

5-Axis Arm Robot Trainer
ED-7255

Part 1

Introduction to Product

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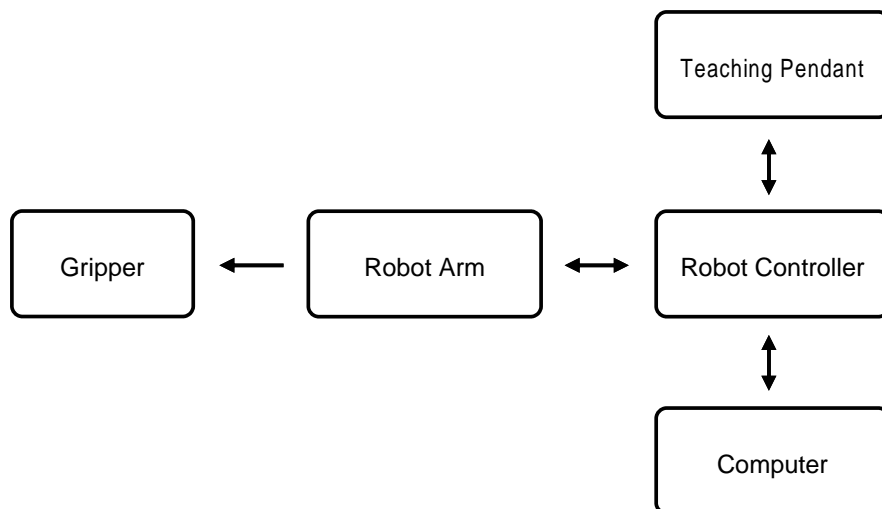
1. Introduction to Product

1-1. Overview

A robot system used for the factory automation in industrial fields is generally composed of Mechanical Arm, Computer-Based Simulator, Robot Controller, End-of-Arm Tooling or Gripper, and Teaching Pendant.

This product is a robot for educational use made for experiment and practice of a vertical articulated (multi-joint) robot, which is widely used in the industrial sites. This education-dedicated vertical articulated robot is constructed as in [Fig. 1-1], which comprises all of the components of industrial robots.

This product includes Robot Arm, Robot Controller, Gripper, Teaching Pendant, and Program Editing Software. For direct control of a vertical articulated robot, a user may use a teaching pendant and a simulator(ED-IRS). The control program used is based on the form of a script language, which restricts the target product to our company's. Employing this, a robot can be programmed within the moving range of its arm, so that it may be freely controlled and operate repetitively.



[Figure 1-1] Constitution of Vertical Articulated Robot System

1-2. Features

- Vertical articulated robot with 5 axes and 1 gripper
- Power transfer conditions and mechanical operation can be observed by applying an open-type mechanism

- Simulator for writing a control program based on the industrial language which is easy to learn
- Functions of writing, executing, and debugging a control program by using a robot simulator
- Simulation of a robot control program using a 3D graphic simulator
- Synchronization of a simulator and a robot, and real-time interlock of them
- a motion controller is mounted, to which the motion control approach used in industrial fields is applied.
- Real-time control with regard to each axis is possible, because the high performance embedded CPU is applied
- Remote control function available because of application of an Ethernet interface
- Two kinds of grippers are supplied, which may grip the 80mm-wide objects
- Motion can be done without the home searching owing to the absolute-type position sensor employed on each axis
- Function of emergency stop is provided to the robot controller and teaching pendant
- Over-load on a motor can be prevented by means of over-current sensing at each axis
- PID gain tuning and real time control for each axis
- Extendable 2-axis and digital/analog input/output ports supplied
- Safety devices for a robot system (an emergency switch, short-circuit protection, and overheating detection)

1-3. Cautions

- 1) Before using this equipment, read this manual and be sure to check the operation procedures.
- 2) Be sure to check the power for controller input at the rear of a robot controller and the power supplied by a user before making connection of them.
- 3) When connecting a robot arm to a motor cable and an encoder cable of a robot controller, be sure to shut down the power for the robot controller.
- 4) Before powering on the equipment, check whether there are mechanical interferences or the foreign substances are jammed in gears. If there is any

foreign substance, remove it.

- 5) Remove the objects located within the moving radius of a robot.
- 6) Do not operate the robot arm with a black cap, mounted on each joint of the robot arm, opened.
- 7) Setting a hard home of the robot arm shall be supported by our company.
- 8) Avoid using this equipment in a humid place.

1-4. Checking Constituents

Please confirm that the following constituents are all included in the package when you unpack the product.

- 1) Robot Arm
- 2) Robot Controller
- 3) Teaching Pendant
- 4) Install CD(ED-IRS)
- 5) Ethernet Cable(Cross Cable)
- 6) Serial(RS-232) Cable
- 7) 15 Pin Encode Cable
- 8) 25 Pin Motor Cable
- 9) Storage Vinyl Bag
- 10) 220V Power Cord
- 11) User Manual

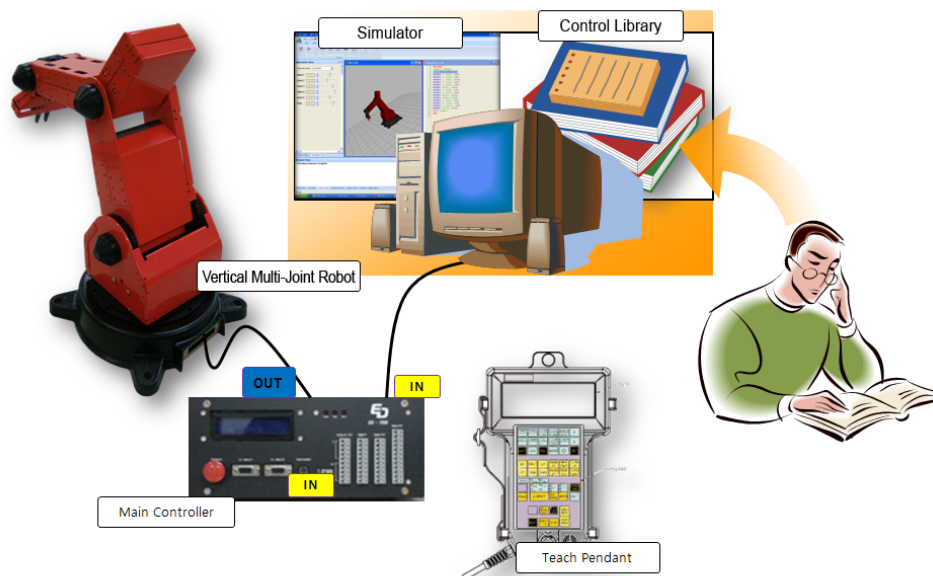
※ To install ED-IRS(ED-Industrial Robot Simulator) in a PC, the following system environment is required.

- O. S. : Windows XP or higher
- Memory : 516MB or more
- HDD : 100MB or more

Note

- If there is any missing or damaged one of the above components, please contact ED Corporation.
- Version of the supplied program is subject to change for improvement of performance.

1-5. Constitution and Features of Product



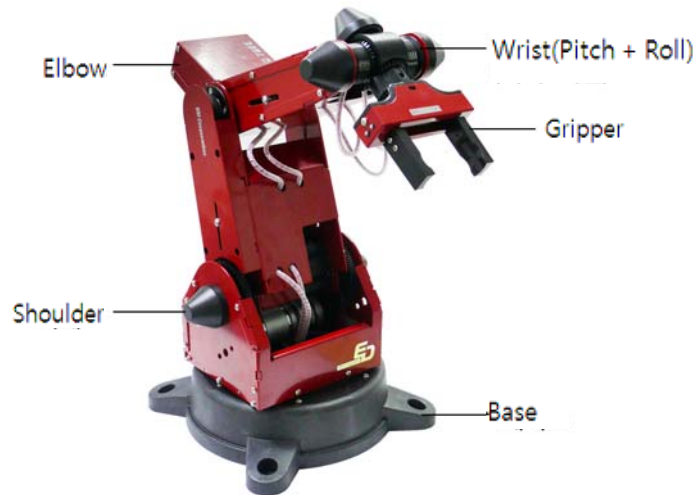
[Figure 1-2] Constituents of Product

1-5-1. Robot Arm

This robot has 5 axes for a base, shoulder, elbow, wrist pitch, and wrist roll, all of which are driven by DC motors. To the wrist, a DC motor-driven gripper is attached. The construction and the name of each part of the robot are represented in [Figure 1-3].

The 6 DC motors respectively have a reduction gear and an encoder which is attached to a real axis. The reduction gear reduces the rotating speed of a motor to

operate a robot arm. The encoder detects the rotating speed of an axis and its rotation direction, as well as the current absolute position during rotation. The encoder used here is an absolute encoder which is designed to sufficiently limit the rotational angle, without any position detecting sensor (such as a limit switch or sensor), by means of the soft limit, and to operate without home searching before it starts operating.



[Figure 1-3] Motor Positions and Names of Robot Arm

Mechanical specifications of a robot arm are listed in [Table 1-1].

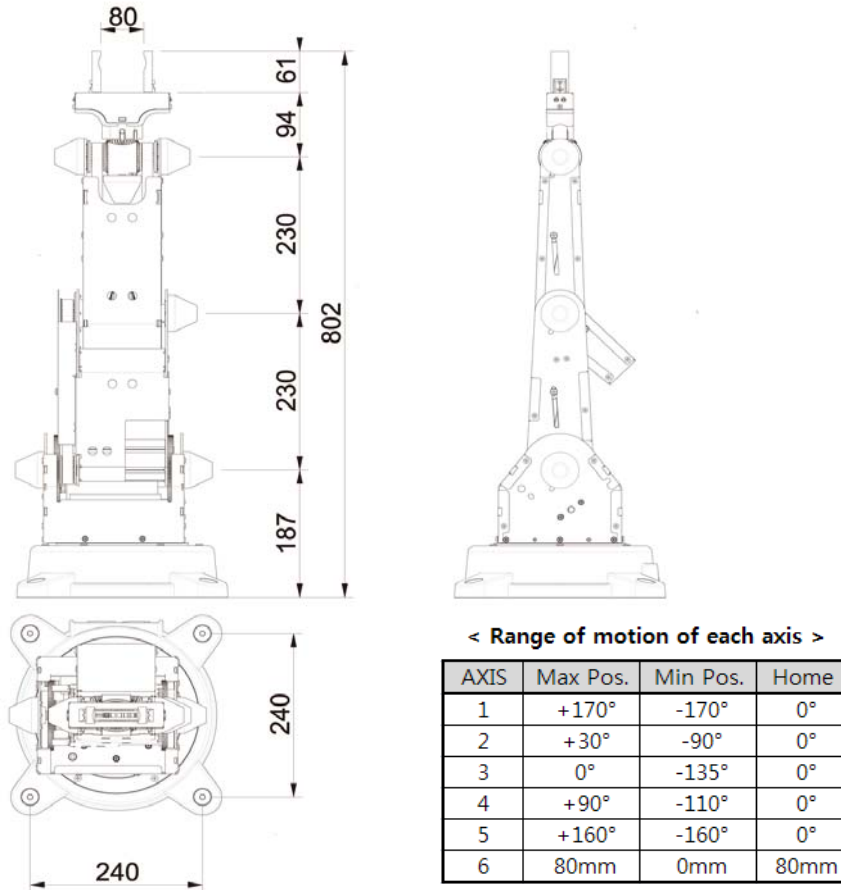
Vertical Articulated Robot Description	
Subject	Description
Construction	Vertical Articulated Arm
Number of Joint	5 Rotational Axis + 1 Gripper
Load Capacity	1.0kg
Motion Maximum Range	Axis1(Base Rotation) : $\pm 170^\circ$ Axis2(Shoulder Rotation) : $-90/+30^\circ$ Axis3(Elbow Rotation) : $0/-135^\circ$ Axis4(Wrist Pitch) : $-110/+90^\circ$ Axis5(Wrist Roll) : $\pm 160^\circ$
Robot Length	max. 802mm
Movement Maximum Speed	750mm/sec
Gripper Opening	80mm
Precision	$\pm 1.0^\circ$
Position detecting type	Absolute encoder
Homing	Absolute encoder Based
Actuator	24V DC Motor
Mass	9.5kg
Operating Temperature	$2^\circ\text{C} - 40^\circ\text{C}$

[Table 1-1] Mechanical Specifications of ED-7255

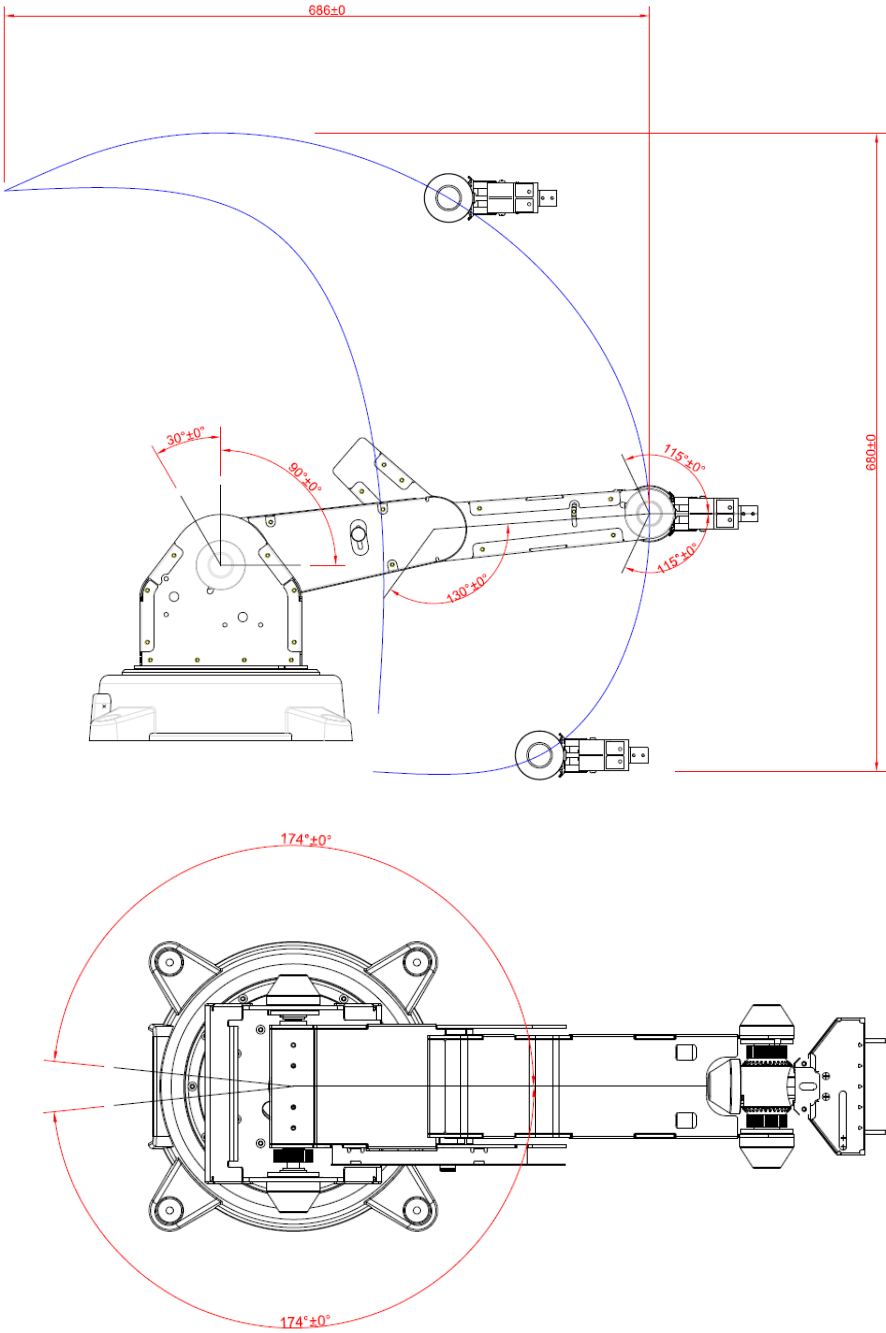
Primary electrical components of a robot arm are as follows.

- DC Motor: 5 axes and fingers can move right and left, up and down according to the rotation direction of DC motors. The rotation direction of a DC motor varies as being supplied positive or negative voltage from a controller. Additionally, each of the 5 axes and the gripper respectively include an absolute encoder therein.
- Encoder : Encoders employed to the 6 motors continuously detect the position of each joint, rotation direction, and rotating speed of a robot arm.
- Cable : Control Box and ED-7255 are connected with a DC motor parallel cable and an encoder parallel cable. Teaching Pendant and Control Box are connected with RS-232 cable and PC and Control Box are connected with Ethernet cable.

A mechanical plan view with dimensional measurements of a robot arm is illustrated in [Figure 1-4], and its work space is as in [Figure 1-5].



[Figure 1-4] Plans and Measurements of Vertical Articulated Robot



[Figure 1-5] Work Space of Vertical Articulated Robot

1-5-2. Robot Controller

A robot controller is a component which creates control signals for robot arm operation. As shown in [Figure 1-6] and [Figure 1-7], it is connected to a computer (host), a teaching pendant, and a robot arm. The robot controller employs LED showing the product status, LCD showing the operation status of the product, Emergency Key for emergency stop of a robot arm, Ports for control of external motor, and Analog and Digital I/O ports for interlock with the external devices. For the detailed information on that, refer to the following figures and description.



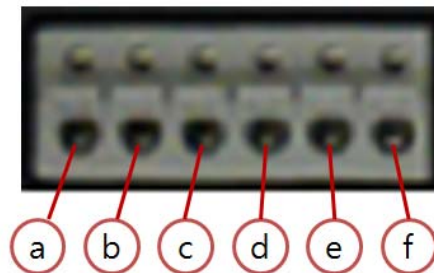
[Figure 1-6] Front View of Robot Controller



[Figure 1-7] Rear View of Robot Controller

- ① Power Switch : Turn on/off a main power source. A state LED lights up after main board booting is completed.
- ② Main Power : As a power supply for a controller, AC 220V or 110V source is used. (Power is forcefully set inside the controller and is supplied.)
- ③ Motor Port : A parallel port for supplying a motor of each joint with power.
- ④ Encoder Port : Values of the encoder of each axis of a robot arm are read through this port.
- ⑤ Ethernet Port : A communication interface which is connected to PC(simulator) and assigns the unique IP in order to download the control program for a robot arm, control the robot arm interlocked with the simulator, and set the system parameters of a robot controller.

- ⑥ JTAG Port : A port for updating the firmware of a motor controller (DSP) inside the controller.
- ⑦ RS232 Port : Connected to PC through a serial cable for serial communication to ARM core in the controller, and is used for a robot control library.
- ⑧ EM Switch : Being pressed, this emergently stops the robot arm.
- ⑨ External input & output terminal board : There are provided 8 ports for respective DIOs(digital input & output) for interlock with peripheral devices, 4 ports for respective analog in-out, 4 ports for SPDT relay, and 2 ports for 12VDC external source.
- ⑩ LCD : The status and the current operation state of a robot is displayed on LCD window.
- ⑪ Pendant Connector : Connected to a cable of a teaching pendant to deliver the pendant commands to a controller by means of a serial communication.
- ⑫ Extra Motor Ports: There are provided two ports for an extra motor control output signal and an encoder input signal for control of motors of peripheral devices.



[Figure 1-8] Extra Motor Port

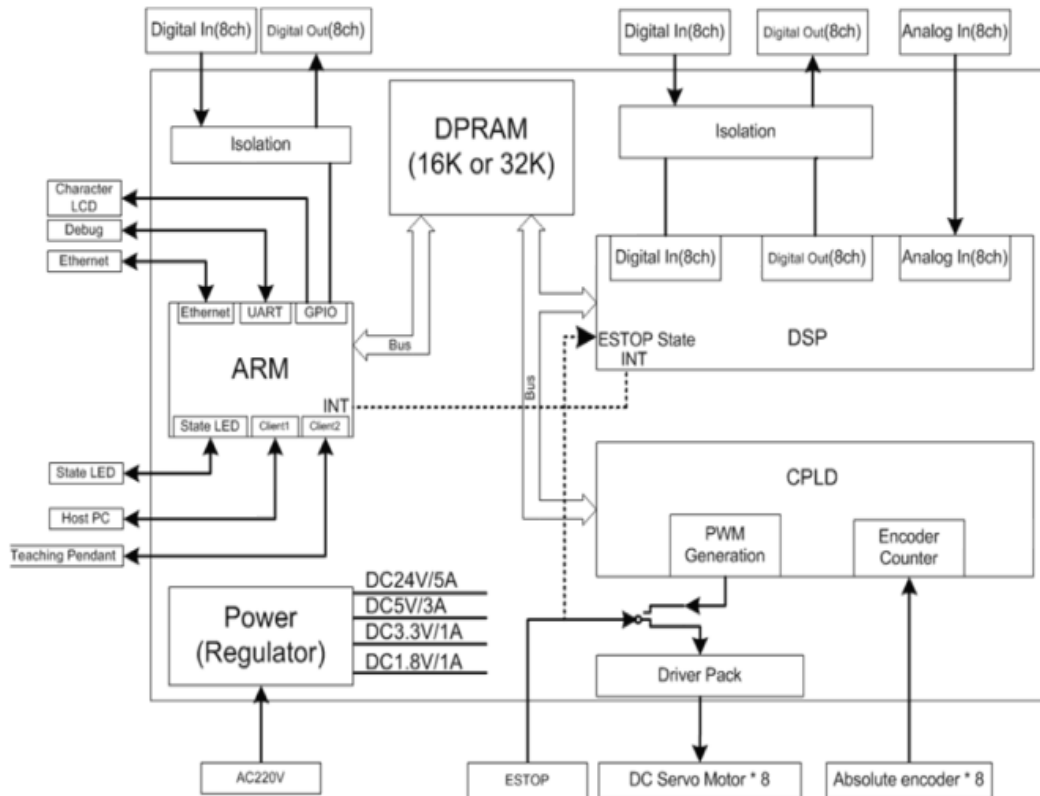
- ① Pin No.1 : Negative(-) of extra motor
- ② Pin No.2 : Positive(+) of extra motor
- ③ Pin No.3 : Ground of extra motor
- ④ Pin No.4 : Supply voltage(5V) of extra motor
- ⑤ Pin No.5 : B Phase of extra motor
- ⑥ Pin No.6 : A Phase of extra motor

Robot controller's specifications of this product is as follows.

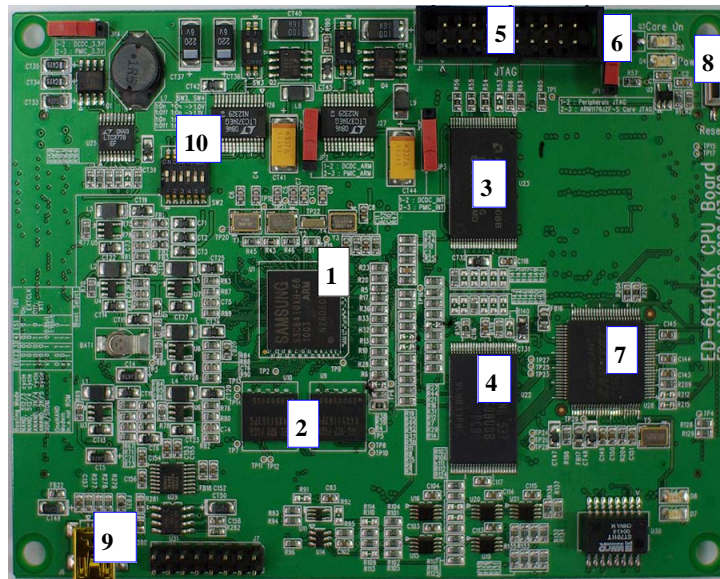
Robot Controller Description	
Subject	Description
Control type	Real-Time, PID, PWM
Number of control axes	6-Axis + 2-Axis(Peripherals)
Path control type	Joint, Linear
Power source	110/220 VAC, 50/60Hz, 160W max.
Communication	Ethernet
External input	8 Digital Inputs : 24V 4 Analog Inputs : 0-12V(8 Bit Resolution)
External output	8 Digital Outputs : 24V / 20mA 4 Relays : SPDT/250VAC-2A/30V-2A 4 Analog Outputs : 0-12V(8 Bit Resolution) / 10mA
External source	+12VDC Power

[Table 1-2] Controller specifications of ED-7255

A robot controller employs, for real time motion control, an embedded (ARM core) processor and acts on a basis of Linux O.S. A robot arm control program written in a simulator is downloaded to a robot controller, and a command interpretation program (parser) of ARM core creates a motion profile. The motion profile creates a motor control signal with the aid of a motor controller so that a robot arm is driven. Hardware architecture of the robot controller which performs series of such processes is shown in [Figure 1-9], and the physical configuration of the control board is shown in [Figure 1-10].



[Figure 1-9] Controller hardware architecture



[Figure 1-10] ARM control board configuration

Primary components of the robot controller are listed in [Table 1-3] and their detailed specifications are shown in [Table 1-4].

No.	Name
1	CPU(S3C6410)
2	mDDR SDRAM
3	Nor Flash
4	NAND Flash
5	JTAG Connector
6	JTAG S/W
7	Ethernet(CS8900)
8	Reset S/W
9	USB (OTG2.0)
10	Dip S/W (Bootloader)

[Table 1-3] Hardware specifications of controller board

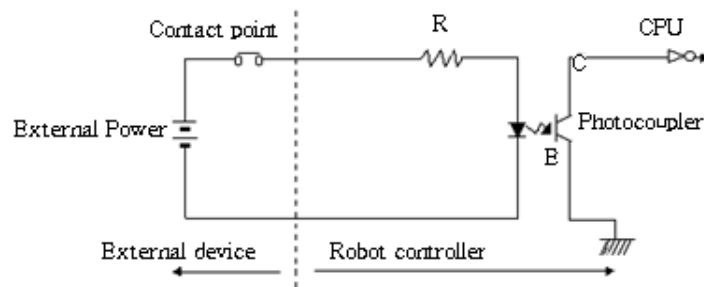
Function	Item	Spec	수량
ARM Process	CPU(6410)	400MHz, Min	1
	FLASH	32MByte	
	SRAM	1MByte(32bits Access)	
	DPRAM	16K or 32k	
DSP	TMS320F2811	Digital In(8 Points)	1
		Digital Out(8 Points)	
		Analog In(8-Ch)	
	Motion Control	Closed loop operation	
Available motor(max 8-axis)			
CPLD	Available PWM Generation	8 axis	1
	Absolute encoder counter	8-ch(PWM method)	
Driver Pack	Operating environment	24V, 120W Max	8
Interface	USB	USB 1,1 A-Type	1
		USB 1,1 B-Type(Host PC)	1
	Ethernet	10Base-T	1
	RS-232		1
	RTC	RTC 4513 Real Time Clock	1
	State LED	Power(3 color), Alarm, Start/stop	3

[Table 1-4] Hardware specifications of controller board

Robot controller's input/output terminals are connected to the external input/output devices and sensors so as to interlock with a vertical articulated robot. To do so, a control program can be written in a simulator.

① Digital input section

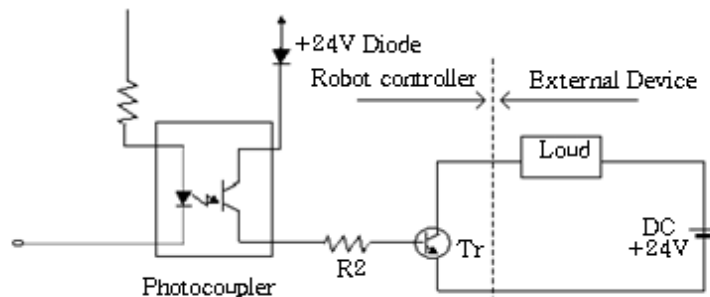
This delivers the signal from external devices to an embedded processor in the robot controller. The input section recognizes 24VDC signal, and the simulator can check the input status. An input section circuit in the controller is shown in [Figure 1-11].



[Figure 1-11] Digital input circuit

② Digital output section

This delivers the result of internal operation of the robot controller to the input of the external devices in order to control the external devices. The output is 24VDC/20mA signal, and the simulator can control the output status. An output section circuit in the controller is shown in [Figure 1-12].



[Figure 1-12] Digital output circuit

③ Analog input section

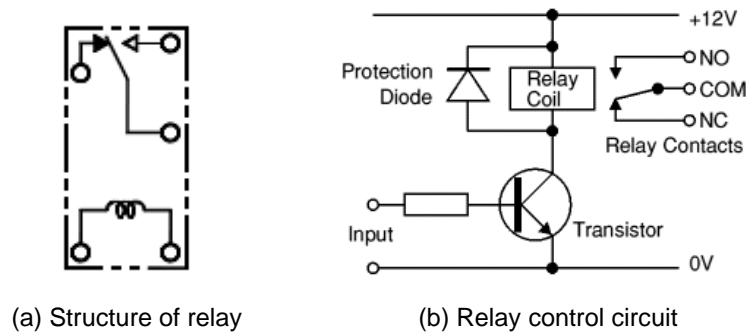
The controller receives from the external devices the signal of 0 to 12VDC, through the analog input terminal, recognizes the signal level and utilizes the signal for a robot control program. The signal level can be checked in the simulator.

④ Analog output section

The robot controller delivers the signal of 0 to 12VDC, through the analog output terminal, to the external devices to apply the signal to the interlock control program between the external devices and the vertical articulated robot program. The signal level can be checked in the simulator.

⑤ Relay terminals

Each of the four relay terminals are composed of three ports, COM, NC, and NO. Since the relay can, in the simulator, control A contact or B contact, it is used for a control program interlocking the vertical articulated robot and the external devices.



[Figure 1-13] Relay structure and control circuit

1-5-3. Teaching Pendant

A teaching pendant, which is connected to PENDANT terminal at a front panel of the robot controller, provides the operation commands to the robot arm. Such operation commands are executed by 19 input keys, and the input key values or text streams are transmitted by a microprocessor to the robot controller. To write the control program and express the status of a vertical articulated robot by using the teaching pendant, LCD display with 7 lines, each of which includes 20 characters per line, is provided. Using only the teaching pendant, the robot arm can be controlled and the control program can be written, and also the control right can be exchanged to the simulator in a host computer.



[Figure 1-14] Teaching Pendant

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