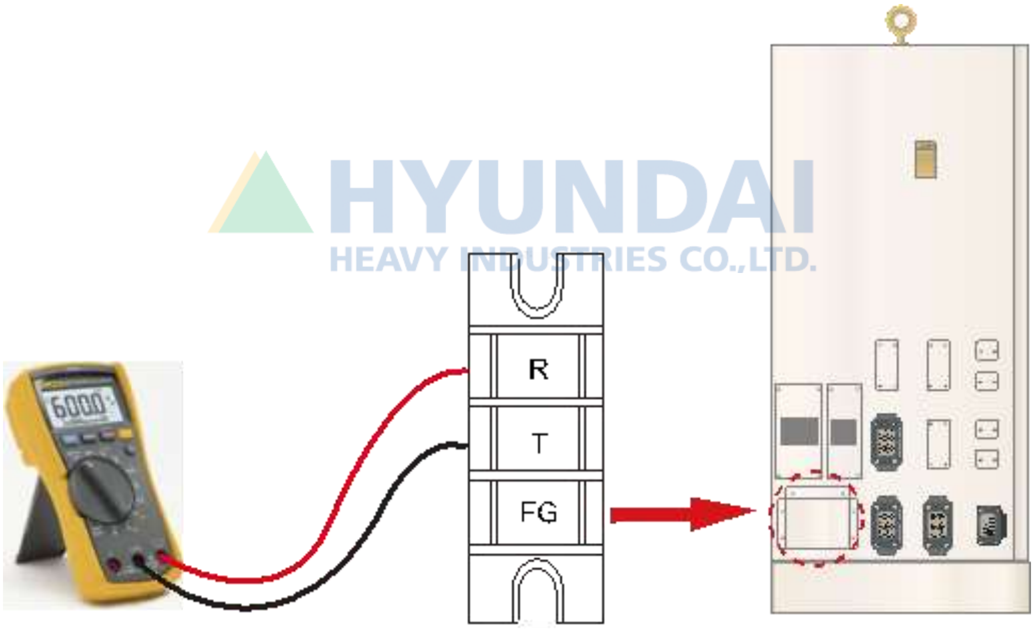


Figure 6.121 Hi-5-C1X Controller’s Single-Phase Power Terminal Block

■ Hi5-C0X Controller: Measuring the Side Terminal Block's Single-Phase Terminal (Socket)

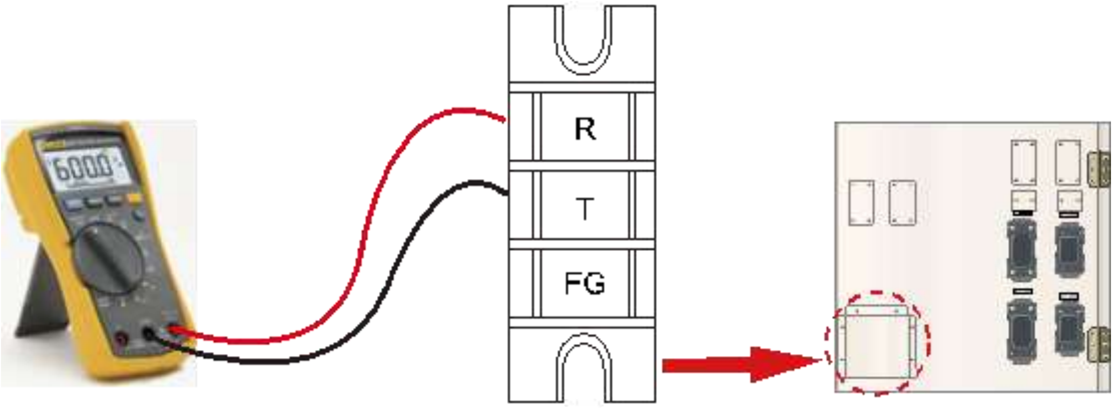


Figure 6.122 Hi-5-C0X Controller's Single-Phase Power Terminal Block

6.1.26. Instructions in examining the Controller’s input voltage (3-phase)

(1) Please check the voltage on the rating plate and the actual input voltage.

Please check if the voltage of controller’s power supply is within the allowed voltage range as described on the rating plate. Allowed range of input voltage is within the 10% of describe value on the rating plate, and it should be over 198V (AC220V standard). Below describes how to measure the input voltage of controller. If the measured voltage is out of the allowed range, please examine the power supply units.

- Hi5-N Controller: Measuring the power line of front switch

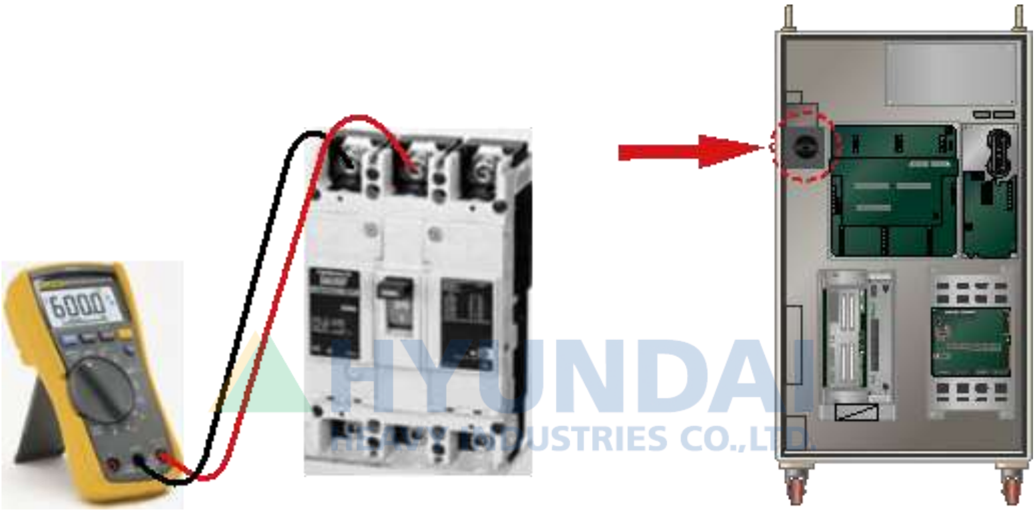


Figure 6.123 Location of Hi5-N Controller’s Power Switch

Warning
Please be cautious. Short-circuit between phases or with surrounding components can occur while measuring the high voltage.

1) Hi5-C1X Controller: Measuring the Side terminal block’s 3-phsae terminal (socket)

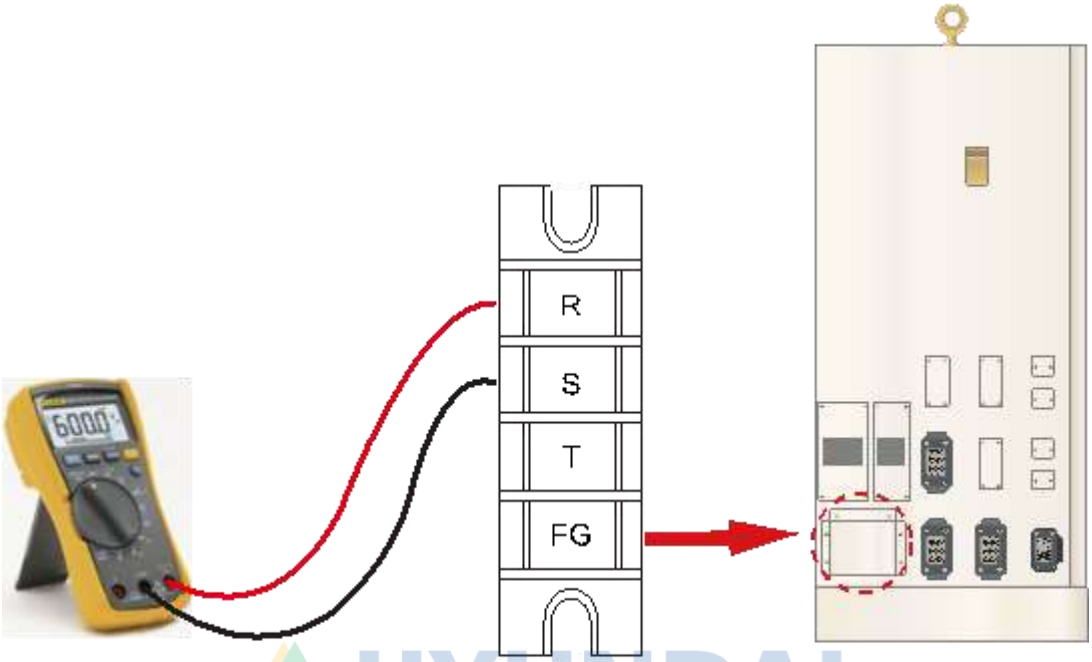


Figure 6.124 Hi-5-C1X Controller’s 3-Phase Power Terminal Block

2) Hi5-C0X Controller: Measuring the Side terminal block’s 3-phase terminal (socket)

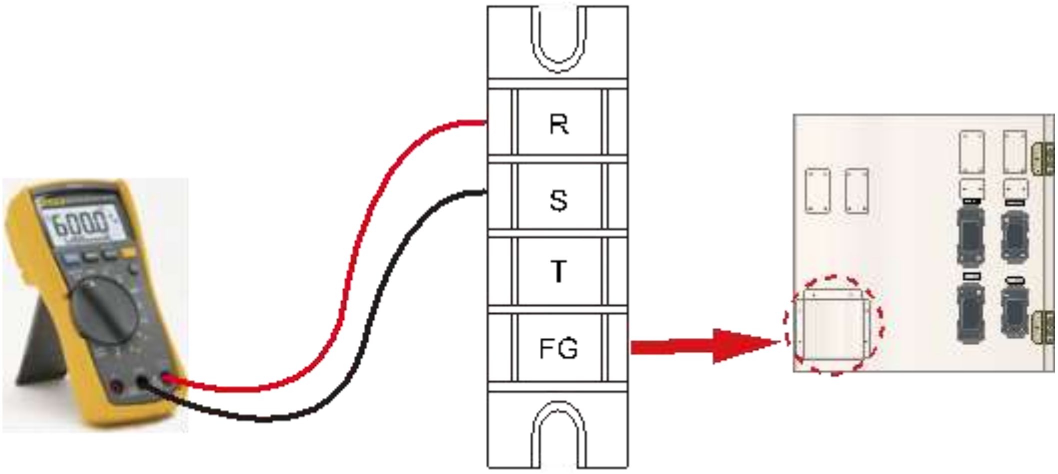


Figure 6.125Hi-5-C0X Controller’s 3-Phase Power Terminal Block

6.1.27. Instructions in examining the Controller's internal voltage (3-phase)

(1) Please check the Controller's internal 3-phase power voltage.

Electrical Module (PDM) that attached at the front of controller is in charge of the distribution and replay of each power supplies, and the 3-phase power supply will be turned on/off by a Magnet switch in the Electrical Module. Please examine if the input voltage to the Electrical Module is within the 10% error range of AC220V standard. If the measured voltage is out of the allowed range, please examine as below.

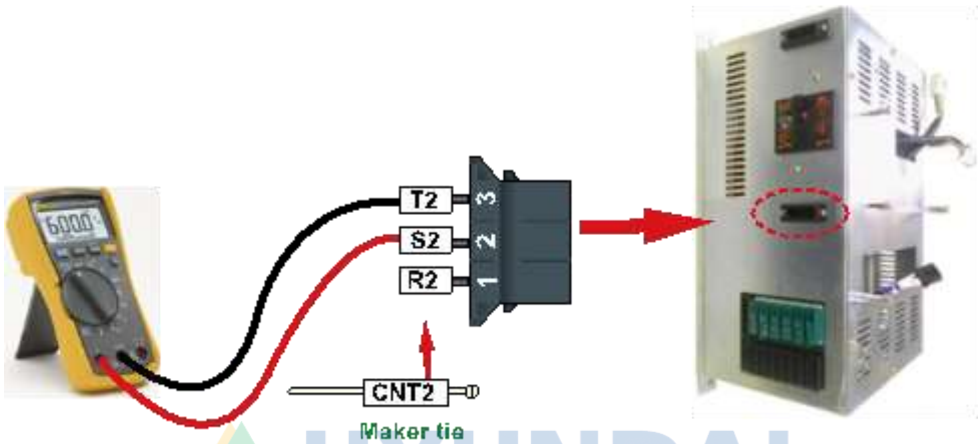


Figure 6.126 3-Phase Power Input to the Electrical Module

Warning

Please be cautious. Short-circuit between phases or with surrounding components can occur while measuring the high voltage.

1) If the input voltage to the controller is AC220V
   If the input voltage to the controller is AC220V, input voltage from external to the power switch or terminal block must be same as the measured voltage from the internal Electrical Module. If there is a difference, please examine the 3-phase power supply wiring.

2) If the input voltage to the controller is not AC220V
   If the input voltage specification to the controller is not AC220V, please use the internally installed transformer to convert the 3-phase voltage into AC220V and it will be connected to the Electrical Module. Please examine if the voltage of the Electrical Module is within the 10% error range of AC220V standard. Also examine if the voltage is maintaining.
   If the measured voltage is out of allowed range, please examine the input of internally installed transformer and the connection status of output terminal (socket). Primary column of the internally installed transformer must be connected with the voltage as it is displayed on a rating panel. Secondary column of the transformer must be set to AC3-phase 220V at all time. If the output from the output terminal (socket) is not AC 3-phase 220V even when the input and output terminals (socket) are connected properly, the transformer is faulty. At this stage the output voltage of transformer's error rate must be within 5 %.

6.2. Instructions in Parts Replacement

This instruction shows how to replace the parts and boards during troubleshooting.

6.2.1. Instructions in Substrate Replacement

Pay attention to the followings during boards replacement.

① Be sure to turn power off before working.

② Keep your hands clean to prevent boards from being stained with oils or water. If you need to grasp the board, please hold around the board. Be sure not to touch the contacting surface of electric parts or pattern, and especially connector.

③ Align the electric potential between the body(hand) of the user and the controller.

④ Each board has a number of connectors. Be sure to insert completely to prevent false inserting, omission, or looseness when replacing. Match the printed names on the nameplate of connector and on the one of boards.

Separation of Boards

Please take the followings actions before taking out main board.

① If you intend to replace main board, you need to back up the necessary program/constant data by using HR-VIEW S/W or SRAM CARD of (Notebook) PC before replacement.

② Since the teaching-program / constant data is stored in SRAM of BD510 board, the previous program / constant data you want is not existed after replacement. After replacement, load the backup contents to the new board before using.

③ Program/constant data remains in SRAM by the battery for backup even when power is removed.

④ Besides, in case that connectors of battery for backup is separated by mistake or by board replacement, capacitor for backup maintains program / constant data up to 1 hour. The battery for backup must be connected to keep the board for long period of time because program/constant data may be deleted afterwards.

Please be aware of the above cautions, and make a replacement of board following the below instructions.

① First, remove input power from power unit.

② Loosen slightly the screw upholding the supporting stand which is above and below of Rack, move the supporting stand to the left, and pull it out.

③ Take all the connectors out of board. Here, for the connector connected by screws, loosen them by using a suitable screwdriver. And be careful of excessive force to connector.

④ Pull out the Ejector mounted on the upper and lower front side of board, and the board will be taken out along the guide rail of Rack.

Insert of Board

① First, turn off the input power of power unit.

② Push inward the Ejector mounted on the upper and lower front side of board along the guide rail of Rack. Here, push it hard until you feel that the connector is inserted into backplane board which is located in the back side of Rack.

③ Connect all the connectors of the board. Here, for the connector connected by screws, tighten it again by using a suitable screwdriver.

④ Move the supporting stand to the right, hooking up to the screw on the upper and lower part of Rack, and then tighten the screw.

Pay attention to the followings after inserting main board.

Make a copy of the program / constant data which is copied prior to the replacement of main in main board memory by using (Notebook) PC or SRAM CARD. And make sure that the battery connector for backup is connected.
If the battery connector is not connected, it is safe while controller power is ON. However, if power is OFF for more than 1 hour, program / constant data will be all deleted.

6.2.2. Instructions in Servo AMP Replacement

Pay attention to the followings during servo AMP replacement.

Check the nameplate in the front side of panel in case that it would not have compatibility with other types of servo AMP.

Separation of Servo AMP

① First, turn off the input power of power unit.
② Loosen the fixed bolt in servo AMP protection cover to take off.
③ Take off wires tightened to terminal block with screws.
④ Take off all the connected connectors.
⑤ Take off the screws tightening the servo AMP.
⑥ Take out the servo AMP.
Be careful when taking out the servo AMP because it is very heavy. And make sure not to damage wires around it.

Connection of Servo AMP

① First, turn off input power of power unit.
② Lift the servo AMP carefully and push it in.
Be careful when pushing in the servo AMP because it is very heavy. And make sure not to damage wires around it.
③ Screw on the servo AMP.
④ Screw on the wires to terminal block.
⑤ Connect all the connectors.
⑥ Tighten the servo AMP protection cover with bolts.

6.2.3. Instructions in Battery Replacement

This controller is a backup battery for SRAM, and uses 3.6V Lithium battery.
Replace the battery every 2 years on a regular basis.
To prevent a damage of SRAM data, back up SRAM data first by using HRVIEW or SRAM CARD.
When replacing the battery, it can be done with the primary power is ON.

① Prepare a new Lithium battery.

② Disconnect the primary power of controller.

③ Replace Lithium battery with a new one.

④ Supply the primary power to controller.

[Warning]

① Do not litter the spent battery.

② Dispose of the spent battery as an industrial waste under the relevant regulations or rules.

③ Do not recharge the used-up battery. It involves a danger of explosion.

④ Use the specified battery only.

⑤ Do not make a short circuit of positive and negative poles.

⑥ Do not burn the spent battery, nor leave it in a high temperature.

6.2.4. Instructions in SMPS Replacement

This SMPS is a complex power unit which is used as a primary control power. Pay close attention to this sophisticated device.

Separation of SMPS

① First, turn off input power of power unit.

② Unscrew the terminal stand of SMPS to take off the attached wires.

③ Loosen 4 screws tightened to the board Rack.

④ Insert your index finger into the hole in upper and lower side of SMPS, and pull it out. Then SMPS will be taken out of the Rack. Here, if pulling too hard, you may involve an injury, so be careful. And make sure not to damage the wires around it.

Connection of SMPS

① First, turn off input power of power unit.

② Grasp the SMPS with the right hand and push it into the first guide rail of Rack, while clearing the surrounding wires away. Here, make sure not to damage the wires around it.

③ Screw it to the Rack.

④ Screw on the wires to terminal stand.

6.3. Instructions in Adjustment

This controller does not require extra adjustment because it has been fully adjusted when delivered from warehouse. However, in case of parts replacement, an adjustment may be needed to some extent. This instruction shows how to adjust and where to adjust. Do not make an adjustment, except that it is needed, unless the cause of trouble is confirmed.

6.3.1. Adjustment of Power System

In case of power system errors or power change, take a measurement of each power voltage, and adjust any voltage below the standard (use a digital voltmeter for measurement).

Table 6-6 Power Standard

Power	Measuring Location	Standard	Adjustment
Primary Power	CB1 input terminal	**AC220V ± 10%**	Define the primary tab of transformer TR1 as AC220V
R6,S6,T6	Servo AMP R, S, T	**AC220V ± 10%**	Check the input voltage of CB1 - AC220V
B2-C2	TB1 B2-C2	**AC220V ± 10%**	Secondary Tab turnover of transformer TR1
P1-M1	SR1 +24V-G2	**DC24V ± 2.0V**	(Note 1)
P5-M0	SR1 +5V-G1	**DC5.1V ± 0.1V**	Volume resistance in SR1
P15-M0	SR1 +15V-G1	**DC15V ± 0.5V**	(Note 1)
N15-M0	SR1 -15V-G1	**DC-15V ± 0.5V**	(Note 1)
P5E-M5E	SR1 +5V-GND	**DC5.4V ± 0.1V**	Volume resistance in SR1 (Note 2)
	Terminal block for Robot external wiring Connectors Pin P5E-M5E	**DC5.1V ± 0.1V**	Volume resistance in SR1 (Note 2)

(Note 1) Replace the SR1 if it is not within the standard.
(Note 2) First, check the standard in the measuring location, and then make a measurement in the nearest terminal stand from robot encoder and between connector Pins. Here, the standard must be DC5.1V±0.1V.

6.3.2. Transformer (TR1)

AC 220V 3-phase must be used for primary power of transformer (TR1).
Do not adjust the secondary terminal because it is connected to power suitable for the internal parts specifications.

AC 220V 3-phase must be used for input power of this controller.
Tab must not be changed without permission of our staff because this controller has been completed in adjusting when delivered from warehouse.

7

Regular inspection

Regular inspection of controller is to minimize robot failures, and to maintain its efficiency. Instructions and working details for regular inspection are explained here.

7.1. Inspection Schedule

The check is conducted basically according to following review. Regular inspection is to prevent robot failures, and to secure and maintain its stability even for a long employment of robot and controller. Regular inspection is a requisite for the use of robot, and even for a normal condition.

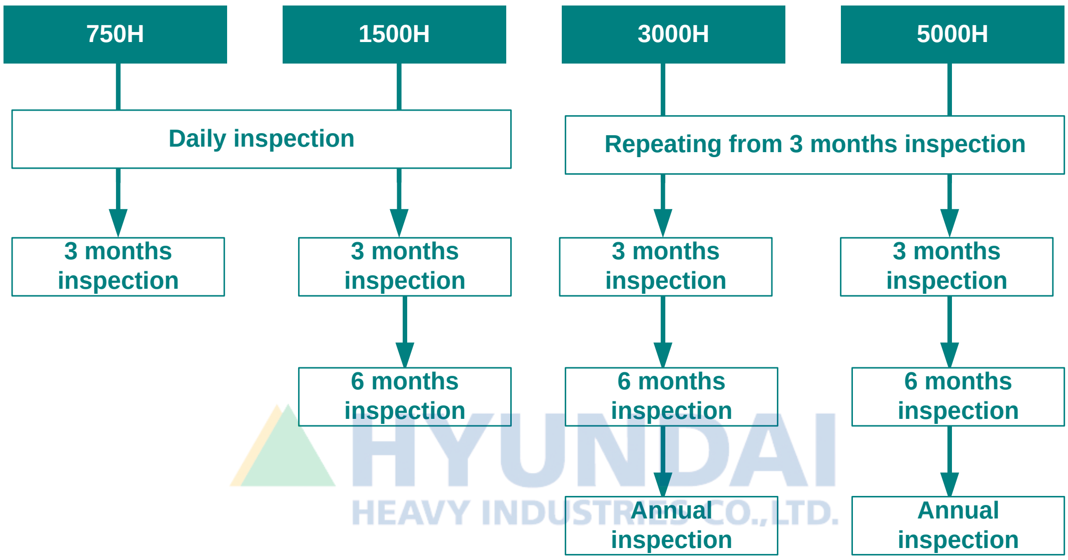


Figure 7.1 Inspection Schedule

7.2. General Instructions for Regular Inspection

① Inspection working should be performed by a personnel who completed our training course in robot school.
② Check the necessary parts & tools, and drawings before inspection work.
③ Be sure to use special replacement parts specified by our company.
④ Be sure to turn power OFF when inspecting robot manipulator.
⑤ Turn primary power OFF when working with controller door open. Prevent dust or other things from entering the working area.
⑥ Pay close attention to IC breaking by static electricity if you need to touch the parts of controller. (Beware of it when touching a connector)
⑦ Be sure to forbid anyone to enter robot's working envelope when performing an inspection with robot manipulator operated.
⑧ Perform a voltage measurement in a specified place, and be careful of electric shock and short circuit.
⑨ Do not inspect robot and controller at the same time.
⑩ Be sure to perform a test operation after inspection to check robot's movement before normal operation.

7.3. Daily Inspection

Table 7-1 Daily Inspection

No.	Inspection Part	Inspection Details	Remarks
1	Controller	Is display lamp working (normal)?	Check with the naked eye
2	Robot Manipulator	Is door completely closed?	Check with the naked eye
		Are there any errors in Teach Pendant screen?	Check with the naked eye
		Is there a noise during operation?	Listen out
		Is a tip joint unscrewed?	Fasten
		Are there any scratch, stain, and damage in a wiring and Wire harness of manipulator?	Check with the naked eye
		Are there any other impediments such as dust soil causing damage to manipulator?	Check with the naked eye & clean
3	Others	Are there any obstacles around controller and robot manipulator?	Check with the naked eye

7.4. First Inspection (750 hours inspection)

Table 7-2 First Inspection

No.	Inspection Part	Inspection Details	Remarks
1	External, major screws	Unscrewed	Fasten
2	Manipulator wiring connector & Wire harness	Loose connector	Fasten
3	Dog & limit switch screws	Unscrewed	Fasten

7.5. Daily Inspection

Table 7-3 Daily Inspection

No.	Cycle (months)			Inspection Part	Inspection Details	Remarks
	3	6	12			
1		◎	◎	Packing of door	· Transformed & torn part	
2	◎	◎	◎	Back side	· Dust & rotation in cooling fan wings of heat exchanger	
					· Damage & dust in regenerative discharge resistance	
					· Check a heating of Transformer Room by touch, and clean the room.	
					· Looseness and damage of terminal blocks (TB1, TBAC1)	
3	◎	◎	◎	Wire harness	· Loose & damaged connector	
4		◎	◎	Drive Unit	· Loose & damaged connector	
5		◎	◎	Connectors of each board	· Check a loose connector by touch	
6	◎	◎	◎	Operating panel	· Check Button switch & LED	
7		◎	◎	Overall Controller	· Dust cleaning	
8	◎	◎	◎	Nameplate	· Inspect all kinds of nameplates	
9		◎	◎	Voltage measurement	· Primary power voltage	Refer to "6.3.1 Adjustment of Power System"
					· C2, B2	
					· SMPS (HDI-200)	
					· BKSMPS (CP SNT 250W): Brake power	
10		◎	◎	Grounding	· Check a loose & removed terminal	
11		◎	◎	Battery	· Voltage inspection & regular replacement	Main LED
12	◎	◎	◎	Teach Pendant	· Exterior inspection, and damage & joint part of connector checking	
					· Check LCD Display	
					· Check LED Display	
					· Check the status of LED and button switch	

No.	Cycle (months)			Inspection Part	Inspection Details	Remarks
	3	6	12			
13	◎	◎	◎	Safety related parts	· Check emergency stop switching (operating panel, teach pendant)	
	◎	◎	◎		· Check primary power disconnecting switch (NFB1)	
	◎	◎	◎		· Check enabling device of teach pendant	
	◎	◎	◎		· Check circuit protector (CP1)	
	◎	◎	◎		· Check magnet connector (MC1, MC2)	
14	◎	◎	◎	Safety related PCB	· Check for BD530 board (connector, exterior relay of board)	

7.6. Inspection for Long-Term Idleness

In case of long-term idleness, inspect the followings before turning off power.

(1) Check if LED for battery discharge detection is normal in main board. If there is an error in battery, LED is turned OFF. In this case, replace it with a rated battery. If turning off a primary power with errors in battery, all program/constant data in a board will be deleted after about 7 days. Thus be sure to back up the program data by using HRView, etc.

(2) Check if controller door is completely closed.

7.7. Parts List for Maintenance

It explains the characteristics of parts.

Maintenance Parts A

Major maintenance parts to prepare in daily inspection.

To maintain a normal operation, parts A-2 and A-3 is a minimum of essential parts, and prepare more than 1 set of these parts.

Table 7-4 Maintenance Parts Inspection A

Type	Details	Remarks
Maintenance Parts A-1	Standard accessory parts to prepare	
Maintenance Parts A-2	Major backup parts	
Maintenance Parts A-3	Regular replacement parts	

Table 7-5 Maintenance Parts A-1 (Standard accessory parts to prepare)

No.	Product Name	Type	Maker	Quantity (EA)	Remarks
1	Fuse (F1,F2)	GP50	Daito	2	250V, 5A
2	Fuse (F3,F4)	GP100	Daito	2	250V, 10A
3	Fuse (F5,F6)	GP50	Daito	2	250V, 5A
4	Fuse (Servo AMP)	GP20	Daito	2	250V, 2A

Table 7-6 Maintenance Parts A-2 (Major Backup Parts)

No.	Product Name	Type	Maker	Quantity (EA)	Remarks
1	Servo AMP	Middle size / Small size	HHI	1	
2	Complex Power Unit	HDI-200	HHI	1	SMPS
3	Teach Pendant	TP510	HHI	1	
4	Electronic module	PDM30/PDM15	HHI	1	
5	Board	BD501	HHI	1	Back plain board
		BD510	HHI	1	Main board
		BD542	HHI	2	Servo board
		BD530/531	HHI	1	System board

Table 7-7 Maintenance Parts A-3 (Regular Replacement Parts)

No.	Product Name	Type	Maker	Quantity (EA)	Remarks
1	Battery (3.6V AA size)	ER6C	Hitachi Maxwell (JAPAN)	1	Replacement required every 2 years

Maintenance Parts B

To many maintain a normal operation parts.

Table 7-8 Maintenance Parts Inspection B

Type	Details	Remarks (reference)
Maintenance Parts B-1	Parts to purchase from HHI, Ltd.	
Maintenance Parts B-2	Purchasable Parts from Maker	

Table 7-9 Maintenance Parts B-1 (Parts to purchase from HHI (Co., Ltd.))

No.	Product Name	Type	Maker	Quantity (EA)	Remarks
1	Wire harness	CMC1	HHI (Co., Ltd.)	1	Controller ⇔ Robot Manipulator
		CMC2	HHI (Co., Ltd.)	1	
		CEC1	HHI (Co., Ltd.)	1	

Table 7-10 Maintenance Parts B-2 (Purchasable Parts from Maker)

No.	Product Name	Type	Maker	Quantity (EA)	Remarks
1	Circuit Breaker for wiring (NFB)	-	-	1	
2	Magnetic Contactor (MC1, MC2)	-	-	2	
3	Circuit Protector (CP1)	-	-	1	

Caution: Pay attention to the followings for maintenance because high-performance parts are mounted on board.

Storage Temperature 0℃ ~ +45℃

To store for a long period of time and maintain high-reliability, keep temperature ranged 25±10℃ and avoid sudden change of temperature (±10℃/time).

Storage Humidity 20% ~ 80%

To store for a long period of time and maintain high-reliability, keep humidity ranged 45%~65%, and in particular, be careful of dew condensation.

Electric Shock Prevention

If extremes are kept dry, static electricity is likely to be charged. Here, semiconductor is likely to be ruined when the charged static electricity is discharged. Thus, when keeping the board separately, use an antistatic treated packing materials.

Others

Please keep at the place where noxious gas, dust and load do not exist.

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