MITSUBISHI ELECTRIC

Mitsubishi Electric Industrial Robot

CR860 Controller
RV-35FR/50FR/80FR Series
Standard Specifications Manual

RV-35FR	RV-35FRM
RV-50FR	RV-50FRM
RV-80FR	RV-80FRM

SAFETY PRECAUTIONS

Read the separate Safety Manual thoroughly before using this product. Take precautions as necessary.

Before using this product, please read this manual and the relevant manuals carefully and pay full attention to safety to handle the product correctly.

The precautions given in this manual are concerned with this product only. For the safety precautions of the robot system, refer to the user's manual for the peripheral equipment used.

In this manual, the safety precautions are classified into three levels: "⚠DANGER", "⚠ WARNING", and "⚠ CAUTION".

⚠ **DANGER**	Precaution indicating cases where there is a risk of operator fatality or serious injury if handling is mistaken. Always observe these precautions to safely use the robot.

⚠ **WARNING**	Precaution indicating cases where the operator could be subject to fatalities or serious injuries if handling is mistaken. Always observe these precautions to safely use the robot.

⚠ **CAUTION**	Precaution indicating cases where operator could be subject to injury or physical damage could occur if handling is mistaken. Always observe these precautions to safely use the robot.

Under some circumstances, failure to observe the precautions given under "⚠CAUTION" may lead to serious consequences.

Observe the precautions of all the levels because they are important for personal and system safety.

Make sure that the end users read this manual and then keep the manual in a safe place for future reference.

A. These show precautions based on the Ordinance on Industrial Safety and Health (Articles 36, 104, 150, 151).

⚠ DANGER

● Provide a fence or enclosure during operation to prevent contact of the operator and robot.
→Installation of safety fence

⚠ 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

● 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

● 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

● 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

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

● 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

● 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

B. This shows precaution points given in the "Safety Manual".

For details, please read the text of the "Safety Manual".

⚠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.

● 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.

● Do not connect the Handy GOT to a programmable controller when using an iQ Platform compatible product with the CR860-R/CR860-Q controller. 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.

● 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 IEC 60825-1 (domestic standards in Japan).)

● 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 IEC 60825-1 (domestic standards in Japan).)

● 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.

⚠ 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.
- Securely ground the robot and controller.
  Failure to observe this could lead to malfunctioning by noise or to electric shock accidents.
- 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.
- 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.
- When transporting the robot using a crane or forklift, make sure to prevent people from supporting the robot.
- Never get on the robot or stand under a crane hoisting it during transportation.
- If an inspection is required immediately after continuous operation, some parts of the arm may be hot. Do not touch such areas with bare hands unintentionally. Doing so may cause burn injury, etc. Be sure to check that the temperature is low enough before starting inspection.
- Warning labels for electric shock, pinch points, and hot areas are affixed to the corresponding parts of the robot arm and controller. Check the dangerous areas in advance. Refer to the safety precautions in the following manuals for the position of the labels.
  📖Robot Arm Setup and Maintenance (BFP-A3781)
  📖Controller setup, basic operation, and maintenance (BFP-A3783)

⚠CAUTION

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

● 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 or tipping over.

● Always use the robot installed on a secure table.
Use in an unstable posture could lead to positional deviation and vibration.

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

● 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.

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

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

● 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.

● 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.

● 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.

● Do not stop the robot or apply emergency stop by turning OFF the controller's main power.
If the controller's 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.

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

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

● Connecting the USB port on the controller to commercially available devices such as computers and LAN hubs may not be compatible with our equipment or the temperature and electrical noise of some FA environments.
If using commercially available devices, check the operation carefully to determine if protection against EMI or the addition of a ferrite core is required.
We cannot guarantee the operation of the product and perform maintenance if the product is connected to commercial devices.

● 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.

● Note that applying excessive force to the arm may cause damage to the brakes of axes or shorten the service life.

● Never remove bolts unless otherwise instructed in the maintenance and inspection instructions.

CR860 controller

⚠ CAUTION

When installing or connecting a unit or cable to inside the robot controller, do not touch the conductive parts, circuit boards, or electronic components directly. Failure to observe this may result in malfunction or failure of the controller.

Cautions for the basic system structure are shown below.

Details of section A

Details of section B
(attached inside the controller)
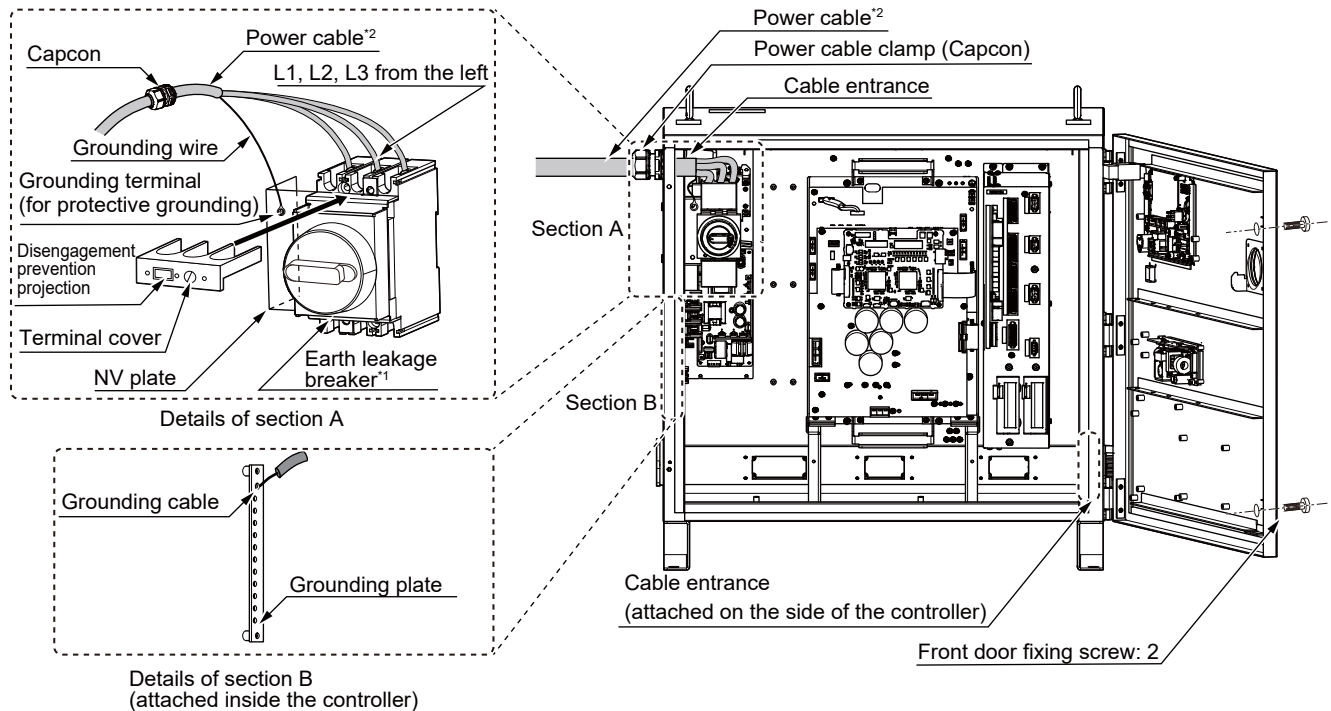
*1 Always use the terminal cover for the earth leakage breaker.

*2 For an example of taking preventive measures against noise (surge) in the primary power supply, refer to the following page:
☞ Page 160 EMC installation guideline

• Connecting the power cable

1. Prepare a power cable with an outer diameter of 19mm to 23mm for power supply (8 AWG ($8mm^2$) or above, three cores) and grounding (8 AWG ($8mm^2$) or above, one core) and a grounding wire for protective grounding (8 AWG ($8mm^2$)). Use a power cable that incorporates power wires and grounding wire.

2. Loosen the two screws fixing the controller front door, then open it. To open the front door, turn the knob on the front of the controller counterclockwise.

Turn the knob on the earth leakage breaker counterclockwise.
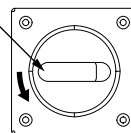
3. Pull out the disengagement prevention projection on the terminal cover of the earth leakage breaker by displacing the projection with your finger.

4. Confirm that the primary power matches the specifications.

5. Ensure that the primary power is shut OFF and the earth leakage breaker of the controller is OFF.

6. Put the power cable through the cable entrance on the side of the controller and fix the cable using a power cable clamp (Capcon).

7. Connect the power cable to the L1, L2, and L3 terminals (M5 screws) of the earth leakage breaker.

8. Connect the grounding wire of the power cable to the grounding terminal (for protective grounding) (M6 screw) of the NV plate.

9. Press down the terminal cover of the earth leakage breaker (removed in step 3) until the cover snaps into place.

10. Close the controller front door, then fix it using the front door fixing screws. IP54 cannot be satisfied unless the front door fixing screws are fixed.

11. Connect the grounding wire for protective grounding to the grounding terminal (for protective grounding) (M6 screw) located next to the power cable clamp (Capcon).

Grounding terminal
(for protective grounding)

Grounding wire for
protective grounding

Power cable clamp (Capcon)
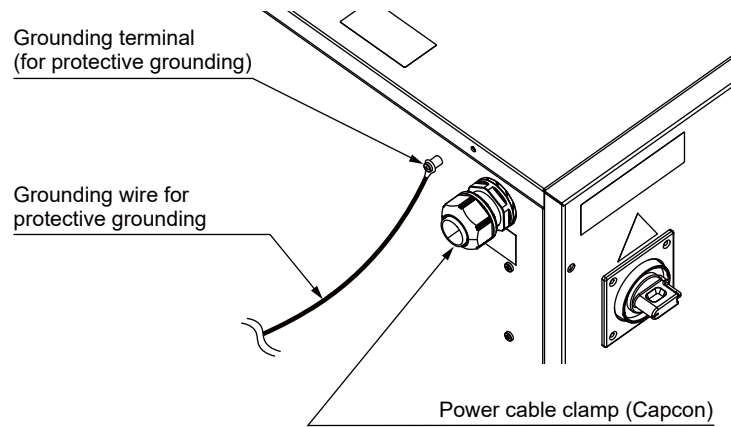
• Connecting the grounding wire

When functional grounding is required, connect a grounding wire to the unused part on the grounding plate in section B. Do not remove any existing cables.

INTRODUCTION

Thank you for purchasing Mitsubishi Electric MELFA industrial robots.

This series provides vertical articulated robots intended to be used for machining and assembly.

To comply with the target application, a work system having a well-balanced robot arm, peripheral devices or robot hand section must be structured.

When creating these standard specifications, we have edited them so that the Mitsubishi Electric 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 Electric branch or dealer.

We hope that you will consider these standard specifications and use our robots. Note that in this specification document the specifications related to the robot arm are described on the following page:

☞ Page 24 ROBOT ARM

For specifications related to the controller, refer to the following page:

☞ Page 60 ROBOT CONTROLLER

For information on the functions of software and the list of commands, refer to the following page:

☞ Page 141 SOFTWARE

For other information on specifications, options, and maintenance parts, refer to the relevant pages.

Information on special handling is also included in this manual as much as possible. However, do not handle the product in ways other than those described in the manual.

This manual is for the following products.

Robot type	Series (generic name used in this document for robots listed in each row)
RV-35FR, RV-35FRM	RV-35FR series
RV-50FR, RV-50FRM	RV-50FR series
RV-80FR, RV-80FRM	RV-80FR series

Additionally, the CR860 controller indicates the CR860-D, CR860-Q, or CR860-R controller.

CONTENTS

1 GENERAL CONFIGURATION

1.1 Equipment

The robot system consists of the following types of equipment.

Standard equipment

The following table shows items enclosed as standard.

No.	Item	Standalone type	MELSEC iQ-R compatible type	MELSEC-Q compatible type
1	Robot arm	○	○	○
2	Robot controller	○	○	○
3	Robot CPU module (compatible with MELSEC iQ-R)[1]	—	○	—
	Robot CPU module (compatible with MELSEC-Q)[1]	—	—	○
4	Machine cable	○	○	○
5	Robot arm installation bolt	○	○	○
6	CD-ROM (Instruction manual)	○	○	○

*1 The robot CPU module connection cable is included.

Option

Users can install options after their delivery. The customer needs to arrange for the installation.

Maintenance parts

Materials and parts for the maintenance use.

1.2 Model name of robot

Robot model names are determined by payload, arm length, and environment specifications. Details are shown below. Select the robot suitable for the customer's application.

How to identify the robot model

$$\underset{1)}{\underline{RV}} - \underset{2)}{\underline{\square\square}} \; \underset{3)}{\underline{FR}} \; \underset{4)}{\bigcirc} - \underset{5)}{\bullet}$$

No.	Symbol	Description
1)	RV	Indicates the vertical articulated robot.
2)	□□	Indicates the maximum payload. Example) 35: 35kg 50: 50kg 80: 80kg
3)	FR	Indicates that the robot is part of the FR series.
4)	○	Indicates the environment specifications or protection specifications. Example) Omitted: Normal environments specifications (Robot: equivalent to IP65, wrist: equivalent to IP67) M: Oil mist specifications (equivalent to IP67)
5)	●	Indicates the controller type. Example) D: Standalone R: MELSEC iQ-R compatible Q: MELSEC-Q compatible

Combination of the robot arm and the controller

Standalone type

Robot arm		Controller
Model[*1]	Environment specifications	
RV-□□FR-D	Standard specifications	CR860-□□VD
RV-□□FRM-D	Protection specifications[*2]	

*1   The "□□" indicates the payload. 35kg: "35", 50kg: "50", 80kg: "80" (Also, "□□" of the controller model name is 35, 50, or 80.)
*2   The protection specifications of this robot arm are equivalent to IP67. The protection specifications of all the controllers are equivalent to IP54 (closed type).

MELSEC iQ-R compatible type

Robot arm		Controller
Model[*1]	Environment specifications	
RV-□□FR-R	Standard specifications	CR860-□□VR
RV-□□FRM-R	Protection specifications[*2]	

*1   The "□□" indicates the payload. 35kg: "35", 50kg: "50", 80kg: "80" (Also, "□□" of the controller model name is 35, 50, or 80.)
*2   The protection specifications of this robot arm are equivalent to IP67. The protection specifications of all the controllers are equivalent to IP54 (closed type).

MELSEC-Q compatible type

Robot arm		Controller
Model[*1]	Environment specifications	
RV-□□FR-Q	Standard specifications	CR860-□□VQ
RV-□□FRM-Q	Protection specifications[*2]	

*1   The "□□" indicates the payload. 35kg: "35", 50kg: "50", 80kg: "80" (Also, "□□" of the controller model name is 35, 50, or 80.)
*2   The protection specifications of this robot arm are equivalent to IP67. The protection specifications of all the controllers are equivalent to IP54 (closed type).

1.3 Description of equipment

Robot arm

The devices shown below can be installed on the robot arm.

6-axis vertical articulated robot

3-piece machine cable set
(power supply and signal cables)[1]
Fixed type: 7m

Machine cable extension (replacement)
　Fixed type: 1F-□□UCBL-44[2]
　Flexible type: 1F-□□LUCBL-44[2]

Hand output cable
・1F-GR2000S-44 (standard 8 points)

Operating range change stopper
・1F-DH-44J1

Hand input cable
・1F-HC2000S-44 (standard 12 points)

Brake releasing device[3]
・2F-BRKBOX-1

Hand Ethernet cable
・1F-LAN2000-44

Power cable for the brake[4]
・2F-BRKCBL-1

Standard configuration equipment

Option

Hand made by the customer

Equipment supplied by customer

*1　One set of machine cable consists of three cables.
*2　□□ represents the cable length. For details, refer to the following page:
　　☞ Page 21 Robot options
*3　Connect it to the robot arm using the machine cable (CN2).
*4　Not included in the brake releasing device. Purchase this cable when connecting the brake releasing device to the robot arm without using the machine cable (CN2).

Controller

The devices shown below can be installed on the controller.

The controllers that can be connected differ depending on the specifications of the robot arm.
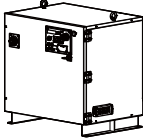
☞ Page 14 Model name of robot

CR860-D controller

| Robot controller CR860-D | Transformer unit 2F-ATBOX | Simple teaching pendant ・R32TB | High-performance teaching pendant ・R86TB |

CC-Link interface
・2D-TZ576

Parallel I/O interface
・2D-TZ368 (sink)
・2D-TZ378 (source)

Parallel I/O unit
・2A-RZ361 (sink)
・2A-RZ371 (source)

Network base card
・EtherNet/IP interface
・PROFINET interface
・CC-Link IE Field interface
・EtherCAT interface

External I/O cable
・2D-CBL05 (5m)
・2D-CBL15 (15m)

External I/O cable
・2A-CBL05 (5m)
・2A-CBL15 (15m)

Programmable controller

External device

Safety option
・4F-SF003-05

Encoder distribution unit
・2F-YZ581

SD memory card
・2F-2GBSD

SD

Computer (incl. connection cable)

RT ToolBox3
・3F-14C-WINE(DVD-ROM)
RT ToolBox3 mini
・3F-15C-WINE(DVD-ROM)
RT ToolBox3 Pro
・3F-16D-WINE(DVD-ROM)

Standard configuration equipment

Option

Instruction Manual (hard copy)
・5F-BT01-PE01

Equipment supplied by customer

CR860-R controller

Robot controller
CR860-R

Transformer unit
2F-ATBOX

Robot CPU module
・R16RTCPU

The following Mitsubishi Electric
MELSEC iQ-R series products are required
to install the robot CPU module.
The customer needs to prepare them.
・ Base unit
・ Power supply module
・ Programmable controller CPU module

Robot CPU module connecting cable
・ SSCNET III cable: MR-J3BUS10M-A
10-m cable to connect the controller and the robot
CPU module.

Robot CPU module connecting cable
・ SSCNET III cable: MR-J3BUS5M-A, 5m
　　　　　　　　 MR-J3BUS20M-A 20m
　　　　　　　　 MR-J3BUS30M-A 30m

Simple teaching pendant
・R32TB

High-performance teaching
pendant
・R86TB

Safety option
・4F-SF003-05

Encoder distribution
unit
・2F-YZ581

Computer (incl. connection cable)

RT ToolBox3
・3F-14C-WINE(DVD-ROM)
RT ToolBox3 mini
・3F-15C-WINE(DVD-ROM)
RT ToolBox3 Pro
・3F-16D-WINE(DVD-ROM)

Instruction Manual (hard copy)
・5F-BT01-PE01

Standard configuration
equipment

Special specifications

Option

Equipment supplied
by customer

- Base unit

Model	Remarks
R35B	For mounting MELSEC iQ-R series modules with 5 slots
R38B	For mounting MELSEC iQ-R series modules with 8 slots
R312B	For mounting MELSEC iQ-R series modules with 12 slots

- Power supply module

Model	Remarks
R61P	AC power supply module. Input: 100 to 240V AC, output: 5V DC/6.5A
R62P	AC power supply module. Input: 100 to 240V AC, output: 5V DC/3.5A, 24V DC/0.6A
R63P	DC power supply module. Input: 24V DC, output: 5V DC/6.5A
R64P	AC power supply module. Input: 100 to 240V AC, output: 5V DC/9A

- Programmable controller CPU module

Model	Remarks
R00CPU	Program capacity: 10K steps, Elementary operation processing speed (LD command): 31.36ns
R01CPU	Program capacity: 15K steps, Elementary operation processing speed (LD command): 31.36ns
R02CPU	Program capacity: 20K steps, Elementary operation processing speed (LD command): 3.92ns
R04CPU	Program capacity: 40K steps, Elementary operation processing speed (LD command): 0.98ns
R08CPU	Program capacity: 80K steps, Elementary operation processing speed (LD command): 0.98ns
R16CPU	Program capacity: 160K steps, Elementary operation processing speed (LD command): 0.98ns
R32CPU	Program capacity: 320K steps, Elementary operation processing speed (LD command): 0.98ns
R120CPU	Program capacity: 1200K steps, Elementary operation processing speed (LD command): 0.98ns

CR860-Q controller

Robot controller CR860-Q

Transformer unit 2F-ATBOX

Robot CPU module
・Q172DSRCPU

The following Mitsubishi Electric MELSEC Q series products are required to install the robot CPU module.
The customer needs to prepare them.
・Base unit
・Power supply module
・Programmable controller CPU module

Robot CPU module connecting cable
・SSCNET III cable: MR-J3BUS10M-A
10-m cable to connect the controller and the robot CPU module.

Robot CPU module connecting cable
・SSCNET III cable: MR-J3BUS5M-A, 5m
                     MR-J3BUS20M-A 20m
                     MR-J3BUS30M-A 30m

Simple teaching pendant
・R32TB

High-performance teaching pendant
・R86TB

Safety option
・4F-SF003-05

Encoder distribution unit
・2F-YZ581

Computer (incl. connection cable)

RT ToolBox3
・3F-14C-WINE(DVD-ROM)
RT ToolBox3 mini
・3F-15C-WINE(DVD-ROM)
RT ToolBox3 Pro
・3F-16D-WINE(DVD-ROM)

Instruction Manual (hard copy)
・5F-BT01-PE01

	Standard configuration equipment
	Special specifications
	Option
	Equipment supplied by customer

• Base unit

Model	Remarks
Q35B	For mounting MELSEC Q series modules with 5 slots
Q38B	For mounting MELSEC Q series modules with 8 slots
Q312DB	For mounting MELSEC Q series modules with 12 slots

• Power supply module

Model	Remarks
Q61P	AC power supply module. Input: 100 to 240V AC, output: 5V DC/6A
Q62P	AC power supply module. Input: 100 to 240V AC, output: 5V DC/3A, 24V DC/0.6A
Q63P	DC power supply module. Input: 24V DC, output: 5V DC/3A, 5V DC/6A
Q64PN	AC power supply module. Input: 100 to 240V AC/200 to 240V AC, output: 5V DC/8.5A

• Programmable controller CPU module

Model	Remarks
Q03UDCPU	Program capacity: 30K steps, Elementary operation processing speed (LD command): 20ns
Q03UDECPU	Program capacity: 30K steps, Elementary operation processing speed (LD command): 20ns
Q04UDHCPU	Program capacity: 40K steps, Elementary operation processing speed (LD command): 9.5ns
Q04UDEHCPU	Program capacity: 40K steps, Elementary operation processing speed (LD command): 9.5ns
Q06UDHCPU	Program capacity: 60K steps, Elementary operation processing speed (LD command): 9.5ns
Q06UDEHCPU	Program capacity: 60K steps, Elementary operation processing speed (LD command): 9.5ns
Q10UDHCPU	Program capacity: 100K steps, Elementary operation processing speed (LD command): 9.5ns
Q10UDEHCPU	Program capacity: 100K steps, Elementary operation processing speed (LD command): 9.5ns
Q13UDHCPU	Program capacity: 130K steps, Elementary operation processing speed (LD command): 9.5ns
Q13UDEHCPU	Program capacity: 130K steps, Elementary operation processing speed (LD command): 9.5ns
Q20UDHCPU	Program capacity: 200K steps, Elementary operation processing speed (LD command): 9.5ns
Q20UDEHCPU	Program capacity: 200K steps, Elementary operation processing speed (LD command): 9.5ns
Q26UDHCPU	Program capacity: 260K steps, Elementary operation processing speed (LD command): 9.5ns
Q26UDEHCPU	Program capacity: 260K steps, Elementary operation processing speed (LD command): 9.5ns
Q50UDEHCPU	Program capacity: 500K steps, Elementary operation processing speed (LD command): 9.5ns
Q100UDEHCPU	Program capacity: 1000K steps, Elementary operation processing speed (LD command): 9.5ns
Q03UDVCPU	Program capacity: 30K steps, Elementary operation processing speed (LD command): 1.9ns
Q04UDVCPU	Program capacity: 40K steps, Elementary operation processing speed (LD command): 1.9ns
Q06UDVCPU	Program capacity: 60K steps, Elementary operation processing speed (LD command): 1.9ns
Q13UDVCPU	Program capacity: 130K steps, Elementary operation processing speed (LD command): 1.9ns
Q26UDVCPU	Program capacity: 260K steps, Elementary operation processing speed (LD command): 1.9ns

Function extension device

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

MELFA-3D Vision 3.0
・3F-53U-WINM

1.4 List of options

Robot options

Product name	Model	Specifications	Remarks
Stopper for changing the operating range	1F-DH-44J1	J1 axis + side: +180 degrees, +160 degrees, +140 degrees, +120 degrees, +100 degrees, +80 degrees, +60 degrees, +40 degrees, +20 degrees - side: -180 degrees, -160 degrees, -140 degrees, -120 degrees, -100 degrees, -80 degrees, -60 degrees, -40 degrees, -20 degrees Two places can be selected from the above. The minimum operating range, however, is 80 degrees. For details, refer to the following manual: 📖Robot Arm Setup and Maintenance (BFP-A3781) Standard specifications are within + 180 degrees to -180 degrees.	The customer should install the optional stopper. A stopper for changing the operating range is mounted to a robot arm at shipment. By using two stoppers (this optional one and the one attached to the robot arm), the operating range can be changed.
Machine cable (replacement)	1F-□□UCBL-44	Fixed type (a set of three cables for power supply and signals)	□□ in model name shows the cable length as follows. 12 = 12m, 17 = 17m, 22 = 22m
	1F-□□LUCBL-44	Flexible type (a set of three cables for power supply and signals)	□□ in model name shows the cable length as follows. 07 = 7m, 12 = 12m, 17 = 17m, 22 = 22m
Hand input cable	1F-HC2000S-44	Robot side: Connector, Hand side: Wire (Input: 12 points, length: 2,000mm)	The customer should connect the cable to the sensor.
Hand output cable	1F-GR2000S-44	Robot side: Connector, Hand side: Wire (Output: 8 points, length: 2,000mm)	
Hand Ethernet cable	1F-LAN2000-44	Robot side: Connector, Hand side: Wire (Total length: 2,000mm)	The customer should use this cable to connect a camera.
Brake releasing device	2F-BRKBOX-1	The brake of one axis (J1 to J6 axes) is released. The brakes of the J2 to J6 axes are intermittently released. Input power specifications: 100 to 240V AC The customer needs to prepare an input power cable. Connect it to the robot arm using the machine cable (CN2). The power cable for the brake can be used for the connection.	The brakes of the robot arm can be released without connecting a controller in emergency.
Power cable for the brake	2F-BRKCBL-1	Cable length: 5m	This cable is used to connect between the brake releasing device and the robot arm and to supply brake power to the robot.

CR860 controller options

Product name	Model	Specifications	Classification [1]		Remarks
			D	R/Q	
Simple teaching pendant	R32TB	Cable length: 7m	○	○	With 3-position enable switch, IP65
	R32TB-15	Cable length: 15m	○	○	
High-performance teaching pendant	R86TB	Cable length: 7m	○	○	
Parallel I/O interface	2D-TZ368 (sink type)/2D-TZ378 (source type)	Input: 32 points, output: 32 points Insulated output signal (Output signal: 0.1A/24V/point) Insulated input signal (Input signal: 9mA/24V/point)	○	—	Used to expand the external I/O points.
External I/O cable (For the parallel I/O interface)	2D-CBL05	5m	○	—	Used to connect the external I/O interface to the peripheral.
	2D-CBL15	15m	○	—	
Parallel I/O unit	2A-RZ361 (sink type)/2A-RZ371 (source type)	Input: 32 points, output: 32 points Insulated output signal (Output signal: 0.1A/24V/point) Insulated input signal (Input signal: 7mA/24V/point)	○	—	Used to expand the external I/O. Attached to the outside of the controller.

Product name	Model	Specifications	Classification [1]		Remarks
			D	R/Q	
External I/O cable (For the parallel I/O unit)	2A-CBL05	5m	○	—	Used to connect between the external I/O unit and the peripheral.
	2A-CBL15	15m	○	—	
CC-Link interface	2D-TZ576	Only supported with intelligent device stations and local stations	○	—	Used to connect a MELSEC programmable controller via CC-Link.
Network base card (EtherNet/IP interface)	2D-TZ535	HMS Anybus CompactCom Module-connecting communication interface. The customer should supply an HMS EtherNet/IP module (AB6314).	○	—	For details, refer to the following manual: ⊞Network Base Card Instruction Manual
Network base card (PROFINET interface)	2D-TZ535-PN	HMS Anybus CompactCom Module-connecting communication interface. HMS PROFINET IO module (AB6489-B) to be supplied by customer.	○	—	For details, refer to the following manual: ⊞Network Base Card Instruction Manual
Network base card (CC-Link IE Field interface)	2F-DQ535	HMS Anybus CompactCom Module-connecting communication interface. HMS CC-Link IE Field module (AB6709) to be supplied by customer.	○	—	For details, refer to the following manual: ⊞Network Base Card Instruction Manual
Network base card (EtherCAT interface)	2F-DQ535-EC	HMS Anybus CompactCom Module-connecting communication interface. HMS EtherCAT module (AB6707) to be supplied by customer.	○	—	For details, refer to the following manual: ⊞Network Base Card Instruction Manual
SD memory card	2F-2GBSD	Capacity: 2GB	○	—	—
Safety option	4F-SF003-05	Item to support the safety I/O.	○	○	For details, refer to the following manual: ⊞Robot Safety Option Instruction Manual
Transformer unit	2F-ATBOX	A step-down transformer for using a controller with 400V power supply.	○	○	For details, refer to the following page: ☞ Page 106 Transformer unit
Encoder distribution unit	2F-YZ581	A unit to connect a rotary encoder to multiple controllers when the tracking function is used.	○	○	For details, refer to the following page: ☞ Page 111 Encoder distribution unit
RT ToolBox3	3F-14C-WINE	DVD-ROM	○	○	Windows 10, Windows 11 Supporting English.
RT ToolBox3 mini	3F-15C-WINE	DVD-ROM	○	○	Windows 10, Windows 11 Supporting English.
RT ToolBox3 Pro	3F-16D-WINE	DVD-ROM	○	○	Windows 10, Windows 11 Supporting English.
Robot CPU module connecting cable	MR-J3BUS□□MA	Cable length: 5 or 20m	—	□	Used for servo communication between a robot CPU module and a controller.
	MR-J3BUS30M-B	Cable length: 30m	—	□	
Instruction Manual (hard copy)	5F-BT01-PE01	Set for the RV-35FR/50FR/80FR series	○	○	—

*1 In the classifications, ○indicates an option and □ indicates the special specifications at shipment.
   D indicates the standalone type. R/Q indicates the MELSEC iQ-R compatible type or the MELSEC-Q compatible type.

Function extension device

Product name	Model	Specifications	Classification [1]		Remarks
			D	R/Q	
MELFA-3D Vision 3.0	3F-53U-WINM	Software that connects a compact 3D vision sensor for robots to measure and recognize parts.	○	○	For details, refer to the following manual: ⊞MELFA-3D Vision 3.0 Instruction Manual

*1 In the classification, ○indicates that the product is optional.
   D indicates the standalone type. R/Q indicates the MELSEC iQ-R compatible type or the MELSEC-Q compatible type.

Communication cable

⚠ CAUTION

- Do not apply the static electricity or the noise to the USB cable. Failure to do so may result in malfunction.
- Connecting the USB port on the front of the robot controller to commercially available devices such as computers, USB hubs, and LAN hubs may not be compatible with our equipment or the temperature and electrical noise of some FA environments. If using commercially available devices, check the operation carefully to determine if protection against EMI or the addition of a ferrite core is required. We cannot guarantee the operation of the product and perform maintenance if the product is connected to commercial devices.

USB cable

The following table lists recommended USB cables.

Product name	Model	Supplier	Outside dimensions
USB cable (USB Type-A to Mini USB Type-B)	GT09-C30USB-5P	Mitsubishi Electric	☞ Page 23 USB cable (GT09-C30USB-5P)
	MR-J3USBCBL3M	Mitsubishi Electric	☞ Page 23 USB cable (MR-J3USBCBL3M)

■USB cable (GT09-C30USB-5P)

Cable
Approx. φ4.2
Outer sheath color: Black

Ferrite core φ19.5×35
Shrink tube color: Red

Unit [mm]
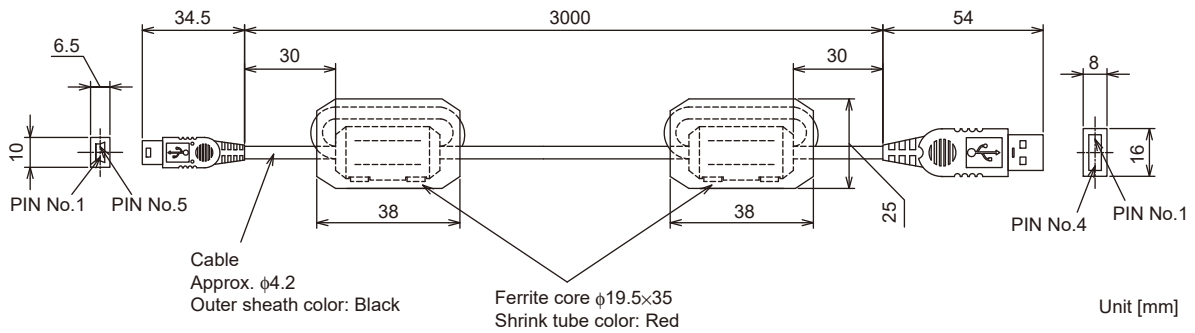
■USB cable (MR-J3USBCBL3M)

Unit [mm]
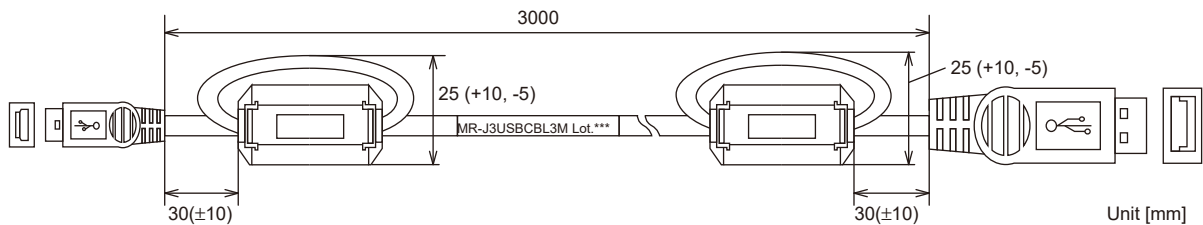
LAN cable (IP54-rated)

Using the following connector can meet the requirements of IP54 while the LAN cable is being connected to the LAN port on the front of the controller. The customer needs to fabricate a LAN cable with the following connector.

Manufacturer: PHOENIX CONTACT
Model name: 1656990
Product name: VS-08-RJ45-5-Q/IP67

2 ROBOT ARM

2.1 Standard specifications

Basic specifications

Item		Unit	Specifications		
			RV-35FR	**RV-50FR**	**RV-80FR**
Environment specifications		—	Omitted: Normal environment specifications, M: Oil mist specifications [*1]		
Degrees of freedom		—	6		
Installation type		—	Floor mounted		
Structure		—	Vertical articulated robot		
Drive system		—	AC servo motor (brake provided on all axes)		
Position detection method		—	Absolute encoder		
Motor capacity	Waist (J1)	W	5000		
	Shoulder (J2)		5000		
	Elbow (J3)		2000		
	Wrist twist (J4)		675		
	Wrist pitch (J5)		675		
	Wrist roll (J6)		675		
Operating range	Waist (J1)	Degree	±180		
	Shoulder (J2)		-105 to 140		
	Elbow (J3)		-135 to 155		
	Wrist twist (J4)		±360		
	Wrist pitch (J5)		±145		
	Wrist roll (J6)		±450		
Maximum speed [*2]	Waist (J1)	Degree/s	180		
	Shoulder (J2)		180		
	Elbow (J3)		185		160
	Wrist twist (J4)		260		185
	Wrist pitch (J5)		260		165
	Wrist roll (J6)		360		280
Maximum reach radius (P point)		mm	2100		
Maximum resultant velocity [*3]		mm/sec	13400		12700
Workpiece mass		kg	35	50	80
Position repeatability [*4]		mm	±0.06		
Ambient temperature [*5]		℃	0 to 45		
Robot weight		kg	560		
Permissible moment	Wrist twist (J4)	N·m	210		336
	Wrist pitch (J5)		210		336
	Wrist roll (J6)		130		194
Permissible inertia	Wrist twist (J4)	kg·m^2	19.6	28	34
	Wrist pitch (J5)		19.6	28	34
	Wrist roll (J6)		7.7	11	13.7
Tool wiring	Hand I/O	—	12 points/8 points		
	LAN cable	—	Equipped (8 cores, Category 5e-compliant)		
	Wiring for user	—	—		
Tool air pipe	Primary piping	—	φ10 × 2		
	Secondary piping	—	—		
Supply pressure		MPa	0.588 max.		
Protection specifications [*6]	Robot arm	—	Normal environments: Equivalent to IP65, Oil mist specifications: Equivalent to IP67 [*7]		
	Wrist	—	Equivalent to IP67		

Item	Unit	Specifications		
		RV-35FR	**RV-50FR**	**RV-80FR**
Noise level [8]	dB(A)	80 or less		
Painting color	—	Off-white (Equivalent to Munsell: 10GY9/1)		

*1　For how to distinguish model names between normal environments and oil mist specifications, refer to the following page:
☞ Page 14 How to identify the robot model

*2　Values in the table indicate the maximum speed, and the actual speed of each axis varies depending on factors such as the posture, load, and the amount of movement.

*3　This is the value at the center point of the mechanical interface when all axes are combined. The value is a theoretical value calculated from the maximum speed of each joint.

*4　For details on the position repeatability, refer to the following page:
☞ Page 26 Position repeatability

*5　Set the temperature of the environment in which the robot is used for the parameter OLTMX. Corresponding to the environment, the continuous control action performance and the overload protection function are optimized. For details, refer to the following manual:
📖 Detailed explanations of functions and operations (BFP-A3478)

*6　For details on the protection specifications, refer to the following page:
☞ Page 30 Protection specifications and applicable fields

*7　The protection performance cannot be ensured with some oil due to its characteristics. Please contact the dealer.

*8　This value is measured at a point 3.1m from the center of the J1 axis during automatic operation under the rated load. The noise level differs depending on the robot's operating posture and conditions.

The counter-force applied to the base of the robot

The counter-force applied to the base of the robot is shown below for reference of the strength design.
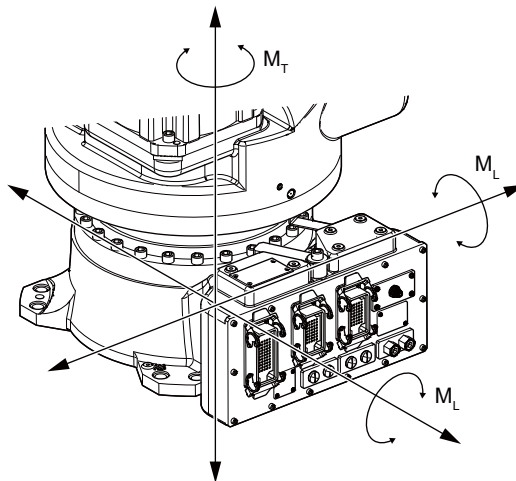
Model	Overturning moment: M_L (N·m)	Torsional moment: M_T (N·m)
RV-35FR/50FR/80FR	15,937	12,101

2.2 Definition of specifications

This section details the specifications listed in catalogs and manuals.

Position 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 "position repeatability" is not guaranteed to be satisfied under the following conditions.

Factor	Description
Operation pattern	When an operation that approaches from different directions and orientations is included in relation to the teaching position during repeated operations
	When the speed at teaching and the speed at execution are different
Load fluctuation	When work is present/absent in repeated operations
Disturbance during operation	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
Temperature	When the environmental temperature changes (Due to motions of the robot arm and timing belt, position accuracy may be decreased.)
	When accuracy is required before and after a warm-up operation
Differences in accuracy definition	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
	When accuracy is required between a position generated by the pallet function and a position within the actual space

Rated load (payload)

⚠ CAUTION

- The payload is greatly influenced by the operating speed of the robot arm and the motion posture. Even if the setting values are within the allowable range mentioned previously, an overload or an overcurrent alarm could occur. In such cases, change the time setting for acceleration/deceleration, the operating speed, and the motion posture.
- 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 reduction gear. 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. 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 be reduced, resulting in vibration.
- Even within the allowable range previously mentioned, an overload alarm may occur if an ascending operation continues at a micro-low speed. In such a case, it is necessary to increase the ascending speed.

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

- The tooling should have the value less than or equal to the allowable inertia and the allowable moment in the following section.

☞ Page 24 Basic specifications

- For the calculation methods of inertia, refer to the following page:

☞ Page 162 Inertia calculation method

- The following section shows the distribution dimensions for the center of gravity in the case where the volume of the load is relatively small. Use the figures as a reference when designing the tooling.

☞ Page 27 Load center of gravity

- Even if the load is force, not the mass, design the tooling so that the moment does not exceed the allowable moment in the following section.

☞ Page 24 Standard specifications

Load center of gravity

- RV-35FR (for the loads with comparatively small volume)

Unit: mm

620 *1
600
530
20kg
500
25kg
400
379
35kg
300
200
J5 axis center of rotation
100
158

990   857   612

1000 900 800 700 600 500 400 300 200 100 0

J6 axis center of rotation

165
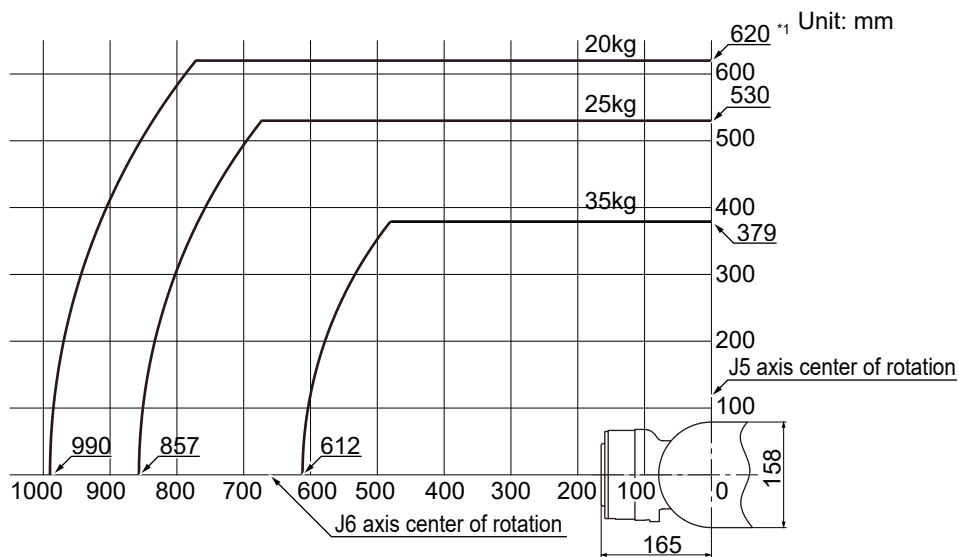
*1   The range for the mass of 20kg is specified so that it does not exceed the permissible inertia.

- RV-50FR (for the loads with comparatively small volume)

Unit: mm

600
500
442
30kg
400
331
40kg
300
265
50kg
200
J5 axis center of rotation
100
158

714   535   428

1000 900 800 700 600 500 400 300 200 100 0

J6 axis center of rotation

165

- RV-80FR (for the loads with comparatively small volume)

Unit: mm

600
500
400
329
60kg
300
70kg
282
247
80kg
200
J5 axis center of rotation
100
158

571   489   428

1000 900 800 700 600 500 400 300 200 100 0

J6 axis center of rotation

165
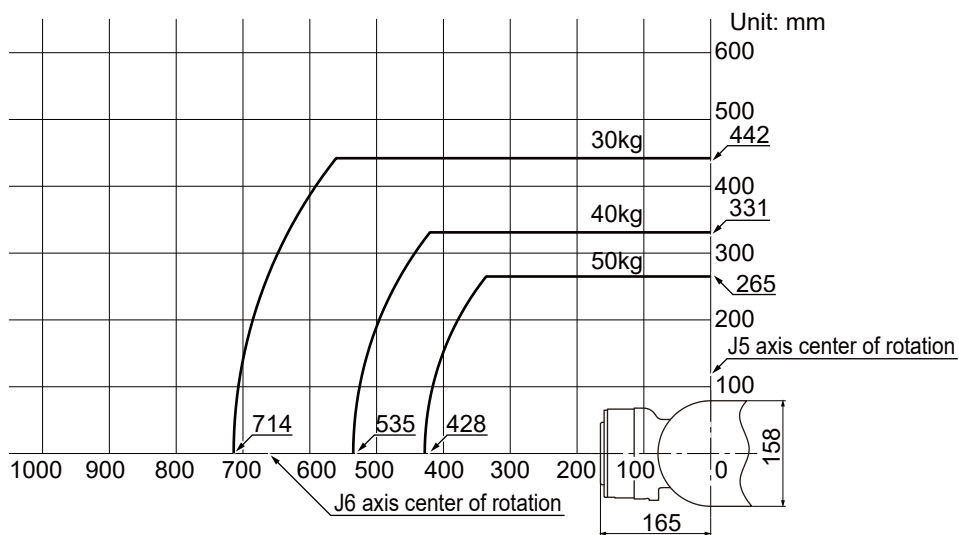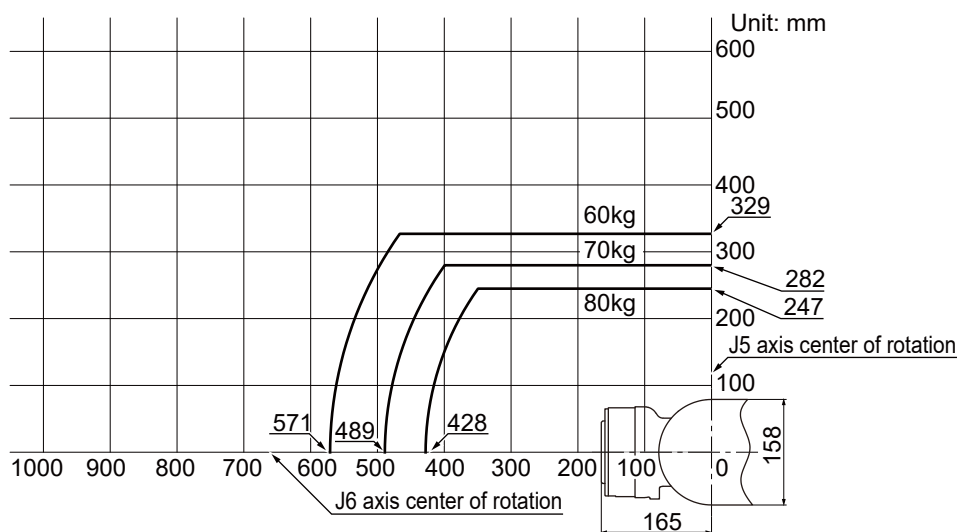
Relationships among the payload, speed, and acceleration/deceleration speed

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, correctly set the actual load data (mass and size of hand and workpiece) to be used. However, vibration, overheating, or errors such as excessive margin and overload may occur, depending on the robot operation pattern or ambient temperature. In such a case, change the setting value to the +20% range. If the values that fall below the mounted load have been set, the life span of the mechanism elements used in the robot may be shortened.

Setting load capacity and size (hand conditions)

Optimum acceleration/deceleration setting parameter: Set up the capacity and size of the hand with the "HNDDAT*" parameter, and set up the capacity and size of the workpiece 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 following manual:

📖Detailed explanations of functions and operations (BFP-A3478)

The robot operates with "LoadSet 0,0" if no "LoadSet" command is specified in the JOG operation or programs.

Default setting value

Series	Parameter name	Hand weight (kg)	Size (mm)			Center-of-gravity position (mm)		
			X	Y	Z	X	Y	Z
RV-35FR	HNDDAT0	35	200.0	200.0	250.0	0.0	0.0	230.0
	WRKDAT*	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RV-50FR	HNDDAT0	50	220.0	220.0	260.0	0.0	0.0	250.0
	WRKDAT*	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RV-80FR	HNDDAT0	80	230.0	230.0	350.0	0.0	0.0	310.0
	WRKDAT*	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Vibrations at the tip of the robot arm during low-speed operation

Vibrations at the tip of the robot arm may increase substantially during the low-speed operation 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 can be reduced by taking the following measures:

- Lower the operating speed of the robot by approximately 5% using the Ovrd command.
- Change and move the teaching points of the robot.
- Change the hand mass and hand inertia.

Shut-down of the controller while the robot arm is operating

⚠ CAUTION

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 reduction gear may be damaged, backlash may occur, and the program data may get corrupted.

If the power supply of the controller is shut down while the robot arm is operating, or if the robot arm stops urgently due to an error related to the servo, such as overload to servo amplifier, excessive margin, or collision detection, each axis position of the robot arm may shift slightly. In this case, check whether the robot arm position is correct. If the position is incorrect, set it to the correct position and then start the automatic operation. If the robot arm position shifts frequently, please contact your dealer.

Grease leakage during robot operation

Grease is used in the reduction gears of each axis of the product. Although the grease does not leak from the product structurally, some grease may leak due to initial oozing or long-time use. To prevent grease from adhering to your workpieces and peripheral equipment, check for grease leakage as described in the following manual daily. If grease is leaking, wipe it off.
Robot Arm Setup and Maintenance (BFP-A3781)

Collision detection function

This series of robots has the "Collision detection function", which detects torque differences caused by collisions with the robot arm. This function is set to "disabled" from the factory. This function can be enabled/disabled with the COL parameter or ColChk command. Enable this function to protect the robot and peripheral devices.

The abnormalities are detected using the robot's kinetics model by presuming torque necessary for movement at any time. Therefore, the setting parameter (HNDDAT*, WRKDAT*) of the hand and the workpiece 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 operation under the low temperature or after long term stop)

To use the collision detection with the optimum sensitivity, adjust the setting parameters (COLLVL, COLLVLJG) for the collision detection level according to the actual usage environment.

And, in the operation under the low temperature or after the long term stop, operate the robot by accustoming at low speed (warm-up) or in the warm-up operation mode.

For details of related parameter, refer to the following manual:

Detailed explanations of functions and operations (BFP-A3478)

The following table shows the settings of collision detection function at shipment.

Series	In JOG operation	In automatic operation
RV-35FR/50FR/80FR	Disabled	Disabled

Protection specifications and applicable fields

Protection specifications

The robot arm has protection specifications that comply with the IEC Standards. The protection specifications and applicable fields are shown below.

Model	Protection specifications (IEC Standards)	Classification	Applicable field	Remarks
RV-35FR, RV-50FR, RV-80FR	Equivalent to IP65 (Wrist: Equivalent to IP67)	Normal environments	General assembly. Slightly dusty environment.	—
RV-35FRM, RV-50FRM, RV-80FRM	Equivalent to IP67	Oil mist specifications	Machine tool (cutting). Machine shop with heavy oil mist. Dusty work site.	Note that if the cutting machine is using abrasive materials, the service life of the robot will be shortened.

The IP numbers stated in IEC ratings indicate the ingress protection level against solid objects and water. They do not indicate that the product's enclosure protects against oil. A definition of the IEC rating is below. Certain liquids may cause the robot to rust or corrode.

■IEC IP65

 • Degree of protection against solids

It indicates the protective enclosure designed to prevent dust from entering inside.

 • Degree of protection against water

It indicates the protective enclosure designed to prevent any harmful effects by jet water from the nozzle (inner diameter: 6.3mm) in any direction from a distance of 2.5 to 3m with 12.5 +/- 0.625 liters of water every minute for 3 minutes or more.

■IEC IP67

 • Degree of protection against solids

It indicates the protective enclosure designed to prevent dust from entering inside.

 • Degree of protection against water

It indicates the protective enclosure that is not harmfully affected even if the device dives underwater for the 30 minutes. The diving depth is shown below. When the height of the device is less than 850mm, the position of the lowest part is 1m from the water surface. When the height of the device is 850mm or more, the position of the highest part is 150mm from the water surface.

About the use with the bad environment

 • The robot arm is designed for use in combination with machining device.
 • If cutting oil that attacks sealing materials (CR, NBR, fluorine, or polyethylene foam) is used, the oil may enter inside the robot arm and lead to failure. When using such oil, take measures to prevent the robot arm from being directly exposed to oil. Alternatively, consider changing to the appropriate oil.
 • Take measures so that the robot will not be exposed to water, oil and/or chips for a long period of time. Also, water droplets lead to the formation of rust on the robot, but would not usually affect the robot's ability to operate normally. The warranty is invalid for any faults that occur when the robot is used under the following conditions. Also, if the cover and/or other parts are damaged by interferences caused by the peripherals and the robot, the protection specifications (seal performance, etc.) may be degraded. Therefore, pay extra attention when handling the robot arm. Also, refer to the following page:

 • In surroundings that generate inflammable gases or corrosive gases.
 • Atmosphere of the mist containing polish liquid, etc.
 • Atmosphere in which the water, the oil, and the dust exceeding protection specification fall on the robot arm directly.

2.3 Part names

Elbow

J4 axis
+

No. 2 arm

J5 axis

Wrist

J3 axis
−
+

Mechanical interface
(flange surface for hand installation)

+

J6 axis
−

No. 1 arm

J2 axis
−
+

Shoulder

−

J1 axis

+

Base
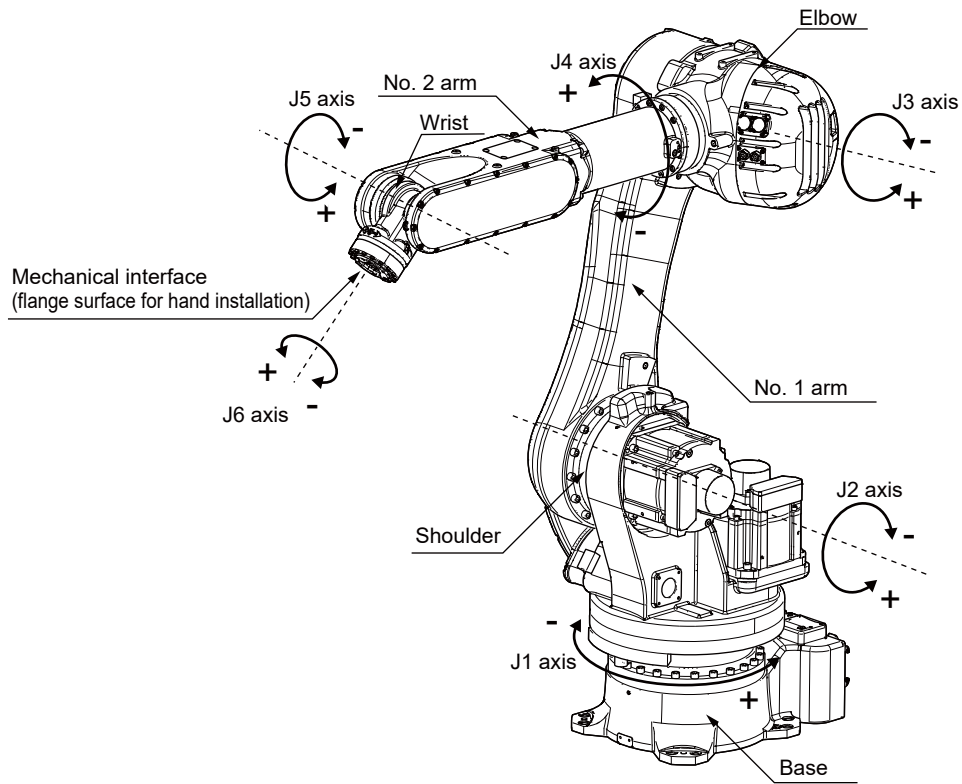
2.4 Outside dimensions and operating range diagrams

Outside dimensions of robot arm

> **⚠ CAUTION**
>
> Do not locate the robot arm in direct sunlight or places affected by the heat from lighting. The surface temperature of the robot arm may increase, causing an error.

Mechanical interface dimensions (View A)

Bottom view B
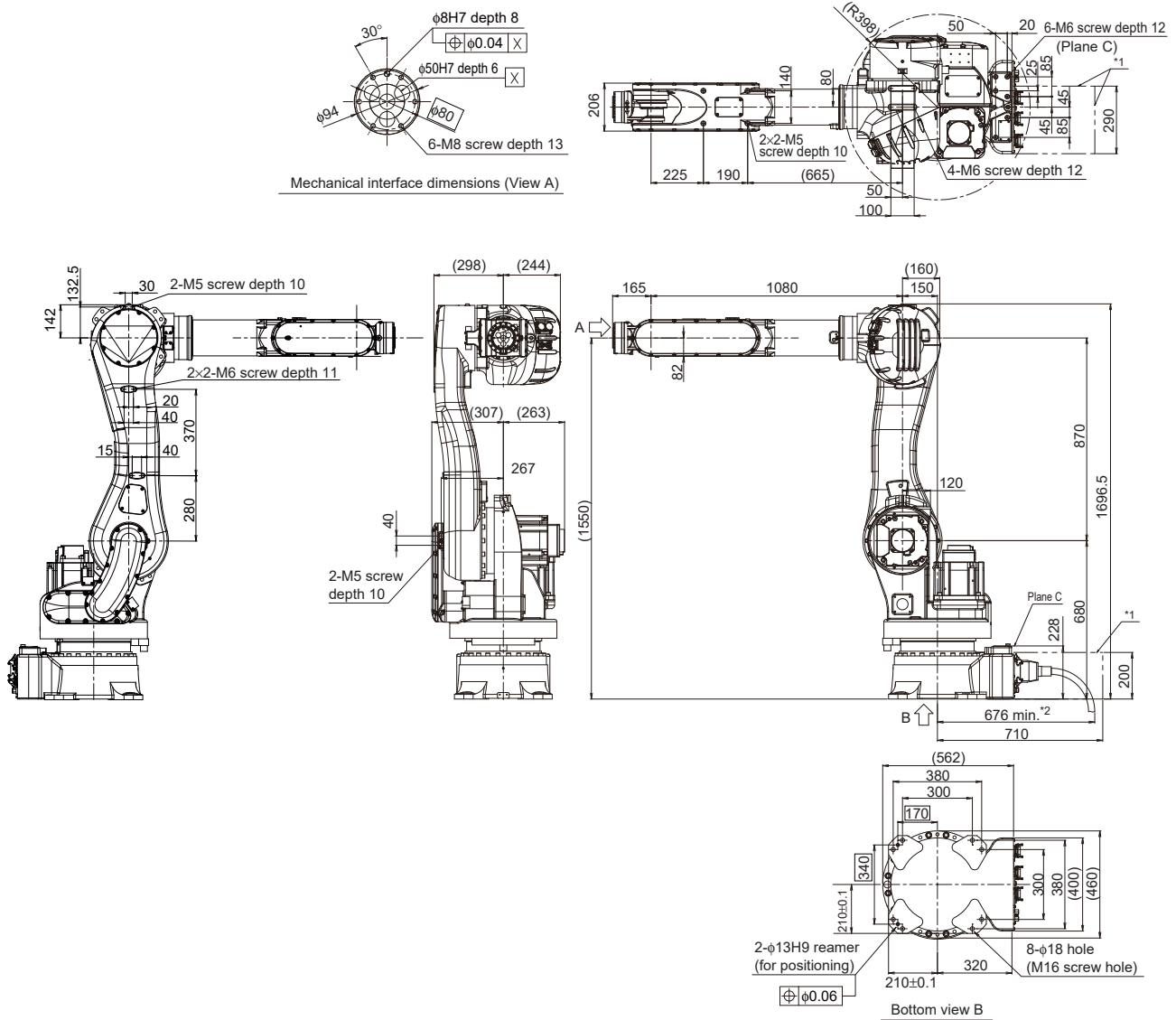
*1 Provide enough space to connect the machine cable and to perform maintenance.
*2 Dimensions including the minimum bending radius for the machine cable

Operating range diagram

The side view figure shows the robot posture when its axes are at the following degrees:
J1 = 0 degrees, J2 = 0 degrees, J3 = 90 degrees, J4 = 0 degrees, J5 = 0 degrees, J6 = 0 degrees

Upper view

Side view

Operating range for each axis:
J1: ±180°
J2: -105 to 140°
J3: -135 to 155°
J4: ±360°
J5: ±145°
J6: ±450°
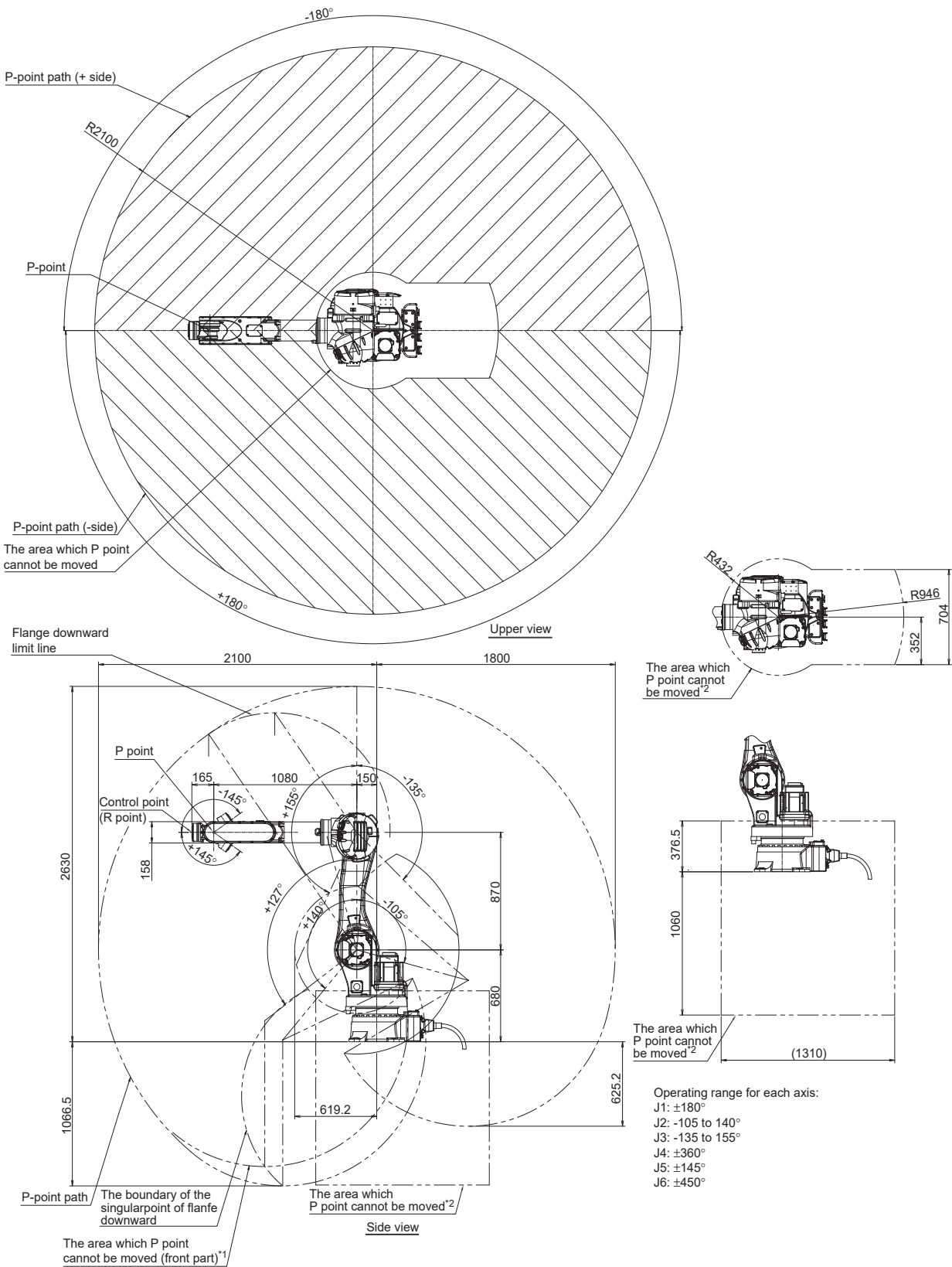
*1 Limits of the front operating range: If the angle of J1 is +137 degrees ≤ J1 or J1 ≤ -137 degrees, then J2 is limited to J2 ≤ +127 degrees.
*2 Area which P point cannot be moved: P point cannot move to the area shown in the diagram.
   This limitation can be released by parameter MELTEXS. This limitation is valid at factory shipping.

Outside dimensions of machine cables

⚠ CAUTION

To extend the machine cable, refer to the following page for the diameter of cable.

☞ Page 44 Machine cable (replacement)

Machine cable (CN1)

[Controller side]　　[Robot side]

Approx. 43　　Approx. 135　　Approx. 130　　Approx. 43

Approx. φ100

Approx. 94

Approx. φ27

Approx. 94

Approx. φ100

Weight: 9.9kg
Minimum bending radius: 160mm

Cable

R

Machine cable (CN2)

[Controller side]　　[Robot side]

Approx. 45　　Approx. 121　　Approx. 124　　Approx. 45

Approx. φ80

Approx. 73

Approx. φ16

Approx. 73

Approx. φ80

Weight: 4.0kg
Minimum bending radius: 98mm

Cable

R

Machine cable (CN3)

[Controller side]　　[Robot side]

Approx. 45　　Approx. 121　　Approx. 124　　Approx. 45

Approx. φ80

Approx. 73

Approx. φ16

Approx. 73

Approx. φ80

Weight: 3.1kg
Minimum bending radius: 95mm

Cable

R

2.5   End-of-arm tooling

Wiring and piping of hands

Shows the wiring and piping configuration for a hand.
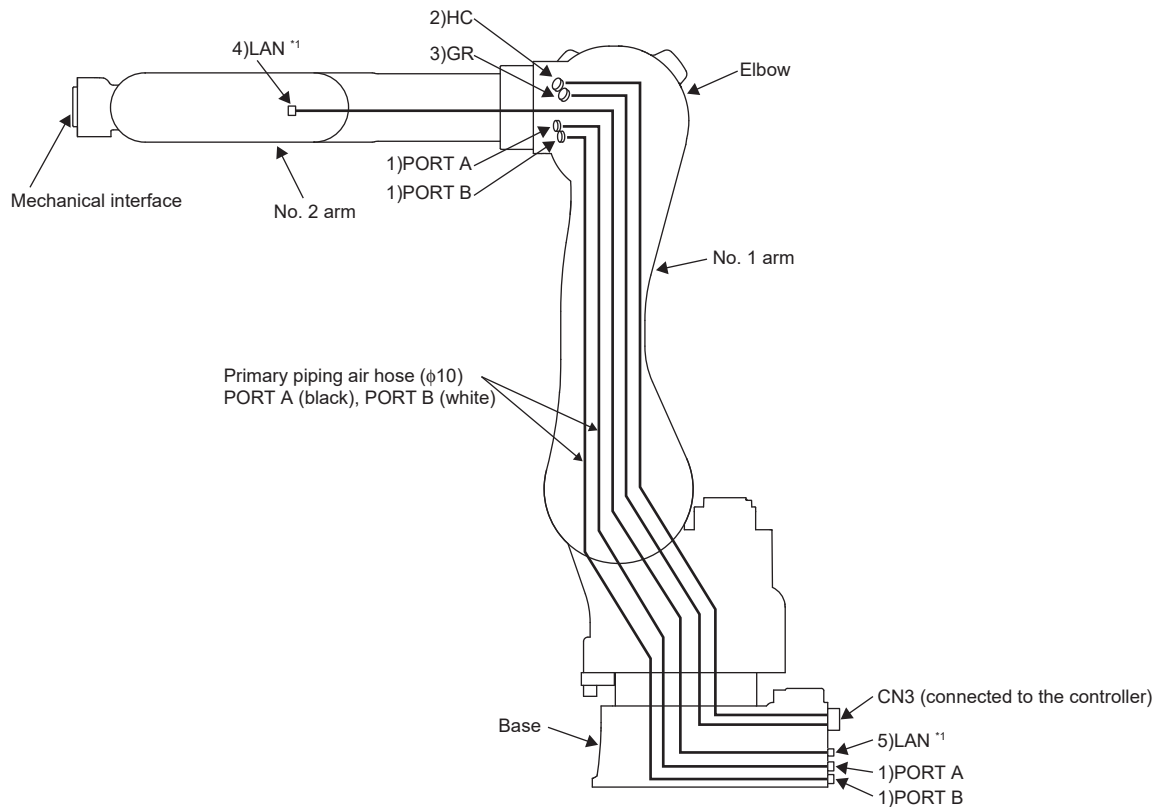
*1   LAN: Connector for Ethernet options
    For details, refer to the following page:
    ☞ Page 37 Wiring and piping system diagram for hand

No.	Item	Quantity	Robot side (robot arm accessory)		Opposite side (supplied by customer)		Manufacturer
			Connector/ coupling	Connector pin	Connector	Connector pin	
1)	Coupling	4	KQ2E10-03A	—	KQ2H10-03AS	—	SMC
2)	Connector (HC)	1	RT0W01419SN	SS24W2F	RT0W61419PNH	SP24W2F	Amphenol
3)	Connector (GR)	1	RT0W01419SW	SS24W2F	RT0W61419PWH	SP24W2F	
4)	Connector (LAN)	1	T4110002081-000	—	T4113002081-000	—	Tyco Electronics Japan G.K. (TE connectivity)
5)	Connector (LAN)	1	T4130012081-000	—	T4110002081-000	—	

Internal pneumatic plumbing

Primary plumbing consists of two φ10 air hoses that run internally from the air inlet port at the base of the robot to the elbow.
Each of the base side and elbow side has two bulkhead female unions (Rc3/8).
Unplug the R3/8 plug and connect couplings such as R3/8 screws.

Internal wiring of the hand output cables

The hand output cables are wired on the elbow cover and connected to the connector. The name of the connector is "GR".
A separate cable is required to connect to the hand. Or an optional hand output cable (1F-GR2000S-44) is required.

Internal wiring of the hand input cables

The hand input cables are wired on the elbow cover and connected to the connector. The name of the connector is "HC".
A separate cable is required to connect to the hand. Or an optional hand input cable (1F-HC2000S-44) is required.

Ethernet cable

The Ethernet cable with eight signal wires runs internally between the base and the No. 2 arm. It can also be used as user wiring. PoE (Power over Ethernet) is not supported.

Allowable current: 1A

Allowable voltage: 24V

Item	Specifications
Communication speed	Category 5e-compliant
Size	#26 AWG ($0.13mm^2$) × four (total eight cores)
External diameter of insulator	Approx. 1.02mm

Wiring and piping system diagram for hand

Shows the system configuration of wiring and piping.
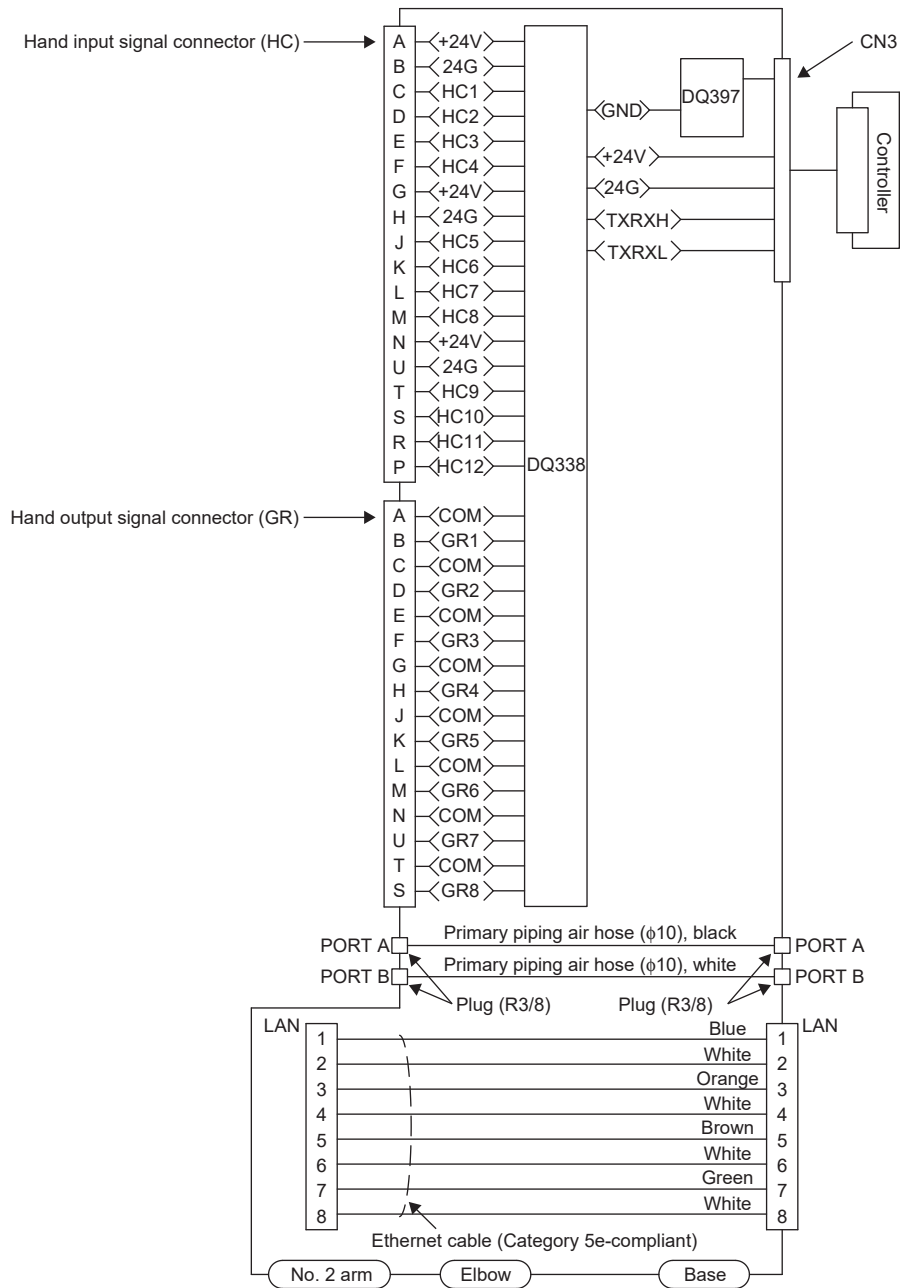
Electrical specifications of hand input/output

Electrical specifications of input circuit

Item		Specifications	Internal circuit
Type		DC input	
Number of input points		12	
Insulation method		Photo-coupler insulation	
Rated voltage		24V DC ±10%	
Rated current		Approx. 7mA	
ON voltage/ON current		19V DC or higher/4mA	
OFF voltage/OFF current		4V DC or lower/1mA	
Input resistance		Approx. 2.8kΩ	
Response time	OFF-ON	10ms or less (24V DC)	
	ON-OFF	10ms or less (24V DC)	
Protects		Protects the overcurrent (0.8A)	

Internal circuit:

Input circuit <Sink type>

+24V Overcurrent protection function

2.8K

820

I_{in_p}

+24V

Approx. 7 mA

HCn*

24G

Input circuit <Source type>

+24V Overcurrent protection function

I_{in_p}

+24V

HCn*

820

Approx. 7 mA

2.8K

24G

* Hand input
HCn = HC1 to HC12

The total current consumption of the hand I/O needs to meet the following conditions:

$I = I_{in} + I_{out} < 0.8$ [A]

I: Total current consumption of hand I/O

I_{in}: Total current consumption of hand input

I_{out}: Total current consumption of hand output

$I_{in} = I_{in\_p} + 7$ [mA] × number of hand inputs to be used

I_{in_p}: Total current consumption of the device connected to the hand input

If the conditions are not met, the protection function shuts off the output. When the conditions are met, automatic restoration will be performed.

Electrical specifications of output circuit

Item		Specifications	Internal circuit
Type		Transistor output	
Number of input points		8	
Insulation method		Digital isolator	
Rated voltage		24V DC ±10%	
Rated current		0.1A/1 point (100%)	
Current leak with power OFF		0.1mA or lower	
Maximum voltage drop with power ON		0.7V (typ.)	
Response time	OFF-ON	2ms or less (hardware response time)	
	ON-OFF	2ms or less (resistance load) (hardware response time)	
Protects		Protects the overcurrent (0.8A)	

The total current consumption of the hand I/O needs to meet the following conditions:

I = Iin + Iout < 0.8 [A]

I: Total current consumption of hand I/O

Iin: Total current consumption of hand input

Iout: Total current consumption of hand output

If the conditions are not met, the protection function shuts off the output. When the conditions are met, automatic restoration will be performed.

Example of current consumption calculation when using the hand I/O

■Sink settings

Hand input circuit

Sensors are connected to HC1 to 4, HC9, and HC10 (six points) with the sink settings.

Hand output circuit

Solenoid valves are connected to GR1 to 3 (three points) with the sink settings.

1	+24V
2	24G
3	HC1
4	HC2
5	HC3
6	HC4
7	+24V
8	24G
10	HC5
11	HC6
12	HC7
13	HC8
14	+24V
15	24G
16	HC9
17	HC10
18	HC11
19	HC12

7 mA → (HC1)
7 mA → (HC2)
7 mA → (HC3)
7 mA → (HC4)
7 mA → (HC9)
7 mA → (HC10)

$I1$ → Sensor 1
$I2$ → Sensor 2
$I3$ → Sensor 3
$I4$ → Sensor 4
$I5$ → Sensor 5
$I6$ → Sensor 6

1	COM(+24V)
2	GR1
3	COM(+24V)
4	GR2
5	COM(+24V)
6	GR3
7	COM(+24V)
8	GR4
9	COM(+24V)
10	GR5
11	COM(+24V)
12	GR6
13	COM(+24V)
14	GR7
15	COM(+24V)
16	GR8

$I1\_o$ → Solenoid valve 1
$I2\_o$ → Solenoid valve 2
$I3\_o$ → Solenoid valve 3

$Iin\_p = I1 + I2 + I3 + I4 + I5 + I6$

$Iin = Iin\_p + 7\ [mA] \times 6$

$Iout = I1\_o + I2\_o + I3\_o$

$I = Iin + Iout$

Ensure that the following relationship is met: $I < 0.8\ [A]$

■Source settings

Hand input circuit

Sensors are connected to HC1 to 4, HC9, and HC10 (six points) with the source settings.

Hand output circuit

Solenoid valves are connected to GR1 to 3 (three points) with the source settings.

Hand input circuit:

1	+24V
2	24G
3	HC1
4	HC2
5	HC3
6	HC4
7	+24V
8	24G
10	HC5
11	HC6
12	HC7
13	HC8
14	+24V
15	24G
16	HC9
17	HC10
18	HC11
19	HC12

Sensor 1, Sensor 2, Sensor 3, Sensor 4, Sensor 5, Sensor 6 connected via I1–I6, each 7 mA.

Hand output circuit:

1	COM(24G)
2	GR1
3	COM(24G)
4	GR2
5	COM(24G)
6	GR3
7	COM(24G)
8	GR4
9	COM(24G)
10	GR5
11	COM(24G)
12	GR6
13	COM(24G)
14	GR7
15	COM(24G)
16	GR8
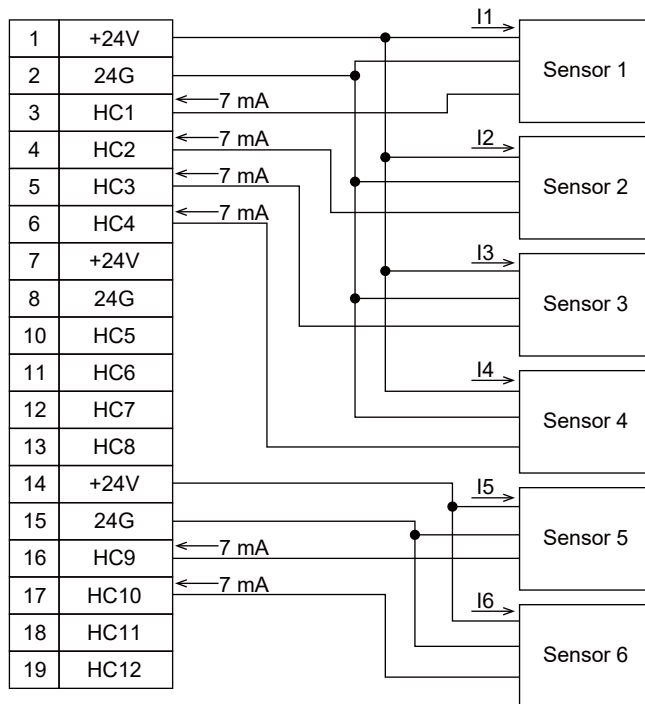
Solenoid valve 1 (I1_o), Solenoid valve 2 (I2_o), Solenoid valve 3 (I3_o).

$Iin\_p = I1 + I2 + I3 + I4 + I5 + I6$

$Iin = Iin\_p + 7 \ [mA] \times 6$

$Iout = I1\_o + I2\_o + I3\_o$

$I = Iin + Iout$

Ensure that the following relationship is met: $I < 0.8 \ [A]$

I/O connector for hand

■Pin assignment of hand input cable

Connect the hand input cable to HC.

Cable color	Pin No.	Name	Remarks
Blue	A	+24 V	Twisted pair
White	B	24G	
Yellow	C	HC1	Twisted pair
White	D	HC2	
Red	E	HC3	Twisted pair
White	F	HC4	
Green	G	+24 V	Twisted pair
White	H	24G	
Purple	J	HC5	Twisted pair
White	K	HC6	
Blue	L	HC7	Twisted pair
Brown	M	HC8	
Yellow	N	+24 V	Twisted pair
Brown	U	24G	
Red	T	HC9	Twisted pair
Brown	S	HC10	
Green	R	HC11	Twisted pair
Brown	P	HC12	

■Pin assignment of hand output cable

Connect the hand output cable to GR.

Cable color	Pin No.	Name		Remarks
		Sink type	Source type	
Blue	A	COM(+24V)	COM(24G)	Twisted pair
White	B	GR1	GR1	
Yellow	C	COM(+24V)	COM(24G)	Twisted pair
White	D	GR2	GR2	
Green	E	COM(+24V)	COM(24G)	Twisted pair
White	F	GR3	GR3	
Red	G	COM(+24V)	COM(24G)	Twisted pair
White	H	GR4	GR4	
Purple	J	COM(+24V)	COM(24G)	Twisted pair
White	K	GR5	GR5	
Blue	L	COM(+24V)	COM(24G)	Twisted pair
Brown	M	GR6	GR6	
Yellow	N	COM(+24V)	COM(24G)	Twisted pair
Brown	U	GR7	GR7	
Green	T	COM(+24V)	COM(24G)	Twisted pair
Brown	S	GR8	GR8	

Example of air supply circuit for hand

An example of air supply circuit for hand is shown below.
- Make sure that a surge voltage protection circuit such as a diode is connected to the solenoid coil in parallel.
- If the air pressure drops below the default value, the clamping force of hand will drop, which may interfere with the work. To prevent it, install a pressure switch to the source of the air as shown in the following figure and use the circuit to stop the robot when pressure drops. Use a hand with a spring-pressure clamp or a mechanical lock-type hand, which can be used in cases where the pressure switch becomes damaged.

Pressure switch

To port A/B of
robot arm (max. 0.588MPa)

Pneumatic source
(clean)
0.7MPa or less

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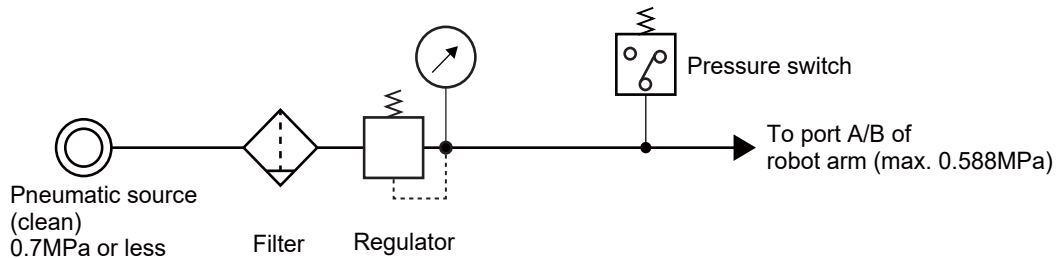
- If the air supply temperature (primary piping) used for the tool, etc. is lower than ambient air temperature, the dew condensation may occur on the coupling or the hose surface.

About the installation of tooling wiring and piping

⚠ CAUTION

- After connecting all wires and hoses to the robot, run the robot at low speed and check that the wires and hoses do not interfere with any part of the robot or peripheral devices.
- When installing metal fixtures and a solenoid valve using the screw holes (for fixing wires and hoses) on the No. 2 arm, add the mass of the metal fixtures and solenoid valve to the mass of a hand, and set the parameter HNDDAT. Moreover, fix the parts, such as a solenoid valve, firmly to prevent the parts getting shaky when the robot arm is operation.

The customer should supply all wires, hoses, and fixtures for tooling.

Screw holes are provided on the robot arm for the installation of tooling wiring, piping, and metal fixtures. Refer to the following page:

Adjust the installation position and the length of wires and hoses to suit the movement of the robot.

2.6   Option

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

Machine cable (replacement)

Order type

- Fixed type: 1F-□□UCBL-44
- Flexible type: 1F-□□LUCBL-44

*1   □□indicates the cable length.

Outline

This cable is used to connect between the controller and the robot.
A fixed type and flexible type are available.

Configuration

Part name	Model [*1]	Quantity	Weight (kg) [*2]	Remarks
Machine cable (replacement): Fixed type	1F-□□UCBL-44	1 set (CN1, CN2, and CN3)	Approx. 26 (12m) Approx. 35.5 (17m) Approx. 44.5 (22m)	Any one of 12, or 17, or 22m
Machine cable (replacement): Flexible type	1F-□□LUCBL-44	1 set (CN1, CN2, and CN3)	Approx. 15 (7m) Approx. 23 (12m) Approx. 31.5 (17m) Approx. 40 (22m)	Any one of 7, or 12, or 17, or 22m Accessories: • Two nylon clamps (NK-18N) • Four nylon clamps (NK-11N) • Two silicon rubbers (30 × 180, t1) • Four silicon rubbers (30 × 100, t1)

*1   □□indicates the cable length.
*2   It indicates the weight of one set.

Specifications

The specifications for the fixed type cables are the same as those for standard cables. The following table shows conditions for using fixed type cables and flexible type cables.

Item	Specifications	
	Fixed type	**Flexible type**
Minimum flexure radius	CN1: 160mm or more CN2: 98mm or more CN3: 95mm or more	154mm or larger
Cableveyor, etc., occupation rate	—	50% or less
Maximum movement speed	—	2,000mm/s or less
Guidance of life count	—	7.5 million times (With silicone grease coated)
Environmental proof	IP67	
Cable configuration	CN1: Approx. φ27mm × 1, CN2: Approx. φ16mm × 1, CN3: Approx. φ16mm × 1	

⚠ CAUTION

- The guidance of the service life of flexible cables may differ depending on the usage environments (items in the above table) or the amount of silicon grease applied. Recommended silicon grease: G-501 (Supplier: Shin-Etsu Chemical Co., Ltd.)
- 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.

Fixing the flexible cable

1. Connect the connectors on the cable to the robot arm and the controller. The connection method to the robot arm is the same as a standard machine cable. Refer to the following manual to connect the cable.

📖Robot Arm Setup and Maintenance (BFP-A3781)

2. Wind the silicon rubber around the cables at a position 300 to 400mm away from the robot arm and controller as shown below, and fix the cables with the nylon clamp to protect the cables from external stress.

Back of the controller   Back of the robot arm base
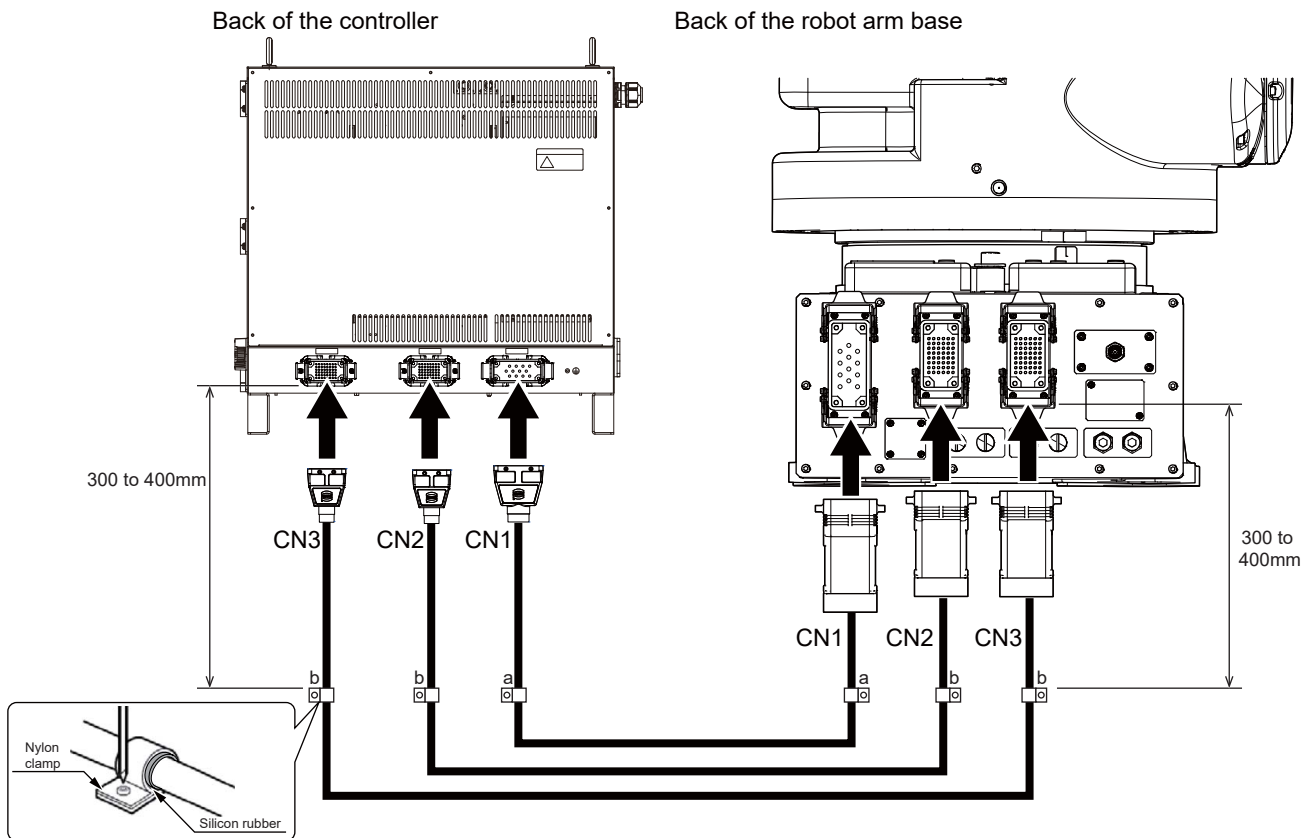
Item	Nylon clamp	Size of silicon rubber	Number of fixed points	Size of screws for fixing nylon clamps
Nylon clamp a	NK-18N	30 × 180 t1	2	M5
Nylon clamp b	NK-11N	30 × 100 t1	4	M5

The bending size of cables are shown below.

Cable connection space

200

676 min.

710
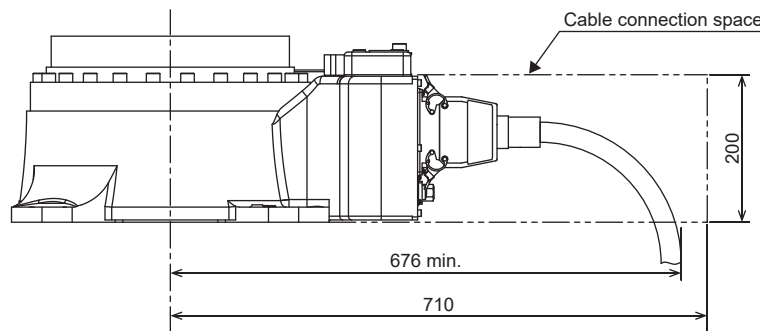
Operating range change stopper

Order type

1F-DH-44J1
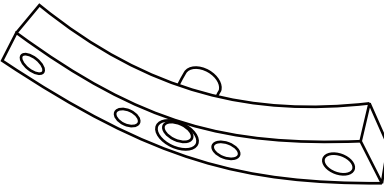
Outline
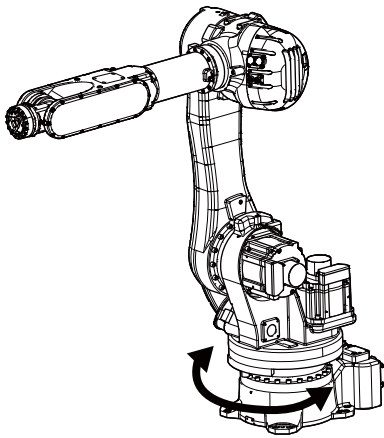
The operating range of the J1 axis is limited by installing mechanical stoppers on the robot arm and changing the relevant controller parameter setting.
If there is a possibility that the robot will interfere with the peripheral devices or similar situations will arise, the robot can be used safely by limiting the operating range.

Configuration

Part	Part name	Quantity	Weight (kg)	Remarks
	Stopper	1	2.4	—
	Bolt (M16 × 40)	4		For fixing stopper

The operating range can be limited by using the following two stoppers together: this optional stopper and the standard stopper pre-installed on the robot.

Changeable angle

The operating angle of the J1 axis can be changed in 20-degree increments.

For details on the installation positions of the stoppers, refer to the following page:

J1 axis changeable angle

Direction	Changeable angle range (°)		Remarks
+ (plus) side	0	+180	The operating angle can be changed in 20-degree increments by changing the installation position. However, to prevent interference between the two stoppers, the difference (absolute value) between the limit angles of the stoppers must be within 80° to 280°. [1]
- (minus) side	0	-180	

[1] Good example: When the limit angles are +60° and -40°
60° - (-40°) = 100° ··· The combination is possible as the difference is 100°.
Bad example: When the limit angles are -40° and -20°
-40° - (-20°) = -20° ··· The combination is not possible as the difference is 20° (absolute value).

Installation position: +60°
Installation position: -40°
Installation example
(limit angles: +60° and -40°)
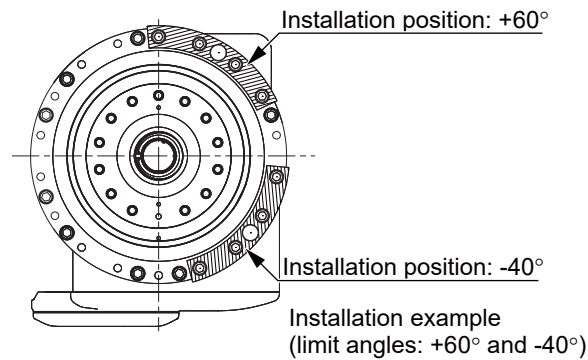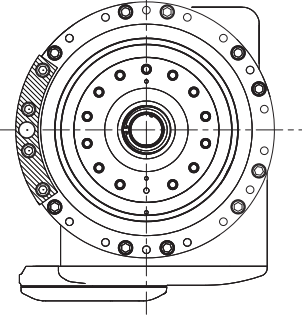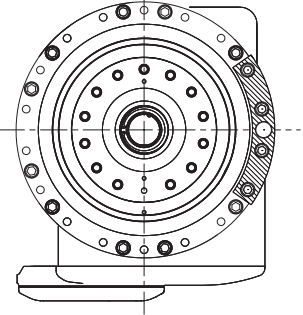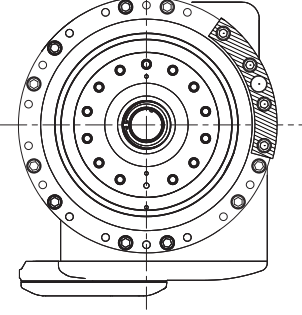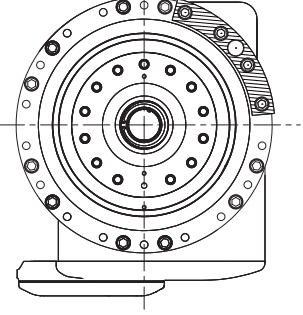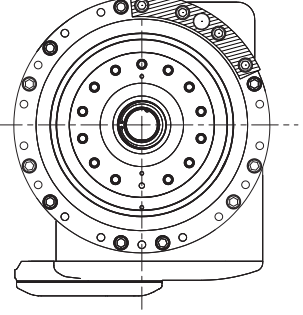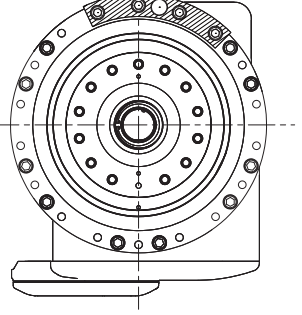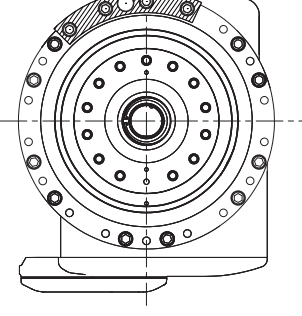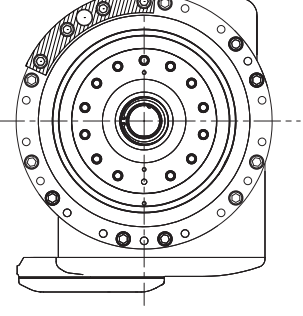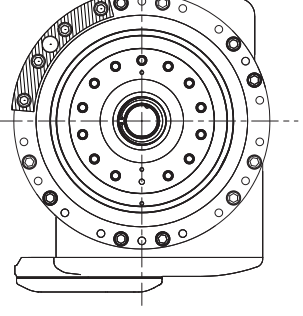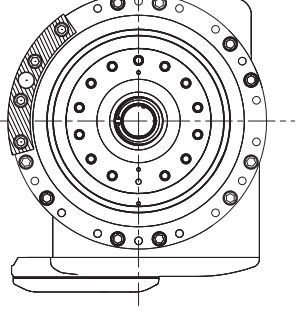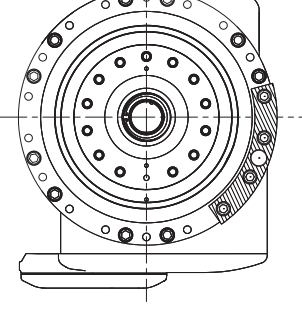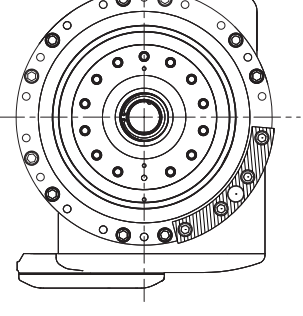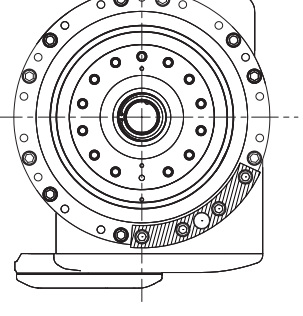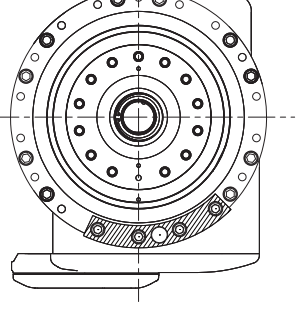
Representative combinations of limit angles
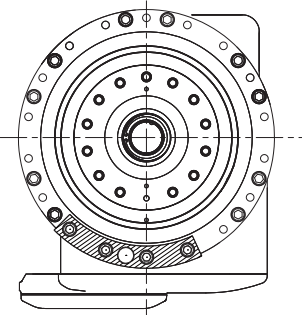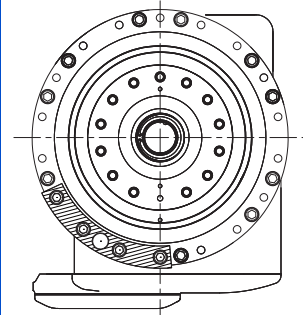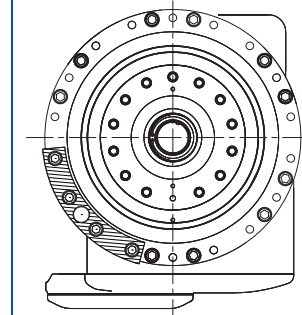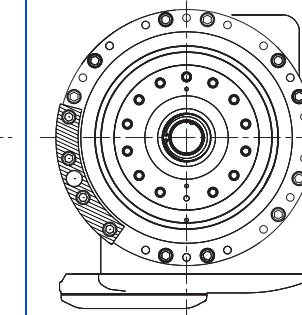
○: Available

		Limit angle on the + (plus) side									
		0°	+20°	+40°	+60°	+80°	+100°	+120°	+140°	+160°	+180°
Limit angle on the - (minus) side	0°	—	—	—	—	○	○	○	○	○	○
	-20°	—	—	—	○	○	○	○	○	○	○
	-40°	—	—	○	○	○	○	○	○	○	○
	-60°	—	○	○	○	○	○	○	○	○	○
	-80°	○	○	○	○	○	○	○	○	○	○
	-100°	○	○	○	○	○	○	○	○	○	○
	-120°	○	○	○	○	○	○	○	○	○	—
	-140°	○	○	○	○	○	○	○	○	—	—
	-160°	○	○	○	○	○	○	○	—	—	—
	-180°	○	○	○	○	○	○	—	—	—	—[1]

[1] Initial installation position

- Shaded area (cross section Z-Z): Stopper installation position

Limit angle (°)			
±180 (initial installation position)	0	—	—
		—	—
+20	+40	+60	+80
+100	+120	+140	+160
-20	-40	-60	-80

2 ROBOT ARM
2.6 Option

Limit angle (°)			
-100	-120	-140	-160

When changing the operating range, reposition the stoppers on the robot arm and change the parameter setting.

For details, refer to the following manual:

📖Detailed explanations of functions and operations (BFP-A3478)

Installation procedure

⚠ CAUTION

As a safety measure, turn off the control power of the robot controller before installing this option.

If installing a stopper just above the CONBOX, change the position to avoid interference of the stopper before turning off the power.

Securely tighten the bolts with a torque of 240N•m. Check that the bolts are securely tightened with the specified torque before moving the robot.

If the angle of the robot's J1 axis cannot be changed to 0° in the process of transporting the robot to a new location or setting the origin, change the stopper position to make the angle 0° before transportation.

When changing the stopper position from the initial position (±180°), be sure to attach two stoppers.

One stopper has been initially pre-installed at robot purchase, and the operating range is set to ±180°.

To change the operating range, reposition two stoppers (the pre-installed and optional stoppers).

When changing the installation positions of the stoppers, follow the steps below.

(If the operating range parameter "MEJAR" has been changed, this may interfere with the work. It is recommended to restore the operating range parameter "MEJAR" to ±180° (initial settings) before starting the work.)

1. Move the J1 axis to the position where the stopper can be removed easily.

2. Power off the robot.

3. Remove the installed stopper.

4. Install the stopper to the position that achieves the desired limit angle range. (Tighten the supplied four screws with a torque of 240N•m to fix the stopper.)

5. If a stopper is to be installed in a difficult to reach position (such as near the CONBOX), power on the robot and move the J1 axis beforehand. When operating the J1 axis, refer to the following :

📖Robot Arm Setup and Maintenance (BFP-A3781)

6. Power off the robot and install the stopper.

7. After installing the stoppers, change the operating range parameter "MEJAR" to achieve the desired limit angle range.

Stopper

M16 × 40 bolt
(Loctite #243 applied)*1

View Y

Hexagon wrench

Robot front

Y →

Stopper →

Z   Z

Robot side view

Stopper installation
position A

Robot front →

Stopper initial installation position
(Operating range: ±180°)

Stopper installation
position B

Cross section Z-Z
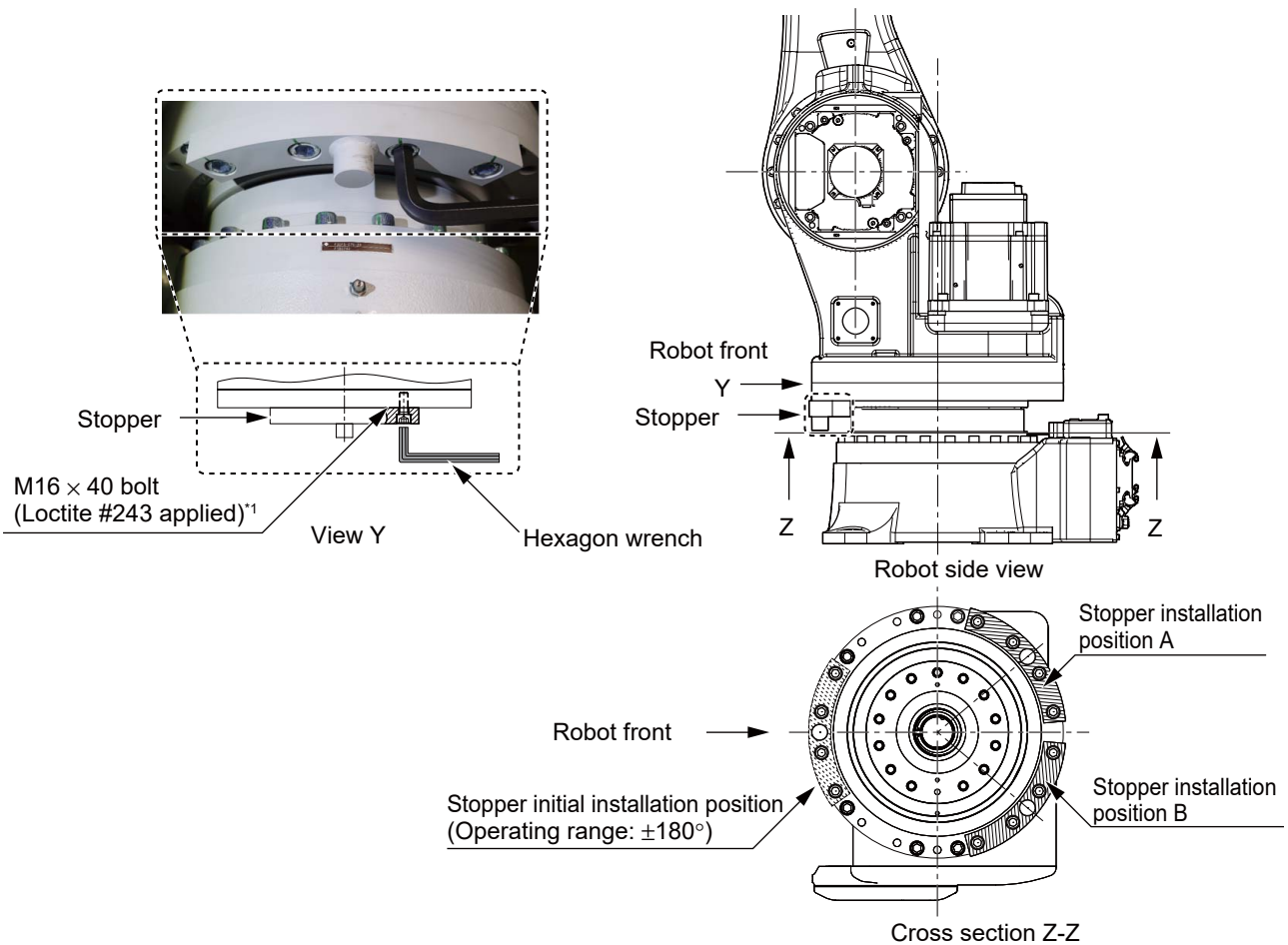
*1   Purchase Loctite #243 from the following supplier:
      Henkel Japan Ltd.

The above figure shows that the J1 axis has been moved to a position near 0° using jog operation and the stoppers are installed at positions A and B.

If the stoppers are positioned as shown above, the operating range of the J1 axis is between 40° in the plus direction and 40° in the minus direction.

Parameter settings

Set the operating range parameter "MEJAR" to achieve the desired limit angle range.

After setting the parameter, restart the controller.

For details on how to set the parameter, refer to the following manual:

📖Detailed explanations of functions and operations (BFP-A3478)

Checking the operation

After the controller has restarted, move the J1 axis to the limit of the operating range using joint jog operation to check that the robot stops at the limit angle.

Hand input cable

Order type

1F-HC2000S-44

Outline

The hand input cable is used for customer-designed pneumatic hands.

Use this to receive the open/close confirmation signals and grasping confirmation signals from the hand to the controller.

Connect one end of the cable to the connector for the hand input signals, which is on the elbow cover of the robot hand.

Connect the other end of the cable to the sensor inside the customer-designed hand.

Configuration

Part name	Model	Quantity	Weight (kg) [*1]	Remarks
Hand input cable	1F-HC2000S-44	1	0.35	—

*1 The weight of one set.

Specifications

Item	Specifications	Remarks
Size/Number of cores	#25 AWG ($0.16mm^2$) × 18 cores	One end: Connector, the other end: Cable connection
Total length	2000mm	—

For the cable color and pin assignment, refer to the following page:

Hand output cable

Order type

1F-GR2000S-44

Outline

The cable is used for customer-designed solenoid valve.

Connect one end of the cable to the connector for hand signal output, which is on the elbow cover of the robot arm.

The other end of the cable is connected.

Configuration

Part name	Model	Quantity	Weight (kg) [*1]	Remarks
Hand output cable	1F-GR2000S-44	1	0.35	—

*1   It indicates the weight of one set.

Specifications

Item	Specifications	Remarks
Size/Number of cores	#25 AWG (0.16mm^2) × 16 cores	One end: Connector, the other end: Cable connection
Total length	2000mm	—

For the cable color and pin assignment, refer to the following page:

Hand Ethernet cable

Order type

1F-LAN2000-44

Outline

Use this cable to connect a camera.

Connect one end of the cable to the LAN connector inside the No. 2 arm.

The other end of the cable is untreated. Select and use a connector according to the usage.

Configuration

Part name	Model	Quantity	Weight (kg) [1]
Hand Ethernet cable	1F-LAN2000-44	1	0.5

[1] It indicates the weight of one set.

Specifications

Item	Specifications
Size/Number of cores	#26 AWG ($0.13mm^2$) × 8 cores [1]
Total length	2,000mm

[1] For information on the colors and pin assignment of the hand Ethernet cable, refer to the following page:
☞ Page 53 Connector pin assignment

Connector

The colors and pin assignment of the hand Ethernet cable are shown below.

■Connector pin assignment

Cable color	Pin No.	Name	Remarks
Blue	1	—	Twisted pair
White	2	—	
Orange	3	—	Twisted pair
White	4	—	
Brown	5	—	Twisted pair
White	6	—	
Green	7	—	Twisted pair
White	8	—	

Brake releasing device

Order type

2F-BRKBOX-1

Outline
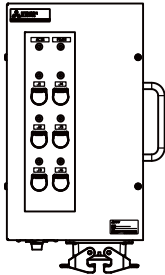
The brakes of the robot arm can be released without using a controller in emergency, such as when the operator got caught in the robot arm and when the posture of the robot arm should be changed in case of the controller failure.

Connect this option to the robot arm using the machine cable (CN2) included as standard or an optional power cable for the brake (2F-BRKCBL-1).

Configuration

Part name	Model	Quantity	Weight (kg)	Remarks
Brake releasing device	2F-BRKBOX-1	1	5.1	—

Specifications

Item	Specifications	Remarks
External dimensions	377 (W) × 124.5 (H) × 220 (D)	☞ Page 54 External dimensions and main functions
Input power supply	100 to 240V AC	*1
Color	Dark gray	—
Connection method	• Connecting the robot arm using the machine cable (CN2) included as standard • Connecting the robot arm using an optional power cable for the brake (2F-BRKCBL-1)	☞ Page 56 Power cable for the brake

*1 The customer needs to prepare a power cable. A cable with a connector that can connect to the C14 inlet on an IEC 60320 power cord is required.

External dimensions and main functions
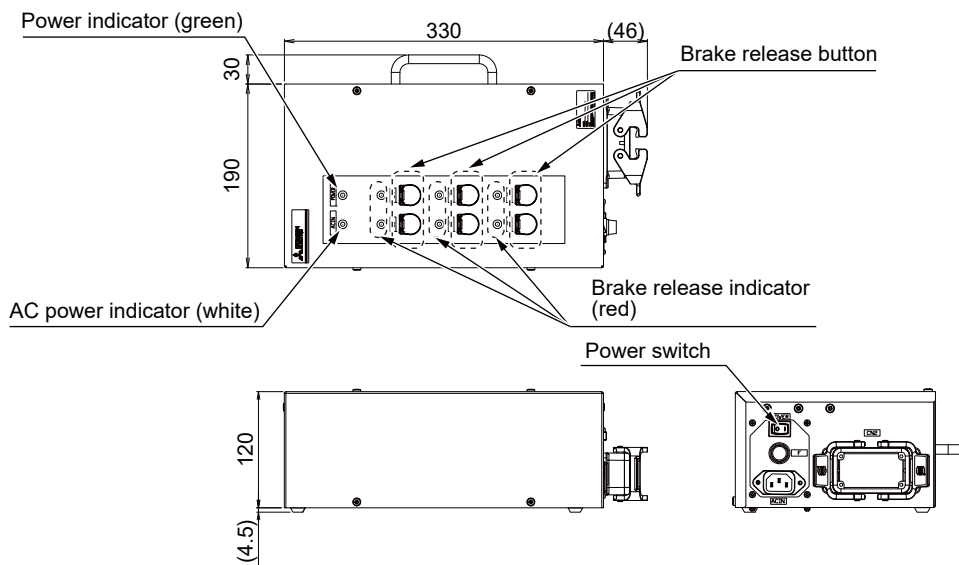
Installation procedure

Brake releasing device

Back of the robot arm baset

CN2 port
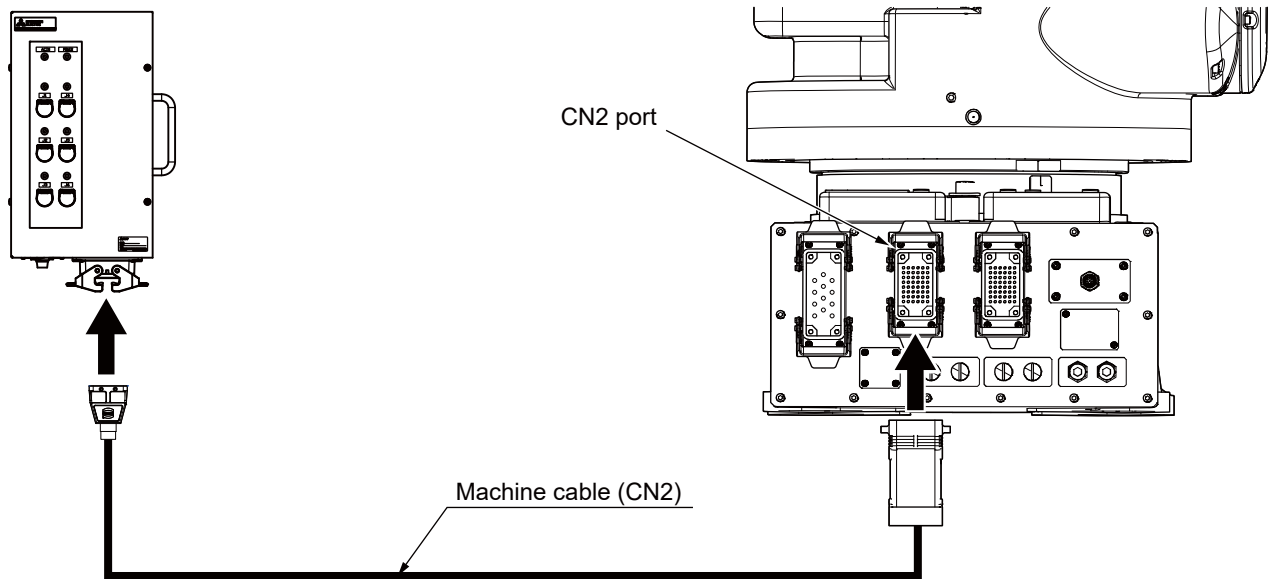
Machine cable (CN2)

1. Power off the controller, and remove the machine cable (CN2) from the controller.

2. Connect the connector on the removed machine cable (CN2) to the brake releasing device. (Connect the CN2 port on the robot and the brake releasing device using the machine cable (CN2).)

3. After connecting the connector, engage the lock levers of the port on the brake releasing device with the projections of the connector on the machine cable (CN2) to fix the connector securely. For information on the connection and removal of the machine cable, refer to the following manual:

📖Robot Arm Setup and Maintenance (BFP-A3781)

📖Controller setup, basic operation, and maintenance (BFP-A3783)

4. Attach the power cable (supplied by customer) to the brake releasing device.

5. Confirm that the power switch of the brake releasing device is off, then connect the power cable to an outlet.

Usage

⚠ CAUTION

• This option is used for the RV-35FR/50FR/80FR series only. Do not use it for other models.
• Use this product in emergency cases only, for example, when the robot cannot be moved using the controller.
• An appropriately skilled operator who is capable of releasing the brake safely can use this product.
• Be sure to use two or more people when releasing the brake.
• Power off the controller before use.
• To ensure safety, it is recommended to release the brake one axis by one axis.
• Releasing the brake may cause situations such as falling and rotation of the arm or the workpiece. Ensure safety during use. In particular, pay attention to falling arm, and take countermeasures such as fixing the arm as required.

1. Supply AC power to the brake releasing device to check that the AC power indicator (white) turns on.

2. Turn on the power switch of the brake releasing device to check that the power indicator (green) turns on.

3. Lift the cover of the brake release button of the intended axis and press the button.

4. Pressing the brake release button will turn on the brake release indicator (red). The brake is released while the button is being pressed. (The brakes of the J2 to J6 axes are intermittently released.)

Power cable for the brake

Order type

2F-BRKCBL-1

Outline
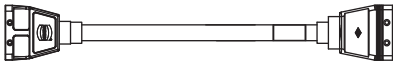
This cable is used to connect between the brake releasing device and the robot arm and to supply brake power to the robot.

If not using the machine cable included as standard, use this cable.

Configuration

Part name	Model	Quantity	Weight (kg)	Remarks
Power cable for the brake	2F-BRKCBL-1	1	2.9	—

Specifications

Item	Specifications	Remarks
Total length	5m	—

Installation procedure

⚠CAUTION

- When connecting and disconnecting the connector, be careful not to get your hand pinched.
- When connecting or disconnecting the connector, keep it parallel to the port. If one side is heavily loaded, a connector pin may be damaged, resulting in poor contact.
- When disconnecting the connector, open the latches to unlock the connector, then hold the connector and pull it out. Pulling the cable may cause it to come off or break.
- The connectors on the power cable for the brake are dedicated for the brake releasing device side and robot arm side, so take special care when connecting the connectors. If connected incorrectly, the connector pins could bend or break. Thus, even if connected correctly, the robot will not operate correctly, creating a dangerous situation.
- Take special care when wiring connection cables. Forcibly pulling or excessively bending the connected cable may result in disconnection of the cable or damage to the connector.
- Connect the power cable for the brake at a place that is not susceptible to dust and oil mist. Prevent dust and oil mist from adhering to the ports on the robot while the power cable for the brake is being disconnected. Otherwise, the robot may malfunction.

Brake releasing device   Back of the robot arm baset

CN2 port

Power cable for the brake
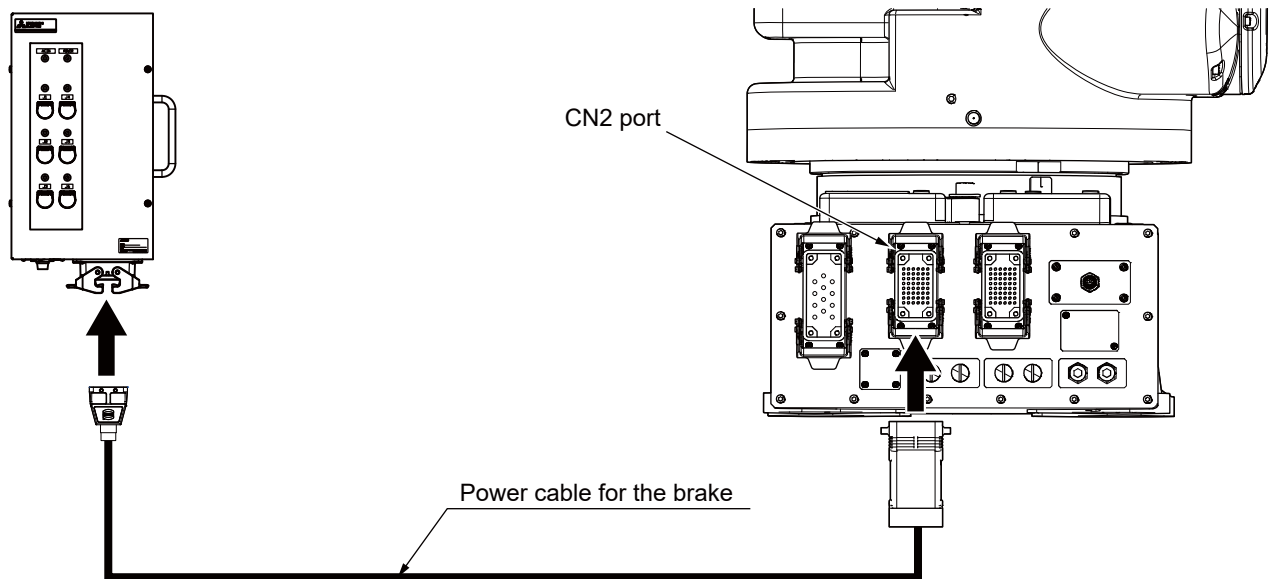
1. Power off the controller, and remove the machine cable (CN2) from the robot.

2. Connect the power cable for the brake (robot arm side) to the CN2 port on the robot.

3. After connecting the connector, engage the lock levers of the CN2 port on the robot with the projections of the connector on the power cable to fix the connector securely.

4. Connect the power cable for the brake (brake releasing device side) to the port on the brake releasing device.

5. After connecting the connector, engage the lock levers of the port on the brake releasing device with the projections of the connector on the power cable to fix the connector securely.

Precautions

- The power cable for the brake is a dedicated cable for the brake releasing device (2F-BRKBOX-1).
- The power cable for the brake can only be connected to the CN2 port on the robot.
- The power cable for the brake cannot be used as the machine cable (CN2). Do not connect to the controller.

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 (such as covers), so that the robots can operate continuously. As a guide, it is recommended that the robot is overhauled before the servo ON time reaches the specified hours (robot arm: 20,000 hours, robot controller: 36,000 hours). (Refer to the following figure.) Note that the degree of part wear and degradation may differ depending on the environment. In particular, operation with high load and frequency may shorten the cycle of repairing mechanical components. For details on the part selection for replacement and the timing of overhaul, contact your dealer.
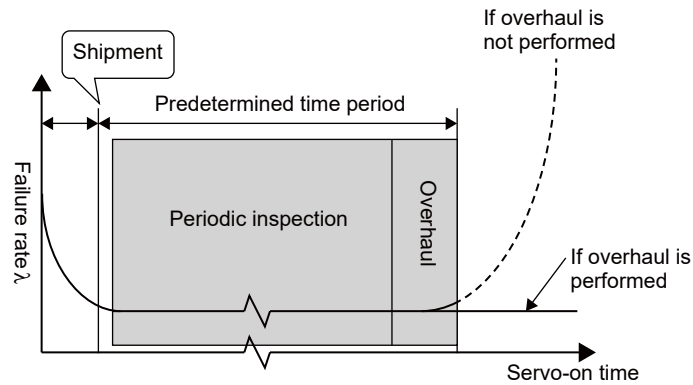
2.8　Maintenance parts

As with any other machine, prolonged use of industrial robots causes their parts to wear and degrade, ultimately causing failure. Periodic maintenance and inspection and replacement of consumable parts are required to prevent failure and keep the robot running smoothly over long periods of time. For details of the maintenance and inspection, refer to the following. The consumable parts and the spare parts that may be required during repair, which are used in the robot arm, are shown in the following table. Purchase these parts from the designated maker or dealer when required. Some Mitsubishi Electric-designated parts differ from the maker's standard parts. Thus, confirm the part name, robot arm, and controller serial number, and purchase the parts from the dealer.

To ask for replacement of AC servo motors and reduction gears, contact the dealer.

📖Robot Arm Setup and Maintenance (BFP-A3781)

No.	Item	Model [*1]	Location	Quantity	Supplier
1	Timing belt	—	J6 axis	1	Mitsubishi Electric
2	Grease (Molywhite A)	—	Reduction gears and gears of each axis	[*2] 1 pail (18Kg)	
3	Lithium battery (Battery: 1S1P×2 LS17500)	—	For servo motor encoders	1	
4	Cable tie	—	For battery fixing	2	

*1　For information on the models, check the serial number on the robot arm, and contact your local sales representative or the dealer.

*2　If grease of all reduction gears is replaced, grease of about 8,000cc is required.
　　For the amount of grease required for each axis, refer to the following manual:
　　📖Robot Arm Setup and Maintenance (BFP-A3781)

Robot arm spare parts list

No.	Item	Location	Quantity	Supplier
1	AC servo motor	J1 axis, J2 axis	2	Mitsubishi Electric
2		J3 axis	1	
3		J4 axis, J5 axis, J6 axis	3	
4	Reduction gear	J1 axis	1	
5		J2 axis	1	
6		J3 axis	1	
7		J4 axis	1	
8		J5 axis	1	
9		J6 axis	1	
10	Gasket	No. 2 arm cover L	1	
11		No. 2 arm cover U	1	
12		Elbow cover	1	
13		No. 1 arm cover A	1	
14		Shoulder cover R	1	
15		Shoulder cover U	1	

3 ROBOT CONTROLLER

3.1 Specifications

Standard specifications

CR860-D controller

Item		Unit	Specifications	Remarks
Model		—	CR860-□□VD	"□□" in type name represents the payload of the robot arm. 35: 35kg, 50: 50kg, 80: 80kg
Number of axes		—	Simultaneously 6	Up to 8 axes can be added.
Memory capacity	Number of teaching positions	Point	39,000	—
	Number of steps	Step	78,000	—
	Number of programs	Point	512	—
Programming language		—	MELFA-BASIC V, VI	—
Position teaching method		—	Teaching or MDI [1]	—
External I/O	General-purpose I/O	Point	0 input points/0 output points	256 inputs/256 outputs max. with an option
	Dedicated I/O	Point	Assigned to general-purpose I/O	The signal number of "STOP" is fixed.
	Hand I/O	Point	12 input points/8 output points	The sink/source type can be switched with parameters.
	Encoder input	Channel	2	—
	External emergency stop input [2]	Point	1 (duplex)	SIL2, PLd/Category 3 [3]
	Door switch input	Point	1 (duplex)	
	Enabling device input	Point	1 (duplex)	
	Emergency stop output	Point	1 (duplex)	[3]
	Mode output	Point	1 (duplex)	
	Robot error output	Point	1 (duplex)	
	Additional axis synchronization output	Point	1 (duplex)	
Interface	Additional axis	Channel	1	SSCNET III/H (Connect with a general-purpose servo amplifier)
	Remote I/O	Channel	1	Ver.1.0/2.0 is supported.
	USB	Port	1	Only the Ver.2.0 High Speed device function is supported. USB mini-B
	Ethernet	Port	1	For user: 1000BASE-T/100BASE-TX/10BASE-T
		Port	1	For T/B: 100BASE-TX/10BASE-T
	Option slot	Slot	2	For installing an optional interface
	SD memory card slot	Slot	1	For extended memory
	RS-422	Port	1	For T/B
	Emergency stop switch	—	1	SIL2, PLd/Category 3
	Mode selector	—	1	
Power supply	Input voltage range	V	Three-phase 200 to 240V AC	The rate of power-supply voltage fluctuation is within +10% to -15%. [4] For details on the robot type, refer to the following page: ☞ INTRODUCTION
	Power capacity	kVA	7.5	Inrush current is not included. [5] For details on the robot type, refer to the following page: ☞ INTRODUCTION
	Power supply frequency	Hz	50/60	—
External dimensions [6]		mm	670 (width) × 500 (depth) × 670 (height)	Protrusions are excluded.
Weight		kg	80	—

Item		Unit	Specifications	Remarks
Construction		—	Self-contained floor type, Enclose type.	IP54[*7] (FAN part: IP2X)
Ambient temperature	In use	℃	0 to 45	Non-freezing
	At transport/storage		-15 to +70	
Ambient humidity	In use	%RH	10 to 85	Non-condensing
	At transport/storage		90 or lower	
Overvoltage category [*8]		—	II or less	—
Pollution degree [*9]		—	2 or lower	—
Altitude		m	1000 or lower	—
Grounding		Ω	100 or lower	100Ω or less (Class D grounding) [*10]
Paint color		—	Dark gray	Equivalent to Mansell: 3.5PB3.2/0.8 Equivalent to PANTONE: 432C

*1 Teaching method: The method to register the current position of the robot arm.
MDI method: Manual Data Input. The method to register by inputting the numerical value manually.

*2 At factory settings, the STO function activated by an external emergency stop input meets the requirements of SIL2, PLd/Category 3. The STO function activated by an external emergency stop input meets the requirements of "SIL3, PLe/Category 4" when the safety diagnosis function (test pulse diagnosis) is set. For the safety diagnosis function (test pulse diagnosis), refer to the following page:
☞Page 164 Safety diagnosis function (test pulse diagnosis)

*3 For details on the functions using external input/output signals, always refer to the following page:
☞Page 163 Classification of external I/O functions

*4 When the power-supply voltage fluctuation rate is close to the lower limit, the lower limit may be exceeded depending on the robot movement, causing an excessive error alarm to occur.

*5 The power capacity represents 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 to 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.
As a reference, the following table lists values of the current used in our standard operation.

Model	Item		Current (A)	Apparent power (kVA)	Voltage at measurement (V)
RV-35FR	At control power ON		0.71	0.26	216
	At servo ON		1.27	0.48	216.03
	In automatic operation	Effective value	6.19	2.31	216.77
		Peak	37.66	13.92	218.26
RV-50FR	At control power ON		0.71	0.26	216
	At servo ON		1.27	0.48	216.03
	In automatic operation	Effective value	6.12	2.26	214.37
		Peak	35.75	12.98	216.52
RV-80FR	At control power ON		0.71	0.26	216
	At servo ON		1.27	0.48	216.03
	In automatic operation	Effective value	5.56	2.08	217.36
		Peak	43.54	15.99	218.51

*6 For details, refer to the following page:
☞Page 77 External dimensions

*7 This controller is designed for use in general environments. For details, refer to the following page:
☞Page 69 Protection specifications and operating environments

*8 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.

*9 This index indicates the degree to which conductive material is generated in 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.

*10 The robot must be grounded by the customer.

3

• CR860-D controller safety performance

Function	Item	Performance	Remarks
STO	Safety Level	SIL3 (IEC 61508:2010)	Performance when: • External emergency stop input when the test pulse diagnosis settings are enabled [1]
		Category 4, PLe (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) [2]	PFH = 1.60×10^{-8} [1/hour]	
	Safety Level	SIL2 (IEC 61508:2010)	Performance when: • External emergency stop input when the test pulse diagnosis settings are disabled (factory settings) • Door switch input • Enabling device input
		Category 3, PLd (EN ISO 13849-1:2015)	
	Mean time to dangerous failure (MTTFd)	MTTFd ≥ 100 years	
	Diagnostic coverage (DC)	DC = 96%	
	Probability of dangerous failure per hour (PFH) [2]	PFH = 2.24×10^{-8} [1/hour]	

[1] To use this product at SIL3, Category 4, PLe, change the parameter setting by referring to the following page:
☞ Page 164 Safety diagnosis function (test pulse diagnosis)

[2] The robot controller PFH or PFHd (Probability of Dangerous Failure per Hour). The PFH of the emergency stop switch and 3-position 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]	Safety performance
R32TB	Emergency stop switch	1×10^6	6000	1667	≥ 99	2.47×10^{-8}	SIL2, PLd/ Category 3
	3-position enable switch	1×10^6	6000	1667	≥ 99	2.47×10^{-8}	
R86TB	Emergency stop switch	2.5×10^5	6000	417	≥ 99	2.47×10^{-8}	
	3-position enable switch	1×10^6	6000	1667	≥ 99	2.47×10^{-8}	

CR860-R controller

The CR860-R controller is connected to the robot CPU module mounted on the base unit of the Mitsubishi Electric MELSEC iQ-R series programmable controller. Specifications of the robot CPU module such as the power supply and external dimensions are the same as those specified for the programmable controller.

For the names of each part, refer to the following page:

For the external dimensions, refer to the following page:

Although the following table shows the specifications for using the robot CPU module and the robot controller (equipped with the servo amplifier for the robots, the safety circuit, etc.) together, the values mainly indicate the specifications of the controller.

Item		Unit	Specifications	Remarks
Model		—	CR860-□□VR	"□□" in type name represents the payload of the robot arm. 35: 35kg, 50: 50kg, 80: 80kg
Number of axes		—	Simultaneously 6	Up to 8 axes can be added.
Memory capacity	Number of teaching positions	Point	39,000	—
	Number of steps	Step	78,000	—
	Number of programs	Point	512	—
Programming language		—	MELFA-BASIC V, VI	—
Position teaching method		—	Teaching or MDI [1]	—
External I/O	General-purpose I/O	Point	0 input points/0 output points	Devices shared among multiple CPUs: 8192 input points/ 8192 output points (Max.)
	Dedicated I/O	Point	Assigned to general-purpose I/O	
	Hand I/O	Point	12 input points/8 output points	The sink/source type can be switched with parameters.
	Encoder input	Channel	2	—
	External emergency stop input [2]	Point	1 (duplex)	SIL2, PLd/Category 3 [3]
	Door switch input	Point	1 (duplex)	
	Enabling device input	Point	1 (duplex)	
	Emergency stop output	Point	1 (duplex)	[3]
	Mode output	Point	1 (duplex)	
	Robot error output	Point	1 (duplex)	
	Additional axis synchronization output	Point	1 (duplex)	
Interface	Additional axis	Channel	1	SSCNET III/H (Connect with a general-purpose servo amplifier)
	Remote I/O	Channel	1	Ver.2.0 is supported. (Safety control)
	Ethernet	Port	1	For user: 1000BASE-T/100BASE-TX/10BASE-T
			1	For T/B: 100BASE-TX/10BASE-T
	Option slot	Slot	2	Only the function extension card is available.
	SD memory card slot	Slot	1	Unusable
	RS-422	Port	1	For T/B
	Emergency stop switch	—	1	SIL2, PLd/Category 3
	Mode selector	—	1	
Power supply	Input voltage range	V	Three-phase 200 to 240V AC	The rate of power-supply voltage fluctuation is within +10% to -15%. [4] For details on the robot type, refer to the following page: ☞INTRODUCTION
	Power capacity	kVA	7.5	Inrush current is not included. [5] For details on the robot type, refer to the following page: ☞INTRODUCTION
	Power supply frequency	Hz	50/60	—
External dimensions [6]		mm	670 (width) × 500 (depth) × 670 (height)	Protrusions are excluded.
Weight		kg	80	—

Item		Unit	Specifications	Remarks
Construction		—	Self-contained floor type, Enclose type.	IP54[*7] (FAN part: IP2X)
Ambient temperature	In use	°C	0 to 45	Non-freezing
	At transport/storage		-15 to +70	
Ambient humidity	In use	%RH	10 to 85	Non-condensing
	At transport/storage		90 or lower	
Overvoltage category [*8]		—	II or less	—
Pollution degree [*9]		—	2 or lower	—
Altitude		m	1000 or lower	—
Grounding		Ω	100 or lower	100Ω or less (Class D grounding) [*10]
Paint color		—	Dark gray	Equivalent to Mansell: 3.5PB3.2/0.8 Equivalent to PANTONE: 432C

*1 Teaching method: The method to register the current position of the robot arm.
　　MDI method: Manual Data Input. The method to register by inputting the numerical value manually.
*2 At factory settings, the STO function activated by an external emergency stop input meets the requirements of SIL2, PLd/Category 3. The STO function activated by an external emergency stop input meets the requirements of "SIL3, PLe/Category 4" when the safety diagnosis function (test pulse diagnosis) is set. For the safety diagnosis function (test pulse diagnosis), refer to the following page:
　　☞Page 164 Safety diagnosis function (test pulse diagnosis)
*3 For details on the functions using external input/output signals, always refer to the following page:
　　☞Page 163 Classification of external I/O functions
*4 When the power-supply voltage fluctuation rate is close to the lower limit, the lower limit may be exceeded depending on the robot movement, causing an excessive error alarm to occur.
*5 The power capacity represents 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 to 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.
　　As a reference, the following table lists values of the current used in our standard operation.

Model	Item		Current (A)	Apparent power (kVA)	Voltage at measurement (V)
RV-35FR	At control power ON		0.71	0.26	216
	At servo ON		1.27	0.48	216.03
	In automatic operation	Effective value	6.19	2.31	216.77
		Peak	37.66	13.92	218.26
RV-50FR	At control power ON		0.71	0.26	216
	At servo ON		1.27	0.48	216.03
	In automatic operation	Effective value	6.12	2.26	214.37
		Peak	35.75	12.98	216.52
RV-80FR	At control power ON		0.71	0.26	216
	At servo ON		1.27	0.48	216.03
	In automatic operation	Effective value	5.56	2.08	217.36
		Peak	43.54	15.99	218.51

*6 For details, refer to the following page:
　　☞Page 77 External dimensions
*7 This controller is designed for use in general environments. For details, refer to the following page:
　　☞Page 69 Protection specifications and operating environments
*8 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.
*9 This index indicates the degree to which conductive material is generated in 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.
*10 The robot must be grounded by the customer.

- Standard specifications of the robot CPU module (CR860-R controller)

Item		Unit	Specifications	Remarks
Model		—	R16RTCPU	—
Interface	Additional axis interface	Port	1	—
Power supply	Power consumption (5V DC)	A	1.7	—
External dimensions		mm	27.8 (width) × 110 (depth) × 106 (height)	—
Weight		kg	0.3	—
Ambient temperature	In use	℃	0 to 55	Non-freezing
	At transport/storage		-15 to +70	
Ambient humidity	In use	%RH	5 to 95	Non-condensing
	At transport/storage		90 or lower	

- CR860-R controller safety performance

Function	Item	Performance	Remarks
STO	Safety Level	SIL3 (IEC 61508:2010)	Performance when: • External emergency stop input when the test pulse diagnosis settings are enabled [*1]
		Category 4, PLe (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) [*2]	PFH = 1.60×10^{-8} [1/hour]	
	Safety Level	SIL2 (IEC 61508:2010)	Performance when: • External emergency stop input when the test pulse diagnosis settings are disabled (factory settings) • Door switch input • Enabling device input
		Category 3, PLd (EN ISO 13849-1:2015)	
	Mean time to dangerous failure (MTTFd)	MTTFd ≥ 100 years	
	Diagnostic coverage (DC)	DC = 96%	
	Probability of dangerous failure per hour (PFH) [*2]	PFH = 2.24×10^{-8} [1/hour]	

*1 To use this product at SIL3, Category 4, PLe, change the parameter setting by referring to the following page:
*2 The robot controller PFH or PFHd (Probability of Dangerous Failure per Hour). The PFH of the emergency stop switch and 3-position 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]	Safety performance
R32TB	Emergency stop switch	1×10^6	6000	1667	≥ 99	2.47×10^{-8}	SIL2, PLd/ Category 3
	3-position enable switch	1×10^6	6000	1667	≥ 99	2.47×10^{-8}	
R86TB	Emergency stop switch	2.5×10^5	6000	417	≥ 99	2.47×10^{-8}	
	3-position enable switch	1×10^6	6000	1667	≥ 99	2.47×10^{-8}	

CR860-Q controller

The CR860-Q controller is connected to the robot CPU module mounted on the base unit of the Mitsubishi Electric MELSEC Q series programmable controller. Specifications of the robot CPU module such as the power supply and external dimensions are the same as those specified for the programmable controller.

For the names of each part, refer to the following page:

For the external dimensions, refer to the following page:

Although the following table shows the specifications for using the robot CPU module and the robot controller (equipped with the servo amplifier for the robots, the safety circuit, etc.) together, the values mainly indicate the specifications of the controller.

Item		Unit	Specifications	Remarks
Model		—	CR860-□□VQ	"□□" in type name represents the payload of the robot arm. 35: 35kg, 50: 50kg, 80: 80kg
Number of axes		—	Simultaneously 6	Up to 8 axes can be added.
Memory capacity	Number of teaching positions	Point	26,000	—
	Number of steps	Step	52,000	—
	Number of programs	Point	512	—
Programming language		—	MELFA-BASIC V, VI	—
Position teaching method		—	Teaching or MDI [*1]	—
External I/O	General-purpose I/O	Point	0 input points/0 output points	Devices shared among multiple CPUs: 8192 input points/ 8192 output points (Max.)
	Dedicated I/O	Point	Assigned to the multi-CPU shared device.	
	Hand I/O	Point	12 input points/8 output points	The sink/source type can be switched with parameters.
	External emergency stop input [*2]	Point	1 (duplex)	SIL2, PLd/Category 3 [*3]
	Door switch input	Point	1 (duplex)	
	Enabling device input	Point	1 (duplex)	
	Emergency stop output	Point	1 (duplex)	[*3]
	Mode output	Point	1 (duplex)	
	Robot error output	Point	1 (duplex)	
	Additional axis synchronization output	Point	1 (duplex)	
Interface	Additional axis	Channel	1	SSCNET III/H (Connect with a general-purpose servo amplifier)
	Remote I/O	Channel	1	Ver.2.0 is supported. (Safety control)
	Ethernet	Port	1	For user: 1000BASE-T/100BASE-TX/10BASE-T
			1	For T/B: 100BASE-TX/10BASE-T
	Option slot	Slot	2	Only the function extension card is available.
	SD memory card slot	Slot	1	Unusable
	RS-422	Port	1	For T/B
	Emergency stop switch	—	1	SIL2, PLd/Category 3
	Mode selector	—	1	
Power supply	Input voltage range	V	Three-phase 200 to 240V AC	The rate of power-supply voltage fluctuation is within +10% to -15%. [*4] For details on the robot type, refer to the following page: ☞INTRODUCTION
	Power capacity	kVA	7.5	Inrush current is not included. [*5] For details on the robot type, refer to the following page: ☞INTRODUCTION
	Power supply frequency	Hz	50/60	—
External dimensions [*6]		mm	670 (width) × 500 (depth) × 670 (height)	Protrusions are excluded.
Weight		kg	80	—

Item		Unit	Specifications	Remarks
Construction		—	Self-contained floor type, Enclose type.	IP54[*7] (FAN part: IP2X)
Ambient temperature	In use	℃	0 to 45	Non-freezing
	At transport/storage		-15 to +70	
Ambient humidity	In use	%RH	10 to 85	Non-condensing
	At transport/storage		90 or lower	
Overvoltage category [*8]		—	II or less	—
Pollution degree [*9]		—	2 or lower	—
Altitude		m	1000 or lower	—
Grounding		Ω	100 or lower	100Ω or less (Class D grounding) [*10]
Paint color		—	Dark gray	Equivalent to Mansell: 3.5PB3.2/0.8 Equivalent to PANTONE: 432C

*1   Teaching method: The method to register the current position of the robot arm.
     MDI method: Manual Data Input. The method to register by inputting the numerical value manually.
*2   At factory settings, the STO function activated by an external emergency stop input meets the requirements of SIL2, PLd/Category 3.
     The STO function activated by an external emergency stop input meets the requirements of "SIL3, PLe/Category 4" when the safety diagnosis function (test pulse diagnosis) is set. For the safety diagnosis function (test pulse diagnosis), refer to the following page:
     ☞ Page 164 Safety diagnosis function (test pulse diagnosis)
*3   For details on the functions using external input/output signals, always refer to the following page:
     ☞ Page 163 Classification of external I/O functions
*4   When the power-supply voltage fluctuation rate is close to the lower limit, the lower limit may be exceeded depending on the robot movement, causing an excessive error alarm to occur.
*5   The power capacity represents 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 to 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.
     As a reference, the following table lists values of the current used in our standard operation.

Model	Item		Current (A)	Apparent power (kVA)	Voltage at measurement (V)
RV-35FR	At control power ON		0.71	0.26	216
	At servo ON		1.27	0.48	216.03
	In automatic operation	Effective value	6.19	2.31	216.77
		Peak	37.66	13.92	218.26
RV-50FR	At control power ON		0.71	0.26	216
	At servo ON		1.27	0.48	216.03
	In automatic operation	Effective value	6.12	2.26	214.37
		Peak	35.75	12.98	216.52
RV-80FR	At control power ON		0.71	0.26	216
	At servo ON		1.27	0.48	216.03
	In automatic operation	Effective value	5.56	2.08	217.36
		Peak	43.54	15.99	218.51

*6   For details, refer to the following page:
     ☞ Page 77 External dimensions
*7   This controller is designed for use in general environments. For details, refer to the following page:
     ☞ Page 69 Protection specifications and operating environments
*8   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.
*9   This index indicates the degree to which conductive material is generated in 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.
*10 The robot must be grounded by the customer.

- Standard specifications of the robot CPU module (CR860-Q controller)

Item		Unit	Specifications	Remarks
Model		—	Q172DSRCPU	—
Interface	Additional axis interface	Port	1	—
Power supply	Power consumption (5V DC)	A	1.44	—
External dimensions		mm	27.4 (width) × 120.3 (depth) × 120.5 (height)	—
Weight		kg	0.38	—
Ambient temperature	In use	℃	0 to 55	Non-freezing
	At transport/storage		-25 to +75	
Ambient humidity	In use	%RH	5 to 95	Non-condensing
	At transport/storage		5 to 95	

- CR860-Q controller safety performance

Function	Item	Performance	Remarks
STO	Safety Level	SIL3 (IEC 61508:2010)	Performance when: • External emergency stop input when the test pulse diagnosis settings are enabled [*1]
		Category 4, PLe (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) [*2]	PFH = 1.60×10^{-8} [1/hour]	
	Safety Level	SIL2 (IEC 61508:2010)	Performance when: • External emergency stop input when the test pulse diagnosis settings are disabled (factory settings) • Door switch input • Enabling device input
		Category 3, PLd (EN ISO 13849-1:2015)	
	Mean time to dangerous failure (MTTFd)	MTTFd ≥ 100 years	
	Diagnostic coverage (DC)	DC = 96%	
	Probability of dangerous failure per hour (PFH) [*2]	PFH = 2.24×10^{-8} [1/hour]	

*1 To use this product at SIL3, Category 4, PLe, change the parameter setting by referring to the following page:
☞ Page 164 Safety diagnosis function (test pulse diagnosis)

*2 The robot controller PFH or PFHd (Probability of Dangerous Failure per Hour). The PFH of the emergency stop switch and 3-position 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]	Safety performance
R32TB	Emergency stop switch	1×10^6	6000	1667	≥ 99	2.47×10^{-8}	SIL2, PLd/ Category 3
	3-position enable switch	1×10^6	6000	1667	≥ 99	2.47×10^{-8}	
R86TB	Emergency stop switch	2.5×10^5	6000	417	≥ 99	2.47×10^{-8}	
	3-position enable switch	1×10^6	6000	1667	≥ 99	2.47×10^{-8}	

Protection specifications and operating environments

Protection specifications

■How to satisfy IP54

Check the following items to satisfy IP54.

- Close the controller front door, then fix it using the front door fixing screws (two places).

Front door fixing screw

Robot controller front
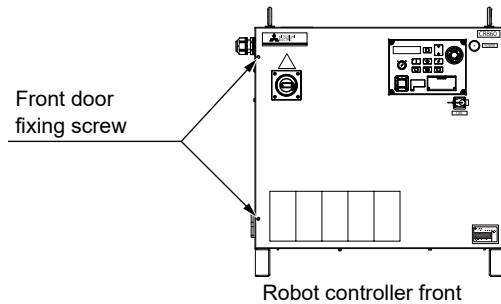
- Attach a T/B connector cap to the T/B port on the front of the controller if a T/B or a dummy connector (sold separately) is not connected to the port.

T/B connector cap

T/B connector

Robot controller front
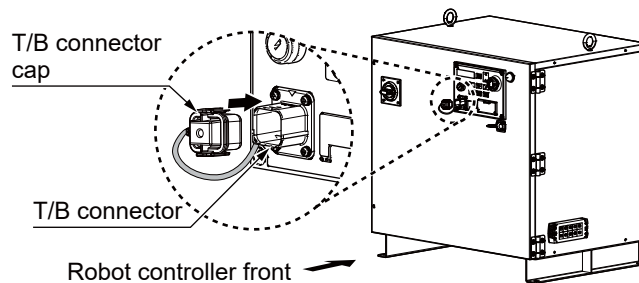
- Attach a LAN connector cap to the LAN port on the front of the controller if an IP54 compliant LAN cable is not used. If the cable connected to the controller is not compatible with IP54, the controller does not satisfy IP54.

LAN connector cap

LAN

LAN port

Cable entrance

Robot controller front
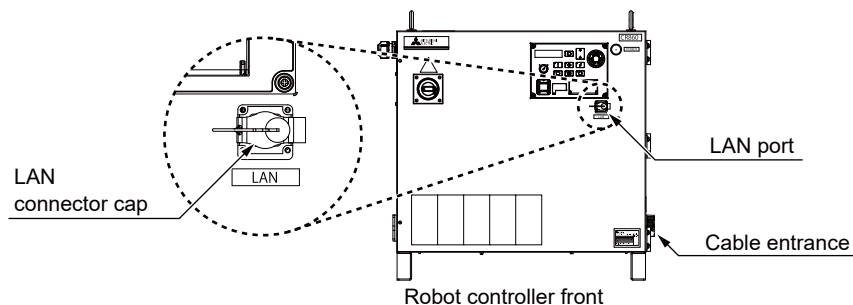
- Check that the size of the cable taken out of the cable entrance is appropriate, and any unused entrance ports are plugged.

📖Controller setup, basic operation, and maintenance (BFP-A3783)

The CR860 controller complies with IEC standards IP54 (enclose type).

The IP performance stated in IEC standards indicates the ingress protection level against solid objects and water. They do not indicate that the product's enclosure protects against oil. Do not feed oil directly to the controller.

■IEC IP54

- Degree of protection against solids

A protective enclosure which prevents dust particles from interfering with proper operation of the product and compromising safety.

- Degree of protection against water

A protective enclosure that can withstand the following:

Fresh-water spray in any direction 180° from vertical at a distance of 300 to 500mm with a water volume of 10 ± 0.5 ℓ/min at 50 to 150kPa over 1 m^2 for a minimum of 10 minutes.

For details on the operating environment , refer to the following page:

Operating environments

The controller has a built-in earth leakage breaker, which works based on the power switch. The specifications of the earth leakage breaker are as shown in the following table.

Item	Unit	Specifications
Model	—	NV63-CVF 3P 50A 100MA
Rated current	A	50
Number of poles	—	3
Rated use voltage	V	100 to 440V AC
Rated sensed current	mA	100

To ensure that the earth leakage breaker in the 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 equal to or less than the value shown below.

TN and TT systems indicate grounding system types.

• For TN system

Item		Unit	Specifications	Remarks
CB, CP, NFB	Model	—	NV63-CVF	—
	Rated current	A	50	—
Input voltage range		V	200 to 240V AC	—
Maximum permissible fault loop impedance		Ω	340	[*1]

*1　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.

• For TT system

Item		Unit	Specifications	Remarks
Earth leakage breaker [*1]	Model	—	NV63-CVF	—
	Rated current	A	50	—
	Rated sensed current (IΔn)	mA	100	—
Input voltage range		V	200 to 240V AC	—
Maximum permissible fault loop impedance		Ω	340	[*2]

*1　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.

*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.

For the operating environments, refer to the following page as well.

3.2　Part Names

Robot controller

⚠ CAUTION

- Connecting the USB port on the controller to commercially available devices such as computers and LAN hubs may not be compatible with our equipment or the temperature and electrical noise of some FA environments. If using commercially available devices, check the operation carefully to determine if protection against EMI or the addition of a ferrite core is required. We cannot guarantee the operation of the product and perform maintenance if the product is connected to commercial devices.
- When USB connection is used between RT ToolBox3 and the robot controller, data communication may become unstable due to noise. In this case, it is recommended to change the communication method to LAN connection.

3

2): Enlarged view of the operation panel

No.	Name	Description
1)	Power switch [*1]	Used to switch the control power ON/OFF state (with an earth leakage breaker function). Turning on the servos while the power switch is ON will supply servo power to the motors.
2)	Operation panel	Operation panel for robot status display, mode switching, emergency stop, computer connection, and other purposes
3)	Display panel (STATUS.NUMBER)	Displays information such as alarm numbers, program numbers, and override values (%). After power-on, it takes approximately one minute for the display panel to turn on.
4)	Display change button (CHNG DISP)	Changes the contents displayed on the display panel in the following order: override → line number → program number → user information → manufacturer information.
5)	UP/DOWN button	Moves the contents displayed on the display panel up or down.
6)	POWER lamp	Indicates the main power (primary power supply) status. • ON: Main power (primary power supply) ON • OFF: Main power (primary power supply) OFF
7)	Emergency stop switch (EMG.STOP)	Brings the robot to an emergency stop, and turns off the servos.
8)	START button (START)	Runs the program to operate the robot. The program runs continuously.
9)	SVO.ON button	Turns on the servos. (Servo ON)
10)	RESET button (RESET)	Resets the error display. It also resets the halted program.
11)	Mode selector (MODE)	Used to switch robot operation rights. • AUTOMATIC: Operations can be performed from the operation panel or external device. Operations that require operation rights cannot be performed from the T/B. (Except automatic program start) • MANUAL: When the T/B is enabled, operation can only be performed with the T/B. Operations that require operation rights cannot be performed from the operation panel or external devices.
12)	SVO.OFF button	Turns off the servos. (Servo OFF)
13)	END button (END)	Stops the operation when the running program reaches the last line or End.
14)	STOP button (STOP)	Stops the robot operated under the program. The servos will not turn off.
15)	T/B connection port (T/B)	When the T/B is not connected to the port, attach a cap or a dummy connector (sold separately) as appropriate for the environment the product is being used in. [*2]
16)	PC	Computer connection port. Open the cover and connect the USB cable. It is not available for the CR860-R/CR860-Q controllers.
17)	LAN	Ethernet connection port. It is not available for the CR860-R/CR860-Q controllers.
18)	CN1 port	Machine cable connection port. Used to connect the robot arm base (CN1) using the machine cable (CN1).
19)	CN2 port	Machine cable connection port. Used to connect the robot arm base (CN2) using the machine cable (CN2).
20)	CN3 port	Machine cable connection port. Used to connect the robot arm base (CN3) using the machine cable (CN3).
21)	Power cable entrance	The service hole from which the primary power supply cable can be accessed.
22)	Cable entrance	The service hole from which a cable other than the primary power supply cable can be accessed.
23)	Pressure regulating valve	Regulates pressure variations in the controller case, which are caused by the temperature difference.

*1　The power switch of the CR860 can be locked with a padlock or similar items to prevent operation. The customer needs to prepare a padlock.
　　☞ Page 74 How to use lockout
*2　For details on the dummy connector, refer to the T/B installation and removal instructions in the following manual:
　　📖 Controller setup, basic operation, and maintenance (BFP-A3783)

Inside the CR860 controller

R800CPU unit

Enlarged view of the R800CPU unit
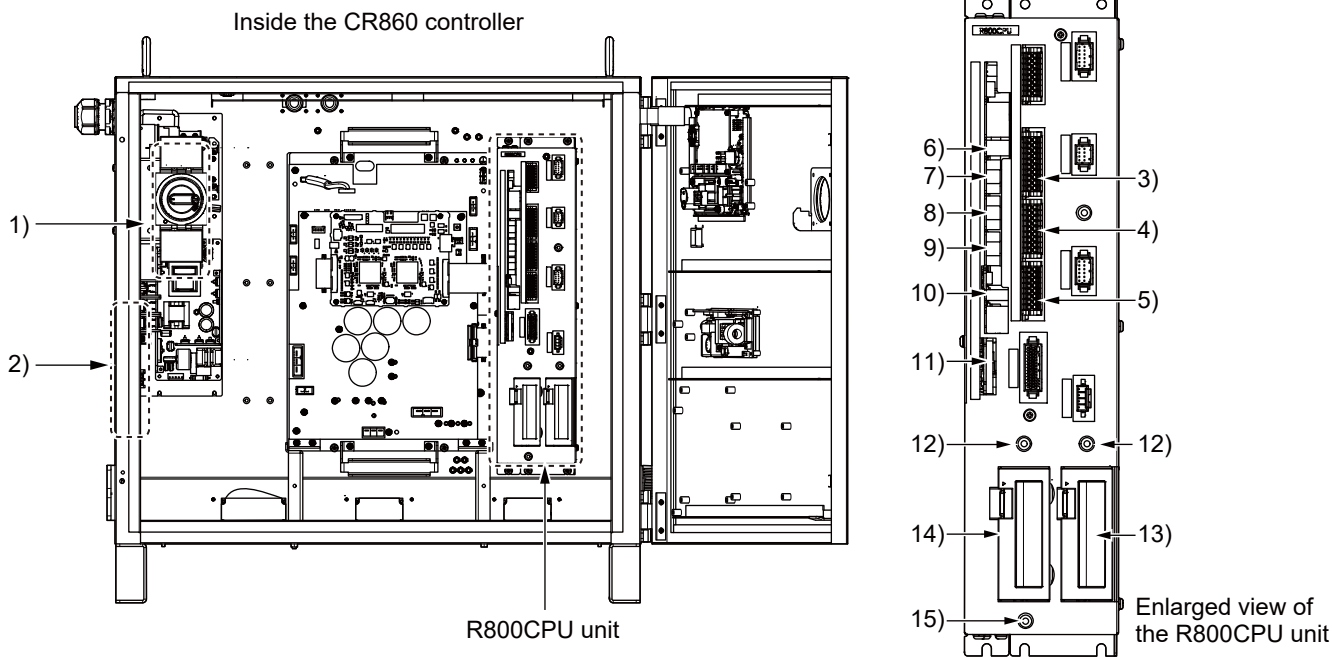
No.	Name	Description
1)	Earth leakage breaker	Connect the primary power supply.
2)	Grounding plate	Plate for grounding the cable. It is fixed to the side inside the robot controller. (Strip off the sheath of the cable and ground the controller case using this plate.)
3)	CNUSR11 port	Ports for robot I/O connection.
4)	CNUSR12 port	
5)	CNUSR13 port	
6)	RIO	Port used to connect the extension parallel I/O unit and safety option
7)	OPT1	Port used to connect the robot CPU. It is not available for the CR860-D controller.
8)	OPT2	Do not use.
9)	AXIS	Port used to connect an additional axis
10)	EXT2	Port for function extension. It is not available for the CR860-R/CR860-Q controllers.
11)	SD CARD	SD memory card slot. It is not available for the CR860-R/CR860-Q controllers.
12)	Functional ground terminal for option slot	Functional ground terminal for the cable connected to the optional card. (M4 screw × 1)
13)	Option slot (SLOT1)	Option card slots (a cover required when not used).
14)	Option slot (SLOT2)	
15)	Protective ground terminal for R800CPU unit	Terminal used for protective grounding of R800CPU unit. (M4 screw × 1)

Point

• What are operation rights?

Even when multiple devices, such as a T/B and computer, are connected to the controller, only one of the devices can operate the controller at a time. This single device has "operation rights".

• What operations require operation rights?

Operations that start the robot, such as starting a program or resetting an alarm, require operation rights. For safety reasons, operations that stop the robot, such as stopping a program or servo OFF, do not require operation rights.

For details on the functions related to operation rights, refer to the following manual:

📖 Detailed explanations of functions and operations (BFP-A3478)

How to use lockout

The following shows the procedure for locking the power switch.
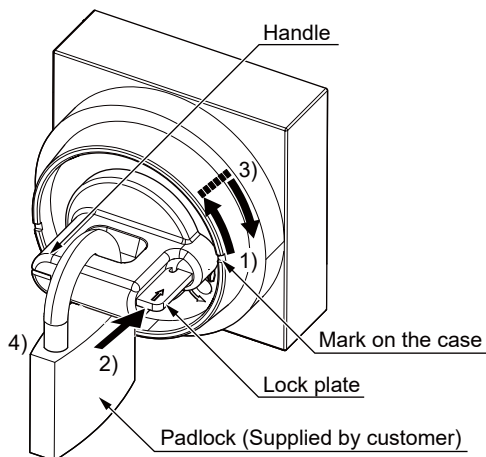
1. Turn the handle in the reset direction until the lock plate aligns with the mark on the case.

2. Push the lock plate.

3. Return the handle to the off position with the lock plate pushed.

4. Install the padlock by putting it through the hole in the middle of the handle.

■Compatible padlock

A padlock that satisfies the following conditions should be prepared by the customer.
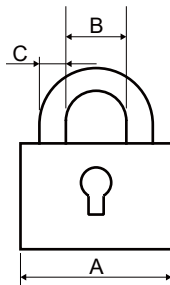
Dimensions (mm)		
A	B	C
35	19	5
40	22 or 23	5.5

How to use tagout

Attach a warning tag to the controller using either of the following methods:

- Hang a warning tag using the center hole on the power switch handle like a padlock.
- Affix a warning tag to the casing near the power switch with a magnet.

Robot CPU module

CR860-R controller

Side view

Bottom view

Front view

Front cover is opened
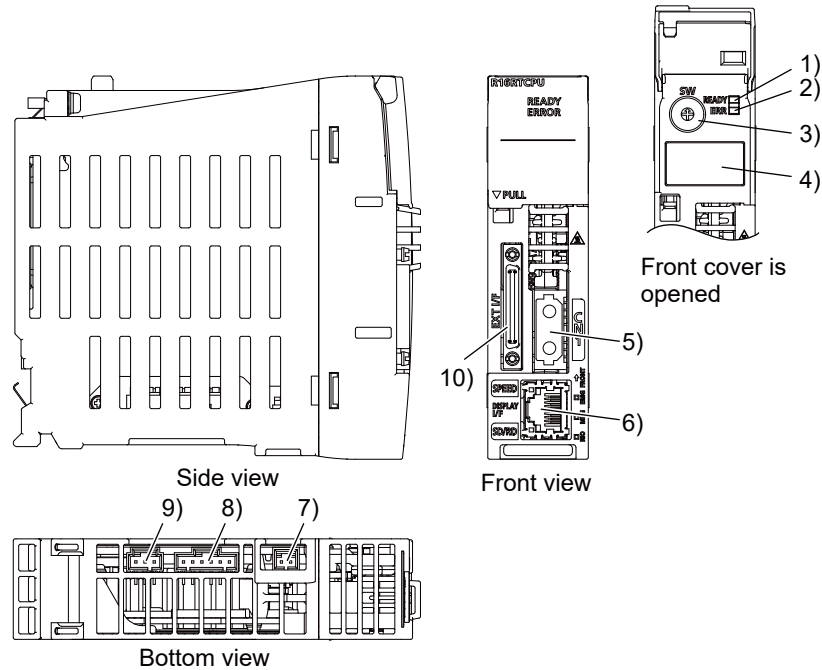
No.	Name	Description
1)	READY LED	Indicates the operation status of the robot CPU and an error status. [*1]
2)	ERROR LED	
3)	Rotary switch	Used for maintenance. Always set 0.
4)	Dot matrix LED	Indicates the operating status and error details (three digits).
5)	CN1 port	Used to connect to the OPT1 port on the controller using the SSCNET III cable.
6)	Network port	Ethernet connection port.
7)	EMG port	Not used.
8)	MPG port	Not used.
9)	RIO port	Not used.
10)	EXT I/F port	Not used.

*1 The following table shows the status of each LED; on, off, or flashing.

READY LED	ERROR LED	Operation status
Off	Off	Power is off or a hardware error occurred.
Flashing	Off	During initialization.
On	Off	During normal operation.
On	Flashing	A moderate error occurred.
Off	On or flashing	A critical error occurred.

CR860-Q controller

Side view

Front view

Front cover is opened

Bottom view
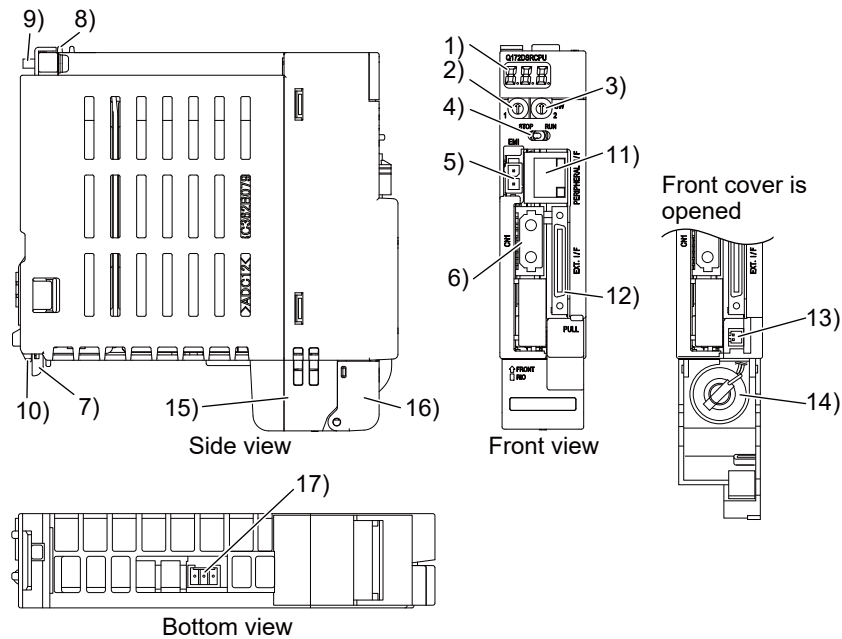
No.	Name	Description
1)	Seven segments LED	Indicates operating status and error details.
2)	Rotary switch (SW1)	Set the operation mode. Always set 0.
3)	Rotary switch (SW2)	Set the operation mode. Always set 0.
4)	RUN/STOP switch	Not used.
5)	Emergency stop input (EMI)	Not used.
6)	CN1 port [*1]	Used to connect to the OPT1 port on the controller using the SSCNET III cable. (Used to connect the servo amplifier of the robot arm.)
7)	Module mounting lever	Used to install the module to the base unit.
8)	Module fixing hook [*2]	Used to fix the module to the base unit. (To support installation work)
9)	Module fixing screw	Used to fix the module to the base unit. (M3 × 13)
10)	Module fixing projection	Used to fix the module to the base unit.
11)	PERIPHERAL I/F port	Ethernet connection port.
12)	EXT I/F port	Not used.
13)	Battery connector	Used to connect a battery.
14)	Battery [*3]	Used to store data. (Q6BAT)
15)	Battery holder	Used to hold the battery.
16)	Battery cover	Battery holder cover.
17)	RIO port	Not used.

*1 Please store cables in the duct or fix the cable section near robot CPU with the bunch wire rod so that prudence of the cables is not applied to the connector section.

*2 Used to support installation of the module on the main base unit. Always fix the module to the base unit with the attached fixing screws.

*3 Always use the external battery. Otherwise, the program in SRAM built in the robot CPU, parameters, origin position data, and other data are not held.

3.3 External dimensions and installation dimensions

External dimensions

Bottom view A

Robot CPU module

■CR860-R controller

■CR860-Q controller
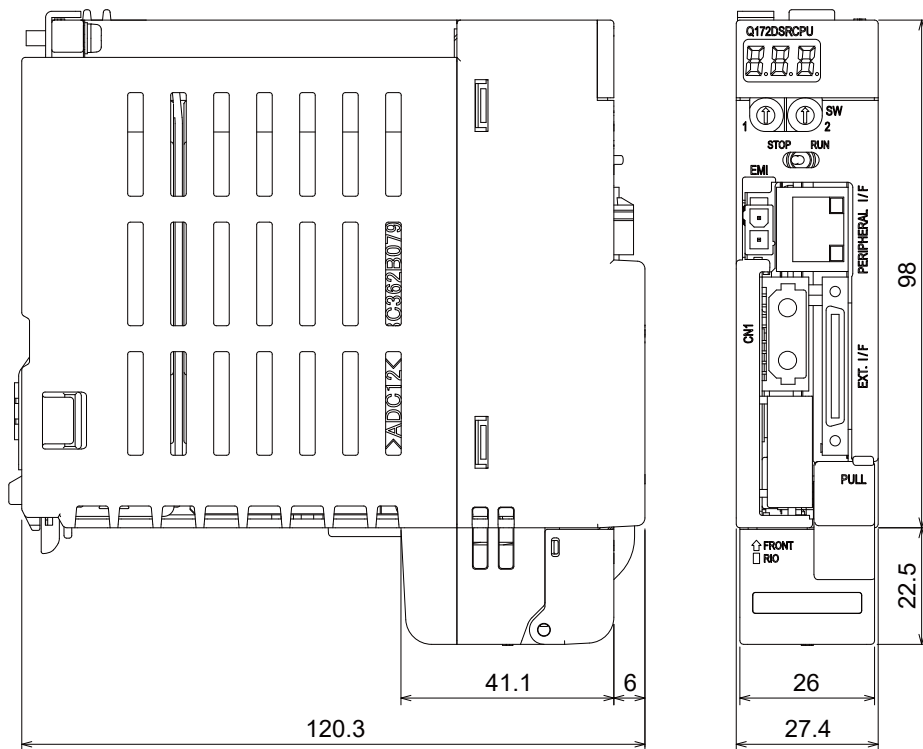
Installation dimensions

Robot controller

⚠ CAUTION

The controller takes in outside air for cooling, and exhausts the air.

The space required for cooling is 100mm or more. Leave a space of 500mm behind the controller for maintenance work.

The following figure shows the space required to install the controller.
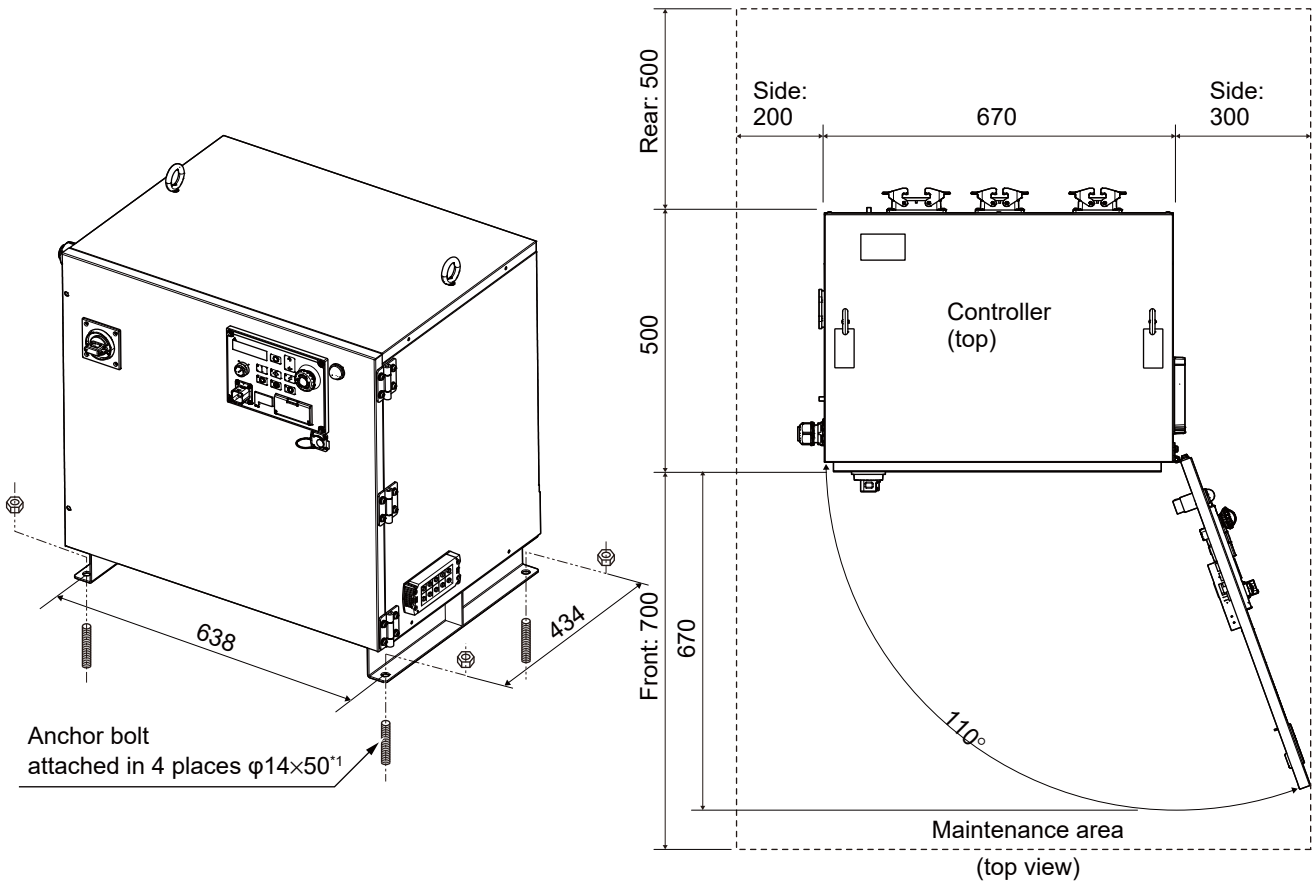
Anchor bolt
attached in 4 places φ14×50[*1]

638 434

Rear: 500

500

Front: 700

670

Side: 200

670

Side: 300

Controller
(top)

110°

Maintenance area
(top view)

*1   External vibration may cause the controller to fall or move, resulting in injury. It is recommended to fix the controller.
     Select anchor bolts that do not come out by more than 50mm from the installation surface.

Robot CPU module

Secure the following distance between both the top and bottom of the module and objects or parts for good ventilation and the facilitation of module replacement.

Ceiling of the control panel, wiring duct, or other parts

Robot CPU unit

5mm or more   5mm or more

40mm or more

100mm
or more

Door

100mm or more
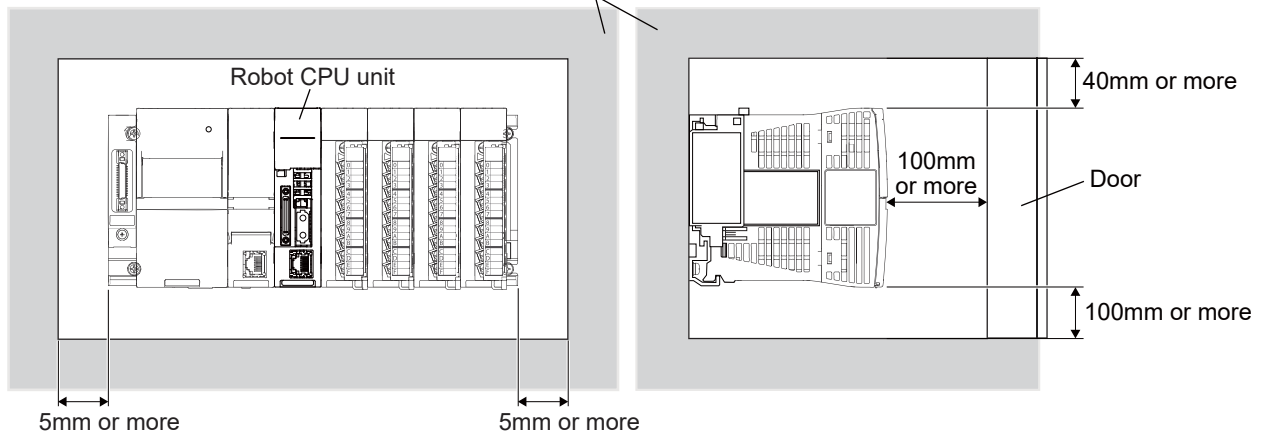
3.4 External I/O

Mode

No.	Mode	Description
1)	Dedicated I/O	Used for the robot remote operation and status display.
2)	General-purpose I/O	Used to create the user program for control of peripherals.
3)	Hand I/O	Used to create the user program related to the hand.
4)	External emergency stop input/special stop input/door switch input/enabling device input	For the wiring to ensure safety such as emergency stop, refer to the following pages: ☞ Page 83 Connecting external emergency stop input, special stop input, door switch input, enabling device input ☞ Page 150 Examples of safety measures
5)	Robot error output/emergency stop output/mode output/additional axis synchronization input	For the wiring to ensure safety such as emergency stop, refer to the following pages: ☞ Page 84 Connecting robot error output/emergency stop output/mode output/additional axis synchronization output ☞ Page 150 Examples of safety measures

By connecting the Mitsubishi Electric indicator, GOT2000 series to the controller via Ethernet, it is possible to control the input/output of the controller from GOT.

3.5　Dedicated I/O

The following table lists the functions of dedicated I/O. For information on other functions, refer to the following manual:
📖Detailed explanations of functions and operations (BFP-A3478)

Each parameter is used by designated the signal number, assigned in the order of input signal number and output signal number.

Parameter name	Input		Level *1	Output	
	Name	Function		Name	Function
TEACHMD	—		—	Teaching mode output signal	Outputs that the teaching mode is set.
ATTOPMD	—		—	Automatic mode output signal	Outputs that the automatic mode is set.
ATEXTMD	—		—	Remote mode output signal	Outputs that the remote mode is set.
RCREADY	—		—	Robot controller turned ON 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 number is fixed to 0. Note) Use the emergency stop input for the stop input signal related to safety.	L	Wait output signal	Outputs that the slot is temporarily stopped.
STOP2	Stop input signal	Stops the program that is currently running. Unlike the STOP parameter, the signal number can be changed. Note) Specifications are the same as those of the STOP parameter.	L	Wait output signal	Outputs that the program is paused. Note) Specifications of this signal are the same as those of the STOP parameter.
SLOTINIT	Program reset input signal	Releases 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	Releases the error state.	E	Error occurring output signal	Outputs that an error has occurred.
CYCLE	Cycle stop input signal	Starts the cycle stop.	E	In cycle stop operation output signal	Outputs that the cycle stop is operating.
SRVOFF	Servo OFF input signal	Turns off the servo for all mechanisms.	L	Servo ON disabled output signal	Outputs the servo ON disabled state. (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/releases the machine lock state for all mechanisms.	E	Machine locking output signal	Outputs that the machine is locked.
SAFEPOS	Home position return input signal	Requests the operation to return to the home position.	E	Home position returning input signal	Outputs that the operation to return to the home position is executing.
OUTRESET	General-purpose output signal reset	Resets the general-purpose output signal.	E	—	
EMGERR	—		—	Emergency output signal	Outputs that an emergency stop has occurred.
S1START ⋮ S32START	Start input	Starts each slot.	E	Operating output	Outputs the operating state for each slot.

3

Parameter name	Input			Level [1]	Output	
	Name	Function			Name	Function
S1STOP ⋮ S32STOP	Stop input	Stops each slot.		L	Waiting output signal	Outputs that each slot is temporarily stopped.
PRGSEL	Program selection input signal	Selects the value set for the program number with numeric value input signals.		E	—	
OVRDSEL	Override selection input signal	Specifies the value set for the override with numeric value input signals.		E	—	
IODATA [2]	Numeric value input (start No., end No.)	Used to specify the program name, override value, and mechanism number.		L	Numeric value output (start No., end No.)	Used to output the program name, override value, and mechanism number.
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 number.		E	Line No. output signal	Outputs that the line number is being output to the numeric value output signal.
OVRDOUT	Override value output request	Requests output of the override value.		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 output of the error number.		E	Error No. output signal	Outputs that the error number 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	—	
JOG-	Jog feed - side for 8-axes	Requests the - side jog operation.		L	—	
HNDCNTL1	—			—	Hand output signal status	Outputs the status of the hand output 764 to 771.
HNDSTS1	—			—	Hand input signal status	Outputs the status of the hand input 764 to 775.
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 has occurred.
AIRERR1 ⋮ AIRERR3	Pneumatic pressure error 1 input signal ⋮ Pneumatic pressure error 3 input signal	Requests the pneumatic pressure error occurrence.		L	Pneumatic pressure error 1 output signal ⋮ Pneumatic pressure error 3 output signal	Outputs that a pneumatic pressure error has occurred.
M1PTEXC ⋮ M3PTEXC	—			L	Maintenance parts replacement time warning signal	Outputs that the maintenance parts have reached the replacement time.
USRAREA [3]	—			—	User-designated area 32-points	Outputs that the robot is in the user-designated area.

*1   The level represents 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 OFF to ON, and the function maintains the original state even when the signal then turns OFF.
*2   Four elements are set in the order of input signal start number, end number, output signal start number, and end number.
*3   Up to 32 points can be set successively in order of start output signal number and end output signal number.

3.6 External emergency stop I/O/special stop input/ door switch input/enabling device input

Connecting external emergency stop input, special stop input, door switch input, enabling device input

> ⚠ **CAUTION**
>
> When installing or connecting a unit or cable to inside the robot controller, do not touch the conductive parts, circuit boards, or electronic components directly. Failure to observe this may result in malfunction or failure of the controller.
>
> Do not connect a power supply other than the one supplied from the inside of the controller to the input terminal. Doing so may cause a malfunction.
>
> Noise or other effects that overload contact capacities will lead to failure.
>
> Do not ground the + side of the customer device's 24V power supply for input (external emergency stop and parallel input) that is used to connect the controller. Connecting the controller with the + side grounded may cause a failure of the controller.
>
> If a stop signal or servo OFF signal is input simultaneously with a door switch open/external emergency stop input, the error "H056n: Servo sys. error (A/D)" may occur.
>
> When a door switch open/external emergency stop is input, the servos will be turned off after the robot stops. It is not necessary to input a stop signal or servo OFF signal. To input a stop signal or servo OFF signal simultaneously, wait for 100ms or more after a door switch open/external emergency stop has been input before inputting the signal.

 • An example of connecting devices such as PLCs
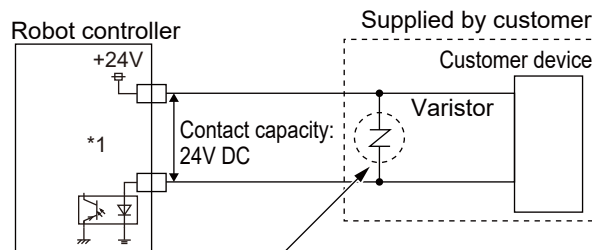
*1: The actual internal controller circuit differs from the internal robot controller circuit in the figure.
The following table lists recommended varistors.

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

Wire the external emergency stop input, special stop input, door switch input, and enabling device input from the "dedicated I/O" terminal connector. The following table lists dedicated I/O terminals.

For information on the connection of external emergency stop input, door switch input, and enabling device input, refer to the following page:

☞ Page 87 Connection diagram of external emergency stop input, door switch input, enabling device input

For information on wiring of other devices, refer to the following table.

Item	Name	Description
Input	External emergency stop input	Applies the emergency stop. Use duplicate NC contacts for redundancy.
Input	Special stop input	Applies the stop. For details, refer to the following page: ☞ Page 92 Special stop input (SKIP)
Input	Door switch input	Turns off the servos. Use duplicate NC contacts for redundancy. For details, refer to the following page: ☞ Page 93 Door switch functions
Input	Enabling device input	Turns off the servos. Use duplicate NC contacts for redundancy. For details, refer to the following page: ☞ Page 94 Enabling device functions

Connecting robot error output/emergency stop output/mode output/additional axis synchronization output

⚠ CAUTION

When installing or connecting a unit or cable to inside the robot controller, do not touch the conductive parts, circuit boards, or electronic components directly. Failure to observe this may result in malfunction or failure of the controller.

The contact capacity of each output terminal is 24V DC and rated 100mA. Do not connect a device that exceeds the range.

Noise or other effects that overload contact capacities will lead to failure.

Do not ground the + side of the customer device's 24V power supply for output (external emergency stop and parallel output) that is used to connect the robot controller. Connecting the controller with the + side grounded may cause a failure of the controller.

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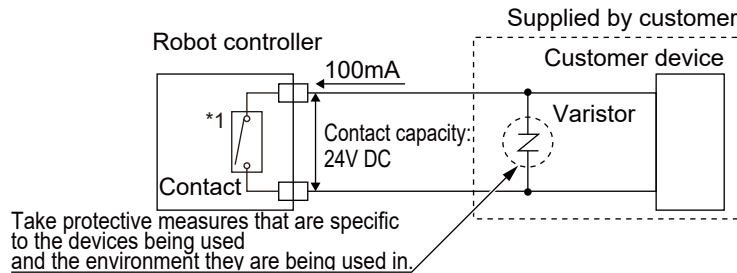
• An example of connecting devices such as relays
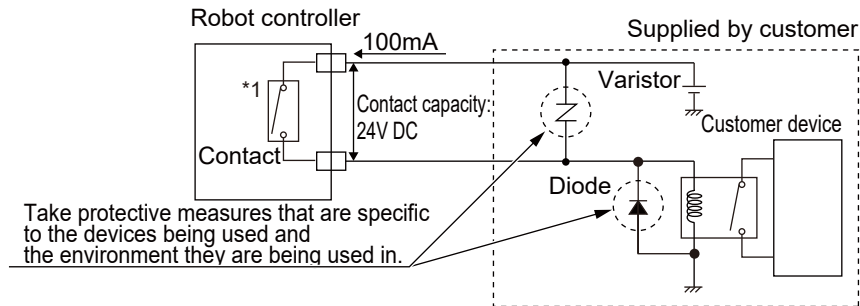
*1: The actual internal controller circuit differs from the internal robot controller circuit in the figure.

The following table lists recommended varistors.

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

Wire the robot error output, emergency stop output, mode output, and additional axis synchronization output from the "dedicated I/O" terminal connector. The following table lists dedicated I/O terminals.

For information on wiring of other devices, refer to the following table.

Item	Name	Description
Output	Robot error output	The contact is open while an error is occurring.
Output	Emergency stop output	The contact opens during external emergency stop input, OP emergency stop input, or T/B emergency stop input.
Output	Mode output	The contact is open during MANUAL mode, and close during AUTOMATIC mode.
Output	Additional axis synchronization output	Used to synchronize the servo ON/OFF state of the additional axis to that of the robot arm. For details, refer to the following page: ☞ Page 97 Additional axis synchronization output

The output contact is always open when the power is off.

Connecting external emergency stop input, door switch input, enabling device input

⚠ CAUTION

- When installing or connecting a unit or cable to inside the robot controller, do not touch the conductive parts, circuit boards, or electronic components directly. Failure to observe this may result in malfunction or failure of the controller.
- Make sure there are no mistakes in the wiring. Connecting differently in the way specified in the manual can result in errors, such as the external emergency stop not being released. In order to prevent errors occurring, be sure to check that all functions (such as the teaching pendant emergency stop, customer external emergency stop, and door switch) are working properly after wiring is complete.
- Wire the external emergency stop, door switch, and enabling device so that they are redundant. If not, the function may not operate properly at the time the relay fails. The robot output contacts (error output, emergency stop output, mode output, additional axis synchronization output) are redundant output contacts that are wired in series. As with external emergency stop and door switches, ensure that all connections to customer devices are duplicated to achieve redundancy.
- If using several external emergency stop switches, be sure to wire them so that they can function independently. Ensure that the switches can function only when the AND condition is met (multiple external emergency stop switches are on).
- The external emergency stop circuit inside the controller is a redundant (duplicated) configuration. Use a 2-contact type external emergency stop switch, and be sure to connect both of the contacts to the connector pins as shown below in order to ensure the wiring is duplicated. If only one of the pins is connected, an error cannot be cleared.
- Use shielded cables for the external emergency stop wiring cable and special stop input wiring cable. Additionally, if using the product in an environment that is easily affected by noise, install a ferrite core (recommended model: E04SR301334 manufactured by SEIWA ELECTRIC MFG CO.Ltd) to the shielded cables. Ensure that the ferrite core is installed within 300mm of the connection terminal.

The following shows how to connect external emergency stop input, door switch input, and enabling device input.

Connect external emergency stop input, door switch input, and enabling device input to the connector of the controller (refer to the figure below).

The external emergency stop input, door switch input, and enabling device input terminals are arranged as shown on the following page. Be sure to prepare devices such as external emergency stop switches, door switches, and enabling devices, and connect them before using the robot. The following shows the connection procedure.

1. Prepare external emergency stop switches, door switches, and enabling devices.

2. Connect the contacts of each switch to the following pins.

- External emergency stop switch

"Pins 1-11" and "pins 6-16" of the CNUSR11 connector

- Door switch

"Pins 4-14" and "pins 9-19" of the CNUSR11 connector

- Enabling device

"Pins 5-15" and "pins 10-20" of the CNUSR11 connector

For the connection diagram of external emergency stop input, door switch input, and enabling device input, refer to the following page:

Also refer to the following page for external emergency stop and other connection examples and precautions.

CNUSR11 port

Inside the CR860 controller

Enlarged view of the R800CPU unit
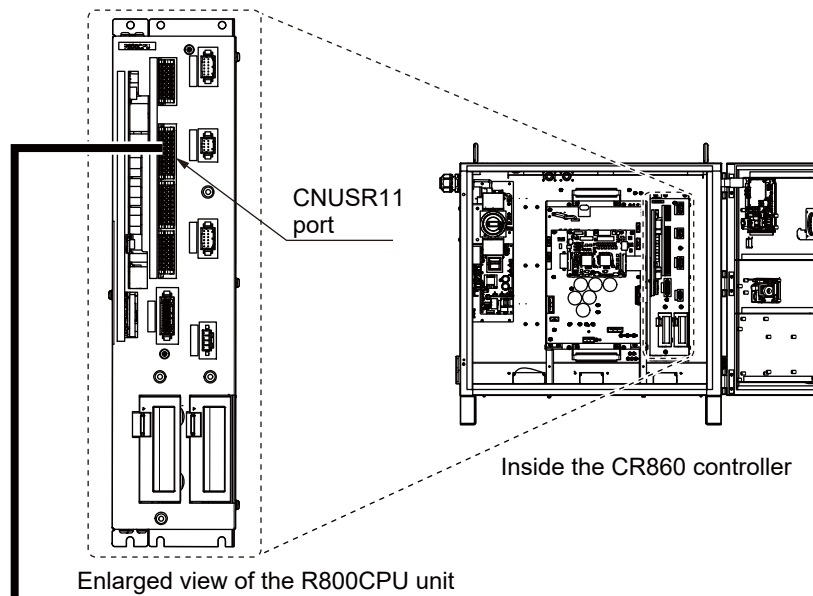
For details on examples of connecting external emergency stop input, door switch input, and enabling device input, positions of dedicated I/O connectors, and pin assignment, refer to the following table.

Item	Reference
Example of connecting external emergency stop input, door switch input, enabling device input	☞ Page 87 Connection diagram of external emergency stop input, door switch input, enabling device input
Position and pin assignment of the dedicated I/O connector	📖 Controller setup, basic operation, and maintenance (BFP-A3783)

Connection diagram of external emergency stop input, door switch input, enabling device input

⚠ WARNING

Do not carry out an insulation pressure test.

Moreover, incorrect connection may cause a malfunction.

⚠ CAUTION

Place an external emergency stop switch in an easily operable position, and be sure to wire the switch to the external emergency stop input by referring to the following.

☞ Page 150 Examples of safety measures

This measure is required to ensure safety by pressing the external emergency stop switch to stop failed robots immediately.
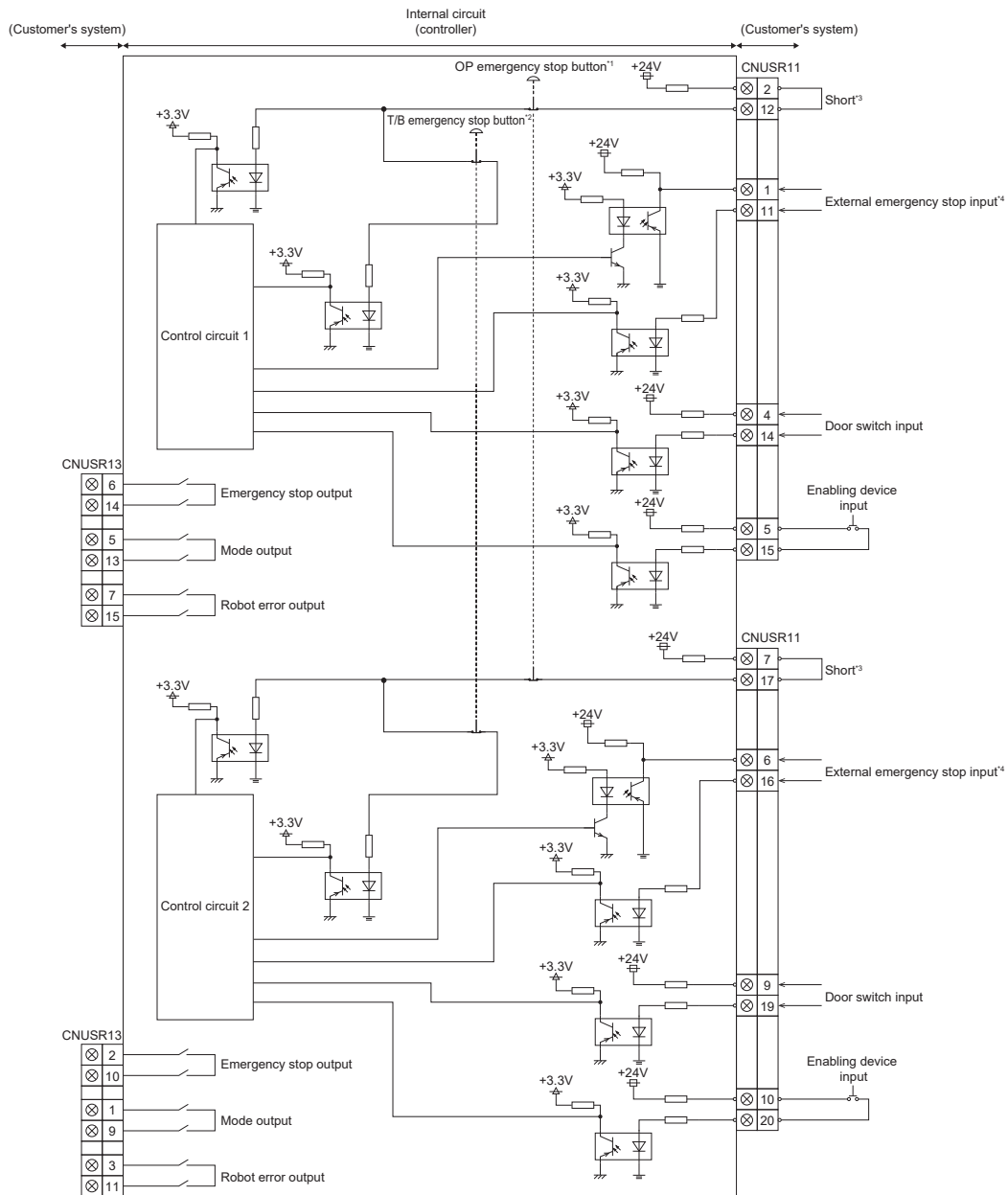
*1   This is the emergency stop button on the front of the robot controller.

*2   This is the emergency stop button of the T/B that is connected to the robot controller.

*3   The terminals are open (unconnected) from the factory. Short-circuit them if using the power supply inside the controller.

*4   The terminals can be used only for the external emergency stop input to the robot controller.

Position of dedicated I/O connectors

The following figure shows the position of dedicated I/O connectors.

For information on the pin assignment of connectors, refer to the following page:

Inside the CR860 controller

Enlarged view of the R800CPU unit
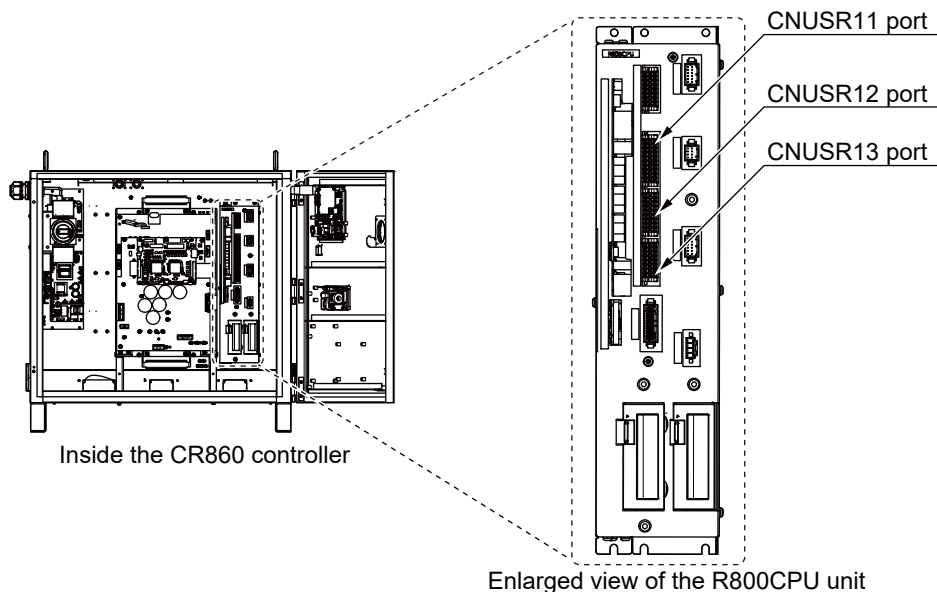
■Pin assignment

• CNUSR11

Pin No.	Name	Function	Remarks	Pin No.	Name	Function	Remarks
1	EXTEMG11	External emergency stop input (common): Channel 1	Constructing an external emergency stop function. Paired with pin 11	11	EXTEMG12	Emergency stop output: Channel 1	Constructing an external emergency stop function. Paired with pin 1
2	TBOPEMG11	T/B and OP emergency stop power supply input: Channel 1	Paired with pin 12	12	TBOPEMG12	T/B and OP emergency stop input: Channel 1 (1)	Paired with pin 2
3	TBOPEMGOUT1	T/B and OP emergency stop input: Channel 1 (1)	Paired with pin 13	13	EXT-GND (RG1)	External power supply GND: Channel 1	Paired with pin 3
4	DOOR11	Door switch input (common): Channel 1	Detecting the opening and closing of a door. Paired with pin 14	14	DOOR12	Door switch input: Channel 1	Detecting the opening and closing of a door. Paired with pin 4
5	ENA11	Enabling device input (common): Channel 1	Paired with pin 15	15	ENA12	Enabling device input: Channel 1	Paired with pin 5
6	EXTEMG21	External emergency stop input (common): Channel 2	Constructing an external emergency stop function. Paired with pin 16	16	EXTEMG22	Emergency stop output: Channel 2	Constructing an external emergency stop function. Paired with pin 6
7	TBOPEMG21	T/B and OP emergency stop power supply input: Channel 2	Paired with pin 17	17	TBOPEMG22	T/B and OP emergency stop input: Channel 2 (1)	Paired with pin 7
8	TBOPEMGOUT2	T/B and OP emergency stop input: Channel 2 (1)	Paired with pin 18	18	EXT-GND (RG1)	External power supply GND: Channel 2	Paired with pin 8
9	DOOR21	Door switch input (common): Channel 2	Detecting the opening and closing of a door. Paired with pin 19	19	DOOR22	Door switch input: Channel 2	Detecting the opening and closing of a door. Paired with pin 9
10	ENA21	Enabling device input (common): Channel 2	Paired with pin 20	20	ENA22	Enabling device input: Channel 2	Paired with pin 10

• CNUSR12

| Pin No.	Name	Function	Remarks	Pin No.	Name	Function	Remarks
1	SKIP41	SKIP41 input (common)	Paired with pin 10	10	SKIP42	SKIP42 input	Paired with pin 1
2	SKIP31	SKIP31 input (common)	Paired with pin 11	11	SKIP32	SKIP32 input	Paired with pin 2
3	SKIP21	SKIP21 input (common)	Paired with pin 12	12	SKIP22	SKIP22 input	Paired with pin 3
4	SKIP11	Special stop input common (COM)	Paired with pin 13	13	SKIP12	Special stop input	Paired with pin 4
5	LBH2	+ (plus) side of differential encoder B-phase signal CH2	Encoder input of a tracking function CH2	14	LBL2	- (minus) side of differential encoder B-phase signal CH2	Encoder input of a tracking function CH2
6	LAH2	+ (plus) side of differential encoder A-phase signal CH2		15	LAL2	- (minus) side of differential encoder A-phase signal CH2	
7	ENC5V	5V for encoder signal	5V input	16	RG	GND for encoder signal	5V input
8	LBH1	+ (plus) side of differential encoder B-phase signal CH1	Encoder input of a tracking function CH1	17	LBL1	- (minus) side of differential encoder B-phase signal CH1	Encoder input of a tracking function CH1
9	LAH1	+ (plus) side of differential encoder A-phase signal CH1		18	LAL1	- (minus) side of differential encoder A-phase signal CH1	

• CNUSR13

Pin No.	Name	Function	Remarks	Pin No.	Name	Function	Remarks
1	MODEOUT11	Mode output: Channel 1	Checking the controller operation mode. Paired with pin 9	9	MODEOUT12	Mode output: Channel 1	Checking the controller operation mode. Paired with pin 1
2	EMGOUT11	Emergency stop output: Channel 1	Checking whether an emergency stop has occurred. Paired with pin 10	10	EMGOUT12	Emergency stop output: Channel 1	Checking whether an emergency stop has occurred. Paired with pin 2
3	ROBOTERR11	Robot error output: Channel 1	Paired with pin 11	11	ROBOTERR12	Robot error output: Channel 1	Paired with pin 3
4	AXMC11	Additional axis synchronization output: Channel 1	Synchronizing an additional axis to the robot's servo ON/OFF. Paired with pin 12	12	AXMC12	Additional axis synchronization output: Channel 1	Synchronizing an additional axis to the robot's servo ON/OFF. Paired with pin 4
5	MODEOUT21	Mode output: Channel 2	Checking the controller operation mode. Paired with pin 13	13	MODEOUT22	Mode output: Channel 2	Checking the controller operation mode. Paired with pin 5
6	EMGOUT21	Emergency stop output: Channel 2	Checking whether an emergency stop has occurred. Paired with pin 14	14	EMGOUT22	Emergency stop output: Channel 2	Checking whether an emergency stop has occurred. Paired with pin 6
7	ROBOTERR21	Robot error output: Channel 2	Paired with pin 15	15	ROBOTERR22	Robot error output: Channel 2	Paired with pin 7
8	AXMC21	Additional axis synchronization output: Channel 2	Synchronizing an additional axis to the robot's servo ON/OFF. Paired with pin 16	16	AXMC22	Additional axis synchronization output: Channel 2	Synchronizing an additional axis to the robot's servo ON/OFF. Paired with pin 8

3

■How to wire user wiring connectors

The following figure shows the wiring position of user wiring connectors.

Enlarged view A:
Connector pin numbers

Enlarged view
of the R800CPU unit
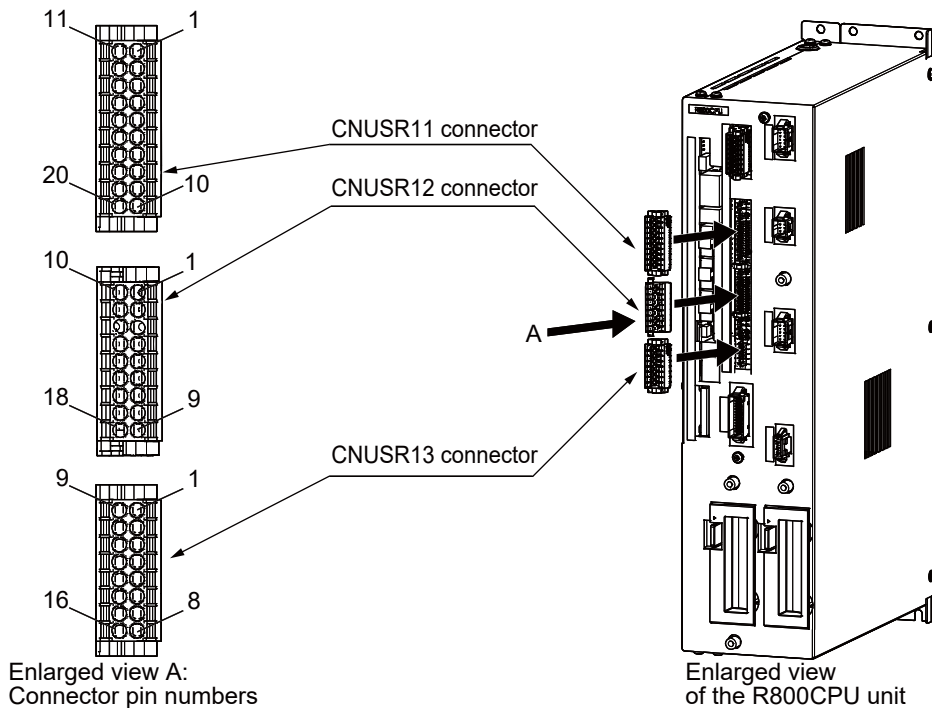
The following shows how to wire cables to the connector.
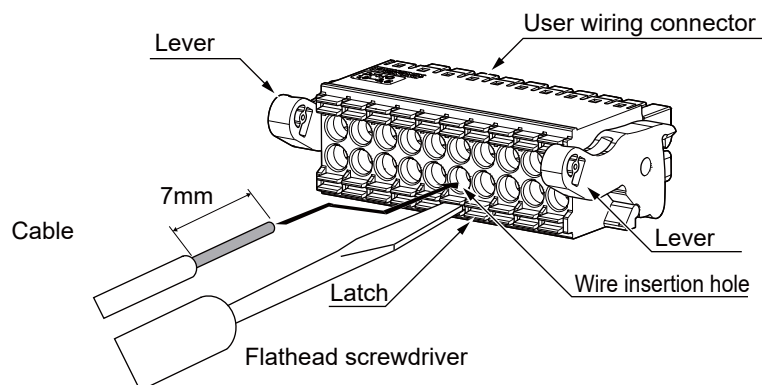
Wire cables to the user wiring connector (attachment) and attach the connector to the CNUSR11, CNUSR12, or CNUSR13 port on the R800CPU unit.

The customer needs to prepare the following items.

· Cable: #24 to 16 AWG (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 7mm of the cable sheath.

3. Insert the cable all the way into the insertion hole, pressing down the latch on the user wiring connector with a flathead screwdriver.

4. Once wiring is complete, attach the user wiring connector to the corresponding port (CNUSR11/CNUSR12/CNUSR13) on the R800CPU unit.

5. Inserting the connector completely will lift the levers on both sides of the connector and fix the connector. (To remove the connector, move the levers down.)

⚠ CAUTION

- To prevent incorrect wiring, carefully check the numbers of the cable insertion hole (connector pin numbers). Connecting a cable to the wrong hole may cause a failure or error of the robot.
- When wiring the CNUSR11, CNUSR12, or CNUSR13 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.

Special stop input (SKIP)

⚠ CAUTION

Do not ground the + side of the customer device's 24V power supply for input/output (emergency stop and parallel I/O) that is used to connect the controller.
Connecting the controller with the + side grounded may cause a failure of the controller.

The SKIP is the input signal to stop the robot. Connect the pin 4 and 13 of the CNUSR12 connector as shown below.

Item		Specifications	Internal circuit
Type		DC input	
Number of input points		1	
Insulation method		Photo-coupler insulation	
Rated input voltage		24V DC	
Rated input current		Approx. 11mA	
Allowable voltage range		21.6 to 26.4V DC (ripple ratio: within 5%)	
ON voltage/ON current		8V DC or higher/2mA or higher	
OFF voltage/OFF current		4V DC or lower/1mA or lower	
Input resistance		Approx. 2.2kΩ	
Response time	OFF-ON	1ms or less	
	ON-OFF	1ms or less	
Common method		1 point per common	
External wiring method		Connector	

Internal circuit: 4 +24V(COM), 330, 13 Input, 2.2K

CNUSR12 port

Inside the CR860 controller

Enlarged view of the R800CPU unit

Refer to the following page for information on how to wire the connector.

Door switch functions

This function uses the status of door switches to turn off robot servos when the door of a machine guard is opened.

Perform wiring so that the contact opens when the door is opened.
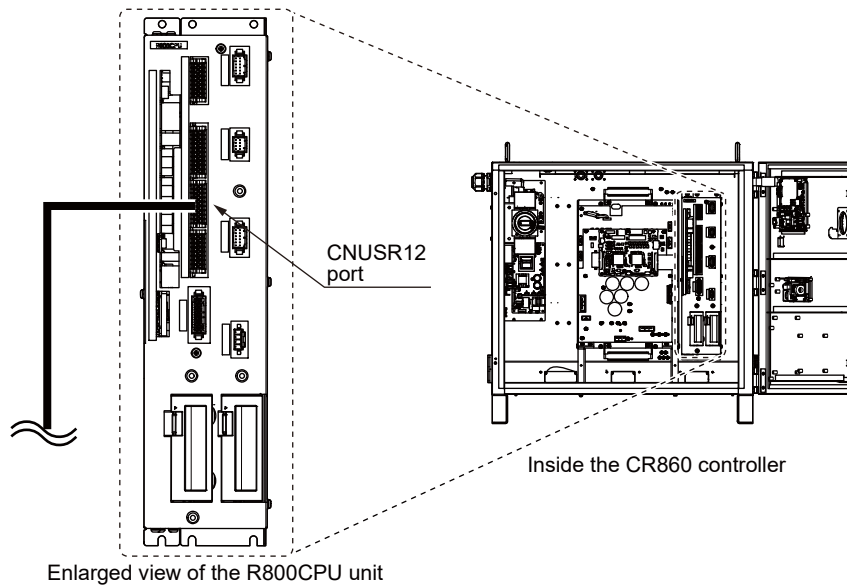
For the connection method, refer to the following pages:

☞ Page 90 How to wire user wiring connectors

☞ Page 150 Examples of safety measures

Details of this function according to the robot status are shown below.

No.	Status	Description
1)	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.
2)	During teaching	Even when the door is opened, using a selector switch allows to turn on the servo with the T/B to operate the robot.

1) During automatic operation

Safety fence

Open

Robot arm (example)

STOP!!

Motor power shut-off

2) During teaching

Safety fence

Open

Robot arm (example)

T/B operation

Turning on/off the three-position enable switch turns on/off the motor power.
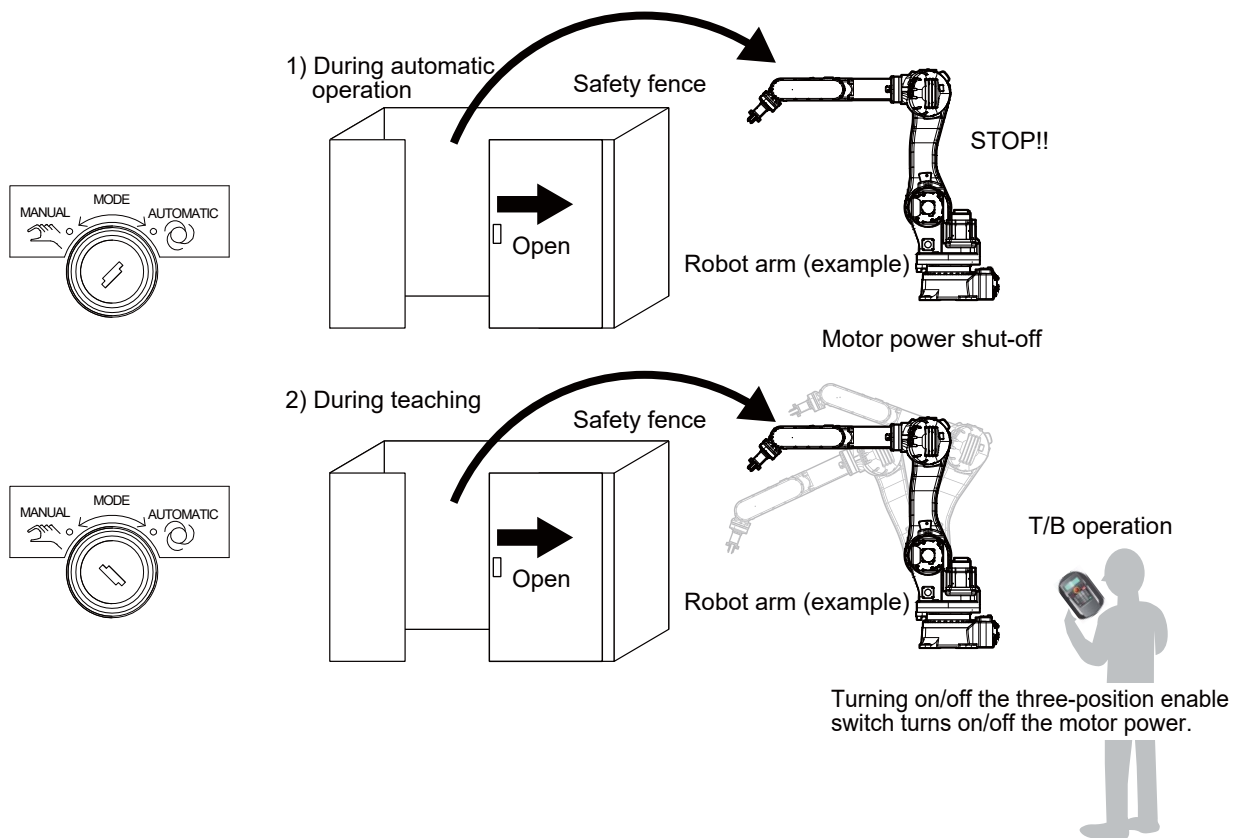
Enabling device functions

If an error occurs during an operation such as teaching, operating the switch on the enabling device will power off the robot servos immediately (Servo OFF), thus increasing safety. Always connect an enabling device to use a robot safety.

The recommended enabling device is shown below.

Manufacturer: IDEC Corporation

Model: HE1G-L20MB

If using a product other than the recommended product, select an enabling device that meets the following conditions:
 • A device that complies with IEC60204-1 (2018), ISO10218-1 (2011), and ISO13849-1 (2015)..
 • The device is a 3-position enabling device.

A 3-position enabling device has a switch with three positions, and each position of the switch indicates the following modes:

a) Not pressed: The robot cannot operate. [*1]

b) Lightly pressed: It is possible to operate the robot and teach it. [*2]

c) Forcefully pressed: The robot cannot operate. [*1]

* The operation is the same regardless of whether the switch is pressed (pulled) in the left or right direction.

 [*1] 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).

 [*2] When using the CR860 controller, keep the enabling switch lightly pressed down even if using step operation to execute commands that do not operate the robot.

Operation when a door is open

Use two people when operating the robot (during teaching, etc.).

To turn the servos on, one person must operate the T/B and the other must operate the enabling device. The T/B 3-position enable switch and the switch on the enabling device must be held down at the same time. Releasing the enabling device switch will turn off the servos immediately. While the enabling device switch is released, the servos cannot be turned on and the brakes cannot be released.

When using the CR860 controller, keep the switches on the T/B and enabling device lightly pressed down if operating the robot using step operation.

Operation when a door is closed

No operation is required on the device. Operating the T/B will turn on the servo. In this case, perform jog operation outside the safeguard.

Required switch statuses for automatic operation, jog operation, and brake release

⚠ CAUTION

The robot arm may fall under its own weight depending on which brake is released.
Take steps such as supporting the arm to prevent it falling under its own weight.

The table below shows the required switch statuses for each operation.

No.	Operation	Required switch status [1]					Description
		Controller mode	[T/B ENABLE] switch	T/B 3-position enable switch	Enabling device input terminal	Door switch input terminal	
1)	Jog Operation	Manual	Enabled	ON	Closed (ON)	—	The status of the door switch input will not be requested when the enabling device input is closed (ON).
2)	Jog Operation [2]	Manual	Enabled	ON	Open (OFF)	Closed (door closed)	The door switch input status must be "closed" (door closed) when the enabling device input is open (OFF).
3)	Release brakes [3]	Manual	Enabled	ON	Closed (ON)	—	The enabling device input must be closed (ON) regardless of the status of the door switch input.
4)	Automatic operation	Automatic	Disabled	—	—	Closed (door closed)	The door switch input status must be "closed" (door closed).

*1   "—" indicates that the status of the switch will not be requested.
For operation of each switch, refer to the following table.

Switch	Reference
CR860 controller mode	☞ Page 71 Part Names
[T/B ENABLE] switch	☞ Page 99 Simple teaching pendant (T/B)
T/B 3-position enable switch	☞ Page 99 Simple teaching pendant (T/B)
Enabling device input terminal	☞ Page 150 Examples of safety measures
Door switch input	☞ Page 150 Examples of safety measures

*2   When the door switch input status is "closed" (door closed), perform jog operation outside the safeguard.
*3   Two people are required to release the brakes. One person should hold down the enabling device switch (input terminals closed) while the other holds down the T/B 3-position enable switch. The brakes can be released by pressing the enabling device switch and T/B 3-position enable switch on the teaching pendant to their half-way positions (position when switch pressed lightly). The input status of the door switch will not be requested.

Door opened

Enabling device operation

T/B operation
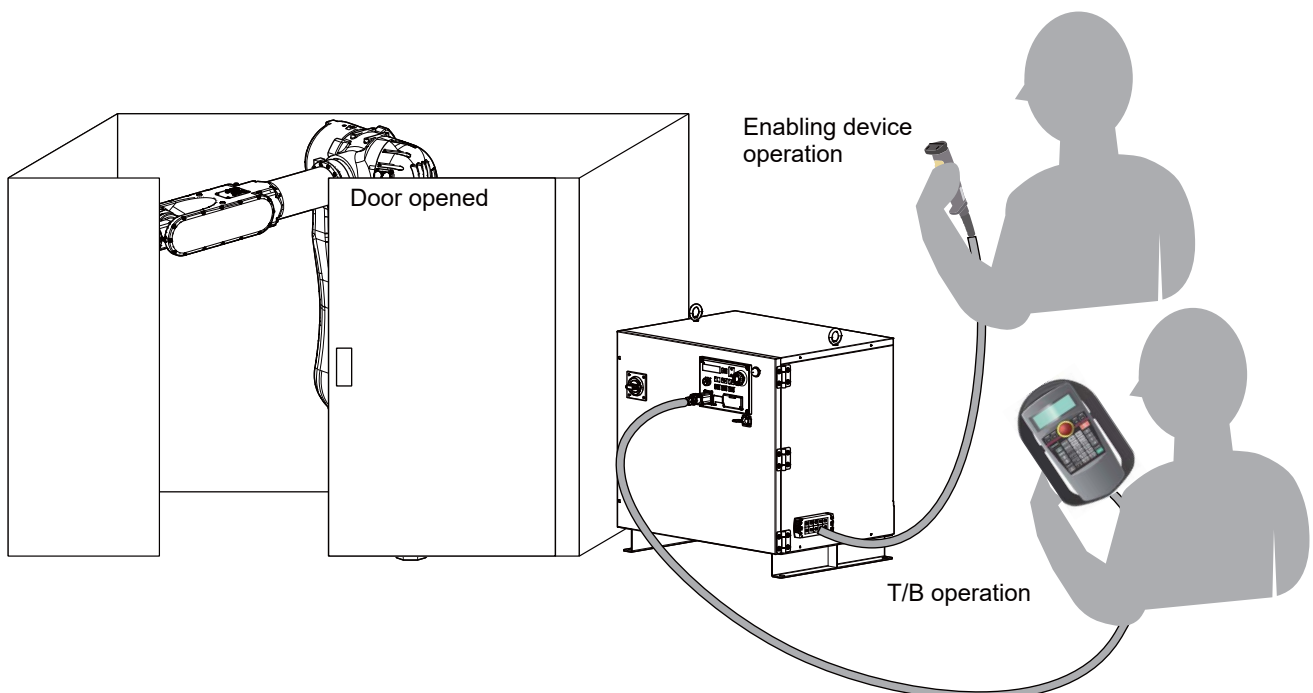
3.7 Additional axis function

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 that supports Mitsubishi Electric's SSCNET III. For details on the additional axis function, refer to the following manual:

📖Additional axis function (BFP-A3504)

Wiring of the additional axis interface

The connector dedicated to additional axes of the controller is shown below.

Also, the following figure shows a connection example (configuration example).

Name	Connector	Details
Connector for additional axes	AXIS	Used to connect the general-purpose servo amplifier.

Enlarged view of the R800CPU unit
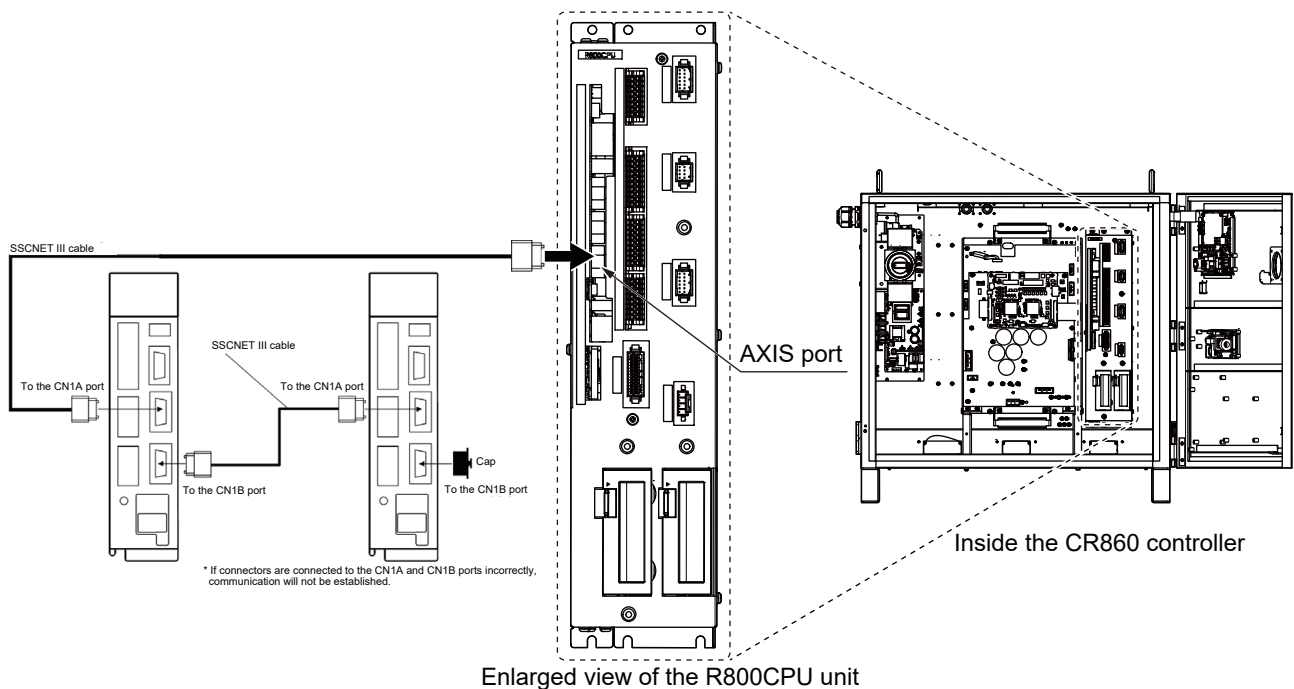
To connect a cable to the additional axis port on the R800CPU unit, wire the cable through the cable entrance on the controller.

📖Controller setup, basic operation, and maintenance (BFP-A3783)

Installation of the noise filter

For information on recommendation filters and how to install the noise filter, refer to the following manual:

📖MELSERVO-J4 SSCNET III/H Interface Servo Amplifier Instruction Manual

3.8 Additional axis synchronization output

If the additional axis function is used, the state of an additional axis (servo ON/OFF) can be synchronized with that of the robot arm in the following way: Configuring a circuit so that the power of the servo amplifier for the additional axis can be shut off by opening the output contact (additional axis synchronization output: AXMC) installed in the controller.

Refer to the following page for a circuit example.

For an image of how to connect the connector, refer to the following page:

If using the additional axis function, connect an appropriate circuit by referring to the figure.

For details on the additional axis function, refer to the following page:

📖 Additional axis function (BFP-A3504)

Do not connect this output signal if using the additional axis function as a user mechanism that operates separately from the robot arm. The user mechanism cannot be brought to the servo ON state in some cases.

Example circuit

⚠ CAUTION

- 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.
- Additional axis synchronization output signals are not safety signals. Keep in mind when reducing risks by taking protective measures using additional axis synchronization signals. When considering protective measures, refer to the instruction manual of the amplifier being used as well.
- To reduce risks by shutting off the power of the amplifier using a contactor, we recommend to install an emergency stop switch that interrupts the opening/closing signals of the contactor.
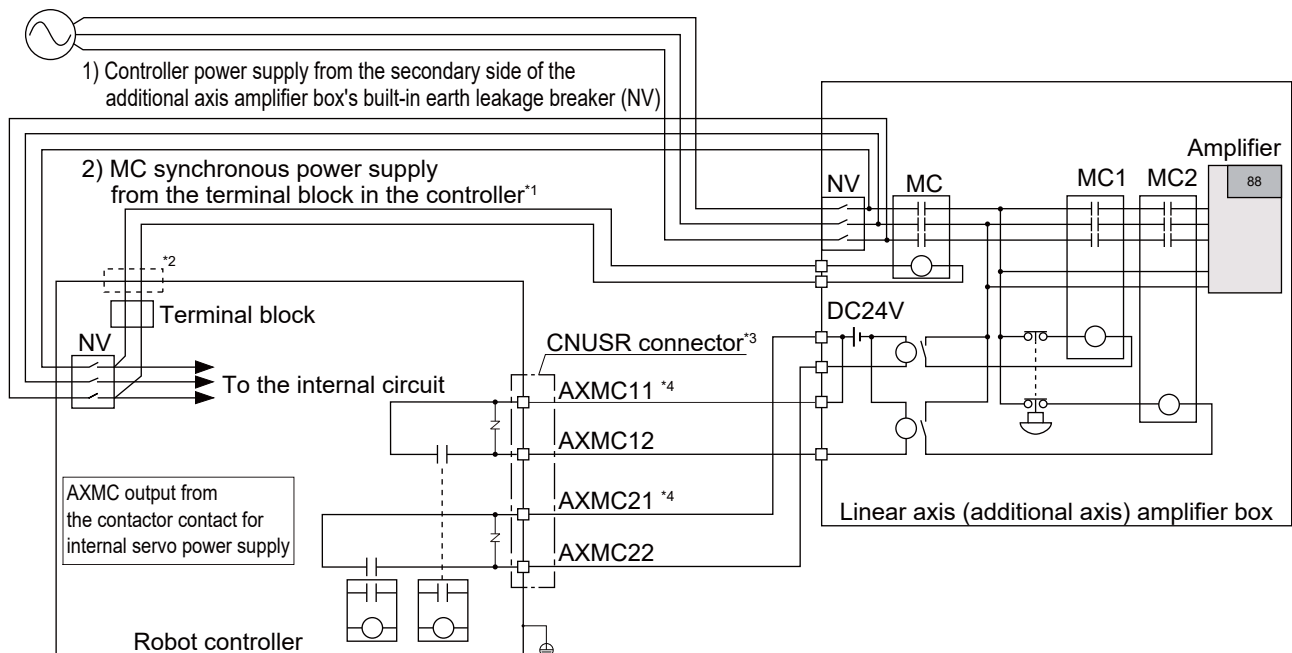
*1 Use the terminal block on the front side. Also fix the cable between the cable entrance and terminal block with the stud pin located at the bottom inside the controller.

*2 Wire the cable connected to the secondary side of the earth leakage breaker (NV) inside the controller to the outside of the controller through the cable entrance.
For information on how to wire the cable through the cable entrance, refer to the following manual:
📖 Controller setup, basic operation, and maintenance (BFP-A3783)

*3   The following table shows the connector and pin numbers.

Signal name	Connector	Pin No.
AXMC11	CNUSR13	4
AXMC12		12
AXMC21		8
AXMC22		16

*4   If the robot servos are turned off due to an alarm or other reasons, this output (contact) will open.
Contact capacity: 24V DC/10mA to 100mA

Image of how to connect the connector
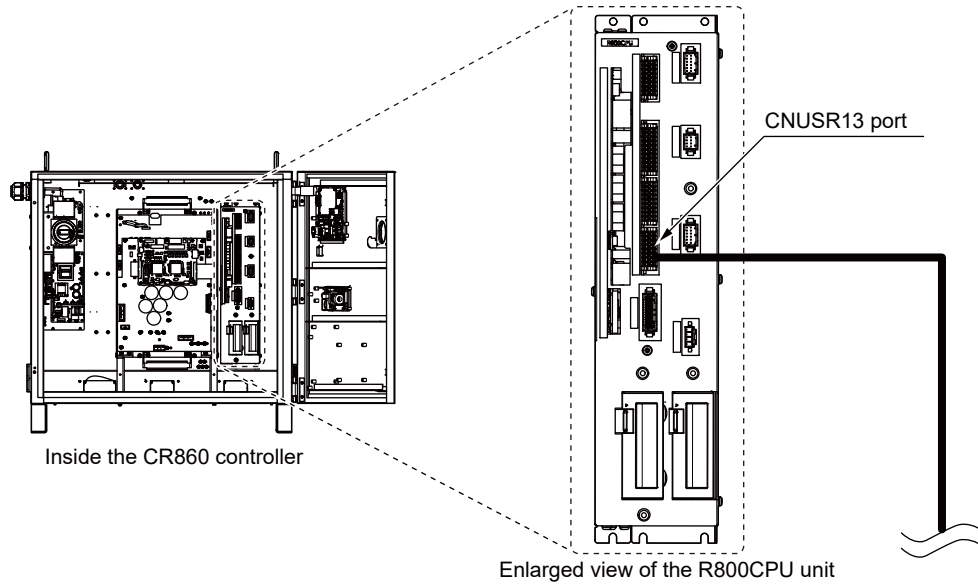
Inside the CR860 controller

CNUSR13 port

Enlarged view of the R800CPU unit

Refer to the following page for information on how to wire the connector.

3.9   Options

There is a variety of options to meet the various needs of customers.

Each customer should install these options.

Common for CR860-D/R/Q controllers

Simple 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 perform jog feed. For safety purposes, a 3-position enable switch is mounted.

For multiple robots, only one teaching pendant can be used to operate the robots by repeatedly disconnecting and connecting.

- 3-position enable switch

In ISO/10218 (2006) 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 "[T/B ENABLE] switch" and "3-position enable switch".

A 3-position enable switch has three states, and each state represents the following modes:

a) Not pressed: The robot cannot operate.[1]

b) Lightly pressed: It is possible to operate the robot and teach it.[2]

c) Forcefully pressed: The robot cannot operate.[1]

* The operation is the same regardless of whether the switch is pressed (pulled) in the left or right direction.

[1]   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).

[2]   When using the CR860 controller, keep the enabling switch lightly pressed down even if using step operation to execute commands that do not operate the robot.

■Configuration

Product name	Model	Quantity	Weight (kg)[1]	Remarks
Teaching pendant	R32TB	One of the products	1.7	Cable: 7m
	R32TB-15		2.8	Cable: 15m

[1]   It indicates the weight of one set.

■Specifications

Item	Specifications	Remarks
External dimensions	195 (W) × 292 (H) × 106 (D)	☞ Page 100 External dimensions
Color	Dark gray	—
Weight	Approx. 0.9kg (only the robot arm, excluding cables)	—
Connection method	Using controllers and connectors.	—
Interface	RS-422	—
Display method	LCD: 24 characters × 8 lines, LCD lighting: Backlight	When the font of 8 × 8 is used.
Operation section	36 keys	—

■External dimensions

The following figure shows the external dimensions of a teaching pendant.

195.2
133
291.9
LCD
Emergency stop
POWER ENABLE
F1 F2
SERVO ERROR
F3 F4
FUNCTION
Operetion key
STOP
Body
Cable (with connector)
<Front>

105.5
<side>

[T/B ENABLE] switch
3-position enable switch
<Back>

63.5
<Bottom>
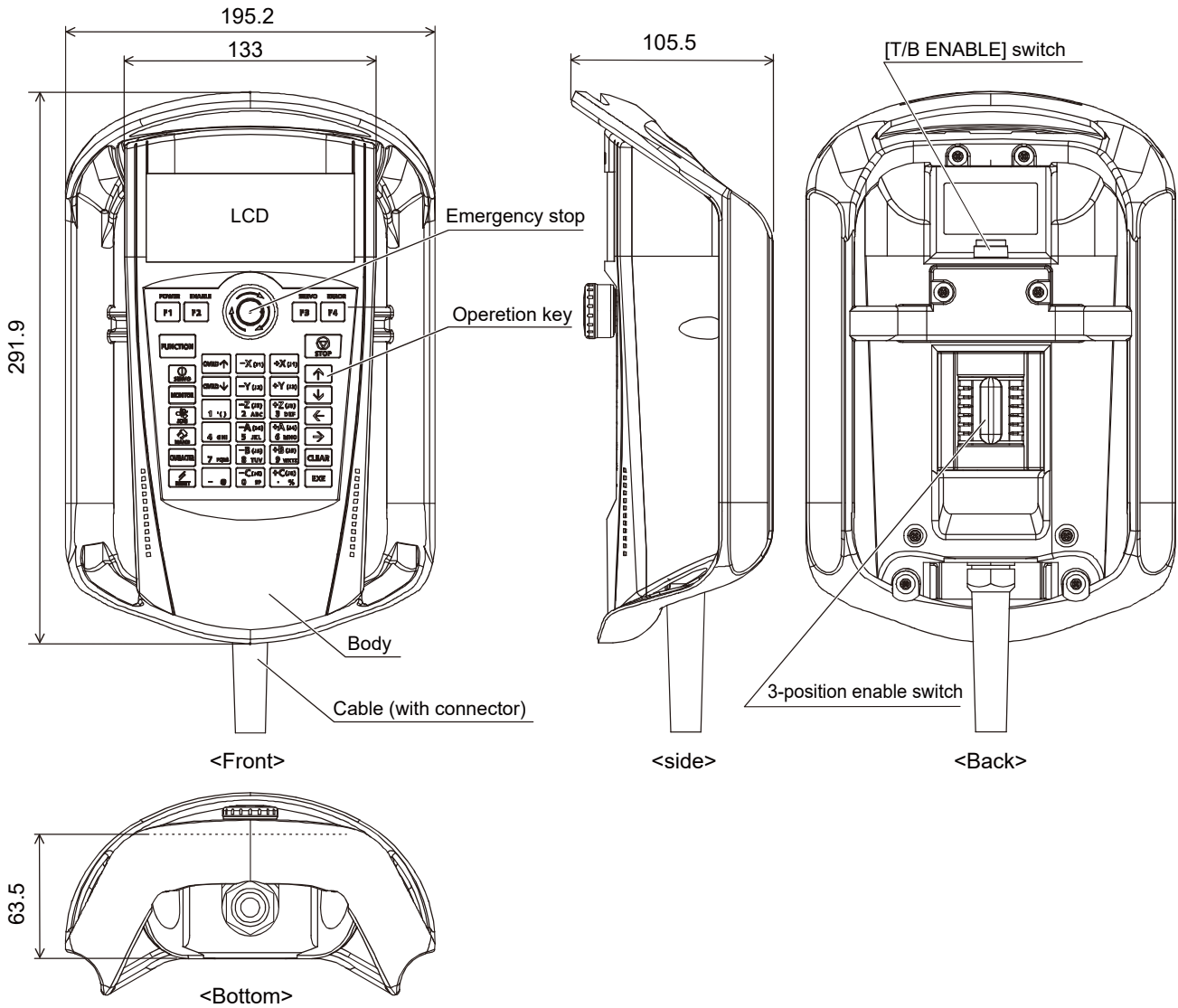
■Installation method

Connect the teaching pendant to the T/B connection port on the controller.

■Key layout and main functions
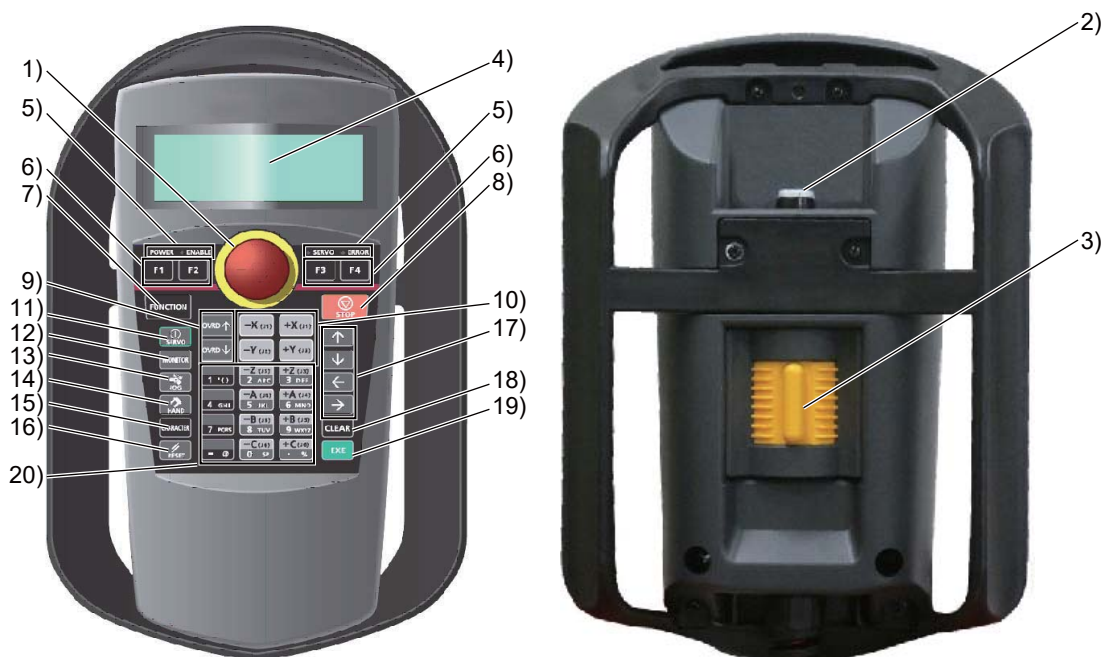
No.	Name	Description
1)	[EMERGENCY STOP] switch	Brings the robot to an emergency stop, and turns off the servos.
2)	[T/B ENABLE] switch	Used to switch to enable or disable the operation of the robot with T/B.
3)	3-position enable switch	When 2 (Enable) is set for the [T/B ENABLE] switch and the key is released or pressed tightly, the robot servo will turn off and the moving robot will stop immediately.
4)	LCD display panel	Displays the state of the robot or each menu.
5)	Status display lamp	Displays the state of T/B or robot.
6)	[F1], [F2], [F3], and [F4] keys	Used to execute the function displayed in the function display of the LCD display panel.
7)	[FUNCTION] key	Used to change the function display of LCD if five or more functions are assigned to the [F1], [F2], [F3], and [F4] keys.
8)	[STOP] key	Used to stop the program and slow down the robot to stop.
9)	[OVRD↑] and [OVRD↓] keys	Changes the robot's override speed. Pressing the [OVRD↑] key will increase the override speed. Pressing the [OVRD↓] key will decrease the override speed.
10)	[JOG operation] key (12 keys from [-X(J1)] to [+C(J6)])	Used to move the robot according to jog mode. Each numerical value can be set.
11)	[SERVO] key	Lightly holding the 3-position enable switch and pressing this key will bring the robot to the servo ON state.
12)	[MONITOR] key	Pressing this key will change the mode to monitor mode and display the monitor menu.
13)	[JOG] key	Pressing this key will change the mode to jog mode and display the jog screen.
14)	[HAND] key	Pressing this key will change the mode to hand mode and display the hand operation screen.
15)	[CHARACTER] key	When characters or numbers can be input with the T/B, this key switches between number input mode and character input mode for the [Number/character] keys.
16)	[RESET] key	Resets the error display. Pressing the [EXE] key while pressing this key will reset the program.
17)	[↑], [↓], [←], and [→] keys	Moves the cursor in each direction.
18)	[CLEAR] key	When numbers or characters can be input, pressing this key will delete one character in the place where the cursor is located.
19)	[EXE] key	Completes the entry. When a direct run command is used, the robot moves as long as this key is being pressed.
20)	[Number/Character] key	When numbers or characters can be input, pressing this key will display a number or character.

High-performance teaching pendant (T/B)

■Order type
- R86TB: Cable length: 7m

■Outline

This is used to create, edit, and control the program, teach the operation position, and perform jog feed. This high-performance teaching pendant is equipped the graphical user interface with a touch panel, which makes it easy to perform each operation. Also, for safety purposes, a 3-position enable switch is mounted.

For multiple robots, only one teaching pendant can be used to operate the robots by repeatedly disconnecting and connecting. Before disconnecting or connecting the teaching pendant, power off the teaching pendant.

- 3-position enable switch

In ISO/10218 (2006) 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 "[TEACH] button" and "3-position enable switch".

A 3-position enable switch has three states, and each state represents the following modes:

a) Not pressed: The robot cannot operate.[1]

b) Lightly pressed: It is possible to operate the robot and teach it.[2]

c) Forcefully pressed: The robot cannot operate.[1]

* The operation is the same regardless of whether the switch is pressed (pulled) in the left or right direction.

[1] 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).

[2] When using the CR860 controller, keep the enabling switch lightly pressed down even if using step operation to execute commands that do not operate the robot.

■Specifications

⚠ CAUTION

- Using this product in environments where a large amount of dust, oil mist, or other substances exists may cause a malfunction. Avoid using or storing this product in such environments.
- A USB memory with a capacity of 32G bytes or more cannot be used.

Using a large-capacity USB memory will consume the system resource dramatically. Use a USB memory whose capacity is as small as possible.

Item	Specifications	Remarks
External dimensions	215 (W) × 284 (H) × 76 (D)	—
Weight	Approx. 1.2kg	Cable not included
Connection method	Connected to a controller with a connector	Cable length: 7m
Interface	RS-422 Ethernet (10BASE-T)	Used to connect a controller.
	USB host (Type-A)	32G bytes or less
Display	10.1" TFT (800 × 1280) color touch panel with a back light	—

■Installation method

Connect the USB memory stick to the T/B connection port on the front of the controller.

To take preventive measures against noise, install two ferrite cores as shown below. The ferrite cores are included with the robot controller.

Position the ferrite cores within 20cm from the connector.

Install them on the controller side of the T/B cable.

Ferrite cores

■Key layout and main functions

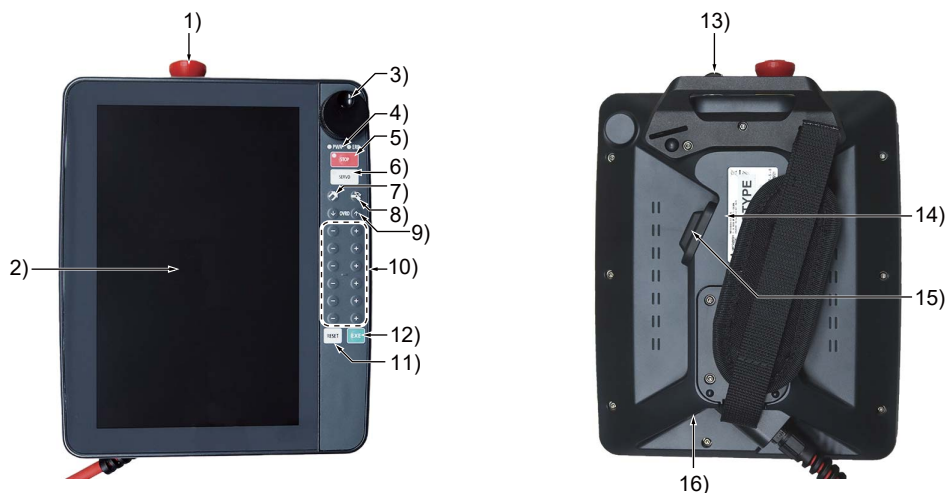| No.	Name	Description
1)	Emergency stop button	Brings the robot to an emergency stop, and turns off the servos. Turn the button to the right to release.
2)	Display (touch panel)	Displays each screen of the T/B. Touch the display with your finger for operation.
3)	Wheel	Moves the cursor to select each menu, etc.
4)	Power lamp and error lamp	The power lamp is always on while power is being supplied. The error lamp flashes during error.
5)	STOP button	Brings the robot to an emergency stop. The servo power remains on. The lamp (red) is on while the robot stops.
6)	SERVO button	By pressing the button while pressing the 3-position enable switch, the servo power is turned on. The lamp (green) is on while the servo is powered on.
7)	HAND button	Displays the hand operation guide.
8)	JOG button	Displays the jog operation guide.
9)	OVRD button	Press the [↑] button to raise the overriding level. Press the [↓] button to lower the overriding level.
10)	+/- button	Used for purposes such as jog operation, hand operation, brake releasing, and program debugging. The explanations of each key are displayed on the key operation guide.
11)	RESET button	Releases the alarm state. When the operation panel is displayed, the program can be reset.
12)	EXE button	Use this button in the following situations: Executing functions to operate the robot such as hand alignment and position jump, moving specified multiple axes using jog operation, or releasing brakes.
13)	Key switch	Switches robot operation rights. Setting the key switch to "MANUAL" will make the T/B acquire operation rights. Robot operations such as turning on the servos and using jog operation are possible while the T/B has operation rights. Setting the key switch to "AUTO" will make the T/B relinquish operation rights.
14)	Grip handle	Grip the grip handle to hold the T/B.
15)	3-position enable switch	By releasing this switch or pressing it firmly when the servo is powered on, the servo power is turned off. When operating the robot in situations such as using jog operation, hold down this switch for the operation.
16)	USB connector	Connect a USB memory.

Safety option

■Order type

4F-SF003-05

■Outline

This unit is used to expand the safety monitoring function.

Using this unit with external devices such as a safety switch and light curtain allows you to approach the work area without stopping the robot.

■Configuration

Product name	Model	Quantity	Weight (kg) [*1]	Remarks
Safety extension unit	4F-SFUNIT2	1	0.4	—
RIO cable	2F-SFRIOCBL05	1	—	Cable length: 5m
DCIN connector set	2F-SFDCINCON	1	—	For primary power wires One port and three pins are attached.
Terminator cap	2F-SFTM	1	—	For connection to the RIO2 socket
Instruction manual	BFP-A3762	1	—	Robot Safety Option Instruction Manual

*1 It indicates the weight of one set.

■Specifications

Item	Specifications	Remarks
External dimensions	40 (W) × 174.5 (H) × 115 (D) (Refer to the following figure.)	—
Color	Dark gray	—
Weight	Approx. 0.4kg (only the robot arm, excluding cables)	—
Voltage [*1]	24V DC ±5%, Ripple voltage: 0.2V (P-P)	—
Maximum power consumption	300mA	Not include the external load current of DO.
Operating temperature	0 to 40℃	Do not use the unit near heat sources including heating appliances.
Relative humidity	45 to 75%	Non-condensing

*1 The customer needs to prepare the external power supply for the safety option.
　　📖Robot Safety Option Instruction Manual

■External dimensions
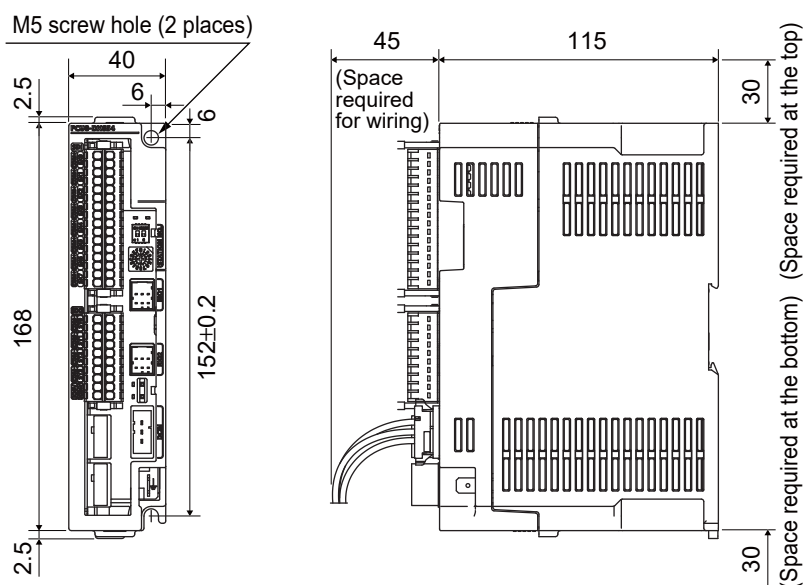
Transformer unit

■Order type
2F-ATBOX

■Outline
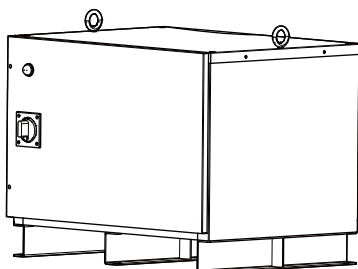
By using this transformer unit, the robot can be operated with 400V power supply. This transformer unit is used to step down the voltage from 400V to 200V. This transformer unit is designed only for the CR860 controller, and is not used for other controllers.

■Configuration

Product name	Model	Quantity	Weight (kg) [*1]	Remarks
Transformer unit	2F-ATBOX	1	120	—

*1   It indicates the weight of one set.

■Specifications

Item	Specifications	Remarks
External dimensions	670 (W) × 500 (H) × 515 (D)	☞ Page 107 External dimensions
Color	Dark gray	—
Weight	Approx. 120kg (only the robot arm, excluding cables)	—
Phase	Three-phase	—
Capacity	10kVA	—
Frequency	50Hz	—
Rated voltage (primary side)	420V AC(±10%)	—
Rated voltage (secondary side)	210V AC(±5%)	It depends on the tap set. ☞ Page 110 Wiring
Wiring	Delta connection	☞ Page 110 Wiring
Operating temperature	0 to 45℃	Non-freezing
Relative humidity	10 to 85%RH	Non-condensing
Elevation	1000m or lower	—
Protection specifications [*1]	IP54	—

*1   For details on the protection specifications, refer to the following page:
   ☞ Page 69 Protection specifications

■External dimensions

Bottom view A
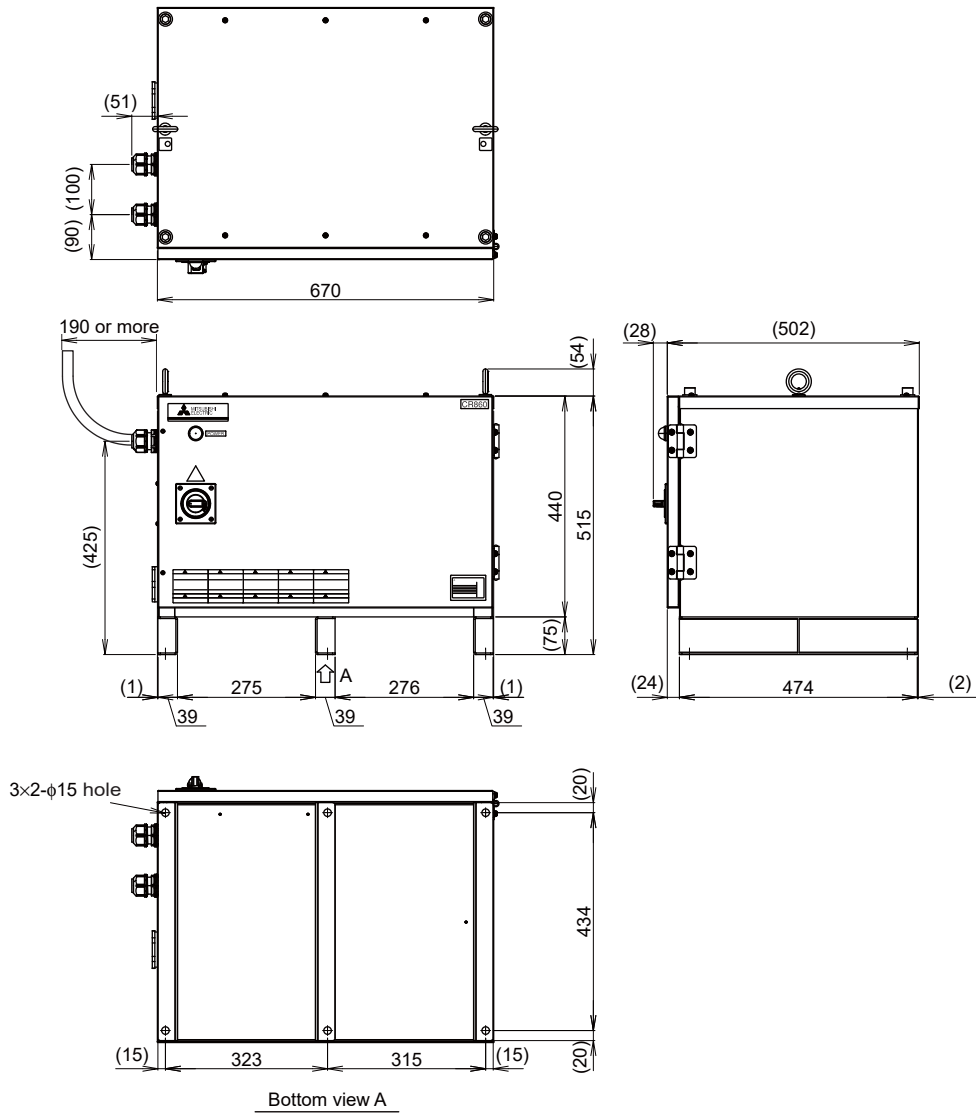
■Transportation instructions

This section explains how to transport the transformer unit.

 ・ When transporting only the transformer unit

Two workers must transport the transformer unit using a crane or lifter.
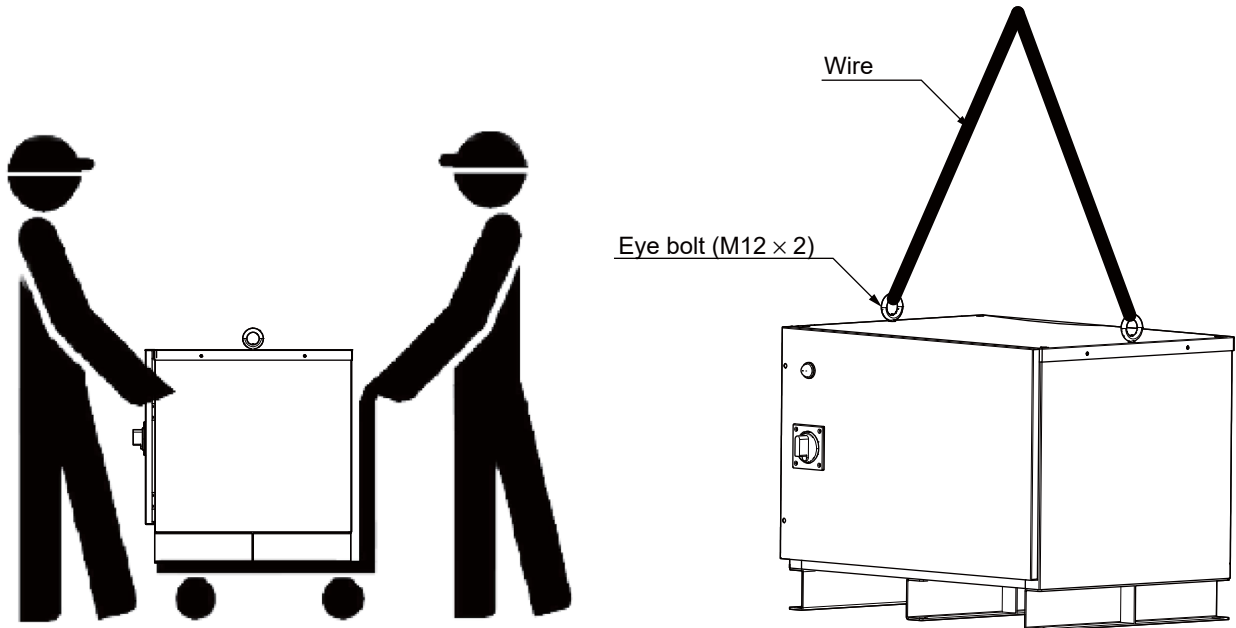
Weight of transformer unit: 120kg

 ・ When transporting the transformer unit and controller

Lift and transport them separately using a crane or lifter.

Do not lift and transport the controller with the transformer unit attached.
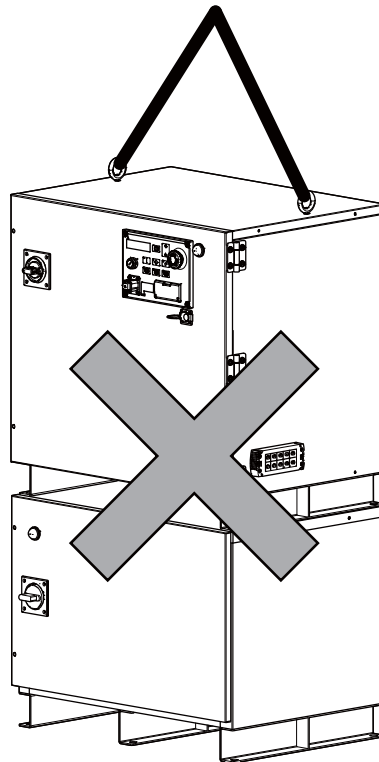
Total weight of transformer unit and controller: 200kg

■Installation instructions

The following figure shows the dimensions required to install the transformer unit.
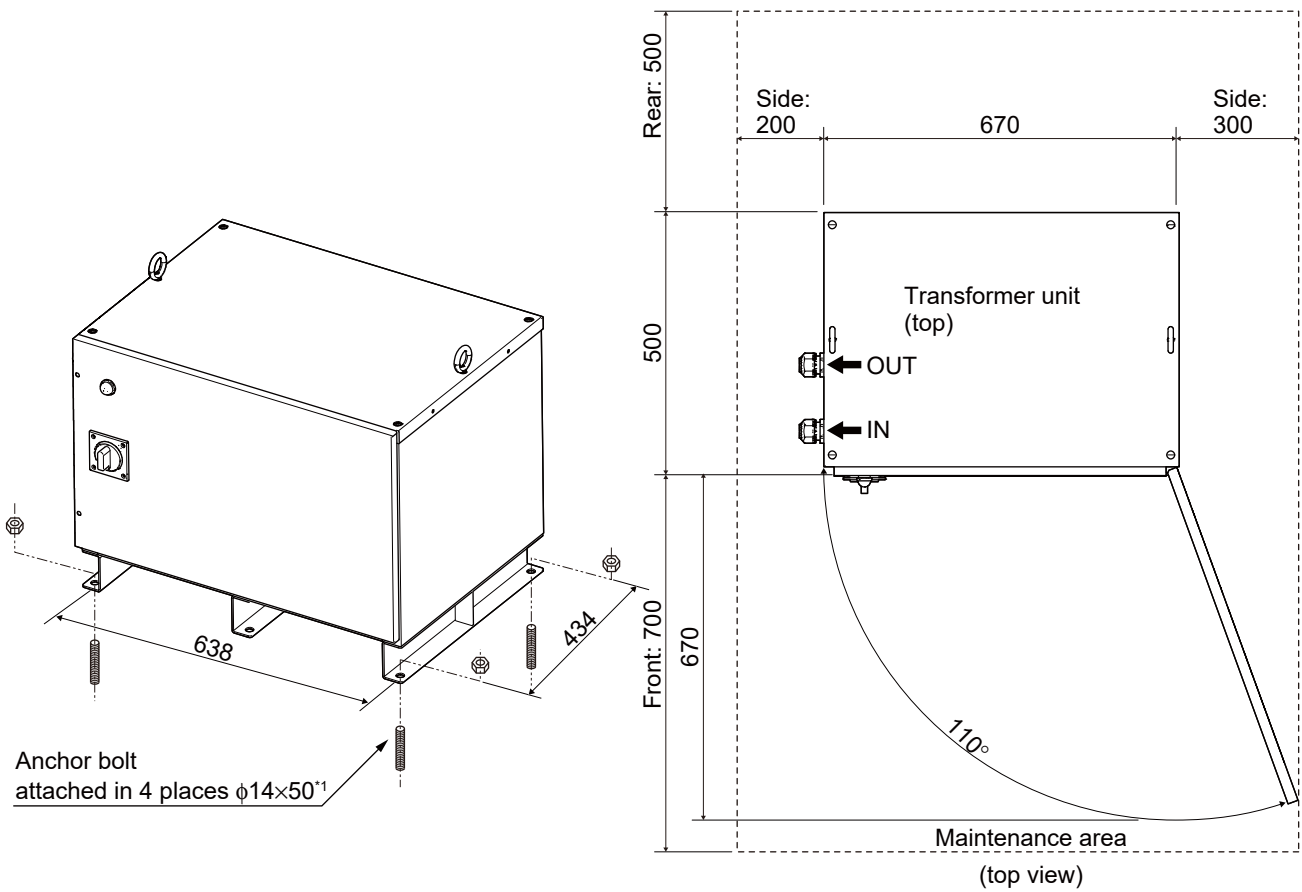
Rear: 500

Side: 200   670   Side: 300

500

Transformer unit (top)

← OUT

← IN

Front: 700

670

110°

Maintenance area

(top view)

638

434

Anchor bolt
attached in 4 places φ14×50[*1]

*1   External vibration may cause the controller to fall or move, resulting in injury. It is recommended to fix the transformer unit.
Select anchor bolts that do not come out by more than 50mm from the installation surface.

■Wiring

⚠ CAUTION

To avoid electric shock, turn off the primary power supply before wiring.

For information on how to connect the power cable or the CR860, refer to the following manual:

📖Controller setup, basic operation, and maintenance (BFP-A3783)

The internal wiring of the transformer unit may have to be changed depending on the voltage of the customer's primary side.The transformer unit has taps 1 to 3 each for the U, W, and V phases. Tap n for all the three phases is referred to as tap set n (n: 1, 2, or 3). Wiring of tap set 2 (for 420V AC (±10%)) is applied from the factory.

For information on the relationship between the input voltage (primary voltage) specifications and the tap set, refer to the following table.

Tap set	Input AC voltage (primary side) specifications [Unit: V]		
	-10%	Rating	+10%
Tap set 1	360.9	401	441.1
Tap set 2	378	420	462
Tap set 3	395.1	439	482.9

If the input voltage is within the range of the specifications, the output voltage is generated within the range shown in the table below.

Output AC voltage (secondary side) specifications [Unit: V]		
-5%	Rating	+5%
189	210	231

When changing the tap set, follow the following steps:

1. Remove the hexagon nuts (M5, opening width: 8mm) connected to taps "6"-"2" with a nut driver. As the hexagon nuts cannot be separated from the metal plates, remove the nuts together with the plates.

2. Attach the hexagon nuts and metal plates removed in step 1 to the tap you want to set ("6"-"1" or "6"-"3") with a nut driver.

When connected to tap set 2 (default)
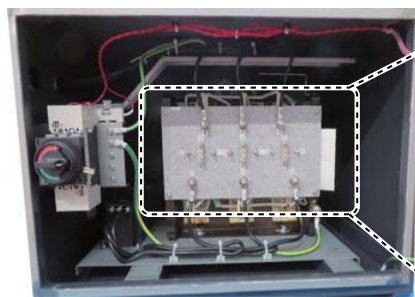
Inside the transformer unit

All the metal plates are attached to taps "6"-"2".
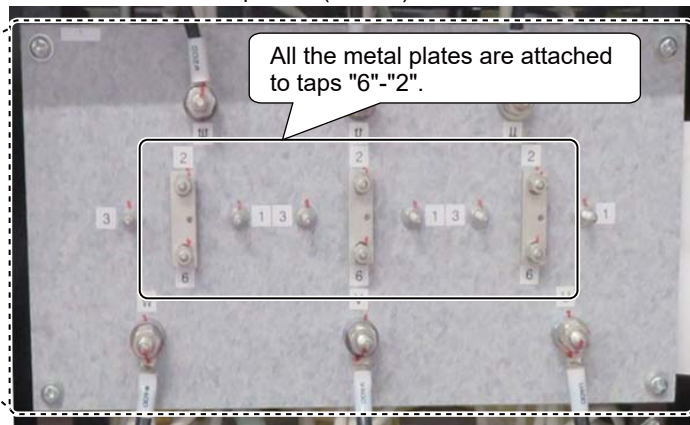
Enlarged view of the tap set and its surroundings

When connected to tap set 1

All the metal plates are attached to taps "6"-"1".

When connected to tap set 3
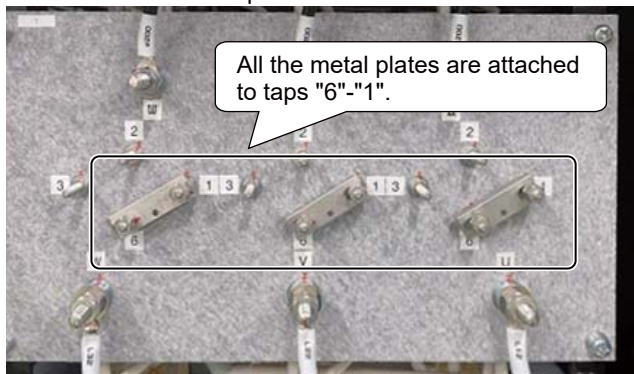
All the metal plates are attached to taps "6"-"3".
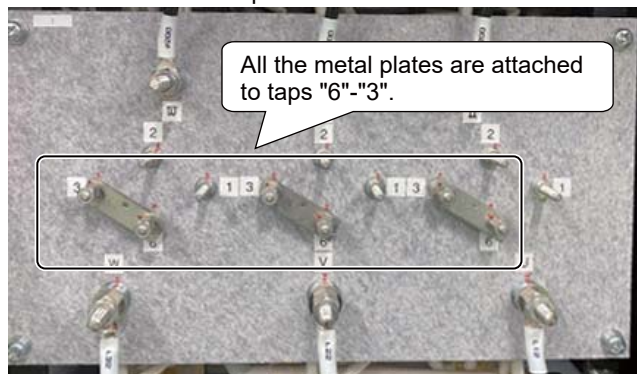
Encoder distribution unit

■Order type

2F-YZ581

■Outline
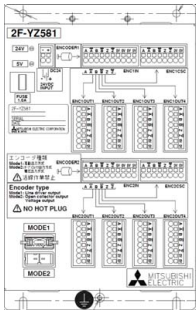
The encoder distribution unit 2F-YZ581 is used to connect one rotary encoder (hereafter "encoder") to multiple robot controllers. For details on the tracking function, refer to the following manual:

📖Tracking Function (BFP-A3520)

■Configuration

Product name	Model	Quantity	Weight (kg) *1	Remarks
Encoder distribution unit	2F-YZ581	1	0.6	—

*1　It indicates the weight of one set.

■Specifications

Item		Specifications	Remarks
Number of encoder inputs		Double channel	It is not necessary to use both.
Supported encoders		Output method: Open collector / Push-pull / Differential line driver Resolution (PPR): 2000 Max. (4000 and 8000 not supported.) Recommended encoder: E6B2-CWZ1X-2000 (OMRON)	The encoder output method can be switched using a short-circuit connector. For details on wiring, refer to the following manual: 📖Encoder Distribution Unit Manual
Cable		Type: Shielded twisted pair cable	For the size and length of the cable, refer to the following manual: 📖Encoder Distribution Unit Manual
Number of outputs (cascade connection)		Single channel	—
Output type		Differential line driver	26L31 outputs or equivalent
Power supply	Input power supply	24V DC (±10%)	—
	Power consumption	500mA	The value varies depending on the connected device.
	Output power supply for encoder	Voltage: 5V DC, current: 160mA	Double channel
Protection specifications		IP20	—
Operating environment		Normal environments	No flammable or corrosive gas
Ambient temperature		0 to 45℃	Non-freezing
Relative humidity		45 to 85%RH	Non-condensing
Weight		0.6kg	—

■External dimensions

■ Outside dimensions

*1 Unit fixing hole   *2 DIN rail adapter installation hole   *3 Grounding hole   *4 Static electricity protection cover installation hole
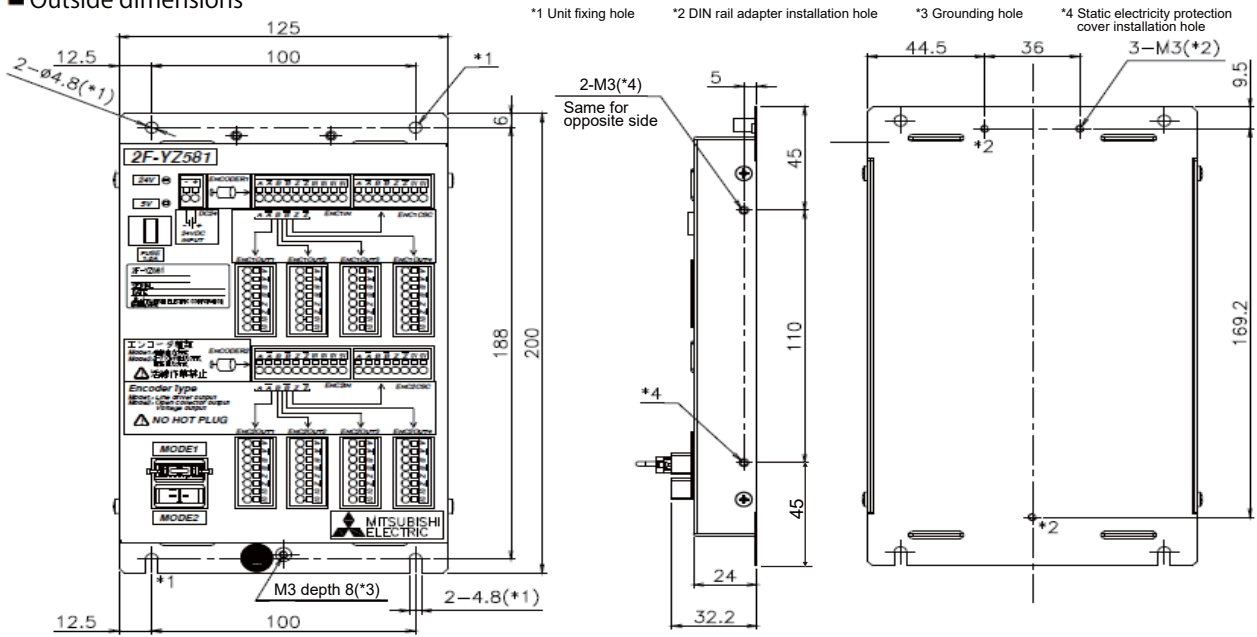
■Usage

Refer to the following manual attached to the robot arm.

📖Tracking Function (BFP-A3520)

MELSOFT RT ToolBox3/MELSOFT RT ToolBox3 mini/MELSOFT RT ToolBox3 Pro

■Order type

The following software is provided by a DVD-ROM for Windows.

- MELSOFT RT ToolBox3: 3F-14C-WINE
- MELSOFT RT ToolBox3 mini: 3F-15C-WINE
- MELSOFT RT ToolBox3 Pro: 3F-16D-WINE

■Outline

RT ToolBox3 has a wide range of uses, which include assisting with program design (editing and creation), setup (program execution, management, debugging), maintenance (maintenance forecast), and checking robot specifications (tact time etc.).

■Configuration

Product name	Model	Medium	Weight (kg) [1]
MELSOFT RT ToolBox3	3F-14C-WINE	DVD-ROM	0.2
MELSOFT RT ToolBox3 mini	3F-15C-WINE	DVD-ROM	0.2
MELSOFT RT ToolBox3 Pro	3F-16D-WINE	DVD-ROM	0.2

[1] It indicates the weight of one set.

■Features

- Simple operation with guidance and menus

The Windows standard is used for windows operation, so it is easy to perform the controller initialization and startup operations by following the instructions given on the screen. Even a beginner can easily perform the series of operations from program creation to execution.

- Increased work efficiency with ample support functions

The work efficiency is greatly improved with the multi-window system that carries out multiple steps and displays in parallel. The renumbering function, copy, search, syntax check, and step execution are especially sufficient, and are extremely useful for 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 SolidWorksMELSOFT RT ToolBox3 Pro allows a simulation of robot operation on three-dimensional CAD software SolidWorks®.

- Increased efficiency of maintenance work with maintenance forecast

The load condition while the robot is actually operating is analyzed. Based on this analysis, the time for maintenance, such as lubrication and belt replacement, is calculated. By utilizing this information, the line stop time as well as the maintenance costs can be reduced.

- Shortening recovery time

The position recovery support 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. Thus, the time required for recovery can be reduced.

■Function

○: Available, ×: Not available

Function		Availability			Details
		*1	*2	*3	
Compatible model		○	○	○	Personal computer running Windows 10 or Windows 11 [4]
Program editing functions	Editing function	○	○	○	• MELFA BASIC V and VI language compatible • Multiple editing screen simultaneously display • Command input, comment writing • Position data editing • File operation (writing to controller and personal computer) • Search and replace function (using characters, line numbers, and labels) • Copy, cut, paste, insert (per character or line), undo (per command statement or position conversion) • Line number automatic generation, renumbering • Batch syntax check • Command template • Position conversion batch editing • Position variable template • Print, print preview
	Control function	○	○	○	Program file control (list, copy, movement, delete, content comparison, name change, protect)
	Debugging function	○	○	○	• 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 function		○	○	○	• 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.

*1　MELSOFT RT ToolBox3 Pro (3F-16D-WINE)

*2　MELSOFT RT ToolBox3 (3F-14C-WINE)

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

*4　Personal computers corresponding to CE Marking, an FCC standard, and a VCCI standard are recommended.

Instruction Manual (hard copy)

■Order type
• 5F-BT01-PE01: A digital copy of the RV-35FR/50FR/80FR series instruction manuals.

■Outline

The hard copy of CD-ROM attached to this product.

■Configuration

Product name		Model	Weight (kg) [*1]	Details
Instruction manual	—	5F-BT01-PE01	3.0	A digital copy of the RV-35FR/50FR/80FR series instruction manuals.
	Safety Manual	BFP-A3541	—	Items relating to safety in handling the robot.
	Standard Specifications	BFP-A3779	—	Specifications of the robot arm and controller.
	Robot Arm Setup and Maintenance	BFP-A3781	—	Installation method of the robot arm, jog operation, and maintenance and inspection procedures.
	Controller setup, basic operation, and maintenance	BFP-A3783	—	Installation method of the controller, basic operation, and maintenance and inspection procedures.
	Detailed explanations of functions and operations	BFP-A3478	—	Functions and operation method of the controller and T/B, and explanation of MELFA-BASIC VI.
	Troubleshooting	BFP-A3480	—	Causes of errors occurred and their countermeasures.
	Additional axis function	BFP-A3504	—	Functions and operation method of the additional axis.
	Tracking Function	BFP-A3520	—	Functions and operation method of the tracking.
	GOT Direct Connection Extended Function Instruction Manual	BFP-A3546	—	Data configuration of the memory between the GOT and the robot, monitoring, and operating procedures.
	iQ Platform Supporting Extended Function	BFP-A3528	—	Data configuration of the memory between the programmable controller and the robot, monitoring, and operating procedures.
	Safety Communication Function	BFP-A3772	—	Usage of the safety communication function
	Ethernet Function	BFP-A3379	—	Ethernet communication method between personal computer and robot controller.

*1   It indicates the weight of one set.

Options for CR860-D controller

Parallel I/O interface

⚠ CAUTION

The combined use with another option, parallel I/O unit (2A-RZ361/2A-RZ371), is also possible. In this case, use a different station number for each unit. The station number is automatically determined by the position of the option slot to which the interface is installed. (Station number 0 to 1)

■Order type

• 2D-TZ368 (sink type)/2D-TZ378 (source type)

■Outline

This is used to expand the external inputs and outputs.

• The connection cable is not included. The external I/O cable (2D-CBL05 or 2D-CBL15) can be provided as the option.

■Configuration

Product name	Model	Quantity	Weight (kg) [*1]	Remarks
Parallel I/O interface	2D-TZ368/2D-TZ378	1	0.4	32 input points/32 output points 2D-TZ368 is sink type. 2D-TZ378 is source type.

*1 It indicates the weight of one set.

■Specifications

⚠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 rated current. The internal transistor may be damaged if maximum rated current is exceeded.

The electrical specifications of input circuit are shown below.

Item		Specifications		Internal circuit
Type		DC input		
Number of input points		32		
Insulation method		Photo-coupler insulation		
Rated input voltage		12V DC	24V DC	
Rated input current		Approx. 3mA	Approx. 9mA	
Allowable voltage range		10.2 to 26.4V DC (ripple ratio: within 5%)		
ON voltage/ON current		8V DC or higher/2mA or higher		
OFF voltage/OFF current		4V DC or lower/1mA or lower		
Input resistance		Approx. 2.7kΩ		
Response time	OFF-ON	10ms or less (24V DC)		
	ON-OFF	10ms or less (24V DC)		
Common method		32 points per common		
External wiring method		Connector		

The electrical specifications of input circuit are shown below.

Item		Specifications	Internal circuit
Type		Transistor output	
Number of output points		32	
Insulation method		Photo-coupler insulation	
Rated load voltage		12V DC/24V DC	
Rated load voltage range		10.2 to 30V DC (peak voltage: 30V DC)	
Maximum load current		0.1A/point (100%)	
Leakage current at OFF		0.1mA or lower	
Max. voltage drop at ON		0.9V DC (TYP.) [1]	
Input resistance		Approx. 2.7kΩ	
Response time	OFF-ON	10ms or less (resistance load) (hardware response time)	
	ON-OFF	10ms or less (resistance load) (hardware response time)	
Fuse rating		Fuse 1.6A (one per common), Replacement possible (up to 3)	
Common method		16 points per common (common terminal: 2 points)	
External wiring method		Connector	
External power supply	Voltage	12/24V DC (10.2 to 30V DC)	
	Current	60mA (TYP.: 24V DC per common) (base drive current)	

[1] 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.

■Installation method

⚠ CAUTION

When using the parallel I/O unit 2A-RZ361/2A-RZ371 together with the parallel I/O interface, use a number different from that of the parallel I/O interface.

Inside the CR860 controller

SLOT2 SLOT1

Enlarged view of the R800CPU unit
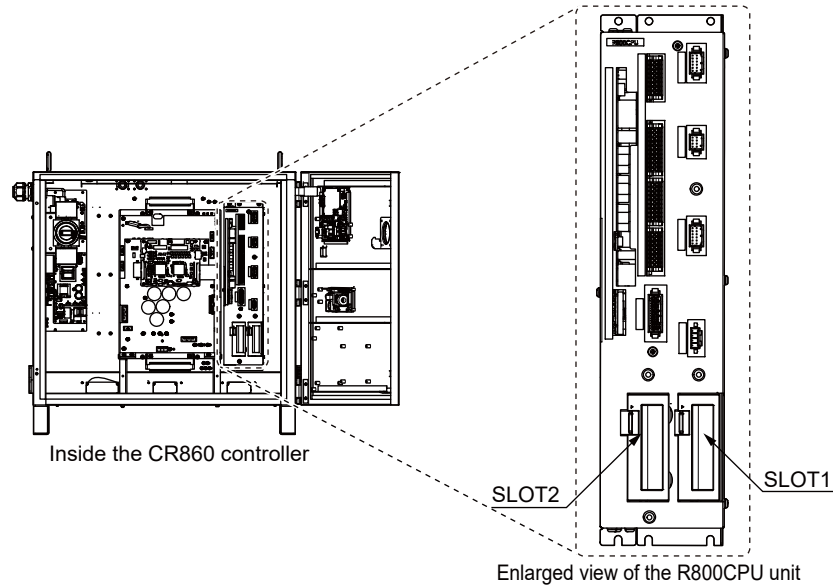
Install the parallel I/O interface to the R800CPU unit. Install it referring to the following.

📖Controller setup, basic operation, and maintenance (BFP-A3783)

If it is installed to 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)

■Pin arrangement of connector

The following figure shows the pin arrangement of the parallel I/O interface.

Connector <2>
Output 16 to 31
Input 16 to 31
(station No.: 0)

Connector <1>
Output 0 to 15
Input 0 to 15
(station No.: 0)
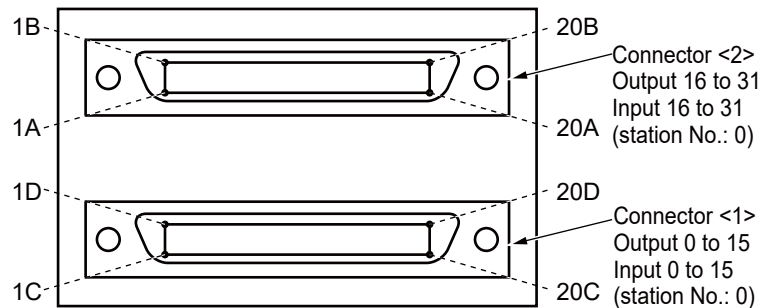
■Connector pin number and signal assignment

The station number is fixed by the slot to be installed and the assignment range of the general-purpose I/O signal is fixed.

Slot number	Station No.	Range of general-purpose I/O 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 following table lists the pin number of the connector on the parallel I/O interface connected to SLOT1 and the signal assignment. If installing the interface to other slots, interpret and utilize.

- List of the connector <1> signal assignment and the color of external I/O cable 2D-CBL□□(SLOT1)

Pin No.	Cable color	Function name		Pin No.	Cable color	Function name	
		Signal name	Power supply/common			Signal name	Power supply/common
1C	Orange/Red a	—	24G/12G: For the pins of 5D to 20D	1D	Orange/Black a	—	+24V/+12V (COM): For the pins of 5D to 20D
2C	Gray/Red a	—	COM: For the pins of 5C to 20C [*1]	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 [*2]	15D	Pink/Black c	General-purpose output 5	—
16C	Orange/Red d	General-purpose input 4	Servo ON input signal [*2]	16D	Orange/Black d	General-purpose output 4	—
17C	Gray/Red d	General-purpose input 3	Start input [*2]	17D	Gray/Black d	General-purpose output 3	Operation rights output signal [*2]
18C	White/Red d	General-purpose input 2	Error reset input signal [*2]	18D	White/Black d	General-purpose output 2	Error occurring output signal [*2]
19C	Yellow/Red d	General-purpose input 1	Servo OFF input signal [*2]	19D	Yellow/Black d	General-purpose output 1	Servo ON output signal [*2]
20C	Pink/Red d	General-purpose input 0	Stop input [*3]	20D	Pink/Black d	General-purpose output 0	Operating output [*2]

*1 Sink type: +24V/+12V (COM), source type: 24G/12G
*2 The dedicated signal is assigned at shipping. It can be changed with the parameter.
*3 The dedicated input signal (STOP) is assigned at shipping. The signal number is fixed.

3

• List of the connector <2> signal assignment and the color of external I/O cable 2D-CBL□□(SLOT1)
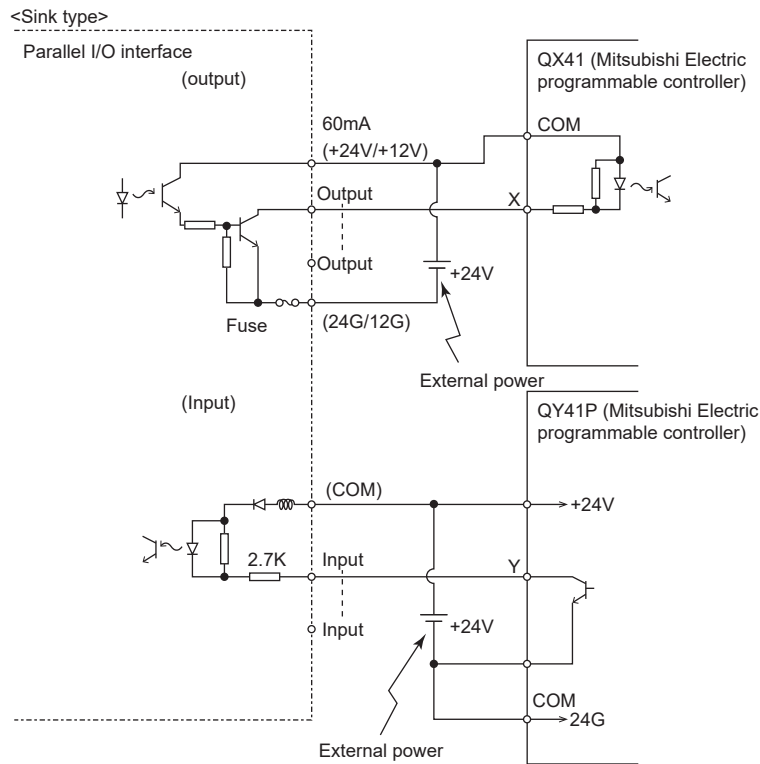
Pin No.	Cable color	Function name		Pin No.	Cable color	Function name	
		Signal name	Power supply/common			Signal name	Power supply/common
1A	Orange/Red a	—	24G/12G: For the pins of 5B to 20B	1B	Orange/Black a	—	+24V/+12V (COM): For the pins of 5B to 20B
2A	Gray/Red a	—	COM: For the pins of 5A to 20A [*1]	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 19	—	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	—

*1 Sink type: +24V/+12V (COM), source type: 24G/12G

The example of connection with a Mitsubishi Electric programmable controller (sink type) is shown below.

⚠ CAUTION

- The customer should supply the external power supply (24V DC) for the I/O circuit.
- Do not ground the + side of the customer device's 24V power supply for input/output (emergency stop and parallel I/O) that is used to connect the controller. Connecting the controller with the + side grounded may cause a failure of the controller.

<Sink type>
Parallel I/O interface
(output)

60mA
(+24V/+12V)
Output
Output
Fuse
(24G/12G)
External power

QX41 (Mitsubishi Electric programmable controller)
COM
X
+24V

(Input)

(COM)
2.7K   Input
Input
+24V
External power

QY41P (Mitsubishi Electric programmable controller)
+24V
Y
COM
24G
External power

The following figure shows an example of connection with a protection circuit.

<Sink type>
Parallel I/O interface
(output)

60mA
(+24V/+12V)
Output
Output
Fuse
(24G/12G)
+24V
External power

QX41 (Mitsubishi Electric programmable controller)
COM
X

(Input)

(COM)
2.7K   Input
Input
+24V
External power

QY41P (Mitsubishi Electric programmable controller)
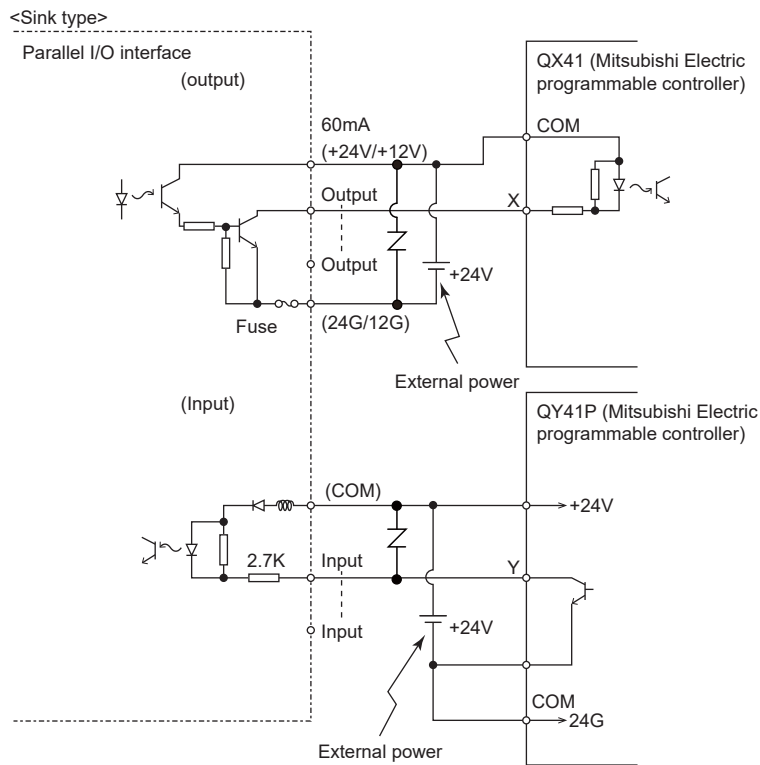+24V
Y
COM
24G
External power

The example of connection with a Mitsubishi Electric programmable controller (source type) is shown below.

⚠ CAUTION

- The customer should supply the external power supply (24V DC) for the I/O circuit.
- Do not ground the + side of the customer device's 24V power supply for input/output (emergency stop and parallel I/O) that is used to connect the controller. Connecting the controller with the + side grounded may cause a failure of the controller.
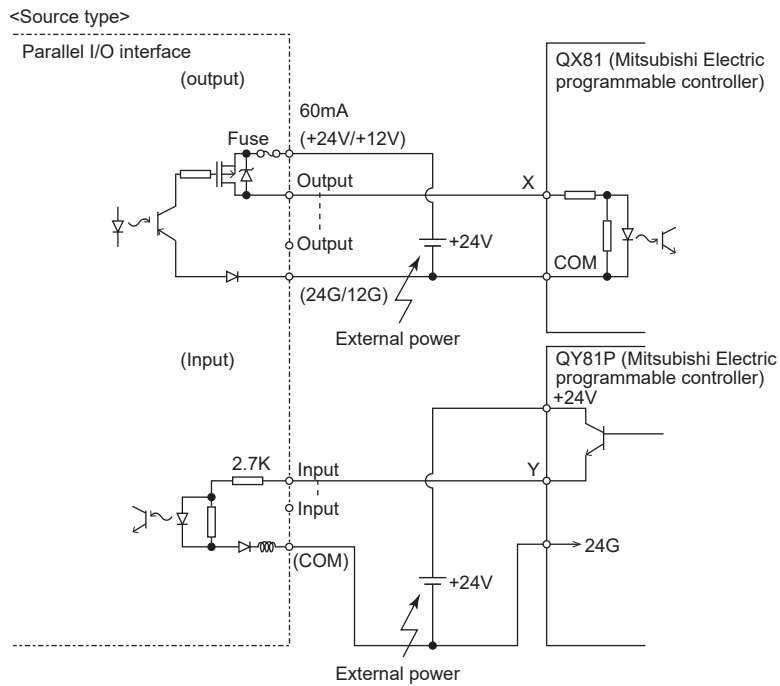

The following figure shows an example of connection with a protection circuit.
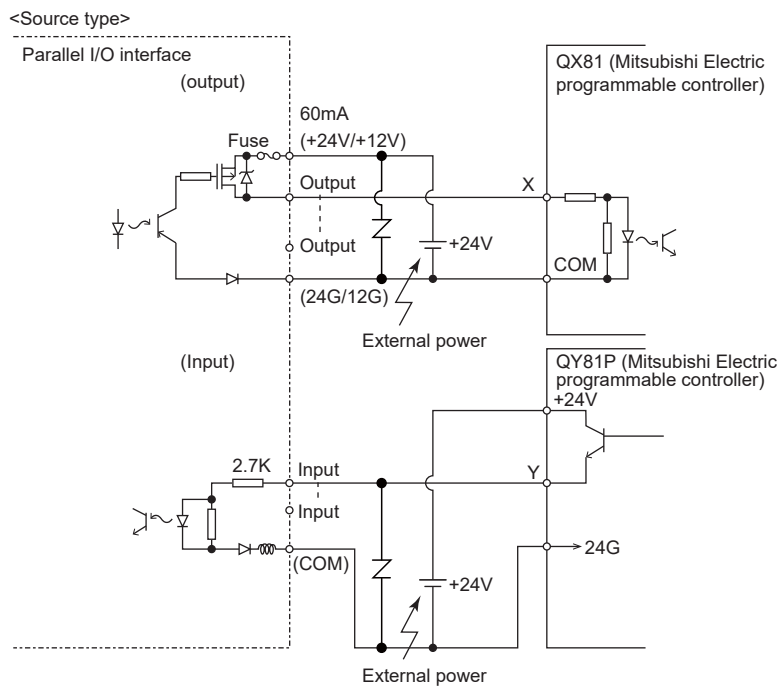
External I/O cable

■Order type

- 2D-CBL□□[1]

[1] □□indicates the length of cable. (05: 5m, 15: 15m)

■Outline

This is the cable dedicated to connecting an external peripheral to the connector on the parallel I/O interface. Use another option 2A-CBL□□for the parallel I/O unit.

One end matches the connector on the parallel I/O interface, and the other end is free. Connect the I/O signal of the peripheral using the free end.

One cable supports the 16 input points and 16 output points.

After installing the parallel I/O interface, the number of input points is 32 and the number of output points is 32. Prepare two cables.

■Configuration

Product name	Model	Quantity	Weight (kg) [1]	Remarks
External I/O cable	2D-CBL□□	1	0.7 (5m) 1.84 (15m)	5m or 15m

[1] It indicates the weight of one set.

■Specifications

Item	Specifications
Size/Number of cores	#28 AWG × 20P (40 cores)
Total length	5m, 15m

■Connector pin number and cable color

Pin No.	Cable color	Pin No.	Cable color	Pin No.	Cable color	Pin No.	Cable color
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

[1] Pin number of the connector <1> is 1C, 2C, ..., 20C, 1D, 2D, ..., or 20D. Pin number of the connector <2> is 1A, 2A, ..., 20A, 1B, 2B, ..., or 20B.

■Connection and external dimensions

The sheath of each signal cable (40 lines) is indicated its color and marked with dots.

Connect each cable referring to the following figure.

☞ Page 123 Connector pin number and cable color

(Example) Pin number: Color indication

1　　:　Orange/Red/a

　　　　└ Type of dot mark
　　　└ Color of dot mark
　　└ Color of sheath

Line color type	Dot pattern
a type	One dot
b type	Two dots
c type	Three dots
d type	Four dots

BKO-FA0839Hxx
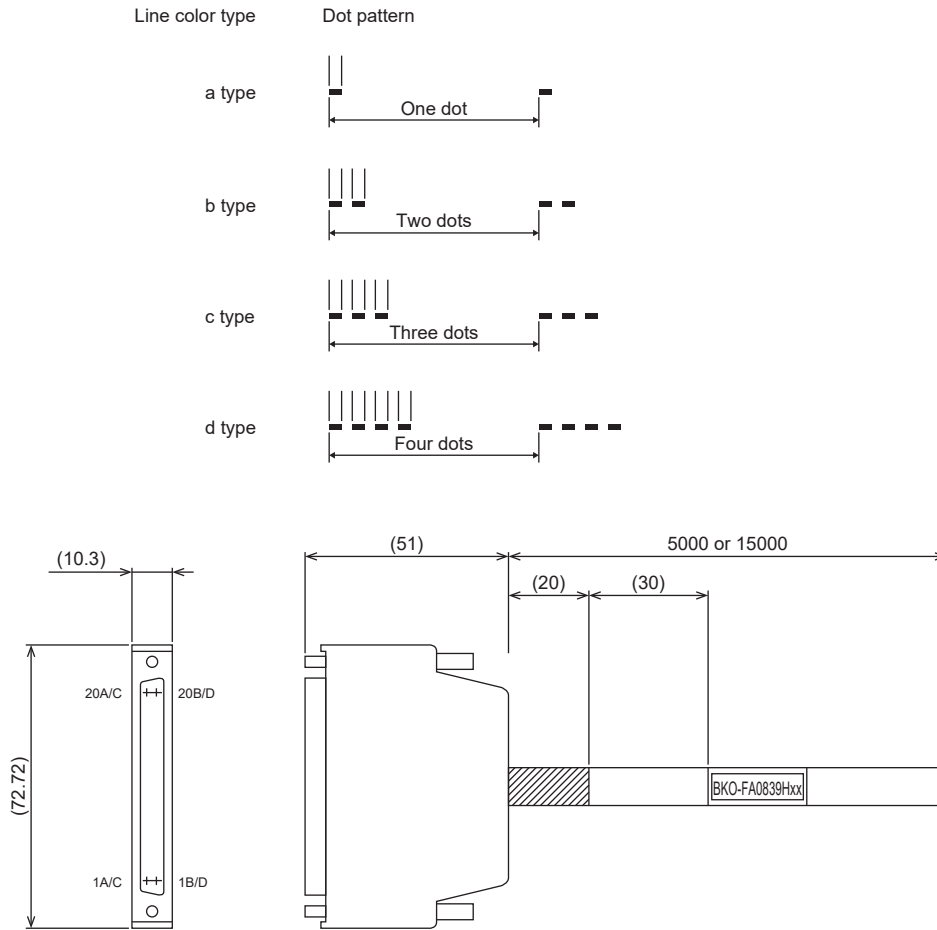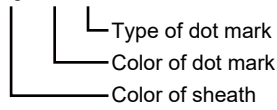
Plug model (manufactured by OTAX Corporation)　Connector : N361J040AU
Cover　　: N360C040B

Parallel I/O unit

■Order type

• 2A-RZ361 (sink type)/2A-RZ371 (source type)

■Outline

This unit is used to expand the external inputs and outputs.

• The connection cable is not included. The external I/O cable (2A-CBL05 or 2A-CBL15) can be provided as the option.
• Use 2A-RZ361 if the external I/O signal logic is sink type. Use 2A-RZ371 if the external I/O signal logic is source type.

*1 The combined use with the parallel I/O interface (2D-TZ368/2D-TZ378) of another option is also possible. In this case, use the setup of the station number by the different number separately. The station number of 0 or 1 is automatically determined by the position of the option slot to which the parallel I/O interface is installed.

■Configuration

Product name	Model	Quantity	Weight (kg) [*1]	Remarks
Parallel I/O unit	2A-RZ361/2A-RZ371	1	0.7	Input: 32 points, Output: 32 points 2A-RZ361 is a sink type module. 2A-RZ371 is a source type module.
Robot I/O link connection connector	NETcable-1	2 sets	—	Connector with pins. The customer should supply and wire the cable.
Power supply connection connector	DCcable-2	Each 1 set	—	Connector with pins. The customer should supply and wire the cable.
Terminator	R-TM	1	—	100Ω(1/4W)

*1 It indicates the weight of one set.

■Specifications

⚠ 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 rated current. The internal transistor may be damaged if maximum rated current is exceeded.
• Input the power supply for control (DCcable-2) of the parallel I/O unit before inputting the power supply of the controller.

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

Item		Specifications	Internal circuit
Type		DC input	
Number of input points		32	
Insulation method		Photo-coupler insulation	
Rated input voltage		12V DC / 24V DC	
Rated input current		Approx. 3mA / Approx. 7mA	
Allowable voltage range		10.2 to 26.4V DC (ripple ratio: within 5%)	
ON voltage/ON current		8V DC or higher/2mA or higher	
OFF voltage/OFF current		4V DC or lower/1mA or lower	
Input resistance		Approx. 3.3kΩ	
Response time	OFF-ON	10ms or less (24V DC)	
	ON-OFF	10ms or less (24V DC)	
Common method		8 points per common	
External wiring method		Connector	

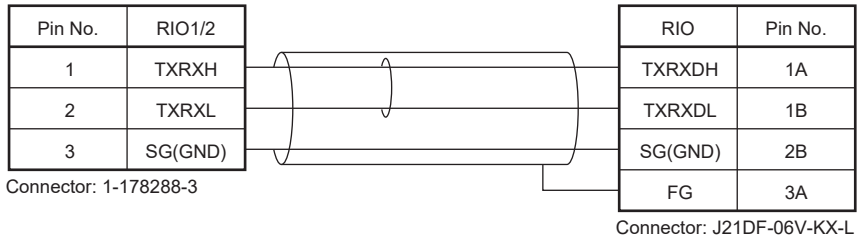The electrical specifications of input circuit are shown below.

Item		Specifications	Internal circuit
Type		Transistor output	
Number of output points		32	
Insulation method		Photo-coupler insulation	
Rated load voltage		12V DC/24V DC	
Rated load voltage range		10.2 to 30V DC (peak voltage: 30V DC)	
Maximum load current		0.1A/point (100%)	
Leakage current at OFF		0.1mA or lower	
Max. voltage drop at ON		0.9V DC (TYP.) [*1]	
Input resistance		Approx. 2.7kΩ	
Response time	OFF-ON	2ms or less (resistance load) (hardware response time)	
	ON-OFF	2ms or less (resistance load) (hardware response time)	
Fuse rating		Fuse 3.2A (one per common), Non-exchangeable	
Common method		8 points per common (common terminal: 4 points)	
External wiring method		Connector	
External power supply	Voltage	12/24V DC (10.2 to 30V DC)	
	Current	60mA (TYP.: 24V DC per common) (base drive current)	

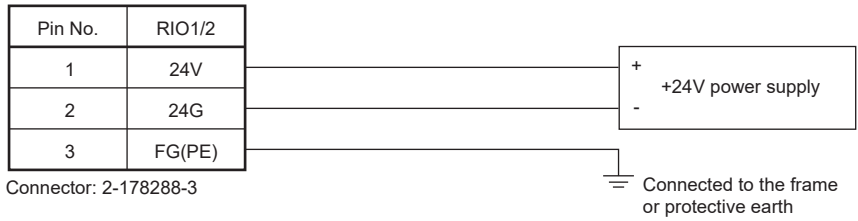*1   The maximum voltage drop value at signal ON.
      Refer to it for the equipment connected to the output circuit.
A voltage exceeding the rated voltage or incorrect wiring may damage the circuit.
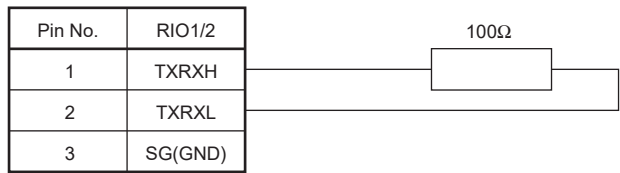
NET cable-1 (network cable)

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
3	FG(PE)

Connector: 2-178288-3

+
+24V power supply
-

Connected to the frame
or protective earth

R-TM (terminator)

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

100Ω

Model	Connector	Contact	Resistance	Manufacturer
NETcable-1	1-178288-3 × 2	1-175218-2 × 6	—	Tyco Electronics Japan G.K. (TE connectivity)
	51103-0300 × 1	50351-8100 × 3	—	MOLEX
	J21DF-06V-KX-L × 1	SJ2F-01GF-P1.0 × 4	—	Japan Solderless Terminal
DCcable-2	2-178288-3 × 1	1-175218-5 × 3	—	Tyco Electronics Japan G.K. (TE connectivity)
R-TM	1-178288-3 × 1	1-175218-3 × 2	100Ω(1/4W) × 1	Equivalent to KOA

*1 The 24V power supply must be prepared by the customer. (The current consumption is approx. 0.3A.)
Do not ground the + side of the customer device's 24V power supply for input/output (emergency stop and parallel I/O) that is used to connect the controller. Connecting the controller with the + side grounded may cause a failure of the controller.

*2 The cable for general purpose can be used as the network cable. The shielded twisted cable of #22 AWG (0.3mm^2) or larger is recommended.

3

■Installation method

Install the expansion parallel I/O unit outside the controller. Connect it using the network connection cable (NETcable-1) from the RIO port on the front of the R800CPU unit.

The following figure shows the installation method of the parallel I/O unit.

RIO port

Inside the CR860 controller

Enlarged view of the R800CPU unit

Upside

(40)
Wiring space

(175)

(128)

6

100
Heat radiation

2-M5 screw

6

156

168

6

54

60

6

150
Radiation/wiring space

<2A-RZ361>
<2A-RZ371>

Control panel
installation dimensions

Installation dimensions of 2A-RZ361/2A-RZ371
(controller outside installation)
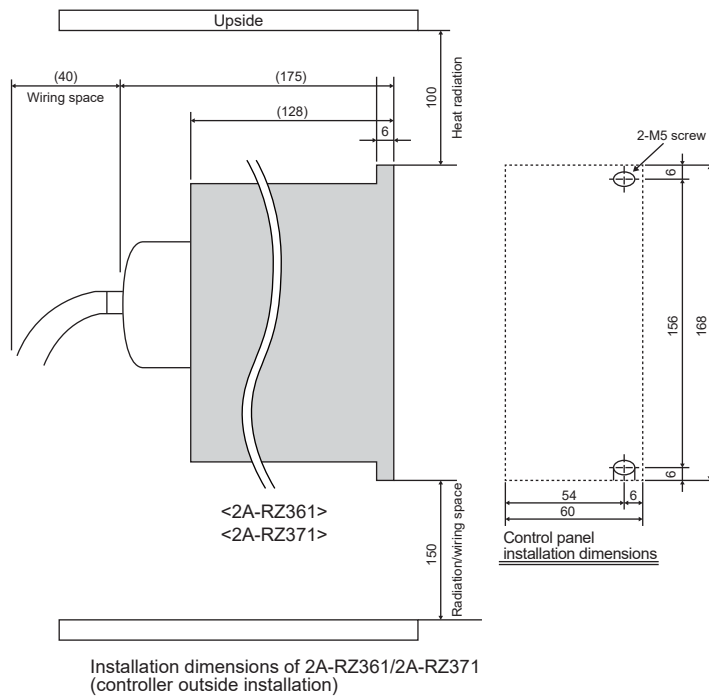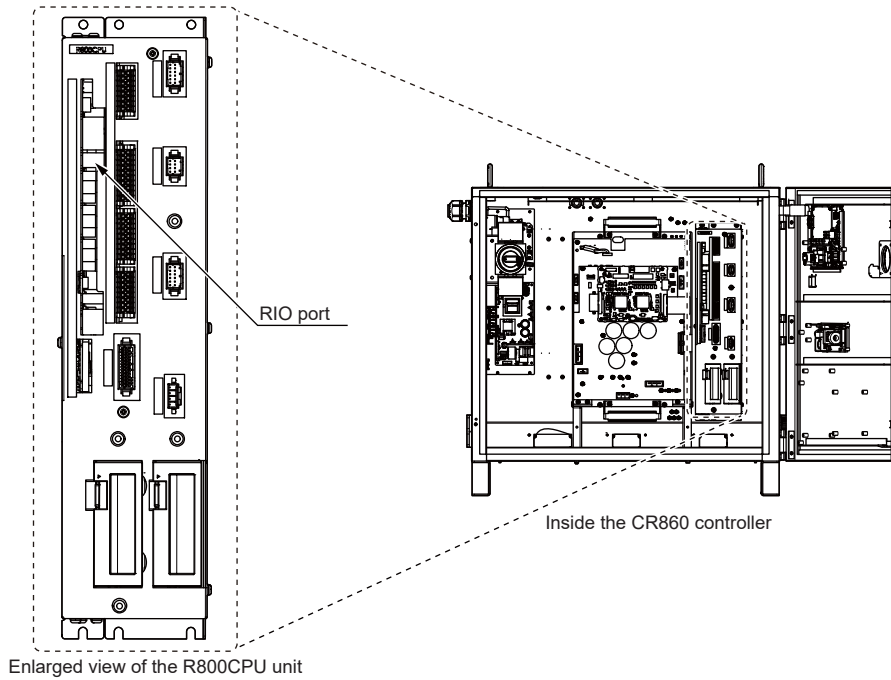
The following figure shows the installation method of the expansion parallel I/O unit.

Within 100mm*1

Parallel I/O unit 1 to 6
Station No. setting 1 to 6

Parallel I/O unit 7
Station No. setting 7

RIO port

FG*2

<CN100>   <CN300>   <CN100>   <CN300>

NETcable-1 cable

RIO1 connector   RIO2 connector   RIO1 connector   RIO2 connector

FG

DCIN connector

FG

NETcable-1 cable   DCIN connector   R-TM terminator

DCcable-2 cable   Front   DCcable-2 cable

RIO1 port

RIO2 port

DCIN socket

I/O unit bottom view: connector layout

Enlarged view of the R800CPU unit

*1   Install the ferrite core within 100mm from each connector.
*2   Grounding terminal position
     Peel the sheath in the position about 200 to 300mm from the connector end of the cable, so you can install and remove the cover.
     Do not damage the shielded line.

Sheath   Sheath
20 to 30mm
Metal braid section
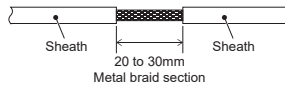
Connect the NETcable-1 to the RIO port on the front of the R800CPU unit. Connect the units in daisy chain.

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

- Always use the shielded NETcable-1 as a measure against noise. Failure to do so may result in malfunction due to noise. Always connect the shielded cable to FG.
- Install a ferrite core to the cable as required. Recommended ferrite core: E04SR301334 (Manufacturer: SEIWA ELECTRIC MFG CO.Ltd)

3

■Pin arrangement of connector

The following figure shows the pin arrangement of the parallel I/O interface.

2A-RZ361/2A-RZ371 has 32 input points and 32 output points (1 station occupied).
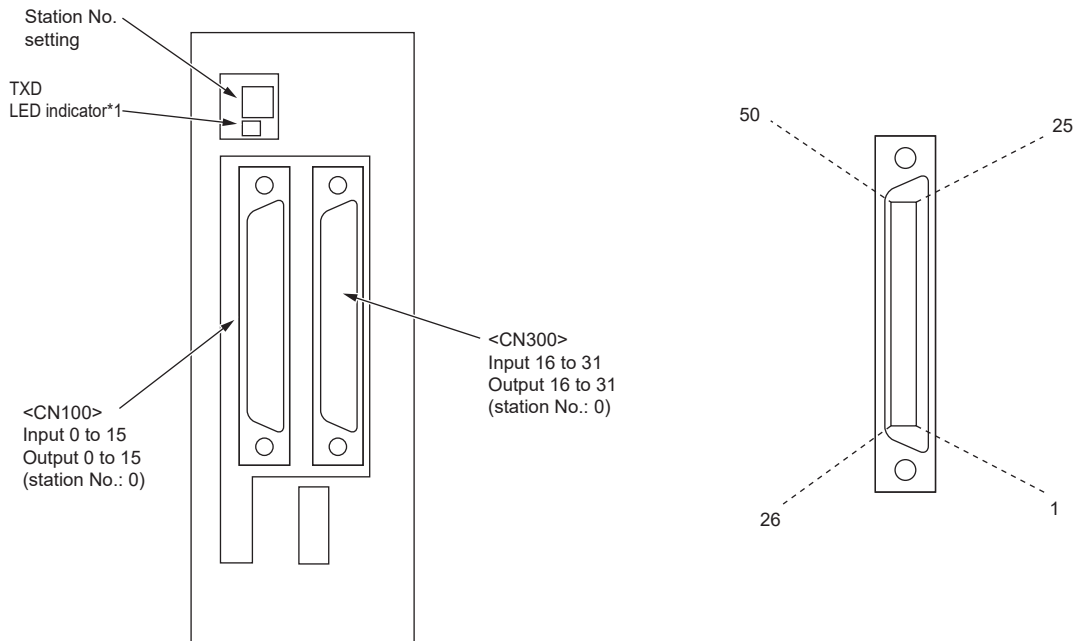
*1 TXD LED display
    Indicator of the communication status. The dimly lit lamp indicates that the unit is in the normal condition. The brightness of the light depends on the communication conditions.

■Connector pin number and signal assignment

The assignment range of the general-purpose I/O signals differs depending on the station number to be set.

The combined use with the optional parallel I/O interface (2D-TZ368/2D-TZ378) is also possible. In this case, use the setup of the station number by the different number separately.

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

The following table lists the pin number of the connector on the parallel I/O interface of station number 0 and the signal assignment.

If installing the interface to other station numbers, interpret and utilize.

- List of the connector CN100 signal assignment and the color of external I/O cable 2A-CBL□□(station number 0)

| Pin No.	Cable color	Function name		Pin No.	Cable 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 the pins of 4 to 7, for the pins of 10 to 13	27	Gray/Blue A	—	0V: For the pins of 29 to 32, for the pins of 35 to 38
3	White/Red A	—	12V/24V: For the pins of 4 to 7	28	White/Blue A	—	12V/24V: For the pins of 29 to 32
4	Yellow/Red A	General-purpose output 0	Operating output [1]	29	Yellow/Blue A	General-purpose output 4	—
5	Pink/red A	General-purpose output 1	Servo ON output signal [1]	30	Pink/Blue A	General-purpose output 5	—
6	Orange/Red B	General-purpose output 2	Error occurring output signal [1]	31	Orange/Blue B	General-purpose output 6	—
7	Gray/Red B	General-purpose output 3	Operation rights output signal [1]	32	Gray/Blue B	General-purpose output 7	—
8	White/Red B	—	0V: For the pins of 4 to 7, for the pins of 10 to 13	33	White/Blue B	—	0V: For the pins of 29 to 32, for the pins of 35 to 38
9	Yellow/Red B	—	12V/24V: For the pins of 10 to 13	34	Yellow/Blue B	—	12V/24V: For the pins of 35 to 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 the pins of 15 to 22 [2]	39	Yellow/Blue C	—	COM1: For the pins of 40 to 47 [2]
15	Pink/Red C	General-purpose input 0	Stop input [3]	40	Pink/Blue C	General-purpose input 8	—
16	Orange/Red D	General-purpose input 1	Servo OFF input signal [3]	41	Orange/Blue D	General-purpose input 9	—
17	Gray/Red D	General-purpose input 2	Error reset input signal [1]	42	Gray/Blue D	General-purpose input 10	—
18	White/Red D	General-purpose input 3	Start input [1]	43	White/Blue D	General-purpose input 11	—
19	Yellow/Red D	General-purpose input 4	Servo ON input signal [1]	44	Yellow/Blue D	General-purpose input 12	—
20	Pink/Red D	General-purpose input 5	Operation rights input signal [1]	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

[1] The dedicated signal is assigned at shipping. It can be changed with the parameter.
[2] Sink type: 12V/24V (COM), source type: 0V (COM)
[3] The dedicated input signal (STOP) is assigned at shipping. The signal number is fixed.

Pin No.	Cable color	Function name		Pin No.	Cable 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 the pins of 4 to 7, for the pins of 10 to 13	27	Gray/Blue A	—	0V: For the pins of 29 to 32, for the pins of 35 to 38
3	White/Red A	—	12V/24V: For the pins of 4 to 7	28	White/Blue A	—	12V/24V: For the pins of 29 to 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 the pins of 4 to 7, for the pins of 10 to 13	33	White/Blue B	—	0V: For the pins of 29 to 32, for the pins of 35 to 38
9	Yellow/Red B	—	12V/24V: For the pins of 10 to 13	34	Yellow/Blue B	—	12V/24V: For the pins of 35 to 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 the pins of 15 to 22 [*1]	39	Yellow/Blue C	—	COM1: For the pins of 40 to 47 [*1]
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

*1 Sink type: 12V/24V (COM), source type: 0V (COM)

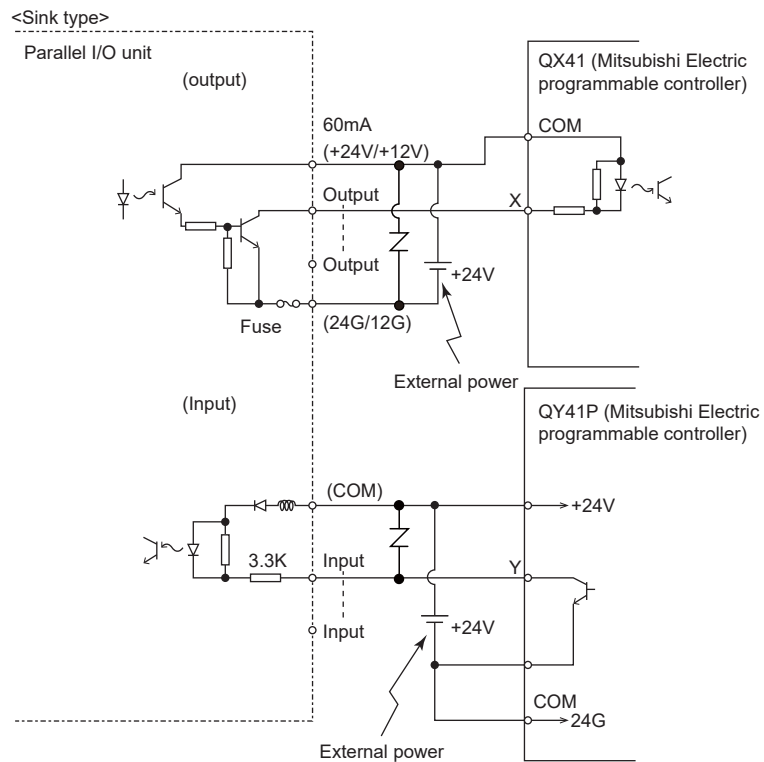The example of connection with a Mitsubishi Electric programmable controller (sink type) is shown below.

⚠ CAUTION

- The customer should supply the external power supply (24V DC) for the I/O circuit.
- Do not ground the + side of the customer device's 24V power supply for input/output (emergency stop and parallel I/O) that is used to connect the controller. Connecting the controller with the + side grounded may cause a failure of the controller.
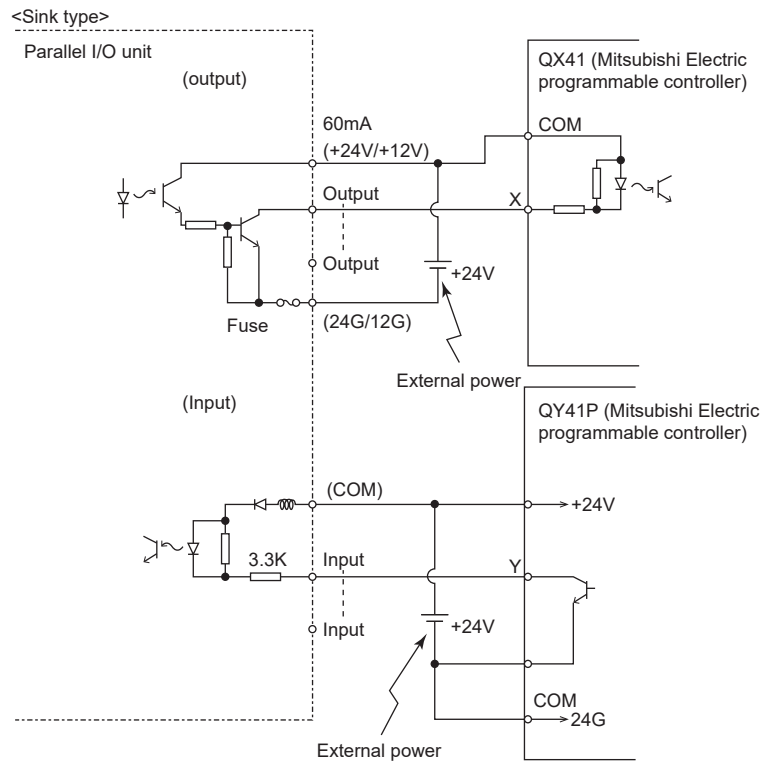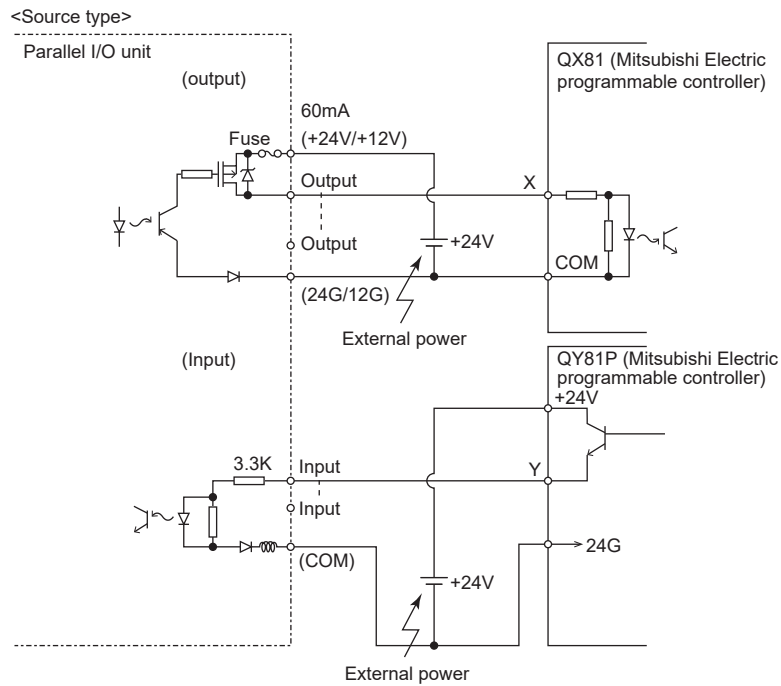

The following figure shows an example of connection with a protection circuit.

The example of connection with a Mitsubishi Electric programmable controller (source type) is shown below.

⚠ CAUTION

- The customer should supply the external power supply (24V DC) for the I/O circuit.
- Do not ground the + side of the customer device's 24V power supply for input/output (emergency stop and parallel I/O) that is used to connect the controller. Connecting the controller with the + side grounded may cause a failure of the controller.

The following figure shows an example of connection with a protection circuit.
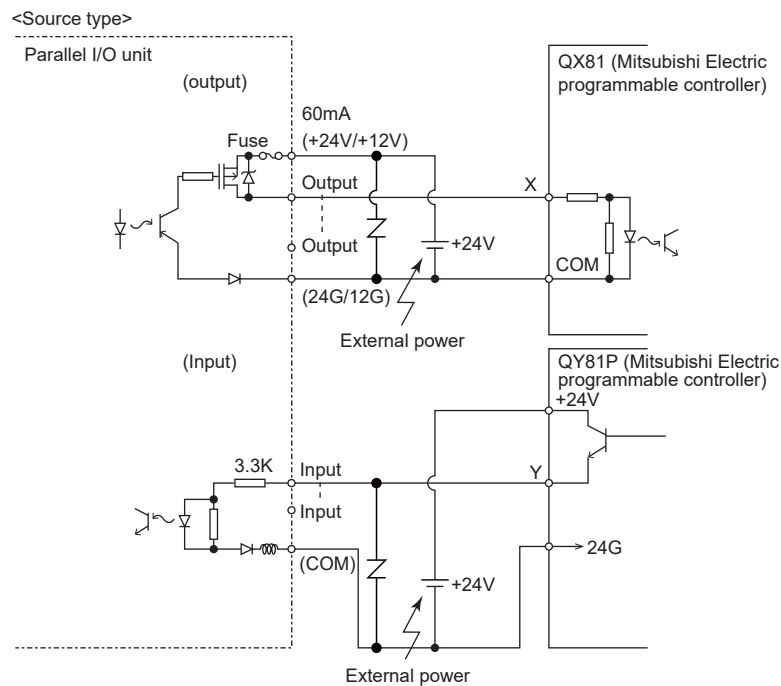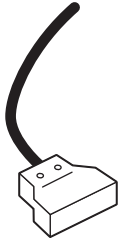
External I/O cable

■Order type

- 2A-CBL□□[*1]

[*1]   □□indicates the length of cable. (05: 5m, 15: 15m)

■Outline

This is the cable dedicated to connecting an external peripheral to the connector on the parallel I/O unit. Use another option 2D-CBL□□for the parallel I/O interface.

One end matches the connector on the parallel I/O unit, and the other end is free.

Connect the I/O signal of the peripheral using the free end.

One cable supports the 16 input points and 16 output points.

After installing the parallel I/O unit, the number of input points is 32 and the number of output points is 32. Prepare two cables.

■Configuration

Product name	Model	Quantity	Weight (kg) [*1]	Remarks
External I/O cable	2A-CBL□□	1	0.7 (5m) 1.84 (15m)	5m or 15m

[*1]   It indicates the weight of one set.

■Specifications

Item	Specifications
Number of cores/Wire size	50 cores × #28 AWG
Total length	5m, 15m

■Connector pin number and cable color

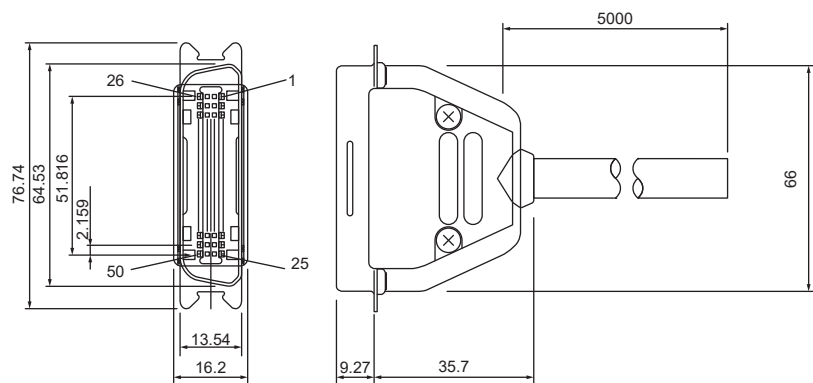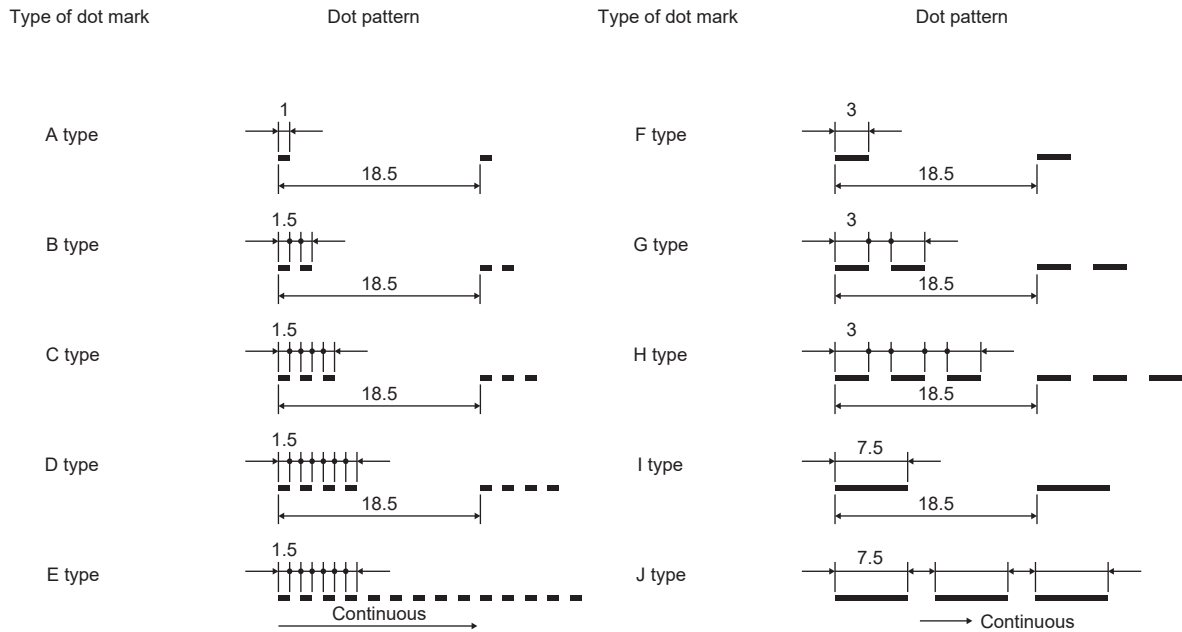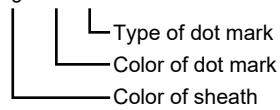| Pin No.	Cable color	Pin No.	Cable color	Pin No.	Cable color	Pin No.	Cable color
1	Orange/Red A	11	Orange/Red C	21	Orange/Blue A	31	Orange/Blue C
2	Gray/Red A	12	Gray/Red C	22	Gray/Blue A	32	Gray/Blue C
3	White/Red A	13	White/Red C	23	White/Blue A	33	White/Blue C
4	Yellow/Red A	14	Yellow/Red C	24	Yellow/Blue A	34	Yellow/Blue C
5	Pink/red A	15	Pink/Red C	25	Pink/Blue A	35	Pink/Blue C
6	Orange/Red B	16	Orange/Red D	26	Orange/Blue B	36	Orange/Blue D
7	Gray/Red B	17	Gray/Red D	27	Gray/Blue B	37	Gray/Blue D
8	White/Red B	18	White/Red D	28	White/Blue B	38	White/Blue D
9	Yellow/Red B	19	Yellow/Red D	29	Yellow/Blue B	39	Yellow/Blue D
10	Pink/Red B	20	Pink/Red D	30	Pink/Blue B	40	Pink/Blue D

■Connection and external dimensions

The sheath of each signal cable (40 lines) is indicated its color and marked with dots.

Connect each cable referring to the following figure.

(Example) Pin number: Color indication

1 : Orange/Red/a

└─ Type of dot mark
└─ Color of dot mark
└─ Color of sheath

Type of dot mark	Dot pattern	Type of dot mark	Dot pattern
A type	1 / 18.5	F type	3 / 18.5
B type	1.5 / 18.5	G type	3 / 18.5
C type	1.5 / 18.5	H type	3 / 18.5
D type	1.5 / 18.5	I type	7.5 / 18.5
E type	1.5 / Continuous	J type	7.5 / Continuous

Receptacle model (circuit board side): 57AE-40500-21D(D8)   ......DDK
Plug model   (cable side): 57YE-30500-2(D8)*1   ......DDK

Manufacturer

*1 The plug type represents the specifications of this cable.
    Use the following recommended connectors.
    · Plug type (cable side):
    57E series (soldering type): DDK
    57FE series (flat cable pressure connection type): DDK

CC-Link interface

■Order type
- 2D-TZ576

■Outline

The CC-Link interface is the optional interface to add the CC-Link Field Network function that sends word data as well as bit data to the robot controller using cyclic transmission.
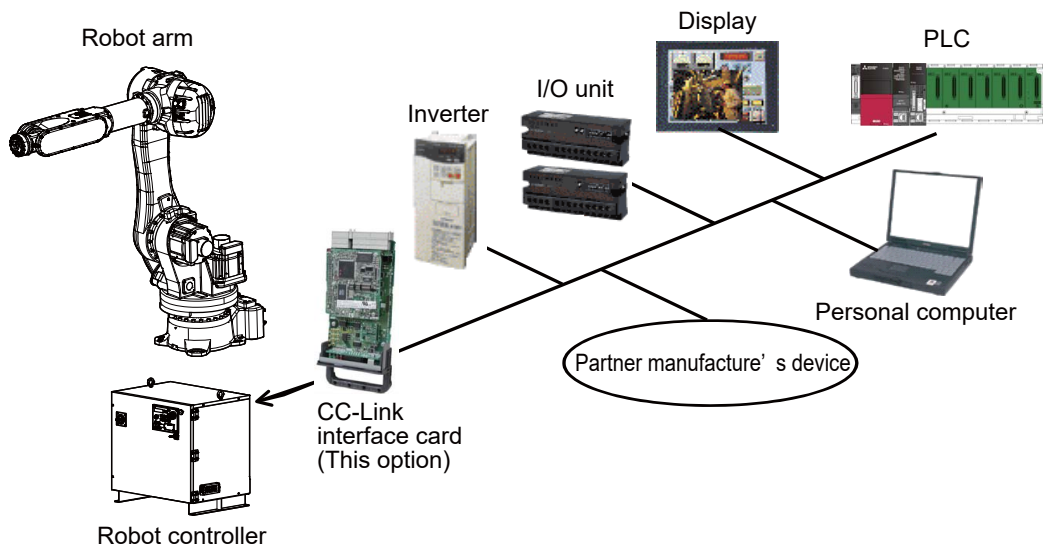
■Configuration

The following table lists the components.

Product name	Model	Quantity	Weight (kg)[1]	Remarks
CC-Link interface card	TZ576	1	0.6	—
Instruction 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	—	—
Terminator cap	A6CON-TR11N	1	—	Resistance value: 110Ω
One-touch connector plug for communication	A6CON-L5P	2	—	—

*1   It indicates the weight of one set.

The following table lists the products to be supplied by the customer.

Product name	Model	Quantity	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	Dedicated cable

Robot arm

Display

PLC

Inverter

I/O unit

Personal computer

Partner manufacture's device

CC-Link interface card (This option)

Robot controller

■Specifications

Item			Specifications				Remarks
Communication function			Bit data and word data can be transmitted.				Word data is used in register areas.
Station type			Intelligent device station [*1]				—
Support station			Local station				No master station function
Version corresponding to CC-Link			Ver.2				The extended cyclic transmission can be set.
Option slot			Slot 1 and 2				—
Number of mountable CC-Link interface cards			1				Only one CC-Link interface card can be inserted.
Number of stations			1 to 64 stations				When four stations are occupied, consecutive station numbers are used.
Transmission speed			10M/5M/2.5M/625k/156kbps				—
Station No.			1 to 64				When two or more stations are occupied, set consecutive station numbers.
Number of occupied stations			1/2/3/4				
Extended cyclic setup			1/2/4/8				
Control specifications	Maximum number of link points	Remote I/O (RX, RY)	896 points for each				The last two points cannot be used.
		Remote register (RWr, RWw)	128 points for each				16 bits/register
	Extended cyclic setup		Single	Double	Quadruple	Octuple	—
	Number of link points per station	When one station is occupied	Remote I/O (RX, RY)	32 points for each	32 points for each	64 points for each	128 points for each	—
			Remote register (RWw)	4 words	8 words	16 words	32 words	—
			Remote register (RWr)	4 words	8 words	16 words	32 words	—
		When two stations are occupied	Remote I/O (RX, RY)	64 points for each	96 points for each	192 points for each	384 points for each	—
			Remote register (RWw)	8 words	16 words	32 words	64 words	—
			Remote register (RWr)	8 words	16 words	32 words	64 words	—
		When three stations are occupied	Remote I/O (RX, RY)	96 points for each	160 points for each	320 points for each	640 points for each	—
			Remote register (RWw)	12 words	24 words	48 words	96 words	—
			Remote register (RWr)	12 words	24 words	48 words	96 words	—
		When four stations are occupied	Remote I/O (RX, RY)	128 points for each	224 points for each	448 points for each	896 points for each	—
			Remote register (RWw)	16 words	32 words	64 words	128 words	—
			Remote register (RWr)	16 words	32 words	64 words	128 words	—
	Maximum number of occupied stations		4				—
The I/O first number of the robot controller			The number corresponding to the station number by the setup of the parameter "CCFIX", which starts from 6000.				—

*1   Not available for the transient transmission function and FX series models that do not support intelligent devices.

■Function

• Communication function

The number of usable points is 896 maximum for bit control and 128 maximum for word control.

• Easy setup

The CC-Link interface card can be set using parameters.

The CC-Link interface card is built in the robot controller. Thus, no separate space is required.

Easy wiring since only four terminals need to be connected.

Dedicated commands (status variables of M_Din and M_Dout) have been added to MELFA-BASIC V, VI (robot programming language); thus, no complex interface programming is required.

• High-speed response

When 64 stations are connected, the link scan time is approximately 7.2ms.

A transmission speed can be selected from 10M, 5M, 2.5M, 625k, and 156kbps according to the transmission distance.

SD memory card

■Order type

• 2F-2GBSD

■Outline
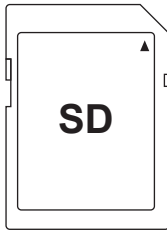
This card is used as extended memory.

Insert an SD card into the SD card slot on the front of the R800CPU unit to save logging data.

■Configuration

Product name	Model	Quantity	Remarks
SD memory card	2F-2GBSD	1	Capacity: 2GB

3.10 Maintenance parts

The consumable parts used in the controller are shown in the following table. Purchase these parts from the designated maker or dealer when required. Some Mitsubishi Electric-designated parts differ from the maker's standard parts. Thus, confirm the part name, robot arm, and controller serial number, and purchase the parts from the dealer.
List of controller consumable parts

No.	Item	Type[*1]	Quantity	Location	Supplier
1	Lithium battery	Q6BAT	1	Robot CPU module: For the Q172DSRCPU (CR860-Q controller only)	Mitsubishi Electric

*1 For information on the models, check the serial number on the robot arm, and contact your local sales representative or the dealer.

4   SOFTWARE

4.1   List of commands

The following table lists the main functions of MELFA-BASIC VI.

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 specified program.	#Include "PRG1"
Position and operation control	Joint interpolation	Moves to the specified position with joint interpolation.	Mov P1
	Linear interpolation	Moves to the specified position with linear interpolation.	Mvs P1
	Circular interpolation	Moves along a specified arc (start point →passing point → start point (end point)) with 3-dimensional circular interpolation (360 degrees).	Mvc P1,P2,P1
		Moves along a specified 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 specified 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	Specify the speed for various interpolation operations with a percentage. (in units of 0.1%)	Ovrd 100
		Specify the speed for joint interpolation operation with a percentage (in units of 0.1%).	JOvrd 100
		Specify the speed for linear and circular interpolation with a numerical value (unit: mm/s).	Spd 123.5
		Specify the acceleration/deceleration time as a percentage in respect to the predetermined maximum acceleration/deceleration. (in units of 1%)	Accel 50,80
		Automatically adjusts the acceleration/deceleration according to the values specified in parameters.	Oadl On
		Set 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
		Specifies smooth operation.	Cnt 1,100,200
		Performance of movement is upgraded corresponding to the application. (Manufacturer standard, high-speed positioning, trace priority, vibration suppression)	MvTune 4
		Specifies the positioning completion conditions with a number of pulses.	Fine 200
		Specifies the positioning completion conditions with a distance in a straight line.	Fine 1, P
		Turns on/off the servo power for all axes.	Servo Off
		Limits the operation of each axis so that the specified torque is not exceeded.	Torq 4,10
	Position control	Specifies the base conversion data.	Base P1
		Specifies the tool conversion data.	Tool P1
	Float control	Lowers the rigidity of the robot arm to soften the movement of the axis. (XYZ coordinate system)	Cmp Pos ,&B00000011
		Lowers the rigidity of the robot arm to soften the movement of the axis. (Joint coordinate system)	Cmp Jnt ,&B00000011
		Lowers the rigidity of the robot arm to soften the movement of the axis. (Tool coordinate system)	Cmp Tool ,&B00000011
		Returns the rigidity of the robot arm to the normal state.	Cmp Off
		Specifies the rigidity of the robot arm.	CmpG 1.0,1.0,1.0,1.0,1.0,1.0,1.0
	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	Passes through a singular point using linear interpolation.	Mvs P1 Type 0,2

Type	Class	Function	Input format (example)
Program control	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 the operation until the specified end conditions are satisfied.	For M1=1 To 10 ⋮ Next M1
		Repeats the operation as long as the specified conditions are satisfied.	While M1<10 ⋮ WEnd
		Branches depending on the value calculated from the specified expression.	On M1 GoTo *La1,*Lb2,*Lc3
		Executes the program block corresponding to the value calculated from the specified expression.	Select Case 1 ⋮ Break Case 2 ⋮ Break End Select
		Process the program on the next line.	Skip
	Collision detection	Switches to enable or disable the collision detection.	ColChk On/Off
		Sets the collision detection level.	ColLvl 100,80,,,,,,
	Subroutine	Executes the specified subroutine. (Within program)	GoSub *L200
		Returns from the subroutine.	Return
		Executes the specified program.	CallP "P10",M1,P1
		Defines the argument of the program to be executed with the CALLP command.	FPrm M10,P10
		Executes the subroutine corresponding to the value calculated from the specified expression.	On M1 GoSub*La1,*La2,*La3
	Interrupt	Defines the interrupt conditions and processes.	Def Act 1, M1=1 GoTo *L123
		Enables or disables the interrupt.	Act 1=1
		Defines the start line of the program to be executed when an interrupt is occurred 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	Specifies the wait time and the pulse output time for the output signal. (in units of 0.01s)	Dly 0.5
		Waits until the variable becomes the specified value.	Wait M_In(20)=1
	Stop	Stops executing the program.	Hlt
		Makes an error. The processing of Continue, Stop, or Servo OFF can be selected for the program.	Error 9000
	End	Ends the execution of the program.	End
Hand	Hand open	Opens the hand.	HOpen 1
	Hand close	Closes the hand.	HClose 1
I/O	Assignment	Defines the I/O variables.	Def IO PORT1=Bit,99
	Input	Receives the general-purpose input signal.	M1=M_In (78)
	Output	Outputs the general-purpose output signal.	M_Out(23) =0
Parallel execution	Mechanism specification	Acquires the mechanism with the specified mechanism number.	GetM 1
		Releases the mechanism with the specified mechanism number.	RelM
	Selection	Selects the specified program for the specified slot.	XLoad 2,"P102"
	Start/stop	Performs parallel execution of the specified programs.	XRun 3,"100",0
		Stops parallel execution of the specified programs.	XStp 3
		Returns the execution line in the specified program to the leading position to select a new program.	XRst 3

Type	Class	Function	Input format (example)
Others	Definition	Defines the integer variables or real number variables.	Def Inte KAISUU
		Defines the character string variables.	Def Char MESSAGE
		Defines the array variables. (Three-dimensional array can be set.)	Dim PDATA(2,3)
		Defines the joint variables.	Def Jnt TAIHI
		Defines the position variables.	Def Pos TORU
		Defines the functions.	Def FN TASU(A,B)=A+B
	Clear	Clears the general-purpose output signal, variables in the program, variables between programs, and other specified values.	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

4.2 List of parameters

The following table lists the main parameters.

Parameter		Details
Standard tool coordinate	MEXTL	Set the default value for the tool data. Unit: mm or deg
Standard base coordinate	MEXBS	Set the relation between the base coordinate system and robot coordinate system. Unit: mm or deg
XYZ operating range	MEPAR	Specify the overrun limit value for the base coordinate system.
Joint operating range	MEJAR	Specify the overrun limit value for each joint axis.
Free plane limit	—	Overrun limit specified with the free plane. A plane is created with the three coordinates x1, y1, and z1 to x3, y3, and z3, and the positions outside of the plane are set as the outside operation range (error). The following three parameters are used.
	SFC1P ⋮ SFC8P	The free plane limit has eight types of SFC1P to SFC8P. There are nine elements. Set them in the order of x1, y1, z1, x2, y2, z2, x3, y3, and z3.
	SFC1ME ⋮ SFC8ME	Specify which mechanism each free plane limit is used for. Specify the mechanism number to be used from 1 to 3.
	SFC1AT ⋮ SFC8AT	Specify whether to enable or disable each free plane limit. (1: Enable 1, -1: Enable 2, 0: Disable)
User-designated area	—	The user can define an area (cube) with two XYZ coordinate points to specify the area as out of operating range and output a signal when the axis enters the area. Up to 32 areas can be defined.
	AREA1CS ⋮ AREA32CS	Specify the coordinate system for the user-designated area. 0: Base coordinate system (The user-designated area are changed when the base coordinate system is changed.) 1: Robot coordinate system (The user-designated area are not changed even if the base coordinate system is changed.)
	AREA1P1 ⋮ AREA32P1	Specify the 1st point of the area. There are eight elements. Set them in the order of x, y, z, a, b, c, L1, and L2. (L1 and L2 are additional axes.)
	AREA1P2 ⋮ AREA32P2	Specify the 2nd point of the area. There are eight elements. Set them in the order of x, y, z, a, b, c, L1, and L2. (L1 and L2 are additional axes.)
	AREA1ME ⋮ AREA32ME	Specify which mechanism each area is used for. Specify the mechanism number to be used from 1 to 3.
	AREA1AT ⋮ AREA32AT	Specify the area check type. (0: Invalid, 1: Zone, 2: Interference) Zone: The dedicated output signal USRAREA is turned on. Interference: An error occurs.
Automatic return setting	RETPATH	Set to restart the program from the interrupt position after an interruption.
Buzzer ON/OFF	BZR	Specify whether to turn on or off the buzzer.
Jog setting	JOGJSP	Specify the speed of jog operation and step operation with joint interpolation. (Set dimensions H/L amount, maximum override)
	JOGPSP	Specify the speed of jog operation and step operation with linear interpolation. (Set dimensions H/L amount, maximum override)
Jog speed limit value	JOGSPMX	Limit the operation speed in teaching mode. Maximum 250 [mm/s]
Hand type	HANDTYPE	Set the hand type of the single/double solenoid and the signal number. (S: Single, D: Double) Set the signal number after the hand type. Example) D764
Stop input b contact designation	INB	Change the dedicated input (stop) to either of normal open or normal close.
User-designated origin	USERORG	Specify the user-designated origin.
Program selection memory	SLOTON	Select the program selected previously when the slot is initialized. When not set, the non-selected state be entered.

Parameter		Details
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	Set the specifications for each slot (program name, operation type, order of priority, etc.) at initialization of slot.
Number of multi-tasks	TASKMAX	Specify the number of programs to be executed simultaneously. (Maximum 32)
Multiple CPU system setting	QMLTCPUN	Specify the number of CPUs with which the base unit is equipped.
	QMLTCPUn	Set the high-speed communication area of each CPU in the multiple CPU system.
	QMLTCPUS	Set the input offset of each CPU in the multiple CPU system.
Nearing singularity function selection	MESNGLSW	Specify whether to enable or disable the nearing singularity. (0: Disable, 1: Enable) When "Enable" is set for this parameter, this warning buzzer will sound even if OFF is set to the parameter BZR (buzzer ON/OFF).
Display language	LNG	Specify the language displayed on the option RT ToolBox3.

4

5 INSTRUCTION MANUAL

5.1 Details of each instruction manual

The following table shows contents and purposes of the documents enclosed with this product.

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	To ensure the safety of robot users, this manual provides information on common precautions and safety measures that should be taken when handling the robot or creating and designing robot systems.
Standard Specifications	Provides information on standard product specifications, factory-set special specifications, options, and maintenance parts. It also provides information on safety and technical precautions when introducing the robot into a new environment.
Robot Arm Setup and Maintenance	Explains pre-operation requirements for the robot (unpacking, transportation, installation, and operation checks) and how to carry out maintenance and inspection.
Controller setup, basic operation, and maintenance	Explains pre-operation requirements for the controller (unpacking, transportation, installation, and operation checks), basic operation from programming to automatic operation, and how to carry out maintenance and inspection.
Detailed explanations of functions and operations	Provides information on functions and operation methods, how to use MELFA-BASIC VI commands in programs, how to connect external input/output devices, and how to set parameters.
Troubleshooting	Provides information on the causes and solutions to errors that may occur while operating the robot.
Additional axis function	Explains the general-purpose servo amplifier control function that is used together with the controller.
Tracking Function	Provides information on the specifications, functions, and usage of the conveyor tracking function.
GOT Direct Connection Extended Function	Describes the data configuration of the memory between the GOT and a standalone type robot, monitoring, and operating procedures.
iQ Platform Supporting Extended Function	Describes the data configuration of the memory between the PLC and an iQ Platform compatible robot, monitoring, and operating procedures.
Safety Communication Function	Explains about the safety communication function which expands the robot safety functions by communicating safely with a safety programmable controller.
Ethernet Function	Explains how to communicate with a computer over Ethernet using TCP/IP protocols.

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.

Self-diagnosis stop functions

This robot has the self-diagnosis functions shown in the following tables for safe use.

• Self-diagnosis stop functions

No.	Function		Details	Remarks
1	Overload protection function [*1]		Activates when the total servo current time exceeds the specified value.	The drive circuit is shut off. The robot stops, and an alarm is indicated.
2	Overcurrent diagnosis function [*1]		Activates when an overcurrent flows to the motor circuit.	The drive circuit is shut off. The robot stops, and an alarm is indicated.
3	Encoder disconnection diagnosis function		Activates when the encoder cable is disconnected.	The drive circuit is shut off. The robot stops, and an alarm is indicated.
4	Deflection over diagnosis function		Activates when the error between the command value and actual position exceeds the specified amount.	The drive circuit is shut off. The robot stops, and an alarm is indicated.
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 is indicated.
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 is indicated.
7	Overrun prevention function	Software limit detection	Provided by the software to enable operation only in the operating range.	The drive circuit is shut off. The robot stops, and an alarm is indicated.
		Mechanical stopper	Provided outside the software.	The robot stops mechanically and function1 or 2 activates.

*1   There is no thermal memory function that conforms to EN61800-5-1:2007/A1:2017.

• List of stop functions

Stop functions	Operation panel	Teaching pendant	External input	Details
Emergency stop	○	○	○	Used to stop the robot in emergency. The servo power is shut off and the mechanical brake activates. To release the operation, reset the alarm and turn on the servo with the servo ON command.
Stop	○	○	○	Used to decelerate the robot to stop in the normal case. Note that the servo power is not shut off. Use this when using the collision evasion sensor.

External I/O signals that can be used for preventative safety measures

The following table list the external I/O signals that can be used for preventative safety measures.

Signal		Connection port	Parameter	Function	Usage method
Input	External emergency stop input [*1]	Connector CNUSR11	—	Shuts off the servo power and stops the robot immediately.	Emergency stop switches to be installed externally. Used for a high-level error.
	Door switch input [*1]		—		Used for the safety protection fence.
	Enabling device input [*1]		—		Enabling device (Safety switch during the teaching work)
	Stop	CR860-D: I/O unit or interface CR860-R/Q: Programmable controller module	STOP, STOP2	Stops executing the program and stops the robot. The servo power is not shut off.	Used to stop the robot when a peripheral fails. The servo power is not shut off.
	Servo OFF		SRVOFF	Shuts off the servo power.	Used to stop the robot when a peripheral fails. Also, the servo power is shut off.
	Automatic operation enable		AUTOENA	Disables switching to automatic mode.	Used for the safety protection fence.
Output	Emergency stop output	Connector CNUSR13	—	Outputs that the external emergency stop signal or T/B emergency stop signal is on.	To warn that the external emergency stop signal or T/B emergency stop signal is turned, turn on the indicator LED.
	In servo ON	CR860-D: I/O unit or interface CR860-R/Q: Programmable controller module	SRVON	Outputs whether the servo power supply is turned on or off.	The servo power ON/OFF state is indicated by the indicator LED.
	Waiting		STOP, STOP2	Outputs that the robot is temporarily stopped.	The temporary stop state of the robot is indicated by the indicator LED.
	In alarm	Connector CNUSR13	ERRRESET	Outputs that an error has occurred in the robot.	The alarm state is indicated by the indicator LED.

*1 For safety, each of the external emergency stop input circuit, door switch input circuit, and enabling device input circuit has two NC contacts for redundancy. If these input circuits are opened when the robot is started up, the robot will not operate. For details on wiring, refer to the following page:

☞Page 150 Examples of safety measures

Also, refer to the following page for the functions of door switch input and enabling device input.

☞Page 95 Required switch statuses for automatic operation, jog operation, and brake release

Precautions for using the 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.

Robot installation

- Secure sufficient workspace required to safely perform work such as teaching and maintenance related to the robot installation.
- Install the controller outside the robot's motion space. (If a safety fence is provided, install the controller outside the fence.)
- Install the controller where the entire robot operation can be viewed.
- Install indicator lamps to indicate the operation states of robot.
- Securely fix the robot arm on the fixing table with the specified bolts.

Prevention of contact with operator

- Install a safety fence or enclosure to prevent workers from entering the operating range of the robot.
- Provide an interlock to the safety fence or enclosure so that the robot can be stopped upon opening of the door.

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 operating range of the robot so that other operators will not operate the operation panel (controller, control panel).

Training

- Train the operators about the operations, maintenance, and safety required for the robot work.
- Only trained and registered operators must operate the robot.

Daily and periodic inspections

- Always inspect the robot before starting operations and confirm that there is no problem.
- Define the criteria of periodic inspections considering the surroundings of the robot and how often the robot is used. Perform periodic inspection accordingly.
- Keep the record of periodic inspections and repairs for necessary terms according to the law of the country where it is used.

Safety measures for automatic operation

- Install safety fences so that operators will not enter the operation area during operation and indicate that automatic operation is in progress with lamps or indicators.
- Create signals to be given when starting operation, assign a person to give the signal, and make sure that the operator follows the signals.

Safety measures for teaching

Observe the following measures when teaching the robot in the operating range of the robot.
- Specify and follow items such as procedures related to teaching.
- Establish measures required to stop the operation in case of trouble and measures required to restart the robot.
- During teaching, indicate that the operator is working using the start switch or LEDs on the robot.
- Before teaching, always inspect the emergency stop devices and other stop functions.
- If a trouble occurs, immediately stop teaching and correct the trouble.
- Establish measures that allow the work supervisor to stop the operation immediately in case of trouble.
- The teaching operators must have completed special training regarding safety. (Training regarding industrial robots and work methods)
- When multiple workers perform tasks at the same time, determine a signaling method.

Safety measures for maintenance and inspections

Before performing inspections, repairs, adjustment, cleaning, or oiling, turn off the power. Also, establish measures to prevent operators other than the relevant operator from pressing the start switch under the work mentioned above.
Establish the following measures to prevent hazards caused by unintentional or mistaken operations for when performing the work while the robot is operating.
- Specify and follow items such as procedures related to maintenance and inspections.
- Establish measures required to stop the operation in case of trouble and measures required to restart the robot.
- During maintenance and inspections, indicate that the operator is working using the start switch or LEDs on the robot.
- Establish measures that allow the work supervisor to stop the operation immediately in case of trouble.
- The workers must have completed special training regarding safety. (Training regarding industrial robots and work methods)
- When multiple workers perform tasks at the same time, determine a signaling method.

Examples of safety measures

⚠ CAUTION

- In the process of wiring customer's emergency stop-related products, if connecting the coil (not a contact) of the relay supplied by customer to the controller, be sure to take preventive measures against surge in the coil section. Moreover, take the service life of surge protective devices into consideration.
- Electrical specifications of the emergency-stop-related output terminal: 24V DC or less, rated 100mA
- Do not ground the + side of the customer device's 24V power supply for input/output (emergency stop and parallel I/O) that is used to connect the controller. Connecting the controller with the + side grounded may cause a failure of the controller.

The dedicated I/O terminal connectors on the controller has a duplicate emergency stop circuit.

This section provides examples of safety measures. Refer to these figures when creating safety measures. The figures represent systems which are operating normally (i.e. Systems not in an emergency stop state).

Wiring example 1

Connect the emergency stop switch of the peripheral equipment.

The power used for emergency stop detection is supplied via the internal power supply of the controller.

This wiring example shows that the input circuit of the external emergency stop input is provided separately. In this circuit, when the safety diagnosis function is enabled, the external emergency stop input complies with SIL3, PLe/Category 4. (If the safety diagnosis function is disabled, the external emergency stop input complies with SIL2, PLd/Category 3.)

<Operation of the emergency stop>

Pressing the emergency stop switch on the peripheral equipment will also bring the robot to an emergency stop.

Wiring example 2

Connect the emergency stop switch of the peripheral equipment.

The power used for emergency stop detection is supplied via the internal power supply of the controller.

This wiring example shows that the OP emergency stop, T/B emergency stop, and external emergency stop switches are connected on one path. In this circuit, the safety function complies with SIL2, PLd/Category 3.

<Operation of the emergency stop>

Pressing the emergency stop switch on the peripheral equipment will also bring the robot to an emergency stop.

*1   This is the emergency stop button on the front of the robot controller.
*2   This is the emergency stop button of the teaching pendant that is connected to the robot controller. If the button is connected as shown in this diagram, it is not possible to remove the teaching pendant from the controller without generating an emergency stop alarm. When the devices are connected as shown in this diagram with the T/B removed, attach a dummy connector (sold separately) to the T/B connection port.
*3   The CNUSR11 connector has two rows of terminals, indicating that there are two channels. Both channels must be connected.
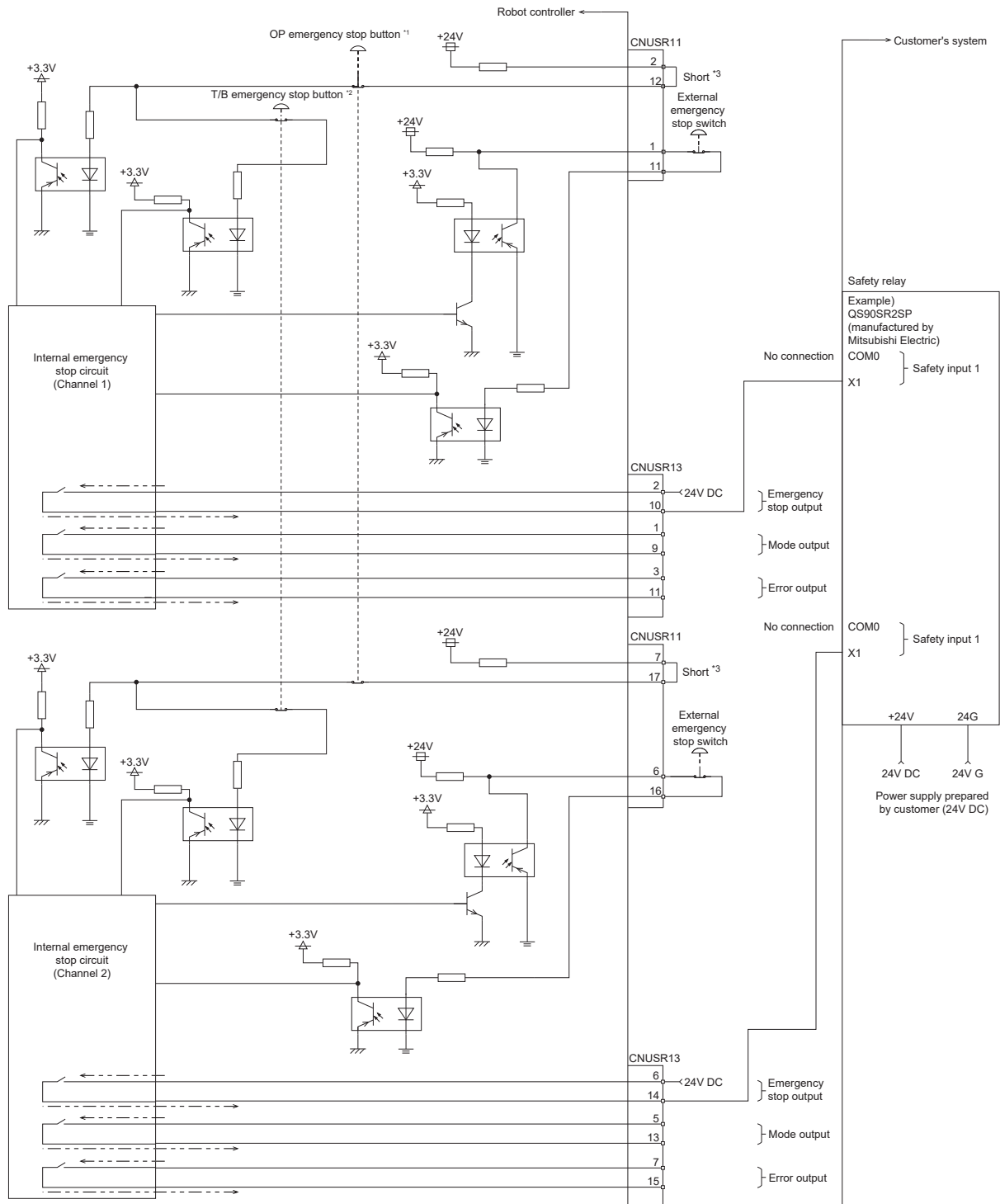*4   The terminals are open (unconnected) from the factory. Short-circuit them if using the power supply inside the controller.

Wiring example 3

Connect the peripheral equipment's emergency stop switch, door switch, and enabling device.

The power used for emergency stop detection is supplied via the peripheral equipment. The emergency stop state is monitored via the peripheral equipment.

This wiring example shows that the OP emergency stop, T/B emergency stop, and external emergency stop switches are connected on one path. In this circuit, the safety function complies with SIL2, PLd/Category 3.

<Operation of the emergency stop>

Pressing the emergency stop switch on the peripheral equipment will also bring the robot to an emergency stop.

Even if the controller is powered off, pressing the emergency stop switch of the controller or T/B can bring the peripheral equipment to an emergency stop state.
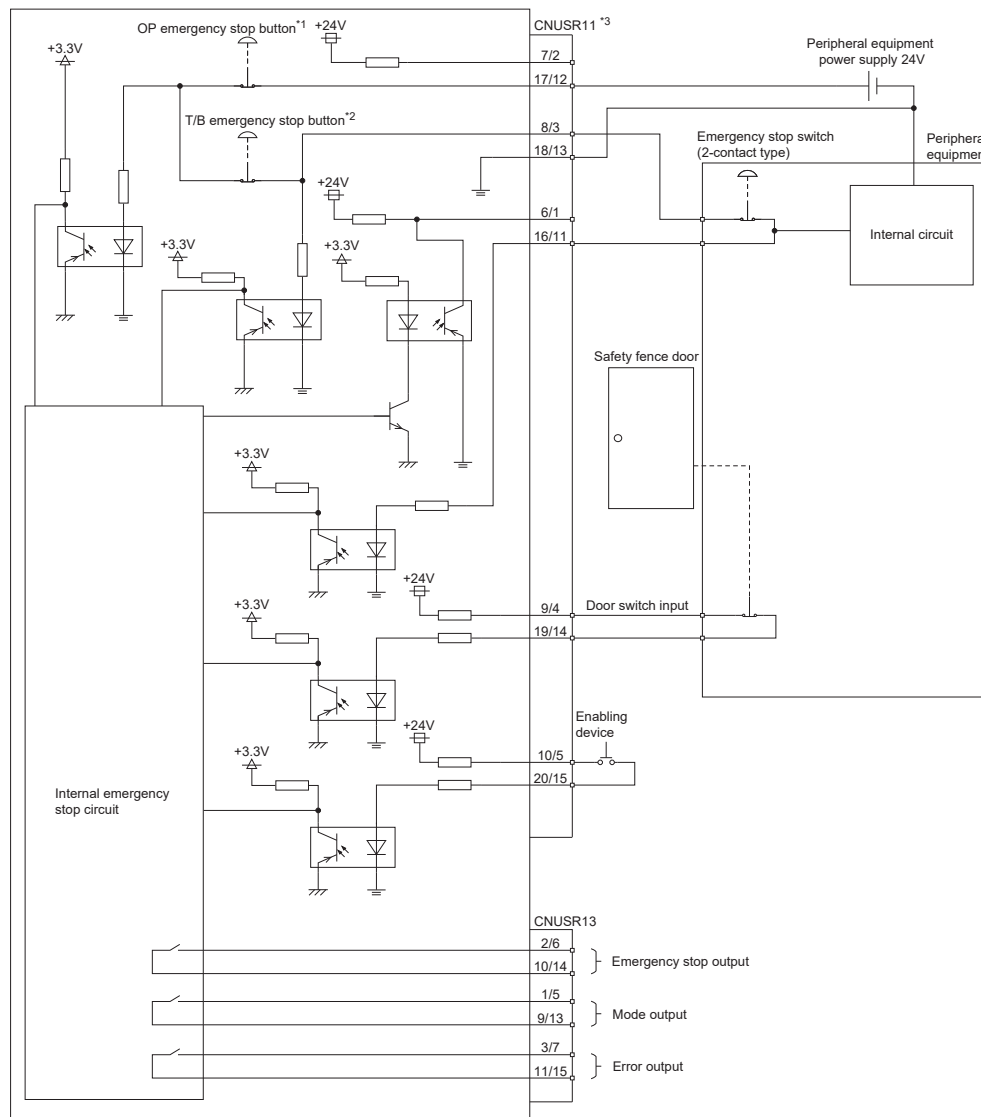
*1   This is the emergency stop button on the front of the robot controller.

*2   This is the emergency stop button of the teaching pendant that is connected to the robot controller. If the button is connected as shown in this diagram, it is not possible to remove the teaching pendant from the controller without generating an emergency stop alarm. When the devices are connected as shown in this diagram with the T/B removed, attach a dummy connector (sold separately) to the T/B connection port.

*3   The CNUSR11 connector has two rows of terminals, indicating that there are two channels. Both channels must be connected.

Wiring example 4

Connect the peripheral equipment's emergency stop switch and door switch to two controllers for interlocking. The power used for emergency stop detection is supplied from the controller.

The emergency stop state is monitored via the peripheral equipment.

<Operation of the emergency stop>

Pressing the emergency stop switch on the peripheral equipment will also bring the robot to an emergency stop.

When the controller power is off, the peripheral devices are in the emergency stop state.
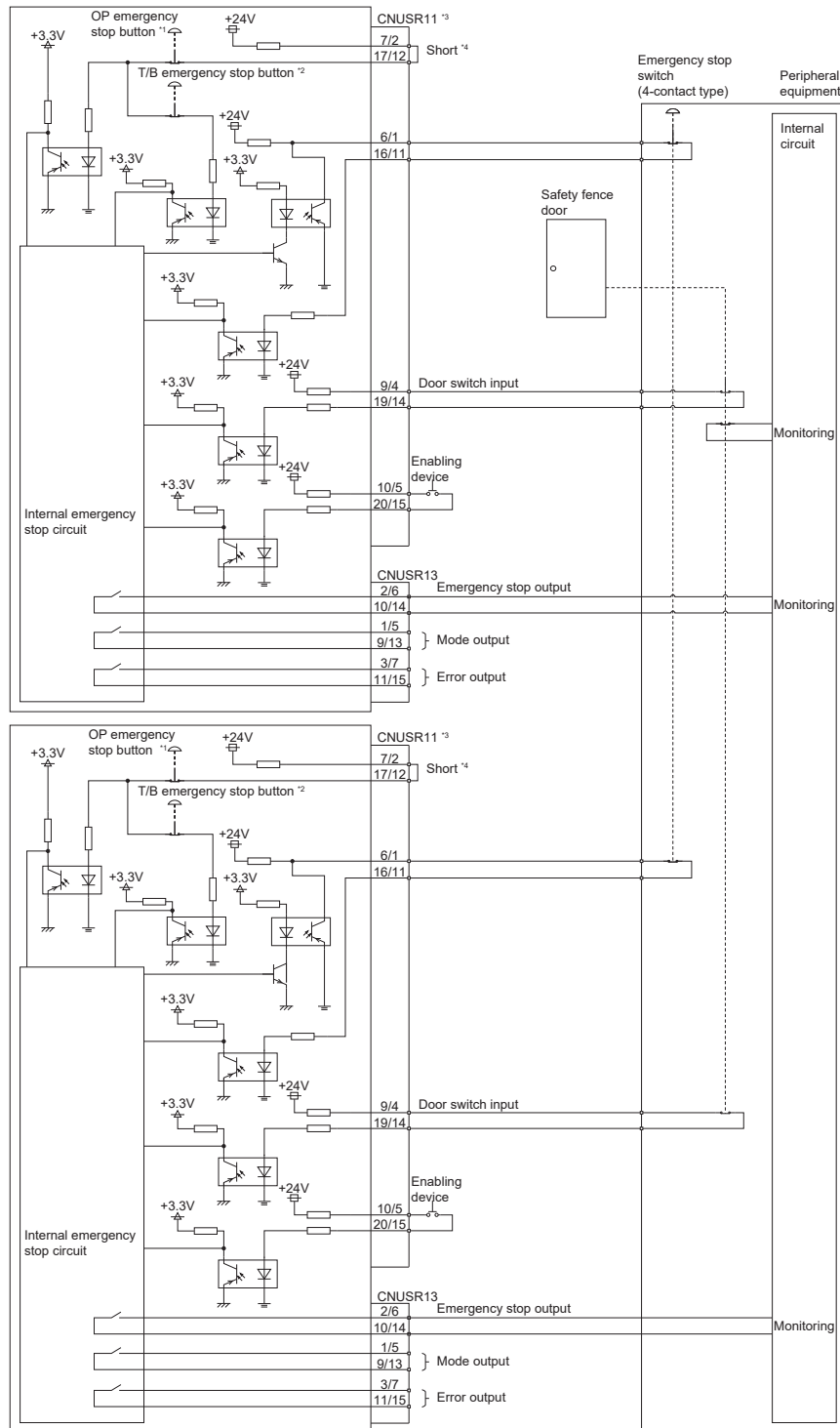
*1   This is the emergency stop button on the front of the robot controller.
*2   This is the emergency stop button of the T/B that is connected to the robot controller.
*3   The CNUSR11 connector has two rows of terminals, indicating that there are two channels. Both channels must be connected.
*4   The terminals are open (unconnected) from the factory. Short-circuit them if using the power supply inside the controller.

Wiring example 5

⚠ CAUTION

- When connecting a safety relay to the system and using the emergency stop button of the controller as an input to the relay, select a safety relay that functions when a signal is input to either one of the two inputs. (Example: QS90SR2SP manufactured by Mitsubishi Electric)
- When connecting the output of the emergency stop button to an external safety relay, set the polarity so that the electric current flows in the direction as indicated by the dotted arrows in the wiring diagram below. If the polarity is set incorrectly, this function will not operate correctly. Connect a power supply of 24V to terminals 2 and 6 of the CNUSR11.

Connect a safety relay to the controller. Use the controller's emergency stop button as an input to the safety relay.

- *1   This is the emergency stop button on the front of the robot controller.
- *2   This is the emergency stop button of the T/B that is connected to the robot controller.
- *3   The terminals are open (unconnected) from the factory. Short-circuit them if using the power supply inside the controller.

Connecting an external emergency stop switch [supplementary explanation]

⚠ CAUTION

- Be sure to perform wiring correctly. Incorrect wiring cannot bring the robot to an emergency stop, and this may result in property damage or bodily injury. After wiring, be sure to press each of the installed emergency stop switches and check whether the emergency stop circuit works properly.
- Wire the emergency stop, door switch, and enabling device so that they are redundant. If not, the function may not operate properly at the time the relay fails.
- The electrical specifications of the emergency stop-related output circuit is rated 100mA/24V DC or lower. Do not connect a device that exceeds this range.
- The user wiring emergency stop input connector installed in the controller can be used for safety measures as shown in the previous figure. However, be aware that there are restrictions on the number of switch contacts, capacity, and cable length.

Switch contact: Prepare a 2-contact type. [1]

Switch contact capacity: Rated 24V DC or more and a no-voltage contact [1]

Cable length: The length of the wire between the switch and connector should be up to 15m. If there is a possibility that the cable is affected by noise from servo amplifiers or other devices, use shielded cables. Additionally, install a ferrite core (recommended model: E04SR301334 manufactured by SEIWA ELECTRIC MFG CO.Ltd) to the shielded cables. The size of the wire used for the CNUSR11 connector is #24 to 16 AWG (0.2 to 1.25mm^2).

[1] The minimum load current of the switch should be 5mA/24V or more.

- Use 2-contact type for all switches.
- Install a limit switch on the doors of safety fences. Wire the switch to the door switch input terminal so that the NO contact (Form-A) turns on the terminal when the door is closed (power applied to switch), and turns off the terminal when the door is open (switch released).
- Use a manual-reset type emergency stop button with duplicate NC contacts for redundancy.
- Classify 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.
- If the OP emergency stop button and either or both of the two buttons (T/B emergency stop button and external emergency stop button) are pressed at the same time, errors related to the T/B emergency stop button and external emergency stop button may not occur.
- If the T/B emergency stop button and external emergency stop button are pressed at the same time, errors related to the external emergency stop button may not occur.
- For information on enabling devices, refer to the following:

☞ Page 94 Enabling device functions

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■Current value limit for connection with devices such as exciting coils of relays
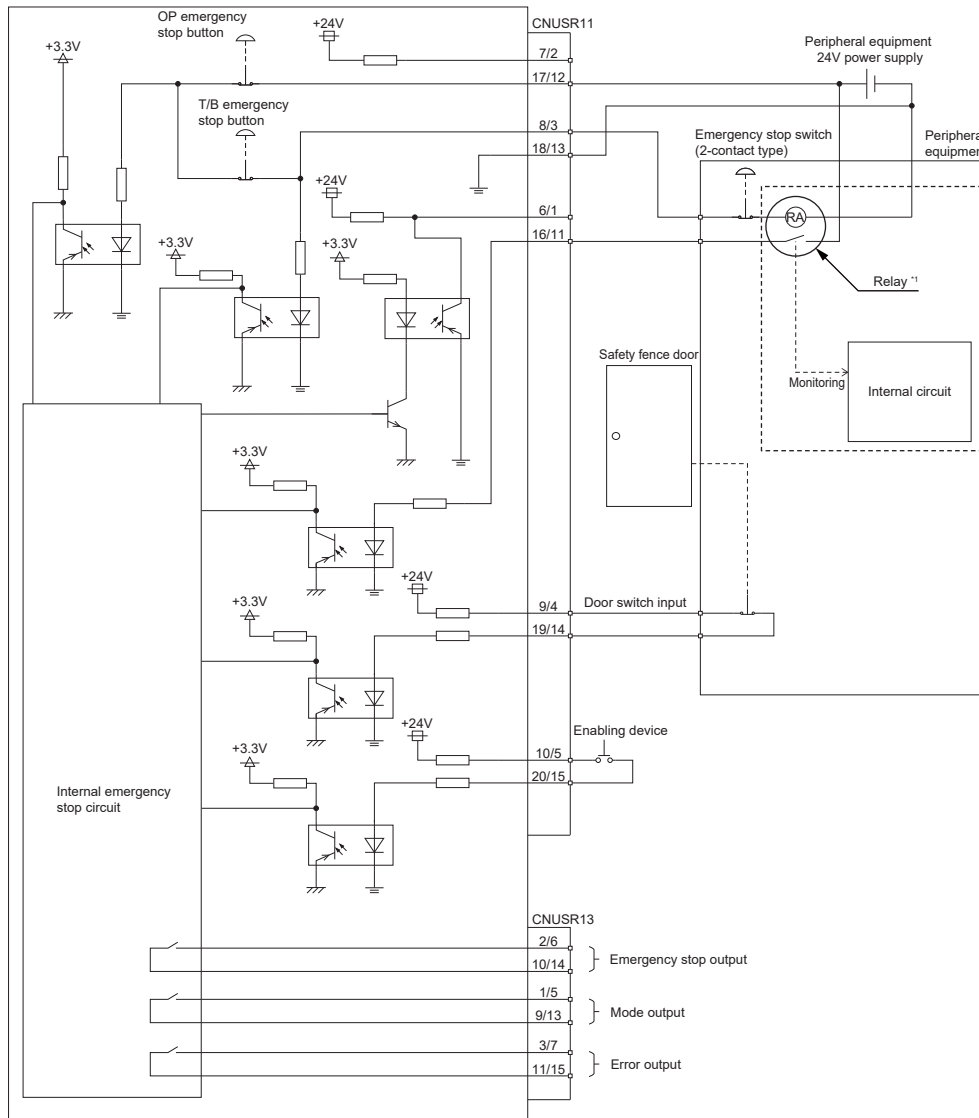
*1   When using an exciting coil of a relay or some other device connected to the external emergency stop input, use a product with a rated voltage of 24V DC. Ensure that the current flowing through the emergency stop circuit is 50 mA or less.

6.2   Operating environments

Do not install the product in the following environments, or its life may be shortened or operation may be affected. If you use the product in the following environments, take precautionary actions beforehand.

Power supply

⚠ CAUTION

The input power voltage fluctuation rate of the robot controller must be within the range from +10% to -15%.
Ensure that the primary power voltage does not drop below 170VAC due to the robot arm operation or voltage change.

- Locations where instantaneous power failure may occur within 20ms.
- Locations where enough power cannot be obtained.
- Locations where voltage may fluctuate outside the input voltage range.

Noise

- Locations where a surge voltage exceeding 2000V, 5kHz (equivalent to EN61000-4-4) 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.

Temperature and humidity

- Locations where the atmospheric temperature exceeds 45℃, lower than 0℃.
- Locations where the relative humidity exceeds 85% RH or below 10% RH, or condensation may occur.
- Locations in direct sunlight or near heat sources including heating appliances.

Vibration

- Locations where the product is subject to excessive vibrations or impacts. (The vibration acceleration should be 34m/s^2 or less during transportation and 5m/s^2 or less during operation.)

Installation environment

- Locations where a strong electric field or magnetic field may exist.
- On a rough surface. (Do not install the product on an uneven or inclined surface.)
- Locations where a large amount of dust or oil mist is present.
- Locations where flammable or corrosive gas is generated.

6.3   Handling precautions

- Robot has brakes on all axes. Forcibly moving the robot with the brakes applied leads to deterioration of robot accuracy, robot backlash, and reduction gear damage.
- When moving the robot arm by hand, move it gradually. If the robot arm is moved suddenly, the accuracy may drop due to an excessive backlash or the backed-up data may get corrupted.
- Note that, even when within the movement range, the wrist section could interfere with the base section depending on the posture. Take care to prevent interference during jog operation. [*1]

*1   The jog operation refers to operating the robot manually using the teaching pendant.

- The robot arm consists of precision parts including 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. Move the robot arm with the joint angle of 30 degrees or larger at a low speed (at about 20% of normal operation speed) from the lower to the upper limit of the movable range for about 10 minutes. After that, speed up the operation gradually. Please use the warm-up mode. For further information, refer to the following manual:

📖Detailed explanations of functions and operations (BFP-A3478)

- The robot arm and controller must be grounded with a ground resistance of 100 ohms or less to secure the noise resistance and to prevent electric shocks.
- The items described in these specifications are premised on the periodic maintenance and inspections described in the instruction manual.
- When using the robot arm on a mobile axis or elevating table, the machine cables enclosed as standard accessories may be disconnected because the cables are designed for fixed installation. In this case, use the optional machine cable designed for flexed installation.
- If the robot arm interferes with the workpiece or peripherals during operation (including jog operation), the position may shift or other troubles may occur. Take care to prevent interference with the workpiece or peripherals during operation. Since this robot has a high payload capability, even a little interference will generate great force. This may cause troubles such as position shifting of the robot or damage to peripherals. If the robot arm position shifts frequently, please contact your dealer.
- 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.
- If the robot is operated with a heavy load and at a high speed, the surface of the robot arm or controller gets very hot. It may cause secondary accidents if touched carelessly.
- 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 reduction gear may be damaged, backlash may occur, and the program data may get corrupted.
- If the J1, J2, or J3 axis collide with the mechanical stopper during the automatic operation of the robot, replace the resin part of the mechanical stopper. Contact Mitsubishi Electric or your local distributor for replacement parts. Continued use of the stopper without changing parts will increase the risk of damaging reduction gears or other mechanisms.
- If power is interrupted, the brakes will be applied. In which case, the arm may deviate from its original path if it is in automatic operation mode. Depending on the movement of the robot when the power is interrupted, the robot arm may come into contact with the mechanical stopper. Take measures to ensure that dangerous situations do not arise from the arm interfering with peripherals. Example) To reduce interference, install a UPS (uninterruptible power supply unit) to the primary power source.
- Do not conduct an insulated voltage test. Doing so may result in a malfunction.
- When the programmable controller system becomes large too much, the robot locus may deteriorate. In this case, please contact your nearest Mitsubishi Electric branch or dealer. And, when it turns out that the system is enlarged in advance, please inform our company.

- If the operating range of joint axis or direct drive axis is very small, fretting may occur on the bearing in the robot arm. Fretting is a phenomenon in which the oil film required for lubrication of the bearing becomes hard to be formed, resulting in abnormal wear. The axis which is not operated is moving slightly by vibration or reaction force. To make no fretting recommends moving these axes 30 degrees or more, or the 20mm or more about once every day.
- 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 batteries (1S1P×2 LS17500, Q6BAT) used in Mitsubishi Electric industrial robots contain lithium and fall under the definition. When the lithium batteries are shipped for storage, 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.
- If the air supply temperature (primary piping) used for the tool is lower than ambient air temperature, the dew condensation may occur on the coupling or the hose surface.
- 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 residual fumigant does 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

6.4 EMC installation guideline

Outline

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 the step-down transformer (supplied by customer), device layout, and wiring, etc. Please make final checks for EMC.

EMC

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

 • Emission (EMI: Electromagnetic Interference)

The capacity not to generate the disturbance noise which has a bad influence outside.

 • Immunity (EMS: Electromagnetic Susceptibility)

The capacity which does not malfunction for the disturbance noise from the outside. Each contents are shown below.

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

EMC measures

Mainly EMC measures are shown below.

 • Store the robot equipment into the sealed metal board.
 • Ground all the conductor that have floated electrically (make the impedance low).
 • Wire the power supply line and the signal line at a distance.
 • Use shielded cables for the cables outside the metal board.
 • Install noise filters.

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

 • Ensure grounding of the equipment.
 • Use shielded cables.
 • Separate the metal board electrically. Narrow the distance/hole.

Note that the electromagnetic noise emitted to environment is changed a lot depending on the distance of metal board or the shielding efficiency of cables.

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.
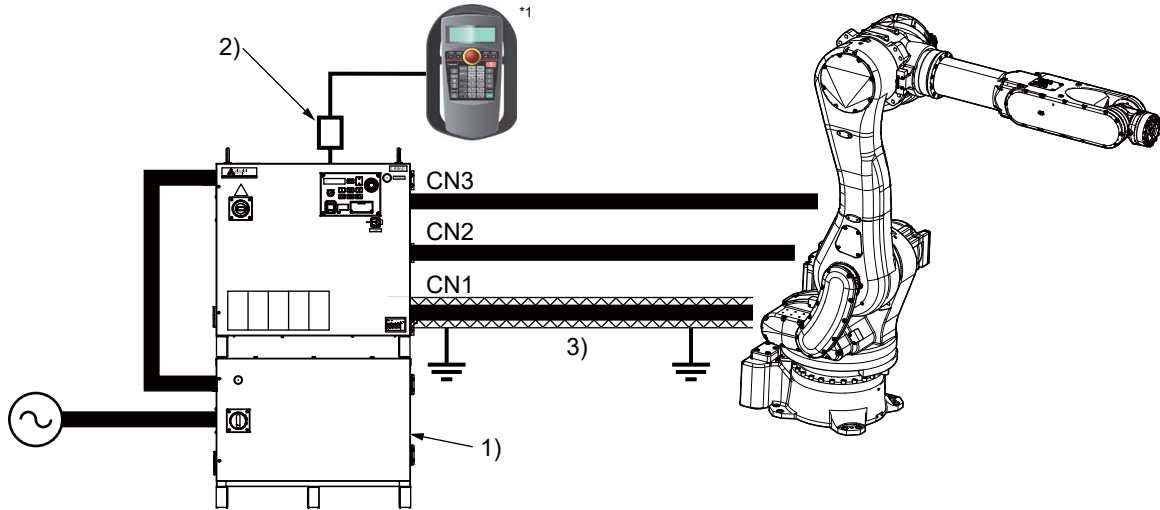
*1 When using the R86TB, install two ferrite cores on the T/B cable. For details, refer to the following page:
 ☞Page 103 Installation method

1. Place the CR860 controller on the optional transformer unit (Item No.1) and perform wiring. For more details, refer to "Installation and removal of the transformer unit" in the following manual:

📖Controller setup, basic operation, and maintenance (BFP-A3783)

2. Install the ferrite cores (Item No.2) on the cable of the teaching pendant.

3. Attach the shield tube (Item No.3) to the machine cable (CN1) and ground both ends of the tube.

The following table lists the parts for EMC measures.

No.	Item	Model	Quantity	Manufacturer
1)	Transformer unit	2F-ATBOX	1	Mitsubishi Electric Corporation
2)	Ferrite core	E04SR301334	1	SEIWA ELECTRIC MFG. CO.,LTD.
3)	Shield tube	MTFX40	1	ZIPPERTUBING(JAPAN), LTD.

Parts for EMC measures

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

For an example of EMC measures, refer to the following page:

APPENDIX

Appendix 1　Inertia calculation method

An allowable moment of inertia is determined in the mechanical interface at the tip of the robot arm. 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. This section describes the load inertia calculation method.

For the vertical articulated robot, consider the load moment and the load inertia on the wrist axes (J4 to J6 axes). To consider them, calculate the load moment and load inertia applied on each of J4 to J6 axes in consideration of the posture of the hand and workpiece. The following figures show the examples.

Example of load moment calculation (for J5 axis with flange facing downwards)

The items shown in the right figure are defined as follows.

Hand weight (kg): W_1 (kg)

Center of gravity of the hand: L_1 (m)

Workpiece weight: W_2 (kg)

Center-of-gravity of the workpiece: L_2 (m)

The load moment applied to the J5 axis is calculated as follows.

g is gravitational acceleration (m/sec^2).

Load moment applied to the J5 axis: M (N·m) = $W_1 \times L_1 \times g + W_2 \times L_2 \times g$

Check that the value of M is equal to or less than the allowable load moment of the target model.
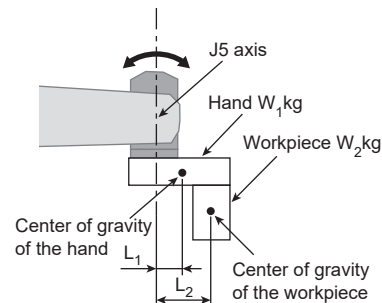
Example of load inertia calculation (for J6 axis)

The items shown in the right figure are defined as follows.

Hand weight (kg): W_1 (kg)

Distance between the center of J6 axis and the center of gravity of the hand: L_1 (m)

Workpiece weight: W_2 (kg)

Center-of-gravity of the workpiece: L_2 (m)

Assume that both hand and workpiece are rectangle.

When their surface areas can be expressed as follows, respectively: $a1 \times b1$, and $a2 \times b2$

(where a = height, b = width), the load inertia about the J6 axis is calculated as follows.

Load inertia about the J6 axis of the hand (kg·m^2):

$I_1 = I_{Z1} + W_1 \times L_1{}^2 = W_1 \times (a1^2 + b1^2)/12 + W_1 \times L_1{}^2$

Load inertia about the J6 axis of the workpiece (kg·m^2):

$I_2 = I_{Z2} + W_2 \times L_2{}^2 = W_2 \times (a2^2 + b2^2)/12 + W_2 \times L_2{}^2$

Total load inertia about the J6 axis of both the hand and workpiece (kg·m^2):

$I = I_1 + I_2$

Check that the value of I is equal to or less than the allowable load moment of the target model.

*1　When the robot changes its posture significantly in a direction other than the vertical downward direction, check the load moment inertia about the J4 axis as well.
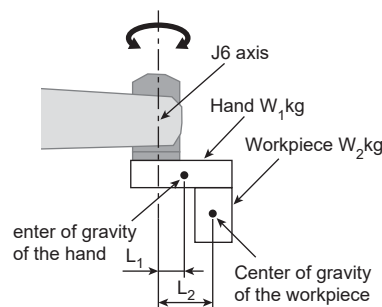
Appendix 2 Classification of external I/O functions

Take note of the following information regarding external I/O functions.

Classification	Function	Description
Safety signal	External emergency stop input	This function detects emergency stop inputs. The STO function will meet SIL3, PLe/Category 4 standard when the safety diagnosis function of the emergency stop input circuit is enabled. The factory default settings meet the requirements of SIL2, PLd/Category 3. To make the STO function meet the requirements of SIL3, PLe/Category 4, change the parameter setting by referring to the following page: ☞ Page 164 Safety diagnosis function (test pulse diagnosis)
	Enabling device input	This function detects the emergency stop signal for enabling device input.
	Door switch input	This function checks the state of machine guard door switches to detect whether machine guard doors are open.
Non-safety signal	Emergency stop output	This function monitors the emergency stop state of the robot.
	Mode output	This function monitors the manual and automatic operation modes.
	Robot error output	This function monitors the error state of the robot.
	Additional axis synchronization output	This function synchronizes the servo ON/OFF state of the additional axis to that of the robot arm. Refer to the following manual for further details. ☞ Page 97 Additional axis synchronization output

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Appendix 3 Safety diagnosis function (test pulse diagnosis)

The Safety diagnosis function checks the emergency stop status of the robot using the pulse output from the emergency stop signals (EXTEMG11, EXTEMG21). By changing the settings of TPOEMG, off pulses can be output regularly from EXTEMG11 and EXTEMG21. The width of the pulses that are output is approximately 20ms. By checking the robot controller test pulses regularly, it is possible to ascertain whether the emergency stop line is working properly.

To use this function, connect the emergency stop switches by referring to the following figure on how to wire the emergency stop lines.

Connect the switches so that the peripherals do not malfunction. Check it by outputting test pulses of this function.

If the external emergency stop input is connected to the OP emergency stop and TB emergency stop on one path as shown in the examples of safety measures in the following pages, this function cannot be used.
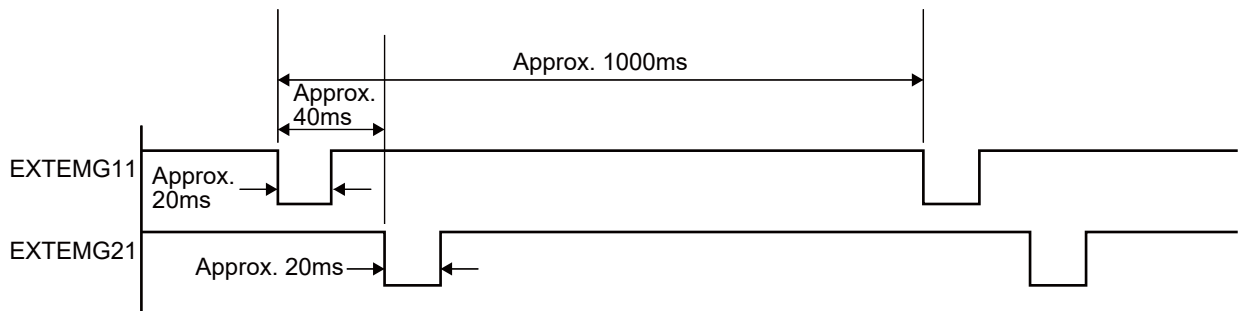
The following table lists information of the parameter.

Item	Description
Parameter name	TPOEMG
Function	Whether to output test pulses or not from the emergency stop ports (EXTEMG11, EXTEMG21) can be specified.
What parameter settings mean	0: No test pulse is output. 1: Test pulses are output.
Initial value	0

The following figure shows how to wire the emergency stop lines.
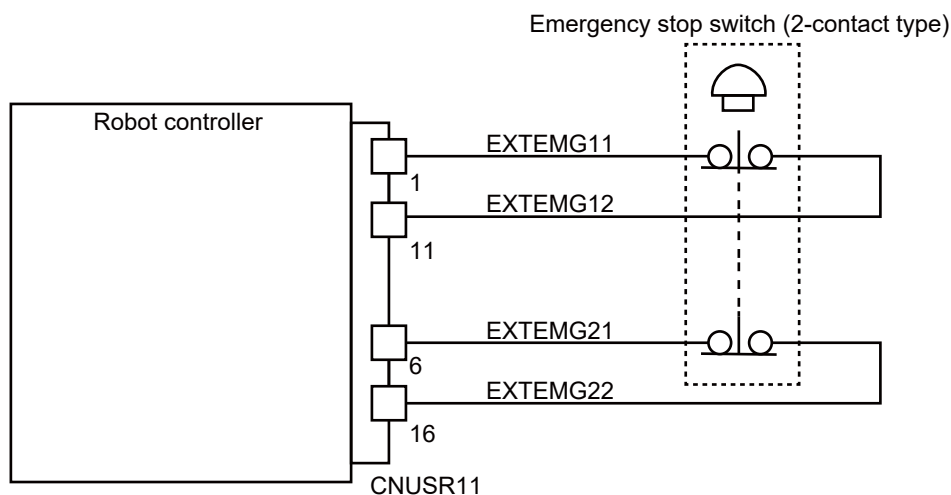
Appendix 4 Safety block diagram
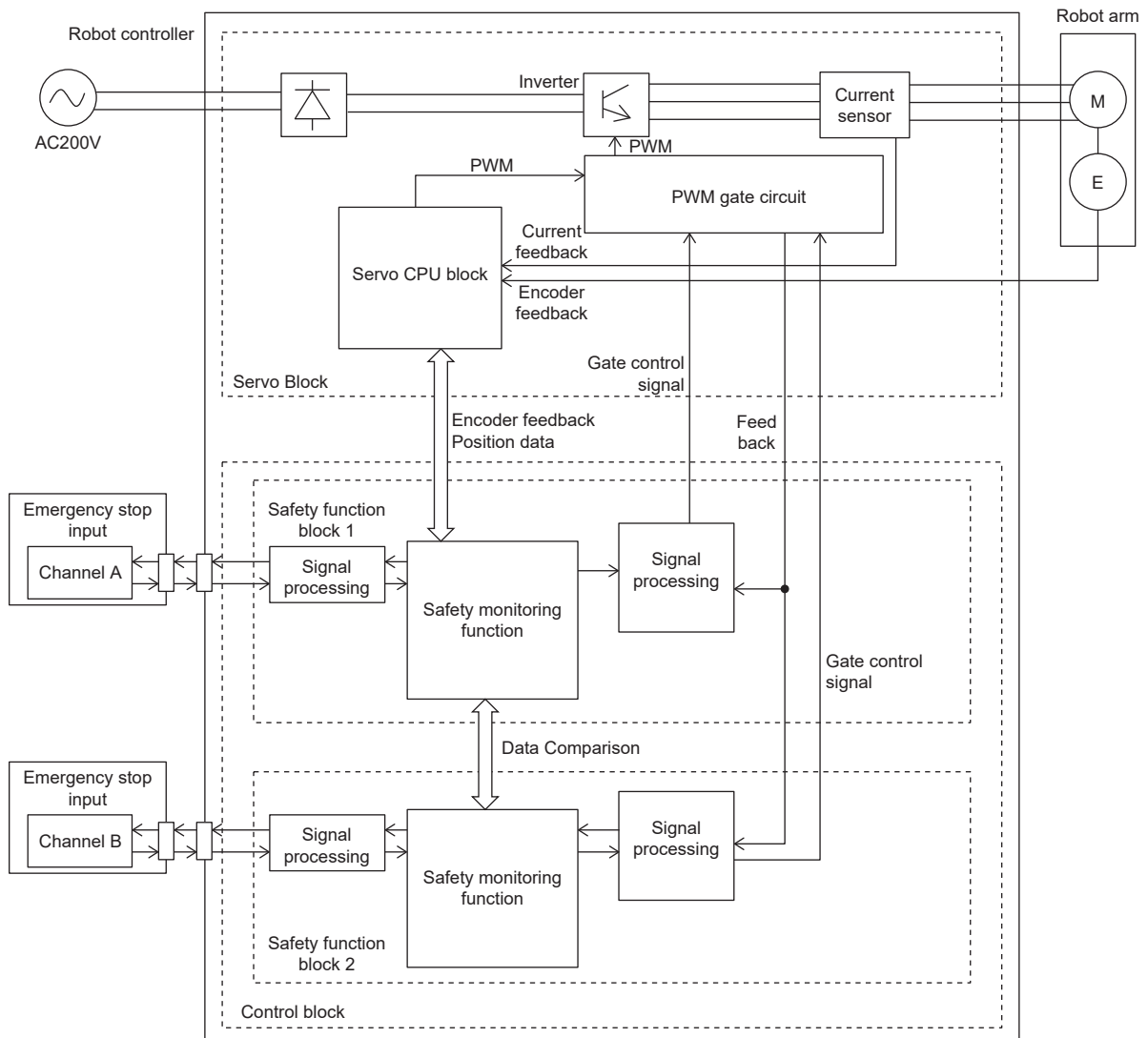
Appendix 5 Declaration of Conformity

The Declaration of Conformity included is the one corresponding to the marking on the rating plates on the robot arm and the controller.

CE mark: EU Declaration of Conformity

UKCA mark: UK Declaration of Conformity

Each Declaration of Conformity describes the following information.

Information	Description
Manufacturer Address	MITSUBISHI ELECTRIC CORPORATION TOKYO 100-8310, JAPAN
Authorized representative in Europe [1] Address [1]	MITSUBISHI ELCTRIC EUROPE B.V., German Branch Mitsubishi-Electric-Platz 1, 40882 Ratingen, Germany
Product description Type of model	Industrial Robot RV-35FR/50FR/80FR series

[1] The information is not described in the UK Declaration of Conformity.

The EU Declaration of Conformity describes the following conformance rules and harmonized standards.

Directive		Harmonized Standard
EMC Directive	2014/30/EU	EN 61000-6-4:2007/A1:2011 EN 61000-6-2:2005 EN 61800-3:2004/A1:2012 (CategoryC2, Second Environment)
Machinery Directive the following essential health and safety requirements have been applied and fulfilled: 1.1.5, 1.1.6, 1.2.1, 1.2.2, 1.2.3, 1.2.4.1, 1.2.4.2, 1.2.4.3, 1.2.5, 1.2.6, 1.3.2, 1.3.6, 1.3.7, 1.3.9, 1.5.1, 1.5.2, 1.5.4, 1.5.6, 1.5.11, 1.5.13, 1.6.3, 1.6.5, 1.7.1.2, 1.7.3, 1.7.4, 1.7.4.1, 1.7.4.2.	2006/42/EC	EN ISO 12100:2010 EN 60204-1:2018 [1] EN ISO 13849-1:2015 EN ISO 13850:2015 EN ISO 10218-1:2011

[1] Exclusion items: 10.2, 10.3

The UK Declaration of Conformity describes the following conformance rules and designated standards.

Statutory Instrument [SI]	Designated Standard
Electromagnetic Compatibility Regulations 2016 No.1091 [as amended]	EN 61000-6-4:2007/A1:2011 EN 61000-6-2:2005 EN 61800-3:2004/A1:2012 (CategoryC2, Second Environment)
Supply of Machinery (Safety) Regulations 2008 No.1597 [as amended] the following essential requirements have been fulfilled: 1.1.5, 1.1.6, 1.2.1, 1.2.2, 1.2.3, 1.2.4.1, 1.2.4.2, 1.2.4.3, 1.2.5, 1.2.6, 1.3.2, 1.3.6, 1.3.7, 1.3.9, 1.5.1, 1.5.2, 1.5.4, 1.5.6, 1.5.11, 1.5.13, 1.6.3, 1.6.5, 1.7.1.2, 1.7.3, 1.7.4, 1.7.4.1, 1.7.4.2.	EN ISO 12100:2010 EN 60204-1:2018 [1] EN ISO 13849-1:2015 EN ISO 13850:2015 EN ISO 10218-1:2011

[1] Exclusion items: 10.2, 10.3

Appendix 6 Specifications discussion material (RV-35FR/50FR/80FR series)

Customer information

Company name: Name:
Address: Telephone:

Purchased model

Specifications	Robot arm [1]			Robot controller [2]
Normal environment	☐RV-35FR-D	☐RV-50FR-D	☐RV-80FR-D	☐CR860-**VD
	☐RV-35FR-R	☐RV-50FR-R	☐RV-80FR-R	☐CR860-**VR
	☐RV-35FR-Q	☐RV-50FR-Q	☐RV-80FR-Q	☐CR860-**VQ
Oil mist	☐RV-35FRM-D	☐RV-50FRM-D	☐RV-80FRM-D	☐CR860-**VD
	☐RV-35FRM-R	☐RV-50FRM-R	☐RV-80FRM-R	☐CR860-**VR
	☐RV-35FRM-Q	☐RV-50FRM-Q	☐RV-80FRM-Q	☐CR860-**VQ

*1   For details on the model, refer to the following page:
     ☞ Page 14 Model name of robot
*2   The asterisks in the robot controller type name represent the payload of the robot arm (35kg: 35, 50kg: 50, 80kg: 80).

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Options (Installable after shipment)

Item		Model	Provided or not, specifications when provided
Robot arm	Machine cable	1F-□□UCBL-44	Fixed type: □12m □17m □22m
		1F-□□LUCBL-44	Flexible type: □7m □12m □17m □22m
	Hand input cable	1F-HC2000S-44	□Not provided □1F-HC2000S-44
	Hand output cable	1F-GR2000S-44	□Not provided □1F-GR2000S-44
	Hand Ethernet cable	1F-LAN2000-44	□Not provided □Provided
	J1 axis operating range change stopper	1F-DH-44J1	□Not provided □Provided
	Brake releasing device	2F-BRKBOX-1	□Not provided □Provided
	Power cable for the brake [*1]	2F-BRKCBL-1	□Not provided □Provided
Controller	Simple teaching pendant	R32TB-□□	□Not provided □7m □15m
	High-performance teaching pendant	R86TB	□Not provided □Provided
	Parallel I/O interface	2D-TZ368/2D-TZ378	□Not provided 2D-TZ368 (sink)/□1 unit □2 units 2D-TZ378 (source)/□1 unit □2 units
	External I/O cable (For the parallel I/O interface)	2D-CBL□□(For 2D-TZ368 and TZ378)	□Not provided □5m: ( ) pc. □15m: ( ) pc.
	Parallel I/O unit	2A-RZ361/2A-RZ371	□Not provided □2A-RZ361 (sink): ( ) pc. □2A-RZ371 (source): ( ) pc.
	External I/O cable (For the parallel I/O unit)	2A-CBL□□(For 2A-RZ361 and 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
	Safety option	4F-SF003-05	□Not provided □Provided
	Transformer module	2F-ATBOX	□Not provided □Provided
	Encoder distribution unit	2F-YZ581	□Not provided □Provided
	SD memory card	2F-2GBSD	□Not provided □Provided
	RT ToolBox3	3F-14C-WINE	□Not provided □DVD-ROM, Windows 10/11 supported
	RT ToolBox3 mini	3F-15C-WINE	□Not provided □DVD-ROM, Windows 10/11 supported
	RT ToolBox3 Pro	3F-16D-WINE	□Not provided □DVD-ROM, Windows 10/11 supported
	Instruction Manual (hard copy)	5F-BT01-PE01	□Not provided □Provided ( ) set
Extended function	MELFA-3D Vision 3.0	3F-53U-WINM	□Not provided □Provided

*1   For the brake releasing device

Maintenance parts

Maintenance parts	□Backup battery 1S1P×2 LS17500 ( ) pc. □Backup battery Q6BAT ( ) pc. □Grease ( ) pc.

Robot selection check list

Work description	□Material handling □Assembly □Machining L/UL □Sealing □Testing and inspection □Others ( )	
Workpiece weight: ( ) g	Hand weight: ( ) kg	Atmosphere: □Normal environment □Oil mist □Other:
Remarks		

REVISIONS

Revision date	*Manual No.	Description
September 2023	BFP-A3779-A	First edition
March 2024	BFP-A3779-B	• Revised "3.6 External emergency stop I/O/special stop input/door switch input/enabling device input". • Revised "3.9 Options". • Changed some sections.

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The details of this manual are subject to change without notice. The specification value is based on our standard test method. Specifications are based on in-house standardized tests.

An effort has been made to make full descriptions in this manual. Do not handle the product in ways other than those described in this manual, and also keep in mind that handling the product in such ways may cause an error.

If any discrepancies or unclear points are found, please contact your dealer.

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