MITSUBISHI ELECTRIC

Mitsubishi Electric Industrial Robot

CR800-D Controller

RH-3CRH/6CRH
Standard Specifications Manual

RH-3CRH series
RH-6CRH series

MELFA

⚠ Safety Precautions

Always read the following precautions and the separate "Safety Manual" before starting use of the robot to learn the required measures to be taken.

⚠ **CAUTION** All teaching work must be carried out by an operator who has received special training. (This also applies to maintenance work with the power source turned ON.)
Enforcement of safety training

⚠ **CAUTION** For teaching work, prepare a work plan related to the methods and procedures of operating the robot, and to the measures to be taken when an error occurs or when restarting. Carry out work following this plan. (This also applies to maintenance work with the power source turned ON.)
Preparation of work plan

⚠ **WARNING** Prepare a device that allows operation to be stopped immediately during teaching work. (This also applies to maintenance work with the power source turned ON.)
Setting of emergency stop switch

⚠ **CAUTION** During teaching work, place a sign indicating that teaching work is in progress on the start switch, etc. (This also applies to maintenance work with the power source turned ON.)
Indication of teaching work in progress

⚠ **DANGER** Provide a fence or enclosure during operation to prevent contact of the operator and robot.
Installation of safety fence

⚠ **CAUTION** Establish a set signaling method to the related operators for starting work, and follow this method.
Signaling of operation start

⚠ **CAUTION** As a principle turn the power OFF during maintenance work. Place a sign indicating that maintenance work is in progress on the start switch, etc.
Indication of maintenance work in progress

⚠ **CAUTION** Before starting work, inspect the robot, emergency stop switch and other related devices, etc., and confirm that there are no errors.
Inspection before starting work

The points of the precautions given in the separate "Safety Manual" are given below.
Refer to the actual "Safety Manual" for details.

⚠ DANGER — When automatic operation of the robot is performed using multiple control devices (GOT, programmable controller, push-button switch), the interlocking of operation rights of the devices, etc. must be designed by the customer.

⚠ CAUTION — Use the robot within the environment given in the specifications. Failure to do so could lead to a drop or reliability or faults. (Temperature, humidity, atmosphere, noise environment, etc.)

⚠ CAUTION — Transport the robot with the designated transportation posture. Transporting the robot in a non-designated posture could lead to personal injuries or faults from dropping.

⚠ CAUTION — Always use the robot installed on a secure table. Use in an instable posture could lead to positional deviation and vibration.

⚠ CAUTION — Wire the cable as far away from noise sources as possible. If placed near a noise source, positional deviation or malfunction could occur.

⚠ CAUTION — Do not apply excessive force on the connector or excessively bend the cable. Failure to observe this could lead to contact defects or wire breakage.

⚠ CAUTION — Make sure that the workpiece weight, including the hand, does not exceed the rated load or tolerable torque. Exceeding these values could lead to alarms or faults.

⚠ WARNING — Securely install the hand and tool, and securely grasp the workpiece. Failure to observe this could lead to personal injuries or damage if the object comes off or flies off during operation.

⚠ WARNING — Securely ground the robot and controller. Failure to observe this could lead to malfunctioning by noise or to electric shock accidents.

⚠ CAUTION — Indicate the operation state during robot operation. Failure to indicate the state could lead to operators approaching the robot or to incorrect operation.

⚠ WARNING — When carrying out teaching work in the robot's movement range, always secure the priority right for the robot control. Failure to observe this could lead to personal injuries or damage if the robot is started with external commands.

⚠ CAUTION — Keep the jog speed as low as possible, and always watch the robot. Failure to do so could lead to interference with the workpiece or peripheral devices.

⚠ CAUTION — After editing the program, always confirm the operation with step operation before starting automatic operation. Failure to do so could lead to interference with peripheral devices because of programming mistakes, etc.

⚠ CAUTION   Make sure that if the safety fence entrance door is opened during automatic operation, the door is locked or that the robot will automatically stop. Failure to do so could lead to personal injuries.

⚠ CAUTION   Never carry out modifications based on personal judgments, or use non-designated maintenance parts.
Failure to observe this could lead to faults or failures.

⚠ WARNING   When the robot arm has to be moved by hand from an external area, do not place hands or fingers in the openings. Failure to observe this could lead to hands or fingers catching depending on the posture.

⚠ CAUTION   Do not stop the robot or apply emergency stop by turning the robot controller's main power OFF. If the robot controller main power is turned OFF during automatic operation, the robot accuracy could be adversely affected. Moreover, it may interfere with the peripheral device by drop or move by inertia of the arm.

⚠ CAUTION   Do not turn off the main power to the robot controller while rewriting the internal information of the robot controller such as the program or parameters.
If the main power to the robot controller is turned off while in automatic operation or rewriting the program or parameters, the internal information of the robot controller may be damaged.

⚠ DANGER   Do not connect the Handy GOT when using the GOT direct connection function of this product. Failure to observe this may result in property damage or bodily injury because the Handy GOT can automatically operate the robot regardless of whether the operation rights are enabled or not.

⚠ DANGER   Do not remove the SSCNET III cable while power is supplied to the multiple CPU system or the servo amplifier. Do not look directly at light emitted from the tip of SSCNET III connectors or SSCNET III cables of the Motion CPU or the servo amplifier. Eye discomfort may be felt if exposed to the light. (Reference: SSCNET III employs a Class 1 or equivalent light source as specified in JIS C 6802 and IEC60825-1 (domestic standards in Japan).)

⚠ DANGER   Do not remove the SSCNET III cable while power is supplied to the controller. Do not look directly at light emitted from the tip of SSCNET III connectors or SSCNET III cables. Eye discomfort may be felt if exposed to the light. (Reference: SSCNET III employs a Class 1 or equivalent light source as specified in JIS C 6802 and IEC60825-1 (domestic standards in Japan).)

⚠ DANGER   Attach the cap to the SSCNET III connector after disconnecting the SSCNET III cable. If the cap is not attached, dirt or dust may adhere to the connector pins, resulting in deterioration connector properties, and leading to malfunction.

⚠ CAUTION   Make sure there are no mistakes in the wiring. Connecting differently to the way specified in the manual can result in errors, such as the emergency stop not being released. In order to prevent errors occurring, please be sure to check that all functions (such as the teaching box emergency stop, customer emergency stop, and door switch) are working properly after the wiring setup is completed.

⚠ CAUTION Use the network equipments (personal computer, USB hub, LAN hub, etc) confirmed by manufacturer. The thing unsuitable for the FA environment (related with conformity, temperature or noise) exists in the equipments connected to USB. When using network equipment, measures against the noise, such as measures against EMI and the addition of the ferrite core, may be necessary. Please fully confirm the operation by customer. Guarantee and maintenance of the equipment on the market (usual office automation equipment) cannot be performed.

⚠ CAUTION To maintain the security (confidentiality, integrity, and availability) of the robot and the system against unauthorized access, DoS[*1] attacks, computer viruses, and other cyberattacks from unreliable networks and devices via network, take appropriate measures such as firewalls, virtual private networks (VPNs), and antivirus solutions.

Mitsubishi Electric shall have no responsibility or liability for any problems involving robot trouble and system trouble by unauthorized access, DoS attacks, computer viruses, and other cyberattacks.
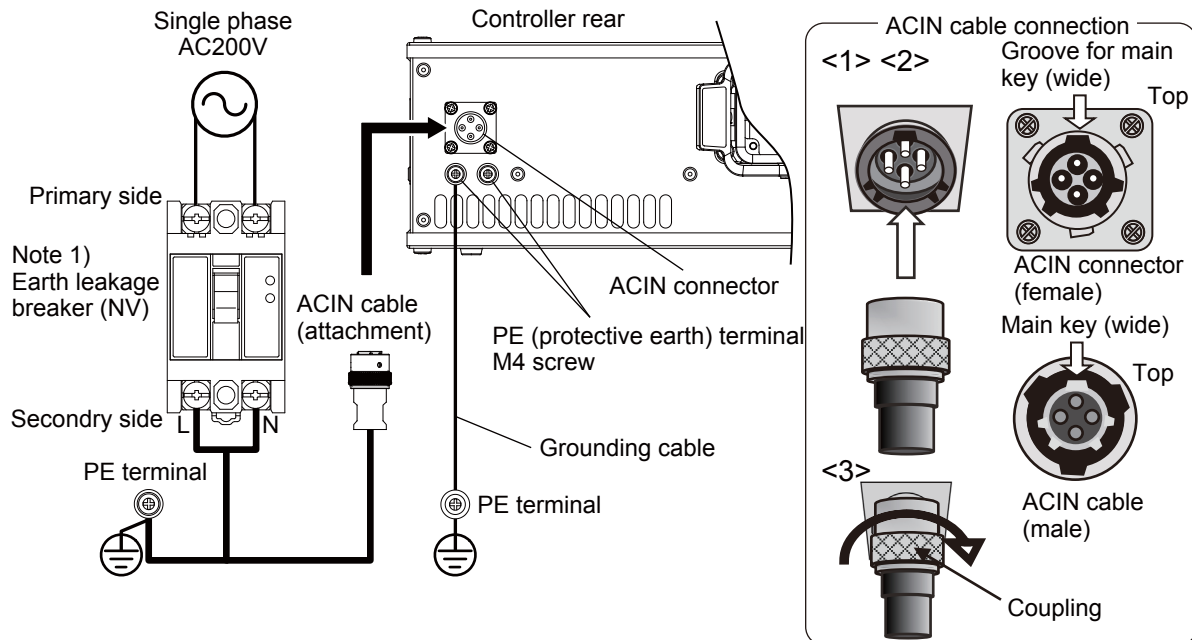
*1 DoS: A denial-of-service (DoS) attack disrupts services by overloading systems or exploiting vulnerabilities, resulting in a denial-of-service (DoS) state.

*CR800 controller

Notes of the basic component are shown.

⚠ **CAUTION**   Please install the earth leakage breaker in the primary side power supply of the controller because of leakage protection.

Note 1) Always use the terminal cover for the earth leakage breaker.

1) Prepare the following items.

Part name	Specifications	Remarks
Earth leakage breaker	The following is recommended product. Single phase: NV30FAU-2P-10A-AC100-240V-30mA (Terminal cover: TCS-05FA2)	Prepared by customer.
Cable for primary power supply	AWG14 (2mm^2) or above	Prepared by customer. Tightening torque for terminal fixing screw is 2 to 3N・m.
Grounding cable	AWG14 (2mm^2) or above	Prepared by customer. Tightening torque for terminal fixing screw is 2 to 3N・m.
ACIN cable	Terminal: M5, cable length: 3m	Supplied with the product.

2) Confirm that the primary power matches the specifications.

3) Confirm that the primary power is OFF and that the earth leakage breaker power switch is OFF.

4) Connect the ACIN cable to the breaker.
   Connect the power terminals of the ACIN cable to the secondary side terminals of the earth leakage breaker. Also, ground the FG terminal of the cable.

5) Connect the ACIN cable to the ACIN connector on the rear of the controller.
   <1> Face the main key on the ACIN cable plug upwards. (Refer to the "ACIN cable connection" illustration.)
   <2> Align the main key of the ACIN cable plug with the grooves on the ACIN connector. Push the plug into the connector as far as it will go.
   The plug may be damaged if it is not correctly aligned with the connector.
   <3> Tighten the coupling on the ACIN cable, turning it to the right until it locks.

6) Connect one end of the grounding cable to the PE (protective earth) terminal on the controller and ground the other end (2-point grounding) in order to comply with the requirements of EN 61800-5-1 for the touch current of 3.5 mA AC or more.

7) Connect the primary power cable to the primary side terminal of the earth leakage breaker.

⚠ CAUTION   Be careful of interference with peripheral equipment.
Especially don't give a shock to the shaft (J3 axis). When you install the
hand, be careful not to knock at the shaft end by the hammer etc. The shaft
may be damaged.

Take care also of the following items.

(1)The robot's locus of movement may change with specified speed.
Especially as for the corner section, short cut distance may change. Therefore, when
beginning automatic operation, moves at low speed at first, and you should gather speed
slowly with being careful of interference with peripheral equipment.

Arch movement (example)
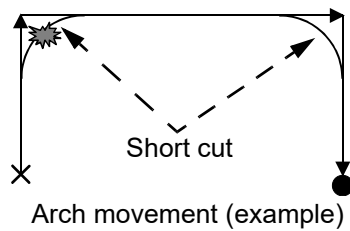
(2)It can be confirmed whether the specified position exist in the defined area by using the
instruction command "Zone". It can utilize as one of the methods for collision evasion. Refer to
the "detailed description of the instructions manual/function, and operation" of the separate
volume for the details of the instruction command.

■Revision history

Date of print	Specifications No.	Details of revisions
2018-03-01	BFP-A3606	• First print. • Environmental conditions of electromagnetic noise was modified.
2018-12-25	BFP-A3606-A	• Added further explanation of the ACIN cable. • Added a network base card for EtherCAT (2F-DQ535-EC). • Added explanation of the parallel I/O interface. • "3.8 Magnet contactor control connector output (AXMC) for addition axes" was modified.

2019-04-19	BFP-A3606-B	• Correction of errors.
		  Communication interface between robot controllers was deleted.
		  Description of connectors (EXT1, OPT1, OPT2) was modified.

2019-07-18	BFP-A3606-C	• Added the procedure for enabling the safety diagnosis function (STO function).

2020-01-24	BFP-A3606-D	• Adopted the DVD-ROM format for RT ToolBox3/RT ToolBox3 mini.
		• Added a figure to "2.1.2 The counter-force applied to the installation surface".
		• Correction of errors.
		  Corrected the name of a contact for NETcable-1 and the number of connectors/contacts. (Fig. 3-24)
		  Corrected the name of a signal. (Table 7-2)

2020-04-24	BFP-A3606-E	• Now supports the robot safety option (4F-SF002-01).
2020-10-30	BFP-A3606-F	• Amended the precautions regarding the prevention of unauthorized access. • Added an example of a protective circuit. (Fig. 3-5) • Added information to the specifications of the earth leakage breaker. • Added precautions for vertical installation of the robot controller. • Corrected the battery name. (ER6 → ER6V) • Corrected other mistakes and changed some sections.
2021-01-22	BFP-A3606-G	• Added "6.4 EMC installation guideline".
2021-01-29	BFP-A3606-H	• Updated contents for the optional product "MELFA-3D Vision 3.0 (3F-53U-WINM)".
2021-02-19	BFP-A3606-J	• Added support for the Function expansion card option (2F-DQ510, 2F-DQ511, 2F-DQ520, 2F-DQ521).
2021-04-01	BFP-A3606-K	• Elaborated on explanations on the STO function.
2021-09-30	BFP-A3606-M	• Corrected the explanation of the parameter "SRVON". • Added illustrations showing the installation position of ferrite cores. (Fig. 3-6) • Revised "(6) Parallel I/O interface". • Revised "(8) Parallel I/O unit". • Corrected the explanation of noise in "6.2 Working environment". • Corrected other mistakes and changed some sections.
2022-01-31	BFP-A3606-N	• Revised "6.4 EMC installation guideline". • Corrected other mistakes and changed some sections.
2022-06-30	BFP-A3606-P	• Corrected the model name of the EtherCAT module manufactured by HMS.
2022-11-30	BFP-A3606-Q	• Changed the parallel I/O interface connector (supplied). • Changed the plug of the external I/O cable for the parallel I/O interface. • Corrected other mistakes and changed some sections.
2023-04-17	BFP-A3606-R	• The HMS module model was corrected. • Added table about controller safety performance. (Table 3-2) • Corrected other mistakes and changed some sections.
2023-06-07	BFP-A3606-S	• Added information on the fault loop impedance to "3.1.2 (2) Operating supply". • Added descriptions to "6.1.1 Table 6-1: Self-diagnosis stop functions" regarding that the thermal memory function is not supported for the overload protection function and overcurrent diagnosis function.

■Introduction

This series offers small-size industrial robots developed using Mitsubishi's latest technology. They are especially designed to handle and assemble mechanical parts. They are Mitsubishi's answer to the customer's need to achieve a compact manufacturing facility capable of highly flexible production, as necessitated by the diffusion of high-density product groups and the shorter product life cycles that have become common-place in recent years.
However, to comply with the target application, a work system having a well-balanced robot arm, peripheral devices or robot and hand section must be structured.
When creating these standard specifications, we have edited them so that the Mitsubishi robot's characteristics and specifications can be easily understood by users considering the implementation of robots. However, if there are any unclear points, please contact your nearest Mitsubishi branch or dealer.
Mitsubishi hopes that you will consider these standard specifications and use our robots.

Note that in this specification document the specifications related to the robot arm is described in , the specifications related to the controller in , and software functions and a command list in separately.

This document has indicated the specification of the following types robot.

Robot type   *RH-3CRH/-S15
               *RH-6CRH/-S15

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1 General configuration

1.1 Structural equipment

Structural equipment consists of the following types.

1.1.1 Standard structural equipment

The following items are enclosed as a standard.
  (1) Robot arm
  (2) Controller
  (3) Machine cable
  (4) Robot arm installation bolts
  (5) CD-ROM (Instruction manual)

1.1.2 Special specifications

For the special specifications, some standard configuration equipment and specifications have to be changed before factory shipping. Confirm the delivery date and specify the special specifications at the order.

1.1.3 Options

User can install options after their delivery.

1.1.4 Maintenance parts

Materials and parts for the maintenance use.

1.2 Model type name of robot

This robot has arranged the type name corresponding to load mass, arm length, and environment specification. Details are shown below, please select the robot suitable for the customer's use.

1.2.1 How to identify the robot model

RH - ◇ **CRH** □□ △△ - **D** - **Sxx**
(a)   (b)   (c)   (d)   (e)   (f)   (g)

(a). RH .... Indicates the horizontal multiple-joint robot.

(b). ◇ .... Indicates the maximum load.
                        Example)
                          3: 3 kg
                          6: 6 kg

(c). CRH .... Indicates the CRH series.

(d). □□ .... Indicates the arm length.
                        Example)
                          40: 400 mm
                          60: 600 mm
                          70: 700 mm

(e). △△ .... Indicates the vertical stroke length.
                        Example)
                          18: 180 mm stroke
                          20: 200 mm stroke

(f). D .... Indicates the controller type.
                        D: Stand alone type

(g). - Sxx .... Indicates a special model. In order, limit special specification.
                      Example)
                          S15: The parallel I/O interface installed on the controller is source type (2D-TZ378). It was originally sink type (2D-TZ368).

1.2.2 Combination of the robot arm and the controller

Table 1-1: Combination of robot arm and controller

Robot (robot arm + controller)	Robot arm	Arm length (mm)	Vertical stroke length (mm)	Controller
RH-3CRH4018-D	RH-3CRH4018-D-A	400	180	
RH-6CRH6020-D	RH-6CRH6020-D-A	600	200	CR800-CHD
RH-6CRH7020-D	RH-6CRH7020-D-A	700	200	

1.3 Contents of the structural equipment

1.3.1 Robot arm

The list of structural equipment is shown in below.

Horizontal four-axis multiple-jointed type
(RH-3CRH/RH-6CRH)

Machine cable
(Standard product: 5 m attachment)

Machine cable extension (replacement type)
• Fixed type: 1F-□□UCBL-42
• Flexed type: 1F-□□LUCBL-42
Note 1) □□ refer the length.
Refer to Page 7, "Table 1-2" for details.
Note 2) Replace the enclosed standard cables with
these cables.

* Refer to Page 10, "2.1 Standard specifications" for details on the specifications.

[Caution]

Standard configuration equipment

Option

Fig.1-1: Structural equipment

1.3.2 Controller

The devices shown below can be installed on the controller.

The controllers that can be connected differ depending on the specification of the robot. (Refer to Page 2, "1.2 Model type name of robot".)
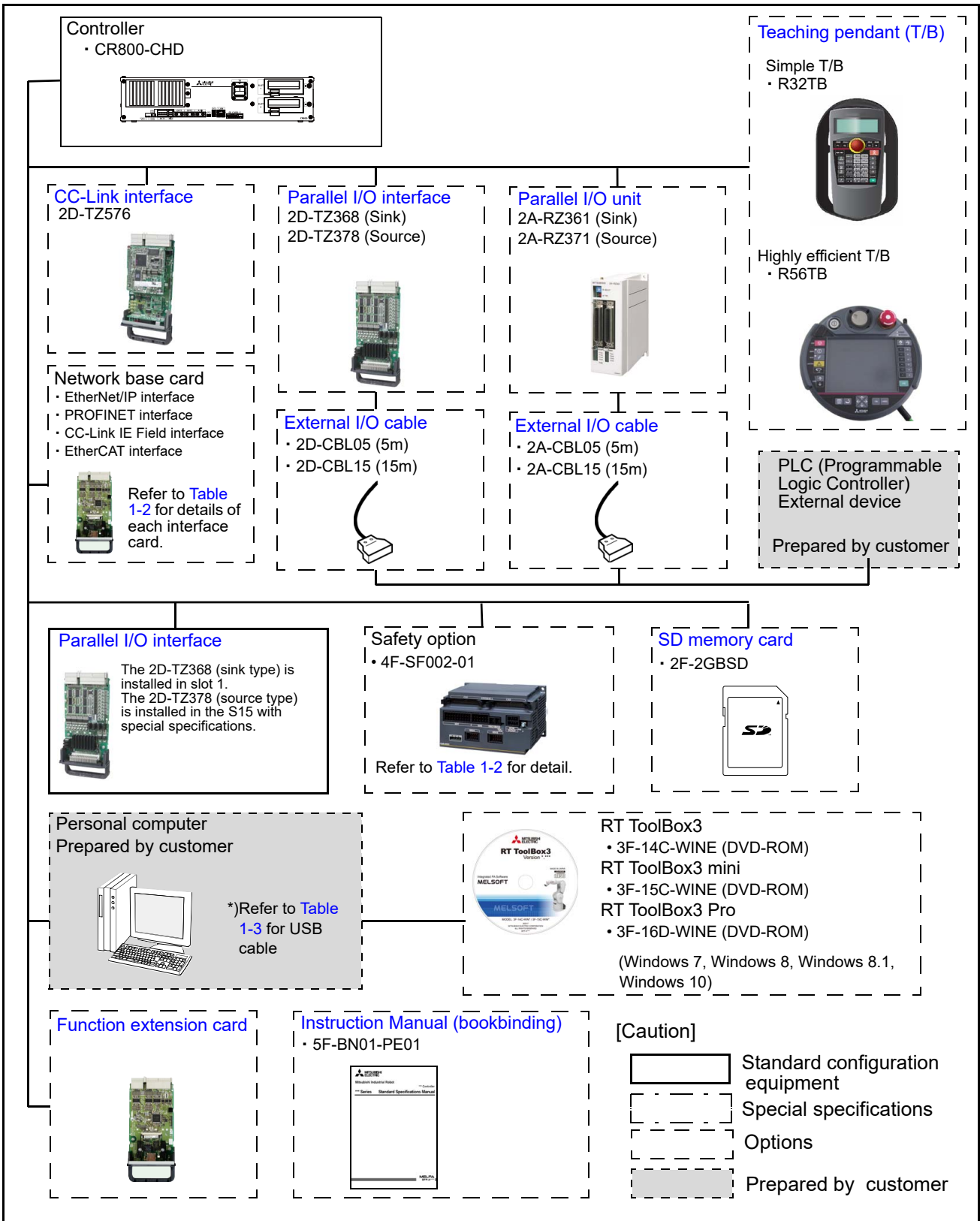
Fig.1-2: Structural equipment

1.3.3 Function extension device

These devices (option) are used to extend the function of the robot.

MELFA-3D Vision 3.0
• 3F-53U-WINM

Fig.1-3: Function extension device

1.4 Contents of the Option equipment and special specification

A list of all Optional equipment and special specifications are shown below.

Table 1-2: List of the optional equipment and special specifications

Item	Model	Specifications	Classification Note1)	Remarks
Machine cables (replacement)	1F-□□UCBL-42	Fixed type	○	3m, 10m, 15m, 20m (used as alternative cables to the standard 5m cables.)
	1F-□□LUCBL-42	Flexed type	○	10m, 15m, 20m (used as alternative cables to the standard 5m cables.)
Simple teaching pendant	R32TB	Cable length: 7m	○	ENABLE switch (three-position switch) is equipped. IP65 compatible
	R32TB-15	Cable length: 15m	○	
Parallel I/O interface	2D-TZ368 (sink type)/ 2D-TZ378 (source type)	Input/output: 32/32 points Insulated type output signal (0.1 A/24 V output per point) Insulated type input signal (9 mA/24 V input per point)	□	An interface that expands the number of external I/O points. The 2D-TZ368 (sink type) is installed in SLOT1 of the robot controller from the factory. The 2D-TZ378 (source type) is installed in the S15 with special specifications.
External I/O cable (for parallel I/O interface)	2D-CBL05	5 m	○	A cable connected between the external I/O interface and peripheral equipment.
	2D-CBL15	15 m	○	
Parallel I/O unit	2A-RZ361 (sink type) / 2A-RZ371 (source type)	Input/output: 32/32 points Insulated type output signal (0.1A/24V output per point) Insulated type input signal (7mA/24V input per point)	○	A unit device for external I/O, attached on the outside of the controller for use.
External I/O cable (for parallel I/O unit)	2A-CBL05	5m	○	A cable connected between the external I/O unit and peripheral equipment.
	2A-CBL15	15m	○	
CC-Link interface	2D-TZ576	Supporting intelligent device stations and local network stations only.	○	Used for connecting to a MELSEC programmable controller through CC-Link network.
Network base card (EtherNet/IP interface)	2D-TZ535	Communication interface for mounting the Anybus CompactCom module manufactured by HMS. The customer needs to prepare the EtherNet/IP module (AB6314-B-218) manufactured by HMS.	○	Refer to separate volume "Network Base Card Instruction Manual" for details.
Network base card (PROFINET interface)	2D-TZ535-PN	Communication interface for mounting the Anybus CompactCom module manufactured by HMS. The customer needs to prepare the PROFINET IO module (AB6489-B) manufactured by HMS.	○	Refer to separate volume "Network Base Card Instruction Manual" for details.
Network base card (CC-Link IE Field interface)	2F-DQ535	Communication interface for mounting the Anybus CompactCom module manufactured by HMS. The customer needs to prepare the CC-Link IE Field module (AB6709-B-116) manufactured by HMS.	○	Refer to separate volume "Network Base Card Instruction Manual" for details.

Item	Model	Specifications	Classification Note1)	Remarks
Network base card (EtherCAT interface)	2F-DQ535-EC	Communication interface for mounting the Anybus CompactCom module manufactured by HMS. The customer needs to prepare the EtherCAT module (AB6707-D-224) manufactured by HMS.	○	Refer to the separate volume "Network Base Card Instruction Manual" for details.
Function extension card	2F-DQ510	MELFA Smart Plus card pack (A-type)	○	Item to enable the software extension function MELFA Smart Plus. Software version of controller: Ver. A5p or later.
	2F-DQ520	MELFA Smart Plus card pack (AB-type)	○	
	2F-DQ511	MELFA Smart Plus card (A-type)	○	
	2F-DQ521	MELFA Smart Plus card (B-type)	○	
SD memory card	2F-2GBSD	Memory card capacity 2GB.	○	
Safety option	4F-SF002-01	Item to support the safety I/O.	○	Refer to separate volume "Robot Safety Option Instruction Manual" for details.
RT ToolBox3	3F-14C-WINE	DVD-ROM	○	Windows 7, Windows 8, Windows 8.1, Windows 10 Supporting English. (With the simulation function)
RT ToolBox3 mini	3F-15C-WINE	DVD-ROM	○	Windows 7, Windows 8, Windows 8.1, Windows 10 Supporting English.
RT ToolBox3 Pro	3F-16D-WINE	DVD-ROM	○	Windows 7, Windows 8, Windows 8.1, Windows 10 Supporting English.
Instruction manual (printed)	5F-BN01-PE01	A set of manuals of RH-3CRH/6CRH	○	
MELFA-3D Vision 3.0	3F-53U-WINM	Software that connects a compact 3D vision sensor for robots to measure and recognize parts.	○	Refer to separate volume "MELFA-3D Vision 3.0 Instruction Manual" for details.

Note1) ○ : option, □ : special specifications.

[Reference]:The recommendation products of the USB cable are shown below

Table 1-3: Recommendation article of the USB cable

Name	Type name	Supplier	Outside dimensions
USB cable (USB A type-USB mini B type)	GT09-C30USB-5P	MITSUBISHI ELECTRIC SYSTEM & SERVICE CO., LTD.	Fig. 1-4
	MR-J3USBCBL3M	MITSUBISHI ELECTRIC CO., LTD.	Fig. 1-5

⚠ Caution Be careful to the USB cable to apply neither the static electricity nor the noise. Otherwise, it becomes the cause of malfunction.

⚠ Caution Use the network equipments (personal computer, USB hub, LAN hub, etc) confirmed by manufacturer. The thing unsuitable for the FA environment (related with conformity, temperature or noise) exists in the equipments connected to USB.
When using network equipment, measures against the noise, such as measures against EMI and the addition of the ferrite core, may be necessary. Please fully confirm the operation by customer. Guarantee and maintenance of the equipment on the market (usual office automation equipment) cannot be performed.

Fig.1-4: USB cable (GT09-C30USB-5P)

Fig.1-5: USB cable (MR-J3USBCBL3M)

2 Robot arm
2.1 Standard specifications
2.1.1 Basic specifications

(1) RH-3CRH

Table 2-1: Standard specifications of robot arm

Type			RH-3CRH4018
Environment			Standard specification
Installation posture			On floor
Degree of freedom			4
Structure			Horizontal, multiple-joint type
Drive system			AC servo motor
Position detection method			Absolute encoder
Motor capacity	J1	W	200
	J2	W	100
	J3 (Z)	W	100
	J4 (θ)	W	100
Brake			J1, J2, J4 axes: no brake J3 axis: with brake
Arm length	№1 arm	mm	225
	№2 arm	mm	175
Reach radius (№ 1+ № 2)		mm	400
Operating range	J1	deg	264(±132)
	J2	deg	282(±141)
	J3 (Z)	mm	180
	J4 (θ)	deg	720(±360)
Speed of motion Note1)	J1	deg/sec	720
	J2	deg/sec	720
	J3	mm/sec	1100
	J4	deg/sec	2600
	J1+J2	mm/sec	7200
Pose repeatability Note2)	X-Y direction	mm	±0.01
	J3 (Z)	mm	±0.01
	J4 (θ)	deg	±0.01
Cycle time Note3)		sec	0.44
Load	Rating	kg (N)	1
	Maximum	kg (N)	3
Allowable inertia (during the large inertia modeNote4))	Rating	kg•m^2	0.005
	Maximum	kg•m^2	0.05 (0.075)
J3(Z) axis pressing force Note5)		N	100
Maximum eccentricity (during the large inertia modeNote6))		mm	150 (10)
Mass		kg	14
Tool wiring			15 points, D-SUB
Tool pneumatic pipes			φ6 × 2, φ4 × 1
Supply pressure		MPa	0.5±10%
Protection specification Note7)			IP20
Ambient temperature Note8)		℃	0 to 40
Painting color			Light gray (reference Munsell color: 0.6B7.6/0.2)
Machine cable		m	5

Note1) The maximum speed is the value which applied MvTune2 (high-speed movement mode).
   In addition, it is the value during load conditions in which the effects of automatic speed compensation due to load mass are not being imparted.
Note2) The pose repeatability details are given in Page 14, "2.2.1 Pose repeatability".

Note3) The value with the movements and conditions below when the MvTune2 (high-speed movement mode) is applied.
　　　• The cycle time may increase with the case where the positioning accuracy of the work etc. is necessary, or by the moving position.

```
        300
|←─────────────→|
 ╭───────────────╮        <Conditions>
 │               │  25    carrying mass of 2 kg
 ▼               ▼
```

(Unit: mm)

Note4) The values in parentheses are the values when the large inertia mode is enabled.
Note5) When the maximum load is installed, the downward pushing force generated at the tip of the load is obtained with J1, J2, and J4 axes stopped. The force shown above is the maximum value. When the force is applied for a long time, an overload error will be generated. Prevent errors from occurring.
Note6) The values in parentheses are the values when the large inertia mode is enabled.
Note7) The protection specification details are given in Page 21, "2.2.7 Protection specifications".
Note8) Sets the robot's operating environmental temperature as parameter OLTMX. Corresponding to the environment, the continuous control action performance and the overload-protection function are optimized. (Refers to "Optimizing the overload level" described in "Chapter 5 Functions set with parameters" of separate instruction manual/ Detailed explanations of functions and operations for details.)

(2) RH-6CRH

Table 2-2: Standard specifications of robot arm

Type			RH-6CRH6020	RH-6CRH7020
Environment			Standard specification	
Installation posture			On floor	
Degree of freedom			4	
Structure			Horizontal, multiple-joint type	
Drive system			AC servo motor	
Position detection method			Absolute encoder	
Motor capacity	J1	W	200	
	J2	W	200	
	J3 (Z)	W	100	
	J4 (θ)	W	100	
Brake			J1, J2 axes: no brake J3, J4 axes: with brake	
Arm length	№1 arm	mm	325	425
	№2 arm	mm	275	
Reach radius (№ 1+ № 2)		mm	600	700
Operating range	J1	deg	264(±132)	
	J2	deg	300(±150)	
	J3 (Z)	mm	200	
	J4 (θ)	deg	720(±360)	
Speed of motion [Note1]	J1	deg/sec	420	360
	J2	deg/sec	720	
	J3	mm/sec	1100	
	J4	deg/sec	2500	
	J1+J2	mm/sec	7800	
Pose repeatability [Note2]	X-Y resultant	mm	±0.02	
	J3 (Z)	mm	±0.01	
	J4 (θ)	deg	±0.01	
Cycle time [Note3]		sec	0.41	0.43
Load	Rating	kg (N)	2	
	Maximum	kg (N)	6	
Allowable inertia (during heavy load mode [Note4])	Rating	kg•m²	0.01	
	Maximum	kg•m²	0.12 (0.18)	
J3(Z) axis pressing force [Note5]		N	100	
Maximum eccentricity (during heavy load mode [Note6])		mm	150 (10)	
Mass		kg	17	18
Tool wiring			15 points, D-SUB	
Tool pneumatic pipes			φ6 × 2, φ4 × 1	
Supply pressure		MPa	0.5±10%	
Protection specification [Note7]			IP20	
Ambient temperature [Note8]		℃	0 to 40	
Painting color			Light gray (Equivalent to Munsell color: 0.6B7.6/0.2)	
Machine cable		m	5	

Note1) The maximum speed is the value which applied MvTune2 (high-speed movement mode).
In addition, it is the value during load conditions in which the effects of automatic speed compensation due to load mass are not being imparted.

Note2) The pose repeatability details are given in Page 14, "2.2.1 Pose repeatability".

Note3) The value with the movements and conditions below when the MvTune2 (high-speed movement mode) is applied.
· The cycle time may increase with the case where the positioning accuracy of the work etc. is necessary, or by the moving position.

Note4) The values in parentheses are the values when the large inertia mode is enabled.
Note5) When the maximum load is installed, the downward pushing force generated at the tip of the load is obtained with J1, J2, and J4 stopped. The force shown above is the maximum value. When the force is applied for a long time, an overload error will be generated. Prevent errors from occurring.
Note6) The values in parentheses are the values when the large inertia mode is enabled.
Note7) The protection specification details are given in Page 21, "2.2.7 Protection specifications".
Note8) Sets the robot's operating environmental temperature as parameter OLTMX. Corresponding to the environment, the continuous control action performance and the overload-protection function are optimized. (Refers to "Optimizing the overload level" described in "Chapter 5 Functions set with parameters" of separate instruction manual/ Detailed explanations of functions and operations for details.)

2.1.2 The counter-force applied to the installation surface

The counter-force applied to the installation surface for the strength design of the robot installation surface is shown.
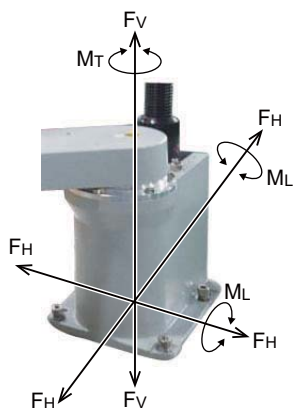
Table 2-3: Value of each counter-force

	Unit	RH-3CRH	RH-6CRH6020	RH-6CRH7020
Falls moment: M_L	N•m	220	410	500
Torsion moment: M_T	N•m	180	260	370
Horizontal translation force: F_H	N	820	800	960
Vertical translation force: F_V	N	320	640	670

2.2 Definition of specifications

The accuracy of pose repeatability mentioned in catalogs and in the specification manual is defined as follows.

2.2.1 Pose repeatability

For this robot, the pose repeatability is given in accordance with JIS B 8432 (Pose repeatability). Note that the value is based on 100 measurements (although 30 measurements are required according to JIS).

[Caution] The specified "pose repeatability" is not guaranteed to be satisfied under the following conditions.

[1] Operation pattern factors
1) When an operation that approaches from different directions and orientations are included in relation to the teaching position during repeated operations
2) When the speed at teaching and the speed at execution are different

[2] Load fluctuation factor
1) When work is present/absent in repeated operations

[3] Disturbance factor during operation
1) Even if approaching from the same direction and orientation to the teaching position, when the power is turned OFF or a stop operation is performed halfway

[4] Temperature factors
1) When the operating environment temperature changes
2) When accuracy is required before and after a warm-up operation

[5] Factors due to differences in accuracy definition
1) When accuracy is required between a position set by a numeric value in the robot's internal coordinate system and a position within the actual space
2) When accuracy is required between a position generated by the pallet function and a position within the actual space

2.2.2 Mass capacity

The robot's mass capacity is expressed solely in terms of mass, but even for tools and works of similar mass, eccentric loads will have some restrictions When designing the tooling or when selecting a robot, consider the following issues.

  (1) The tooling should have the value less or equal than the smaller of the allowable moment of inertia found in Page 10, "2.1.1 Basic specifications".
  (2) Fig. 2-1 and Fig. 2-2 shows the distribution dimensions for the center of gravity in the case where the volume of the load is relatively small. Use this figure as a reference when designing the tooling. Please use the robot in the allowable moment of inertia of maximum moment of inertia shown in Fig. 2-1 and Fig. 2-2.

[Caution] Depending on the operating speed and operating posture of the robot, vibration, overload, and overcurrent alarms may occur even if the mass and inertia of the hand, workpiece, etc. are within the permissible range above. In such cases, please reduce acceleration and deceleration (Accel command) speeds and movement speed (Ovrd command). Although the standard value to reduce is 50% for each command, please adjust corresponding to the movement posture. Refer to separate "Instruction Manual/Detailed Explanation of Functions and Operations" for details of each command. Furthermore, these sorts of events will occur more readily if, for example, the hand/workpiece parameters are not set correctly, or the optimum acceleration/deceleration setting is disabled.

[Caution] Refer to Page 16, "2.2.3 Relationships Among Mass Capacity, Speed, and Acceleration/Deceleration Speed", and set the values of the mass, magnitude, and distance to the centroid of a tool and a workpiece to parameters.
If parameters are not set exactly, the lifetime of reduction gears, a belt, etc. is affected.

[Caution] The overhang amount of the load, such as the mass capacity and the allowable moment of inertia defined in this section, are dynamic limit values determined by the capacity of the motor that drives axes or the capacity of the speed reducer. Therefore, it does not guarantee the accuracy on all areas of tooling. Guaranteed accuracy is measured from the center point of the mechanical interface surface. Please note that if the point of operation is kept away from the mechanical interface surface by long and low-rigid tooling, the positioning accuracy may deteriorate or may cause vibration. Note that the allowable offset value (Z direction) from the lower edge of the shaft to the position of center of gravity is 100 mm.

[Caution] Even within the allowable range previously mentioned, an overload alarm may be generated if an ascending operation continues at a micro-low speed. In such a case, it is necessary to increase the ascending speed.

[Caution] This robot will restrict speed automatically by internal controls when the load center-of-gravity position separates from the shaft center. Refer to Page 16, "2.2.3 Relationships Among Mass Capacity, Speed, and Acceleration/Deceleration Speed" in detail.
The allowance distance (allowance offset amount) from the center of the shaft to the center of gravity for loads is 150 mm.

[Caution] When the large inertia mode is enabled, it is possible to use large hands (or workpieces) that exceed the allowable inertia for the standard load mode, but if the inertia exceeds the allowable inertia for the standard load mode, the permissible value for the distance from the center of the shaft to the center of gravity of the load (the offset amount) is 10 mm.
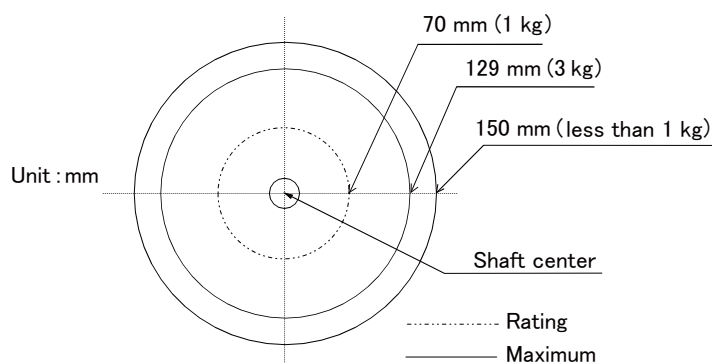
Fig.2-1: Position of the center of gravity for loads (for loads with comparatively small volume): RH-3CRH
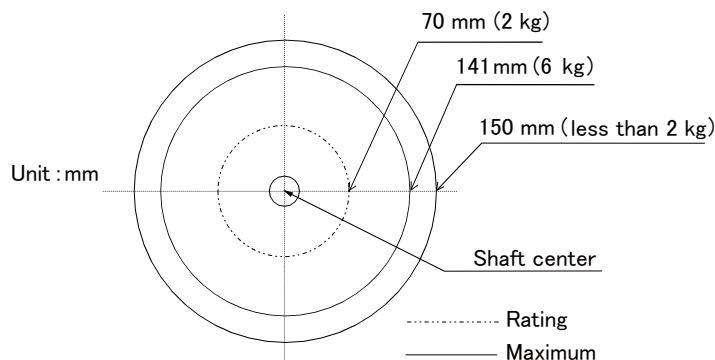
Fig.2-2: Position of the center of gravity for loads (for loads with comparatively small volume): RH-6CRH

2.2.3 Relationships Among Mass Capacity, Speed, and Acceleration/Deceleration Speed

This robot automatically sets the optimum acceleration and deceleration speeds and maximum speed, according to the load capacity and size that have been set, and operates using these automatically set speeds.

To achieve that, it is necessary to correctly set the actual load data (mass and size of hand and work) to be used. However, vibration, overheating and errors such as excessive margin of error and overload may occur, depending on the robot operation pattern or ambient temperature.

In this case, reduce the speed and the acceleration and deceleration rate before continuing to use. This is done by accessing the robot program and adjusting the speed settings (Ovrd) and the acceleration and deceleration settings (Accel).

If a setting is performed in such a way that it falls below the mounted load, the life span of the mechanism elements used in the robot may be shortened. In the case of a work requiring a high degree of accuracy, set up the load correctly and use the robot by lowering the ratios of the acceleration and deceleration speeds.

(1) Setting Load Capacity and Size (Hand Conditions)

Set up the capacity and size of the hand with the "HNDDAT*" parameter (optimum acceleration/deceleration setting parameter), and set up the capacity and size of the work with the "WRKDAT*" parameter. Numbers 0 to 8 can be used for the asterisk (*) part. Designate the "HNDDAT*" and "WRKDAT*" parameters to be used using the "LoadSet" command in a program.

For more details, refer to the separate "Instruction Manual/Detailed Explanation of Functions and Operations."

It is the same meaning as "LoadSet 0.0" if not using the "LoadSet".

<Factory default settings>

	Hand mass kg	size X mm	size Y mm	size Z mm	center-of-gravity position X mm	center-of-gravity position Y mm	center-of-gravity position Z mm
RH-3CRH series							
HNDDAT*	3.0	82.0	82.0	60.0	0.0	0.0	20.0
WRKDAT*	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	Hand mass kg	size X mm	size Y mm	size Z mm	center-of-gravity position X mm	center-of-gravity position Y mm	center-of-gravity position Z mm
RH-6CRH series							
HNDDAT*	6.0	82.0	82.0	60.0	0.0	0.0	20.0
WRKDAT*	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note) The position of the center of gravity is located at the center of the surface at the bottom of the shaft. Set the X, Y and Z center of gravity positions for the tool coordinate directions (the Z center of gravity position will be a plus for downward directions).

2.2.4 Vibrations at the Tip of the Arm during Low-Speed Operation of the Robot

Vibrations at the tip of the arm may increase substantially during the low-speed operation of the robot, depending on the combination of robot operation, hand mass and hand inertia. This problem occurs when the vibration count specific to the robot arm and the vibration count of the arm driving force are coming close to each other. These vibrations at the tip of the arm can be reduced by taking the following measures:

1) Change the robot's operating speed by using the Ovrd command.
2) Change and move the teaching points of the robot.
3) Change the hand mass and hand inertia.

2.2.5 Vibration of shaft (J3 axis) position and arm end

Vibrations at the tip of the arm may increase substantially during operation under the shaft position near the low end or the high end of the robot, depending on the combination of hand mass and hand inertia. This problem occurs according to that inertia, because the distance from the shaft support section to the shaft end becomes long. When this vibration affects the robot's operations, please change operating speed etc. like the above

(1) Relationship Between Mass Capacity and Speed

A function to optimize the maximum speed of each axis according to the setting value of the load capacity will be activated (Refer to Fig. 2-3).

However, this function does not work with the load mass of 2 kg or less.

When the load mass is changed to exceed 2 kg, the maximum speed is compensated according to the load mass.

[CAUTION] Depending on the operation pattern, the speed and/or acceleration/deceleration at the front edge may not be parallel with the speed and the rate of change of acceleration/deceleration specified in a program.
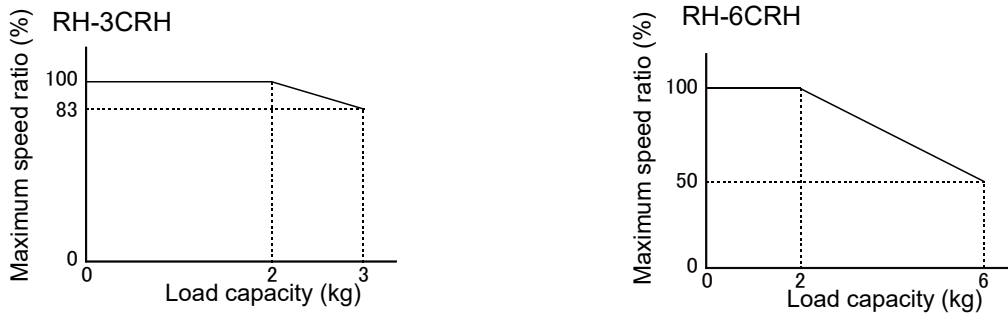
Fig.2-3: Automatic compensation of speed

(2) Relationship Between Height of Shaft (J3 Axis) and Acceleration/Deceleration Speed

A function to optimize the acceleration/deceleration speed according to the height of the shaft (Refer to Fig. 2-4, Fig. 2-5) will be activated. This function is invalid if the shaft (axis J3) operates at a position above P3 in Fig. 2-4. Acceleration/deceleration is compensated for at a position below P3 in Fig. 2-4 if the position of the center of gravity of the load is located at the front edge of the shaft.
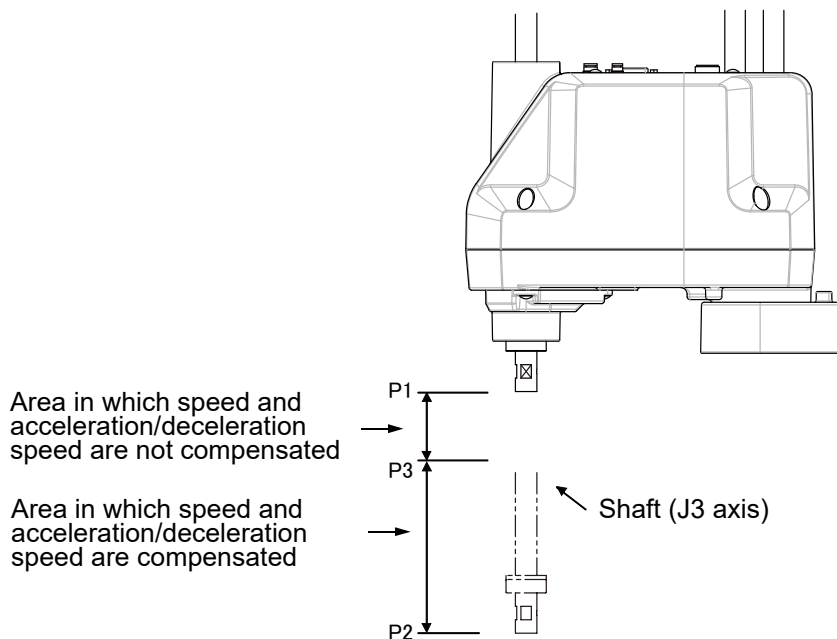
Fig.2-4: Area in which acceleration/deceleration speed is compensated

Table 2-4: Area in which acceleration/deceleration speed is compensated

Type	J3 axis stroke (mm)			Compensation area (P2 to P3)
	Stroke length	P1(Upper end)	P2(Lower end)	
RH-3CRH	180	144.5	-35.5	-35.5 to 70
RH-6CRH	200	149	-51	-51 to 99
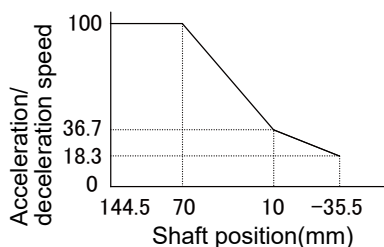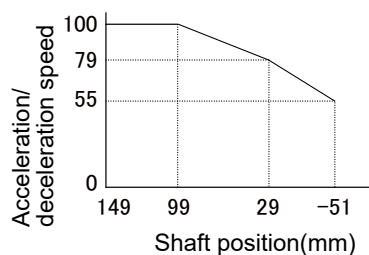
Fig.2-5: Automatic compensation of acceleration/deceleration speed

(3) Relationship Between Offset Amount and Maximum Speed

A function to optimize the maximum speed of each axis according to the offset amount will be activated. (Refer to Fig. 2-6.)

RH-3CRH

RH-6CRH
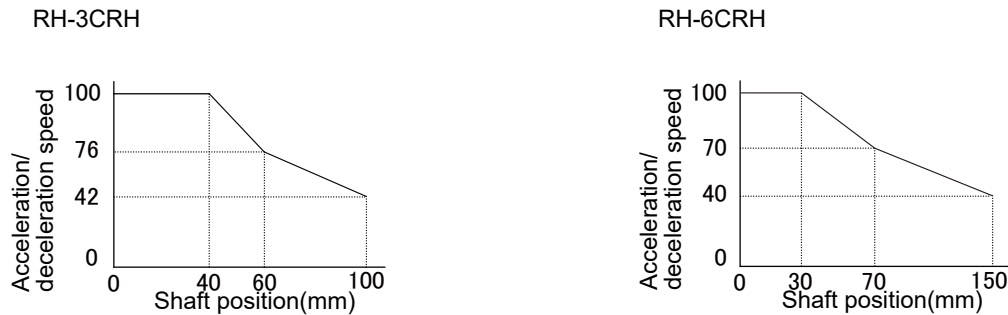
Fig.2-6: Relationship Between Offset Amount and Maximum Speed

[Supplementary explanation 1]: The setting which shortens execution time
The execution time can be improved by using the following methods.
1) Perform continuous path operation using the Cnt command.
2) Control the optimum acceleration/deceleration using the Oadl command.
3) Control the optimum speed using the Spd command.

[Supplementary explanation 2]: The setting which improves continuous control action performance in a short wait time
The continuous control action performance can be improved by setting a smaller value in the optimum acceleration/deceleration adjustment rate parameter (JADL). In this robot, the acceleration/deceleration speed is initialized for quick moves (setting of A in the Fig. 2-7).
If quick moves (short moving time) are required, such as L/UL work on machined parts, the acceleration/deceleration speed can be increased by initial setting (setting of A in the Fig. 2-7).
However, please note that some setting values of acceleration/deceleration speed tend to cause overload and overheat errors. In such a case, extend the wait time, reduce the acceleration/deceleration speed, or decrease the moving speed. This setting is suited for continuous operations that have a short tact time, such as palletizing work.
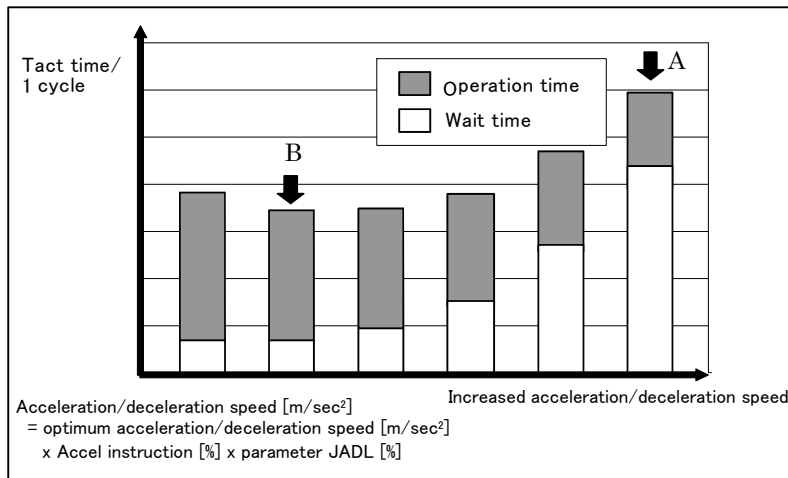
Fig.2-7: Relationship between Acceleration/deceleration Speed and Tact Time (Conceptual Drawing)

(4) Time to reach the position repeatability

When using this robot, the time to reach the position repeatability may be prolonged due to the effect of residual vibration at the time of stopping. If this happens, take the following measures:

1) Change the operation position of the Z axis to the location near the top as much as possible.
2) Increase the operation speed prior to stopping.
3) When positioning the work near the bottom edge of the Z axis, if no effectiveness is achieved in step "2)" above, perform operation ① (robot path: O → A → C). In the case of operation ② (robot path: O → B → C), residual vibration may occur. (Refer to Fig. 2-8.)
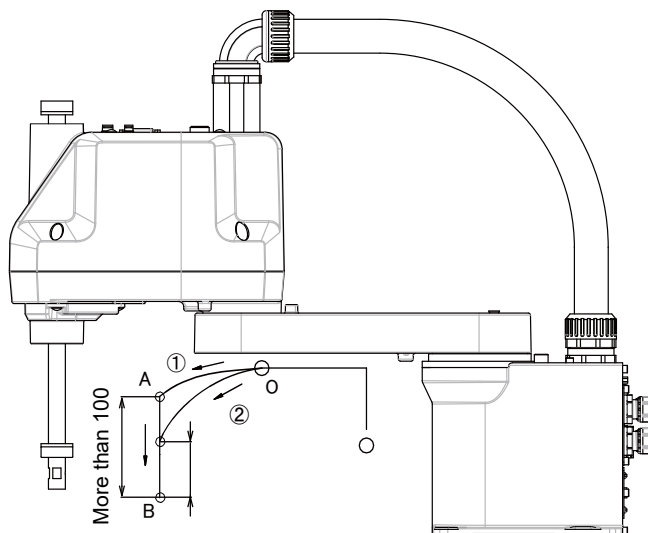
Fig.2-8: Recommended path when positioning at the bottom edge of the Z axis

2.2.6 Collision detection

This series have the "collision detection function" which detects the abnormalities by the collision of the robot arm, and the initial setting has set this function as the enable to suppress damage to the minimum. Although the enable/disable of this function can be changed by parameter: COL and command: ColChk, you should use in valid condition of this function for protection of the robot and of the peripheral equipment. The abnormalities are detected by the robot's kinetics model, presuming torque necessary for movement at any time. Therefore, the setting parameter (HNDDAT*, WRKDAT*) of the hand and the work piece conditions should be right. And, it may be detected as the collision in movement as speed and motor torque are changed rapidly. (for example, the movement near the place of the origin by linear interpolation, the reversal movement, the cold condition, the operation after long term stoppage)
In such a case, by adjusting the value of the setting parameter (COLLVL, COLLVLJG) of the collision detection level according to actual use environment, the sensitivity of collision detection can be optimized and the damage risk can be reduced further. And, in the operation after the low temperature or long term stoppage, please operate by accustoming at low speed (warm-up), or use the warm-up operation mode. Refer to the separate instruction manual "Detailed explanations of functions and operations" for details of related parameter.

Table 2-5: Factory-shipments condition

	JOG operation	Automatic
RH-3CRH/RH-6CRH	Valid	Invalid

2.2.7 Protection specifications
(1) Types of protection specifications

The robot arm has protection specifications that comply with the IEC Standards. The protection specifications and applicable fields are shown in Table 2-6.

Table 2-6: Protection specifications and applicable fields

Type	Protection specifications (IEC Standards value)	Classification	Applicable field	Remarks
RH-3CRH	Robot arm: IP20	General-purpose environment specifications	General assembly Slightly dusty environment	
RH-6CRH				

The IEC IP symbols define the degree of protection against solids and fluids, and do not indicate a protective structure against the entry of oil.
The IEC standard is described by the following "Information" And, the corrosion of the rust etc. may occur to the robot with the liquids.

[Information]
• The IEC IP20

It indicates the protective structure that prevents an iron ball 12 $_0^{+0.05}$ mm diameter, which is being pressed with the power of 3.1 kg±10%, from going through the opening in the outer sheath of the supplied equipment.

2.3 Names of each part of the robot

Fig.2-9: Names of each part of the robot

⚠ **CAUTION** When the brake release switch is pressed, the J3 axis will drop by its own weight. For added safety, provide support or take other precaution to prevent the falling of the J3 axis.

2.4 Outside dimensions / Operating range diagram

2.4.1 Outside dimensions / Operating range diagram

(1) Normal environmental specification

Note   Rev. *

*1) The space is required for battery replacement. The distance to the minimum bending radius of the machine cable is specified.

*2) The screw hole for fixing wiring and piping installed by the user.

Fig.2-10: Outside dimensions of RH-3CRH4018

Fig.2-11: Operating range diagram of RH-3CRH4018

Rev. *

Note
*1) The space is required for battery replacement. The distance to the minimum bending radius of the machine cable is specified.
*2) The screw hole for fixing wiring and piping installed by the user.
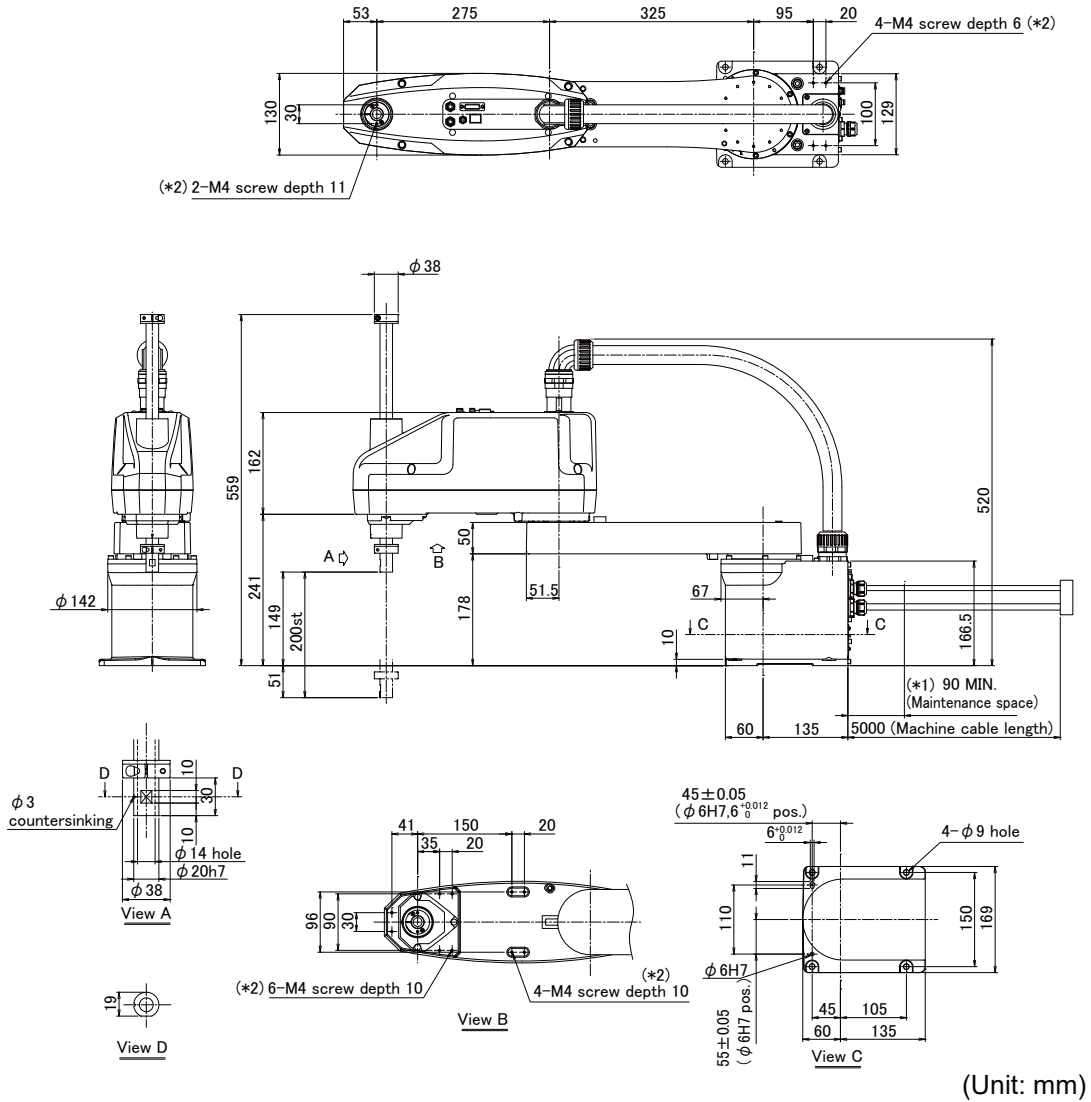
Fig.2-12: Operating range diagram of RH-6CRH6020
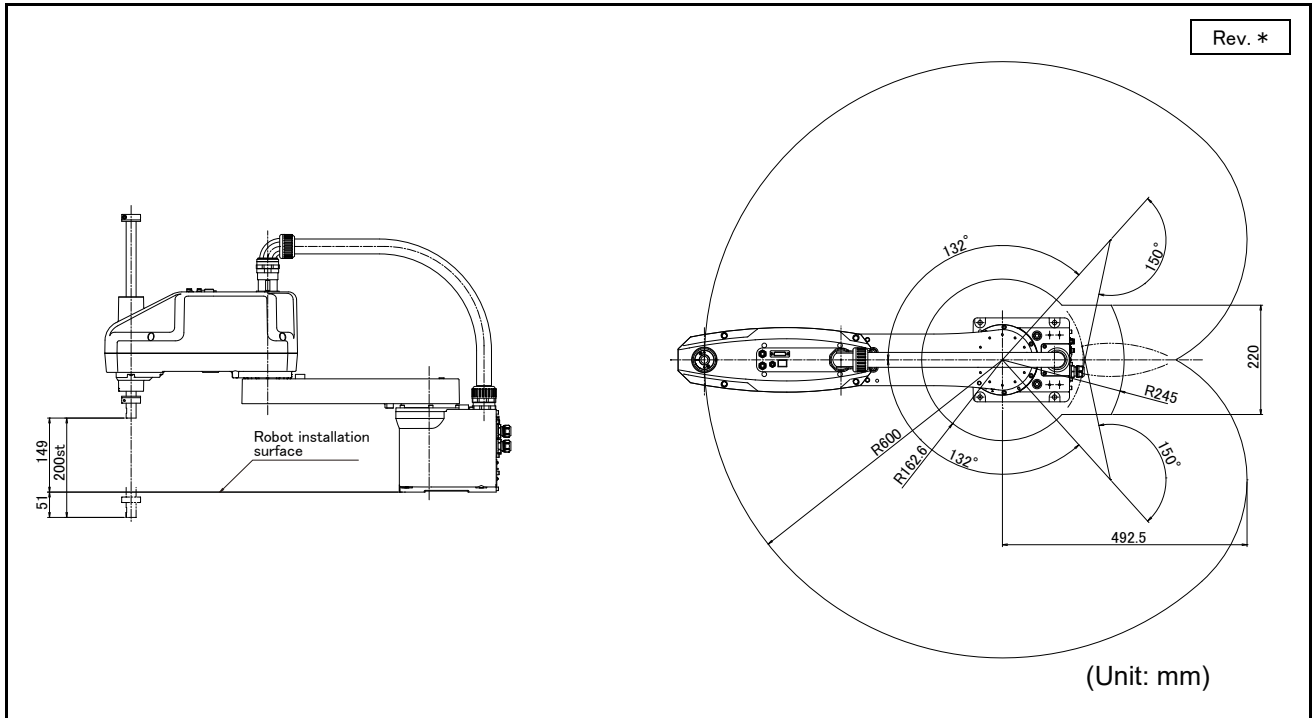
Fig.2-13: Operating range diagram of RH-6CRH6020

Note

*1) The space is required for battery replacement. The distance to the minimum bending radius of the machine cable is specified.

*2) The screw hole for fixing wiring and piping installed by the user.
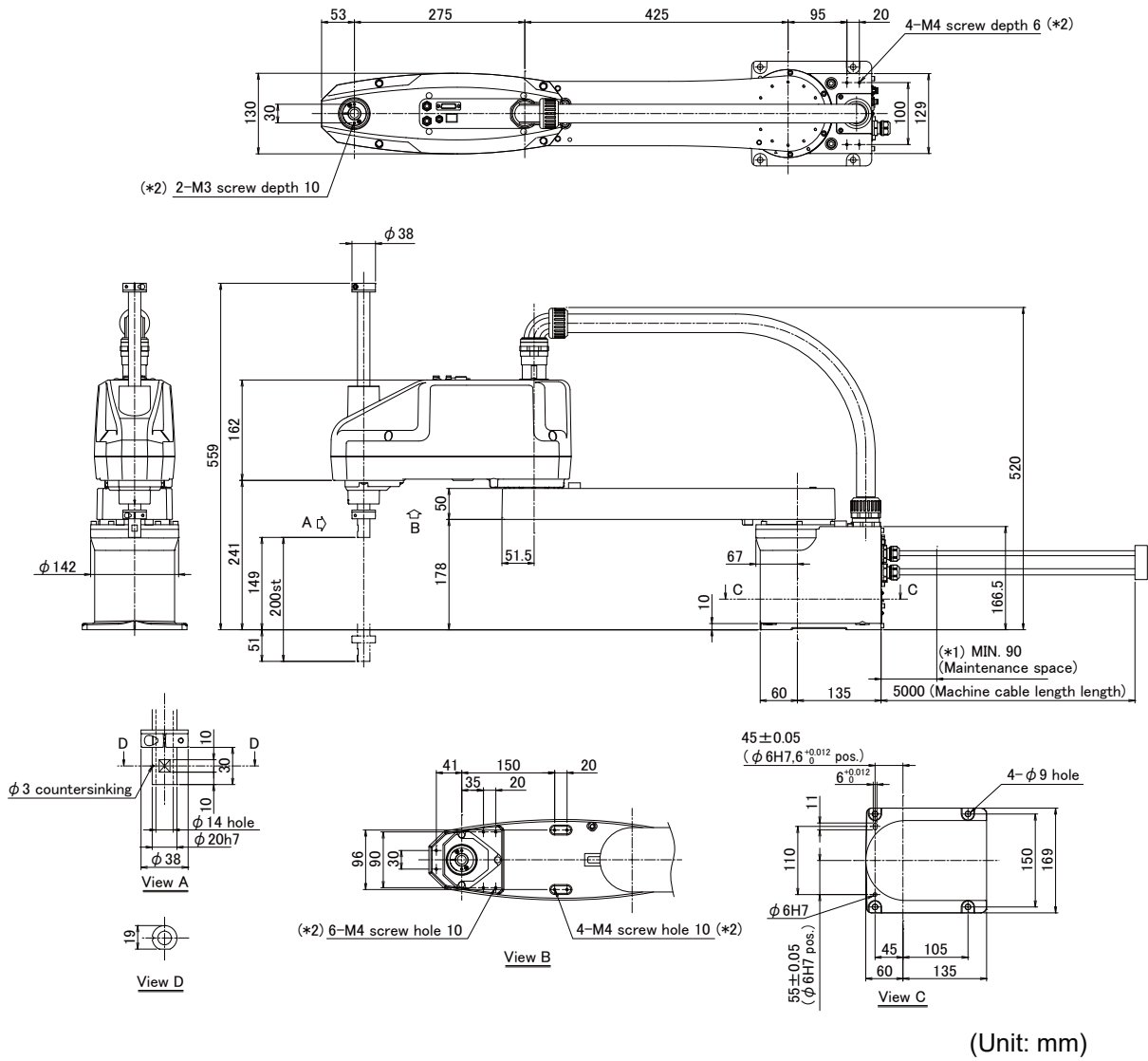
Fig.2-14: Operating range diagram of RH-6CRH7020
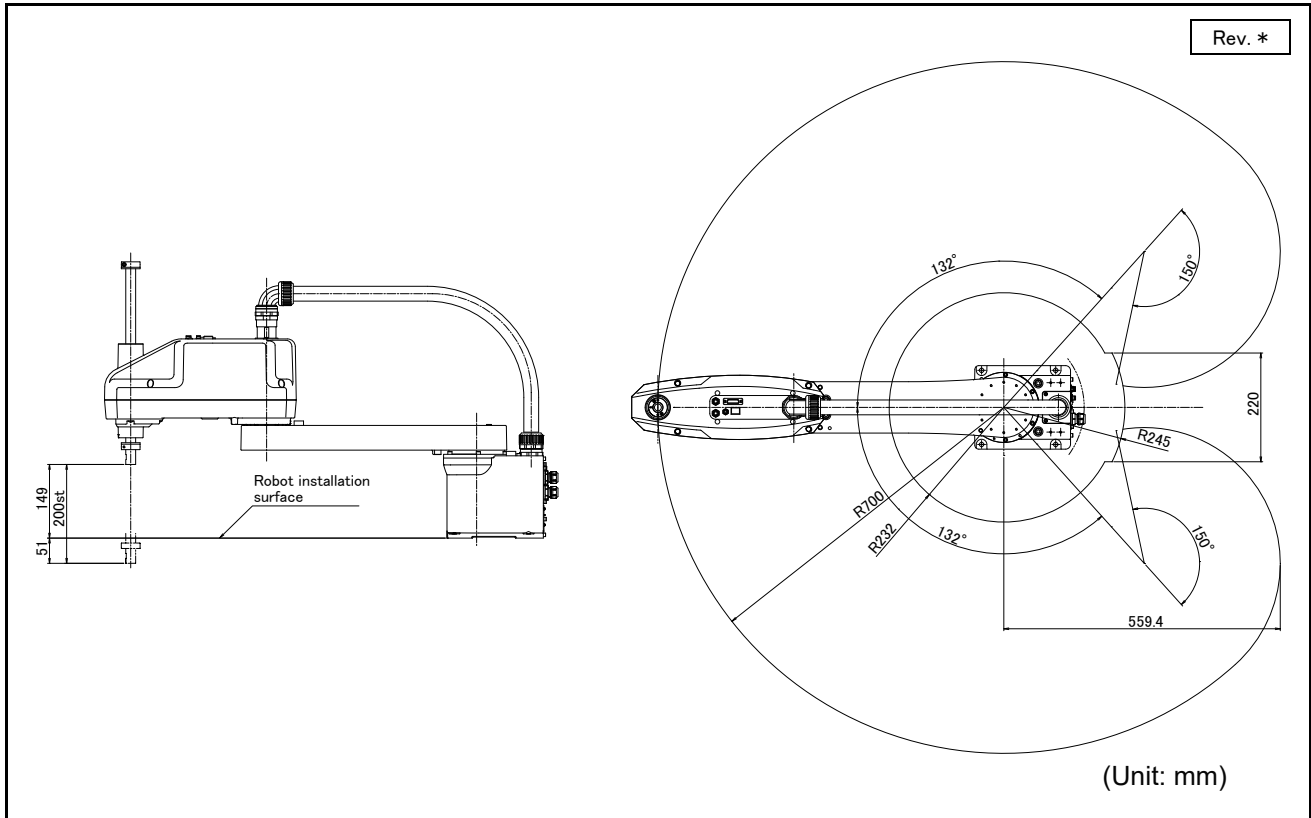
Fig.2-15: Operating range diagram of RH-6CRH7020

2.4.2 Outside dimensions of machine cables
(1) RH-3CRH/RH-6CRH (fixed type)

[Controller side]

Approx.101

Approx.85

Approx.φ11

φ77

Approx.45

Approx.73

Approx.φ8

Mass: 1.7kg
Minimum bending radius: 45mm

Cable

45mm

[Robot arm]

(Unit: mm)
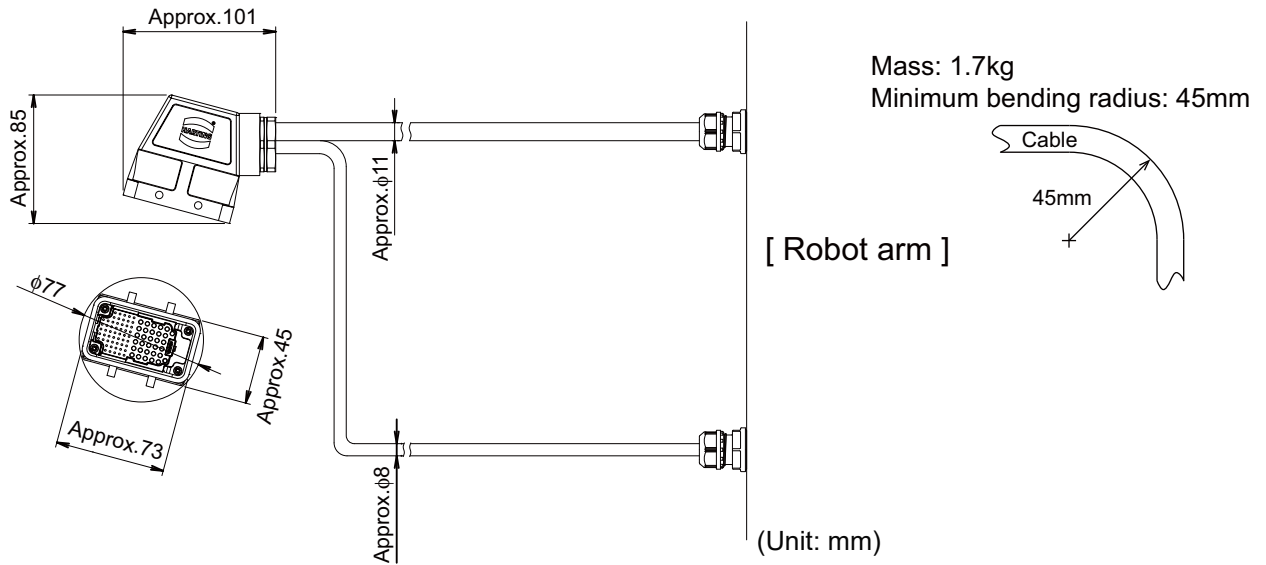
(2) RH-3CRH/RH-6CRH (flexed type)

Approx. 101

Approx. 85

Approx. φ21

[Controller side]

φ77

Approx. 45

Approx. 73

Approx. φ9

[Robot arm]

Flexible cable range

Approx. 500

(Unit: mm)
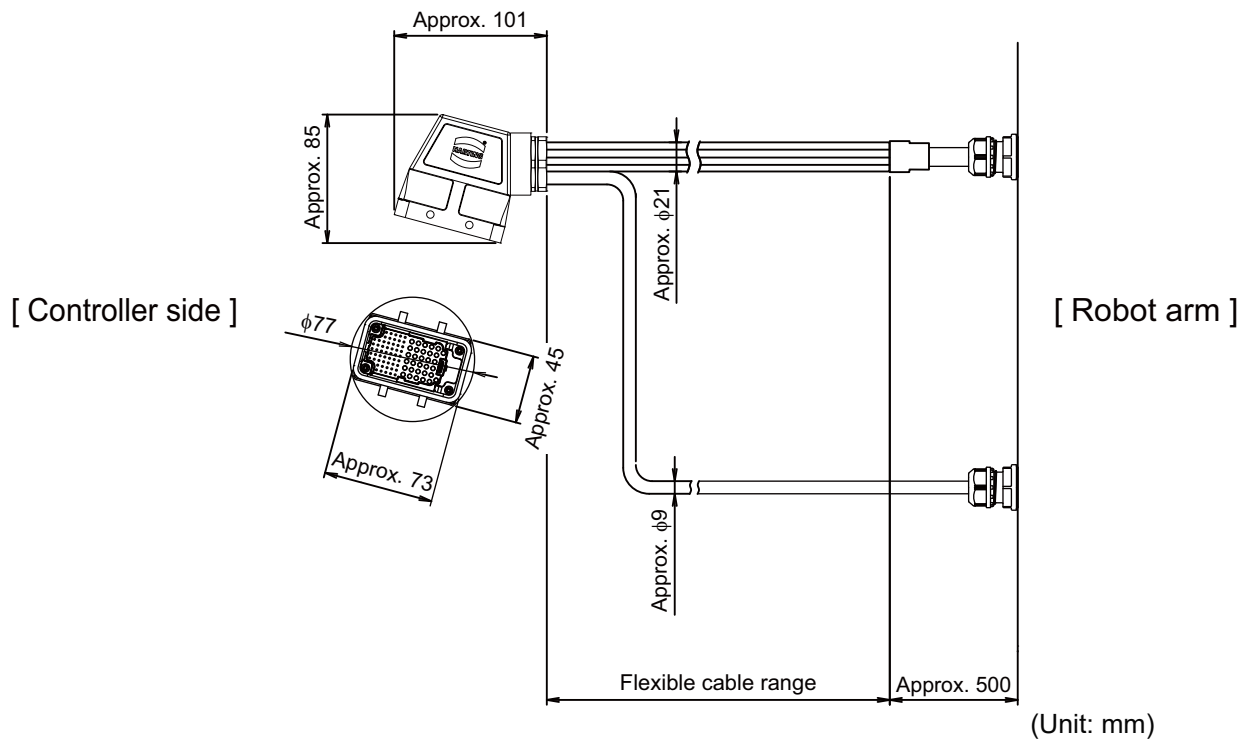
2.5 Tooling

2.5.1 Wiring and piping for hand

Shows the wiring and piping configuration for a standard-equipped hand.
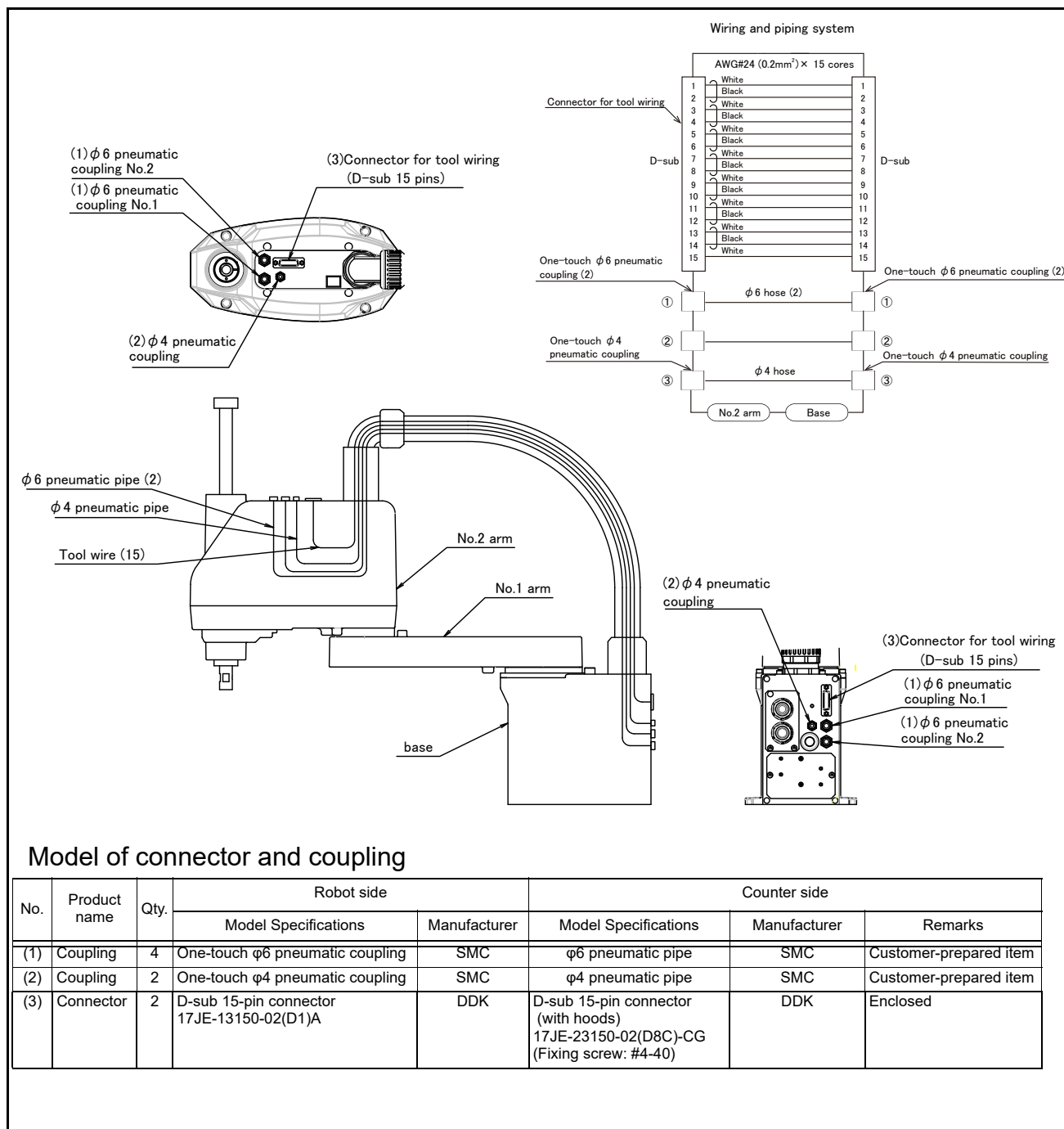
Fig.2-16: Wiring and piping for hand

Model of connector and coupling

No.	Product name	Qty.	Robot side		Counter side		
			Model Specifications	Manufacturer	Model Specifications	Manufacturer	Remarks
(1)	Coupling	4	One-touch φ6 pneumatic coupling	SMC	φ6 pneumatic pipe	SMC	Customer-prepared item
(2)	Coupling	2	One-touch φ4 pneumatic coupling	SMC	φ4 pneumatic pipe	SMC	Customer-prepared item
(3)	Connector	2	D-sub 15-pin connector 17JE-13150-02(D1)A	DDK	D-sub 15-pin connector (with hoods) 17JE-23150-02(D8C)-CG (Fixing screw: #4-40)	DDK	Enclosed

2.5.2 Internal wiring and piping
(1) General environment
    1) In the robot, two lengths of φ6 pneumatic hose and a length of φ4 pneumatic hose are piped as the primary piping between the pneumatic inlet on the base and the top part of the No.2 arm.
    2) The pneumatic inlet ports on both the base and the No.2 arm equip φ6 pneumatic couplings and φ4 pneumatic couplings as a bridge.

2.5.3 Internal wiring for the hand output cable
    1) In the robot, a cable for the hand is wired between the base and the top part of the No.2 arm (AWG #24 (0.2 mm^2) × 15 cores).The cable ends in connectors as a bridge of data.

2.5.4 About the Installation of Tooling Wiring and Piping (Examples of Wiring and Piping)
The customer is required to provide tooling wiring, piping and metal fixtures.
Screw holes are provided on the robot arm for the installation of tooling wiring, piping and metal fixtures.
(Refer to the Fig. 2-17.)
The length of wiring and piping and the installation position on the robot must be adjusted according to the work to be done by the robot. Please use the following example as reference.

<Precautions>
• After performing wiring and piping to the robot, operate the robot at low speed to make sure that each part does not interfere with the robot arm and the peripheral devices.
• If you install metal fixtures and a solenoid valve using the screw holes on the No.2 arm portion, add the mass of the metal fixtures and the solenoid valve to mass of a hand then set the HNDDAT parameter. Moreover, Fix the parts, such as a solenoid valve, firmly to prevent the parts getting shaky during operation of a robot.
• Depending on the connection of a number of hand cables to a flexible tube or its connecting condition, an excessive power is applied to the flexible tube. Thus, the life of the flexible tube may be shortened or the mounting nut of the flexible tube may be loosened.

RH-3CRH

(Unit: mm)
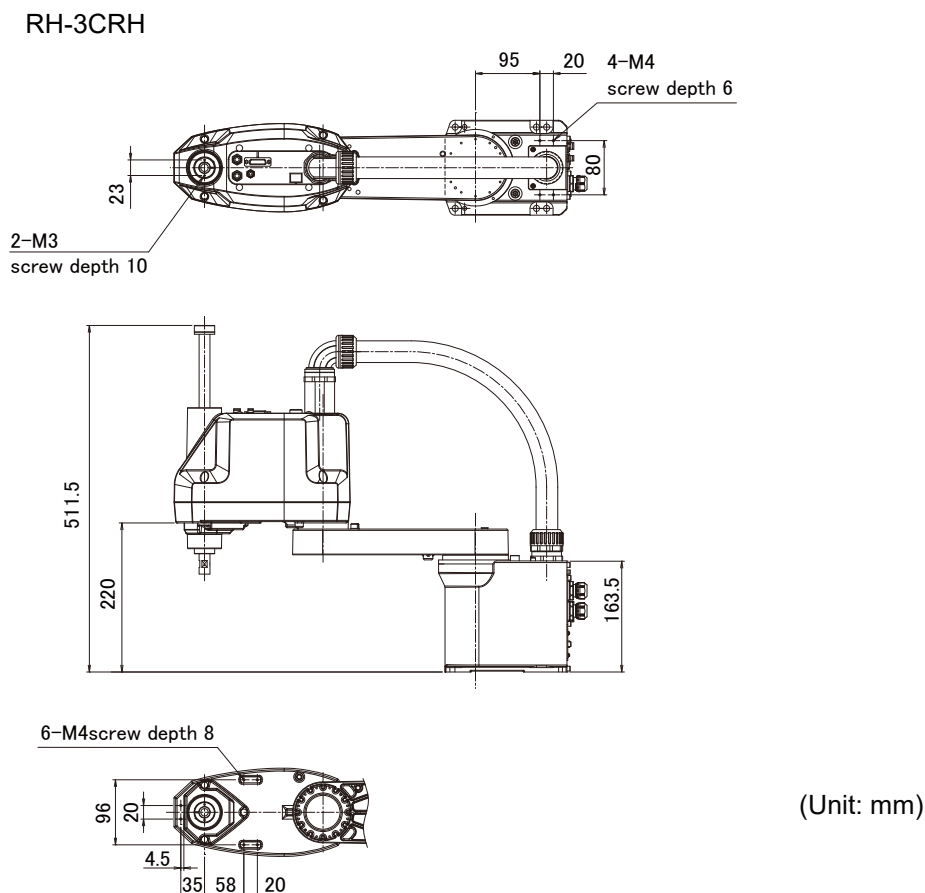
Fig.2-17: Location of screw holes for fixing wiring/piping (RH-3CRH)

RH-6CRH
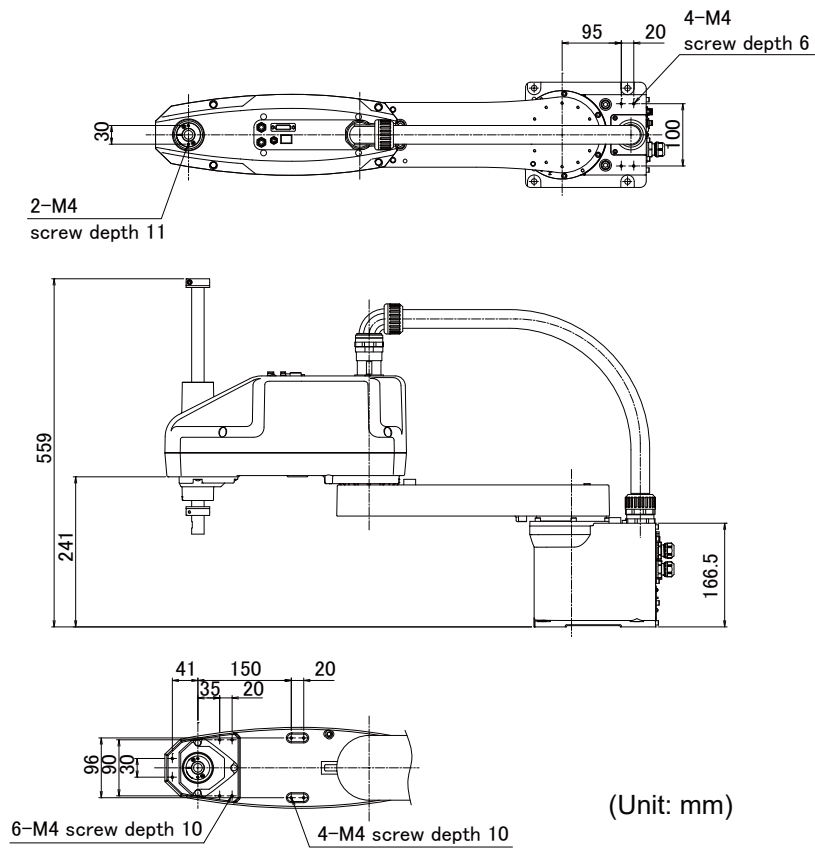
Fig.2-18: Location of screw holes for fixing wiring/piping (RH-6CRH)

(Unit: mm)

2.5.5 Air supply circuit example for the hand

Fig. 2-19 shows an example of the pneumatic circuit of air supply for the hand.

(1) Make sure that a surge voltage protection circuit such as a diode is connected to the solenoid coil in parallel.

(2) When the factory pneumatic pressure drops, as a result of the hand clamp strength weakening, there can be damage to the work. To prevent it, install a pressure switch to the source of the air as shown in Fig. 2-19 and use the circuit described so that the robot stops when pressure drops. Use a hand with a spring-pressure clamp, or a mechanical lock-type hand, that can be used in cases where the pressure switch becomes damaged.

(3) If the air supply temperature (primary piping) used for the tool etc. is lower than ambient air temperature, the dew condensation may occur on the coupling or the hose surface.
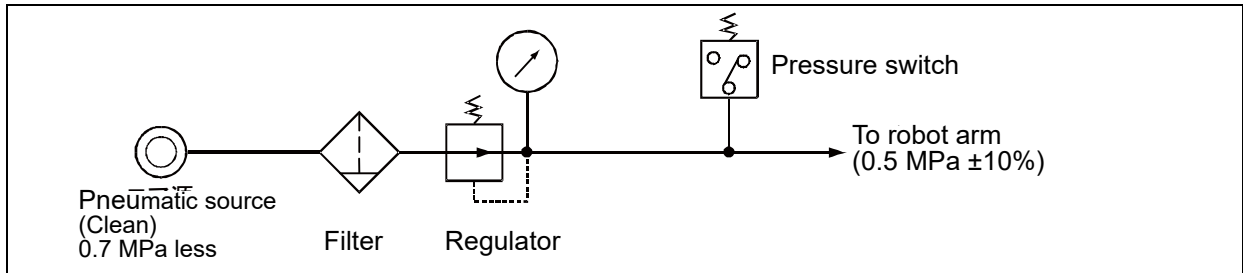
Fig.2-19: Air supply circuit example for the hand

2.6 Options

■What are options?

There are a variety of options for the robot designed to make the setting up process easier for customer needs.

customer installation is required for the options.

(1) Machine cable (replacement): Fixed type

■Order type :　　●1F- □□ UCBL-42　　　　　Note) □□ represents the cable length.

■Outline
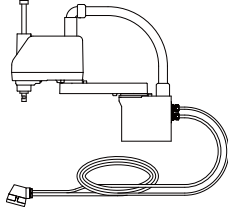
Replace the enclosed 5 m standard machine cables (fixed type) with these cables to reduce or extend the distance between the controller and the robot arm.
The cables consist of a signal cable and a power cable.

■Configuration
Table 2-7: Configuration equipment and types

Part name	Type Note1)	Qty.	Remarks
Machine cable (replacement): Fixed type	1F- □□ UCBL-42	1 pcs.	3 m, 10 m, 15 m, or 20 m each
Cable ties	T18R	3 pcs.	Incl. 2 spare pcs.

Note1) □□ represents the cable length.

(2) Machine cable (replacement): Flexed type

■Order type:　　　●1F-□□LUCBL-42　　　　Note) □□ represents the cable length.

■Outline
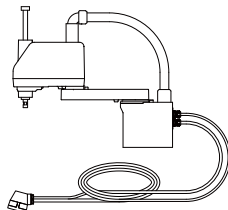
These cables consist of flexed cables, and used for extending the distance between the controller and the robot arm. Replace the enclosed standard cables (5 m) with these cables.
The cables consist of a signal cable and a power cable.

■Configuration
Table 2-8: Configuration equipment and types

Part name	Type Note1)	Qty.	Remarks
Machine cable (replacement): Flexed type	1F-□□LUCBL-42	1 pcs.	10 m, 15 m, or 20 m each
Nylon clamp	NK-10N	2 pcs.	For signal cable
Nylon clamp	NK-16N	2 pcs.	For power cable
Silicon rubber		4 pcs	
Cable ties	T18R	3 pcs.	Incl. 2 spare pcs.

Note1) □□ represents the cable length.

■Specifications
Shows usage conditions for flexed type cables in Table 2-9.

Table 2-9: Conditions for the flexed type cables

Item		Specifications
Minimum flexed radius		100 mm or more
Cableveyor, etc., occupation rate		50% or less
Maximum movement speed		2,000 mm/s or less
Guidance of life count		7.5 million times (With silicone grease coating)
Environmental proof		IP20
Cable configuration	Motor signal cable	φ8.5 × 1
	Motor power cable	φ9 × 1, φ6.5 × 4, φ6.2 × 1

[Caution] The guidance of life count may greatly differ according to the usage state items related to Table 2-9 and to the amount of silicon grease applied in the cableveyor.
　　　　　Recommendation grease: G-501 (Supplier: Shin-Etsu Chemical Co., Ltd.)
[Caution] When a cableveyor is used, partitions are required to avoid overlapping or riding up of the cables.
　　　　　Also, adjust the cable length to eliminate tension or excessive looseness, and fix it securely.

■Cable configuration
The configuration of the flexed cable is shown in Table 2-10. Refer to this table when selecting the cableveyor.
The configuration is the same between the length difference in the cable, and extension type / direct type.

Table 2-10: Cable configuration (Flexed type)

Item	Motor signal cable	Motor power cable		
No. of cores	AWG#24 (0.2 mm^2)-4P	AWG#16 (1.25 mm^2)-4C	AWG#18 (0.75 mm^2)-3C	AWG#24 (0.2 mm^2)-4P
Finish dimensions	Approx. φ8.5 mm	Approx. φ9 mm	Approx. φ6.5 mm	Approx. φ6.2 mm
No.of cables used	1 cable	1 cable	4 cables	1 cable
No. in total	7 cables			

■Fixing the flexed cable
    (1) Connect the connector to the robot arm.
        The connection method to a robot arm is the same as a standard machine cable. Refer to the
        separate volume "Robot Arm Setup & Maintenance" and connect.
    (2) For protection of wires from external stress, see Fig. 2-20 to wrap the cable with supplied silicon
        rubber and fix the wires with nylon clamps in the area between the heat shrink tube on the robot arm
        side and the cable gland on the controller side (flexible cable area). The motor power cable is
        configured with multiple cables. Fix all the cables with a nylon clamp.
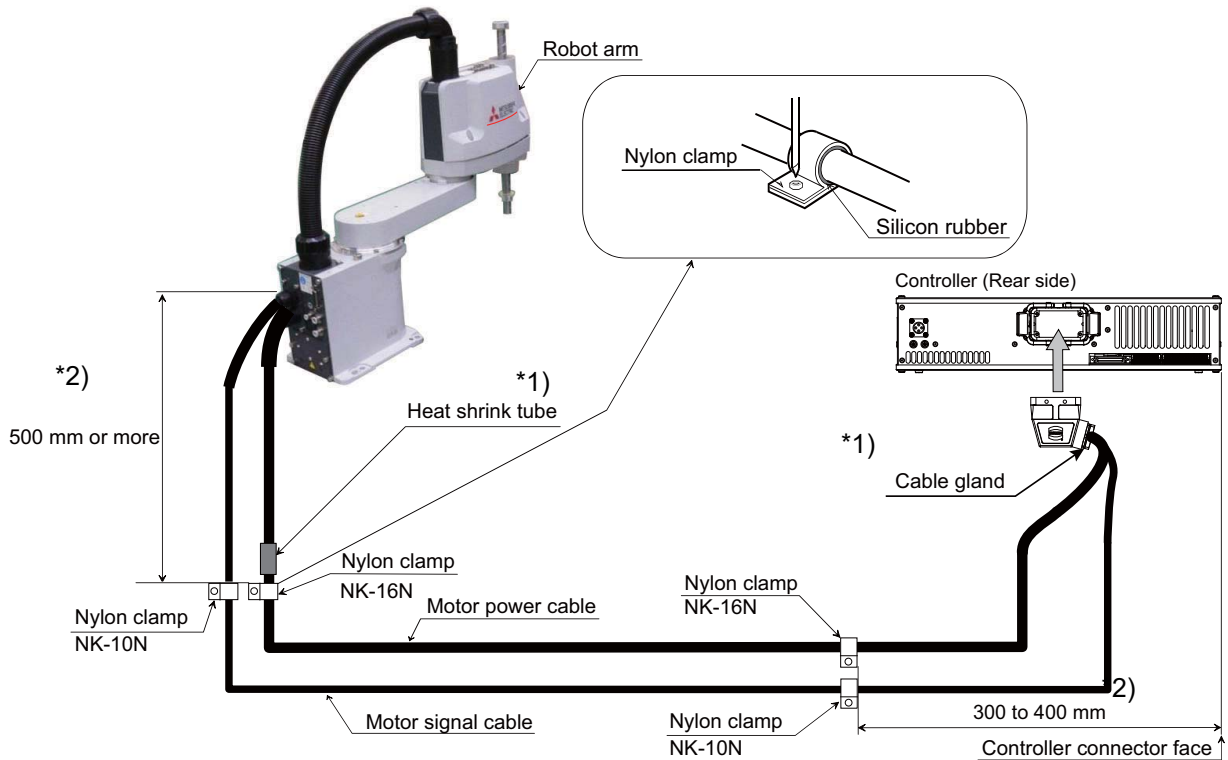
*1) The flexible cable area of the motor power cable is between the heat shrink tubes on the robot arm side and cable
    gland on the controller side. Refer to Page 29, "2.4.2 Outside dimensions of machine cables" for details of the area
    allowing bending cables.
*2) Motor power cable and motor signal cable should be fixed at the same position.

Fig.2-20: Fixing the flexed cable

2.7 About Overhaul

Robots which have been in operation for an extended period of time can suffer from wear and other forms of deterioration. In regard to such robots, we define overhaul as an operation to replace parts running out of specified service life or other parts which have been damaged, so that the robots may be put back in shape for continued use. As a rule of thumb, it is recommended that overhaul be carried out before the total amount of servo-on time reaches the specified time (24,000 hours for the robot arm and 36,000 hours for the controller) (See Fig. 2-21.). However, the degree of the equipment's wear and deterioration presumably varies depending on their operating conditions. Especially for operation with high load and frequency, the maintenance cycle may be shorter. For details on the part selection for replacement and the timing of overhaul, contact your dealer.
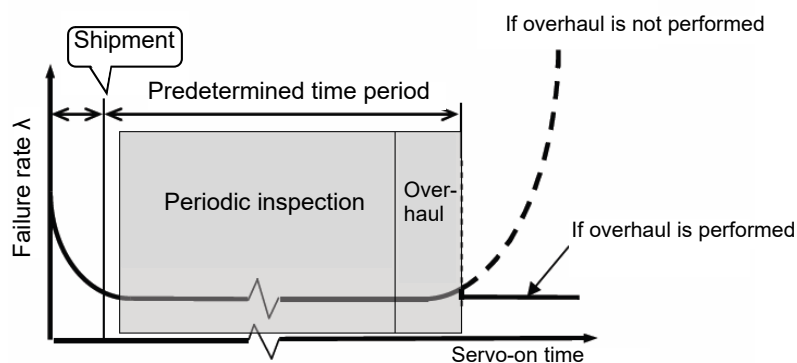
Fig.2-21: Periodic inspection/overhaul periods

2.8 Maintenance parts

A long-term use of industrial robots causes a malfunction due to wear or deterioration of their components, as well as general machines. To prevent such a malfunction and perform smooth operation of the robot for a long term, the regular maintenance, inspection, and replacement of consumable parts are required. Refer to "Maintenance and Inspection" in the separate manual "INSTRUCTION MANUAL/ROBOT ARM SETUP & MAINTENANCE" for details of the maintenance and inspection. The consumable parts used in the robot arm are shown in Table 2-11. Purchase these parts from the designated maker or dealer when required. Some Mitsubishi-designated parts differ from the maker's standard parts. Thus, confirm the part name, robot arm and controller serial No. and purchase the parts from the dealer.

Table 2-11: Consumable part list

No.	Part name	Type [Note1]	Usage place	Qty.	Supplier
1	Grease		Reduction gears of each axis	As needed	Mitsubishi Electric
2			Ball screw/spline	As needed	
3	Lithium battery	ER6V	Front part of the base section	2	
4	Timing belt		J3 axis	1	Mitsubishi Electric
5			J4 axis motor side	1	
6			J4 axis shaft side	1	
7	Felt		Ball screw/spline	1	

Note1) Confirm the robot arm serial No., and contact the dealer or service branch of Mitsubishi Electric Co., for the type.

3 Controller

3.1 Standard specifications

3.1.1 Basic specifications

Table 3-1: Specifications of controller

Item		Unit	Specification	Remarks
Type			CR800-CHD	Note1)
Number of control axis			Simultaneously 4	Additional 8 axes available.
Memory capacity	Programmed positions	point	39,000	
	No. of steps	step	78,000	
	Number of program		512	
Robot language			MELFA-BASIC V, VI	
Teaching method			Pose teaching method, MDI method Note2)	
External input and output	Input/output	point	32/32	2D-TZ368 (sink type) is attached at the time of shipment.The 2D-TZ378 (source type) is installed from the factory in the S15 with special specifications.
	Dedicated input/output		Assigned with general-purpose input/output	The signal number of "STOP" input signals is fixing.
	Hand open/close input/output	point	8/8	The sink/source type can be switched with parameters.
	Emergency stop input Note3)	point	1 (duplicated)	Note4)
	Emergency stop output	point	1 (duplicated)	
	Mode selector switch input Note5)	point	1 (duplicated)	
	Mode output	point	1 (duplicated)	
	Robot error output	point	1 (duplicated)	
	Additional axis synchronization output	point	1 (duplicated)	
	Door switch input	point	1 (duplicated)	
	Ecoder input	Channel	2	
Interface Power source	Additional axis	Channel	1	SSCNET III/H (Connect with MR-J4-B series)
	Remote input/output	Channel	1	Compatible with Ver. 1.0/2.0
	USB	port	1	Ver. 2.0 HighSpeed device functions only. USB mini-B
	Ethernet	port	1	For customer: 1000BASE-T/ 100BASE-TX/10BASE-T
			1	Dedicated T/B port: 100BASE-TX/ 10BASE-T
	Option slot	slot	2	For option interface 2D-TZ368 is installed to slot 1. The 2D-TZ378 is installed in the S15 with special specifications. Note6)
	SD memory card slot	slot	1	For extended memory
	RS-422	port	1	Dedicated T/B port
Power source	Input voltage range	V	Single phase AC 200 to 230	The rate of power-supply voltage fluctuation is within 10%.
	Power capacity	kVA	0.5	Does not include rush current. Note7)
	Power supply frequency	Hz	50/60	
Outline dimensions Note8)		mm	430(W) x 425(D) x 99.5(H)	Excluding protrusions
Mass		kg	Approx. 12.5	
Construction			Self-contained floor type, Opened type. Installation vertically or horizontally	IP20 Note9)

Item		Unit	Specification	Remarks
Ambient temperature	In use	℃	0 to 40	Without freeze
	At transport/storage		-15 to +70	
Ambient humidity	In use	%RH	45 to 85	Without dew drops
	At transport/storage		90 or less	
Overvoltage category Note10)			II or less	
Pollution level Note11)			2 or less	
Altitude		m	1000 or less	
Grounding		Ω	100 or less	100Ωor less (class D grounding)Note12)
Paint color			Dark gray	Equivalent to Munsell: 3.5PB3.2/0.8, PANTONE: 432C

Note1) For details of the operation procedure, basic operations, and maintenance and inspection items of the controller, refer to the information on the CR800-D in the separate volume "Controller Setup, Basic Operation and Maintenance".

Note2) Pose teaching method: The method to register the current position of the robot arm.
MDI method: The method to register by inputting the numerical value Immediate.

Note3) At factory settings, the STO function activated by an external emergency stop input meets the requirements of SIL 2, Category 3, and PL d. The STO function activated by an external emergency stop input meets the requirements of SIL 3, Category 4, and PL e when the parameter setting is changed by referring to Page 127, "Appendix 3 : Safety diagnosis function (Test pulse diagnosis)".

Note4) For details on the functions using external input/output signals, always refer to Page 126, "Appendix 2 : Classification of functions using external input/output signals".

Note5) Provide a mode selector switch to change the mode (MANUAL/AUTOMATIC) of the controller. Select the switch that meets the following specifications.
• The switch can be locked in each position of the selected mode.
• The selected switch position can be clearly distinguished from each other.
• Only one mode can be selected at a time.
(Recommended switch model: HA1K-2C2A-2 manufactured by IDEC. The key switch can be locked in each position by removing its key.)
The mode can be changed by other means than the selector switch.
For example, the user can use a mode change program. In the program, provide a means to lock the selected mode with a password.

Note6) Two connectors for 2D-TZ368/2D-TZ378 are attached (FCN-360 BKO-C11465H03).

Note7) The power capacity is the recommended value. The power capacity does not include the rush current when the power is turned ON. The power capacity is a guideline and the actual operation is affected by the input power voltage. Use the short circuit breaker which operates by the current leakage under the commercial frequency domain (50-60Hz). If sensitive to the high frequency ingredient, it will become the cause in which below the maximum leak current value carries out the trip.
The following lists the current values of the representative models as a reference.

Item		Current [A]	Apparent power [kVA]	Voltage at measurement [V]
At control power ON		0.41	0.09	216.8
At servo ON		0.53	0.12	217.0
In automatic operation	Effective value	1.98	0.43	217.2
	Peak	4.60	0.99	218.7

Note8) Refer to Page 46, "3.3.1 Outside dimensions" for details.

Note9) This controller is standard specification. (Refer to Page 43, "3.1.2 Protection specifications and operating supply".)

Note10) This indicates the section of the power supply to which the equipment is assumed to be connected between the public electrical power distribution network and the machinery within premises.
Category II applies to equipment for which electrical power is supplied from fixed facilities. The surge voltage withstand level for up to the rated voltage of 300V is 2500V.

Note11) This index indicates the degree to which conductive material is generated in terms of the environment in which the equipment is used.
Pollution level 2 is when only non-conductive pollution occurs. A temporary conductivity caused by condensing must be expected occasionally.

Note12) The robot must be grounded by the customer.

Table 3-2 : Controller safety performance

Function	Item	Performance	Remarks
STO	Safety Level	SIL 3 (IEC 61508:2010)	Performance when: · External emergency stop input when the test pulse diagnosis settings are enabled [Note1]
		Category 4, PL e (EN ISO 13849-1:2015)	
	Mean time to dangerous failure (MTTFd)	MTTFd ≥ 100 years	
	Diagnostic coverage (DC)	DC = 99%	
	Probability of dangerous failure per hour (PFH) [Note2]	PFH = 1.40×10^{-8} [1/hour]	
	Safety Level	SIL 2 (IEC 61508:2010)	Performance when: · External emergency stop input when the test pulse diagnosis settings are disabled (factory settings) · Door switch input · Mode selector switch input
		Category 3, PL d (EN ISO 13849-1:2015)	
	Mean time to dangerous failure (MTTFd)	MTTFd ≥ 100 years	
	Diagnostic coverage (DC)	DC = 90%	
	Probability of dangerous failure per hour (PFH) [Note2]	PFH = 1.57×10^{-8} [1/hour]	

Note1) To use this product at a performance level of SIL 3, Category 4, PL e, refer to Page 126, "Appendix 2 : Classification of functions using external input/output signals" and set the parameters accordingly.

Note2) The robot controller PFH or PFHd (Probability of Dangerous Failure per Hour). The PFH of the emergency stop switch and enable switch on the teaching pendant is shown in the table below.

Teaching pendant	Switch	B10d [cycle]	N_{op} [cycle/year]	MTTFd [year]	DC [%]	PFH [1/hour]
R32TB	Emergency stop switch	1×10^6	6000	1667	≥ 99	2.47×10^{-8}
	Enable switch	1×10^6	6000	1667	≥ 99	2.47×10^{-8}
R56TB	Emergency stop switch	1×10^6	6000	1667	≥ 99	2.47×10^{-8}
	Enable switch	7×10^6	6000	11667	60 ≤ DC < 90	1.57×10^{-7}

3.1.2 Protection specifications and operating supply

(1) Protection specifications

A protection method complying with the IEC Standard IP20 (Opened type) is adopted for CR800 controller.

The IEC IP symbols refer only to the degree of protection between the solid and the fluids, and don't indicated that any special protection has been constructed for the prevention against oil and water.

[Information]

• The IEC IP20

It indicates the protective structure that prevents an iron ball $12\ 0^{+0.05}$mm diameter, which is being pressed with the power of 3.1 kg±10%, from going through the opening in the outer sheath of the supplied equipment.

(2) Operating supply

The controller is supposed to be installed and used in the customer's system. Supply the primary power of the controller from the system. In addition, provide a safety device (ex. earth leakage breaker) that can shut off the power of the controller in the customer's system. When using an earth leakage breaker as a safety device, select a product with the highest sensitivity possible referring to the specifications in the table below.

Item	Unit	Specification
Rated voltage	V	AC200 to 230
Rated sensitivity current	mA	30 or more, but as low as possible
Rated current	A	10 or more, but as low as possible

To ensure that the earth leakage breaker used with the CR800 controller meets the requirements of the shut-off time defined in EN 60364-4-41, set the fault loop impedance of the customer wiring section to the value shown below.

For TN system [Note 1)]

Item		Unit	Specification	Remarks
CB, CP, NFB	Model name	-	NV30FAU-2P-10A-AC100-240V-30mA	-
	Rated current	A	10	-
Input voltage range		V	200 to 230 VAC	-
Maximum permissible fault loop impedance		mΩ	284.9	Note 2)

For TT system [Note 1)]

Item		Unit	Specification	Remarks
Earth leakage breaker Note 3) Note 4)	Model name	-	NV30FAU-2P-10A-AC100-240V-30mA	-
	Rated current	A	10	
	Rated sensed current (IΔn)	mA	30	-
Input voltage range		V	200 to 230 VAC	-
Maximum permissible fault loop impedance		Ω	1199	Note 2)

Note 1) It indicates the grounding system type.

Note 2) Check that the fault loop impedance of the customer wiring section is equal to or less than the value shown in the table. This value does not include the fault loop impedance of the controller.

Note 3) For TT system, the rated sensed current and maximum permissible fault loop impedance may be specified by the authorities. Follow the instructions of the authorities.

Note 4) For TT system, use a Type B earth leakage breaker as required.

3.2 Names of each part

3.2.1 Controller

Controller front
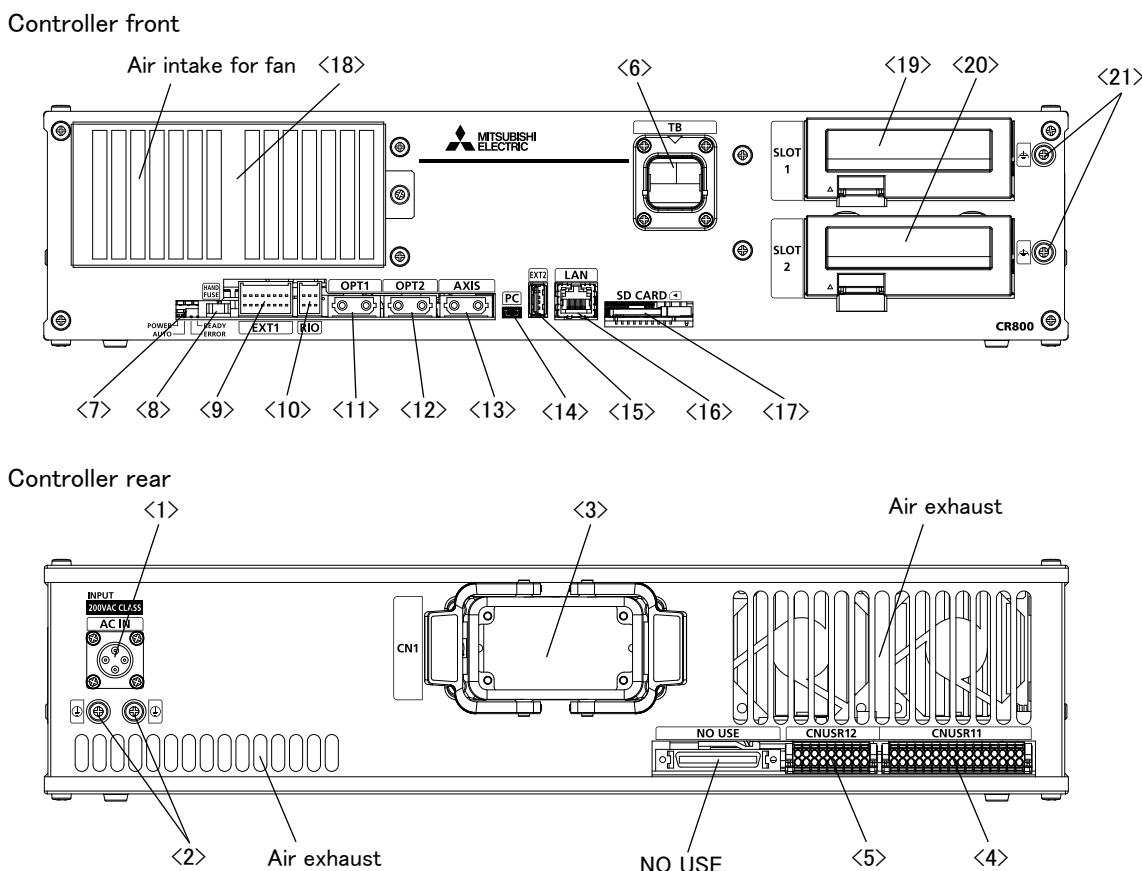
Controller rear

Fig.3-1: Names of controller parts

<1> ACIN connector...........................Supplied ACIN cable connector (input voltage: AC200V).

Number of phase	ACIN cable
Single phase	Terminal: M5, cable length: 3m

<2> PE terminal ....Terminals for grounding (M4 screw x 2).

<3> CN1 cable ....Machine cable connector.

<4> <5> CNUSR connector ....Robot I/O cable connectors.

<4>: CNUSR11, <5>: CNUSR12

<6> TB connector..............................Dedicated connector for connecting T/B.

<7> LED..Four LEDs indicating the controller status.

LED	Details
POWER	Indicates the control power status. On: Control power ON Off: Control power OFF
AUTO	Indicates the controller mode. On: AUTOMATIC mode Off: MANUAL mode

LED	Details
ERROR	Indicates the error status. On: Error occurred. Rapid flashing: High-level error occurred. Off: Normal operation
READY	Indicates the operation status. On: ON (ready) Slow flashing: During operation Rapid flashing: Operation suspended.

<8> HAND FUSE .... Fuse for the hand.
<9> EXT1 .... Connector for releasing the brake in an emergency.
For details on the method of releasing the brake in an emergency, refer to the separate manual, "INSTRUCTION MANUAL/ROBOT ARM SETUP & MAINTENANCE".
<10> RIO... Parallel I/O extension connector.
<11> OPT1 .... Unused.
<12> OPT2....................................... Unused.
<13> AXIS .... Connector for additional axis connection.
<14> PC .... Connector for communication with a personal computer.
<15> EXT2 .... Connector for function extension.
<16> LAN .... Connector for Ethernet communication.
<17> SD CARD .... SD memory card slot.
<18> Filter cover .... Dustproof dust filter cover. An air filter is provided inside the filter cover.
<19> <20>Option slot....................... Option card slots (must be covered when not used).
The 2D-TZ368 (sink type) is installed in SLOT1 of the robot controller from the factory. The 2D-TZ378 (source type) can be installed in the S15 (special specifications).
<19> SLOT1, <20> SLOT2
<21> FG terminal .... Option card cable terminals for grounding (M4 screw x 2).

⚠ Caution Use the network equipments (personal computer, USB hub, LAN hub, etc) confirmed by manufacturer. The thing unsuitable for the FA environment (related with conformity, temperature or noise) exists in the equipments connected to USB. When using network equipment, measures against the noise, such as measures against EMI and the addition of the ferrite core, may be necessary. Please fully confirm the operation by customer. Guarantee and maintenance of the equipment on the market (usual office automation equipment) cannot be performed.

3.3 Outside dimensions/Installation dimensions

3.3.1 Outside dimensions
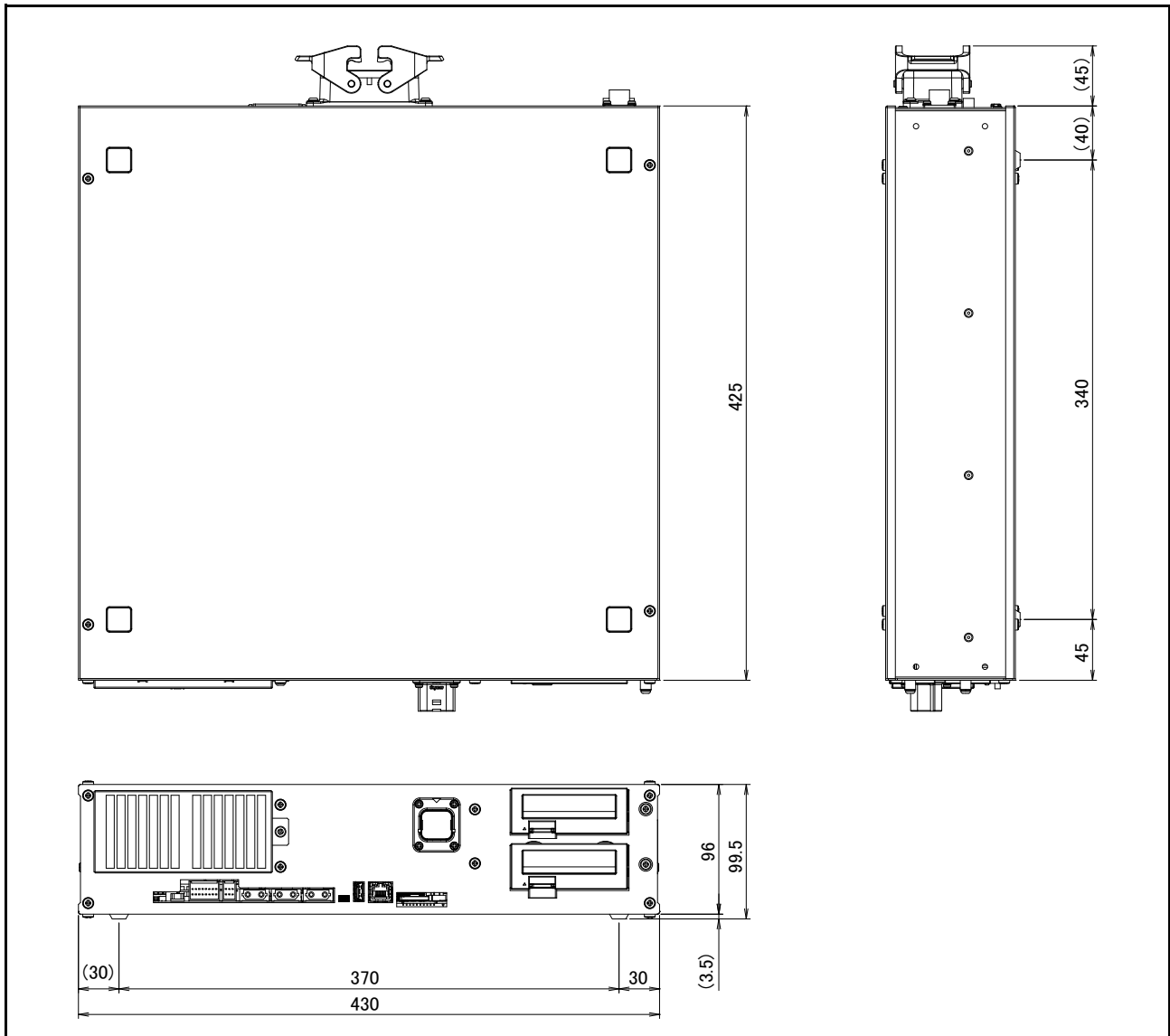
Fig.3-2: Outside dimensions of controller

3.3.2 Installation dimensions

The following figures show the dimensions required installing the controller.
For the placement of the controller on its side (the horizontal installation), two stacks is permitted.

Horizontal installation
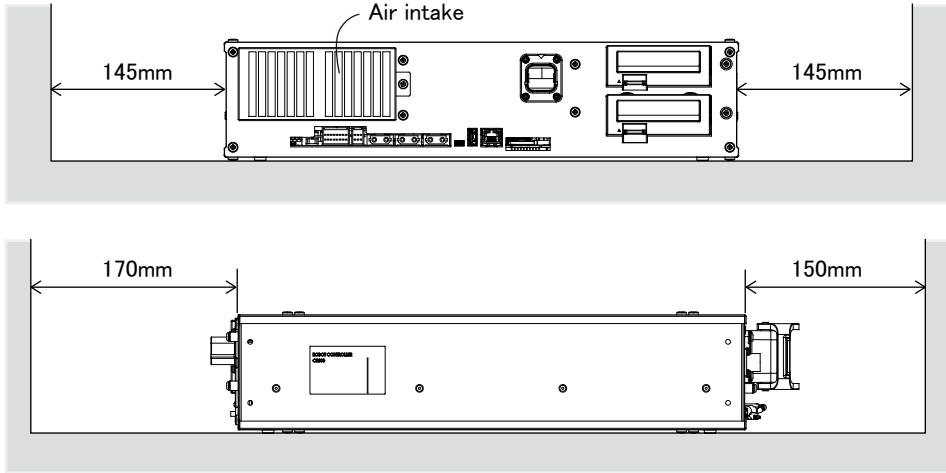
Vertical installation
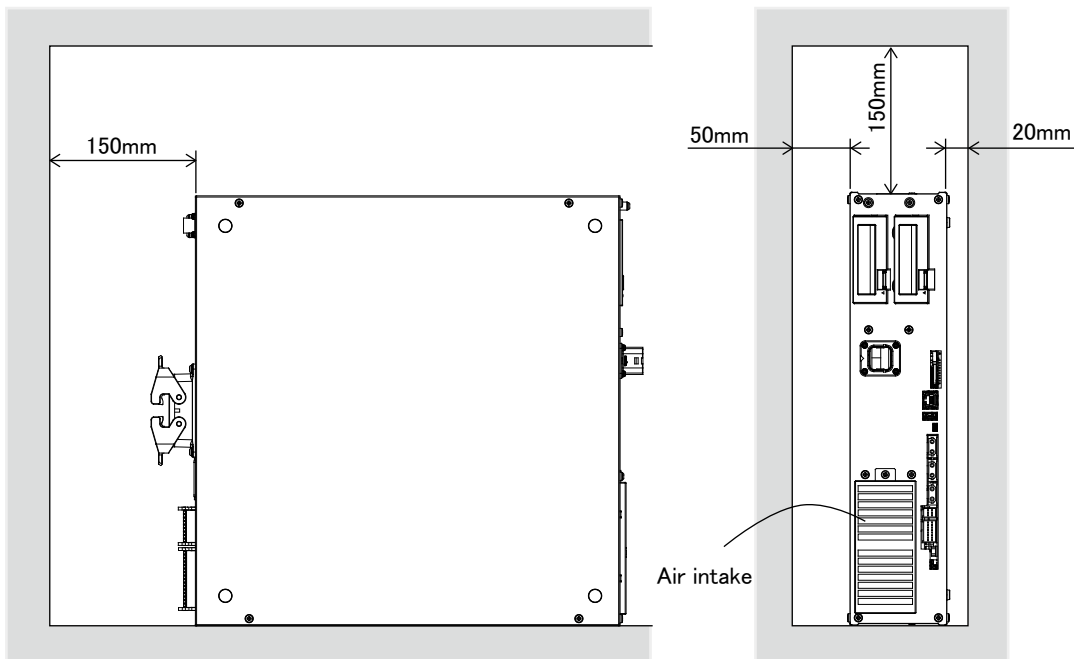
Fig.3-3: Installation dimensions

⚠**CAUTION**   When installing the controller vertically, ensure that the air intake is at the bottom as illustrated in Fig. 3-3.

⚠**CAUTION**   Fixing installation section sure for prevention from the fall, when using the controller placing vertically. The reference figure of the metal plate for fixing is shown in Fig. 3-4.
You should install the metal plate for fixation to the controller with M4 x 8 or the shorter screw. The screw projection length inside the controller (side board thickness is 1.2 mm) surely makes 6.8 mm or less.

⚠ CAUTION   When storing the controller in a cabinet, etc., take special care to the heat radiating properties and ventilation properties so that the ambient temperature remains within the specification values. And, don't install the controller in the position where direct rays or the heat of lighting hits. The skin temperature of the controller may rise, and the error may occur.
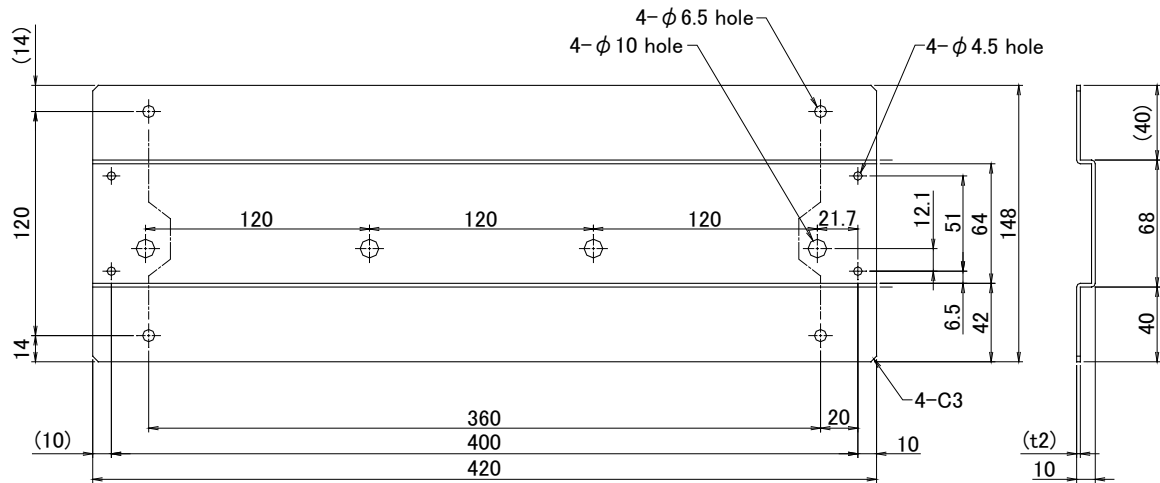
Fig.3-4: Reference figure of the fixing metal plate for vertical installation

3.4 External input/output

3.4.1 Types

    (1) Dedicated input/output..................... These inputs and outputs carry out the robot remote operation and status display.

    (2) General-purpose input/output .... These are inputs and outputs that the customer can program for peripheral device control.

    (3) Hand input/output .... These are inputs and outputs related to the hand that the customer can program.

    (4)Emergency stop/Door switch input ... Information on wiring the emergency stop and wiring used to ensure safety can be found on Page 53, "3.6 Emergency stop input and output etc." and on Page 116, "6.1.7 Examples of safety measures".

<For Reference>

Linking our GOT2000 Series display equipment to the robot controller over the Ethernet permits you to control robot controller's input/output from a GOT (graphic operation terminal).

3.5 Dedicated input/output

Show the main function of dedicated input/output in the Table 3-3. Refer to attached instruction manual "Detailed explanations of functions and operations" in the product for the other functions. Each parameter indicated with the parameter name is used by designated the signal No., assigned in the order of input signal No. and output signal No.

Table 3-3: Dedicated input/output list

Parameter name	Input			Output	
	Name	Function	Level Note1)	Name	Function
TEACHMD	None			Teaching mode output signal	Outputs that the teaching mode is entered.
ATTOPMD	None			Automatic mode output signal	Outputs that the automatic mode is entered.
ATEXTMD	None			Remote mode output signal	Outputs that the remote mode is entered.
RCREADY	None			Controller power ON complete signal	Outputs that external input signals can be received.
AUTOENA	Automatic operation enabled input signal	Allows automatic operation.	L	Automatic operation enabled output signal	Outputs the automatic operation enabled state.
START	Start input signal	Starts all slots.	E	Operating output signal	Outputs that the slot is operating.
STOP	Stop input signal	Stops all slots. The input signal No. is fixed to 0. Note) Use the emergency stop input for stop inputs related to safety.	L	Wait output signal	Outputs that the slot is temporarily stopped.
STOP2	Stop input signal	The program during operation is stopped. Unlike the STOP parameter, change of the signal number is possible. Notes) Specification is the same as the STOP parameter.	L	Wait output signal	Outputs that the slot is temporarily stopped. Notes) Specification is the same as the STOP parameter.
SLOTINIT	Program reset input signal	Resets the wait state.	E	Program selection enabled output signal	Outputs that the slot is in the program selection enabled state.
ERRRESET	Error reset input signal	Resets the error state.	E	Error occurring output signal	Outputs that an error has occurred.
CYCLE	Cycle stop input signal	Carries out cycle stop.	E	In cycle stop operation output signal	Outputs that the cycle stop is operating.
SRVOFF	Servo ON enabled input signal	Turns the servo OFF for all mechanisms.	L	Servo ON enabled output signal	Outputs servo-on disable status. (Echo back)
SRVON	Servo ON input signal	Powers on the robot servos. For multiple mechanisms, it powers on the servos of all the mechanisms.	E	In servo ON output signal	Outputs the servo ON state. For multiple mechanisms, the output is performed when at least one of the mechanisms is in the servo ON state.
IOENA	Operation rights input signal	Requests the operation rights for the external signal control.	L	Operation rights output signal	Outputs the operation rights valid state for the external signal control.
MELOCK	Machine lock input signal	Sets/resets the machine lock state for all mechanisms.	E	In machine lock output signal	Outputs the machine lock state.
SAFEPOS	Evasion point return input signal	Requests the evasion point return operation.	E	In evasion point return output signal	Outputs that the evasion point return is taking place.

Parameter name	Input		Level Note1)	Output	
	Name	Function		Name	Function
OUTRESET	General-purpose output signal reset	Resets the general-purpose output signal.	E	None	
EMGERR	None			Emergency stop output signal	Outputs that an emergency stop has occurred.
S1START : S32START	Start input	Starts each slot.	E	In operation output	Outputs the operating state for each slot.
S1STOP : S32STOP	Stop input	Stops each slot.	L	In wait output	Outputs that each slot is temporarily stopped.
PRGSEL	Program selection input signal	Designates the setting value for the program No. with numeric value input signals.	E	None	
OVRDSEL	Override selection input signal	Designates the setting value for the override with the numeric value input signals.	E	None	
IODATA Note2)	Numeric value input (start No., end No.)	Used to designate the program name, override value., mechanism value.	L	Numeric value output (start No., end No.)	Used to output the program name, override value., mechanism No.
PRGOUT	Program No. output request	Requests output of the program name.	E	Program No. output signal	Outputs that the program name is being output to the numeric value output signal.
LINEOUT	Line No. output request	Requests output of the line No.	E	Line No. output signal	Outputs that the line No. is being output to the numeric value output signal.
OVRDOUT	Override value output request	Requests the override output.	E	Override value output signal	Outputs that the override value is being output to the numeric value output signal.
ERROUT	Error No. output request	Requests the error No. output.	E	Error No. output signal	Outputs that the error No. is being output to the numeric value output signal.
JOGENA	Jog valid input signal	Validates jog operation with the external signals	E	Jog valid output signal	Outputs that the jog operation with external signals is valid.
JOGM	Jog mode input 2-bit	Designates the jog mode.	L	Jog mode output 2-bit	Outputs the current jog mode.
JOG+	Jog feed + side for 8-axes	Requests the + side jog operation.	L	None	
JOG-	Jog feed - side for 8-axes	Requests the - side jog operation.	L	None	
HNDCNTL1 : HNDCNTL3	None			Mechanism 1 hand output signal status : Mechanism 3 hand output signal status	Mechanism 1: Outputs the status of general-purpose outputs 900 to 907. Mechanism 2: Outputs the status of general-purpose outputs 910 to 917. Mechanism 3: Outputs the status of general-purpose outputs 920 to 927.
HNDSTS1 : HNDSTS3	None			Mechanism 1 hand input signal status : Mechanism 3 hand input signal status	Mechanism 1: Outputs the status of hand inputs 900 to 907. Mechanism 2: Outputs the status of hand inputs 910 to 917. Mechanism 3: Outputs the status of hand inputs 920 to 927.

Parameter name	Input		Level Note1)	Output	
	Name	Function		Name	Function
HNDERR1 : HNDERR3	Mechanism 1 hand error input signal : Mechanism 3 hand error input signal	Requests the hand error occurrence.	L	Mechanism 1 hand error output signal : Mechanism 3 hand error output signal	Outputs that a hand error is occurring.
AIRERR1 : AIRERR3	Pneumatic pressure error 1 input signal : Pneumatic pressure error 3 input signal	Request the pneumatic pressure error occurrence.	L	Pneumatic pressure error 1 output signal. : Pneumatic pressure error 3 output signal.	Outputs that a pneumatic pressure error is occurring.
M1PTEXC : M3PTEXC	None		L	Maintenance parts replacement time warning signal	Outputs that the maintenance parts have reached the replacement time.
USERAREA Note3)	None			User-designated area 8-points	Outputs that the robot is in the user-designated area.

Note1) The level indicates the signal level.

      L: Level signal → The designated function is validated when the signal is ON, and is invalidated when the signal is OFF.

      E: Edge signal → The designated function is validated when the signal changes from the OFF to ON state, and the function maintains the original state even when the signal then turns OFF.

Note2) Four elements are set in the order of input signal start No., end No., output signal start No. and end No.

Note3) Up to eight points can be set successively in order of start output signal No. and end output signal No.

3.6 Emergency stop input and output etc.

Do wiring of the external emergency stop, the special stop input, the door switch, and the mode selector switch from the "special input/output" terminal connector.

Table 3-4: Special input/output terminal

Item	Name	Function
Input	Emergency stop	Applies the emergency stop. Dual line, normal close
Input	Special stop input	Applies the stop. (Refer to Page 58, "3.6.2 Special stop input (SKIP)")
Input	Door switch	Servo-off. Dual line, normal close (Page 59, "3.6.3 Door switch function")
Input	Mode selector switch	Changes the mode (MANUAL/AUTOMATIC) of the controller. Dual line (Page 59, "3.6.4 Mode selector switch function")
Output	Robot error output	Contactor is opening during error occurrence.
Output	Emergency stop output	The point of contact opens under occurrence of emergency stop of external input signal, emergency stop of T/B.
Output	Mode output	MANUAL mode: contactor is opening, AUTOMATIC mode: contactor is closing.
Output	Additional axis synchronization output	When an additional axis is used, the servo ON/OFF status of the additional axis can be synchronized with the robot arm. (Page 65, "3.8 Additional axis synchronization output")

*At the time of the power supply OFF, the output point of contact is always open.

[Note] Wire for each input terminal as shown in Fig. 3-8.
The contact capacity of each input/output terminal is DC24V/100mA. Do not connect the equipment except for this range. Noise or other effects that overload contact capacities will lead to failure. An example of noise prevention is shown in Fig. 3-5.
In the customer's system, do not ground the + side of 24V power supply prepared by customer for connect to the controller. (related with emergency stop and parallel input/output) If it connects with the controller under the condition that the + side is grounded, it will lead to failure of controller.

An example of connecting devices such as PLCs
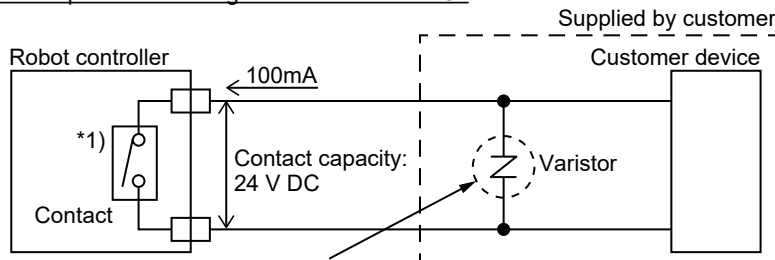
An example of connecting devices such as relays
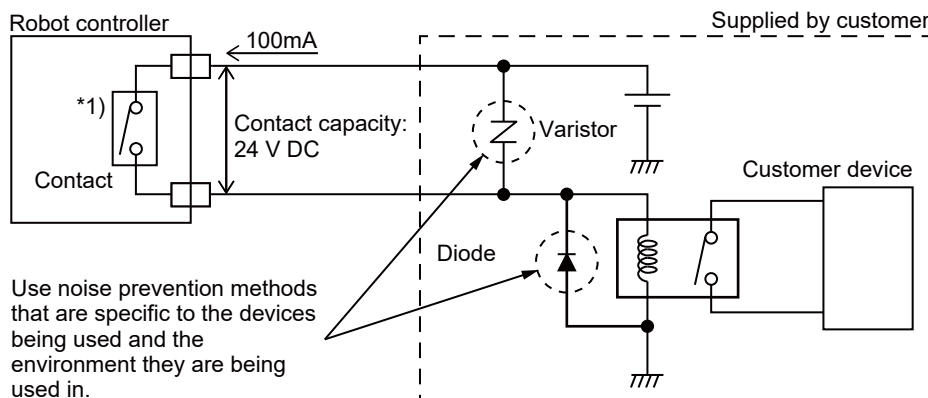
*1) The actual internal robot controller circuit differs from the internal robot controller circuit in the figure.

Recommended varistor

Model	Manufacturer	Varistor voltage	Max. permissible circuit voltage
ERZV10D390	Panasonic	39V	31V
72210S0250K101	TDK	39V	31V

Fig.3-5: Protection circuit example

[Note] If a stop signal or servo OFF signal is input simultaneously with a door switch open/emergency stop input, the error, H056n "Servo sys. error (A/D)" may occur.
When a door switch open/emergency stop is input, the robot turns off the servo after it stops. It is unnecessary to input a stop signal or servo OFF signal. To input a stop signal or servo OFF signal with a door switch open/emergency stop input, wait for 100ms or more after a door switch open/emergency stop input.

Pin number assignment of each terminal and the circuit diagram are shown in Fig. 3-8.

3.6.1 Connection of the external emergency stop and mode selector switch

The input terminals for the external emergency stop, door switch, and mode selector switch are arranged as shown in Fig. 3-8. Customers should be sure to prepare the external emergency stop, door switch, and mode selector switch, etc. and use the robot while these are connected. Connection procedures are shown below.

In addition, refer to Page 116, "6.1.7 Examples of safety measures" for the information on the emergency stop connection and cautions.

[Caution] The emergency stop circuit is duplicated inside the controller. The emergency stop switch uses a double contact-type switch, so please be sure to fix both of the contacts to the connector pins as shown below in order to ensure the wiring is duplicated. An error will continue to occur in the event that only one of the pins is connected.

1) Please prepare the emergency stop switch, door switch, and mode selector switch.
2) Connect the contacts of each switch to the contacts as shown below:
   a) External emergency switch
      CNUSR11 connector "between 7 and 23" and "between 14 and 30".
   b) Door switch
      CNUSR11 connector "between 6 and 22" and "between 13 and 29".
   c) Mode selector switch
      CNUSR11 connector "between 5 and 21" and "between 12 and 28".

[Caution] Be sure to use a shield cable for the emergency stop wiring cable and dedicated stop input wiring cable. And when operating in an environment that is easily affected by noise, be sure to install the ferrite core (recommended model name: E04SR301334, manufacturer: Seiwa Electric Mfg. Co., Ltd.). Be sure to place the ferrite core in 300mm or less from the connecting terminal section.
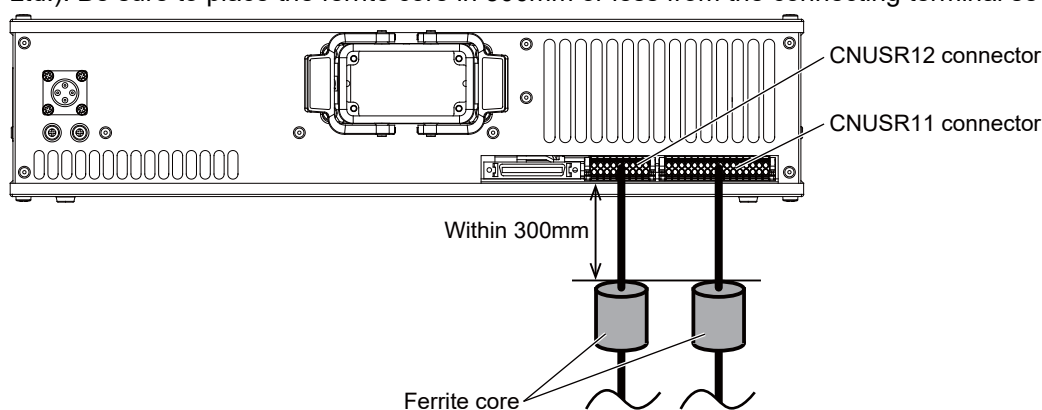
Fig.3-6: Installation position of ferrite cores
For information on the installation method, follow the instructions of the ferrite core being used.

⚠ CAUTION Make sure there are no mistakes in the wiring. Connecting differently to the way specified in the manual can result in errors, such as the emergency stop not being released. In order to prevent errors occurring, please be sure to check that all functions (such as the teaching box emergency stop, customer emergency stop, and door switch) are working properly after the wiring setup is completed.

⚠CAUTION You should always connect doubly connection of the emergency stop, the door switch, and the mode selector switch. In connection of only one side, if the relay of customer use should break down, it may not function correctly.
The robot output contacts (error output, emergency stop output, mode output, additional axis synchronization output) are duplicated output contacts that are wired in series. As with emergency stop switches and door switches, ensure that all connections to customer devices are duplicated to achieve redundancy.

⚠CAUTION Please make sure to wire the multiple emergency stop switches so that they each function independently. Check and make sure that the emergency stop doesn't only function under an AND condition (when multiple emergency stop switches are ON at the same time).

CNUSR11 connector
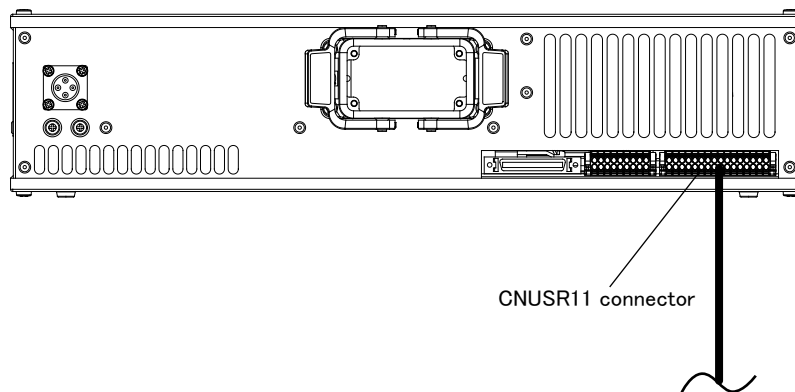
Fig.3-7: Emergency stop cable and mode selector switch connection

Fig.3-8: External emergency stop connection

WARNING Please do not carry out an insulation pressure test. Moreover, it becomes the cause of failure if it connects incorrectly.

Please refer to the example of safety measures of "Specifications Manual".

*1)The terminal can be used only for the external emergency stop input to the robot controller.
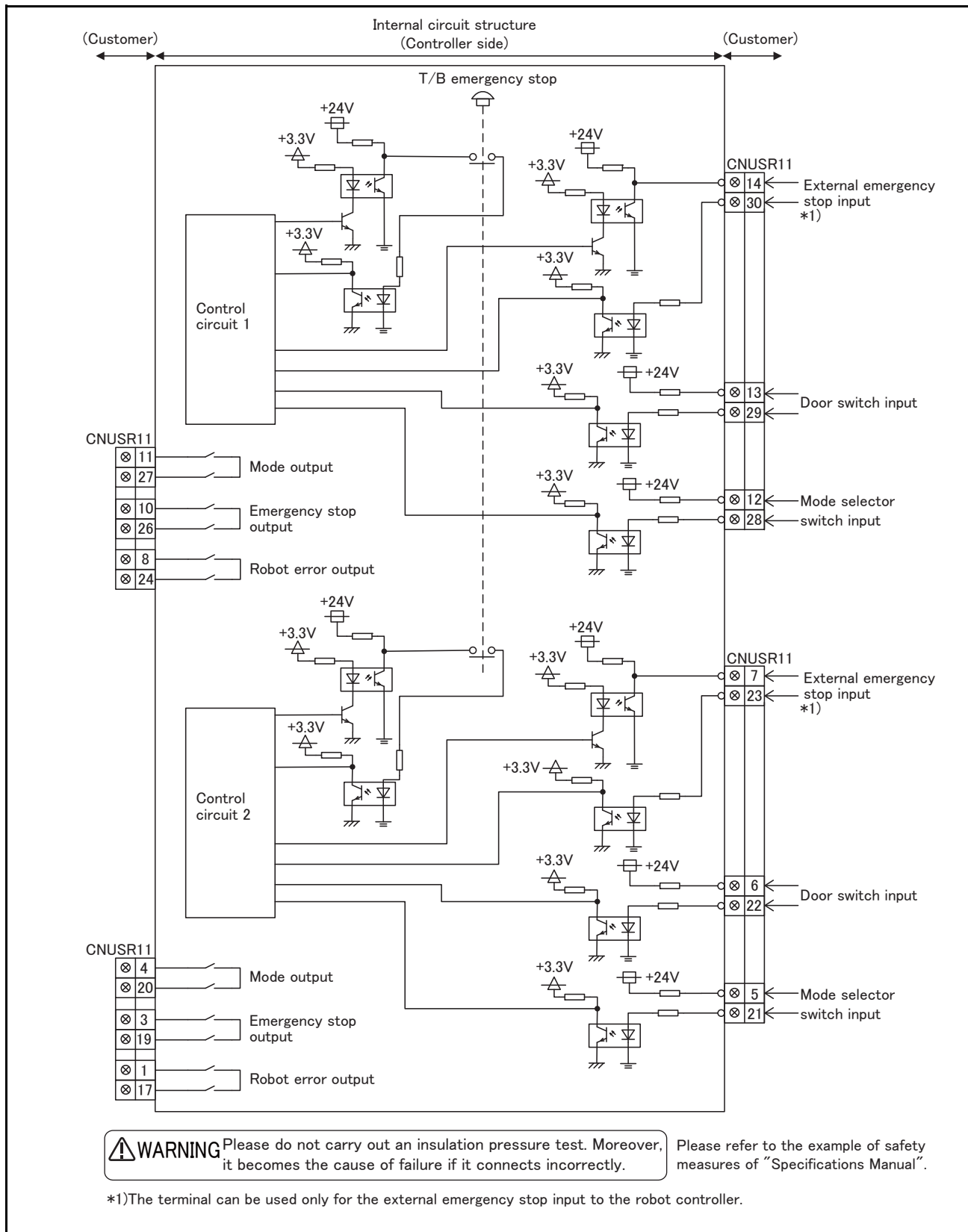
CAUTION Place the emergency stop switch in an easily operable position, and be sure to wire it to the emergency stop correctly by referencing Page 116, "6.1.7 Examples of safety measures". This is a necessary measure in order to ensure safe operation so that the robot can be stopped immediately by pressing the emergency stop switch in the event that the robot malfunctions.

View A: Pin number of connector

1   16

17   32

CNUSR11 connector

1   9

10   18

CNUSR12 connector

Wiring to a connector

Lever

User wiring connector

7mm

Cable

Latch

Lever

Cable insertion hole

Flathead screwdriver

CNUSR12 connector   A

CNUSR11 connector

Connection procedure

Wire cables to the CNUSR11 and CNUSR12 user wiring connectors (attachment), and fit them into the corresponding connectors (ports) located on the rear side of the controller.
The customer needs to prepare the following items.

• Cable: AWG24 to 16 (0.2 to 1.5mm^2)
• Flathead screwdriver: The width of the tip is 2.5mm.

    1) Prepare the user wiring connector (attachment).
    2) Strip off 7 mm of the cable sheath.
    3) Insert the cable all the way in the insertion hole while pressing down the latch on the user wiring connector
       with a flatblade screwdriver.
    4) When all the required wirings have been completed, fit the user wiring connector (CNUSR11/CNUSR12)
       into the corresponding connector (CNUSR11/CNUSR12 port) on the controller.
    5) When the user wiring connector has properly fitted, the levers on both sides of the connector rise and the
       connector is fixed. (To dismount the connector, lower the levers.)

The connection has been completed.

Fig.3-9: Wiring method to the user wiring connector

⚠ CAUTION   Fully check the number of the cable insertion hole (connector pin number) for incorrect connection. Incorrect wiring may damage the robot or cause a malfunction.

⚠ CAUTION   When wiring to the CNUSR11/CNUSR12 connector, pay attention to fraying wires of the core wires. The fraying wires can come into contact with the adjacent terminal, causing a short circuit.
Do not apply solder on core wires. Doing so may cause a contact failure.

3.6.2 Special stop input (SKIP)

The SKIP is the input signal to stop the robot. Please connect the pin 4, 13 of the CNUSR12 connector shown in Fig. 3-10.

Table 3-5: Special stop input electric specification

Item		Specifications	Internal circuit
Type		DC input	
No. of input point		1	
Insulation method		Photo-coupler insulation	
Rated input voltage		DC24V	
Rated input current		Approx. 11mA	
Working voltage range		DC 21.6 to 26.4V (Ripple rate within 5%)	
ON voltage/ON current		DC 8V or more / 2mA or more	
OFF voltage/OFF current		DC 4V or less / 1mA or less	
Input resistance		Approx. 2.2kΩ	
Response time	OFF→ON	1ms or less	
	ON→OFF	1ms or less	
Common method		1 point per common	
External wire connection method		Connector	

* Refer to Page 57 "Fig. 3-9: Wiring method to the user wiring connector" for more details about how to wire a connector.

CNUSR12 connector
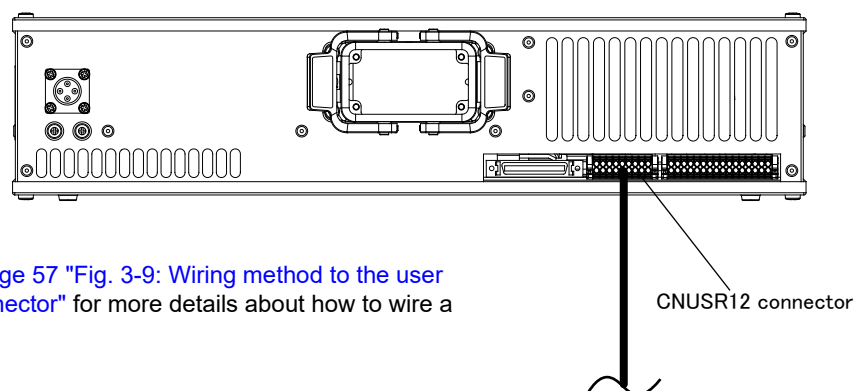
Note) In the customer's system, do not ground the + side of 24V power supply prepared by customer for connect to the controller. (related with emergency stop and parallel input/output) If it connects with the controller under the condition that the + side is grounded, it will lead to failure of controller.

Fig.3-10: Connection of the special-stop-input

3.6.3 Door switch function

This function acquires the status of the switches attached on the door of the safety fence, and it turns OFF the servo to stop the robot when the door is opened. Perform wiring so that the contact opens when the door is opened.

Follow the wiring example shown in Page 56 "Fig. 3-8: External emergency stop connection" and Page 116, "6.1.7 Examples of safety measures". Details of this function according to the robot status are shown below (Fig. 3-11).

*During automatic operation ....When the door is opened, the servo turns OFF and the robot stops. An error occurs. The process of the restoration: Close the door, reset the alarm, turn on the servo, and restart.

*During teaching...........................Even when the door is opened, using a selector switch allows to turn the servo ON with the teaching pendant to operate the robot.
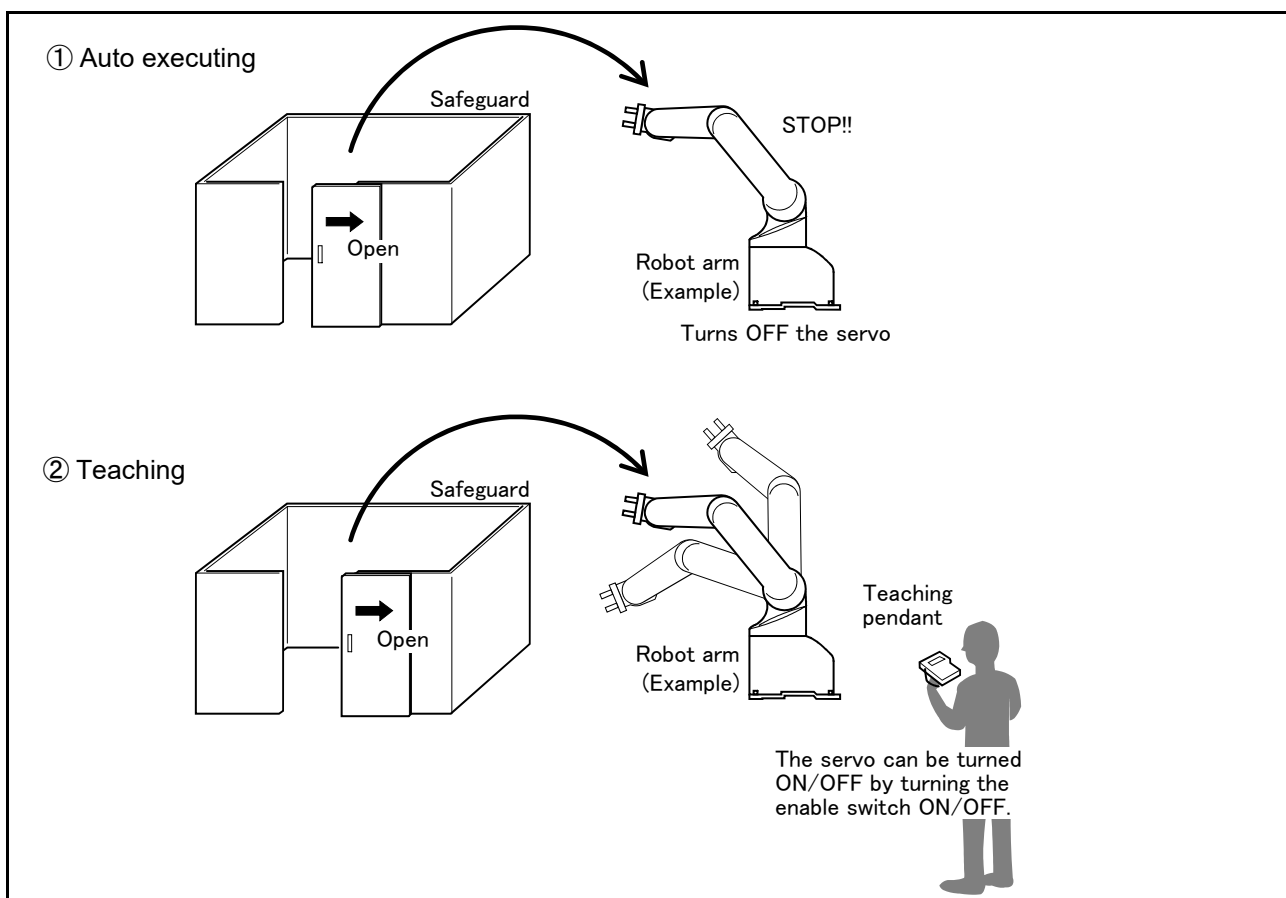
Fig.3-11: Door switch function

3.6.4 Mode selector switch function

The mode selector switch switches the mode of the controller between MANUAL mode and AUTOMATIC mode.

Table 3-6: States of input terminal

Mode of controller	Input terminal
MANUAL (Teaching)	Open
AUTOMATIC (Automatic operation)	Close

(1) Automatic Operation/Jog Operation/Brake Release and Necessary Switch Settings
The following is a description of various operations performed on the robot and switch settings that are required.

Table 3-7: Various operations and necessary switch settings

No	Operation	Related switch settings Note1)				Description
		T/B enable/disable	T/B enable switch	Mode selector switch input terminal	Door switch input terminal	
1	Jog operation	Enable	ON	Open (MANUAL mode)	–	If the mode selector switch input is set to Open (MANUAL mode), the state of door switch input does not matter.
3	Brake release Note2)	Enable	ON	Open (MANUAL mode)	–	If the mode selector switch input is set to Open (MANUAL mode), the state of door switch input does not matter.
4	Automatic operation	Disable	–	Close (AUTOMATIC mode)	Close (Door Close)	Door switch input must always be in a state of Close (Door Close).

Note1) "-" in the table indicates that the state of switch concerned does not matter.
Refer to the following for operation of each switch.
Note2) T/B is used for the brake release operation. Brake release can be effected only when the T/B enable switch is placed in intermediate position (lightly gripped position). At this point, the state of door switch input does not matter.

T/B being manipulated
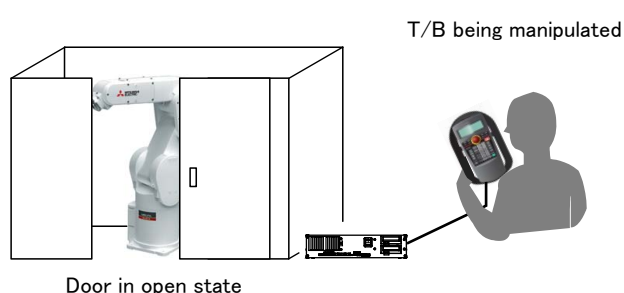
⚠CAUTION

Upon the release of brake, the robot arm may fall under its own weight depending on the axis which has been released. To ensure safety, take appropriate measures such as supporting the axis to avoid the free fall.

Door in open state

Fig.3-12: Brake release operation

3.7 Additional Axis Function

This controller is equipped with an additional axis interface for controlling an additional axis when a traveling axis or rotary table is added to the robot. A maximum of eight axes of servo motors can be controlled at the same time by connecting a general-purpose servo amplifier (MR-J4-B series) that supports Mitsubishi's SSCNET III.
Refer to the separate "Additional axis function Instruction Manual" for details on the additional axis function.

3.7.1 Wiring of the Additional Axis Interface

Table 3-8 shows the connectors for additional axes inside the controller.
Fig. 3-13 shows a connection example (configuration example).

Table 3-8: Dedicated connectors inside the controller

Name	Connector name	Details
Connector for additional axes	AXIS	The connector for connecting the general-purpose servo amplifier.
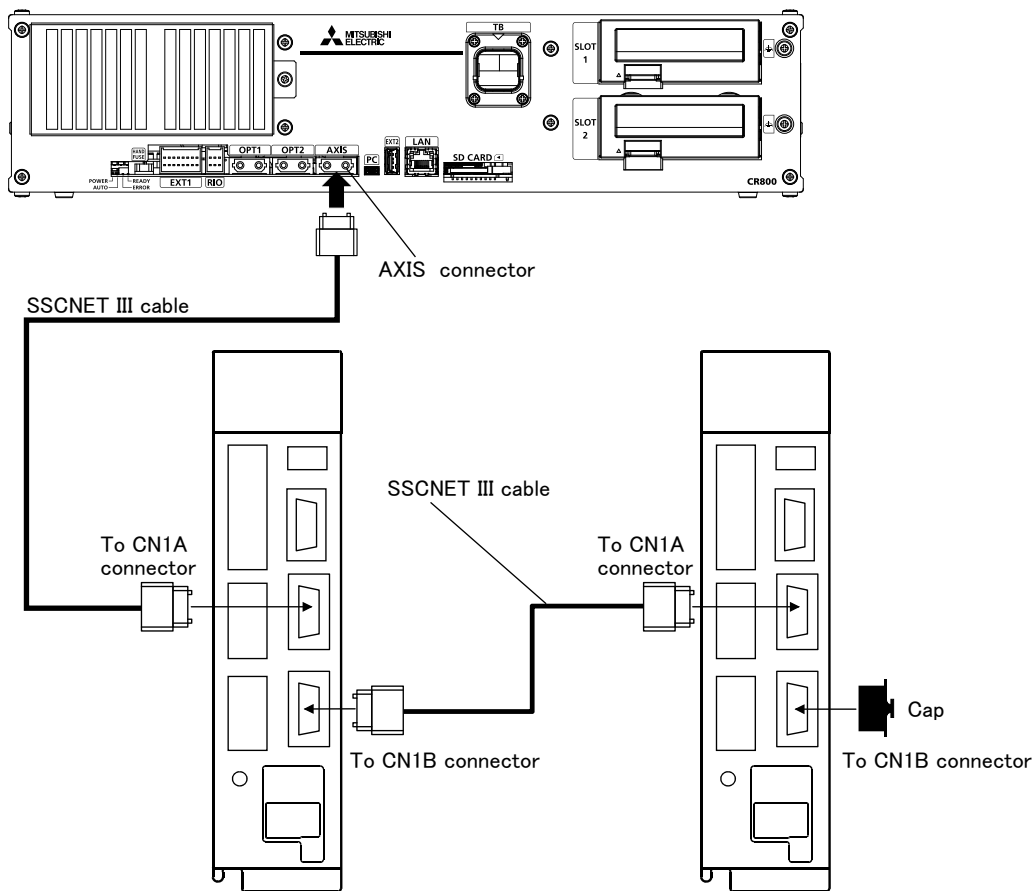
Fig.3-13: Example of addition axis connection

3.7.2 Example of the installation of the noise filter
■EMC filter (recommended)

Please install the recommendation filter shown below according to the example of connection.

Table 3-9: Combination of a servo amplifier and filter (Soshin Electric)

| Servo amplifier | Recommended filter (Soshin Electric) | | | | Mass [kg] |
	Model	Rated current [A]	Rated voltage [VAC]	Leakage current [mA]	
MR-J4-10B(-RJ) to MR-J4-100B(-RJ)	HF3010A-UN Note1)	10	250	5	3.5
MR-J4-200B(-RJ) MR-J4-350B(-RJ)	HF3030A-UN Note1)	30			5.5
MR-J4-500B(-RJ) MR-J4-700B(-RJ)	HF3040A-UN Note1)	40		6.5	6
MR-J4-11KB(-RJ) MR-J4-15KB(-RJ) MR-J4-22KB(-RJ)	HF3100A-UN Note1)	100			12
MR-J4-60B4(-RJ) MR-J4-100B4(-RJ)	TF3005C-TX	5	500	5.5	6
MR-J4-200B4(-RJ) MR-J4-700B4(-RJ)	TF3020C-TX	20			
MR-J4-11KB4(-RJ)	TF3030C-TX	30			7.5
MR-J4-15KB4(-RJ)	TF3040C-TX	40			12.5
MR-J4-22KB4(-RJ)	TF3060C-TX	60			
MR-J4-10B1(-RJ) to MR-J4-40B1(-RJ)	TF3010A-UN Note1)	10	250	5	3.5

Note1) Following surge protector is separately required to use any of these EMC filters.
RSPD-250-U4 (Manufacture: OKAYA Electric Industries CO., Ltd.)

Table 3-10: Combination of a servo amplifier and filter (COSEL)

| Servo amplifier | Recommended filter (COSEL) | | | | Mass [kg] |
	Model	Rated current [A]	Rated voltage [VAC]	Leakage current [mA]	
MR-J4-11KB(-RJ) to MR-J4-22KB(-RJ)	FTB-100-355-L Note1)	100	500	40	5.3
MR-J4-22KB4(-RJ)	FTB-80-355-L Note1)	80	500	80	5.3

Note1) Following surge protector is separately required to use any of these EMC filters.
RSPD-500-U4 (Manufacture: OKAYA Electric Industries CO., Ltd.)

■Installing an EMC noise filter
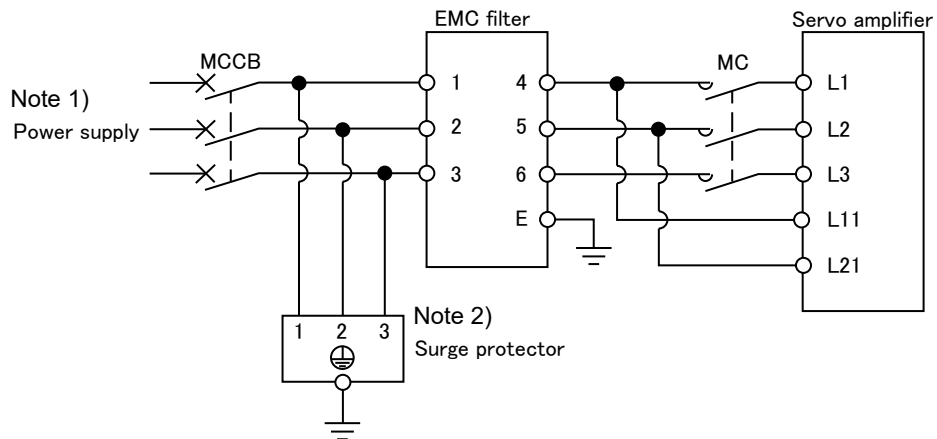
Note 1) For 1-phase 200V to 230VAC power supply, connect the power supply to L1, L2 and leave L3 open.
There is no L3 for 1-phase 100 to 120 VAC power supply.
Note 2) The example is when a surge protector is connected.

Fig.3-14: Example of EMC noise filter installation

(1) Line noise filter

This filter is effective in suppressing noises radiated from the power supply side and output side of the servo amplifier and also in suppressing high-frequency leakage current (zero-phase current) especially within 0.5MHz to 5MHz band.

Connection diagram	Outline drawing [Unit: mm]
Use the line noise filters for wires of the main power supply (L₁ · L₂ · L₃) and of the motor power supply (U · V · W). Pass each of the 3-phase wires through the line noise filter an equal number of times in the same direction. For the main power supply, the effect of the filter rises as the number of passes increases, but generally four passes would be appropriate. For the motor power supply, passes must be four times or less. Do not pass the grounding (earth) wire through the filter, or the effect of the filter will drop. Wind the wires by passing through the filter to satisfy the required number of passes as shown in Example 1. If the wires are too thick to wind, use two or more filters to have the required number of passes as shown in Example 2. Place the line noise filters as close to the servo amplifier as possible for their best performance.	FR-BSF01 (for wire size 3.5mm² (AWG12) or less))

Fig.3-15: Example of noise filter installation

3.8 Additional axis synchronization output

When an additional axis is used, the servo ON/OFF status of the additional axis can be synchronized with the servo ON/OFF status of the robot itself by using the output contact (AXMC) provided on the rear or inside of the controller and configuring a circuit so that the power to the servo amplifier for the additional axis can be turned off when this output is open.

An example circuit is shown in Page 65, "(1) Example circuit". An image of how to connect the connector is shown in Page 66, "(2) Image of how to connect the controller connector".

When you are using an additional axis, please perform appropriate circuit connections by referring to these drawings. Refer to Page 61, "3.7 Additional Axis Function"and the separate "Additional axis function Instruction Manual" for details on the additional axis function.

Note1) you use the addition axis function as a user mechanism who became independent of the robot arm, please do not connect this output signal. Servo-on of the user mechanism may be unable.

(1) Example circuit

Signal	Connector	Pin number
AXMC11 AXMC12	CNUSR11	9 25
AXMC21 AXMC22	CNUSR11	2 18

Note 1) Connector and pin number

Note 2) This output is opened, if the robot turns off the servo by occurrence of alarm etc.
<Electric specification>
DC24V/10mA to 100mA
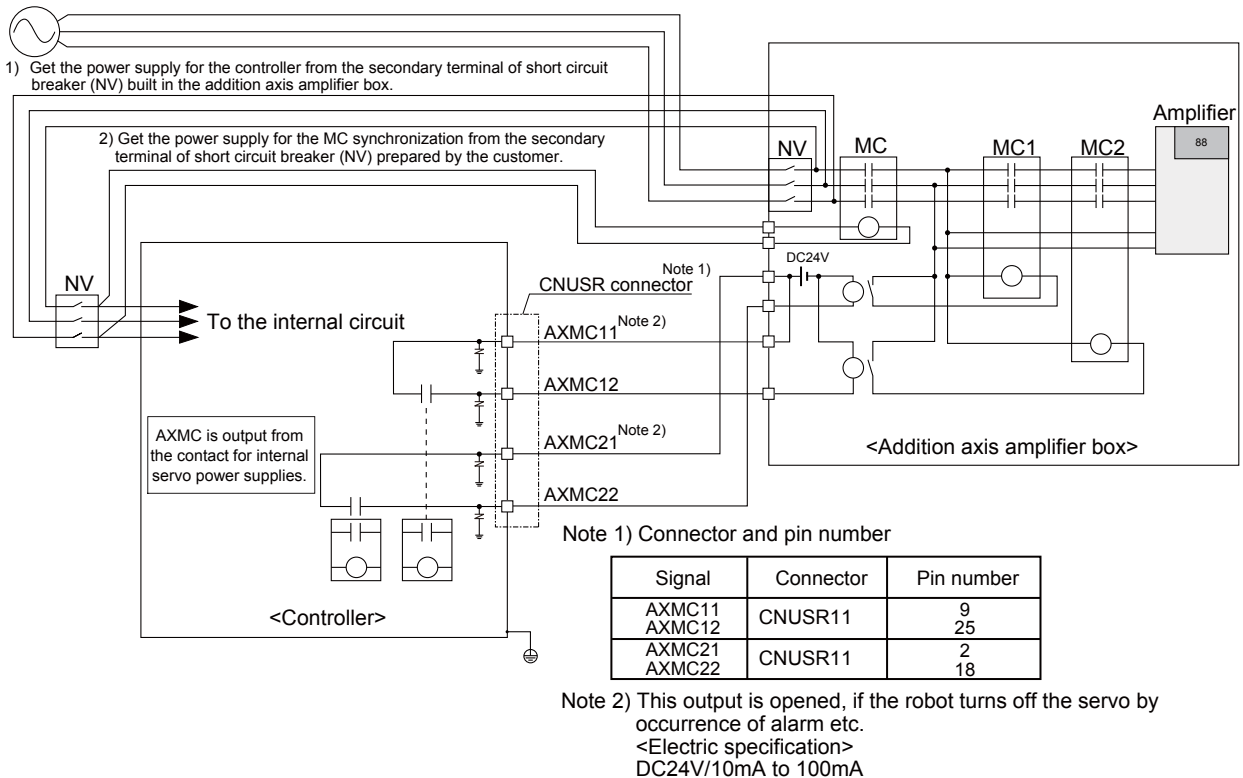
[Note] For the input/output cable (CNUSR connector cable) that connects customer's system and the controller, prevent ground faults from occurring at the + side of the 24V power supply prepared by customer. A ground fault may lead to a failure of the protection device in the controller.
Bending or frictional forces may be applied to the input/output cable repeatedly depending on the system configuration or layout. In this case, use a flexible cable for the input/output cable. Note that a fixed cable may be broken, resulting in a ground fault.

Fig.3-16: Example of circuit for additional axis synchronization output

(2) Image of how to connect the controller connector
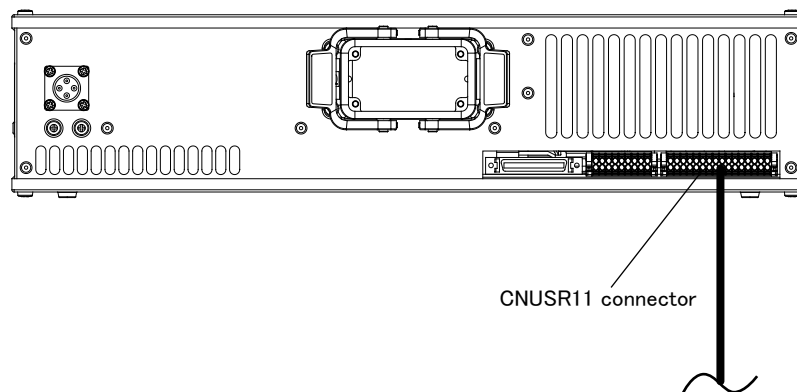
* Refer to Page 57 "Fig. 3-9: Wiring method to the user wiring connector" for more details about how to wire a connector.

Fig.3-17: AXMC terminal connector

3.9 Options

■What are options?

There are a variety of options for the robot designed to make the setting up process easier for user needs. User installation is required for the options.

(1) Teaching pendant (T/B)
■Order type: ●R32TB   :Cable length 7m
         ●R32TB-15   :Cable length 15m

■Outline

This is used to create, edit and control the program, teach the operation position and for jog feed, etc. For safety proposes, a 3-position enable switch is mounted. [*1]

For multiple robots, you can operate them with just one teaching pendant by repeating the removal of it from another robot and the connection of it to the target robot.

■Configuration
Table 3-11: Configuration device

Part name	Type	Qty.	Mass (kg) [Note1]	Remarks
Teaching pendant	R32TB	Either one pc.	1.7	Cable length is 7m.
	R32TB-15		2.8	Cable length is 15m.

Note1) Mass indicates one set.

■Specifications
Table 3-12: Specifications

Items	Specifications	Remarks
Outline dimensions	195(W) x 292(H) x 106(D) (refer to outline drawing)	
Body color	Dark gray	
Mass	Approx. 0.9kg (body only, excluding cables)	
Connection method	Connects with controller via connector.	
Interface	RS-422	
Display method	LCD method: 24 characters x 8 lines, LCD illumination: with backlight	At 8x8 font
Operation section	36 keys	

[*1] <3-position enable switch>
In ISO/10218 (1992) and JIS-B8433 (1993), this is defined as an "enable device". These standards specify that the robot operation using the teaching pendant is enabled only when the "enable device" is at a specified position.
With the Mitsubishi Electric industrial robot, the above "enable device" is configured of an "Enable/Disable switch" and "Enable switch".
The 3-position enable switch has three statuses. The following modes are entered according to the switch state.
a) "Not pressed" ....The robot does not operate. [*]
b) "Pressed lightly" ....The robot can be operated and teaching is possible.
c) "Pressed with force" ....The robot does not operate. [*]
   [*] Releasing or forcefully pressing the 3-position enable switch cuts power to the servos in the same way as when the emergency stop is input. This helps to ensure safety.
   Operations such as editing programs and displaying the robot's status are possible while the 3-position enable switch is released or forcefully pressed (excludes operating the robot).

Fig.3-18: Outside dimensions of teaching pendant

■Installation method
The teaching pendant is connected to the TB connector on the front of the controller.

■Key layout and main functions

1) [Emergency stop] switch .... The robot servo turns OFF and the operation stops immediately.
2) [TB ENABLE] switch .... This switch changes the T/B key operation between enable and disable.
3) Enable switch .... When the [Enable/Disable] switch "2)" is enabled, and this key is released or pressed with force, the servo will turn OFF, and the operating robot will stop immediately.
4) LCD display panel .... The robot status and various menus are displayed.
5) Status display lamp .... Display the state of the robot or T/B.
6) [F1], [F2], [F3], [F4] .... Execute the function corresponding to each function currently displayed on LCD.
7) [FUNCTION] key .... Switch the function display to check another functions assigned to the function keys ([F1], [F2], [F3], and [F4]) when five or more functions are available for next operation, where only four function keys are available.
8) [STOP] key .... This stops the program and decelerates the robot to a stop.
9) [OVRD↑][OVRD↓] key .... Change moving speed. Speed goes up by [OVRD↑] key. Speed goes down by [OVRD↓] key
10) [JOG] operation key .... Move the robot according to jog mode. And, input the numerical value.
11) [SERVO] key .... Press this key with holding enable switch lightly, then servo power will turn on.
12) [MONITOR] key .... It becomes monitor mode and display the monitor menu.
13) [JOG] key .... It becomes jog mode and display the jog operation.
14) [HAND] key .... It becomes hand mode and display the hand operation.
15) [CHARCTER] key .... Switch the function of the number/character keys between number input and character (letter or some special character) input when both inputs are available on the T/B.
16) [RESET] key .... This resets the error. The program reset will execute, if this key and the [EXE] key are pressed.
17) [↑][↓][←][→] key .... Moves the cursor each direction.
18) [CLEAR] key .... Erase a text on the cursor position when number/character input is available.
19) [EXE] key .... Input operation is fixed. And, while pressing this key, the robot moves when direct mode.
20) Number/character key .... Input the number or character when the number/character input is available.

Fig.3-19: Teaching pendant key layout and main functions

(2) High efficient teaching pendant (T/B)
■Order type: ●R56TB   :Cable length 7m
           ●R56TB-15   :Cable length 15m

■Outline

This is used to create, edit and control the program, to teach the operation position, or to perform jog feed, etc. This highly efficient teaching pendant has a touchscreen graphical user interface (GUI) which allows easy operation. In addition, the 3-position enable switch [*1] is provided for the safety use.

For multiple robots, you can operate them with just one teaching pendant by repeating the removal of it from another robot and the connection of it to the target robot.

■Configuration

Table 3-13: Configuration device

Part name	Type	Qty.	Mass (kg) [Note1]	Remarks
High efficient teaching pendant	R56TB	Either one pc.	2.1	Cable length is 7m.
	R56TB-15		3.2	Cable length is 15m.

Note1) Mass indicates one set.

■Specifications

Table 3-14: Specifications

Items	Specifications	Remarks
Outline dimensions	252(W) x 240(H) x 114(D) (refer to outline drawing)	
Body color	Dark gray	
Mass	Approx. 1.25kg (body only, excluding cables)	
Connection method	Connects with controller via connector.	
Interface	RS-422, Ethernet (10BASE-T)	For connection with robot controller
	USB host	Note1)
Display	6.5" TFT (640 x 480) color touchscreen, with backlight	

Note1) The operation of the following USB memory sticks has been confirmed.
    a) Kingston Data TravelerManufacture: Kingston, Type: USB 2.0 memory stick,
              Memory sizes: 128 MB - 1GB
    b) Transcend Jet FlashManufacture: Transcend, Type: USB 2.0 memory stick,
              Memory sizes: 128 MB - 1GB
Notice) The operation of those other than the above is not guaranteed.

■Installation method
    The teaching pendant is connected to the TB connector on the front of the controller.

---

*1) <3-position enable switch>
In ISO/10218 (1992) and JIS-B8433 (1993), this is defined as an "enable device". These standards specify that the robot operation using the teaching pendant is enabled only when the "enable device" is at a specified position.
With the Mitsubishi Electric industrial robot, the above "enable device" is configured of an "Enable/Disable switch" and "Enable switch".
The 3-position enable switch has three statuses. The following modes are entered according to the switch state.

a) "Not pressed" .... The robot does not operate. [*]
b) "Pressed lightly" .... The robot can be operated and teaching is possible.
c) "Pressed with force" .... The robot does not operate. [*]
    *) Releasing or forcefully pressing the 3-position enable switch cuts power to the servos in the same way as when the emergency stop is input. This helps to ensure safety.
    Operations such as editing programs and displaying the robot's status are possible while the 3-position enable switch is released or forcefully pressed (excludes operating the robot).
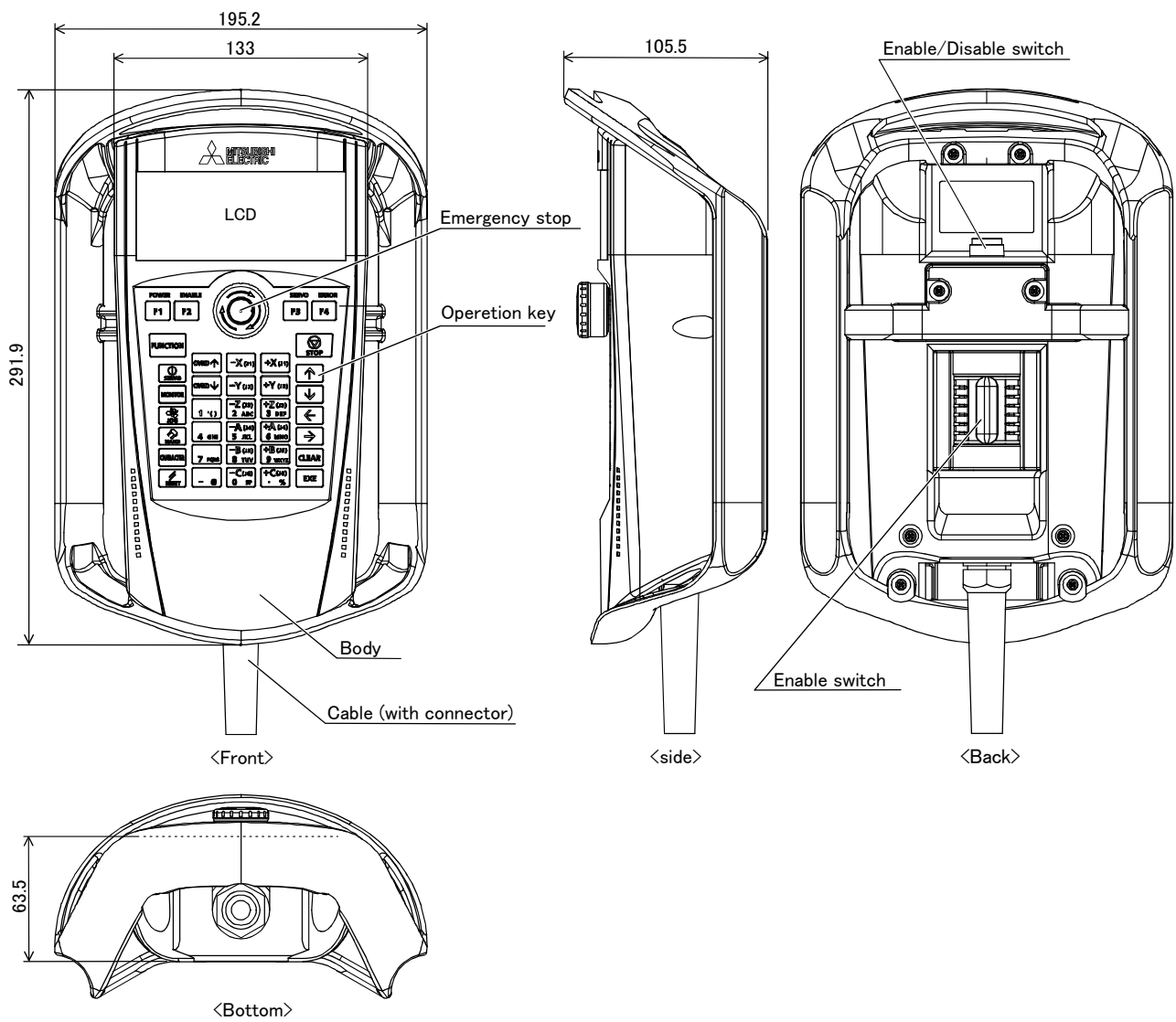
■Outside dimensions and main functions
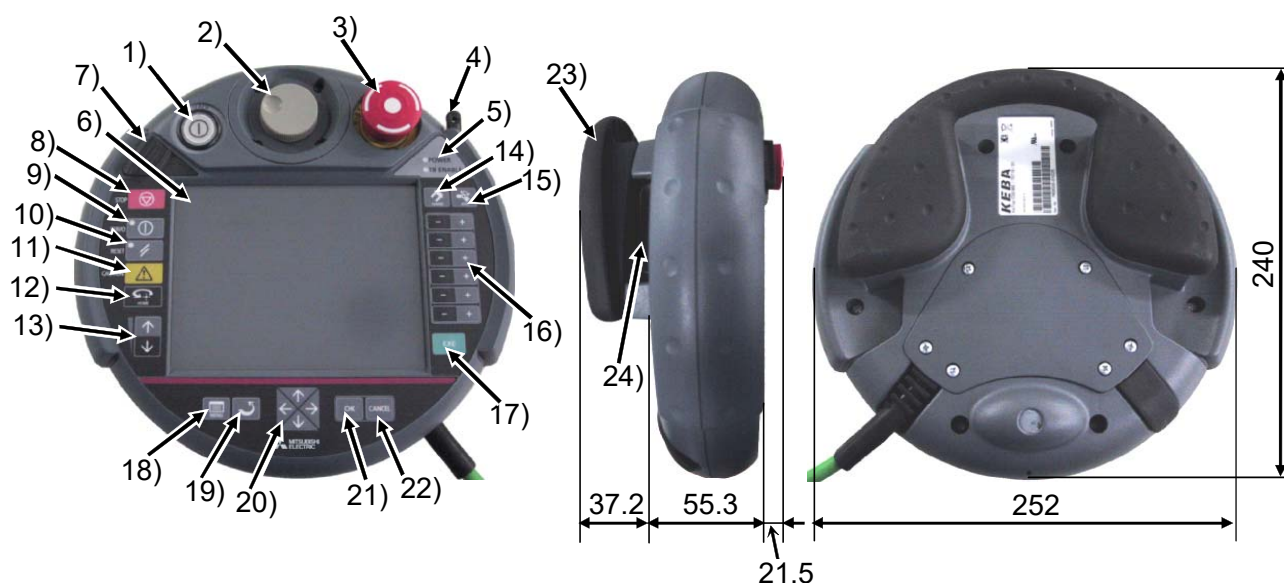
1) TEACH button .... This changeover switch is used to enable or disable the T/B key operations. The lamp (white) lights up during enabling state.
2) Wheel .... Move the cursor to select the menu and so on.
3) Emergency stop button .... This stops the robot in an emergency state. The servo turns OFF. Turn to the right to cancel.
4) Touch stylus (Integrated in housing)
    The pen which operates the touch panel.
5) Power supply LED, T/B enable LED
    POWER LED lights up during supplying the power supply. TB ENABLE LED lights up during enabling state.
6) Touch panel .... Tap to operate with the stylus pen and the screen is displayed.
7) USB connecter .... Plug-in the USB memory stick.
8) STOP button .... This stops the robot immediately. The servo does not turn OFF.
9) SERVO button .... This turns ON the servo power simultaneously with the enable switch. The LED (green) lights during servo ON.
10) RESET button .... This key resets an error state that has occurred.
11) CAUTION button .... If this button is pushed in jog operation, the limit switch can be canceled. Moreover, push this button, when releasing the brake.
12) HOME button .... Not use.
13) OVRD button .... This scrolls override up or down.
14) HAND button .... Display the screen of hand operation.
15) JOG button .... Display the screen of jog operation.
16) +/- button .... This button operates corresponding to the selected operation.
17) EXE button .... Move the robot, such as hand alignment.
18) MENU button .... Display the menu screen.
19) RETURN button .... Close each operation screen.
20) Arrow button .... Move the cursor
21) OK button .... Fix each screen operation.
22) CANCEL button .... Cancel each screen operation.
23) Multi grip handle .... Holds the T/B.
24) Enable switch .... If this switch is released or pressed with force while the T/B is enabled, the servo power supply turns OFF. To move the robot in jog operation or the like, press the switch lightly and hold it. The enable switch is mounted on each of the multi grip handle.

    Fig.3-20: Teaching pendant outside dimensions and main functions

(3) Function extension card

■Order type: ●2F-DQ510 .... MELFA Smart Plus card pack (A-type)
　　　　　　 ●2F-DQ520 .... MELFA Smart Plus card pack (AB-type)
　　　　　　 ●2F-DQ511 .... MELFA Smart Plus card (A-type)
　　　　　　 ●2F-DQ521 .... MELFA Smart Plus card (B-type)

■Outline

This card is used to enable the MELFA Smart Plus option.
Insert this card in the option slot on the front of the controller, and enable the MELFA Smart Plus software extension function.

■Configuration
Table 3-15: Configuration device

Part name		Type	Qty.	Mass (Kg)	Remarks
MELFA Smart Plus card pack	A-type	2F-DQ510	1	0.5	Software version of controller: Ver. A5p or later
	AB-type	2F-DQ520	1	0.5	
MELFA Smart Plus card	A-type	2F-DQ511	1	0.5	
	B-type	2F-DQ521	1	0.5	

(4) MELSOFT RT ToolBox3/MELSOFT RT ToolBox3 mini/MELSOFT RT ToolBox3 Pro

■Order type:　　●MELSOFT RT ToolBox3
　　　　　　　　　　*For windows DVD-ROM　: 3F-14C-WINE
　　　　　　　　●MELSOFT RT ToolBox3 mini
　　　　　　　　　　*For windows DVD-ROM　: 3F-15C-WINE
　　　　　　　　●MELSOFT RT ToolBox3 Pro
　　　　　　　　　　*For windows DVD-ROM　: 3F-16D-WINE

■Outline

This is handy software that fully uses the personal computer functions. It can be used in various stages from the robot specifications study (tact study, etc.) to the design support (creation and editing of programs), start up support (execution, control and debugging of program), and maintenance (maintenance forecast).

■Configuration
Table 3-16: Product configuration

Part name	Type	Medium	Mass (kg) [Note1]	Remarks
RT ToolBox3	3F-14C-WINE	DVD-ROM	0.2	
RT ToolBox3 mini	3F-15C-WINE	DVD-ROM	0.2	
RT ToolBox3 Pro	3F-16D-WINE	DVD-ROM	0.2	

Note1) Mass indicates one set.

■Features
(1) Simple operation with guidance method and menu method
The Windows standard is used for windows operation, so the controller initialization and startup operations can be carried out easily by following the instructions given on the screen. Even a beginner can easily carry out the series of operations from program creation to execution.

(2) Increased work efficiency with ample support functions
The work efficiency is greatly improved with the multi-window method that carries out multiple steps and displays in parallel. The renumbering function, and copy, search, syntax check and step execution are especially sufficient, and are extremely useful when editing or debugging the program.
With the simulation function support of MELSOFT RT ToolBox3, the program can be debugged and the tact checked before starting the machine at the site. This allows the on-site startup work efficiently to be greatly improved.
MELSOFT RT ToolBox3 Pro allows a simulation of robot operation on three-dimensional CAD software SolidWorks®.

(3) The maintenance forecast function increases the efficiency of maintenance work. Analyze the load condition while the robot is actually operating. Based on this analysis, calculate the time for maintenance, such as lubrication and belt replacement. By utilizing this information, the line stop time as well as the maintenance costs can be reduced.

(4) The position recovery support function increases the recovery efficiency in the event of origin position displacement. This function compensates the origin settings and position data by just reproducing several previous teaching points when hand and/or arm displacement occurs, when replacing the motor and the belts, or when reloading the robot. This function can reduce the time required for recovery.

■Functions
Table 3-17: Functions

Function		Functional existence[Note1)]			Details
Compatible model		○	○	○	Personal computer running Windows 7, Windows 8, Windows 8.1, or Windows 10. [Note2)]
Program editing functions	Editing functions	○	○	○	• MELFA BASIC V, VI language compatible • Multiple editing screen simultaneously display • Command input, comment writing • Position data editing • File operation (writing to controller, personal computer) • Search and replace function (using characters, line Nos., labels) • Copy, cut, paste, insert (per character, line), undo (per command statement, position conversion) • Line No. automatic generation, renumbering • Batch syntax check • Command template • Position conversion batch editing • Position variable template • Print, print preview
	Control functions	○	○	○	• Program file control (list, copy, movement, delete, content comparison, name change, protect)
	Debugging functions	○	○	○	• Direct editing of program in controller • Confirmation of robot program operation (step execution, direct execution)
Simulation function		○	○	×	• Off-line simulation of robot program operation using CG (computer graphics) • Tact time calculation
Monitor functions		○	○	○	• Robot operation monitor (robot operation state, stop signal, error monitor, program monitor (execution program, variables), general-purpose input/output signals (forced output possible), dedicated input/output signals, operation confirmation (operation range, current position, hand, etc.) • Operation monitor (working time statistics, production information, robot version) • Servo monitor (load)
Maintenance function		○	○	○	• Parameter setting • Batch, divided backup
Simulation function on SolidWorks.		○	×	×	• Off-line simulation of robot program operation using CG (computer graphics) • Tact time calculation • Complex motion path generation, etc.

RT ToolBox3 mini
(3F-15C-WINE)

RT ToolBox3
(3F-14C-WINE)

RT ToolBox3 Pro
(3F-16D-WINE)
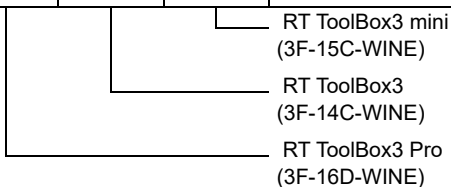
Note1) The functions included with the MELSOFT RT ToolBox3 ,MELSOFT RT ToolBox3 mini, and the MELSOFT RT ToolBox3 Pro are shown below. ○: Function provided   ×: Function not provided
Note2) Recommend corresponding to CE Marking, an FCC standard, and a VCCI standard.

(5) Instruction Manual (bookbinding)

■Order type: ●5F-BN01-PE01 .... RH-3CRH/6CRH series

■Outline
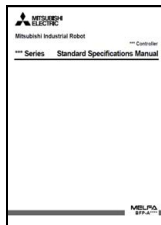
This is a printed version of the CD-ROM (instruction manual) supplied with this product.

■Configuration

Table 3-18: Product configuration

Name	Type	Mass (Kg) Note1)	Specifications
Instruction Manual	5F-BN01-PE01	3.0	The instructions manual set of RH-3CRH/6CRH.
Safety Manual	BFP-A3541	-	Items relating to safety in handling the robot
Standard Specifications	BFP-A3606	-	Specification of the robot arm and controller
Robot Arm Setup & Maintenance	BFP-A3609	-	Installation method of the robot arm, jog operation, and maintenance and inspection procedures
Controller Setup, Basic Operation and Maintenance	BFP-A3476	-	Installation method of the controller, basic operation, and maintenance and inspection procedures
Detailed Explanation of Functions and Operations	BFP-A3478	-	Functions of the controller and T/B, operation method, and explanation of MELFA-BASIC VI.
Troubleshooting	BFP-A3480	-	Causes of errors occurred and their countermeasures
Additional axis function	BFP-A3504	-	Function of the additional axis, operation method.
Tracking Function	BFP-A3520	-	Function of the tracking, operation method.
GOT Direct Connection Extended Function	BFP-A3546	-	Explains of data configuration of shared memory, monitoring, and operating procedures, between the GOT and controller.
Ethernet Function	BFP-A3379	-	Ethernet communication method between personal computer and robot controller.

Note1) Mass indicates one set.

(6) Parallel I/O interface

■Order type : ●2D-TZ368 (Sink type)/2D-TZ378 (Source type)

■Outline

This is used to expand the external inputs and outputs.
• The connecting cable with external equipment is not attached. Since we are preparing the external input-and-output cable (2D-CBL05 or 2D-CBL15) as the option, please use.
Notes)Although the combined use with the parallel input-and-output unit (2A-RZ361/ 2A-RZ371) of another option is also possible, please use the setup of the station number by the different number separately. The station number is automatically determined by the position of the option slot which installed this interface. (station number 0 to 1)

■Configuration
Table 3-19: Configuration device

Part name	Type	Qty.	Mass (kg) Note1)	Remarks
Parallel I/O interface	2D-TZ368	Either one pc.	0.4	Input/output 32 points/32 points
	2D-TZ378			2D-TZ368 is sink type. 2D-TZ378 is source type.
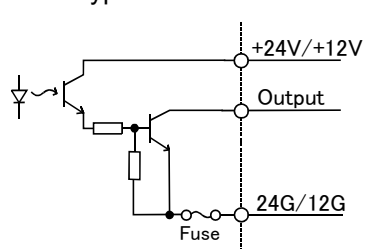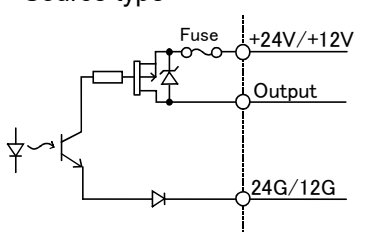
Note1) Mass indicates one set.

■Specifications
Table 3-20: Electrical specifications of input circuits

Item		Specification		Internal circuit
Type		DC input		<Sink type>
Number of input points		32		
Insulation method		Photo coupler insulation		
Rated input voltage		DC12V	DC24V	
Rated input current		Approx. 3mA	Approx.9mA	
Working voltage range		DC10.2 to 26.4V (Ripple factor should be less than 5%)		
ON voltage/ON current		DC8V or more/2mA or more		<Source type>
OFF voltage/ OFF current		DC4V or less/1mA or less		
Input resistance		Approx. 2.7kΩ		
Response time	OFF-ON	10ms or less(DC24V)		
	ON-OFF	10ms or less(DC24V)		
Common method		32 points per common		
External cable connection method		Connector		

Table 3-21: Electrical specifications for the output circuits

Item		Specification	Internal circuit
Type		Transistor output	<Sink type>
No. of output points		32	
Insulation method		Photo-coupler insulation	
Rated load voltage		DC12V/DC24V	
Rated load voltage range		DC10.2 to 30V (peak voltage DC30V)	
Max. load current		0.1A/point (100%)	
Leakage current at OFF		Within 0.1mA	
Max. voltage drop at ON		DC0.9V(TYP.) Note1)	
Response time	OFF-ON	10ms or less (Resistance load) (hardware response time)	<Source type>
	ON-OFF	10ms or less (Resistance load) (hardware response time)	
Fuse rating		Fuse 1.6A (one per common) Replacement possible (max. 3)	
Common method		16 points per common (common terminal: 2points)	
External wire connection method		Connector	
External power supply	Voltage	DC12/24V(DC10.2 to 30V)	
	Current	60mA (TYP.DC24V per common) (base drive current)	

Note1) The maximum voltage drop value at signal ON.
Refer to it for the equipment connected to the output circuit.

*A voltage exceeding the rated voltage or incorrect wiring may damage the circuit.

⚠ **Caution** The protection fuse of the output circuit prevents the failure at the time of the load short circuit and incorrect connection. The load connected of the customer should be careful not to exceed maximum rating current. The internal transistor may be damaged if maximum rating current is exceeded.

■Installation method
The expansion parallel input/output interface is installed in the controller. Refer to separate "Instruction Manual/ Controller setup, basic operation, and maintenance" for details on the installing method.
If it installs in the option SLOT of the controller, the station number will be assigned automatically.

SLOT1: station number 0 (0 to 31)
SLOT2: station number 1 (32 to 63)

⚠ **Caution** If it uses together with parallel input-and-output unit 2A-RZ361/2A-RZ371, please do not overlap with the station number of the parallel input-and-output interface.

SLOT1   SLOT2
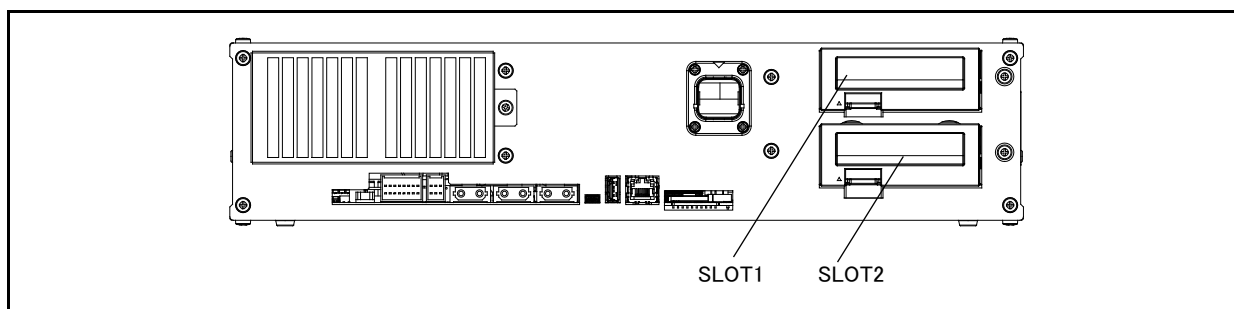
Fig.3-21: Parallel I/O interface installation position

■Pin layout of connector


```
1B ┌──────────────────┐ 20B
   │ ⊙ ┌──────────┐ ⊙ │
1A │   └──────────┘    │ 20A          Connector⟨2⟩
1D │ ⊙ ┌──────────┐ ⊙ │ 20D          Output 16 to 31
1C │   └──────────┘    │ 20C          Input    16 to 31
   └──────────────────┘               (when station number 0)
                                      Connector⟨1⟩
                                      Output 0 to 15
                                      Input    0 to 15
                                      (when station number 0)
```
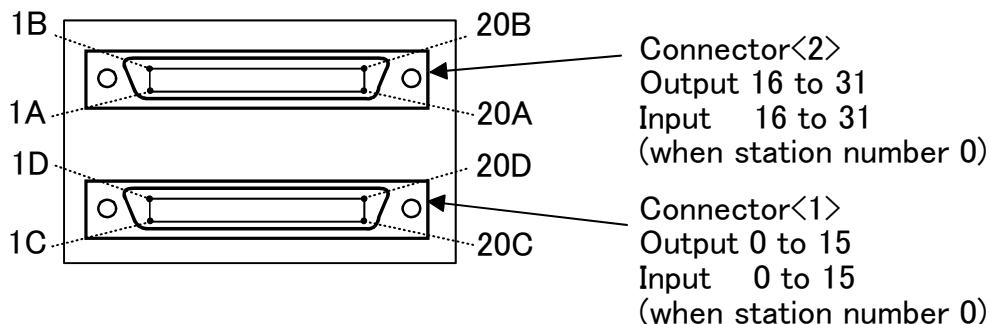
Fig.3-22: Pin layout of connector

■Connector pin No. and signal assignment
 The station number is fixed by the slot to install and the allocation range of the general-purpose input-and-output signal is fixed.

Table 3-22: The slot number and the station number

Slot number	Station number	Range of the general-purpose input-and-output signal	
		Connector <1>	Connector <2>
SLOT1	0	Input: 0 to 15 Output: 0 to 15	Input: 16 to 31 Output: 16 to 31
SLOT2	1	Input: 32 to 47 Output: 32 to 47	Input: 48 to 63 Output: 48 to 63

   The connector pin number of the parallel input-and-output interface installed in SLOT1 and signal number allocation are shown in Table 3-23 and Table 3-24. If it installs in other slots, please interpret and utilize.

Table 3-23: Connector<1> pin assignment list and external I/O cable (2D-CBL**) color(SLOT1)

Pin No.	Line color	Function name		Pin No.	Line color	Function name	
		General-purpose	Dedicated/power supply, common			General-purpose	Dedicated/power supply, common
1C	Orange/Red a		24G/12G: For pins 5D-20D COM: For pins 5C-20C[Note1]	1D	Orange/Black a		+24V/+12V(COM): For pins 5D-20D
2C	Gray/Red a			2D	Gray/Black a		Reserved
3C	White/Red a		Reserved	3D	White/Black a		Reserved
4C	Yellow/Red a		Reserved	4D	Yellow/Black a		Reserved
5C	Pink/Red a	General-purpose input 15		5D	Pink/Black a	General-purpose output 15	
6C	Orange/Red b	General-purpose input 14		6D	Orange/Black b	General-purpose output 14	
7C	Gray/Red b	General-purpose input 13		7D	Gray/Black b	General-purpose output 13	
8C	White/Red b	General-purpose input 12		8D	White/Black b	General-purpose output 12	
9C	Yellow/Red b	General-purpose input 11		9D	Yellow/Black b	General-purpose output 11	
10C	Pink/Red b	General-purpose input 10		10D	Pink/Black b	General-purpose output 10	
11C	Orange/Red c	General-purpose input 9		11D	Orange/Black c	General-purpose output 9	
12C	Gray/Red c	General-purpose input 8		12D	Gray/Black c	General-purpose output 8	
13C	White/Red c	General-purpose input 7		13D	White/Black c	General-purpose output 7	
14C	Yellow/Red c	General-purpose input 6		14D	Yellow/Black c	General-purpose output 6	
15C	Pink/Red c	General-purpose input 5	Operation rights input signal [Note2]	15D	Pink/Black c	General-purpose output 5	
16C	Orange/Red d	General-purpose input 4	Servo ON input signal [Note2]	16D	Orange/Black d	General-purpose output 4	
17C	Gray/Red d	General-purpose input 3	Start input [Note2]	17D	Gray/Black d	General-purpose output 3	Operation rights output signal [Note2]
18C	White/Red d	General-purpose input 2	Error reset input signal [Note2]	18D	White/Black d	General-purpose output 2	Error occurring output signal [Note2]
19C	Yellow/Red d	General-purpose input 1	Servo OFF input signal [Note2]	19D	Yellow/Black d	General-purpose output 1	In servo ON output signal [Note2]
20C	Pink/Red d	General-purpose input 0	Stop input [Note3]	20D	Pink/Black d	General-purpose output 0	Operating output [Note2]

Note1) Sink type: +24V/+12V(COM), Source type: 24G/12G
Note2) The dedicated signal is assigned at shipping. It can change with the parameter.
Note3) The dedicated input signal (STOP) is assigned at shipping. The signal number is fixing.

Table 3-24: Connector<2> pin assignment list and external I/O cable (2D-CBL**) color(SLOT1)

Pin No.	Line color	Function name		Pin No.	Line color	Function name	
		General-purpose	Dedicated/power supply, common			General-purpose	Dedicated/power supply, common
1A	Orange/Red a		24G/12G: For pins 5B-20B COM: For pins 5A-20A[Note1]	1B	Orange/Black a		+24V/+12V(COM): For pins 5B-20B
2A	Gray/Red a			2B	Gray/Black a		Reserved
3A	White/Red a		Reserved	3B	White/Black a		Reserved
4A	Yellow/Red a		Reserved	4B	Yellow/Black a		Reserved
5A	Pink/Red a	General-purpose input 31		5B	Pink/Black a	General-purpose output 31	
6A	Orange/Red b	General-purpose input 30		6B	Orange/Black b	General-purpose output 30	
7A	Gray/Red b	General-purpose input 29		7B	Gray/Black b	General-purpose output 29	
8A	White/Red b	General-purpose input 28		8B	White/Black b	General-purpose output 28	
9A	Yellow/Red b	General-purpose input 27		9B	Yellow/Black b	General-purpose output 27	
10A	Pink/Red b	General-purpose input 26		10B	Pink/Black b	General-purpose output 26	
11A	Orange/Red c	General-purpose input 25		11B	Orange/Black c	General-purpose output 25	
12A	Gray/Red c	General-purpose input 24		12B	Gray/Black c	General-purpose output 24	
13A	White/Red c	General-purpose input 23		13B	White/Black c	General-purpose output 23	
14A	Yellow/Red c	General-purpose input 22		14B	Yellow/Black c	General-purpose output 22	
15A	Pink/Red c	General-purpose input 21		15B	Pink/Black c	General-purpose output 21	
16A	Orange/Red d	General-purpose input 20		16B	Orange/Black d	General-purpose output 20	
17A	Gray/Red d	General-purpose input 29		17B	Gray/Black d	General-purpose output 19	
18A	White/Red d	General-purpose input 18		18B	White/Black d	General-purpose output 18	
19A	Yellow/Red d	General-purpose input 17		19B	Yellow/Black d	General-purpose output 17	
20A	Pink/Red d	General-purpose input 16		20B	Pink/Black d	General-purpose output 16	

Note1) Sink type: +24V/+12V(COM), Source type: 24G/12G

<Reference> The example of connection with our PLC
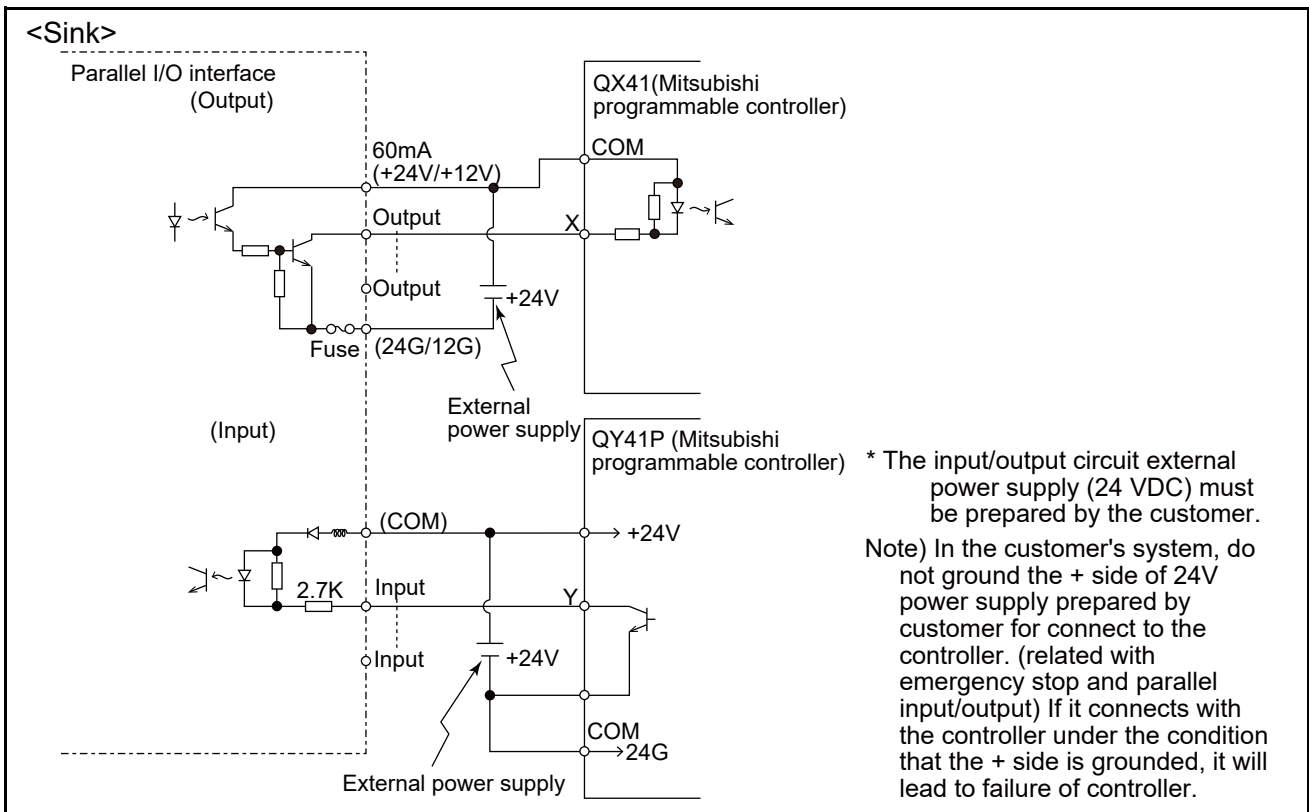
Fig.3-23: Connection with a Mitsubishi PLC (Example of sink type)

The following shows an example of a protective circuit.
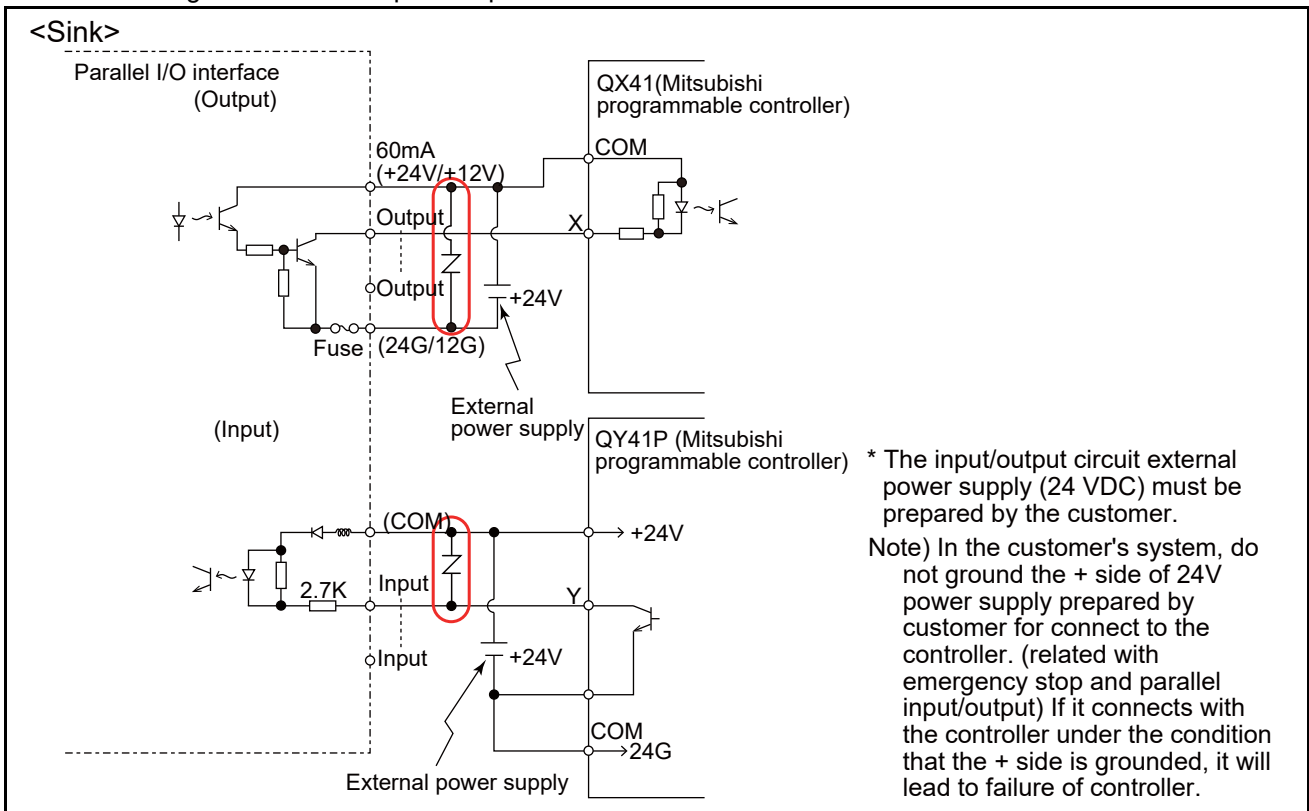
Fig.3-24: Connection with a Mitsubishi PLC (Example of sink type) for use of a protective circuit
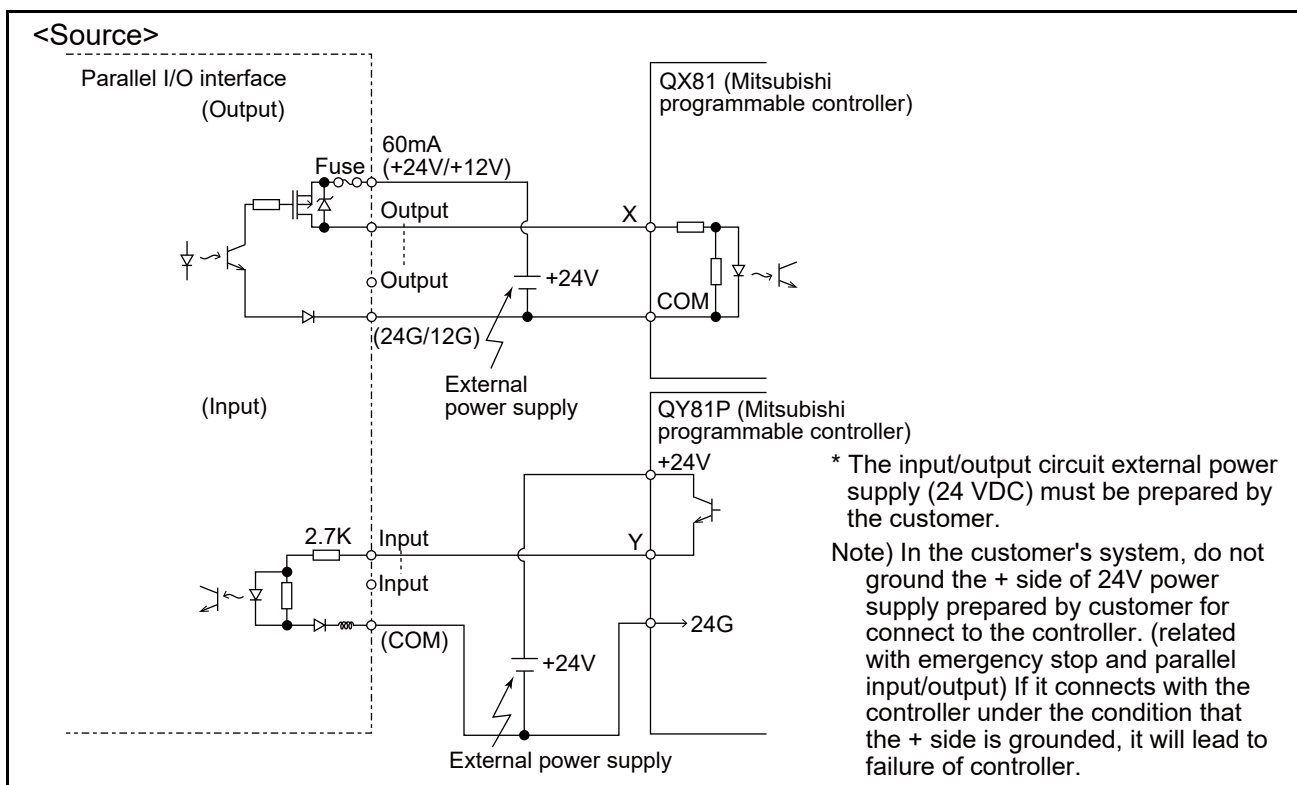
Fig.3-25: Connection with a Mitsubishi PLC (Example of source type)

The following shows an example of a protective circuit.
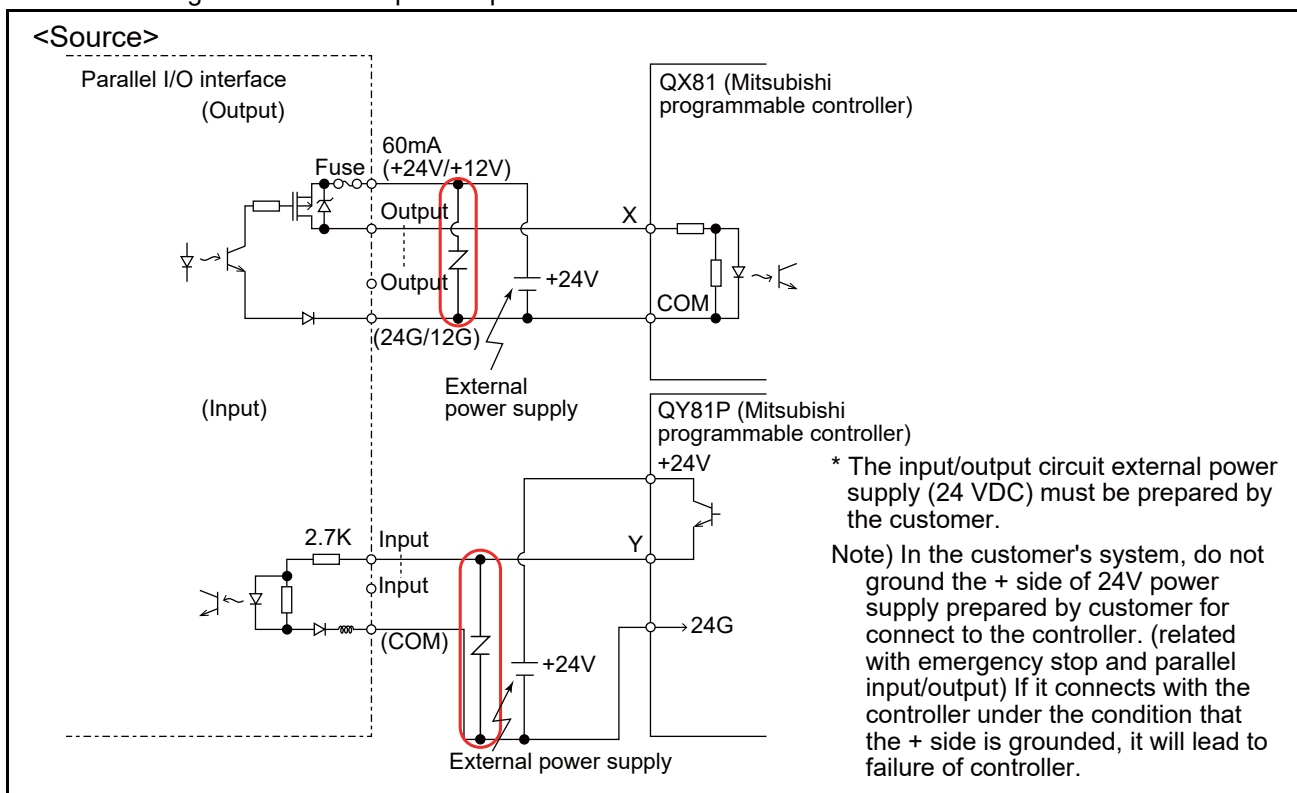
Fig.3-26: Connection with a Mitsubishi PLC (Example of source type) for use of a protective circuit

(7) External I/O cable

■Order type : ●2D-CBL□□[Note]The numbers in the boxes□□ refer to the length. (05: 5m, 15: 15m)

■Outline

This is the dedicated cable used to connect an external peripheral device to the connector on the parallel I/O interface. For parallel I/O unit is another option 2A-CBL**.
One end matches the connector on the parallel input/output unit, and the other end is free. Connect the peripheral device's input/output signal using the free end.
One cable correspond to the input 16 points and output 16 points.
Two cables are needed to connection of (input 32 points and output 32 points) with built-in standard.

■Configuration
Table 3-25: Configuration device

Part name	Type	Qty.	Mass (kg) Note1)	Remarks
External I/O cable	2D-CBL□□	1 pc.	0.7(5m) 1.84(15m)	5m or 15m

Note1) Mass indicates one set.

■Specifications
Table 3-26: Specifications

Items	Specifications
Number of cables x cable size	AWG #28 x 20P (40 cores)
Total length	5m, 15m

■Connector pin numbers and cable colors
Table 3-27: Connector pin numbers and cable colors

Pin no.	Cable colors	Pin no.	Cable colors	Pin no.	Cable colors	Pin no.	Cable colors
1A/C	Orange/Red a	11A/C	Orange/Red c	1B/D	Orange/Black a	11B/D	Orange/Black c
2A/C	Gray/Red a	12A/C	Gray/Red c	2B/D	Gray/Black a	12B/D	Gray/Black c
3A/C	White/Red a	13A/C	White/Red c	3B/D	White/Black a	13B/D	White/Black c
4A/C	Yellow/Red a	14A/C	Yellow/Red c	4B/D	Yellow/Black a	14B/D	Yellow/Black c
5A/C	Pink/Red a	15A/C	Pink/Red c	5B/D	Pink/Black a	15B/D	Pink/Black c
6A/C	Orange/Red b	16A/C	Orange/Red d	6B/D	Orange/Black b	16B/D	Orange/Black d
7A/C	Gray/Red b	17A/C	Gray/Red d	7B/D	Gray/Black b	17B/D	Gray/Black d
8A/C	White/Red b	18A/C	White/Red d	8B/D	White/Black b	18B/D	White/Black d
9A/C	Yellow/Red b	19A/C	Yellow/Red d	9B/D	Yellow/Black b	19B/D	Yellow/Black d
10A/C	Pink/Red b	20A/C	Pink/Red d	10B/D	Pink/Black b	20B/D	Pink/Black d

Notes) Pin number of connector<1> are 1C, 2C, ...20C, 1D, 2D, ...20D, connector<2> are 1A, 2A, ...20A, 1B, 2B, ...20B.

■Connections and outside dimensions
The sheath of each signal cable (40 lines) is color indicated and marked with dots. Refer to the cable color specifications in "Table 3-36: Connector pin numbers and cable colors" when making the connections.

(Eg.) Pin number: color indication
1 : Orange / Red / a

Type of dot mark (see figure below)
Color of dot mark

Line color type | Pattern of the print mark

a type | One dot

b type | Two dots

c type | Three dots

d type | Four dots

(10.3)

(72.72)

20A/C | ++ | 20B/D

1A/C | ++ | 1B/D

(51)

5000 or 15000

(20) (30)

BKO-FA0839Hxx

Plug (OTAX Corporation)   Connector: N361J040AU
Cover: N360C040B
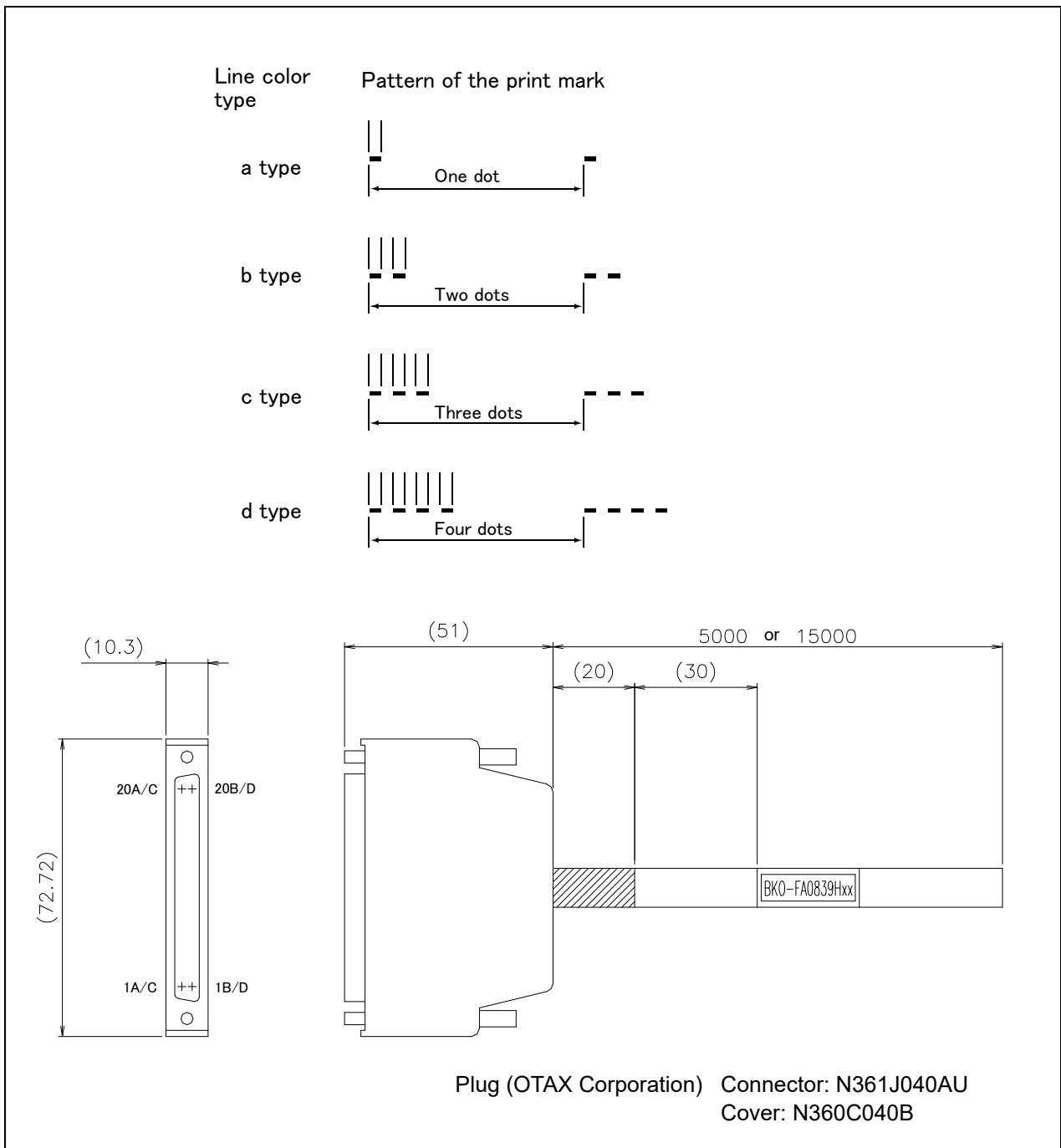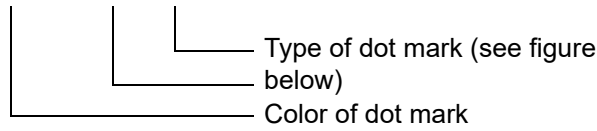
Fig.3-27: Connections and outside dimensions

(8) Parallel I/O unit

■Order type: 2A-RZ361(Sink type)/2A-RZ371(Source type)

■Outline

This is used to expand the external inputs and outputs.
- The connection cable is not included. .Prepare the optional external input/output cable (2A-CBL05 or 2A-CBL15).
- Use 2A-RZ361 if the external input/output signal logic is of the sink type and 2A-RZ371 for source type signal logic.

Notes) Although the combined use with the parallel I/O interface (2D-TZ368/2D-TZ378) of another option is also possible, please use the setup of the station number by the different number separately. The station number is automatically fixed by the position of the option slot which installed the parallel I/O interface in 0-1.

■Configuration
Table 3-28: Configuration device

Part name	Type	Qty.	Mass (kg) [Note1]	Remarks
Parallel I/O unit	2A-RZ361	Either one pc.	0.7	Input/output 32 points/32 points 2A-RZ361 is the sink type. 2A-RZ371 is the source type.
	2A-RZ371			
Robot I/O link connection connector	NETcable-1	2 sets	-	Connector with pins. The cable must be prepared and wired by the customer.
Power connection connector	DCcable-2	Each 1 set	-	Connector with pins. The cable must be prepared and wired by the customer.
Terminator	R-TM	1 pc.	-	100Ω (1/4W)

Note1) Mass indicates one set.

■Specifications
1) Up to eight stations can be connected to this unit (one station occupies one unit).
The combined use with another optional parallel I/O interface (2D-TZ368/2D-TZ378) is possible, but the maximum number of stations is eight in total. In this case, set any of station numbers carefully so that they do not duplicate.
2) The power supply (24V) must be prepared by the customer and connected with the power connection cable (DCcable-2)
A separate 24V power supply is required for the input/output circuit wiring.

Table 3-29: Electrical specifications of input circuits
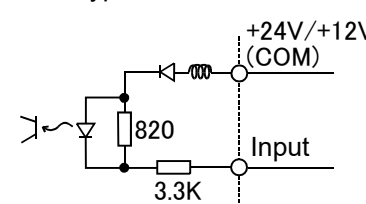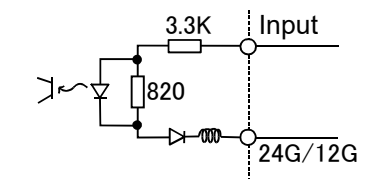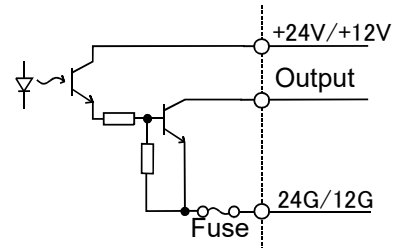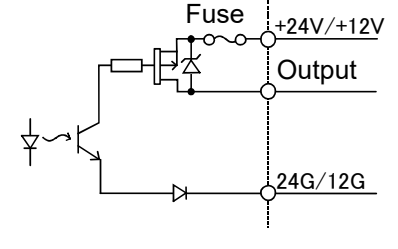
Item		Specification		Internal circuit
Type		DC input		<Sink type>
Number of input points		32		
Insulation method		Photo coupler insulation		
Rated input voltage		12VDC	24VDC	
Rated input current		Approx 3mA	Approx 7mA	
Working voltage range		10.2 to 26.4VDC(Ripple factor should be less than 5%.)		
ON voltage/ON current		8VDC or more/ 2mA or more		
OFF voltage/ OFF current		4VDC or less/ 1mA or less		<Source type>
Input resistance		Approx. 3.3kΩ		
Response time	OFF-ON	10ms or less (24VDC)		
	ON-OFF	10ms or less (24VDC)		
Common method		8 points per common		
External cable connection method		Connector		

Table 3-30: Electrical specifications for the output circuits

Item		Specification	Internal circuit
Type		Transistor output	〈Sink type〉
No. of output points		32	
Insulation method		Photo-coupler insulation	
Rated load voltage		12VDC/24VDC	
Rated load voltage range		10.2 to 30VDC(peak voltage 30VDC)	
Max. load current		0.1A/point (100%)	
Leakage current at OFF		0.1mA or less	
Max. voltage drop at ON		0.9VDC(TYP.) Note1)	
Response time	OFF-ON	2ms or less (hardware response time)	
	ON-OFF	2ms or less (Resistance load) (hardware response time)	〈Source type〉
Fuse rating		Fuse 3.2A (one per common) Replacement not possible	
Common method		8 points per common (common terminal: 4 points)	
External wire connection method		Connector	
External power supply	Voltage	12VDC/24VDC(10.2 to 30VDC)	
	Current	60mA (TYP. 24VDC per common) (base drive current)	

Note1) The maximum voltage drop value at signal ON.
　　　　Refer to it for the equipment connected to the output circuit.

*A voltage exceeding the rated voltage or incorrect wiring may damage the circuit.

⚠ CAUTION　The output circuit protective fuses prevent failure in case of load short-circuit and improper connections. Please do not connect loads that cause the current to exceed the maximum rated current. If the maximum rated current is exceeded, the internal transistors may be damaged.

⚠ CAUTION　Inputs the power supply for control (DCcable-2) then inputs the controller's power supply.

NET cable-1 (Network cable)

Pin No.	RIO1/2
1	TXRXH
2	TXRXL
3	SG(GND)

Connector: 1-178288-3

RIO	Pin No.
TXRXDH	1A
TXRXDL	1B
SG(GND)	2B
FG	3A

Connector: J21DF-06V-KX-L

DCcable-2 (Power cable)

Pin No.	RIO1/2
1	24V
2	24G(RG)
3	FG(PE)

Connector: 2-178288-3

+24V Power

Connected the frame ground or protect ground

R-TM (Terminator)

Pin No.	RIO1/2
1	TXRXH
2	TXRXL
3	SG(GND)

100Ω

List of parts and manufacturer

Type	Connector type	Contact type	Resistant	Manufacturer
NETcable-1	1-178288-3 (2)	1-175218-2 (6)	-	Tyco Electronics
	51103-0300 (1)	50351-8100 (3)	-	MOLEX
	J21DF-06V-KX-L (1)	SJ2F-01GF-P1.0 (4)	-	JST
DCcable-2	2-178288-3 (1)	1-175218-5 (3)	-	Tyco Electronics
R-TM	1-178288-3 (1)	1-175218-3 (2)	100Ω(1/4W) (1)	Equivalent to KOA.

Note 1) The 24V power supply is prepared by customer (The power consumption is approx. 0.3A.)
    In the customer's system, do not ground the + side of 24V power supply prepared by customer for connect to the controller. (related with emergency stop and parallel input/output) If it connects with the controller under the condition that the + side is grounded, it will lead to failure of controller.
Note 2) The cable for general purpose can be used to the network cable. However, use the twisted shield cable of AWG#22(0.3mm^2) or more.

Fig.3-28: Specifications for the connection cable

■Installation method
　　The expansion parallel input/output unit is installed outside of the controller. Connect with the network connection cable (NETcable-1) from the RIO connector in the front of the controller.

RIO

Upside

(40)
Wiring space

(175)

128

6

100

Heat radiation space

2-M5 screw

6

156

168

6

54

60

6

Control panel installation dimensions

〈2A-RZ361〉
〈2A-RZ371〉

150

Radiation/wiring space

Downside

Installation dimensions of 2A-RZ361/2ARZ-371 (The controller outside installation.)
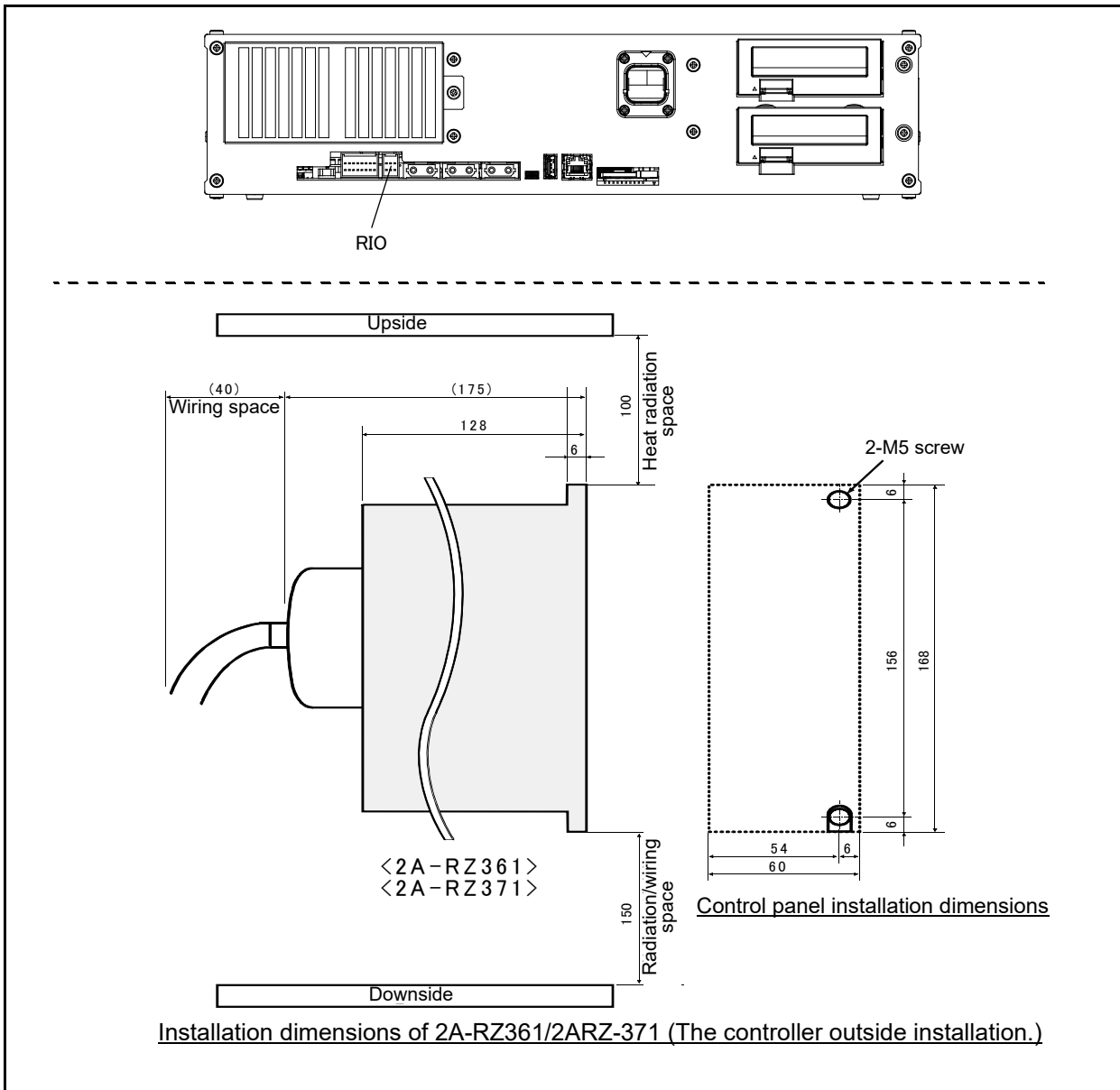
Fig.3-29: Installing the parallel I/O unit
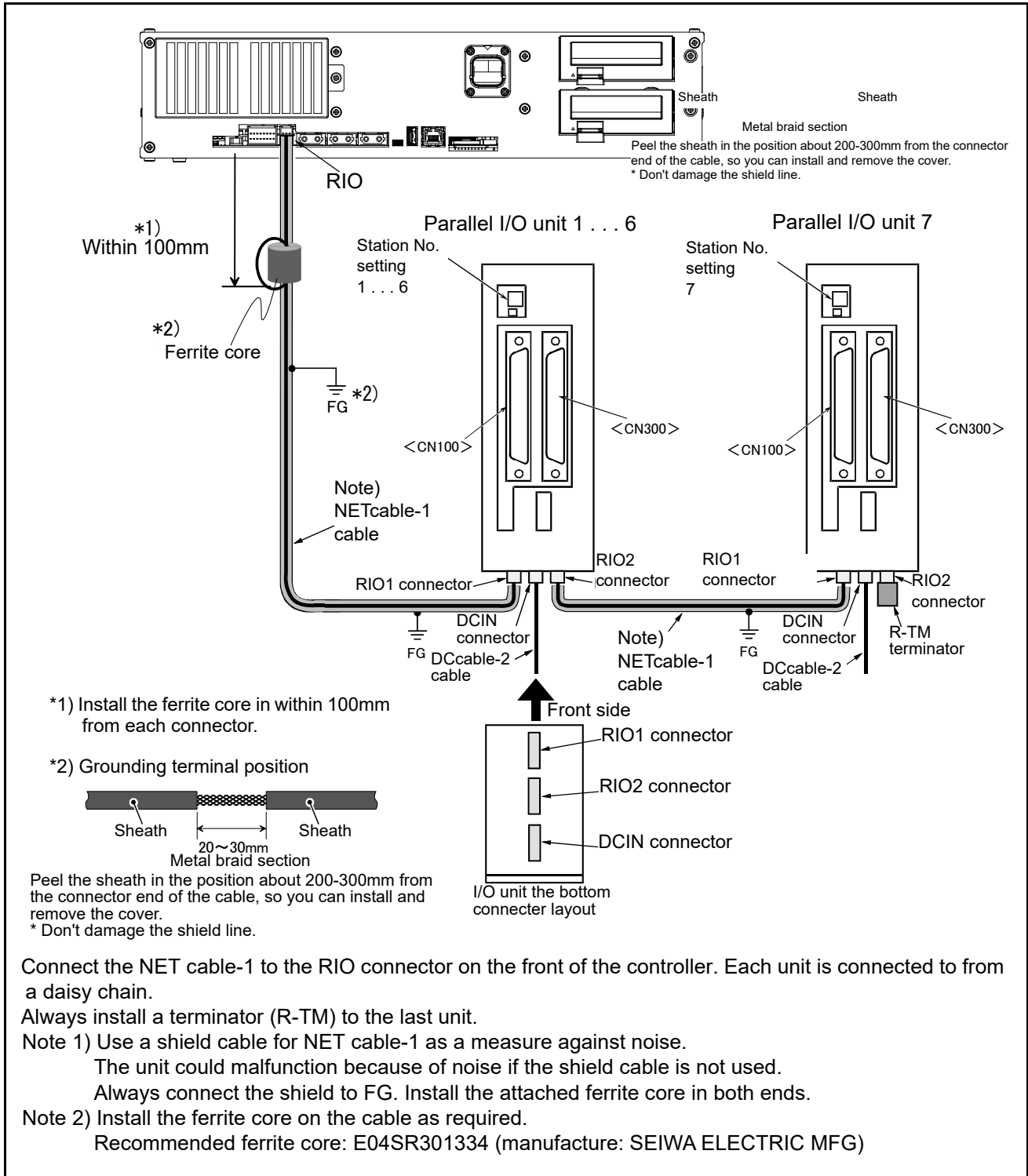
Fig.3-30: Connection method of expansion parallel I/O unit

Sheath   Sheath

Metal braid section

Peel the sheath in the position about 200-300mm from the connector end of the cable, so you can install and remove the cover.
* Don't damage the shield line.

RIO

*1) Within 100mm

*2) Ferrite core

FG *2)

Parallel I/O unit 1 . . . 6

Station No. setting 1 . . . 6

＜CN100＞   ＜CN300＞

Note) NETcable-1 cable

RIO1 connector   RIO2 connector

FG   DCIN connector

DCcable-2 cable

Parallel I/O unit 7

Station No. setting 7

＜CN100＞   ＜CN300＞

RIO1 connector   RIO2 connector

FG   DCIN connector   R-TM terminator

Note) NETcable-1 cable   DCcable-2 cable

*1) Install the ferrite core in within 100mm from each connector.

*2) Grounding terminal position

Sheath   Sheath
20～30mm
Metal braid section

Peel the sheath in the position about 200-300mm from the connector end of the cable, so you can install and remove the cover.
* Don't damage the shield line.

Front side

RIO1 connector
RIO2 connector
DCIN connector

I/O unit the bottom connecter layout

Connect the NET cable-1 to the RIO connector on the front of the controller. Each unit is connected to from a daisy chain.

Always install a terminator (R-TM) to the last unit.

Note 1) Use a shield cable for NET cable-1 as a measure against noise.
The unit could malfunction because of noise if the shield cable is not used.
Always connect the shield to FG. Install the attached ferrite core in both ends.

Note 2) Install the ferrite core on the cable as required.
Recommended ferrite core: E04SR301334 (manufacture: SEIWA ELECTRIC MFG)

■Pin arrangement of the connector

*2A-RZ361/2 A-RZ371 are 32/32 input-and-output units. (One-station occupancy)

Fig.3-31: Pin arrangement of the parallel I/O unit

■Assignment of pin number and signal
The assignment range of the general-purpose input-and-output signal is fixed by the setup of the station number.
Although the combined use with the parallel I/O interface (2D-TZ368/2D-TZ378) of another option is also possible, please use the setup of the station number by the different number separately.

Table 3-31: Assignment of pin number and signal

Unit Number	Station number	CN100	CN300
1st set	0	Input: 0 to 15 Output: 0 to 15	Input: 16 to 31 Output: 16 to 31
2nd set	1	Input: 32 to 47 Output: 32 to 47	Input: 48 to 63 Output: 48 to 63
3rd set	2	Input: 64 to 79 Output: 64 to 79	Input: 80 to 95 Output: 80 to 95
4th set	3	Input: 96 to 111 Output: 96 to 111	Input: 112 to 127 Output: 112 to 127
5th set	4	Input: 128 to 143 Output: 128 to 143	Input: 144 to 159 Output: 144 to 159
6th set	5	Input: 160 to 175 Output: 160 to 175	Input: 176 to 191 Output: 176 to 191
7th set	6	Input: 192 to 207 Output: 192 to 207	Input: 208 to 223 Output: 208 to 223
8th set	7	Input: 224 to 239 Output: 224 to 239	Input: 240 to 255 Output: 240 to 255

The connector pin number of the parallel I/O unit of the station number 0 and signal number assignment are shown in Table 3-32 and Table 3-33. If it is set as other station number, please interpret and utilize.

■Parallel I/O interface (First expansion unit)
Table 3-32: Connector CN100pin No. and signal assignment list (2A-CBL□□)

Pin No.	Line color	Function name General-purpose	Function name Dedicated/power supply, common	Pin No.	Line color	Function name General-purpose	Function name Dedicated/power supply, common
1	Orange/Red A		FG	26	Orange/Blue A		FG
2	Gray/Red A		0V:For pins 4-7, 10-13	27	Gray/Blue A		0V:For pins 29-32, 35-38
3	White/Red A		12V/24V:For pins 4-7	28	White/Blue A		12V/24V:For pins 29-32
4	Yellow/Red A	General-purpose output 0	Operating output Note1)	29	Yellow/Blue A	General-purpose output 4	
5	Pink/Red A	General-purpose output 1	In servo ON output signal Note1)	30	Pink/Blue A	General-purpose output 5	
6	Orange/Red B	General-purpose output 2	Error occurring output signal Note1)	31	Orange/Blue B	General-purpose output 6	
7	Gray/Red B	General-purpose output 3	Operation rights output signal Note1)	32	Gray/Blue B	General-purpose output 7	
8	White/Red B		0V:For pins 4-7, 10-13	33	White/Blue B		0V:For pins 29-32, 35-38
9	Yellow/Red B		12V/24V:For pins 10-13	34	Yellow/Blue B		12V/24V:For pins 35-38
10	Pink/Red B	General-purpose output 8		35	Pink/Blue B	General-purpose output 12	
11	Orange/Red C	General-purpose output 9		36	Orange/Blue C	General-purpose output 13	
12	Gray/Red C	General-purpose output 10		37	Gray/Blue C	General-purpose output 14	
13	White/Red C	General-purpose output 11		38	White/Blue C	General-purpose output 15	
14	Yellow/Red C		COM0:For pins 15-22 Note2)	39	Yellow/Blue C		COM1:For pins 40-47 Note2)
15	Pink/Red C	General-purpose input 0	Stop input Note3)	40	Pink/Blue C	General-purpose input 8	
16	Orange/Red D	General-purpose input 1	Servo OFF input signal Note1)	41	Orange/Blue D	General-purpose input 9	
17	Gray/Red D	General-purpose input 2	Error reset input signal Note1)	42	Gray/Blue D	General-purpose input 10	
18	White/Red D	General-purpose input 3	Start input Note1)	43	White/Blue D	General-purpose input 11	
19	Yellow/Red D	General-purpose input 4	Servo ON input signal Note1)	44	Yellow/Blue D	General-purpose input 12	
20	Pink/Red D	General-purpose input 5	Operation rights input signal Note1)	45	Pink/Blue D	General-purpose input 13	
21	Orange/Red E	General-purpose input 6		46	Orange/Blue E	General-purpose input 14	
22	Gray/Red E	General-purpose input 7		47	Gray/Blue E	General-purpose input 15	
23	White/Red E		Reserved	48	White/Blue E		Reserved
24	Yellow/Red E		Reserved	49	Yellow/Blue E		Reserved
25	Pink/Red E		Reserved	50	Pink/Blue E		Reserved

Note1) The dedicated signal is assigned at shipping. It can change with the parameter.
Note2) Sink type:12V/24V(COM),Source type:0V(COM)
Note3) The dedicated input signal (STOP) is assigned at shipping. The signal number is fixing.

Table 3-33: Connector CN300pin No. and signal assignment list (2A-CBL□□)

Pin No.	Line color	Function name		Pin No.	Line color	Function name	
		General-purpose	Dedicated/power supply, common			General-purpose	Dedicated/power supply, common
1	Orange/Red A		FG	26	Orange/Blue A		FG
2	Gray/Red A		0V:For pins 4-7, 10-13	27	Gray/Blue A		0V:For pins 29-32, 35-38
3	White/Red A		12V/24V:For pins 4-7	28	White/Blue A		12V/24V:For pins 29-32
4	Yellow/Red A	General-purpose output 16		29	Yellow/Blue A	General-purpose output 20	
5	Pink/Red A	General-purpose output 17		30	Pink/Blue A	General-purpose output 21	
6	Orange/Red B	General-purpose output 18		31	Orange/Blue B	General-purpose output 22	
7	Gray/Red B	General-purpose output 19		32	Gray/Blue B	General-purpose output 23	
8	White/Red B		0V:For pins 4-7, 10-13	33	White/Blue B		0V:For pins 29-32, 35-38
9	Yellow/Red B		12V/24V:For pins 10-13	34	Yellow/Blue B		12V/24V:For pins 35-38
10	Pink/Red B	General-purpose output 24		35	Pink/Blue B	General-purpose output 28	
11	Orange/Red C	General-purpose output 25		36	Orange/Blue C	General-purpose output 29	
12	Gray/Red C	General-purpose output 26		37	Gray/Blue C	General-purpose output 30	
13	White/Red C	General-purpose output 27		38	White/Blue C	General-purpose output 31	
14	Yellow/Red C		COM0:For pins 15-22[Note1)]	39	Yellow/Blue C		COM1:For pins 40-47 [Note1)]
15	Pink/Red C	General-purpose input 16		40	Pink/Blue C	General-purpose input 24	
16	Orange/Red D	General-purpose input 17		41	Orange/Blue D	General-purpose input 25	
17	Gray/Red D	General-purpose input 18		42	Gray/Blue D	General-purpose input 26	
18	White/Red D	General-purpose input 19		43	White/Blue D	General-purpose input 27	
19	Yellow/Red D	General-purpose input 20		44	Yellow/Blue D	General-purpose input 28	
20	Pink/Red D	General-purpose input 21		45	Pink/Blue D	General-purpose input 29	
21	Orange/Red E	General-purpose input 22		46	Orange/Blue E	General-purpose input 30	
22	Gray/Red E	General-purpose input 23		47	Gray/Blue E	General-purpose input 31	
23	White/Red E		Reserved	48	White/Blue E		Reserved
24	Yellow/Red E		Reserved	49	Yellow/Blue E		Reserved
25	Pink/Red E		Reserved	50	Pink/Blue E		Reserved

Note1) Sink type:12V/24V(COM),Source type:0V(COM)

<Reference> The example of connection with our PLC

Fig.3-32: Connection with a Mitsubishi PLC (Example of sink type)

The following shows an example of a protective circuit.

Fig.3-33: Connection with a Mitsubishi PLC (Example of sink type) for use of a protective circuit
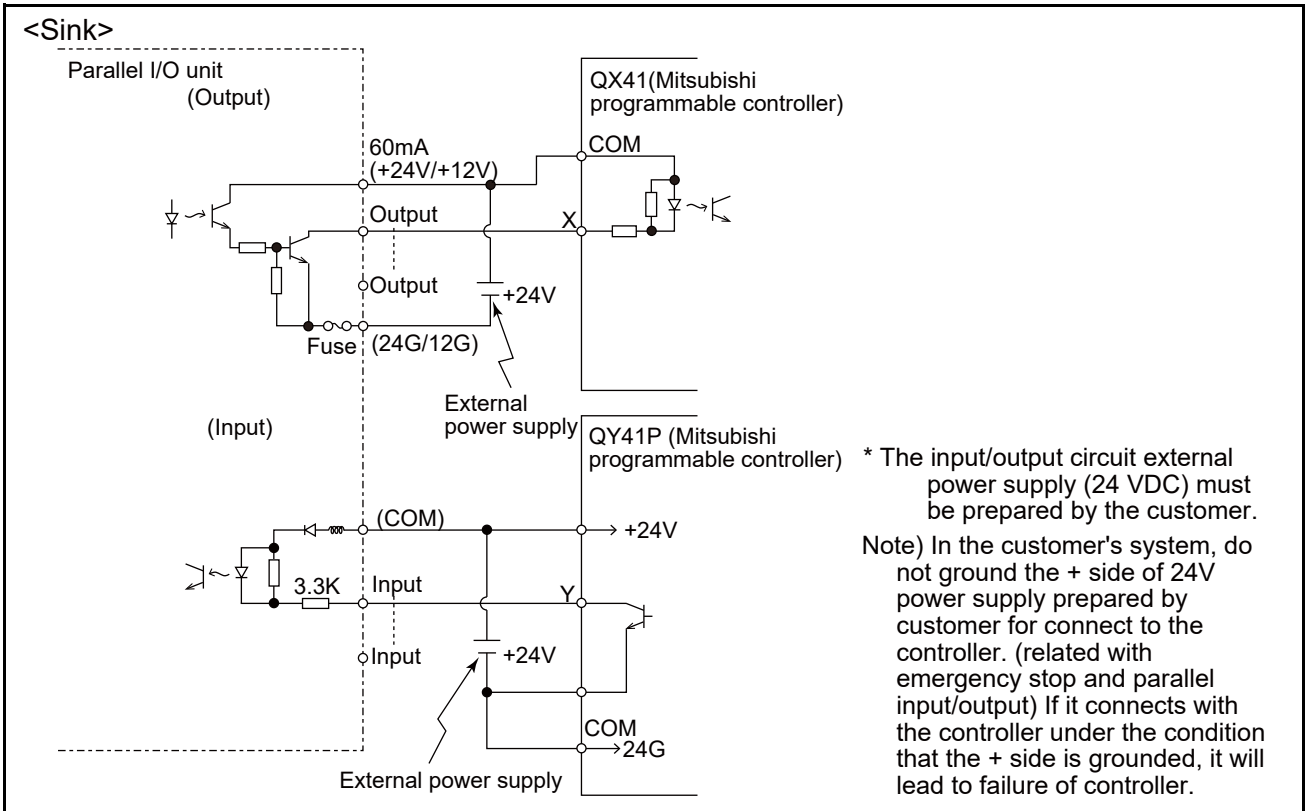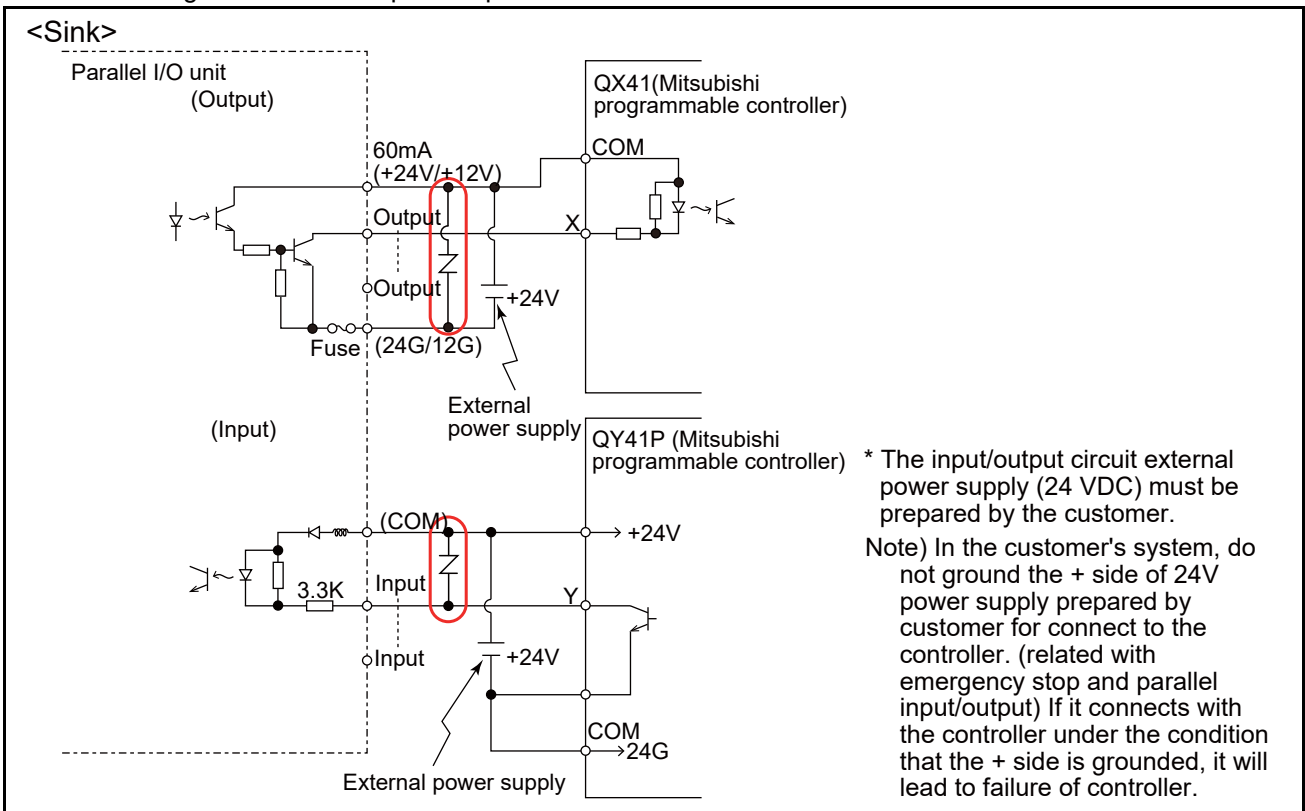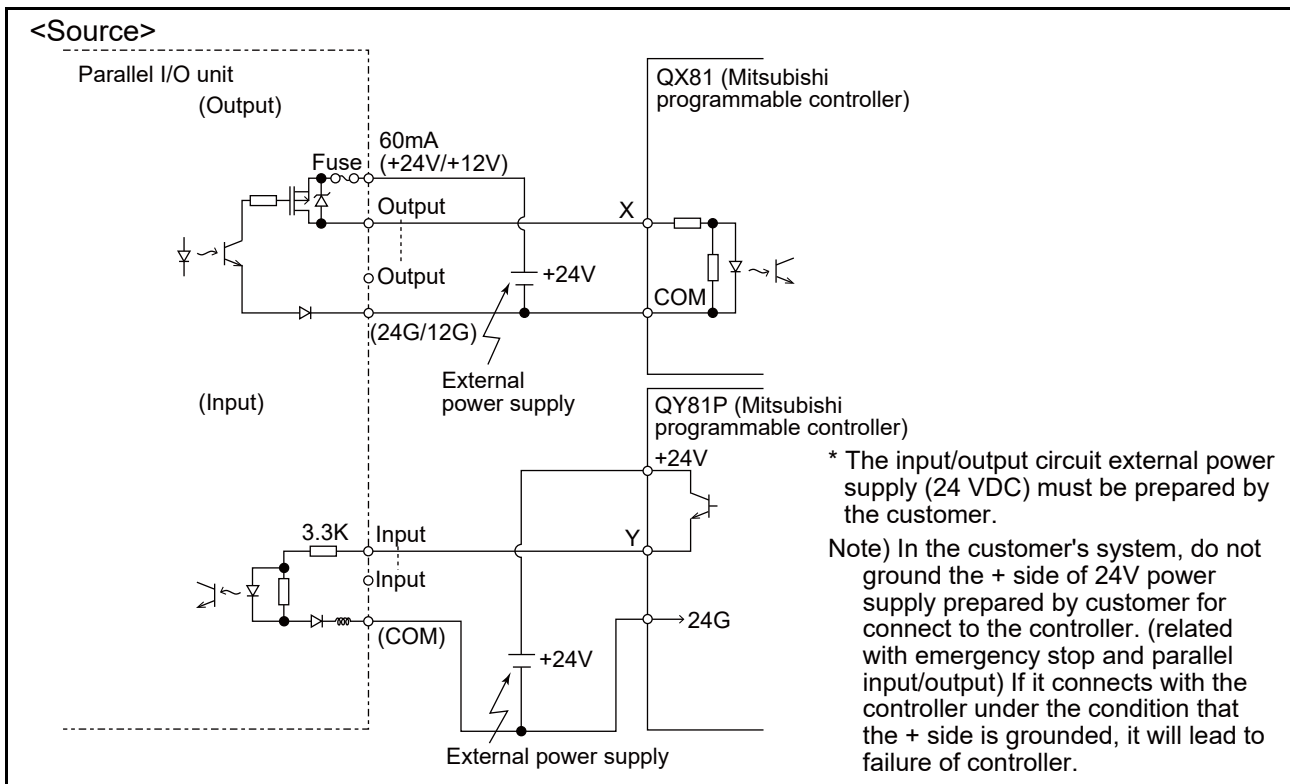
Fig.3-34: Connection with a Mitsubishi PLC (Example of source type)

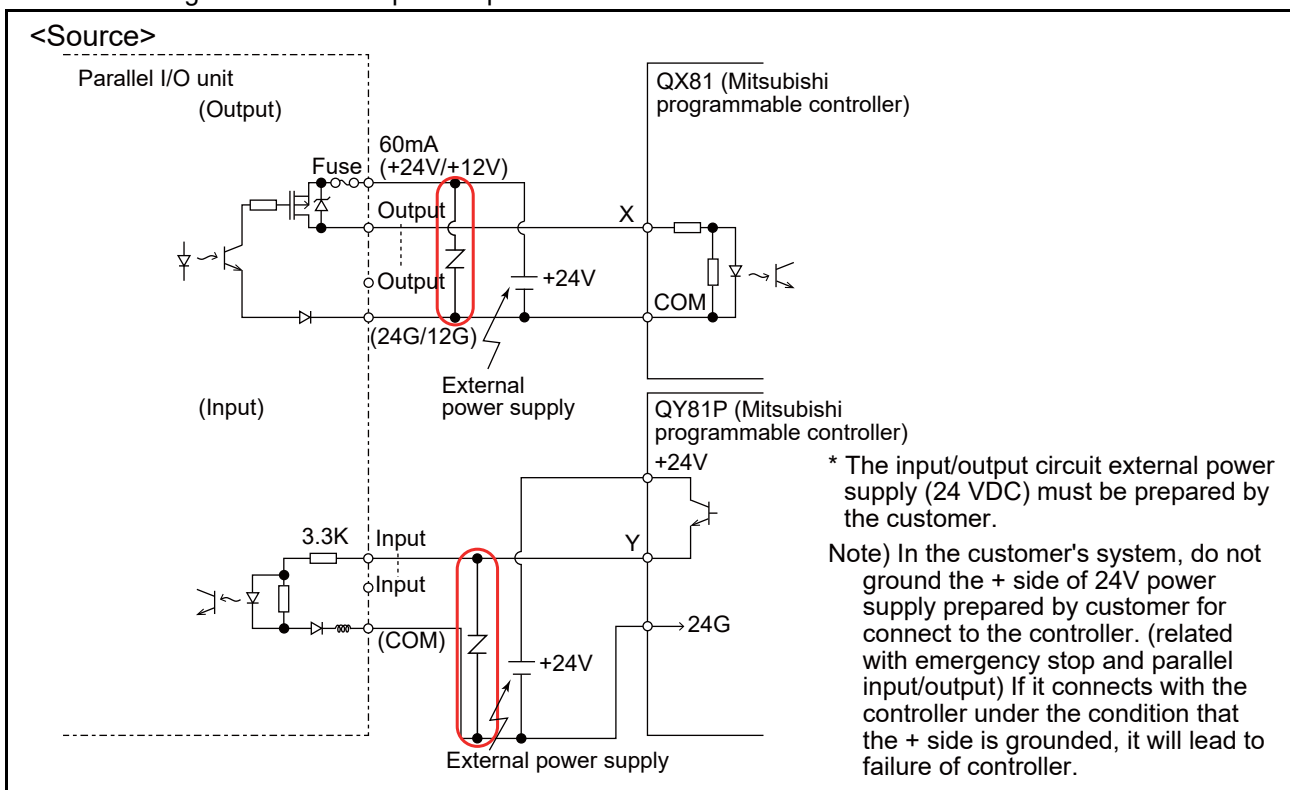The following shows an example of a protective circuit.

Fig.3-35: Connection with a Mitsubishi PLC (Example of source type) for use of a protective circuit

(9) External I/O cable

■Order type: 2A-CBL□□ Note)The numbers in the boxes□□ refer to the length.(05: 5m, 15: 15m)

■Outline

This is the dedicated cable used to connect an external peripheral device to the connector on the parallel input/output unit.
One end matches the connector on the parallel input/output unit, and the other end is free. Connect the peripheral device's input/output signal using the free end.
One cable correspond to the input 16 points and output 16 points.
Two cables are needed to connection of (input 32 points and output 32 points) with built-in standard.

■Configuration
Table 3-34: Configuration device

Part name	Type	Qty.	Mass(kg)[Note1]	Remarks
External I/O cable	2A-CBL□□	1pc.	0.7(5m) 1.84(15m)	5m or 15m

Note1) Mass indicates one set.

■Specifications
Table 3-35: Specifications

Items	Specifications
Number of cables x cable size	50 cores x AWG #28
Total length	5m or 15m

■Connector pin numbers and cable colors
Table 3-36: Connector pin numbers and cable colors

Pin no.	Cable colors	Pin no.	Cable colors	Pin no.	Cable colors	Pin no.	Cable colors	Pin no.	Cable colors
1	Orange/Red A	11	Orange/Red C	21	Orange/Red E	31	Orange/Blue B	41	Orange/Blue D
2	Gray/Red A	12	Gray/Red C	22	Gray/Red E	32	Gray/Blue B	42	Gray/Blue D
3	White/Red A	13	White/Red C	23	White/Red E	33	White/Blue B	43	White/Blue D
4	Yellow/Red A	14	Yellow/Red C	24	Yellow/Red E	34	Yellow/Blue B	44	Yellow/Blue D
5	Pink/Red A	15	Pink/Red C	25	Pink/Red E	35	Pink/Blue B	45	Pink/Blue D
6	Orange/Red B	16	Orange/Red D	26	Orange/Blue A	36	Orange/Blue C	46	Orange/Blue E
7	Gray/Red B	17	Gray/Red D	27	Gray/Blue A	37	Gray/Blue C	47	Gray/Blue E
8	White/Red B	18	White/Red D	28	White/Blue A	38	White/Blue C	48	White/Blue E
9	Yellow/Red B	19	Yellow/Red D	29	Yellow/Blue A	39	Yellow/Blue C	49	Yellow/Blue E
10	Pink/Red B	20	Pink/Red D	30	Pink/Blue A	40	Pink/Blue C	50	Pink/Blue E

■Connections and outside dimensions
The sheath of each signal cable (50 lines) is color indicated and marked with dots. Refer to the cable color specifications in "Table 3-36: Connector pin numbers and cable colors" when making the connections.

(Eg.) Pin number: color indication
1 : Orange / Red / A

Type of dot mark (see figure below)
Color of dot mark
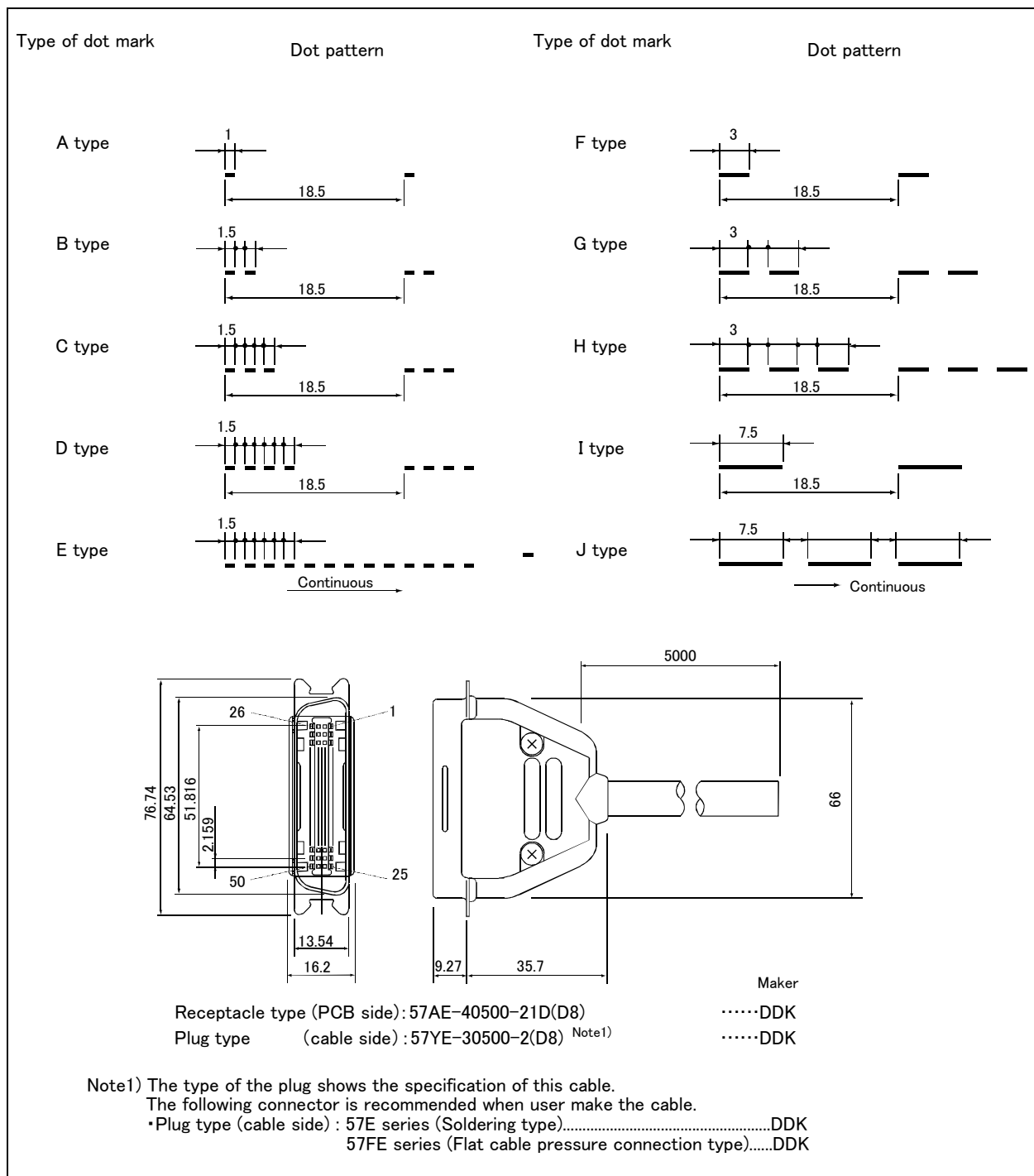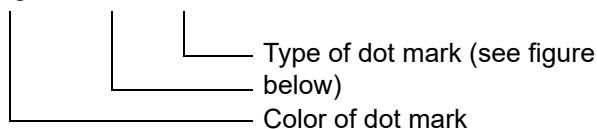
Fig.3-36: Connections and outside dimensions

Receptacle type (PCB side): 57AE-40500-21D(D8)　　……DDK
Plug type　　(cable side): 57YE-30500-2(D8) Note1)　　……DDK

Note1) The type of the plug shows the specification of this cable.
The following connector is recommended when user make the cable.
・Plug type (cable side) : 57E series (Soldering type)...DDK
57FE series (Flat cable pressure connection type)......DDK

(10) CC-Link interface

■Order type: ●2D-TZ576

■Outline

The CC-Link interface is the optioninterface to not only add bit data to the robot controller, but also to add CC-Link field network function that allows cyclic transmission of word data.

■Configuration

Table 3-37: Configuration device

Part name	Type	Qty.	Mass(kg)[Note1)]	Remarks
CC-Link interface	TZ576	1	0.6	
Manual	BFP-A8634	1	-	CD-ROM
Ferrite core	E04SR301334	2	-	Be sure to install this for noise countermeasure.
Cable clamp	AL4	2	-	
	AL5	2	-	
On-line connector for communication	A6CON-LJ5P	1	-	
Terminal resistor	A6CON-TR11N	1	-	Resistance value: 100Ω
One-touch connector plug for communication	A6CON-L5P	2	-	

Note1) Mass indicates one set.

Table 3-38: Procured by the customer

Part name	Type	Qty.	Remarks
Master station	FX3U-16CCL-M (FX series)	1	
	RJ61BT11 (R series)		
	QJ61BT11 (Q series)		
	QJ61BT11N (Q series)		
	AJ61QBT11 (QnA series)		
	A1SJ61QBT11 (QnAS series)		
	AJ61BT11 (A series)		
	A1SJ61BT11 (AnS series)		
	A80BD-J61BT11 (personal computer board)		
Communication cable	-	1	Ddedicated cable
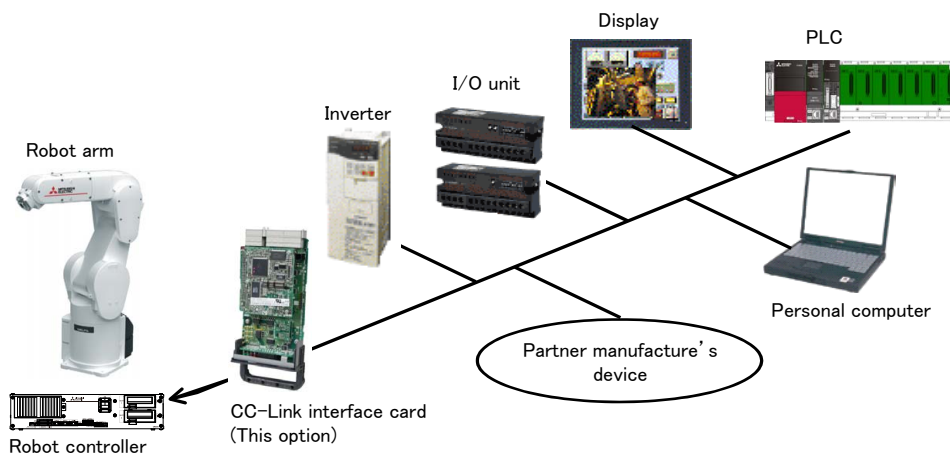
Fig.3-37: Example of CC-Link Product Configuration

■Specifications

Table 3-39: Specifications

Item			Specifications				Remarks
Communication function			Bit data and word data can be transmitted.				Word data are used by the registers.
Station type			Intelligent device station Note1)				
Support station			Local station				No master station function
The version corresponding to CC-Link			Ver.2				The extended cyclic setup is possible.
Mountable option slot			Slot 1, 2				
Number of mountable CC-Link interface cards			1				Multiple CC-Link interface cards cannot be inserted.
Number of stations			1 to 64 stations				When four stations are occupied, continuous station numbers are used. The station numbers are set by a DIP switch.
Transmission speed			10M/5M/2.5M/625K/156K bps				This is set by the rotary SW.
Station number			1 to 64				When two or more stations are occupied, continuous station numbers are used.
Number of occupied stations			1/2/3/4				
Extended cyclic setup			1/2/4/8				
Maximum link point	Remote I/O (RX, RY).		Each 896 points				The two last cannot be used.
	Remote register (RWr, RWw)		Each 128 register				16 bits/register
Extended cyclic setup	-		1 fold setup	2 fold setup	3 fold setup	4 fold setup	
Link point per set	When one station is occupied	Remote I/O (RX, RY).	32 point	32 point	64 point	128 point	
		Remote register (RWw)	4 word	8 word	16 word	32 word	
		Remote register (RWr)	4 word	8 word	16 word	32 word	
	When two stations is occupied	Remote I/O (RX, RY).	64 point	96 point	192 point	384 point	
		Remote register (RWw)	8 word	16 word	32 word	64 word	
		Remote register (RWr)	8 word	16 word	32 word	64 word	
	When three stations is occupied	Remote I/O (RX, RY).	96 point	160 point	320 point	640 point	
		Remote register (RWw)	12 word	24 word	48 word	96 word	
		Remote register (RWr)	12 word	24 word	48 word	96 word	
	When four stations is occupied	Remote I/O (RX, RY).	128 point	224 point	448 point	896 point	
		Remote register (RWw)	16 word	32 word	64 word	128 word	
		Remote register (RWr)	16 word	32 word	64 word	128 word	
Number of the maximum occupancy station			4 stations				
The I/O first number of the robot controller.			No. 6000 -. The number corresponding to the station number by the setup of the parameter "CCFIX."				

Note1) Not available for the transient transmission function and FX-series models that do not support intelligent devices.

■Functions

(1) Communication function
  • The number of usable points is 896 points maximum for bit control and 128 points maximum for word control.

(2) Easy setup
  • The CC-Link interface card can be set by a rotary switch or DIP switch.
  • No separate space is required to mount the CC-Link interface card as it is embedded in the robot controller (can only be mounted into slot 2).
  • Easy wiring since only four terminals need to be connected.
  • Dedicated commands have been added to MELFA-BASIC V, VI (robot programming language); thus, no complex interface programming is required.

(3) High-speed response
  • The link scan time when connecting 64 stations is approximately 7.2 ms.
  • A transmission speed can be selected from 10M, 5M, 2.5M, 625K and 156K bps according to the transmission distance.

(11) SD memory card
■Order type: 2F-2GBSD

■Outline

This card is used as an extended memory.
Insert this card to the slot (SD CARD) on the front of the controller, and store robot programs, logging data, or other data.

■Configuration
Table 3-40: Configuration device

Part name	Type	Qty.	Remarks
SD memory card	2F-2GBSD	1	Memory card capacity: 2GB

3.10 Maintenance parts

The consumable parts used in the controller are shown in Table 3-41. Purchase these parts from your dealer when required. Some Mitsubishi-designated parts differ from the maker's standard parts. Thus, confirm the part name, robot arm and controller serial No. and purchase the parts from your dealer.

Table 3-41: Controller consumable parts list

No.	Name	Type Note1)	Qty.	Usage place	Supplier
1	Filter	BKOFA0773H42	1	Inside the filter cover	Mitsubishi Electric

Note1) Confirm the robot arm serial No., and contact the dealer or service branch of Mitsubishi Electric Co., for the type.

4 Software

4.1 Functions and specifications of RH-3CRH/RH-6CRH

4.1.1 Changed functions/specifications

Some functions of RH-3CRH/RH-6CRH controller and some functions/specifications of MELFA-BASIC VI programming language are changed from the functions/specifications of RH-F series. Table 4-1 shows details on the changes.

Table 4-1: List of changed functions/specifications

	Changed function/specification	Outline	Reference page
1	Definition change of component C in XYZ coordinate data	The numerical value range of component C is extended.	Page 102
2	Functionality change of some commands and a function in MELFA-BASIC VI	In connection with No.1 above, the functionality of Mvs command, Def Plt command, and Zone function are changed.	Page 103
3	Addition of the parameter to select the component C indication method	A parameter to select the indication method between the one mentioned in No. 1 above and the conventional one.	Page 104
4	Method change for setting a user-defined area	In connection with No.1 above, the setting method is changed.	Page 104
5	Large inertia mode	Enabling the large inertia mode has the effect to suppress vibrations of the robot arm when the hand (or workpiece) with a large inertia is used.	Page 104

4.1.2 Descriptions of changed functions/specifications

■Definition change of component C in XYZ coordinate data

The definition of component C in XYZ coordinate data is changed for RH-3CRH/RH-6CRH. Refer to the following descriptions for the details.

The format of the robot position data is divided into two categories: XYZ coordinate and JOINT coordinate. XYZ coordinate format data includes position data, posture data, and associated information (flags). For a horizontal, multiple-joint type robot, the data is displayed in format such as (X, Y, Z, , , C)(FL1, FL2). The component C represents rotational angle about the Z axis.

For conventional robots (ex. RH-F, RH-SD/SQ), the component C range is defined as -180 $\leqq$ C $\leqq$ +180 (Fig. 4-1). For RH-3CRH/RH-6CRH, it is defined more widely (Fig. 4-2). See Fig. 4-2 to find two diagrams of (a) Forward rotation, and (b) Reverse rotation.

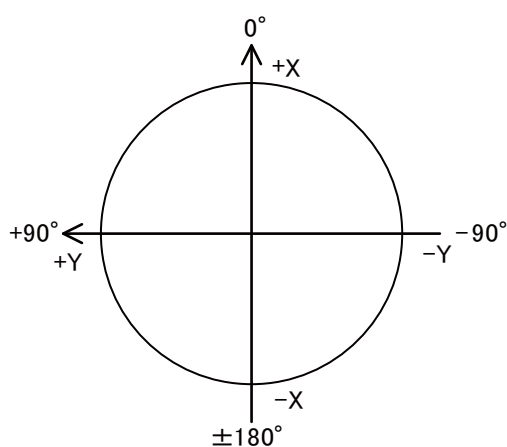Fig.4-1: Definition of component C for conventional robots (within ±180)

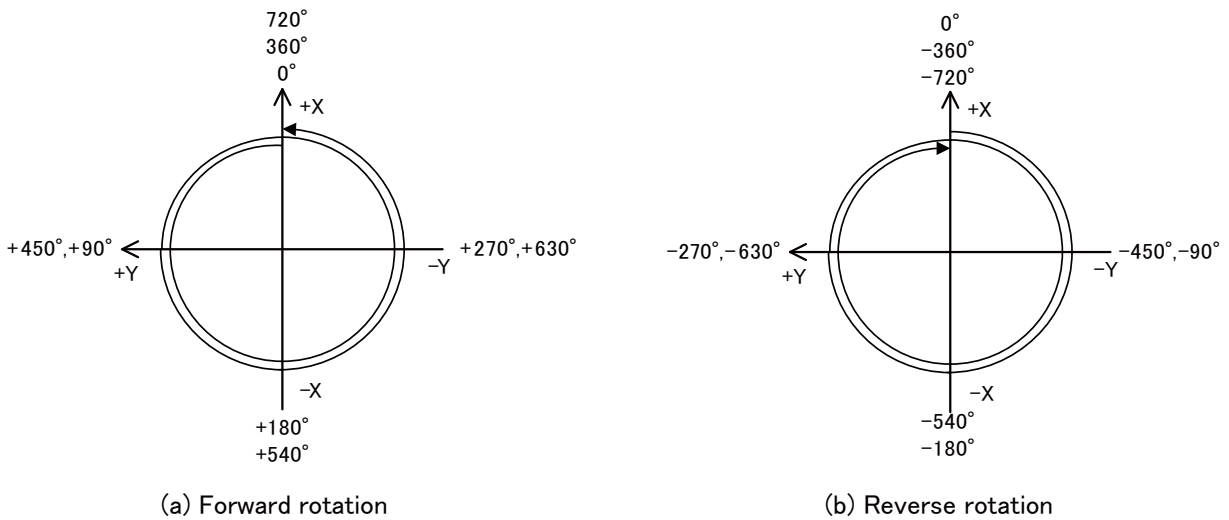(a) Forward rotation   (b) Reverse rotation

Fig.4-2: Definition of component C for RH-3CRH/RH-6CRH (over ±180)

As the component C covers a value less than -180 or more than +180, an actual rotational angle can be set for the rotational angle for linear interpolation or perfect circle/circular interpolation. To move the work at a target angle in the robot programming, the rotation direction was set by specifying an operation in the argument Type or changing the multi-rotation flag (FL2) for conventional robots but is set just by specifying an angle for RH-3CRH/RH-6CRH value of the FL2 is always 0.

Due to this change, the robot program used for the conventional robots may malfunction. In such cases, refer to Page 103, "■ Functionality change of some commands and a function in MELFA-BASIC VI" to change the robot programming.
Or the definition of component C can be converted back into the conventional definition by setting a related parameter to maintain compatibility among the robot program or robot operations. For information on how to adjust the parameter, refer to Page 104, "■ Parameter to select the component C indication method".

■Functionality change of some commands and a function in MELFA-BASIC VI

Due to the definition change of component C in XYZ coordinate data, some commands and a function in MELFA-BASIC VI are changed. Table 4-2 shows details on the changes.

Table 4-2: List of changed commands/function for RH-3CRH/RH-6CRH

Command/ function	Descriptions

Mvs	- The initial value of "constant 1" specified in the argument Type differs according to the setting value of the parameter DISPCTYP.
	   When DISPCTYP=0 (initial value): The initial value of "constant 1" is 1 (roundabout).
	   When DISPCTYP=1: The initial value of "constant 1" is 0 (shortcut) (compatible with the conventional robots).

Zone	- When DISPCTYP=0 (initial value) for RH-3CRH/RH-6CRH, the posture angle (component C) is checked whether it satisfies the following formula: Position 2 $\leqq$ Position 1 $\leqq$ Position 3.
	
	  Make sure to so define the posture angle as to satisfy the requirement of "Position 2 < Position 3". If the wrong requirement of "Position 3 < Position 2" is defined, check results are not returned correctly.
	  When DISPCTYP=1, the posture angle is checked, as for the conventional robots, whether it is within the area covered by the robot arm's forward rotation from Position 2 to Position 3.
	- When the posture angle (component C) check is not performed, set the component C to sufficient large values, for example, -10000 for Position 2, and +10000 for Position 3.

■Parameter to select the component C indication method

The definition of component C in XYZ coordinate data is changed for RH-3CRH/RH-6CRH. However, in order to maintain operational compatibility with the conventional models (RH-F, RH-SD/SQ, etc.), it is possible to use the definition of component C in XYZ coordinate data for the conventional models by setting the parameter.

Table 4-3 describes the parameter.

Table 4-3: Parameter added for RH-3CRH/RH-6CRH

Parameter	Parameter name	Number of arrays Number of characters	Description	Factory default setting
Multi-rotation indication method	DISPCTYP	Integer 1	Indication method for multi-rotation of component C in XYZ coordinate data. 0: Invalid (The component C value is not rounded to the value within +/-180 degrees.) 1: Valid (The component C value is rounded to the value within +/-180 degrees to maintain compatibility with the conventional models.) Turn off and on the controller's power supply after changing the setting of this parameter. For using robot programs for the conventional models (RH-F, RH-SD/SQ) after introducing RH-3CRH/RH-6CRH, change the parameter setting to "1" (valid).	RH-3CRH/ RH-6CRH 0 Other models 1

■Method change for setting a user-defined area

The definition and evaluation of a user-defined area is changed for RH-3CRH/RH-6CRH.

(1) When DISPCTYP=0 (initial value) for RH-3CRH/RH-6CRH, the posture angle (component C) is checked whether it satisfies the following formula: AREAnP2 $\leq$ current position $\leq$ AREAnP3.
Make sure to so define the posture angle as to satisfy the requirement of "AREAnP2 < AREAnP3".
If the wrong requirement of "AREAnP3 < AREAnP2" is defined, check results are not returned correctly.
When DISPCTYP=1, the posture angle is checked, as for the conventional robots, whether it is within the area covered by the robot arm's forward rotation from AREAnP2 to AREAnP3.

(2) When the posture angle (component C) check is not performed, set the component C to sufficient large values, for example, -10000 for AREAnP2, and +10000 for AREAnP3.

■Large inertia mode

Enabling the large inertia mode has the effect to suppress vibrations of the robot arm when the hand (or workpiece) with a large inertia is used. When the hand (or workpiece) with a large inertia is used, enable the large inertia mode. Table 4-4 shows the allowable inertia when the large inertia mode is enabled. Table 4-5 describes the parameter.

When the large inertia mode is enabled, if the inertia exceeds the allowable inertia for the standard load mode, the permissible value for the distance from the center of the shaft to the center of gravity of the load (the offset amount) is 10 mm.

Table 4-4: List of the allowable inertia when the large inertia mode is enabled

Item	Unit	Inertia mode	RH-3CRH	RH-6CRH
Allowable inertia (Maximum)	kg m^2	Standard load mode	0.05	0.12
		Large inertia mode	0.075	0.18

Table 4-5: Parameter added for RH-3CRH/RH-6CRH

Parameter	Parameter name	Number of arrays Number of characters	Description	Factory default setting
Inertia mode	PYLDMODE	Integer 1	Specify whether the large inertia mode is enabled or disabled. 0: Standard load mode 1: Large inertia mode Enabling the large inertia mode has the effect to suppress vibrations of the robot arm when the hand (or workpiece) with a large inertia is used. When the hand (or workpiece) with a large inertia is used, enable the large inertia mode. This parameter is valid only for the RH-CRH series. It cannot be used for other series.	0

4.1.3 Origin position adjustment of J2 axis

When a calculated point is used for a robot's work point, the accuracy of J2 axis is important. This paragraph "4.1.3 Origin position adjustment of J2 axis" gives the details of an origin position adjustment by the configuration flag (RIGHT/LEFT).
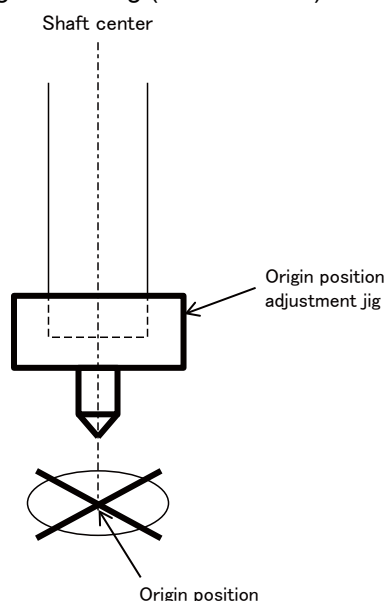

Fig.4-3: Origin position adjustment

For the origin position adjustment, a reference point is an axis center of a shaft. When a center of the hand is offset from a center of the shaft, the hand must be removed before the origin position adjustment.

Origin position adjustment procedure
1) Designate any point as an origin position.
2) Match the center of the shaft with the origin position in a right hand coordinate system.
3) Perform teaching work to the joint variables JR.
4) Match the center of the shaft with the origin position in a left hand coordinate system.
5) Perform teaching work to the joint variables JL.

6) Execute the following commands in the order presented.

```
MDJNT_J2=(JR.J2+JL.J2)/2
JDJNT_Data=(0,0,0,0,0,0)
JDJNT_Data.J2=JDJNT_Data.J2-(MDJNT_J2)
PrmWrite 1,"DJNT",JDJNT_Data
```

7) Move J2 axis to 0 degrees, and check the robot position.

After the origin position adjustment, an adjusted value is stored in the parameter DJNT.
For another origin position adjustment with retaining an earlier adjusted value after the first adjustment is finished, change "JDJNT_Data=(0,0,0,0,0,0)" into "PrmRead 1,"DJNT",JDJNT_Data" before command execution.
As a repeat of command execution causes an accumulation of the adjusted values, clear the parameter DJNT back to 0 before another origin position adjustment.

4.2 List of commands

The available new functions in MELFA-BASIC VI are given in Table 4-6.

Table 4-6: List of MELFA-BASIC VI commands

Type	Class	Function	Input format (example)

Structured programming	Function procedure	Defines the Function procedure.
		Function procedure summarizes a series of processing enclosed by the Function statement and the FEnd statement.
			Function M Func(M1, M2)
			  M3=M1+M2
			  Func=M3
			   Exit Function
			FEnd

Library function	#Include statement	Reads the designated program.	#Include "PRG1"
Position and operation control	Joint interpolation	Moves to the designated position with joint interpolation.	Mov P1
	Linear interpolation	Moves to the designated position with linear interpolation.	Mvs P1
	Circular interpolation	Moves along a designated arc (start point→passing point→start point (end point)) with 3-dimensional circular interpolation (360 degrees).	Mvc P1,P2,P1
		Moves along a designated arc (start point→passing point→end point) with 3-dimensional circular interpolation.	Mvr P1,P2,P3
		Moves along the arc on the opposite side of a designated arc (start point→reference point→end point) with 3-dimensional circular interpolation.	Mvr2 P1,P9,P3
		Moves along a set arc (start point→end point) with 3-dimensional circular interpolation.	Mvr3 P1,P9,P3
	Speed designation	Designates the speed for various interpolation operations with a percentage (0.1% unit).	Ovrd 100
		Designate the speed for joint interpolation operation with a percentage (0.1% unit).	JOvrd 100
		Designates the speed for linear and circular interpolation with a numerical value (mm/s unit).	Spd 123.5
		Designates the acceleration/deceleration time as a percentage in respect to the predetermined maximum acceleration/deceleration. (1% unit)	Accel 50,80
		Automatically adjusts the acceleration/deceleration according to the parameter setting value.	Oadl ON
		Sets the hand and work conditions for automatic adjustment of the acceleration/deceleration.	Loadset 1,1
	Operation	Adds a process unconditionally to the operation.	Wth
		Adds a process conditionally to the operation.	WthIf
		Designates smooth operation.	Cnt 1,100,200
		Performance of movement is upgraded corresponding to the application.	MvTune 4
		Designates the positioning completion conditions with a No. of pulses.	Fine 200
		Designates the positioning completion conditions with a distance in a straight line	Fine 1, P
		Turns the servo power ON/OFF for all axes.	Servo OFF
		Limits the operation of each axis so that the designated torque is not exceeded.	Torq 4,10
	Position control	Designates the base conversion data.	Base P1
		Designates the tool conversion data.	Tool P1
	Float control	The robot arm rigidity is lowered and softened. (XYZ coordinate system)	Cmp Pos ,&B00000011
		The robot arm rigidity is lowered and softened. (JOINT coordinate system)	Cmp Jnt ,&B00000011
		The robot arm rigidity is lowered and softened. (TOOL coordinate system)	Cmp Tool ,&B00000011
		The robot arm rigidity is returned to the normal state.	Cmp Off
		The robot arm rigidity is designated.	CmpG 1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0

Type	Class	Function	Input format (example)
Position and operation control	Pallet	Defines the pallet.	Def Plt 1,P1,P2,P3,P4,5,3,1
		Operates the pallet grid point position.	Plt 1,M1
	Singular point passage	Move to a specified position using linear interpolation passing through a singular point.	Mvs P1 Type 0,2
	Branching	Branches unconditionally to the designated place.	GoTo *LBL
		Branches according to the designated conditions.	If M1=1 Then GoTo *L100 Else GoTo *L200 EndIf
		Repeats until the designated end conditions are satisfied.	For M1=1 To 10 Next M1
		Repeats while the designated conditions are satisfied.	While M1<10 WEnd
		Branches corresponding to the designated expression value.	On M1 GoTo *La1, *Lb2, *Lc3
		Executes program block corresponding to the designated expression value.	Select Case 1 Break Case 2 Break End Select
		Moves the program process to the next line.	Skip
	Collision detection	Set to enable/disable the collision detection.	ColChk On/Off
		Set the detection level of the collision detection.	ColLvl 100,80,,,,,,
	Subroutine	Executes the designated subroutine. (Within program)	GoSub *L200
		Returns from the subroutine.	Return
		Executes the designated program.	CallP "P10",M1,P1
		Defines the program argument executed with the CALLP command.	FPrm M10,P10
		Executes the subroutine corresponding to the designated expression value.	On M1 GoSub*La1,*La2,*La3
	Interrupt	Defines the interrupt conditions and process.	Def Act 1, M1=1 GoTo *L123
		Enables/disables the interrupt.	Act 1=1
		Defines the start line of the program to be executed when an interrupt is generated from the communication line.	On Com(1) GoSub *LABC
		Enables the interrupt from the communication line.	Com(1) On
		Disables the interrupt from the communication line.	Com(1) Off
		Stops the interrupt from the communication line.	Com(1) Stop
	Wait	Designates the wait time, and the output signal pulse output time. (0.01s unit)	Dly 0.5
		Waits until the variable becomes the designated value.	Wait M_In(20)=1
	Stop	Stops the program execution.	Hlt
		Generates an error. During program execution, continue, stop or servo OFF can be designated.	Error 9000
	End	Ends the program execution.	End
Hand	Hand open	Opens the designated hand.	HOpen 1
	Hand close	Closes the designated hand.	HClose 1
Input/output	Assignment	Defines the input/output variables.	Def IO PORT1=Bit,99
	Input	Retrieves the general-purpose input signal.	M1=M_In (78)
	Output	Calls out the general-purpose output signal.	M_Out(23) =0
Parallel execution	Mechanism designation	Acquires the mechanism with the designated mechanism No.	GetM 1
		Releases the mechanism with the designated mechanism No.	RelM 1
	Selection	Selects the designated program for the designated slot.	XLoad 2,"P102"
	Start/stop	Carries out parallel execution of the designated program.	XRun 3,"100",0
		Stops parallel execution of the designated program.	XStp 3
		Returns the designated program's execution line to the head and enters the program selection enabled state.	XRst 3

Type	Class	Function	Input format (example)
Others	Definition	Defines the integer type or real number type variable.	Def Inte KAISUU
		Defines the character string variable.	Def Char MESSAGE
		Defines the layout variable. (Up to 3-dimensional possible)	Dim PDATA(2,3)
		Defines the joint variable.	Def Jnt TAIHI
		Defines the position variable.	Def Pos TORU
		Defines the function.	Def FN TASU(A,B)=A+B
	Clear	Clears the general-purpose output signal, variables in program, variables between programs, etc.	Clr 1
	File	Opens a file.	Open "COM1:" AS #1
		Closes a file.	Close #1
		Inputs data from a file.	Input #1,M1
		Outputs data to a file.	Print #1,M1
	Comment	Describes a comment.	Rem "ABC"
	Label	Indicates the branching destination.	*SUB1

4.3 List of parameters

Show the main parameter in the Table 4-7.

Table 4-7: List of parameters

Parameter		Details
Standard tool coordinates.	MEXTL	Set the default value for the tool data. Unit: mm or deg.
Standard base coordinates	MEXBS	Set the relation of the world coordinate system and robot coordinate system. Unit: mm or deg.
XYZ operation range	MEPAR	Designate the overrun limit value for the world coordinate system.
JOINT operation range	MEJAR	Set the overrun limit value for each joint axis.
Free plane limit		This is the overrun limit set with the free plane. Create a plane with the three coordinates x1, y1, z1 to x3, y3, z3, and set the outer side of the plane as the outside operation range (error). The following three types of parameters are used.
	SFC1P : SFC8P	Eight types of free plane limits can be set in SFC1P to SFC8P. There are nine elements, set in the order of x1, y1, z1, x2, y2, z2, x3, y3, z3.
	SFC1ME : SFC8ME	Designate which mechanism to use eight types of set free plane limits. The mechanism No. to use is set with 1 to 3.
	SFC1AT : SFC8AT	Set the validity of the eight types of set free plane limits. (Valid 1/Valid 2/invalid = 1/-1/0)
User-defined area		An area (cube) defined with two XYZ coordinate points can be designated and that area set as the outside operation range. Furthermore, a signal can be output when the axis enters that area. Up to 32 types of area can be designated.
	AREA1CS : AREA32CS	Specify the coordinate system of the user definition area *. 0: Base coordinate system (conventional compatibility) 1: Robot coordinate system
	AREA1P1 : AREA32P1	Designated the 1st point of the area. There are eight elements, set in the order of x, y, z, a, b, c, L1, L2. (L1 and L2 are the additional axes.)
	AREA1P2 : AREA32P2	Designated the 2nd point of the area. There are eight elements, set in the order of x, y, z, a, b, c, L1, L2. (L1 and L2 are the additional axes.)
	AREA1ME : AREA32ME	Designate which mechanism to use the 32 types of set area. The mechanism No. to use is set with 1 to 3.
	AREA1AT : AREA32AT	Designate the area check type. (Invalid/zone/interference = 0/1/2) Zone: The dedicated output signal USRAREA turns ON. Interference: An error occurs..
Automatic return setting	RETPATH	Set to restart the program after returning to the interrupt position when resuming operation after an interruption.
Buzzer ON/OFF	BZR	Designate whether to the turn buzzer ON or OFF.
Jog setting	JOGJSP	Designate the joint jog and step operation speed. (Set dimension H/L amount, max. override.)
	JOGPSP	Designate the linear jog and step operation speed. (Set dimension H/L amount, max. override.)
Jog speed limit value	JOGSPMX	Limit the operation speed during the teaching mode. Max. 250[mm/s]
Hand type	HANDTYPE	Set the hand type of the single/double solenoid, and the signal No. (Single/double = S/D) Set the signal No. after the hand type. Example) D900
Stop input B contact designation	INB	Change the dedicated input (stop) to either of normal open or normal close.

Parameter		Details
User-designated origin	USERORG	Designate the user-designated origin position.
Program selection memory	SLOTON	Select the program selected previously when initializing the slot. The non-selected state will be entered when not set.
Communication setting	CBAU232	Set the baud rate.
	CLEN232	Set the character length.
	CPRTY232	Set the parity.
	CSTOP232	Set the stop bit.
	CTERM232	Set the end code.
Slot table	SLT1 : SLT32	Make settings (program name, operation type, order of priority, etc.) for each slot during slot initialization.
No. of multi-tasks	TASKMAX	Designate the No. of programs to be executed simultaneously. (Max. 32)
Multi CPU system setting	QMLTCPUN	At the multi CPU system, set the number of CPU units with which the standard base unit is equipped.
	QMLTCPUn	Sets the high-speed communication area of each CPU unit in the multi CPU system.
	QMLTCPUS	Sets the input offset of each CPU unit in the multi CPU system.
Select the function of singular point adjacent alarm	MESNGLSW	Designate the valid/invalid of the singular point adjacent alarm. (Invalid/Valid =0/1) When this parameter is set up "VALID", this warning sound is buzzing even if parameter: BZR (buzzer ON/OFF) is set up "OFF".
Display language	LNG	Sets the display language on the RT ToolBox3 (option).

5 Instruction Manual

5.1 The details of each instruction manuals

The contents and purposes of the documents enclosed with this product are shown below.
Use these documents according to the application.
For special specifications, a separate instruction manual describing the special section may be enclosed.

Manual name	Description
Safety Manual	Explains the common precautions and safety measures to be taken for robot handling, system design and manufacture to ensure safety of the operators involved with the robot.
Standard Specifications	Explains the product's standard specifications, factory-set special specifications, option configuration and maintenance parts, etc. Precautions for safety and technology, when incorporating the robot, are also explained.
Robot Arm Setup & Maintenance	Explains the procedures required to operate the robot arm (unpacking, transportation, installation, confirmation of operation), and the maintenance and inspection procedures.
Controller setup, basic operation, and maintenance	Explains the procedures required to operate the controller (unpacking, transportation, installation, confirmation of operation), basic operation from creating the program to automatic operation, and the maintenance and inspection procedures.
Detailed explanations of functions and operations	Explains details on the functions and operations such as each function and operation, commands used in the program, connection with the external input/output device, and parameters, etc.
Troubleshooting	Explains the causes and remedies to be taken when an error occurs. Explanations are given for each error No.
Additional axis function	Explains the specifications, functions and operations of the additional axis control.
Tracking Function	Explains the control function and specifications of conveyor tracking.
GOT Direct Connection Extended Function	Explains the detailed description of data configuration of shared memory, monitoring, and operating procedures about the GOT (standalone type robot).
Ethernet Function	Explains the measures to perform communication with personal computers on Ethernet with the TCP/IP protocol.

6 Safety

6.1 Safety

Measures to be taken regarding safety of the industrial robot are specified in the "Labor Safety and Sanitation Rules". Always follow these rules when using the robot to ensure safety.

6.1.1 Self-diagnosis stop functions

This robot has the self-diagnosis stop functions shown in Table 6-1 and the stop functions shown in Table 6-2 for safe use.

Table 6-1: Self-diagnosis stop functions

No.	Function		Details	Remarks
1	Overload protection function [Note 1)]		Activates when the total servo current time exceeds the specified value.	The drive circuit is shut off. The robot stops, and an alarm displays.
2	Overcurrent diagnosis function [Note 1)]		Activates when an overcurrent flows to the motor circuit.	The drive circuit is shut off. The robot stops, and an alarm displays.
3	Encoder disconnection diagnosis function		Activates when the encoder cable is disconnected.	The drive circuit is shut off. The robot stops, and an alarm displays.
4	Deflection over diagnosis function		Activates when an error occurs between the command value and actual position, and the error exceeds the specified amount.	The drive circuit is shut off. The robot stops, and an alarm displays.
5	AC power voltage drop diagnosis function		Activates when the AC power voltage drops below the specified value.	The drive circuit is shut off. The robot stops, and an alarm displays.
6	CPU error detection function		Activates when an error occurs in the CPU.	The drive circuit is shut off. The robot stops, and an alarm displays.
7	Overrun prevention function	Software limit detection	This is the limit provided by the software to enable operation only in the operation range.	The drive circuit is shut off. The robot stops, and an alarm displays.
		Mechanical stopper	This is the mechanical stopper provided outside the software.	The robot mechanically stops, and function 1 or 2 activates.

Note 1) There is no thermal memory function that conforms to EN 61800-5-1:2007/A1:2017.

Table 6-2: List of stop functions

Stop function	Teaching pendant	External input	Details
Emergency stop	○	○	The servo power is shut off and the mechanical brakes activate to stop the robot by stopping operation in an emergency. To recover, reset the alarm, and turn the servo ON with the servo ON command.
Stop	○	○	The robot immediately decelerates to stop by stopping operation as usual. Note that the servo power is not shut off. Use this when using the collision evasion sensor, etc.

6.1.2 External input/output signals that can be used for safety protection measures

Table 6-3: External input/output signals that can be used for safety protection measures

	Signal	Connection point	Parameter	Functions	Usage method
Input	External emergency stop Note1)	Connector CNUSR11	-	This servo power is shut off, and the robot stops immediately.	Externally installed emergency stop switch. Stopping at high-level error occurrence.
	Door switch input Note1)		-		The door switch of the safe protection fence.
	Stop	Parallel I/O unit or interface	STOP, STOP2	The program execution is stopped, and the robot stops. The servo power is not shut off.	The robot is stopped when a peripheral device fault occurs. The servo power is not shut off.
	Servo OFF		SRVOFF	The servo power can be shut off.	The robot is stopped when a peripheral device fault occurs. The servo power is also shut off.
	Automatic operation enable		AUTOENA	Disables automatic operation when inactive.	Door switch on safety protection fence.
Output	Emergency stop output	Connector CNUSR11	-	Outputs the input signal of external emergency stop or emergency stop switch of T/B turned on.	Display and warn the pilot lamp, the input signal of external emergency stop or the emergency stop switch of T/B turned on.
	In servo ON	Parallel I/O unit or interface	SRVON	The servo power ON/OFF state is output.	The servo power ON/OFF state is shown and alerted with the display lamps.
	Waiting		STOP, STOP2	Outputs that the robot is temporarily stopped.	The temporary stop state is shown and alerted with the display lamps.
	In alarm	Connector CNUSR11	ERRRESET	Outputs when an alarm occurs in the robot.	The alarm state is shown and alerted with the display lamps.

Note1) The external emergency stop input and the door switch input have duplicate NC contacts for redundancy. Thus, if the emergency stop input circuit is opened when the robot is started up, the robot will not operate.
Refer to Page 116, "6.1.7 Examples of safety measures"for details.
And, refer to Page 60, "(1) Automatic Operation/Jog Operation/Brake Release and Necessary Switch Settings"for the function of the door switch input and the mode selector switch input.

6.1.3 Precautions for using robot
The safety measures for using the robot are specified in the "Labor Safety and Sanitation Rules". An outline of the rules is given below.

(1) Robot installation
- Secure sufficient work space required to safely perform work such as teaching and maintenance related to the robot.
- Install the controller outside the robot's motion space. (If a safety fence is provided, install outside the fence.)
- Install the controller where the entire robot operation can be viewed.
- Install display lamps, etc., to indicate the robot's operation state.
- Securely fix the robot arm onto the fixing table with the designated bolts.

(2) Prevention of contact with operator
- Install a safety fence or enclosure so that the operator cannot easily enter the robot's motion space.
- Install an interlock function that will stop the robot if the safety fence or enclosure door is opened.

(3) Work procedures
- Create and observe work procedures for the robot teaching, operation, inspection and emergencies.
- Create hand signals to be followed when several operators are working together.
- Create displays such as "Teaching in Progress" and "Inspection in Progress" to be put up when an operator is in the robot's motion space so that other operators will not operate the operation panel (controller, control panel).

(4) Training
- Train the operators about the operations, maintenance and safety required for the robot work.
- Only trained and registered operators must operate the robot.
  Participation in the "Special training for industrial robots" sponsored by the Labor Safety and Sanitation Committee, etc., is recommended for safety training.

(5) Daily inspection and periodic inspection
- Always inspect the robot before starting daily operations and confirm that there are no abnormalities.
- Set the periodic inspection standards in view of the robot's ambient environment and operation frequency, and perform periodic inspections.
- Make records when periodic inspections and repairs have been done, and store the records for three or more years.

6.1.4 Safety measures for automatic operation
(1) Install safety fences so that operators will not enter the operation area during operation and indicate that automatic operation is in progress with lamps, etc.
(2) Create signals to be given when starting operation, assign a person to give the signal, and make sure that the operator follows the signals.

6.1.5 Safety measures for teaching
Observe the following measures when teaching, etc., in the robot's operation range.
(1) Specify and follow items such as procedures related to teaching work, etc.
(2) Take measures so that operation can be stopped immediately in case of trouble, and measures so that operation can be restarted.
(3) Take measures with the robot start switch, etc., to indicate that teaching work is being done.
(4) Always inspect that stop functions such as the emergency stop device before starting the work.
(5) Immediately stop the work when trouble occurs, and correct the trouble.
(6) Take measures so that the work supervisor can immediately stop the robot operation when trouble occurs.
(7) The teaching operator must have completed special training regarding safety. (Training regarding industrial robots and work methods, etc.)
(8) Create signals to be used when several operators are working together.

6.1.6 Safety measures for maintenance and inspections, etc.
Turn the power OFF and take measures to prevent operators other than the relevant operator from pressing the start switch when performing inspections, repairs, adjustments, cleaning or oiling.
If operation is required, take measures to prevent hazards caused by unintentional or mistaken operations.
(1) Specify and follow items such as procedures related to maintenance work, etc.
(2) Take measures so that operation can be stopped immediately in case of trouble, and measures so that operation can be restarted.
(3) Take measures with the robot start switch, etc., to indicate that work is being done.
(4) Take measures so that the work supervisor can immediately stop the robot operation when trouble occurs.
(5) The operator must have completed special training regarding safety. (Training regarding industrial robots and work methods, etc.)
(6) Create signals to be used when several operators are working together.

6.1.7 Examples of safety measures

The controller's dedicated I/O terminal connector has a duplicate emergency stop circuit.

The safety measure examples are shown in Fig. 6-1 to Fig. 6-4. Create a circuit as shown below for safety measures. In addition, the figure shows the normal state which is not in the emergency stop state.

[Note] · In the emergency-stop related wiring by the customer, if the coil (is not the contact points) of the relay prepared by the customer is connected to the controller, please be sure to implement the measure against the noise by the customer in the coil section. And, please also take the lifetime of noise suppression parts into consideration.

 · Electric specification of the emergency-stop-related output terminal: 24V DC or less, related current 100mA or less.

 · In the customer's system, do not ground the + side of 24V power supply prepared by customer for connect to the controller. (related with emergency stop and parallel input/output) If it connects with the controller under the condition that the + side is grounded, it will lead to failure of controller.

〈Wiring example 1〉: Connect the emergency stop switch of peripheral equipment to the controller.
 The power supply for emergency stop input uses the power supply in the controller.
 〈Operation of the emergency stop〉
 If the emergency stop switch of peripheral equipment is pushed, the robot will also be in the emergency stop state.

*1) The CNUSR11 connector is a two-level terminal block, indicating that there are two circuits (channels). Two terminals (cable insertion holes) need to be used for one circuit.
*2) The T/B emergency stop button connected with the controller.
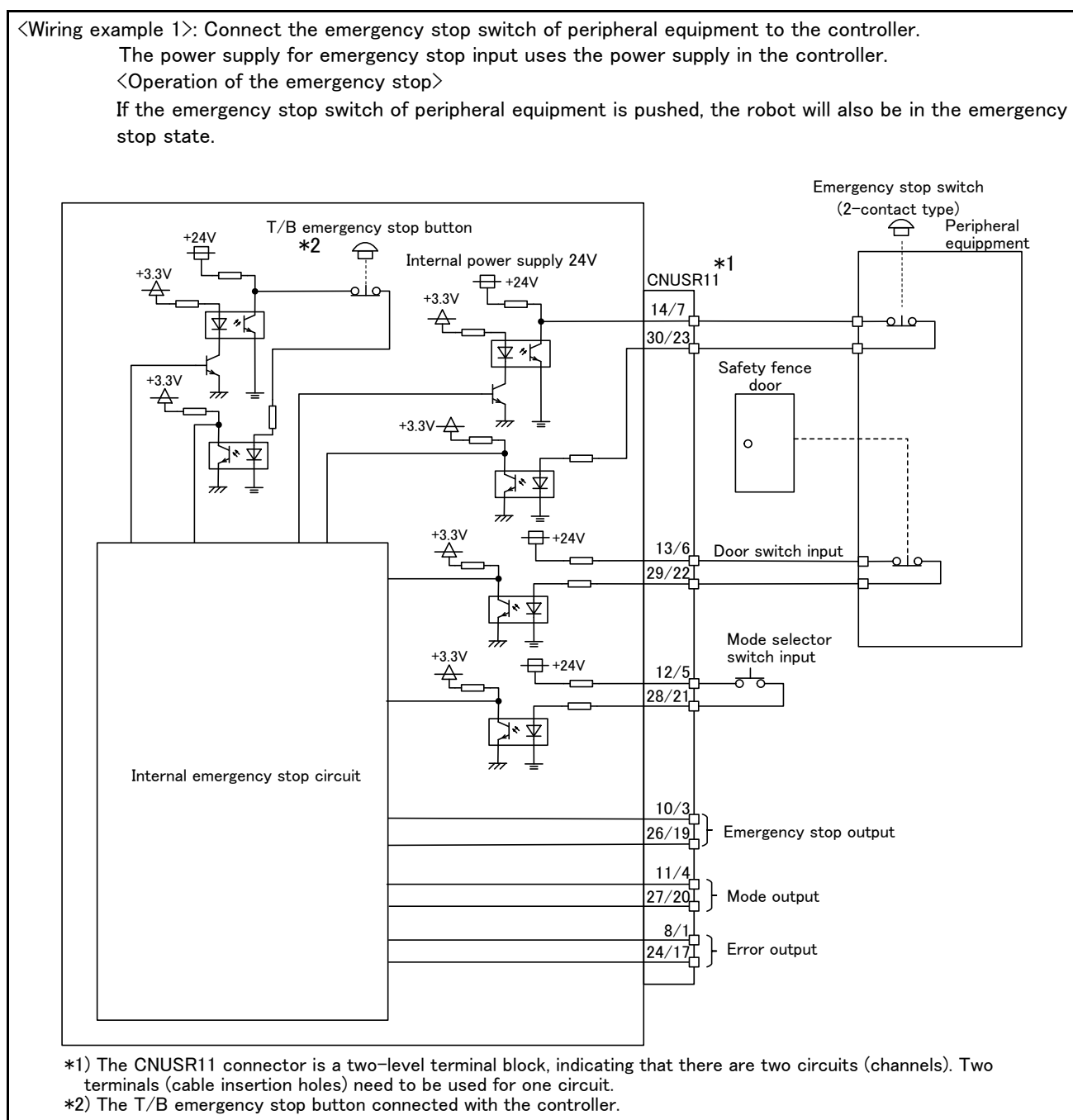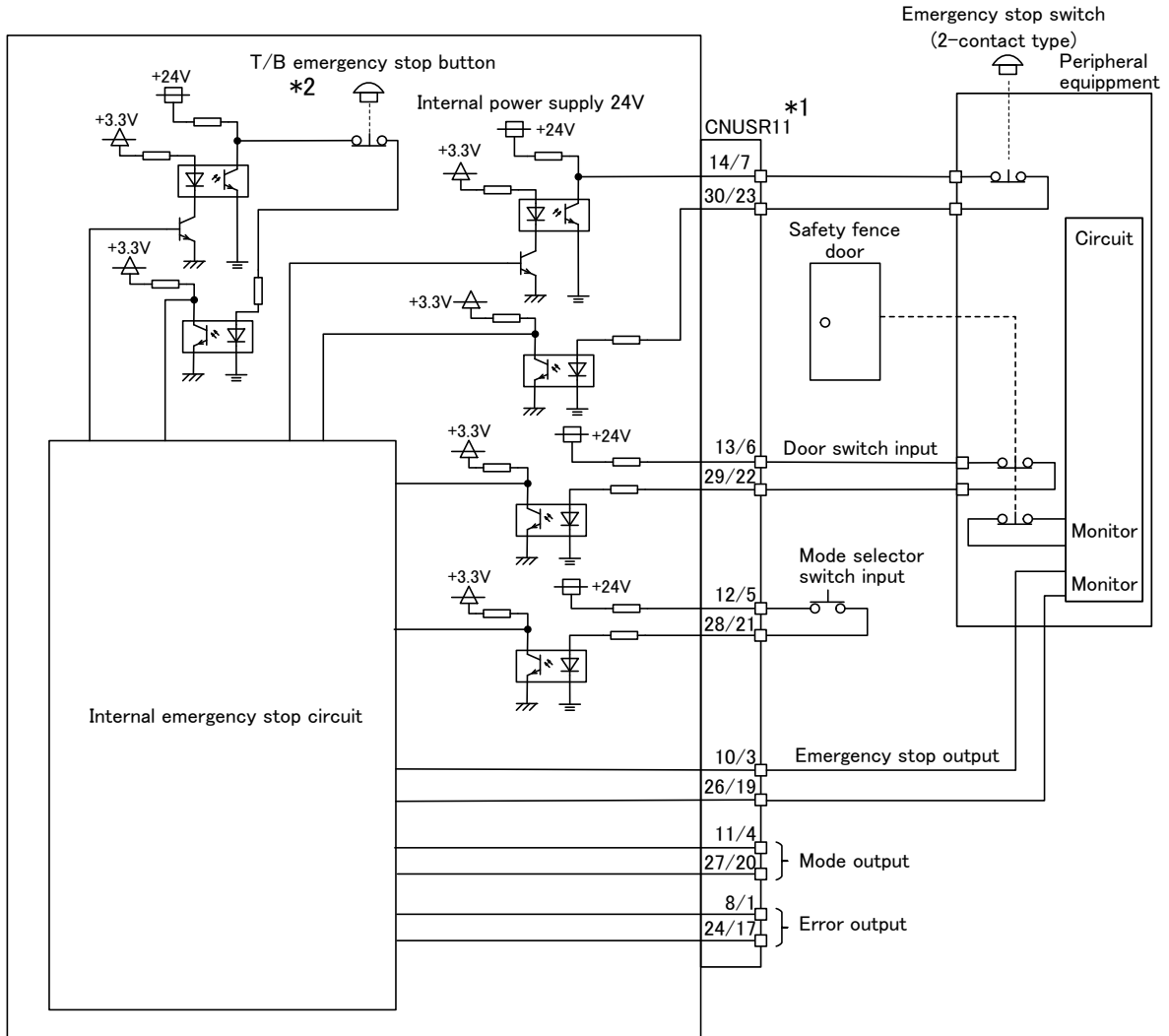
Fig.6-1: Example of safety measures (wiring example 1)

<Wiring example 2>: Connect the emergency stop switch, and door switch of peripheral equipment to the controller.
The power supply for emergency stop input uses the power supply in the controller. Monitor the emergency stop state by the peripheral equipment side.
<Operation of the emergency stop>
If the emergency stop switch of peripheral equipment is pushed, the robot will also be in the emergency stop state.
When the controller power is OFF, the peripheral devices are in the emergency stop state.

*1) The CNUSR11 connector is a two-level terminal block, indicating that there are two circuits (channels). Two terminals (cable insertion holes) need to be used for one circuit.
*2) The T/B emergency stop button connected with the controller.

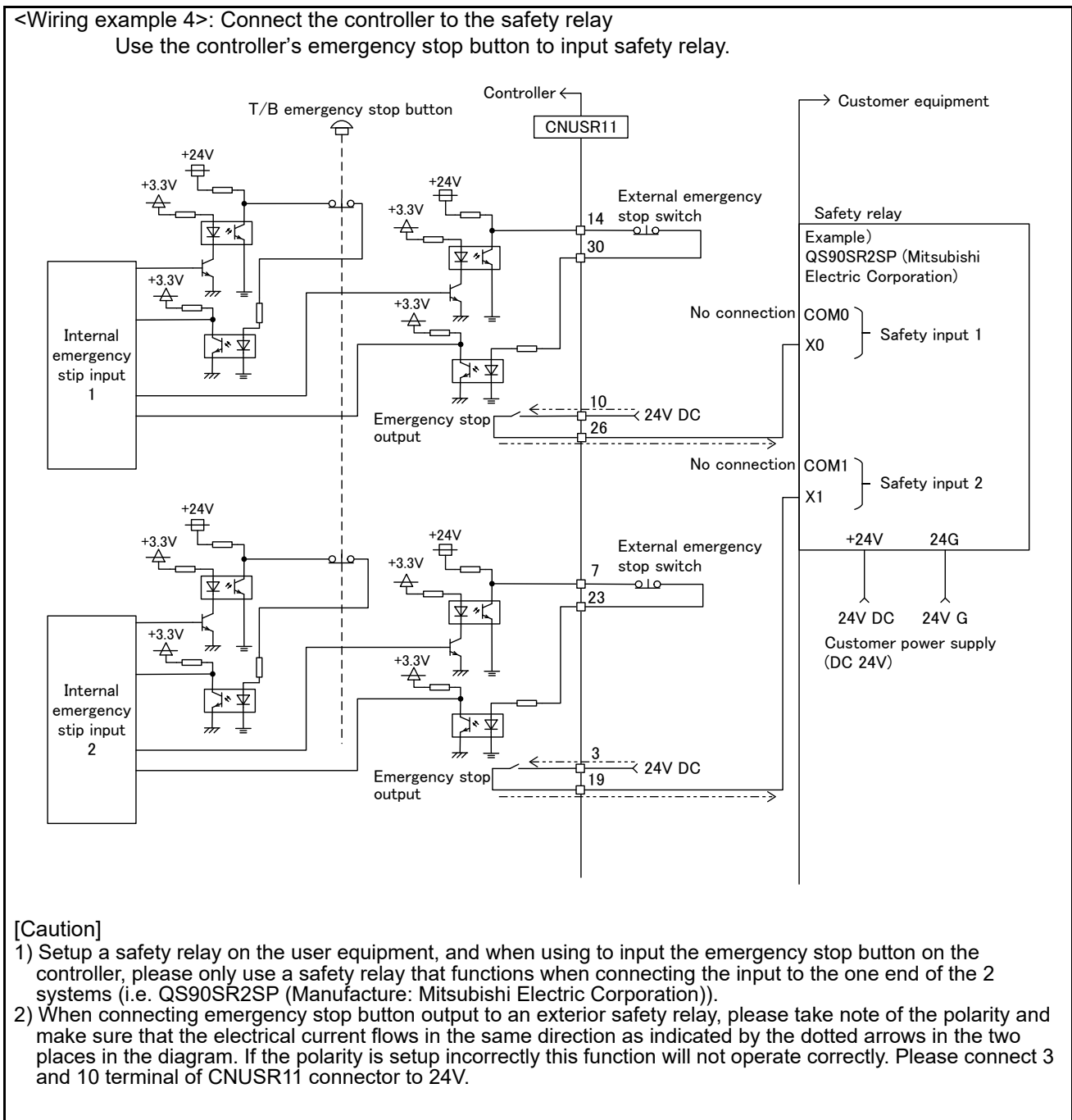Fig.6-2: Example of safety measures (wiring example 2)

<Wiring example 3>: Connect the emergency stop switch of peripheral equipment, and the door switch to two controllers, and it interlocks. The power supply for emergency stop input uses the power supply in the controller. Monitor the emergency stop state by the peripheral equipment side.

<Operation of the emergency stop>

If the emergency stop switch of peripheral equipment is pushed, the robot will also be in the emergency stop state.

When the controller power is OFF, the peripheral devices are in the emergency stop state.
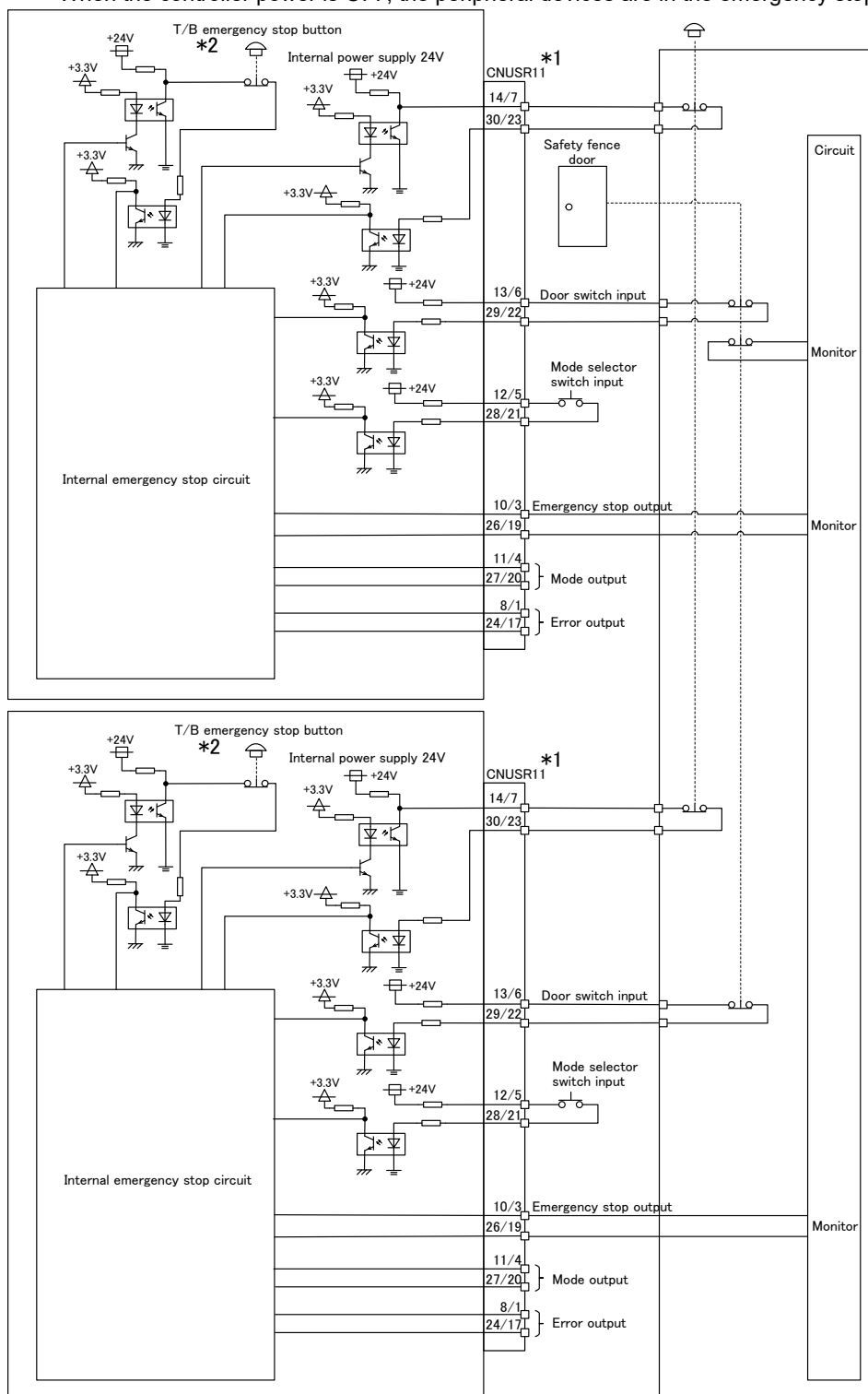
*1) The CNUSR11 connector is a two-level terminal block, indicating that there are two circuits (channels). Two terminals (cable insertion holes) need to be used for one circuit.

*2) The T/B emergency stop button connected with the controller.

Fig.6-3: Example of safety measures (wiring example 3)

<Wiring example 4>: Connect the controller to the safety relay
Use the controller's emergency stop button to input safety relay.

[Caution]
1) Setup a safety relay on the user equipment, and when using to input the emergency stop button on the controller, please only use a safety relay that functions when connecting the input to the one end of the 2 systems (i.e. QS90SR2SP (Manufacture: Mitsubishi Electric Corporation)).
2) When connecting emergency stop button output to an exterior safety relay, please take note of the polarity and make sure that the electrical current flows in the same direction as indicated by the dotted arrows in the two places in the diagram. If the polarity is setup incorrectly this function will not operate correctly. Please connect 3 and 10 terminal of CNUSR11 connector to 24V.

Fig.6-4: Example of safety measures (wiring example 4)

(1) External emergency stop connection [supplementary explanation]
    (1) Use a 2-contact type switch for all switches.
    (2) Install a limit switch on the safety fence's door. With a constantly open contact (normal open), wire to the door switch input terminal so that the switch turns ON (is conducted) when the door is closed, and turns OFF (is opened) when the door is open.
    (3) Use a manual-return type of normal close which have two lines for the emergency stop button.
    (4) Classify the faults into minor faults (faults that are easily restored and that do not have a great effect) and major faults (faults that cause the entire system to stop immediately, and that require care in restoration), and wire accordingly.

[Caution] The emergency stop input (terminal block) on the user wiring in the controller can be used for safety measures as shown in figure above. Note that there are limits to the No. of switch contacts, capacity and cable length, so refer to the following and install.

      • Switch contact .... Prepare a 2-contact type.[*1)]

      • Switch contact capacityRelated current of 24 VDC or higher for a no-voltage contact.[*1)]

      • Cable length .... The length of the wire between the switch and terminal block must be max. 15m or less. Please use the shield line, in case of the cable may receive the noise etc. by other equipment, such as servo amplifier. And, if it is necessary, please fix a ferrite core (recommended model name: E04SR301334, manufacturer: Seiwa Electric Mfg. Co., Ltd.) to the shielded cable.
          The size of the wire that fits to use is shown below.
          CNUSR11 connector: AWG24 to 16 (0.2 to 1.25mm^2)

Electric specification of the emergency stop related output circuit is 100 mA/24 V or less. Don't connect the equipment except for this range.

⚠ **CAUTION**   Be sure to perform wiring correctly. If there are mistakes in the wiring, the robot may not stop when the emergency stop button is pressed and there will be a risk of damage or personal injury occurring.
After wiring, be sure to press each of the installed emergency stop switches and check whether the emergency stop circuit works properly.

⚠ **CAUTION**   Be sure to duplicate connection of the emergency stop, door switch and mode selector switch. If not duplicated, these functions may fail due to a broken relay used by customer, etc.

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*1) The minimum load electric current of the switch is more than 5mA/24V.

6.2 Working environment

Avoid installation in the following places as the equipment's life and operation will be affected by the ambient environment conditions. When using in the following conditions, the customer must pay special attention to the preventive measures.

(1) Power supply
- Where the voltage fluctuation will exceed the input voltage range.
- Where a momentary power failure exceeding 20ms may occur.
- Where the power capacity cannot be sufficiently secured.

⚠ **CAUTION**　Please use the controller with an input power supply voltage fluctuation rate of 10% or less. In the case of 200 VAC input, for example, if the controller is used with 180 VAC during the day and 220 VAC during the night, turn the servo off once and then on again.
If this is not performed, an excessive regeneration or overvoltage error may occur.

(2) Noise
- Where a surge voltage exceeding 2000V, 5kHz (equivalent to EN 61000-4-4) may be applied on the primary voltage. Locations where a strong electric field or magnetic field exists, such as near large inverters, high output frequency oscillator, large contactors and welding machines.
  [Recommendation]
  A noise-cut transformer; a noise filter; reinforcement of ground lines and electromagnetic shields; isolation by keeping away from noise sources; reduction of noise level of emission.

This product has undergone EMC testing for products intended for use in industrial environments (tested to standards EN 61000-6-2 and EN 61000-6-4). This product is not intended to be connected to residential, commercial, or light-industrial power supplies.

(3) Temperature and humidity
- Where the atmospheric temperature exceeds 40 degree , lower than 0 degree.
- Where the relative humidity exceeds 85%RH, lower than 45%RH, and where dew may condense.
- Where the robot will be subject to direct sunlight or near heat generating sources such as heaters.

(4) Vibration
- Where excessive vibration or impact may be applied. (Use in an environment of $34m/s^2$ or less during transportation and $5m/s^2$ or less during operation.)

(5) Installation environment
- Where strong electric fields or magnetic fields are generated.
- Where the installation surface is rough. (Avoid installing the robot on a bumpy or inclined floor.)
- Where there is heavy powder dust and oil mist present.

6.3 Precautions for handling
(1) This robot has brakes on J3 axes. The precision of the robot may drop, looseness may occur and the reduction gears may be damaged if the robot is moved with force with the brakes applied.
(2) Avoid moving the robot arm by hand. When unavoidable, gradually move the arm. If moved suddenly, the accuracy may drop due to an excessive backlash, or the backed up data may be destroyed.
(3) Note that depending on the posture, even when within the movement range, the shaft section could interfere with the base section. Take care to prevent interference during jog. [*1)]
(4) The robot arm consists of precision parts such as bearing. Lubricants such as grease are also applied on the moving parts to keep the mechanical accuracy. In a cold start under low temperature or in the first start after being stored for one month or longer, lubricants may not be spread enough. Such condition may lower the positioning accuracy, cause servo and overload alarms, and early wearing of the moving parts. To avoid such situation, perform warm-up operation of the machine at a low speed (at about 20% of normal operation speed). Move the robot arm from the lower to the upper limit of the movable range

＊1） Jog operation refers to operating the robot manually using the teaching pendant.

with the 30 degree joint angle or more for about 10 minutes. After that, speed up the operation gradually. Please use the warm-up operation. (About the details of the warm-up operation, refer to "INSTRUCTION MANUAL/Detailed explanations of functions and operations".)

(5) When the air hoses and cables are used inside the shaft (J3 axis), the grease for cable protection may ooze out or abrasion powders may be generated from the tip of the shaft while the robot is moving. However, movements and performance of the robot are not affected. Wipe off the grease or powders as required.

(6) The robot arm and controller must be grounded with 100Ω or less (class D grounding) to secure the noise resistance and to prevent electric shocks.

(7) The items described in these specifications are conditions for carrying out the periodic maintenance and inspections described in the instruction manual.

(8) When using the robot arm on a mobile axis or elevating table, the machine cables enclosed as standard configuration may break due to the fixed installation specifications. In this case, use a flexed type cable which is one of the optional machine cables (replacement).

(9) If this robot interferes with the workpiece or peripheral devices during operation, the position may deviate, etc. Take care to prevent interference with the workpiece or peripheral devices during operation.

(10) Do not attach a tape or a label to the robot arm and the controller. If a tape or a label with strong adhesive power, such as a packaging tape, is attached to the coated surfaces of the robot arm and controller, the coated surface may be damaged when such tape or label is peeled off.

(11) If the robot is operated with a heavy load and at a high speed, the surface of the robot arm gets very hot. It would not result in burns, however, it may cause secondary accidents if touched carelessly.

(12) Do not shut down the input power supply to stop the robot. If the power supply is frequently shut down during a heavy load or high-speed operation, the speed reducer may be damaged, backlash may occur, and the program data may be destroyed.

(13) During the robot's automatic operation, a break is applied to the robot arm when the input power supply is shut down by a power failure, for instance. When a break is applied, the arm may deviate from the operation path predetermined by automatic operation and, as a result, it may interfere with the mechanical stopper depending on the operation at shutdown. In such a case, take an appropriate measure in advance to prevent any dangerous situation from occurring due to the interference between the arm and peripheral devices.
Example) Installing a UPS (uninterruptible power supply unit) to the primary power source in order to reduce interference.

(14) Do not conduct an insulated voltage test. If conducted by mistake, it may result in a breakdown.

(15) Fretting may occur on the axis which moving angle or moving distance move minutely, or not moves. Fretting is that the required oil film becomes hard to be formed if the moving angle is small, and wear occurs. The axis which not moved is moving slightly by vibration etc. To make no fretting recommends to move these axes about once every day the 30 degree or more, or the 20mm or more.

(16) The United Nations' Recommendations on the Transport of Dangerous Goods must be observed for transborder transportation of lithium batteries by air, sea, and land. The lithium batteries (ER6V) used in Mitsubishi industrial robots contain lithium and fall under the definition.
When the lithium batteries are shipped for storage, etc., they will be classified as Class 9: Miscellaneous dangerous substances and articles. Please contact your transportation company and must provide appropriate transport safety measures as the customer's consignor.

(17) If the air supply temperature (primary piping) used for the tool etc. is lower than ambient air temperature, the dew condensation may occur on the coupling or the hose surface.

(18) Collision detection function is valid condition for both of automatic and jog operation at shipping. So, the robot stops immediately if the robot's tool or arm interferes with a peripheral device, minimizing damage. Therefore, please use in the valid condition.

(19) When fumigants that contain halogen materials such as fluorine, chlorine, bromine, and iodine are used for disinfecting and protecting wooden packaging from insects, they cause malfunction when entering our products. Please take necessary precautions to ensure that remaining materials from fumigant do not enter our products, or treat packaging with methods other than fumigation (heat method). Additionally, disinfect and protect wood from insects before packing products.

6.4 EMC installation guideline

6.4.1 Outlines

Industrial robots are one of the components of automation systems as well as main components. This section introduces methods and parts to ensure electromagnetic compatibility (EMC) in automation systems. We test for EMC in the environment described in this manual, but the noise level varies depending on device types, layout, control panel structure, and wiring, etc. Please make final checks for EMC.

6.4.2 EMC

EMC can be broadly classified into two categories: EMI and EMS.

(1) Emission (EMI: Electromagnetic Interference).......The capacity not to generate the disturbance noise which has a bad influence outside.

(2) Immunity (EMS: Electromagnetic Susceptibility)....The capacity which does not malfunction for the disturbance noise from the outside.

Each contents are shown below.

Item	Name	Contents
Emission (EMI)	Radiative noise disturbance	The electromagnetic noise etc. which are emitted to environs.
	Electrical-conduction noise disturbance	The electromagnetism noise etc. which flow out of the power-supply line.
Immunity (EMS)	Electrostatic discharge immunity test	The noise from the electrified human body.
	Radiated, radio-frequency, electromagnetic field immunity test susceptibility test	The electromagnetism noise from the transceiver, the broad-casting station, etc.
	Electrical fast transient burst immunity test	The relay noise or the electromagnetism noise etc. which are caused in power-supply ON/OFF.
	Immunity to conducted distrurbances induced radio-frequency fields	The electromagnetism noise etc. which flow in through the power source wire and the grounding wire.
	Power frequency magnetic field immunity test	The electromagnetism noise with a power supply frequency of 50/60 Hz etc.
	Voltage dips, short interruptions and voltage variations immunity test	The noise in the variation of the source voltage of the power dispatching, etc.
	Surge immunity test	The electromagnetism noise by the thunderbolt, etc.

6.4.3 EMC measures

There are mainly following items in the EMC measures.

(1) Store into the sealed metal board.
(2) Grounding all the conductor that have floated electrically (makes the impedance low).
(3) Wiring so that the power source wire and signal wire are separated.
(4) Use the shield cable for the cable which wired outside of the metal board.
(5) Install the noise filter.

To suppress the noise emitted out of the board, be careful of the following item.

(1) Ensure grounding of the equipment.
(2) Use the shield cable.
(3) Separate the metal board electrically. Narrows the distance/hole.
   The strength of electromagnetic noise emitted to environment is changed a lot by the shielding efficiency of cable and the distance of metal board, so it should be careful.

6.4.4 Example of EMC measures

Industrial robots are designed for use with other devices. We test our industrial robots for conformity with EMC standards in the following system architecture. However, it does not mean that every system meets the requirements of EMC standards.

Electromagnetic compatibility depends on the relationship between the industrial robot and devices in the system, wiring conditions, layout, or other factors. Therefore, check whether the entire machinery/system meets the requirements.
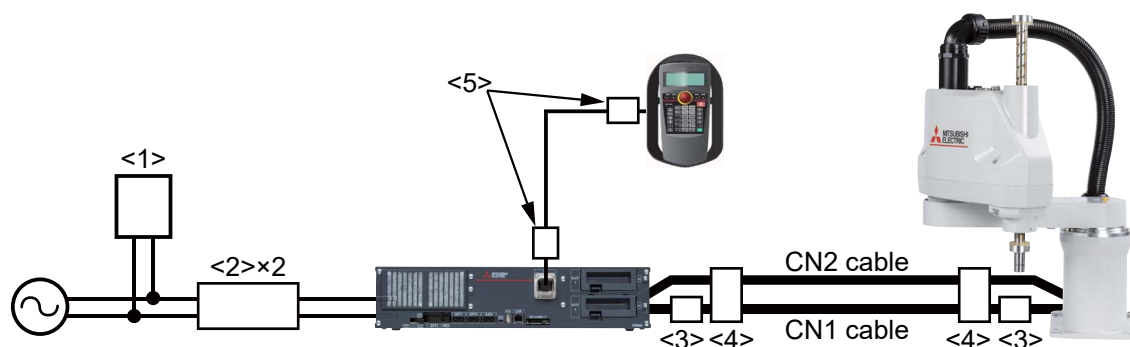
Fig.6-5: Example of EMC measures

1) Install ferrite cores <3> and <4> as follows.
   Install the ferrite cores <3> on the CN1 cable only.
   Install the ferrite cores <4> on both the CN1 and CN2 cables.
2) Install the ferrite cores <5> on the cable of the teaching pendant.
3) Attach the noise filters <2> and surge protector <1> to the power cable.

Table 6-4: Parts for EMC measures

No.	Item	Model	Quantity	Manufacturer	Remarks
1	Surge protector	LV275DI-Q4	1	OKAYA ELECTRIC INDUS-TRIES CO., LTD.	-
2	Noise filter	RSMN-2016	2	TDK-Lambda Corporation	-
3	Ferrite core	GRFC-13	2	KITAGAWA INDUSTRIES CO.,LTD.	Install the ferrite cores on the CN1 cable only.
4	Ferrite core	RFC-20	2	KITAGAWA INDUSTRIES CO.,LTD.	Install the ferrite cores on both the CN1 and CN2 cables.
5	Ferrite core	E04SR301334	2	SEIWA ELECTRIC MFG CO.Ltd	-

6.4.5 Parts for EMC measures

For details on the parts for EMC measures described on , contact your nearest Mitsubishi branch or dealer.

7 Appendix

Appendix 1 : Inertia calculation method

An allowable moment of inertia in the mechanical interface at the tip of the robot arm is determined. If a load exceeding the allowable moment of inertia is put, on the tip of the arm, vibration during operation and an overload alarm may occur. Therefore, consider the matching/appropriateness of the hand and load to be mounted on the tip of the arm for the robot specifications when you select a robot. The following describes the load inertia calculation method.

Calculate the total moment of inertia about the J4 axis.

$$I = Iz_1 + Iz_2 + W_1 L_1{}^2 + W_2 L_2{}^2$$

I: total moment of inertia about the J4 axis
Iz: load inertia
W: mass (kg)

Rectangular shape

Load inertia: $Iz = W \cdot \dfrac{a^2 + b^2}{12}$

Cylindrical shape

Load inertia: $Iz = W \cdot \dfrac{r^2}{2}$
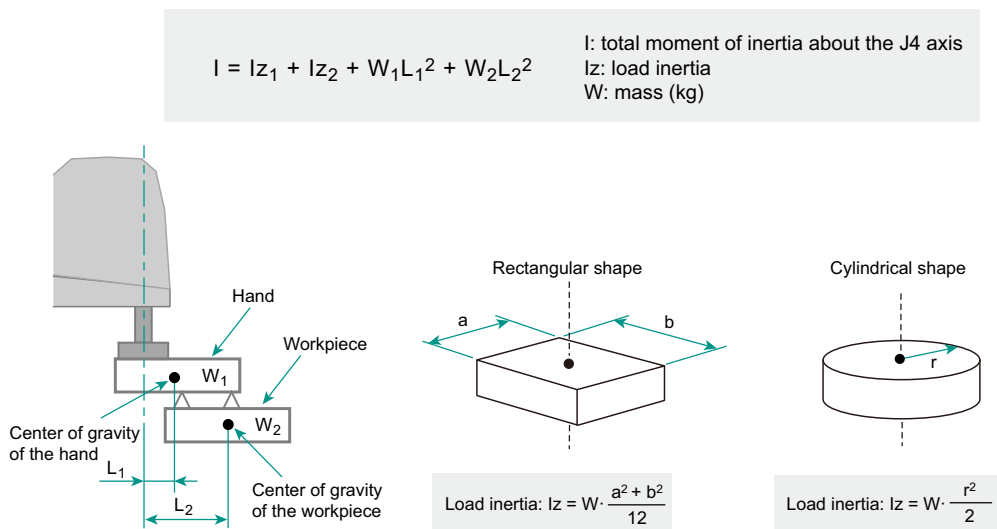
[Calculation example]

Hand

Load inertia: $Iz_1 = 2.5 \times \dfrac{0.15^2 + 0.1^2}{12}$

= 0.0068 kg·m²

Workpiece

Load inertia: $Iz_1 = 1.5 \times \dfrac{0.04^2}{2}$

= 0.0012 kg·m²

Total moment of inertia about the J4 axis

$I = 0.0068 + 0.0012 + 2.5 \times 0.05^2 + 1.5 \times 0.1^2$
$= 0.030$ kg·m²

The calculation result (0.030 kg·m²) is greater than the allowable inertia (rating) of 0.01 kg·m² for RH-6FRH.
However, if the center of gravity of the hand is aligned with the axis of rotation of J4 and the workpiece is held directly below the J4 axis, both L_1 and L_2 become zero and the total inertia around the J4 axis is calculated as follows.

$I = 0.0068 + 0.0012 = 0.008$ kg·m² < 0.01 kg·m²

The result is smaller than the allowable inertia.

If the total moment of inertia exceeds the allowable inertia, consider changing the alignment or other conditions for the holding system.

Appendix 2 : Classification of functions using external input/output signals

Before using the functions, note the following.

Table 7-1: Classification of functions using external input/output signals

Classification	Function	Description
Safety signal	Emergency stop input	Detects emergency stop inputs. The safety diagnosis function for the emergency stop input circuit makes the STO function meet the requirements of SIL 3, Category 4, PL e. At factory settings, the STO function meets the requirements of SIL 2, Category 3, PL d. To make the STO function meet the requirements of SIL 3, Category 4, PL e, change the parameter setting by referring to Page 127, "Appendix 3 : Safety diagnosis function (Test pulse diagnosis)".
	Mode selector switch input	Switches the controller mode between MANUAL and AUTOMATIC.
	Door switch input	Receives the status of the switch installed on the door of the safety fence to detect the opening of the door.
Non-safety signal	Emergency stop output	Monitors whether the robot is in the emergency stop state.
	Mode output	Monitors whether the robot operates in MANUAL or AUTOMATIC mode.
	Robot error output	Monitors the error status of the robot.
	Additional axis synchronization output	Synchronizes the state of the additional axes (servo ON/OFF) with that of the robot arm. For details, refer to Page 65, "3.8 Additional axis synchronization output".

Appendix 3 : Safety diagnosis function (Test pulse diagnosis)

This function enables diagnosis of external wiring by pulse signals output from the emergency stop ports (EXTEMG11, EXTEMG21). Changing parameter TPOEMG allows EXTEMG11 and EXTEMG21 to output off-pulses regularly. The width of output pulses is always approximately 20 ms. Checking regularly the test pulses inside the robot controller enables confirming the correct operation of the emergency stop lines. When using this function, connect emergency stop switches by seeing Fig. 7-2.

Make sure to prevent test pulses of this function from causing faulty operation of peripheral devices.
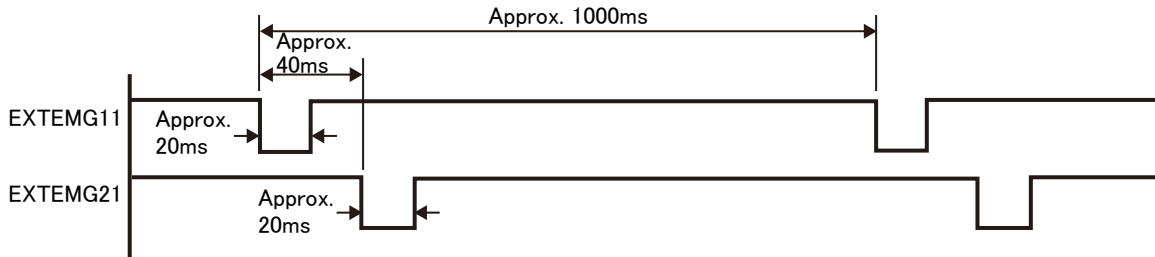
Fig.7-1: Test pulse diagnosis

Table 7-2: Parameter details

Item	Description
Parameter name	TPOEMG
Function	This enables configuring the pulse output function for outputting test pulse signals from emergency stop ports (EXTEMG11, EXTEMG21).
What parameter settings means	0: Outputs no test pulses 1: Outputs test pulses
Default	0
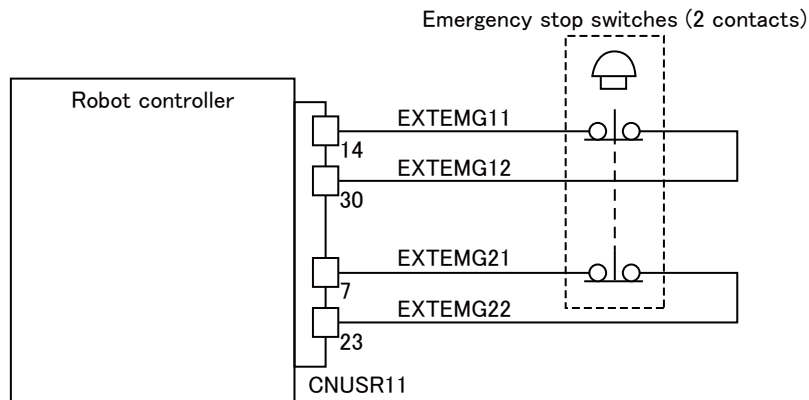
Fig.7-2: How to wire emergency stop lines

Appendix 4 : Safety block diagram
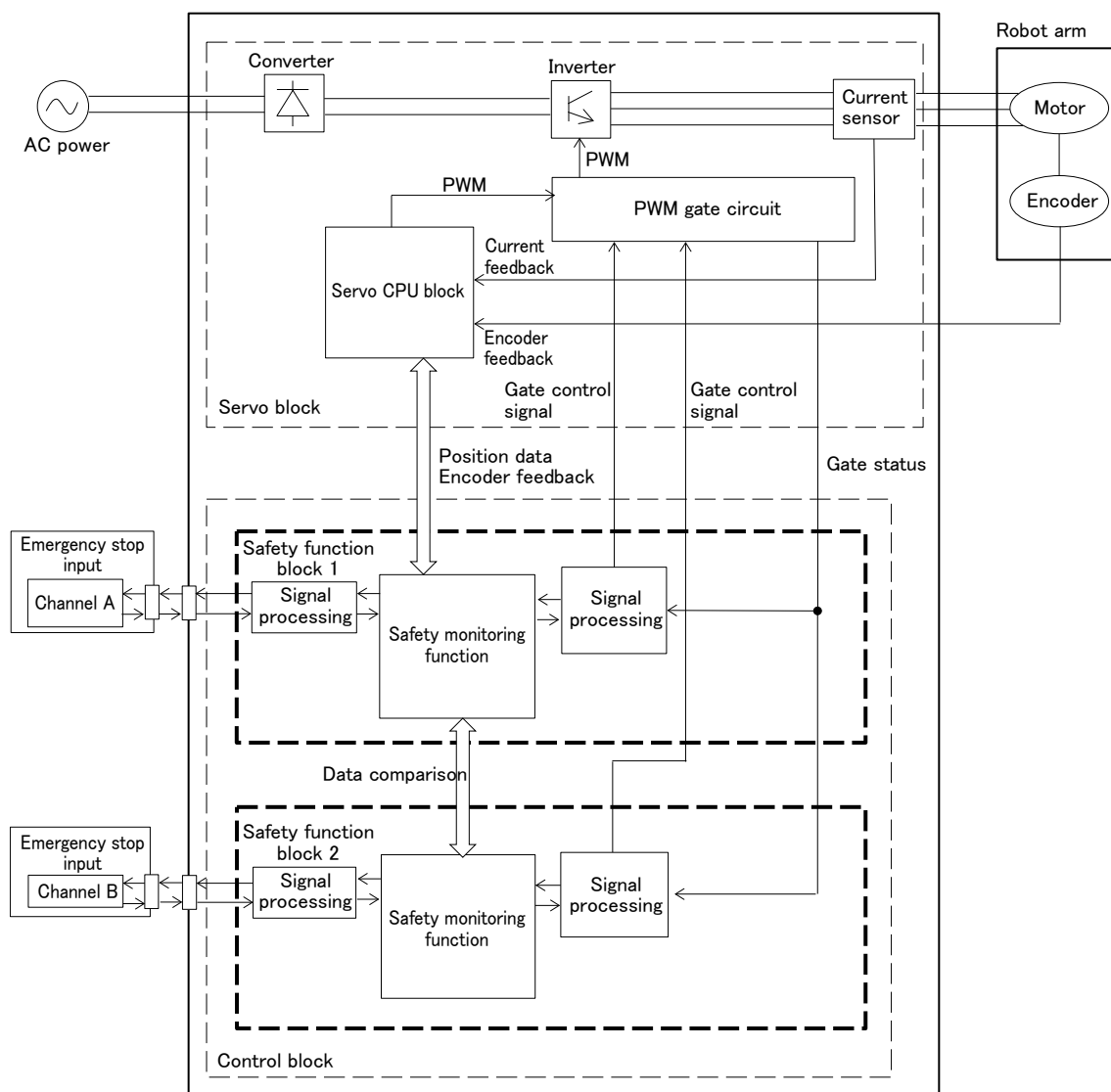
Fig.7-3: Safety block diagram

Appendix 5 : Specifications discussion material (RH-3CRH series)

■Customer information

Company name		Name	
Address		Telephone	

■Purchased model

Item	Type	Arm length	Stroke	Controller
General specification	RH-3CRH4018-D	■400	■180	CR800-CHD

■Options (Installable after shipment)

Item		Type	Provision, and specifications when provided.
Robot arm	Machine cable (replacement)	1F-□□UCBL-42	Fixed type: □Not provide □3m □10m □15m □20m
		1F-□□LUCBL-42	Flexed type:□Not provide □10m □15m □20m
Controller	Simple teaching pendant	R32TB-□□	□Not provided □7m □15m
	Highly efficient teaching pendant	R56TB-□□	□Not provided □7m □15m
	Parallel I/O interface	2D-TZ368/ 2D-TZ378	□Not provided 2D-TZ368(Sink type)/ □-1pc. □-2pc. 2D-TZ378(Source type)/□-1pc. □-2pc.
	External I/O cable (For parallel I/O interface)	2D-CBL□□ (2D-TZ368/TZ378)	□Not provided □5m-( )pc. □15m-( )pc.
	Parallel I/O unit	2A-RZ361/ 2A-RZ371	□Not provided □2A-RZ361(Sink type)/( ) unit □2A-RZ371(Source type)/( ) unit
	External I/O cable (For Parallel I/O unit)	2A-CBL□□ (2A-RZ361/RZ371)	□Not provided □5m-( )pc. □15m-( )pc.
	CC-Link interface	2D-TZ576	□Not provided □Provided
	EtherNet/IP interface	2D-TZ535	□Not provided □Provided
	PROFINET interface	2D-TZ535-PN	□Not provided □Provided
	CC-Link IE Field interface	2F-DQ535	□Not provided □Provided
	EtherCAT interface	2F-DQ535-EC	□Not provided □Provided
	Function extension card	2F-DQ510	MELFA Smart Plus card pack (A-type): □Not provided □Provided
		2F-DQ520	MELFA Smart Plus card pack (AB-type): □Not provided □Provided
		2F-DQ511	MELFA Smart Plus card (A-type): □Not provided □Provided
		2F-DQ521	MELFA Smart Plus card (B-type): □Not provided □Provided
	SD memory card	2F-2GBSD	□Not provided □Provided
	Safety option	4F-SF002-01	□Not provided □Provided
	RT ToolBox3	3F-14C-WINE	□Not provided □Windows 7/8/8.1/10 English DVD-ROM
	RT ToolBox3 mini	3F-15C-WINE	□Not provided □Windows 7/8/8.1/10 English DVD-ROM
	RT ToolBox3 Pro	3F-16D-WINE	□Not provided □Windows 7/8/8.1/10 English DVD-ROM
	Instructions manual	5F-BN01-PE01	□Not provided □Provided ( ) sets
Function extension	MELFA-3D Vision 3.0	3F-53U-WINM	□Not provided □Provided

■Maintenance parts (Consumable parts)

Maintenance parts	□Backup batteries ER6V ( ) pcs. □Grease ( ) cans

■Robot selection check list

Work description	□Material handling □Assembly □Machining L/UL □Sealing □Testing and inspection □Other ( )	
Workpiece mass ( )g	Hand mass ( )g	
Remarks		

Appendix 6 : Specifications discussion material (RH-6CRH series)

■Customer information

Company name		Name	
Address		Telephone	

■Purchased model

Item	Type	Arm length	Stroke	Controller
General specification	RH-6CRH□□20-D	□600 □700	■200	CR800-CHD

■Options (Installable after shipment)

	Item	Type	Provision, and specifications when provided.
Robot arm	Machine cable (replacement)	1F-□□UCBL-42	Fixed type: □Not provide □3m □10m □15m □20m
		1F-□□LUCBL-42	Flexed type:□Not provide □10m □15m □20m
Controller	Simple teaching pendant	R32TB-□□	□Not provided □7m □15m
	Highly efficient teaching pendant	R56TB-□□	□Not provided □7m □15m
	Parallel I/O interface	2D-TZ368/ 2D-TZ378	□Not provided 2D-TZ368(Sink type)/ □-1pc. □-2pc. 2D-TZ378(Source type)/□-1pc. □-2pc.
	External I/O cable (For parallel I/O interface)	2D-CBL□□ (2D-TZ368/TZ378)	□Not provided □5m-( )pc. □15m-( )pc.
	Parallel I/O unit	2A-RZ361/ 2A-RZ371	□Not provided □2A-RZ361(Sink type)/( ) unit □2A-RZ371(Source type)/( ) unit
	External I/O cable (For Parallel I/O unit)	2A-CBL□□ (2A-RZ361/RZ371)	□Not provided □5m-( )pc. □15m-( )pc.
	CC-Link interface	2D-TZ576	□Not provided □Provided
	EtherNet/IP interface	2D-TZ535	□Not provided □Provided
	PROFINET interface	2D-TZ535-PN	□Not provided □Provided
	CC-Link IE Field interface	2F-DQ535	□Not provided □Provided
	EtherCAT interface	2F-DQ535-EC	□Not provided □Provided
	Function extension card	2F-DQ510	MELFA Smart Plus card pack (A-type): □Not provided □Provided
		2F-DQ520	MELFA Smart Plus card pack (AB-type): □Not provided □Provided
		2F-DQ511	MELFA Smart Plus card (A-type): □Not provided □Provided
		2F-DQ521	MELFA Smart Plus card (B-type): □Not provided □Provided
	SD memory card	2F-2GBSD	□Not provided □Provided
	Safety option	4F-SF002-01	□Not provided □Provided
	RT ToolBox3	3F-14C-WINE	□Not provided □Windows 7/8/8.1/10 English DVD-ROM
	RT ToolBox3 mini	3F-15C-WINE	□Not provided □Windows 7/8/8.1/10 English DVD-ROM
	RT ToolBox3 Pro	3F-16D-WINE	□Not provided □Windows 7/8/8.1/10 English DVD-ROM
	Instructions manual	5F-BN01-PE01	□Not provided □Provided ( ) sets
Function extension	MELFA-3D Vision 3.0	3F-53U-WINM	□Not provided □Provided

■Maintenance parts (Consumable parts)

Maintenance parts	□Backup batteries ER6V ( ) pcs. □Grease ( ) cans

■Robot selection check list

Work description	□Material handling □Assembly □Machining L/UL □Sealing □Testing and inspection □Other ( )
Workpiece mass ( )g	Hand mass ( )g	
Remarks	