FANUC

GE Fanuc Automation

Computer Numerical Control Products

Series 16i / 18i / 160i / 180i – Model A

Connection Manual (Hardware)

Warnings, Cautions, and Notes
as Used in this Publication

$$\boxed{\text{Warning}}$$

Warning notices are used in this publication to emphasize that hazardous voltages, currents, temperatures, or other conditions that could cause personal injury exist in this equipment or may be associated with its use.

In situations where inattention could cause either personal injury or damage to equipment, a Warning notice is used.

$$\boxed{\text{Caution}}$$

Caution notices are used where equipment might be damaged if care is not taken.

Note

Notes merely call attention to information that is especially significant to understanding and operating the equipment.

This document is based on information available at the time of its publication. While efforts have been made to be accurate, the information contained herein does not purport to cover all details or variations in hardware or software, nor to provide for every possible contingency in connection with installation, operation, or maintenance. Features may be described herein which are not present in all hardware and software systems. GE Fanuc Automation assumes no obligation of notice to holders of this document with respect to changes subsequently made.

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APPENDIX

1 PREFACE

This manual describes the electrical and structural specifications required for connecting the CNC control unit to a machine tool. The manual outlines the components commonly used for FANUC CNC control units, as shown in the configuration diagram in Chapter 2, and supplies additional information on using these components. Refer to individual manuals for the detailed specifications of each component.

The models covered by this manual, and their abbreviations, are :

Product Name	Abbreviations	
FANUC Series 16i–TA	16i–TA	Series 16i
FANUC Series 16i–MA	16i–MA	
FANUC Series 18i–TA	18i–TA	Series 18i
FANUC Series 18i–MA	18i–MA	
FANUC Series 160i–TA	160i–TA	Series 160i
FANUC Series 160i–MA	160i–MA	
FANUC Series 180i–TA	180i–TA	Series 180i
FANUC Series 180i–MA	180i–MA	

Related manuals

The table below lists manuals related to MODEL A of Series 16i, Series 18i, Series 160i and Series 180i.
In the table, this manual is marked with an asterisk(*).

Table 1 Manuals Related

Manual name	Specification Number	
DESCRIPTIONS	B–63002EN	
CONNECTION MANUAL (HARDWARE)	B–63003EN	*
CONNECTION MANUAL (FUNCTION)	B–63003EN–1	
OPERATOR'S MANUAL (For LATHE)	B–63004EN	
OPERATOR'S MANUAL (For MACHINING CENTER)	B–63014EN	
MAINTENANCE MANUAL	B–63005EN	
PARAMETER MANUAL	B–63010EN	
PROGRAMMING MANUAL (Macro Compiler / Macro Executer)	B–61803E–1	
FAPT MACRO COMPILER PROGRAMMING MANUAL	B–66102E	

Table 1 Manuals Related

Manual name	Specification Number	
FANUC Super CAP T OPERATOR'S MANUAL	B–62444E–1	
FANUC Super CAP M OPERATOR'S MANUAL	B–62154E	
FANUC Super CAP M PROGRAMMING MANUAL	B–62153E	
CONVERSATIONAL AUTOMATIC PROGRAMMING FUNCTION I FOR LATHE OPERATOR'S MANUAL	B–61804E–1	
CONVERSATIONAL AUTOMATIC PROGRAMMING FUNCTION II FOR LATHE OPERATOR'S MANUAL	B–61804E–2	
CONVERSATIONAL AUTOMATIC PROGRAMMING FUNCTION I FOR MACHINING CENTER OPERATOR'S MANUAL	B–61874E–1	

2 CONFIGURATION

The following figure shows the configuration of the electrical system of the machine tool with which this control is used.

This manual describes how to connect the units illustrated in this diagram. The machine tool body, machine operator's panel, power magnetic circuit, and sensor/actuator are specific to the machine tool and are the builder's responsibility. This manual does not cover the internal connection of these units to the machine tool. The numbers in parentheses shown in the diagram are section references for this manual.

(7.3 to 7.6)

Host computer

Heat exchanger (3.7)

Relay connector (7.2)

I/O device

MDI unit (7.1)

Manual pulse generator (6.3.6)

Control unit (3.9)

Operator's I/O moduler etc. (6.4, 6.5, 6.7)

Machine operator's panel

(5)

I/O module I/O unit etc. (6.3, 6.6)

(Note 1)

Power magnetic circuit

Sensor/ actuator

DC24V Power supply

Servo amplifier (7.9)

(Note 2)

Servo motor

Multi–tap transformer

Spindle amplifier (7.8)

(Note 2)

Spindle motor

Power supply

Distribution board

NOTE
1 For the I/O unit, refer to "FANUC I/O Unit Model A Connection/Maintenance Manual (B–61813E)" and "FANUC I/O Unit Model B Connection Manual (B–62163E)."
2 For the connection between the amplifier and motor, see the following manuals:
   – FANUC AC Servo Motor α Series Descriptions (B–65142E)
   – FANUC AC Spindle Motor α Series Descriptions (B–65152E)
   – FANUC Control Motor Amplifier α Series (B–65162E)

3 INSTALLATION

3.1
ENVIRONMENTAL REQUIREMENTS OUTSIDE THE CABINET

The peripheral units and the control unit have been designed on the assumption that they are housed in closed cabinets. In this manual "cabinet" refers to the following:

● Cabinet manufactured by the machine tool builder for housing the control unit or peripheral units;

● Cabinet for housing the flexible turnkey system provided by FANUC;

● Operation pendant, manufactured by the machine tool builder, for housing the control unit or operator's panel.

● Equivalent to the above.

The environmental conditions when installing these cabinets shall conform to the following table. Section 3.4 describes the installation and design conditions of a cabinet satisfying these conditions.

	Condition	Series 16*i*/18*i*	Series 160*i*/180*i* with PC Function
Ambient Temperature	Operating	0°C to 45°C	5°C to 40°C
	Storage, Transport	−20°C to 60°C	
Temperature Change		Max. 1.1°C/min.	Max. 0.3°C/min.
Humidity	Normal	75%RH or less, no condensation	10% to 75%RH, no condensation
	Short period (less than 1 month)	95%RH or less, no condensation	10% to 90%RH, no condensation
Vibration	Operating	0.5 G or less	
	Non–operating	1.0 G or less	
Environ-ment	Normal machine shop environment (The environment must be considered if the cabinets are in a location where the density of dust, coolant, and/or organic solvent is relatively high.)		

3.2
INSTALLATION REQUIREMENTS OF CONTROL UNIT AND SERVO UNIT

	Series 16*i*/18*i*	Series 160*i*/180*i*
Ambient Temperature	0°C to 58°C (Operating)	0°C to 53°C (Operating)
	−20°C to 60°C (Storage, Transport)	
Room temperature	In operation	0°C to +55°C
	In storage or transporta-tion	−20°C to +60°C
Relative humidity	95% RH or less (no condensation)	
Vibration	0.5 G or less	
Environment	The unit shall not be exposed direct to cutting oil, lubricant or cutting chips.	

3.3
POWER SUPPLY FOR CNC CONTROL UNITS

The following units, related to the CNC control unit, require the input of 24 VDC±10%.

Unit	Power Supply Voltage	Power Supply
Series 16*i*/18*i* control unit without option slot		2 A including LCD and MDI unit.
Series 16*i*/18*i* control unit with option 2 slots		4A including LCD, MDI unit, and option board.
Series 16*i*/18*i* control unit with option 4 slots		6A including LCD, MDI unit, and option board.
Series 160*i*/180*i* control unit (with PC functions) without option slot	24 VDC ±10% (±10% includes momentary surges and ripples.)	4A including LCD, MDI unit, hard disk drive and floppy disk drive.
Series 160*i*/180*i* control unit (with PC functions) with option 2 slots		6A including LCD, MDI unit, hard disk drive, floppy disk drive, option board.
Series 160*i*/180*i* control unit (with PC functions) with option 4 slots		8A including LCD, MDI unit, hard disk drive, floppy disk drive, option board.
ISA extension		Max. 1.5 A (Note 2)

NOTE
1 For other peripheral devices (I/O, etc.), refer to the power supply data for each device and add the value to the above.
2 Variable depending on the ISA board in use.
3 The power supply to the Series 160*i*/180*i* control unit with HSSB is identical to that of the Series 16*i*/18*i* control unit.

3.4
DESIGN AND INSTALLATION CONDITIONS OF THE MACHINE TOOL MAGNETIC CABINET

When a cabinet is designed, it must satisfy the environmental conditions described in Section 3.1. In addition, the magnetic interference on the CRT screen, noise resistance, and maintenance requirements must be considered. The cabinet design must meet the following conditions :

● The cabinet must be fully closed.

The cabinet must be designed to prevent the entry of airborne dust,coolant,and organic solvent.

Cabinets that let in air may be designed for the servo amplifier and servo transformer provided that they :

❏ Use an air filter on the air inlet ;

❏ Place the ventilating fan so that it does not blow air directly toward the unit;

❏ Control the air flow so that no dust or coolant enters the air outlet

● The cabinet to hold the control unit must be designed to maintain a difference in temperature of up to 13°C between the air in the cabinet and the outside air when the temperature in the cabinet rises. The cabinet to hold the servo unit must be designed to maintain a difference in temperature of up to 10°C between the air in the cabinet and the outside air when the temperature in the cabinet rises.
For details of the thermal design, see 3.5 and 3.7.

● A closed cabinet must be equipped with a fan to circulate the air within. (This is not necessary for a unit with fan.)
The fan must be adjusted so that the air moves at 0.5 m/sec along the surface of each installed unit.
CAUTION : If the air blows directly from the fan to the unit, dust easily adheres to the unit. This may cause the unit to fail. (This is not necessary for a unit with fan.)

● For the air to move easily, a clearance of 100 mm is required between each unit and the wall of the cabinet. (This is not necessary for a unit with fan.)

● Packing materials must be used for the cable port and the door in order to seal the cabinet.

● The display unit must not be installed in such a place that coolant would directly fall onto the unit. The control unit has a dust–proof front panel, but the unit should not be placed in a location where coolant would directly fall onto it.

● Noise must be minimized.
As the machine and the CNC unit are reduced in size, the parts that generate noise may be placed near noise–sensitive parts in the magnetics cabinet.
The CNC unit is built to protect it from external noise. Cabinet design to minimize noise generation and to prevent it from being transmitted to the CNC unit is necessary. See section 3.7 for details of noise elimination/management.

● The hard disk drive and floppy disk drive must not be installed near the source of a strong magnetic field.

● The installation conditions of the I/O unit and connector panel I/O module must be satisfied.
To obtain good ventilation in the module, the I/O unit and connector panel I/O module must be installed in the direction shown in the following figure. Clearances of 100 mm or more both above and below the I/O unit are required for wiring and ventilation.
Equipment radiating too much heat must not be put below the I/O unit and connector panel I/O module.
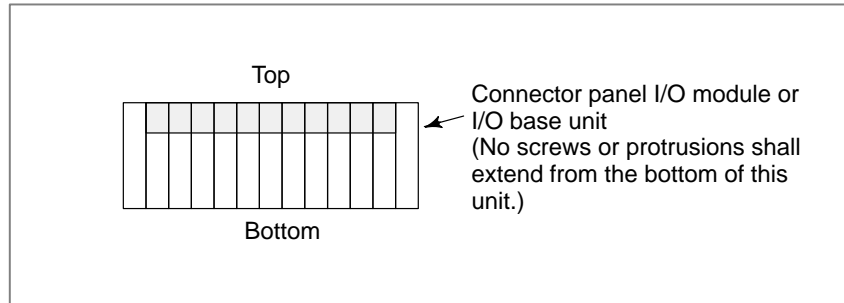
● The operator's panel cabinet which contains the CNC control unit should be designed so that the printed circuit boards and connectors can be easily accessed for maintenance, for example, from the rear of the cabinet.
Fig. 3.5 shows a recommended cabinet structure with hinges that is easy to open and close.

● Operating ambient temperature of control units with PC functions
A temperature sensor in each control unit monitors the temperature to determine whether it is within the optimum range.

(1) When the temperature is out of range when the power is turned on
The control unit does not start until the temperature settles to within the optimum range.

(2) If the temperature drifts out of range after normal start–up
Error occurs when the hard disk is accessed.

● A control unit with PC functions and data server board must be carefully isolated against vibration.
The CNC control unit or hard disk unit itself may resonate at certain frequencies. Perform a thorough check after mounting the CNC control unit on the machine.

CAUTION

For a control unit with PC functions or data server board, data stored on the hard disk may be destroyed due to operator errors or accidents even when the environmental conditions above are satisfied. To guard against such data loss, back up the important hard disk data regularly. In particular, never turn off the power, even momentarily, while the hard disk is being accessed or the operating system is running, as doing so is highly likely to destroy part of the contents of the disk. End users should be made fully aware of this, to ensure that they do not inadvertently lose important data.

- If a unit with PC functions or a data server board is used, be careful when installing the MDI unit.

  (1) The MDI unit must be installed immediately below the control unit (immediately below or next to the control unit, if the data server board is used), allowing no space between the two units.

  (2) The MDI unit must be installed vertically.

- If a unit with PC functions or a data server board is used, the following altitude limitations are placed due to the limitations of the hard disk:

  Operating altitude: –60 to 3,000 m
  Non–operating altitude: –60 to 12,000 m

3.5
THERMAL DESIGN OF OPERATOR'S PANEL CABINET

The objective of thermal design of operator's panel cabinet is to maintain a difference in temperature of up to 13°C between the air in the cabinet and the outside air when the temperature in the cabinet rises.

The air in the cabinet is heated by the heat dissipated by the unit and component in the cabinet while the heat is dissipated from the surface of the cabinet itself. The air in the cabinet reaches thermal equilibrium at a certain temperature. If the heat source is constant, the temperature rise decreases as the surface area of the cabinet increases.

This section describes a method of thermal design of the operator's panel cabinet which contains the control unit.

With a small cabinet like the operator's panel cabinet, the heat dissipating capacity of the cabinet is as shown below, assuming that there is sufficient mixing of the air inside the cabinet.

   Coated metal surfaces: 8 W/m^2°C
   Plastic surfaces: 3.7 W/m^2°C

An example of the thermal design for the cabinet shown in Fig. 3.5 is shown below.
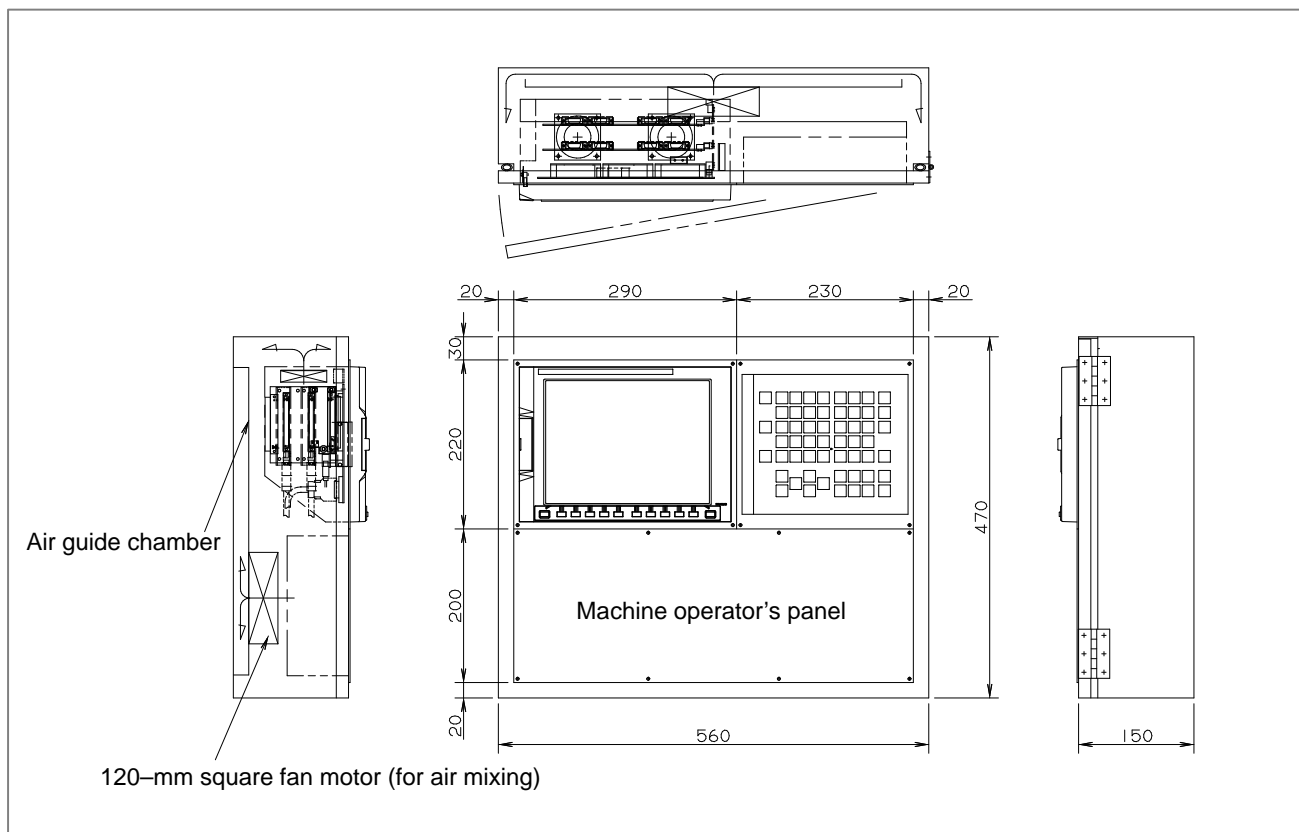
Fig. 3.5 Example of the thermal design of operator's panel cabinet

Assume the following.
Thermal exchange rates : Coated metal surfaces 8W/m^2°C
                          : Plastic surfaces 3.7W/m^2°C
Allowable temperature rise: 13°C higher than the exterior temperature
Also, assume the following.
Dimensions of pendant type cabinet: 560(W) $\times$ 470(H) $\times$ 150(D)mm
Surface area of metallic sections: 0.5722m^2
Surface area of plastic sections: 0.2632m^2

In this case, the allowable total heat dissipation for the cabinet is:

$8 \times 0.5722 \times 13 + 3.7 \times 0.2632 \times 13 = 72W$.

When the heat dissipation of the fan motor for mixing the air inside the cabinet (assumed as 8 W) is excluded, the heat dissipation of the control unit is:

$72 - 8 = 64W$.

In consequence, it can be concluded that the units shown in Table 3.5 on the next page can be installed in this cabinet.

Table 3.5

Series 16i/18i control unit with option 2 slots	33W
Sub–CPU board	13W
C board	3W
Distributed operator's panel I/O module	12W
Total heat dissipation of the above	63W ($<$64W)

3.6
HEAT DISSIPATED BY EACH UNIT

Unit		Power Consumption (W)
Series 16*i*/18*i* basic unit		33 W including LCD and MDI unit.
Series 160*i*/180*i* basic unit (with PC functions)		45 W including LCD, MDI unit, hard disk drive and floppy disk drive.
Option board	Sub–CPU board	13 W
	C board	5 W
	Loader control board	10 W
	Serial communication board (remote buffer, DNC1, DNC2)	6 W
	Data server board	9 W
	RISC board	9 W
	CAP II board	5 W
	HSSB board	3 W
ISA extension		(Note 3)
Operator's panel I/O module		12 W
Connector panel I/O module (basic)		8 W
Connector panel I/O module (external)		5 W

NOTE
1 For the other peripheral equipment, see the heat dissipation indicated in the corresponding section.
2 When using option boards, the total heat dissipation of the selected option boards must not exceed the value indicated below:

Cabinet type	Total heat dissipation
2–slot cabinet	26 W
4–slot cabinet	38 W

3 The heat dissipation depends on the ISA board to be used. Consider the heat dissipation of the ISA board to be used.
4 The heat dissipation of the Series 160*i*/180*i* with HSSB is obtained by adding the heat dissipation of the Series 16*i*/18*i* control unit and of the HSSB board.

3.7
THERMAL DESIGN OF THE CABINET

The purpose of the thermal design of the cabinet is to limit the difference in temperature between the air in the cabinet and the outside air to 10°C or less when the temperature in the cabinet increases.

The internal air temperature of the cabinet increases when the units and parts installed in the cabinet generate heat. Since the generated heat is radiated from the surface of the cabinet, the temperature of the air in the cabinet and the outside air balance at certain heat levels. If the amount of heat generated is constant, the larger the surface area of the cabinet, the less the internal temperature rises. The thermal design of the cabinet refers to calculating the heat generated in the cabinet, evaluating the surface area of the cabinet, and enlarging that surface area by installing heat exchangers in the cabinet, if necessary. Such a design method is described in the following subsections.

3.7.1
Temperature Rise within the Cabinet

The cooling capacity of a cabinet made of sheet metal is generally 6 W/°C per $1m^2$ surface area, that is, when the 6W heat source is contained in a cabinet having a surface area of 1 m^2, the temperature of the air in the cabinet rises by 1°C. In this case the surface area of the cabinet refers to the area useful in cooling , that is, the area obtained by subtracting the area of the cabinet touching the floor from the total surface area of the cabinet. There are two preconditions : The air in the cabinet must be circuited by the fun, and the temperature of the air in the cabinet must be almost constant.The following expression must then be satisfied to limit the difference in temperature between the air in the cabinet and the outside air to 10°C or less when the temperature in the cabinet rises:

Internal heat loss P [W] $\leqq$

$6[W/m^2 \cdot °C] \times$ surface area $S[m^2] \times 10[°C]$ of rise in temperature

For example, a cabinet having a surface area of $4m^2$ has a cooling capacity of 24W/°C. To limit the internal temperature increase to 10°C under these conditions, the internal heat must not exceed 240W. If the actual internal heat is 320W, however, the temperature in the cabinet rises by 13°C or more. When this happens, the cooling capacity of the cabinet must be improved using the heat exchanger described next.

3.7.2
Cooling by Heat Exchanger

If the temperature rise cannot be limited to 10°C by the cooling capacity of the cabinet, a heat exchanger must be added. The heat exchanger forcibly applies the air from both the inside and outside of the cabinet to the cooling fin to obtain effective cooling. The heat exchanger enlarges the surface area. Section 3.7 explains five heat exchangers supplied by FANUC. Select one of these according to the application.

If cooling fin A is used for the cabinet, the total cooling capacity of a cabinet having a surface area of 4 m^2 in the example above is improved as follows :

$6W/m^2 \cdot °C \times 4m^2 + 9.1W/°C = 33.1W/°C$

The calculated value verifies that even if the internal heat is 320 W, the temperature rise can be limited to less than 10°C.

See Section 3.7.3, 3.7.4 for installing the heat exchanger.

3.7.3
Cooling Fin A/B/C

The cooling fin is shown.
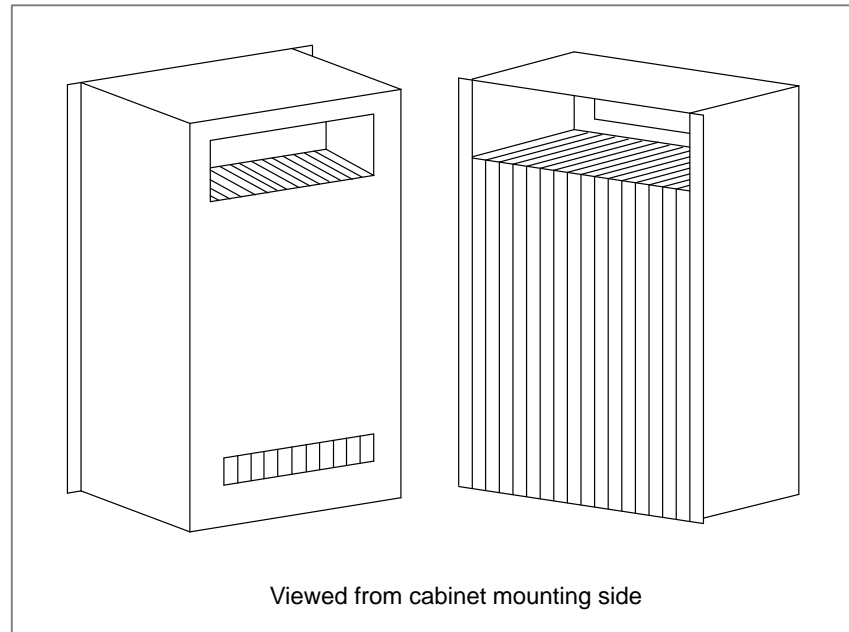
Fig. 3.7.3(a) External view of cooling fin

It is installed in a cabinet made by the machine tool builder.
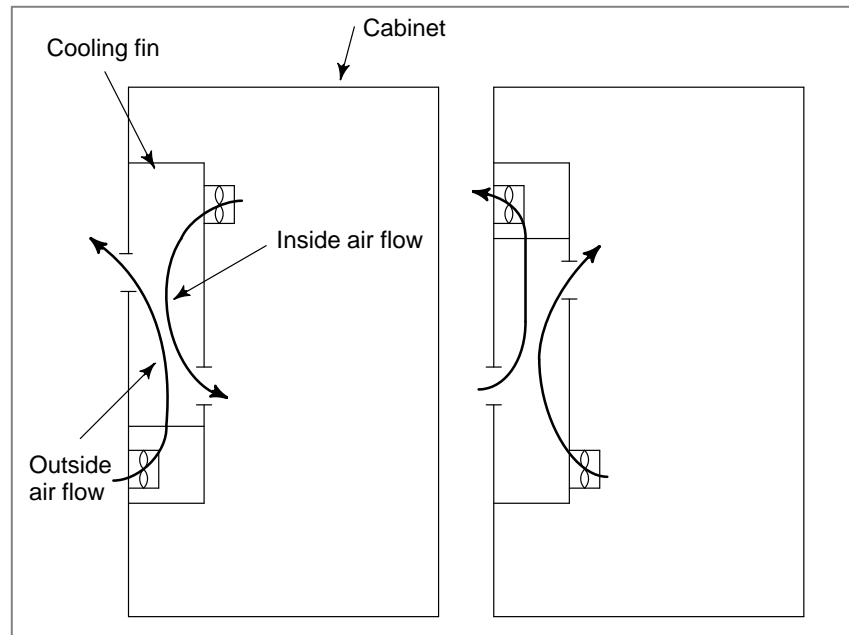
Fig. 3.7.3(b) Internal view of cooling fin

The cooling fin can be installed in two ways, as shown in Fig.3.7.3 (b). The following lists the general precautions to be observed when using the cooling fins :

- The fans are not included with the cooling fin. They should be provided by the machine tool builder.
- Bring in the outside air from the bottom and exhaust the hot air from the top.

- The inside air may flow from top to bottom or bottom to top. However, generally decide the direction as follows :

  ☐ Bring in the air near high heat loss components.

  ☐ Exhaust the air toward the most important components to be cooled.

- For the cooling fin to display the specified cooling capacity, the air inside the cooling fins must flow at a velocity of 2.5 m/sec or greater.

(velocity of air flow measurement)

Set the slit to the intake side and measure the velocity at the slit.
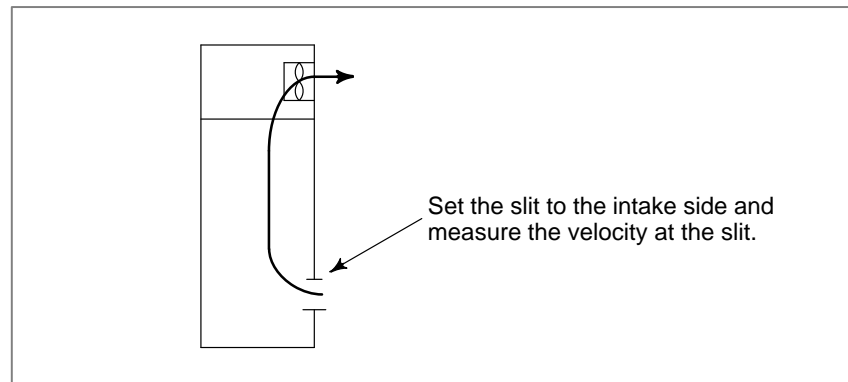
● Generally, install the cooling fins to the door. But be sure that the door does not bend when installing the cooling fin. The cooling fins are equipped with packing.
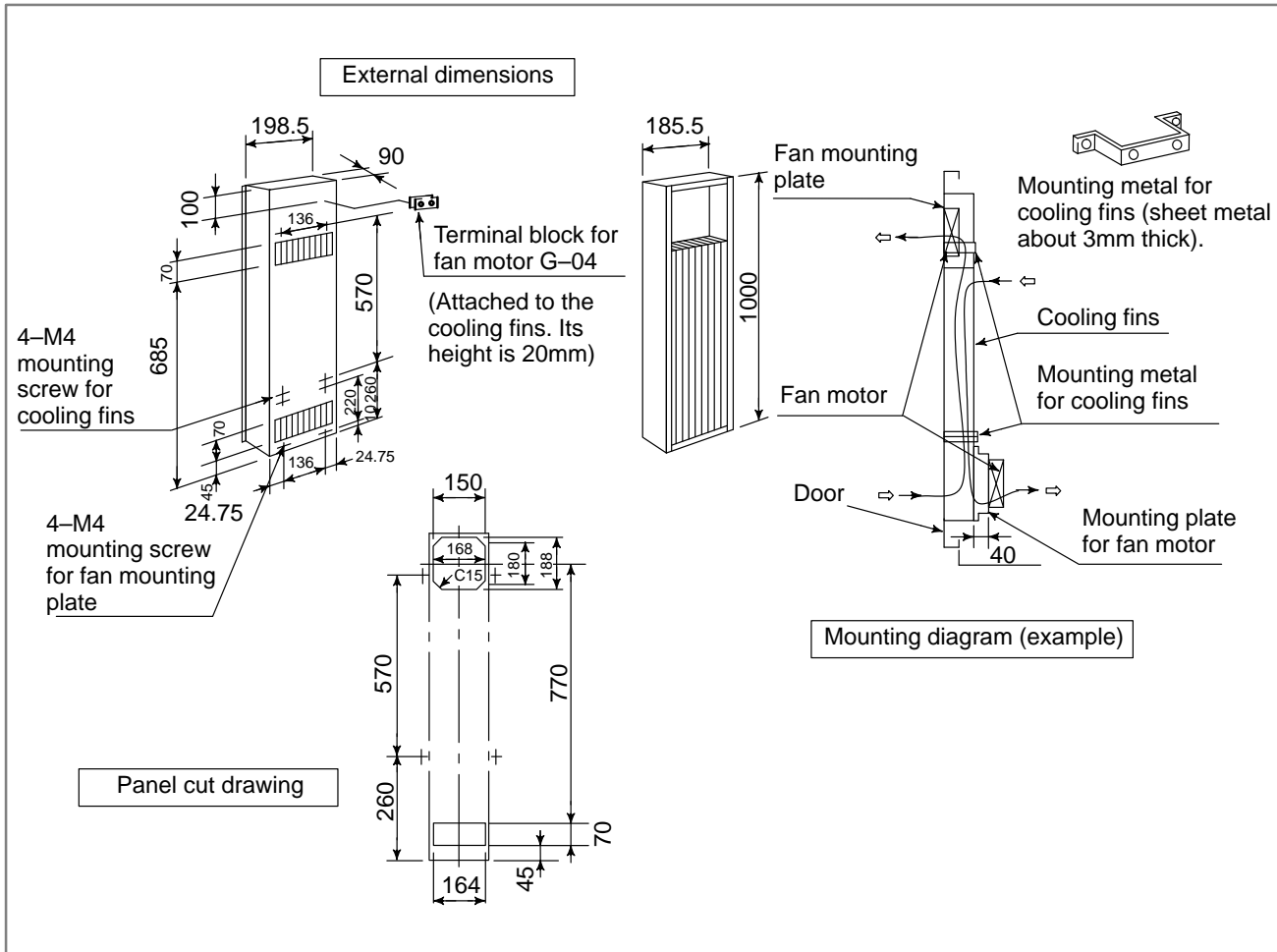
Fig. 3.7.3 (c) External dimension and mounting method of cooling fin A (A02B–0053–K303)

NOTE
1 Fan motor, mounting plate for fan motor and mounting metal for cooling fins are not attached to the cooling fins. So, prepare them at the machine tool builder.
2 Use two fan motors with about 50W power.
3 Weight : 6.5kg
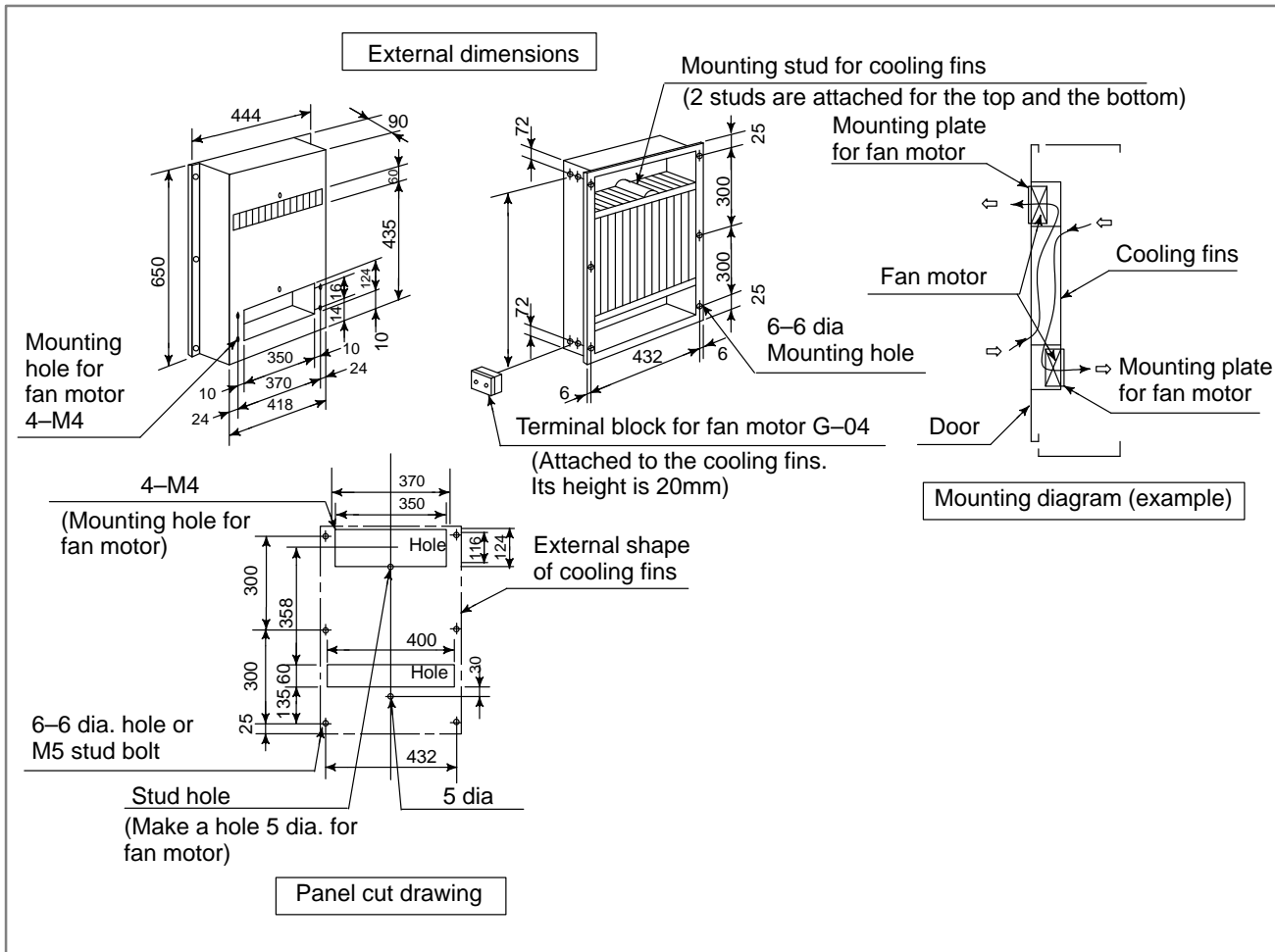
Fig. 3.7.3(d) External dimension and mounting method of cooling fin B (A02B–0053–K304)

NOTE
1 Fan motor and mounting plate are not attached to the cooling fins. So, prepare them, at the machine tool builder.
2 Use four fan motors with about 20W power.
3 Weight : 7.5kg

External dimensions

Mounting stud for cooling fins
(Attached to the cooling fins)

Mounting plate for fan motor

Cooling fins

Fan motor

8–6 dia. mounting hole

Mounting plate for fan motor

Door

Mounting diagram (example)

Terminal blok for fan motor G–04 (Attached to the cooling fins. Its height is 20mm)

6–M4 Mounting hole for fan motor

5M–4 (Mounting hole for fan motor)

External shape of cooling fins

5 dia

(This hole combines mounting hole and stud hole.)

8–6 dia. hole or M5 stud bolt

Panel cut drawing

Fig. 3.7.3(e) External dimension and mounting method of cooling fin C (A02B–0053–K305)

NOTE
1 Fan motor and mounting plate for fan motor are not attached to the cooling fins. Prepare them at the machine tool builder.
2 Use two fan motors with about 40W power.
3 Weight : 13.5kg

3.7.4
The Heat Pipe Type
Heat Exchanger

3.7.4.1
Installation

The heat pipe type heat exchanger is used for cooling the airtight cabinet of small sized electronic devices. It is a compact, lightweight, and heat–efficient unit. Because the fan is built–in, it is used simply by installing it, performing the 'panel cut' operation.

Specifications

Installation format		Installation type in board	
Fan specifications	Cooling ability (W/°C)	9 (50Hz when operating)	
	Voltage (V)	200VAC	
	Frequency (Hz)	50	60
	Rating current (A)	0.28	0.24
	Rating input (W)	28	26
Weight (kg)		4	
Color		Munsell signal N1.5	

● Order specifications

Heat exchanger A02B–0094–C901
   A02B–0200–C901 (CE marking compatible)

Remarks
● A filter is installed on the outside air inhalation side.
● The installation board thickness is the standard 1.6 t.
● When a fan motor and filter are necessary for maintenance, prepare them separately.

Fan motor specifications
    A90L–0001–0219#A
    A90L–0001–0219#AF (for CE marking compatible products)

Filter specifications
    A250–0689–X004
    A250–0689–X006 (for CE marking compatible products)

External dimensions
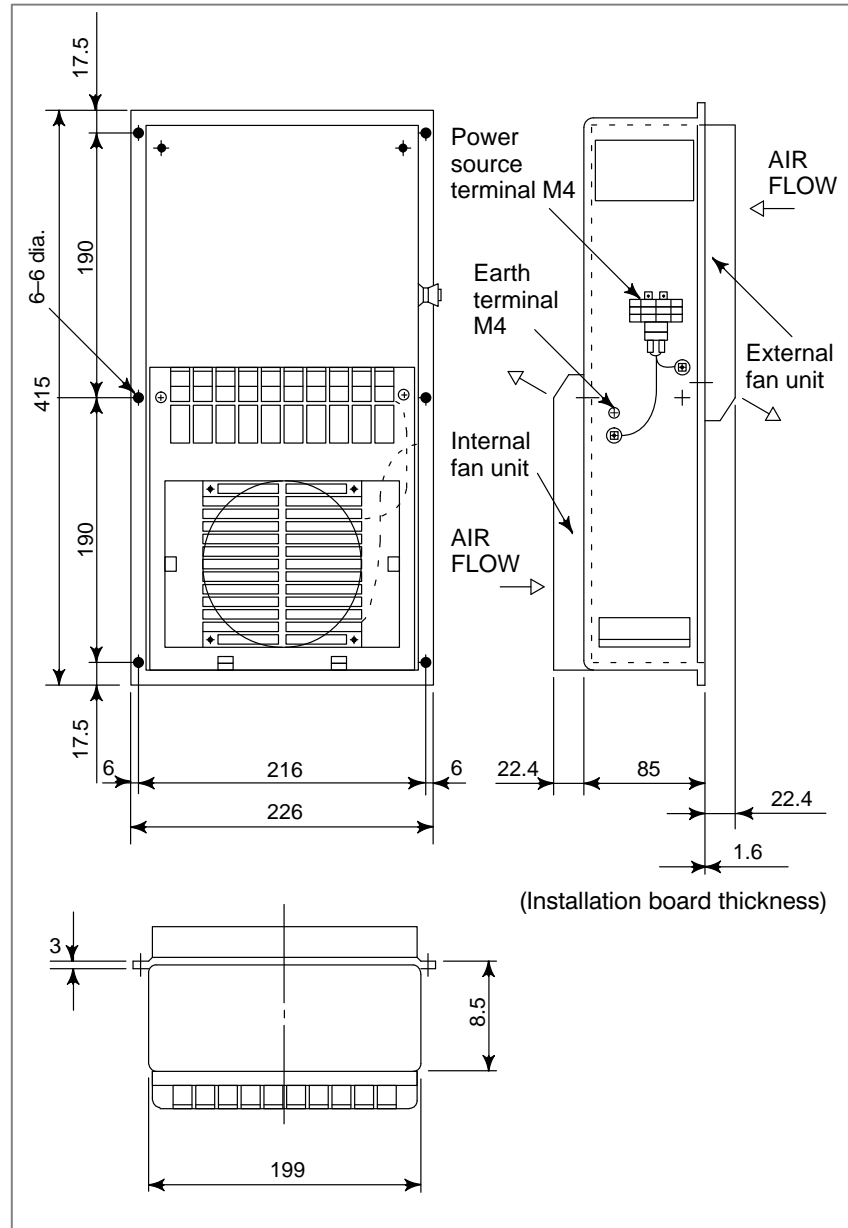
Fig. 3.7.4(a) External dimensions of heat pipe type heat exchanger

Panel cut dimensions
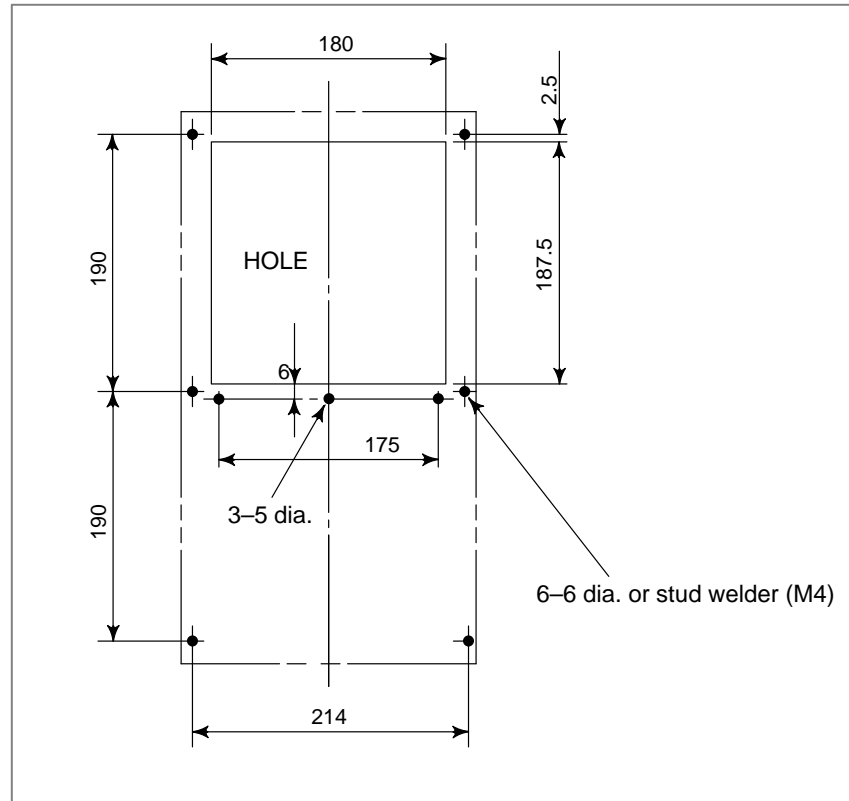
Fig. 3.7.4(b) Panel cut dimensions for the heat pipe type heat exchanger

Installation method   Please install the heat exchanger by the following sequence:

1 Take out the external fan unit from the heat exchanger main unit. (Fig. 1)

Detach the external fan unit installation screws A (2 pieces), take out the unit from the main unit by sliding it down, and detach the earth cable and the power cable to the fan. Also detach the installation screw B (1 piece).

2 Install the heat exchanger main unit in the installation section which has been panel cut. (Fig. 2)

When fastening down the heat exchanger main unit with the screws, first, temporarily secure the panel and the heat exchanger main unit with the installation screw B, which was taken out in **1**). After that, secure the main unit by the installation screws. In this case, the external fan unit installation screw holes should be aligned with the main unit screw holes. (Please provide the installation screws for the heat exchanger main unit.)

Because this product is composed of plastic, set the value shown below for the screw tightening torque.

   Heat exchanger main unit (M4 screw) : 11 kgf.cm

   External fan unit (M3 screw) : 5 kgf.cm

3 Connect the power cable and the earth cable to the external fan unit (the unit detached in **1**), and secure the installation screw A to the main unit from the outside.

The installation is now complete.

Fig. 1   Take out the external fan unit from the   **Fig. 2   Install the heat exchanger main unit and**
heat exchanger main unit   **the external fan unit**
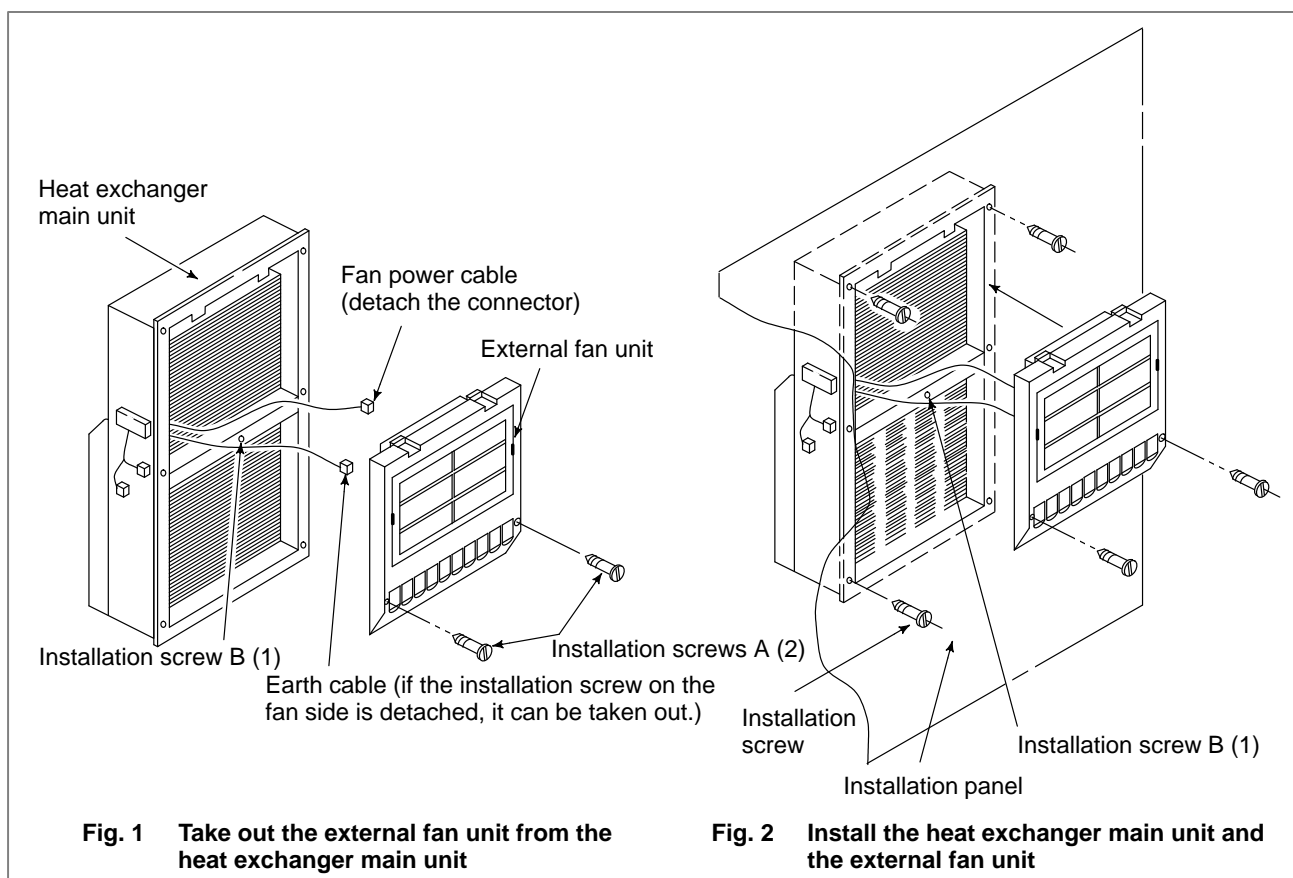
Fig. 3.7.4(c) Installing the heat pipe type heat exchanger

3.8
ACTION AGAINST NOISE

The CNC has been steadily reduced in size using surface–mount and custom LSI technologies for electronic components. The CNC also is designed to be protected from external noise. However, it is difficult to measure the level and frequency of noise quantitatively, and noise has many uncertain factors. It is important to prevent both noise from being generated and generated noise from being introduced into the CNC. This precaution improves the stability of the CNC machine tool system.

The CNC component units are often installed close to the parts generating noise in the power magnetics cabinet. Possible noise sources into the CNC are capacitive coupling, electromagnetic induction, and ground loops.

When designing the power magnetics cabinet, guard against noise in the machine as described in the following section.

3.8.1
Separating Signal Lines

The cables used for the CNC machine tool are classified as listed in the following table:

Process the cables in each group as described in the action column.

Group	Signal line	Action
A	Primary AC power line	Bind the cables in group A separately (Note 1) from groups B and C, or cover group A with an electromagnetic shield (Note 2). See Section 3.8.4 and connect spark killers or diodes with the solenoid and relay.
	Secondary AC power line	
	AC/DC power lines (containing the power lines for the servo and spindle motors)	
	AC/DC solenoid	
	AC/DC relay	
B	DC solenoid (24VDC)	Connect diodes with DC solenoid and relay. Bind the cables in group B separately from group A, or cover group B with an electromagnetic shield. Separate group B as far from Group C as possible. It is more desirable to cover group B with the shield.
	DC relay (24VDC)	
	DI/DO cable between the CNC and power magnetics cabinet	
	DI/DO cable between the CNC and machine	
C	Cable between the CNC and servo amplifier	Bind the cables in group C separately from group A, or cover group C with an electromagnetic shield. Separate group C as far from Group B as possible. Be sure to perform shield processing in Section 3.8.5.
	Cable for position and velocity feedback	
	Cable between the CNC and spindle amplifier	
	Cable for the position coder	
	Cable for the manual pulse generator	
	Cable between the CNC and the MDI	
	RS–232C and RS–422 interface cable	
	Cable for the battery	
	Other cables to be covered with the shield	

> **NOTE**
> 1 The groups must be 10 cm or more apart from one another when binding the cables in each group.
> 2 The electromagnetic shield refers to shielding between groups with grounded steel plates.
> 3 The shield is not required when the cable between the CNC and MDI is shorter than 30 cm.

Power magnetics cabinet

Operator's cabinet

| DC 24 V power supply | Spindle amplifier | Servo amplifier | I/O unit | CNC control unit |

to motor

Duct

Cable of group A

Cable of group B, C

Section of duct

Group A   Group B, C

Cover
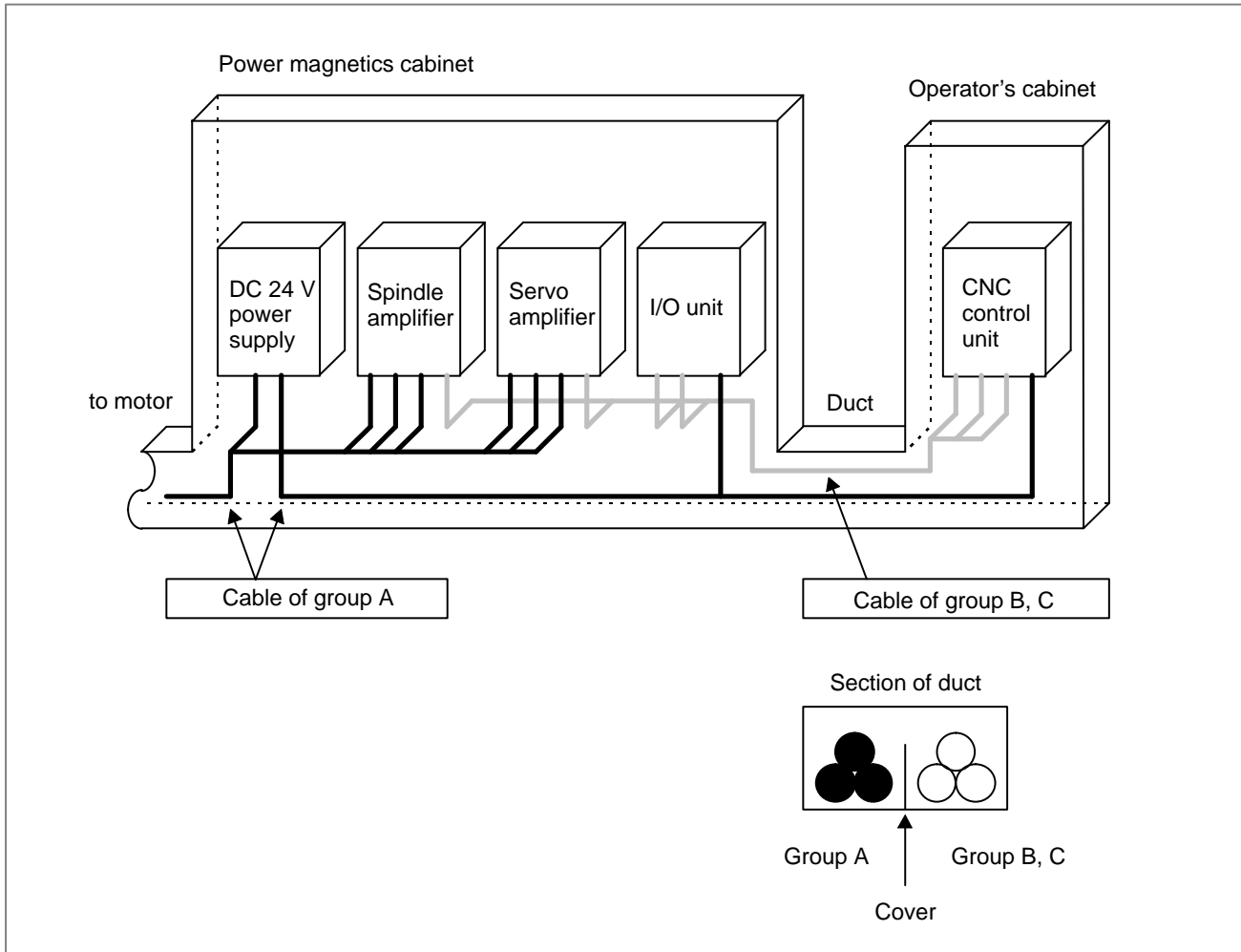
**3.8.2
Ground**

The following ground systems are provided for the CNC machine tool:

- **Signal ground system (SG)**
  The signal ground (SG) supplies the reference voltage (0V) of the electrical signal system.

- **Frame ground system (FG)**
  The frame ground system (FG) is used for safety, and suppressing external and internal noises. In the frame ground system, the frames, cases of the units, panels, and shields for the interface cables between the units are connected.

- **System ground system**
  The system ground system is used to connect the frame ground systems connected between devices or units with the ground.
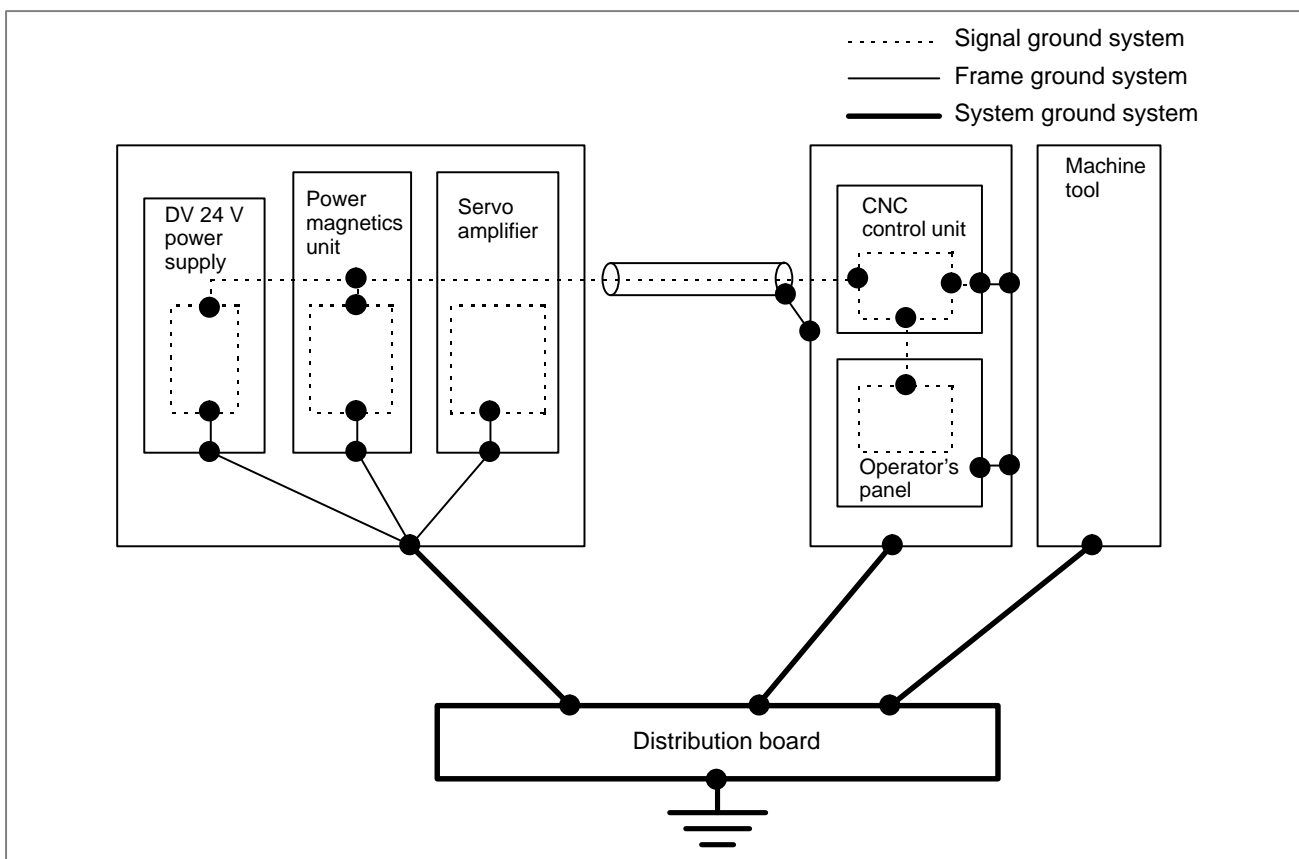
Notes on connecting the ground systems

- Connect the signal ground with the frame ground (FG) at only one place in the CNC control unit.
- The grounding resistance of the system ground shall be 100 ohms or less (class 3 grounding).
- The system ground cable must have enough cross–sectional area to safely carry the accidental current flow into the system ground when an accident such as a short circuit occurs.
  (Generally, it must have the cross–sectional area of the AC power cable or more.)
- Use the cable containing the AC power wire and the system ground wire so that power is supplied with the ground wire connected.

3.8.3
Connecting the Signal
Ground (SG) of the
Control Unit

M4 stud

Grounding cable,
wire 2 mm^2 or more
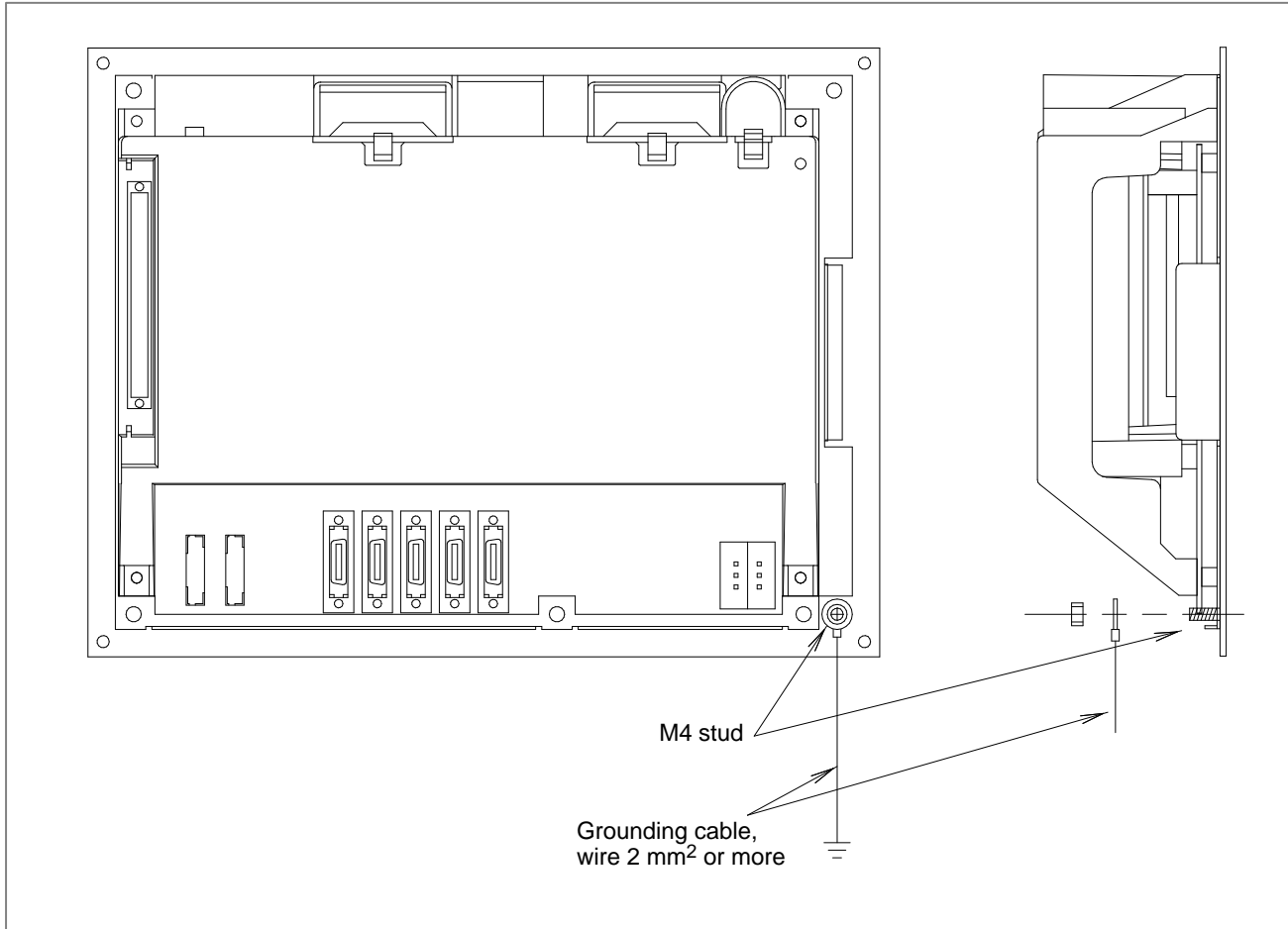
Connect the 0 V line of the electronic circuit in the control unit with the
ground plate of the cabinet via the signal ground (SG) terminal.
For the locations of the grounding terminals of other units, see
"EXTERNAL DIMENSIONS OF EACH UNIT" in APPENDIX.

3.8.4
Noise Suppressor

The AC/DC solenoid and relay are used in the power magnetics cabinet. A high pulse voltage is caused by coil inductance when these devices are turned on or off.
This pulse voltage induced through the cable causes the electronic circuits to be disturbed.

Notes on selecting the spark killer

- Use a spark killer consisting of a resistor and capacitor in series. This type of spark killer is called a CR spark killer.(Use it under AC) (A varistor is useful in clamping the peak voltage of the pulse voltage, but cannot suppress the sudden rise of the pulse voltage. FANUC therefore recommends a CR spark killer.)

- The reference capacitance and resistance of the spark killer shall conform to the following based on the current (I (A)) and DC resistance of the stationary coil:

  1) Resistance (R) : Equivalent DC resistance of the coil

  2) Capacitance (C) : $\dfrac{I^2}{10} \sim \dfrac{I^2}{20}$ (μF)

      I : Current at stationary state of the coil

Equivalent circuit of the spark killer

Mount the noise eliminator near a motor or a relay coil.

Note) Use a CR–type noise eliminator. Varistor–type noise eliminators clamp the peak pulse voltage but cannot suppress a sharp rising edge.

Diode (used for direct–current circuits)

Use a diode which can withstand a voltage up to two times the applied voltage and a current up to two times the applied current.

3.8.5
Cable Clamp and
Shield Processing

If a cable connected to the CNC, servo amplifier, spindle amplifier, or other device requires shielding, clamp the cable as shown below. The clamp both supports and shields the cable. Use this clamp to ensure stable operation of the system.

Partially peel out the sheath and expose the shield. Push and clamp by the plate metal fittings for clamp at the part. The ground plate must be made by the machine tool builder, and set as follows :
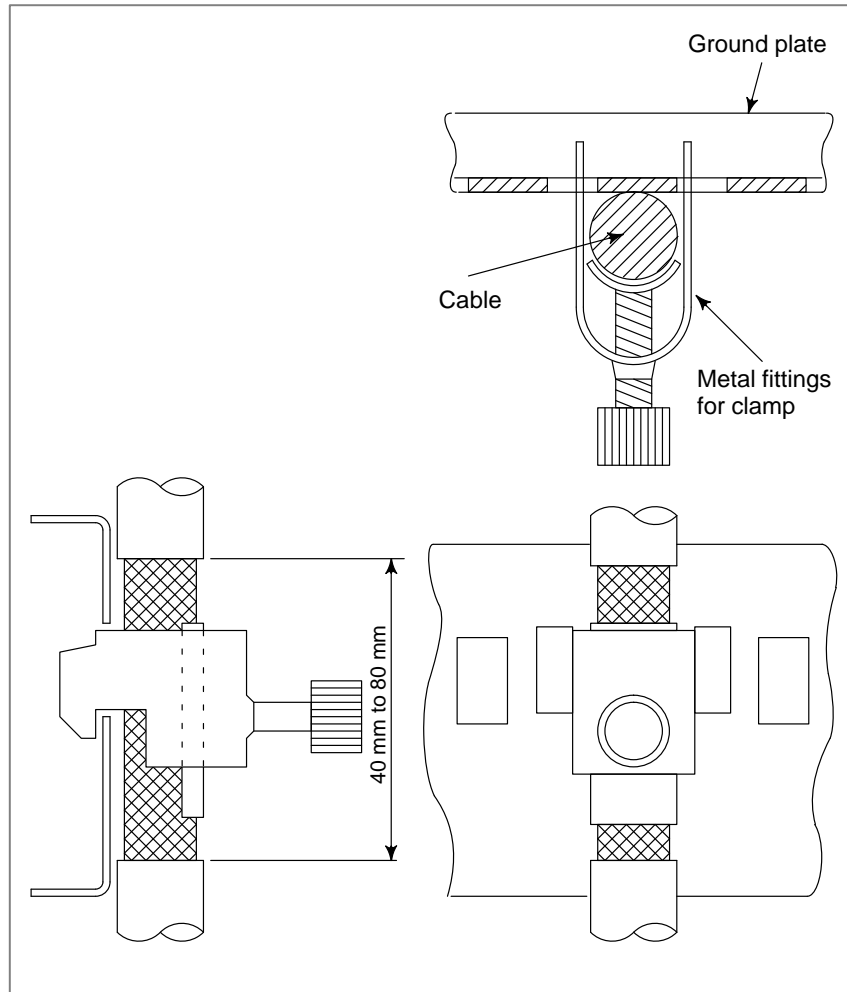
Fig. 3.8.5(a) Cable clamp (1)
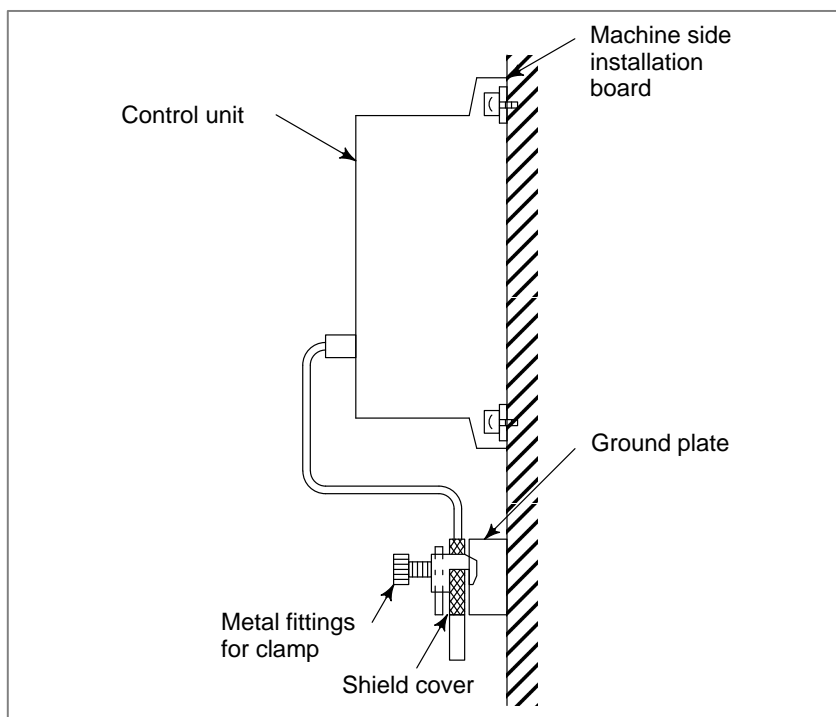
Fig. 3.8.5(b) Cable clamp (2)

Prepare ground plate like the following figure.
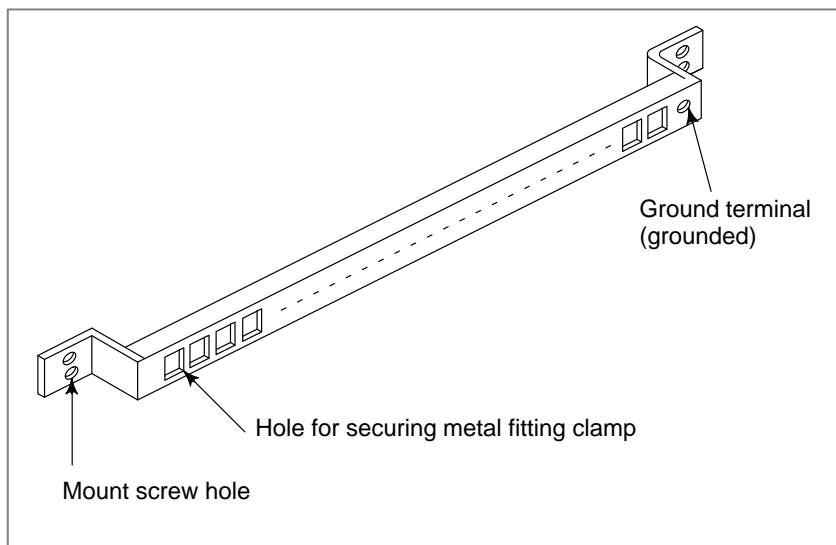
Fig. 3.8.5(c) Ground plate

For the ground plate, use a metal plate of 2 mm or thicker, which surface is plated with nickel.
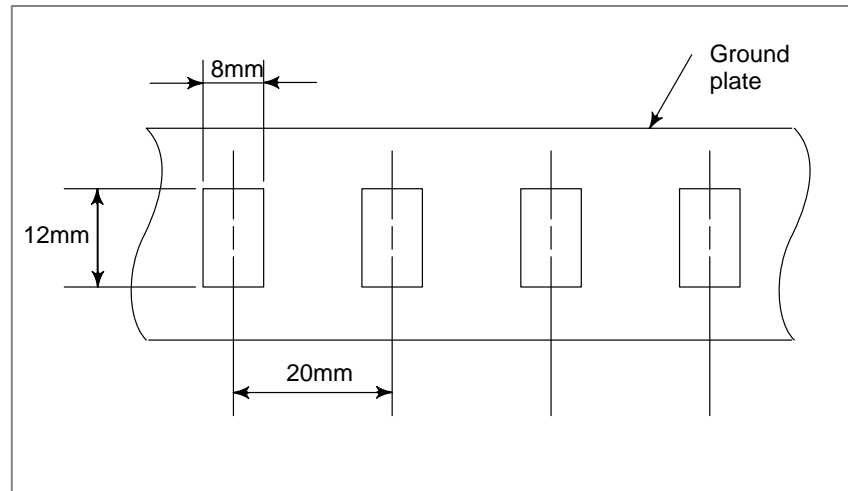
Fig. 3.8.5(d) Ground plate holes

(Reference) Outer drawings of metal fittings for clamp.
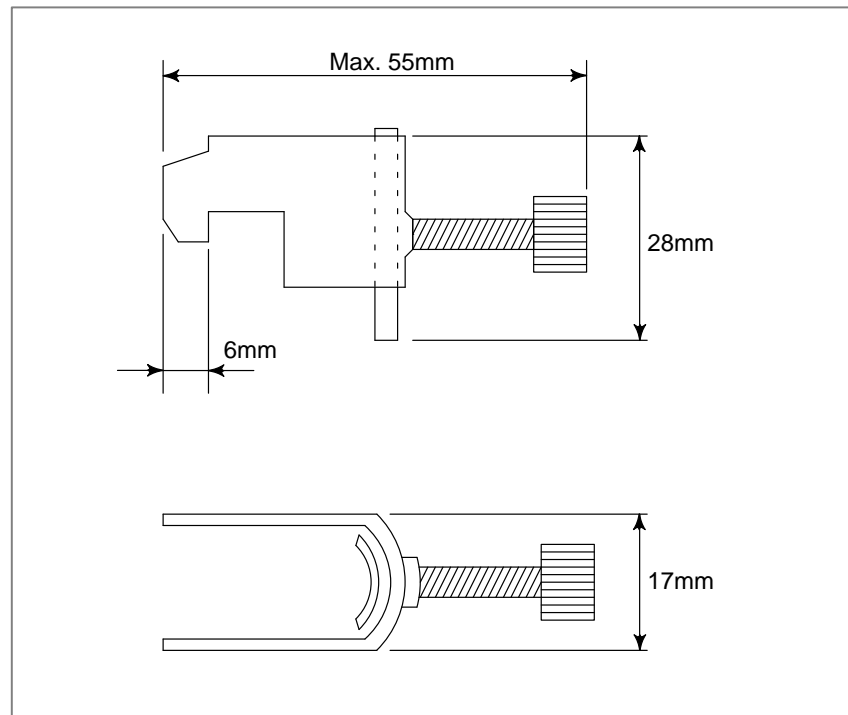
Fig. 3.8.5(e) Outer drawings of metal fittings for clamp

Ordering specification for metal fittings for clamp
  A02B–0083–K301 (5 pieces)

3.9
CONTROL UNIT

3.9.1
Configuration of the Control Unit

The control units of the Series 16*i*/18*i*/160*i*/180*i* can be broadly classified as indicated in the table below.

Figs. 3.9.1(a) and 3.9.1(b) show the configuration of the control units of the Series 16*i*/18*i*/160*i*/180*i*.

Table 3.9.1 Types of Control Units

Control unit	Option slots	Display unit	Re-marks
Series 16*i*/18*i* control unit	No option slots	7.2″ monochrome STN LCD	
		8.4″ color TFT LCD	
		9.5″ monochrome STN LCD	
		10.4″ color TFT LCD	
	With 2 option slots	7.2″ monochrome STN LCD	
		8.4″ color TFT LCD	
		9.5″ monochrome STN LCD	
		10.4″ color TFT LCD	
	With 4 option slots	7.2″ monochrome STN LCD	
		8.4″ color TFT LCD	
		9.5″ monochrome STN LCD	
		10.4″ color TFT LCD	
Series 160*i*/180*i* control unit	With 2 option slots	7.2″ monochrome STN LCD	(Note 1)
		8.4″ color TFT LCD	(Note 1)
		9.5″ monochrome STN LCD	(Note 1)
		10.4″ color TFT LCD	(Note 1)
	With 4 option slots	7.2″ monochrome STN LCD	(Note 1)
		8.4″ color TFT LCD	(Note 1)
		9.5″ monochrome STN LCD	(Note 1)
		10.4″ color TFT LCD	(Note 1)
	No option slots	10.4″ color TFT LCD	(Note 2)
	With 2 option slots	10.4″ color TFT LCD	(Note 2)
	With 2 option slots	10.4″ color TFT LCD	(Note 2)

NOTE
1 The model has an HSSB interface board and can perform high–speed data communication with a PC.
2 The model has a control unit incorporating PC functions.

Serial communication board	Loader control board	Mother board
Remote buffer /DNC1/DNC2/HDLC	Loader control function • 2/4–axis control	CPU for controlling the CNC • Power supply • 2–axis to 8–axis control • Spindle interface • LCD/MDI • I/O Link • PMC–RB5/RB6 • Analog output/high– speed DI • RS–232C × 2 • Memory card interface • PC functions (Series 160i with PC functions)

Sub–CPU board

Sub–CPU for two–path control
• 2–axis to 8–axis control
• Spindle interface
• Analog output

Data server board

Data server function

RISC board

High–precision contour control function

C board

C functions for PMC

HSSB interface board

High–speed serial bus inter-face (for the Series 160i only)

CAP II board

Graphic conversation

Basic system

Option

Without option slots or with two or four option slots

On a unit with two option slots, two option boards can be mounted.
On a unit with four option slots, four option boards can be mounted.
(On the unit with four option slots, just a data server board or HSSB interface board can be fit into the slot furthest from the LCD.)

Fig. 3.9.1(a) Configuration of the control unit (Series 16i/160i)

| Serial communication board |
| Remote buffer /DNC1/DNC2/HDLC |

| Sub–CPU board |
| Sub–CPU for two–path control
• 2–axis to 6–axis control
• Spindle interface
• Analog output |

| C board |
| C functions for PMC |

| CAP II board |
| Graphic conversation |

| Loader control board |
| Loader control function
• 2/4–axis control |

| Data server board |
| Data server function |

| HSSB interface board |
| High–speed serial bus interface (for the Series 180i only) |

| Mother board |
| CPU for controlling the CNC
• Power supply
• 2–axis to 6–axis control
• Spindle interface
• LCD/MDI
• I/O Link
• PMC–RB5/RB6
• Analog output/high–
  speed DI
• RS–232C × 2
• Memory card interface
• PC functions (Series 180i
  with PC functions) |

Basic system

Option

Without option slots or with two or four option slots

On a unit with two option slots, two option boards can be mounted.
On a unit with four option slots, four option boards can be mounted.
(On the unit with four option slots, just a data server board or HSSB interface board can be fit into
the slot furthest from the LCD.)

Fig. 3.9.1(b) Configuration of the control unit (Series 18i/180i)

3.9.2
Installation of the
Control Unit

The control unit has a built–in fan motor.

Air enters the control unit through the bottom and is drawn through the fan motor which is located on the top of the control unit.

Space (1), shown in Fig. 3.9.2, must be provided to ensure unrestricted air flow. Also, space (2) should be provided whenever possible. When space (2) cannot be provided, ensure that nothing is placed in the immediate vicinity which could obstruct the air flow.
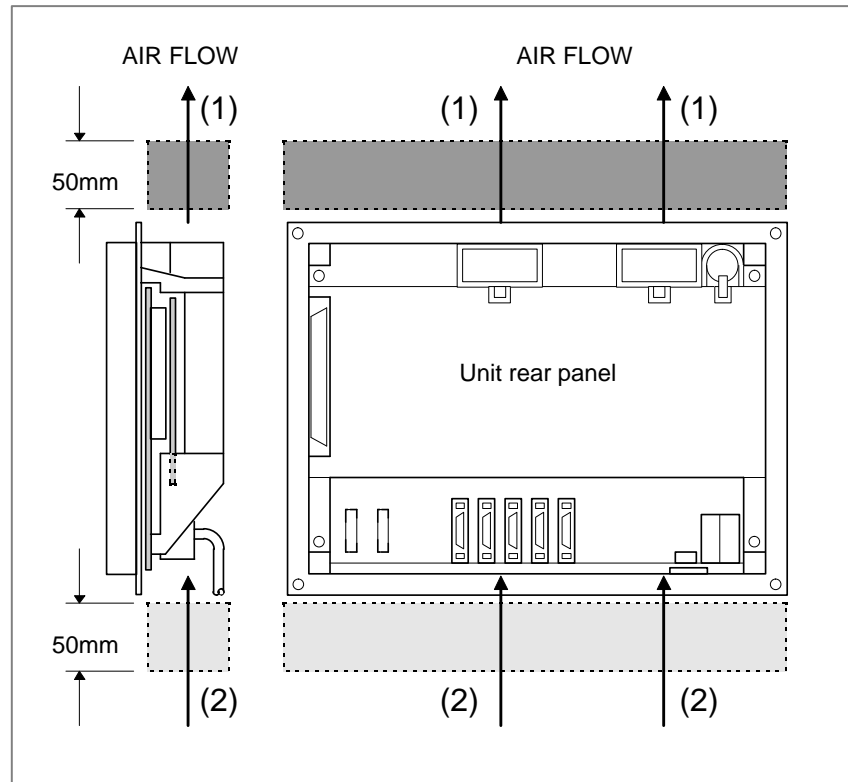
Fig. 3.9.2 Installing of the control unit

3.9.3
Battery for Memory Backup

Part programs, offset data, and system parameters are stored in CMOS memory in the control unit. The power to the CMOS memory is backed up by a lithium battery mounted on the front panel of the control unit. The above data is not lost even when the main battery goes dead. The backup battery is mounted on the control unit at shipping. This battery can maintain the contents of memory for about a year.

When the voltage of the battery becomes low, alarm message "BAT" blinks on the LCD display and the battery alarm signal is output to the PMC. When this alarm is displayed, replace the battery as soon as possible. In general, the battery can be replaced within one or two weeks, however, this depends on the system configuration.

If the voltage of the battery becomes any lower, memory can no longer be backed up. Turning on the power to the control unit in this state causes system alarm 910 (SRAM parity alarm) to occur because the contents of memory are lost. Clear the entire memory and reenter data after replacing the battery.

When replacing the memory backup battery, do so while the control unit is turned off.

The following two kinds of batteries can be used.

- Lithium battery built into the CNC control unit.
- Two alkaline dry cells (size D) in the external battery case.

NOTE
  A lithium battery is installed as standard at the factory.

Replacing the lithium battery

(1) Prepare a new lithium battery (ordering drawing number: A02B–0236–K102).

(2) Turn the Series 16*i*/18*i*/160*i*/180*i* on for about 30 seconds.

(3) Turn the Series 16*i*/18*i*/160*i*/180*i* off.

(4) Remove the old battery from the top of the CNC control unit.
   First unplug the battery connector then take the battery out of its case. The battery case of a control unit without option slots is located at the top right end of the unit. That of a control unit with 2 slots or 4 slots is located in the central area of the top of the unit (between fans).
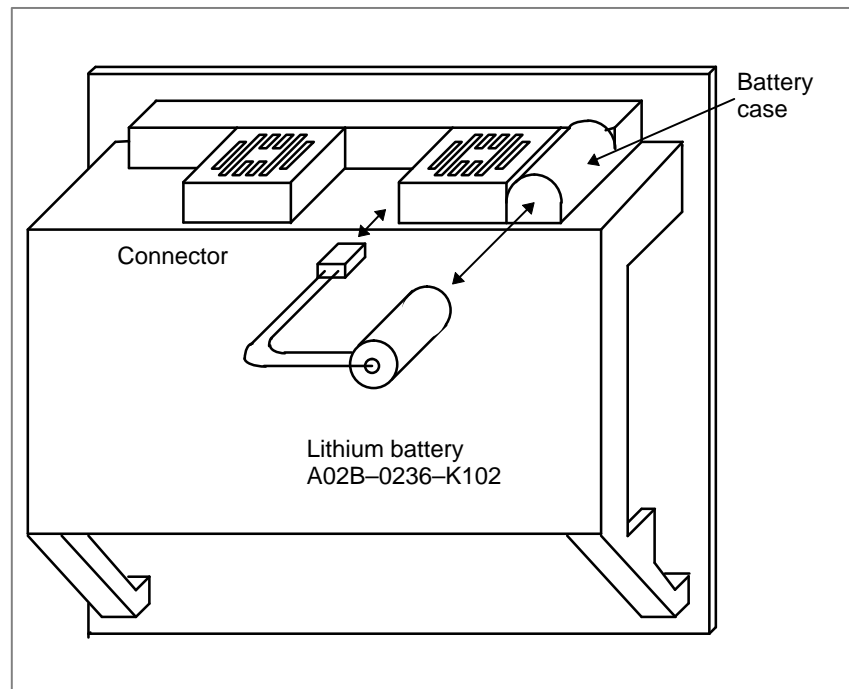
(5) Insert a new battery and reconnect the connector.

CAUTION

Complete the steps (3) to (5) within 30 minutes (within 5 minutes, for the Series 160*i*/180*i* with PC functions).

If the battery is left disconnected for a long time, the contents of memory will be lost.

If there is a possibility that the replacement is not completed within 30 minutes, save the whole contents of the CMOS memory to a memory card in advance. The data can be easily restored in case the memory contents are lost.

For the operating procedure, refer to the maintenance manual.

WARNING

Using other than the recommended battery may result in the battery exploding.

Replace the battery only with the specified battery (A02B–0236–K102).

Dispose of used batteries as follows.

(1) Small quantities (less than 10)

Discharge the batteries and dispose of them as ordinary unburnable waste.

(2) Large quantities

Please consult FANUC.

Replacing the alkaline dry cells (size D)

(1) Prepare two new alkaline dry cells (size D).

(2) Turn the Series 16*i*/18*i*/160*i*/180*i* on.

(3) Remove the battery case cover.

(4) Replace the batteries, paying careful attention to their orientation.

(5) Replace the battery case cover.

> **NOTE**
> When replacing the dry cells while the power is off, use the same procedure as that for lithium battery replacement procedure, described above.

Dry cell × 2

Cover

Connection terminal on the rear

Mounting hole × 4

Battery case
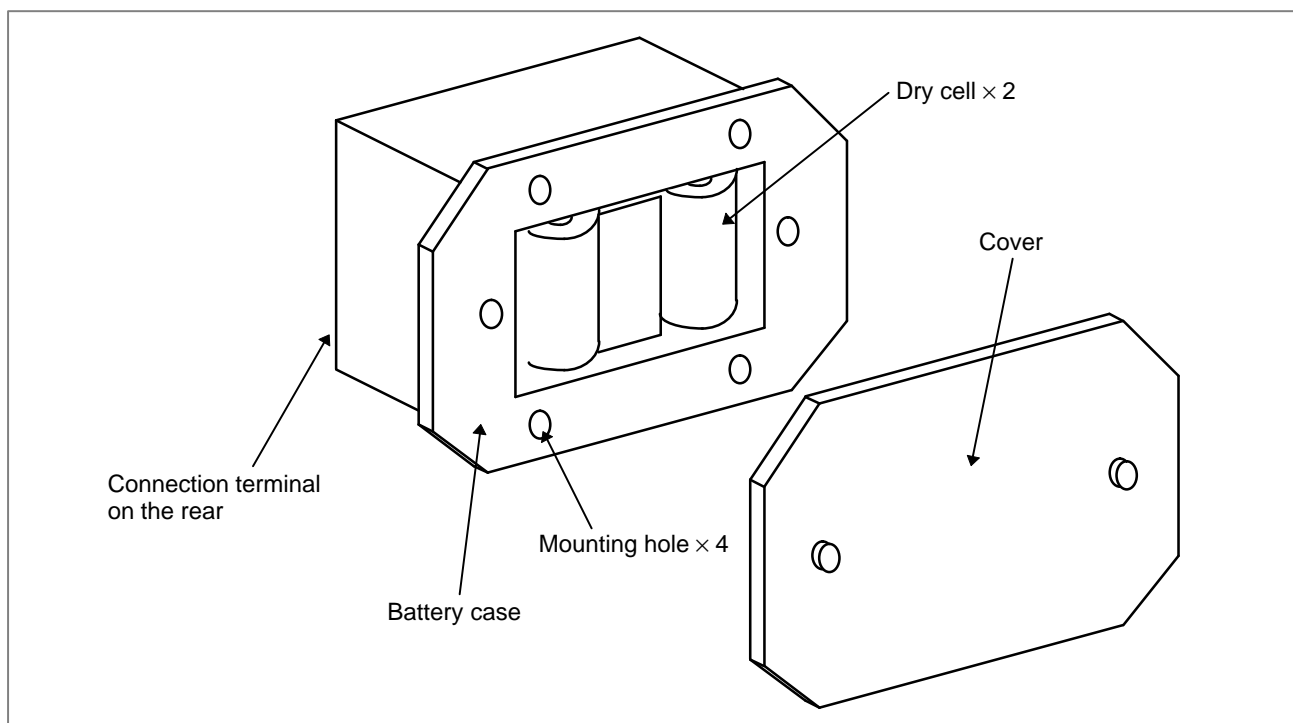
Use of alkaline dry cells (size D)

Connection

Power from the external batteries is supplied through the connector to which the lithium battery is connected. The lithium battery, provided as standard, can be replaced with external batteries in the battery case (A02B–0236–C281) according to the battery replacement procedures described above.
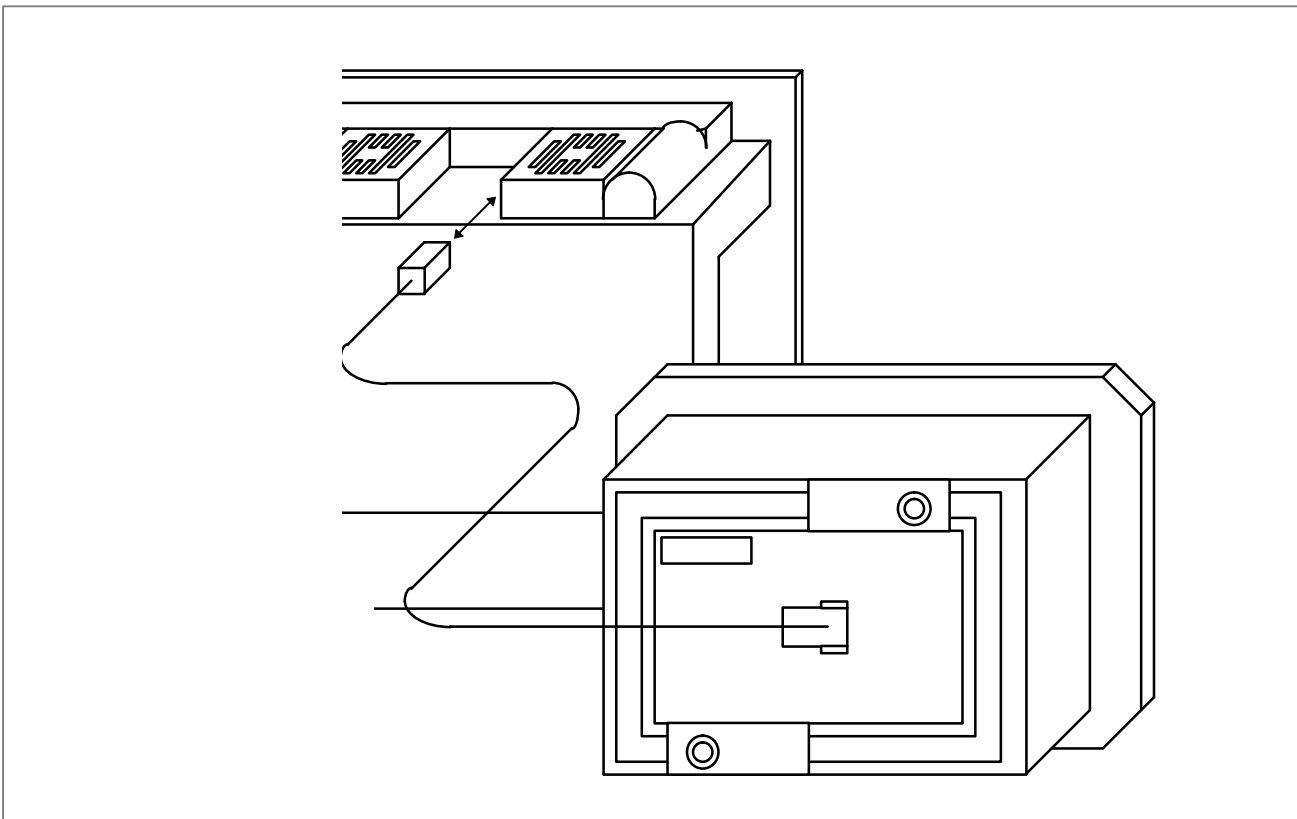
NOTE
Install the battery case (A02B–0236–C281: 14–m cable) in a location where the batteries can be replaced even when the control unit power is on.
The battery cable connector is attached to the control unit by means of a simple lock system. To prevent the connector from being disconnected due to the weight of the cable or tension within the cable, fix the cable section within 50 cm of the connector.

3.9.4
Battery for Separate
Absolute Pulse Coders

One battery unit can maintain current position data for six absolute pulse coders for a year.

When the voltage of the battery becomes low, APC alarms 306 to 308 are displayed on the CRT display. When APC alarm 307 is displayed, replace the battery as soon as possible. In general, the battery should be replaced within one or two weeks, however, this depends on the number of pulse coders used.

If the voltage of the battery becomes any lower, the current positions for the pulse coders can no longer be maintained. Turning on the power to the control unit in this state causes APC alarm 300 (reference position return request alarm) to occur. Return the tool to the reference position after replacing the battery.

See 7.9.2 for details of connecting the battery to separate absolute pulse coders. The battery for the built–in absolute pulse coder is installed in the servo amplifier. For an explanation of the replacement procedure, refer to the FANUC CONTROL MOTOR AMPLIFIER α Series Maintenance Manual.

3.10 CABLE–LEAD–IN DIAGRAM

Figs. 3.10(a) to 3.10(d) show the layout of the connectors. Figs. 3.10(e) to 3.10(i) show the connector positions on option boards.
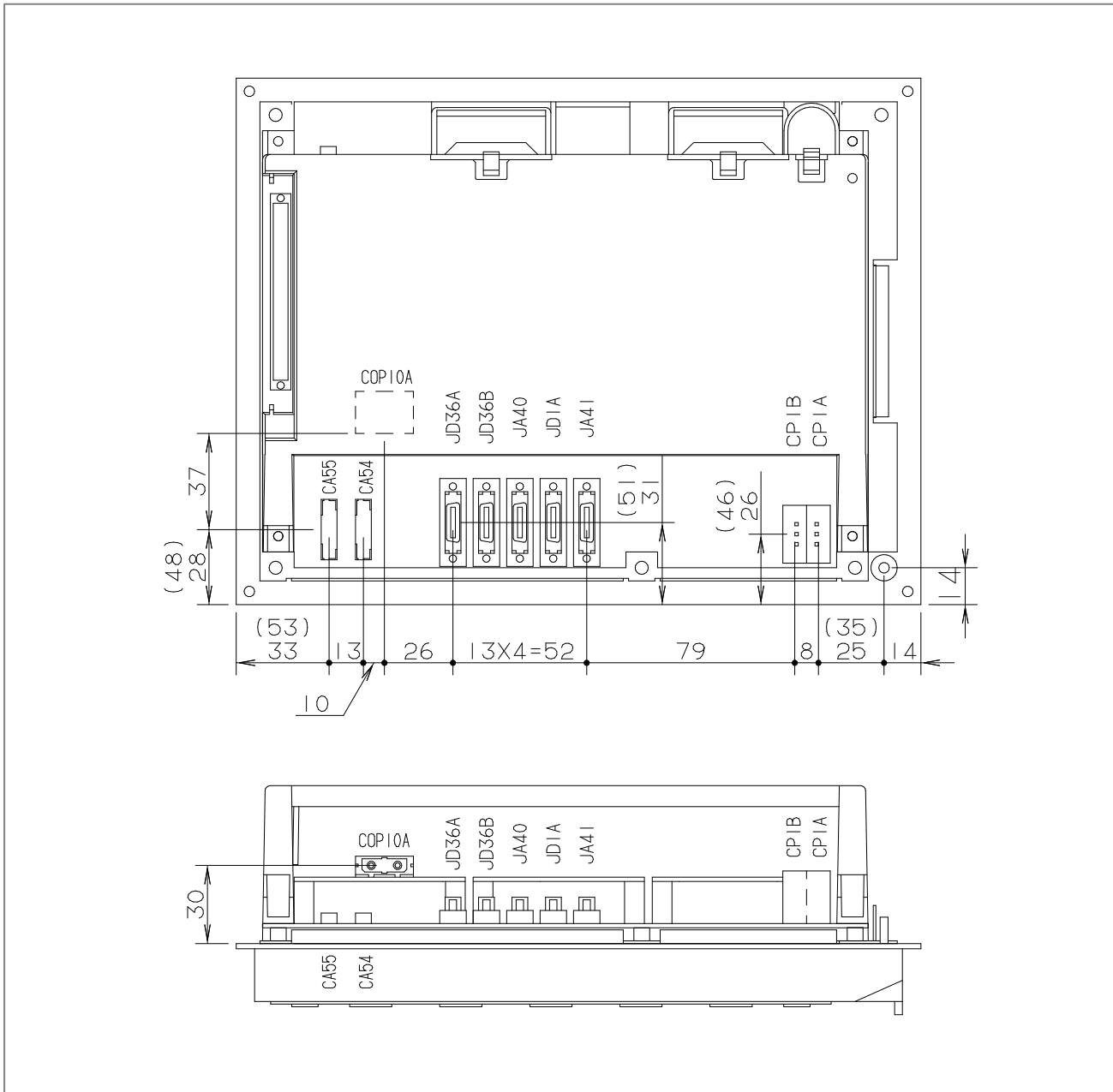
Fig. 3.10(a) Connector layout on the series 16*i*/18*i* control unit (without PC functions)

> **NOTE**
> The numbers indicate the dimensions on the unit with 7.2″ or 8.4″ LCD. The numbers in parentheses indicate the dimensions on the unit with 9.5″ or 10.4″ LCD.
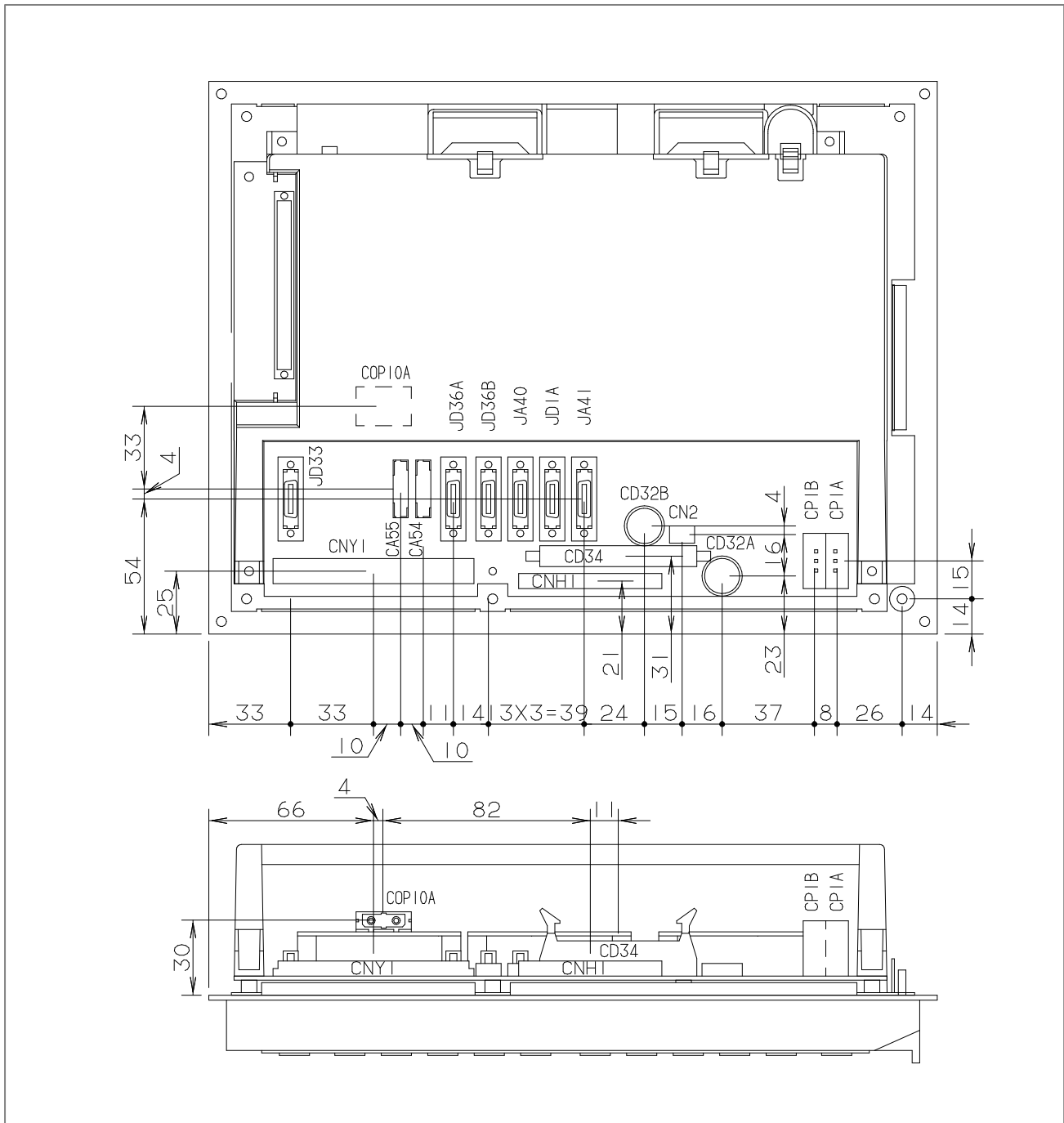
Fig. 3.10(b) Connector layout on the series 160*i*/180*i* control unit (with PC functions)
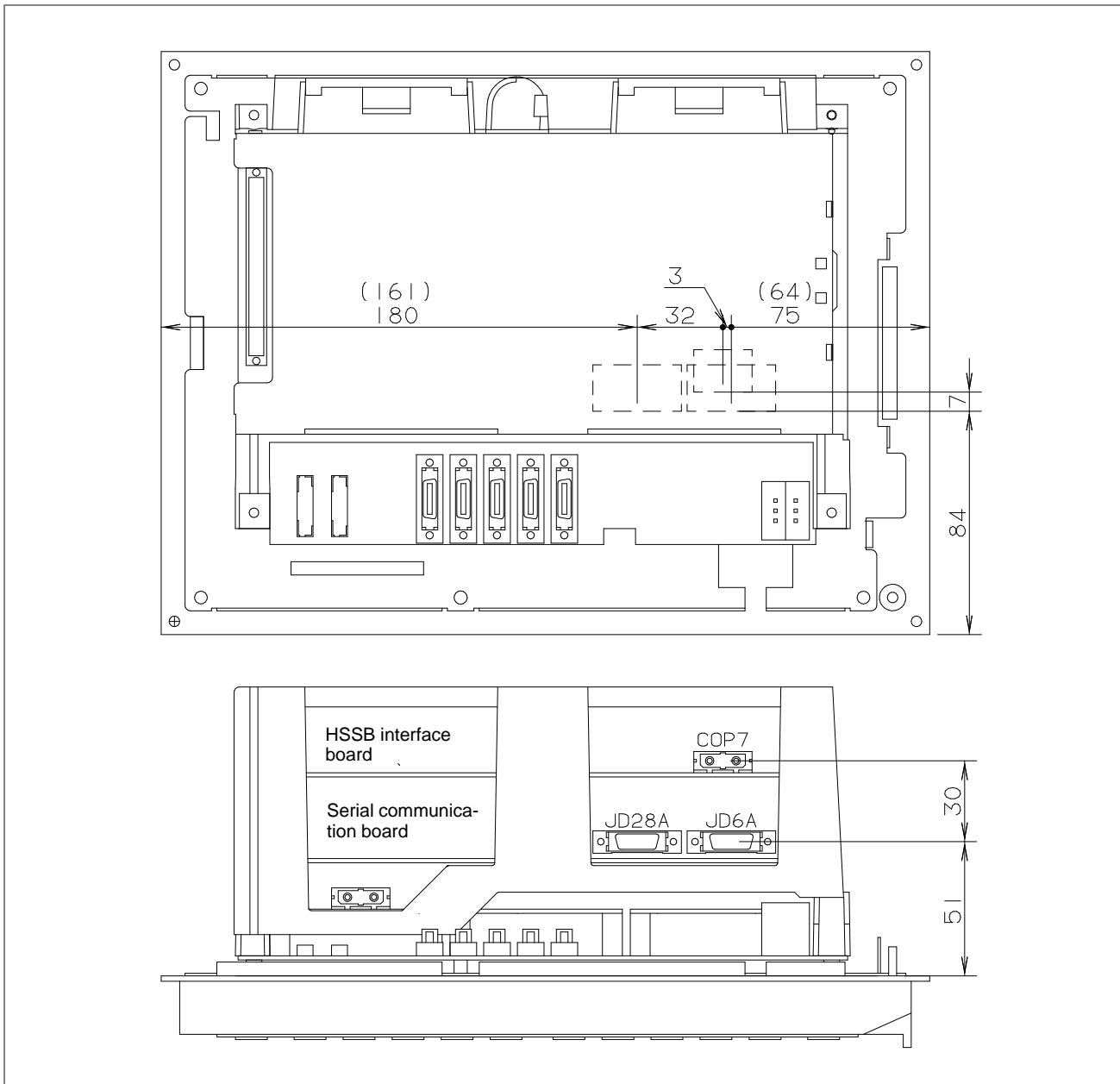
Fig. 3.10(c) Layout of option board connectors on the control unit with two option slots

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NOTE
The numbers indicate the dimensions on the unit with 9.5″ or 10.4″ LCD. The numbers in parentheses indicate the dimensions on the unit with 7.2″ or 8.4″ LCD.
The option boards are interchangeable.
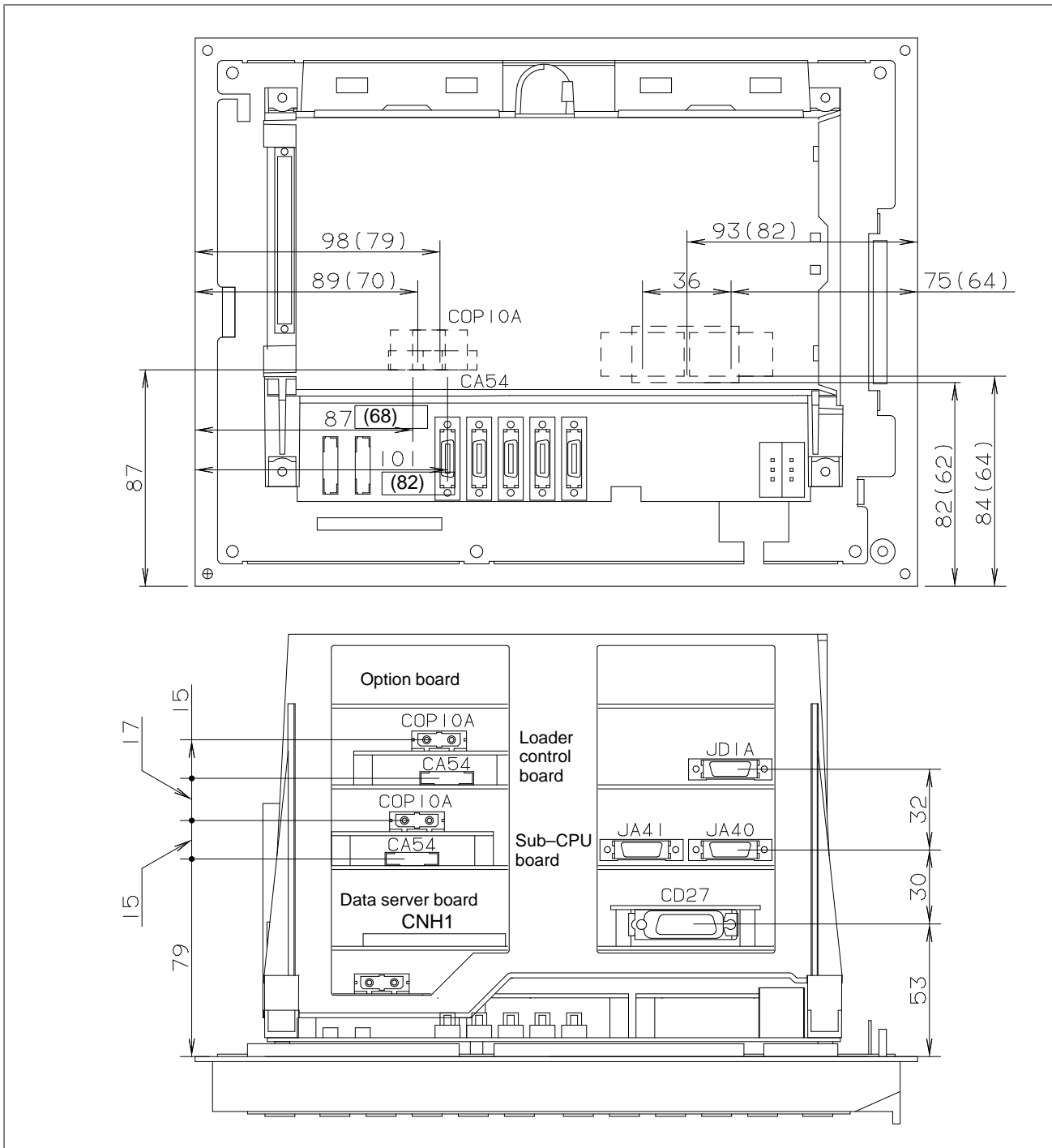
Fig. 3.10(d) Layout of the option board connectors on the control unit with four option slots

NOTE
   The numbers indicate the dimensions on the unit with 9.5″ or 10.4″ LCD. The numbers in parentheses indicate the dimensions on the unit with 7.2″ or 8.4″ LCD.
   The option boards are interchangeable.
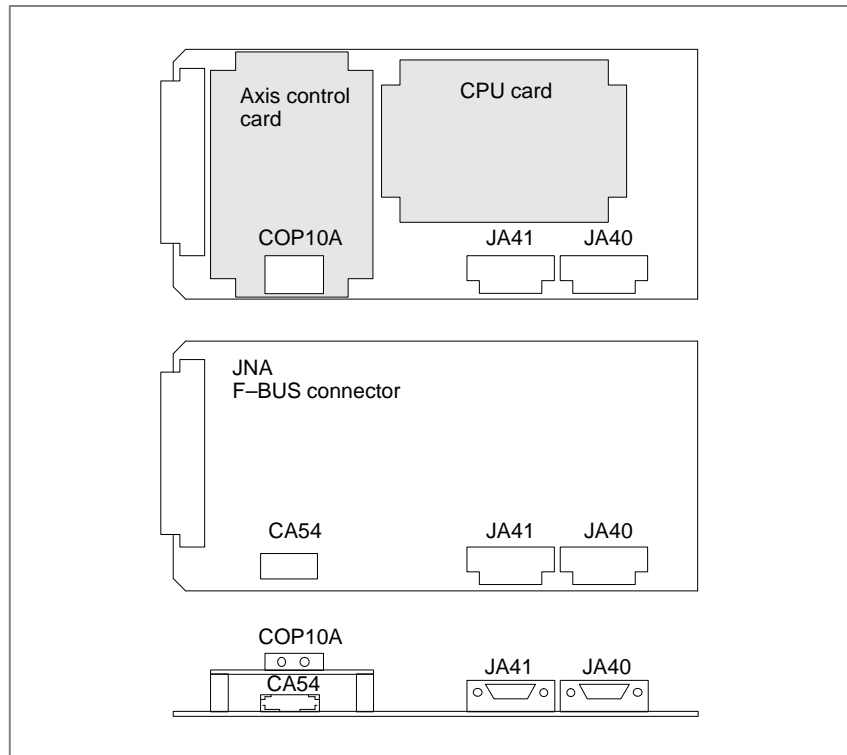
Fig. 3.10(e) Connector positions on the sub–CPU board
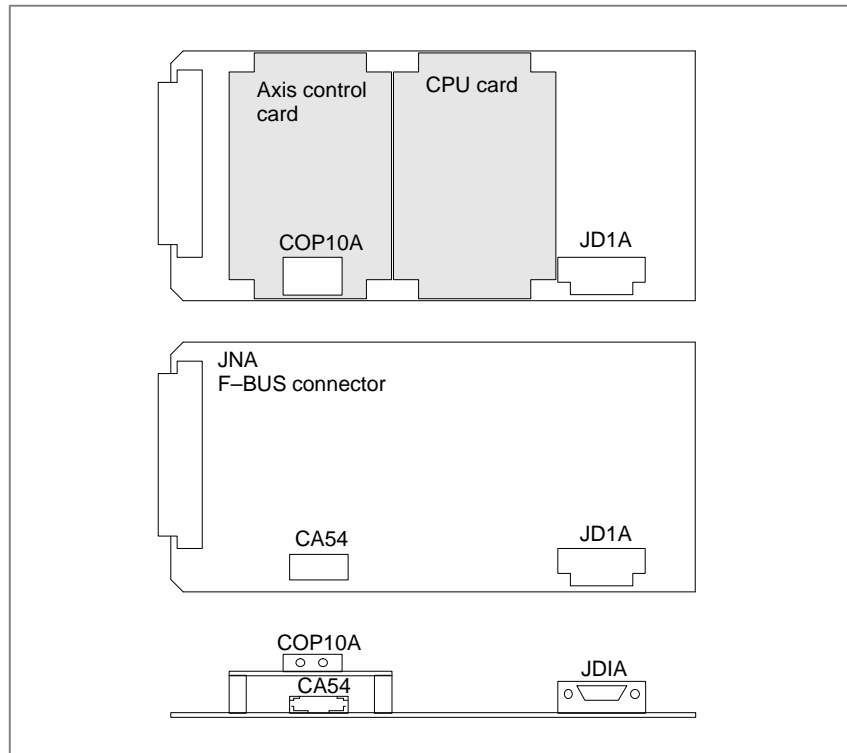
Fig. 3.10(f) Connector positions on the loader control board
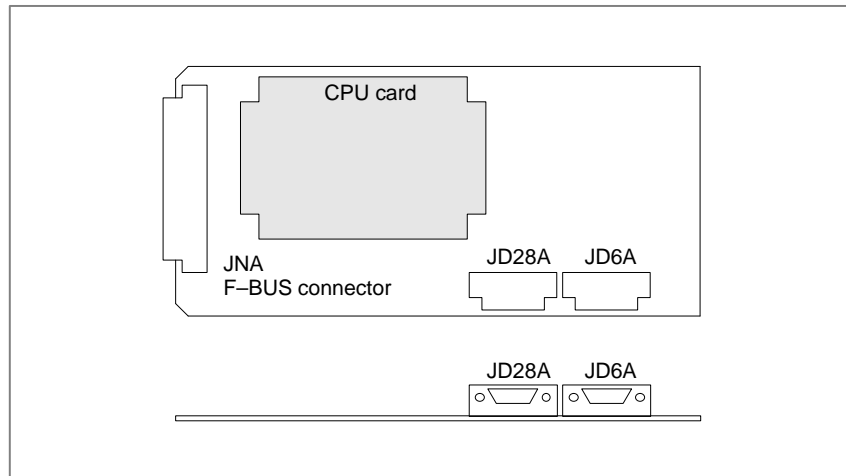
Fig. 3.10(g) Connector positions on the serial communication board
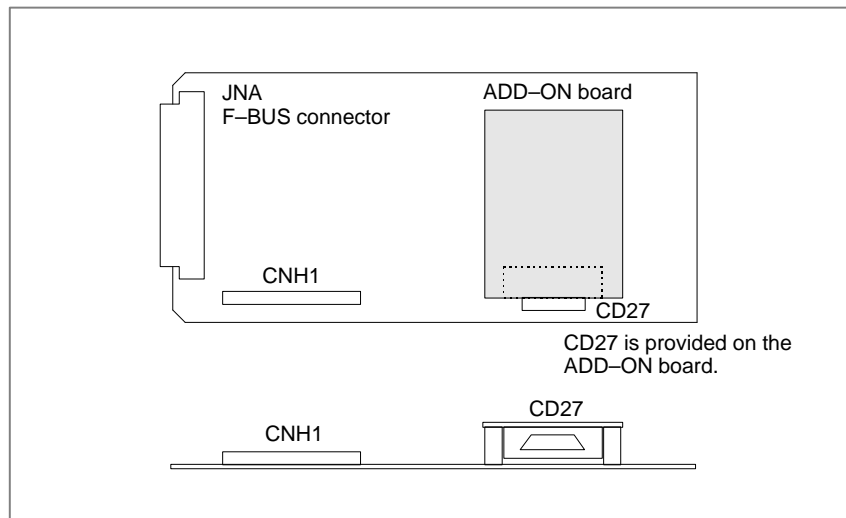
Fig. 3.10(h) Connector positions on the data server board
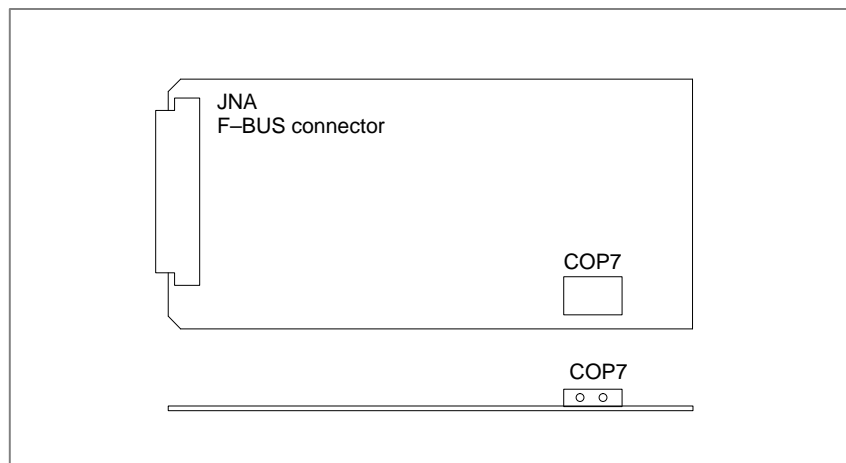
Fig. 3.10(i) Connector positions on the HSSB interface board

4 TOTAL CONNECTION

Mother board
(with LCD)

24V–IN(CP1A)   24 VDC power

24V–OUT(CP1B)   to I/O device

MDI UNIT

Soft key cable   CK2

MDI(CA55)   CK1

R232–1(JD36A)   RS–232C I/O device

R232–2(JD36B)   Touch panel or RS–232C I/O device
(When the unit has PC functions, the touch panel
is connected to JD33.)

A–OUT&HDI(JA40)   Analog output for tool drive

                  High–speed skip input

Distributed I/O
board   Manual pulse generator

DC24V   CPD1   JA3

                   JD1B   Operator's
panel
I/O–LINK(JD1A)   JD1A

DC24V   CPD1   Distributed I/O
board   Power
magnetics
cabinet
                  JD1B   Distributed I/O
board, I/O unit,
etc.
                  JD1A

Serial communication
board
Remote buffer card
DNC1 board
DNC2 board

R232–3(JD28A) — RS–232C I/O device
(When the remote buffer board or DNC2 board is used)

R422–1(JD6A) — RS–422 I/O device
(When the remote buffer board or DNC1 board is used)

Sub–CPU board

A–OUT(JA40) — Analog output for tool drive

SPDL&POS(JA41) — { — Position coder

PSM

Position coder

Spindle motor

SPM

To 2nd spindle

Servo card

FSSB(COP10A)

COP10B
COP10A
SVM — Sub 1st servo motor

COP10B
COP10A
SVM — Sub 2nd servo motor

COP10B
COP10A
SVM — Sub 3rd servo motor

COP10B
COP10A
SVM — Sub 4th servo motor

Up to six or eight axes, depending on the model

SV–CHK(CA54) — Servo check

Data server board

HDD(CNH1) — Hard disk unit

The hard disk unit is mounted in the rear of the MDI unit.
The cable for the hard disk unit is provided by FANUC.

10BASE5(CD27) — Ethernet

Loader control board

Loader I/O board

DC24V

I/O Link (JD1A) — JD1B

JD1A

PSM

Servo card

FSSB(COP10A) — COP10B   SVM   Loader 1st axis servo motor
COP10A

COP10B   SVM   Loader 2nd axis servo motor
COP10A

COP10B   SVM   Loader 3rd axis servo motor
COP10A

COP10B   SVM   Loader 4th axis servo motor
COP10A

SV–CHK(CA54) — Servo check

HSSB board

HSSB(COP7) — Personal Computer

The following figure shows the specific connection to the Series 160*i*/180*i* control unit having PC functions.
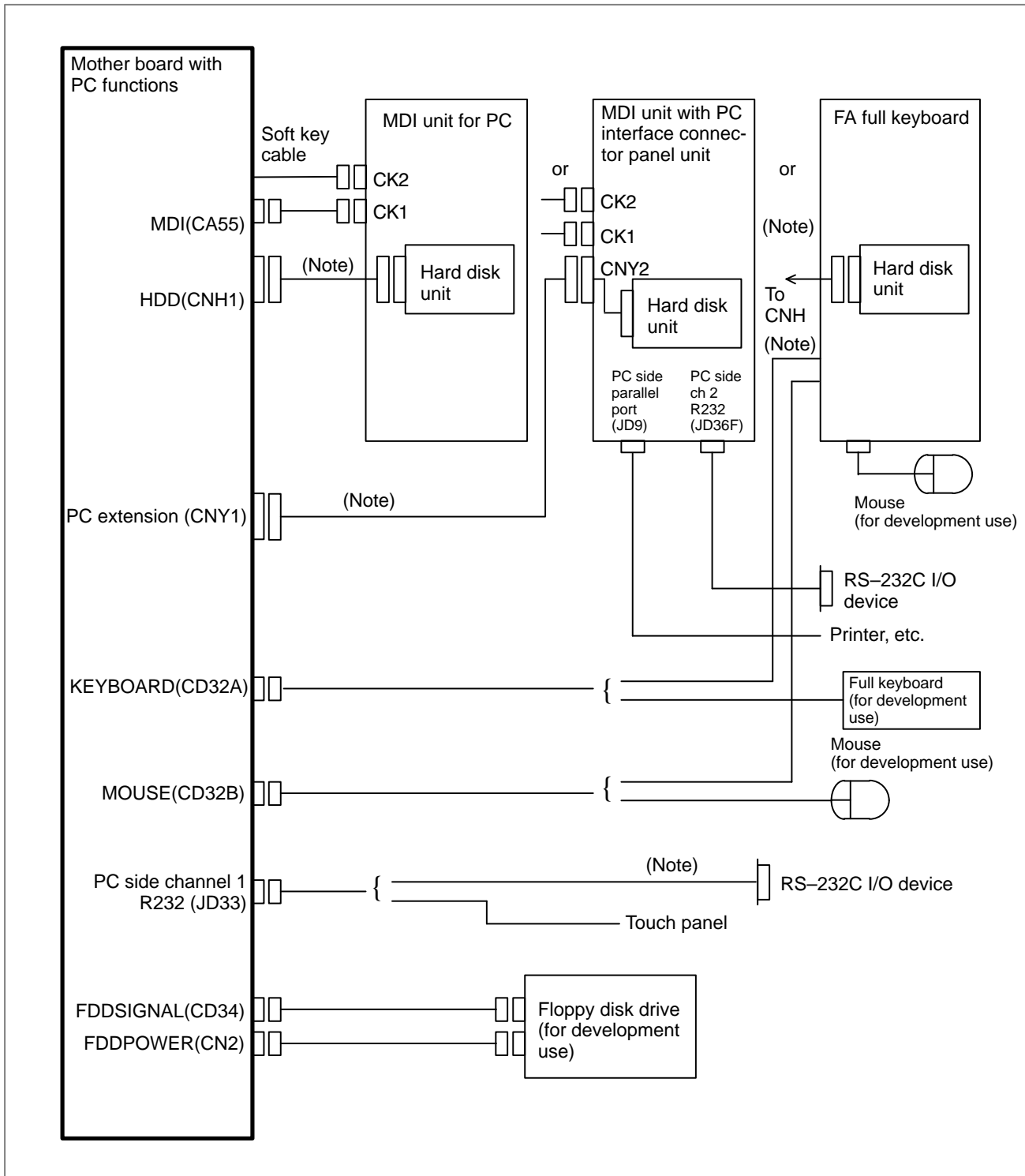
NOTE
The cables for the hard disk unit, PC interface connector unit and FA full keyboard are provided by FANUC.

5 POWER SUPPLY UNIT CONNECTION

5.1
TURNING ON AND
OFF THE POWER TO
THE CONTROL UNIT

5.1.1
Power Supply for the Control Unit

Supply power (24 VDC) to the control unit of Series 16*i*/18*i*/160*i*/180*i* from an external sources.

Install a power switch at (1) in Fig. 5.1.1(a).

When the Series 160*i*/180*i* control unit with PC functions is used, apply countermeasures to guard against the possible destruction of hard disk storage due to momentary power failure or power outage, by installing an uninterruptible power supply, etc.

The power rating is equal to the sum of the capacity of the control unit (total heat dissipation of the unit indicated in 3.6 plus a margin of about 20% to 30%) and the output via the control unit (output from CP1B).
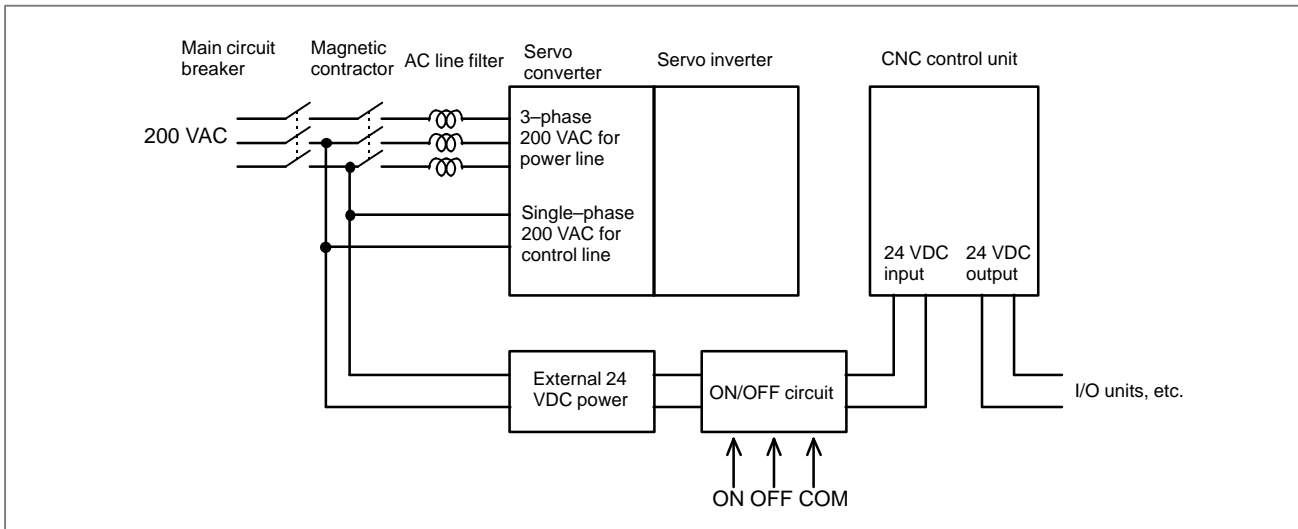
Fig. 5.1.1(a)

ON/OFF circuit (example)

For example, "ON/OFF circuit" is as shown in Fig. 5.1.1(b).

Select the circuit devices, in consideration of its capacity.
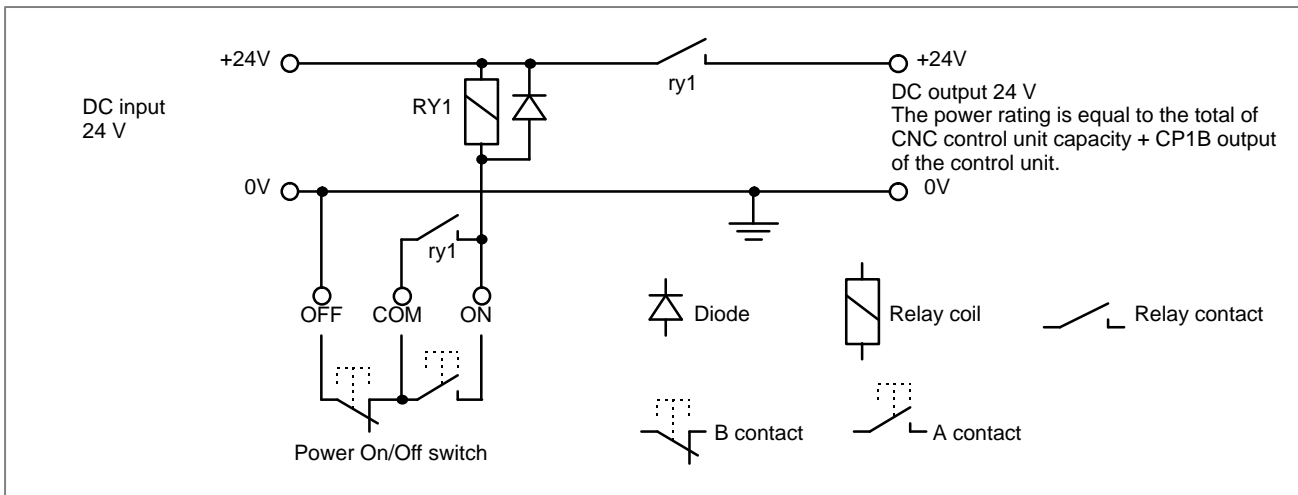
Fig. 5.1.1(b)

5.1.2
Procedure for Turning on the Power

Turn on the power to each unit in the following order or all at the same time.

---

1 Power supplies (200 VAC) for the entire machine
2 Power supplies (24 VDC) for slave I/O devices connected using the FANUC I/O Link (such as the I/O Unit–MODEL A)
3 Power supplies (24 VDC) for the control unit and CRT unit (200 VAC for the PDP unit)

Do not disconnect the battery for memory backup (3 VDC) or the battery for the separate absolute pulse coders (6 VDC) regardless of whether the power to the control unit is on or off. If batteries are disconnected when the power to the control unit is turned off, current data stored in the control unit for the pulse coders, parameters, programs etc, are lost.
Make sure that the power to the control unit is on when replacing batteries.
See Section 3.9.3 for how to replace the batteries for memory backup.

5.1.3
Procedure for Turning off the Power

Turn off the power to each unit in the following order or all at the same time.
An interval of 500 ms or longer is necessary between steps 1 and 2.

---

1 Power supplies (24VDC) for slave I/O devices connected using the FANUC I/O Link (such as the I/O Unit–MODEL A)
2 Power supplies (24 VDC) for the control unit and CRT unit (200 VAC for the PDP unit)
3 Power supplies (200 VAC) for the entire machine

Motors cannot be controlled when the power is turned off or momentarily interrupted. Take appropriate action on the machine side when necessary. For example, when the tool is moved along a vertical axis, apply brakes to prevent the axis from falling. Apply a brake that clamps the motor when the servo is not operating or the motor is not rotating. Release the clamp only when the motor is rotating. When the servo axis cannot be controlled when the power is turned off or momentarily interrupted, clamp the servo motor. In this case, the axis may fall before the relay for clamping starts operating. The designer should make sure if the distance results in trouble.

CAUTION
For the Series 160*i*/180*i* with PC functions, shut down the OS before turning off the control unit. Do not turn off the control unit while the hard disk is being accessed or before the OS is terminated. Otherwise, the data stored on the hard disk may be destroyed.

5.2
CABLE FOR POWER SUPPLY TO CONTROL UNIT

Supply power to the control unit from external resource.
The 24 VDC input to CP1A can be output from CP1B for use in branching.

CNC

External power

CP1A

1	+24V
2	0V
3	

24 VDC stabilized power
24 VDC±10%

Select a source that meets the external power terminal.

CP1B

1	+24V
2	0V
3	

24–VDC input device

Cable connection

+24V(1) ——————— +24V

0V(2) ——————— 0V

Recommended cable: A02B–0124–K830 (5 m)
(Crimp terminal of size M3 is available on the external power side)
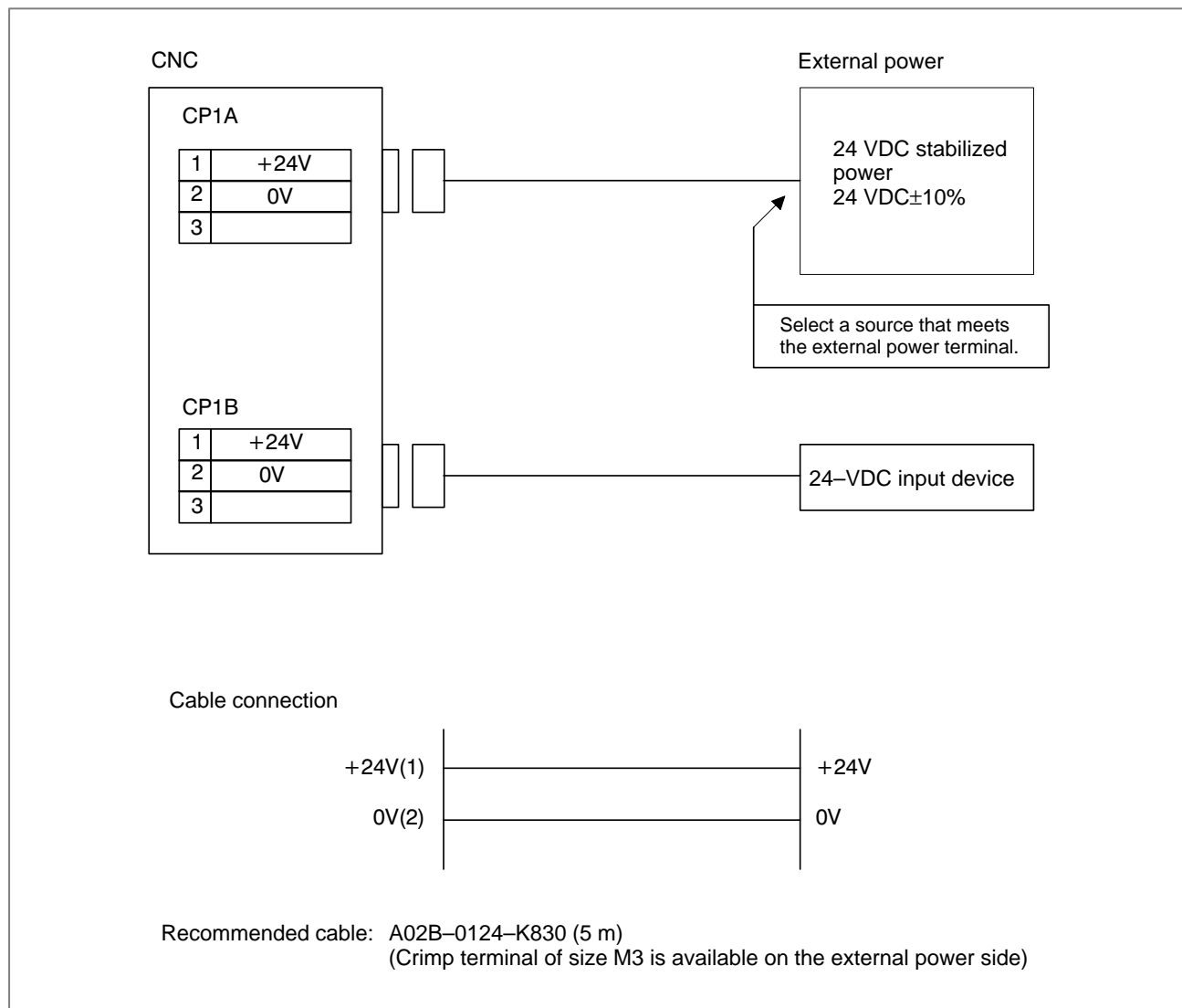
6 CONNECTION OF I/O UNITS TO MACHINE INTERFACE

6.1
GENERAL

Combinations of the units listed in Table 6.1 can be used as the machine interface I/O.

The I/O unit for the FANUC I/O Link is installed separately from the control unit, and the two units are mutually connected by a specialized serial link (FANUC I/O Link). Multiple units can be placed in separate locations as shown below. The machine operator's panel that uses many input/output signals can be easily interfaced especially by placing the interface unit for machine operator's panel and the operator's panel connection unit in the immediate vicinity of the machine operator's panel. The FANUC I/O Link enables high–speed data transfer between the control unit and an external unit. The statuses of signals input from the machine are transferred to the control unit at constant intervals. The output signals from the control unit are sent to the external unit at constant intervals. The FANUC I/O Link has more applications. For example, the FANUC I/O Link is used to connect the FANUC Power Mate, which is single–axis CNC, or the FANUC System F–Model D Mate (F–D Mate), which is a cell controller. For details, see the subsequent description.

For details of the units which are not listed in Table 6.1, see the corresponding operating manual.

Table 6.1 Types of machine interface I/O (for FANUC I/O Link)

Unit	Description	Reference
Connector panel I/O module	Distribution type I/O unit that handles the input/output signals required by the power magnetics circuit; it has an interface with a manual pulse generator.	Sec. 6.3
Operator's panel I/O module (for matrix input)	Unit having an interface with a machine operator's panel; it has an interface with a manual pulse generator.	Sec. 6.4
Operator's panel I/O module	Unit having an interface with a machine operator's panel that handles the input/output signals required by the power magnetics circuit; it has an interface with a manual pulse generator.	Sec. 6.5
FANUC I/O Unit– MODEL A	Modular I/O unit that supports a combination of the input/output signals required by a power magnetics circuit.	Sec. 6.6 (B–61813E)
FANUC I/O Unit– MODEL B	Distribution type I/O unit that supports a combination of input/output signals required by a power magnetics circuit.	B–62163E
Machine operator's panel interface unit	Unit having an interface with a matrix of key switches and LEDs on the machine operator's panel as well as an interface with a manual pulse generator.	B–62753EN
Operator's panel connection unit	Unit having an interface with a machine operator's panel	B–62753EN
Source type output operator's panel connection unit	Unit having an interface with a machine operator's panel; a source type output circuit is used in the DO signal output driver.	Sec. 6.7

Table 6.1 Types of machine interface I/O (for FANUC I/O Link)

Unit	Description	Reference
FANUC I/O Link connection unit	Unit connecting FANUC I/O Link masters to enable the transfer of DI/DO signals	Sec. 6.8
FANUC servo unit β series (with I/O Link)	Unit connected with the CNC via the FANUC I/O Link to control a servo motor	Sec. 6.9

CAUTION

1 The emergency stop signal should be simultaneously input to the CNC control unit and servo unit so that the power supply to the motor is interrupted. For detailed connection of the servo emergency stop signal, refer to "FANUC Control Motor Amplifier α Series (B–65162E)."

2 The input signals X008.0 to X008.7 include an emergency stop signal. These signals require a sink–type connection.

6.2
CONNECTION OF THE
FANUC I/O Link

6.2.1
General

The FANUC I/O Link (hereafter simply referred to as I/O Link) has the interface connector JD1A on its mother board. The I/O Link starts from this connector and is daisy–chained to the I/O unit and operator's panel interface.

In the I/O Link there are the master station and its slave stations. The master is the control unit of the CNC, and the slaves are the I/O unit and interface unit for the operator's panel. The slaves are divided into groups, and up to 16 groups can be connected to one I/O Link. A maximum of two base I/O units can be connected as a group. The operator's panel connection unit and interface unit for the operator's panel are each counted as one group.

The two connectors of the I/O link are named JD1A and JD1B, and are common to all units (that have I/O Link function). A cable is always connected from JD1A of a unit to JD1B of the next unit. Although JD1B of the last unit is not used and left open, it need not be connected with a terminator.

The pin assignments of connectors JD1A and JD1B are common to all units on the I/O Link, and are illustrated on the next page. Use the figures when connecting the I/O Link irrespective of the type of unit.
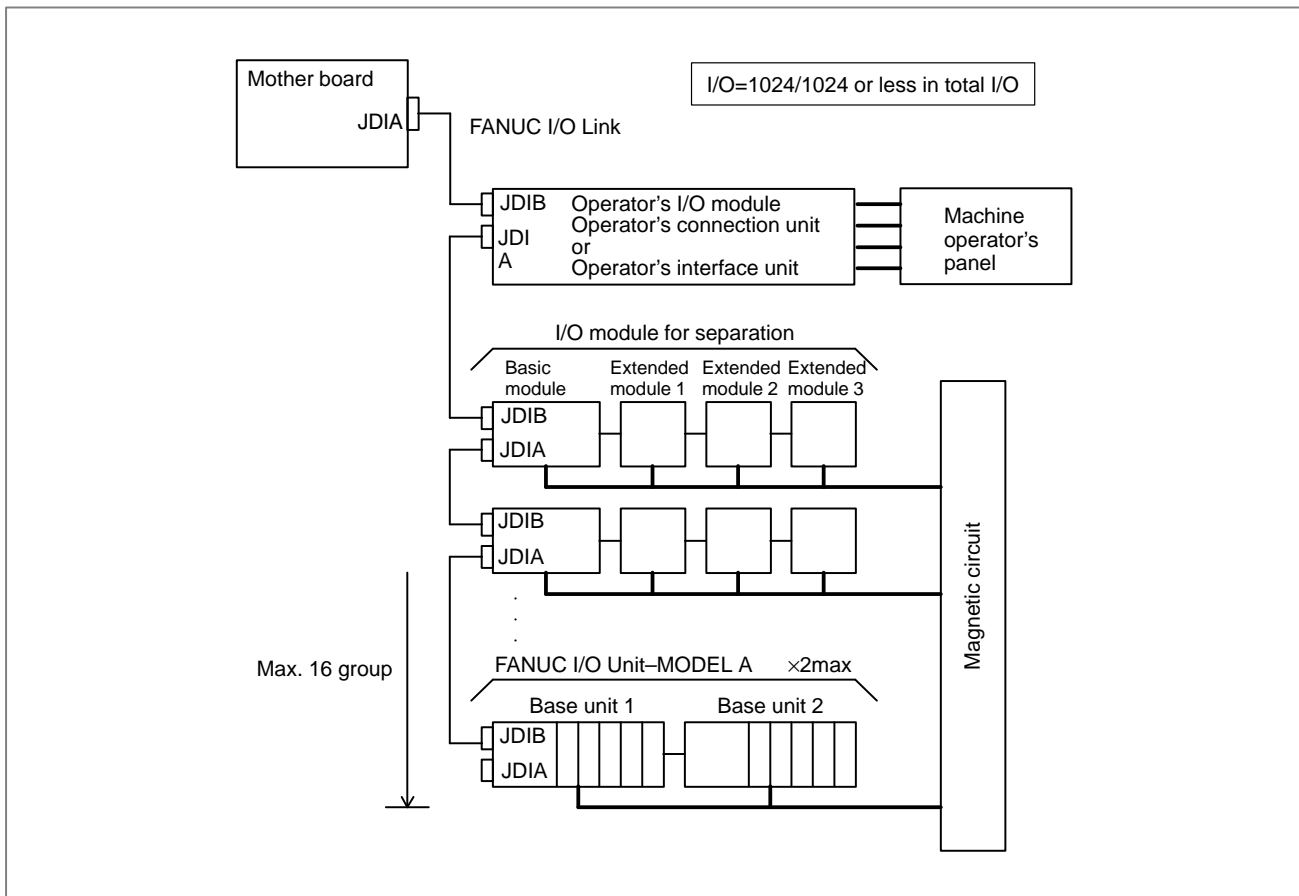
Fig.6.2.1 I/O Link connection diagram

6.2.2
Connection of FANUC I/O Link by Electric Cable

```
Control unit or preceding
slave unit                        I/O unit MODEL A

JD1A                              JD1B                        JD1A
(PCR–EV20MDT)                     (PCR–E20LMD)                (PCR–E20LMD)

 1 SIN    11 0V          JD1B      1 SIN    11 0V
 2 *SIN   12 0V                    2 *SIN   12 0V                    Next
 3 SOUT   13 0V                    3 SOUT   13 0V                    slave
 4 *SOUT  14 0V                    4 *SOUT  14 0V                    unit
 5        15                       5        15
 6        16                       6        16
 7        17                       7        17
 8        18 (+5V)                 8        18 (+5V)
 9 (+5V)  19                       9 (+5V)  19
10        20 (+5V)                10        20 (+5V)
```
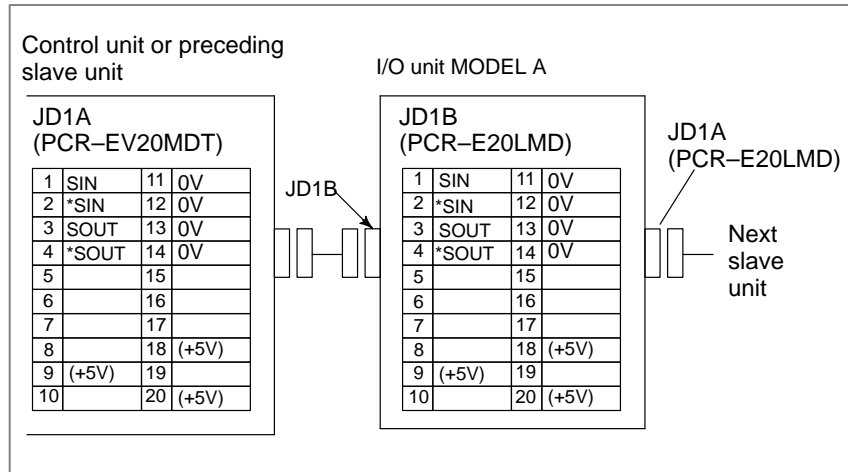
+5 V terminals are for an optical I/O link adapter. They are not necessary when connecting with a metal cable.
A line for the +5V terminal is not required when the Optical I/O Link Adapter is not used.

```
Cable wiring

SIN    1 ───┐   ┌─── 3  SOUT
*SIN   2 ───┘   └─── 4  *SOUT
SOUT   3 ───┐   ┌─── 1  SIN
*SOUT  4 ───┘   └─── 2  *SIN
0V    11 ───┐   ┌─── 11 0V
0V    12 ───┘   └─── 12 0V
0V    13 ───┐   ┌─── 13 0V
0V    14 ───┘   └─── 14 0V

              Shield
         ⏚
      Grounding Plate
```

Recommended Cable Material
A66L–0001–0284#10P(#28AWG×10pair)
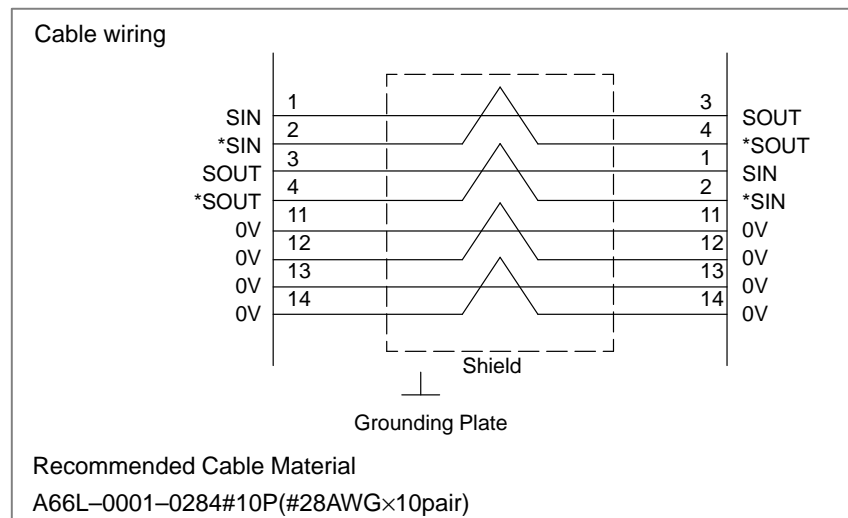
6.2.3
Connection of FANUC I/O Link Optical Fiber Cable

The FANUC I/O Link can be extended to the maximum length of 200 m with optical fiber cables using an optical I/O link adapter.

> **NOTE**
> In the following cases, use an optical fiber cable.
> - When the cable is more than 10 meters long.
> - When the cable runs between different cabinets and it is impossible to connect the cabinets with a grounding wire of 5.5 mm^2 or thicker.
> - When there is concern that the cable is influenced by strong noise; for example :
>   When there is a strong electromagnetic noise source beside the cable such as a welding machine.
>   When a noise generating cable such as a power cable runs for a long distance in parallel with the cable.

External dimension of optical link adapter
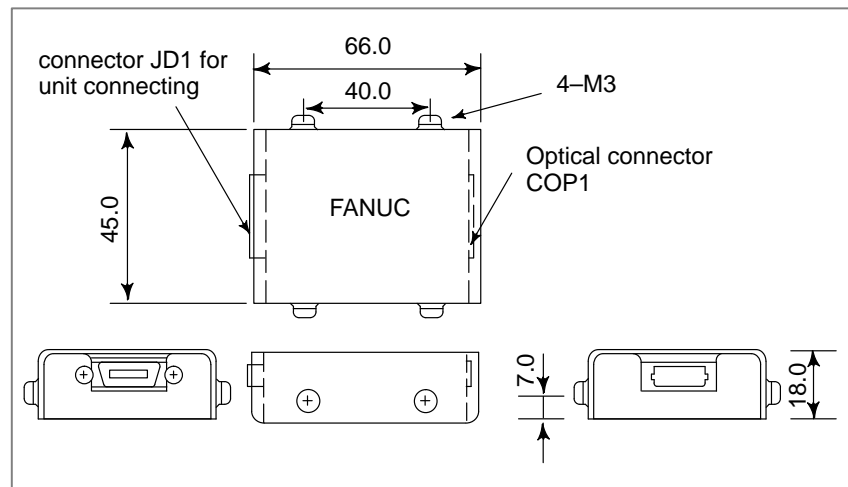
Weight of optical link adapter

Main body : Approx. 100 g.

Connection

● **Connection diagram**

- **Interunit connecting cables**

01	SIN	11	0V
02	*SIN	12	0V
03	SOUT	13	0V
04	*SOUT	14	0V
05		15	0V
06		16	0V
07		17	
08		18	+5V
09	+5V	19	
10		20	+5V

Unit side
JD1A,JD1B

Adapter side
JD1

Unit side JD1A,JD1B		Adapter side JD1
SIN(01)		(03)SOUT
*SIN(02)		(04)*SOUT
SOUT(03)		(01)SIN
*SOUT(04)		(02)*SIN
+5V(09)		(09)+5V
+5V(18)		(18)+5V
+5V(20)		(20)+5V
0V(11)		(11)0V
0V(12)		(12)0V
0V(13)		(13)0V
0V(14)		(14)0V
0V(15)		(15)0V
0V(16)		(16)0V
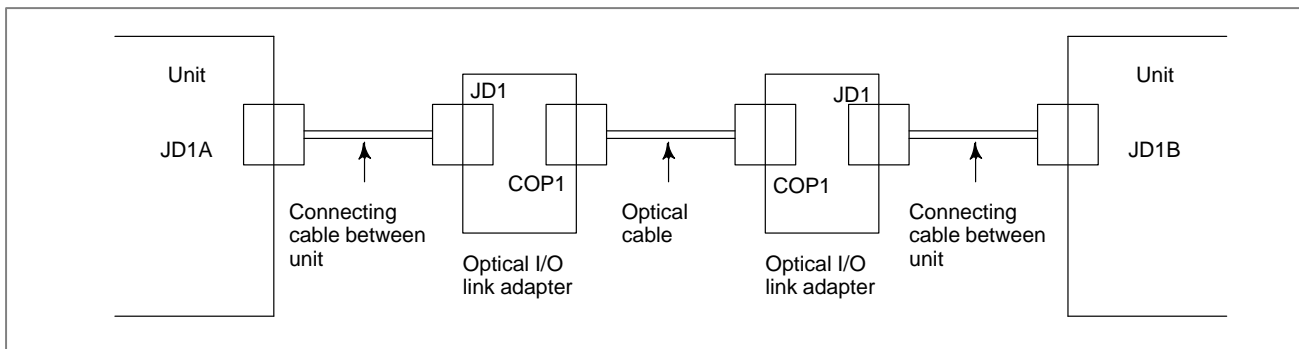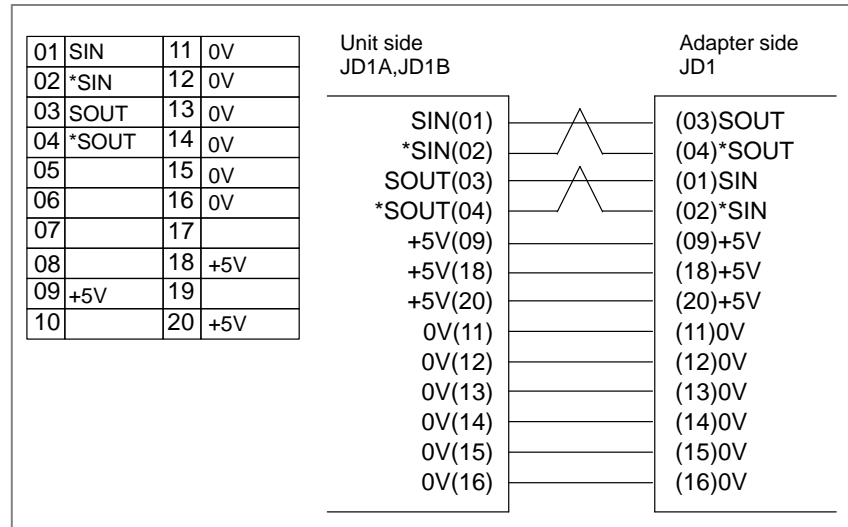
- Recommended connector for cable side :
  PCR–E20FS (made by HONDA TSUSHIN KOGYO CO., LTD.)
- Recommended cable (wire material) : A66L–0001–0284#10P
- Cable length : Max. 2 m (when the recommended cable is used)

- **Optical cable**
  - Specification : A66L – 6001 – 0009
    (Make sure to use one with this specification)
  - Cable length: Max. 200 m

Power source
- Power voltage : 4.75V to 5.25V (at the receiving end)
- Consumption current : 200mA

Installation conditions
- The optical link adapter enclosure is not fully sealed ; install it with the CNC control unit in the fully enclosed cabinet.
- Ground the case using the case fixing screw of the optical link adapter.
- The optical link adapter is light, and it may not be necessary to mount it with screws. However, keep it from coming in contact with other circuits to prevent possible short–circuits. When mounting the optical link adapter in a cabinet, attach it with an L–type fitting using the case fixing screws (M3) of the optical link adapter.

L fitting
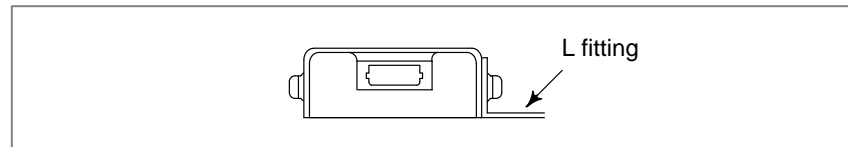
Required parts

For making up an I/O link using the optical link adapter, the following parts are necessary:

- Optical I/O link adapter   2
- Interunit connecting cable   2
- Optical cable   1

6.3 CONNECTION OF CONNECTOR PANEL I/O MODULE

6.3.1 Configuration

Flat cable for module connection

Extension module 3

Extension module 2

Extension module 1
(with manual pulse generator)

Basic module

I/O Link cable

Manual pulse generator cable
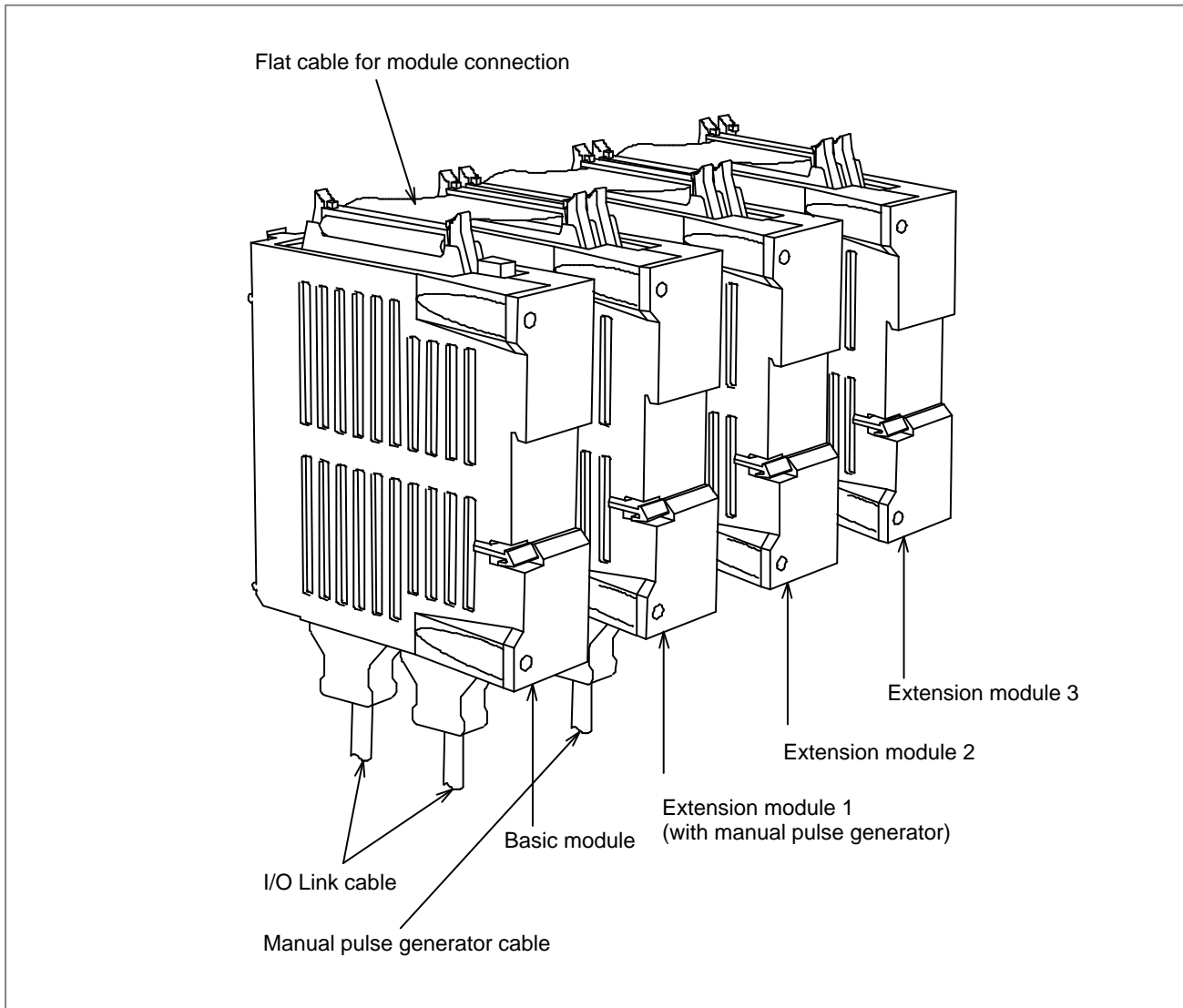
6.3.2
Connection Diagram
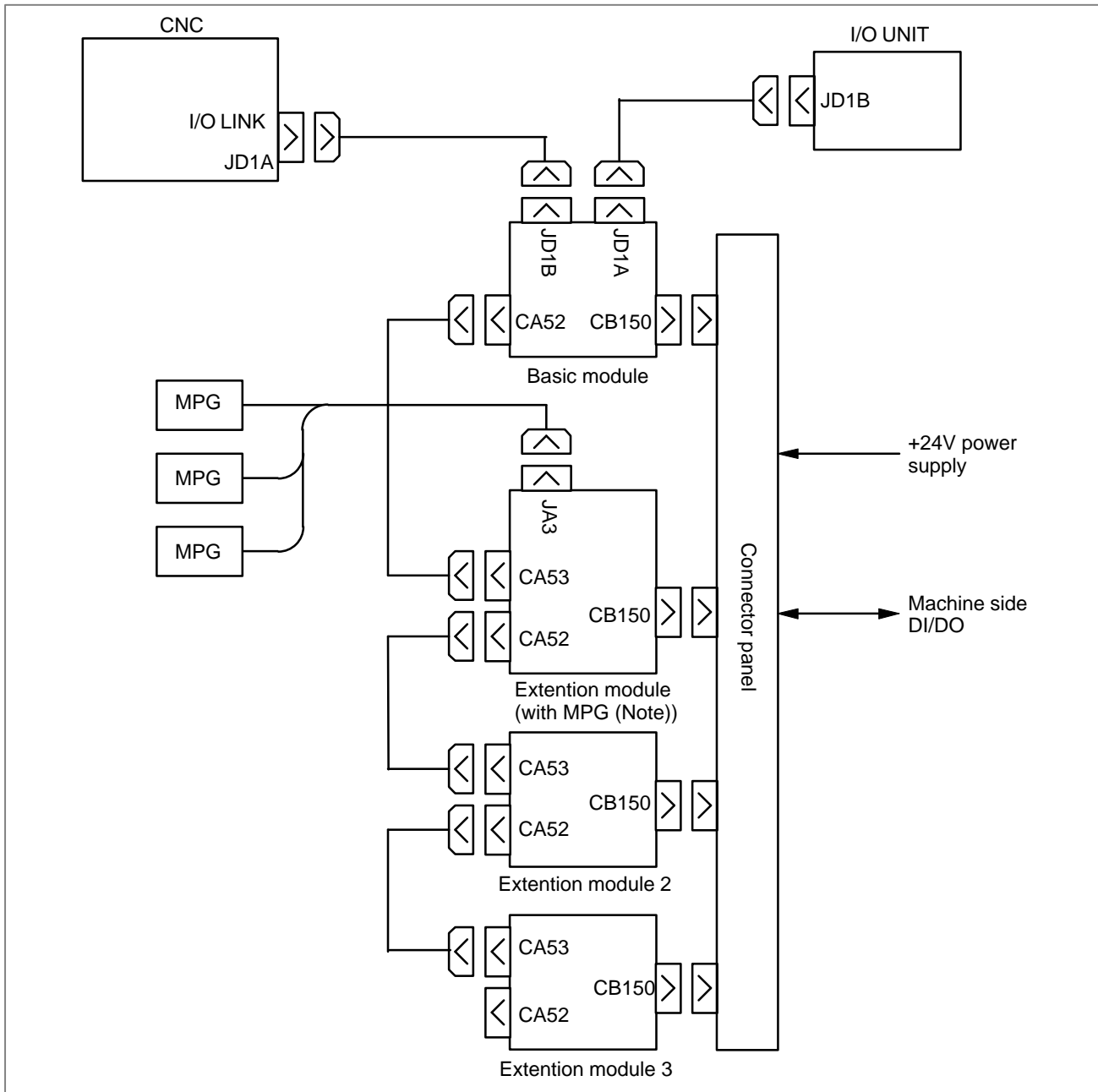
NOTE
Ensure that the extension module with the MPG interface is located nearest to the basic module, as shown in the figure. The MPG can be connected to the connector panel I/O module only when the i series CNC is used. When the connector panel I/O module is used together with a unit (such as an operator's panel I/O module) connected to the I/O Link supporting another MPG interface, only the MPG interface of the unit (module) closest to the CNC connected to the I/O Link is effective.

6.3.3
DI/DO Connector Pin Assignment

CB150 (HONDA MR–50RMA)

33	DOCOM
34	Yn+0.0
35	Yn+0.1
36	Yn+0.2
37	Yn+0.3
38	Yn+0.4
39	Yn+0.5
40	Yn+0.6
41	Yn+0.7
42	Xm+0.0
43	Xm+0.1
44	Xm+0.2
45	Xm+0.3
46	Xm+0.4
47	Xm+0.5
48	Xm+0.6
49	Xm+0.7
50	+24V

19	0V
20	0V
21	0V
22	0V
23	0V
24	DICOM0
25	Xm+1.0
26	Xm+1.1
27	Xm+1.2
28	Xm+1.3
29	Xm+1.4
30	Xm+1.5
31	Xm+1.6
32	Xm+1.7

01	DOCOM
02	Yn+1.0
03	Yn+1.1
04	Yn+1.2
05	Yn+1.3
06	Yn+1.4
07	Yn+1.5
08	Yn+1.6
09	Yn+1.7
10	Xm+2.0
11	Xm+2.1
12	Xm+2.2
13	Xm+2.3
14	Xm+2.4
15	Xm+2.5
16	Xm+2.6
17	Xm+2.7
18	+24V

50 male pins with fittings for fixing the connector covers

NOTE

The DI and DO addresses for the basic and extension modules run contiguously. These basic and extension module DI and DO addresses are allocated to the I/O Link as a group. For example, when the DI and DO top addresses are X0004 and Y0000 (m = 4 and n = 0), respectively, then the addresses are allocated as shown in the following table.

	DI	DO
Basic module	X4 to X6	Y0 to Y1
Extension module 1	X7 to X9	Y2 to Y3
Extension module 2	X10 to X12	Y4 to Y5
Extension module 3	X13 to X15	Y6 to Y7

6.3.4
DI (Input Signal) Connection

○ A maximum of 96 points are provided (24 points per module; 1 basic module + 3 extension modules).

Pin number

Address number

Bit number

+24V

CB150(18)
CB150(50)

Xm+2.0   RV   CB150(10)

+24V   0V

+24 V stabilized power supply

Xm+2.1   RV   CB150(11)

Xm+2.2   RV   CB150(12)

Xm+2.3   RV   CB150(13)

Xm+2.4   RV   CB150(14)

Xm+2.5   RV   CB150(15)

Xm+2.6   RV   CB150(16)

Xm+2.7   RV   CB150(17)

CB150(19),(20),(21)
(22),(23)
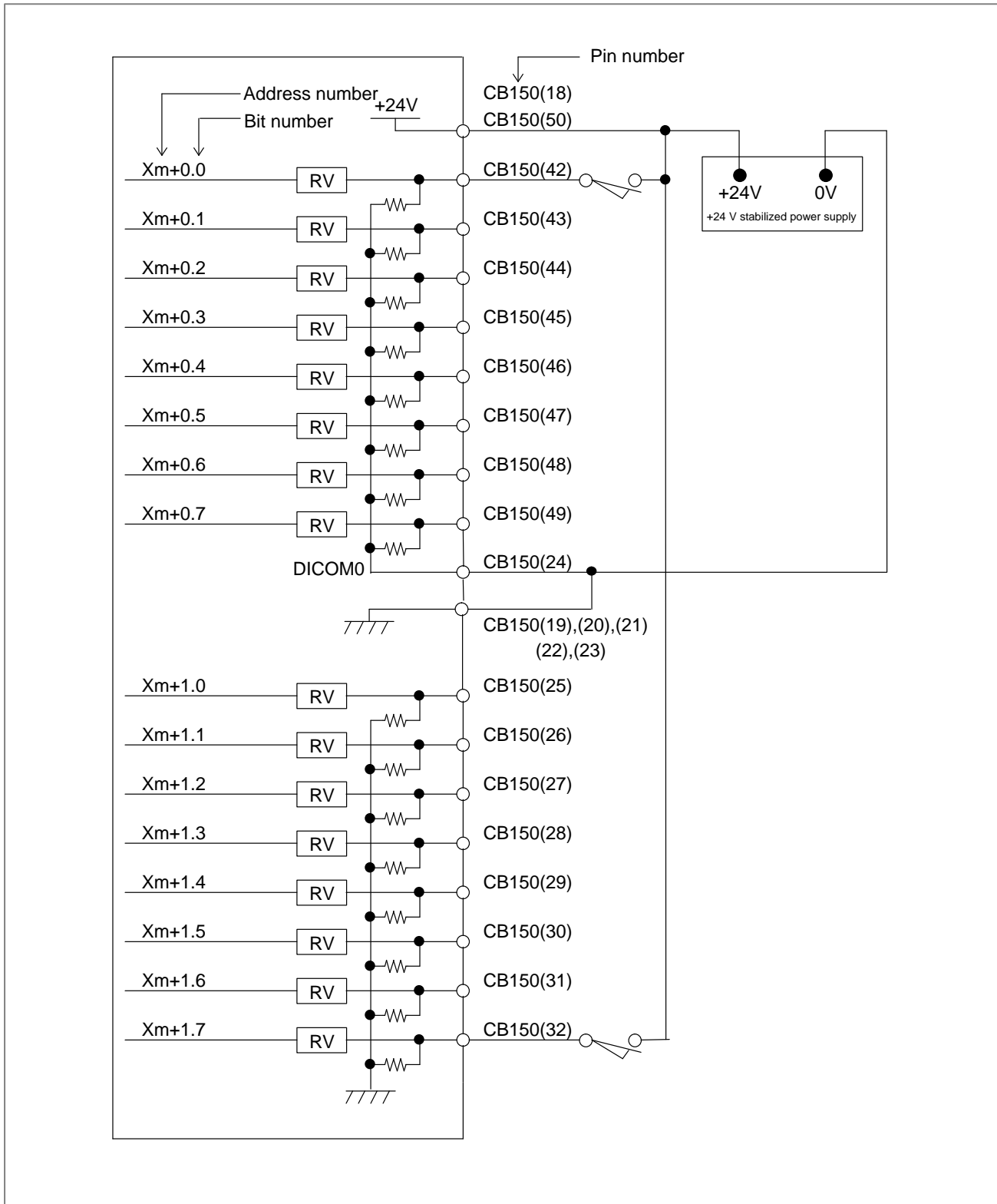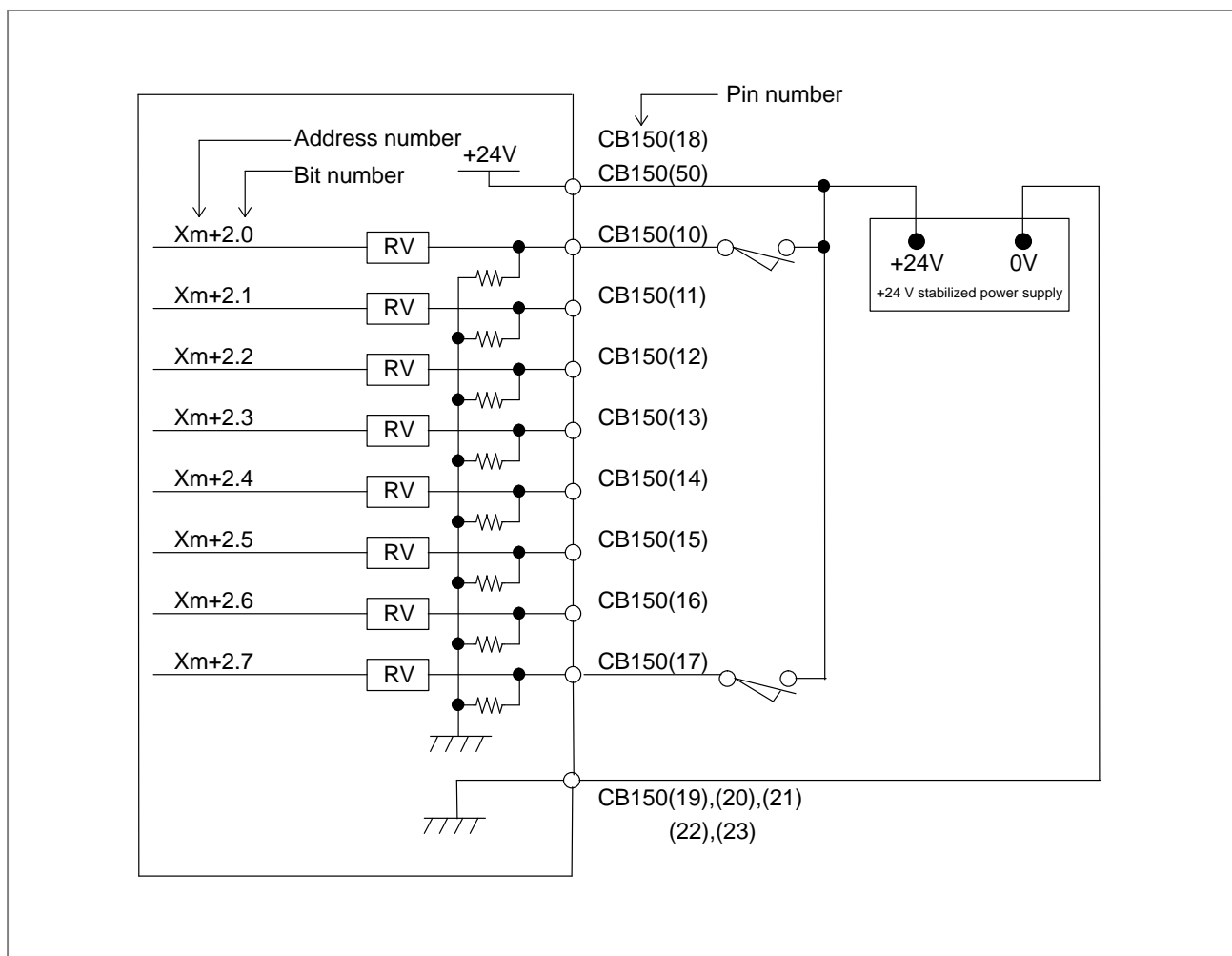
NOTE
1 Xm+0.0 through Xm+0.7 are DI pins for which a common voltage can be selected. That is, by connecting the DICOM0 CB150(24) pin to the +24 V power supply, a DI signal can be input with its logical state reversed. If, however, a cable is connected to ground, it has the same effect as inputting an ON state DI signal. To prevent such accidents, the connection of the DICOM0 CB150(24) pin to the 0 V power supply is recommended wherever possible.
2 For safety reasons, the emergency stop signal needs to be allocated to an appropriate bit of the addresses for which the common voltage is fixed, ranging from Xm+1.0 to Xm+1.7 or from Xm+2.0 to Xm+2.7. See 6.2 for information about how to allocate the emergency stop signal.
3 For unused DI pins allocated to the addresses for which the common voltage is fixed (from Xm+1.0 to Xm+1.7 and from Xm+2.0 to Xm+2.7), the logic is fixed to "0". For unused pins allocated to Xm+0.0 to Xm+0.7 for which the common voltage can be selected, the logic is fixed to "0" when the DICOM0 CB150(24) pin is connected to the 0 V power supply. When the DICOM0 CB150(24) pin is connected to the +24 V power supply, the logic is fixed to "1". The logic of the unused pins allocated to Xm+0.0 to Xm+0.7 is variable when the contact of the DICOM0 CB150(24) pin is open.

6.3.5
DO (Output Signal) Connection

○ A maximum of 64 points are provided (16 points per module; 1 basic module + 3 extension modules).
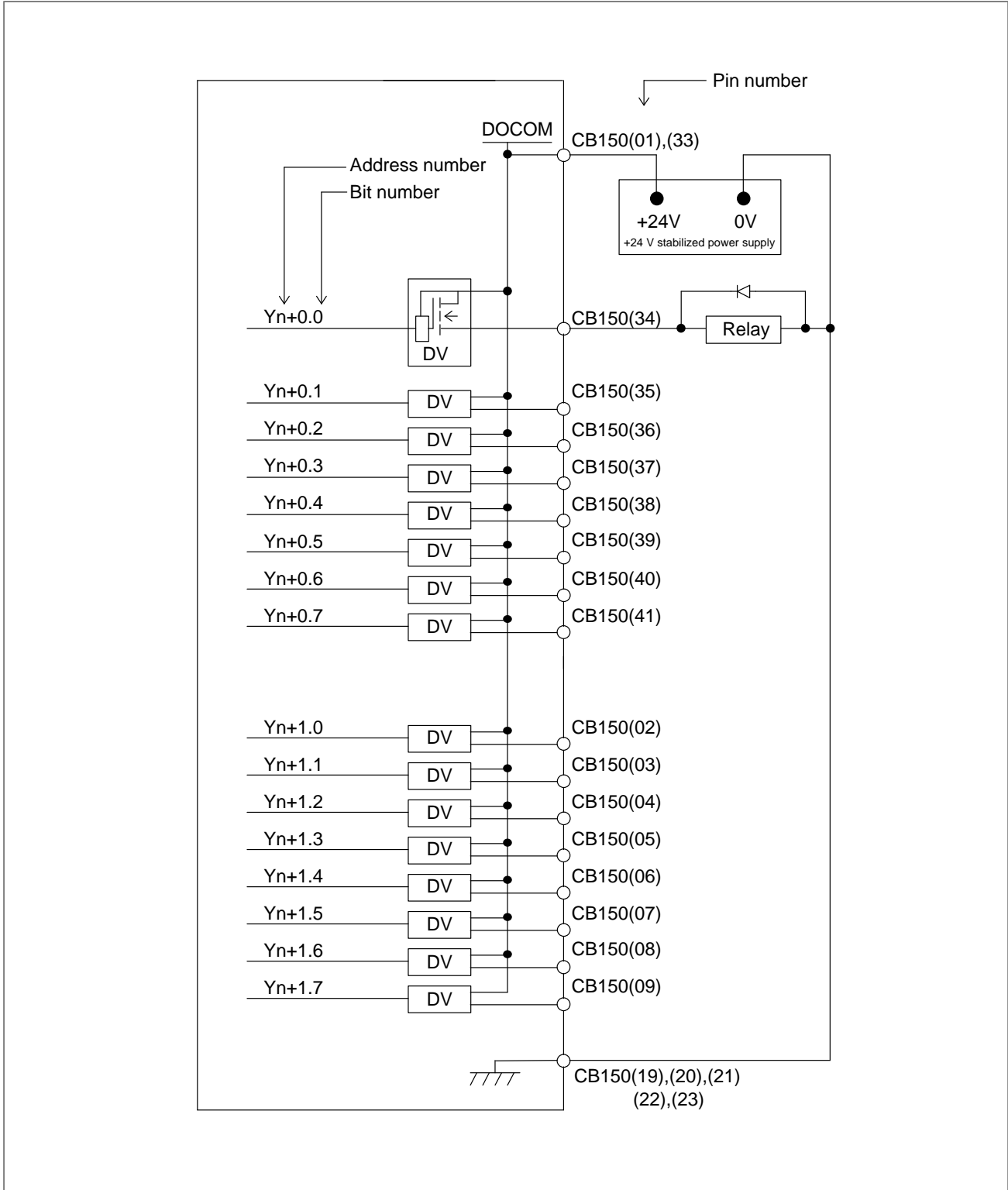
6.3.6
Manual Pulse
Generator Connection

An example in which three manual pulse generators are connected is shown below. The manual pulse generator can be connected only for the *i* series CNC.

Extension module 1

Manual pulse generators

JA3
(PCR–E20LMDT)

1	HA1	11	
2	HB1	12	0V
3	HA2	13	
4	HB2	14	0V
5	HA3	15	
6	HB3	16	0V
7		17	
8		18	+5V
9	+5V	19	
10		20	+5V

Manual pulse generator #1
(M3 screw terminal)

3	4	5	6
+5V	0V	HA1	HB1

Manual pulse generator #2
(M3 screw terminal)

3	4	5	6
+5V	0V	HA2	HB2

Manual pulse generator #3
(M3 screw terminal)

3	4	5	6
+5V	0V	HA3	HB3

Cable connection

JA3

Terminal block

Manual pulse generators

JA3		Terminal block		Manual pulse generators
HA1	1	HA1	5	HA1
HB1	2	HB1	6	HB1
+5V	9	+5V	3	+5V
0V	12	0V	4	0V
HA2	3	HA2	5	HA2
HB2	4	HB2	6	HB2
+5V	18	+5V	3	+5V
0V	14	0V	4	0V
HA3	5	HA3	5	HA3
HB3	6	HB3	6	HB3
+5V	20	+5V	3	+5V
0V	16	0V	4	0V

Shield

Ground plate

Cable

Wire

Recommended cables:

> A02B–0120–K841 (7 m) (for connecting three manual pulse generators)
> A02B–0120–K848 (7 m) (for connecting two manual pulse generators)
> A02B–0120–K847 (7 m) (for connecting one manual pulse generator)
> (These cables do not include the wire shown in the above figure.)

Cable length for manual pulse generator

Like a pulse coder, the manual pulse generator operates on 5 VDC. The supply voltage drop due to the cable resistance must be held below 0.2 V (when those of the 0–volt and 5–volt wires are combined), as expressed in the following expression:

$$0.2 \geqq \frac{0.1 \times R \times 2L}{m}$$

Wher
0.1 = manual pulse generator supply current (0.1 A)
R = resistance per unit cable length (Ω/m)
m = number of 0–volt and 5–volt wires
L = cable length (m).

Therefore, the cable length can be determined using the following expression.

$$L \leqq \frac{m}{R}$$

In the case of the A66L–0001–0286 cable, for example, when three pairs of signal wires and six power supply wires (20/0.18, 0.0394 Ω/m) are used (three power supply wires connected to 5 V and the other three to 0 V), the cable length is:

$$L \leqq \frac{3}{0.0394} = 76.75[m]$$

However, the maximum pulse transmission distance for the manual pulse generator is 50 m. Taking this into consideration, the cable length may be extended to:
38.37 m (when two generators are used), or
25.58 m (when three generators are used).

Signal specifications of the manual pulse generator

When using other manufacturers' manual pulse generators, ensure that the following specifications are satisfied.

● **Pulse width**

The relationship between the HAn and HBn signals and the CNC pulses shall be as shown in Fig. 6.3.6(a).
Pulse cycle T_1 shall be $200 \mu sec$ or more. Pulse cycle $T_1/4$ shall be $50 \mu sec$ or more.
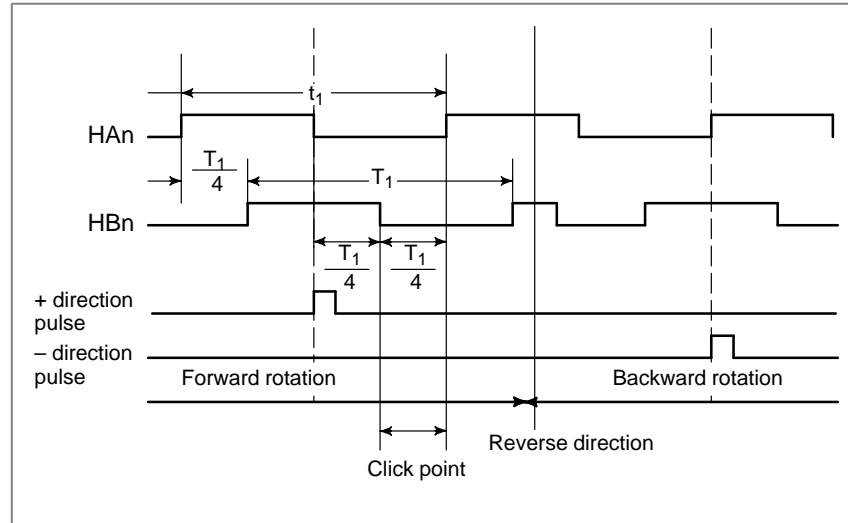
Fig. 6.3.6(a)

● **Receiver**

The circuit that receives signals input from the manual pulse generator shall be configured as shown in Fig. 6.3.6(b).
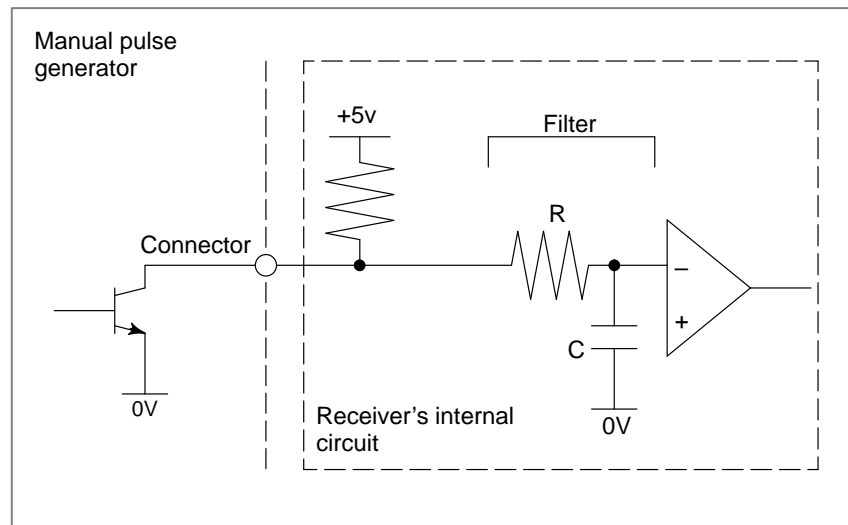
Fig. 6.3.6(b)

Input signal level change point (threshold)
  When the voltage is 3.7 V or higher, the input signal level changes from low to high.
  When the voltage is 1.5 V or lower, the input signal level changes from high to low.

6.3.7
Connection of Basic and Extension Modules

Modules can be connected in the same way, regardless of whether you are connecting the basic module to an extension module or connecting two extension modules. Connect the modules by using 34–pin flat cable connectors as shown in the figure below. Ensure that all 34 pins at one end of the cable are connected to the corresponding pins at the other end; e.g., connect the A1 pin to the pin having the same designation (A1) at the other end.
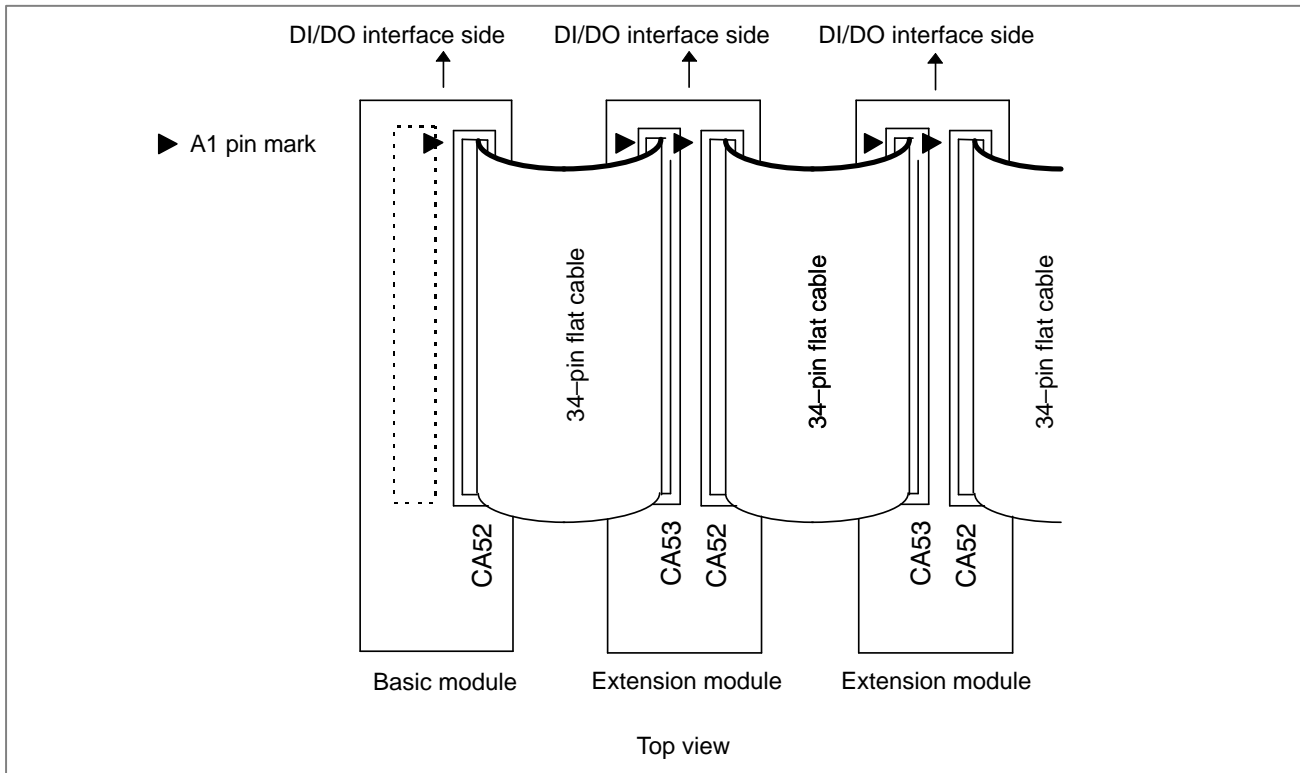
Flat cable–side connector specification:
    HIF3BA–34DA–2.54R (Hirose Electric Co., Ltd.)
Module connector–side specification:
    HIF3BA–34PA–2.54DS (Hirose Electric Co., Ltd.) or
    FAP–3403–1202–OBS (Yamaichi Denki Co., Ltd.)

NOTE
1 Modules need to be spaced at least 32 mm apart, in which case a flat cable of about 20 mm in length is required. To install modules further away from each other, the cable length will be 20 mm plus the extra distance. Note that the maximum length of a flat cable is 100 mm.
2 To ensure adequate ventilation, install the modules in such a way that the flat cables lie on top of them. The basic module has a vent at the top (as indicated by the dotted lines in the above figure). When connecting modules, install extension modules so that the flat cables do not cover the vent, as shown in the above figure.

6.3.8
Module Installation

When connecting a connector panel printed circuit board directly (external module view and mounting diagram)

Dimensions of connector panel printed circuit board

Board thickness 1.6 mm

Square hole

0.9

28

No. 1 pin

Note)

Square hole

10

I/O interface

I/O Link interface

MPG interface (for extension module)
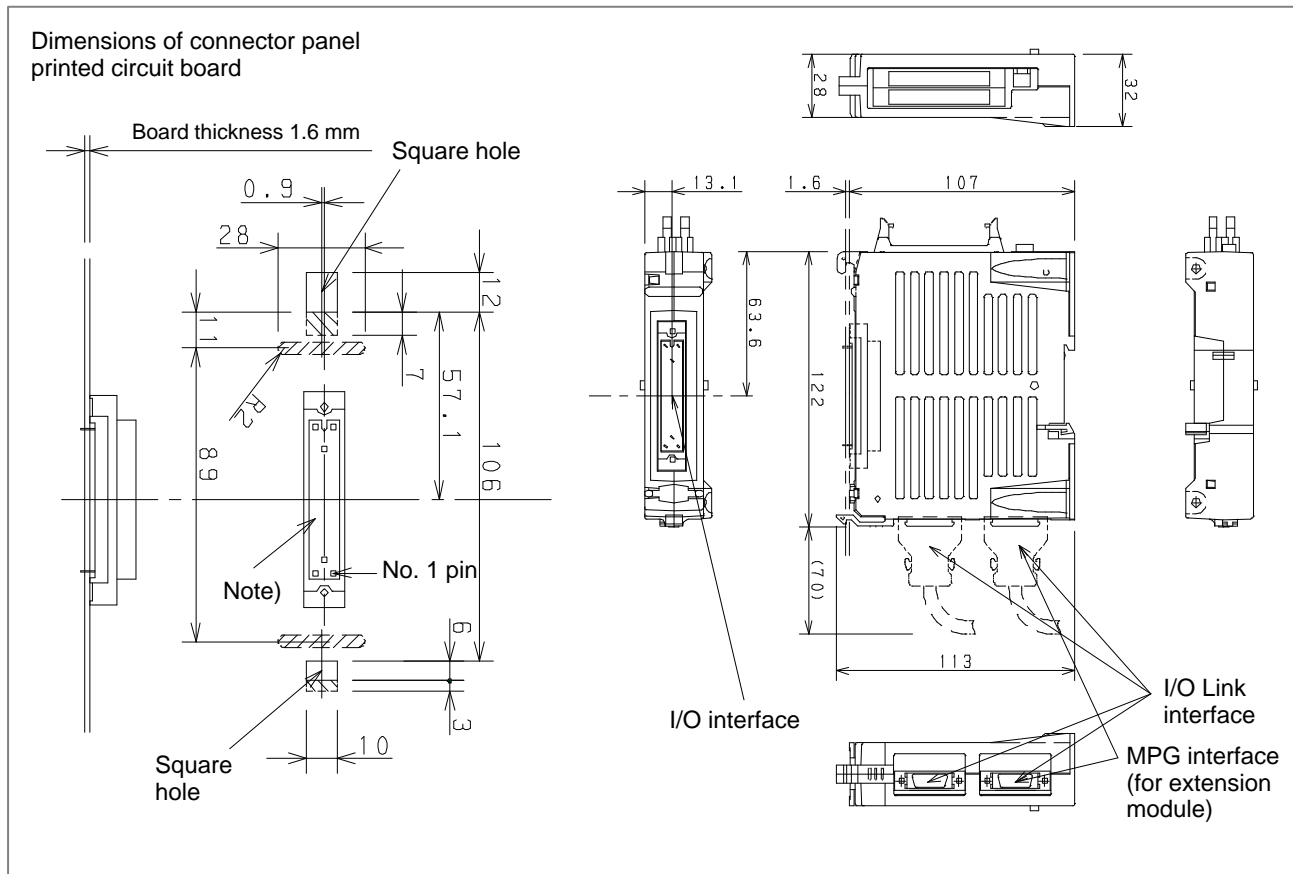
Connector panel printed circuit board connector specification:
HONDA MRH–50FD
(50–pin female straight connector without fitting)

NOTE
1 A connector with a fitting (HONDA MRH–50RMA) is used for the module–side I/O interface.
  Always use a connector having no fitting for the connector panel printed circuit board.
2 Area where pattern printing is prohibited

   Prohibited area on component side
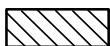
   Prohibited area on soldered side

When connecting a connector panel printed circuit board directly (mounting and dismounting a module)
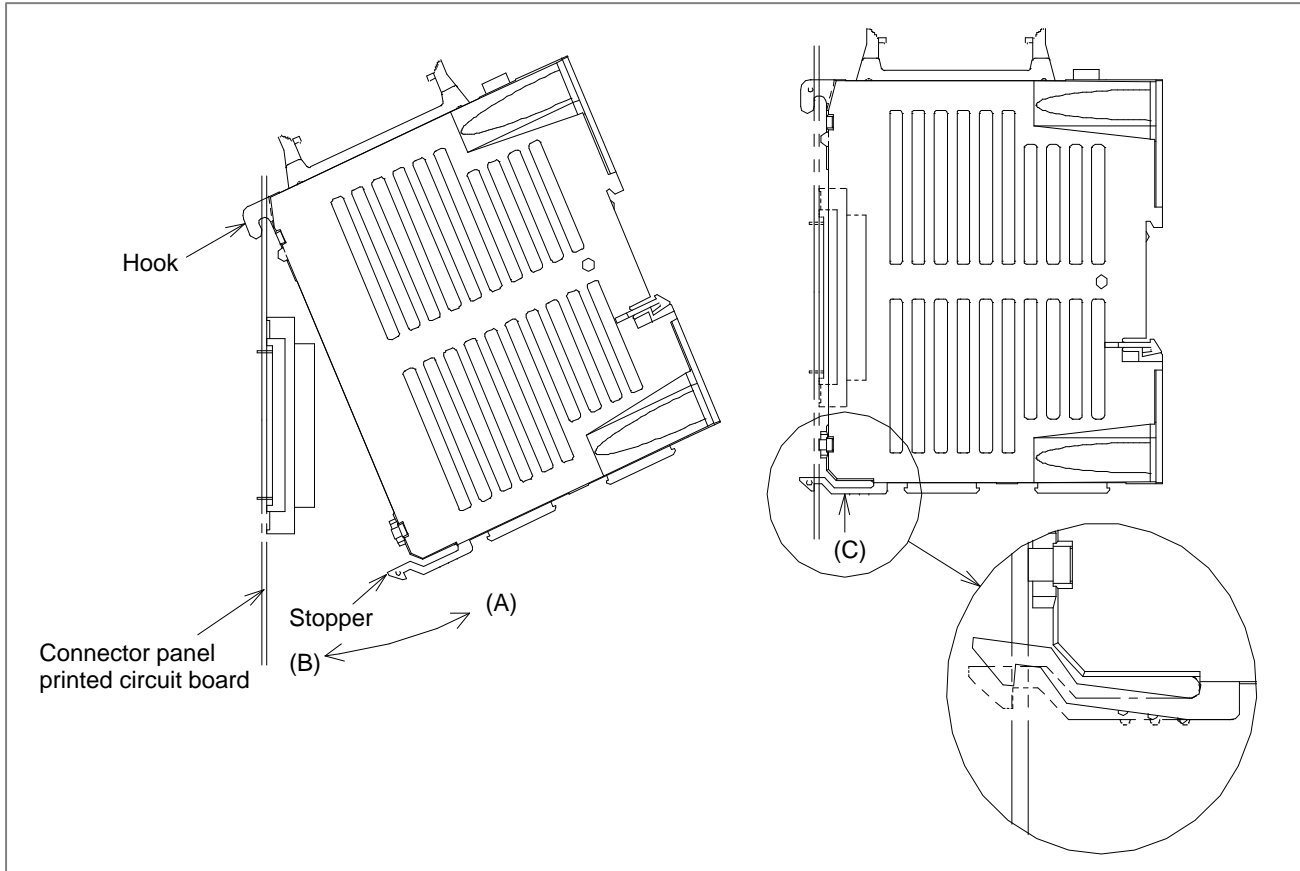
Mounting the module

1. Insert the hook of the module into the square hole located at the upper part of the connector panel printed circuit board.

2. Using the hook as a fulcrum, push the module in the direction of (B), and attach the module's connector to the connector on the printed circuit board.

3. Push the stopper into the lower hole of the printed circuit board until it clicks into place.

Dismounting the module

1. Press the stopper (C) upward.

2. Using the hook as a fulcrum, pull the lower part of the module in the direction of (A).

CAUTION
When mounting and dismounting a module, hold the module by its top and bottom surfaces. Avoid applying force to the sides where there are slits.

When mounting a DIN rail (external module view and mounting diagram)
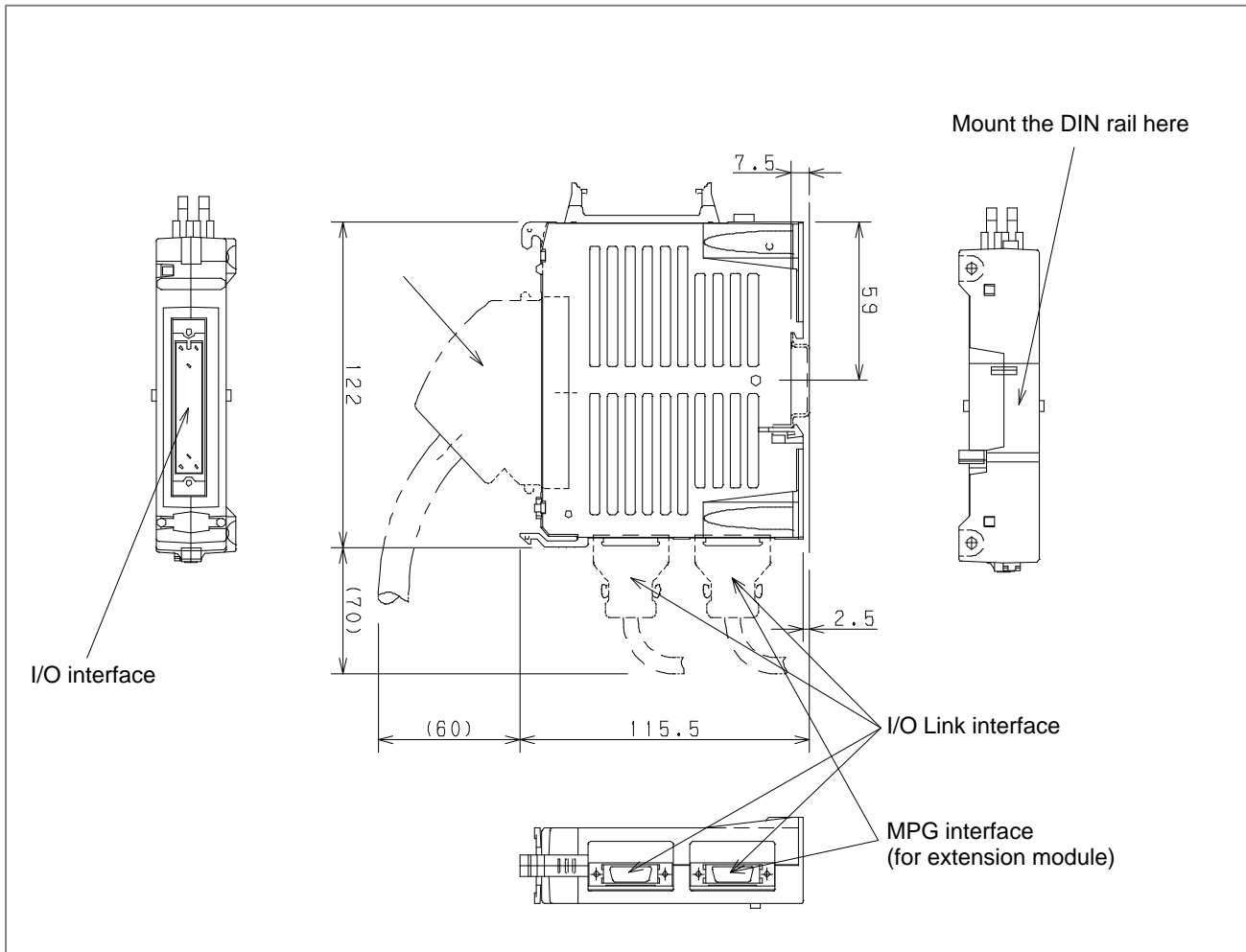
NOTE
Recommended connector: A02B–0098–K891 (including the following connector and case)
(Connector: HONDA MR–50FH solder type)
(Case: HONDA MR–50NSB angled type)
Recommended cable: A66L–0001–0042 (7/0.18, 50 pins)

When mounting a DIN rail (mounting and dismounting a module)
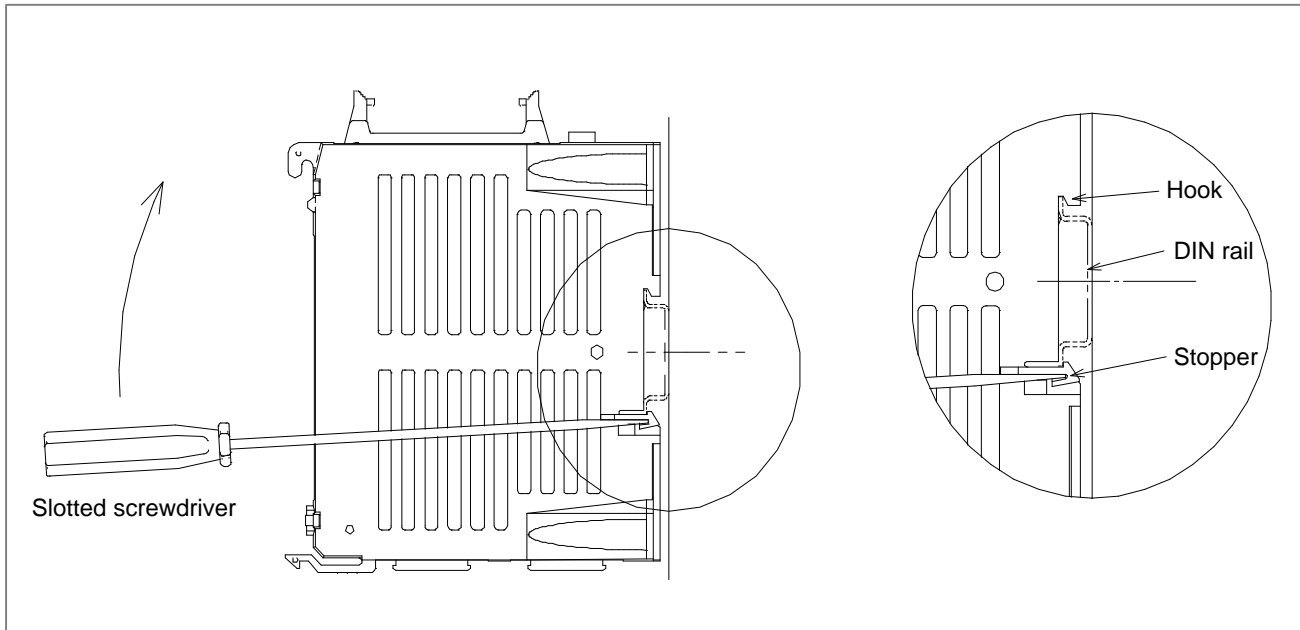
Mounting the module

1. Hook the module at the upper end of the DIN rail.

2. Push the stopper into the slit located at the lower end of the rail until it clicks into place.

Dismounting the module

1. Insert the tip of the slotted screwdriver and push out the stopper in the direction indicated by the arrow.

CAUTION
When dismounting the module, take care not to damage the stopper by applying excessive force with the screwdriver.
When mounting and dismounting a module, hold the module by its top and bottom surfaces. Avoid applying force to the sides where there are slits.

When mounting a module using screws (external module view and mounting diagram)
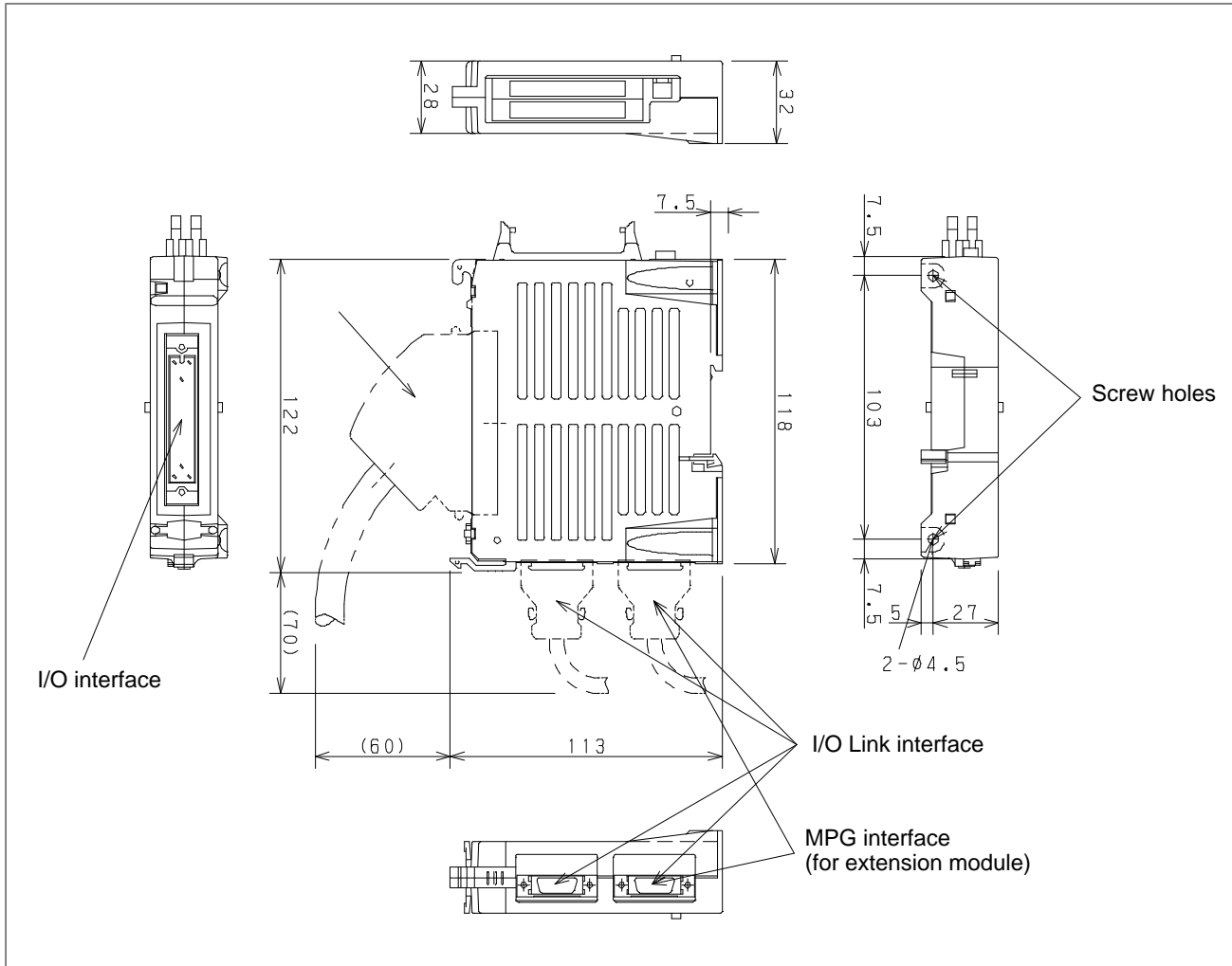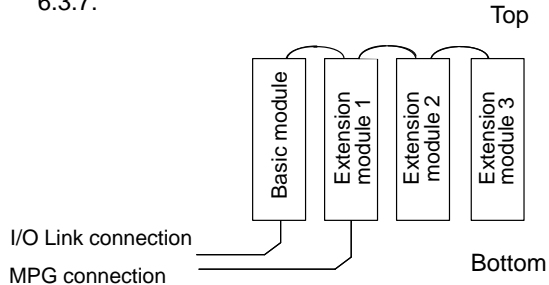
I/O interface

Screw holes

I/O Link interface

MPG interface
(for extension module)

NOTE
Recommended connector: A02B–0098–K891 (including the following connector and case)
(Connector: HONDA MR–50FH solder type)
(Case: HONDA MR–50NSB angled type)
Recommended cable: A66L–0001–0042 (7/0.18, 50 pins)

6.3.9
Specifications

Installation specifications

Ambient temperature	During operation 0° to 55°C During storage and transportation −20°C to 60°C
Temperature change	Max. 1.1°C/min.
Relative humidity	Normal : 75% or less Short term (1 month or less) : 95% or less
Vibration	During operation: 0.5 G or less
Environment	Ordinary machining factory environment (Special consideration is required when installing the module in a dusty location or where highly concentrated cutting lubricant or organic solvent is used.)
Other requirements	(1) Install the I/O module in a fully enclosed cabinet. (2) To ensure adequate ventilation between I/O modules, install them as shown in the figure below. Allow a minimum of 100 mm above and below each module for wiring and ventilation. Do not place heat–generating apparatus under the I/O modules. (3) Ensure that the flat cables do not cover the vents of the basic module. For details, see 6.3.7.

Ordering specifications

Item	Specification	Remarks
Connector panel I/O module (basic module)	A03B–0815–C001	DI/DO: 24/16
Connector panel I/O module (extension module with MPG interface)	A03B–0815–C002	DI/DO: 24/16
Connector panel I/O module (extension module without MPG interface)	A03B–0815–C003	DI/DO: 24/16
Fuse (replacement part)	A03B–0815–K002	1 A
Flat cable for module connection	A03B–0815–K100	Cable length: 20 mm (when modules are spaced 32 mm apart)

Module specifications

Item	Specification	Remarks
DI points	24 points	24 points per module (both basic and extension modules)
DO points	16 points	16 points per module (both basic and extension modules/source type output)
CNC interface	FANUC I/O Link connection	Up to 16 modules can be connected as CNC slaves. Or, a maximum of 1024 points can be supported on both the input and output sides.
Interface between basic and extension modules	Bus connection using flat cables	Up to three extension modules can be connected to one basic module. Four modules can support up to 96 DI and 64 DO points.
MPG interface (for extension modules)	Max. 3 modules	Extension modules can be connected only for the *i* series CNC.

Power supply rating

Module	Supply voltage	Power supply rating	Remarks
Basic module	24 VDC ±10% is supplied from I/O connector CB150. The ±10% tolerance includes momentary and ripple currents.	0.2 A+7.3 mA×DI	DI = number of DI points in the ON state
Extension module		0.1 A+7.3 mA×DI	DI = number of DI points in the ON state

DI (input signal) specifications

Contact rating	30 VDC, 16 mA or more
Open circuit intercontact leakage current	1 mA or less (at 26.4 V)
Closed circuit intercontact voltage drop	2 V or less (including cable voltage drop)
Delay	Receiver delay: Max. 2 ms The time required for I/O Link transmission between the CNC and I/O module (max. 2 ms + CNC ladder scan cycle) must also be taken into account.

DO (output signal) specifications

Maximum load current in ON state	200 mA or less (including momentary current)
Saturation voltage in ON state	Max. 1 V (when load current is 200 mA)
Withstand voltage	24 V +20% or less (including momentary values)
Leakage current in OFF state	20 μA or less
Delay	Driver delay: Max. 50 μs The time for I/O Link transmission between the CNC and I/O module (max. 2 ms + CNC ladder scan cycle) must also be taken into account.

6.3.10
Other Notes

DO signal reaction to a system alarm

If a system alarm occurs in a CNC using the connector panel I/O module, or if I/O Link communication between the CNC and connector panel I/O module fails, all the DO signals of the I/O module are turned off. Therefore, due care must be taken when setting up the machine sequence. Also, the same phenomenon occurs if the power to the CNC or the I/O module is turned off.

Address allocation

For the connector panel I/O module, I/O addresses are mapped as follows.

DI space map

Xm	Basic module
Xm+1	
Xm+2	
Xm+3	Extension module 1
Xm+4	
Xm+5	
Xm+6	Extension module 2
Xm+7	
Xm+8	
Xm+9	Extension module 3
Xm+10	
Xm+11	
Xm+12 (for 1st MPG)	Extension module 1
Xm+13 (for 2nd MPG)	
Xm+14 (for 3rd MPG)	
Xm+15 (DO alarm detection)	Basic module

DO space map

Yn	Basic module
Yn+1	
Yn+2	Extension module 1
Yn+3	
Yn+4	Extension module 2
Yn+5	
Yn+6	Extension module 3
Yn+7	

The basic connector panel I/O module is allocated a group of DI addresses (16 bytes) and a group of DO addresses (8 bytes). Up to three hardware extension modules can be added or removed as required. The reason for this address allocation is explained below.

The MPG interface (MPG counter) occupies a DI space from Xm+12 through Xm+14. These addresses are fixed regardless of whether extension module 2 or 3 is used, and Xm+12 through Xm+14 must be allocated as a DI work area to enable the use of the MPG. Therefore, when using an MPG for the i series CNC, allocate DI addresses in units of 16 bytes. Do not use the DI space from Xm+12 through Xm+14 for Ladder; the CNC processes the MPG counter value directly.

DI address Xm+15 is used for detecting overcurrent and overheating alarms that occur in the IC used in the DO driver. [For details, see the section describing the detection of DO (output signal) alarms.] This address is fixed regardless of whether extension module 2 or 3 is used, and it must be allocated as a work area before it can be used. When using this area, therefore, allocate DI addresses in units of 16 bytes.

Basically, I/O addresses can be allocated to the connector panel I/O modules freely. When allocating DI addresses, however, consider also the addresses that are directly supervised by the CNC, and keep the following in mind.

Fixed addresses directly supervised by the CNC (for single–path system)

ADDRESS	7	6	5	4	3	2	1	0
X0004	SKIP	ESKIP	–MIT2	+MIT2	–MIT1	+MIT1	ZAE	XAE
		SKIP6	SKIP5	SKIP4	SKIP3	SKIP2	SKIP8	SKIP7
	SKIP	ESKIP	SKIP5	SKIP4	SKIP3	ZAE	YAE	XAE
		SKIP6				SKIP2	SKIP8	SKIP7
X0005								
X0006								
X0007								
X0008				*ESP				
X0009	*DEC8	*DEC7	*DEC6	*DEC5	*DEC4	*DEC3	*DEC2	*DEC1

The upper row indicates those signals used for the T series. Those in the lower row are for the M series.

When DI addresses are allocated in units of 16 bytes, starting at X0004

DI space map

X0004	Basic module	←─SKIPn and other fixed signals
X0005		
X0006		
X0007	Extension module 1	
X0008		←──*ESP fixed signal
X0009		←──*DECn fixed signal
X0010	Extension module 2	
X0011		
X0012		
X0013	Extension module 3	
X0014		
X0015		
X0016 (for 1st MPG)	Extension module 1	
X0017 (for 2nd MPG)		
X0018 (for 3rd MPG)		
X0019 (DO alarm detection)	Basic module	

The minimum configuration consists of the basic module and extension module 1. Extension modules 2 and 3 may be added as required. This allows fixed signals, such as SKIPn and *DECn, to always be used and the *ESP fixed signal to be allocated to an address for which the common voltage is fixed to 24 V. Also, with the i series CNC, the MPG interface provided by extension module 1 can always be used.

When DI addresses are allocated in units of 16 bytes, starting at X0007

X0007	Basic module	
X0008		← *ESP fixed signal
X0009		← *DECn fixed signal
X0010	Extension module 1	
X0011		
X0012		
X0013	Extension module 2	
X0014		
X0015		
X0016	Extension module 3	
X0017		
X0018		
X0019 (for 1st MPG)	Extension module 1	
X0020 (for 2nd MPG)		
X0021 (for 3rd MPG)		
X0022 (DO alarm detection)	Basic module	

The minimum configuration consists of the basic module only. Extension modules 1, 2, and 3 may be added as required. In the minimum configuration, SKIP and other fixed signals and the MPG interface of extension module 1 cannot be used. In this case, however, the *DECn fixed signal can always be used and the *ESP fixed signal can be allocated to an address for which the common voltage is fixed to 24 V in the minimum configuration.

Turning the DO (output signal) power on and off (DOCOM)

All the DO signals of each module can be turned off simultaneously by turning off (opening) the DO (output signal) power supply pin "DOCOM". Doing so causes the DO signal status to change as shown below.
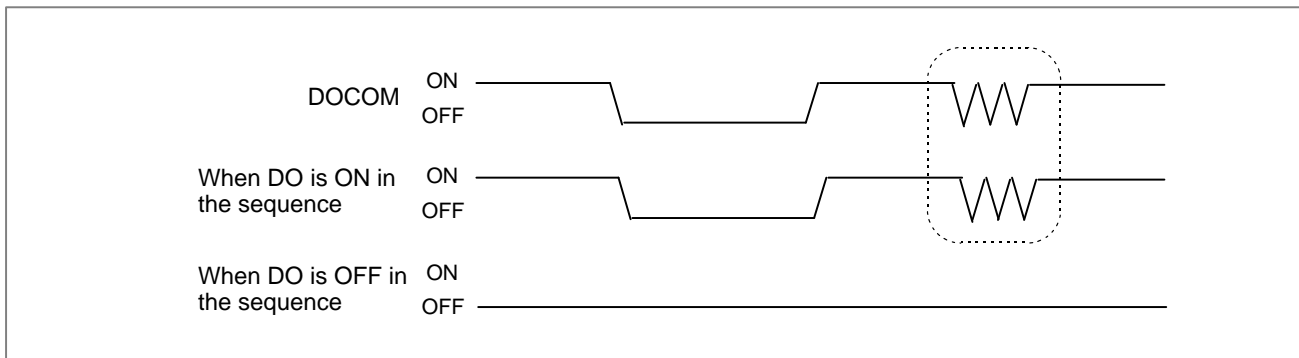
NOTE
1 When the DO signal is in the ON state in the sequence, the ON or OFF state of the DOCOM pin determines the state of the signal, as shown within the dotted lines in the above figure.
2 Do not turn off the +24 V supply to the I/O module during this operation. Turning off the +24 V supply causes a CNC communication alarm. When turning on the power, the +24 V supply to the I/O module must be started before or at the same time as the power supply to the CNC. When turning off the power, the +24 V supply to the I/O module must be stopped after or at the same time as the power supply to the CNC.

Parallel DO (output signal) connection

The DO load current can be doubled by connecting two DO points in parallel and turning them on and off simultaneously in sequence, as shown in the figure below. The maximum load current per DO point is 200 mA. Connecting two DO points in parallel and turning them on at the same time produces a current of 400 mA. Note that, however, when two DO points are connected in parallel, the leakage current also doubles when they are off (max. $40\,\mu$A).

DO (output signal) alarm detection

The DO driver of the I/O module is capable of detecting an overcurrent and measuring its own temperature. If an accident, such as the connecting of the cable to ground, causes an abnormal increase in the load current or in the driver temperature, a protection circuit, which is provided for each DO driver (1 byte), is activated and keeps the DO signal for the relevant 1 byte in the OFF state until the cause of the problem is eliminated. Even if this occurs, the CNC and I/O module continue operating. The DI address (Xm+15) identifies the DO driver which has detected the alarm. The following table shows the correspondence between the DI address (Xm+15) bits and the DO addresses. Bit value "1" indicates that the corresponding DO driver has detected an alarm. The contents of the Xm+15 area can be checked by using the DGN screen of the CNC or by performing alarm processing for the area in advance by using Ladder. This helps alarm detection and recovery.

Alarm detection address and bit	DO address	Location
Xm+15.0	Yn+0	Basic module
Xm+15.1	Yn+1	Basic module
Xm+15.2	Yn+2	Extension module 1
Xm+15.3	Yn+3	Extension module 1
Xm+15.4	Yn+4	Extension module 2
Xm+15.5	Yn+5	Extension module 2
Xm+15.6	Yn+6	Extension module 3
Xm+15.7	Yn+7	Extension module 3

6.4
CONNECTION OF OPERATOR'S PANEL I/O MODULE (FOR MATRIX INPUT)

6.4.1
Overall Connection Diagram

> **NOTE**
> 1 The MPG can be connected to this operator's panel I/O module only when the i series CNC is used. When the operator's panel I/O module is used together with a unit (connector panel I/O module) connected to the I/O Link supporting another MPG interface, only the MPG interface of the unit (module) closest to the CNC connected to the I/O Link is enabled.
> 2 The following screw type connectors, newly incorporated into the i series main board, cannot be used to connect the I/O Link.

Connectors that cannot be used on the cable side

	Specification	Manufacturer
Connector case	FI–20–CV7	Hirose Electric Co., Ltd.
Connector case and connector	FI30–20S–CV7	Hirose Electric Co., Ltd.

6.4.2
Power Connection

Provide the CPD1 (IN) connector, shown below, with the power necessary for printed circuit board operation and that for DI operation. To facilitate power division, the power is output to CPD1 (OUT) exactly as it is input from CPD1 (IN). When power division is required, use CPD1 (OUT).

Recommended cable–side connector: A02B–0120–K324
(including the following connector housing and case)
(Housing: Japan AMP 1–178288–3)
(Contacts: Japan AMP 1–175218–5)

NOTE
1 The specification of the power supply connector CPD1 (IN) is the same as that for CPD1 (OUT). There are no indications on the printed circuit board to distinguish between the IN and OUT connectors.
2 Do not turn off the +24 V supply to the connector during operation. Turning off the +24 V supply will cause a CNC communication alarm. When turning on the power, the +24 V supply to the I/O module must be turned on before or at the same time as the power supply to the CNC. When turning off the power, the +24 V supply to the I/O module must be turned off after or at the same time as the power supply to the CNC.

6.4.3
DI/DO Connector Pin Arrangement

	CE53				CE54	
	A	B			A	B
01	0V	0V		01	0V	0V
02	N.C.	+24V		02	COM1	+24V
03	Xm+0.0	Xm+0.1		03	Xm+1.0	Xm+1.1
04	Xm+0.2	Xm+0.3		04	Xm+1.2	Xm+1.3
05	Xm+0.4	Xm+0.5		05	Xm+1.4	Xm+1.5
06	Xm+0.6	Xm+0.7		06	Xm+1.6	Xm+1.7
07	Yn+0.0	Yn+0.1		07	Yn+3.0	Yn+3.1
08	Yn+0.2	Yn+0.3		08	Yn+3.2	Yn+3.3
09	Yn+0.4	Yn+0.5		09	Yn+3.4	Yn+3.5
10	Yn+0.6	Yn+0.7		10	Yn+3.6	Yn+3.7
11	Yn+1.0	Yn+1.1		11	Yn+4.0	Yn+4.1
12	Yn+1.2	Yn+1.3		12	Yn+4.2	Yn+4.3
13	Yn+1.4	Yn+1.5		13	Yn+4.4	Yn+4.5
14	Yn+1.6	Yn+1.7		14	Yn+4.6	Yn+4.7
15	Yn+2.0	Yn+2.1		15	Yn+5.0	Yn+5.1
16	Yn+2.2	Yn+2.3		16	Yn+5.2	Yn+5.3
17	Yn+2.4	Yn+2.5		17	Yn+5.4	Yn+5.5
18	Yn+2.6	Yn+2.7		18	Yn+5.6	Yn+5.7
19	KYD0	KYD1		19	Yn+6.0	Yn+6.1
20	KYD2	KYD3		20	Yn+6.2	Yn+6.3
21	KYD4	KYD5		21	Yn+6.4	Yn+6.5
22	KYD6	KYD7		22	Yn+6.6	Yn+6.7
23	KCM1	KCM2		23	KCM5	KCM6
24	KCM3	KCM4		24	KCM7	DOCOM
25	DOCOM	DOCOM		25	DOCOM	DOCOM

6.4.4
DI (General–Purpose Input Signal) Connection

○ 16 points
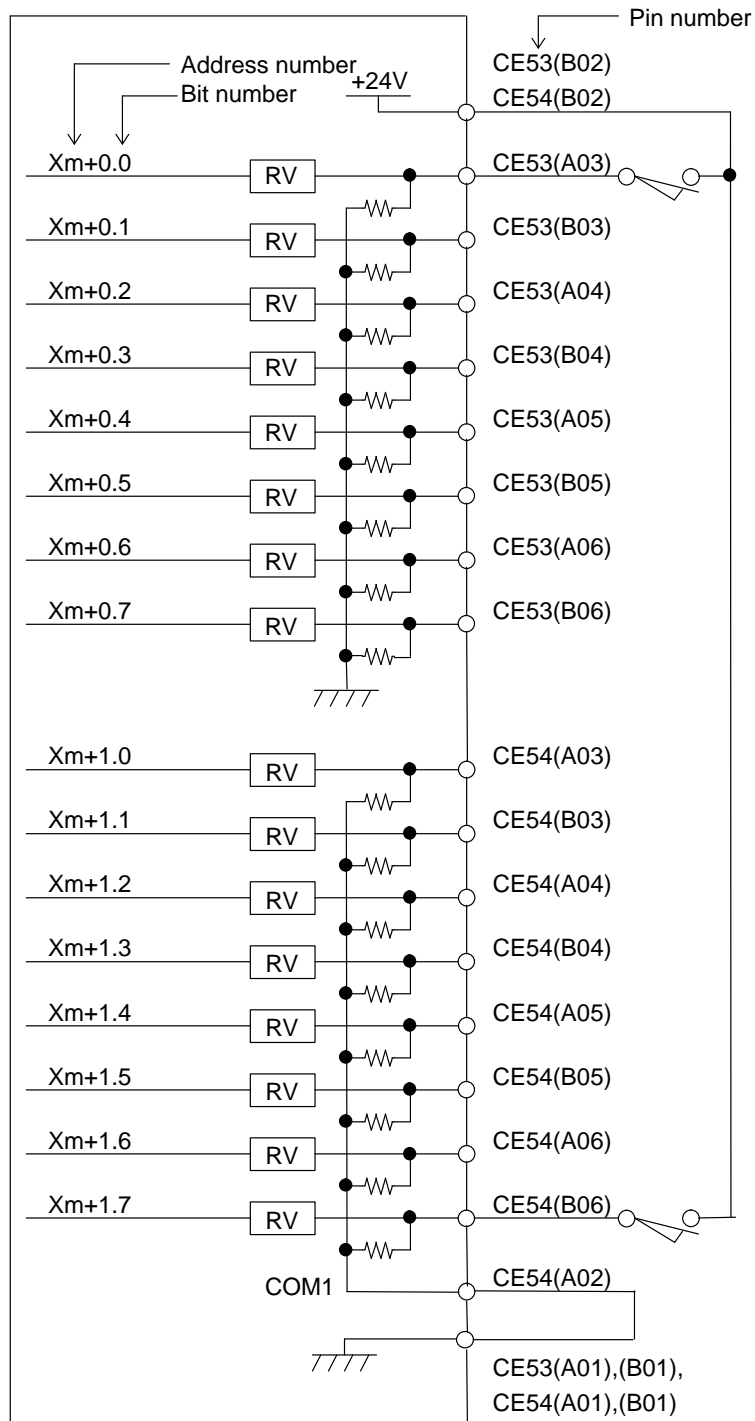
NOTE
1 Xm+1.0 through Xm+1.7 are DI pins for which a common voltage can be selected. That is, by connecting the COM1 CE54(A02) pin to the +24 V power supply, a DI signal can be input with its logical state reversed. If, however, a cable is connected to ground, it has the same effect as inputting an ON state DI signal. To prevent this from occurring, the connection of the COM1 CE54(A02) pin to the 0 V power supply is recommended wherever possible.
2 For safety reasons, the emergency stop signal needs to be allocated to an appropriate bit of the addresses for which the common voltage is fixed, ranging from Xm+0.0 to Xm+0.7. See "Address allocation" in 6.4.10 for details of how to allocate the emergency stop signal.
3 For unused DI pins allocated to the addresses for which the common voltage is fixed (from Xm+1.0 to Xm+1.7), the logic is fixed to "0". For unused pins allocated to Xm+1.0 to Xm+1.7 for which the common voltage can be selected, the logic is fixed to "0" when the COM1 CE54(A02) pin is connected to the 0 V power supply. When the COM1 CE54(A02) pin is connected to the +24 V power supply, the logic is fixed to "1". The logic of the unused pins allocated to Xm+1.0 to Xm+1.7 is variable when the contact of the COM1 CE54(A02) pin is open.

6.4.5
DI (Matrix Input Signal) Connection

○ A maximum of 56 points are provided.
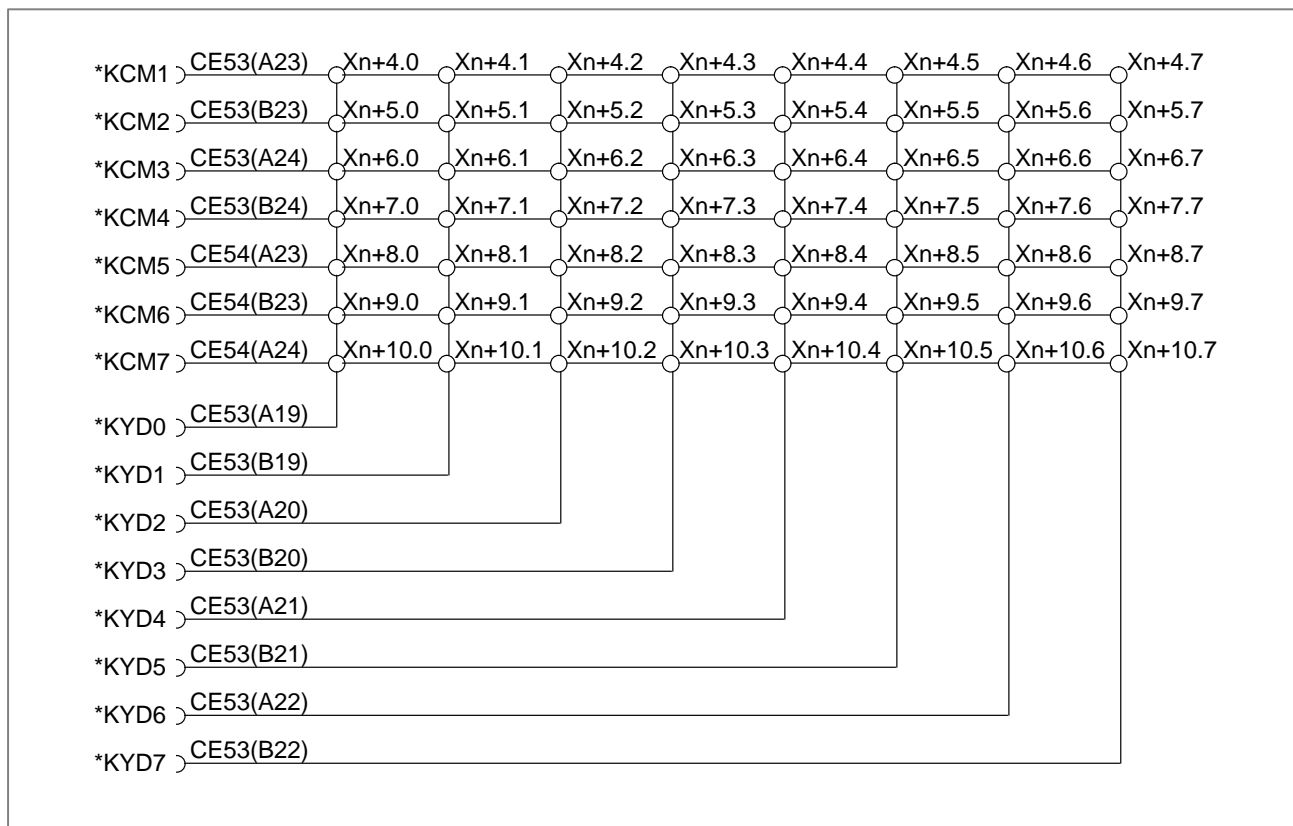
NOTE
   Detour prevention diodes must be incorporated for matrix
   signal input, as shown in the following figure. Otherwise,
   only two signals can be input at the same time. Inputting
   three or more signals simultaneously without using detour
   prevention diodes may result in data input errors.

6.4.6
DO (Output Signal)
Connection

○ A maximum of 56 points are provided.

Pin number

CE53(A25,B25)

DOCOM

CE54(A25,B24,B25)

Address number

Bit number

+24V   0V

+24 V stabilized power supply

Yn+4.0   CE54(A11)   Relay

DV

Signal	Pin
Yn+4.1	CE54(B11)
Yn+4.2	CE54(A12)
Yn+4.3	CE54(B12)
Yn+4.4	CE54(A13)
Yn+4.5	CE54(B13)
Yn+4.6	CE54(A14)
Yn+4.7	CE54(B14)
Yn+5.0	CE54(A15)
Yn+5.1	CE54(B15)
Yn+5.2	CE54(A16)
Yn+5.3	CE54(B16)
Yn+5.4	CE54(A17)
Yn+5.5	CE54(B17)
Yn+5.6	CE54(A18)
Yn+5.7	CE54(B18)

CE53(A01,B01)

CE54(A01,B01)
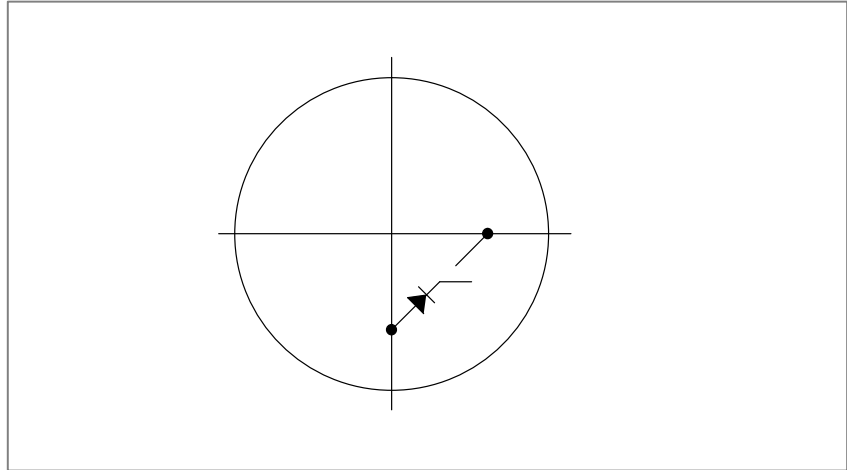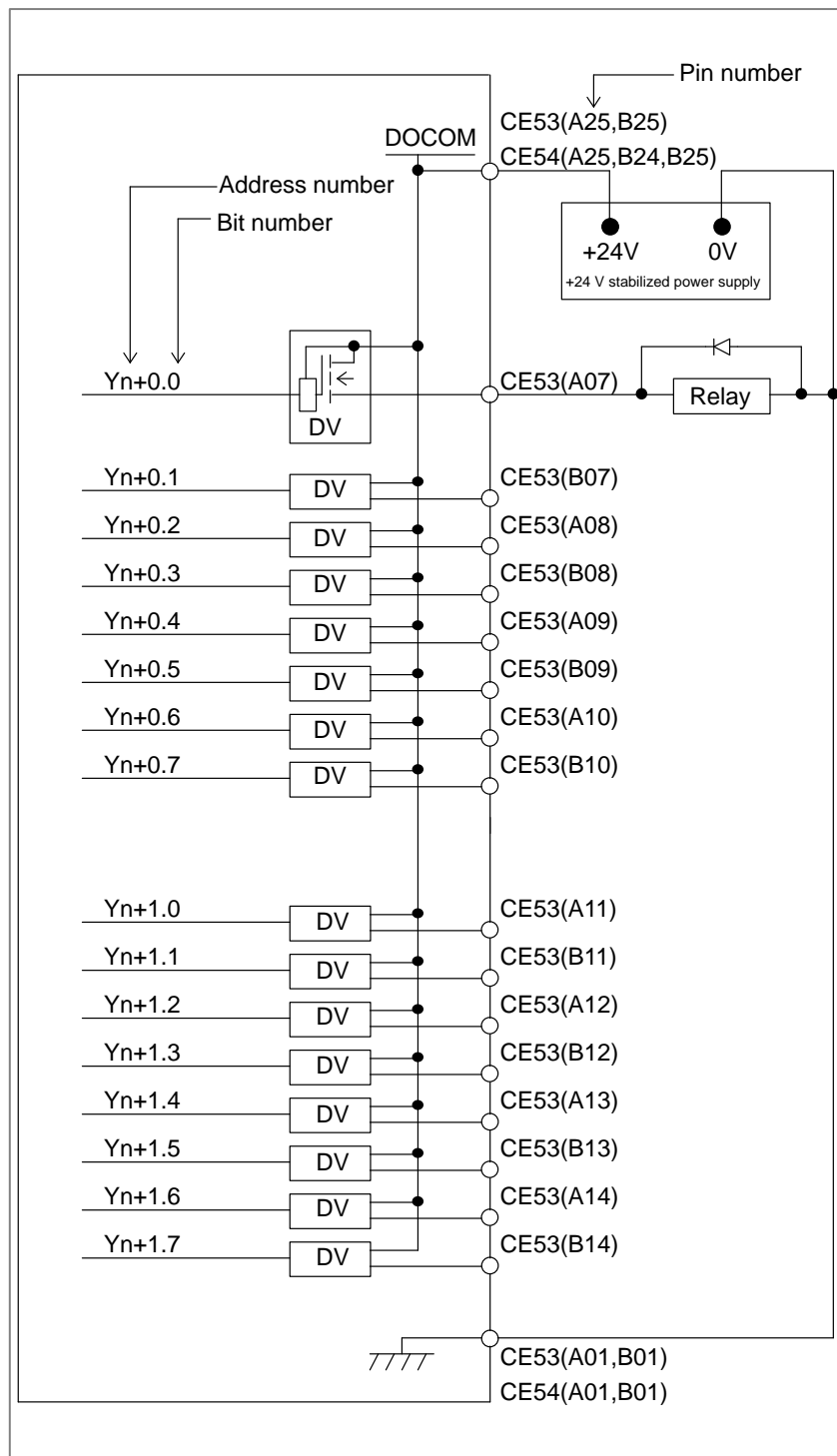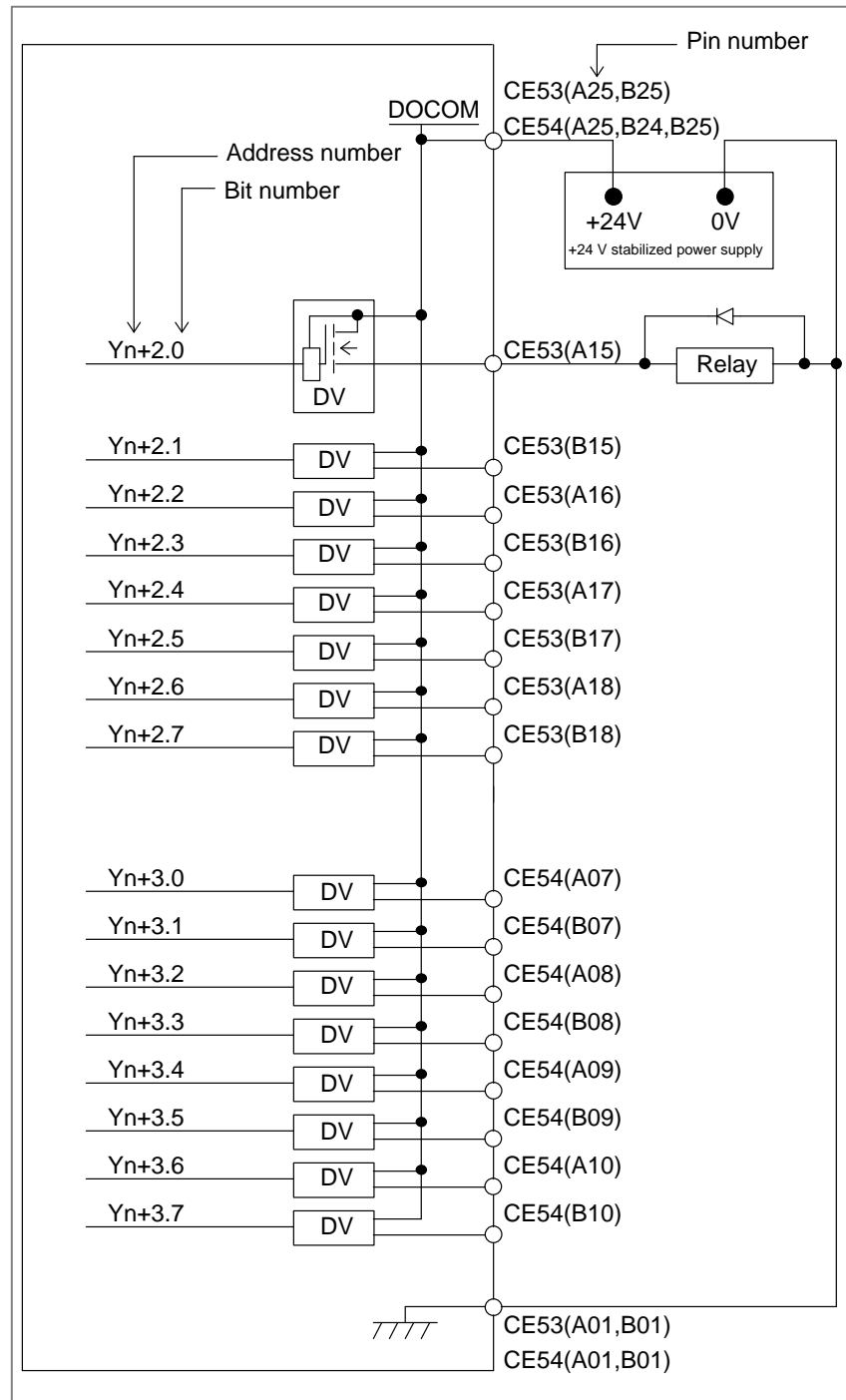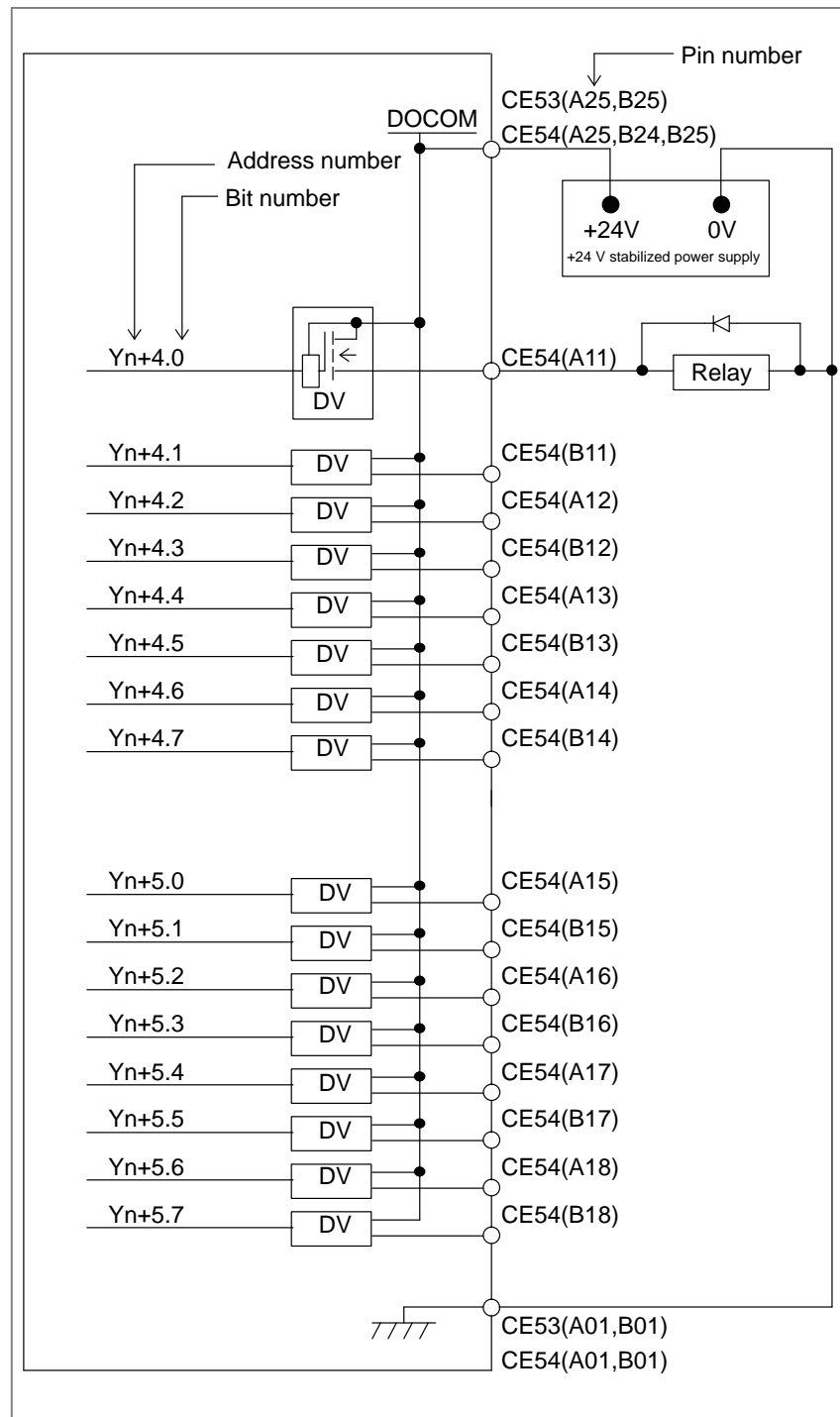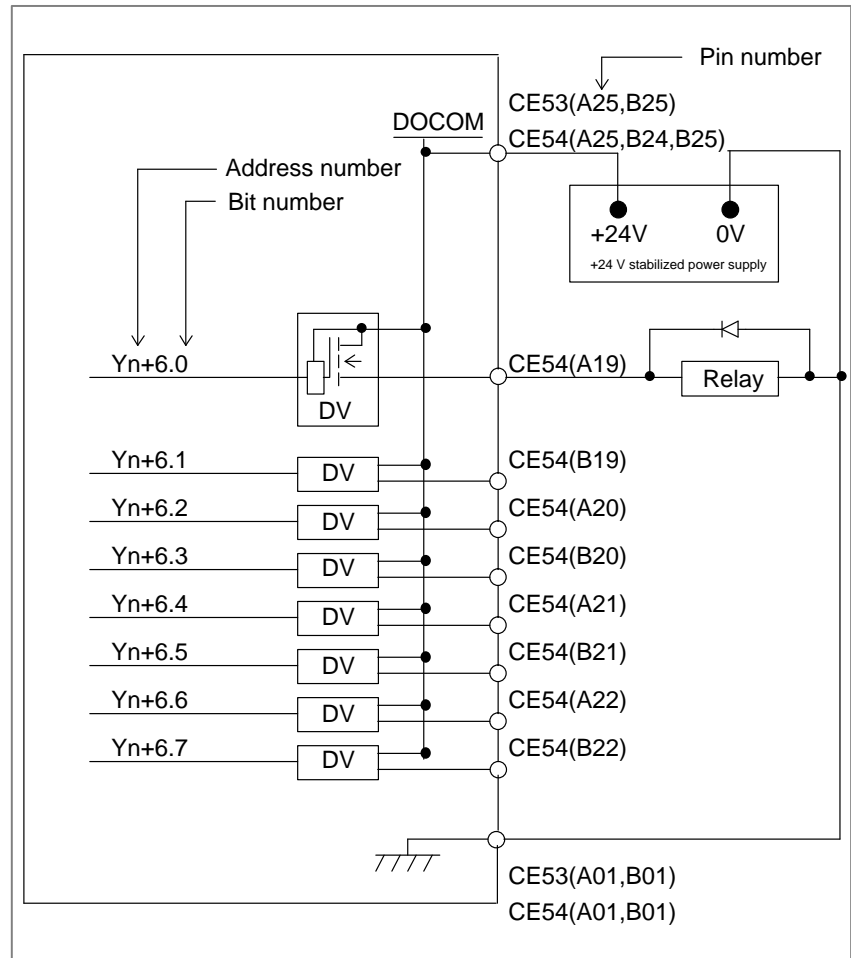
6.4.7
Manual Pulse
Generator Connection

For details of the connection of the manual pulse generator, see 6.3.6.

6.4.8
External View

Note) Lead wires and other components are mounted on the rear face of the printed circuit board. Ensure that printed circuit boards are spaced 5 mm or more from one another to prevent interference.

24 V power supply connection
Manual pulse generator connection
I/O Link signal connection
Machine operator's panel DI/DO interface

Mounting area (rear view)

6.4.9
Specifications

Installation specifications

Ambient temperature	During operation 0° to 58°C During storage and transportation –20°C to 60°C
Temperature change	Max. 1.1°C/min.
Relative humidity	Normal : 75% or less Short term (1 month or less): 95% or less
Vibration	During operation: 0.5 G or less
Environment	Ordinary machining factory environment (Special consideration is required when installing the module in a dusty location or where highly concentrated cutting lubricant or organic solvent is used.)
Other requirements	(1) Install the I/O module in a fully enclosed cabinet.

Ordering specifications

Item	Specification	Remarks
Operator's panel I/O module	A20B–2002–0470	General–purpose DI: 16 points Matrix DI: 56 points DO: 56 points MPG interface is supported.
Fuse (replacement part)	A03B–0815–K001	1A

Module specifications

Item	Specification	Remarks
General–purpose DI	16 points	24–V input
Matrix DI	56 points (8×7)	5–V input
DO points	56 points	24 V source type output
CNC interface	FANUC I/O Link connection	Up to 16 modules can be connected as CNC slaves. Or, a maximum of 1024 points can be supported on both the input and output sides.
MPG interface	Max. 3 units	MPG interface can be used only for the *i* series CNC.

Power supply rating

Module	Supply voltage	Current rating	Remarks
Operator's panel I/O module	24 VDC ±10% supplied from the power supply connector CPD1. The allowance of ±10% should include instantaneous voltage and ripple voltage.	0.35 A	The total power consumption of DI points is included. The power consumption of DO points is not included.

DI (input signal) specifications

(General–purpose input signal)

Contact rating	30 VDC, 16 mA or more
Open circuit intercontact leakage current	1 mA or less (at 26.4 V)
Closed circuit intercontact voltage drop	2 V or less (including cable voltage drop)
Delay	Receiver delay: Max. 2 ms The time required for I/O Link transmission between the CNC and I/O module (max. 2 ms + CNC ladder scan cycle) must also be taken into account.

(Matrix input signal)

Contact rating	6 VDC, 2 mA or more
Open circuit intercontact leakage current	0.2 mA or less (at 26 V)
Closed circuit intercontact voltage drop	0.9 V or less (with a current of 1 mA)
Delay	The maximum matrix period of 16 ms, the maximum time of I/O Link transfer between CNC and I/O module of 2 ms, and the ladder scanning period (by CNC) must be considered.

NOTE
When detour prevention diodes are used, the voltage drop across closed contacts indicated above must be maintained, including the diode voltage drop.

**DO (output signal)
specifications**

Maximum load current in ON state	200 mA or less (including momentary current)
Saturation voltage in ON state	Max. 1 V (when load current is 200 mA)
Withstand voltage	24 V +20% or less (including momentary values)
Leakage current in OFF state	20 μA or less
Delay	Driver delay: Max. 50 μs The time required for I/O Link transmission between the CNC and I/O module (max. 2 ms + CNC ladder scan cycle) must also be taken into account.

NOTE
Ensure that the maximum current per DOCOM pin (DO power supply pin) does not exceed 0.7 A.

6.4.10
Other Notes

DO signal reaction to a system alarm

If a system alarm occurs in the CNC using the operator's panel I/O module, or if I/O Link communication between the CNC and operator's panel I/O module fails, all the DO signals of the I/O module are turned off. Therefore, sufficient care is necessary when setting up the machine sequence. Also, the same phenomenon occurs if the power to the CNC or the I/O module is turned off.

Address allocation

For the operator's panel I/O module, I/O addresses are mapped as follows.

DI space map

Xm	General–purpose input signal
Xm+1	
Xm+2	Reserved
Xm+3	
Xm+4	Matrix input signal
Xm+5	
Xm+6	
Xm+7	
Xm+8	
Xm+9	
Xm+10	
Xm+11	Reserved
Xm+12(for 1st MPG)	MPG
Xm+13(for 2nd MPG)	
Xm+14(for 3rd MPG)	
Xm+15(DO alarm detection)	DO alarm detection

DO space map

Yn	Output signal
Yn+1	
Yn+2	
Yn+3	
Yn+4	
Yn+5	
Yn+6	
Yn+7	Reserved

The operator's panel I/O module is allocated a group of DI addresses (16 bytes) and a group of DO addresses (8 bytes). This address allocation is explained below.

The MPG interface (MPG counter) occupies DI space from Xm+12 through Xm+14. These addresses are fixed, and Xm+12 through Xm+14 must be allocated as a DI work area to enable the use of the MPG. Therefore, when using an MPG for the *i* series CNC, allocate DI addresses in units of 16 bytes. Do not use the DI space from Xm+12 through Xm+14 for Ladder; the CNC processes the MPG counter value directly.

DI address Xm+15 is used for detecting overcurrent and overheating alarms that may occur in the IC used in the DO driver. [For details, see the section describing the detection of DO (output signal) alarms.] This address is fixed, and must be allocated as a work area before it can be used. Therefore, when using this area, allocate DI addresses in units of 16 bytes.

Basically, I/O addresses can be allocated to the operator's panel I/O module freely. When allocating DI addresses, however, consider also the fixed addresses that are directly supervised by the CNC, and keep the following in mind.

Fixed addresses directly supervised by the CNC (for single–path system)

ADDRESS	7	6	5	4	3	2	1	0
X0004	SKIP	ESKIP	–MIT2	+MIT2	–MIT1	+MIT1	ZAE	XAE
		SKIP6	SKIP5	SKIP4	SKIP3	SKIP2	SKIP8	SKIP7
	SKIP	ESKIP	SKIP5	SKIP4	SKIP3	ZAE	YAE	XAE
		SKIP6				SKIP2	SKIP8	SKIP7
X0005								
X0006								
X0007								
X0008				*ESP				
X0009	*DEC8	*DEC7	*DEC6	*DEC5	*DEC4	*DEC3	*DEC2	*DEC1

The upper row indicates those signals used for the T series. Those in the lower row are for the M series.

When DI addresses are allocated in units of 16 bytes, starting at X0008

X0008	General–purpose input signal
X0009	
X0010	Reserved
X0011	
X0012	Matrix input signal
X0013	
X0014	
X0015	
X0016	
X0017	
X0018	
X0019	Reserved
X0020(for 1st MPG)	MPG
X0021(for 2nd MPG)	
X0022(for 3rd MPG)	
X0023(DO alarm detection)	DO alarm detection

←——*ESP fixed signal
←——*DECn fixed signal

Although fixed signals such as SKIP cannot be used, allocating DI addresses starting from X0008 allows the *DECn signal to be used and the *ESP fixed signal to be allocated to an address for which the common voltage is fixed to 24 V. (Fixed signals cannot be allocated to the for the matrix input signals.)

Turning the DO (output signal) power on and off (DOCOM)

All the DO signals can be turned off simultaneously by turning off (opening) the DO (output signal) power supply pin "DOCOM". Doing so causes the DO signal status to change as shown below.
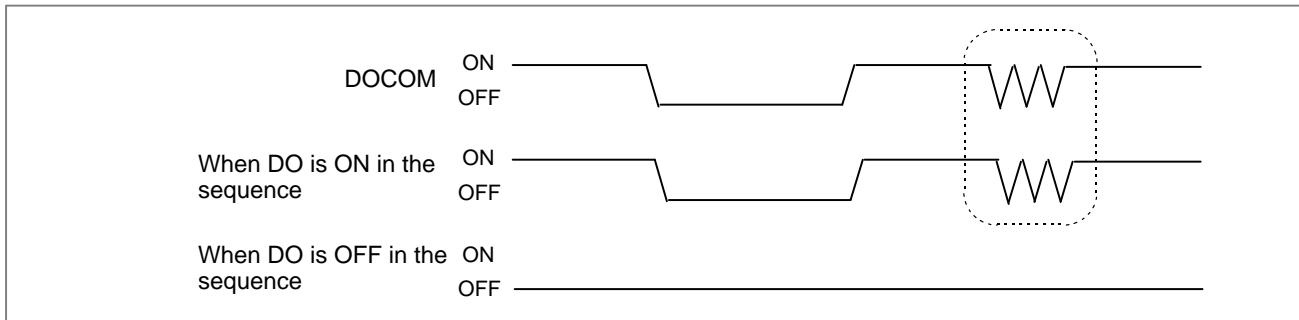
NOTE
1 When the DO signal is in the ON state in the sequence, the ON or OFF state of the DOCOM pin determines the state of the signal, as indicated by the dotted lines in the above figure.
2 Do not turn off the +24 V supply, provided by the CPD1 to the I/O module, during the operation. Turning off the +24 V supply would cause a CNC communication alarm. When turning on the power, the +24 V supply to the I/O module must be turned on before or at the same time as the power supply to the CNC. When turning off the power, the +24 V supply to the I/O module must be turned off after or at the same time as the power supply to the CNC.

Parallel DO (output signal) connection

The DO load current can be doubled by connecting two DO points in parallel and turning them on and off simultaneously in sequence, as shown in the figure below. The maximum load current per DO point is 200 mA. Connecting two DO points in parallel and turning them on at the same time produces a current of 400 mA. Note that, however, when two DO points are connected in parallel, the leakage current also doubles while they are off (max. 40 μA).
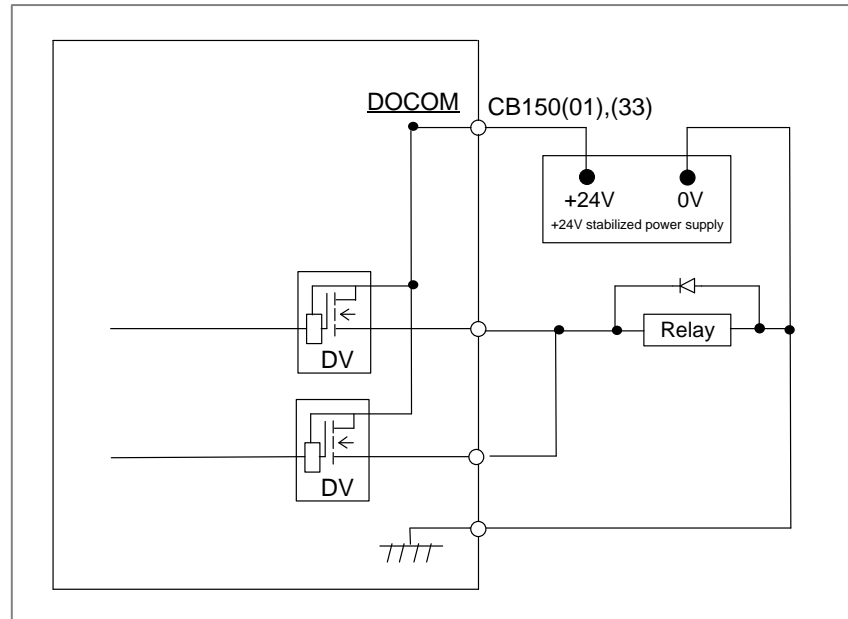
DO (output signal) alarm detection

The DO driver of the I/O module is capable of detecting an overcurrent and measuring its own temperature. If an accident, such as connecting the cable to ground, causes an abnormal increase in the load current or in the driver temperature, a protection circuit, which is provided for each DO driver (1 byte), is activated which keeps the DO signal for the relevant 1 byte in the OFF state until the cause of the problem is eliminated. Even if this occurs, the CNC and the I/O module continue operating. The DI address (Xm+15) identifies which DO driver has detected an alarm. The following table shows the correspondence between the DI address (Xm+15) bits and the DO addresses. Bit value "1" indicates that the corresponding DO driver has detected an alarm. The contents of the Xm+15 area can be checked by using the DGN screen of the CNC or by performing the alarm processing for the area in advance by using Ladder. This helps alarm detection and recovery.

Alarm detection address and bit	DO address	Remarks
Xm+15.0	Yn+0	
Xm+15.1	Yn+1	
Xm+15.2	Yn+2	
Xm+15.3	Yn+3	
Xm+15.4	Yn+4	
Xm+15.5	Yn+5	
Xm+15.6	Yn+6	
Xm+15.7	Yn+7	Reserved

6.5
CONNECTION OF
OPERATOR'S PANEL
I/O MODULE

6.5.1
Overall Connection
Diagram

NOTE
1 The MPG can be connected to this operator's panel I/O module only when the i series CNC is used. When the operator's panel I/O module is used together with a unit (connector panel I/O module) connected to the I/O Link supporting another MPG interface, only the MPG interface of the unit (module) closest to the CNC connected to the I/O Link is enabled.
2 The following screw type connectors, newly incorporated into the i series main board, cannot be used to connect the I/O Link.

Connectors that cannot be used on the cable side

	Specification	Manufacturer
Connector case	FI–20–CV7	Hirose Electric Co., Ltd.
Connector case and connector	FI30–20S–CV7	Hirose Electric Co., Ltd.

6.5.2
Power Connection

Provide the CPD1 (IN) connector, shown below, with the power necessary for the printed circuit board operation and that for DI operation. To facilitate power division, the power is output to CPD1 (OUT) exactly as it is input from CPD1 (IN). When power division is required, use CPD1 (OUT).

Recommended cable–side connector: A02B–0120–K324
(including the following connector housing and case)
(Housing: Japan AMP 1–178288–3)
(Contacts: Japan AMP 1–175218–5)

> **NOTE**
> 1 The specification of the power supply connector CPD1 (IN) is the same as that for CPD1 (OUT). There are no indications on the printed circuit board to distinguish between the IN and OUT connectors.
> 2 Do not turn off the +24 V supply to the connector during operation. Turning off the +24 V supply will cause a CNC communication alarm. When turning on the power, the +24 V supply to the I/O module must be turned on before or at the same time as the power supply to the CNC. When turning off the power, the +24 V supply to the I/O module must be turned off after or at the same time as the power supply to the CNC.

6.5.3
DI/DO Connector Pin Arrangement

	CE56				CE57	
	A	B			A	B
01	0V	+24V		01	0V	+24V
02	Xm+0.0	Xm+0.1		02	Xm+3.0	Xm+3.1
03	Xm+0.2	Xm+0.3		03	Xm+3.2	Xm+3.3
04	Xm+0.4	Xm+0.5		04	Xm+3.4	Xm+3.5
05	Xm+0.6	Xm+0.7		05	Xm+3.6	Xm+3.7
06	Xm+1.0	Xm+1.1		06	Xm+4.0	Xm+4.1
07	Xm+1.2	Xm+1.3		07	Xm+4.2	Xm+4.3
08	Xm+1.4	Xm+1.5		08	Xm+4.4	Xm+4.5
09	Xm+1.6	Xm+1.7		09	Xm+4.6	Xm+4.7
10	Xm+2.0	Xm+2.1		10	Xm+5.0	Xm+5.1
11	Xm+2.2	Xm+2.3		11	Xm+5.2	Xm+5.3
12	Xm+2.4	Xm+2.5		12	Xm+5.4	Xm+5.5
13	Xm+2.6	Xm+2.7		13	Xm+5.6	Xm+5.7
14	DICOM0			14		DICOM5
15				15		
16	Yn+0.0	Yn+0.1		16	Yn+2.0	Yn+2.1
17	Yn+0.2	Yn+0.3		17	Yn+2.2	Yn+2.3
18	Yn+0.4	Yn+0.5		18	Yn+2.4	Yn+2.5
19	Yn+0.6	Yn+0.7		19	Yn+2.6	Yn+2.7
20	Yn+1.0	Yn+1.1		20	Yn+3.0	Yn+3.1
21	Yn+1.2	Yn+1.3		21	Yn+3.2	Yn+3.3
22	Yn+1.4	Yn+1.5		22	Yn+3.4	Yn+3.5
23	Yn+1.6	Yn+1.7		23	Yn+3.6	Yn+3.7
24	DOCOM	DOCOM		24	DOCOM	DOCOM
25	DOCOM	DOCOM		25	DOCOM	DOCOM

6.5.4
DI (General–Purpose
Input Signal)
Connection
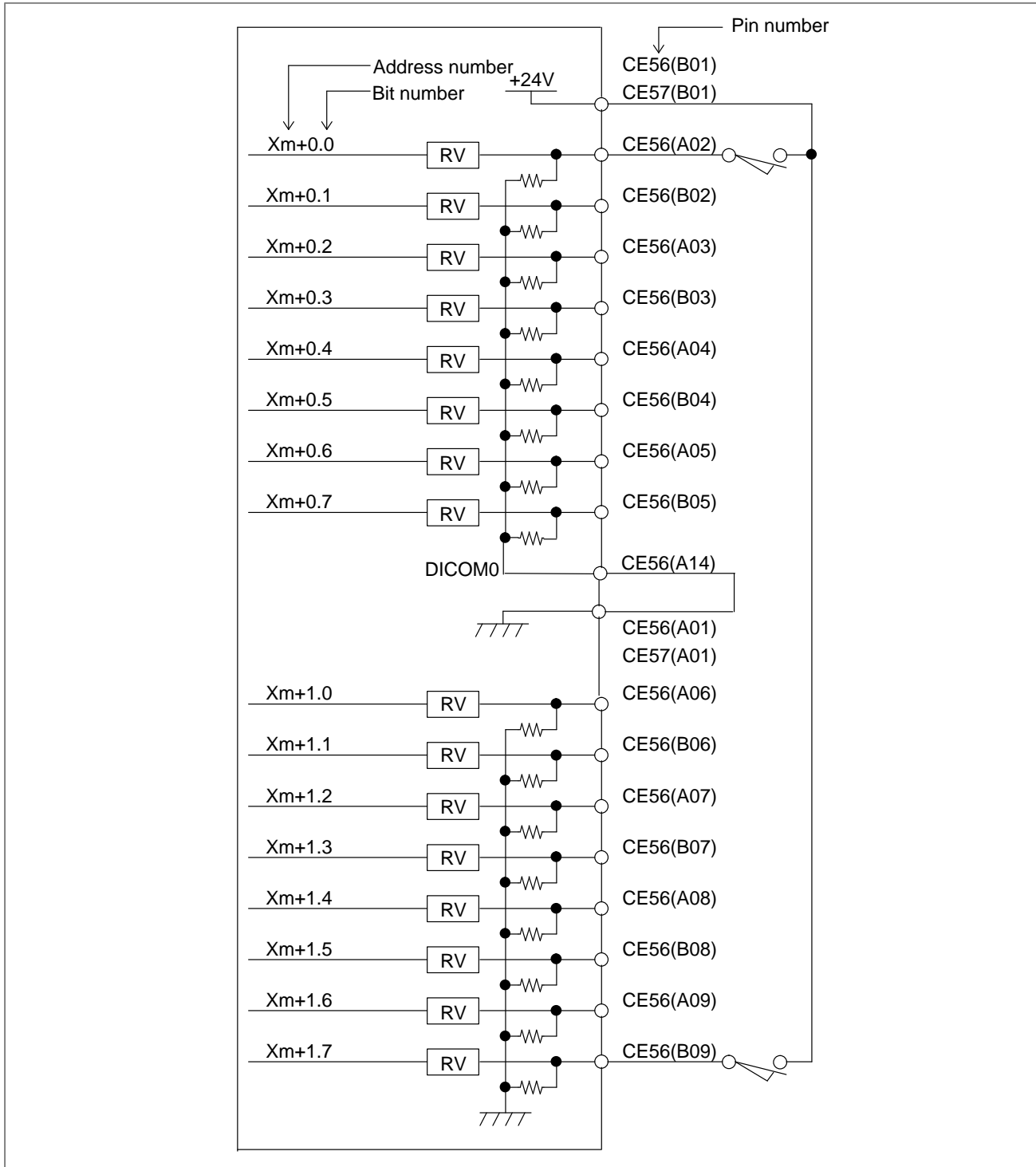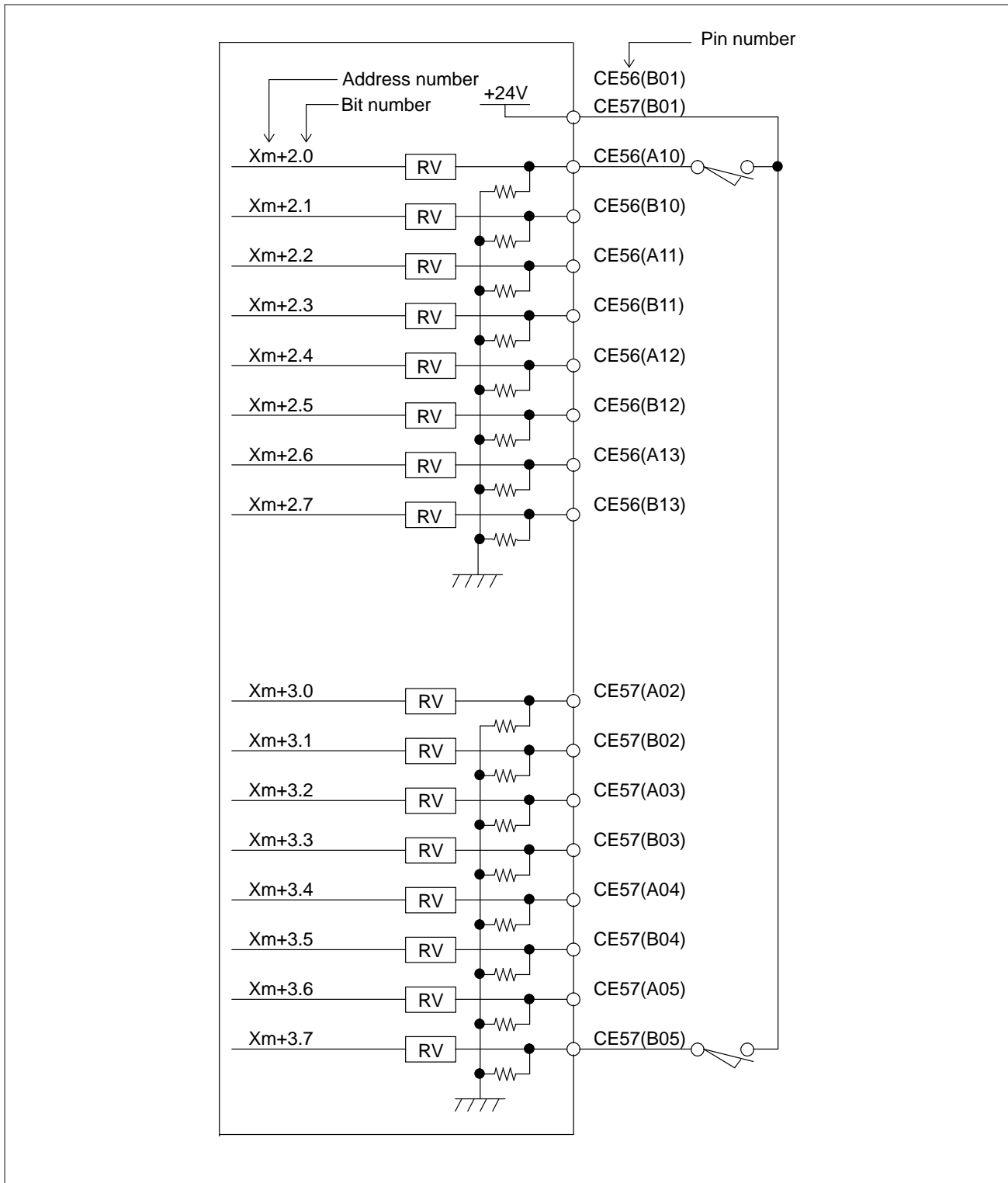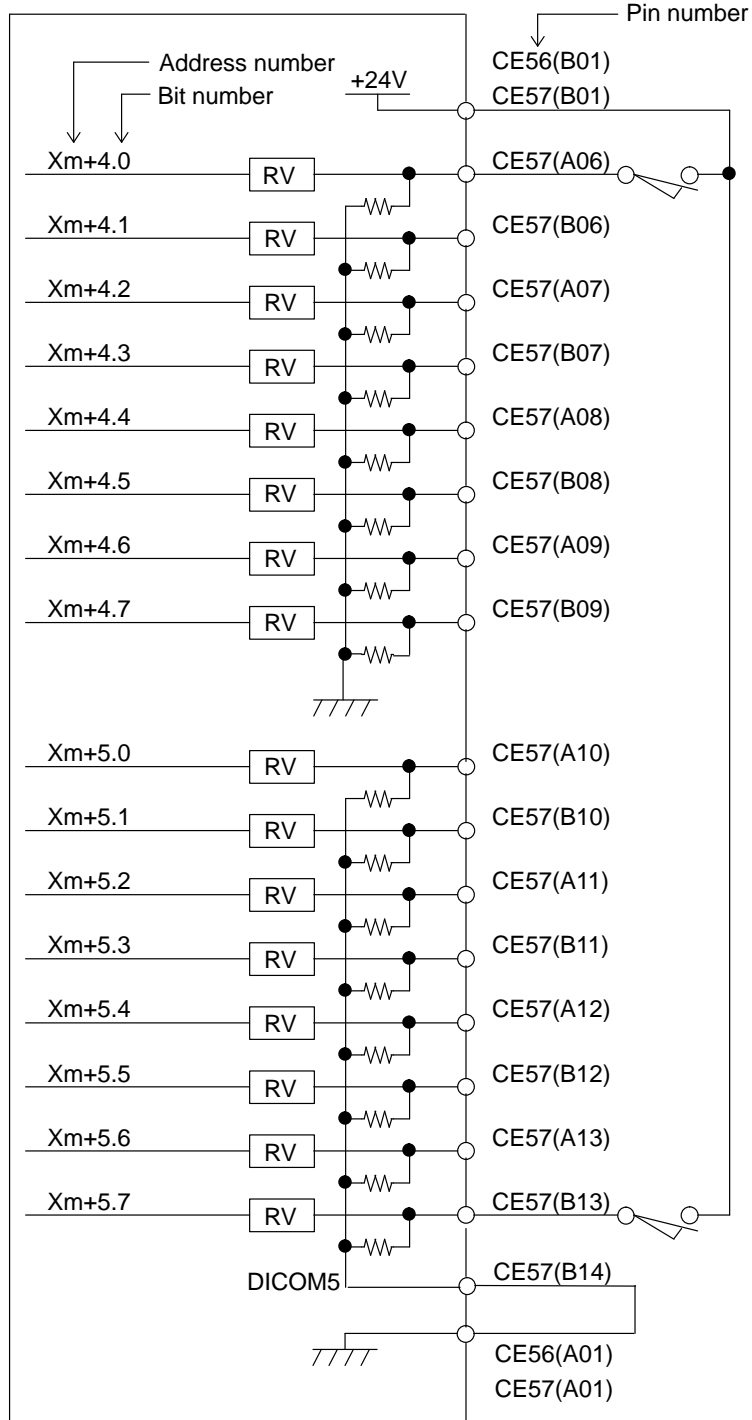
NOTE
1 Xm+0.0 through Xm+0.7 and Xm+5.0 through Xm+5.7 are DI pins for which a common voltage can be selected. That is, by connecting the DICOM0 CE56(A14) or DICOM5 CE57(B14) pin to the +24 V power supply, a DI signal can be input with its logical state reversed. If, however, a cable is connected to ground, it has the same effect as inputting an ON state DI signal. To prevent this from occurring, the connection of the DICOM0 CE56(A14) and DICOM5 CE57(B14) pins to the 0 V power supply is recommended wherever possible.
2 For safety reasons, the emergency stop signal needs to be allocated to an appropriate bit of the addresses for which the common voltage is fixed. See "Address allocation" in 6.5.9 for details of how to allocate the emergency stop signal.
3 For unused DI pins allocated to the addresses for which the common voltage is fixed, the logic is fixed to "0". For unused pins allocated to the addresses for which the common voltage can be selected, the logic is fixed to "0" when the DICOM0 CE56(A14) or DICOM5 CE57(B14) pin is connected to the 0 V power supply. When the DICOM0 CE56(A14) or DICOM5 CE57(B14) pin is connected to the +24 V power supply, the logic is fixed to "1". The logic of the unused pins is variable when the contact of the COM1 CE54(A02) pin is open.

6.5.5
DO (Output Signal) Connection

Pin number

CE56(A24,B24,A25,B25)

DOCOM

CE57(A24,B24,A25,B25)

Address number

Bit number

+24V   0V

+24 V stabilized power supply

Yn+2.0

DV

CE57(A16)   Relay

Yn+2.1   DV   CE57(B16)
Yn+2.2   DV   CE57(A17)
Yn+2.3   DV   CE57(B17)
Yn+2.4   DV   CE57(A18)
Yn+2.5   DV   CE57(B18)
Yn+2.6   DV   CE57(A19)
Yn+2.7   DV   CE57(B19)

Yn+3.0   DV   CE57(A20)
Yn+3.1   DV   CE57(B20)
Yn+3.2   DV   CE57(A21)
Yn+3.3   DV   CE57(B21)
Yn+3.4   DV   CE57(A22)
Yn+3.5   DV   CE57(B22)
Yn+3.6   DV   CE57(A23)
Yn+3.7   DV   CE57(B23)

CE56(A01)
CE57(A01)

6.5.6
Manual Pulse
Generator Connection

For details of the connection of the manual pulse generator, see 6.3.6.

6.5.7
External View

Note) Lead wires and other components are mounted on the rear face of the printed circuit board. Ensure that the printed circuit boards are spaced 5 mm or more from one another to prevent interference.

24 V power supply connection

Manual pulse generator connection

I/O Link signal connection

Machine operator's panel DI/DO interface

Mounting area (rear view)

6.5.8
Specifications

Installation specifications

Ambient temperature	During operation 0° to 58°C During storage and transportation –20°C to 60°C
Temperature change	Max. 1.1°C/min.
Relative humidity	Normal : 75% or less Short term (1 month or less) : 95% or less
Vibration	During operation: 0.5 G or less
Environment	Ordinary machining factory environment (Special consideration is required when installing the module in a dusty place or where highly concentrated cutting lubricant or organic solvent is used.)
Other requirements	(1) Install the I/O module in a fully enclosed cabinet.

Ordering specifications

Item	Specification	Remarks
Operator's panel I/O module (with MPG interface)	A20B–2002–0520	DI: 48 points DO: 32 points MPG interface is supported.
Operator's panel I/O module (without MPG interface)	A20B–2002–0521	DI: 48 points DO: 32 points MPG interface is not supported.
Fuse (replacement part)	A03B–0815–K001	1 A

Module specifications

Item	Specification	Remarks
DI points	48 points	24 V input
DO points	32 points	24 V source type output
CNC interface	FANUC I/O Link connection	Up to 16 modules can be connected as CNC slaves. Or, a maximum of 1024 points can be supported on both the input and output sides.
MPG interface	Max. 3 units	MPG interface can be used only for the *i* series CNC.

Power supply rating

Module	Supply voltage	Power supply rating	Remarks
Operator's panel I/O module	24 VDC ±10% is supplied from power supply connector CPD1. The tolerance of ±10% includes momentary and ripple currents.	0.3 A+7.3 mA×DI	DI = number of DI points in the ON state

DI (input signal) specifications

(General–purpose input signal)

Contact rating	30 VDC, 16 mA or more
Open circuit intercontact leakage current	1 mA or less (at 26.4 V)
Closed circuit intercontact voltage drop	2 V or less (including cable voltage drop)
Delay	Receiver delay: Max. 2 ms The time required for I/O Link transmission between the CNC and I/O module (max. 2 ms + CNC ladder scan cycle) must also be taken into account.

DO (output signal) specifications

Maximum load current in ON state	200 mA or less (including momentary current)
Saturation voltage in ON state	Max. 1 V (when load current is 200 mA)
Withstand voltage	24 V +20% or less (including momentary values)
Leakage current in OFF state	20 μA or less
Delay	Driver delay: Max. 50 μs The time required for I/O Link transmission between the CNC and I/O module (max. 2 ms + CNC ladder scan cycle) must also be taken into account.

NOTE
Ensure that the maximum current per DOCOM pin (DO power supply pin) does not exceed 0.7 A.

6.5.9
Other Notes

DO signal reaction to a system alarm

If a system alarm occurs in a CNC using this operator's panel I/O module, or if I/O Link communication between the CNC and operator's panel I/O module fails, all the DO signals of the I/O module are turned off. Therefore, due care must be taken when setting up the machine sequence. Also, the same phenomenon occurs if the power of the CNC or the I/O module is turned off.

Address allocation

For the operator's panel I/O module, I/O addresses are mapped as follows.

DI space map			DO space map	
Xm			Yn	
Xm+1			Yn+1	Output signal
Xm+2	Input signal		Yn+2	
Xm+3			Yn+3	
Xm+4				
Xm+5				
Xm+6				
Xm+7				
Xm+8	Not used			
Xm+9				
Xm+10				
Xm+11				
Xm+12 (for 1st MPG)				
Xm+13 (for 2nd MPG)	MPG			
Xm+14 (for 3rd MPG)				
Xm+15 (DO alarm detection)	DO alarm detection			

Basically, this operator's panel I/O module is allocated a group of DI addresses (16 bytes) and a group of DO addresses (4 bytes). This address allocation is explained below.

The MPG interface (MPG counter) occupies DI space from Xm+12 through Xm+14. These addresses are fixed, and Xm+12 through Xm+14 must be allocated as a DI work area to enable the use of the MPG. Therefore, when using an MPG for the *i* series CNC, allocate DI addresses in units of 16 bytes. Do not use the DI space from Xm+12 through Xm+14 for Ladder; the CNC processes the MPG counter value directly.

DI address Xm+15 is used for detecting overcurrent and overheating alarms that occur in the IC used in the DO driver. [For details, see the section describing the detection of DO (output signal) alarms.] This address is fixed, and must be allocated as a work area before it can be used. When using this area, therefore, allocate DI addresses in units of 16 bytes.

Basically, I/O addresses can be allocated to the operator's panel I/O module freely. When allocating DI addresses, however, consider also the fixed addresses that are directly supervised by the CNC, and keep the following in mind.

Fixed addresses directly supervised by the CNC (for single–path system)

	7	6	5	4	3	2	1	0
X0000	SKIP	ESKIP	–MIT2	+MIT2	–MIT1	+MIT1	ZAE	XAE
		SKIP6	SKIP5	SKIP4	SKIP3	SKIP2	SKIP8	SKIP7
	SKIP	ESKIP	SKIP5	SKIP4	SKIP3	ZAE	YAE	XAE
		SKIP6				SKIP2	SKIP8	SKIP7
X0001								
X0002								
X0003								
X0004				*ESP				
X0005	*DEC8	*DEC7	*DEC6	*DEC5	*DEC4	*DEC3	*DEC2	*DEC1

The upper row indicates those signals for the T series. Those in the lower row are for the M series.

When DI addresses are allocated in units of 16 bytes, starting at X0008

X0000	Input signal	
X0001		
X0002		
X0003		
X0004		←——*ESP fixed signal
X0005		←——*DECn fixed signal
X0006	Not used	
X0007		
X0008		
X0009		
X0010		
X0011		
X0012 (for 1st MPG)	MPG	
X0013 (for 2nd MPG)		
X0014 (for 3rd MPG)		
Xm+15 (DO alarm detection)	DO alarm detection	

Allocating DI addresses from X0000 allows the fixed signals, such as SKIP and *DECn, to be used and the *ESP fixed signal to be allocated to an address for which the common voltage in fixed to 24 V.
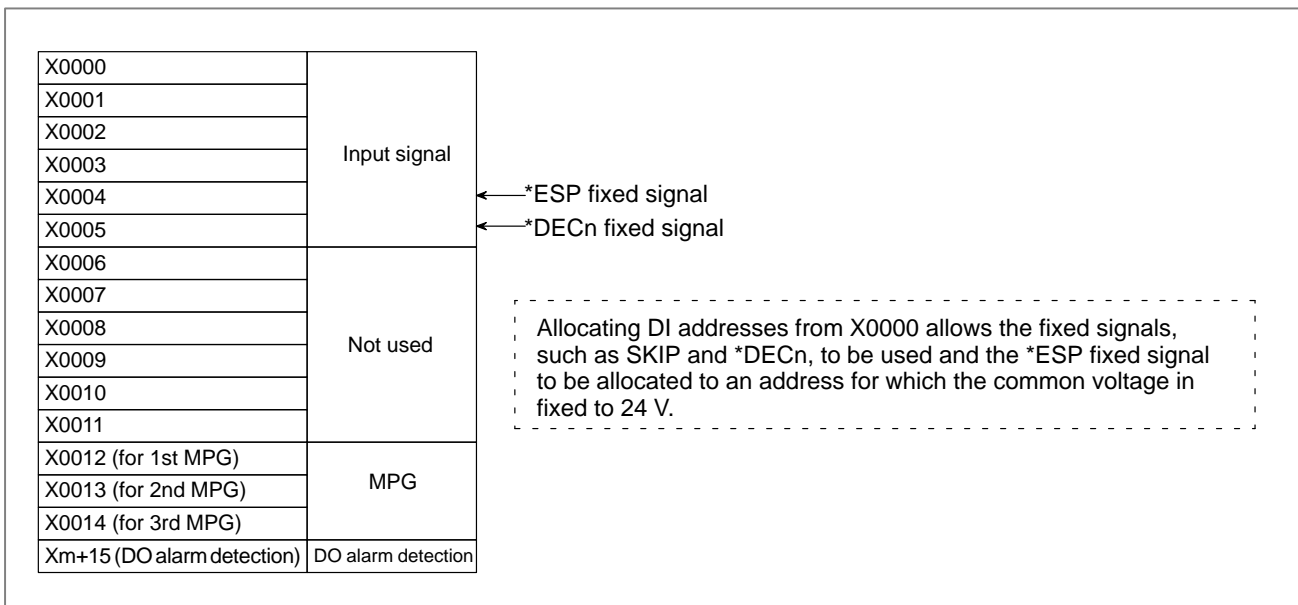
Turning the DO (output signal) power on and off (DOCOM)

All the DO signals can be turned off simultaneously by turning off (opening) the DO (output signal) power supply pin "DOCOM". Doing so causes the DO signal status to change as shown below.
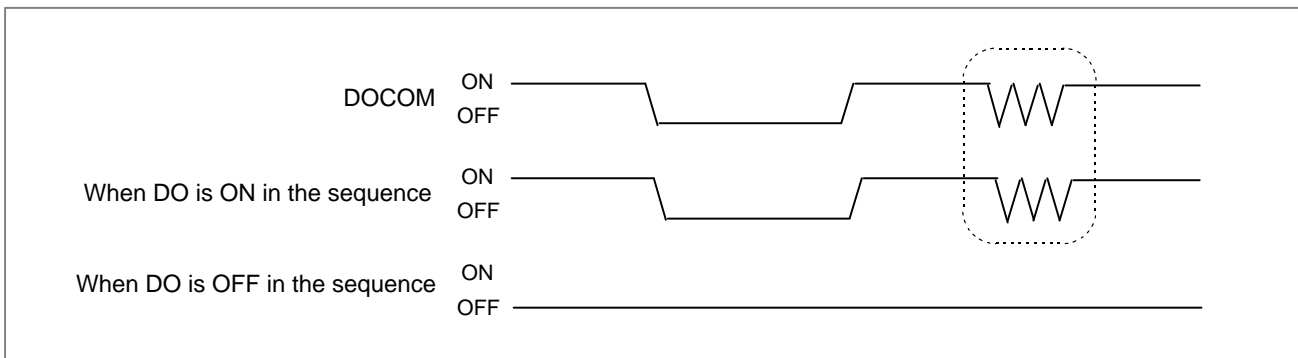
NOTE
1 When the DO signal is in the ON state in the sequence, the ON or OFF state of the DOCOM pin determines the state of the signal, as shown within dotted lines in the above figure.
2 Do not turn off the +24 V supply provided by the CPD1 to the I/O module during the operation. Turning off the +24 V supply causes a CNC communication alarm. When turning on the power, the +24 V supply to the I/O module must be turned on before or at the same time as the power supply to the CNC. When turning off the power, the +24 V supply to the I/O module must be turned off after or at the same time as the power supply to the CNC.

Parallel DO (output signal) connection

The DO load current can be doubled by connecting two DO points in parallel and turning them on and off simultaneously in sequence, as shown in the figure below. The maximum load current per DO point is 200 mA. Connecting two DO points in parallel and turning them on at the same time produces a current of 400 mA. Note that, however, when two DO points are connected in parallel, the leakage current also doubles when they are off (max. $40\,\mu$A).

DO (output signal) alarm detection

The DO driver of the I/O module is capable of detecting an overcurrent and measuring its own temperature. If an accident, such as the connecting of the cable to ground, causes an abnormal increase in the load current or in the driver temperature, a protection circuit, which is provided for each DO driver (1 byte), is activated and keeps the DO signal for the relevant 1 byte in the OFF state until the cause of the problem is eliminated. Even if this occurs, the CNC and I/O module continue operating. The DI address (Xm+15) identifies the DO driver which has detected the alarm. The following table shows the correspondence between the DI address (Xm+15) bits and the DO addresses. Bit value "1" indicates that the corresponding DO driver has detected an alarm. The contents of the Xm+15 area can be checked by using the DGN screen of the CNC or by performing alarm processing for the area in advance by using Ladder. This helps alarm detection and recovery.

Alarm detection address and bit	DO address	Remarks
Xm+15.0	Yn+0	
Xm+15.1	Yn+1	
Xm+15.2	Yn+2	
Xm+15.3	Yn+3	
Xm+15.4	Yn+4	Reserved
Xm+15.5	Yn+5	Reserved
Xm+15.6	Yn+6	Reserved
Xm+15.7	Yn+7	Reserved

6.6
CONNECTION OF THE FANUC I/O Unit–MODEL A

The FANUC I/O Unit–MODEL A ("I/O Unit") is a modular–type I/O unit. It interfaces with the machine when connected to the control unit via the I/O Link. One I/O unit can be configured by mounting the I/O modules required for either the 5– or 10–slot base unit. A variety of I/O modules are provided so appropriate modules can be selected according to the use, points, voltage level, current capacity, and signal specifications.

6.6.1
Structure of FANUC I/O Unit–MODEL A

Base Unit ABU05A(5 slots) or ABU10A(10 slots)

| I/F | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Various I/O modules (Up to 10 modules)

Interface module AIF01A or AIF01B
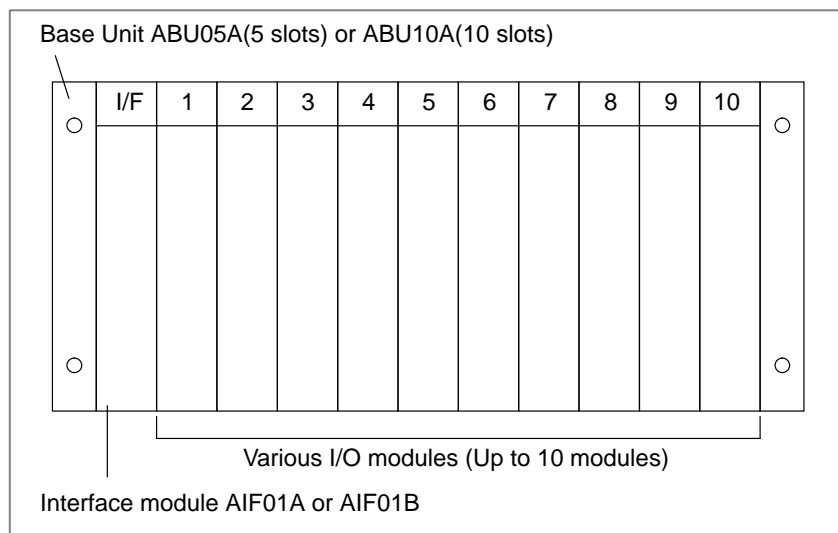
AIF01A is used for connection to FANUC I/O Link
AIF01B expands I/O Units in the same group.

6.6.2
Outer Dimensions

(80)   142

90

20

A

B

130

ø5 (mounting hole)
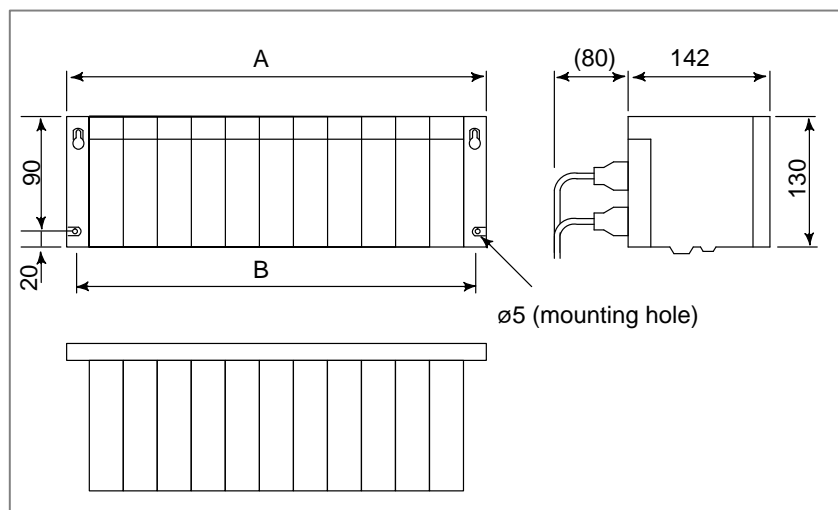
	A	B
For 5–slot base unit (ABU05A)	253	238
For 10–slot base unit (ABU10A)	430	415

6.6.3
Mounting and
Dismounting Modules

Interface modules and various types of I/O modules can be mounted to and dismounted from the base unit easily as shown below.

Mounting
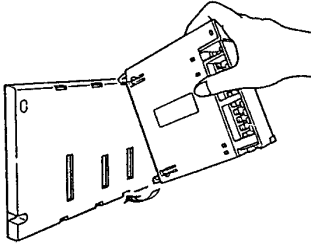
1 Hang the hook at the top of the module on the groove in the upper side of the base unit.

2 Make the connector of the module engage with that of the base unit.

3 Push the module in the lower groove of the base unit till the stopper in the lower side of the module stops.

Dismounting
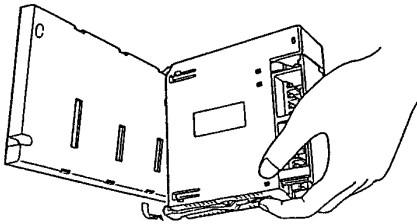
1 Release the stopper by pushing the lever at the bottom of the module.

2 Push the module upwards.

6.6.4
Connection Diagram
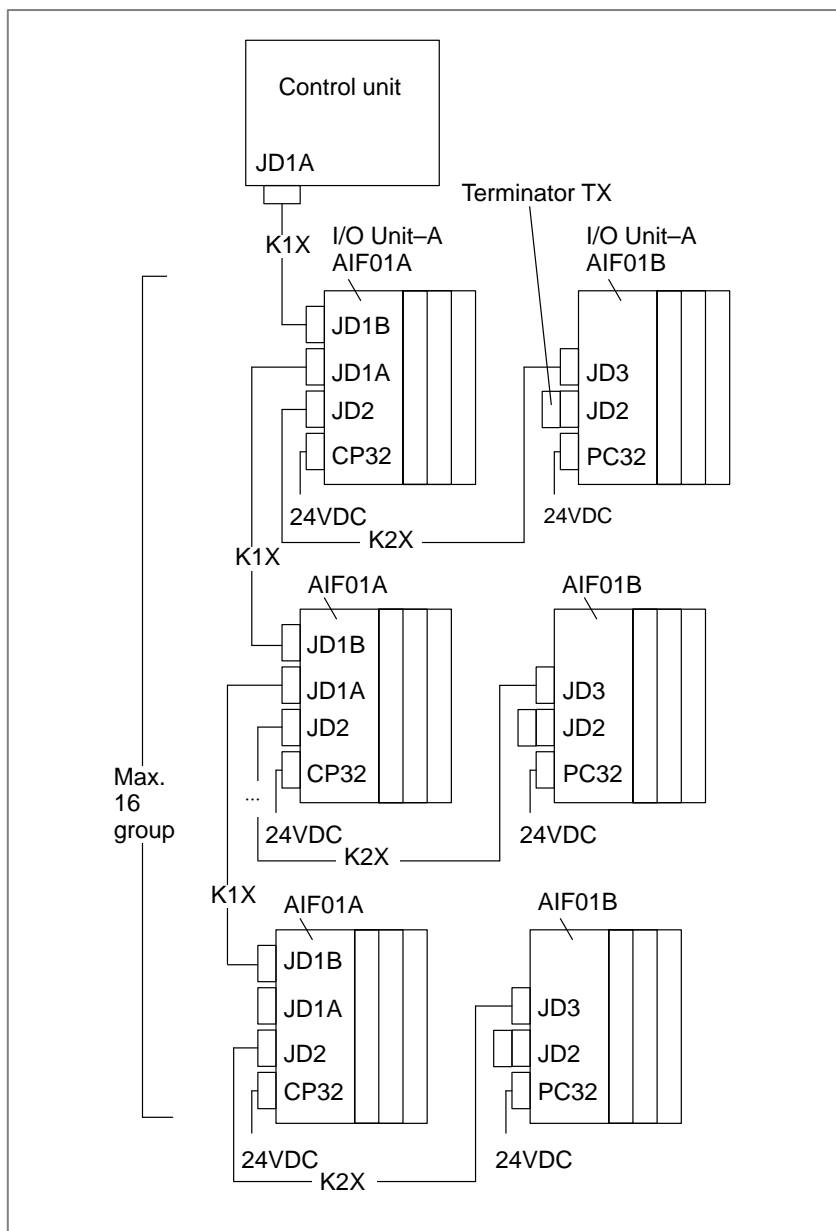
CAUTION
1 Number of I/O Units and connecting method are restricted depending on the allocation of the I/O points.
   See 6.2 "Connection of FANUC I/O Link" and 6.6.11 "Number of I/O points for the I/O Unit–A".
2 Cable K1X can be an optical fiber cable by using the optical I/O link adapter.
   Refer to item 6.2.3.

6.6.5
Connecting Input
Power Source

Connect the following power source to the connector CP32 of the interface module (AIF01A or AIF01B).

- Voltage : 24VDC±10%
- Current : Determine from Table 6.6.6.
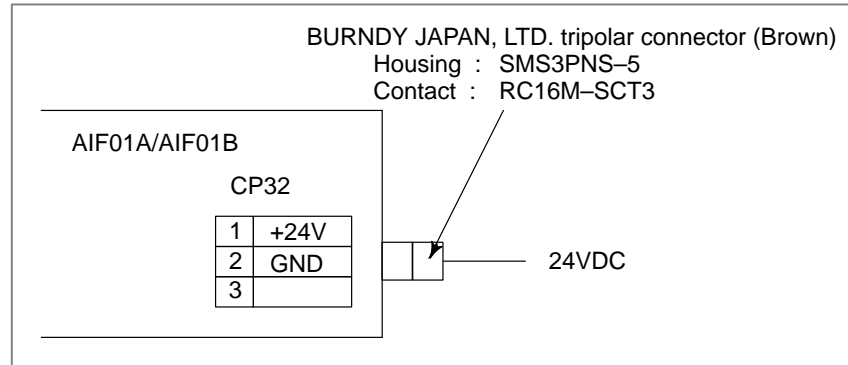
CAUTION
Turn ON the power for the I/O unit just before or when the power for the CNC is turned ON. When the CNC power is turned OFF, make sure to turn the power to the I/O unit OFF as well.

t : more than –500ms
  (Turn ON of the power for I/O unit can be late 500ms or less.)
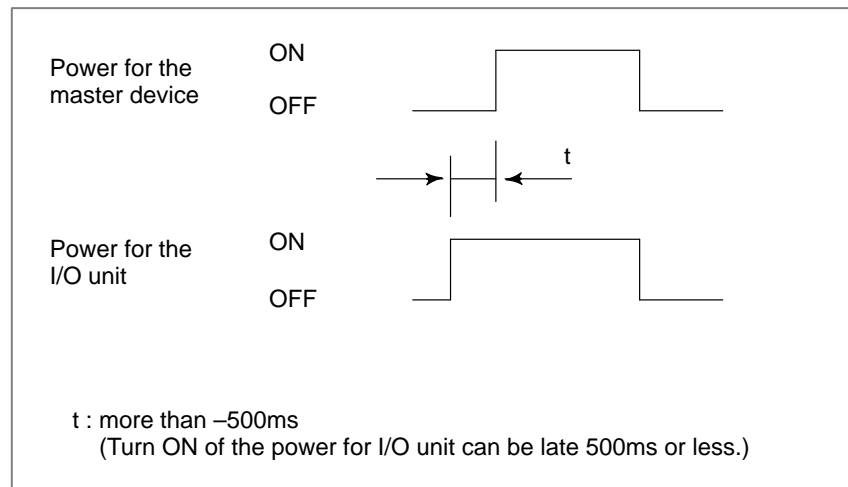
6.6.6
Grounding

● Ground the base unit (ABU05A, ABU10A) by its grounding terminal

Base unit (ABU05A, ABU10A)

M4 Screw terminal
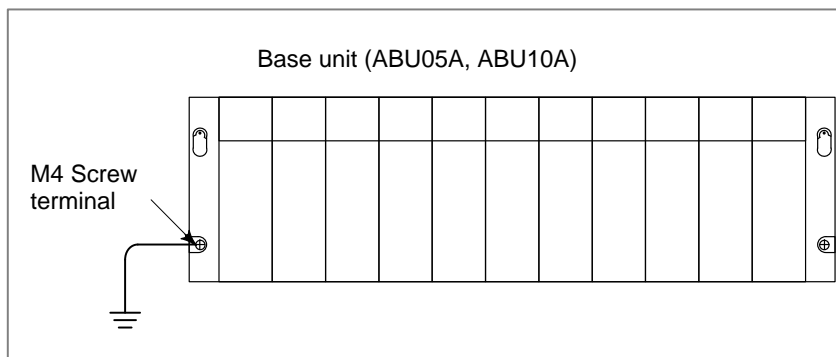
● When the cable K1X (see connection diagram in section 6.6.4) runs between different cabinets, make sure to connect the cabinets with a grounding wire more than 5.5 mm^2.

Table 6.6.6 Required current of each module

Module name	Required current (mA) of +24V	
	A	B
AIF01A	50	
AIF01B	50	
AID32A	$20+0.5 \times n$	$30+7.5 \times n$
AID32B	$20+0.5 \times n$	$30+7.5 \times n$
AID16C	5	
AID16D	5	
AID32E	5	
AID32F	5	
AIA16G	$5+1.5 \times n$	
AOD08C	$5+2 \times n$	
AOD08D	$5+2 \times n$	
AOD16C	$5+2 \times n$	
AOD16D	$5+2 \times n$	
AOD32C	$5+0.5 \times n$	
AOD32D	$5+0.5 \times n$	
AOA05E	$5+5.5 \times n$	
AOA08E	$5+5.5 \times n$	
AOA12F	$5+4.5 \times n$	
AOR08G	5	$10 \times n$
AOR16G	5	$10 \times n$
AAD04A	5	130

n : Number of the input and output points (for each module) which turn ON simultaneously

● The current sum requirement for modules used in Column A should not exceed 500 mA.

● The current sum requirement for modules used in Column B should not exceed 1500 mA.

6.6.7
Connecting Signal
Cables

Details of the cables K1X, K2X and the terminator shown in the general connection diagram are as follows.

Cable K1X
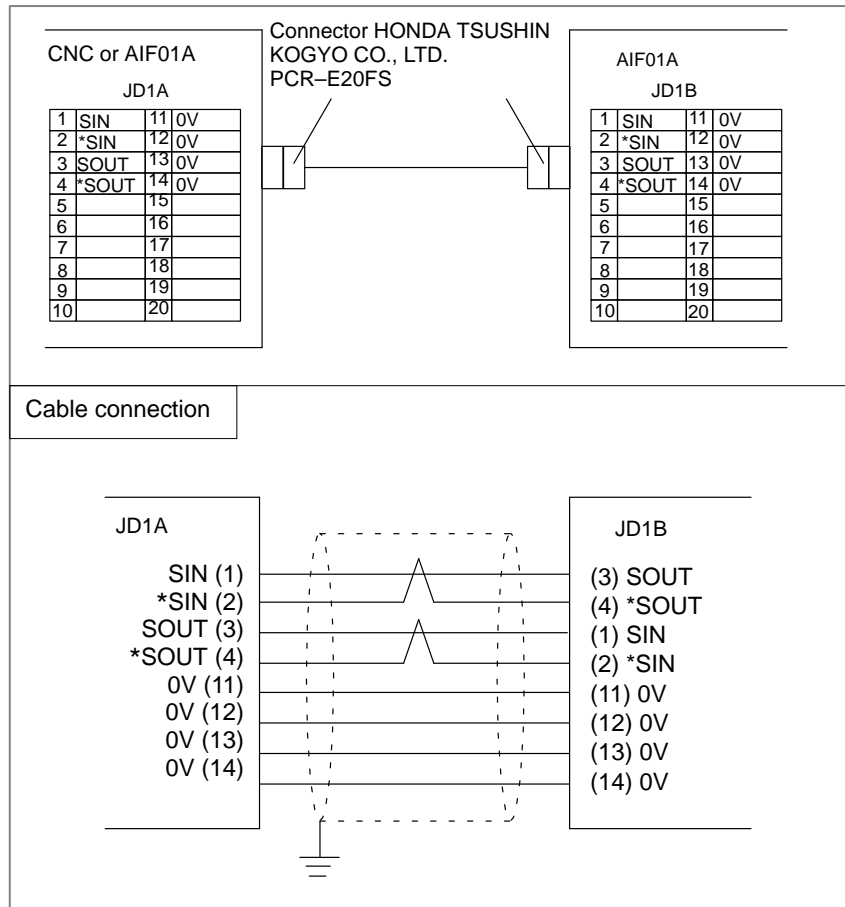
- Use twisted pair wires for signal SIN and *SIN, and signals SOUT and *SOUT.

- Recommended cable material : A66L–0001–0284#10P
                              (twisted pair/shielded)

- Shielding wires should be connected with the grounding plate of the cabinet at the JD1A side using a cable clamp.

- Maximum cable length: 10 m

- Do not make any wire connections to the connector spare pins.

- Use an optical I/O link adapter and an optical fiber cable, [in the following cases] :

  ❏ When the cable is more than 10 meters long.

  ❏ When the cable runs between different cabinets and there is no appropriate ground wire between the cabinets.

  ❏ When there is concern that the cable is influenced by strong noise.

Cable K2X
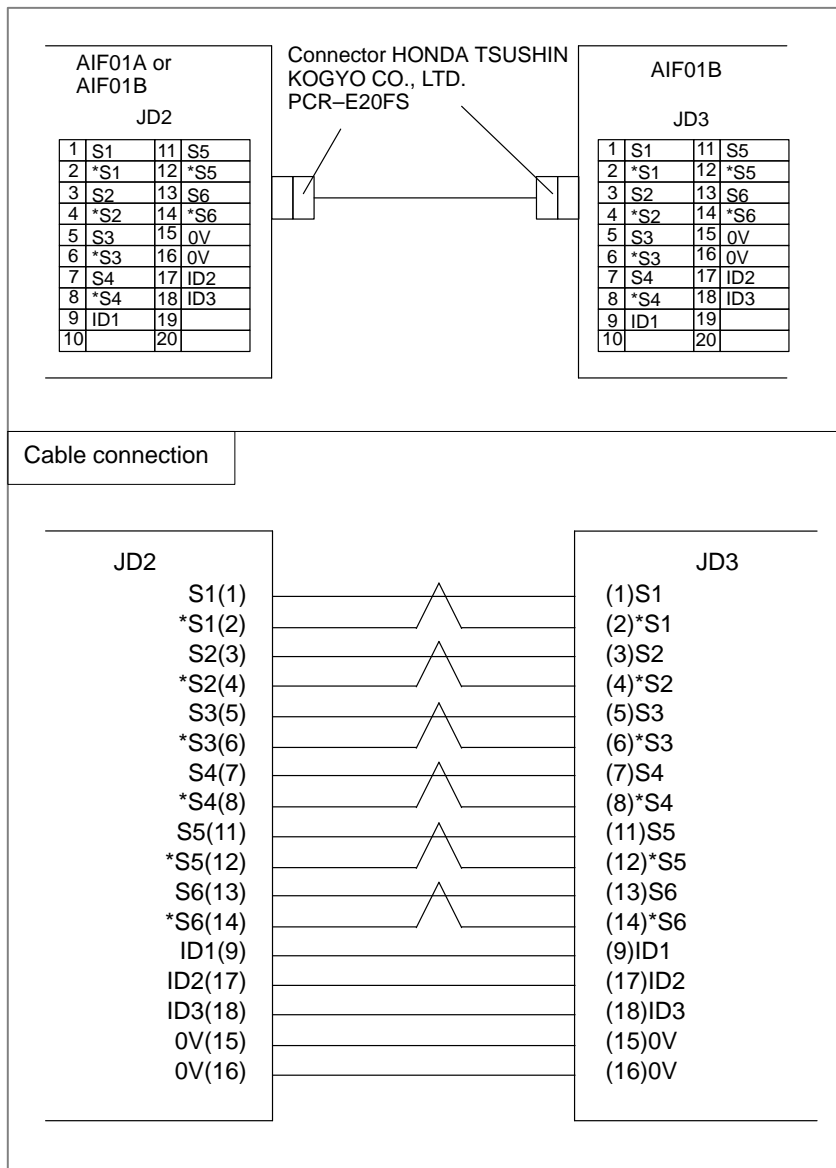
- Connect the signals with the same name.
- Make sure to use twisted pair wires for the following signals:

  S1 and *S1, S2 and *S2, S3 and *S3

  S4 and *S4, S5 and *S5, S6 and *S6
- Do not connect the pins No. 10, No. 19 and No. 20, as they are used internally.
- Recommended cable material : A66L – 0001 – 0284#10P
  (twisted pair/shielded)
- Maximum cable length : 2 m

Terminator TX

```
AIF01B

       JD2
┌────┬──────┬────┬──────┐
│ 1  │      │ 11 │      │
│ 2  │      │ 12 │ TRM2 │
│ 3  │      │ 13 │      │
│ 4  │ TRM1 │ 14 │ TRM3 │
│ 5  │      │ 15 │      │
│ 6  │      │ 16 │      │
│ 7  │      │ 17 │      │
│ 8  │      │ 18 │      │
│ 9  │      │ 19 │ TRM2 │
│ 10 │ TRM1 │ 20 │ TRM3 │
└────┴──────┴────┴──────┘
```

Connector
HONDA TSUSHIN KOGYO CO., LTD.
PCR–E20FS

(a) Terminate the connector
JD2 of the last AIF01B in
a single group with the terminator.

(b) Short–circuit the TRM1 signals
as shown. Repeat the shorting
procedure for signals TRM2
and TRM3.

Cable connection

```
              JD2

                              Shorting jumper
         TRM1   (4) ┐
                    ├──────┐
         TRM1  (10) ┘

                              Shorting jumper
         TRM2  (12) ┐
                    ├──────┐
         TRM2  (19) ┘

                              Shorting jumper
         TRM3  (14) ┐
                    ├──────┐
         TRM3  (20) ┘
```

6.6.8
Connecting with I/O Modules

For an external connecting method, there are two types of I/O modules : one with a terminal block, and one with a connector.
The terminal block is a removable type.

Terminal block type   Connector type

Input/Output display LED

A0 . . .7
B0 . . .7

Terminal block cover

Connector
HONDA
TSUSHIN
KOGYO
CO., LTD.
MR–50RMA

M3.5 screw terminal (20 terminal)
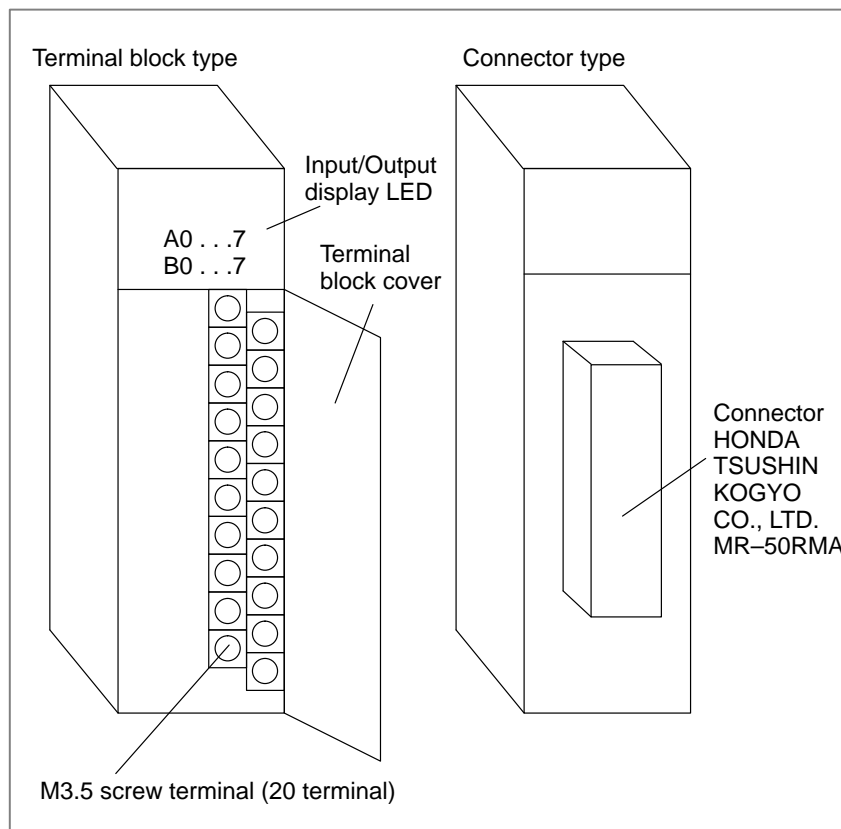
Mounting the terminal block
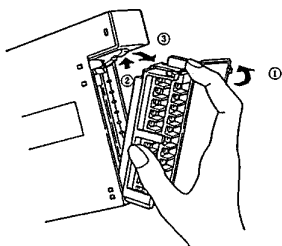
1 Insert the protruding portion at the bottom of the terminal block in the groove of the module side.

2 Push the terminal block using the engaging point of the protruding portion and the groove as an axis and mount it in the module firmly.

3 Open the cover of the terminal block and check to make sure the latch at the top of the terminal block is firmly set.
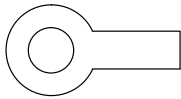
Dismounting the terminal block
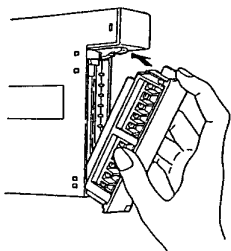
1 Open the cover of the terminal block.

2 Push up the latch at the top of the terminal block.

3 Drag out the tab at the top of the terminal block and pull it out.
The terminal block will be removed from the module.

Cautionary points when wiring terminal block type

- Wiring material : AWG22 – 18 (0.3 – 0.75mm^2)

  A wire as thin as possible is recommended.

- Crimp style terminal : M3.5

  Crimp style terminal with no insulation sleeve and a short distance "A", as illustrated in the drawing below, is recommended.

A : Approx. 4.5mm

DAIDO SOLDERLESS TERMINAL MFG. CO., LTD	1.25–S3.5
NICHIFU EUROPE B.V NICHIFU AMERICA, INC.	1.25–3.5S, etc.

- Mark tube : As short a mark tube as possible ; cover climped part with the mark tube.

6.6.9
Digital Input/Output Module

Digital input modules

Input type	Module name	Rated voltage	Rated current	Polarity	Response time	Points	External connection	LED display
Non–insulation DC input	AID 32A	24VDC	7.5mA	Both	Maximum 20ms	32	Connector	not provided
	AID 32B	24VDC	7.5mA	Both	Maximum 2ms	32	Connector	not provided
Insulation type DC input	AID 16C	24VDC	7.5mA	NEG	Maximum 20ms	16	Terminal block	provided
	AID 16D	24VDC	7.5mA	POS	Maximum 20ms	16	Terminal block	provided
	AID 32E	24VDC	7.5mA	Both	Maximum 20ms	32	Connector	not provided
	AID 32F	24VDC	7.5mA	Both	Maximum 2ms	32	Connector	not provided
AC input	AIA 16G	100–120VAC	10.5mA (120VAC)	ON Max 35ms OFF Max 45ms		16	Terminal block	provided

CAUTION
1 Polarity
   Negative : 0 V common (current source type)
   – The input is defined as ON when at a low level
   Positive : 24 V common (current sink type)
   – The input is defined as ON when at a high level
2 For the details of the specifications for each module, refer to FANUC I/O Unit–MODEL A Connection·Maintenance Manual (B–61813E).

Digital output modules

Output type	Module name	Rated voltage	Rated current	Polarity	Points	Points /common	External connection	LED display	Fuse
Insulation type DC output	AOD 08C	12–24 VDC	2A	NEG	8	8	Terminal block	provided	provided
	AOD 08D		2A	POS	8	8	Terminal block	provided	provided
	AOD 16C		0.5A	NEG	16	8	Terminal block	provided	not provided
	AOD 16D		0.5A	POS	16	8	Terminal block	provided	not provided
	AOD 32C		0.3A	NEG	32	8	Connector	not provided	not provided
	AOD 32D		0.3A	POS	32	8	Connector	not provided	not provided
AC output	AOD 05E	100–240V AC	2A	–	5	1	Terminal block	provided	provided
	AOD 08E		1A	–	8	4	Terminal block	provided	provided
	AOD 12F	100–120V AC	0.5A	–	12	6	Terminal block	provided	provided
Relay output	AOR 08G	Maximum 250VAC/ 30VDC	4A	–	8	1	Terminal block	provided	not provided
	AOR 16G		2A	–	16	4	Terminal block	provided	not provided

CAUTION
1 Polarity
    Negative : 0 V common (current sink type)
        – Output is at low level when ON.
    Positive : 24 V common (current source type)
        – Output is at high level when ON.
2 For the details of the specifications for each module, refer
    to FANUC I/O Unit–MODEL A Connection·Maintenance
    Manual (B–61813E).

6.6.10
Correspondence between I/O Signals and Addresses in a Module
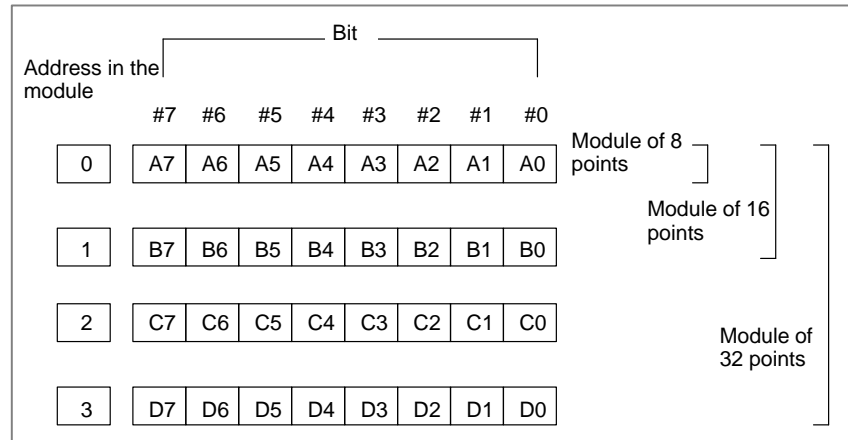
Addresses in a module are defined relatively, with the beginning address as 0. Real addresses viewed by the sequence program of the PMC are set by the programmer.

For input modules, an input signal becomes "1" when the contact point connected with the input is turned ON. For output modules, an output contact point (or transistor) is turned ON when the output signal is "1".

6.6.11
Number of Points for I/O Unit–MODEL A

Determine the number of I/O points for the I/O Unit –MODEL A using the following.

- **Output points**

Sum of the actual output points in a group		Occupied output points
0 to 32	→	32 points
40 to 64	→	64 points
72 to 128	→	128 points
136 to 256	→	256 points

NOTE
 Count AOA05E as 8 points and AOA12F as 16 points.

- **Input points**

Sum of the actual input points in a group		Occupied input points
0 to 32	→	32 points
40 to 64	→	64 points
72 to 128	→	128 points
136 to 256	→	256 points

As a result of the calculation above, when the number of input points is smaller than that of the output points in a single group, the number of input points is assumed to be equal to that of the output points.

Example 1:
 When the following modules are used in the group No. 0
 AOD32C 3
 AOA12F 2
 AID32A 5
 AIA16G 3
 [Input points]
 $32 \times 5 + 16 \times 3 = 208 \rightarrow 256$ points
 [Output points]
 $32 \times 3 + 16 \times 2 = 128 \rightarrow 128$ points

Example 2:
 When the following modules are used in the group No. 2.
 AOD16C 7
 AOA05F 9
 AID16A 4
 AIA16G 3
 [Input points]
 $16 \times 4 + 16 \times 3 = 112 \rightarrow 128$ points
 [Output points]
 $16 \times 7 + 8 \times 9 = 184 \rightarrow 256$ points
 In this case, as the number of input points is smaller than that of the output points, the number of input points is assumedl to be equal to that of the output points, in other words, 256 points.

6.7 CONNECTION OF SOURCE OUTPUT TYPE CONNECTION UNIT

The operator's panel connection unit (A16B–2202–0730, 0731), which connects to the control unit via the FANUC I/O Link, acts as an interface with the machine operator's panel.

Connectors CM51, CM52, CMB3, and CMB4, used to interface with the operator's panel, feature an electrical interface and pin assignment which are fully compatible with those of the operator's panel connection unit for the Series 15. The following two units are available with different numbers of I/O points:

Specifications	No. of input points	No. of output points
A16B–2202–0730	96	64
A16B–2202–0731	64	32

Operator's Panel Connection Unit
A16B-2202-0730, 0731

Control unit
or
I/O unit JD1A — JD1B JD1A — To next device

When no other device is connected to the connection unit, leave JD1A open.

24V DC power —

BURNDY 3P CONNECTOR (Brown)
Housing: SMS3PNS-5
Contact: RC16M-SCT3

CM51
CM52 Machine operation's panel
CMB3
CMB4

1	+24V
2	GND
3	

Power input regulations
Voltage : 24V DC$\pm$10%
Capacity : 500+7. 3$\times$n (mA)
n: Number of input points which are simultaneously turned on

CAUTION
Use 30/0.18 (0.75 mm^2) or heavier wire as the power cable.

6.7.1
Input Signal Specifications for Source Output Type Connection Unit

Most input signals for the source output type connection unit support a sink type (0–V common) non–isolated interface. For some input signals, however, either sink or source type can be selected. (Note, however, that safety standards require the use of the sink type.)

The machine's contacts shall conform to the following specifications:

Capacity: 30 VDC, 16 mA or higher
Intercontact leakage current in closed circuit:
          1 mA or less (at 26.4 V)
Intercontact voltage drop in closed circuit:
          2 V or less (including the voltage drop in the cables)
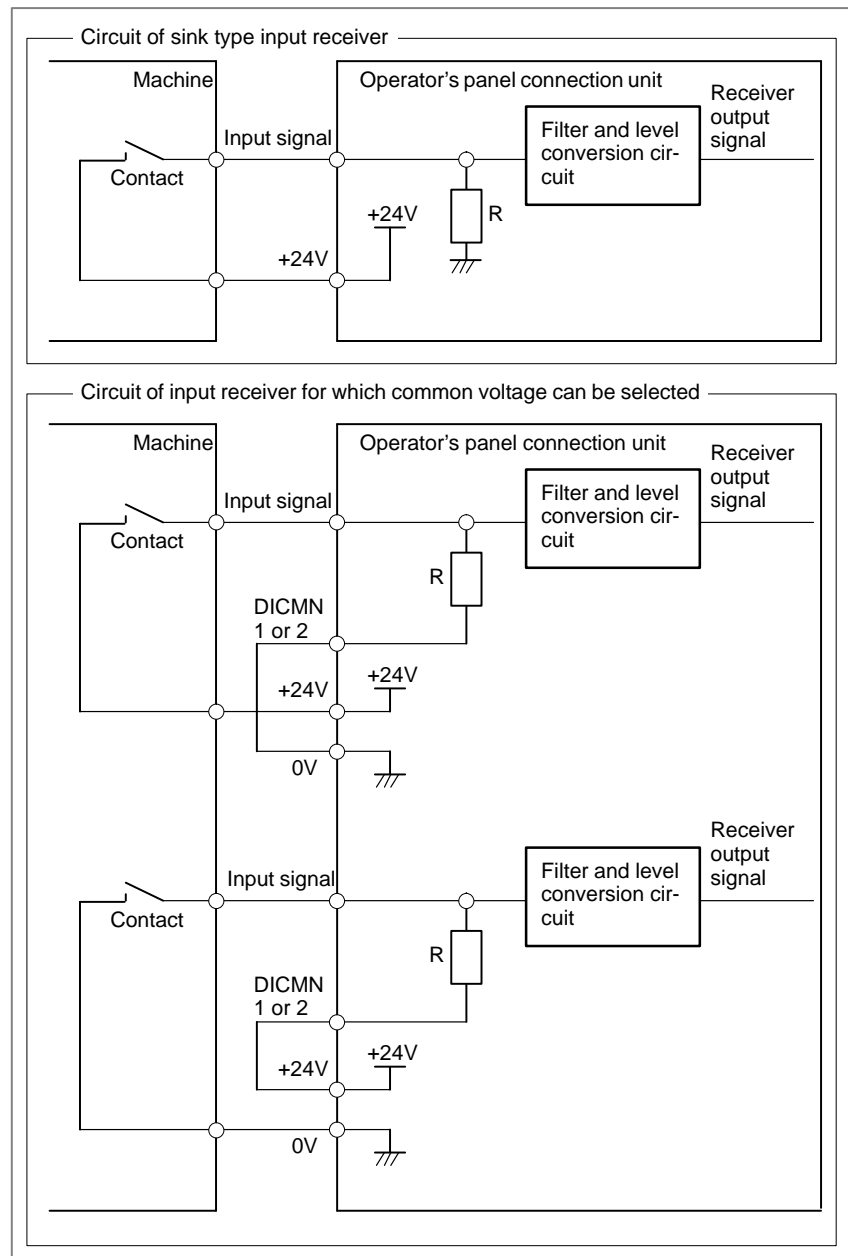
Fig. 6.7.1 (a) Receiver circuit

> **CAUTION**
> The DICMN1 and DICMN2 pins is connected to the +24V or
> 0V power supply. The contact of these pins is not open.
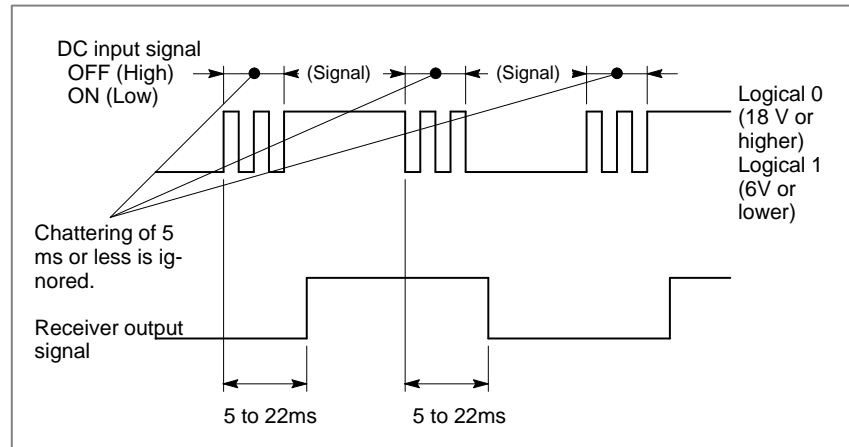
Fig. 6.7.1 (b) Signal width and delay of input signal

In the above figure, logical 0 corresponds to open contacts, while logical 1 corresponds to closed contacts.

> **CAUTION**
> When a source interface is used, a ground fault in an input
> signal has the same effect as closing the contacts. From the
> viewpoint of safety, therefore, FANUC does not recommend
> the use of such an interface for input signals.

6.7.2
Output Signal Specifications for Source Output Type Connection Unit

The output signals shall satisfy the following:

> Maximum load current when driver is on:
>   200 mA (including momentary values)
> Saturation voltage when driver is on:
>   1.0 V max.
> Withstand voltage: 24 V +20% (including momentary values)
> Leakage current when driver is off:
>   100 μA

Prepare the following external power supply for the output signals:

> Supply voltage: +24 V ±10%
> Supply current (per board):
>   At least total maximum load current
>   (including momentary values) + 100 mA
> Power–on timing: At the same time as or before turning on the power to the control unit
> Power–off timing: At the same time as or after turning on the power to the control unit

> **CAUTION**
> A power supply which satisfies the above specifications shall be connected to the DOCOM and 0V power supply terminals for the output signals. The maximum current that can be carried by the DOCOM pin is 2.0 A. The total load current must not exceed this value, therefore.

Output signal driver

The output signal driver used with the operator's panel connection unit can output up to eight signals.

The driver element monitors the current of each output signal. If an overcurrent is detected, the output of that signal is turned off. Once a signal has been turned off, the overcurrent will no longer exist, such that the driver turns the signal on again. Therefore, in the case of a ground fault or overload, the output of a signal will be repeatedly turned on and off. This also occurs when a load which causes a high surge current is connected.

The driver element contains an overheat detector, which turns off all eight output signals if the temperature in the device exceeds the set value as a result of an overcurrent caused by a ground fault or some other failure. This off state is held. To restore signal output, logically turn the output off then back on again, for each signal, after the temperature falls below the set value. Signal output can also be restored by turning the system power off then back on again.

On the PCB, a red LED beside the driver element lights once the overheat detection circuit operates.

> **NOTE**
> The overheat detection circuit also causes a system alarm to be issued to the CNC. (When setting pins CP1 on the PCB are closed (jumpered), this alarm is not issued to the CNC.)

Correspondence between red LEDs and DO signals

Red LED name	DO signals	Remarks
DAL1	Y q + 0.0 to Y q + 0.7	
DAL2	Y q + 1.0 to Y q + 1.7	
DAL3	Y q + 2.0 to Y q + 2.7	
DAL4	Y q + 3.0 to Y q + 3.7	
DAL5	Y q + 4.0 to Y q + 4.7	
DAL6	Y q + 5.0 to Y q + 5.7	
DAL7	Y q + 6.0 to Y q + 6.7	
DAL8	Y q + 7.0 to Y q + 7.7	

> **NOTE**
> The above red LED and alarm transfer to the CNC are supported by PCBs of version 03B and later.

If the output of a signal cannot be turned on even though the CNC diagnostic indicates that the signal is on, that signal or another signal being handled by the same element may be overloaded, thus causing the eight output signals to be turned off. In such a case, turn the system power off and eliminate the cause of the overload.

● **Driver element block diagram**
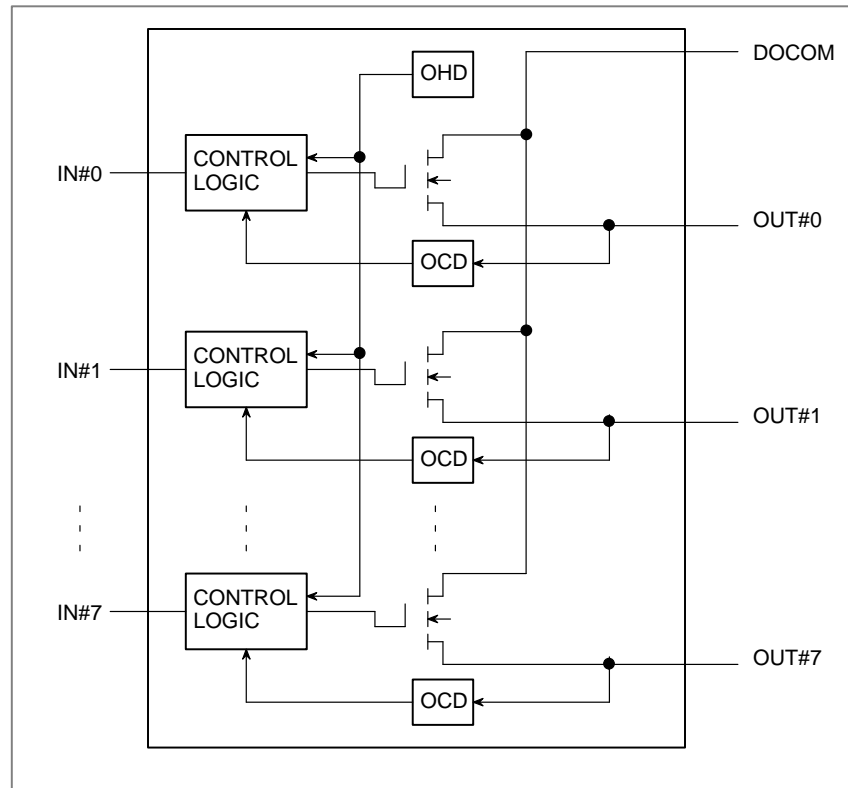
OHD: Overheat detection circuit
OCD: Overcurrent detection circuit
The power for operating this driver element is supplied from DOCOM (24 VDC).

Notes on output signals

Observe the following precautions when connecting output signals:

Output pins shall not be connected in parallel, as shown below.
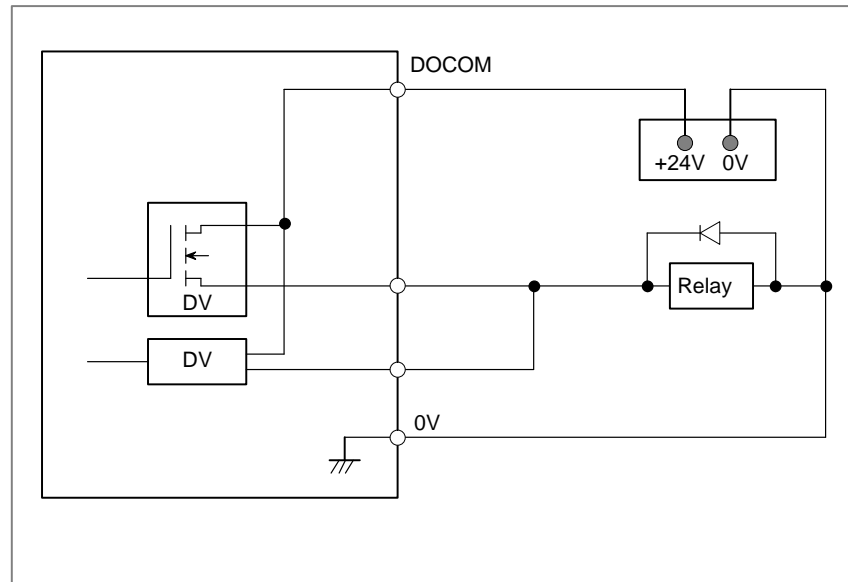
> **CAUTION**
> When using a dimming resistor, connect a diode to prevent leakage.
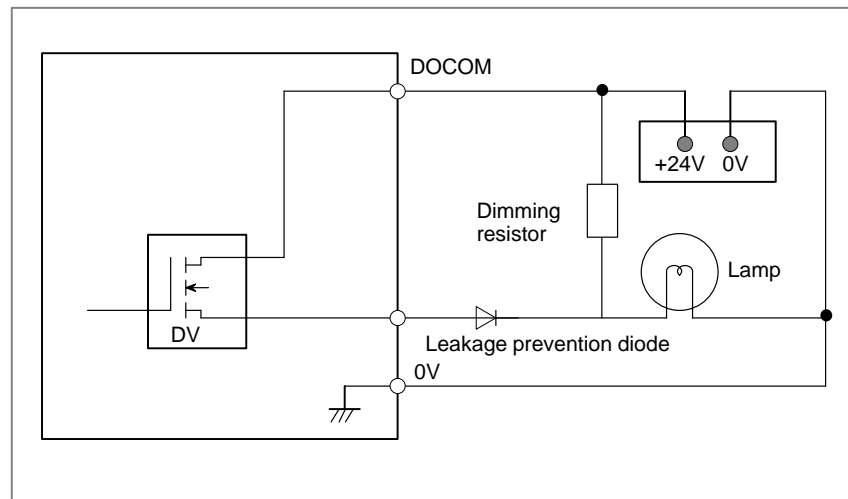
6.7.3
Connector Pin Layout
for Source Output Type
Connection Unit

CM51

Pin	Signal	Pin	Signal	Pin	Signal
1	DI00			33	DICMN1
2	DI03	19	DI01	34	DI02
3	DI06	20	DI04	35	DI05
4	DI11	21	DI07	36	DI10
5	DI14	22	DI12	37	DI13
6	DI17	23	DI15	38	DI16
7	DI22	24	DI20	39	DI21
8	DI25	25	DI23	40	DI24
9	DI27	26	DI30	41	DI26
10	DI32	27	DI33	42	DI31
11	DI35	28	DI36	43	DI34
12	DI40	29	DI41	44	DI37
13	DI43	30	DI44	45	DI42
14	DI46	31	DI47	46	DI45
15	DI51	32	DI52	47	DI50
16	DI54			48	DI53
17	DI56			49	DI55
18	+24V			50	DI57

CM52

Pin	Signal	Pin	Signal	Pin	Signal
1	DI60			33	0V
2	DI63	19	DI61	34	DI62
3	DI66	20	DI64	35	DI65
4	DI71	21	DI67	36	DI70
5	DI74	22	DI72	37	DI73
6	DI77	23	DI75	38	DI76
7	DI82	24	DI80	39	DI81
8	DI85	25	DI83	40	DI84
9	DI87	26	DI90	41	DI86
10	DI92	27	DI93	42	DI91
11	DI95	28	DI96	43	DI94
12	DIA0	29	DIA1	44	DI97
13	DIA3	30	DIA4	45	DIA2
14	DIA6	31	DIA7	46	DIA5
15	DIB1	32	DIB2	47	DIB0
16	DIB4			48	DIB3
17	DIB6			49	DIB5
18	+24V			50	DIB7

CMB3

Pin	Signal	Pin	Signal	Pin	Signal
1	DO00			33	0V
2	DO03	19	DO01	34	DO02
3	DO06	20	DO04	35	DO05
4	DO11	21	DO07	36	DO10
5	DO14	22	DO12	37	DO13
6	DO17	23	DO15	38	DO16
7	DO22	24	DO20	39	DO21
8	DO25	25	DO23	40	DO24
9	DO27	26	DO30	41	DO26
10	DO32	27	DO33	42	DO31
11	DO35	28	DO36	43	DO34
12	DO40	29	DO41	44	DO37
13	DO43	30	DO44	45	DO42
14	DO46	31	DO47	46	DO45
15	DO51	32	DO52	47	DO50
16	DO54			48	DO53
17	DOCOM			49	DO55
18	DICMN2			50	DOCOM

CMB4

Pin	Signal	Pin	Signal	Pin	Signal
1	DO61			14	DO60
2	DO64	8	DO62	15	DO63
3	DO67	9	DO65	16	DO66
4	DO72	10	DO70	17	DO71
5	DO75	11	DO73	18	DO74
6	DO56	12	DO76	19	DO77
7	0V	13	DO57	20	DOCOM

> **NOTE**
> When the operator's panel connection unit having 64 DIs
> and 32 DOs is selected, connector CMB4 is not mounted on
> the PCB.

DICMN1, DICMN2: Pins used to switch the DI common. Usually, jumper these pins with 0V. (input)

+24V: +24 VDC output pin. This pin shall be used only for DI signals input to the operator's panel connection unit. (output)

DOCOM: Power supply for the DO driver. All DOCOM pins are connected in the unit. (input)

I/O addresses

The following PMC addresses are assigned to the operator's panel connection unit, depending on the number of I/O points (DI/DO = 96/64 or 64/32):

[DI address]

	7	6	5	4	3	2	1	0
X p	DI07	DI06	DI05	DI04	DI03	DI02	DI01	DI00
X p+1	DI17	DI16	DI15	DI14	DI13	DI12	DI11	DI10
X p+2	DI27	DI26	DI25	DI24	DI23	DI22	DI21	DI20
X p+3	DI37	DI36	DI35	DI34	DI33	DI32	DI331	DI30
X p+4	DI47	DI46	DI45	DI44	DI43	DI42	DI41	DI40
X p+5	DI57	DI56	DI55	DI54	DI53	DI52	DI51	DI50
X p+6	DI67	DI66	DI65	DI64	DI63	DI62	DI61	DI60
X p+7	DI77	DI76	DI75	DI74	DI73	DI72	DI71	DI70
X p+8	DI87	DI86	DI85	DI84	DI83	DI82	DI81	DI80
X p+9	DI97	DI96	DI95	DI94	DI93	DI92	DI91	DI90
X p+10	DIA7	DIA6	DIA5	DIA4	DIA3	DIA2	DIA1	DIA0
X p+11	DIB7	DIB6	DIB5	DIB4	DIB3	DIB2	DIB1	DIB0

DI: 96 points (Xp to Xp+11)
DI: 64 points (Xp to Xp+7)

- Address p is determined by the machine tool builder.
- The common voltage can be selected for the DIs assigned to the following 20 addresses:

  Xp+0.0, Xp+0.1, Xp+0.2, Xp+0.7
  Xp+1.0, Xp+1.1, Xp+1.2, Xp+1.7
  Xp+4.0 to Xp+4.7
  Xp+11.4, Xp+11.5, Xp+11.6, Xp+11.7

[DO address]

		7	6	5	4	3	2	1	0
DO: 64 points	DO: 32 points								
	Y q	DO07	DO06	DO05	DO04	DO03	DO02	DO01	DO00
	Y q+1	DO17	DO16	DO15	DO14	DO13	DO12	DO11	DO10
	Y q+2	DO27	DO26	DO25	DO24	DO23	DO22	DO21	DO20
	Y q+3	DO37	DO36	DO35	DO34	DO33	DO32	DO31	DO30
	Y q+4	DO47	DO46	DO45	DO44	DO43	DO42	DO41	DO40
	Y q+5	DO57	DO56	DO55	DO54	DO53	DO52	DO51	DO50
	Y q+6	DO67	DO66	DO65	DO64	DO63	DO62	DO61	DO60
	Y q+7	DO77	DO76	DO75	DO74	DO73	DO72	DO71	DO70

Address q is determined by the machine tool builder.

For details of address assignment, refer to the FANUC PMC Ladder Language Programming Manual (B–61863E).

6.7.4
Dimensions of Source Output Type Connection Unit
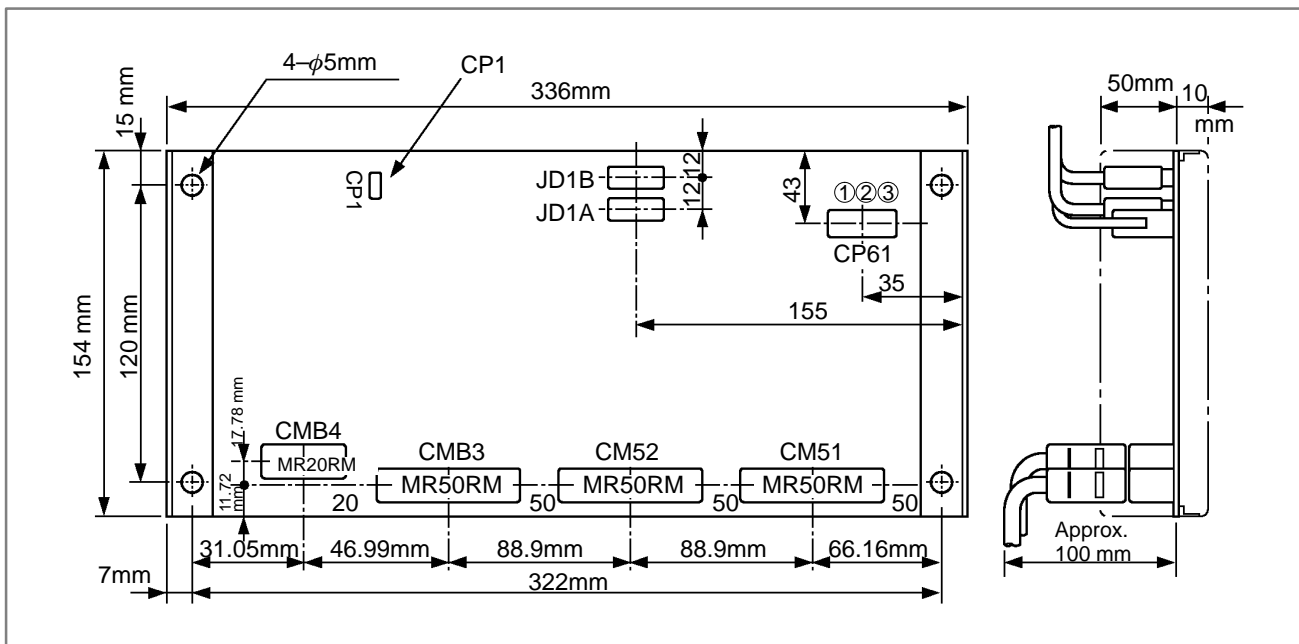
The following LEDs, variable resistors, and setting pins are mounted on the PCB:

[LEDs]

DB1 (green, pilot) : Lights while the power to the PCB is on.
DB2 (red, alarm) : Lights if an error occurs in the PCB or CNC.
DAL1 to DAL8 : See Section 6.7.2

[Variable resistors]

VR1 and VR2   : Factory–set by FANUC. The machine tool builder need not adjust these resistors.

[Setting pin]

CP1   : Used to specify whether the CNC will be notified of a DO signal error as a system alarm (see Section 6.7.2).

6.8
FANUC I/O LINK
CONNECTION UNIT

6.8.1
Overview

This unit connects FANUC I/O Link master devices, such as the CNC and F–D Mate, via an I/O Link to enable the transfer of DI/DO signals.
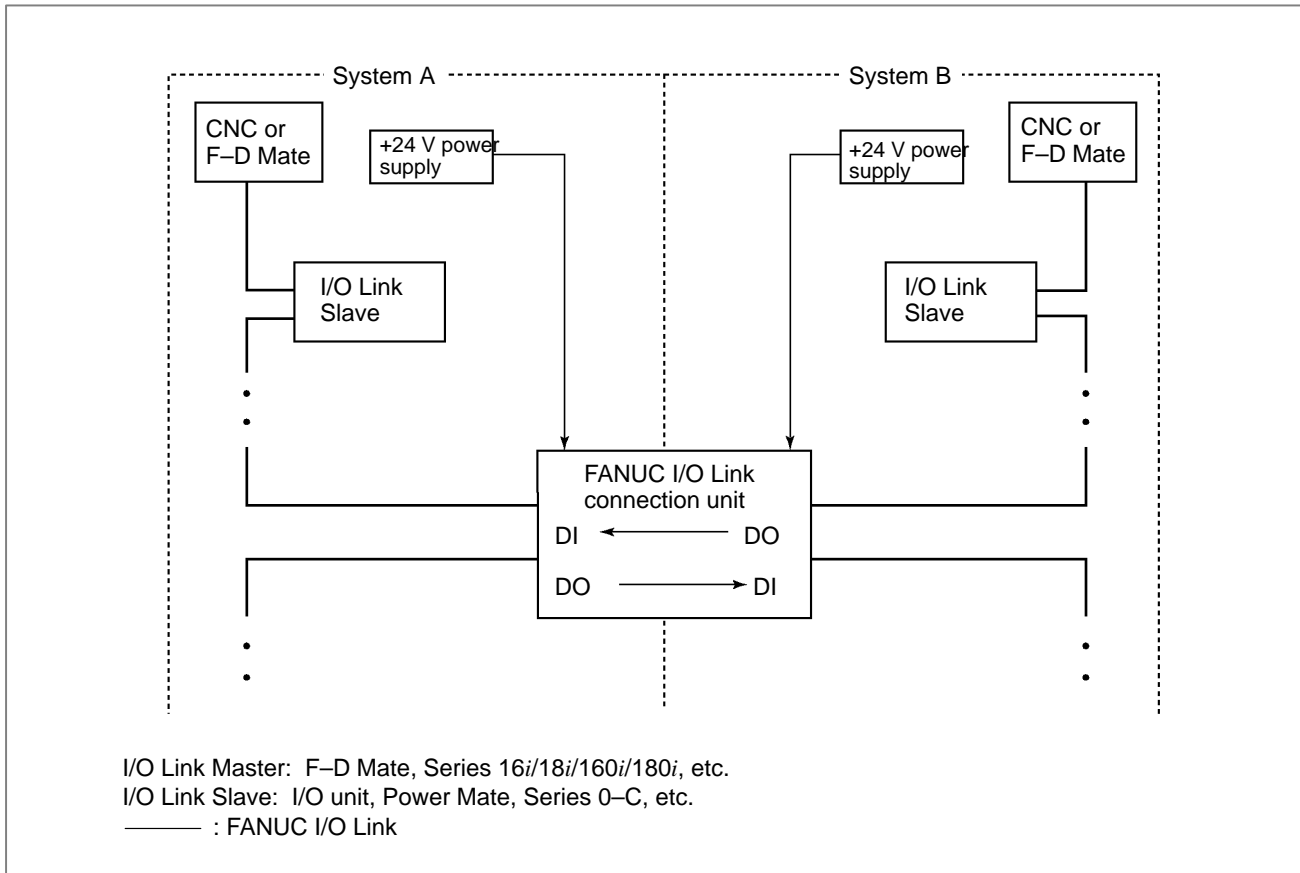
Fig. 6.8.1 System which uses FANUC I/O Link connection units

NOTE
This system enable I/O data transfer between two independent FANUC I/O Link master device. When the system is adjusted and maintained, the FANUC I/O Link can be operated with the system power for one of the FANUC I/O Link lines switched off, that is, the link operation is stopped. In this case, DI data sent from a system at rest consists entirely of zeros. If one of the links is stopped, either abnormally or normally, it takes up to several hundred milliseconds for this function to take effect. During this period, that data which exists immediately before the link stops is sent out. Take this into account when designing your system.

6.8.2
Specification

I/O Link function	Provided with two slave mode I/O Link interface channels, between which DI/DO data can be transferred. [Interface types] One of the following combinations is selected: Electrical – optical Electrical – electrical Optical – optical
Number of DI/DO data items	DI: Up to 256, DO: Up to 256 (The number of data items actually used varies depending on the mount of data assigned in the host.)
Power supply	Each I/O Link interface must be independently supplied with +24 VDC. 　　　Voltage: +24 VDC +10%, –15% 　　　Current: 0.2 A (excluding surge) If a master unit does not have sufficient capacity to supply power to each unit (0.2 A per slot), use an external power supply unit. The power supply must be switched on, either simultaneously with or before, the I/O Link master. The two systems can be switched on and off independently of each other. Data from a system to which no power is supplied appears as zeros when viewed from the other system. The data becomes 0 within 200 ms of the power being switched off.
External dimensions	180X　　150X　　About 50 mm 　　　W　　　H　　　D Fig. 6.8.2(b) is an outline drawing of the unit.
Installation	The unit, which is a separate type, is installed in the power magnetics cabinet. Fig. 6.8.2(c) shows how to mount the unit.
Operating environment	Temperature: 0 to 60°C Humidity　:　5 to 75% RH (non–condensing) Vibration　:　0.5 G or less

Ordering information

Interface type	Specification
Electrical–optical interface	A20B–2000–0410
Electrical–electrical interface	A20B–2000–0411
Optical–optical interface	A20B–2000–0412

LED indications
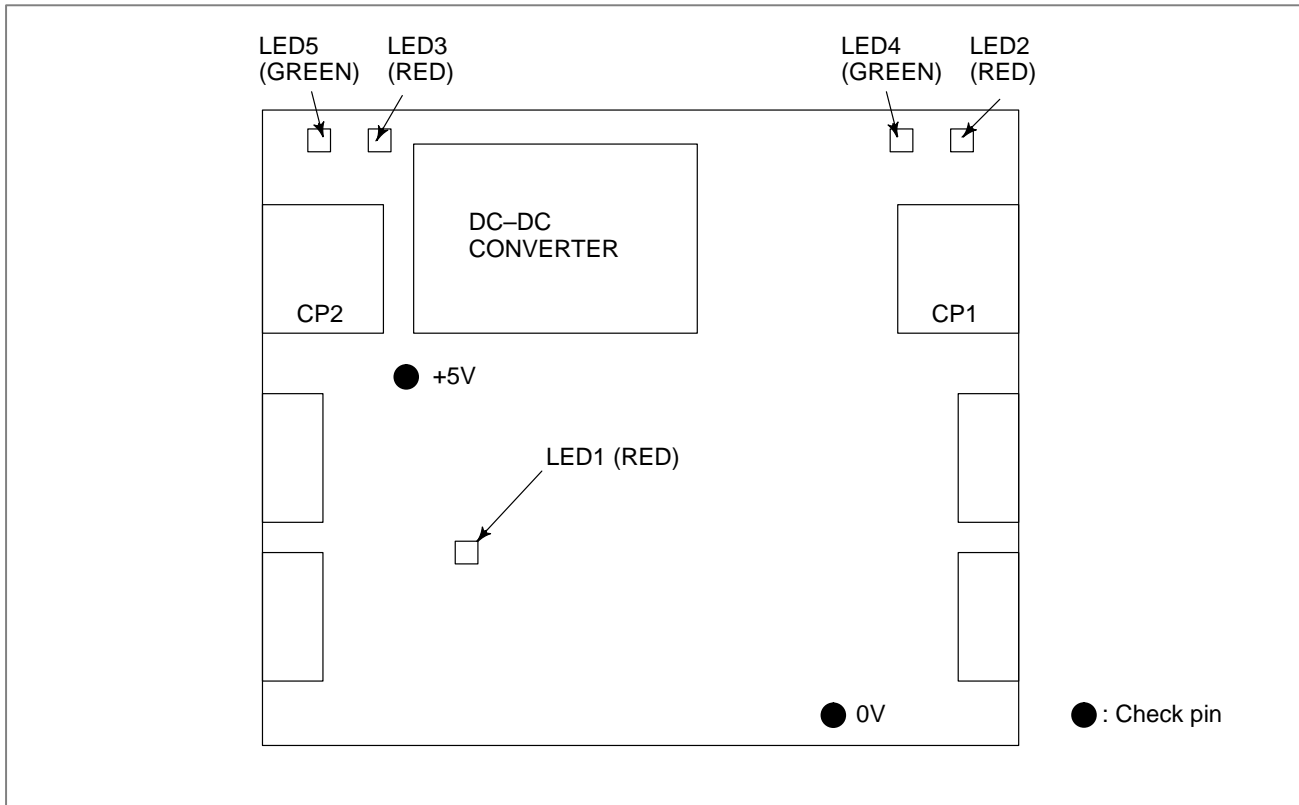
Fig. 6.8.2(a) LED locations

	LED status	Description
1	LED1 ☐	Normal
	LED1 ■	A RAM parity error occurred because of a hardware failure.
2	LED4 LED2 ■ ☐	CP1 is supplied with the specified voltage. (Pilot lamp)
	LED4 LED2 ☐ ■	CP1 is supplied with a voltage that is lower than specified or zero.
	LED4 LED2 ■ ■	A communication error occurred in a channel of CP1.
3	LED5 LED3 ■ ☐	CP2 is supplied with the specified voltage. (Pilot lamp)
	LED5 LED3 ☐ ■	CP2 is supplied with a voltage that is lower than specified or zero.
	LED5 LED3 ■ ■	A communication error occurred in a channel of CP2.

■: ON   ☐: OFF
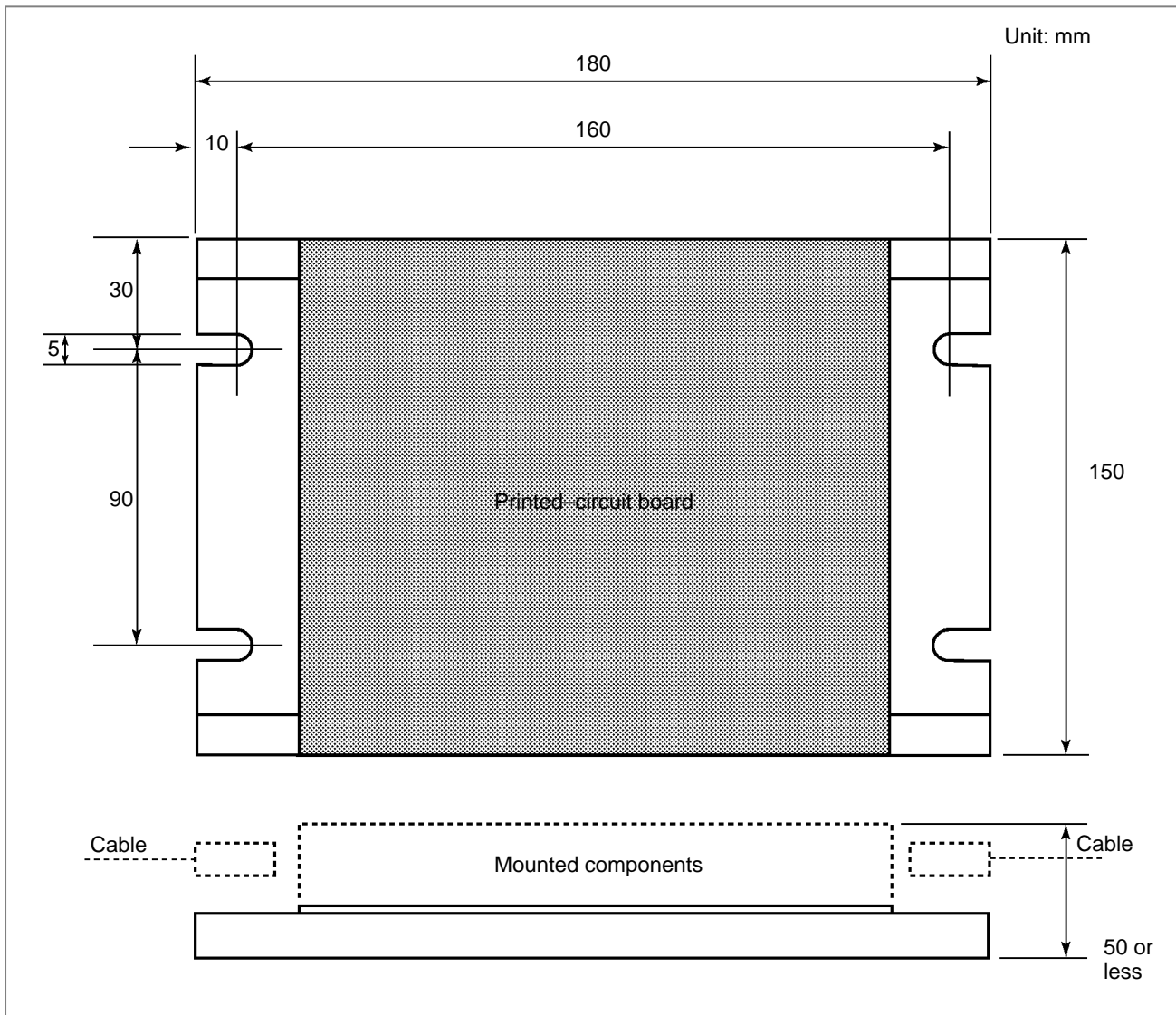
Fig. 6.8.2(b) Outline drawing
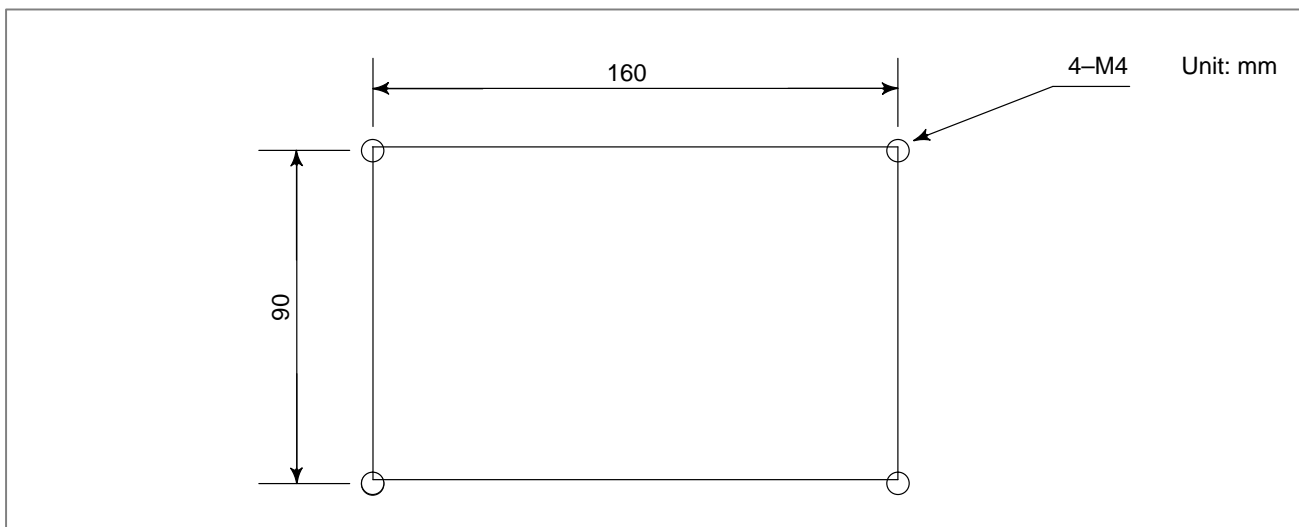
Fig. 6.8.2(c) Mounting location

6.8.3
Connection

6.8.3.1
I/O Link interface

(1) Connection diagram (example)

(1): Signal cable (electrical)
(2): Signal cable (optical)
(3): Power supply cable

Additionally, the FANUC I/O Link connection unit
frame must be grounded.

*1: 1 or 2 (channel No.)
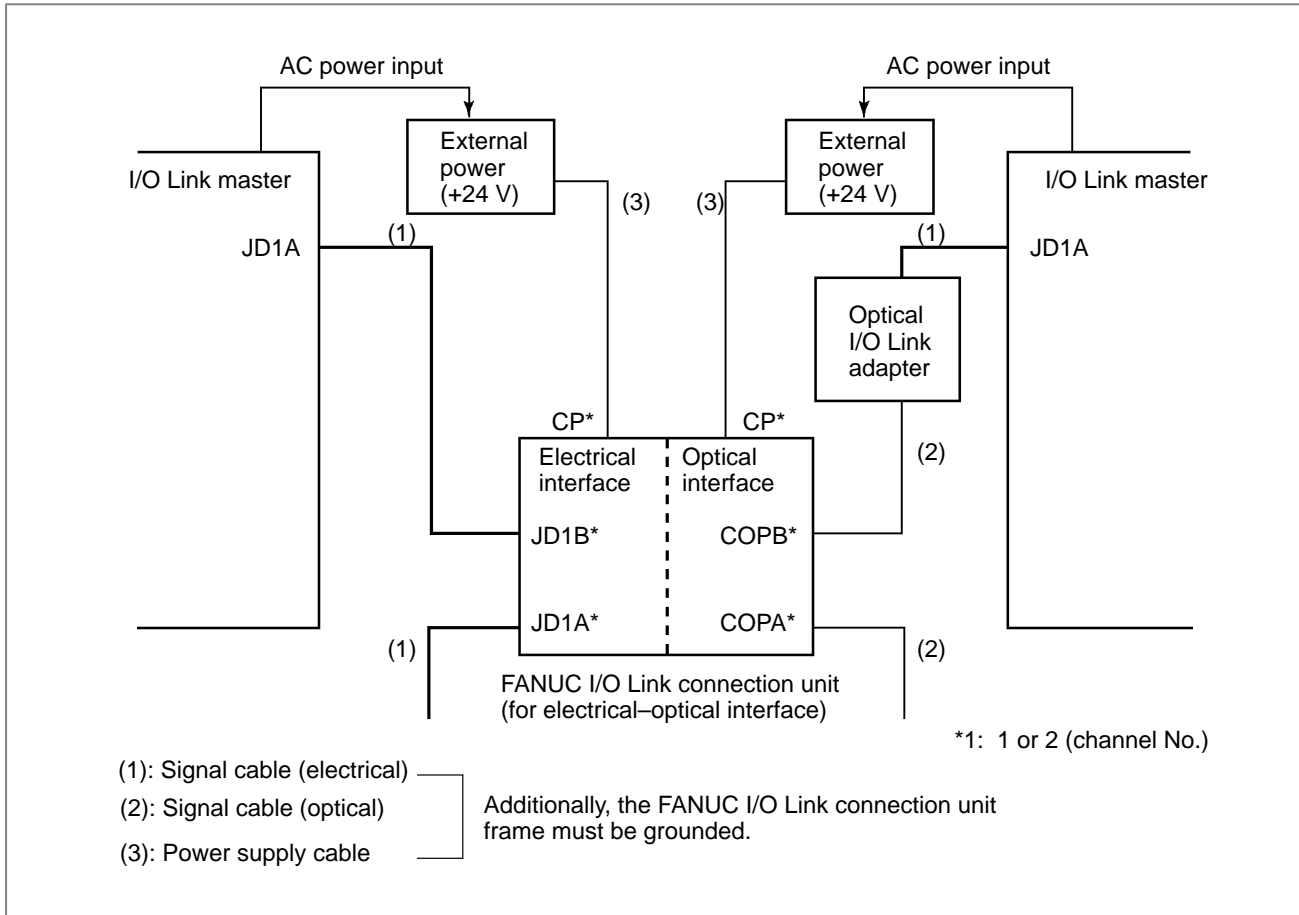
[Name of I/O Link connection unit connectors]

Electrical–optical

Connector name I/O Link interface	
Channel 1	Channel 2
JD1A1	COPA2
JD1B1	COPB2
CP1	CP2

Electrical–electrical

Connector name I/O Link interface	
Channel 1	Channel 2
JD1A1	JD1A2
JD1B1	JD1B2
CP1	CP2

Optical–optical

Connector name I/O Link interface	
Channel 1	Channel 2
COPA1	COPA2
COPB1	COPB2
CP1	CP2

(2) Signal cable (electrical)

JD1A1/JD1A2

11	0V	1	RXB
12	0V	2	*RXB
13	0V	3	TXB
14	0v	4	*TXB
15	0v	5	
16	0v	6	
17		7	
18	–	8	
19		9	–
20	–	10	

JD1B1/JD1B2

11	0V	1	RXA
12	0V	2	*RXA
13	0V	3	TXA
14	0v	4	*TXA
15	0v	5	
16	0v	6	
17		7	
18	–	8	
19		9	–
20	–	10	

This unit (JD1A1/JD1A2) ↔ Another device (JD1B)
or
Another device (JD1A) ↔ This unit (JD1B1/JD1B2)

RXB (01) — (03) TXA
*RXB (02) — (04) *TXA
TXB (03) — (01) RXA
*TXB (04) — (02) *RXA
(09) — (09)
Note — (18) — (18) — Note) An optical I/O Link adapter
(20) — (20) cannot be connected to this
0V (11) — (11) 0V unit, because the electrical
0V (12) — (12) 0V interface for this unit cannot
0V (13) — (13) 0V supply +5 V. To use an opti-
0V (14) — (14) 0V cal interface, prepare an ap-
0V (15) — (15) 0V propriate unit.
0V (16) — (16) 0V These wires can, therefore,
be omitted.

Indicates a twisted pair.

Shield
Frame ground (the shield must be grounded at either end of the cable)

- Cable–side connector specification: PCR–E20FA (manufactured by Honda Tsushin)
- Recommended cable material specification: A66L–0001–0284#10P
- Cable length: 10 m (maximum)

(3) Signal cable (optical)

- Optical cable specification : A66L–6001–0009#XXXX
  A66L–6001–0026#XXXX
  (where XXXX is a cable length specification)
  For the cable length and notes, see APPENDIX D.

- Cable length: 200 m (maximum)

(4) Power supply cable

CP1/CP2 connector

	1	2	3	
Y	+24 V	0 V		(Input)
X	+24 V	0 V		(Output)

- 24 VDC is supplied via a Y–connector. Provided the power supply has sufficient capacity, power can be supplied to another device with the X–side as output.

- Power must be supplied to both CP1 and CP2.

- Cable–side connector specification
  Y–connector: A63L–0001–0460#3LKY (AMP Japan, 2–178288–3)
  X–connector: A63L–0001–0460#3LKX (AMP Japan, 1–178288–3)
  Contact: A63L–0001–0456#BS (AMP Japan, 175218–5)
  Ordering information: Y + 3 contacts: A02B–0120–K323
  X + 3 contacts: A02B–0120–K324

- Cable material: Vinyl–insulated electrical wire AWG20–16

- Cable length: Determine the length of the cable such that the supplied voltage at the receiving end satisfies the requirements, because the voltage may fluctuate and drop as a result of the resistance of the cable conductor.

(5) Frame grounding
Ground the frame of the unit using a wire having a cross section of at least 5.5 m^2 (class 3 or higher). An M4 frame ground terminal is provided.

6.9
CONNECTING THE
FANUC SERVO UNIT
β SERIES WITH I/O
LINK

6.9.1
Overview

The FANUC servo unit β series with I/O Link (called the β amplifier with I/O Link in this chapter) is a power motion control servo unit that can be easily connected to a CNC control unit via the FANUC I/O Link.
The β amplifier with I/O Link can be connected to the Series 16*i*/18*i*/160*i*/180*i* using the FANUC I/O Link.

> **NOTE**
> Using the β amplifier requires that the power motion manager software function be installed in the Series 16*i*/18*i*/160*i*/180*i*. This function is included as one of the Series 16*i*/18*i*/160*i*/180*i* option functions.

6.9.2
Connection

The β amplifier with I/O Link is connected to the Series 16*i*/18*i*/160*i*/180*i* using the usual FANUC I/O Link connection.

6.9.3
Maximum Number of Units that can be Connected

The maximum number of β amplifiers with I/O Link that can be connected to a control unit depends on the maximum number of FANUC I/O Link points provided by that control unit, as well as their assignments. For the Series 16*i*/18*i*/160*i*/180*i*, the maximum number of FANUC I/O Link DI and DO points are 1024 and 1024, respectively. One β amplifier with I/O Link occupies 128 DI/DO points in the FANUC I/O Link. If no units other than the β amplifiers with I/O Link are connected to the control unit, up to eight β amplifiers can be connected.

6.9.4
Address Assignment by Ladder

If the β amplifier with I/O Link is used as an I/O Link slave, I/O addresses are assigned in the PMC in the CNC. Because data output from the slave is made in 16–byte units, the number of input/output points must be set to 128.
The module names are PM16I (input) and PM16O (output).
The BASE is always 0, and the SLOT is 1.

7 CONNECTION TO CNC PERIPHERALS

7.1
MDI UNIT INTERFACE

The specifications of the keyboard interface are common to all MDI units.

CNC

MDI unit

CA55
JAE   LY20–20P–DTI–P

	A	B
1	*KEY00	*KEY02
2	*KEY01	*KEY03
3	*KEY04	*KYE06
4	*KYE05	*KYE07
5	*COM00	*COM02
6	*COM01	*COM03
7	*COM04	*COM06
8	*COM05	*COM07
9	*COM08	*COM10
10	*COM09	*COM11

Japan Aviation Electronics
LY10–DC20 (Housing)
LY10–C2–5–10000
(Contact)

Soft key cable

CK1
PCR–E20MD

1	*KEY00	11	*KEY01
2	*KEY02	12	*KEY03
3	*KEY04	13	*KYE05
4	*KYE06	14	*KYE07
5	*COM00	15	*COM01
6	*COM02	16	*COM03
7	*COM04	17	*COM05
8	*COM06	18	*COM07
9	*COM08	19	*COM09
10	*COM10	20	*COM11

CK2

Cable connection

CA55			CK1	
*KEY00	A1	1	*KEY00	
*KEY02	B1	2	*KEY02	
*KEY01	A2	11	*KEY01	
*KEY03	B2	12	*KEY03	
*KEY04	A3	3	*KEY04	
*KEY06	B3	4	*KEY06	
*KEY05	A4	13	*KEY05	
*KEY07	B4	14	*KEY07	
*COM00	A5	5	*COM00	
*COM02	B5	6	*COM02	
*COM01	A6	15	*COM01	
*COM03	B6	16	*COM03	
*COM04	A7	7	*COM04	
*COM06	B7	8	*COM06	
*COM05	A8	17	*COM05	
*COM07	B8	18	*COM07	
*COM08	A9	9	*COM08	
*COM10	B9	10	*COM10	
*COM09	A10	19	*COM09	
*COM11	B10	20	*COM11	

Shield

Grounding plate

Recommended cable specifications: A02B–0236–K811 (15 cm)
                                     A02B–0236–K812 (25 cm)
Recommended cable material specification: A66L–0001–0284#10P
                                     (#28AWG × 10 pairs)

NOTE
- An MDI cable of up to 30 cm does not need to be shielde.
- The MDI cable connector utilizes a simple lock mechanism. When a long cable is connected, the cable must be secured without tension within a range of 50 cm from the connector, so that the cable will not be disconnected by the weight of the cable itself or by tension.

7.2
I/O DEVICE
INTERFACE

7.2.1
RS–232C Serial Port

CNC

JD36A,JD36B
PCR–E20MD

1	RD	11	SD
2	0V	12	0V
3	DR	13	ER
4	0V	14	0V
5	CS	15	RS
6	0V	16	0V
7	CD	17	
8		18	+5V
9		19	+24V
10	+24V	20	+5V

Relay connector

DBM–25S

1	FG	14	
2	SD	15	
3	RD	16	
4	RS	17	
5	CS	18	
6	DR	19	
7	SG	20	ER
8	CD	21	
9		22	
10		23	
11		24	
12		25	+24V
13			
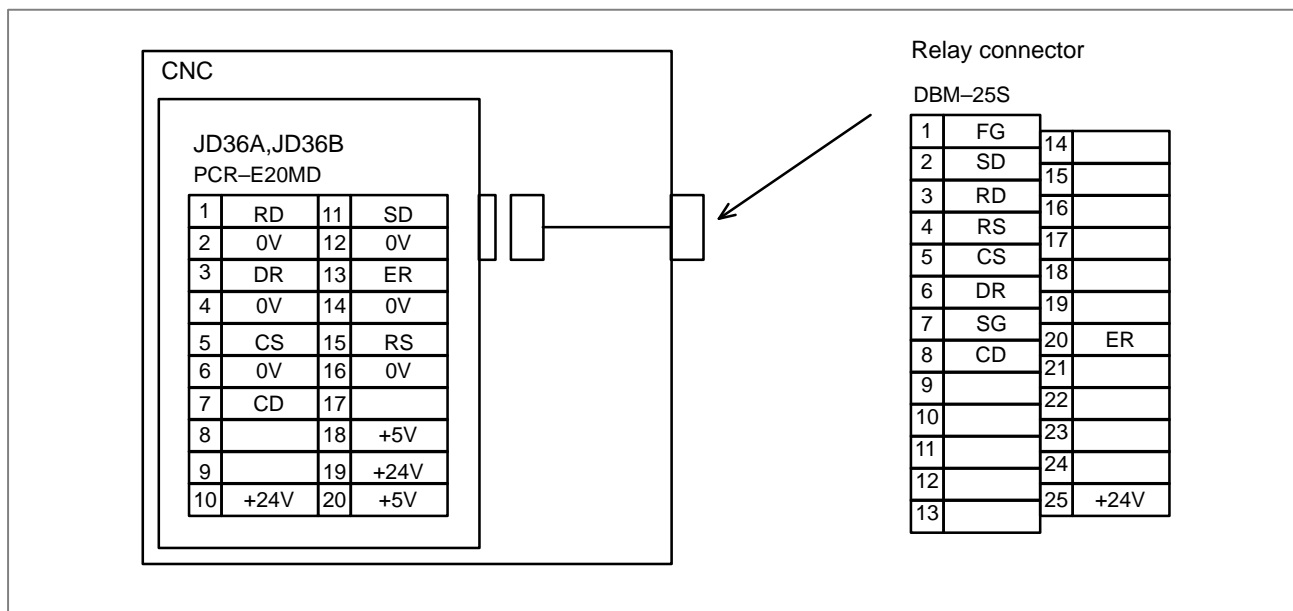
NOTE
The +5–V pins 18 and 20 are provided to connect a touch panel. The pins should not be used for other purposes.
The +24–V pins are used for power supply of FANUC RS–232C device.

Cable connection

JD36A,JD36B

				Relay connector

RD | 1 | | 3 | RD

0V | 2 | | |

DR | 3 | | 6 | DR

0V | 4 | | |

CS | 5 | | 5 | CS

0V | 6 | | |

CD | 7 | | 8 | CD

0V | 8 | | |

| 9 | | |

| 10 | | |

+24V | | | |

SD | 11 | | 2 | SD

0V | 12 | | |

ER | 13 | | 20 | ER

0V | 14 | | |

RS | 15 | | 4 | RS

0V | 16 | | 7 | SG

| 17 | | |

| 18 | | |

5V | | | |

| 19 | | 25 | +24V

24V | | | |

| 20 | | 1 | FG

5V | | | |

Shield

GND

Grounding plate

Recommended cable specification
A66L–0001–0284#10P (#28AWG × 10 pairs)
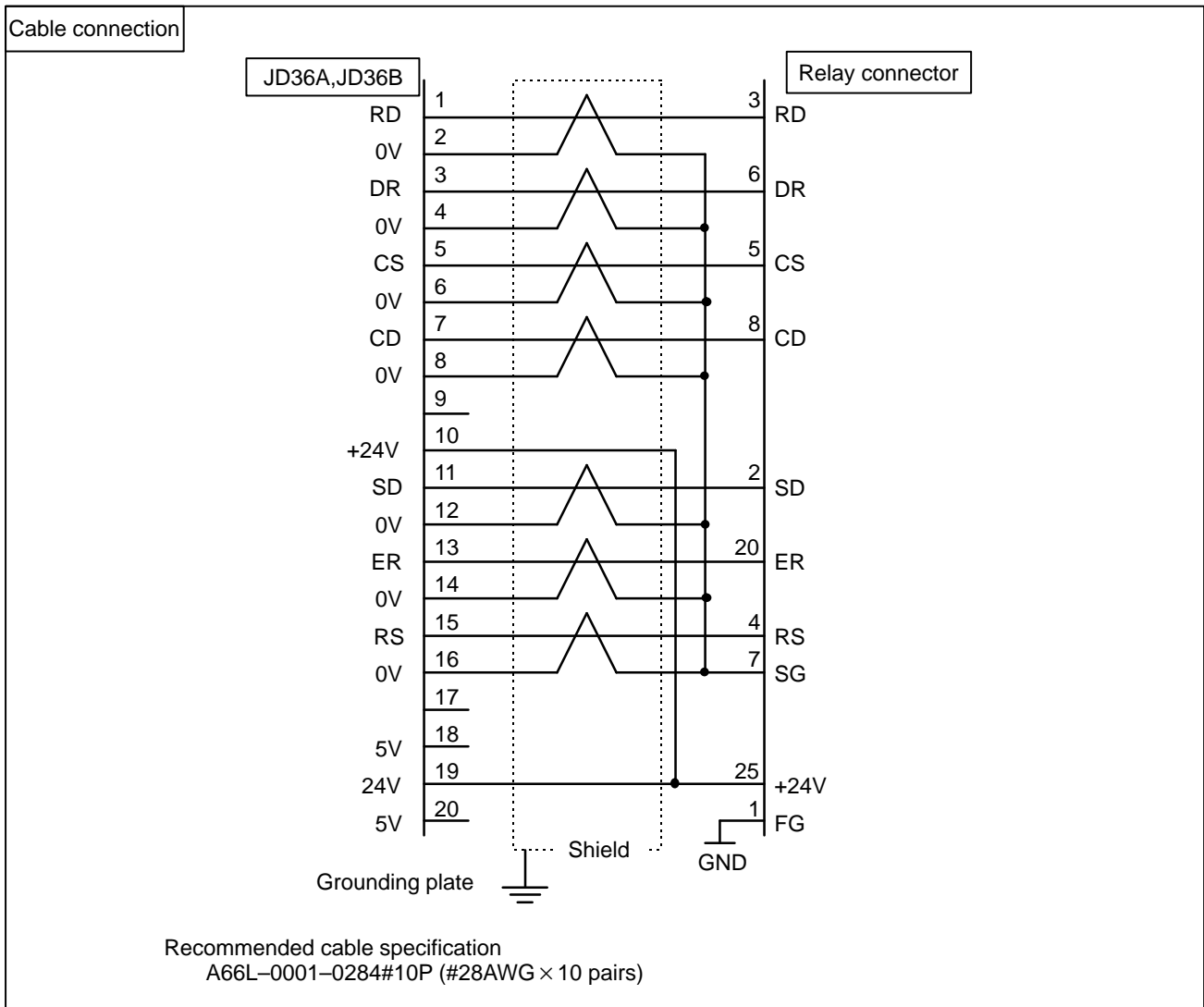
7.2.2
Portable Tape Reader Connection

Relaying connector signal layout

1	2	3	4	5	6	7	8	9	10	11	12	13
FG	SD	RD	RS	CS	DR	SG	CD					

	14	15	16	17	18	19	20	21	22	23	24	25
							ER					+24

Relaying connector
Connector : DBM-25S
    (JAPAN AVIATION ELECTRONIC
    INDUSTRY., LTD.)
Lock metal : D20418-J2
    (JAPAN AVIATION ELECTRONIC
    INDUSTRY., LTD.)

Cable side connector
Connector : DBM-25P
    (JAPAN AVIATION ELECTRONIC
    INDUSTRY., LTD.)
Lock metal : DB–C2–J9
    (JAPAN AVIATION ELECTRONIC
    INDUSTRY., LTD.)

CNC

JD5A, JD5B

(PCR-EV20MDT)

1	RD	11	SD
2	0V	12	0V
3	DR	13	ER
4	0V	14	0V
5	CS	15	RS
6	0V	16	0V
7	CD	17	
8	0V	18	
9		19	+24V
10	+24V	20	

FG

Relaying cable

Accessory for portable tape reader

Portable tape reader

Cable side plug
WF7013 (MATSUSHITA
ELECTRIC WORKS CO., LTD.)

Plug receptacle
WF3012E (MATSUSHITA
ELECTRIC WORKS CO., LTD.)

Input power supply

200VAC (+10%, −15%)
50/60Hz ± 1Hz, 110VA (Without reel)
50/60Hz ± 1Hz, 130VA (With reel)

NOTE
1 Prepare the relaying connector, the relaying cable and the plug receptacle at the machine tool builder.
2 Prepare the power supply for PPR at the machine tool builder.
3 Use the unified shielded cable for signal cable.
Recommended cable specification :
   A66L-0001-0284#10P (#28AWG × 10 pairs)
4 When connecting the portable tape reader, set the corresponding parameter to use reader puncher interface (baud rate is 4800 baud).

7.2.3
FANUC FLOPPY CASSETTE Connection

Relaying connector signal layout

1	2	3	4	5	6	7	8	9	10	11	12	13
FG	SD	RD	RS	CS	DR	SG	CD					

14	15	16	17	18	19	20	21	22	23	24	25
						ER					+24

Cable side connector
Connector : DBM-25P
　(JAPAN AVIATION ELECTRONIC INDUSTRY., LTD.)
Lock metal : DDB–C2–J9
　(JAPAN AVIATION ELECTRONIC INDUSTRY., LTD.)

Relaying connector
Connector : DBM-25S
　(JAPAN AVIATION
　ELECTRONIC
　INDUSTRY., LTD.)
Lock metal : D20418-J2
　(JAPAN AVIATION
　ELECTRONIC
　INDUSTRY., LTD.)

CNC

JD5A, JD5B
(PCR-EV20MDT)

1	RD	11	SD
2	0V	12	0V
3	DR	13	ER
4	0V	14	0V
5	CS	15	RS
6	0V	16	0V
7	CD	17	
8	0V	18	
9		19	+24V
10	+24V	20	

Relaying cable

FG

FANUC FLOPPY CASSETTE

Accessory for FLOPPY CASSETTE

NOTE
1　Machine tool builder shall furnish relay connector and relay cable.
2　Use a unified shielded cable for the signal cable.
　Recommended cable specification :
　　A66L-0001-0284#10P (#28AWG × 10 pairs)
3　Open all terminals other than illustrated.
4　Set a parameter to be able to use reader puncher interface when connecting FANUC cassette.
　The baud rate is 4800 baud.
5　Connect the FANUC cassette to either JD5A or JD5B.
　Do not use both pins; the power capacity may exceed that of +24V and blow the fuse.

7.2.4
FANUC Handy File Connection

Cable–side connector
Connector: DBM–25P (Japan Aviation Electronic Inc., Ltd.)
Lock metal: DB–C2–J9 (Japan Aviation Electronic Inc., Ltd.)

CNC

JD36A, JD36B

(PCR-E20MD)

1	RD	11	SD
2	0V	12	0V
3	DR	13	ER
4	0V	14	0V
5	CS	15	RS
6	0V	16	0V
7	CD	17	
8	0V	18	
9		19	+24V
10	+24V	20	

Relay cable

FANUC
FLOPPY
CASSETTE

FG

Accessory for
HANDY FILE

Relaying connector
Connector: DBM–25S (Japan
Aviation Electronic Inc., Ltd.)
Lock metal: D20418–J9
(Japan Aviation Electronic
Inc., Ltd.)

Relay connector signal layout

1	2	3	4	5	6	7	8	9	10	11	12	13
FG	SD	RD	RS	CS	DR	SG	CD					

	14	15	16	17	18	19	20	21	22	23	24	25
							ER					+24

NOTE
1 Machine tool builder shall furnish relay connector and relay cable.
2 Use a totally shielded cable for the signal cable.
  Recommended cable specification:
    A66L–0001–0284#10P (#28AWG × 10 pairs)
3 Open all terminals other than illustrated.
4 Set suitable parameters on reader/puncher interface for FANUC Handy File. The baud rate is 4800 baud in standard.
5 Connect the FANUC Handy File to either JD36A or JD36B. Do not use both pins; the power capacity may exceed that of +24 V and blow the fuse.

7.3
REMOTE BUFFER
INTERFACE
(RS–232C)
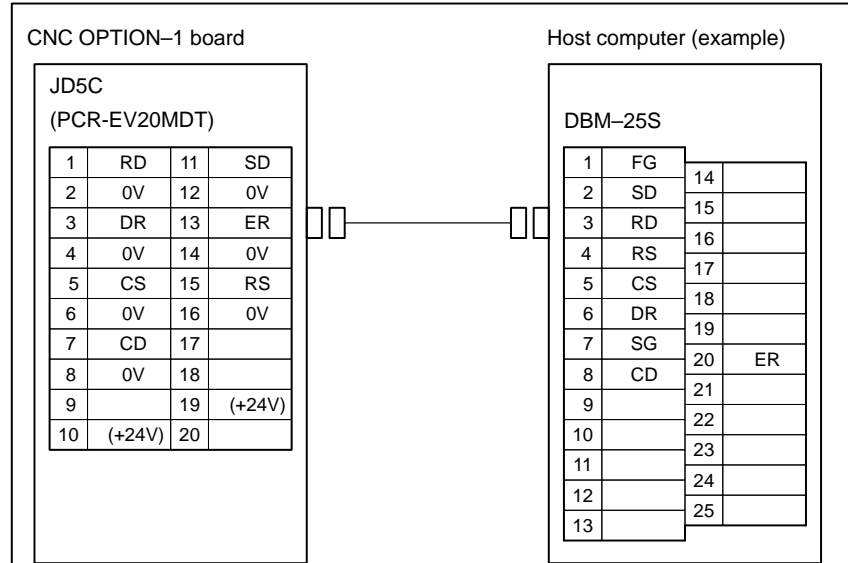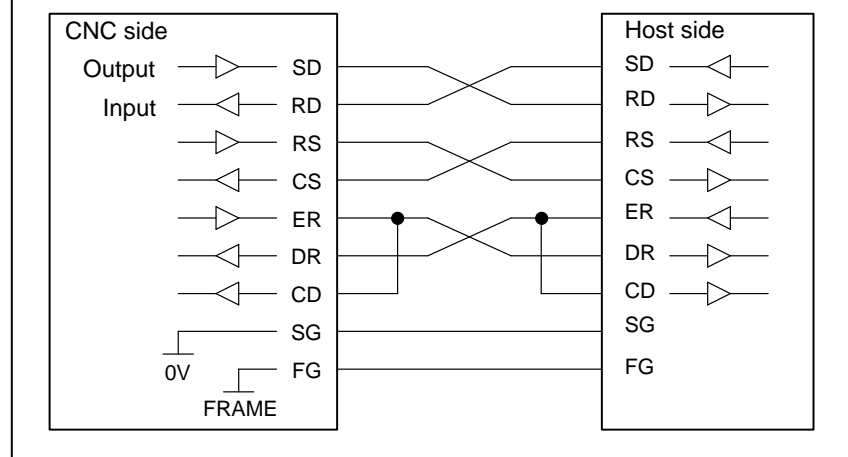
CNC OPTION–1 board

JD5C
(PCR-EV20MDT)

1	RD	11	SD
2	0V	12	0V
3	DR	13	ER
4	0V	14	0V
5	CS	15	RS
6	0V	16	0V
7	CD	17	
8	0V	18	
9		19	(+24V)
10	(+24V)	20	

Host computer (example)

DBM–25S

1	FG		
2	SD	14	
3	RD	15	
4	RS	16	
5	CS	17	
6	DR	18	
7	SG	19	
8	CD	20	ER
9		21	
10		22	
11		23	
12		24	
13		25	

Conceptional diagram of signal connection

CNC side

Output ———▷— SD
Input ——◁— RD
———▷— RS
——◁— CS
———▷— ER
——◁— DR
——◁— CD
——— SG
0V FG
FRAME

Host side

SD —◁—
RD —▷—
RS —◁—
CS —▷—
ER —◁—
DR —▷—
CD —▷—
SG
FG

NOTE
No +24–V pins are provided for power supply of FANUC RS–232C device. If necessary, the machine tool builder should provide the +24–V pins.
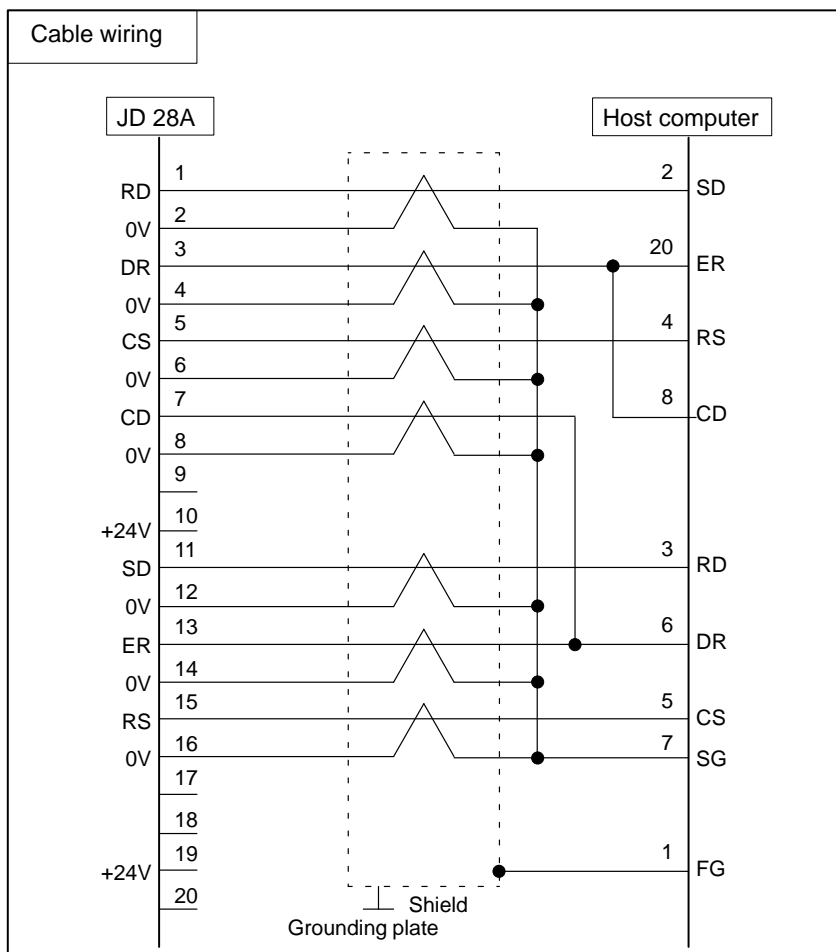
Connect CS to RS if CS is not used. However, when protocol A or expanded protocol A is used, connect as shown above because CS is used for busy control. Connect DR to ER when DR is not used. Be sure to connect CD to ER.

7.4
REMOTE BUFFER
INTERFACE (RS–422)

CNC OPTION–1 board

JD6A

(PCR-EV20MDT)

1	RD	11	SD
2	*RD	12	*SD
3	RT	13	TT
4	*RT	14	*TT
5	CS	15	RS
6	*CS	16	*RS
7	DM	17	TR
8	0V	18	*TR
9	*DM	19	
10		20	

Host computer (Example)

1	FG		
2		20	
3		21	
4	SD	22	*SD
5		23	
6	RD	24	*RD
7	RS	25	*RS
8	RT	26	*RT
9	CS	27	*CS
10		28	
11	DM	29	*DM
12	TR	30	*TR
13		31	
14		32	
15		33	
16		34	
17	TT	35	*TT
18		36	
19	SG	37	
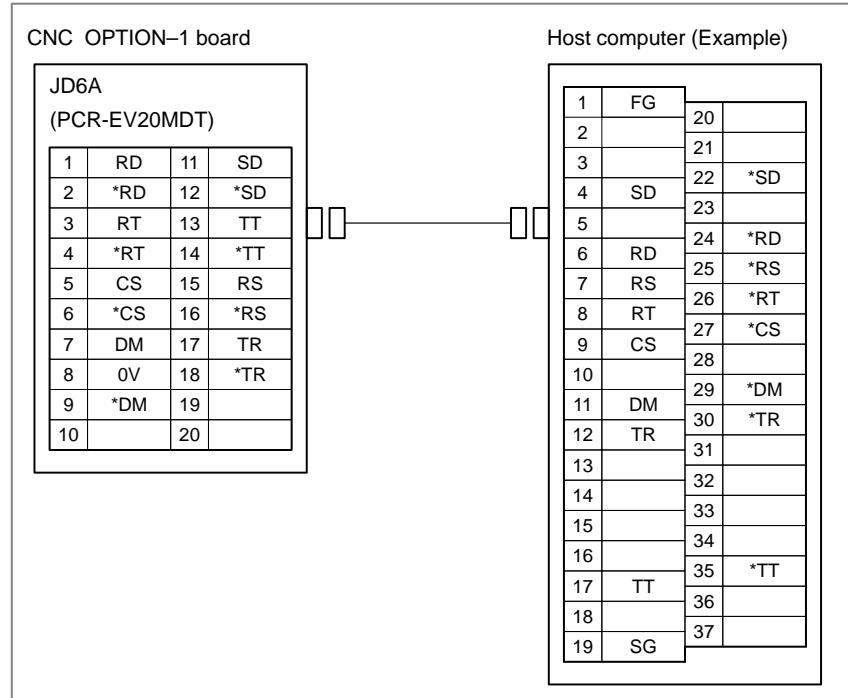
Conceptional diagram of signal connection

The figure below shows a signal connection between CNC and a host computer. Since signals other than FG and SG perform differential signal transmission, two wires of signal lines are used for those signals.

Conceptional diagram of signal connection

CNC side
Output   SD
Input   RD
          RS
          CS
          TR
          DM
          TT
          RT
          SG
0V   FG
    FRAME

Host side
          SD
          RD
          RS
          CS
          TR
          DM
          TT
          RT
          SG
          FG
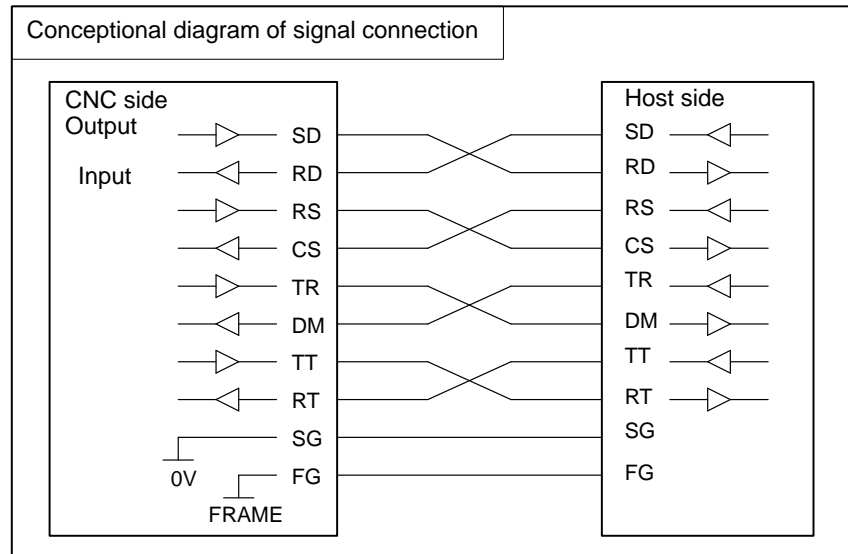
Actual example of RS–422 signal wiring

Cable wiring

JD 6A — Host computer

JD 6A				Host computer
RD	1		4	SD
*RD	2		22	*SD
RT	3		17	TT
*RT	4		35	*TT
CS	5		7	RS
*CS	6		25	*RS
DM	7		12	TR
*DM	9		30	*TR
0V	8		19	SG
+24V	10			
SD	11		6	RD
*SD	12		24	*RD
TT	13		8	RT
*TT	14		26	*RT
RS	15		9	CS
*RS	16		27	*CS
TR	17		11	DM
*TR	18		29	*DM
+24V	19		1	FG
	20			

Shield
Grounding plate

FRAME
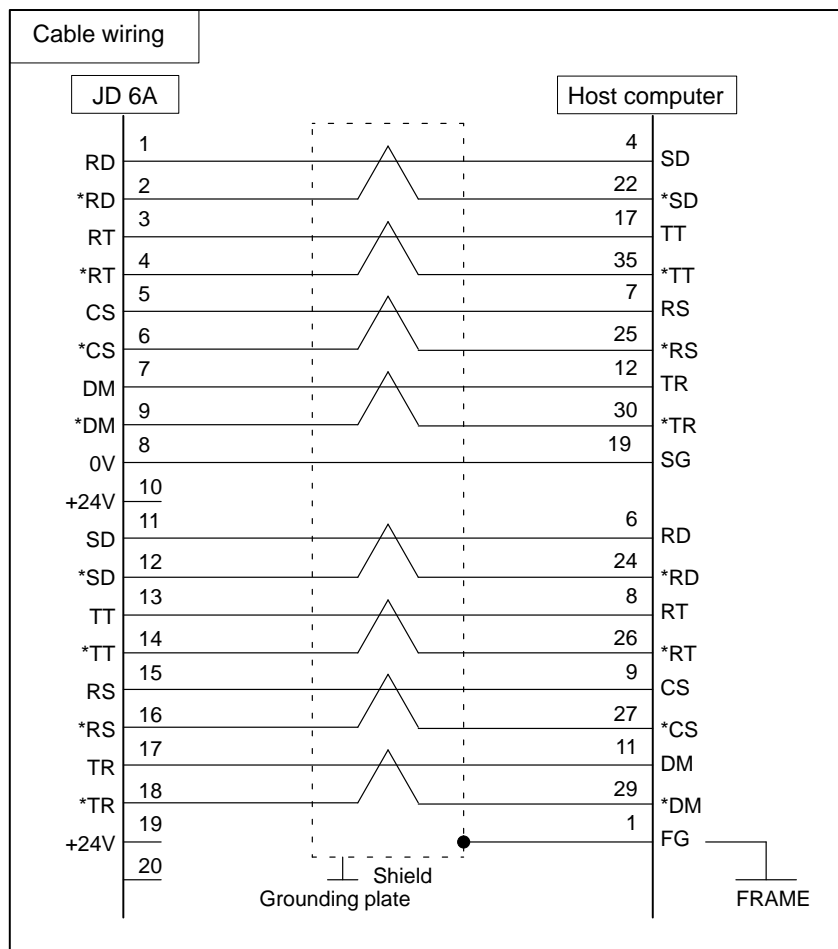
CAUTION
1 Be sure to use twisted pair cable.
2 Note that the pin position of the *DM signal on the CNC side is positioned irregularly relative to the other signals. This is to reduce the risk of damage to the circuit when this connector is erroneously connected to the connector on the other side.

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7.5
DNC1 INTERFACE

7.5.1
Multi–points
Connection

CNC OPTION–1 board

JD6A
(PCR-EV20MDT)

1	TRD1 (+)	11	TRD2 (+)
2	TRD1 (–)	12	TRD2 (–)
3		13	
4		14	
5		15	
6		16	
7		17	
8	SG	18	
9		19	
10		20	

Tap

1	TRD2(+)			14	
2	TRD2(–)	8		15	
3		9		16	
4		10	TRD1(+)	17	
5		11	TRD1(–)	18	
6		12		19	
7	SG	13		20	

Cable wiring

	PCR connector		MR connector (MR20 Female)	
TRD1 (+)	1		10	TRD1 (+)
TRD1 (–)	2		11	TRD1 (–)
TRD2 (+)	11		1	TRD2 (+)
TRD2 (–)	12		2	TRD2 (–)
SG	8		7	SG

PCR connector

MR connector
(MR20 Female)

7.5.2
1 to 1 Connection

CNC OPTION–1 board

JD6A
(PCR-EV20MDT)

1	RD	11	SD
2	*RD	12	*SD
3	RT	13	TT
4	*RT	14	*TT
5	CS	15	RS
6	*CS	16	*RS
7	DM	17	TR
8	SG	18	*TR
9	*DM	19	
10		20	

Tap

1	SD	8	TT	14	CS
2	*SD	9	*TT	15	*CS
3	TR	10	RD	16	
4	*TR	11	*RD	17	
5	RS	12	DM	18	RT
6	*RS	13	*DM	19	*RT
7	SG			20	

Cable wiring

SD	11	1	SD
*SD	12	2	*SD
RD	1	10	RD
*RD	2	11	*RD
TT	13	8	TT
*TT	14	9	*TT
RT	3	18	RT
*RT	4	19	*RT
RS	15	5	RS
*RS	16	6	*RS
CS	5	14	CS
*CS	6	15	*CS
DM	7	12	DM
*DM	9	13	*DM
TR	17	3	TR
*TR	18	4	*TR
SG	8	7	SG

Twisted pair cable

Recommended cable material $\geqq 0.3$mm^2

HONDA TSUSHIN KO-
GYO CO., LTD.
MR20 (Female)

7.6
DNC2 INTERFACE
(RS–232C)

CNC OPTION–1 board

JD5C

(PCR-EV20MDT)

1	RD	11	SD
2	0V	12	0V
3	DR	13	ER
4	0V	14	0V
5	CS	15	RS
6	0V	16	0V
7	CD	17	
8	0V	18	
9		19	
10		20	

Host computer (Example)

DBM–25S

1	FG		
		14	
2	SD		
		15	
3	RD		
		16	
4	RS		
		17	
5	CS		
		18	
6	DR		
		19	
7	SG		
		20	ER
8	CD		
		21	
9			
		22	
10			
		23	
11			
		24	
12			
		25	
13			

Conceptional diagram of signal connection

CNC side
output   SD
Input   RD
                 RS
                 CS
                 ER
                 DR
                 CD
                 SG
0V   FG
        FRAME

Host side
SD
RD
RS
CS
ER
DR
CD
SG
FG
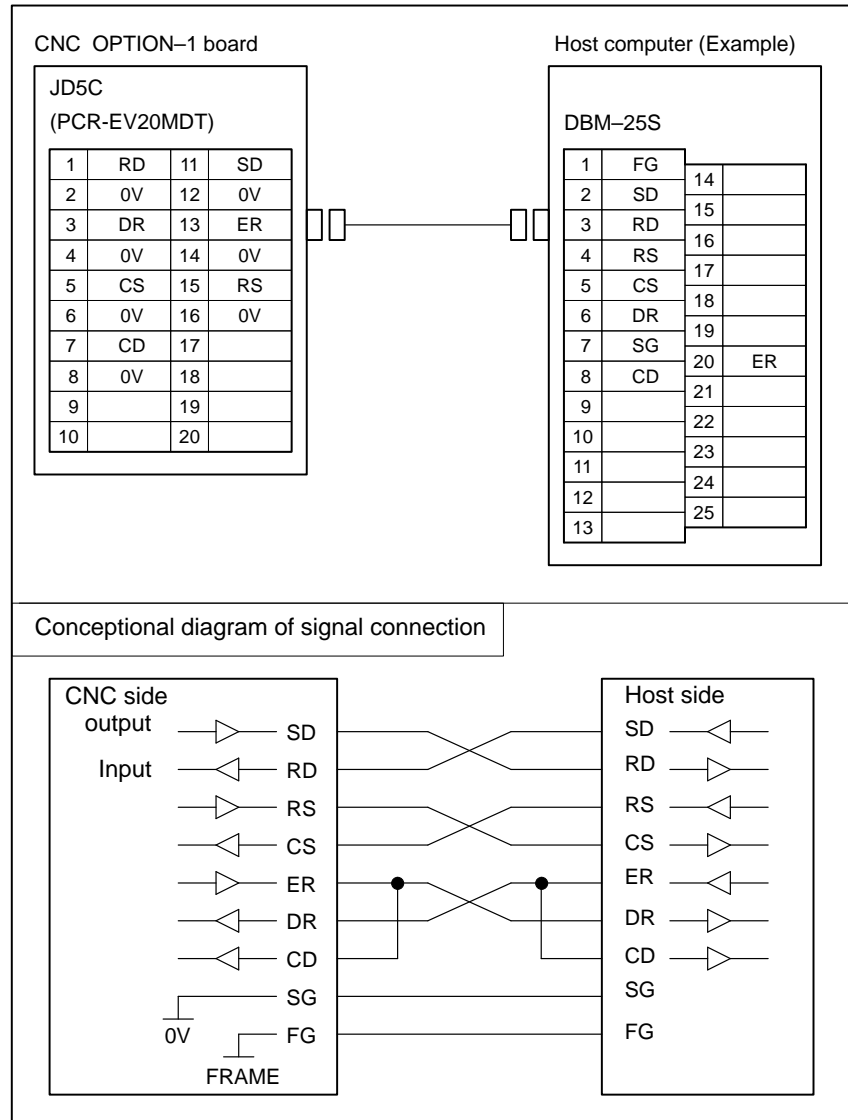
When not using CS, connect it to RS.
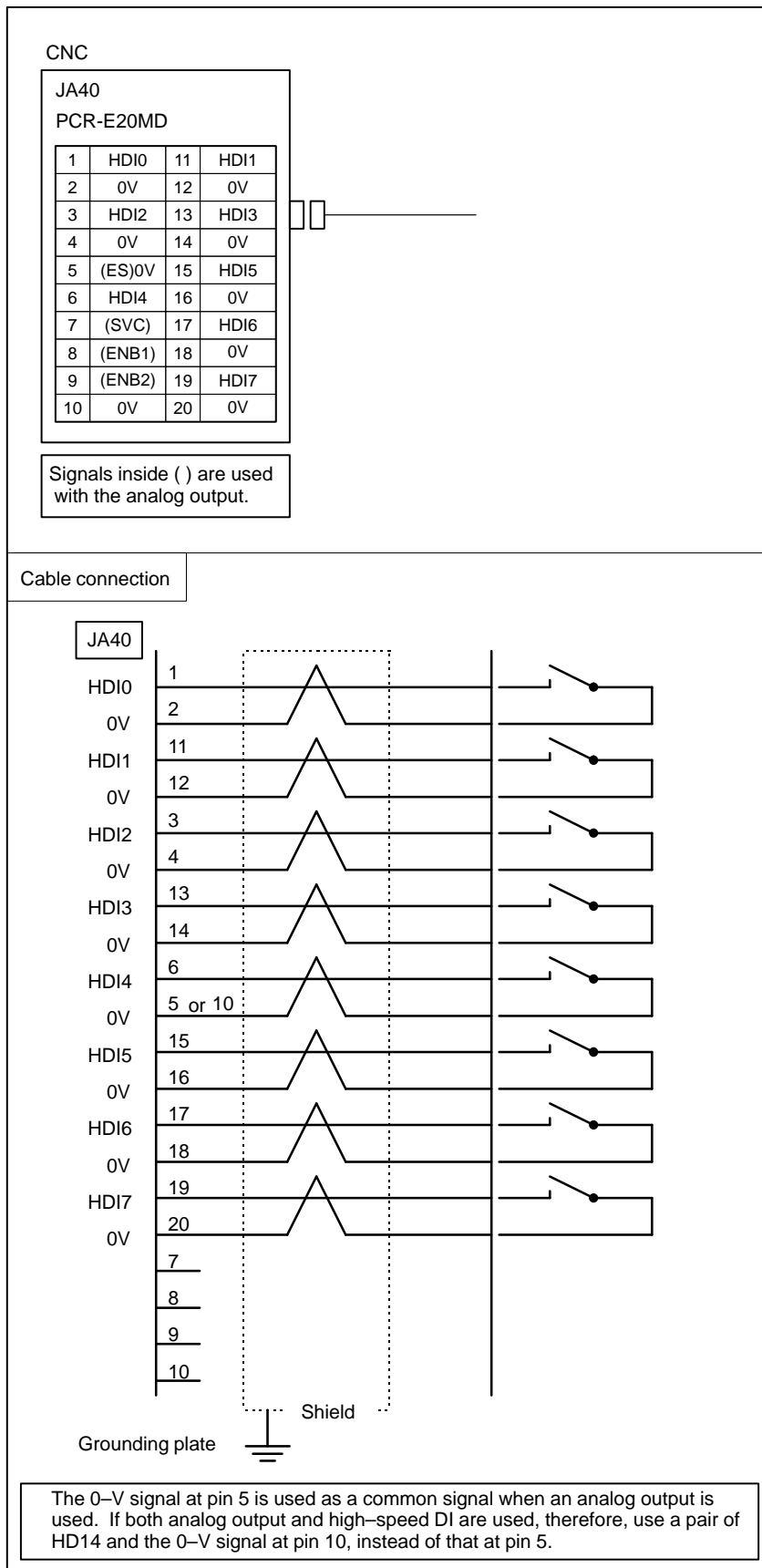When not using DR, connect it to ER. Always connect CD to ER.

CAUTION
If the host computer is an IBM PC–AT, connect its CS with its ER because RS on the CNC goes low when the CNC enters the reception phase.
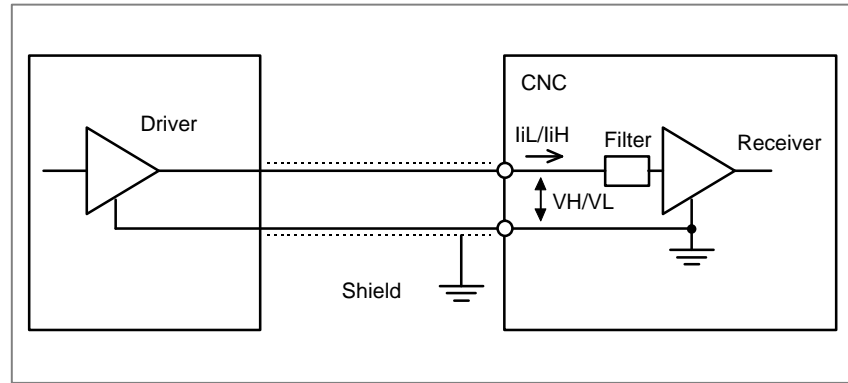

NOTE
No +24–V pins are provided for power supply of FANUC RS–232C device. If necessary, the machine tool builder should provide the +24–V pins.

7.7
HIGH SPEED DI
SIGNAL INTERFACE

CNC

JA40

PCR-E20MD

1	HDI0	11	HDI1
2	0V	12	0V
3	HDI2	13	HDI3
4	0V	14	0V
5	(ES)0V	15	HDI5
6	HDI4	16	0V
7	(SVC)	17	HDI6
8	(ENB1)	18	0V
9	(ENB2)	19	HDI7
10	0V	20	0V

Signals inside ( ) are used
with the analog output.

Cable connection

JA40

HDI0	1
0V	2
HDI1	11
0V	12
HDI2	3
0V	4
HDI3	13
0V	14
HDI4	6
0V	5 or 10
HDI5	15
0V	16
HDI6	17
0V	18
HDI7	19
0V	20
	7
	8
	9
	10

Shield

Grounding plate

The 0–V signal at pin 5 is used as a common signal when an analog output is
used. If both analog output and high–speed DI are used, therefore, use a pair of
HD14 and the 0–V signal at pin 10, instead of that at pin 5.

7.7.1
Input Signal Rules for the High–Speed DI

Circuit configuration

Absolute maximum rating

Input voltage range Vin: –3.6 to +13.6 V

Input characteristics

| Item	Symbol	Specification	Unit	Remarks
High–level input voltage	VH	3.6 to 11.6	V	
Low–level input voltage	VL	0 to 1.0	V	
High–level input current	IiH	0.5 max	mA	Vin=5 V
		9.3 max	mA	Vin=10 V
Low–level input current	IiL	–8.0 max	mA	Vin=0 V
Input signal pulse duration		20 min	μs	

NOTE
1 The sign added to the IiH or IiL value indicates the direction in which the current flows: The plus sign (+) represents that the current flows into the receiver; The minus sign (–) represents that the current flows out of the receiver.
2 The level of the high–speed skip signal is assumed as 1 when the input voltage is low and 0 when the input voltage is high.
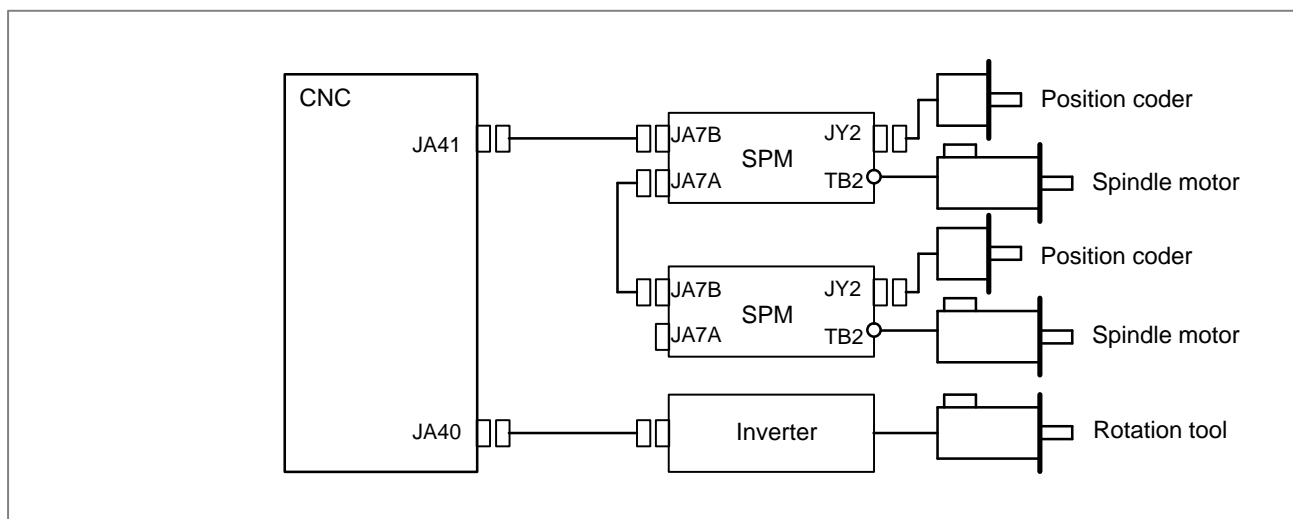

7.8
SPINDLE INTERFACE

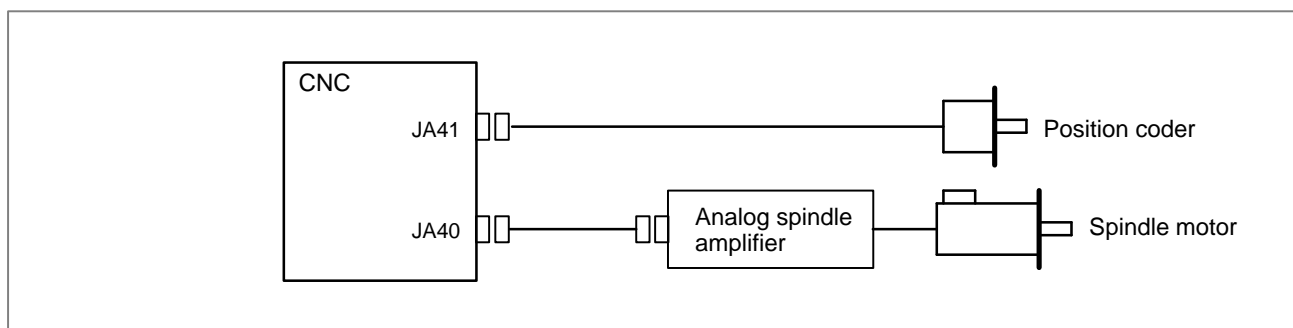The following three configurations of the spindle interface are variable.

1. α Series spindle amplifier
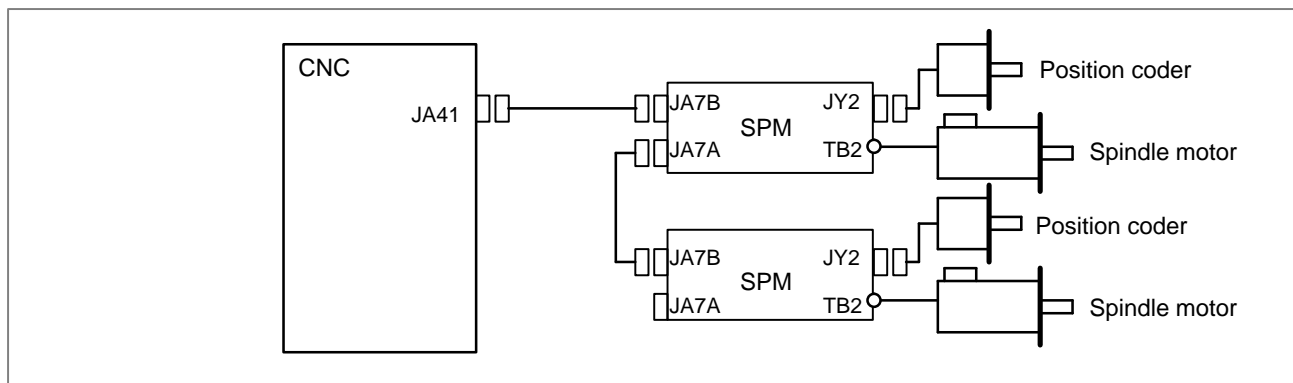
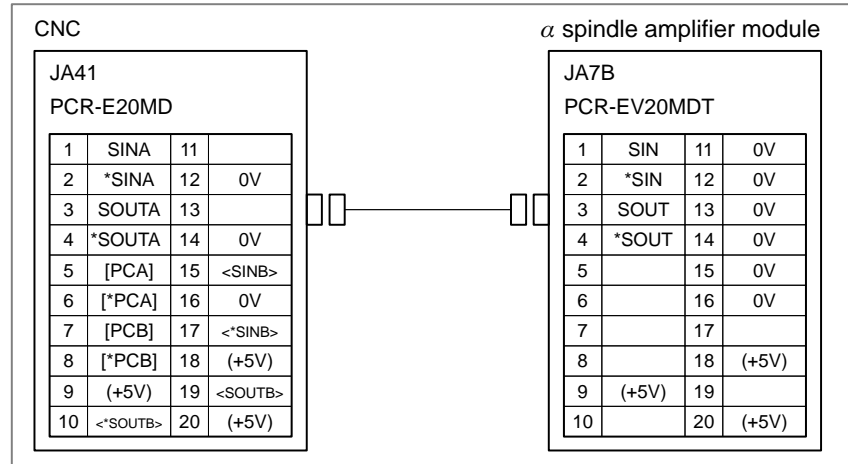2. α Series spindle amplifier + rotation tool

3. Analog spindle

NOTE
For the connection of the spindle amplifier to the spindle motor or position coder, refer to the manuals on SPINDLE MOTOR α Series.

7.8.1
α **Spindle Interface**

CNC   α spindle amplifier module

JA41
PCR-E20MD

1	SINA	11	
2	*SINA	12	0V
3	SOUTA	13	
4	*SOUTA	14	0V
5	[PCA]	15	<SINB>
6	[*PCA]	16	0V
7	[PCB]	17	<*SINB>
8	[*PCB]	18	(+5V)
9	(+5V)	19	<SOUTB>
10	<*SOUTB>	20	(+5V)

JA7B
PCR-EV20MDT

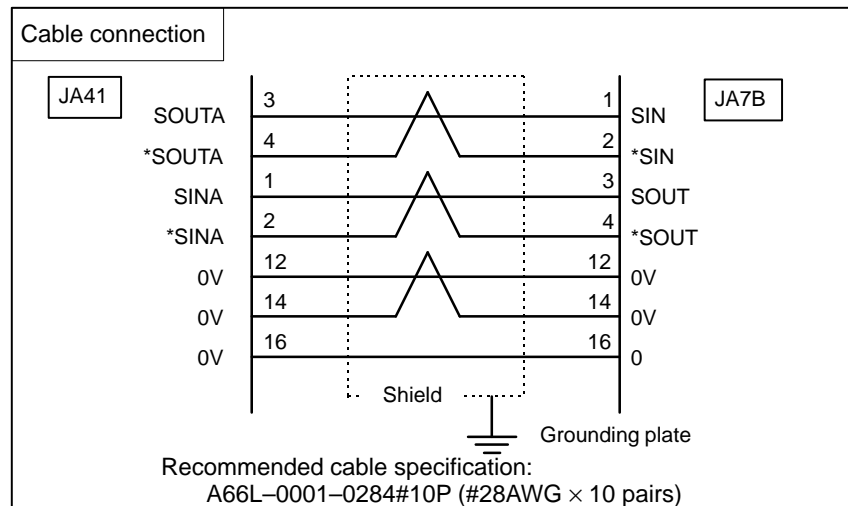| 1	SIN	11	0V
2	*SIN	12	0V
3	SOUT	13	0V
4	*SOUT	14	0V
5		15	0V
6		16	0V
7		17	
8		18	(+5V)
9	(+5V)	19	
10		20	(+5V)

NOTE
The +5–V signals inside ( ) are power supply signals to the optical I/O link adapter to be used when an optical I/O link adapter is used for the connection between NC and the spindle amplifier. Do not connect this signal when the optical cable is not used.
The signals inside [ ] are for use when position coders are used. Those signals cannot be used for the serial spindle.
The signals inside <> are provided for use with the second serial spindle interface. Those signals cannot be used with some models.

Cable connection

JA41			JA7B
SOUTA	3	1	SIN
*SOUTA	4	2	*SIN
SINA	1	3	SOUT
*SINA	2	4	*SOUT
0V	12	12	0V
0V	14	14	0V
0V	16	16	0

Shield

Grounding plate

Recommended cable specification:
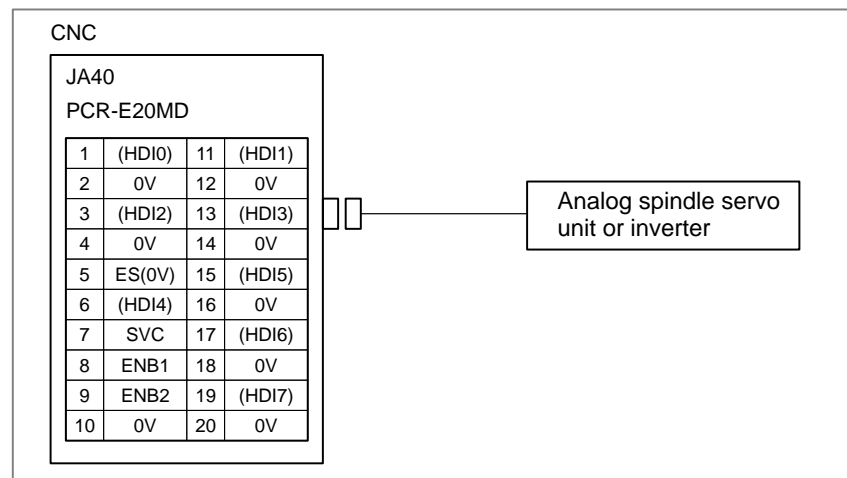A66L–0001–0284#10P (#28AWG × 10 pairs)

> **NOTE**
>   When this cable is placed near a power cable or other cable, the shield must be connected to the grounding plate.
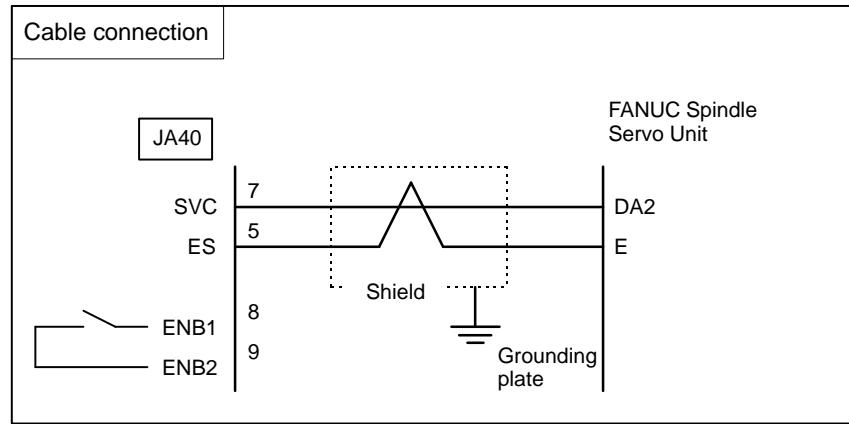>   The shield need not be grounded if the CNC is mounted near the spindle amplifier module.
>   In the following cases, use optical fiber cable connection through an optical I/O link adapter:
>   - When the cable length is 20 m or greater
>   - When the cable goes through different cabinets and when a grounding wire of 5.5 mm^2 or greater cannot be connected between the cabinets
>   - When the cable may be strongly affected by noise: For example, when there is a source of strong electromagnetic noise, such as a welder, near the cable
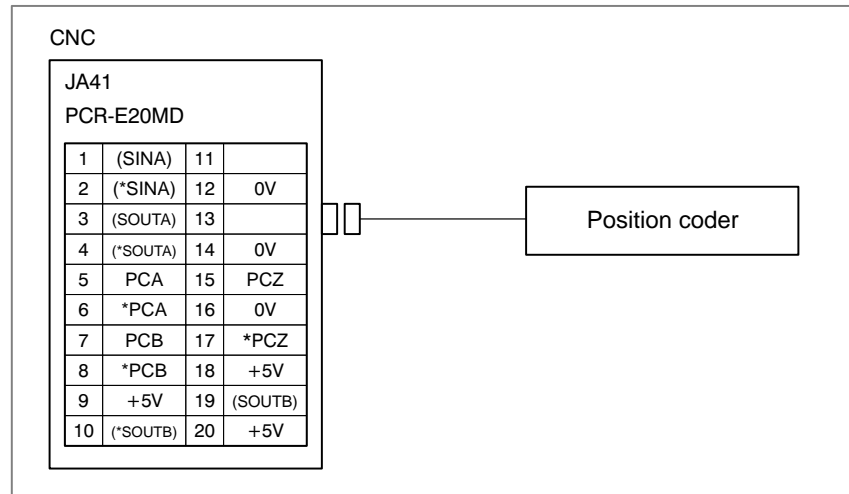
7.8.2
Analog Spindle Interface

```
CNC

 JA40
 PCR-E20MD

  1  (HDI0)  11  (HDI1)
  2   0V     12   0V
  3  (HDI2)  13  (HDI3)
  4   0V     14   0V
  5  ES(0V)  15  (HDI5)
  6  (HDI4)  16   0V
  7   SVC    17  (HDI6)
  8  ENB1    18   0V
  9  ENB2    19  (HDI7)
 10   0V     20   0V
```

Analog spindle servo unit or inverter

> **NOTE**
>   The signals inside () are high–speed DI input signals.
>   SVC, ES: Spindle command voltage and common signal
>   ENB1, ENB2: Spindle enable signal. The signal goes on when the spindle command voltage is effective. The signal is provided for use with the FANUC Spindle Servo Unit. When the signal is set off, the applied voltage should be 30 V or below. When the signal is set on, the current should be 200 mA or below.
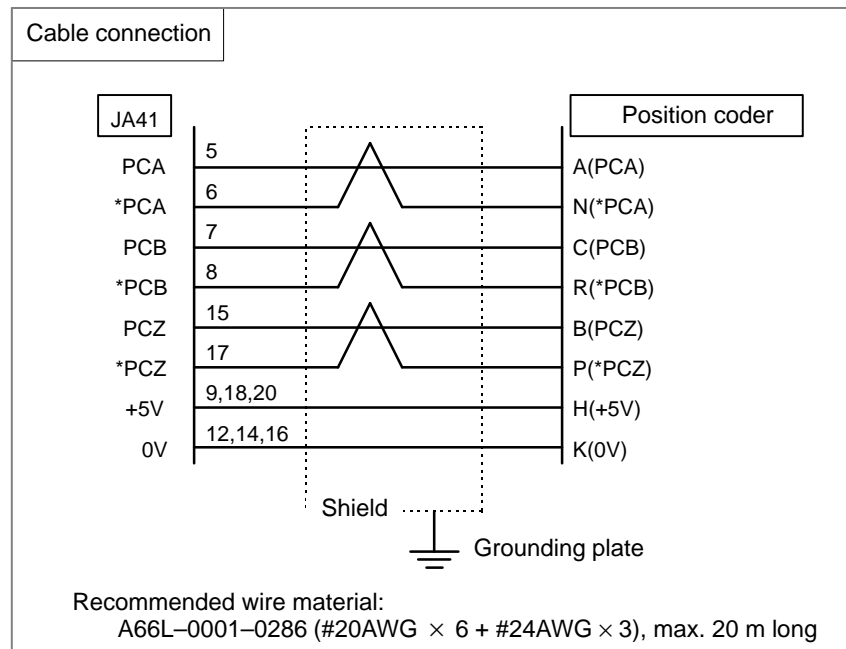
Cable connection

JA40

SVC   7 ──────────────────── DA2   FANUC Spindle
ES   5 ──────────────────── E   Servo Unit

                    Shield

ENB1   8
ENB2   9   Grounding
                           plate

7.8.3 Position Coder Interface

CNC

JA41

PCR-E20MD

1	(SINA)	11	
2	(*SINA)	12	0V
3	(SOUTA)	13	
4	(*SOUTA)	14	0V
5	PCA	15	PCZ
6	*PCA	16	0V
7	PCB	17	*PCZ
8	*PCB	18	+5V
9	+5V	19	(SOUTB)
10	(*SOUTB)	20	+5V

Position coder

NOTE
The signals inside ( ) are provided for the serial spindle motor interface. Those signals are not used with a position coder.

Cable connection

JA41

JA41		Position coder
PCA	5	A(PCA)
*PCA	6	N(*PCA)
PCB	7	C(PCB)
*PCB	8	R(*PCB)
PCZ	15	B(PCZ)
*PCZ	17	P(*PCZ)
+5V	9,18,20	H(+5V)
0V	12,14,16	K(0V)

Shield

Grounding plate

Recommended wire material:
A66L–0001–0286 (#20AWG × 6 + #24AWG × 3), max. 20 m long

NOTE
The 15–pin solder–type connector FI40B–2015S (former FI40–2015S) of Hirose Electric cannot be used as the cable–side connector.

7.9
SERVO INTERFACE
(FSSB)

The connection between the CNC control unit and the servo amplifiers should use only one optical fiber cable, regardless of the number of controlled axes.

For the connection of the α Series control motor amplifier, refer to "FANUC Control Motor Amplifier α Series Descriptions (B–65162E)."
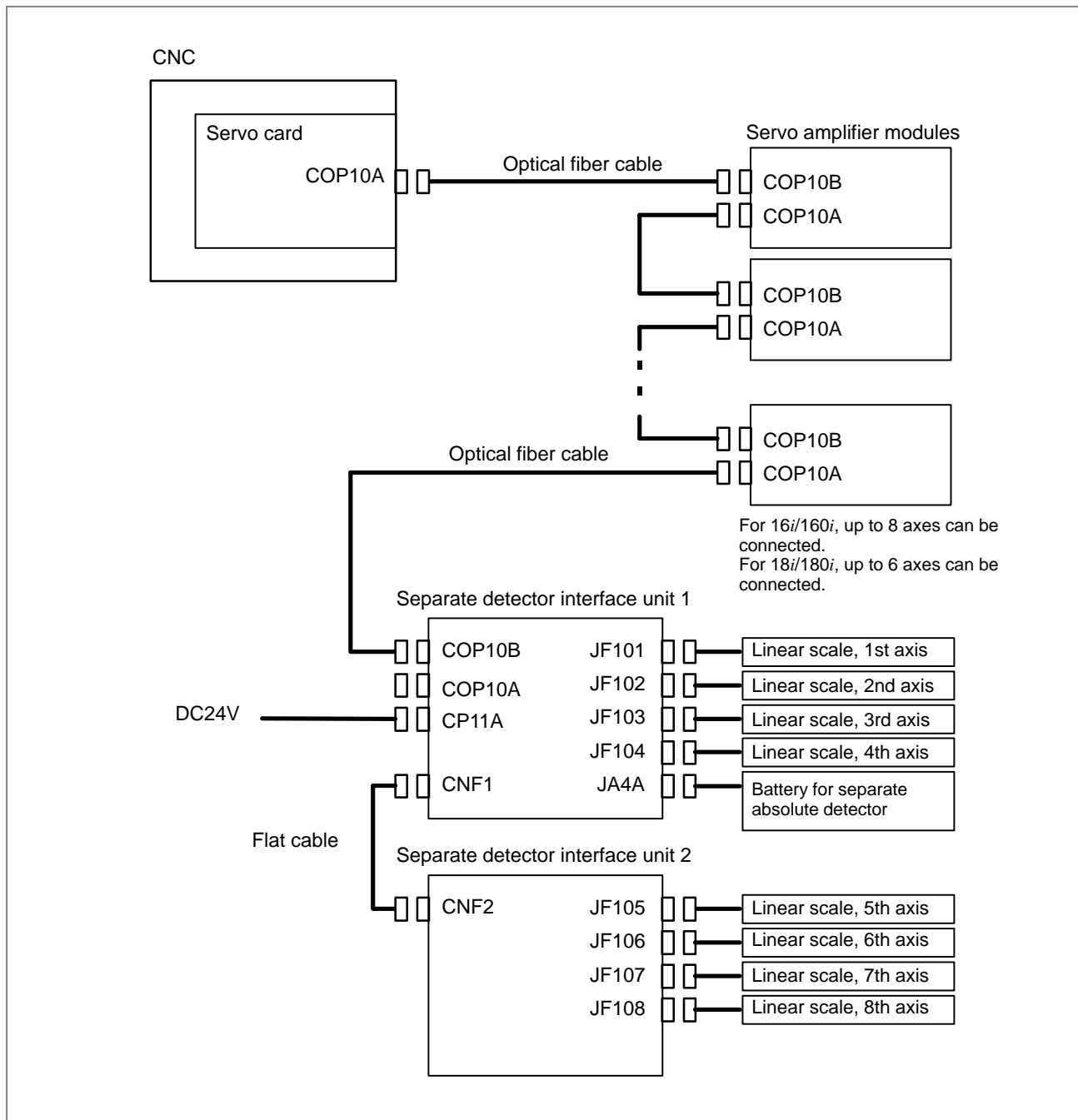
Recommended cable (optical fiber cable)
> Power magnetics cabinet internal cable/fixed type:
> > A66L–6001–0023#L △△△△
> Power magnetics cabinet external cable/portable type:
> > A66L–6001–0026#L △△△△

For the length requirements and other notes, see Appendix D.

When a separate pulse coder or linear scale is used, a separate detector interface unit, as shown above, is required. The separate detector interface unit should be connected to the CNC control unit through an optical fiber cable, as one of the units on the servo interface (FSSB). Although the above figure shows the separate detector interface connected in the final stage of the FSSB line, it can also be connected, at the nearest location, to the CNC control unit. Or, it can be installed between two servo amplifier modules.
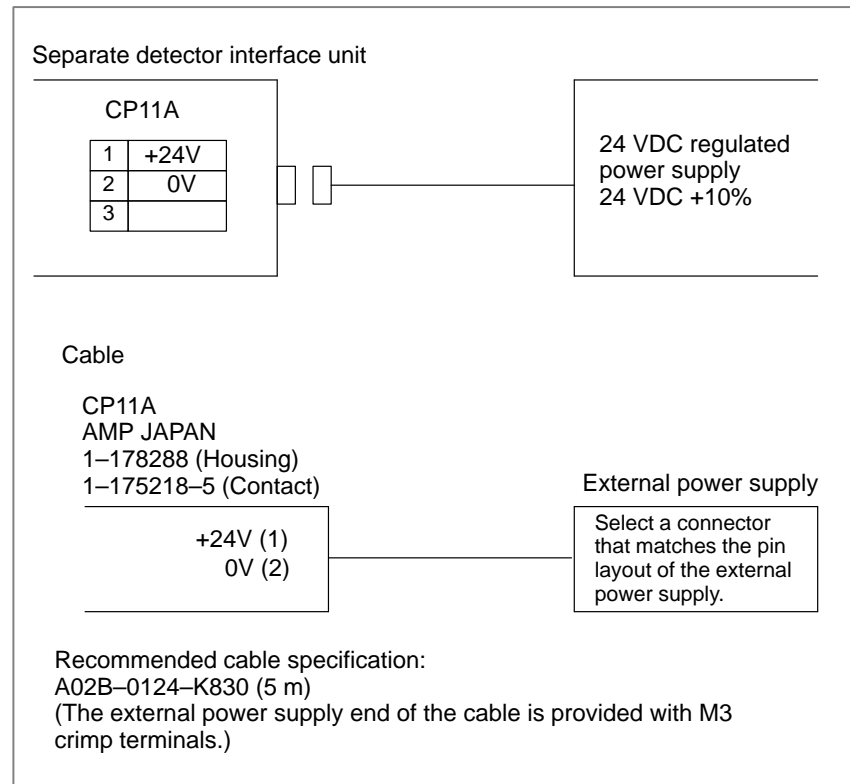
7.9.1
Specifications of the Separate Detector

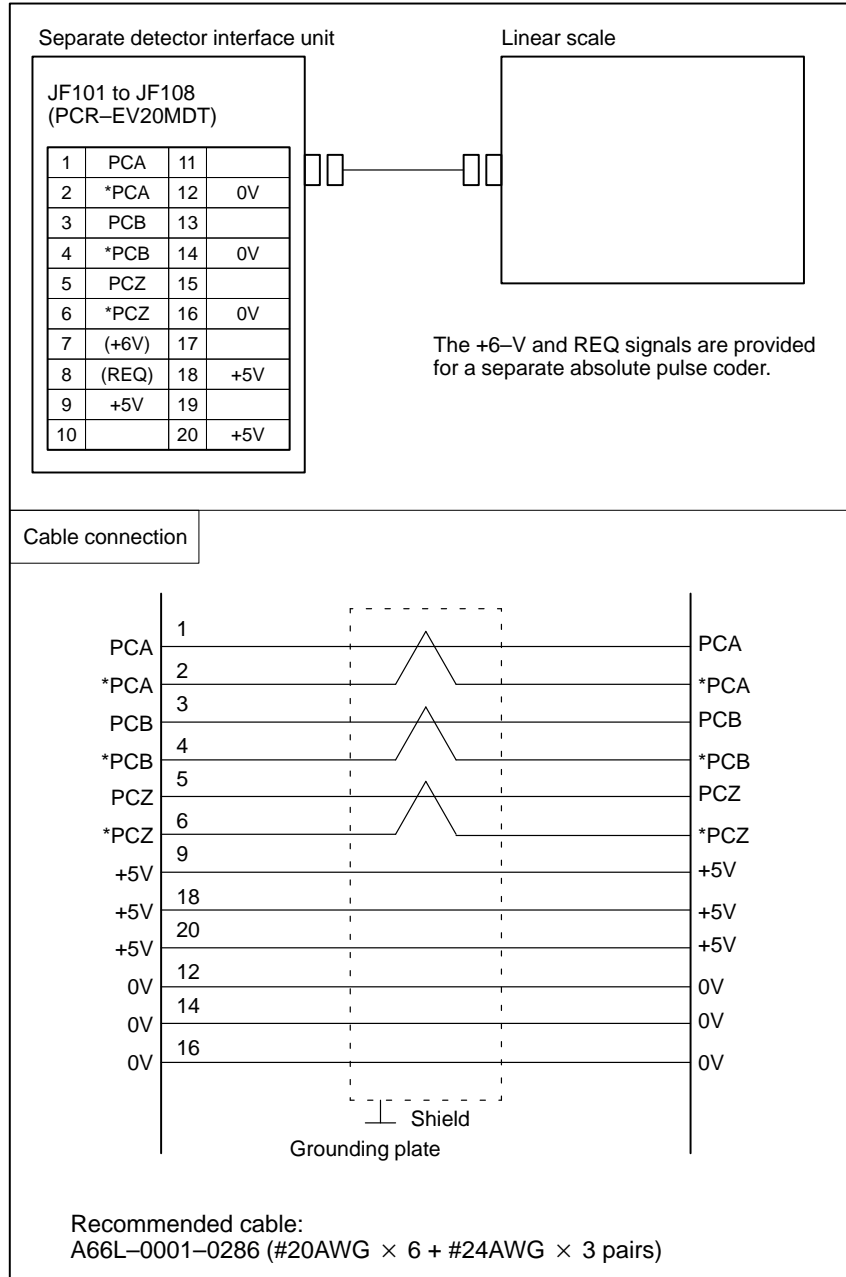| Item	Specifications
Power supply	Voltage: +24 VDC ±10% Current: 0.9 A (for unit 1 only), 1.5 A (for unit 1 and unit 2)
Ordering specification	A02B–0230–C201 (basic four axes) A02B–0236–C202 (additional four axes)
Installation	The unit can be secured with screws or DIN rail. When securing the unit with screws, see the figure below. (The method of mounting the unit with the DIN rail is under development.)
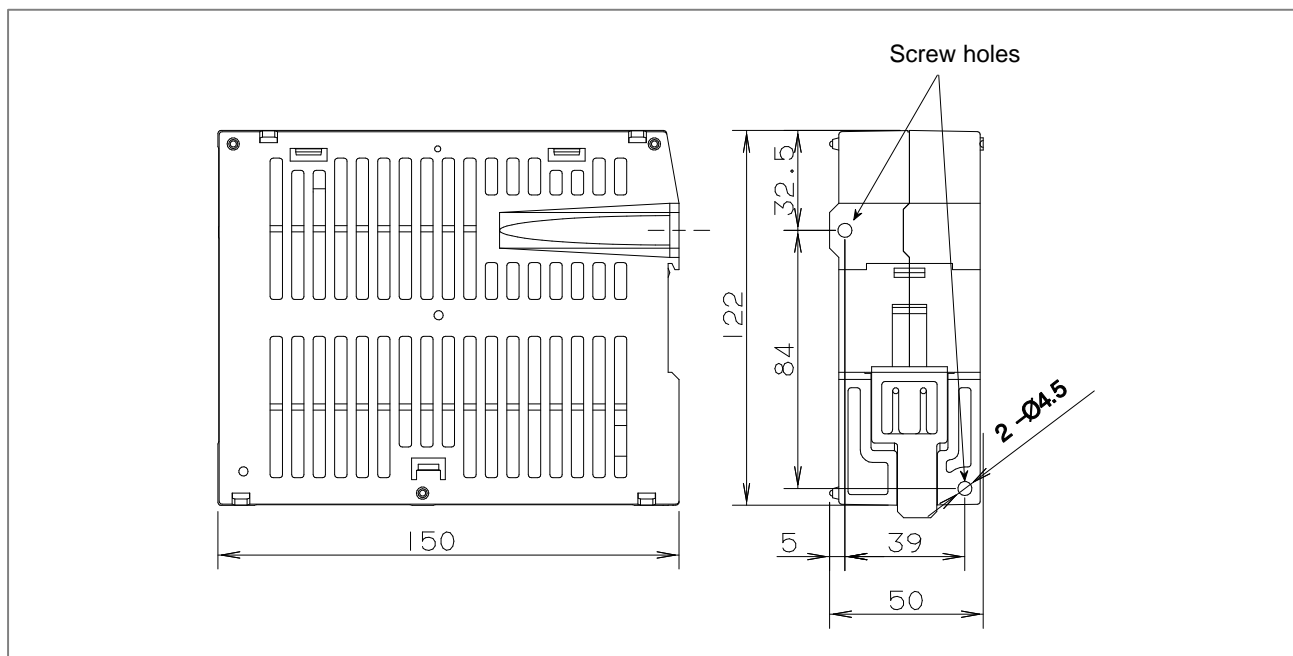
Connection of power supply

Power to the separate detector interface unit should be supplied from an external 24 VDC power supply.

```
Separate detector interface unit

   CP11A

   1 │ +24V                              24 VDC regulated
   2 │  0V                               power supply
   3 │                                   24 VDC +10%


  Cable

   CP11A
   AMP JAPAN
   1–178288 (Housing)
   1–175218–5 (Contact)                External power supply

                                       Select a connector
         +24V (1)                      that matches the pin
          0V (2)                       layout of the external
                                       power supply.

  Recommended cable specification:
  A02B–0124–K830 (5 m)
  (The external power supply end of the cable is provided with M3
  crimp terminals.)
```
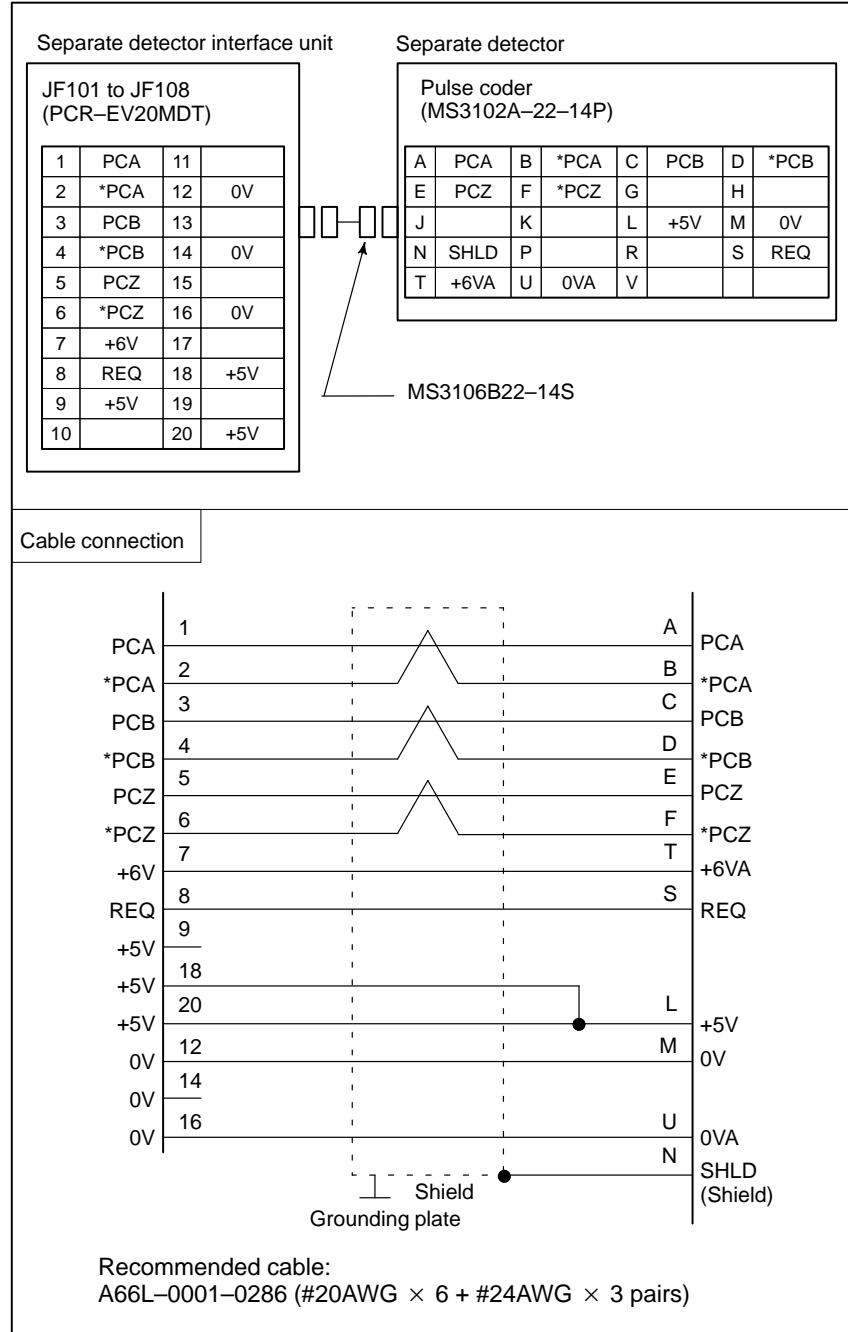
The 24 VDC input to CP11A can be output at CP11B for use in branching. The connection of CP11B is identical to that of CP11A.
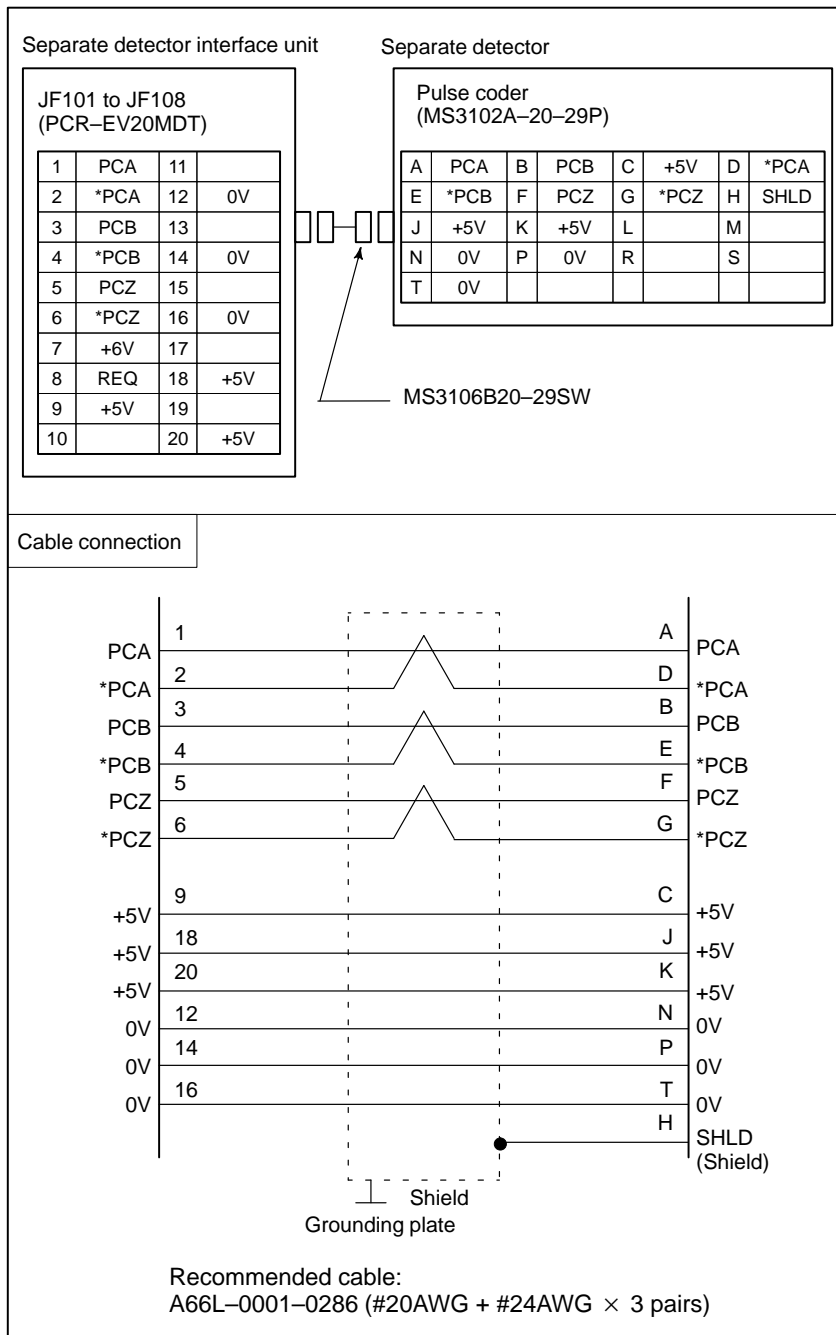
Linear scale interface

Separate detector interface unit

Linear scale

JF101 to JF108
(PCR–EV20MDT)

1	PCA	11	
2	*PCA	12	0V
3	PCB	13	
4	*PCB	14	0V
5	PCZ	15	
6	*PCZ	16	0V
7	(+6V)	17	
8	(REQ)	18	+5V
9	+5V	19	
10		20	+5V

The +6–V and REQ signals are provided
for a separate absolute pulse coder.

Cable connection

PCA	1	PCA
*PCA	2	*PCA
PCB	3	PCB
*PCB	4	*PCB
PCZ	5	PCZ
*PCZ	6	*PCZ
+5V	9	+5V
+5V	18	+5V
+5V	20	+5V
0V	12	0V
0V	14	0V
0V	16	0V

Shield
Grounding plate

Recommended cable:
A66L–0001–0286 (#20AWG × 6 + #24AWG × 3 pairs)

Separate pulse coder interface

● **Absolute detection**

Separate detector interface unit   Separate detector

JF101 to JF108
(PCR–EV20MDT)

1	PCA	11	
2	*PCA	12	0V
3	PCB	13	
4	*PCB	14	0V
5	PCZ	15	
6	*PCZ	16	0V
7	+6V	17	
8	REQ	18	+5V
9	+5V	19	
10		20	+5V

Pulse coder
(MS3102A–22–14P)

A	PCA	B	*PCA	C	PCB	D	*PCB
E	PCZ	F	*PCZ	G		H	
J		K		L	+5V	M	0V
N	SHLD	P		R		S	REQ
T	+6VA	U	0VA	V			

MS3106B22–14S

Cable connection

Recommended cable:
A66L–0001–0286 (#20AWG × 6 + #24AWG × 3 pairs)

● **For incremental detector**

Separate detector interface unit

JF101 to JF108
(PCR–EV20MDT)

1	PCA	11	
2	*PCA	12	0V
3	PCB	13	
4	*PCB	14	0V
5	PCZ	15	
6	*PCZ	16	0V
7	+6V	17	
8	REQ	18	+5V
9	+5V	19	
10		20	+5V

Separate detector

Pulse coder
(MS3102A–20–29P)

A	PCA	B	PCB	C	+5V	D	*PCA
E	*PCB	F	PCZ	G	*PCZ	H	SHLD
J	+5V	K	+5V	L		M	
N	0V	P	0V	R		S	
T	0V						

MS3106B20–29SW

Cable connection

PCA	1	A	PCA
*PCA	2	D	*PCA
PCB	3	B	PCB
*PCB	4	E	*PCB
PCZ	5	F	PCZ
*PCZ	6	G	*PCZ
+5V	9	C	+5V
+5V	18	J	+5V
+5V	20	K	+5V
0V	12	N	0V
0V	14	P	0V
0V	16	T	0V
		H	SHLD (Shield)

Shield
Grounding plate

Recommended cable:
A66L–0001–0286 (#20AWG + #24AWG × 3 pairs)

Input signal requirements

The standard of the feedback signal from the additional detector is as shown below.

(1) A and B phase signal input

This is a method to input position information by the mutual 90 degree phase slip of A and B phase signals.
Detection of the position is performed with the state in which the B phase is leading taken as a shift in the plus direction, and the state in which the A phase is leading as a shift in the minus direction.
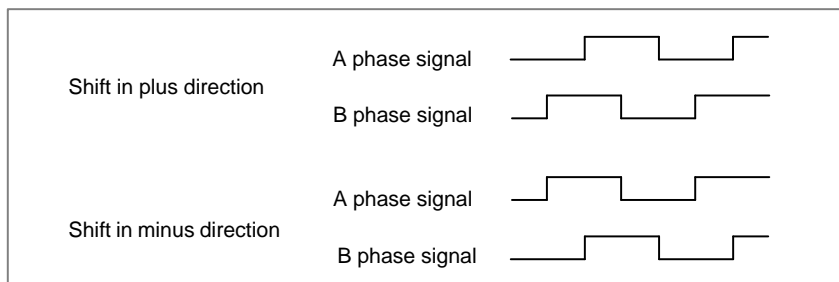
(2) Phase difference and minimum repeat frequency
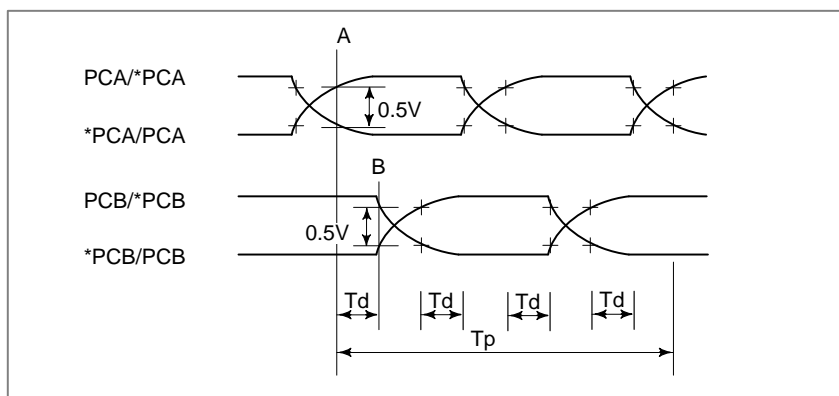
(3) Z phase signal input

For the Z phase signal (1 rotation signal), a signal width of more than 1 frequency of the A phase or B phase signals is necessary.
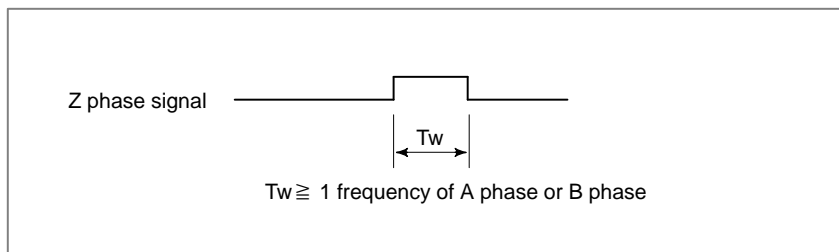
Time requirements

Requirements for the signals at the input pins of input connectors JF101 to JF108

TD $\geqq$ 0.15 µsec

The signals for these connectors are differential input signals with A and B phases. An important factor is time TD from point A, when the potential difference between PCA and *PCA exceeds 0.5V, to point B, when the potential difference between PCB and *PCB becomes lower than 0.5V. The minimum value of TD is 0.15 µs. The period and pulse width of the signals must be long enough to satisfy the above requirements.

Receiver circuit
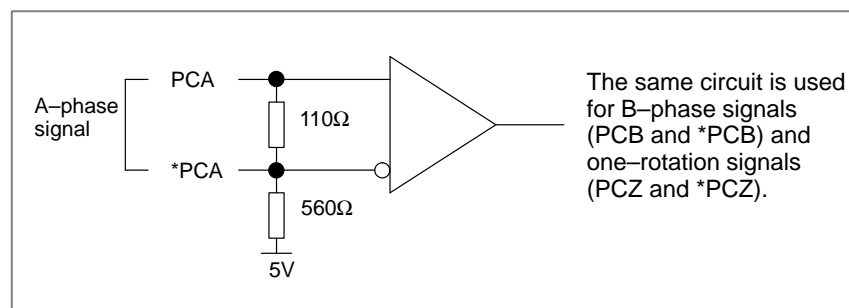
7.9.2
Connection of Battery for Separate Absolute Detector

```
┌──────────────────────────────────────────────────────────────────────────┐
│  CNC                                              Battery box              │
│  ┌──────────────────────┐                         ┌────────────────────┐   │
│  │ JA4                  │                         │ (M3 terminal)      │   │
│  │ (PCR-EV20MDT)        │                         │                    │   │
│  │  ┌───┬────┬────┬───┐ │    ┌┐┌┐          ○      │  ┌─────┬─────┐     │   │
│  │  │ 1 │    │ 11 │   │ │    └┘└┘─────────────     │  │  +  │  −  │     │   │
│  │  │ 2 │    │ 12 │   │ │                         │  ├─────┼─────┤     │   │
│  │  │ 3 │ 0V │ 13 │   │ │                         │  │ +6V │ 0V  │     │   │
│  │  │ 4 │    │ 14 │   │ │                         │  └─────┴─────┘     │   │
│  │  │ 5 │    │ 15 │   │ │                         └────────────────────┘   │
│  │  │ 6 │    │ 16 │   │ │                                                   │
│  │  │ 7 │+6V │ 17 │   │ │                                                   │
│  │  │ 8 │    │ 18 │   │ │                                                   │
│  │  │ 9 │    │ 19 │   │ │                                                   │
│  │  │10 │    │ 20 │   │ │                                                   │
│  │  └───┴────┴────┴───┘ │                                                   │
│  └──────────────────────┘                                                   │
│                                                                            │
│  ┌──────────────┐                                                           │
│  │ Cable wiring │                                                           │
│  └──────────────┘                                                           │
│                                                                            │
│              JA4A                          Battery case                     │
│                                                                            │
│              │  7              +    │                                       │
│       +6V ───┤─────────────────────├─── +6V                                 │
│              │  3              −    │                                       │
│        0V ───┤─────────────────────├─── 0V                                  │
│              │                     │                                        │
│                                                                            │
│  Recommended cable material   ≧ 0.2mm$^2$ (7/0.18)                          │
│                                                                            │
└──────────────────────────────────────────────────────────────────────────┘
```
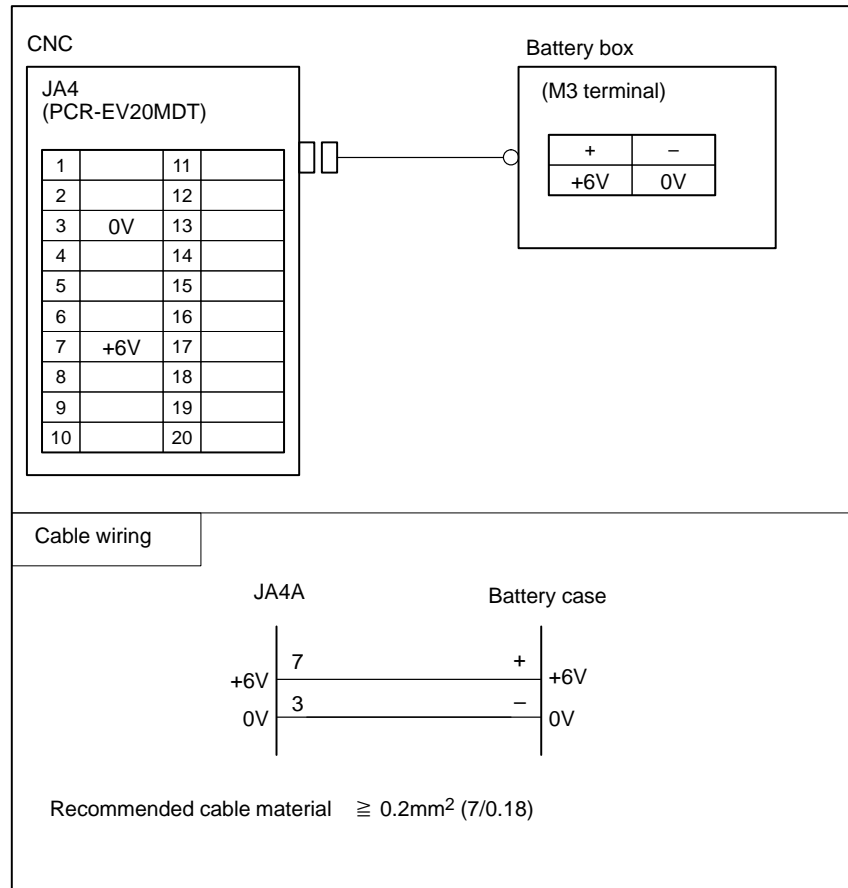
> **NOTE**
> This absolute battery is exclusively used for a scale. Install a battery of pulse coder of a motor on the α series amplifier side.

7.10
HIGH–SPEED SERIAL BUS (HSSB) INTERFACE

This interface can be used in a system of the Series 160*i*/180*i* and cannot be used in a system of the Series 16*i*/18*i*.
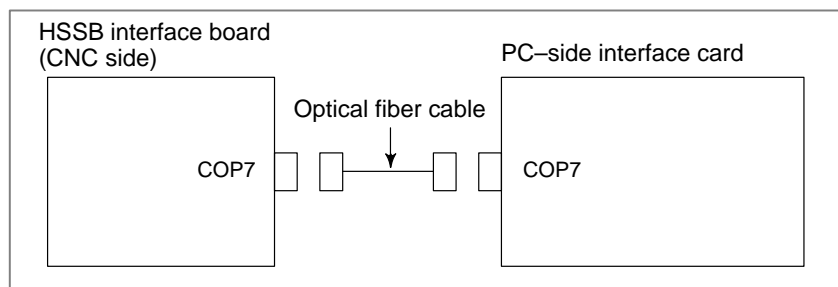
1) Recommended cables (optical fiber cables)
   A66L–6001–0021#L △△△△
   A66L–6001–0022#L △△△△
   A66L–6001–0026#L △△△△

For the length requirements and other notes, see Appendix D.

7.11
DATA SERVER INTERFACE
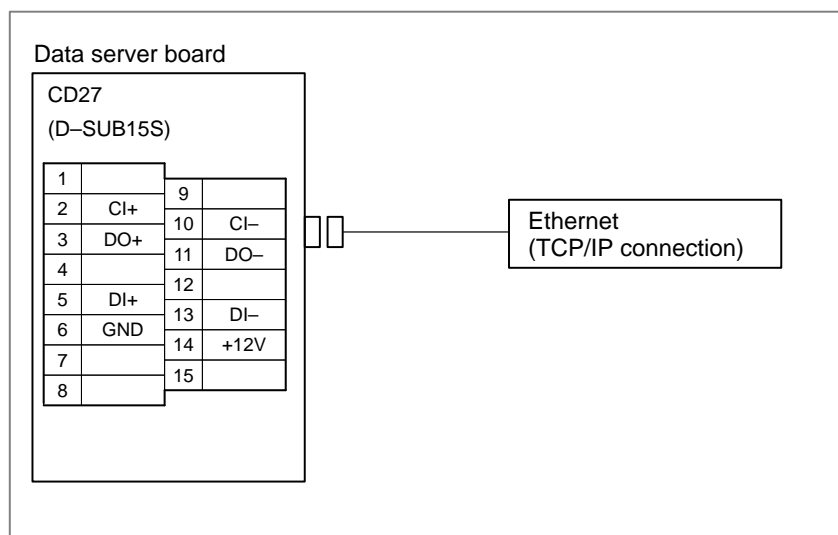
7.12
CONNECTION OF THE SPECIAL INTERFACE OF THE CNC WITH PC FUNCTIONS

The control unit of some Series 160*i*/180*i* models incorporates PC functions. This chapter describes how to connect the special interface of the CNC with PC functions.

7.12.1
Connection of Serial Port

With the control unit with PC functions, parameters and programs are input and output through the RS–232C serial port of the personal computer. When the touch panel function is used, however, this interface is used by the touch panel, so parameters and programs should be input and output through the 2nd channel of the serial port on the personal computer side, which is located on the PC interface connector unit described in Section 7.12.5.

CNC				Connector panel (Example)			

JD33
PCR-E20MD

1	RD	11	SD
2	0V	12	0V
3	DR	13	ER
4	0V	14	0V
5	CS	15	RS
6	(RES)	16	(RES)
7	CD	17	(RES)
8	(RES)	18	+5V
9	RI	19	+24V
10	+24V	20	+5V

Serial port
(D–Sub25)

1	FG	14	
2	SD	15	
3	RD	16	
4	RS	17	
5	CS	18	
6	DR	19	
7	SG	20	ER
8	CD	21	
9		22	
10		23	RI
11		24	
12		25	
13			
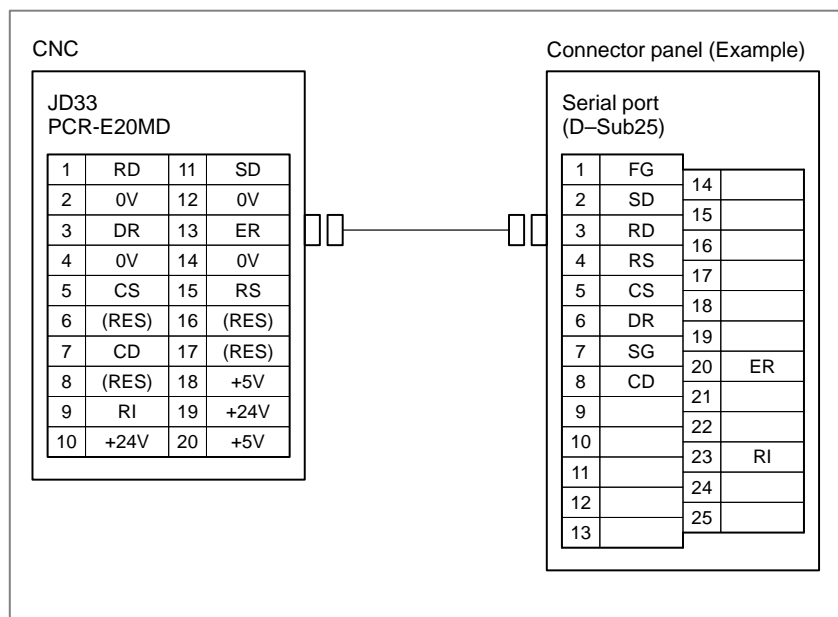
NOTE
The +5–V signal of the interface is provided to connect a touch panel. Do not use this signal for any other purposes. The +24–V signal is used as the power supply of a FANUC RS–232C device. Do not use this signal for any other purposes.

Do not connect two or more I/O units concurrently. Otherwise, the power rating of +24 V may be exceeded.

For the DNC operation that the CNC directly processes and for remote diagnosis, use the RS–232C interface (JD36A, JD36B) of the CNC.
Leave the (RES) pin open.
The conventional CNC punch panel cannot be used with this interface.

```
Cable connection
(Example)

      JD33                              Connector panel

        SD    11                    2   SD
        RD    1                     3   RD
        RS    15                    4   RS
        CS    5                     5   CS
        DR    3                     6   DR
        ER    13                   20   ER
        CD    7                     8   CD
        RI    9                    22   RI
        0V    2,12                  7   SG
                                   17   FG
                                 GND
```

Recommended cable material specification:
A66L–0001–0284#10P (#28AWG × 10 pairs)
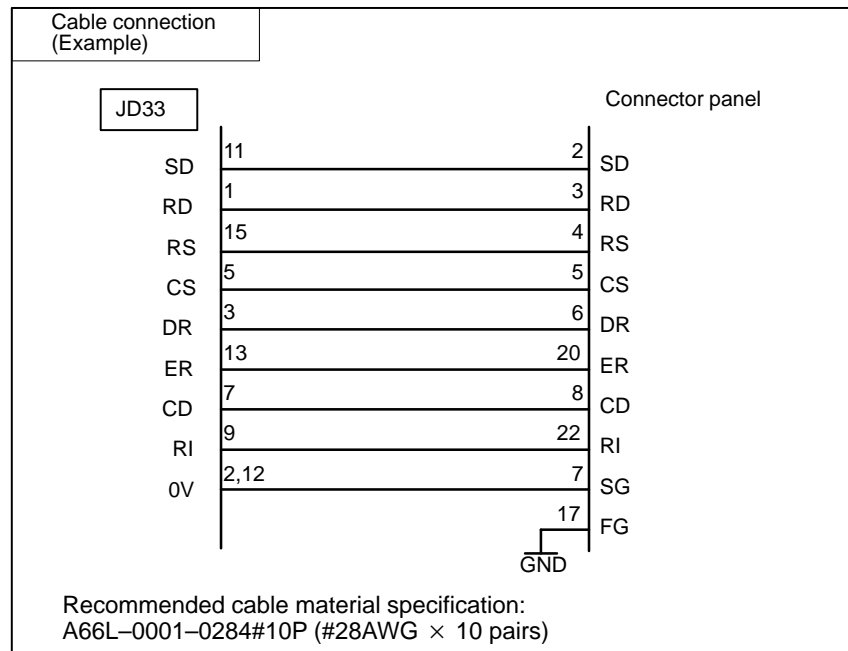
7.12.2
Connection of FDDs
(Floppy Disk Drives)
(Signal & Power)
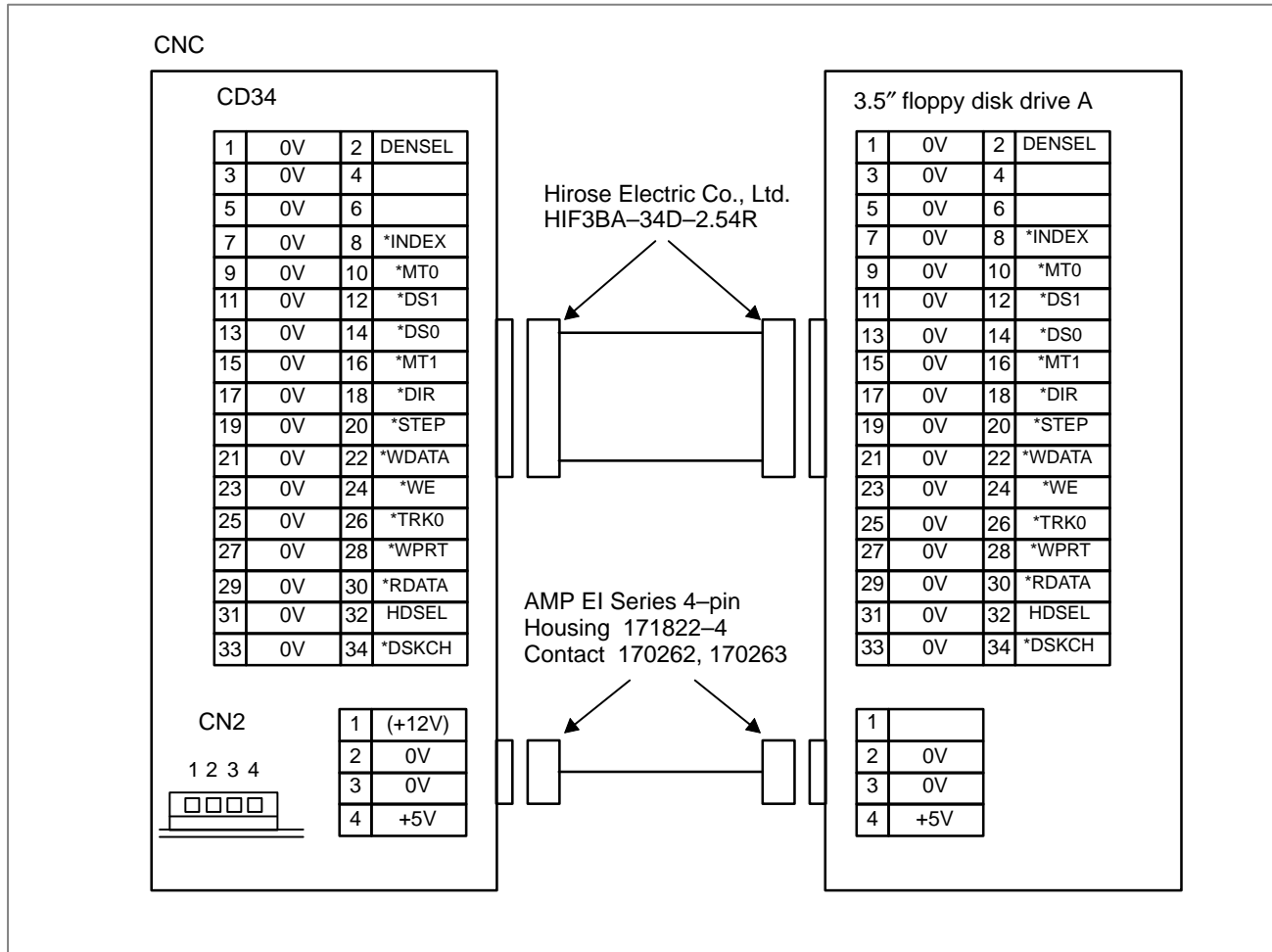
NOTE
1 This is an IBM PC–compatible standard interface. Particular care should be paid to the following points, however.
  (1)Only two modes (720K/1.44M bytes) can be used.
  (2)"DENSEL" is fixed to the low level.
  (3)A floppy disk drive which requires +12 VDC cannot be used.
2 Since many commercially available floppy disk drives perform differently with any one given personal computer, FANUC cannot guarantee all operations. Machine tool builders are requested to confirm the compatibility of each drive, and the operations that are supported. Also, be careful when using commercially available floppy disk drives because none offer dust–proof or drip–proof properties.
3 The FDD–side interface is merely an example. Each cable should be designed according to the interface of the actual drive to be used.

Floppy disk drive
cable connection

CNC (CD34)   Drive B   Drive A
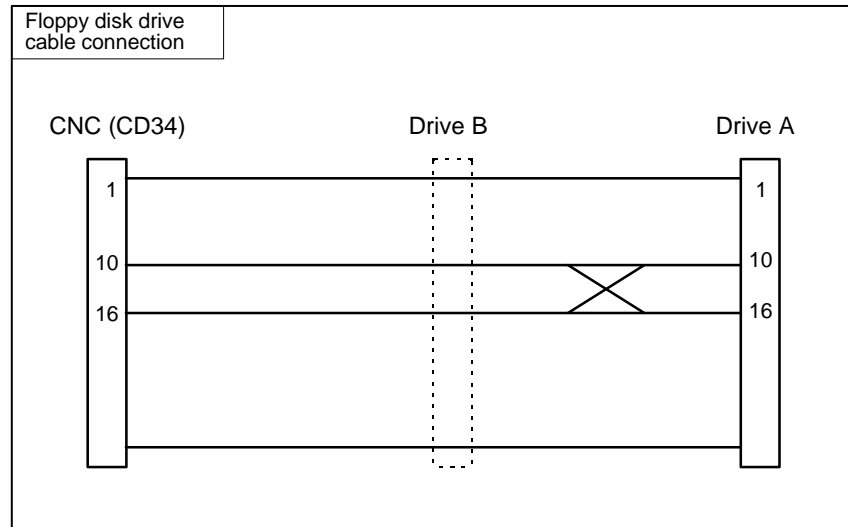
NOTE
This is the IBM PC standard interface. Commercially
available connecting cables feature wires for pins 10 to 16
that are twisted between the CNC and drive A, as shown in
the above figure. When using such a cable, set the "Drive
number setting pin" on drive A to "1" (second drive).

7.12.3
Connection to the
Full–Keyboard and
Mouse

CNC

Full keyboard

JD32A
(mini–DIN6)

1	CLOCK	11		
2	0V		12	+5V
3	DATA	13		

JD32B
(mini–DIN6)

1	CLOCK	11		
2	0V		12	+5V
3	DATA	13		

Mouse

Recommended full keyboard:
A86L–0001–0210 (101–key type)
A86L–0001–0211 (106–key type)
Recommended mouse:
A86L–0001–0212 (Standard PS/2 mouse)
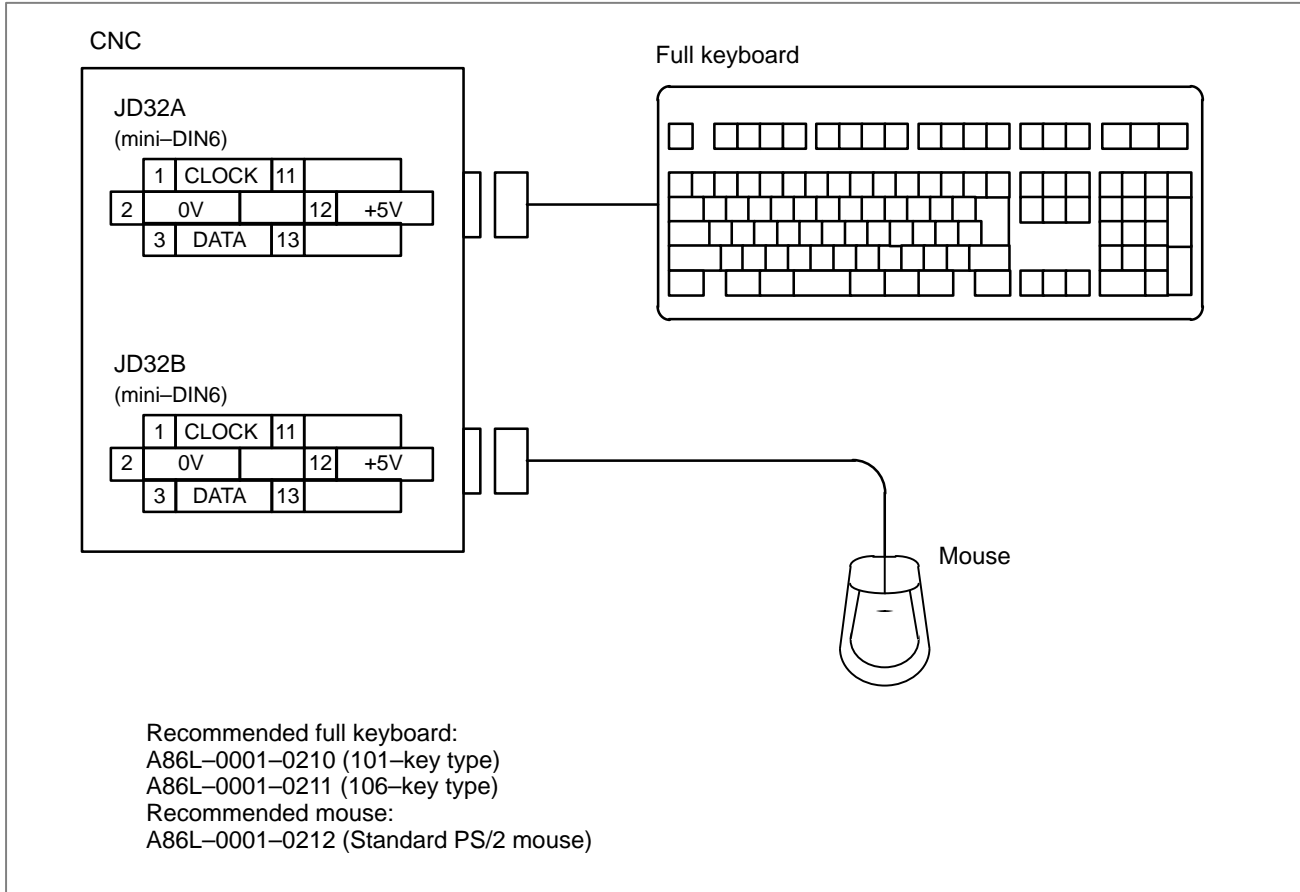
NOTE
This interface and the recommended devices are exclusively for applications development and maintenance. However, their use is possible only when the A02B–0236–C130#JC or A02B–0236–C130 EC FA full keyboard is used as the full keyboard.

7.12.4
Connection of HDD
(Hard Disk Drive)

Connection

The hard disk drive itself is installed at the rear of the FANUC MDI unit. The machine tool builder is requested to connect the cable from the hard disk drive to connector "CNH1" of the CNC control unit by applying the following procedure.
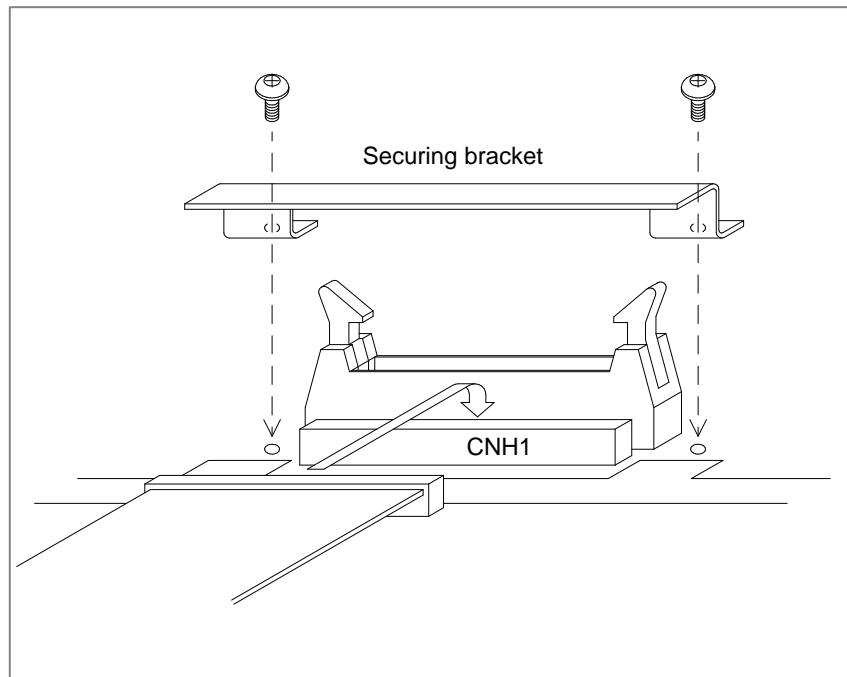
1. Remove the securing bracket from connector "CNH1". (Remove the two screws for this.)
2. Plug the cable from the hard disk drive into connector "CNH1" of the control unit.
3. Place the securing bracket on the connector and tighten the two screws.

7.12.5
Connection of the PC Interface Connector Panel Unit

Connection method

1. If the hard disk drive is connected to the control unit (CNH1), disconnect it.

2. Remove the screws (×2) from the control unit.

3. Plug the connector (CN1) of the cable from the PC interface connector panel unit into the connector (CNY1) of the control unit.

4. Tighten the screws (×2).
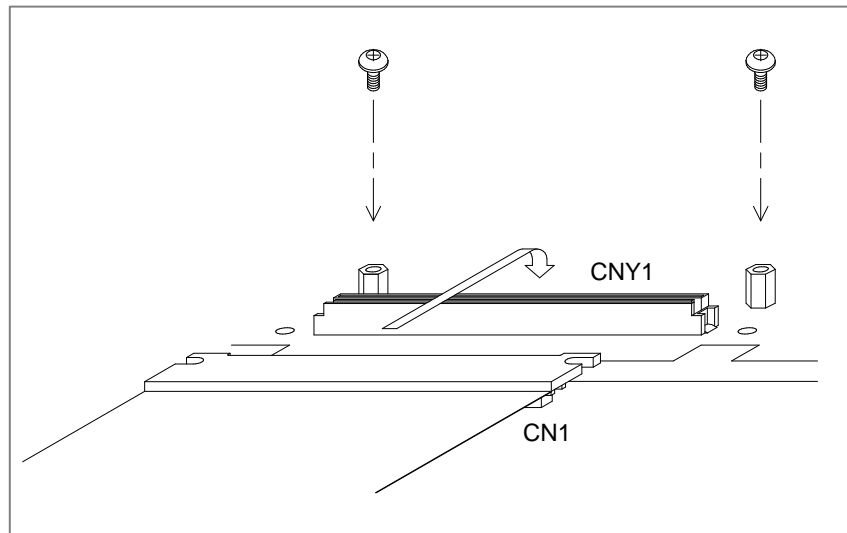
7.12.5.1
Centronics parallel port

PC interface connector panel unit

JD9
(PCR–E20MD)

1	STD0	11	*STB
2	STD1	12	0V
3	STD2	13	*AFD
4	STD3	14	0V
5	STD4	15	*INIT
6	STD5	16	0V
7	STD6	17	*SLIN
8	STD7	18	*ACK
9	PE	19	*ERROR
10	SLCT	20	BUSY

Example) Printer

1	*STB	19	0V
2	STD	20	0V
3	STD1	21	0V
4	STD2	22	0V
5	STD3	23	0V
6	STD5	24	0V
7	STD4	25	0V
8	STD6	26	0V
9	STD7	27	0V
10	*ACK	28	0V
11	BUSY	29	0V
12	PE	30	0V
13	SLCT	31	*INT
14	*AFD	32	*ERROR
15		33	0V
16	0V	34	
17	FG	35	
18		36	*SLIN

NOTE
1 The printer–side interface shown above is merely an example. Each cable should be designed according to the interface of the device which is connected to the PC interface connector panel unit.
2 Since many commercially available external devices, including printers, perform differently with any one given personal computer, FANUC cannot guarantee all operations. Machine tool builders are requested to confirm the compatibility of each drive, and the operations that areupported. Also, be careful when using commercially available external devices because none offer dust–proof or drip–proof properties.

7.12.5.2
Serial Port 2

PC interface connector panel unit   Example) Host computer

JD36F
(PCR–E20MD)

1	RD	11	SD
2	0V	12	0V
3	DR	13	ER
4	0V	14	0V
5	CS	15	RS
6	0V	16	0V
7	CD	17	
8	0V	18	(+5V)
9	RI	19	(+24V)
10	(+24V)	20	(+5V)

( ) :   For use by a
          FANUC I/O
          device

(DBM–25S)

1	FG		
2	SD	14	
3	RD	15	
4	RS	16	
5	CS	17	
6	DR	18	
7	SG	19	
8	CD	20	ER
9		21	
10		22	RI
11		23	
12		24	
13		25	
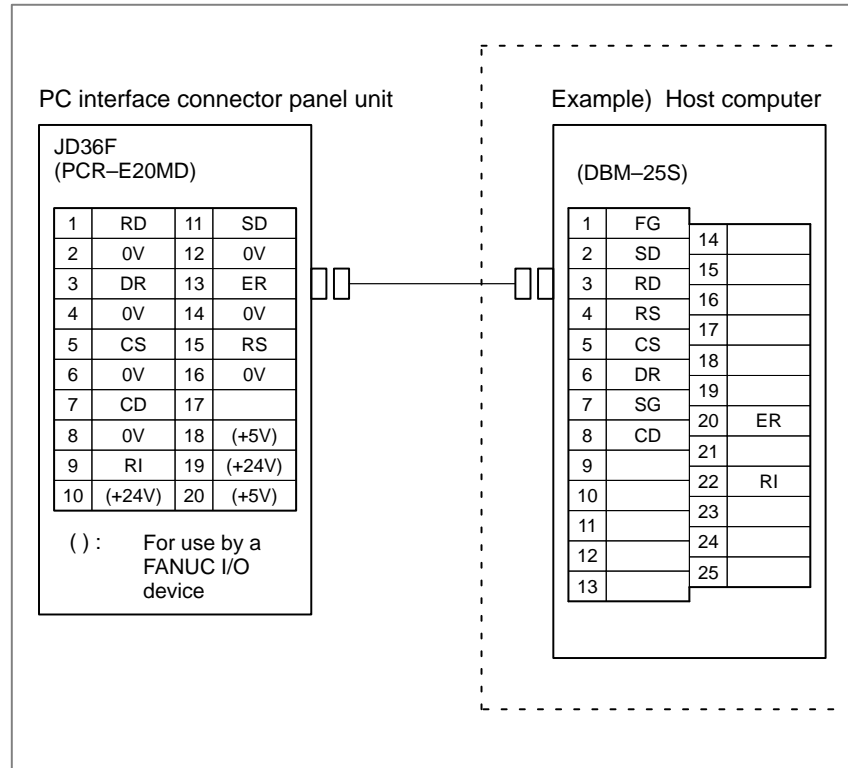
NOTE
1 The host computer–side interface shown above is merely
   an example. Each cable should be designed according to
   the interface of the actual device to be connected to the PC
   interface connector panel unit.
2 The +24–V power of the interface on the PC interface
   connector panel unit side in the above figure is exclusively
   for use by a FANUC I/O device (FANUC Cassette, FANUC
   Handy File, etc.). Do not use it for other purpose. Also, do
   not to connect more than one FANUC I/O device to a CNC
   control unit, as the rating of the +24–V power supply may be
   exceeded if more than one I/O device is used
   simultaneously.

7.12.6
ISA Expansion Units

7.12.6.1
Installation procedure

(1) Usable boards
Up to two ISA expansion boards, as shown below, can be used.

Rear face component height: No more than 3.81 mm

Front face component height: No more than 13.34 mm

Section held by anti–vibration bracket

94 mm to 115 mm

(A board whose dimensions fall outside the above range cannot be held by the anti–vibration bracket.)

127

No more than 170 mm

Unit: mm
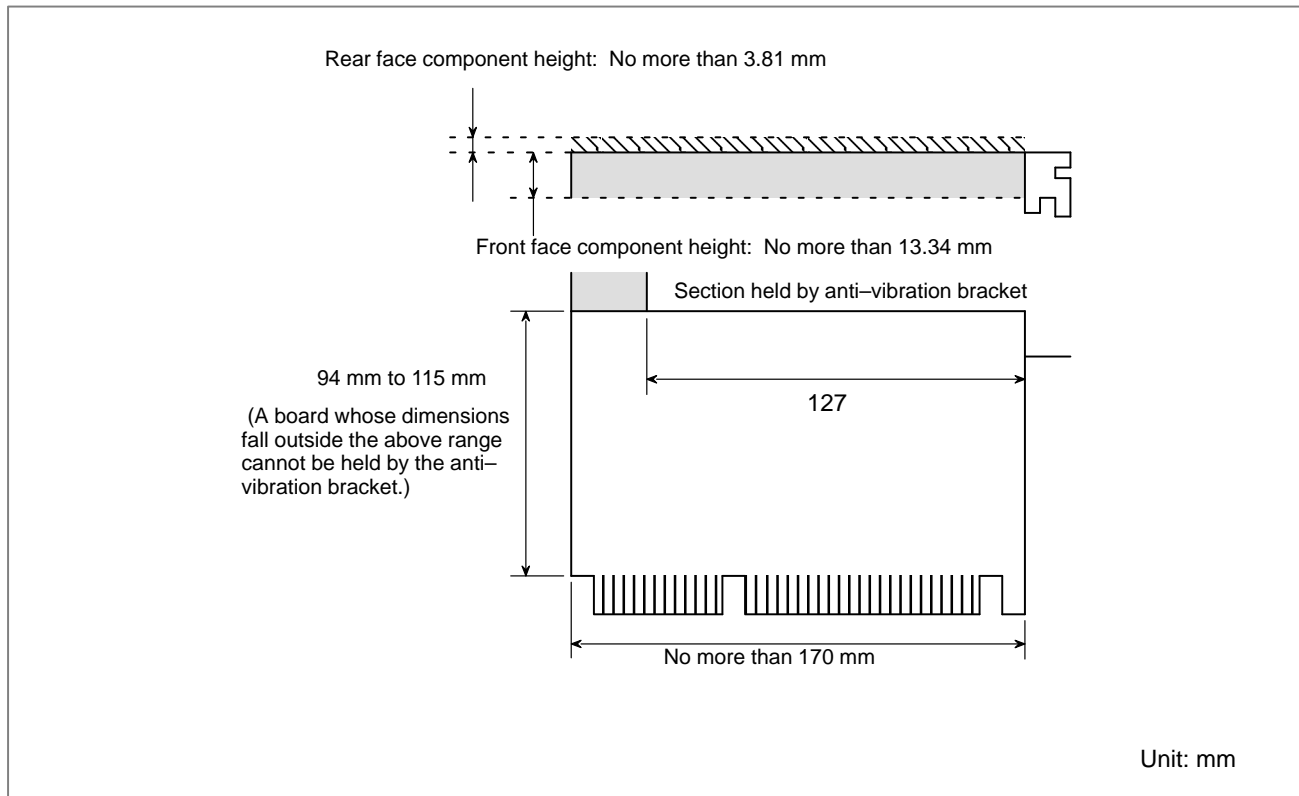
NOTE
FANUC does not guarantee the operation of, or provide maintenance for, commercially available ISA expansion boards.

(2) ISA expansion board installation procedure(See Fig. 7.12.6.1.)

(a) Remove the anti–vibration brackets.

(b) Insert each board into the connector. Push it fully home.

(c) Secure each board with the screw.

(d) Attach the anti–vibration bracket to each board by tightening screws while holding the bracket against the board.
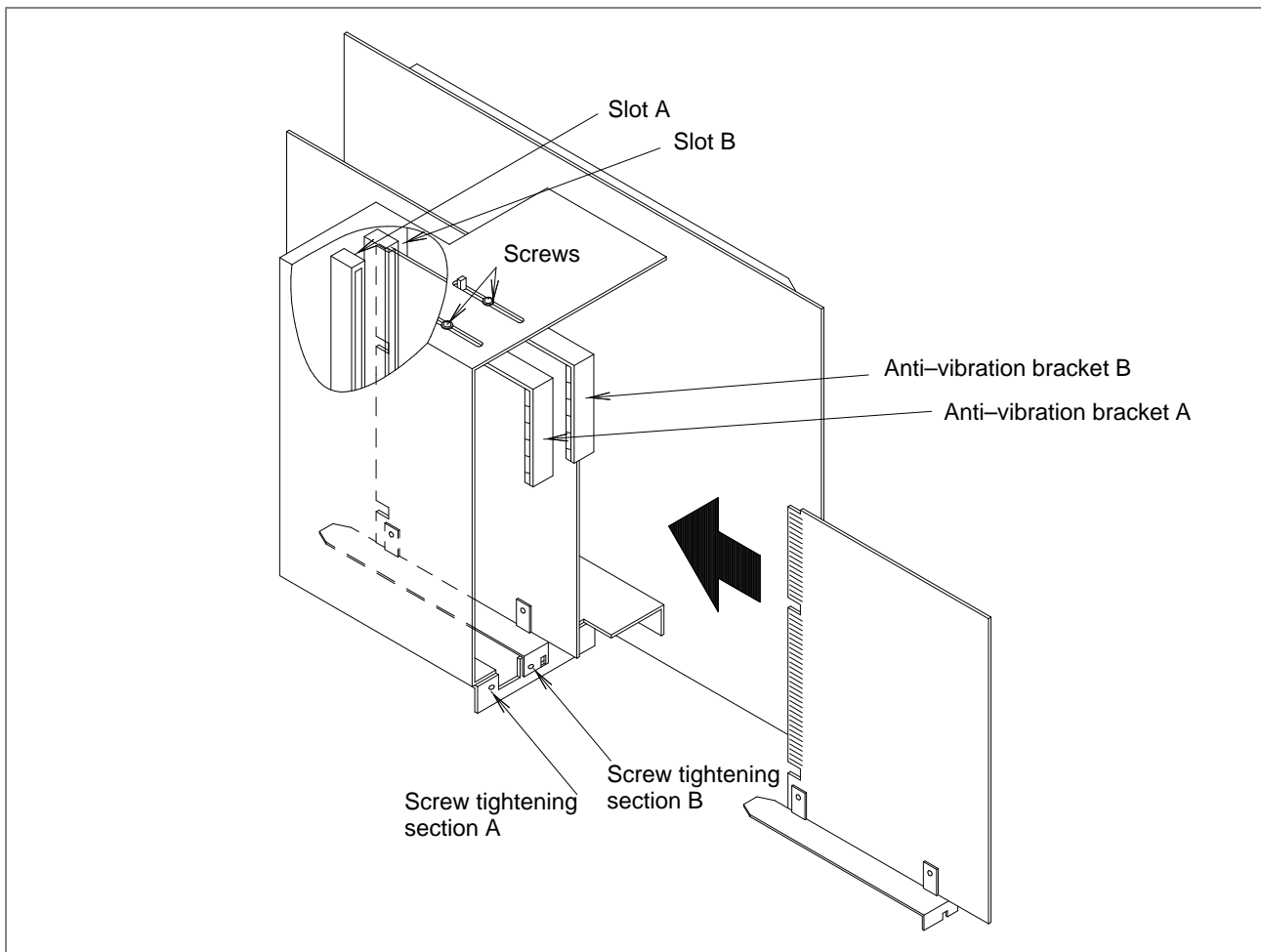
Fig. 7.12.6.1 Installing ISA expansion boards

**7.12.6.2
Operating precautions**

(1) Address map

- The memory space is identical to that of IBM PC–compatible personal computers. There is no special area used by Series 160*i*/180*i*.
- In the I/O space, addresses 280H to 28FH are used by the Series 160*i*/180*i*, such that they are not available for the ISA expansion boards.

  (These addresses can be changed, however. They can be set with a rotary switch on the PC interface connector panel unit.)

  Other areas in the I/O space are identical to an IBM PC–compatible personal computer.

The I/O addresses of Series 160*i*/180*i* are: LMN0H to LMNFH.
L, M and N are set as shown below when the unit is shipped from FANUC.
L = 0 (SW3)
M = 2 (SW2)
N = 8 (SW1)

SW3 (L)   SW2 (M)   SW1 (N)

(2) Interrupt, DMA request
- Of the IRQ signals, the following are not used by the Series 160*i*/180*i*.
  IRQ10, IRQ11
- Of the DRQ signals, the following is used by the Series 160*i*/180*i*
  DRQ2: Floppy disk drive.

(3) Installation and environmental conditions for ISA expansion boards
See 3.1. If, however, the specifications of the ISA expansion boards are inferior to those listed in 3.1, these conditions are restricted by those of the ISA expansion boards.

(4) Power supply to the ISA extension board
The table below lists the maximum power that can be supplied to the ISA extension board (total power for the two slots).

Voltage	Current
+5 V±10%	Up to 3.0 A
+12 V±10%	Up to 0.4 A
−12 V±10%	Up to 0.1 A
−5 V±10%	Up to 0.05 A

(5) Others
In addition to the cautions given above, normal operation may be impossible under any of the following conditions.
- When pull–up or pull–down processing has been applied to the ISA bus signals.
- When the refresh cycle of the ISA bus is in use.
  In addition to the above, note that further conditions may be added in the future.

APPENDIX

A EXTERNAL DIMENSIONS OF EACH UNIT

Name		Specifications	Fig. No.
Series 16*i*/18*i* control unit	7.2″ STN monochrome LCD	A02B–0236–B531, B532, B533	Fig. 1
	8.4″ TFT color LCD	A02B–0236–B–501, B502, B503	
	9.5″ STN monochrome LCD	A02B–0236–B541, B542, B543	Fig. 2
	10.4″ TFT color LCD	A02B–0236–B511, B512, B513, B521, B522, B523	
Series 160*i*/180*i* control unit	10.4″ TFT color LCD	A02B–0236–B551, B552, B553, B561, B562, B563, B571, B572, B573	
Separate–type small–size MDI unit	For 7.2″/8.4″	A02B–0236–C120#TBR, #MBR	Fig. 3
Separate–type standard MDI unit	For 7.2″/8.4″	A02B–0236–C121#TBR, #MBR	Fig. 4
	For 9.5″/10.4″	A02B–0236–C125#TBR, #MBR	Fig. 5
	For 9.5″/10.4″	A02B–0236–C126#TBR, #MBR	Fig. 6
	For 10.4″ (with PC)	A02B–0236–C127#TBR, #MBR	Fig. 7
FA full keyboard		A02B–0236–C130#EC, #JC	Fig. 8
Full keyboard (for debugging)		A86L–0001–0210, 0211	Fig. 9
Mouse (for debugging)		A86L–0001–0212	Fig. 10
High–speed serial bus interface board type 2 (for PC)		A20B–8100–0100	Fig. 11
Position coder	4000 rpm	A86L–0027–0001#102	Fig. 12
	6000 rpm	A86L–0027–0001#002	
Manual pulse generator		A860–0202–T001	Fig. 13
Pendant–type manual pulse generator		A860–0202–T004, T005, T006, T007, T010, T011, T012, T013	Fig. 14
Separate detector interface unit		A02B–0236–C201, C202	Fig. 15
ABS battery case for separate detector		A06B–6050–K060	Fig. 16
Tap unit for DNC1		A13B–0156–C100	Fig. 17
Terminal resistance unit for DNC1		A13B–0156–C200	Fig. 18
External CNC battery unit		A02B–0236–C281	Fig. 19
Punch panel (narrow type)	1 m	A02B–0236–C191	Fig. 20
	2 m	A02B–0236–C192	
	5 m	A02B–0236–C193	

Fig. 1 External dimensions of CNC control unit with 7.2″/8.4″ LCD

At the rear of the metal panel, the area within 8 mm of the outside edge is left unpainted.

Mounting hole diagram

M4 stud
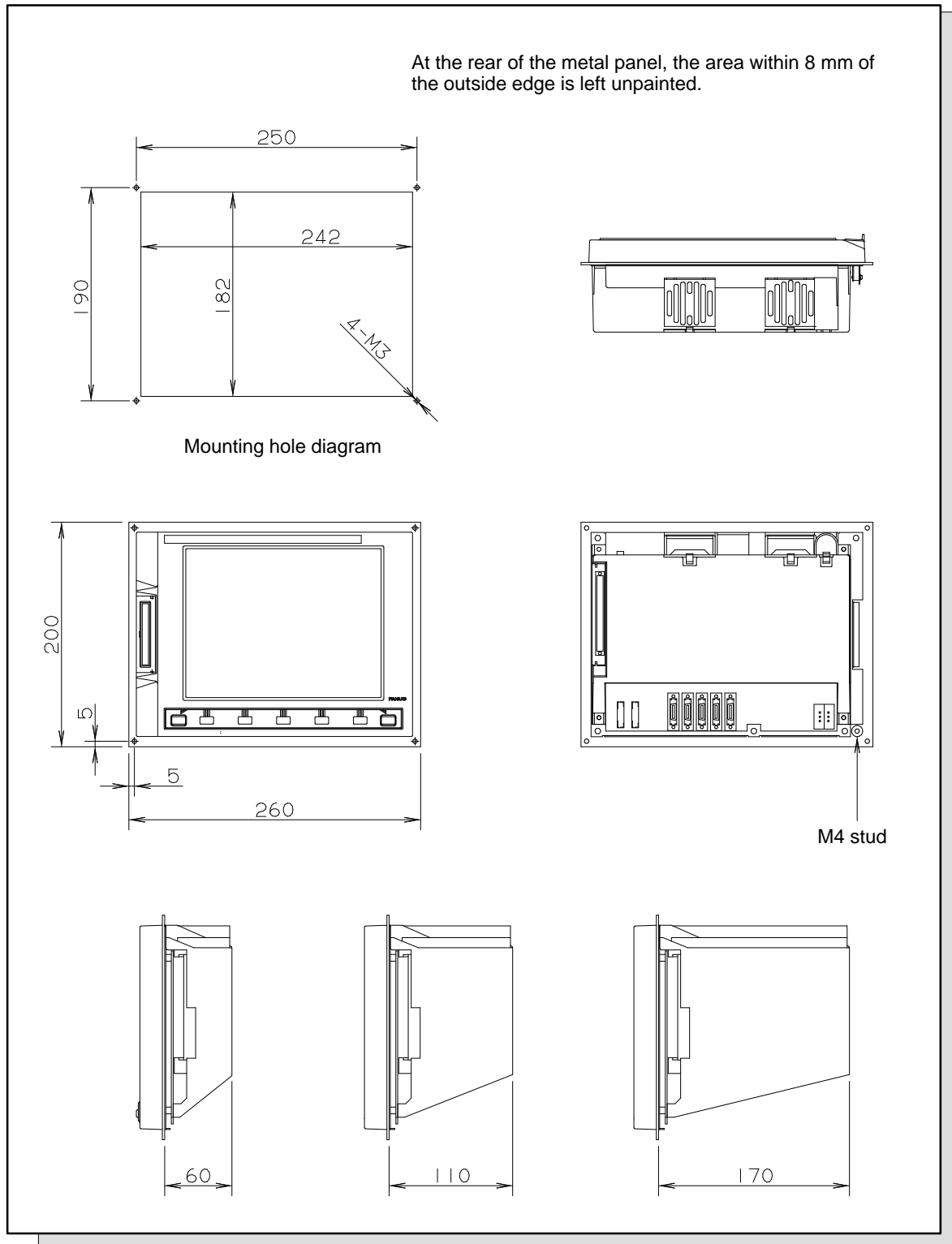
Fig. 2 External dimensions of CNC control unit with 9.5″/10.4″ LCD

At the rear of the metal panel, the area within 8 mm of the outside edge is left unpainted.

280

272

210

202

4–M3

Mounting hole diagram

220

5

5

290

M4 stud

60

110

170
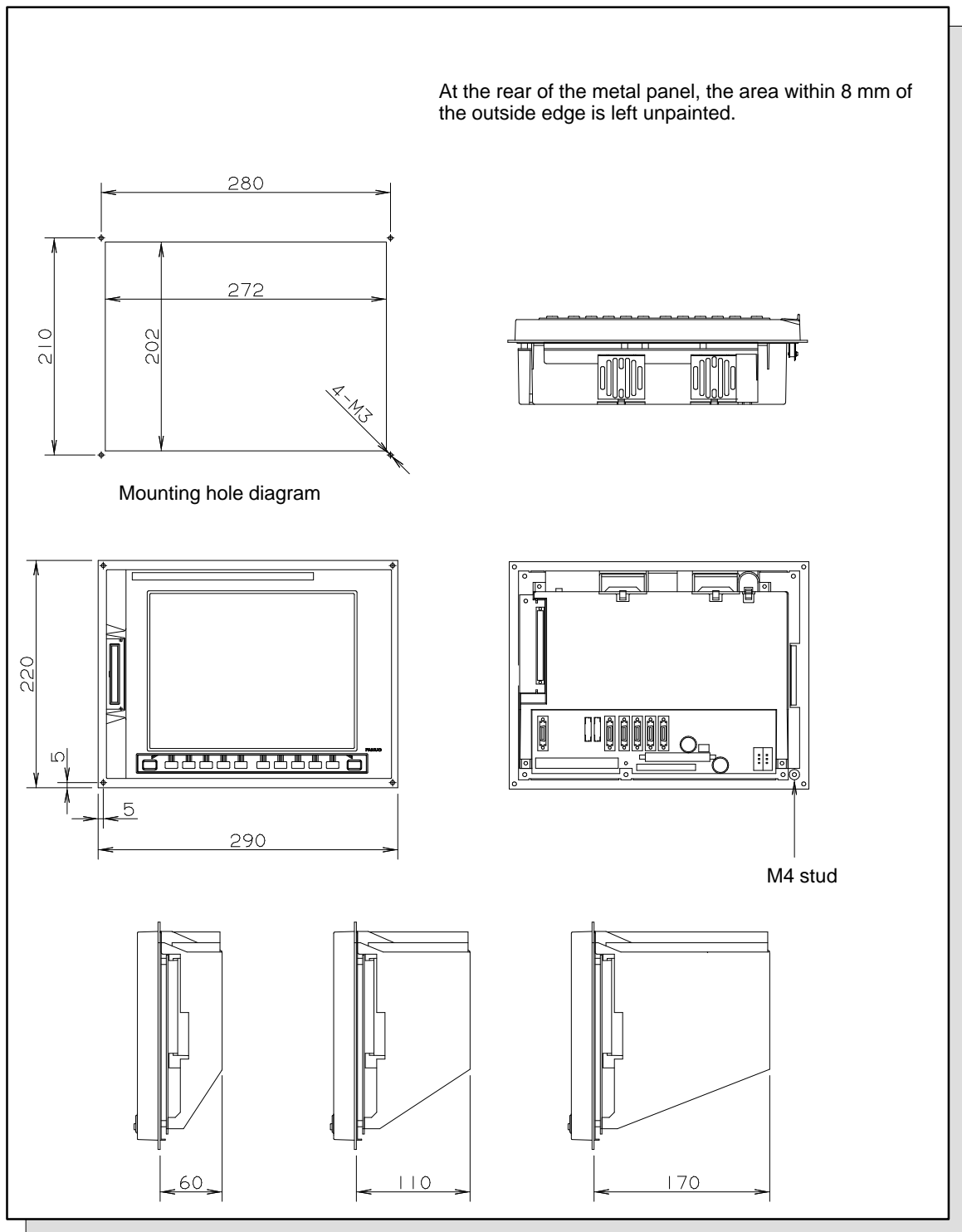
Fig. 3 External dimensions of separate–type small–size MDI unit

Mounting hole diagram

At the rear of the metal panel, the area within 8 mm of
the outside edge is left unpainted.

Fig. 4　External dimensions of separate–type standard MDI unit

At the rear of the metal panel, the area within 8 mm of the outside edge is left unpainted.
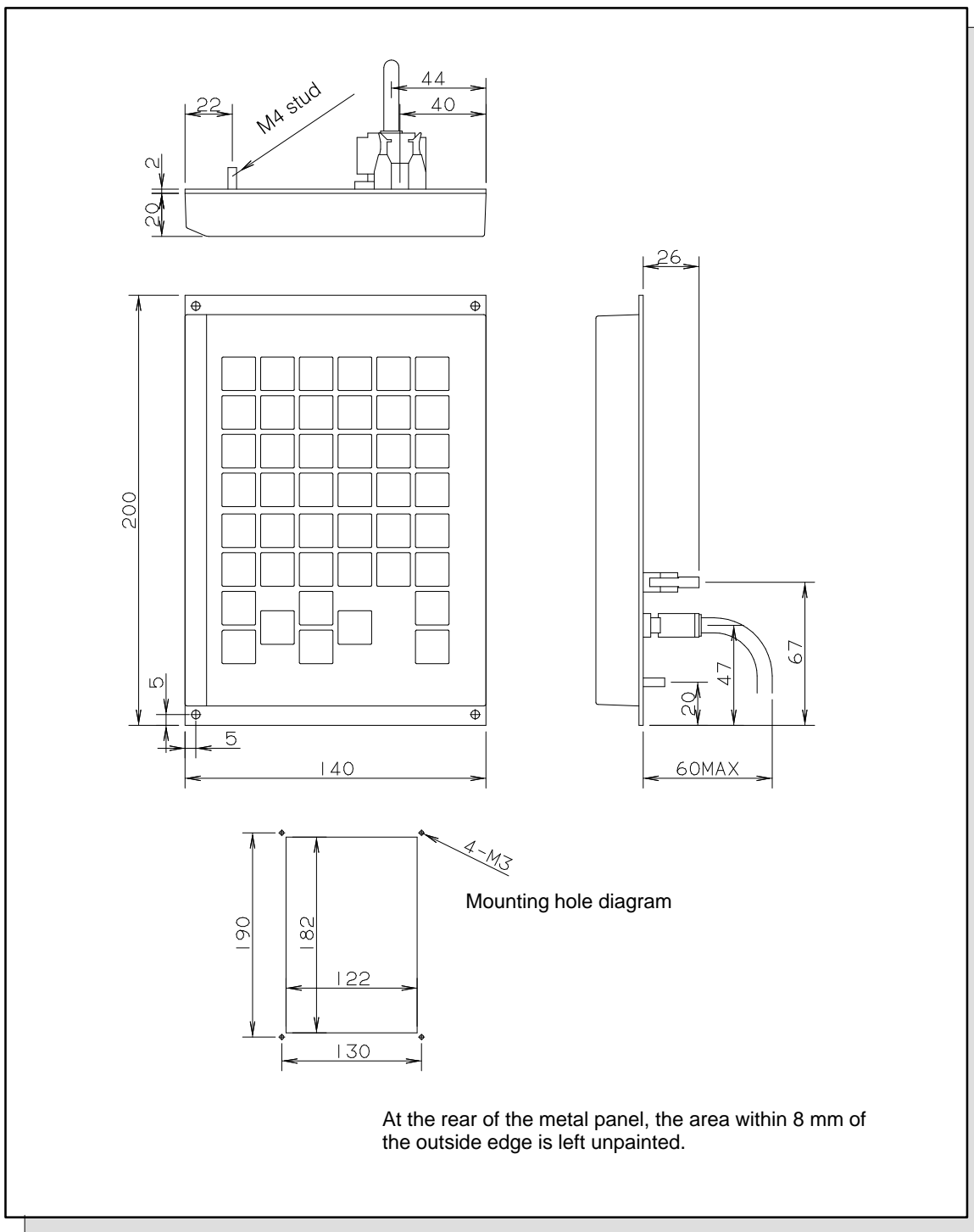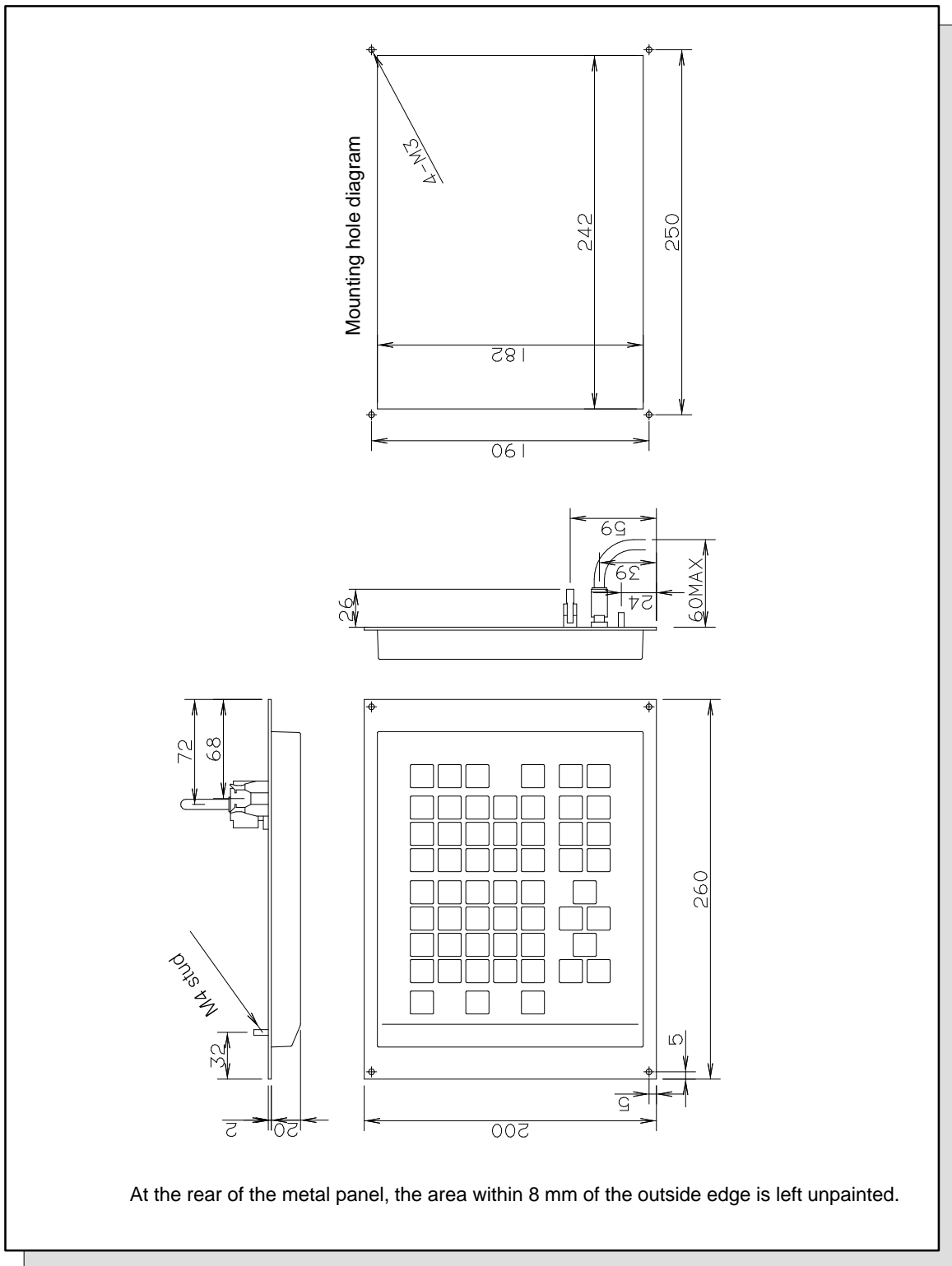
Fig. 5 External dimensions of separate–type standard MDI unit (horizontal type)

At the rear of the metal panel, the area within 8 mm of the outside edge is left unpainted.

Fig. 6 External dimensions of separate–type standard MDI unit (vertical type)

At the rear of the metal panel, the area within 8 mm of the outside edge is left unpainted.
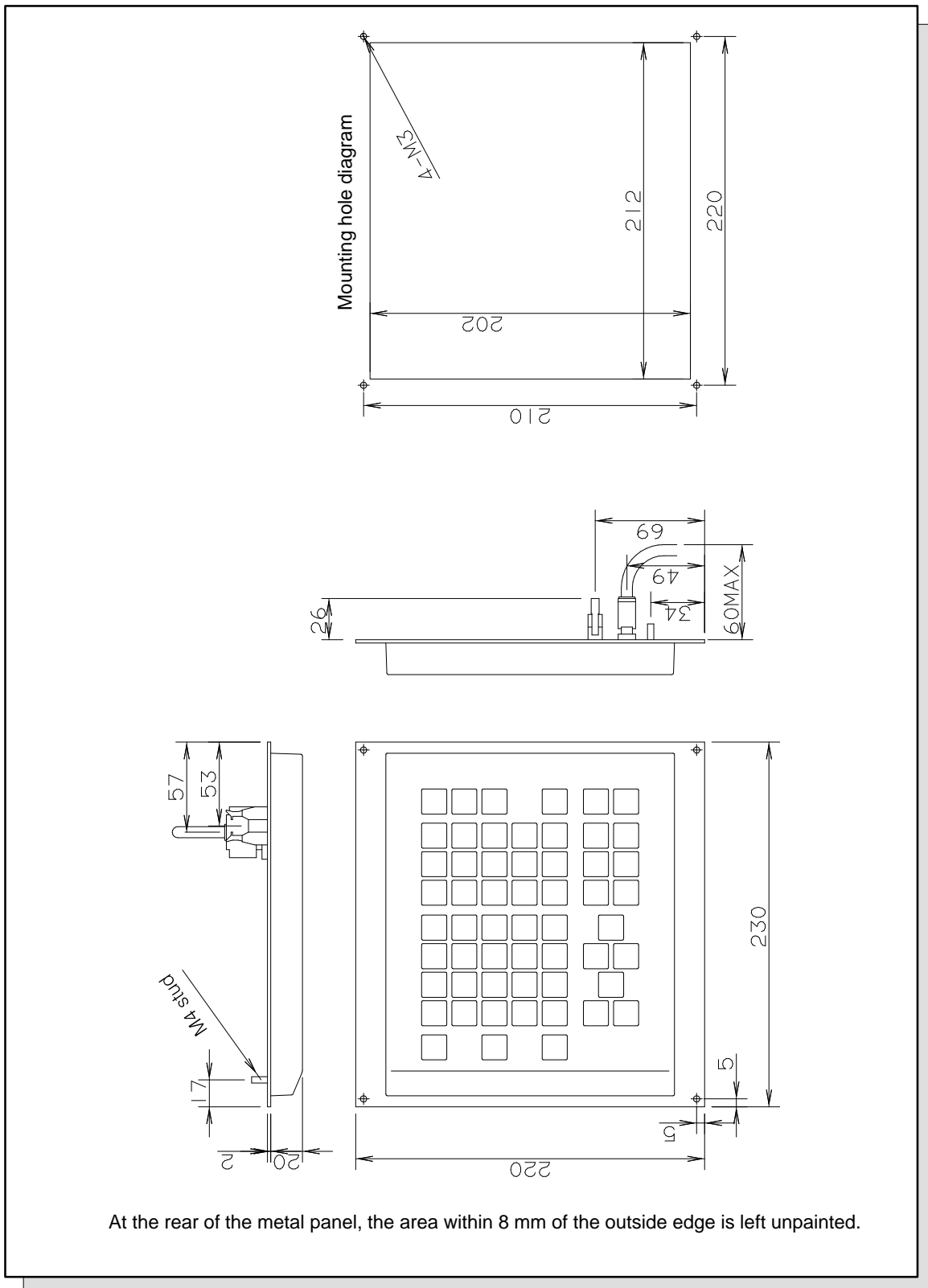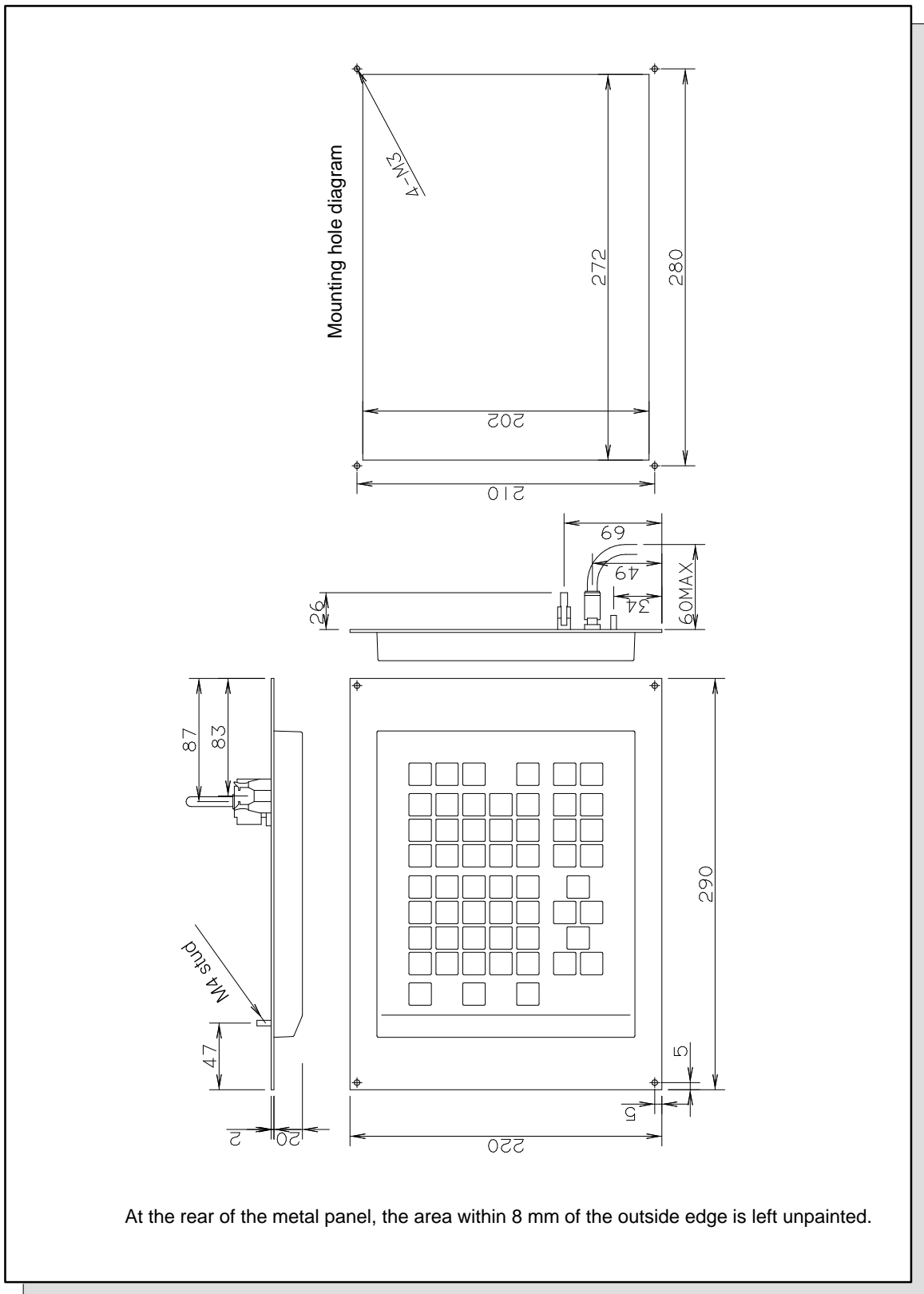
Fig. 7 External dimensions of separate–type standard MDI unit (vertical type) for 160*i*/180*i*

At the rear of the metal panel, the area within 8 mm of the outside edge is left unpainted.
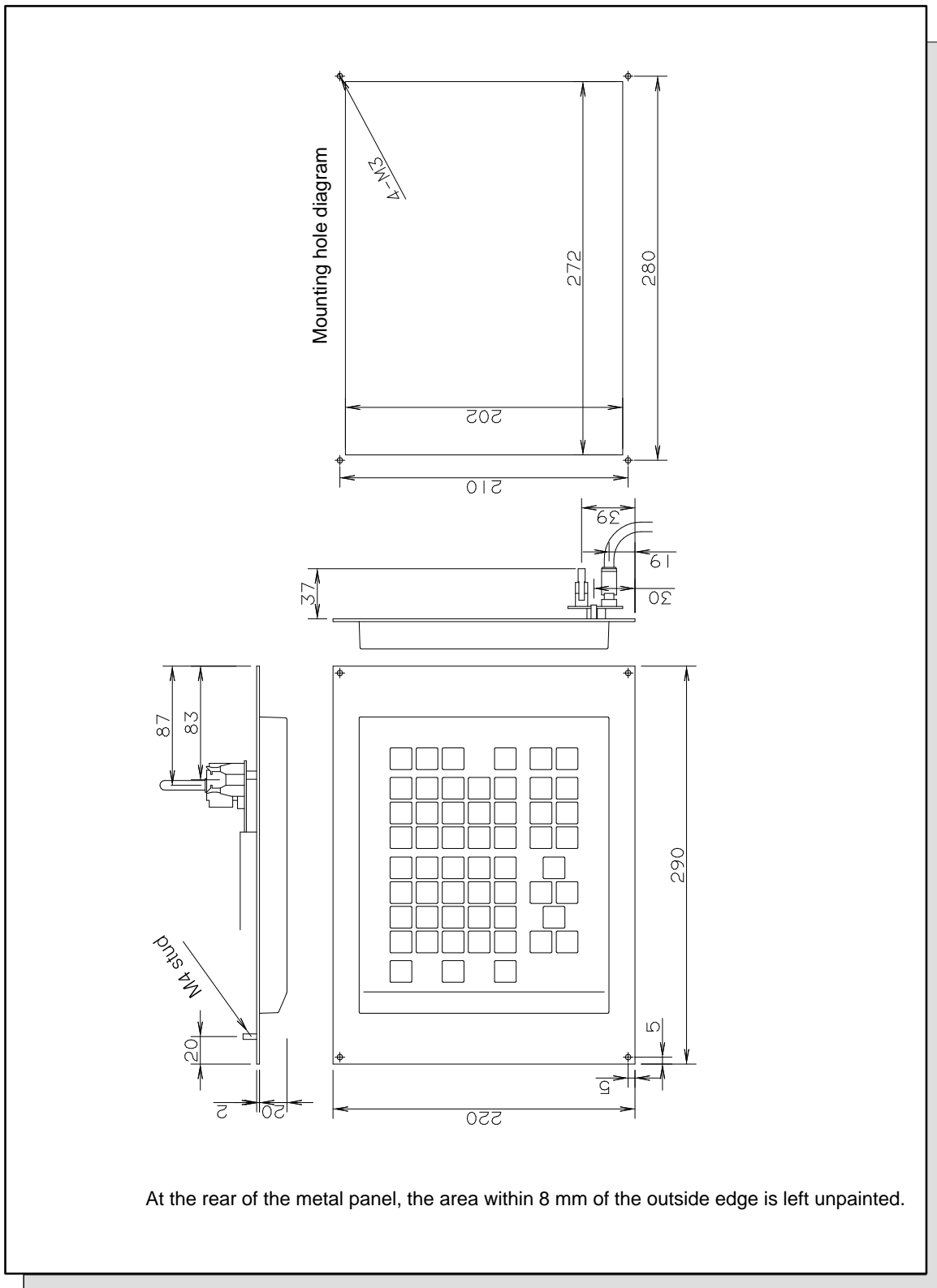
Fig. 8   External dimensions of FA full keyboard

Mounting hole diagram

272

280

4–M3

202

210

250

1550

30

20

290

5

5

20

M4 stud

220

At the rear of the metal panel, the area within 8 mm of the outside edge is left unpainted.
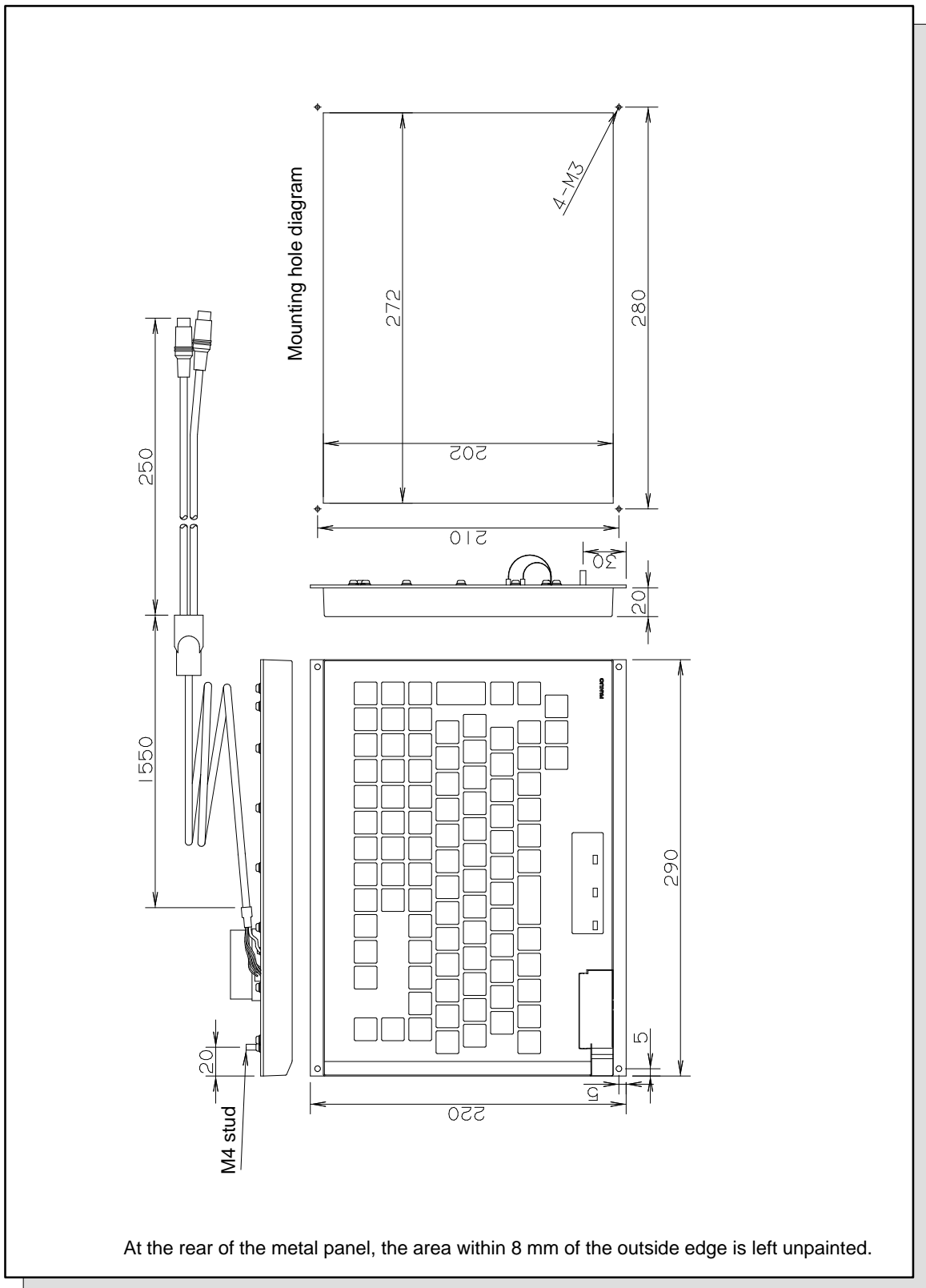
Fig. 9(a) External dimensions of 101–type full keyboard (English)

Specification No.: A86L–0001–0210
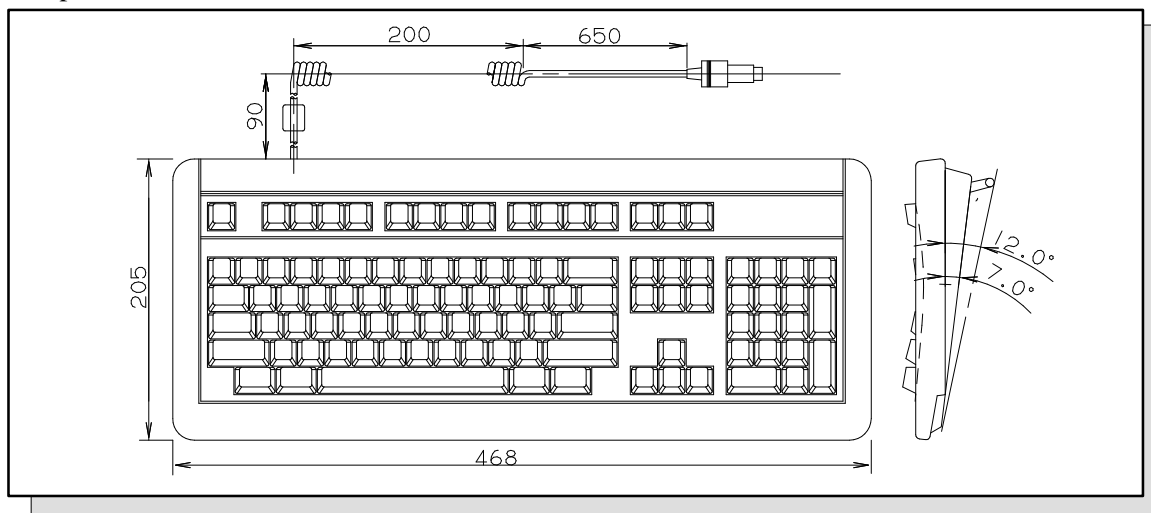
NOTE
> This keyboard is not dust–proof. It should be used for program development only. It can be used at temperatures of between 0 and 40°C.

Fig. 9(b) External dimensions of 106–type full keyboard (Japanese)

Specification No.: A86L–0001–0211
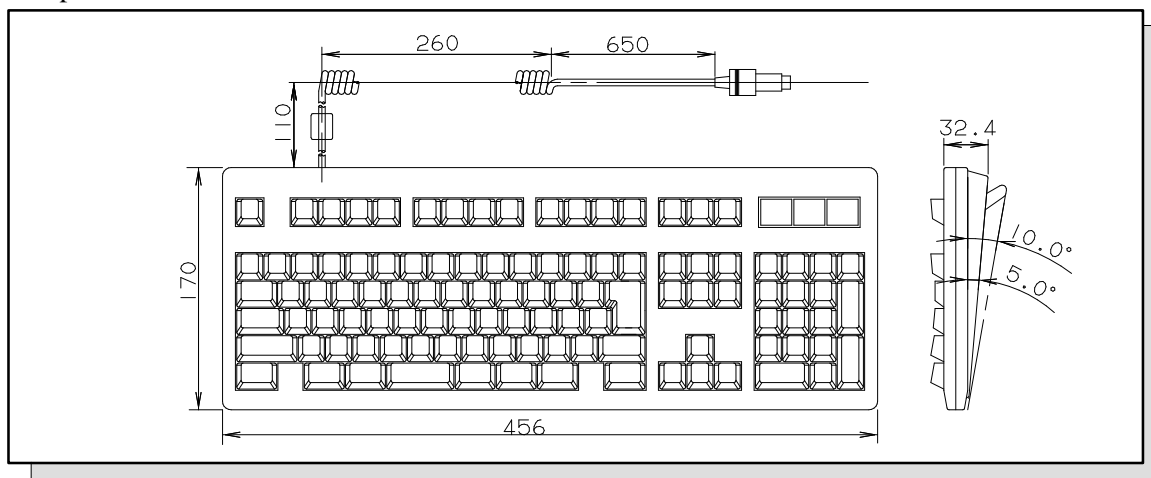
NOTE
> This keyboard is not dust–proof. It should be used for program development only. It can be used at temperatures of between 0 and 40°C.

Fig. 10 External dimensions of mouse

Specification No.: A86L–0001–0212

Unit : mm
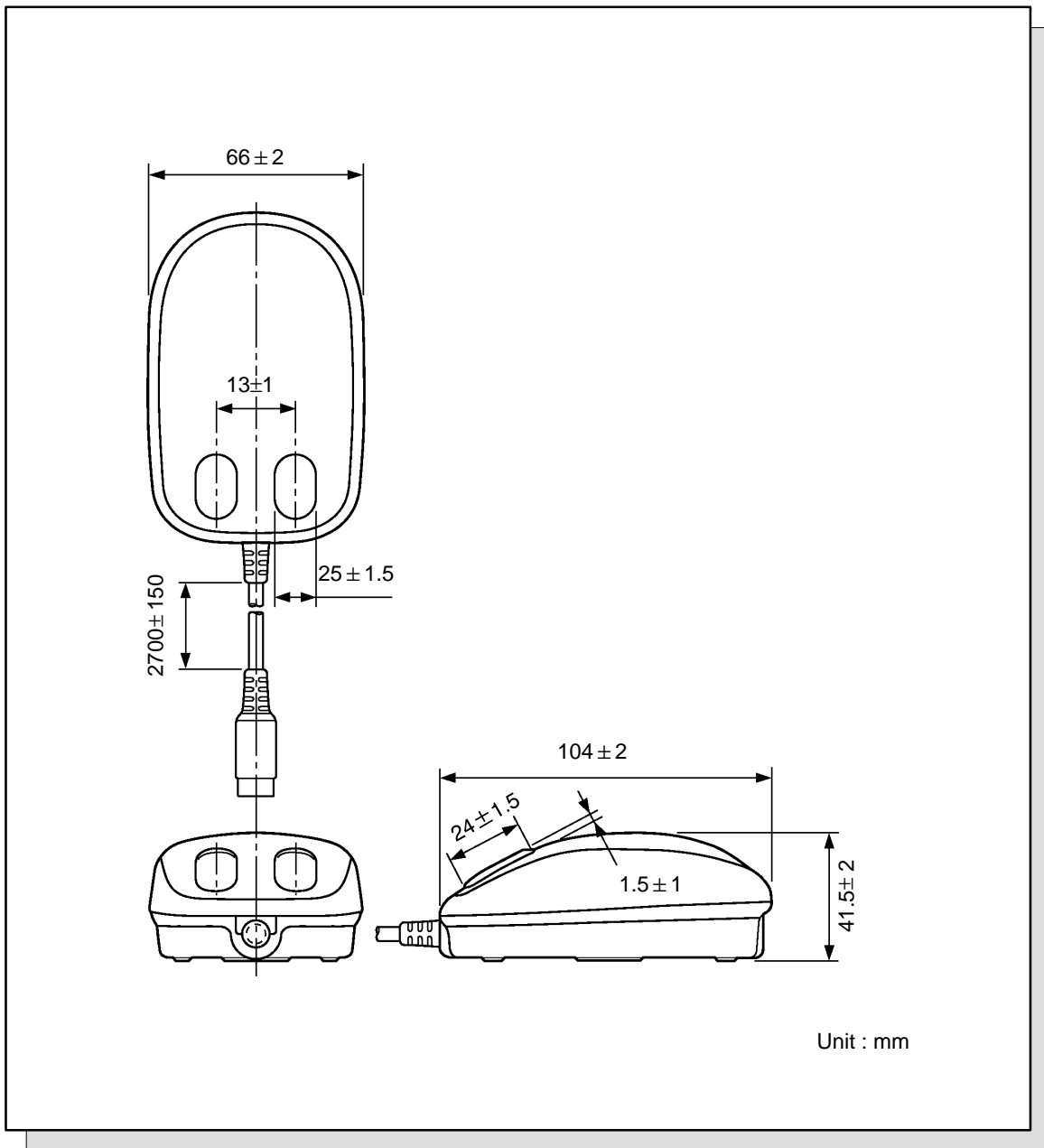
NOTE
This mouse is not dust–proof. It should be used for program development only. It can be used at temperatures of between 0 and 40°C. The mouse is fitted with a 2.7–m cable.

Fig. 11 External dimensions of high–speed serial bus interface board type 2 (for PC)

Specification No.: A20B–8100–0100
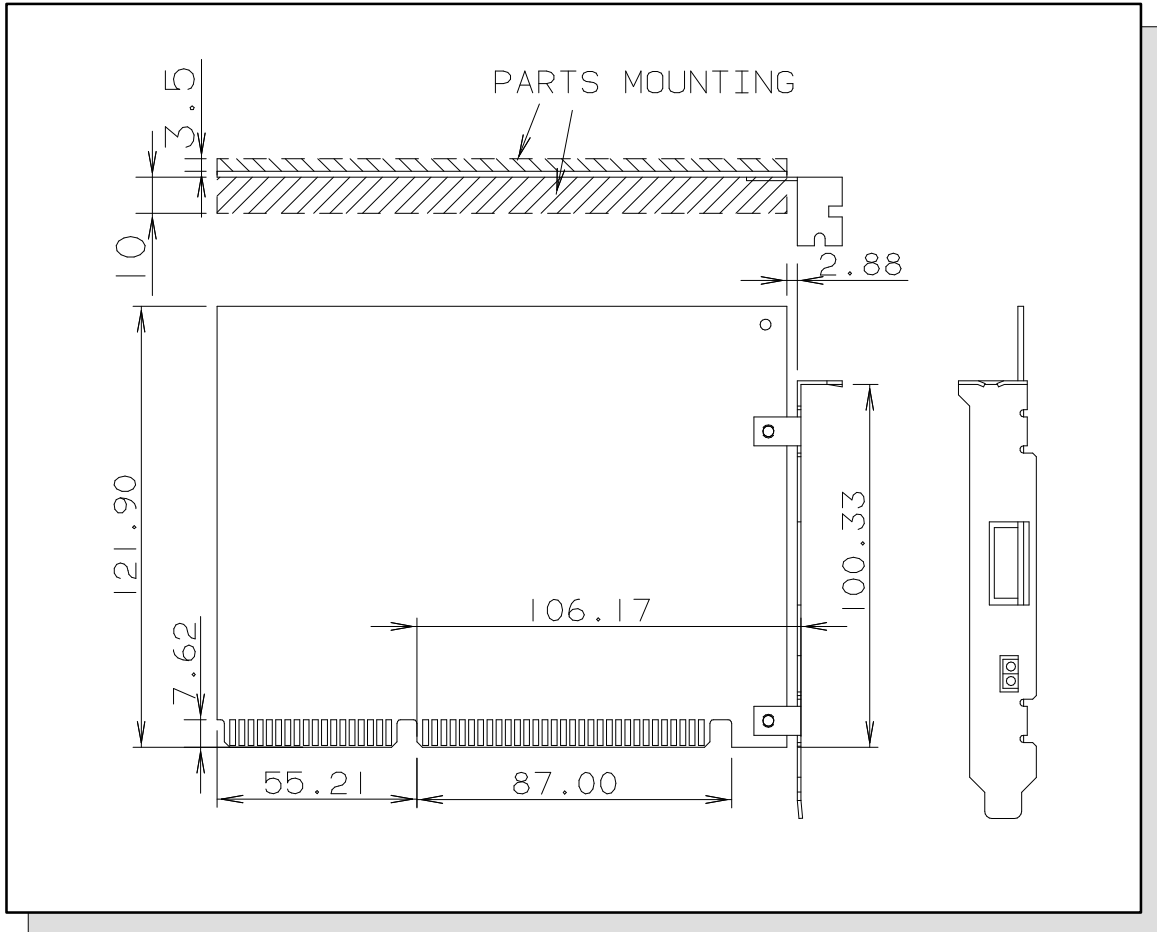
Fig. 12 Position coder

Specification No.: A86L–0026–0001#102 (Max. 4000rpm)
                    A86L–0026–0001#002 (Max. 6000rpm)

Note : Mechanical specifications of the position coder
are as follows :
(1) Input axis inertia
     1.0×10^{-3} kg·cm·sec^2 or less
(2) Input axis starting torque
     1000g·cm or less
(3) Input axis permissible loads

	Radial	Thrust
Operation	1kg or less	1kg or less
Idle	20kg or less	10kg or less

Attach a pulley directly to the position coder
shaft and drive the timing belt. Confirm that the
loads conform with the above allowable value.

(4) Weight :   1kg or less

Fig. 13 Manual pulse generator

Specification No.: A860–0202–T001

83.5
ϕ80.0
ϕ55.0
50.0
30.0
60.0
M4X8.0

3 holes equally spaced
on a 72 dia

120.0°

11.0

PULSE GENERATOR
FANUC LTD

0V   A 5VB

120.0°

M3 screw terminal
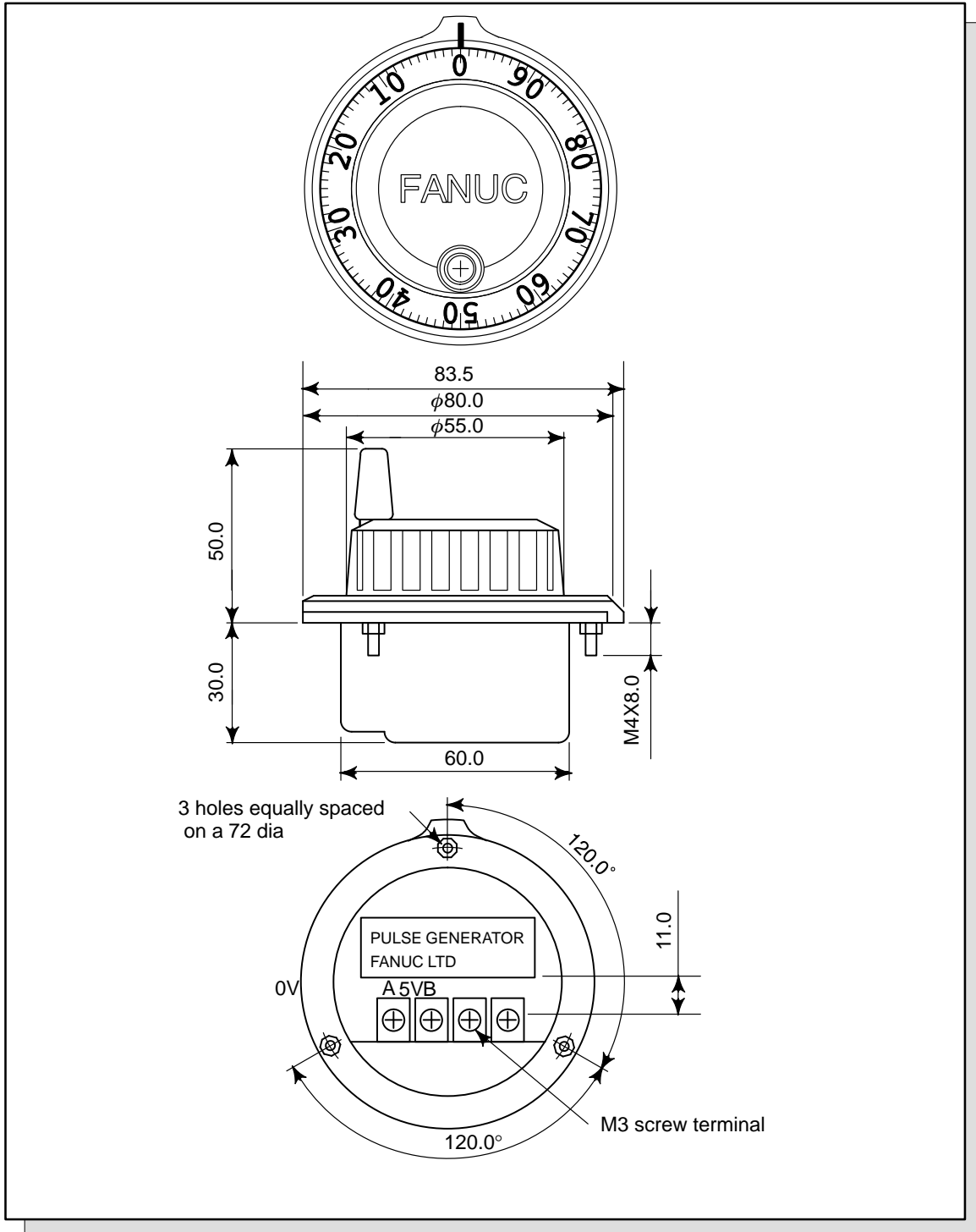
Fig. 14   Pendant type manual pulse generator

Specification No.:   A860–0202–T004 to T015
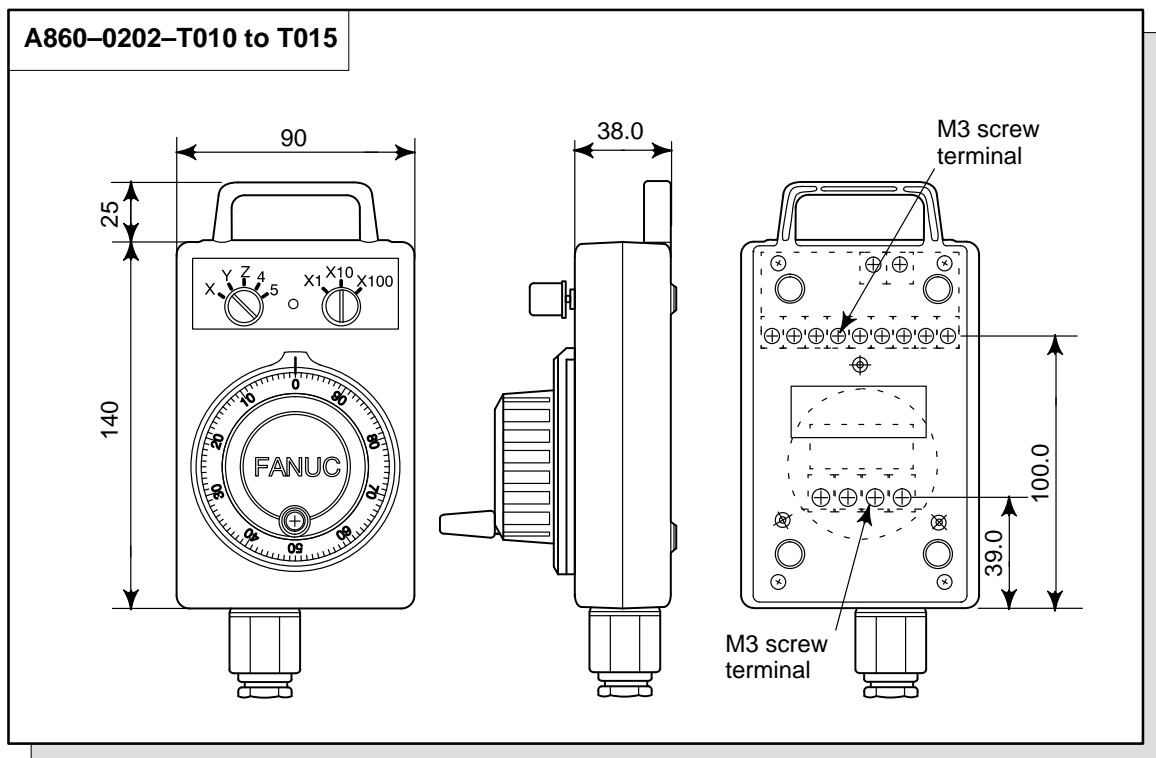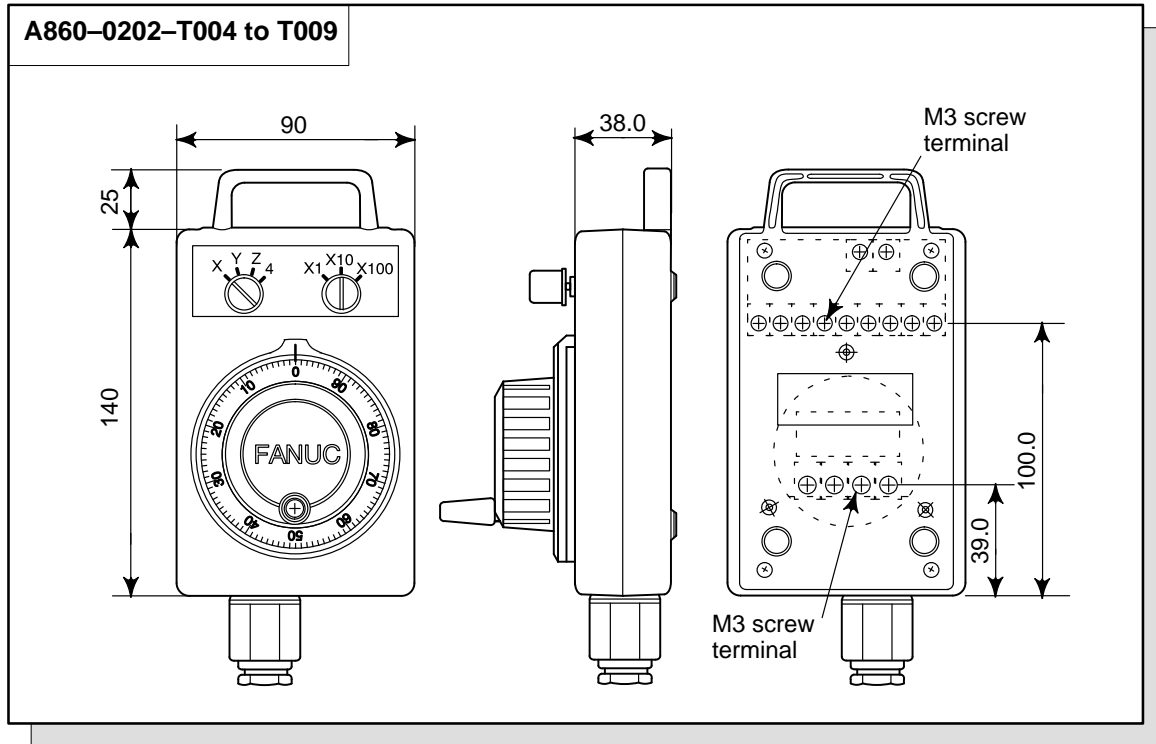
Fig. 15 External dimensions of separate detector interface unit
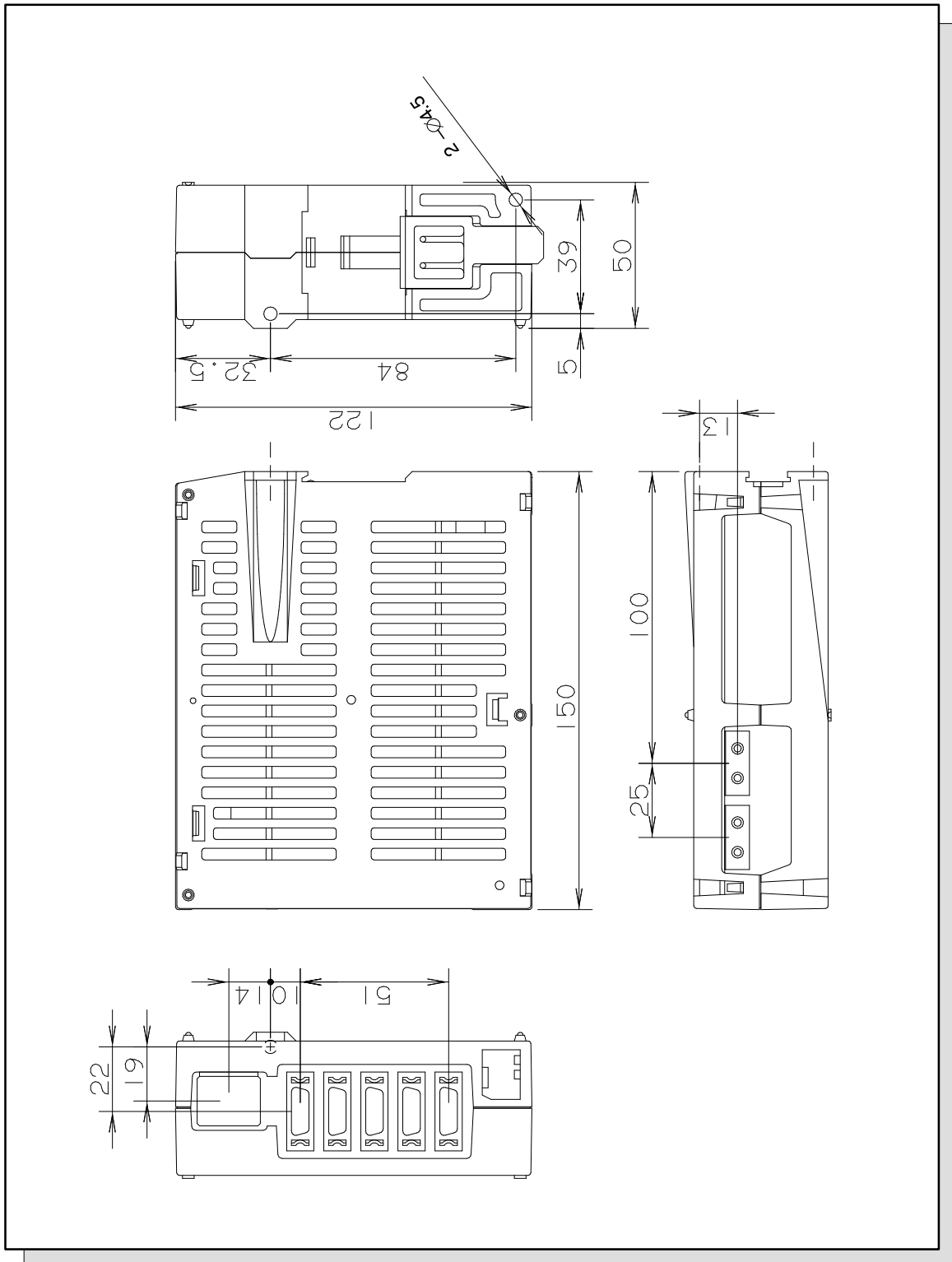
Fig. 16   Battery case for separate type absolute pulse coder

Specification No.: A06B–6050–K06
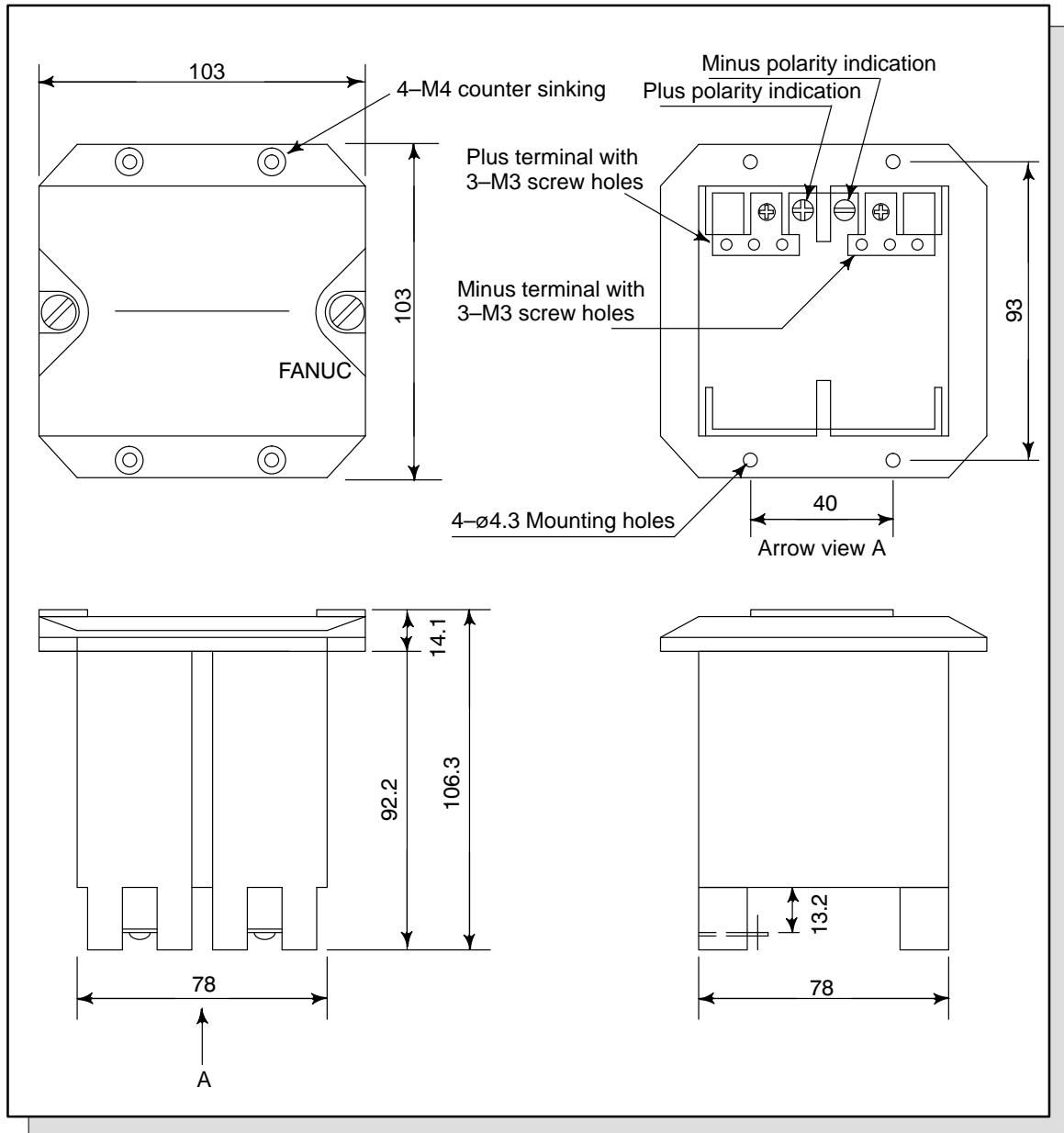
Fig. 17 External dimensions of tap
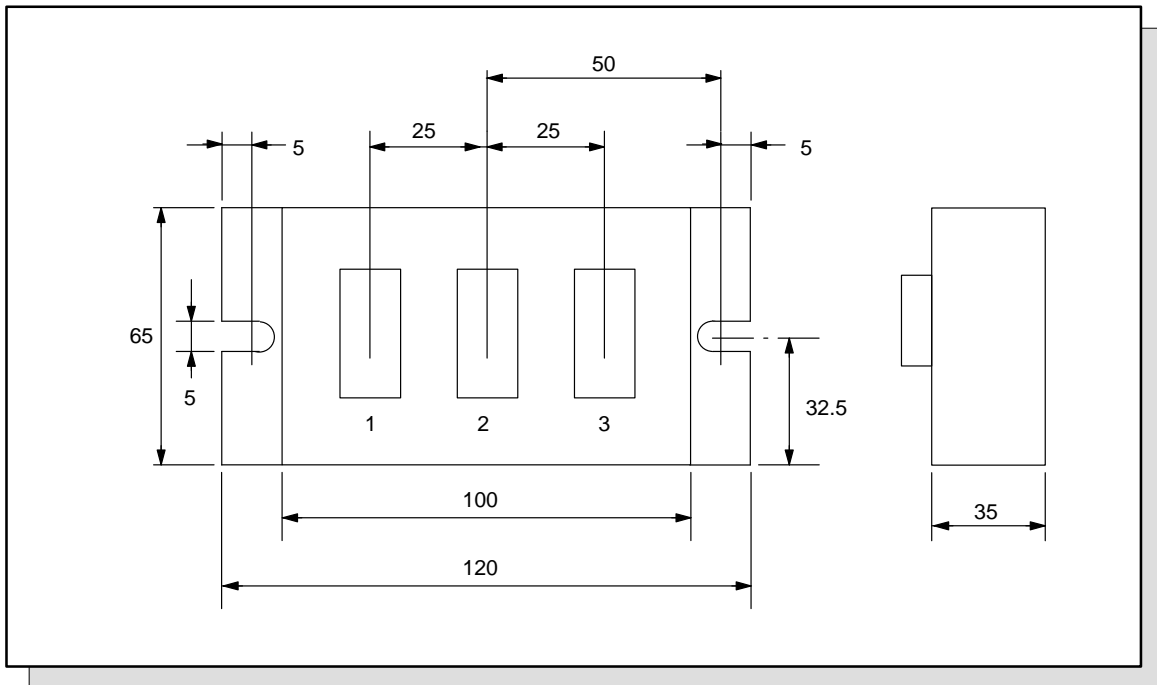
Fig. 18 External dimensions of terminal resistance unit
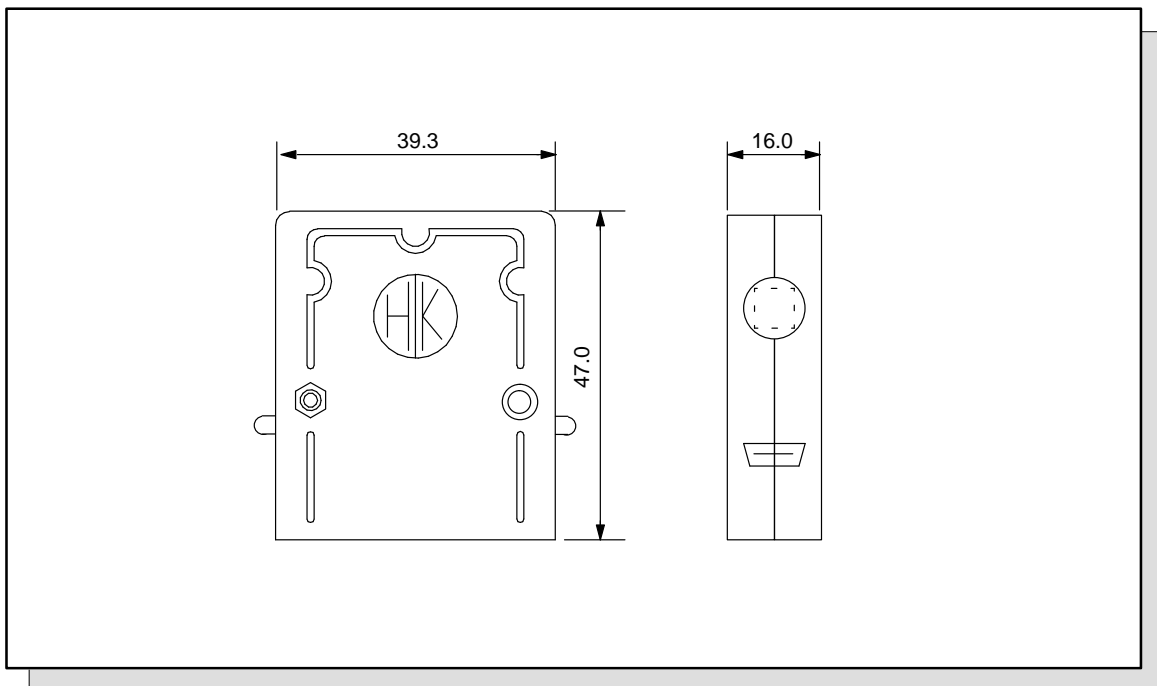
Fig. 19   External dimensions of external CNC battery unit

Cover

Main unit

103

5

13.5

47

115

70

M4 tap × 4

81

93

Mounting panel hole drilling

Mounting hole
(countersink)

FANUC

145

The battery unit is fitted with a 14–m battery cable.
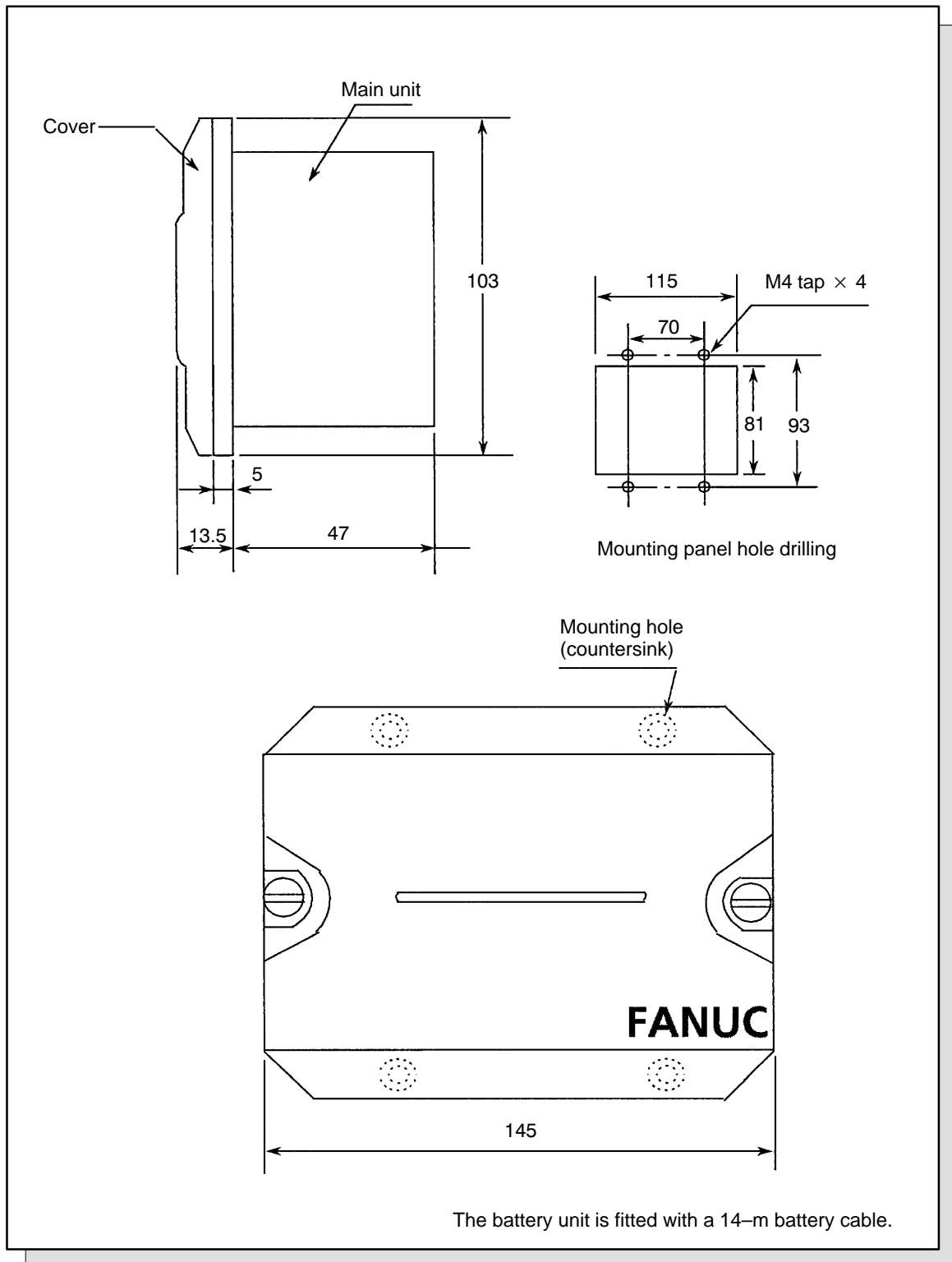
Fig. 20 External dimensions of punch panel (narrow type)

At the rear of the metal panel, the area within 8 mm of
the outside edge is left unpainted.

Mounting hole diagram
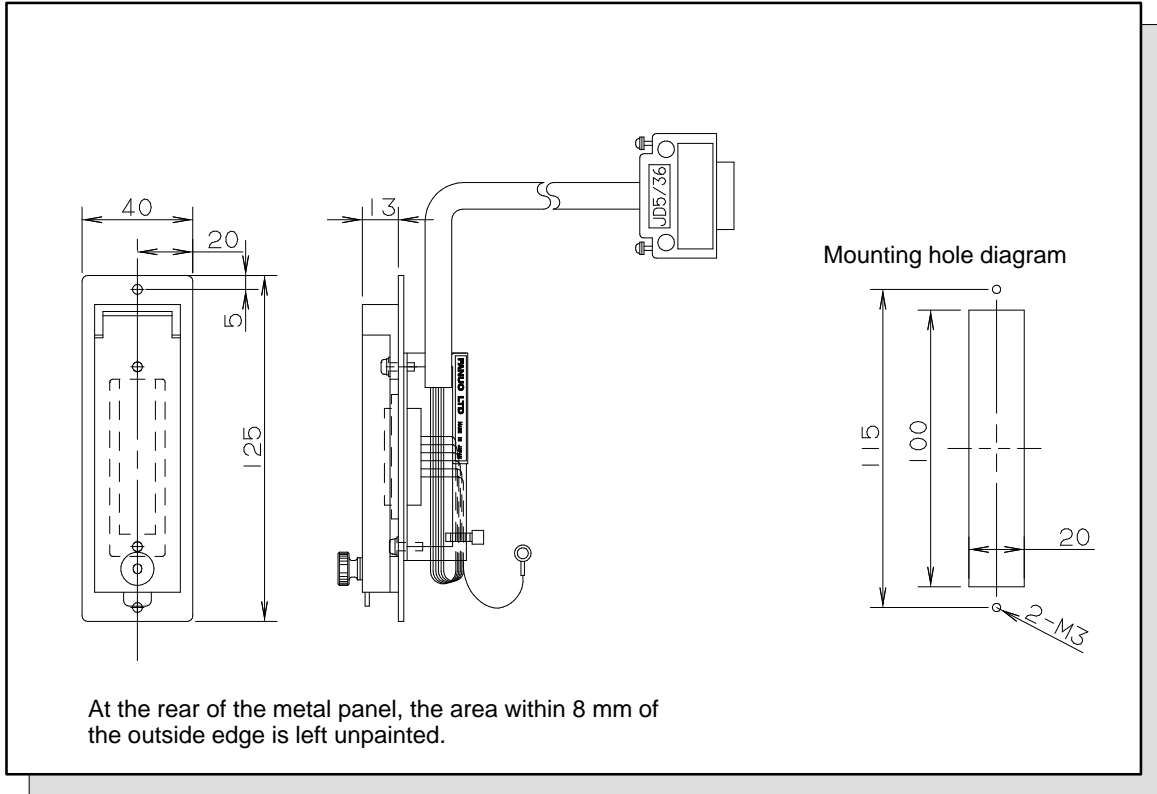
B EXTERNAL DIMENSIONS OF CONNECTORS

Fig. title	Specification No.	Fig. No.
PCR connector (soldering type)	PCR–E20FS	Fig. 1
FI40 connector	FI40–2015S	Fig.2
Connector case (HONDA PCR type)	PCR–V20LA, PCR–V20LB	Fig.3
Connector case (HIROSE FI type)	FI–20–CV	Fig.4
Connector case (FUJITSU FCN type)	FCN–240C20–Y/S	Fig.5
Connector case (HIROSE PCR type)	FI–20–CV7	Fig.6
AMP connector (1) for servo side	AMP1–178128–3	Fig.7
AMP connector (2) for servo side	AMP2–178128–3	Fig.8
AMP connector (3) for +24 V power supply	AMP1–178288–3	Fig.9
AMP connector (4) for +24 V power supply	AMP2–178288–3	Fig.10
Contact for AMP connector	AMP1–175218–2/5 AMP1–175196–2/5	Fig.11
HONDA connector (case)		Fig.12
HONDA connector (angled case)		Fig.13
HONDA connector (male)		Fig.14
HONDA connector (female)		Fig.15
HONDA connector (terminal layout)		Fig.16
Connector (Burndy Japan)(3 pins/brown)	SMS3PN–5	Fig.17
Connector (Japan Aviation Electronics) (for MDI)	LY10–DC20	Fig.18
Contact (Japan Aviation Electronics) (for MDI)	LY10–C2–5–1000	Fig.19
Punch panel connector for reader/punch interface		Fig.20
Locking plate for reader/punch interface connector		Fig.21
Connector for HIROSE flat cable	HIF3BB–50D–2.54R	Fig. 22

Fig. 1 PCR Connector (Soldering type)

TYPE : HONDA PCR–E20FS(SOLDERING TYPE)
USAGE : GENERAL
MATING : HONDA PCS–E20LA(METAL)
HOUSING : HONDA PCR–V20L(PLASTIC)

DIMENSION

	A	B
PCR−E20FS	21.65	11.43

Fig. 2 FI40 Connector

TYPE   : HIROSE FI40–2015S
USAGE   : PULSE CODER INTERFACE
                           LINEAR SCALE INTERFACE
                           MPG INTERFACE
MATING/HOUSING   : HIROSE FI–20–CV

DIMENSION

Note
This connector does not
have contacts for positions
11,13,15,17, and 19.

Tab for
shield
connection

Section AA
(Standard 1/10)

View from the back (soldering side)

Fig. 3 Connector case (Honda PCR type)

TYPE : HONDA PCR–V20LA (for 6 dia. cable)
USAGE : GENERAL PCR–V20LB (for 8 dia. cable)

DIMENSION

9.5

21

11.4

(1)

(2)

HONDA

37

30

(3) (6)

(5)

(4)

(1) (2) Case
(3) Cable clamp
(4) Lock bracket
(5) Lock lever
(6) Set screw for cable clamp

Fig. 4   Connector case (Hirose FI type)

TYPE   : HIROSE FI–20–CV
USAGE   : PULSE CODER INTERFACE
               LINEAR SCALE INTERFACE
               MPG INTERFACE

DIMENSION

(1) (2) Case
(3)   Cable clamp
(4)   Lock bracket
(5)   Lock lever
(6)   Set screw for cable clamp

Fig. 5 Connector case (Fujitsu FCN type)

TYPE   : FUJITSU FCN–240C20–Y/S(for 5.8 dia. cable)
USAGE   : GENERAL

9.5

21

11.4

(2)

E
C020–02

37

30

Cable clamp
Screw
Lock lever

Fig. 6 Connector case (PCR type (Hirose Electric))

Fig. 7 AMP Connector (1)

TYPE : AMP1–178128–3

USAGE : POWER SUPPLY UNIT 200VAC INPUT   CP1

3	G
2	S
1	R

■ Key location

POWER SUPPLY UNIT   CP2 CP3

3	G
2	200B
1	200A

10″LCD/MDI UNIT   CP11

3	G
2	200B
1	200A

DIMENSION

(25.5)

Circuit No.

X

22.8

16.3

19.24

10.16

5.08

3.1

4.05

6.55

0.6

7.15

Circuit No.

Fig. 8   AMP Connector (2)

TYPE   : AMP2–178129–6

USAGE   : POWER SUPPLY UNIT   CP4
                ON/OFF CONTROL

B3	FB	A3	COM
B2	FA	A2	OFF
B1	AL	A1	ON

DIMENSION

Circuit No.

Circuit No.

Fig. 9 AMP Connector (3)

TYPE   : AMP2–178288–3

USAGE   : POWER SUPPLY UNIT CP5
              +24V OUTPUT

3	
2	0V
1	+24

DIMENSION

Circuit No.

(22.96)

16.3

22.8

16.7

7.62

3.81

3.1

4.05

6.55

0.6

7.15

Circuit No.

Fig. 10   AMP Connector (4)

TYPE   : AMP1–178288–3

USAGE   : POWER SUPPLY UNIT CP6
                 +24E OUTPUT

3	
2	0V
1	+24E

DIMENSION

Circuit No.

(22.96)

22.8

16.3

16.7

7.62
3.81

0.6

3.1
4.05

6.55

7.15

Circuit No.

Fig. 11   Contact for AMP Connector

SEPARATE   : AMP1–175218–2(Gold coated)
                  AMP1–175218–5(Tin coated)

REEL   : AMP1–175196–2(Gold coated)
                  AMP1–175196–5(Tin coated)

WIRE   : AWG   16, 18, 20

Fig. 12   Honda connector (Case)

Specification	Symbol	A	(B)	C	(D)	Number of terminals
MR–20LMH (Plug)		39.3	44.9	39.8	17	20
MR–20LFH (Jack)						
MR–50LMH (Plug)		67.9	73.5	44.8	18	50
MR–50LFH (Jack)						

Symbol	Name
1	Connector cover
2	Cable clamp
3	Stopper
4	Screw for cable clamp
5	Plug (MR–20, 50MH)
	Jack (MR–20, 50FH)

Outer diameter of the cable
 MR–20L dia.10mm max
 MR–50L dia.16mm max

Fig. 13 Honda connector (angled–type case)

External dimensions of 50–pin connector

Fig. 14   Honda connector (Female)

	A	B	Number of terminals
MR–20RMH	32.8	27.8	20
MR–50RHF	61.4	56.4	50

Symbol	Name
1	Cable clamp
2	Screw 2.6dia.×8
3	Connector (MR–20,–50FH)

Fig. 15 Honda connector (Male)

	A	B	Number of terminals
MR–20RMH	32.8	27.8	20
MR–50RMH	61.4	56.4	50

Symbol	Name
1	Cable clamp
2	Screw 2.6dia.×8
3	Connector (MR–20,–50FH)

Fig. 16   Honda connector (Terminal layput)

● **MR–50MH (50–core, plug)**

● **MR–50MH(50–core, jack)**

● **MR–20MH(20–core, plug)**

● **MR–20MH(20–core, jack)**
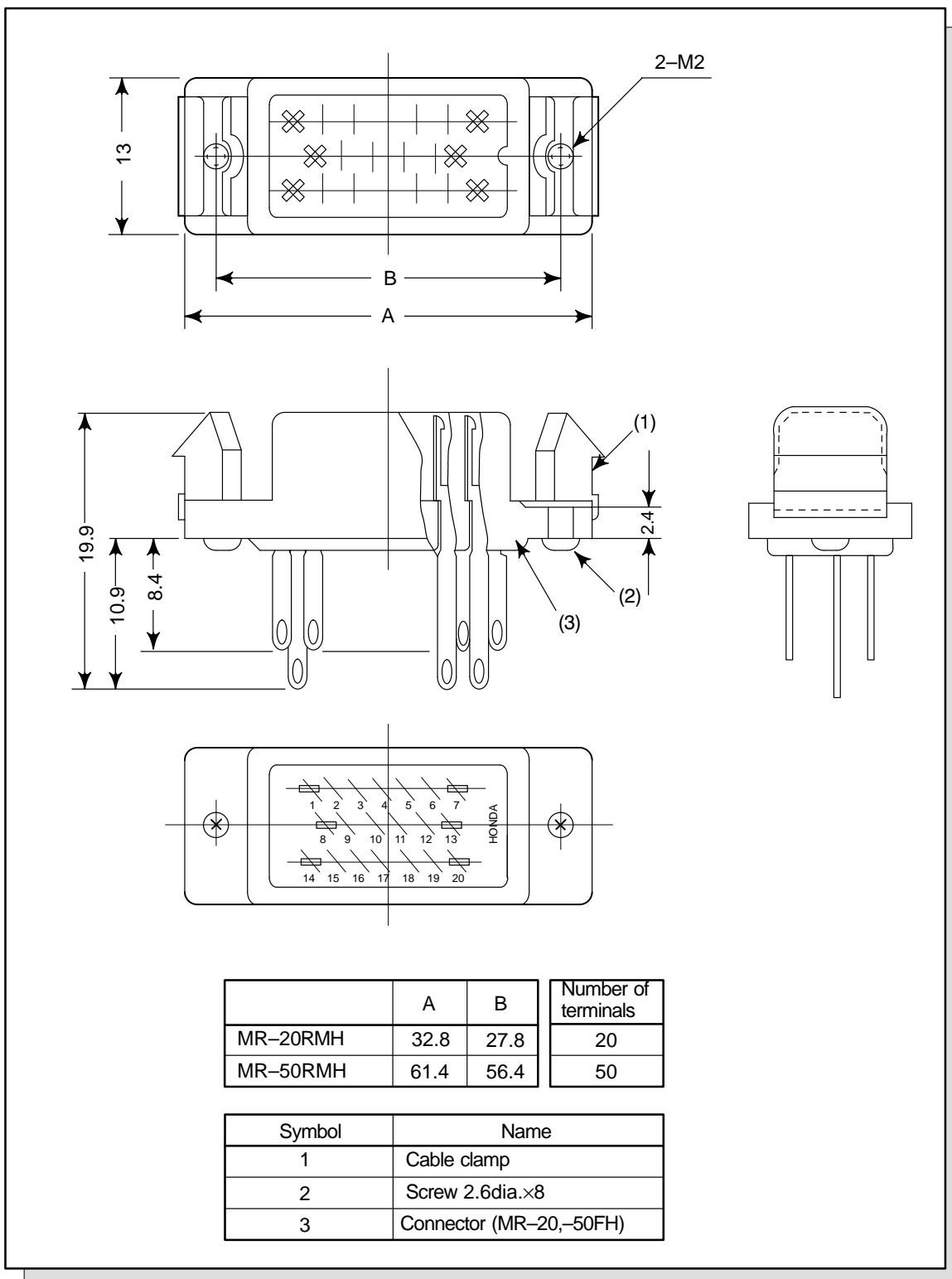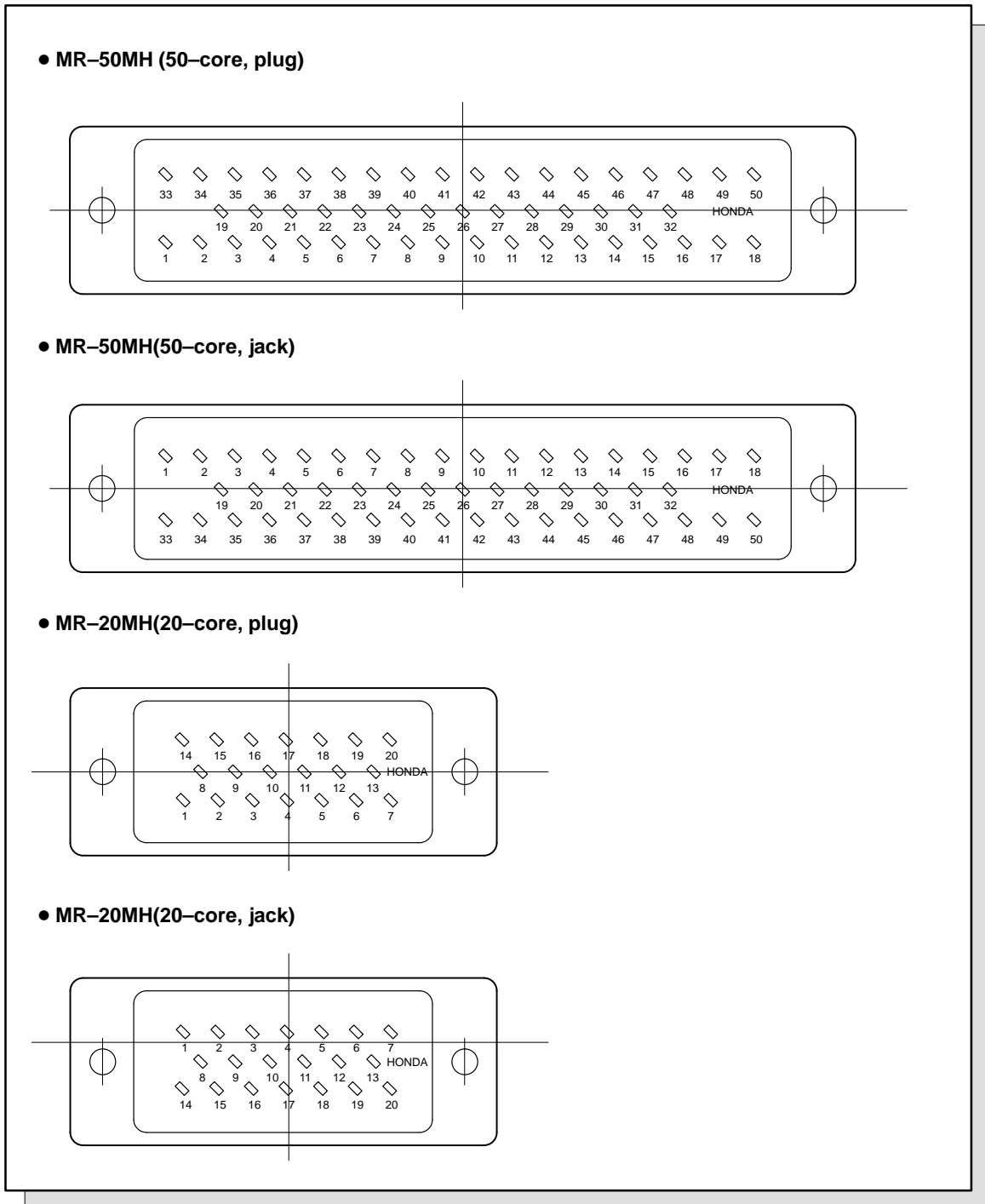
Fig. 17 Connector made by burndy (3 pins, brown)

Manufacturer : BURNDY JAPAN, LTD.

Name		Specification (Connector maker number)	Remarks
Connector housing for cable		SMS3PK–5	Brown
Contact	(Crimp type)	RC16M–23T3	For details on tools required for crimp terminals,contact the manufacturer.
	(Solder type)	RC16M–SCT3	

Cables :   Cross sectional area   : 0.75mm^2(30/0.18)

Insulation diameter   : 2.8mm max

Peeling length   : 7.2mm
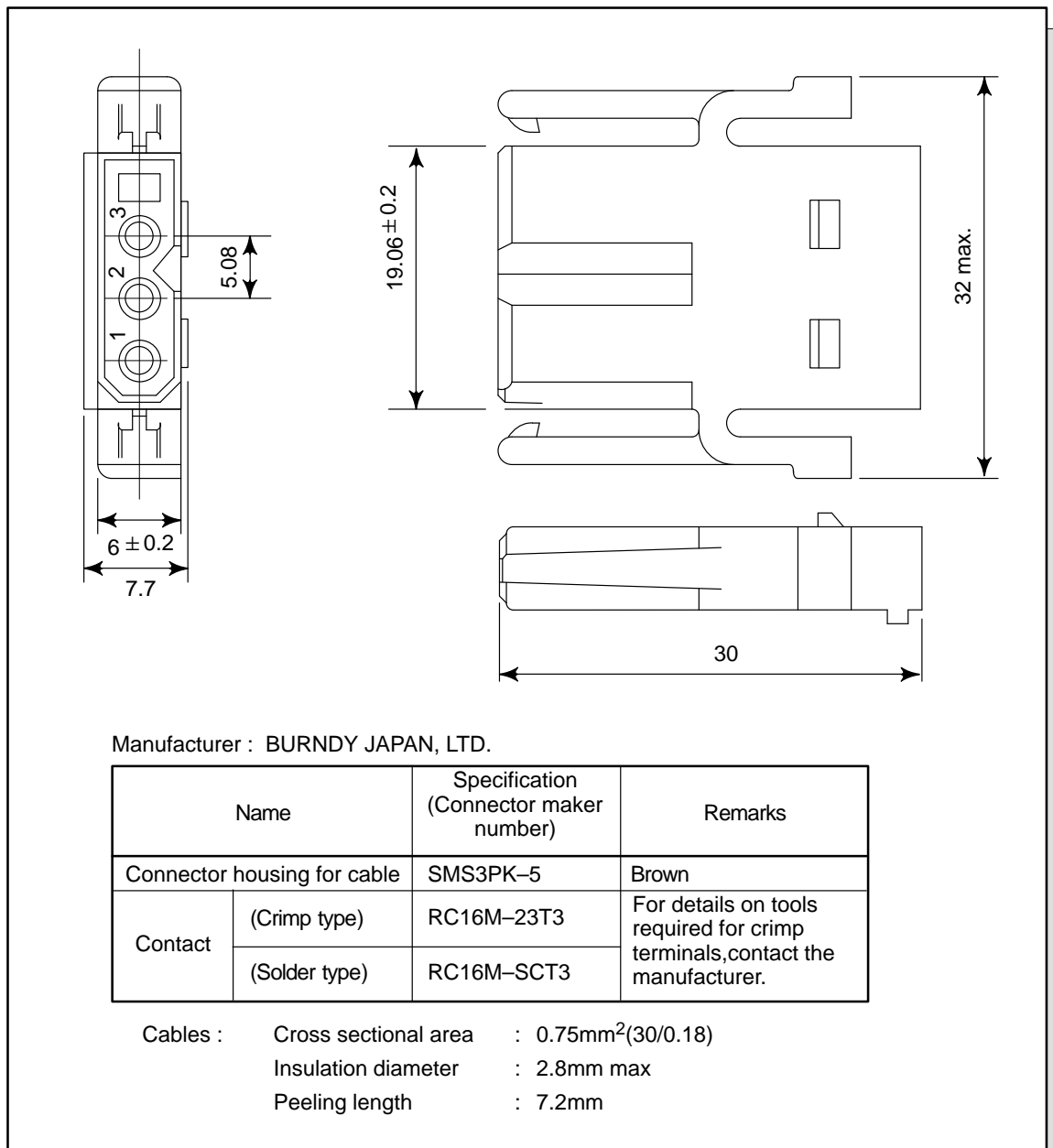
Fig. 18 Connector (Japan Aviation Electronics)(for MDI)

Fig. 19   Contact (Japan Aviation Electronics)(for MDI)

Section A–A

Contact position

0.4

(5 . 4 5)

Excluding the crimp terminal

Detailed contact diagram (Scale: 10:1)

Product name
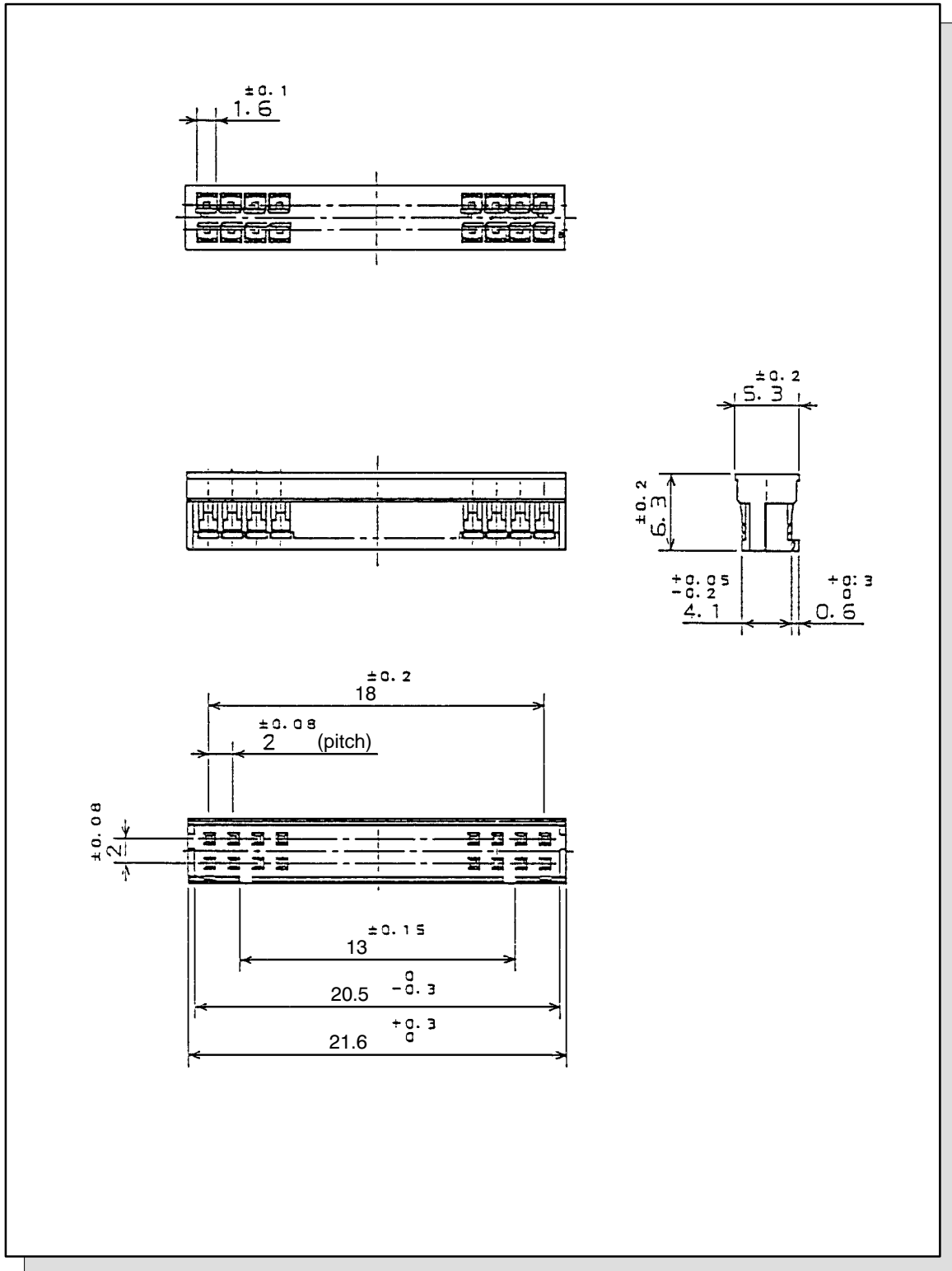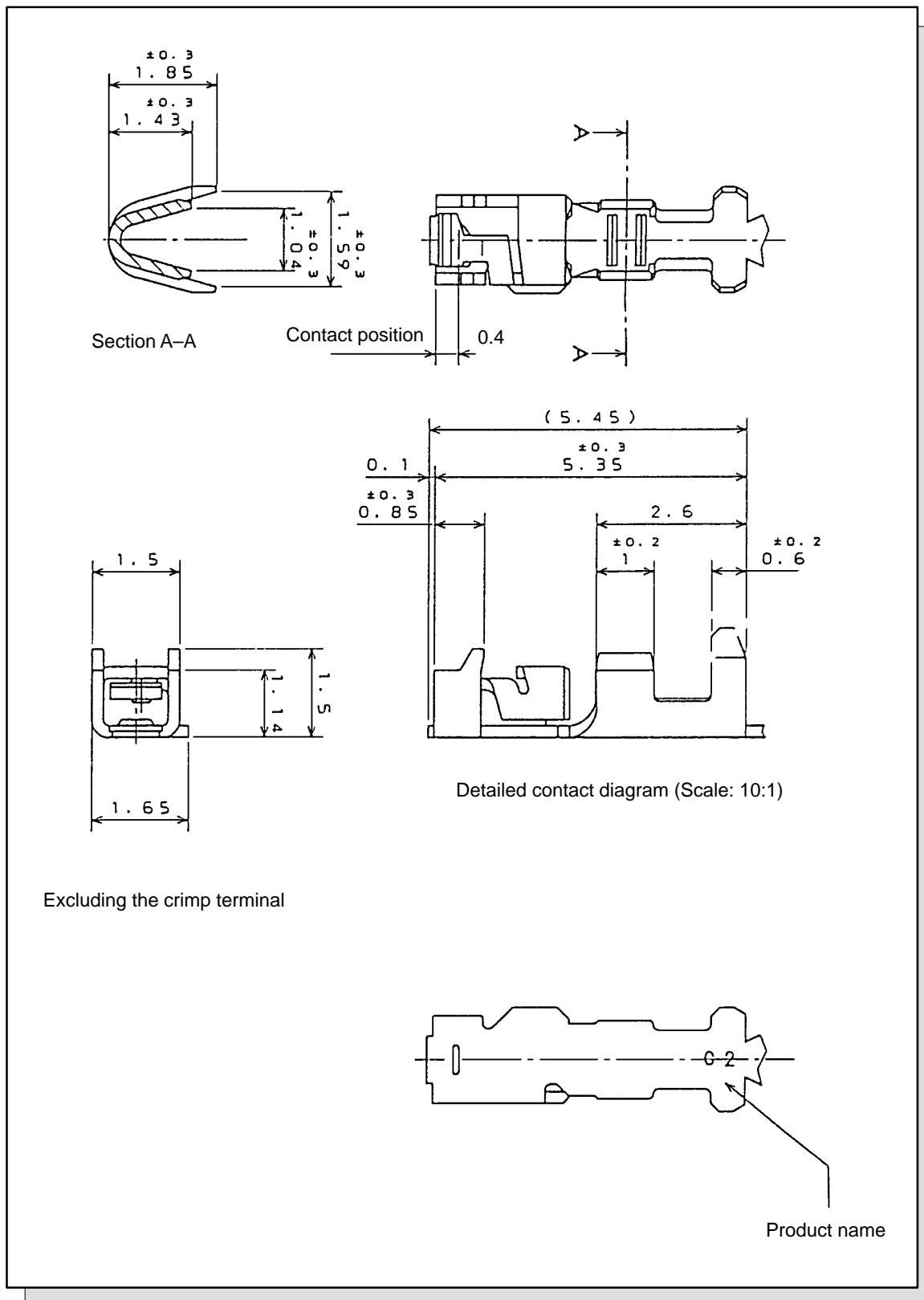
Fig. 20 Reader puncher panel connector

A	53.0	D	7.8	G	10.7
B	38.3	E	12.6	H	1.2
C	47.0	F	41.3	J	0.8

A–A
cross section

2–3.05φ

Fig. 21 Reader puncher connector metal fitting for lock

M2.6×P0.45 screw   Interlock screw

Small round
head screw

1.2 groove

6.1

1.2

6.2

Spring washer

12.7

Fig. 22 Connector for hirose flat cable

Specification   HIROSE ELEC. CO.
HIF3BA–20D–2. 54R (20contacts)
HIF3BB–50D–2. 54R (50contacts)

HIF3BA

HIF3BB

1.27 1.27
1.27

Section A–A'

1.09

Section B–B'

15.6   14.4

ASS'Y DIAGRAM

MAIN BODY   PROTECTOR   CRAMP

6.0   2.54   A
A   A'   B

1.27   2.54
B'   3.81
B

6.0   A
HRS

A   D   3.6
6.0

3.8 *1
*2
*3
7.0

2.7   C

10.5 7.0 3.5 0.3 0.95
1.05   D   3.5   2.3   4.5

HRS

8.5 8.1
2.3 3.5

Dimensions

Description	No.of contact	A	B	C	D
HIF3BA–20D–2.54R	20	29.97	22.86	24.13	25.5
HIF3BB–50D–2.54R	50	68.07	60.96	62.23	63.6

FLAT CABLE CONNECTOR CONTACT NUMBER (HIROSE)

OUTVIEW FROM CONNECTOR SIDE.

20PINS

AOI MARK (SIDE)

POLARITY GUIDANCE

ROW B
ROW A

ROW A →
ROW B →

01   03   05   07   09
02   04   06   08   10

OUTVIEW FROM CONNECTOR SIDE.

50PINS

01   03   05   07   09   11   13   15   17   19   21   23   25
02   04   06   08   10   12   14   16   18   20   22   24

C 20–PIN INTERFACE CONNECTORS AND CABLES

C.1
BOARD–MOUNTED
CONNECTORS

C.1.1
Vertical–Type
Connectors

Models: PCR–EV20MDT (Honda Tsushin)
52618–2011 (Molex Japan)

These board–mounted connectors have been specially developed to achieve the high packing density required for FANUC products. As explained in the following subsection, Honda PCR series connectors can be used as cable connectors because the mating mechanism of the newly developed connectors is compatible with that of the Honda PCR series connectors. To support this specification extensively, many connector manufacturers are now developing custom–tailored cable connectors. (Note that these cables cannot be used with screw–fixing cable connector housings.)

C.1.2
Straight and
Right–Angled
Connectors (for Spring
and Screw–Fixing
Connector Housings)

Models: PCR–E20MDK–SL–A (Honda Tsushin)(straight connector)
PCR–E20LMDETZ–SL (Honda Tsushin)
(right–angledconnector)

These connectors are used for the main and option boards of the *i* series. As cable connectors, they are compatible with screw–fixing connector housings as well as the spring locking connector housings.

C.2
CABLE–SIDE CONNECTORS

Cable–side connectors consist of a connector main body and housing. The models listed below are available. Those connectors not marked with an asterisk are currently being mass–produced as manufacturer's standard models. Those marked with an asterisk are produced according to custom specifications by FANUC.

Table C.2 Cable–side connectors

	Use	Type	Manufac-turer	Connector model	Housing model	Applicable cable outside diameter
Cable–side connector	General use (MDI, IO LINK, AMP, SPDL, etc.)	Strand wire press–mount type	Honda	PCR–E20FA	PCR–V20LA*	ϕ6 mm (ϕ5.7 to 6.5)
					PCS–E20LA	ϕ6 mm (ϕ5.7 to 6.5)
			Hirose	FI30–20S*	FI–20–CV2*	ϕ6.2 mm (ϕ5.5 to 6.5)
				FI30–20S*	FI–20–CV7* (Note 1)	ϕ6.2 mm (ϕ5.5 to 6.5)
			Fujitsu	FCN–247J020–G/E	FCN–240C020–Y/S*	ϕ5.8 mm (ϕ5.5 to 6.5)
			Molex	52622–2011*	52624–2015*	ϕ6.2 mm (ϕ5.9 to 6.5)
		Soldering type	Honda	PCR–E20FS	PCR–V20LA*	ϕ6 mm (ϕ5.7 to 6.5)
					PCS–E20LA	ϕ6 mm (ϕ5.7 to 6.5)
			Hirose	FI40–20S*	FI–20–CV2*	ϕ6.2 mm (ϕ5.5 to 6.5)
				FI40B–20S* (FI40A–20S*)	FI–20–CV5*	ϕ9.2 mm (ϕ8.9 to 9.5)
				FI40B–20S*	FI–20–CV6*	ϕ10.25 mm (ϕ9.5 to 11.0)
	For pulse coder, coaxial cable, linear scale, manual pulse generator, etc.	Soldering type	Honda	PCR–E20FS	PCR–V20LA*	ϕ6 mm (ϕ5.7 to 6.5)
					PCS–E20LA	ϕ6 mm (ϕ5.7 to 6.5)
			Hirose	FI40B–2015S* (Note 2) (FI40–2015S*)	FI–20–CV*	ϕ9.2 mm (ϕ8.9 to 9.5)
				FI40B–20S* (FI40A–20S*)	FI–20–CV5*	ϕ9.2 mm (ϕ8.9 to 9.5)
				FI40B–20S*	FI–20–CV6*	ϕ10.25 mm (ϕ9.5 to 11.0)

NOTE
1 Low screw–lock housing
2 The connector cannot be used for the position coder interface of the i series.

Supplementary description of cable–side connectors

- Strand wire press–mount connector:
  With this connector, #28AWG wires are press–connected to each pin at the same time. The cost of producing a cable/connector assembly with this connector model is much lower than with connectors designed for crimping or soldering.
  Also, the following connector housing has been newly developed for use with the *i* series.

Housing (manufacturer)	Description
FI–20–CV7 (Hirose)	Low connector housing, more compact than conventional models. The housing can be fastened to a board–mounted connector by means of a screw lock. It is intended mainly for connecting the board–mounted connectors used on the main and option boards of the *i* series. Note that this connector housing cannot be used for conventional board–mounted connectors.

- Solder type connectors
  The table below gives further details of solder type connectors and the housings.

Connector model (manufacturer)	Description
PCR–E20FS (Honda)	For general signal applications. Suitable for assembly of a small number of cables or for on–site cable assembly
FI40–20S (Hirose)	Equivalent to the Honda PCR–E20FS
FI40B–20S (Hirose) (former FI40A–20S)	This connector has as many pins as the FI40–20S and a wider space between soldering portions. This results in increased work efficiency in soldering. A thick wire can be soldered. In comparison with the conventional FI40A–20S, with which a wire of up to about #20AWG can be soldered, this connector has higher pin strength and allows wires of up to about #17AWG to be soldered. When a thick wire such as #17AWG is used, it is recommended that a strong housing such as FI–20–CV6 be used.
FI40B–2015S (Hirose) (former FI40–2015S)	The number of pins has been thinned out to expand a space between soldering portions. This connector has higher pin strength than the conventional FI40–2015S. If the outside diameter of a cable does not exceed 8.5 mm, thick wires of up to about #17AWG can be soldered. This connector cannot be used with the position coder interface of the *i* series.

Housing (manufacturer)	Description
FI–20–CV5 (Hirose)	Plastic housing recommended for the FI40B–20S Applicable cable outside diameter: 9.2 mm
FI–20–CV6 (Hirose)	Diecast metal housing developed for the FI40B–20S Applicable cable outside diameter: 10.25 mm

For the solder type connectors of Hirose Electric and the housings, the combinations indicated below are possible as well as the combinations indicated in Table C.2. Use a cable of which outside diameter matches the limitation of the housing.

Connector model

Housing model
(applicable cable outside diameter)

FI40B–2015S
  (formerly FI40–2015S) $\longleftrightarrow$ FI–20–CV (8.5 mm) No other diameters

FI40–20S

FI40B–20S
  (formerly FI40A–20S) $\longleftrightarrow$ FI–20–CV2 (ϕ6.2mm)

FI–20–CV5 (ϕ9.2mm)   Mutually
                                                applicable
FI–20–CV6 (ϕ10.25mm)

C.3 RECOMMENDED CONNECTORS, APPLICABLE HOUSING, AND CABLES

Table C.3 Recommended connectors, applicable housings, and cables

Connector name referenced in the Connection Manual	FANUC–approved connector (manufacturer)	FANUC–approved housing (manufacturer)	Compatible cable (cable diameter) FANUC development FANUC specification number	Remark
PCR–E20FA Strand press–mount type	PCR–E20FA (Honda Tsushin)	PCR–E20LA (Honda Tsushin)	A66L–0001–0284#10P (6.2 mm in diameter)	Plastic housing
		PCS–E20LA (Honda Tsushin)		Metal housing
	FI30–20S (Hirose Electric)	FI–20–CV2 (Hirose Electric)		Plastic housing
		FI–20–CV7 (Hirose Electric)		Plastic housing
	FCN–247J020–G/E (Fujitsu Takamizawa)	FCN–240C020–Y/S (Fujitsu Takamizawa)		Plastic housing
	52622–2011 (Molex)	52624–2015 (Molex)		Plastic housing
PCR–E20FS Soldering type	PCR–E20FS (Honda Tsushin)	PCR–V20LA (Honda Tsushin)		Plastic housing
		PCS–E20LA (Honda Tsushin)		Metal housing
	FI40–20S (Hirose Electric)	FI–20–CV2 (Hirose Electric)		Plastic housing
FI40B–2015S (formerly FI40–2015S) 15–pin soldering type	F140B–2015S (formerly FI40–2015S) (Hirose Electric)	FI–20–CV2 (Hirose Electric)	A66L–0001–0286 (Note) A66L–0001–0402 (Note) (8.5 mm in diameter)	Plastic housing
FI40B–20S (formerly FI40A–20S) Soldering type	FI40B–20S (formerly FI40A–20S) (Hirose Electric)	FI–20–CV5 (Hirose Electric)	A66L–0001–0367 A66L–0001–0368 (9.2 mm in diameter)	Plastic housing
	FI40B–20S (Hirose Electric)	FI–20–CV6 (Hirose Electric)	A66L–0001–0403 (Note) (9.8 mm in diameter)	Metal housing

> **NOTE**
> Cable A66L–0001–0286 has been recommended for use as a pulse coder cable. It can be up to 20 m long. Two cables, A66L–0001–0402 and A66L–0001–0403, have recently been developed. A66L–0001–0402 and A66L–0001–0403 can be as long as 30 m and 50 m, respectively. (See the Section on the cable materials for detailed specifications.)
> Both cables have the same level of oil and bending resistance (cable, 100 mm in diameter, capable of withstanding at least 10 million bending cycles) as conventional cables, and are UL– and CSA–certified.

C.4
PRESS–MOUNT TYPE CONNECTOR ASSEMBLY TOOLS AND JIGS

Connector model referenced in the Connection Manual	FANUC–approved connector (manufacturer)	Wire forming tool	Press–mounting tool	Remark
PCR–E20FA	PCR–E20FA (Honda Tsushin)	PCS–K2A	FHPT–918A	Low cost
		JGPS–015–1/1–20 JGPS–014	MFC–K1 PCS–K1	
		FHAT–918A		
	FI30–20S (Hirose Electric)	FI30–20CAT	FI30–20/ID	Low cost
		FI30–20CAT1	HHP–502 FI30–20GP	
	FCN–247J020 (Fujitsu)	FCN–237T–T043/H	FCN–237T–T109/H FCN–247T–T066/H	
		FCN–237T–T044/H		
		FCN–237T–T062/H		
	52622–2011 (Molex)	57289–5000	57830–5000	Low cost
		57823–5000	57824–5000	

NOTE
1 Those tools indicated by shading are available from FANUC (specification number A02B–0120–K391).
2 The tools available from each manufacturer are specifically designed for use with the connectors manufactured by that manufacturer.

C.5
MATERIALS FOR CABLE ASSEMBLIES

Machine tool builders are required to manufacture or procure the materials for the cable assemblies to be used with their products. FANUC recommends the following materials as being suitable for interface connectors. Individual machine tool builders are encouraged to contact each cable manufacturer for themselves, as required.

Table C.5 Recommended materials for cable assemblies

Material	Use	Constitution	FANUC specification number	Manufacturer	Remark
10–pair cable	General use	0.08 mm^2 10 pairs	A66L–0001–0284#10P	Hitachi Cable, Ltd. Oki Electric Cable Co., Ltd.	
5–conductor coaxial cable	CRT interface (long–distance)	5–conductor coaxial	A66L–0001–0371	Hitachi Cable, Ltd.	50 m or less
12–conductor composite cable (Note)	Pulse coder, linear scale, manual pulse generator	0.5 mm^2 6 conductors 0.18 mm^2 3 pairs	A66L–0001–0286	Hitachi Cable, Ltd. Oki Electric Cable Co., Ltd.	20 m or less
		0.75 mm^2 6 conductors 0.18 mm^2 3 pairs	A66L–0001–0402	Oki Electric Cable Co., Ltd.	30 m or less Usable on movable parts
		1.25 mm^2 6 conductors 0.18 mm^2 3 pairs	A66L–0001–0403	Oki Electric Cable Co., Ltd.	50 m or less Usable on movable parts

NOTE
For a pulse coder, scale, manual pulse generator, or other unit using +5 V power, select cable wires considering the voltage drop due to the cable resistance.

10–pair cable

● **Specifications**

Item		Unit	Specifications
Product No.		–	A66L–0001–0284#10P
Manufacturer			HITACHI CABLE, LTD. OKI ELECTRIC CABLE., LTD.
Rating		–	60°C 30V:UL2789 80°C 30V:UL80276
Material	Conductor	–	Stranded wire of tinned annealed copper (ASTM B–286)
	Insulator	–	Cross–linked vinyl
	Shield braid	–	Tinned annealed copper wire
	Sheath	–	Heat–resistant oilproof vinyl
Number of pairs		Pairs	10
Conductor	Size	AWG	28
	Structure	Conductors/mm	7/0.127
	Outside diameter	mm	0.38
Insulator	Thickness	mm	0.1 Thinnest portion : 0.08 (3.1mm)
	Outside diameter (approx.)	mm	0.58
	Core style (rating)	mm	UL15157(80°C, 30V)
Twisted pair	Outside diameter (approx.)	mm	1.16
	Pitch	mm	20 or less
Lay		–	Collect the required number of twisted pairs into a cable, then wrap binding tape around the cable. To make the cable round, apply a cable separator as required.
Lay diameter (approx.)		mm	3.5
Drain wire		Conductors/mm	Hitachi Cable : Not available Oki Electric Cable : Available,10/0.12
Shield braid	Element wire diameter	mm	0.12
	Braid density	%	85 or more
Sheath	Color	–	Black
	Thickness	mm	1.0
	Outside diameter (approx.)	mm	6.2
Standard length		m	200
Packing method		–	Bundle
Electrical performance	Electric resistance(at 20°C)	Ω/km	233 or less
	Insulation resistance (at 20°C)	MΩ–km	10 or less
	Dielectric strength (AC)	V/min.	300
Flame resistance		–	Shall pass flame resistance test VW–1SC of UL standards.

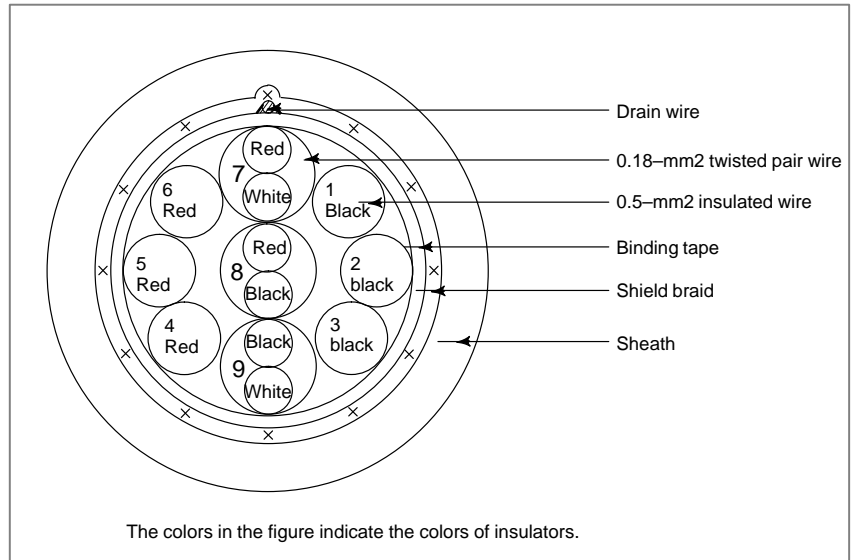● **Cable structure**   The cable structure is shown below.

Wire identification table (HITACHI)

Wire No.	Insulator color	
	First wire	Second wire
1	Blue	White
2	Yellow	White
3	Green	White
4	Red	White
5	Purple	White
6	Blue	Brown
7	Yellow	Brown
8	Green	Brown
9	Red	Brown
10	Purple	Brown

The numbers assigned to the wires correspond to the numbers in the table at right.
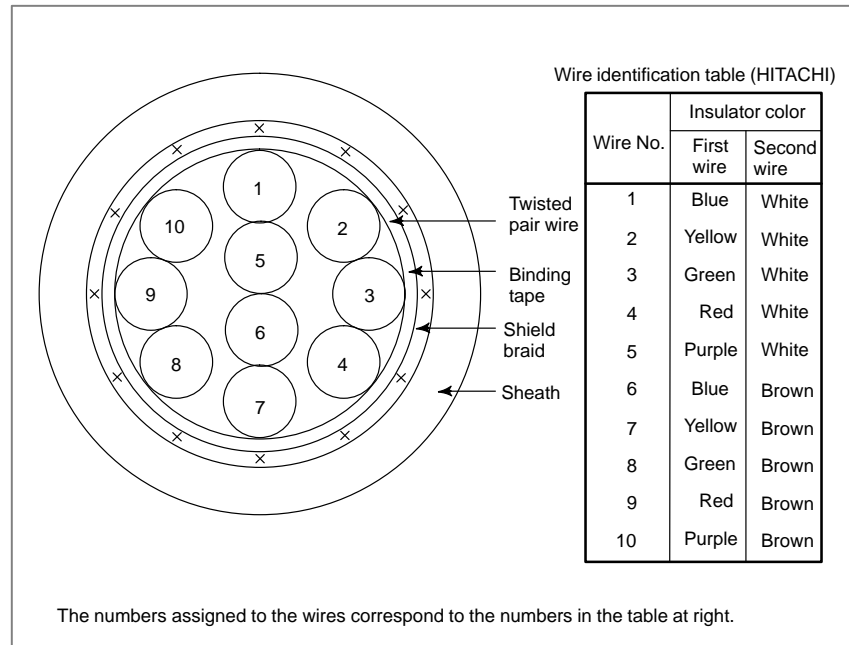
Fig. 5(a) Cable made by Hitachi Cable

Wire identification table (OKI)

Pair No.	Insulator color	Dot mark (1 pitch)	Dot mark color	
			First wire	Second wire
1	Orange	–	Red	Black
2	Gray	–	Red	Black
3	white	–	Red	Black
4	Yellow	–	Red	Black
5	Pink	–	Red	Black
6	Orange	——	Red	Black
7	Gray	——	Red	Black
8	White	——	Red	Black
9	Yellow	——	Red	Black
10	Pink	——	Red	Black

The numbers assigned to the wires correspond to the numbers in the table at right.
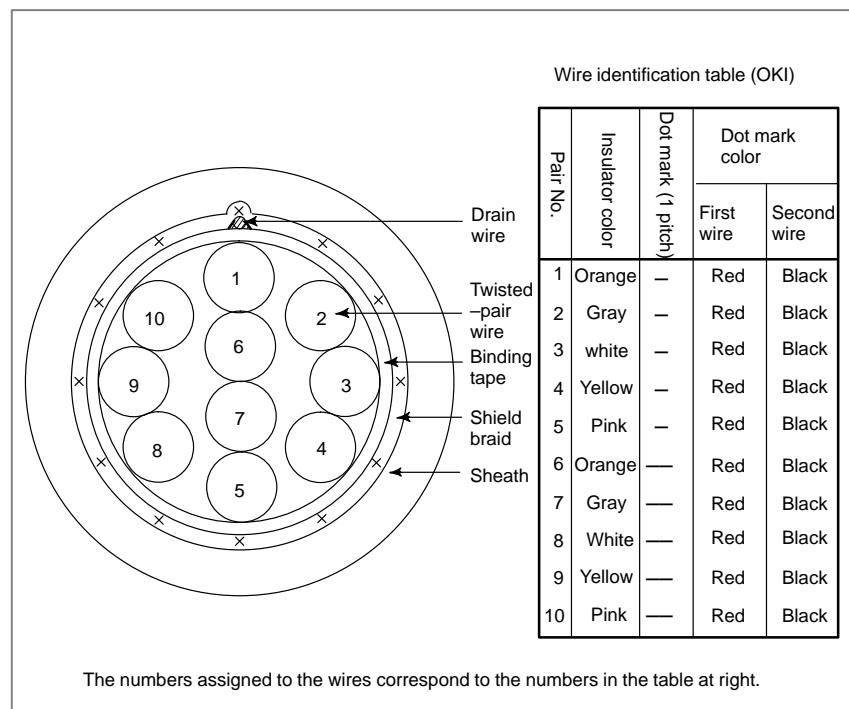
Fig. 5(b) Cable made by Oki Electric Cable

5–core coaxial cable

● **Specifications**

Item		Unit	Description
Specification		–	A66L–0001–0371
Manufacture		–	HITACHI CABLE CO., LTD.
Manufacture's specification		–	CO–IREFV(0)–CX–75–SB 5X0.14SQ
Number of Conductors		Core	5
Inside Conductor	Size	mm^2	0.14
	Components	Conductors (PCS)/mm	7/0.16
	Material	–	Tin–coated Soft Copper Wire
	Diameter	mm	0.48
Insulator	Material (Color)	–	Polyethylene (White)
	Thickness	mm	0.71
	Diameter	mm	1.90
Outside Conductor	Material	–	Tin–coated Soft Copper Wire (Rolled)
	Diameter of Component–Wire	mm	0.08
	Density	%	95 or more
	Diameter	mm	0.2
Jacket	Material	–	Vinyl
	Color	–	Black. White. Red. Green. Blue
	Thickness	mm	0.15
	Diameter	mm	2.6
Twisted Assembly Diameter		mm	7.1
Thickness of Paper Tape		mm	0.05
Shield braid	Wire dia. Material	mm	0.12 Tin–coaded soft copper wire
	Density	%	80 or more
	Thickness	mm	0.3
	Diameter	mm	7.8
Sheath	Material, Color	–	Oil Tight Vinyl Black
	Thickness	mm	0.7 (Min. thickness: 0.56)
Finish Diameter		mm	9.2 ±0.3
Conductor Resistance (20°C)		Ω/km	143 or less
Withstand Voltage (A.C.)		V/min.	1000
Insulation Resistance (20°C)		MΩ–km	1000 or more
Impedance (10MHz)		Ω	75±5
Standard Capacitance (1MHz)		nF/km	56
Standard Attention (10MHz)		dB/km	53
Weight		kg/km	105
Standard Length		m	200
Package form		–	Bundle

● **Cable structure**

The cable structure is shown below.

Coaxial core

Thread

red

green

black

White   blue

Tape
Shield braid
Sheath

Inside conductor

Insulator

Outside conductor (braid)

Jacket
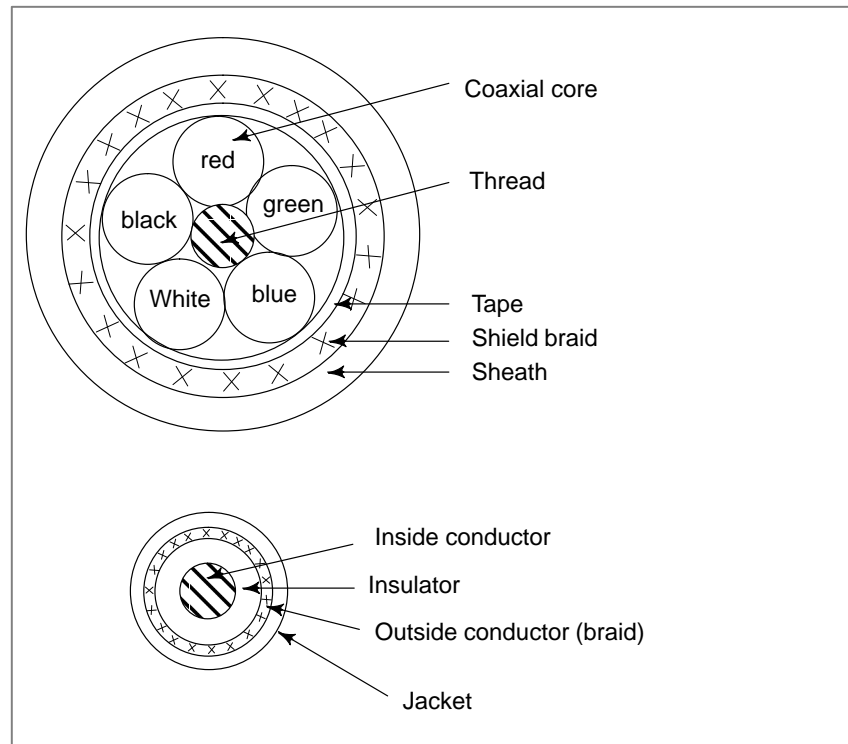
12–core cable

● **Specifications**

Item		Unit	Specifications	
Product No.		–	A66L–0001–0286	
Manufacturer		–	HITACHI CABLE, LTD. OKI ELECTRIC CABLE., LTD.	
Rating		–	80°C, 30V	
Material	Conductor,braid–shielded wire,drain wire	–	Strand wire of tinned annealed copper (JIS C3152)	
	Insulator	–	Heat–resistant flame–retardant vinyl	
	Sheath	–	Oilproof, heat–resistant, flame–retardant vinyl	
Number of wires (wire ons.)		Cores	6 (1 to 6)	6 (three pairs) (7 to 9)
Conductor	Size	mm^2	0.5	0.18
	Structure	Conductors /mm	20/0.18	7/0.18
	Outside diameter	mm	0.94	0.54
Insulator	Standard thickness (The minimum thickness is at least 80% of the standard thickness.)	mm	0.25	0.2
	Outside diameter	mm	1.50	0.94
Twisted pair	Outside diameter	mm		1.88
	Direction of lay	–		Left
	Pitch	mm		20 or less
Lay		–	Twist the wires at an appropriate pitch so the outermost layer is right–twisted, and wrap tape around the outermost layer. Apply a cable separator as required.	
Lay diameter		mm	5.7	
Drain wire	Size	mm^2	0.3	
	Structure	Wires/ mm	12/0.18	
	Outside diameter	mm	0.72	
Shield braid	Element wire diameter	mm	0.12	
	Thickness	mm	0.3	
	Braid density	%	70	
	Outside diameter	mm	6.3	
Sheath	Color	–	Black	
	Standard thickness (The minimum thickness is at least 85% of the standard thickness.)	mm	1.1	
	Outside diameter	mm	8.5Max. 9.0(1)	
Standard length		m	100	
Packing method		–	Bundle	
Electrical performance	Electric resistance (at 20°C) (wire nos.)	Ω/km	39.4(1 to 6)	113(7 to 9)
	Insulation resistance (at 20°C)	MΩ–km	15	
	Dielectric strength (AC)	V/min.	500	
Flame resistance		–	Shall pass flame resistance test VW–1SC of UL standards,	

NOTE

The maximum outside diameter applies to portions other than the drain wire.

- **Markings on cable**   ● Name or symbol of the manufacturer
                               ● Manufacturing year

- **Cable structure**   The cable structure is shown below.

The colors in the figure indicate the colors of insulators.

● **Specifications**

Item		Specification			
FANUC specification number		A66L–0001–0402		A66L–0001–0403	
Manufacturer		Oki Electric Cable Co., Ltd.			
		A–conductor	B–conductor	A–conductor	B–conductor
Conductor	Constitution Number of conductors/mm	16/0.12 (0.18mm^2)	3/22/0.12 (0.75mm^2)	16/0.12 (0.18mm^2)	7/16/0.12 (1.25mm^2)
	Typical outside diameter (mm)	0.55	1.20	0.55	1.70
Insulation (polyester)	Color	White, red, black	Red, black	White, red, black	Red, black
	Typical thickness (mm)	0.16	0.23	0.16	0.25
	Typical outside diameter (mm)	0.87	1.66	0.87	2.20
Pair twisting	Constitution	White–red, white–black, and black–red		White–red, white–black, and black–red	
	Direction of twisting	Left Typical pitch: 20 mm		Left Typical pitch: 20 mm	
Assembling by twisting	Number of strands or conductors	3	6	3	6
	Direction of twisting	Left		Left	
	Taping	Twisting is wrapped with washi, or Japanese paper, tape.		Twisting is wrapped with washi, or Japanese paper, tape.	
	Typical outside diameter (mm)	5.7		6.9	
Braided shielding	Typical strand diameter (mm)	0.14			
	Typical density (mm)	80			
	Drain	A 12/0.18 mm wire is roughly wrapped under braided shielding.			
	Typical outside diameter (mm)	6.4		7.6	
Sheath (polyurethane)	Color	Black (matted)			
	Typical thickness (mm)	1.05		1.1	
	Vertical taping	Vertically taped with washi under sheathing.			
	Outside diameter (mm)	8.5 ± 0.3		9.8 ± 0.3	
Finished assembly	Typical length (m)	100			
	Short size	Basically not approved.			

Item		Specification			
FANUC specification number		A66L–0001–0402		A66L–0001–0403	
Manufacturer		Oki Electric Cable Co., Ltd.			
		A–conductor	B–conductor	A–conductor	B–conductor
Finished assembly performance	Rating	80°C 30V			
	Standard	Shall comply with UL STYLE 20236 and CSA LL43109 AWM I/II A 80°C 30V FT–1.			
	Flame resistance	Shall comply with VW–1 and FT–1.			
Electrical performance	Conductor resistance Ω/km (20°C)	103 or lower	25.5 or lower	103 or lower	15.0 or lower
	Insulation resistance MΩ/km (20°C)	1 or higher			
	Dielectric strength V–min	A. C 500			
Insulation performance	Tensile strength N/mm^2	9.8 or higher			
	Elongation %	100 or higher			
	Tensile strength after aging %	At least 70% of that before aging			
	Elongation after aging %	At least 65% of that before aging			
	Aging condition	For 168 hours at 113°C			
Sheathing performance	Tensile strength N/mm^2	9.8 or higher			
	Elongation %	100 or higher			
	Tensile strength after aging %	At least 70% of that before aging			
	Elongation after aging %	At least 65% of that before aging			
	Aging condition	For 168 hours at 113°C			
Cable cross section					

D OPTICAL FIBER CABLE

This CNC uses optical fiber cables for the following interfaces.

(1) Serial spindle interface
(2) I/O Link interface
(3) High–speed serial bus (HSSB) interface
(4) Serial servo bus (FSSB) interface

The optical fiber cables used for these interfaces all comply with the same specifications. This section describes the specifications and notes of the optical fiber cable.

Notes on the specifications of optical fiber cable C

1. Supported optical fiber cables

   (1) Internal cord type cable : A66L–6001–0023#L☐ R☐☐☐
                                                  (only for the FSSB interface)
       Cable length   : 0.15 to 10 m
       Code diameter   : 2.2 mm × 2 cords
       Tensile strength   : Optical fiber cord : 7 kg per cord
       Between optical fiber cord and connector   : 2 kg
       Minimum bending radius of optical fiber cord : 25 mm
       Operating temperature   : –20 to 70°C
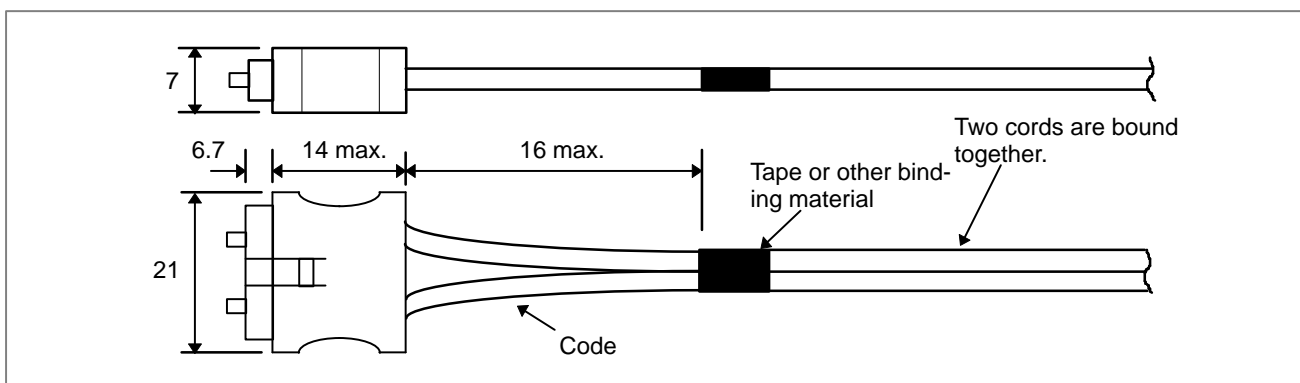
Fig. D (a) External dimensions of internal cord type cable Unit: mm

(2) External type cable : A66L–6001–0026#L☐ R☐☐☐
Cable length : 1 to 50 m
Optical fiber cord diameter : 2.2 mm × 2 cords
Diameter of cable with reinforced cover : 7.6 mm
Tensile strength : Cable with reinforced cover : 75 kg
Optical fiber cord : 7 kg per cord
Between optical fiber cord and connector : 2 kg
Minimum bending radius of optical fiber cord : 25 mm
Minimum bending radius of cable with reinforced cover : 50 mm
Bending resistance (cable with reinforced cover) :
10 million bending cycles at room temperature
(when the bending radius is 100 mm)
Flame resistance : Equivalent to UL VW–1
Operating temperature : –20 to 70°C
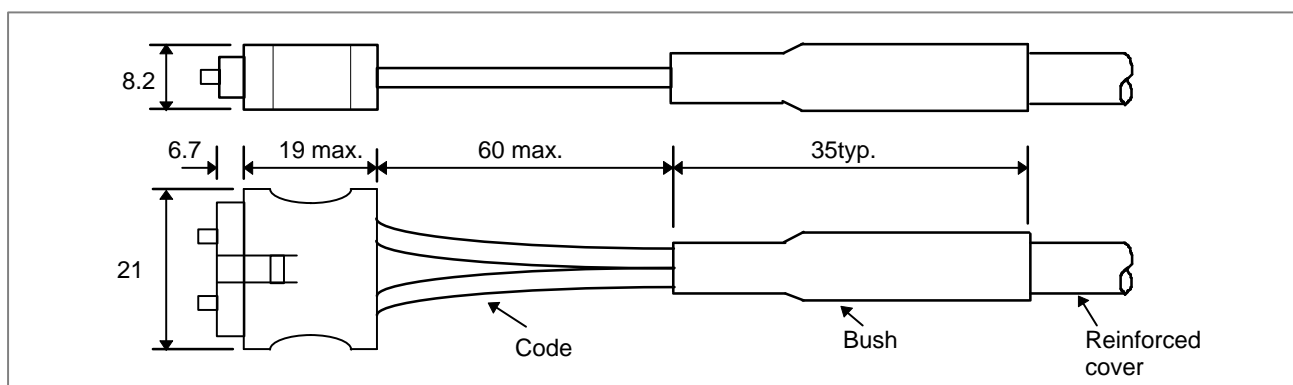
Fig. D (b) External dimensions of external cable Unit: mm

Table D(a) Standard cable length

Internal cord type cable		External cable	
A66L–6001–0023#		A66L–6001–0026#	
Specification	Length	Specification	Length
L150R0	0.15 m	L1R003	1.0 m
L300R0	0.3 m	L2R003	2.0 m
L500R0	0.5 m	L3R003	3.0 m
L1R003	1.0 m	L5R003	5.0 m
L2R003	2.0 m	L7R003	7.0 m
L3R003	3.0 m	L10R03	10.0 m
L5R003	5.0 m	L15R03	15.0 m
L7R003	7.0 m	L20R03	20.0 m
L10R03	10.0 m	L30R03	30.0 m
		L50R03	50.0 m

2. Cable selection

- Always use an external cable (A66L–6001–0026#) when the cable is to be laid outside the power magnetics cabinet or main unit cabinet, where it may be pulled, rubbed, or stepped on.

- Use an external cable when part of the cabling is to be subject to movement. For example, when connecting a portable operation pendant box to the power magnetics cabinet, the use of an external cable is desirable because the cable is likely to be bent, pulled, or twisted repeatedly even though frequent system operation is not expected. However, the force likely to be applied when the cable is installed or moved for maintenance purposes does not need to be taken into consideration.

- Use an external cable in locations where sparks or flame are a danger. Although the internal cord type cable (A66L–6001–0023#) is covered by nonflammable resin, the cover, if exposed to frame for a long time, may melt, allowing the fiber cable inside to burn.

- Use an external cable when the cable is expected to be pulled with considerable force during installation (the force applied to the cable must be within the specified tensile strength limit at all times). For example, even though installing a cable in a cable duct can be regarded as internal cabling, a cable of the appropriate type must be selected according to the tensile force to be applied to the cable during installation.

- Both the internal cord type and external cables have the same oil and heat resistance properties.

3. Procuring the cable

All the optical fiber cables mentioned above are special cable products with optical connectors, which are designed, produced, and tested to ensure the required system performance and reliability.   It is technically impossible for users to produce these cables or process (cut and reconnect) them after purchase. Users are requested to purchase cables of the necessary length from an appropriate supplier. Cables are available from either FANUC or any of the FANUC–approved manufacturers listed in Table D(b).

Table D(b) FANUC–approved cable manufacturers and cable model numbers (retail)

(1) Internal cord type cable: AA66L–6001–0023#L☐R☐☐☐

Manufacturer	Model number	Remarks
Japan AMP, Co., Ltd.	*–353373–*	
Japan Aviation Electronics Industry, Ltd.	PF–2HB209–**M–F–1	** indicates the cable length (m).
Hirose Electric Co., Ltd.	H07–P22–F2VCFA–**	** indicates the cable length (m).

(2) External cable: A66L–6001–0026#L☐R☐☐☐

Manufacturer	Model number	Remarks
Japan AMP, Co., Ltd.	*–353199–*	
Japan Aviation Electronics Industry, Ltd.	CF–2HB208–**M–F–1	** indicates the cable length (m).
Hirose Electric Co., Ltd.	H07–P22–F2NCFA–**	** indicates the cable length (m).
Oki Electric Cable Co., Ltd.	OPC201HPXF–**MB	** indicates the cable length (m).

4. Handling precautions

(1) Protection during storage

When the electrical/optical conversion module mounted on the printed circuit board and the optical fiber cable are not in use, their mating surfaces must be protected with the lid and caps with which they are supplied. If left uncovered, the mating surfaces are likely to become dirty, possibly resulting in a poor cable connection.
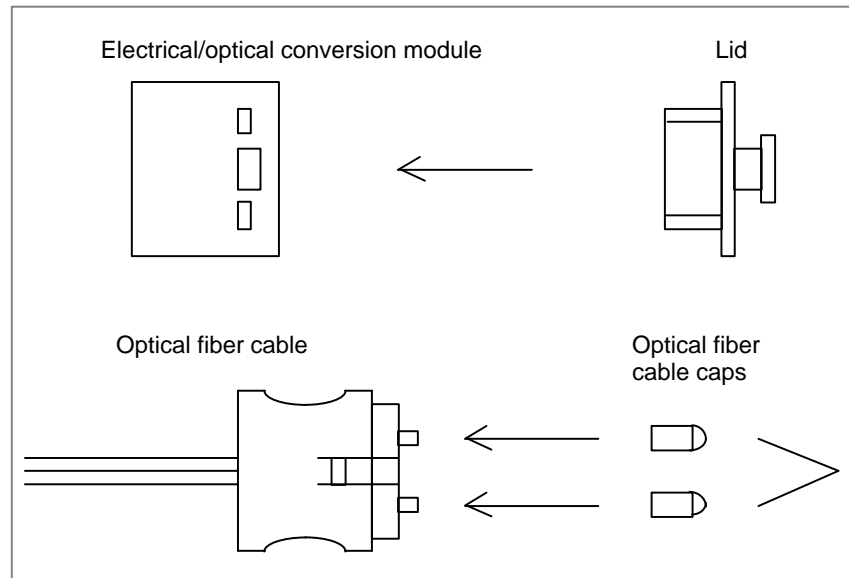
Fig. D (c) Protection of electrical/optical conversion module and optical fiber cable (when not in use)

(2) Optical fiber cable

● Although the reinforcing cover of the external cable has sufficient mechanical strength, be careful not to drop heavy objects on the cable.

● Grasp the optical connector firmly when connecting or disconnecting the cable. Do not pull on the optical fiber cord itself. (The maximum tensile strength between the fiber cord and connector is 2 kg. Applying greater force to the cord is likely to cause the connector to come off, making the cable unusable.)

● Once connected, the optical connector is automatically locked by the lock levers on its top. To remove the connector, release the lock levers and pull the connector.

● Although optical connectors cannot be connected in other than the correct orientation, always take note of the connector's orientation before making the connection.

- Before installing an external cable, fix either a wire with a hook or a tension member to the reinforcing cover of the optical connector and pull the wire or tension member, as shown in Fig. D(d). This is done to prevent a tensile force from being applied between the fiber cord and connector. If no tensile force is applied between the fiber cord and connector when installing the cable, you can hold the reinforcing cover of the connector directly and pull it.

  In the case of an internal cord, which does not have a reinforcing cover, apply the same protective measures, as instructed in Fig. D(d), for that portion of the cable where the two cords are bound together, in order to prevent a tensile force from being applied between the fiber cord and connector.

  In the same way as for an external cable, if no tensile force is applied between the fiber cord and connector during installation, you can hold the shielded part of the cable directly and pull it. Because the combined tensile strength of the two cords is only 14 kg, however, avoid applying too great a force to the cable during installation, regardless of whether you have taken the protective measures.
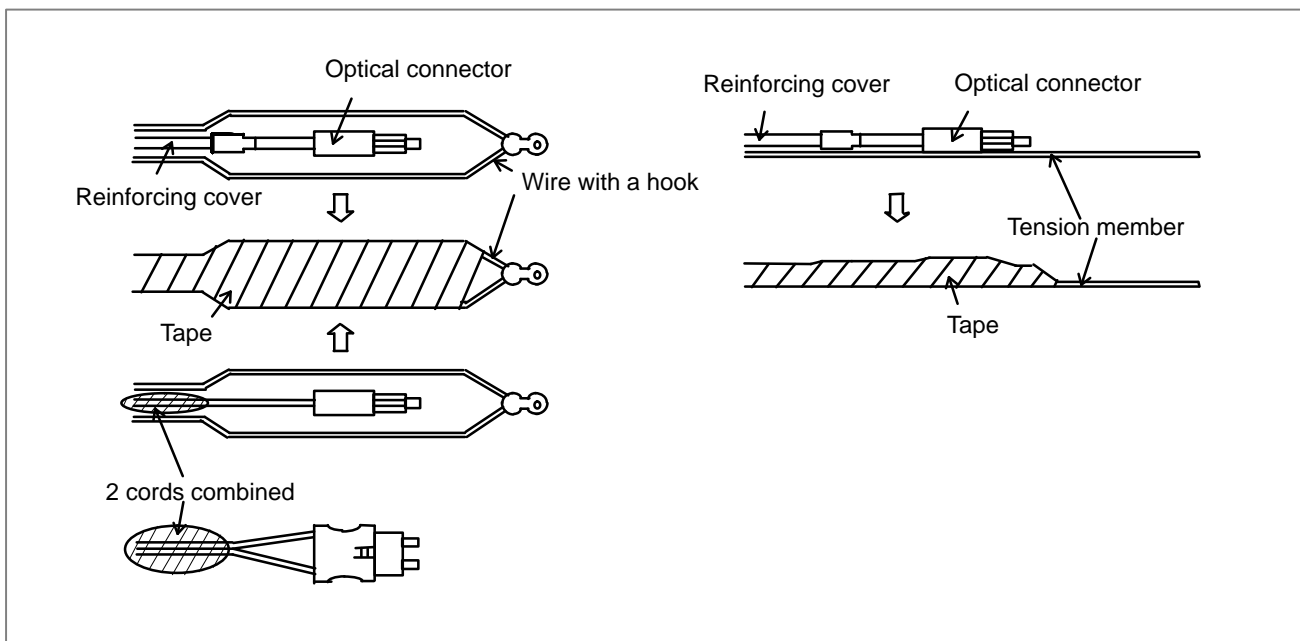
Fig. D (d) Prior to installing a cable

- Take care to keep both parts of the optical connector (cable side and PCB side) clean. If they become dirty, wipe them with tissue paper or absorbent cotton to remove dirt. The tissue paper or absorbent cotton may be moistened with ethyl alcohol. Do not use any organic solvent other than ethyl alcohol.

● Fix the reinforcing cover of the external cable or the cord binding portion of the internal cord type cable by using a cable clamp, as shown in Fig. D(e), to prevent the weight of the optical fiber cable from being applied directly to the connecting part of the optical connector.

(Recommended cable clamp):

Recommended cable clamps are listed below. Use a clamp that grasps the optical cable lightly; the clamp should not apply excessive pressure to the cable.

For an external cable:

CKN–13SP (with sponge)(Kitagawa Industry Co., Ltd.)

For an internal cord type cable:

MN–1 (Kitagawa Industry Co., Ltd.)
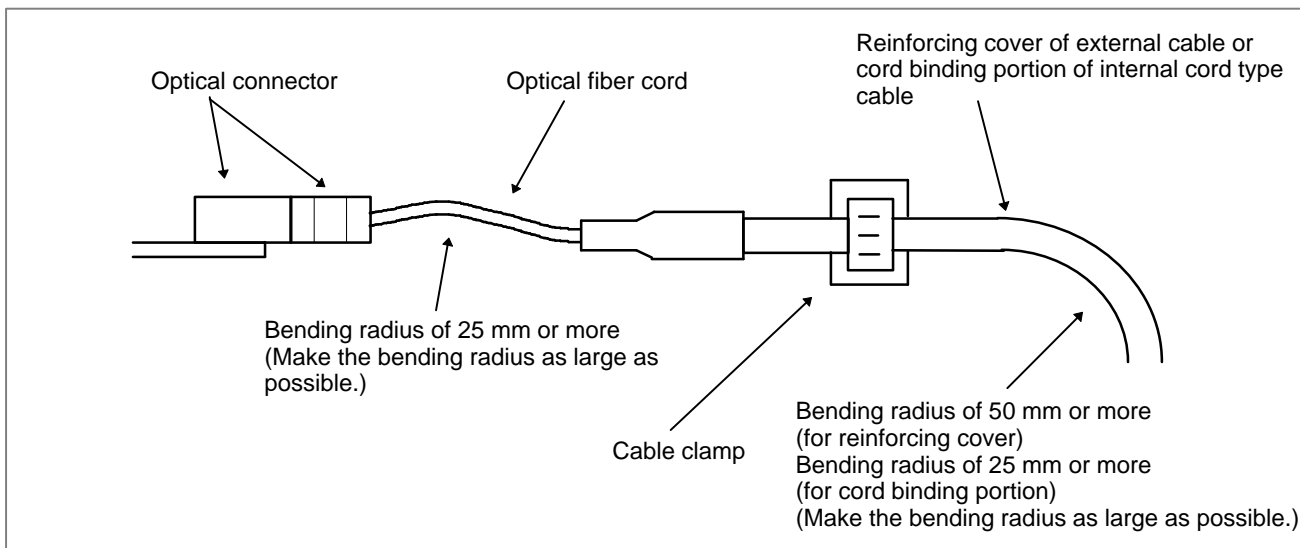
Fig. D (e) Fixing the cable with a clamp

● Any superfluous portion of the cable may be wound into a loops. Should this prove necessary, make sure the diameter of each loop is at least 150 mm (for an external cable) or at least 100 mm (for an internal cord type cable). Winding the cable into smaller loops may produce sharp curves that exceed the specified bending radius limit without the user being aware. Such bending can result in a greater transmission loss, ultimately leading to a communication failure.

● When using a nylon band (cable tie) as a cable clamp, follow the instructions given below. Also, take care not to apply a bending force to one particular part of the cable when fixing it with a clamp. Failing to clamp the cable correctly may cut or damage it.

External cable:

Do not clamp the uncovered portion of the cable with a nylon band. When clamping the cable by the reinforcing cover, the clamping force is not an important factor to consider. However, ensure that the clamping force is as small as possible to ensure that the reinforcing cover is not deformed by the clamping. If possible, the clamping force should be 5 kg or less.

Internal cord type cable:
>Lightly clamp the optical cable with a nylon band so that the cable shield is not deformed. If possible, the clamping force should be 1 or 2 kg (make sure that no force is applied to the cable). Due care is required when clamping the internal cord type cable because its cable shield is weaker than the reinforcing cover of the external cable.

5. Compatibility with previous models of FANUC optical fiber cables
FANUC has offered other types of optical cables for different applications (see Table D(c)).
Note that the optical cables for FANUC I/O Link and FANUC high–speed serial bus applications cannot be used for the servo interface application. On the other hand, however, the external optical cable for the servo interface application can be used in place of previous cables types, as shown in Table D(d). (The external optical cable for the servo interface application is designed to offer a level of performance equivalent to that of the previous cables. This is not the case with the internal cord type cable, so it cannot replace the previous cables.)

Table D(c) FANUC optical fiber cables

	System application	FANUC specification No.	Specification
Previous optical fiber cables	FANUC I/O Link	A66L–6001–0008#L ~	Internal cable/fixed type
		A66L–6001–0009#L ~	External cable/fixed type
	FANUC high–speed serial bus	A66L–6001–0021#L ~	External cable/fixed type
		A66L–6001–0022#L ~	External cable/fixed type
New optical fiber cables	Servo interface	A66L–6001–0023#L ~	Internal cable/fixed type
		A66L–6001–0026#L ~	External cable/fixed or portable type

Table D(d) Previous optical fiber cables that can be replaced by the new external cable (A66L–6001–0026#L)

Optical cable	→	Replaceable optical fiber cables
External cable for servo interface A66L–6001–0026#L ~	→	FANUC I/O Link: A66L–6001–0009#L ~
	→	FANUC high–speed serial bus: A66L–6001–0021#L ~
	→	FANUC high–speed serial bus: A66L–6001–0022#L ~

6. Optical fiber cable relay
    When used for the FANUC I/O Link application, optical fiber cables
    can be connected by using an optical fiber adapter, as follows.
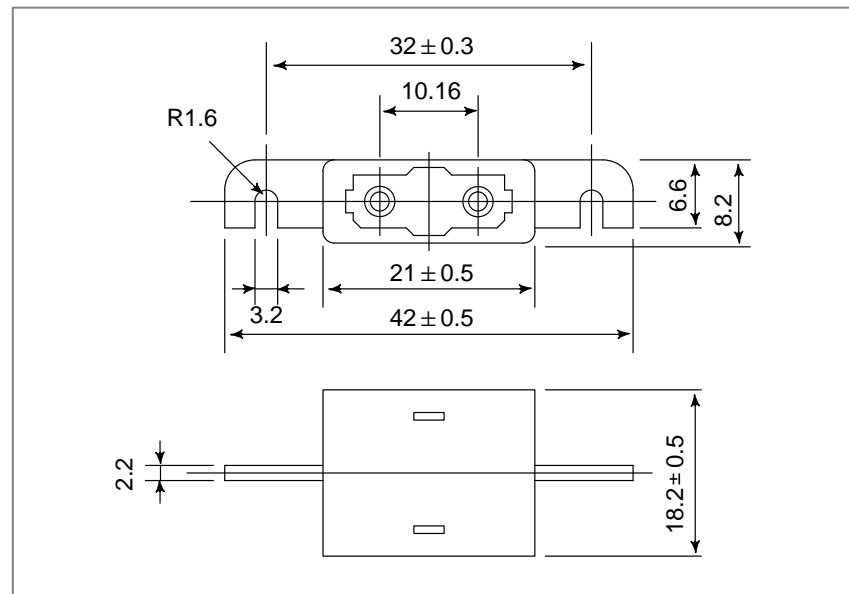
Fig. D(f) External view of an optical fiber adapter
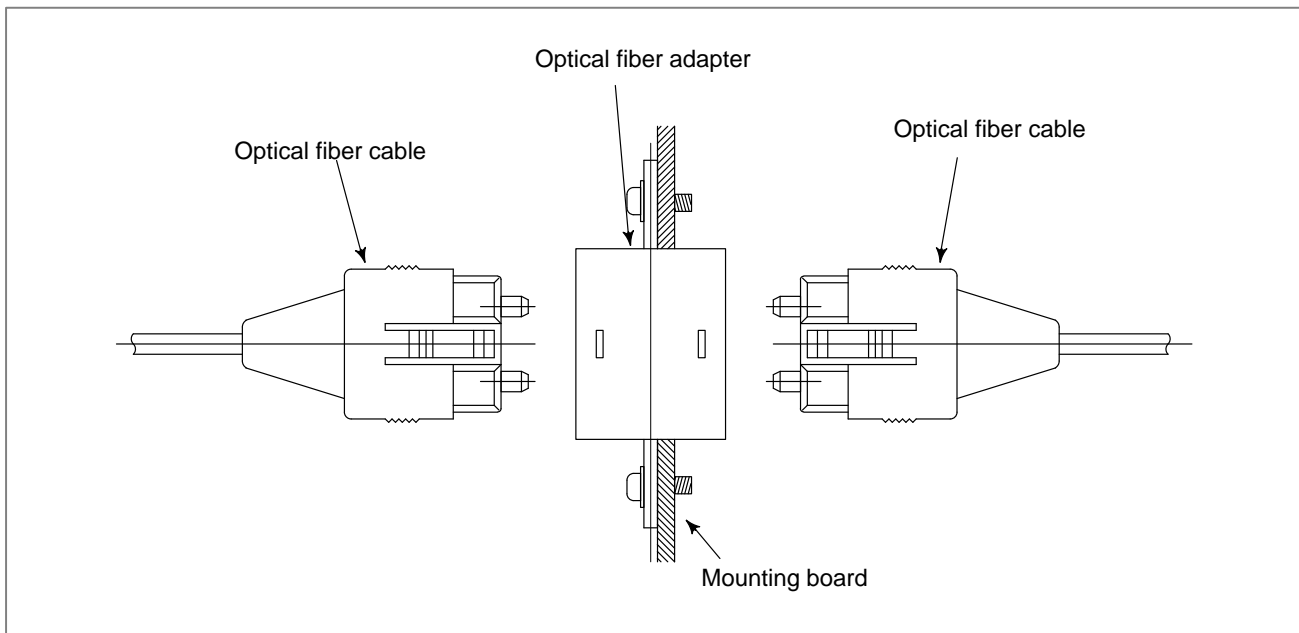
Fig. D(g) Example of the use of an optical fiber adapter

> **NOTE**
> Up to one relay points are permitted.

Revision Record

FANUC Series 16*i*/18*i*/160*i*/180*i* – MODEL A CONNECTION MANUAL (HARDWARE) (B–63003EN)

Edition	Date	Contents	Edition	Date	Contents
01	Mar., '97				